Instituto Tecnológico de Costa Rica

Escuela de Electromecánica

Informe Final de Práctica de Especialidad para optar por el grado de Licenciado en Ingeniería en Mantenimiento Industrial

Proyecto Administrativo:

Mantenimiento Preventivo aplicado a Aerogeneradores Neg Micon NM750.

Proyectos de Diseño:

Análisis de Vibraciones en Cajas Multiplicadoras y Generadores, aplicados a fallas en rodamientos y engranajes.

Programa de implementación de un Historiador de datos en los Aerogeneradores por medio de PLCs de comunicación.

Planta Eólica Aeroenergía S.A.

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Nota a la versión impresa:

El informe completo con la totalidad de los anexos se muestra en el documento digital de Microsoft Word que lleva como nombre Informe Final de Práctica. Algunos anexos se omiten por motivo de espacio.

Dedicatoria

En la base de esta práctica está el señor José Ángel Prati.
El es quien merece la dedicatoria.
También el profesor Gustavo Jiménez por su paciencia
(a quien le deseo éxitos).
Sin embargo, también deben figurar en ella
aquellos que pasean conmigo por la vida:
Miguel, mis familiares,
mis compañeros de estudio, los héroes;
aquellos que entran y salen,
y aquellos que están por entrar.
A la promesa de las energías limpias.
A la promesa del FUTURO.

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Glosario para términos provenientes del idioma Inglés

Enveloping: Traducido por SKF como Envolvente. Técnica matemática de análisis

SEE: Spectral Emitted Energy o Energía Espectral Emitida. Técnica de análisis.

HFD: High Frecuency Detection. Detección de Altas Frecuencias. Técnica de análisis.

FFT: Fast Fourier Transform. Transformada Rápida de Fourier. Función Matemática.

Trafo: Abreviatura de Transformador en inglés.

Tip: Punta móvil del aspa.

Slip Ring: Anillos deslizantes. Dispositivo de transmisión de señales eléctricas.

Nylon: Material de los conos en las aspas.

Coolant: Anticongelante. Líquido que mejora las propiedades del agua.

OPC: OLE for Process Control. Norma para dispositivos de control de procesos.

PLC: Programmable Logic Controller. Controlador Lógico Programable.

RCM: Reliability Centered Maintenance. Mantenimiento Centrado en la Confiabilidad.

TPM: Total Productive Maintenance. Mantenimiento Centrado en la Confiabilidad.

Buffer: Lugar de la memoria RAM.

Send: Función de enviar información.

Receive: Función de recibir información.

FMEA: Failure Mode and Effect Analysis. Análisis de Modos de Falla y Efectos.

Impeller: Impulsor.

Bearing: Rodamiento.

Service: Servicio de inspecciones de mantenimiento.

Sensar: Percibir un fenómeno y representarlo por medio de una señal.

1. Resumen

Este resumen presenta los tres innovadores proyectos realizados en la Planta Eólica Aeroenergía S.A. durante el primer semestre del año 2004.

El proyecto administrativo plantea el problema y una solución al complejo Mantenimiento Preventivo para este tipo particular de tecnología. Los rasgos principales del Mantenimiento Preventivo como la codificación, los manuales, las inspecciones y la planificación se conservan. No obstante, el documento se complementa con procedimientos o diagramas de flujo para control de alarmas, con diagramas de las máquinas y también con una gran recopilación de información digital básica para el mantenimiento ágil del parque, obtenida a lo largo de la investigación.

El proyecto de Análisis de Vibraciones en Cajas Multiplicadoras y Generadores, aplicados a fallas en rodamientos y engranajes representó un reto en la búsqueda de información y el análisis de los sistemas. El objetivo del Plan fue lograr un sistema de Análisis de Vibraciones completo y lo más simple posible para este tipo de máquina en particular. En él se realizan análisis y cálculos para estimar el comportamiento de las vibraciones en los sistemas de cajas planetarias y en los generadores de Aeroenergía S.A. A lo largo del estudio se hace uso de información producto de la persistencia y meses de indagación. El proyecto detalla desde la configuración de las mediciones y rutas para la toma de datos hasta las particularidades matemáticas. El resultado es una metodología única que contempla todas las etapas del Análisis de Vibraciones y plantea los próximos pasos a seguir en estas técnicas predictivas. Por otro lado, por su impacto directo en la operación, el mantenimiento y la gestión del equipo resulta fácil de justificar económicamente.

La gran ventaja del análisis de vibraciones en turbinas eólicas es que refleja el estado real de la máquina de manera bastante fidedigna y permite intervenciones en el momento mismo en que los datos se analizan sin esperar a que los activos se deterioren; tarea imposible de realizar por otros medios de diagnóstico.

Como tercer proyecto se presenta la primera de cuatro fases de desarrollo de un Historiador de datos de proceso en los Aerogeneradores por medio de PLCs de comunicación serial 485. En él se seleccionan sensores y dispositivos para ampliar el rango de acción de las alarmas existentes y lograr la comunicación y almacenamiento de sus datos de manera permanente.

De esta forma, los tres proyectos versan sobre aspectos esenciales de los sistemas eólicos y por ello implican un hito en el manejo del parque como totalidad. Con la conclusión de la práctica, se espera la continuidad de los proyectos por parte de la administración de Aeroenergía S.A. por el valor que encierran para la empresa.

2. Introducción

A continuación, se expone conceptos básicos para la compresión del presente documento.

2.1. Tendencias del Mantenimiento[1]

Por "Mantenimiento de Máquinas" debe entenderse el conjunto de acciones destinadas a conservar o llevar de nuevo el equipo a su funcionamiento óptimo, bajo ciertos estándares de operación y seguridad.

2.1.1 El Mantenimiento Correctivo

El primero de los paradigmas de Mantenimiento consiste en dejar que la máquina falle para intervenirla. El Mantenimiento Correctivo es y ha sido funcional cuando la producción no es un aspecto apremiante, cuando los costos ocasionados por dar otro tipo de mantenimiento a la máquina son más elevados que dejarla fallar o cuando no tiene sentido darle otro tipo de mantenimiento. Por ello, el Mantenimiento Correctivo ofrece como ventajas una inversión mínima y relativamente pocos gastos administrativos. No obstante, este paradigma acarrea gastos elevados por destrucción y deterioro de partes de la máquina, pérdidas que no se pueden enmendar en la producción y una gran cantidad de repuestos en bodega. Incluso, por la premura de reanudar el funcionamiento de la máquina, la máquina recibe muchas veces una solución temporal e indeseable para resolver su problema.

[1] Todo este apartado se basa en la información detallada en: "Compilación de Material sobre Análisis de Vibraciones de SKF" y "Folleto del curso de Administración del Mantenimiento I".

2.1.2 El Mantenimiento Preventivo

El Mantenimiento Preventivo nació por la necesidad de mejorar los resultados del paradigma de Mantenimiento Correctivo.

Con el Preventivo, las empresas decidieron no dejar que las máquinas fallaran y se propusieron minimizar los paros imprevistos y sus elevados costos. Dentro de las acciones por tomar en un Preventivo, están las de estudiar las máquinas, hacer inspecciones para verificar su condición, probar las máquinas, hacer ajustes y estudiar los momentos óptimos para el cambio de piezas que están prontas a fallar. Este paradigma mejoró considerablemente los resultados del anterior sistema pero también tenía implícitas ciertas desventajas. El Mantenimiento Preventivo se popularizó porque las máquinas fallaban menos, operaban en mejores condiciones y porque los operadores y técnicos utilizaban herramientas administrativas útiles para obtener experiencia y mejores resultados. Sin embargo, pronto se descubrió que en las rutinas de mantenimiento se cambiaba piezas que aún contaban con una vida útil considerable; que muchas catástrofes no eran evitables sólo con los criterios de Prevención; que los gastos por cambios innecesarios de piezas aumentaron y que las empresas estaban lejos de lograr que sus máquinas no fallaran. Estas necesidades no satisfechas darán cabida a los siguientes paradigmas de mantenimiento.

Cuando se habla de Mantenimiento Preventivo se habla de documentación. Entre los documentos usuales está la “Orden de Trabajo”, el “Historial de la máquina”, el “Reporte de fallas”, el “Cálculo de los valores de funcionamiento global”, los “Reportes de mano de obra directa”, la “Solicitud de compra de repuestos, materiales y herramientas”, el “Informe de movimiento de los repuestos en bodega” y la “Solicitud de salida de repuestos y materiales de la Bodega”.

Por eso, cuando se diseña un Programa de Mantenimiento Preventivo intervienen varios aspectos para lograr una propuesta específica para el sitio. En un Programa Preventivo se seleccionan las máquinas que entrarán dentro del mantenimiento, se valora su deterioro, se busca información técnica sobre la máquina, se codifica, se define los parámetros de funcionamiento global, se define los objetivos del Programa de Mantenimiento Preventivo y se hace divisiones de las máquinas en Partes y SubPartes. Además, se elabora un Manual de Mantenimiento Preventivo, se determina los repuestos necesarios para las inspecciones diseñadas, se calcula la disponibilidad de mano de obra para el mantenimiento y se procede a programar las inspecciones con fechas bajo el esquema de Gantt.

Eso explica porqué dentro del esquema básico del manual de mantenimiento se observa información sobre la codificación, la descripción, la frecuencia de las inspecciones, el tiempo de duración, el tipo de acción propuesta y la cantidad de técnicos necesarios para una inspección determinada.

Pese a sus desventajas, el Mantenimiento Preventivo es aún hoy una tendencia muy utilizada dados su facilidad de aplicación y relativo bajo costo.

2.1.3 El Mantenimiento Predictivo

A raíz de necesidades más imperantes en las empresas, celosas de la producción y las soluciones rápidas para los problemas, han surgido nuevos paradigmas de Mantenimiento, como el Mantenimiento Predictivo, el TPM, el RCM, el RCM 2, el Mantenimiento de Precisión y otros que resultan aplicables en empresas con una gran cantidad de máquinas, muchas actividades de mantenimiento y producción, un manejo de personal considerable, y un alto volumen de decisiones y coordinación.

El Mantenimiento Predictivo o “a Condición” pretende usar nuevas tecnologías para determinar la situación actual del equipo, monitorear su condición a lo largo del tiempo y lograr la detección de fallas e intervenciones en el momento justo en que deben realizarse por medio de la corrección de la raíz del problema. Lo usual dentro del Mantenimiento Predictivo es el Análisis de Vibraciones, las Termografías, el Análisis de aceite, los Ultrasonidos, los Rayos X y los Líquidos penetrantes, entre otros. Por medio de estas herramientas ingenieriles se pretende entender el funcionamiento de las máquinas y responder a preguntas básicas: el cómo, cuándo y porqué fallarán. Las desventajas que presentan las técnicas predictivas en general son: el alto costo inicial del equipo, lo indispensable de la capacitación del personal y, finalmente, el tiempo y la experiencia necesarias para que los resultados se tornen tangibles.

El Análisis de Vibraciones para rodamientos y engranajes fue inventado por la empresa SKF con el objetivo de obtener una herramienta de detección de problemas en máquinas rotativas. Los problemas detectables por medio del Análisis de Vibraciones son los de Soltura mecánica, Desbalance, Desalineación, Eje Torcido, Soltura de cojinetes, Fallas en la pista interior, en la pista exterior, en la canasta o en los elementos rodantes de los rodamientos, Fallas en los sistemas de engrane y Problemas de lubricación principalmente.

Para lograrlo, se vale de diversos tipos de instrumentos y métodos de análisis numéricos que toman las señales de vibración, las convierten en señales de Transformada Rápida de Fourier (FFT o Fast Fourier Transform) y usualmente despliegan resultados en forma de frecuencias y amplitudes de vibración de las que se vale el analizador de vibraciones para obtener un diagnóstico. La evolución de las fallas en las máquinas rotativas a partir del Análisis de Vibraciones inician de manera acústica e indetectable para el oído humano, luego continúa en forma de vibración y termina en forma de ruido hasta que la falla ocurre. Este comportamiento se muestra en la figura 2.1.3.1.

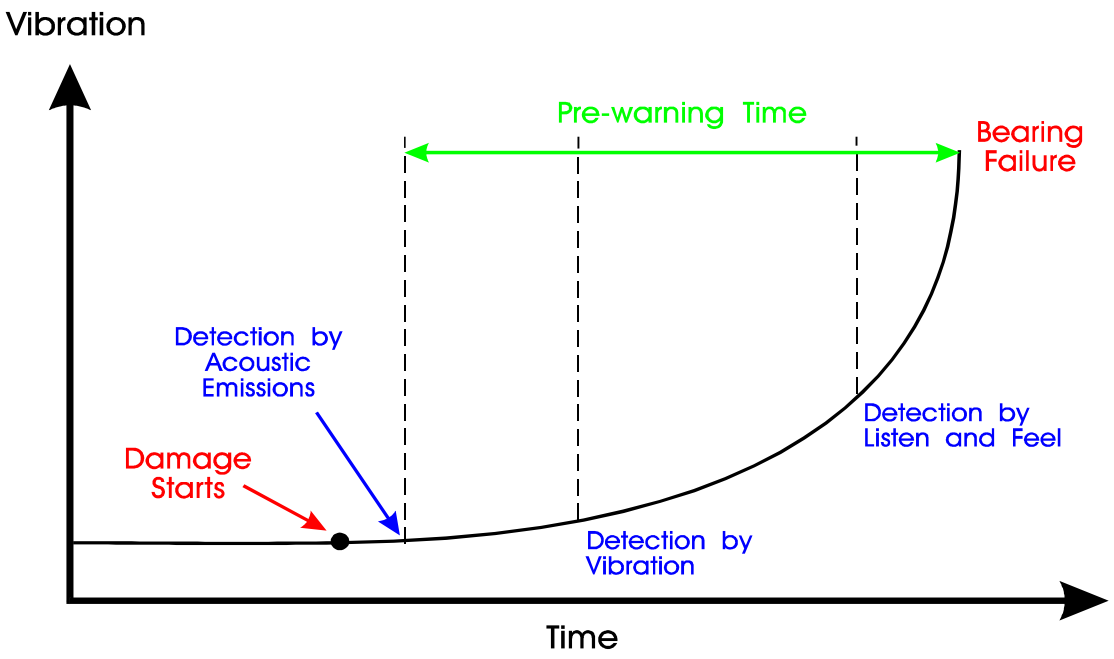


Figura 2.1.3.1. Evolución de la falla: Vibración vs Tiempo[2]

Para determinar la gravedad de las amplitudes para cada tipo de problema, el analizador debe recurrir a la Norma 2372 y a los estándares del fabricante. Si el personal de la planta no conoce los datos del fabricante debe al menos saber las velocidades de giro de los elementos. Debe conocer el tipo de rodamiento, el número de dientes de los engranajes y el número de aspas de las turbinas, para que por medio de ecuaciones y modelos matemáticos se pueda llegar a las frecuencias de falla.

Las ecuaciones simplificadas para encontrar las frecuencias de falla de los rodamientos por ejemplo, son los siguientes[3]:

a. Fi = BPFI (problemas en la pista Interior) = 0.6 (fr) (n)
b. Fe = BPFO (problemas en la pista exterior) = 0.4 (fr) (n)
c. Fb = BSF (Problemas en los roles) = (dm/(2d)) (fr) (1 – (d/dm)^2 (cos^2 β))

[2] Tomado de "Compilación de Material sobre Análisis de Vibraciones de SKF".
[3] Tomado de "Compilación de Material sobre Análisis de Vibraciones de SKF".

d. $Ft = FTF$ (Problemas en la canasta) $= (fr/2)\,(1 - (d / dm)\,(\cos \beta)$,

fr es la frecuencia de giro del rodamiento, n es el número de esferas por rodamiento, dm es el diámetro del rodamiento de centro a centro de las esferas, d es el diámetro de la pista interna y β es el ángulo de ataque del rodamiento.

Las frecuencias de falla de los engranes o de las turbinas en general (i.e. ventiladores) se obtienen de la multiplicación de la frecuencia de giro de los engranes por el número de dientes o aspas. En las cajas de transmisión es necesario saber la configuración de las ruedas, el número de dientes y la velocidad de cada rueda, así como el tipo de rodamiento que utilizan los ejes para poder determinar los datos básicos para el análisis.

Los parámetros más comunes por considerar son el Desplazamiento, Velocidad, Aceleración, la fase, el Enveloping, el SEE (Spectral Emitted Energy) y el HFD (High Frecuency Detection). Las señales de desplazamiento son utilizadas cuando las velocidades de rotación son bajas o cuando el movimiento de la máquina es indeseable. Para problemas en bajas frecuencias, como es el caso de la Soltura mecánica, el Desbalance, la Desalineación, el Eje Torcido y la Soltura de cojinetes, se utiliza la lectura de velocidad y la referencia de fase. Los problemas de alta frecuencia (como los problemas en engranajes, aspas y rodamientos), son detectados por medio de análisis de aceleración y para ello no es necesario tomar la referencia de fase.

La señal de Enveloping se obtiene de la manipulación de la señal de FFT. Una vez que la señal de la Transformada de Fourier se realiza, el colector de datos registra las señales de las armónicas de las frecuencias más significativas y las suma. Esto aumenta la amplitud original de la señal. De esta forma, la señal de Enveloping muestra picos que son producto de la señal principal original más las armónicas de esa misma señal. Esta técnica es utilizada por su efectividad en la detección de fallas en sus etapas más tempranas. Al ver el espectro, el analizador sabrá discernir fácilmente a cuáles frecuencias debe prestar atención y buscará a qué problema se refieren esas frecuencias.

A continuación se presenta una tabla de severidad para mediciones en Enveloping y diversas aplicaciones.

Tabla: 2.1.3.1. Tabla de severidad para valores de Enveloping y diversas aplicaciones[4]

SEVERIDAD		DIAMETRO DEL EJE (mm) / VELOCIDAD (rpm)		
F max 500 Hz	F max 1000 Hz	Ø 200 a 500 mm < 500 rpm	Ø 50 a 300 mm 500 a 1800 rpm	Ø 20 a 150 1800 a 3600 rpm
0,075	0,1	BUENO	BUENO	BUENO
0,35	0,5			
0,55	0,75	SATISFACTORIO		
0,75	1		SATISFACTORIO	
1,5	2	ALERTA		SATISFACTORIO
3,5	4		ALERTA	
7,5	10	NO ADMISIBLE		ALERTA
			NO ADMISIBLE	
				NO ADMISIBLE

[4] Tomado de “Compilación de Material sobre Análisis de Vibraciones de SKF”.

El SEE es una técnica especial para detección de problemas de lubricación o de inicio de problemas en cojinetes. El SEE registra muy altas frecuencias y tiene como resultado un número que engloba la energía emitida en un rango del espectro de FFT. Con estos datos se puede identificar una lubricación insuficiente, la contaminación del fluido o el comienzo de un defecto en el rodamiento. El HFD es un número global producto del análisis de las vibraciones en un rango de altas frecuencias y bajas amplitudes. El uso del HFD es especial para corroborar la tendencia de un rodamiento a fallar pero no indica nada acerca de las causas de la falla.

Los sensores más usados son los de aceleración, pues por medio de ellos el analizador de vibraciones puede integrar la señal y obtener las lecturas de velocidad; también puede obtener la señal de Enveloping, principalmente. Los acelerómetros funcionan por el efecto piezoeléctrico, muchos de ellos son aptos para alta temperatura y requieren de dispositivos electrónicos para producir su señal.

El análisis de los espectros implica no solo la identificación de frecuencias puntuales, sino también la interpretación de las frecuencias de los armónicos múltiplos de las frecuencias de falla, en bajas y altas frecuencias. Como se muestra en la Figura 2.1.3.2, el determinar que una falla está presente implica la existencia de armónicos de la frecuencia de la falla.

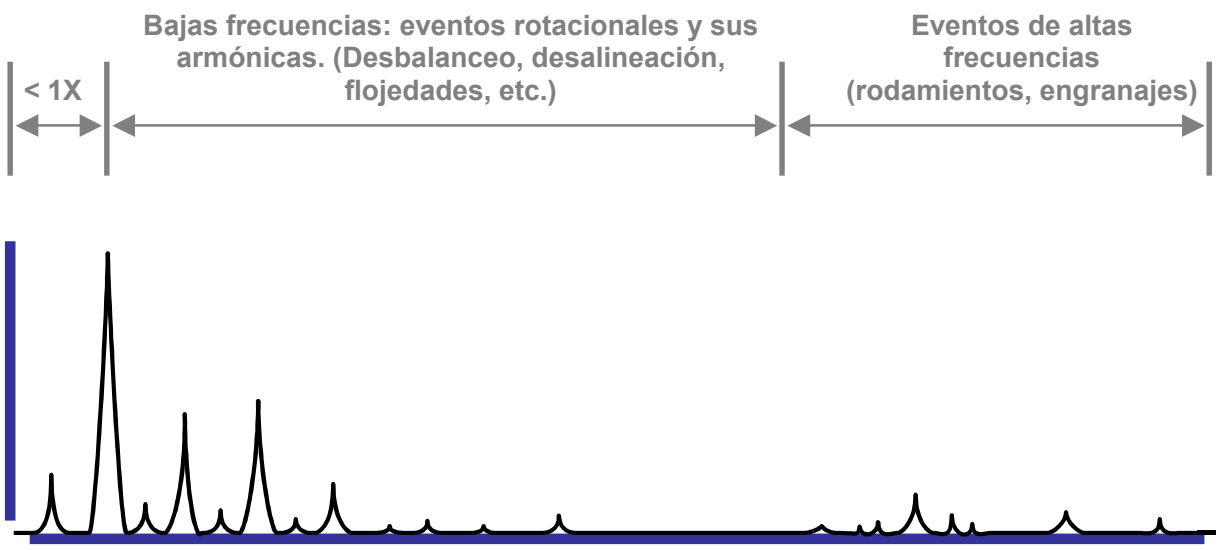


Figura 2.1.3.2 Análisis de armónicos en bajas y altas frecuencias[5]

Las fallas evolucionan por etapas. En la primera etapa no existen mayores amplitudes en la frecuencia de falla ni en sus armónicas. En la segunda etapa las armónicas de la frecuencia de falla aparecen. En una tercera etapa aparecen defectos en las frecuencias de falla. Y finalmente, aparecen bandas laterales en las armónicas y en las frecuencias de falla. Estas etapas pueden ser vistas en la figura Figura 2.1.3.3.

[5] Tomado de "Compilación de Material sobre Análisis de Vibraciones de SKF".

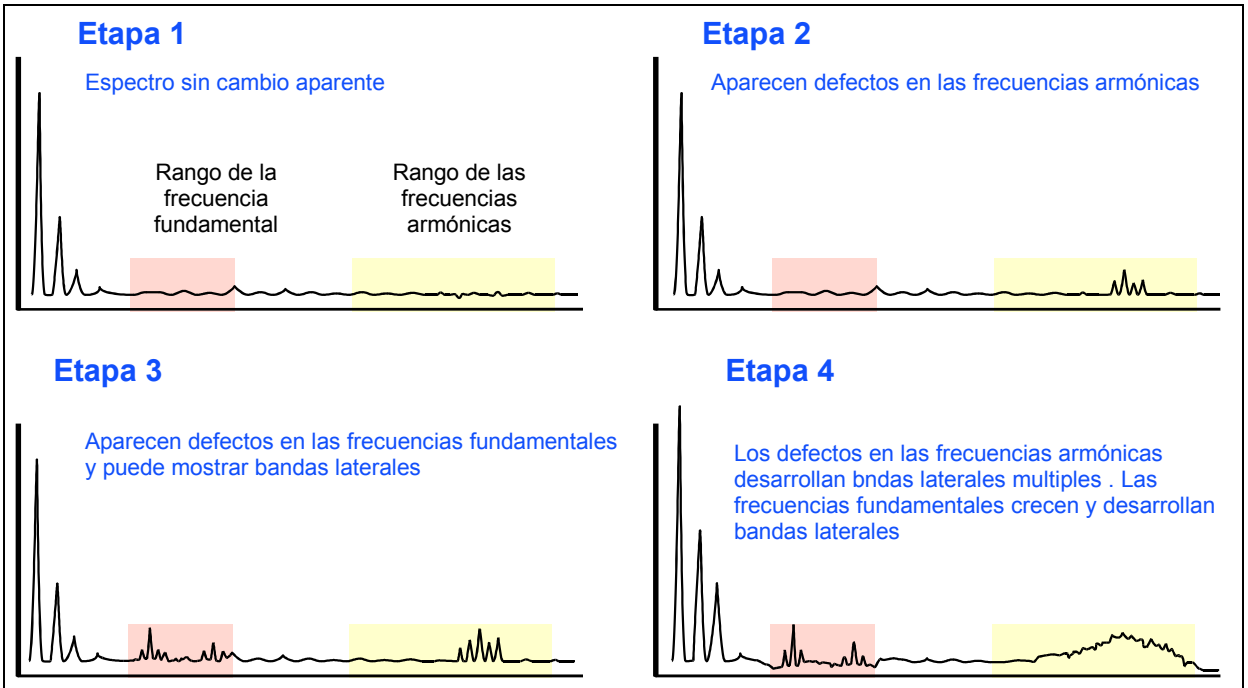


Figura 2.1.3.3 Etapas en la evolución de una falla[6]

Si se considera estos aspectos, además de contar con la experiencia y con las recomendaciones del fabricante, el personal de vibraciones puede iniciar su monitoreo.

Una de las formas más comunes de hacer monitoreo de vibraciones consiste en visualizar los registros de vibraciones de diferentes días desplegadas bajo una misma línea de coordenadas o en forma de cascada. De esta manera, el analizador de vibraciones percibe los cambios y el nacimiento de fallas en sus etapas tempranas tal y como se observa en la Figura 2.1.3.4.

[6] Tomado de "Compilación de Material sobre Análisis de Vibraciones de SKF".

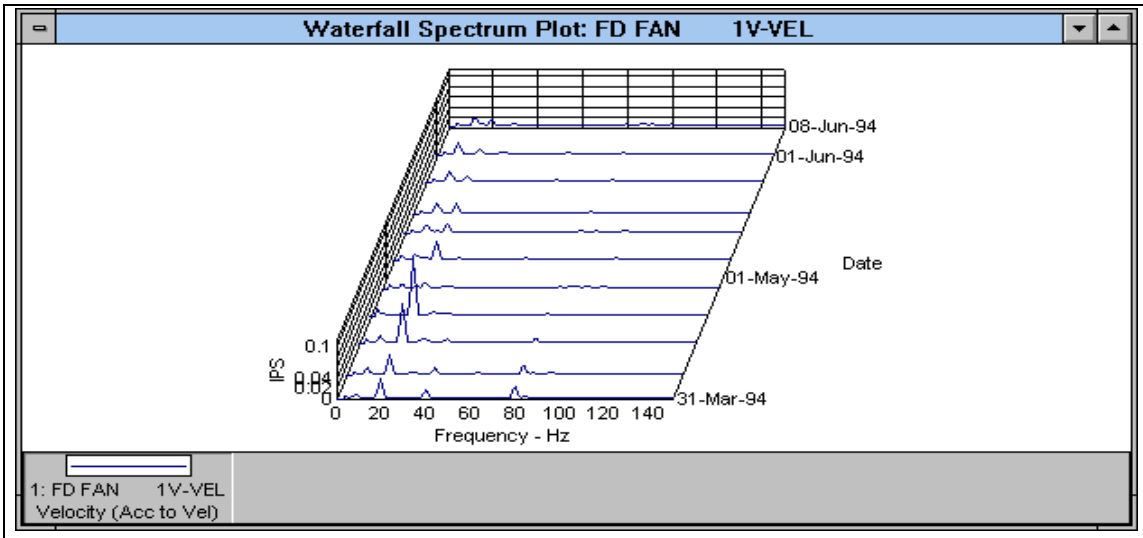


Figura 2.1.3.4 Cascada de espectros de vibraciones[7]

Una forma de reconocer la gravedad de la condición de un punto cualquiera en la máquina, sin saber la causa y el porqué, es el monitoreo de los Valores de Tendencia Global en Velocidad cuya normativa es la ISO 2372 de la Figura 2.1.3.6. [8].

[7] Tomado de "Compilación de Material sobre Análisis de Vibraciones de SKF".
[8] Un Hp equivale a 746 W.

Tabla 2.1.3.2 Tabla de severidad en los Valores Globales para velocidad de la Norma ISO 2374[9]

Vibration Severity Range Limits (Velocity) From ISO 2372		Vibration Severity Ranges for Machines Belonging to:			
In/Sec (PK)	MM/Sec (RMS)	Class I < 20 HP	Class II 20-100 HP	Class III >100 HP	Class IV >100 HP
0.015	0.28	A	A	A	A (Good)
0.025	0.45				
0.039	0.71	B			
0.062	1.12		B		
0.099	1.80	C		B	
0.154	2.80		C		B (Allowable)
0.248	4.50	D		C	
0.392	7.10		D		C (Tolerable)
0.617	11.2			D	
0.993	18.0				D (Not Permissable)
1.540	28.0				
2.480	45.0				
3.940	71.0				

A: Good
B: Allowable
C: Tolerable
D: Not Permissible

Suggested Classifications:

Class I: Small (up to 15kW) machines and subassemblies of larger machines.

Class II: Medium size (15kW to 75kW) machines without special foundations, or machines up to 300kW rigidly mounted on special foundations.

Class III: Large rotating machines rigidly mounted on foundations which are stiff in the direction of vibration measurement.

Class IV: Large rotating machines mounted on foundations which are flexible in the direction of vibration measurement.

[9] Tomado de “Compilación de Material sobre Análisis de Vibraciones de SKF”.

2.1.4 El Mantenimiento de Precisión

Según la tendencia, se espera que el siguiente paradigma dentro de las filosofías del mantenimiento sea el Mantenimiento de Precisión. Basado en el Mantenimiento Correctivo, el Mantenimiento Preventivo y el Mantenimiento Predictivo, el Mantenimiento de Precisión trataría de que cuando se realice un trabajo de reparación, la máquina quede en las mejores condiciones posibles. Ello implica una ardua tarea de entrenamiento en herramientas y refacciones de calidad, calibración, balanceo y alineación de máquinas. Por los altos costos y la complejidad de este mantenimiento se espera que sea exitoso en áreas donde la expectativa de fallos sea mínima y donde el valor de la maquinaria sea elevado lo suficiente como para deteriorar el equipo con un mal mantenimiento.

2.1.5 El Mantenimiento Programado

El Mantenimiento Programado es un tipo de mantenimiento circunstancial que resuelve problemas de manera programada fuera del Mantenimiento Preventivo. Estas tareas surgen de la toma de conciencia sobre problemas, nace de incidentes recientes, de la realización rutinaria del mantenimiento preventivo, de la necesidad de modificar parámetros en las máquinas, de la avería y cambio de una máquina o de alguna actividad inconclusa en las rutinas de mantenimiento preventivo. Dentro de un Plan de Mantenimiento Preventivo debe dejarse el tiempo suficiente para poder realizar Mantenimiento Programado. Los Aerogeneradores implican una gran cantidad de Mantenimiento Programado. Así, en un mismo parque un problema que se encuentra en una máquina tiende a hacerse presente inmediatamente en el resto del parque y por ello deben programarse acciones correctivas de forma pronta.

2.1.6. El TPM, el RCM y el RCM 2

El TPM, el RCM y RCM 2 son técnicas que implementan las filosofías fundamentales del Mantenimiento (Mantenimiento Correctivo, Preventivo, Predictivo y de Precisión) basadas principalmente en la toma de decisiones y en el personal.

El objetivo del TPM (Total Productive Maintenance) o Mantenimiento Productivo Total es centrarse en aquellas funciones que permitan preservar el funcionamiento de los equipos bajo estándares de operación deseables. Por ello se apuesta a equipos de trabajo altamente capacitado (Empowerment) que puedan tomar decisiones por sí mismos (Mantenimiento Autónomo) mediante un esquema de organización horizontal donde la solución de los problemas sea definida en una acción conjunta. El TPM busca, a su vez, la simplificación de las metas, el entendimiento de las máquinas, el trabajo conjunto con el área de producción, la implementación de procedimientos, el aprovechamiento de la sinergia y la motivación del personal, y el mejoramiento continuo. Por ello se dice que el TPM impacta principalmente en la cultura de la empresa. El éxito del TPM se ha mostrado en empresas donde la coordinación entre Producción y Mantenimiento es fuerte así como donde la producción y el manejo del personal puede resultar complejo.

El RCM y el RCM2 (Reliability Centered Maintenance) o Mantenimientos Centrados en la Confiabilidad Operacional son tendencias de gestión que pretenden la optimización de la confiabilidad operacional de las máquinas seleccionadas por parte del equipo de trabajo mediante la meditación y la programación de las medidas más adecuadas. Valora la criticidad y prioridad de cada activo en relación con cómo afecta la producción y cómo atenta contra la seguridad y el ambiente. Ambos utilizan los FMEAs (Failure Mode and Effect Analysis) o Análisis de Modos y Efectos de Falla para deducir las mejores acciones por tomar. El Mantenimiento Centrado en la Confiabilidad se ha mostrado efectivo en procesos complejos en los que la solución de las fallas no parece obvia.

2.2 Los Controladores Lógicos Programables (PLC)

2.2.1 Los PLCs

Los PLCs o Controladores Lógicos Programables nacieron con la idea de reemplazar los antiguos sistemas de control basados en contactores, “relays” y demás dispositivos de naturaleza mecánica y eléctrica. No obstante, los PLC han ido más allá de ser controladores de entradas y salidas. También realizan operaciones matemáticas y comunican información por medio de redes bajo diversos protocolos de comunicación, entre otras funciones.

Los PLCs son usualmente programados por medio de Lenguaje de Escalera o Ladder. Estos lenguajes permiten obtener información rápidamente de manera visual mediante la utilización de funciones lógicas estandarizadas.

Es importante resaltar que un proyecto de automatización o comunicación por medio de PLCs difícilmente puede iniciarse sin haber elegido un controlador, pues cada marca ofrece diferentes formas de programar y diferentes funciones.

2.2.2 Conceptos fundamentales de la comunicación electrónica

Algunos de los conceptos principales de la comunicación son los siguientes:[10]

a) Bit: Mínima unidad de medida de información con dos estados posibles.

b) Byte: Secuencia de 8 bits

c) Word o Palabra: Línea de bits.

d) Protocolo de comunicación: El protocolo de comunicación es el conjunto de reglas que definen el formato y la transmisión de datos entre dispositivos electrónicos.

e) Protocolo de Texto ASCII: Es el protocolo más sencillo y lento. La comunicación es basada en texto. Requiere de 7 bits y está contenido en campos de 8 bits.

f) Protocolo Modbus: Protocolo de Comunicación especial para comunicación de programas de computadoras y aplicaciones de automatización.

[10] Todas estas definiciones, con la excepción de las de la comunicación Serial, fueron basadas en las definiciones de la página: hyperdictionary.com

g) Puertos serial: RS-485, RS-232, RS-422: La comunicación RS-232 utiliza señales representadas por voltajes con referencia a una señal de tierra. Es utilizada para conexiones punto a punto (un dispositivo, una conexión). La comunicación RS-485 y RS-422 es parecida por su par trenzado de cables con voltajes alternados de 0 a 5 Volt. No obstante, el RS-422 usa dos pares de cables por lo que puede transmitir y recibir de punto a punto. El RS-485 funciona para comunicación multipunto, con muchos dispositivos conectados en un mismo cable bajo direccionamientos y sistemas de Esclavo y Maestro[11].

h) Baud Rate: unidad de medición de la capacidad de envío de información de un canal. Un baudio equivale a un estado por segundo.

i) Bit de paridad: es un bit agregado a una transmisión de datos binaria con tal de identificar por medio de un 1 o un 0 si la transmisión de datos es un número “even” o “odd” (par o impar).

j) Bit de término (Stop Bit): Una vez que todos los bit de una línea se han transmitido, se posiciona un 1 como bit de término seguido del bit de paridad. Este bit denota el fin de una unidad de información.

k) Buffer: Lugar temporal en la memoria RAM donde los datos esperan para ser enviados a otras locaciones de memoria o a otros dispositivos.

[11] Tomado de la dirección: http://www.hw.cz/english/docs/rs485/rs485.html

2.2.3. Sensores Analógicos y Digitales

Los sensores digitales son utilizados en casos donde existen dos estados posibles, como encendido - apagado, o presente - no presente. Ese es el caso de los sensores de RPM, los sensores de proximidad, los interruptores y demás. Lo usual es encontrar que las salidas de estos sensores son de 24 Volt.

Los sensores analógicos son utilizados para sensar parámetros que crecen o decrecen progresivamente y poseen una densidad de datos significativa. Usualmente los sensores analógicos reflejan por medio de rangos de corriente de 4 a 20 mA, estados que van desde un nivel inferior hasta un nivel superior. Las típicas mediciones analógicas son de temperatura, viento, flujo, etc.

2.2.4. PLC Mitsubishi FX $_{1N}$- 14MR

La particularidad de la PLC Mitsubishi FX $_{1N}$ -14MR reside en su tarjeta de RS-485. Esta tarjeta la habilita para comunicarse vía puerto serial con otros dispositivos que también estén diseñados para comunicarse por RS-485. Además contiene una serie de funciones para manipular los datos.

Para diseñar y monitorear los programas en el PLC Mitsubishi FX, se utiliza el programa Melsoft GX Developer. Este software permite acceder a las funciones, monitorear las variables, diseñar las decisiones lógicas y comunicar el PLC.

2.2.5. Funciones lógicas y elementos básicos del lenguaje de Escalera del PLC Mitsubishi FX $_{1N}$- 14MR

En el lenguaje visual de escalera el elemento principal es el contactor. El contactor se representa por dos líneas paralelas y verticales, con la letra X y un número que lo diferencia de otros contactores. Los contactores usan el mismo concepto que los interruptores: cuando son activados se cierran (eso es cierto cuando los contactores son normalmente abiertos) con lo que permiten el paso de energía entre las dos líneas de los lados del diagrama. Con las señales de entrada, los PLC toman decisiones, realizan operaciones o almacenan y transfieren información.

El otro elemento básico de los diagramas son las salidas, que son encerradas entre paréntesis y denotadas con una Y más un número que la identifica. Las salidas actúan como interruptores de elementos en el proceso real. Las salidas activan las máquinas o los dispositivos a partir de las señales y estímulos en las entradas, o a partir de decisiones en el programa del PLC.

Algunas de las funciones principales son: RST (Reset), C0 (Contador), T250 (Timer), Mov (Mover datos), Div (División de datos) y End (Fin de la programación). La función Reset sirve para volver la cuenta a cero en algunas funciones como los temporizadores, los contadores, y otros. La función del Contador es sumar la cantidad de veces que se pulsa un contactor en la entrada designada para ello. Cuando la cuenta llega a un valor determinado, se activa un contactor del contador.

Los temporizadores se parecen a los cronómetros en su función. Cuando son energizados en la entrada de disparo, los temporizadores inician la cuenta del tiempo hasta que algo la detiene.

El comando Move es utilizado para mover datos de un lugar de memoria a otro.

Los lugares de memoria se designan con la letra D más un número diferenciador. La función del comando División es la de efectuar una división de dos valores en memoria y almacenar el resultado en otro Buffer. Finalmente, la función End fuerza al PLC a reconocer la conclusión del programa. Al declarar End al final del diagrama de escalera el PLC funciona de forma más rápida que si no tuviera esa función.

2.3. Explicación básica del funcionamiento de los Aerogeneradores Neg Micon NM750.

Las turbinas eólicas Neg Micon NM750 utilizadas en Aeroenergía son sistemas con tres aspas en el rotor, sistema de freno en las puntas de las aspas (Tips), Caja multiplicadora de velocidad y un generador asincrónico. Además de esos componentes tiene sistemas de orientación con el viento para el mayor aprovechamiento de la energía, tiene un sistema de freno de disco en el rotor y cuenta con un complejo sistema de monitoreo y control de variables.

La función de la caja multiplicadora de velocidad está en el generador. El generador está conectado a la malla del ICE y por ello el campo en el estator gira a 1812 rpm aproximadamente para 4 polos. Ahora bien, las aspas por sí solas no pueden girar a 1812rpm con la simple acción del viento. Por ello debe diseñarse el sistema para que gire a una velocidad mucho menor y que esta sea incrementada en la caja multiplicadora de velocidad.

La parte superior de la turbina es llamada góndola. La góndola se sitúa a 40 metros sobre la tierra. Dentro de los aspectos de seguridad debe tomarse en cuenta que trabajar a esas alturas, con un alto nivel de vibraciones, una gran cantidad de dispositivos en movimiento, suciedad y calor, puede resultar peligroso y por ello las tareas de mantenimiento se dificultan.

2.4. Explicación básica del funcionamiento del Programa iHistorian y el OPC[12].

El programa "iHistorian" es un software innovador de almacenamiento de datos especial para procesos industriales. El iHistorian está en capacidad de colectar datos cada 1/1000 segundos. Los datos pueden ser manipulados por sistemas comunes de bases de datos como SQL. Esto proporciona una mayor practicidad a la herramienta. Con el iHistorian los datos entran provenientes del proceso hacia el servidor OPC y de allí a módulos de visualización donde ayudan al personal a tomar decisiones administrativas. Es compatible con las principales marcas de sistemas de control del mercado porque opera bajo el concepto de OPC.

OPC significa *OLE for Process Control*. Las siglas OLE representan Object Linking and Embedding (Vínculo y fijación de objetos), que es un sistema distribuido de objetos creado por Microsoft. La OPC es entonces una especificación hecha para simplificar las tareas de comunicación en la industria, a partir de sistemas de direccionamiento y compatibilidad con productos Microsoft. Así, el usuario o cliente puede conectarse a un proceso moderado por un PLC y observar los datos que le envía el servidor. Ese servidor opera como un programa en la computadora que aplica la especificación de OPC.

Además, General Electric ha concebido el programa "info Agent" con tal de poder transferir la información a diferentes computadoras y proporcionar conectividad con redes.

[12] Basado en la información de la página web: www.softwaretoolbox.com

2.5. Explicación básica del funcionamiento del programa Prism4 de SKF y el Colector de datos CMVA-55 Microlog para análisis de Vibraciones

El programa Prism4 es utilizado por diferentes tipos de tecnologías en análisis de vibraciones de la empresa SKF. Prism4 permite diseñar las rutas de análisis de vibraciones y determinar los parámetros de cada punto. Con la ruta de mediciones lista, el personal encargado puede proceder a descargar la ruta en la máquina colectora de datos CMVA-55 Microlog y con ello tomar las señales de las máquinas.

Con los datos de las máquinas en el Microlog, el personal puede cargar los datos en la computadora y visualizar las tendencias de vibración, los espectros y los valores globales, entre otros. En ese sentido, el programa Prism4 se convierte en una herramienta de base de datos.

3. Reseña sobre la Planta Eólica de Aeroenergía S.A.

3.1 Historia de Aeroenergía S.A.

La empresa Aeroenergía S.A. se construyó en 1994 con el propósito de co-generar energía eólica en conjunto con el ICE con el amparo de la Ley No. 7200. Esta ley ha regido la generación autónoma y paralela de energía en Costa Rica. El contrato de compra – venta con el Instituto Costarricense de Electricidad se firmó el 14 de abril de 1997.

3.2 Organigrama de la empresa

Aeroenergía es una empresa pequeña con una estructura simple como se muestra en el Organigrama.

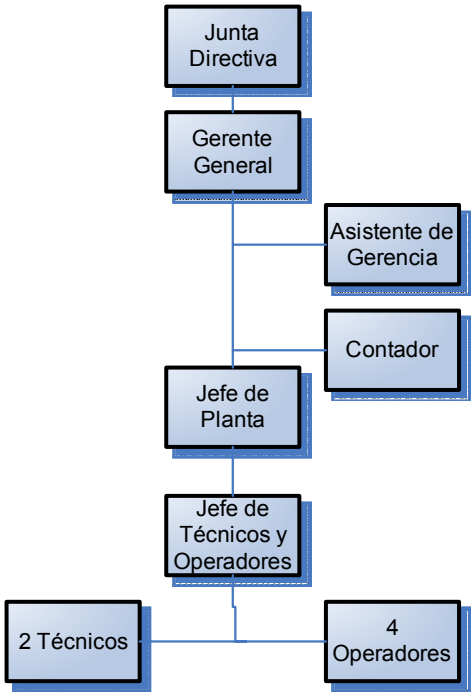


Figura 3.2.1. Organigrama de Aeroenergía S.A.

3.3 Tecnología utilizada

El diseño original de las turbinas corresponde a la M1800 NM750 de la empresa Neg Micon, con paso fijo, dos velocidades y generadores asíncronos de 1812 y 1210 rpm (de 750 y 250 kW). La máquina viene equipada con sistema de sensores y un controlador WP3000 que coordina las acciones de la turbina y dispara alarmas en caso de fallo.

Como se puede observar en los manuales de la máquina que se presentan en el Anexo 38, la máquina está equipada con un rotor, tres aspas, un eje, una caja multiplicadora, acoples y un generador. Además contempla motores y frenos de orientación lateral para hacer frente al viento en cualquier momento, y un complejo sistema de control.

4. Mantenimiento Preventivo aplicado a Aerogeneradores Neg Micon M1800, 750kW

4.1 Definición del problema

Conocedores de la diferencia entre el estilo del Mantenimiento Industrial común y el Mantenimiento de Aerogeneradores, Aeroenergía S.A. aceptó el proyecto de Mantenimiento Preventivo como forma de probar con nuevas herramientas para hacer frente a las tareas diarias en la planta.

El campo de la energía eólica está aún en su etapa de desarrollo. Por eso, cada día se encuentra mejores diseños de aerogeneradores y formas de dar mantenimiento al equipo. El mantenimiento de los aerogeneradores difiere en gran medida del Mantenimiento Industrial por varios motivos. La mayoría de los componentes de la turbina se encuentra en sitios de difícil acceso, en condiciones incómodas y peligrosas. Es por ello que la estancia en el sitio debe ser la mínima y eso dificulta el acercamiento con la máquina para aprender de ella. Además limita poder asumir las tareas de mantenimiento debido a la falta del equipo adecuado para efectuar múltiples tareas.

Bajo regímenes de viento fuertes, como es el caso usual de ciertos periodos en la zona de Tilarán, Guanacaste, el acceso a la máquina no es posible e incluso las máquinas deben detenerse ante una operación insegura con vientos por encima de los 25 m/s. En esas condiciones, la máquina no volverá a iniciar su funcionamiento sino hasta que el viento se mantenga a menos de 18 m/s durante un mínimo de diez minutos.

Dadas algunas cuestiones de seguridad, lo impredecible del viento, los elevados costos de tener la máquina detenida con vientos adecuados para la producción eléctrica y lo pequeño del parque, el mantenimiento necesita de una comunicación rápida que se despliegue a todos los niveles de la empresa para la toma de una decisión determinada. La flexibilidad y eficiencia necesarias en esta aplicación hace del sistema de Órdenes de trabajo un sistema inaplicable. En cambio, la comunicación, análisis y autorización de las intervenciones se realiza por vía telefónica, vía radio-transmisor o por Internet y estos medios resultan más adecuados a un parque de 9 turbinas donde las intervenciones son poco usuales y deben ser decididas con rapidez.

Frente a dichas particularidades de los parques eólicos, el fabricante Neg Micon A/S desarrolló un tipo de mantenimiento basado en Alarmas y por inspecciones que se realizan cada 6 meses y cada 2 años, llamados Service B y C respectivamente.

El Service A corresponde a una rigurosa inspección al inicio de las operaciones del parque. Este sistema de Service tiene una naturaleza altamente preventiva y programada con aplicaciones eventuales de técnicas predictivas como el análisis de aceite y el análisis de vibraciones. Usualmente, estas inspecciones se realizan entre septiembre y octubre, o en abril, cuando los vientos son escasos y la pérdida de energía derivadas de detener las turbinas es menor.

Algunos de los documentos del Mantenimiento Preventivo que Aeroenergía mantiene al día son: el Historial de la máquina (bitácora ubicada en el Panel de Control de cada turbina), el Reporte de fallas, los Valores de funcionamiento global (Curva de potencia versus velocidad de viento), los Reportes de mano de obra directa (Informe semanal de labores), y la Solicitud de compra de repuestos, materiales y herramientas.

De los documentos usuales, el Informe de movimiento de los repuestos en bodega, o la Solicitud de salida de repuestos y materiales de la Bodega no son utilizados porque la bodega es relativamente pequeña. La experiencia de Aeroenergía muestra que no es conveniente tener muchos repuestos en bodega por lo caro de las partes, porque algunos de ellos pueden ser obtenidos en la Planta eólica Movasa y por el deterioro normal. En caso de visualizarse la necesidad de repuestos se hace una requisición a Neg Micon Dinamarca y en cuestión de días los repuestos llegan a la Planta.

Gran parte de la información de la máquina es considerada por Neg Micon A/S como confidencial. Eso obstruye la posibilidad de dar un mantenimiento certero por parte de los dueños de las máquinas.

En ese sentido, la tarea fundamental de esta práctica de especialidad es estudiar la máquina, los múltiples cambios que ha sufrido, colectar información de sus partes, recopilar parte de la experiencia de los encargados del mantenimiento de Aeroenergía y traducirla en el diseño y programación un Plan de Mantenimiento con su respectivo Manual de Mantenimiento, sus diagramas detallados, imágenes y sus inspecciones.

4.2 Fuentes de información

El presente trabajo de Mantenimiento Preventivo se ha basado en la experiencia que ha dejado el quehacer de las inspecciones o Service en manos de terceros a lo largo de los años. De esta forma, ha sido difícil determinar la efectividad de las acciones que se recomiendan en las presentes inspecciones, principalmente en aquellos casos nuevos que nunca han sido probados en estas máquinas.

4.3 Codificación del Parque

4.3.1 Codificación del Parque

Toda codificación en la Planta Aeroenergía comienza con las letras AE. Este inicio de código es necesario para evitar problemas en una eventual ampliación del uso de este documento y su posible utilización conjunta con la Planta de Energía Eólica Movasa.

Las componentes ingenieriles principales del parque se dividen en este documento en Turbinas, Subestación, Transformadores de las turbinas, Transformador del edificio y Torres de Meteorología. Por ello, cada uno de estos componentes tiene su propio código. Las Turbinas se denotan con la letra T más el consecutivo del número con el cual están ordenados en el Parque. Ejemplo: Turbina 1: AE-T01.

La Subestación está codificada con las letras SE. Ejemplo: Subestación: AE-SE.

Los transformadores de las turbinas se denotan con el código de la turbina a la que pertenecen más la letra T. Ejemplo: Transformador de T1: AE-T01-T.

El Transformador del Edificio se denota con TE. Ejemplo: Transformador del Edificio: AE-TE.

Las Torres Meteorológicas se denotan con TM más un consecutivo. Ejemplo: Torre Meteorológica 1: TM-1. La lista completa de la codificación se muestra en el Anexo 1.

4.3.2. Codificación de los bloques de mantenimiento

La codificación de las partes de la turbina se ha unido con la codificación de otros elementos que no están en la turbina (como por ejemplo, la subestación). Esto tiene el fin de usar esta codificación en los Manuales de Mantenimiento y en las inspecciones.

Las diferentes partes se han designado con números y no con letras porque muchas veces es difícil encerrar en abreviaturas los conceptos que engloba un bloque de mantenimiento.

En el presente trabajo se han conformado bloques de máquinas que desde el punto de vista del mantenimiento están muy relacionadas. Ese caso se presenta con el bloque de la Estación Hidráulica, el Aspa y el Tip, en la cual la interrelación es muy significativa, pese a que los sistemas son diferentes.

La codificación puede observarse en el Anexo 2.

4.4 Diagramas de la máquina

Al inicio de la práctica, Aeroenergía poseía esquemas básicos facilitados por Neg Micon sobre máquinas similares a la M1800 (NM 750). Sin embargo, a lo largo de los años a las máquinas originales les han cambiado el generador, la caja, los sistemas de enfriamiento y algunos otros sistemas. De esta forma, los diagramas originales no correspondían más a las máquinas actuales. Por este motivo los diagramas fueron re-dibujados en Autocad con la idea de poder rotular sus componentes y facilitar el entendimiento del Programa de Mantenimiento.

Los esquemas se muestran en el Anexo 3

4.5 Diseño de la documentación

Como se mencionó en la introducción, en Aeroenergía se llevan una serie de documentos que cumplen las funciones de la documentación básica del Mantenimiento. La explicación de los documentos es la siguiente:

4.5.1. Solicitud o Orden de trabajo

Como se indicó en la sección Definición del Problema, en Aeroenergía no se utiliza la Orden de trabajo principalmente porque los problemas de las máquinas deben ser comunicados rápidamente. En cuestión de minutos, todos en la empresa deben conocer el problema para poder encargarse de él o proponer una solución.

4.5.2. Historial de las Máquinas

Neg Micon utiliza una bitácora en el Panel de Control al pie de la Turbina. En esa bitácora se explican las labores de los Service y de otras intervenciones. Esa bitácora no se pasa a una versión electrónica, sino que se deja en el papel. Sin embargo, la única información que se lleva en la bitácora de la turbina es el detalle del trabajo, la producción acumulada, la fecha, la hora y el responsable de las labores.

Además de que el técnico apunte los acontecimientos en la bitácora de la Turbina, el operador del Parque anota en la bitácora de operaciones las labores de mantenimiento que ocurren en las máquinas. En el futuro, las hojas de Inspecciones darán información sobre las intervenciones.

4.5.3. Documento de Datos Técnicos

Parte de los datos técnicos de la Máquina se han obtenido del Manual de Operación de Micon y de un archivo llamado: datos_tech_750.pdf. Antes de esta práctica ningún manual o documento contenía la información unificada ni completa, de ahí parte de la misión del presente documento.

Otros datos han sido tomados directamente de las máquinas y su información buscada en Internet o solicitada al Fabricante. Pese a que la información es limitada, actualmente se cuenta con una buena cantidad de datos. Esa información se encuentra vinculada en la tabla del Anexo 38.

4.5.4. Reporte de fallas

El documento de Control de Alarmas es el que sustituye al tradicional Reporte de Fallas. Además de reportar fallas, el Control de Alarmas también indica los paros manuales de la máquina que ocurren cuando se realizan los Service. El reporte completo despliega información del tipo de Alarma por la que ha sido detenida, el número de turbina, la fecha en la que ocurrió la alarma, el número de error al que corresponde, la descripción del error, las condiciones de viento, producción, tiempo total de operación desde que inició la máquina, la persona informada de la alarma, el operador que se hizo cargo de la alarma, el detalle del problema, la hora en la que entró a funcionar de nuevo la turbina, el régimen de viento en el cual entró y el tiempo total durante el que estuvo detenida por la falla.

Este documento se lleva en versión electrónica e incluye la disponibilidad de las máquinas durante determinado periodo de tiempo (mes).

El documento se puede observar en el Anexo 8

4.5.5. Valores de Funcionamiento Global

En los Generadores Eólicos el patrón más significativo es la Curva de potencia versus velocidad de viento. Este dato es registrado por el Medidor de Calidad de Energía Mutilin de la General Electric. Los datos se guardan con un formato electrónico propio del programa. Así, los operadores deben guardar la curva de potencia tres veces al día.

4.5.6. Reportes de Mano de Obra Directa

Los encargados del mantenimiento llevan Informes semanales de labores. Estos informes se llevan a mano y puede observarse en el Anexo 9

4.5.7. Solicitud de compra de repuestos, materiales y herramientas.

La solicitud de salida de repuestos y materiales de la bodega no es utilizada porque la bodega es relativamente pequeña y las labores no son tan frecuentes como en aplicaciones industriales o de mayor escala. Las solicitudes de compras son planteadas oralmente al Jefe de Planta y al personal. Para ello, no se llena ninguna documentación. Cuando existe una compra o pago de alguna labor, se llena un formato en una hoja de Excel con el detalle de lo ocurrido.

Esa hoja de Excel se observa en el Anexo 10.

4.6 Manuales de Mantenimiento

Los Manuales de Mantenimiento contienen información sobre las subdivisiones de cada parte de la máquina, aclara la función de la parte, la codifica, estima una acción de mantenimiento adecuada para el programa, le asigna una periodicidad, un número determinado de técnicos, y estima un tiempo de realización de la tarea. Este manual es una guía básica para la reflexión sobre el diseño de las inspecciones. Los manuales se muestran en el Anexo 4. Los datos técnicos y los enlaces a manuales se observan en el Anexo 38. Los detalles acerca de la ubicación de cada parte se pueden observar en las fotos del Anexo 11 o en los esquemas del Anexo 3.

En los manuales, no se utiliza codificación para aludir al tipo de inspecciones, pues puede provocar confusiones.

4.7 Inspecciones

Las inspecciones están basadas en gran medida en el sistema de Neg Micon de Service tipo B y C; y del Mantenimiento Programado. Las inspecciones del presente documento fueron confeccionadas con la experiencia del personal de Aeroenergía, las recomendaciones del fabricante y la meditación sobre las tareas más acertadas de mantenimiento. Para aquellas tareas que no habían sido contempladas en los Service, se diseñó un tipo de inspección llamado Ex (Extras).

Las inspecciones indican la parte a la que le dan mantenimiento, el número de inspección e información sobre el resultado de la inspección con un espacio para hacer anotaciones. Además existe una casilla para llenar el tiempo real de finalización de la labor de manera que se pueda estimar mejor el tiempo de las labores futuras. En el momento de realizar las inspecciones se debe cambiar el código de la inspección, e imprimir. Antes de realizar la inspección debe llenarse la fecha en la que se realiza la inspección.

Las inspecciones pueden verse en el Anexo 5

4.8 Programación de actividades de mantenimiento propuestas

Como se mencionó en la Introducción, las actividades de mantenimiento se realizan en época de poco viento. Usualmente eso ocurre entre setiembre y octubre y de manera menos evidente en otros meses, para el caso de Tilarán. No obstante, si en determinado año el viento es bueno para la generación, la administración no permitirá que turbina se detenga y el mantenimiento no podrá realizarse. Por ello se dice que la Programación es una propuesta cuyo cumplimiento no depende del personal de la planta sino de las condiciones de operación en el momento.

El Gantt que se observa en el Anexo 6

4.9 Procedimientos frente a Alarmas

Las turbinas de Neg Micon M1800 (NM750) cuentan son un sofisticado sistema de alarmas que muestra el momento en que alguna anomalía se presenta. Parte de este trabajo de Mantenimiento Preventivo contempla el diseño de diagramas de flujo con instrucciones sobre cómo hacer frente a una alarma. Por ello, se han confeccionado diagramas de Flujo en el programa Microsoft Visio. Por cuestiones de tiempo y practicidad, las alarmas con diagramas de flujo son un porcentaje pequeño del total de alarmas del sistema. Sin embargo, fueron escogidas aquellas más frecuentes e importantes.

Los diagramas pueden observarse en el Anexo 7.

4.10 Aspectos de Seguridad o Precaución

Las tablas de inspecciones llevan notas de seguridad o precaución junto al número de la inspección. Los aspectos de precaución son descritos a continuación:

P1: Máquina en Service. Generador desconectado. Freno asegurado. Mínimo dos personas en la inspección. Cortar la comunicación del Panel con el Parque.

P2: Si para revisar los dispositivos es necesario intervenir el Panel, entonces se debe apagar la turbina. Poner la máquina en Service. Desconectar la alimentación. Desconectar la comunicación. Mínimo dos personas en la inspección. Freno asegurado.

P3: Cuidado con los elementos rotativos. Cuidado con el sensor esférico de vibración.

P4: Igual que P1. Además, desconectar la alimentación del dispositivo intervenido.

P5: Igual que P1. Además, anclar el freno para que las aspas queden en Y. Linga de seguridad atada al Rodamiento Principal. Casco.

P6: Igual que P5. Además, apoyar apropiadamente las plataformas de Sky Damper a la torre para trabajar en las aspas.

P7: Arnés y casco puesto. Alertar al personal. Cuidado en el manejo de herramientas y accesorios.

P8: Desconectar las turbinas. Aterrizar la subestación. Interrumpir los alimentadores.

P9: Cuidado con aislar los polos de la batería.

P10: Cuidado. Posibilidad de descargas eléctricas.

4.11 Análisis costo beneficio del Proyecto Administrativo de la Práctica de Especialidad

Con base en el contrato logrado entre el ICE y Aeroenergía S.A. se puede deducir un monto promedio de producción por turbina por hora de $45. El tiempo de la práctica fue de 5 meses. El costo administrativo que representa el practicante es de $541 (con un salario de $325 al mes). Un análisis rápido que no tome en cuenta el valor del dinero en el tiempo, indica que Aeroenergía vería paga su inversión según el siguiente cálculo

$$0 = \$45 \times h - \frac{5}{3} \times \$325; \qquad h = \frac{5 \times \$325}{3 \times \$45} = 12 \text{ horas}$$

cuando se logre 12 horas menos de paro en una turbina bajo el nuevo esquema. Eso corresponde a disminuir los tiempos de paro en un 7,6%, si se toma en cuenta que en el mes de marzo del 2004, las turbinas permanecieron detenidas 157,5 horas. Eso es fácilmente asequible pues con la información y herramientas del Programa de Mantenimiento Preventivo las decisiones se tomarán más rápido y las máquinas pasarán menos tiempo detenidas.

Otros beneficios no cuantificados del programa son: los Sistemas de inspecciones, los Procedimientos frente a alarmas y la Programación de las actividades de Mantenimiento. Por ello, el proyecto en realidad se paga en menos de las 12 horas indicadas.

4.12 Recomendaciones

Para lograr un nivel óptimo en el funcionamiento del mantenimiento y en vista del nivel de operaciones que la empresa Aeroenergía tendría que asumir en caso de una expansión, la empresa debería realizar actividades para fortalecer la visión de la toma de decisiones en conjunto y del trabajo en equipo.

Además, por la planificación y la complejidad de las labores de mantenimiento en estas condiciones, el personal debería capacitarse en técnicas de montaje, alineación y cambio de piezas para poder asumir cada vez más funciones en las máquinas. El personal debería adoptar la filosofía del Kaisen o del Mejoramiento Continuo de los Planes de Mantenimiento Preventivo que se ha expuesto en esta práctica y poder mejorar las inspecciones y la información contenida en este documento.

5. Análisis de Vibraciones en Cajas Multiplicadoras y Generadores, aplicado a fallas en rodamientos y engranajes en Generadores Eólicos Neg Micon NM 750.

5.1 Definición del Problema

Al inicio de la práctica, la empresa Neg Micon ya había realizado análisis de vibraciones en las cajas y los generadores. No obstante, esa información nunca llegó a manos de la empresa.

Por ese motivo y por la dificultad de detectar problemas en condiciones tan difíciles, además de las particularidades vibratorias de este tipo de tecnología, la empresa Aeroenergía decidió iniciar un programa de Análisis de Vibraciones aplicado a los rodamientos de los generadores, a los engranes y rodamientos de las cajas multiplicadoras y los rodamientos del rodamiento principal.

La idea original era utilizar el equipo de la Escuela de Mantenimiento del Instituto Tecnológico de Costa Rica (CMVA 55 Microlog). Sin embargo, el equipo no estaba en buenas condiciones. Por ello, la reparación, la espera y el pago de una póliza por parte de Aeroenergía fueron necesarios.

Además, no existía en la Escuela alguien anuente a explicar el uso correcto del software ni de la toma de mediciones, por lo cual se tuvo que aprender todas las partes del proceso del Análisis de Vibraciones. No obstante, se debe resaltar la participación de los profesores Eligio Astorga, Juan Carlos Miranda y Manuel Mata, todos de la Escuela de Mantenimiento, en la revisión del proyecto.

5.2 Aislamiento de Señales externas a los elementos por analizar

Las turbinas Neg Micon NM750 (como las presentes en Aeroenergía) poseen una serie de amortiguadores laterales en la parte trasera de la góndola, amortiguadores en los apoyos del Generador, amortiguadores en los apoyos de la Caja Multiplicadora y amortiguadores en los acoples flexibles que unen los ejes de la máquina.

Al realizar el análisis de vibraciones se supone que este conjunto de amortiguadores logrará impedir que las vibraciones del vaivén de la torre, las aerodinámicas propias del aspa, las producidas por otras máquinas en el entorno y las producidas por fluctuaciones eléctricas instantáneas interfirieran en gran medida con las propias de las fallas de los mecanismos. No obstante, se sabe que esto no es posible. Para remediarlo no queda más que la experiencia que permita discernir las señales que son causadas por fallas posibles de aquellas que son producidas por agentes externos.

5.3 Análisis de Vibraciones en la Caja

5.3.1 El Problema de Analizar Vibraciones en cajas.

Las Cajas Multiplicadoras de Flender PEAC 4300.4 son máquinas muy compactas y con gran cantidad de elementos rodantes. Esto le suma complejidad al análisis de vibraciones por la gran cantidad de ruido en las señales vibratorias de los múltiples elementos y por tener relativamente poca masa en la cual disipar las vibraciones.

En los programas de Análisis de Vibraciones quien dicta los patrones admisibles de vibración en Aceleración y Enveloping es la empresa fabricante a través del estudio de su propio producto. No obstante, al solicitar información las empresas Flender y Neg Micon han presentado datos insuficientes o de dudosa aplicación.

De ahí que parte del problema de no poder determinar posibles fallas con certeza en los primeros meses del Análisis de Vibración, se debiera a que el personal debe aprender por su cuenta cómo funciona la máquina y cómo se comportan sus vibraciones. El funcionamiento promedio de los mecanismos en diversos puntos se ha estimado por medio de una tabla de Excel y un sistema de promedios simples. Esta hoja se observa en el Anexo 12.

5.3.2 Información adquirida. Verificación, estudio y consecución de datos restantes.

La información facilitada por la empresa Flender se encuentra en el Anexo 19.

La empresa Flender no envió ningún tipo de confirmación de que esos datos fueran aplicables a las Cajas Multiplicadoras de Aeroenergía. El problema principal es que en Europa, con un sistema eléctrico de 50 Hz, las cajas giran a 1510 rpm en la etapa de salida. En Costa Rica, las cajas giran a 1812 rpm. Ese aspecto cambia considerablemente las frecuencias.

5.3.2.1. Rodamientos

En el caso de los rodamientos de la caja, las frecuencias fueron calculadas para 1812 rpm y sus armónicas fueron estimadas. Las tablas con la información reacondicionada se muestra en el Anexo 20. No obstante, debe agregarse que estos datos son dudosos. Hace algún tiempo, las cajas empezaron a fallar a nivel mundial y con ellas, las cajas de Aeroenergía sufrieron un cambio en algunos rodamientos. En las siguientes etapas, Aeroenergía debe procurar verificar los datos de vibraciones con la empresa Flender.

Además, los rodamientos en la caja fueron demarcados con letras. Estas letras se observan en el diagrama de la caja que se observa en el Anexo 22.

5.3.2.2. Engranajes

Las frecuencias de los engranajes brindados por la empresa Flender fueron reacondicionados. Estos datos se muestran en el Anexo 21.

Para este tipo de caja se hace un análisis adicional en el Anexo 23. Este análisis determina la frecuencia de giro en los piñones de la caja por el Método Analítico de Tabulación.

5.3.3. Selección de puntos en la caja.

Los puntos en la caja que se muestran en el Anexo 22 fueron escogidos para los siguientes fines. El punto 1 monitorea los piñones planetarios, la rueda sol, la rueda de la carcaza y los rodamientos B C e I. El punto 2 monitorea los mismos aspectos que el punto 1.

El punto 3 sensa el rodamiento A. El punto 4 monitorea los rodamientos G y D y los engranajes en la etapa intermedia. El punto 5 sensa los rodamientos G y F. El punto 6 determina las vibraciones en D y E y en la etapa final de velocidad.

El punto 7 determina el desalineamiento o los problemas de vibración axial.

El punto 20 sensa las vibraciones del rodamiento H y los engranes de la etapa intermedia. El punto 21 determina las vibraciones en los rodamientos E y F y las fallas en la etapa de salida del reductor.

5.4 Análisis de Vibraciones en los Generadores

5.4.1 El Problema de Analizar Vibraciones en Generadores

El principal problema en los generadores Elin ha sido la falta de respuesta de la empresa sobre datos de Análisis de Vibraciones. A raíz de la falta de información, los cálculos de las frecuencias de falla de los rodamientos del generador fueron realizados en el Anexo 24.

Además, se procedió a realizar un cálculo del promedio de los valores globales en todos los puntos del generador para determinar un nivel estándar y normal de vibración en esos lugares. Esos valores pueden ser apreciados en la hoja de Excel que aparece en el Anexo 12.

5.4.2 Presentación de los datos de vibraciones para el Generador Elin

Finalmente, después de acondicionar los datos, las frecuencias de falla para el generador se presentan en el Anexo 25.

5.4.3. Selección de puntos

El sensor fue puesto en el generador de manera radial lateral en el punto10 para el rodamiento delantero y en el punto 11 para el rodamiento trasero. Además existe otro punto denominado 12 que toma los datos axiales del generador con tal de saber si tiene problemas en el eje.

Estos puntos pueden ser apreciados en el Anexo 26.

5.5. Selección de tipos de medición pertinentes

Según corresponda, en los puntos donde los elementos sensados giren a bajas velocidades, la medición será de Velocidad.

Cuando los puntos por medir reflejen datos de elementos con velocidades de giro considerables, o se esté en presencia de engranajes y rodamientos, se tomarán mediciones en Velocidad, Enveloping y Aceleración.

Cuando los datos del punto deban reflejar desalineaciones y problemas en el eje se tomarán mediciones por Velocidad.

5.6. Configuración final de todos los puntos en el Software Prism 4

Los puntos en Velocidad se configuraron de la manera presentada en el Anexo 27.

Los puntos en Enveloping han sido configurados como se muestra en el Anexo 28.

La configuración de los puntos en Aceleración se observan en el Anexo 29.

5.7 Sistema de Análisis de los datos.

En vista de que no existe información de severidad de aceleración o patrones normales de vibración proporcionada por los fabricantes de esta aplicación, se optó por el siguiente sistema: a lo largo de las mediciones en los diferentes puntos de la máquina se ha conformado una hoja de Excel donde se incluye los datos de los valores globales obtenidos de las últimas mediciones del Reporte del Software. El propósito de la hoja de Excel es tabular los datos para comparar todas las máquinas del parque y calcular un promedio simple de cada punto con la idea de tener un *estándar*.

Esa hoja de Excel se observa en el Anexo 12

5.7.1. Paso 1 del Análisis de Datos

Esa hoja debe ser actualizada con cada medición para mejorar el valor tomado como estándar de cada punto. Debe tenerse el cuidado de verificar que la expresión matemática es correcta.

5.7.2. Paso 2 del Análisis de Datos

En el paso 2 se debe llenar el formato del Anexo 13. Con ese formato se establecen los valores globales, se determina la severidad de esa medición, se compara con los valores promedio de la hoja de Excel. Finalmente, se determina si es necesario mirar los espectros de determinados puntos en busca de fallas. Se incluye un ejemplo desarrollado de este formato en el Anexo 15.

5.7.3. Paso 3 del Análisis de Datos

En el formato presente en el Anexo 14 se analizan los espectros. En la hoja se denota las frecuencias más relevantes, se vincula esas frecuencias a posibles fallas, se analiza el estado de las vibraciones en bajas y altas frecuencias de manera que se pueda determinar en qué etapa se encuentra la falla y se decida si es conveniente intervenir la máquina. El ejemplo está disponible en el Anexo 16.

5.8 Análisis de los datos colectados en la Caja de la Turbina 1

Los pasos 1, 2 y 3 del análisis de los datos para la turbina 1 se puede observar en los Anexos 17 y 18. Después del Paso 2 se decide observar los espectros de los puntos 4, 6, 10, 11 y 12. En el Paso 3 se analizan los espectros y se tabula las cualidades de los espectros para concluir si se debe intervenir la máquina o no.

5.9 Conclusiones sobre la Turbina 1

Las conclusiones sobre el Análisis de Vibraciones se escriben sobre el formato del Análisis de Espectros del Anexo 18. En el caso de la turbina 1, se concluyó que el problema con el eje debe ser intervenido. Probablemente, las vibraciones reflejen problemas de desalineación y para saberlo con certeza debe utilizarse equipo especial para desalineación. Después de un diagnóstico sobre el problema, debe procederse a solucionarlo. Las demás vibraciones deben seguir siendo monitoreadas para obtener conclusiones.

5.10 Sobre el estudio de vibraciones a 1210 rpm.

Las turbinas de Aeroenergía rara vez se conectan a 1210 rpm. El periodo en el que se realizó el estudio de práctica no coincidió con las temporadas de vientos bajos. De esta forma, todos los datos y las mediciones necesarias para hacer análisis de vibraciones con 1210 rpm no estuvieron disponibles.

5.11 Análisis costo-beneficio del Análisis de Vibraciones

En la práctica con Aeroenergía, el costo de obtener el equipo fue el pago de c60.000 (menos de $140) del monto de la póliza del seguro por daño. Además de ello, el tiempo de la práctica fue de 5 meses. El salario estimado del practicante es menor de $325 (c130.000) por mes. El costo por proyecto es una tercera parte de lo pagado al practicante más la póliza. Con ello se puede obtener el costo del Proyecto.

$$\text{Costo del Análisis de Vibraciones por cada rodamiento} = \frac{(\$140 + 5/3^* \$325)}{9 \times 2} = \$37.5$$

Para analizar el costo-beneficio del análisis de vibraciones se verá su efecto sobre la vida de un solo rodamiento en un generador. Según los cálculos de SKF, el 90% de los rodamientos como el usado en el generador duraría 6 años y 7 meses bajo las mismas condiciones, tal como se muestra en el Anexo 30. No obstante, los rodamientos de Aeroenergía no tienen una vida tan larga. El costo de cada rodamiento del generador es de $2500.

De esta forma, el programa de Análisis de Vibraciones *se justifica al extender la vida de cada rodamiento de generador en 1 mes y 5 días.* La razón es que un rodamiento tiene un costo por hora de $2500/ 57850 h ($0.0432/h). Con ello se obtiene el tiempo de retorno.

T de retorno por rodamiento = $37.5 / ($0.0432 / h) = 868 h = 1 mes, 5 días.

Esto se puede lograr fácilmente al determinar problemas en los ejes o rodamientos y proceder a lubricar o balancear. No obstante, este cálculo no estima los beneficios del análisis en la Caja Multiplicadora.

5.12 Conclusiones y recomendaciones

El Análisis de Vibraciones puede ser una herramienta muy útil para este tipo de tecnología en especial. Por esa razón es importante que se le de continuidad al proyecto aplicado a Rodamientos y Engranajes. No obstante, es recomendable extender el análisis de vibraciones con tomas de referencias de fase para determinar problemas en ejes; toma del HFD en los puntos más importantes de la Ruta y la toma del SEE para reconocer problemas de lubricación en los rodamientos del generador y los rodamientos de entrada y salida de la Caja Flender.

Por otro lado, se debe iniciar una evaluación más técnica de la desalineación en los generadores con el objetivo de corregir los problemas lo antes posible.

6. Programa de implementación de un Historiador de datos en los Aerogeneradores por medio de PLCs de comunicación

6.1. Definición del problema

El problema por resolver desde un inicio era la necesidad de tomar datos constantemente del proceso para que el Historiador se volviera una herramienta de decisiones administrativas. En el contrato con el ICE Aeroenergía se compromete a cumplir con cierta cantidad de energía cada mes. De no cumplirse ese monto, el ICE aplica sanciones. Por ello, un sistema de monitoreo de variables, permitiría a lo largo de los años hacer posible un estudio de las condiciones, predecir el comportamiento de ciertos rubros y disminuir la posibilidad de ser multados por incumplimiento de cantidad de energía.

La idea original del proyecto era conectar la red de controladores WP3000 de las turbinas con una computadora y que en ella el programa iHistorian de la casa fabricante General Electric grabara los datos más importantes. No obstante, esto no fue posible porque según los fabricantes de los controladores WP3000 (Mita Teknik) los sistemas no son compatibles con los OPC de General Electric.

Luego de la respuesta dada por Mita Teknik, se pidió una cotización a la empresa Electricidad Americana para que asumiera el diseño del proyecto. La idea entonces ya no era tomar los datos del controlador WP3000, sino conectar sensores (anemómetros, sensores de rpm y sensores de temperatura) extra y dispositivos (el dispositivo de Vibración Tac 84 y el relé de protección SEG) que no habían sido comunicados en el proceso y enlazarlos todos con un PLC para transferir datos a la Computadora y luego al programa iHistorian.

La empresa Electricidad Americana envió la solicitud a la representante SisFlex S.A. en México. Las empresas SisFlex y Electricidad Americana contestaron a la solicitud con una lista de software por un monto de $28,046.00 más impuestos (que no incluye el Hardware) (Anexo 31).

Los administradores de Aeroenergía consideraron que el proyecto no parecía justificable dados esos costos. Por ello, se buscó incrementar los beneficios del proyecto por medio de la inclusión en el proyecto de sensores de flujo y de nivel de aceite en las cajas. Estos sensores arrojarían alarmas en caso de que una fuga o obstrucción en el circuito de aceite ocurriera. Las fallas en el circuito hidráulico no son monitoreables en este momento por medio del sistema de Mita Teknik.

Cuando se pidió a SisFlex que asumiera la selección de los sensores de flujo y de nivel, la comunicación con ellos se perdió. De esa forma, todo el proyecto quedó en nuestras manos. Se consultó con la empresa de los Aerogeneradores Neg Micon sobre los sensores. Neg Micon contestó que en anteriores ocasiones ellos habían intentado sensar flujo y nivel de aceite en las cajas multiplicadoras sin buenos resultados.

Ante esta nueva negativa, se procedió a hacer requisiciones de sensores de flujo y nivel de aceite para dicha aplicación. Las empresas consultadas fueron Elvatron S.A., SPC y JRControles. De todas esas empresas, la única que dio respuesta fue Elvatron, sin embargo hasta la fecha no han encontrado una forma adecuada de medir dichos parámetros.

En ese momento, ya faltaba un mes para la conclusión del tiempo de práctica. Entonces fue cuando se procedió a consultar a la profesora Ana Lucía Morera, de la Escuela de Electromecánica, para solicitarle un PLC. Este, debía tener un módulo Modbus para los dispositivos de la turbina, una serie de entradas digitales y un módulo de entradas analógicas. El único PLC disponible tenía una tarjeta de comunicación RS-485 y entradas digitales. La conexión por Modbus y por vía analógica no era posible por medio de ese PLC y por ello, la implementación de gran parte del proyecto debía ser postergada.

Se procedió entonces a pedir el PLC a la Escuela de Electromecánica, a replantear los objetivos y a programar las siguientes etapas de desarrollo del Proyecto. El tiempo faltante para la conclusión de la práctica en el momento de la adquisición del PLC era de dos semanas.

6.2 Objetivos del Proyecto

Por medio de una PLC Mitsubishi FX_{1N} – 485 BD, se conectará:

a) El dispositivo de Vibración Tac 84C. Protocolo de Texto, ASCII. RS 485.

b) El relé de protección SEG. Modbus.

c) Anemómetro. Entrada Analógica.

d) PT100. Sensor de temperatura. Entrada Analógica.

e) Sensor de RPM. Entrada digital.

f) Sensor de flujo de aceite. Entrada analógica.

g) Sensor de nivel de aceite. Entrada analógica.

Al lograr manejar los diferentes dispositivos y sensores, el PLC debe conectarse por OPC Server al iHistorian. Por último, debe configurarse el programa iHistorian para almacenar los datos leídos.

6.3 Etapas en el desarrollo del Proyecto

6.3.1. Primera etapa de implementación

La primera etapa consta de:

a) Adquisición de información del PLC para programar el controlador.

b) Adquisición de información sobre la comunicación del dispositivo TAC 84c.

c) Conexión de la tarjeta de la comunicación RS 485 del PLC.

d) Propuesta de diagrama escalera para transferir datos del TAC 84c por RS-485.

e) Diagrama escalera para manipular la información del sensor de RPM.

f) Propuesta de sensor de nivel de aceite.

g) Propuesta de sensor de flujo de aceite

f) Cotización de PLC Mitsubishi FX_{1N}-485 DB, con dispositivos de entradas analógicas, Módulo Modbus y tarjeta de comunicación RS 485.

g) Desplegar los datos comunicados en un cuadro.

6.3.2. Segunda etapa de implementación

La segunda etapa consta de:

a) Adquirir el equipo de PLC con los módulos requeridos.

b) Adquirir un sensor de nivel de aceite en la caja multiplicadora.

c) Adquirir un sensor de flujo de aceite en la entrada de la caja multiplicadora.

d) Adquirir el módulo de comunicación Modbus del relé de protección SEG.

e) Comunicar vía Modbus el relé SEG con el PLC.

f) Comunicar los PT100 y anemómetros al PLC, en las entradas analógicas.

g) Desplegar los datos comunicados en pantalla.

6.3.3. Tercera etapa de implementación

La tercera etapa consta de:

a) Comunicar el sensor de nivel de aceite con el PLC.

b) Comunicar el sensor de flujo de aceite con el PLC.

c) Estudiar la configuración de los datos en el demo del programa iHistorian.

6.3.4. Cuarta etapa de implementación

La cuarta etapa consta de comunicar todos los datos del PLC al Historiador y configurar el programa para colectar datos.

6.4. Resultados de la primera etapa de desarrollo del proyecto.

6.4.1 Información técnica de programación del PLC

Se ha obtenido el manual de programación II en papel. Este manual se aplica a las versiones de Mitsubishi FX 1S, FX 1N, FX2N y FX2NC y por lo tanto sirve para la programación del PLC en las siguientes etapas.

Además de este manual se adquirió una serie de archivos digitales que se observan en el Anexo 32. Sin embargo, al leer los manuales se llega a la conclusión de que falta la continuación del manual S-080006-B (Manual del Módulo de comunicación Q), que tiene la solución definitiva de la comunicación del TAC 84c en el Capítulo 13: Comunicación con código ASCII. Ese manual es el SH-080007-B.

6.4.2. Información sobre el dispositivo TAC 84c

En el Anexo 33 se observa el único documento técnico que los diseñadores del Dispositivo TAC 84 han facilitado.

En ese archivo se muestra que la comunicación del TAC 84c está cableada para comunicación de un par en 485. El pin de 485 A, enlaza internamente el envío y la recepción de datos A; el pin 485 B es el nodo del envío y la recepción de datos de B.

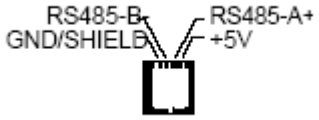


Figura 6.4.2.1. Comunicación RS-485 del TAC 84c[13]

Además de ello, se sabe que transfiere datos a 9600 baudios, que se comunica por protocolo de texto ASCII, que su Identificador de Nodo es 1 y que al encender despliega en pantalla un ID de Programa 10011101.

[13] Tomado del archivo TAC 84c del Anexo 33.

6.4.3. Conexión de la tarjeta de comunicación FX_{1N} - 485 BD

Como el TAC 84c está internamente cableado a un par, la tarjeta que recibe la señal también debe estar conectada para comunicación como un par agrupado de terminales de send y receive. En la figura siguiente se observan las conexiones y la resistencia necesaria para realizar dicha configuración.

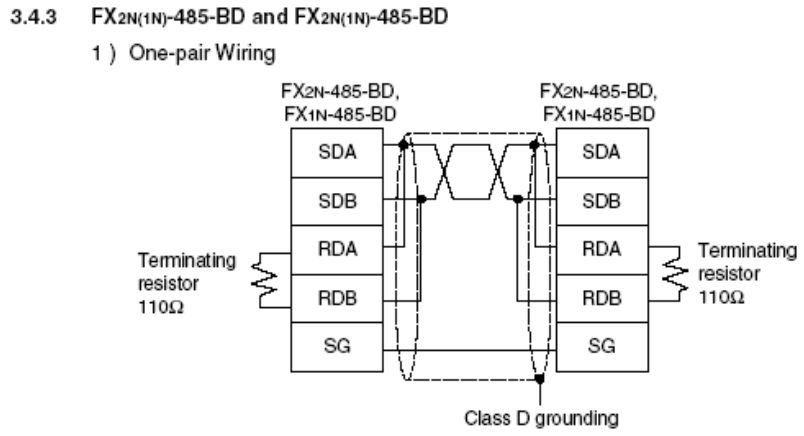


Figura 6.4.3.1. Conexión de la tarjeta de comunicación 485 en el PLC[14]

6.4.4. Propuesta de diagrama escalera para comunicar el TAC 84c por RS-485.

Debido al limitado tiempo que quedaba entre la adquisición del PLC, la información y el fin de la práctica la comunicación serial no pudo ser desarrollada plenamente en esta etapa del proyecto. No obstante, sí queda una idea clara de cómo desarrollar la comunicación.

[14] Tomado del archivo JY992D69901-E.pdf que aparece en el Anexo 32.

En el Manual Digital Completo de Programación (que se ofrece en el Anexo 32) y en el Manual en papel se puede observar la Función RS desarrollada por Mitsubishi para la comunicación de Dispositivos Externos vía Serial. Esta información se encuentra en el apartado FNC 80 – 89: External FX Serial Devices en 5-94; o bien en la hoja 236 del documento en formato PDF.

6.4.5. Diagrama escalera para comunicar el sensor de RPM

La información del sensor de RPM no se presenta en el Anexo 31. Pero se sabe que envía pulsos de 24 Volt tres veces por cada vuelta del rotor (tiene tres aldabas reflectoras distribuidas a 120°).

Con ello, se construyó el diagrama de escalera presente en el Anexo 34.

6.4.6. Propuesta de sensor de nivel de aceite.

Sobre este aspecto, la empresa Neg Micon fue consultada. Ellos informaron haberlo intentado sin resultados en el pasado. Pese a ello, Aeroenergía está interesada en realizar el trabajo. Para esto hay que escoger un sensor que se adapte a las condiciones de temperatura, presión y viscosidad del aceite de la caja (la hoja de datos del aceite de la caja se ve en el Anexo 35).

La temperatura del aceite es de 70°C y la presión es siempre menor a 16 bar. La idea es utilizar el espacio donde actualmente existe una mirilla. El esquema se observa en el Anexo 36.

En la imagen se observa que la actual mirilla tiene una raya que indica el nivel deseable de aceite. El nivel mínimo (Alarma por bajo nivel) es a 1 cm por debajo de esa raya. El máximo nivel (Alarma por exceso de aceite) debe estar a 1cm por encima de la raya roja. Además, en el Anexo se observa un archivo con una propuesta de tecnología a utilizar. Son sensores analógicos de nivel. Este sensor estaría en un contenedor sujeto a las tomas de la mirilla actualmente instalada en la caja. El sensor debe estar diseñado para soportar las condiciones de operación. Una ventaja de estos sensores de nivel es su reducido costo.

6.4.7. Propuesta de sensor de flujo de aceite

De la misma forma en que luego de que se preguntó sobre el sensor de nivel en la caja, la empresa Neg Micon aseguró haber intentado poner un sensor de flujo en circunstancias parecidas sin resultados.

Al buscar una solución, se encontró que la empresa Hydac que fabrica las bombas que suplen aceite a la caja fabrica sensores de flujo para la bomba utilizada en las turbinas. En una ocasión la empresa Hydac fue consultada sin contestación. El catálogo general del sensor se muestra en el Anexo 37.

6.4.8. Cotización de PLC Mitsubishi FX_{1N}-485 DB, con dispositivos de entradas analógicas, Módulo Modbus y tarjeta de comunicación RS 485.

La cotización pedida al Ing. Alexander Agüero de la empresa Hi-TEC incluye

a) PLC FX1N-14MR con 8 entradas de 24 Vdc, 6 salidas relé, alimentación de 120 V: 300,00$

b) Tarjeta de comunicación RS-485 FX1N-485-BD: 56,00$

c) Cable de programación SC09: 222,00$

d) Software de programación original: 617,00$

TOTAL: $1.195,00

I.V: $155,35

TOTAL I.V.I: $1.350,00

La inclusión de un módulo analógico de 2 canales, en el rango de 4 a 20 mA le añadiría $216 más impuesto a la cotización inicial ($244). El monto final del equipo es de $1594. La entrega es inmediata. Este conjunto de elementos contiene todo lo necesario para desarrollar todas las etapas del proyecto. Un costo adicional se debería a los sensores de nivel y de flujo, y el módulo Modbus del Relé SEG. Los elementos adicionales (sensores principalmente) podrían costarle al proyecto unos $800 más, para un posible total de $2394.

6.4.9. Despliegue de datos en pantalla

Los PLC Mitsubishi pueden desplegar los datos con el comando Entry Data Monitor o Monitoreo de entrada de datos. Allí se puede vigilar cualquier Buffer o dispositivo del PLC.

6.5. Análisis de Costos del Proyecto

En este documento se ha explicado que la producción promedio por turbina por hora es de $45. Se puntualizó que el costo de los materiales del proyecto podría estar valorado en $2394. A este dato se suma el costo de la práctica de especialidad (estimado en $541) y el costo del software iHistorian (con valor de $4163).

De esa forma se obtiene que el proyecto se pagaría con un total de 6 días, 13 horas, en total de turbinas detenidas, como se muestra a continuación.

$$\$2394 + \$541 + \$4163 = \$45 \times \text{Horas de turbina detenida}$$

$$H = 157 \text{ horas, } 44 \text{ minutos} = 6 \text{ días, } 13 \text{ horas.}$$

Ese tiempo distribuido entre las 9 turbinas corresponde a 17 horas, 30 minutos. Esas 17 horas, 30 minutos corresponden al 11% de tiempo de paro del parque en marzo del 2004 (mes en el cual el tiempo de paro fue de 157,5 horas). De esa forma, se pagaría la inversión si se logra evitar un 11% de las horas de paro, por nueve meses.

No obstante, este proyecto está en capacidad de evitar gastos por reparaciones de bombas, por deterioro de la góndola, por deterioro en la caja y por sanciones ante el incumplimiento de la cuota de energía prometida al ICE al mes. Esos son aportes extra que no están cuantificados en la justificación y que disminuyen el tiempo de retorno de la inversión.

6.6. Conclusiones

La principal conclusión es que el proyecto implica una inversión de tiempo importante y su realización es posible. Además se trata de un proyecto costoso y con un alto nivel de complejidad técnica. Se ha demostrado que muchos de los elementos necesarios para desarrollar el proyecto deben ser comprados y seleccionados cuidadosamente, así como que la programación del PLC es un aspecto que amerita de tiempo.

6.7 Recomendaciones

Antes de proceder con las siguientes etapas de desarrollo debe encontrarse la solución a los sensores de flujo y de nivel de aceite y debe poderse configurar experimentalmente la comunicación a la computadora con un sistema de PLC que incluya entradas Modbus, analógicas, digitales y vía puerto serial para asegurar desde el inicio las ventajas de la inversión.

Se recomienda la continuidad del proyecto y la evaluación meticulosa de cada etapa en el desarrollo de la idea.

7. Fuentes de información

Libros

- Hamilton H. Mabie y Charles F. Reinholz. Mecanismos y Dinámica de Máquina. Segunda Edición. Editorial Limusa S.A. Mexico, 1999.

Folletos, recopilaciones y manuales

- Miranda, Juan Carlos. Compilación de Material sobre Análisis de Vibraciones de SKF. Instituto Tecnológico de Costa Rica, 2004.

- Valverde, Jorge. Folleto del curso de Administración del Mantenimiento I. Instituto Tecnológico de Costa Rica, 2002.

- Manual de operaciones de Neg Micon, M1500 M1800. Micon A/S. Versión en Inglés. Artículo número 18.275.00 GB.

Archivos digitales

- Información sobre el PLC FX $_{1N}$ – 485BD:
JY992D69901-E.pdf

- Archivo digital sobre el Dispositivo de Vibración TAC 84c
TAC 84c.pdf

-Presentación de Power Point sobre el programa de Re-acondicionamiento en las Cajas Flender:
presentation_master_UK_180200.ppt

Información de internet

- Información sobre sensor de flujo de Aceite Hydac:
http://212.88.134.40/index_start.php

-Diccionario Hyperdictionary de términos técnicos en Internet:
http://www.hyperdictionary.com/dictionary

- Página Web sobre comunicación serial:
http://www.hw.cz/english/docs/rs485/rs485.html

- Información sobre OPC (OLE for Process Control):
http://www.softwaretoolbox.com/Tech_Support/TechExpertiseCenter/OPC/OPCWhatisIt/opcwhatisit.html

8. ANEXOS

Anexo 1: Codificación del Parque

Tabla A.1.1. Codificación del Parque

Descripción	Nombre	Código
Lugar	Parque Aeroenergía	AE
Turbina	Turbina 1	T01
Turbina	Turbina 2	T02
Turbina	Turbina 3	T03
Turbina	Turbina 4	T04
Turbina	Turbina 5	T05
Turbina	Turbina 6	T06
Turbina	Turbina 7	T07
Turbina	Turbina 8	T08
Turbina	Turbina 9	T09
Subestación	Subestación	SE
Transformador	Transformador Turbina 1	T01-T
Transformador	Transformador Turbina 2	T02-T
Transformador	Transformador Turbina 3	T03-T
Transformador	Transformador Turbina 4	T04-T
Transformador	Transformador Turbina 5	T05-T
Transformador	Transformador Turbina 6	T06-T
Transformador	Transformador Turbina 7	T07-T
Transformador	Transformador Turbina 8	T08-T
Transformador	Transformador Turbina 9	T09-T
Transformador	Transformador Edificio	TE
Torre meteorológica	Torre meteorológica 1	TM-1

Volver

Anexo 2: Codificación de las partes de la Turbina y equipos a mantener

Tabla A.2.1. Codificación de partes de la Turbina y equipos

Parte	Función	Código	*Estudio de la Parte*[1]	*FMEA*[15]
Generador	Generar energía trifásica	01	AET-1	AET-1
Freno hidráulico del eje	Bloquear el rotor de la turbina	02	AET-2	AET-2
Caja Multiplicadora de Velocidad	Convertir la velocidad de giro de 26 a 1812 rpm.	03	AET-3	AET-3
Sistema de Rotor, Estación, Aspa y Tip	Producir el giro o frenar las aspas	04	AET-4	AET-4
Torre	Permitir el ascenso del personal a la góndola	05	AET-5	AET-5
Transmisión: Eje y rodamiento principal	Transmitir el movimiento del rotor hasta la caja	06	AET-7	AET-7
Sistema de orientación	Mover la turbina lateralmente	07	AET-8	AET-8
Paneles de control y sensores	Controlar la máquina y su óptimo funcionamiento	08	AET-10	AET-10
Subestación y Malla de Tierra	Transmitir la energía proveniente de las torres hacia la red del ICE	SE	AET-11	AET-11
Transformadores	Elevar el voltaje de la electricidad proveniente de las torres hacia la subestación	T	AET-13	AET-13
Torre de Meteorología	Monitorear nuevos posibles sitios	TM	AET-13	AET-13

Volver

[15] Los Estudios de la parte y los FMEA son sólo como una opción. A medida que se necesiten se irán realizando.

Anexo 3: Esquemas de la Máquina

Generador

Freno de Disco

Caja Multiplicadora

Estación Hidráulica, Tip, Rotor y Aspa

Torre

Transmisión: Eje y rodamiento principal

Sistema de Orientación o Guiñada

Volver

Anexo 4: Manuales de Mantenimiento

Parte: Generador

Código: AET-01

Volver

Tabla A.4.1. Manual de Mantenimiento del Generador

Sub-Parte	**Función**	*Código*	*Acción*	*Periodo*	*Tiempo Estimado (Min)*	*Técnicos*
Superficie del generador	Proteger los dispositivos internos	1.1	Limpieza Visual	B C B C	10 5	2
Colectores de grasa	Evitar derrames	1.2	Visual	B C	5	2
Rodamiento trasero y delantero	Giro libre del rotor	1.3	Lubricar Temperatura	Ex Ex	15 10	2
Caja de conexiones	Fija la conexión del estator	1.4	Visual	B C	5	2
Sellos del Generador	Sella el interior del generador	1.5	Visual	B C	5	2
Radiador	Enfría el agua	1.6	Visual Limpieza	B C B C	5 10	2
Coolant del Radiador	Mejora las propiedades del agua	1.7	Control	B C	10	2

Bomba de agua	Hacer circular el agua	1.8	Visual Socado	Ex Ex	10 10	2
Protecciones térmicas, sobrecargas y contactores	Proteger el generador	1.9	Revisión Visual	B B	20	2
Cableado eléctrico de potencia	Portar la energía	1.10	Visual	B	20	2
Acople	Transmitir el movimiento desde la caja	1.11	Socado Calibrar	B C C	20 60	2
Tornillos de la Base del Generador	Fijar el cuerpo a la góndola	1.12	Socado	C	10	2
Mangueras, uniones y purga de agua	Circular el agua, y purga aire.	1.13	Visual	B C	10	2
Eje	Transporta el giro mecánico	1.14	Limpieza Corrosión	Ex	10	2

Parte: Frenos de Disco

2TWA-36 Sime-Stromag

Código: AET-02

Volver

Tabla A.4.2. Manual de Mantenimiento del Freno de Disco

Sub-Parte	*Función*	*Código*	*Acción*	*Periodo*	*Tiempo Estimado (Min)*	*Técnicos*
Disco de freno	Sirve de superficie de frenado	2.1	Visual Ajuste	B C	5 30	2
Pastilla de freno	Aplica el torque contrario al giro	2.2	Alarma Cambio		40	2
Mangueras y uniones	Llevan el aceite de la bomba a las mordazas	2.3	Visual	B C	5	2
Acumulador cercano a la bomba	Mantiene aceite a presión para evitar arranques de la bomba	2.4	Visual	B C	5	2
Acumulador cercano al disco	Mantiene el aceite a presión, y se usa en modo soft.	2.5	Visual	B C	5	2
Acople	Conecta mecánica mente el freno, el generador y la caja	2.6	Visual Resocado	B B	5 10	2
Bomba	Posibilita la circulación de aceite	2.7	Visual Auditivo	B C B C	10 5	2

Aceite	Fluido a presión que permite aplicación de fuerza	2.9	Muestra Cambio	Ex Ex	30 40	2
Conexiones eléctricas	Energizan el motor y envían señales	2.10	Visual	Ex	30	2
Cobertor	Proteger al personal	2.11	Limpieza	Ex	10	2
Seguro de posición en Y	Permitir el anclaje de las aspas	2.12	Visual	Ex	5	2
Pistón	Transmitir la fuerza a las zapatas	2.13	Visual	Ex	10	2
Nivel de aceite	Indicar cuánto aceite contiene la bomba	2.14	Visual	B C	5	2
Zapata de freno	Servir de superficie de contacto	2.15	Visual Ajuste	B C B C	5 5	2
Prensas de freno	Transmitir la fuerza a la zapata	2.16	Visual Ajuste	B C B C	5 40	2
Tornillo de alivio	Permitir retraer el pistón y soltar el freno	2.17	Visual	Ex	5	2
Electro válvulas y válvula de alivio	Abren o cierran el paso del aceite con señales eléctricas	2.18	Visual Prueba	Ex	20	2

Parte: Caja multiplicadora de Velocidad Flender PEAC 4300.4

Código: AET-03

Volver

Tabla A.4.3. Manual de Mantenimiento de la Caja

Sub-Parte	*Función*	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Engranes internos	Aumentar la velocidad de giro	3.1	Visual Vibración Muestra	B C M B C Ex	30	2
Rodamientos de la caja	Soportar los ejes en movimiento	3.2	Vibración Muestra	M B C Ex	30 20	2 2
Acople	Acople la caja con el eje principal	3.3	Socado	B C	10	2
Sellos de la caja	Sella el interior de la caja del entorno.	3.4	Visual	B C	5	2
Amortiguador	Fijar la máquina a la góndola	3.5	Socado	B	10	2
Tapa de Registro	Sujetar el registro. Permitir monitoreo	3.6	Visual Socado	B B	5	2
Eje del amortiguador	Disipar las vibración entre la góndola y la caja	3.7	Socado	B C	10	2
Uniones y mangueras	Conducir el aceite	3.8	Visual	B C	5	2

Filtro	Limpiar el aceite de impurezas	3.9	Cambio	Ex	30	2
Bomba	Hacer circular el aceite	3.10	Visual Auditivo Socado	B C B C B C	20	2
Aceite	Evacuar el calor de la caja	3.11	Visual Muestra Cambio	B B Ex	5 10 30	2
Ventilador y radiador	Evacuar el calor del aceite de la caja	3.12	Visual	B C	5	2
Electro válvula cerca del filtro	Cierran o abren el paso al aceite	3.13	Prueba	Ex	10	2
Válvula Térmica Wahlen	Bloquea el paso directo a la caja al subir la temperatura	3.14	Prueba	Ex	20	2
Válvula manual cerca del filtro	Permite la purga y cambio de aceite.	3.15	Prueba	Ex	20	2
Tapas y registros traseros	Para agregar partes o monitoreo	3.16				
Nivel de aceite	Indica la cantidad de aceite en cárter	3.17	Visual	B C	5	2
Válvula manual inferior en lado de alta velocidad	Permite purgar el aceite del cárter	3.18	Prueba	Ex	20	2

Parte: Estación hidráulica, Tips, Rotor y Aspas

Código: AET-04

Volver

Tabla A.4.4. Manual de Mantenimiento del Freno Aerodinámico y Rotor

Sub-Parte	*Función*	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Motor de Estación Hidráulica	Producir el movimiento de la bomba	4.1	Prueba	B C	25	2
Bomba de Estación Hidráulica	Generar presión y la circulación de aceite para el Tip	4.2	Prueba	B C	25	2
Electro válvulas de la Estación	Permite o impide el paso del aceite hacia el pistón	4.3	Prueba Visual	B C B C	25 5	2
Caja de conexión de Estación	Contiene las señales y la potencia de la Estación	4.4	Visual	B	10	2
Uniones y mangueras de Estación	Permiten el trasiego del aceite	4.5	Visual Socado	B C B C	20 30	2
Tornillos de fijación Estación	Fijan la Estación a la torre	4.6	Visual Socado	B C B C	5 10	2
Tapa y agujero inserción de aceite.	Permiten el cambio, el muestreo y la renovación del aceite	4.7	Visual	B C	5	2

Acumulador de la Estación	Contiene el aceite a presión	4.8	Visual Socado	B C B C	5 5	2
Sensor de presión. Estación	Sensar la presión	4.9	Visual	B C	5	2
Aceite	Permite la retracción del pistón	4.10	Cambio	Ex	30	2
Slip Rings	Transmite señales de control de la estación	4.11	Visual	B C	20	2
Cables de transmisión de datos de Slip Ring	Transmite señales de control de la estación	4.12	Visual	B C	10	2
Cables de tensión del Tip	Transmitir el movimiento	4.13	Visual	Ex	120	3
Eje del aspa	Transmitir el movimiento	4.14	Visual	Ex	20	3
Pieza mecanizada del aspa	Orientar el giro del aspa	4.15	Visual Aceitado	Ex	20	3
Conos de Nylon	Fijan el Tip en posición retraída	4.16	Cambio	Ex	20	3
Muescas de montaje del Tip	Fijar el aspa	4.17	Visual	Ex	10	3
Marcos de aspas, cubos y extensiones.	Sujetar piezas y plataforma	4.18	Socado	C	100	3
Pistón	Recibir señales, ejercer fuerza	4.19	Visual Socado Cambio	B C C Ex	10 15 20	2

Cables de potencia	Llevan la energía necesaria para el motor	4.20	Visual	B C	15	2
Ejes empotrados en aspas	Soporte estructural	4.21	Visual	B C	15	2
Resortes	Producir estiramiento	4.22	Visual	Ex	10	2
Caja de registro en aspas	Permitir las inspecciones	4.23	Visual Socado	Ex Ex	10 10	2
Unión del pistón con cables	Transfiere el movimiento al Tip	4.24	Visual	B C	10	2
Perfiles metálicos del pistón	Fijan el pistón	4.25	Visual Socado	B C C	10 15	2
Acoples entre cable del tip y elementos	Transfiere el movimiento al Tip	4.26	Visual	Ex	20	2
Cable de tierra	Conduce sobrecargas hacia malla de tierra	4.27	Visual	B C	5	2
Eje de movimiento del Tip	Permite la extensión del tip	4.28	Visual	Ex	10	2
Ángulo de Aspas	Determina el equilibrio dinámico de las aspas	4.29	Ajuste	Ex	15	2
Superficie del rotor, las aspas y extensiones	Convertir el viento en torque para el rotor	4.30	Limpieza Pintura	C C	180 180	3

Registros del Rotor	Permitir el acceso al rotor	4.31	Visual Socado	B C B C	20 20	2

Parte: Torre

Código: AET-05

Volver

Tabla A.4.5. Manual de Mantenimiento de la Torre

Sub-Parte	Función	Código	Acción	Periodo	Tiempo Estimado (Min)	Técnico
Cables de arnés	Sostiene al técnico en caso de caer	5.1	Visual	B C	20	2
Pernos en la base de la torre	Sujetan la torre al cimiento	5.2	Visual Socado Cambio	B C C Ex	20 40 120	2
Mecanismo de la Puerta Principal	Permiten la apertura y el cierre de la puerta	5.3	Visual Aceite	B C B C	5 5	2
Plataformas de ascenso	Permiten el descanso al subir	5.4	Visual	B C	15	2
Escalera	Medio de ascenso a la góndola	5.5	Visual Socado	B C C	15 40	2
Luces	Permitir la visibilidad en todas condiciones	5.6	Visual	B C	20	2
Extintores	Extinguir fuego dentro de la torre	5.7	Cambio	Ex	30	2
Luz de navegación aérea	Alertar a aeronaves la posición de las torres	5.8	Visual	B C	5	2

Grúa	Elevar herramientas y otros, a la góndola	5.9	Visual Prueba	B C B C	10	2
Contrapeso detrás del Generador	Amortiguar el nivel de vibración	5.10	Visual Prueba	B C	10	2
Compuertas del techo de la góndola	Descubrir la góndola	5.11	Visual	B C	5	2
Costuras laterales soldadas	Unir las placas que conforman la torre	5.12	Visual Prueba	B C Ex	15 180	3
Cimientos de acero y cemento	Afirmar la torre a la tierra	5.13	Prueba	Ex	120	3
Placas o caras de la torre	Formar la estructura de la torre	5.14	Prueba	Ex	180	3
Cables de potencia y separador	Conducir los cables y la electricidad	5.15	Visual	B C	15	2
Collarines de la torre	Unir las etapas de la torre	5.16	Visual	C	25	3
Superficie de la torre	Soportar el peso de la turbina	5.17	Visual Pintura	C C	120 240	3

Parte: Transmisión

Rodamiento principal y Eje

Código: AET-06

Volver

Tabla A.4.6. Manual de Mantenimiento de la Transmisión

Sub-Parte	Función	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Acople del eje principal con la Caja	Transmitir el movimiento	6.1	Socado	C	15	2
Acople del eje principal con el rotor	Transmitir el movimiento	6.2	Socado	C	15	2
Cepillo contra sobrecargas	Desviar sobrecargas a tierra	6.3	Visual	B C	5	2
Rodamiento Principal	Transmitir movimiento del rotor	6.4	Socado	C	20	2
Eje principal	Transmitir movimiento del rotor	6.5	Visual Limpieza	B C B C	5 20	2
Sellos	Aislar los diferentes mecanismos del ambiente	6.6	Visual Engrase	B C	5 20	2
Marco del cubo	Unen el rotor con el rodamiento principal	6.7	Socado	C	20	2

Parte: Sistema de orientación

Código: AET-07

Volver

Tabla A.4.7. Manual de Mantenimiento del Sistema de Orientación

Sub-Parte	Función	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Pastillas del freno de fricción	Aplicar torque de freno	7.1	Visual Calibrar	B C	30	2
Pernos de sujeción del freno	Fijar el freno a la torre	7.2	Socado	C	20	2
Cubierta del freno y sus pernos	Impedir entrada de suciedad al freno	7.3	Visual	B C	5	2
Motores de guiñada	Orientar nacelle	7.4	Visual Socado Lubricado Corrosión	B C C C B C	5 20 20 5	2
Acople interno del motor de guiñada	Transmitir giro del reductor al piñón	7.5				
Protección y contactor del motor	Proteger y energizar motor	7.6	Visual	B	10	2
Caja de conexión eléctrica	Conectan la potencia al motor	7.7	Visual	B	10	2

Piñón de guiñada	Transmite el torque a la corona	7.8	Visual Lubricar	B C B C	5 15	2
Tapa Inferior del piñón	Sostienen el piñón a la altura de la rueda	7.9	Cambio	Ex	40	2
Corona dentada	Mueve la góndola con el torque del piñón	7.10	Visual Lubricar	B C C	5 20	2
Pernos de sujeción del motor	Fijan el motor a la torre	7.12	Visual Resocar	B C C	5 20	2
Disco de freno y sensor	Indicar el giro	7.13	Visual	B	5	2
Cableado de potencia de los motores	Transmite la potencia eléctrica a los motores	7.14	Visual	B	10	2
Pernos o sistema de sujeción de corona	Mantener la corona en posición	7.15	Visual Lubricar Resocar	B C B C C	5 20 25	2

Parte: Paneles de control y sensores

Código: AET-08

Volver

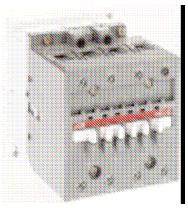
Tabla A.4.8. Manual de Mantenimiento del panel de control y sensores

Sub-Parte	Función	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Barras de los breakers	Transmitir la potencia desde el breaker al trafo	8.1	Monitoreo	Ex	10	2
Aterrizado	Protege el sistema contra descargas	8.2	Visual	Ex	5	2
Contactory contactor auxiliar	Conectan y desconectan la potencia con señales de control	8.3	Visual Alarma	B C	10	2
Fusibles	Proteger los dispositivos contra sobrecarga eléctrica	8.4	Visual Alarma	B C	10	2
Banco capacitivo	Proporciona energía reactiva al generador	8.5	Visual Alarma	B C	10	2
Breakers	Interrumpir la corriente frente a sobrecargas	8.6	Visual Alarma	B C	5	2
Sensores de corriente y voltaje	Sensar los parámetros para disparar alarmas en caso de anomalía	8.7	Visual Alarma	B C	5	2

WP2060	Sincronizar las entradas y salidas de los generadores	8.8	Visual Alarma	B C	5	2
WP3000	Controla el funcionamiento de la turbina	8.9	Visual Cambio	B C Ex	5 120	2
Tiristores	Regula la onda de la señal	8.10	Visual Alarma	B C	5	2
Transformador	Convierte la energía de un voltaje a otro	8.11	Visual Alarma	B C	5	2
Sensores de velocidad	Sensar la velocidad de giro de las máquinas rotativas	8.12	Visual Alarma	B C	5	2
Veletas	Sensar la dirección del viento	8.13	Visual Alarma	B C	5	2
Anemómetros	Sensar la velocidad del viento fuera de la góndola	8.14	Visual Alarma	B C	5	2
Sensor de bola de vibración	Alarmar por nivel excesivo de vibraciones	8.15	Visual Alarma	B C	5	2
Tac 84	Sensar el nivel de vibraciones en la góndola	8.16	Visual Alarma	B C	5	2
Relé SEG	Sacar la turbina de alimentación por frecuencia o voltaje	8.17	Visual Alarma	B C	5	2
PT-100	Sensar la temperatura	8.18	Visual Alarma	B C	5	2

Sensor de compuerta de las escaleras	Impedir el paso de personal no capacitado a la góndola con la turbina energizada	8.19	Visual Alarma	B C	5	2
Sensores de presión hidráulica y en Tips	Sensar la presión	8.20	Visual Alarma	B C	5	2
Sensor de velocidad de guiñada	Sensar la velocidad y la dirección de la guiñada	8.21	Visual Alarma	B C	5	2
Sensor de freno liberado	Alerta cuando el freno mecánico sobre el eje no está aplicado	8.22	Visual Alarma	B C	5	2
Sensor de torsión de cables	Alerta por cables arrollados	8.23	Visual Alarma	B C	5	2
Filtros del panel	Impedir la entrada de polvo	8.24	Cambio	Ex	20	2
Caja de control en la góndola	Energiza diferentes dispositivos	8.25	Visual	Ex	10	2

Parte: Subestación y Malla de Tierra



Código: AET-09

Volver

Tabla A.4.9. Manual de la Subestación y la Malla de Tierra

Sub-Parte	Función	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Interruptor de la Subestación	Interrumpe el alimentador	9.1	Visual	Ex	60	3
Banco y cargador de baterías	Protegen el equipo de control de la subestación	9.2	Visual Medición	Ex Ex	10 30	2
Equipo de Multilin	Monitorea la condición de la subestación	9.3	Visual	Ex	20	2
Aire Acondicionado	Mantiene las condiciones del ambiente	9.4	Visual Cambio	Ex Ex	20 10	2
Maya de tierras	Protege la subestación y fija el neutro	9.5	Prueba	Ex	120	3

Parte: Transformadores

Código: AET-10

Volver

Tabla A.4.10. Manual de Mantenimiento de los Transformadores

Sub-Parte	Función	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Superficie y pintura exterior del Trafo	Proteger los componentes internos del ambiente	10.1	Tratado	Ex 5 años	120	2
Devanados y Armadura del Trafo	Convertir voltajes	10.2	Alarma			
Bujes (bushings)	Sostienen las terminales aislándolos de la caja	10.3	Visual	Ex	20	2
Tanque de de circulación de aceite	Almacena el aceite	10.4	Tratado	Ex 5 años	120	2
Aceite	Medio por el cual se evacua el calor a cierta presión	10.5	Visual Prueba	Ex Ex	10 10	2
Aletas de enfriamiento	Maximizar el área de evacuación de calor del aceite	10.6	Visual	Ex	15	2
Cableado de mediana tensión subterráneo	Transmitir la potencia de los generadores a diferente voltaje hacia la subestación	10.7	Visual	Ex	15	2
Puesta a tierra	Protege las instalaciones contra descargas	10.8	Visual	Ex	10	2

Pernos de sujeción del Trafo al cimiento	Mantener el transformador en posición, inmóvil	10.9	Visual Socado	Ex Ex	10 15	2
Fusibles de las fases	Proteger el transformador contra sobre corriente	10.10	Alarma	Ex	20	2

Parte: Torres de Meteorología

Código: AET-11

Volver

Tabla A.4.11. Manual de Mantenimiento de la Torre

Sub-Parte	Función	*Código*	*Acción*	*Periodo*	*Tiempo estimado (Min)*	*Técnicos*
Estructura	Sostener los dispositivos	11.1	Visual Socado	Ex Ex 6 M	15 20	3
Controlador WP1000	Registrar los datos	11.2	Prueba	Ex 6 M	15	2
Cajas	Proteger los dispositivos	11.3	Visual	Ex 6 M	10	2
Cables de señales	Transportar los datos	11.4	Visual	Ex 6 M	10	2
Anemómetro	Sensar la velocidad del viento	11.5	Visual	Ex 6 M	10	2
Veleta	Sensar la dirección del viento	11.6	Visual	Ex 6 M	10	2
Sensores	Tomar diversas variables	11.7	Visual	Ex 6 M	10	2

Anexo 5: Inspecciones

Tabla A.5.1. Hojas de inspección del Generador B, C, EX

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**B**

Máquina AEROGENERADOR	**Parte** Generador	**Código** AE-T01-01

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Generador			
01 P1	Revisión de los colectores de grasa y los sellos del Generador. Anotación:			
02 P1	Revisión de las conexiones de la caja del generador. Anotación:			
03 P2	Chequeo de protecciones, los contactores y los dispositivos eléctricos Anotación:			
04	Búsqueda de muestras de corrosión o deterioro. Limpieza Anotación:			
	Subparte Cables			
05	Revisión del deterioro del cableado a lo largo de la turbina. Anotación:			
	Subparte Radiador			
06	Búsqueda de deterioro en tapa de radiador y las uniones de mangueras Anotación:			
07	Control de la cantidad de coolant: Anotación:			
08	Revisión y limpieza de las rejillas y serpentines del radiador: Anotación:			
	Subparte Mangueras y uniones			
09	Revisión general de fugas, corrosión y problemas en las uniones. Anotación:			
	Subparte Acople del lado del generador			
10	Problemas de desbalanceo y estado general de los acoples Anotación:			

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**C**

Máquina AEROGENERADOR	**Parte** Generador	**Código** AE-T01-01

Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok**	**X**
	Subparte Generador			
01 P1	Revisión de los colectores de grasa y los sellos del Generador. Anotación:			
02 P1	Revisión de las conexiones de la caja del generador. Anotación:			
03 P2	Chequeo de las protecciones térmicas, los contactores y otros Anotación:			
04	Búsqueda de muestras de corrosión o deterioro. Limpieza Anotación:			
05	Revisión, ajuste de amortiguador de soporte. M24 – 8.8 y 390 Nm Anotación:			
	Subparte Cables			
06	Revisión del deterioro del cableado a lo largo de la turbina. Anotación:			
	Subparte Radiador			
07	Búsqueda de deterioro en tapa de radiador y las uniones de mangueras Anotación:			
08	Control de la cantidad de coolant: Anotación:			
09	Revisión y limpieza de las rejillas y serpentines del radiador: Anotación:			
	Subparte Mangueras y uniones			
10	Revisión general de fugas, corrosión y problemas en las uniones. Anotación:			
	Subparte Acople del lado del generador			
11	Problemas de desbalanceo y estado general de los acoples. Ajuste de los pernos en los acoples Anotación:			

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Ex

Máquina AEROGENERADOR	**Parte** Generador	**Código** AE-T01-01

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Generador			
01 P3	Análisis de Vibraciones mensual Anotaciones:			
02 P1	Lubricación de los rodamientos y chequeo de los colectores de grasa. Mobiltemp SHC 100, 60 gr. Cada 3000 h. Anotación:			
03	Revisión de la temperatura de los rodamientos: con ello se puede complementar el monitoreo del estado de los rodamientos. Cada mes. Temperatura estándar es de 60 °C Anotación:			
04	Pruebas de desempeño eléctrico. Curva de potencia, monitoreo de corriente, inspección de devanados. Cada 5 años. Anotación:			
	Subparte Eje			
05 P1	Limpieza y búsqueda de corrosión en el eje. Con el Service B. Anotación:			
	Subparte Bomba de agua			
06	Revisión de fugas. Con el Service B. Anotación:			
07	Revisión y ajuste de las bases y sus pernos. Con el Service B. Anotación:			
08	Revisión del grado de corrosión. Con el Service B Anotación:			
09 P4	Revisión del motor y sus conexiones. Con el Service B Anotación:			
10 P2	Revisión de los elementos térmicos, contactores, auxiliares. Con el Service B. Anotación:			

Tabla A.5.2. Hoja de inspección Freno de Disco B, C, Ex

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Máquina AEROGENERADOR	**Parte** Freno de disco	**Código** AE-T01-02

Número	**Inspección** **Hora de inicio:** **Hora de salida:**	**T (min)**	**Ok**	**X**
	Subparte Disco y Pastillas			
01 P1	Revisión de la superficie del disco Anotación:			
02 P1	Revisión y ajuste de las pastillas del disco y el sensor Anotación:			
	Subparte Bomba			
03 P3	Revisión del estado de los rodamientos, estado del acople, estado de los sellos, alineación del eje, estado del impeller (Verla trabajando). Anotación:			
04	Revisión de fugas. Anotación:			
05 P4	Revisión del nivel de aceite con la bomba apagada. Anotación:			
06	Revisar el estado de la corrosión en todos los dispositivos de freno. Anotación:			
	Subparte Acople			
07 P1	Revisar y ajustar alineación. Socar tornillos Anotación:			

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**C**

Máquina AEROGENERADOR	**Parte** Freno de disco	**Código** AE-T01-02

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Disco y pastillas			
01 P1	Revisión de la superficie del disco. Anotaciones:			
02 P1	Revisión, ajuste de alineación de la pastilla con disco. Anotación:			
	Subparte Armadura			
03 P1	Ajustar los pernos, las tuercas y soportes de todo el mecanismo Anotación:			
04 P1	Resocar los pernos del disco de apriete Anotación:			
	Subparte Bomba			
05 P1	Revisión del estado de los rodamientos, estado del acople, estado de los sellos, alineación del eje, estado del impeller (Verla trabajando con el Generador apagado). Anotación:			
06 P3	Revisión de fugas. Anotación:			
07 P4	Revisión del nivel de aceite con la bomba apagada. Anotación:			
	Subparte Todo el conjunto del freno			
08	Probar el freno. Anotación:			
09	Revisar el estado de la corrosión en todos los dispositivos de freno. Anotación:			

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**Ex**
Máquina AEROGENERADOR	**Parte Freno de disco**	**Código** AE-T01-02

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Pistón			
01	Revisión de sellos y obstrucciones. Cada tres años. Anotaciones:			
02	Cambio de la pastilla con el disparo de una alarma			
	Subparte Bomba			
03 P4	Revisión y ajuste de las bases y sus pernos. Revisión del grado de corrosión general. Con service B. Anotación:			
04 P4	Revisión del motor y sus conexiones. Con service B Anotación:			
05 P4	Pruebas al aceite de freno Hydro TL 15. Cada 2 años. Anotación:			
06 P4	Cambio del líquido de freno Hydro TL 15. Cada 5 años. Anotación:			
07 P2	Revisión de protección térmica, contactores, auxiliares Con Service B. Anotación:			
	Subparte Parte eléctrica			
08 P1	Revisión de las electroválvulas. Con service B Anotación:			
	Subparte Acumuladores			
09	Revisión de la superficie de los acumuladores. Con service B. Anotación:			
	Subparte Anclaje en posición Y			
10	Revisión del estado del anclaje. Con service B. Anotación:			

Tabla A.5.3. Hoja de inspección de la Caja Multiplicadora B, C, Ex

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Máquina AEROGENERADOR	**Parte** Caja Multiplicadora	**Código** AE-T01-03

Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok X**
	Subparte Engranes y los rodamientos de la Caja		
01 P1	Inspección visual de dientes: picaduras, marcas, virutas, lubricación. Anotaciones:		
02 P1	Toma de muestra de Aceite para Análisis. Anotación:		
	Subparte Caja		
03 P4	Revisión del nivel de aceite. Con la turbina y la bomba detenida. no puede estar a más o a menos de dos centímetros de la raya Anotación:		
04 P1	Revisión y ajuste de los pernos y amortiguadores de la caja. Anotación:		
05 P1	Resocado de pernos del acople con el Eje Principal		
06 P1	Revisión del estado de los sellos de la Caja. Anotación:		
07	Revisar el estado de la corrosión y la pintura de la caja. Anotación:		
	Subparte Bomba Hydac		
08 P1	Revisión del estado de los rodamientos, estado del acople, estado de los sellos, alineación del eje, estado del impeller (Verla trabajando). Anotación:		
09	Revisión y ajuste de las bases y sus pernos. Anotación:		
10	Revisión del grado de corrosión. Anotación:		
	Subparte Radiador		
11	Revisión de deterioro de los sellos, tapa, uniones de las mangueras Anotación:		

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**C**

Máquina AEROGENERADOR	**Parte** Caja Multiplicadora	**Código** AE-T01-03

Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok X**
	Subparte Engranes y los rodamientos de la Caja		
01 P1	Inspección visual de dientes: picaduras, marcas, virutas, lubricación. Anotaciones:		
02 P1	Toma de Aceite. Análisis de aceite. Toma de una muestra de aceite. Anotación:		
	Subparte Caja		
03 P4	Visual. Revisión del nivel de aceite. Con la turbina y la bomba detenida. No puede estar a más o a menos de dos centímetros de la raya Anotación:		
04 P1	Ajuste. Revisión y ajuste de los pernos y amortiguadores de la caja. Anotación:		
05	Visual. Revisión del estado de los sellos de la Caja. Anotación:		
06	Visual. Revisar el estado de la corrosión y la pintura de la caja. Anotación:		
	Subparte Bomba Hydac		
07 P1	Visual, Auditivo. Revisión del estado de los rodamientos, estado del acople, estado de los sellos, alineación del eje, estado del impeller (Verla trabajando). Anotación:		
08	Revisión y ajuste de las bases y sus pernos. Anotación:		
09	Revisión del grado de corrosión. Anotación:		
	Subparte Radiador		
10	Revisión de deterioro de los sellos, tapa, uniones de las mangueras Anotación:		

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**Ex**

Máquina AEROGENERADOR	**Parte** Caja Multiplicadora	**Código** AE-T01-03

Número	Inspección Hora de inicio: Hora de salida:	T	Ok X
	Subparte Engranes y los rodamientos de la Caja		
01	Análisis de vibraciones. Mensual. Anotaciones:		
02 P1	Revisión de viruta en el fondo del contenedor cada cambio de filtro. Anotación:		
	Subparte Caja		
03 P4	Cambio de aceite. Anotación:		
	Subparte Bomba Hydac		
04 P3	Revisión de fugas. Cada Service B Anotación:		
05 P4	Revisión del motor y sus conexiones. Cada service B. Anotación:		
06 P2	Revisión de los elementos térmicos, contactores, contactores auxiliares Cada service B. Anotación:		
	Subparte Mangueras, juntas y válvula manual y válvula térmica		
07	Revisión de corrosión, uniformidad del material y fugas en mangueras. Cada service B. Anotación:		
08	Revisión de válvulas y electroválvulas. abrir y cerrar. Cada Service B. Anotación:		
09	Revisión del funcionamiento de válvula térmica de By –pass Wahlen. Anotación:		
	Subparte Radiador		
10	Revisión y limpieza de las rejillas, del motor y serpentines del radiador. Cada service B. Anotación:		
11 P4	Revisión de conexiones del motor de ventilador. protección y contactor Cada service B. Anotación:		

Tabla A.5.4. Hoja de inspección Rotor, Estación, Tip, Aspa B, C, Ex

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Máquina AEROGENERADOR	**Parte** Rotor, Estación, Tip, Aspa		**Código** AE-T01-04	
Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok**	**X**
	Subparte Marcos de todo el conjunto			
01 P5	Revisar el deterioro de los marcos metálicos que sujetan la *estación hidráulica*, del *marco del acumulador*, del *marco del pistón*, del *cubo* en general y las extensiones. Anotación:			
	Subparte Estación Hidráulica			
02 P5	Revisar el deterioro de mangueras y uniones. Resocar uniones. Revisar fugas generales. Revisar estado de acumuladores, del pistón. Anotación:			
03 P5	Revisar la conexión de la tierra del pistón. Anotación:			
04	Revisar la presión. La presión debe rondar por 80 bar Anotación:			
05 P5	Revisar la firmeza del sensor de presión, las tapas de aceite y la electroválvula Anotación:			
06 P5	Revisión de la caja de conexiones			
	Subparte Slip Rings			
07 P3	Revisión de los Slip. Verificar que todos los datos de la estación hidráulica se comunican con el parque. Verificar el funcionamiento mecánico Anotación:			
	Subparte Funcionamiento General			
08 P5	Debe probarse desde el rotor cada uno de los tips, sacando y retrayendo el mecanismo Anotación:			

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Máquina AEROGENERADOR	**Parte** Rotor, Estación, Tip, Aspa	**Código** AE-T01-04

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Tornillos y Marcos			
01 P5	Resocar los tornillos de a) la Estación al rotor, b) Cubo al eje, c) Cubo a las extensiones, d) Marco del pistón, e) caja de registro en aspa, f) registro de rotor Anotación:			
02 P5	Revisar corrosión de marcos metálicos de a) estación b) marco de acumulador, c) marco de pistón, d) cubo Anotación:			
	Subparte Estación Hidráulica			
03 P5	Revisar deterioro en manguera, acumulador, pistón. Anotación:			
04 P5	Revisar la conexión de la tierra del pistón. Anotación:			
05	Revisar la presión. Anotación:			
06 P5	Revisar firmeza de sensor de presión, válvulas, tapas. Anotación:			
	Subparte Slip Ring			
07 P3	Revisión de los Slip Ring. Comunicación de datos. Anotación:			
	Subparte Aspa y rotor			
08 P6	Limpiar las aspas y el rotor y retocar la pintura. Anotación:			
09 P6	Revisar con galga las aletas metálicas.			
	Subparte Funcionamiento general			
10 P6	Debe probarse desde el rotor cada uno de los tips. Anotación:			

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Máquina AEROGENERADOR	**Parte** Rotor, Estación, Tip, Aspa	**Código** AE-T01-04

Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok**	**X**
	Subparte Estación Hidráulica			
01 P5	Cambiar el pistón cada 5 años. Cambiar sellos y revisar el bástago. Anotaciones:			
02 P5	Cambio de aceite. Se puede probar un cambio de aceite cada 5 años. Anotación:			
	Subparte Tip			
03 P6	Revisar el cable del Tip desde el registro del aspa cada 4 años. No reventaduras. Firmeza en la unión de los hilos. Anotación:			
04 P6	Revisar manualmente que el mecanismo del Tip funcione desde la caja del tip, bajando y subiendo el tip Anotación:			
05 P6	Lubricar el piñón helicoidal que permite el giro del tip cada 4 años desde el registro. Anotación:			
06 P6	Cambiar los conos de Nylon cada 3 años. Anotación:			
07 P5	Revisión del eje del aspa. Cada vez que se inspeccione el aspa. Anotación:			
08 P5	Ajuste del ángulo del aspa desde el rotor. Anotación:			

Tabla A.5.5. Hoja de inspección de la torre B, C, Ex

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**B**

Máquina AEROGENERADOR	**Parte** Torre	**Código** AE-T01-05

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Escaleras			
01 P7	Resocar, revisar la estructura, sujeción, agarre de escalera. Anotación:			
	Subparte Accesorios			
02 P7	Revisar uniformidad y sujeción en extremos de arnés. Anotación:			
03 P1	Revisar funcionamiento de grúa sin atascarse. Deterioro Anotación:			
04 P7	Revisar interruptores, luz de navegación, luces, cables Anotación			
05 P1	Revisar que el movimiento lateral del contrapeso sea leve Anotación:			
06 P7	Revisar que cables estén unidos al separador, sin fisuras Anotación:			
	Subparte Cerrojos de puerta, compuertas del nacelle, plataformas			
07	Revisar y aceitar el mecanismo del cerrojo Anotación:			
08 P1	Revisar pines de cierre, prensas, brazos de las compuertas Anotación:			
09 P1	Resocar y revisar plataformas y tapas. Firmes y sin soltura. Anotación:			
	Subparte Costuras soldadas y superficie de la torre			
10 P1	Analizar las costuras, revisarlas visualmente. Anotación:			
11 P6	Revisar corrosión y pintar las torres en puntos corroídos. Anotación:			

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**C**

Máquina AEROGENERADOR	**Parte** Torre	**Código** AE-T01-05

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Escaleras			
01 P7	Resocar tuercas, estructura, sujeción con torre. Agarre Anotación:			
	Subparte Accesorios			
02 P7	Revisar cable de arnés. Uniforme y sujeto en extremos Anotación:			
03 P1	Revisar que grúa no atasque. Deterioro. Anotación:			
04 P7	Revisar cobertor, contacto, fluorescente, cables. Revisar unión de cable con separador y su deterioro. Anotación			
05 P1	Revisar que movimiento lateral de contrapeso sea leve Anotación:			
06 P1	Resocar todos los pernos. Revisar corrosión. Revisar la posición, sujeción, deterioro de collarines. Anotación:			
	Subparte Puerta, compuertas de nacelle, plataformas y tapas			
07	Revisar y aceitar el mecanismo del cerrojo Anotación:			
08 P1	Revisar pin de cierre, las prensas del techo del nacelle Anotación:			
09 P1	Resocar, revisar plataforma y tapa. Firmes. Anotación:			
	Subparte Costuras soldadas y superficie de la torre			
10 P1	Analizar las costuras, revisarlas visualmente. Revisar corrosión y pintar las torres por corrosión. Anotación:			

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Máquina AEROGENERADOR	**Parte** Torre	**Código** AE-T01-05

Número	**Inspección** **Hora de inicio:** **Hora de salida:**	**T (min)**	**Ok**	**X**
	Subparte Extintores			
01	Rellenar los extinguidores. Los extintores deben ser rellenados cada año. Anotaciones:			
	Subparte Costuras y estructura			
02	Analizar las costuras, los cimientos y la estructura por Técnicas No Destructivas. Cada 5 años. Anotación:			
03	Pintura de la torre por corrosión. Revisar cada 3 años.			
	Subparte Pernos de la base			
04	Cambio de los pernos de la base de la torre. Cada 4 años.			

Tabla A.5.6. Hoja de inspección Transmisión B, C

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**B**
Máquina AEROGENERADOR	**Parte** Transmisión	**Código** AE-T01-06

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Rodamiento y eje principal			
01 P1	Engrasar y ajustar los sellos. Anotaciones:			
02 P1	Revisar el estado de la pintura e indicios de corrosión. Anotación:			
03 P1	Ajustar la escobilla contra sobrecargas eléctricas. Anotación:			

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Máquina AEROGENERADOR	**Parte** Transmisión	**Código** AE-T01-06

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Rodamiento y eje principal			
01 P1	Engrasar y ajustar los sellos. Anotaciones:			
02 P1	Revisar el estado de la pintura e indicios de corrosión. Anotación:			
03 P1	Ajustar la escobilla contra sobrecargas eléctricas. Anotación:			
04 P1	Revisar y resocar los tornillos de los extremos del eje. Anotación:			
05 P1	Revisar y resocar los tornillos de los marcos y los cimientos del Bearing Anotación:			
06 P1	Limpieza del eje y del rodamiento. Anotación:			
07 P1	Resocado de acoples del rotor con el rodamiento y del eje con la caja			

Tabla A.5.7. Hoja de inspección de Guiñada B, C, Ex

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**B**

Máquina AEROGENERADOR	**Parte** Sistema de guiñada	**Código** AE-T01-07

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Frenos de guiñada			
01 P4	Revisar y calibrar la alineación del freno y del sensor de velocidad. Anotación:			
02 P4	Revisar y calibrar el juego de los rodamientos Anotación:			
03 P4	Revisar sellos del freno, que no estén deteriorados. Anotación:			
04 P1	Control de corrosión y lubricación de los dientes Anotación:			
05 P4	Lubricación del freno. Anotaciones:			
	Subparte Corona			
06 P4	Revisar y controlar los sellos de corona. Anotación:			
07 P1	Revisar corrosión en dientes de corona. Lubricar Anotación:			
08 P1	Engrasar la corona Anotación:			
	Subparte Motores de guiñada			
09 P1	Revisar corrosión en dientes. Lubricar los dientes. Anotación:			
10 P1	Revisar el estado de la pintura y la corrosión. Anotación:			
11 P4	Revisión de los sellos, las conexiones, cable, contactor, protección. Anotación:			

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Máquina AEROGENERADOR	**Parte** Sistema de guiñada	**Código** AE-T01-07

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Frenos de guiñada			
01 P4	Revisar y calibrar alineación del freno y del sensor Anotación:			
02 P4	Revisar y calibrar el juego de los rodamientos Anotación:			
03 P4	Revisar el deterioro de los sellos del freno. Control de la corrosión y la lubricación de dientes Anotación:			
04 P1	Lubricación del freno. Anotación:			
05 P1	Revisar y ajustar el juego de los dientes del freno Anotación:			
06 P1	Revisar y resocar tornillos de sujeción del freno Anotación:			
	Subparte Corona			
07 P4	Revisar y resocar la sujeción de la corona. Revisar corrosión en dientes de corona. Lubricar. Revisar y controlar sellos de corona. Engrasar Anotación:			
	Subparte Motores de Guiñada			
08 P4	Revisar y resocar los tornillos fijadores del motor. Anotación:			
09 P4	Revisar el nivel de aceite del reductor del motor Anotación:			
10 P4	Revisar, lubricar en dientes. Revisar sellos Anotación:			
11 P4	Revisar el estado de la pintura y la corrosión Anotación:			

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Máquina AEROGENERADOR	**Parte** Sistema de guiñada	**Código** AE-T01-07

Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok**	**X**
	Subparte Motor de guiñada			
01 P4	Lubricar el motor cada 3 años. Anotación:			
02 P1	Cambio de tornillos de la tapa inferior de los dientes de guiñada cada 3 años Anotación:			

Tabla A.5.8. Hoja de inspección de paneles de control y sensores B, C, Ex

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**B**

Máquina AEROGENERADOR	**Parte** Paneles de control y sensores	**Código** AE-T01-08

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Sensores			
01 P2 P4	Revisión y chequeo de funcionamiento de los sensores de a) sensor de torsión en cables, b)sensores de RPM, c) sensor de vibración, d)desgaste en las pastillas de freno, e) veletas, f)anemómetro, g) sensores de temperatura, h)sensor de guiñada, i) botón de switch general. Anotación:			
02 P2 P4	Revisión y chequeo en el resto de los sensores Anotación:			
	Subparte Controladores y paneles			
03 P4	Revisión de las terminales de las conexiones, contactores y dispositivos del panel. Anotación:			
04 P2	Revisión de las fuentes y los dispositivos de poder del tablero. Anotación:			
	Subparte Estructura			
05 P7	Revisión de los separadores de los cables de potencia. Anotación:			

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Máquina AEROGENERADOR	**Parte** Paneles de control y sensores	**Código** AE-T01-08

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Sensores			
01 P2 P4	Revisión y chequeo de funcionamiento de los sensores de a) sensor de torsión en cables, b)sensores de RPM, c) sensor de vibración, d)desgaste en las pastillas de freno, e) veletas, f)anemómetro, g) sensores de temperatura, h)sensor de guiñada, i) botón de switch general. Anotación:			
02 P2 P4	Revisión y chequeo en el resto de los sensores Anotación:			
	Subparte Controladores y paneles			
03 P4	Revisión de las terminales de las conexiones, contactores y dispositivos. Anotación:			
04 P2	Revisión de las fuentes y los dispositivos de poder del tablero. Anotación:			
	Subparte Estructura			
05 P7	Revisión de los separadores de los cables de potencia Anotación:			

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**Ex**

Máquina AEROGENERADOR	**Parte** Paneles de control y sensores	**Código** AE-T01-08

Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok**	**X**
	Subparte Controladores y paneles			
01 P4	Cambio de WP3000 cada 3 años. Anotación:			
02 P4	Revisión de las conexiones y los switches en las cajas de control de la góndola. Cada Service B Anotación:			
03 P4	Revisión de la conexión a tierra. Cada Service B Anotación:			
	Subparte Estructura			
04 P4	Cambio de filtros de los ventiladores en los paneles de control. Cada Service B. Anotación:			

Tabla A.5.9. Hoja de inspección Subestación y malla de tierra Ex

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**Ex**
Máquina AEROGENERADOR	**Parte** Subestación y Malla de Tierra	**Código** AE-09

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Interruptores			
01 P8	Revisión del desgaste de los contactos interruptivos Cada 2 años. Anotación:			
	Subparte Baterías			
02 P9	Lavar vent plugs batería con agua, secar. Cada 2 años Anotación:			
03	Medir a) niveles de electrolitos, b) el voltaje (El voltaje en terminales debe ser N x U, donde N es el número de baterías conectadas y U es el voltaje de flotación por celda), c) gravedad específica d) temperatura. Mensual. Anotación:			
	Subparte Multilin y los sensores en la Subestación			
04 P10	Revisar de las conexiones, el cableado. Cada dos años. Revisar consistencia de datos de multilin con Turbinas. Anotación:			
	Subparte Acondicionamiento del aire			
05	Limpiar filtros de aire acondicionado. Cada mes. Revisar Equipo Compacto de aire acondicionado. Anotación:			
06	Revisión de humedad. Mensual Anotación:			
	Subparte Maya			
07	Toma de mediciones y diagnóstico. Revisar deterioro. Anual. Anotación:			

Tabla A.5.10. Hoja de inspección de Transformadores Ex

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**Ex**
Máquina AEROGENERADOR	**Parte** Transformadores	**Código** AE-T01-10

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Fusibles			
01 P4	Cambiar fusibles de fase cuando se dispara una alarma. Anotación:			
	Subparte Armazón del transformador			
02 P4	Retoque de la pintura cada 5 años Anotación:			
03	Inspeccionar visualmente en busca de fugas. Mensual. Anotación:			
04	Reafirmado de anclajes de Transformador al cimiento Mensual. Anotación:			
	Subparte Parte eléctrica			
05 P10	Puntos calientes en terminales del transformador. Mensual. Anotación:			
06 P10	Revisión de cableado, dispositivos, maya a tierra. Anual Anotación:			
07 P10	Revisión del cableado de mediana tensión. Anual Anotación:			
	Subparte Aceite			
08 P10	Análisis de aceite. Anual. Anotación:			
09 P10	Verificar presión y temperatura de operación en plena carga. La presión puede ser + 1 bar o – 1 bar. Mensual. Anotación:			

Tabla A.5.11. Hoja de inspección de la Torre de Meteorología Ex

Empresa AEROENERGIA
Departamento de Mantenimiento

HOJA DE INSPECCION

Ex

Mantenimiento Preventivo

Máquina AEROGENERADOR	**Parte** Torre de meteorología	**Código** AE -11

Número	Inspección Hora de inicio: Hora de salida:	T (min)	Ok	X
	Subparte Sensores, cajas y los cables			
01 P10	Revisión y lubricación de los sensores móviles con rodamientos cada 6 meses Anotación:			
02 P10	Revisar el estado de los cables y las cajas, su desgaste y corrosión cada 6 meses. Anotación:			
	Subparte Controladores WP1000			
03	Entrevistar el controlador para corroborar que está funcionando bien. Corroborar que la comunicación está en buen estado. Cada 6 meses. Anotación:			
04 P10	Revisar que los cables estén firmemente conectados. Cada 6 meses Anotación:			
05 P10	Revisar visualmente el interior del controlador. No deben verse dispositivos corroídos o parcialmente quemados. Cada 6 meses Anotación:			
	Subparte Estructura			
06 P10	Revisión de la corrosión y la pintura cada 6 meses Anotación:			
07	Resocar las tuercas de los cimientos, verificar las soldaduras, resocar y verificar el estado de los anclajes y los cables. Cada 6 meses Anotación:			

Tabla A.5.12. Hoja de inspección de Inspecciones generales B

Empresa AEROENERGIA Mantenimiento Preventivo	HOJA DE INSPECCION	**B**

Máquina AEROGENERADOR	**Parte** Inspecciones generales	**Código** AE-T01-12

Número	**Inspección Hora de inicio: Hora de salida:**	**T (min)**	**Ok**	**X**
01	Corroborar que la góndola se posicione de cara a la dirección del viento. Visualmente Anotación:			
02	Revizar el nivel y el tipo de ruido y vibración de las máquinas trabajando. Auditivo. Anotación:			
03	Revizar el frenado de disco como único dispositivo de frenado. Anotación:			
04	Revizar el frenado aerodinámico como único dispositivo de frenado. Anotación:			
05	Controlar e imprimir los setpoints. Anotación:			
06	Imprimir los errores Anotación:			
07	Imprimir la curva de potencia Anotación:			

Anexo 6: Gantt para el año 2004

Gantt 2004: Inspecciones tipo B y Ex

Volver

AEROENERGIA S.A.

MANTENIMIENTO PREVENTIVO

Nota:

GANTT ANUAL 2004

INSPECCIONES				JULIO				AGOSTO				SETIEMBRE				OCTUBRE				NOVIEMBRE				DICIEMBRE			
Inspección	Per	Fre	Dur	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
AE-T01-01 B	B	2	150									150																	
AE-T02-01 B	B	2	150									150																	
AE-T03-01 B	B	2	150									150																	
AE-T04-01 B	B	2	150									150																	
AE-T05-01 B	B	2	150									150																	
AE-T06-01 B	B	2	150									150																	
AE-T07-01 B	B	2	150									150																	
AE-T08-01 B	B	2	150									150																	
AE-T09-01 B	B	2	150									150																	
AE-T01-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T01-01 Ex: 05-10	B	2	60									60																	
AE-T02-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T02-01 Ex: 05-10	B	2	60									60																	
AE-T03-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T03-01 Ex: 05-10	B	2	60									60																	
AE-T04-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T04-01 Ex: 05-10	B	2	60									60																	
AE-T05-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T05-01 Ex: 05-10	B	2	60									60																	
AE-T06-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T06-01 Ex: 05-10	B	2	60									60																	
AE-T07-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T07-01 Ex: 05-10	B	2	60									60																	
AE-T08-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T08-01 Ex: 05-10	B	2	60									60																	
AE-T09-01 Ex: 01, 03,	M	12	120	120				120					120				120				120				120				
AE-T09-01 Ex: 05-10	B	2	60									60																	
AE-T01-02 B	B	2	80									80																	
AE-T02-02 B	B	2	80									80																	
AE-T03-02 B	B	2	80									80																	
AE-T04-02 B	B	2	80									80																	
AE-T05-02 B	B	2	80									80																	
AE-T06-02 B	B	2	80									80																	
AE-T07-02 B	B	2	80									80																	
AE-T08-02 B	B	2	80											80															
AE-T09-02 B	B	2	80											80															
AE-T01-02 Ex	B	2	60											60															
AE-T02-02 Ex	B	2	60											60															
AE-T03-02 Ex	B	2	60											60															
AE-T04-02 Ex	B	2	60											60															
AE-T05-02 Ex	B	2	60											60															
AE-T06-02 Ex	B	2	60											60															
AE-T07-02 Ex	B	2	60											60															
AE-T08-02 Ex	B	2	60											60															
AE-T09-02 Ex	B	2	60											60															
AE-T01-03 B	B	2	120											120															
AE-T02-03 B	B	2	120											120															
AE-T03-03 B	B	2	120											120															
AE-T04-03 B	B	2	120											120															
AE-T05-03 B	B	2	120											120															
AE-T06-03 B	B	2	120											120															
AE-T07-03 B	B	2	120											120															
AE-T08-03 B	B	2	120											120															
AE-T09-03 B	B	2	120											120															
AE-T01-03 Ex: 04-08, 10, 11	B	2	60												60														
AE-T02-03 Ex: 04-08, 10, 12	B	2	60												60														
AE-T03-03 Ex: 04-08, 10, 13	B	2	60												60														
AE-T04-03 Ex: 04-08, 10, 14	B	2	60												60														
AE-T05-03 Ex: 04-08, 10, 15	B	2	60												60														
AE-T06-03 Ex: 04-08, 10, 16	B	2	60												60														
AE-T07-03 Ex: 04-08, 10, 17	B	2	60												60														
AE-T08-03 Ex: 04-08, 10, 18	B	2	60												60														
AE-T09-03 Ex: 04-08, 10, 19	B	2	60												60														
AE-T01-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T02-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T03-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T04-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T05-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T06-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T07-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T08-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T09-03 Ex: 01	M	12	10	10				10				10				10				10				10				10	
AE-T01-04 B	B	2	60												60														
AE-T02-04 B	B	2	60												60														
AE-T03-04 B	B	2	60												60														
AE-T04-04 B	B	2	60												60														
AE-T05-04 B	B	2	60												60														
AE-T06-04 B	B	2	60												60														
AE-T07-04 B	B	2	60												60														
AE-T08-04 B	B	2	60												60														
AE-T09-04 B	B	2	60												60														
AE-T01-04 Ex: 07, 08	B	2	60												60														
AE-T02-04Ex: 07,08	B	2	60												60														
AE-T03-04 Ex: 07,08	B	2	60												60														
AE-T04-04 Ex: 07,08	B	2	60												60														
AE-T05-04 Ex: 07,08	B	2	60												60														
AE-T06-04 Ex: 07,08	B	2	60												60														
AE-T07-04 Ex: 07,08	B	2	60												60														
AE-T08-04 Ex: 07,08	B	2	60												60														
AE-T09-04 Ex: 07,08	B	2	60												60														
AE-T01-05 B	B	2	80													80													
AE-T02-05 B	B	2	80													80													
AE-T03-05 B	B	2	80													80													
AE-T04-05 B	B	2	80													80													
AE-T05-05 B	B	2	80													80													
AE-T06-05 B	B	2	80													80													
AE-T07-05 B	B	2	80													80													
AE-T08-05 B	B	2	80													80													
AE-T09-05 B	B	2	80													80													
AE-T01-06 B	B	2	10													10													
AE-T02-06 B	B	2	10													10													
AE-T03-06 B	B	2	10													10													
AE-T04-06 B	B	2	10													10													
AE-T05-06 B	B	2	10													10													
AE-T06-06 B	B	2	10													10													
AE-T07-06 B	B	2	10													10													
AE-T08-06 B	B	2	10													10													
AE-T09-06 B	B	2	10													10													
AE-T01-07 B	B	2	90													90													
AE-T02-07 B	B	2	90													90													
AE-T03-07 B	B	2	90													90													
AE-T04-07 B	B	2	90													90													
AE-T05-07 B	B	2	90													90													
AE-T06-07 B	B	2	90													90													
AE-T07-07 B	B	2	90													90													
AE-T08-07 B	B	2	90													90													
AE-T09-07 B	B	2	90													90													
AE-T01-08 B	B	2	40														40												
AE-T02-08 B	B	2	40														40												
AE-T03-08 B	B	2	40														40												
AE-T04-08 B	B	2	40														40												
AE-T05-08 B	B	2	40														40												
AE-T06-08 B	B	2	40														40												
AE-T07-08 B	B	2	40														40												
AE-T08-08 B	B	2	40														40												
AE-T09-08 B	B	2	40														40												
AE-T01-08 Ex: 02-04	B	2	20														20												
AE-T02-08 Ex: 02-04	B	2	20														20												
AE-T03-08 Ex: 02-04	B	2	20														20												
AE-T04-08 Ex: 02-04	B	2	20														20												
AE-T05-08 Ex: 02-04	B	2	20														20												
AE-T06-08 Ex: 02-04	B	2	20														20												
AE-T07-08 Ex: 02-04	B	2	20														20												
AE-T08-08 Ex: 02-04	B	2	20														20												
AE-T09-08 Ex: 02-04	B	2	20														20												
AE-09 Ex: 03, 05, 06	M	12	60				60				60							60				60				60			
AE-T01-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T02-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T03-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T04-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T05-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T06-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T07-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T08-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-T09-10 Ex: 03-05, 09	M	12	30				30				30							30				30				30			
AE-11 Ex	B	2	120															120											
AE-T01-12 B	B	2	40															40											
AE-T02-12 B	B	2	40															40											
AE-T03-12 B	B	2	40															40											
AE-T04-12 B	B	2	40															40											
AE-T05-12 B	B	2	40															40											
AE-T06-12 B	B	2	40															40											
AE-T07-12 B	B	2	40															40											
AE-T08-12 B	B	2	40															40											
AE-T09-12 B	B	2	40															40											
Disponibilidad				1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Programado				1170	0	0	330	1170	0	0	330	1710	1760	1780	1620	1710	1620	810	0	90	1080	330	0	90	1080	330	0	90	0
Diferencia				630	1800	1800	1470	630	1800	1800	1470	90	40	20	180	90	180	990	1800	1710	720	1470	1800	1710	720	1470	1800	1710	1800

Nota: La programación del Gantt se realizó estimando la disponibilidad de un solo técnico que trabaja 6 horas.

No obstante, en la Empresa Aeroenergía existen 3 técnicos y trabajan 8 horas por día.

Este tipo de estimación fue necesario para evitar repercusiones por ausencia de algunos técnicos,

falta de disponibilidad de herramientas o piezas, asignación repentina de tareas correctivas o la

necesidad de un técnico para otras labores.

CALENDARIO 2004

ENERO

SEMANA	D	L	K	M	J	V	S
					1	2	3
1	4	5	6	7	8	9	10
2	11	12	13	14	15	16	17
3	18	19	20	21	22	23	24
4	25	26	27	28	29	30	31

FEBRERO

SEMANA	D	L	K	M	J	V	S
5	1	2	3	4	5	6	7
6	8	9	10	11	12	13	14
7	15	16	17	18	19	20	21
8	22	23	24	25	26	27	28
9	29						

MARZO

SEMANA	D	L	K	M	J	V	S
9		1	2	3	4	5	6
10	7	8	9	10	11	12	13
11	14	15	16	17	18	19	20
12	21	22	23	24	25	26	27
13	28	29	30	31			

ABRIL

SEMANA	D	L	K	M	J	V	S
13					1	2	3
14	4	5	6	7	8	9	10
15	11	12	13	14	15	16	17
16	18	19	20	21	22	23	24
17	25	26	27	28	29	30	

MAYO

SEMANA	D	L	K	M	J	V	S
17							1
18	2	3	4	5	6	7	8
19	9	10	11	12	13	14	15
20	16	17	18	19	20	21	22
21	23	24	25	26	27	28	29
22	30	31					

JUNIO

SEMANA	D	L	K	M	J	V	S
22			1	2	3	4	5
23	6	7	8	9	10	11	12
24	13	14	15	16	17	18	19
25	20	21	22	23	24	25	26
26	27	28	29	30			

JULIO

SEMANA	D	L	K	M	J	V	S
26					1	2	3
27	4	5	6	7	8	9	10
28	11	12	13	14	15	16	17
29	18	19	20	21	22	23	24
30	25	26	27	28	29	30	31

AGOSTO

SEMANA	D	L	K	M	J	V	S
31	1	2	3	4	5	6	7
32	8	9	10	11	12	13	14
33	15	16	17	18	19	20	21
34	22	23	24	25	26	27	28
35	29	30	31				

SETIEMBRE

SEMANA	D	L	K	M	J	V	S
35				1	2	3	4
36	5	6	7	8	9	10	11
37	12	13	14	15	16	17	18
38	19	20	21	22	23	24	25
39	26	27	28	29	30		

OCTUBRE

SEMANA	D	L	K	M	J	V	S
39						1	2
40	3	4	5	6	7	8	9
41	10	11	12	13	14	15	16
42	17	18	19	20	21	22	23
43	24	25	26	27	28	29	30
44	31						

NOVIEMBRE

SEMANA	D	L	K	M	J	V	S
44		1	2	3	4	5	6
45	7	8	9	10	11	12	13
46	14	15	16	17	18	19	20
47	21	22	23	24	25	26	27
48	28	29	30				

DICIEMBRE

SEMANA	D	L	K	M	J	V	S
48				1	2	3	4
49	5	6	7	8	9	10	11
50	12	13	14	15	16	17	18
51	19	20	21	22	23	24	25
52	26	27	28	29	30	31	

Anexo 7: Flujogramas frente a Alarmas

Alarm 1
Alarm 13
Alarm 47
Alarm 48
Alarm 120 y 121
Alarm 130
Alarm 221
Alarm 223
Alarm 300 y 302
Alarm 322
Alarm 415
Alarm 422
Alarm 437
Alarm 438
Alarm 600
Alarm 601
Alarm 602
Alarm 620
Alarm 715
Alarm 722
Alarm 904
Alarm 906

Volver

Anexo 8: Reporte mensual de Fallas

Documento electrónico

Este es un ejemplo correspondiente al mes de febrero del año 2004

ALARMA0204.xls

Volver

PLANTA AEROENERGIA
CONTROL DE ALARMAS
FEBRERO 2004

TIPO ALARMA	NUMERO TURBINA	FECHA	HORA ALARMA	NUMERO ERROR	DESCRIPCION ERROR	VIENTO SALIDA	PRODUCCION ACUMULADA	TIEMPO OPERACION	PERSONA AVISADA	OPERADOR	DIAGNOSTICO	HORA ENTRADA	VIENTO ENTRADA	TIEMPO DETENIDA	PROCESO 10 MIN	TOTAL TIEMPO DETENIDA
ALARMA	1	08-Feb-04	22:30:00	250	wind>max	28.7 m/s	17,515,916	41,440		Jorge	Promedio de viento mayor a los 25 m/s	4:10:00	21 m/s	6:40:00	0:10:00	6:50:00
ALARMA	1	13-Feb-04	12:40:00	13	Manual stop	15 m/s	17,588,408	41,545	Henry	Andres	Colocar proteccion	13:06:00	15 m/s	0:26:00	0:10:00	0:36:00
ALARMA	1	18-Feb-04	7:10:00	250	wind>max	27 m/s	17,658,694	41,659	Henry	Jorge	Promedio de viento mayor a los 25 m/s	9:13:00	22 m/s	2:23:00	0:10:00	2:33:00
ICE	1	21-Feb-04	18:47:00	525	(G) bypass feed back	12.3 m/s	17,705,904	41,740	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	19:18:00	12.3 m/s	0:31:00	0:10:00	0:41:00
ALARMA	1	28-Feb-04	8:42:00	250	wind>max	27 m/s	17,761,462	41,890	Henry	Melvin	Promedio de viento mayor a los 25 m/s	10:37:00	23 m/s	1:55:00	0:10:00	2:05:00
ALARMA	2	08-Feb-04	21:33:00	250	wind>max	26.6 m/s	17,426,515	40,286	Faddy	Andres	Promedio de viento mayor a los 25 m/s	5:25:00	20 m/s	7:52:00	0:10:00	8:02:00
ALARMA	2	09-Feb-04	5:36:00	302	Tacho defect	22 m/s	17,426,515	40,286	Henry	Jorge	Defecto en el tacometro	6:32:00	20 m/s	1:04:00	0:10:00	1:14:00
ALARMA	2	13-Feb-04	15:40:00	13	Manual stop	16 m/s	17,499,347	40,391	Henry	Jorge	Colocar proteccion	15:58:00	15 m/s	0:18:00	0:10:00	0:28:00
ALARMA	2	18-Feb-04	6:43:00	250	wind>max	26 m/s	17,567,587	40,502	Henry	Jorge	Promedio de viento mayor a los 25 m/s	9:35:00	22 m/s	2:52:00	0:10:00	3:02:00
ICE	2	21-Feb-04	18:47:00	525	(G) bypass feed back	11.7 m/s	17,614,717	40,583	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	22:36:00	10.7 m/s	3:49:00	0:10:00	3:59:00
ALARMA	2	28-Feb-04	8:41:00	250	wind>max	27 m/s	17,669,412	40,730	Henry	Melvin	Promedio de viento mayor a los 25 m/s	10:36:00	22.6 m/s	1:55:00	0:10:00	2:05:00
ALARMA	3	07-Feb-04	19:28:00	250	wind>max	28.3 m/s	18,301,403	42,688	Henry	Oscar	Promedio de viento mayor a los 25 m/s	20:34:00	21.3 m/s	1:06:00	0:10:00	1:16:00
ALARMA	3	08-Feb-04	4:38:00	250	wind>max	27 m/s	18,306,963	42,696	Henry	Andres	Promedio de viento mayor a los 25 m/s	6:11:00	23 m/s	1:33:00	0:10:00	1:43:00
ALARMA	3	08-Feb-04	10:23:00	250	wind>max	25 m/s	18,309,880	42,700	Henry	Melvin	Promedio de viento mayor a los 25 m/s	13:49:00	21.2 m/s	3:26:00	0:10:00	3:36:00
ALARMA	3	08-Feb-04	21:19:00	250	wind>max	28.1 m/s	18,315,243	42,707	Faddy	Andres	Promedio de viento mayor a los 25 m/s	5:28:00	21 m/s	7:08:00	0:10:00	7:18:00
ALARMA	3	11-Feb-04	14:06:00	13	Manual stop	16.2 m/s	18,356,025	42,764	Jose Pratti	Oscar		16:02:00	16.1 m/s	1:56:00	0:10:00	2:06:00
ALARMA	3	18-Feb-04	6:39:00	250	wind>max	26 m/s	18,456,837	42,923	Henry	Jorge	Promedio de viento mayor a los 25 m/s	9:39:00	22 m/s	3:00:00	0:10:00	3:10:00
ICE	3	21-Feb-04	18:47:00	525	(G) bypass feed back	12.9 m/s	18,503,977	43,002	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	19:30:00	11.1 m/s	0:43:00	0:10:00	0:53:00
ALARMA	3	28-Feb-04	0:42:00	250	wind>max	26 m/s	18,554,876	43,176		Jorge	Promedio de viento mayor a los 25 m/s	5:09:00	22 m/s	4:27:00	0:10:00	4:37:00
ALARMA	3	28-Feb-04	7:28:00	250	wind>max	26.1 m/s	18,556,344	43,148	Henry	Melvin	Promedio de viento mayor a los 25 m/s	8:09:00	23 m/s	0:41:00	0:10:00	0:51:00
ALARMA	3	28-Feb-04	9:11:00	250	wind>max	26 m/s	18,557,040	43,149	Henry	Melvin	Promedio de viento mayor a los 25 m/s	10:38:00	22 m/s	1:27:00	0:10:00	1:37:00
ALARMA	4	07-Feb-04	19:41:00	250	wind>max	27.1 m/s	18,355,693	41,865	Henry	Oscar	Promedio de viento mayor a los 25 m/s	20:29:00	22.3 m/s	0:48:00	0:10:00	0:58:00
ALARMA	4	08-Feb-04	2:58:00	250	wind>max	25.1 m/s	18,360,785	41,422	Henry	Andres	Promedio de viento mayor a los 25 m/s	3:39:00	23 m/s	0:41:00	0:10:00	0:51:00
ALARMA	4	08-Feb-04	4:29:00	250	wind>max	27 m/s				Andres	Promedio de viento mayor a los 25 m/s	6:15:00	21 m/s	1:16:00	0:10:00	1:26:00
ALARMA	4	08-Feb-04	10:27:00	250	wind>max	27 m/s	18,365,752	41,876	Henry	Melvin	Promedio de viento mayor a los 25 m/s	13:53:00	21 m/s	3:26:00	0:10:00	3:36:00
ALARMA	4	08-Feb-04	21:03:00	250	wind>max	28 m/s	18,368,589	41,883	Faddy	Andres	Promedio de viento mayor a los 25 m/s	4:10:00		7:07:00	0:10:00	7:17:00
ALARMA	4	14-Feb-04	10:47:00	13	Manual stop	10.4 m/s	1,853,989	42,007	Henry	Oscar	Colocar proteccion	11:00:00	12.3 m/s	0:13:00	0:10:00	0:23:00
ALARMA	4	18-Feb-04	6:40:00	250	wind>max	26.2 m/s	18,511,295	42,099	Henry	Jorge	Promedio de viento mayor a los 25 m/s	9:38:00	21 m/s	2:58:00	0:10:00	3:08:00
ICE	4	21-Feb-04	18:48:00	525	(G) bypass feed back	11 m/s	18,558,421	42,180	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	19:35:00	11.7 m/s	0:48:00	0:10:00	0:58:00
ALARMA	4	27-Feb-04	0:43:00	250	wind>max	27 m/s	18,609,509	42,318		Jorge	Promedio de viento mayor a los 25 m/s	5:09:00	21.5 m/s	4:26:00	0:10:00	4:36:00
ALARMA	4	28-Feb-04	9:23:00	250	wind>max	26 m/s	18,612,306	42,322	Henry	Melvin	Promedio de viento mayor a los 25 m/s	10:57:00	22 m/s	1:40:00	0:10:00	1:50:00
ALARMA	5	08-Feb-04	11:09:00	250	wind>max	27 m/s	18,370,826	42,616	Henry	Melvin	Promedio de viento mayor a los 25 m/s	14:03:00	22.2 m/s	2:06:00	0:10:00	2:16:00
ALARMA	5	08-Feb-04	21:33:00	250	wind>max	27.1 m/s	18,376,146	42,624	Faddy	Andres	Promedio de viento mayor a los 25 m/s	4:58:00	22 m/s	7:25:00	0:10:00	7:35:00
ALARMA	5	14-Feb-04	12:20:00	13	Manual stop	11.2 m/s	18,460,476	42,749	Henry	Oscar	Colocar proteccion	12:52:00	11.10	0:30:00	0:10:00	0:40:00
ALARMA	5	18-Feb-04	7:03:00	250	wind>max	28 m/s	18,515,978	42,839	Henry	Jorge	Promedio de viento mayor a los 25 m/s	9:41:00	22 m/s	2:38:00	0:10:00	2:48:00
ALARMA	5	21-Feb-04	18:47:00	525	(G) bypass feed back	11.2 m/s	18,562,382	42,920	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	19:46:00	11.2 m/s	1:03:00	0:10:00	1:13:00
ALARMA	5	28-Feb-04	10:15:00	250	wind>max	26 m/s	18,618,960	43,071	Henry	Melvin	Promedio de viento mayor a los 25 m/s	11:06:00	23 m/s	0:51:00	0:10:00	1:01:00
ALARMA	6	08-Feb-04	11:11:00	250	wind>max	26.9 m/s	17,644,442	43,000	Henry	Melvin	Promedio de viento mayor a los 25 m/s	14:08:00	22.1 m/s	2:57:00	0:10:00	3:07:00
ALARMA	6	08-Feb-04	22:41:00	250	wind>max	26 m/s	17,650,528	43,009		Jorge	Promedio de viento mayor a los 25 m/s	5:30:00	21 m/s	6:49:00	0:10:00	6:59:00
ALARMA	6	14-Feb-04	12:14:00	13	Manual stop	10.9 m/s	17,734,726	43,138	Henry	Oscar	Colocar proteccion	14:26:00	12.5 m/s	0:12:00	0:10:00	0:22:00
ICE	6	21-Feb-04	18:48:00	525	(G) bypass feed back	11.6 m/s	17,835,902	43,310	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	19:51:00	10.1 m/s	1:03:00	0:10:00	1:13:00
																0:00:00
ALARMA	7	09-Feb-04	16:06:00	13	Manual stop	21.3 m/s	17,251,465	43,473	Henry	Oscar	Se detiene para que la maquina meta bien los Tips	16:09:00	16.6 m/s	0:03:00	0:10:00	0:13:00
ALARMA	7	15-Feb-04	2:00:00	221	W.direc.nonidentical	17 m/s	17,337,996	43,630	Henry	Oscar	Veleta no marca direccion de viento correctamente	2:02:00	12.5 m/s	0:02:00	0:10:00	0:12:00
ALARMA	7	16-Feb-04	13:03:00	13	Manual stop	17.1 m/s	17,345,365	43,640	Henry	Oscar	Revisar veleta,engrase de generador y colocar rele	13:42:00	12.4 m/s	0:39:00	0:10:00	0:49:00
ICE	7	21-Feb-04	18:46:00	525	(G) bypass feed back	12.3 m/s	17,420,373	43,765	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	19:55:00	9.9 m/s	1:07:00	0:10:00	1:17:00
ALARMA	7	26-Feb-04	12:00:00	13	Manual stop	7.2 m/s	17,443,711	43,870	Faddy	Andres	Serviced B	14:58:00	.4 m/s	2:58:00	0:10:00	3:08:00
ALARMA	8	08-Feb-04	23:21:00	250	wind>max	26.8 m/s	16,801,669	43,494		Jorge	Promedio de viento mayor a los 25 m/s	4:58:00	20.7 m/s	4:36:00	0:10:00	4:46:00
ALARMA	8	16-Feb-04	14:15:00	13	Manual stop	16 m/s	16,905,582	43,672	Henry	Jorge	Colocar proteccion	14:17:00	17 m/s	0:02:00	0:10:00	0:12:00
ALARMA	8	16-Feb-04	15:21:00	13	Manual stop	16 m/s	16,906,309	43,673	Henry	Jorge	Colocar proteccion	15:42:00	12 m/s	0:21:00	0:10:00	0:31:00
ALARMA	8	17-Feb-04	13:36:00	13	Manual stop	19.1 m/s	16,921,703	43,695	Henry	Oscar	Piñon de motor de guiñada quebrado	16:33:00	16.8 m/s	2:57:00	0:10:00	3:07:00
ALARMA	8	18-Feb-04	15:49:00	13	Manual stop	19.3 m/s	16,938,824	43,718	Henry	Oscar	Se detiene para que meta los tips	15:44:00	19.1 m/s	0:03:00	0:10:00	0:13:00
ALARMA	8	19-Feb-04	17:14:00	13	Manual stop	16.3 m/s	16,957,805	43,743	Jose Pratti	Oscar	Se adiciono tornillo a piñon de guiñada	17:23:00	14.4 m/s	0:09:00	0:10:00	0:19:00
ICE	8	21-Feb-04	18:46:00	525	(G) bypass feed back	10.5 m/s	16,976,976	43,793	Henry	Oscar	Disparo linea 230 Ciudad Quesada - Toro	19:57:00	10.1 m/s	1:09:00	0:10:00	1:19:00
ALARMA	8	26-Feb-04	7:42:00	13	Manual stop	4.5 m/s	16,998,321	43,896	Henry	Andres	Serviced B	10:10:00	5.7 m/s	2:28:00	0:10:00	2:38:00
ALARMA	8	26-Feb-04	10:29:00	13	Manual stop	7.8 m/s	16,998,327	43,897	Henry	Andres	Serviced B	15:59:00	10.3 m/s	5:30:00	0:10:00	5:40:00
ALARMA	9	03-Feb-04	21:42:00	221	W.direc.nonidentical	13.1 m/s	15,998,511	43,497	Henry	Melvin	Veleta no marca direccion de viento correctamente	21:44:00	15.6 m/s	0:02:00	0:10:00	0:12:00
ALARMA	9	03-Feb-04	21:55:00	221	W.direc.nonidentical	16.3 m/s	15,998,541	43,497	Henry	Melvin	Veleta no marca direccion de viento correctamente	22:05:00	17 m/s	0:10:00	0:10:00	0:20:00
ALARMA	9	03-Feb-04	22:57:00	221	W.direc.nonidentical	17 m/s	15,998,768	43,498	Henry	Andres	Veleta no marca direccion de viento correctamente	23:02:00	10.7 m/s	0:05:00	0:10:00	0:15:00
ALARMA	9	03-Feb-04	0:04:00	221	W.direc.nonidentical	15.4 m/s	15,999,237	43,499	Henry	Andres	Veleta no marca direccion de viento correctamente	0:06:00	17 m/s	0:06:00	0:10:00	0:16:00
ALARMA	9	04-Feb-04	6:23:00	221	W.direc.nonidentical	13 m/s	16,002,729	43,505	Henry	Jorge	Veleta no marca direccion de viento correctamente	7:07:00	14.3 m/s	0:44:00	0:10:00	0:54:00
ALARMA	9	26-Feb-04	11:40:00	13	Manual stop	8.3 m/s	16,272,293	44,028	Faddy	Andres	Serviced B	12:21:00	6.6 m/s	0:22:00	0:10:00	0:32:00
																0:00:00
																0:00:00
																0:00:00

DISPONIBILIDAD POR TORRE **JUNIO 2001**

FALLAS VARIAS

ERR	1	1	2	11	5	1	2	4	2	29
HRS	2.06	1.06	1.42	15.43	9.31	0.16	1.01	4.12	1.25	37.02
MES	717.54	718.54	718.18	704.17	710.29	719.44	718.59	715.48	718.35	682.58
	99.66%	99.80%	99.75%	97.80%	98.65%	99.92%	99.80%	99.37%	99.77%	99.39%
	1	2	3	4	5	6	7	8	9	

FALLAS ICE

	8	8	7	9	6	7	6	6	6	63
HRS	4.30	8.48	4.23	13.18	3.59	4.22	5.36	4.23	7.05	56.24
MES	715.30	711.12	715.37	706.42	716.01	715.38	714.24	715.37	712.55	663.36
	99.35%	98.77%	99.36%	98.11%	99.45%	99.36%	99.20%	99.36%	98.97%	99.10%

WIND MAX

ERR	0	0	0	2	1	0	0	0	0	3
HRS	0.00	0.00	0.00	2.26	1.36	0.00	0.00	0.00	0.00	4.02
MES	720.00	720.00	720.00	717.34	718.24	720.00	720.00	720.00	720.00	715.58
	100.00%	100.00%	100.00%	99.63%	99.76%	100.00%	100.00%	100.00%	100.00%	99.93%

SERVICE

ERR	0	0	0	0	0	0	0	0	0	0
HRS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MES	720.00	720.00	720.00	720.00	720.00	720.00	720.00	720.00	720.00	720.00
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

ACUMULADO DE FALLAS POR TORRE

ERR	9	9	9	22	12	8	8	10	8	95
HRS	6.36	9.54	8.31	30.37	13.30	4.38	6.37	8.35	8.30	97.28
MES	713.24	710.06	711.29	689.23	706.30	715.22	713.23	711.25	711.30	622.32
	99.06%	98.62%	98.79%	95.73%	98.10%	99.34%	99.06%	98.78%	98.79%	98.47%

	1	2	3	4	5	6	7	8	9	
										0:00:00
1					ICE					0:00:00
2	4:30:00	8:48:00	4:23:00	13:18:00	3:59:00	4:22:00	5:36:00	4:23:00	7:05:00	56:24:00
3										0:00:00
4					WIND MAX					0:00:00
5			2:26:00	1:36:00						4:02:00
6										0:00:00
7										0:00:00
8					VARIAS					0:00:00
9	2:06:00	1:06:00	1:42:00	15:43:00	9:31:00	0:16:00	1:01:00	4:12:00	1:25:00	37:02:00
10										0:00:00
11					TOTAL					0:00:00
12										0:00:00
13										0:00:00
27										0:00:00
										0:00:00
	6:36:00	9:54:00	8:31:00	30:37:00	13:30:00	4:38:00	6:37:00	8:35:00	8:30:00	97:28:00

Anexo 9: Reporte de Mano de obra directa

Reporte Semanal de Labores de Encargados del Mantenimiento

Volver

Volver

MANTENIMIENTO

Nombre Empleado: **Faddy Chaves Barahona**

Semana **19/04/2004 al 25/04/2004**

	CODIGO	HORAS		TRABAJO
LUNES	**AETB08**	07:00 a.m.	11:00 a.m.	Revicion de las turbinas T8, T9, T6.
				Visita del TEC (atencion)
19	**AEEO01**	02:00 p.m.	04:00 p.m.	Limpieza del jardin frente al edificio
MARTES	**AETB08**	07:00 a.m.	09:00 a.m.	Se recojieron extintores y descargaron por mantenimiento
		09:00 a.m.	02:00 p.m.	Vieje a Liberia a dejar los extintores
20				Cotizacion de herramienas en Cañas
		02:00 p.m.	03:30 p.m.	Inspeccion de la T6 (tips abierto)
MIERCOLES	**AETB08**	07:00 a.m.	03:30 p.m.	Trabajos en la T9 (cambio de la luz piloto, se desarrollo,
				inspeccion de la aspa (cable reventado), cambio de base fotocelda
21		03:30 p.m.		Viaje a Liberia por zapatos de personal
JUEVES	**AEBD02**	07:00 a.m.	04:00 p.m.	Se trabajo en la construccion del banco de trabajo .
				Solodadura,corte de maderas,fijamiento, puesta de prensa.
22				
VIERNES	**AETB08**	07:00 a.m.	08:30 a.m.	Se preparo herramienta para trabajo de la T8
	AETB08	08:30 a.m.	03:30 p.m.	Se le cambio el motor de guiñada de la T8
23				
SABADO				
24				
DOMINGO				
25				

Trabajador

V° B°

MANTENIMIENTO

Nombre Empleado: **Faddy Chaves Barahona**

Semana **26/04/2004 al 02/05/2004**

	CODIGO	HORAS		TRABAJO
LUNES				Reporte de trabajos
	AEBD02	07:00 a.m.	11:00 a.m.	Limpieza y acomodamiento de herramientas
26	**AESCS05**	12:00: MD	04:00: PM	Se pusieron laminas de la casa de Salo (fibrolit)
MARTES	**AETB08**	07:00 a.m.	11:00 a.m.	Inspección de las turbinas T1, T3 con la gente de EMS
	AETB08			Se les cambio filtro de aceite, se bajaron los extintores y luz piloto
27				
MIERCOLES	**AEPR04**	07:00 a.m.	08:00: AM	Limpieza de la perrera
	AEEO01	08:00: AM	09:00: AM	Limpieza de jardín de frente al edificio y puesta de agua
28	**AEPR04**	09:00: AM	11:00: AM	Visita del veterinario por los perros
		11:00: AM	01:00: PM	Se soldó el carro de Don Carlos López
JUEVES	**AESCS05**	07:00 a.m.	09:00: AM	Riega de hervicidas en camino de la casa Salo
	AESCS05	09:00 a.m.	11:30: AM	Chapia de el solar de la casa de Salo
29		12:30: PM	01:30: PM	Se trajo motor de guiñada de la torre T8
	AEBD02	02:00: PM	04:00: PM	Se trabajo en la recuperación del repuesto motor guiñada
VIERNES	***AETB08***	07:00 a.m.	09:00: AM	Termografia a panel de potencia de la Turbinas
	AETB08	09:00 a.m.	11:00: AM	Limpieza de la base de las maquinas
30	**AEBD02**	11:00: AM	12:30: PM	Se trabajo en la recuperación del repuesto motor guiñada
	AETB08	01:30: PM	04:00: PM	Cambio de filtro de aire del extractor pequeño del panel y análisis
				vibración de la T8, T7 con Carlos Vargas
SABADO				
1				
DOMINGO				
2				

Trabajador

V° B°

MANTENIMIENTO

Nombre Empleado: **Faddy Chaves Barahona**

Semana **03/05/2004 al 09/05/2004**

	CODIGO	HORAS		TRABAJO
LUNES				Reporte de trabajo
	AETB08	7:00 a:m	4:00p:m	Engrase de la T1,T2, T3
3				
MARTES	**AETB08**			Se le cambiaron los Alemite a las torre 1, 2, 3, 4.
	AETB08	7:00 a:m	4:00p:m	Lubricacion de la T1, T2, T3, T4 generador, frenos y main bearing
4				
MIERCOLES	**AETF09**			Trabajos en la cerca de los Herreras (lineas limitrofes)
		7:00 a:m	5:30p:m	Mediciones de vibraciones en MOVASA
5				
JUEVES	**AEBD02**			Limpieza y ordenamiento de la bodega
	AEEO01			Limpieza del desague frente al edificio y jardin
6	**AEBD02**			Recuperacion de repuestos (mor de guiñada)
	AESCS05			Pasadores para porton de la casa de Salo
	AETF09			Trabajos en la cerca de los Herreras (lineas limitrofes)
	AEBD02	7:00 a:m	4:30p:m	Marcacion de Herramientas
VIERNES	***AEEO01***			Limpieza de jardin frente edificio
	AEBD02			Marcacion de Herramientas
7	**AEST03**	7:00 a:m	4:00p:m	Limpieza de subestacion y se enceraron los paneles
SABADO	**AEEO01**	1:30: p:m	3:00: p:m	Reparacion de la silla de operaciones (soldadura)
8				
DOMINGO				
9				

Trabajador

V° B°

MANTENIMIENTO

Nombre Empleado: _____

Semana _____

	CODIGO	HORAS		TRABAJO
LUNES				
10				
MARTES				
11				
MIERCOLES				
12				
JUEVES				
13				
VIERNES				
14				
SABADO				
15				
DOMINGO				
16				

_____ Trabajador

_____ V° B°

Anexo 10: Formato de pagos y compras

Ejemplo de formato de Pago

Volver

Trabajo limpieza maleza acceso a transformadores y cajas de registro.

DESCRIPCION DEL TRABAJO:
Limpieza de maleza alrededor de los transformadores de plataforma, y cajas de registro
Aplicar herbicida, y barrer maleza alrededor de cada transformador.

Codigo: **AETF07**

Agroveterinaria
Tilaran

Item	Descripción de materiales	Cant.	Costo/ unidad	Costo Total
1	Galones de bioquil	2	¢ 5,500.00	¢ 11,000.00

Total: **¢ 11,000.00**

Nota: Pago al crédito, factura 062309
Fecha 11/05/2004

Anexo 11: Imágenes de la máquina

Imágenes de las partes de la turbina

Anexo 11: Imágenes de la máquina

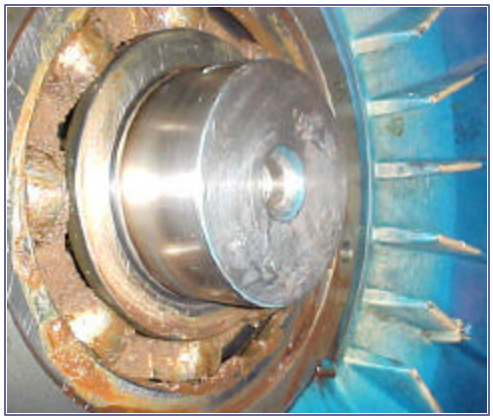

Fig. A11.1: Rodamiento trasero y delantero

Fig.A11.2: Caja de conexiones, cables de potencia, pernos de la tapa frontal del generador, manguera de entrada a la bomba

Fig. A11.3: Radiador de agua, conexiones de entrada y salida, purga, cable aterrizado

Fig. A11. 4: Bomba, motor, caja de conexiones del motor, pernos de sujeción del motor, purga manual, pernos de sujeción del Generador, contrapesos de la góndola, mangueras y uniones.

Fig.A11.5: Entrada y salida del agua al generador, contrapesos, motor y bomba, caja de conexiones del motor, pernos de sujeción del generador, agarraderas del generador

Fig. A11.6: Cables de potencia del generador, frenos de fricción de guiñada, motorreductores de guiñada, eje principal y su acople, plataforma de ascenso.

Fig. A11.7: Entradas y salidas de potencia del generador, caja de conexiones del generador, cable de sensor, manguera y unión del radiador del aceite de la caja

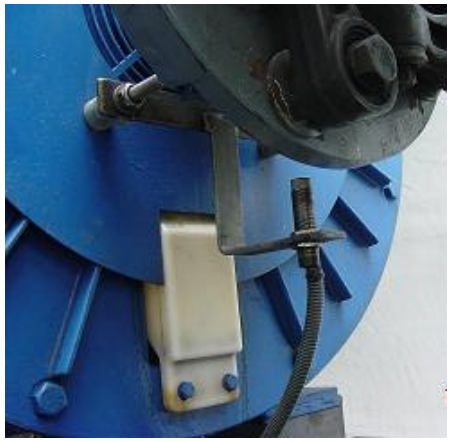

Fig.A11.8: Depósito de grasa del generador, sensores de velocidad, pernos del acople flexible y elementos de unión del acople, pernos del depósito de grasa, pernos de la tapa frontal del generador

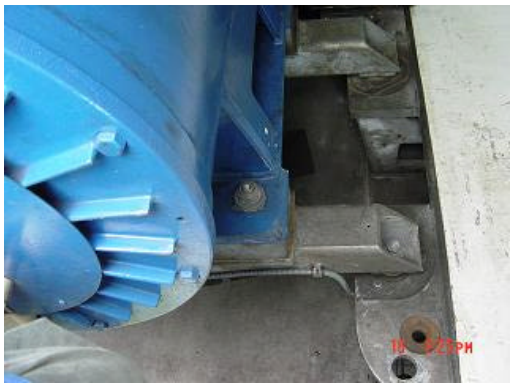

Fig. A11.9: Pernos, base y amortiguadores de sujeción del generador, cable del sensor, pernos de la tapa frontal

Fig.A11.11: Cables de la caja de conexiones al estator del generador, agarraderas del generador, caja de conexiones

Fig.A11.10: Tapa del radiador de agua y manguera de purga del generador

Fig.A11.12: Acople y eje del generador, pernos de tapa frontal, caja de conexiones, mangueras de entrada y salida de agua, radiador de aceite, purga de agua, agarraderas de instalación del generador.

Fig.A11.13:Disco de frenos, pernos de disco de frenos, pastillas de freno, bridas y pernos, acople flexible del generador

Fig.A11.14: Ejes, acople del generador, disco de freno, pernos de disco de freno, pastillas de freno, mecanismo de freno, pernos, prensas, brida con la caja, lightning brush, manguera de aceite, filtro de aceite

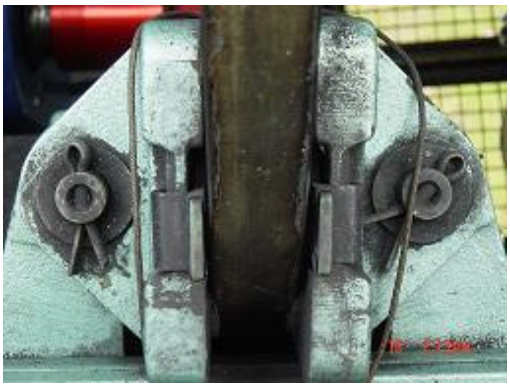

Fig.A11.15: Disco de freno, prensas, cable de sensor, pastillas

Fig. A11.16:Pernos de sujeción de mecanismos, tuercas de ajuste del mecanismo de freno, mecanismo en general

Fig.A11.17: Acumulador de aceite, uniones de aceite de freno, mangueras de aceite, pernos y estructura de sujeción de la bomba del freno, bomba de freno, mangueras de la bomba de freno, cableado de la bomba

Fig.A11.18: Caja de conexiones de la bomba, cables de señales, pernos de sujeción de la bomba, motor y bomba de freno, mangueras y uniones, vertedero de aceite.

Fig.A11.19: Pernos de ajuste del mecanismo de freno, prensas, pernos, acumulador del soft brake, pastillas de freno, cable de señal de desgaste del freno, disco de freno, acople flexible en el freno.

Fig.A11.20: Nivel de aceite de la bomba, bomba y motor de freno, pernos y estructura de sujeción de la bomba, vertedero de aceite, uniones y mangueras.

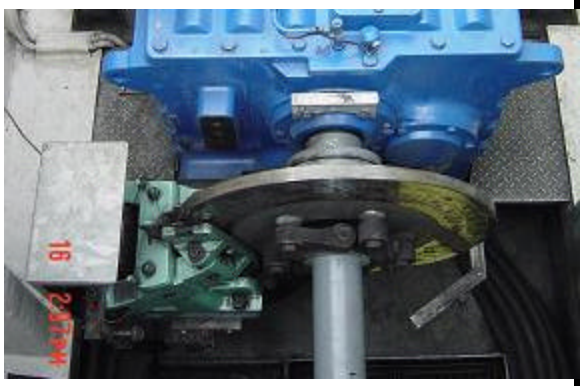

Fig.A11.21: Acople flexible en freno, pastilla de freno, lightning brush, caja, pernos y registros, eje, pastillas de freno, mecanismo de freno, brida del eje, PT100.

Fig.A11.22: Motor del ventilador, caja de conexiones del ventilador, rejilla del ventilador, aspas del ventilador, radiador, mangueras del radiador

Fig.A11.23: Slip Ring, aro sujetador de palanca de SlipRing, indicador de aceite de bomba de freno, motor y bomba de freno, mangueras de bomba de freno

Fig.A11.24: Slip Ring, aro sujetador de palanca de Slip Ring, medidor de aceite, cable de datos de Slip Ring, perno de sujeción trasero de Caja multiplicadora, bomba de frenos.

Fig.A11.25: Esfera de vibración, mangueras de aceite de caja, uniones, filtro de caja, electroválvula, válvula manual de purga

Fig.A11.26: Nivel de aceite en caja, pernos de registro trasero de la caja, PT-100, válvula manual de purga

Fig.A11.27:Bomba y motor de aceite de caja, mangueras de entrada y salida, cables de sensores, plataforma y pernos de sujeción de la bomba.

Fig.A11.**28: Slip Ring, aro de sujeción de Slip Ring, cable de datos, nivel de aceite, pernos de tapa trasera de la caja, bomba de freno.**

Fig.A11.29: Uniones y mangueras de aceite arriba de la caja, pernos de las tapas superiores de la caja, caja de control, disco de fr

Fig.A11.30: Pernos y acople con el eje principal, eje principal, pernos de tapa frontal de la caja, pernos de sujeción, placa eje y pernos del amortiguador, pernos de la tapa superior de la caja

Fig.A11.31: Pernos de tapa frontal caja, unión y mangueras de aceite, caja de control.

Fig.A11.32: Escobillas de descarga eléctrica, PT-100, Pernos de registro de la caja, pernos de la tapa superior, brida de unión con el freno, registro y pernos laterales, rejilla del elevador mecánico.

Fig.A11.33: Tablero de control, uniones y mangueras de aceite de la caja, registros y pernos superiores de la caja, escobilla de descarga eléctrica, registros y pernos traseros de la caja, disco de freno, acople de disco de freno, motores de guiñada, pernos de sujeción de la caja a la góndola.

Fig.A11.34:Tablero de control, pernos de la tapa superior de la caja, generador, mangueras de aceite de la caja

Fig.A11.35: Manguera de aceite de la caja, unión, electro válvula, filtro, estructura y pernos de sujeción del filtro.

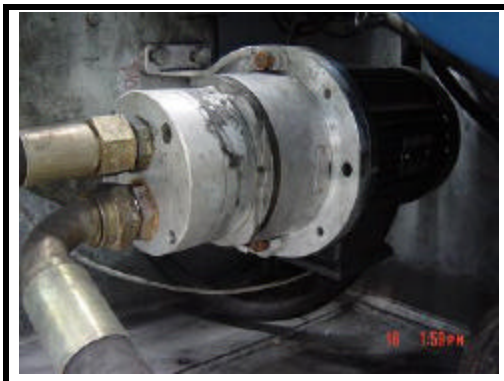

Fig.A11.36: Motor y Bomba de aceite, entrada y salida, pernos y marco de sujeción de la bomba, mangueras y uniones.

Fig.A11.37: Unión y mangueras de aceite, pernos y tapas de registros superiores, pernos de tapa superior, agarraderas de la caja

Fig.A11.38: Pernos de la tapa superior, pernos de registro superior, escobilla contra descargas eléctricas, pernos de sujeción del disco, pernos de la brida, mecanismos de freno, PT-100

Fig.A11.39: pernos y acople con el eje principal, pernos de la tapa frontal, freno de guiñada.

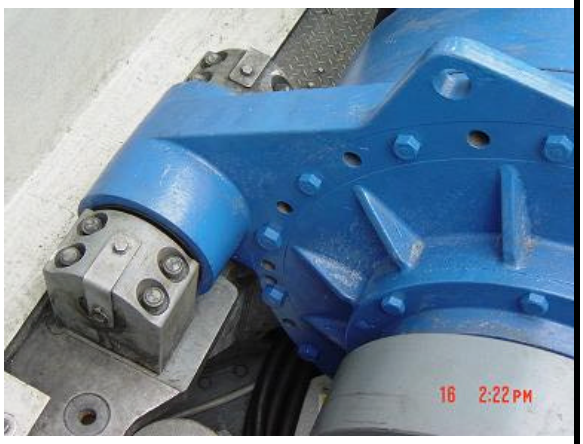

Fig.A11.40: Pernos de sujeción de la caja con el amortiguador; pernos, placa metálica y eje del amortiguador; pernos de la tapa frontal de la caja, agarradera.

Fig.A11.41: Pistón, acumulador, electro válvula.

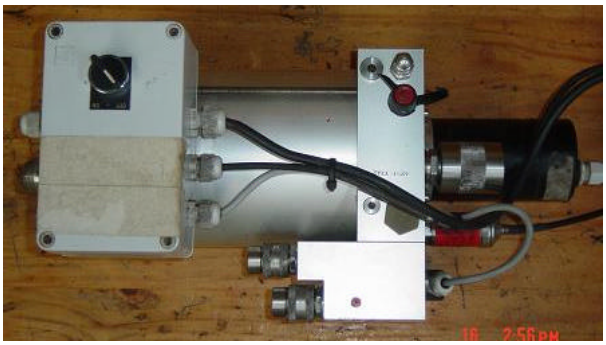

Fig.A11.42: Estación hidráulica, caja de conexiones, cables de control y de potencia, entradas y salidas de aceite, bomba y motor, sensores, vertedero de aceite, electroválvula

Fig.A11.43: Slip Ring, aro de sujeción de Slip Ring, cable de datos, nivel de aceite, pernos de tapa trase ra de la caja, bomba de freno.

Fig.A11.44: Entrada y retorno de aceite en el pistón

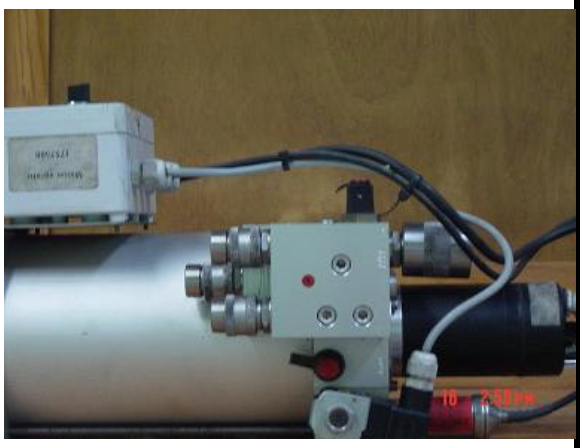

Fig.A11.45: Estación hidráulica, caja de conexiones, cables de control y de potencia, entradas y salidas de aceite, bomba y motor, sensores, vertedero de aceite, electro válvula

Fig. A11.46: Bola de vibraciones, sensor de palanca, asentamiento de la bola

Fig.A11.47: Grúa, gancho, brazo móvil

Fig.A11.48: Luz de navegación, veleta, anemómetro, sensor de luz

Fig.A11.49: Sujetador de compuertas, grúa, gancho, brazo móvil.

Fig.A11.50: Pernos de base de cimentación

Fig.A11.51: Gancho del Main Bearing, pernos del cubo, pernos de Main Bearing. Eje.

Fig.A11.52: Buje, las extensiones del cubo, aspas

Fig.A11.53: Registro en el buje, aspas, extensores del cubo, cubierta de la góndola

Fig.A11.54: Freno de fricción, tapa de freno, pernos de tapa

Fig.A11.55: Motor y reductores de guiñada, pernos de fijación a la torre, caja de conexiones, acople del motor, cable de potencia del motor

Fig.A11.56: Motor y reductor de guiñada, caja de conexiones, cable de potencia, acople del motor

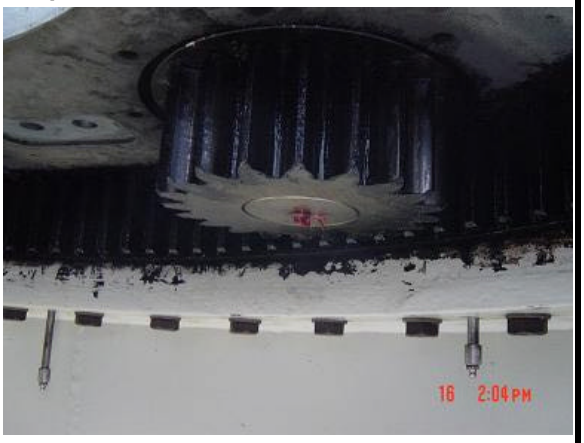

Fig.A11.57: Piñón y rueda de guiñada, tapa del pinón

Fig.A11.58: Tapa inferior al piñón con tornillos avellanados

Fig.A11.59: Disco y sensores de guiñada, pernos de fijación del freno a la torre, mecanismo de freno

Fig.A11.60: Veletas, anemómetros, sensor de luminosidad, luces de navegación aérea, pararrayos

Anexo 12: Tendencia de Valores Globales de Vibración

Tendencia de Valores Globales

Volver

Cálculo de la Media

Punto	Tipo	T1	T1 U	T2	T2 U	T3	T3 U	T4	T4 U *	T5	T5 U	T6	T6 U	T7	T7 U	T8	T8 *	T9	T9 U	Promedio simple
P1	Vel		2.33		1.8		2.15		0.85		1.6		2.02		2.09		1.92	1.58	2.4	1.874
P1	Acc		0.79		0.55		1.31		0.55		0.44		1.1		0.59		0.28	2.73	1.7	1.004
P1	Env		2.86		2.5		4.84		2		1.88		3.97		1.72		1.17	4.89	5.28	3.111
P2	Acc	0.89	0.7	0.59	0.48	1.6	1.1	0.4	0.41	0.99	2.05	1.5	1.22	1.48	1.05	0.66	0.48	1.13	1.91	1.035555556
P2	Env	2.3	3.02	2.13	2.05	2.74	2.02	1.6	1.26	2.7	3.05	3.3	2.89	3.33	2.78	2.1	1.19	4.19	6.16	2.711666667
P2	Vel	1.3	3.7	2.09	1.54	1.88	3.77	1.5	0.88	1.7	3.29	1.4	2.89	2.02	4.99	2.18	0.99	1.54	3.22	2.271111111
P20	Acc		2.3		3.29		2.69		1.28		1.83		2.35		2.78		0.78	3.65	1.79	2.274
P3	Vel	1.62	2.45	1.02	2.06	1.48	1.79	0.87	0.68	1.86	1.44	2.1	2.13	1.8	1.52	1.95	0.66	1.63	1.61	1.592777778
P4	Acc	3.77	2.23	1.56	1.59	1.08	1.75	1.16	1.32	1.4	1.41	1.91	2.14	3.7	2.15	2.8	0.55	3.5	2.62	2.035555556
P4	Vel	0.99	3.93	1.51	1.62	1.6	2.92	2.47	1.1	1.41	2.76	1.38	2.93	2.27	2.71	1.27	2.4	1.94	3.91	2.173333333
P4	Env	13.8	6.25	4.19	3.02	8.95	3.99	4.53	2.5	6.13	3.75	6.43	7.39	8.66	3.56	3.94	1.22	8	4.43	5.596666667
P5	Acc		1.84		1.17		1.55		0.44		1.1		1.47		1.96		0.39	2.5	2.26	1.468
P5	Env		6.5		3.72		5.13		1.3		3.11		3.23		4.09		1.03	4.35	3.67	3.613
P5	Vel		2.85		3.24		3.26		1.72		1.95		2.7		2.25		1.36	2.07	1.85	2.325
P6	Acc		2.5	0.72	1.19	1.66	1.08	0.4	0.57	1.08	0.81	0.77	1.61	0.85	1.2	0.81	0.66	2.23	0.79	1.113529412
P6	Env	5.2	8.3	4	3.34	2.8	3.63	1.55	1.77	3.02	1.84	5.12	5.29	6.94	2.27	3.75	1.73	11.99	4.02	4.253333333
P6	Vel	1.1	2.7	1.33	1.29	1.3	1.39	1.17	0.94	1.07	1.13	1.47	2.93	1.96	1.77	1.13	0.86	3.41	1.83	1.598888889
P21	Acc		1.55		1.12		1.64		0.54		1.08		1.28		1.47		0.57	3.61	2.2	1.506
P7	Acc		1.05		1.94		1.7		0.55		1.1		1.86		1.85		0.29	1.93	0.919	1.3189
P7	Env		3.35		3.61		5.43		1.97		5.34		5.6		7.37		1.9	10.5	2.36	4.743
P7	Vel		1.88		1.92		1.66		1.27		1.89		1.72		2.94		0.72	2.37	1.53	1.79
P10	Acc	0.15	0.15	0.165	3.97	0.13	0.12	0.41	0.18	0.12	0.09	0.14	0.11	0.13	0.16	0.18	0.1	1.01	1.27	0.476944444
P10	Env	7.02	2.25	5.55	1.68	1.11	0.62	0.12	0.59	1.33	0.91	2.61	2.31	1.75	1.14	1.68	0.85	11.9	13.26	3.148888889
P10	Vel		7.2		3.97		5.25		9.22		2.27		3.57		6.1		4.36	2.4	5.89	5.023
P11	Acc	0.23	0.11	0.12	0.06	0.11	0.12	0.4	0.17	0.1	0.07	0.1	0.07	0.1	0.1	0.19	0.12	0.4	0.35	0.162222222
P11	Vel		5.84		1.83		4.3		9.939		3.96		5.52		4.41		5.59	1.4	5.12	4.7909
P11	Env	3.54	2.22	1.97	1.54	0.99	0.93	0.7	0.76	2.07	2.38	1.78	6.87	0.9	1.46	1.69	2.11	3.9	4.67	2.248888889
P12 AxFront	Vel		12.34		2.47		6.95		5.38		0.72		1.28		7.14		4.73		3.42	4.936666667

P11	Muy desalineado	Desalineado	No desalineado	No desalineac	P4	Desalineación	P4
P4					P2		P6
							P2
							P10

Sospechosos		
Cajas	7	9
Generadores	1	9

Anexo 13: Hoja de Análisis de Valores Globales

Tabla A.13.1. Hoja de análisis de Valores Globales

Empresa AEROENERGIA	**Análisis de Valores Globales de Vibración en Velocidad**	
Turbina:	Día:	Hora:
Velocidad del viento:	Potencia:	Producción acumulada:

Punto Medición	**Valor global**	**Severidad**	**Valor promedio**	**Ver Espectros**	
				Si	**No**

Semana No:	Anotaciones generales:
Tomó las mediciones:	Analizó los datos:

Volver

Anexo 14: Hoja de Análisis de Espectros

Tabla A.14.1. Hoja de análisis de espectros

Empresa AEROENERGIA		
Turbina:	Día:	Hora:
Velocidad del viento:	Potencia:	Producción acumulada:

Punto Medición	**Frecuencias observadas (Hz)**	**Posibles fallas**	**Armónicos**		**Etapa de falla**	**Intervenir**	
			Bf	**Af**		**Si**	**No**

Semana No:	Anotaciones generales:
Tomó las mediciones:	Analizó los datos:
Conclusiones:	

Posibles fallas:
A: Pista interior del Rodamiento
B: Pista exterior del Rodamiento
C: Elementos Rodantes
D: Canasta
E: Desalineación, Desbalance, eje torcido; o demás problemas con el eje.
F: Problemas en los dientes de los engranajes.

Anexo 15: Ejemplo de Análisis para la Turbina 9

Tabla A.15.1. Análisis para turbina 9

Empresa AEROENERGIA	**Análisis de Valores Globales de Vibración en Velocidad y Enveloping**	
Turbina: 9	Día: 13/05/2004	Hora: 10:50
Velocidad del viento: -----	Potencia: -------	Producción ------ acumulada:

Punto	Medición	Valor global	Severidad	Valor promedio	Ver Espectros	
					Si	No
P1	Vel	2,4	B Permisible	1,87		
P1	Env	5,28	Alerta			
P2	Vel	3,22	B Permisible	2,27		
P2	Env	6,16	Alerta			
P3	Vel	1,61	A Bien	1,6		
P4	Vel	3,91	B Permisible	2,17		
P4	Env	4,43	Alerta			
P5	Vel	1,85	A Bien	2,32		
P5	Env	3,67	Satisfactorio			
P6	Vel	1,83	A Bien	1,6		
P7	Vel	1,53	A Bien	1,8		
P10	Vel	5,89	C Tolerable	5	X	
P10	Env	13,26	No admisible		X	
P11	Vel	5,12	C Tolerable	4,79	X	
P11	Env	4,6	Alerta		X	
P12	Front Vel	3,42	B Permisible	4,93	X	

Semana No:	Anotaciones generales:
Tomó las mediciones:	Analizó los datos:

Anexo 16: Ejemplo de Análisis de Espectros

Turbina 9

Tabla A.16.1. Análisis de espectros de Turbina 9

Empresa AEROENERGIA		
Turbina: 9	Día: 13/05/2004	Hora: 10:50 am
Velocidad del viento: -----	Potencia: -------	Producción ------ acumulada:

Punto Medición	Frecuencias observadas (Hz)	Posibles fallas	Armónicos		Etapa de falla	Intervenir	
			Bf	Af		Si	No
P10 Vel	30, 80, 150	A, E			1		
Acc	146, 176, 1250, 1286			1x			
Env	30	Fallas en etapas tempranas	x	x			
P11 Vel	30, 90, 150	A, E			1		
Acc	30, 86, 146, 555			1x			
Env	30						
P12 Front Vel	30, 150, 180	F	x	x	3		

Semana No:	Anotaciones generales: datos insuficientes. Tendencia a falla en Bearing delantero.
Tomó las mediciones: Carlos V.	Analizó los datos: Carlos V.

Conclusiones: Gran cantidad de vibraciones en 30 Hz. Problemas en el eje.

Posibles fallas:
A: Pista interior del Rodamiento
B: Pista exterior del Rodamiento
C: Elementos Rodantes
D: Canasta
E: Desalineación, Desbalance, eje torcido; o demás problemas con el eje.
F: Problemas en los dientes de los engranajes.

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Anexo 17: Ejemplo de Análisis para la Turbina 1

Tabla A.17.1. Análisis de turbina 1

Empresa AEROENERGIA

Turbina: 1	Día: 15/05/2004	Hora: 12:06 pm
Velocidad del viento: -----	Potencia: -------	Producción ------ acumulada:

Punto	Medición	Valor global	Severidad	Valor promedio	Ver Espectros	
					Si	No
P1	Vel	2,33	B Permisible	1,87		
P1	Env	2,86	Satisfatorio	3,11		
P2	Vel	3,7	B Permisible	2,27		
P2	Env	3,02	Alerta	2,71		
P3	Vel	2,45	B Permisible	1,6		
P4	Vel	3,93	B Permisible	2,17		
P4	Env	13,05 - 6,25	No admisible	5,6	X	
P5	Vel	2,85	B Permisible	2,32		
P5	Env	6,5	Alerta	3,61		
P6	Vel	2,7	B Permisible	1,6		
P6	Env	8,3	No admisible	4,25	X	
P7	Vel	1,88	A Bien	1,8		
P10	Vel	7,2	C Tolerable	5	X	
P10	Env	7,02 – 2,25	No admisible	3,14	X	
P11	Vel	5,85	C Tolerable	4,79	X	
P11	Env	3,54 – 2,22	Alerta	2,24		
P12	Front Vel	12,34	D No permisible	4,93	X	

Semana No:	Anotaciones generales: Se debe corregir la alineación.
Tomó las mediciones:	Analizó los datos:

Volver

Anexo 18: Ejemplo de Análisis de Espectros para la Turbina 1

Tabla A.18.1. Análisis de espectros para turbina 1

Empresa AEROENERGIA		
Turbina: 1	Día: 13/05/2004	Hora: 10:50 am
Velocidad del viento: -----	Potencia: -------	Producción ------ acumulada:

Punto	Medición	Frecuencias observadas (Hz)	Posibles fallas	Armónicos		Etapa de falla	Intervenir	
				Bf	Af		Si	No
P4	Vel	5				3		
	Env	5, 55				Logarítmica	Monitorear	
	Acc	1870				Side bands		
P6	Vel	30, 200, 1870, 2080	E, B,					
	Env	10, 200, 3740, 3950	E, B			Forma de U	Monitorear	
	Acc	1870	A			Side bands		
P10	Vel	30	E			1	Monitorear	
	Acc	-						
	Env	240	C				Monitorear	
P11	Vel	30, 90	E, B			1	Monitorear	
	Acc	30, 93	E, B			1		
	Env	-						
P12	Front Vel	5, 30	E			1	X	

Semana No:	Anotaciones generales:.
Tomó las mediciones: Carlos V.	Analizó los datos: Carlos V.

Conclusiones: El problema con el eje debe ser intervenido. Las demás vibraciones deben ser monitoreadas para obtener conclusiones.

A: Pista interior del Rodamiento
B: Pista exterior del Rodamiento
C: Elementos Rodantes
D: Canasta
E: Desalineación, Desbalance, eje torcido; o demás problemas con el eje.
F: Problemas en los dientes de los engranajes.

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Anexo 19: Información sobre Vibraciones en la Caja Multiplicadora Flender PEAC 4300.4 proporcionada por Flender

Información de Flender sobre Monitoreo a Condición

Tabla de Frecuencias en los rodamientos de Flender

Tabla de frecuencias para Engranajes de Flender

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Bearing frequencies (in Hz)

Generator bearings/output side	Remarks	N_WK	KÄFIG	WK	AR	IR
22226 EC3	bearing position L	18	10,650	158,190	191,720	260,980
NJ 2224 EC/C3	bearing position K	17	10,650	160,100	180,980	246,570
Helical gear shaft	Remarks	N_WK	KÄFIG	WK	AR	IR
NJ 2224 EC/C3	bearing position J	17	4,040	60,690	68,600	93,460
NJ 2224 EC/C3	bearing position H	17	4,040	60,690	68,600	93,460
Bearings sun gear shaft	Remarks	N_WK	KÄFIG	WK	AR	IR
SL 182960-INA	bearing position G	35	0,950	23,090	33,200	39,720
SL 181860-INA	bearing position F	56	0,980	37,070	55,070	61,600
Bearings planetary gear shafts	Remarks	N_WK	KÄFIG	WK	AR	IR
24132 CC/C3	bearing position D/E	21	0,450	7,890	9,500	12,200
Bearings input shaft	Remarks	N_WK	KÄFIG	WK	AR	IR
SL 181868-INA	bearing position C	62	0,190	7,890	11,770	13,030
SL 181892-INA	bearing position B	58	0,190	7,370	10,970	12,230

Drehfr.	- rotary frequency		WK	- ball spin frequency
N_WK	- number of rolling elements		AR	- ball pass frequency outer race
Käfig	- cage frequency		IR	- ball pass frequency inner race

Anexo 20: Frecuencias de Falla en los rodamientos de la Caja Multiplicadora

Tabla A.20.1. Velocidad y frecuencia de rotación de salida

Frecuencia de rotación			
1812	RPM	30.2	Hz

Tabla A.20.2. Rodamientos en el eje del engrane helicoidal (NJ 2224 EC/C3) (D, G)

Tipo de frecuencia	Detalle	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (pista interior)	93,460	111,97	224	336	448	560	672	784	896	1008	1120
Fe	BPFO (pista exterior)	68,600	82,18	164	247	329	411	493	575	657	740	822
Fb	BSF (elementos rodantes)	60,69	72,71	145	218	291	364	436	509	582	654	727
Ft	FTF (problemas en la canasta)	4,040	4,84	10	15	19	24	29	34	39	44	48

Tabla A.20.3. Rodamientos del eje del Engrane Sol del Sistema Planetario (SL 182960-INA) (I)

Tipo	Detalle del Tipo	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (Pista interior)	39,720	47,58	95	143	190	238	286	333	381	428	476
Fe	BPFO (Pista exterior)	33,200	39,77	80	119	159	199	239	278	318	358	398
Fb	BSF (ruedas)	23,09	27,66	55	83	111	138	166	194	221	249	277
Ft	FTF (canasta)	0,95	1,14	2	3	5	6	7	8	9	10	11

Tabla A.20.4. Rodamientos del Engrane Sol del Sistema Planetario (SL181860-INA) (H)

Tipo de frecuencia	Detalle del Tipo	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (Inner Race; pista interior)	61,600	73,80	148	221	295	369	443	517	590	664	738
Fe	BPFO (Outer Race; pista exterior)	55,070	65,97	132	198	264	330	396	462	528	594	660
Fb	BSF (Ball Spin Frecuency; elementos rodantes)	37,07	44,41	89	133	178	222	266	311	355	400	444
Ft	FTF (problemas en la canasta)	0,98	1,17	2	4	5	6	7	8	9	11	12

Tabla A.20.5. Rodamientos en los ejes de los Planetarios (24132CC/C3) (B)

Tipo de frecuencia	Detalle del Tipo	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (pista interior)	12,200	14,62	29	44	58	73	88	102	117	132	146
Fe	BPFO (pista exterior)	9,500	11,38	23	34	46	57	68	80	91	102	114
Fb	BSF (elementos rodantes)	7,890	9,45	19	28	38	47	57	66	76	85	95
Ft	FTF (problemas en la canasta)	0,45	0,54	1	2	2	3	3	4	4	5	5

Tabla A.20.6. Rodamiento en la salida de la caja del lado del generador (22226 EC3) (F)

Tipo	Detalle del Tipo	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (pista interior)	260,98	312,65	625	938	1251	1563	1876	2189	2501	2814	3127
Fe	BPFO (pista exterior)	191,72	229,68	459	689	919	1148	1378	1608	1837	2067	2297
Fb	BSF (elementos rodantes)	158,19	189,51	379	569	758	948	1137	1327	1516	1706	1895
Ft	FTF (problemas en la canasta)	10,65	12,76	26	38	51	64	77	89	102	115	128

Tabla A.20.7. Rodamiento de salida de la caja del lado del generador (NJ 2224 E3/C3) (E)

Tipo	Detalle del Tipo	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (pista interior)	246,57	295,39	591	886	1182	1477	1772	2068	2363	2659	2954
Fe	BPFO (pista exterior)	180, 98	216,81	434	650	867	1084	1301	1518	1735	1951	2168
Fb	BSF (elementos rodantes)	160,1	191,80	384	575	767	959	1151	1343	1534	1726	1918
Ft	FTF (problemas en la canasta)	10,65	12,76	26	38	51	64	77	89	102	115	128

Tabla A.20.8. Rodamiento en la entrada de la caja (SL 181868-INA) (A)

Tipo	Detalle del Tipo	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (pista interior)	13,030	15,61	31	47	62	78	94	109	125	140	156
Fe	BPFO (pista exterior)	11,77	14,10	28	42	56	71	85	99	113	127	141
Fb	BSF (elementos rodantes)	7,890	9,45	19	28	38	47	57	66	76	85	95
Ft	FTF (problemas en la canasta)	0,19	0,23	0	1	1	1	1	2	2	2	2

Tabla A.20.9. Rodamiento en la entrada de la caja (SL 181892-INA) (C)

Tipo de frecuencia	Detalle del Tipo	Hz (1510 rpm)	Hz (1810 rpm)	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (pista interior)	12,230	14,65	29	44	59	73	88	103	117	132	147
Fe	BPFO (pista exterior)	10,97	13,14	26	39	53	66	79	92	105	118	131
Fb	BSF (elementos rodantes)	7,370	8,83	18	26	35	44	53	62	71	79	88
Ft	FTF (problemas en la canasta)	0,19	0,23	0	1	1	1	1	2	2	2	2

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Anexo 21: Frecuencias de Falla en los engranes de la caja multiplicadora

Tabla A.21.1. Engranes de la caja en las diferentes etapas[16].

Tipo	Detalle del Tipo	0.5	N	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h
Etapa Epicíclica	Conjunto de planetarios y sol	15	30	60	91	121	151	182	212	243	273	303	334
Etapa intermedia	Engranes en paralelo (morado)	102	204	408	612	816	1020	1224	1428	1632	1837	2041	2245
Etapa de salida	Engranes de salida (blanco)	467	934	1869	2803	3738	4673	5607	6542	7477	8411	9346	10281

Volver

[16] La tabla muestra las frecuencias a la mitad de la frecuencia principal (0.5), a la frecuencia principal (N) y a las diferentes armónicas (xh).

Anexo 22: Puntos de medición de vibraciones en la caja, señalamiento y codificación de rodamientos

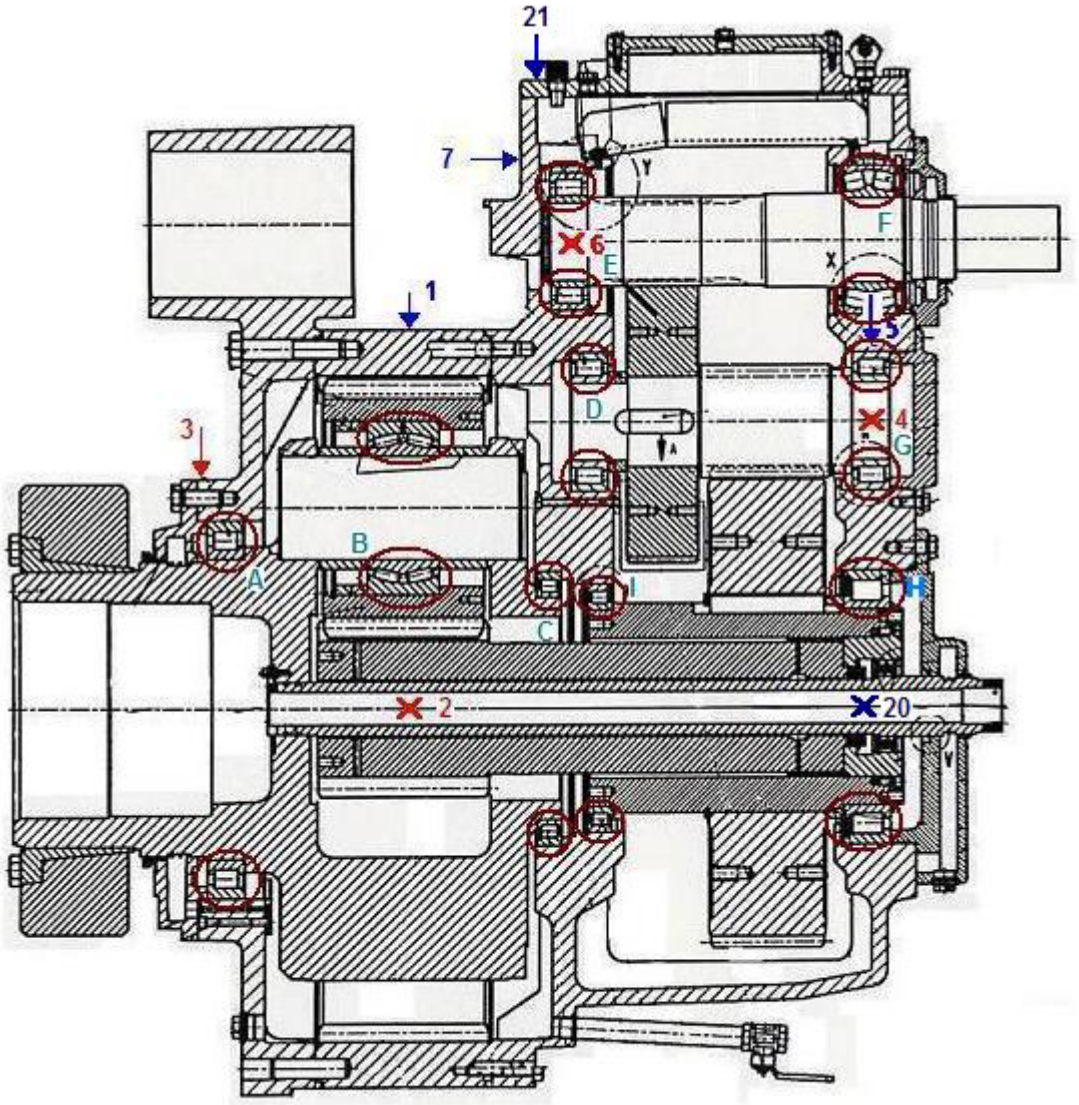

Figura.A.22.1. Puntos de medición en la Caja Multiplicadora

Volver

Anexo 23: Frecuencia de giro en los piñones de la caja por el Método Analítico de Tabulación.

En la siguiente figura se muestra una imagen de la Caja Flender PEAC 4300.4

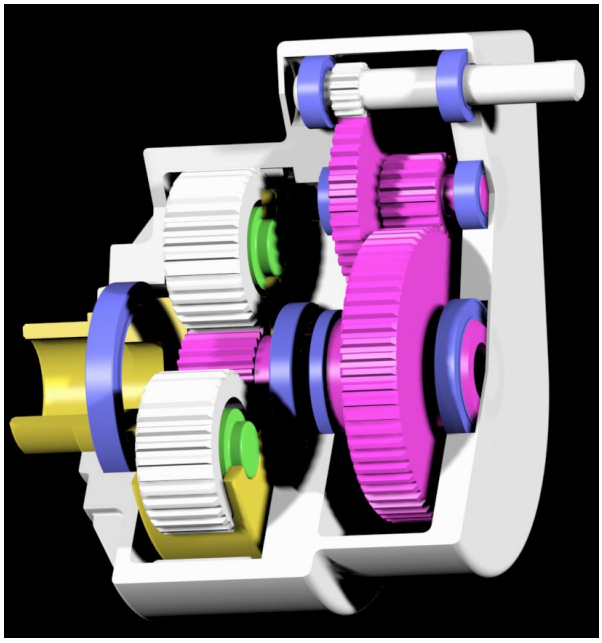

Figura.A.23.1. Distribución interna de la Caja Multiplicadora[17]

Para una configuración planetaria igual a la presentada por la Caja Flender se presenta la tabla básica del Método de Tabulación[18].

[17] Tomado de la Presentación de las mejoras en las Cajas Multiplicadoras
[18] Esta tabla fue tomada del libro Mecanismos y Dinámica de Máquina. Hamilton H. Mabie y Charles F. Reinholz.

Tabla A.23.1. Tabla de cálculos por el método de Tabulación

	Corona	Rueda sol	Piñón Planetario	Brazo transmisor
Movimiento con el Brazo relativo al bastidor	+1	+1	+1	+1
Movimiento relativo al brazo	-1	+ N1/N2	- N1 / N3	0
Movimiento total relativo al bastidor	0	1 + (N1/N2)	1 – (N1/N3)	+1

De esta forma, se obtienen las velocidades de cada elemento, sabiendo que se cuenta con 68 dientes en la corona de la carcaza, 26 dientes en el piñón planetario, 16 dientes en la rueda sol, que la relación de velocidades en la etapa intermedia es 24.04 y la relación de velocidades en la etapa de salida es 67.466.

Tabla A.23.2. Tabla de velocidades y frecuencias de los ejes de la Caja Multiplicadora

Velocidades de giro de los ejes en la Caja			
Velocidad en el brazo de entrada	i = 1	26 rpm	0.43 Hz
Velocidad en el piñón planetario	i = -1.615	42 rpm	0.7 Hz
Velocidad en la rueda sol	i = 5.25	136.5 rpm	2.275 Hz
Velocidad en la etapa intermedia	i= 24.04	625 rpm	10.41 Hz
Velocidad en la etapa de salida	i = 67.466	1812 rpm	30.2 Hz

Volver

Anexo 24: Muestra de Cálculo de las frecuencias de los Rodamientos Traseros y Delanteros del Generador

Tabla A.24.1. Tabla de datos de los rodamientos del generador

Tabla de Datos		
n_{bolas}	8 bolas	
fr	1812 rpm	30.2 Hz
dm	190 mm	
d	56 mm	
β	40°	

Tabla A.24.2. Frecuencias de falla en el generador

Frecuencia		Ecuación	Resultado (Hz)
Fi	BPFI	$0.6\ (fr)(n_{esferas})$	144.96
Fe	BPFO	$0.4\ (fr)(n_{esferas})$	96.64
Fb	BSF	$\frac{dm\ (fr)}{2d}\ [\ 1 - ((\ d / d_m\ )^2\ \ (\cos\ (\beta))^2)]$	48.620
Ft	FTF	$\frac{fr}{2d}\quad [\ 1 - ((\ d\ )\ (\cos\ (\beta)))]$	11.690

Volver

Anexo 25: Frecuencias de falla del Rodamiento Trasero y Delantero del Generador

Tabla A.25.1. Marca y designación de los rodamientos del generador

Marca	Designación
SKF	6324/C3VL0241

Tabla A.25.2. Velocidad y frecuencia del generador

Frecuencia de rotación			
1812	RPM	30.2	Hz

Tabla A.25.3. Frecuencias de falla en la Caja Multiplicadora

Tipo de frecuencia	Detalle del Tipo	Hz	2x	3x	4x	5x	6x	7x	8x	9x	10x
Fi	BPFI (Inner Race; pista interior)	144.9	290	435	580	725	870	1015	1160	1305	1450
Fe	BPFO (Outer Race; pista exterior)	96.6	193	290	387	483	580	676	773	870	966
Fb	BSF (Ball Spin Frecuency; elementos rodantes)	48.6	97	146	194	243	292	340	389	438	486
Ft	FTF (Fundamental Train Frecuency; problemas en la canasta)	11.6	23	35	47	58	70	82	94	105	117

Volver

Anexo 26: Puntos de medición de vibraciones en el Generador

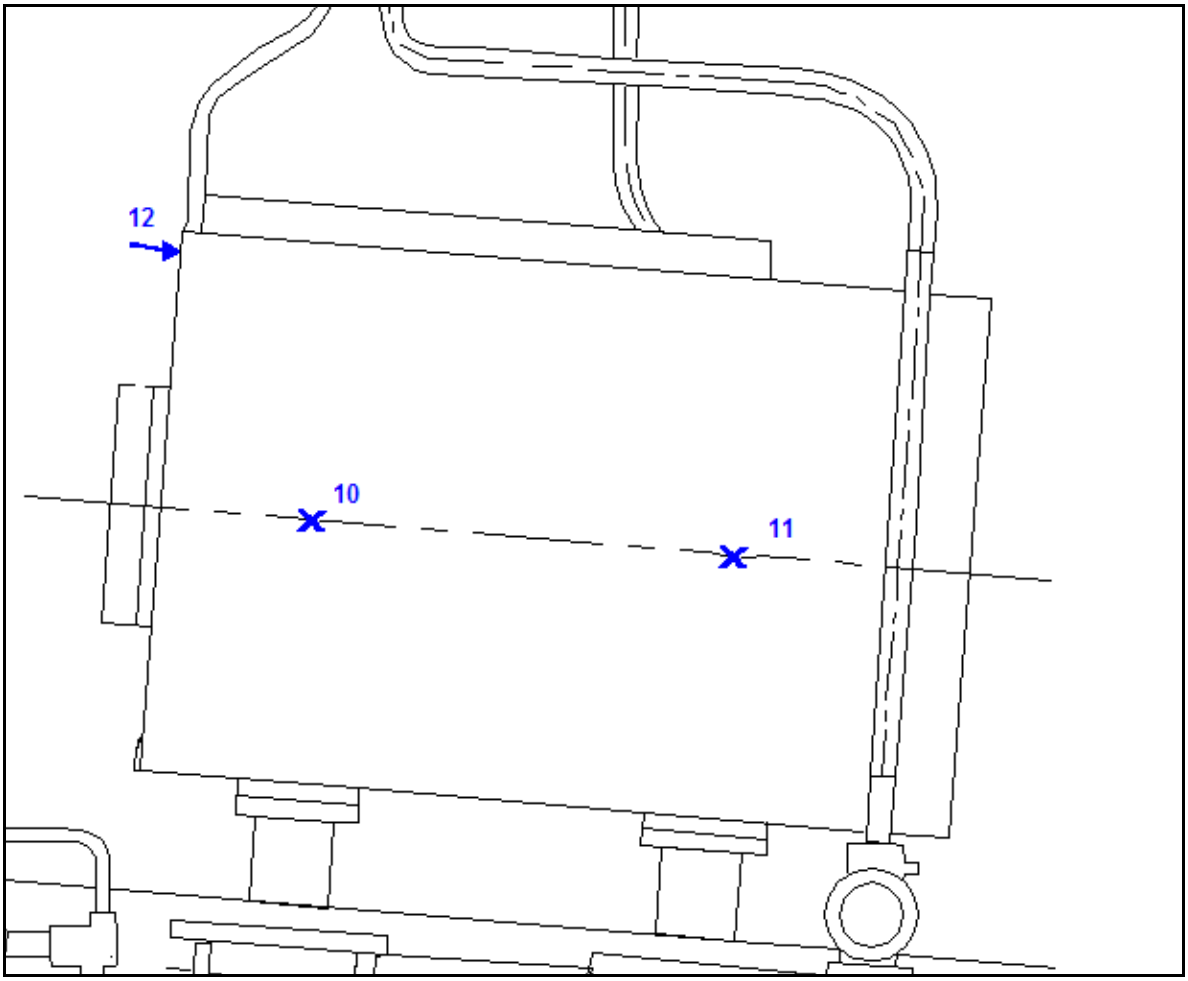

Figura A.26.1 Puntos de medición en el Generador Elin

Volver

Anexo 27: Configuración de las mediciones de Velocidad

Tabla A.27.1. Configuración de las mediciones de velocidad

Configuración de mediciones de Velocidad		
Full scale	10 mm/sec	El máximo esperable de los datos de velocidad es 10 mm/sec. Después de ese valor, una falla es obvia.
Input mV/EU	100	Este es el valor del sensor original del equipo.
Detection	RMS	Las tablas de la Norma ISO 2374 están en RMS
Low Frecuency limit	2 Hz	El limites de baja frecuencia debe ser un valor bajo.
Save Data	FFT and Time	Al salvar los datos en modo FFT and Time, se toma en cuenta el valor de la señal en el tiempo y se obtienen mejores señales
AutoCapture	Always	Con el modo de captura de datos en Always se agilizan las mediciones
Frequency Type	Fixed Span	El tipo Order Track es especial para toma de fases. En esta ocasión, la toma de fase no se aplica.
Speed	136 RPM	Esta velocidad cambia conforme cambia el punto a medir.
Start Frequency	0 Hz	Se inicia en 0 Hz con tal de no perder las señales en bajas frecuencias.
Lines	400	El número de lineas recomendable es 400. Un valor menor implica menos capacidad de análisis, y un valor mayor implica una toma de datos más lento.
End Frecuency	4000 Hz	Este dato puede cambiar a partir de la velocidad del elemento monitoreado.
Storage Depht	12	Para planes de monitoreo de vibraciones a largo plazo este dato debe incrementarse.
Window	Hanning	Este parámetro se usa para medición generales.
Averages	3	El número de datos con el cual obtiene el promedio debe ser bajo para agilizar la medición y evitar medidas sobrecargadas.
Speed Ratio	1	

Volver

Anexo 28: Configuración de las mediciones de Enveloping

Tabla A.28.1. Configuración de las mediciones de Enveloping

Configuración de mediciones de Velocidad		
Full scale	25 gE	El máximo esperable de los datos de velocidad es 25 gE. Ese valor es exagerado y no debería pasar de 10 gE.
Input mV/EU	100	Este es el valor del sensor original del equipo.
Detection	Peak to Peak	Usualmente los valores de Enveloping se miden de pico a pico.
Input Filter Range	500 Hz to 10 kHz	Para aplicaciones de 1800 rpm se usa el filtro 3 de Enveloping.
Save Data	FFT and Time	Al salvar los datos en modo FFT and Time, se toma en cuenta el valor de la señal en el tiempo y se obtienen mejores señales
AutoCapture	Always	Con el modo de captura de datos en Always se agilizan las mediciones
Frequency Type	Fixed Span	El tipo Order Track es especial para toma de fases. En esta ocasión, la toma de fase no se aplica.
Speed	1810 RPM	Esta velocidad cambia conforme cambia el punto a medir.
Start Frequency	0 Hz	Se inicia en 0 Hz con tal de no perder las señales en bajas frecuencias.
Lines	400	El número de líneas recomendable es 400. Un valor menor implica menos capacidad de análisis, y un valor mayor implica una toma de datos más lento.
End Frecuency	4000 Hz	Este dato puede cambiar a partir de la velocidad del elemento monitoreado.
Storage Depht	12	Para planes de monitoreo de vibraciones a largo plazo este dato debe incrementarse.
Window	Hanning	Este parámetro se usa para medición generales.
Averages	3	El número de datos con el cual obtiene el promedio debe ser bajo para agilizar la medición y evitar medidas sobrecargadas.
Speed Ratio	1	

Volver

Anexo 29: Configuración de las mediciones de Aceleración

Tabla A.29.1. Configuración de las mediciones de Aceleración

Configuración de mediciones de Velocidad		
Full scale	6 Gs	El máximo esperable de los datos es de 6 Gs.
Input mV/EU	100	Este es el valor del sensor original del equipo.
Detection	Peak	Usualmente los valores de Aceleración se miden en pico.
Low Frequency Limit	2 Hz	Este valor debe ser bajo.
Save Data	FFT and Time	Al salvar los datos en modo FFT and Time, se toma en cuenta el valor de la señal en el tiempo y se obtienen mejores señales
AutoCapture	Always	Con el modo de captura de datos en Always se agilizan las mediciones
Frequency Type	Fixed Span	El tipo Order Track es especial para toma de fases. En esta ocasión, la toma de fase no se aplica.
Speed	1810 RPM	Esta velocidad cambia conforme cambia el punto a medir.
Start Frequency	0 Hz	Se inicia en 0 Hz con tal de no perder las señales en bajas frecuencias.
Lines	400	El número de lineas recomendable es 400. Un valor menor implica menos capacidad de análisis, y un valor mayor implica una toma de datos más lento.
End Frecuency	4000 Hz	Este dato puede cambiar a partir de la velocidad del elemento monitoreado.
Storage Depht	12	Para planes de monitoreo de vibraciones a largo plazo este dato debe incrementarse.
Window	Hanning	Este parámetro se usa para medición generales.
Averages	3	El número de datos con el cual obtiene el promedio debe ser bajo para agilizar la medición y evitar medidas sobrecargadas.
Speed Ratio	1	

Volver

Anexo 30: Cálculo de la vida nominal del rodamiento del generador

El dato del L_{10h} es la vida alcanzada por al menos el 90% de una serie de rodamientos idénticos bajo las mismas condiciones y un buen funcionamiento.

El cálculo del L_{10h} para el rodamiento del Generador (6324/C3VL0241) es el que sigue:

$L_{10h} = (1000000/60 \times n) (C/P)^p$

Donde n = 1812 es igual a la velocidad en rpm de giro del eje; C = 208 kN es la capacidad de carga dinámica y corresponde a un dato de catálogo; P = 1.15 toneladas es la carga dinámica correspondiente al peso del rotor principal distribuido en dos apoyos (el peso del eje del generador es mucho menor que el del eje principal); y p = 3 para rodamientos de bolas (dato de catálogo).

Sustituyendo los valores:

$L_{10h} = (1000000/60 \times 1812) (208000N/1150 Kgf \times 9.8 N/Kgf)^3 = 57850 h = 6$ años, 7 meses.

Volver

Anexo 31: Cotización de Electricidad Americana sobre el software del Proyecto del Historiador de datos

Cotización del Software

Volver

De:	Ing. Rodrigo Fuentes (rodrigofuentes@att.net.mx)
Para:	Lic. Yolanda Neira
Empresa.	Electricidad Americana
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Fecha:	30 de enero de 2004
No. de Páginas:	-3-
Referencia Cliente	IHISTORIAN & INFOAGENT / AEROENERGÍA
Referencia SisFlex	ELECTRICIDADAMERICANA(300104)

Partida	Cant.	No. De Parte	Descripción	P.U. $ USD	Total $ USD
10	1	27004635001K	iFIX Professional SCADA Pak 900 I/O Developer Ver 3.5	$9,200.00	$9,200.00
20	2	iGC	1 GlobalCare por un año para 27004635001K	$1,500.00	$3,000.00
30	1	27014620000C	iHistorian Standard Server 300 Pts Ver 2.0	$2,500.00	$2,500.00
40	2	iGC	1 GlobalCare por un año para 27014620000C	$500.00	$1,000.00
50	1	27017210000C	iHistorian Client Connection Pack (5 Users)	$1,663.00	$1,663.00
60	2	iGC	1 GlobalCare por un año para 27017210000C	$330.00	$660.00
70	1	27018511000C	infoAgent Enterprise Client Pack 5 Users Ver 2.0	$7,500.00	$7,500.00
80	2	iGC	1 año de iGlobalCare para 27018511000C	$1,500.00	$3,000.00
90	1	901002420003	General Electric Ethernet (GE9) RES	$500.00	$500.00
100	1	91121860000C	MBR-Modicon Modbus Remote for Win 95/NT Ver 6.0 CD w/ E-DOC	$500.00	$500.00
				Subtotal 1	$29,523.00
				Menos: descuento del 5%	$1,476.15
				Subtotal 2	$28,046.85
				Mas: (*) Factor Gastos de Importación (LAB) 0%	$0.00
				TOTAL USD (Sin IVA)	$28,046.85

(*) Se Considera la siguiente tabla para efectos de gastos de importación de acuerdo al monto TOTAL de su orden de compra:

MONTO TOTAL ORDEN DE COMPRA (USD)	PORCENTAJE GASTOS DE IMPORTACIÓN (%)
Menor a $1,000.00	*8%*
Entre $1,001.00 hasta $5,000.00	*5%*
Mayor a $5,001.00	*0%*

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Col. Obispado
CP 64060
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Tel. +52 (81) 83338270
Fax. +52 (81) 83338280

INFORMACIÓN TÉCNICA

Requisitos Técnicos (**Mínimos**)

- IBM compatible, procesador Pentium III, 266 MHz, computadora personal o industrial que corra sobre plataforma Windows NT/2000/XP **en idioma inglés**.
- 96 MB RAM.
- 120 MB en disco duro.
- Drive CD-ROM.
- Monitor de color SVGA o mayor, con tarjeta de gráficos de 24 bit.
- Dispositivo apuntador.
- Puerto paralelo o USB.
- Adaptador de red: Compatible con Net-Bios ó adaptador de interfase de red TCP/IP.

INFORMACIÓN COMERCIAL

i. NOTAS

Condición de Entrega (Incoterm)	**LAB AEROPUERTO MÉXICO**
Tipo de Moneda	Dólares Americanos
Forma de Pago	100% al ordenar
Tiempo de Entrega	2 a 3 semanas posteriores a la colocación de su orden de compra
Vigencia de la Oferta	30 días

- Si su pago es en Moneda Nacional, favor de considerar el Tipo de Cambio a la venta de ventanilla del día de pago.
- Favor de incluir en el precio el 15% del I.V.A.
- Al colocar su Orden de Compra le solicitamos nos anexe los datos del Usuario Final: Nombre de la empresa, dirección, teléfono y nombre del Contacto.

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ii. CUENTAS BANCARIAS

DATOS	CUENTA 1	CUENTA 2	CUENTA 3
Banco	BANCOMER	BANAMEX	BANORTE
Sucursal	0447837461	621	San Jerónimo 584
Cuenta - M.N.	0447837453	17753	584-01171-8
Cuenta - USD	-	-	103-83577-1

iii. DATOS FISCALES

Razón Social:	SisFlex, S.A. de C.V.
R.F.C.:	SIS 960307 217
Domicilio:	Sierra Madre 730 Col. Obispado, Monterrey, N.L. C.P. 64060

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Anexo 32: Manuales digitales para la conexión y programación del PLC Mitsubishi FX $_{1N}$ y sus dispositivos.

Manual del hardware de la Tarjeta de FX $_{1N}$ -485BD

Manual del Módulo de comunicación de la serie Q

Manual de comunicación por RS-485, RS-232, RS-422

Manual del Hardware del PLC FX $_{1N}$

Manual Completo de Programación (Para observar la función RS ver página 237)

Q Corresponding Serial Communication Module

MITSUBISHI

User's Manual

(Basic)

Mitsubishi Programmable Logic Controller

MELSEC-Q

QJ71C24
QJ71C24-R2
SW0D5C-QSCU-E

• SAFETY PRECAUTIONS •

(Always read these instructions before using this equipment.)

Before using this product, please read this manual and the relevant manuals introduced in this manual carefully and pay full attention to safety to handle the product correctly.
The instructions given in this manual are concerned with this product. For the safety instructions of the programmable controller system, please read the user's manual of the CPU module to use.
In this manual, the safety instructions are ranked as "DANGER" and "CAUTION".

⚠ DANGER	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠ CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in medium or slight personal injury or physical damage.

Note that the ⚠CAUTION level may lead to a serious consequence according to the circumstances. Always follow the instructions of both levels because they are important to personal safety.

Please save this manual to make it accessible when required and always forward it to the end user.

[Design Instructions]

⚠ DANGER

- See manuals of each data link for the operating status of each station when there is a communication error in the data link.
  There is the risk of an accident occurring due to output error or malfunctioning.
- When using the notification function, the pager receiver may not be contacted due to the frequency transmission status from the system setup environment and error on the receiver side.
  To ensure the safety of the PLC system, install a call circuit with a lamp display or buzzer sound.
- When performing the control of the PLC in operation (changing data) by connecting a peripheral devices to the CPU module or personal computer, etc. to the intelligent device module, configure an interlock circuit in a sequence program so the safety of the overall system is always maintained.
  Also when performing other controls of the PLC in operation (changing program and operation status (status control)), read this manual carefully and confirm if the overall safety is maintained.
  Especially, when this control is performed to a remote PLC from an external device, troubles that have occurred on the PLC side may not be able to immediately be handled if there is a data communication error.
  Define a troubleshooting agreement between external devices and the PLC CPU for data communication error occurrences, as well as construct an interlock circuit in the sequence program.
- Do not write data into the "system area" of the buffer memory of intelligent function modules.
  Also, do not use any "prohibited to use" signals as an output signal to an intelligent function module from the PLC CPU.
  Writing data into the "system area" or outputting a signal for "prohibited to use" may cause a PLC system malfunction.

[Design Instructions]

⚠ CAUTION

- Do not bunch the control wires or communication cables with the main circuit or power wires, or install them close to each other.
  They should be installed 100mm(3.9inch) or more from each other.
  Not doing so could result in noise that may cause malfunction.
- When using the module while values, such as buffer memory set values, are registered in the Flash ROM, do not turn off the power supply for the module loading station nor reset the PLC CPU.
  If the power supply for the module loading station is turned off or the PLC CPU is reset while any values are registered, the data contents in the Flash ROM become inconsistent and as a result the values must be set again in the buffer memory, etc. and reregistered to the Flash ROM.
  Also, this may cause failure and malfunction of the module.

[Installation Instructions]

⚠ CAUTION

- Use the PLC in an environment that meets the general specifications contained in the user's manual of the CPU module to use.
  Using this PLC in an environment outside the range of the general specifications may cause electric shock, fire, malfunction, and damage to or deterioration of the product.
- When installing the module, securely insert the module fixing tabs into the mounting holes of the base unit while pressing the installation lever located a t the bottom of the module downward.
  Securely fix the module with screws if it is subject to vibration during use.
- Tighten the screws within the range of specified torque.
  If the screws are loose, it may cause the module to fallout, short circuits, or malfunction.
  If the screws are tightened too much, it may cause damage to the screw and/or the module, resulting in fallout, short circuits or malfunction.
- Switch all phases of the external power supply off when mounting or removing the module.
  Not doing so may cause damage to the module.
- Do not directly touch the conductive area or electronic components of the module.
  Doing so may cause malfunction or failure in the module.

[Wiring Instructions]

⚠ CAUTION

- When turning on the power and operating the module after installation and wiring are completed, always attach the terminal cover that comes with the product.
  There is a risk of electric shock if the terminal cover is not attached.
- Perform correct pressure-displacement, crimp-contact or soldering for external wire connections using the tools specified by the manufactures.
  Incorrect connection may cause short circuits, fire, or malfunction.
- Attach connectors to the module securely.
- Be sure to fix communication cables or power supply cables leading from the module by placing them in the duct or clamping them.
  Cables not placed in the duct or without clamping may hang or shift, allowing them to be accidentally pulled, which may cause a module malfunction and cable damage.
- Before connecting the cables, check the type o f interface to be connected.
  Connecting or erroneous wiring to the wrong interface may cause failure to the module and external devices.
- Tighten the terminal screws within the range of specified torque.
  If the terminal screws are loose, it may result in short circuits or malfunction.
  If the screws are tightened too much, it may cause damage to the screw and/or the module, resulting in fallout, short circuits or malfunction.
- When removing the communication cable or power supply cable from the module, do not pull the cable. When removing the cable with a connector, hold the connector on the side that is connected to the module.
  When removing the cable connected to the terminal block, first loosen the screws on the part that is connected to the terminal block.
  Pulling the cable that is still connected to the module may cause malfunction or damage to the module or cable.
- Be careful not to let foreign matters such as sawdust or wire chips get inside the module.
  They may cause fires, failure or malfunction.
- The top surface of the module is covered with protective film to prevent foreign objects such as cable offcuts from entering the module when wiring.
  Do not remove this film until the wiring is complete.
  Before operating the system, be sure to remove the film to provide adequate heat ventilation.

[Startup/Maintenance Instructions]

⚠ CAUTION
• Do not disassemble or modify each module. Doing so could cause failure, malfunction injury or fire. • Switch all phases of the external power supply off when mounting or removing the module. Not doing so may cause failure or malfunction of the module. • Do not touch the connector while the power is on. Doing so may cause malfunction. • Switch all phases of the external power supply off when cleaning or retightening terminal screws and module installing screws. Not doing so may cause failure or malfunction of the module. If the screws are loose, it may cause the module to fallout, short circuits, or malfunction. If the screws are tightened too much, it may cause damages to the screws and/or the module, resulting in the module falling out, short circuits or malfunction.

[Operation Instructions]

⚠ CAUTION
• When performing the control of the PLC in operation (especially changing data, program, and operation status (status control)) by connecting a personal computer, etc. to the intelligent function module, read this manual carefully and confirm if the overall safety is maintained. Failure to perform correct operation s to change data, program, or the status may result in system malfunction, machine damage, or an accident.

[Disposal Instructions]

⚠ CAUTION
• When disposing of this product, treat it as industrial waste.

REVISIONS

* The manual number is given on the bottom left of the back cover.

Print Date	* Manual Number	Revision
Dec., 1999	SH (NA) 080006-A	First Printing
Oct., 2000	SH (NA) 080006-B	Add the contents of the function version B. Correction Contents, Entire manual (change MELSECNET/10H to MELSECNET/H), About Manuals, About The Generic Terms and Abbreviations, Product Configuration, Section 1.2, 1.2(8), 1.3 POINT, Section 2.2, 2.3, 2.5, 2.6, Section 3.1, 3.6, 3.9, Section 4.2, 4.4.1(2)(a)(Figure), 4.6(1), Chapter 5(all), Section 6.1.1, 6.1.3, 6.1.4, Section 7.1.1, 7.1.2, 7.2.2, Section 8.1, 8.2.1, 8.2.2, 8.3.1, 8.3.2, Section 9.2 to 9.7, Section 10.1.1, 10.2.1, 10.3.8, 10.3.18, Appendix 1.1(2), Appendix 2(all), appendix 3(2), Appendix 7, appendix 8 Addition Entire manual (add the explanation on MELSECNET/H remote I/O station), The Manual's Use and Structure, Section 2.1, Section 3.1(Table), Section 4.4.2(1)(d), 4.9.2, Section 8.3.2 POINT, Section 10.2.1 (7164H, 7E70H), Appendix 3(1)

Japanese Manual Version SH-080001-F

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INTRODUCTION

Thank you for purchasing the MELSEC-Q series PLC.
Before using the equipment, please read this manual carefully to develop full familiarity with the functions and performance of the Q series PLC you have purchased, so as to ensure correct use.
Please forward a copy of this manual to the end user.

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SH-080007-B

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About Manuals

The following table lists the manuals relating to this product. Please order the desired manual(s) as needed.

Related manuals

Manual Name	Manual Number (Model Code)
Q Corresponding Serial Communication Module User's Manual (Application) This manual explains the specifications and operating procedures for the special module functions, the settings for use of special functions, and data-communication method for use with external devices. (sold separately)	SH-080007 (13JL87)
Q Corresponding MELSEC Communication Protocol Reference Manual This manual explains how the external devices read and write PLC CPU data through communication with the MC protocol using the serial communication module/Ethernet module. (sold separately)	SH-080008 (13JF89)

Conformation to the EMC Directive and Low Voltage Instruction

For details on making Mitsubishi PLC conform to the EMC directive and low voltage instruction when installing it in your product, please see Chapter 3, "EMC Directive and Low Voltage Instruction" of the User's Manual (Hardware) of the CPU module to use.
The CE logo is printed on the rating plate on the main body of the PLC that conforms to the EMC directive and low voltage instruction.

● How to use this manual

In this manual, details of the serial communication modules (QJ71C24 and QJ71C24-R2) are organized as shown below, according to their applications. Please use this manual using the contents below as a reference.

(1) To learn about features, functions and component parts

(a) To learn about features and functions
- Chapter 1 describes the features of the serial communication modules.
- Chapter 3 describes the common specifications and functions of the serial communication modules.

(b) To learn about the packed items and system-configured items
- The section prior to Chapter 1, "Product Configuration", describes the parts that are packed along with the serial communication module.
- Parts and components other than those packed with the module must be prepared separately by the user.

(2) To learn about processing required to start up the serial communication module

(a) To learn about the startup procedure
- Section 4.2 describes the general procedures prior to starting the operation of the serial communication module.

(b) To learn about the connection with the external devices
- Section 4.4 describes the connection methods for each type of interface.

(c) To learn about processing required prior to operation of the serial communication module
- Section 4.5 explains the parameter settings with GX Developer in order to use the serial communication module.
- Section 4.6 and Chapter 8 describe the settings from QSCU to perform the initial setting of the serial communication module.
  To change an initial value, follow the procedure described in Chapter 8.

(d) To check for failure in the serial communication module
- Section 4.7 describes the test of the individual serial communication module.

(e) To learn how to check for a connection error with the external devices
- Section 4.8 describes how to perform the individual module test and the loopback test using MC protocol-based communication.

* Details of the loopback test command are described in the reference manual.

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(3) To learn about data communication functions and detailed explanations

(a) To learn about the communication functions

- Section 3.4 describes an overview of the serial communication module functions.

(b) To learn about detailed explanations of the communication functions

- The basic communication methods are described in Chapters 5 to 7.
- Special functions are described in the User's Manual (Application).

(4) To learn about data communication functions and programming

(a) To learn how to read data from and written to the PLC CPU

- Data is read from and written to the PLC CPU with a communication function using the MC protocol.

＊ Details are described in the Reference Manual.

- Chapter 5 describes an overview of the basic communication support tool (CSKP) that supports communication using the MC protocol.

(b) To learn how to send and receive data between the PLC CPU and the external devices

- Data communication between the PLC CPU and the external devices is performed with a communication function using the non procedure protocol or the bidirectional protocol.
- Chapter 6 explains details of the communication functions and programming using the non procedure protocol.
- Chapter 7 explains details of the communication functions and programming using the bidirectional protocol.

(5) To learn how to check for error occurrences and take corrective actions

Chapter 10 describes troubleshooting, how to check for errors, and detailed explanations of error codes.

(6) To learn about functions that have been added or changed in function version B

- Section 1.3 lists the functions that have been added or changed as well as manuals that provide detailed explanations hereof.
- Appendix 1.1 provides a breakdown of the functions of Q series C24/QSCU by function version/software version.

- The structure of this manual

  The module's buffer memory stores default values that are used as initial settings to execute the data send/receive functions in order to communicate with the external devices.
  Data can be sent to or received from the external devices using these default values. However, it may be necessary to change the default values, depending on system specifications.
  This manual explains how to perform the initial settings in order to use each function of the utility package available for this module (SW0D5C-QSCU-E).
  When changing a default value for sending and receiving data to/from an opposite device, first see the section describing the applicable function to verify the initial setting item and setting value you wish to change, then change the default value as explained in Chapter 8.

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About The Generic Terms and Abbreviations

This manual uses the following generic terms and abbreviations to describe the serial communication modules, unless otherwise specified.

(1) Generic terms and abbreviations of relevant modules

In this manual, the following generic terms and abbreviations are used to indicate the PLC CPU and other modules used for the data-communication functions of the serial communication modules. Module model names are provided when relevant model names are needed to be shown.

Generic term/abbreviation	Description of generic term/abbreviation	
Ethernet modules Q series E71 (E71)	Abbreviation for Q series Ethernet interface modules QJ71E71, QJ71E71-B2. (Indicated as "E71" in the diagrams)	
Q series C24 (C24)	Abbreviation for Q series serial communication modules QJ71C24, QJ71C24-R2. (Indicated as "C24" in the diagrams)	
QC24	Generic term for AJ71QC24, AJ71QC24-R2, AJ71QC24-R4, A1SJ71QC24, A1SJ71QC24-R2.	
QC24N	Generic term for AJ71QC24N, AJ71QC24N-R2, AJ71QC24N-R4, A1SJ71QC24N, A1SJ71QC24N-R2.	
QC24(N)	Generic term for QC24, QC24N.	
QCPU	Q mode	Generic term for Q02CPU, Q02HCPU, Q06HCPU, Q12HCPU, Q25HCPU.
QCPU station	Abbreviation for the PLC with QCPU installed.	
QnACPU	Generic term for Q2ACPU, Q2ACPU-S1, Q2ASCPU, Q2ASCPU-S1, Q2ASHCPU, Q2ASHCPU-S1, Q3ACPU, Q4ACPU, Q4ARCPU.	
QnACPU station	Abbreviation for the PLC with QnACPU installed.	
Q/QnACPU	Generic term for QCPU, QnACPU.	
UC24 Computer link module	Generic term for AJ71UC24, A1SJ71UC24-R2, A1SJ71UC24-R4, A1SJ71UC24-PRF, A1SJ71C24-R2, A1SJ71C24-R4, A1SJ71C24-PRF, A2CCPUC24, A2CCPUC24-PRF. ＊ A series computer link modules.	
Serial communication module	Generic term for the module below.	
	QnA series	AJ71QC24, AJ71QC24-R2, AJ71QC24-R4, A1SJ71QC24, A1SJ71QC24-R2, AJ71QC24N, AJ71QC24N-R2, AJ71QC24N-R4, A1SJ71QC24N, A1SJ71QC24N-R2.
	Q series	QJ71C24, QJ71C24-R2

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(2) Other generic terms and abbreviations

This manual uses the following generic terms and abbreviations to explain the data-communication devices for the serial communication module. The names/model names are provided when it is necessary to explicitly identify the model being discussed.

Generic term/abbreviation	Description of generic term/abbreviation
ACT	Abbreviation for MX Component (SWnD5C-ACT-E). (n in the model name should be 0 or greater)
Buffer memory	Generic term for memory of the intelligent function modules/special function modules used for storing data sent to or received from the PLC CPU (setting values, monitor values, etc.)
Computer	Generic term for one of the external devices with which data can be sent/received using the MC protocol or the bidirectional protocol.
CSKP	Abbreviation for MX Links (SWnD5F-CSKP-E). (n in the model should be 3 or greater)
Data communication functions	Generic term for MC protocol, non procedure protocol, and bidirectional protocol.
GX Developer	Abbreviation for GX Developer (SWnD5C-GPPW-E). (n in the model should be 4 or greater)
I/F	Abbreviation for interface
Intelligent function module devices	Generic term for buffer memory of the intelligent function modules used for storing data sent to or received from the PLC CPU (setting values, monitor values, etc.)
Intelligent function modules	Generic term for the Q series PLC modules that are operated by commands from the PLC CPU (equivalent to the A series PLC special function modules). Examples: • CC-Link interface module • A/D and D/A conversion modules • Ethernet interface module • Serial communication module
MELSECNET/10	Abbreviation for MELSECNET/10 network system.
MELSECNET/H	Abbreviation for MELSECNET/H network system.
Opposite devices (external devices)	Generic term for computers, indicators, measuring instruments, ID modules, bar code readers, regulators, other serial communication modules, UC24, etc. that are connected to this serial communication module for data communication.
QSCU	Abbreviation for GX Configurator-SC (SW0D5C-QSCU-E). Initial settings for the module, monitoring and testing can be performed without using a sequence program and without considering I/O signals or buffer memory.
Reference Manual	Q Corresponding MELSEC Communication Protocol Reference Manual
RS-232 (interface)	Abbreviation for interface conforming to RS-232.
RS-422/485 (interface)	Abbreviation for interface conforming to RS-422 and RS-485.
Special function modules	Generic term for the A/QnA series PLC modules that are operated by commands from the PLC CPU (equivalent to the Q series PLC intelligent function modules). Examples: • CC-Link interface module • A/D and D/A conversion modules • High-speed counter module • Ethernet interface module • Computer link module and serial communication module
User's Manual (Application) or Application	Q Corresponding Serial Communication Module User's Manual (Application)
User's Manual (Basic) or Basic	Q Corresponding Serial Communication Module User's Manual (Basic)

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Definitions and Descriptions of Terminology

The following table lists the definitions and descriptions of terminology used in this manual and related manuals for the Q series serial communication modules.

Terms	Description
A compatible IC frame (Formats 1 to 4)	One of the message formats for the serial communication module for performing communication using the MC protocol and ASCII code data. This is the same message format as when communicating using the protocol for the A series computer link modules. Device memory read/write operations for the QCPU are allowed within the device range of the AnACPU. For details, see Chapter 5 of the Reference Manual.
Bidirectional protocol	A communication procedure for the serial communication modules and one of the data communication functions for communicating any data between the PLC CPU and an opposite device. Details are explained in Chapter 7.
Independent operation	A mode of interface operation to communicate data with external devices using a function specified in each communication protocol setting. Two interfaces of serial communication modules do not interact.
Linked operation	The operation mode of each of the two interfaces for a serial communication module that are connected to external devices and linked to one another in order to send/receive data to/from the external devices. The two interfaces communicate data using the identical data-communication function (MC protocol (identical format) or non procedure protocol) and the identical transmission specifications. (Linked operation using the bidirectional protocol is not allowed.)
MELSEC communication protocol (MC protocol)	A communication procedure for the Q series serial communication modules or the Ethernet interface modules, and a name of communication method for accessing to the PLC CPU from an opposite device. (This is called the MC protocol in this manual.) There are two communication methods; one uses ASCII code data and the other uses binary code data. Details are explained in the Reference Manual.
Message send function (Printer function)	This function registers character data (messages) to be sent to external devices (mainly printers) in the serial communication module as an user frame in advance, and sends the registered data for multiple user frames using the non procedure protocol (sent by an instruction from the PLC CPU).
Multidrop connection	A name of the connection when multiple external devices or other serial communication modules are connected in a 1:n or m:n mode using the serial communication module's RS-422/485 interface.
Non procedure protocol	An user's communication procedure and one of the data communication functions for communicating any data between the PLC CPU and an opposite device. Details are explained in Chapter 6.
QnA compatible 2C frame (Formats 1 to 4)	One of the message formats for the serial communication module for performing communication using the MC protocol and ASCII code data. This is the same message format as the communication frame using the protocol for the QnA series serial communication modules. • QnA compatible 2C frame (Formats 1 to 4): QnA simplified frame (Formats 1 to 4) Details are explained in Chapter 4 of the Reference Manual.
QnA compatible 3C frame (Formats 1 to 4) QnA compatible 4C frame (Formats 1 to 4)	One of the message formats for the serial communication module for performing communication using the MC protocol and ASCII code data. This is the same message format as the communication frame using the protocol for the QnA series serial communication modules. • QnA compatible 3C frame (Formats 1 to 4): QnA frame (Formats 1 to 4) • QnA compatible 4C frame (Formats 1 to 4): QnA extension frame (Formats 1 to 4) Details are explained in Chapter 3 of the Reference Manual.

Terms	Description
QnA compatible 4C frame (Format 5)	One of the message formats for the serial communication module for performing communication using the MC protocol and binary code data. This is the same message format as the communication frame using the protocol for the QnA series serial communication modules. • QnA compatible 4C frame (Format 5): QnA extension frame (Format 5) Details are explained in Chapter 3 of the Reference Manual.
User frame	Data name when the fixed format portion of messages to be sent or received between a serial communication module and an opposite device is registered in the module and used for sending and receiving data with the functions listed below. (The contents of an user frame data should conform to the specifications of the opposite device). The data array of the head and tail sections of a message (transmission control code, C24 station number, sum check, fixed data, etc.) to be sent and received is registered in the serial communication module before use. • MC protocol on-demand function. • Data communication function using the non procedure protocol. Details are explained in Chapter 9 of the User's Manual (Applications).

Product Configuration

The following lists the product configuration of the Q series serial communication modules.

Model	Item name	Quantity
QJ71C24	QJ71C24 serial communication module	1
	Terminal resistor 330Ω 1/4 W (for RS-422 communication)	2
	Terminal resistor 110Ω 1/2 W (for RS-485 communication)	2
QJ71C24-R2	QJ71C24-R2 serial communication module	1
SW0D5C-QSCU-E	SW0D5C-QSCU-E serial communication module setting·monitor tool	1
	SW0D5F-QSCKEY-E license key FD	1

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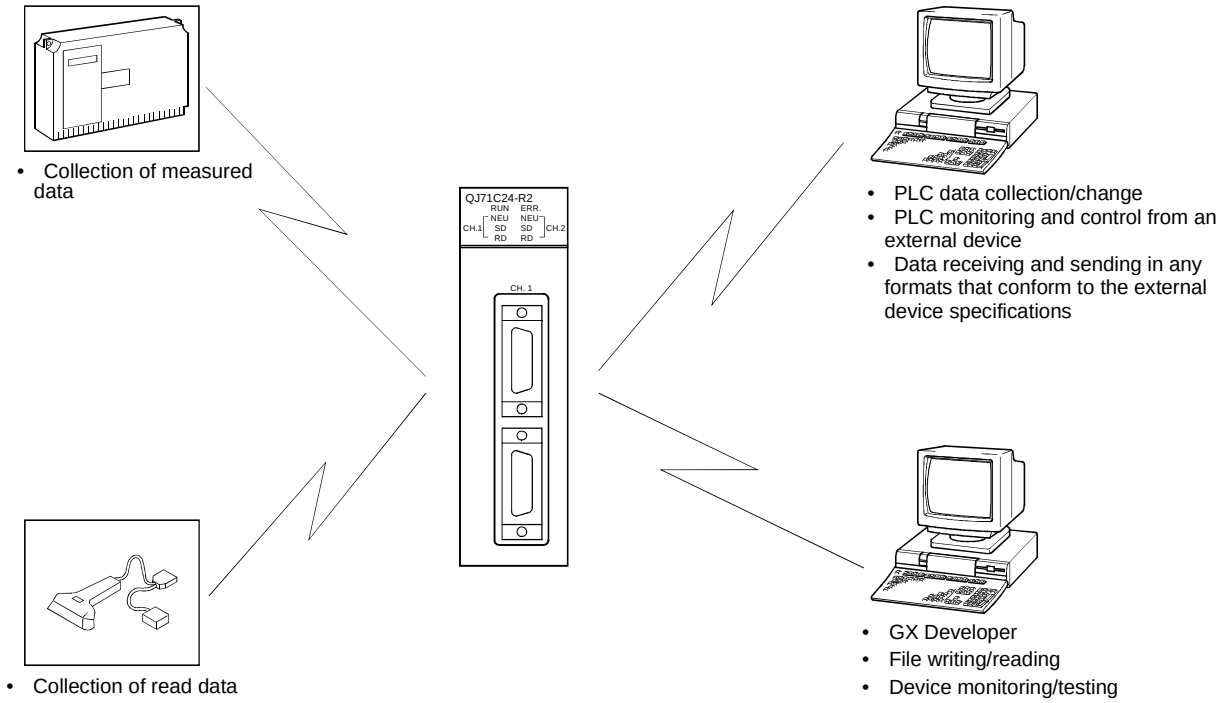
1 OVERVIEW

This manual describes the specifications for the QJ71C24 (-R2) serial communication module (hereinafter referred to as "Q series C24"), as well as the procedures prior to starting the operation, maintenance, inspection, data communication methods for use with external devices and troubleshooting.

1.1 Overview of the Serial Communication Module

The Q series C24 is a module that connects the Q series PLC CPU and an external device using an RS-232 or RS-422/485 line for serial communication, in order to achieve the data communication described below.
By using a modem/terminal adapter, a public line (analog/digital) can be used for data communication with a remote location.

- PLC data collection/change from the external devices
  (See the MELSEC Communication Protocol Reference Manual.)
- PLC monitoring and control from the external devices (See Chapter 2 of the User's Manual (Application).)
- Data receiving and sending in any formats that conform to the external device specifications (See (2) and (3) of Section 1.2.)
- Collection of measured data from a measuring device (See (2) of Section 1.2.)
- Operation of a PLC CPU that is connected to a personal computer (hereinafter abbreviated as PC) installed with GX Developer (SW4D5C-GPPW-E or later, hereinafter abbreviated as GX Developer). (See the GX Developer Manual.)



✻ Being a convenient means of connection among different devices (PCs, display devices, printers, etc.), the serial communication line is the most widely used medium on the market today.

1 - 1

1.2 Features of the Serial Communication Module

The following describes the features of the Q series C24.

(1) Data communication based on the MELSEC communication protocol (hereinafter referred to as the MC protocol)
(Details are explained in the MELSEC Communication Protocol Reference Manual.)

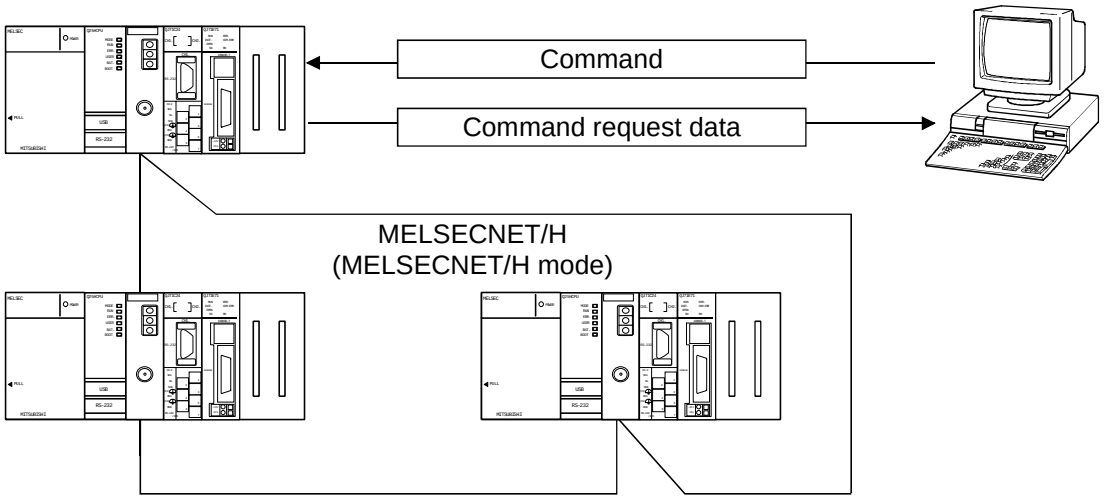
(a) External devices can read/write the PLC device data and sequence programs, and can monitor PLC equipment status.
With the exception of the on-demand function described below, the PLC does not require a sequence program because the PLC sends and receives data based solely on commands from external devices.

(b) Using the on-demand function, data can be sent from the PLC CPU to the external devices in each frame format of the MC protocol.

(c) Data communication can be performed using a program at the external device side that has been created for communicating data with conventional A/QnA series computer link module/serial communication modules.

(d) If the external device is a PC running one of the basic operation systems below, it is possible to create a communication program for the external device without considering the detailed MC protocol (transmission/reception procedures) using one of the following separately sold communication support tools.
(Supported basic operation systems)
- Microsoft® Windows® 95 operating system
- Microsoft® Windows® 98 operating system
- Microsoft® Windows NT® Workstation4.0 operating system

(Separately sold communication support tools)
- MX Component (SW0D5C-ACT-E, hereinafter abbreviated as ACT)
- MX Links (SW3D5F-CSKP-E and later, hereinafter abbreviated as CSKP)



* In the MELSECNET/10 mode, other stations (including the A/QnA series PLC CPUs) can be accessed during data link operation.
* The MC protocol is equivalent to the communication function using a dedicated protocol that is supported by the A/QnA series computer link module/serial communication modules.

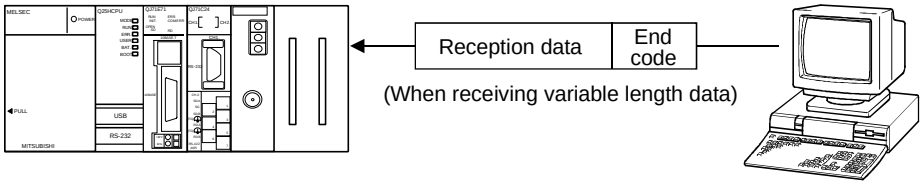
(2) Data communication using the non procedure protocol

(Details are explained in Chapter 6 and the User's Manual (Application).)

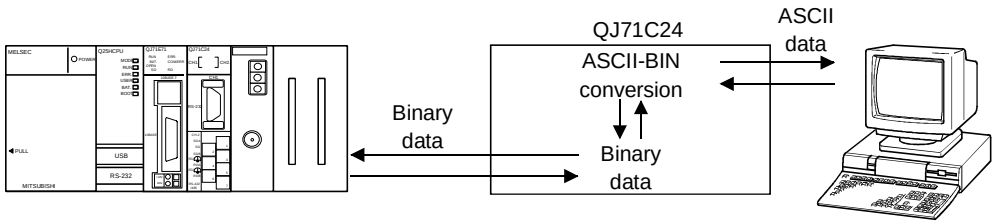
(a) Data can be transferred in any message formats that conform to the specifications of external devices (measuring devices, PCs, etc.).

(b) Fixed or variable length messages can be received in accordance with the external device specifications.

- How to receive the variable length data
  The external device sends data by adding at the end of the message the end-code data (CR+LF or any one-byte data) that is set for the Q series C24.
- How to receive the fixed length data
  The external device sends the amount of data equivalent to the size of the end data that is set for the Q series C24.



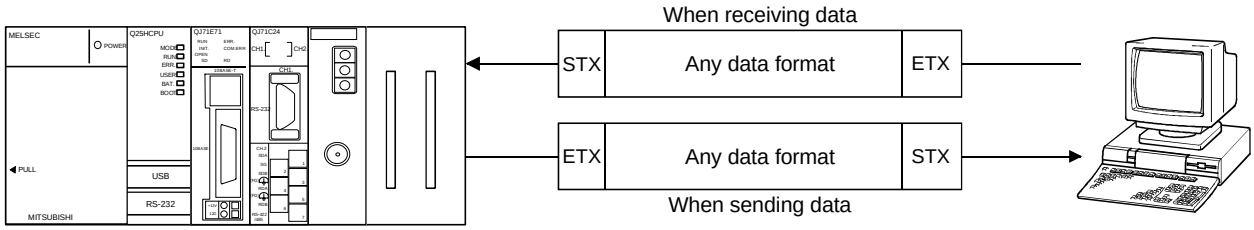
(c) ASCII code data can be used for communication using the ASCII-BIN conversion function.



(d) It is necessary to create a sequence program for communication control that conforms to the external device.

(e) Communication can be performed using an user frame by registering the fixed format portion of the head and tail sections of a message as an user frame.

- When sending data, the Q series C24 adds an user frame to any data specified by the user.
- When receiving data, the Q series C24 transfers any data excluding the user frame to the PLC CPU.



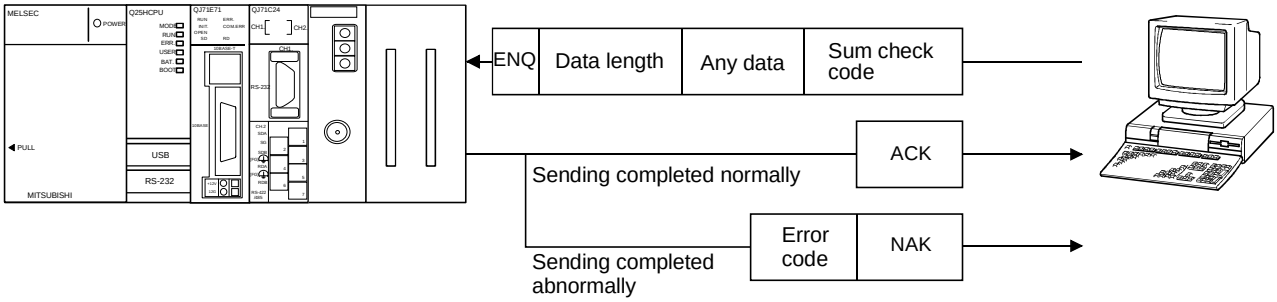
(f) It is possible to clear the current reception data without interrupting the transmission processing by using the dedicated instruction "CSET."

(3) Data communication using the bidirectional protocol

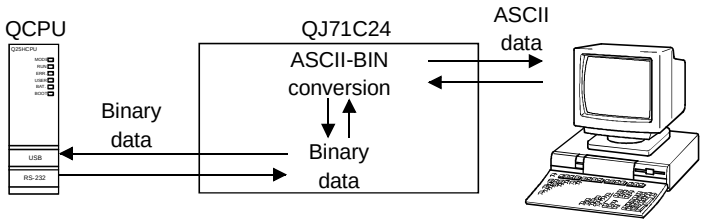
(Details are explained in Chapter 7 and the User's Manual (Application).)

(a) In communication between PLC CPUs and communication with an external device for which transmission/receive control programming is allowed, data communication is performed in a sequence of "data transmission and response receipt".

(b) Error check of received data can be performed using the sum-check code, while the occurrence of a reception error at an external device can be checked via an ACK/NAK response.



(c) ASCII code data can be used for communication using the ASCII-BIN conversion function.



(4) Monitoring the PLC CPU

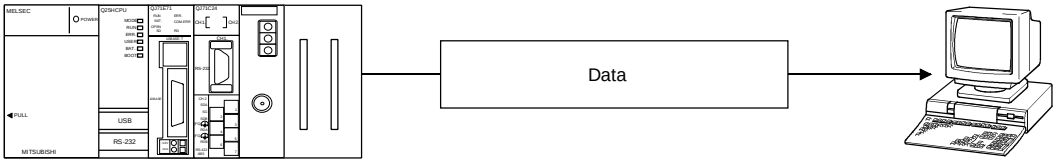
(Details are explained in the User's Manual (Application).)

(a) The self-station's PLC CPU can be monitored at time intervals set by the user without using a sequence program.

1) The following monitoring information can be sent/notified as the result of monitoring the PLC CPU.
   - Transmission of information on devices and the PLC CPU status to be monitored. (It is also possible to send the monitoring information through combined use of the modem function.)
   - Notification of a notification message (string data) registered as the connection data of the modem function, through combined use of the modem function.

2) The user can select either one of the following timing choices at which to send the PLC CPU monitoring result to the external device.
   - Send/notify every time the PLC CPU is monitored (periodic transmission).
   - Send/notify when the information read from the PLC CPU matches the conditions set by the user (conditional transmission).

(b) The PLC CPU monitoring function can be used in communication using the MC or non procedure protocol.



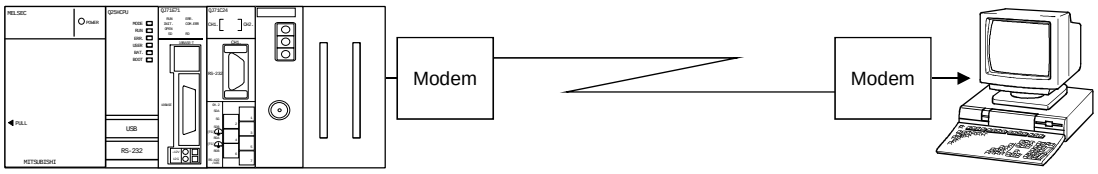
(5) Remote communications using the modem function

(Details are explained in the User's Manual (Application).)

(a) Data communication can be performed with a remotely located external device.

(b) Modem initialization and line connection/disconnection can be performed.

(c) Data communication can be performed using the MC, non procedure or bidirectional protocol.



(6) Initial settings and communication settings without using a sequence program

Various initial settings can be performed using the GX Congifurator-SC (SW0D5C-QSCU-E, hereinafter abbreviated as QSCU).

(7) Connecting the GX Developer and the GOT

(a) Connecting the GX Developer (Details are explained in the GX Developer Operating Manual.)

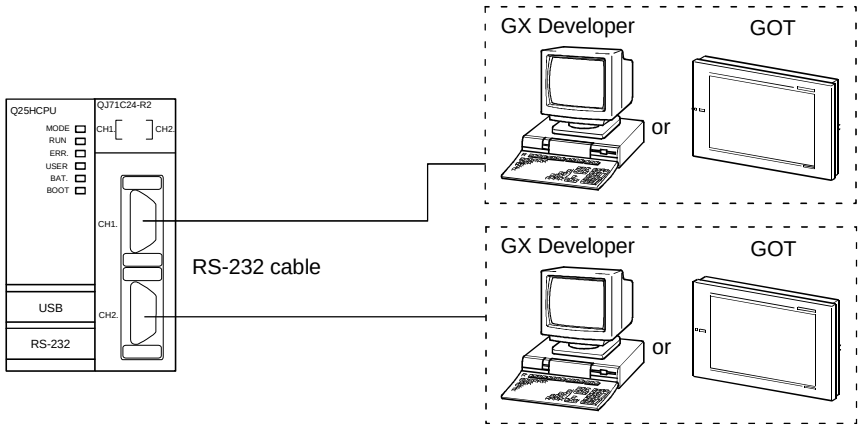
- By connecting a PC installed with a GX Developer to the interface of the Q series C24 at the same time, operations such as programming, monitoring and testing for the PLC CPU can be performed.
- By connecting multiple PCs installed with GX Developers to the PLC CPU or Q-series C24 at the same time, operations such as programming and monitoring can be performed simultaneously by multiple operators. Operating the GX Developers using these simultaneous connections can improve program performance.
- Operations can be performed from a GX Developer by setting the communication protocol of the Q series C24 interface to which a PC is connected to "0" with the switch setting using the GX Developer.

(b) Connecting the GOT (Details are explained in the GOT User's Manual (Connection).)

- By connecting a GOT (graphic operation terminal) to the interface for the Q series C24 operations such as monitoring the PLC CPU can be performed.
- Operations such as monitoring the PLC CPU can be performed by setting the communication protocol of the Q series C24 interface to which a GOT is connected to "0" with the switch setting using a GX Developer.

(c) Simultaneous connection of GX Developer and GOT

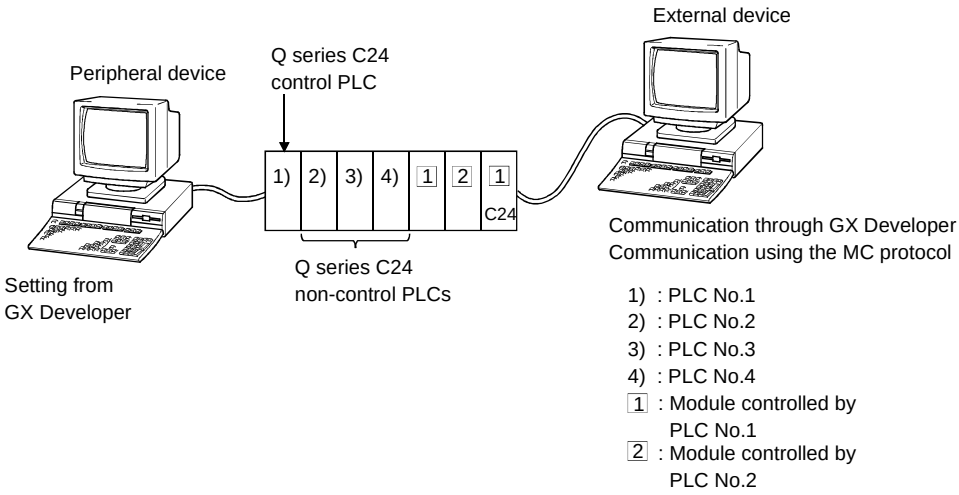
- It is possible to connect a PC with GX Developer and the GOT to two interfaces of the Q series C24 at the same time. It is thus possible for more than one user to perform programming, monitoring, etc. simultaneously.
- When the GOT and the PC with GX Developer are connected at the same time, the two interfaces of the Q series C24 cannot perform an interlock operation.



(8) Functions supporting multiple PLC systems (Details are explained in the Reference Manual.)

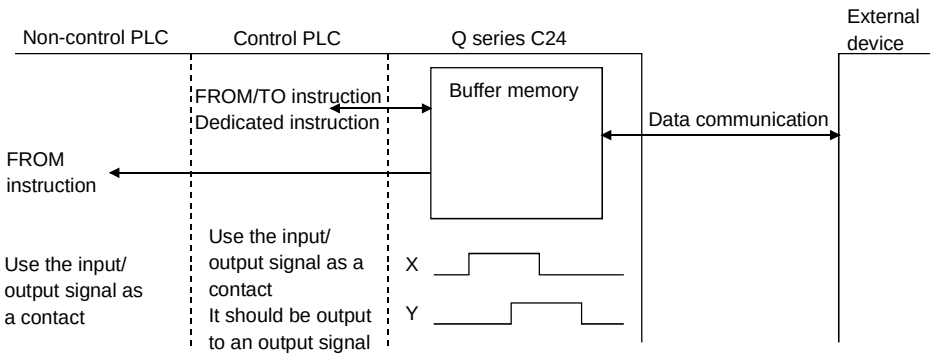
(a) When accessing QCPUs in a multiple PLC system using the MC protocol or through GX Developer (SW6D5C-GPPW-E), it is possible to perform data communication such as reading/writing device data by specifying the QCPU to be accessed.

- When using the Q series C24 in a multiple PLC system, a QCPU controlling the Q series C24 (hereinafter referred to as the control PLC) should be specified using GX Developer (SW6D5C-GPPW-E).
  It is also possible to mount a Q series C24 of function version A in a multiple PLC system and access to the only control PLC (PLC No.1).



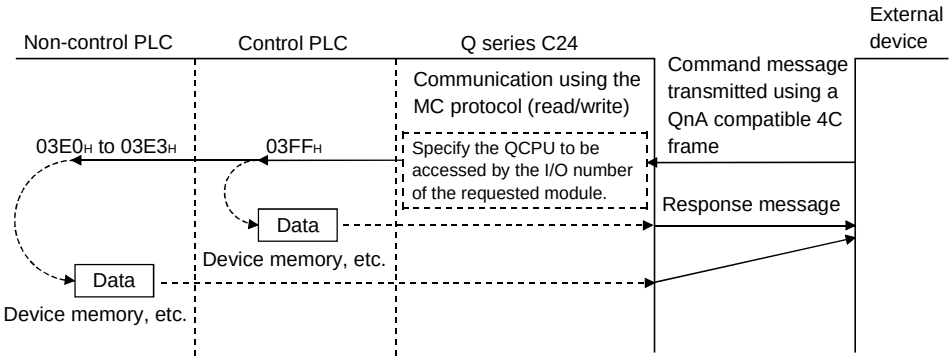
(b) When a Q series C24 CPU of function version B is used in a multiple PLC system, the following forms of data communication can be performed with the Q series C24.

1) It is possible to perform data communication using the non procedure/bidirectional protocols from the control PLC
2) It is possible to read the buffer memory from non-control PLCs. Input/output signals can be used as contacts.



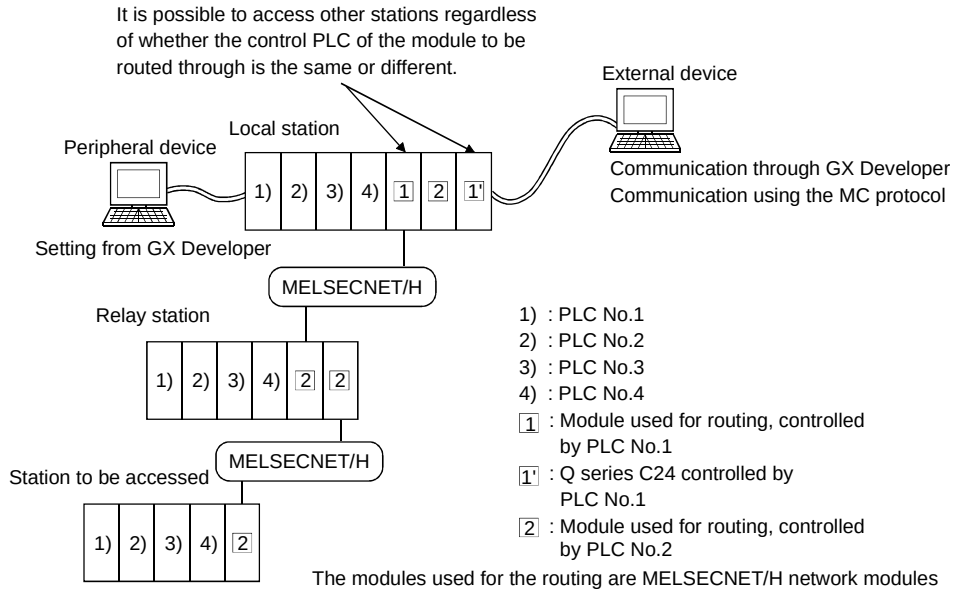
POINT
In a multiple PLC system mounted the Q series C24, it is only the control PLC of the Q series C24 that can use the functions of the Q series C24.

3) It is possible to access the control PLC and non-control PLCs using the MC protocol and through GX Developer (SW6D5C-GPPW-E) from the external device.
In addition, data communication with the control PLC of the Q series C24 can be performed using the non procedure/bidirectional protocol.



If the MC protocol is used to access other stations, it is possible to access the control PLC and non-control PLCs of the station to be accessed even if the relay station and the accessed station are multiple PLC systems.

(Example)



* The QnA compatible 4C frame should be performed for access to non-control PLCs when communicating using the MC protocol.
However, the available functions differ depending on the QCPU to be accessed (whether it is a control PLC or a non-control PLC).
See the Reference Manual for the available functions and accessible range.

* A module used for routing can access the following modules when accessing other stations:
  - MELSECNET/H, MELSECNET/10 network module
  - Q series C24 • Ethernet interface module

* If there is a module of function version A among the modules for routing, it is possible to access the control PLC of that particular module only. In addition, it is possible to access other stations via a module controlled by the same control PLC.

(9) Remote password check function

(Details are explained in the User's Manual (Application) and the Reference Manual.)

(a) The remote password check function of the Q series C24 prevents users at a remote location to access QCPUs illegally using the modem function of the Q series C24.

(The remote password is checked in the following forms of data communication)

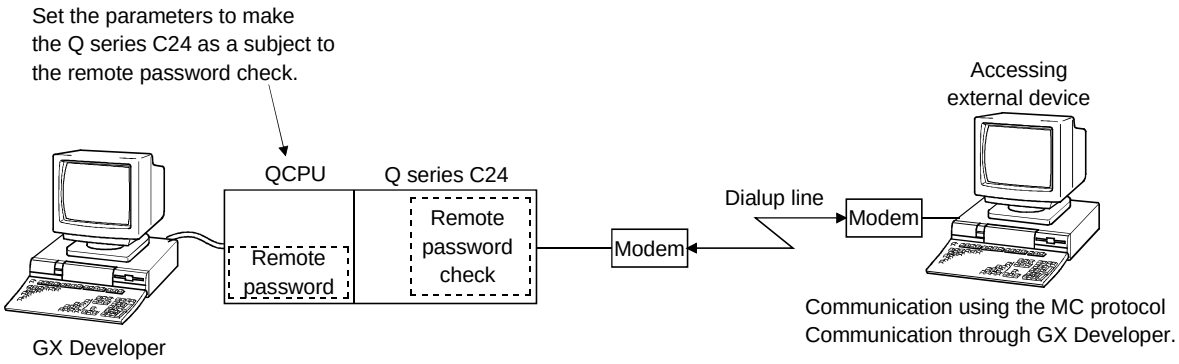
- Communication using the MC protocol
  (The remote password check is not carried out in data communication using the non procedure/bidirectional protocols.)
- Access to the PLC through GX Developer (SW6D5C-GPPW-E)

* The remote password function is one of the QCPU functions and used for preventing illegal access to the QCPU by other users.
  Use GX Developer (SW6D5C-GPPW-E) to set a remote password for the QCPU in order to activate the remote password function of the QCPU.

(b) If the Q series C24 is specified in the parameters of a QCPU as being subject to the remote password check, the remote password can be unlocked (canceled) using either one of the methods below, to allow data communication from the external device. It is necessary to connect a line to the modem first.

- When communicating using the MC protocol
  Use the dedicated command for communication using the MC protocol to unlock the remote password from the external device.
- When accessing the PLC through GX Developer (SW6D5C-GPPW-E)
  Unlock the remote password using GX Developer (SW6D5C-GPPW-E) at the start of online operation.

The remote password is automatically locked by disconnecting the line to the modem.



1.3 About Added/Changed Functions in Function Version B

The table below lists the functions that have been added or changed in the Q series C24 of function version B.

Function	Outline of function	Reference section
Simultaneous connection of GX Developer and GOT	This function allows access to the PLC from a PC with GX Developer and a GOT connected to two different interfaces of the Q series C24 at the same time.	Section 1.2 of User's Manual (Basic)
Clearing reception data by a dedicated instruction	This function allows clearing reception data using the CSET instruction during data communication using the non procedure protocol. It is possible to clear the data even when data is being transmitted.	Chapter 6, Section 9.8 of User's Manual (Basic)
Transmission of the PLC CPU monitoring information through combined use of the modem function	When the PLC CPU monitoring function is active, this function sends the monitoring information of the PLC CPU to the external device through the modem.	Chapter 2 of User's Manual (Application)
Addition of changeable data to the user frame	The following codes can be registered as changeable data for user frames for data communication: • Horizontal parity code • Sum check code of two's-complement number	Chapter 9 of User's Manual (Application)
Adding a reception function through the use of user frames	This function allows reception of a message consisting of the head frame and any data field when receiving data by specifying the head frame. The data length of the data field can be specified freely for each combination of user frames for reception set by the user. (Receiving 1 byte providing ACK/NAK only is also possible by setting the data length of the data field to "0.")	Chapter 11 of User's Manual (Application)
Multiple specification of transparent codes for transmission	This function allows specification of a maximum of 10 types of transparent codes for transmission per interface when sending data using one of the following protocols: • Non procedure protocol • Bidirectional protocol	Chapter 12 of User's Manual (Application)
Remote password check	This function allows data communication after the external device completes the unlock processing of the remote password set at a QCPU. It is executed when the QCPU is accessed from a remote location using the modem function of the Q series C24 in the following forms of data communication: • Communication using the MC protocol • Communication using GX Developer (SW6D5C-GPPW-E)	Chapter 3 of User's Manual Section 3.18 of Reference Manual
Support for multiple PLC system	This function allows access to the control/non-control PLCs specified by the user when performing the following forms of data communication with a multiple PLC system: • Communication using the MC protocol • QCPU access from GX Developer (SW6D5C-GPPW-E)	Section 2.10 of Reference Manual
Data transmission/reception at low speed	This function allows data communication with an external device at a transmission speed of 50 bps.	Chapter 4 of User's Manual (Basic)

POINT

(1) See Appendix 1.1 for a comparison of functions by function version.
(2) See Section 2.6 for how to check the function version.

2 SYSTEM CONFIGURATION AND AVAILABLE FUNCTIONS

This Chapter describes the system configuration and available functions.

2.1 Applicable Systems

The following describes applicable systems.

(1) Applicable modules and number of modules that can be mounted

The following table lists the CPU module and remote I/O stations that the Q series C24 can be mounted and the number of modules which can be mounted.

Applicable module		Number of modules that can be mounted	Remarks
CPU module	Q02CPU Q02HCPU Q06HCPU Q12HCPU Q25HCPU	Maximum 64	Can only be mounted in Q mode.
Remote I/O station	QJ72LP25-25 QJ72BR15		MELSECNET/H remote I/O station

(2) The base module to which the Q series C24 can be mounted

The Q series C24 can be mounted into any I/O slot (*1) of the base module.

*1 Limited to within the range of I/O points for the CPU module and remote I/O station

(3) Applicable software packages

The following table lists the software/setting & monitor tool available for the Q series C24.

(a) Software/setting & monitor tool for the PLC

Item name	Model	Remarks
GX Developer	SWnD5C-GPPW-E (-V)	MELSEC PLC programming software The "n" in the model name is 4 or greater
GX Configurator-SC	SWnD5C-QSCU-E	Q series serial communication module setting/monitor tool SWnD5C-GPPW-E is required

(b) Communication support tools for external device

Item name	Model	Remarks
MX Component	SWnD5C-ACT-E	ActiveX library for communication The "n" in the model name is 0 or greater.
MX Links	SWnD5C-CSKP-E	DLL library for communication The "n" in the model name is 3 or greater.

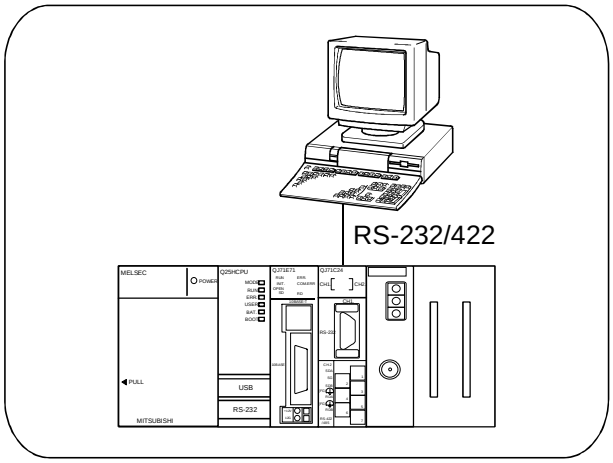
2.2 Combinations of PLC CPU and External Device, and Available Functions

The following describes the system configurations and available functions when using the Q series C24.

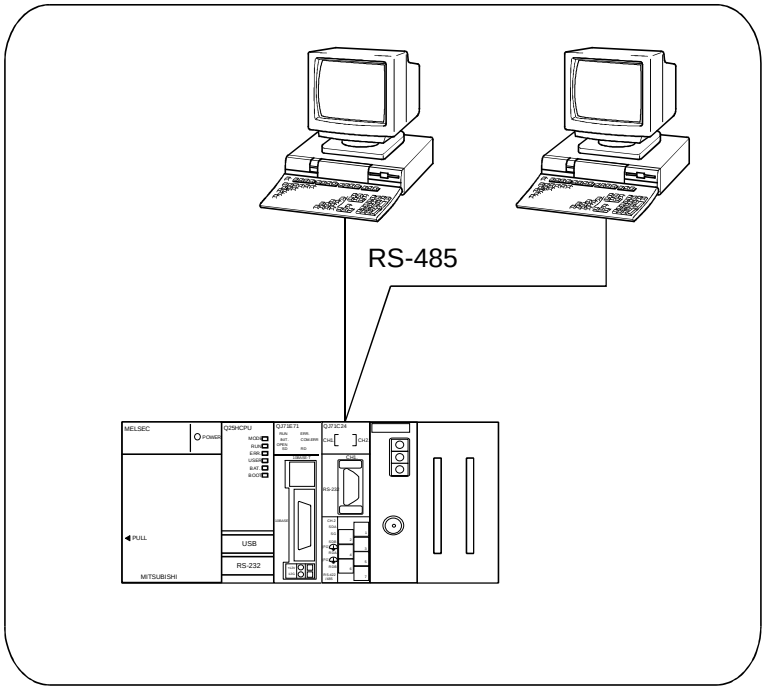
(1) System configurations

System configurations (combinations of PLC CPU and external device) for data communication are shown below.

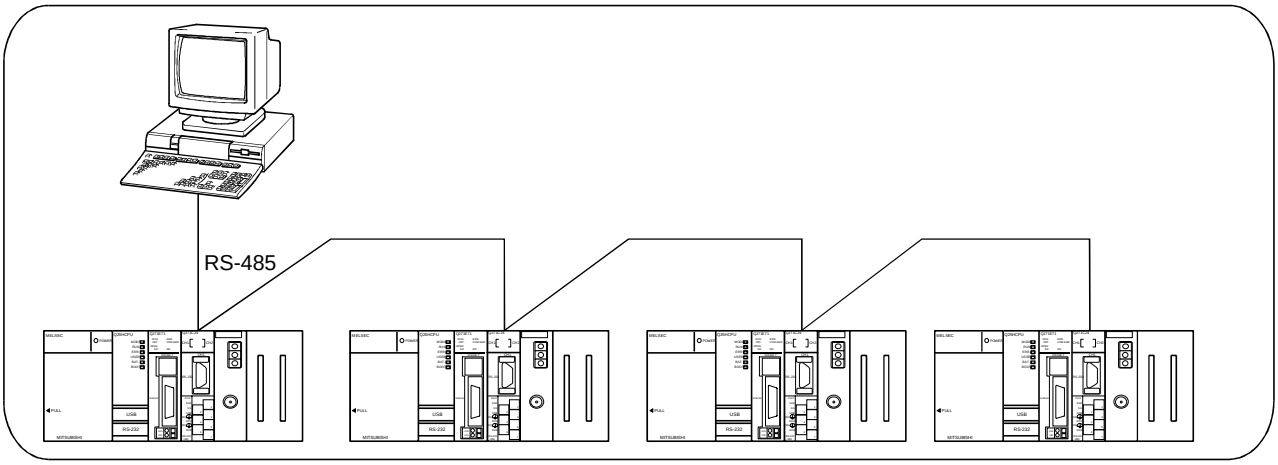
(a) For 1:1 system configuration (external device: Q series C24)

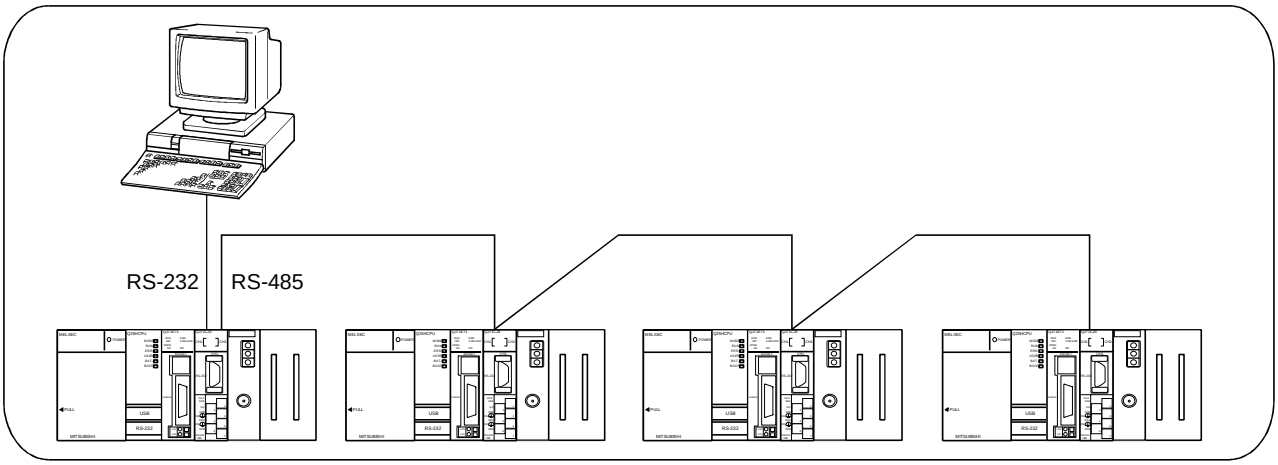


(b) For n:1 system configuration (external device: Q series C24)

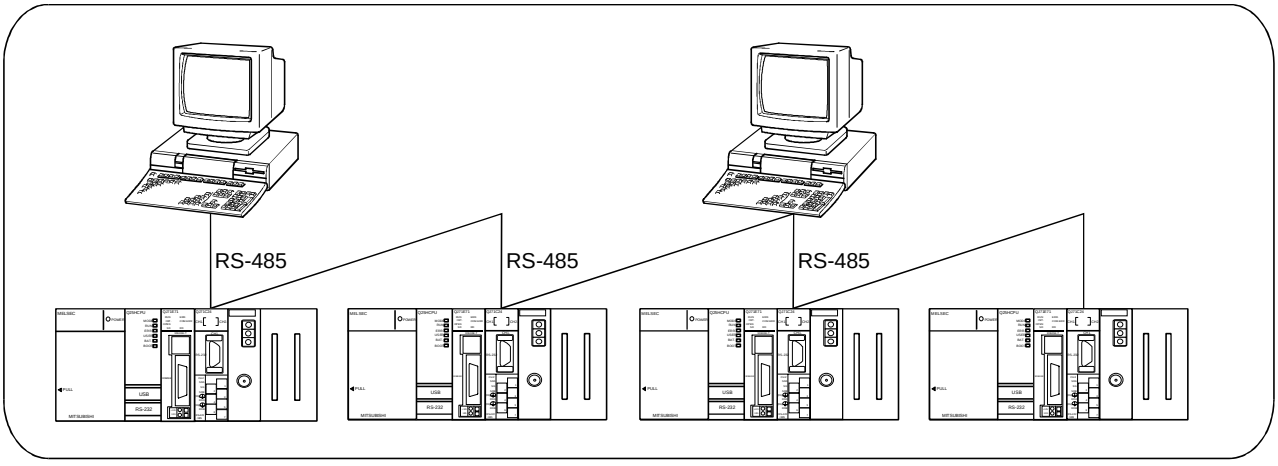


(c) For 1:n system configuration (external device: Q series C24)





(d) For m:n system configuration (external device: Q series C24)



(2) Correspondence between the data communication functions and system configurations

The following shows system configurations that can use the data communication functions of the Q series C24.

The manual names shown in the reference section column in the table below are as follows:

- Application
  Q Corresponding Serial Communication Module User's Manual (Application)
- Reference
  Q Corresponding MELSEC Communication Protocol Reference Manual

(a) Communication using the MC protocol (○ : Available, × : Not available)

Functions of the Q series C24	System configuration				Reference section	
	1 : 1	n : 1	1 : n	m : n		
PLC CPU device memory read/write	○	○	○	○	Reference	Section 3.3
Intelligent function module buffer memory read/write	○	○	○	○		Section 3.5
Sequence program read/write	○	○	○	○		Section 3.8
PLC CPU status control (remote RUN, STOP, etc.)	○	○	○	○		Section 3.6
On-demand function	○	×	×	×		Section 3.11
					Application	Chapter 10
Global function	○	○	○	○	Reference	Section 3.10
Accessing the PLC of other stations in the MELSECNET/H, MELSECNET/10	○	○	○	○		Section 2.7
PLC CPU monitoring function	○	×	×	×	Application	Chapter 2

(b) Communication using the non procedure protocol

(○ : Available, × : Not available)

Functions of the Q series C24	System configuration				Reference section	
	1 : 1	n : 1	1 : n	m : n		
Data transmission/receiving in arbitrary format	○	○	○	○	This manual	Chapter 6
Data transmission/receiving with user frames	○	○	○	○	Application	Chapter 11
PLC CPU monitoring function	○	×	×	×		Chapter 2
Reading received data using interrupt programs	○	○	○	○		Chapter 4
Sending/receiving ASCII data using ASCII-BIN conversion	○	○	○	○		Chapter 13

(c) Communication using the bidirectional protocol

(○ : Available , × : Not available)

Functions of the Q series C24	System configuration				Reference section	
	1 : 1	n : 1	1 : n	m : n		
Data transmission/receiving	○	×	×	×	This manual	Chapter 7
Reading received data using interrupt programs	○	×	×	×	Application	Chapter 4
Sending/receiving ASCII data using ASCII-BIN conversion	○	×	×	×		Chapter 13

✻ In general, if data communication is performed using a system configuration of other than 1:1 connection mode, the following points should be well noted.

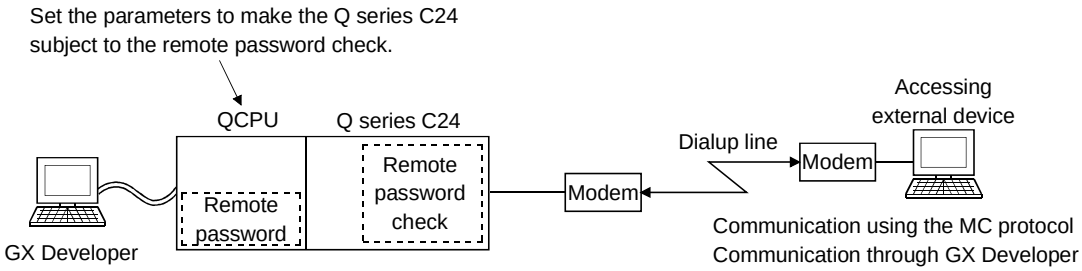
- Avoid simultaneous transmission.
- Discard data received other than that addressed to the local station.

2.3 When Using the Remote Password Function of the QCPU

This section explains how to use the remote password function of the QCPU.

(1) Use the following Q series C24 and QSCU to QCPU remote password to activate the remote password check function of the Q series C24.
- Q series C24 of function version B
- QSCU software of version C (20C) or later

(2) Forms of data communication in which a remote password is checked:
- Communication using the MC protocol
  ✻ The remote password check is not carried out in data communication using the non procedure/bidirectional protocols.
- Access to the PLC through GX Developer (SW6D5C-GPPW-E)



POINT

(1) It is possible to use the remote password function of the QCPU by using any of the following QCPUs (in Q mode).
- QCPU of function version A (Q mode)
- QCPU (in Q mode) that first 5 digits of the serial No. 02092 ✻✻✻✻✻✻✻✻✻✻ are 02092 or later

See Section 2.6 for how to check the function version and serial No.

(2) Refer to the following manuals when using the remote password function of the QCPU.
- Section 1.2 (9) of this manual
- Section 3.3.3 of the User's Manual (Application)

2.4 When Using the Q Series C24 at a Remote I/O Station

This section describes the overview or reference section for each of the purposes that the Q series C24 is used for at a remote I/O station in MELSECNET/H network.

POINT

(1) It is not necessary to read this section if the Q series C24 is mounted at the QCPU station.

(2) The system for the MELSECNET/H (remote I/O network) can be configured by using any of the following QCPUs (in Q mode).
- QCPU of function version A (Q mode)
- QCPU (in Q mode) that first 5 digits of the serial No. 02092 ＊＊＊＊＊＊＊＊＊＊ are 02092 or later

See Section 2.6 for how to check the function version and serial No.

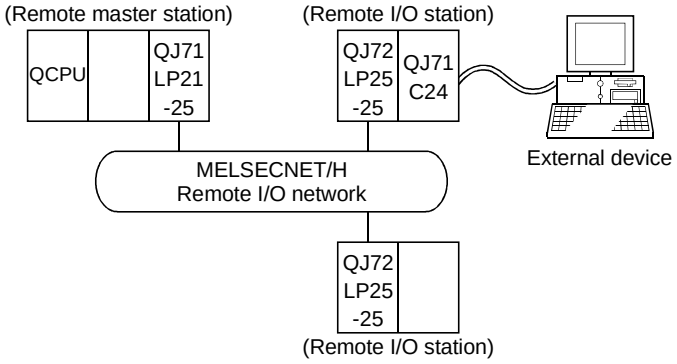
(3) Refer to the following manual together with this section when using the Q series C24 at a remote I/O station in MELSECNET/H network.
Q Corresponding MELSECNET/H Network System Reference Manual (Remote I/O Net)

(1) Remote I/O stations on which the Q series C24 can be mounted

See Section 2.1 for a list of the remote I/O stations on which the Q series C24 can be mounted.

(2) System configuration when using the Q series C24 at a remote I/O station

(Example)



(3) Available functions

The following functions are available when the Q series C24 is mounted on a remote I/O station.

* See Appendix 1.1 for a list of the Q series C24 functions available for each function version.

Function		Function available when mounted at a remote I/O station	Remarks
Communication using the MC protocol (*1)		○	See Reference Manual
Communication using the non procedure protocol		×	—
Communication using the bidirectional protocol		×	
Communication using the dedicated instructions		×	
Communication via public line, etc. (modem function)		×	
	Remote password check	×	
Transmission control	DC code control (including Xon/Xoff control)	○	
	DTR/DSR (ER/DR) control	○	
Communication protocol switching		×	
Independent/linked operation of each interface		○	
Initial setting and monitoring/testing the setting values by the utility package		○	
Connecting GX Developer and GOT at the same time		○	
Supporting multiple PLC system		—	A remote I/O station supports a single CPU system
	Communication with non-control PLCs using the MC protocol		
	Setting multiple PLCs using GX Developer		
Data transmission/reception at low speed (transmission speed: 50 bps)		○	—

○ : Available × : Not available

*1 The following functions are available when communicating with the MELSECNET/H remote I/O station using the MC protocol.

Available function	Function
Device memory read/write	Batch read and batch write
	Random read, test (random write)
	Monitor data registration, monitoring
	Batch read of multiple blocks, batch write of multiple blocks
Buffer memory read/write	Reading/writing from/to the buffer memory of the Q series C24
Reading/writing buffer memory of an intelligent function module	Reading/writing from/to the buffer memory of the specified intelligent function module

The following devices of a remote I/O station can be accessed by the device memory read/write function. Note that the accessible devices and the ranges vary depending on the type of frames used for the data communication.
See the Reference Manual for a detailed explanation.

Device name	Device symbol	Device name	Device symbol
Special relay	SM	Link relay	B
Special register	SD	Data register	D
Input relay	X	Link register	W
Output relay	Y	Link special relay	SB
Internal relay	M	Link special register	SW

REMARK

It is only possible to read/write from/to the buffer memory of an intelligent function module for the MELSECNET/10 remote I/O station compatible with the QnA/A series.

(4) Setting from GX Developer (SW6D5C-GPPW-E)

The following parameters should be set through GX Developer (SW6D5C-GPPW-E) in order to use the Q series C24 mounted to a remote I/O station.
Each of setting is the same way as when setting the parameters for the Q series C24 mounted to a QCPU station: see Section 4.5 and after.
See the operating manual for DX Developer for how to display each setting screen.
(Parameter setting items for the Q series C24 mounted to a remote I/O station)

Parameter setting item	Setting	Remarks
I/O Assignment	Set the module mounting information	See Section 4.5.1
Switch setting for I/O and intelligent function module	Set the transmission specification and the communication protocol for communication with the external device	See Section 4.5.2

POINT

(1) Connect GX Developer (SW6D5C-GPPW-E) to a remote I/O station and set the parameters.
(2) Reset the remote I/O station after changing the setting.

(5) When monitoring/setting with QSCU

(a) Use QSCU software of version D (30D) when using the Q series C24 at a remote I/O station in the MELSECNET/H network.
- Add-in to the GX Developer (SW6D5C-GPPW-E)
- QSCU software of version C (20C) or earlier cannot be used when using the Q series C24 at a remote I/O station in the MELSECNET/H network.

(b) About the automatic refresh setting
1) When reading/writing data created by the automatic refresh setting using PLC, the read/write operation should be performed by GX Developer. It cannot be performed from QSCU.
2) The devices used for the automatic refresh setting must be of the types M, B, D, or W.

POINT

(1) QSCU should be connected to a remote I/O station before the monitoring/setting.
(2) The remote I/O station should be reset after changing the setting.

2.5 When Using the Q Series C24 under the Multiple PLC System with Several QCPUs (Function Version B)

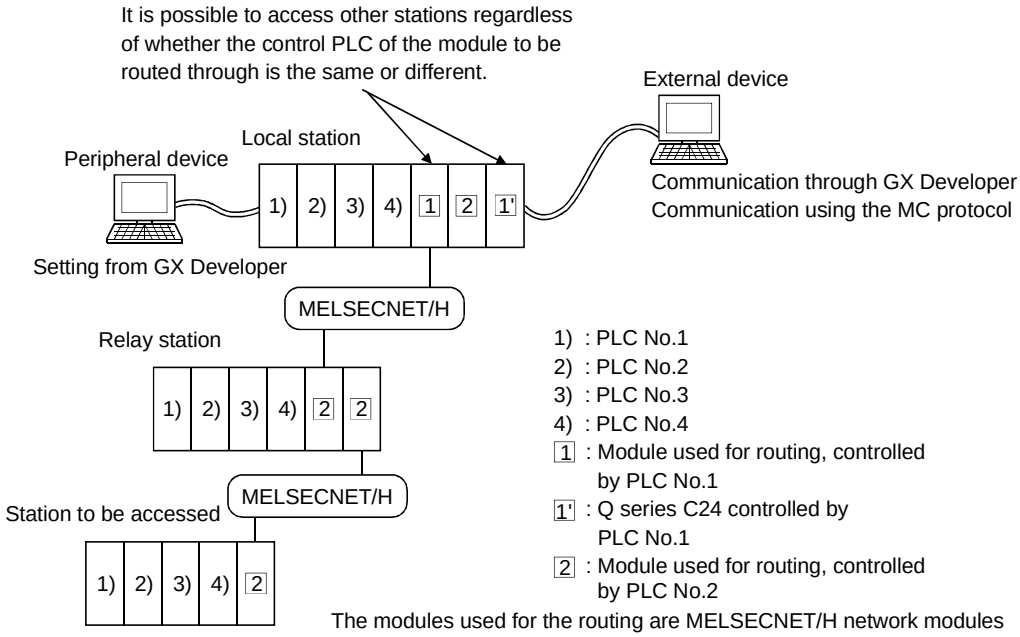
This section explains how to access non-control PLCs when using the Q series C24 under the multiple PLC system.
See Section 2.1 for other than below.

(1) The following Q series C24 and QSCU should be used when accessing non-control PLCs of the Q series C24 from a device connected to the Q series C24, using the functions shown in (2) below.
- Q series C24 of function version B
- QSCU software of version C (20C) or later

∗ If QSCU software of version B (10B) or earlier is used, it is possible to perform monitoring/setting within the function range of the Q series C24 of function version A.

(2) Forms of data communication in which the external device can access a non-control PLC.
- When the external device uses communication functions to access a non-control PLC using the MC protocol
- When accessing a non-control PLC through GX Developer (SW6D5C-GPPW-E)

(3) If the other stations to be accessed belong to the multiple PLC system, the modules used for routing and QCPUs at the local station, all the relay stations, and the accessed station should be modules of function version B. This has to hold in all cases of accessing the non-control PLC of the module used for routing at the accessed station.



∗1 When accessing other stations, a module used for routing can access the following modules:
- MELSECNET/H, MELSECNET/10 network modules
- Q series C24
- Ethernet interface modules

POINT

(1) A multiple PLC system can be built by using function version B of QCPUs (Q mode). See Section 2.6 for how to check function version.

(2) Refer to the QCPU (Q mode) User's Manual (Function Explanation/Program Fundamentals) before using the Q series C24 under the multiple PLC system.

2.6 Checking the Function Version, Serial No., and Software Version

This section explains how to check the QSCU software version, and the function version and serial No. of related products that can use the functions added by the improvement of the Q series C24.

(1) Correspondence of related products for use additional functions of Q series C24

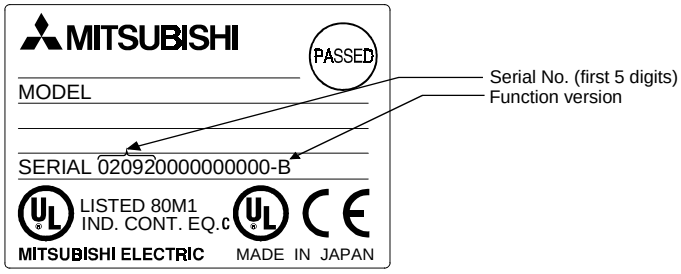
Additional function	Version of the related product		
	CPU module	Q series C24	QSCU
Simultaneous connection of GX Developer and GOT	—	Function version B	S/W version 20C
Clearing reception data by a dedicated instruction			
Transmission of the PLC CPU monitoring information through combined use of the modem function			
Addition of changeable data to the user frame			
Reception by user frame (reception according to format-1)			
Multiple specification of transparent codes for transmission			
Remote password check	Function version A, product that first 5 digits of the serial no. 02092 ∗ ∗ ∗ ∗ ∗ ∗ ∗ ∗ ∗ ∗ are 02092 or later		
Support for multiple PLC system	Function version B		
Data transmission/ reception at low speed (50 bps)	—		
MELSECNET/H remote mounted on I/O station	Function version A, product that first 5 digits of the serial no. 02092 ∗ ∗ ∗ ∗ ∗ ∗ ∗ ∗ ∗ ∗ are 02092 or later		S/W version 30D

—: Shows that there are no restrictions as to the serial No. or version of the related corresponding product when using additional functions of the Q series C24.

(2) Checking the version and serial No. of Q series PLC functions

(a) Using the rated plate on the side of the module to check

The serial No. and function version of the corresponding module is shown in the SERIAL column of the rated plate.



(b) Using the GX Developer to check

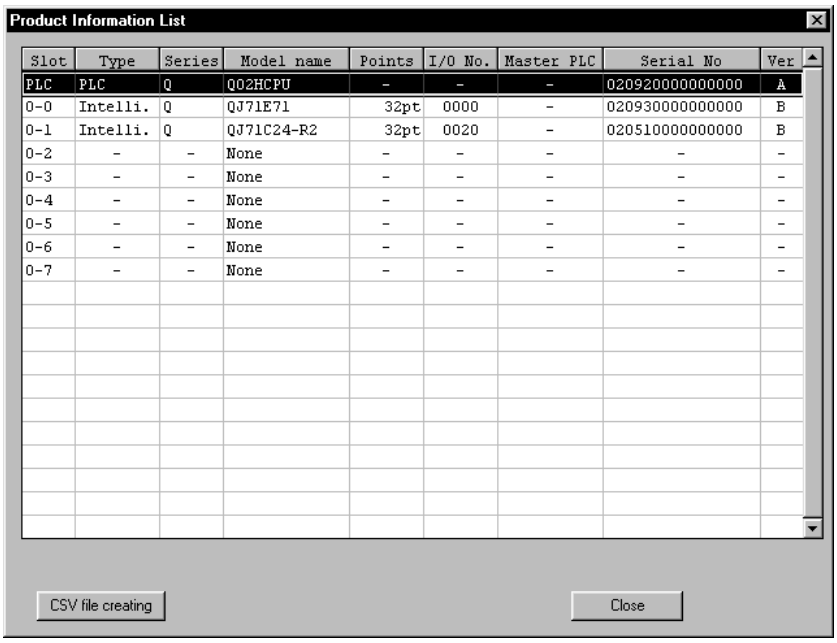
The method of checking the serial No. and function version of the corresponding module with the GX Developer using SW6D5C-GPPW-E is shown.

The serial No. and function version are displayed on the GX Developer "Product Information List" or "Module's Detailed Information" screen.

The method of checking the serial No. and function version on the "Product Information List" screen is shown below. (See Section 10.1.1 for details about the "Module's Detailed Information" screen.)

[Start Procedure]

"Diagnostics" → "System monitor" → "Product Inf. List"



[Serial No., Ver.]

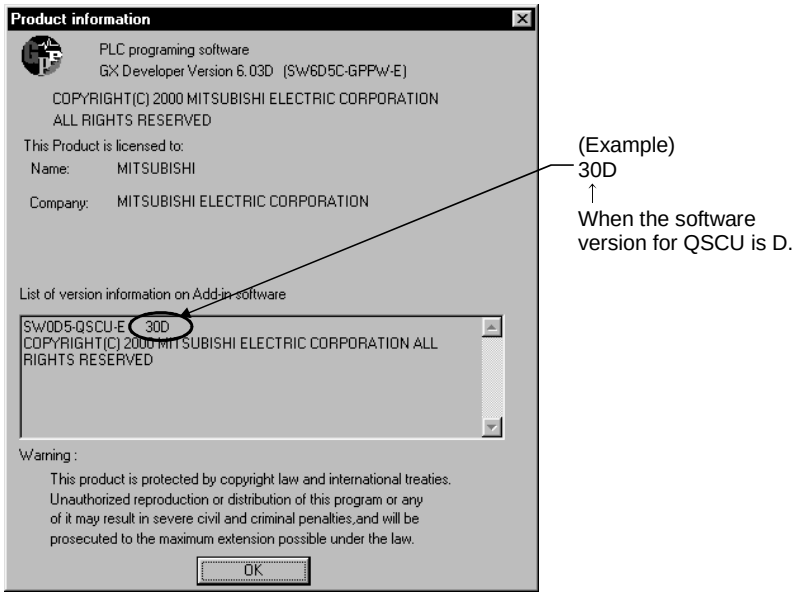
- The corresponding module's serial No. is shown in the Serial No. column.
- The function version of the corresponding module is shown in the Ver. column.

(3) Checking the software version of the intelligent function module

The QSCU software version can be checked on the "Product Information List" screen of the GX Developer.

[Start Procedure]

"Help" → Product Information



(For SW6D5C-GPPW-E)

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3 SPECIFICATIONS

The following shows the Q series C24 performance specifications.
See the User's Manual of the QCPU (Q mode) for general specifications.

3.1 Performance Specifications

The following shows the Q series C24 performance specifications. For the transmission specifications when communicating via the modem function, see this section and Chapter 3 of User's Manual (Application).

(1) Transmission specification

<table>
<tr><td colspan="2" rowspan="2">Item</td><td colspan="4">Specifications</td></tr>
<tr><td colspan="2">QJ71C24</td><td colspan="2">QJ71C24-R2</td></tr>
<tr><td rowspan="2">Interface</td><td>CH.1</td><td colspan="2">Conform to RS-232 (D-sub 9 pin)</td><td colspan="2">Conform to RS-232 (D-sub 9 pin)</td></tr>
<tr><td>CH.2</td><td colspan="2">Conform to RS-422/485 (two-piece terminal block)</td><td colspan="2">Conform to RS-422/485 (D-sub 9 pin)</td></tr>
<tr><td rowspan="4">Communications system (＊1)</td><td></td><td>Protocol</td><td>Line</td><td>Protocol</td><td>Line</td></tr>
<tr><td>MC protocols communication</td><td>Half-duplex communications</td><td rowspan="3">Full-duplex/half-duplex communications</td><td>Half-duplex communications</td><td rowspan="3">Full-duplex/half-duplex communications</td></tr>
<tr><td>Non procedure protocol communication</td><td>Full-duplex/half-duplex communications</td><td>Full-duplex/half-duplex communications</td></tr>
<tr><td>Bidirectional protocol communication</td><td>Full-duplex/half-duplex communications</td><td>Full-duplex/half-duplex communications</td></tr>
<tr><td colspan="2">Synchronization system</td><td colspan="4">Start-stop synchronous system</td></tr>
<tr><td colspan="2">Transmission rate (bps)</td><td colspan="4">50, 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200
＊ Can be used when the total transmission rate of the two interfaces is 115200 bps or less.</td></tr>
<tr><td rowspan="4">Data format</td><td>Start bits</td><td colspan="4">1</td></tr>
<tr><td>Data bits</td><td colspan="4">7 or 8</td></tr>
<tr><td>Parity bits</td><td colspan="4">1 (vertical parity) or none</td></tr>
<tr><td>Stop bits</td><td colspan="4">1 or 2</td></tr>
<tr><td rowspan="2">Access cycle</td><td>MC protocol communication</td><td colspan="4">Processes one request during installed PLC CPU END processing.
＊ Number of scans that must be processed/number of link scans depends on the contents of the request. (See Reference Manual.)</td></tr>
<tr><td>Non procedure protocol communication
Bidirectional protocol communication</td><td colspan="4">Sends each time a send request is issued. Can receive at any time.</td></tr>
<tr><td rowspan="2">Error detection</td><td>Parity check</td><td colspan="4">All protocols. When TES, ODD/EVEN is selected by parameter.</td></tr>
<tr><td>Sum check code</td><td colspan="4">MC protocols/bidirection protocol selected by parameter.
Non procedure protocol selected by user frame.</td></tr>
<tr><td rowspan="5">Transmission control</td><td></td><td>RS-232</td><td>RS-422/485</td><td colspan="2" rowspan="5">DTR/DSR signal control and DC code control are selected by the user.</td></tr>
<tr><td>DTR/DSR (ER/DR) control</td><td>YES</td><td>NO</td></tr>
<tr><td>RS/CS control</td><td>YES</td><td>NO</td></tr>
<tr><td>CD signal control</td><td>YES</td><td>NO</td></tr>
<tr><td>DC1/DC3 (Xon/Xoff) control
DC2/DC4 control</td><td>YES</td><td>YES</td></tr>
</table>

(Continued on next page)

(Continued from preceding page)

Item			Specifications	
			QJ71C24	QJ71C24-R2
Line configuration (Connection) (*2)	RS-232		1:1	
	RS-422/485		1:1, 1:n, n:1, m:n	—
Line configuration (Data communication) (*2)	RS-232	MC protocols communication	1:1, 1:n, m:n	1:1
		Non procedure protocol communication	1:1, 1:n, n:1	1:1
		Bidirectional protocols communication	1:1	1:1
	RS-422/485	MC protocols communication	1:1, 1:n, m:n	—
		Non procedure protocol communication	1:1, 1:n, n:1	
		Bidirectional protocols communication	1:1	
Transmission distance (total distance)	RS-232		Max. 15 m (49.2 ft.)	
	RS-422/485		Max. 1200 m (3937.2 ft.) (total distance)	—
Installation possible station			Q CPU (Q mode), MELSECNET/H remote I/O station	
Number of installation possible modules per station			Max. 64 (Installation is possible within the I/O signal points)	
Dielectric withstand voltage			Depends on the specifications of the loaded station's power supply module	
Insulation resistance				
Noise durability				
Flash ROM write count			Maximum 100000 times to the same area	
Number of I/O occupied points			32 (occupy one slot) (*3)	
Recommended cable	RS-232		7/0.127 □P HRV-SV…Outside diameter 8.5 mm (0.33 in.) or more (Oki Electric Cable Co., Ltd…Number of pairs designated in □.)	
	RS-422/485		SPEV (SB)-MC-0.2 × 3P… Outside diameter Approx. 6.5 mm (0.26 in.) SPEV (SB)-0.2 × 3P…… Outside diameter Approx. 7.5 mm (0.3 in.) (Both MITSUBISHI CABLE INDUSTRIES, Ltd.) (*4)	
Connector applicable for external wiring			9-pin D sub (male) screw-in type (*5)	
5 V DC internal consumption (A)			0.31	0.26
Weight (kg{lb.})			0.20 (0.44)	
External dimensions (mm{in.})			98 (3.9) (H) × 27.4 (1.1) (W) × 90.5 (3.6) (D)	

*1 Set to transfer data with external devices by full-duplex communications system when the Q series C24 is started. Switch to half-duplex communications system as described in User's Manual (Application).

*2 Indicates possible combinations when connecting the PLC CPU and external devices (external device side: PLC CPU side). The total number of n and m+n is up to 32 stations.

*3 In order to use the Q series C24, it is necessary to perform a switch setting using GX Developer. To do so, perform an I/O assignment (32 points for intelligent functional module) for the Q series C24. Set the model type to "QJ71C24" or "QJ71C24-R2" that corresponds to the module loaded.

*4 Recommended cables SPEV (SB)-MPC-0.2 × 3P and SPEV (SB)-0.2 × 3P have the same electrical characteristics, but their external dimensions and internal wire colors are different.

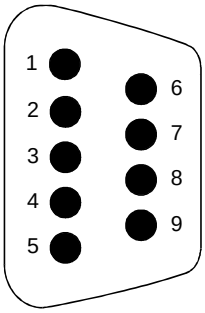
*5 See Section 3.2.1 (3) for the recommended connector.

3.2 RS-232 Interface Specification

The following shows the RS-232 interface specifications.

3.2.1 RS-232 connector specifications

The following shows the specifications of the RS-232 connector that connects the Q series C24 to an external device.



Pin number	Signal abbreviation	Signal name	Signal direction C24 ⟷ External device
1	CD	Carrier detect	←
2	RD(RXD)	Receive data	←
3	SD(TXD)	Send data	→
4	DTR(ER)	Data terminal ready	→
5	SG	Signal ground	⟷
6	DSR(DR)	Dataset ready	←
7	RS(RTS)	Request to send	→
8	CS(CTS)	Clear to send	←
9	RI(CI)	Call Indicate	←

(1) The control signals are described below. (The pin numbers of the connector are enclosed in parentheses.)

1) CD signal (1)

- The Q series C24 operates according to the setting CD terminal check (see Section 8.4.5) of the Q series C24.

	CD terminal check enabled	CD terminal check disabled
Full-duplex communication	• The Q series C24 performs send and receive processing when the CD signal (receive carrier detection) is ON. • If the CD signal is turned off during data communication, the Q series C24 initializes the transmission sequence.	• The Q series C24 performs send and receive processing regardless of the ON/OFF status of the CD signal. • Data communications is possible with an external device that cannot turn the CD signal ON/OFF.
Half-duplex communication	See Chapter 8 of User's Manual (Application)	Setting impossible.

2) RD signal
This is a signal to receive data.

3) SD signal
This is a signal to send data.

3 - 3

4) DTR signal (4)
   - When communicating data using the non procedure protocol, the Q series C24 turns on or off (on when data is receivable) depending on the amount of unused memory in the OS area allocated for receive data storage, if DTR/DSR control is being performed.
     Read the receive data from the sequence program, as the receive data is stored in the OS area when the DTR signal is OFF.
     If DTR/DSR control is not implements, the DTR signal is always ON.
   - If an MC protocol or bidirectional protocol is performing data communication, the Q series C24 turns ON when communications is enabled.

5) DSR signal (6)
   - During DTR/DSR control, if this signal is OFF, the Q series C24 does not send data to the external device.
     Be sure that this signal is always turned ON when the external device is ready to receive.
   - If DTR/DSR control is not implemented, the DSR signal status is ignored.

6) RS signal (7)
   - The Q series C24 turns ON/OFF the RS signal as shown below.
   - When the communication system is full-duplex communications, if the Q series C24 ready signal (X1E) is ON, the Q series C24 turns ON the RS signal.
   - When the communication system is half-duplex communications, when the Q series C24 sends data to an external device, it turns ON the RS signal.
   - The RS signal is not turned OFF even when the receive data cannot be stored in the Q series C24.

7) CS signal (8)
   - The Q series C24 does not send data to an external device when this signal is OFF.
   - Be sure that this signal is always turned ON when the external device is ready to receive.

8) RI signal (9)
   - The RI signal is used when the modem status is monitored on the Q series C24 side. If should be connected as needed. The RI signal is not needed to be connected when the modem is not connected.

REMARK

The control signals status of DTR, DSR, RS and CD are confirmed by the RS-232 control signal status storage area (address 254H, 264H) of the buffer memory for the Q series C24 or QSCU during the data communication.

Bit position	Buffer memory address	
	CH1 side	CH2 side
	254H	264H
b0	RTS (ON/OFF)	
b1	DSR (ON/OFF)	
b2	DTR (ON/OFF)	
b3	CD (ON/OFF)	
b4	—	
b5	RI (ON/OFF)	
b6 to b15	—	

(2) The ON and OFF states of each signal indicate the following conditions:

	(Output side)	(Input side)
ON	····· 5 V DC to 15 V DC,	3 V DC to 15 V DC
OFF	····· –5 V DC to –15 V DC,	–3 V DC to –15 V DC

(3) Interface connector

The Q series C24 uses the following type of RS-232 interface connector.
9-pin D sub (female) screw fixing type, DDK Ltd. made, 17L-10090-27-D9AC
Use one of the following as a connector shell for the connection cable of the the Q series C24 side (for sizes of installation possible connector shells, see Section 5 of Appendix).

- 3M
  Plug model: 8209-6009 Shell model: 3702-2209 M2.6
- AMP
  Plug model: 747904-2 Shell model: 747515 or 174469-2

3.2.2 RS-232 cable specification

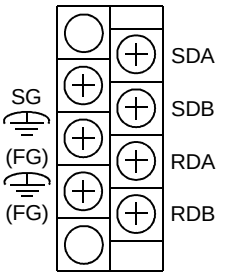
- Use a 15 m (49.21 ft.), or shorter, cable conforming to the RS-232 standard as the RS-232 cable.
  (Recommended cable)
  7/0. 127 □P HRV-SV…□: Designates the number of pairs. (For 13 pairs 7/0.127 13P HRV-SV)
  (Oki Electric Cable Co., Ltd)

3.3 RS-422/485 Interface Specifications

The following shows the RS-422/485 interface specification.

3.3.1 RS-422/485 terminal block specifications

The following shows the specifications of the RS-422 connector and RS-422/485 terminal block that connect to an external device.



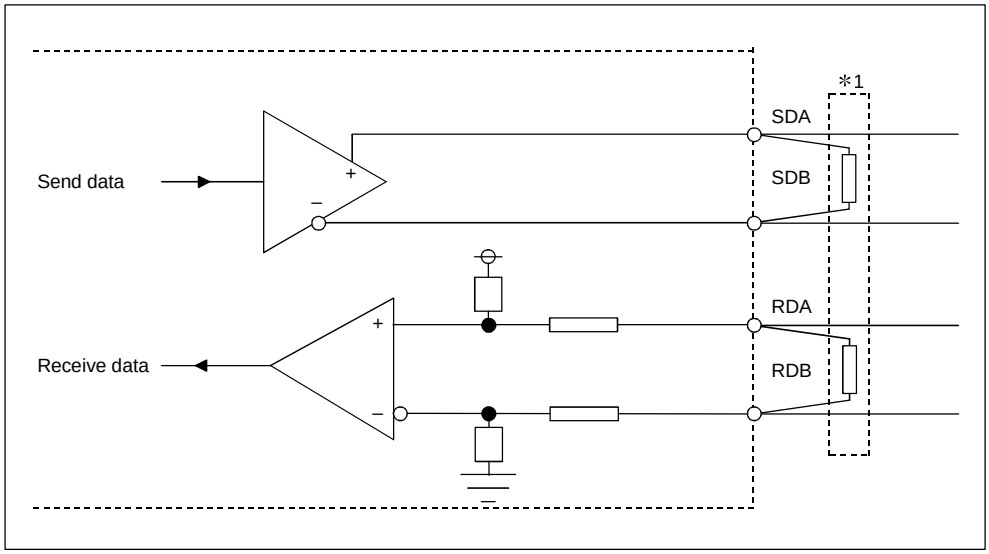
Signal abbreviation	Signal name	Signal direction C24 ⟷ External device
SDA	Send data (+)	→
SDB	Send data (–)	→
RDA	Receive data (+)	←
RDB	Receive data (–)	←
SG	Signal ground	⟷
FG	Frame ground	⟷
FG	Frame ground	⟷

(1) The following describes the control signals.

1) SDA, SDB signals
These are signals to send data from the Q series C24 to the external device.

2) RDA, RDB signals
These are signals for the Q series C24 to receive data from the external device.

(2) The following shows the function block diagrams.
(RS-422/485 interface)



* The following shows the terminal resistor connection.
Connect the terminal resistor according to Section 4.4.2 or the User's Manual (Hardware) of the Q series C24 used.

3.3.2 RS-422/485 cable specifications

The following shows the RS-422/485 cable specification.

(1) Use a 1200 m (3937 ft.), or shorter, cable that satisfies the following specification for the RS-422/485 cable (cable to connect the Q series C24 terminal block).

(2) Make the total distance within 1200 m (3937 ft.) when two or more device are connected in a 1:n or m:n configuration.

(3) The RS-422/485 cable specification is shown below.

Item	Description
Cable type	Shielded cable
Number of pairs	3P
Conductor resistance (20 C°)	88.0 Ω /km or less
Insulation resistance	10000 M Ω - km or more
Dielectric strength	500 V DC, 1 minute
Electrostatic capacitance (1 kHz)	60nF/km or less on average
Characteristic impedance (100 kHz)	110 ± 10 Ω

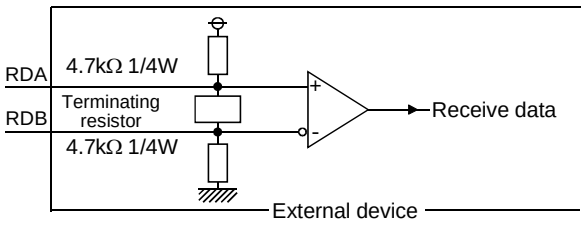
(Recommended cable)
SPEV (SB)-MPC-0.2 × 3P ····· (MITSUBISHI CABLE INDUSTRIES, Ltd.)
SPEV (SB)-0.2 × 3P ····· (MITSUBISHI CABLE INDUSTRIES, Ltd.)
* SPEV (SB)-MPC-0.2 × 3P and SPEV (SB)-0.2 × 3P have the same electrical characteristics, but different external diameter and internal wire colors.

3.3.3 Precautions when transferring data using RS-422/485 circuit

The following precautions must be observed when transferring data with an external device through the Q series C24 RS-422/485 interface.
Take the following into account when the transferring data with the external device.

(1) Error receive data countermeasures at external device during RS-422/485 connection

If the external device may receive erroneous data, install a pull-up or pull-down resistor to the external device as follows.
Installing a pull-up or pull-down resistor (resistance value criteria: approx. 4.7 kΩ 1/4 W) can prevent the reception of erroneous data.



POINT

When there is a pull-up or pull-down resistor at the external device, erroneous data is not received.

REMARK

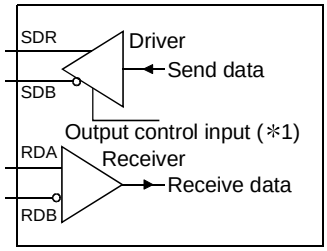
The following describes the case when a pull-up or pull-down resistor is not installed to the external device.
When no station is sending, the send line becomes high impedance and noise, etc. may cause the send line to change and the external device to receive erroneous data.
In this case, there is probably a parity error or framing error.
Therefore, skip the erroneous data.
Since the first data during data reception is fixed in the following cases, also skip the receive data until the fixed head data is received.

- When using an MC protocol to send data, the first data is fixed according to the frame and format the user uses.
- When transferring data using user frames with non procedure protocol or bidirectional protocol, the first data is selected according to the user frame that the user registers to the Q series C24.

(2) RS-422/485 interface operation

1) RS-422-485 interface construction

The following illustration shows the construction of the Q series C24 RS-422/485 interface driver (send)/receiver (receive).



*1 "Output control input" (also called send gate) of the driver (send) section of the illustration at the left determines whether or not data from SDA/SDB is output to the outside.

2) RS-422/485 interface operation

When the "Output control input" in the illustration above is ON, the interface enters the low impedance state (state in which data can be sent).
When the "Output control input" is OFF, the interface enters the high impedance state (state in which data cannot be sent).

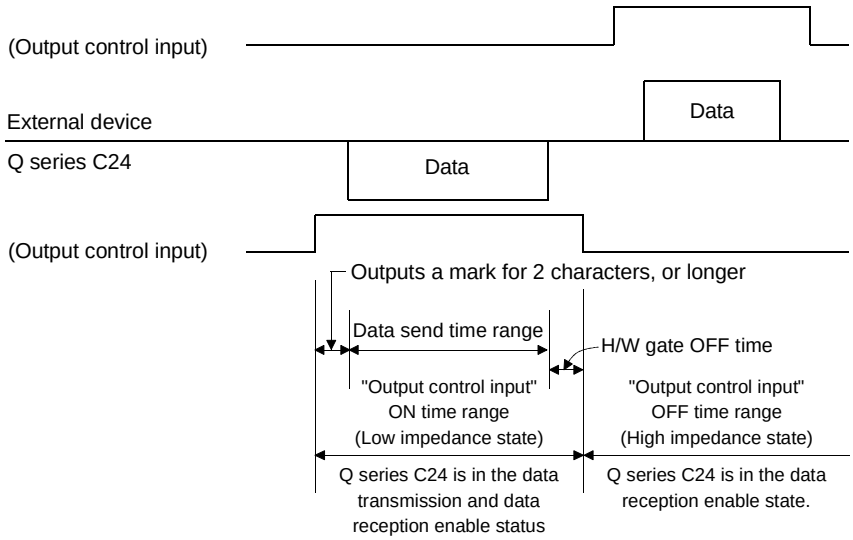
3) Timing to start sending and to complete the transmission processing for the Q series C24

- Timing to start sending

  During data transmission, the Q series C24 outputs the actual data after sending a mark for 2 characters, or longer, after the high impedance set by the operations described in 1) and 2) above is reset.

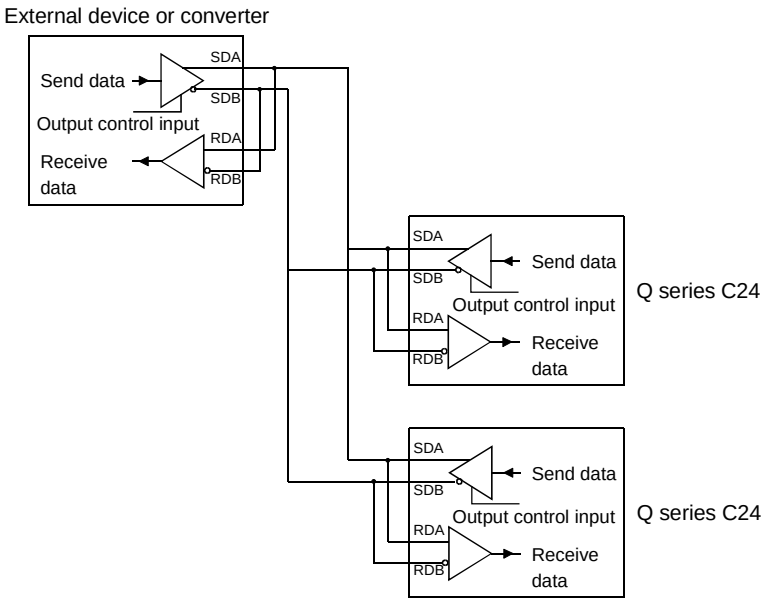
- Timing to complete the transmission processing

  the Q series C24 requires several μs as H/W gate OFF time from the data transmission completion until the transmission processing completion (put it in the high impedance state).



POINT

(1) When the external device and the Q series C24 connected in n:1 and m:n configurations
When the send signal of each device is connected as shown below, if the "Output control input" is turned ON at two or more devices, the relevant devices output (send) data at the same time.
For the external device to transfer data normally,
- "Output control input" must be turned ON only when sending data.
- "Output control input" must be turned OFF when not sending data.



(2) When the Q series C24 is used, if operation of the two interfaces is linked (see Section 4.5.2 (2)), the time to send one character becomes the Q series C24 H/W gate OFF time.
(The Q series C24 turns OFF the gate after the one-character send time.)
＊ Only QJ71C24 can perform linked operation between two interfaces:

3.4 Serial Communication Module Function List

The following table lists the functions of the Q series C24.

Function				Reference section
Communication using MC protocol (*1)	Communication with ASCII code	Communication with QnA compatible 3C frame	Formats 1 to 4 exist for each.	Chapter 5 Reference Manual
		Communication with QnA compatible 4C frame		
		Communication with QnA compatible 2C frame		
		Communication with A compatible 1C frame		
	Communication with binary code	Communication with QnA compatible 4C frame	Format 5	
	Read/write of device memory	Batch read/write in bit/word units		
		Monitoring of device memory		
		Batch read/write of multiple blocks		
		Read/write by extension designation		
		Accessing other stations via network system		
	Reading/writing from/to the buffer memory of the Q series C24			
	Reading/writing from/to the buffer memory of intelligent function modules			
	Reading/writing from/to sequence program files			
	Monitoring the PLC CPUs (PLC CPU monitoring function)			
	Status control of the PLC CPUs (remote RUN/STOP, etc.)			
	Turning on/off input signals of the Q series C24 from an external device (global function)			
	Data transmission from a PLC CPU to an external device (on-demand function)			
Communication using non procedure protocol (*2)	Data transmission/reception in any format			Chapter 6
	Data transmission/reception using user frames			User's Manual (Application)
	Data reception by interrupt programs			
	Monitoring the PLC CPUs (PLC CPU monitoring function)			
	ASCII data transmission/reception by ASCII-BIN conversion			
	Data transmission/reception by specifying transparent code			
Communication using bidirectional protocol (*1)	Data transmission/reception in any format			Chapter 7
	Data reception by interrupt programs			User's Manual (Application)
	ASCII data transmission/reception by ASCII-BIN conversion			
	Data transmission/reception by specifying transparent code			
Communication via public network, etc. (modem function)				
Transmission control	DC code control (including Xon/Xoff control)			
	DTR/DSR (ER/DR) control			
Communication protocol switching				
Independent/linked operation of each interface				Section 4.5.2
Monitoring/testing of initial settings and setting values with utility software				Chapter 8
Supporting multiple PLC system				Section 2.10 of Reference Manual
Remote password check				Section 3.3.3 of User's Manual (Application)

*1 If the external device is capable of incorporating a program and communicating data using a protocol of the MELSEC PLC, it is possible to access the PLC CPU using the above mentioned MC protocol. Furthermore, it is possible to transfer any data using the bidirectional protocol.

*2 When it is necessary to communicate using the protocol of an external device, such as a measuring instrument or a bar code reader, the above-mentioned non procedure protocol is used for data communication. In that case, the processing of the communication data becomes easier by using the user frame communication function.

3.5 Dedicated Instruction List

The following table lists dedicated instructions that can be used in the Q series C24.

○ : Available × : Not available

Classification	Instruction	Description		Protocol			Reference section
				MC	Non	Bi	
For data communication	ONDEMAND	Sends data with the on-demand function		○	×	×	Chapter 9
	OUTPUT	Sends designated number of data		×	○	×	
	INPUT	Receives data (reads received data)		×	○	×	
	BIDOUT	Sends data		×	×	○	
	BIDIN	Receives data (reads received data)		×	×	○	
	SPBUSY	Reads the status of data sent/received with each dedicated instruction		○	○	○	
	CSET	Allows clearing data received up to the present without interrupting the data transmission processing.		×	○	×	
	BUFRCVS	Receives data with an interrupt program (reads received data)		×	○	○	Chapter 16 of User's Manual (Application)
	PRR	Sends data with user frames using transmission schedule table		×	○	×	
Setting value registration/ reading	PUTE	Stores user frames in flash ROM of the Q series C24 (writing)		○	○	○	
	GETE	Reads user frames stored in flash ROM of the Q series C24		○	○	○	
PLC CPU monitoring instructions	CSET	Performs PLC CPU monitoring registration	For PLC CPU monitoring function	○	○	×	
		Cancels PLC CPU monitoring					
Initial value setting instruction		Sets the unit for the number of communication data (words/bytes) and the data communication area				○	

∗ Abbreviations used in the Protocol column
MC : MC protocol
Non : Non procedure protocol
Bi : Bidirectional protocol

3.6 Utility Package (QSCU) Function List

The following table lists the utility package function for the Q series C24.

(○ : Protocol for which setting is valid)

Function			MC	Non-procedure protocol	Bidirectional protocol	Explanation page	Remarks
Auto refresh setting		Refresh the Q series C24's error codes and set devices on the PLC CPU side.	○	○	○	Section 4.6	Can be used via online operation. Can be used via offline operation.
User frame		Register the user frame in the flash ROM.	○	○	—	Section 8.4.1	
Data for modem initialization		Register the data for modem initialization in the flash ROM.	○	○	○	Section 8.4.2	
Data for modem connection		Register the data for model connection in the flash ROM.	○	○	○	Section 8.4.3	
Modem function system setting		Register the system setting values for model function in the flash ROM.	○	○	○	Section 8.4.4	
System setting	CHn Transmission control and others system setting	Set the transmission specifications with the other device. DTR/DSR control, DC code control, communication method, data communication monitoring timer value, etc.	○	○	○	Section 8.4.5	
	CHn MC protocol system setting	Assign the buffer memory for on-demand function, set the user frame number, etc.	○	—	—	Section 8.4.6	
	CHn Non procedure system setting	Assign the buffer memory needed to perform data communication using the non procedure protocol, and change the setting values, etc.	—	○	—	Section 8.4.7	
	CHn Bidirectional system setting	Assign the buffer memory needed to perform data communication using the bidirectional protocol, and change the setting values, etc.	—	—	○	Section 8.4.8	
	CHn PLC CPU monitoring system setting	Set the PLC CPU monitoring function.	○	○	—	Section 8.4.9	
	CHn Transmission user frame No. designation system setting	Set the user frame number to be transmitted, etc.	—	○	—	Section 8.4.10	
System setting default		Reset the setting values in the buffer memory to their default values.	○	○	○	Section 8.4.11	Can be used only via online operation.
System setting write		Write the setting values in the buffer memory to the flash ROM.	○	○	○	Section 8.4.11	
Flash ROM write allow/prohibit designation		Set whether to allow or prohibit writing to the flash ROM.	—	—	—	Section 8.4.12	
X · Y monitor/test		Perform the monitoring/testing of I/O signals to/from the PLC CPU.	○	○	○	Section 8.6.1	
Modem function monitor/test		Monitor the execution status of the modem function.	○	○	○	Section 8.6.2	
Monitor	CHn Transmission control and others monitor	Monitor the status of interface control signals, values set from the GX Developer, etc.	○	○	○	Section 8.6.3	
	CHn MC protocol monitor	Monitor the data communication result, I/O signal status, and setting values in the buffer memory.	○	—	—	Section 8.6.4	
	CHn Non procedure monitor/test		—	○	—	Section 8.6.5	
	CHn Bidirectional monitor		—	—	○	Section 8.6.6	
	CHn PLC CPU monitoring monitor	Monitor the setting values and operating status of the PLC CPU monitoring function.	○	○	—	Section 8.6.7	
	CHn User frame No. designation monitor for transmission	Monitor the setting value for user frame to be transmitted.	○	○	—	Section8.6.8	
Monitor others		Monitor the data reception result, error occurrence status, etc.	○	○	○	Section 8.6.9	
ERR LED off		Turn off the ERR LEDs on the front face of the module.	○	○	○	Section 8.6.10	
Non procedure protocol receive data clear		Clear the currently received data.	—	○	—	Section 8.7	

3.7 List of GX Developer Setting Items for Serial Communication Modules

The following table lists the parameters that are set using the GX Developer.

Parameter setting item	Parameter description	Set data		Reference section
I/O assignment setting	Performs I/O assignment for the Q series C24 and enables the switch settings listed below.	Type		Section 4.5.1
		Model name		
		Points		
		Start X/Y		
Switch setting	Switch 1	CH1 Transmission setting		Section 4.5.2
		CH1 Communication rate setting		
	Switch 2	CH1 Communication protocol setting		
	Switch 3	CH2 Transmission setting		
		CH2 Communication rate setting		
	Switch 4	CH2 Communication protocol setting		
	Switch 5	Station number setting		
Interrupt pointer setting	Performs setting for reading reception date with interrupt programs.	CPU side	Interrupt pointer Start No.	Section 4.5.3
			Interrupt pointer No. of units	
		Intelligent module side	Start I/O No.	
			Start SI No.	
Remote password settings	Sets the remote password and the Q series C24 that performs the check.	Password settings		Section 3.3.3 of User's Manual (Application)
		Password active module settings	Model name	
			Start XY	

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3.8 List of Input/Output Signals for the PLC CPU

This section describes the input/output signals of the Q series C24.
For assignments of the input/output signals shown in the table below, it is assumed that the Q series C24 is mounted in slot 0 of the basic base unit.
Device numbers starting with X indicate input signals from the Q series C24 to the PLC CPU, and device numbers starting with Y indicate output signals from the PLC CPU to the Q series C24.
The following table lists the input/output signals for the PLC CPU.

Device number	Signal description	Reference section	Device number	Signal description	Reference section
X0 ＊1	CH1 Transmission normal completion ON: Normal completion	Section 8.6.4 Section 8.6.5 Section 8.6.6	Y0	CH1 Transmission request ON: Requesting transmission	—
X1 ＊1	CH1 Transmission abnormal completion ON: Abnormal completion		Y1	CH1 Reception data read completion ON: Data read completed	
X2 ＊1	CH1 Transmission processing ON: Transmission in progress		Y2	CH1 Mode switching request ON: Requesting switch	Application, Chapter 15
X3 ＊2	CH1 Reception data read request ON: Requesting read	Section 6.1 Section 7.1 Section 8.6.5 Section 8.6.6	Y3	Use prohibited	—
X4 ＊2	CH1 Reception abnormal detection ON: Abnormal detection		Y4		
X5	(For system)	—	Y5		
X6 ＊3	CH1 Mode switching ON: Switching	Application, Chapter 15	Y6		
X7 ＊1	CH2 Transmission normal completion ON: Normal Completion	Section 8.6.4 Section 8.6.5 Section 8.6.6	Y7	CH2 Transmission request ON: Requesting transmission	—
X8 ＊1	CH2 Transmission abnormal completion ON: Abnormal completion		Y8	CH2 Reception data read completion ON: Data read completed	
X9 ＊1	CH2 Transmission processing ON: Transmission in progress		Y9	CH2 Mode switching request ON: Requesting switch	Application, Chapter 15
XA ＊2	CH2 Reception data read request ON: Requesting read	Section 6.1 Section 7.1 Section 8.6.5 Section 8.6.6	YA	Use prohibited	—
XB ＊2	CH2 Reception abnormal detection ON: Abnormal detection		YB		
XC	(For system)	—	YC		
XD ＊3	CH2 Mode switching ON: Switching	Application, Chapter 15	YD		
XE	CH1 ERR. occurrence ON: Error occurring	Section 8.6.10 Section 10.1.2	YE	CH1 ERR.clear request ON: Requesting error clear	Section 8.6.10 Section 10.1.2
XF	CH2 ERR. occurrence ON: Error occurring		YF	CH2 ERR. clear request ON: Requesting error clear	
X10	Modem initialization completion ON: Initialization completed	Section 8.6.2 Application, Chapter 3	Y10	Modem initialization request (standby request) ON: Requesting initialization	Section 8.6.2 Application, Chapter 3
X11	Dialing ON: Dial in progress		Y11	Connection request ON: Requesting connection	
X12	Connection ON: Connection in progress		Y12	Modem disconnection request ON: Requesting disconnection	
X13	Initialization/connection abnormal completion ON: Initialization/ connection abnormally completed		Y13	Use prohibited	—
X14	Modem disconnection complete ON: Disconnection completed		Y14	Notification- issued request OFF: Requesting notification issuance	
X15	Notification normal completion ON: Normal completion		Y15	Use prohibited	—
X16	Notification abnormal completion ON: Abnormal completion		Y16		
X17 ＊1	Flash ROM read completion ON: Completed	—	Y17	Flash ROM read request ON: Requesting	—
X18 ＊1	Flash ROM write completion ON: Completed		Y18	Flash ROM write request ON: Requesting	
X19	Flash ROM system setting write completion ON: Completed		Y19	Flash ROM system setting write request ON: Requesting	

Device number	Signal description	Reference section	Device number	Signal description	Reference section
X1A	CH1 Global signal ON: Output instructed	Section 3.10, Reference	Y1A	Use prohibited	—
X1B	CH2 Global signal ON: Output instructed		Y1B		
X1C	System setting default completion ON: Completed	Section 8.4.11	Y1C	System setting default request ON: Requesting	Section 8.4.11
X1D	(For system)	—	Y1D	Use prohibited	—
X1E ＊4	QJ71C24 (-R2) ready ON: Accessible	—	Y1E		
X1F ＊5	Watchdog timer error (WDT error) ON : Module error occurred OFF: Module being normally operated	—	Y1F		

＊1 The device does not turn on/off by execution of a dedicated instruction when a function that corresponds to the input signal is used.

＊2 The device does turn on/off by execution of a dedicated instruction when a function that corresponds to the input signal is used (from ON to OFF: Data read completed).

＊3 Do not request data communication to the target interface while switching modes (X6 and XD are ON).
(The data communication processing of the Q series C24 is stopped while switching modes.)

＊4 The QJ71C24 ready signal indicates whether or not it is possible to access the Q series C24 from the PLC CPU.
Use it as a interlock signal for a sequence program.
(It turns on about one second after turning the power ON and reset operation.)

＊5 Restart the PLC CPU when the watchdog timer error signal is turned on (reset the power and the CPU module).

IMPORTANT

(1) Of the input/output signals to the PLC CPU, the signals marked with "Use prohibited" must not be output (ON).
If any of the "Use prohibited" signals is output, the PLC system may malfunction.

(2) When the modem function is not used, X10 to X16 become reserved for the system and Y10 to Y16 become use prohibited.

POINT

(1) The input/output signals shown in this section are the signals used when a QnA series serial communication module program is utilized for the Q series C24 (see Section 2 in appendix).
In the QCPU, the on/off of input/output signals to intelligent function modules is executed with a dedicated instruction.
It is not necessary to turn the signals on/off by the sequence program, except for the input/output signals shown in the programming of each function reference page.

(2) When a program for a QnA series serial communication module is also utilized for the Q series C24, it is recommended to replace the instructions with the dedicated instructions shown on the corresponding function reference page of each manual for the Q series C24.

3.9 List of Applications and Assignments of the Buffer Memory

This section describes the buffer memory.

(1) Configuration of the buffer memory

A buffer memory consists of a user area and a system area, as shown below.

(a) User area

1) This is the area where users write/read data.
2) The user area consists of areas for storing setting values for data communication, for actual data communication, and for storing communication status and communication error information.
3) Data read/write to the user area should be performed following the instructions in the corresponding detailed reference page.

(b) System area

This area is used by the Q series C24 system.

(2) List of buffer memory assignments

A buffer memory is configured with 16 bits per address.
Name, default value, etc. of each address of the buffer memory is shown in the lists on the following pages.

1) Abbreviations in the target Protocol column
   MC : MC protocol
   Non: Non procedure protocol
   Bi : Bidirectional protocol
2) Meaning of symbols shown in the target Protocol column
   The following symbols are assigned to protocols related to the setting values of a corresponding area and to areas used for controlled with user settings, and indicate what kind of access is allowed to the area in question.
   RW : Area where it is possible to read/write from/to the PLC CPU and an external device.
   R : Area where only reading is possible from the PLC CPU and an external device.
   – : System area used by the system or area not used by the corresponding protocol.
3) Meaning of symbols shown in the Registration allowed/not allowed column
   Indicates whether or not it is possible to use a value in the corresponding area by registering it to the flash ROM of the Q series C24.
   Allowed : Area that can be registered and used.
   Not allowed : Area that cannot be registered.

IMPORTANT

Do not write data in the "System area" of the buffer memory.
If data is written to any of the system areas, the PLC system may malfunction.
Some of the user areas are partially system areas. Care must be taken when performing read/write to the buffer memory.

POINT

(1) Use the FROM/TO instructions or other applicable commands to access the buffer memory shown in this section when a program for a QnA series serial communication module is utilized for the Q series C24 (see Section 2 in Appendix).
In QCPU, the access to the buffer memory of an intelligent function module is executed with a dedicated instruction.
It is not necessary to access directly using the FROM/TO instructions or other instructions from the sequence program, except when accessing the buffer memory as shown in the programming on each function reference page.

(2) When a program for a QnA series serial communication module is utilized for the Q series C24, it is recommended to replace the instructions with the dedicated instructions shown on the corresponding function reference page of each manual for the Q series C24.

(3) The following initial settings (changing the default values) for data communication must be performed by a registration operation using QSCU or by executing the CSET instruction for the sequence program.

1) Initial settings for communication using the MC protocol
   - Setting the unit of data length sent by the on-demand function
     Word/byte units designation (addresses 150 (96H), 310 (136H))
   - Setting the buffer memory used by the on-demand function
     Buffer memory head address designation (addresses 160 (A0H), 320 (140H))
     Data length designation (addresses 161 (A1H), 321 (141H))

2) Initial settings for communication using the non procedure/bidirectional protocols
   - Setting the unit of data length to be sent and received
     Word/byte units designation (addresses 150 (96H), 310 (136H))
   - Setting the transmission area
     Transmission buffer memory head address designation (addresses 162 (A2H), 322 (142H))
     Transmission buffer memory length designation (addresses 163 (A3H), 323 (143H))
   - Setting the reception area
     Receive buffer memory head address designation (addresses 166 (A6H), 326 (146H))
     Receive buffer memory length designation (addresses 167 (A7H), 327 (147H))

✻ For more details on the registration operation by QSCU, see the explanation of the system settings of the corresponding protocol in Sections 8.4.5 to 8.4.8.
For more details on the CSET instruction, see Section 16.4 of the User's Manual (Application).

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Applicable protocol Non	Applicable protocol Bi	Registration allowed/not allowed	Reference section
0 (0H)		For LED and communication error clear	Communication error clear request for CH1 and to turn LED off 0: ON, No initialization request 1: OFF, Initialization requested SD. WAIT (b0) C/N (b4) SIO (b1)) NAK. (b5) PRO. (b2) ACK. (b6) P/S (b3) NEU. (b7) For system (b8) to (b15)	0	RW			Not allowed	Section 8.6.10 Section 10.1.1 Section 10.1.2
	1 (1H)		Communication error clear request for CH2 and to turn LED off 0: ON, No initialization request 1: OFF, Initialization requested SD. WAIT (b0) NAK. (b5) SIO (b1) ACK. (b6) PRO. (b2) NEU. (b7) P/S (b3) CH2 ERR. (b14) C/N (b4) CH1 ERR. (b15) For system (b8) to (b13)						
2 (2H)		For flash ROM access	Register/read/delete instructions 0: No request 1: Register request 2: Read request 3: Delete request	0	RW	—		Not allowed	Section 8.4.1 Section 8.4.2 Section 8.4.11 Section 8.4.12
3 (3H)			Frame No. direction 0: No designation Other than 0: Frame No.						
4 (4H)			Registration/read/delete result storage 0: Normal completion Other than 0: Abnormal completion						
5 (5H)			Number of data bytes registered designation 0 : No designation Other than 0: Number of data bytes registered (maximum 80 bytes)						
6 to 45 (6H to 2DH)			User frame 0 : No designation Other than 0: Registered data (maximum 80 bytes)						
46 (2EH)		For designation of modem function-1	Modem connection channel designation 0: Non 1: CH1 2: CH2	0	RW			Allowed	Section 8.4.2 Section 8.4.3 Section 8.4.4 Chapter 3 of User's Manual (Application)
47 (2FH)			Notification execution designation 0: Do not execute. 1: Execute.	0					
48 (30H)			Number of connection retries designation 1 to 5: Number of retries	3					
49 (31H)			Connection retry interval designation 90 to 300: Connection retry interval (unit: s)	180					
50 (32H)			Initialization/connection timeout designation 1 to 60: Timeout (unit: s)	60					
51 (33H)			Number of initialization retries designation 1 to 5: Number of retries	3					
52 (34H)			Data No. for initialization designation 0H : Send initialization data designated by the designated area of the user frame for transmission. 7D0H to 801F: Data No. for initialization	7D0H					
53 (35H)			Data No. for connection designation BB8H to 801FH: Data No. for connection	0					
54 (36H)			GX Developer connection designation 0: Do not connect. 1: Connect.						
55 (37H)			No - communication interval time designation 0 : Wait infinitely 1 to 120: No communication interval (Waiting time for line disconnection) (unit: min.)	30					
56 (38H)			RS · CS control yes/no designation 0: No control 1: Controlled	1					
57 to 143 (39H to 8FH)		Use prohibited	System area	—					

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application		Name	Initial value	Applicable protocol MC	Non	Bi	Registration allowed/not allowed	Reference section
144 (90H)	304 (130H)	CH1	For designation of mode switching	Switching mode No. (1 to 7) designation 1: MC protocol (format 1) 5: MC protocol (format 5) 2: MC protocol (format 2) 6: Non procedure protocol 3: MC protocol (format 3) 7: Bidirectional protocol 4: MC protocol (format 4)	0	RW			Not allowed	Section 4.5.2 Chapter 15 of User's Manual (Application)
145 (91H)	305 (131H)			Transmission specifications after switching designation Designates transmission specifications (below) after switching when b15 of this area is 1 (ON). Operation setting (b0) 0: Independent 1: Link Data bit (b1) 0: 7 bit 1: 8 bit Parity bit (b2) 0: No 1: Yes Odd/even parity (b3) 0: Odd 1: Even Stop bit (b4) 0: 1 bit 1: 2 bit Sum check code (b5) 0: No 1: Yes Write during RUN (b6) 0: Prohibited 1: Allowed Setting modification (b7) 0: Prohibited 1: Allowed Communication rate (b8 to b11) 50 bps to 115200 bps For system (b12 to b14) All 0 Transmission specifications after switching (b15) designation 0: Match settings in GX Developer 1: Match settings in this area					
146 (92H)	306 (132H)		Use prohibited	System area	—					
147 (93H)	307 (133H)		For designation of transmission control	DTR/DSR(ER/DR), DC control designation • Transmission control (b0) 0: DTR/DSR control 1: DC code control • DC1/DC3 control (b8) 0: No control 1: Controlled • DC2/DC4 control (b9) 0: No control 1: Controlled	0	RW			Allowed	Section 8.4.5 Chapter 7 of User's Manual (Application)
148 (94H)	308 (134H)			DC1/DC3(Xon/Xoff) code designation • DC1 code (b0 to b7) 00H to FFH: DC1 code • DC3 code (b8 to b15) 00H to FFH: DC3 code	1311H					
149 (95H)	309 (135H)			DC2/DC4 code designation • DC2 code (b0 to b7) 00H to FFH: DC2 code • DC4 code (b8 to b15) 00H to FFH: DC4 code	1412H					
150 (96H)	310 (136H)		For designation of communication control	Word/byte units designation 0: Word units 1: Byte units	0	RW				Chapters 6 Chapter 7 Section 8.4.5
151 (97H)	311 (137H)			CD terminal check designation (for RS-232) 0: Check 1: No check	1					Section 3.2.1 Section 8.4.5
152 (98H)	312 (138H)			Communication system designation (for RS-232) 0: Full duplex communication 1: Half-duplex communication	0					Chapter 7 Section 8.4.5 Section 8.4.8 Chapter 8 of User's Manual (Application)
153 (99H)	313 (139H)		For half-duplex communications control designation (RS-232)	Simultaneous transmission priority/non-priority designation 0: Priority Other than 0: Non-priority (transmission wait time, unit: 100 ms)	0	RW				
154 (9AH)	314 (13AH)			Retransmission time transmission method designation 0: Do not resend. 1: Resend.						
155 (9BH)	315 (13BH)			Simultaneously transmission data valid/invalid designation • Receive data valid/invalid (b0) 0: Valid 1: Invalid • Transmission data valid/invalid (b8) 0: Valid 1: Invalid		—		RW		

Address Decimal (Hex)		Application	Name	Initial value	Applicable protocol			Registration allowed/not allowed	Reference section
CH1	CH2				MC	Non	Bi		
156 (9CH)	316 (13CH)	For designation of data communica-tion time monitoring	No-reception monitoring time (timer 0) designation 0H : Wait infinitely 28H to FA0H: Monitoring time (unit: byte)	0H	RW			Allowed	Section 8.4.5 Chapter 6 of User's Manual (Application)
157 (9DH)	317 (13DH)		Response monitoring time (timer 1) designation 0H : Wait infinitely 1H to BB8H: Monitoring time (unit: 100 ms)	32H (5 sec.)	RW	—	RW		
158 (9EH)	318 (13EH)		Transmission monitoring time (timer 2) designation 0H : Wait infinitely 1H to BB8H: Monitoring time (unit: 100 ms)	708H (3 min.)		RW			
159 (9FH)	319 (13FH)	Use prohibited	System area	—					
160 (A0H)	320 (140H)	For designation of on-demand function	Buffer memory head address designation (400H to 1AFFH)	CH1: 400H CH2: 800H	RW	—		Allowed	Section 8.4.6 Reference Manual
161 (A1H)	321 (141H)		Data length designation	0					
162 (A2H)	322 (142H)	For designation of transmission area	Transmission buffer memory head address designation	CH1: 400H CH2: 800H	—	RW	RW		Chapter 6 Chapter 7 Section 8.4.5 Section 8.4.7 Section 8.7
163 (A3H)	323 (143H)		Transmission buffer memory length designation	200H					
164 (A4H)	324 (144H)	For data reception	Received data count designation 0 : No designation for received data count 1 or more: Received data count	1FFH			—		
165 (A5H)	325 (145H)		Receive complete code designation FFFFH : No designation for receive complete code 0H to FFH: Receive complete code	0D0AH: (CR+LF)					
166 (A6H)	326 (146H)	For designation of reception area	Receive buffer memory head address designation	CH1: 600H CH2: A00H			RW		
167 (A7H)	327 (147H)		Receive buffer memory length designation	200H					
168 (A8H)	328 (148H)	For data reception	Receive data clear request 0: No request 1: Requested	0			—	Not allowed	
169 (A9H)	329 (149H)	For designation of on-demand user frame	First frame No. designation 1st 0: No designation Other than 0: Designated	0	RW	—		Allowed	Section 8.4.6 Chapters 9 and 10 of User's Manual (Application)
170 (AAH)	330 (14AH)		First frame No. designation 2nd 0: No designation Other than 0: Designated						
171 (ABH)	331 (14BH)		Last frame No. designation 1st 0: No designation Other than 0: Designated						
172 (ACH)	332 (14CH)		Last frame No. designation 2nd 0: No designation Other than 0: Designated						
173 (ADH)	333 (14DH)	For designation of receive user frame	User frame use enable/disable designation 0: Do not use 1: Use 2: Data communication possible (Q series C24 set)		—	RW	—		Section 8.4.7 Chapters 9 and 11 of User's Manual (Application)
174 to 177 (AEH to B1H)	334 to 337 (14EH to 151H)		First frame No. designation 1st (1st to 4th) 0H: No designation 1H or more: Head frame No.						
178 to 181 (B2H to B5H)	338 to 341 (152H to 155H)		Last frame No. designation (1st to 4th) 0H: No designation 1H or more: Last frame No.	1: 0DH 2: 0AH 3: 0H 4: 0H		RW			
182 (B6H)	342 (156H)	User frame being transmitted	User frame being transmitted 0 : Not send 1 to 100: User frame being transmitted (nth)	0		R		Not allowed	
183 (B7H)	343 (157H)	For user frame being transmitted designation	CR/LF output designation 0: Do not send. 1: Send.	0	—	RW	—	Allowed	
184 (B8H)	344 (158H)		Output head pointer designation 0: No designation 1 to 100: Send from nth						
185 (B9H)	345 (159H)		Output count designation 0: No designation 1 to 100: Output n						
186 to 285 (BAH to 11DH)	346 to 445 (15AH to 1BDH)		Output frame No. designation (A maximum of 100 can be specified) 0: No transmission designation 1 or more: Output frame No.						

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Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Applicable protocol Non	Applicable protocol Bi	Registration allowed/not allowed	Reference section
286 (11EH)	446 (1BEH)	For designation of transmission wait time	Message wait time designation 0: No wait time 1H to FH: Wait time (unit: 10 ms)	0	RW	—		Allowed	Section 8.4.6
287 (11FH)	447 (1BFH)	For designation of transparent code	Transmission transparent code designation 1st 0000H : No designation Other than 0000H: Designated (below) • Transparent code (b0 to b7) 00H to FFH: Transparent code • Additional code (b8 to b15) 00H to FFH: Additional code		—	RW			Section 8.4.5 Chapter 12 of User's Manual (Application)
288 (120H)	448 (1C0H)		Receive transparent code designation 0000H : No designation Other than 0000H: Designated (below) • Transparent code (b0 to b7) 00H to FFH: Transparent code • Additional code (b8 to b15) 00H to FFH: Additional code						
289 (121H)	449 (1C1H)	For conversion designation	ASCII-BIN conversion designation 0: No conversion 1: Convert						
290 to 303 (122H to 12FH)	450 to 511 (1C2H to 1EFH)	Use prohibited	System area	—					
512 (200H)		For confirmation of station No. setting status	Station No. setting status (setting number with GX Developer)	Depends on parameter setting	R			Not allowed	Section 4.3 Section 4.5.2 Section 8.6.9
513 (201H)		For confirmation of LED ON status and communication error status	LED ON status and communication error status on CH1 side 0: Turned off/OFF, no error 1: Turned on/ON, error SD.WAIT (b0) C/N (b4) SIO (b1) NAK. (b5) PRO. (b2) ACK. (b6) P/S (b3) NEU. (b7) For system (b8) to (b15)	Depends on module status					
514 (202H)			LED ON status and communication error status on CH2 side 0: Turned off/OFF, no error 1: Turned on/ON, error SD.WAIT (b0) NAK. (b5) SIO (b1) ACK. (b6) PRO. (b2) NEU. (b7) P/S (b3) CH2.ERR. (b14) C/N (b4) CH1 ERR. (b15) For system (b8) to (b13)						
515 (203H)		For confirmation of switch setting and mode switching	Switch setting error and mode switching error status 0: No error Other than 0: Switch setting error and mode switching error CH1 Communication protocol setting No. (b0) 0: Normal 1: Error CH1 Communication rate setting (b1) 0: Normal 1: Error CH1 Setting change prohibit time mode switching (b3) 0: Normal 1: Error CH2 Communication protocol setting No. (b4) 0: Normal 1: Error CH2 Communication rate setting (b5) 0: Normal 1: Error CH2 Setting change prohibit time mode switching (b7) 0: Normal 1: Disable Setting station No. (b14) 0: Normal 1: Out of range Linked operation setting (b15) 0: Normal 1: Error	0					

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Applicable protocol Non	Applicable protocol Bi	Registration allowed/not allowed	Reference section
516 (204_H)		For confirmation of user frame	Number of registered user frames 0_H: No registration 1 or more: Number of registered frames	Depends on registration status	R		—	Not allowed	Section 8.6.9
517 to 541 (205_H to $21D_H$)			User frame registration status (for confirmation of registration No.) 0: No registration 1: Registered * Bit corresponding to registration No. is 0(ON)/1(OFF). Registration No.$3E8_H$ (1000) : Address 205_H (b0) to Registration No. $4AF_H$ (1199) : Address 211_H (b7)						
542 ($51E_H$)			Number of registered default registration frames (for system)		R		—		Section 8.6.9 Section 9.1.2 of User's Manual (Application)
543 ($51F_H$)		Use prohibited	System area	—					
544 (220_H)		For confirmation of flash ROM write result	Flash ROM system parameters write result 0 : Normal completion Other than 1 (error code) : Abnormal completion	0	RW			Not allowed	Section 8.6.9
545 (221_H)		For confirmation of modem function	Modem function error code (error code when modem function is being used) 0 : Normal completion Other than 1 (error code) : Abnormal completion		R			Not allowed	Section 8.6.2 Chapter 3 of User's Manual (Application)
546 (222_H)			Modem function sequence status 0: Idle 4: Checking password 1: Waiting for initialization 5: Communicating 2: Initializing modem 6: Notification in progress 3: Waiting						
547 (223_H)			Number of data registration for connection 0: No registration 1 or more: Number of registration						
548 to 549 (224_H to 225_H)			Data registration status for connection (for confirmation of registration No.) 0: No registration 1: Registered * Bit corresponding to registration No. is 0(ON)/1(OFF). Registration No. $BB8_H$ (3000) : Address 224_H (b0) to Registration No. $BD5_H$ (3029) : Address 225_H (b13)						
550 (226_H)			Number of data registration for initialization 0: No registration 1 or more: Number of registrations						
551 to 552 (227_H to 228_H)			Data registration status for initialization (for confirmation of registration No.) 0: No registration 1: Registered * Bit corresponding to registration No. is 0(ON)/1(OFF). Registration No.$9C4_H$ (2500) : Address 227_H (b0) to Registration No. $9E1_H$ (2529) : Address 228_H (b13)						
553 (229_H)		For confirmation of notification status	Number of notification execution 0: Not executed 1 or more: Number of executions	0	R				
554 ($22A_H$)			Data storage area 1: Notification execution data No. 0 : Notification not executed $BB8_H$ or more: Notification executed (notification execution No.)		R				
555 to 557 ($22B_H$ to $22D_H$)			Data storage area 1: System area (use prohibited)		—				
558 to 561 ($22E_H$ to 231_H)			Data storage area 2	The configuration of each area is the same as the data storage area 1.					
562 to 565 (232_H to 235_H)			Data storage area 3						
566 to 569 (236_H to 239_H)			Data storage area 4						
570 to 573 ($23A_H$ to $23D_H$)			Data storage area 5						
574 to 591 ($23E_H$ to $24F_H$)		Use prohibited	System area	—					

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Non	Bi	Registration allowed/not allowed	Reference section
592 (250H)	608 (260H)	For confirmation of transmission control status	Communication protocol setting status (setting with GX Developer) 0: GX Developer connection 5: MC protocol (format 5) 1: MC protocol (format 1) 6: Non procedure protocol 2: MC protocol (format 2) 7: Bidirectional protocol 3: MC protocol (format 3) 8: (For linked operation) 4: MC protocol (format 4)	Depends on parameter setting	R			Not allowed	Section 4.5.2 Section 8.6.3 Section 10.1.3
593 (251H)	609 (261H)		Transmission setting status (setting with GX Developer) Operation setting (b0) 0: Independent 1: Link Data bit (b1) 0: 7 bit 1: 8 bit Parity bit (b2) 0: No 1: Yes Odd/even parity (b3) 0: Odd 1: Even Stop bit (b4) 0: 1 bit 1: 2 bit Sum check code (b5) 0: No 1: Yes Write during RUN (b6) 0: Prohibited 1: Allowed Setting modification (b7) 0: Prohibited 1: Allowed Communication rate (b8 to b11) 50 bps to 115200 bps For system (b12 to b15) All 0					
594 (252H)	610 (262H)		Communication protocol status (current) 0: GX Developer connection 5: MC protocol (format 5) 1: MC protocol (format 1) 6: Non procedure protocol 2: MC protocol (format 2) 7: Bidirectional protocol 3: MC protocol (format 3) 8: (For linked operation) 4: MC protocol (format 4)						
595 (253H)	611 (263H)		Transmission status (current) Operation setting (b0) 0: Independent 1: link Data bit (b1) 0: 7 bit 1: 8 bit Parity bit (b2) 0: No 1: Yes Odd/even parity (b3) 0: Odd 1: Even Stop bit (b4) 0: 1 bit 1: 2 bit Sum check code (b5) 0: No 1: Yes Write during RUN (b6) 0: Prohibited 1: Allowed Setting modification (b7) 0: Prohibited 1: Allowed Communication rate (b8 to b11) 50 bps to 115200 bps For system (b12 to b15) All 0					
596 (254H)	612 (264H)	Control signal status	RS-232 control signal status 0: OFF status 1: ON status RTS (b0) DTR (b2) RI (b5) DSR (b1) CD (b3) Not used (b4, b6 to b15) All 0	Depends on signal status	R				
597 (255H)	613 (265H)	For confirmation of communication result	Transmission sequence status (For confirmation of MC protocol communication status) 0: Waiting for receiving command 1: Receiving command 2: Command reception complete 3: Waiting to access PLC CPU 4: Accessing PLC CPU 5: PLC CPU access complete 6: Response message transmission	0	R	—			Section 8.6.4 Section 10.1.4
598 (256H)	614 (266H)		On-demand execution result 0 : Normal completion 1 or more: Abnormal completion (error code)		RW	—			
599 (257H)	615 (267H)		Data transmission result 0 : Normal completion 1 or more: Abnormal completion (error code)		RW				Chapter 6 Chapter 7 Section 8.6.5 Section 8.6.6
600 (258H)	616 (268H)		Data reception result 0 : Normal completion 1 or more: Abnormal completion (error code)						
601 (259H)	617 (269H)		System area	—					
602 (25AH)	618 (26AH)		MC protocol transmission error code (excludes A compatible 1C frame communication) 0: No error 1 or more: Transmission error code	0	RW	—		Not allowed	Section 8.6.4
603 (25BH)	619 (26BH)		Receive user frame (nth) 0 : Not received 1 to 4: Combination of user frame No. designations for reception message		—	R	—		Section 8.6.5

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Applicable protocol Non	Applicable protocol Bi	Registration allowed/not allowed	Reference section
604 to 607 (25CH to 25FH)	620 to 1023 (26CH to 3FFH)	Use prohibited	System area	—					
1024 (400H)	2048 (800H)	Transmission/receive area	Transmission data count designation 0: No designation 1 or more: Number of send data	0	RW			Not allowed	Chapter 6 Chapter 7 Section 8.4.5 Section 8.4.7
1025 to 1535 (401H to 5FFH)	2049 to 2559 (801H to 9FFH)		Transmission data designation Data to be sent to an external device						
1536 (600H)	2560 (A00H)		Receive data count (Number of data for which read is requested) 0: No receive data 1 or more: Number of receive data						
1537 to 2047 (601H to 7FFH)	2561 to 3071 (A01H to BFFH)		Receive data Data received from an external device						
3072 to 6911 (C00H to 1AFFH)		For user	User free area (3840 words) * Determined by the user.	0	RW			Not allowed	—
6912 (1B00H)		For designation of user frame	User frame Area for registration number 8001H: Number of registration data bytes designation 0 : No designation 1 to 40: Number of registration data bytes	0	RW	—		Not allowed	Chapter 9 of User's Manual (Application)
6913 to 6952 (1B01H to 1B28H)			User frame * It is possible to designate up to 40 words.						
6953 to 6993 (1B29H to 1B51H)			For registration No. 8002H	The configuration of each area is the same as the area for the User frame registration No. 8001H.					
6994 to 7034 (1B52H to 1B7AH)			For registration No. 8003H						
7035 to 7075 (1B7BH to 1BA3H)			For registration No. 8004H						
7076 to 7116 (1BA4H to 1BCCH)			For registration No. 8005H						
7117 to 7157 (1BCDH to 1BF5H)			For registration No. 8006H						
7158 to 7198 (1BF6H to 1C1EH)			For registration No. 8007H						
7199 to 7239 (1C1FH to 1C47H)			For registration No. 8008H						
7240 to 7280 (1C48H to 1C70H)			For registration No. 8009H						
7281 to 7321 (1C71H to 1C99H)			For registration No. 800AH						
7322 to 7362 (1C9AH to 1CC2H)			For registration No. 800BH						
7363 to 7403 (1CC3H to 1CEBH)			For registration No. 800CH						
7404 to 7444 (1CECH to 1D14H)			For registration No. 800DH						
7445 to 7485 (1D15H to 1D3DH)			For registration No. 800EH						
7486 to 7526 (1D3EH to 1D66H)			For registration No. 800FH						
7527 to 7567 (1D67H to 1D8FH)			For registration No. 8010H						
7568 to 7608 (1D90H to 1DB8H)			For registration No. 8011H						
7609 to 7649 (1DB9H to 1DE1H)			For registration No. 8012H						
7650 to 7690 (1DE2H to 1E0AH)			For registration No. 8013H						
7691 to 7731 (1E0BH to 1E33H)			For registration No. 8014H						
7732 to 7772 (1E34H to 1E5CH)			For registration No. 8015H						
7773 to 7813 (1E5DH to 1E85H)			For registration No. 8016H						
7814 to 7854 (1E86H to 1EAEH)			For registration No. 8017H						
7855 to 7895 (1EAFH to 1DE7H)			For registration No. 8018H						
7896 to 7936 (1ED8H to 1F00H)			For registration No. 8019H						
7937 to 7977 (1F01H to 1F29H)			For registration No. 801AH						
7978 to 8018 (1F2AH to 1F52H)			For registration No. 801BH						
8019 to 8059 (1F53H to 1F7BH)			For registration No. 801CH						
8060 to 8100 (1F7CH to 1FA4H)			For registration No. 801DH						
8101 to 8141 (1FA5H to 1FCDH)			For registration No. 801EH						
8142 to 8182 (1FCEH to 1FF6H)			For registration No. 801FH						

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Non	Bi	Registration allowed/not allowed	Reference section
8183 to 8191 (1FF7H to 1FFFH)		Use prohibited	System area	—					
8192 (2000H)		System designation	Flash ROM write allow/prohibit designation 0: Write prohibited 1: Write allowed	0	RW			Not allowed	Section 8.4.12
8193 to 8199 (2001H to 2007H)	8448 to 8455 (2100H to 2107H)	Use prohibited	System area	—					
8200 (2008H)		For designation of modem function -2	Modem initialization time DR (DSR) signal valid/invalid designation 0: Do not ignore DR signal. 1: Ignore DR signal.	1	RW			Allowed	Section 8.4.4 Chapter 3 of User's Manual (Application)
8201 (2009H)			Complete signal handling for modem function designation 0: Do not turn on/off X13 to X16. 1: Turn on/off X13 to X16.	1					
8202 (200AH)			Wait time of notification designation 0000H to FFFFH: Wait time (unit: s)	10					
8203 (200BH)		Use prohibited	System area	—					
8204 (200CH)		For remote password function	Remote password mismatch notification count designation 0: No designation 1H to FFFFH: Notification times	0	RW	—		Allowed	Section 5.1.5 Section 8.4.4 Chapter 3 of User's Manual (Application)
8205 (200DH)			Remote password mismatch notification accumulated count designation 0: No designation 1H to FFFFH: Cumulative times of notification	1					
8206 (200EH)		For designation of modem function -3	Circuit disconnect wait time (PLC CPU watch use) 0000H to FFFFH: Wait time (unit: s)	0	RW		—		Section 8.4.4 Chapter 3 of User's Manual (Application)
8207 (200FH)	8456 to 8463 (2108H to 210FH)	Use prohibited	System area	—					
8208 (2010H)	8464 (2110H)	Interrupt designation	Receive interrupt-issued designation 0: Do not issue interrupt. 1: Issue interrupt.	0	—	RW		Allowed	Chapter 4 of User's Manual (Application)
8209 to 8223 (2011H to 201FH)	8465 to 8479 (2111H to 211FH)	Use prohibited	System area	—					
8224 to 8227 (2020H to 2023H)	8480 to 8483 (2120H to 2123H)	For designation of user frame receiving method	User frame receive format designation (1st to 4th) 0: Format-0, 1: Format-1	0	—	RW	—	Allowed	Section 3.4.7 Chapter 11 of User's Manual (Application)
8228 to 8231 (2024H to 2027H)	8484 to 8487 (2124H to 2127H)		Exclusive format-1 received data count (1st to 4th) 0 or more: Exclusive format-1 received data count						
8232 to 8239 (2028H to 202FH)	8488 to 8495 (2128H to 212FH)	Use prohibited	System area	—					
8240 to 8248 (2030H to 2038H)	8496 to 8504 (2130H to 2138H)	For designation of transparent code	Transmission transparent code designation (2nd to 4th) 0000H :No designation Other than 0000H :Designated (below) • Transparent code (b0 to b7) 00H to FFH : Transparent code • Additional code (b8 to b15) 00H to FFH : Additional code	0	—	RW	Allowed		Section 3.4.5 Chapter 12 of User's Manual (Application)
8249 to 8255 (2039H to 203FH)	8505 to 8511 (2139H to 213FH)	Use prohibited	System area	—					

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Applicable protocol Non	Applicable protocol Bi	Registration allowed/not allowed	Reference section
8256 (2040H)	8512 (2140H)	For designation of PLC CPU monitoring function	Cycle time units designation 0: 100 ms 1: s 2: min	2	R	—		Allowed	Chapter 2 of User's Manual (Application)
8257 (2041H)	8513 (2141H)		Cycle time designation 0H : No designation 1H to FFFFH: PLC CPU monitoring cycle time	5H					
8258 (2042H)	8514 (2142H)		PLC CPU monitoring function designation 0: Do not use the function. 1: Fixed cycle transmission 2: Condition agreement transmission	0					
8259 (2043H)	8515 (2143H)		PLC CPU monitoring transmission measure designation (for fixed cycle transmission) 0: Data transmission (device data and CPU status data) 1: Notification	0					
8260 (2044H)	8516 (2144H)		Transmission pointer designation (For fixed cycle transmission and data transmission) 1 to 100: Output head point (send from the nth) * Send the user frames designated in the following transmission frame No. designation areas from the designated pointer position. (addresses: CH1 side = BAH to 11DH, CH2 side = 15AH to 1BDH)	0					
8261 (2045H)	8517 (2145H)		Output count designation (for fixed cycle transmission and data transmission) 1 to 100:Output count (designate the number of frame transmissions.)						
8262 (2046H)	8518 (2146H)		Data No. for connection designation (for fixed cycle transmission and notification) 0BB8H to 0BD5H, 8001H to 801FH: Data No. for connection	0					
8263 to 8268 (2047H to 204CH)	8519 to 8524 (2147H to 2149H)	Use prohibited	System area	—					
8269 (204DH)	8225 (214DH)	For designation of PLC CPU monitoring function	Number of registered word blocks designation 0 : No designation 1 to 10: Number of blocks of word devices	0	R	—		Allowed	Chapter 2 of User's Manual (Application)
8270 (204EH)	8226 (214EH)		Number of registered bit blocks designation 0 : No designation 1 to 10: Number of blocks of bit devices						
8271 (204FH)	8527 (214FH)		PLC CPU abnormal monitoring designation 0: Do not monitor. 1: Monitor.						
8272 (2050H)	8528 (2150H)		No. 1 block monitoring device: Monitoring device designation 90H to CCH: Device code						
8273 to 8274 (2051H to 2052H)	8529 to 8530 (2151H to 2152H)		Head device No. designation 0 or more: Head device No.						
8275 (2053H)	8531 (2153H)		Read point designation 1 or more: Number to read points						
8276 (2054H)	8532 (2154H)		Monitoring condition designation (judgment condition designation) 1 or more: Monitoring condition						
8277 (2055H)	8533 (2155H)		Monitoring condition value designation At bit device 0: OFF 1: ON At word device 0 to FFFFH: Monitoring condition value						
8278 (2056H)	8534 (2156H)		Transmission pointer designation (for condition agreement transmission and data transmission) 1 to 100: Output head point (send from nth) * Send the user frames designated in the following transmission frame No. designation areas from the designated pointer position. (address: CH1 side = BAH to 11DH, CH2 side = 15AH to 1BDH)						
8279 (2057H)	8535 (2157H)		Output count designation (for condition agreement transmission and data transmission) 1 to 100: Output count (designate the number of frame transmissions)						
8280 (2058H)	8536 (2158H)		Data No. for connection designation (for condition agreement transmission and notification) 0BB8H to 0BD5H, 8001H to 801FH: Data No. for connection						

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name		Initial value	Applicable protocol MC	Non	Bi	Registration allowed/not allowed	Reference section
8281 to 8361 (2059H to 20A9H)	8537 to 8617 (2159H to 21A9H)	For designation of PLC CPU monitoring function	Block monitoring devices No. 2 to 10	The structure of each area is the same as the first block monitoring device area See *1 for the details of each area.						
8362 to 8421 (20AAH to 20E5H)	8618 to 8677 (21AAH to 21E5H)	Use prohibited	System area		—					
8422 (20E6H)	8678 (21E6H)	For designation of PLC CPU monitoring function	CPU abnormal monitoring designation	Transmission pointer designation (for condition agreement transmission) 1 to 100: Output head point (send from nth) * Send the user frames designated in the following transmission frame No. designation areas from the designated pointer position. (address: CH1 side = BAH to 11DH, CH2 side = 15AH to 1BDH)	0	R	—	Allowed	Chapter 2 of User's Manual (Application)
8423 (20E7H)	8679 (21E7H)			Output count designation (for condition agreement transmission) 1 to 100: Output count (designate the number of frame transmissions)						
8424 (20E8H)	8680 (21E8H)			Data No. for connection designation (for condition agreement transmission and notification) 0BB8H to 0BD5H, 8001H to 801FH: Data No. for connection						
8425 to 8447 (20E9H to 20FFH)	8681 to 8703 (21E9H to 21FFH)	Use prohibited	System area		—					
8704 to 8707 (2200H to 2203H)	8960 to 8963 (2300H to 2303H)	Use prohibited	System area		—					
8708 (2204H)	8964 (2304H)	PLC CPU monitoring function	PLC CPU monitoring function operation status 0: Not executed (waiting for registration of PLC CPU monitoring) 1: Wait for PLC CPU monitoring time (waiting to access PLC CPU) 2: Accessing PLC CPU 3: Sending monitoring results		0	R	—	Not allowed	Chapter 2 of User's Manual (Application)	
8709 (2205H)	8965 (2305H)		PLC CPU monitoring function execution result (current) 0: Normal completion 1 or more: Abnormal completion (error code)							
8710 (2206H)	8966 (2306H)		PLC CPU monitoring function number of transmission 0: Not executed 1 or more: Number of transmissions							
8711 (2207H)	8967 (2307H)		Monitoring condition arrival block No. 0 : The monitoring condition is not enabled for any block 1 to 10: Registration order of word/bit block (nth) 4096 : CPU abnormal monitoring block * The latest block No. for which monitoring condition is enabled is stored.							
8712 to 8954 (2208H to 22FAH)	8968 to 9215 (2308H to 23FFH)	Use prohibited	System area		—					
8755 (22FBH)		For the remote password function	Accumulated count of unlock process normal completion 0 or more: Accumulated count of normal completion		0	RW	—	Not allowed	Section 5.1.5 Section 8.6.2 Chapter 3 of User's Manual (Application)	
8756(22FCH)			Accumulated count of unlock process abnormal completion processing 0 or more: Accumulated count of abnormal completion							

Address Decimal (Hex) CH1	Address Decimal (Hex) CH2	Application	Name	Initial value	Applicable protocol MC	Applicable protocol Non	Applicable protocol Bi	Registration allowed/not allowed	Reference section
8757 to 8758 (22FDH to 22FEH)		Use prohibited	System area	—					
8759(22FFH)		For the remote password function	Accumulated count of lock process based on circuit disconnection 0 or more: Accumulated count of lock process based on circuit disconnection	0	RW	—		Not allowed	Section 5.1.5 Section 8.6.2 Chapter 3 of User's Manual (Application)
9216 to 9471 (2400H to 24FFH)		Use prohibited	System area	—					

∗1 The following tables show the areas of block monitoring devices No. 1 to 10 (CH1 side: 8272 to 8361 (2050H to 20A9H), CH2 side: 8528 to 8617 (2150H to 21A9H)), which are assigned for designating the PLC CPU monitoring function.

[CH1 side buffer memory address: decimal (hexadecimal)]

nth block monitoring device 1	2	3	4	5	6	7	8	9	10	Name
8272 (2050H)	8281 (2059H)	8290 (2062H)	8299 (206BH)	8308 (2074H)	8317 (207DH)	8326 (2086H)	8335 (208FH)	8344 (2098H)	8353 (20A1H)	Monitoring device designation
8273 to 8274 (2051H to 2052H)	8282 to 8283 (205AH to 205BH)	8291 to 8292 (2063H to 2064H)	8300 to 8301 (206CH to 206DH)	8309 to 8310 (2075H to 2076H)	8318 to 8319 (207EH to 207FH)	8327 to 8328 (2087H to 2088H)	8336 to 8337 (2090H to 2091H)	8345 to 8346 (2099H to 209AH)	8354 to 8355 (20A2H to 20A3H)	Head device No. designation
8275 (2053H)	8284 (205CH)	8293 (2065H)	8302 (206EH)	8311 (2077H)	8320 (2080H)	8329 (2089H)	8338 (2092H)	8347 (209BH)	8356 (20A4H)	Designation of number of points read
8376 (2054H)	8385 (205DH)	8294 (2066H)	8303 (206FH)	8312 (2078H)	8321 (2081H)	8330 (208AH)	8339 (2093H)	8348 (209CH)	8357 (20A5H)	Monitoring condition designation (Judgment condition designation)
8277 (2055H)	8286 (205EH)	8295 (2067H)	8304 (2070H)	8313 (2079H)	8322 (2082H)	8331 (208BH)	8340 (2094H)	8349 (209DH)	8358 (20A6H)	Monitoring condition value designation
8278 (2056H)	8287 (205FH)	8296 (2068H)	8305 (2071H)	8314 (207AH)	8323 (2083H)	8332 (208CH)	8341 (2095H)	8350 (209EH)	8359 (20A7H)	Transmission pointer designation (for conditional transmission, data transmission)
8279 (2057H)	8288 (2060H)	8297 (2069H)	8306 (2072H)	8315 (207BH)	8324 (2084H)	8333 (208DH)	8342 (2096H)	8351 (209FH)	8360 (20A8H)	Designation of number of outputs (for conditional transmission, data transmission)
8280 (2058H)	8289 (2061H)	8298 (206AH)	8307 (2073H)	8316 (207CH)	8325 (2085H)	8334 (208EH)	8343 (2097H)	8352 (20A0H)	8361 (20A9H)	Designation of data No. for connection (for conditional transmission and notification)

[CH2 side buffer memory address: decimal (hexadecimal)]

nth block monitoring device 1	2	3	4	5	6	7	8	9	10	Name
8528 (2150H)	8537 (2159H)	8546 (2162H)	8555 (216BH)	8564 (2174H)	8573 (217DH)	8582 (2186H)	8591 (218FH)	8600 (2198H)	8609 (21A1H)	Monitoring device designation
8529 to 8530 (2151H to 2152H)	8538 to 8539 (215AH to 215BH)	8547 to 8548 (2163H to 2164H)	8556 to 8557 (216CH to 216DH)	8565 to 8566 (2175H to 2176H)	8574 to 8575 (217EH to 217FH)	8583 to 8584 (2187H to 2188H)	8592 to 8593 (2190H to 2191H)	8601 to 8602 (2199H to 219AH)	8610 to 8611 (21A2H to 21A3H)	Head device No. designation
8531 (2153H)	8540 (215CH)	8549 (2165H)	8558 (216EH)	8567 (2177H)	8576 (2180H)	8585 (2189H)	8594 (2192H)	8603 (219BH)	8612 (21A4H)	Designation of number of points read
8532 (2154H)	8541 (215DH)	8550 (2166H)	8559 (216FH)	8568 (2178H)	8577 (2181H)	8586 (218AH)	8595 (2193H)	8604 (219CH)	8613 (21A5H)	Monitoring condition designation (Judgment condition designation)
8533 (2155H)	8542 (215EH)	8551 (2167H)	8560 (2170H)	8569 (2179H)	8578 (2182H)	8587 (218BH)	8596 (2194H)	8605 (219DH)	8614 (21A6H)	Monitoring condition value designation
8534 (2156H)	8543 (215FH)	8552 (2168H)	8561 (2171H)	8570 (217AH)	8579 (2183H)	8588 (218CH)	8597 (2195H)	8606 (219EH)	8615 (21A7H)	Transmission pointer designation (for conditional transmission, data transmission)
8535 (2157H)	8544 (2160H)	8553 (2169H)	8562 (2172H)	8571 (217BH)	8580 (2184H)	8589 (218DH)	8598 (2196H)	8607 (219FH)	8616 (21A8H)	Designation of number of outputs (for conditional transmission, data transmission)
8536 (2158H)	8545 (2161H)	8554 (216AH)	8563 (2173H)	8572 (217CH)	8581 (2185H)	8590 (218EH)	8599 (2197H)	8608 (21A0H)	8617 (21A9H)	Designation of data No. for connection (for conditional transmission and notification)

4 SETTINGS AND PROCEDURES PRIOR TO OPERATION

This chapter explains the settings and procedures required before starting a system that uses the Q series C24.

POINT
(1) When using the Q series C24, please read the safety precautions at the beginning of this manual. (2) The installation and setup methods of the Q series C24 are the same as those for CPU modules. (3) For module installation and setup, see the user's manual for the PLC CPU used.

4.1 Handling Precautions

The following explains the precautions for handling the Q series C24:

(1) Do not drop the module or subject it to heavy impact since it is made of resin.

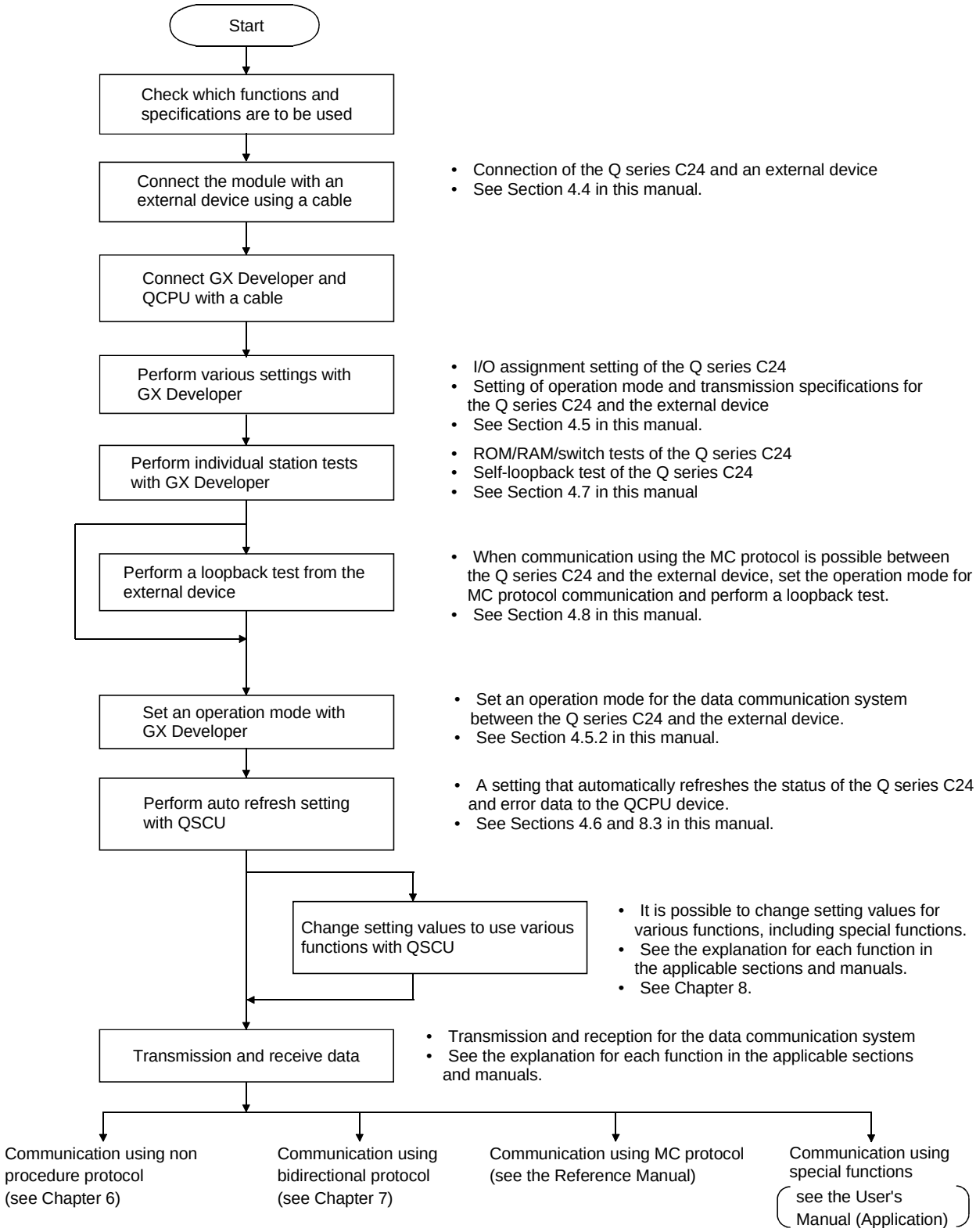
(2) Tighten the module terminal and fixing screws within the specified clamping torque range as follows:

Screw	Clamping torque range
RS-422/485 terminal block terminal screws (M3)	42 to 58 N · cm
Module fixing screw (not necessary for standard use) (M3) (*1)	36 to 48 N · cm

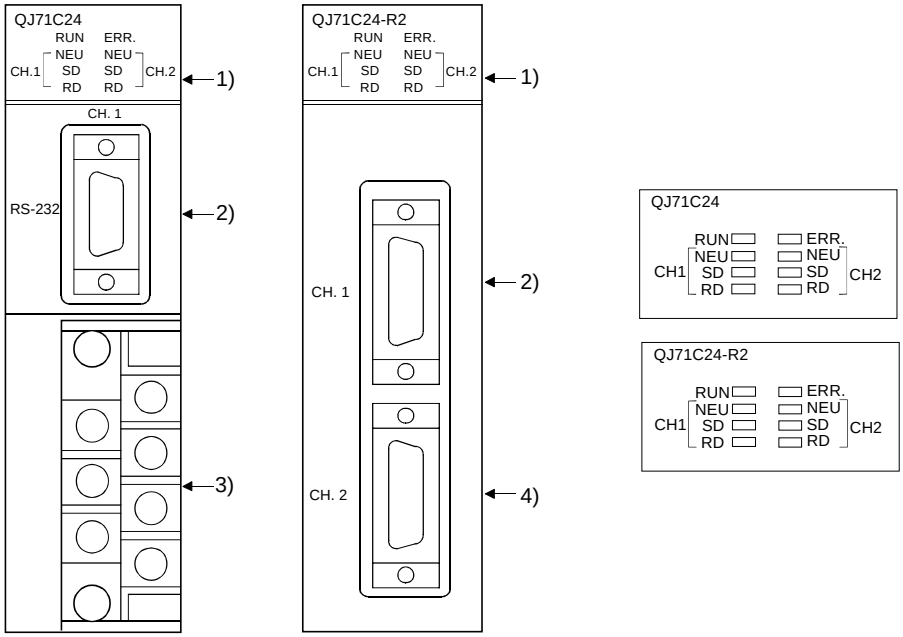
*1 A module can be easily fixed to a base unit using the hooks in the upper part of the module. However, it is recommended that the module will be fixed using the module mounting screws when it is used in a place subject to vibration or impact.

4.2 Settings and Procedures Prior to Operation

The outline of the procedure before operation is shown below.



4.3 Part Names and Functions



	Name	Description
1)	Displayed LED	Displayed LED (see (1) for description.)
2)	RS-232 interface on CH1 side	RS-232 interface on CH1 (D-sub 9 pin) for performing serial communication with an external device.
3)	RS-422/485 interface on CH2 side	RS-422/485 interface on CH2 (two piece terminal block) for performing serial communication with an external device.
4)	RS-232 interface on CH2 side	RS-232 interface on CH2 (D-sub 9 pin) for performing serial communication with an external device.

(1) List of LEDs displayed

CH	LED name	Description	● : Lit/flashing	○: Off	Supported protocol		
					MC	Non procedure protocol	Bidirectional protocol
—	RUN	Normal operation display	Normal	Abnormal, reset	○		
	ERR	Error existence display (＊1)	Error occurrence	Normal			
CH1	NEU	Neutral status display on CH1 side (＊2)	Waiting to receive MC command message	Receiving command message	○	×	
	SD	Send data status display	Sending data	Not sent	○		
	RD	Receive data status display	Receiving data	Not received			
CH2	NEU	Neutral status display on CH2 side (＊2)	Waiting to receive MC command message	Receiving command message	○	×	
	SD	Send data status display	Sending data	Not sent	○		
	RD	Receive data status display	Receiving data	Not received			

＊1 This LED is lit when there is a hardware error in the Q series C24 or error in the data communication (see Chapter 10).

＊2 These LEDs display the status of the data communication using the MC protocol.
Lit : Waiting to receive a command message from the external device.
Off : Processing a command message received from the external device.

4.4 External Wiring

This section explains wiring between the Q series C24 and external device.

As the wiring precautions, external wiring which is resistant to the effects of external noise is a prerequisite for reliable system operation and full use of the Q series C24 function.

(1) Ground the shield at only one point.

(2) When connecting with an external device using an RS-232 line, use a connector shell as specified in Section 3.2.1 on the Q series C24 side.

(3) The RS-422/485 interface terminal block uses M3 terminal screws.
Fasten suitable sized crimped terminals to the terminals.

(4) Connect the external device according to its specifications.

(5) See Appendix 5 for the bend radius of the connection cable.

4.4.1 Connecting the RS-232 interface (full-duplex communications)

The following shows the connection precautions and connection examples when using the Q series C24 RS-232 interface for full-duplex communications.

(1) Connection precautions

(a) For further information about the following items, see the explanation in the applicable section in the User's Manual (Application).

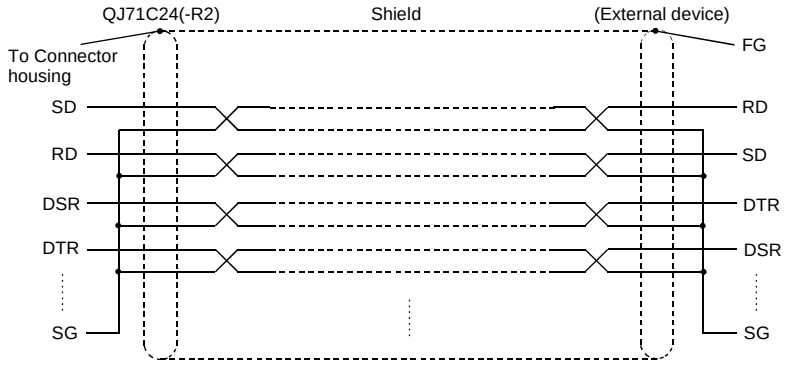
- Controlling the communication on the Q series C24 side by the external device side using the CD signal of the RS-232 interface.
  ✻ This is affected by the "RS-232 CD terminal check setting" in "CHn transmission control and others system setting change" screen on QSCU.
- Performing half-duplex communication using specifications on the external device side (an example of such a connection is shown in this section).
- Using modem functions.

(b) The connection cable FG signal and shield are connected as follows.

	Connection on the Q series C24 side	Notes
Connection cable FG signal	Connect to the Q series C24 connector housing	Do not short the communication cable FG signal and the SG signal. When the FG signal and the SG signal are connected inside the external device, do not connect the FG signal to the Q series C24.
Connection cable shield	Connect to the external device FG terminal or the Q series C24 connector housing	

(c) When normal data communication is not obtained due to external noise, perform the wiring as follows:

1) Connect the FG terminals on the external device and the Q series C24 using the shield of the connection cable.
2) Signals other than SG should be connected with SG signals in the twisted pair.

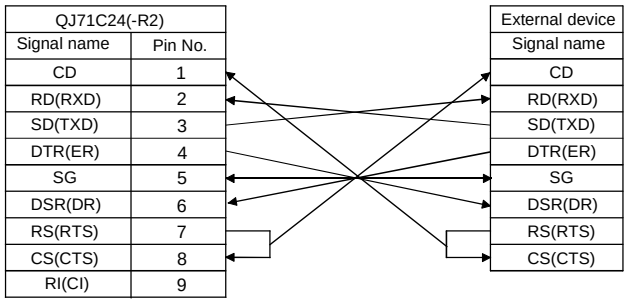


POINT

When using an RS-232 to RS-422 converter to connect the external device and the Q series C24, use a converter that is compatible with the external device and PLC CPU system configuration (1:1).

(2) Connection examples

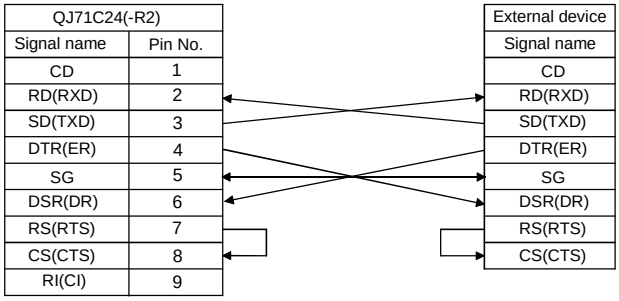
(a) Connection example with an external device capable of turning on and off the CD signal (No. 1 pin)



* The CD terminal check setting is set according to the specification of the external device. When wiring shown above, DTR/DSR control or DC code control may be performed.

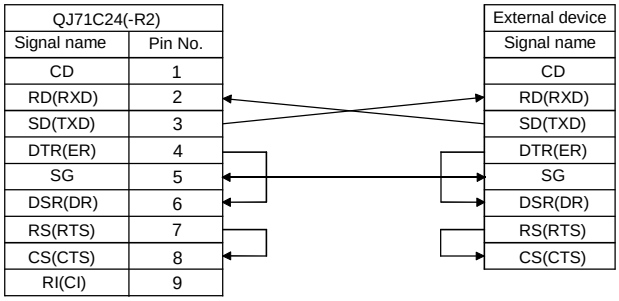
(b) Connection example with an external device not capable of turning on and off the CD signal

1) Connection example 1



* When wiring shown above, DTR/DSR control or DC code control may be performed.

2) Connection example 2



* When wiring shown above, DC code control may be performed.

POINT

If the PLC CPU and an external device cannot be communicated, try to perform data communication as a connection test, using the wiring connection as shown in Connection example 2.
If data can be communicated using the wiring connection shown in Connection example 2, rewire after checking the interface specifications on the external device side.

4.4.2 Connecting the RS-422/485 interface

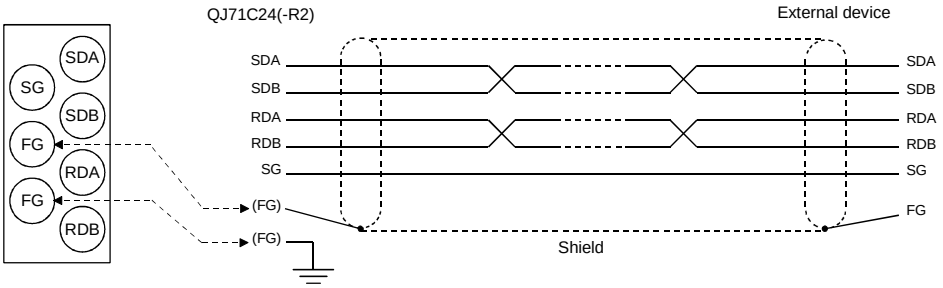
The following shows the connection precautions and connection examples when using the Q series C24 RS-422/485 interface.

(1) Connection precautions

(a) When connecting the Q series C24 SG and FG signals to the external device, connect them according to the specifications of the external device.

(b) Connect the shield of the connection cable to the FG terminal on either of the connected devices.
If normal data communication is not obtained due to external noise even if wiring is made as shown above, perform wiring as follows:

1) Connect between the FG of both stations with the shield of the connection cable.
On the external device side, however, follow the instruction manual of the external device.
2) Connect the (FG) of the Q series C24 side to the FG terminal at the power supply module of the station which has the Q series C24 is installed, or to the FG terminal of the control panel on which the Q series C24 PLC is installed.
3) Connect nnA and nnB of each signal in the connection cable as a pair.

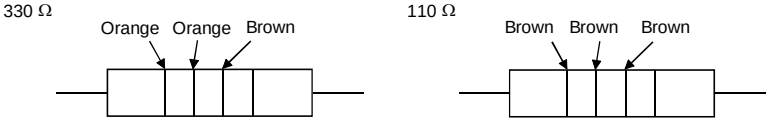


Correspondance of the RS-422/485 terminal block and signal location.

(e) Terminal resistor must be set (or connected) for the station of both ends on the circuit.
Match the Q series C24 to the specifications of the external device and connect a terminal resistor (packed with the Q series C24) according to this section.
Connect, or set a terminal resistor at the external device according to the instruction manual of the external device.
(The terminal resistor to connect to the Q series C24)

- When communications performed using RS-422, "330Ω 1/4 W" resistor is connected.
- When communications performed using RS-485, "110Ω 1/2 W" resistor is connected.

＊ How to discriminate between the terminating resistors



(d) If data cannot be communicated with the external device at all, the polarity of the external device could be wrong and should be checked again. If the polarities of the Q series C24 and the external device do not match, reverse the polarity of each signal on either device side and connect the devices with the cable; this may enable the data to be communicated.

POINT

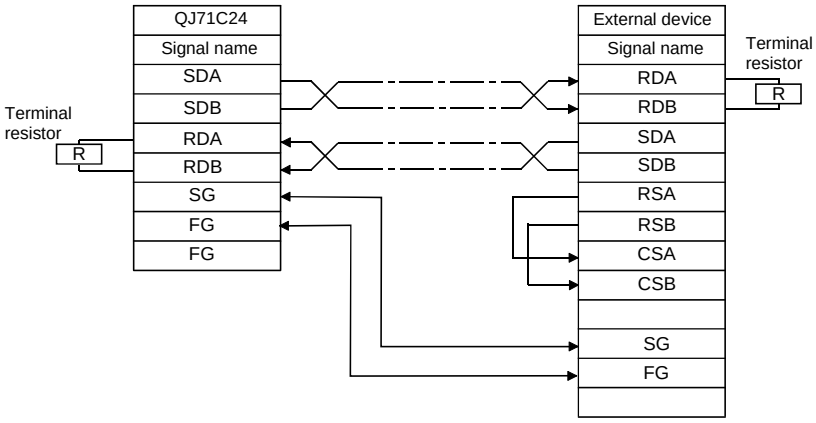
(1) For terminal resistor setting/connection described in this section, when the RS-232 to RS-422 converters or similar device is used at the external device at both ends of the circuit, a terminal resistor must be set, or connected, at the converter.

(2) When using the RS-232C to RS-422 converters to connect the external devices and the Q series C24, use a converter that is compatible with the external device and PLC CPU system configuration (1:1, 1:n, m:n).

(3) Device connected to the Q series C24 RS-422/485 interface must be standardized as RS-422 or RS-485, including 1:n and m:n connections.

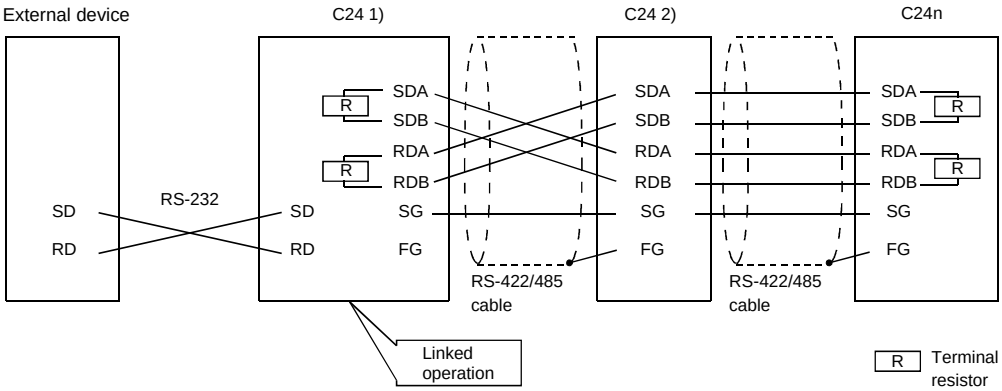
(2) Connection examples

(a) When connected in a 1:1 configuration (external device: Q series C24)

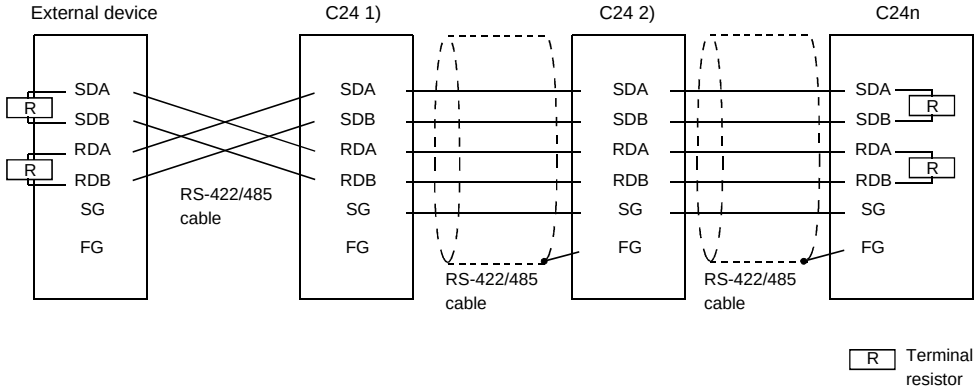


(b) When connected in a 1:n configuration (multidrop connection) (external device: Q series C24)

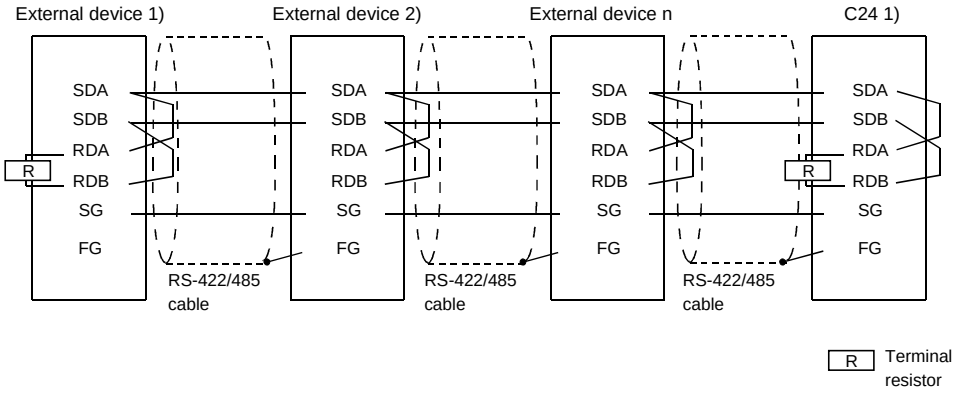
1) Connection example



2) Connection example 2



(c) When connected in a n:1configuration (multidrop connection) (external device: Q series C24)



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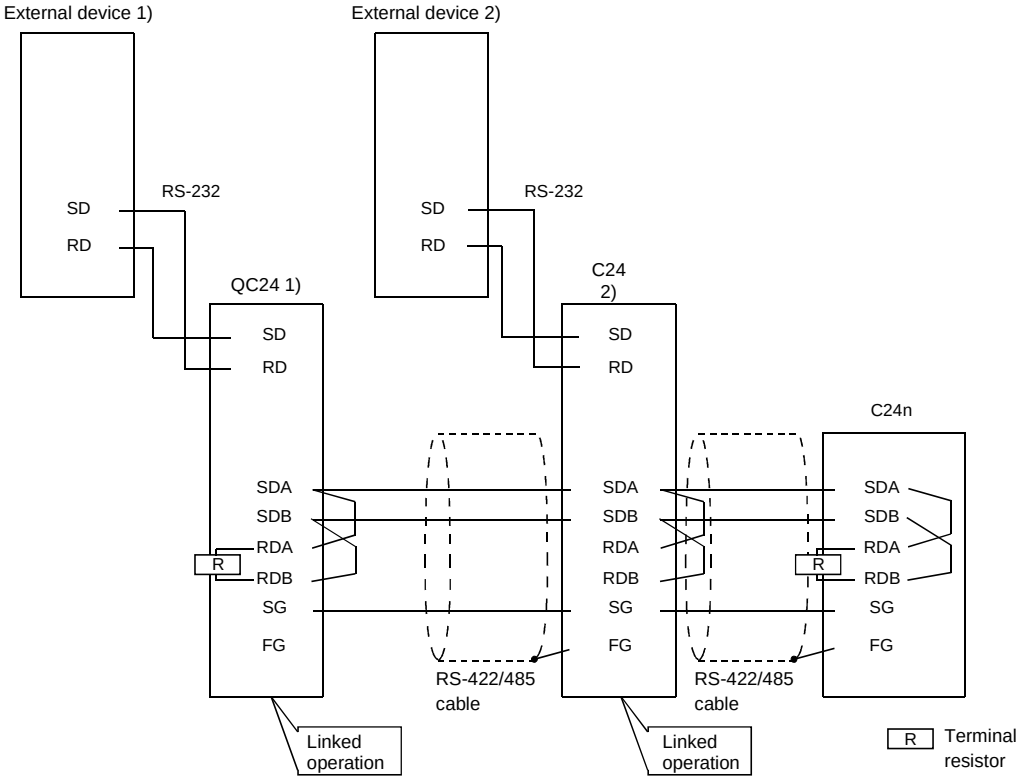
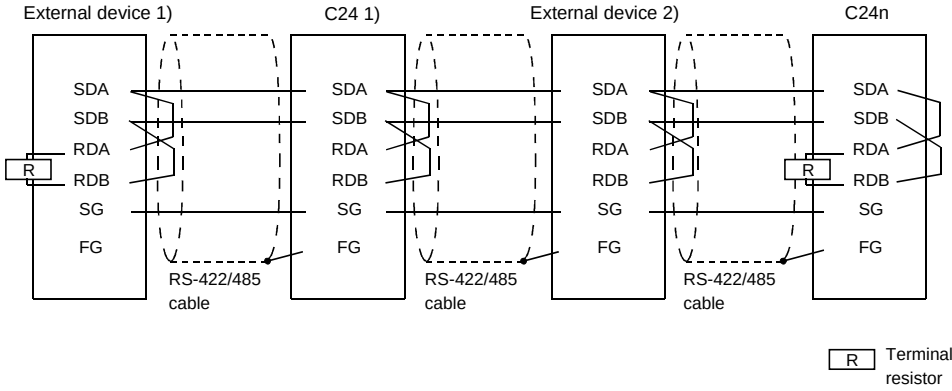
(d) When connected in a m:n configuration (multidrop connection) (external device: Q series C24)

1) Connection example 1



2) Connection example 2



4.5 Settings for GX Developer

This chapter explains various settings via GX Developer that allow the Q series C24 to perform data communication with external devices.
See Section 3.3.3 of the User's Manual (Application) for how to perform the remote password setting.

4.5.1 I/O assignment settings

[Setting purpose]

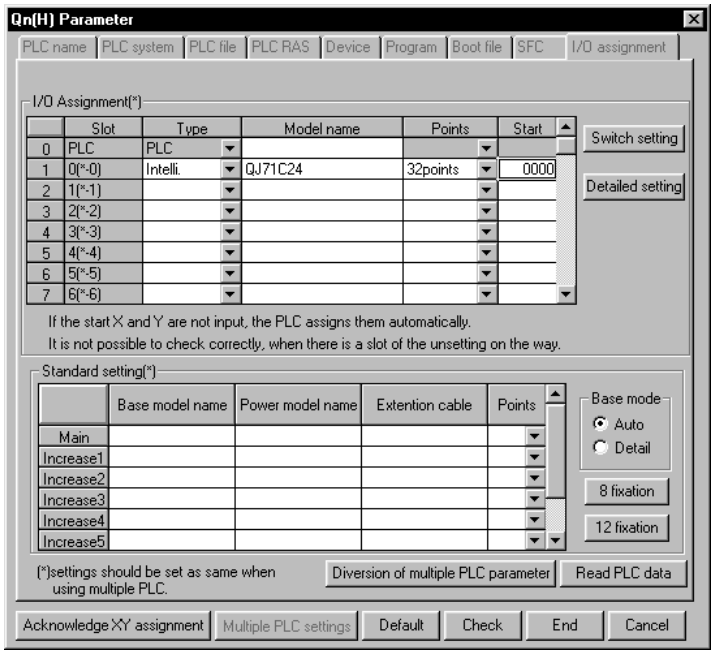
The I/O assignment settings perform the settings for the types of modules to be mounted on a base unit, the range of input/output signals, and switches of the Q series C24.

[Startup procedure]

[GX Developer] → [PLC parameters] → I/O assignment.

For screen display, see the GX Developer Operating Manual.

[Setting screen]



(For SW6D5C-GPPW-E)

[Display description]

Item name		Setting for item	Remarks
I/O assignment	Type	Select "intelli."	—
	Model name	Enter the module model name to be mounted (QJ71C24 or QJ71C24-R2).	
	Points	Select 32 points.	
	Start XY	Enter the start I/O signal (Hexadecimal) for the target module.	
	Switch setting	Set the communication rate, transmission specifications, communication protocol, etc.	See Section 4.5.2.
	Detailed setting	Select the control PLC of the Q series C24 when a multiple PLC system is employed.	See QCPU (Q mode) User's Manual (Function Description/Program Basics)
Multiple PLC settings		Select when using a multiple PLC system.	

4.5.2 Switch settings for I/O and intelligent functional module

[Setting purpose]

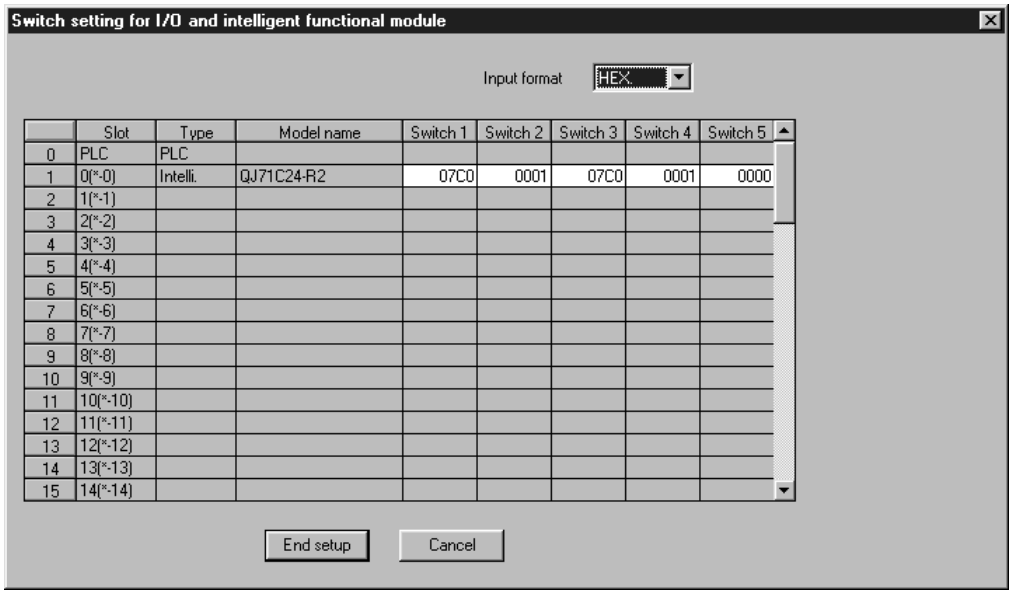
The switch settings for I/O module and intelligent functional module perform the settings for transmission specifications and communication protocol for communicate with external devices.

[Setting procedure]

[GX Developer] → [PLC parameters] → [I/O assignment setting] → Switch setting .

For screen display, see the GX Developer Operating Manual.

[Setting screen]



[Display description]

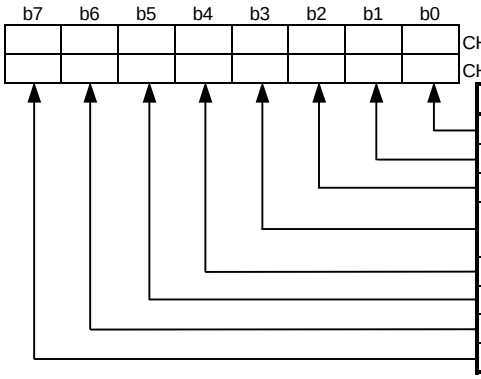
(1) Switches 1 to 5

Set the transmission specifications and communication protocol of each interface using the combinations of setting values for each switch with 16 bit binary data according to the following table.

Switch number	Description		Remarks
Switch 1	b15 to b8	b7 to b0	See a) and b)
	CH1 Communication rate setting	CH1 Transmission setting	
Switch 2	CH1 communication protocol setting		See c)
Switch 3	b15 to b8	b7 to b0	See a) and b)
	CH2 Communication rate setting	CH2 Transmission setting	
Switch 4	CH2 Communication protocol setting		See c)
Switch 5	Station number setting		See d)

∗ For settings to perform linked operation between two Q series C24 interfaces, see (2).

(a) Transmission setting (CH1 side: switch 1 (lower level); CH2 side: switch 3 (lower level))



Bit	Description	OFF (0)	ON (1)	Remarks
b0	Operation setting	Independent	Link	Must be set to OFF on CH1
b1	Data bit	7	8	Parity bit is not included
b2	Parity bit	NO	Yes	Vertical parity
b3	Even/odd parity	Odd	Even	Valid only when parity bit is set to Yes
b4	Stop bit	1	2	—
b5	Sum check code	NO	Yes	—
b6	Write during RUN	Prohibited	Allowed	—
b7	Setting modifications	Prohibited	Allowed	—

* All items listed in the table should be set to OFF for the interfaces for which "GX Developer connection" is set in the communication protocol setting.

1) Operation setting
   - This sets whether to use each of the two Q series C24 interfaces for independent data communication, or to use the two for linked data communication.
   - The setting and data flow for linked operation is explained in (2).
2) Data bit setting
   This sets the bit length for one character in data communicated with an external device according to the specifications of the external device. (When data communication is performed using format 5 of the MC protocol (for binary code communication), it is necessary to set it to 8 bits when processing the sum check code with the bidirectional protocol.)
3) Parity bit setting
   - This sets whether or not a parity bit (vertical parity) is added for one byte of transmission/receive data, according to the specifications of the external device.
   - The addition of the parity bit to the transmission data and the checking of the parity bit of receive data are performed by the Q series C24.
4) Even/odd parity setting
   This sets whether the parity bit (vertical parity) should be odd parity or even parity when adding the parity bit (vertical parity), according to the specifications of the external device.
5) Stop bit setting
   This sets the stop bit length for one character in data communicated with an external device, according to the specifications of the external device.
6) Sum check code setting
   - This sets according to the specifications of the external device whether or not a sum check code is added to transmission and reception messages of each frame and format during data communication using the MC or bidirectional protocol.
   - For an explanation of the message configuration and sum check code when a sum check code is added (set to Yes), see the applicable explanation of each protocol.

7) Write during RUN setting
   - This sets according to the system specifications whether or not data transmitted using the MC protocol is written to the PLC CPU from an external device while the PLC CPU is running.
   - When write during RUN is prohibited (disabled), the data is not written and an NAK message is returned if the external device requests the PLC CPU to write data while it is running.
   - For an explanation of the functions available in this setting, check in the "write allowed setting" and "write prohibited setting" columns in the command list of the Reference Manual.

8) Setting modifications setting
   This sets whether or not the following actions are allowed after starting up the Q series C24.
   Changing data communication functions and transmission
   - Specifications, and the switching mode of each interface
   - Writing data to the flash ROM (writing the system setting values and user frame)

POINT

(1) A setting change in the connected interface side should be set to Allowed, in order to register a user frame to the flash ROM from an external device using the MC protocol.

(2) Setting changes in interfaces on the CH1 and CH2 sides should both be set to Allowed, in order to register the system setting values and user frames to the flash ROM from the PLC CPU.

(b) Communication rate setting (CH1 side: switch 1 (upper level); CH2 side: switch 3 (upper level))

Communication rate (Unit: bps)	Bit position b15 to b8	Communication rate (Unit: bps)	Bit position b15 to b8	Remarks
50	$0F_H$	14400	06_H	Try lowering the communication rate when data cannot be communicated normally with an external device due to overrun errors and framing errors etc.
300	00_H	19200	07_H	
600	01_H	28800	08_H	
1200	02_H	38400	09_H	
2400	03_H	57600	$0A_H$	
4800	04_H	115200	$0B_H$	
9600	05_H	—	—	

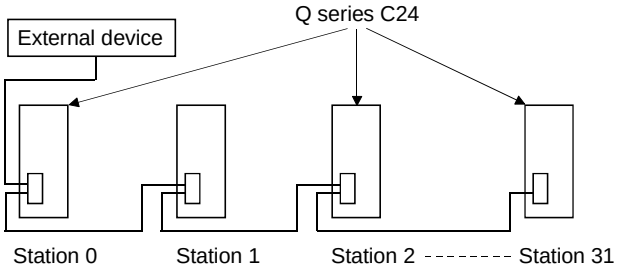
* When the two interfaces are each connected to an external device, set the communication rate so that the total of the two interfaces is 115,200 bps or less.
  When only one interface is connected to an external device, the connected interface can be set to a maximum communication rate of 115, 200 bps. In this case, set the communication rate of the unconnected interface at 300 bps.
* Set "00_H" in the communication protocol settings for interface side for which "GX Developer connection" is selected.

(c) Communication protocol setting (CH1 side: switch 2; CH2 side: switch 4)

Set number	Description		Remarks
0H	GX Developer connection		GX Developer communication rate and transmission specifications are automatically set.
1H	MC protocol	Format 1	For communication with ASCII code in the specified form of an A compatible 1C frame or QnA compatible 2C/3C/4C frame
2H		Format 2	
3H		Format 3	
4H		Format 4	
5H		Format 5	For communication with binary code in a QnA compatible 4C frame
6H	Non procedure protocol		For communication using non procedure protocol
7H	Bidirectional protocol		For communication using bidirectional protocol
8H	For linked operation setting		Set to the CH1 side when CH1 and CH2 interfaces are used in linked operation (operated with the communication protocol of the CH2 side).
9H to DH	Setting prohibited		—
EH	ROM/RAM/switch test		For self-diagnosis of the modules
FH	Individual station loopback test		For checking operation of each interface of the modules

(d) Station number setting (switch 5 (common for both CH1 and CH2 sides))

- This setting is for communication using the MC protocol.
- When several the Q series C24s are connected on the same line with multidrop connection, set the station number designated in the data items of the transmission frame in each external device to 0 to 31 (0H to 1FH).
  ✻ This number designates which external device is to be communicated with the Q series C24.
- Set the station number to 0 when the system configuration of the external device and the PLC CPU is 1:1.



POINT

If the communication of data with external device is to be started, check the specifications of the functions to be used and then make the settings and connect the cables.

Make the following switch settings from the GX Developer if there is to be no communication (if the cables are not to be connected) at the interface.

- Communication protocol setting : Set between 0H and 7H.
- Transmission setting, communication rate setting: Set all to OFF.

(2) The setting and data flow in linked operation

(a) Set the related switches as follows when two Q series C24 interfaces are in linked operation.

Switch number		Settings		Setting value
Switch 1	CH1 side	Transmission setting	Operation setting	b0 = OFF
			Data bit setting	Set each switch on both CH1 and CH2 sides to the same specification.
			:	
		Communication rate setting		Match the external device.
Switch 2		Communication protocol setting		8
Switch 3	CH2 side	Transmission setting	Operation setting	b0 = ON
			Data bit setting	Set each switch on both CH1 and CH2 sides to the same specification.
			:	
		Communication rate setting		Match the external device.
Switch 4		Communication protocol setting		0 to 7
Switch 5		Station number setting		Set according to (d) of (1)

(b) Do not use the above settings for the following cases, because linked operation cannot be performed.

1) When an external device is not connected to either of the interfaces.
2) When the bidirectional protocol is used for data communication.
3) When communicating data with an external device connected to two interfaces that are not interacting, using functions set in the communication protocol settings (MC protocol/non procedure protocol).

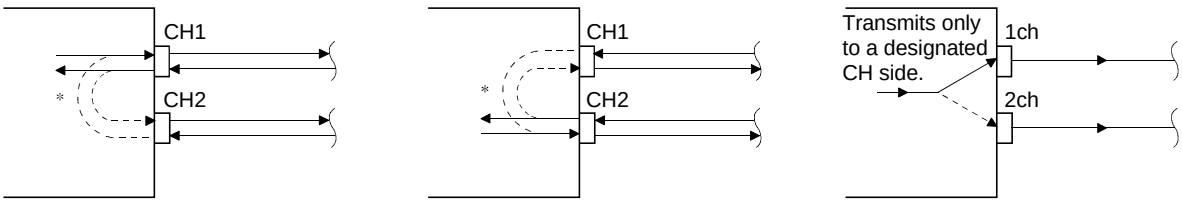
POINT

When two interfaces are in linked operation, the transmission time for one character becomes equal to the hardware gate off time of the Q series C24.

(c) The data flow in linked operation is as follows.

1) Two interfaces operate linked together using functions defined with the communication protocol setting on the CH2 side (MC protocol in the same format or a non procedure protocol) within the transmission specifications set in the respective transmission settings (specifications for CH1 and CH2 must be the same).

Q series C24 (data flow in linked operation)



* In linked operation, all data received from one of the two interfaces is transmitted from the other interface. In this case, exclusive control of the received data is necessary when data is communicated using the non-procedure protocol since all the connected stations receive the data. When data communication is performed using the MC protocol, only the Q series C24 having the station number designated in the message performs the process designated by the command. Furthermore, when data communication is performed using QnA compatible 2C/3C/4C frames of the MC protocol, the header information for linked operation is added to messages directed to other stations linked by multidrop connection.

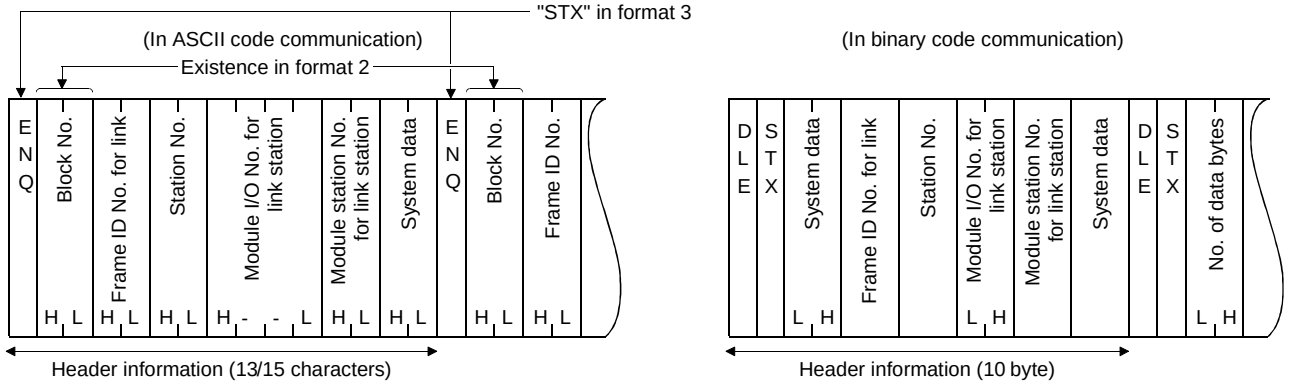
  ⓐ Processing performed by the Q series C24 connected to an external device
  - The header information is added to the command messages received from the external device that are directed to other stations and sends them to the stations through the other interface.
  - The header information is deleted from the response messages received from other stations and sends them to the external device using the other interface.
    (The header information is also sent during m:n connection.)

  ⓑ Operation of the accessed station
  The accessed station processes the request contained in the command message, adds the header information to a response message, and sends it using the interface that received the command message.

REMARK

The following describes the header information that is added by the Q series C24 to a message in linked operation.

1) When communicating with ASCII code (formats 1 to 4)
   The following 13/15 character header information is added immediately before the control code (ENQ/STX/ACK/NAK) at the start of each message (13 characters for formats 1, 3 and 4; 15 characters for format 2).
2) When communicating in binary mode (format 5)
   The following 10 byte header information is added immediately before the control code (DLE + STX) at the start of each message.



4.5.3 The Intelligent function module interrupt pointer setting

The following explains the interrupt pointer setting with GX Developer in order to receive data using an interrupt program.
For the method to receive data using an interrupt program, see User's Manual (Applications) Chapter 4.

[Setting purpose]

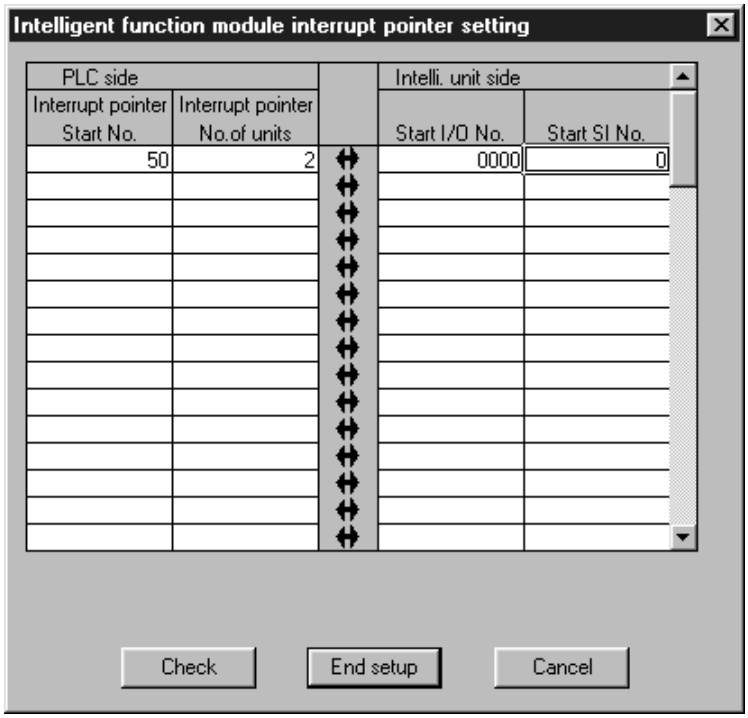
The intelligent function module interrupt pointer sets the information to read the receive data with an interrupt program of the PLC CPU during communication using the non procedural/bidirectional protocol.
By performing this setting, an interrupt program starts when data is received from an external communicating device and the reading of data received by the PLC CPU becomes possible.

[Startup procedure]

[PLC parameters] → [PLC system setting] → Interrupt pointer setting .

For display screen, see the GX Developer Operating Manual.

[Setting screen]



[Setting description]

(1) Interrupt pointer start No. on the PLC side
Set the start number (ranging from 50 to 255) of the interrupt pointer (Ixx) for use in the sequence program.

(2) Interrupt pointer No. of units on the PLC side
Set the number of units (2) of interrupt pointers (I) for use in the sequence program.

(3) Start I/O No. on the intelligent module (unit) side
Set the start I/O No. for the Q series C24.

(4) Start SI No. on intelligent module (unit) side

1) Assign control numbers (SI) on the Q series C24 side to the interrupt pointers (Ixx) used in the sequence program.
2) Set the start SI No. (0) of the interrupt control numbers.
3) The interfaces for data reception corresponding to the interrupt control numbers are as follows:
SI No. 0: for interface on the CH1 side
SI No. 1: for interface on the CH2 side

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4.6 Settings with the Utility Package (QSCU)

The settings defined with QSCU for operation of the Q series C24 are described in Chapter 8.

The following concerns the data set from QSCU.

1) Data set in the Q series C24 for the use of specific functions
2) Data set in the PLC CPU to communicate information between the Q series C24 and the PLC CPU of the mounting station.

This section explains the "Auto refresh settings" of the data mentioned in 2) above.

[Setting purpose]

The auto refresh settings are defined to automatically store the error and status information stored in the buffer memory of the Q series C24 in devices designated by the PLC CPU.

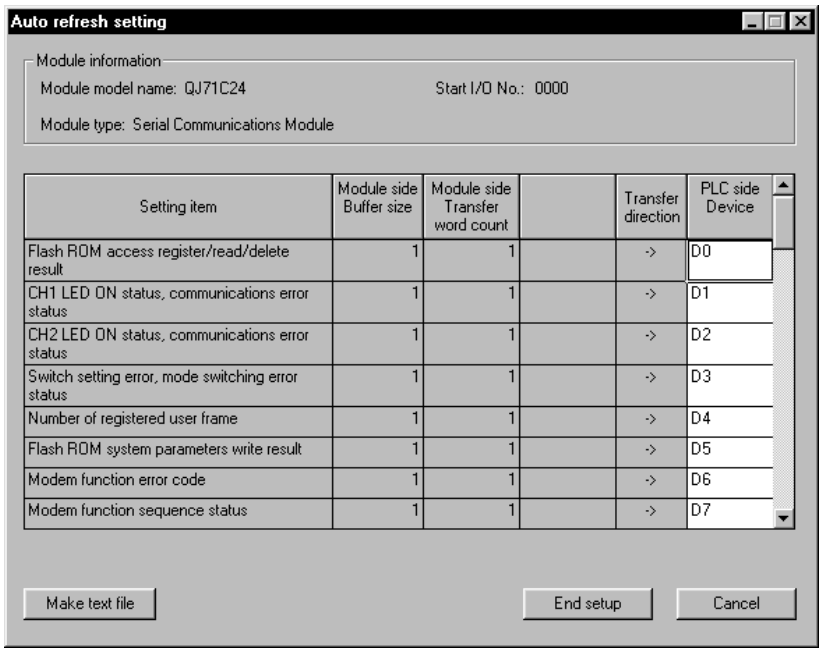
By this setting, the users can see the module error and status information without accessing the Q series C24.

[Setup procedure]

[GX Developer] → [Tools] → [Intelligent function utility] → [Start] → "Intelligent function module parameter setting module select"→ Auto refresh .

For display screen, see Section 8.3.

[Setting screen]



[Setting items]

Setting item		Buffer memory address	Reference section
Flash ROM access register/read/delete result		4H	Section 8.6.9 Section 10.1
CH1/CH2 LED ON status, communication error status (*1)		201H /202H	
Switch setting error, mode switching error status (*1)		203H	
Number of registered user frame		204H	
Flash ROM system parameters write result		220H	
Modem function error code		221H	Section 8.6.2 Section 3.3 of User's Manual (Application)
Modem function sequence status		222H	
Number of data registrations for connection		223H	
Number of data registrations for initialization		226H	
Number of notification execution		229H	
Data storage area 1 notification execution data No.		22AH	
Data storage area 2 notification execution data No.		22EH	
Data storage area 3 notification execution data No.		232H	
Data storage area 4 notification execution data No.		236H	
Data storage area 5 notification execution data No.		23AH	
Accumulated count of unlock process normal completion		22FBH	
Accumulated count of unlock process abnormal completion		22FCH	
Accumulated count of lock process based on circuit disconnection		22FFH	
CH1/CH2 communication protocol status (*1)		252H/262H	Section 4.5.2 Section 8.6.3 Section 10.1
Transmission status (*1)		253H/263H	
RS-232 control signal status (*1)		254H/264H	
Transmission sequence status (*1)		255H/265H	Sections 8.6.4 to 8.6.6 Section 10.1
On-demand execution result		256H/266H	
Data transmission result		257H/267H	
Data reception result		258H/268H	
MC protocol transmission error code		25AH/26AH	
Receive user frame nth		25BH/26BH	Section 8.6.5 Chapter 11 of User's Manual (Application)
User frame being transmitted		B6H/156H	
PLC CPU monitoring function	Operation status	2204H/2304H	Section 8.6.7 Chapter 2 of User's Manual (Application)
	Execution result	2205H/2305H	
	Number of transmission	2206H/2306H	
Monitoring condition arrival block No.		2207H/2307H	

*1 See Section 10.1 for the contents of the buffer memory.

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(1) Devices

(a) Set the word device of the PLC CPU which stores error and status information in the setting item field when using the auto refresh function between the Q series C24 and the PLC CPU.

(b) The devices used must be of the types X, Y, M, L, B, T, C, ST, D, W, R, or ZR.

* If bit devices of types X, Y, M, L, or B are used, a number that can be divided by 16 points (e.g., X30, Y120, M16, etc.) should be specified. The buffer memory data is stored in 16 point units from the specified device number (e.g., if M16 is set, data is stored from M16 to M31).

(c) The device can be set to auto refresh for required information only.

(2) Writing auto refresh settings to QCPU and saving them in a file

(a) Writing auto refresh settings to QCPU
Use GX Developer or online PLC write function of QSCU.

(b) Saving in a file
Use the file storage function shown in the file items in the parameter module selection screen shown in Section 8.3.2. of QSCU.

POINT

(1) The auto refresh settings are stored in the intelligent function module parameter.
After the intelligent function module parameters have been written to the CPU module, it enables the auto refresh setting by turning the power OFF → ON or by resetting the CPU module.

(2) The auto refresh settings cannot be changed from the sequence program. However it is possible to add a process similar to auto refresh by using the FROM/TO command of the sequence program.

4.7 Individual Station Test

After installing the Q series C24 to the base unit of QCPU, perform an individual station test first to check the switch setting (see Section 4.5.2) and operation of the Q series C24.

POINT

(1) When a problem occurs during data communication with an external device, perform an individual station test as described in this section to check whether or not there is any problem in the operation of the Q series C24.

(2) In order to avoid problems, set the PLC CPU to STOP status during the individual station test.

(3) Test both interfaces of the Q series C24 simultaneously in an individual station test. Alternatively, either one of the interfaces can be tested in an individual station loopback test.
In that case, ignore the test results on the interface side for which the test is not performed.

(4) Cable removal and reconnection before and after the individual station loopback test should be performed with the power to the Q series C24 mounting station turned off.

(5) To restart data communication with an external device after an individual station test, check the specifications of the devices used before defining various settings and reconnecting cables.
For the interface that is not used for communication (no cable connection), define the switch settings in GX Developer as follows (for the setting method, see Section 4.5.2).
- Communication protocol setting: 0_H to 7_H
- Transmission control settings and communication rate settings: all set to OFF.

(6) If an error occurs even though the correct settings have been made for the Q series C24 through an individual station test, please consult your nearest dealer or branch office with a description of the error.

4.7.1 ROM/RAM/switch tests

A ROM/RAM/switch test checks the contents of the memory of the Q series C24 and the switch settings set with GX Developer.
Perform a ROM/RAM/switch test with the procedure described below.

(Procedure 1) Communication protocol setting and transmission setting (see Section 4.5.2)

(1) Set the communication protocol setting on the CH2 side to E_H (ROM/RAM/switch test). Set the communication protocol setting on the CH1 side to the number (1 to 8) used for data communication with an external device following the test.

(2) Set the transmission settings for the two interfaces to match the specifications used when communicating data with an external device.

(Procedure 2) Performing ROM/RAM/switch tests

(1) Set the PLC CPU to STOP status.

(2) Restart the PLC CPU station or reset the CPU. The test starts automatically in about one second.

(3) For the Q series C24, the following tests should be performed once.

1) ROM check
Read the ROM data and verify the sum check.

2) RAM check
Write data to RAM, and read and check it.

3) Switch check
Check whether or not each switch is set within the tolerance range and the operation setting in the transmission settings is set to off.

4) Linked operation setting check (perform this test with the operation setting in the transmission settings of CH2 set to on)
Check to see that the communication protocol setting on CH1 is set to 8H and whether the communication rate setting of each channel is within the tolerance range.

＊ A linked operation setting check is performed when values are set as follows:
- Communication protocol setting on the CH1 side : 8H
- Operation setting in the transmission settings on the CH2 side: bit 8 = ON.

(Procedure 3) Checking results of ROM/RAM/switch tests

(1) The test is completed when the NEU LED on CH1 side is lit (approximately 2 seconds).

(2) The test is completed normally when the ERR LED turns off.

(3) The test is completed with error when the ERR LED turns on. Check the error description in one of the following screens.
- The "Monitor others" screen of QSCU (see Section 8.6.9)
- The buffer memory monitor screen of GX Developer (see the GX Developer Manual for the operation method)

＊ When checking errors in the buffer memory monitor screen of GX Developer, monitor the following buffer memory.

Check the error descriptions on the screens by bit-decoding the monitored value (16-bit integer). Each bit corresponds to the following error description.

<table>
<tr><th colspan="4">Buffer memory monitored</th><th colspan="2" rowspan="2">Description when corresponding bit is on</th><th rowspan="2">Corrective action</th></tr>
<tr><th>Address / Bit location</th><th>CH1 side
201H</th><th>CH2 side
202H</th><th>CH1/CH2 side
203H</th></tr>
<tr><td>b0</td><td colspan="2">—</td><td>—</td><td colspan="2">—</td><td rowspan="5">Review setting value
(see Section 4.5.2)</td></tr>
<tr><td>b1</td><td colspan="2">SIO</td><td>—</td><td rowspan="2">When linked operation setting</td><td>Transmission setting error</td></tr>
<tr><td>b2</td><td colspan="2">PRO</td><td>—</td><td>Protocol setting error</td></tr>
<tr><td>b3</td><td colspan="2">P/S</td><td>—</td><td rowspan="2">When independent operation setting</td><td>Transmission setting error</td></tr>
<tr><td>b4</td><td colspan="2">C/N</td><td>—</td><td>Protocol setting error</td></tr>
<tr><td>b5 to b6</td><td colspan="2">—</td><td>—</td><td colspan="2">—</td><td>—</td></tr>
<tr><td>b7</td><td>NEU</td><td>—</td><td></td><td colspan="2">Test completed</td><td>—</td></tr>
<tr><td>b8 to b13</td><td colspan="3">—</td><td colspan="2">—</td><td>—</td></tr>
<tr><td rowspan="2">b14</td><td rowspan="3">—</td><td>CH2 ERR</td><td>—</td><td colspan="2">RAM error</td><td>(＊1)</td></tr>
<tr><td>—</td><td>Setting station number</td><td colspan="2">Out of the setting station number range</td><td>Review setting value
(see Section 4.5.2)</td></tr>
<tr><td>b15</td><td>CH1 ERR</td><td>—</td><td colspan="2">ROM error</td><td>(＊1)</td></tr>
</table>

＊1 Consult your nearest dealer.

(Procedure 4) Ending a ROM/RAM/switch test

(1) Perform the following procedures after checking normal completion/abnormal completion of the test results.
Normal completion : Perform operation (2) to finish tests.
Upon error occurrence : When an error occurs in a switch check or linked operation setting check, set the correct values and test again.
When an error occurs in a ROM or RAM check, check the mounting status of module and test again.
If there is no error in the mounting status of module, consult your nearest dealer or branch office.

(2) Perform the ending procedure for ROM/RAM/switch test

1) Follow the procedure in Section 4.7.2 to perform an individual loopback test operation.
2) Perform the following procedure to end the test and start data communication with an external device.
- Set the switch settings on GX Developer according to the procedure specified in Section 4.5.2.
- Turn off the power to the station on which the Q series C24 is installed and connect the communication cable with an external device.
- Turn on the power to the station on which the Q series C24 is installed.

4.7.2 Individual station loopback test

The individual station loopback test checks the operation of the communication function of the Q series C24.
Follow the procedure below to perform an individual station loopback test.

(Procedure 1) Connecting cable

(1) Connect cables to two interfaces as follows.
- Connect cables to the RS-232 interface within the connector and install it to the interface.
- Connect cables to the RS-422/485 interface on a terminal block.

RS-232 interface (D-Sub 9 pin)

QJ71C24 side (-R2)		Cable connection
Signal name	Pin number	
CD	1	
RD (RXD)	2	
SD (TXD)	3	
ER (DTR)	4	
SG	5	
DR (DSR)	6	
RS (RTS)	7	
CS (CTS)	8	
RI (CI)	9	

RS-422/485 interface

QJ71C24 side		Cable connection
Signal name	Pin number	
SDA		
SDB		
RDA		
RDB		
SG		
FG		
FG		

(Procedure 2) Communication protocol setting and transmission setting (see Section 4.5.2)

(1) Set the communication protocol setting to FH (individual station loopback test) for both interfaces.

(2) Set each transmission setting of the two interfaces according to the transmission specification for data communication with an external device.

(Procedure 3) Performing the individual station loopback test

(1) Set the PLC CPU to STOP status.

(2) Restart the PLC CPU station or reset the CPU. The test starts automatically in about one second.

(3) For the Q series C24, perform the following tests in sequence and repeat them (one test cycle takes approximately one second).
* End testing when all test results become abnormal.
  1) Check communication with the PLC CPU
     Read and check the model type of the PLC CPU.
  2) Check transmission and reception functions of the interface
     Perform communication while changing data.

(4) The LED corresponding to a test item flashes when the test starts.
- The CH1 NEU LEDs flash when checking communication with the PLC CPU.
- The SD and RD LEDs of the interface being tested flash when checking the communication functions of each interface.

(Procedure 4) Checking the results of an individual loopback test

(1) This test is performed repeatedly. When the ERR LED is off, the test is being executed normally.

(2) The test is completed with an error when the ERR LED is lit. Check the error description on one of the following screens. (The ERR LED is lit upon error occurrence, and the test is completed.)
- The "Monitor others" screen of QSCU (see Section 8.6.9)
- The buffer memory monitor screen of GX Developer (see the GX Developer Manual for operation method)

  ∗ When checking for errors in the buffer memory monitor screen of GX Developer, monitor the LED ON status storage area (address CH1: 201H, CH2: 202H).

Check the error descriptions on the screens by bit-decoding the monitored value (16-bit integer). Each bit corresponds to the following error description.

Buffer memory monitored: Address / Bit location	CH1 side 201H	CH2 side 202H	Description when corresponding bit is on	Corrective action
b0 to b3	—		—	—
b4	C/N	—	Error occurrence in the CPU module.	Remove errors occurring in the CPU module.
			Not enough power supply capacity.	Examine the power supply capacity.
			Module is not mounted correctly.	Reinstall the module properly.
			Error occurrence in the base unit, extension cable, CPU module, or the Q series C24.	Check each module and remove the cause of the error. Reconnect the cable correctly. Reinstall the module correctly.
b5 to b13	—		—	—
b14	—	CH2 ERR	CH2 side communication error	Reconnect the cable correctly. Examine the test wiring connection.
b15		CH1 ERR	CH1 side communication error	

(Procedure 5) Ending individual station loopback test

(1) Perform the following procedures after checking normal completion/abnormal completion of the test result.
Normal completion : Perform operation (2) to finish the test.
Upon error occurrence : Remove the cause of the error according to the corrective action specified in the table above, and test again.

(2) Perform the ending procedure for individual station loopback test

1) Follow the procedure in Section 4.7.1 to perform a ROM/RAM/switch test.
2) Perform the following procedure to end the test and start data communication with an external device.
   - Set the switch settings on GX Developer according to the procedure specified in Section 4.5.2.
   - Turn off the power to the station on which the Q series C24 is installed and connect the communication cable with the external device.
   - Turn on the power to the station on which the Q series C24 is installed.

4.8 Loopback Test

A loopback test performs a communication test using the loopback test function of the MC protocol, in order to check the connection between the Q series C24 and an external device, the communication function of each device, and the operation of the communication program of the external device.

(Procedure 1) Connecting the Q series C24 to an external device

Turn off the power to the station on which the Q series C24 is installed and connect a communication cable to an external device to perform data communication using the MC protocol (see Section 4.4).

(Procedure 2) Switch setting with GX Developer

(1) Set the switch settings with GX Developer as shown in Section 4.5 and write the parameters to the PLC CPU in order to perform data communication using the MC protocol.

(2) The following shows an example of the settings when performing a loopback test on the interface on the CH1 side.

- Switch 1: 0544H — Transmission setting — Operation setting : Independent operation
  - Data bit : 7 bit
  - Parity bit : Yes (odd)
  - Stop bit : 1 bit
  - Sum check code : No
  - Write during RUN : Allowed
  - Setting modification : Prohibited
  - Communication rate setting : 9600 bps
- Switch 2: 0001H — Communication protocol setting : MC protocol (format 1)
- Switch 3: 0000H
- Switch 4: 0000H
- Switch 5: 0000H — Station number setting : 0 station

(Procedure 3) Performing a loopback test

(1) Set the PLC CPU to STOP status, and turn the power on or reset the CPU (communication is enabled in about one second).

(2) Create a program for a loopback test on the external device side and send a command message like the one in the example below to the Q series C24.
The commands used are as follows:

- When performing communication test in an A compatible 1C frame: TT command (for an example, see the following page)
- When performing communication test in a QnA compatible frame: 0619 command

* See the Reference Manual when performing communication tests in a QnA compatible frame.

(Procedure 4) Checking loopback test result

(1) The Q series C24 sends a response message to the external device when it receives a loopback test command message.

* The Q series C24 sends the external device the received data as is.

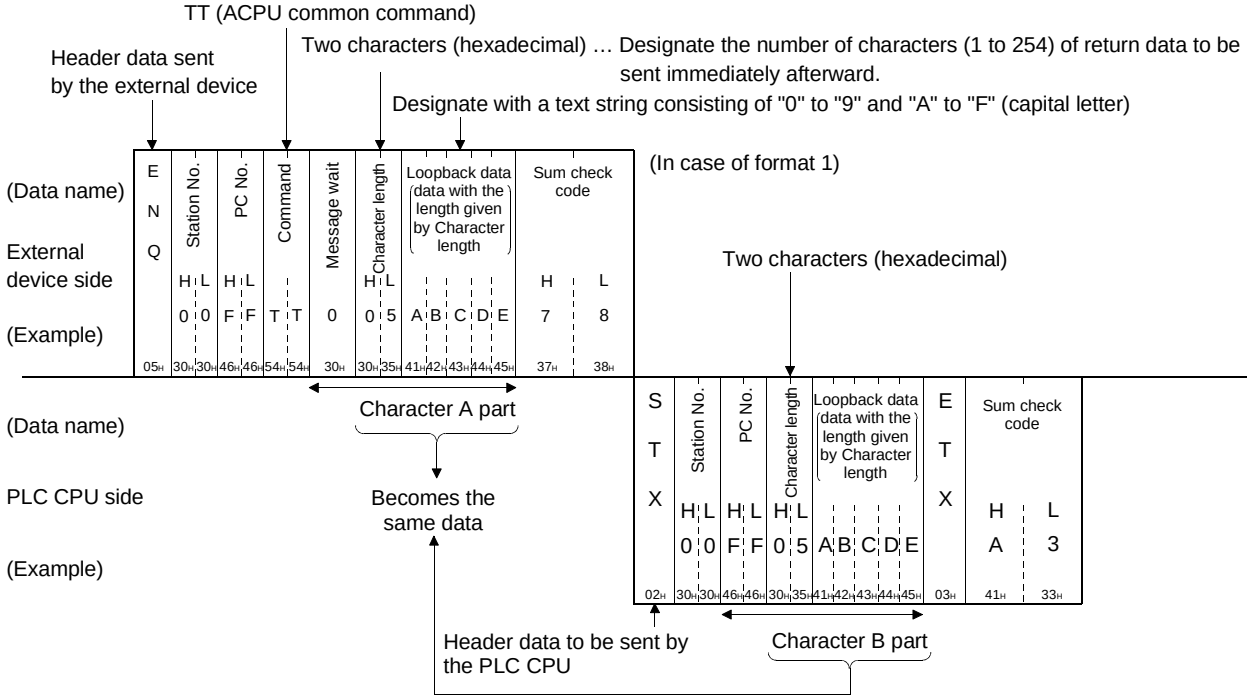
(2) Check on the external device whether the data received from the Q series C24 matches the data sent from the external device.

(Procedure 5) Ending the loopback test

Perform the following procedure according to the function used, and start data communication.

- Set the switch settings with GX Developer according to the procedure specified in Section 4.5.2.
- Turn on the power to the station on which the Q series C24 is installed.

* An example control procedure when the TT command is used in the loopback test mentioned in Procedure 3.
  (Station number: 00, sum check code: Yes)



4.9 Maintenance and Inspection

This section explains the maintenance and inspection and installing and removing of the Q series C24.

4.9.1 Maintenance and inspection

The Q series C24 has no special inspection items other than below.
For items other than listed below, perform inspection according to the inspection items listed in the User's Manual of the PLC CPU module in order to always use the system in the optimal condition.

(the Q series C24 inspection items)

1) Check if the terminal resistors and cables are connected securely.
2) Verify that the module installation screws and the terminal block installation screws are securely tightened.

POINT
Be sure to read through the Safety Precautions in the beginning of this manual regarding the Q series C24 inspection and maintenance.

4.9.2 When mounting/dismounting the module

Please read 4.1, "Handling Precautions" before mounting or dismounting the module, and make sure to pay attention to safety and handle the module properly during the operation.
When replacing the Q series C24 and QCPU, it becomes necessary to register the following data on the Q series C24 again for the module to be replaced.

- Q series C24: System setting data in the flash ROM
- QCPU: PLC parameters (I/O assignment, switch setting, etc.)

The procedure for replacing a module, including re-registration of data, is as follows.

<Operation procedure when replacing the Q series C24>

(Step 1) Read all the system setting data of the Q series C24 using the Read from module function of QSCU.
(Step 2) Save the system setting data read to the specified file using the File Save function of QSCU (*1).
(Step 3) Turn the power supply to the Q series C24 off.
(Step 4) Dismount the cables and the module itself.
(Step 5) Replace the module and start up the module according to "4.2 Settings and Procedures Prior to Operation."
(Step 6) Read the data saved in (Step 2) back into the system and register the system setting data to the flash ROM of the Q series C24 using the Write to module function of QSCU.

<Operation procedure when replacing the QCPU>

(Step 1) Read the PLC parameters with GX Developer from the QCPU and save them.
(Step 2) Replace the QCPU. (See the user's manual for QCPU.)
(Step 3) Register the PLC parameter saved by GX Developer back into the QCPU again.

*1 It is recommended to record and save the system setting parameters not only when replacing the module, but also when changing the system setting parameters using QSCU.

5 DATA COMMUNICATION USING THE MELSEC COMMUNICATION PROTOCOL

This chapter explains an overview of the MELSEC communication protocol (hereinafter abbreviated as the MC protocol). See the following manual for a detailed explanation of the data communication functions that are available when using the MC protocol.
Q Corresponding MELSEC Communication Protocol Reference Manual (SH-080008)

5.1 Data Communication Functions

The MELSEC protocol (MC protocol) is a communication system for the Q series PLCs. Using this protocol, the external devices can read or write device data and programs for the PLC CPUs via the Q series C24 or Q series Ethernet interface module.
Any external devices on which application programs can be installed and which can transmit and receive data in accordance with the MELSEC PLC protocol can communicate with the PLC CPUs using the MC protocol.

5.1.1 Accessing the PLC CPUs using the MC protocol

This section describes the main functions for accessing the PLC CPUs using the MC protocol.
(An overview of the data communication functions using the MC protocol is provided in Section 3.4).
With the exception of the on-demand function described below, the Q series C24 sends and receives data based on commands from the external devices.
Thus, the PLC CPU side does not require sequence programs for data communication.

(1) Data read/write

This function reads and writes data from/to the PLC CPU device memory of the local-station or other station on the MELSECNET/H, MELSECNET/10 as well as the intelligent function module buffer memory.
By reading and writing data, the PLC CPU operation monitoring, data analysis and production management can be performed on the external device side.
Also, production directions can be executed on the external device side.

(2) File read/ write

This function reads and writes files stored in the PLC CPU such as sequence programs and parameter files. By reading and writing files, file management for the QCPU and the QnACPUs of other stations can be performed on the external station side.
Also, execution programs can be changed (replaced) from the external device side.

(3) Remote control of the PLC CPU

This function executes remote RUN/STOP/PAUSE/latch clear/reset operations.
Remote operations of the PLC CPU can be performed from the external device side using the PLC CPU remote control function.

(4) Monitoring the PLC CPU

This function monitors the operating status of the PLC CPU and the data in the device memory.
The PLC CPU status and the device memory data can be sent to the external device at fixed intervals, when an error occurs in the machine equipment, or when certain conditions are satisfied.
This function reduces the data read processing load on the external device side.

(5) Sending data from the PLC CPU to the external device

A function for requesting data transmission from the PLC CPU to the external device is called the on-demand function.
Urgent data that must be forwarded to the external device can be sent as on-demand data to the external device by starting up from the PLC CPU.

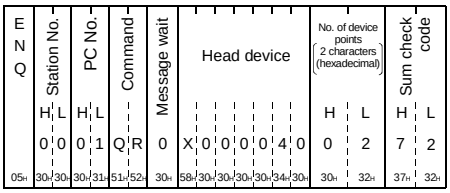
5.1.2 Message format and control procedure for data communication

The data communication functions using the MC protocol correspond to the data communication functions using the dedicated protocol for the conventional products listed below.

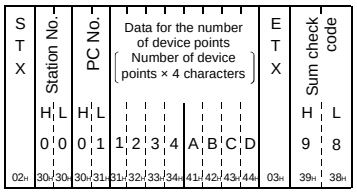
- A series computer link module
- QnA series serial communication module

Therefore, the message format and control procedure are the same as when accessing the PLC using these conventional modules.
The external device side can access the Q series PLC with a program used for accessing the PLC via a conventional module.

(Example)



(Command message for A compatible 1C frame)



(Response for A compatible 1C frame)

POINT

The following manual is available for performing data communication using the MC protocol.
MELSEC Communication Protocol Reference Manual (sold separately)

5.1.3 PLC CPU setting for performing data communication

Data communication using the MC protocol is achieved by performing the GX Developer settings indicated below on a PC, performing the system settings by the QSCU, and registering the settings to the PLC.

(1) Settings using the GX Developer (Required)

Perform the I/O assignments and switch settings indicated in Section 4.5 and write the parameters to the PLC CPU where the Q series C24 is installed.

(2) System settings using the QSCU

When it is necessary to change the default values registered in the Q series C24, perform the settings as indicated in Chapter 8 and register these to the flash ROM in the Q series C24.

- MC protocol system setting
- Transmission control and others system setting

POINT

To write from the external device to the intelligent function module installed in the MELSECNET/H, MELSECNET/10 remote I/O station during communication using the MC protocol, set the "Write allow/prohibit during PLC CPU RUN" in the GX Developer to enable. (The remote I/O station is always in RUN status. RUN and STOP cannot be switched.)

5.1.4 Support for Multiple PLC systems

When the external device accesses a QCPU in a multiple PLC system, it is possible to access either the control PLC or the non-control PLCs; the target QCPU should be specified in the "requested module I/O number" in the QnA compatible 4C frame for the MC protocol.

See Section 2.10 of the Reference Manual for the details hereof.

See Section 2.5 of this manual for an explanation of the system configuration.

(Example)

	ASCII code	Frame ID No.	Station No.	Network No.	PC No.	Requested module I/O No.	Requested module station No.	Self-station No.	Command	Sub command	Device code	Head device	Number of device points	Sum check code
		H L	H L	H L	H L	H — — L	H L	H L	H — — L	H — — L		H — — — — L	H — — L	H L
		F 8	0 5	0 7	0 7	0 3 E 0	0 0	0 0	0 4 0 1	0 0 0 1	X *	0 0 0 0 4 0	0 0 5	3 6
05H	35H	46H 38H	30H 35H	30H 37H	30H 37H	30H 33H 45H 30H	30H 30H	30H 30H	30H 34H 30H 31H	30H 30H 30H 31H	58H 2AH	30H 30H 30H 30H 34H 30H	30H 30H 30H 35H	33H 36H

(Command massage of the QnA compatible 4C frame format 1)

REMARK

- When using the Q series C24 in a multiple PLC system, it is necessary to specify the QCPU that controls the Q series C24 (hereinafter referred to as the control PLC) using GX Developer (SW6D5C-GPPW-E).
- It is also possible to mount a Q series C24 of function version A in a multiple PLC system. In this case, it is only possible to access the control PLC (PLC No.1).
- It is only possible to access the control PLC if data is communicated by means of frames other than the QnA compatible 4C frame.

5.1.5 Support for the QCPU remote password function

This section explains an overview of the remote password function when a remote password is set for the Q series C24 mounted to a QCPU.
See Chapter 3 of the User's Manual (Application) for a detailed explanation.

(1) Checking remote passwords

If the following items are set to the QCPU using GX Developer (SW6D5C-GPPW-E), the Q series C24 performs a remote password check whenever an external device accesses the PLC using the modem function of the Q series C24.

(a) Setting by GX Developer (SW6D5C-GPPW-E)

- When the remote password is set on the QCPU with the Q series C24.
- When the Q series C24 is set to be subject to the remote password check.

(b) Access in which the remote password is checked

The remote password is checked when the following access is attempted. Access attempts to all PLCs of the local station (the local station with the Q series C24 and other stations accessed via the local station) are subject to the remote password checking.

(Access function to the PLC in which the remote password is checked)

- Data communication using the MC protocol
- Access to the PLC using GX Developer (SW6D5C-GPPW-E)

* The remote password is not checked in data communication using the non procedure/bidirectional protocols.

(c) Remote password to be checked

The check is performed against the remote password set to the local station QCPU with the Q series C24.

* Access to the specified station is allowed if the remote password specified by the user and the remote password set to the QCPU match when accessing.

(2) Data communication procedure

1) Initialize the modem.
2) Connect the line from the external device.
3) Unlock (cancel) the remote password of the QCPU belonging to the station with the Q series C24 mounted from the external device via the dedicated command for communication using the MC protocol.
4) Initiate the data communication between the external device and PLC using the MC protocol.
5) Disconnect the modem line from the external device side when completing the data communication using the MC protocol.
   The remote password is automatically locked when the modem is disconnected.

REMARK

The remote password should be set to a QCPU using GX Developer (SW6D5C-GPPW-E) in order to use the remote password function of the QCPU.

- Unlocking the remote password is possible only for the QCPU of the local station with the Q series C24.
  It is impossible to unlock the remote password for the QCPU of other stations.
  See Section 3.18 of the Reference Manual for the command for unlocking the remote password.
- When accessing the PLC using GX Developer (SW6D5C-GPPW-E), the remote password should be unlocked when starting the online operation.

(3) Q series C24 setting and monitoring function when using the QCPU remote password function

(a) Modem function system setting by QSCU

1) Remote password mismatch notification count designation
   Designate the number of times before notification when a remote password disagreement occurs at the unlock processing by the user/external device after the line is connected.
   The Q series C24 automatically disconnects the line if more remote password disagreements occur than the number of times designated by this value.

2) Remote password mismatch notification accumulated count designation
   Designate the number of times before notification when remote password disagreements occur at the unlock processing by the user/external device after the startup of the Q series C24.
   The error signal on the CHn side (XE, XF) and the ERR LED turn on if remote password disagreements occur more than the number of times designated by this value (the line is not disconnected).
   ✻ The user can clear the cumulative value counted by the Q series C24 at an occurrence of remote password disagreement using either one of the methods below:
   - Set the cumulative number of abnormal completions of unlock processing to "0" in the modem function monitor/test screen of QSCU.
   - Write "0" to the storage area in the buffer memory corresponding to the Accumulated count of abnormal completions of unlock processing (address: 8756 ($22FC_H$)).

(b) Modem function monitor/test by QSCU

It is possible to monitor the setting values for the remote password and the number of occurrences up to the present, such as the designation of the number of times before notifying an unmatched remote password and the current number of occurrences.

* It is possible to set each monitor value to "0."

Monitored items in the “modem function monitor/test” screen	Buffer memory address
Remote password mismatch notification count designation	8204 (200C$_H$)
Remote password mismatch notification accumulated count designation	8205 (200D$_H$)
Accumulated count of unlock process normal completion	8755 (22FB$_H$)
Accumulated count of unlock process abnormal completion	8756 (22FC$_H$)
Accumulated count of lock process based on circuit disconnection	8759 (22FF$_H$)

5.2 Utilizing the MX Component and MX Links

If the external device to access to the PLC is a PC running one of the basic operation systems below, it is possible to create a communication program for the external device without considering the detailed MC protocol (transmission/reception procedures) using one of the following separately sold communication support tools.

(Supported basic operation systems)

- Microsoft® Windows® 95 operating system
- Microsoft® Windows® 98 operating system
- Microsoft® Windows NT® Workstation4.0 operating system

(Separately sold communication support tools)

- MX Component (SW0D5C-ACT-E, hereinafter abbreviated as ACT)
- MX Links (SW3D5F-CSKP-E and later, hereinafter abbreviated as CSKP)

The functions of the CSKP communication support tool are listed below. See the operating manual and programming manual for each communication support tool for the details.

POINT

(1) For details on accessing PLCs of other stations in the network system, see the corresponding system manual.

(2) The PLC CPUs on Ethernet can be accessed via the MELSECNET/H, MELSECNET/10 using the Q series Ethernet interface module MELSECNET/H, MELSECNET/10 relay communication functions.
For details, see Chapter 4, "Communicating by Relaying via the MELSECNET/H, MELSECNET/10" in the Q Corresponding Ethernet Interface Module User's Manual (Application).

The following lists the CSKP functions:

Function	Description
MELSEC data link utility	
Computer link utility	Performs settings for communicating via a serial communication line. (Uses the serial communication module/computer link module)
Ethernet utility	Performs settings for communicating via the Ethernet network system.
CPU COM utility	Performs settings for directly connecting the PLC CPU and the PC to perform communication.
CPU USB utility	Performs settings for connecting the CPU directly to the PC to perform USB communication.
MELSECNET/10 utility	Performs settings for communicating via the MELSECNET/10 network system. (This is a shared utility with the board side package.)
CC-Link utility	Performs settings for communicating via the CC-Link system. (This is a shared utility with the board side package.)
CC-Link G4 utility	Performs settings for communicating via the CC-Link G4 module.
Other utility software	
Shared device utility	Performs settings for using the EM and ED.
Shared device server utility	Performs refresh settings for the device between PCs or between the PC and PLC.
Ladder logic test utility	Performs settings when the logic test function (LLT) is used.
Device monitor utility	Monitors the status of each device via the network.
Error viewer	Displays the error history.
MELSEC data link library (functions)	
mdOpen	Opens a communication line.
mdClose	Closes a communication line.
mdSend	Writes data to device in batch mode.
	Sends data (SEND function).
mdReceive	Reads data from device in batch mode.
	Receives data (RECV function).
mdRandW	Writes data to device in random mode.
mdRandR	Reads data from device in random mode.
mdDevSet	Sets a bit device.
mdDevRst	Resets a bit device.
mdTypeRead	Reads the PLC CPU type.
mdControl	Remote RUN/STOP/PAUSE
mdInit	Refreshes data in the MELSEC data link library.
mdBdRst	Resets own board.
mdBdModSet	Sets the mode of own board.
mdBdModRead	Reads the mode of own board.
mdBdLedRead	Reads the LED information of own board.
mdBdSwRead	Reads the switch status of own board.
mdBdVerRead	Reads the version information of own board.

6 DATA COMMUNICATION USING THE NON PROCEDURE PROTOCOL

Data communication using the non procedure protocol is a function for sending and receiving data between a PLC CPU and an external device using the message format and transmission control procedure specified by the user.
Data can be transferred using the non procedure protocol when it is necessary to perform data communication using the protocol for external devices such as a measuring instrument and a bar code reader. In that case, transmission/receive data processing can be simplified by using the communication functions with the user frames described in the User's Manual (Application).

This chapter explains the basic transmission and reception methods when performing data communication using the non procedure protocol.
Follow the procedure described in this chapter to create sequence programs for sending and receiving data for the PLC CPU.
For details on the additional functions listed below for data communication using the non procedure protocol, see the separate User's Manuals (Application).

- Sending/receiving data using user frames (See Chapter 11, Application)
- Monitoring the PLC CPU (automatic information function) (See Chapter 2, Application)
- Switching modes from the PLC CPU (See Chapter 15, Application)
- Reading received data using interrupt programs (See Chapter 4, Application)
- Sending/receiving data using transparent code designation (See Chapter 12, Application)
- Sending/receiving data using ASCII data (ASCII-BIN conversion) (See Chapter 13, Application)
- Controlling half-duplex communication (See Chapter 8, Application)

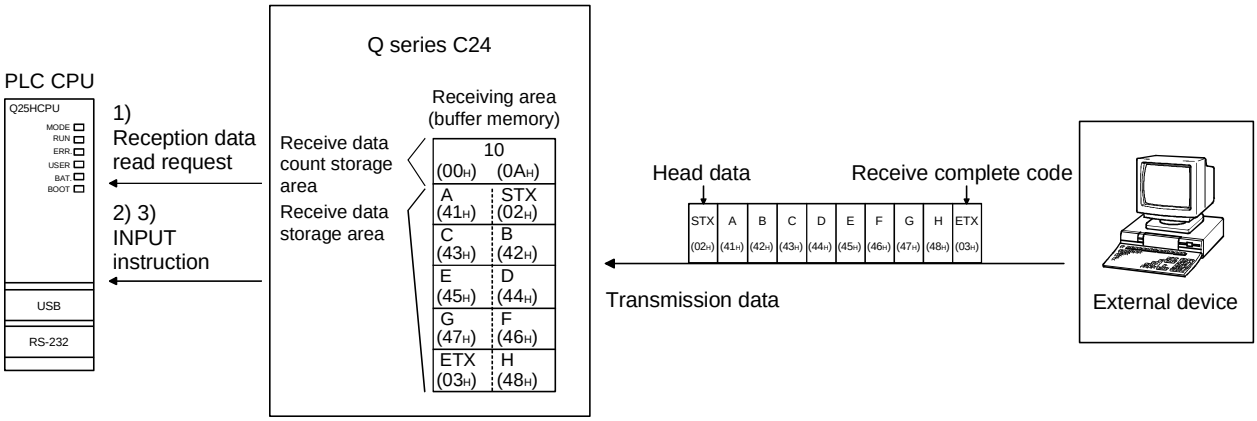
6 - 1

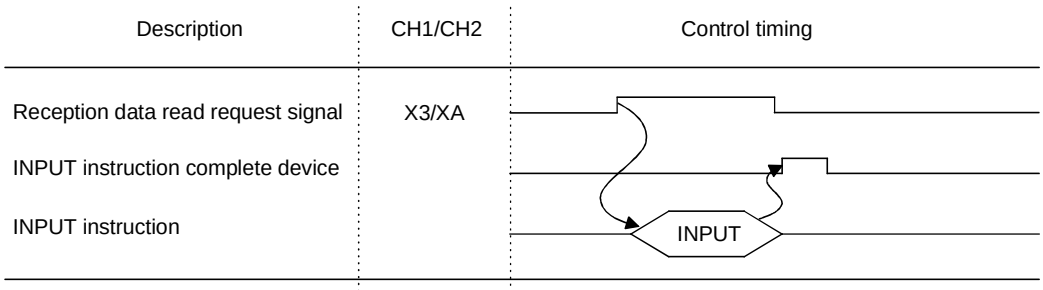
6.1 Data Reception from the External Device

This section explains data reception from the external device.
There are two methods for receiving data: the "reception via receive complete code" for receiving variable length messages, and the "reception via received data count" for receiving fixed length messages. The receive complete code and received data count used for data reception can be changed to any setting values chosen by the user using QSCU.

6.1.1 Receiving methods

The following shows the methods for receiving data in any format using the non-procedure protocol.
There are two methods for receiving data: the "reception via receive complete code" for receiving variable length messages, and the "reception via received data count" for receiving fixed length messages. The receive complete code and received data count used for data reception can be changed to any setting values chosen by the user using QSCU.





1) When data is received from the external device using either "reception via receive complete code" or "reception via received data count" method, the reception data read request signal turns ON.
2) Control data is stored in the device designated with the INPUT instruction.
3) When the INPUT instruction is executed, receive data is read from the reception area of the buffer memory.

(1) Data reception by receive complete code (for variable length reception)

(a) This method is used to send data by adding the receive complete code set in the Q series C24 at the complete of the message to be sent from the external device.

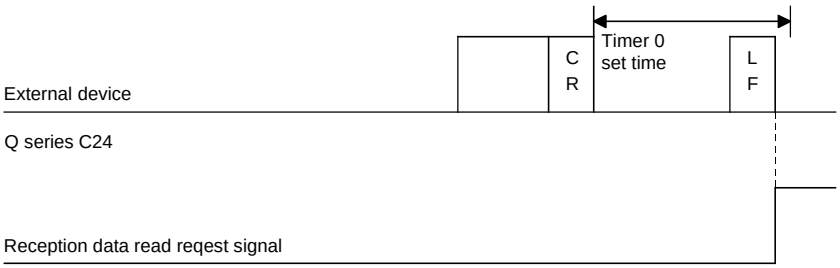
(b) When the Q series C24 receives the receive complete code data preset in QSCU by the user, it sends a receive data read request to the sequence program.
The read request from the Q series C24 allows the sequence program to read the receive data up to the receive complete code received from the external device.

(c) The receive complete code can be changed to match the specifications of the external device. An arbitrary 1-character (1-byte) code within the 00_H to FF_H range can be designated.

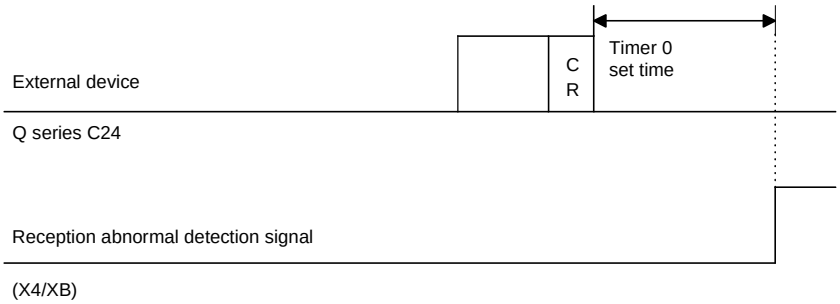
(d) The Q series C24 issues a receive data read request to the PLC CPU as follows, according to the set value of the receive end code.

1) When receive complete code not changed (Default value: $0D0A_H$)
(CR+LF is added to the end of the message and sent from the external device.)

• If LF is received within the time set in the no-reception monitoring time (timer 0) after CR is received, the Q series C24 stores the receive data up to CR+LF to the buffer memory receive data storage area and turns on the read request signal to the PLC CPU.

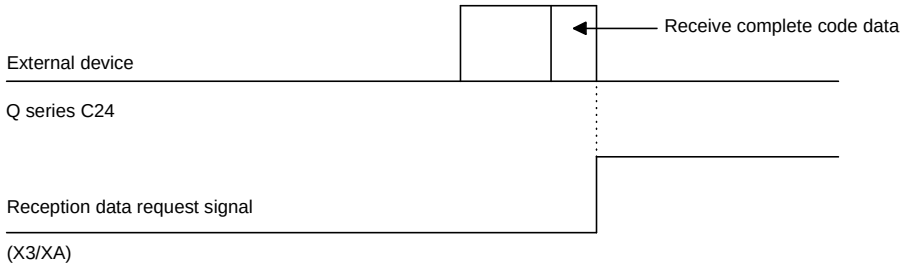


• If the next data (LF, etc.) is not received within the time set in the no-reception monitoring time (timer 0) after CR is received, the Q series C24 stores the receive data up to CR to the buffer memory receive data storage area and turns on the reception abnormal detection signal to the PLC CPU.



* If the following data (excluding LF) is received within the time set in the no-reception monitoring time (timer 0) after receiving a CR, the CR is treated as 1 byte of data included in the message. (In this case, CR is not treated as data belonging to the receive complete code.)

2) When the receive complete code is changed and an arbitrary code is designated (00□□H designated)
(User defined receive complete code data is added to the end of the message and sent from the external device).
When the Q series C24 receives the receive complete code data changed by the user, it stores the receive data up to the receive complete code to the buffer memory receive area and turned on the read request signal to the PLC CPU.



3) When receive complete code not designated (FFFFH designated)
Reading by received data count is enabled.
See (2) for a description of reading by received data count.

(2) Reception by received data count (For fixed length reception)

(a) This method is used to receive messages of the same length (size) from the external device every time.

(b) When the Q series C24 receives data of the received data count preset in QCSU by the user, it sends a reception data read request to the sequence program.
When the sequence program receives the read request from the Q series C24, it reads data up to the received data count received from the external device.

(c) The received data count default value is set to 511 (words). However, it can be changed within the size of the receive data storage area depending on the data contents exchanged with the external device.

POINT

(1) When the receive complete code and received data count are set to QSCU, both become valid.
In this case, if the Q series C24 receives the receive complete code before data corresponding to the received data count, it outputs (X3/XA: ON) a reception read request signal to the sequence program.

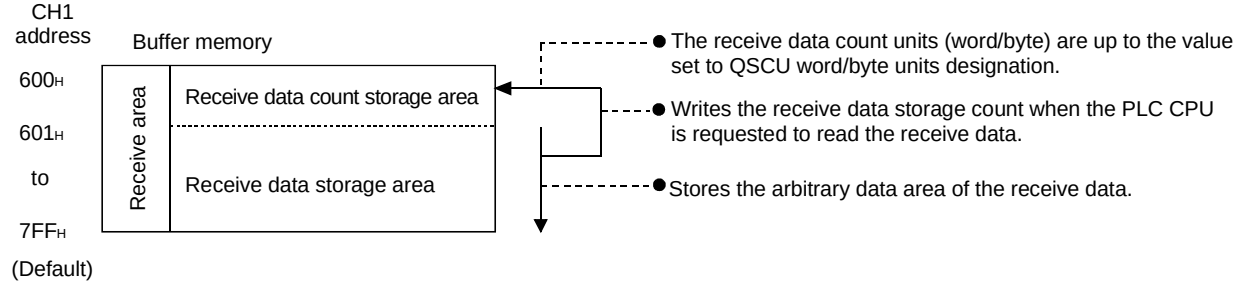
(2) For details on how to change the receive complete code and received data count, see Section 8.4.7.

6.1.2 The receive area and the received data list

The following shows the list of the receive area and the receive data for performing data reception using the non procedure protocol.

(1) Receive area

The receive area is a memory area for storing the data received from the external device and the receive data count in order to read the receive data for the PLC CPU. By default, the receive area is assigned to addresses 600H to 7FFH (CH1 side) and A00H to BFFH (CH2 side).



POINT

(1) The position and size of the receive area in the buffer memory can be changed with the QSCU in accordance with the specifications of the external device and the receive data length. (See Section 8.4.7.)

(a) When changing the position and size of the receive area in the buffer memory with QSCU, specify as follows:

1) Receive buffer memory head address designation
Designate the starting address for the area to be used as the receive area in the user-definable area of the buffer memory.
2) Receive buffer memory length designation
Designate by address the length of the area to be used as the receive area in the user-definable area of the buffer memory.

(b) If the following functions are also used when the position and size of the receive area in the buffer memory are changed, make sure that the addresses of the receive area do not overlap with those for the buffer memory that stores the transmission and reception data to be used by these functions.

1) MC protocol buffer memory read/write function
2) MC protocol on-demand function
3) Non procedure protocol transmission/receive function
4) Bidirectional protocol transmission/receive function

(2) When sending data from the external device to the Q series C24, one of the following two adjustments should be made so that the relationship shown below is maintained.

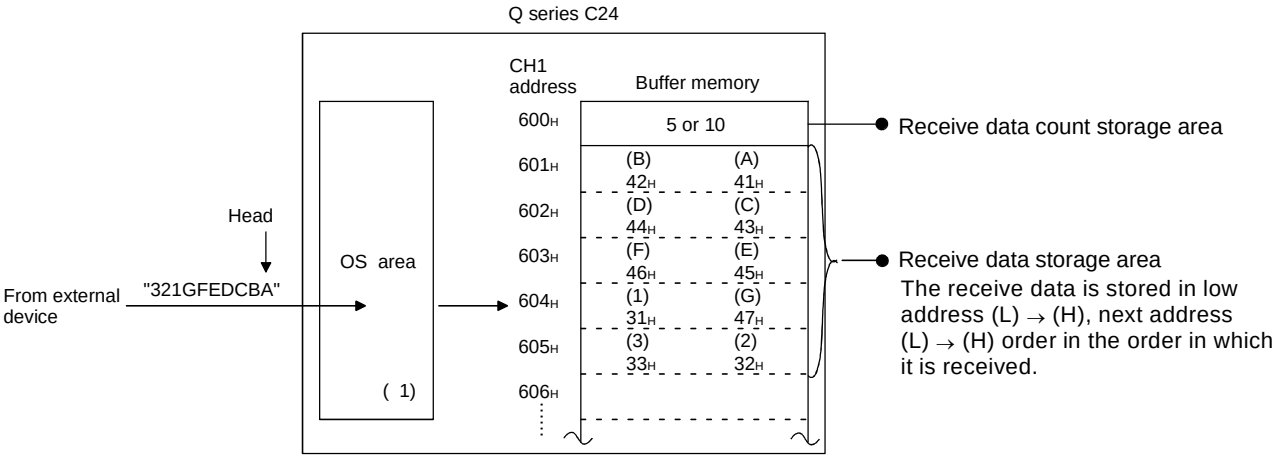
1) Reduce the transmission data size.
2) Increase the receive area.
Receive data storage area ≧ Size of data sent from the external device

(2) Receive data list

The following describes the data list when data received from an external device is stored to the receive area.

1) The receive message is stored to the Q series C24 buffer memory (receive data storage area).
2) The data is stored to the receive data storage area in low address (L) → (H), next address (L) → (H) order.
   ＊ Under the following conditions, when the receive data count is an odd byte, 00H is stored in the upper byte of the final data storage position:
   - When the unit for the received data count is designated in bytes.
   - When data reception is performed using the receive complete code.

(Example) When receive arbitrary data area "ABCDEFG123" was stored (The receive area is the default value.)



＊1 The OS area of the Q series C24 shown in the above diagram is the memory (2304 bytes) that temporarily stores the data to be received while a request for the reading of the receive data is being made to the PLC CPU. (The user cannot read the receive data in the OS area).
When the sequence program finishes reading the receive data in the buffer memory in response to the read request, the receive data in the OS area, and any succeeding receive data, is stored successively in the receive area of the buffer memory when the next read request is issued.
Also, when the OS area's free space, which stores the receive data, is reduced to 64 bytes or less, a request to discontinue data reception from the external device is issued by the following transmission control (the RS signal does not turn OFF):

- When DTR control is set, the DTR signal turns OFF.
- When DC1/DC3 transmission control is set, DC3 is sent.

When there is no more free space in the OS area to store receive data, an SIO error occurs and the SIO information bit in the communication error information storage area (address: 201H/202H) in the buffer memory turns ON. In that case, succeeding receive data is discarded until a free space becomes available in the OS area.

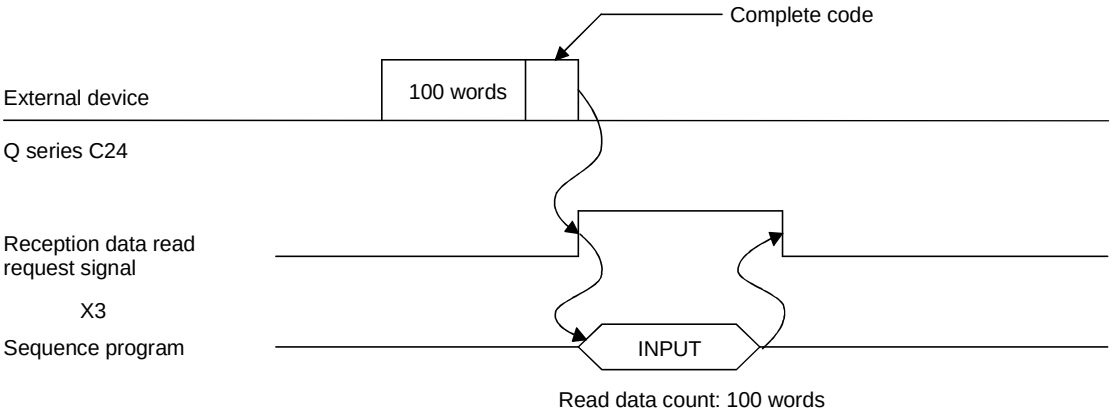
＊ For more details on the transmission control, see Chapter 7 of the User's Manual (Application).

REMARK

(1) Data reception when the receive data storage area is larger than the receive data length

The following control is performed.

(Example) When the receive area for the CH1 side interface is located at addresses 600H to 7FFH (default values) and data of 511 words or less is received by the CH1 side interface.

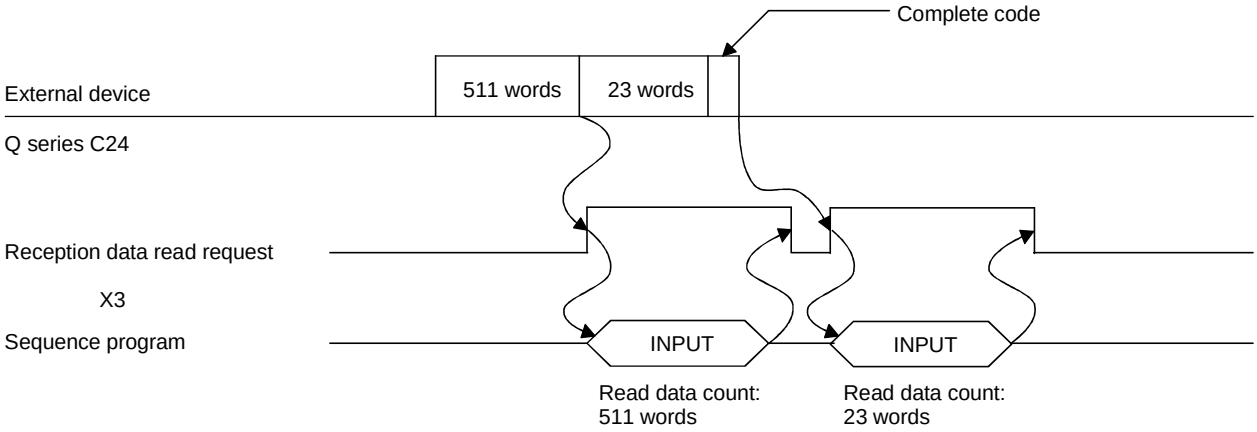


(2) Data reception when the receive data storage area is smaller than the receive data length

Since the following control is performed, data link processing is required in the sequence program.

1) Reception using the complete code

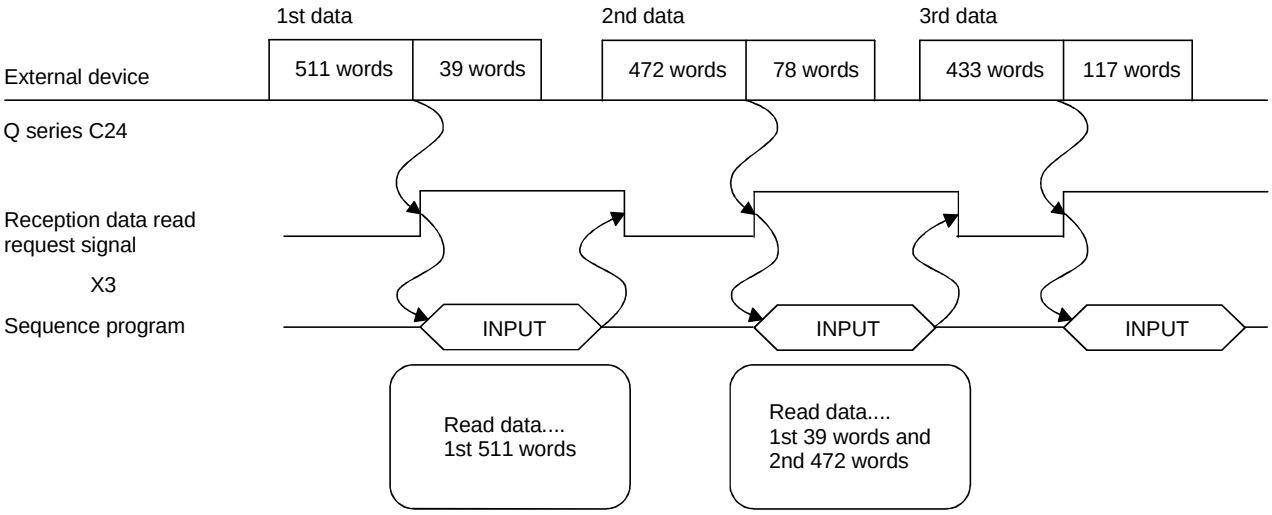
(Example) When the receive area for the CH1 side interface is located at addresses 600H to 7FFH (default values), and data of 534 words is received by the CH1 side interface.



2) Reception by received data count
When the received data count is set larger than the receive data storage area, the receive buffer memory length (default: 512 words) -1 set in buffer memory addresses A7H/147H is processed as the received data count.

(Receive data storage area) > (Data length received from external device)

(Example) When 550 words of data is received through the CH1 interface in three parts when the CH1 interface receive area consists of addresses 600H to 7FFH (default value)



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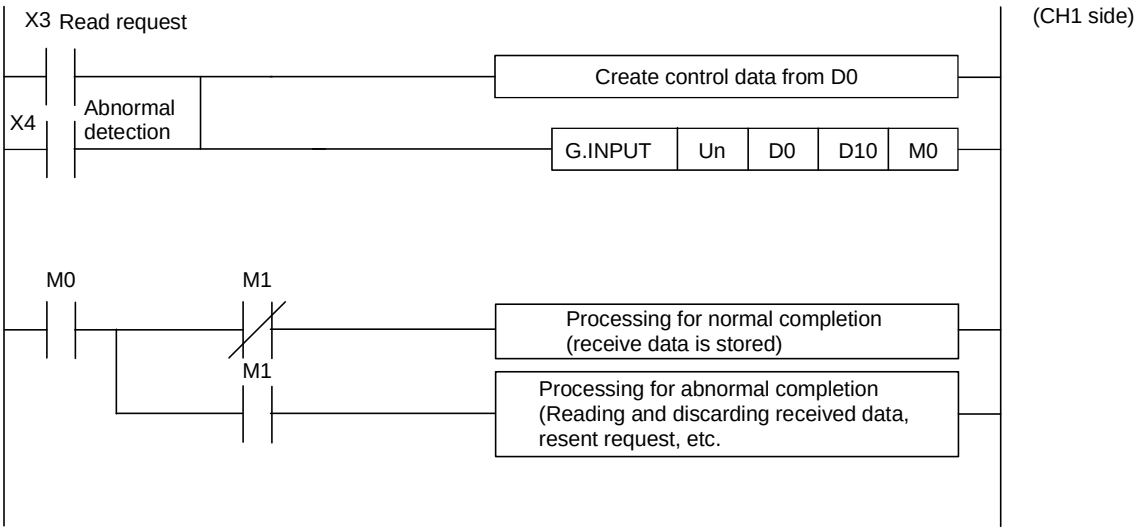
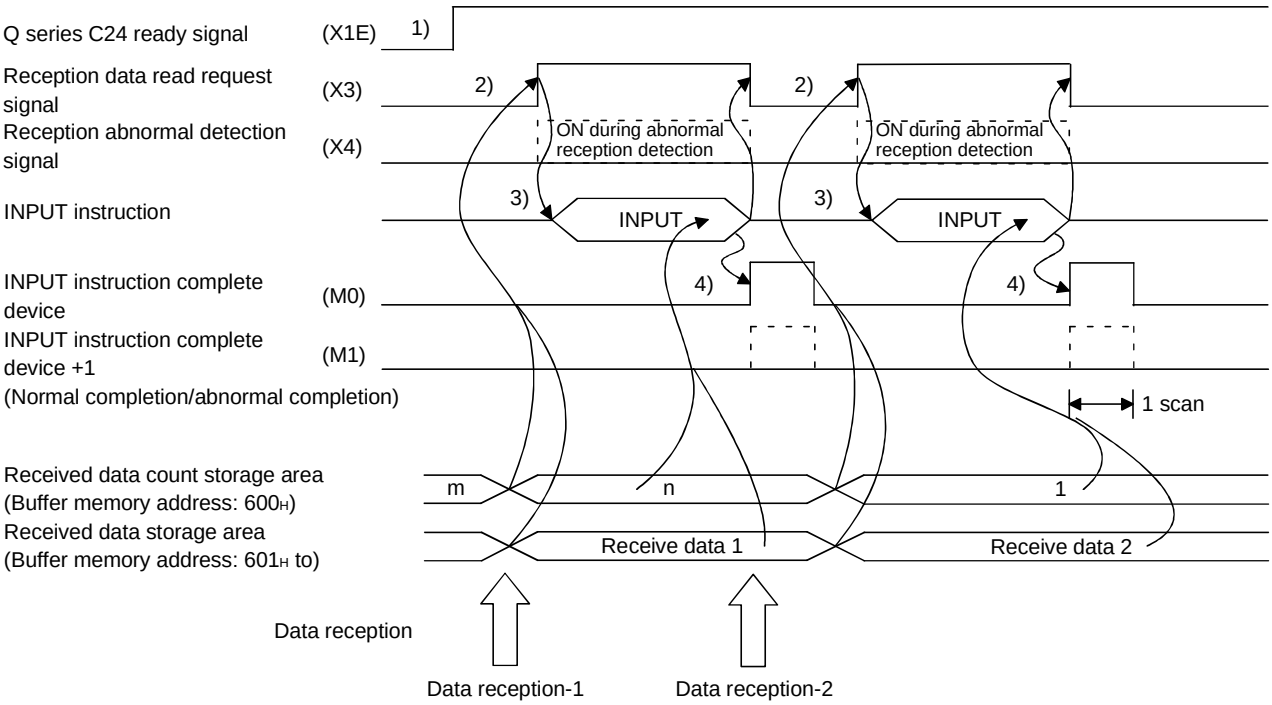
6.1.3 Sequence program for data reception

This section explains the sequence program for data reception.
For details on the INPUT instruction for data reception, see Chapter 9.



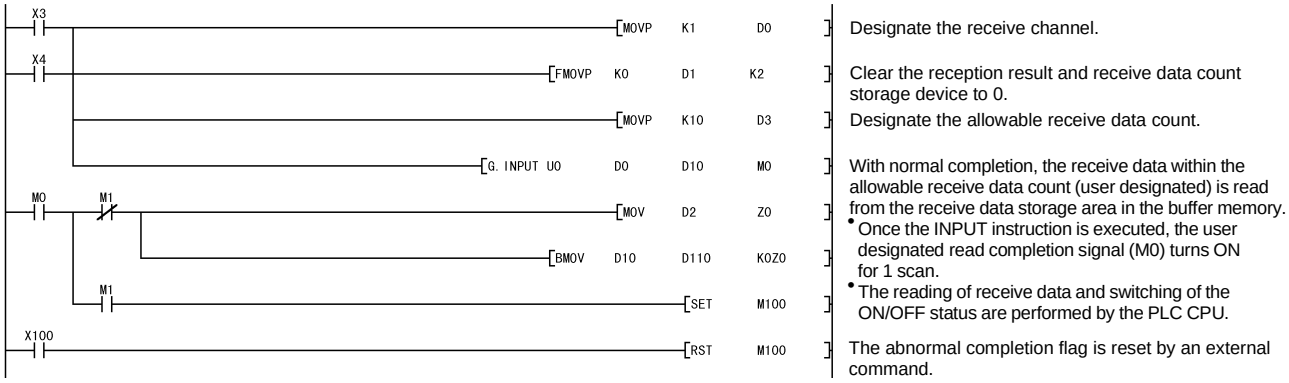
(CH1 side)

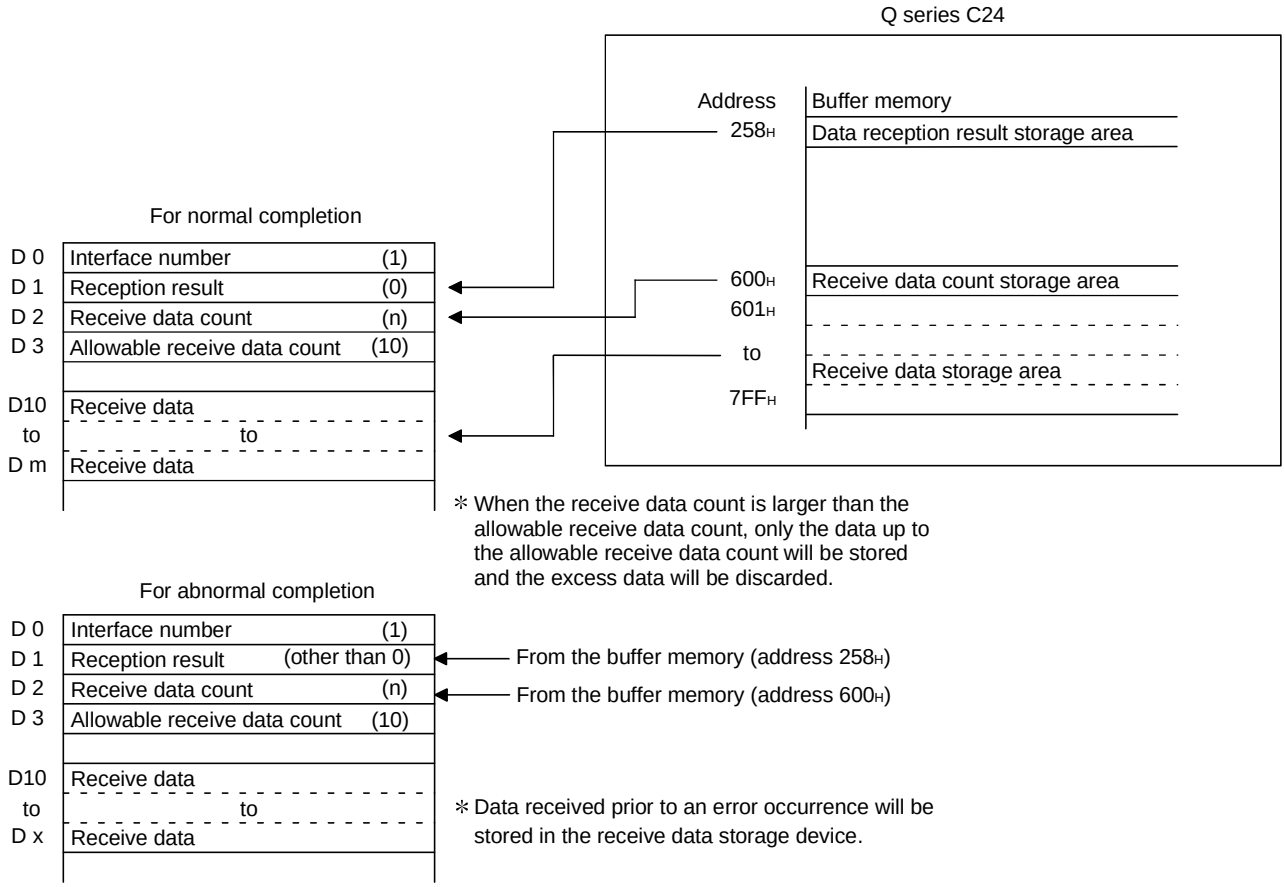


1) Start the self-station PLC.
   The values specified with GX Developer are stored in the Q series C24.
2) When the amount of data specified by the received data count or data containing the receive complete code is received from the external device, the reception data read request signal turns ON.
3) After the control data for the INPUT instruction is stored in the device, the sequence program executes the INPUT instruction and reads the receive data.

4) The device completing the INPUT instruction turns ON when the reading of receive data is completed.
When the complete device + 1 (abnormal completion signal) turns ON, the error code is stored in the control data completion status (S1 + 1).

(Program example)
When the Q series C24 I/O signals are from X/Y00 to X/Y1F:





POINT

(1) Receive data can also be read using interrupt programs.
For more details on reading receive data with interrupt programs, see Chapter 4 of the User's Manual (Application).
Note that if the reading of data received from the same interface is to be performed, it is not possible to combine the reading of data received by the main program and reading of data received by the interrupt program.
Accordingly, use one or the other of the above programs to read the data received.

(2) The SPBUSY instruction is used to read the execution status when using a dedicated instruction. (See Chapter 9.)

(3) More than one INPUT instruction cannot be executed simultaneously.
Execute the next INPUT instruction only after the execution of the first INPUT instruction is completed.

(4) When the communication data count is set in word units, and if the received data count is an odd byte when requesting the reading of received data to the PLC CPU, the receive data count is processed as follows:
Receive data count = Receive data byte count/2 ⋯ Fractions following the decimal point are rounded up
Also, 00H is stored in the higher byte of the final data storage position in the receive area where receive data is stored.

6.1.4 Receive data clear

For the data receiving with the non procedure protocol, when the error occurs in the data transfer to the Q series C24 by the trouble of the external device, the data received up to that point can be cleared.
The reception data can be cleared using the following methods:

1) Clear the reception data by the dedicated instruction "CSET."
2) Write to/read from the reception data clear request area (address A8H/148H). (FROM/TO instruction)
3) Clear the reception data by QSCU (see Section 8.7).

(1) Receive data clear processing

The Q series C24 performs the following procession when the receive data clear is performed.

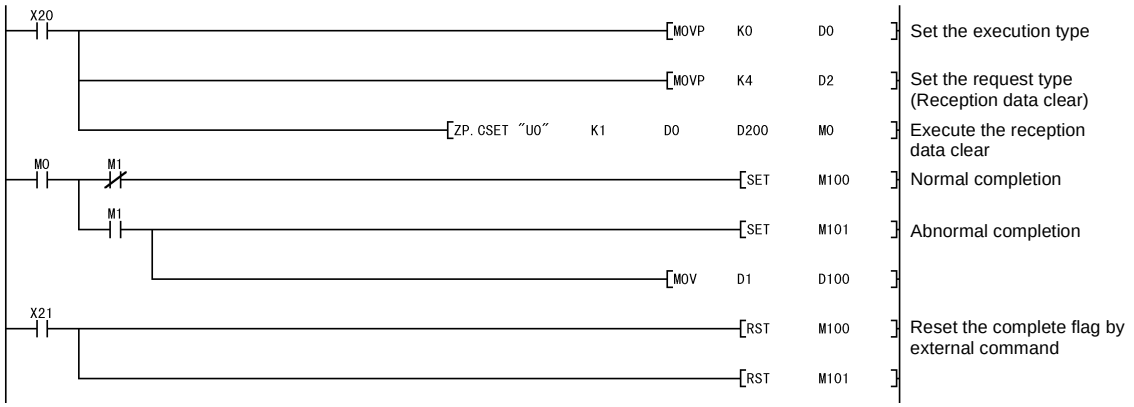
- The data received up to that point can be ignored.
- The receive data count up to that point is "0".
  (The receive area in the buffer memory is not initialized).
- Set to the status prior to the start of data reception.

(2) Procedure for clearing the reception data by the dedicated instruction "CSET"

This instruction clears the reception data up to the present without interrupting the data transmission processing.
(Procedure for clearing) ··· In case of the CH1 side interface

1) Execute the CSET instruction
   If the CSET instruction is executed while the read request (X03/X0A) or reception abnormal detection signal (X04/X0B) is turned on, the CSET instruction is kept waiting until the signal is turned off.
2) The reception data clear processing is executed at the OS area of the Q series C24 (see Section 6.1.2).

The following is a program example of clearing the reception data by the dedicated instruction "CSET."



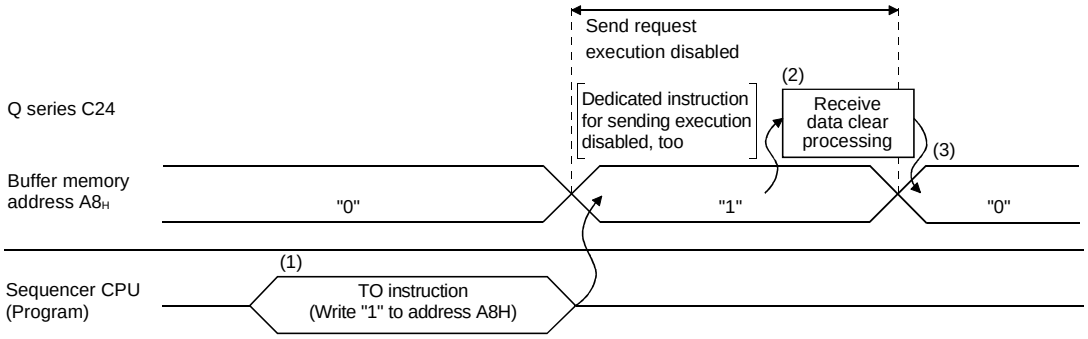
(3) Receive data clear procedure using FROM/TO instruction

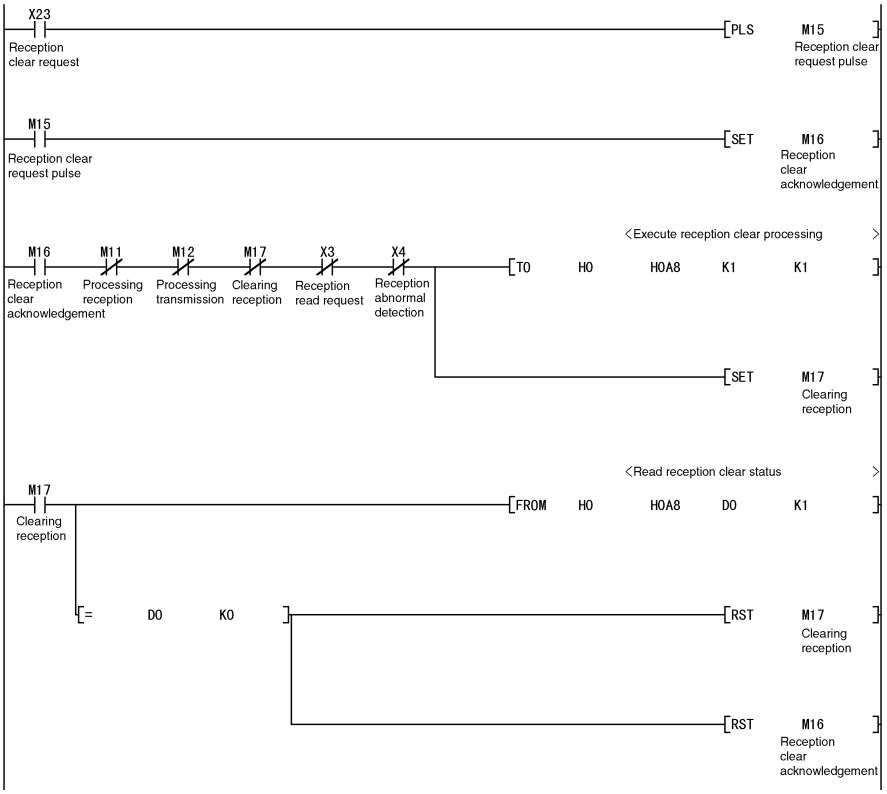
Write and read the buffer memory receive data clear request area (addresses A8H/148H) using the procedure described below.
Before resuming data transmission from the external device, clear buffer memory addresses A8H/148H to [0].
(Depending on the data communications system, the PLC CPU may have to inform the external device that data transmission can be resumed.)
(Clear procedure) ··· CH1 interface

1) When all the receive processing, send processing and receive data clear processing are not performed, writing [1] to buffer memory address A8H with the sequence program TO instruction.
2) The Q series C24 clears the OS area (see Section 6.1.2 ＊1) receive data.
3) When clearing of the receive data is complete, the Q series C24 changes the [1] written to buffer memory address A8H to [0].

The following page shows an example of a program to clear receive data with the FROM/TO instruction.
Create a program that contains the contacts (user flags, etc.) indicating the following statuses in the TO instruction.

- Contact when the CHn reception data read request signal (X3/XA) is OFF
- Contact when the CHn reception abnormal detection signal (X4/XB) is OFF
- Contact indicating that send and receive processes are not currently being performed
- Contact indicating that reception data clear processing is not currently being performed





REMARK

(1) When transmitting data from the Q series C24 to an external device for the dedicated instruction execution, do not issue the receive data clear request described above.
If a receive data clear request is issued while data is being transmitted to an external device, the Q series C24 will terminate data transmission and ends the dedicated transmission instruction abnormally. (The transmission complete signal does not turn ON). When a reception data clear request is executed while data is being received, the data received prior to the request will be cleared.

(2) When resuming transmission after clearing the received data, execute the OUTPUT instruction after the value of the receive data clear request area (address: A8H/148H) of the above buffer memory is changed from "1" to "0."

6.1.5 How to detect reception errors

This section explains how to detect errors that may occur when receiving data from the external device.

The following items are considered as the primary causes of errors that may occur during data reception.

Cause of reception error	Reference section	
A transmission error occurred due to noise.	—	
A timeout for the no-reception monitoring (timer 0) occurred.	User's Manual (Application)	Chapter 6
Received data that could not be converted using the ASCII-BIN conversion.		Chapter 13
Received data larger than the size that could be stored in the OS area of the Q series C24.	Section 6.1.2	

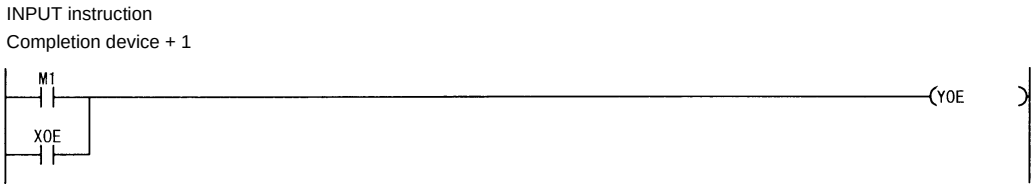
(1) Confirmation using the sequence program

1) The following device and input signals turn ON.
   - INPUT instruction complete device + 1
   - Reception abnormal detection signal (X4/XB)
   - ERR LED ON signal (XE/XF)
2) The reception error code can be checked using the INPUT instruction control data ((S1) + 1).
   Or, it can be checked by reading the data reception result storage area in the buffer memory (addresses 258H/268H).
   For details on how to check the error code contents and take corrective actions, see Chapter 10.

(b) How to turn off the ERR LED and clear the error code (see Section 10.1.2.)

1) To turn off only the ERR LED, write "1" to the LED OFF request area (addresses 0H/1H) in the buffer memory.
2) To turn off the ERR LED and clear the error code, turn ON the ERR LED OFF request output signal (YE/YF).

(Example) To perform the ERR LED OFF and the error code clear on the CH1 side



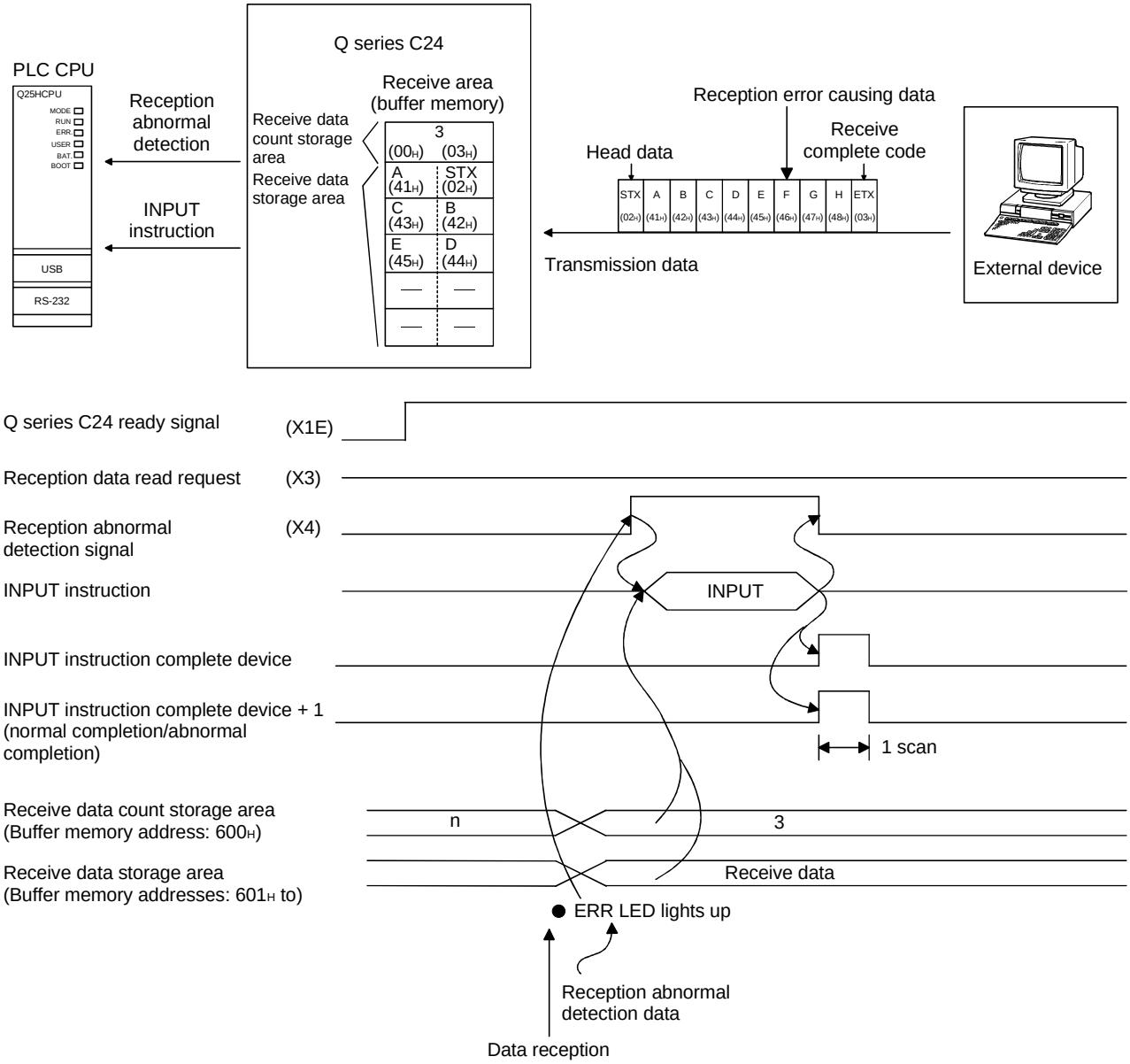
(2) Confirmation using the module and QSCU

1) Confirmation using the display LED
   When the Q series C24 detects an error, including a transmission error, the ERR LED lights up. (See Chapter 10.)
2) Confirmation using QSCU
   - The monitor function is used to check for errors. (See Sections 8.6.3 and 8.6.5.)
   - The ERR LED is turned off with the ERR LED OFF function. (See Section 8.6.10.)
3) Confirming the error code
   Use one of the following to confirm the error code.
   - QSCU monitor function (See Section 8.6.5.)
   - GX Developer buffer memory monitor function (monitors addresses 258H/268H)

(3) Receive data when a reception error occurs

(a) Storing receive data
The receive data for which an error was detected is discarded and only the normally received data is stored in the Q series C24.
Thus, there may be missing data among the data that has been read to the PLC CPU when a reception error occurs.

(b) Reading receive data
When receive data is read to the PLC CPU by turning the reception abnormal detection signal (X4/XB) ON, the data that was normally received prior to the error detection is read. Read and discard receive data as needed.



* When the data from "G" to in the reception message shown in the figure above is received normally, the data is stored in the Q series C24 OS area.
The receive data stored in the OS area will be read to the PLC CPU in the succeeding read operation.

6.1.6 Received data count and receive complete code settings

The following default values have been set for the received data count and receive complete code that are used for data reception with the non procedure protocol.
If it is necessary to change the following default settings, change the settings on the QSCU "Non procedure system setting" screen according to the specifications of the external device (see Sections 8.4.5 and 8.4.7).

Setting data	Default value	Allowable range	Buffer memory address where the setting value is stored	Remarks
Received data count	511 (1FF$_H$)	Less than the size of the receive data storage area	A4$_H$/144$_H$	Unit is in accordance with the word/byte units designation
Receive complete code	0D0A$_H$ (CR, LF)	0000$_H$ to 00FF$_H$	A5$_H$/145$_H$	When any code is set
		FFFF$_H$		When there is no receive complete code

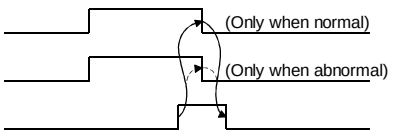
REMARK

Other than through the setting using QSCU or the T0 instruction at the startup of the Q series C24, the received data count and receive complete code setting values can be changed even after data communication has started if the timing is as shown in the chart below.
The following describes the procedure for changing setting values for data reception via the non procedure protocol after the start of data communication, and for the resumption of data reception processing. Specifically, the module restrictions are explained, along with the timing and procedure for changing the setting values.

(1) Data receiving method

Reception using a dedicated instruction (INPUT) or an interrupt program (*1) cannot be performed. (Transmission using a dedicated instruction (OUTPUT) can be performed.) Data must be received using the FROM instruction in the main program.
The following describes the I/O signals. (A program example is shown on the following page.)

*1 For details on the data reception using interrupt programs, see the User's Manual (Application).

	I/O signal		Signal name	Device that turns ON/OFF		Timing
	CH1 side	CH2 side		CPU	Q series C24	
Reception	X3	XA	Reception data read request		○	
	X4	XB	Reception abnormal detection		○	
	Y1	Y8	Reception data read completion	○		

POINT

When the reception abnormal detection signal (X4/XB) turns ON, read the error code from the buffer memory below, and then check the type of error and take corrective action based on the information found in Chapter 10.

- Data reception result storage area (addresses 258/268$_H$)

(2) Setting values that can be changed

Of the initial settings from QSCU stored in the buffer memory, only the following setting values can be changed after data communication has started.

- Received data count (buffer memory addresses: A4H, 144H)
- Receive complete code (buffer memory addresses: A5H, 145H)

(3) Timing and procedure for changing the setting values

1) Timing of change

To change the receive complete code and received data count after data communication has started, change the setting when the status of the I/O signals relating to the reading of receive data is as follows.

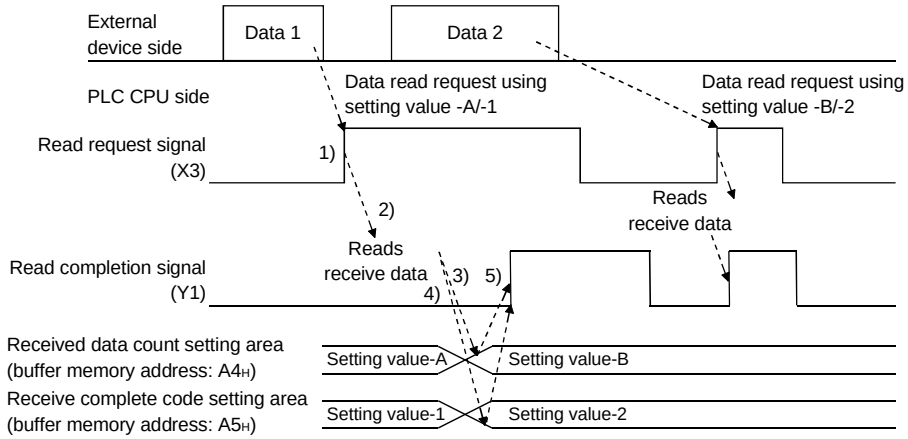
- Reception data read request signal (X3, XA) or reception abnormal detection signal (X4, XB): ON
- Reception data read completion signal (X1, Y8): OFF

2) Change procedure

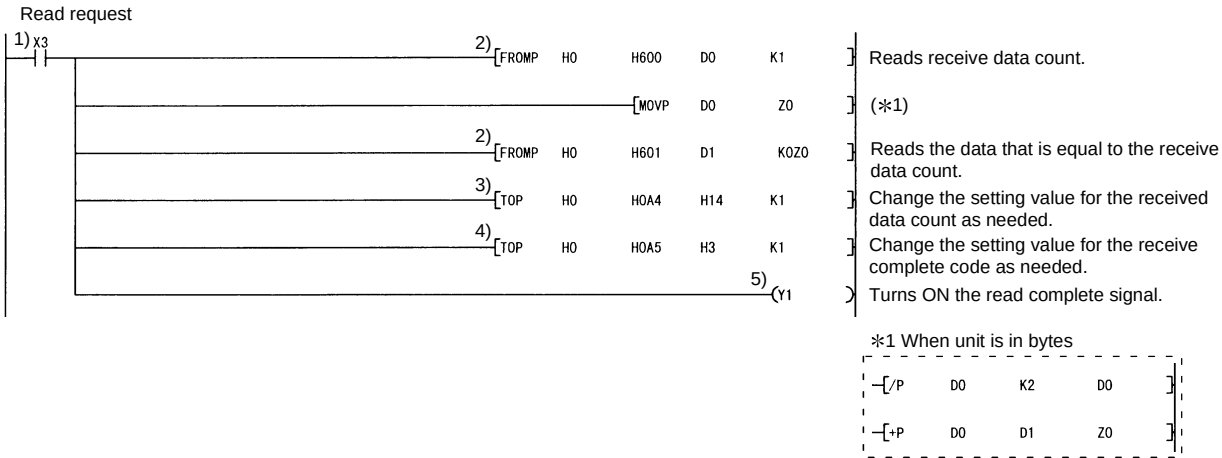
When data reception from an external device causes the reception data read request signal/reception abnormal detection signal to turn ON, turn ON the reception data read completion signal after performing the following.

- Read the receive data.
- Change the setting values for the receive complete code and the received data count.

(Example) When reading data received in the CH1 side interface



(Program example: I/O signals for the Q series C24 are from X/Y00 to X/Y1F)

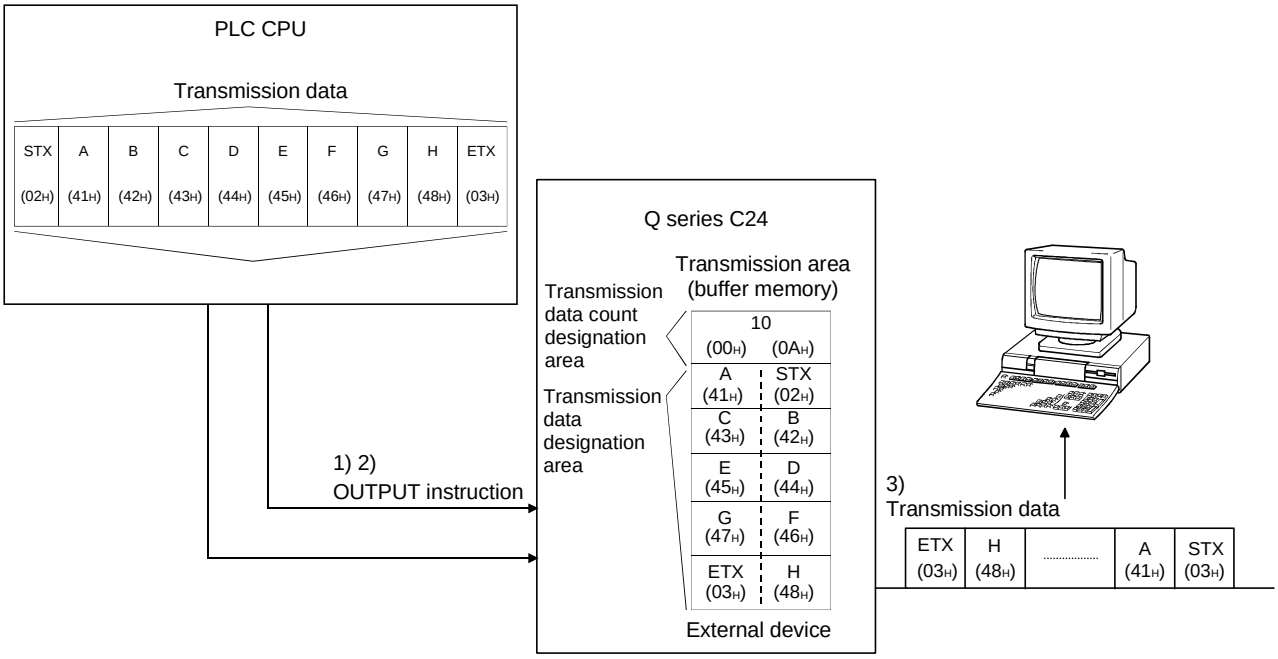


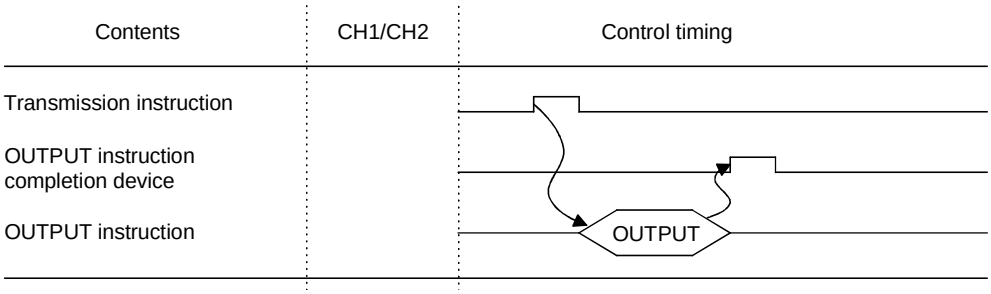
6.2 Sending Data to the External Device

This section explains data transmission from the PLC CPU to the external device.

6.2.1 Transmission methods

The following shows how to send data in any format using the non procedure protocol.





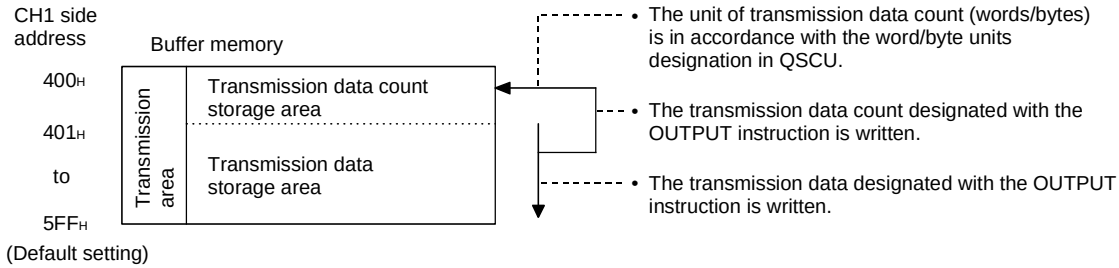
1) Transmission data is stored in the device designated with the OUTPUT instruction.
2) Control data is stored in the device designated with the OUTPUT instruction.
3) When the OUTPUT instruction is executed, the Q series C24 sends the amount of data designated by the transmission data count from the transmission data area to the external device in ascending order of the transmission data area addresses.

6.2.2 Arrangement and contents of the transmission area and the transmission data

This section explains the arrangement and contents of the transmission area and the transmission data for performing data transmission using the non procedure protocol.

(1) Transmission area

The transmission area is a memory area for storing the data and the data count that are transmitted from the PLC CPU to the external device via the Q series C24. By default, the transmission area is assigned to addresses 400H to 5FFH (CH1 side) and 800H to 9FFH (CH2 side).



POINT

(1) The position and size of the transmission area in the buffer memory can be changed with QSCU in accordance with the specifications of the external device and the received data length. (See Sections 8.4.5 and 8.4.7.)

(a) When changing the position and size of the transmission area in the buffer memory with QSCU, specify as follows:

1) Transmission buffer memory head address designation
Designate the starting address for the area to be used as the transmission area in the user definable area of the buffer memory.
2) Transmission buffer memory length designation
Designate by addresses the length of the area to be used as the transmission area in the user definable area of the buffer memory.

(b) If the following functions are also used when the position and size of the transmission area in the buffer memory are changed, make sure that the addresses of the transmission area do not overlap with those for the buffer memory that stores the transmission and receive data to be used by these functions.

1) MC protocol buffer memory read/write function
2) MC protocol on-demand function
3) Non procedure protocol transmission/receive function
4) Bidirectional protocol transmission/receive function

(2) Set the size of data per data transmission from the PLC CPU to the external device so that it is smaller than the size of the transmission data's designated area in the buffer memory.

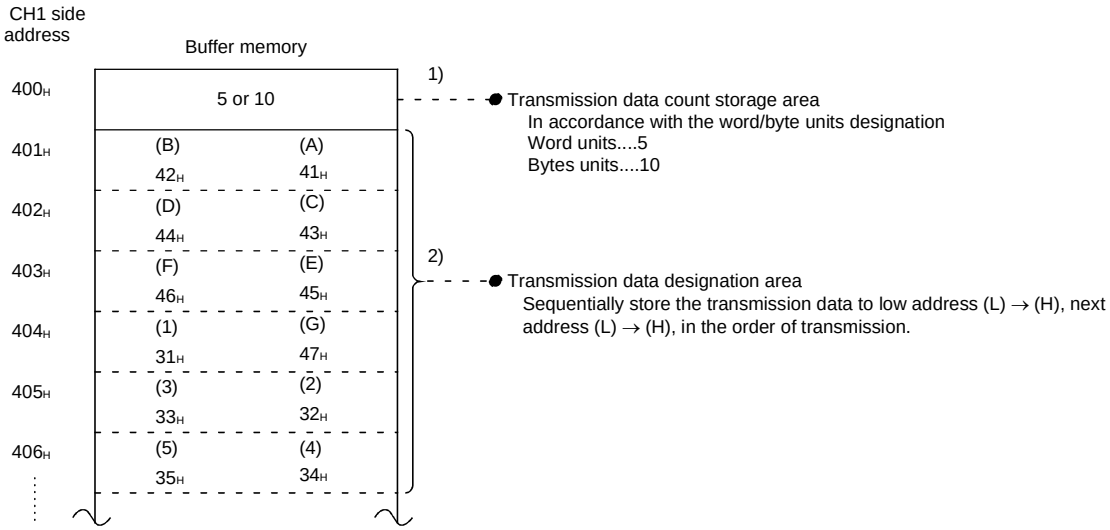
(Transmission data designation area) ≧ (Size of arbitrary data portion to be sent from the PLC CPU)

To transmit data whose size is larger than the transmission data designation area, increase the transmission area, or divide the transmission data before sending.

(2) Transmission data arrangement

The following example shows an arrangement of the transmission data to be sent to the external device when storing it in the transmission area.

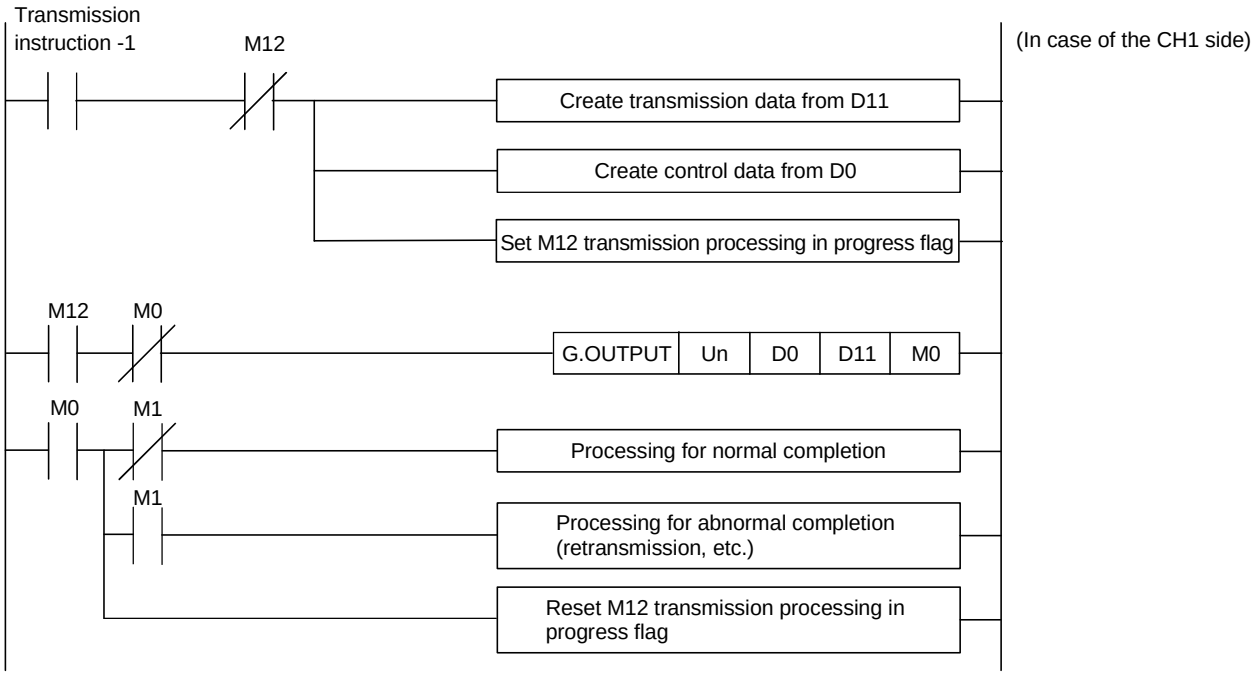
(Example) When transmitting "ABCDEFG123" (The transmit area is the default value.)

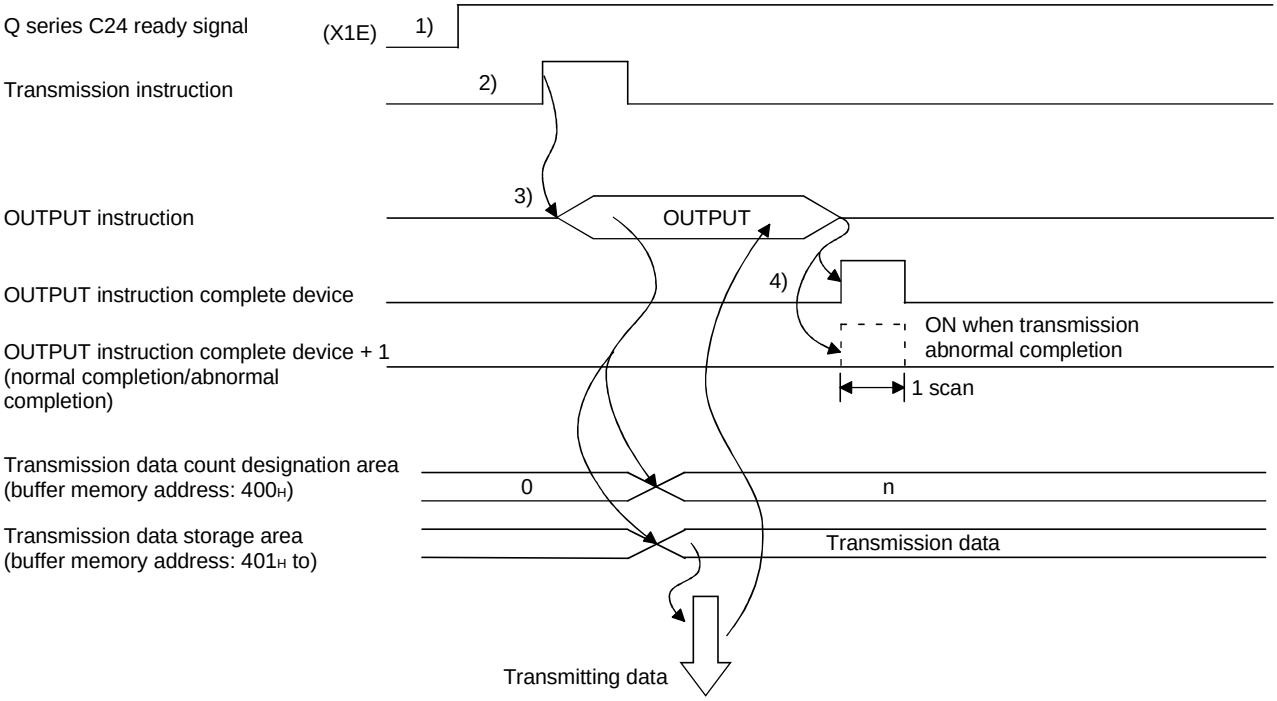


6.2.3 Sequence program for transmission data

A sequence program for transmission data is explained below.

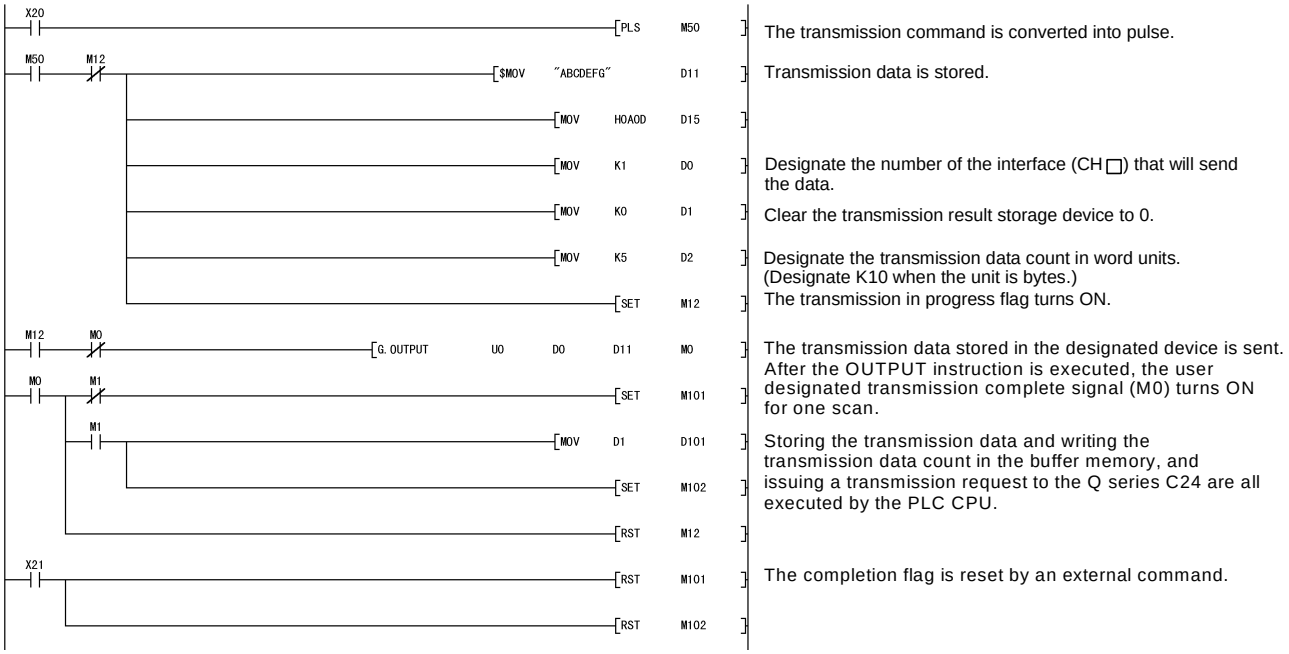
For details on the OUTPUT instruction used for data transmission, see Chapter 9.

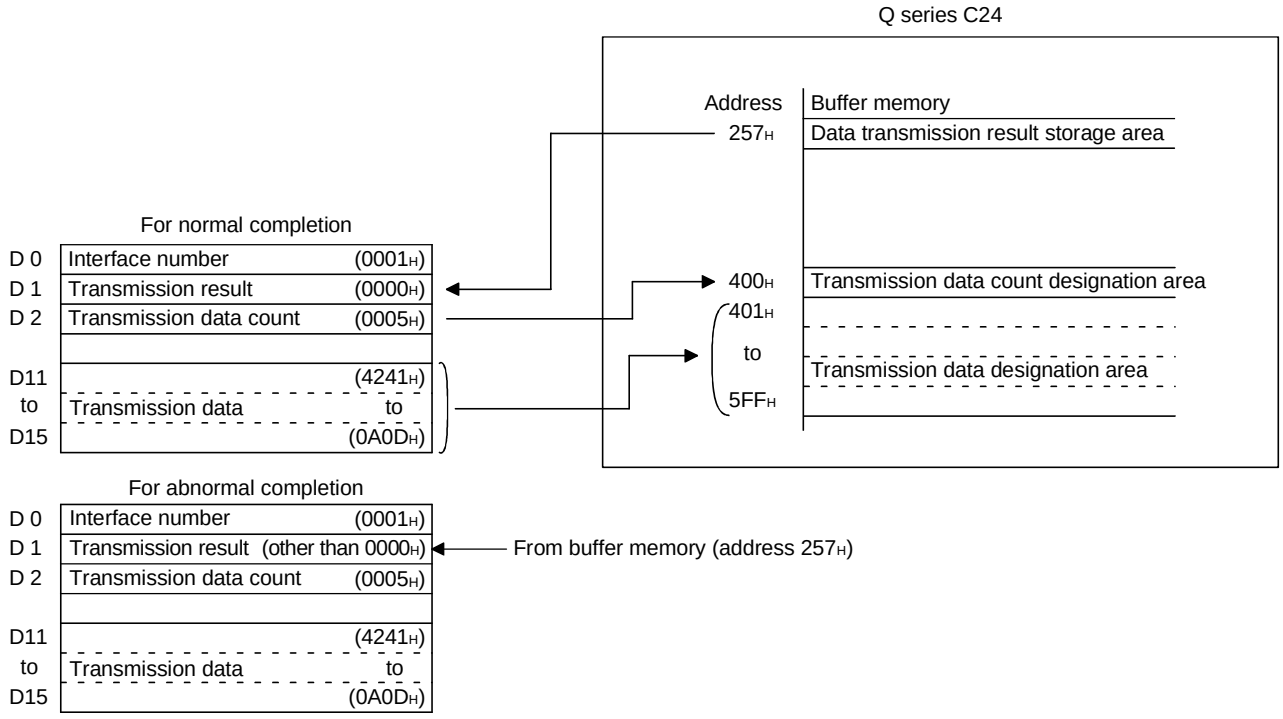




1) Starts the local station PLC.
   The setting values for GX Developer are stored in the Q series C24.
2) Inputs the user data transmission command signal.
3) Executes the OUTPUT instruction after storing the transmission data and the control data for the OUTPUT instruction in the device.
   Data is sent when the OUTPUT instruction is executed.
4) When the Q series C24 transmission processing completes, the completion device for the OUTPUT instruction turns ON.
   When the completion device + 1 (abnormal completion signal) turns ON, the error code is stored in the control data completion status (S1+1).

(Program example)
When Q series C24 I/O signals are from X/Y00 to X/Y1F:





POINT

(1) The SPBUSY instruction is used to read the execution status when using a dedicated instruction. (See Chapter 9.)

(2) More than one OUTPUT instruction cannot be executed simultaneously. Execute the next OUTPUT instruction only after the execution of the first OUTPUT instruction is completed.

6.2.4 How to detect transmission errors

This section explains how to detect errors that may occur when sending data to the external device.

The following items are considered as the primary causes of errors that may occur during data transmission.

Cause of reception error	Reference section	
A timeout occurred for the transmission monitoring time (timer 2)	User's Manual (Application)	Section 6.3
Designated number of transmission data was larger than the size that could be stored in the transmission area	Section 6.2.2	

(1) Confirmation using the sequence program

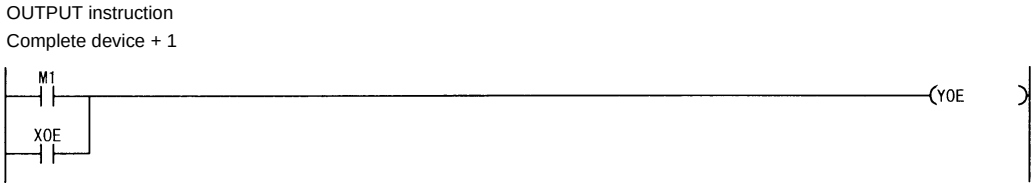
(a) Detecting a transmission error

1) The following device and input signal turn ON.
   - OUTPUT instruction complete device + 1
   - ERR LED ON signal (XE/XF)
2) The transmission error code can be checked using the OUTPUT instruction control data ((S1) + 1).
   Or, it can be checked by reading the data transmission result storage area in the buffer memory (addresses 257H/267H).
   For details on how to check the error code contents and corrective actions, see Chapter 10.

(b) How to turn off the ERR LED and clear the error code (see Section 10.1.2)

1) To turn off only the ERR LED, write a "1" to the LED OFF request area (addresses 0H/1H) in the buffer memory.
2) To turn off the ERR LED and clear the error code, turn ON the ERR LED OFF request output signal (YE/YF).

(Example) To perform the ERR LED OFF and the error code clear on the CH1 side



(2) Confirmation using the module and QSCU

1) Confirmation using the display LED
   When the Q series C24 detects an error, including a transmission error, the ERR LED lights up. (See Chapter 10.)
2) Confirmation using the QSCU
   - The monitor function is used to check for errors. (See Sections 8.6.3 and 8.6.5.)
   - The ERR LED is turned off with the ERR LED OFF function. (See Section 8.6.10.)
3) Confirming the error code
   Use one of the following to confirm the error code.
   - QSCU monitor function (See Section 8.6.5.)
   - GX Developer buffer memory monitor function (monitors addresses 257H/267H)

POINT
When a transmission error occurs, the PLC CPU may not transmit all the designated data. It is recommended that data communications be performed by establishing a user arbitrary communication procedure that can check normal transmission by reception of a response to data transmission.

6.3 Data Communications Precautions

The following describes the precautions to be taken during non procedure protocol data communications.

(1) The Q series C24 transmission sequence initialization conditions

The initial status indicates the status where transmission has stopped and reception data has been discarded.
The Q series C24 transmission sequence initialization conditions are as follows.

1) When the power is turned on, the Reset switch on the CPU panel is operated, or the Q series C24 mode is switched
2) When the receive data was cleared.
3) When the CD signal was turned off when data communications were performed by setting CD terminal check enable during full-duplex communications through the RS-232 interface.

(2) Generation of framing error in external device

When nothing is transmitted from the Q series C24 to the external device through the RS-422 or RS-422/485 interface, a framing error may be generated by the noise etc, in the external device.
Send an arbitrary code to identify the head of the send data from the Q series C24 to the external device.
Before data communication check the Q series C24 interface specifications.

(3) Data communications with external device (computer, etc.) over a multidrop link

When the external device PLC CPU are connected by a 1:n multidrop link, each the Q series C24 receives the data transmitted by the external device.
With a multidrop link, receive data by user frame (*1).
If data is not received by user frame, a sequence program that ignores the receive data other than the receive data addressed to the local station by sequence program, including the data indicating the objective PLC CPU in the message, must be written.
(Sample message)

(Example)

STX	Space	Station No. 0	Station No. 2	Data length (BIN data)	Data	CR	LF
(02_H)	(20_H)	(32_H)	(32_H)			($0D_H$)	($0A_H$)

*1 See chapter 11 of User's Manual (Application)

(4) Retry processing for data reception errors

The data when reception error occurred is discarded and only the data for the normal reception is taken into the Q series C24. For this reason, the reception message may be missing data when an error occurs. To assure the correct transmission and reception of data it is recommended that a normal/error response message is received and a response message reception timeout check is conducted for data transmitted between the PLC CPU and the external equipment and that measures be taken when an error message is received or when an error timeout occurs, such as retransmitting the data (transmission retry).

7 DATA COMMUNICATION USING THE BIDIRECTIONAL PROTOCOL

Data communication using the bidirectional protocol is a function for sending/receiving any data using the message format and transmission control procedure for the Q series C24 bidirectional protocol between external devices and PLC CPUs.
Any external devices that can install application programs and transmit and receive data in accordance with the MELSEC PLC protocol can communicate with the PLC CPUs using the bidirectional protocol.

This chapter explains the basic transmission and reception methods when performing data communication using the bidirectional protocol.
Follow the procedure described in this chapter to create sequence programs for sending and receiving data for the PLC CPU.
Regarding the additional functions listed below for data communication using the bidirectional protocol, see the separate User's Manuals (Application)

- Reading receive data using interrupt programs
  (See Chapter 4 of Application)
- Sending/receiving data using ASCII data (ASCII-BIN conversion)
  (See Chapter 13 of Application)
- Sending/receiving data using transparent code designation
  (See Chapter 12 of Application)

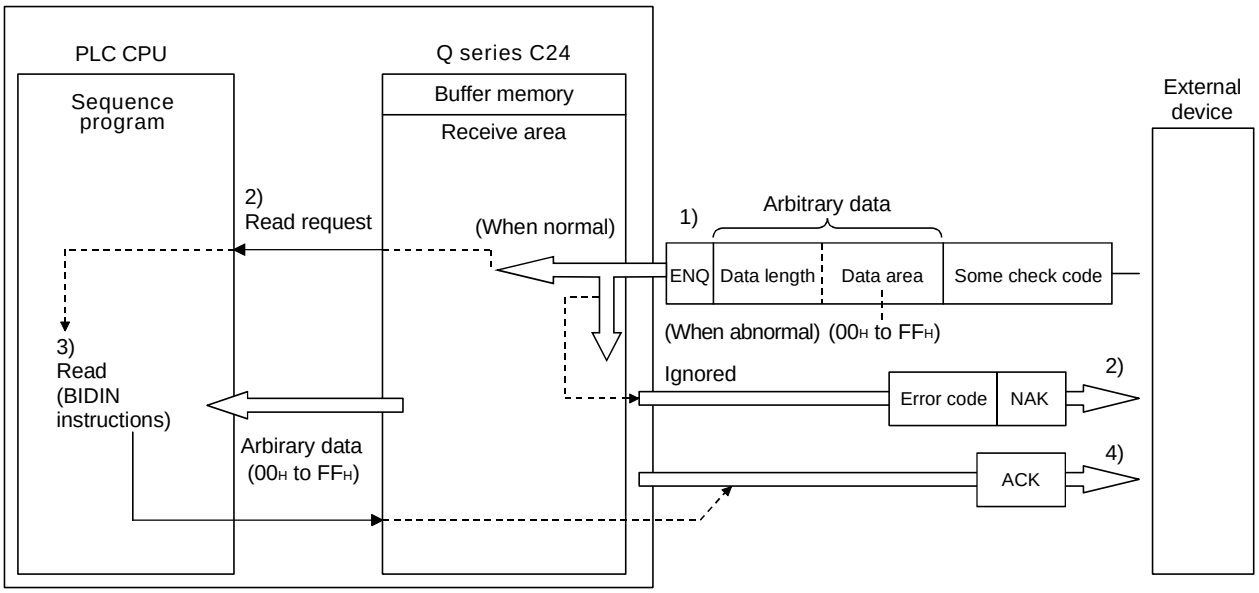
7 - 1

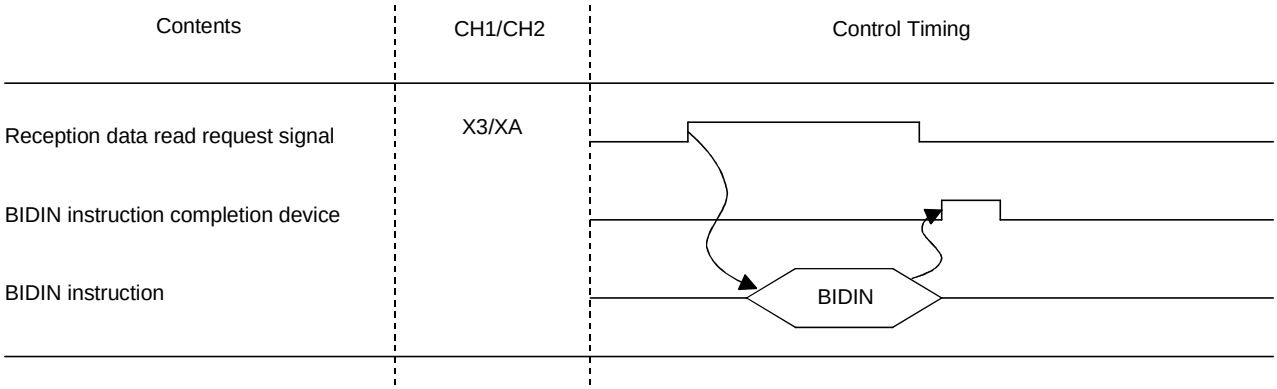
7.1 Data Reception from the External Device

This section explains the data reception from the external device.

7.1.1 Receiving methods

The following shows how to receive data sent from the external device using the bidirectional protocol. Since the size of each message received is recognized using the "data length" information contained in the message, messages of any size can be sent from the external device.





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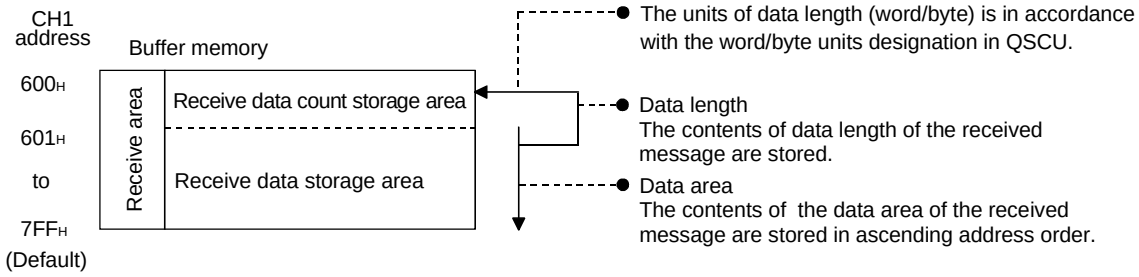
1) When the control code ENQ is received, the Q series C24 starts data reception processing.
   When the data specified by the data length is received, the Q series C24 ends the reception processing of that data.
   If "Sum check" is set with GX Developer, the Q series C24 checks whether the message is normal or abnormal using the sum check code received immediately after the message and the sum check code calculated by internal processing.
   ✻ If "No sum check" is set with GX Developer, messages are not checked using the sum check codes.
2) If the message has normally been received, the reception data read request signal turns ON.
   ✻ If an error has been detected when receiving the message, the Q series C24 sends an abnormal end response (NAK message) to the external device.
   The reception data read request will not be sent to the PLC CPU.
3) Control data is stored in the device designated with the BIDIN instruction and then the BIDIN instruction is executed.
   Receive data is read from the receive area of the buffer memory.
4) When the BIDIN instruction has been executed, the Q series C24 sends a normal end response (ACK message) to the external device.

7.1.2 Arrangement and contents of the receive area and the receive data

This section shows the arrangement and contents of the receive area and the receive data for performing data reception using the bidirectional protocol.

(1) Receive area

The receive area is a memory that stores the received data length (receive data count) and data area received from an external device.
The receive area is allocated to addresses 600H to 7FFH (CH1 side) and A00H to BFFH (CH2 side) at initial setting.



POINT

(1) The position and size of the receive area in the buffer memory can be changed with QSCU in accordance with the specifications of the external device and the received data length. (See Sections 8.4.5 and 8.4.7.)

(a) When changing the position and size of the receive area in the buffer memory with QSCU, specify as follows:

1) Receive buffer memory head address designation
Designate the starting address for the area to be used as the receive area in the user definable area of the buffer memory.
2) Receive buffer memory length designation
Designate by addresses the length of the area to be used as the receive area in the user definable area of the buffer memory.

(b) If the following functions are also used when the position and size of the receive area in the buffer memory are changed, make sure that the addresses of the receive area do not overlap with those for the buffer memory that stores the transmission and reception data to be used by these functions.

1) MC protocol buffer memory read/write function
2) MC protocol on-demand function
3) Non procedure protocol transmission/receive function
4) Bidirectional protocol transmission/receive function

(2) When sending data to the Q series C24 from the external device, one of the following two adjustments should be made so that the relationship shown below is maintained.

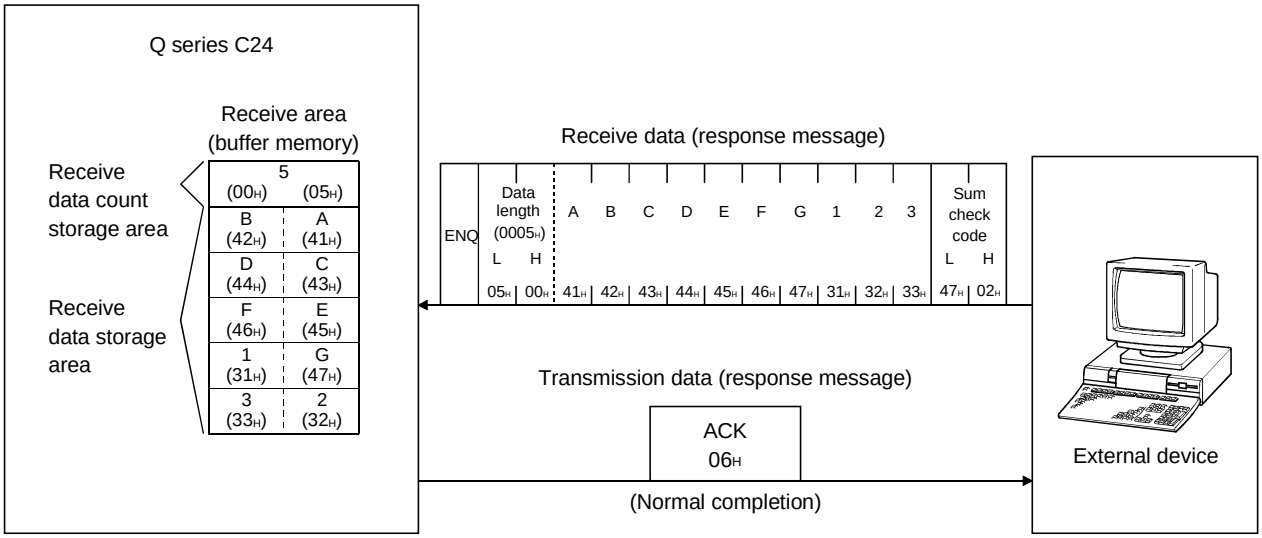
1) Reduce the send data size.
2) Increase the receive area.

(Receive data storage area) ≧ (Size of data portion sent from the external device)

(2) Arrangement of receive data

The following example illustrates the arrangement of data received from the external device when it is stored in the receive area.

1) The receive message is stored to the Q series C24 buffer memory (receive data storage area).
2) The data is stored to the receive data storage area in low address (L) → (H), next address (L) → (H) order.
   If the received data is "ABCDEFG123", it will be stored as shown below (for the CH1 side):



∗ When the data length unit is in bytes, 00H is stored in the higher byte of the last data storage position in the receive area when the data length of the message is an even byte.

(3) Contents of receive data

∗ The contents of receive data, including the receive data as indicated in Section 7.2.2, are explained below.

(a) Control codes

The types of control codes are shown in the table below.

Signal name	Code (hexadecimal)	Contents	Application
ENQ	05H	Enquiry	Code for starting data transmission.
ACK	06H	Acknowledge	Response code to the opposite side when data was received normally.
NAK	15H	Negative Acknowledge	Response code to the opposite side when data could not be received normally. (Error code is sent immediately after the response code.)

1) For data communication from the external device to the Q series C24 the Q series C24 checks and processes the control code received. It cannot be read from the sequence program.
2) For data communication from the Q series C24 to the external device The control code to be transmitted is added by the Q series C24.

(b) Data length

This indicates the number of bytes or words for the data portion of the message.

The unit of data length (words/bytes) is in accordance with the word/byte units designation in QSCU.

1) For data communication from the external device to the Q series C24
The Q series C24 checks the length of the data received.
When the reception is normal, the Q series C24 stores the receive data in the receive data storage area of the Q series C24 buffer memory, assigning the first byte as the lower byte (L).
2) For data communication from the Q series C24 to the external device
The length of the transmission data is the number of the transmission data designated by the sequence program using the BIDOUT instruction.
The Q series C24 sends this value as is from the lower byte (L).

(c) Data portion

This consists of an array of original one-byte data to be transmitted to the external device side, which can handle 00_H to FF_H code data.

1) For data communication from the external device to the Q series C24
If the receive data portion is normal, the Q series C24 takes the codes as is and stores them in the receive data storage area in sequence, beginning with the youngest address.
The storage size is in accordance with the data length in the message (See item (b) above) and the word/byte units designation in QSCU.
2) For data communication from the Q series C24 to the external device
The transmission data portion is the number of the transmission data designated by the sequence program using the BIDOUT instruction.
The Q series C24 sends the transmission data using the existing codes until the transmission data count is reached in accordance with the word/byte units designation in QSCU to the transmission data designation area.

(d) Sum check code

The sum check code expresses the numeric value for the lower two bytes (16 bits) of the results (sum) from the addition of the data length and the data portion in the message as binary code data.

When "Sum check" is specified with the transmission setting in GX Developer, it is necessary to add a sum check code at the end of the message.

1) For data communication from the external device to the Q series C24

The Q series C24 checks and processes the sum check code received. It cannot be read from the sequence program.

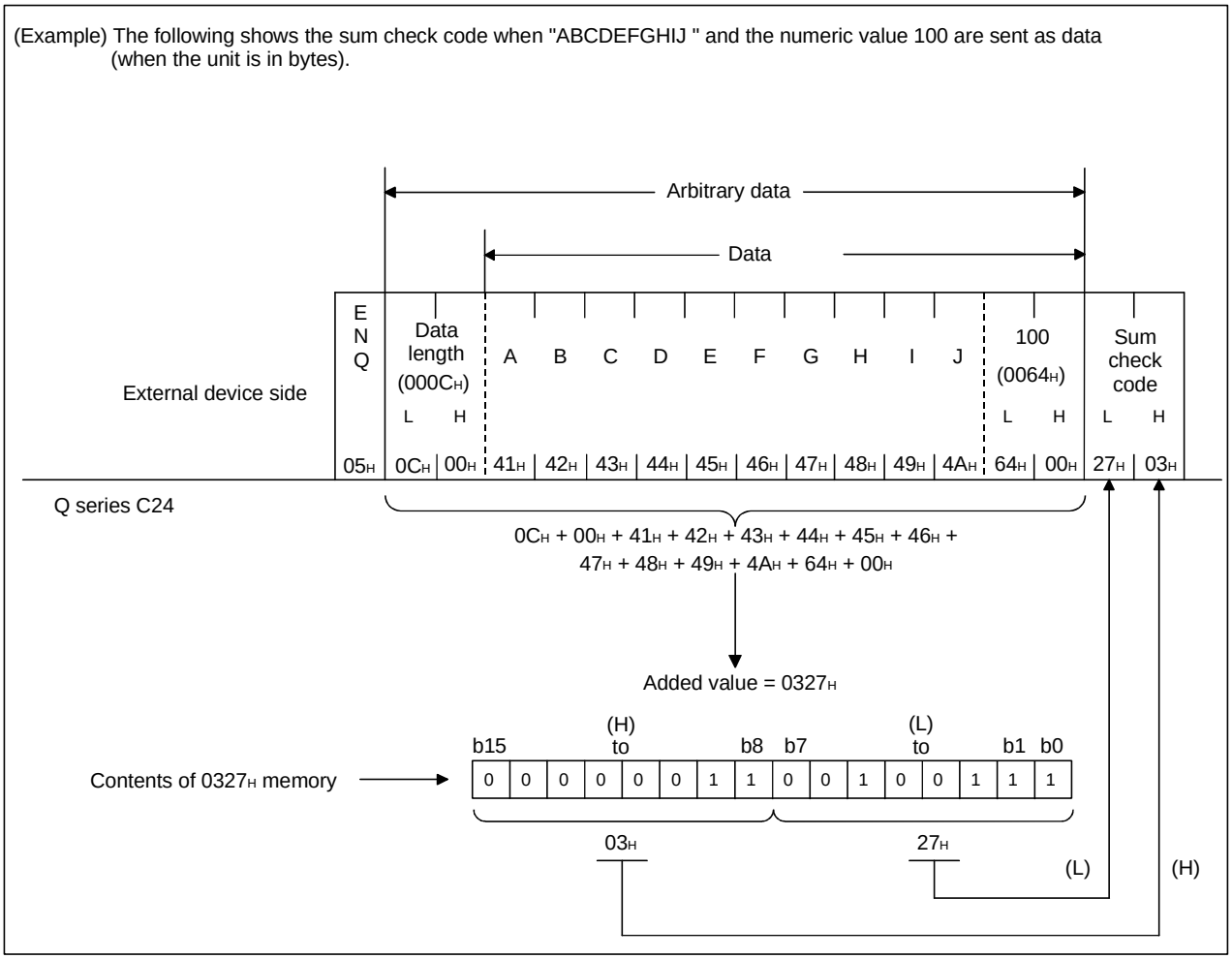
When "No sum check" is specified, once a data portion of message corresponding to the data length is received, the succeeding data received will be ignored up to the control code that follows (See (a)).

The following example shows the contents of a sum check code in the message.

2) For data communication from the Q series C24 to the external device

The sum check code to be transmitted is calculated and added by the Q series C24. When "No sum check" is specified, no sum check code is transmitted.

(Example) The following shows the sum check code when "ABCDEFGHIJ " and the numeric value 100 are sent as data (when the unit is in bytes).



(e) Error code

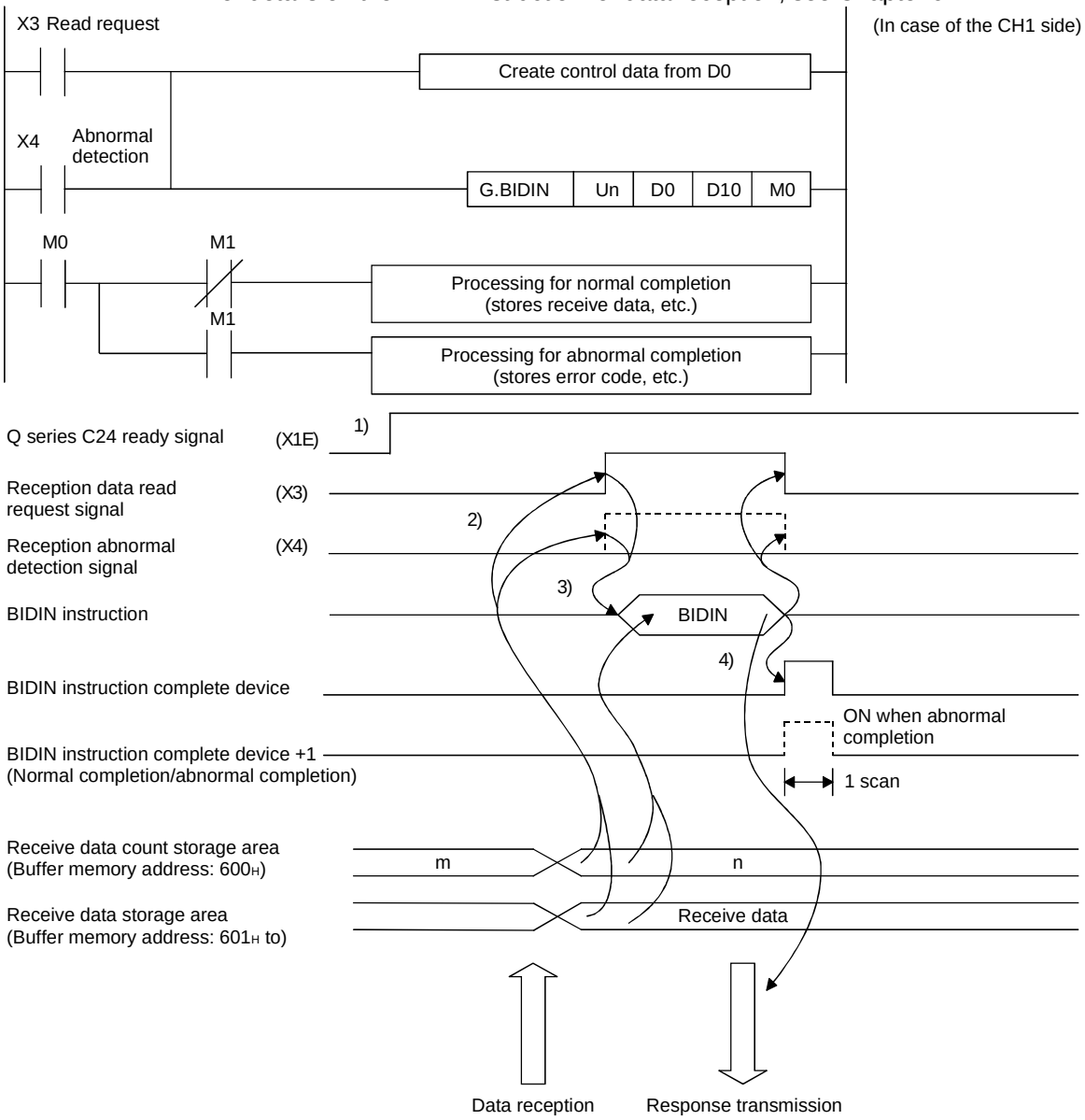
The error code indicates the definition of the error during NAK response. (For more details on the error codes, see Chapter 10.)

1) For data communication from the external device to the Q series C24
Transmit 0022_H to $005F_H$ as error codes.
The Q series C24 stores the received error codes as a completion status in the control code for the BIDOUT instruction.
They are also stored in the data transmission result storage area in the buffer memory (address: 257_H).

2) For data communication from the Q series C24 to the external device
The error codes are added by the Q series C24.
When an error code is transmitted, the Q series C24 writes the same error code in the data reception result storage area of the buffer memory (address: 258_H).
Since the error codes are defined by the user, corrective actions should be taken based on the definition of the error for which the corresponding error code has been assigned.

7.1.3 Sequence program for data reception

This section explains the sequence program for data reception.
For details on the BIDIN instruction for data reception, see Chapter 9.

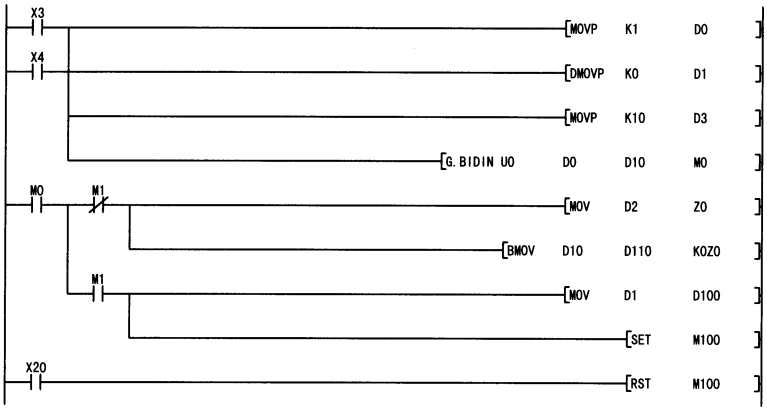


1) Start the local station PLC.
   The values specified with GX Developer are stored in the Q series C24.
2) When data is received from the external device, the reception data read request signal turns ON.
3) After the control data for the BIDIN instruction is stored in the device, the sequence program executes the BIDIN instruction and reads the receive data.
4) When the reading of receive data is completed, a response message (ACK message when the operation was completed normally) is sent and the device that has completed the BIDIN instruction turns ON. When the complete device + 1 (abnormal completion signal) turns ON, the error code is stored in the control data completion status (S1+1).

(Program example)

When Q series C24 I/O signals are from X/Y00 to X/Y1F:

Read request



Designate the interface number (CH☐) that reads the receive data.

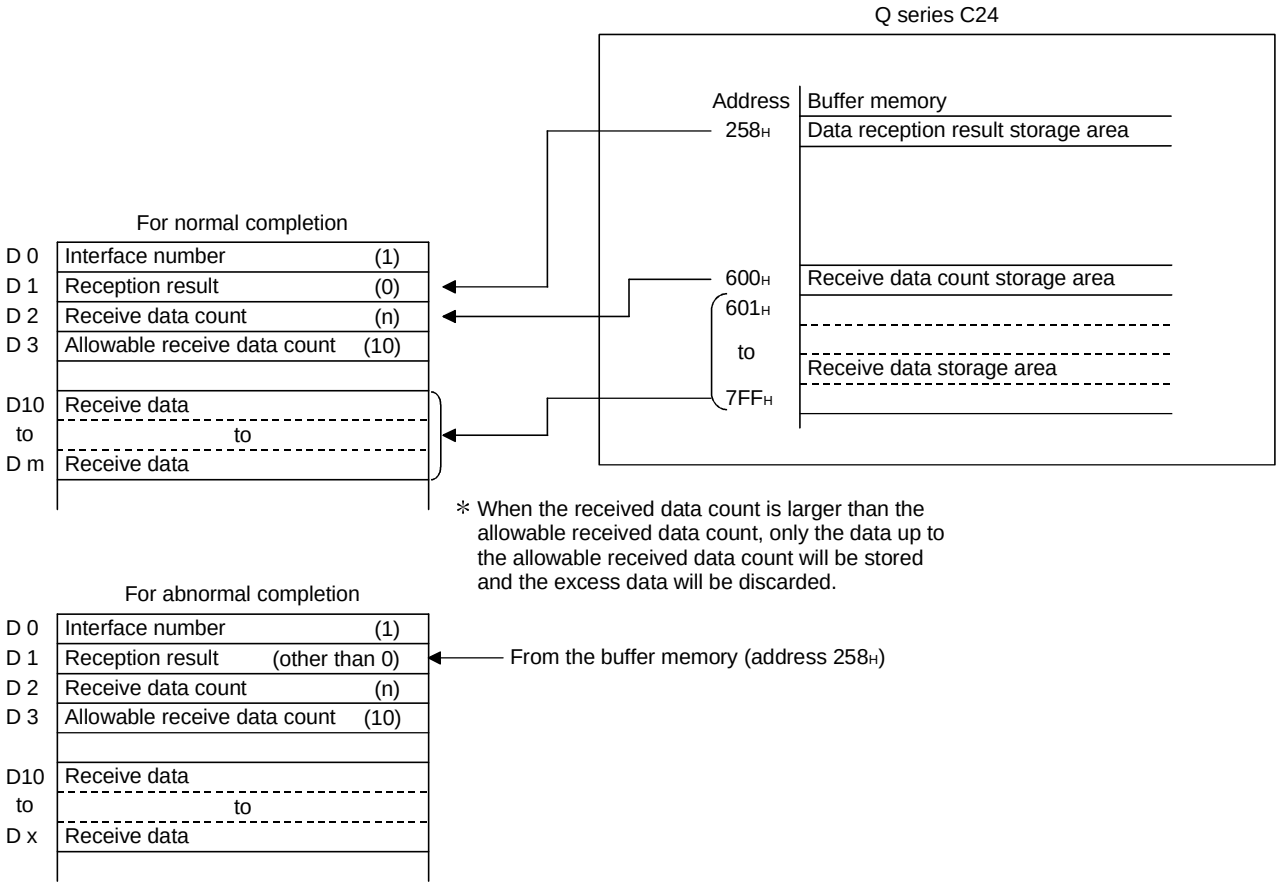
Clear the reception result and receive data count storage device to 0.

Designate the allowable receive data count.

With normal completion, the receive data within the allowable receive data count (user designated) is read from the receive data storage area in the buffer memory.

- After the BIDIN instruction is executed, the user designated read completion signal (M0) turns ON for 1 scan.
- The reading of receive data and switching of the ON/OFF status of a read completion signal are performed by the PLC CPU.

The abnormal completion flag is reset by the external instruction.



* When the received data count is larger than the allowable received data count, only the data up to the allowable received data count will be stored and the excess data will be discarded.

POINT

(1) Receive data can also be read using interrupt programs.
For more details on reading receive data with interrupt programs, see Chapter 4 of the User's Manual (Application).
Note that if the reading of data received from the same interface is to be performed, it is not possible to combine the reading of data received by the main program and reading of data received by the interrupt program.
Accordingly, use one or the other of the above programs to read the data received.

(2) The SPBUSY instruction is used to read the execution status when using a dedicated instruction. (See Chapter 9.)

(3) More than one BIDIN instruction cannot be executed simultaneously.
Execute the next BIDIN instruction only after the execution of the first BIDIN instruction is completed.

(4) If the communication data count is set in byte units and the receive data count is an odd byte when requesting the reading of receive data to the PLC CPU, 00H is stored in the higher byte of the final data storage position in the receive data storage area.

7.1.4 How to detect reception errors

This section explains how to detect errors that may occur when receiving data from the external device.

The following items are considered as the primary causes of errors that may occur during data reception.

Cause of reception error	Reference section	
A transmission error occurred because of noise.	—	
A timeout occurred for the no-reception monitoring time (timer 0).	User's Manual (Application)	Section 6.1
A timeout occurred for the transmission monitoring time (timer 2)		Section 6.2
Data that could not be converted with the ASCII-BIN conversion was detected.		Chapter 13
Received the data length that was too long to store in the receiving area.	Section 7.1.2	
Simultaneous transmissions occurred.	Section 7.3	

(1) Confirmation using the sequence program

(a) Detecting the occurrence of a reception error

1) The following device and input signal turn ON.
   - BIDIN instruction complete device + 1
   - ERR LED ON signal (XE/XF)
2) The reception error code can be checked using the BIDIN instruction control data ((S1) + 1).
   Or, it can be checked by reading the data reception result storage area in the buffer memory (addresses 258H/268H).
   For details on how to check the error code contents and corrective actions, see Chapter 10.

(b) How to turn off the ERR LED and clear the error code (see Section 10.1.2)

1) To turn off only the ERR LED, write a "1" to the LED OFF request area (addresses 0H/1H) in the buffer memory.
2) To turn off the ERR LED and clear the error code, turn ON the ERR LED OFF request output signal (YE/YF).
   (Example) To perform the ERR LED OFF and the error code clear on the CH1 side

(2) Confirmation using the module and QSCU

1) Confirmation using the display LED
   When the Q series C24 detects an error, including a transmission error, the ERR LED lights up. (See Chapter 10.)
2) Confirmation using QSCU
   - The monitor function is used to check for errors. (See Sections 8.6.3 and 8.6.6.)
   - The ERR LED is turned off with the ERR LED OFF function. (See Section 8.6.10.)
3) Confirming the error code
   Use one of the following to confirm the error code.
   - QSCU monitor function (See Section 8.6.6.)
   - GX Developer buffer memory monitor function (monitors addresses 258H/268H)

(3) Handling of receive data when a reception error occurs

1) All of the receive data for which an error was detected is ignored and an response message indicating an abnormal completion (NAK message) is sent to the external device.
   ✻ When an error is detected during message reception, the Q series C24 does not issue a reception data read request to the PLC CPU.
2) The receive area in the buffer memory will contain the data received normally just prior to the error occurrence. (Data will not be rewritten.)

7.1.5 Receive data clear

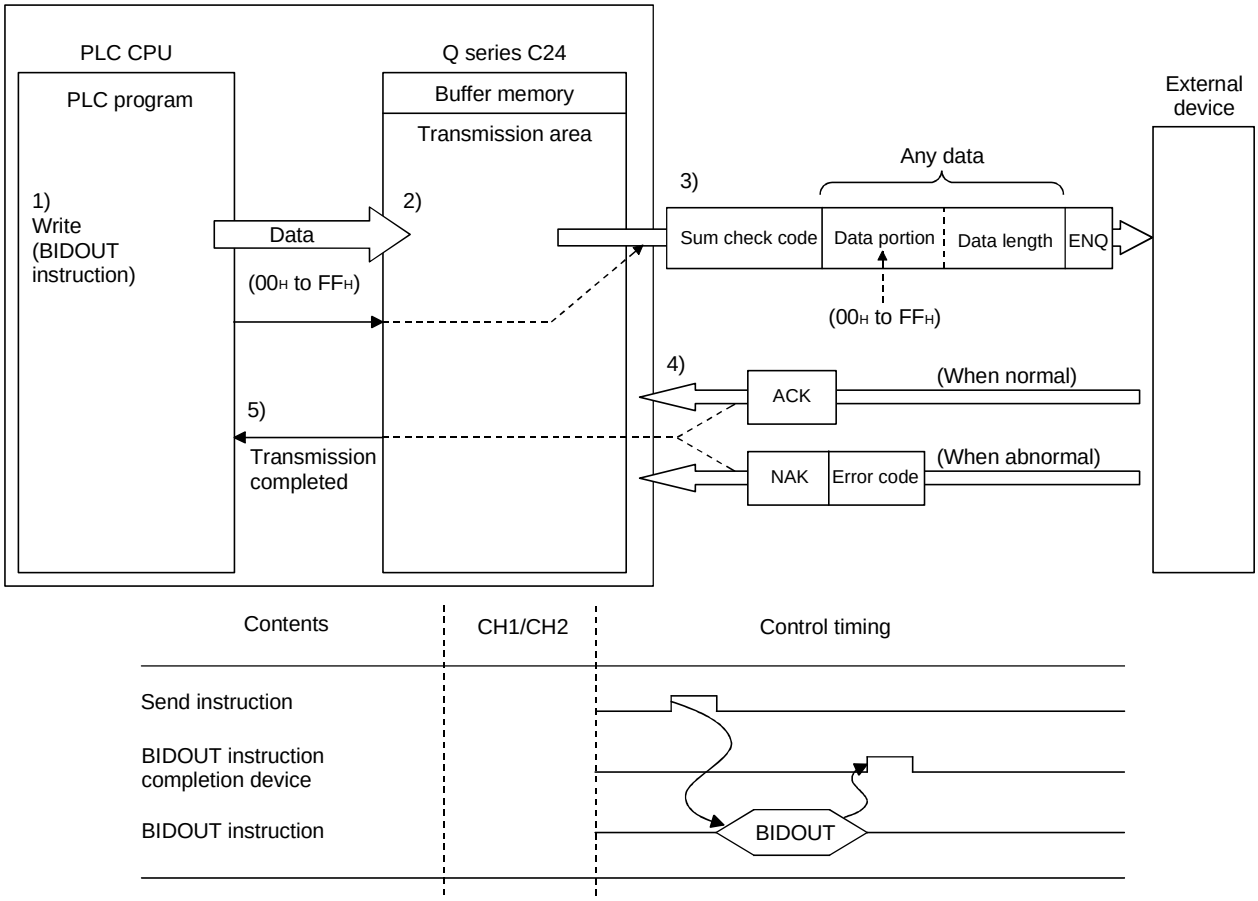
Data communications using the bidirectional protocol must be performed after a response message is received in reply to the preceding data transmission.
If the Q series C24 detects an error while receiving data, it sends an NAK message (response message) to the external device after the data reception completion and ignores the data being received when the error was detected.
Therefore, the receive data does not have to be cleared.

7.2 Sending Data to the External Device

This section explains data transmission from the PLC CPU to the external device.

7.2.1 Transmission methods

The following shows the method of sending data to the external device through data communication using the bidirectional protocol.



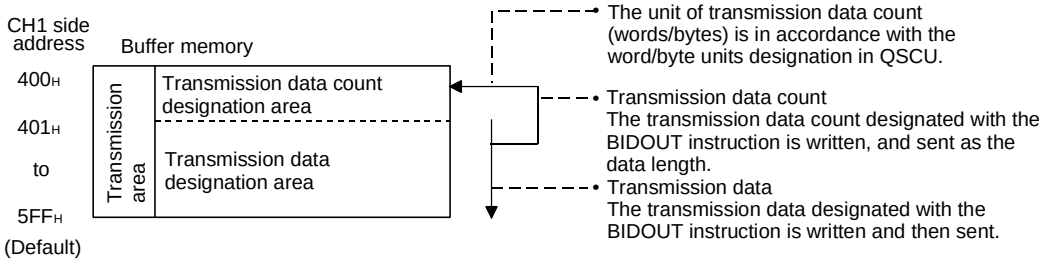
1) Data such as control data and transmission data are stored in the device designated with the BIDOUT instruction and then the BIDOUT instruction is executed.
2) The transmission data count and transmission data are written into the transmission area of the buffer memory.
3) The Q series C24 sends data by adding the control code ENQ at the beginning of the data.
   ＊ When "Sum check" is designated with GX Developer, the Q series C24 adds the sum check code calculated by internal processing to the end of the message and then transmits the message.
   When "No sum check" is designated with GX Developer, no sum check code is sent.
4) A response for the data transmission (for normal completion: ACK message; for abnormal completion: NAK message) is received.
5) The execution of the BIDOUT instruction completes with the transmission processing completion of the Q series C24.

7.2.2 Arrangement and contents of the transmission area and the transmission data

This section explains the arrangement and contents of the transmission area and the transmission data for performing data transmission using the bidirectional protocol. For details on the contents of transmission data, see Section 7.1.2 (3).

(1) Transmission area

The transmission area is a memory area for storing the data and the data count that are transmitted from the PLC CPU to the external device via the Q series C24. By default, the transmission area is assigned to addresses 400H to 5FFH (CH1 side) and 800H to 9FFH (CH2 side).



POINT

(1) The position and size of the transmission area in the buffer memory can be changed with QSCU in accordance with the specifications of the external device and the transmission data length. (See Section 8.4.5.)

(a) When changing the position and size of the transmission area in the buffer memory with QSCU, designate as follows:

1) Transmission buffer memory head address designation
Designate the starting address for the area to be used as the transmission area in the user definable area of the buffer memory.
2) Transmission buffer memory length designation
Designate by addresses the length of the area to be used as the transmission area in the user definable area of the buffer memory.

(b) If the following functions are also used when the position and size of the transmission area in the buffer memory are changed, make sure that the addresses of the transmission area do not overlap with those for the buffer memory that stores the transmission and receive data to be used by these functions.

1) MC protocol buffer memory read/write function
2) MC protocol on-demand function
3) Non procedure protocol transmission/receive function
4) Bidirectional protocol transmission/receive function

(2) Set the size of data per data transmission from the PLC CPU to the external device to be smaller than the size of the transmission data designation area in the buffer memory.

(Transmission data designation area) ≧ (Size of data portion to be sent from the PLC CPU)

To transmit data whose size is larger than the transmission data designation area, increase the transmission area, or divide the transmission data before sending.

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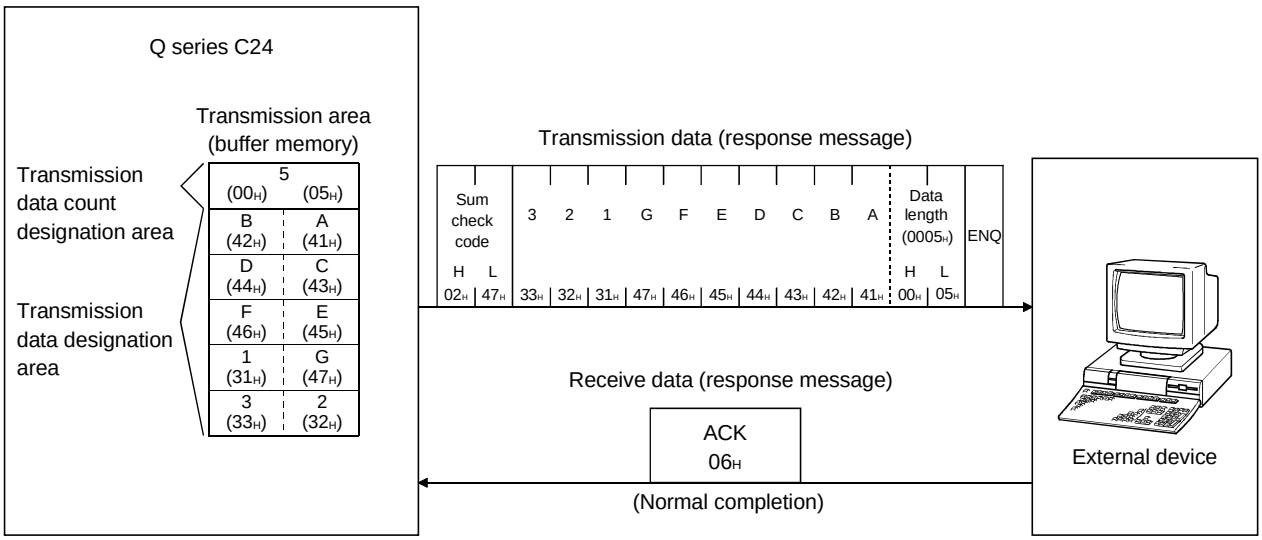
(2) Transmission data arrangement

The following example shows an arrangement of the transmission data to be sent to the external device when storing it in the transmission area.

(Example) When "ABCDEFG123" is sent:



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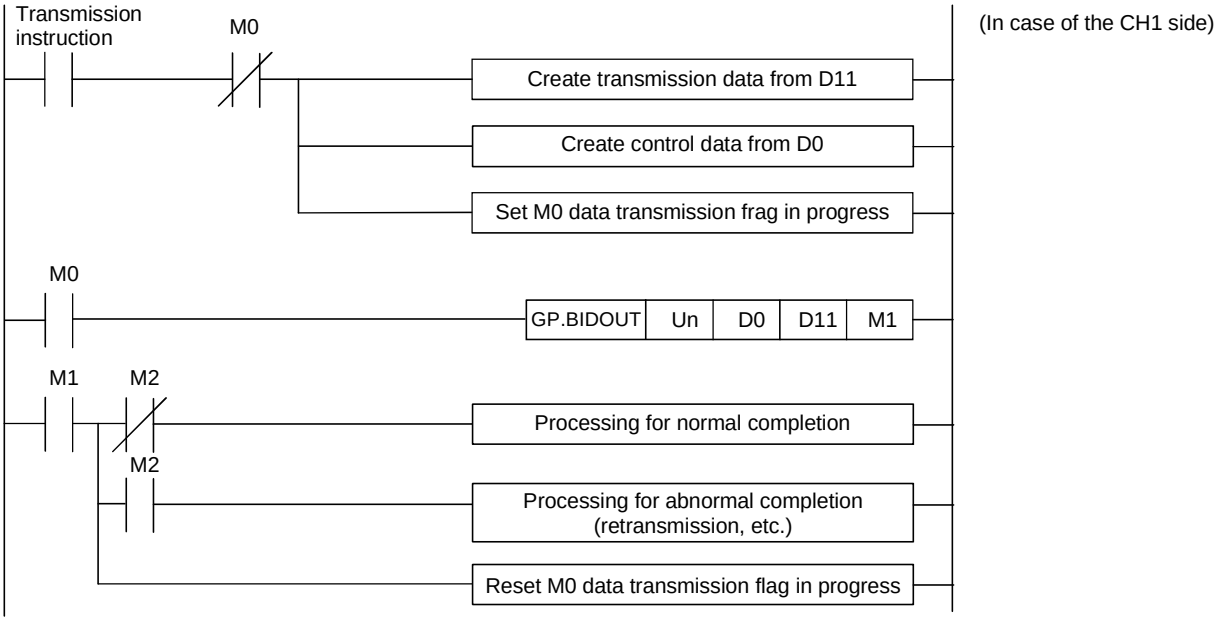
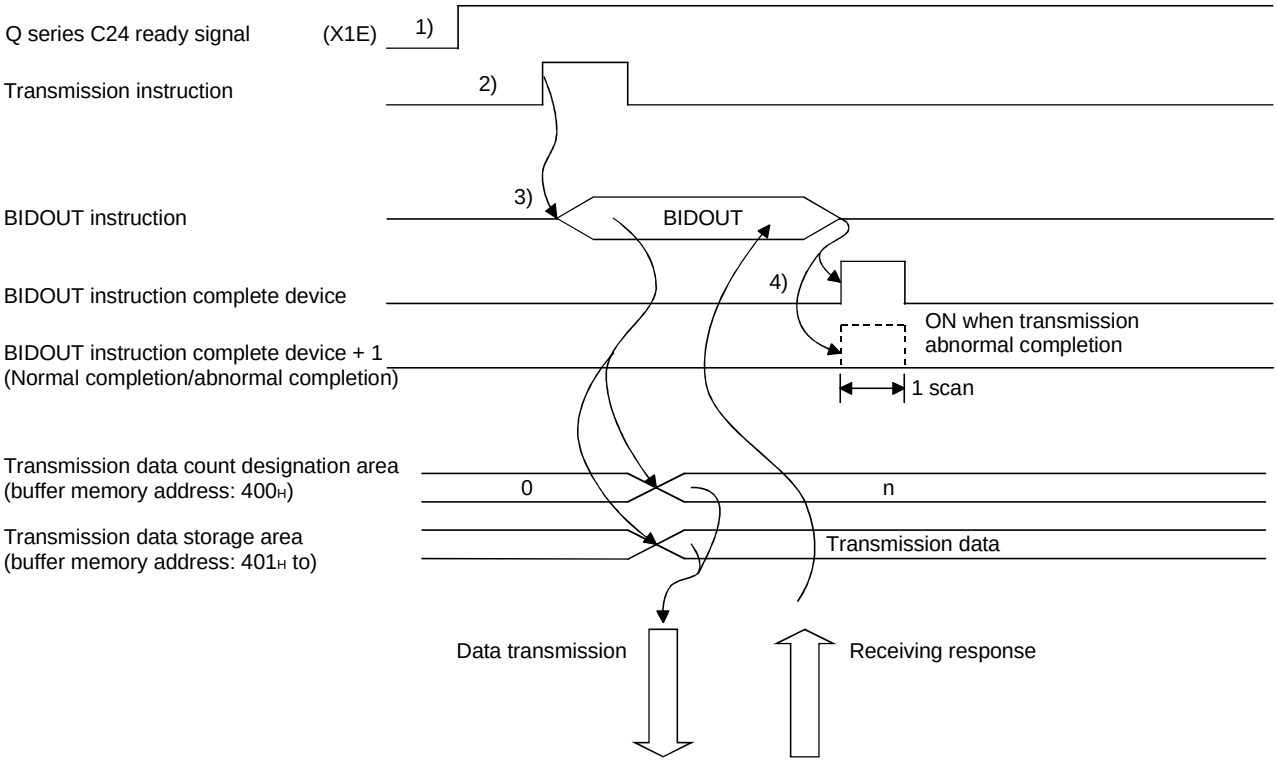
7.2.3 Sequence program for data transmission

A sequence program for data transmission is explained below.
For details on the BIDOUT instruction for data transmission, see Chapter 9.





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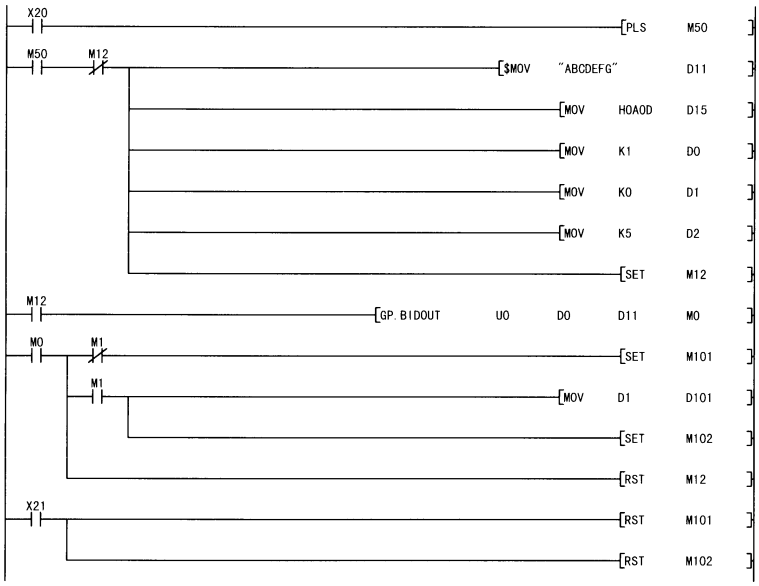
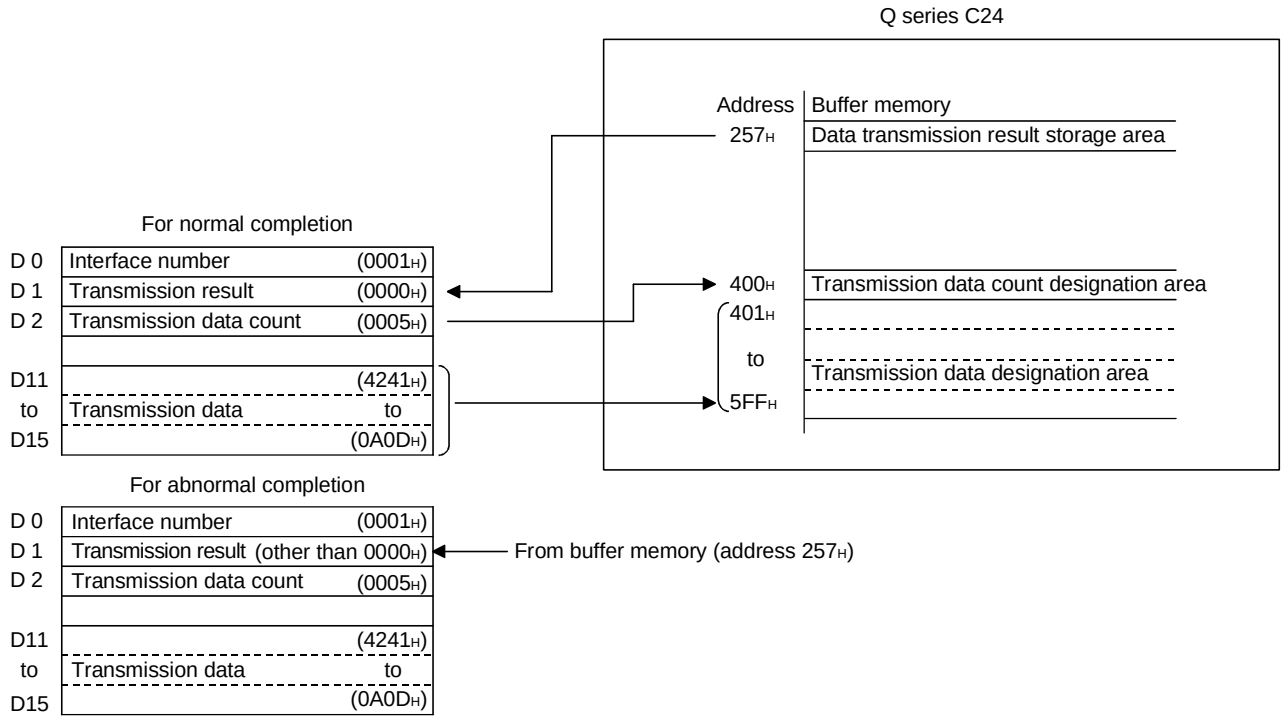
1) Starts the local station PLC.
   The setting values for GX Developer are stored in the Q series C24.
2) Inputs the user data transmission instruction signal.
3) Executes the BIDOUT instruction after storing the transmission data and the control data for the BIDOUT instruction in the device.
   Data is sent when the BIDOUT instruction is executed.
4) A response message for the data transmission (for normal completion: ACK message; for abnormal completion: NAK message) is received.
5) When the response is received, the Q series C24 transmission processing completes and the device that has completed the BIDOUT instruction turns ON.
   When the BIDOUT instruction ends abnormally due to the reception of an NAK message, the complete device +1 (abnormal completion signal) turns ON and the error code is stored in the control data completion status (S1+1).

(Program example)
When Q series C24 I/O signals are from X/Y00 to X/Y1F:





POINT
(1) The SPBUSY instruction is used to read the execution status when using a dedicated instruction. (See Chapter 9.)
(2) More than one BIDOUT instruction cannot be executed simultaneously. Execute the next BIDOUT instruction only after the execution of the first BIDOUT instruction is completed.

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7.2.4 How to detect transmission errors

This section explains how to detect errors that may occur when sending data to the external device.

The following items are considered as the primary causes of errors that may occur during data transmission.

Cause of transmission error	Reference section	
A transmission error occurred because of noise.	—	
A timeout occurred for the no-reception monitoring time (timer 0).	User's Manual (Application)	Section 6.1
A timeout occurred for the response monitoring time (timer 1).		Section 6.2
A timeout occurred for the transmission monitoring time (timer 2)		Section 6.3
Data that could not be converted with the ASCII-BIN conversion was detected.		Chapter 13
Designated the transmission data count that exceeded the transmission area size.	Section 7.2.2	
Simultaneous transmissions occurred.	Section 7.3	

(1) Confirmation using the sequence program

(a) Detecting a transmission error

1) The following device and input signal turn ON.
   - BIDOUT instruction complete device + 1
   - ERR LED ON signal (XE/XF)
2) The transmission error code can be checked using the BIDOUT instruction control data ((S1) + 1).
   Or, it can be checked by reading the data transmission result storage area in the buffer memory (addresses 257H/267H).
   For details on how to check the error code contents and corrective actions, see Chapter 10.

(b) How to turn off the ERR LED and clear the error code (see Section 10.1.2)

1) To turn off only the ERR LED, write a "1" to the LED OFF request area (addresses 0H/1H) in the buffer memory.
2) To turn off the ERR LED and clear the error code, turn ON the ERR LED OFF request output signal (YE/YF).
   (Example) To perform the ERR LED OFF and the error code clear on the CH1 side:

(2) Confirmation using the module and QSCU

1) Confirmation using the display LED
   When the Q series C24 detects an error, including a reception error, the ERR LED lights up. (See Chapter 10.)
2) Confirmation using QSCU
   - The monitor function is used to check for errors. (See Sections 8.6.3 and 8.6.6.)
   - The ERR LED is turned off with the ERR LED OFF function. (See Section 8.6.10.)
3) Confirming the error code
   Use one of the following to confirm the error code.
   - QSCU monitor function (See Section 8.6.6.)
   - GX Developer buffer memory monitor function (monitors addresses 257H/267H)

7.3 Processing when Simultaneous Transmission Performed During Full-Duplex Communications

This section explains the processing when simultaneous transmissions occur in full-duplex communication.

7.3.1 Processing when simultaneous transmissions occur

This section explains the processing performed by the Q series C24 when the external device and the Q series C24 transmit at the same time during data communications using the bidirectional protocol.
Since the external device and the Q series C24 do not transmit at the same time during half-duplex communications (see User's Manual (Application) Chapter 8), this section does not have to be read.

When an external device and the Q series C24 transmit at the same time, the Q series C24 processing depends on the setting of "Simultaneous transmission data valid/invalid designation" with QSCU.

* The QSCU setting value, "Simultaneous transmission data valid/invalid designation" is stored in the following areas of the buffer memory.
  Simultaneous transmission data valid/invalid designation area (addresses: $9B_H$/$13B_H$)
  The Q series C24 communication data processing for each setting is described in Section 7.3.2.

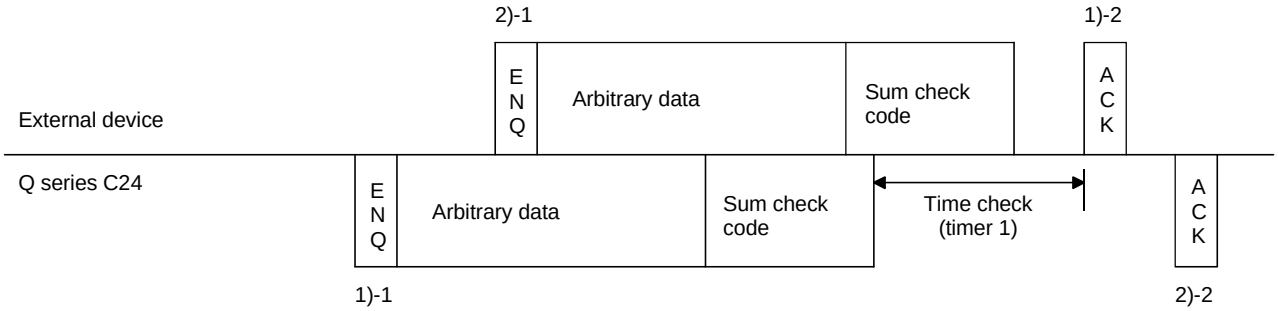
Setting contents with QSCU	Value set to buffer memory (Address $9B_H$/$13B_H$)	Q series C24 processing contents	
		Message transmit processing	Message receive processing
Transmission data: Valid Receive data: Valid	0000_H	Waits to receive the response message (1)-2) while checking time-out after data transmission (1)-1) is complete. Posts normal end or abnormal end according to whether or not the PLC CPU received a response message through the buffer memory.	Transmits a response message (2)-2) after data reception (2)-1) is complete. Posts the receive data and receive result to the PLC CPU through the buffer memory.
Transmission data: Invalid Receive data: Valid	0100_H	Posts a simultaneous transmission error to the PLC CPU through the buffer memory after data transmission (1)-1). Does not wait for a response massage (1)-2) in reply to data transmission (1)-1).	Transmits a response message (2)-2) after data reception (2)-1) is complete. Posts the receive data and receive result to the PLC CPU through the buffer memory.
Transmission data: Valid Receive data: Invalid	0001_H	Waits to receive the response message (1)-2) while checking time-out after data transmission (1)-1) is complete. Posts normal end or abnormal end according to whether or not the PLC CPU received a response message through the buffer memory.	Ignores data reception (2)-1) and discards the received data. Does not transmit a response message (2)-2). Does not inform the PLC CPU that data was received.
Transmission data: Invalid Receive data: Invalid	0101_H	Posts a simultaneous transmission error to the PLC CPU through the buffer memory after data transmission (1)-1). Does not wait to a response massage (1)-2) in reply to data transmission (1)-1).	Ignored data reception (2)-1) and discards the receive data. Does not transmit a response message (2)-2). Does not inform the PLC CPU that data was received.

( )-m) is the number showing the correspondence with the messages in the illustration shown in Section 7.3.2.

7.3.2 Communication data processing when simultaneous transmissions occur

Examples of the Q series C24 communication data processing for various settings of "Simultaneous transmission data valid/invalid designation" by QSCU are explained.

(1) Transmission: valid, reception: valid

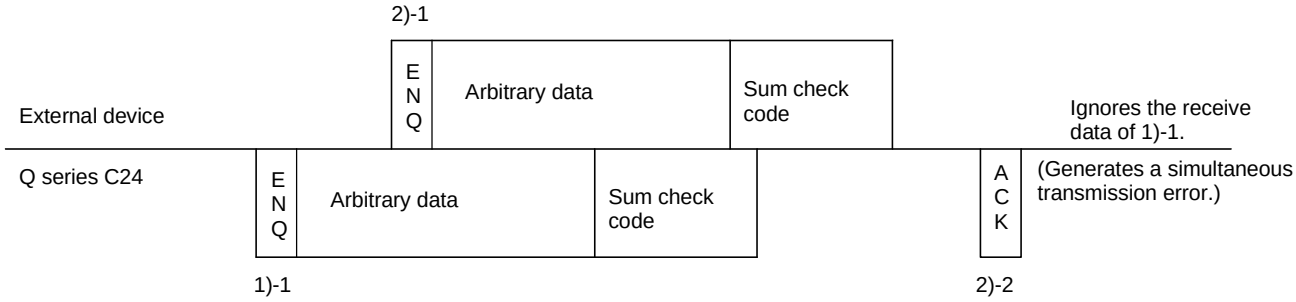


POINT

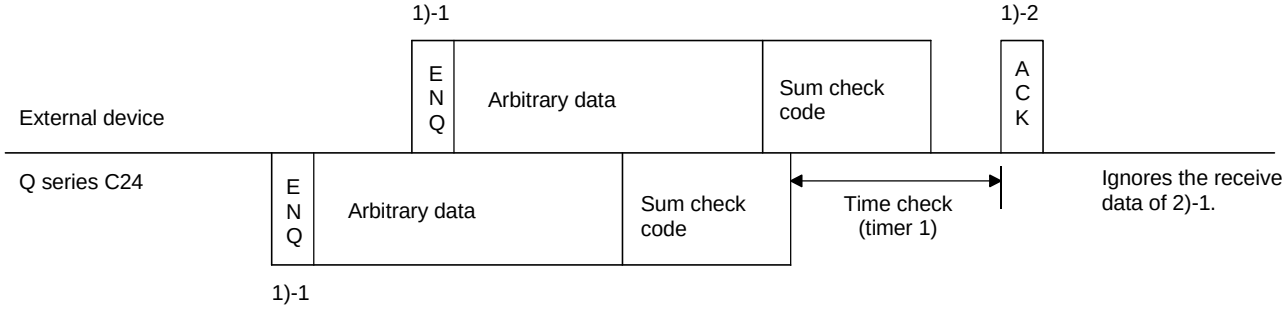
When the entire message of 2)-1 was received while transmitting the message of 1)-1 in the illustration.

- The Q series C24 outputs the receive data read request signal of 2)-1 to the PLC CPU after transmitting all 1)-1. (Turns on the X3/XA.)

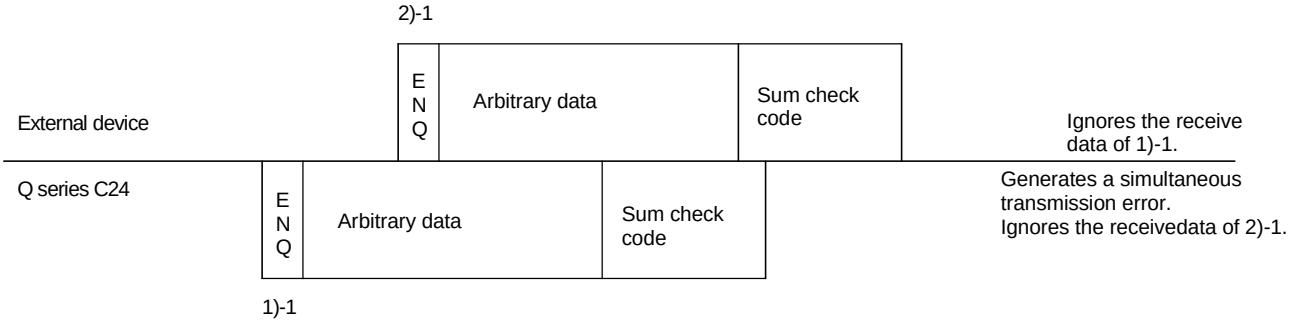
(2) Transmission: invalid, reception: valid



(3) Transmission: valid, reception: invalid



(4) Transmission: invalid, reception: invalid



REMARK

Time-check timer 1 (response monitoring time) shown in the illustration is described in Section 6.2 of User's Manual (Application).

POINT

When the transmission control (see Chapter 9 of User's Manual (Application)) is performed, and the simultaneous transmission data valid/invalid designation sets that the receive data is valid and transmission data is valid, the Q series C24 performs message transmission and message reception processing as described below.

During message transmission processing, time check by timer 1 (response monitoring time) is performed.

1) Message transmission (1)-1 in the illustration)
   - If the Q series C24 receives a terminate transmission request (DC3 received/DSR signal OFF) from the external device during message transmission, it terminates data transmission.
   - When the Q series C24 receives the ready to send signal (DC1 received/DSR signal ON), it restarts data transmission.
2) Message reception
   - If the Q series C24 cannot send a response message to the external device in response to message reception because the external device issued a terminate transmission request (DC3 received/DSR signal OFF), it transmits the response message after it receives the ready to send signal (DC1 received/DSR signal ON) from the external device.

7.4 Data Communications Precautions

The following shows the precautions when performing data communications using the bidirectional protocol.

(1) When the transmission sequence is in the initial status, it indicates that data transmission and reception processing has not been started.
The Q series C24 transmission sequence is initialized in the following cases.
- The power is turned on, the CPU is reset.
- When operating, or the mode is switched.
- When a response message (ACK, NAK, etc.) was received in reply to data transmission.
- When a response message (ACK, NAK, etc.) was transmitted in reply to data reception.
- When the CD signal was turned off during data communications using Check CD terminal in full-duplex communications through the RS-232 interface.

(2) As a data transmission procedure, data transmission from the external device or the Q series C24 should be performed after an response for the immediately preceding data transmission has been received.

(3) The external device and PLC CPU must agree so that the units of the data length (word count/byte count) in the message to be transmitted and received is the same.
The PLC CPU units can be set using the QSCU word/byte units designation.
Make the length of the data area in the message to be transmitted and received the size of the Q series C24 buffer memory transmission data designation area and receive data storage area, or less.

(4) NAK code response
1) Response from the Q series C24 to external device
After the error detection message reception complete, it transmits the NAK code to the external device.
2) Response from external device to the Q series C24
Transmit the error code (22_H to $5F_H$) immediately after the NAK response.

POINT

(1) Perform error processing according to the error code received immediately after the NAK message at the device that received NAK as the response message after data transmission.
Chapter 10 shows the error codes that are transmitted from the Q series C24.

(2) If the Q series C24 receives an NAK response while transmitting data to an external device, it completes data transmission, then reads the NAK, perform abnormal completion.

(3) If the Q series C24 detects an error while receiving data, it ignores the receive data corresponding to the data length.
If the data length is abnormal, the Q series C24 ignores all the data up to the receive message head data (ENQ, etc.) received thereafter.

(5) External device time-out check

When checking time-out up to reception of the response message at the external device during data transmission from external device to the Q series C24, make the time-out time the time shown below, or longer.

(PLC CPU maximum scan time × 2) + 100 ms

(6) External device framing error

When nothing is transmitted from the Q series C24 to the external device though the RS-422 or RS-422/485 interface, a framing error may be generated in the external device.

Make the external device skip the data up to transmission of the head data (ENQ, NAK, etc.) of the message from the Q series C24.

Before communicating data through the RS-422/485 interface, check Q series C24 specifications given in Section 3.3.

(7) Data bit settings

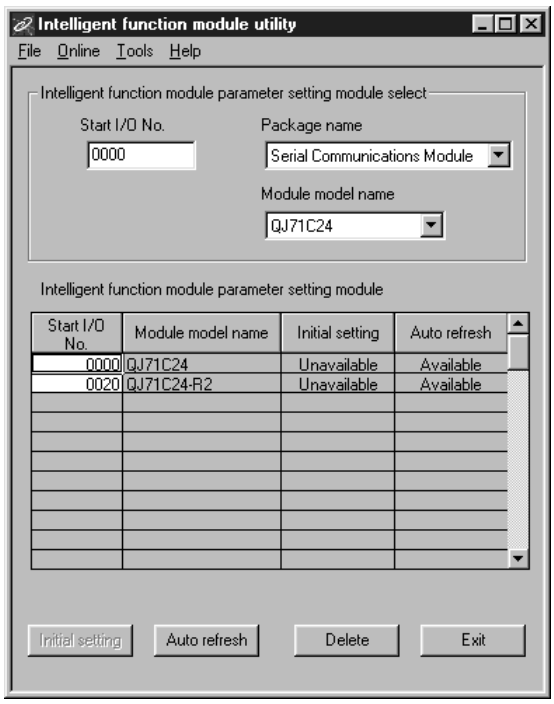
When adding a sum check code to a message, set the data bits to 8 bits using the transmission setting of the GX Developer.

For more details on the data bit settings, see Section 4.5.

8 UTILITY PACKAGE (SW0D5C-QSCU-E)

The utility package for the Q series C24 (hereinafter referred to as "QSCU") have been designed to facilitate user-friendly the Q series C24 operations such as initial settings and monitoring using the dedicated screens, so that the user is free from any concerns for the I/O signals and buffer memory.

The utility package can also be used together with the GX Simulator (SWnD5□-LLT-E).



8.1 Functions Available with Utility Package

The following table lists the utility package function.
(○ : indicates that the setting is valid with the applicable protocol.)

Function			MC	Non procedure protocol	Bidirectional protocol	Explanation page	Remarks
Auto refresh setting		Refresh the Q series C24's error codes and set devices on the PLC CPU side.	○	○	○	Section 4.6	Can be used via online operation. Can be used via offline operation.
User frame		Register the user frame in the flash ROM.	○	○	—	Section 8.4.1	
Data for modem initialization		Register the data for modem initialization in the flash ROM.	○	○	○	Section 8.4.2	
Data for modem connection		Register the data for model connection in the flash ROM.	○	○	○	Section 8.4.3	
Modem function system setting		Register the system setting values for model function in the flash ROM.	○	○	○	Section 8.4.4	
System setting	CHn Transmission control and others system setting	Set the transmission specifications with the other device. DTR/DSR control, DC code control, communication method, data communication monitoring timer value, etc.	○	○	○	Section 8.4.5	
	CHn MC protocol system setting	Assign the buffer memory for on-demand function, set the user frame number, etc.	○	—	—	Section 8.4.6	
	CHn Non procedure system setting	Assign the buffer memory needed to perform data communication using the non procedure protocol, and change the setting values, etc.	—	○	—	Section 8.4.7	
	CHn Bidirectional system setting	Assign the buffer memory needed to perform data communication using the bidirectional protocol, and change the setting values, etc.	—	—	○	Section 8.4.8	
	CHn PLC CPU monitoring system setting	Set the PLC CPU monitoring function.	○	○	—	Section 8.4.9	
	CHn Transmission user frame No. designation system setting	Set the user frame number to be transmitted, etc.	—	○	—	Section 8.4.10	
System setting default		Reset the setting values in the buffer memory to their default values.	○	○	○	Section 8.4.11	Can be used only via online operation.
System setting write		Write the setting values in the buffer memory to the flash ROM.	○	○	○	Section 8.4.11	
Flash ROM write allow/prohibit designation		Set whether to allow or prohibit writing to the flash ROM.	—	—	—	Section 8.4.12	
X · Y monitor/test		Perform the monitoring/testing of I/O signals to/from the PLC CPU.	○	○	○	Section 8.6.1	
Modem function monitor/test		Monitor the execution status of the modem function.	○	○	○	Section 8.6.2	
Monitor	CHn Transmission control and others monitor	Monitor the status of interface control signals, values set from the GX Developer, etc.	○	○	○	Section 8.6.3	
	CHn MC protocol monitor	Monitor the data communication result, I/O signal status, and setting values in the buffer memory.	○	—	—	Section 8.6.4	
	CHn Non procedure monitor/test		—	○	—	Section 8.6.5	
	CHn Bidirectional monitor		—	—	○	Section 8.6.6	
	CHn PLC CPU monitoring monitor	Monitor the setting values and operating status of the PLC CPU monitoring function.	○	○	—	Section 8.6.7	
	CHn User frame No. designation monitor for transmission	Monitor the setting value for user frame to be transmitted.	○	○	—	Section8.6.8	
Monitor others		Monitor the data reception result, error occurrence status, etc.	○	○	○	Section 8.6.9	
ERR LED off		Turn off the ERR LEDs on the front face of the module.	○	○	○	Section 8.6.10	
Non procedure protocol receive data clear		Clear the currently received data.	—	○	—	Section 8.7	

8 - 2

8.2 Installing and Uninstalling Utility Package

For installing and uninstalling utility package, see the GX Developer Operating Manual (Startup).

8.2.1 Usage precautions

The following describes the precautions on using the utility package:

(1) Important safety information

Since the utility package is add-in software for GX Developer, read "Safety Precautions" and the basic operating procedures contained in GX Developer's Operating Manual.

(2) About installation

The SW0D5C-QSCU-E is an add-in package for SW4D5C-GPPW-E (V) or later versions.

Therefore, install SW0D5C-QSCU-E in a peripheral device in which SW4D5C-GPPW-E (V) or a later version has been installed.

(3) About the license key floppy disk

(a) The license key floppy disk is necessary to install and uninstall the SW0D5C-QSCU-E software.
Installation and uninstallation is impossible without the license key floppy disk.

(b) Use the license key floppy disk that was purchased along with the software as it is (a copy of the license key floppy disk cannot be used).

(c) Store the license key floppy disk carefully.

POINT

Do not perform any of the following operations on the license floppy disk.

* The license key floppy disk will be rendered useless if any of the following happens.
  - Formatting the floppy disk.
  - Writing a file to the floppy disk.
  - Copying a file in the floppy disk (copying to another drive, copying from another drive)
  - Deleting, changing names, and changing attributes of any of the files in the floppy disk.
  - Running an analysis tool (e.g. SCANDISK) on the floppy disk.

(4) About display screen errors while using the intelligent function module utility

There may be cases in which the screen will not properly display while the intelligent function module utility is being used, due to a lack of system resources. If this occurs, close the intelligent function module utility first and then GX Developer (program, comments, etc.) and other applications. Then, restart GX Developer and the intelligent function module utility.

(5) To start the intelligent function module utility

(a) In GX Developer, select "QCPU (Q mode)" for the PLC series and specify the project.
If anything other than "QCPU (Q mode)" is selected for the PLC series, or if the project is not specified, the intelligent function module utility will not start.

(b) Multiple intelligent function module utilities can be started.
However, the [Open file]/[Save file] intelligent function module's parameter operations can only be performed by a single intelligent function module utility. Other intelligent function module utilities can perform the [Monitor/Test] operation only.

(6) How to change screens when two or more intelligent function module utilities are started

When two or more intelligent function module utility screens cannot be displayed side by side, use the task bar to change the intelligent function module utility screen so that it is displayed on top of other screens.

8.2.2 Operating environment

This section explains the operating environment of the SW0D5C-QSCU-E.

Item		Peripheral devices
Installation (Add-in) ＊1		Add-in to SW4D5-GPPW-E (English version) or later
CPU		Pentium 133 MHz or faster recommended
Memory		32 MB or more recommended
Free space	For installation (HD)	Minimum 3 MB
	For execution (Virtual memory)	Minimum 10 MB
Display		800 × 600 pixels or higher resolution
Operating system (OS)		Microsoft® Windows® 95 operating system (English version), Microsoft® Windows® 98 operating system (English version), Microsoft® Windows® NT Workstation 4.0 operating system (English version)

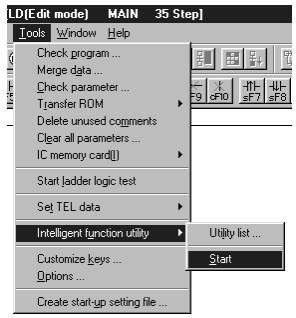
＊1: Please install SWnD5C-GPPW (n is 4 or greater) and SW0D5C-QSCU-E with a software package of the same language.
SWnD5C-GPPW (Japanese version) cannot be installed with SW0D5C-QSCU-E (English version), and SWnD5C-GPPW-E (English version) cannot be installed with SW0D5C-QSCU (Japanese version).

＊2: SW0D5C-QSCU-E cannot add-in to SW3D5C-GPPW-E and SW3D5F-GPPW or before.

8.3 Explanation of Utility Package Operation

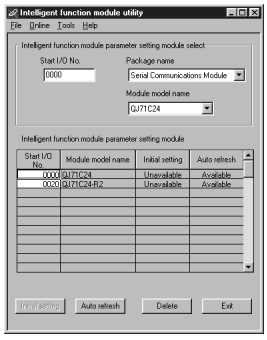
8.3.1 Operation overview

GX Developer screen



[Tools] – [Intelligent function utility] – [Start]

Intelligent Function Module
Select Parameter Setting Module screen



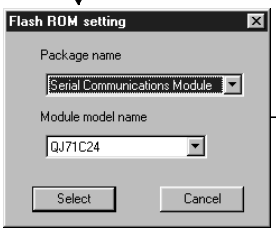
See Section 8.3.2

When used via online operation → 1) Go to next page

When auto refresh is set → 2) Go to next page

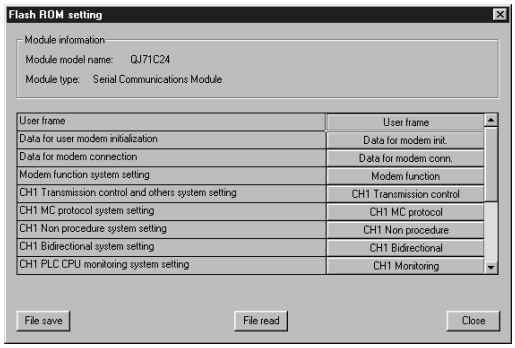
When used via offline operation

Select [Tools] – [Flash ROM stting] from the menu bar.



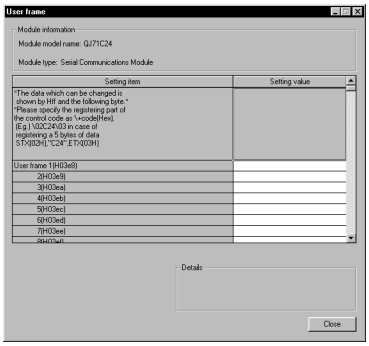
Select the package name and module model name.

Flash ROM settings screen



See Section 8.4

To each setting screen



See Sections 8.4.1 through 8.4.10

POINT

The following settings must be performed before starting the intelligent function module utility:

- Set the project using the GX Developer
- Set "QCPU (Q mode)" for the PC series.

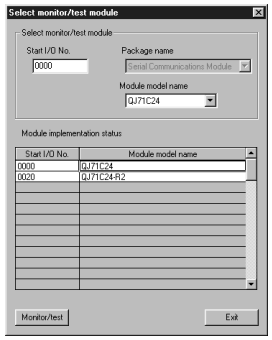
POINT

The various setting values to be registered in the Q series C24's flash ROM can be saved in a file of the PC via offline operation. Use online operation to write system setting values to the Q series C24.

1) When using online operation

Select [Online] – [Monitor/test] from the menu bar.

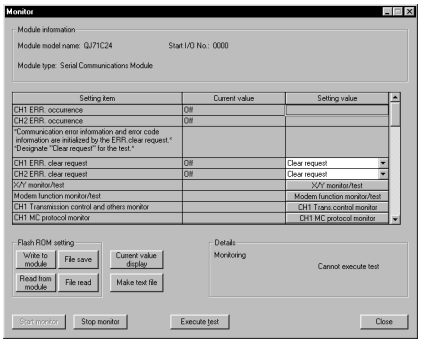
Select monitor/test module screen



Monitor/test

Select the parameter setting module for monitor/test.

Monitor/test screen



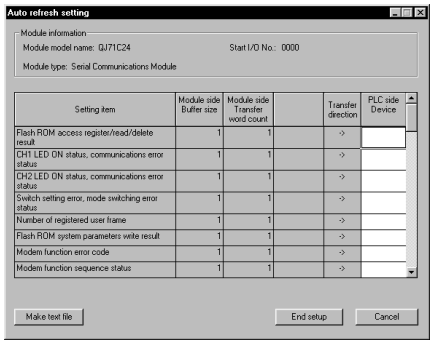
See Section 8.4
See Section 8.6

2) When setting auto refresh

Auto refresh

Enter "Start I/O No.," then select "Package name" and "Module model name."

Auto refresh screen



See Screen 4.6

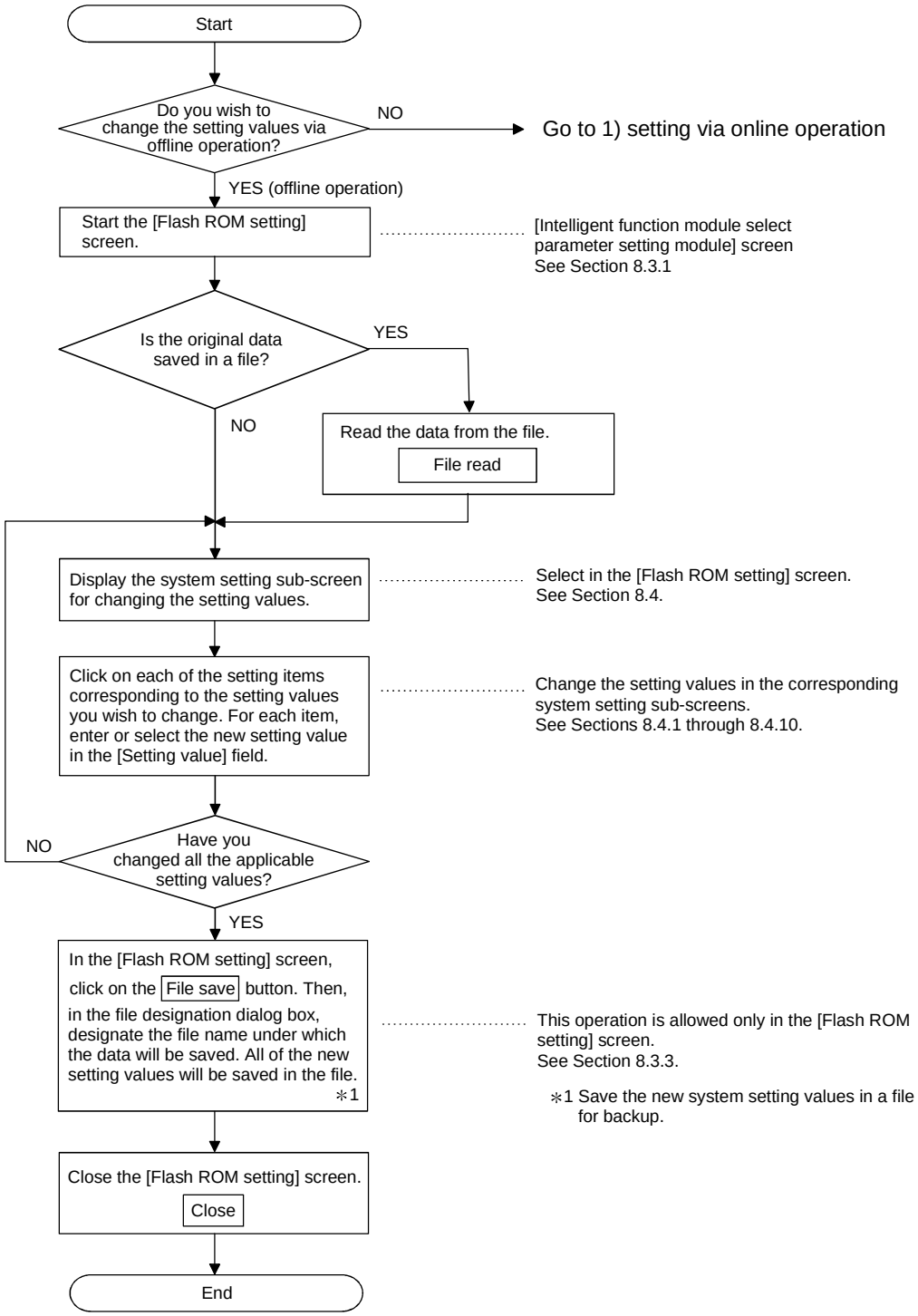
POINT

(1) When the setting operation is complete in each system setting screen, register the system setting data in the flash ROM, then restart the PLC CPU resume data transmission.

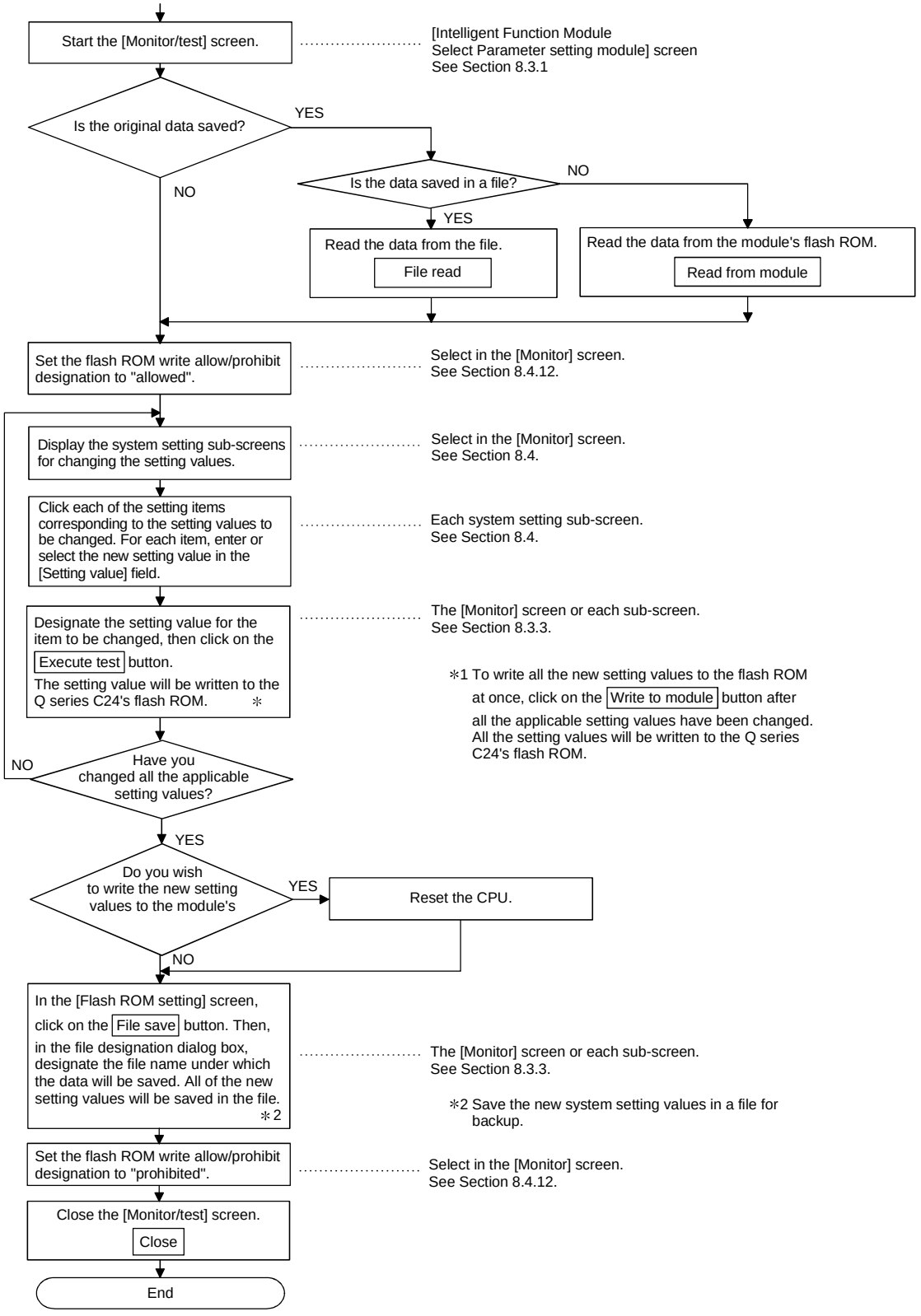
(2) With the Q series C24, monitoring, testing, and reading/writing of setting values can be performed via online operation.

REMARK

The following diagram illustrates the overview of a procedure in which the QSCU is used to change the system setting values of the Q series C24 and save the new values to a file or write them to the Q series C24's flash ROM.



1) (Online operation)



8.3.2 Starting the intelligent function module utility (displaying the [select parameter setting module] screen)

[Purpose]

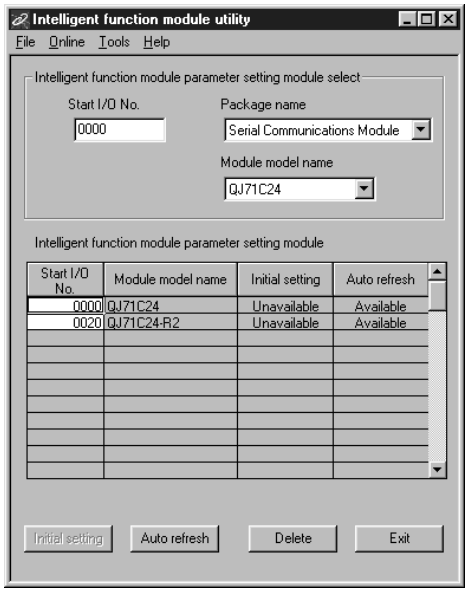
Start the intelligent function module utility from the GX Developer, and display the module selection screen for the intelligent function module utility parameter setting. The screens that perform system setting, auto refresh setting, and monitoring/testing for the Q series C24 can be started from this module selection screen.

POINT
To start the Intelligent function module utility, a project created with the GX Developer whose PLC series is set as "QCPU (Q mode)" is required.

[Startup procedure]

[Tools] → [Intelligent function module utility] → [Start]

[Setting screen]



- Start I/O No.
  Enter the start I/O number for the applicable the Q series C24 using a hexadecimal expression.
- Package name
  Select [Serial communication module].
- Module model name
  Select the module model name of the applicable the Q series C24.
- Intelligent function module parameter setting module
  The modules for which parameters are set with the intelligent function module utility are displayed.
  Select the target module of your operation.

* It is not necessary to select [Intelligent function module, select parameter setting module] to perform monitor/test operation.

[Explanation of items]

(1) How to start each screen

(a) Starting the flash ROM setting screen
[Tools] → [Flash ROM setting] → "Package name" → "Module model Name" → Select

(b) Starting auto refresh settings
"Start I/O No." → "Package name" → "Module model name" → Auto refresh

(c) Monitor/test module selection screen
[Online] → [Monitor/test] → "Module selection" → Monitor/test

(2) Command buttons

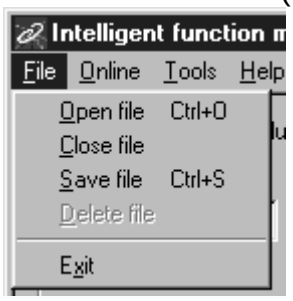
Initial settings : Cannot be selected.

Auto refresh : Starts the auto refresh setting screen.

Delete : Deletes the initial settings and auto refresh settings.

Exit : Closes the parameter setting module selection screen.

(3) Menu bar



(a) File items

The intelligent function module parameters (data for auto refresh) for the project opened by GX Developer can be processed in file operation.

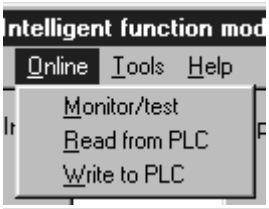
[Open file] : Reads the parameter file.

[Close file] : Closes the parameter file. If revisions are made, the dialog box asking whether to save the file appears.

[Save file] : Saves the parameter file.

[Delete file] : Deletes the parameter file.

[Exit] : Closes the parameter setting module selection screen.

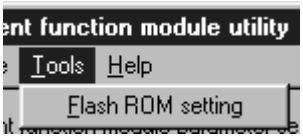


(b) Online items

[Monitor/test] : Starts the monitor/test module selection screen.

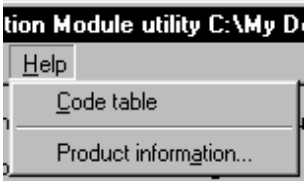
[Read from PLC] : Reads the intelligent function module parameters from the CPU module.

[Write to PLC] : Writes the intelligent function module parameters to the CPU module.



(c) Tool items

[Flash ROM setting] : Starts the flash ROM setting screen.



(d) Help items

[Code list] : Displays the ASCII code list. Use this list as reference when setting data.

[Product information] : Displays the version information of the intelligent function module utility.

POINT

(1) Saving the intelligent function module parameter files

Since files cannot be saved using the GX Developer project save operation, save the files on the module selection screen for parameter setting described above.

(2) Reading from and writing to PLC operations for the intelligent function module parameters using GX Developer

(a) After the intelligent function module parameters are saved in a file, they can be read from and written into the PLC.

(b) Set the target PLC using the GX Developer [Online] → [Transfer setup]. Only use the control PLC for the Q series C24 to write the intelligent function module parameters for a multiple PLC system to the PLC.

(c) Use the GX Developer for PLC reading or PLC writing the intelligent function module parameters at the remote I/O station. QSCU can not be used.

8.3.3 Performing common utility operations

This section explains how to perform the common operations in the data setting, auto refresh setting and monitor/test screens.

(1) Available Control Keys

The following table lists the special keys that can be used during operation of utility and their applications:

Name of key	Application
Esc	Cancels a newly entered value when entering data in a cell. Closes the window.
Tab	Moves between the controls in the window.
Ctrl	Used in conjunction with the mouse to select multiple cells in the selection test.
Delete	When a cell is selected, clears all set data.
Back space	Deletes the character where the cursor is positioned.
↑ ↓ ← →	Moves the cursor.
Page up	Moves the cursor one page up.
Page Down	Moves the cursor one page down.
Enter	Confirms the value entered in the cell.

(2) Operation Command Buttons

Current value display : Displays the current value of the selected item.

Make text file : Creates a text file (TXT format) under the specified file name and saves to it the contents currently displayed on the screen.

Start monitor : Starts monitoring of the current value field.

Stop monitor : Stops monitoring of the current value field.

Execute test : Registers the system setting data of the selected item in the flash ROM. ∗1

To apply Execute test to multiple items simultaneously, set the data for the corresponding items, select the multiple items while pressing down Ctrl, then click Execute test.

∗1 The settings for "receive data clear request" and "flash ROM write allow/prohibit designation" are written to the buffer memory.

Write to module : Registers all system setting data for the Q series C24 in the flash ROM.

Read from module : Reads all system setting data for the Q series C24 from the flash ROM.

File save	: Saves all system setting data for the Q series C24 to the designated file (extension: UMD).
File read	: Reads all system setting data for the Q series C24 from the designated file (extension: UMD).
Close	: Closes the currently displayed screen and returns to the previously displayed screen.
End setup	: Saves/writes the system setting data, closes the current screen, and returns to the previously displayed screen. * With offline operation, only [File save] and [File read] are enabled.

POINT

(1) When the setting operation is complete in each system setting screen, register the system setting data in the flash ROM, then restart the PLC CPU to resume data transmission.

(2) If two or more intelligent function module utility package are running, perform each operation after selecting the target utility package from the task bar and making it active.

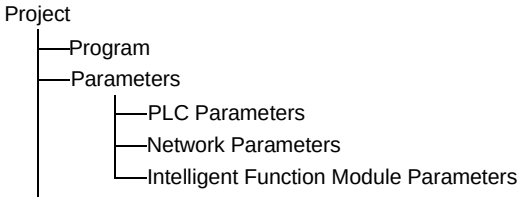
(3) When the menu screen for system registration to flash ROM (see Section 8.4) is closed, all the system setting data will be cleared. Before closing the screen, write the data to the module (enabled only via online operation) or save it to a file.

(3) Data/file to be created with utility package

The data and files shown below that are created with utility package are also used by GX Developer operation. Figure 8.1 shows an operation used to create data with utility package.

<Intelligent function module parameters>

(a) This data is created with the auto refresh settings, and stored in the intelligent function module parameter file of the project to be created using GX Developer.



(b) Steps 1) to 3) shown in Figure 8.1 are performed using the following operations.

1) Operating from GX Developer.
[Project] → [Open existing project] / [Save project] / [Save project as]
2) Operating from the utility parameter setting module selection screen.
[File] → [File read] / [File save]
3) Operating from the GX Developer.
[Online] → [Read from PLC / [Write to PLC] → "Intelligent function module parameters"
Or, operate from the utility parameter setting module selection screen.
[Online] → [Read from PLC] / [Write to PLC]

<Flash ROM data>

(a) The data set in [Flash ROM setting] can be saved in the desired directory separately from the GX Developer project.

(b) Operations 4) and 5) shown in Figure 8.1 are performed as follows:

4) This operation can be performed from the [Flash ROM setting] screen or [Monitor/test] screen.
[Flash ROM setting] screen → [File read]/[File save]
[Monitor/test] screen → [File read]/[File save]

5) This operation can be performed from the [Monitor/Test] screen of the utility.
[Monitor/test] screen → [Read from module]/[Write to module]

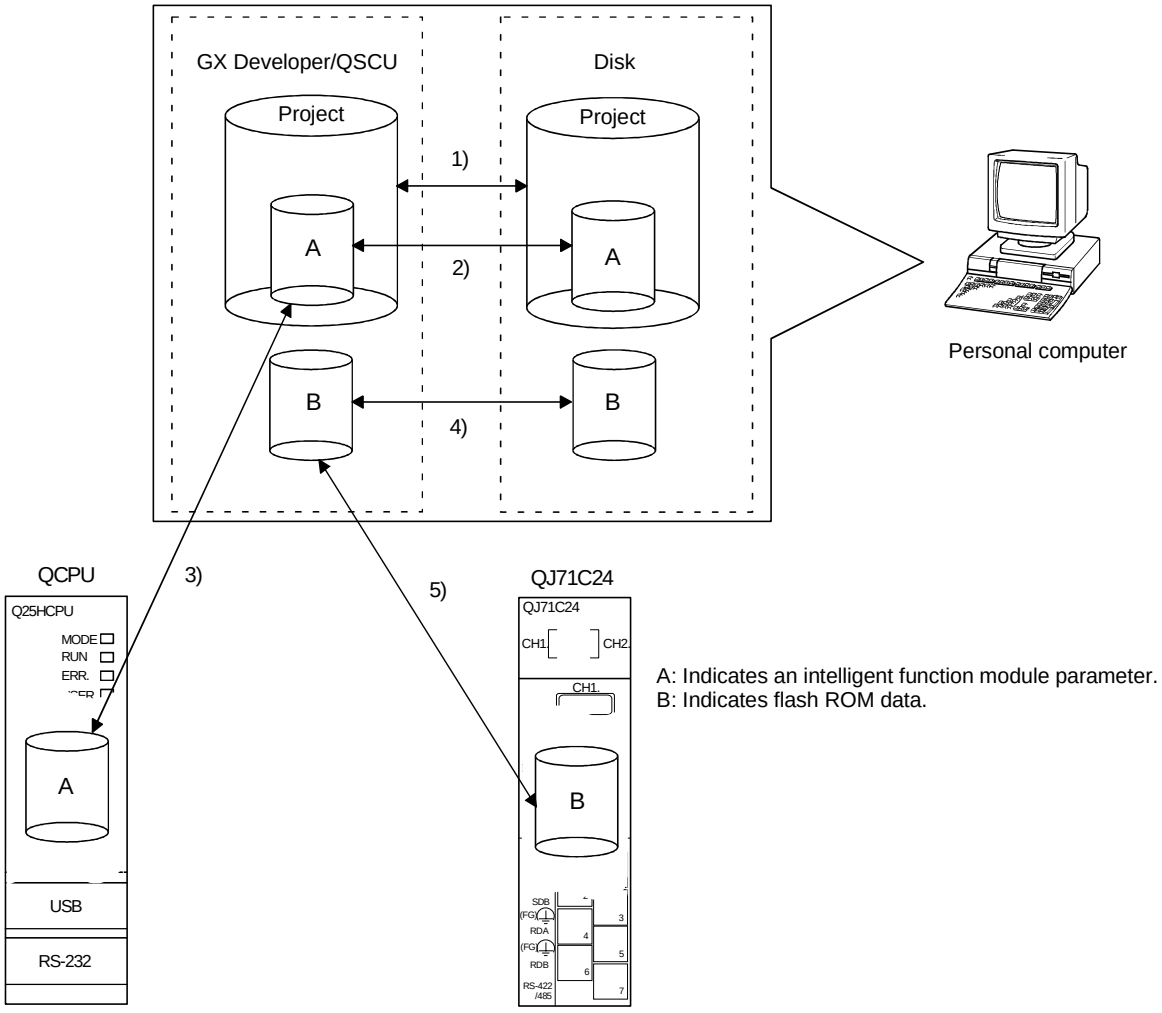


Figure 8.1 Correlation chart for data created by the utility package

8.4 System Registration to Flash ROM

[Purpose]

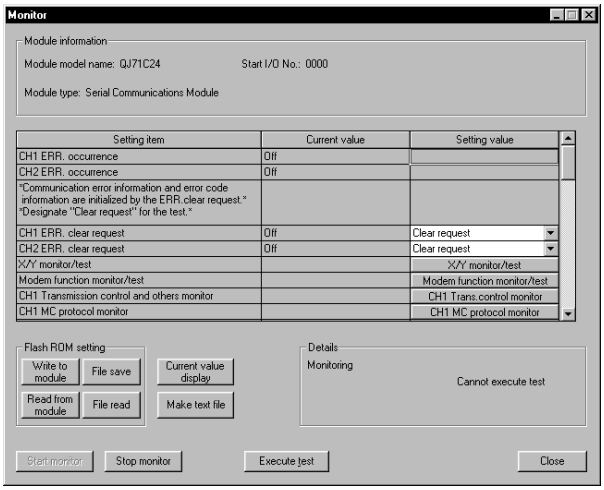
Display the menu screen for flash ROM registration, which is used to change the initial values set in the Q series C24's buffer memory.

[Startup procedure]

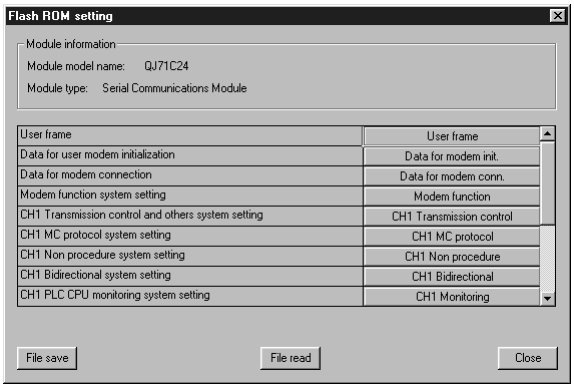
- Online operation
  - ∗ Startup from Intelligent function module utility
    (GX Developer (SW4D5C-GPPW-E or later))
    [Online] → [Monitor/test] → "Select monitor/test module" → Monitor/test → [Monitor] screen
  - ∗ Startup from the system monitor (GX Developer (SW6D5C-GPPW-E)).
    [GX Developer] → [Diagnostics] → [System Monitor] → "Select the Q series C24 by installation status" → Diagnostics... → [Monitor] screen
- Offline operation
  [Tools] → Flash ROM setting → [Flash ROM setting] screen

[Setting screen]

Screen displayed during online operation (∗1)



Screen displayed during offline operation



∗1 The selection menus for system setting/registration are displayed by scrolling on the [Monitor] screen during online operation.
The selection buttons pertaining to flash ROM registration are displayed in blue on the screen.

[Setting Items]

The following table shows the selection menus for system setting/registration to be displayed:

Function	Section	Remarks
User frame registration	Section 8.4.1	Can be used via online operation. Can be used via offline operation.
Data for modem initialization registration	Section 8.4.2	
Data for modem connection registration	Section 8.4.3	
Modem function system setting	Section 8.4.4	
Transmission control and others system setting	Section 8.4.5	
MC protocol system setting	Section 8.4.6	
Non procedure system setting	Section 8.4.7	
Bidirectional system setting	Section 8.4.8	
PLC CPU monitoring system setting	Section 8.4.9	
Transmission user frame No. designation system setting	Section 8.4.10	
Resetting buffer memory/flash ROM setting values to default values	Section 8.4.11	Can be used only via online operation.
Flash ROM write allow/prohibit setting	Section 8.4.12	

POINT

(1) The User's Manual (Basic) and QSCU's Help function provide the code list. Use this list as a reference.

(2) The values set in the respective setting screens explained in Section 8.4 can be written to the Q series C24 module (via online operation only) or saved to a file.

(3) Perform the following operations in advance to enable the registration of setting values in the flash ROM:
   (a) Switch setting using the GX Developer (see Section 4.5.2)
   Set "Setting change" under [Transmission settings] to "Enable" for both the CH1 and CH2 sides.
   (b) Setting using QSCU (see Section 8.4.12)
   Set the flash ROM write allow/prohibit designation to "Allowed".

(4) Some system setting screens have a pair of screens: one for CH1 and the other for CH2. Please note that the explanations given in Section 8.4.1 and thereafter apply to the online operations performed in the CH1 screens.
The setting items are the same between CH1 and CH2, but different buffer memory addresses are used to store the setting values. The respective addresses are indicated as follows where applicable.
(Left side: address for the CH1 side, right side: address for the CH2 side)

Setting item	Setting value storage buffer memory address	Reference section containing detailed explanation
DTR/DC control designation	93H/133H	Chapter 7 of User's Manual (Application)

(5) When a multiple PLC system is employed, QSCU should be connected to the control PLC of the Q series C24, and the system setting data register in the flash ROM.
It is not possible to set target PLC to multiple PLC setting of "Transfer setup" of GX Developer and register the system setting data in the flash ROM.

8.4.1 User frame registration

[Purpose]

Register the user frame used in the following functions:

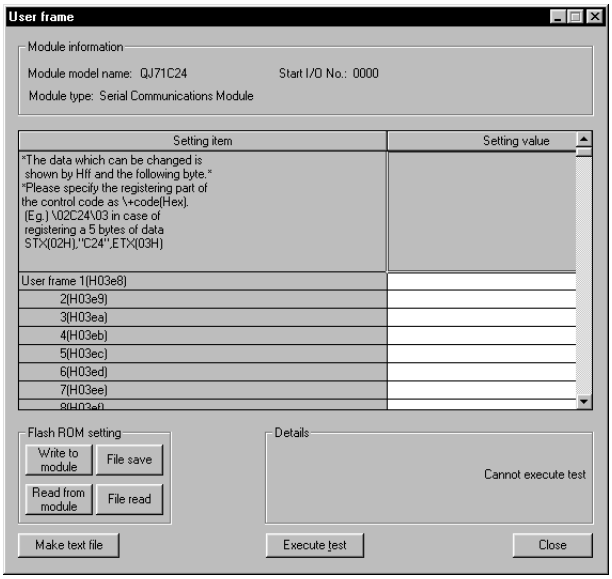
- On-demand function using the MC protocol.
- Data transmission/receive function using the non procedure protocol.

[Startup procedure]

- Online operation
  [Monitor] screen → User frame

- Offline operation
  [Flash ROM setting] screen → User frame

[Setting screen]



[Setting item]

Setting item	Setting value storage buffer memory address	Reference section containing detailed explanation
User frame 1 to 200	—	Chapter 9 of User's Manual (Application)

REMARK

Use \ + code to specify hexadecimal numbers in the control code registration field if QSCU is used for registering a user frame.

(Example) To register the 5 bytes of data, STX (02_H), "C24," and ETX (03_H), specify the following:
\02C24\03

8.4.2 Data for modem initialization registration

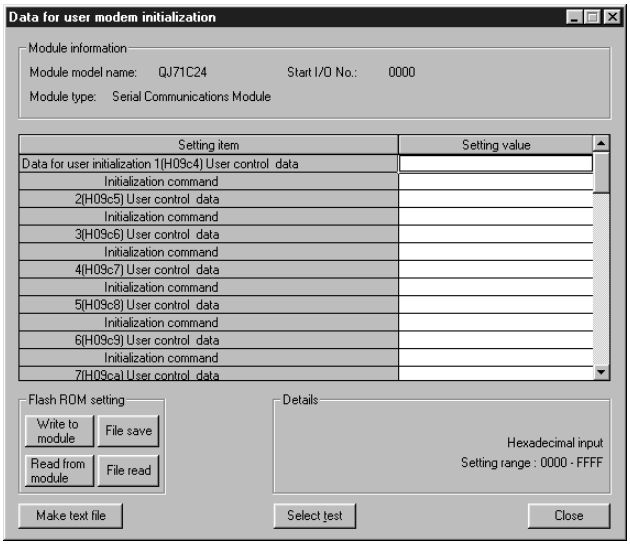
[Purpose]

Register the data for initializing the modem connected to the Q series C24.

[Startup procedure]

- Online operation
  [Monitor] screen → Data for user modem initialization
- Offline operation
  [Flash ROM setting] screen → Data for user modem initialization

[Setting screen]



[Setting item]

Setting item	Setting value storage buffer memory address	Reference section containing detailed explanation
Data for user initialization 1 to 30 User control data	—	Chapter 3 of User's Manual (Application)
Data for user initialization 1 to 30 Initialization command		

8.4.3 Data for modem connection registration

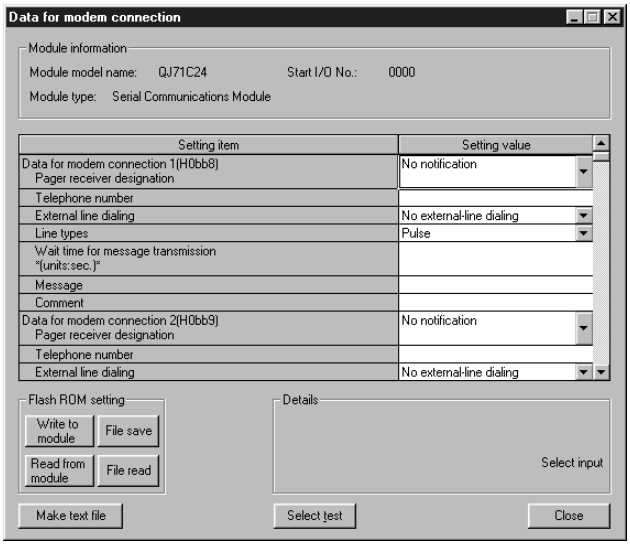
[Purpose]

For data communication and notification using the modem function, register the data for connection with external devices.

[Startup procedure]

- Online operation
  [Monitor] screen → Data for modem connection
- Offline operation
  [Flash ROM setting] screen → Data for modem connection

[Setting screen]



[Setting items]

Setting item		Setting value storage buffer memory address	Reference section containing detailed explanation
Data for modem connection 1 to 30	Pager receiver designation	—	Chapter 3 of User's Manual (Application)
	Telephone number		
	External line dialing		
	Line types		
	Wait time for message transmission units: s		
	Message		
	Comment		

8.4.4 Modem function system setting/registration

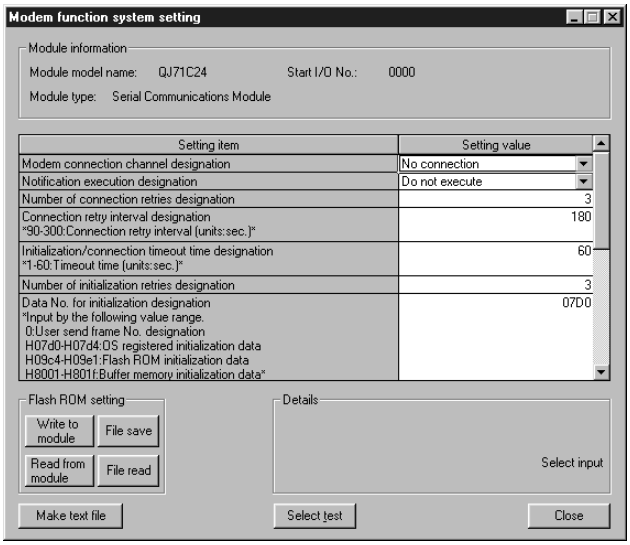
[Purpose]

For data communication using the modem function, register system setting values.

[Startup procedure]

- Online operation
  [Monitor] screen → Modem function system setting
- Offline operation
  [Flash ROM setting] screen → Modem function system setting

[Setting screen]



[Setting items]

Setting item	Setting value storage buffer memory address	Reference section containing detailed explanation
Modem connection channel designation	2EH	Chapter 3 of User's Manual (Application)
Notification execution designation	2FH	
Number of connection retries designation	30H	
Connection retry interval designation ✻ units: s ✻	31H	
Initialization/connection timeout time designation ✻ units: s ✻	32H	
Number of initialization retries designation	33H	
Data No. for initialization designation	34H	
Data No. for connection designation	35H	
GX Developer connection designation	36H	
No-communication interval time designation ✻ units: min ✻	37H	
RS · CS control yes/no designation	38H	
Modem initialization time DR signal valid/invalid designation	2008H	
Wait time of notification ✻ units: s ✻	200AH	
Circuit disconnect wait time (PLC CPU watch use) ✻ units: s ✻	200EH	
Remote password mismatch notification count designation	200CH	
Remote password mismatch notification accumulated count designation	200DH	

8.4.5 Transmission control and others system settings

[Purpose]

For data communication with external devices, register system setting values for the transmission control method, monitoring time, and buffer memory assignment.

[Startup procedure]

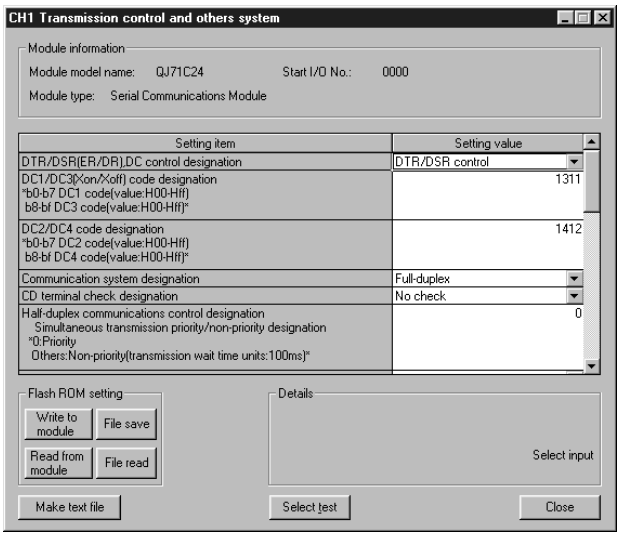
- Online operation

  [Monitor] screen → CH□ Transmission control system setting

- Offline operation

  [Flash ROM setting] screen → CH□ Transmission control system setting

[Setting screen]



[Setting items]

Setting item	Setting value storage buffer memory address	Reference section containing detailed explanation
DTR/DSR (ER/DR), DC control designation	93H/133H	Chapter 7 of User's Manual (Application)
DC1/DC3 (Xon/Xoff) code designation	94H/134H	
DC2/DC4 code designation	95H/135H	
Communication system designation	98H/138H	Section 3.2 of User's Manual (Basic)
CD terminal check designation	97H/137H	
Half-duplex communications control designation Simultaneous transmission priority/non-priority designation	99H/139H	Chapter 8 of User's Manual (Application)
Half-duplex communications control designation Retransmission time transmission method designation	9AH/13AH	
No-reception monitoring time (timer 0) designation	9CH/13CH	Chapter 6 of User's Manual (Application)
Response monitoring time (timer 1) designation	9DH/13DH	
Transmission monitoring time (timer 2) designation	9EH/13EH	
Word/byte units designation	96H/136H	Chapter 5 of User's Manual (Application)
Transmission buffer memory head address designation	A2H/142H	Chapters 6 and 7 of User's Manual (Basic)
Transmission buffer memory length designation	A3H/143H	
Receive buffer memory head address designation	A6H/146H	
Receive buffer memory length designation	A7H/147H	
Transmission transparent code designation 1st	11FH/1BFH	Chapter 12 of User's Manual (Application)
Transmission transparent code designation 2nd to 10th	2030H to 2038H/ 2130H to 2138H	
Receive transparent code designation	120H/1C0H	
ASCII-BIN conversion designation	121H/1C1H	Chapter 13 of User's Manual (Application)
Receive interrupt-issued designation	2010H/2110H	Chapter 4 of User's Manual (Application)

8.4.6 MC protocol system setting

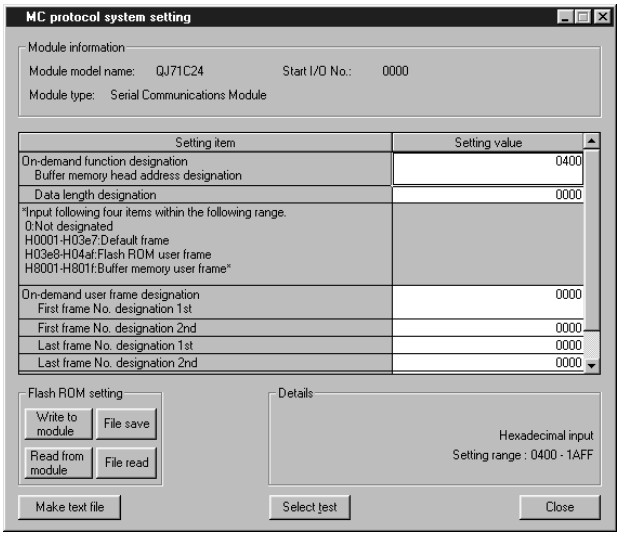
[Purpose]

For data transmission using the MC protocol, register system setting values.

[Startup procedure]

- Online operation
  [Monitor] screen → CH□ MC protocol system setting
- Offline operation
  [Flash ROM setting] screen → CH□ MC protocol system setting

[Setting screen]



[Setting items]

Setting item		Setting value storage buffer memory address	Reference section containing detailed explanation
On-demand function designation	Buffer memory head address designation	A0H/140H	Chapter 10 of User's Manual (Application)
	Data length designation	A1H/141H	
On-demand user frame designation	First frame No. designation 1st	A9H/149H	
	First frame No. designation 2nd	AAH/14AH	
	Last frame No. designation 1st	ABH/14BH	
	Last frame No. designation 2nd	ACH/14CH	
Message wait time designation waiting time ✻ units: 10 ms ✻		11EH/1BEH	

8.4.7 Non procedure system setting

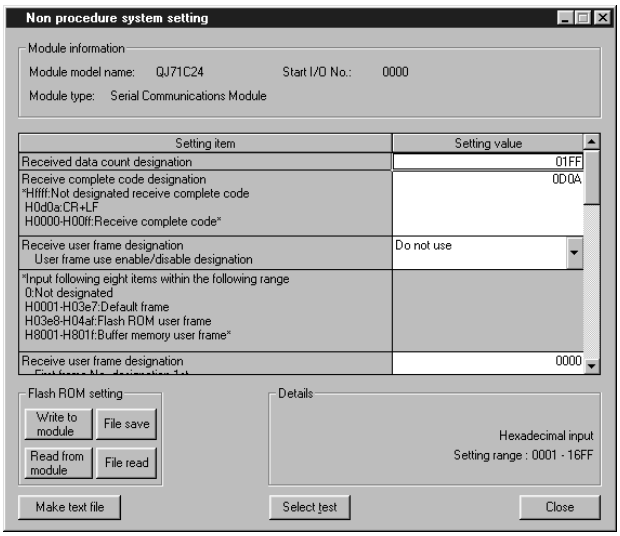
[Purpose]

For data transmission using the non procedure protocol, register system setting values.

[Startup procedure]

- Online operation
  [Monitor] screen → CH□ Non procedure system setting
- Offline operation
  [Flash ROM setting] screen → CH□ Non procedure system setting

[Setting screen]



[Setting items]

Setting item		Setting value storage buffer memory address	Reference section containing detailed explanation
Received data count designation		A4H/144H	Chapter 6 of User's Manual (Basic)
Receive complete code designation		A5H/145H	
Receive user frame designation	User frame use enable/disable designation	ADH/14DH	Chapters 9 and 11 of User's Manual (Application)
	First frame No. designation 1st to 4th	AEH to B1H/14EH to 151H	
	Last frame No. designation 1st to 4th	B2H to B5H/152H to 155H	
User frame receive format designation 1st to 4th		2020H to 2023H/ 2120H to 2123H	
Exclusive format-1 received data count 1st to 4th		2024H to 2027H/ 2124H to 2127H	
Transmission user frame designation	CR/LF output designation	B7H/157H	
	Output head pointer designation	B8H/158H	
	Output count designation	B9H/159H	

8.4.8 Bidirectional system setting

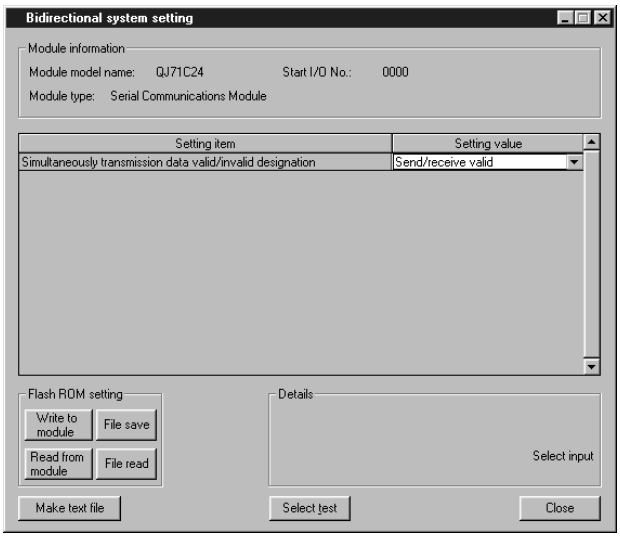
[Purpose]

For data transmission using the bidirectional protocol, register system setting values.

[Startup procedure]

- Online operation
  [Monitor] screen → CH☐ Bidirectional system setting
- Offline operation
  [Flash ROM setting] screen → CH☐ Bidirectional system setting

[Setting screen]



[Setting item]

Setting item	Setting value storage buffer memory address	Reference section containing detailed explanation
Simultaneously transmission data valid/invalid designation	9BH/13BH	Section 7.3 of User's Manual (Basic)

8.4.9 PLC CPU monitoring system setting

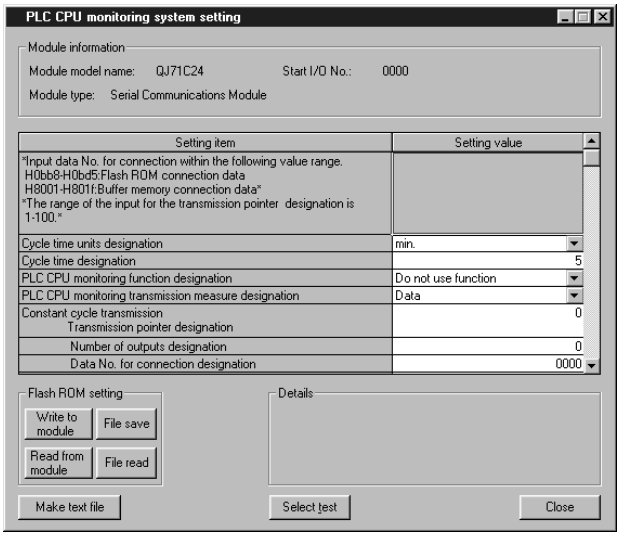
[Purpose]

Register system setting values to use the PLC CPU monitoring function.

[Startup procedure]

- Online operation
  [Monitor] screen → CH□ Monitoring system setting
- Offline operation
  [Flash ROM setting] screen → CH□ Monitoring system setting

[Setting screen]



[Setting items]

Setting item		Setting value storage buffer memory address	Reference section containing detailed explanation
Cycle time units designation		2040H/2140H	Chapter 2 of User's Manual (Application)
Cycle time designation		2041H/2141H	
PLC CPU monitoring function designation		2042H/2142H	
PLC CPU monitoring transmission measure designation		2043H/2143H	
Constant cycle transmission	Transmission pointer	2044H/2144H	
	Output count designation	2045H/2145H	
	Data No. for connection designation	2046H/2146H	
Number of registered word blocks designation		204DH/214DH	
Number of registered bit blocks designation		204EH/214EH	
PLC CPU abnormal monitoring designation		204FH/214FH	
No. n block monitoring device Monitoring device designation		2050H/2150H to 20A1H/21A1H	
Head device No. designation		2051H-2052H/2151H-2152H to 20A1H-20A2H/21A1H-21A2H	
Read point designation		2053H/2153H to 20A3H/21A3H	
Condition agreement transmission Monitoring condition designation		2054H/2154H to 20A4H/21A4H	
Monitoring condition value designation		2055H/2155H to 20A5H/21A5H	
Transmission pointer designation		2056H/2156H to 20A6H/21A6H	
Number of output designation		2057H/2157H to 20A7H/21A7H	
Data No. for connection designation		2058H/2158H to 20A8H/21A8H	
PLC PCU abnormal monitoring designation Condition agreement transmission Transmission pointer		20E5H/21E5H	
Output count designation		20E6H/21E6H	
Data No. for connection designation		20E7H/21E7H	

8.4.10 Transmission user frame No. designation system setting

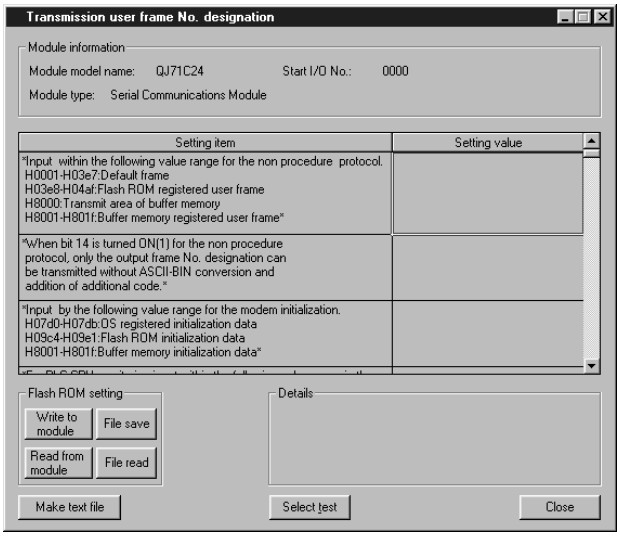
[Purpose]

Register the output frame number to transmit data with the non procedure protocol using the user frame.

[Startup procedure]

- Online operation
  [Monitor] screen → CH□ Output frame system setting
- Offline operation
  [Flash ROM setting] screen → CH□ Output frame system setting

[Setting screen]



[Setting item]

Setting item	Setting value storage buffer memory address	Reference section containing detailed explanation
Output frame No. designation 1st to 100th	BA$_H$ to 11D$_H$/ 15A$_H$ to 1BD$_H$	Chapter 11 of User's Manual (Application)

8.4.11 Resetting the buffer memory/flash ROM setting values to the default values

This section explains how to reset the values set in the buffer memory/flash ROM to their default values.

[Startup procedure]

[Online] → [Monitor/test] →"Select monitor/Test module" → Monitor/test → [Monitor] screen

[Operating procedure]

(Procedure 1) In the [Monitor] screen, select [Default request] for [System setting default].

(Procedure 2) Click on Execute test.

The setting values in the buffer memory will return to their default values.

(Procedure 3) Change the setting of [Flash ROM write allow/prohibit] to "Allowed."

(Procedure 4) In the [Monitor] screen, select [Write request] for [System setting write].

(Procedure 5) Click on Execute test.

The setting values in the flash ROM will return to their default values.

* When confirming the processing results in QSCU, perform Read from module.

(Items subject to this operation in the [Monitor] screen)

Setting item	Current value	Setting value
System setting can be made default with the following procedure. Select test "System setting default" Make "Flash ROM write allow/prohibit designation" "Allow" Select test "System setting write"		
System setting default	Default request	Default request
Flash ROM write allow/prohibit designation	Allow	Allow
System setting write	Write request	Write request

8.4.12 Flash ROM write allow/prohibit setting

This section explains the settings to allow or prohibit writing to the flash ROM.

[Startup procedure]

[Online] → [Monitor/test] → "Select monitor/Test module" → Monitor/test → [Monitor] screen

[Operating procedure]

(Procedure 1) In the [Monitor] screen, select [Flash ROM write allow/prohibit] and set "Allowed" or "Prohibited."

(Procedure 2) Click on Execute test.

[Flash ROM write allow/prohibit] will be set to "Allowed" or "Prohibited," accordingly.

8.5 Auto Refresh Settings

The Auto Refresh Settings are used to automatically store the error information and status information currently stored in the Q series C24's buffer memory in the device specified by the PLC CPU.
For details, see Section 4.6.

8.6 Monitor/Test

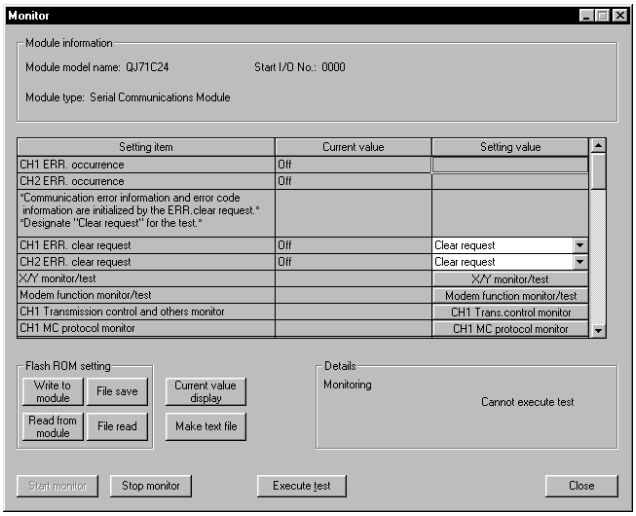
[Purpose]

The displayed menu screen is used to perform various operations, including the monitoring of the Q series C24's operating status and setting values and the testing of its output signals. The monitor/test operations can be performed only via online operation.

[Startup procedure]

* Startup from Intelligent function module utility
  (GX Developer (SW4D5C-GPPW-E or later))
  [Online] → [Monitor/test] → "Select monitor/Test module" → Monitor/test
  → [Monitor] screen
* Startup from the system monitor (GX Developer (SW6D5C-GPPW-E)).
  [GX Developer] → [Diagnostics] → [System Monitor] → "Select the Q series C24 by installation status" → Diagnostics... → [Monitor] screen

[Monitor screen]



[Monitor items]

The following selection menus for monitor/test operation will be displayed.

Function	Reference section containing explanation
ERR. occurrence	Section 8.6.10
ERR. clear request (Communication error information, error code information)	
X · Y monitor/test	Section 8.6.1
Modem function monitor/test	Section 8.6.2
Transmission control and others monitor	Section 8.6.3
MC protocol monitor	Section 8.6.4
Non procedure monitor/test	Section 8.6.5
Bidirectional monitor	Section 8.6.6
PLC CPU monitoring monitor	Section 8.6.7
Transmission user frame No. designation monitor	Section 8.6.8
Monitor others	Section 8.6.9
System setting default, system setting write	Section 8.4.11
Flash ROM write allow/prohibit designation	Section 8.4.12

8.6.1 X · Y monitor/test

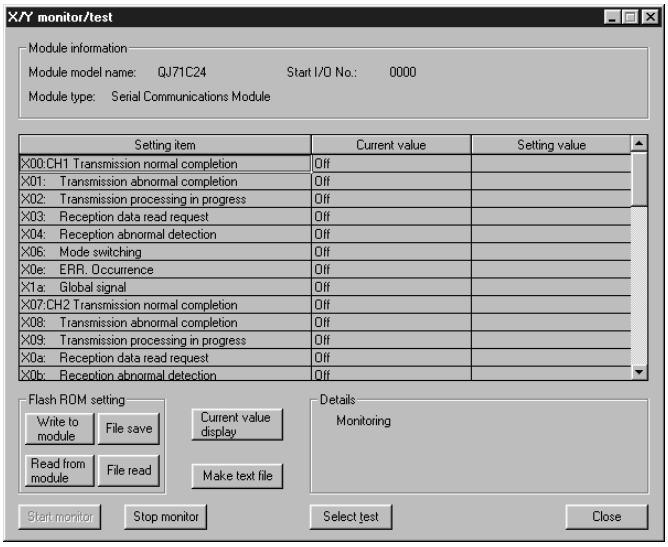
[Purpose]

Perform the monitoring of I/O signals and testing of output signals.

[Startup procedure]

[Monitor] screen → X · Y monitor/test

[Monitor/test screen]



[Monitor/test items]

Monitor/test items	Setting value storage buffer memory address	Reference section containing detailed explanation
X00: CH1 Transmission normal completion	—	(Reference section containing detailed explanation) ✻ See Section 3.8.
X01: CH1 Transmission abnormal completion	—	
X02: CH1 Transmission processing in progress	—	
X03: CH1 Reception data read request	—	
X04: CH1 Reception abnormal detection	—	
X06: CH1 Mode switching	—	
X0E: CH1 ERR. Occurrence	—	
X1A: CH1 Global signal	—	
X07: CH2 Transmission normal completion	—	
X08: CH2 Transmission abnormal completion	—	
to	to	
Y18: Flash ROM write request	—	
Y19: Flash ROM system setting request	—	
Y1C: System setting default request	—	

8.6.2 Modem function monitor/test

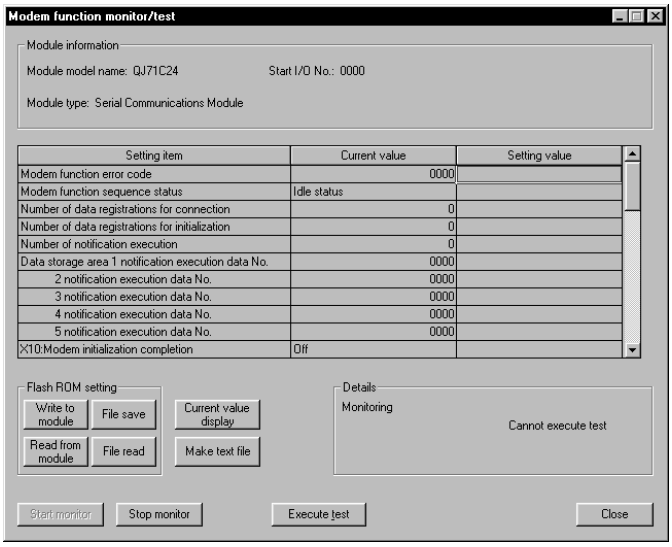
[Purpose for monitor/test]

Monitor/test the operating status and setting values of the modem function.

[Startup procedure]

[Monitor] screen → Modem function monitor/test

[Monitor/test screen]



[Monitor items]

Monitor items	Setting value storage buffer memory address	Reference section containing detailed explanation
Modem function error code	221H	Section 3.3 of User's Manual (Application)
Modem function sequence status	222H	
Number of data registration for connection	223H	
Number of data registrations for initialization	226H	
Number of notification execution	229H	
Data storage area 1 notification execution data No.	22AH	
Data storage area 2 notification execution data No.	22EH	
Data storage area 3 notification execution data No.	232H	
Data storage area 4 notification execution data No.	236H	
Data storage area 5 notification execution data No.	23AH	
X10: Modem initialization completion	—	
X11: Dial in progress	—	
X12: Connection in progress	—	
X13: Initialization/connection abnormal completion	—	
X14: Modem disconnection completion	—	
X15: Notification normal completion	—	

Monitor items	Setting value storage buffer memory address	Reference section containing detailed explanation
X16: Notification abnormal completion	—	Section 3.3 of User's Manual (Application)
Y10: Modem initialization request	—	
Y11: Connection request	—	
Y12: Modem disconnection request	—	
Y14: Notification-issued request	—	
Modem connection channel designation	2EH	
Notification execution designation	2FH	
Number of connection retires designation	30H	
Connection retry interval designation ∗ units: s ∗	31H	
Initialization/connection timeout designation ∗ units: s ∗	32H	
Number of initialization retries designation	33H	
Data No. for initialization designation	34H	
Data No. for connection designation	35H	
GX Developer connection designation	36H	
No-communication interval time designation ∗ units: min ∗	37H	
RS · CS control yes/no designation	38H	
Modem initialization time DR signal valid/invalid designation	2008H	
Wait time of notification ∗ units: s ∗	200AH	
Circuit disconnect wait time (PLC CPU watch use) ∗units: s∗	200EH	
Remote password mismatch notification count designation	200CH	
Remote password mismatch notification accumulated count designation	200DH	
Accumulated count of unlock process normal completion	22FBH	
Accumulated count of unlock process abnormal completion	22FCH	
Accumulated count of lock process based on circuit disconnection	22FFH	

[Test Items]

The following accumulated count of times counter values can be cleared to "0" by the select test function.

Test items	Setting value storage buffer memory address	Reference section containing detailed explanation
Accumulated count of unlock process normal completion	22FBH	Section 3.3 of User's Manual (Application)
Accumulated count of unlock process abnormal completion	22FCH	
Accumulated count of lock process based on circuit disconnection	22FFH	

[Operation procedure]

(Step 1) Display the "Modem function monitor/test" screen.

(Step 2) Click the setting value area of the item to be cleared to "0."

(Step 3) Click the "Execute test."

The counter value of the selected item becomes "0."

8.6.3 Transmission control and others monitor

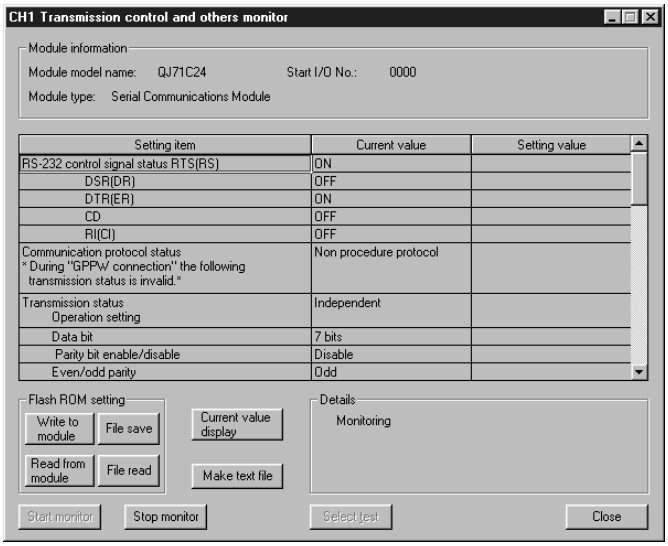
[Purpose]

Monitor the RS-232 signal status and the various setting values for data communication.

[Startup procedure]

[Monitor] screen → CH□ Transmission control monitor

[Monitor screen]



[Monitor items]

Monitor items		Setting value storage buffer memory address	Reference section containing detailed explanation
RS-232 control signal status	RTS (RS)	254H/264H ··· b0	Section 4.4.1 of User's Manual (Basic)
	DSR (DR)	254H/264H ··· b1	
	DTR (ER)	254H/264H ··· b2	
	CD	254H/264H ··· b3	
	RI (CI)	254H/264H ··· b4	
Communication protocol status		252H/262H	Section 4.5.2 of User's Manual (Basic)
Transmission status	Operation setting	253H/263H ··· b0	
	Data bit	253H/263H ··· b1	
	Parity bit enable/disable	253H/263H ··· b2	
	Even/odd parity	253H/263H ··· b3	
	Stop bit	253H/263H ··· b4	
	Sum check code	253H/263H ··· b6	
	Write during RUM	253H/263H ··· b6	
	Setting modification	253H/263H ··· b7	

Setting item		Setting value storage buffer memory address	Reference section containing detailed explanation
Transmission status	Communication rate	253H/263H ··· b8 to b11	Section 4.5.2 of User's Manual (Basic)
DTR/DSR (ER/DR), DC control designation		93H/133H	Chapter 7 of User's Manual (Application)
DC1/DC3 (Xon/Xoff) code designation		94H/134H	
DC2/DC4 code designation		95H/135H	
Communication system designation		96H/136H	Section 4.5.2 of User's Manual (Basic)
CD terminal check designation		97H/137H	
Half-duplex communications control designation Simultaneous transmission priority/non-priority designation		99H/139H	Chapter 8 of User's Manual (Application)
Half-duplex communications control designation Retransmission time transmission method designation		9AH/13AH	
No-reception monitoring time (timer 0) designation ✻ units: byte ✻		9CH/13CH	Chapter 6 of User's Manual (Application)
Response monitoring time (timer 1) designation ✻ units: 100 ms ✻		9DH/13DH	
Transmission monitoring time (timer 2) designation ✻ units: 100 ms ✻		9EH/13EH	
Word/byte units designation		96H/136H	Chapter 5 of User's Manual (Application)
Transmission buffer memory head address designation		A2H/142H	Chapters 6 and 7 of User's Manual (Basic)
Transmission buffer memory length designation		A3H/143H	
Receive buffer memory head address designation		A6H/146H	
Receive buffer memory length designation		A7H/147H	
Transmission transparent code designation 1st		11FH/1BFH	Chapter 12 of User's Manual (Application)
Transmission transparent code designation 2nd to 10th		2030H to 2038H/ 2130H to 2138H	
Receive transparent code designation		120H/1C0H	
ASCII-BIN conversion designation		121H/1C1H	Chapter 13 of User's Manual (Application)
Receive interrupt-issued designation		2010H/2110H	Chapter 4 of User's Manual (Application)

8.6.4 MC protocol monitor

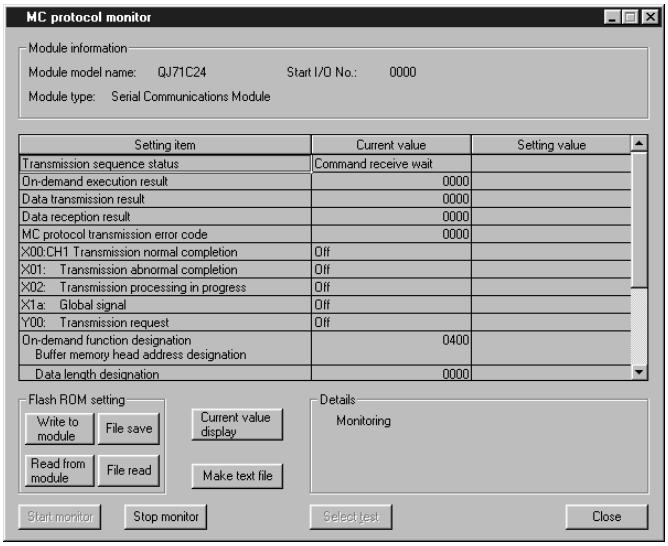
[Purpose]

Monitor the status and setting values of the data communication using the MC protocol.

[Startup procedure]

[Monitor] screen → CH□ MC protocol monitor

[Monitor screen]



[Monitor items]

Monitor items		Setting value storage buffer memory address	Reference section containing detailed explanation
Transmission sequence status		255H/265H	Chapter 10 of User's Manual (Basic) Sections 3.10 and 3.11 of Reference Manual
On-demand execution result		256H/266H	
Data transmission result		257H/267H	
Data reception result		258H/268H	
MC protocol transmission error code		25AH/26AH	
X00: CH1 Transmission normal completion		—	
X01: CH1 Transmission abnormal completion		—	
X02: CH1 Transmission processing in progress		—	
X1A: CH1 Global signal		—	
Y00: CH1 Transmission request		—	
On-demand function designation	Buffer memory head address designation	A0H/140H	
	Data length designation	A1H/141H	
On-demand user frame designation	First frame No. designation 1st	A9H/149H	Chapter 10 of User's Manual (Application)
	First frame No. designation 2nd	AAH/14AH	
	Last frame No. designation 1st	ABH/14BH	
	Last frame No. designation 2nd	ACH/14CH	
Message wait time designation ＊units: 10 ms＊		11EH/1BEH	Chapter 6 of User's Manual (Application)

8.6.5 Non procedure monitor/test

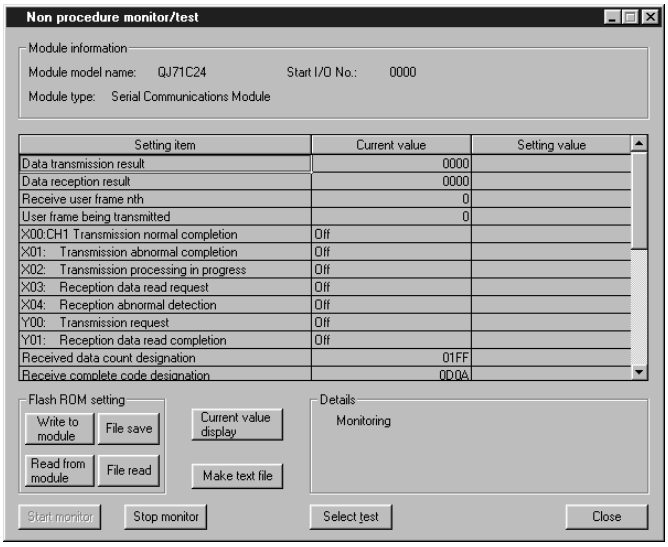
[Purpose]

Monitor the status and setting values of the data transmission using the non procedure protocol. The test operation for the receive data clear is explained in Section 8.7.

[Startup procedure]

[Monitor] screen → CH□ Non procedure monitor/test

[Monitor/test screen]



[Monitor/test items]

Monitor/test items		Setting value storage buffer memory address	Reference section containing detailed explanation
Data transmission result		257H/267H	Chapter 10 of User's Manual (Basic)
Data reception result		258H/268H	
Receive user frame nth		25BH/26BH	Chapter 11 of User's Manual (Application)
User frame being transmitted		B6H/156H	
X00: CH1 Transmission normal completion		—	Chapter 6 of User's Manual (Basic)
X01: CH1 Transmission abnormal completion		—	
X02: CH1 Transmission processing in progress		—	
X03: CH1 Reception data read request		—	
X04: CH1 Reception abnormal detection		—	
Y00: CH1 Transmission request		—	
Y01: CH1 Reception data read completion		—	
Receive user frame designation	User frame use enable/disable designation	ADH/14DH	Chapter 9 of User's Manual (Application)
	First frame No. designation 1st to 4th	AEH to B1H/14EH to 151H	
	Last frame No. designation 1st to 4th	B2H to B5H/152H to 155H	
User frame receive format designation 1st to 4th		2020H to 2023H/2120H to 2123H	
Exclusive format-1 received data count 1st to 4th		2024H to 2027H/2124H to 2127H	
Transmission user frame designation	CR/LF output designation	B7H/157H	
	Output head pointer designation	B8H/158H	
	Output count designation	B9H/159H	
Receive data clear request		A8H/148H	Chapter 6 of User's Manual (Basic)

8.6.6 Bidirectional monitor

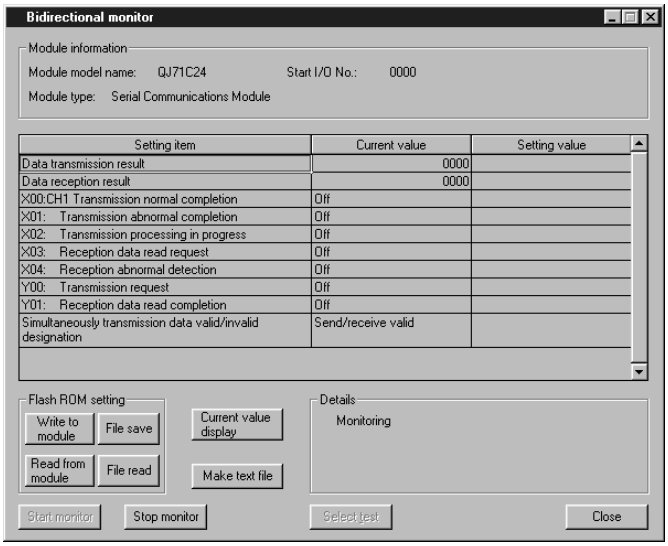
[Purpose]

Monitor the status and setting values of the data transmission using the bidirectional protocol.

[Startup procedure]

[Monitor] screen → CH□ Bidirectional monitor

[Monitor screen]



[Monitor items]

Monitor items	Setting value storage buffer memory address	Reference section containing detailed explanation
Data transmission result	257H/267H	Chapter 10 of User's Manual (Basic)
Data reception result	258H/268H	
X00: CH1 Transmission normal completion	—	Chapter 7 of User's Manual (Basic)
X01: CH1 Transmission abnormal completion	—	
X02: CH1 Transmission processing in progress	—	
X03: CH1 Reception data read request	—	
X04: CH1 Reception abnormal detection	—	
Y00: CH1 Transmission request	—	
Y01: CH1 Reception data read completion	—	
Simultaneously transmission data valid/invalid designation	9BH/13BH	Section 7.3 of User's Manual (Basic)

8.6.7 PLC CPU monitoring monitor

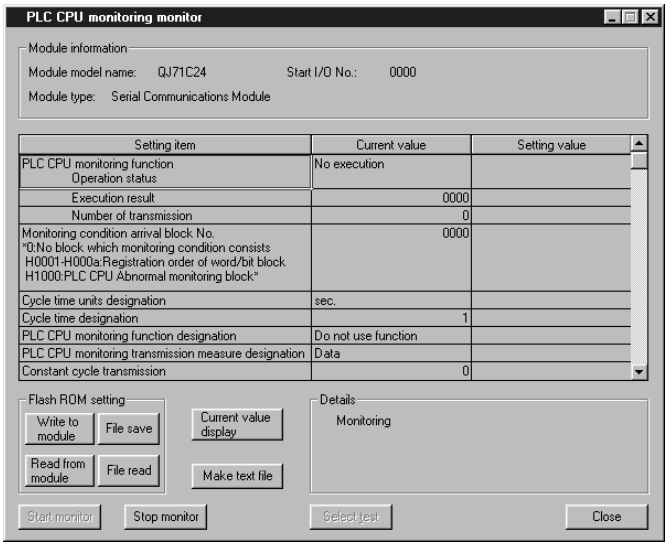
[Purpose]

Monitor the operating status and setting values of the PLC CPU monitoring function.

[Startup procedure]

[Monitor] screen → CH□ Monitoring monitor

[Monitor screen]



[Monitor items]

Monitor items		Setting value storage buffer memory address	Reference section containing detailed explanation
PLC CPU monitoring function	Operation status	2204H/2304H	Chapter 2 of User's Manual (Application)
	Execution result	2205H/2305H	
	Number of transmission	2206H/2306H	
Monitoring condition arrival block No.		2207H/2307H	
Cycle time units designation		2040H/2140H	
Cycle time designation		2041H/2141H	
PLC CPU monitoring function designation		2042H/2142H	
PLC CPU monitoring transmission measure designation		2043H/2143H	
Constant cycle transmission	Transmission pointer	2044H/2144H	
	Output count designation	2045H/2145H	
	Data No. for connection designation	2046H/2146H	
Number of registered word blocks designation		204DH/214DH	
Number of registered bit blocks designation		204EH/214EH	
PLC CPU abnormal monitoring designation		204FH/214FH	
No. n block monitoring device Monitoring device designation		2050H/2150H to 20A1H/21A1H	
Head device No. designation		2051H-2052H/2151H-2152H to 20A1H-20A2H/21A1H-21A2H	
Read point designation		2053H/2153H to 20A3H/21A3H	
Condition agreement transmission Monitoring condition designation		2054H/2154H to 20A4H/21A4H	
Monitoring condition value designation		2055H/2155H to 20A5H/21A5H	
Transmission pointer designation		2056H/2156H to 20A6H/21A6H	
Output count designation		2057H/2157H to 20A7H/21A7H	
Data No. for connection designation		2058H/2158H to 20A8H/21A8H	
PLC PCU abnormal monitoring designation Condition agreement transmission Transmission pointer		20E5H/21E5H	
Number of output designation		20E6H/21E6H	
Data No. for connection designation		20E7H/21E7H	

8.6.8 Transmission user frame No. designation monitor

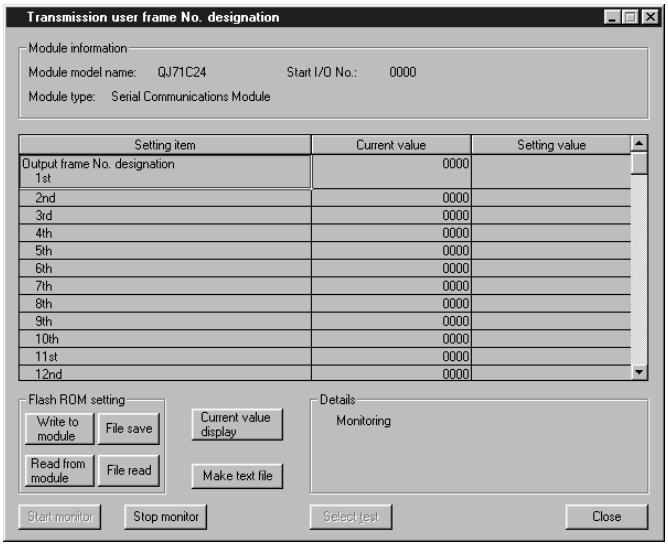
[Purpose]

Monitor the setting value of output frame number used when transmitting data with the non procedure protocol using the user frame.

[Startup procedure]

[Monitor] screen → CH□ Output frame monitor

[Monitor screen]



[Monitor item]

Monitor item	Setting value storage buffer memory address	Reference section containing detailed explanation
Output frame No. designation 1st to 100th	BAH to 11DH/ 15AH to 1BDH	Chapters 9 through 11 of User's Manual (Application)

8.6.9 Monitor others

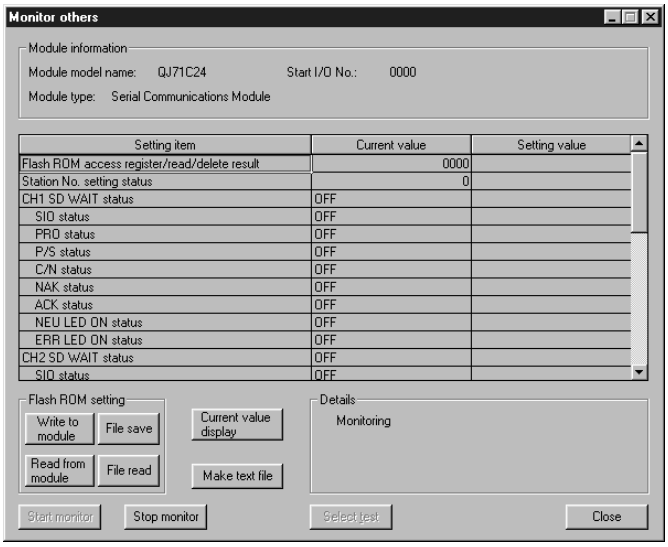
[Purpose]

Monitor the result of access to the flash ROM, the data communication status of each interface, and the result of the intelligent function module switch settings using GX Developer.

[Startup procedure]

[Monitor] screen → Monitor others

[Monitor screen]



[Monitor items]

Monitor items		Setting value storage buffer memory address	Reference section containing detailed explanation
Flash ROM access register/read/delete result		4H	Chapter 10 of User's Manual (Basic)
Station No. setting status		200H	
CH1	SD WAIT status	201H ··· b0	
	SIO status	201H ··· b1	
	PRO status	201H ··· b2	
	P/S status	201H ··· b3	
	C/N status	201H ··· b4	
	NAK status	201H ··· b5	
	ACK status	201H ··· b6	
	NEU LED status	201H ··· b7	
	ERR LED status	202H ··· b15	
CH2	SD WAIT status	202H ··· b0	
	SIO status	202H ··· b1	
	PRO status	202H ··· b2	
	P/S status	202H ··· b3	
	C/N status	202H ··· b4	
	NAK status	202H ··· b5	
	ACK status	202H ··· b6	
	NEU LED status	202H ··· b7	
	ERR LED status	202H ··· b14	
CH1 Communication protocol setting No. error		203H ··· b0	
CH1 Communication rate setting error		203H ··· b1	
CH1 Mode switching error of setting change prohibit time		203H ··· b3	
CH2 Communication protocol setting No. error		203H ··· b4	
CH2 Communication rate setting error		203H ··· b5	
CH2 Mode switching error of setting change prohibit time		203H ··· b7	
Station No. out of range error		203H ··· b14	
Linked operation setting error		203H ··· b15	
Number of registered user frame		204H	
Number of registered default registration frames		21EH	
Flash ROM system parameters write result		220H	

8.6.10 Display LED off and communication error information/error code initialization

This section explains how to turn off the display LEDs of the Q series C24 and initialize its communication error information and error codes.

By using this function, the display LEDs can be turned off and the communication error information and error codes can be initialized, without resetting or powering off the PLC CPU.

[Operation procedure]

(Procedure 1) Display the [Monitor] screen. (See Section 8.4.)
(Procedure 2) Select "Off" in the setting of "All CH error LED off request" or "CHn error LED off request".
(Procedure 3) Click on Execute test.

The communication error information and error codes will be initialized.

8.7 Non Procedure Protocol Receive Data Clear

This section explains how to clear the received data using the non procedure protocol.

By using this function, the receive data can be cleared from QSCU while the communication with the non procedure protocol is still in progress, without resetting the PLC CPU or turning off the power.

[Operation procedure]

(Procedure 1) Display the [Non procedure monitor/test] screen. (See Section 8.6.5.)
(Procedure 2) Set [Clear request issued] for "Receive data clear request".
(Procedure 3) Click on Execute test.

The received data will be cleared.

POINT
Clear the received data when transmission/reception are not in progress with the external device. Executing a receive data clear while the data transmission is in progress causes the Q series C24 to stop the data transmission abruptly, resulting in an abnormal completion of the dedicated transmission instruction. (The transmission completion signal will not be lit.) When the receive data clear is executed while the data reception is in progress, the data received up to that point will be cleared.

9 DEDICATED INSTRUCTIONS

Dedicated instructions are used to simplify programming when using intelligent function module functions.
This chapter describes the dedicated instructions for the Q series C24, which is part of the functions of the QCPU (in Q mode) explained in this manual.

9.1 Dedicated Instruction List

The following table lists the dedicated instructions explained in this chapter.

Application	Dedicated instruction	Description of function	Explanation page
On-demand function transmission	ONDEMAND	Sends data using the on-demand function of the MC protocol.	Section 9.2
Non procedure protocol communication	OUTPUT	Sends data for the specified data count.	Section 9.3
	INPUT	Reads received data.	Section 9.4
Bidirectional protocol communication	BIDOUT	Sends data for the designated data count.	Section 9.5
	BIDIN	Reads received data.	Section 9.6
Communication status confirmation	SPBUSY	Reads the status of data transmission/reception via a dedicated instruction.	Section 9.7
Receive data clear	CSET	Perform the receive data clear without stopping the transmission processing during the non procedure protocol.	Section 9.8

POINT

(1) The user should not change data values (control data, request data, etc.) designated by a dedicated instruction until the execution of the dedicated instruction is completed.

(2) Dedicated instructions for the Q series C24 are executed based on the current setting values stored in the buffer memory.
When it is necessary to change a setting value, change the value by QSCU before starting up the module.
Alternatively, a setting value can be changed via the sequence program using a CSET instruction before starting up the PLC CPU (See the User's Manual (Application)).

1) Area of buffer memory assigned as applicable functions for dedicated instructions.
2) Setting values for data communication
   - Word/byte units designation
   - Receive complete code
   - Received data count

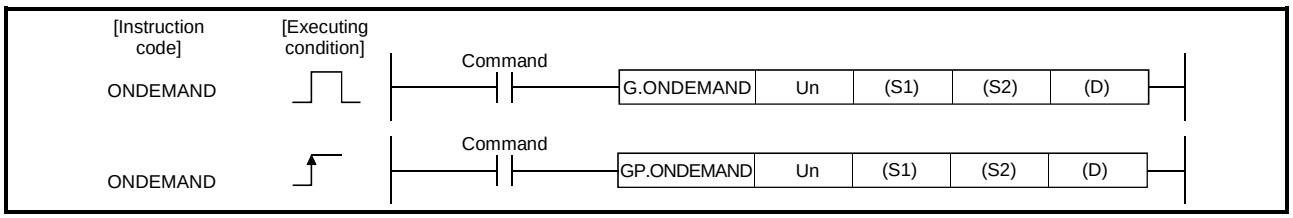
   etc.

9 - 1

9.2 ONDEMAND Instruction

The ONDEAMAND instruction transmission data using the on-demand function of the MC protocol.

Set data	Applicable device								
	Internal device (System, user)		File register	MELSECNET/H, MELSECNET/10 Direct J□\□		Special module U□\G□	Index register Zn	Constant	Others
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(S2)	—	○		—					
(D)	○	○		—					



Set data

Set data	Description	Set by	Data type
Un	Start I/O signal of the module (00 to FE: Top two-digit when I/O signals are expressed in 3-digit.)	User	BIN16 bit
(S1)	Head number of the devices in which control data is stored.	User, system	Device name
(S2)	Head number of the devices in which transmission data is stored.	User	
(D)	Bit device number to be turned on at completion of execution.	System	Bit

The file register per local device and program cannot be used as the set data.

Control data

Device	Item	Set data	Setting range	Set by
(S1) + 0	Transmission channel	• Set transmission channel 1: Channel 1 (CH1 side) 2: Channel 2 (CH2 side)	1, 2	User
(S1) + 1	Transmission result	• Result read by an ONDEMAND instruction is stored. 0: Normal Other than 0: Error code ＊1	—	System
(S1) + 2	Transmission data count	• Set the transmission data count.＊2	1 or more	User

＊1 For error codes relating to abnormal completion, see Chapter 10 of the User's Manual (Basic).

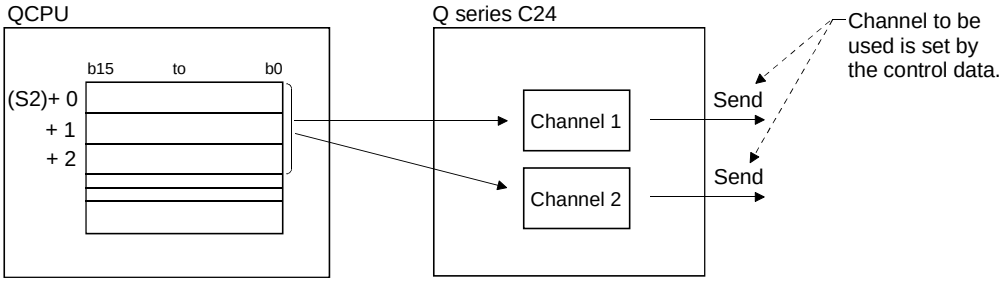
＊2 When setting "Word/byte units designation" by QSCU, set the number of bytes when bytes are designated and set the number of words when words are designated.

＊3 The settings are done by either of the following:

- User: Data set by the user before executing the ONDEMAND instructions.
- System: The PLC CPU stores the execution result of the ONDEMAND instructions.

Function

(1) Data stored in the device designated in (S2) and succeeding devices are sent according to the control data of the device designated in (S1) and succeeding devices, via the on-demand function of the MC protocol of the module designated in Un.



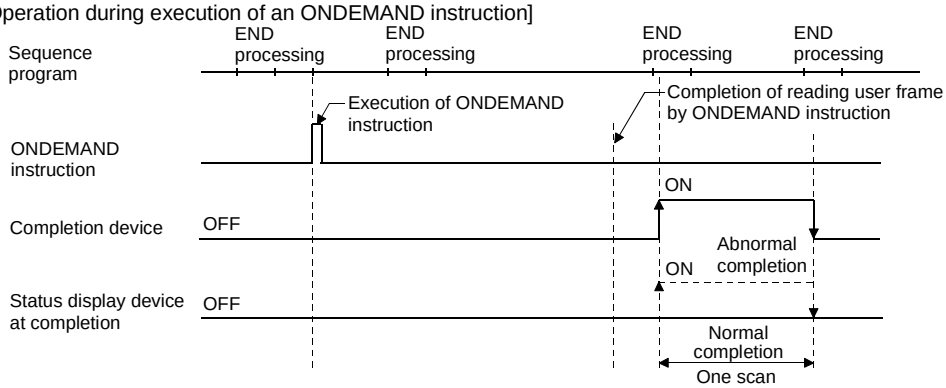
(2) When an ONDEMAND instruction is executed on a channel, other ONDEMAND instructions cannot be executed on that channel at the same time.
If an attempt is made during execution of an ONDEMAND instruction to execute another ONDEMAND instruction, the second instruction will not be executed until the execution of the first instruction is completed.

(3) Whether an ONDEMAND instruction was completed normally or abnormally can be checked by the completion device ((D)) or status display device at completion ((D)+1).

(a) Completion device : Turns on at the END processing of the scan where the ONDEMAND instruction is completed, and turns off at the next END processing.

(b) Status display device at completion : Turns on and off depending on the completion status of the ONDEMAND instruction.
- Normal completion : Off with no change.
- Abnormal completion: Turns on at the END processing of the scan where the ONDEMAND instruction is completed, and turns off at the next END processing.

[Operation during execution of an ONDEMAND instruction]

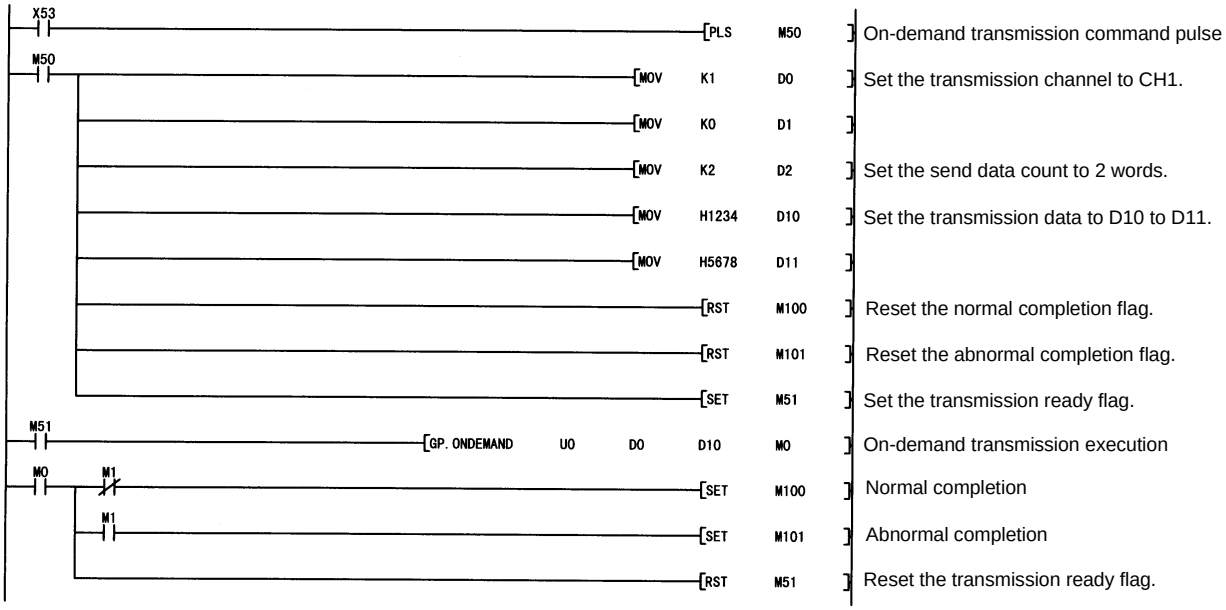


Error

(1) When a dedicated instruction is completed abnormally, the abnormal completion signal, (D)+1, turns on and the error code is stored in the transmission result (S1)+1.
In case of operation errors, the error flag (SM0) turns on and the error code is stored in the SD0.
See one of the following manuals according to the error code, and check and correct the error.
<Error code>
4FFF$_H$ or less : QCPU(Q Mode) User's Manual
(Hardware Design, Maintenance and Inspection)
7000$_H$ or more: Section 10.2 of the User's Manual (Basic)

Program example

A program that sends data stored in D10 to D11 using an on-demand transmission
When input/output signals of the Q series C24 are from X/Y00 to X/Y1F



POINT

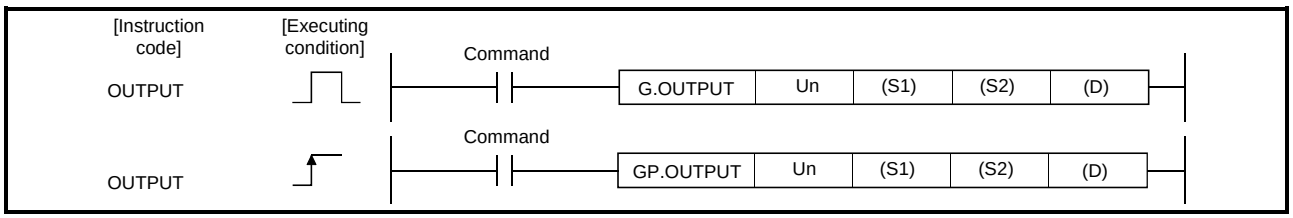
(1) The status of communication via dedicated instructions can be read by an SPBUSY instruction.

(2) Designate the storage capacity of transmission data (stored in D10 to D11 in the program example above) and data length (stored in D2 in the program example above) within the range of the buffer memory the user has assigned for an on-demand function.

9.3 OUTPUT Instruction

This instruction transmission data in any message format specified by the user using the non procedure protocol.

Set data	Applicable device								
	Internal device (System, user)		File register	MELSECNET/H, MELSECNET/10 Direct J□\□		Special module U□\G□	Index register Zn	Constant	Others
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(S2)	—	○		—					
(D)	○	○		—					



Set data

Set data	Description	Set by	Data type
Un	Start I/O signal of the module (00 to FE: Top two-digit when I/O signals are expressed in 3-digit.)	User	BIN16 bit
(S1)	Head number of the devices in which control data is stored.	User, system	Device name
(S2)	Head number of the devices in which transmission data is stored.	User	
(D)	Bit device number to be turned on at completion of execution.	System	Bit

The file register per local device and program cannot be used as the set data.

Control data

Device	Item	Set data	Setting range	Set by
(S1) + 0	Transmission channel	• Set transmission channel 1: Channel 1 (CH1 side) 2: Channel 2 (CH2 side)	1, 2	User
(S1) + 1	Transmission result	• Transmission result by an OUTPUT instruction are stored. 0: Normal Other than 0: Error code ＊1	—	System
(S1) + 2	Transmission data count	• Set the transmission data count.＊2	1 or more	User

＊1 For error codes relating to abnormal completion, see Chapter 10 of the User's Manual (Basic).

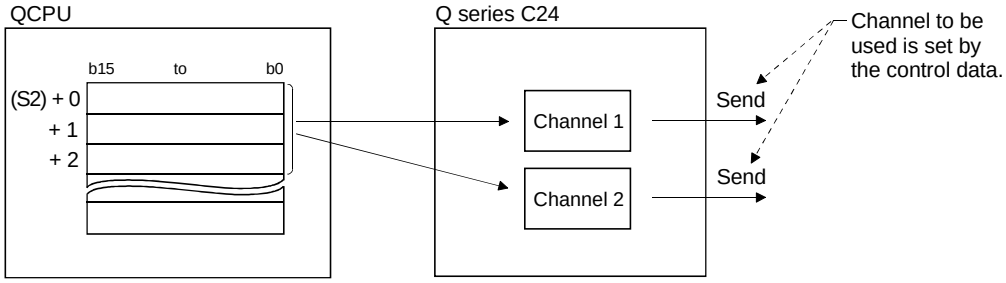
＊2 When setting "Word/byte units designation" by QSCU, set the number of bytes when bytes are designated and set the number of words when words are designated and set the number of words when words are selected as the unit types.

＊3 The settings are done by either of the following:

- User: Data set by the user before executing the OUTPUT instructions.
- System: The PLC CPU stores the execution result of the OUTPUT instructions.

Function

(1) Data stored in the device designated in (S2) and succeeding devices are sent according to the control data of the device designated in (S1) and succeeding devices, via the non procedure protocol of the module specified in Un.



(2) The following instructions cannot be executed on a channel on which an OUTPUT instruction is being executed.

- Other OUTPUT instructions
- PRR instructions

If an attempt is made during execution of an OUTPUT instruction to execute one of the instructions above, the second instruction will not be executed until the execution of the OUTPUT instruction is completed.

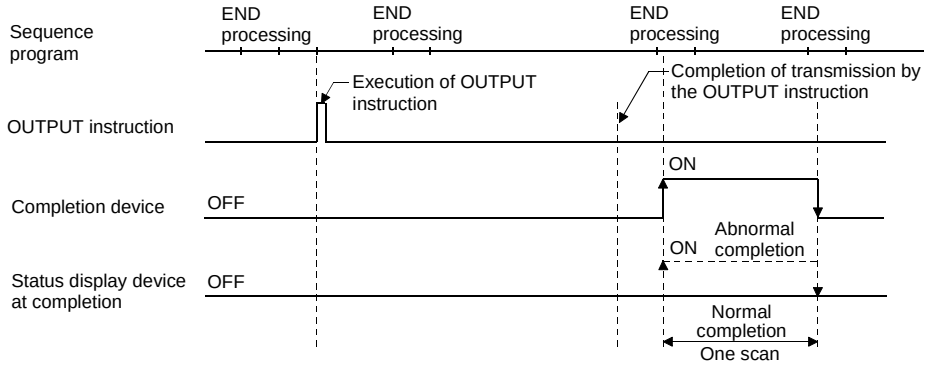
(3) Whether an OUTPUT instruction was completed normally or abnormally can be checked by the completion device ((D)) or status display device at completion ((D)+1).

(a) Completion device: Turns on at the END processing of the scan where the OUTPUT instruction is completed, and turns off at the next END processing.

(b) Status display device at completion : Turns on and off depending on the completion status of the OUTPUT instruction.

- Normal completion : Off with no change.
- Abnormal completion: Turns on at the END processing of the scan where the OUTPUT instruction is completed, and turns off at the next END processing.

[Operation during execution of an OUTPUT instruction]

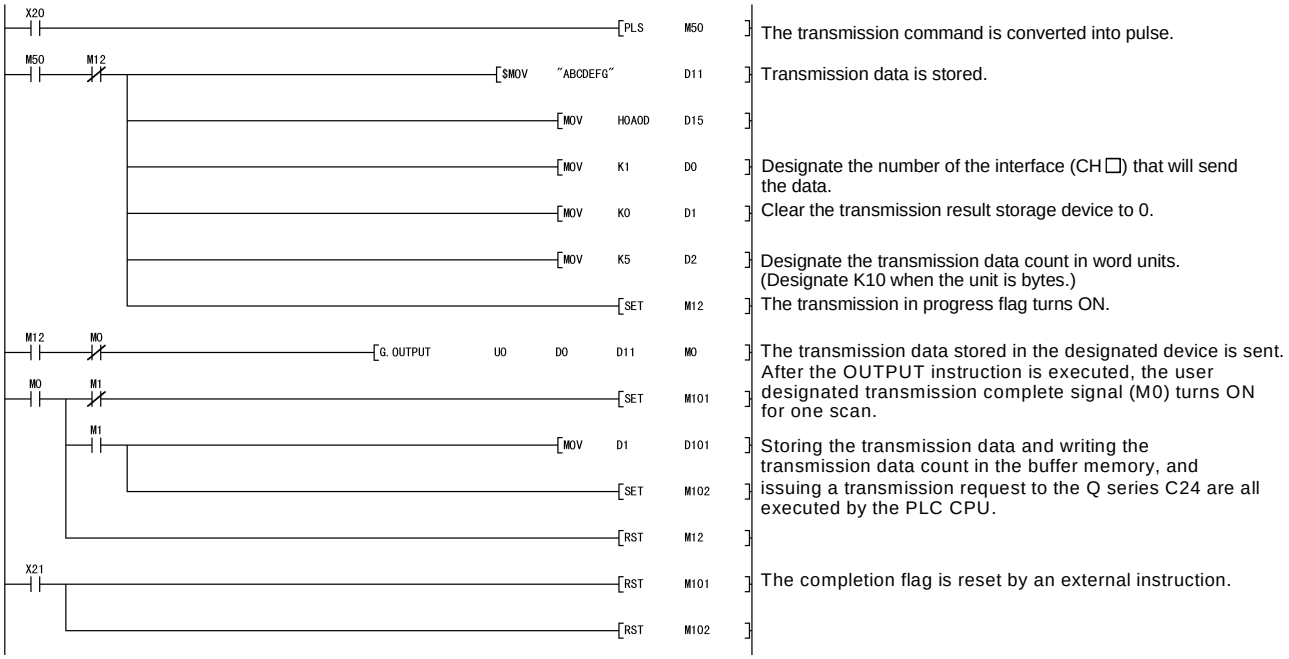


Error

(1) When a dedicated instruction is completed abnormally, the abnormal completion signal, (D)+1, turns on and the error code is stored in the transmission result (S1)+1.
In case of operation errors, the error flag (SM0) turns on and the error code is stored in the SD0.
See one of the following manuals according to the error code, and check and correct the error.
<Error code>
4FFF$_H$ or less : QCPU(Q Mode) User's Manual
(Hardware Design, Maintenance and Inspection)
7000$_H$ or more: Section 10.2 of the User's Manual (Basic)

Program example

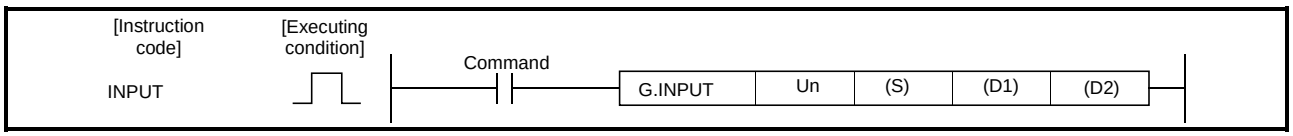
The following example shows a program that sends any data stored in D11 to D15 using the non procedure protocol.
When input/output signals of the Q series C24 are from X/Y00 to X/Y1F:



9.4 INPUT Instruction

This instruction receives data in any message format specified by the user using the non procedure protocol.

Set data	Applicable device								
	Internal device (System, user)		File register	MELSECNET/H, MELSECNET/10 Direct J□\□		Special module U□\G□	Index register Zn	Constant	Others
	Bit	Word		Bit	Word				
(S)	—	○		—					
(D1)	—	○		—					
(D2)	○	○		—					



Set data

Set data	Description	Set by	Data type
Un	Start I/O signal of the module (00 to FE: Top two-digit when I/O signals are expressed in 3-digit.)	User	BIN16 bit
(S)	Head number of the devices in which control data is stored.	User, system	Device name
(D1)	Head number of the devices in which receive data is stored.	System	
(D2)	Bit device number to be turned on at completion of execution.	System	Bit

The file register per local device and program cannot be used as the set data.

Control data

Device	Item	Set data	Setting range	Set by
(S) + 0	Receive channel	• Set receive channel 1: Channel 1 (CH1 side) 2: Channel 2 (CH2 side)	1, 2	User
(S) + 1	Reception result	• Reception result by an INPUT instruction are stored. 0: Normal Other than 0: Error code ＊1	—	System
(S) + 2	Receive data count	• Receive data count is stored. ＊2	0 or more	System
(S) + 3	Allowable number of receive data	• Set the allowable number of words for received data that can be stored in (D1).	1 or more	User

POINT

(1) The command of G.INPUT cannot be converted into pulse.

(2) G.INPUT should be executed while the read request of the input/output signal is turned on.

*1 For error codes relating to abnormal completion, see Chapter 10 of the User's Manual (Basic).

*2 When setting "Word/byte units designation" by QSCU, set the number of bytes when bytes are designated and set the number of words when words are designated.

*3 The settings are done by either of the following:
- User: Data set by the user before executing the INPUT instructions.
- System: The PLC CPU stores the execution result of the INPUT instructions.

Function

(1) The function stores in the device designated in (D1) and succeeding devices the data received with the non procedure protocol of the module designated in Un, according to the control data of the device designated in (S) and succeeding devices.

(2) When an INPUT instruction is executed on a channel, other INPUT instructions cannot be executed on the channel at the same time.
If an attempt is made during execution of an INPUT instruction to execute another INPUT instruction, the second instruction will not be executed until the execution of the first INPUT instruction is completed.

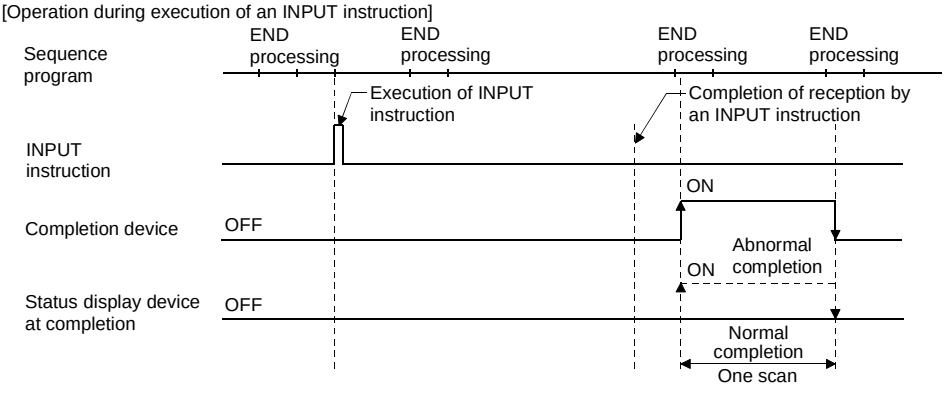
(3) In case of reading the receive data to the same interface, it cannot be used along with BUFRCVS instruction (for interrupt programs).

(4) Whether an INPUT instruction was completed normally or abnormally can be checked by the completion device ((D2)) or status display device at completion ((D2)+1).

(a) Completion device: Turns on at the END processing of the scan where the INPUT instruction is completed, and turns off at the next END processing.

(b) Status display device at completion : Turns on and off depending on the completion status of the INPUT instruction.
- Normal completion : Off with no change.
- Abnormal completion: Turns on at the END processing of the scan where the INPUT instruction is completed, and turns off at the next END processing.

[Operation during execution of an INPUT instruction]

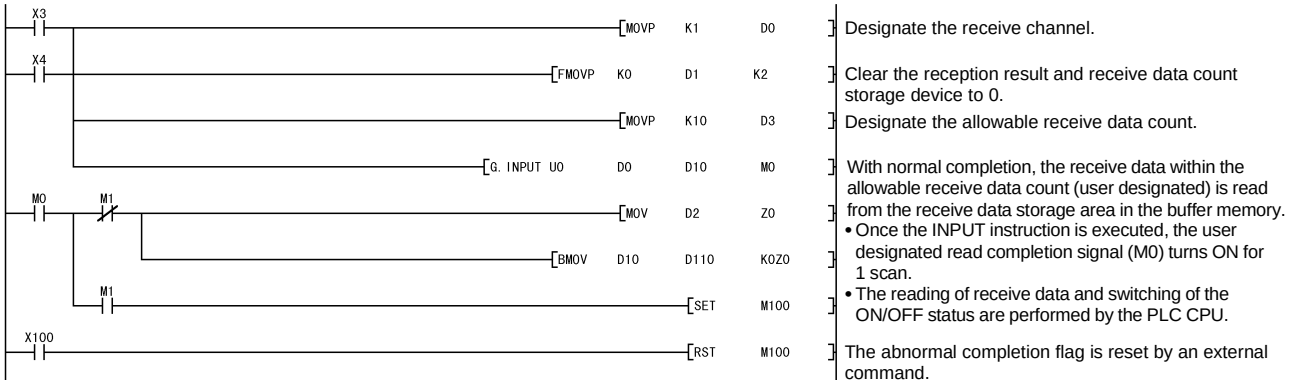


Error

(1) When a dedicated instruction is completed abnormally, the abnormal completion signal (D2)+1, turns on and the error code is stored in the transmission result (S1)+1.
In case of operation errors, the error flag (SM0) turns on and the error code is stored in SD0.
See one of the following manuals according to the error code, and check and correct the error.
<Error code>
4FFF$_H$ or less : QCPU(Q Mode) User's Manual
(Hardware Design, Maintenance and Inspection)
7000$_H$ or more: Section 10.2 of the User's Manual (Basic)

Program example

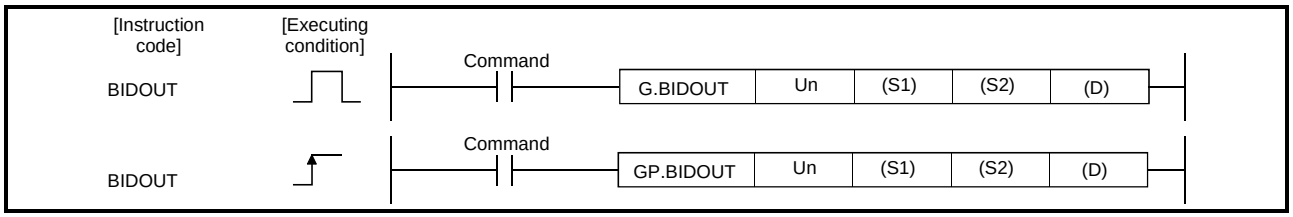
The following example shows a program that stores data received via the non-procedure protocol in D10 and later.
When the input/output signals of the Q series C24 are from X/Y00 to X/Y1F:



9.5 BIDOUT Instruction

This instruction transmission data using the bidirectional protocol.

Set data	Applicable device								
	Internal device (System, user)		File register	MELSECNET/H, MELSECNET/10 Direct J□\□		Special module U□\G□	Index register Zn	Constant	Others
	Bit	Word		Bit	Word				
(S1)	—	○		—					
(S2)	—	○		—					
(D)	○	○		—					



Set data

Set data	Description	Set by	Data type
Un	Start I/O signal of the module (00 to FE: Top two-digit when I/O signals are expressed in 3-digit.)	User	BIN16 bit
(S1)	Head number of the devices in which control data is stored.	User, system	Device name
(S2)	Head number of the devices in which transmission data is stored.	User	
(D)	Bit device number to be turned on at completion of execution.	System	Bit

The file register per local device and program cannot be used as the set data.

Control data

Device	Item	Set data	Setting range	Set by
(S1) + 0	Transmission channel	• Set transmission channel 1: Channel 1 (CH1 side) 2: Channel 2 (CH2 side)	1, 2	User
(S1) + 1	Transmission result	• Transmission result by a BIDOUT instruction are stored. 0: Normal Other than 0: Error code ＊1	—	System
(S1) + 2	Transmission data count	• Set the transmission data count.＊2	1 or more	User

＊1 For error codes relating to abnormal completion, see Chapter 10 of the User's Manual (Basic).

＊2 When setting "Word/byte units designation" by QSCU, set the number of bytes when bytes are designated and set the number of words when words are designated.

＊3 The settings are done by either of the following:

- User: Data set by the user before executing the BIDOUT instructions.
- System: The PLC CPU stores the execution result of the BIDOUT instructions.

Function

(1) The function sends data stored in the device designated in (S2) and succeeding devices according to the control data of the device designated in (S1) and succeeding devices, via the bidirectional protocol of the module designated in Un.

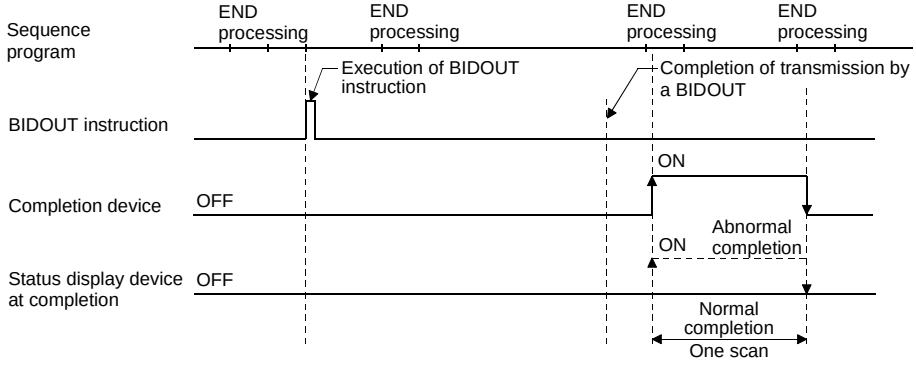
(2) When a BIDOUT instruction is executed on a channel, other BIDOUT instructions cannot be executed on that channel at the same time.
If an attempt is made during execution of a BIDOUT instruction to execute another BIDOUT instruction, the second instruction will not be executed until the execution of the first instruction is completed.

(3) Whether a BIDOUT instruction was completed normally or abnormally can be checked by the completion device ((D)) or status display device at completion ((D)+1).

(a) Completion device: Turns on at the END processing of the scan where the BIDOUT instruction is completed, and turns off at the next END processing.

(b) Status display device at completion : Turns on and off depending on the completion status of the BIDOUT instruction.
- Normal completion : Off with no change.
- Abnormal completion: Turns on at the END processing of the scan where the BIDOUT instruction is completed, and turns off at the next END processing.

[Operation during execution of a BIDOUT instruction]



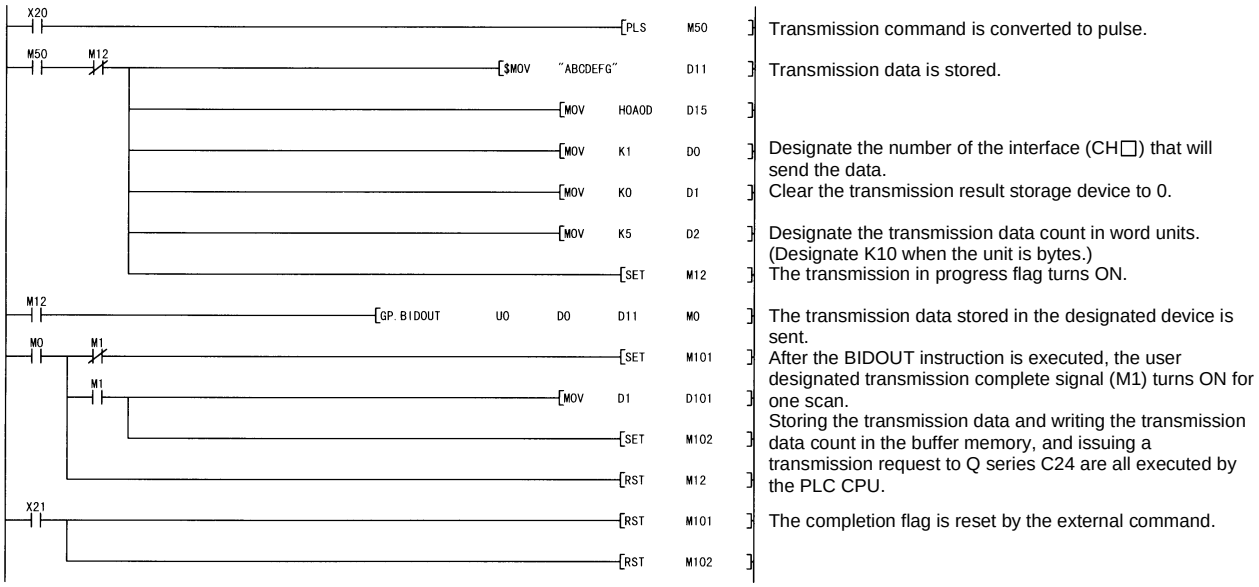
Error

(1) When a dedicated instruction is completed abnormally, the abnormal completion signal (D)+1, turns on and the error code is stored in the transmission result (S1)+1.
In case of operation errors, the error flag (SM0) turns on and the error code is stored in SD0.
See one of the following manuals according to the error code, and check and correct the error.
<Error code>
4FFF$_H$ or less : QCPU(Q Mode) User's Manual
(Hardware Design, Maintenance and Inspection)
7000$_H$ or more: Section 10.2 of the User's Manual (Basic)

Program example

The following example shows a program that sends any data stored in D11 to D15 using the bidirectional protocol.

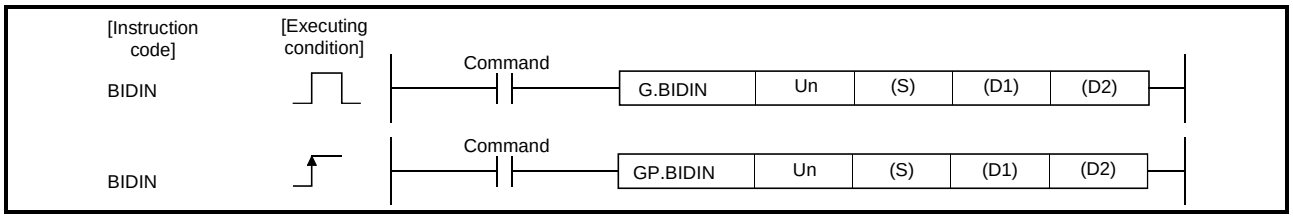
When the input/output signals of the Q series C24 are from X/Y00 to X/Y1F:



9.6 BIDIN Instruction

This instruction receives data using the bidirectional protocol.

Set data	Applicable device								
	Internal device (System, user)		File register	MELSECNET/H, MELSECNET/10 Direct J□\□		Special module U□\G□	Index register Zn	Constant	Others
	Bit	Word		Bit	Word				
(S)	—	○		—					
(D1)	—	○		—					
(D2)	○	○		—					



Set data

Set data	Description	Set by	Data type
Un	Start I/O signal of the module (00 to FE: Top two-digit when I/O signals are expressed in 3-digit.)	User	BIN16 bit
(S)	Head number of the devices in which control data is stored.	User, system	Device name
(D1)	Head number of the devices in which receive data is stored.	System	
(D2)	Bit device number to be turned on at completion of execution.	System	Bit

The file register per local device and program cannot be used as the set data.

Control data

Device	Item	Set data	Setting range	Set by
(S) + 0	Receive channel	• Set receive channel 1: Channel 1 (CH1 side) 2: Channel 2 (CH2 side)	1, 2	User
(S) + 1	Reception result	• Reception result by a BIDIN instruction are stored. 0: Normal Other than 0: Error code ＊1	—	System
(S) + 2	Receive data count	• The number of data received is stored.＊2	1 or more	System
(S) + 3	Allowable number of receive data	• Set the allowable number of words for received data that can be stored in (D1).	1 or more	User

POINT

(1) The command of G (P).BIDIN cannot be converted into pulse.

(2) G (P).BIDIN should be executed while the read request of the input/output signal is turned on.

*1 For error codes relating to abnormal completion, see Chapter 10 of the User's Manual (Basic).

*2 When setting "Word/byte units designation" by QSCU, set the number of bytes when bytes are designated and set the number of words when words are designated as the unit types.

*3 The settings are done by either of the following:
- User: Data set by the user before executing the BIDIN instructions.
- System: The PLC CPU stores the execution result of the BIDIN instructions.

Function

(1) The function stores in the device designated in (D1) and succeeding devices the data received via the bidirectional protocol of the module designated in Un, according to the control data of the device designated in (S) and succeeding devices.

(2) When a BIDIN instruction is executed on a channel, other BIDIN instructions cannot be executed on the channel at the same time.
If an attempt is made during execution of a BIDIN instruction to execute another BIDIN instruction, the second instruction will not be executed until the execution of the first instruction is completed.

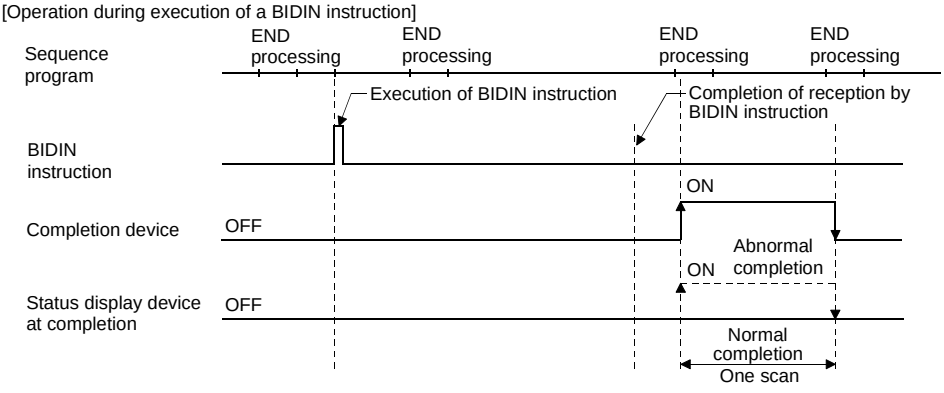
(3) It cannot be used along with BUFRCVS instruction (for interrupt programs).

(4) Whether a BIDIN instruction was completed normally or abnormally can be checked by the completion device ((D2)) or status display device at completion ((D2)+1).

(a) Completion device: Turns on at the END processing of the scan where the BIDIN instruction is completed, and turns off at the next END processing.

(b) Status display device at completion : Turns on and off depending on the completion status of the BIDIN instruction.
- Normal completion : Off with no change.
- Abnormal completion: Turns on at the END processing of the scan where the BIDIN instruction is completed, and turns off at the next END processing.

[Operation during execution of a BIDIN instruction]



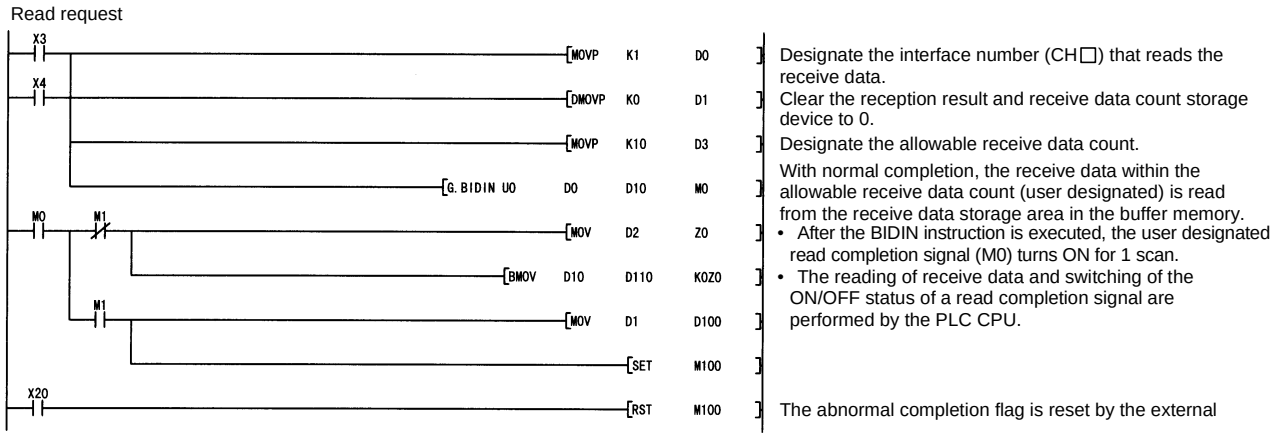
Error

(1) When a dedicated instruction is completed abnormally, the abnormal completion signal (D2)+1, turns on and the error code is stored in the transmission result (S1)+1.
In case of operation errors, the error flag (SM0) turns on and the error code is stored in SD0.
See one of the following manuals according to the error code, and check and correct the error.
<Error code>
4FFF$_H$ or less : QCPU(Q Mode) User's Manual
(Hardware Design, Maintenance and Inspection)
7000$_H$ or more: Section 10.2 of the User's Manual (Basic)

Program example

The following example shows a program that receives any data using the bidirectional protocol and stores that data in D10 or later.

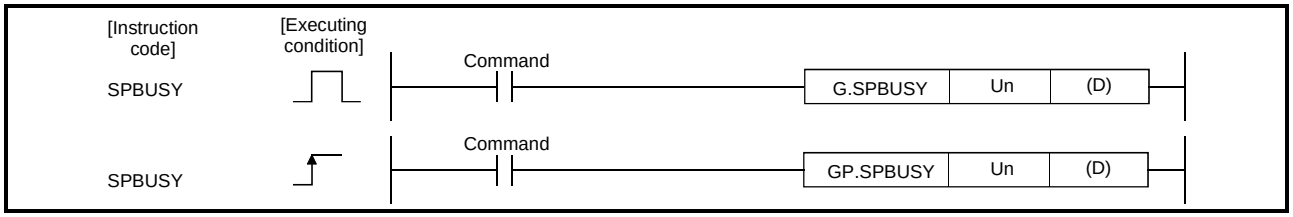
The input/output signals of the Q series C24 are from X/Y00 to X/Y1F:



9.7 SPBUSY Instruction

This instruction reads the status of data transmission and reception executed with dedicated instructions.

Set data	Applicable device								
	Internal device (System, user)		File register	MELSECNET/H, MELSECNET/10 Direct J□\□		Special module U□\G□	Index register Zn	Constant	Others
	Bit	Word		Bit	Word				
(D)	○			—					



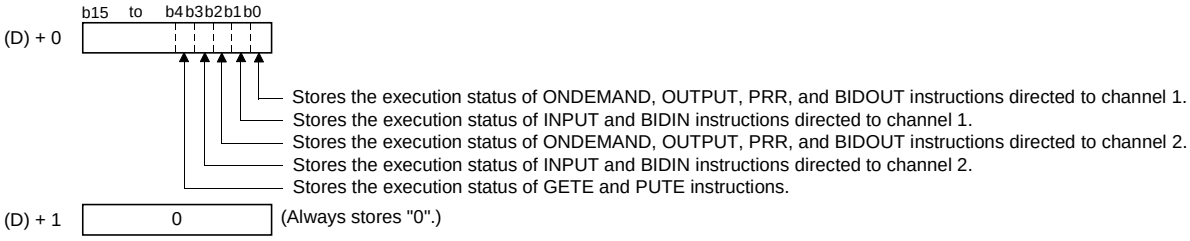
Set data

Set data	Description	Set by	Data type
Un	Start I/O signal of the module (00 to FE: Top two-digit when I/O signals are expressed in 3-digit.)	User	BIN16 bit
(D)	Head number of devices in which the read communication status is stored.	System	Device name

Function

(1) The function reads the execution status of a dedicated instruction directed to a module designated by the start I/O signal, and stores it in the device designated by (D) or later.

(2) The execution status is stored in (D) in the form of "1" at the corresponding bit when the processing of each instruction is started, and "0" when the processing is completed.
The processing of each instruction is completed when the completion flag of each instruction is turned from on to off.



(3) The SPBUSY instruction is executed for every scan while the read command is ON, if the system is executing during ON. And, the instruction will be executed for a single scan when the read command rises from OFF to ON, if the system is starting up.

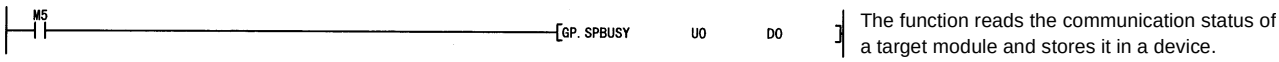
Error

(1) In case of operation errors, the error flag (SM0) turns on and the error code is stored in SD0.
See one of the following manuals according to the error code, and check and correct the error.
<Error code>
4FFF$_H$ or less : QCPU(Q Mode) User's Manual
(Hardware Design, Maintenance and Inspection)
7000$_H$ or more: Section 10.2 of the User's Manual (Basic)

Program example

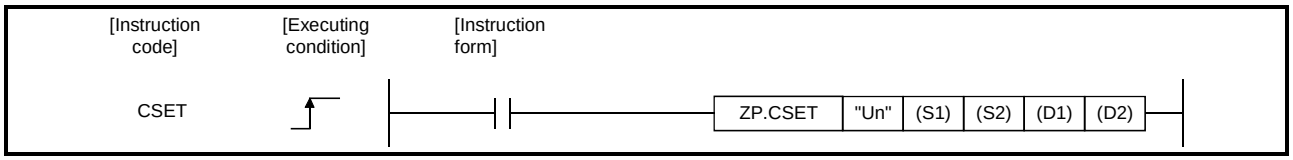
A program that reads the communication status of a target module.

When input/output signals of the Q series C24 are from X/Y00 to X/Y1F



9.8 CSET (Receive data clear)

Set data	Applicable device								
	Internal device (System, user)		File register	MELSECNET/H, MELSECNET/10 Direct J□\□		Special module U□\G□	Index register Zn	Constant	Others
	Bit	Word		Bit	Word				
(S1)	—	○		—				K, H	—
(S2)	—	○		—					
(D1)	—	○		—					
(D2)	○	○		—					



Set data

Set data	Description	Set by	Data type
"Un"	Start I/O signal of the module (00 to FE: Top two-digit when I/O signals are expressed in 3-digit.)	User	BIN16 bit
(S1)	Number of the channel that transmits the monitoring result. 1: Channel 1 (CH1 side) 2: Channel 2 (CH2 side)		
(S2)	Head number of the device that stores the control data.	User, System	Device name
(D1)	Dummy	—	Device name
(D2)	Head number of the bit device at the self-station that turns on for one scan at the completion of the instruction. (D2) + 1 also turns on at an abnormal completion.	System	Bit

Each of file registers for local device and program cannot be used as the setting data.

Control data

Device	Item	Set data	Setting range	Set by
(S2) + 0	Execution type	Select 0.	0	User
(S2) + 1	Complete status	The execution result at the completion of the instruction is stored. 0: Normal Other than 0: Abnormal (error code)	—	System
(S2) + 2	Request type	Specify the request. 4: Receive data clear request	4	User

REMARK

(1) See the "Error" explanation on the following page for details on errors caused by wrong data specifications by the user.

(2) The setting sides are partitioned as follows:
- User: Data set by the user before executing the dedicated instruction.
- System: The PLC CPU stores the execution result of the dedicated instruction.

Function

(1) This function clears reception data in the OS area. It does not clear the user data reception area in the buffer memory.

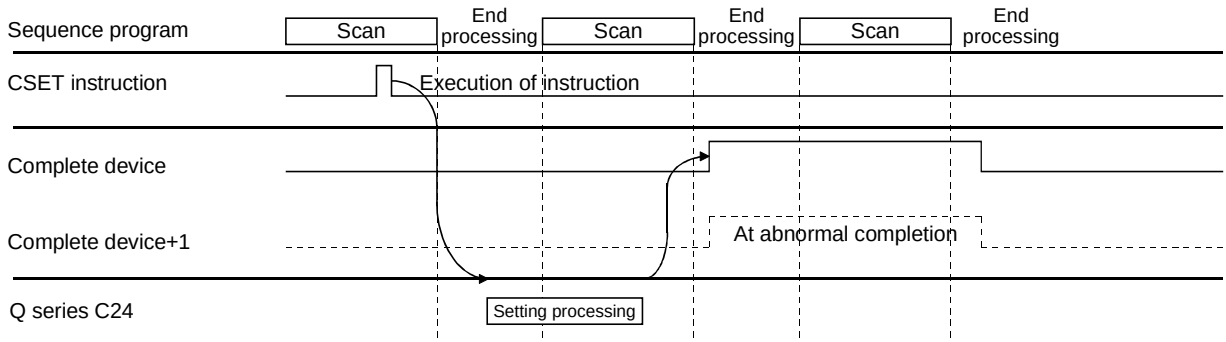
(2) If the CSET instruction is executed while the read request (X03/X0A) or reception abnormal detection signal (X04/X0B) is turned on, the CSET instruction is kept waiting until the signal is turned off.

(3) The status of the CSET instruction, whether it is being executed or completed normally/abnormally, can be checked by the complete device (D2) specified by the setting data.

(a) Complete device ((D2) + 0)
This device turns on at the End processing of the scan at which the CSET instruction is completed and turns off at the next End processing.

(b) Complete device ((D2) + 1)
It turns on/off by the status at which the CSET instruction is completed.
- At normal completion: It is kept turned off and does not change.
- At abnormal completion: It turns on at the END processing of the scan at which the CSET instruction is completed and turns off at the next END processing.

[Operation at execution of CSET instruction]



Error

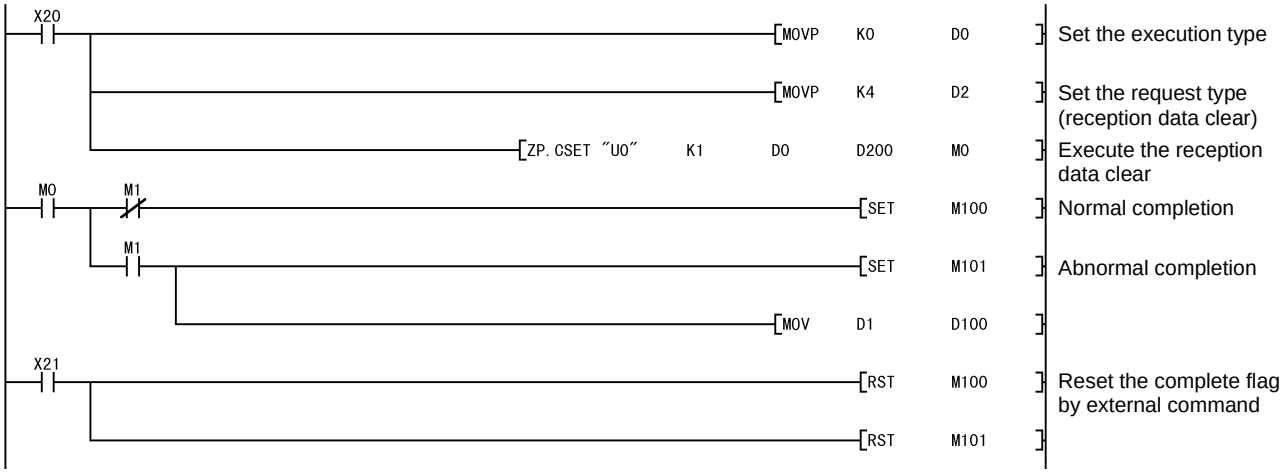
(1) If the dedicated instruction is abnormally completed, the error flag (SM0) turns on and the error code is stored in SD0.
See the following manuals according to the error code, and check/take action according to the error.

<Error code>
4FFFH or less: QCPU User's Manual
(Hardware Design, Maintenance and Inspection)
7000H or more: Section 10.2 of the User's Manual (Basic)

Program example

This is an example of a program that clears reception data on the Q series C24 side.

It is assumed that the input/output signals of the Q series C24 are X/Y00 to X/Y1F.



10 TROUBLESHOOTING

This chapter explains the definitions of errors that may occur during data communication between the Q series C24 and external devices, and the corrective actions.

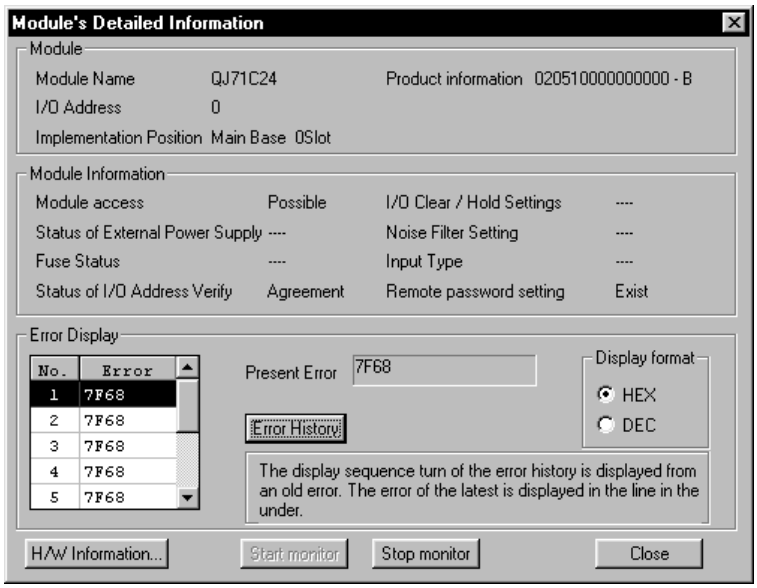
10.1 Checking the Status of the Serial Communication Module

10.1.1 Checking the LED ON status, communications error status, and switch setting status of the serial communication module

This section explains how to check the status of communication between the Q series C24 and external devices, the transmission status of the Q series C24, and the switch setting status of the Q series C24.
When a communication problem occurs, check the error status using one of the following procedures:

(1) Checking the module status and error codes in the detailed module information screen of the GX Developer diagnostic functions

[Startup procedure]
GX Developer → [Diagnostics] → [System monitor] →
Module's Detailed Information



(For SW6D5C-GPPW-E)

10

[Displays]

- Module

  The following information is displayed:

  Module name : The name of the module installed
  I/O Address : The start input/output signal (number) of the target module
  Implementation Position: The slot position where the module is mounted
  Product information : Product information
  ∗ The last character of the product information indicates the function version of the module.
  (Example) If the last character is "B," it means that the module is of function version B.

- Unit access (Module access)

  Displays access permissions when the Ready signal (X1E) is turned on and the WDT error signal (X1F) is turned off.

- Status of I/O Address Verify

  Displays whether or not the module for which the user set the parameters matches the module installed.

- Remote password setting status

  Displays the setting status of the remote password.

- Present Error

  Displays the error code of the latest error occurrence.

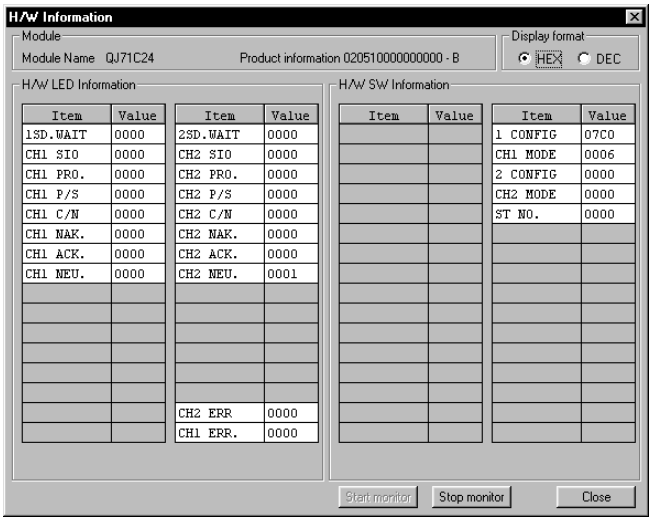
- Error Display

  Displays the error codes for any errors that have occurred in any of the functions being used.

(2) Checking using the hardware information screen of the GX Developer diagnostic functions

[Startup procedure]

GX Developer → [Diagnostics] → [System monitor] →
Module's Detailed Information → H/W Information



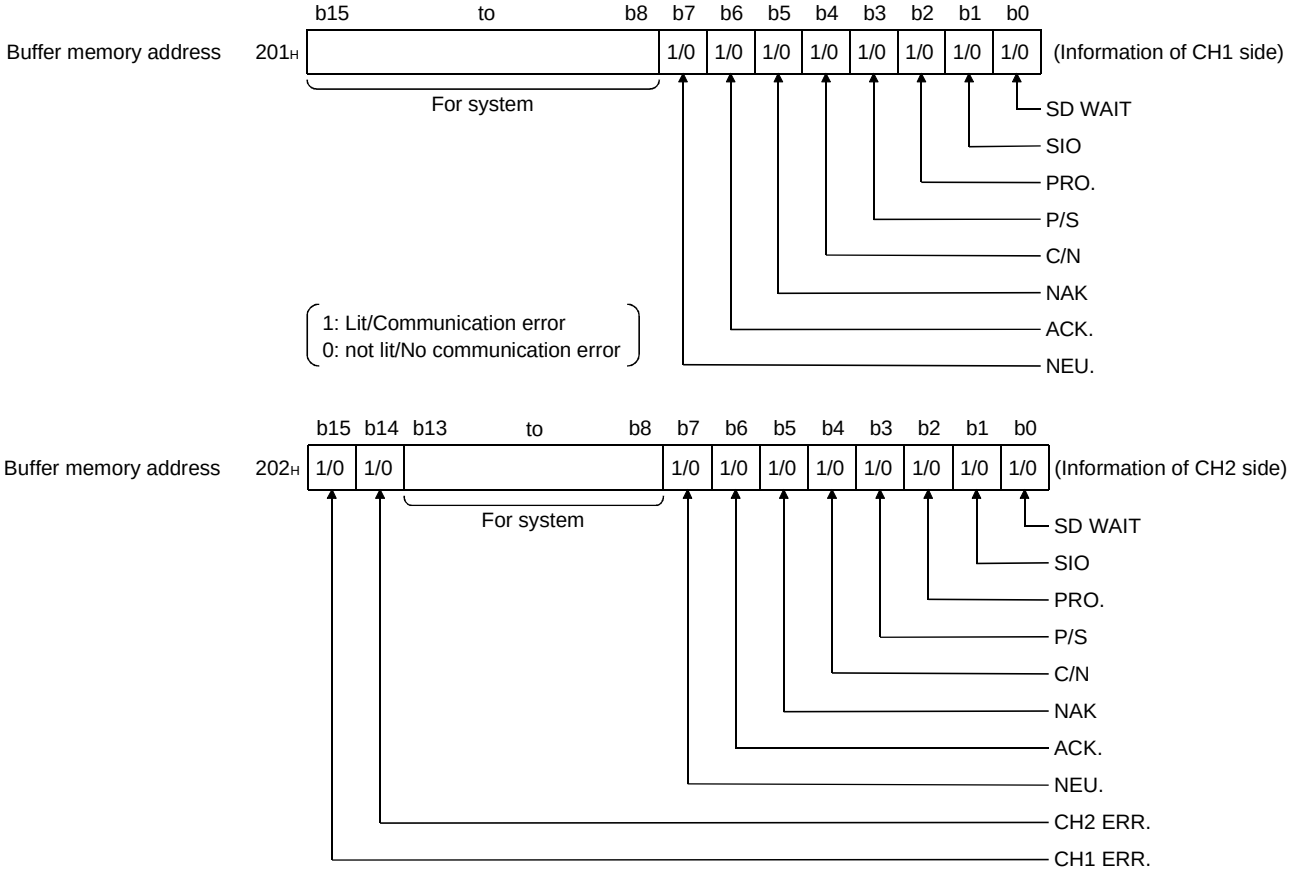
(For SW6D5C-GPPW-E)

[Displays]

1) H/W LED Information Right side (Left side: CH1 information/
Right side: CH2 information)

Displays the transmission status and the communications error status of the Q series C24.

(Displays 201H/202H of the buffer memory.)



2) H/W SW Information Parameter

The switch information of the Q series C24 is displayed.

Numbers 1 through 5 correspond to switches 1 through 5 shown in Section 4.5.2.

(See Section 4.5.2 of the User's Manual (Basic).)

(3) Checking by QSCU

Display the "Monitor others" screen.
For details on display screens, see Section 8.6.9 of the User's Manual (Basic).

(4) Description of LED ON status and communications error status

No.	Status signal name	Description	Description when ON (when LED is turned on (1))	Description when OFF (when LED is turned off (0))	Initial state	Related protocol		
						MC	Non procedure protocol	Bidirectional protocol
1	SD WAIT	Transmission wait status	Waiting for data transmission	Data transmission start	OFF	○		
2	SIO	SIO error status	Overrun or framing error occurred.	Normal	OFF	○		
			OS area is full. ＊ Received data was deleted.		OFF	—	○	
3	PRO.	Communication protocol error status	Error occurred.	Normal	OFF	○	—	
4	P/S	Status of parity error or sum check error	Error occurred.	Normal	OFF	○		
5	C/N	Access status with the PLC CPU	(＊1)	Normal	OFF	○	—	
6	NAK	Abnormal completion status	Abnormal completion transmission	Normal completion transmission	OFF			
7	ACK.	Normal completion status	Normal completion transmission	Abnormal completion transmission	OFF			
8	NEU.	Neutral status ＊ Waiting to receive command	Neutral	Command reception	(＊2)			
9	CH2. ERR	Error occurrence status on CH2 side	Switch setting error Mode switching error Transmission error Reception error On-demand error	Normal	OFF	○		
10	CH1. ERR	Error occurrence status on CH1 side			OFF			

＊1 C/N turns on in the following cases:

- An external device issued a data read request to the PLC CPU when write during RUN is set to prohibit in the switch settings by GX Developer (see Section 4.5.2).

  ＊ For functions that cannot be used when write during RUN is set to prohibit, see the explanation section in each command list of the Reference Manual.
- When an error has occurred during access between the Q series C24 and the PLC CPU.

＊2 NEU. is valid when a target interface is set to use the MC protocol.
When the target interface is set to other than the MC protocol, the status of NEU. is off.

(a) When a communication error occurs, take corrective action according to Section 10.3.

(b) The initial status of the LED ON and communications error indicates the status when the Q series C24 starts up by turning on the power or resetting the PLC CPU.

(c) Each of the communications error status, C/N to SIO, CH1 ERR. and CH2 ERR., turns on when an error occurs, and keeps its on-status even after the communication returns to normal.
The PLC CPU can check the aforementioned LED ON status and communications error status, and initialize any error information using read/write to the buffer memory of the Q series C24 and input/output signals. Initialize the error information according to Section 10.1.2.

(d) NAK to NEU. (No. 6 to 8) turn on/off depending on the status.

(e) SD WAIT turns on when data cannot be sent to the external device by the transmission control of the Q series C24 (waiting for data transmission).
- When transmission cannot be started.
- When a transmission pause request is received during data transmission. (DSR signal is off, reception by DC3)
SD WAIT turns off when transmission becomes possible and data transmission is started/resumed.

10.1.2 Initializing error information of the serial communication module

This section explains the ERR. LED ON factors and the error information initialization (clear) for the Q series C24.

(1) ERR. LED ON factors

When any of the following errors occurs, its error code is stored in the buffer memory corresponding to the interface (CH) where the error occurred, and the ERR. LED turns on.

Cause of error	Error code storage buffer memory			Applicable protocol		
	Address		Name	MC	Non-procedure protocol	Bidirectional protocol
	CH1	CH2				
Switch setting error Mode switching error	203H		Switch setting error, mode switching error storage area	○	○	○
On-demand execution error	256H	266H	On-demand execution result storage area	○	×	×
Data transmission error	257H	267H	Data transmission result storage area	○	○	○
Data reception error	258H	268H	Data reception result storage area	○	○	○
MC protocol transmission error	025AH	026AH	MC protocol transmission error code	○	×	×
Monitoring device error	2205H	2305H	PLC CPU monitoring function execution result	○	○	○

(2) Turning off the ERR. LED and initializing the error information by QSCU

Display the "Monitor" screen.
Performing the initialization operation for the error information on the "Monitor" screen will turn off the ERR. LED of the Q series C24, and the error information stored is initialized.
For details on how to display this screen, see Section 8.6.10 of the User's Manual (Basic).

(3) Turning off the ERR. LED and initializing the error information by the PLC CPU

(a) Input signals used to notify of error occurrences and output signals used to initialize the error information

I/O signal		Name of status information	Description/function
Input signal	XE	Error occurrence on CH1 side	Turns on upon error occurrence in CH1 interface.
	XF	Error occurrence on CH2 side	Turns on upon error occurrence in CH2 interface.
Output signal	YE	CH1 Error information initialization request	Turns on when initializing error information of interface on CH1 side.
	YF	CH2 Error information initialization request	Turns on when initializing error information of interface on CH2 side.

* Initialization of error information is continuously performed when output signal (YE/YF) is on.

POINT

Error information on the CHn side can be initialized by an off request to the LED off request area (address 1H) of the buffer memory. By using output signals YE to YF, the error codes stored in the above buffer memory can also be initialized (cleared).

(b) Initializing communication error information by writing

Communication error information can be initialized by writing "1" to the corresponding bit in the buffer memory addresses 0H to 1H.

* The displayed LEDs and communication error information may be turned on/off in the following cases:
  - NEU. to NAK turn on/off depending on the status.
  - C/N to SIO turn on when errors occur and keep the ON-status even after the operation returns to normal.

1) LED and communications error information initialization request area (address: 0H to 1H)

The contents of the error information corresponding to each bit in this request area are the same as those for the LED ON/communication error status storage area (address: 201H to 202H).

For more details, see Section 10.1.1 (1).

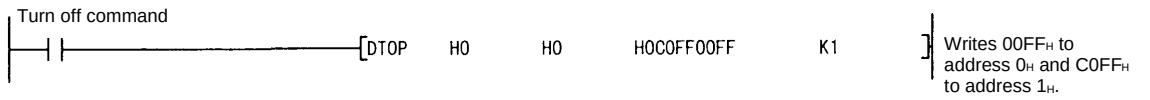
The following describes the correspondence between the LED OFF request areas and the LED ON status storage areas:

- LED and communication error information initialization request area (address: 0H) LED ON and communications error status storage area (address: 201H)
- LED and communications error information initialization request area (address: 1H) LED ON and communications error status storage area (address: 202H)

2) Example of a program for turning off displayed LEDs

The following shows an example of a program that issues an initialization request for all the communication error information. (Input/output signals X/Y00 to X/Y1F of QC24)

● Example of TO instruction



POINT

(1) Initialization requests are valid only when write operation is performed.
The initialization requests clear all data in the LED ON and communication error information storage area (201H to 202H) at the same time.
Furthermore, when initialization of error information on the CH1 and CH2 sides is requested, XE and XF also turn off.

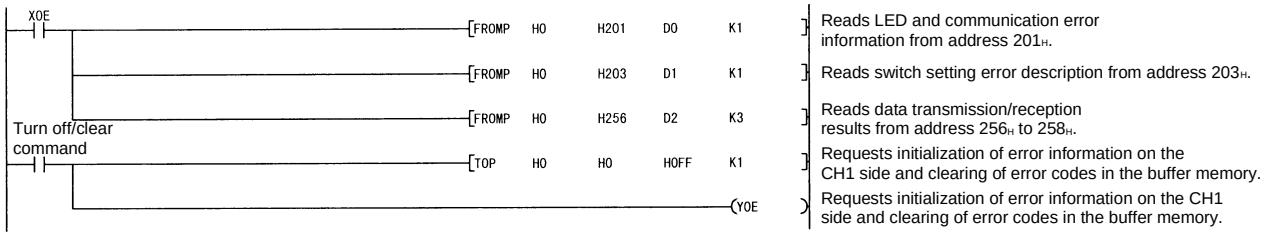
(2) Data written to the buffer memory address 0H to 1H is cleared after initialization processing.

(3) If errors persist even after completion of the initialization processing, the corresponding communication error information is stored again and the corresponding bit in the LED ON and communications error status storage area (201H to 202H) turns on (1).

(c) Examples of programs that initialize displayed LED and communication error information

The following shows examples of a program that reads error codes when errors described in (1) above occur in an interface on the CH1 side and initializes the displayed LED and communication error information.
Incorporate the necessary part of the program.
(Input/output signals X/Y00 to X/Y1F of the Q series C24)

1) When data is communicated using the MC protocol



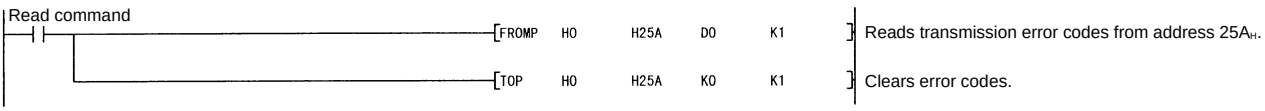
Check the error codes and take corrective action according to Section 10.2.

2) When data is communicated using the non procedure or bidirectional protocol

Check the error codes and take corrective action according to Section 10.2.

REMARK

When data is communicated using the MC protocol, the displayed ERR. LED may not be turned on if the Q series C24 sends an NAK message to the external device in response to the command message.
Error codes (see Section 10.2) corresponding to the error content when the NAK message is sent back to the external device are stored in the following areas. (when communicating with an A compatible 1C frame, the error codes differ from the transmission error code.)
When checking error codes transmitted by the PLC CPU, incorporate the following program (in case of the interface on the CH1 side).



Check the error codes and take corrective action according to Section 10.2.

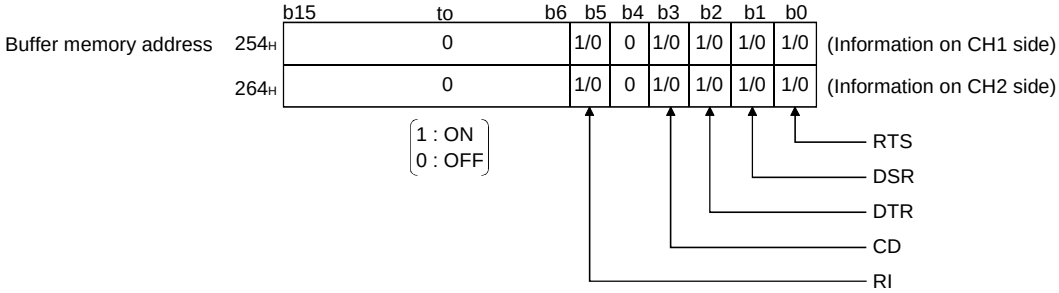
10.1.3 Reading the RS-232 control signal status

This section explains how to read the control signal status stored in the buffer memory during communication using RS-232 interface.
When QSCU is used, check the status using the "Transmission control and others monitor" screen (see Section 8.6.3).

When a transmission problem occurs, read operation is executed to check the signal on/off status of the RS-232 interface.

(1) RS-232 control signal status storage area (address: 254H, 264H)

The status of the RS-232 signals is stored in buffer memory addresses 254H and 264H as follows:



REMARK

(1) For more details on signals for RS-232, see Section 3.2.1.

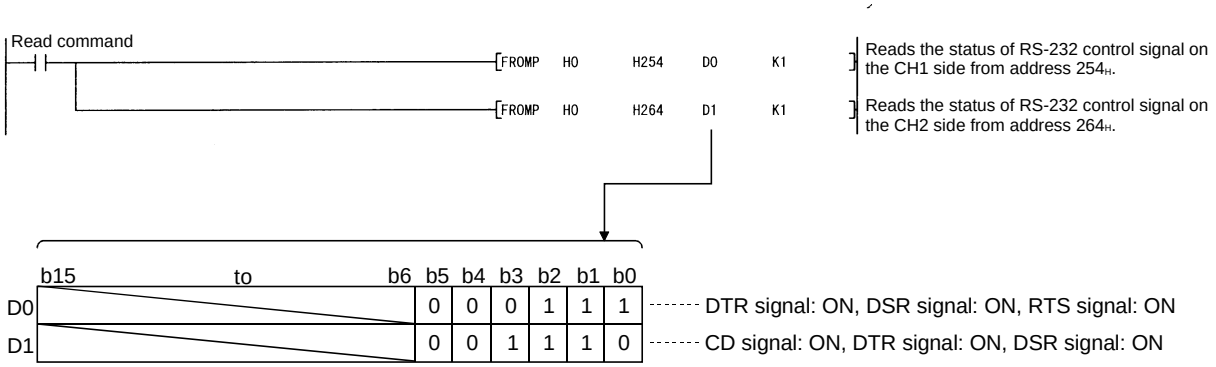
(2) Signals output from the Q series C24 side (RTS and DTR) are controlled by the operating system (OS) of the Q series C24.
They cannot be directly controlled by the sequence program.

(3) There is a maximum delay of 100 ms in signal status stored in the buffer memory above.

(2) Example of a program that reads from RS-232 control signal status storage area

The following shows an example of a program that reads the RS-232 control signal status.
(input/output signals X/Y00 to X/Y1F of the Q series C24)

● Example of FROM instruction



10.1.4 Reading the data communication status (Transmission sequence status)

This section explains how to read the current status of the data communication using the MC protocol stored in the buffer memory.
When QSCU is used, check the status using the "MC protocol monitor" screen (see Section 8.6.4).

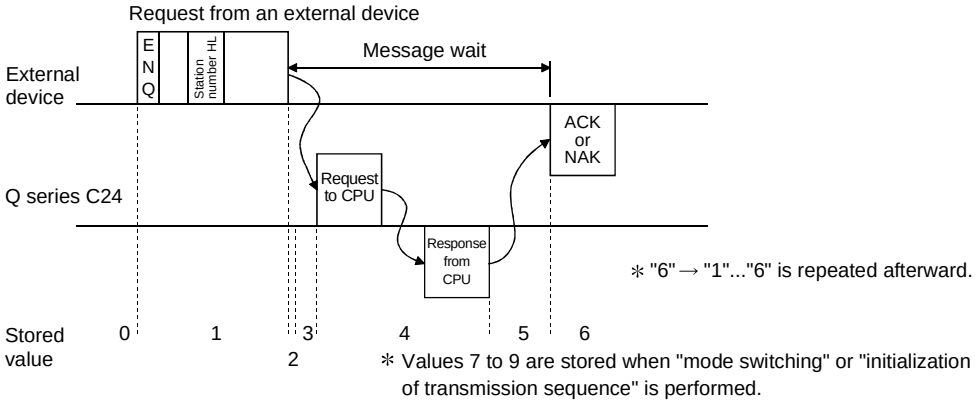
When a transmission problem occurs, read operation is executed to check the status of the data communication using the MC protocol.

(1) Transmission sequence status storage area (address: 255H and 265H)

The status of data communication using the MC protocol is stored as a numerical value in buffer memory addresses 255H and 265H.

Buffer memory address		b15 to b0	
	255H	0 to 9	(Information on the CH1 side)
	265H	0 to 9	(Information on the CH2 side)

The following shows the correspondence between the numerical values in the transmission sequence status storage area and the data communication status.



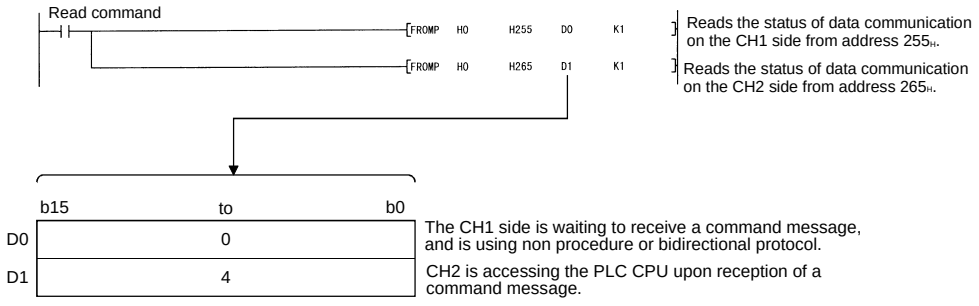
REMARK

When the target interface is not set to use the MC protocol, "0" is stored in the transmission sequence status storage area.

(2) Example of a program that reads from transmission sequence status storage area

The following shows an example of a program that reads from the transmission sequence status storage area.
(input/output signals X/Y00 to X/Y1F of the Q series C24)

● Example of FROM instruction



10.1.5 Reading the switch setting status

This section explains how to read the setting status of various switches of the Q series C24 stored in the buffer memory.
When QSCU is used, check the status in the "Monitor others" screen (see Section 8.6.9).

When a switch setting error occurs, read operation is executed to check the status of various switches of the Q series C24.
The Q series C24 reads the switch settings designated in GX Developer at startup from the PLC CPU and operates according to the settings.

REMARK

(1) The communication protocol and transmission settings can be changed at mode switching (see Chapter 15 of the User's Manual (Application)).

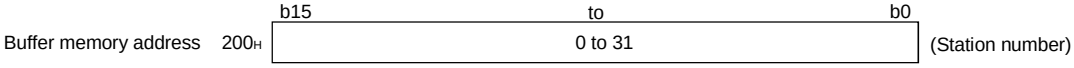
(2) If switch setting errors occur after mode switching, check the setting changed by the user by performing read operations as described in Section 10.1.6.

(3) For the description of the communication protocol, station number, and transmission settings, see Section 4.5.

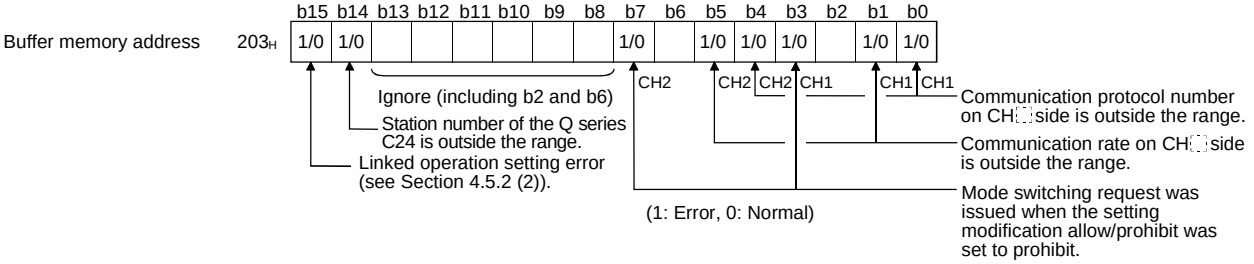
(1) Setting status storage area

The switch settings by GX Developer and setting error information are stored in different areas of the buffer memory shown below.

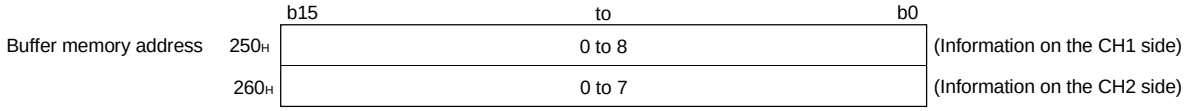
1) Station number setting status storage area (address: 200H)



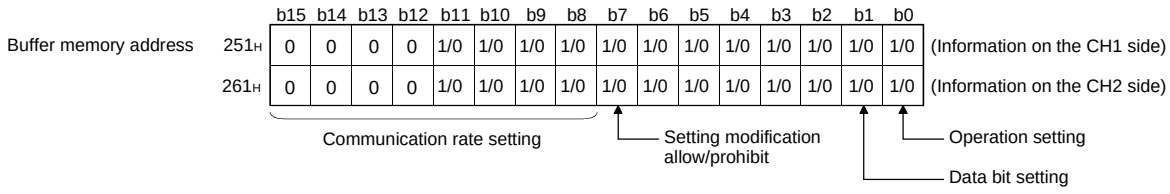
2) Switch setting error/mode switching error storage area (address: 203H)



3) Communication protocol setting storage area (address: 250H and 260H)



4) Transmission setting status storage area (address: 251H and 261H)



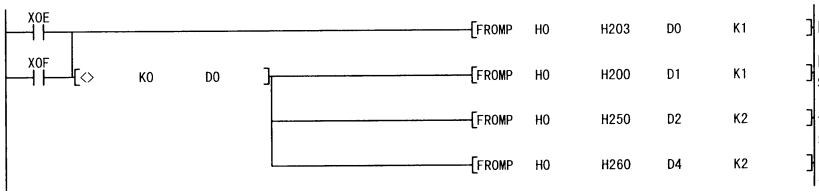
(2) Example of a program that reads from the setting status storage area

The following shows an example of a program that reads the setting of various switches of the Q series C24 from the setting status storage area.

For details on XE and XF of the input/output signals used in the program, see Section 10.1.2 (3).

(input/output signals X/Y00 to X/Y1F of the Q series C24)

● Example of FROM instruction



Reads error description from address 203H.

Reads station number setting and switch setting description from address 200H.

Reads communication protocol setting and transmission setting description on the CH1 side from addresses 250H to 251H.

Reads communication protocol setting and transmission setting description on CH2 from addresses 260H to 261H.

Restarts the Q series C24 after checking the error code and resetting switches.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	
D0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Error description (1: Communication protocol number setting error)
D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Setting station number of the Q series C24 (0).
D2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	CH1 side: Communication protocol setting number (9).
D3	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	CH1 side: (transmission setting description)
D4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	CH2 side: Communication protocol setting number (1).
D5	0	0	0	0	0	1	0	1	0	1	1	0	1	0	1	0	CH2 side: (transmission setting description)

Displays communication protocol number setting error status on the CH1 side

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10.1.6 Reading the switch setting status for the current operation

This section explains how to read the switch setting status stored in the buffer memory that are relevant to the current operation of the Q series C24.
When QSCU is used, check the status in the "Transmission control and others monitor" screen (see Section 8.6.3).

When a switch setting error occurs after mode switching (see Chapter 15 of the User's Manual (Application)), read operation is executed to check settings changed by the user.
The switch settings by GX Developer can be changed at mode switching and if the setting at mode switching is incorrect, a switch setting error occurs.

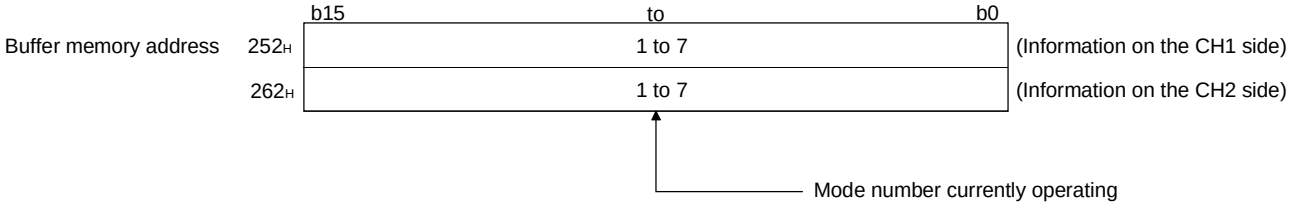
REMARK

- The status of the switch settings by GX Developer can be checked by performing read operations as described in Section 10.1.5.
- For the description of the communication protocol and transmission settings, see Section 4.5.

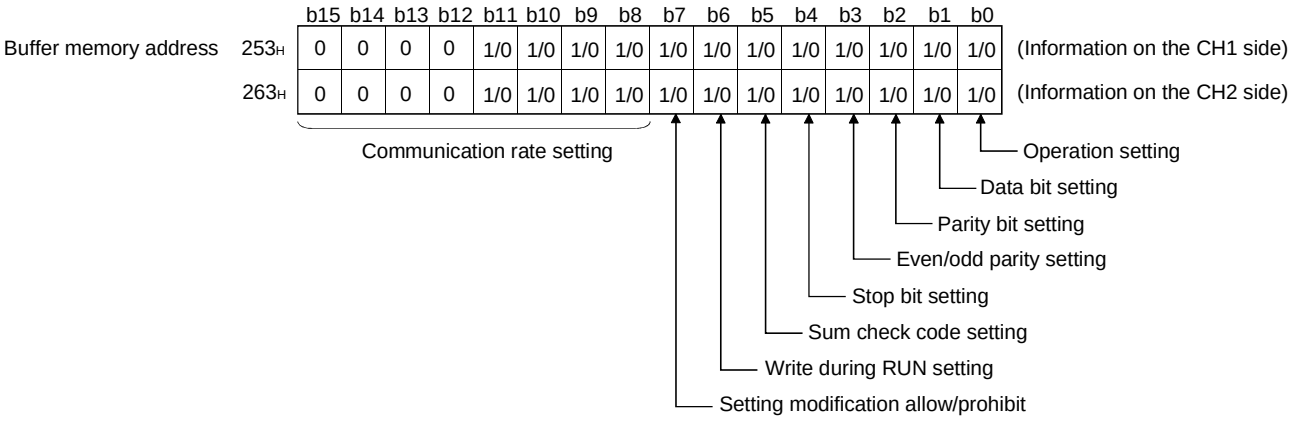
(1) Operation mode status storage area

The status of the switch settings for the current operation of the Q series C24 is stored in the areas of the buffer memory shown below.

1) Communication protocol setting status storage area (addresses: 252H and 262H)



2) Transmission setting status storage area (address : 253H, 263H)



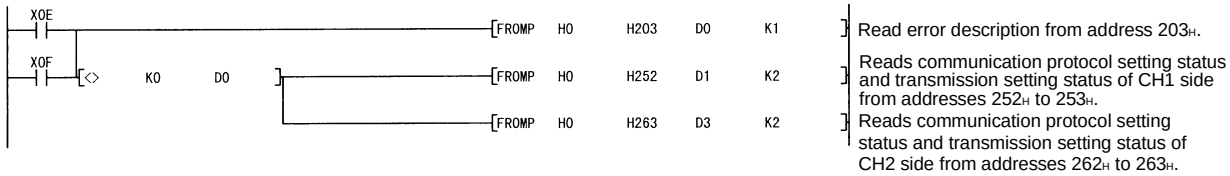
(2) Example of a program that reads from the current setting status storage area

The following shows an example of a program that reads from the switch setting status storage area for current operation of the Q series C24.

For details regarding XE and XF of the input/output signals used in the program, see Section 10.1.2 (3).

(input/output signals X/Y00 to X/Y1F of the Q series C24)

● Example of FROM instruction



After checking error codes and changed setting values, designate the correct setting values and switch mode.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	
D0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	Communication protocol Error description (2: Communication rate error)
D1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	CH1 side: Setting communication protocol number 6 (transmission setting description)
D2	0	0	0	0	1	1	1	1	0	0	0	0	1	0	1	0	
D3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	CH2 side: Setting communication protocol number 1 (transmission setting description)
D4	0	0	0	0	0	1	0	1	0	1	1	0	1	0	1	0	

While the CH1 side is set to the non procedure protocol and the CH2 side is set to the MC protocol (format 1), this indicates the communication rate setting error on the CH1 side.

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10.2 Error Code Tables

The following shows the error codes, error contents, and corrective action for errors that are generated during communications between the Q series C24 and an external device.
For errors without a corresponding LED entered to errors generated with the MC protocol communication, only the "NAK" LED is turned ON.

10.2.1 QnA compatible 2C/3C/4C frame communications/Flash ROM access error code table

The following shows the error codes, error contents, and corrective action for errors generated during communications using the QnA compatible 2C/3C/4C frame, and during Flash ROM access.
("*" in the table is the error code when the target CPU is not a Q/QnACPU.)

Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Protocol		
					MC	Non Proce-dure	Bidire-ctional
3E8H to 3FFFH	—	(Error detected by the CPU)	—	• See Troubleshooting of the QCPU (Q mode) maintenance and inspection user's manual and take corrective action.	○		
4000H to 4FFFH	—	(Error detected by the CPU)	—	• See Appendix of the QCPU (Q mode) maintenance and inspection user's manual (details) and take corrective action.	○		
7103H	PLC access error	• Cannot communicate with the Q series C24 CPU.	C/N	• Make the watchdog timer (timer 1) time longer. • Check if the CPU can communicate in communication protocol No. "F".	○		
7140H *	Request data error	• Number of request points exceeds the range for the command. • A word device was designated in a bit units command. • The last device No. exceeds the range. (Given device last No. ≧ Designated head device No. + Designated number of points)	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7142H *	Device name error	• A device that cannot be designated by the given command was designated.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7143H *	Device No. error	• The head device No. is out of range.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7144H *	Monitor data write error	• Monitoring was requested before the device to be monitored was written.	PRO	• Write the device to be monitored before issuing a monitor request.	○		
7145H *	Monitor PLC No. error	• The written PLC No. and PLC No. in the monitor request are different.	C/N	• Rewrite the monitor data.	○		
7146H *	Monitor CPU model name error	• The written CPU model name and the CPU monitor name in the monitor request are different.	C/N	• Rewrite the monitor data.	○		
7147H *	Written number of monitoring points overrun error	• The written number of monitoring points exceeds the designated range.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7148H *	Extension R block No. error	• A nonexistent extension file register block No. was designated. • A block No. being used as an extension comment area, sampling trace area, or status latch area was designated.	PRO	• Correct the designated block No. and restart data communications.	○		

Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Protocol		
					MC	Non Proce-dure	Bidire-ctional
714A$_H$ *	Cannot execute a command during RUN	• A write command was designated when "Disable write during RUN" was set. • Parameter or sequence program was written during RUN.	C/N	• Change the setting to "Enable write during RUN" and restart data communications. • Stop the CPU and restart data communications.	○		
714E$_H$ *	Monitor network No. error	• The written monitor network No. and the monitor request network No. are different.	C/N	• Check and correct the other station access valid module No. in the network parameters. • Rewrite the monitor data.	○		
7151$_H$	PLC No. designation error	• A PLC No. other than "FF" or "0 to 64(00$_H$ to 40$_H$)" was designated.	C/N	• Check and correct the external device transmit message and restart data communications.	○		
7153$_H$	Frame length error	• The received message length has exceeded the allowable range.	CHn ERR.	• Review the transmission message. • Correct the message format so the number of access points is within the allowable range.	○		
7155$_H$	Unwritten monitor data error	• Monitoring was requested before monitor data was written.	PRO	• Write the device to be monitored before issuing a monitor request.	○		
7160$_H$	PLC access error	• CPU model name cannot be confirmed.	C/N	• If there is an error in the CPU, remove the CPU error and restart data communications.	○		
7164$_H$	Request error	• Either the request or the device designation method is wrong.	—	• Check the transmission message/request from the external device, make the necessary corrections, and send again.	○		
7167$_H$	Cannot execute a command during RUN	• A write command was designated when "Disable write during RUN" was set.	C/N	• Change the setting to "Enable write during RUN" and restart data communications.	○		
7168$_H$		• A command that cannot be executed during RUN was designated.	C/N	• Stop the CPU and restart data communications.	○		
7169$_H$	CPU error	• Cannot communicate normally with the CPU.	C/N	• If there is an error in the CPU, remove the CPU error and restart data communications.	○		
716D$_H$	Monitor data write error	• Monitor data was not written using QnA compatible 2C/3C/4C frame.	PRO	• Rewrite monitor data.	○		
716E$_H$		• Monitor data was not written using A compatible 1C frame.	PRO				
7170$_H$	A compatible 1C frame error	• Number of access points exceeded the range.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7171$_H$		• A device that cannot be designated was designated.	PRO		○		
7172$_H$		• Written number of monitoring points is incorrect. For example, [0] was designated.	PRO		○	○	○
7173$_H$	Monitor data write error	• Monitor data was written for a CPU other than a Q/QnACPU using QnA compatible 2C/3C/4C frame.	PRO	• Write the monitor data and use the A compatible 1C frame to a CPU other than a Q/QnACPU.	○		
7E06$_H$	Buffer memory address setting error	• Transmit/receive buffer memory addresses are in the special applications area.	—	• Change the buffer memory addresses so that they are outside the special applications area.			
7E40$_H$	Command error	• A nonexistent command or subcommand was designated.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7E41$_H$	Data length error	• A data length exceeding the number of points that can communicate during random read/write was designated.	PRO	• Check and correct the external device transmit message and restart data communications.	○		

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Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Protocol		
					MC	Non Proce-dure	Bidire-ctional
7E42H	Error count error	• Number of requested points exceeds the range for the command.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7E43H	Device error	• A nonexistent device was designated. • Device that cannot be specified by the corresponding command was designated.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7E44H	Timer 1 time-out error	• A response message was not returned within the response monitoring time (timer 1) monitoring time.	C/N	• Make the timer 1 monitoring time longer. • When accessing another station's CPU, check if the routing parameters match.	○		
7E47H	Continuous request error	• The next request was received before a response message was returned for the preceding request.	PRO	• Do not issue continuous requests from the external device. • Set the timer 1 monitoring time to the external device time-out time.	○		
7E4FH	Device point count error	• Access point count is incorrect.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7E50H	User frame No. designation error	• A user frame No. outside the range was designated.	PRO	• Check and correct the external device transmit message and restart data communications. • Recheck the frame No..	○		
7E51H	Unwritten user frame error	• An unwritten user frame No. was designated.	PRO	• Write the frame beforehand. • Change the frame No. and restart data communications. • Recheck the frame No..	○		
7E52H	User frame overwrite error	• A written frame No. overwrite request was issued.	PRO	• Change the write destination to an unwritten frame No. • When overwriting, delete the given No. beforehand.	○		
7E53H	User frame access data error	• A nonexistent command was designated in a subcommand. • Byte count exceeding the number of bytes that can be requested was designated.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7E54H	Modification allowed error	• Flash ROM write allow/prohibit designation from QSCU is set to OFF. • At the switch setting on GX Developer, modification allowed switch was set to OFF.	PRO	• Set to ON at QSCU. • Set to ON at GX Developer.	○	○	○
7E55H	User frame data error	• There is an error in the user frame variable data.	PRO	• Check and correct the external device transmit message and restart data communications.	○	○	
7E57H	Flash ROM write error	• Cannot write to Flash ROM normally.	PRO	• Re-execute the write operation. If the error is generated again, replace the module.	○		
7E58H	Mode modification error	• There was an error in the mode No. or transmission specification designated contents when changing the mode.	PRO	• Check and correct the contents of the external device transmit message and restart data communications. • Recheck the switch setting on the Q series C24.	○	○	○

Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Protocol		
					MC	Non Proce-dure	Bidire-ctional
7E5FH	I/O number error on requested module	• I/O number of requested module is incorrect.	—	• Correct the I/O number of the module to which data is sent.	○	○	
7E60H	Device monitoring duplicate registration error	• PLC CPU monitoring registration was performed twice.	—	• Cancel the PLC CPU monitoring and perform the PLC CPU monitoring registration again.	○	○	
7E61H	Cycle time units range error	• Setting value of cycle time units is out of range.	—	• Correct the setting value of the cycle time units.	○	○	
7E62H	PLC CPU monitoring function error	• Setting value of PLC CPU monitoring function is out of range.	—	• Correct the setting value of the PLC CPU monitoring function.	○	○	
7E63H	Transmission measure setting error	• Setting of transmission measure of the PLC CPU monitoring is incorrect.	—	• Correct the setting value of the transmission measure.	○	○	
7E64H	Registration point range error	• Registration point (word/bit) is out of range.	—	• Correct the setting value of the registration point (word/byte)	○	○	
7E65H	PLC CPU abnormal monitoring number error	• Setting value of the PLC CPU abnormal monitoring is out of range.	—	• Correct the setting value of the PLC CPU abnormal monitoring.	○	○	
7E66H	Monitoring condition error of monitoring device	• Setting value of transmission condition is out of range.	—	• Correct the setting value of the transmission condition.	○	○	
7E67H	CPU abnormal monitoring setting value error	• Setting value (fixed value) of CPU abnormal monitoring is out of range.	—	• Correct the setting value (fixed value) of the CPU abnormal monitoring.	○	○	
7E68H	Transmission condition range error of monitoring device	• Setting value of transmission condition (condition agreement transmission) is out of range.	—	• Correct the setting value of the transmission condition (condition agreement transmission).	○	○	
7E69H	CPU abnormal monitoring setting value error	• Setting value (fixed value) of CPU abnormal monitoring is out of range.	—	• Correct the setting value (fixed value) of the CPU abnormal monitoring.	○	○	
7E6AH	Monitoring device read point range error	• Read point of monitoring device is out of range.	—	• Correct the setting value of the read point of the monitoring device.	○	○	
7E6BH	CPU abnormal monitoring setting value error	• Setting value (fixed value) of CPU abnormal monitoring is out of range.	—	• Correct the setting value (fixed value) of the CPU abnormal monitoring.	○	○	
7E6CH			—		○	○	
7E6DH			—		○	○	
7E6FH	Modem connection error	• Modem is connected to an incorrect channel.	—	• Correct the CH to which notification is sent.	○	○	
7E70H	CPU error	• The communication with the CPU could not be performed normally.	C/N	• If there is an error in the CPU, eliminate the error on the CPU side and communicate again.	○	○	
7EC3H	Double send request error	• A send request was performed while another send request was being processed.	—	• Interlock (handshake) the send requests.		○	○
7EC4H	Transmission data count error	• Data larger than the transmit buffer size was transmitted.	—	• Make the transmission data count smaller than the transmit buffer size. • Make the non procedure protocol transmit buffer size larger.		○	○
7EC5H	Flash ROM access error	• Write to Flash ROM was requested when the setting modification enable/disable switch in the GX Developer was set to OFF.	—	• When writing to Flash ROM, set switch shown left of the given interface to ON and restart the Q series C24.	○	○	○
7EC6H		• There is an error in the Flash ROM read/write request contents.	—	• Check the read/write request data and designate the correct data.	○	○	○

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Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Protocol		
					MC	Non Proce-dure	Bidire-ctional
7F01H	Buffer full error	• The next data was received before processing of the previous data was completed.	—	• Increase the transmission time by performing handshake with the external device, etc.	○		○
		• Multiple requests was simultaneously issued for one channel.		• Perform handshake with the request source external device.	○	○	○
7F20H	ASCII → BIN conversion error	• An ASCII code that cannot be converted to binary code was received.	PRO	• Check and correct the external device transmit message and restart data communications.		○	○
		• An odd number of bytes of data was received during data communications using ASCII - BIN conversion.		• When communicating using ASCII - BIN conversion, always transmit the data in even number bytes units.			
7F21H	Receive header area error	• There is an error in the command (frame) part.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
		• An ASCII code that cannot be converted to binary code was received.					
7F22H	Command error	• A nonexistent command or device was designated. • The remote password length is wrong.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7F23H	MC protocol message error	• There is no data (ETX, CR-LF, etc.) following the character area, or designation was incorrect.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
7F24H	Sum check error	• The sum check calculated by the Q series C24 and the received sum check are not the same.	P/S	• Recheck the external device sum check.	○	○	
7F25H	Data length error	• The length of the received data exceeds the receive area size.	CHn ERR.	• Correct the "data length" that is transmitted from the external device. • Change the "word/byte units" set by the Q series C24 to byte units. • Increase the receiving area of the Q series C24.			○
7F26H	Command error	• Another command was received before an unlock processing while the remote password is registered.	CHn ERR.	• Perform the communication after the unlock processing is normally completed.	○		
7F30H	BIN → ASCII conversion error	• The send data contains data that cannot be converted to ASCII code.	—	• Check and correct the send data.		○	○
7F31H	Simultaneous transmission error	• The Q series C24 and an external device started transmitting simultaneously.	—	• Process by agreement with the external device. • When necessary, change the simultaneous transmission data valid/invalid designation setting by QSCU. (buffer memory addresses 9BH/13BH)			○
7F40H	Time-out error	• No reception watchdog timer (timer 0) time-out occurred.	PRO	• Check if data was dropped from the receive data. • Check if DTR control, etc. interrupted reception.	○	○	○
7F41H		• Response watchdog timer (timer 1) time-out occurred.	—	• Check the status of the message transmission destination and restart data communications, as required.	○		○
7F42H		• Transmit watchdog timer (timer 2) time-out occurred.	—	• Check if DTR control, etc. interrupted transmission.	○	○	○
7F67H	Overrun error	• The Q series C24 received the next data before it completed receive processing of the previous data.	SIO	• Decrease the data transmission rate and restart data communications. • Check whether a temporary stop has occurred in the station in which the Q series C24 is installed. (For the QCPU this can be checked using special register SD1005.) If a temporary stop has occurred, remove its cause.	○	○	○

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Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Protocol		
					MC	Non Proce-dure	Bidire-ctional
7F68H	Framing error	• Data does not match the stop bit setting.	SIO	• Match the Q series C24 and external device settings.	○	○	○
7F69H	Parity error	• Data does not match the parity bit setting.	P/S	• Match the Q series C24 and external device settings.	○	○	○
7F6AH	Buffer full error	• OS receive buffer overflowed and receive data was skipped.	SIO	• Use DTR and DC control and perform data communications so that the buffer does not become full. (Perform RS · CS control when the modem function is used.) • If the Read Request signal was turned ON, execute read immediately.	○	○	○
7F6BH	CD signal control error	• Data was received when CD signal is OFF when "CD terminal check enabled" was designated.	CHn ERR.	• Recheck the CD signal control of the external device. (Send while the CD signal is ON.) • Set "no CD terminal checking" and perform communication.	○	○	○
7F6CH	Transmission error	• Data cannot be sent because the line is not connected.	CHn ERR.	• Transmit data after line connection processing on the interface side that uses the modem function.	○	○	○
7FE6H	Processing disabled	• Remote passwords do not match.	—	• Check the remote password and communicate again.	○		
7FE7H		• The remote password is not registered. • The remote password processing command was received on the interface side where the modem function is not used. • The GX Developer connection is selected in the communication protocol setting on the corresponding CH.	CHn ERR.	• A remote password processing command is not necessary when a remote password is not registered. • Perform a remote password unlock processing through GX Developer. Alternatively, change the communication protocol setting of the corresponding CH to the MC protocol.	○		
7FE8H		• The number of remote password disagreements exceeded the value designated at the address 200DH.	CHn ERR.	• Clear the storage area of the cumulative number of abnormal completions of unlock processing (address: 22FCH) to 0.	○		
7FF0H	Dedicated instructions simultaneous execution error	• Executed dedicated instructions simultaneously.	—	• Do not use dedicated instructions simultaneously.	○	○	
7FF1H	Control data error	• Setting value is incorrect. • Setting value is out of range.	—	• Correct the setting value in the control data.	○	○	
7FF2H	Communication protocol setting error	• Instruction cannot be executed with the current communication protocol.	—	• Correct the setting value of the communication protocol.	○	○	
7FF5H	Transmission cancel at mode switching/ transmission sequence initialization	• Data transmission was cancelled by performing mode switching/reception data clearing during data transmission.	—	• Do not perform mode switching/reception data clearing during data transmission.	○	○	
7FF7H	Simultaneous access error	• Multiple external devices accessed a remote station on the same network at the same time.	—	• Multiple external devices must not access a remote station on the same network at the same time.	○		
F000H to FFFFH	—	Errors detected by the MELSECNET/H, MELSECNET/10 network system	—	• Take corrective action by referring to MELSECNET/H, MELSECNET/10 network system reference manual.	○		

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10.2.2 A compatible 1C frame communications error code table

The following table lists the error code, error contents, and corrective action for errors generated during A compatible 1C frame communications.

Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Protocol		
					MC	Non Proce-dure	Bidire-ctional
00H	Disable during RUN	• A write command was designated when "Disable write during RUN" was set. • Parameter or sequence program was written during RUN.	C/N	• Change the setting to "Enable write during RUN" and restart data communications. • Stop the CPU and restart data communications.	○		
01H	Parity error	• The data does not match the parity bit setting.	P/S	• Match the Q series C24 and external device settings.	○		
02H	Sum check error	• The sum check calculated by the Q series C24 and the transmitted sum check are not the same.	P/S	• Check the external device sum check.	○		
03H	Protocol error	• Received message that is different from the control procedure with the communication protocol setting.	PRO	• Check and correct the external device transmit message and restart data communications.	○		
04H	Framing error	• The data does not match the stop bit setting.	SIO	• Match the Q series C24 and external device settings.	○		
05H	Overrun error	• The next data was received before the Q series C24 received all the preceding data.	SIO	• Decrease the transmission rate and restart data communications.	○		
06H	Character area error	• Designation method error in part of a message. • A command that does not exist was designated. • The number of processing points is outside the range for the command. • A device that does not exist was designated.	PRO	• Check and correct the external device transmit message and restart data transmission.	○		
07H	Character error	• Received data that cannot be used.	PRO		○		
08H	PLC access error	• The CPU cannot communicate with the Q series C24.	C/N	• Replace the CPU with a CPU that can communicate with the Q series C24.	○		
10H	PLC No. error	• The PLC No. is not "FF", or a station No. set in the network parameters.	C/N	• Check and correct the external device transmit message and restart data communications.	○		
11H	Mode error	• An error was detected upon access to the PLC CPU.	—	• Send again. • Conduct individual station recovery test and check the Q series C24.	○		
12H	Special function module designation error	• A special function module does not exist at the specified position.	C/N	• Check and correct the external device transmit message and restart data communications.	○		
21H	Special function module bus error	• An error was detected upon access to a special function module at the specified position.	C/N	• Check the error and take corrective action according to the manual of the corresponding module.	○		
42H	Other errors	✻ See POINT .			○		

POINT

- If an error occurs during A compatible 1C frame communications, the Q series C24 adds a 2-character error code (00H to 10H, 42H) to the "NAK" code and returns the "NAK" code to the external device and stores the error code (equivalent to QnA compatible 2C/3C/4C frame error code) to buffer memory address 25AH (CH1) or 26AH (CH2).
  The exact error contents can be checked by reading the value stored to the buffer memory.
  See Section 10.2.1 for a detailed description of the error codes.

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10.2.3 Error code list while modem function is used

The following describes the error codes, contents and corrective actions for errors (including errors at the abnormal completion) that may occur while the Q series C24 modem function is used.
The error codes for the modem function are stored in the modem function error code storage area (address : 221H(545)) of the buffer memory.

* The reference pages listed in the table below are found in the User's Manual (Application).

Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Reference section
7FD0H	Modern function error	There is an error in the designation of the notification execution.	CHn ERR.	Set 0 to 1 to the notification execution designation.	Section 3.3.4
7FD1H		There is an error in the designation of the number of connection retries.		Set the number of connection retries in the range of 1 to 5.	
7FD2H		There is an error in the designation of the connection retry interval.		Set the connection retry interval in the range of 90 to 300 (s).	
7FD3H		There is an error in the initialization/connection time-out designation.		Set the initialization/connection time- out in the range of 1 to 60 (s).	
7FD4H		There is an error in the designation of the number of initialization retries.		Set the number of initialization retries in the range of 1 to 5.	
7FD5H		There is an error in the designation of the data number for initialization.		Designate the registered data number for initialization, or 0.	Section 3.3.4 Section 3.4.7
7FD6H		There is an error in the data for connection designated by the data number for connection.		Recheck the pager receiver designation.	Section 3.4.6
7FD7H				Recheck the dialing number of the external line.	
7FD8H				Recheck the telephone number designation.	
7FD9H		The line to the destination is being connected.		Connect the line or notify when the line to the destination is not connected.	Section 3.4.8 Section 3.4.9
7FDAH		There is an error in the designation of the data number for connection.		Designate a registered number for the data for connection.	Section 3.3.4 Section 3.4.8
7FDBH		There is an error in the designation of the GX Developer connection.		Set 0 to 1 to the GX Developer connection designation.	Section 3.3.4
7FDCH		There is an error in the data for connection designated by the data number for connection.		Recheck the waiting time for the notification-message part of the message transmission.	Section 3.4.6
7FDDH		A connection time-out error occurred.		• Recheck the telephone number in the data for connection. • Check if the destination is ready for a connection. • Recheck the set value of the connection time-out. • Recheck the initialization command.	Section 3.3.4 Section 3.4.5 Section 3.4.6
7FDEH		Connection to the modem/TA was unsuccessful, or the modem/TA is not connected.		• Check if there is any problem with the modem/TA by seeing the operation manual of the modem/TA. • Connect the modem/TA to the Q series C24. • Check the connection cable by seeing the operation manual of the modem/TA.	Section 3.2
7FDFH		Modem connection channel number is not designated.	—	Set 1 to 2 to the modem connection channel designation.	Section 3.3.4
7FE0H		Designated value of modem connection channel is incorrect.			

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Error code (Hexa-decimal)	Error	Error Contents	Corres-pondence signal name	Corrective action	Reference section
7FE1H	Modern function error	There is an error in the designation of the user frame number.	CHn ERR.	• Recheck the user frame number. • Designate the registered user frame number. • Register the designated data for initialization.	Section 3.4.5 Section 3.4.6 Section 3.4.7
		There is an error in the designation of the output head pointer.		• Designate the output head pointer in the range of 1 to 100. • Designate the position (n-th position) where the data for initialization number is designated. • Designate the data for initialization number at the designated position (n-th position).	Section 3.4.7
7FE2H		There is an error in the designation of the output frame number.		Designate a registered data for initialization number within the range of the designated number of outputs from the location of the output head pointer.	Section 3.4.7
7FE3H		There is an error in the designation of the number of registered data bytes.		• Designate the data for initialization in the range of 1 to 78. • Designate 80 for the data for connection.	Section 3.4.5 Section 3.4.6
7FE4H		There is an error in the data for connection.		• Recheck the message length of the message for notification.	Section 3.4.6
7FE5H		There is an error in the designation of the no-communication interval time.		• Designate the no-communication interval time in the range of 0 to 120.	Section 3.3.4
7FE8H		The number of remote password mismatch exceeded the value designated at the address 200DH.		• Clear the storage area of the Accumulated count of unlock process abnormal completion (address: 22FCH) to 0.	

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10.3 Troubleshooting by Symptom

This following shows troubleshooting of trouble generated during communications between the Q series C24 and external device according to the trouble symptom. When trouble occurs, first confirm the status of the Q series C24 and check the relevant item in the table below.

Symptom	Symptom description	Protocol			Reference section
		Dedicated	Non procedure	Bidirec-tional	
LED turns on/off (check according to Section 4.3)	• "RUN" LED turned off.	○	○	○	Section 10.3.1
	• "RD" does not blink even through an external device is transmitting a message.	○	○	○	Section 10.3.2
	• An external device transmitted a message and "RD" blinked, but the Q series C24 did not return a response message.	○			Section 10.3.3
	• An external device transmitted a message and "RD" blinked, but the Q series C24 did not turn ON the read request.		○	○	Section 10.3.4
	• ERR. LED turns on.	○	○	○	Section 10.3.20
Communication errors occurred (check according to Section 10.1.1)	• The "NAK" was turned ON.	○	○	○	Section 10.3.5
	• The "C/N" was turned ON.	○	○	○	Section 10.3.6
	• The "P/S" was turned ON.	○	○	○	Section 10.3.7
	• The "PRO" was turned ON.	○			Section 10.3.8
	• The "SIO" was turned ON.	○	○	○	Section 10.3.9
	• The "CH1. ERR. " or "CH2. ERR. " was turned ON.	○	○	○	Section 10.3.10
	• Communications are intermittently established and lost.	○	○	○	Section 10.3.11
	• Data that cannot be decoded was transmitted and received.	○	○	○	Section 10.3.12
	• Whether the cause of the communications error is in the Q series C24 or the external device is unknown.	○	○	○	Section 10.3.13
Cannot connect via modem	• Cannot communicate with GX Developer that supports the Q series C24.	○			Section 10.3.14
	• Cannot communicate with ISDN sub-address.	○			Section 10.3.15
The PLC CPU monitoring function does not operate in the designated cycle time.	• Does not operate in the cycle time designated in the constant cycle transmission setting.	○	○	○	Section 10.3.16
	• Does not operate in the cycle time designated in condition agreement transmission setting.	○	○	○	Section 10.3.17
Cannot receive by an interrupt program	• Cannot receive data.		○	○	Section 10.3.17
Cannot perform initial setting	• Cannot write setting value in flash ROM of the Q series C24.	○	○	○	Section 10.3.19

* If an error occurs while performing data exchange using the modem function described in User's Manual (Application) Chapter 3, first check the following items and confirm whether or not the error is caused by the modem/TA connection.
  If an error relating to the modem function is occurring, perform necessary corrective actions for each cause according to the reference sections given below:
  - Check the ON/OFF status of current I/O signals of the Q series C24.
  - Check the storage status for error codes related to the modem function. (See Sections 10.2.3.)
  - Check the ON/OFF status of the DR terminal of the modem/TA. (See the manual for the modem/TA.)

REMARK

The following are precautionary notes when exchanging data with an external device via one of the Q series C24 interfaces.

(1) When the power supply to the Q series C24 or external device is started, the remote device that is connected may generate a reception error.

(2) If the remote device that is connected starts up while data is being transmitted, the remote device side will generate a reception error.

(3) When the Q series C24 error LED lights up because a reception error has occurred, turn off the light if necessary in accordance with Section 10.1.
Also, if a reception error has occurred on the external device side, handle the error by seeing to the operating manual for the external device.

* Handle the occurrence of a reception error on the Q series C24 side using the following corrective actions.
  - When communicating with the MC protocol
    The Q series C24 will disregard the received data or returns a response message indicating an abnormal termination if it detects a reception error after receiving the head data of the command message in the set format.
    If the reception error is detected before the head data of the command message in the set format is received, the received data will be disregarded.
  - When communicating using non procedure protocol
    If the Q series C24 detects a reception error, the reception abnormal detection signal (X4, XB) turns ON.
    Perform procedures such as detection of reception error or clearing received data as required by following the explanations found in Sections 6.1.4 and 6.1.5.
  - When communicating using bidirectional protocol
    When the Q series C24 detects a reception error after the head data of a communication message for bidirectional protocol is received, it returns a response message indicating an abnormal termination.
    If the reception error is detected before the head data of the communication message for bidirectional protocol is received, the received data will be disregarded.

10.3.1 Troubleshooting when "RUN" LED is turned OFF

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• The Q series C24 "RUN" LED turned off.	• A transmission setting switch is set to an unusable position.	• Set the switch by GX Developer correctly and after writing to the CPU reset the CPU.	○	○	○
	• PLC CPU error.	• Remove the cause of the CPU error and reset the CPU. Note • During the Q series C24 and external device loopback test, the minimum parameters file must be written to the CPU beforehand.	○	○	○
	• Power module 5 V current capacity is insufficient.	• Calculate the 5 V current drain of each installed module. If the current capacity is insufficient, check power module selection. Note • Whether or not the current capacity is insufficient can be checked by disconnecting the expansion base and installing only the Q series C24 to the basic base.	○	○	○
	• Extraneous noise caused the Q series C24 to abnormal operation.	• Check if the shield wire is 2-point ground. • When ground is used with other devices, ground the Q series C24 independently.	○	○	○

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10.3.2 Troubleshooting when "RD" LED does not blink even though an external device is transmitting a message

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• "RD" does not blink even through an external device is transmitting a message.	• Signal lines are not connected correctly.	• Check if the Q series C24 and external RD and SD signal lines are cross connected. • Use the external device OPEN statement to check if the opened port and the cable connection port are matched.	○	○	○
	• External device transmission control signals are not turned ON.	• Connect the wiring so that the "DSR", "CS", and other transmission control signals are ready. Note • Since the control signal specifications depend on the device, connect the wiring by seeing the instruction manual of the device used.	○	○	○
	• If the message passes through an RS-232 ↔ RS-422 converter, modem, etc., the signal is interrupted at one of the intervening devices.	• Check the specifications of the converter and modem and recheck the settings and wiring	○	○	○

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10.3.3 Troubleshooting when the Q series C24 does not return a response message even though an external device transmitted a message and the "RD" LED blinked

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• An external device transmitted a message and "RD" blinked, but the Q series C24 did not return a response message. ("NEU" remains on and "SD" does not blink)	• Communication protocol is set incorrectly.	• Check if the communication protocol is set correctly. • Check if the mode was switched without using the buffer memory mode switching area. Note • The communication protocol setting contents and the communication protocol in the current operation can be checked at buffer memory addresses 250H to (CH1) and 260H (CH2).	○		
	• When "Check CD terminal" was set, the CD terminal was turned OFF.	• Since the message is initialized (skipped reading) when the CD terminal is turned OFF when "Check CD terminal" is set, change the wiring so that the CD terminal remains on all the time.	○		○
	• The header byte of the message is not data needed by the set protocol and format.	• Check if the external device sent a message matched to the protocol and format. Note • The Q series C24 skips all the messages transmitted until the header byte set for each protocol and format (for example, "ENQ (05H)" for format 1) is received.	○		○
	• The Q series C24 station No. switch setting and message station No. designation do not match.	• Check the Q series C24 station No. setting and message station No. designation. Note • When the station No. designation is local station after the header byte set for each protocol and format is received, the Q series C24 performs receive processing.	○		
	• The Q series C24 data communications monitoring time is set to "infinite", or the monitoring time is too long.	• Set, or shorten, the monitoring time and retransmit the message from the external device and determine the trouble from the contents of the time-out error. Note • Error detection by watchdog timers (timer 0 to timer 2) is possible in the following cases. • When part of a message is skipped. • When transmission from an external device is interrupted. • When a link error was generated while accessing another station over a MELSECNET/H, MELSECNET/10. See Chapter 6 of User's Manual (Application) for a detailed description of the monitoring time.	○		○
	• The path setting of the PLC CPU to be accessed is incorrect.	Check the path of the PLC CPU to be accessed and set the path again.	○		

10.3.4 Troubleshooting when an external device transmitted a message and "RD" LED blinked, but the Read Request signal was not turned ON

Symptom	Cause	Corrective action	MC	Bidirectiona	Non procedure
• An external device transmitted a message and "RD" blinked, but the read request signal (X0) was not turned ON.	• Communication protocol is set incorrect.	• Check if the communication protocol is set correctly. • Check if the mode was switched without using the buffer memory mode switching area. Note • The communication protocol setting contents and the communication protocol in the current operation can be checked at buffer memory addresses 250H to (CH1) and 260H (CH2).		○	○
	• When "Check CD terminal" was set, the CD terminal was turned off.	• Since messages are skipped when the CD terminal is turned OFF when "Check CD terminal" is set, change the wiring so that the CD terminal remains on all the time.		○	○
	• When DC control is selected, the necessary DC codes are not transmitted.	• Check if a message is transmitted without transmitting "DC1 (11H)" after the external device transmits "DC3 (13H)" during DC1/DC3 external control. • Check if the next message is transmitted without adding "DC2 (12H)" after the external device transmits "DC4 (14H)" during DC2/DC4 external control.		○	○
	• The end code was not received, or fixed length data was not received.	• Check if the end code set at the Q series C24 and the end code transmitted from the external device are the same. • Check if the external device transmitted the fixed length designated at the Q series C24. • Check if the trailer frame was transmitted during communications by user frame. Note • When the send data from the external device is correct, take the corrective action described in Sections 10.3.10 and 10.3.11.		○	○
	• The Q series C24 setting and message format do not match.	• The data count basics, message format, etc. depend on the following settings. · ASCII-BIN conversion enable/disable · Transparent code setting · User frame setting See the relevant section for a description of operation according to the set contents and setting of each item.		○	○
	• The Q series C24 data communications monitoring time is set to "infinite", or the monitoring time is too long.	• Set, or shorten, the monitoring time and retransmit the message from the external device and determine the trouble from the contents of the time-out error. Note • Error detection by the watchdog timer (timer 0 to timer 2) is possible in the following cases. · When part of a message is skipped. · When transmission from an external device is interrupted. See Chapter 6 of User's Manual (Application) for a detailed description of the monitoring time.		○	○

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10.3.5 Troubleshooting when communication error "NAK" generates

<table>
<tr><th>Symptom</th><th>Cause</th><th>Corrective action</th><th>MC</th><th>Bidirectional</th><th>Non procedure</th></tr>
<tr><td rowspan="2">• Communication error signal "NAK" turned on.</td><td>• See section that describes the communication error signal ("C/N", "P/S", "PRO", "SIO") that are turned on simultaneously when the "NAK" signal is turned on.</td><td>• Take corrective action corresponding to the contents of the error.</td><td>○</td><td></td><td></td></tr>
<tr><td colspan="5">Note
Since the error code is added to "NAK" and is transmitted from the Q series C24 to the external device when the "NAK" signal is turned on, take the corrective action described in the error code table (see Section 10.2).
Since the error code added when "NAK" is transmitted is stored to the Q series C24 buffer memory shown below, it can also be checked at the Q series C24.
<table>
<tr><th colspan="2">Error code storage buffer memory address</th></tr>
<tr><td>CH1 side</td><td>25AH</td></tr>
<tr><td>CH2 side</td><td>26AH</td></tr>
</table></td></tr>
</table>

10.3.6 Troubleshooting when communication error "C/N" generates

<table>
<tr><th>Symptom</th><th>Cause</th><th>Corrective action</th><th>MC</th><th>Bidirectional</th><th>Non procedure</th></tr>
<tr><td rowspan="3">• Communication error signal "C/N" turned on.</td><td>• The Q series C24 cannot be installed in the CPU.</td><td>• Change to a CPU to which the Q series C24 can be installed.</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>• PLC No. designated local station (FF), or a station other than a station No. set with the network parameters.</td><td>• Change the PLC No. to local station (FF), or a station No. set with the network parameter and restart data communications.</td><td>○</td><td></td><td></td></tr>
<tr><td>• Routing parameters between CPU with the Q series C24 loaded and communications destination CPU are not set.</td><td>• Check the routing parameters and set them up to the communications destination CPU.</td><td>○</td><td></td><td></td></tr>
</table>

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• Communication error signal "C/N" turned on.	• An error was generated on the MELSECNET/ H, MELSECNET/10.	• Check the error contents from the state of SB and SW related to the MELSECNET/H, MELSECNET/10 with the GX Developer monitor, etc. and perform the checks and take the corrective action described in the MELSECNET/H, MELSECNET/10 reference manual.	○		
	• The local station CPU on the MELSECNET/H, MELSECNET/10 generated an error.				
	• Module installation address designation during communications with intelligent function module is incorrect.	• Change the transmit message designation data.	○	○	○
	• A command that cannot be transmitted during RUN (sequence program, parameters, etc.) was transmitted, or "Disable write during RUN" is set.	• Stop the CPU and restart data communications.	○		
		• Set the "Enable/disable write during RUN" switch to "Enable" by command.	○		

10.3.7 Troubleshooting when communication error "P/S" generates

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• Communication error signal "P/S" turned on.	• Data does not match the parity bit setting.	• Check the Q series C24 and external device data format and match the settings.	○	○	○
	• Sum check codes do not match.	• Check if the sum check code transmitted from the external device is correct. (Recalculate)	○		
	• When CH1 and CH2 are used in the linked mode, the cable is not connected to one of the interface.	• When using CH1 and CH2 independently, check that the Q series C24 is not in the linked mode. • When using CH1 and CH2 in the linked mode, also connect the cable to both of the interfaces. Note • If the cable is not connected to one of the interfaces when CH1 and CH2 are used in the linked mode, noise may enter and the data may be destroyed and "Data cannot be decoded" or "Communications error cause" may occur.	○	○	○

10.3.8 Troubleshooting when communication error "PRO." generates

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• Communication error signal "PRO" turned on.	• Communications were performed with a control procedure different from the Q series C24 communication protocol setting. • Some of the data are different from the control procedure. • Designated command does not exist. • The device No. designation is not the character count corresponding to the command.	• Check the Q series C24 communication protocol setting and the message from the external device and match the settings, or correct the message and restart data communications.	○		
	• The characters in the message include a data other than the "A to Z", "0 to 9", "␣", and control data.	• Check and correct the external device message and restart data communications. Note • Only the data "0 to 9" and "A to F" can be handled as character area data during communications using an MC protocol (ASCII mode). Therefore, when transmitting a character string as data, convert the ASCII code of each character string to 2-byte binary code. Examples) • Transmitting the character "G" The ASCII code for the character "G" is 47H and is transmitted as the two bytes 34H, 37H. • Transmitting the character "A" The ASCII code for "A" is 41H and is transmitted as the two bytes 34H, 31H. If the ASCII code 41H for the character "A" is transmitted unchanged, the Q series C24 ASCII-BIN conversion will convert it to AH (10) and pass it to the PLC CPU.	○		
	• A device No. outside the designated range was designated.	• When designating a device, check "Device setting" of the parameters written to the CPU and correct it to a device No. within the designated range and restart data communications.	○		
	• A remote RUN/STOP request was issued while remote STOP was applied from another module.	• Check if remote STOP is applied from another module and restart data communications.	○		

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10.3.9 Troubleshooting when communication error "SIO" generates

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• Communication error signal "SIO" turned on.	• Data does not match the stop bit setting.	• Check if the Q series C24 and external device settings are the same.	○	○	○
	• Transmission rate is too fast and the next data is transmitted before the Q series C24 completes processing of the receive data.	• Decrease the transmission rate and restart data communications.	○	○	○
	• Data larger than the receive buffer size was received.	• Use DTR and DC control and interrupt transmission before the buffer becomes full. Perform RS and CS control when the modem function is used. • Increase the transmission interval and provide an ample PLC CPU read processing time. Note • The non procedure protocol stores the data received up to first the end code received, or fixed length data, to the non procedure receive buffer memory and turns on the Read Request signal to the PLC CPU. If the next data is sent while the Read Request signal is ON, the data is temporarily stored to the OS receive buffer. When the OS receive buffer becomes full, the Q series C24 skips the rest of the data and turns on the "SIO" LED.		○	○
	• With a multidrop link, two or more devices transmitted data at the same time.	• Connect the external devices and the Q series C24 in a 1:1 configuration and perform a communications test. Since data is transmitted simultaneously from two or more devices with a multidrop link when normal communications among all the devices is possible, interlock the devices so that cannot transmit simultaneously.	○	○	○

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10.3.10 Troubleshooting when communication error "CH1 ERR.", "CH2 ERR." generate

<table>
<tr><th>Symptom</th><th>Cause</th><th>Corrective action</th><th>Dedicated</th><th>Bidirectional</th><th>Non procedure</th></tr>
<tr><td rowspan="6">• "ERR." LED turned on.</td><td>• There is an error in the communication protocol or transmission setting.</td><td>• Read the error code from the buffer memory and check the error contents and change the switch setting to the correct setting.</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>• There is an error in the on-line mode switching designation.</td><td>• Read the error code from the buffer memory and check the error contents and correct the designation contents.</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>• On-demand execution generated an error.</td><td>• Read the error code from the buffer memory and check the error contents and correct the designation contents.</td><td>○</td><td></td><td></td></tr>
<tr><td>• The Q series C24 detected an error while transmitting data.</td><td>• Read the error code from the buffer memory and take the corrective action corresponding to the error contents.</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>• The Q series C24 detected an error while receiving data.</td><td>• Read the error code from the buffer memory and take the corrective action corresponding to the error contents.</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td colspan="5">Note
• When the "ERR." LED is turned on, the error code is stored to the following buffer memory.
<table>
<tr><th rowspan="2">Error cause</th><th colspan="3">Error code storage buffer memory</th></tr>
<tr><th colspan="2">Address</th><th rowspan="2">Name</th></tr>
<tr><th>CH1</th><th>CH2</th></tr>
<tr><td>Switch setting error</td><td colspan="2" rowspan="2">203H</td><td rowspan="2">Switch setting error, mode switching error storage area</td></tr>
<tr><td>Mode switching error</td></tr>
<tr><td>On-demand execution error</td><td>256H</td><td>266H</td><td>On-demand execution result storage area</td></tr>
<tr><td>Data transmission error</td><td>257H</td><td>267H</td><td>Data transmission result storage area</td></tr>
<tr><td>Data receive error</td><td>258H</td><td>268H</td><td>Data receive result storage area</td></tr>
<tr><td>Modern function error</td><td colspan="2">221H</td><td>Modern function error code storage area</td></tr>
<tr><td>MC protocol transmission error</td><td>025AH</td><td>026AH</td><td>MC protocol transmission error code</td></tr>
<tr><td>Monitoring device error</td><td>2205H</td><td>2305H</td><td>PLC CPU monitoring function execution result</td></tr>
</table>
∗ See Section 10.2 for a detailed description of the error codes.</td></tr>
</table>

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10.3.11 Troubleshooting when communications is intermittently established and lost

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• Communications are intermittently established and lost. (*1)	• With a multidrop link, two or more devices transmitted data at the same time.	• Connect the external devices and the Q series C24 in a 1:1 configuration and perform a communications test. Since data is transmitted simultaneously from two or more devices with a multidrop link when normal communications among all the devices is possible, interlock the external devices so that they do not transmit simultaneously.	○	○	○
	• The signal cable wiring connection is faulty.	• Replace the cable, or make the connections firm.	○	○	○
	• When "Check CD terminal" is set, the CD signal is turned on/off repeatedly.	• Change the wiring so that the CD signal remains ON all the time, or change the setting to "Do not check CD terminal".	○	○	○
	• When half-duplex communications is selected, the ON/OFF timing of each signal is not matched.	• Control the external device so that the ON/OFF timing of each signal is matched. See Chapter 8 of User's Manual (Application).		○	○
	• Requested processing of the next transmission before the processing of the current transmission is completed. • Requested processing of the next reception before the processing of the current reception is completed.	• Make sure to obtain handshake in the sequence program.	○	○	○

*1 The following explains how to take corrective actions when a normal exit response message cannot be received upon sending of a command message.

1) When a response message of abnormal end is received
When an external device sent a command message and received an abnormal end response message, take corrective action with the error according to the error code in the response message (see Section 10.2).

2) When response messages cannot be received
Change the setting value for the response monitoring time (timer 1, default value is 5 seconds).
(See Section 6.2 of the User's Manual (Application).)
If response messages still cannot be received after changing the setting value, check the communication protocol setting of the corresponding interface, the ON status of the displayed LED, and the connection cable.

3) When the first part of a response message cannot be received
Increase the setting value of the message wait time (the default value is 0 ms).
(See Section 6.4 of the User's Manual (Application).)
If response messages still cannot be received after increasing the setting value, it is necessary to reduce the processing time from the end of transmission processing to the start of reception processing on the external device side.

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10.3.12 Troubleshooting when data that cannot be decoded is transmitted and received

Symptom	Cause	Corrective action	MC	Bidirectional	Non procedure
• Data that cannot be decoded was transmitted and received	• With a multidrop link, two or more devices transmitted data at the same time.	• Connect the external devices and the Q series C24 in a 1:1 configuration and perform a communications test. Since data is transmitted simultaneously from two or more devices with a multidrop link when normal data communications among all the devices is possible, interlock the external devices so that they do not transmit simultaneously.	○	○	○
	• Data does not match the parity bit setting.	• Match the Q series C24 and external device parity bit settings. Note • If the setting of one side is data bit length 7 bits and with parity and the setting of the other side is data length 8 bits and without parity, the number of transmission/receive bits will be the same and the data will sent and receive without generating an error.	○	○	○
	• Data does not match the parity bit setting.		○	○	○
	• Transmission rate settings do not match.	• Match the Q series C24 and external device transmission rates.	○	○	○
	• With a multidrop link, the terminal resistor is not connected correctly.	• Check if the terminal resistor (110Ω or 330Ω in case of the Q series C24) is connected to the stations at both ends of the link.	○	○	○
	• When CH1 and CH2 are used to the linked mode, there is an interface without cable connection.	• When using CH1 and CH2 independently, check that the Q series C24 is not in the linked mode. • When using CH1 and CH2 in the linked mode, also connect the cable to both of the interfaces. Note • If the cable is not connected to one of the interfaces when CH1 and CH2 are used in the linked mode, noise may enter and destroy the data and "Data cannot be decoded" or "Communication error cause" may occur.	○	○	○

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10.3.13 Troubleshooting when it is unclear whether the communication error cause is in the Q series C24 or an external device

Symptom	Cause	Corrective action	Dedicated	Bidirectional	Non procedure
• Whether the communications error cause is in the Q series C24 or an external device is unclear.	—	• Test the Q series C24 as described below to check where the cause is. 1) Check the hardware. • The Q series C24 must be installed firmly. • The pins of the Q series C24 must not be bent or otherwise abnormal. 2) Test the Q series C24 alone. (See Section 4.7.) • ROM/RAM/switch test must not generate any errors. • Self loopback test must not generate any errors. 3) Check the state of the PLC CPU. • There must not be any errors that stop PLC CPU operation. Note • The following methods are available for testing if normal communications are possible with the Q series C24 alone. 1) With one the Q series C24, set CH1 and CH2 to the non procedure protocol and connect the wiring the same as for the self loopback test and transmit data from one channel and receive the transmitted data at the other channel. If the transmitted data and the received data are the same, transmit and receive processing is performed normally. 2) When two Q series C24 are available, set one Q series C24 to the non procedure protocol and the other Q series C24 to a dedicated protocol and transmit an MC protocol message from the non procedure protocol station. If the MC protocol station returns the transmit message normally, transmit and receive processing is normal.	○	○	○

10.3.14 Troubleshooting when data cannot be communicated with the GX Developer that supports serial communication modules

Circumstance	Cause	Corrective action	MC	Non procedure protocol	Bidirectional protocol
• Data cannot be communicated with GX Developer supporting the Q series C24.	• Communication protocol setting is incorrect.	• Set the communication protocol to MC protocol, format 5.	○	○	○
	• Transmission setting does not match the external device.	• Review the transmission setting.	○	○	○
	• Communication rate does not match the external device.	• Review the communication rate setting.	○	○	○

10.3.15 Troubleshooting when data cannot be communicated with the ISDN sub-address

Circumstance	Cause	Corrective action	MC	Non procedure protocol	Bidirectional protocol
• Data cannot be communicated with ISDN sub-address	• Sub-address is incorrect.	• Review the sub-address.	○	○	
	• Modem does not support ISDN sub-address.	• Use modem that supports ISDN sub-address.	○	○	
	• Sub-address is incorrectly partitioned.	• Review how to partition the sub-address using the TA manual.	○	○	

10.3.16 Troubleshooting when constant cycle transmission does not operate normally

Circumstance	Cause	Corrective action	MC	Non procedure protocol	Bidirectional protocol
• Does not operate in the cycle time designated in the constant cycle transmission setting	• The setting value of the constant cycle transmission is incorrect.	• Review the constant cycle transmission setting.	○	○	
	• The cycle time is affected by some causes.	• Remove the causes or designate the cycle time anticipating the causes.	○	○	

10.3.17 Troubleshooting when condition agreement transmission does not operate normally

Circumstance	Cause	Corrective action	MC	Non procedure protocol	Bidirectional protocol
• Does not operate in the cycle time designated in condition agreement transmission setting	• The setting value of the condition agreement transmission is incorrect.	• Review the condition agreement transmission setting.	○	○	
	• The cycle time is affected by some causes.	• Remove the causes or designate the cycle time anticipating the causes.	○	○	

10.3.18 Troubleshooting when data cannot be received by an interrupt program

Circumstance	Cause	Corrective action	MC	Non procedure protocol	Bidirectional protocol
• Cannot receive data with the interrupt program	• Interrupt issuance was not designated.	• Designate interrupt issuance.		○	○
	• Receiving by instruction other than BUFRCVS.	• Use BUFRCVS instruction to receive interrupt data.		○	○
	• "Parameter setting" - "PC system setting" - or "Interrupt pointer setting" are not set on the PLC CPU side, or the settings are incorrect.	• Review "Parameter setting" - "PS system setting" - "Interrupt pointer setting" on the PLC CPU side		○	○

10.3.19 Troubleshooting when data cannot be written to Flash ROM

Circumstance	Cause	Corrective action	MC	Non procedure protocol	Bidirectional protocol
• Cannot write data to Flash ROM	• Flash ROM overwrite allow/prohibit was not set to allow.	• Set Flash ROM overwrite allow/prohibit to allow.	○	○	○
	• Setting change was not set to allow in the switch settings by GX Developer.	• Set setting change to allow in the switch setting by GX Developer.	○	○	○

10.3.20 Troubleshooting when the "ERR" LED is lit

Circumstance	Cause	Corrective action	MC	Non procedure protocol	Bidirectional protocol
• "ERR" LED is lit	• A communication error has occurred.	• Check the error and remove the cause according to Section 10.1.1.	○	○	○
	• Switch settings of the Q series C24 are incorrect.	• Review the switch settings of the Q series C24.	○	○	○

APPENDIX

Appendix 1 Functional Improvements of the Q Series C24

The Q series C24 of function version B has several functions that have been added or changed from the conventional product (function version A).
This chapter explains a comparison of the functions of Q series C24/QSCU accompanied by the change/addition of functions, and explains how to utilize programs created for function version A as well as how to incorporate function version B modules into the existing system.

Appendix 1.1 Comparison of the Functions of Q Series C24/QSCU

(1) Comparison of the functions of Q series C24

The following table lists the functions added and changed for function version B.

Function				○ : Function added/ Changed
Communication using the MC protocol				
	Communication with ASCII code	Communication with QnA compatible 2C/3C/4C frame	Formats 1 to 4 exist for each.	
		Communication with A compatible 1C frame		
	Communication with binary code	Communication with QnA compatible 4C frame	Format 5	
	Read/write of device memory	Batch read/write in bit/word units		
		Monitoring of device memory		
		Batch read/write of multiple blocks		
		Read/write by extension designation		
		Accessing other stations via network system		
	Reading/writing from/to the buffer memory of the Q series C24			
	Reading/writing from/to the buffer memory of intelligent function modules			
	Reading/writing from/to sequence program files			
	Monitoring the PLC CPUs (PLC CPU monitoring function)			
		Transmission of the monitoring information using the modem function.		○
	Status control of the PLC CPUs (remote RUN/STOP, etc.)			
	Turning on/off input signals of the Q series C24 from an external device (global function)			
	Data transmission from a PLC CPU to an external device (on-demand function)			
Communication using non-procedure protocol				
	Data transmission/reception in any format			
	Data transmission/reception using user frames			
	Data reception using format-0 (* 1)			
	Data reception using format-1			○
	Data reception by interrupt programs			
	Monitoring the PLC CPUs (PLC CPU monitoring function)			
		Transmission of the monitoring information using the modem function.		○
	ASCII data transmission/reception by ASCII-BIN conversion			
	Data transmission/reception by specifying transparent code			
		Specification of Receive transparent code		
		Specification of Transmission transparent 1st (* 2)		
		Multiple specification of Transmission transparent 2nd to 10th		○
	Reception data clear by dedicated instruction (CSET instruction)			○

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Function				○ : Function added/ Changed
Communication using bidirectional protocol				
	Data transmission/reception in any format			
	Data reception by interrupt programs			
	ASCII data transmission/reception by ASCII-BIN conversion			
	Data transmission/reception by specifying transparent code			
		Specification of Receive transparent code		
		Specification of Transmission transparent 1st (＊2)		
		Multiple specification of Transmission transparent 2nd to 10th		○
Registration of user frame for data communication				
	Registration of changeable data (horizontal parity code and sum check code of two's-complement number are added)			○
Communication via public network, etc. (modem function)				
	Remote password check			○
Transmission control		DC code control (including Xon/Xoff control)		
		DTR/DSR (ER/DR) control		
Communication protocol switching				
Independent/linked operation of each interface				
Monitoring/testing of initial settings and setting values with utility package				
	Startup from the system monitor (＊3)			
	Addition to the setting items			○ (See (2))
GX Developer and GOT connection				○
	Simultaneous connection of GX Developer and GOT to the Q series C24 (＊4)			○
Support for multiple PLC system				○
	Communication with non-control CPU using the MC protocol			
		Communication with QnA compatible 4C frame (ASCII code)	Formats 1 to 4	○
		Communication with QnA compatible 4C frame (binary code)	Format 5	○
	Multiple PLC setting using GX Developer (I/O assignment, switch setting, interrupt pointer setting, etc.)			○
Data transmission/reception at low speed (transmission speed: 50 bps)				○

＊1 The data reception using format-0 refers to the method of receiving data by user frame, which was supported in the Q series C24 of function version A.

＊2 The Q series C24 of function version A is capable of setting one pair of transparent code and additional code per interface for both transmission and reception.

＊3 This function is available in GX Developer (SW6D5C-GPPW-E).

＊4 GX Developer can only be connected to the CH1 side in case of the Q series C24 of function version A.
It is not possible to connect both GX Developer and the GOT to the two interfaces at the same time.

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(2) List of added setting items for QSCU

The following table lists the setting items added to QSCU to conform to the specification of the Q series C24 of function version B.

Screen (System setting/monitor)	Additional setting item	Software version			Reference section
		D, C	B	A	
Modem function system setting	Circuit disconnect wait time (PLC CPU watch use)	○	×	×	Section 8.4.4 Section 8.6.2
	Remote password mismatch notification count designation				
	Remote password mismatch notification accumulated count designation				
Modem function monitor/test	Accumulated count of unlock process normal completion				
	Accumulated count of unlock process abnormal completion				
	Accumulated count of lock process based on circuit disconnect				
Transmission control and others system settings Transmission control and others monitor	Transmission transparent code designation (2nd to 10th)				Section 8.4.5 Section 8.6.3
Non procedure system setting Non procedure monitor/test	User frame receive format designation (1st to 4th)				Section 8.4.7 Section 8.6.5
	Exclusive format-1 received data count (1st to 4th)				
Auto refresh setting	Accumulated count of unlock process normal completion				Section 4.6
	Accumulated count of unlock process normal completion				
	Accumulated count of lock process based on circuit disconnect				

○ : Setting possible × : Setting impossible

POINT

(1) QSCU software of version C or later supports the Q series C24 of function version B.

(2) See Section 2.6 of this manual for how to check the software version of QSCU.

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Appendix 1.2 Precautions when Updating the Module from Function Version A to B

This section explains how to utilize programs created for the Q series C24 of function version A for the Q series C24 of function version B and how to incorporate function version B into the existing system.

(1) Program utilization

Programs created for the Q series C24 of function version A can be used as they are for the Q series C24 of function version B.

(2) Incorporation into the existing system

The wiring used for function version A can be used as is for the Q series C24 of function version B.

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Appendix 2 QnA/A Series Module

This section explains a comparison of the functions of the Q series C24 and QnA/A series modules, and explains how to utilize programs created for A series modules as well as how to install the Q series C24 into the existing system.
QnA/A modules refer to the following products.

Model name	Product name
QC24N	AJ71QC24N (-R2,R4), A1SJ71QC24N (-R2)
QC24	AJ71QC24 (-R2,R4), A1SJ71QC24 (-R2)
UC24, C24-S8	AJ71UC24, A1SJ71UC24 (-R2,R4,PRF), AJ71C24-S8

Appendix 2.1 Functional Comparison with the Q series C24 and the QnA/A Series Modules

The following shows a functional comparison between the Q series C24 and the QnA/A series modules.
The ○ symbol in the model name columns indicates that the corresponding functions are compatible between the applicable models (for more information, see the manual for each module).
Indicates functions that have been added to or modified from the QnA/A series modules.

Function			Q series C24	QC24N	QC24	UC24	C24-S8
Communication using MC protocol			—				
	Communication in QnA compatible 3C frame	Communication with ASCII code	○	○		×	×
	Communication in QnA compatible 4C frame		○	○			
	Communication in QnA compatible 2C frame		○	○	×	×	×
	Communication in A compatible 1C frame		○	○			
	Communication in QnA compatible 4C frame	Communication with binary code	○	○		×	×
	Read/write of QCPU device memory		—				
	Batch read/write of device memory (＊5) ＊ Excluding multiple block batch read/write.		○	○		○ (＊1)	○ (＊1)
	Multiple block batch read/write (＊5)		○ (＊2)	○ (＊2)	×	×	×
	Accessing other stations (via network/data link)		○ (＊3)	○		○	○
	Transmission from the PLC CPU (on-demand)	Arbitrary data	○	○		○	○
		Using user frame	○	○		×	×
	Communication with m:n connection between the PLC CPU and external devices		○	○			
Communication using non procedure protocol			—				
	Transmission/receive with arbitrary format		○	○			
	Transmission/receive with user frame		○	○		○ (＊4)	×
	Transmission/receive with ASCII-BIN conversion		○	○		×	×
	Transmission/receive with transparent code designation		○	○		×	×
Communication using bidirectional protocol			—				
	Transmission/receive with arbitrary format		○	○			
	Transmission/receive with ASCII-BIN conversion		○	○		×	×
	Transmission/receive with transparent code designation		○	○		×	×

Function		Q series C24	QC24N	QC24	UC24	C24-S8
Accessing other stations with link dedicated instructions		×	○ (via QC24 (N))		×	×
Interrupt processing (at data reception)	Non procedure protocol	○	×	×	×	×
	Bidirectional protocol					
Communication via public lines using modem function		○	○	×	×	×
Communication using the PLC CPU monitoring function		○	×		×	×
Auto refresh directed to the PLC CPU		○	×		×	×
Transmission control	DC code control	○	○			
	DTR/DSR signal control	○	○			
Half-duplex communication control		○	○			
Mode switching		○	○			
Independent operation of two interfaces	Setting the same protocol	○	○		×	
	Setting different protocols	○	○			
Linked operation of two interfaces		○	○		○	
Registering initial setting values of the buffer memory		○ (Flash ROM)	○ (EEPROM)		×	×
Registering user frame					×	×
Connection forms with external devices	1:1, 1:n	○	○			
	m:n	○	○			
I/O signal transmission/receive by multi drop link function		×	×		○	×
Connection of GX Developer		○	○			
Registering and monitoring of setting values by the utility package		○	×		×	×
PLC that can be mounted		QCPU MELSECNET/H remote I/O station	QnACPU MELSECNET/10, Remote I/O station		ACPU AnACPU AnUCPU QnACPU	ACPU AnACPU AnUCPU QnACPU
Data transmission rate (bps)		115200 maximum	115200 maximum	19200 maximum	19200 maximum	19200 maximum

○: Function exists/possible ×: No function/impossible

*1 Access is possible only within the range of an AnACPU device.

*2 A multiple block batch read/write function can be used for the local station QCPU to which the Q series C24 is mounted and the next CPU module, which will be another station, via MELSECNET/H, MELSECNET/10.

Function	PLC CPU			
	QCPU	QnACPU	Q2AS(H)	Q4AR
Multiple block batch read/write	(All allowed)	(9707B or later products) *		(All allowed)

* This function is added to modules showing 9707B or later in the package indication and the DATE column of the rating plate.

*3 Access to other stations cannot be performed via data link system (MELSECNET(II), MELSECNET/B).

*4 Transmission is only possible using the printer function.

*5 When the Q series C24 is used, it is possible to read/write a maximum of 960 words (in case of QC24(N), it is possible to read/write a maximum of 480 words.)

Appendix 2.2 Using Programs Designed for the QC24 (N) and Installing the Q Series C24 into Existing Systems

This section explains how to use programs designed for serial communication modules in the QnA series and the installation of the Q series C24 into an existing system.

POINT

When using the Q series C24, make sure to set the operation mode, station number, and transmission specifications with the following parameter setting screen of GX Developer.

- "Intelligent function module switch setting" screen

The Q series C24 does not have the setting switches to set the operation mode, station number, and transmission specification that are available in the serial communication modules for QnA series.

Appendix 2.2.1 Using programs designed for the QC24 (N)

The data communication between the QnACPU and external devices as well as other QnACPU which has been performed by QC24(N) can also be performed by the Q series C24.
The following explains how to use programs designed for QC24(N) during data communication using the Q series C24.

(1) The communication programs directed to the QC24(N) on the external device side and the communication programs on the QnACPU (self-station) side to which the QC24(N) is mounted can be used for the Q series C24.
However, note the following points.
- There is no function that allows data communication with other station's PLC CPUs by a data link instruction.
Delete the part of data communication program by data link instructions.
- When using a new function, create a new program.

(2) Make sure to check operation when using communication programs for QC24(N) on the external device side and the QnACPU (self-station) side.

(3) The notes during data communication by RS-422/485 interface also apply to the Q series C24.
- Take measures against data error reception on the external device side (see Section 3.3.3).
- Operation of RS-422/485 interface on the PLC side.

Appendix 2.2.2 Installing on existing systems

The following explains the Installation of the Q series C24 on an existing system.

(1) Installing on a multidrop connection system

The Q series C24 can be installed on an existing system to which the PLC CPU and external devices are connected as 1:n or m:n multidrop connection (*1).

*1 This is when a QC24(N) or a computer link module (such as AJ71UC24) is used as the PLC CPU module of the multidrop connection.

However, there are frame restrictions when data communication is performed. (See the Reference Manual.)

(2) Replacing the QnACPU module with a QCPU

The wiring used by the QC24(N) can be used as is.

POINT
The functional use is the same, except for the functions added by the Q series C24 to the conventional module. However, with the introduction of high-speed QCPUs, there may be cases in which communication cannot be performed normally when a PLC module in the QnA series is replaced by a Q series PLC. When a module is changed to a Q series PLC module, make sure to perform an operation check.

Appendix 2.3 Using Programs Designed for the Computer Link Module and Installing the Q Series C24 into Existing Systems

This section describes how to use programs created for A series computer link modules and installing the Q series C24 into an existing system.

POINT
When using the Q series C24, make sure to set the operation mode, station number, and transmission specifications with the following parameter setting screen of GX Developer. • "Intelligent function module switch setting" screen The Q series C24 does not have the setting switches to set the operation mode, station number, and transmission specification that are available in the computer link module for A series.

Appendix 2.3.1 Using programs designed for the computer link module

The data communication between the PLC CPU and external device as well as other PLC CPU that has been performed by A series computer link modules (hereinafter abbreviated as UC24/C24-S8) can also be performed using the Q series C24. However, UC24/C24-S8 and the Q series C24 have major differences in the following points.
For PLC CPU side, create a new program according to the explanation in the section of the function used.
(Differences between UC24/C24-S8 and the Q series C24)

- Initial setting items and the setting method of addresses and special application areas of the buffer memory
- Input/output signals for handshake
- Dedicated instructions of the PLC CPU

(1) Initial settings for special application area in buffer memory

1) In the Q series C24 the addresses for special application areas in the buffer memory are different from those of UC24/C24-S8. The Q series C24 has more initial setting items.
   The setting method is different such that the settings are performed using the utility package (QSCU).
2) Register necessary initial setting values according to Chapter 8.
3) The default value for the CD terminal check setting is changed to "No check".

(2) Data communication using the MC protocol (identical to the communication functions of the dedicated protocol of UC24/C24-S8)

(a) Communication protocol setting
   Data communication is performed using an A compatible 1C frame by setting the communication protocol setting of the Q series C24 specified by GX Developer to the same form as set in the mode setting switch of UC24/C24-S8.

(b) Command message and response message

1) The message format used in the data communication using the A compatible 1C frame is the same as the message format of UC24/C24-S8.
2) Check available commands and devices that can be accessed in Chapter 8 of the Reference Manual, and access the PLC CPU from the external device.
3) For the QCPU, only read/write of device memory is possible.
For the range of devices that can be accessed, see Section 5.2.1 of the Reference Manual.
* The devices added to the QCPU, i.e. the latch relay (L), step relay (S), and file register (R) devices, are accessed using commands for QnA compatible 2C/3C/4C frames. It is necessary to create new programs.

(c) Accessing other stations

1) When accessing other station's PLC CPU via the MELSECNET/10, "Valid module during other station access" must be designated in the parameter setting by GX Developer.
2) Check the stations that can be accessed in Chapter 5 of the Reference Manual, and access the PLC CPU from the external device.
3) When it is necessary to access other stations on other MELSECNET/10, data communication must be performed in a QnA compatible 3C/4C frame.
Create a new program for the external device side according to Chapter 3 of the Reference Manual.
4) It is not possible to access other stations via the MELSECNET(II)/B.

(d) Transmitting data to the external device by the on-demand function

1) The program for data transmission on the PLC CPU side is different from when UC24/C24-S8 is used.
Create a new program on the PLC CPU side according to Section 3.11 in the Reference Manual.
2) Data to be sent to the external device is identical to when the UC24/C24-S8 is used.

(3) Data communication using the non procedure protocol

(a) Data transmission/reception

1) The same data transmission/reception as used by UC24/C24-S8 can be performed.
2) Create a new program for data communication upon checking functions and instructions used on the PLC CPU side in Chapter 6 of this manual and Chapter 11 of the User's Manual (Application).
Data transmission/reception is performed using dedicated instructions.

3) When data is received by a reception end code, the external device side must send the end code data (the default is CR+LF (code: 0D$_H$ and 0A$_H$) at the end of the data sent to the PLC CPU side.
Once any end code is registered, data can be transmitted in the same way as for the UC24/C24-S8.
4) The external device side can receive data from the Q series C24 in the same ways as UC24.

(b) Message transmission by printer function (when using programs designed for UC24)

1) Message transmission using the printer function of the UC24 can be implemented by the data transmission function that uses a user frame.
2) For the PLC CPU, register and send messages according to the User's Manual (Application).
Messages handled by the UC24 will become user frames in the Q series C24.

(4) Data communication using the bidirectional protocol

(a) Setting to add a sum check code to a message
The setting to add a sum check code to a message has been changed. It is set during switch setting operation by GX Developer.

(b) Data transmission/reception

1) The same data transmission/reception as used by UC24/C24-S8 can be performed.
2) Create a new program for data communication upon checking functions and instructions used on the PLC CPU side in Chapter 7.
Data transmission/reception is performed using dedicated instructions.
3) The external device can transmission/receive data in the same way as the UC24/C24-S8.

(5) Others

1) The Q series C24 has other functions that are equivalent to those of UC24/C24-S8, which are not mentioned above.
2) Check functions and specifications in this manual and the manuals listed below, and use the applicable functions.
- User's Manual (Application)
- Reference Manual

Appendix 2.3.2 Installing the Q series C24 into existing systems

This section shows the notes when installing the Q series C24 into an existing system that uses UC24/C24-S8.

(1) Data communication using m:n connection

When the Q series C24 is installed into an existing system that has an m:n system structure between the PLC CPU and external devices, and data communication is performed using the MC protocol, the following notes should be considered:

(a) Accessing the PLC using a frame for form 5

When the UC24/C24-S8 is connected on the line, it is not possible to access the PLC in the QnA compatible 4C frame (form 5) for binary code communication.

(b) Data communication between external devices

1) When data communication is performed in order to link with an external devices to perform a 1:1 communication with the PLC CPU, it is necessary to change the station number (80_H to $A0_H \rightarrow 00_H$ to $1F_H$) designated in the "Station number" and "Local station number" items in the messages on the external device side. (It is not necessary to specify this when an A compatible 1C frame is used.)
Alternatively, it is necessary to change the message frame so that it has a data order different from that of the MC protocol.
   - Station number: Designate the number of device to which data is sent
   - Local station number: Designate the number of the device that sends data

2) Perform the data communication according to Chapter 14 of the User's Manual (Application).

(c) Processing reception data on the external device side

Set the external device so that it ignores the following reception messages that are unrelated to the local station.
- The command message and the corresponding response message that are sent from other stations when accessing the PLC CPU using the MC protocol.
- Messages when accessing between external devices.

(2) Data communication using 1:n connection

When the UC24/C24-S8 is connected on the line, it is not possible to access the PLC in the QnA compatible 4C frame (format 5) for binary code communication.

POINT

Since performances and response speeds are different between the Q series C24 and the UC24/C24-S8, communication may not be performed normally when a PLC module in the A series is replaced by a Q series PLC.
When a module is changed to a Q series PLC module, make sure to check operation.

Appendix 3 Processing Time

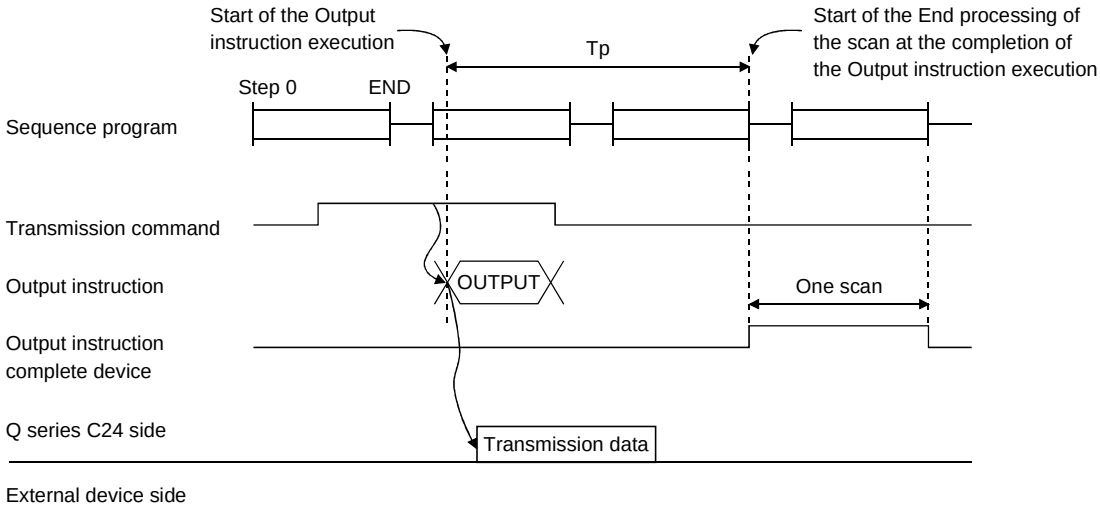
(1) Time required to process communication using the non procedure protocol (guideline)

The processing time for the Output and Input instructions can be estimated by the following formula. Note, however, that the processing time may become longer depending on other communication functions (e.g., communication using the MC protocol) and special functions (e.g., ASCII-binary conversion, transmission control) that are used at the same time.
The value obtained from the following formula should be used as a guideline for the processing time when reception or transmission only is performed using only CH1 (RS-232 connection).

(a) Output instruction

$Tp = St + (D_{le}/Cr \times 1000 + 0.07) \times Ds + 4.86$

Tp (*1) : The time from the start of execution of the Output instruction to the End processing of the sequence scan at the completion of the Output instruction execution (ms)
St : Scan time
D_{le} : Data length of 1 byte at data transmission (number of bits)
Cr : Communication rate (bps)
Ds : Number of bytes of transmission data
*1 This stands for the time range of processing (Tp).



[Calculation example]
Estimate the time required to process the Output instruction when transmitting 100 bytes of data using the non procedure protocol (unit: ms).

- Scan time : 10 ms
- Data length : 10 bits (1 start bit, 8 data bits, 1 stop bit, no parity bit)
- Communication rate : 19200 bps

$10 + (10/19200 \times 1000 + 0.07) \times 100 + 4.86 \fallingdotseq 73.94$ (ms)

(b) Input instruction

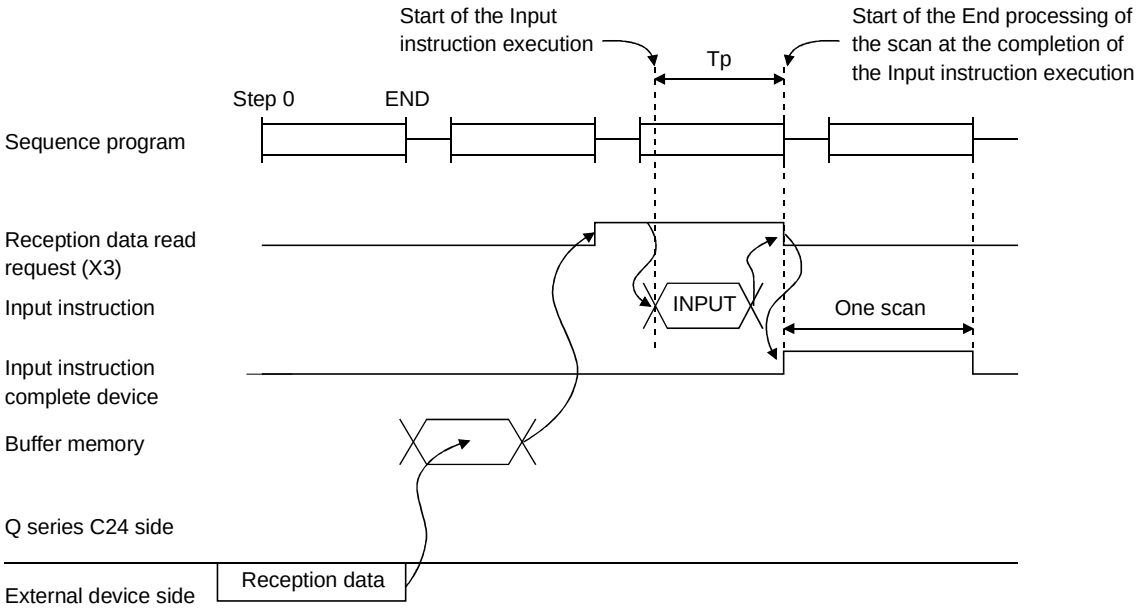
Tp = Sr + 0.09 × Dr + 14.91

Tp (*1) : Time from the start of execution of the Input instruction to the End processing of the sequence scan at the completion of the Input instruction execution (ms)

Sr : Scan time

Dr : Number of bytes of reception data

*1 This stands for the time range of processing (Tp).



[Calculation example]

Estimate the time required to process the Input instruction when receiving 100 bytes of data using the non procedure protocol (unit: ms).

- Scan time : 10 ms

10 + 0.09 × 100 + 14.91 ≒ 33.91 (ms)

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2) Processing time of dedicated instructions
The following table shows the operation processing time (rough standard) of each dedicated instruction.
The operation processing time differs slightly depending on the system configuration and communication protocol.

Instruction name	Processing time (unit: ms)		Instruction execution condition		
	Q02CPU	QnHCPU	Transmission rate	Transmission/receive (registered) data count	Others
ONDEMAND	52.9	51.5	19200 bps	40 bytes	Send in form 3
OUTPUT	38.5	35.9		40 bytes	—
PRR	38.5	35.9		40 bytes ∗ 8 bytes × 5 frames	—
INPUT	28.5	28.4		40 bytes	—
BIDOUT	52.3	50.3		40 bytes	—
BIDIN	40.0	40.0		40 bytes	—
PUTE	798.7	791.3	—	40 bytes	—
GETE	2.1	1.0	—	40 bytes	—
SPBUSY	0.6	0.2	—	—	—
CSET	2.3	1.1	—	—	Transmission/ receive buffer setting
BUFRCVS	21.3	21.3	19200 bps	40 bytes	—

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Appendix 4 ASCII-Code Table

The ASCII-code table is shown below. (7-bit code)
The codes 00H to 1FH indicated by the ★ are used as Q series C24 control codes. (DC codes 11H to 14H can be changed by the user.)

LSD \ MSD		0	1	2	3	4	5	6	7
		000	001	010	011	100	101	110	111
0	0000	NUL★	DLE★	SP	0	@	P	,	p
1	0001	SOH	DC1★	!	1	A	Q	a	q
2	0010	STX★	DC2★	"	2	B	R	b	r
3	0011	ETX★	DC3★	#	3	C	S	c	s
4	0100	EOT★	DC4★	$	4	D	T	d	t
5	0101	ENQ★	NAK★	%	5	E	U	e	u
6	0110	ACK★	SYN	&	6	F	V	f	v
7	0111	BEL	ETB	/	7	G	W	g	w
8	1000	BS	CAN	(	8	H	X	h	x
9	1001	HT	EM	)	9	I	Y	i	y
A	1010	LF★	SUB	*	:	J	Z	j	z
B	1011	VT	ESC	+	;	K	[	k	{
C	1100	FF★	FS	,	<	L	\	l	|
D	1101	CR★	GS	—	=	M	]	m	}
E	1110	SO	RS	.	>	N	↑	n	~
F	1111	SI	US	/	?	O	←	o	DEL

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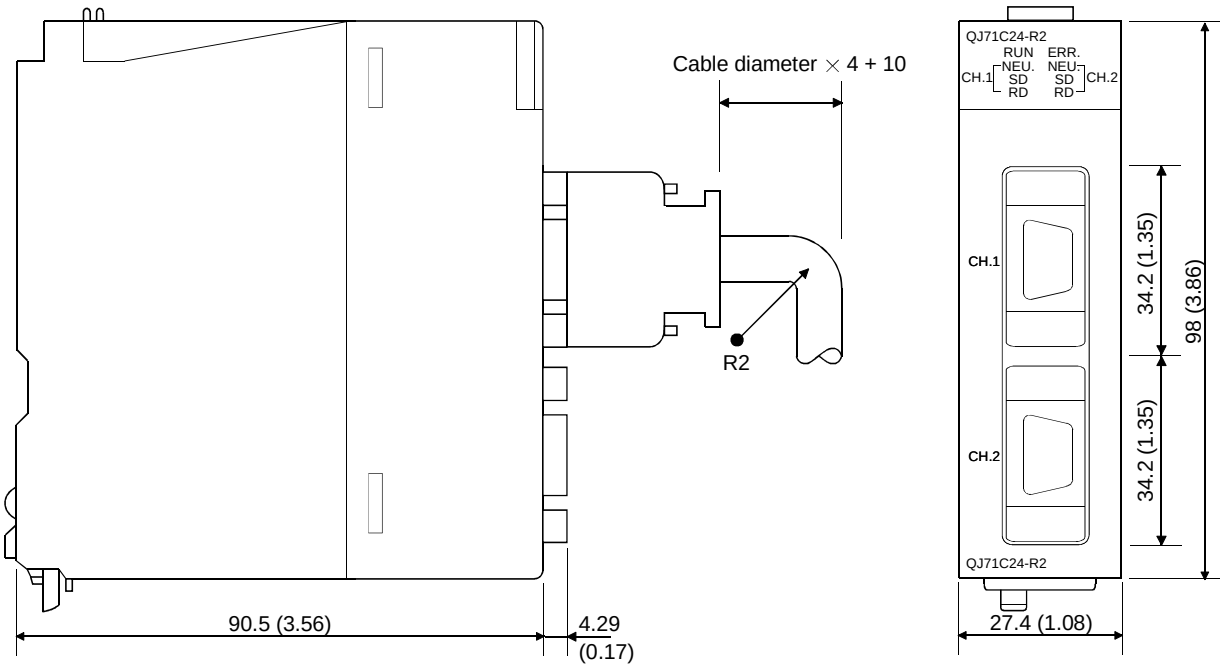
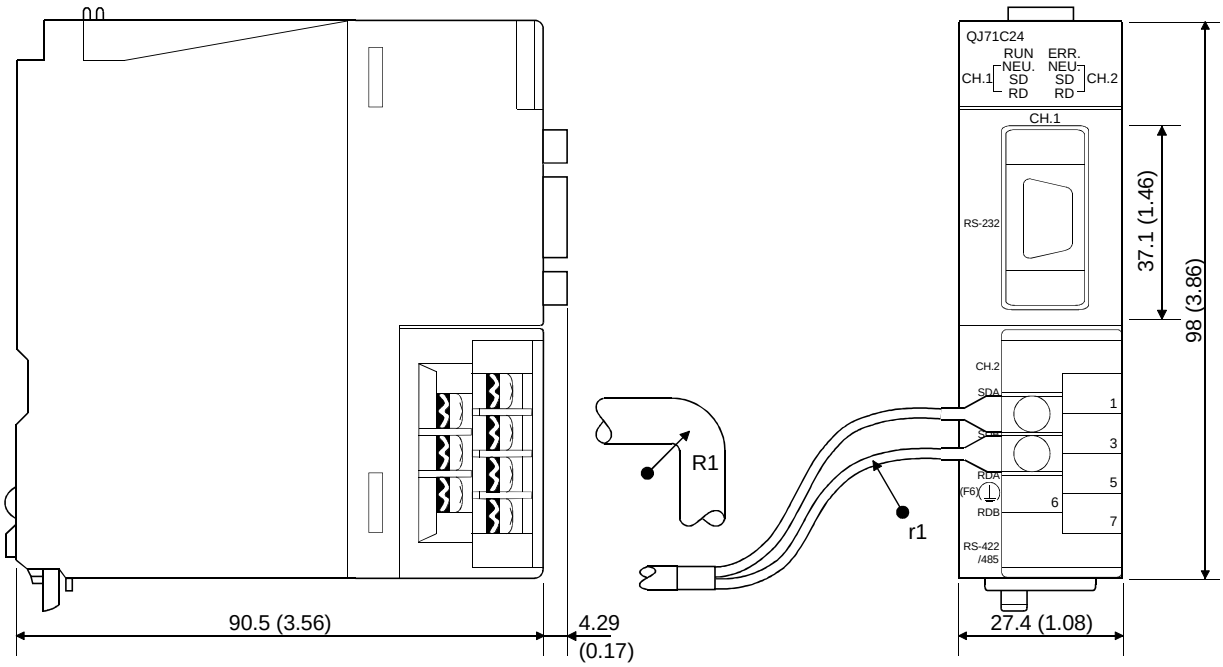
Appendix 5 External Dimensions





(Unit : mm (inch))

* R1 (bend radius near terminal board): Cable diameter × 4
* R2 (bend radius near connector) : Cable diameter × 4
* r1 (bend radius near crimp terminal) : Can be connected within the range over which bending is not excessive

Appendix 6 Example of Connection when a Converter is Used

The following shows an example of a connection where the RS-232 to RS-422/485 converters are used in order to communicate data using data communication functions with the MC, non-procedure, or bidirectional protocol.

The converters covered in the Appendix are as follows:

Manufacturer	Model name (Products that can be connected)	Contact	Tel No. Fax No.
EL Engineering Ltd.	EL-LINE-II	Funato-cho 7-16, Nakagawa-ku, Nagoya, 454-0805	Tel: (052) 361-2290 Fax: (052) 363-1050
System Sacom Co., Ltd.	KS-1 KS-10P KS-485	Shibuya Property West Bldg 12F, Higashi 1-32-12 , Shibuya-ku, Tokyo, 150-0011	Tel: (03) 3797-0211 Fax: (03) 3797-0231

* "Products that can be connected" indicates products whose specifications (standards) allow connection with modules of our company.
Before using them, make sure they confirm to the stated specifications (standards).

(1) Combination between available converters and connections

Q series C24 side connection interface	System configuration with external devices	External device interface	Available converter	Description No. of connection example
RS-232	1:1	RS-422	EL-LINE-II	Connection example 1
			KS-1 KS-10P	Connection example 2
		RS-485	KS-485	Connection example 3
RS-422/485	1:1, 1:n, m:n	RS-232	KS-485	Connection example 4

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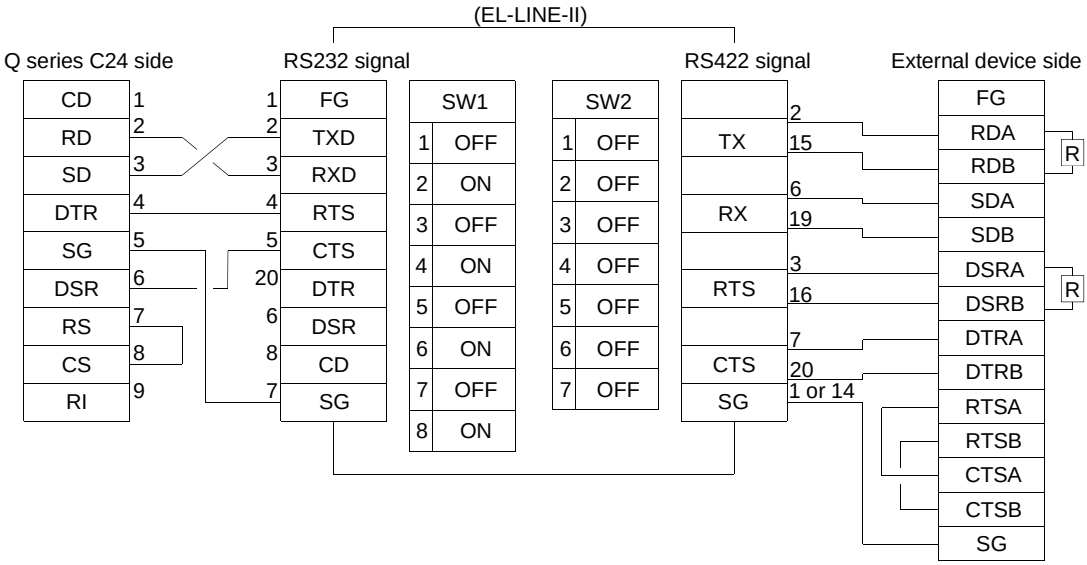
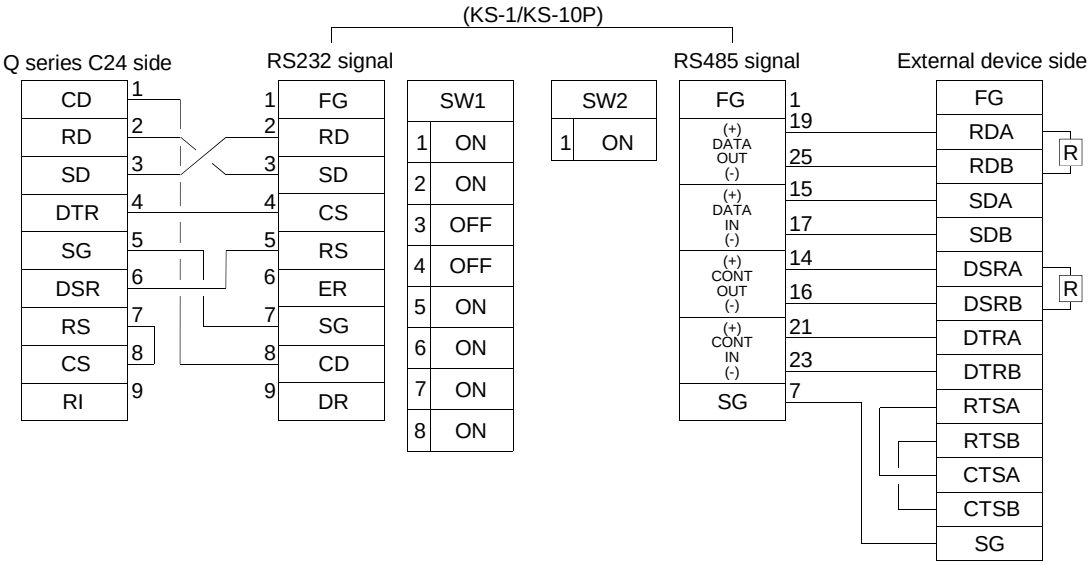
(2) Connection example

(Connection example 1)



* • The CD terminal check setting should be set to "No check" according to the explanation in Section 3.2.1 (1).
  • DC code control or DTR/DSR control becomes possible for transmission control.

(Connection example 2)



* • The CD terminal check setting should be set to "No check" according to the explanation in Section 3.2.1 (1).
  • DC code control or DTR/DSR control becomes possible for transmission control.

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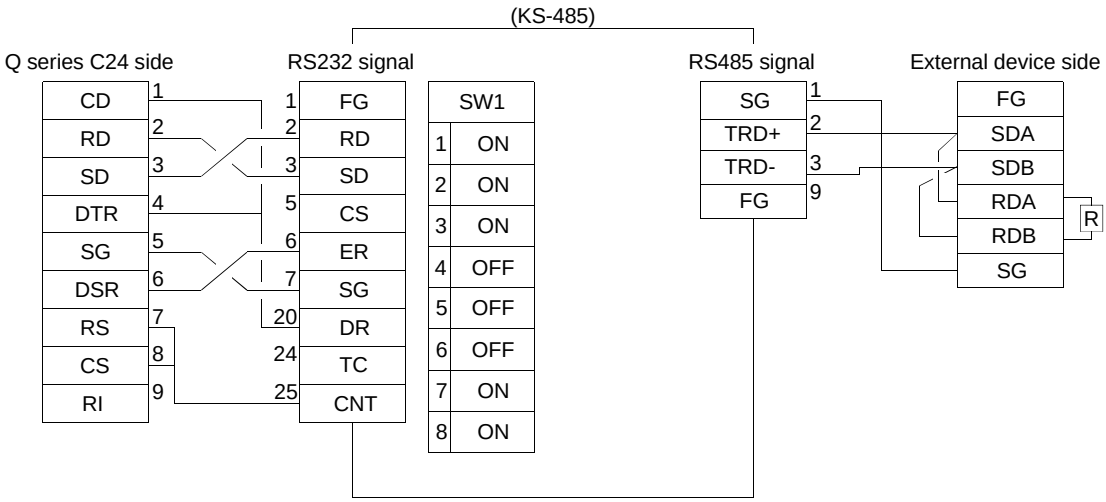
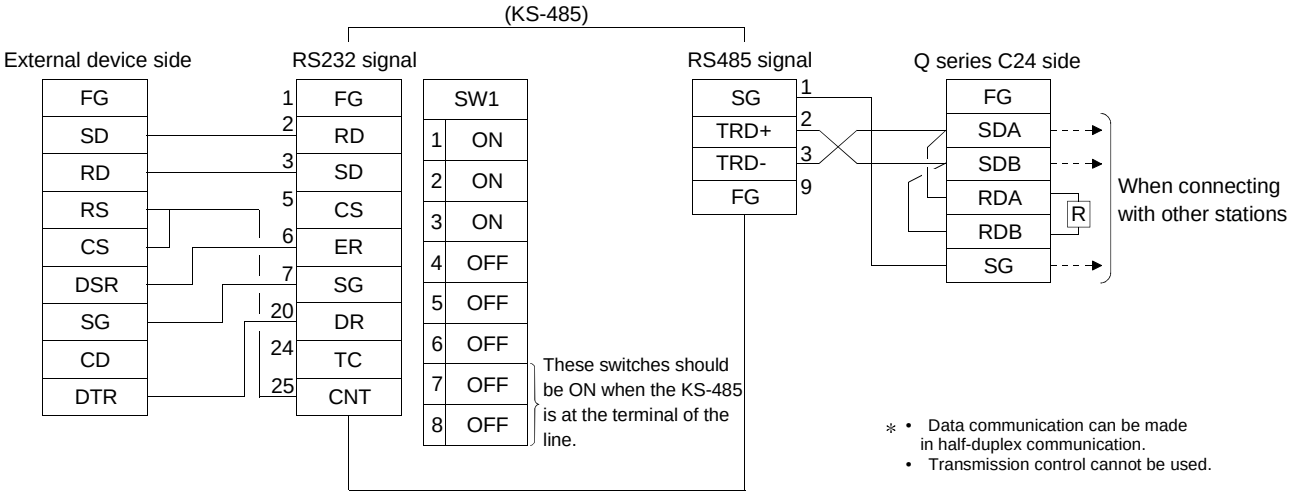
(Connection example 3)



∗ • Data communication can be made in half-duplex communication.
• The CD terminal check setting should be set to "No check" according to the explanation in Section 3.2.1 (1).
• Transmission control cannot be used.

(Connection example 4)



∗ • Data communication can be made in half-duplex communication.
• Transmission control cannot be used.

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Appendix 7 MELSEC Communication Support Tool

By using the Mitsubishi communication support tool for supporting communication between the MELSEC-Q Series and personal computer, the communication program on the personal computer side connected with a computer link etc., can be simplified. The following sections explain the function overview and data link functions of the MX Links (SWnD5F-CSKP-E, hereinafter CSKP). The programming methods on personal computer side for reading/writing data to the MELSEC PLC CPU using CSKP are also explained.

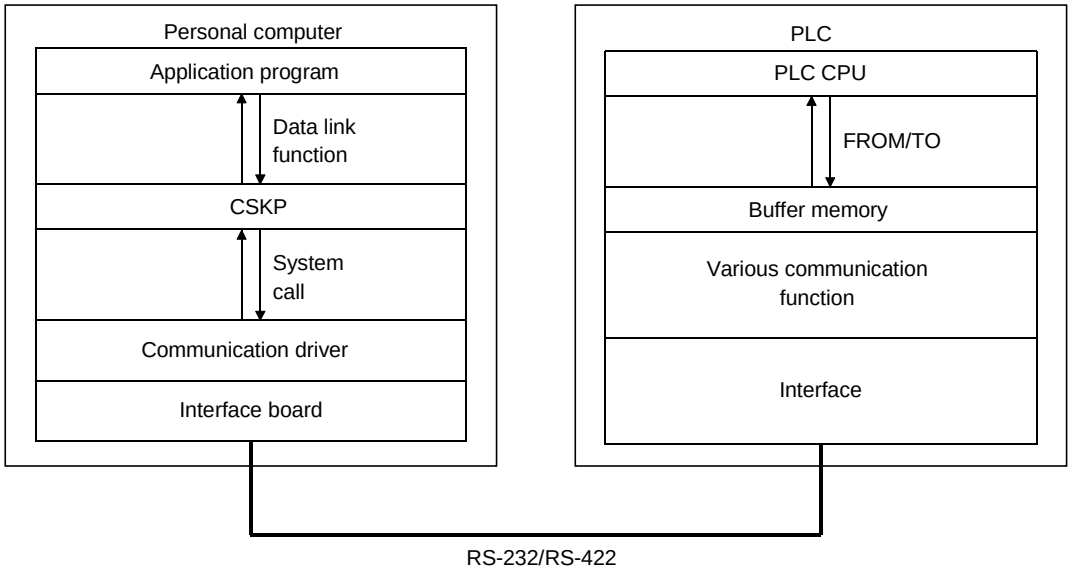
* For details on the CSKP, see the CSKP manual.

Appendix 7.1 Overview of MX Links

This section shows the overview of CSKP.

(1) The CSKP is installed into the personal computer and used.

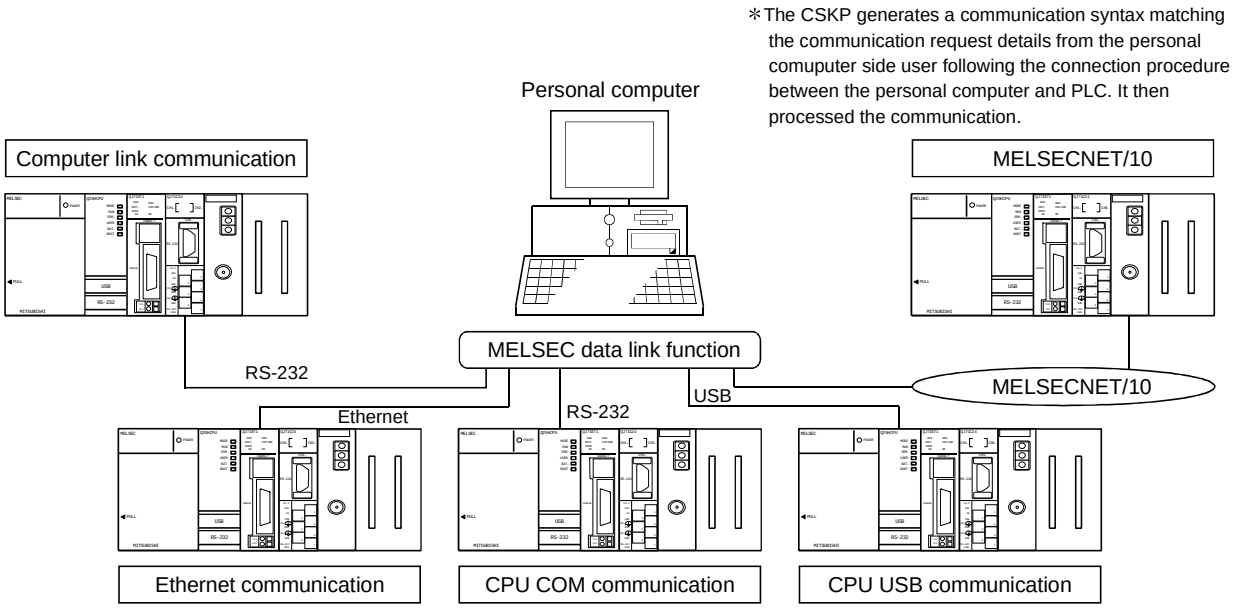
(Example) Software structure diagram for computer link connection



(2) Ample support of communication protocols

The personal computer side user can easily access the PLC's CPU by designating the connection type and communication request details using the following CSKP data link function arguments.

* The user does not need to understand the communication syntax unique to the intelligent function module on the PLC side. The connection procedure can be changed just by changing part of the program (mdOpen argument's communication channel No.) in the program created by the user.
  Once created, the user program can be used effectively.



(3) Data link functions dedicated for communicating data with PLC are supported

- Functions required for communicating data with the PLC, such as communication line open/close and device read/write, are prepared as data link functions.
- Various communication programs can be created easily, so development of the communication system using Ethernet/serial communication, etc. with the PLC side is easily.

Function name	Data link function's function
mdOpen	Initializes and opens the designated communication line channel.
mdClose	Closes the designated communication line channel.
mdSend	Writes the data in a batch to the designated device.
mdReceive	Reads the data in a batch from the designated device.
mdRandR	Reads data from a randomly designated device.
mdRandW	Writes the data to a randomly designated device.
mdDevSet	Sets (ON) the designated bit device.
mdDevRst	Resets (OFF) the designated bit device.
mdControl	Carries out remote RUN/STOP/PAUSE in respect to the designated PLC CPU.
mdTyperead	Reads the type of designated PLC CPU.

(4) Various utilities are enclosed

The communication between the PLC and personal computer can be tested and monitored with the communication diagnosis utility and device monitor utility enclosed with the product.

(5) Supporting system construction without programming

By using the CSKP along with the MX Chart (SWnD5F-OLEX-E) and MX Monitor (SWnD5F-XMOP-E), a system may be constructed without programming.

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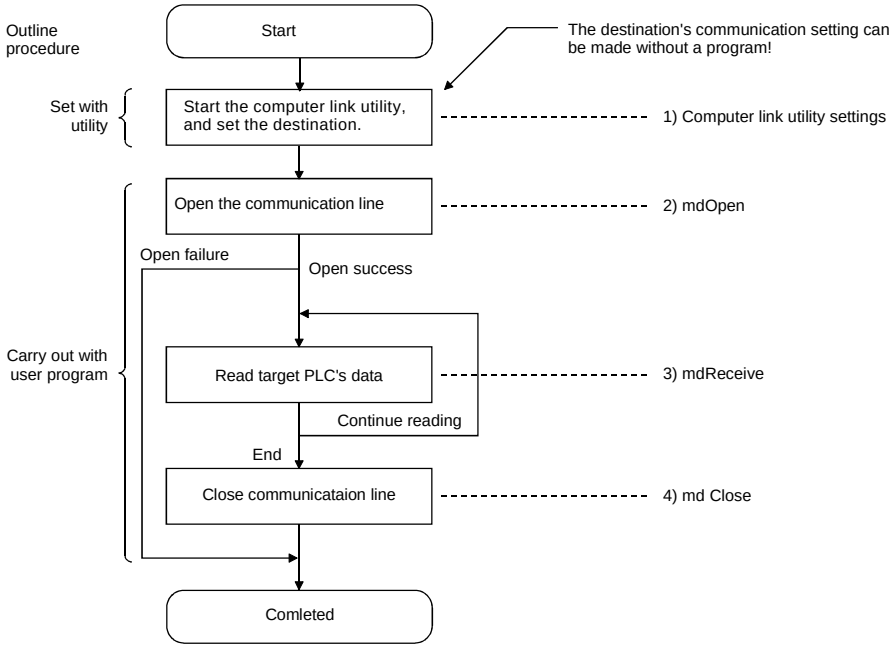
Appendix 7.2 Examples of Using MX Links

Programming procedures and program examples for connecting to the PLC's computer link module and the Q series C24 and accessing the PLC's CPU from a personal computer are described in this section.
For the program example, the personal computer reads the data register (D) for the Q Series PLC CPU, and displays the results on the screen.

(1) Programming procedures (Outline flow of procedures)

The flow of the data read process for creating a personal computer side program to access the PLC CPU using CSKP is shown below.



1) Computer link utility settings
   Set the computer link module/Q series C24 model (QJ71C24), module station number and COM port communication condition of the PLC to be communicated with over a computer link connection. This information is saved as a logic station No.
2) mdOpen
   This function initializes and opens the serial communication line channel (Serial port (COM port) channel number = 31 to 40).
   The path of the opened communication line is returned as the execution results.
   The path is required to execute the function (mdReceive) for reading the PLC data, and the function (mdClose) for closing the line.
3) mdReceive
   This function reads the PLC CPU's device data.
   The target PLC's logic station No., device to be read and No. of points are assigned to the argument.
4) mdClose
   This function closes the opened communication line channel.
   The communication line must be closed when reading and writing are completed.

(2) Example of programming (a Visual C++ compiler is used in the example)

The following shows a programming that reads the values of D0 to D1 of the target PLC CPU via the communication line of logical station number 0, and displays them in the MS-DOS Windows prompt for Microsoft®Windows®95 operating system, Microsoft®windows®98 operating system, Microsoft® Windows NT®Workstation4.0 operating system.

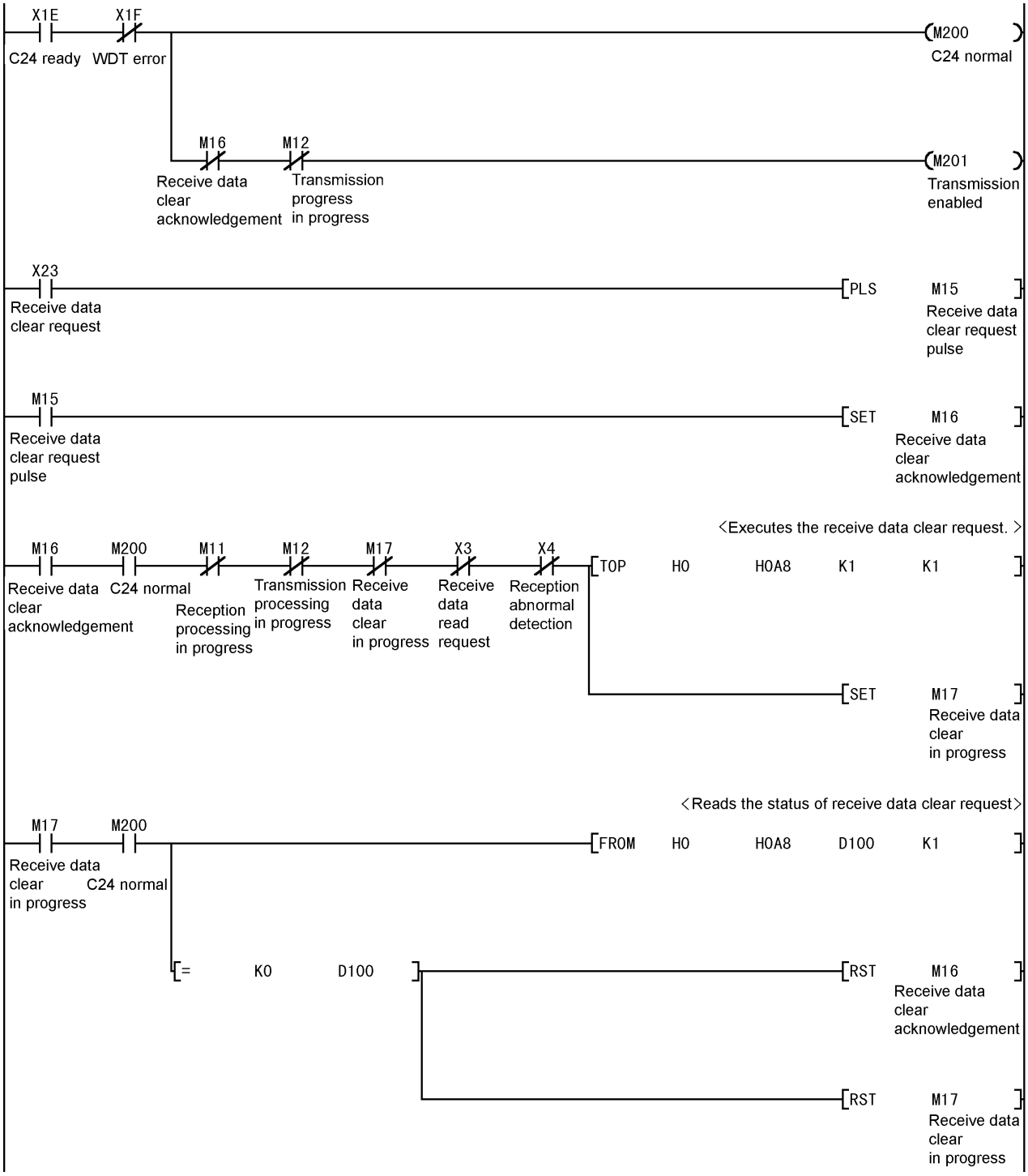
```
/*************************
* Include                *
*************************/
#include      <stdio.h>
#include   <windows.h>          /* Include file                          */
#include     "mdfunc.h"         /* Data link function include file       */
/*************************
* Constant declaration   *
*************************/
#define   CHSN_COM1          31   /* Computer link communication channel (common for C24, UC24, QC24)  */
#define   MODE_DUMMY         –1   /* Dummy (fixed to –1)                                               */
#define   STNO_ROGIC         0    /* Logic station No.                                                 */
#define   DEVTYPE_D          13   /* Device type "D"                                                   */
#define   DEVNO_0            0    /* Read head device No.                                              */
#define   SIZE_R_BYTES       4    /* No. of read data bytes                                            */
#define   DATA_INITIAL       0    /* Read area initial value                                           */
/*************************************************
* The logic station No. "0" PLC data is read.    *
* The logic station No. is preset with the computer link utility.  *
*************************************************/
void main( )
{
    /* Declare mdOpen argument                 */
    long      path;                          /*Path save function                  */
    short     chan;                          /*Communication line channel No.      */
    short     mode;                          /*Dummy (fixed to –1)                 */
    short     oret;                          /*mdOpen function return value        */
    /* Declare mdReceive argument              */
```

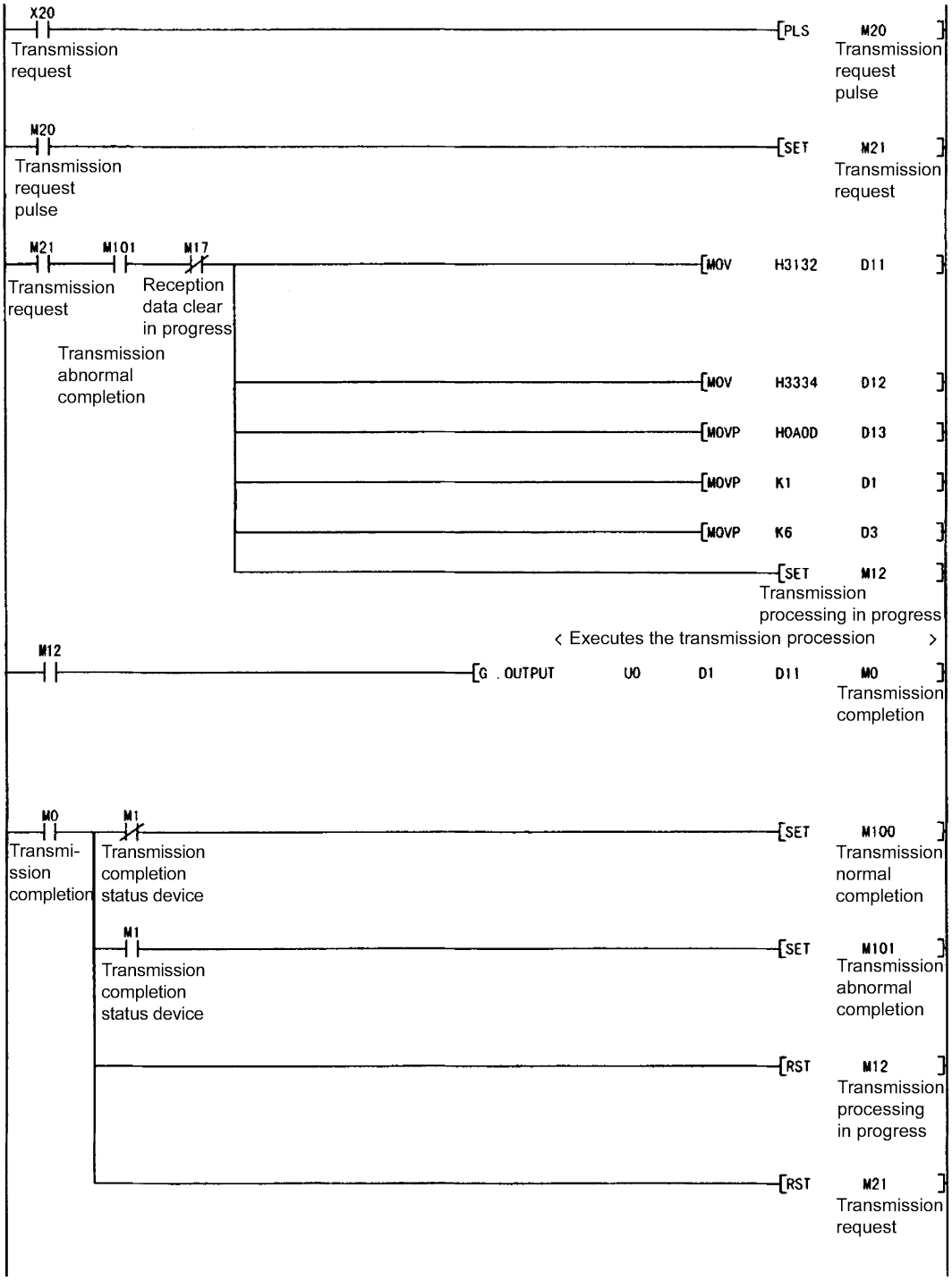
```
    short     stno;                                   /*Station No.                          */
    short     devtyp;                                 /*Device type                          */
    short     devno;                                  /* Read head device No.               */
    short     size;                                   /* No. of read data bytes             */
    short     data[2];                                /* Read data buffer                   */
    short     rret;                                   /* mdReceive function return value    */
    /* Declare mdClose argument                 */
    short     cret;                                   /* mdClose function return value      */
    /* Declare mdOpen argument setting          */
    chan      = CHSN_COM 1;                           /* Computer link communication channel */
    mode      = MODE_DUMMY;                           /* Dummy (fixed to –1)                */
    /* Execute mdOpen and open line             */
    oret = mdOpen( chan, mode, &path );
    if( oret != 0 ){
              /* If function fails, return error                    */
              printf("mdOpen error[%04x]\n", oret );
    }else{
              /* Continue process only when mdOpen succeeds         */
              /* Set mdReceive argument                             */
              stno      = STNO_ROGIC;                 /* Logic station No.                  */
              devtyp    = DEVTYPE_D;                  /* Device type "D"                    */
              devno     = DEVNO_0;                    /* Read device No. 0, 1               */
              size      = SIZE_R_BYTES;               /* 2-point, 4-byte
                                                         (word device is 1-point 2-byte)    */
              data[0]   = DATA_INITIAL;               /* Initialize read data area          */
              data[1]   = DATA_INITIAL;               /* Initialize read data area          */
              /* Execute mdReceive and read                         */
              /* Use path acquired with mdOpen                      */
              rret = mdReceive( path, stno, devtyp, devno, &size, &data );
              if( rret != 0 ){
                        /* If function fails, return error          */
                        printf("mdReceive error[%04x]\n", rret );
              }else{
                        /* Display read data                        */
                        printf("data0 [%4x]\n", data[0] );  /* Data display               */
                        printf("data1 [%4x]\n", data[1] );  /* Data display               */
              }
              /* Execute mdClose and close line                     */
              /* Use path acquired with mdOpen                      */
              cret = mdClose( path );
              if( cret != 0 ){
                        /* If function fails, return error          */
                        printf("mdClose error[%04x]\n", cret );
              }
    }
}
```

Appendix 8 Example of Clear Process Program for Receive Data

When performing data communications with non procedure protocol, use the receive data clear request shown in 6.1.4. and display the sequence program example if clearing the receive data from external device. (If the Q series C24 input/output signal is X/Y000 to X/Y01F.)

The following I/O signals (X) and internal relays (M) are used in the program.




X20
Transmission request
PLS M20
Transmission request pulse
M20
Transmission request pulse
SET M21
Transmission request
M21
Transmission request
M101
Transmission abnormal completion
M17
Reception data clear in progress
MOV H3132 D11
MOV H3334 D12
MOVP H0A0D D13
MOVP K1 D1
MOVP K6 D3
SET M12
Transmission processing in progress
< Executes the transmission procession >
M12
G. OUTPUT U0 D1 D11 M0
Transmission completion
M0
Transmi-ssion completion
M1
Transmission completion status device
SET M100
Transmission normal completion
M1
Transmission completion status device
SET M101
Transmission abnormal completion
RST M12
Transmission processing in progress
RST M21
Transmission request

Appendix 9 Setting Value Recording Sheet

The following sheet is for recording parameter setting values set by GX Developer.
Use as many copies as needed.

* In order to review the setting values of the utility package (QSCU), print out the content of the file generated by the "Make text file" function of QSCU which can be used as the setting value recording sheet.

[Module No.]

Recording sheet 1 (Intelligent function module interrupt pointer setting)

GX Developer setting screen	Data item name		Set data	
			Setting value	Remarks
Intelligent function module interrupt pointer setting	CPU side	Interrupt pointer start No.		Input format: Decimal
		Interrupt pointer No. of modules	2 (fixed)	
	Intelligent module side	Start I/O number		Input format: Hexadecimal
		Start SI number	0 (fixed)	Input format: Decimal

Recording sheet 2 (Intelligent function module switch setting)

Switch number	Description															
Switch 1	CH1 Communication rate setting								CH1 Transmission setting							
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	H															
Switch 2	CH1 Communication protocol setting =															
Switch 3	CH2 Communication rate setting								CH2 Transmission setting							
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	H															
Switch 4	CH2 Communication protocol setting =															
Switch 5	Station number setting =															

* Check the setting values in the next page and record them.

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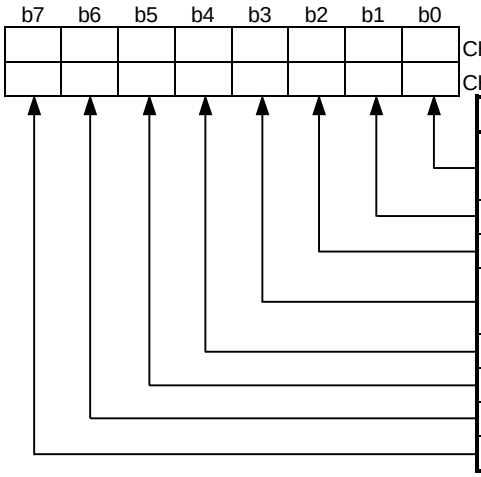
(GX Developer "Intelligent function module switch setting" setting values recording check sheet)

(1) Transmission setting (Enter "0" or "1" in the bit position field)



Bit	Description	OFF (0)	ON (1)	Remarks
b0	Operation setting	Independent	Linked	Always set to OFF on CH1 side.
b1	Data bit	7	8	Do not include parity bit.
b2	Parity bit	No	Yes	Vertical parity
b3	Odd/even parity	Odd	Even	Valid only when parity bit is set to Yes.
b4	Stop bit	1	2	—
b5	Sum check code	No	Yes	—
b6	Write during RUN	Prohibit	Allow	—
b7	Setting modification	Prohibit	Allow	—

(2) Communication rate setting (Enter check marks in the CH1 and CH2 fields)

CH1	CH2	Setting value	Communication speed (unit: bps)
		F_H	50
		0_H	300
		1_H	600
		2_H	1200
		3_H	2400
		4_H	4800
		5_H	9600
		6_H	14400
		7_H	19200
		8_H	28800
		9_H	38400
		A_H	57600
		B_H	115200

(3) Communication protocol setting (Enter check marks in the CH1 and CH2 fields)

CH1	CH2	Setting value	Setting data	
		0_H	GX Developer connection	
		1_H	MC protocol	Format 1
		2_H		Format 2
		3_H		Format 3
		4_H		Format 4
		5_H		Format 5
		6_H	Non procedure protocol	
		7_H	Bidirectional protocol	
		8_H	For linked operation setting	
		9_H to D_H	Setting prohibited	
		E_H	ROM/RAM/Switch test	
		F_H	Individual station recovery test	

MEMO

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WARRANTY

Please confirm the following product warranty details before starting use.

1. Gratis Warranty Term and Gratis Warranty Range

If any faults or defects (hereinafter "Failure") found to be the responsibility of Mitsubishi occurs during use of the product within the gratis warranty term, the product shall be repaired at no cost via the dealer or Mitsubishi Service Company. Note that if repairs are required at a site overseas, on a detached island or remote place, expenses to dispatch an engineer shall be charged for.

[Gratis Warranty Term]

The gratis warranty term of the product shall be for one year after the date of purchase or delivery to a designated place.

Note that after manufacture and shipment from Mitsubishi, the maximum distribution period shall be six (6) months, and the longest gratis warranty term after manufacturing shall be eighteen (18) months. The gratis warranty term of repair parts shall not exceed the gratis warranty term before repairs.

[Gratis Warranty Range]

(1) The range shall be limited to normal use within the usage state, usage methods and usage environment, etc., which follow the conditions and precautions, etc., given in the instruction manual, user's manual and caution labels on the product.

(2) Even within the gratis warranty term, repairs shall be charged for in the following cases.

1. Failure occurring from inappropriate storage or handling, carelessness or negligence by the user. Failure caused by the user's hardware or software design.
2. Failure caused by unapproved modifications, etc., to the product by the user.
3. When the Mitsubishi product is assembled into a user's device, Failure that could have been avoided if functions or structures, judged as necessary in the legal safety measures the user's device is subject to or as necessary by industry standards, had been provided.
4. Failure that could have been avoided if consumable parts (battery, backlight, fuse, etc.) designated in the instruction manual had been correctly serviced or replaced.
5. Failure caused by external irresistible forces such as fires or abnormal voltages, and Failure caused by force majeure such as earthquakes, lightning, wind and water damage.
6. Failure caused by reasons unpredictable by scientific technology standards at time of shipment from Mitsubishi.
7. Any other failure found not to be the responsibility of Mitsubishi or the user.

2. Onerous repair term after discontinuation of production

(1) Mitsubishi shall accept onerous product repairs for seven (7) years after production of the product is discontinued. Discontinuation of production shall be notified with Mitsubishi Technical Bulletins, etc.

(2) Product supply (including repair parts) is not possible after production is discontinued.

3. Overseas service

Overseas, repairs shall be accepted by Mitsubishi's local overseas FA Center. Note that the repair conditions at each FA Center may differ.

4. Exclusion of chance loss and secondary loss from warranty liability

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to damages caused by any cause found not to be the responsibility of Mitsubishi, chance losses, lost profits incurred to the user by Failures of Mitsubishi products, damages and secondary damages caused from special reasons regardless of Mitsubishi's expectations, compensation for accidents, and compensation for damages to products other than Mitsubishi products and other duties.

5. Changes in product specifications

The specifications given in the catalogs, manuals or technical documents are subject to change without prior notice.

6. Product application

(1) In using the Mitsubishi MELSEC programmable logic controller, the usage conditions shall be that the application will not lead to a major accident even if any problem or fault should occur in the programmable logic controller device, and that backup and fail-safe functions are systematically provided outside of the device for any problem or fault.

(2) The Mitsubishi general-purpose programmable logic controller has been designed and manufactured for applications in general industries, etc. Thus, applications in which the public could be affected such as in nuclear power plants and other power plants operated by respective power companies, and applications in which a special quality assurance system is required, such as for Railway companies or National Defense purposes shall be excluded from the programmable logic controller applications.

Note that even with these applications, if the user approves that the application is to be limited and a special quality is not required, application shall be possible.

When considering use in aircraft, medical applications, railways, incineration and fuel devices, manned transport devices, equipment for recreation and amusement, and safety devices, in which human life or assets could be greatly affected and for which a particularly high reliability is required in terms of safety and control system, please consult with Mitsubishi and discuss the required specifications.

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Q Corresponding Serial Communication Module

User's Manual (Basic)

MODEL	QJ71C24-U-KI-E
MODEL CODE	13JL86
SH(NA)-080006-B(0010)MEE	

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE : MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100-8310 TELEX : J24532 CABLE MELCO TOKYO
NAGOYA WORKS : 1-14 , YADA-MINAMI 5 , HIGASHI-KU, NAGOYA , JAPAN

When exported from Japan, this manual does not require application to the Ministry of International Trade and Industry for service transaction permission.

Specifications subject to change without notice.

Anexo 33: Información sobre sensores y dispositivos por comunicar

Dispositivo de vibraciones TAC 84c

Anemómetro

PT100: Sensor de temperatura

SEG: Relé de protección por bajo voltaje o baja frecuencia

Part no. 954184C

TAC 84C is used to monitor lowfrequent wing vibration in wind turbines.
A four character display shows measuring values and parameters.
The sensor is mounted in the rear end of the nacelle.
Self-test of sensor, see table for sensor error.
LED indications of relay status and revolution signal.
User adjustment of vibration fail level in m/s².
User adjustment of revolution fail level.
User adjustment of band-pass filter frequency and bandwidth.
The measuring principle: Sampling of data. Digital signal processing of the sampled values.
RS485 communication port. Text protocol and Modbus protocol.
11 pin plug-in socket.
Used with vibration sensor type VS05 nr. 9590100, sensitivity 240-650 mV/g. (typical 400 mV/g)

TAC 84C Vibration Guard / RS485

Parameter list

[163] [0]	[188] [1]	Text	Min.	Nom.	Max	Unit
1:	1:	* Vibration filtered NB	0.00	-	-	m/s²
2:	2:	* Vibration wideband WB	0.00	-	-	m/s²
3:	3:	* Actuel RPM	0	-	-	RPM
4:	4:	Filter center frequency	1.00	2.50	10.00	Hz
5:	5:	Filter bandwidth	fo/90	0.50	fo/0.5	Hz
6:	6:	Vibrations Limit Max.	0.01	1.00	3.00	m/s²
7:	7:	*** RPM Limit Max.	0	32	2300	RPM
8:	8:	**Min.RPM (Vibr.-sensor ch.)	0	18	2300	RPM
	9:	**Max.RPM (RPM-sensor)	0	8	2300	RPM
9:	10:	Pulse per revolution IPR	1	8	50	-
10:	11:	Delay Sensor error	1	600	5000	sek
11:	12:	Vibr. WB (RPM sensor)	0.01	0.40	0.70	m/s²
12:	13:	Vibr. WB (Vibr. sensor)	0.01	0.10	0.70	m/s²
13:	14:	Sensor calibration	240	300	650	mV/g
14:	15:	Avaragetime NB	1	3	15	sek
15:	16:	Max. registrated vibration	-	-	-	m/s²
15:	17:	Max. registrated RPM	-	-	-	RPM
17:	18:	Relay function (see table)	0	0	8	
18:	19	* Actual error code	-	-	-	****
19-28:	20-29:	* Last error codes	-	-	-	****
29	30	Preset all parameters	-	-	-	++
30	31	Calibration Date	-	-	-	++
31	32	RX/TX Mode Baud rate	0	2	3	++
32	33	Node ID	0	1	255	++
33	34	Protocol ID 0=text, 1=Modbus	0	0	1	++

Keyboard operation

The program version is displayed after power-up.
Press "NEXT" for next parameter. Activation of the "NEXT" key in more than 1 sec. moves the cursor to the top of the list.
Press "PARAM" for parameter text presentation. At a new press "PARAM" the text presentation is ended.
To alter parameters press "PARAM" and "NEXT" at the same time.
The first digit is flashing and can be altered by pressing "PARAM".
Press "NEXT" to move on to next digit.
At the fourth activation of the "NEXT" key the altering is ended.
Please note that the filter bandwidth can be changed in 31 steps only by pressing "PARAM".

* Presentation only (no parameter settings).
** Sensor check disabled when parameter is 0 RPM.
*** RPM level disabled when parameter is 0 RPM.

**** Error codes 1 = High vibration 2 = High RPM
4 =Sensor error RPM 8 = Sensor error vibration
Note: With several errors, this will be a combination.
E.g. 5 = High vibration (1) + sensor error RPM (4)

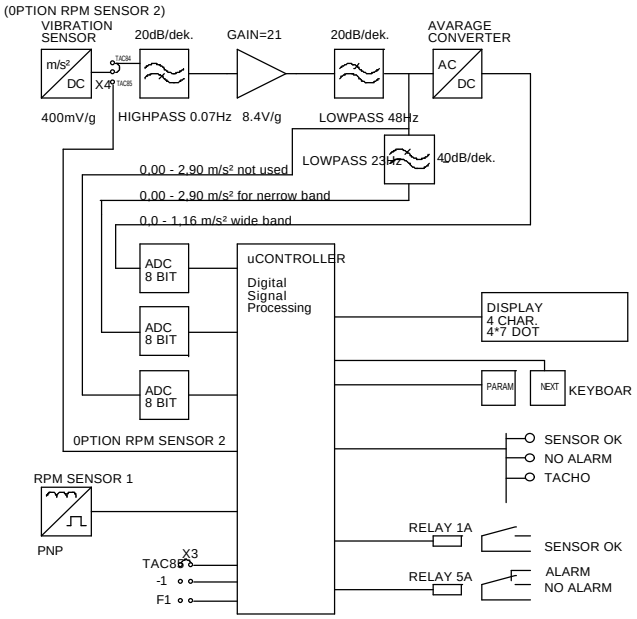
++ Those parameters can be altered by pressing "PARAM" down in 4 sec. and pressing å "NEXT" at the same time more than 4 times. Parameters are parameters and should not normally be altered.
Baud rate: 0= off, 1= 4800, 2= 9600, 3= 19200, (8N1)

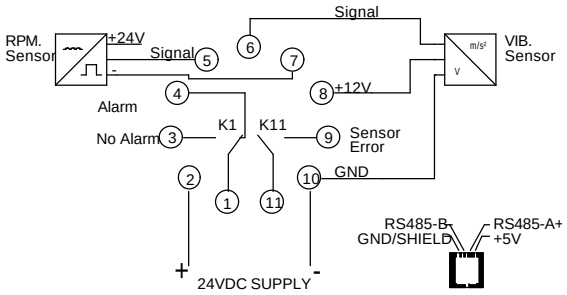
Relay functions [0] [163]	[1] [188]	No error	High vibration	High RPM	Sensorerror vibration	Sensor error RPM
0	0	K1 on, K11 on	K1 off, K11 off	K1 off, K11 off	K11 off	K11 off
1	1	K1 on, K11 on	K1 off, K11 off	K11 off	K1 on 1 sec, off 1 sec	K1 on 1 sec, off 1 sec
2		K1 on, K11 on	K11 off	K1 off	K11 on 1 sec, off 0,5 sec	K11 on 0,5 sec, off 1 sec
3		K1 on, K11 on	K11 off	K1 off, K11 off **	K11 off	K1 off, K11 off **
	2	K1 on, K11 on	K11 off	K1 off **	K11 on 1 sec, off 0,5 sec	K11 on 0,5 sec, off 1 sec **
	3	K1 on, K11 on	K11 off	K1 off, K11 off **	K11 on 0,5 sec, off 0,2 sec	K1 off, K11 on 0,2 sec, off 0,5 sec. **
	4	K1 on, K11 on	K11 off	K1 off	K11 on 1 sec, off 0,5 sec	K11 on 0,5 sec, off 1 sec
	5	K1 on, K11 on	K11 off	K1 off, K11 off **	K11 off	K1 off, K11 off **
	6	K1 on, K11 on	K11 off	K1 off, K11 off	K11 on 1 sec, off 0,5 sec	K1 off, K11 on 0,5 sec, off 1 sec.
	7	K1 on, K11 on	K11 off	K1 off **	K11 on 1 sec, off 0,5 sec	K1 offK11 on 0,5 sec, off 1 sec
	8	K1 on, K11 on	K11 off	K1 off **	K11 on 1 sec, off 0,5 sec	K11 on 0,5 sec, off 1 sec

** Relay functions marked with ** means that reset of error must be done manualy by pressing "PARAM" or "NEXT"

Part no. 954184C

Table for sensor check mode [0] Mode [1] in parentheses (x)	RPM <= parameter 8 (9)	RPM > parameter 8 (8)	RPM <= parameter (8)	RPM > parameter (9)
2 Wide band < par.11 (12)	RPM-sensor OK			RPM sensor OK
2 Wide band >= par.11 (12)	RPM-sensor error(after timedelay)			RPM sensor OK
2 Wide band < par. 12 (13)		Vibrations sensor error(after timedelay)	Vibrations sensor OK	
2 Wide band >= par. 12 (13)		Vibrations sensor OK	Vibrations sensor OK	





X3Program mode	TAC85	-1	F1
TAC84c mode 0 (former163)	OFF	OFF	-
TAC84c mode 1 (former188)	OFF	ON	-
TAC85-1 Direction guard	ON	-	-

Technical data	Min.	Max.	Unit
Vibration measuring range, narrow band ch. (1) (at 400 mV/g)	0.01	2.90	m/s²
Band-pass filter frequency Fo	1.00	10.00	Hz
Band-pass filter bandwidth (80dB/decade)	Fo/90	Fo/0.5	Hz
Vibration measuring range, wideband ch. (2) (ved 400 mV/g)	0.01	1.16	m/s²
Vibration measuring range,wideband ch. (2) - 3 dB	0.07	48	Hz
Measuring accuracy m/s² for ch. 1 and 2	-4	+4	%
Avaragetime narrow band ch. (1) (Response time)	1	15	Sec.
Avaragetime wide band ch. (2) (Response time)		3	Sec.
Measuring range revolution ch. (3)	0,1	700	Hz
Revolution reaction time (min. 3 pulses)		0.3	Sec.
Supply voltage 24 VDC	18	32	V
Supply current		80	mA
Temperature range	-20	60	°C
Mechanical data W * H * D 35 * 80 * 90 (Exl. socket)			mm
Weight		115	g

Mita-Teknik a/s

DK-8840 Rødkærsbro
Ph.:+45 86 65 86 00
Fax:+45 86 65 92 90

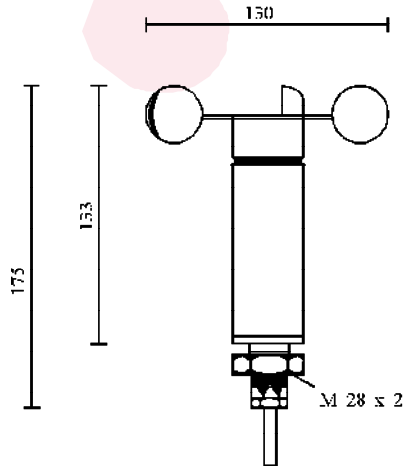
The PV 01-2 is an anemometer, used in connection with Mita-Teknik wind turbine electronics for starting and stopping the wind turbine.

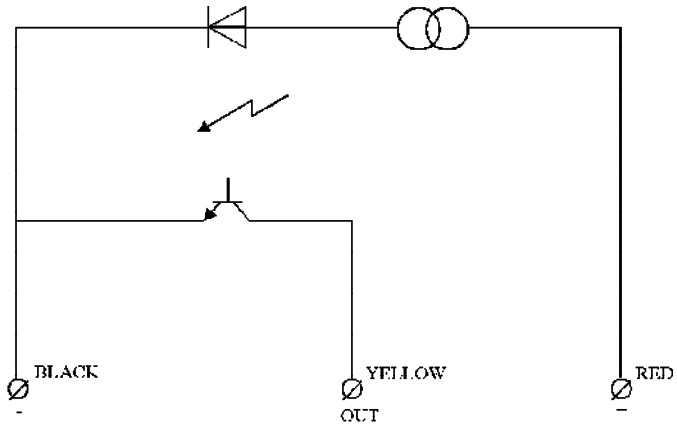
- Opto-electronic sensor pickup action.
- Registers wind speed from 2 to 30 m/s.
- The rotor is made of varnished stainless steel.
- The casing in PVC.
- Equipped with 2 m PVC cable.
- Fastening: External thread M 28 x 2.
- Part.no. 7690220

ANEMOMETER PV01-2

Mita-Teknik a/s

DK-8840 Rødkærsbro
Ph.:+45 86 65 86 00
Fax:+45 86 65 92 90





TECHNICAL DATA	MIN.	MAX.	
Measuring range	2	30	m/s
Resolution		10	imp./rpm
Signal output		30	mA
Open collector NPN		30	V DC
Mains voltage	12	24	V DC
Load	20		mA
Temperature	-20	+50	°C
Weight		320	g

ANEMOMETER PV01-2

PT100 Sensor

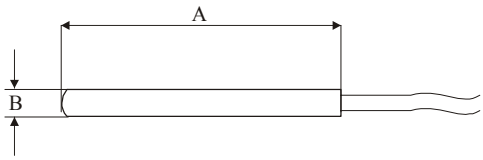
- The PT100 Sensors are used for flexible temperature surveillance
- Easy mounting
- Direct connection to IC/WP-Controllers
- Correction of distance via a 3-core or 4-core system

Description

PT100 is delivered in various mechanical designs for easy mounting at generators, bearings, gear box, or other places in connection with wind turbines.

The sensor compensates for the cable length between the WP or IC control unit and the PT100 sensor so that an accurate temperature measurement is achieved.

Dimensions



Part no.	A	B	Cable length	Cable type
	mm	Ø mm	m	
7631020	100	8	3	GLGLP
7631025	100	8	5	GLGLP
7631028	100	8	10	SHIELDED
7631030	60	6	3	SILICONE
7631032	60	6	5	SILICONE
7631034	60	6	10	SILICONE
7631035	60	6	3	GLGLP
7631037	60	6	5	GLGLP

Technical data

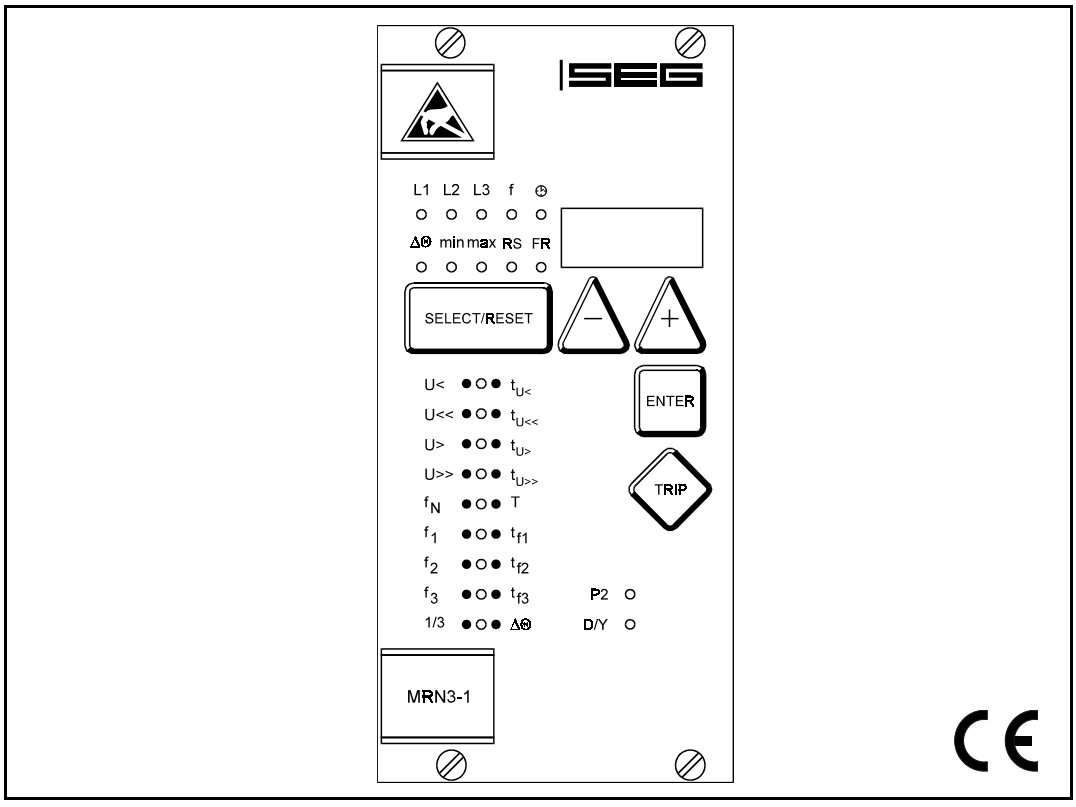
Permissible ambient conditions	
Operation temperature	-40 to 180°C
Transportation/Storage temp.	-50 to 180°C
Max. operation height	2000 m. above sea level
Construction	
Dimensions (WxHxD)	Dependent on the type (see 'Dimensions' of this data sheet)
Weight	Dependent of the type
Standard	IEC 60751

Ordering data

PT100 Sensors (different types) (see 'Dimensions' of this data sheet)	P/N.: 7631020.....37

Håndværkervej 1 ● DK-8840 Rødkærsbro ● Tel.: +45 8665 8600 ● Fax: +45 8665 9290 ● mail@mita-teknik.com ● www.mita-teknik.com

MRN3 - Mains decoupling relay



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1 Introduction and application

The *MRN3* is a universal mains decoupling device and covers the protection requirements from VDEW and most other utilities for the mains parallel operation of power stations.

- Over/ and undervoltage protection,
- over/ and underfrequency protection,
- extremely fast decoupling of generator in case of mains failure (*MRN3-1*) or
- rate of change of frequency df/dt (*MRN3-2*)

Because of combination of three protectional functions in one device the *MRN3* is a very compact mains decoupling device. Compared to the standardly used single devices it has a very good price/performance ratio.

For applications where the single protection functions are required SEG can offer the single *MR*-relays as follows:

- *MRU3-1* four step independent over-/ and undervoltage protection (also used for generator earth fault protection).
- *MRU3-2* two step independent over-/ and undervoltage protection with evaluation of the symmetrical voltage components.
- *MRF3* four step independent over/ and underfrequency protection and two step frequency gradient supervision df/dt.
- *MRG2* generator mains monitor / vector surge detection.

Important:
For additional common data of all *MR*-relays please refer to technical description "*MR* - Digital Multifunctional Relays".

2 Features and characteristics

- Microprocessor technology with watchdog,
- effective analog low pass filter for suppressing harmonics when measuring frequency and vector surge,
- digital filtering of the measured values by using discrete Fourier analysis to suppress higher harmonics and d.c. components induced by faults or system operations,
- integrated functions for voltage, frequency and vector surge in one device as well as single voltage, frequency and vector surge devices,
- two parameter sets,
- voltage supervision each with two step under-/ and overvoltage detection,
- frequency supervision with three step under-/ or overfrequency (user setting),
- completely independent time settings for voltage and frequency supervision,
- adjustable voltage threshold value for blocking frequency and vector surge measuring,
- display of all measuring values and setting parameters for normal operation as well as tripping via a alphanumerical display and LEDs,
- display of measuring values as primary quantities
- Storage of trip values and switching-off time (t_{CBFP}) of 5 fault occurences (fail-safe of voltage),
- recording of up to eight fault occurences with time stamp
- for blocking the individual functions by the external blocking input, parameters can be set according to requirement,
- user configurable vector surge measurement 1-of-3 or 3-of-3,
- reliable vector surge measuring by exact calculation algorithm,
- suppression of indication after an activation (LED flash),
- free assignment for output relays,
- display of date and time,
- in complience with VDE 0435, part 303 and IEC 255,
- serial data exchange via RS485 interface possible; alternatively with SEG RS485 Pro-Open Data Protocol or Modbus Protocol.

3 Design

3.1 Connections

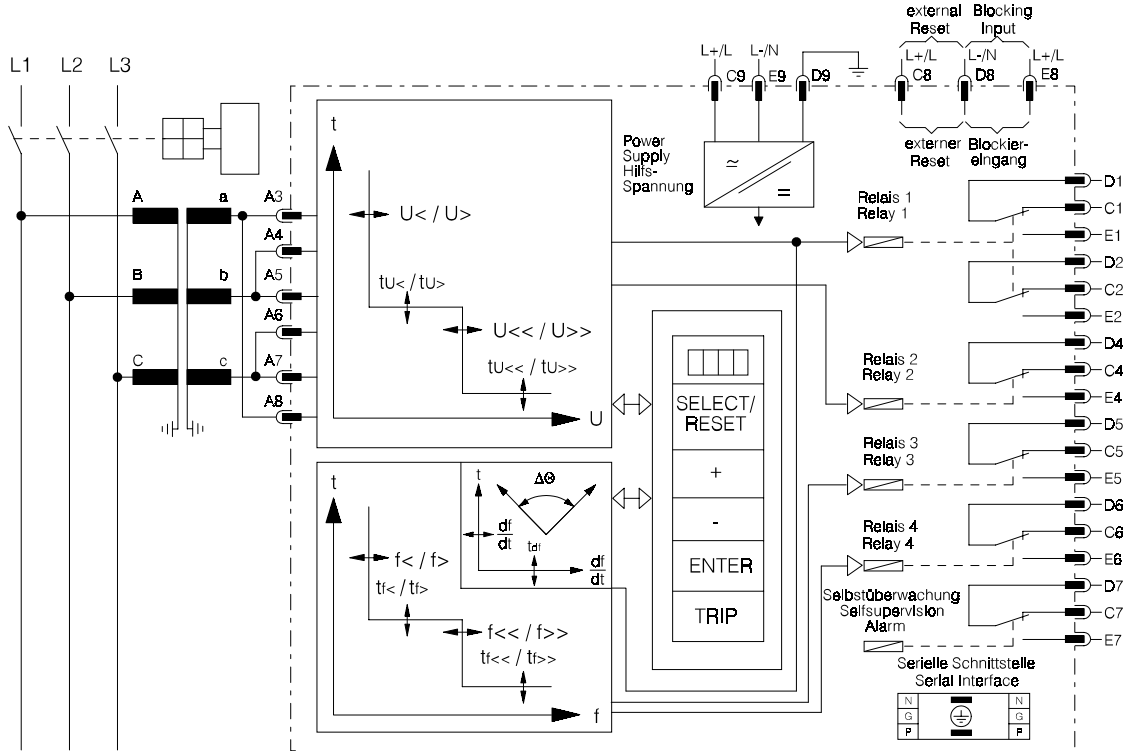


Figure 3.1: Connection diagram MRN3-1 and MRN3-2

3.1.1 Analog input circuits

The analog input voltages are galvanically decoupled by the input transformers of the device, then filtered and finally fed to the analog digital converter. The measuring circuits can be applied in star or delta connection (refer to chapter 4.3.1).

3.1.2 Blocking input

The blocking function can be set according to requirement. By applying the auxiliary voltage to D8/E8, the previously set relay functions are blocked (refer to 4.8 and 5.7.1).

3.1.3 Reset input

Please refer to chapter 5.9.1.

3.1.4 Output relays

The *MRN3* is equipped with 5 output relays. Apart from the relay for self-supervision, all protective functions can be optionally assigned:

- Relay 1: C1, D1, E1 and C2, D2, E2
- Relay 2: C3, D3, E3 and C4, D4, E4
- Relay 3: C5, D5, E5
- Relay 4: C6, D6, E6
- Relay 5: Signal self-supervision (internal failure of the unit) C7, D7, E7

All trip and alarm relays are working current relays, the relay for self supervision is an idle current relay.

3.1.5 Fault recorder

The *MRN3* has a fault value recorder which records the measured analog values as instantaneous values.
The instantaneous values

U_{L1}; U_{L2}; U_{L3} for star connection
or U_{12}; U_{23}; U_{21} for delta connection

are scanned at a raster of 1.25 ms (at 50 Hz) and 1.041 ms (at 60 Hz) and saved in a cyclic buffer. It is possible to store 1 - 8 fault occurences with a total recording time of 16 s (with 50 Hz) and 13.33 s (with 60 Hz) per channel.

Storage division

Independent of the recording time, the entire storage capacity can be divided into several cases of disturbance with a shorter recording time each. In addition, the deletion behaviour of the fault recorder can be influenced.

No writing over

If 2, 4 or 8 recordings are chosen, the complete memory is divided into the relevant number of partial segments. If this max. number of fault event has been exceeded, the fault recorder block any further recordings in order to prevent that the stored data are written over. After the data have been read and deleted, the recorder to ready again for further action.

Writing over

If 1, 3 or 7 recordings are chosen, the relevant number of partial segments is reserved in the complete memory. If the memory is full, a new recording will always write over the oldest one.

The memory part of the fault recorder is designed as circulating storage. In this example 7 fault records can be stored (written over).

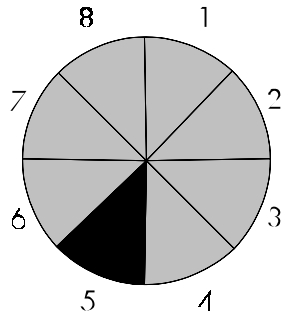


Figure 3.2: Division of the memory into 8 segments, for example

Memory space 6 to 4 is occupied.
Memory space 5 is currently being written in

Since memory spaces 6, 7 and 8 are occupied, this example shows that the memory has been assigned more than eight recordings. This means that No. 6 is the oldest fault recording and No. 4 the most recent one.

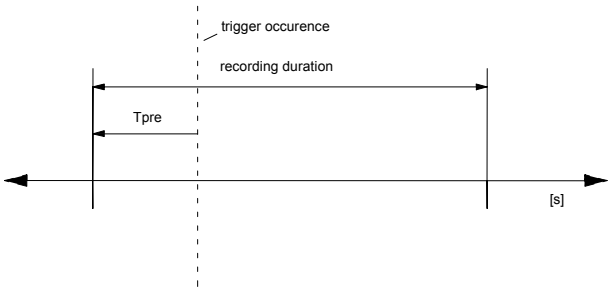


Figure 3.3: Basic set-up of the fault recorder

Each memory segment has a specified storage time which permits setting of a time prior to the trigger event.

Via the interface RS485 the data can be read and processed by means of a PC (HTL/PL-Soft4). The data is graphically edited and displayed. Binary tracks are recorded as well, e.g. activation and trip.

3.2 Parameter settings

System parameters

Parameter settings	*MRN3-1*	*MRN3-2*
U_{prim}/U_{sek}	X	X
Δ/Y	X	X
fN	X	X
P2/FR	X	X
LED-Flash	X	X

Table 3.1: System parameters

Protection parameters

Setting parameter	*MRN3-1*	*MRN3-2*
U<	X	X
$t_{U<}$	X	X
U<<	X	X
$t_{U<<}$	X	X
U>	X	X
$t_{U>}$	X	X
U>>	X	X
$t_{U>>}$	X	X
T	X	X
f_1	X	X
t_{f1}	X	X
f_2	X	X
t_{f2}	X	X
f_3	X	X
t_{f3}	X	X
df		X
dt		X
1/3	X	
ΔΘ	X	
U_B<	X	X
RS485/Slave	X	X
Baud-Rate*	X	X
Parity-Check*	X	X

Table 3.2: Protection parameters
*only Modbus

Blocking functions

Parameter settings	*MRN3-1*	*MRN3-2*
U<	X	X
U<<	X	X
U>	X	X
U>>	X	X
f1	X	X
f2	X	X
f3	X	X
Δθ	X	
df/dt		X

Table 3.3: Blocking functions

Parameters for the fault recorder

Parameter setting	*MRN3-1*	*MRN3-2*
Number of fault events	X	X
Trigger events	X	X
Pre-Triggerzeit T_{pre}	X	X

Table 3.4: Parameters for the fault recorder

Additional functions

Parameter settings	*MRN3-1*	*MRN3-2*
Ralay assignment	X	X
Fault recorder	X	X

Table 3.5: Additional functions

Date and time

Parameter settings		*MRN3-1*	*MRN3-2*
Year	Y = 99	X	X
Month	M = 03	X	X
Day	D = 16	X	X
hour	h = 07	X	X
minute	m = 29	X	X
second	s = 56	X	X

Table 3.6: Date and time

The window for parameter setting is located behind the measured value display. The parameter window can be accessed via the <SELECT/RESET> key.

3.3 LEDs

All LEDs (except LED RS, min. and max.) are two-coloured. The LEDs on the left side, next to the alpha-numerical display light up green during measuring and red after tripping.

The LEDs below the push button <SELECT/RESET> are lit green during setting and inquiry procedure of the setting values which are printed on the left side next to the LEDs. The LEDs will light up red after parametrizing of the setting values next to their right side.

The LED marked with letters RS lights up during setting of the slave address of the device for serial data communication.

The LED marked with the letters FR is alight while the fault recorder is being adjusted.

3.4 Front plate

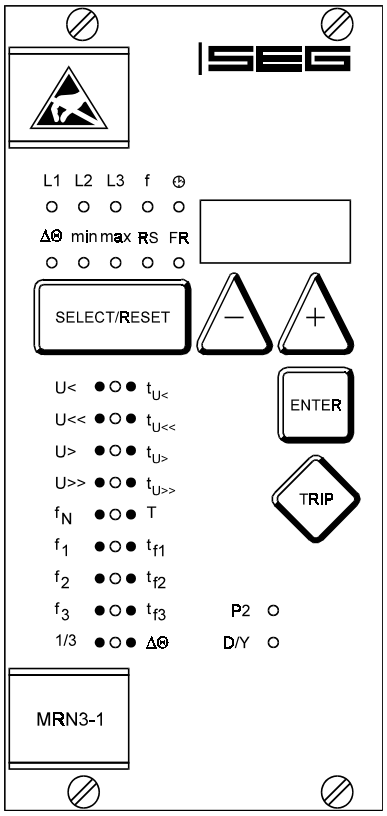


Figure 3.4: Front plate MRN3-1

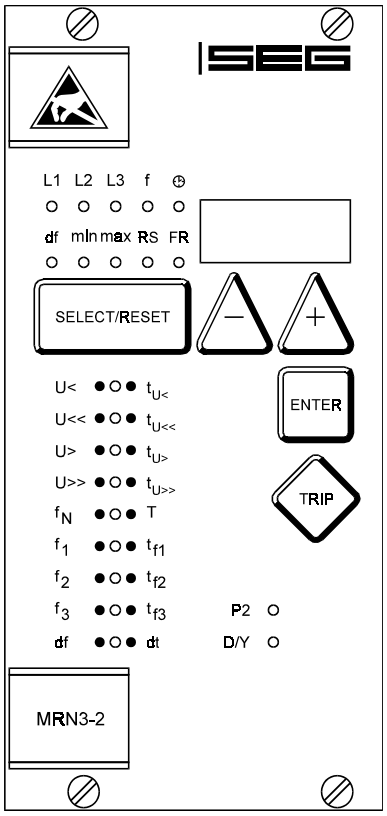


Figure 3.5: Front plate MRN3-2

4 Working principle

4.1 Analog circuits

The input voltages are galvanically insulated by the input transformers. The noise signals caused by inductive and capacitive coupling are supressed by an analog R-C filter circuit.

The analog voltage signals are fed to the A/D-converter of the microprocessor and transformed to digital signals through Sample- and Hold- circuits. The analog signals are sampled with a sampling frequency of 16 x f_N, namely, a sampling rate of 1.25 ms for every measuring quantity, at 50 Hz.

4.2 Digital circuits

The essential part of the *MRN3* relay is a powerful microcontroller. All of the operations, from the analog digital conversion to the relay trip decision, are carried out by the microcontroller digitally. The relay program is located in an EPROM (Electrically-Programmable-Read-Only-Memory). With this program the CPU of the microcontroller calculates the three phase voltage in order to detect a possible fault situation in the protected object.

For the calculation of the voltage value an efficient digital filter based on the Fourier Transformation (DFFT - Discrete Fast Fourier Transformation) is applied to suppress high frequency harmonics and d.c. components caused by fault-induced transients or other system disturbances. The microprocessor continuously compares the measured values with the preset thresholds stored in the parameter memory (EEPROM). If a fault occures an alarm is given and after the set tripping delay has elapsed, the corresponding trip relay is activated.

The relay setting values for all parameters are stored in a parameter memory (EEPROM - Electrically Erasable Programmable Read Only Memory), so that the actual relay settings cannot be lost, even if the power supply is interrupted.
The microprocessor is supervised by a built-in "watchdog" timer. In case of a failure the watchdog timer resets the microprocessor and gives an alarm signal via the output relay "self supervision".

4.3 Voltage supervision

The voltage element of *MRN3* has the application in protection of generators, consumers and other electrical equipment against over-/and undervoltage.
The relay is equipped with a two step independent three-phase overvoltage (U>, U>>) and undervoltage (U<, U<<) function with completely separate time and voltage settings.
In delta connection the phase-to-phase voltages and in star connection the phase-to-neutral voltages are continuously compared with the preset thresholds.

For the overvoltage supervision the highest, for the undervoltage supervision of the lowest voltage of the three phases are decisive for energizing.

4.3.1 Selection of star or delta connection

All connections of the input voltage transformers are led to screw terminals. The nominal voltage of the device is equal to the nominal voltage of the input transformers. Dependent on the application the input transformers can be connected in either delta or star. The connection for the phase-to-phase voltage is the delta connection. In star connection the measuring voltage is reduced by $1/\sqrt{3}$. During parameter setting the connection configuration either Y or Δ has to be adjusted.

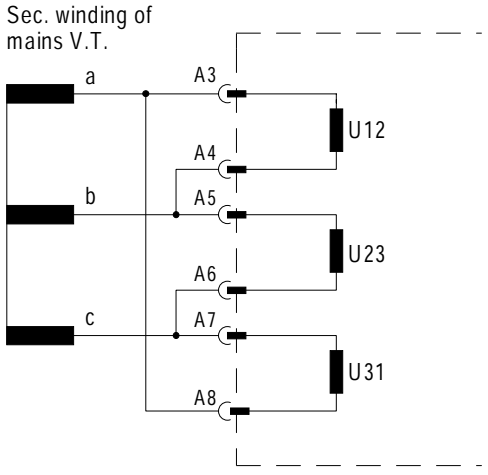


Figure 4.1: Input v.t.s in delta connection (Δ)

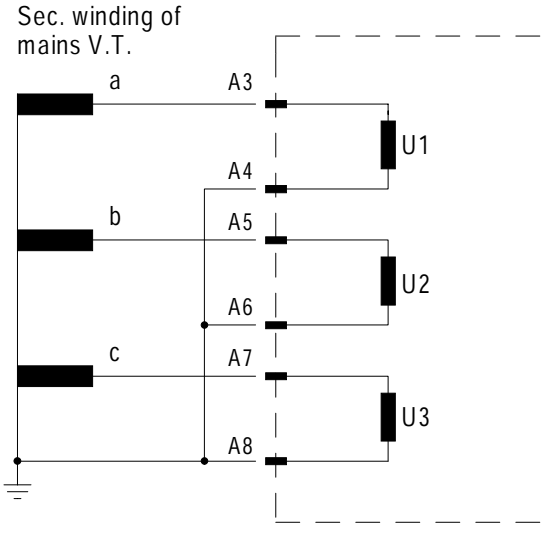


Figure 4.2: Input v.t.s in star connection (Y)

4.4 Principle of frequency supervision

The frequency element of *MRN3* protects electrical generators, consumers or electrical operating equipment in general against over- or underfrequency.
The relay has independent three frequency elements f_1 - f_3 with a free choice of parameters, with separate adjustable pickup values and delay times.

The measuring principle of the frequency supervision is based in general on the time measurement of complete cycles, whereby a new measurement is started at each voltage zero passage. The influence of harmonics on the measuring result is thus minimized.

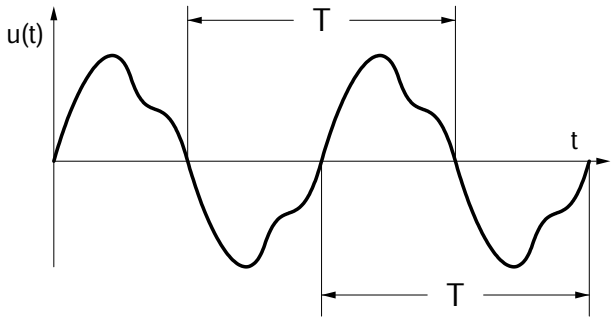


Figure 4.3: Determination of cycle duration by means of zero passages.

In order to avoid false tripping during occurence of interference voltages and phase shifts the relay works with an adjustable measuring repetition. (refer to chapter 5.4.2)

Frequency tripping is sometimes not desired by low measured voltages which for instance occur during alternator acceleration. All frequency supervision functions can be blocked with the aid of an adjustable voltage threshold U_B in case the measured voltages value is below this value.

4.5 Measuring of frequency gradient (*MRN3-2*)

Electrical generators running in parallel with the mains, e.g. industrial internal power supply plants, should be separated from the mains when failure in the intrasystem occurs for the following reasons:

- It must be prevented that the electrical generators are damaged when mains voltage recovering asynchrone, e.g. after a short interruption.
- The industrial internal power supply must be maintained.

A reliable criterion of detecting mains failure is the measurement of the rate of change of frequency df/dt. Precondition for this is a load flow via the mains coupling point. At mains failure the load flow changing then spontaneously leads to an increasing or decreasing frequency. At active power deficit of the internal power station a linear drop of the frequency occurs and a linear increase occurs at power excess. Typical frequency gradients during application of "mains decoupling" are in the range of 0.5 Hz/s up to over 2 Hz/s. The *MRN3* detects the instantaneous frequency gradient df/dt of each mains voltage period in an interval of one half period each. Through multiple evaluation of the frequency gradient in sequence the continuity of the directional change (sign of the frequency gradient) is determined. Because of this special measuring procedure a high safety in tripping and thus a high stabilty against transient processes, e.g. switching procedure are reached. The total switching off time at mains failure is between 60 ms and 80 ms depending on the setting.

4.6 Vector surge supervision (*MRN3-1*)

The vector surge supervision protects synchronous generators in mains parallel operation due to very fast decoupling in case of mains failure. Very dangerous are mains auto reclosings for synchronous generators. The mains voltage returning after 300 ms can hit the generator in asynchronous position. A very fast decoupling is also necessary in case of long time mains failures. Generally there are two different applications:

a) Only mains parallel operation no single operation:
In this application the vector surge supervision protects the generator by tripping the generator circuit breaker in case of mains failure.

b) Mains parallel operation and single operation:
For this application the vector surge supervision trips the mains circuit breaker. Here it is insured that the gen.-set is not blocked when it is required as the emergency set.

A very fast decoupling in case of mains failures for synchronous generators is known as very difficult. Voltage supervision units cannot be used because the synchronous alternator as well as the consumer impedance support the decreasing voltage.

For this the mains voltage drops only after some 100 ms below the pickup threshold of voltage supervision relays and therefore a safe detection of mains auto reclosings is not possible with this kind of relay.

Frequency relays are partial unsuitable because only a highly loaded generator decreases its speed within 100 ms. Current relays detect a fault only when short-circuit type currents exist, but cannot avoid their development. Power relays are able to pickup within 200 ms, but they cannot prevent power to rise to short-circuit values too. Since power changes are also caused by sudden loaded alternators, the use of power relays can be problematic.

Whereas the *MRN3-1* detects mains failures within 60 ms without the restrictions described above because they are specially designed for applications where very fast decoupling from the mains is required.

Adding the operating time of a circuit breaker or contactor, the total disconnection time remains below 150 ms. Basic requirement for tripping of the generator/mains monitor is a change in load of more than 15 - 20% of the rated load. Slow changes of the system frequency, for instance at regulating processes (adjustment of speed regulator) do not cause the relay to trip.

Trippings can also be caused by short-circuits within the grid, because a voltage vector surge higher than the preset value can occur. The magnitude of the voltage vector surge depends on the distance between the short-circuit and the generator. This function is also of advantage to the Power Utility Company because the mains short-circuit capacity and consequently the energy feeding the short-circuit is limited.

To prevent a possible false tripping the vector surge measuring can be blocked at a set low input voltage (refer to 5.4.7). The undervoltage lockout acts faster then the vector surge measurement.

Vector surge tripping is blocked by a phase loss so that a VT fault (e.g. faulty VTs fuse) does not cause false tripping.
When switching on the aux. voltage or measuring voltage , the vector surge supervision is blocked for 5 s (refer to chapter 4.8).

Note:
In order to avoid any adverse interference voltage effects, for instance from contactors or relays, which may cause overfunctions, *MRN3-1* should be connected separately to the busbar.

4.6.1 Measuring principle of vector surge supervision

When a synchronous generator is loaded, a rotor displacement angle is build between the terminal voltage (mains voltage U1) and the synchronous internal voltage (Up). Therefore a voltage is difference ΔU is built between Up and U1 (Fig. 4.4).

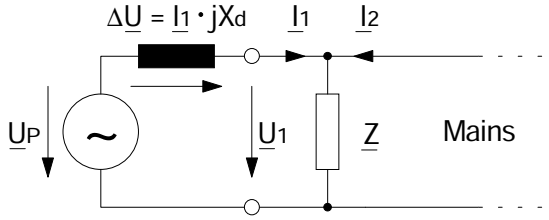


Figure 4.4: Equivalent circuit at synchronous generator in parallel with the mains

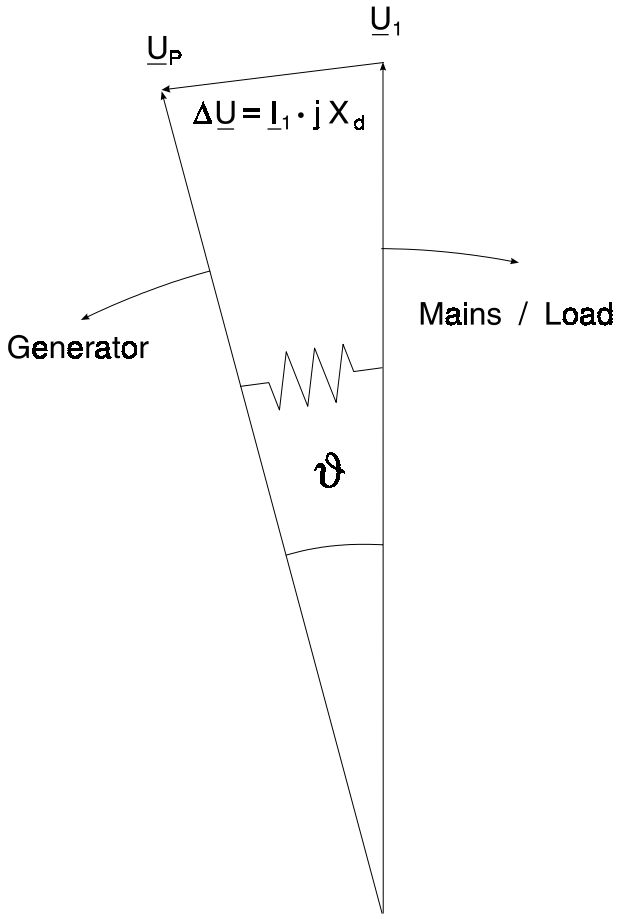


Figure 4.5: Voltage vectors at mains parallel operation

The rotor displacement angle ϑ between stator and rotor is depending of the mechanical moving torque of the generator shaft. The mechanical shaft power is balanced with the electrical feeded mains power, and therefore the synchronous speed keeps constant (Fig. 4.5).

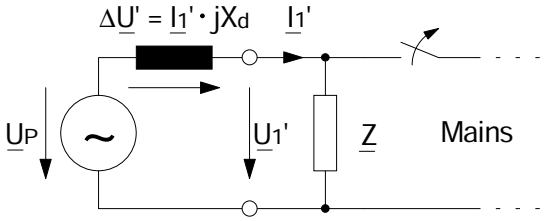


Figure 4.6: Equivalent circuit at mains failure

In case of mains failure or auto reclosing the generator suddenly feeds a very high consumer load. The rotor displacement angle is decreased repeatedly and the voltage vector $\underline{U}_1$ changes its direction ($\underline{U}_1$') (Fig. 4.6 and 4.7).

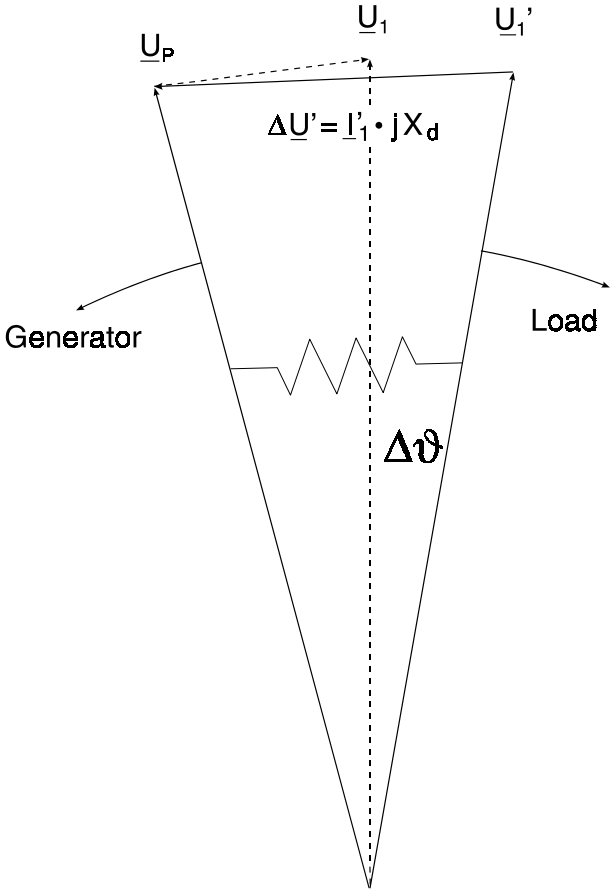


Figure 4.7: Voltage vectors at mains failure

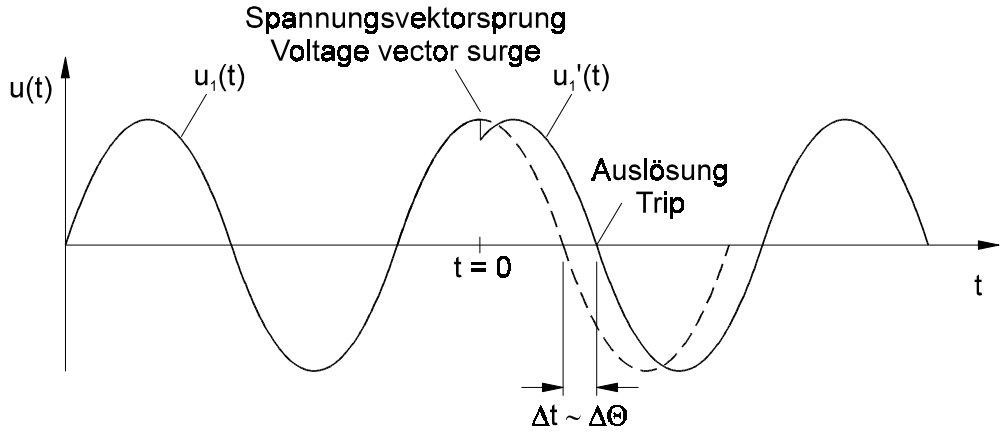


Figure 4.8: Voltage vector surge

As shown in the voltage/time diagram the instantaneous value of the voltage jumps to another value and the phase position changes. This is named phase or vector surge.

The *MRN3-1* measures the cycle duration. A new measuring is started at each voltage zero passage. The measured cycle duration is internally compared with a quartz stable reference time and from this the deviation of the cycle duration of the voltage signal is ascertained. In case of a vector surge as shown in fig. 4.8, the zero passage occurs either earlier or later. The established deviation of the cycle duration is in compliance with the vector surge angle.
If the vector surge angle exceeds the set value, the relay trips immediately.

Tripping of the vector surge is blocked in case of loss of one or more phases of the measuring voltage.

Tripping logic for vector surge measurement:

The vector surge function of the *MRN3-1* supervises vector surges in all three phases at the same time. Tripping of the relay can be adjusted for an one phase vector surge (more sensitive measurement). For this the parameter 1/3 has to be set to "1Ph". When the parameter 1/3 is set to "3Ph", tripping of the vector surge element occurs only if the vector surge angle exceeds the set value in all three phases at the same time.

Application hint

Although the vector surge relay guarantees very fast and reliable detection of mains failures under nearly all operational conditions of mains parallel running alternators, the following borderline cases have to be considered accordingly:

a) None or only insignificant change of power flow at the utility connection point during mains failures.

This can occure during peak lopping operation or in CHP stations (Combined Heat and Power) where the power flow between power station and the public grid may be very low. For detection of a vector surge at parallel running alternators, the load change must be at least 15 - 20% of the rated power. If the active load at the utility connection point is regulated to a minimal value and a high resistance mains failure occurs, then there are no vector surge nor power and frequency changes and the mains failure is not detected.

This can only happen if the public grid is disconnected near the power station and so the alternators are not additionally loaded by any consumers. At distant mains failures the synchronous alternators are abruptly loaded by remaining consumers which leads directly to a vector surge and so mains failure detection is guaranteed.
If such a situation occurs the following has to be taken into account:

In case of an undetected mains failure, i.e. with the mains coupling C.B. closed, the vector surge relay reacts upon the first load change causing a vector surge and trips the mains C.B.

For detecting high resistance mains failures a minimum current relay with an adjustable trip delay can be used. A trip delay is needed to allow regulating actions where the current may reach "zero" at the utility connection point. At high resistance mains failures, the mains coupling C.B. is tripped by the minimum current relay after the time delay.

To prevent asynchronous switching on, an automatic reclosing of the public grid should be not possible during this time delay.

A further measure could be, that the load regulation at the utility connection point guarantees a minimum power flow of 15 - 20% of rated power.

b) Short circuit type loading of the alternators at distant mains failures

At any distant mains failure, the remaining consumers cause sudden short circuit type loading of the power station generators. The vector surge relay detects the mains failure in about 60 ms and switches off the mains coupling C.B. The total switch off time is about 100 - 150 ms. If the generators are provided with an extremely fast short circuit protection e.g. able to detect di/dt, the alternators might be switched off unselectively by the generator C.B., which is not desireable because the power supply for the station is endangered and later on synchronized changeover to the mains is only possible after manual reset of the overcurrent protection.

To avoid such a situation, the alternator C.B.s must have a delayed short circuit protection. The time delay must be long enough so that mains decoupling by the vector surge relay is guaranteed.

4.7 Voltage threshold value for frequency measuring

At low measuring voltages, e.g. during generator start-up, frequency and vector surge or df/dt-measuring is perhaps not desired.

By means of the adjustable voltage threshold value $U_B<$, functions f_1 - f_3, df/dt or $\Delta\Theta$ are blocked if the measured voltage falls below the set value.

4.8 Blocking function

No.	Dynamic Behaviour	U</<<	U>/>>	f_1, f_2, f_3	$\Delta\Theta$	df/dt
1	voltage to external blocking input is applied	free programmable	free programmable	free programmable	free programmable	free programmable
2	blocking input is released	released instantaneously	released instantaneously	released after 1 s	released after 5 s	released after 5 s
3	supply voltage is switched on	blocked for 200 ms	blocked for 200 ms	blocked for 1 s	blocked for 1 s	blocked for 1 s
4	3ph measuring volt. is suddenly applied	released	released	blocked for 1 s	blocked for 5 s	blocked for 5 s
5	one or several measuring voltages are switched off suddenly (phase failure)	released	released	blocked	blocked	blocked
6	measuring voltage smaller $U_B<$ (adjustable voltage threshold value)	released	released	blocked	blocked	blocked

*Table 4.1: Dynamic behaviour of **MRN3** functions*

Blocking function set in compliance with requirements:

The *MRN3* has an external blocking input. By applying the auxiliary voltage to input D8/E8, the requested protection functions of the relay are blocked (refer to 5.7.1).

5 Operation and setting

5.1 Display

Function	Display shows	Pressed pushbutton	Corresponding LED	Type of relay
Normal operation	|SEG			all types
Measured operating values	Actual measured value Min. and max. values of voltage, frequency and vector surge	<SELECT/RESET> one time for each value	L1, L2, L3, f, min, max ΔΘ df	 MRN3-1 MRN3-2
Transformer ratio of the CT's	(SEK) 1.01 – 6500 = prim	<SELECT/RESET><+><->	L1, L2, L3	
Setting values: star/delta connection	Y/DELT	<SELECT/RESET><+><->	Δ/Y	
Parameter switch/ext. Trigger for FR	SET1, SET2, B_S2, R_S2, B_FR, R_FR, S2_FR	<SELECT/RESET><+><->	P2	
Switch-over LED flash No LED flash	FLSH NOFL	<SELECT/RESET><+><->		
undervoltage (low set) tripping delay of low set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U< $t_{U<}$	
undervoltage (high set) tripping delay of high set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U<< $t_{U<<}$	
overvoltage (low set) tripping delay of low set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U> $t_{U>}$	
overvoltage (high set) tripping delay of high set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U>> $t_{U>>}$	
rated frequency	setting value in Hz	<SELECT/RESET><+><->	f_N	
frequency measuring repitition	setting value	<SELECT/RESET><+><->	T	
frequency element f_1 tripping delay of frequency element f_1	setting value in Hz setting value in seconds	<SELECT/RESET><+><-> one time for each value	f_1 t_{f1}	
frequency element f_2 tripping delay of frequency element f_2	setting value in Hz setting value in seconds	<SELECT/RESET><+><-> one time for each value	f_2 t_{f2}	
frequency element f_3 tripping delay of frequency element f_3	setting value in Hz setting value in seconds	<SELECT/RESET><+><-> one time for each value	f_3 t_{f3}	
1-of-3/3-of-3 measurement	1Ph/3Ph	<SELECT/RESET><+><->	1/3	MRN3-1
threshold for vector surge	setting value in degree	<SELECT/RESET><+><->	ΔΘ	MRN3-1
setting value df/dt measuring repitition df/dt	setting value in Hz/s setting value in periods	<SELECT/RESET><+><-> one time for each value	df dt	MRN3-2
Blocking	EXIT	<+> until max. setting value	LED of blocked parameter	
Undervoltage blocking of frequency and vector surge measuring (df/dt for *MRN3-2*)	setting value in Volt	<SELECT/RESET><+><->	f, ΔΘ, df	
Slave address of serial interface	1 - 32	<SELECT/RESET><+><->	RS	
Baud-Rate [1]	1200-9600	<SELECT/RESET> <+><->	RS	
Parity-Check [1]	even odd no	<SELECT/RESET> <+><->	RS	
Recorded fault data: star–connection: U1, U2, U3	tripping values in Volt	<SELECT/RESET><+><-> one time for each phase	L1, L2, L3, U<, U<<, U>, U>>	
delta-connection: U12, U23, U31	tripping values in Volt	<SELECT/RESET><+><-> one time for each phase	L1, L2, L3 U<, U<<, U>, U>>	
frequency	tripping values in Hz	<SELECT/RESET><+><-> one time for each phase	f, f1, f2, f3	
rate of change of frequency	tripping value in Hz/s	<SELECT/RESET><+><->	df	MRN3-2
vector surge	tripping value in degree	<SELECT/RESET><+><-> one time for each phase	ΔΘ + L1, L2 or L3	MRN3-1
Delete failure memory	wait	<-> <SELECT/RESET>		

[1] only Modbus

Function	Display shows	Pressed pushbutton	Corresponding LED	Type of relay
Enquiry failure memory	FLT1; FLT2.....	<-><+>	L1, L2, L3, U<, U<<, U>, U>>, f, Ddf/dt, ΔΘ	
Save parameter?	SAV?	<ENTER>		
Save parameter!	SAV!	<ENTER> for about 3 s		
Trigger signal for the fault recorder	TEST, P_UP, A_PI, TRIP	<SELECT/RESET> <+><->	FR	
Number of fault occurences	S = 2, S = 4, S = 8	<SELECT/RESET> <+><->	FR	
Display of date and time	Y = 99, M = 10, D = 1, h = 12, m = 2, s = 12	<SELECT/RESET> <+><->	◷	
Software version	First part (e.g. D02-) Sec. part (e.g. 6.01)	<TRIP> one time for each part		
Manual trip	TRI?	<TRIP> three times		
Inquire password	PSW?	<SELECT/RESET>/ <+>/<->/<ENTER>		
Relay tripped	TRIP	<TRIP> or fault tripping		
Secret password input	XXXX	<SELECT/RESET>/ <+>/<->/<ENTER>		
System reset	|SEG	<SELECT/RESET> for about 3 s		

Table 5.1: Possible indication messages on the display

5.2 Setting procedure

In this paragraph the settings for all relay parameters are described in detail. For parameter setting a password has to be entered first (please refer to 4.4 of description "*MR*-Digital Multifunctional Relays").

5.3 Systemparameter

5.3.1 Display of residual voltage U_E as primary quantity (U_{prim}/U_{sec})

The residual voltage can be shown as primary measuring value. For this parameter the transformation ratio of the VT has to be set accordingly. If the parameter is set to "sek", the measuring value is shown as rated secondary voltage.

Example:
The voltage transformer used is of 10 kV/100 V. The transformation ratio is 100 and this value has to be set accordingly. If still the rated secondary voltage should be shown, the parameter is to be set to 1.

5.3.2 Δ/Y – Switch over

Depending on the mains voltage conditions, the input voltage transformers can be operated in delta or Y connection. Change-overs are effected via the <+> and the <-> keys and stored with <ENTER>.

5.3.3 Setting of nominal frequency

For proper functioning it is necessary to first adjust the rated frequency (50 oder 60 Hz).

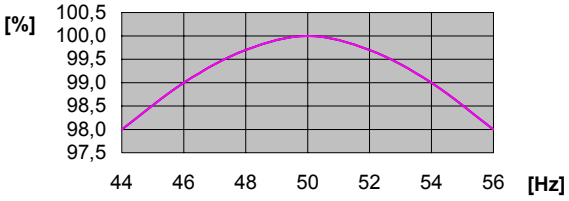
For this a distinction has to be made between the settings v = 50 Hz / f = 50 Hz or v = 60 Hz / f = 60 Hz
The difference lies in the method of voltage measuring. With the setting "v" = 50/60 Hz voltage measuring is independent of the existing frequency. This means, the voltage value can be correctly measured between 30 Hz and 80 Hz without adverse effects from the frequency.

With the setting "f" = 50/60 Hz the measured voltage value is influenced by the frequency. (see Table 5.2)

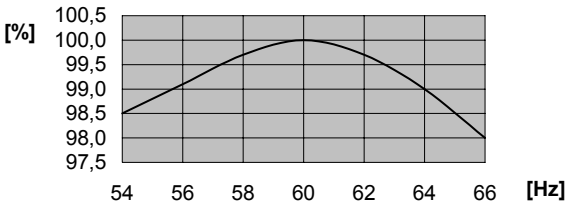
This difference in settings is required for the fault recorder. If the fault recorder is to be used, the setting must be f = 50 Hz or f = 60 Hz.
The different designations "f" or "v" have no influence on any of the other functions.

All frequency functions are determined by setting the nominal frequency, i.e. whether the set frequency thresholds are evaluated as over- or underfrequency (see also chapter 5.4.4). Also the cycle duration (20 ms at 50 Hz and 16.67 ms at 60 Hz) derives from this setting which determines the minimum tripping delay for frequency elements f_1 - f_3 with an adjustable multiplier (see also chapter 5.4.5).
During setting of the nominal frequency a value in Hz is shown on the display.

Declination of measuring value at 50Hz



Declination of measuring value at 60Hz



Setting	v = 50	f = 50	v = 60	f = 60
Rated frequency	50 Hz	50 Hz	60 Hz	60 Hz
Influence on voltage measurement	none	0.5..1%/Hz (see table 5.2)	none	0.5..1%/Hz (see table 5.2)
Fault recorder	Recording distorted**	Recording correct***	Recording distorted**	Recording correct***
Influence on all other functions	none	none	none	none

Table 5.2: Deviation of measured value at 50 or 60 Hz

* Setting is important for differentiation between over- and underfrequency
** Sample rate is variably adjusted to the momentarily measured frequency. 16 samples are always measured in one period.
*** Sample rate setting is fixed to 50 Hz or 60 Hz. 16 samples per 20 ms or 16.67 ms are always measured.

5.3.4 Display of the activation storage (FLSH/NOFL)

If after an activation the existing current drops again below the pickup value, e.g. U<, without a trip has been initiated, LED U< signals that an activation has occured by flashing fast. The LED keeps flashing until it is reset again (push button <RESET>). Flashing can be suppressed when the parameter is set to NOFL.

5.3.5 Parameterswitch/external trigger for the fault recorder

By means of the parameter-change-over switches it is possible to activate two different parameter sets. Switching over of the parameter sets can either be done by means of software or via the external inputs RESET or blocking input. Alternatively, the external inputs can be used for Reset or blocking and for the triggering of the fault recorder.

Software-parameter	Blocking input used as	RESET input used as
SET1	Blocking input	RESET input
SET2	Blocking input	RESET input
B_S2	Parameter switch	RESET input
R_S2	Blocking input	Parameter switch
B_FR	External triggering of the fault recorder	Reset input
R_FR	Blocking input	External triggerung of the fault recorder
S2_FR	Parameter switch	External triggerung of the fault recorder

With the settings SET1 or SET2 the parameter set is activated by software. Terminals C8/D8 and D8/E8 are then available as external reset input or blocking input.

With the setting B_S2 the blocking input (D8, E8) is used as parameter-set change-over switch. With the setting R_S2 the reset input (D8, E8) is used as parameter-set change-over switch. With the setting B_FR the fault recorder is activated immediately by using the blocking input. On the front plate the LED FR will then light up for the duration of the recording. With the setting R_FR the fault recorder is activated via the reset input. With the setting S2_FR parameter set 2 can be activated via the blocking input and/or the fault recorder via the reset input. The relevant function is then activated by applying the auxiliary voltage to one of the external inputs.

With the setting R_FR the fault recorder is activated via the reset input. With the setting S2_FR parameter set 2 can be activated via the blocking input and/or the fault recorder via the reset input.
The relevant function is then activated by applying the auxiliary voltage to one of the external inputs.

Important note:
When functioning as parameter change over facility, the external input RESET is not available for resetting. When using the external input BLOCKING the protection functions must be deactivated by software blocking separately (refer to chapter 5.7.1).

5.4 Protection parameters

5.4.1 Parameter setting of over- and undervoltage supervision

The setting procedure is guided by two coloured LEDs. During setting of the voltage thresholds the LEDs U<, U<<, U> and U>> are lit green. During setting of the trip delays $t_{U>}$, $t_{U>>}$, $t_{U<}$ and $t_{U<<}$ the according LEDs light up red.

Thresholds of the voltage supervision

During setting of the threshold U>, U>>, U< and U<< the displays shows the voltages directly in volt. The thresholds can be changed by the <+> <-> push buttons and stored with <ENTER>.

The undervoltage supervision (U< and U<<) as well as the overvoltage supervision (U> and U>>) can be deactivated by setting the threshold to "EXIT".

Tripping delay of voltage supervision

During setting of the tripping delays $t_{U<}$, $t_{U<<}$, $t_{U>}$ and $t_{U>>}$ the display shows the value directly in seconds. The tripping delay is changed via the push button <+> and <-> in the range of 0,04 s to 50 s and can be stored with the push button <ENTER>.
When setting the tripping delay to "EXIT" the value is infinit meaning only warning, no tripping.

5.4.2 Number of measuring repetitions (T) for frequency functions

In order to avoid false tripping of the unit at short voltage drops of the system voltage or interference voltages, *MRN3* works with an adjustable measuring repetition. When the instantaneous frequency measuring value exceeds (at overfrequency) or falls below (at underfrequency) the set reference value, the counter is incremented, otherwise the counter is decremented down to the minimum value of 0. Only when the counter exceeds the value adjusted at T, alarm is given and after the tripping delay of the frequency element has elapsed the tripping command is given.
The setting range for T is between 2 - 99.

Recommendation for setting:
For short tripping times, e.g. for machine protection or for mains decoupling T should be set in the range from 2 - 5.
At precision measurements, e.g. exact measurement of the system frequency a setting of T in the range from 5 - 10 is recommended.

5.4.3 Threshold of frequency supervision

The frequency supervision of *MRN3* has three frequency elements independent from each other. Acc. to setting the pickup value above or below the nominal frequency, these elements can be used for over- or under frequency supervision.

Dependent on the preset nominal frequency f_N the pickup values from 30 Hz up to 70 Hz at f_N = 50 Hz and from 40 Hz to 80 Hz at f_N = 60 Hz can be set. During setting of the pickup values f_1 - f_3 the display shows the values in Hz. A value of for instance 49,8 Hz is indicated with "4980".

The function of the individual frequency elements can be deactivated by setting the pickup values to "EXIT". The setting value "EXIT" corresponds to the rated frequency.

5.4.4 Tripping delays for the frequency elements

Tripping delays t_{f1} - t_{f3} of the four frequency elements can be set independently from $t_{f1\,min}$ - 50 s. The minimum tripping delay $t_{f1\,min}$ of the relay depends upon the number of set measuring repetitions T (periods) and amounts to:

T	$t_{f\,min}$
2....49	(T+1)·20 ms
50....69	(T - 49)·50 ms + 1 s
70....99	(T - 69)·100 ms + 2 s

When setting the tripping delay to "EXIT" by pressing push button <+> up to the maximum setting value, the corresponding tripping relay is blocked. Pickup of the frequency element is however displayed on the front plate by the corresponding LED, an assigned alarm relay is also activated. This setting applies to 50 Hz and 60 Hz.

5.4.5 Parameter setting of vector surge supervision (*MRN3-1*)

Both the vector surge angle ΔΘ as well as the tripping logic concerning the vector surge have to be adjusted for a vector surge supervision.
If the tripping logic is set to 1-of-3 (= "1Ph" on the display), the relay trips as soon as the measured vector surge angle has exceeded the set value ΔΘ in one of the three phases. This is the more sensitive adjustment when compared with the three phase tripping logic 3-of-3 (= "3Ph" on the display), where tripping occurs only if the vector surge angle exceeds the set value in all three phases.

We recommend to choose the one phase tripping logic "1Ph". Only if this adjustment is too sensitive, adjustment "3Ph" should be used.

The recommended setting of the vector surge angle ΔΘ in a low impedance mains is 4 - 6 degrees. This setting is sufficient in most cases, because low impedance mains do not have a vector surge greater than this value. In case of an auto reclosing, this value is exceeded. In high impedance mains the setting should be 10° to 12° to avoid failure tripping when switching on or switching off big consumer loads.

The vector surge function of this device can be checked as follows:

a) Generator in isolated operation: Switching off and on of loads (approx. 20% of the nominal generator capacity) must trip the relay. Later in normal isolated operation the tripping of the relay is inhibited.

b) In mains parallel operation switching on and switching off of consumer loads and controlling the governor of the prime mover should not trip the relay.

If possible the test described under a) and b) should be double checked by a real auto reclosing.

Threshold for the vector surge supervision

When the pickup value of the vector surge supervision is set, a value in angular degree is indicated at the display. The pickup value requested can be adjusted by pushbuttons <+> and <-> in the range of 2° to 22°. LED ΔΘ lights up red during this procedure.

5.4.6 Parameter setting of frequency gradient (*MRN3-2*)

The pickup value of frequency gradient (parameter df) can be set between 0.2 to 10 Hz/s. The number of measuring repetitions (parameter dt) can be set between 2 - 64 cycles. This parameter defines the number of df/dt measurements, which have to exceed the set value, before tripping.

Setting information:
The power difference after mains failure causes a change in frequency, which can approximately be calculated as follows:

$$\frac{df}{dt} = -\frac{f_N}{T_A} \cdot \Delta P$$

with
f_N = rated frequency in Hz
T_A = starting time at rated torque
ΔP = per unit power deficit with reference to the rated active power of the generator

If the inertia time constant is known and a power difference given, the frequency gradient can be estimated by the a.m. equation. At a supposed power difference of 20% and an inertia time constant of 10 s, the frequency gradient is 1 Hz/s.

To prevent false trippings at loading, deloading or failure signals, we would recommend a setting value for dt of minimum 4 cycles.

5.4.7 Voltage threshold value for frequency and vector surge measuring (df/dt at *MRN3-2*)

Correct frequency measuring or vector surge measuring cannot be obtained if the system voltage is very low, for instance during generator start up or voltage failure. False tripping of the *MRN3* in such cases is prevented by an adjustable voltage threshold U_B. If the system voltage is below this threshold, these functions of the relay are blocked.
During adjustment of U_B< LEDs f and ΔΘ or df light up in the upper display part.

5.4.8 Adjustment of the slave address

By pressing push buttons <+> and <-> the slave address can be set in the range of 1 - 32. During this adjustment the LED RS lights up.

5.4.9 Setting of Baud-rate (applies for Modbus Protocol only)

Different transmission rates (Baud rate) can be set for data transmission via Modbus Protocol.
The rate can be changed by push buttons <+> and <-> and saved by pressing <ENTER>.

5.4.10 Setting of parity (applies for Modbus Protocol only)

The following three parity settings are possible :

- "even" = even
- "odd" = odd
- "no" = no parity check

The setting can be changed by push buttons <+> and <-> and saved by pressing <ENTER>.

5.5 Adjustment of the fault recorder

The *MRI3* is equipped with a fault recorder (see chapter 3.7). Three parameters can be determined.

5.5.1 Number of the fault recordings

The max. recording time is 16 s at 50 Hz or 13.33 s at 60 Hz.
The number of max. recordings requested has to be determined in advance. There is a choice of (1)* 2, (3)* 4 or (7)* 8 recordings and dependent on this the duration of the individual fault recordings is defined, i.e.

(1)* 2 recordings for a duration of 8 s (with 50 Hz) (6.66 s with 60 Hz)
(3)* 4 recordings for a duration of 4 s (with 50 Hz) (3.33 s with 60 Hz)
(7)* 8 recordings for a duration of 2 s (with 50 Hz) (1,66 s with 60 Hz)
* is written over when a new trigger signal arrives

Caution:
If the fault recorder is used, the frequency should be set to f = 50 Hz or f = 60 Hz (see chapter 5.3.3).

5.5.2 Adjustment of trigger occurences

There is a choice between four different occurences:

P_UP (PickUP)	Storage is initiated after recognition of a general activation.
TRIP	Storage is initiated after a trip has occured.
A_PI (After Pickup)	Storage is initiated after the last activation threshold was fallen short of.
TEST	Storing is activated by simultaneous actuation of the keys <+> and <->. During the recording time the display shows "Test".

5.5.3 Pre-trigger time (T_{pre})

By the time T_{pre} it is determined which period of time prior to the trigger occurence should be stored as well. It is possible to adjust a time between 0.05s and the max. recording interval (2, 4 and 8s). With keys <+> and <-> the values can be changed and with <ENTER> be saved.

5.6 Adjustment of the clock

When adjusting the date and time, LED ◷ lights up.
The adjustment method is as follows:

Date :	Year	Y=00
	Month	M=00
	Day	D=00
Time :	Hour	h=00
	Minute	m=00
	Second	s=00

The clock starts with the set date and time as soon as the supply voltage is switched on. The time is safeguarded against short-term voltage failures (min. 6 minutes).

Note:
The window for parameter setting is located behind the measured value display. The parameter window can be accessed via the <SELECT/RESET> key.

5.7 Additional functions

5.7.1 Setting procedure for blocking the protection functions

The blocking function of the *MRN3* can be set according to requirement. By applying the aux. voltage to D8/E8, the functions chosen by the user are blocked. Setting of the parameter should be done as follows:

- When pressing push buttons <ENTER> and <TRIP> at the same time, message "BLOC" is displayed (i.e. the respective function is blocked) or "NO_B" (i.e. the respective function is not blocked). The LED allocated to the first protection function U< lights red.
- By pressing push buttons <+> <-> the value displayed can be changed.
- The changed value is stored by pressing <ENTER> and entering the password.
- By pressing the <SELECT/RESET> push button, any further protection function which can be blocked is displayed.
- Thereafter the menu is left by pressing <SELECT/RESET> again.
- If the <SELECT/RESET> key is actuated again, the blocking menu is left and the assignment mode is accessed^.

Function	Description	Display	LED
U<	Undervoltage step 1	BLOC	red
U<<	Undervoltage step 2	BLOC	red
U>	Overvoltage step 1	NO_B	red
U>>	Overvoltage step 2	NO_B	red
f1	Frequency step 1	BLOC	red
f2	Frequency step 2	BLOC	rec
f3	Frequenzstufe 3	NO_B	red
ΔΘ	Vector surge	BLOC	red
df/dt	Frequency changing rate	BLOC	red

Table 5.3: Blockadefunktion für twei Parametersätze

Assignment of the output relays:
Unit *MRN3* has five output relays. The fifth output relay is provided as permanent alarm relay for self supervision is normally on. Output relays 1 - 4 are normally off and can be assigned as alarm or tripping relays to the voltage functions which can either be done by using the push buttons on the front plate or via serial interface RS485. The assignment of the output relays is similar to the setting of parameters, however, only in the assignment mode. The assignment mode can be reached only via the blocking mode.
By pressing push button <SELECT/RESET> in blocking mode again, the assignment mode is selected.

The relays are assigned as follows: LEDs U<, U<<, U> and U>>, f1, f2, f3 are two-coloured and light up green when the output relays are assigned as alarm relays and $t_{U<}$, $t_{U<<}$, $t_{U<}$, $t_{U<<}$, tf1, tf2, tf3 df/dt and ΔΘ red as tripping relays.

Definition:
Alarm relays are activated at pickup.
Tripping relays are only activated after elapse of the tripping delay.

After the assignment mode has been activated, first LED U< lights up green. Now one or several of the four output relays can be assigned to under voltage element U< as alarm relays. At the same time the selected alarm relays for under voltage element 1 are indicated on the display. Indication "1_ _ _" means that output relay 1 is assigned to this under voltage element. When the display shows "_ _ _ _", no alarm relay is assigned to this under voltage element. The assignment of output relays 1 - 4 to the current elements can be changed by pressing <+> and <-> push buttons. The selected assignment can be stored by pressing push button <ENTER> and subsequent input of the password. By pressing push button <SELECT/RESET>, LED U< lights up red. The output relays can now be assigned to this voltage element as tripping relays.

Relays 1 - 4 are selected in the same way as described before. By repeatedly pressing of the <SELECT/RESET> push button and assignment of the relays all elements can be assigned separately to the relays. The assignment mode can be terminated at any time by pressing the <SELECT/RESET> push button for some time (abt. 3 s).

Note:
- The function of jumper J2 described in general description "MR Digital Multifunctional Relays" does not apply for *MRN3*. For relays without assignment mode this jumper is used for parameter setting of alarm relays (activation at pickup or tripping).

A form is attached to this description where the setting requested by the customer can be filled-in. This form is prepared for telefax transmission and can be used for your own reference as well as for telephone queries.

Relay function		Output relays				Display-	Corresponding
		1	2	3	4	Indication	LED
U<	alarm		X			_ 2 _ _	U<; green
tU<	tripping	X				1 _ _ _	tU< red
U<<	alarm		X			_ 2 _ _	U<< green
tU<<	tripping	X				1 _ _ _	tU<< red
U>	alarm		X			_ 2 _ _	U> green
tU>	tripping	X				1 _ _ _	tU> red
U>>	alarm		X			_ 2 _ _	U>> green
tU>>	tripping	X				1 _ _ _	tU>> red
f1	alarm			X		_ _ 3 _	f1 green
tf1	tripping	X				1 _ _ _	tf1 red
f2	alarm			X		_ _ 3 _	f2 green
tf2	tripping	X				1 _ _ _	tf2 red
f3	alarm			X		_ _ 3 _	f3 green
tf3	tripping	X				1 _ _ _	tf3 red
$\Delta\Theta$	tripping				X	_ _ _ 4	$\Delta\Theta$ red
df/dt	tripping				X	_ _ _ 4	df/dt red

Tabelle 5.4: Example of assignment matrix of the output relay (default settings).

5.8 Indication of measuring values

5.8.1 Measuring indication

In normal operation the following measuring values can be displayed.

Voltages (LED L1, L2, L3 green)
- In star connection all phase-to-neutral voltages
- In delta connection all phase-to-phase voltages

Frequency (LED f green *MRN3-1*)
Vector surge (LED $\Delta\Theta$ green)
Frequency gradient df/dt (LED df green; *MRN3-2*)

Min. and max. values prior to the last reset:
- Frequency (LED f + min or f + max)
- Vector surge (LED $\Delta\Theta$ + min or $\Delta\Theta$ + max)
- Frequency gradient (LED df + min or df + max)

5.8.2 Min./Max.- values

The *MRN3* offers a minimum/maximum storage each for the measuring values of the vector surge as well as the frequency gradient. These min./max. values are mainly used to appraise the system quality. Always the highest and lowest values of each cycle are measured and stored until the next reset.

Min./max. frequency measuring:
The *MRN3* ascertains the actual frequency from each cycle of the system voltage. These measuring values are entered into the min./max. storage. The latest entered min./max. values replace the previously stored values.

Dependent on the adjustment of dt and tripping delay, it is possible that the stored min./max. values are higher than the tripping threshold without causing a trip. The reason for this is storage of instantaneous values.

Min./Max. measuring of the frequency gradient:
The procedure described above applies also to storage of min./max. values of df/dt measurement. Since each instantaneous df/dt value is stored, high values can occur which, however, do not cause any tripping.

This can for instance happen during switching procedures where high positive and negative df/dt values occur, but they do not cause any tripping due to the special measuring method.

Min./max. vector surge measuring :
The procedure described above applies also to storage of min./max. values of vector surge measuring. Since each instantaneous $\Delta\Theta$ value is stored, also here high values are possible which, however, do not cause any tripping.

These min./max. measurements are of great advantage for long-time analysis of the grid quality.

As to operation :
After each reset (ref. 5.9.1) the min./max. storages are cleared. As from this instant there is no time limit for the min./max. storage until the next reset.
By repeatedly pressing the <SELECT/RESET> push button, the measuring values of the min./max. storage can be queried. The respective LEDs light up at the same time; e.g. during minimum frequency is displayed, LEDs "f" and "min" light up.

5.8.3 Unit of the measuring values displayed

The measuring values can optionally be shown in the display as a multiple of the "sec" rated value (x In) or as primary current (A). According to this the units of the display change as follows:

Indication as	Range	Unit
sec. voltage	000V – 999V	V
primary voltage	.000 – 999V	V
	1K00 – 9K99	KV
	10K0 – 99K9	KV
	100K – 999K	KV
	1M00 – 3M00	MV

Table 5.5: Units of the display

5.8.4 Indication of fault data

All faults detected by the relay are indicated on the front plate optically. For this purpose, the four LEDs (L1, L2, L3, f) and the four function LEDs (U<, U<<, U>, U>>, f1, f2, f3, $\Delta\Theta$ und df/dt) are equipped at *MRN3*. Not only fault messages are transmitted, the display also indicates the tripped protection function. If, for example an overcurrent occurs, first the respective phase LED will light up. LED I> lights up at the same time. After tripping the LEDs are lit permanently.

5.9 Fault memory

When the relay is energized or is energized or trips, all fault data and times are stored in a non-volatile memory manner. The *MRN3* is provided with a fault value recorder for max. five fault occurrences. In the event of additional trippings always the oldest data set is written over.

For fault indication not only the trip values are recorded but also the status of LEDs. Fault values are indicated when push buttons <-> or <+> are pressed during normal measuring value indication.

- Normal measuring values are selected by pressing the <SELECT/RESET> button.
- When then the <-> button is pressed, the latest fault data set is shown. By repeated pressing the <-> button the last but one fault data set is shown etc. For indication of fault data sets abbreviations FLT1, FLT2, FLT3, ... are displayed (FLT1 means the latest fault data set recorded). At the same time the parameter set active at the occurence is shown.
- By pressing <SELECT/RESET> the fault measuring values can be scrolled.
- By pressing <+> it can be scrolled back to a more recent fault data set. At first FLT8, FLT7, ... are always displayed.When fault recording is indicated (FLT1 etc), the LEDs flash in compliance with the stored trip information, i.e. those LEDs which showed a continuous light when the fault occured are now blinking blinking to indicate that it is not a current fault. LEDs which were blinking blinking during trip conditions, (element had picked up) just briefly flash.
- If the relay is still in trip condition and not yet reset (TRIP is still displayed), no measuring values can be shown.
- To delete the trip store, the push button combination <SELECT/RESET> and <->, has to be pressed for about 3s. The display shows "wait".

Recorded fault data:

Measuring	Displayed value	Corresponding LED
Voltage	L1; L2; L3; L1/L2; L2/L3; L3/L1	L1; L2; L3
Frequency	f; f min f max	f; min; max
Frequency changing rate	df	df
Vektorsprung	$\Delta\Theta$	$\Delta\Theta$
Time stamp		
Date:	Y = 99	🕒
	M = 03	🕒
	D = 10	🕒
Time:	h = 17	🕒
	m = 21	🕒
	s = 14	🕒

5.9.1 Reset

All relays have the following three possibilities to reset the display of the unit as well as the output relay at jumper position J3=ON.

Manual Reset
- Pressing the push button <SELECT/RESET> for some time (about 3 s)

Electrical Reset
- Through applying auxiliary voltage to C8/D8

Software Reset
- The software reset has the same effect as the <SELECT/RESET> push button (see also communication protocol of RS485 interface)

The display can only be reset when the pickup is not present anymore (otherwise "TRIP" remains in display).

During resetting of the display the parameters are not affected.

5.9.2 Erasure of fault storage

To delete the trip store, the push button combination <SELECT/RESET> and <->, has to be pressed for about 3s. The display shows "wait".

6 Relay testing and commissioning

The following test instructions should help to verify the protection relay performance before or during commissioning of the protection system. To avoid a relay damage and to ensure a correct relay operation, be sure that:

- The auxiliary power supply rating corresponds to the auxiliary voltage on site.
- The rated frequency and rated voltage of the relay correspond to the plant data on site.
- The voltage transformer circuits are connected to the relay correctly.
- All signal circuits and output relay circuits are connected correctly.

6.1 Power-On

NOTE!
Prior to switch on the auxiliary power supply, be sure that the auxiliary supply voltage corresponds to the rated data on the type plate.

Switch on the auxiliary power supply to the relay and check that the message "ISEG" appears on the display and the self supervision alarm relay (watchdog) is energized (Contact terminals D7 and E7 closed).
It may happen that the relay is tripped because of under- voltage condition after power-on. (The message "TRIP" on the display and LED L1, L2, L3 and U< light up red). An undervoltage condition has been detected after power-on, because no input voltages are applied to the relay. In this case:

- Press the push button <ENTER>, thus entering into the setting mode. Now set the parameters U< and U<< to "EXIT" to block the undervoltage functions. After that, press the <SELECT/RESET> for app. 3 s to reset the LEDs and "TRIP" message.
- The undervoltage tripping after power on can also be eliminated by applying three phase rated voltages after power-on and reset the LED and "TRIP" message.
- Apply auxiliary voltage to the external blocking input (Terminals E8/D8) to inhibit the undervoltage functions (refer to 6.5) and press the <SELECT/RESET> for app. 3 s to reset the LEDs and "TRIP" message.

6.2 Testing the output relays

NOTE!
Prior to commencing this test, interrupt the trip circuit to the circuit breaker if tripping is not desired.

By pressing the push button <TRIP> once, the display shows the first part of the software version of the relay (e.g. „D08-"). By pressing the push button <TRIP> twice, the display shows the second part of the software version of the relay (e.g. „4.01". The software version should be quoted in all correspondence. Pressing the <TRIP> button once more, the display shows "PSW?". Please enter the correct password to proceed with the test. The message "TRI?" will follow. Confirm this message by pressing the push button <TRIP> again. All output relays should then be activated and the self supervision alarm relay (watchdog) be deenergized one after another with a time interval of 1 second. Thereafter, reset all output relays back to their normal positions by pressing the push button <SELECT/RESET>.

6.3 Checking the set values

By repeatedly pressing the push button <SELECT>, all relay set values may be checked. Set value modification can be done with the push button <+><-> and <ENTER>. For detailed information about that, please refer to chapter 4.3 of the description "MR – Digital multifunctional relays".

As relay input energizing quantities, three phase voltages should be applied to *MRN3* relay input circuits. Depending on the system conditions and the voltage transformer used, three voltages can be connected to the relay input circuits with either star or delta connection. In case of a star connection the phase-to-neutral voltage will be applied to the voltage input circuits, while the phase-to-phase voltages will be connected to the voltage input circuits in case of a delta connection. The voltage input connection must be set as a parameter, and should correspond with the actual voltage input connection:

Star connection:	Phase-to-neutral voltages will be measured and evaluated.
Delta connection:	Phase-to-phase voltages will be measured and evaluated.

6.4 Secondary injection test

6.4.1 Test equipment

- Voltmeter and frequency meter with class 1 or better,
- auxiliary power supply with the voltage corresponding to the rated data on the type plate,
- three-phase voltage supply unit with frequency regulation (Voltage: adjustable from 0 to 2 x U_N; Frequency: adjustable from 40 - 70 Hz),
- timer to measure the operating time (Accuracy class ±10 ms),
- switching device and
- Test leads and tools

6.5 Example of test circuit

For testing of the *MRN3* relay, a three phase voltage source with adjustable voltage and frequency is required. Figure 6.1 shows an example of a three-phase test circuit energizing the *MRN3* relay during test. The three phase voltages are applied to the relay in Y-connection.

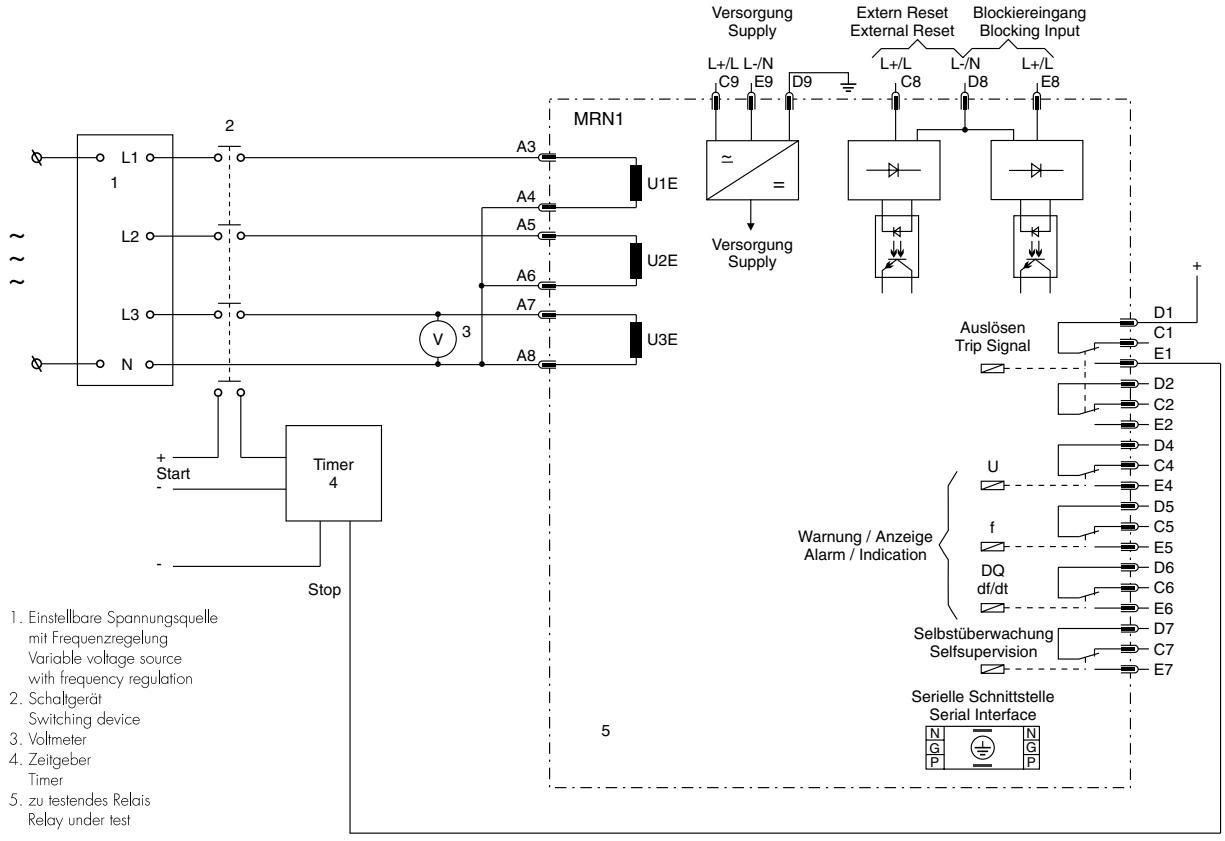


Figure 6.1: Test circuit

For testing the vector surge function of the relay, a test circuit which can produce phase angle change (vector surge) is required to simulate mains failures (please refer to chapter 6.5.6).

For testing the df/dt function of the relay, a special test equipment is required, which produces a constant rate of change of frequency.

6.5.1 Checking the input circuits and measuring functions

Apply three voltages of rated value to the voltage input circuits (terminals A3 - A8) of the relay. Check the measured voltages, frequency and vector surge on the display by pressing the push button <SELECT/RESET> repeatedly. The displayed measuring voltages (shown in Volt) are dependent on the wiring of the input voltage converters and the set transformation ratio.

The voltages are indicated on the display in volts.
At Y-connection:
- Phase-to-neutral voltages: LED L1, L2, L3

At Delta-connection:
- Phase-to-phase voltages: LED L1+L2, L2+L3, L3+L1

The frequency is indicated on the display in Hz: LED f (system frequency = 50.01Hz, Indication = 5001)
The vector surge is indicated on the display in degrees (for *MRN3-1*): LED $\Delta\Theta$ (Indication $\Delta\Theta$ in °)
The rate of change of frequency (LED df) is indicated on the display in Hz/s (for *MRN3-2*)

Change the voltages around the rated value and check the measured voltages on the display.
Change the system frequency around the rated frequency and check the measured frequency on the display.

Compare the voltage and frequency on display with the signal on voltmeter and frequency meter. The deviation for the voltage must not exceed 1% and for frequency <0.01 Hz.

By using an RMS-metering instrument, a greater deviation may be observed if the test voltage contains harmonics. Because the *MRN3* relay measures only the fundamental component of the input signals, the harmonics will be rejected by the internal DFFT-digital filter. Whereas the RMS-metering instrument measures the RMS-value of the input signals.

6.5.2 Checking the operating and reset ting values of the over/undervoltage functions

Note:
When the measuring voltage is connected or disconnected, vector surge tripping or df/dt tripping can occur. In order to ensure a trouble-free test procedure, the vector surge function or df/dt function of the relay have to be blocked before tests are started.

Apply three voltages with the rated value and gradually increase (decrease) the voltages until the relay starts, i.e. at the moment when the LED U> (or U<) lights up or the voltage alarm output relay (contact terminals D4/E4) is activated. Read the operating voltage indicated by the voltmeter. The deviation must not exceed 1% of the set operating value.

Furthermore, gradually decrease (increase) the voltages until the relay resets, i.e. the voltage alarm output relay is disengaged. Check that the dropout to pickup ratio for voltage is greater than 0.97 (for overvoltage function) or smaller than 1.03 (for undervoltage).

6.5.3 Checking the relay operating time of the over/undervoltage functions

To check the relay's operating time, a timer must be connected to the trip output relay contact (Contact terminals D1/E1). The timer should be started simultaneously with the voltage change from sound condition to a faulty condition and stopped by the trip relay contact. The operating time measured by timer should have a deviation about 3% of the set value or <20 ms.

6.5.4 Checking the operating and reset ting values of the over/underfrequency functions

Note:
Due to frequency changes, vector surge tripping or df/dt - tripping can occur during frequency tests. In order to ensure a trouble-free test procedure, the vector surge function or df/dt function of the relay have to be blocked before tests are started.
During frequency tests, each of the frequency elements should be tested separately. This makes it necessary that the other frequency elements of the relay have to be blocked by setting the frequency pickup values f_1 - f_3 to "EXIT". For testing the pickup and dropout to pickup values, the test frequency has to be increased (decreased) until the relay is engergized. This is indicated by lighting up of LEDs f_1 - f_3.
When comparing the values displayed with those of the frequency meter, the deviation must not exceed 0.01 Hz. The dropout to pickup values are ascertained by increasing (decreasing) the test frequency slowly until the output relay releases.
The dropout to pickup value for overfrequency must be >0.99, and for underfrequency <1.01.

6.5.5 Checking the relay operating time of the over/underfrequency functions

The operating time of the over/underfrequency functions can be tested in the similar manner as in chapter 6.5.3 for over/undervoltage functions.

6.5.6 Checking the vector surge function

With the help of an advanced relay test equipment a phase shift (vector surge) on the voltage signal can be obtained to test the vector surge function of *MRN3* relay. If there is no such testing facility available, a very simple simulation circuit may be used to test the vector surge function of the relay with a sufficient accuracy. Figure 6.2 shows the possibility to simulate a phase shift by means of a RC circuit. Closing or opening the switch S1 causes the phase angle of the input voltage to change depending on the adjustable resistor R.

The phase angle obtained may be calculated with the following formula and is almost independent on the test voltages.
In case of a 3-phase vector surge, the angle $\Delta\Theta$ can be calculated with the following formula if the parameters R_0, R and C are known:

$$\Delta\Theta = \text{arctg}\frac{1}{R_0 \cdot \omega \cdot C} - \text{arctg}\frac{1}{(R_0 + R) \cdot \omega \cdot C}$$

Example: R_0 = 1 Ohm, R = 363 Ohm, C = 3 µF

then: $\Delta\Theta \cong 19°$

Usually the voltage source impedance R_0 is negligible, hence R_0 may be assumed zero. Thus, the value of R may be calculated using the following simplified formula:

$$\Delta\Theta = 90° - \text{arctg}\ \frac{1}{R \cdot \omega \cdot C}$$

Note!
Using the above test circuit with single-phase vector surge, the resulting measured angle $\Delta\Theta$ is about half the value of $\Delta\Theta$ calculated for a 3-phase vector surge.
To make tripping possible during a one phase test procedure, the vector surge tripping has to be set to "1Ph".

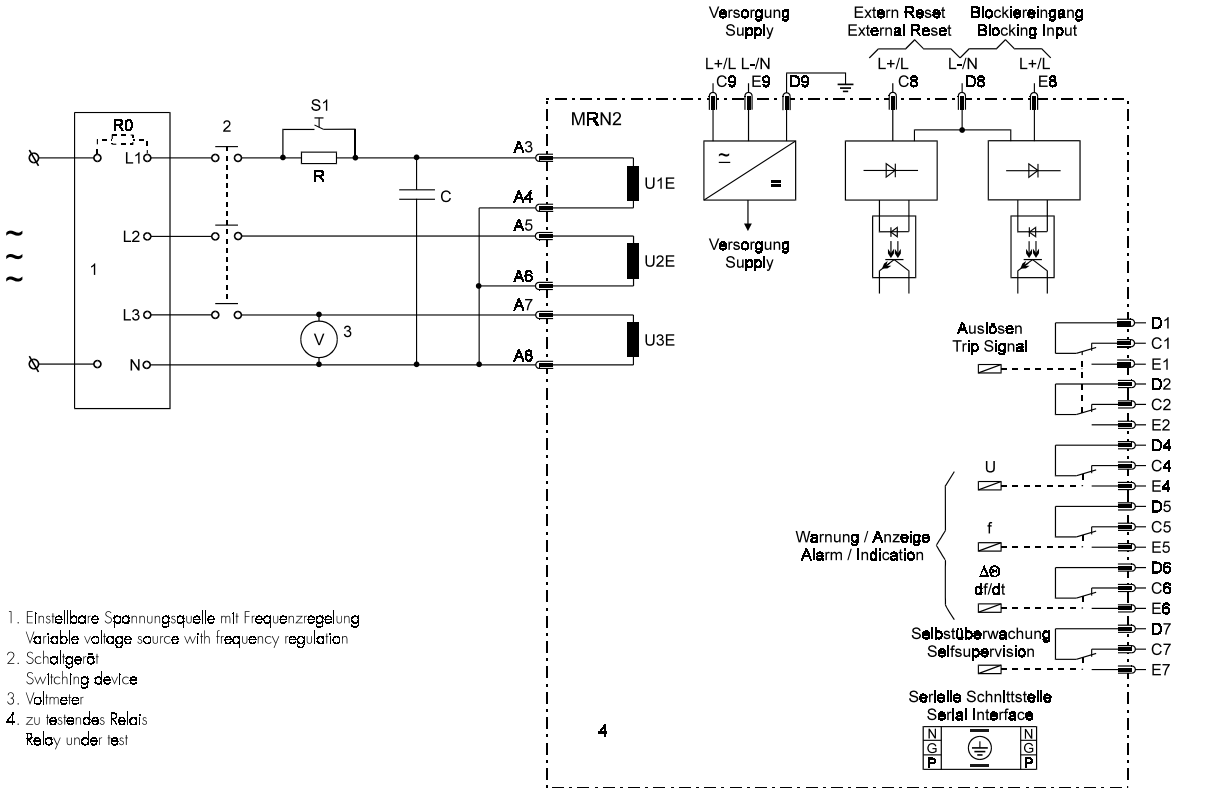


Figure 6.2: Test circuit for the vector surge function

6.5.7 Checking the external blocking and reset functions

The external blocking input is free programmable by the user.
To test the blocking function apply auxiliary supply voltage to the external blocking input of the relay (terminals E8/D8). Inject a test voltage which could cause tripping for the testes functions. Observe that there is no trip and alarm for those functions.

Remove the auxiliary supply voltage from the blocking input. Apply test voltages to trip the relay (message „TRIP" on the display). Return the test voltages to the sound condition and apply auxiliary supply voltage to the external reset input of the relay (terminals C8/D8). The display and LED indications should be reset immediately.

6.6 Primary injection test

Generally, a primary injection test could be carried out in the similar manner as the secondary injection test described above. With the difference that the protected power system should be, in this case, connected to the installed relays under test „on line", and the test voltages should be injected to the relay through the voltage transformers with the primary side energized. Since the cost and potential hazards are very high for such a test, primary injection tests are usually limited to very important protective relays in the power system.

Because of its powerful combined indicating and measuring functions, the *MRN3* relay may be tested in the manner of a primary injection test without extra expenditure and time consumption.

In actual service, for example, the measured voltage and frequency values on the *MRN3* relay display may be compared phase by phase with the concerned indications of the instruments of the switchboard to verify that the relay works and measures correctly.

6.7 Maintenance

Maintenance testing is generally done on site at regular intervals. These intervals vary among users depending on many factors: e.g. the type of protective relays employed; the importance of the primary equipment being protected; the user's past experience with the relay, etc.

For electromechanical or static relays, maintenance testing will be performed at least once a year according to the experiences. For digital relays like *MRN3*, this interval can be substantially longer. This is because:

- The *MRN3* relays are equipped with very wide self-supervision functions, so that many faults in the relay can be detected and signalised during service. Important: The self-supervision output relay must be connected to a central alarm panel!
- The combined measuring functions of *MRN3* relays enable supervision the relay functions during service.
- The combined TRIP test function of the *MRN3* relay allows to test the relay output circuits.

A testing interval of two years for maintenance will, therefore, be recommended.
During a maintenance test, the relay functions including the operating values and relay tripping times should be tested.

7 Technical data

7.1 Measuring input circuits

Rated data:	Nominal voltage U_N	100 V, 230 V, 400 V
	Nominal frequency f_N	40 - 70 Hz
Power consumption in voltage circuit:	<1 VA	
Thermal rating:	continuously	2 x U_N
Undervoltage lockout for frequency and vector surge measurement:	U< adjustable (5%...100% U_N)	

7.2 Common data

Dropout to pickup ratio:	for U>/U>> : >97%;	for U</U<< : <103%
	for f>/f>> : >99.98%;	for f</f<< : <100.02%
Dropout time:	60 ms	
Time lag error class index E:	±10 ms	
Minimum operating time:	40 ms	
Max. allowed interruption of the auxiliarxy supply without a facting the function of the device:	50 ms	
Influences on voltage measuring:		
Aux. voltage:	in the range 0.8 <U_H/U_{HN} <1.2 no additional influences to be measured	
Frequency:	in the range 0.8 <f / f_N <1.4 (for f_N = 50 Hz) <0.15% / Hz	
Harmonics:	up to 20% of the 3rd harmonic <0.1% per percent of the 3rd harmonic	
	up to 20% of the 5th harmonic <0.05% per percent of the 5th harmonic	
Influences on frequency measuring:		
Aux. voltage:	in the range <0.8 U_N/U_{HN} <1.2 no additional influences to be measured	
Frequency:	no influences	
Influences on delay time:	no additional influences to be measured	
GL-Approbation:	98776-96HH	
Bureau Veritas Approbation:	2650 6807 A00 H	

7.3 Setting ranges and steps

Function	Para-meter	Setting range	Steps	Tolerance
Transformer ratio	U_{prim}/U_{sek}	(SEC) 1.01...6500	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0; 10; 20; 50	
Rated frequency	f_N	f = 50 Hz / f = 60 Hz		
Switch group	Δ/Y	Δ = Delta/Y = Stern		
Switch over	P2/FR	SET1/SET2/B_S2/R_S2/B_FR/R_FR/ S2_FR		
LED blinking at pick-up		FLSH/NOFL		
U</<<	U</<<	U_N = 100 V: 2...200 V (EXIT) U_N = 230 V: 2...460 V (EXIT) U_N = 400 V: 4...800 V (EXIT) 0.04...50 s (EXIT)	 1 V 1 V 2 V 0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0 s	 ± 1 % of set value or < 0.3% U_N ±1% or ±15 ms
U>/>>	U>/>> $t_{U>}$ $t_{U>>}$	U_N = 100 V: 2...200 V (EXIT) U_N = 230 V: 2...460 V (EXIT) U_N = 400 V: 4...800 V (EXIT) 0,04...50 s (EXIT)	 1 V 1 V 2 V 0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0 s	 ±1% of set value or <0,3% U_N ±1% or ±15 ms
Frequency measuring repetition	T	2...99 (Cycles)	1	
Frequency element 1 - 3	f_1 - f_3 t_{f1} - t_{f3}	30...49.99; EXIT; 50.01...70 Hz[1] 40...59.99; EXIT; 60.01...80 Hz[2] $t_{f,min}$[3]...50 s; EXIT	0.1; 0.01 Hz 0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0 s	0.005 Hz ±1% or ±20 ms
df/dt-Step df/dt-Measuring repetition	df dt	0,2...10 Hz/s (EXIT) 2...64 Periods	0.1; 0.2; 0.5 Hz/s 1	0.1 Hz/s
ΔΘ	ΔΘ	2°...22° (EXIT)	1°	±1°
Vector surge logic	1/3	1Ph / 3Ph		
Voltage theshold for frequency measuring	U_B (LED 'f'+ ΔΘ/df)	U_N = 100 V: 5...100 V U_N = 230 V: 12...230 V U_N = 400 V: 20...400 V	 1 V 1 V 2 V	 ±1% of set value or <0.3% U_N

Table 7.1: Setting ranges and steps

[1] At 50 Hz rated frequency
[2] At 60 Hz rated frequency
[3] $t_{f,min}$ min. time delay; $t_{f,min}$ = (T+1) x 20 ms
[4] only Modbus

7.3.1 Interface parameter

Function	Parameter	Modbus-Protocol	RS485 Open Data Protocol
RS	Slave-Address	1 - 32	1 - 32
RS	Baud-Rate*	1200, 2400, 4800, 9600	9600 (fixed)
RS	Parity*	even, odd, no	"even Parity" (fixed)

Table 7.1: Interface parameter

*only Modbus Protocol

7.3.2 Parameters for the fault recorder

Function	Parameter	Adjustment example
FR	Number of recordings	(1)* 2 x 8 s; (3)* 4 x 4 s; (7)* 8 x 2 s (with 50 Hz) (1)* 2 x 6.66 s, (3)* 4 x 3.33 s, (7)* 8 x 1.66 s (60 Hz)
FR	Saving of the recording at the occurence	P_UP; TRIP; A_PI; TEST
FR	Pre-trigger-time	0.05 s – 8.00 s

Table 7.2: Parameters for the fault recorder

* is written over when a new trigger signal arrives

7.4 Output relays

Relay type	Trip relays / change-over contacts	Alarm relays / change-over contacts
MRN3	2/2	3/1

Table 7.3: Output relays

8 Order form

Mains decoupling relay ***MRN3-***					
with voltage-, frequency and vector surge supervision		**1**			
Voltage, frequency and df/dt-supervision		**2**			
Rated voltage	100 V		**1**		
	230 V		**2**		
	400 V		**4**		
Housing (12TE)	19"-rack			**A**	
	Flush mounting			**D**	
RS485	Alternatively with Modbus Protocol				**-M**

Technical data subject to change without notice!

Setting list *MRN3*

Project: _____ SEG job.-no.: _____

Function group: = _____ Location: + _____ Relay code: - _____

Relay functions: _____ Password: _____

Setting of the parameters

System parameter

Function		Unit	Relay type *MRN3-1*	*MRN3-2*	Default settings Set 1/Set 2	Actual settings Set 1/Set 2
U_{prim}/U_{sek}	Voltage transformer ratio		X	X	SEK	
Δ/Y	Input voltage correction dependent on the connection of the input transformer		X	X	Y	
f_N	Rated frequency	Hz	X	X	v = 50 Hz	
LED Flash	Display of the activation storage		X	X	FLSH	
P2	2 parameter sets/ext. Trigger for FR		X	X	SET1	

Protection parameter

Function		Unit	Default settings	Actual settings
			Set 1 / Set 2	Set 1 / Set 2
U<	pickup value for undervoltage element (low set)	V	90/210/360*	
t_U<	tripping delay for undervoltage element	s	0.04	
U<<	pickup value for undervoltage element (high set)	V	80/190/320*	
t_U<<	tripping delay for undervoltage element	s	0.04	
U>	pickup value for overvoltage element (low set)	V	110/250/440*	
t_U>	tripping delay for overvoltage element	s	0.04	
U>>	pickup value for overvoltage element (high set)	V	120/270/480*	
t_U>>	tripping delay for overvoltage element	s	0.04	
T	frequency measuring repetition in periods	cycles	4	
f_1	pickup value for frequency element 1	Hz	4800	
t_{f1}	tripping delay for frequency element 1	s	0.1	
f_2	pickup value for frequency element 2	Hz	4900	
t_{f2}	tripping delay for frequency element 2	s	0.1	
f_3	pickup value for frequency element 3	Hz	5100	
t_{f3}	tripping delay for frequency element 3	s	0.1	
df	pickup value for rate of frequency (dt/dt) in	Hz/s	EXIT	
dt	measuring repetition for df/dt	periods	4	
1/3	vector surge tripping logic		1PH	
ΔΘ	pickup value for vector surge	°	2.0	
U_B<	voltage threshold value for frequency and vector surge measuring (or df/dt)	V	10/23/40*	
RS	Slave address of the serial interface		1	
RS**	Baud-Rate		9600	
RS**	Parity-Check		even	

* thresholds dependent on rated voltage 100 V / 230 V / 400 V
** only Modbus

Fault recorder

Function		Unit	Default settings	Actual settings
FR	Number of recordings		4	
FR	Saving of the recording at the occurrence		TRIP	
FR	Time prior to trigger impulse	s	0.05	
🕒	Year setting	year	Y=00	
🕒	Month setting	month	M=00	
🕒	Day setting	day	D=00	
🕒	Setting of the hour	hour	h=00	
🕒	Setting of the minute	minute	m=00	
🕒	Setting of the setting	second	s=00	

Blocking function

	Default settings				Actual settings			
	Blocking		Not blocking		Blocking		Not blocking	
Parameter set	Set 1	Set 2	Set 1	Set 2	Set 1	Set 2	Set 1	Set 2
U<	X		X					
U<<	X		X					
U>		X		X				
U>>		X		X				
f1	X		X					
f2	X		X					
f3		X		X				
ΔΘ	X		X					
df/dt	X		X					

Assignment of the output relays

Function	Relay 1		Relay 2		Relay 3		Relay 4	
	Default settings	Actual settings	Default settings	Actual settings	Default settings	Actual settings	Default settings	Actual settings
U< alarm			X					
$t_{U<}$ tripping	X							
U<< alarm			X					
$t_{U<<}$ tripping	X							
U> alarm			X					
$t_{U>}$ tripping	X							
U>> alarm			X					
$t_{U>>}$ tripping	X							
f1 alarm					X			
tf1 tripping	X							
f2 alarm					X			
tf2 tripping	X							
f3 alarm					X			
tf3 tripping	X							
ΔΘ tripping							X	
df/dt tripping							X	

Setting of code jumpers

Code jumper	J1		J2		J3	
	Default settings	Actual settings	Default settings	Actual settings	Default settings	Actual settings
Plugged						
Not plugged	X		No function		X	

Code jumper	Low/High-range for Reset input		Low/High-range for blockage input	
	Default settings	Actual settings	Default settings	Actual settings
Low=plugged	X		X	
High=not plugged				

All settings must be checked at site and should the occasion arise, adjusted to the object/item to be protected.

This technical manual is valid for
software version number: D01-8.08 (*MRN3-1*)
D04-8.08 (*MRN3-2)*

Modbus version number: D51-1.13 (*MRN3-1*)
D54-1.13 (*MRN3-2)*

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Anexo 34: Diagrama de escalera del sensor de RPM

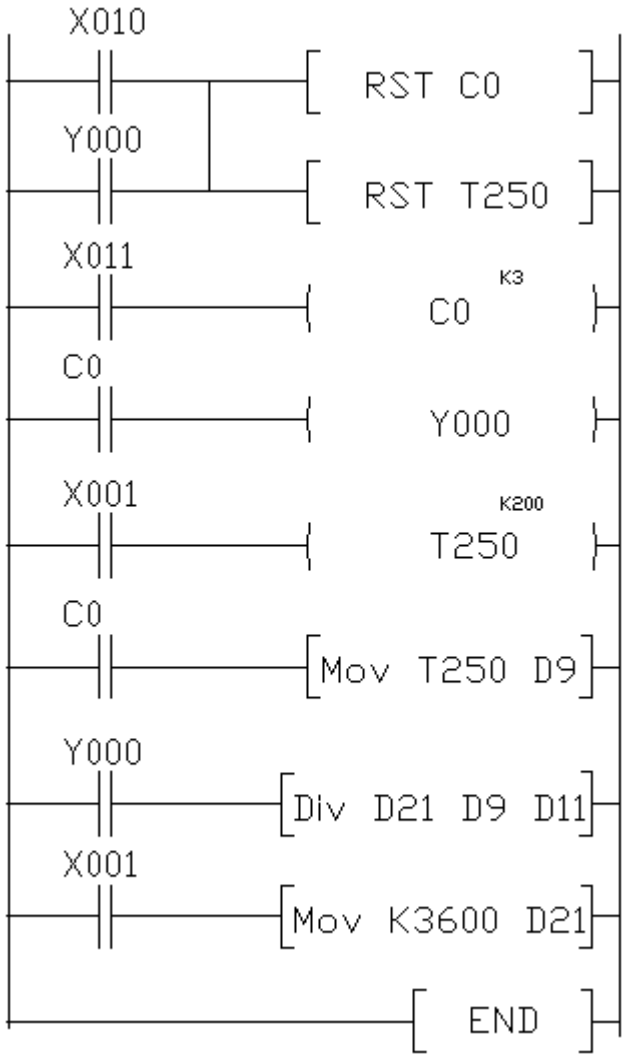

Figura A.34.1 Diagrama escalera para control del RPM

Notas: El sensor funciona con pulsos de 24V, por ello se conecta como la entrada digital X11. El programa necesita hacer reset antes de iniciar el sensado. El reset es X10. El X10 debe presionarse por un momento solamente. Para activar el sensor debe dejarse activa la entrada X1.

Anexo 35: Información técnica del aceite de la caja

Aceite de la Caja Multiplicadora (Mobil Gear)

Volver

Mobilgear® SHC XMP Series

Gear Oil

Product Description

Mobilgear SHC XMP Series supreme performance, fully synthetic industrial gear oils designed to provide optimum equipment protection and oil life even under extreme conditions. Mobil's polyalphaolefin (PAO) technology has been selected for its exceptional oxidation resistance and thermal properties, naturally high viscosity index, excellent low temperature fluidity and absence of undesirable compounds that are often found in mineral oils. The high viscosity index and low traction coefficient of this oil combine to provide a significant reduction in power consumption in many gear drives. Mobilgear SHC XMP Series lubricants contain an advanced and carefully blended proprietary additive system designed to provide excellent protection against conventional wear modes such as scuffing but also provides a high level of resistance against micropitting fatigue. In addition, compared to conventional gear oil chemistries, it offers the potential for improved lubrication of gearbox rolling element bearings. Mobilgear SHC XMP Series products offer outstanding rust and corrosion protection versus conventional gear oils, including seawater and acidic water protection. They show no tendency to plug fine filters even when wet and have excellent compatibility with ferrous and non-ferrous metals even at elevated temperatures.

Mobilgear SHC XMP lubricants are recommended for enclosed industrial gear drives including steel-on-steel spur, helical, and bevel gears. It is especially recommended for applications that may be subject to micropitting: especially heavily loaded gearboxes with surface-hardened tooth metallurgies. It may also be used in gear applications where extreme low and/or high temperatures are encountered and applications where corrosion may be severe.

Because of their unique mix of properties, including resistance to micropitting wear, and their performance in tough applications and wide temperature range, Mobilgear SHC XMP Series products enjoy a growing reputation among customers and OEMs around the world.

Features & Benefits

The Mobil brand lubricants designated as SHC is recognised and appreciated around the world for innovation and outstanding performance. These molecular design PAO synthetic products, pioneered by our research scientists, symbolise the continuing commitment to using advanced technology to provide outstanding products. A key factor in the development of Mobilgear SHC XMP Series was the close contacts between our scientists and application specialists with key OEMs to ensure that our product offerings will provide exceptional performance with the rapidly evolving industrial gear designs and operation.

Our work with equipment builders has helped confirm the results from our own laboratory tests showing the exceptional performance of the Mobilgear SHC XMP Series lubricants. Not least among the benefits shown in work with OEMs is the ability to resist micropitting wear which can occur with some highly loaded, case-hardened gearing applications. This cooperative work also demonstrated the all-round balanced performance benefits for the new Mobilgear SHC XMP technology, including a wide temperature range of application.

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To address the issue of micropitting gear wear, our product formulation scientists designed a proprietary combination of additives which would resist traditional gear wear mechanisms as well as protecting against micropitting. Our formulators chose proprietary PAO synthetic base oils to provide exceptional oil life and deposit control and resistance to thermal/oxidative and chemical degradation, as well as the balance of the performance features. The wax-free nature of the synthetic base oil also provides low temperature fluidity characteristcs unmatched by mineral products and is a key benefit for remote, low ambient, applications. The Mobilgear SHC XMP Series lubricants offer the following benefits:

Features	Advantages and Potential Benefits
Superb protection from micropitting fatigue wear as well as high resistance to traditional scuffing wear	Extended gear and bearing life in enclosed gear drives operating under extreme conditions of load, speed and temperature
	Reduced unexpected downtime and less maintenance – especially critical for difficult to access gearboxes.
Excellent resistance to degradation at high temperatures	Extended oil life and drain intervals reduced oil consumption and manpower costs
Low traction PAO base stocks for improved gear efficiency	Reduced energy consumption and lower operating temperatures
High viscosity index base stocks reduce viscosity change with temperature	Ability to operate at both high and low temperatures: especially critical in remote applications with no oil heating or cooling
Excellent resistance to rust and corrosion and very good demulsibility	Smooth, trouble-free operation at high temperatures or in water-contaminated applications
	Excellent compatibility with soft metals
No filter plugging, even in presence of water	Less filter changes and reduced maintenance costs
Excellent compatibility with common gearbox materials of construction and with mineral-based gear oils	Easy changeover from mineral products

Applications

Application Considerations: While the Mobilgear SHC XMP Series are compatible with mineral oil based products, admixture may detract from their performance. Consequently it is recommended that before changing a system to one of the Mobilgear SHC XMP Series, it should be thoroughly cleaned out and flushed to achieve the maximum performance benefits.

Mobilgear SHC XMP Series supreme performance, fully synthetic industrial gear oils designed to provide optimum equipment protection and oil life even under extreme conditions. They are especially formulated to resist micropitting of modern, case hardened gearing and can operate in both high and low temperature environments. Typical applications include:

- Wind turbines, especially highly loaded and shock loaded units, remotely located units and extreme temperature environments
- Plastic extruder gearboxes
- Modern, highly loaded gearboxes used in the paper, steel, oil, textile, lumber and cement industries where gear protection and optimum oil life are required.

Specifications & Approvals

Mobilgear SHC XMP meets or exceeds the following industry specifications	150	220	320	460	680
Meets AGMA 9005-D94 –S (at appropriate viscosity grade)	X	X	X	X	X
Meets DIN 51517 Part 3 (CLP)	X	X	X	X	X
Meets ISO 12925-1 Type CKD	X	X	X	X	X

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Mobilgear SHC XMP Series has the following builder approvals	150	220	320	460	680
HANSEN	X	X	X	X	X
DAVID BROWN	X	X	X	X	X
FLENDER	X	X	X	X	-
JAHNEL-KESTERMANN	X	X	X	X	X

Typical Properties

Mobilgear SHC XMP Series	150	220	320	460	680
ISO Viscosity Grade	150	220	320	460	680
Viscosity, ASTM D 445					
cSt @ 40º C	150	220	335	460	680
cSt @ 100º C	20.7	27.8	38.3	48.7	65.3
Viscosity Index, ASTM D 2270	161	163	164	166	168
Pour Point, ºC, ASTM D 97	-48	-45	-38	-36	-30
Flash Point, ºC, ASTM D 92	240	244	242	232	238
Specific Gravity @15.6º C kg/l, ASTM D 4052	0.855	0.859	0.860	0.863	0.866
FZG Micropitting, FVA Proc No. 54,					
Fail Stage	-	10	10	10	10
GFT-Class	-	High	High	High	High
FZG Scuffing, DIN 51534 (mod) A/16.6/90, Fail Stage	13+	14+	14+	14+	14+
4-Ball Wear test, ASTM D 4172, mm (Mod 1,800 RPM, 20kg, 54º C, 60 Minutes)	0.25	0.25	0.25	0.25	0.25
Rust protection, ASTM D665, Sea Water	Pass	Pass	Pass	Pass	Pass
Water Seperability, ASTM D 1401, Time to 40/37/3 at 82º C, minutes	10	10	10	10	10
Foaming Characteristics, ASTM D 892, Seq. II, Tendency/Stability, ml/ml	0/0	0/0	0/0	0/0	0/0

Health & Safety

Based on available information, this product is not expected to produce adverse effects on health when used for the intended application and the recommendations provided in the Material Safety Data Sheet (MSDS) are followed. MSDS's are available upon request through your sales contract office, or via the Internet. This product should not be used for purposes other than its intended use. If disposing of used product, take care to protect the environment.

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Anexo 36: Diagrama de instalación del sensor de nivel buscado

La imagen puede apreciarse mejor en su archivo digital

Diagrama propuesto de colocación del Sensor de Nivel

Tecnología de Sensor propuesto

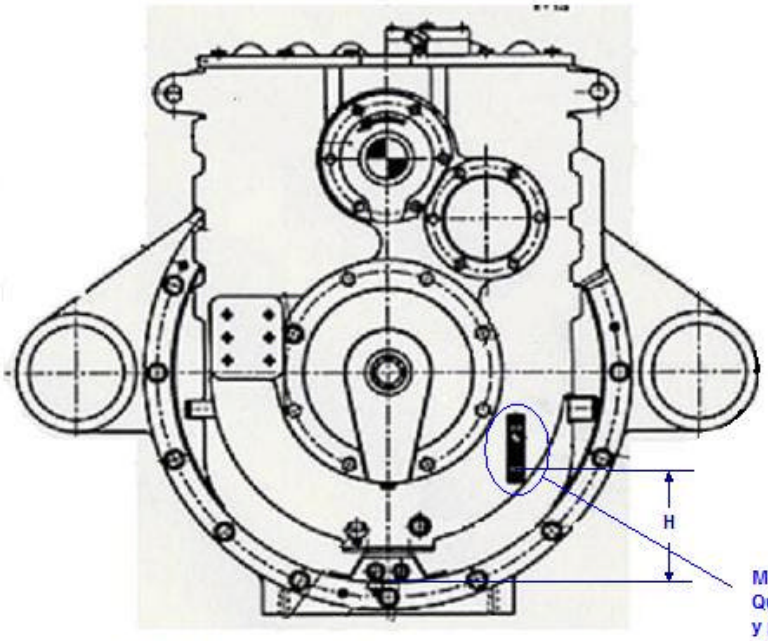
Volver

Diagrama de la Caja Reductora

AEROENERGIA S.A.

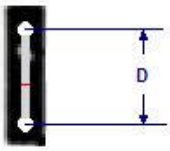
Carlos Vargas
E-mail: carlos_vargas_gonzalez@hotmail.com
Teléfono: 833-3297

Vista Trasera de la Caja



Mirilla puesta de fábrica. Queremos quitar la mirilla y poner un sensor de nivel entre los dos tomas existentes

Detalle aproximado de la mirilla



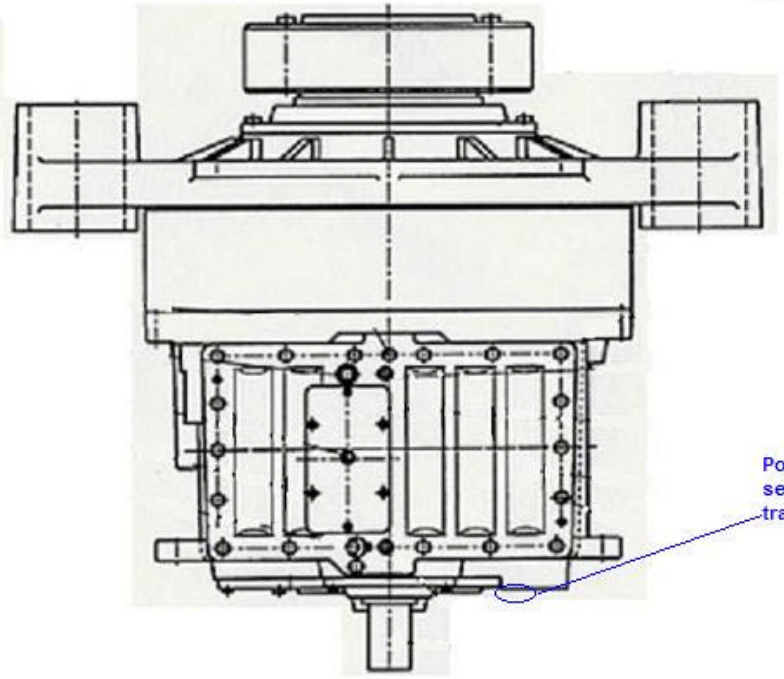
Medidas aproximadas

H: Distancia desde el fondo del cárter al toma inferior de la mirilla

D: Distancia de centro a centro entre los tomas de la mirilla

D = 128 mm
H = 182 mm

Vista Superior de la Caja



Posición aproximada del sensor en la parte trasera de la caja

Nota: La mirilla está fijada a la Caja por medio de tornillos M10, con 17mm de cabeza.

Anexo 37: Información sobre el sensor de flujo Hydac

Catálogo del sensor de flujo Hydac

Volver

Flow Rate Sensors

HYDAC Flow Rate Sensors are designed especially for use in hydraulic systems. Operation is based on turbine principle. Available with aluminium or stainless steel housing featuring thread connections for pressure and temperature sensors.

Products

EVS 3100
- material of housing: Aluminium (for mineral oil)
- range of viscosity 1...100 cSt (calibrated at 30 cSt)
- output signals 4...20 mA
- measuring ranges 1.2...20 l/min, 6...60 l/min, 15...300 l/min, 40...600 l/min. Further ranges on request

EVS 3110
- material of housing: Stainless steel (for water based fluids)
- range of viscosity 1...100 cSt (kalibriert bei 5 cSt)
- output signals 4...20 mA
- measuring ranges 1.2...20 l/min, 6...60 l/min, 15...300 l/min, 40...600 l/min. Further ranges on request

Tomado de http://212.88.134.40/index_start.php

Anexo 38: Información Técnica y enlaces a catálogos y documentos electrónicos

Tabla A.38.1. Enlaces a documentos electrónicos

Catálogos e información digital	
Líneas de transmisión y postes: Cálculos de diseño	PDF: linea2
Aspas LM: Información general.	PDF: General+info
Aspas LM: protección contra descargas	PDF: Lightning+Prot
Aspas LM: Manual de Instalación y Mantenimiento	JPEG: Carpeta
Aspas LM: Información de LM	PDF: Información LM
Contactores ABB: EH, EK	PDF: EH700_Manual
Arrancador EH 700: Esquema físico	PDF: EH700S9
Contactores ABB: Guía de Inspección y Mantenimiento	PDF:EH_700_Service_Manual
Contactores ABB: Datos de Placa	EXCEL: Placa de contactor

Generador: Datos de Placa	JPEG: generador_plate
Comunicación: Diagrama de fibra óptica	PDF: fiber_optic_park PDF: fiber_optic_park_PC
Torres Meteorológicas: Controlador WP1000	PDF: IC1000_Weather_St
Breaker ABB: Catálogo técnico	PDF: Isomax_es
Breaker ABB: Catálogo técnico, protección para motores.	PDF: MotorProtection_en
Breaker ABB: Información general	PDF: PromoIsomax_ES
Relé SEG Main Decoupling Relay: Catálogo	PDF: SEG_MRN3
Panel de Control: Thyristor	PDF: Thyristor
Mita Teknik A/S: Presentation general	PDF: Wind_GB
WP3000: Información general	PDF: WP3000_controller
Fibra Optica: Tarjeta WP 3045 de interfase de fibra óptica	PDF: WP3045_1_Board

RS-232: Tarjeta WP 3046 interfase de RS-232	PDF: WP3046_Board
Panel: Display WP3059	PDF: WP3059_Display
Transformadores de medición de voltaje WP3090: Información General	PDF: WP3090
Módulo de conexión WP4060: Información general	PDF: WP4060_Connection
Norma 60034-1: Máquinas eléctricas rotativas. Parte 1	PDF: iec60034-1{ed10.2}b
Norma 60034-1: Máquinas eléctricas rotativas. Enmienda 1. Parte 1	PDF: iec60034-1-amd1{ed10.0}b
Norma 60034-1: Máquinas eléctricas rotativas. Enmienda 2. Parte 1	PDF: iec60034-1-amd2{ed10.0}b
Norma 60034-1: Máquinas eléctricas rotativas. Parte 2	PDF: iec60034-2{ed3.0}b.img
Norma 60034-1: Máquinas eléctricas rotativas. Correcciones a la Parte 3	PDF: iec60034-3-cor1{ed4.0}b

Norma 60034-1: Máquinas eléctricas rotativas. Parte 14. Vibraciones mecánicas	PDF: iec60034-14{ed2.0}b
Norma 60034-1: Máquinas eléctricas rotativas. Carga y elevación de la temperatura	PDF: iec61986{ed1.0}b
Generador: Mobil Temp SHC 100	HTML: Mobiltemp SHC 100
Generador: Conceptos teóricos para turbinas eólicas y su electrónica de potencia	PDF: ris-r-1205
Sensor: RPM: Carta técnica	PDF: sensor_rpm
Análisis de Vibraciones: Programa de SKF para Condition Monitoring en turbinas eólicas	PDF: SKF_DATA
Motores de Guiñada: información técnica y de diseño. Parte 1	PDF: 300_1
Parte 2	PDF: 300_2
Parte 3	PDF: 300_3
Parte 4	PDF: 300_4

Parte 5	PDF: 300_5
Parte 6	PDF: 300_6
Parte 7	PDF: 300_7
Motores de Guiñada: Aplicaciones eólicas	PDF: 700_eolico_uk
Motores de Guiñada: Información técnica	PDF: bn_1 PDF: bn_2
Motores de Guiñada: Manual de Instalación, operación y servicio	PDF: man300ind
Motores de Guiñada: Información técnica	PDF: mancafsbn1 PDF: mancafsbn2
Estación Hidráulica: Sensor de presión Danfoss	PDF: 03M33
Estación Hidráulica: Catálogo de AVN	PDF: Profilemagazine
Estación Hidráulica: Acumulador AVN	PDF: Acumulador
Estación Hidráulica: Bomba	PDF: Bomba
Estación Hidráulica: Tipos de Bomba	PDF: Tipos de Bomba

Estación Hidráulica: Slip Ring	PDF: slip_ring
Turbina M1500: Manual en español	JPEG: Carpeta
WP3000: Alarmas, notas y programación	Word: Carpeta
Turbina NM750: Datos Técnicos	PDF: DATOS_TECNICOS_750_44
WP3000: Alarmas	PDF: r_statuskoderoversigt_5_2_gb PDF: r_statuskoderudvidet_5_3_gb
Sensores: Veletas	PDF: OD04_1 PDF: OD05_1H
Sensores: PT100	PDF: PT100_100.60
Sensores: Anemómetro: Datos	PDF: PV01_2
Sensor de torsión de cables: Datos	PDF: SIEK-UV1
Motor del ventilador: Instalación, alineación	PDF: AEG_Motors_spanish
Motor del ventilador: Catálogo de motores	PDF: MOTORES_AEG
Comunicación: Convertidor de RS-232 a fibra óptica	PDF: Standard_LS16

Comunicación: Programa WPMS: Información	PDF: wpms
Comunicación: Programa WPMS: Web Browser	PDF: WPMS_WEB
Turbina NM750: Especificaciones Técnicas	PDF: NM750_44_GB
Transmisión: Recloser	PDF: 28030
Transmisión: Recloser: Procesador	PDF: recloser
Subestación: Cargador de baterías	PDF: cargador_baterias
Subestación: interruptores	PDF: sk1021dgb
Transformadores: Información	PDF: GET-6859B
Freno de disco: Ejemplo con información	PDF: 035_nce_shd5
Caja Multiplicadora: Bomba Hydac	PDF: BombaHydace5702
Subestación: Cargador SAFT	PDF: cargador_saft
Acoples: Centa link	PDF: centa PDF: Centalink

Turbina NM750: Certificado Danés	PDF: CertificadoDanesTurbina
Turbina NM750: Datos Técnicos	PDF: datos_tech_750
Control: Esquema eléctrico de la turbina	PDF: ESQUEMA_ELECTRICO
Grasa general: Mobilith	PDF: glxxengrsmomobilithshcseries
Grasa generador: Mobiltemp	PDF: glxxengrsmomobiltempshcseries
Aceite Caja Multiplicadora	PDF: glxxenindmomobilgearshcxmpseries
Generador: Bomba: Catálogo	PDF: Grundfosliterature-1865BombaAgua
Generador: Bomba: Manual de instalación y operación	PDF: InstallationandOperationGrundfos
Subestación: Multilin: Información Software	PDF: Multilin239-d9_6
Caja Multiplicadora: Presentación de las mejoras en la Caja	Power Point: presentation_master_UK_180200
Freno de disco: Sistema de Softbrake: Información	PDF: softbrake

Caja Multiplicadora: Esquema	JPEG: flender
Caja Multiplicadora: Información de Analisis de Vibracion, Flender	PDF: condition_monitoring_of
Caja Multiplicadora: Datos de Vibración, Flender	PDF: GEARFREQUENCYC4300
Reportes de Service B	Excel: Turbina 1 (aeroenergia #1) Excel: Turbina 3 (aeroenergia #3)

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DATOS GENERALES PARA EL DISEÑO

Tipo de conductor : ACSR

Calibre	: 336.4 kCM
Cableado	: 26/2
Peso	: 0.687 kg/m
Diámetro	: 18.31 mm
Tensión de ruptura	: 6375 kg
Módulo Elasticidad	: 8000 kg/mm^2
Coef. Dilatac. Ter.	: 18.9x10^6 /ªC
Nombre	: Linnet

Hilo de Guarda : ACSR

Calibre	: 4/0
Cableado	: 6/1
Peso	: 0.433 kg/m
Nombre	: Penguin

Temperatura ambiente : 35 ºC

Temperatura máxima : 55 ºC

Estructuras : Postes de Madera

Tipo de poste	: Southern Yellow Pine
Clase del poste	: H2
Peso	: 2246 kg (4941 lb)
Fiber Stress	: 5.63 kg/mm^2 (8000 p.s.i.)
Carga de ruptura	: 2910kg (6400 lb)
Circunf. inferior	: 1.37 m (54 pulg, a 6 pies de la base)
Circunf. superior	: 0.79 m (31 pulg)
Tapper	: 20.83 mm/m (0.25 pulg/pie)
Fabricación	: ANSI 05.1

Aisladores de suspensión : Rígidos

Máxima carga cantiliver	: 1090 kg
Condic. normal operación	: 435 kg (40%)

Aisladores para ángulos y remates : ANSI C52-5 Tipo J

Altura	: 125 mm (5.75 pulg)
Diámetro	: 254 mm (10 pulg)
Peso	: 5.4 kg (12 lb)

Velocidad máx. Viento : 120 k/h

Factor de seguridad : 4 (Cuatro), Grado B del NESC

Ancho de la servidumbre : 10 m.

CRITERIOS BASICOS DE DISEÑO

La tensión de diseño del conductor es del 19% de la tensión de ruptura. Esta tensión es de 1210 kg.
La tensión de diseño del hilo guarda es del 25% de la tensión de ruptura. Esta tensión es de 950 kg.
Las condiciones inciales y finales de ambos conductores no deben sobrepasar el 30% de la tensión de ruptura (máximo), ni un 15% de esa tensión, como condición mínima.
Debido a que tanto los conductores como el hilo guarda son del tipo ACSR, se diseña para que la fecha máxima del hilo guarda sea tan solo el 80% de la fecha del conductor.
La distancia de claros mínimos debe ser de 7 metros.

CÁLCULO DEL VANO MAXIMO PERMITIDO (MAS, Maximum Allowable Span)

Para realizar el cálculo de los "vanos máximos permitidos" (MAS) se utilizaron los datos de diseño del punto 1 de esta memoria.
Se analizaron dos casos:

a) con una velocidad de viento de 160 km/h con un factor de seguridad de 1.

b) con velocidad de viento de 120 km/h pero con un factor de seguridad de 4.

Se utilizó una hoja electrónica diseñada para tales fines y que se muestra en el anexo 1.

De esta tabla se concluye, que para postes sin anclas el MAS es de 290 m. (caso a) y 275 m. (caso b). Por lo tanto se escoje el vano de 275 m como máximo.

LOCALIZACION DE SITIOS DE POSTE

La localización de los sitios de poste se realizó teniendo en cuenta el valor CVAL, dado por el programa de diseño, este valor se obtuvo para la condición de 55° C, sin viento y con tensiones finales (10 años creep).

La localización, de acuerdo a los planos de planta y perfil es como se muestra en la siguiente tabla, además se muestran los valores de las longitudes de los tramos de peso y viento (esto fue calculado para una tensión de diseño del 19 % de la tensión de ruptura del conductor):

Número Estructura	Angulo (°)	Estacionamiento (km)	Elevación (m.s.n.m)	Tramo de viento (m)	Tramo de peso (m)
1PR-10	0	0.000	682.0	91.7	433.5
2PS-10	0	0.180	647.0	205.1	79.1
3PA-10	8	0.405	619.4	199.25	225.5
4PA-10	21	0.575	596.0	114.25	328.9
5PA-10	12	0.630	581.7	176.8	-110.9
6PA-10	23	0.925	553.4	309.5	375.8
7PA-10	8	1.244	510.8	309.2	-51.9
8PA-10	2	1.539	531.9	202.6	286.6
9PA-10	5	1.648	534.5	120.9	355.8
10PS-10	0	1.780	520.0	171.6	69.9
11PA-10	7	1.990	509.1	185.9	314.3
12PA-10	8	2.150	489.1	121.8	203.5
13PA-10	15	2.231	475.2	181.3	-75.5
14PA-10	40	2.511	468.1	263.0	116.4
15PA-10	25	2.756	482.3	171.8	280.9
16PA-10	28	2.854	481.9	49.0	41.8

Se pueden separar las estructuras en cuatro tipos diferentes:

- Postes de suspensión, 2 en total (postes números 2 y 10)

- Postes con ángulos inferiores a 15°, 6 en total (postes números 3, 5, 7, 9, 11 y 12)

- Postes con ángulos superiores a 15° e inferiores a 30°, 6 en total (postes números 4, 5, 6, 13, 15 y 16)

- Postes de remate sea final o intermedio (postes números 1, 14 y XX)

Para cada uno de estos tipos de postes es necesario definir el tipo de vientos y anclas que tendrán

Se hizo una comprobación para los ángulos inferiores a los 15°, de forma tal que se conociera si era posible utilizar cadenas de suspensión o por el contrario aisladores rígidos. Para realizar esto se debe tomar encuenta: el peso de la cadena de aisladores, los tramos de peso y viento que afectan a cada uno de los casos.
Mediante este procedimiento se comprobó que las mencionadas estructuras deben tener aisladores rígidos.

VIENTOS Y ANCLAJES

Para realizar el cálculo de cables de los vientos se diseñaron hojas electrónicas que permiten, teniendo las tensiones para condiciones iniciales y finales, así como los vanos que afectan a los postes, deducir el calibre de los cables que se utilizarán
Los cálculos se realizaron para las presiones de viento generadas por vientos de 120 km/h y 160 km/h, el primero con un factor de seguridad de 4 y el segundo con factor de 1.
Estas hojas se realizaron para los postes de remate y ángulo.
De los cálculos realizados se deduce que el calibre de los cables para anclas es de 11.1 mm (7/16 de pulgada)
Aunque existen algunas anclas que podrían ser de un calibre inferior (9,5 mm, 3/8") es preferible "normalizar" el calibre hacia el cable superior.

Los anclajes que se utilizarán es del tipo "Cross Plate". este tipo de ancla tiene la ventaja de que no es necesaria una máquina para su instalación, además permite una capacidad de 30000 pulg-libra en suelos de clase 5

ATERRIZAMIENTOS

Se considera que para realizar los aterrizamientos de todos y cada uno de los postes, y para lograr al menos 10 ohmios de resistencia de puesta a tierra, las estructuras debe tener al menos dos varillas de puesta a tierra con una longitud de 3 m. y un diámetro de 16 mm.
Los detalles de estos aterrizamientos se muestran en la figura 4-5 para todos los casos.

Para el aterrizamiento de todas las estructuras se utilizan un cable de cobre sólido # 2, que sobresale 45 centímetros de la parte superior del poste, además el mismo cable se utiliza como bajante a través de todo el poste. En la parte inferior del poste se debe terminar el cable en forma de espiral. Los detalles se muestran en la figura Nº 8

CALCULO DE MATERIALES

Para realizar el cálculo de materiales también se diseñaron hojas electrónicas de forma que se pudieran calcular el total de materiales requeridos en forma sencilla.
Los materiales se calculan para los cuatro tipos de estructuras que tiene la línea de transmisión, es decir, remate, ángulo pequeño (menos de 15°), ángulos medianos (entre 15 y 30°) y para las dos estructuras de suspensión.
Al final de esta memoria se muestra la cantidad total de materiales que se deben adquirir.
Se recomienda una compra adicional de 15% o 10% en todos los items.

CONSTRUCCION DE LA LINEA

La norma a seguir para la construcción de la línea es el estándar T-805 A de la REA (Rural Electrification Administration) boletín 50-2

Para construir la línea se muestran las figuras Nº 4, 5, 6 y 7:

1. Para estructuras con ángulos entre 15º y 30º la figura principal es la Nº 4, los detalles se muestran en las figuras 4-1 hasta 4-6.

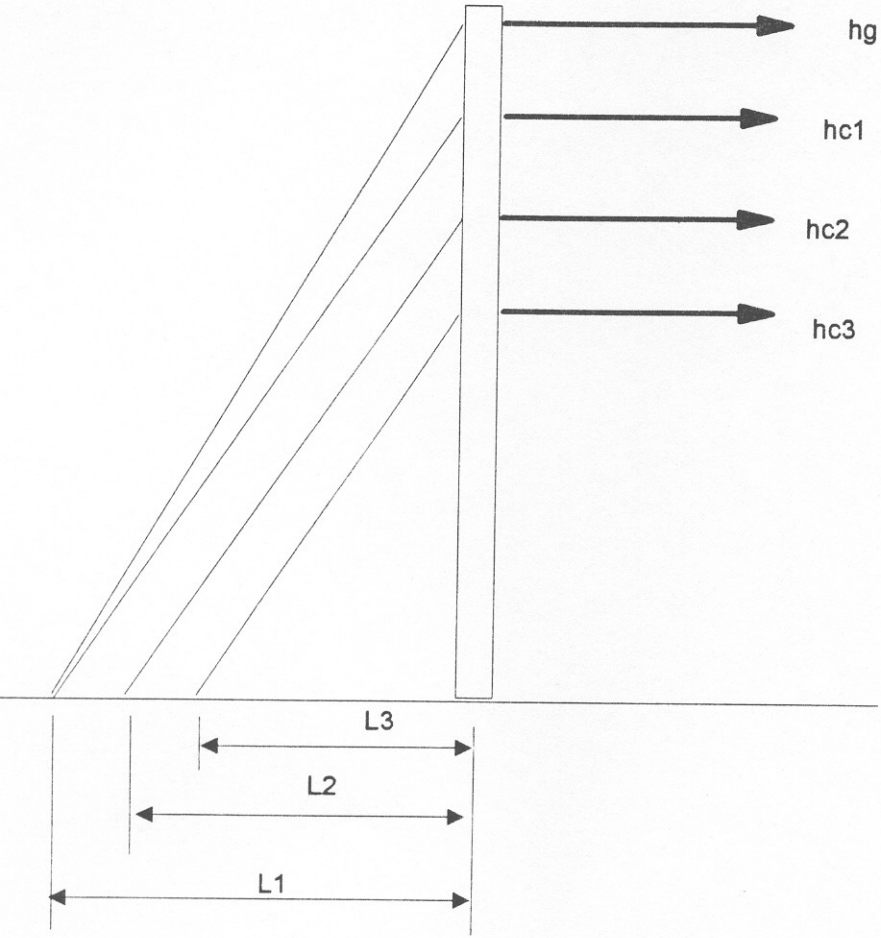
2. Para estructuras con ángulos entre 2º y 12º la figura principal es la Nº 5, los detalles se muestran en las figuras 5-1, 5-2 y 5-3, aquí se repiten algunos detalles comunes a las estructuras anteriores: figuras 4-3, 4-4 y 4-5.

3. Para estructuras de suspensión (tangenciales) se debe utilizar la figura Nº 6. Se muestran detalles en la figura 6-2.

4. Para estructuras de remate final o intermedio la figura correspondiente es la Nº 7. Los detalles se muestran en las figuras Nº 7-1 y Nº 7-2. Al igual que en casos anteriores se requieren otros ensambles para las anclas vientos y aterrizamiento: figuras Nº 4-3, Nº 4-4 y Nº 4-5.

Figura Nº 2

Localización de anclas, Postes de Remate



L3 = 35 pies (10.6 m)
L2 = 40.4 pies (12.2 m)
L1 = 45.3 pies (13,7 m)

CALCULO DE TENSIONES SOPORTADAS POR EL ANCLA hc1

Condición \ Vanos	Tensiones (kg, calculadas con programa) 50	225	375	375	430
Inicial 35°C, 120km/h	1542	1919	2055	2055	2166
Inicial 35°C, sin viento	1211	1209	1207	1207	1205
Final 35°C, 120 km/h	1335	1818	1983	1983	2115
Final 55°C, sin viento	690	932	1010	1010	1060
Angulo de la línea	30	15	25	40	0

OCF Anclas Grado B =	1,5
OCF Carga de viento =	2,67

Circunf@2.95	27,7
Circunf@8.40	29,1

Cálculo para PV = 14.4

Fc =	1051,4	1308,4	1401,1	1401,1	1476,8
Fw =	327,7	1644,9	2572,3	2174,2	2440,8
Fp =	283,85	283,85	283,85	283,85	283,85
Fa =	544,23	341,56	606,52	958,43	0,00
R =	2207,2	3578,7	4863,8	4817,6	4201,5

Cálculo para PV = 25.6

Fc =	1051,4	1308,4	1401,1	1401,1	1476,8
Fw =	582,6	2924,2	4572,9	3865,2	4339,3
Fp =	504,62	504,62	504,62	504,62	504,62
Fa =	544,23	341,56	606,52	958,43	0,00
R =	2682,8	5078,8	7085,2	6729,4	6320,7

Cargas máximas

	PV = 14.4	PV = 25.6
R =	4863	7085
DGL =	6878,4	10021,2
GSL =	7642,6	11134,7

Cable para el ancla hc3:

- **Acero 7/16"**
- **7 hilos HS**
- **Diámetro: 0.436"**
- **Peso: 0.399 lb/pie**
- **UTS :18 000 lbs**

Anchoring:

- **1 Cross Plate**

CALCULO DE TENSIONES SOPORTADAS POR EL ANCLA hc2

Tensiones (kg, calculadas con programa)

Condición \ Vanos	50	225	375	375	430
Inicial 35°C, 120km/h	1542	1919	2055	2055	2166
Inicial 35°C, sin viento	1211	1209	1207	1207	1205
Final 35°C, 120 km/h	1335	1818	1983	1983	2115
Final 55°C, sin viento	690	932	1010	1010	1060
Angulo de la línea	30	15	25	40	0

OCF Anclas Grado B =	1,5
OCF Carga de viento =	2,67

Circunf.@8.4	29,1
Circunf@13.3	30,3

Cálculo para PV = 14.4

Fc =	1051,4	1308,4	1401,1	1401,1	1476,8
Fw =	327,7	1644,9	2572,3	2174,2	2440,8
Fp =	296,84	296,84	296,84	296,84	296,84
Fa =	544,23	341,56	606,52	958,43	0,00
R =	2220,2	3591,7	4876,8	4830,6	4214,5

Cálculo para PV = 25.6

Fc =	1051,4	1308,4	1401,1	1401,1	1476,8
Fw =	582,6	2924,2	4572,9	3865,2	4339,3
Fp =	527,72	296,84	296,84	296,84	296,84
Fa =	544,23	341,56	606,52	958,43	0,00
R =	2705,9	4871,1	6877,4	6521,6	6112,9

Cargas máximas

	PV = 14.4	PV = 25.6
R =	4876	6877
DGL =	6896,7	9727,0
GSL =	7663,1	10807,8

Cable para el ancla hc2:

- **Acero 7/16"**
- **7 hilos HS**
- **Diámetro: 0.436"**
- **Peso: 0.399 lb/pie**
- **UTS :18 000 lbs**

Anchoring:

- **1 Cross Plate**

CALCULO DE TENSIONES SOPORTADAS POR EL ANCLA hc3

	Tensiones (kg, calculadas con programa)				
Condición \ Vanos	50	225	375	375	430
Inicial 35ºC, 120km/h	1542	1919	2055	2055	2166
Inicial 35ºC, sin viento	1211	1209	1207	1207	1205
Final 35ºC, 120 km/h	1335	1818	1983	1983	2115
Final 55ºC, sin viento	690	932	1010	1010	1060
Angulo de la línea	30	15	25	40	0

OCF Anclas Grado B =	1,5
OCF Carga de viento =	2,67

Circunf@13.3	30,3
Circunf@20.7	32,2

Cálculo para PV = 14.4

Fc =	1051,4	1308,4	1401,1	1401,1	1476,8
Fw =	327,7	1644,9	2572,3	2174,2	2440,8
Fp =	312,33	312,33	312,33	312,33	312,33
Fa =	544,23	341,56	606,52	958,43	0,00
R =	2235,6	3607,2	4892,3	4846,1	4230,0

Cálculo para PV = 25.6

Fc =	1051,4	1308,4	1401,1	1401,1	1476,8
Fw =	582,6	2924,2	4572,9	3865,2	4339,3
Fp =	555,26	555,26	555,26	555,26	555,26
Fa =	544,23	341,56	606,52	958,43	0,00
R =	2733,5	5129,5	7135,8	6780,0	6371,4

Cargas máximas

	PV = 14.4	PV = 25.6
R =	4892	6780
DGL =	6919,4	9589,8
GSL =	7688,2	10655,4

Cable para el ancla hc1:

- **Acero 3/8"**
- **7 hilos HS**
- **Diámetro: 0.360"**
- **Peso: 0.273 lb/pie**
- **UTS :10 800 lbs**

Anchoring:

- **1 Cross Plate**

LM is an international company with modern production facilities on the most important markets for wind energy.

The world's leading supplier of wind turbine rotor blades

LM Glasfiber A/S is the world's leading supplier of rotor blades for wind turbines. We offer a wide range of products that includes blades for all sizes of wind turbines from 250 kW to the biggest MW turbines, as well as the development of rotor blades for individual customers.

Today more than 40,000 LM rotor blades are in operation all over the world. This means that LM has accumulated the industry's most extensive knowledge bank on the production and operation of rotor blades. This knowledge, combined with decades of technological experience, is the foundation of our targeted research and development which is designed to optimise the energy production of rotor blades and ensure our customers reliability and optimum operation.

LM is always close to its customers with production and sales companies in Denmark, Germany, the Netherlands, Spain, the USA, India and China. This provides the basis for a project-oriented partnership in which, together with customers, we create the best possible solutions.

Some of the key words in connection with future utilisation of wind power are offshore wind farms and increasingly large wind turbines. LM has already gained valuable experience in these areas – so LM today is in full swing in designing wings for the wind turbines of the future.

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LM Glasfiber A/S

The world's leading supplier of wind turbine rotor blades

A core competence of unique experience

LM Glasfiber A/S is the world's leading supplier of rotor blades for wind turbines. We have created this position through constantly focusing on quality and customer service and due to intensive, innovative research and product development in collaboration with our customers.

LM rotor blades are characterised by their high quality which is based on the company's extensive knowledge of composite materials and production technologies.

Our core competence is derived from a unique fund of experience in the fields of development, mould building, production and testing wind turbine rotor blades. Our knowledge bank is based on more than 40 years' product development using composite technology and the production of more than 40,000 rotor blades.

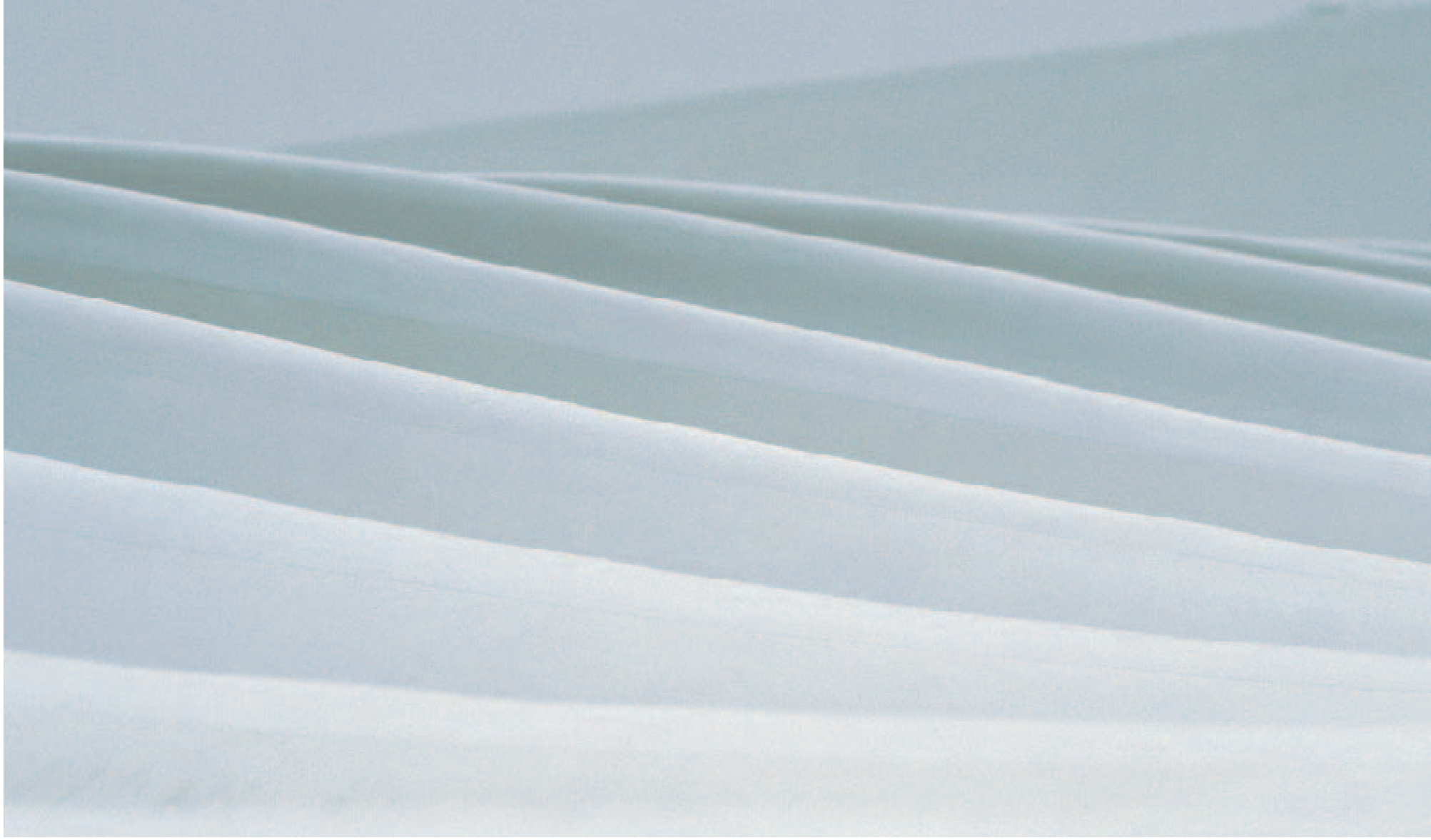
LM Glasfiber was among the pioneers when the development of modern wind turbines began. Today the company employs more than 2,000 people in Denmark, Germany, the Netherlands, Spain, the USA, India and China.

This global production, sales and service organisation ensures rapid, efficient deliveries accompanied by a high level of service, irrespective of where in the world the wind turbines will be erected. This provides our customers with security and quality, and LM Glasfiber with an excellent starting point to maintain its position as the world's leading supplier of rotor blades for wind turbines.

Decades of experience with technology and intensive development have provided LM with the ability necessary to supply rotor blades for wind turbines from 250 kW to the largest MW turbines.

A wide range of products

A rotor blade for all wind turbines



LM's experience and capacity create the background for a comprehensive series production of large rotor blades for MW wind turbines.

LM Glasfiber has a comprehensive range of products comprising more than 30 different types of rotor blades which vary in length from 12 metres to way in excess of three times this length. This makes it possible for us to offer rotor blades for all sizes of wind turbines, from the smaller 250 kW to the biggest, most advanced MW wind turbines for offshore use. Our product range includes blades for pitch, stall and active stall regulation, as well as for wind turbines that run at a constant or variable speed of rotation.

Our various products are suitable for all erection sites – no matter whether these are high or low wind areas. No matter whether erection is carried out under demanding climatic conditions in arctic or tropical surroundings. And LM has also developed rotor blades for offshore wind turbines where the corrosive marine environment and the demand for minimum maintenance weigh heavily in the balance.

We can meet our customers' wishes on the basis of our standard range, where the individual blades can be customised. But we can also supply blades developed especially for the individual customer.

All rotor blades that leave LM's factories are made to customers' specifications irrespective of whether these are blades from our standard range or were specially developed for the individual customers.

Our targeted product development ensures that LM will also be able to supply the rotor blades required by our customers in the future.

The aerodynamic efficiency of rotor blades can be increased with the help of LM Vortex Generators, while the high-strength steel root construction and the lightning protection of the blades offer maximun safety.

LM's rotor blades are recognised for their high quality which is systematically laid down throughout all stages of the process – from development, mould building, production and testing to delivery and service. Quality comes to expression in the long lifetime of the blades, reliable operation and high yields – but also in their simple maintenance requirements.

The lifetime of the rotor blades is founded on a thoroughly considered choice of materials. In addition a high level of safety is achieved thanks to a series of effective features such as LM's familiar, well-tested root construction, tip brake, vibration damping and lightning protection.

The aerodynamic efficiency of the rotor blade can be optimised to suit the individual wind turbine and wind conditions at the site. This is brought about with the help of various LM accessories which include our Vortex Generators that can improve the wind turbine's energy production by up to 4-6 percent.

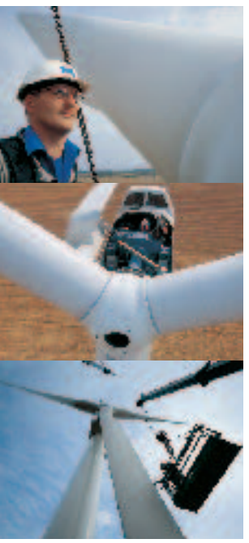
LM rotor blades harmonise with nature. An intensive development programme has reduced blade noise by more than 50 percent and made LM rotor blades some of the most comparatively noiseless blades in the world, while the extremely matt surfaces of the rotor blades minimise reflection. But developments do not stop at this. Our targeted product development is a guarantee that we will also be able to supply the blades that customers want in the future. Irrespective of demands on size and specific features.

Rotor blades are subjected to demanding tests on LM's test-beds with physical loads that correspond to more than 20 years' operation.

More than 40,000 LM rotor blades in operation

Quality ensures security and optimum operation

The LM SafeGuard® service concept provides systematic inspection of LM rotor blades. This prevents damage and increases the lifetime of the blades.



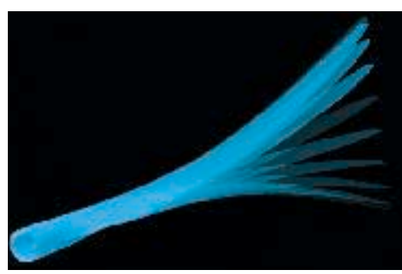
A wind turbine is a major investment. It must function to the optimum – at all times and throughout its lifetime. With more than 20 years' experience of manufacturing rotor blades LM Glasfiber possesses the competence and the capacity to guarantee high quality series production for our customers. Our quality assurance system is certified in compliance with ISO 9001 by Det Norske Veritas, and blades are tested and approved in accordance with the industry's most exacting guidelines in collaboration with Risø National Laboratory, Det Norske Veritas and Germanischer Lloyd.

LM has carried out static and dynamic full-scale tests on a very large number of rotor blades over the past 20 years. This comprehensive programme has led to the acquisition of valuable knowledge which is utilised today in the design and construction of new rotor blades.
This process includes extensive aeroelastic calculations and simulations of the loads rotor blades are exposed to under the most extreme conditions over a lifetime of 20 years. Prototypes are constructed on the basis of these calculations and tested with physical loads that correspond to 20 years' operation. This has allowed us to make ongoing improvements in the materials used, blade construction and production processes, and LM rotor blades are therefore characterised by great strength, excellent fatigue properties and a high level of safety. Facts documented by the experience gained from the more than 40,000 blades in operation.

A good starting point should be maintained. This is why we have developed LM SafeGuard® – a complete service concept designed to ensure the trouble-free operation and maintenance of rotor blades throughout their lifetime. Damage that could lead to expensive repairs and interrupted operation can be avoided with the help of systematic preventive maintenance inspection.

LM SafeGuard® means that the warranty period for rotor blades can be extended from two years up to ten years. This provides wind turbine owners with the maximum reliability for trouble-free operation and financial security.

Comprehensive calculations and simulations of 20 years' operation precede the design and testing of new prototypes.



LM's extensive capacity and competence in research and development are utilised in the design and construction of the new generation of large rotor blades.

Goal-oriented research and development

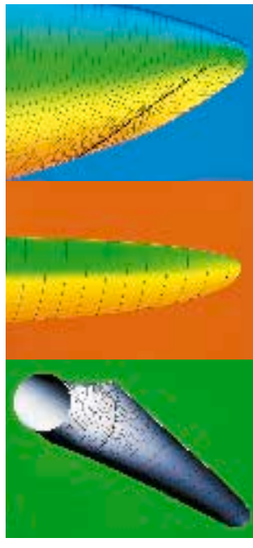
We optimise rotor blade energy production

Rotor blades are a wind turbine's engine. LM Glasfiber therefore constantly focuses on optimising their energy production for the purpose of reducing the price of the electricity produced with the help of wind power as much as possible.

For decades LM has been in the lead when it comes to developing rotor blades. This is due to the fact that we have carried out comprehensive research and development programmes in such areas as aerodynamics, blade construction, materials and production processes.

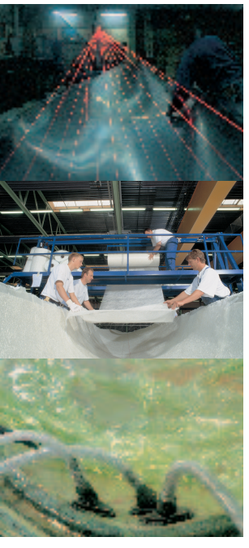
Programmes which range from the development of new profiles, which pave the way for lighter, less expensive blades, to the construction of the huge wind turbine rotor blades of the future for offshore use. In addition to this we make a continuous effort to optimise such areas as blade noise reduction, vibration damping, aerodynamics, de-icing and lightning protection. The results are solutions and technologies that improve the efficiency of the rotor blades and create the foundation for the longest possible lifetime for both wind turbines and blades.

Intensive research and development put LM rotor blades in the lead in such areas as aerodynamics and design.



Advanced development facilities are combined with precision craftsmanship in the design and construction of blade moulds and production tools.

The quality of LM rotor blades is laid down through all phases of the process, from design and construction to mould building and series production.



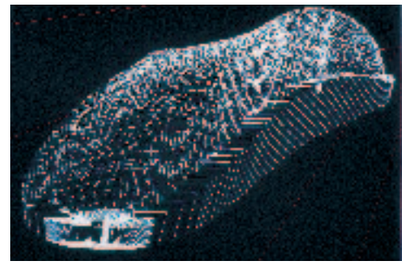
Intensive material and process development is carried out at LM's R&D laboratory in close collaboration with suppliers and institutes of technology. The knowledge derived from these efforts will help to extend the limits of what is possible in modern rotor blade construction in the future. As a result of this LM now exclusively develops rotor blades for series production using vacuum infusion technology. This provides better, more uniform product quality and greatly improves the working environment.

LM's research and development is based on advanced analysis and design tools. Some of these tools now constitute a valuable bridge between blade construction, mould building and blade testing. This offers our customers the advantage of shorter development times, high precision and reliability.

A targeted development effort has increased the efficiency of wind turbines year after year. This development will continue with the ongoing optimisation of rotor blades, wind turbine controls, gears and generators – individually in a necessary interaction. This is the reason why we carry out our development programmes on an international basis in close collaboration with our customers and a series of institutes of technology, universities and knowledge centres.

This is the only way we can continue to make wind power an increasingly competitive source of energy – for the benefit of our customers and the environment.

Advanced analysis and calculation tools used in design and construction ensure our customers rapid, effective development of new rotor blades.



LM has accumulated a unique fund of knowledge and experience based on a total production of more than 40,000 rotor blades.

The industry's most comprehensive knowledge bank

Building the future on decades of experience

Experience is a necessary foundation for the ability to develop and manufacture quality products. The production of more than 40,000 rotor blades has provided LM Glasfiber with a unique fund of knowledge and experience in connection with all aspects of rotor blade construction. Everything from design, choice of materials, mould building, the pro-duction of prototypes and testing, to series production, shipping, handling in connection with rotor blade installation, and service.
A corresponding knowledge bank has been built up around the performance of rotor blades. LM blades are in trouble-free operation in most parts of the world in highly varying climates, which range from arctic to tropical wind and weather conditions.

LM began working with fibre glass as early as 1953 utilising the material's many properties and areas of use. This meant that LM had accumulated a considerable amount of knowledge on fibre glass when, as one of the pioneers, the company started manufacturing rotor blades for wind turbines at the end of the 1970s.

Product and process development have been in focus at LM Glasfiber ever since. The consequence of this is that the company today possesses a detailed knowledge and great experience of production technology in connection with composite materials and their use.

Knowledge and experience that point directly to the future.

The finish and uniformly high quality of LM rotor blades are founded on decades of targeted research into composite materials and their many uses.

Wind turbine projects are becoming increasingly extensive heightening the demands on business partners.

A project-oriented partnership

Creating the best solution – together

LM Glasfiber not only manufactures rotor blades. We develop and manufacture a fifth part of a wind turbine in a close partnership with our customers. A project-oriented collaboration whose goal is to produce the best solution.

By working together with LM, customers gain access to the industry's most extensive knowledge bank in connection with rotor blade technology. This makes us an attractive business partner and adviser capable of participating actively at all stages of the process from the initial preparation of technical specifications to the securing of type approval and erecting the wind turbine.

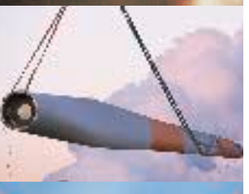
The significance of having the right business partners is growing in step with the increasing size and complexity of wind turbine projects. This heightens the demands on business and development partners.

LM is a well-consolidated company with a comprehensive development and production capacity. Our own mould building facilities and test-beds mean that our customers can reap the benefits of more rapid rotor blade construction and the flexible adaptation of our production capacity.

LM's comprehensive competence and capacity in the fields of research and production ensure our customers an efficient development process and reliable deliveries.

LM has the ability to carry the weight of development projects originating in customers' requirements for increasingly large rotor blades.

Our experience ensures efficient management and drive in wind turbine projects and we can play an active role at all stages - from concept development to the erection of wind turbines.



Our goal-oriented, long-term investment strategy ensures that our company will remain at the forefront of developments in the future. We are therefore capable of performing the comprehensive development projects that arise from the need for increasingly large rotor blades for megawatt wind turbines and offshore wind farms.

Many years' participation in development projects have given us the necessary experience to ensure effective project management and drive. Our customers can therefore rely on us to carry out even the most extensive, complex projects within the agreed time.

LM manufactures customer specific blades as well as customer modified standard blades. Our close collaboration with customers is therefore both important and relevant – because wind turbine design and rotor blade design are closely connected.

Irrespective of the nature of the project a solution is arrived at through a close, constructive collaboration between the customer and LM. This ensures high quality and subsequent satisfaction – also for the wind turbine owner, who must benefit from his investment for more than 20 years.

Our international organisation provides our customers with advantages regarding economy and logistics, in addition to professional service, no matter where in the world the rotor blades are supplied.

Global production and service

LM is always close to its customers

LM Glasfiber is an international company with production facilities located at the most important markets for wind power. This provides our customers with a financial advantage as well as reliable deliveries and service.

Being close to the market means that we can act effectively and flexibly.
In many cases we can utilise the group's international capacity to manufacture rotor blades in those places they are in demand. This ensures optimum logistics for our customers and reduces the cost of transport.

In addition LM's international organisation makes it possible for us to offer professional, global service. Irrespective of where in the world the rotor blades are to be delivered, or the wind turbines erected.

LM's position on the world market was established in the 1980s. Since then we have acquired market shares all over the world and today LM's rotor blades are turning on all continents. Our headquarters at Lunderskov, Denmark, co-ordinates activities in the production and sales companies in Denmark, Germany, the Netherlands, Spain, the USA, India and China. In total the group has in excess of 150,000 m^2 of premises at its disposal and employs more than 2,000 people world-wide.

LM's global production and service are founded on a comprehensive transfer of technology and a quality assurance system certified in accordance with ISO 9002. This means that our customers can rely on a uniformly high level of quality – no matter where in the world our rotor blades are manufactured or delivered.

LM's position on the global market was established in the 1980s. Today LM rotor blades are turning on every continent.

Focus on large wind turbines and offshore wind farms

LM designs the rotor blades for tomorrow's wind turbines

LM possesses the industry's most comprehensive offshore experience in the field of rotor blade technology.

The wind energy produced in the future will be characterised by increasingly bigger and more cost effective wind turbines and huge offshore wind farms. LM Glasfiber has worked purposefully to meet the challenges that these developments present.

LM can offer the market's biggest commercial rotor blades in the form of series production and we have the industry's greatest offshore experience in the field of blade technology. In this connection LM rotor blades were used at the Danish offshore wind farm at Vindeby off the island of Lolland, at the Swedish Bockstigen offshore wind farm near Gotland and the wind farm at Ijselmeer in the Netherlands.

The offshore based wind farms of the future will be even bigger and will include all the challenges of wind power. These wind turbines will require the development of increasingly large rotor blades adapted to the special offshore conditions in order to continue increasing yields and the lifetime of the blades. Servicing offshore wind turbine rotor blades is very expensive. The goal is therefore for the blades to be able to stand up to the corrosive marine environment without ongoing maintenance, just as the blades LM has supplied for the existing offshore wind turbines can.

LM Glasfiber will continue at the forefront of international wind turbine technology in the future. We wish to extend the limits of what is possible in modern rotor blade construction. On the basis of our experience, resources and capacity, and in close collaboration with wind turbine manufacturers, we will help to ensure that it will be possible to reduce the price of electricity produced with the help of wind power on an ongoing basis. For the benefit of the utilisation of wind power. For the benefit of the environment. And for the benefit of our customers.

APPENDIX B.

INSTALLATION AND MAINTENANCE MANUAL FOR LM 19.1 ROTOR BLADES

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			With Standard LM lightning conductor:
Suppl:	1) Tipspoiler	No. 023200	No. 025500
	2) Root section	No. 067327	No. 296901
	3) Blade handling	No. 071527	

4) Specification of damage not covered by warranty. M:\GARANTI\GAR-ENG.WPD

LM Glasfiber A/S Rolles Møllevej 1 DK-6640 Denmark

GENERAL DATA FOR ROTOR BLADE TYPE: LM 19.1

Dimensions:

Blade length	l	:	19037	mm	± 20 mm
Max. root chord	Croot	:	1650	mm	± 20 mm
Tip chord	Ctip	:	70	mm	± 10 mm
Blade area	A	:	21.9	m²	
Twist		:	20.0	°	± 0.5 °
Airfoil section		:	FFA-W3, NACA 634		
Natural frequency flapwise		:	1.74	Hz	
Natural frequency edgewise		:	3.16	Hz	
Blade weight	m	:	1960	kg	± 50 kg
Momentum of inertia per blade (rotor D=41.0 m)		:	144000	kgm²	
C of G distance from rootbase	C.o.G.	:	6000	mm	

Direction of rotation (downwind)	:	Clockwise
Selfstarting	:	Yes

Installation dimensions:

Root flange outside diameter	Du	:	1075	mm	
Bolt circle diameter	BCD	:	1000	mm	± 1 mm
Number of bolts	n	:	40		
Bolt size	M	:	24	mm	
1st hole of BCD rel. to tip chord seen from tip	clockwise	:	4.5	°	± 0.5 °
Tip to tower distance (min.)		:	2160	mm	

GRP/steel connection:

Embedded high strength steel bolts, with internal M24 threads.

Aerodynamic brake:

Type	:	Tipspoiler	
Length	:	2687 mm	± 10 mm
Movement	approx :	74°	
Activation	:	Hydraulic cylinder placed near root flange (included from factory)	
Weight	:	70 kg	+4 / -3 kg
Center of Gravity for tip weight	:	2255 mm	± 50 mm from tip
With standard LM lightning conductor:			
Weight	:	74.5 kg	+4 / -3 kg
C.o.G. for tip weight	:	2170 mm	± 50 mm from tip

Materials used:

Skin, spar and root	:	Fibre glass/polyester
Embedded bolts for mounting	:	Crome steel alloy
Spoiler mechanism	:	Stainless steel / Carbonfibre-epoxy

LM Glasfiber A/S reserves the right to amend specifications without further notice.

04.06.97
FML

GENERAL OPERATIONAL LIMITS FOR ROTOR BLADE TYPE: LM 19.1

Rotor configuration:

Number of blades in rotor	i	:	3	
Placement of rotor		:	upwind	
Power control		:	stall	
Yaw system		:	forced	
Hub design		:	rigid	

Operational limits: (max. values)

Rotor diameter	D	:	44	m	
Number of revolutions (operation)	no	:	30.00	rpm	
Tip speed (operation)	Vtip	:	62.00	m/s	
Generator power	Pel	:	750	kW	1)
Yaw error (operation)	sw	:	20	°	2)
Cut out wind	Vo	:	25	m/s	1)
Survival wind	Ve	:	70	m/s	3)
Tipspeed for release of tipspoiler	nc	:	1.3 · Vtip		
Brake torque (nominal on rotor shaft)	Mbr	:	711	kNm	
Brake torque (emergency)	Mbr,e	:	948	kNm	

Time for activation of tipspoiler : $0.8 < t$ sec. 4)

Min hydraulic retaining pressure = calculated pressure at 15% overspeed for the heaviest tip in a set. For calculations please ask LM.
Eg. D=44m, n=26,9rpm, Vtip=62m/s, Hydraulic cylinder ø60/30mm, Tip weight=78,5 kg with standard LM lightning conductor.
Retaining pressure = 91,6 Bar.

Operation temperature	:	Min. -20° C.- Max. 55° C. OAT (Outside Ambient Temperature). Min. -30° C. Optional Otherwise ask the manufacturer.
Mounting	:	Min. and Max. requirements are laid down in the Installation and Maintenance Manual.
Operation under icing conditions	:	Under extreme climatic conditions where icing has added an unbalance, the operation must stop until a de-icing has taken place.

All wind speeds stated are measured in hub height.

1) 10 min. mean values.
2) At a max. yaw error of 20° is understood:The angle between the wind direction and the axis of the turbine systematically has a mean value greater than 20°.
3) 2 sec. mean value.
4) The hydraulic system must be dampened in order to prevent damage on the tip mechanism, from inertia forces on the tipspoiler.

LM Glasfiber A/S reserves the right to amend specifications without further notice.

23.06.98/MM

DESCRIPTION.

The LM 19.1 blade is built as a self-supporting structure comprising of two skin-halves mounted round two main webs going from root end to tip.

Bushings with internal thread are embedded in the root section, and so forming the attachment to the hub. This root-to-hub-mounting-principle has been extensively tested at the Aarhus Institute of Technology where basicly the fatique properties were evaluated.

Shells, spars and root section are made of fibre-glass reinforced polyester, where the main strength properties have been achieved by using continuous fibres (Unidirectional Rowings). The bushings are made of chrome alloy steel. All metal parts for the aerodynamic blade tip brake are made of stainless steel and carbon fiber/epoxy.

The aerodynamic tip brake consists of the outer 2687 mm of the blade, mounted on a carbon/epoxy shaft.

During operation of the turbine, the tip is kept in place by a hydraulic cylinder placed near the root flange, and connected with the tip through a stainless steel wire. By activation of the tip brake, the hydraulic pressure is released, and the centrifugal forces on the tip are used to obtain an axial displacement of the tip and the shaft of approx. 180 mm.

During the displacement the tip is forced to turn app. 74° by a tooted wheel with diagonally teeth. The hydraulic cylinder is throttled, so the deployment of the tip is dampened in order to protect the tip mechanism against damage, due to inertial forces in the moving parts.

The profile chosen FFA-W3 and NACA 634 series has proven highly productive and show little sensitivity to dirt. Also its stalling properties are fine.

Each blade of a set is balanced to have the same weight in the root as well as in the tip as the two other blades of the set. A record is kept of this momentum in order to make a replacement easier in case of damage occurring during transport or installation.

The production takes place according to the quality system of LM Glasfiber A/S that meets the requirements of ISO 9001.

Further to this in connection with the production surveillance by for instance the Germanischer Lloyd or Det Norske Veritas, a "product certificate of conformity" can be issued.

The blade is calculated for normal security class acc. to Danish standards.

<u>Standard LM Lightning Conducting system - General Description.</u>

The lightning conducting system is built as an internal system, which in a controlled way is capable of conducting the lightning current from the tip of the blade to the root flange.

The system is developed in the light of extensive statistic material, showing where LM blades are struck by lightning along with laboratory tests where lightning currents have been simulated into the main components. Furthermore field tests on blades struck by lightning, confirmed the capability of the system to conduct lightning current.

The lightning conducting system consists of a capture part, where the visual parts "the so -called lightning receptors" are placed outermost on the tip. Lightning receptors are connected to the root flange via the internal lightning conducting components.

The lightning conducting system contains two parts, which depending on the lightning frequency, may be considered as wearing parts. Replacement of these parts are described under the section: Servicing of Standard LM Lightning Conducting System.

04.06.97.
FML

FUNCTIONAL DESCRIPTION

Hydraulic airbrake mechanism (drawing No. 023200) (drawing No. 025500 with LM lightning protection)

Design:

1. The shaft (008705) being embedded in the main structure of the tip carries at the opposite end an epoxyglued spline. This spline connects to wire (229501) through an eye screw - part No. 126601.

   The wire leads to the rootend through a PVC tube (009501) and connects to the hydraulic cylinder (127901) through a rigging screw.

   The tip is aligned to the blade by means of 2 nylon cones (064801), guiding into 2 female cones embedded in the tip bulkhead.

   The tip movement while being activated is controlled by a guideblock (internal threaded) (126201).

   The coil spring (128401) secures that the guideblock performs an axial movement of about 26 mm to clear the nylon cones prior to initiate the pivoting movement.

   The coil spring (128701) assures that the tip stays deployed during slow rotation.

   By dismantling inspection cover (079804) and lid (126901) the guide block (126201), the mail spring, the eye screw (126601), the wire inclusive of its forked terminal as well as the small coil spring (128401) become accessible.

Function:

2. During normal operation the tip will be aligned and held firm to the blade as a result of the hydraulic line pressure acting on the cylinder.

   In an overspeed situation the centrifugal forces acting on the cylinder through the stainless steel wire create an increase in the hydralic line pressure. A pilotguided pressure valve registers this increased line pressure and opens up at a predetermined pressure level.

   As the hydraulic system becomes depressurized, the tip brake becomes activated. The actual movement of the tip amounts to 180 ± 4 mm, with the pivoting movement being approx. 74° nose-up.

   The movement must be damped through a throttling of the oil flow. This is accomplished through the mounting of an orifice in the cylinder outlet.

Resetting of the tip:

3. Under normal operation, the tip is being reset by supplying the hydraulic system its normal pressure.

   The rotor has to be stopped, before resetting the tip.

   By normal stop the system must be made thus it automatically resets the blade tip when the rotor stops, and in this situation it shall remain with so much hydraulic pressure that it at least keeps the blade tips fixed in closed position.

22.04.98
TM

INSTALLATION.

Prior to installation, note the blade numbers for reference purpose (these are embedded in the cylindrical surface close to the root and on a label to be found on the root flange).

I. The condition of the surface:

The gelcoat surface has to be clean and smooth without scratches. Scratches, if any, are spot painted. If the spoiler is covered with tape (to prevent foreign particles from entering the brake while in transit), remove it.

Glue from the tape if any must be removed. Please be sure that the wax film is intact.

II Opening and closing of the air brake for inspection purposes:

a. When the tape has been removed from the tip cutting and there is no pressure on the hydraulic system, the tip brake will open itself due to the built in spring device.

Check that the suspension of the hydraulic cylinder on the root end is intact and without any wryness due to transport or other handling.

Check all visible mechanical joints.

Check the attachment of the wire to the piston rod of the hydraulic cylinder.

The surface of the piston rod has to be intact.

b. General inspections

The hydraulic system is checked visually for leaks at the gasket, bleading valve and connection.

c. Airing of the hydraulic system

It is of great importance that carefull airing is carried out followed by refilling with hydraulic fluid, prior to operating the generator.

Remember that the blade-(and with that the hydraulic pipe), while airing, must be positioned in such a way that air can escape from the system.

With air in the hydraulic an uncontrolled release of the air brake could take place, which might have a destructive effect on the attachments of the flap.

The airing is done one blade at a time by purching oil until air stops coming out of the air relief valve on the cylinder barrel.
To ensure that a ventilated blade is not sucking air into the system, while the other blade are ventilated, it is recommended that each hydraulic line is separated, while the airing takes place.

06.05.96
TM

IMPORTANT !!!

As long as the hydraulic system has not been filled and bleading has been completed, the rotor has to be stopped.

III Attachment of the blade to the hub:

Make sure that the blade root flange lays flat onto the hub.

The load on the bolts must be dispersed even.

The bolts for mounting must be new and of quality ISO class 8.8.
The free length of the bolt must be Min. 100 mm (4 x bolt diameter). All sliding surfaces of the bolt must be greased with Molybdenum disulphide or similar. Torqueing moment according to DS 412.

If the hub is made of cast steel, a bushing (washer) with a large supporting surface must be incorporated between bolthead and steel casting.

IV. Pitching:

The pitch angle is stated by the turbine manufacturer (depending on the location of the turbine, rotor diameter, RPM and max. power output).

The tip chord is marked on the root flange and further more assisted with a logging scale.

The accuracy adjustment for the 3 blades of the turbine in mutual ought to be within 1/2°.

V. Check plane of rotation:

Checking the plane of rotation is done by measuring the distance from the tip of the blade to the tower. The measurement must be carried out on all 3 blades at the same spot on the tower.

The mutual distance between the blades may only vary +/- 50 mm.

VI. Requirements on hub rigidity:

Please note that the natural frequency of the fitted blade will be influenced if the hub is not in possession of sufficient rigidity.

17.11.92
KB/

MOUNTING OF TIP AND CYLINDER:

By remounting of tip and/or hydraulic cylinder of your rotor blades use the procedure described below:

Mounting of tip (ref. drawing No. 023200): (drawing No. 025500 with LM lightning protection)

- In the guide house for the pivoting of the tip movement mount the coil spring (#128401) and plastic guide block (#126201) with inside spline, in such a way that the mark indication of the 1. tooth of the spline is pointing upwards and towards the root end.

- Guide the spline end of the carbon-fibre shaft (#008705) into the guide block (#126201) in such a way that the tip meets the mainblock parallelly in normal position.

- The 1¼" pipe threads on the eye screw and in the spline are inspected for damage and impurities. After a thorough cleaning of the threads, they are greased with "Metallfreie Montagepasta TC 575 # 175016".

- Position the forked stop collar (#126301) on the eye screw (#126601), which afterwards is screwed lightly into the spline (#008705). Then tighten eye screw (#126601).

- Pointed screw (#001993) on spline (#008705) is to be tightened.

- Setscrew (#020003) on Cover (#126901) and screw (#033803) on inspection cover (#079804) is to be tightened.

Mounting of hydraulic cylinder (ref. drawing No. 023200): (drawing No. 025500 with LM lightning protection)

- 2 ea supports for cylinder (#110501) is to be mounted on the flange (#114201) by means of setscrews M12 x 50 mm (#007903) and selflocking nuts (#002243).

- 2 ea electrical insulating bushings (#124301) to be mounted in the hydraulic cylinder (#127901).

- Hydraulic cylinder (#127901), completely premounted, is to be placed in the supports (#110501), and to be mounted with a transverse bolt (#111501), 2 ea washers (#002363) and 2 ea splits (#002083).

- Connect wire to the cylinder by means of bolt.

Adjusting of tip during mounting:

- Mount the rigging screw on to the wire and the hydraulic cylinder (#127901), tighten rigging screw so that the distance between tip and blade in open position is 180 ± 4 [mm].

07.03.97
PTO

MAINTENANCE

After some time of use, it is inevitable that a border will be shaped on the front edge of the blade, consisting of insects and dirt.

This border might have a negative influence on the effect of the blades, and if it is requested to be removed, the following instruction can be recommended:

1. The blades are waxed with Yacht Cleaner which is a highly concent rated cleansing agent without grinding mediums, based on water, that can be thinned with water.

2. Hereafter Yacht Polish is used which is a wax fluid with grinding mediums. This polish cleans and polishes in 1 (one) working operation. For extreme difficult spots and rooted dirt, Yacht Rubbing can be used.

3. To obtain the best possible result of this treatment, it is recommended to finish off with Yacht Wax, which is a wax fluid without grinding mediums. This wax protects and preserves the blade.

You may be content with only giving Yacht Wax on the front edge of the blade.

All the abovementioned products are of the make **International Farvefabrik A/S, Knud Bro Allé 10, DK-3600 Stenlase.**

We draw your attention to the fact, that the instructions on the labels are followed.

If there are scratches, rust extracts on the root flange etc. these have to be repaired.

If it is necessary to repair damages on the surface of the blades, please follow the instructions given in the enclosed Guidance to Repair of Fibreglass-reinforced Polyester.

We congratulate you on your LM rotor blades - in case you have further questions you are always welcome to contact us.

17.11.92
KB/

SERVICING OF THE HYDRAULIC TIPSPOILER OF THE LM 19.1 BLADE.

3½ months service inspection:

1. Check that the tip is totally closed during normal operational RPM and normal pressure.
   The wire # 229501 is tightened by turning the rigging screw at the hydraulic cylinder.

2. The hydraulic system has to be checked visually for leaks at the gasket, bleading valve, and connection during hydraulic pressure.

3. All movable parts must travel freely.
   Metal guide an movable plastic guide block are applied with teflon spray # 407716 in order to ensure low friction.

4. When resetting the tip, check that the trailing edges of the tip align with the trailing edges of the blade, as soon as the pivoting movement stops. Check this alignment at app. 20 mm. gap between the tip and the blade.
   If the trailing edges do not align when the turning movement stops, the stopcollar (126401) has to be adjusted.

5. Check the fixing of the blade tips to the blade by means of the 2 conical nylon guides # 064801.

6. Overspeed: Check that the release of the tip spoiler takes place within the fixed interval.

Annual service inspection:

Same as at the 3½ months' inspection, also inspect the following:

1. Check on corrosion on all metallized parts (only at the rootend of the blade) and repair.

2. Check that the sealing between bladeflange (#114201) and GRP-blade is intact.

3. Demount inspection cover (079801) and lid (126901).

4. Check eye screw (126601) for proper fit into the shaft (008705). Locking nut must be present and tightened.

5. Check the wire (229501) connection to the eye screw (126601). A split must be present.

6. Check Circlip ring (128901) for damage and proper mounting.

7. Check guideblock house visually for dirt.

8. Check guideblock for excessive clearance. While deployed, force the tip up and down. Under this manoevre the trailing moves beyond a +/- 15 mm limit.

22.04.99/TM

SERVICING OF THE HYDRAULIC TIPSPOILER OF THE LM 19.1 BLADE.

Annual service inspection:

Same as at the 3½ months inspection, also inspect the following:

9. Inspect nylon cones (064801) for screw wear.

10. Reinstall all the covers. Fill up the 4 bolt holes with Sikaflex and smoothe out the surface.

26.04.95
TM

SERVICING OF STANDARD LM LIGHTNING CONDUCTING SYSTEM.

Replacement of lightning receptor.

When lightning receptors are struck by lightning, they are exposed to very high temperatures which are capable of evaporating some of the material from the lightning receptor.
Lightning receptors are therefore shaped and mounted in such a way that replacement is possible. Replacement of lightning receptors is performed as follows:

a. Remove the old receptor from the tip by means of a special tool. Use the two small holes in the surface of the receptor, if they are intact. Alternatively the old receptor must be removed by drilling.

b. Remove the old sealer from the hole for the receptor and degrease thoroughly.

c. Grind the new receptor to a matt finish on the sides and degrease thoroughly.

d. Apply two droplets of adhesive to receptor thread (Loctite 243). Install the receptor in the thread and tighten it by means of a special tool. Use the two small holes in the surface of the receptor.

e. Fill the groove between the receptor and the blade as well as the two small holes in the surface with a sealer. Groove and holes are filled from bottom to top to avoid air holes under the surface. Remove excess sealer, if any.

Replacement of frame connection.

To protect the hydraulic cylinder against lightning current, a frame connection is mounted from the rigging screw to the root flange. The frame connection is mounted directly from the rigging screw to the flange, or by means of fittings and strips. If the frame connection is subject to replacement due to wear etc., a similar frame connection should be used, i.e. the sectional area, length and the mounting have to be the same. Deviation in sectional area, length and mounting could cause damage to the hydraulic cylinder and the frame connection.

04.06.97
FML

ERROR LOCATION

1.If one or both of the bladetips are moving sluggish, this may be caused by the following:

a. The bleeding filter # 065901 is blocked and has to be replaced.

b. Blocked nozzle # 203001, caused by dirt in the hydraulic fluid. All fluid of the whole hydraulic system has to be washed out 25 times and filtered to 10μ.

c. Dirt or wear and tear in the mechanical parts. Inspect all movable parts. Clean and grease.

2. If one or more of the bladetips are moving fast with high sound:

a. Nozzle # 203001 is missing.

b. Air in the hydraulic system. Airing through test nipple # 056011 until you are sure that there is no more air in the system.

Repeated bladetip activations with the two abovementioned errors will damage the blade badly, why it is of great importance to inspect before starting the rotor in connection with servicing.

24.11.93
KB/SM

REPAIR INSTRUCTIONS - FIBRE GLASS REINFORCED POLYESTER.

1. SANDING OF DAMAGED AREA.

   The damaged area is sanded (sandpaper with grain size 80-120) until the surface is completely clean. The area is then washed with acetone in order to remove the slip and to ensure complete dryness.

2. BUILDING-UP OF DAMAGED AREA

   If the damaged area has a depth exceeding approx. 1 mm, it is necessary to build up the area with fibre glass reinforced polyester until the built-up area is approx. 0.5 - 0.8 mm lower than the surrounding surface. If a fibre glass mat with a weight of 450 g/m² is used, each fibreglass laminate will have a thickness of approx. 1 mm. When the fibre glass laminate has hardened, gelcoat is used to complete the building-up process.

The actual process is as follows:

A. Always make sure that the polyester has been accelerated (cobalt naphtanate added). This is done by mixing 1-2 cm^3 with approx. 5 drops of catalyst (hardener). If the consistency of the mixture remains constant after 20-30 minutes at 18-20° C, the polyester cannot be used until accelerator (cobalt naphtanate) has been added. Contact your polyester supplier.

B. Never mix more than can be used within 15 minutes.

   Use 15 - 20 ml hardener (1.5 - 2,0%) for each kg polyester. After thorough mixing, the mixture is applied with a brush to the sanded area. The fibreglass mat is then placed on top and worked-up with a metal roller until the fibreglass is saturated. This procedure is repeated until the sanded area is almost level with the surrounding area (see point 2).

   When the fibreglass laminate has hardened, gelcoat is applied (layer thickness 0.5 - 1.0 mm, hardener 2.0 - 2.5%), until the entire repaired area is higher than the surrounding area.

   The repaired area is then wet-sanded (sandpaper grain size 300) until the repaired area is almost flush with the surrounding area.
   Sanding is then completed with wet sandpaper, grain size 600.

NB:Always remember to use abundant water when wet-sanding. After the last sanding, the repaired area should be polished 2-3 times with wax, giving the surface a smooth and glossy finish.

17.11.92
KB/

Instr. 5309 660-30 Y
Edition 4 Dec 2001

Contactors Schütze Contacteurs Kontaktorer Contattori Contactores

EH 80...EH 800, EK 100...EK 550

ENGLISH | *DEUTSCH* | *FRANCAIS* | *SVENSKA* | *ITALIANO* | *ESPANOL*

Mounting and maintenance

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Installation

Installation in enclosure (box, cubicle) or locked, dry and clean room. Auxiliary contact terminals are finger proof (degree of protection IP 20). Main terminals are not protected. Except for the terminals, no live parts are accessible.
The contactor can be mounted on a vertical or sloping wall which has a horizontal or vertical circuit, on a desk or suspended from the roof.

EH 80...145 are installed with two diagonally placed M5 screws,
EH 150...800, EK 100...EK 550 with four M6 screws. Mounting hardware kit with damping devices comes with the contactor sizes EH 250...EH 800 and EK 160...550.

The minimum distance between arc-chute and unisolated wall has to be:

For	Min.
EH 80...90	30 mm
EK 100...145, EK 100	40 mm
EH 150...160, EK 160	15 mm
EH 250	30 mm
EH 370...800	40 mm
EK 370, EK 550	40 mm

The voltage of the contactor coil is stated next to the coil terminals (marked A1 and A2) and should correspond with the control voltage. The contactor will work within the voltage range 80 to 110 %.

Einbau

Einbau in Kapselungen (Kästen, Schränke) oder verschließbaren, trockenen und sauberen Raum.
Das Schütz hat berührungsgeschütze Hilfskontakt- und Spulenanschlüße (Finger- und Handrückensicher,
IP 20). Die Hauptanschlüße sind jedoch nicht berührungsgeschützt. Darüber hinaus hat das Schütze keine von außen erreichbare Spannungsführende Teile.
Die Schütze können an vertikale oder schräge Wand mit horizontalen oder vertikalen Strombanen, stehend oder "hängend" montiert werden.

EH 80...145 wird mit 2 diagonal versetzten M5 Schrauben angebaut.
EH 150...800, EK 100...EK 550 mit 4 St M6 Schrauben.
Einbausatz mit Dämpfelementen wird für Schützegrößen EH 250...EH 800 und EK 160...550 mitgeliefert.

Mindesabstand zwischen Lichtbogenkammer und unisolierter Wand:

Für	Min.
EH 80...90	30 mm
EH 100...145, EK 100	40 mm
EH 150...160, EK 160	15 mm
EH 250	30 mm
EH 370...800	40 mm
EK 370, EK 55	40 mm

Die Nennspannung der Schützspule ist an den Spulenanschlüßen angegeben (mit A1 und A2 vermerkt) und soll mit der Betätigungsspannung übereinstimmen. Das Schütz funktioniert auch wenn Spannungsvariationen von 80 - 110 % vorkommen.

Installation

Installation sous enveloppe (coffret ou armoire) ou dans un local sec et propre, fermé. Les bornes des circuits auxiliaires sont protégées contre le toucher (protection IP 20). Les bornes de puissance ne sont pas protégées. Hormis les bornes de puissance, la protection contre le toucher de toute pièce sous tension est assurée.

Fixation des contacteurs:
Les contacteurs peuvent-être montés horizontaux , verticaux ou suspendus.
EH 80...145 se fixent par deux vis M5 en diagonale,
EH 150...800, EK 100...EK 550 se fixent par quatre vis M6. Les contacteurs EH 250...EH 800 et EK 160...550 sont livrès avec un kit de fixation et avec silent block

La distance à la masse de la chambre de coupure (face avant) doit être au minimum de:

Pour	
EH 80...90	30 mm
EH 100...145, EK 100	40 mm
EH 150...160, EK 160	15 mm
EH 250	30 mm
EH 370...800	40 mm
EK 370, EK 550	40 mm

La tension et la fréquence de chaque bobine sont marquées à coté des bornes bobine (repérées A1, A2) et doivent correspondre à celles des circuits de contrôle. Le contacteur peut fonctionner dans une plage de tension comprise entre 80 % et 110 % de la tension nominale.

Installation

Installation i kapsling (låda, skåp) eller låst, torrt och rent rum. Kontaktorn har beröringsskyddade hjälpkontakt- och spoluttag (fingersäkra, IP 20 men huvuduttagen är inte beröringsskyddade. Kontaktorn har för övrigt inga utifrån åtkomliga spänningsförande delar. Kontaktorn kan monteras på vertikal eller lutande vägg med horisontal eller vertikal strömbana, på bord eller i tak.

EH 80...145 monteras med 2 diagonalt placerade M5-skruvar,
EH 150...800, EK 100...EK 550 med 4 st M6 skruvar. Monteringssats med dämpdon medföljer kontaktorstorlekarna EH 250...EH 800 och EK 160...550.

Vid montering ska avståndet mellan ljusbågsskärm och oisolerad vägg vara:

För	Min. mått
EH 80...90	30 mm
EH 100...145, EK 100	40 mm
EH 150...160, EK 160	15 mm
EH 250	30 mm
EH 370...800	40 mm
EK 370, EK 550	40 mm

Kontaktorspolens märkspänning står angiven vid spoluttagen (märkta A1 och A2) och ska överensstämma med manöverspänningen. Kontaktorn fungerar även om spänningsvariationer på 80–110 % förekommer.

Installazione

Installazione in custodia (cassetta, armadio) o locale asciutto, pulito e lucchettato. I morsetti dei contatti ausiliari e le parti attive, ad eccezione dei morsetti principali, sono protetti contro il contatto accidentale, (grado di protezione IP 20). E' possibilie montare il contattore in verticale, in orizzontale o sospeso.

I contattori da **EH 80 a 145** vengono installati mediante 2 viti M5 collocate agli estremi diagonali.
I contattori da EH 150 a 800, EK 100 a EK 550 con 4 viti M6. I contattori da EH 250 a EH 800, EK 160 a 550 vengono forniti muniti di viti e ammortizzatori di gomma.

La distanza minima tra la caduta dell'arco e la parete non isolata deve essere:

Per	
EH 80...90	30 mm
EH 100...145, EK 100	40 mm
EH 150...160, EK 160	15 mm
EH 250	30 mm
EH 370...800	40 mm
EK 370, EK 550	40 mm

La tensione della bobina del contattore è indicata vicino ai morsetti della bobina (indicati con A1 e A2) e deve corrispondere alla tensione di comando. Il contattore lavora con un campo da 80 a 110 % della tensione.

Instalación

Instalación en una envolvente (caja, cubículo) o en una sala cerrada, seca y limpia. Los bornes de los contactos auxiliares están protegidos contra contactos fortuitos con los dedos (grado de protección IP 20). Los bornes principales no están protegidos. A excepción de los bornes, no puede accederse a ninguna pieza conductora de la electricidad. Es posible instalar el contactor sobre un plano vertical, horizontal o suspendido.

Los **EH 80...145** se instalan con dos tornillos M5 en diagonal, los **EH 150...800, EK 100...EK 550** se instalan con 4 tornillos M6. El kit de componentes de fijación con amortiguadores se incluye en el suministro de los contactores de tamaños EH 250...EH 800 y EK 160...550.

La distancia mínima entre la cámara de soplado del arco y la pared no aislada debe ser de:

Para	Mínimo
EH 80...90	30 mm
EH 100...145, EK 100	40 mm
EH 150...160, EK 160	15 mm
EH 250	30 mm
EH 370...800	40 mm
EK 370, EK 550	40 mm

La tensión de la bobina del contactor se indica juntoi a los bornes de la bobina (marcados como A1 y A2) y debería coincidir con la tensión de mando. El contactor funcionará correctamente con unas tensiones comprendidas entre el 60 y el 110 %.

Short-circuit protection

The contactor should be short-circuit protected by series connected fuses in the main circuit. Maximum permitted blade fuses (time/current zone gI, gL or gG) as following:

Contactor size	Max. fuse (without relay) Type 2 acc. to IEC 947-4-1
EH 80	125 A
EH 90	160 A
EH 100, EK 100	200 A
EH 145	250 A
EH 150, 160	355 A
EK 160	355 A
EH 250	500 A
EH 370, EK 370	630 A
EH 550, EK 550	630 A
EH 700, 800	800 A

Schutz gegen Kurzschluß

Das Schütz soll gegen Kurzschluß in der Hauptstrombahn geschützt werden. Werden gewöhnliche NH-Sicherungseinsätze verwendet (Auslösekennwerte gI, gL oder gG) sind folgende max Sicherungen zulässig.

Schütz Grösse	Max. Sicherung (ohne Relais) Typ 2 laut IEC 947-4-1
EH 80	125 A
EH 90	160 A
EH 100, EK 100	200 A
EH 145	250 A
EH 150, 160	355 A
EK 160	355 A
EH 250	500 A
EH 370, EK 370	630 A
EH 550, EK 550	630 A
EH 700, 800	800 A

Protection contre les courts-circuits

Cette protection peut être assurée soit:

- par disjoncteur (demander tableaux de coordination).
- par fusibles gI, gL ou gG, en série avec circuit de puissance

Contacteur type	Fusible maxi (sans relais thermique) Type 2 selon IEC 947-4-1
EH 80	125 A
EH 90	160 A
EH 100, EK 100	200 A
EH 145	250 A
EH 150, 160	355 A
EK 160	355 A
EH 250	500 A
EH 370, EK 370	630 A
EH 550, EK 550	630 A
EH 700, 800	800 A

Kortslutningsskydd

Kontaktorn ska skyddas mot kortslutning i huvudströmbanan. Används vanliga knivsäkringar (utlösningskarakteristik gI, gL eller gG) tillåts max säkring enligt följande

Kontaktor-storlek	Max säkring (utan relä) Typ 2 enligt IEC 947-4-1
EH 80	125 A
EH 90	160 A
EH 100, EK 100	200 A
EH 145	250 A
EH 150, 160	355 A
EK 160	355 A
EH 250	500 A
EH 370, EK 370	630 A
EH 550, EK 550	630 A
EH 700, 800	800 A

Protezione contro il corto circuito

Il contattore può essere protetto contro il corto circuito collegando dei fusibili in serie al circuito principale. La massima portata dei fusibili (tempo/corrente per tipi gI, gL o gG) à la seguente:

Taglia del contattore	Fusibile max. (senza relé) Tipo 2 Secondo IEC 947-4-1
EH 80	125 A
EH 90	160 A
EH 100, EK 100	200 A
EH 145	250 A
EH 150, 160	355 A
EK 160	355 A
EH 250	500 A
EH 370, EK 370	630 A
EH 550, EK 550	630 A
EH 700, 800	800 A

Protección contra cortocircuitos

El contactor deberá protegerse contra cortocircuitos mediante fusibles conectados en serie en el circuito principal. Los fusibles máximos permitidos (zona tiempo/corriente, gI, gL o gG) deben ser los siguientes:

Tamaño contactor	Fusible máximo (sin relé) Tipo 2 según IEC 947-4-1
EH 80	125 A
EH 90	160 A
EH 100, EK 100	200 A
EH 145	250 A
EH 150, 160	355 A
EK 160	355 A
EH 250	500 A
EH 370, EK 370	630 A
EH 550, EK 550	630 A
EH 700, 800	800 A

Diagram for connection

A Main diagram EH 80...800
B Main diagram EK 100...550
C Connection of ON and OFF pushbutton and pilot lamp
D Connection of control switch for selection between inching and normal operation.
E Connection of control switch, which is closed during running.

Anschlußschema

A Hauptschema EH 80...800
B Hauptschema EK 100...550
C Anschluß von Ein- und Aus-Drucktaster und der Signallampe
D Anschluß des Bedienungsschalters für die Wahl zwischen Vorrücken und normalem Betrieb.
E Anschluß des Bedienungsschalters, der schließt, wenn der Betrieb beginnen soll, und öffnet, wenn der Betrieb aufhören soll.

Schémas de branchement

A Schéma principal EH 80...800.
B Schéma principal EK 100...550.
C Commande Marche-Arrêt par boutons poussoirs avec lampe de signalisation
D Commande par interrupteur pour marche par à coups ou auto-alimentation.
E Commande par interrupteur à 2 positions Marche-Arrêt.

Schema för anslutning

A Huvudschema EH 80...800
B Huvudschema EK 100...550
C Anslutning av till- och fråntryckknapp, signallampa
D Anslutning av manöverkopplare för val mellan framryckning och normal drift.
E Anslutning av manöverkopplare som sluter när driften ska börja, öppnas när driften ska sluta.

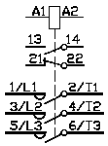
Schemi di collegamento

A Schema principale EH 80...800.
B Schema principale EK 100... EK 550.
C Collegamento di pulsante ON e OFF, spia di segnalazione.
D Collegamento per l'interruttore di comando per la scelta tra il funzionamento a scatti e quello normale.
E Collegamento dell'interruttore di comando che rimane chiuso durante l'esercizio.

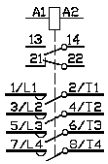
Esquema de conexión

A Esquema principal EH 80...800.
B Esquema principal EK 100... 550.
C Conexión del pulsador de marcha y parada y lámpara de señalización.
D Conexión del interruptor de control para selección de avance intermitente o funcionamiento normal.
E Conexión del interruptor de control que se cierra al empezar el funcionamiento y se abre al terminar éste.

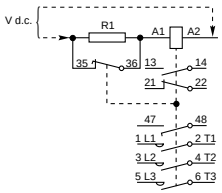
A/AC, CA



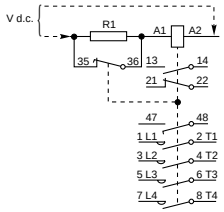
B/AC, CA



A/DC, CC



B/DC, CC



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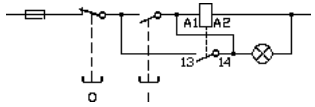
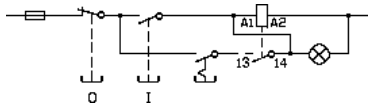
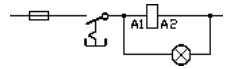


D

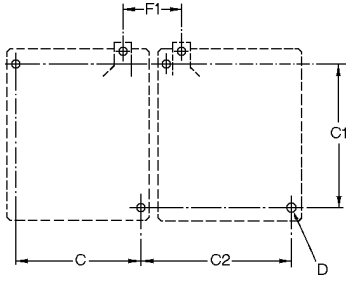


E



Drilling plan
Bohrplan
Plan de perçage
Borrplan
Dima di foratura
Plantilla de taladros

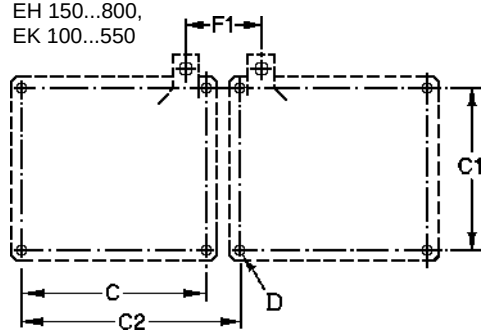
EH 80..145



Dimensions in mm/Maße in mm/Dimensions en mm/Mått i mm/Dimensioni in mm/Dimensiones en mm

	C	C1	C2				D
			1)	2)	3)	4)	For/Für/Pour/För/Per/Para
EH 80, EH 90	90	100	103	108	116	129	M5
EH 100	110	120	125	125	136	147	M5
EH 145	110	120	127	127	136	147	M5
EH 150, EH 160	120	140	137	137	149	161	M6
EH 250	160	140	183	186	190	197	M6[5)]
EH 370, EH 550	170	200	201	201	208	217	M6[5)]
EH 700	220	200	246	246	254	263	M6[5)]
EH 800	220	200	246	276	254	263	M6[5)]
EK 100	120	140	166	166	177	187	M6
EK 160	160	140	202	202	214	226	M6[5)]
EK 370, EK 550	220	200	268	268	280	292	M6[5)]

EH 150...800,
EK 100...550



1) Smallest distance.
2) Gives min. distance F1 = distance between the poles, on one contactor.
3) Allows space for three auxiliary contact blocks between the contactors.
4) Allows space for four auxiliary contact blocks between the contactors.
5) Screws and damping elements are included.

1) Mindestabstand.
2) Ergibt Maß F1 ≈ Maß zwischen den Phasen bei einem Schütz.
3) 3 Blöcke zwischen den Schützen.
4) 4 Blöcke zwischen den Schützen.
5) Schrauben und Dämpfelement einbegriffen.

1) Distance minimum possible.
2) Entraine F1 = entr'axe entre pôles principaux sur un contacteur
3) Avec 3 blocs de contacts auxiliaires montés entre les 2 contacteurs.
4) Avec 4 blocs de contacts auxiliaires montés entre les 2 contacteurs.
5) Visserie et silent bloc inclus

1) Minsta möjliga mått
2) Ger min. mått F1 = kontaktorns fas- avstånd
3) Ger plats för tre hjälpkontaktblock mellan kontaktorerna.
4) Ger plats för fyra hjälpkontaktblock mellan kontaktorerna.
5) Skruv och dämpdon ingår.

1) Distanza minima.
2) Indica la distanza F1, cioè la distanza fra le fasi di un contattore.
3) Con 3 blocchi di contatti montati fra i contattori .
4) Con 4 blocchi di contatti montati fra i contattori .
5) Viti e ammortizzatori sono compresi.

1) Mínima distancia permitida.
2) Indica la distancia F1 = distancia entre los polos de un contactor.
3) Caben 3 bloques de contacto entre los contactores.
4) 4 bloques de contacto entre los contactores.
5) Se incluyen tornillos y gomas amortiguadoras para la instalación.

Before any dismantling of the contactor

Make dead by,
- turning off the contactor.
- opening the main circuit by turning off the main switch, if any, or by removing the main fuses in all three phases.
- To protect against making attempt, open also the control circuit.

Maßnahmen vor dem Zerlegen des Schützes

- Schütz ausschalten.
- Hauptstrom über Trennschalter oder Leistungsschalter ausschalten oder die Hauptsicherungen in allen drei Phasen herausnehmen.
- Um Einschaltversuche zu verhindern auch die Betätigungsstrombahnen öffnen.

Avant tout démontage du contacteur

- Mettre hors tension le contacteur.
- Ouvrir le circuit de puissance en cadenassant en position ouverte le dispositif de sectionnement en amont du contacteur ou à défaut en enlevant les fusibles de puissance sur toutes les phases.
- Mettre hors tension le circuit de contrôle pour protéger contre toute fermeture intempestive.

Före ingrepp i kontaktorn

- Gör spänningslöst genom att slå ifrån kontaktorn.
- Bryt huvudströmmen genom att slå ifrån frånskiljare eller effektbrytare eller genom att ta ur huvudsäkringen i alla tre faserna.
- För att förhindra tillslagsförsök, bryt även manöverströmbanan.

Prima di amontare il contattore

Disattivarlo mediante
- disalimentazione del contattore
- apertura del circuito principale spegnendo l'interruttore principale, se esiste o rimuovendo i fusibili dalle 3 fasi.
- Per una protezione più completa aprire anche il circuito di comando.

Antes de desmontar el contactor

Desactívelo:
- desconectando el contactor.
- abriendo el circuito principal desconectando para ello el interruptor principal, si existe, o desmontando los fusibles principales de las tres fases.
- para proteger contra cualquier intento de conexión, abra también el circuito de mando.

Change of contacts

The change can be done on an installed contactor. Replace all of the main contacts at the same time.

EH 80 and 90

- Remove the arc-chute.
- Remove the moving contacts. By lifting and pushing them forward, they will go free from the clamp which holds them in position. See the figure.
- Exchange the fixed contacts.
- Put in the new moving contacts.

EH 100 and 145

- Remove the arc-chute.
- Press out the moving contacts. Lift the contact somewhat to let the contact easier slide out.
- Exchange the fixed contacts.
- Put in the new moving contacts.

Kontaktwechsel

Der Austausch kann auf montiertes Schütz erfolgen. Sollte ein Hauptkontaktstück ausgetauscht werden, tausche alle.

EH 80 und 90

- Entferne Lichtbogenkammer.
- Entferne die beweglichen Kontaktstücke. Hebe und schiebe gleichzeitig das Kontaktstück vorwärts so daß es aus der Bügelhalterung herauskomt. Siehe Fig. unten.
- Tausche danach die festen Kontaktstücke.
- Nehme bewegliche Kontaktstücke einsetzen.

EH 100, 145 und EK 100

- Entferne Lichtbogenkammer.
- Entferne die beweglichen Kon taktstücke. Die Kontaktstücke gleich zeitig etwas aufwärts he ben so daß dieselben leichter herausgeschoben werden können.
- Tausche danach die festen Kontaktstücke.
- Neue bewegliche Kontaktstücke einsetzen.

Remplacement des contacts

Peut se faire sur un contacteur installé. Remplacer tous les contacts principaux en même temps.

EH 80 et 90

- Enlever la cage de soufflage.
- Démontage des contacts mobiles: soulever le contact d'un seul coté en poussant vers l'avant pour qu'il échappe à son verrouillage (voir dessin).
- Changer les contacts fixes.
- Mettre les nouveaux contacts mobiles.

EH 100, 145 et EK 100

- Enlever la cage de soufflage.
- Pousser les contacts mobiles: Soulever légérement le contact pour qu'il glisse plus facilement.
- Changer les contacts fixes.
- Mettre les nouveaux contacts mobiles.

Byte av kontakter

Byte kan göras med kontaktorn installerad. Om någon huvudkontakt behöver bytas, byt alla.

EH 80 och 90

- Tag bort ljusbågsskärmen.
- Tag bort de rörliga kontakterna. Genom att lyfta och samtidigt skjuta kontakten framåt går den fri från bygeln som håller den på plats. Se nedanstående figur.
- Byt därefter de fasta kontakterna.
- Sätt i de nya rörliga kontakterna.

EH 100, 145 och EK 100

- Tag bort ljusbågsskärmen
- Tag bort de rörliga kontakterna. Lyft samtidigt kontakten något uppåt så att kontaktbelägget går fritt. Se nedanstående figur.
- Byt därefter de fasta kontakterna.
- Sätt i de nya rörliga kontakterna.

Sostituzione dei contatti

La sostituzione può essere effettuata su un contattore installato. Sostituire i contatti principali tutti insieme.

EH 80 e 90

- Togliere la camera spegniarco.
- Rimuovere i contatti mobili sollevandoli e spingendoli in avanti; si sganceranno cosí dal morsetto che li tiene agganciati in posizione. Vedere figura.
- Sostituire i contatti fissi.
- Inserire i nuovi contatti mobili.

EH 100, 145 e EK 100

- Togliere la camera spegniarco.
- Spingere fuori i contatti mobili facendo pressione su un lato. Vedere figura.
- Sostituire i contatti fissi.
- Inserire i nuovi contatti mobili.

Cambio de contactos

La sustitución puede realizarse en un contactor instalado. Cambie todos los contactos principales al mismo tiempo.

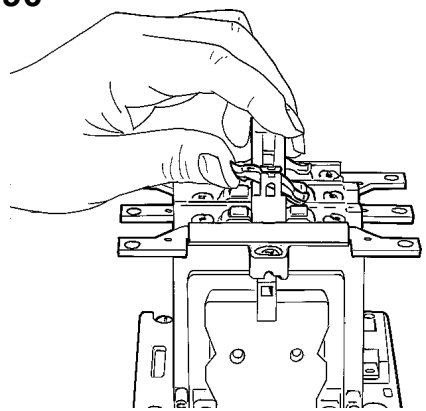
EH 80 y 90

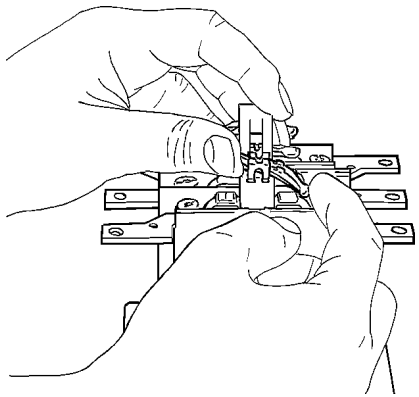
- Desmonte la cámara de soplado del arco.
- Desmonte los contactos móviles. Elevándolos y empujándolos hacia adelante, se liberarán de la abrazadera que los sujeta en su posición. Véase la figura.
- Cambie los contactos fijos.
- Introduzca los nuevos contactos móviles.

EH 100, 145 y EK 100

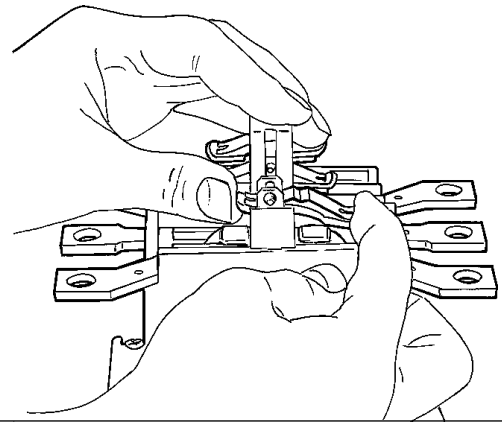
- Desmonte la cámara de soplado del arco.
- Extraiga los contactos móviles. Levante ligeramente el contacto para permitir que éste salga más fácilmente deslizándose.
- Cambie los contactos fijos.
- Introduzca los nuevos contactos móviles.

EH 80, EH 90





EH 100, EH 145, EK 100



EH 150 ... 800, EK 160...550
see page 6

EH 150 ... 800, EK 160...550
siehe Seite 6.

EH 150 ... 800, EK 160...550
voir page 6

EH 150 ... 800, EK 160...550
se sida 6

EH 150 ... 800, EK 160...550
vedere pag. 6

EH 150 ... 800, EK 160...550
véase página. 6

Change of contacts EH 150...800, EK 160...550

- Remove the arc-chute, see page 7.
- **EH 150...800, EK 160...550** Press out the moving contacts, see Fig. 1.
- **EH 370...800, EK 370...550** Moving main contacts: Lift the respective clamp and press the contact into neutral position. See Fig. 2. Remove the contacts.
- Exchange the fixed contacts. See Fig. 3.
- Put in the new movable contacts.

Kontaktwechsel EH 150...800, EK 160...550

- Entferne Lichtbogenkammer, siehe Seite 7.
- **EH 150...800, EK 160...550** Die beweglichen Schaltstücke herausschieben. Siehe Fig. 1.
- **EH 370...800, EK 370...550** Bewegliche Hauptschaltstücke: Hebe den jeweiligen Haltebügel und schiebe das Kontaktstück heraus so daß es entfernt werden kann. Siehe Fig. 2.
- Feste Kontaktstücke austauschen. Siehe Fig. 3.
- Neue bewegliche Kontaktstücke einsetzen.

Remplacement des contacts EH 150...800, EK 160...550

- Enlever la gace de soufflage (voir page 7)
- **EH 150...800, EK 160...550:** Pousser les contacts mobiles : (voir figure 1)
- **EH 370...800, EK 370...550:** L'opération précédente permet d'ôter les contacts d'arc. Pour enlever les contacts principaux: Soulever le portecontacts avec un tournevis en utilisant un contact d'arc comme cale puis pousser le contact principal en position déverrouillée (voir figure 2), et le sortir.
- Changer les contacts fixes (voir figure 3).
- Monter les nouveaux contacts mobiles.

Byte av kontakter EH 150...800, EK 160...550

- Tag bort ljusbågsskärmen, se sida 7.
- **EH 150...800, EK 160...550** Tryck ut de rörliga kontakterna, se Fig. 1.
- **EH 370...800, EK 370...550** Rörliga huvudkontakter: Lyft upp respektive bygel och skjut kontakten i friläge. Se Fig. 2. Tag därefter bort kontakterna.
- Byt ut de fasta kontakterna. Se Fig. 3.
- Montera därefter de nya rörliga kontakterna.

Sostituzione dei contatti per EH 150...800, EK 160...550

- Rimovere la camera spegniarco, vedere pag. 7.
- **EH 150...800, EK 160...550** sollevare tirando i contatti mobili, vedere Fig. 1.
- **EH 370...800, EK 370...550** Contatti mobili principali: sollevare i rispettivi morsetti e spingere il contatto nella posizione neutra, vedere Fig. 2. Rimuovere i contatti.
- Sostituire i contatti fissi, vedere Fig. 3.
- Sostituire i nuovi contatti principali mobili.

Cambio de contactos EH 150...800, EK 160...550

- Desmonte la cámara de soplado del arco, véase página 7.
- **EH 150...800, EK 160...550** Extraiga los contactos móviles, véase Figura 1.
- **EH 370...800 , EK 370...550** Extrayendo los contactos principales: extraiga la abrazadera respectiva y desplace el contacto a la posición de punto muerto.Véase Fig. 2. Desmonte los contactos.
- Cambie los contactos fijos. Véase Fig. 3.
- Introduzca los nuevos contactos móviles.

Fig. 1
EH 150 ...800, EK 160...550

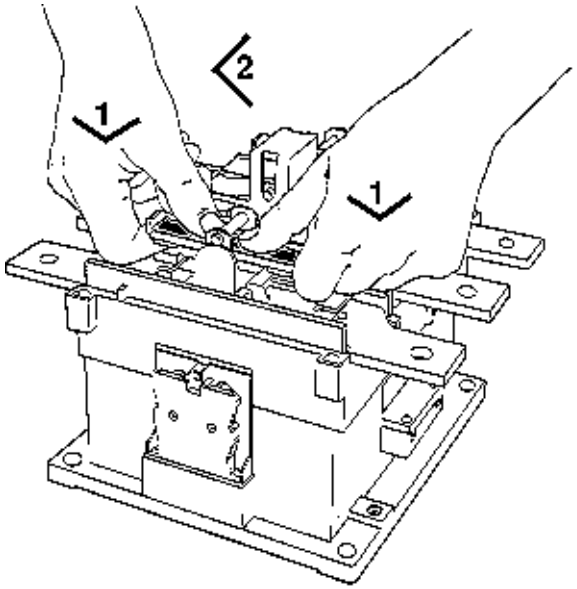


Fig. 2
EH 370 ...800, EK 370...550

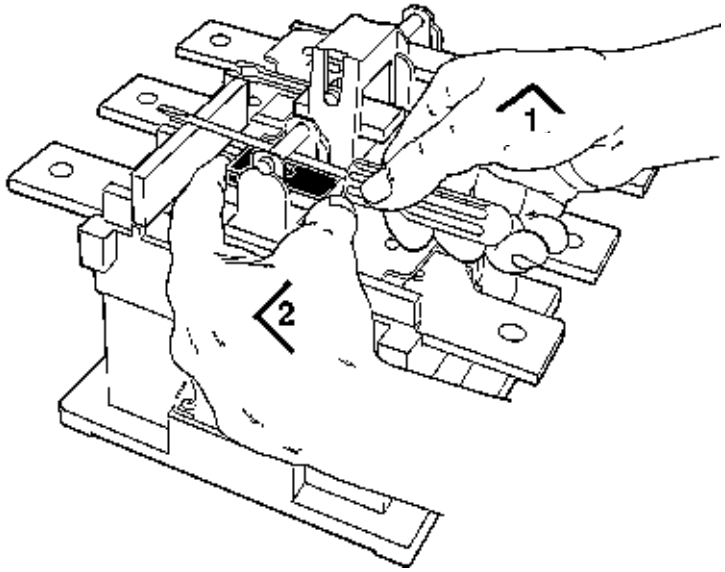
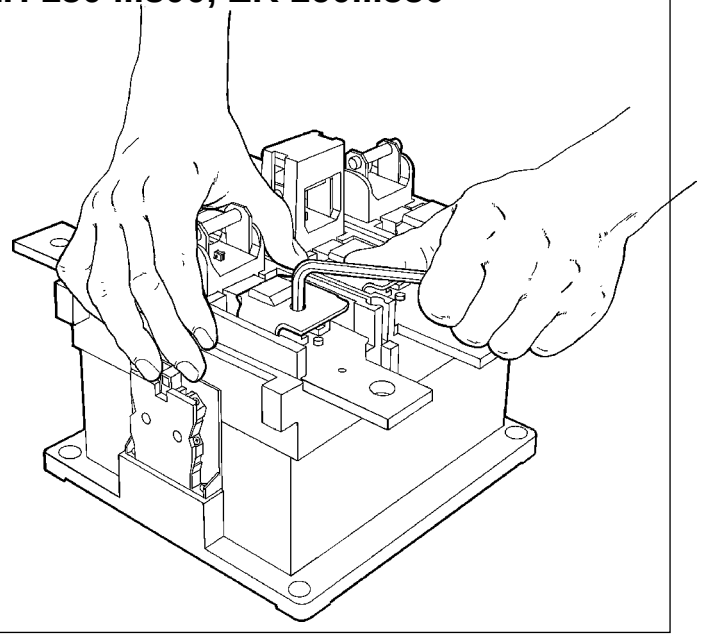


Fig. 3
EH 150 ...800, EK 160...550



Change coil on EH 80...145

To be done on work bench (installed contactor must be removed).

- Change coil according to Fig. 1. Make sure that the return springs will fit into the guide ho les in the coil when the contac tor is replaced on the plate.

EH 150...800, EK 100...550

On installed contactor, main cables and coil cables must be loosened.

- Change coil according to Fig. 2. Make sure that the return springs will fit into the guide holes in the coil when the contactor is replaced on the plate.

Coils see page 10.

Spulenwechsel EH 80...145

Wird auf einer Arbeitsbank vorgenommen (Schütz muß vom Aufstellungsplatz abmontiert werden)

- Spulentausch laut Fig. 1. Kontrolliere daß die Führungs vertiefungen in der Spule hinein kommen wenn das Schütz wie der auf die Grundplatte montiert wird.

EH 150...800, EK 100...550

Schütz braucht nicht abmontiert werden aber die Hauptstrom- und Spulenkabeln müßen gelöst werden.

- Spulentausch laut Fig. 2. Kontrolliere daß die Führungs- vertiefungen in der Spule hineinkommen wenn das Schütz wieder auf die Grundplatte moniert wird.

Spulen siehe Seite 10

Changement de bobine EH 80...145

Doit se faire sur une table (un contacteur installé doit être démonté).

- Changer la bobine (voir figure 1). Bien s'assurer que les ressorts de rappel sont bien engagés dans les logements de la bobine quand on refixe le contacteur sur sa plaque.

EH 150...800, EK 100...550

Sur un contacteur installé, les cables de puissance et ceux de la bobine doivent être déconnectés.

- Changer la bobine (voir figure 2). Bien s'assurer que les ressorts de rappel sont bien engagés dans les logements de la bobine quand le contacteur est refixé sur sa base.

Bobines voir page 10.

Byte av spole EH 80...145

Utförs på arbetsbänk (installerad kontaktor måste tas loss)

- Byt spole enligt Fig. 1. Se till att frånslagningsfjädrarna kommer rätt i styrhålen i spolen när kontaktorn ställs tillbaka på plåten.

EH 150...800, EK 100...550

På installerad kontaktor måste huvud- och spolkablar lossas.

- Byt spole enligt Fig. 2. Se till att frånslagningsfjädrarna kommer rätt i styrhålen i spolen när kontaktorn ställs tillbaka på plåten.

Spolar se sidan10.

Sostituzione della bobina su EH 80...145

Da effetturare su un piano di lavoro (rimuovere il contattore se installato).

- Sostituire la bobina come da Fig. 1. Accertarsi che la molla di ritorno si adatti ai fori guida della bobina quando il contattore viene rimesso sulla piastra.

EH 150...800, EK 100...550

Sui contattori installati è necessario allentare i cavi principali e quelli della bobina.

- Sostituire la bobina come da Fig. 2. Accertarsi che la molla di ritorno si adatti ai fori guida della bobina quando il contattore viene rimesso sulla piastra.

Bobine vedere pag.10.

Cambio de las bobinas EH 80...145

Debe realizarse en un banco de taller (debe desmontarse el contactor instalado)

- Cambie la bobina según la Fig. 1. Asegúrese de que los muelles de recuperación entran en los agujeros guía de la bobina cuando se coloca de nuevo el contactor sobre la placa.

EH 150...800, EK 100...550

Con el contactor instalado, debe aflojar los cables principales y los cables de la bobina.

- Cambie la bobina según la Fig. 2. Asegúrese de que los muelles de recuperación entran en los agujeros guía de la bobina cuando se coloca de nuevo el contactor sobre la placa.

Bobinas véase página 10.

Fig. 1
EH 80...145

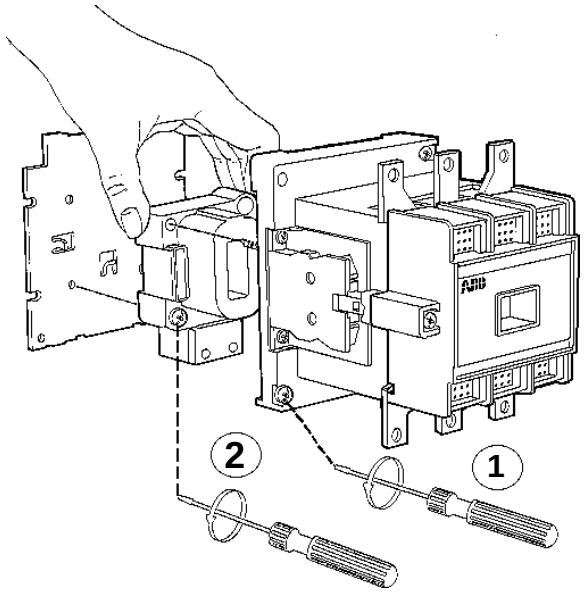
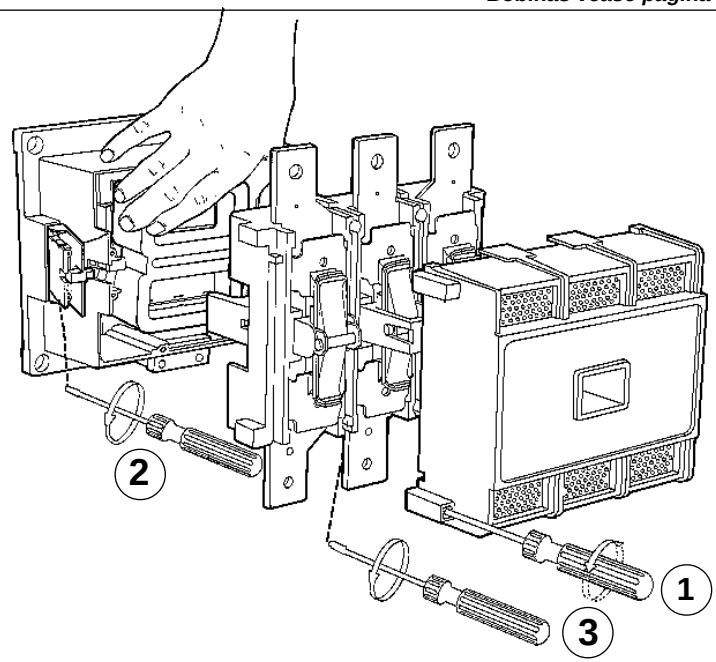


Fig. 2
EH 150...800, EK 100...550



ACCESSORIES

Additional auxiliary contact blocks

AC-version
A maximum of 3 blocks can be mounted on the contactor beyond the one mounted as standard. Technically, all blocks are identical, which means that the same block can be used in all three positions. If the demand for correct position marking has to be met, order block B, C etc. mounted as shown in the figure 1.

DC-version
A maximum of 1 contact block can be mounted on the contactor's left side. The right side is blocked by the operating unit for DC.

1) **SK 829 002-E** is a special auxiliary contact block with overlapping. Can be mounted on the contactor's right side only . No other block can be mounted outside (figure 2). Contact 35–36 has late opening. 47–48 has late closing.

2) **Block A,** spare for the contactor's auxiliary contact block.

ZUBEHÖR

Zusätzliche Hilfsschalterblöcke

Drehstromausführung
Höchstens 3 Kontaktblöcke außer dem in der Lieferung bereits erhaltenen Kontaktblock, können am Schütz montiert werden. Technisch sind die Blöcke gleichwertig, der gleiche Block kann also auf allen drei Plätzen angewendet werden. Falls jedoch verschiedene Anschlußbezeichnungen gefordert werden, bestellt man Block B, C und D die gemäß Fig. 1 angebracht werden.

Gleichstromausführung
Höchstenst 1 Kontaktblock kann auf der linken Seite des Schützes angebracht werden. Die rechte Seite ist vom Sparwiederstand besetzt.

1) **SK 829 002-E** ist ein spezieller Hilfskontaktblock mit Überlappung. Kann nur auf der rechten Seite des Schützes angebracht werden. Kein weiterer zusätzlicher Block kann montiert werden. Die Kontakte 35–36 haben Öffnungsverzug, und 47–48 haben Schließverzug

2) **Block A** ist Ersatz für den befindlichen Block.

ACCESSOIRES

Contacts auxiliaires supplémentaires

Pour contacteurs avec circuit de commande en courant alternatif – AC
3 blocs de contacts auxiliaires supplémentaires peuvent être montés sur l'appareil standard livré avec le bloc A monté. Les blocs sont montables indifféremment dans les 3 positions, cependant si on veut conserver un repérage correct, il faut respecter l'ordre de montage indiqué B–C...(Fig. 1).

Pour contacteurs avec circuit de commande en courant continu– DC
Un seul bloc de contacts auxiliaires peut être ajouté à gauche du contacteur. Le côté droit est occupé par le "bloc: résistance d'economie et contact d'insertion".

1) **SK 829 002-E** est un bloc de contacts auxiliaires spécial à re couvrement. Il doit être monté à droite du contacteur et ne permet pas de rajouter un bloc de contacts auxiliaires supplémentaire (Fig. 2). Le contact 35–36 est à ouverture retardée. Le contact 47–48 est à fermeture avancèe.

2) **SK 829 002- A** est livré monté sur le contacteur standard et peut être commandé en rechange.

TILLBEHÖR

Extra hjälpkontakt-block

Växelströmsutförande
Högst 3 kontaktblock kan monteras på kontaktorn, utöver det som finns där vid leveransen. Tekniskt är blocken likadana, så samma block kan användas på alla tre platserna. Men om krav på skilda uttagsbeteckningar finns beställs block B, C och D som placeras enligt figur 1.

Likströmsutförande
Högst 1 kontaktblock kan monteras på kontaktorns vänstra sida. Höger sida är blockerad av manöverenheten för likström.

1) **SK 829 002-E** är ett speciellt hjälpkontaktblock med överlappning. Kan endast placeras på kontaktorns högra sida. Inget ytterligare block kan monteras utanpå. Kontakt 35–36 har sen brytning och 47–48 har sen slutning.

2) **Block A** är ersättning för befintligt block.

ACCESSORI

Blocchetti aggiuntivi di contatti ausiliari

Versione in c.a.
Possono essere montati fino *a un massimo di 3 blocchetti* di contatti oltre a quello già montato di fabbrica. Tecnicamente tutti i blocchetti sono identici, il che significa che lo stesso blocchetto può essere montato in tutte e 3 le posizioni. Se viene richiesta la corretta numerazione del morsetti, è necessario ordinare il blocchetto B, C ecc. e montarlo come indicato nella figura 1.

Versione in c.c.
Può essere montato *un solo blocchetto* di contatti ausiliari sul lato sinistro del contattore. Il lato destro è occupato dalla resistenza in c.c.

1) **SK 829 002-E** è un blocchetto speciale di contatti ausiliari a doppia punta. Può essere montato solo sul lato destro del contattore e non è possibile aggiungere altri contatti su quel lato. (Figura 2). Il contatto 35–36 è ritardato all'apertura, il 47–48 è ritardato in chiusura.

2) **Blocchetto A,** ricambio del blocchetto di contatti ausiliari montato di serie sul contattore.

ACCESORIOS

Bloques adicionales de contactos auxiliares

Versión c.a.
Puede instalarse *un máximo de 3 bloques* en el contactor, aparte del ya instalado de forma estandár. Técnicamente, todos los bloques son idénticos, lo que supone que puede emplearse el mismo bloque en las tres posiciones. Si debe cumplirse la exigencia de una identificación correcta de las numera, solicite los bloques B, C etc. instalados como se muestra en la Fig. 1.

Versión c.c.
Puede instalarse *un máximo de un bloque* de contactos en la parte izguierda del contactor. La parte derecha está bloqueada por la unidad de accionamiento para c.c.

1) **SK 829 002-E** es un bloque especial de contactos auxiliares con solapamiento. Puede instalarse sólo en la parte derecha del contactor. Ningún otro blo que puede instalarse fuera (Figura 2). Los contactos 35–36 tienen apertura retardada. Los 47–48 tienen cierre retardado.

2) **Bloque A,** recambio del bloque de contactos auxiliares del contactor.

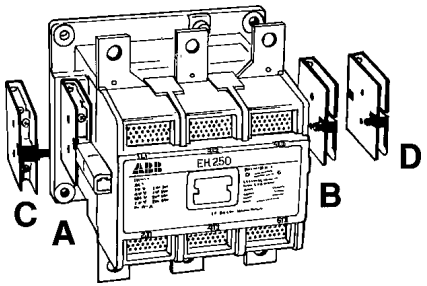


Fig. 1

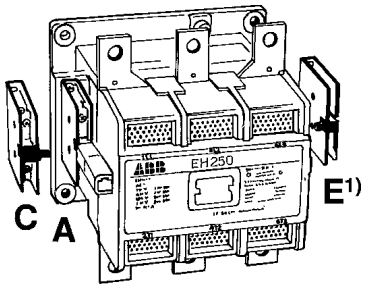


Fig. 2

Diagram Anschlüßschema Schémas Schema Schema Esquema	Cat.No. Bestellnr. Réf. Beställningsnr Codice numero Ref. pedido
	SK 829 002-B
	SK 829 002-C
	SK 829 002-D
	SK 829 002-E 1)
	SK 829 002-A 2)

Cable clamps

Quantity 1.

For	mm^2	Cat.No.
For Cu-cable		
EH 100, EK 100	25–70	SK 175 0001
EH 100, EK 100	25–120	SK 175 0003
EH 145...160, EK 160	35–150	SK 175 0005
EH 145...160, EK 160	25–185	SK 175 0007
EH 250...550, EK 370, 550	70–300	SK 175 0009
For Al-cable (and Cu-cable)		
EH 80, 90	6–50	SK 173 001-AA
EH 80, 90	10–70	SK 173 001-AG
EH 100, EK 100	10–70	SK 173 001-AB
EH 145...160, EK 160	35–120	SK 173 001-AC
EH 250...550, EK 370, 550	70–300	SK 173 001-AD
EH 700	95–300	SK 173 001-AE
Double clamps		
EH 370,550, EK 370, 550	2× 35–185	SK 173 001-BD
EH 700	2× 95–300	SK 173 001-BE

Note: For UL-approval, to be valid, special clamps must be used. Contact your local sales office.

Kabelklemmen

Anzahl 1 Stück

Für	mm^2	Bestellnr.
Für Cu-Kabel		
EH 100, EK 100	25–70	SK 175 0001
EH 100, EK 100	25–120	SK 175 0003
EH 145...160, EK 160	35–150	SK 175 0005
EH 145...160, EK 160	25–185	SK 175 0007
EH 250...550, EK 370, 550	70–300	SK 175 0009
Für Al-Kabel (und Cu-Kabel)		
EH 80, 90	6–50	SK 173 001-AA
EH 80, 90	10–70	SK 173 001-AG
EH 100, EK 100	10–70	SK 173 001-AB
EH 145...160, EK 160	35–120	SK 173 001-AC
EH 250...550, EK 370, 550	70–300	SK 173 001-AD
EH 700	95–300	SK 173 001-AE
Doppelklemmen		
EH 370,550, EK 370, 550	2× 35–185	SK 173 001-BD
EH 700	2× 95–300	SK 173 001-BE

Achtung: Soll UL-Approbation gelten sind spezielle Anschlußklemmen erforderlich. Bitte bei einen ABB-Vertriebsbüro nachfragen.

Connecteurs

Vente parl 1.

Pour	mm^2	Réf.
Pour câble Cu		
EH 100, EK 100	25–70	SK 175 0001
EH 100, EK 100	25–120	SK 175 0003
EH 145...160, EK 160	35–150	SK 175 0005
EH 145...160, EK 160	25–185	SK 175 0007
EH 250...550, EK 370, 550	70–300	SK 175 0009
Pour câble Al (ou Cu)		
EH 80, 90	6–50	SK 173 001-AA
EH 80, 90	10–70	SK 173 001-AG
EH 100, EK 100	10–70	SK 173 001-AB
EH 145...160, EK 160	35–120	SK 173 001-AC
EH 250...550, EK 370, 550	70–300	SK 173 001-AD
EH 700	95–300	SK 173 001-AE
Connecteur double		
EH 370,550, EK 370, 550	2× 35–185	SK 173 001-BD
EH 700	2× 95–300	SK 173 001-BE

Note: Pour conformité avec UL, utiliser des connecteurs spéciaux, nous consulter.

Kabelklämmor

Antal 1 st

För	mm^2	Beställningsnr
För Cu-kabel		
EH 100, EK 100	25–70	SK 175 0001
EH 100, EK 100	25–120	SK 175 0003
EH 145...160, EK 160	35–150	SK 175 0005
EH 145...160, EK 160	25–185	SK 175 0007
EH 250...550, EK 370, 550	70–300	SK 175 0009
För Al-kabel (och Cu-kabel)		
EH 80, 90	6–50	SK 173 001-AA
EH 80, 90	10–70	SK 173 001-AG
EH 100, EK 100	10–70	SK 173 001-AB
EH 145...160, EK 160	35–120	SK 173 001-AC
EH 250...550, EK 370, 550	70–300	SK 173 001-AD
EH 700	95–300	SK 173 001-AE
Dubbelklämmor		
EH 370,550, EK 370, 550	2× 35–185	SK 173 001-BD
EH 700	2× 95–300	SK 173 001-BE

Obs: För att UL-godkännande skall gälla måste speciella klämmor användas, kontakta närmaste säljkontor.

Morsetti

Quantità: 1

Per	mm^2	Codice numero
Per cavo Cu		
EH 100, EK 100	25–70	SK 175 0001
EH 100, EK 100	25–120	SK 175 0003
EH 145...160, EK 160	35–150	SK 175 0005
EH 145...160, EK 160	25–185	SK 175 0007
EH 250...550, EK 370, 550	70–300	SK 175 0009
Per cavo Al (e cavo Cu)		
EH 80, 90	6–50	SK 173 001-AA
EH 80, 90	10–70	SK 173 001-AG
EH 100, EK 100	10–70	SK 173 001-AB
EH 145...160, EK 160	35–120	SK 173 001-AC
EH 250...550, EK 370, 550	70–300	SK 173 001-AD
EH 700	95–300	SK 173 001-AE
Morsetti doppi		
EH 370,550, EK 370, 550	2× 35–185	SK 173 001-BD
EH 700	2× 95–300	SK 173 001-BE

N.B.: Affinche l'omologazione UL sia valida, devono essere utilizzati morsetti speciali.

Terminales para cables

Cantidad 1

Para	mm^2	Ref. pedido
Para cable Cu		
EH 100, EK 100	25–70	SK 175 0001
EH 100, EK 100	25–120	SK 175 0003
EH 145...160, EK 160	35–150	SK 175 0005
EH 145...160, EK 160	25–185	SK 175 0007
EH 250...550, EK 370, 550	70–300	SK 175 0009
Para cable Al (y cable Cu)		
EH 80, 90	6–50	SK 173 001-AA
EH 80, 90	10–70	SK 173 001-AG
EH 100, EK 100	10–70	SK 173 001-AB
EH 145...160, EK 160	35–120	SK 173 001-AC
EH 250...550, EK 370, 550	70–300	SK 173 001-AD
EH 700	95–300	SK 173 001-AE
Terminal doble		
EH 370,550, EK 370, 550	2× 35–185	SK 173 001-BD
EH 700	2× 95–300	SK 173 001-BE

NOTA: Para UL-homologación, utilizar terminales especiales, consultar.

Coils

AC and DC

For	Cat.No. ☐☐ replace with code letters acc. to the table below
EH 80, 90	SK 823 100-☐☐
EH 100 and145	SK 824 101-☐☐
EH 150, 160 and EK 100	SK 825 100-☐☐
EH 250 and EK 160	SK 826 100-☐☐
EH 370 and 550	SK 827 100-☐☐
EH 700, 800 and EK 370, 550	SK 828 100-☐☐

Spulen

DS und GS

Für	Bestellnummer ☐☐ ersetzen mit Kode-Buchstaben laut Tabelle unten
EH 80, 90	SK 823 100-☐☐
EH 100 und 145	SK 824 101-☐☐
EH 150, 160 und EK 100	SK 825 100-☐☐
EH 250 und EK 160	SK 826 100-☐☐
EH 370 und 550	SK 827 100-☐☐
EH 700, 800 und EK 370, 550	SK 828 100-☐☐

Bobines

Courant alternatif et continu

Pour	Réf. ☐☐ compléter par code lettres, Voir tableau ci-dessous
EH 80, 90	SK 823 100-☐☐
EH 100 et 145	SK 824 101-☐☐
EH 150, 160 et EK 100	SK 825 100-☐☐
EH 250 et EK 160	SK 826 100-☐☐
EH 370 et 550	SK 827 100-☐☐
EH 700, 800 et EK 370, 550	SK 828 100-☐☐

Spolar

växelström och likström

För	Beställningsnr ☐☐ ersätts av kodbokstäver enligt separat tabell
EH 80, 90	SK 823 100-☐☐
EH 100 och 145	SK 824 101-☐☐
EH 150, 160 och EK 100	SK 825 100-☐☐
EH 250 och EK 160	SK 826 100-☐☐
EH 370 och 550	SK 827 100-☐☐
EH 700, 800 och EK 370, 550	SK 828 100-☐☐

Bobine

c.a. e c.c.

Per	Codice numero ☐☐ Sostituire ai codici alfabetici della tabella sotto riportata
EH 80, 90	SK 823 100-☐☐
EH 100 e 145	SK 824 101-☐☐
EH 150, 160 e EK 100	SK 825 100-☐☐
EH 250 e EK 160	SK 826 100-☐☐
EH 370 e 550	SK 827 100-☐☐
EH 700, 800 e EK 370, 550	SK 828 100-☐☐

Bobinas

c.a. y c.c.

Para	Ref. pedido ☐☐ sustituir por los códigos de letras según la tabla inferior
EH 80, 90	SK 823 100-☐☐
EH 100 y145	SK 824 101-☐☐
EH 150, 160 y EK 100	SK 825 100-☐☐
EH 250 y EK 160	SK 826 100-☐☐
EH 370 y 550	SK 827 100-☐☐
EH 700, 800 y EK 370, 550	SK 828 100-☐☐

Operating units for DC See the figure below

Coil and contact block with economising resistor

For	Cat.No. ☐☐ replace with code letters acc. to the table below
EH 80, 90	SK 823 151-☐☐
EH 100 and 145	SK 824 151-☐☐
EH 150, 160 and EK 100	SK 825 150-☐☐
EH 250 and EK 160	SK 826 150-☐☐
EH 370 and 550	SK 827 150-☐☐
EH 700, 800 and EK 370, 550	SK 828 150-☐☐

Betätigungseinheit für Gleichstrom

Siehe Fig. unten

Spule und Hilfskontaktblock mit Sparwiederstand

Für	Bestellnummer ☐☐ ersetzen mit Kode-Buchstaben laut Tabelle unten
EH 80, 90	SK 823 151-☐☐
EH 100 und 145	SK 824 151-☐☐
EH 150, 160 und EK 100	SK 825 150-☐☐
EH 250 und EK 160	SK 826 150-☐☐
EH 370 und 550	SK 827 150-☐☐
EH 700, 800 und EK 370, 550	SK 828 150-☐☐

Ensemble pour courant continu

(Voir figure ci-dessous)

Bobine livrée avec un bloc comprenant résistance d'économie et contact d'insertion

Pour	Réf. ☐☐ compléter par code lettres, Voir tableau ci-dessous
EH 80, 90	SK 823 151-☐☐
EH 100 et 145	SK 824 151-☐☐
EH 150, 160 et EK 100	SK 825 150-☐☐
EH 250 et EK 160	SK 826 150-☐☐
EH 370 et 550	SK 827 150-☐☐
EH 700, 800 et EK 370, 550	SK 828 150-☐☐

Manöverenheter för likström Se figur nedan

Spole och kontaktblock med sparmotstånd

För	Beställningsnr ☐☐ ersätts av kodbokstäver enligt separat tabell
EH 80, 90	SK 823 151-☐☐
EH 100 och 145	SK 824 151-☐☐
EH 150, 160 och EK 100	SK 825 150-☐☐
EH 250 och EK 160	SK 826 150-☐☐
EH 370 och 550	SK 827 150-☐☐
EH 700, 800 och EK 370, 550	SK 828 150-☐☐

Unita di funzionamento in c.c.

Vedere figura sotto indicata

Comprende bobina e blocchetto contatti con resistenza di economia

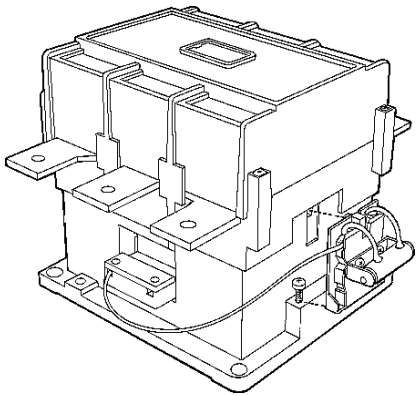
Per	Codice numero ☐☐ Sostituire ai codici alfabetici della tabella sotto riportata
EH 80, 90	SK 823 151-☐☐
EH 100 e 145	SK 824 151-☐☐
EH 150, 160 e EK 100	SK 825 150-☐☐
EH 250 e EK 160	SK 826 150-☐☐
EH 370 e 550	SK 827 150-☐☐
EH 700, 800 e EK 370, 550	SK 828 150-☐☐

Unidades de acciona-míento para c.c.

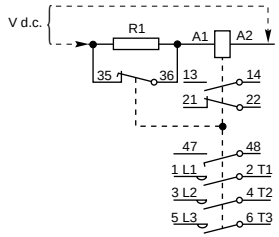
Véase figura inferior

Bobina y bloque de contactos con resistencia economizadora

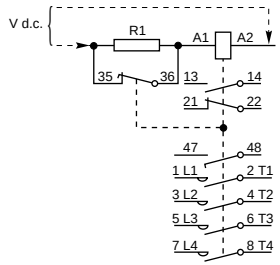
Para	Ref. pedido ☐☐ sustituir por los códigos de letras según la tabla inferior
EH 80, 90	SK 823 151-☐☐
EH 100 y 145	SK 824 151-☐☐
EH 150, 160 y EK 100	SK 825 150-☐☐
EH 250 y EK 160	SK 826 150-☐☐
EH 370 y 550	SK 827 150-☐☐
EH 700, 800 y EK 370, 550	SK 828 150-☐☐



EH 80...800



EK 100...550



Code letters
Kode-Buchstaben
Code lettres
Kodbokstäver
Codici alfabetici
Código de letras

AC, CA

Alternating current
Drehstrom
Courant Alternatif
Växelström
Corrente alternata
Corriente alterna

50 Hz V	60 Hz V	□□	50Hz V	60 Hz V	□□
	24[2]	**AA**	220	240[2]	**AL**
24[1]		**AB**	230–240		**AM**
42[1]	48[1]	**AC**	380		**AN**
48		**AD**	380	440	**AP**
	110	**AE**	400–415		**AR**
110	120	**AF**	480		**AS**
127		**AG**	440		**AT**
	208	**AZ**	500		**AU**
190	220	**AH**	600		**AV**
	240	**AK**			

DC, CC

Direct current
Gleichstrom
Courant continu
Likström
Corrente continua
Corriente continua

DC V	□□
12[1]	**DA**
24	**DB**
36	**DC**
48	**DD**
60	**DT**
110	**DE**
125	**DU**
220	**DF**
440	**DH**

[1] Not for /Nicht für / Sauf / Ej för / Non per / No para / EH 370...EH 800
[2] Only for / Nur für / Seulement pour / Endast för / Solo per / Sólo para / EH 370...EH 800

Protective cover

For	Cat.No.	Qty
For contactor connected by **Cu-cable lugs**		
EH 80,90	SK 178 001-AA	1
EH 100, 145	SK 178 001-BA	1
EH 150, 160	SK 178 001-CA	1
EH 250	SK 178 001-DA	1
EH 370, 550	SK 178 001-EA	1
EH 700	SK 178 001-FA	1
For contactor connected by **cable clamps**		
EH 80,90	SK 178 003-AA	1
EH 100, 145	SK 178 003-BA	1
EH 150, 160	SK 178 003-CA	1
EH 250	SK 178 003-DA	1
EH 370, 550	SK 178 003-EA	1
EH 700	SK 178 003-FA	1

Note: If the contactor is associated with a thermal O/L relay, a special protec-tive cover is needed on the relay side, consult your local sales office.

Berührungsschutz

Für	Bestellnr	An-zahl
Für Schütz angeschloßen mit **Cu-Kabelschuh**		
EH 80,90	SK 178 001-AA	1
EH 100, 145	SK 178 001-BA	1
EH 150, 160	SK 178 001-CA	1
EH 250	SK 178 001-DA	1
EH 370, 550	SK 178 001-EA	1
EH 700	SK 178 001-FA	1
Für Schütz angeschloßen mit **Kabelklemmen**		
EH 80,90	SK 178 003-AA	1
EH 100, 145	SK 178 003-BA	1
EH 150, 160	SK 178 003-CA	1
EH 250	SK 178 003-DA	1
EH 370, 550	SK 178 003-EA	1
EH 700	SK 178 003-FA	1

Achtung: Wenn das Schütz mit einem thermischen Überstromrelais zusammengebaut ist benötigt man eine besondere Schutz-abdeckung für die Relais-seite.Bitte bei einen ABB Ver-triebsbüro nachfragen.

Cache-bornes

Pour	Réf.	Vente par
Pour contacteurs équipés **de connecteurs cuivre**		
EH 80,90	SK 178 001-AA	1
EH 100, 145	SK 178 001-BA	1
EH 150, 160	SK 178 001-CA	1
EH 250	SK 178 001-DA	1
EH 370, 550	SK 178 001-EA	1
EH 700	SK 178 001-FA	1
Pour contacteurs équipés **de connecteurs cosses**		
EH 80,90	SK 178 003-AA	1
EH 100, 145	SK 178 003-BA	1
EH 150, 160	SK 178 003-CA	1
EH 250	SK 178 003-DA	1
EH 370, 550	SK 178 003-EA	1
EH 700	SK 178 003-FA	1

Note: Si le contacteur est associé avec un relais thermique, un cachet-borne spécial est nécessaire côté relais, nous consulter.

Beröringsskydd

För	Beställningsnr	Antal
För kontaktor ansluten med **Cu-kabelsko**		
EH 80,90	SK 178 001-AA	1
EH 100, 145	SK 178 001-BA	1
EH 150, 160	SK 178 001-CA	1
EH 250	SK 178 001-DA	1
EH 370, 550	SK 178 001-EA	1
EH 700	SK 178 001-FA	1
För kontaktor ansluten med **kabelklämmor**		
EH 80,90	SK 178 003-AA	1
EH 100, 145	SK 178 003-BA	1
EH 150, 160	SK 178 003-CA	1
EH 250	SK 178 003-DA	1
EH 370, 550	SK 178 003-EA	1
EH 700	SK 178 003-FA	1

Obs: Om kontaktorn monteras tillsam-mans med termiskt överlastrelä behövs ett speciellt skydd över reläsidan, kontakta närmaste säljkontor.

Protezione dei morsetti

Per	Codice numero	Quant.
Per contattori collegati con **capocorda Cu**		
EH 80,90	SK 178 001-AA	1
EH 100, 145	SK 178 001-BA	1
EH 150, 160	SK 178 001-CA	1
EH 250	SK 178 001-DA	1
EH 370, 550	SK 178 001-EA	1
EH 700	SK 178 001-FA	1
Per contattori collegati con **morsetti**		
EH 80,90	SK 178 003-AA	1
EH 100, 145	SK 178 003-BA	1
EH 150, 160	SK 178 003-CA	1
EH 250	SK 178 003-DA	1
EH 370, 550	SK 178 003-EA	1
EH 700	SK 178 003-FA	1

N.B.: Se al contattore è associato un relé termico è necessaria un protezione speciale. Si prega rivolgersi al nostro ufficio vendite nella vostra zona.

Cubiertas protectoras

Para	Ref. pedido	Canti-dad
Para contactor conectado **con terminales para cables de Cu**		
EH 80,90	SK 178 001-AA	1
EH 100, 145	SK 178 001-BA	1
EH 150, 160	SK 178 001-CA	1
EH 250	SK 178 001-DA	1
EH 370, 550	SK 178 001-EA	1
EH 700	SK 178 001-FA	1
Para contactor conectado mediante **terminales sujetacables**		
EH 80,90	SK 178 003-AA	1
EH 100, 145	SK 178 003-BA	1
EH 150, 160	SK 178 003-CA	1
EH 250	SK 178 003-DA	1
EH 370, 550	SK 178 003-EA	1
EH 700	SK 178 003-FA	1

NOTA: Si el contactor se monta junto con un relé térmico no necesita una protección especial sobre el lado del relé. Póngase en contacto con la Oficina de ventas más próxima.

Care

The contactors do not need any care except for an occasional check up of contact condition. The contact wear depends mainly on burning from the arc and will increase considerably when the contactor is used for inching or direct reversing (AC-4 operations; compare with the electrical endurance diagram in the catalogue). Contactors regularly used for AC-4 operations need more frequent inspections, but main contact exchange is not necessary until the contact tips are almost totally worn out.

Wartung

Die Schütze benötigen keine Wartung außer einer gelegentlichen Kontrolle, daß die Hauptkontakte nicht verschließen sind. Der Verschleiß beruht praktisch vollständig auf Abbrennung durch EIN- und AUS-schaltlichtbogen. Beachte, daß bei Betrieb, bei dem das Schütz oft den Startstrom ausschalten muß (Vorrücken, Direktumkehr), eine Inspektion öfter durchgeführt werden muß, vergleiche mit den Lebensdauerkennlinien im Katalog. Die Kontaktstücke brauchen jedoch nicht ausgewechselt zu werden, bevor die Schaltflächen fast ganz verschließen sind.

Entretien

Les contacteurs ne nècessitent aucun entretien, à l'exception de l'examen pèriodique de l'ètat des contacts. L'usure des contacts dépend surtout de l'érosion due à l'arc électrique et augmente considérablement quand le contacteur est utilisé en marche par à coups ou en inversion de sens de marche (catégorie d'emploi AC-4; voir courbes d'endurance électrique). Les contacteurs utilisés en catégorie AC-4 ont besoin d'examens périodiques, mais l'échange des contacts n'est pas nécessaire tant que leurs pastilles ne sont pas totalement usées.

Skötsel

Kontaktorerna behöver ingen skötsel annat än viss kontroll att inte huvudkontakterna är utslitna. Slitaget beror praktiskt taget helt på avbränning genom slut- och brytljusbågarna. Märk, att vid drift där kontaktorn ofta får bryta startströmmen (framryckning, direktreversering) ökar behovet av inspektion; jämför livslängdskurvorna i katalogen. Kontakterna behöver dock inte bytas förrän kontaktbeläggen är nästan helt utslitna.

Manutenzione

Il contattore non necessita alcuna manutenzione tranne nel caso di verifica delle condizioni dei contatti. L'usura dei contatti dipende principalmente dalle bruciature provocate dall'arco e aumenta notevolmente quando il contattore viene impiegato a scatti o per inversione (categoria d'impiego AC4; confrontare con diagramma di durata elettrica sul catalogo). I contattori utilizzatti in AC4 necessitano di controlli più frequenti, ma la sostituzione dei contatti non è necessaria se le estremità degli stessi non sono quasi totalmente consumate.

Cuidado

Los contactores no requieren ningún cuidado a exceptión de una comprobación ocasional del estado de los contactos. El estado de éstos depende fundamentalmente del quemado provocado por el arco y aumentará considerablemente cuando el contactor se emplee para avance paso a pso o para inversión directa (funcionamiento en la categoría de empleo AC-4; consulte la tabla de longevidad eléctrica del catálogo). Los contactos utilizados habitualmente para accionamientos de categoría AC-4 requiren una inspección más frecuente, pero el cambio de los contactos principales no es necesario hasta que las puntas de los contactos no están casi completamente desgastadas.

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Instr. 5309 660-30 Y Edition 4 Dec 2001

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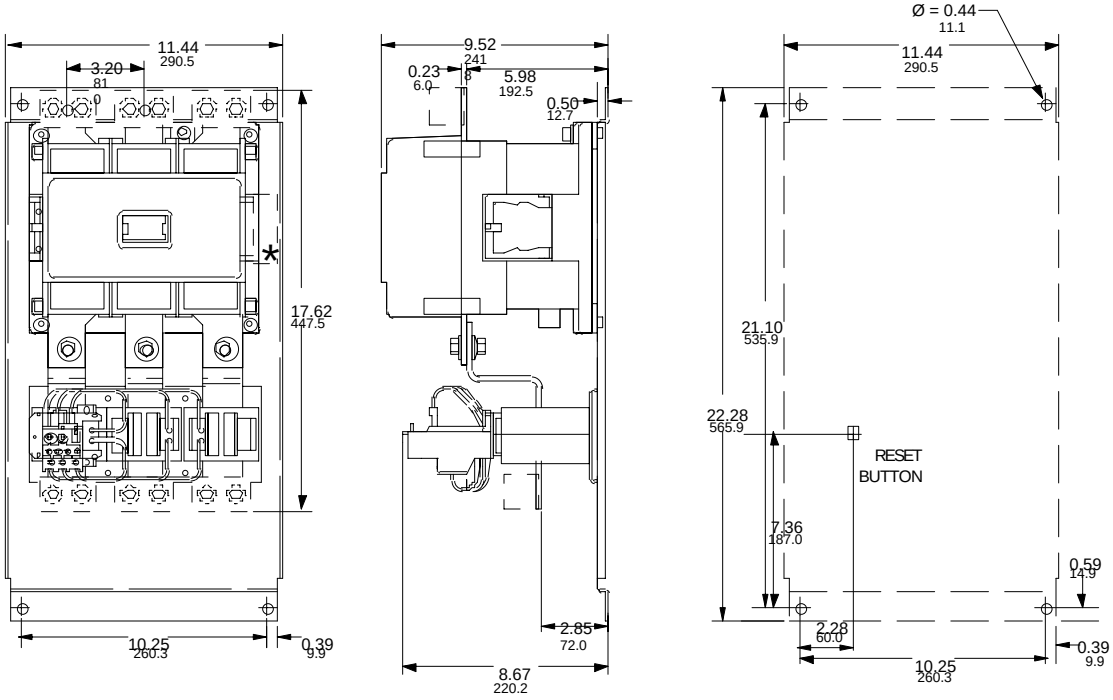

* NOTE: FOR DC-OPERATED CONTACTORS, THE DC AUXILIARY BLOCK AND ECONOMISING RESISTOR ADD 1.00" TO THE WIDTH OF THE EH CONTACTORS.

EH 700 STARTER / T900

ABB Control Inc.
5-20-98
REV. B

Guidelines for inspection and maintenance of main circuit contacts

ABB A-line and EH series Contactors

Contents

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Maintenance of contacts	2
Interpreting levels of electrical contact wear	3
Changing contacts	5
Trouble shooting	8

Mechanical wear

The number of mechanical operations has a low impact on the life of the main contacts and their overall electrical life. However general information concerning mechanical wear could be of interest.

AC-Hum

Pollution of the magnet pole surfaces will create a slight hum coming from the contactor in the closed position.
When cleaning, use a soft and dry piece of cloth.
Hum can also occur if the pole surfaces are deformed.
A louder hum will occur if the shading coil is broken because the magnet will cause the contactor to chatter.
If so the contactor needs to be exchanged.

Another reason for AC-hum could be corrosion caused by environmental conditions that exceed the contactor specifications.

Contactors need to be protected from condensation in order to keep the pole surfaces of the magnet free from corrosion.
For more specific information regarding this please see the our technical catalogue, section: *Climatic withstand of devices.*

Contact bounce

The operational limit of the contactor is between 85 and 110% of the rated coil voltage.
A voltage variation of ± 5% will minimize the contact wear. The reason for this is that higher voltages will increase the speed of the electromagnet at closing. Lower voltages will decrease the speed at closing. Both these factors can lead to a higher level of contact bounce at closing. High voltage and the increased speed at closing also contribute to some increased sound level.

Maintenance of Contacts

A contact is not necessarily damaged or worn out, just because the surface is rough and discolored. The contacts in the figure below may look rather inferior but experience has shown that they are better than a new set of contacts.
This is because they are ”electrically seated” and make good contact over the entire surface.
Based on this it would be completely wrong to change a contact only by judging from the appearance of the surface.

Filing of contacts

Today, with highly developed contact materials and high performance contactors, filing, grinding, or other attempts to restore contacts or contact surfaces should be avoided.
Our experience shows that this increases the risk of causing other problems. For example the risk of increasing the contacts resistance is high due to remnants from grinding paper, etc.

Also lack of cleanliness when attempting to restore the contacts can influence the contactor performance.

Maintenance should be limited to inspection of the contacts for the level of contact wear. This is to ensure a trouble free operation of the contactor until the next service is required.
At the same time observations can be made to judge if the contactor operates well in the application and that no signs of abnormal wear or damages are present on the contacts.

The appearance of contacts after a very low number of operation in an AC-3 application.

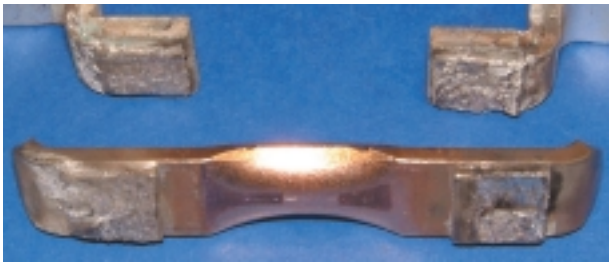
A contact just having reached a ‘good worn in’ level in an AC-3 application.

Interpreting levels of electrical contact wear

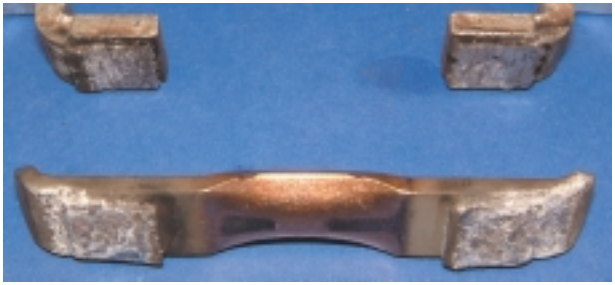
Determining the level of wear on contactors in use is essential from both the functional and economical point of view. Premature service on contactors will increase the overall cost. However, service at the right time to avoid interruptions or breakdowns is more cost effective.

General

The rate of wear is different depending of the utilization category or the application of the contactor. For motor control it also depends on the selected starting method. The following main utilization categories are the most common.



Early stage of fixed and movable contacts in an AC-3 application.



Mid-life stage of fixed and movable contacts in an AC-3 application

End of life of fixed and movable contacts in an AC-3 application

AC-1. (General purpose) Non-inductive or slightly inductive loads, resistance furnaces.

The closing of the main contacts is relatively easy as the starting current is equivalent to the rated current of the load. Breaking is made at full voltage, the arc has a rather low level of energy.

AC-2. Slip-ring motors. Starting, switching off

Typical making and breaking is with approximately 2,5 times the rated current of the motor (Ie x 2.5) the voltage is corresponding to the nominal voltage.

AC-3. Cage motors. Starting, switching off running motors

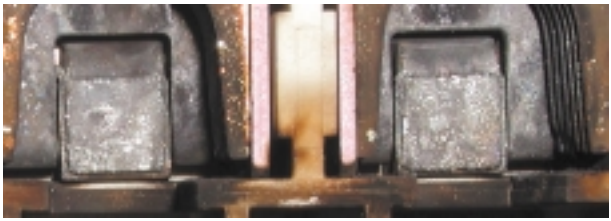
Closing of the main contacts with approximately 6 to 8 times the rated motor current, depending on motor characteristics and type of load.
Breaking is easier, as the current equals the rated motor current, and voltage is reduced to 17 % of the rated voltage.
Typical electrical wear comes from the contact making operation.
Visual inspection of an AC-3 application normally shows none or very little material from the contact tips thrown out into the arc-extinction packages.

AC 4. Cage motors. Starting, plugging, inching.

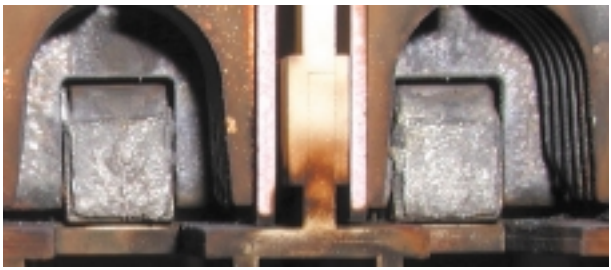
Making and breaking the motor starting current approximately 6 to 8 times the rated motor current. Voltage is not reduced and equals the rated voltage of the motor.

Both making and breaking are contributing to the contact wear. The arc-extinction packages have an important role in extinguishing the arc. Therefore material from the contact tips is in most cases thrown out in the packages. See Figure B on page 5.

Contact wear in AC 4 application, making/breaking locked rotor current



Early stage of fixed (above) and movable contacts (right), 5000 operations.



Mid-life stage of fixed (above) and movable contacts (right) 10000 operations.

End of life.

Changing Contacts

Fig. A

Fig. B

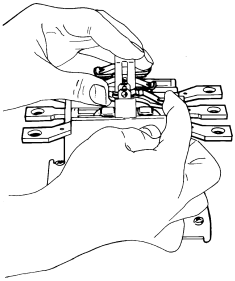
Typical appearance of contacts (Fig. A) and extinction package (Fig B) when breaking locked rotor current (LRC) in an AC-4 application.

Changing contacts on installed units.

EH/ EK Contactors

(1SFC 380002-89)

Replace all of the main contacts at the same time.



EH 100 ... 300

- Remove the arc-chute.
- Press out the moving contacts. Lift the contact somewhat to let the contact easier slide out.
- Exchange the fixed contacts.
- Put in the new moving contacts.

EH 370...800,
EK 370...1000

- Remove the arc-chute.
- Press out the moving arc contacts, see Fig. 1.
- Moving main contacts: Lift the respective clamp and press the contact into neutral position. See Fig. 2. Remove the contacts.
- Exchange the fixed contacts. See Fig. 3.
- Put in the new movable contacts.

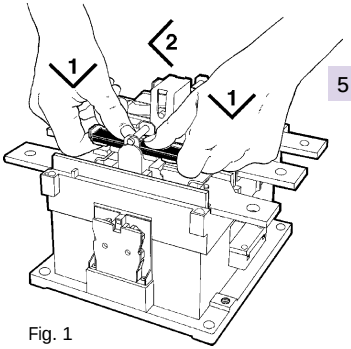


Fig. 1

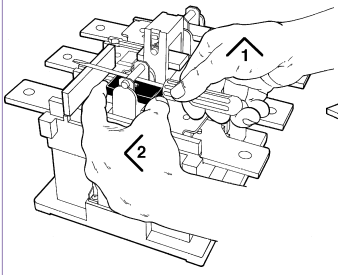


Fig. 2

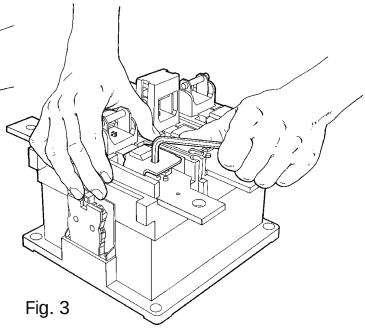


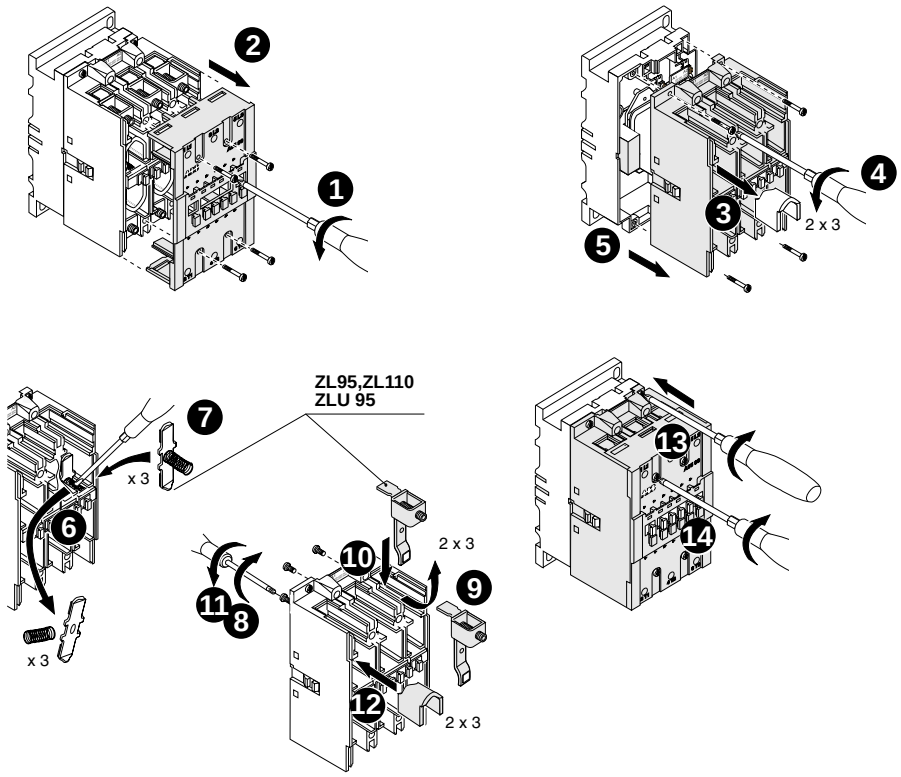
Fig. 3

A-Line Contactors – see page 6 →

Changing Contacts *(cont.)*

Changing contacts
on installed units.

A-Line Contactors, A 95-110



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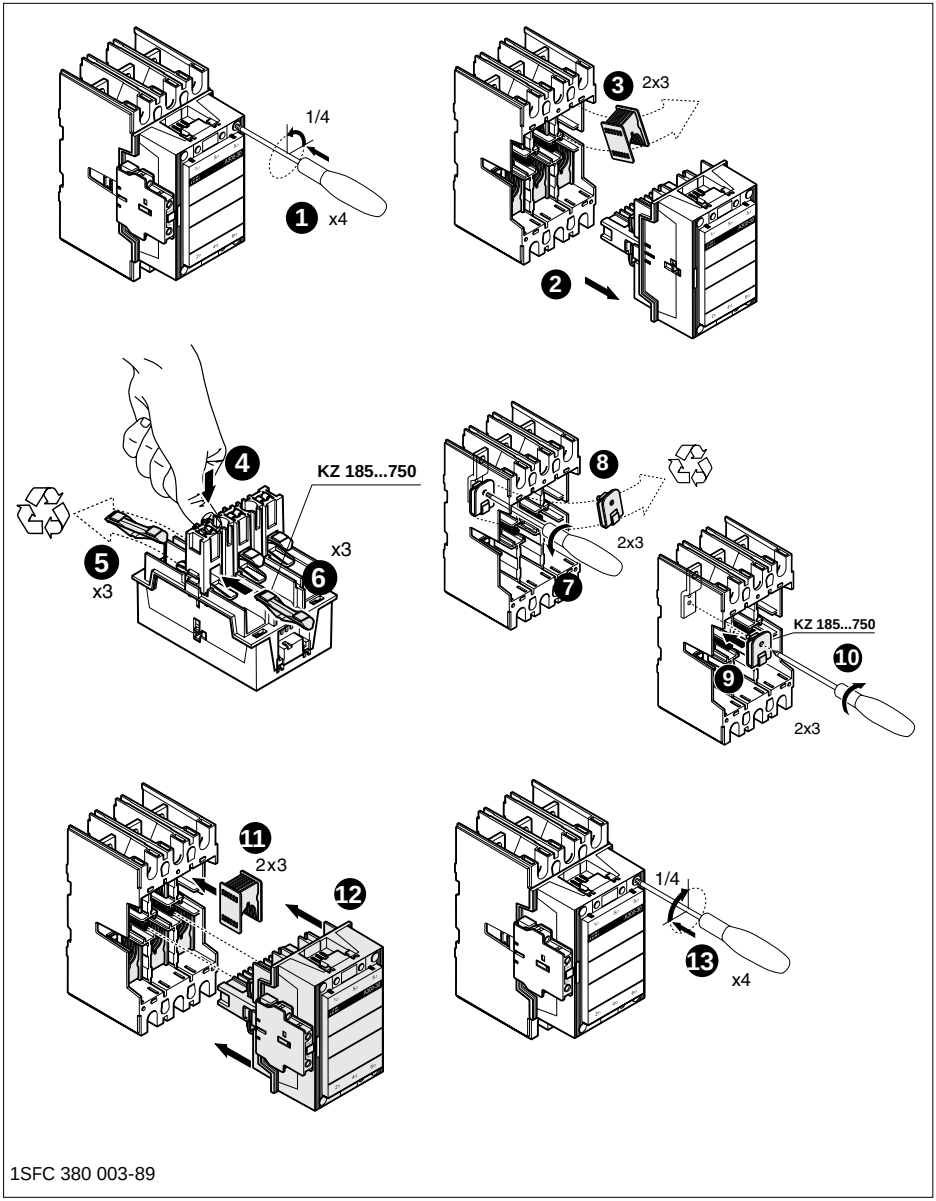


1SFC 380 003-89

Trouble shooting

Some examples of common reasons for excessive contact wear and shortened contact life:

Voltage drop during start up of the motor
Voltage drop to less than 85 % of nominal voltage for 5 to 10 ms can be enough for the contactor to start opening.
Also, other disturbances in the control voltage could be responsible for this problem.
The result of these voltage problems can be increased contact wear and also lead to welding of main contacts.

...related to different starting methods.

DIRECT ON LINE (ACROSS-THE-LINE) MOTOR STARTING

Current peaks due to heavy duty starting

- If the application requires a high level of torque during start-up, for example a fan or a pump, it is important that the contactor's making capacity and short time withstand current are capable of handling the starting current and current peak.

Restarting with motor idling

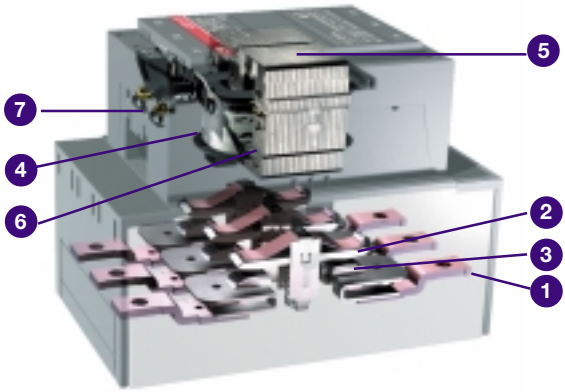
- Attempting to restart the motor before the motor has come to a full stop will cause a current peak that theoretically can reach twice the current compared to starting the motor from a standstill.
  This can result in welded contacts.

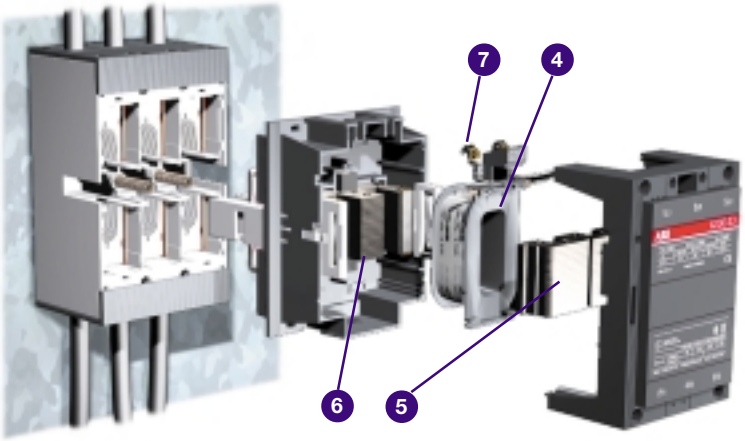
STAR DELTA (WYE-DELTA) STARTERS
Change over time between star and delta.

- Setting the change over time between star and delta too short will not allow the motor to reach 80-90% of its nominal speed. This will cause the star contactor to break a higher current than expected. If the starter stays in the star position for too long of a period; this will increase the stress of the star contactor because the star contactor is mainly sized for the short time current rating.
- The change over time between the star and delta is important. If no timer or other device is used to get an idle time between opening of the star contactor and closing of the delta contactor, there is a risk that the arc inside the star contactor could remain and create a short circuit.

If the elapsed time is too long, the motor starts to decelerate and the delta closing will create a higher current peak than expected. This can result in welded contacts.
Generally the idle time should not exceed 50 ms.

1 Terminal bar
2 Moving contact
3 Fixed contact
4 Operating coil
5 Armature
6 Core
7 Coil terminal





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Telephone + 46 21 32 07 00 Fax + 46 21 12 60 01
Pamphlet 1SFC 101001M0201, December , 2001

1/L1	2/L2	5/L3

ABB

EH 700

LISTED 776 D
IND. CONTEQ

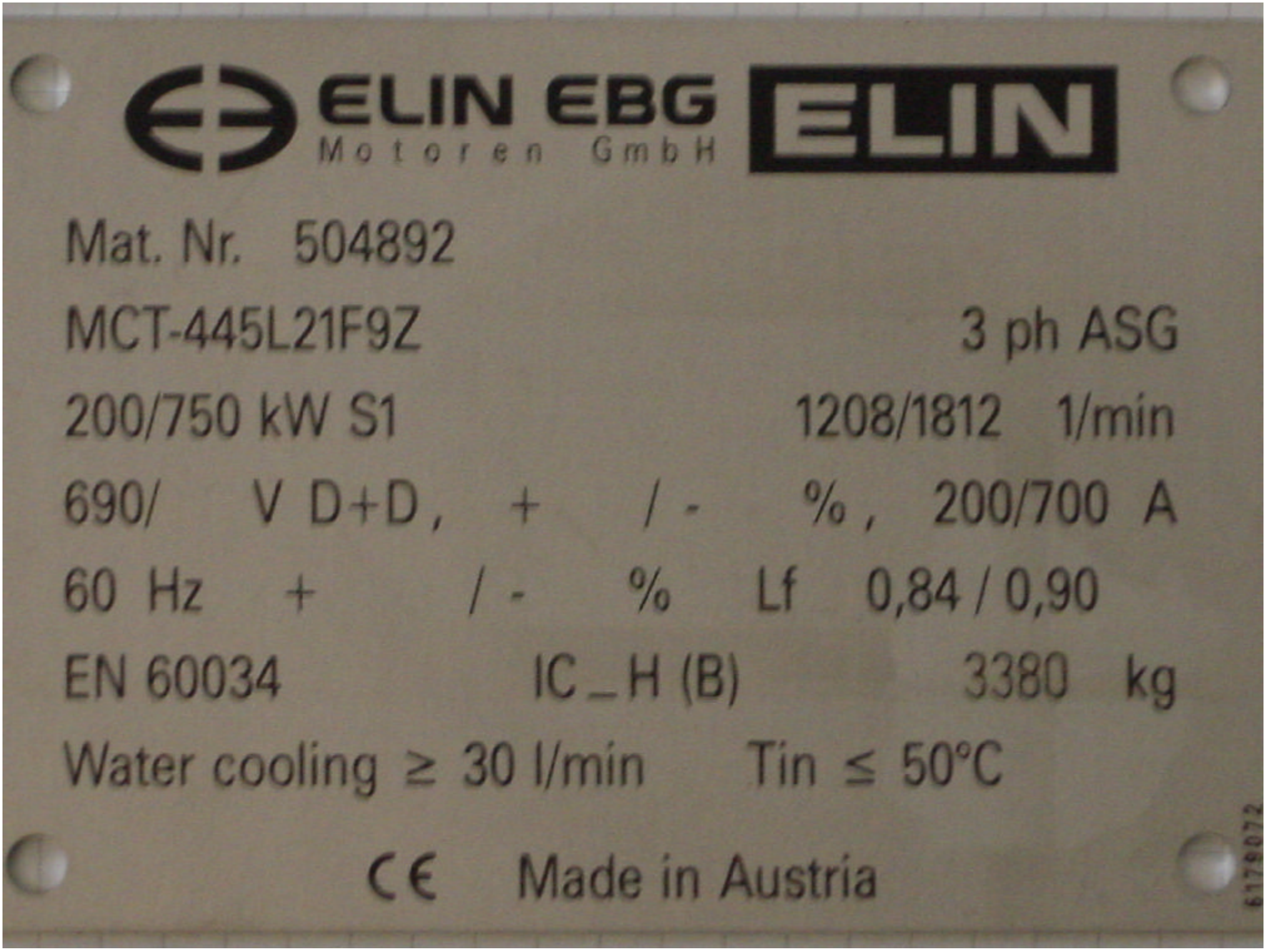
IEC 947 - 4 - 1 Ui = 1000 V
AC 1 1000 A
AC 3

Max. 3hp ratings.
3 pole breaking

220 - 240 V	220 kW	220 - 208 V	200 hp
380 - 400 V	370 kW	220 - 240 V	250 hp
415 V	400 kW	440 - 480 V	500 hp
660 - 690 V	600 kW	550 - 600 V	600 hp
1000 V	315 kW	715 Amp. 600 V AC	

SK 828 004 - ☐ ☐

2/T1	4/T2	6/T3


ELIN EBG
Motoren GmbH
ELIN
Mat. Nr. 504892
MCT-445L21F9Z
3 ph ASG
200/750 kW S1
1208/1812 1/min
690/ V D+D, + / - %, 200/700 A
60 Hz + / - % Lf 0,84 / 0,90
EN 60034
IC_H (B)
3380 kg
Water cooling ≥ 30 l/min
Tin ≤ 50°C
CE
Made in Austria
6178072

Mita-Teknik a/s

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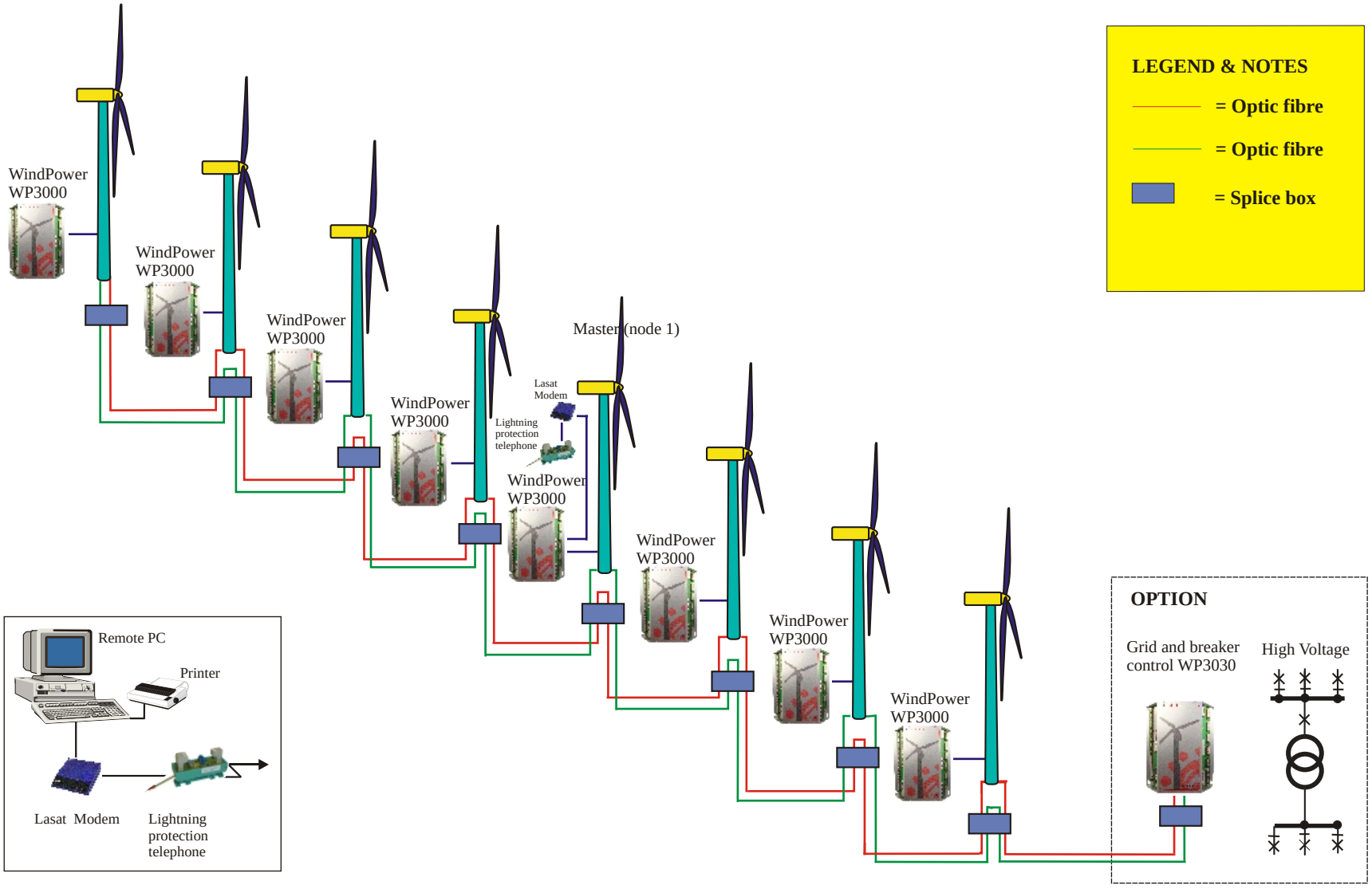
Fax:+45 86 65 92 90



WIND PARK COMMUNICATION - EXAMPLE OF PARK COMMUNICATION BY FIBRE OPTICS

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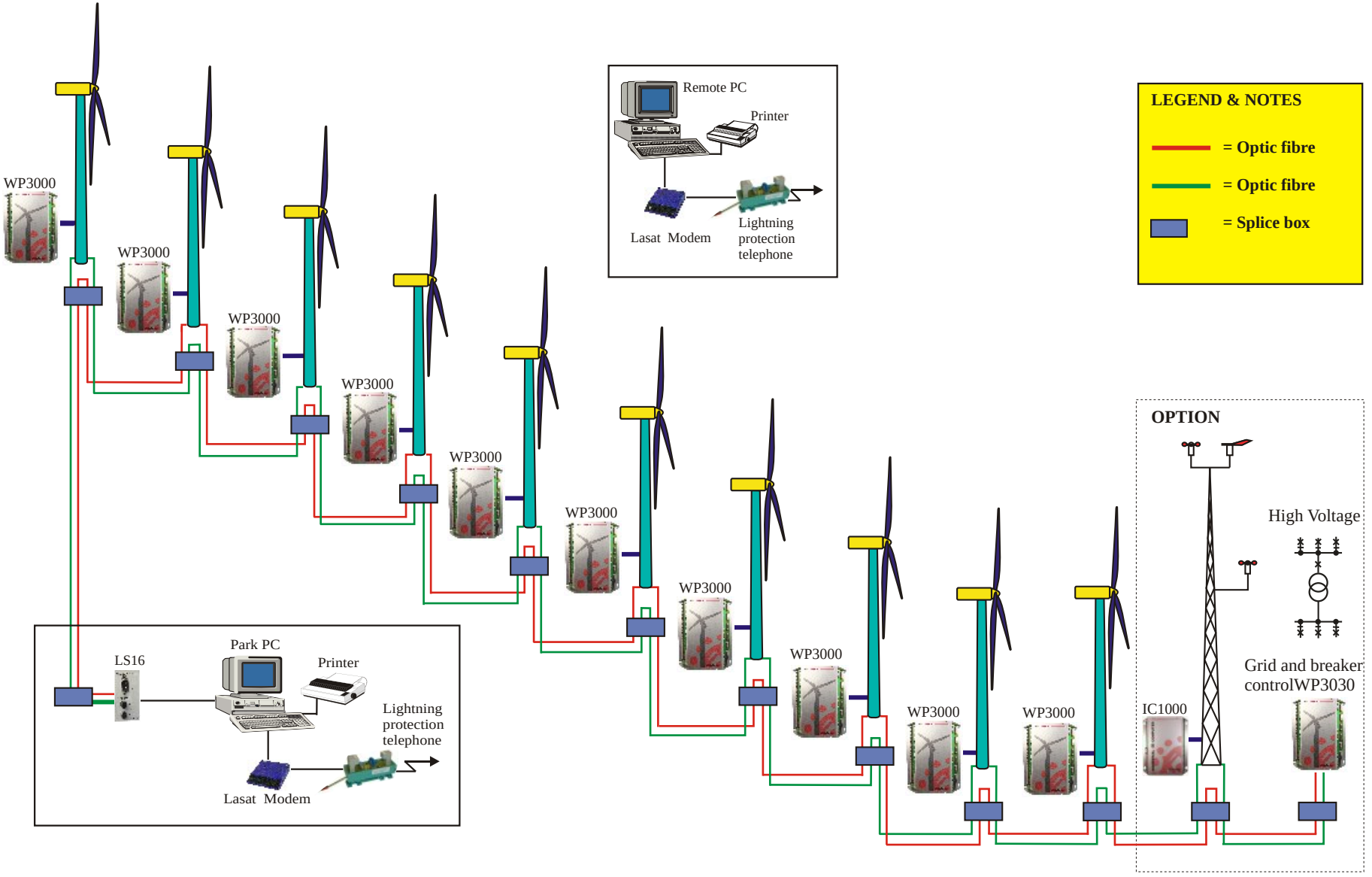

WIND PARK COMMUNICATION - EXAMPLE OF PARK COMMUNICATION WITH PARK PC BY FIBRE OPTICS

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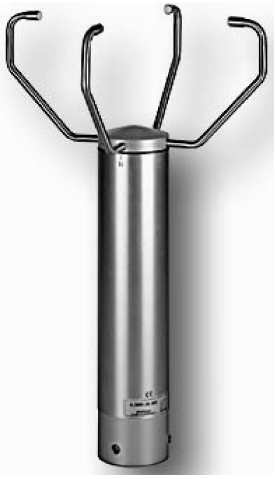

The weather station, type IC1000, is used in wind parks for surveillance and collection of the following data: Wind speed, win direction, temperature, and air pressure.

- The weather station is supplied in a weatherproof GRP-Cabinet IP65.
- The weather station is supplied complete with all standard sensors.
- The mast (pole), is not scope of supply.
- For data collection and stastitics, the weather station communicates with the Mita-Teknik management system.
- The wind speed is measured in the range(0-60)m/s. The primary ultrasonic anemometer is batched by a reference anemometer, mounted at a different level.
- Communication in wind parks with WP3000 controllers.
- The weather station logs wind & weather data and system information, e.g. summary of the latest 31 days in 1 day intervals. 36 hours log for 10 min. mean, max., min. and std. deviation values.
- The wind direction is measured in the range (0-359)°.
- The temperature is measured in the range (-40 - +70.0) °C
- The air pressure is measured in the range (0-200.0)kPa.
- As an option, the weather station is prepared for the connection of ice & lightning detectors, rain sensors, sun sensors etc.
- The weather station is UPS backed.
- The weather station IC1000 (Part no.: 99599018) is produced in accordance with the demands in the DS/EN ISO 9001-standard and is EMC-tested according to EN50082-2 and EN50081-2.

WEATHER STATION IC1000

Mita-Teknik a/s

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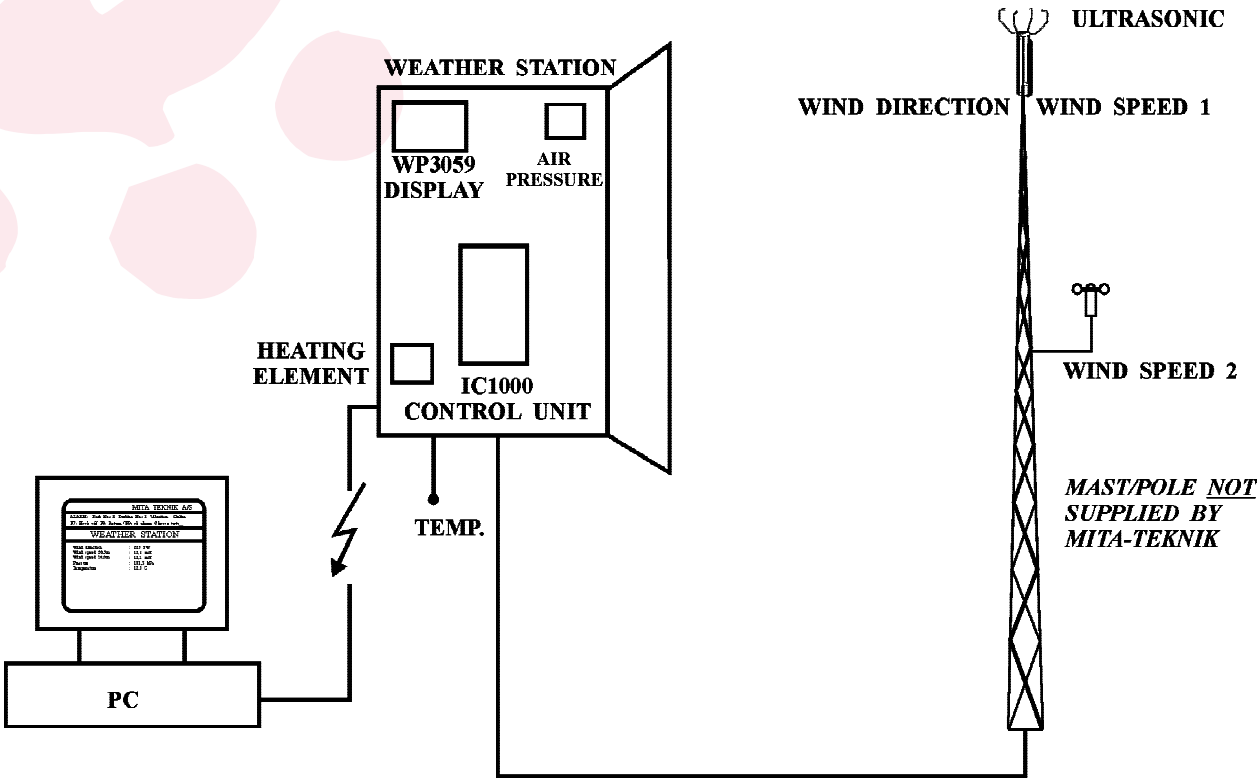
Ph.:+45 86 65 86 00
Fax:+45 86 65 92 90



TECHNICAL DATA		MIN.	MAX.	RESOLUTION	UNIT
Communication: M-Net (8 bit, no parity) Optic fibre multimode 62.5/125µm (RS485 OPTION)		Communication 1200, 2400, 4800, 9600 14400,19200 and 38400			BAUD
Standard sensors:					
Wind direction & speed, 1		0.1	60	0.1	m/s
Wind speed, 1	accuracy	+/- 0.1 m/s	+2		%
Wind direction, 1	accuracy	-1.5	+1.5	1	°
Wind speed 2,	option	0.5	50	0.1	m/s
Temp. 1 Ultrasonic		-40	+70		°C
Temp. 1 Ultrasonic	accuracy	- 0.5°k	+ 0.5°k	0.1	°
Temp.2 (PT100)		-30	+70.0	0.1	°
Pressure		0	200.0	0.1	kPa
Averaging (wind speed, temperature, pressure)		0.1	1		sec.
Averaging (wind direction)		0.5	10		min.
Power Supply 230VAC 50/60Hz - OPTION: 110VAC				5	A
Temperature,	continuous operation	-20	+60		°C
	stock	-30	+60		°C
Weight			50		Kg
Height			700		mm
Width			500		mm
Depth			270		mm

WEATHER STATION IC1000

Catálogo técnico

649240/041 es
Mayo '97

Interruptores automáticos
en caja moldeada de baja tension

SACE Isomax S

690 V • 125-1600 A • 16-100 kA (380/415 V)

ABB SACE

ÍNDICE GENERAL

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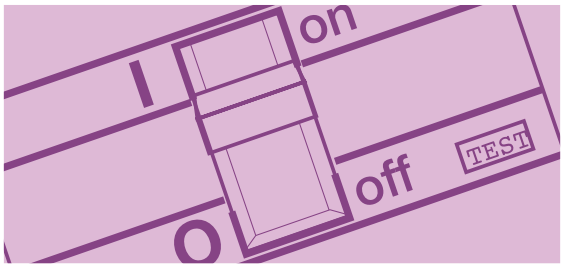

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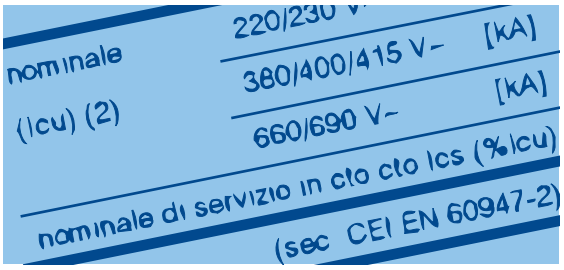

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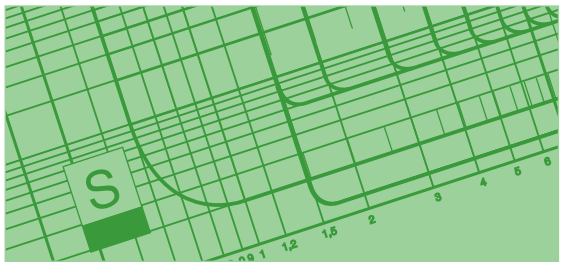

Accesorios, relés y
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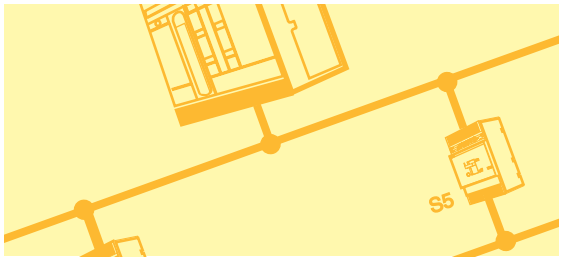
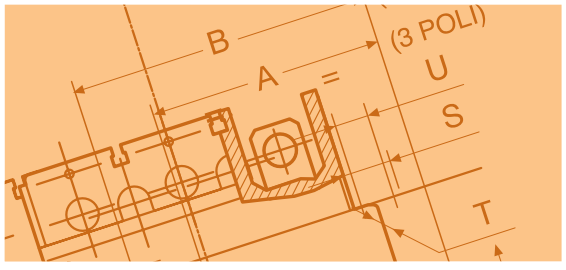


Aplicaciones del interruptor



Dimensiones generales y
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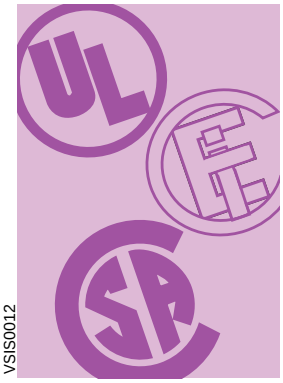
Códigos para efectuar el pedido

Tecnología, innovación y fiabilidad.
El fruto de la investigación más avanzada

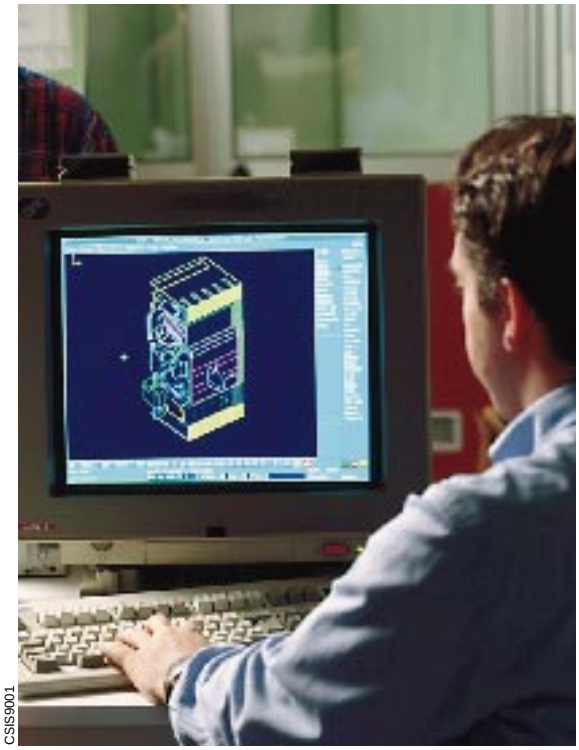


VSIS0012

Siete modelos de interruptores conformes a las normas internacionales IEC 947-2.
SACE Isomax S significa también una gama de interruptores automáticos conformes a las normas estadounidenses UL489 y canadienses CSA 22.2.

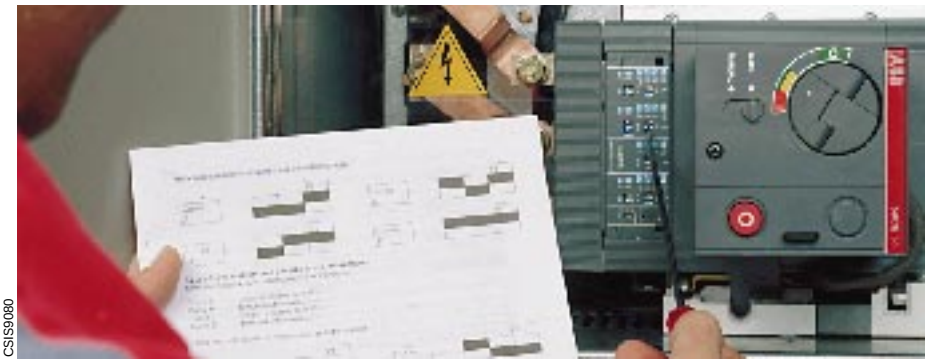
Nueva tecnología para la protección y el control de las instalaciones

La rápida y continua evolución tecnológica ha llevado a un constante aumento de la complejidad de las instalaciones eléctricas; hoy más que nunca las mismas aplicaciones requieren continuidad de servicio, fiabilidad y un número de intervenciones de mantenimiento lo menor posible.
Para que las instalaciones satisfagan estas condiciones son fundamentales los aparatos de protección y, en especial, los interruptores automáticos y diferenciales que, en consecuencia, adquieren un papel fundamental.
Para responder a estas nuevas exigencias de las instalaciones, ABB SACE ha proyectado la nueva serie de interruptores automáticos en caja moldeada de baja tensión SACE Isomax S, que representa un salto generacional en la tecnología del proceso de interrupción de la corriente y, más en general, en la distribución y en el control de la energía eléctrica.
Toda la gama se articula en cinco modelos básicos, S1, S2, S3, S4, S5, S6 y S7, con corrientes permanentes asignadas de 125 a 1600 A y con poder de corte de 16 a 100 kA (380-415 V).



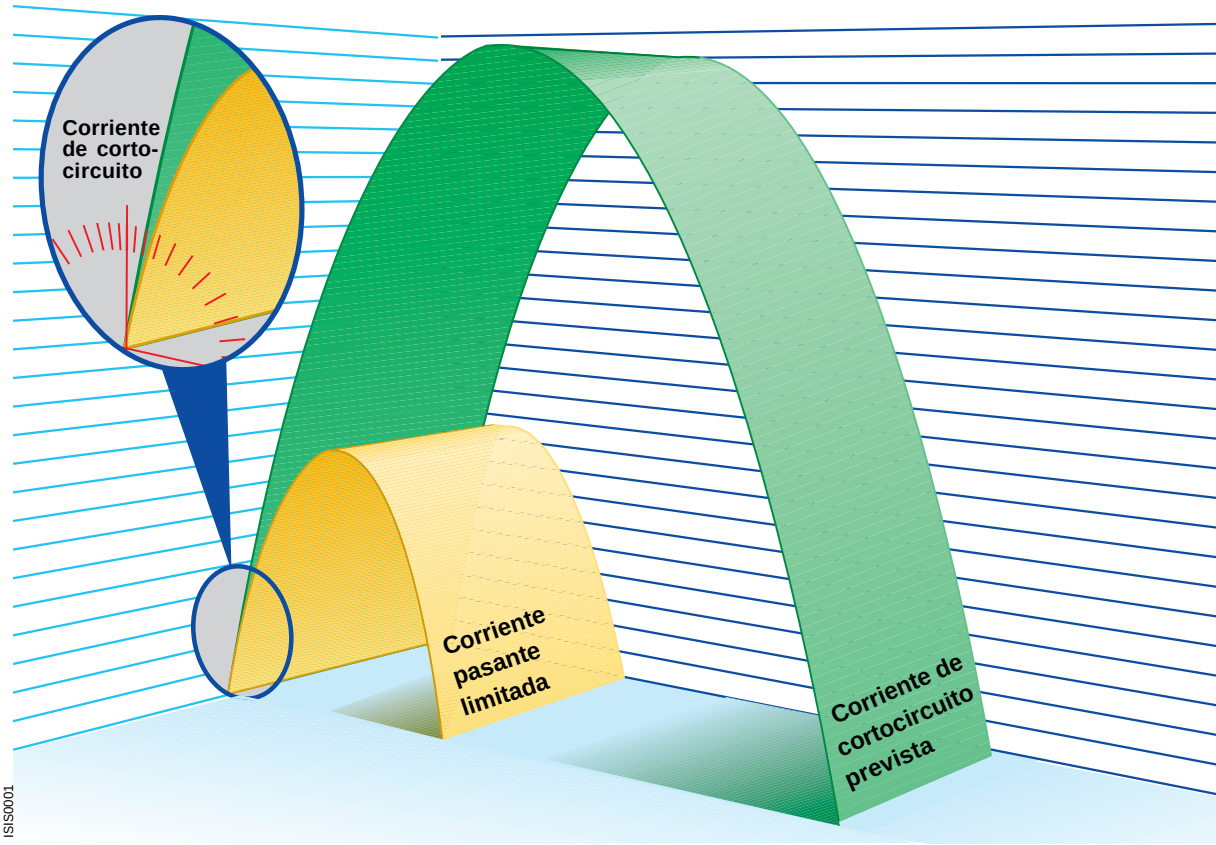
CSIS9001

La gama SACE Isomax S, fruto de un atento análisis de las exigencias del mercado, ofrece un alto nivel de prestaciones con unas dimensiones generales especialmente reducidas, flexibilidad, uso práctico, facilidad de instalación y, por lo tanto, un alto nivel tecnológico. En los relés con microprocesador, la parte electrónica, caracterizada por la precisión y la fiabilidad obtenidas gracias a una realización esmerada tanto de los proyectos de los componentes como de los algoritmos de funcionamiento, ha consentido añadir a las tradicionales funciones de protección típicas de los relés termomagnéticos, funciones como el control y la comunicación para obtener una integración completa de los interruptores automáticos con las lógicas de gestión relativas a los sistemas de supervisión y control de la red eléctrica.
Los algoritmos que determinan las funciones de protección se memorizan directamente en el microprocesador del relé. El funcionamiento se controla en los laboratorios de ABB SACE y se basa en la medición del verdadero valor eficaz según criterios de medición, muestreo y reconstrucción de la señal de corriente adecuada a las diferentes condiciones de defecto que se pueden producir en una instalación.
La nueva serie ha sido estudiada de acuerdo con los más modernos criterios ergonómicos como demuestran los premios otorgados a los interruptores automáticos SACE Isomax S en el Forum Design de Hannover y en el Electro de París.
Los interruptores SACE Isomax S se caracterizan por un innovador sistema de corte, alcanzan niveles de seguridad casi totales para el personal encargado de las instalaciones y se realizan completamente con materiales reciclables; esto demuestra que una mayor atención hacia el hombre y el medio ambiente no es incompatible con las eventuales soluciones de los problemas técnicos relacionados con la distribución de la energía eléctrica.


CSIS9080

La mayor velocidad de apertura de los contactos, la acción dinámica de soplado ejercida por el campo magnético y la estructura de la cámara de arco contribuyen a extinguir el arco en el menor tiempo posible con la consiguiente limitación del valor de la energía específica pasante I^2t y del pico de corriente.

CSIS9002
ISIS0001



Corriente alterna y corriente continua. Una única gama para todas las aplicaciones

CSIS9003

La estructura modular en siete modelos, las profundidades coordinadas, los volúmenes reducidos y la variedad de conexiones permiten reducir las dimensiones de los cuadros y simplificar la instalación incluso en cuadros prefabricados.

Mismas posibilidades de aplicación

Los interruptores automáticos SACE Isomax S se pueden utilizar en todas las instalaciones industriales y civiles para la producción y la distribución de energía eléctrica en corriente alterna con corrientes de servicio de 10 a 1600 A y en corriente continua de 10 a 800 A. Por lo tanto, se aplican en los cuadros de distribución primaria (Power Center) y secundaria (Panel Board) para la protección y el mando de motores (Motor Control Center), generadores y usuarios finales. Sin embargo, las prestaciones son especialmente interesantes cuando se presentan situaciones críticas (corrientes nominales y de defecto muy elevadas) o cuando se necesitan instalaciones complejas (exigencias especiales de coordinación y automatización de las instalaciones). Además, la amplitud de la gama y las posibilidades de empleo están garantizadas por la presencia de una serie de accesorios completa y flexible, idénticos para los grupos de interruptores S1-S2/S3-S4-S5/S6-S7. Esto consiente satisfacer cualquier tipo de exigencia, racionalizar el almacén y reducir las reservas necesarias.

VSIS0003

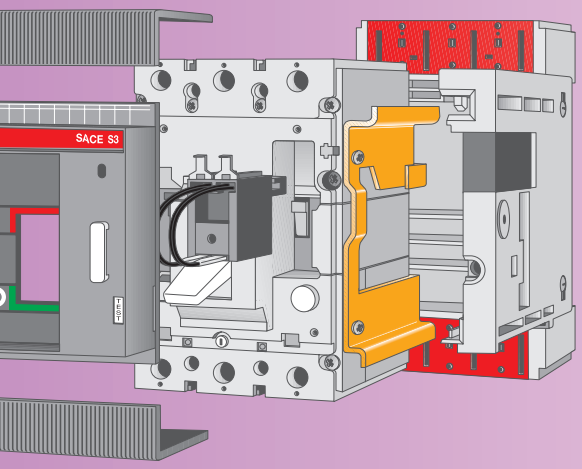
Las aplicaciones de corriente continua y de corriente alterna consienten satisfacer todas las exigencias de distribución, protección y control de los dispositivos de la instalación, desde los cables hasta las máquinas.

Funcionalidad y seguridad para los usuarios finales

Los interruptores automáticos, diferenciales, de maniobra-seccionadores de la serie SACE Isomax S han sido proyectados de manera que todas las personas que los utilizan (instaladores, operadores y encargados del mantenimiento) trabajen en plena seguridad gracias a algunas características especiales como:

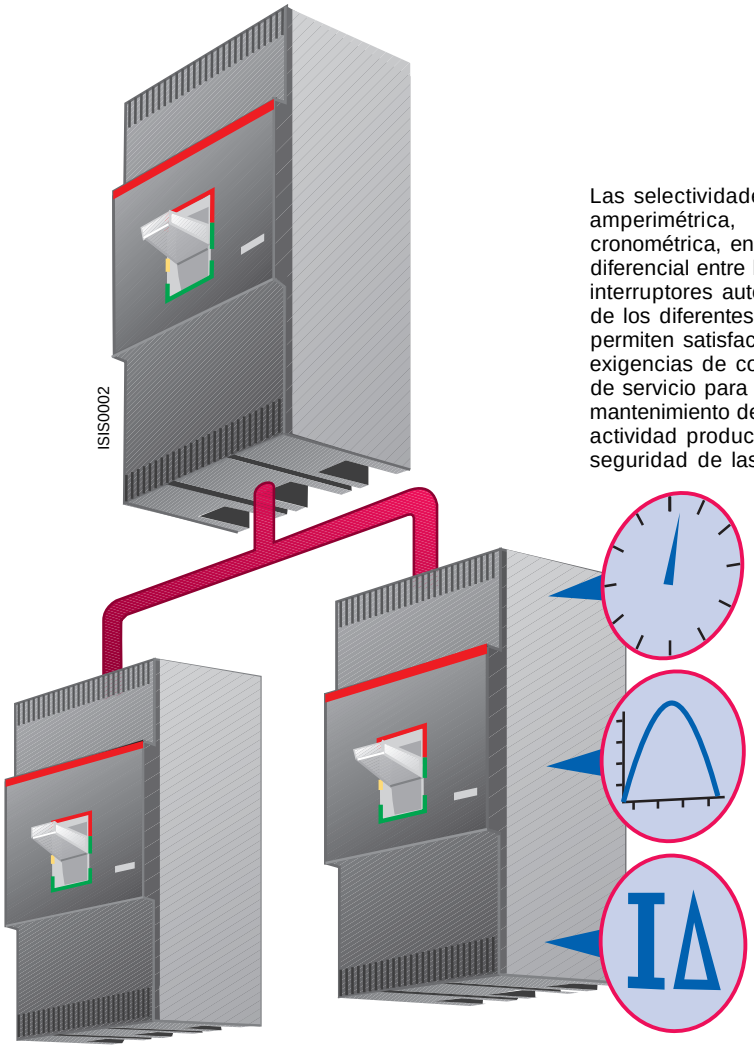
- **doble aislamiento**
- **bloqueo de la puerta de la celda con interruptor cerrado**
- **posibilidad de extraer el interruptor con la puerta de la celda cerrada**
- **seccionamiento de los circuitos auxiliares de los accesorios para las versiones enchufables y extraíbles**
- **maniobra positiva gracias a la cual se tiene la certeza de que la posición de la palanca (interruptor abierto o cerrado) corresponde exactamente a la posición de los contactos del interruptor**
- **facilidad de inspeccionar el interruptor con lo que es posible efectuar el correcto mantenimiento y reducir los tiempos de intervención y los paros de la instalación.**

Para satisfacer de la mejor manera cualquier exigencia de la red de distribución, los nuevos interruptores automáticos unen, a las tradicionales funciones de protección, la coordinación selectiva, la protección de tierra, la medición y la transmisión de los datos y la posibilidad de la gestión centralizada.



Los interruptores automáticos con corrientes asignadas de 10 a 1600 A de corriente alterna pueden combinarse con relés diferenciales que funcionen con una tensión asignada de servicio a partir de 50 V. Esto garantiza la seguridad continua de la instalación incluso en condiciones de funcionamiento crítico debido a bajadas de tensión por defectos de alimentación; en estas circunstancias, la protección diferencial contra contactos indirectos y riesgos de incendio por pérdida de los aislamientos permanece activada.

Los relés diferenciales pueden usarse para corrientes de fuga a tierra de 0,03 a 30 A con actuación retardable hasta 5 s y se pueden aplicar a todos los interruptores automáticos de la serie SACE Isomax S; es posible elegir entre los relés diferenciales SACE RC211 o RC212 (para montar directamente en versión lateral o vertical a los interruptores S1, S2 y S3) y el relé diferencial de cuadro SACE RCQ (utilizable con todos los interruptores).



Las selectividades amperimétrica, cronométrica, energética y diferencial entre los interruptores automáticos de los diferentes modelos permiten satisfacer las exigencias de continuidad de servicio para el mantenimiento de la actividad productiva y la seguridad de las personas.

Dimensionamiento óptimo, versatilidad en la aplicación. La mejor relación entre las prestaciones y los costes

Múltiples soluciones para proyectar las instalaciones

Con los interruptores automáticos SACE Isomax S el proyectista dispone de una amplia gama de soluciones que le permiten dimensionar adecuadamente cualquier tipo de instalación, tanto desde un punto de vista técnico como económico.

La tipología de los interruptores comprende:

- **Interruptores automáticos en versión fija, enchufable y extraíble, con cinco niveles de poder de corte de 16 a 100 kA, identificados por las siglas B, N, S, H y L**
- **Interruptores de maniobra-seccionadores**
- **Interruptores automáticos diferenciales**
- **Interruptores diferenciales**
- **Interruptores para proteger los motores con relés solo magnéticos**
- **Interruptores para máquinas herramienta**
- **Interruptores para ambientes marinos o tropicales**
- **Componentes de la serie SACE SD para la integración en sistemas de supervisión y control.**

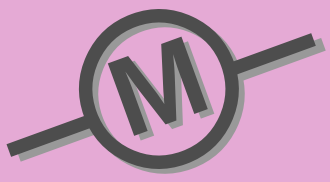
La variedad de las versiones es fruto de la combinación de las ejecuciones disponibles y de la posibilidad de elegir entre diferentes tipos de relés (termomagnéticos o electrónicos con microprocesador) de manera que se puedan satisfacer todas las exigencias de aplicación. La elección del modelo permite identificar las características eléctricas fundamentales (corrientes asignadas y poder de corte), la elección del relé, el tipo de aplicación (corriente alterna, corriente continua, protección contra la sobrecarga, cortocircuito, defecto a tierra, comunicación y supervisión).

Tipo	Iu (40 °C)	Ue [V]		Categoría	Relé	Icu (380 - 415 V c.a.)						
		c.a.	c.c.			16 kA	25 kA	35 kA	50 kA	65 kA	85 kA	100 kA
S1 125	125 A	500	250 (2 polos en serie)	A	TM	B	N					
S2 160	160 A	690	500 (3 polos en serie)	A	TM	B		N	S			
S3 160	160 A	690	750 (3 polos en serie)	A	TM			N		H	L	
S3 250	250 A	690	750 (3 polos en serie)	A	TM			N		H	L	
S4 160	160 A	690	–	A	µP			N		H		L
S4 250	250 A	690	–	A	µP			N		H		L
S5 400	400 A	690	750 (3 polos en serie)	B	TM / µP			N		H		L
S5 630	630 A	690	750 (3 polos en serie)	A	TM / µP			N		H		L
S6 630	630 A	690	750 (3 polos en serie)	B	TM / µP			N	S	H		L
S6 800	800 A	690	750 (3 polos en serie)	B	TM / µP			N	S	H		L
S7 1250	1250 A	690	–	B	µP				S	H		L
S7 1600	1600 A	690	–	B	µP				S	H		L

TM = Relés de sobrecorriente termomagnéticos
µP = Relés de sobrecorriente con microprocesador

Interruptores automáticos para corriente continua

Los interruptores automáticos para corriente continua con relés termomagnéticos se encuentran disponibles para tensiones de servicio hasta 750 Vcc (con 3 polos en serie) y para corrientes de servicio de 10 a 800 A. La conexión en serie de los polos consiente realizar aplicaciones en condiciones de uso más difíciles y en cualquier tipo de red (aislada, con polaridad a tierra y con punto medio de la alimentación a tierra).

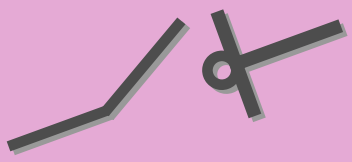


Interruptores automáticos para la protección de motores

Son ideales para la protección y la maniobra de motores para potencias hasta 355 kW, alcanzando un nivel de coordinación “tipo 2” con arrancadores ABB.
El arrancador se compone de diferentes dispositivos según si el interruptor automático realiza funciones de maniobra, protección contra el cortocircuito o contra la sobrecarga.

Interruptores automáticos para el mando de máquinas herramienta

Las versiones con corrientes asignadas de 32 a 400 A se encuentran disponibles en ejecución para el mando y el control de máquinas herramienta, incluso de elevada potencia. Concretamente, la ejecución con mando giratorio en el interruptor, relé de mínima tensión y contacto auxiliar anticipado (que mantiene desexcitado el relé de mínima con el interruptor automático abierto) ha sido estudiada para cumplir con las normas IEC 204-1, CEI 44-5 y VDE 0113.

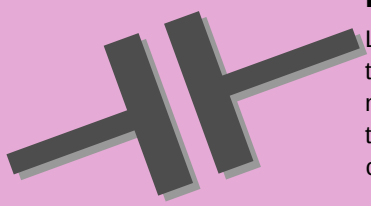


Interruptores de maniobra-seccionadores

Los interruptores de maniobra-seccionadores derivan de los correspondientes interruptores automáticos de los cuales conservan inalteradas las dimensiones generales, las ejecuciones y los accesorios. El dispositivo de disparo puede ser accionado por el relé de mínima tensión o por el relé de apertura. También se pueden dotar con relés diferenciales.

Interruptores automáticos para la protección de generadores

La corriente de cortocircuito permanente, en caso de defecto aguas abajo de un generador, depende de la impedancia síncrona de la máquina y, en general, es ligeramente superior a la corriente asignada del generador. Por este motivo, es necesario utilizar interruptores automáticos con un umbral de actuación instantáneo bajo, disponibles en las versiones con relé electrónico con microprocesador.



Interruptores automáticos para la protección de condensadores

La maniobra de conexión de una batería de condensadores puede provocar una sobrecorriente transitoria, incluso de gran intensidad. Gracias a los elevados poderes de cierre, a la larga durabilidad mecánica y eléctrica y al amplio campo de regulación de los diferentes parámetros, los interruptores automáticos SACE Isomax S están especialmente indicados para la maniobra y la protección de las baterías de condensadores.

Sistemas centralizados de supervisión y control

La fiabilidad, la eficiencia y la calidad del servicio de distribución de la energía eléctrica en baja tensión están considerablemente reforzadas gracias a una continua supervisión de los servicios y de todos los parámetros de la misma instalación, de manera que ha sido posible añadir nuevas oportunidades, como la actualización en tiempo real del estado de conexión de la red, el mando remoto de los interruptores de maniobra-seccionadores, la recogida de datos sobre el servicio de la red, el mantenimiento preventivo, la reconstrucción o nivel de gestión de la situación de la instalación, la gestión integrada de la red de distribución de la energía eléctrica. Las informaciones sobre la instalación se recogen mediante componentes de campo con microprocesadores que pueden montarse directamente en los aparatos, como el relé SACE PR212/P, o mediante dispositivos capaces de adquirir magnitudes analógicas y/o digitales significativas para el control de la instalación, como los dispositivos de la familia SACE SD. Además, el uso del software SACE SD-View 810 consiente transformar un simple ordenador personal en una estación para la supervisión y el control de las instalaciones de distribución de energía eléctrica.

Una elección guiada...
.....para una fácil instalación

Elaboración de proyectos y dimensionamiento de las instalaciones eléctricas

Se encuentran disponibles cinco instrumentos de trabajo muy útiles (el software DOC, el kit de reglas, la guía para la selección de aparamenta de baja tensión, el catálogo electrónico C.A.T. y el software INSINT) que facilitan los cálculos, aseguran la conformidad del equipo con las normativas y disminuyen los riesgos de error.

CSIS9004

El software DOC permite que el proyectista realice, en poco tiempo, un correcto dimensionamiento técnico y económico utilizando los equipos ABB.
Asimismo, dicho software permite que el proyectista desarrolle una documentación del proyecto clara y completa sobre las bases de los modelos de cálculo previstos por las normativas y de los datos experimentales deducidos en las pruebas sobre los componentes.

CSIS9005

Cuatro reglas de diferente color, que constituyen el kit ABB, permiten rápidos cálculos de dimensionamiento del equipo eléctrico según los métodos deducidos de las vigentes normas UNE, IEC y de la práctica en el sector. Es posible efectuar:
– El dimensionamiento de los cables y el cálculo de las corrientes de cortocircuito (regla amarilla).
– La Verificación de las protecciones contra los contactos directos y de cortocircuito de los cables (regla naranja).
– La coordinación selectiva y de acompañamiento (regla verde).
– El dimensionamiento de las líneas de motor y salidas de los transformadores (regla azul).

CSIS9006

La Guía para la selección de aparamenta de baja tensión permite el cálculo de la instalación y la optimización técnica y económica en la selección de la aparamenta.
Constituye una herramienta de consulta práctica e imprescindible para proyectistas e instaladores.

CSIS9007

Para facilitar la elección de los interruptores se encuentra disponible el **catálogo electrónico multimedia C.A.T.** (**C**omputer **A**ided **T**echnical selection) en CD-ROM, con el cual es posible, mediante unos recorridos guiados, seleccionar y solicitar directamente el interruptor más adecuado a las exigencias de la instalación y elaborar una documentación técnico-comercial personalizada sobre los productos formada por fichas técnicas, curvas de actuación, dimensiones, pedido, etc., todo ello impreso o en un fichero.
INSINT, instrumento disponible en disquetes en el cual se recogen, en formato “dxf” y “dwg”, los planos de dimensiones de los interruptores en las varias ejecuciones, disponibles ya en el CD-ROM del C.A.T.

Racionalización constructiva

Las características constructivas de los nuevos interruptores automáticos simplifican considerablemente la instalación y la conexión.
Los criterios de elaboración del proyecto y los nuevos materiales utilizados han permitido mejorar la relación entre el poder de corte y el volumen del interruptor automático.
En consecuencia, y gracias también a las características de los interruptores - modularidad en 7 modelos, profundidades coordinadas, volúmenes reducidos y marco común (de S1 a S5 para ventana de 45 mm o de S3 a S7 para ventana de 105 mm) - ha sido posible reducir especialmente las dimensiones de los cuadros.

A partir del modelo S3, los accesorios se pueden montar directamente por la parte frontal; unos huecos especiales realizados de acuerdo con el perfil de los accesorios facilitan la inserción. No se requieren regulaciones y, en ningún caso, es necesario quitar la tapa del interruptor, gracias a la cual se garantiza el doble aislamiento y, por lo tanto, el mejoramiento de las condiciones de seguridad del operador en la gestión y la inspección de las instalaciones. Para los interruptores S1 y S2, los accesorios se fijan a la tapa del interruptor.
Además, la diversificada gama de terminales disponibles hace que los interruptores SACE Isomax S sean adecuados para cualquier tipo de conexión (superiores de un tipo e inferiores de tipo diferente), para la mayor flexibilidad de instalación.

CSIS9008

Normas, homologaciones, certificados y sistemas de calidad empresarial

Los interruptores automáticos SACE Isomax S y sus accesorios responden a las normas internacionales IEC 947-2, EN 60947-2 (armonizadas en 17 países del CENELEC), UNE EN 60947 e IEC 1000 y son conformes a las directivas CE:

– "Low Voltage Directives" (LVD) nº 73/23 EEC.
– "Electromagnetic Compatibility Directive" (EMC) nº 89/336 EEC.

Los certificados de conformidad con las normativas de productos anteriormente mencionadas, son expedidos, según lo establecido por la norma europea EN 45011, por el organismo de certificación italiano ACAE (Associazione per la Certificazione delle Apparecchiature Elettriche), reconocido por el instituto europeo LOVAG (Low Voltage Agreement Group).

El Sistema de Calidad ABB SACE es conforme a la norma internacional ISO 9001 (modelo para asegurar la calidad durante la elaboración de proyectos, desarrollo, fabricación, instalación y asistencia) y a las equivalentes normas europeas EN ISO 9001 e italianas UNI EN ISO 9001.

El tercer instituto de certificación es el RINA-QUACER.

ABB SACE ha obtenido, en 1990, el primer certificado con validez trienal y, en la actualidad, ha obtenido la tercera reconfirmación.

Los equipos son conformes a cuanto dispuesto por las normativas para las instalaciones en bugues y han sido homologados por los registros navales indicados al lado.

CSIS9009

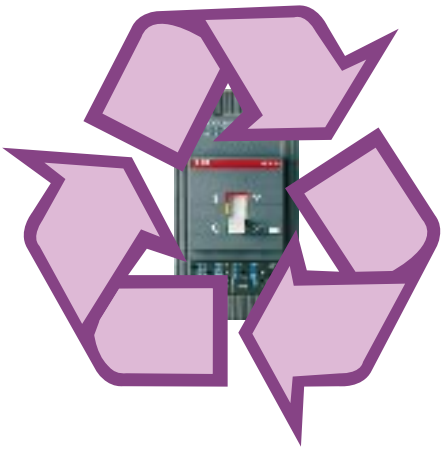
CSIS9098

CSIS9099

ISO 9001

La atención por la salvaguardia del medio ambiente es otra cuestión prioritaria para ABB SACE como demuestra el hecho de que el sistema de gestión medio-ambiental ha obtenido la certificación del instituto RINA. ABB SACE, primera industria del sector electromecánico que en Italia ha obtenido este reconocimiento, ha reducido un 20% el consumo de materias primas y de residuos creados durante la fabricación gracias a una revisión del proceso productivo desde un punto de vista ecológico.

El empeño de ABB SACE en la protección del medio ambiente se concretiza también en las evaluaciones del ciclo de vida de los productos (LCA, del inglés Life Cycle Assessment), realizadas en el Centro de Investigación. La selección de los materiales, de los procesos y de los embalajes se ha efectuado con miras a reducir el impacto real del producto en el medio ambiente y prever la eficacia energética y su reciclabilidad.


CSIS9010

Un producto flexible para una gestión fácil. Servicio y asesoramiento para cualquier exigencia

Pedidos inmediatos y gestión flexible

Para los interruptores automáticos de la serie SACE Isomax S se han previsto unos procedimientos de realización de pedidos muy rápidos; además, la lógica según la cual se ha configurado la serie, permite gestionar los almacenes de manera eficiente y flexible.
Es posible generar un fichero de pedido compatible con el sistema EDIFACT (Metel o ABB), listo para convertirse en formato EDI y enviarse electrónicamente. El uso del EDI (Electronic Data Interchange) para el envío del pedido, racionaliza la cadena logística y reduce los tiempos de transmisión y los riesgos de error. El envío mediante EDI permite la carga automática del pedido en ABB SACE con el envío inmediato al departamento de producción y la confirmación del pedido al cliente.
Para facilitar la realización de los pedidos se encuentran disponibles tanto los códigos correspondientes al interruptor ensamblado como los códigos correspondientes a los accesorios o kits de componentes. La disponibilidad de los accesorios unificados por grupos de interruptores permite reducir la cantidad en el almacén y los tiempos de aprovisionamiento muy breves permiten limitar los stocks ya que se pueden restablecer con facilidad.

La formación: un instrumento indispensable para los profesionales

ABB SACE, empresa del sector distribución del grupo ABB, desea poner a disposición de los profesionales su experiencia, acumulada en más de 60 años de actividad, mediante cursos de formación técnica que, realizados por expertos, representen una oportunidad para la puesta al día y el enriquecimiento.
La información y la formación son siempre factores de éxito para el crecimiento y el desarrollo profesional. La puesta al día profesional, tanto desde un punto de vista técnico y del producto como de un punto de vista normativo y legislativo, es indispensable debido a las notables implicaciones para la seguridad de las personas y de las instalaciones. El primer objetivo de los cursos es, precisamente, responder a las exigencias de información de los profesionales, sobre todo, convirtiendo los conceptos técnicos y normativos-legislativos en términos prácticos que se puedan aplicar directamente a los diferentes productos e instalaciones.

CSIS9081

CSIS9082

El “Servicio ABB SACE”

También existen cursos de formación cuyo objetivo es la preparación del personal de servicio y de mantenimiento que trabaja en los interruptores y los sistemas ABB SACE.
Con este objetivo, la empresa, en respuesta a las exigencias de adecuación y mantenimiento de las instalaciones eléctricas existentes, dispone de una “Division Service” en su estructura que se propone como interlocutor cualificado para desarrollar, en estrecha colaboración con los gestores y usuarios de las instalaciones, actividades de mantenimiento, reparación y revisión en la sede de ABB SACE y en los locales del usuario, servicio de recambios y montaje y puesta en servicio de cuadros de construcción propia.

CSIS9011

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Interruptores automáticos
SACE Isomax S - IEC 947-2

S1

S2

S3

Corriente permanente asignada **Iu**			[A]	**125**		**160**			**160 - 250**		
Nº de polos			Nr.	3-4		3-4			3-4		
Tensión asignada de servicio **Ue**		(c.a.) 50-60 Hz	[V~]	500		690			690		
		(c.c.)	[V–]	250		500			750		
Tensión asignada soportada a impulso **Uimp**			[kV]	6		6			8		
Tensión asignada de aislamiento, **Ui**			[V]	500		690			800		
Tensión de prueba a frecuencia industrial por 1 minuto			[V]	3000		3000			3000		
Poder asignado de corte último en cortocircuito **Icu**				**B**	**N**	**B**	**N**	**S**	**N**	**H**	**L**
	(c.a.) 50-60 Hz	220/230 V~	[kA]	25	40	25	50	65	65	100	170
	(c.a.) 50-60 Hz	**380/415 V~**	**[kA]**	**16**	**25**	**16**	**35** (1)	**50**	**35** (1)	**65**	**85**
	(c.a.) 50-60 Hz	440 V~	[kA]	10	16	10	20	25	30	50	65
	(c.a.) 50-60 Hz	500 V~	[kA]	8	12	8	12	15	25	40	50
	(c.a.) 50-60 Hz	690 V~	[kA]	—	—	6	8	10	14	18	20 (5)
	(c.c.)	250 V– (2 polos en serie)	[kA]	16	25	16	35	50	35	65	85
	(c.c.)	500 V– (2 polos en serie)	[kA]	—	—	—	—	—	35	50	65
	(c.c.)	500 V– (3 polos en serie)	[kA]	—	—	16	35	50	—	—	—
	(c.c.)	750 V– (3 polos en serie)	[kA]	—	—	—	—	—	20	35	50
Poder asignado de corte de servicio en cortocircuito **Ics** (2)			[%Icu]	50%	50%	100%	75%	75%	100%	75%	75%
Poder asignado de cierre en cortocircuito (415 V~) **Icm**			[kA]	32	52,5	32	74	105	74	143	187
Tiempo de apertura (415 V~)			[ms]	8	6	8	7	6	8	7	6
Corriente asignada de corta duración admisible (1 s) **Icw**			[kA]								
Categoría de empleo (según UNE EN 60947-2)				A		A			A		
Aptitud al seccionamiento				■		■			■		
IEC 947-2, EN 60 947-2				■		■			■		
Relés	termomagnéticos	T fijo, M fijo 5 Ith		■	■						
		T fijo, M fijo 10 Ith		■	■						
		T regulable, M fijo 5 Ith				■	■		■	■	■
		T regulable, M fijo 10 Ith				■	■	■	■	■	■
		T regulable, M regulable									
	sólo magnético	M fijo			■	■	■	■	■	■	■
	con microprocesador	PR211/P (I - LI)									
		PR212/P (LSI - LSIG)									
	intercambiabilidad										
Versiones - Terminales											
	Fija			FC - R		EF - FC - FC CuAl - R			F - EF - FC - FC CuAl - RC - R		
	Enchufable			FC - R		FC - R			EF - FC - R		
	Extraíble (3)			—		—			EF - FC - R		
Fijación sobre perfil DIN				DIN EN 50022		DIN EN 50022			DIN EN 50023		
Durabilidad mecánica			[Nº maniobras / operaciones hora]	25000 / 240		25000 / 240			25000 / 120		
Durabilidad eléctrica (a 415 V~)			[Nº maniobras / operaciones hora]	8000 / 120		8000 / 120			10000 (160A) - 8000 (250A) / 120		
Dimensiones básicas	fijo	3 / 4 polos	L [mm]	78 / 103		90 / 120			105 / 140		
			P [mm]	70		70			103,5		
			H [mm]	120		120			170		
Pesos	fijo	3 / 4 polos	[kg]	0,9 / 1,2		1,1 / 1,5			2,6 / 3,5		
	enchufable	3 / 4 polos	[kg]	1 / 1,4		1,3 / 1,7			3,1 / 4,1		
	extraíble	3 / 4 polos	[kg]	—		—			3,5 / 4,5		

CSIS9015

S4

CSIS9016

S5

CSIS9017

S6

CSIS9018

S7

160 - 250			**400 - 630**			**630 - 800**				**1250 - 1600**		
3-4			3-4			3-4				3-4		
690			690			690				690		
—			750			750				—		
8			8			8				8		
800			800			800				800		
3000			3000			3000				3000		
N	**H**	**L**	**N**	**H**	**L**	**N**	**S**	**H**	**L**	**S**	**H**	**L**
65	100	200	65	100	200	65	85	100	200	85	100	200
35 (1)	**65**	**100**	**35 (1)**	**65**	**100**	**35 (1)**	**50**	**65**	**100**	**50**	**65**	**100**
30	50	80	30	50	80	30	45	50	80	40	55	80
25	40	65	25	40	65	25	35	40	65	35	45	70
18	22	30	20	25	30	20	22	25	30	20	25	35
—	—	—	35	65	100	35	50	65	100	—	—	—
—	—	—	35	50	65	20	35	50	65	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	20	35	50	16	20	35	50	—	—	—
100%	100%	75%	100%	100%	75%	100%	100%	100%	75%	100%	75%	50%
74	143	220	74	143	220	74	105	143	220	105	143	220
8	7	6	8	7	6	10	9	8	7	22	22	22
			5 (400 A)			7,6 (630 A) - 10 (800 A)				15 (1250 A) - 20 (1600 A)		
A			B (400 A) - A (630 A)			B				B		
■			■			■				■		
■			■			■				■		
			■	■	■	■	■	■	■			
■	■	■	■	■	■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■	■	■	■	■	■
sí			sí			sí				sí		
F - EF - FC - FC CuAl - RC - R			F- EF- FC- FC CuAl/RC (400A)- R			F - EF - FC CuAl - RC - R				F-EF -FC CuAl (1250A) -HR -VR		
EF - FC -R			EF - FC -R (4)			—				—		
EF - FC -R			EF - FC -R - VR (630A)			EF - HR - VR				EF - HR - VR		
DIN EN 50023			DIN EN 50023			—				—		
20000 / 120			20000 / 120			20000 / 120				10000 / 120		
10000 (160A) - 8000 (250A) / 120			7000 (400A) - 5000 (630A) / 60			7000 (630A) - 5000 (800A) / 60				7000(1250A)-5000(1600A) / 20		
105 / 140			140 / 184			210 / 280				210 / 280		
103,5			103,5			103,5				138,5		
254			254			268				406		
4 / 5,3			5 / 7			9,5 / 12				17 / 22		
4,5 / 5,9			6,1 / 8,4			—				—		
4,9 / 6,3			6,4 / 8,7			12,1 / 15,1				21,8 / 29,2		

Notas

1) Todas las versiones con Icu=35kA están certificadas para 36kA.
2) Para interruptores S3 N/H/L, S4 N/H/L, S5 N/H y S6 N/S/H, la prestación porcentual de Ics a 690V se reduce un 25%.
3) Los interruptores en versión extraíble se suministran con el frontal para el mando por palanca o con los accesorios alternativos a éste como, por ejemplo, el mando giratorio o el mando motor.
4) Para el interruptor S5, la versión enchufable se encuentra disponible solamente para la corriente asignada de 400A (S5 N/H/L/ 400).
5) El interruptor SACE S3 con poder de corte L a 690V sólo se puede alimentar desde la parte superior.

Interruptores de maniobra-seccionadores SACE Isomax S - IEC 947-3

S3D

S6D

S7D

			S3D	S6D	S7D
Corriente térmica convencional a [°C], **Ith**		[A]	**100 - 160 - 250 - 320**	**400 - 630 - 800**	**1000 - 1250 - 1600**
Nº de polos			3 - 4	3 - 4	3 - 4
Tensión asignada de servicio **Ue**	a.c. 50-60 Hz	[V~]	690	690	690
	d.c.	[V–]	750	750	750
Corriente asignada de servicio **Iu**		[A]	100-160-250-320	400-630-800	1000-1250-1600
Tensión asignada soportada a impulso **Uimp**		[kV]	8	8	8
Tensión asignada de aislamiento **Ui**		[V]	800	800	800
Tensión de prueba a frecuencia industrial durante 1 minuto		[V]	3000	3000	3000
Poder asignado de cierre en cortocircuito (415 V~) **Icm**		[kA]	**10**	**30**	**52,5**
Corriente asignada de corta duración admisible (1 s) **Icw**		[kA]	**6,5**	**15**	**25**
Aptitud al seccionamiento			■	■	■
IEC 947-3			■	■	■
Durabilidad mecánica			25000 / 120	20000 / 120	10000 / 120
Versiones - Terminales	Fija		F-EF-FC-FCCuAl-RC-R	F-EF-FCCuAl-RC-R	F-EF-FCCuAl (1250 A)-HR-VR
	Enchufable		F FC R	–	–
	Extraíble		F FC R	F HR VR	F HR VR
Dimensiones L x H x P	fijo tripolar	[mm]	105 x 170 x 103,5	210 x 268 x 103,5	210 x 406 x 138,5
	fijo tetrapolar	[mm]	140 x 170 x 103,5	280 x 268 x 103,5	280 x 406 x 138,5
Peso	fijo, 3/4 polos	[kg]	2,6 - 3,5	9,5 - 12	17 - 22

Coordinación con los interruptores automáticos

Tipo		S3D 100	S3D 160	S3D 250	S3D 320	S6D 400	S6D 630	S6D 800	S7D 1000	S7D 1250	S7D 1600
S1	**B**	16									
	N	25									
S2	**B**	16	16								
	N	35	35								
	S	50	50								
S3	**N**	35	35	35	35						
	H	65	65	65	65						
S5	**N**					35	35	35			
	H					65	65	65			
S6	**N**					35	35	35			
	S					50	50	50			
	H					65	65	65			
S7	**S**								50	50	50
	H								65	65	65

Las versiones

Los interruptores de maniobra-seccionadores son de tres tipos: S3D, S6D y S7D y derivan de los correspondientes interruptores básicos, a saber:

- Los interruptores S3D 100-160-250-320 A derivan del interruptor básico S3N250
- Los interruptores S6D 400-630-800 A derivan del interruptor básico S6N630
- Los interruptores S7D 1000-1250-1600 A derivan del interruptor básico S7S1250.

En su campo de empleo, estos interruptores son verdaderos interruptores de maniobra-seccionadores ya que no se ha previsto ningún disparo directo para ningún nivel de corriente que los atraviese durante su uso.

La protección

Tienen que estar protegidos por interruptores automáticos instalados aguas arriba o formar parte de un conjunto en el cual se hayan instalado dispositivos de protección coordinados con los mismos. Cada interruptor de maniobra-seccionador SACE Isomax está protegido a condición de que aguas arriba del mismo haya un interruptor automático SACE Isomax de características adecuadas o inferiores a las del interruptor del cual deriva y hasta el máximo poder de corte del nivel H. Por ejemplo, un interruptor de maniobra-seccionador de tipo S3D está protegido si hay un interruptor S3H, S3N, S2B-N-S o S1B-N aguas arriba. En caso de cortocircuito, la actuación del interruptor automático situado aguas arriba garantiza la protección (backup) del interruptor de maniobra-seccionador situado aguas abajo.

Las funciones

Los interruptores de maniobra-seccionadores se emplean principalmente como interruptores generales de subcuadros, como órganos de maniobra y seccionamiento de líneas, de barras o de conjuntos de maniobra, como un acoplador de barras o en un conjunto de maniobra y protección de un motor. Los interruptores de maniobra-seccionadores pueden efectuar y garantizar:

- la maniobra de las corrientes en condiciones normales del circuito: cierre, conducción y corte;
- el seccionamiento del circuito: con la palanca en posición de abierto, se tiene la certeza de que todos los polos se encuentran en la posición de abierto (maniobra positiva) y las distancias de aislamiento son las adecuadas para no favorecer el cebado del arco, en conformidad con las normas IEC 947 sobre la aptitud al seccionamiento;
- el cierre en específicos valores de cresta de corriente de cortocircuito, poder de cierre Icm:
  - S3D: 10 kA
  - S6D: 30 kA
  - S7D: 52,5 kA.

  El poder de cierre es muy importante para la seguridad ya que un aparato de maniobra ha de poder soportar, sin destruirse, las solicitaciones dinámicas, térmicas y de corriente que pueden producirse durante el cierre, hasta las condiciones de cierre en cortocircuito.
- la capacidad de soportar en posición de cerrado la corriente asignada de corta duración admisible I_{cw} durante 1 segundo:
  - S3D: 6,5 kA
  - S6D: 15 kA
  - S7D: 25 kA.

La maniobra de apertura o cierre es de tipo independiente con actuación rápida, para que la velocidad y la fuerza de la maniobra sean independientes de la fuerza ejercida por el operador.

Accesorios y aplicaciones

En los interruptores de maniobra-seccionadores se pueden realizar en todas las versiones y aplicaciones de los correspondientes interruptores de los que derivan.

El dispositivo de disparo puede ser accionado por el relé de mínima tensión o por la bobina de apertura. El interruptor S3D también se puede equipar con los relés diferenciales SACE RC211/3 - RC212/3. Los interruptores de maniobra-seccionadores conservan inalteradas las dimensiones generales, las ejecuciones, los sistemas de fijación y la posibilidad de incorporar los accesorios de los interruptores automáticos de los cuales derivan.

Molded Case Circuit-Breakers - MCCB according to UL489 CSA C22.2

S3

S3

S4

Maximum frame continuous rated current (40 °C)			[A]	**225**			**150**			**250**
Poles			Nr.	2-3			2-3			2-3
Rated voltage	(a.c.)	50-60 Hz	[V~]	240			600			600
	(d.c.)		[V–]	500			600			600
Test voltage (1 min.)		50 /60 Hz	[V~]	3000			3000			3000
UL / CSA short-circuit interrupting rating				**B**	**N**	**H**	**L**	**N**	**H**	**L**
	(a.c.) 50-60 Hz	240 V~	[kA r.m.s.]	150	65	100	150	65	150	200
	(a.c.) 50-60 Hz	**480 V~**	**[kA r.m.s.]**	–	25	50	85	25	65	100
	(a.c.) 50-60 Hz	600 V~	[kA r.m.s.]	–	14	14	25	18	22	35
	(d.c.)	500 V– (2 poles in series)	[kA]	50	35	50	65	–	–	–
	(d.c.)	600 V– (3 poles in series)	[kA]	–	20	35	50	–	–	–
Overcurrent trip unit / relays										
		Thermal-magnetic		■		■			–	
		Microprocessor-based		–		–			■	
		Interchangeability		–		–			■	
Version	fixed 2/3 poles		H [in]	6.70		6.70			10.00	
			W [in]	4.13		4.13			4.13	
			D [in]	4.07		4.07			4.07	
Endurance mechanical			[op. / frequency]	25000 / 120		25000 / 120			20000 / 120	
Weights	fixed 3 poles		[lbs]	6.75		6.75			8.8	

Underwriters Laboratories Recognized Component

Motor Control Protection - MCP

MCCB	Rating	Trip unit	Adjustment range	Poles
S3L	3 A	Magnetic only	12 ... 36 A	3
	5 A	Magnetic only	20 ... 60 A	3
	10 A	Magnetic only	40 ... 120 A	3
	25 A	Magnetic only	100 ... 300 A	3
	50A	Magnetic only	200 ... 600 A	3
	100 A	Magnetic only	400 ... 1200 A	3
	150 A	Magnetic only	600 ... 1500 A	3
S4N/H/L	100 A	PR211/P - I	150 ... 1200 A	3
	250 A	PR211/P - I	375 ... 3000 A	3
S5N/H/L	400 A	PR211/P - I	600 ... 4800 A	3
S6N/H/L	600 A	PR211/P - I	900 ... 7200 A	3
	800 A	PR211/P - I	1200 ... 9600 A	3
S7H	1000 A	PR211/P - I	1500 ... 12000 A	3
	1200 A	PR211/P - I	1800 ... 14400 A	3

S3L MCP Interruption capacity

Rating [A]	3	5	10	25	50	100	150
Interruption capacity							
240 V a.c. [kA r.m.s.]	50	50	50	50	150	150	150
480 V a.c. [kA r.m.s.]	25	25	25	25	85	85	85
600 V a.c. [kA r.m.s.]	10	10	10	10	25	25	25
500 V d.c. [kA]	–	–	–	65	65	65	65
600 V d.c. [kA]	–	–	–	50	50	50	50

S5

S6

S7

400			600 - 800			1200
2-3			2-3			2-3
600			600			600
600			600			600
3000			3000			3000
N	**H**	**L**	**N**	**H**	**L**	**H**
65	150	200	65	150	200	100
35	65	100	50	65	100	65
22	22	35	25	35	42	50
35	50	65	35	50	65	–
20	35	50	20	35	50	–
■			■			–
■			■			■
■			■			■
10 (300 A) 13.62 (400 A)			14.25			16
5.51			8.27			8.27
4.07			4.07			5.45
20000 / 120			20000 / 120			10000 / 120
11.0			22.0			37.5

Molded Case Switches - MCS

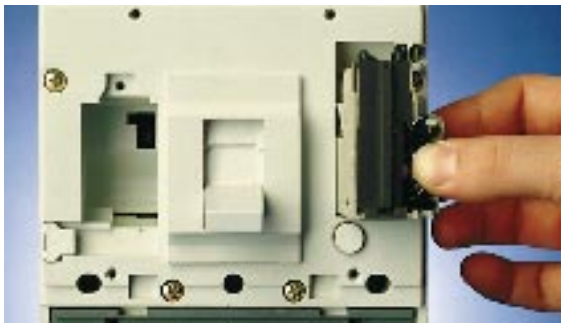
Type	S3B-D	S3H-D	S4H-D	S5H-D	S6H-D	S7H-D
Rating [A]	225	150	250	400	600-800	1000-1200
Poles	3	3	3	3	3	3
Magnetic trip [A]	2250	1500	3000	5000	10000	20000
Rated voltage						
(a.c.) 50-60 Hz [V~]	240	600	600	600	600	600
(d.c.) [V–]	500	600	600	600	600	600

Los interruptores SACE Isomax S, conformes a las normas UL489 y CSA 22.2 se pueden pedir mediante unos códigos especiales que suministra ABB SACE. La conformidad con las normas indicadas está certificada y declarada en la etiqueta de las prestaciones. La gama se compone de interruptores automáticos en caja moldeada, interruptores automáticos con relés exclusivamente magnéticos (Motor Control Protection - MCP) e interruptores de maniobra (Molded Case Switch - MCS).
Los interruptores se suministran en ejecución fija con terminales anteriores para cables de cobre-aluminio y se encuentran disponibles, con la correspondiente certificación, los siguientes accesorios:

– relé de mínima tensión y correspondiente conector
– relé de apertura y correspondiente conector
– contactos auxiliares y correspondiente conector
– mando a motor (de acción directa y por acumulación de energía) y correspondiente conector
– mando giratorio
– frontal para mando por palanca
– cubrebornes y tornillos precintables
– unidad “Trip test” para relés con microprocesador.

Para mayor información, ponerse en contacto con el distribuidor local.

Características constructivas


CSIS9027

Doble aislamiento

La técnica del doble aislamiento consiste en la separación total entre los circuitos de potencia y los auxiliares y caracteriza todos los interruptores automáticos SACE Isomax S a partir del tamaño S3. La sede de cada accesorio eléctrico está completamente segregada del circuito de potencia; de esta manera, se evita todo riesgo de contacto con las partes activas y se aumenta, así, las condiciones de seguridad del operador en la gestión y la inspección de las instalaciones.
Entre las partes activas interiores, el interruptor automático presenta, además, un aislamiento redundante, tanto por el espesor de los materiales como por las distancias, superiores a las requeridas por las Normas IEC y conformes a cuanto previsto por los estándares estadounidenses.

CSIS9028

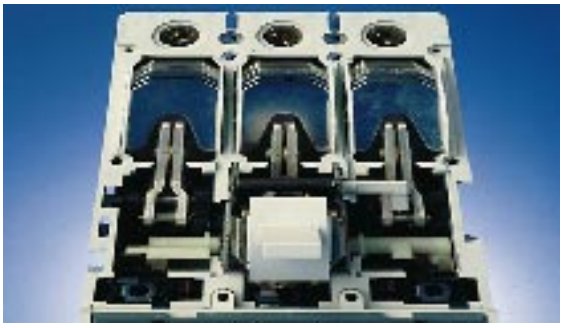
Maniobra positiva

La palanca de maniobra indica siempre la posición precisa de los contactos móviles del interruptor automático garantizando, así, unas señalizaciones seguras y fiables (I = Cerrado; O = Abierto; *línea amarilla* = Abierto por actuación de los relés). El mecanismo del mando del interruptor es de disparo libre independiente de la presión sobre la palanca y de la velocidad de la operación. La actuación de los relés abre automáticamente los contactos móviles: para cerrarlos hay que rearmar el mando, empujando la palanca de maniobra desde la posición intermedia hasta la extrema inferior de abierto.
Para interruptores enchufables o extraíbles, la separación de la parte móvil de la parte fija solamente puede efectuarse con el interruptor abierto (contactos móviles separados de los contactos fijos).

ISIS0016

Selectividad

La completa gama de relés disponibles permite coordinar las funciones de protección de los interruptores automáticos según cadenas de selectividad de tipo amperimétrico, cronométrico, energético o diferencial. De esta manera es posible aislar sólo la zona del defecto y asegurar la máxima continuidad de servicio. Los interruptores automáticos de categoría B se encuentran disponibles a partir de 400 A de corriente permanente asignada.


CSIS9029

Facilidad de control

Con el interruptor fuera de servicio es posible controlar directamente el estado de las piezas interiores y de los componentes activos del interruptor. Las cámaras de arco y los contactos fijos y móviles son accesibles tras quitar simplemente la tapa del interruptor. Esta operación, facilitada por el número limitado de componentes, reduce los tiempos de mantenimiento y garantiza un nivel superior de seguridad.

CSIS9030

Aptitud al seccionamiento

En la posición de abierto, el interruptor automático garantiza el seccionamiento del circuito en conformidad con la Norma IEC 947-2. Para interruptores extraíbles o enchufables, en posición de extraído o removido, los circuitos de potencia y auxiliares se encuentran aislados, para garantizar que ninguna parte se encuentre bajo tensión. En estas condiciones es posible efectuar, mediante los correspondientes conectores, pruebas en blanco y maniobrar el interruptor con plena seguridad. Las distancias de aislamiento redundantes garantizan la ausencia de corrientes de fuga y la rigidez dieléctrica a eventuales sobretensiones entre entrada y salida.

CSIS9031

Extracción con la puerta cerrada

Este sistema, presente por primera vez en una serie de interruptores automáticos en caja moldeada, a partir de 160 A, permite insertar y extraer el interruptor con la puerta de la celda cerrada, aumentando la seguridad del operador y permitiendo realizar cuadros de baja tensión a prueba de arco interno. La extracción se puede efectuar sólo con el interruptor abierto, utilizando una manivela de extracción suministrada con el interruptor en ejecución extraíble.

CSIS9109

Compatibilidad electromagnética

Con el uso de los relés de sobreintensidad con microprocesador SACE PR211/P y PR212/P y de los relés electrónicos diferenciales SACE RC211 y RC212 se garantiza la ausencia de intervenciones intempestivas incluso bajo la presencia de interferencias provocadas por aparatos electrónicos, perturbaciones atmosféricas o descargas de naturaleza eléctrica. Además, no se generan interferencias a otros aparatos electrónicos cerca de la instalación . Todo ello, en conformidad con las normativas IEC 947 - 2 Apéndice F, IEC 1000-4, EN 61000-4, EN 50081-2, Directiva Europea Nº 49/12-12-1992 sobre la compatibilidad electromagnética - EMC.

CSIS9110

Tropicalización

Todos los interruptores automáticos y accesorios de la serie SACE Isomax S respetan las más severas prescripciones para el uso en un clima cálido-húmedo-salino (conformidad al climatograma 8 de las normas IEC 721-2-1) gracias a:

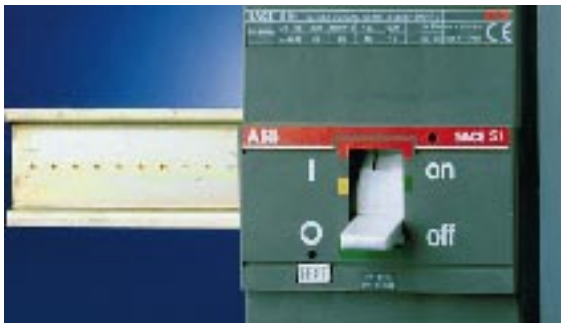
- Cajas aislantes de resinas sintéticas reforzadas con fibra de vidrio.
- Tratamiento anticorrosivo en las partes principales metálicas (ambiente C - UNI 3564-65).
- Cincado Fe/Zn 12 (UNI ISO 2081) protegido por una capa de conversión formada, prevalentemente, por cromados (UNI ISO 4520).

Características constructivas

CSIS9112

Grados de protección

En los interruptores automáticos SACE Isomax S se han adoptado diversas soluciones para alcanzar el grado de protección IP20, para el interruptor en ejecución fija, enchufable y extraíble, salvo los terminales, e IP30 para las partes frontales de los interruptores instalados en el cuadro.
Las partes fijas siempre están predispuestas con grado de protección IP20. Es posible alcanzar el grado de protección IP54 con el interruptor instalado en cuadro utilizando el mando giratorio reenviado a la puerta de la celda y el correspondiente accesorio para protección IP54 que se pueden pedir por separado.



CSIS9033

Montaje sobre guía DIN hasta 630 A

Los accesorios de fijación a los perfiles normalizados DIN EN 50022 para S1 y S2 y DIN EN 50023 para S3, S4 y S5 simplifican el montaje de los interruptores automáticos hasta 630 A en cuadros estándares. Esto permite disponer de estructuras de soporte normalizadas y simplifica la fase de elaboración de proyecto y de realización de la carpintería del cuadro

CSIS9111

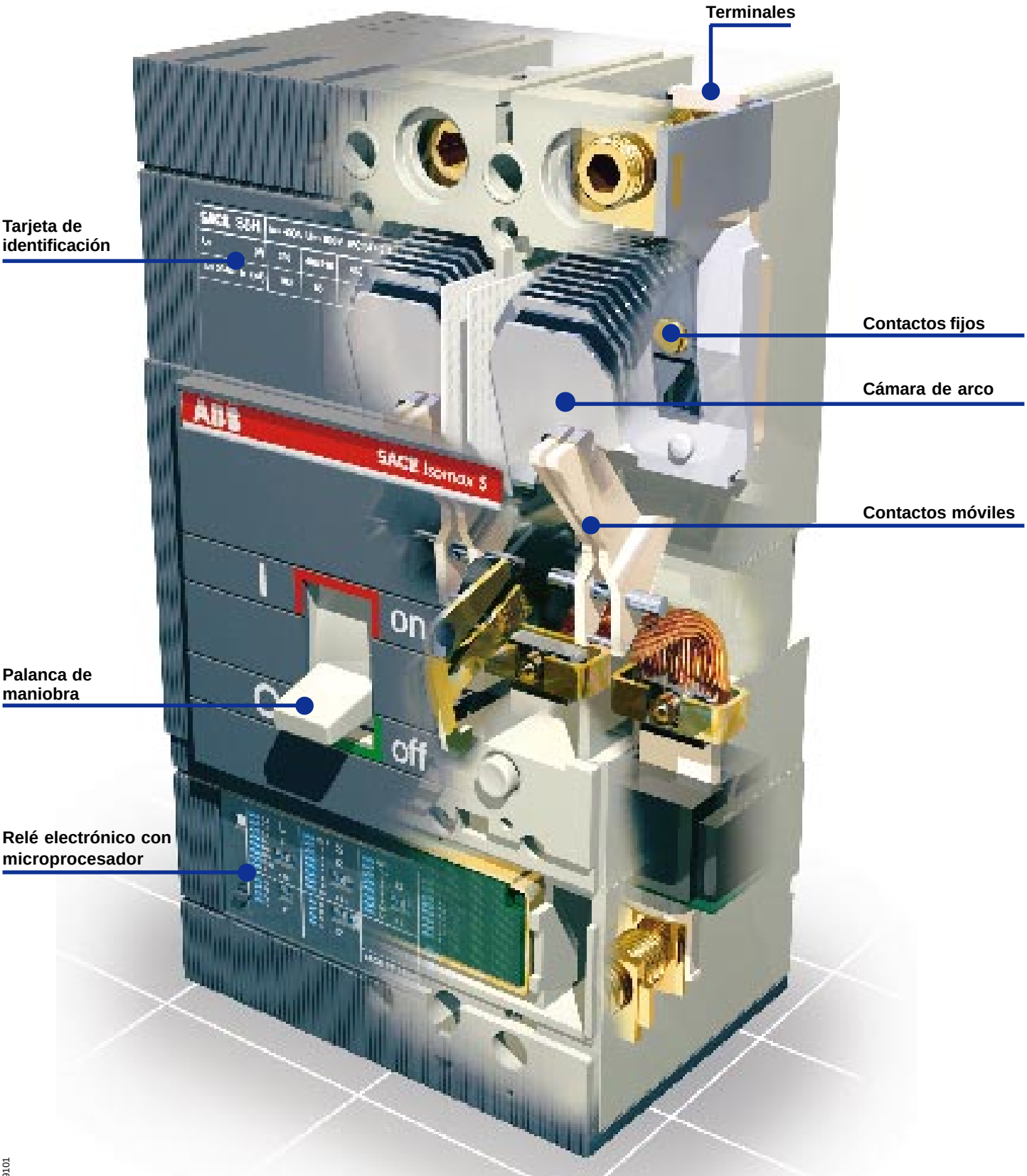
Resistencia a las vibraciones

Los interruptores son insensibles a las vibraciones generadas mecánicamente o por efecto electromagnético en conformidad con las normas IEC 68-2-6 y a los estándares más severos de las entidades de clasificación:
– RINA
– DET Norske Veritas
– Lloyd's Register of Shipping
– Germanischer Lloyd
– Bureau Veritas.

CSIS9035

Posiciones de instalación

Las características asignadas del interruptor no varían sea cual sea la posición de instalación. En conformidad a las Normas IEC 947-2, los interruptores automáticos SACE Isomax S se pueden alimentar indiferentemente mediante los terminales superiores o inferiores sin perjudicar la funcionalidad del aparato.
Se pueden instalar en cuadros, directamente montados en la placa de fondo o en la guía DIN hasta el modelo S5.


Terminales
Tarjeta de identificación
Contactos fijos
Cámara de arco
Contactos móviles
Palanca de maniobra
Relé electrónico con microprocesador
SACE Isomax S
on
off

CSIS9101

Ejecuciones y terminales de conexión

Los interruptores automáticos SACE Isomax S están formados por una caja aislante que sirve de estructura portante realizada con material vitro-poliéster que garantiza la indeformabilidad incluso en las condiciones más severas de cortocircuito. El disparo de los contactos móviles es libre y consiente que éstos retornen y permanezcan en la posición de abierto cuando la apertura está provocada por los relés de sobreintensidad, y también después del inicio del cierre del interruptor automático o bien en caso de que la palanca del mando de cierre se mantenga por fuerza. La acción de disparo es simultánea para todos los polos del interruptor automático.
Toda la gama se realiza solamente en 3 profundidades:
– 70 mm para S1 y S2 (10-160 A);
– 103,5 mm para S3, S4, S5 y S6 (32-800 A);
– 138, 5 mm para S7 (400-1600 A).
con lo cual es posible realizar cuadros con celdas adecuadas a varios interruptores y la fijación en la placa de fondo a la misma cota.

La parte frontal de los interruptores ha sido normalizada por grupos:
– H = 45 mm para S1, S2, S3, S4 y S5 (10-630 A)
– H = 105 mm para S3, S4, S5, S6 y S7 (32-1600 A)
con lo que se consigue obtener notables ventajas en cuanto a la normalización de los cuadros.
El interruptor en ejecución fija, tripolar o tretrapolar prevé:
– los terminales superiores e inferiores iguales, del tipo anterior para cables de cobre para S1 y S2 (con diafragmas separadores) y del tipo anterior para conexión en barra para S3, S4, S5, S6 y S7;
– el mando por palanca;
– el relé de sobreintensidad, termomagnético para S1, S2, S3, S5 y S6 o bien electrónico con microprocesador para S4, S5, S6 y S7;
– el marco para la puerta del cuadro.

	F Terminales anteriores	**EF** Terminales anteriores prolongados	**FC** Terminales anteriores para cable Cu	**FC CuAl** Terminales anteriores para cable Cu/Al	**RC** Terminales posteriores para cable Cu/Al	**R** Terminales posteriores roscados	**HR** Terminales posteriores planos horizontales	**VR** Terminales posteriores planos verticales
S1 125	—	—	F - P	—	—	F - P	—	—
S2 160	—	F	F - P	F	—	F - P	—	—
S3 160	F	F - P - W	F - P - W	F	F	F - P - W	—	—
S3 250	F	F - P - W	F - P - W	F	F	F - P - W	—	—
S4 160	F	F - P - W	F - P - W	F	F	F - P - W	—	—
S4 250	F	F - P - W	F - P - W	F	F	F - P - W	—	—
S5 400	F	F - P - W	F - P - W	F	F	F - P - W	—	—
S5 630	F	F - W (separados)	F	—	—	F - W	—	W
S6 630	F	F - W	—	F	F	F	W	W
S6 800	F	F - W	—	F	F	F	W	W
S7 1250	F	F - W	—	F	—	—	F - W	F - W
S7 1600	F	F - W	—	—	—	—	F - W	F - W

Los interruptores automáticos SACE Isomax S están disponibles en ejecución FIJA, ENCHUFABLE o EXTRAÍBLE, tripolar o tetrapolar.

CSIS9036

F
FIJO

CSIS9037

P
ENCHUFABLE

CSIS9038

W
EXTRAÍBLE

El interruptor en ejecución ENCHUFABLE se compone de:
– parte fija que se tiene que instalar directamente en la placa de fondo de compartimiento;
– parte móvil obtenida del interruptor fijo con el añadido de los contactos de seccionamiento en correspondencia de los terminales de conexión, de la estructura metálica posterior para la fijación a la parte fija y de los cubre bornes.

La remoción del interruptor se efectúa desenroscando los tornillos de fijación superiores e inferiores. Un bloqueo impide la inserción y la remoción del interruptor automático con los contactos en posición de cerrado.

Interruptor	F Fijo	P Enchufable	W Extraíble
S1 125	■	■	–
S2 160	■	■	–
S3 160	■	■	■
S3 250	■	■	■
S4 160	■	■	■
S4 250	■	■	■
S5 400	■	■	■
S5 630	■	–	■
S6 630	■	–	■
S6 800	■	–	■
S7 1250	■	–	■
S7 1600	■	–	■

El interruptor en ejecución EXTRAÍBLE se compone de:
– parte fija que se tiene que instalar directamente en la placa de fondo de compartimiento o bien en el perfil (hasta S5), con el grupo guía lateral montado en la parte fija para consentir el movimiento de extracción/inserción;
– parte móvil obtenida del interruptor fijo con el añadido de los contactos de seccionamiento en correspondencia de los terminales de conexión, de la estructura metálica posterior (que se acopla al lateral previsto en la parte fija para el deslizamiento) y de los cubre-bornes.
– accesorio que se tiene que aplicar en la parte frontal del interruptor, a elegir entre frontal para mando por palanca, mando a motor y mando giratorio; la aplicación de uno de estos accesorios consiente realizar el bloqueo del interruptor en posición de extraído.

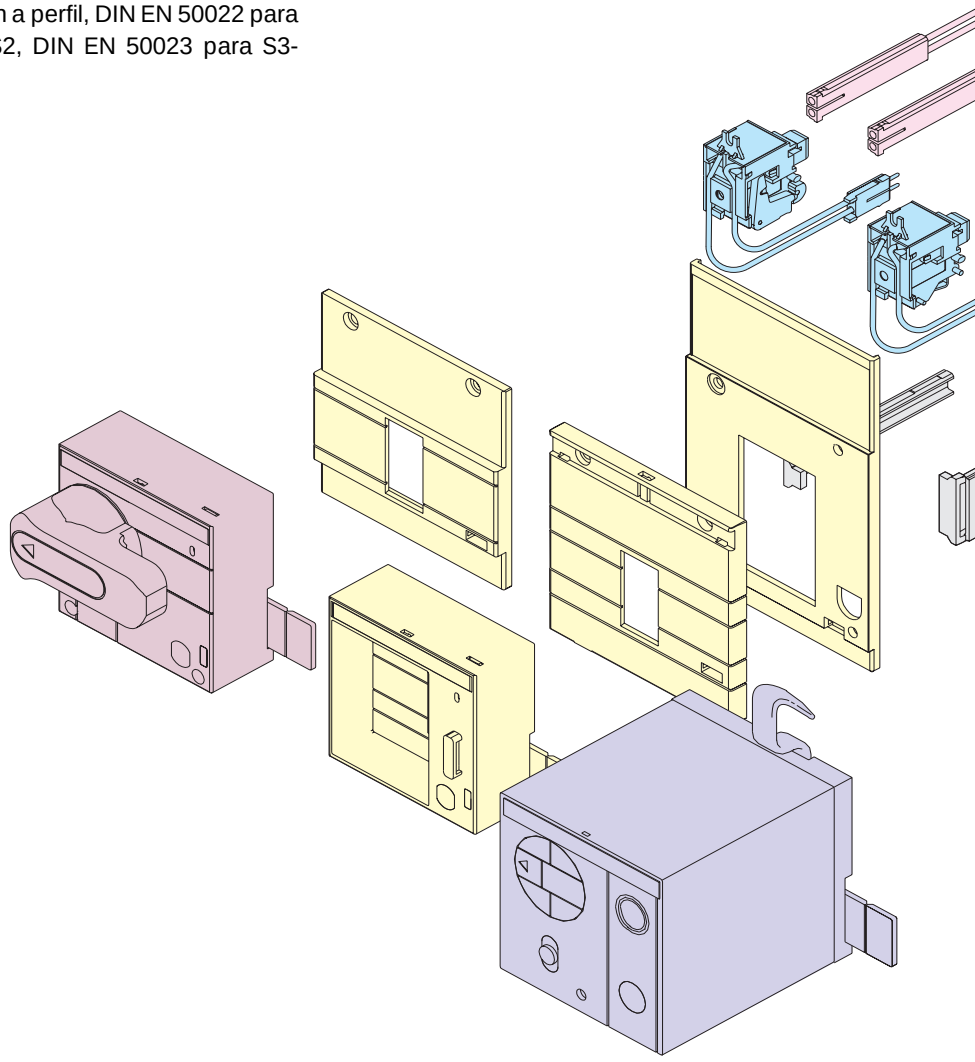
La inserción/extracción de la parte móvil se efectúa por medio de la correspondiente manivela de maniobra suministrada con el interruptor en la versión parte móvil de interruptor extraíble o con el kit de transformación del interruptor fijo en parte móvil de interruptor extraíble. El mecanismo permite poner el interruptor en posición de seccionado (con los circuitos de potencia y auxiliares desconectados) con la puerta de la celda cerrada, mejorando así la seguridad del operador. La manivela puede insertarse solamente con el interruptor abierto.

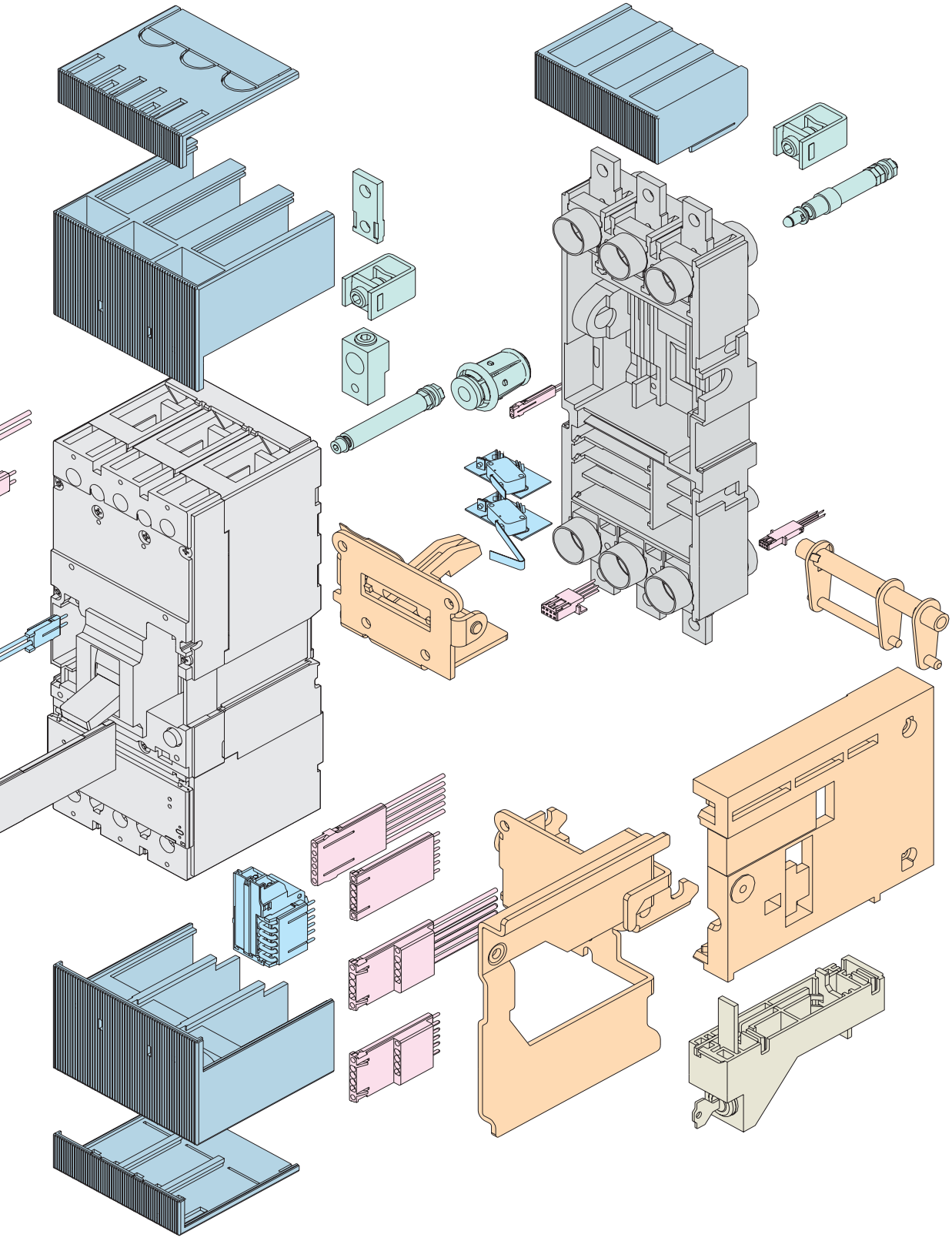
Tras remover o extraer el interruptor, puede maniobrarse en abierto/cerrado y, mediante las correspondientes prolongaciones de conexión, pueden realizarse pruebas en blanco de funcionalidad de los circuitos de mando auxiliar.

Accesorios

Partiendo dal interruptor automático en ejecución fija, mediante el montaje del kit de transformación, se obtienen todas las demás versiones que satisfacen las diversas exigencias de instalación.
Están disponibles:
– El kit para la transformación de interruptor fijo a parte móvil para interruptor enchufable y extraíble
– El kit de transformación para los terminales de conexión que permiten obtener terminales anteriores y posteriores para cable CU/Al, terminales anteriores y posteriores para pletina.

También están disponibles diversos accesorios:
– Relé de apertura
– Relé de mínima tensión
– Contactos auxiliares
– Contactos de posición
– Accesorio para fijación a perfil, DIN EN 50022 para los interruptores S1-S2, DIN EN 50023 para S3-S4-S5
– Mando motor de acción directa y de acumulación de energia
– Mando giratorio directo y reenviado para la puerta del compartimiento
– Relés diferenciales
– Accesorios para relés de sobrecorriente con microprocesador como la unidad de señalización, la unidad de diálogo y la unidad de actuación, y TA externo
– La parte fija para interruptores enchufables o extraíbles con terminales anteriores para cable o pletina y terminales posteriores para pletina.





Relés de sobreintensidad con microprocesador

CSIS9039

Relé SACE PR211/P

CSIS9040

Relè SACE PR212/P

Los interruptores automáticos SACE Isomax S4, S5, S6 y S7 para la protección en corriente alterna pueden equiparse con relés de sobreintensidad de la serie SACE PR211/P y SACE PR212/P realizados con la tecnología electrónica del microprocesador. Esto permite obtener funciones de protección que garantizan una elevada fiabilidad, precisión de las intervenciones e insensibilidad al ambiente exterior. La alimentación necesaria para el correcto funcionamiento está suministrada directamente por los transformadores de corriente del relé, en presencia de una corriente de fase ≥15% de la corriente nominal de los mismos, incluso con una sola fase bajo tensión. La regulación es única para las fases y el neutro y el disparo es simultáneo para todos los polos del interruptor con características de actuación que no notan la influencia del ambiente externo. La funcionalidad del relé puede controlarse mediante el dispositivo de test SACE TT1 portátil, alimentado con pilas normales.

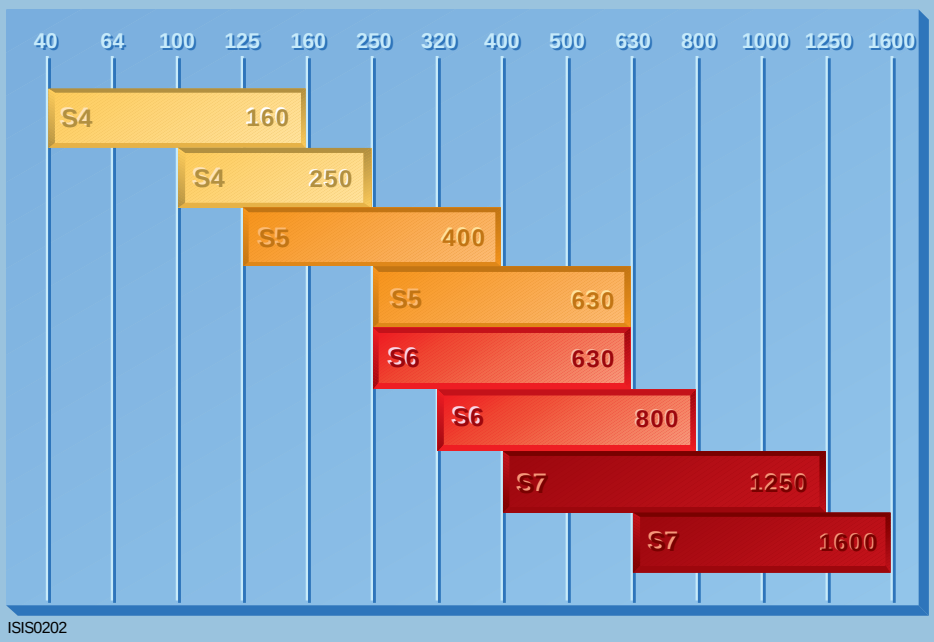
SACE PR211/P

El relé SACE PR211/P realiza funciones de protección contra la sobrecarga L y el cortocircuito instantáneo I, y se encuentra disponible en las versiones con funciones I y LI.
Gracias a la amplitud de las regulaciones, dicho relé está especialmente indicado para todas las aplicaciones de distribución en las cuales se necesitan fiabilidad y precisión en las actuaciones y cuando se necesita exclusivamente la protección magnética (de 1,5 ...12 x In), utilizando el relé SACE PR211/P en la versión I.

SACE PR212/P

El relé SACE PR212/P realiza funciones de protección contra la sobrecarga L, el cortocircuito retardado S e instantáneo I, y contra el defecto a tierra G. Se encuentra disponible en las versiones PR212/P con funciones LSI y LSIG; esta última consiente adoptar las unidades de señalización PR212/K, de diálogo PR212/D y de actuación PR212/T que pueden utilizarse simultáneamente o por separado, salvo la unidad de actuación PR212/T que se suministra siempre con la unidad de diálogo.
Está especialmente indicado en aplicaciones con exigencias de coordinación selectiva, protección de tierra contra los riesgos de incendio y defectos evolutivos, control y parametrización remoto, supervisión de la red y gestión centralizada de las cargas.

En los interruptores tretrapolares, normalmente el neutro está protegido con regulaciones que corresponden al 50% de la regulación de la protección de las fases. Con los interruptores tripolares y neutro distribuido, se pueden utilizar transformadores



Campo de aplicación de los interruptores automáticos con relé de sobreintensidad con microprocesador.

amperimetricos externos que se han de conectar directamente tanto al relé SACE PR211/P como al relé SACE PR212/P según las regulaciones indicadas en la tabla. Si se solicita en el pedido, es posible obtener la protección plena del neutro con una regulación correspondiente al 100% de la regulación de la protección de las fases.

TRANSFORMADORES AMPERIMÉTRICOS EXTERNOS

	100 A	160 A	250 A	320 A	400 A	630 A	800 A	1000 A	1250 A	1600 A
S4 160	■	■								
S4 250			■							
S5 400				■	■					
S5 630						■				
S6 630						■				
S6 800							■			
S7 1250								■	■	
S7 1600										■

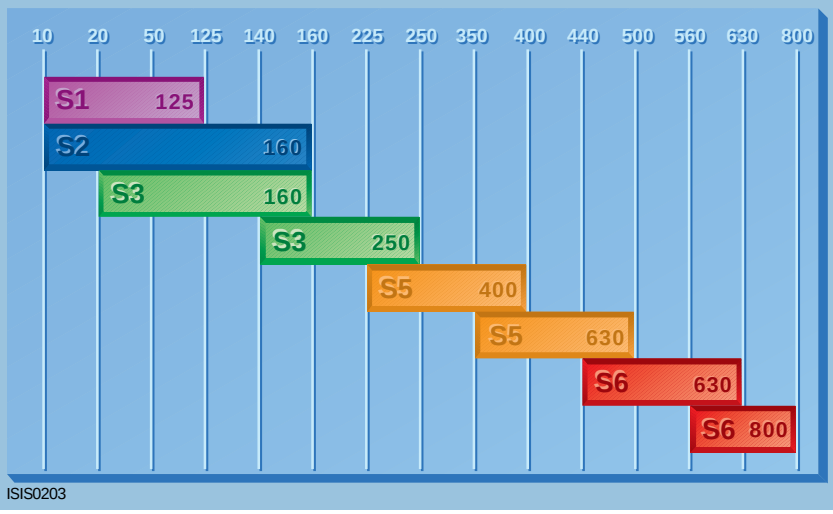
PROTECCIÓN		**SACE PR211**	**SACE PR212**
L	Contra sobrecarga con intervención retardada a tiempo largo inverso y característica de intervención según una curva de tiempo inverso (I^2t=const) **I_1= 0,4-0,5-0,6-0,7-0,8-0,9-0,95-1 x In**	t_1= 3 ... 18 s curvas A, B, C, D no desactivable	t_1= 3 ... 18 s curvas A, B, C, D no desactivable
S	Contra cortocircuito con intervención retardada a tiempo corto inverso (característica de intervención a I^2t=const) o bien con intervención con retardo a tiempo corto independiente **I_2=1-2-3-4-6-8-10 x In**	—	t_2= 0,05 ... 0,5 s curvas A, B, C, D desactivable
I	Contra cortocircuito con intervención instantánea regulable **I_3=1,5-2-4-6-8-10-12 x In**	t_3 = instantáneo desactivable	t_3 = instantáneo desactivable
G	Contra defecto a tierra con intervención retardada a tiempo corto inverso y característica de intervención según una curva de desconexión de tiempo inverso (I^2t=const) **I_4= 0,2-0,3-0,4-0,6-0,8-0,9-1 x In**	—	t_4= 0,1 ... 0,8 s curvas A, B, C, D desactivable

In	**100 A**	**160 A**	**250 A**	**320 A**	**400 A**	**630 A**	**800 A**	**1000 A**	**1250 A**	**1600 A**
S4 160	■	■								
S4 250			■							
S5 400				■	■					
S5 630						■				
S6 630						■				
S6 800							■			
S7 1250								■	■	
S7 1600										■
L	40...100	64...160	100...250	128...320	160...400	252...630	320...800	400...1000	500...1250	640...1600
S	100...1000	160...1600	250...2500	320...3200	400...4000	630...6300	800...8000	1000...10000	1250...12500	1600...16000
I	150...1200	240...1920	375...3000	480...3840	600...4800	945...7560	1200...9600	1500...12000	1875...15000	2400...19200
G	20...100	32...160	50...250	64...320	80...400	126...630	160...800	200...1000	250...1250	320...1600
neutro	20...50	32...80	50...125	64...160	80...200	126...315	160...400	200...500	250...625	320...800

Relés de sobreintensidad termomagnéticos

CSIS9041

Los interruptores automáticos SACE Isomax S1, S2, S3, S5 y S6 pueden equiparse con relés termomagnéticos y se utilizan en la protección de redes en corriente alterna con los interruptores S1, S2 y S3 (para aplicaciones de 10 a 250 A) y en corriente continua con los interruptores S1, S2, S3, S5 y S6 (de 10 a 800 A). Efectúan la protección contra las sobrecargas con dispositivo térmico (con umbral fijo para S1 y regulable para S2, S3, S5 y S6) realizado con la técnica del bimetal y la protección contra el cortocircuito con dispositivo magnético (con umbral fijo para S1, S2 y S3 y regulable para S5 y S6). Los interruptores tetrapolares se suministran siempre con el neutro protegido por el relé.



Campo de aplicación de los interruptores automáticos con relé de sobreintensidad termomagnéticos.

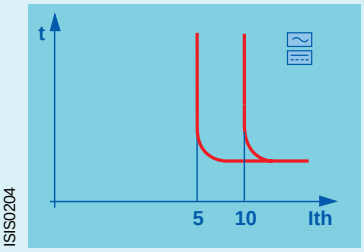
Relés termomagnéticos

L1 - L2 - L3		R10	R12.5	R16	R20	R25	R32	R32	R40	R50	R50	R63	R80	R100	R125	R125
neutro		R10	R12.5	R16	R20	R25	R32	R32	R40	R50	R50	R63	R80	R100	R125	R80
S1 125		■	■	■	■	■	■		■	■		■	■	■	■	
S2 160			■	■	■	■	■		■	■		■	■	■		■
S3 160								■			■		■	■		■
S3 250																
S5 400																
S5 630																
S6 630																
S6 800																
10Ith	**L1-L2-L3**	500	500	500	500	500	500	500	500	500	500	630	800	1000	1250	1250
	neutro	500	500	500	500	500	500	500	500	500	500	630	800	1000	1250	800
5Ith	**L1-L2-L3**	160	160	160	200	200	200	300	200	250	300	320	400	500	630	630
	neutro	160	160	160	200	200	200	300	200	250	300	320	400	500	630	400
TM regulable	**L1-L2-L3**															
	neutro															

Relés solo magnéticos

L1 - L2 - L3		R16	R40	R50	R50	R63	R80	R100	R125	R125	R125	R160	R200	R250
neutro		R16	R40	R50	R50	R63	R80	R100	R125	R80	R80	R100	R125	R160
S1 125		■	■	■		■	■	■	■					
S2 160		■	■	■		■	■	■		■		■		
S3 160					■		■	■			■	■		
S3 250													■	■
10Ith	**L1-L2-L3**			500	500	630	800	1000	1250	1250	1250	1600	2000	2500
	neutro			500	500	630	800	1000	1250	800	800	1000	1250	1600
5Ith	**L1-L2-L3**	160	200	250	300	320	400				630			
	neutro	160	200	250	300	320	400				400			

Los relés solo magnéticos en los interruptores automáticos SACE S1, S2 y S3 poseen un umbral de intervención fijo según lo indicado en la tabla. Para S1, el relé solo magnético está disponible en la versión con poder de corte N=25 kA; para S2 con poder de corte S= 50 kA, no está disponible el relé solo magnético en la versión 5Ith.

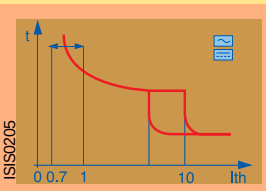


ISIS0204

R160	R200	R250	R320	R400	R500	R630	R800
R100	R125	R160	R200	R250	R320	R400	R500
■							
■							
	■	■					
			■	■			
					■		
						■	
							■
1600	2000	2500					
1000	1250	1600					
800	1000	1250					
500	625	800					
			3200	4000	5000	6300	8000
			2000	2500	3200	4000	5000

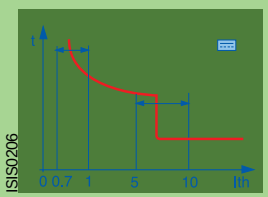
La indicación “R” identifica la corriente de regulación para la protección de las fases (L1-L2-L3) y del neutro (segunda línea). Las combinaciones indicadas son las combinaciones suministradas de serie. Bajopedido, se pueden suministrar interruptores con neutro al 100% de la regulación de las fases

Los relés termomagnéticos en los interruptores automáticos SACE S2 y S3 poseen el elemento térmico con umbral regulable 0,7 ... 1 x In. El valor de corriente regulado que se obtiene actuando en el correspondiente selector tiene que considerarse nominal a 40 °C. El elemento magnético posee un umbral de actuación fijo con valores de intervención que varían en función de la regulación de las fases.



ISIS0205

Los relés termomagnéticos en los interruptores automáticos SACE S5 y S6 poseen el elemento térmico con umbral regulable 0,7 ... 1 x In. El valor de corriente regulado que se obtiene actuando en el correspondiente selector tiene que considerarse nominal a 40 °C. El elemento magnético se puede regular de 5 ... 10 x In. En la tabla se indican los valores máximos de intervención magnética (10 x In) para la protección de las fases (L1-L2-L3) y del neutro.



ISIS0206

Los umbrales de intervención de la protección magnética dependen de la regulación adoptada tanto para la protección de las fases (L1-L2-L3)como del neutro. Los relés denominados 10 Ith están indicados para todas las aplicaciones de distribución mientras que los relés denominados 5 Ith se usan especialmente cuando se necesita un umbral de intervención magnética baja.

Relés diferenciales

CSIS9042

CSIS9043

Relés diferenciales SACE RC211 y RC212

Los relés diferenciales de la serie SACE RC211 y RC212 pueden instalarse tanto en los interruptores automáticos SACE Isomax S1, S2 y S3 como en el interruptor de maniobra-seccionador SACE S3D. Los interruptores automáticos diferenciales combinan en un único aparato la función diferencial con la función de protección contra las sobrecorrientes e intervienen tanto por la fuga de corriente hacia tierra como por la sobrecarga/cortocircuito. Los interruptores diferenciales “puros”, que se obtienen con el interruptor de maniobra-seccionador S3D solamente son sensibles a la corriente de defecto a tierra y se utilizan generalmente como seccionadores principales en pequeños cuadros de distribución hacia servicios finales.

El uso de interruptores diferenciales “puros” y “no puros” permite la monitorización y el control continuo del estado de aislamiento de la instalación con lo que se asegura una protección eficaz contra los riesgos de incendio y de explosión y, en los casos de dispositivos con $I_{\Delta N} \leq 30$ mA, aseguran la protección de las personas contra los contactos directos e indirectos como integración de las medidas obligatorias previstas por las normativas y por las prescripciones de seguridad.

Los relés diferenciales SACE RC211 y RC212 han sido realizados con tecnología electrónica analógica. No requieren alimentación auxiliar ya que se alimentan directamente de la red y el funcionamiento está garantizado incluso con una sola fase en tensión y en presencia de corrientes unidireccionales pulsantes con componentes continuas. Es posible controlar constantemente las condiciones de funcionamiento del relé mediante pulsador de prueba del circuito electrónico e indicador magnético de intervención diferencial.

Los relés diferenciales están realizados en conformidad con las normativas:

– IEC 947-2 apéndice B,
– IEC 255-4 e IEC 1000: para la protección contra los disparos intempestivos;
– IEC 755: para la insensibilidad a las componentes continuas de corriente.

Los relés SACE RC211 y RC212 actúan directamente en el interruptor mediante un solenoide de apertura suministrado con el relé, que se tiene que alojar en el correspondiente hueco realizado en la zona del tercer polo.

		SACE RC211	SACE RC212
Tensión primaria de funcionamiento	[V]	220 ... 500	50 ... 500
Umbral de intervención IΔn	[A]	0,03 - 0,1 - 0,3	0,03 - 0,1 - 0,3 - 0,5 - 3
Tolerancia para IΔn	[%]	+0, -25	+0, -20
Tiempos de intervención	[s]	instantáneo	0 - 0,1 - 0,25 - 0,5 - 1 - 1,5
Tolerancia en los tiempos de intervención	[%]		± 20
Señalización de intervención		■	■
Autoalimentación		■	■
Entrada para la apertura a distancia			■
Indicación de prealarma al 50%			■
Tipo AC exclusivamente para corriente alterna		■	■
Tipo A para corriente alterna, pulsante		■	■
Baja sensibilidad		■	■
Alta sensibilidad		■	■
Montaje vertical		■	■
Montaje lateral		■	■

Relé diferencial SACE RCQ

CSIS9044

Los interruptores automáticos SACE Isomax S4, S5, S6 y S7 pueden combinarse con los relés diferenciales SACE RCQ con transformador toroidal separado (se tienen que instalar externamente en los conductores de línea) y se pueden utilizar con umbrales hasta 30 A de intervención y retardos hasta 5 s o cuando las condiciones de instalación son especialmente difíciles, como en el caso de interruptores ya instalados, espacio reducido en la celda del interruptor, etc.

El relé de cuadro SACE RCQ, gracias a la amplia gama de regulaciones, es adecuado para aplicaciones en las cuales se desea realizar un sistema de protección diferencial coordinado con varios niveles de distribución, desde el cuadro principal a los servicios finales. Está especialmente indicado cuando se requiere una protección diferencial de baja sensibilidad como, por ejemplo, en cadenas selectivas parciales (amperimétrica) o totales (cronométrica), y en aplicaciones de alta sensibilidad (con sensibilidad fisiológica) para realizar la protección de las personas contra los contactos directos.

Cuando se produce una caída de la tensión de alimentación auxiliar, actúa el mando de apertura tras un tiempo mínimo de 100 ms y tras el tiempo programado más 100 ms.

El relé SACE RCQ es adecuado en presencia de corrientes de tierra exclusivamente alternas (Tipo AC), para corrientes alternas y/o pulsantes con componentes continuas (Tipo A) y para realizar la selectividad diferencial.

El relés SACE RCQ es del tipo de acción indirecta y actúa en el mecanismo de disparo del interruptor automático mediante el relé de apertura del interruptor y que se tiene que solicitar e que se tiene que montar en el correspondiente alojamiento del interruptor automático.

			SACE RCQ
Tensión de alimentación	c.a.	[V]	80 … 500
	c.c.	[V]	48 … 125
Regulación del umbral de intervención IΔn			
- 1ª gama de regulaciones		[A]	0,03 - 0,05 - 0,1 - 0,3 - 0,5
- 2ª gama de regulaciones		[A]	1 - 3 - 5 - 10 - 30
Regulación de los tiempos de intervención		[s]	0 - 0,1 - 0,2 - 0,3 - 0,5 - 0,7 - 1 - 2 - 3 - 5
Regulación del umbral de prealarma		[%] x $I_{\Delta n}$	25 ÷ 75% x $I_{\Delta n}$
Gama de empleo de los transformadores cerrados $I_{\Delta n}$			
- Transformador toroidal Ø 60 [mm]		[A]	0,03 … 30
- Transformador toroidal Ø 110 [mm]		[A]	0,03 … 30
- Transformador toroidal Ø 180 [mm]		[A]	0,1 … 30
Gama de empleo de los transformadores abribles (núcleo partido)		$I_{\Delta n}$	
- Transformador toroidal Ø 110 [mm]		[A]	0,3 … 30
- Transformador toroidal Ø 180 [mm]		[A]	0,1 … 30
- Transformador toroidal Ø 60 [mm]		[A]	1 … 30
Señalización alarma preumbral			Led amarillo parpadeante 1 contacto NA 6 A - 250 V c.a. 50/60 Hz
Señalización de intervención del relé diferencial			Led amarillo parpadeante 2 contactos (NA/ NC; NA) 6 A - 250 Vc.a. 50/60 Hz
Mando de apertura a distancia			Contacto NA Tiempo de intervención 15 ms
Conexión al transformador toroidal			Mediante 4 conductores trenzados Longitud máxima 5 m
Dimensiones L x H x P		[mm]	96 x 96 x 131,5
Taladrado para el montaje en la puerta		[mm]	92 x 92

Condiciones de uso

CSIS9107

Temperatura de funcionamiento

Los interruptores automáticos SACE Isomax S pueden utilizarse en condiciones ambientales en las cuales la temperatura de la atmósfera circundante presente unos valores comprendidos entre –25 y +70 °C. Los interruptores automáticos equipados con relés de sobreintensidad termomagnéticos poseen el elemento térmico regulado para una temperatura de referencia de 40 °C. Para temperaturas comprendidas entre 40 y 70 °C a paridad de regulación se produce una disminución del umbral de intervención térmica debido al comportamiento del bimetal del relé ante la temperatura. Para temperaturas inferiores a 40 °C, se tiene que considerar, en cambio, un aumento de los umbrales de intervención térmica (véanse las tablas en el capítulo “Accesorios, relés y curvas características”). Los relés electrónicos con microprocesador no sufren variaciones de las prestaciones cuando varía la temperatura, pero hay que reducir la regulación máxima para la protección contra las sobrecargas (L) para tener en cuenta los fenómenos de inercia que se producen en las partes de cobre del interruptor atravesadas por la corriente de fase (contactos, móviles y fijos, terminales de conexión) que comportan una disminución de la corriente permanente asignada. Para temperaturas superiores a los 70 °C, no se garantiza el mantenimiento de las prestaciones del interruptor automático. Para asegurar la continuidad de funcionamiento de las instalaciones hay que valorar con atención cómo poder mantener la temperatura dentro de los límites aceptables para el funcionamiento de los diferentes dispositivos y no sólo de los interruptores automáticos, es decir, hay que valorar si conviene utilizar, por ejemplo, sistemas de ventilación forzada en los cuadros y en los locales en los que están instalados.

CSIS9108

Altitud

Hasta 2000 metros de altitud, los interruptores automáticos SACE Isomax S no sufren alteraciones en las prestaciones asignadas. Al aumentar la altitud, se modifican las propiedades de la atmósfera en cuanto a la composición, la capacidad dieléctrica, el poder refrigerante y la presión. Por lo tanto, las prestaciones de los interruptores automáticos pasan a un clase inferior, que puede determinarse esencialmente mediante la variación de los parámetros significativos como la tensión asignada máxima de funcionamiento y la corriente asignada permanente.

Altitud		[m]	≤ 2000	3000	4000
Tensión asignada de servicio	Ue	[V]	690	600	500
Corriente asignada	In	[A]	In	0,95 x In	0,90 x In

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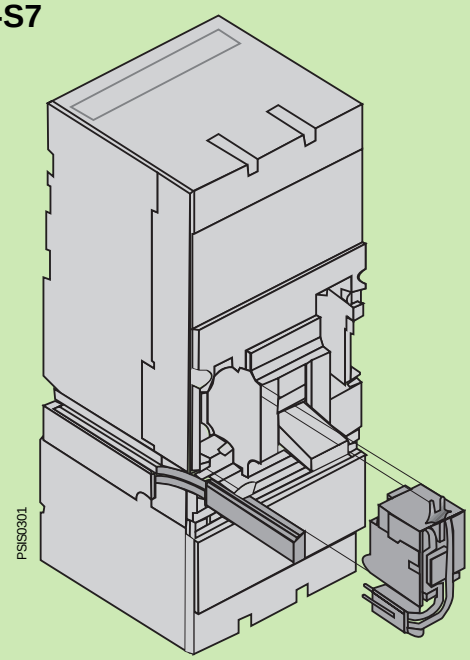
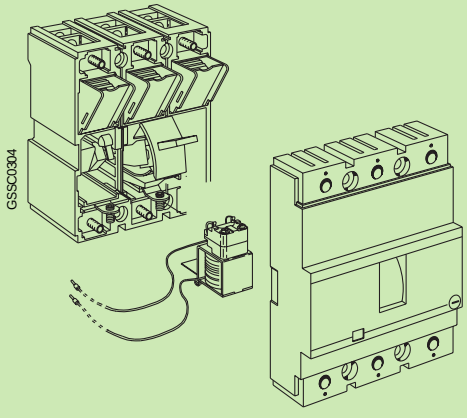
Relés de apertura y mínima

Permiten la apertura del interruptor automático mediante un mando eléctrico (relé de apertura) o mediante la variación de la tensión de alimentación en los bornes del interruptor (relé de mínima tensión). Los relés de apertura y de mínima tensión, alojados y fijados en un hueco de la parte izquierda del interruptor, son siempre en alternativa entre sí.
La alimentación se efectúa mediante los correspondientes conectores que se pueden utilizar indiferentemente para los dos relés. Se exceptúan los interruptores SACE S1 y S2 para los cuales la alimentación se efectúa mediante cables libres de 0,6 m de longitudo con conectores macho - hembra volantes.

SACE S3-S4-S5-S6-S7



SACE S1-S2



Para los interruptores SACE S1 y S2, los relés de apertura y de mínima se fijan a la tapa del interruptor.

Relé de apertura

Permite abrir el interruptor automático mediante un mando eléctrico. El funcionamiento del relé está garantizado para una tensión comprendida entre el -30% y el +10% del valor de la tensión asignada de alimentación Un, en corriente continua y corriente alterna. Se suministra siempre con contacto auxiliar de final de carrera. En la tabla se indican los valores de potencia absorbida en el arranque

Ps	**S1 ... S5**	~	100	[VA]
		-	120	[W]
	S6 - S7	~	150	[VA]
		-	150	[W]

y los valores de la tensión de alimentación Un [V].

Relé de apertura

S1 - S2		**S3 -S4 - S5**		**S6 - S7**	
50-60 Hz	c.c.	50-60 Hz	c.c.	50-60 Hz	c.c.
24 ... 30			12		12
48	60	24	24	24	24
100 ... 130		48	48	48	48
220 ... 250		60	60	60	60
380 ... 440		110 ... 120	110 ... 125	110 ... 120	110 ... 125
	24	220 ... 240	220 ... 250	220 ... 240	220 ... 250
	48	380 ... 400		380 ... 400	
	110	480		480	
	220				
	250				

A cada fila y a cada grupo de interruptores (S1, S2, S3, S4, S5, S6 y S7) les corresponde un relé y un código de pedido.

CSIS9046

Conectores para relés

Permiten conectar el relé de apertura o el de mínima tensión al circuito de alimentación. Se encuentran disponibles en las versiones:
– conector macho - hembra para interruptores S1 y S2
– para interruptores fijos S3 .. S7
– para interruptores enchufables/extraíbles S3..S7
El montaje se efectúa a presión en los correspondientes alojamientos situados en el lado izquierdo del interruptor. Normalmente se suministran con cables de 1 m de longitud. Para los interruptores SACE S3, S4 y S5 en ejecución fija se encuentran disponibles bajo demanda con cables de 2 m de longitud.

Prolongación de control

Disponible para interruptores automáticos SACE S3, S4, S5, S6 y S7, permite alimentar los relés con el interruptor en posición de extraído. De esta manera, con el interruptor en condiciones de seguridad, es decir, seccionado con respecto a los circuitos de potencia, es posible efectuar pruebas en blanco sobre la funcionalidad del interruptor.

CSIS9047

Relé de mínima tensión

Abre el interruptor automático por falta de tensión de alimentación del relé o debido a disminuciones hasta valores por debajo de 0,7 x Un con un campo de intervención de 0,7 a 0,35 x Un. Tras la intervención es posible volver a cerrar el interruptor automático a partir de una tensión superior a 0,85 x Un. El montaje del relé se efectúa a presión en la correspondiente sede situada en la parte izquierda del interruptor. Para los interruptores SACE S1 y S2 se sujeta a la tapa.

En la tabla se indican los valores de potencia absorbida durante el servicio,

Pc	**S1 ... S5**	~	6	[VA]
		-	3	[W]
	S6 - S7	~	10	[VA]
		-	4	[W]

y los valores de la tensión de alimentación Un [V] para grupos de interruptores.

Relés de mínima tensión

S1 - S2			**S3 -S4 - S5**		**S6 - S7**	
50 Hz	60 Hz	c.c.	50-60 Hz	c.c.	50-60 Hz	c.c.
24			24		24	
48	48		48		48	
110			60		60	
	110		110 ... 127		110 ... 127	
220			220 ... 250		220 ... 250	
380	380 ... 440		380 ... 440		380 ... 440	
			480		480	
		24		24		24
		48		48		48
		60		60		60
		110		110 ... 125		110 ... 125
		220		220 ... 250		220 ... 250

A cada fila y a cada grupo de interruptores (S1, S2, S3, S4, S5, S6 y S7) les corresponde un relé y un código de pedido.

CSIS9048

Relé de mínima tensión retardado

El relé de mínima tensión se puede suministrar con un retardador electrónico exterior para retardar la apertura del interruptor en caso de disminución o de falta de tensión de alimentación, según unos retardos fijos de 0,5 - 1- 2 - 3 [s] y evitar, así, intervenciones intempestivas causadas por defectos temporales en la tensión de alimentación del relé. Se encuentra disponible para los interruptores S3, S4, S5, S6 y S7 con tensiones de alimentación de 110 - 220 V (50 - 60 Hz); el relé de mínima tensión suministrado se encuentra alimentado por el retardador con una tensión de 310 Vcc.

Señalizaciones eléctricas

Permiten llevar al exterior del interruptor automático informaciones sobre el estado de funcionamiento del mismo.
La instalación de estos accesorios se efectúa directamente por la parte frontal del interruptor, en los correspondientes huecos, situados en la parte derecha del interruptor, totalmente segregados de las partes bajo tensión, proporcionando más seguridad al usuario.

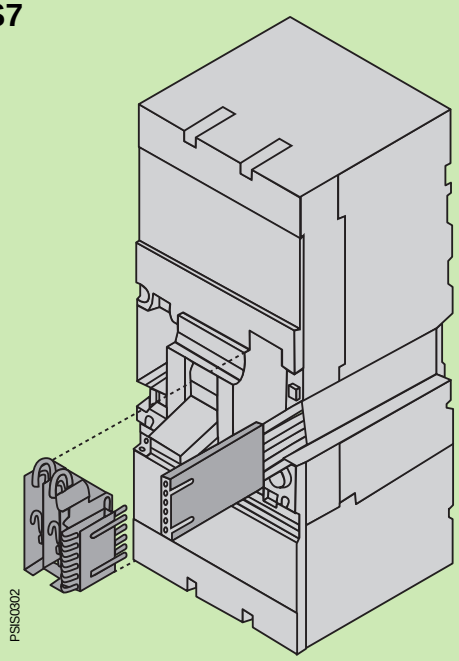
CSIS9121

Contactos auxiliares

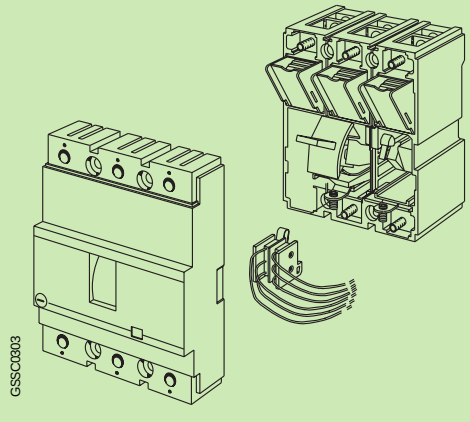
Realizan la señalización eléctrica del estado de funcionamiento del interruptor automático:
– Abierto/Cerrado: indica la posición de los contactos del interruptor.
– Intervención de relés: señala la apertura del interruptor debido a una intervención del relé de sobrecorriente (debido a sobrecarga, cortocircuito), diferencial, de apertura o de mínima tensión, pulsador de apertura de emergencia del mando del motor o debido a la activación del pulsador de prueba. La señalización se pone a cero al rearmar el interruptor (restablecimiento).

Para los interruptores SACE S3, S4, S5, S6 y S7, los contactos auxiliares del interruptor también se encuentran disponibles en versión dorada para señales digitales, adecuados al uso incluso para tensiones Un < 24 V, con el mismo tipo de señalizaciones y ejecuciones que los de versión estándar.
En alternativa se encuentran disponibles:
– Dos contacto de señalización (conmutados) abierto/cerrado.
– Un contacto de señalización (conmutado) abierto/cerrado más contacto de señalización (conmutado) de la intervención de relés.
– Un contacto de señalización abierto, un contacto de señalización cerrado y un contacto de señalización (normalmente abierto) de intervención de relés (sólo para S6 y S7).

SACE S3-S4-S5-S6-S7


PSIS0302

SACE S1-S2


GSSC0303

Para los interruptores SACE S1 y S2, los contactos auxiliares se sujetan a la tapa del interruptor.

SACE Isomax S1-S2

Tensión asignada V~ (50-60 Hz)	Un V–	Carga óhmica In [A]	Carga óhmica - inductiva In [A]
	30	4	
127		4	2A (cosφ = 0,3)
220		4	2A (cosφ = 0,3)

SACE Isomax S3-S4-S5-S6-S7

Tensión asignada V~ (50-60 Hz)	Un V–	Carga óhmica In [A]
	125	0,3
	250	0,15
250		6
400		3

CSIS9050

Conectores para contactos auxiliares

Permiten conectar los contactos auxiliares al correspondiente circuito de alimentación. Para los interruptores SACE S1 y S2, la alimentación se efectúa mediante cables libres o con conectores macho-hembra volantes. Para los interruptores SACE S3, S4, S5, S6 y S7 los contactos auxiliares (dotados con conectores macho) sólo se pueden alimentar mediante los correspondientes conectores hembra que se deben solicitar indicando el modelo y la versión del interruptor (fijo o enchufable/extraíble). El montaje se efectúa a presión en los alojamientos correspondientes situados en el lado derecho del interruptor.

CSIS9051

Prolongación de control para los contactos auxiliares

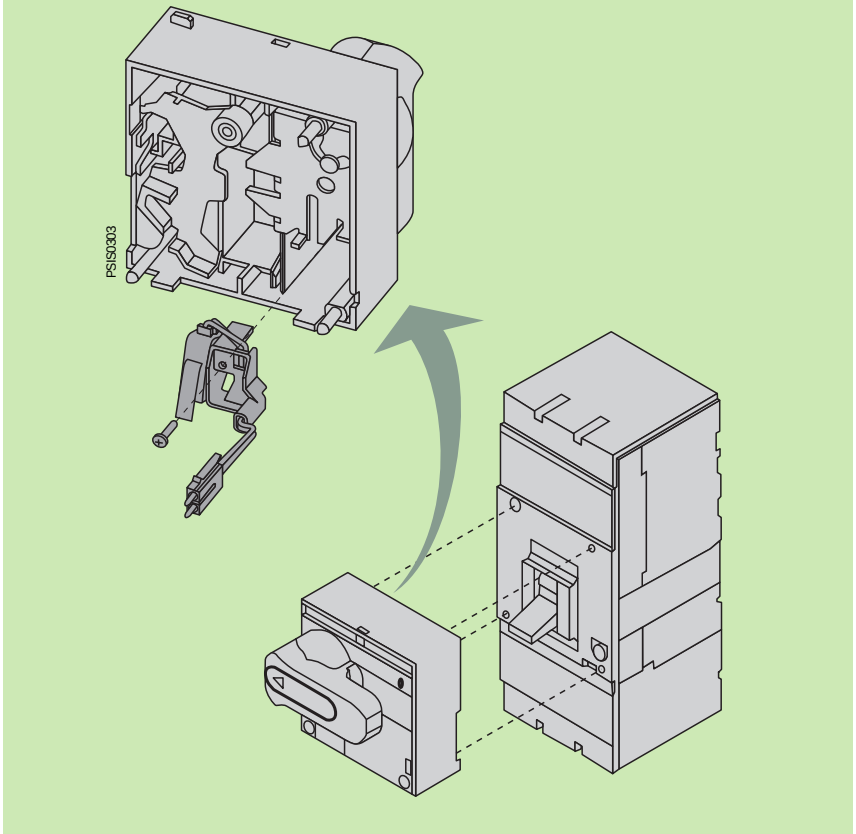
Disponible para los interruptores automáticos SACE S3, S4, S5, S6 y S7, permite conectar los contactos auxiliares al correspondiente circuito de alimentación con el interruptor en posición extraído. Con el interruptor en posición de seguridad, es decir, seccionado con respecto a los circuitos de potencia, es posible efectuar pruebas en blanco sobre la funcionalidad del interruptor.

CSIS9118

Contacto auxiliar anticipado para relés de mínima tensión

El contacto auxiliar anticipado para relé de mínima tensión, accionado por el mando giratorio, mantiene desexcitado el relé de mínima tensión con el interruptor abierto. Sólo se puede aplicar en los interruptores automáticos fijos SACE S3, S4 y S5 con mando giratorio montado directamente en el interruptor. Se suministra con conector hembra del tipo de doble patín para la conexión simultánea del relé de mínima tensión y del contacto de consenso.

SACE S3-S4-S5


PSIS0303

Mando a motor

Permite el mando de apertura y cierre del interruptor automático a distancia y está particularmente indicado para el uso en sistemas de supervisión y control de la red eléctrica. Está dotado con palanca de maniobra manual y pulsador de apertura de emergencia. Un selector permite pasar del funcionamiento automático al funcionamiento manual. Se encuentra siempre preparado para el bloqueo por candados (hasta tres candados con vástago de Ø 6 mm - no suministrados) y, si se solicita, se puede dotar con un bloqueo a llave en posición de abierto, con diferentes llaves para cada interruptor o llaves iguales para grupos de interruptores. La aplicación del mando a motor (en la parte frontal del interruptor) es en alternativa al frontal para el mando por palanca, al mando giratorio y al frontal H = 45 mm (siempre en dotación con el interruptor básico). El montaje del mando a motor no altera las propiedades ni la funcionalidad del interruptor automático. En particular no cambian las versiones disponibles (fija, enchufable/extraíble), los tipos de terminales ni los accesorios aplicables y, para los interruptores SACE S3, S4 y S5, los orificios de las puertas.
Para el uso del interruptor automático en sistemas de automatización en combinación con la unidad de actuación SACE PR212/T se utilizan las versiones con tensión de alimentación a 110Vca/Vcc y 220 V ca.

CSIS9052

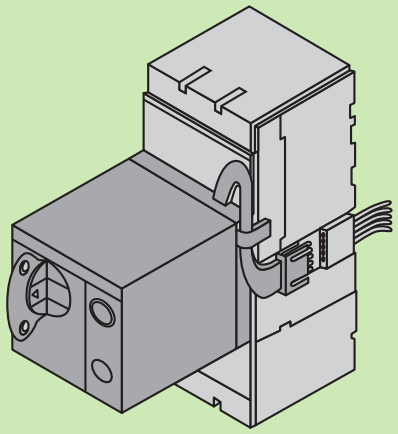
Mando a motor de acción directa para interruptores SACE S3, S4 y S5

Los mandos de apertura y cierre se efectúan mediante el motor que actúa directamente en la palanca del interruptor. En la tabla se indican los valores de la tensión de alimentación Un (V).

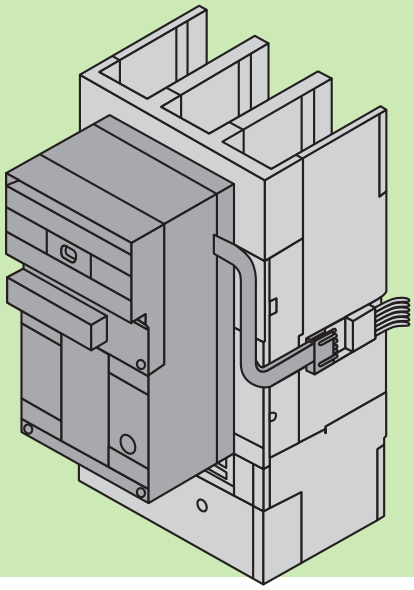
c.a.	c.c.
-	24
-	48-60
110-127	110-125
220-240	220-250
380	-
440	-

Potencia absorbida al arranque	c.a.	~	500	[VA]
Ps	c.c.	-	500	[W]
Potencia absorbida en servicio	c.a.	~	350	[VA]
	c.c.	-	350	[W]
Duración	apertura		0,1	[s]
	cierre		0,1	[s]

SACE S3-S4-S5


PSIS0304

SACE S6-S7



CSIS9083

Mando a motor de acumulación de energía para los interruptores SACE S6 y S7

Con el mando de acumulación de energía, al realizar la apertura del interruptor automático, el mecanismo precarga automáticamente un sistema propio de resortes; la energía acumulada se utiliza para efectuar posteriormente el cierre del interruptor. Está dotado con relés internos de apertura (Ps=100VA~/100W-) y de cierre (Ps=100VA~/100W-) y se suministra con el marco para la puerta de la celda. En la tabla se indican los valores de la tensión de alimentación Un (V).

c.a.	c.c.
-	24
-	48
-	60
110	110
120-127	120-127
220-250	220-250
380	-
440	-

Potencia absorbida	c.a.	~	660	[VA]
al arranque Ps	c.c.	-	600	[W]
Potencia absorbida	c.a.	~	180	[VA]
en servicio Pc	c.c.	-	180	[W]
	cierre		0,09	[s]
Duración	apertura		1.2	[s]
	rearme		2	[s]

CSIS9054

Conectores para mandos a motor

Los mandos a motor sólo se pueden alimentar mediante conectores específicos. Son del tipo de doble patín y permiten conectar simultáneamente el mando a motor y los contactos auxiliares con el correspondiente circuito de alimentación. Son en alternativa a los correspondientes conectores sólo para los contactos auxiliares ya que se instalan en el mismo alojamiento. Se tienen que solicitar especificando el modelo y la versión del interruptor (fija o enchufable/extraíble).

Prolongación de control para los mandos a motor

Disponible para los interruptores automáticos SACE S3, S4, S5, S6 y S7, permite conectar tanto los mandos a motor como los contactos auxiliares al correspondiente circuito de alimentación con el interruptor automático en posición de extraído. Con el interruptor en posición de seguridad, es decir, seccionado con respecto a los circuitos de potencia, es posible efectuar pruebas en blanco sobre la funcionalidad del interruptor.
Se tiene que solicitar especificando el modelo y la versión del interruptor (fija o enchufable/extraíble) y excluye automáticamente la correspondiente prolongación de control de los contactos auxiliares.

Mandos y bloqueos

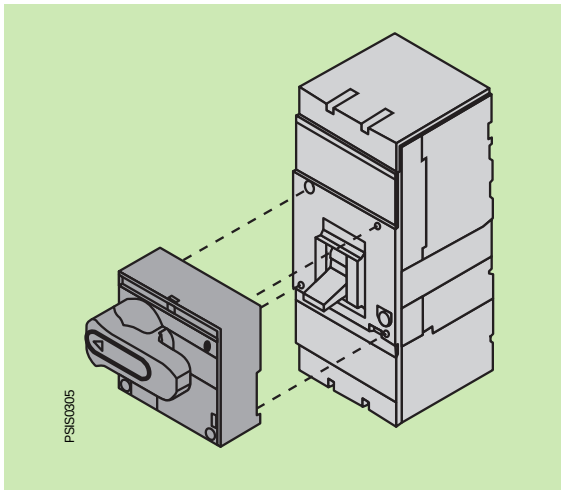
CSIS9055

Mando giratorio

El mando giratorio facilita la maniobra del interruptor automático gracias a su empuñadura ergonómica. Se encuentra dotado siempre con bloqueo por candados que impide el cierre del interruptor. El ojal del bloqueo puede recibir hasta 3 candados - Ø vástago 6 mm (no suministrados).
Si se solicita, se puede dotar con un bloqueo de la puerta de la celda y un bloqueo a llave en posición de abierto. Para los interruptores automáticos SACE S3, S4, S5, S6 y S7, la aplicación del mando giratorio es en alternativa al frontal para bloqueos para interruptores con mando por palanca y al mando a motor. Se encuentran disponibles diferentes tipos de mandos giratorios.

	S1-S2	S3-S4-S5		S6-S7	
	F / P	F / P	W	F	W
Directo	-	•	•	•	•
Reenviado a distancia fija	119,5 mm	-	-	-	-
Reenviado a distancia regulable	-	300 mm	-	500 mm	-
Directo de emergencia	-	•	-	-	-
Reenviado de emergencia	-	300 mm	-	-	-
Prolongación para mando reenviado	300 mm	500 mm	-	-	-

Para los interruptores automáticos SACE S1 y S2, el mando giratorio es de tipo reenviado con un eje de prolongación de longitud fija para el montaje en la puerta de la celda. Se puede suministrar un accesorio para regular la distancia hasta una longitud de 300 mm. Para los interruptores automáticos SACE S3, S4 y S5, el mando giratorio de emergencia está dotado de una maneta de color rojo y una placa amarilla y es adecuado para el mando de máquinas herramienta. Para los interruptores SACE S3, S4 y S5, la versión a distancia regulable para el montaje en la puerta de la celda para interruptor fijo o enchufable se suministra con eje de prolongación de 300 mm de longitud. Se puede suministrar un accesorio para regular la distancia hasta una longitud de 500 mm. La posición del mando giratorio indica con exactitud la posición de los contactos: abierto, cerrado, abierto por relés, etc.. La regulación de los relés de sobreintensidad y la tarjeta de caracteristicas del interruptor automático permanecen accesibles al usuario. Para los interruptores fijos SACE S6 y S7 siempre se suministra el marco para la puerta de la celda, mientras que para los interruptores fijos o enchufables SACE S3, S4 y S5 se puede utilizar el marco normal suministrado con el interruptor fijo con mando por palanca.


PSIS0305

CSIS9056

Frontal para mando por palanca

Se puede instalar en los interruptores automáticos SACE S3, S4, S5, S6 y S7 fijos, enchufables o extraíbles. En caso de interruptores extraíbles instalados en celda, permite mantener el grado de protección IP40 durante toda la carrera de seccionamiento del interruptor. Se suministra siempre con bloqueo por candados en posición de abierto (Ø vástago 6 mm hasta tres candados - no suministrados) que impide el cierre del interruptor. Si se solicita, se puede dotar con bloqueo a llave en posición de abierto para uno o más interruptores y con bloqueo de la puerta de la celda. Se encuentra disponible en las versiones:
– para interruptor fijo o enchufable;
– para interruptor extraíble.
Para los interruptores fijos SACE S6 y S7 siempre se suministra el marco para la puerta de la celda, mientras que para los interruptores fijos o enchufables SACE S3, S4 y S5 se puede utilizar el marco normal suministrado con el interruptor fijo con mando por palanca.

CSIS9057

Bloqueo a llave en posición de abierto

Permite bloquear la maniobra mecánica de cierre del interruptor automático. Se encuentran disponibles en la versiones:
– bloqueo con llave diferente para cada interruptor;
– bloqueo con llaves iguales para grupos de interruptores.

Se suministran bloqueos diferentes para mando a motor de acción directa, mando a motor de acumulación de energía, mandos giratorios o frontal para bloqueos para mando por palanca. El bloqueo del interruptor automático en posición de abierto asegura el seccionamiento del circuito en conformidad con la Norma IEC 947-2.

CSIS9060

Bloqueo de la puerta de la celda

Impide la apertura de la puerta de la celda con el interruptor cerrado. Se puede utilizar con los interruptores SACE S3, S4, S5, S6 y S7 en ejecución fija, enchufable o extraíble y equipados con mando giratorio o frontal para bloqueos para mando por palanca. Está formado por dos elementos: uno aplicado al mando giratorio o al frontal para bloqueos y el otro formado por un tope metálico que se debe aplicar en la puerta de la celda.
Para los interruptores automáticos SACE S1-S2 forma parte integrante del mando giratorio.

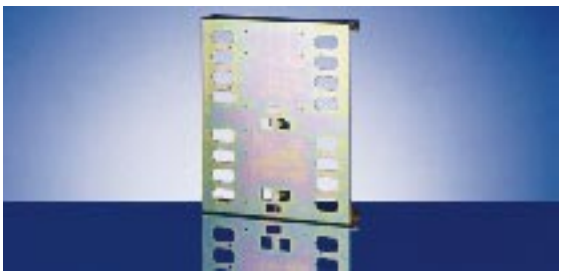
CSIS9058

Bloqueo por candados para palanca de maniobra

Se aplica a la tapa de los interruptores automáticos SACE S1 y S2 para impedir el movimiento de la palanca de maniobra. Si se encuentra activado, el interruptor permanece bloqueado en posición de abierto garantizando el seccionamiento del circuito en conformidad con la Norma IEC 947-2.

Bloqueo antimanipulación

Se aplica a la tapa de los interruptores automáticos SACE S2 y S3 en correspondencia con el botón de regulación del elemento térmico del relé termomagnético e impide la manipulación.

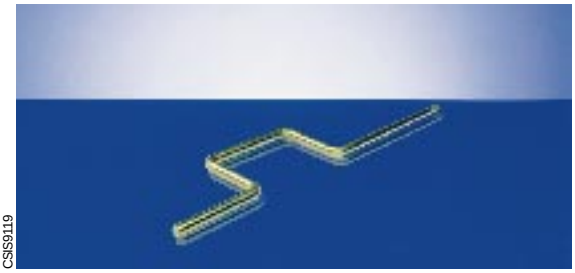

CSIS9061

Enclavamiento mecánico entre dos interruptores

Permite instalar dos interruptores en un único soporte y los convierte mecánicamente interdependientes mediante bielismos. Impide el funcionamiento en paralelo de dos fuentes de alimentación (por ejemplo normal - emergencia). Está formado por un kit de palancas y accesorios de montaje y por un soporte metálico.
Los interruptores y los accesorios de mando se tienen que solicitar aparte. El enclavamiento mecánico se encuentra disponible para interruptores SACE S3, S4, S5, S6 y S7 en dos versiones: para interruptores montados lateralmente y para interruptores sobrepuestos.

Kit de transformación

Los interruptores automáticos SACE Isomax S, a partir de la versión fija con terminales anteriores, se pueden transformar en las diferentes ejecuciones utilizando los Kit de transformación. Esto hace que la gestión del producto, de sus versiones y de los almacenes sea muy flexible. En cualquier caso, siempre es posible solicitar el interruptor en la versión deseada completamente preparada en la fábrica.


CSIS9119

Manivela de extracción

Permite extraer e insertar, incluso con la puerta cerrada, el interruptor extraíble en la parte fija. La manivela es igual para toda la gama de interruptores y se suministra siempre en dotación con el kit de transformación o con los interruptores suministrados en versión extraíble.

CSIS9062

Kit de transformación en parte móvil para interruptor enchufable

Permite transformar el interruptor fijo con terminales anteriores en la parte móvil de un interruptor enchufable. El kit está formado por:
– contactos de seccionamiento en forma de tulipa
– estructura metálica
– tornillos y tuercas de montaje
Para completar el interruptor se necesita la parte fija.

CSIS9063

Kit de transformación en parte móvil para interruptor extraíble

Permite transformar el interruptor fijo con terminales anteriores en la parte móvil de un interruptor extraíble. El kit está formado por contactos de seccionamiento, estructura metálica, tuercas y tornillos de montaje. El interruptor extraíble tiene que estar dotado con uno de los siguientes accesorios:
– frontal para bloqueos para mando por palanca
– mando giratorio directo
– mando a motor
para poder realizar el bloqueo a la extracción/inserción, si es necesario. Para completar el interruptor se necesita la parte fija.

Accesorios para parte fija del interruptor enchufable o extraíble

CSIS9104

CSIS9065

Parte fija

La parte fija permite realizar el interruptor automático en versión enchufable o extraíble. Se puede montar en el cuadro incluso como alimentación de reserva para completar con el interruptor automático cuando sea necesario. Para los interruptores en ejecución enchufable o extraíble existen diversas posiciones del interruptor:
– Enchufable: insertado - removido
– Extraíble: insertado - extraído - removido
La parte fija para interruptores en versión extraíble está dotada con una guía para sostener la parte móvil en las operaciones de seccionamiento o extracción de la parte móvil, para los interruptores SACE S3, S4 y S5.
Para los interruptores automáticos SACE S6 y S7 las guías son dos.

Guía para la parte fija

Guía para preparar la parte fija de interruptores en versión enchufable en la parte fija de interruptor extraíble SACE S3, S4 y S5.

Terminales para parte fija

Preparan la parte fija para recibir conexiones en cable o en barra. La parte fija para interruptor enchufable o extraíble puede dotarse con terminales de conexión según las indicaciones ilustradas en la tabla.

	S1	S2	S3	S3D	S4	S5	S6	S6D	S7	S7D
Anteriores			●	●	●	●	●	●	●	●
Anteriores para cables de Cu	●	●	●	●	●	●				
Posteriores roscados	●	●	●	●	●	●				
Posteriores planos horizontales							●	●	●	●
Posteriores planos verticales							●	●	●	●

En el caso de parte fija para interruptores SACE S3, S4 y S5 con terminales para cables de Cu se suministra en dotación los cubrebornes altos. Para la parte fija, cada código se refiere a un kit para la aplicación completa de los terminales, tanto superiores como inferiores.

Contactos de posición del interruptor

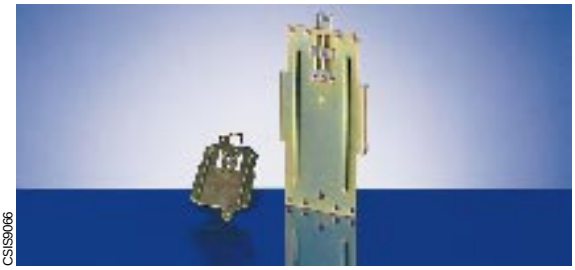
Para la parte fija de los interruptores automáticos SACE S2, S3, S4, S5, S6 y S7 efectúan la señalización eléctrica de posición del interruptor con respecto a la parte fija: insertado, extraído. Sólo se pueden conectar mediante cables libres y se encuentran disponibles en las versiones:
– contactos de señalización interruptor insertado
– contactos de señalización interruptor extraído
En la parte fija es posible instalar un número máximo de tres contactos para S2, dos contactos para S3, tres contactos para S4 y S5, y cinco contactos para S6 y S7, en cualquier combinación.
Los contactos de posición del interruptor también se encuentran disponibles en versión dorada para señales digitales, adecuados al uso incluso para tensiones Un < 24 V, con el mismo tipo de señalizaciones y ejecuciones que los de versión estándar.

SACE Isomax	Tensión asignada Un V~ (50-60 Hz)	V–	Carga óhmica In [A]	Carga óhmica- inductiva In [A]
S2		30	4	
	127		4	2A (cosφ = 0,3)
	220		4	2A (cosφ = 0,3)
S3-S4-S5-S6-S7		125	0,3	
		250	0,15	
	250		6	
	400		3	

Bloqueos para parte fija de interruptor extraíble

Existen una serie de bloqueos a llave o por candados para aplicar a la guía de la parte fija de un interruptor extraíble e impedir la inserción de la parte móvil. Se encuentran disponibles las siguientes versiones:
– Bloqueo por candados, que puede llevar hasta tres candados con Ø vástago de 6 mm (no suministrados).
– Bloqueo a llave en posición de extraido con diferente llave para cada interruptor.
– Bloqueo a llave en posición de extraido entre dos o más interruptores con la misma llave para cada grupo de interruptores.
– Bloqueo a llave tipo Ronis (sin llave).

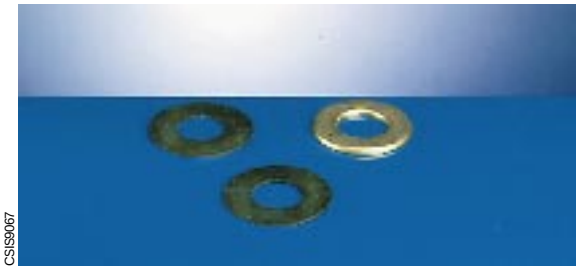
Accesorios de instalación


CSIS9066

Accesorio para fijación a perfil DIN

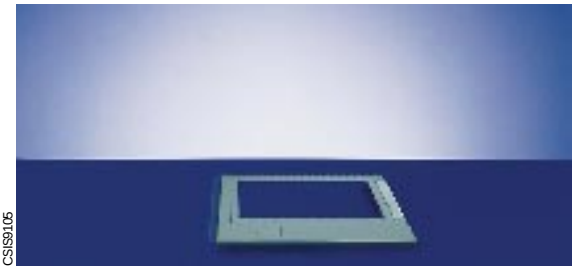
Se aplica al interruptor fijo y permite la instalación en el perfil normalizado DIN. Simplifica el montaje, en cuadros estándar, de los interruptores hasta 630 A.
- Accesorio para fijación a perfil DIN EN 50022 para los interruptores SACE S1 y S2.
- Accesorio para fijación a perfil DIN EN 50023 para los interruptores SACE S3, S4 y S5.

El kit para fijación a perfil DIN para los interruptores SACE S3, S4 y S5 también incluye el frontal H = 45mm.


CSIS9067

IP54 protection for crank handle

For meeting protection class IP54. Available in the following versions:
- for fixed-depth crank handle operating mechanism on compartment door for SACE S1-S2 circuit-breakers
- for adjustable-depth crank handle operating mechanism on compartment door for SACE S3-S4-S5-S6-S7 circuit-breakers.


CSIS9105

Marco para la puerta de la celda

Se suministra siempre con el interruptor automático. Para los interruptores SACE S3, S4 y S5, el marco suministrado con el interruptor fijo se puede utilizar también para el mando giratorio directo, el frontal de bloqueos para mando por palanca y el mando a motor para los interruptores en versiones fijo y enchufable. En caso de que se adopten estos accesorios en los interruptores SACE S6 y S7 en version fijo, se suministra un marco con el accesorio que se debe utilizar en lugar del suministrado con el interruptor fijo.

Para los interruptores extraíbles se suministran marcos específicos que pueden utilizarse también para el mando giratorio directo y el mando motor. Con el mando motor para los interruptores SACE S6-S7 se suministra un marco que se debe utilizar en lugar del suministrado. Para los interruptores SACE S1, S2 y S3 suministrados con diferencial SACE RC211 y RC212 montado lateralmente y preparados para la instalación en el perfil, no se suministra el marco.

CSIS9106

Ejecución extraíble

Los interruptores en ejecución extraíble tienen que estar siempre dotados, en alternativa, con frontal para bloqueos para mando por palanca (dotación estándar), mando giratorio o mando a motor.

Piezas de repuesto

Se encuentran disponibles las siguientes piezas de repuesto:
- palanca de maniobra
- grupo tapa
- cámaras de arco
- contactos de seccionamiento
- solenoide de apertura para relés diferenciales de la serie SACE RC211 y RC212
- kit de arandelas, tornillos y tacos para el montaje de los terminales de conexión

Para más detalles solicitar el catálogo de piezas de repuestos a la División Service de ABB SACE.

Relés diferenciales

CSIS9103

CSIS9102

Relés diferenciales electrónicos SACE RC211 y RC212

Los relés diferenciales electrónicos SACE RC211, RC212 se pueden instalar en los interruptores automáticos tetrapolares SACE S1, S2 y S3 en ejecución fija y se pueden suministrar en dos versiones:
– para el montaje lateral al interruptor
– para el montaje debajo del interruptor
Se encuentran disponible los siguientes relés:
– SACE RC211/1 y RC212/1 para interruptores S1
– SACE RC211/2 y RC212/2 para interruptores S2
– SACE RC211/3 y RC212/3 para interruptores S3
El interruptor automático tetrapolar con relé diferencial se puede dotar con accesorios eléctricos normalmente disponibles para el interruptor:
– relé de apertura
– relé de mínima tensión
– contactos auxiliares
– protección transparente antimanipulación del dispositivo de regulación del relé térmico para los interruptores automáticos SACE S2 y S3.

Los relés de apertura y de mínima tensión se instalan en el correspondiente hueco realizado en el cuarto polo.

Relé diferencial montado lateralmente al interruptor automáticos tetrapolar

Se suministra con:
– cables de potencia para la conexión a los terminales inferiores del interruptor (respetar la correspondencia del neutro y de las fases)
– un solenoide de apertura que se debe instalar en la zona del tercer polo dotado con conector macho - hembra para la conexión al diferencial.
– 2 bridas para la sujeción al perfil DIN (una para el interruptor y la otra para el diferencial)
– conector macho para conectar el pulsador de apertura a distancia (a realizar por el cliente).

Para los interruptores automáticos tetrapolares SACE S1 y S2, el relé diferencial está dotado con terminales anteriores para cables. Para el interruptor automático tetrapolar SACE S3, el relé diferencial está dotado con terminales anteriores y se suministra también un frontal H= 45 mm para el interruptor.
Si se solicita, se pueden montar en los interruptores S3 los terminales anteriores para cables, utilizando el kit estándar del interruptor.

Relé diferencial montado debajo del interruptor automático tetrapolar

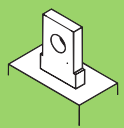
Se suministra con:
– un solenoide de apertura que se debe instalar en la zona del tercer polo con conector macho - hembra para la conexión al diferencial.
– conector macho para conectar el pulsador de apertura a distancia (a realizar por el cliente) con el relé diferencial SACE RC212
– marco para la puerta de la celda (uno para SACE S1 y S2; dos para SACE S3)
– protección para el montaje en la zona entre el interruptor automático y el diferencial.

En la versión para interruptores automáticos tetrapolares SACE S1 y S2, el relé diferencial se suministra con terminales anteriores para cables. Si se solicita, se pueden montar los terminales posteriores roscados, utilizando el kit estándar del interruptor. En la versión para interruptores automáticos tetrapolares SACE S3, se suministra también un frontal H = 45 mm para el interruptor. El relé diferencial está dotado con terminales anteriores. Si se solicita, utilizando el kit estándar del interruptor, se pueden montar los:
– terminales anteriores para cables
– terminales anteriores prolongados
– terminales posteriores para cables
o se puede montar los terminales posteriores utilizando el kit de 4 piezas para el interruptor (código 1SDA023365R1) y el kit para el diferencial (código 1SDA025543R1).

Terminales de conexión

S2

S3-S4-S5 400

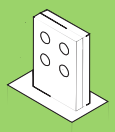

S3-S4-S5 (parte fija)

S6 (parte fija)

S6 630A

S6 800A

S7


S7 (parte fija)

Terminales anteriores y anteriores prolongados

Permiten conectar barras o cables con terminal.

	Ejecuciones	Cantidad	Pletina L[mm]	P[mm]	min P	Ø	Apriete [Nm]
S2 160	F	1	20	4	–	M8	9
S3 160	F-P-W	1	20	6	–	M8	9
S3 250	F-P-W	1	20	6	–	M8	9
S4 160	F-P-W	1	20	6	–	M8	9
S4 250	F-P-W	1	20	6	–	M8	9
S5 400	F-P-W	2	25	5	3	M10	18
S6 630	F-W	2	40	5	5	M10	9
S6 800	F-W	2	50	5	5	M12	9
S7 1250	F-W	2	50	8	15	M10	18
S7 1600	F-W	2	50	10	15	M10	18

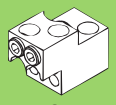
S1-S2

S3-S4-S5

S5

S6 630A

S6 800A


S7

Terminales anteriores para cables de cobre

Permiten conectar cables de cobre directamente en el interruptor.

	Ejecuciones	cables	sección cable [mm^2]	Ø borne [mm]	Apriete [Nm]
S1 125	F - P	1	1.5 ... 50	11	2.5 - 5
S2 160	F - P	1	1.5 ... 70	12.5	2.5 - 5
S3 160	F - P - W	1	6 ... 185	18	16
S3 250	F - P - W	1	6 ... 185	18	16
S4 160	F - P - W	1	6 ... 185	18	16
S4 250	F - P - W	1	6 ... 185	18	16
S5 400	F - P - W	1	16 ... 240	24	25
S5 630	F - W	2	50 ... 185	20	31

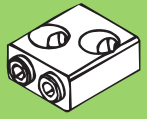
Terminales anteriores para cables de cobre o aluminio

Permiten conectar cables de cobre o de aluminio directamente al interruptor.

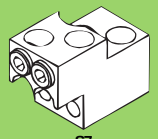
Para el interruptor SACE S2 estos terminales se tienen que conectar a los terminales anteriores prolongados, que se suministran si el interruptor se solicita equipado directamente en fábrica; mientas que se tiene que especificar el kit de terminales anteriores prolongados, si se solicitan como piezas sueltas.

S2-S3-S4-S5

S5


S6 630A

S6 800A


S7

	Ejecuciones	cables	sección cable [mm^2]	Ø borne [mm]	Apriete [Nm]
S2 160	F	1	2.5 ... 50	9.5	5.6
		1	35 ... 95	13.5	13.5
S3 160	F	1	35 ... 95	13.5	13.5
S3 250	F	1	25 ... 150	17	31
S4 160	F	1	35 ... 95	13.5	13.5
S4 250	F	1	25 ... 150	17	31
S5 400	F	1	120 ... 240	20.5	43
		2	95 ... 120	15.5	31
S6 630	F	2	120 ... 240	21.5	31
S6 800	F	3	95 ... 185	19	43
S7 1250	F	4	95 ... 240	21.5	43

El interruptor automático en versión base se suministra con:
- terminales anteriores para los interruptores automáticos SACE S3, S4, S5, S6 y S7;
- terminales anteriores para cables de cobre para los interruptores automáticos SACE S1 y S2.

Se encuentran disponibles diferentes tipos de terminales que se pueden combinar de varias maneras entre sí (superiores de un tipo, inferiores de otro tipo) permitiendo conectar el interruptor automático de la manera más idónea según las exigencias de instalación.

Se puede distinguir entre:
- **terminales anteriores** que permiten conectar cables o barras directamente desde la parte delantera del interruptor.
- **terminales posteriores** que permiten instalar los interruptores en cuadros con acceso posterior a las conexiones en cables y en barras.

Se encuentran disponibles terminales para la conexión de barras o cables con terminales y terminales para la conexión directa de cables. Para cada tipo de terminal se resumen las informaciones necesarias para efectuar la conexión. Para las conexiones con barras se aconsejan pletinas de dimensiones y formas diferentes. Además, se indica el grosor mínimo que debe poseer la pletina que se tiene que conectar, si es de composición diferente al aconsejado. Para la conexión directa con cables sin terminal se indican las secciones mínima y máxima de los cables que se pueden apretar en los bornes y el diámetro del borne. Se indican los valores del par de apriete que se tiene que aplicar a los tornillos de los terminales para cables y a los tornillos utilizados para conectar las barras a los terminales en pletina.

Los interruptores automáticos se pueden solicitar con los terminales deseados, directamente montados en la fábrica, o se pueden solicitar los terminales por separado en kits de 3, 4, 6 y 8 piezas. Existen unos códigos para solicitar directamente interruptores en la configuración con terminales superiores / inferiores del mismo tipo.

Cubrebornes aislantes

Los cubrebornes se aplican en los terminales del interruptor automático para evitar contactos accidentales con partes bajo tensión y garantizar, de esta manera, la protección contra contactos indirectos. Se encuentran disponibles:
- **cubrebornes bajos**, garantizan un grado de protección IP40 para interruptores fijos con terminales posteriores y para partes móviles de interruptores enchufables o extraíbles.
- **cubrebornes altos**, garantizan un grado de protección IP40 para interruptores fijos con terminales anteriores, anteriores para cables y posteriores.
- **cubrebornes para partes fijas** de interruptores enchufables o extraíbles, garantizan un grado de protección IP40 en el frente con la parte móvil insertada. Se encuentran disponible en una sola versión.

Los grados de protección indicados valen para el interruptor instalado en el cuadro.
En los interruptores fijos con terminales:
– anteriores
– anteriores prolongados
– anteriores para cables de cobre
se pueden montar los cubrebornes bajos y los cubrebornes altos, mientras que en los interruptores fijos:
– con terminales anteriores para cables de cobre o aluminio, sólo se pueden montar cubrebornes altos;
– con terminales posteriores planos verticales o horizontales, sólo se pueden montar cubrebornes bajos;
– con terminales posteriores roscados, siempre se suministran los cubrebornes bajos;
– con terminales posteriores para cables de cobre o aluminio, siempre se suministran cubrebornes altos.

Siempre se suministran los cubrebornes altos para los interruptores:
– SACE S2 160 con terminales anteriores para cables de cobre o aluminio.
– SACE S5 400 con terminales anteriores para cables de cobre o aluminio del tipo 2x120 mm².
– SACE S6 800 con terminales anteriores para cables de cobre o aluminio.

Para los interruptores SACE S7 sólo se encuentran disponibles cubrebornes bajos.
Para partes fijas de interruptores enchufables o extraíbles:
– con terminales anteriores prolongados, los cubrebornes se encuentran disponibles sobre demanda;
– con terminales anteriores para cables de cobre, los cubrebornes siempre se suministran;
– con terminales posteriores o en pletina, los cubrebornes no se pueden montar.

Para las partes móviles de los interruptores enchufables o extraíbles y en el kit de transformación de la ejecución del interruptor de fijo a parte móvil siempre se prevén cubrebornes bajos. Los cubrebornes bajos para los interruptores SACE S3, S4, S5 siempre se suministran con diafragmas separadores que se pueden utilizar para garantizar un mejor aislamiento entre las fases.
Los interruptores automáticos SACE S1-S2 siempre se suministran con diafragmas separadores que se pueden utilizar para garantizar un mejor aislamiento entre las fases de alimentación al interruptor automático.
El aislamiento de los conductores o de las barras en el exterior del interruptor corren a cargo del cliente.

Tornillos para precintar los cubrebornes

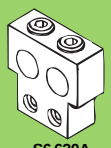
Se aplican a los cubrebornes de los interruptores fijos o a las partes móviles de los interruptores enchufables o extraíbles. Impiden la remoción de los cubrebornes, altos o bajos, y se pueden bloquear mediante un hilo y un precinto de plomo.

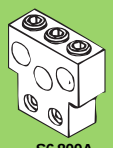
Terminales posteriores para cables de cobre o aluminio

Permiten conectar cables de cobre o aluminio directamente al interruptor.

	Ejecuciones	cables	sección cable [mm²]	Ø borne [mm]	Apriete [Nm]
S3 160	F	1	50 ... 120	16	31
S3 250	F	1	50 ... 120	16	31
S4 160	F	1	50 ... 120	16	31
S4 250	F	1	50 ... 120	16	31
S5 400	F	1	120 ... 240	21	43
S6 630	F	2	50 ... 150	21	31
S6 800	F	3	120 ... 240	17,5	43

S3-S4-S5

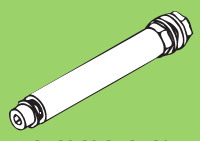

S6 630A

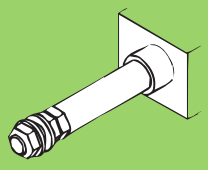

S6 800A

Threaded rear terminals

Enable busbars to be connected to the rear.

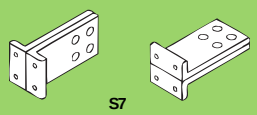
		longitud terminales [mm]	[mm]	Ø	pletina L [mm]	P [mm]
S1 125	F	42	75	M8	16	3
	P	40	76		16	3
S2 160	F	42	75	M8	18	4
	P	40	76		18	4
S3 160	F	55	100	M12	20	6
	P - W	48	100		20	6
S3 250	F	55	100	M12	20	6
	P - W	48	100		20	6
S4 160	F	55	100	M12	20	6
	P - W	48	100		20	6
S4 250	F	55	100	M12	20	6
	P - W	48	100		20	6
S5 400	F	62	108	M16	25	2 x 5
	P - W	58	108		25	2 x 5
S5 630	F	70	135	M24 x 2	40	2 x 5
S6 630	F	68	68	M24 x 2	40	2 x 5
S6 800	F	68	68	M24 x 2	50	2 x 5


S1-S2-S3-S4-S5-S6

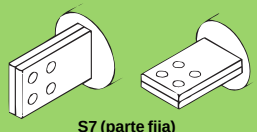

S1-S2-S3-S4-S5 (parte fija)

Terminales posteriores planos horizontales y verticales

	ejecuciones	cantidad	Pletina L	P	Ø	Apriete [Nm]
S5 630	W	2	40	5	M10	30
S6 630	W	2	40	5	M12	30
S6 800	W	2	50	5	M12	30
S7 1250	F - W	2	50	8	M10	18
S7 1600	F - W	2	50	10	M10	18

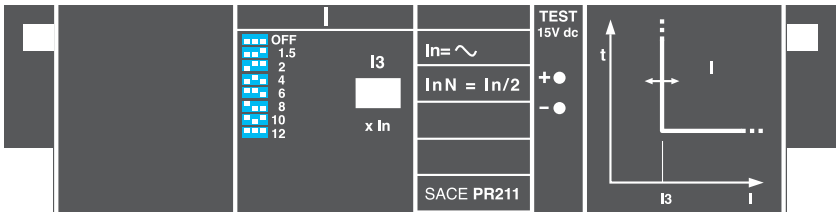

S7

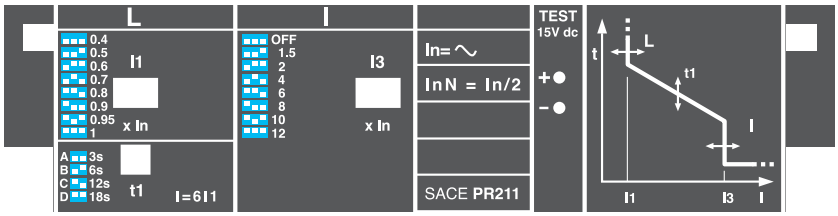
S6 (parte fija)


S7 (parte fija)

Relés de sobreintensidad con microprocesador

Los relés con microprocesador SACE PR211/P y SACE PR212/P pueden instalarse en los interruptores automáticos SACE S4, S5, S6 y S7; están autoalimentados y garantizan el correcto funcionamiento de las funciones de protección, incluso con una sola fase en tensión, en presencia de una corriente mayor o igual al 15% del valor asignado de la fase.
El relé de protección está formado por los transformadores amperimétricos (tres o cuatro en función del número de polos del interruptor automáticos), por la unidad de protección SACE PR211/P o SACE PR212/P y por un solenoide de apertura de desmagnetización SA que actúa directamente en el mecanismo de disparo del mando del interruptor automático. Los transformadores amperimétricos se encuentran en el interior de la caja del relé de sobreintensidad y suministran la energía necesaria para el correcto funcionamiento de la protección y la señal necesaria para detectar la corriente. Se encuentran disponibles con corriente asignada primaria según se indica en la tabla.





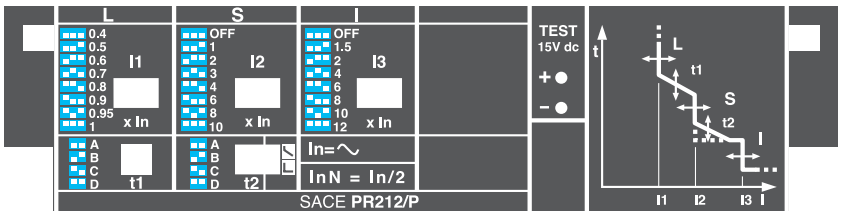
	Iu [A]	In [A]
S4	160	100
		160
	250	250
S5	400	320
		400
	630	630
S6	630	630
	800	800
S7	1250	1000
		1250
	1600	1600

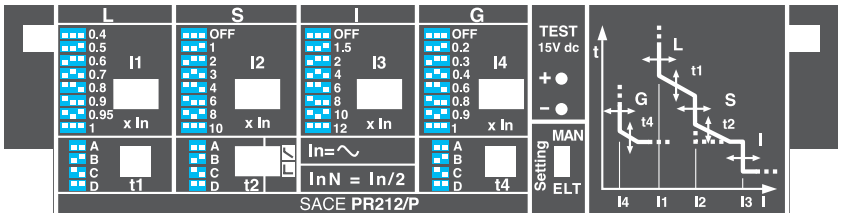
La protección permite la elaboración de la señal amperimétrica del polo neutro al 50% del valor de las fases. Si se solicita, es posible disponer del polo neutro con elaboración al 100% del valor de las fases mediante la indicación de un código adicional en el pedido (1SDAO 37505R1). Cuando la protección interviene, el interruptor se abre mediante el

		Curvas tiempo-corriente			
Umbral de intervención		A	B	C	D
L I_1= 0,4-0,5-0,6-0,7-0,8-0,9-0,95-1 x In intervención entre 1,05 ... 1,30 x I_1 (IEC 947-2) No excluible		t_1 = 3 s a 6 x I_1	t_1 = 6 s a 6 x I_1	t_1 = 12 s a 6 x I_1	t_1 = 18 s a 6 x I_1
		tolerancia: ±10% hasta 2 x In; ±20% mayor que 2 x In			
S I_2= 1-2-3-4-6-8-10 x In Tolerance ±10% Excluible	I^2t = cost ON	t_2 = 0,05 s a 8 x In	t_2 = 0,1 s a 8 x In	t_2 = 0,25 s a 8 x In	t_2 = 0,5 s a 8 x In
		tolerancia: ±20%			
	I^2t = cost OFF	t_2 = 0,05 s	t_2 = 0,1 s	t_2 = 0,25 s	t_2 = 0,5 s
		tolerancia: ±20%			
I I_3 = 1,5-2-4-6-8-10-12 x In Tolerance ±20% sobre el umbral y el tiempo Excluible		–	–	–	–
G I_4 = 0,2-0,3-0,4-0,6-0,8-0,9-1 x In Tolerance ±20% Excluible	I^2t = cost ON	hasta 3,25 x I_4	hasta 2,25 x I_4	hasta 1,6 x I_4	hasta 1,25 x I_4
		t_4=100 ms a 3,25 x I_4	t_4=200 ms a 2,25 x I_4	t_4=400 ms a 1,6 x I_4	t_4=800 ms a 1,25 x I_4
		tolerancia: ±20%			
	I^2t = cost OFF	I > 3,25 x I_4	I > 2,25 x I_4	I > 1,6 x I_4	I > 1,25 x I_4
		t_4=100 ms	t_4=200 ms	t_4=400 ms	t_4=800 ms
		tolerancia: ±20%			

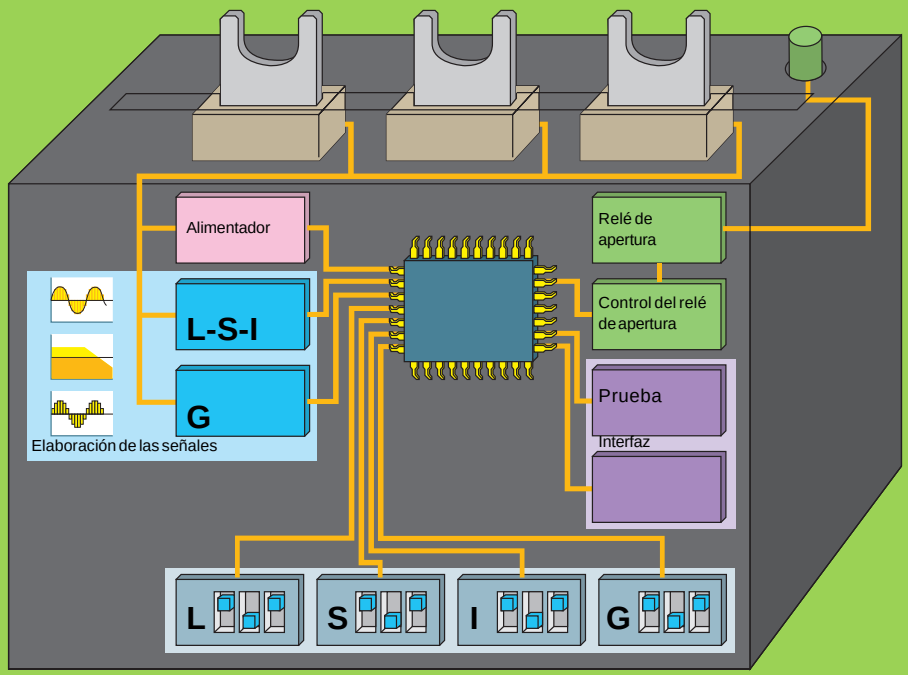
solenoide de apertura SA, el cual conmuta un contacto para la señalización de intervención del relé de sobrecorriente. El restablecimiento de la señalización es de tipo mecánico y se efectúa mediante el rearme de la palanca de maniobra del interruptor automático.
Es posible efectuar la prueba del solenoide de apertura SA mediante el dispositivo de prueba SACE TT1. El resultado positivo de la prueba coincide con la apertura del interruptor.
En la versión con relé SACE PR212/P - LSIG es posible programar los parámetros de regulación de las funciones de protección directamente desde el frente (dip switch en posición MAN), o programar los parámetros a distancia (dip switch en posición ELT) gracias al uso de la unidad de diálogo SACE PR212/D.
En caso de anomalías al establecer los parámetros a distancia, la protección adopta automáticamente el grupo de parámetros programados manualmente en el frente del interruptor. Las unidades de señalización PR212/K o de diálogo PR212/D alimentan de manera continua el relé de protección PR212/P - LSIG (24 Vcc ± 20%) y esto permite programar a distancia los parámetros de regulación incluso con el interruptor abierto.

Dimensiones (H x L x P)	32 x 93 x 45 mm
Temperatura de funcionamiento	–25 °C ... +70 °C
Humedad relativa	90%
Frecuencia de trabajo	45 ... 66 Hz
Compatibilidad electromagnética (LF y HF)	IEC 947-2 Anexo F
Descargas electrostáticas	IEC 1000-4-2
Campo electromagnético irradiado	IEC 1000-4-3
Transitorios de breve duración	IEC 1000-4-4
MTBF previsto	15 años (45 °C)
Características del contacto de señalización	
Máxima corriente permanente asignada	0,5 A
Máxima tensión permanente asignada	24 Vcc/ca
Poder de corte asignado	3 W/VA
Aislamiento contacto/contacto	500 Vc.a.
Aislamiento contacto/bobina	1000 Vc.a.





PR211/P		PR212/P	
LI	I	LSI	LSIG
●		●	●
		●	●
●	●	●	●
			●



CSIS9070

CSIS9071

Unidad de señalización SACE PR212/K

La unidad de señalización SACE PR212/K puede convertir las señales digitales suministradas por la unidad de protección SACE PR212/P - LSIG en señales eléctricas mediante contactos eléctricos normalmente abiertos. Para el funcionamiento de la unidad se requiere una alimentación auxiliar con una tensión estabilizada a 24 Vcc (±20%, con ondulación máxima - ripple ±5%) e aislada de tierra y funciona independientemente de la presencia de la unidad de diálogo SACE PR212/D. Está conectada al bus interior de la unidad de protección mediante una línea de transmisión serie dedicada a la cual el usuario no puede acceder y por la que transitan todas las informaciones sobre el estado de activación de las funciones de protección en función de las cuales se cierran los correspondientes contactos de potencia para señalar:

– prealarma de la función de protección L (I>0,9 x I1)
– intervención de las funciones de protección L, S, I, G
– intervención del relé
– error de comunicación con la unidad de protección.

La señalización de prealarma permanece activa en toda la duración de la sobrecarga hasta que interviene el relé. Las señalizaciones de intervención de las protecciones se activan durante las fases de temporización y permanecen activadas incluso tras la intervención del relé. Si la señalización de anomalías en el bus interno es activa, la unidad PR212/K deshabilita automáticamente todas las señalizaciones precedentes. Un pulsador de RESET permite poner a cero todas las señalizaciones.

Características del relé de señalización

Alimentación auxiliar	24 V c.c. ±20% ondulación máxima 5%
Máxima corriente permanente asignada	5 A
Máxima tensión permanente asignada	250 V c.a. / 130 V c.c.
Poder de interrupción - carga resistiva	50 W / 800 VA (48 V c.c. e 220 V c.a.)
Poder de interrupción - carga inductiva	25 W / 500 VA (48 V c.c. e 220 V c.a.)
Aislamiento contacto/contacto	1000 Veff
Aislamiento contacto/bobina	2000 Veff

Unidad de diálogo SACE PR212/D

La unidad de diálogo SACE PR212/D permite la comunicación del interruptor automático hacia el exterior y viceversa, mediante una línea de transmisión serie EIA RS485 y según el protocolo de comunicación ABB INSUM (velocidad de transmisión 150 ... 19.200 baud). Se puede adoptar en presencia de la unidad de protección SACE PR212/P - LSIG y se efectúa con módulos exteriores adecuados para la instalación en perfil DIN para interruptores automáticos SACE S4 y S5 o se instala directamente en la caja del relé para interruptores automáticos SACE S6 y S7. Tiene que estar alimentada con una tensión estabilizada a 24 Vcc (±20%, con ondulación máxima - ripple ±5%) y aislada de tierra.

La comunicación hacia el exterior se dirige, en general, a una unidad de Front-End insertada en los sistemas de supervisión y control que, recoge y memoriza las informaciones correspondientes al tramo de instalación controlado y las envía a la unidad de gestión centralizada según las lógicas adoptadas.

Se pueden obtener, mediante el bus de campo, las informaciones correspondientes al estado de la unidad de protección y el estado del interruptor automático:

– prealarma (I>0,9 x I1), sobrecarga función L, S, I, G intervención del relé
– programación del selector local/remoto, estado normal o de parametrización, correcta comunicación en el bus interno
– parámetros programados manualmente mediante los dip-switch
– exactitud de los parámetros programados electrónicamente
– estado del interruptor (abierto - cerrado) y posición del interruptor (insertado - removido/extraído)
– corriente de las fases, del neutro y de tierra, protección de neutro (50/100%), última corriente interrumpida
– número de maniobras mecánicas del interruptor
– calibre TA, tipo de interruptor, tag name de 8 caracteres y 4 números de identificación para el uso del usuario.

En caso de error en la comunicación serie debido a una avería de la unidad de diálogo o debido a la falta de alimentación auxiliar, la unidad de protección SACE PR212/P - LSIG actúa en función de los últimos parámetros programados y, de todas formas, según cuanto programado manualmente. La unidad de diálogo SACE PR212/D siempre se suministra en combinación con la unidad de actuación SACE PR212/T que permite efectuar el cierre o la apertura del interruptor a distancia (Control Remoto) mediante dos salidas digitales, que se pueden inhibir gracias al dip switch (LOC/REM) en posición LOC.
En la parte superior de la unidad de diálogo se encuentran los selectores (Dip switch) que permiten programar la unidad.

CSX9137

Unidad de actuación SACE PR212/T

La unidad de actuación SACE PR212/T permite la apertura y el cierre del interruptor automático mediante el mando a motor instalado en el interruptor. Siempre se suministra en combinación con la unidad de diálogo SACE PR212/D. Para el funcionamiento de la unidad se requiere una alimentación auxiliar con una tensión estabilizada a 24 Vcc (±20%, con ondulación máxima - ripple ±5%) y aislada con respecto a tierra.

La unidad de diálogo PR212/D envía los comandos de apertura y cierre digitales, recibidos por el sistema de supervisión y control, a las entradas de la unidad de actuación SACE PR212/T que efectúa el cierre y la apertura del interruptor mediante el relé de potencia. A estos relés se tiene que conectar el mando a motor del interruptor (utilizar la versión con tensión de alimentación a 110 Vca/cc y 220 Vca).

TA para neutro externo

CSIS9073

Se aplica al conductor neutro y permite efectuar la protección contra defectos a tierra con interruptores automáticos tripolares. El interruptor tiene que estar dotado con el relé SACE PR212/P - LSIG. El transformador tiene que estar conectado al relé de sobrecorriente mediante los conectores específicos X3-X4, seleccionados en función de la ejecución del interruptor automático y del tipo de relé de protección adoptado.

Conectores

CSIS9114

Permiten la conexión del relé de sobrecorriente con microprocesador con una unidad o componentes de la instalación externos. De hecho, se utilizan para que se encuentre disponible, en el exterior, la señal de intervención del relé y para conectar el transformador para protección del conductor neutro externo al interruptor automático o a las unidades de actuación, diálogo y señalización, si se encuentran presentes.
- Conectores X3 para interruptor fijo equipado con relés SACE PR211/P, SACE PR212/P - LSI.
- Conector X3 para interruptores enchufables/ extraíbles (para aplicar en la parte fija) equipados con relé SACE PR211/P, SACE PR212/P - LSI.
- Conectores X3 -X4 para interruptor fijo equipado con relé SACE PR212/P - LSIG.
- Conector X3 - X4 para interruptores enchufables/ extraíbles (para aplicar en la parte fija) equipados con relé SACE PR212/P - LSIG.

Unidad de prueba SACE TT1

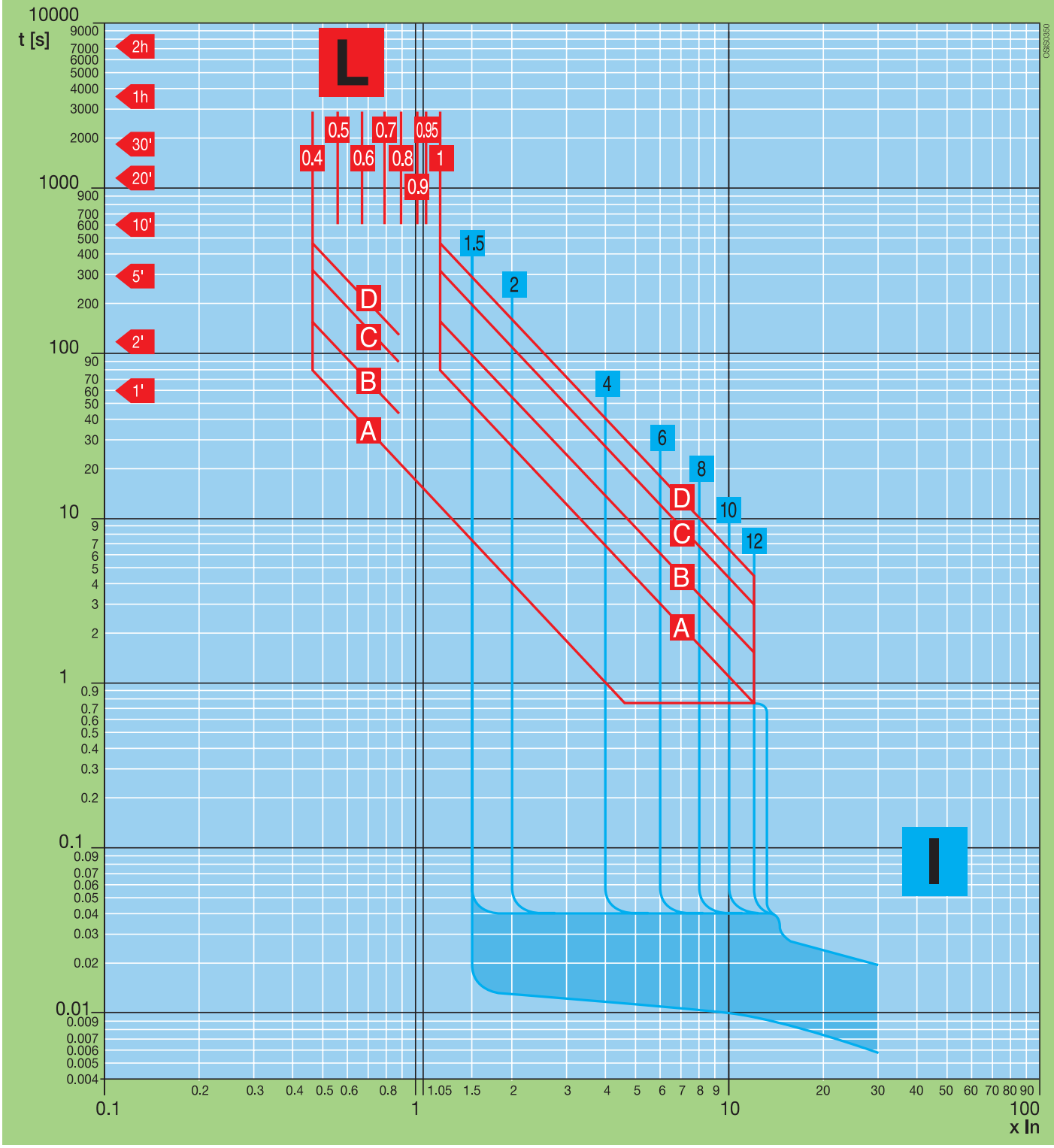
CSIS9086

Permite controlar la intervención de los relés electrónicos con microprocesador SACE PR211/P y SACE PR212/P y la prueba de intervención del solenoide de apertura SA. El dispositivo se alimenta mediante una batería de 12 V sustituible, está dotado con un conector-palpador de dos polos polarizados alojados en el fondo de la caja que permite la conexión del dispositivo a los casquillos de entrada de TEST situados en el frente de los relés SACE PR211/P y SACE PR212/P.
Las dimensiones reducidas del accesorio lo hacen prácticamente de bolsillo. El dispositivo de trip test se puede utilizar en los interruptores automáticos SACE Isomax S4, S5, S6 y S7.

Curvas tiempo-corriente de los interruptores con relés de sobreintensidad con microprocesador

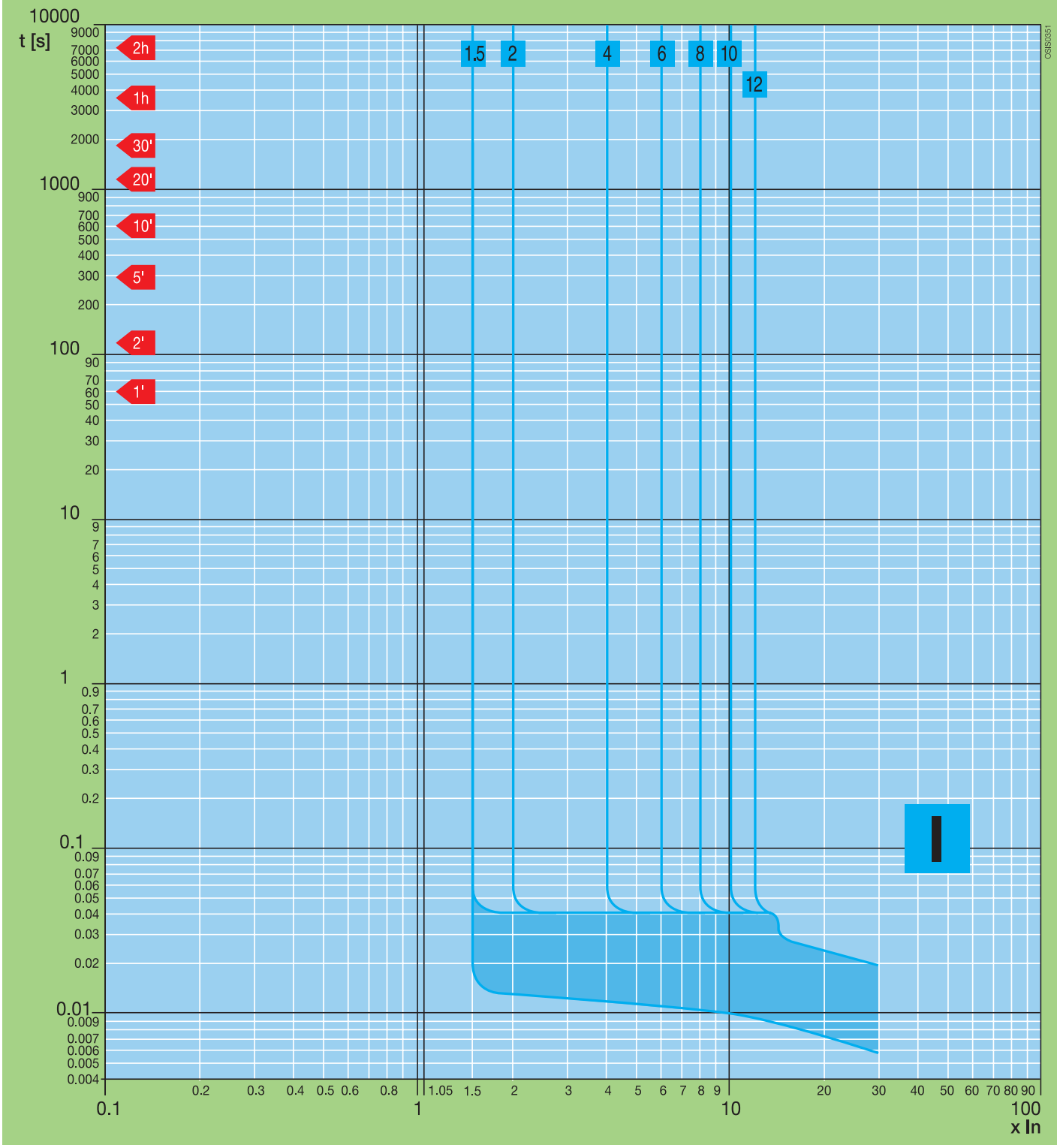
SACE S4 - S5 - S6 - S7

SACE PR211/P - Función LI



SACE S4 - S5 - S6 - S7

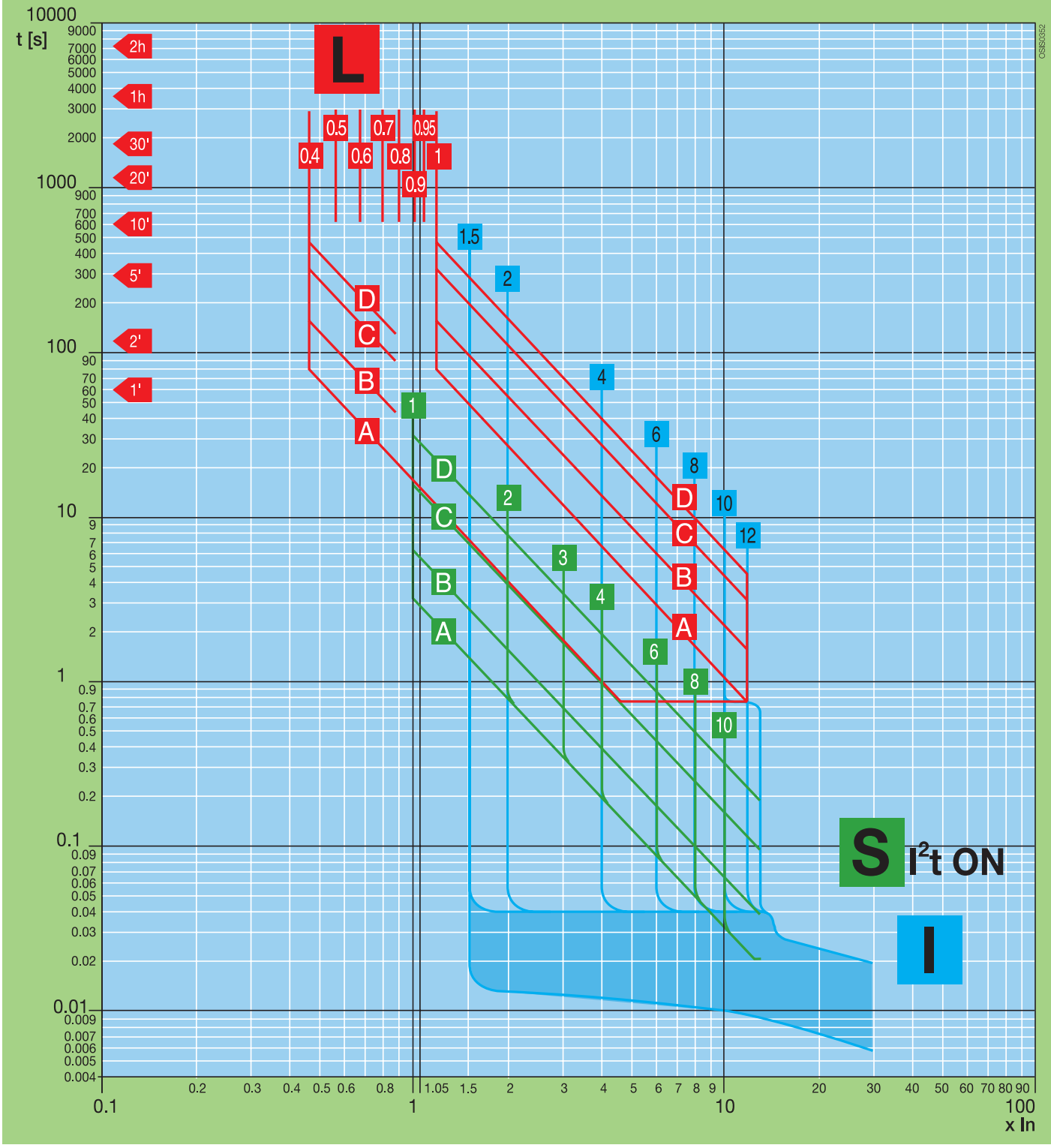
SACE PR211/P - Función I



Curvas tiempo-corriente de los interruptores con relés de sobreintensidad con microprocesador

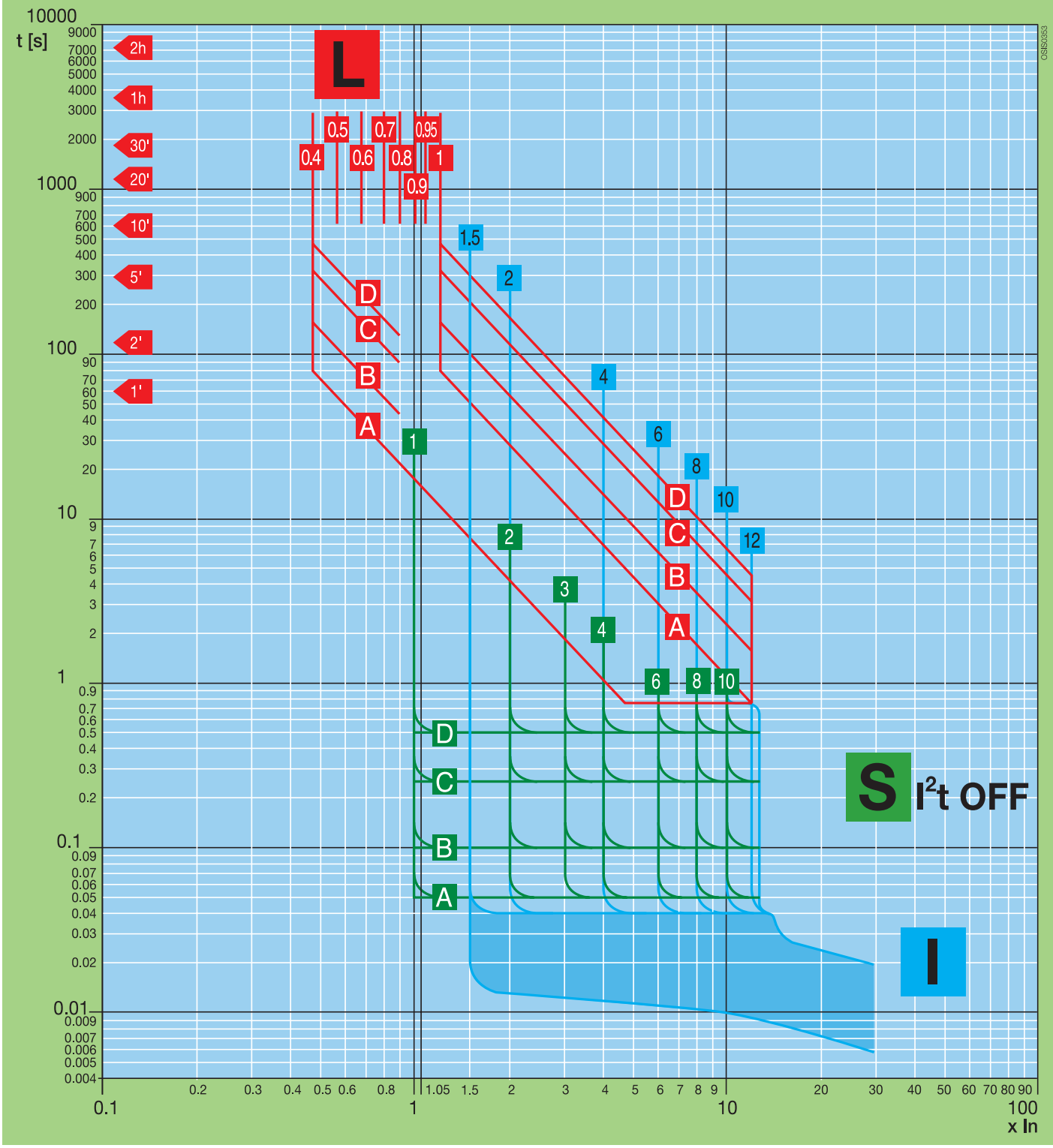
SACE S4 - S5 - S6 - S7

SACE PR212/P - Funciones LSI - S retardada a tiempo corto inverso (I^2t = ON)



SACE S4 - S5 - S6 - S7

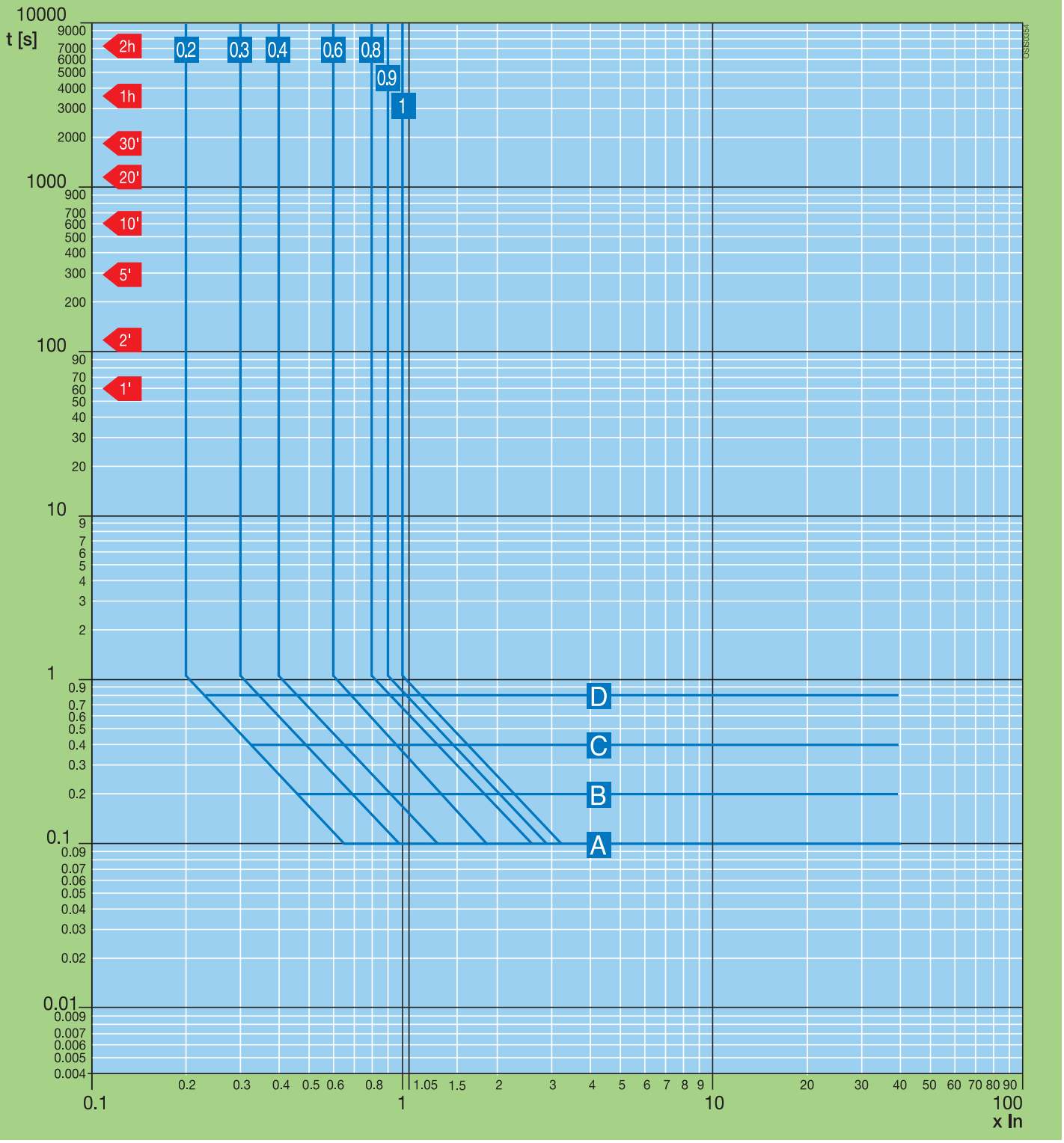
SACE PR212/P - Funciones LSI - S retardada a tiempo corto independiente (I^2t = OFF)



Curvas tiempo-corriente de los interruptores con relés de sobreintensidad con microprocesador

SACE S4 - S5 - S6 - S7

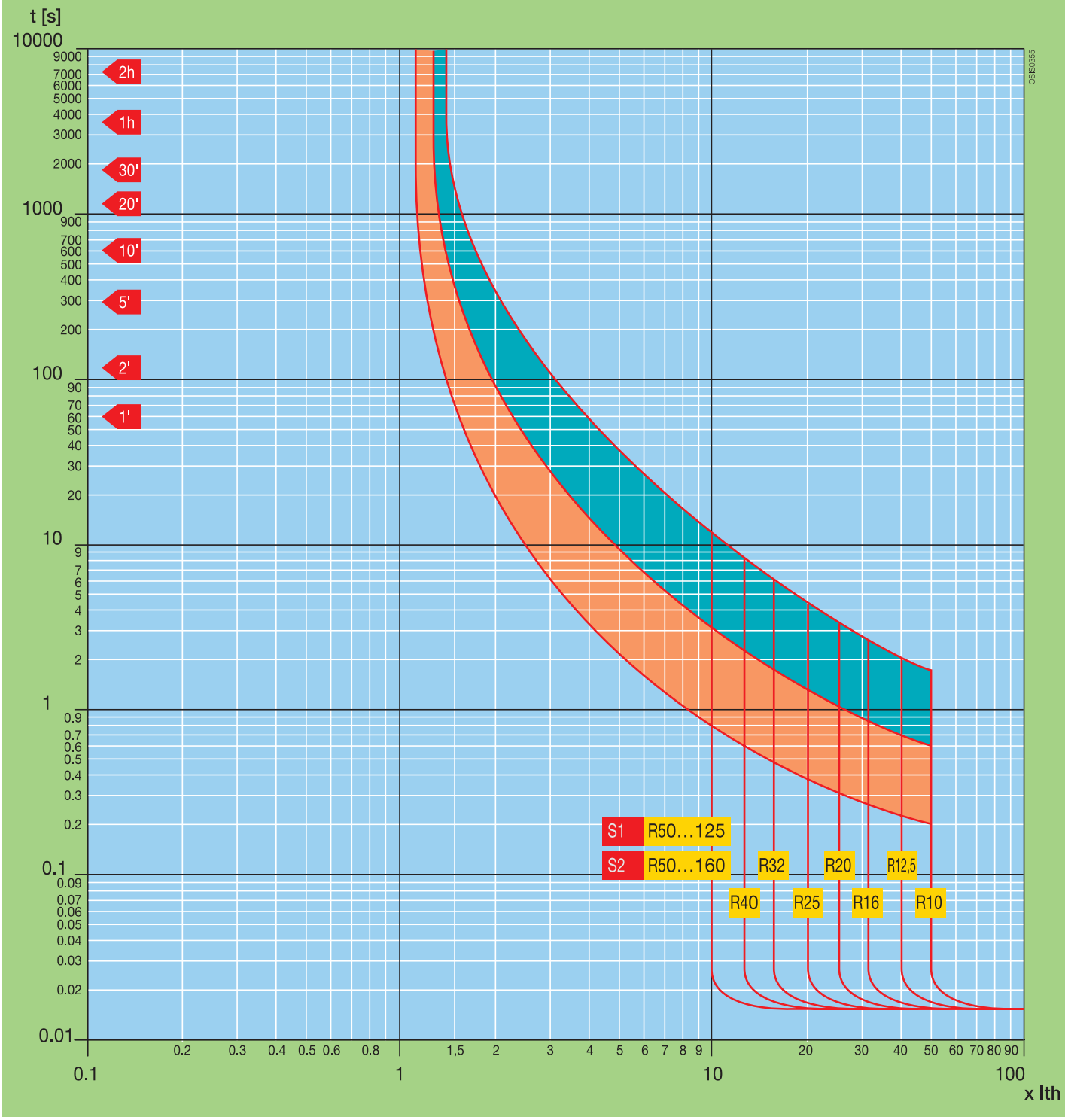
SACE PR212/P - Función G



Curvas tiempo-corriente de los interruptores con relés de sobreintensidad termomagnéticos

SACE S1 125 - S2 160

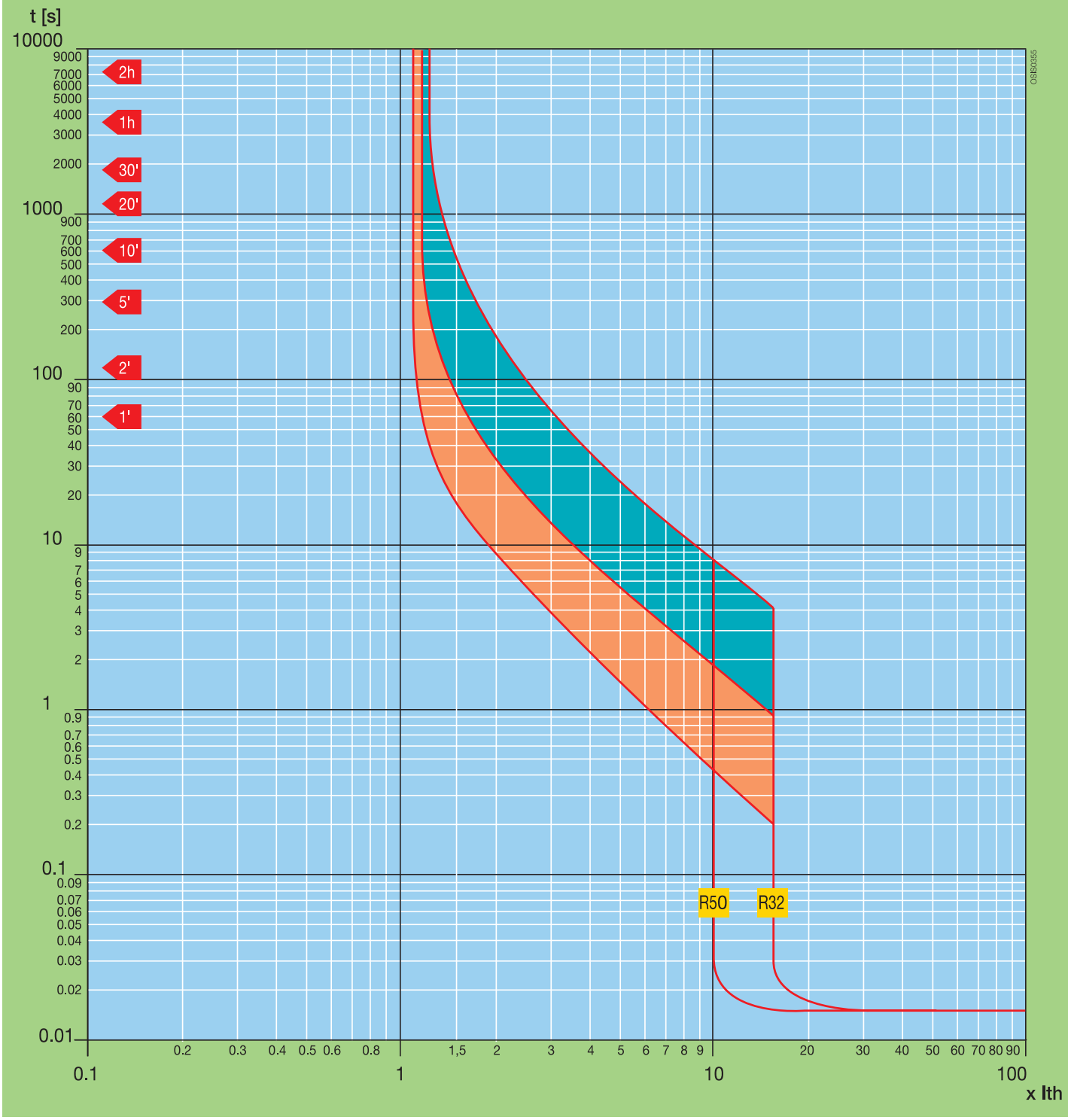
Umbral de intervención magnética Im = 10 x Ith



Curvas tiempo-corriente de los interruptores con relés de sobreintensidad termomagnéticos

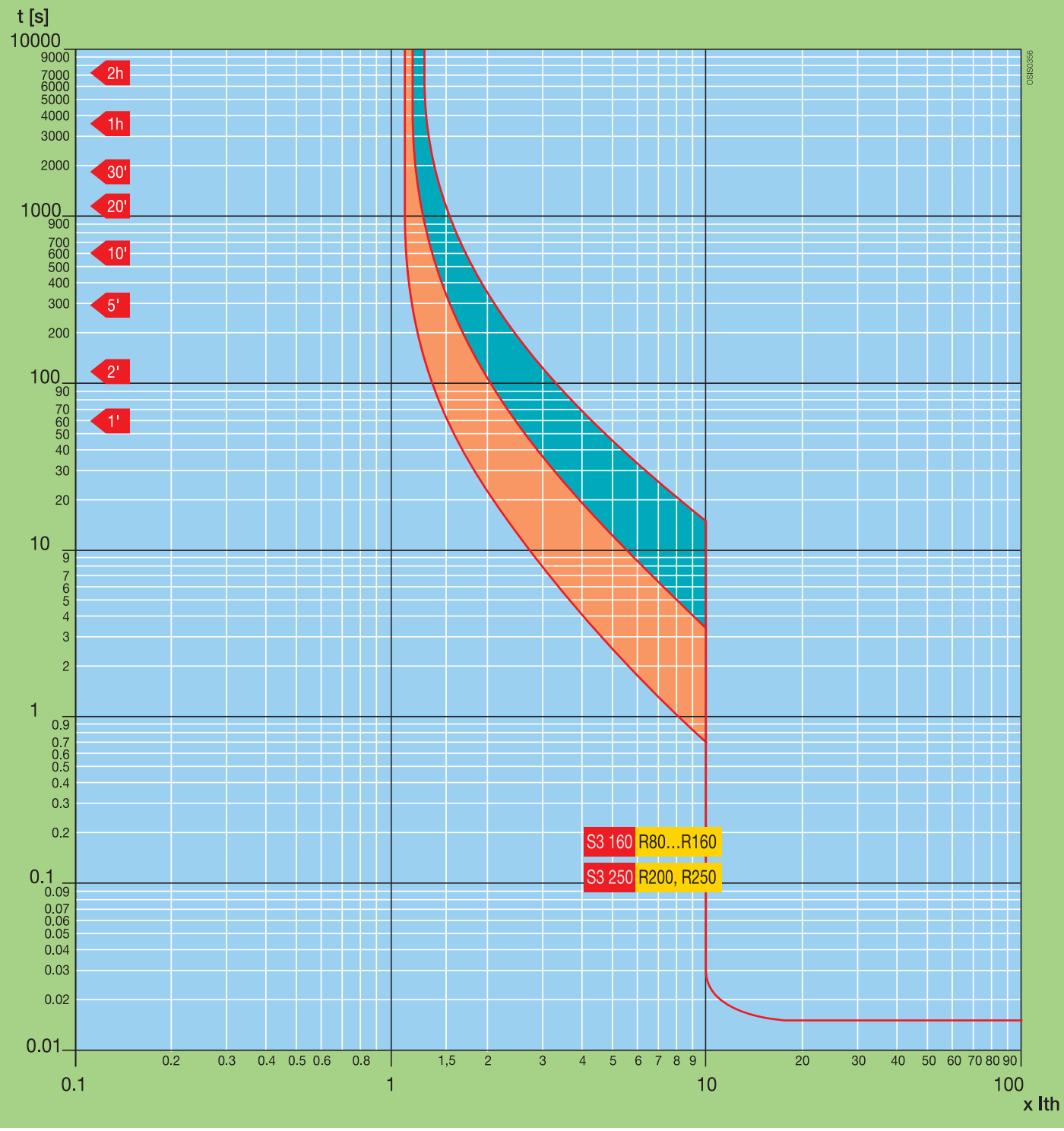
SACE S3 160

Umbral de intervención magnética Im = 10 x Ith



SACE S3 160 - S3 250

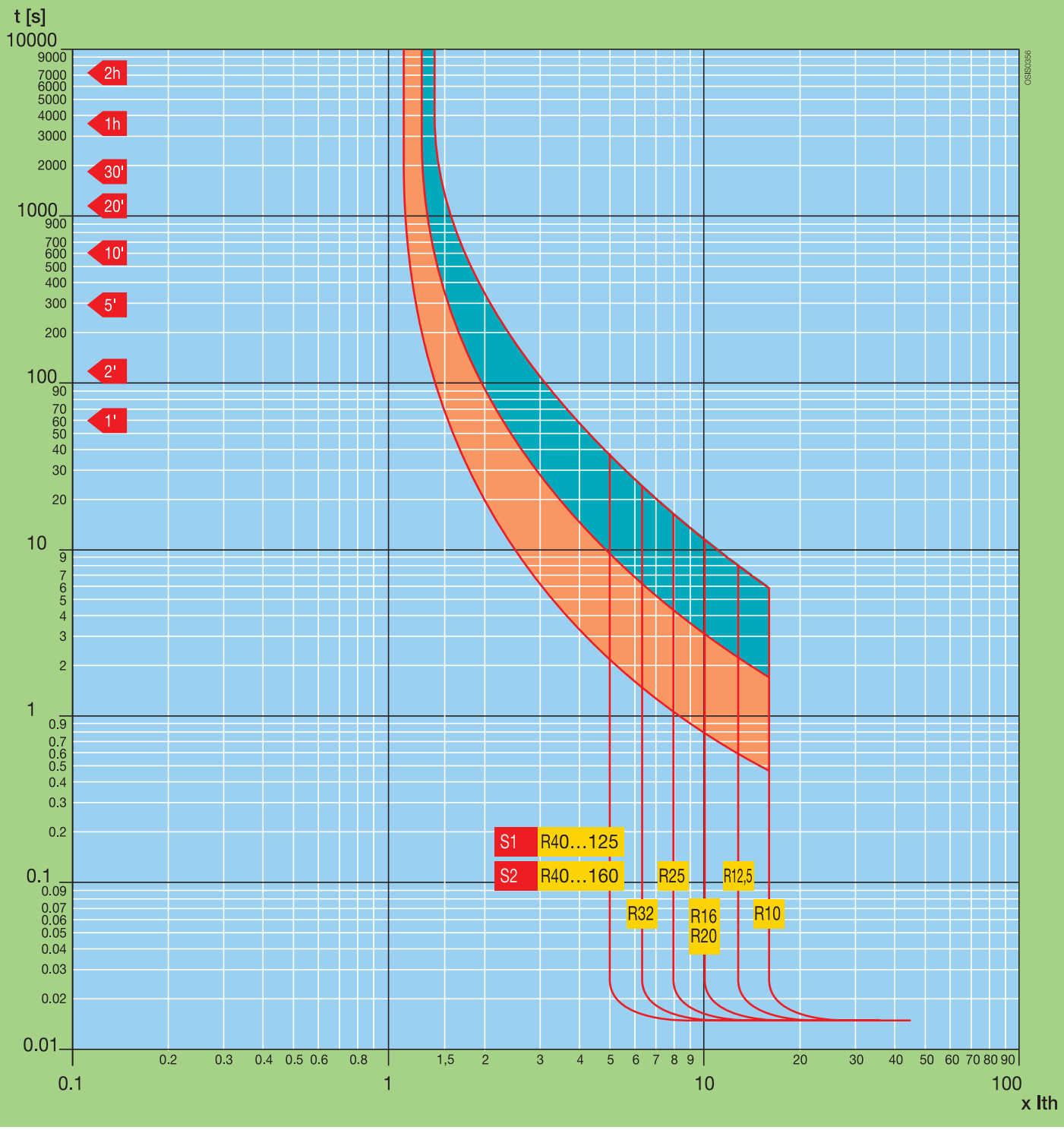
Umbral de intervención magnética Im = 10 x Ith



Curvas tiempo-corriente de los interruptores con relés de sobreintensidad termomagnéticos

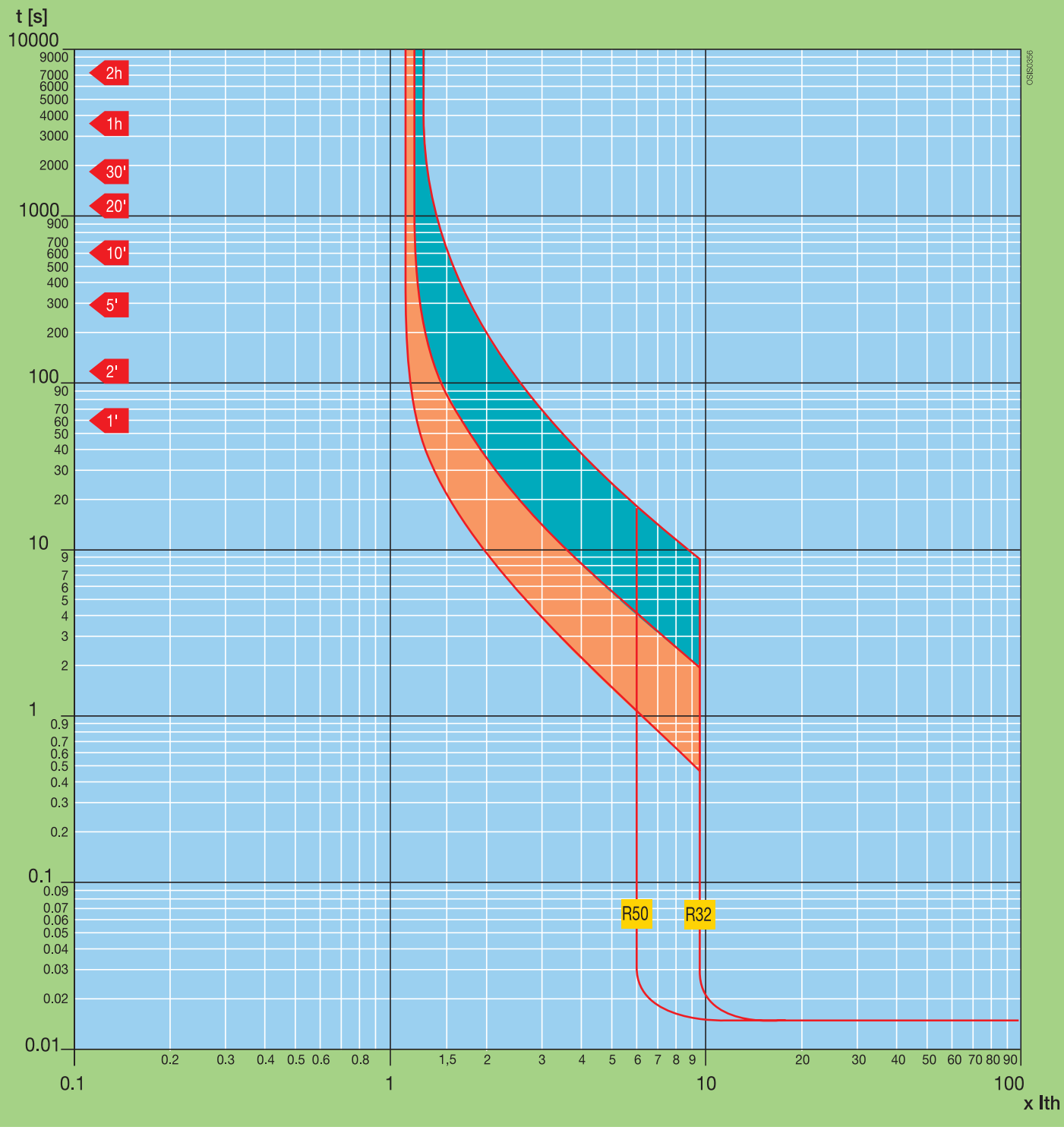
SACE S1 125 - S2 160

Umbral de intervención magnética Im = 5 x Ith



SACE S3 160

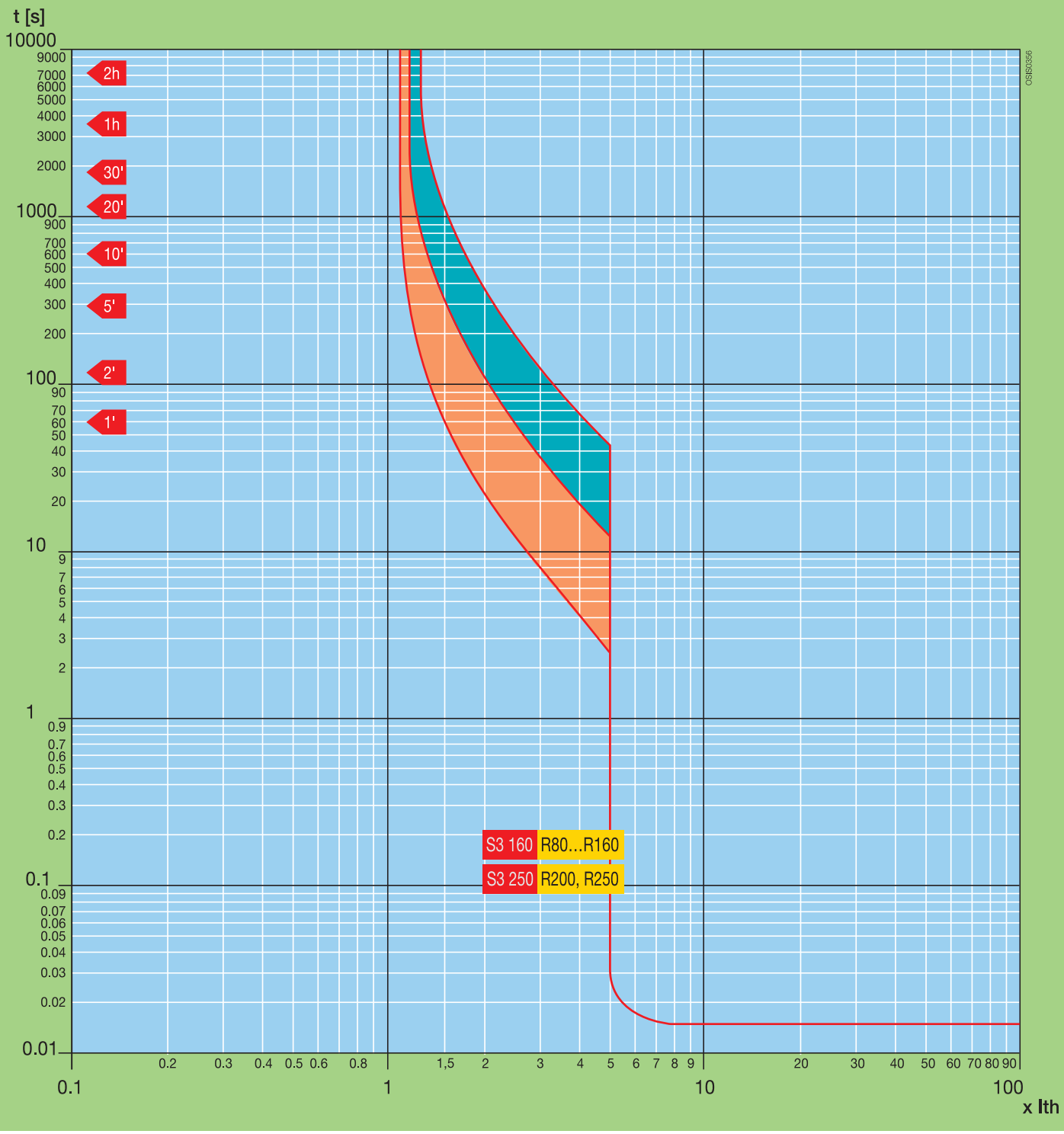
Umbral de intervención magnética Im = 5 x Ith



Curvas tiempo-corriente de los interruptores con relés de sobreintensidad termomagnéticos

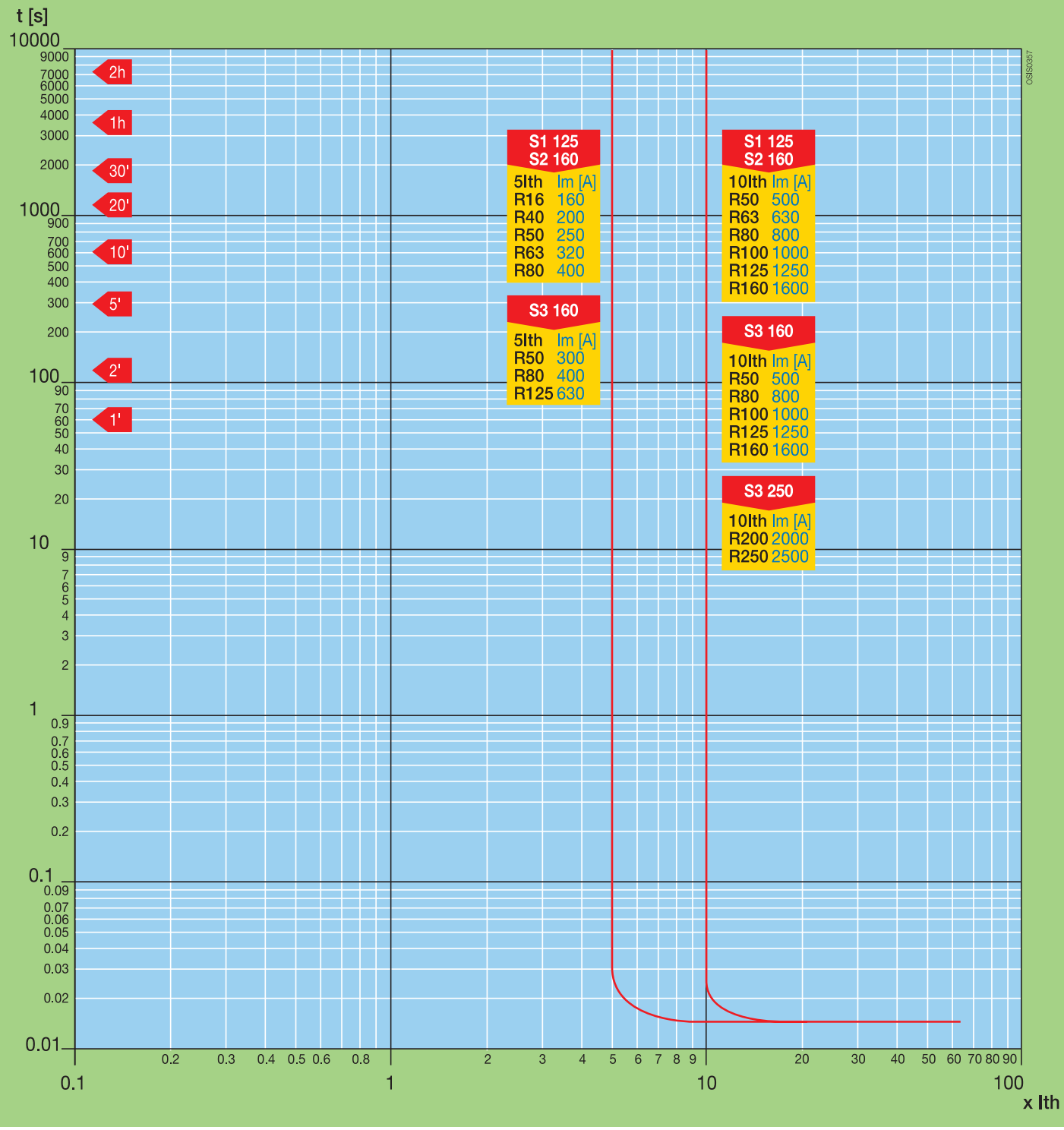
SACE S3 160 - S3 250

Umbral de intervención magnética Im = 5 x Ith



SACE S1 125 - S2 160 - S3 160 - S3 250

Relé solo magnético

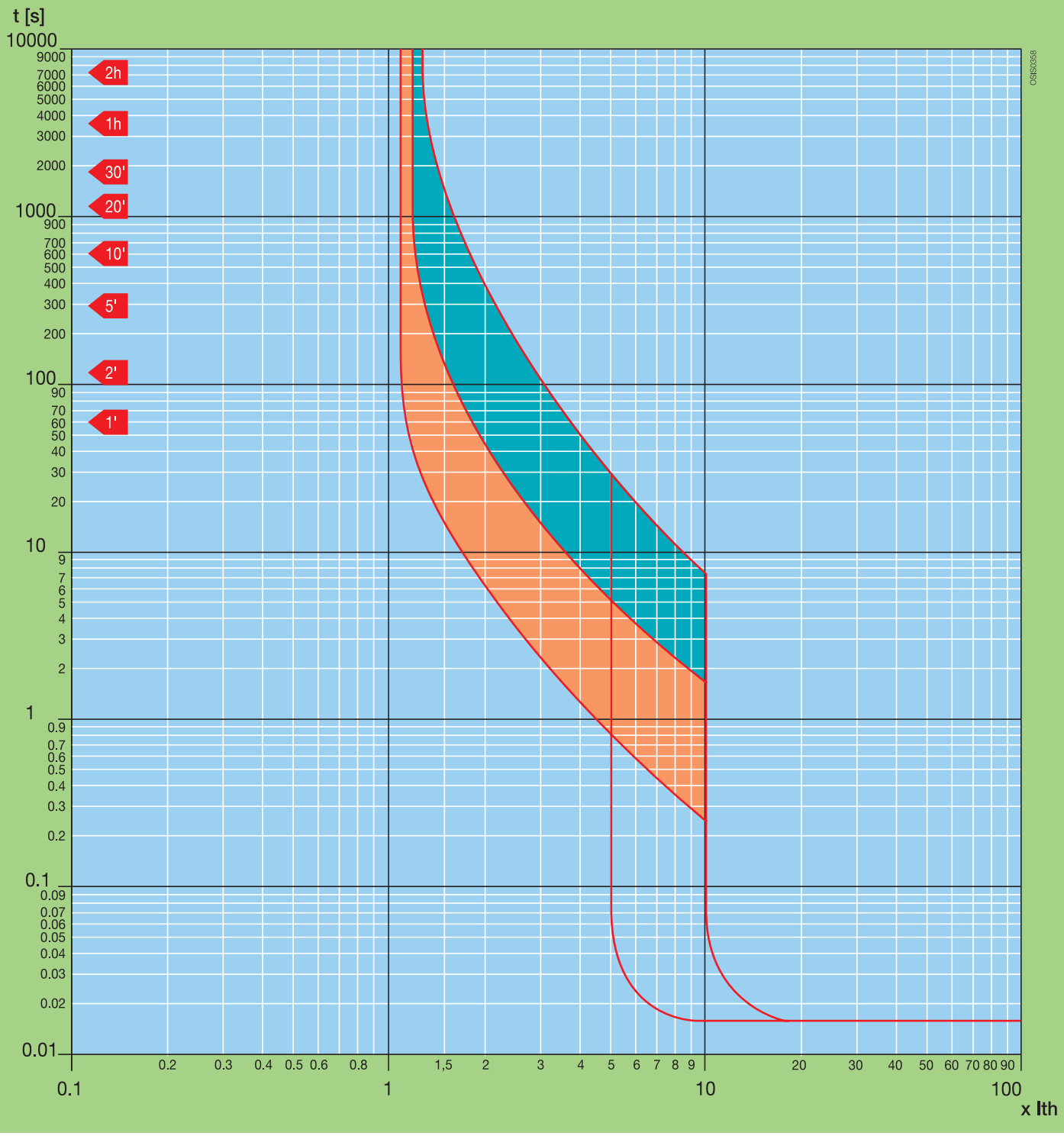


Curvas tiempo-corriente de los interruptores con relés de sobreintensidad termomagnéticos

SACE S5 400 (R320-R400)

Umbral de intervención térmica In = 0,7 ... 1 x Ith

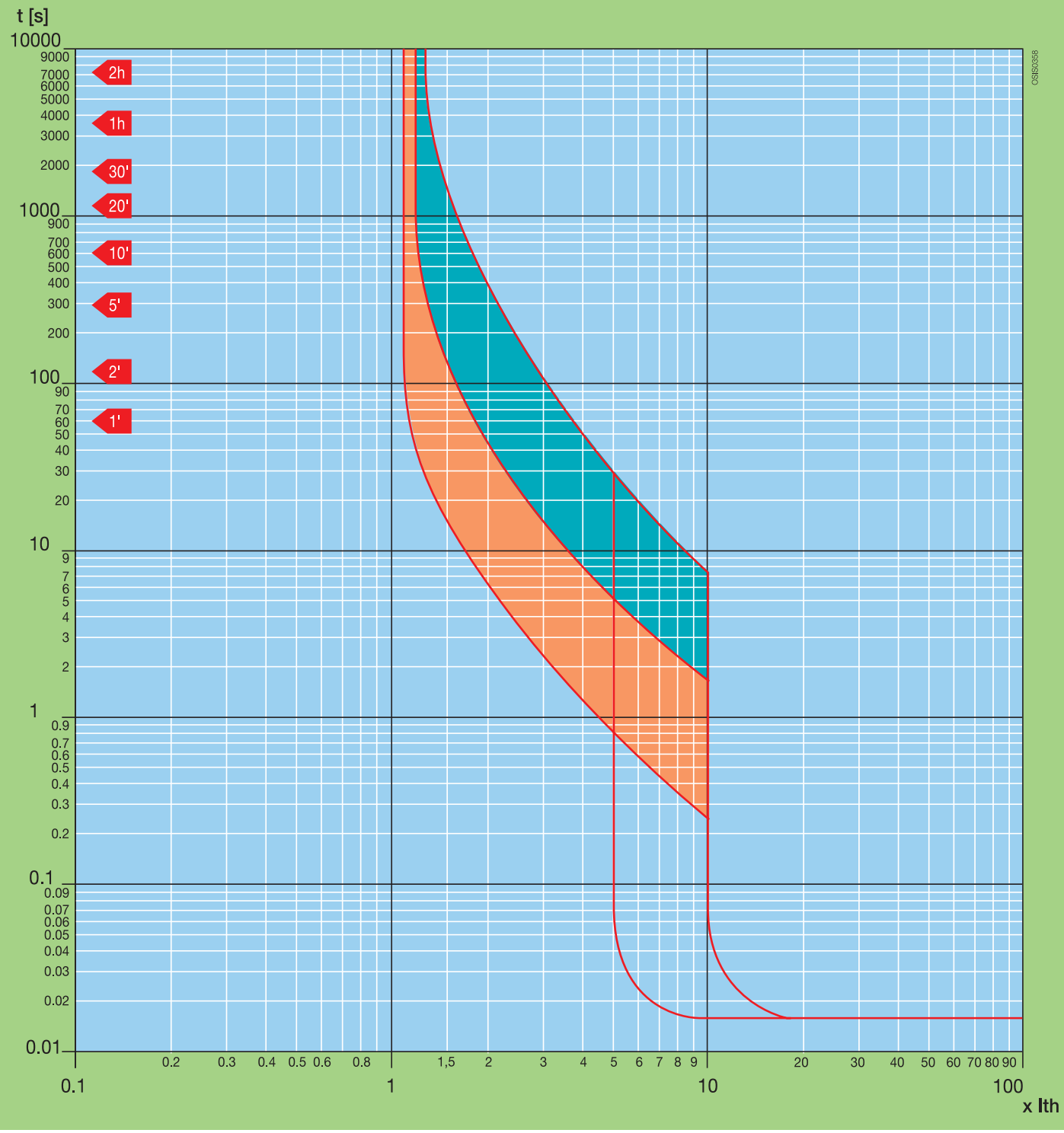
Umbral de intervención magnética Im = 5 ... 10 x Ith



SACE S5 630 (R500)

Umbral de intervención térmica In = 0,7 ... 1 x Ith

Umbral de intervención magnética Im = 5 ... 10 x Ith

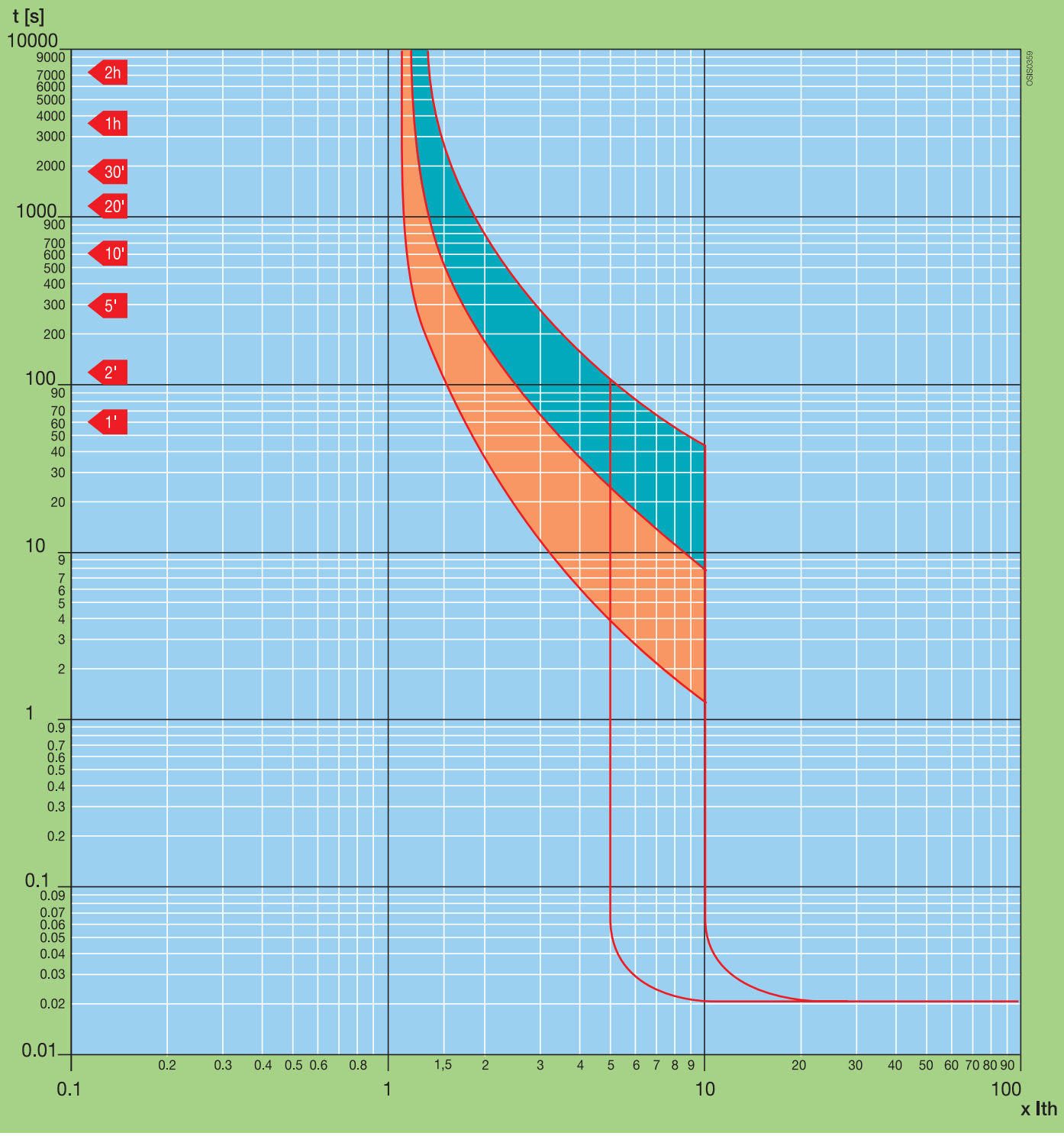


Curvas tiempo-corriente de los interruptores con relés de sobreintensidad termomagnéticos

SACE S6 630 (R630)

Umbral de intervención térmica In = 0,7 ... 1 x Ith

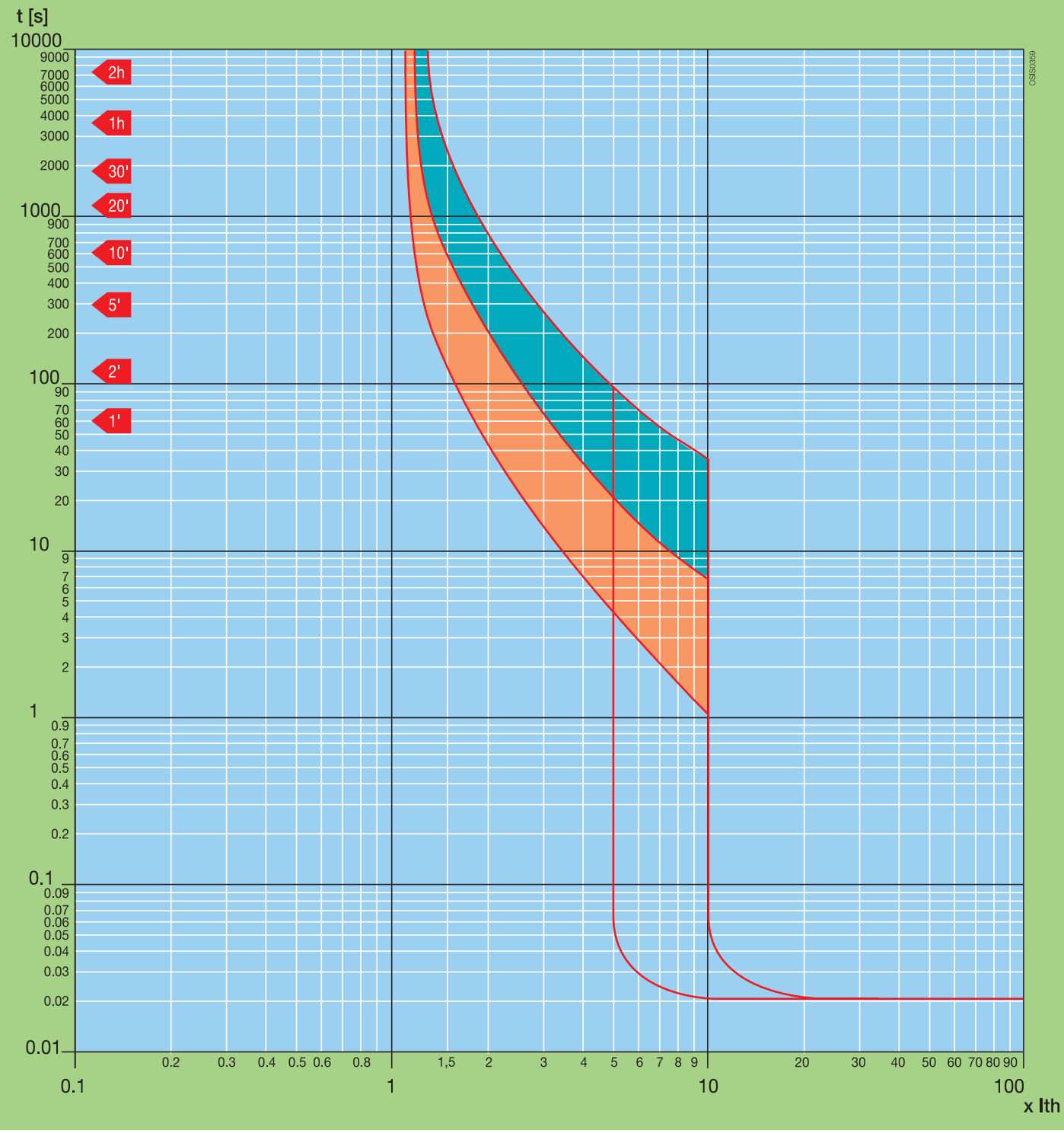
Umbral de intervención magnética Im = 5 ... 10 x Ith



SACE S6 800 (R800)

Umbral de intervención térmica In = 0,7 ... 1 x Ith

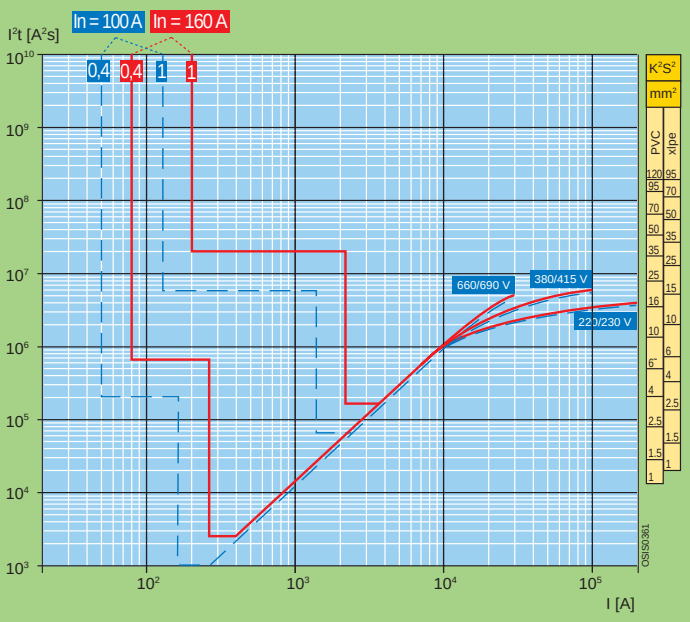
Umbral de intervención magnética Im = 5 ... 10 x Ith



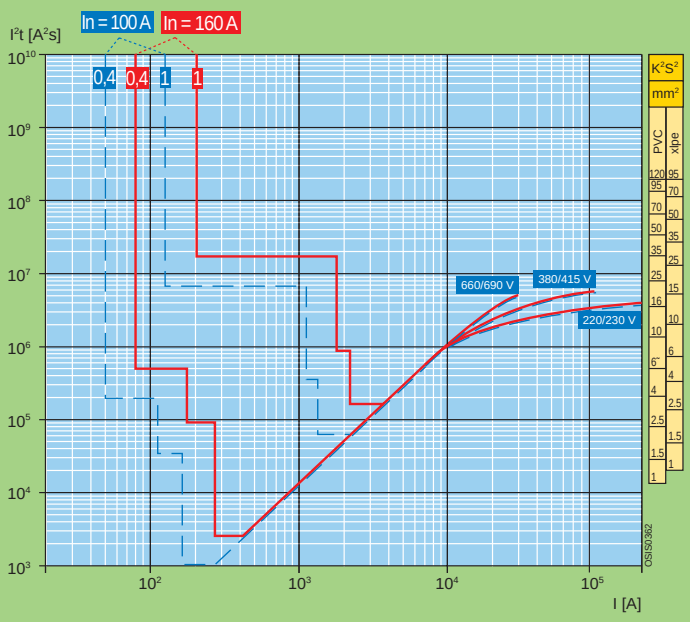
Curvas de energía específica pasante de los interruptores con relés de sobreintensidad con microprocesador

SACE S4 160

PR211/P

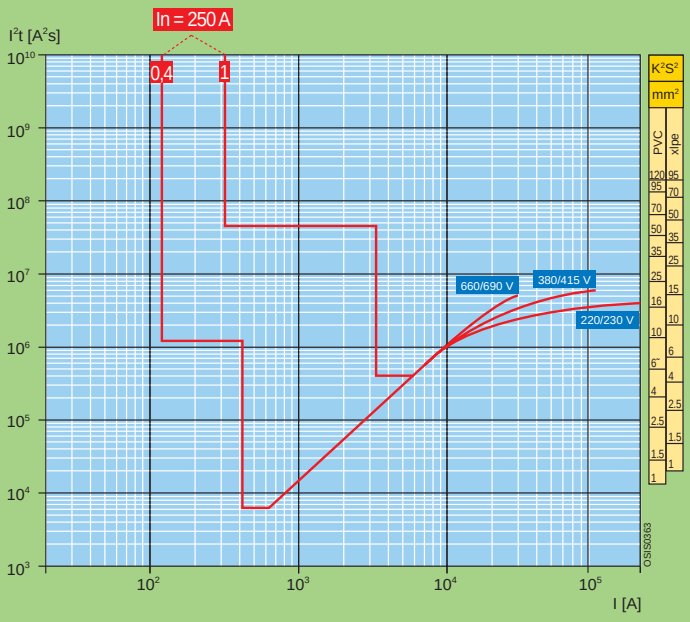


PR212/P

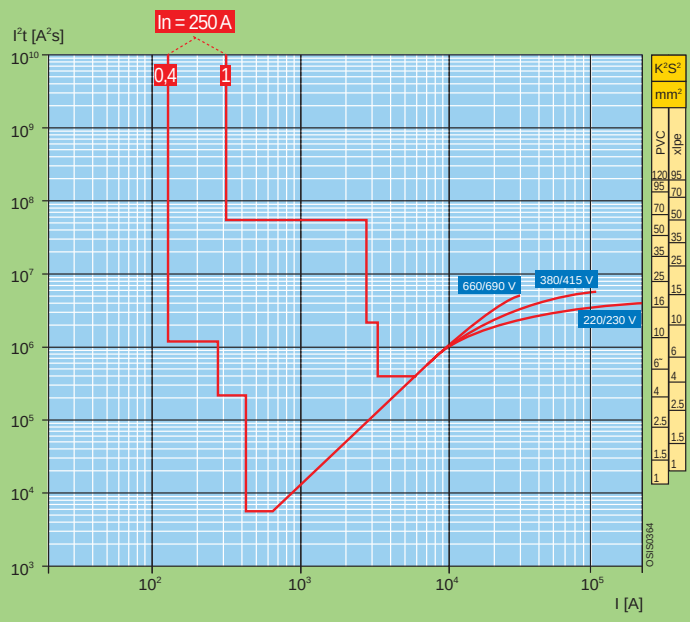


SACE S4 250

PR211/P

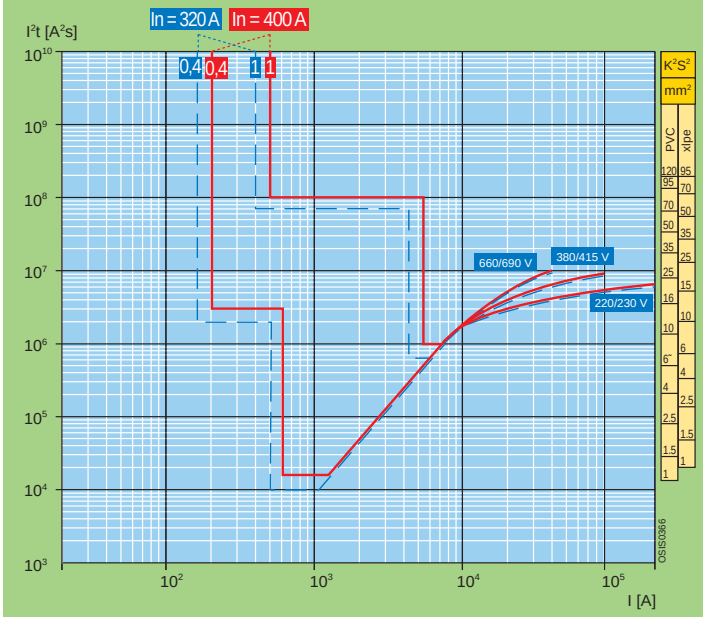


PR212/P

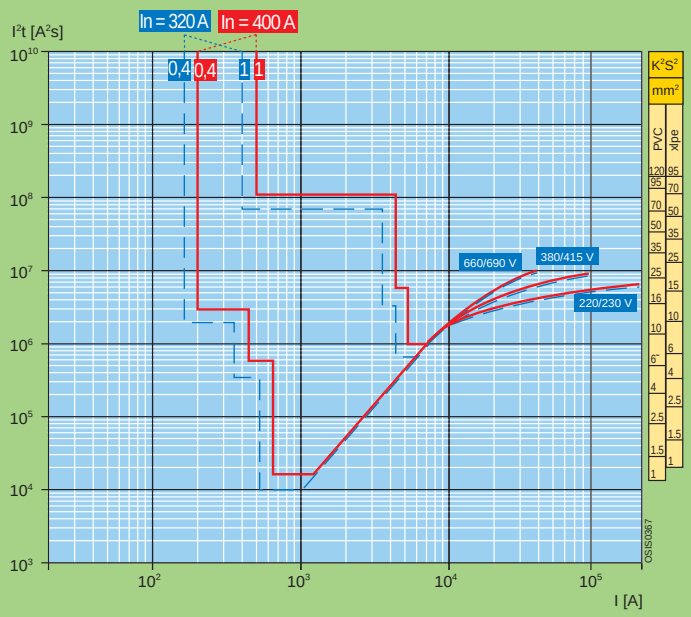


SACE S5 400

PR211/P

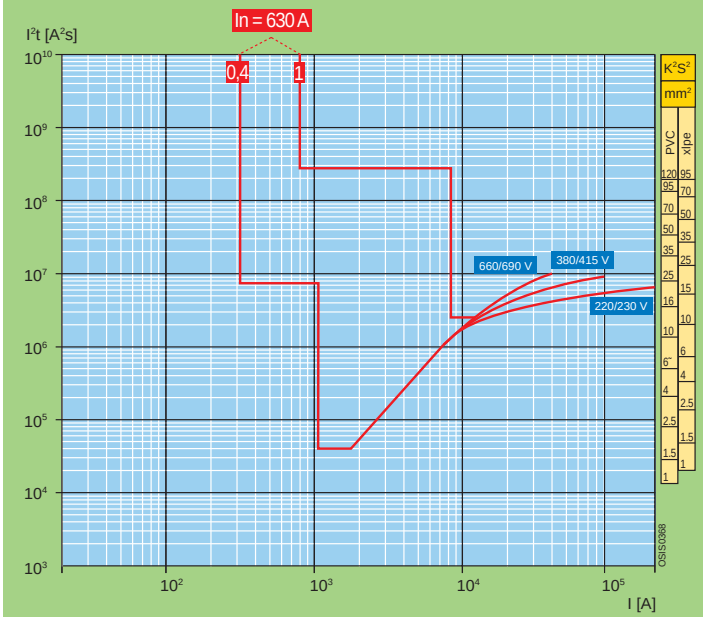


PR212/P

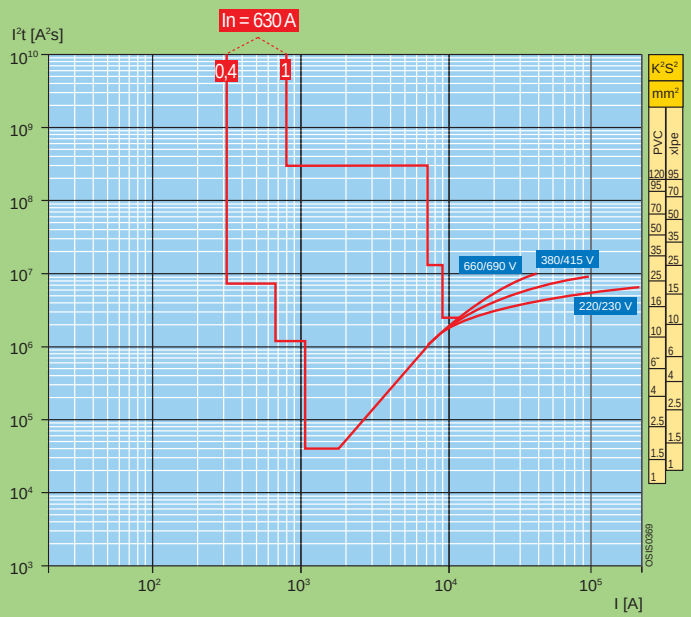


SACE S5 630

PR211/P



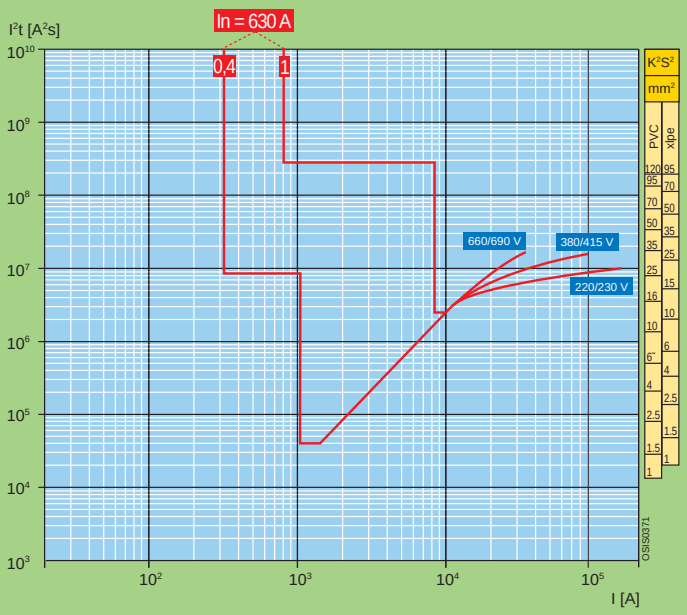
PR212/P



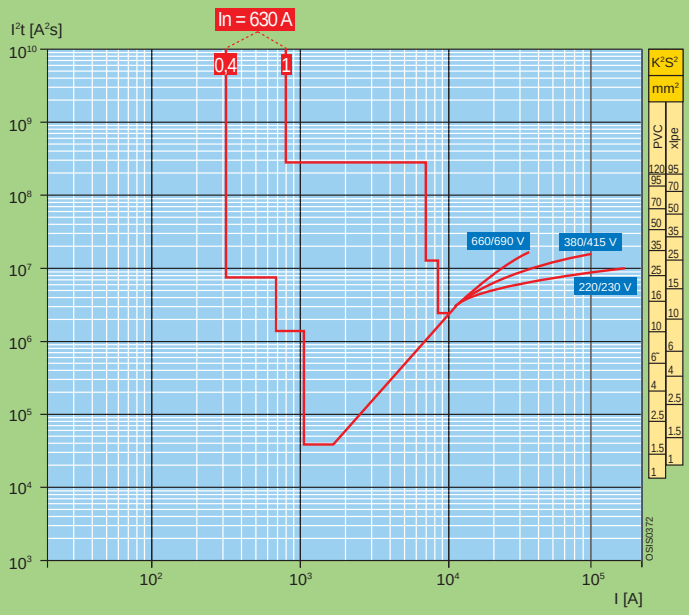
Curvas de energía específica pasante de los interruptores con relés de sobreintensidad con microprocesador

SACE S6 630

PR211/P

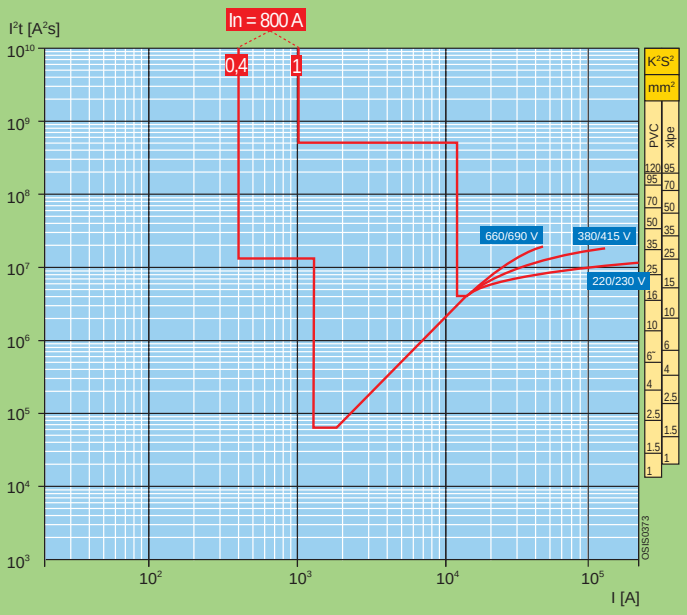


PR212/P

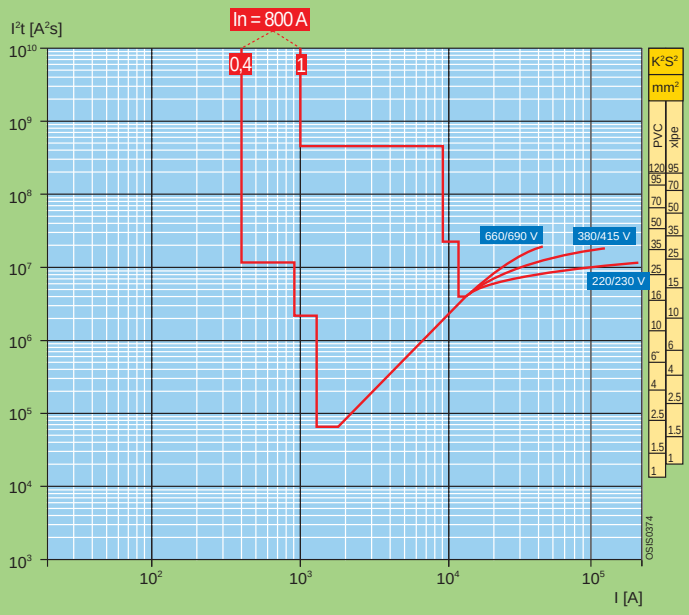


SACE S6 800

PR211/P

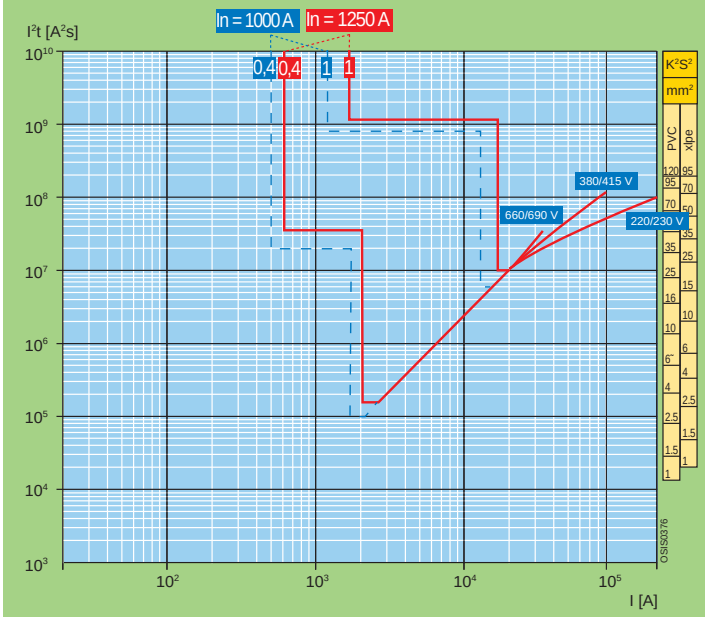


PR212/P

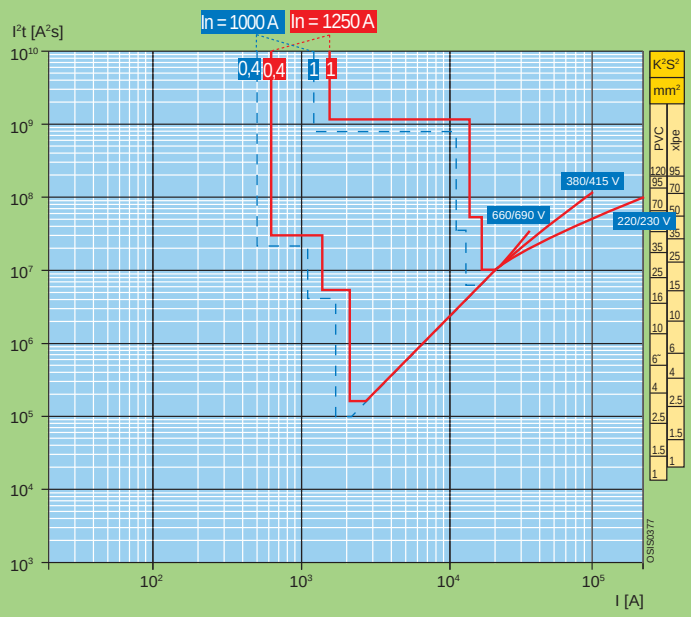


SACE S7 1250

PR211/P

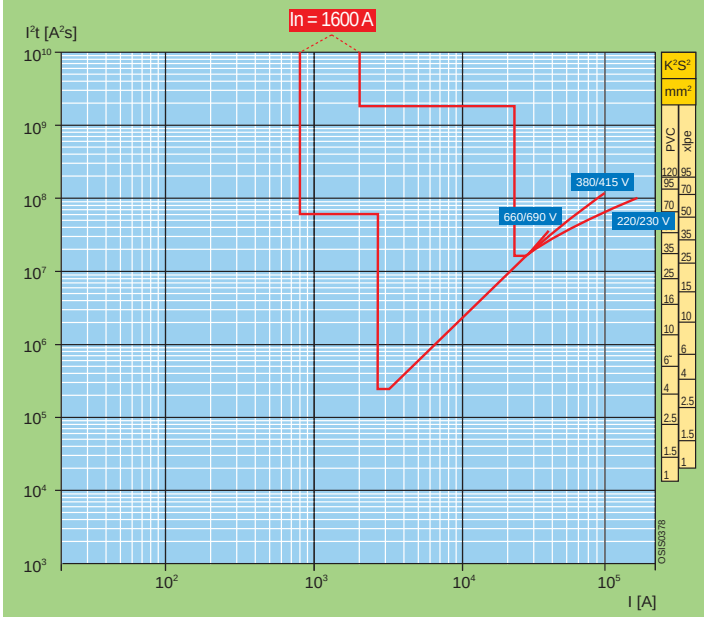


PR212/P

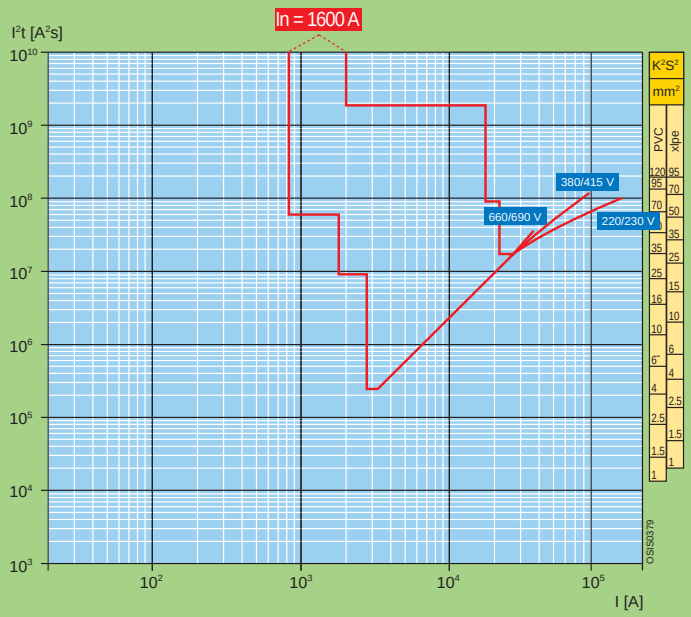


SACE S7 1600

PR211/P



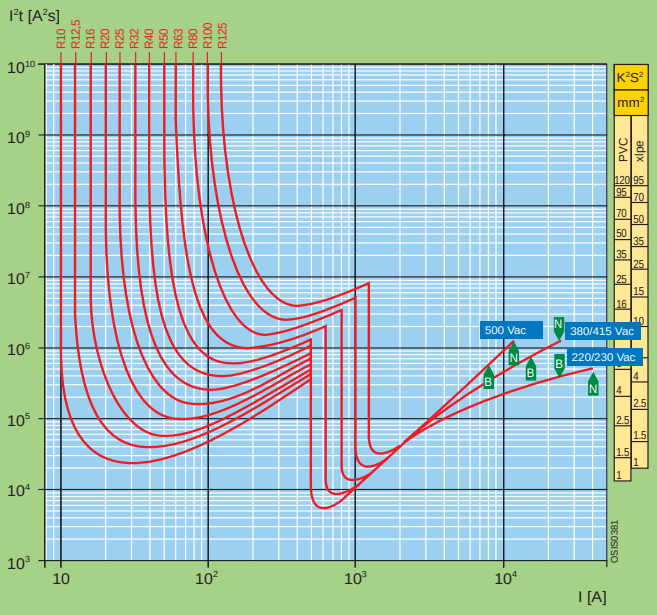
PR212/P



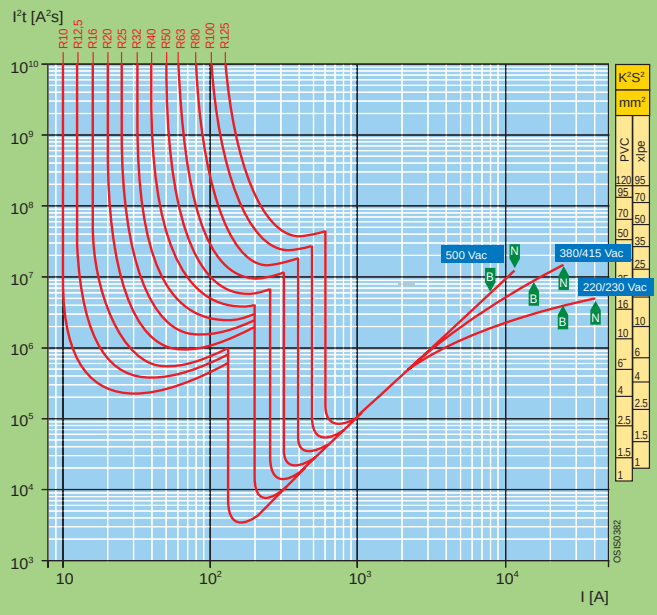
Curvas de energía específica pasante de los interruptores con relés de sobreintensidad termomagnéticos

SACE S1 125

Relé con umbral de intervención magnética Im = 10 x Ith

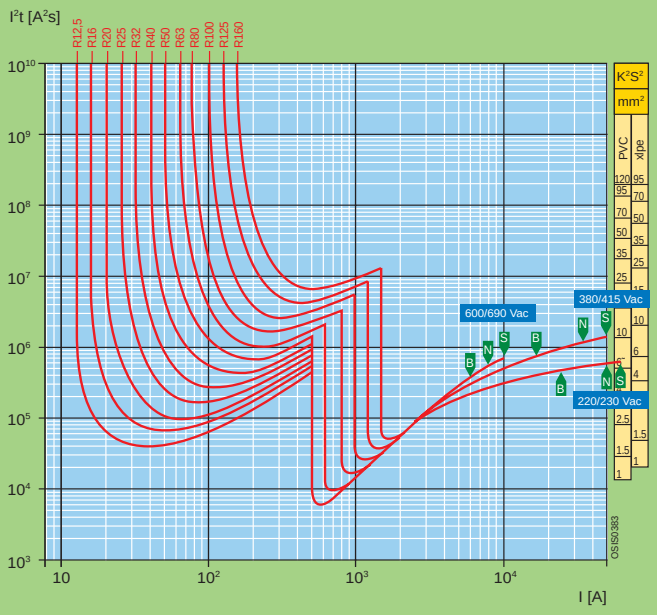


Relé con umbral de intervención magnética Im = 5 x Ith

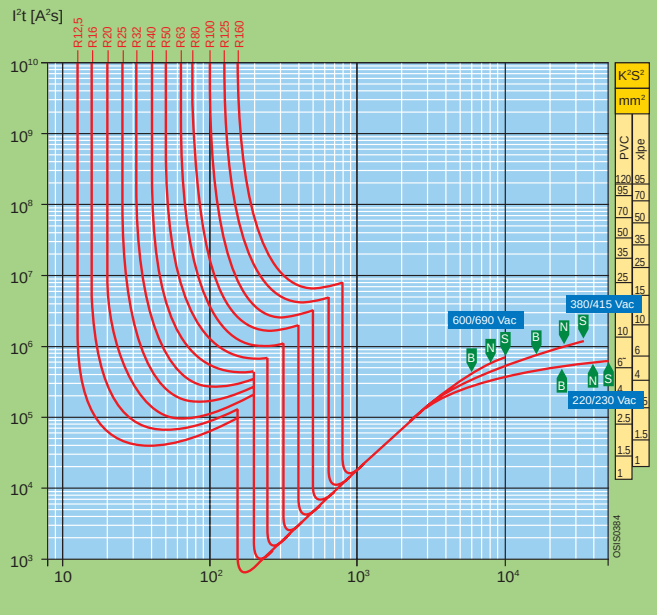


SACE S2 160

Relé con umbral de intervención magnética Im = 10 x Ith

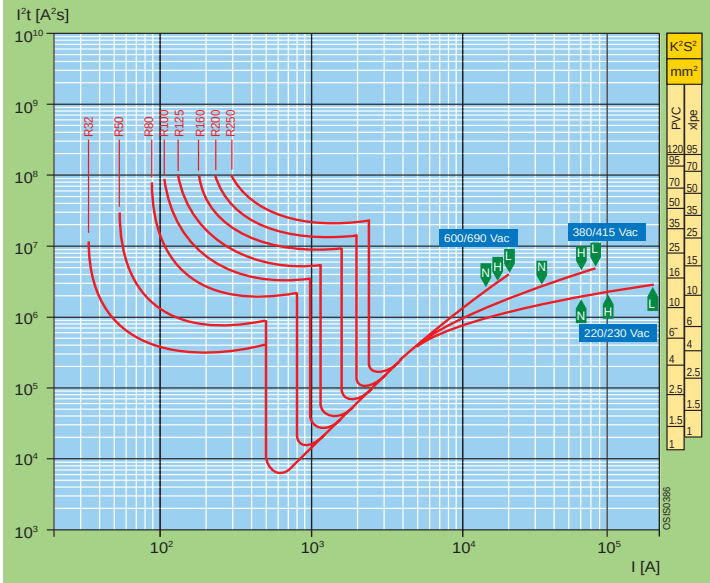


Relé con umbral de intervención magnética Im = 5 x Ith

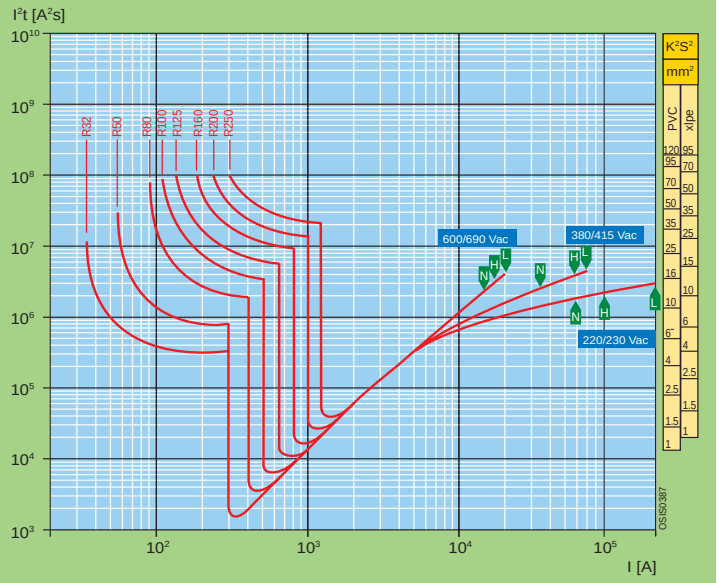


SACE S3 160 - S3 250

Relé con umbral de intervención magnética Im = 10 x Ith



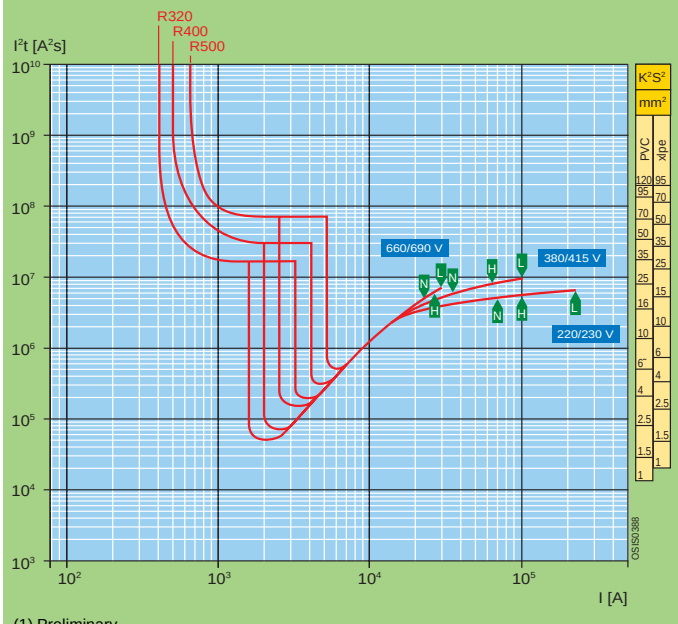
Relé con umbral de intervención magnética Im = 5 x Ith



SACE S5 400 - S5 630 (1)

Umbral de intervención térmica In = 0,7 ... 1 x Ith

Umbral de intervención magnética Im = 5 ... 10 x Ith

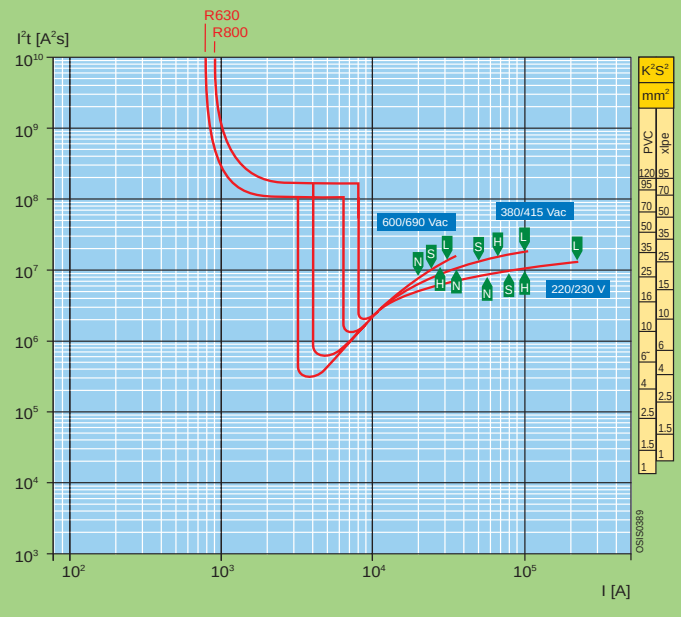


(1) Preliminary

SACE S6 630 - S6 800 (1)

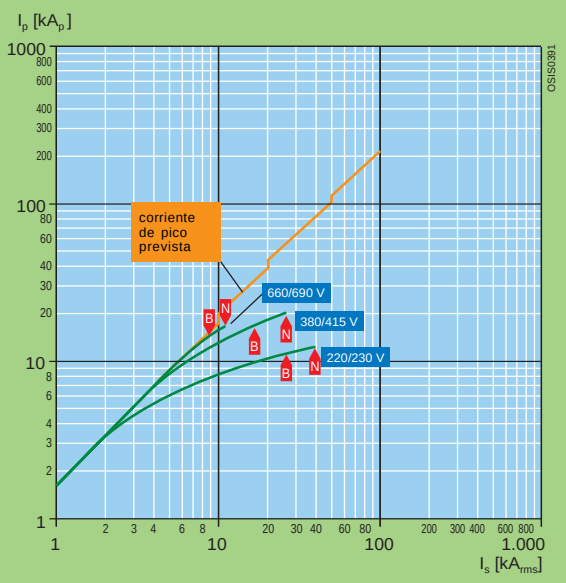
Umbral de intervención térmica In = 0,7 ... 1 x Ith

Umbral de intervención magnética Im = 5 ... 10 x Ith

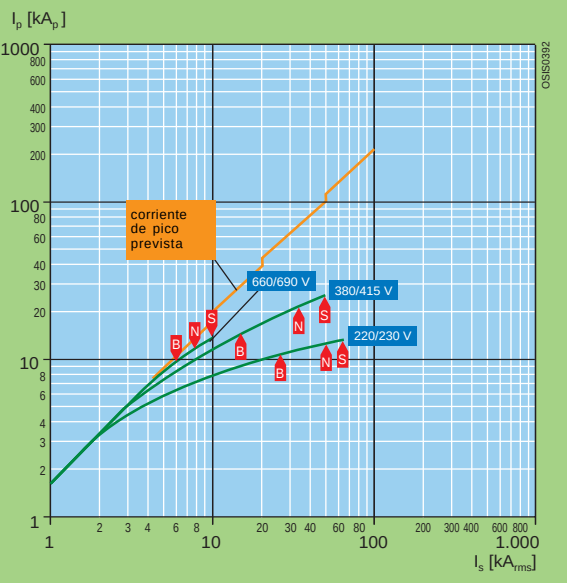


Curvas de limitación

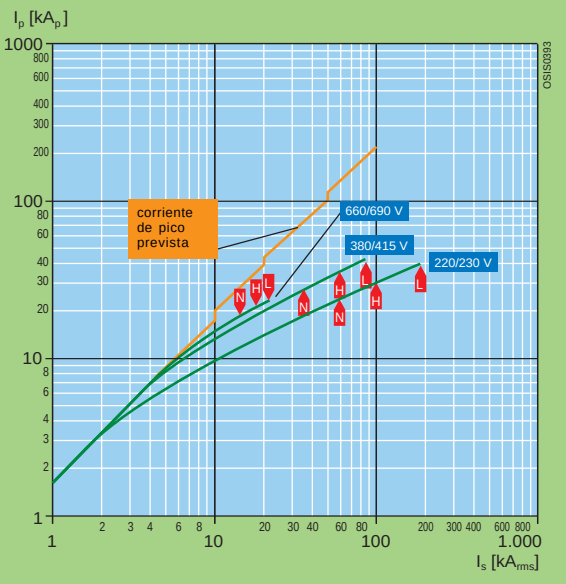
SACE S1



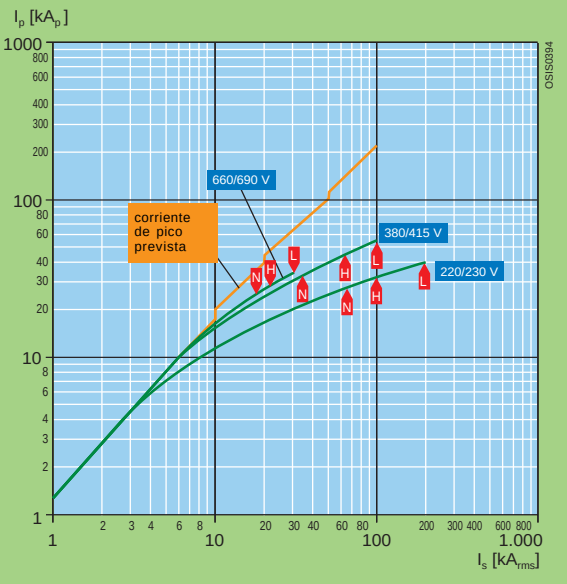
SACE S2



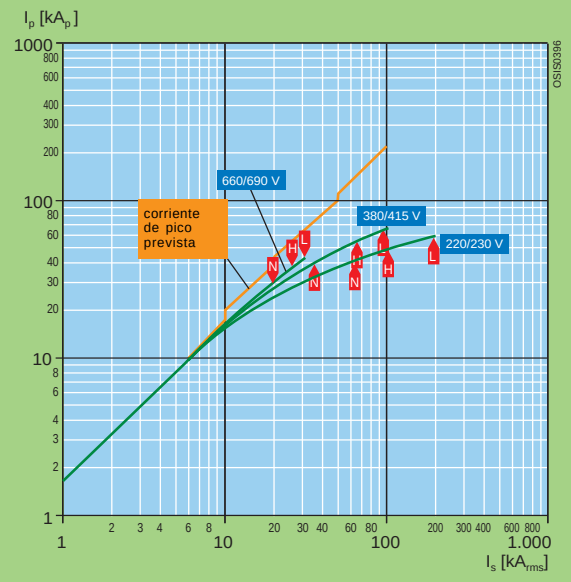
SACE S3



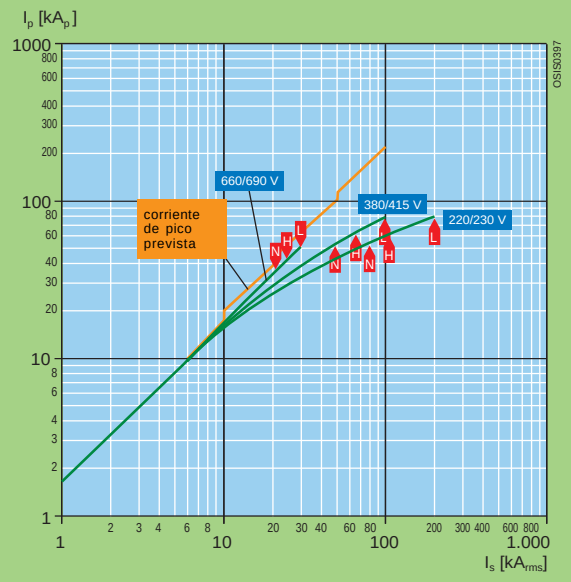
SACE S4



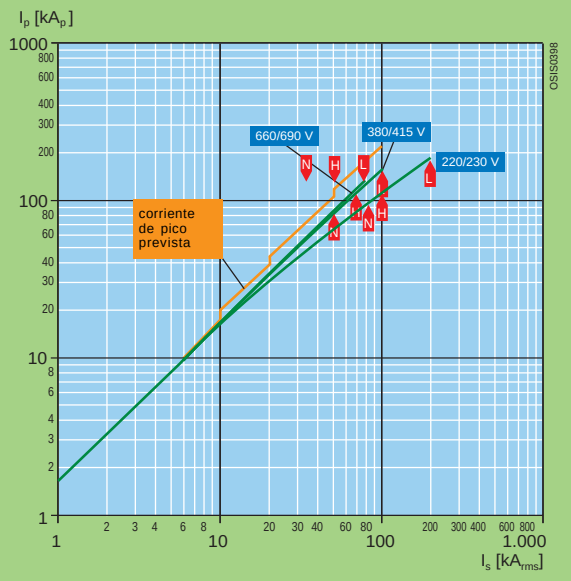
SACE S5



SACE S6



SACE S7

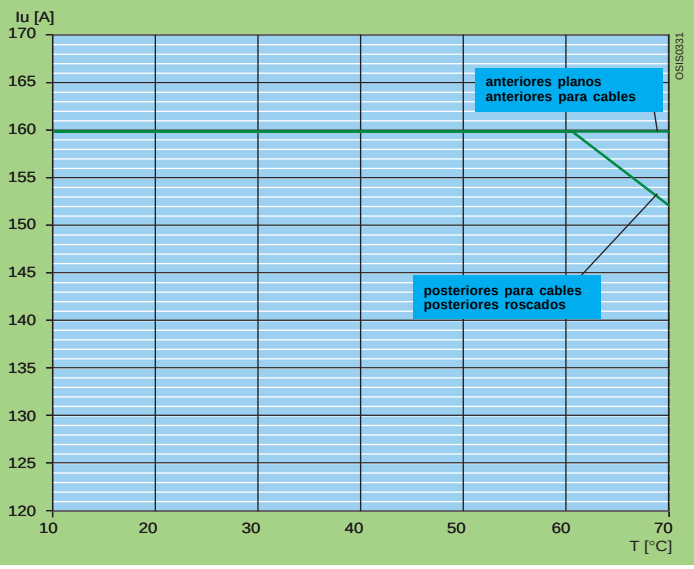


Prestaciones en temperatura de los interruptores con relés de sobreintensidad con microprocesador

SACE S4 160

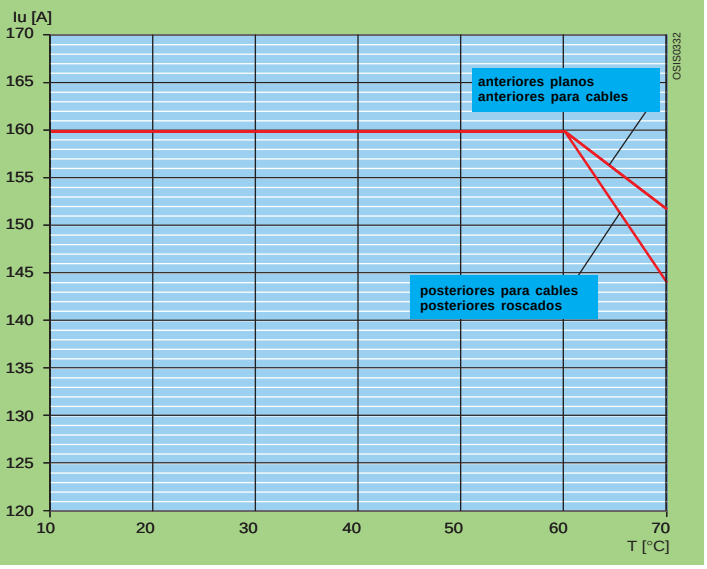
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**160**	1	160	1	160	1	160	1
anteriores para cables	**160**	1	160	1	160	1	160	1
posteriores para cables	**160**	1	160	1	160	1	152	0,95
posteriores roscados	**160**	1	160	1	160	1	152	0,95



enchufable - extraíble

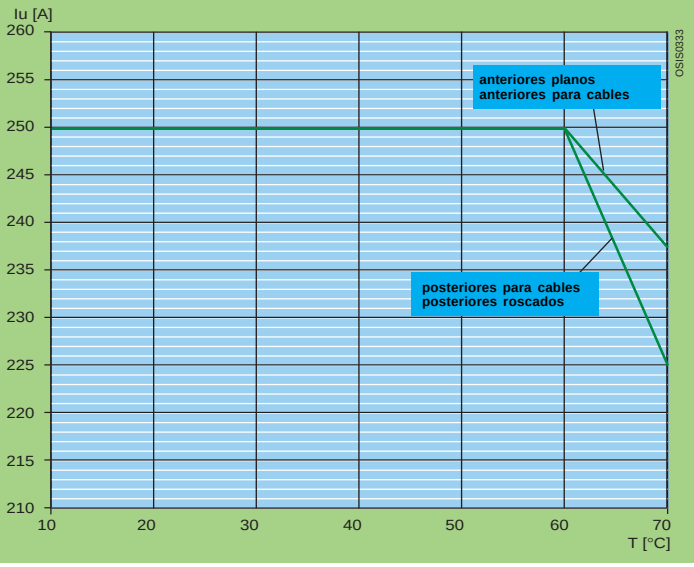
terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**160**	1	160	1	160	1	152	0,95
anteriores para cables	**160**	1	160	1	160	1	152	0,95
posteriores para cables	**160**	1	160	1	160	1	144	0,9
posteriores roscados	**160**	1	160	1	160	1	144	0,9



SACE S4 250

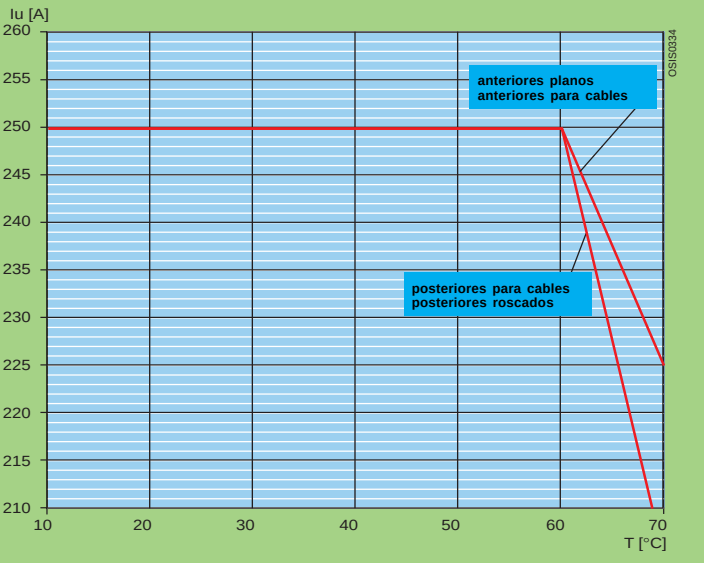
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**250**	1	250	1	250	1	237,5	0,95
anteriores para cables	**250**	1	250	1	250	1	237,5	0,95
posteriores para cables	**250**	1	250	1	250	1	225	0,9
posteriores roscados	**250**	1	250	1	250	1	225	0,9



enchufable - extraíble

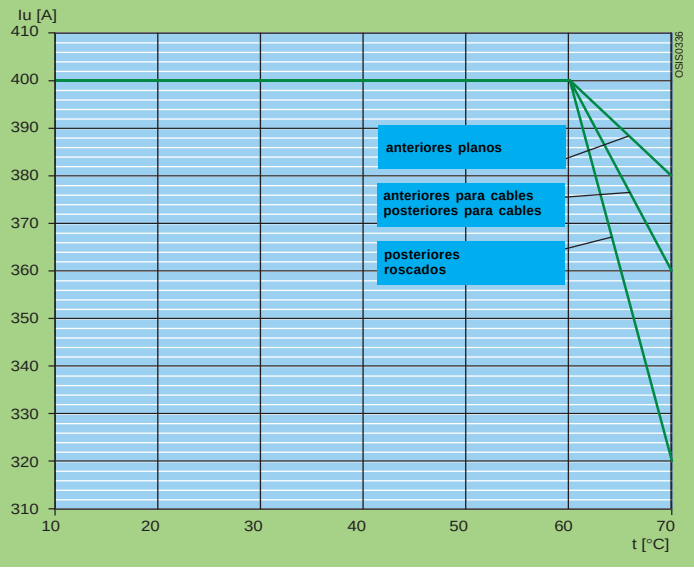
terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**250**	1	250	1	250	1	225	0,9
anteriores para cables	**250**	1	250	1	250	1	225	0,9
posteriores para cables	**250**	1	250	1	250	1	200	0,8
posteriores roscados	**250**	1	250	1	250	1	200	0,8



SACE S5 400

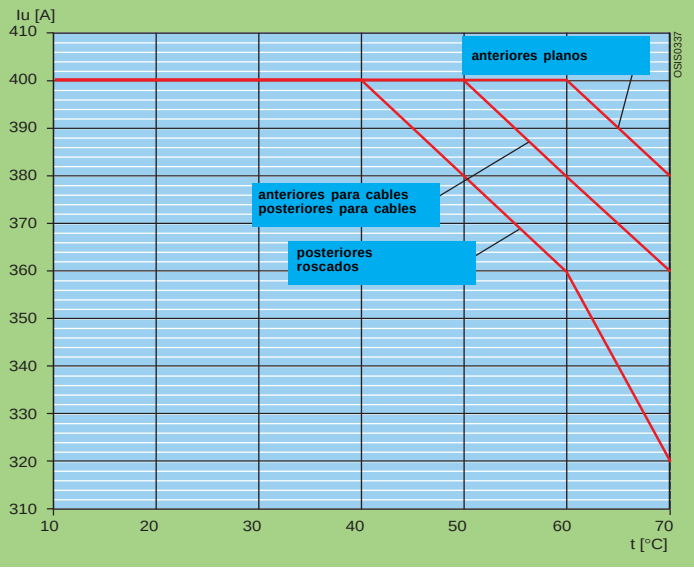
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**400**	1	400	1	400	1	380	0,95
anteriores para cables	**400**	1	400	1	400	1	360	0,9
posteriores para cables	**400**	1	400	1	400	1	360	0,9
posteriores roscados	**400**	1	400	1	400	1	320	0,8



enchufable - extraíble

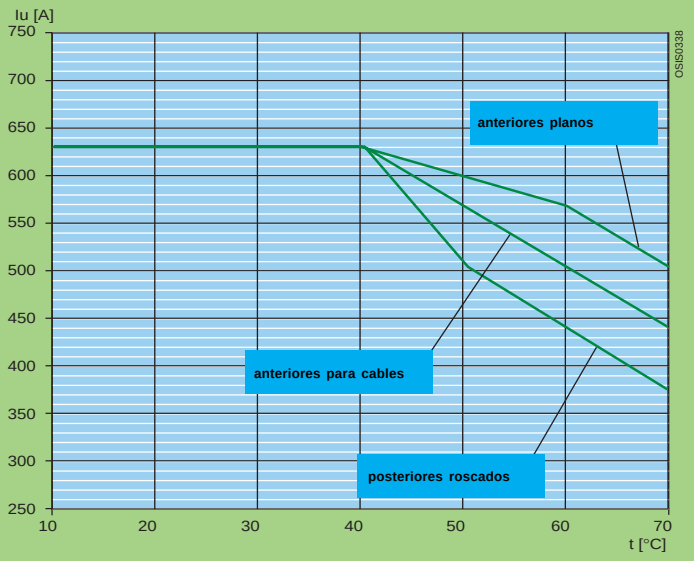
terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**400**	1	400	1	400	1	380	0,95
anteriores para cables	**400**	1	400	1	380	0,95	360	0,9
posteriores para cables	**400**	1	400	1	380	0,95	360	0,9
posteriores roscados	**400**	1	380	0,95	360	0,9	320	0,8



SACE S5 630

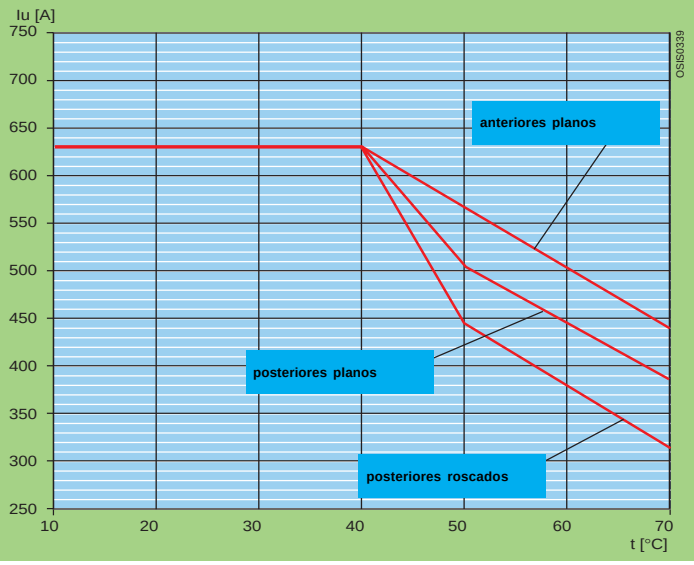
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**630**	1	598,5	0,95	567	0,9	504	0,8
anteriores para cables	**630**	1	567	0,9	504	0,8	441	0,7
posteriores roscados	**630**	1	504	0,8	441	0,7	378	0,6



enchufable - extraíble

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**630**	1	567	0,9	504	0,8	441	0,7
posteriores planos	**630**	1	504	0,8	441	0,7	378	0,6
posteriores roscados	**630**	1	441	0,7	378	0,6	315	0,5

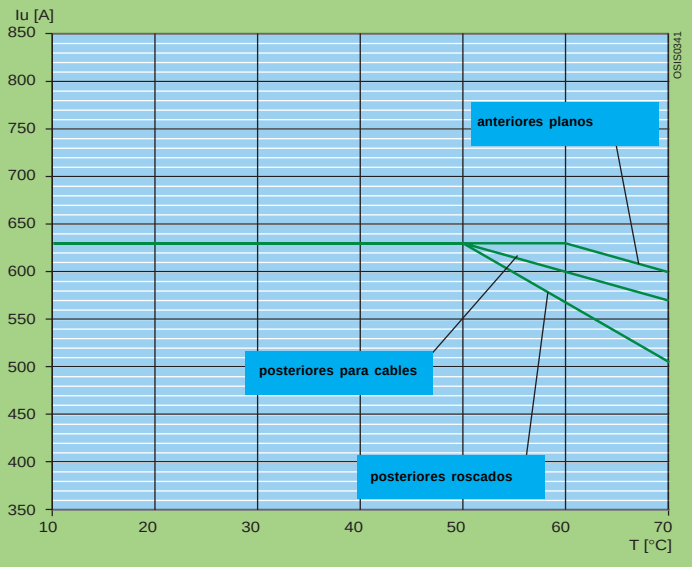


Prestaciones en temperatura de los interruptores con relés de sobreintensidad con microprocesador

SACE S6 630

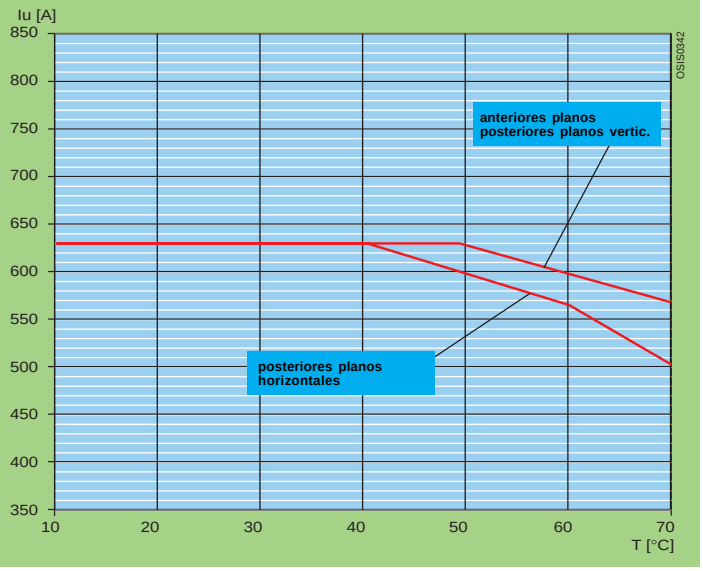
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**630**	1	630	1	630	1	598,5	0,95
anteriores para cables	**630**	1	630	1	598,5	0,95	567	0,9
posteriores para cables	**630**	1	630	1	598,5	0,95	567	0,9
posteriores roscados	**630**	1	630	1	567	0,9	504	0,8



enchufable - extraíble

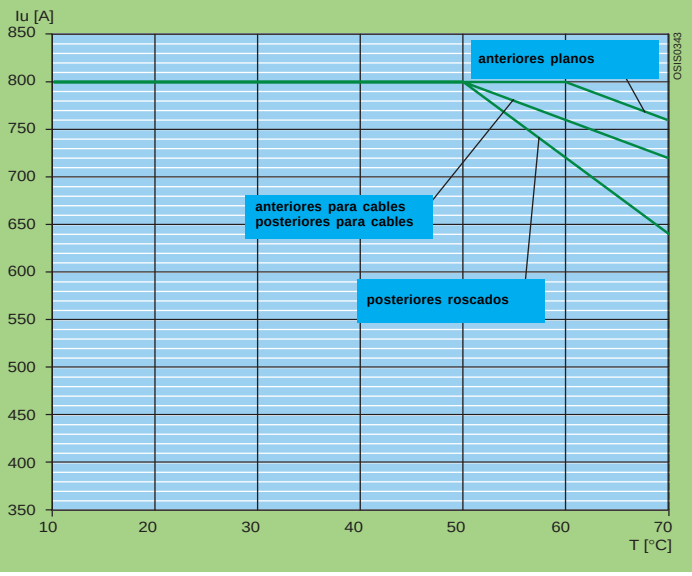
terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**630**	1	630	1	598,5	0,95	567	0,9
posteriores planos verticales	**630**	1	630	1	598,5	0,95	567	0,9
posteriores planos horizontales	**630**	1	598,5	0,95	567	0,9	504	0,8



SACE S6 800

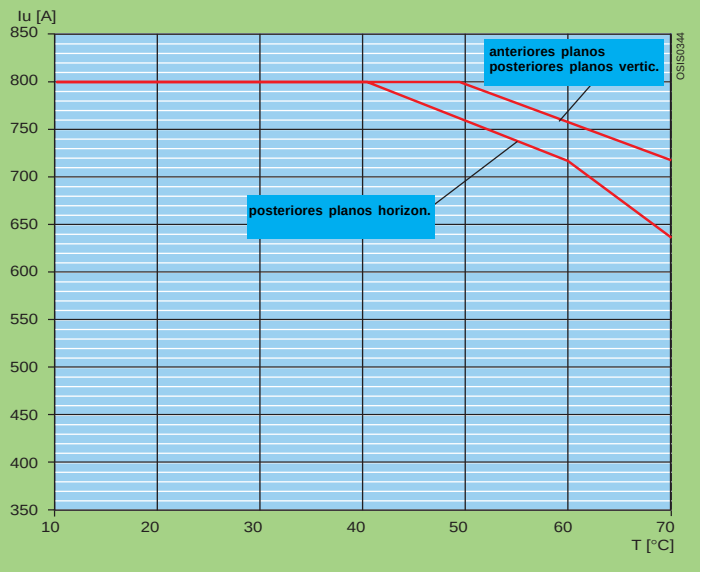
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**800**	1	800	1	800	1	760	0,95
anteriores para cables	**800**	1	800	1	760	0,95	720	0,9
posteriores para cables	**800**	1	800	1	760	0,95	720	0,9
posteriores roscados	**800**	1	800	1	720	0,9	640	0,8



enchufable - extraíble

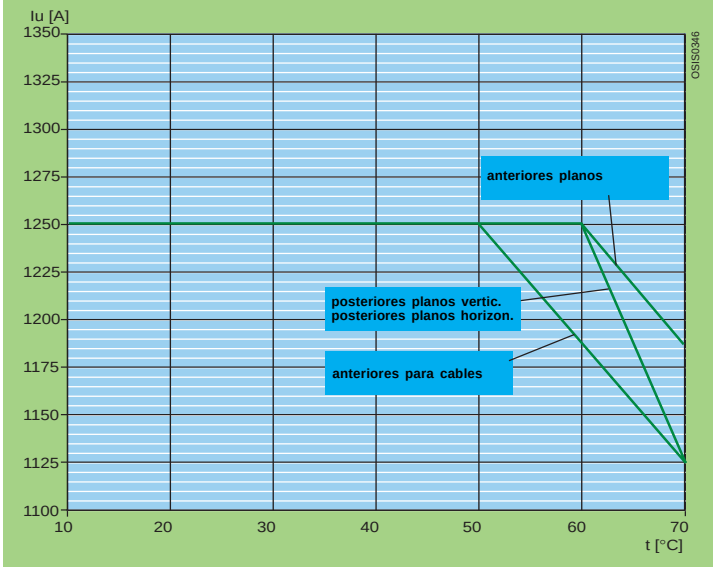
terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**800**	1	800	1	760	0,95	720	0,9
posteriores planos verticales	**800**	1	800	1	760	0,95	720	0,9
posteriores planos horizontales	**800**	1	760	0,95	720	0,9	640	0,8



SACE S7 1250

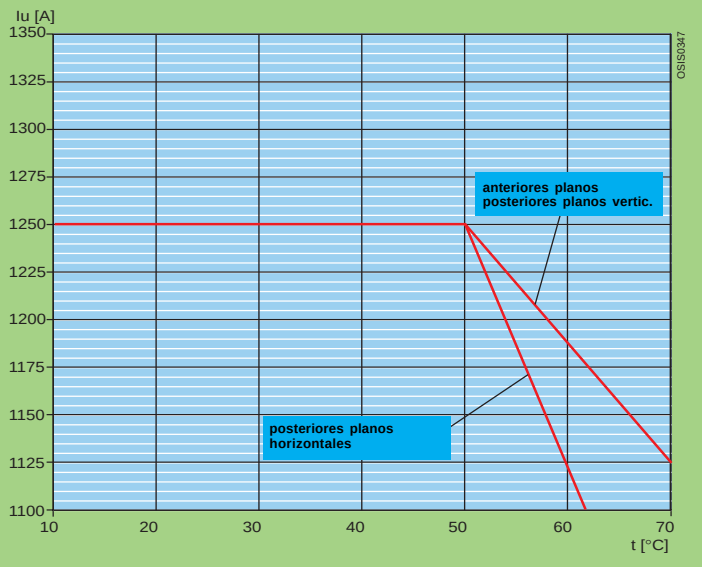
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**1250**	1	1250	1	1250	1	1187,5	0,95
anteriores para cables	**1250**	1	1250	1	1187,5	0,95	1125	0,9
posteriores planos vertic.	**1250**	1	1250	1	1250	1	1125	0,9
posteriores planos horizon.	**1250**	1	1250	1	1250	1	1125	0,9



enchufable - extraíble

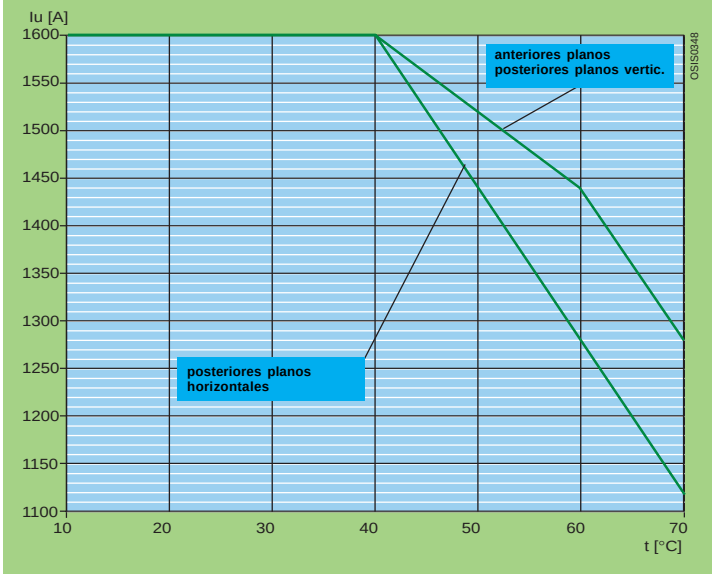
terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**1250**	1	1250	1	1187,5	0,95	1125	0,9
posteriores planos verticales	**1250**	1	1250	1	1187,5	0,95	1125	0,9
posteriores planos horizon.	**1250**	1	1250	1	1125	0,9	1000	0,8



SACE S7 1600

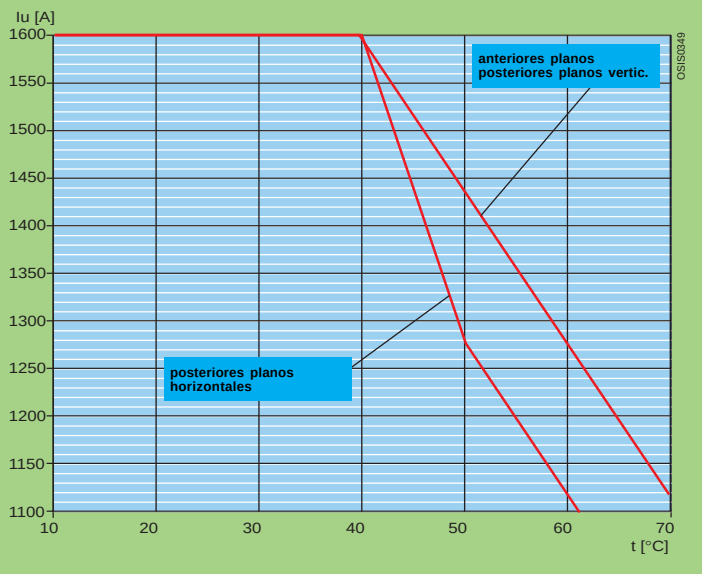
fijo

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**1600**	1	1520	0,95	1440	0,9	1280	0,8
posteriores planos verticales	**1600**	1	1520	0,95	1440	0,9	1280	0,8
posteriores planos horizon.	**1600**	1	1440	0,9	1280	0,8	1120	0,7



enchufable - extraíble

terminales	hasta 40 °C		50 °C		60 °C		70 °C	
	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1	Imax [A]	I_1
anteriores planos	**1600**	1	1440	0,9	1280	0,8	1120	0,7
posteriores planos verticales	**1600**	1	1440	0,9	1280	0,8	1120	0,7
posteriores planos horizon.	**1600**	1	1280	0,8	1120	0,7	906	0,6



Prestaciones en temperatura de los interruptores con relés de sobreintensidad termomagnéticos

SACE S1

	10°	20°	30°	**40°**	50°	60°	70°C
R10	13	12	11	**10**	9	8	7
R12,5	15,5	14,5	13,5	**12,5**	11,5	10,5	9,5
R16	20	18,5	17	**16**	15	14	13
R20	24	22,5	21	**20**	19	18	17
R25	30	28	26,5	**25**	23	21	19
R32	38	36	34	**32**	30	28	26
R40	49	45	43	**40**	37	35	34
R50	60	56	53	**50**	47	44	41
R63	75	71	67	**63**	59	55	51
R80	96	91	86	**80**	74	68	62
R100	120	114	108	**100**	94	88	82
R125	145	138	132	**125**	120	112	104

SACE S2

	10°	20°	30°	**40°**	50°	60°	70°C
R12,5	11…15,5	10…14,5	9,5…13	**9…12,5**	8…11,5	7,5…10,5	6,5…9,5
R16	14…19	13…18	11,5…17	**11…16**	10,5…15	9,5…14	8,5…13
R20	18…24,5	16,5…23	15…21,5	**14…20**	13…18	12…17	11…16
R25	21…30	19,5…28	18,5…26,5	**17,5…25**	16,5…23	15…21	13…19
R32	28…38	25,5…36	24…34	**22,5…32**	20,5…29	19…27	17…25
R40	33…47	32…45	30…42	**28…40**	26…37	24…34	21…31
R50	44…58	39…56	38…53	**35…50**	33…47	30…43	27…40
R63	53…74	50…70	47…66	**44…63**	42…60	38…56	34…52
R80	66…94	63…90	59…85	**56…80**	52…75	49…70	44…65
R100	84…118	80…112	76…106	**70…100**	65…94	59…85	49…75
R125	102…145	100…140	93…133	**88…125**	81…116	75…108	68…101
R160	130…184	125…176	120…168	**112…160**	106…150	100…140	90…130

SACE S3

	10°	20°	30°	**40°**	50°	60°	70°C
R32	26…43	24…39	22…36	**19…32**	16…27	14…24	11…21
R50	37…62	35…58	33…54	**30…50**	27…46	25…42	22…39
R80	59…98	55…92	52…86	**48…80**	44…74	40…66	32…58
R100	83…118	80…113	74…106	**70…100**	66…95	59…85	49…75
R125	103…145	100…140	94…134	**88…125**	80…115	73…105	63…95
R160	130…185	124…176	118…168	**112…160**	106…150	100…140	90…130
R200	162…230	155…220	147…210	**140…200**	133…190	122…175	107…160
R250	200…285	193…275	183…262	**175…250**	168…240	160…230	150…220

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Pequeñas y medias instalaciones

Con pequeña potencia instalada: complejos residenciales (civiles); centros comerciales y bancos (terciario); pequeñas naves industriales, máquinas (pequeña industria).

Cuadros y cajas con profundidad reducida, en general apoyados a la pared con acceso solamente desde la parte frontal tanto para los aparatos como para los cables.
Es la ejecución más utilizada para las aplicaciones y los cuadros eléctricos de la distribución secundaria y de los circuitos de los servicios finales con corrientes asignadas hasta 400 A; subcuadros, cuadros de distribución con interruptores montados en guías DIN y ranuras de instalación de 45mm, panel de bordo, cuadro de superficie y cuadros para el mando de motores (MCC), normalmente combinados con el cuadro de distribución.

Medias instalaciones

Con media potencia instalada o servicios finales de instalaciones más grandes en las cuales se toleran interrupciones de servicio en caso de defecto.

Cuadros con acceso desde la parte anterior para los aparatos y desde la parte posterior para los cables (pasillo posterior de anchura ≥ 600 mm).
Es la ejecución más utilizada para los cuadros eléctricos Power Center y para los cuadros de subdistribución.

Grandes instalaciones

Cuando no se admiten interrupciones en caso de defecto, por ejemplo, en lugares o procesos de trabajo en los que la falta de servicio provoca situaciones de peligro para las personas, grandes daños, peligros de explosión: hospitales, grandes centros comerciales, grandes bancos (terciario), industrias químicas y petroquímicas, instalaciones siderúrgicas, máquinas - máquina única o proceso - (industria mediana).

CSIS9125

hasta 400 A

Enchufable con terminales anteriores para cables o para pletina de cobre

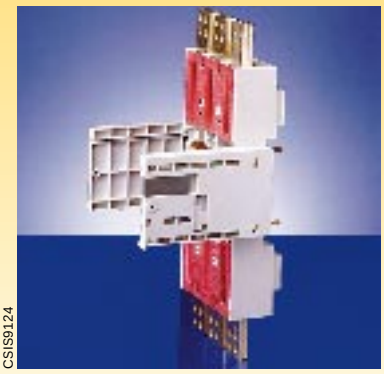
Cuadros y cajas con profundidad reducida, en general apoyados a la pared con acceso solamente desde la parte frontal tanto para los aparatos como para los cables; o donde sea necesario prever instalaciones futuras de más líneas; o donde se han instalado líneas de reserva a otras con un único interruptor enchufable para cada par. Sólo se admiten breves interrupciones de servicio en caso de defectos o mantenimiento.
Disponible hasta S5 400.
Es la ejecución más utilizada para los cuadros eléctricos Power Center y para los cuadros de subdistribución en general con canal lateral para cables.

CSIS9123

hasta 1600 A

Extraíble con terminales posteriores roscados hasta S5 630 o posteriores planos para S6 y S7

Cuadros con acceso desde la parte anterior para los aparatos y desde la parte posterior para los cables (pasillo posterior de anchura ≥ 600 mm); o donde se han previsto instalaciones futuras; o donde se han instalado líneas de reserva a otras con un único interruptor extraíble para cada par. No se admiten interrupciones de servicio y sólo se admiten breves interrupciones en caso de defecto.
Disponible para S3 ... S7 de 160 a 1600A.
Es la solución utilizada para los cuadros eléctricos Power Center y en los cuadros de subdistribución con elevadas potencias en juego, así como en posibles segregaciones hasta el grado máximo (Forma 4).


CSIS9124

hasta 1600 A

Extraíble con terminales anteriores para cables hasta S5 o para pletinas de cobre para S6 y S7

Cuando el espacio de profundidad es limitado y hay que desarrollar el cuadro en longitud.
Cuadros y cajas con profundidad reducida, en general apoyados a la pared con acceso desde la parte frontal para el aparato y para los cables; o donde sea necesario prever instalaciones futuras de más líneas; o donde se han instalado líneas de reserva a otras con un único interruptor extraíble para cada par. Sólo se admiten breves interrupciones de servicio en caso de defectos o mantenimiento.
Disponible para S3 ... S7 de 160 a 1600A.
Es la solución utilizada para los cuadros eléctricos Power Center y en los cuadros de subdistribución con elevadas potencias en juego, así como en posibles segregaciones hasta el grado máximo (Forma 4).

Sistemas de distribución de la energía eléctrica: cómo escoger el interruptor automático

El número de los polos y el tipo de protección que los interruptores automáticos han de poseer depende del tipo del sistema de distribución utilizado (TT, TN o IT) y del tipo de circuito (trifásico o monofásico). Los sistemas eléctricos se clasifican en función:

de la tensión asignada

Categoría	tensión asignada Un [V]
0	≤ 50 c.a.
	≤ 120 c.c.
I	50 < Un ≤ 1000 c.a.
	120 < Un ≤ 1500 c.c.

del sistema de distribución de los conductores activos

Sistema	número de conductores activos
Monofásico	2 fase - fase
	3 fase - neutro
Trifásico	3 L1- L2 - L3
	4 L1- L2 - L3 -N

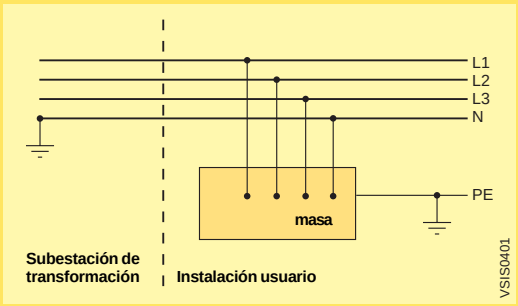
del estado del neutro en relación al cual hay que utilizar un interruptor automático con un número de polos adecuado y prever, eventualmente, la protección y el seccionamiento del conductor de neutro en función del sistema de distribución y del tipo de circuito.

Sistema	Circuitos															
	Trifásico			Bifásico		Fase + N		Trifásico + neutral								
								$S_N \geq S_F$				$S_N < S_F$				
	L1	L2	L3	L1	L2	L1	N	L1	L2	L3	N	L1	L2	L3	N	
TN - C	P	P	P	P	P	P	no	P	P	P	no	P	P	P	no	
TN - S	P	P	P	P	P	P		P	P	P		P	P	P	P	
TT	P	P	P	P	P	P		P	P	P		P	P	P		
IT	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	

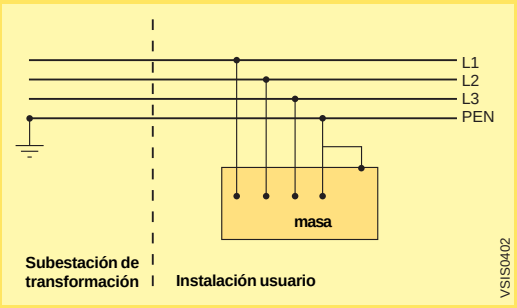
La letra “P” indica cuándo proteger las fases o el neutro y, en consecuencia, el número de polos del interruptor automático
S_N = sección del conductor de neutro
S_F = sección del conductor de fase

El conductor de neutro, cuando está protegido, no tiene que abrirse antes ni tiene que cerrarse después de los conductores de fase, como se garantiza con los interruptores automáticos SACE Isomax S en los cuales la apertura se produce simultáneamente en todos los polos.

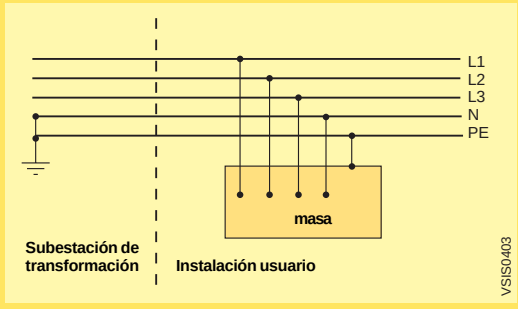
SISTEMA TT



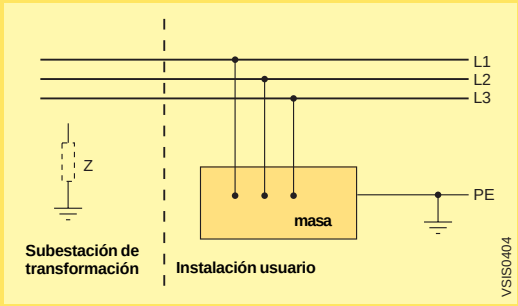
SISTEMA TN-C



SISTEMA TN-S



SISTEMA IT



Sistema con dos instalaciones de tierra separadas:
– una para el neutro de la subestación de transformación
– una para la instalación de distribución.

El conductor de protección PE para la conexión a tierra de las estructuras metálicas (masas) va a parar al sistema de tierra de la instalación de distribución de la compañía y está completamente separado del conductor del neutro N.
La protección contra contactos indirectos está garantizada cuando la tensión hacia tierra UI es menor o igual a 50 V y, en casos particulares, 25 V.
Por lo tanto, debe resultar

$$Rt \leq 50 / I,$$

donde I es la corriente de intervención de la protección de sobreintensidad en el tiempo de 0,4 s o de 5 s o la corriente de intervención del dispositivo diferencial.
Se deduce, por lo tanto, que la protección contra contactos indirectos sólo se puede efectuar con relés de sobreintensidad o relés diferenciales a menos que se obtengan valores bajísimos de la resistencia de tierra Rt.
El sistema TT se adopta para pequeñas y medias instalaciones en las que la compañía eléctrica efectúa el suministro en baja tensión, o en partes periféricas de una instalación de distribución del usuario para las cuales puede tener sentido efectuar redes de tierra separadas.

Sistema con una única instalación de tierra para la subestación de transformación y para la instalación de distribución o para algunas de sus partes.
Un único conductor PEN efectúa la función de neutro N para la alimentación de las cargas que lo requieran y de conductor PE para la conexión a tierra de seguridad de las estructuras metálicas (masas); por lo tanto, el conductor PEN no puede ni debe ser interrumpido ni por interruptores automáticos ni por ningún órgano de seccionamiento durante el funcionamiento normal ya que faltaría la protección de las personas.
La protección contra las tensiones de contacto se efectúa coordinando la corriente de intervención I del dispositivo de protección (sobreintensidad o diferencial) según la fórmula:

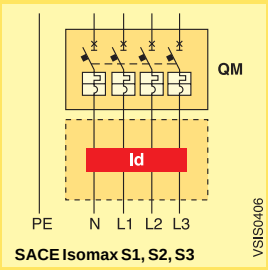
$$I \leq \frac{U_o}{Z_g}$$

donde:
U_o es la tensión asignada a tierra (220 V para sistemas trifásicos a 380 V)
Z_g es la impedancia total del anillo de defecto.
La medición de la resistencia de tierra Rt es necesaria para el control de la coordinación con las protecciones de la parte de la instalación de media tensión antes del transformador, en función de la corriente convencional de tierra I_g y de los tiempos de eliminación del defecto de manera que no se creen tensiones de paso y de contacto superiores a 160 V por periodos de tiempo de ≤ 0,5 s.
El sistema TN-C se utiliza para grandes/medias instalaciones en las que la compañía eléctrica efectúa el suministro en alta tensión o media tensión y el usuario realiza después, una o más subestaciones de transformación efectuando, posteriormente, en el lado de baja tensión, la distribución con 4 conductores (3 fases + N/PE).
Con este sistema de distribución se tienen que utilizar interruptores automáticos tripolares y el conductor PEN se debe seleccionar con una sección suficiente para que quede protegido por los relés de las fases. En caso contrario, hay que prever un relé de sobrecorriente en el conductor PEN que provocará la apertura del interruptor automático sin interrumpir el conductor PEN.

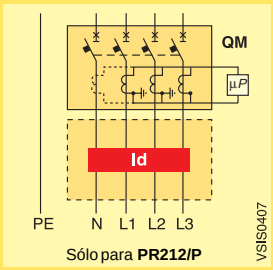
Sistema con una única instalación de tierra para la subestación de transformación y para la instalación de distribución
El conductor PE, para la conexión a tierra de seguridad de las estructuras metálicas (masas), se distribuye completamente separado del conductor del neutro N, si bien se encuentra conectado, en el origen, a la misma instalación de tierra.
También se tiene que considerar como sistema TN-S la parte de la instalación de un sistema mixto TN-CS posterior al punto en el cual se separa el neutro N y el PE y éstos se distribuyen totalmente separados y no conectados entre sí.
El sistema TN-S se utiliza para medias instalaciones en las que la compañía eléctrica efectúa el suministro en media tensión y el usuario realiza después, una o más subestaciones de transformación distribuyendo el neutro totalmente separado del conductor PE e instalando, también, las protecciones diferenciales de tierra.

Sistema en el que ninguna parte activa se encuentra conectada a tierra y, por lo tanto, el neutro del sistema se encuentra aislado de tierra o conectado a ésta mediante una alta impedancia.
La instalación de tierra se efectúa para conectar las masas por motivos de seguridad de las personas. El sistema IT se utiliza en las instalaciones en las cuales es indispensable poseer una continuidad de servicio elevada, como, por ejemplo: hospitales, clínicas, quirófanos, instalaciones con peligro de incendio o explosión como petroquímicas, fábricas de papel, laminados, etc. y, por lo tanto, el primer defecto a tierra no debe provocar una interrupción del servicio.
Se tiene que instalar un dispositivo para el control continuo del aislamiento para señalar el primer defecto a tierra. El segundo defecto es detectado por los relés de sobreintensidad o por los dispositivos diferenciales. Al producirse el primer defecto a tierra hay que eliminar lo antes posible las causas para que no se creen problemas de servicio con un segundo defecto.
Las normas CEI 64-8/3/473.3.2.2 recomiendan no distribuir el neutro ya que en el caso de que se produzca un defecto a tierra en el neutro, se puede perder la continuidad de servicio, que es el motivo que determina la selección del sistema IT.

La polaridad del interruptor



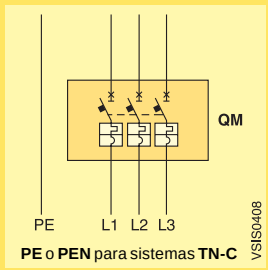
SACE Isomax S1, S2, S3



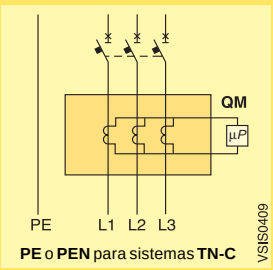
Sólo para **PR212/P**

Interruptores automáticos tetrapolares para circuitos trifásicos en corriente alterna con neutro distribuido (4 hilos + PE)

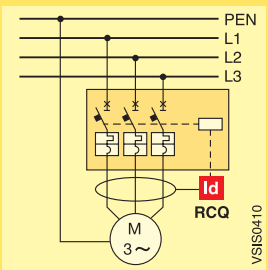
- Se emplean en sistemas de distribución de tipo TT, TN-S e IT para circuitos con neutro distribuido. No se utilizan en sistemas de tipo TN-C.
- El relé termomagnético en el neutro puede omitirse si el circuito está equilibrado y si la protección del conductor de neutro está asegurada por la protección de los conductores de fase. Si se ha previsto, la regulación del neutro tiene que garantizar la protección del conductor de neutro. Para conductores de fase con secciones superiores a 25 mm^2, la sección del neutro es, en general, igual a la mitad de la sección de las fases y, por lo tanto, hay que emplear un relé de protección con regulación reducida para el neutro, como se suministra normalmente con los interruptores automáticos tetrapolares SACE Isomax S.
- Para sistemas IT, el interruptor automático tetrapolar solamente se tiene que utilizar cuando no se tiene en cuenta la recomendación de no distribuir el neutro, establecida por las correspondientes Normas.
- El relé diferencial se emplea en los sistemas de distribución de tipo TT e IT. En los sistemas TN, la coordinación para la protección de tierra se puede obtener dentro de ciertos límites con los relés con microprocesador SACE PR212/P - LSIG, con la función “G” de protección contra defecto a tierra.



PE o **PEN** para sistemas **TN-C**

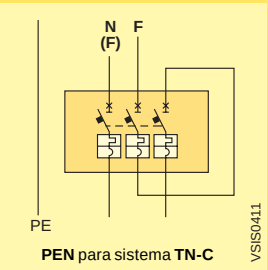


PE o **PEN** para sistemas **TN-C**



Interruptores automáticos tripolares para circuitos trifásicos en corriente alterna sin neutro distribuido (3 hilos + PE)

- Se emplean en sistemas de distribución de tipo TT, TN-S e IT para circuitos con neutro no distribuido y en sistemas de tipo TN-C con o sin neutro. En este último caso, cuando se halla presente el neutro, forma un único cuerpo con el conductor de tierra PE, dando lugar al conductor PEN que no tiene que ser ni interrumpido ni seccionado.
- En los sistemas de tipo TN-S o TT, se utiliza sólo para servicios que no utilizan el neutro, como es el caso de la maniobra y la protección de los motores.
- La protección diferencial no se emplea en los sistemas de distribución TN-C salvo en casos especiales. Para estos últimos, el conductor de puesta a tierra de los servicios a proteger tiene que conectarse al PEN antes de la protección diferencial, como sucede en la protección de un motor contra los defectos a tierra ilustrada en la figura.



PEN para sistema **TN-C**

Interruptores automáticos para circuitos monofásicos en corriente alterna

Para circuitos monofásicos fase-fase o fase-neutro, se pueden utilizar los interruptor automáticos SACE Isomax S tanto tripolares como tetrapolares prestando atención en no interrumpir el conductor PEN en los sistemas de distribución de tipo TN-C.

Instalación en cuadro

Los interruptores automáticos SACE Isomax S pueden adaptarse perfectamente y montarse con facilidad en cualquier tipo de cuadro gracias a los tamaños coordinados en altura, profundidad y anchura. Se pueden montar indistintamente tanto en posición vertical como en posición horizontal a condición de que se respeten siempre las distancias mínimas a las paredes del cuadro. Permiten realizar fácilmente todas las formas de segregación establecidas por las Normas IEC 439-1/CEI EN 60439-1. Para la instalación en cuadro se pueden obtener todos los grados de protección siempre que se instalen los elementos necesarios como, por ejemplo, las juntas en las puertas para los grados IP50/IP54, el cierre o las pantallas en las ranuras de ventilación, el mando en la puerta de la celda para obtener un grado de protección superior al estándar mediante el accesorio que se suministra en dotación con la misma.

Disipación de la potencia

La disipación de la potencia es un dato útil para valorar el perfil de la temperatura que se crea en un cuadro durante su funcionamiento normal. Para ello, para cada unidad del cuadro eléctrico hay que hacer un cálculo de control sobre la disipación térmica teniendo en cuenta:

– las dimensiones generales
– la corriente asignada de las barras y de las conexiones y las correspondientes disipaciones
– las disipaciones de los aparatos montados en el cuadro.

Los valores indicados se refieren a interruptores automáticos tripolares con todos los polos atravesados por corriente. El cálculo para determinar la sobretemperatura puede efectuarse con ayuda del programa DOC de ABB SACE.

Potencia disipada [W]		**S1**		**S2**		**S3**		**S4**		**S5**		**S6**		**S7**	
Regulación	I_n [A]	F	P	F	P	F	P-W	F	P-W	F	P-W	F	P-W	F	P-W
R10	10	4,3	4,5												
R12,5	12,5	5,8	6,0	6,2	6,5										
R16	16	7	7,3	7,9	8,5										
R20	20	8,6	8,9	8,4	9										
R25	25	7,9	8,3	11,3	12										
R32	32	8,6	8,4	12,9	13,5	12,4	13								
R40	40	8,6	9,5	13,1	14										
R50	50	10	11	13,7	15	16,4	18								
R63	63	12,8	13	16,9	19										
R80	80	13,5	15	21,9	25	17,9	21								
R100	100	13,8	15,5	21,6	26	21	25								
R125	125	25	30	27,7	34	19,5	26								
R160	160			30	40	30	40								
R200	200					36	46								
R250	250					50	65								
R320	320									60	90				
R400	400									66,4	96				
R500	500									–	–				
R630	630											92	117		
R800	800											93,2	119		
I_n=100	100							5,2	8						
I_n=160	160							15	22						
I_n=250	250							40	55						
I_n=320	320									45,5	65				
I_n=400	400									60	90				
I_n=630	630											90	115		
I_n=800	800											96	125		
I_n=1000	1000													102	140
I_n=1250	1250													160	220
I_n=1600	1600													260	360

Maniobra y protección del lado Baja Tensión de los transformadores trifásicos

Los transformadores se utilizan para cambiar la tensión de alimentación, tanto en suministros de media tensión como en alimentaciones de baja tensión.
En el caso de transformación Media/Baja tensión, la maniobra y la protección de los transformadores introduce problemáticos de coordinación de las protecciones. Efectivamente, cuando se encuentran instalados dos o más transformadores que funcionan en paralelo, el interruptor automático situado en el lado de B.T. del transformador tiene que abrirse cada vez que se abre el interruptor de protección (automático o de maniobra - seccionador con fusibles) del lado de M.T. del transformador, que puede suceder debido a la intervención de los relés de protección, de los fusibles o del relé Buchholz del transformador o debido a una maniobra manual realizada voluntariamente para dejar fuera de servicio el transformador y efectuar, por ejemplo, el mantenimiento.
La apertura del interruptor automático de B.T. mediante un circuito con un relé de apertura impide que el transformador se ponga nuevamente bajo tensión mediante el lado de B.T. con la consecuencia que se alimente el defecto o, todavía peor, se deje bajo tensión una parte de la instalación a la cual se tiene que acceder para efectuar el mantenimiento. Se aconseja realizar dicho circuito de apertura incluso si se prevé instalar en el futuro uno o más transformadores adicionales ya que, inicialmente, dicho circuito puede utilizarse como apertura de emergencia para la línea de alimentación general.
En régimen, las corrientes en vacío pueden alcanzar valores equivalentes al 4-5% de la corriente asignada a plena carga; al elegir los dispositivos de protección hay que considerar los fenómenos transitorios de conexión del transformador durante los cuales la corriente puede presentar valores equivalentes al doble de la corriente asignadaa plena carga.
La maniobra y la protección se puede efectuar con los interruptores automáticos SACE S1, S2, S3, S4, S5, S6 y S7 de 10 a 1600 A como máximo, en corriente alterna. El interruptor automático situado des-

Para elegir los interruptores automáticos SACE Isomax S que se han de instalar tanto en los ramales de los transformadores como en las líneas derivadas después de los mismos, se puede consultar la siguiente tabla correspondiente a los transformadores con tensión en vacío en el secundario igual a 400 V que es la condición de empleo más común. La tabla ha sido realizada considerando una potencia infinita aguas arriba del primario del transformador y se ha supuesto el caso más desfavorable, es decir, que el cortocircuito se produzca en los bornes del transformador.
Por lo que se refiere a los servicios, el cortocircuito se ha considerado después de los bornes del interruptor automático de salida. Los interruptores automáticos de salidas indicados en la tabla garantizan la completa selectividad con los interruptores automáticos de salidade los ramales de los transformadores.

Transformadores de alimentación				Interruptor en el secundario del transformador			
P	U_{cc}	I_b ramal	I_b total	I_{cc} ramal	SACE Isomax S	Relé	
[kVA]	%	[A]	[A]	[kA]	tipo	tipo	regulación
1x63	4	91	91	2.3	S1B125	R100	–
2x63		91	182	2.3	S1B125	R100	–
1x100	4	144	144	3.6	S2B160	R160	0.95
2x100		144	288	3.6	S2B160	R160	0.95
1x125	4	180	180	4.5	S3N/S4N250	R200/I_n = 250	0.95/0.8
2x125		180	360	4.5	S3N/S4N250	R200/I_n = 250	0.95/0.8
1x160	4	231	231	5.8	S3N/S4N250	R250/I_n = 250	0.95/0.95
2x160		231	462	5.8	S3N/S4N250	R250/I_n = 250	0.95/0.95
1x200	4	289	289	7.2	S5N400	I_n = 320 A	0.95
2x200		289	578	7.2	S5N400	I_n = 320 A	0.95
1x250	4	361	361	9	S5N400	I_n = 400 A	0.95
2x250		361	722	9	S5N400	I_n = 320 A	0.95
1x315	4	455	455	11.4	S6N630	I_n = 630 A	0.8
2x315		455	910	11.4	S6N630	I_n = 630 A	0.8
1x400	4	577	577	14.4	S6N630/S6N800	I_n = 630/1000	0.95/0.6
2x400		577	1154	14.4	S6N630/S6N800	I_n = 630/1000	0.95/0.6
1x500	4	722	722	18	S6N800/S7S1250	I_n = 800/1000	0.95/0.8
2x500		722	1444	18	S6N800/S7S1250	I_n = 800/1000	0.95/0.8
1x630	4	909	909	22.7	S71250	I_n = 1000 A	0.95
2x630		909	1818	22.7	S71250	I_n = 1000 A	0.95
3x630		909	2727	45.4	S71250	I_n = 1000 A	0.95
1x800	5	1155	1155	23.1	S7S1250/S7S1600	I_n = 1250 A	0.95
2x800		1155	2310	23.1	S7S1250/S7S1600	I_n = 1250 A	0.95
3x800		1155	3465	46.2	S7S1250/S7S1600	I_n = 1250 A	0.95
1x1000	5	1443	1443	28.9	S7S1600	I_n = 1600 A	0.95
2x1000		1443	2686	28.9	S7S1600	I_n = 1600 A	0.95
3x1000		1443	4329	57.8	S7H1600	I_n = 1600 A	0.95

pués de un transformador, además de garantizar el seccionamiento del circuito, protege el transformador contra las sobrecargas y las barras de distribución, situadas después, contra los cortocircuitos. La elección del interruptor automático adecuado para la aplicación se realiza en función:

– de la corriente asignada secundaria del transformador que depende de la potencia aparente en kVA y de la tensión de servicio; el modelo del interruptor automático se elige de manera que se obtenga una corriente asignada superior un 10% como mínimo a la corriente asignada secundaria del transformador
– de la corriente de cortocircuito en el punto de aplicación que depende de la potencia P en kVA y del número de transformadores que funcionan en paralelo así como de la tensión de servicio y de la tensión de cortocircuito U_{cc}% (indicada también con las siglas V_{cc}% o Z_{cc}%) calculada según la siguiente fórmula:

$$I_{cc} = \frac{P \times 100}{1{,}73 \times V \times Ucc}$$

Donde

P = potencia asignada del transformador en kVA

V = tensión asignada secundaria del transformador en V

U_{cc} % = tensión de cortocircuito asignada trifásica del lado de B.T.

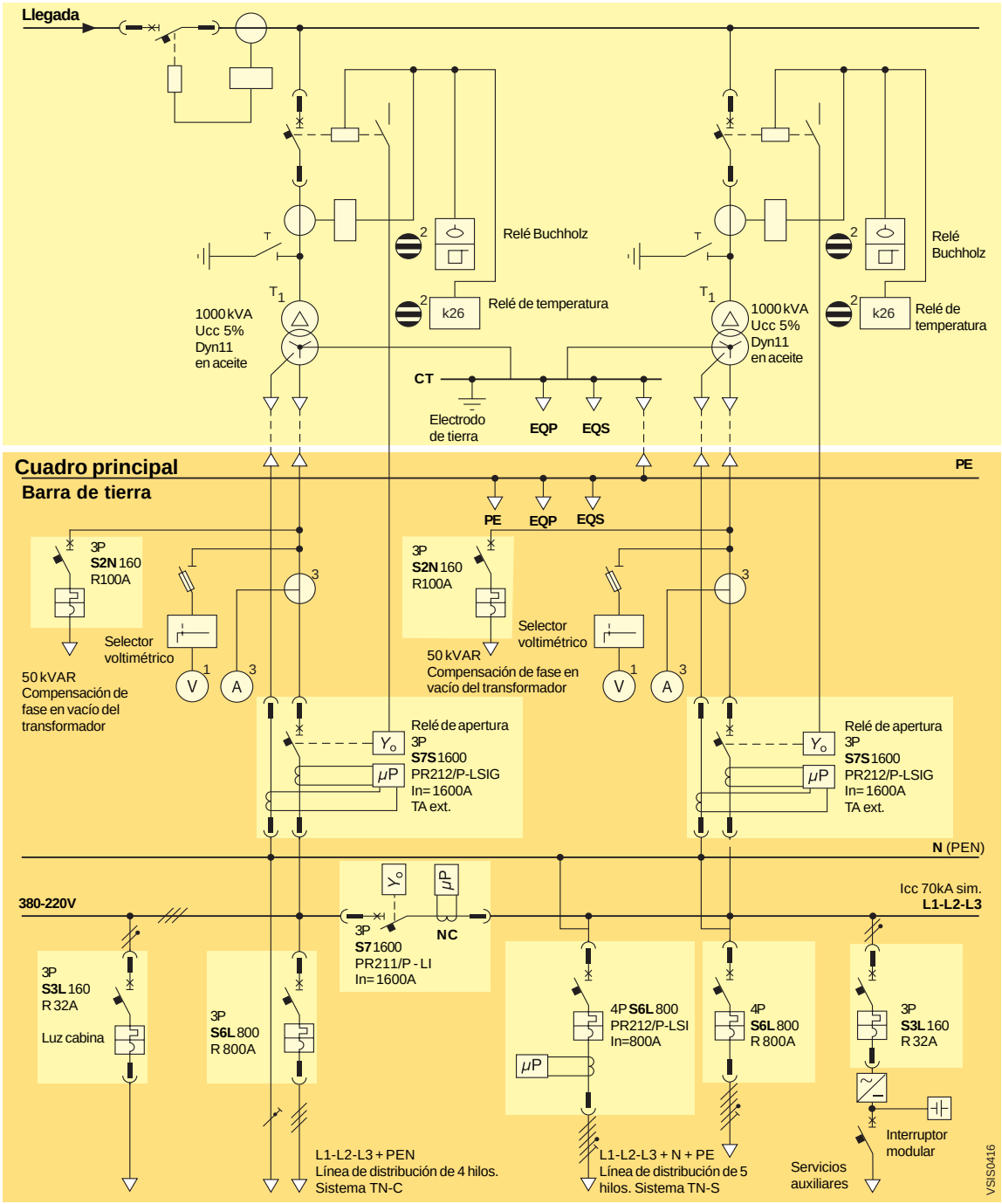
Para mayor información sobre el cálculo de la corriente de cortocircuito es posible utilizar el programa DOC para ordenador personal o bien las reglas de cálculo realizadas y distribuidas por ABB SACE. Para los interruptores automáticos que protegen el secundario de los transformadores, el poder de corte tiene que ser mayor que la corriente de cortocircuito debida al número total de los transformadores de igual potencia que están en paralelo menos uno. Obsérvese que, en general, dos transformadores para poder funcionar correctamente en paralelo han de tener el mismo grupo de conexión y la misma tensión de cortocircuito U_{cc}%.

Interruptor salida servicio

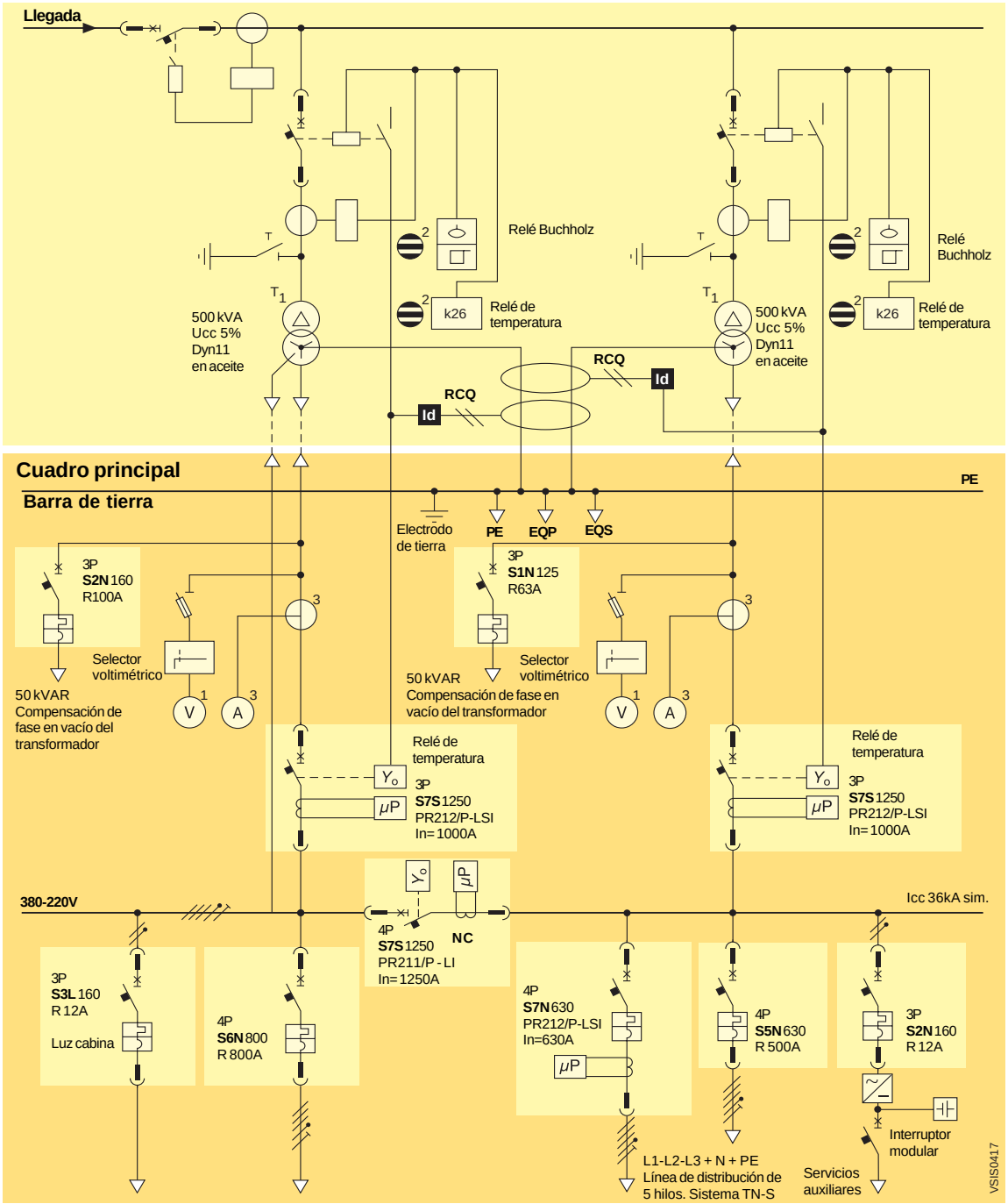
I_{cu} servicio	Corriente asignada y tipo de interruptor automático									
[kA]	32 A	63 A	125 A	160 A	250 A	400 A	630 A	800 A	1250 A	1600 A
2.3	S250	S250	S1B125							
4.6	S250	S250	S1B125							
3.6	S250	S250	S1B125							
7.2	S250	S250	S1B125							
4.5	S250	S250	S1B125	S2B160						
9	S250	S250	S1B125	S2B160						
5.8	S250	S250	S1B125	S2B160	S3N250					
11.6	S250	S250	S1B125	S2B160	S3N250					
7.2	S1B125	S1B125	S1B125	S2B160	S3N250	S5N400				
14.4	S1B125	S1B125	S1B125	S2B160	S3N250	S5N400				
9	S1B125	S1B125	S1B125	S2B160	S3N250	S5N400				
18	S1N125	S1N125	S1N125	S2N160	S3N250	S5N400				
11.4	S1B125	S1B125	S1B125	S2B160	S3N250	S5N400	S5N630			
22.8	S1N125	S1N125	S1N125	S2N160	S3N250	S5N400	S5N630			
14.4	S1B125	S1B125	S1B125	S2B160	S3N250	S5N400	S5N / S6N630			
28.8	S2N125	S2N125	S2N125	S2N160	S3N250	S5N400	S5N / S6N630			
18	S1B125	S1B125	S1B125	S2N160	S3N250	S5N400	S5N / S6N630	S6N800		
36	S2N160	S2N160	S2N160	S2N160	S3N250	S5N400	S5N / S6N630	S6N800		
22.7	S1N125	S1N125	S1N125	S2N160	S3N250	S5N400	S5N / S6N630	S6N800	S7S1250	
45.4	S2S160	S2S160	S2S160	S2S160	S3H250	S5H400	S5H / S6S630	S6S800	S7S1250	
68.1	S3L160	S3L160	S3L160	S3L250	S3L250	S5L400	S5L / S6L630	S6L800	S7L1250	
23.1	S1N125	S1N125	S1N125	S2N160	S3N250	S5N400	S5N / S6N630	S6N800	S7S1250	
46.2	S2S160	S2S160	S2S160	S2S160	S3H250	S5H400	S5H / S6S630	S6S800	S7S1250	
69.3	S3L160	S3L160	S3L160	S3L160	S3L250	S5L400	S5L / S6L630	S6L800	S7L1250	
28.9	S2N160	S2N160	S2N160	S2N160	S3N250	S5N400	S5N / S6N630	S6N800	S7S1250	S7S1250
57.8	S3H160	S3H160	S3H160	S3H160	S3H250	S5H400	S5H / S6H630	S6H800	S7H1250	S7H1250
86.7	S4L160	S4L160	S4L160	S4L160	S3L250	S5L400	S5L / S6L630	S6L800	S7L1250	S7S1250

El desarrollo de la red de distribución después del transformador tiene que responder a las exigencias de continuidad de alimentación, flexibilidad en la conducción y, no por último, tiene que realizarse para responder a los precisos requisitos de protección de la instalación de distribución en su totalidad. Las lógicas de conducción llevan a configurar el sistema de distribución según esquemas radiales, de anillo o de doble sistema de barras, mientras que el sistema de protección también ha de tener en cuenta el tipo de sistema de distribución. Los esquemas propuestos se refieren a dos casos típicos de distribución según los sistemas TN-C y TN-S a través de los cuales se evidencia cómo es posible utilizar los interruptores automáticos SACE Isomax en los diferentes niveles de una instalación, elegir

Sistema de distribución TN-C



una versión adecuada (tripolar o tetrapolar) y cómo se pueden determinar las protecciones de sobrecorriente y diferenciales. La coordinación de las protecciones es más necesaria cuanto más elevada es la corriente asignada de los transformadores y, en consecuencia, la posibilidad de provocar problemas de servicio importantes y/o graves daños, o bien cuanto más importante es la continuidad de servicio (por ejemplo, hospitales, centros de cálculo, lugares con presencia de muchas personas, interruptores generales de una instalación). Para el sistema TN-S, el relé diferencial SACE RCQ, insertado entre el centro estrella del transformador y la puesta a tierra del mismo consiente detectar la corriente total a tierra en el caso de que dos transformadores funcionen en paralelo.



Sistema de distribución TN-S

Maniobra y protección de motores trifásicos en c.a.

La maniobra y la protección de los motores eléctricos están realizadas, en general, por un conjunto de dispositivos llamado arrancador protegido. Al elegir estos dispositivos hay que considerar diferentes factores como la potencia del motor, el tipo de motor, el esquema de arranque y las condiciones de defecto que se pueden producir en el tramo de red implicada.

El conductor que alimenta el motor ha de tener una sección mínima suficiente para soportar las corrientes de arranque e, incluso, una capacidad superior a la regulación del relé térmico.

El interruptor automático es el dispositivo que responde completamente a la función de protección contra el cortocircuito y, a veces, a la de maniobra (según el número de maniobras y la frecuencia de las mismas). Los motores de B.T. en corriente alterna pueden protegerse mediante interruptores automáticos SACE Isomax S de S3 a S6 (800 A) para potencias de 0,37 kW hasta un máximo de 355 kW y con las siguientes coordinaciones:

– **Tipo 1** que admite la sustitución o la reparación de los dispositivos del arrancador tras un cortocircuito.
– **Tipo 2** que obliga a que el arrancador pueda reemprender el servicio tras un cortocircuito, se admiten soldaduras en los contactos a condición de que se puedan eliminar con una sencilla operación de mantenimiento.

Por encima de estas potencias, normalmente se utilizan motores alimentados en M.T. (por ejemplo 3 o 6 kV). Para casos especiales con motores de baja tensión con potencias superiores a 355 kW, se emplean interruptores automáticos abiertos de la serie Emax o Megamax. El sistema de protección de los motores tiene que garantizar la salvaguardia ante eventos que pueden provocar sobrecorrientes como, por ejemplo, un funcionamiento anómalo monofásico para motores asincrónicos trifásicos, una excesiva reducción de la tensión de alimentación y la creación de pares resistentes excesivos.

La maniobra y la protección de los motores asincrónicos trifásicos en B.T. se efectúan según unos esquemas en los cuales el interruptor automático realiza diferentes funciones en función de la versión. Los más típicos son los siguientes:

– Arranque directo con un único sentido de marcha. Se emplea en el 90% de los casos.
  El arrancador se compone de diferentes dispositivos según si el interruptor automático realiza funciones de maniobra, protección contra cortocircuito y protección contra sobrecarga.

MANIOBRA

Arrancador protegido formado por:
– interruptor de maniobra-seccionador tripolar
– tres fusibles para la protección contra el cortocircuito
– contactor de maniobra tripolar
– relé térmico combinado con el contactor para la protección de la sobrecarga

Empleo típico:
instalaciones en las cuales se admiten paradas para sustituir los fusibles en caso de defecto.

MANIOBRA - PROTECCIÓN CONTRA CORTOCIRCUITO

Arrancador protegido formado por:
– interruptor automático con mando manual y relé solo magnético
– contactor de maniobra tripolar
– relé térmico combinado con el contactor para la protección de la sobrecarga

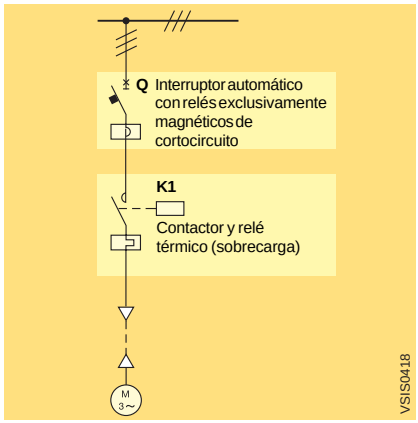
Empleo típico:
instalaciones en las cuales no se admiten paradas para sustituir los fusibles en caso de defecto.

MANIOBRA - PROTECCIÓN CONTRA CORTOCIRCUITO Y SOBRECARGA

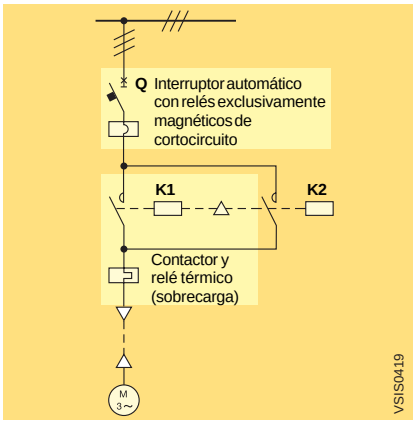
Arrancador protegido formado por:
– interruptor automático tripolar con relé de sobrecorriente y mando manual y/o eléctrico a distancia para el seccionamiento, la protección contra la sobrecarga y el cortocircuito y la maniobra del motor.

Empleo típico:
– grandes motores caracterizados por maniobras muy escasas, por lo que se puede emplear un interruptor
– con mando exclusivamente manual, puede utilizarse en la maniobra y la protección de pequeños motores con corrientes nominales hasta 25-30 A, con muy pocas maniobras y cuando se tolere o sea necesario que el motor no se desconecte de la red de alimentación en caso de falta de tensión como en instalaciones no controladas, sin mandos a distancia ni arranques automáticos tras el fallo de la tensión.

Las funciones del interruptor automático en los esquemas de arranque directo con un único sentido de marcha.



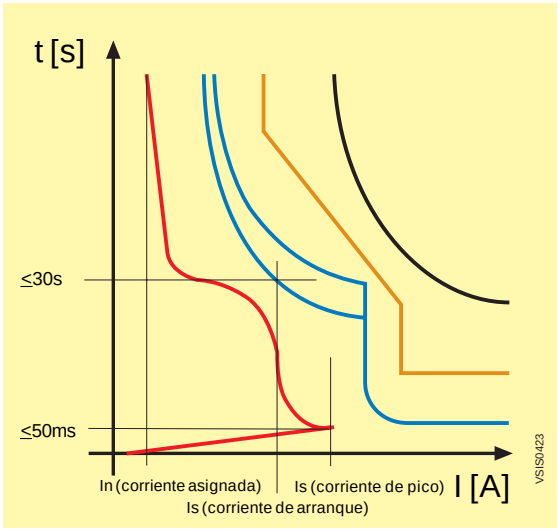
Esquema de arranque directo del motor con un único sentido de marcha



Esquema de arranque directo del motor con inversión de marcha

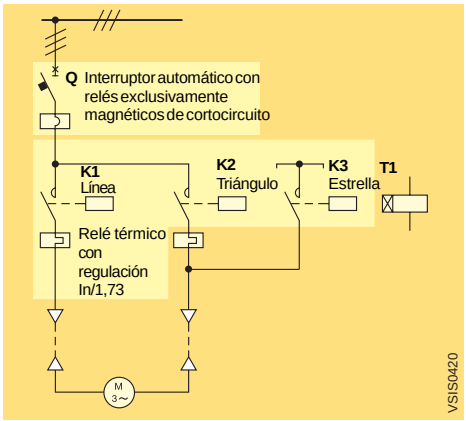
– Arranque directo con inversión de marcha.
– Arranque estrella-triángulo. Se utiliza pare reducir las corrientes absorbidas durante el arranque y no sobrecargar la red de alimentación.
– Arranque con reactancia para disminuir las corrientes absorbidas durante el arranque y no sobrecargar la red de alimentación.
– Arranque con alimentador estático progresivo para disminuir las corrientes absorbidas durante el arranque sin sobrecargar la red de alimentación y con posibilidad de variar la curva de aplicación de la tensión y adaptarla a la máquina acoplada al motor y a las características de la red de alimentación.

Para una correcta elección del interruptor automático hay que determinar:
– la corriente asignada del motor $\mathbf{I_e}$;
– la corriente de cortocircuito en el punto de aplicación; si las cargas de la instalación son mayormente motrices, al valorar el nivel de defecto hay que considerar la contribución de los motores que, en el momento del cortocircuito, se comportan como generadores y, en consecuencia, aumentan el valor de la corriente de defecto con una contribución que se puede valorar aproximadamente en 4 veces la suma de la corriente asignada de todos los motores simultáneamente en servicio en las barras
– la corriente y el tiempo de arranque; las corrientes de arranque para un motor asincrónico varían de 5-7,6 x I_e para un tiempo variable en función de la máquina acoplada (normalmente inferior a 5-6 s);
– la corriente de pico inicial de arranque, al primer instante de conexión, puede variar entre 7,5-15xI_e.

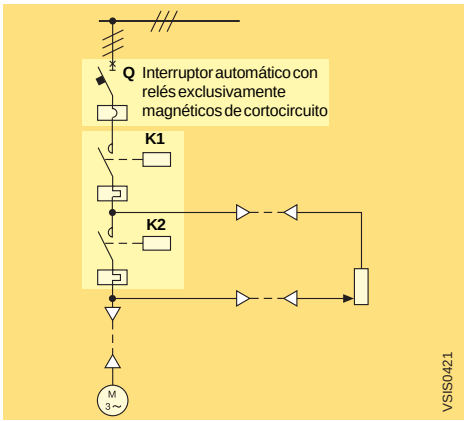


Característica de funcionamiento del motor asíncrono

Para evitar intervenciones intempestivas, el elemento instantáneo de los relés de sobrecorriente de los interruptores automáticos tiene que regularse para una corriente que permita superar la corriente de pico inicial de arranque y la corriente de arranque; además, tiene que coordinarse con el relé térmico en función de su límite de autoprotección. La protección contra cortocircuito es para la línea de alimentación del motor: cuando el cortocircuito se produce en el interior del bobinado del motor no hay nada para proteger en el motor, al máximo se trata de proteger el lugar contra incendios y reducir los daños que puedan afectar a los dispositivos del arrancador.



Esquema de arranque estrella-triángulo del motor



Esquema de arranque con reactancia

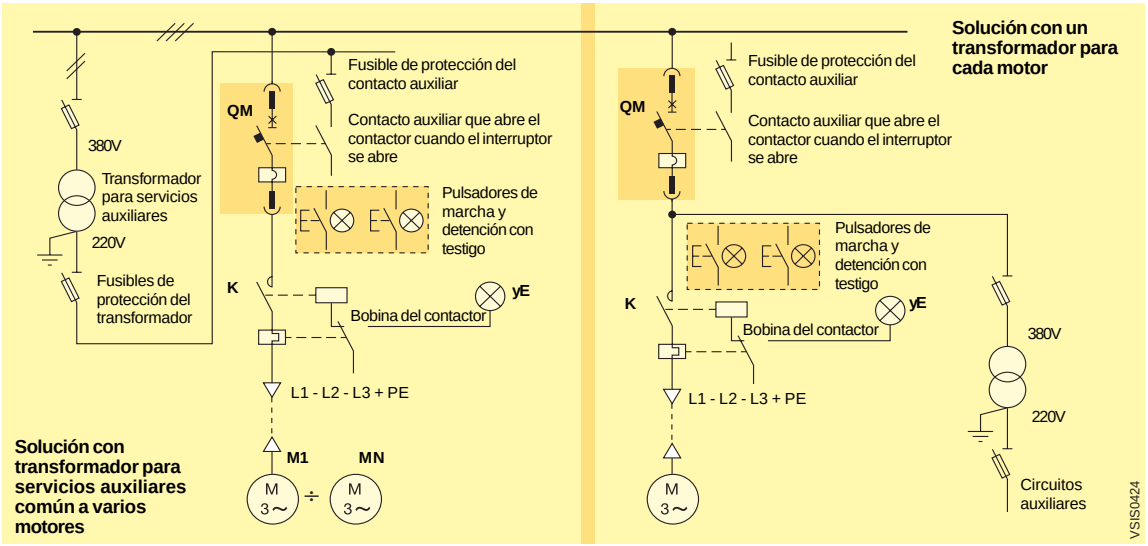
Arrancador formado por interruptor automático, contactor y relé térmico

Las maniobras locales y a distancia se efectúan mediante el contactor de maniobra.
La protección de sobrecarga se efectúa mediante el relé térmico que provoca la apertura del contactor. El relé térmico también asume la función de protección por fallo de fase debida a la interrupción de un conductor o del bobinado del motor y debido al desequilibrio entre las fases como consecuencia de un cortocircuito de algunas espiras del bobinado del motor. En caso de que se produzcan estos defectos, el relé interviene e impide que el motor funcione, se sobrecargue y, por lo tanto, se dañe. La protección por falta de tensión está realizada normalmente por la bobina del contactor, alimentada en general a la tensión del motor (directamente o por medio de un transformador auxiliar) que al desexcitarse abre el contactor. La protección por falta de tensión es fundamental para casi todos los motores debido a los siguientes motivos:

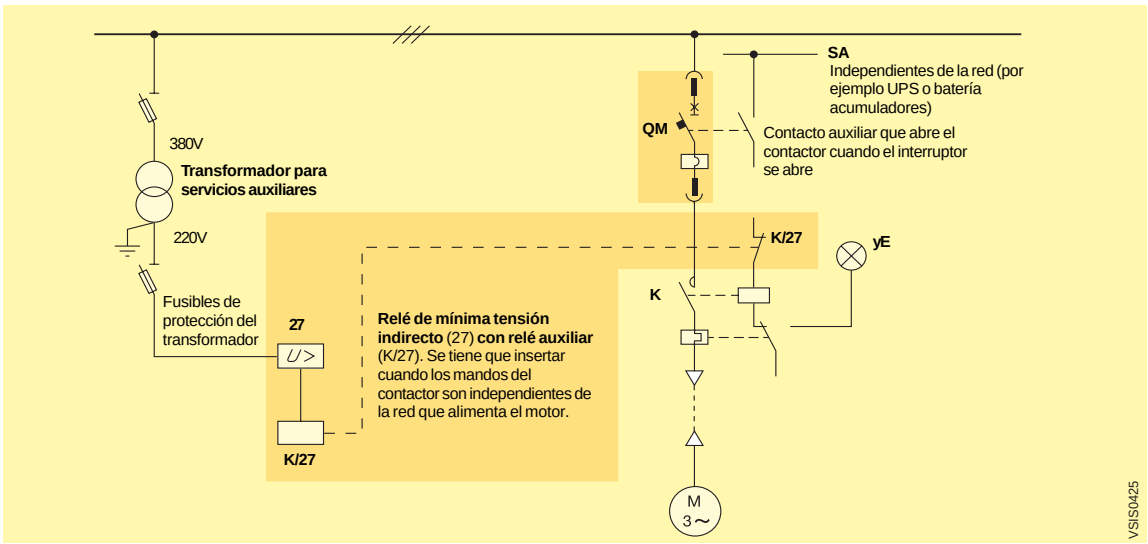
– impedir el arranque simultáneo de todos los motores al restablecerse la tensión ya que podría provocar la intervención de los relés de sobrecorriente de los interruptores automáticos principales y generar problemas de servicio globales;
– impedir el arranque del motor al restablecerse la tensión para garantizar la seguridad de los operadores que acceden a los motores.

Si la bobina no está alimentada por la tensión de red sino por una fuente de alimentación auxiliar con otro origen, por ejemplo, de la batería de acumuladores

Arrancador directo para motor con transformador auxiliar



Arrancador directo para motor con transformador auxiliar y circuito de mando del contactor independientes



de los servicios auxiliares, hay que instalar, en las barras del cuadro, una protección de mínima tensión indirecta que, por medio de relés auxiliares, provoque la apertura de los contactores de los arrancadores.
El interruptor automático se selecciona considerando una corriente asignada de regulación de al menos el 20% de la corriente asignada del motor y un poder de corte igual o superior a la corriente de cortocircuito en el punto de instalación.
Para casos especiales, como por ejemplo, los ventiladores, se pueden necesitar tiempos de arranque muy largos que llegan incluso a 20 s. En dicho caso, hay que aislar (by-pass) el relé térmico con un contactor durante la fase de arranque o bien elegir relés térmicos para arranque pesado que pueden soportar arranques iniciales importantes sin provocar la apertura del contactor.
A continuación, se ilustran dos tablas para facilitar la elección de los interruptores automáticos SACE Isomax S en función de las exigencias de coordinación con los otros dispositivos del arrancador. Las tablas se refieren a motores con una tensión asignada de 400 V.

Interruptores automáticos en caja moldeada SACE Isomax S

Arranque directo normal de tipo 2 a 25 kA, 400 V y 50 Hz

Motor			Interruptor			Contactor		Relé térmico		Cable	Grupo
Potencia asignada	Corriente asignada	Tipo	Tipo	Corriente de reg. relé magnético	Campo de reg. relé magnético	Tipo	Distancia a respetar	Tipo	Campo de regulación corriente	Cu	
P_e [kW]	I_e [A]			[A]	[A]		[mm]		[A]	S mín. [mm2]	I_{max} [A]
30	56	MBT 200 L	S3N 160	800		B 75-30-00	20	T 75 DU 63	45-63	16	63
37	68	MBT 225 S	S3N 160	800		B 75-30-00	20	T 75 DU 80	60-80	16	75
45	83	MBT 225 M	S3N 160	1000		A 95-30-00	30	TA 110 DU 90	65-90	25	90
55	98	MBT 250 M	S3N 160	1600		A 110-30-00	30	TA 110 DU 110	80-110	25	110
75	135	HXV 280 S	S3N 250	2000		EH 145-30-11	30	T 200 DU 150	110-150	50	145
90	158	HXV 280 M	S5N 400 PR211	2560	1920-3840	EH 175-30-11	30	T 200 DU 175	130-175	70	175
110	193	HXV 315 S	S5N 400 PR211	3200	1920-3840	EH 210-30-11	30	T 450 DU 235	165-235	95	210
132	232	HXV 315 MA	S5N 400 PR211	3840	1920-3840	EH 260-30-11	30	T 450 DU 310	220-310	120	305
160	282	HXV 315 SMC	S5N 400 PR211	4800	2400-4800	EH 370-30-11	40	T 450 DU 400	285-400	155	400
200	349	HXV 315 MLA	S6N 630 PR211	6300	3780-7560	EH 370-30-11	40	T 450 DU 400	285-400	185	400
250	430	HXV 355 S	S6N 630 PR211	7560	3780-7560	EH 550-30-11	40	T 900 DU 500	355-500	300	500
290	520	MEUL 355 LL4	S6N 800 PR211	9600	4800-9600	EH 550-30-11	40	T 900 DU 650	465-650	2x120	550
315	545	HXV 355 SMA	S6N 800 PR211	9600	4800-9600	EH 700-30-11	40	T 900 DU 650	465-650	2x150	650
355	610	HXV 355 SMB	S6N 800 PR211	9600	4800-9600	EH 700-30-11	40	T 900 DU 650	465-650	2x150	650

Interruptores automáticos en caja moldeada SACE Isomax S

Arranque directo pesado de tipo 2 a 50 kA, 400 V y 50 Hz

Motor			Interruptor			Contactor		Relé térmico		Cable	Grupo
Potencia asignada	Corriente asignada	Tipo	Tipo	Corriente de reg. relé magnético	Campo de reg. relé magnético	Tipo	Distancia a respetar	Tipo	Campo de regulación corriente/ n° espiras	Cu	
P_e [kW]	I_e [A]			[A]	[A]		[mm]		[A/turns]	S mín. [mm2]	I_{max} [A]
30	56	MBT 200 L	S3H 160	800		B 75-30-00	20	T 450 SU 185	43,3-61,7 /3	16	61,7
37	68	MBT 225 S	S3H 160	800		B 75-30-00	20	T 450 SU 185	65-92,5 /2	16	75
45	83	MBT 225 M	S3H 160	1000		A 110-30-11	30	T 450 SU 105	75-105 /1	25	92,5
55	98	MBT 250 M	S3H 160	1600		EH 145-30-11	30	T 450 SU 105	75-105 /1	25	117,5
75	135	HXV 280 S	S3H 250	2000		EH 175-30-11	30	T 450 SU 140	100-140 /1	50	175
90	158	HXV 280 M	S5H 400 PR211	2560	1920-3840	EH 260-30-11	30	T 450 SU 185	130-185 /1	70	185
110	193	HXV 315 S	S5H 400 PR211	3200	1920-3840	EH 370-30-11	40	T 450 SU 235	165-235 /1	95	235
132	232	HXV 315 MA	S5H 400 PR211	3840	1920-3840	EH 370-30-11	40	T 450 SU 310	220-310 /1	120	310
160	282	HXV 315 SMC	S5H 400 PR211	4800	2400-4800	EH 370-30-11	40	T 450 SU 310	220-310 /1	155	310
200	349	HXV 315 MLA	S6H 630 PR211	6300	3780-7560	EH 550-30-11	40	T 450 SU 400	285-400 /1	185	400
250	430	HXV 355 S	S6H 630 PR211	7560	3780-7560	EH 700-30-11	40	T 900 SU 500	355-500 /1	300	500
290	520	MEUL 355 LL4	S6H 800 PR211	9600	4800-9600	EH 700-30-11	40	T 900 SU 650	465-650 /1	2x120	650
315	545	HXV 355 SMA	S6H 800 PR211	9600	4800-9600	EH 700-30-11	40	T 900 SU 650	465-650 /1	2x150	650
355	610	HXV 355 SMB	S6H 800 PR211	9600	4800-9600	EH 700-30-11	40	T 900 SU 650	465-650 /1	2x150	650

Maniobra y protección de condensatores trifásicos en c.a.

Compensación de la potencia reactiva

La exigencia de compensar la potencia reactiva se presenta tanto en las redes de transmisión como en las redes de distribución y en las redes industriales. En general, la compensación de la potencia reactiva es necesaria para limitar las pérdidas en la línea, las caídas de tensión y para aprovechar como potencia activa toda la potencia de alimentación de las instalaciones y para impedir que el factor de potencia (cos ϕ) disminuya a valores demasiado bajos, considerando también el hecho de que la compañía eléctrica penaliza los excesos de energía reactiva, de cualquier tipo, inductiva o capacitativa.

Una carga óhmica-inductiva absorbe de la red una corriente tanto más desfasada con relación a la tensión (cos ϕ bajo) cuanto más prevalece el efecto inductivo. A paridad de componente activa en fase con la tensión, la corriente en línea es tanto mayor cuanto mayor es el ángulo de desfase. Insertando un condensador en paralelo con la carga, éste suministra parte de la corriente reactiva solicitada por la carga: efectivamente, cuando el condensador se descarga, la parte inductiva de la carga se carga y viceversa, cuando la parte inductiva se descarga, ésta carga el condensador y, en consecuencia, se reduce la corriente suministrada por la línea que resulta menos desfasada con relación a la tensión.

Según la Norma IEC 70 y CEI, los condensadores han de poder funcionar en régimen con una corriente de valor eficaz hasta 1,3 veces la corriente asignada I_{cn} del condensador a causa de la posible presencia de armónicos en la tensión de red. La conexión de una batería de condensadores se puede comparar a un cierre en cortocircuito en el cual la corriente de cierre I_p asume valores de cresta elevados, especialmente cuando se insertan baterías de condensadores en paralelo con otras ya en tensión.

Estas condiciones de funcionamiento tienen que considerarse cuando se elija el interruptor automático (que deberá tener un poder de cierre adecuado), y cuando se regule el relé de sobrecorriente para evitar intervenciones intempestivas en el momento de insertar la batería de condensadores. Generalmente, la corriente asignada I_{ni} de los dispositivos de maniobra y, por lo tanto, también de los interruptores automáticos y de los correspondientes relés y cables de alimentación tiene que ser $I_{ni} = 1,43xI_n$ donde I_n es la corriente teórica calculada en función de la potencia de los condensadores sin tener en cuenta la presencia de armónicos. Para tener en cuenta la corriente de conexión de los condensadores, el umbral de intervención para la protección contra cortocircuito tiene que ser, como mínimo, igual a $10xI_{ni}$.

Cuando se utilizan baterias de condesadores para la compensación automática, la maniobra la realizan en general los contactores, mientras que los interruptores automáticos SACE Isomax S se pueden utilizar en función del número de maniobras y de la frecuencia de las mismas. A la tensión de servicio de 380/415 Vca, la protección de una batería de condensadores se efectúa con interruptores automáticos SACE Isomax S con modelos de S1 a S7, para corrientes de 10 hasta 1600 A; para una potencia máxima hasta 736 kVAR con el interruptor automático S7 1600 A.

En Baja Tensión, se utilizan normalmente condensadores trifásicos conectados en triángulo y dotados de resistencia de descarga. La compensación de reactiva puede ser:

– **Distribuida** en cada uno de los servicios y conectada a los mismos tanto directamente como con interruptores propios. Es el caso utilizado en grandes servicios (por ejemplo, grandes motores) y en el secundario de los transformadores de las sub-

Tabla de elección de los interruptores automáticos SACE Isomax S en función de la corriente asignada de la batería de condensadores y de la potencia del transformador instalado.

Interruptor automático	Icu 380/415 V	Corriente asignada del relé	Corriente asignada del condensador	Máx. regulación del relé magnético	Máxima potencia de la batería de condensadores en kVAR - 50 Hz					Durabilidad mecánica		Durabilidad eléctrica	
tipo	[kA]	[A]	[A]		380 V	440 V	500 V	660 V	690 V	man	man/h	man	man/h
S1 B/N 125	16 / 25	10...125	87	10 In	57	66	65	100	103	25000	240	8000	120
S2 B/N/S 160	16 / 35 / 50	12.5...160	112	10 In	74	85	97	128	133	25000	240	8000	120
S3 N/H/L 160	35 / 65 / 85	32...160	112	10 In	74	85	87	128	133	25000	120	10000	120
S3 N/H/L 250	35 / 65 / 85	200... 250	175	10 In	115	133	151	200	208	25000	120	8000	120
S4 N/H/L 160	35 / 65 / 100	100...160	112	12 In	74	85	97	128	133	20000	120	10000	120
S4 N/H/L 250	35 / 65 / 100	250	175	12 In	115	133	151	200	208	20000	120	8000	120
S5 N/H/L 400	35 / 65 / 100	320 - 400	280	12 In	184	213	242	320	334	20000	120	7000	60
S5 N/H/L 630	35 / 65 / 100	630	441	12 In	290	336	382	504	526	20000	120	7000	60
S6 N//H/L 630	35/50/65/100	630	441	12 In	290	336	382	504	526	15000	120	7000	60
S6 N//H/L 800	35/50/65/100	800	560	12 In	368	427	485	640	668	15000	120	6000	20
S7 S/H/L 1250	50 / 65 / 100	1000 - 1250	875	12 In	575	667	758	1000	1044	10000	120	6000	20
S7S/H/L 1600	50 / 65 / 100	1600	1120	12 In	736	853	970	1280	1336	10000	120	6000	20

estaciones de distribución para compensar exclusivamente la potencia magnetizante que es mayormente reactiva y es igual, mediamente, al 5% de la potencia asignada en kVA del transformador. El poder de corte del interruptor automático tiene que ser adecuado al número de los transformadores conectados en paralelo.

– **Parcializada**, realizada con unidades conectadas a los cuadros de los diferentes grupos de servicios. Se utiliza para instalaciones muy amplias y con varias subestaciones de transformación o distribución.
– **Centralizada**, realizada con equipos de compensación normalmente con regulación automática y mando automático y conectadas antes de todas las cargas que se desea compensar e inmediatamente después del punto de medición del cos f o cerca del cuadro general de baja tensión. Es el caso adoptado con más frecuencia y empleado para instalaciones de baja y media potencia con extensión limitada.
El número de las maniobras de los condensadores, al ser mandadas automáticamente, resulta muy elevado por lo que, generalmente, se emplean contactores especiales con resistencias de conexión.

La potencia de la batería de condensadores para obtener una determinada compensación depende de la potencia de la carga que se desea compensar, del cos ϕ inicial y del cos ϕ que se desea obtener.

											cos ϕ que se desea obtener		
cos ϕ inicial	0,81	0,85	0,9	0,91	0,92	0,93	0,94	0,95	0,96	0,97	0,98	0,99	1
0,60	0,584	0,714	0,849	0,878	0,905	0,939	0,971	1,005	1,043	1,083	1,131	1,192	1,334
0,61	0,549	0,679	0,815	0,843	0,870	0,904	0,936	0,970	1,008	1,048	1,096	1,157	1,299
0,62	0,515	0,645	0,781	0,809	0,836	0,870	0,902	09,36	0,974	1,014	1,062	1,123	1,265
0,63	0,483	0,613	0,749	0,777	0,804	0,838	0,870	0,904	0,942	0,982	1,030	1,091	10233
0,64	0,450	0,580	0,716	0,744	0,771	0,805	0,837	0,871	0,909	0,949	0,997	1,058	1,200
0,65	0,419	0,549	0,685	0,713	0,740	0,774	0,806	0,840	0,878	0,918	0,966	1,007	1,169
0,66	0,388	0,518	0,654	0,682	0,709	0,743	0,775	0,809	0,847	0,887	0,935	0,996	1,138
0,67	0,358	0,488	0,624	0,652	0,679	0,713	0,745	0,779	0,817	0,857	0,905	0,966	1,108
0,68	0,329	0,459	0,595	0,623	0,650	0,984	0,716	0,750	0,788	0,828	0,876	0,937	1,079
0,69	0,299	0,429	0,565	0,593	0,620	0,654	0,686	0,720	0,758	0,798	0,840	0,907	1,049
0,70	0,270	0,400	0,536	0,564	0,591	0,625	0,657	0,691	0,729	0,769	0,811	0,878	1,020
0,71	0,242	0,372	0,508	0,536	0,563	0,597	0,629	0,663	0,701	0,741	0,783	0,850	0,992
0,72	0,213	0,343	0,479	0,507	0,534	0,568	0,600	0,634	0,672	0,712	0,754	0,821	0,963
0,73	0,186	0,316	0,452	0,400	0,507	0,541	0,573	0,607	0,645	0,685	0,727	0,794	0,936
0,74	0,159	0,289	0,425	0,453	0,480	0,514	0,546	0,580	0,618	0,658	0,700	0,767	0,909
0,75	0,132	0,262	0,398	0,426	0,453	0,487	0,519	0,553	0,591	0,631	0,673	0,740	0,882
0,76	0,105	0,235	0,371	0,399	0,426	0,460	0,492	0,526	0,564	0,604	0,652	0,713	0,855
0,77	0,079	0,209	0,345	0,373	0,400	0,434	0,466	0,500	0,538	0,578	0,620	0,687	0,829
0,78	0,053	0,182	0,319	0,347	0,374	0,408	0,440	0,474	0,512	0,552	0,594	0,661	0,803
0,79	0,026	0,156	0,292	0,320	0,347	0,381	0,413	0,447	0,485	0,525	0,567	0,634	0,776
0,80		0,130	0,266	0,294	0,321	0,355	0,387	0,421	0,459	0,499	0,541	0,608	0,750
0,81		0,104	0,240	0,268	0,295	0,329	0,361	0,395	0,433	0,473	0,515	0,582	0,724
0,82		0,078	0,214	0,242	0,269	0,303	0,335	0,369	0,407	0,447	0,489	0,556	0,698
0,83		0,052	0,188	0,216	0,243	0,277	0,309	0,343	0,381	0,421	0,462	0,530	0,672
0,84		0,026	0,162	0,190	0,217	0,251	0,283	0,317	0355	0,395	0,437	0,504	0,645
0,85			0,136	0,164	0,191	0,225	0,257	0,291	0,329	0,369	0,417	0,478	0,620
0,86			0,109	0,140	0,167	0,198	0,230	0,264	0,301	0,343	0,390	0,450	0,593
0,87			0,083	0,114	0,141	0,172	0,204	0,238	0,275	0,317	0,364	0,424	0,567
0,88			0,054	0,085	0,112	0,143	0,175	0,209	0,246	0,288	0,335	0,395	0,538
0,89			0,028	0,059	0,086	0,117	0,149	0,183	0,230	0262	0,309	0,369	0,512
0,90				0,031	0,058	0,089	0,121	0,155	0,192	0,234	0,281	0,341	0,484

Coeficiente para calcular la potencia de la batería de condensadores en kVAR/kW para elevar el valor de cosϕ.

El interruptor automático se emplea generalmente en versión tripolar, mientras que en la versión tetrapolar se utiliza cuando hay instrumentos y aparatos que utilizan también el neutro, como, por ejemplo, pequeños cuadros de compensación de reactiva. En dichos casos, puede ser oportuno prever la protección diferencial (para sistemas de distribución TT y TN-S) ya que la presencia del neutro indica la presencia de instrumentos accesibles a las personas.

Maniobra y protección de generadores trifásicos en c.a.

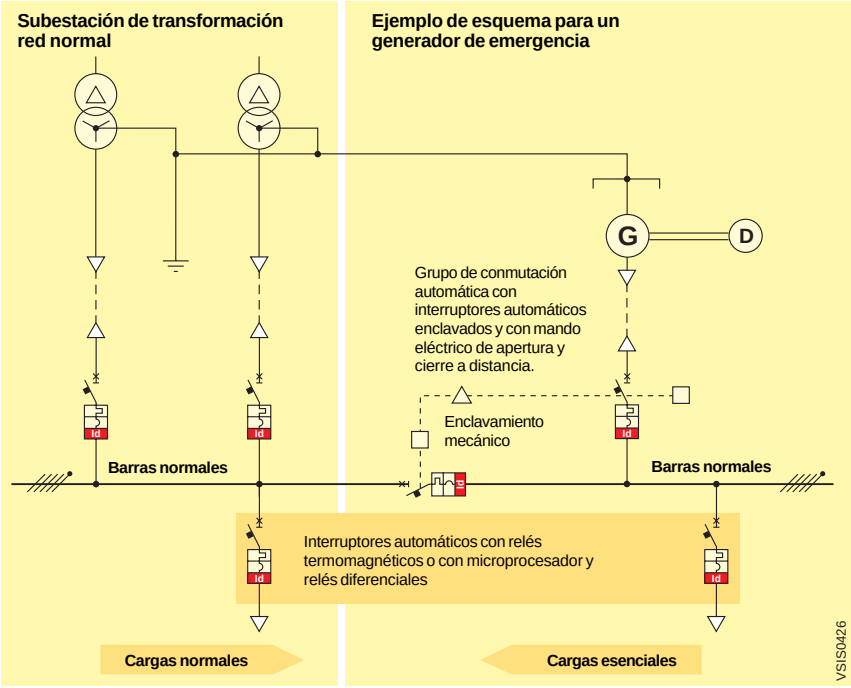
En los casos más frecuentes, el generador de baja tensión constituye la alimentación de emergencia de la red de alimentación normal y se activa cuando falta la tensión mediante sistemas de conmutación automática para garantizar la alimentación de la parte de instalación con servicios esenciales, sobre todo, si el corte de alimentación puede provocar situaciones de peligro para las personas afectadas, pérdidas de producción importantes o problemas significativos para la seguridad y la gestión de las instalaciones (señalizaciones, alarmas, sistema antiincendio, iluminación). Normalmente, el grupo de emergencia está formado por un motor diesel acoplado a un alternador de potencia limitada que no supera los 1000 kVA. Además, los generadores también son ampliamente utilizados en el sector naval.
Los interruptores automáticos en caja moldeada SACE Isomax S pueden utilizarse como interruptores de máquina y/o como interruptores de salida con relés de protección contra las sobrecorrientes, concretamente, los relés con microprocesador SACE PR211/P y PR212/P y los relés solo magnéticos con bajo umbral de intervención.
Al elegir el interruptor automático que se ha de utilizar hay que considerar la corriente asignada del generador (en función de la potencia generador y de la tensión de servicio) y la corriente de cortocircuito en el punto de aplicación que se puede calcular en función de la reactancia subtransitoria X"d(%) según la siguiente fórmula:

$$I_{cc} = \frac{P \times 100}{U_e \times X''d}$$

La corriente de cortocircuito del generador presenta, normalmente, valores muy limitados con relación a los de la red; asimismo hay que prestar una especial atención a las regulaciones de los relés de sobreintensidad para los cuales se han de prever regulaciones del elemento magnético entre 3 y 5 veces la corriente asignada, tanto si el interruptor automático se emplea como interruptor general del generador como si se emplea como interruptor de salida.
Si el generador funciona en paralelo con la red de alimentación normal, la corriente de cortocircuito que hay que tener en cuenta al elegir el interruptor automático es la debida a la subestación de transformación ya que asume un valor más elevado con relación a la debida eventualmente por un defecto alimentado por el generador. Para los interruptores automáticos insertados después del generador, el poder de corte se determina en función de la corriente de cortocircuito debida al número total de generadores de igual potencia que hay en paralelo menos uno.
La siguiente tabla permite elegir los interruptores automáticos de protección de los generadores trifásicos a 400 V - 50 Hz.

Potencia del generador	Corriente asignada	Interruptores automáticos											
[kVA]	[A]	S1 125	S2 160	S3 160	S3 250	S4 160	S4 250	S5 400	S5 630	S6 630	S6 800	S7 1250	S7 1600
10	14,5	R16	R16										
15	21,7	R40	R40										
20	29	R40	R40	R50									
25	36	R40	R40	R50									
30	43,3	R50	R50	R50									
40	57,8	R63	R63	R80		In=100							
50	72,2	R80	R80	R80		In=100							
63	91	R100	R100	R100		In=100							
100	144,5		R160	R160	R200	In=160	In=250	In=320					
160	231,2				R250		In=250	In=320					
200	289							In=320	In=630	In=630			
250	361							In=400	In=630	In=630	In=800		
315	455								In=630	In=630	In=800	In=1000	
400	578								In=630	In=630	In=800	In=1000	
500	723										In=800	In=1000	In=1600
630	910											In=1000	In=1600
800	1156											In=1250	In=1600
1000	1445												In=1600
1120	1589												In=1600

Al emplear los generadores como alimentación de emergencia es muy importante la elección del sistema de distribución (TT, TN e IT) ya que puede ser diferente para el funcionamiento normal y el de emergencia. Por ejemplo, podría haber un sistema TN-S para la red normal y un sistema IT para la red de emergencia con solamente el generador en servicio, que necesita la instalación de un dispositivo para controlar el aislamiento y la señalización del primer defecto a tierra de manera que se pueda intervenir para eliminar las causas y evitar las consecuencias de un eventual segundo defecto a tierra. Por lo tanto hay que prestar una especial atención al elegir el número de polos, los disparadores o relés de sobrecorriente y los diferenciales que han de garantizar las protecciones en ambos regímenes de funcionamiento.



Red de alimentación normal /de emergencia con enclavamiento y conmutación

1 **El número de polos** del interruptor automático depende del sistema de distribución (TT, TN e IT).

2 **El relé de protección** contra las sobrecorrientes: termomagnético para los interruptores automáticos S1, S2, S3, S5 y S6 y con microprocesador para los interruptores automáticos S4, S5, S6 S7, PR211/P o PR212/P, en versión LSI para realizar cadenas de selectividad con los interruptores automáticos situado aguas abajo, en versión LSIG para la protección contra los defectos a tierra en los casos en cuales ésta protección no se pueda efectuar con relés de protección contra las sobrecorrientes.

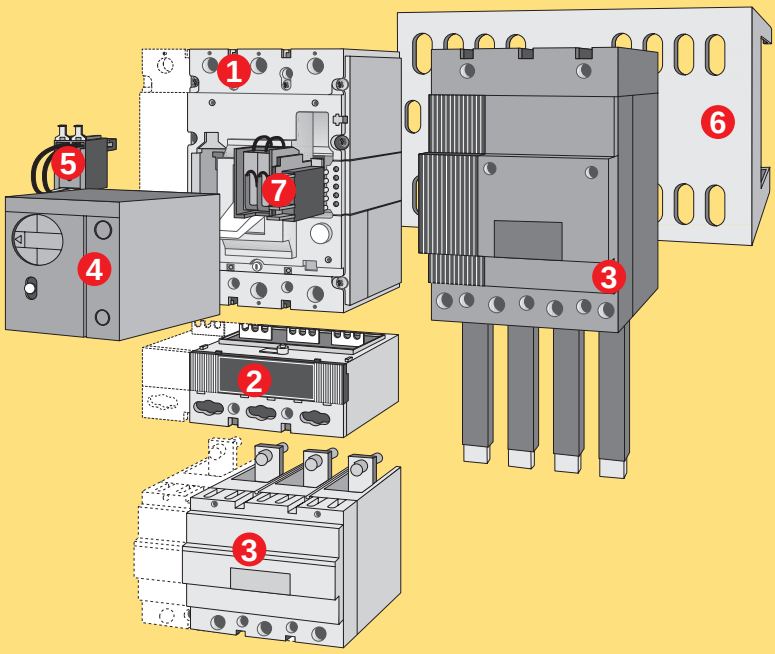
3 **Protección diferencial**, realizada con los relés SACE RC211 y RC212 para los interruptores automáticos tetrapolares S1, S2 y S3 o un relé diferencial de cuadro RCQ con transformador toroidal para los interruptores automáticos S4, S5, S6 y S7 para la protección contra los defectos a tierra en los casos en los cuales ésta no se puede efectuar con la función G del relé PR212. En general, la protección diferencial se utiliza en los sistema TT, TN-S e IT. Es preferible que el relé diferencial se inserte en el centro estrella del generador y la puesta a tierra del mismo cuando ésta se efectúa.

4 **Mando a distancia** para el arranque y la parada automática y en manual.

5 **Relé de apertura** a distancia con el correspondiente contacto de final de carrera para la inserción de todas las protecciones típicas del grupo diesel-alternador:
- lubricación, refrigeración, nivel del carburante y máxima temperatura
- relé indirecto de retorno de energía para un generador que funcione en paralelo con la red, para impedir que funcione como motor absorbiendo corriente en lugar de suministrarla
- relé indirecto de máxima y mínima frecuencia, relé indirecto de máxima y mínima tensión y eventual relé indirecto diferencial de sobreintensidad y apertura de emergencia.

6 **Enclavamiento mecánico** entre el interruptor automático del generador y el interruptor automático general de red de las cargas esenciales.

7 **Contactos auxiliares** para las señalizaciones o los enclavamientos, de insertado/extraído, abierto/cerrado o abierto por intervención del relé.



Corriente continua

Distribución en corriente continua

La corriente continua representa uno de los modos de distribución de energía eléctrica de las instalaciones eléctricas para industrias y sector terciario y requiere redes de distribución que satisfagan completamente las exigencias de coordinación de las protecciones, de flexibilidad, por ejemplo, para futuras ampliaciones, así como interruptores automáticos adecuados en cuanto a regulaciones, ejecuciones y prestaciones con corrientes de defecto.

CSIS9117

Alimentación de emergencia o de servicios auxiliares

El empleo de la corriente continua es debido a la necesidad de disponer de una fuente de energía de reserva que permita alimentar servicios esenciales como sistemas de protección, luces de emergencia, sistemas de alarma, circuitos de hospitales y fábricas, centros de cálculo, utilizando, por ejemplo, baterías de acumuladores, instaladas cerca de los servicios y alimentadas en tampón por la red, y caracterizadas en la mayoría de los casos por tensiones de servicio hasta 500 V y corrientes de defecto muy elevadas en proximidad de las fuentes de alimentación debido a la baja resistencia interna de las baterías. Constituyen la fuente de energía más segura para alimentar dichos servicios, tanto directamente en corriente continua como por medio de grupos de continuidad UPS cuando la alimentación de las cargas es en corriente alterna.

CSIS9115

Tracción eléctrica

Las ventajas en cuanto a la regulación de la velocidad ofrecidas por el empleo de motores en corriente continua y la alimentación mediante línea de contacto única hacen que la alimentación en corriente continua sea la solución más adoptada para ferrocarriles, metro, tranvías, ascensores y medios de transporte en general. Las aplicaciones típicas de los interruptores automáticos son la protección de las líneas y de los dispositivos, la maniobra de motores y el accionamiento. Se caracterizan por tensiones de servicio hasta 1000 V con posibles sobretensiones transitorias, corrientes variables frecuentemente en relación con las condiciones de servicio, corrientes de cortocircuito elevadas, exposición a condiciones ambientales agresivas en presencia eventualmente de golpes y vibraciones.

CSIS9116

Instalaciones industriales especiales

Pueden ser instalaciones para procesos electrolíticos o bien aplicaciones en las cuales se presentan especiales exigencias de servicio de las máquinas eléctricas como pueden ser las necesidades de una rápida amortiguación de la corriente en su circuito de excitación. En dichas condiciones, la tensión puede alcanzar picos 5-10 veces el valor de ejercicio normal y la corriente puede superar incluso 3 o 4 veces los valores nominales de excitación.

Interruptor		S1 125		S2 160			S3 160 / 250			S5 400 / 630			S6 630 / 800			
Corriente nominal In		10 ... 125 A		12.5 ... 160 A			32 ... 250 A			225 ... 500 A			440 ... 800 A			
Icu [kA]		B	N	B	N	S	N	H	L	N	H	L	N	S	H	L
2 polos en serie	250 [V]	16	25	16	35	50	35	65	85	35	65	100	35	50	65	100
	500 [V]	–	–	–	–	–	35	50	65	35	50	65	20	35	50	65
3 polos en serie	500 [V]	–	–	16	35	50	–	–	–	–	–	–	–	–	–	–
	750 [V]	–	–	–	–	–	20	35	50	20	35	50	16	20	35	50

Poder de corte en kA en corriente continua y número de polos a conectar en serie.

Las corrientes de defecto en corriente continua son, normalmente, muy elevadas cerca de las fuentes de alimentación debido a la baja resistencia interna de las baterías. A diferencia de la corriente alterna para la cual existe un natural paso por cero en cada semiperiodo y al cual le corresponde un apagado del arco que se forma durante la apertura del circuito, en corriente continua, para garantizar el apagado del arco, hay que forzar el paso de la corriente por el cero. El corte del paso de corriente puede provocar picos de tensión que dependen, básicamente, de la falta de disipación de la energía electromagnética acumulada en el circuito y pueden favorecer el cebado del arco.

Estos fenómenos de naturaleza energética dependen especialmente del nivel de tensión de servicio de la instalación y obligan a instalar los interruptores automáticos según unos esquemas de conexión en los cuales los polos del interruptor automático se encuentran conectados en serie con lo que se mejoran las prestaciones en cortocircuito ya que el poder de corte del interruptor automático resulta mayor cuanto mayor es el número de contactos que abren el circuito a la máxima tensión de servicio de la instalación.

Esto significa que, al aumentar la tensión, hay que aumentar el número de los cortes de corriente en serie para obtener un número de polos para el corte adecuado al nivel de defecto.

En estos casos, es necesario disponer de interruptores automáticos como SACE Isomax S que aseguran:

– rápida intervención con adecuado poder de corte;
– elevada capacidad de limitar la corriente de defecto y de contener el efecto térmico y el electrodinámico debido al cortocircuito
– contención de las sobretensiones
– relés de tipo termomagnético de bimetal adecuados al funcionamiento en corriente continua.

Cómo elegir los interruptores

Los interruptores automáticos SACE Isomax S ofrecen una gama completa en corriente continua para corrientes de servicio de 10 a 800 A. La elección del interruptor automático depende de los datos principales de la instalación, a saber:

– la corriente de servicio en función de la cual se determina el modelo del interruptor automático (SACE S1, S2, S3, S4, S5 y S6) y la regulación para el relé de sobrecorriente termomagnético que se tiene que montar en el interruptor automático
– la corriente de cortocircuito prevista en el punto de instalación del interruptor automático de la cual depende la elección de la versión del interruptor automático en cuanto a las prestaciones en cortocircuito (B, N, S, H y L);
– la tensión de servicio U_b en función de la cual se determina el número de polos a conectar en serie;
– el esquema de conexión del interruptor automático del cual depende el número de polos del interruptor automático.

Para conectar el interruptor es necesario, por lo tanto, definir el esquema de conexión del interruptor a la red que depende esencialmente de:

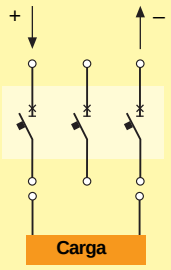
– el número de polos a conectar en serie;
– el tipo del sistema de distribución que puede ser aislado de tierra, con una polaridad a tierra, o con el punto medio de la alimentación a tierra;
– del tipo de defecto contra el cual hay que proteger la red; en una instalación de corriente continua se pueden producir dos tipos de defecto:
  Defecto franco entre las polaridades: representa el caso más peligroso en términos de nivel de defecto en función del cual hay que elegir el poder de corte del interruptor automático.
  Defecto polaridad-masa: la influencia de este tipo de defecto depende esencialmente del tipo de red de distribución. Puede no tener influencia en la protección si la polaridad implicada está ya conectada a tierra (red con polaridad a tierra) o aislada de tierra (red aislada), mientras puede ser interesante la protección de sobrecorriente si la polaridad implicada se trata de la polaridad no a tierra (red con polaridad a tierra o con punto medio a tierra) o si se producen simultáneamente defectos a tierra de ambas polaridades (red aislada).

Los esquemas de conexión

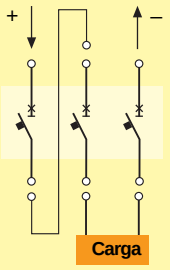
Para obtener el número de polos en serie necesario para garantizar el poder de corte requerido en las diferentes tensiones de funcionamiento tienen que utilizarse esquemas de conexión adecuados.

Protección y seccionamiento del circuito con interruptores automáticos tripolares

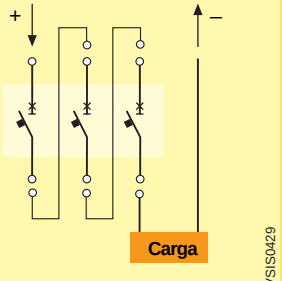
Esquema A: corte con 1 polo por polaridad



Esquema B: corte con 2 polos en serie para una polaridad y 1 polo para la otra polaridad

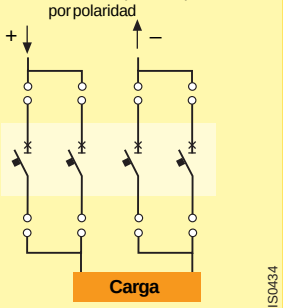


Esquema C: corte con 3 polos en serie por polaridad

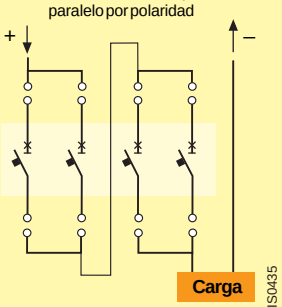


Polos en paralelo

Esquema D: corte con 2 polos en paralelo por polaridad

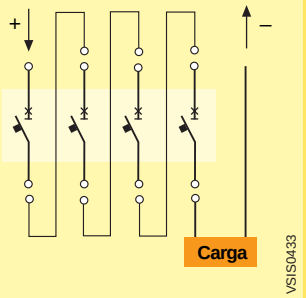


Esquema E: corte con serie de 2 polos en paralelo por polaridad

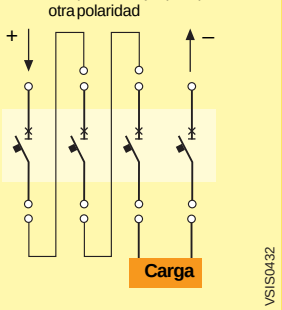


Empleo a 1000 Vcc con interruptores automáticos tetrapolares

Esquema F: corte con 4 polos en serie para una polaridad

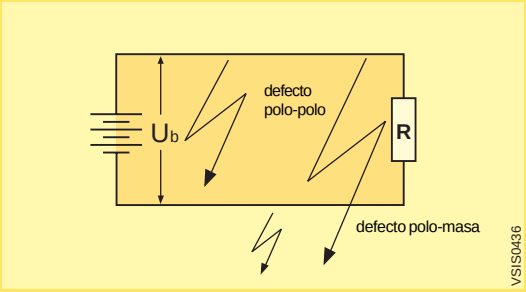


Esquema G: corte con 3 polos en serie para una polaridad y 1 polo para la otra polaridad



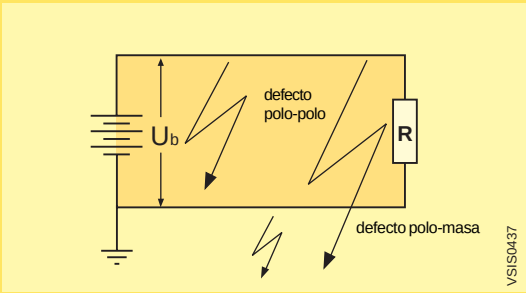
La elección del sistema de conexión adecuado depende del tipo de red de distribución.

Red con ambas polaridades aisladas de tierra



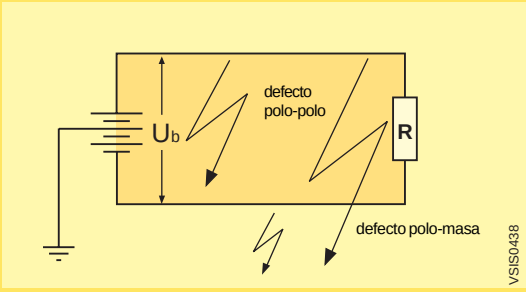
Ningún punto de la red de distribución está conectado a tierra.
El defecto franco entre las dos polaridades establece una corriente de cortocircuito a la cual contribuyen ambas polaridades con una tensión plena U_b y en función de la cual hay que elegir el poder de corte del interruptor automático.
Los defectos entre cada polaridad y la tierra, si no se producen simultáneamente, no tienen consecuencias desde el punto de vista del funcionamiento de la instalación mientras que, si se producen simultáneamente, significa que hay un defecto de tipo franco entre los polos.
El interruptor automático tiene que conexionarse distribuyendo los polos necesarios al corte en ambas polaridades. Sin embargo, para garantizar el seccionamiento, es indispensable que ambas polaridades se interrumpan.
Con este sistema es oportuno prever en la instalación un relé para señalar el defecto a tierra o la disminución del aislamiento hacia tierra de una polaridad de manera que se pueda eliminar inmediatamente y, en consecuencia, se pueda evitar que un sucesivo defecto a tierra en la otra polaridad provoque problemas de servicio totales debidos a la intervención de los relés del interruptor automático tras el cortocircuito que, en dichos casos, se produce entre las dos polaridades a través de la tierra.

Red con una polaridad a tierra



Se conecta a masa una de las dos polaridades.
El defecto franco entre las dos polaridades establece una corriente de cortocircuito a la cual contribuyen las dos polaridades con tensión plena U_b y en función de la cual hay que elegir el poder de corte del interruptor automático.
El defecto hacia masa de la polaridad no conectada a tierra establece una corriente que puede afectar las protecciones de sobrecorriente en función de la resistencia de tierra. El defecto hacia masa de la polaridad puesta a tierra no tiene consecuencias desde un punto de vista del funcionamiento de la instalación.
Por estas razones, con miras a la protección, es suficiente instalar el interruptor automático solamente en la polaridad aislada de tierra. Si se desea obtener también el seccionamiento, es necesario prever un polo de corte suplementario en la polaridad a masa.

Red con punto medio de la fuente de alimentación conectado a tierra



El defecto franco entre las dos polaridades establece una corriente de cortocircuito a la cual contribuyen las dos polaridades con tensión plena U_b. Los defectos de una polaridad hacia la masa establecen una corriente de defecto a una tensión igual a ½ U_b hacia la cual hay que proteger el circuito. Para proteger el circuito hacia este tipo de defecto, el interruptor automático tiene que conexionarse obligatoriamente en las dos polaridades. Pero, debido al nivel de defecto es posible repartir en cada polaridad los polos necesarios para cortar la sobreintensidad de cortocircuito a la tensión de ½ U_b. Esto garantiza la protección tanto en el caso de defecto franco entre dos polaridades como en el caso de defecto de una polaridad hacia la masa. De esta manera se asegura el seccionamiento del circuito.

En la siguiente tabla se indica qué esquema de conexión hay que adoptar en función del número de polos a conectar en serie para obtener el poder de corte requerido en función del tipo de red de distribución.

		Red aislada de tierra	Red con una polaridad a tierra	Red con punto medio a tierra
2 polos en serie	Protección	–	E (4p)	–
	Protección y Seccionamiento	A (3p) - D (4p)	B (3p)	A (3p)
3 polos en serie	Protección	–	C (3p)	–
	Protección y Seccionamiento	B (3p)	F (4p)	G (4p) - B (3p)

Esquema de conexión en función de la red de distribución

Los esquemas de conexión D y E se utilizan exclusivamente con el interruptor automático SACE S6 630 y S6 800 y permiten conectar en paralelo dos polos del interruptor automático para aplicaciones con corriente de servicio de 800 a 1440 A. Las conexiones externas a los terminales del interruptor automático tienen que ser realizadas por el usuario de manera que se consiga el perfecto equilibrio de la conexión que garantice el balance en la distribución de la corriente que circule en cada polo. En estas condiciones se pueden tener en cuenta los factores de equivalencia con la regulación en c.a. descritos a continuación. La capacidad de conducción de corriente del interruptor automático se calcula mediante la siguiente fórmula:

$$In_{(2\ polos\ en\ paralelo)} = (I_{th} \times 2) \times 0,9$$

con regulación de 0,7 a 1. Por lo tanto, con dos polos en paralelo, el interruptor automático SACE S6 630 puede utilizarse en el campo de 800 a 1100 A mientras que el interruptor automático SACE S6 800 puede utilizarse en el campo de 1000 a 1440 A.
Los esquemas de conexión F y G requieren el empleo de interruptores automáticos tetrapolares con el neutro al 100% de la regulación de las fases y pueden utilizarse con los interruptores SACE S3, S5 y S6 para tensiones superiores a 750 V y hasta 1000V. Para mayor información, diríjase directamente a ABB SACE.
Los relés de sobreintensidad termomagnéticos para c.a. son adecuados para emplearse en c.c. teniendo en cuenta que los valores de intervención del elemento térmico corresponden a los indicados para el funcionamiento en. c.a. mientras que el umbral de intervención del elemento magnético tiene que regularse considerando que la intervención se produce a un valor superior con respecto al análogo caso en c.a. debido a los fenómenos magnéticos. En la siguiente tabla, para cada interruptor automático se indica el valor de corrección a adoptar para los umbrales de protección.

Interruptor	Esquema A	Esquema B	Esquema C
S1	k_m= 1,3	k_m= 1	k_m= 1
S2	k_m= 1,3	k_m= 1	k_m= 1
S3	k_m= 1,3	k_m= 1,15	k_m= 1,15
S5	k_m= 1,1	k_m= 1	k_m= 1
S6	k_m= 1,1	k_m= 1	k_m= 1

Ejemplo de adaptación de los umbrales de intervención en c.c. - esquema A

Regulación	S1 125			S2 160			S3 160			S3 250		
	I_{th}	I_m=10I_{th}	I_m=5I_{th}	I_{th}	I_m=10I_{th}	I_m=5I_{th}	I_{th}	I_m=10I_{th}	I_m=5I_{th}	I_{th}	I_m=10I_{th}	I_m=5I_{th}
R 10	10	650	208									
R 12,5	12,5	650	208	9...12,5	650	208						
R 16	16	650	208	11,2...16	650	208						
R 20	20	650	260	14...20	650	260						
R 25	25	650	260	17,5...25	650	260						
R 32	32	650	260	22,5...32	650	260	19...32	650	390			
R 40	40	650	260	28...40	650	260						
R 50	50	650	325	35...50	650	325	30...50	650	390			
R 63	63	819	416	44...63	819	416						
R 80	80	1040	520	56...80	1040	520	48...80	1040	520			
R 100	100	1300	650	70...100	1300	650	70...100	1300	650			
R 125	125	1625	819	87,5...125	1625	819	87,5...125	1625	819			
R 160				112...160	2080	1040	112...160	2080	1040			
R 200										140...200	2600	1300
R 250										175...250	3250	1625

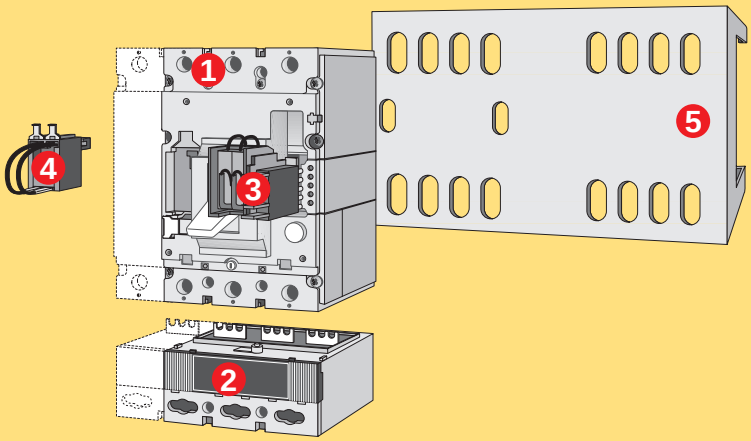
1 **El numero de polos del interruptor automático** depende del tipo de red de distribución. Se pueden utilizar los interruptores automáticos SACE S1, S2, S3 S4, S5 y S6.

2 **El relé de sobreintensidad** es de tipo termomagnético.

3 **Contactos auxiliares** para las señalizaciones o los enclavamientos de insertado/extraído, abierto/cerrado o abierto por intervención del relé.

4 **Relé de apertura** a distancia con el correspondiente contacto de final de carrera a utilizar como apertura de emergencia para la línea de alimentación general o bien como mando a distancia de apertura y cierre para el telemando o en el caso que se tenga que realizar una conmutación automática.

5 **Enclavamiento mecánico** entre interruptores automáticos como en el caso de dos interruptores de una conmutación automática para garantizar que la fuente de alimentación normal y la de emergencia no puedan funcionar en paralelo.



VSIS441a

Regulación	S5 400		S5 630		S6 630		S6 800	
	I_{th} = 0,7...1x I_n	I_m = 5...10 x I_n	I_{th} = 0,7...1 x I_n	I_m = 5...10 x I_n	I_{th} = 0,7...1 x I_n	I_m = 5...10 x I_n	I_{th} = 0,7...1 x I_n	I_m = 5...10 x I_n
R 320	225...320	1760...3520						
R 400	280...400	2200...4400						
R 500			350...500	2750...5500				
R 630					440...630	3065...6930		
R 800							560...800	4400...8800

El factor de corrección para el elemento magnético cuando el interruptor automático se utiliza en c.c. significa que para el mismo ajuste, en c.c. aumenta el valor de la corriente de intervención del elemento magnético respecto a la corriente de intervención en c.a.
Conocido el valor de la corriente de intervención hay que adecuar el ajuste del elemento magnético al valor de ajuste corregido para c.c.

Por ejemplo:
- Corriente de servicio: Ib = 600 A
- Protección magnética deseada: Im = 5000 A
- Ajuste del umbral magnético:

$$\text{ajuste} = \frac{I_m}{k_m \times I_n}$$

therefore in this specific case, having chosen circuit-breaker S6 R630 (In = 630 A), the magnetic threshold setting value will be:

$$\text{ajuste} = \frac{5000}{1{,}1 \times 630} \approx 7$$

Protección contra defectos a tierra

Los contactos directos e indirectos

La protección contra los contactos directos o indirectos entra en el tema general de la seguridad y tiene una importancia fundamental si se piensa, por ejemplo, que el contacto entre las personas y los aparatos eléctricos es inevitable. El tema está regulado por la ley y por las normas que establecen unos requisitos mínimos indispensables para evitar y/o prevenir accidentes. Pero, por su naturaleza, la seguridad no puede limitarse a los requisitos mínimos, especialmente por el hecho de que la explotación de las instalaciones y el uso de los dispositivos existentes en las mismas comporta un cambio continuo del estado de la instalación. El contacto contra partes bajo tensión puede provocar el paso de una corriente a través del cuerpo de la persona con consecuencias incluso mortales. Los sistemas de protección permiten reducir la exposición a dicho peligro, limitando la corriente y el tiempo durante el cual puede pasar dicha corriente. Además, es necesario que el sistema de protecciones ofrezca garantías incluso contra los fenómenos evolutivos que afectan a la instalación durante el ciclo de vida de la misma.

Convencionalmente (Norma CEI 64-8/410), se distingue entre:

– contactos directos, cuando se puede entrar en contacto con una parte de la instalación normalmente bajo tensión
– contactos indirectos, cuando se produce el contacto con partes que normalmente no están bajo tensión durante un defecto de aislamiento.

Las Normas CEI 11-8/3.1.14 - CEI 64-8/481.2.3 CEI 64-8/410 prevén obligatoriamente:

– una medida de protección contra los contactos indirectos tanto en los “locales normales” como en los “locales eléctricos”
– una medida de protección “total” contra los contactos directos en cualquier local que no sea un “local eléctrico”.

La protección contra los contactos directos tiene que efectuarse mediante aislamientos, envolventes o barreras que impidan el contacto con partes bajo tensión. La protección contra los contactos indirectos de una persona que entre en contacto con una masa metálica que se haya puesto bajo tensión debido a un defecto, como por ejemplo, el deterioro del aislamiento, se realiza mediante dispositivos de corte automático, de sobreintensidad o diferenciales. Utilizando un interruptor automático con relé de protección es posible proteger conductores de longitud elevada contra los contactos indirectos disminuyendo el umbral de intervención de la protección magnética contra cortocircuito, mientras que el uso de dispositivos diferenciales hace que la protección contra contactos indirectos sea independiente del tipo de instalación.

	Las prescripciones de la Norma CEI 64-8
TT	Para efectuar la protección mediante dispositivos de sobrecorriente a tiempo inverso tiene que satisfacerse la siguiente relación: **$Rt \leq 50 / I$** en la cual: – I es la corriente de intervención en 5 s del dispositivo de protección – Rt es la resistencia de la instalación de tierra en condiciones más desfavorables
TN	Para efectuar la protección mediante dispositivos de sobreintensidad a tiempo inverso o dispositivos diferenciales, es necesario que en cualquier punto del circuito se satisfaga la siguiente relación: **$I \leq Uo / Zg$** en la cual: – Uo es la tensión a tierra de la instalación – Zg es la impedancia del anillo de defecto para defecto franco a masa – I es la corriente de intervención en 5 s del dispositivo de protección
IT	La tensión en las masas tiene que superar el valor de 25 V en el caso de primer defecto a tierra mientras que en el caso de segundo defecto a tierra la intervención del dispositivo de protección tiene que intervenir en 5 s. En caso de un único defecto a tierra, la corriente de defecto está fuertemente limitada por la capacidad de la línea hacia tierra y, por lo tanto, no se requiere el corte, sino la señalización para evitar riesgos debidos al segundo defecto a tierra.

Tabla de las prescripciones Norma CEI

La protección diferencial

Los interruptores diferenciales se emplean tanto para la protección de las personas como para la protección contra los defectos a tierra. La protección diferencial se admite como protección contra los contactos indirectos ya que consiente eliminar un defecto mientras se admite únicamente como protección adicional contra los contactos directos de una persona que entre en contacto con los conductores activos de un circuito eléctrico ya que no puede garantizar la protección de las personas en caso de:

– persona aislada de tierra que toca simultáneamente dos conductores activos; en dicho caso, la corriente de defecto se cierra a través de la persona y es defectada por el dispositivo diferencial;
– persona en contacto con el terreno que toca simultáneamente dos conductores activos; en dicho caso, la corriente de defecto se cierra en parte a través de la persona y en parte a través del terreno y es solamente ésta la que defecta el dispositivo diferencial que, por lo tato, no puede garantizar la protección de la persona.

Se encuentran disponibles:

– los relés diferenciales SACE RC211 y RC212 para el montaje lateral o vertical con los interruptores SACE S1, S2 y S3 en versión fija tetrapolar, utilizables para valores de corriente I_{Δ} a partir de 30 mA hasta 3A y retardos de tiempo programables hasta 1,5 s con el relé diferencial RC212;
– el relé diferencial de cuadro SACE RCQ con transformador toroidal separado (abribles y cerrados), combinable con todos los interruptores automáticos de S1 a S7, se puede utilizar para valores de corriente I_{Δ} a partir de 30 mA hasta 30 A y retardos de tiempo que se pueden programar hasta 5 s.

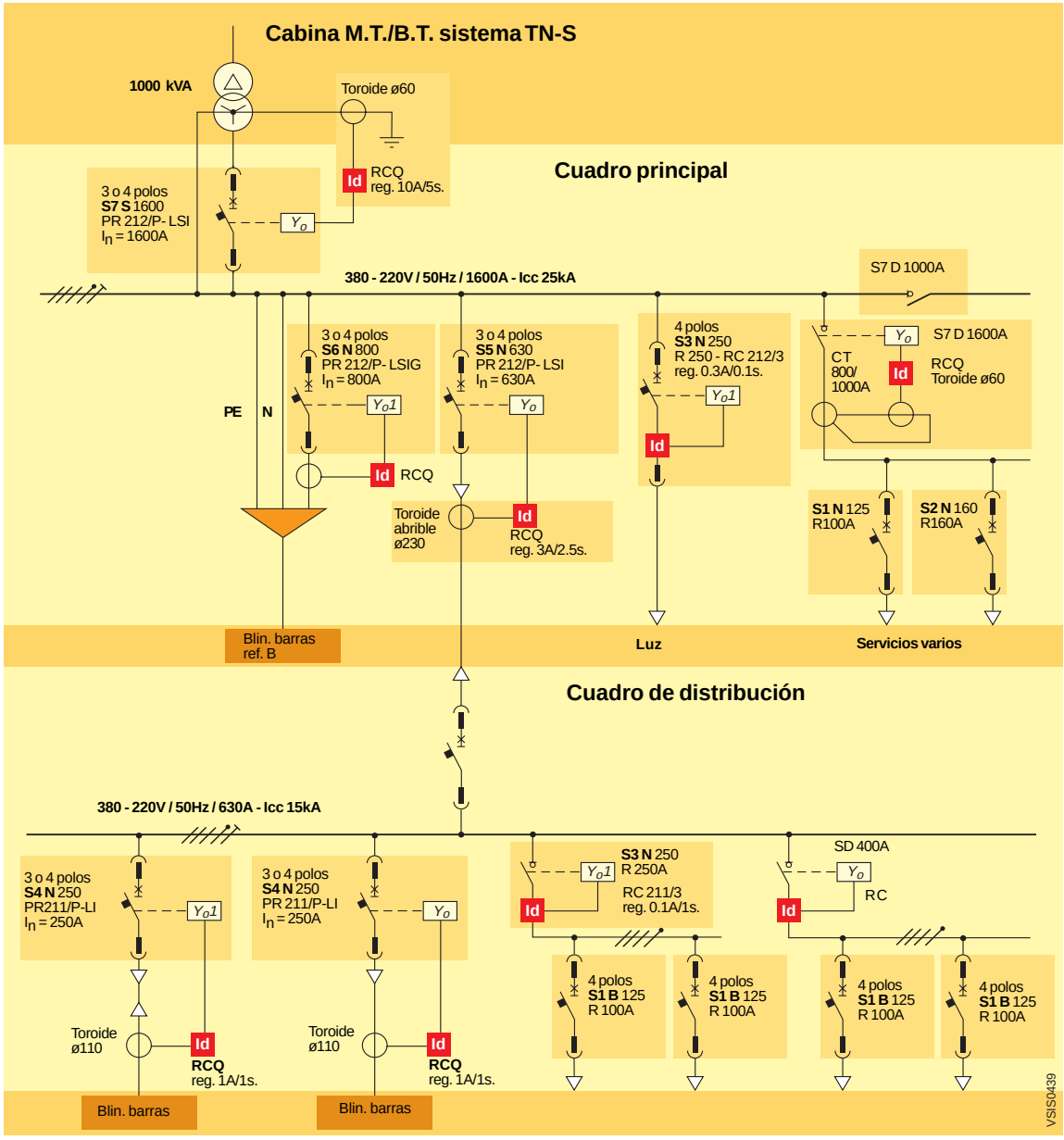
Las condiciones de corte por defecto a masa tienen que coordinarse con el valor de la resistencia de tierra en las instalaciones de tipo TT y con el valor de la impedancia del anillo de defecto en una instalación de tipo TN, con el objetivo de evitar que la tensión de contacto alcance valores superiores a los de la curva límite de seguridad y, concretamente, permanezca en valores superiores a 50 V por un tiempo superior a 5 s.

Además, la protección diferencial es seguramente la más eficaz contra los incendios debidos a causas eléctricas. Dicha protección detecta efectivamente los valores más bajos de las corrientes de defecto a tierra compatibles con las exigencias de funcionamiento de la instalación. Las más pequeñas corrientes de dispersión a tierra son, a menudo, peligrosas porque el arco eléctrico que se puede crear en el caso de un contacto a tierra discontinuo, puede provocar pequeños focos de incendios que al inicio son difíciles de detectar pero que al persistir pueden tener graves consecuencias.

En la instalación	Protección diferencial
Considerando que para los dispositivos normales de protección a tiempo inverso, el valor de la corriente a la cual corresponde el tiempo de intervención de 5 s está comprendido, orientativamente, entre 3 y 6 veces la In, las situaciones en las cuales la protección contra los contactos indirectos puede obtenerse con los dispositivos de protección contra sobreintensidad son muy raras. Además, al aumentar la potencia empleada, el valor de la resistencia del electrodo de la pica de tierra tendría que disminuir hasta el punto de hacer impracticable esta vía.	**PRÁCTICAMENTE NECESARIA** Tiene que prestarse atención en los casos en los cuales después de la protección diferencial, el neutro se pone a tierra. Dicha conexión transforma el sistema de TT a TN y un defecto a tierra del neutro no se detecta y puede permanecer por mucho tiempo.
Para los circuitos de distribución se admiten tiempos de intervención de las protecciones hasta 5 s. Con este tipo de sistema, la ventaja es la de poder utilizar los dispositivos de sobreintensidad para la protección contra los contactos indirectos. La práctica sugiere realizar una conexión equipotencial para reducir la tensión de contacto y aprovechar dicha ventaja. La protección diferencial es aconsejable cuando: – la impedancia del anillo de defecto después del punto en cuestión no se conoce o es difícil de determinar – existe el peligro de rotura del conductor de tierra o de protección – cables de longitud considerable – masas lejanas no interconectadas – se cambia el sistema de neutro.	**ACONSEJADA** a condición de que no se use en los sistemas TN-C y que no emplee un conductor PEN después de los dispositivos diferenciales en los sistemas TN-C. Con los dispositivos diferenciales, se obtiene una mayor seguridad ya que las elevadas corrientes de defecto, típicas de los sistemas TN provocan la intervención en un tiempo comprendido entre 30 y 40 ms, con lo cual se pueden tolerar tensiones hasta 280 V.
En presencia de doble defecto a masa, resulta difícil establecer la impedancia del anillo de defecto que comprende de los bobinados de fase del transformador de alimentación, los conductores de la dos fases a masa y una porción de los conductores de tierra. De esto deriva la dificultad de verificar que el defecto se pueda eliminar en menos de 5 s y, en consecuencia, la necesidad de recurrir en la casi totalidad de los casos al empleo de dispositivos de tipo diferencial.	**OPCIONAL** En los sistemas de tipo IT, la protección diferencial de los servicios es eficaz en el caso de una fase a tierra.

La función “G” de protección contra defectos a tierra

El defecto a tierra, originado normalmente por un defecto del aislamiento, provoca una corriente definida convencionalmente de defecto a tierra. La corriente de defecto a tierra tiene un carácter evolutivo y puede provocar un defecto franco fase-masa (cortocircuito monofásico).
En los interruptores automáticos SACE S4, S5, S6 y S7, la protección contra los defectos a tierra puede obtenerse también mediante la función “G” utilizando los relés de sobreintensidad con microprocesador PR212/P - LSIG. La regulación de 0,2 a 1 x In permite abarcar un campo de aplicaciones desde I_{Δ} de 20 A con el interruptor automático SACE S4 hasta 1600 A con el interruptor automático SACE S7. El retardo de la intervención se puede programar entre 0,1 y 0,8 s y permite realizar cadenas de selectividad con los relés diferenciales situados después e incluso con los interruptores automáticos instalados en el mismo cuadro.
El empleo de estos interruptores permite, por lo tanto, satisfacer las exigencias de protección contra los defectos a tierra hasta la subestación de transformación donde es necesario, primordialmente, la protección contra los grandes defectos a tierra.



Protección diferencial en un sistema TN-S

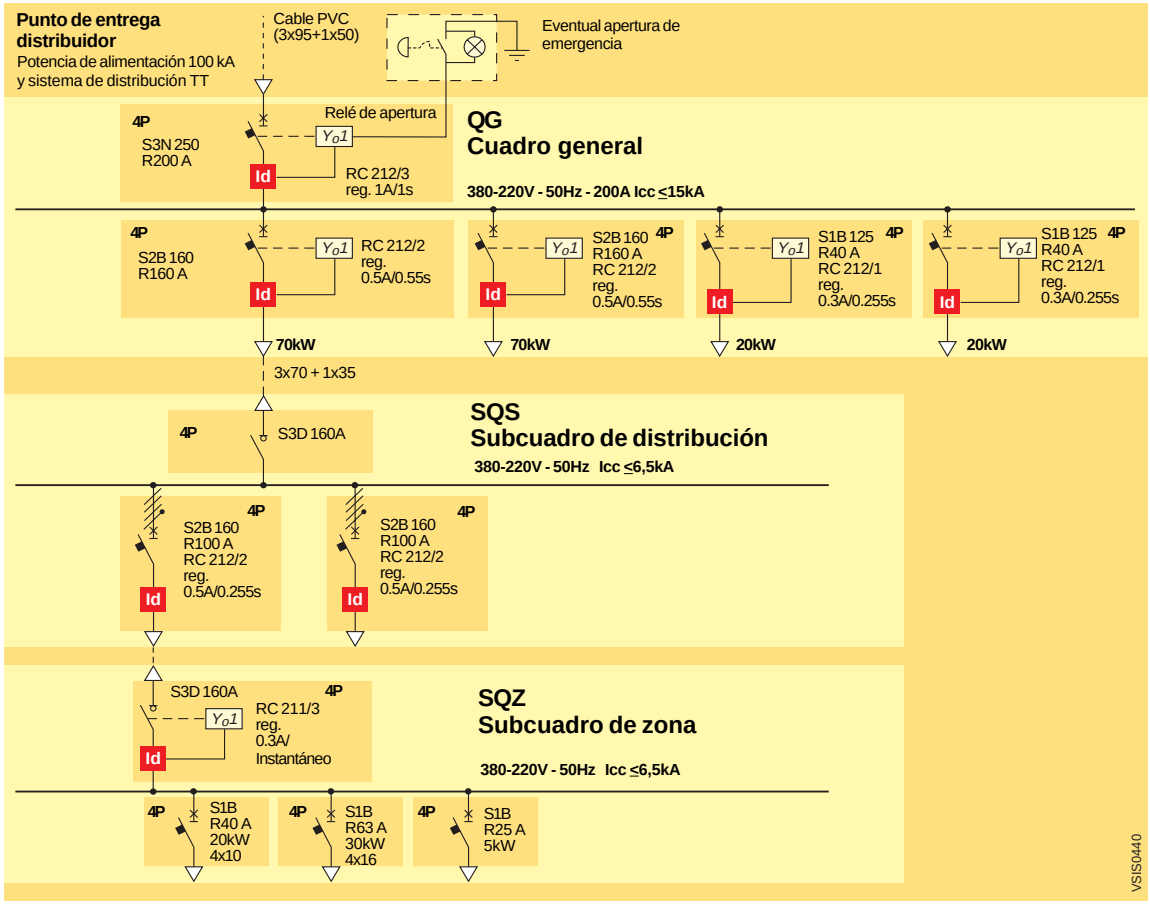
Selectividad entre dispositivos diferenciales

Para garantizar la continuidad de servicio, especialmente en las instalaciones en las que es indispensable por motivos de seguridad, como en los hospitales y en algunas instalaciones industriales, es necesario realizar la selectividad entre los dispositivos conectados en serie entre sí situados en los diferentes puntos de la instalación. En función del tipo de instalación, el sistema de protección diferencial puede realizarse para garantizar:

– un cierto nivel de selectividad horizontal, insertando dispositivos de protección diferencial en las diferentes derivaciones principales situadas después del interruptor automático general de manera que un eventual defecto a tierra no provoque la puesta fuera de servicio de toda la instalación;
– la selectividad vertical cuando el interruptor automático general también es interruptor diferencial; en dicho caso, la corriente diferencial asignada de intervención del interruptor general tiene que ser, como mínimo, el doble de la corriente de intervención de los dispositivos diferenciales situados después para garantizar una selectividad parcial amperimétrica o bien emplear interruptores diferenciales retardados para poder realizar una selectividad diferencial cronométrica; para ello, se puede utilizar en los interruptores automáticos S4 a S7 la función “G” de protección contra defecto a tierra con los relés a microprocesador SACE PR212/P - LSIG.

En general, la regulación del retardo del dispositivo diferencial aguas arriba tiene que ser superior al tiempo total de corte de los interruptores diferenciales situados después, considerando que el retardo máximo en los circuitos terminales de la distribución puede llegar hasta 1 s. La regulación de la corriente del dispositivo diferencial anterior tiene que ser, como mínimo, dos veces la del dispositivo diferencial en serie situado inmediatamente después con el cual se desea obtener la selectividad.

El relé diferencial SACE RC212, la función “G” de los relés SACE PR212/P-LSIG y el relé diferencial de cuadro SACE RCQ permiten realizar cadenas de selectividad diferencial cronométrica y amperimétrica utilizando, aguas abajo de los mismos, dispositivos oportunamente regulados y el relé diferencial con intervención instantánea SACE RC211.



Protección diferencial en el sistema de distribución TT

Interruptores para utilización a 400 Hz

Los interruptores de fabricación normal pueden utilizarse en corriente alterna con frecuencias mayores con relación a los 50-60 Hz para las cuales se han regulado las corrientes y los tiempos de intervención. A frecuencias elevadas, las prestaciones se reclasifican para tener en cuenta fenómenos típicos como:

– el aumento del efecto skin o pelicular y el aumento de la reactancia inductiva directamente proporcional a la frecuencia que, a igual sección del cobre, comportan una disminución de la conductividad y un aumento de los fenómenos de inercia que causan un recalentamiento de los conductores o de las piezas de cobre que en un interruptor automático están normalmente atravesadas por corriente;
– el ciclo de histéresis se alarga y disminuyen la saturación magnética y las fuerzas electromotrices inducidas por el campo magnético que se generan a una cierta corriente.

Por lo tanto, en general, estos fenómenos repercuten en el comportamiento de las partes de cobre tanto de los relés termomagnéticos como de las partes de interrupción de un interruptor automático, introduciendo la necesidad de reclasificar las prestaciones de los interruptores por cuanto concierne a las características de intervención de los relés. También en presencia de relés de sobreintensidad con microprocesador SACE PR211/P, que en general poseen una estabilidad de comportamiento ante las variaciones de frecuencia, hay que tener en cuenta estos fenómenos debido a las partes de cobre del interruptor automático y debido al aumento de la temperatura como resultado de la frecuencia.

Relés de sobreintensidad con microprocesador

Para el empleo a 400 Hz, los interruptores automáticos SACE S4, S5 , S6 y S7 pueden dotarse con relés de sobreintensidad con microprocesador SACE PR211/P. Los umbrales de intervención de la protección contra sobrecorriente tienen que regularse según los intervalos indicados en la tabla para tener en cuenta los fenómenos relacionados con la conductividad de las partes de cobre y del hecho de que los relés con microprocesador no son sensibles a la frecuencia.
Con la utilización a 400 Hz, se modifican los intervalos de tolerancia en los tiempos de intervención correspondientes a los umbrales de intervención de la función L de protección contra la sobrecarga (+10%).

Interruptores		**L**		**I**
	In[A]	regulación	I1 (400 Hz)	regulación
S4 160	100	0,4 ... 0,8	40 ... 80	1,5 ... 12
	160	0,4 ... 0,8	64 ... 128	1,5 ... 12
S4 250	250	0,4 ... 0,8	100 ... 200	1,5 ... 12
S5 400	320	0,4 ... 0,8	128 ... 256	1,5 ... 12
	400	0,4 ... 0,8	160 ... 320	1,5 ... 12
S5 630	630	0,4 ... 0,8	252 ... 504	1,5 ... 12
S6 630	630	0,4 ... 0,8	252 ... 504	1,5 ... 12
S6 800	800	0,4 ... 0,8	320 ... 640	1,5 ... 12
S7 1250	1250	0,4 ... 0,8	500 ... 1000	1,5 ... 12
S7 1600	1600	0,4 ... 0,8	640 ... 1280	1,5 ... 12

Relés de sobreintensidad termomagnéticos

El umbral de intervención del elemento térmico disminuye al aumentar la frecuencia a causa de la reducida conductividad de los materiales y del aumento de los fenómenos térmicos relacionados. En cambio, el umbral de intervención magnética aumenta al aumentar la frecuencia debido a los pequeños campos magnéticos inducidos.
En las siguientes tablas se resumen las prestaciones a la frecuencia de 400 Hz de los interruptores automáticos SACE Isomax S con los relés termomagnéticos o solo magnéticos.
Cuanto indicado en la tabla significa que a igual regulación, respecto a la frecuencia de 50/60 Hz, disminuyen los valores de intervención térmica y aumentan los valores de las corrientes de intervención magnética o, viceversa, tras determinar el valor de intervención térmica y magnética hay que ajustar los umbrales de intervención según las escalas de fondo reclasificadas.

Interruptor	Regulación	Relé						
			5Ith			10Ith		
		Ith (400 Hz)	Im (50Hz)	k1	Im (400 Hz)	Im (50Hz)	k2	Im (400 Hz)
S1 125	R10	10	160	2	320	500	2	1000
	R12,5	12,5	160	2	320	500	2	1000
	R16	16	160	2	320	500	2	1000
	R20	19	200	2	400	500	2	1000
	R25	23	200	2	400	500	2	1000
	R32	30	200	2	400	500	2	1000
	R40	37	200	2	400	500	2	1000
	R50	46	250	2	500	500	2	1000
	R63	58	320	2	640	630	2	1260
	R80	74	400	2	800	800	2	1600
	R100	90	500	2	1000	1000	2	2000
	R125	112	630	2	1260	1250	2	2500

Interruptor	Regulación	Relé								
		Ith (400 Hz)			5Ith			10Ith		
		MIN	MED	MAX	Im (50Hz)	k1	Im (400 Hz)	Im (50Hz)	k2	Im (400 Hz)
S2 160	R12,5	9	10,75	12,5	160	2	320	500	2	1000
	R16	11,2	13,6	16	160	2	320	500	2	1000
	R20	13	16	19	160	2	320	500	2	1000
	R25	16	19,5	23	200	2	400	500	2	1000
	R32	21	25,5	30	200	2	400	500	2	1000
	R40	26	31,5	37	200	2	400	500	2	1000
	R50	32	39	46	200	2	400	500	2	1000
	R63	40	49	58	320	2	640	630	2	1260
	R80	52	63	74	400	2	800	800	2	1600
	R100	65	77,5	90	500	2	1000	1000	2	2000
	R125	80	96	112	630	2	1260	1250	2	2500
	R160	100	122,5	145	800	2	1600	1600	2	3200
S3 160	R32	18	24	30	300	1,7	510	500	1,7	850
	R50	28	37	46	300	1,7	510	500	1,7	850
	R80	44	59	74	400	1,7	680	800	1,7	1360
	R100	65	77,5	90	500	1,7	850	1000	1,7	1700
	R125	80	96	112	630	1,7	1071	1250	1,7	2125
	R160	100	122,5	145	800	1,7	1360	1600	1,7	2720
S3 250	R200	125	152,5	180	1000	1,7	1700	2000	1,5	3400
	R250	160	192,5	225	1250	1,7	2125	2500	1,5	4250

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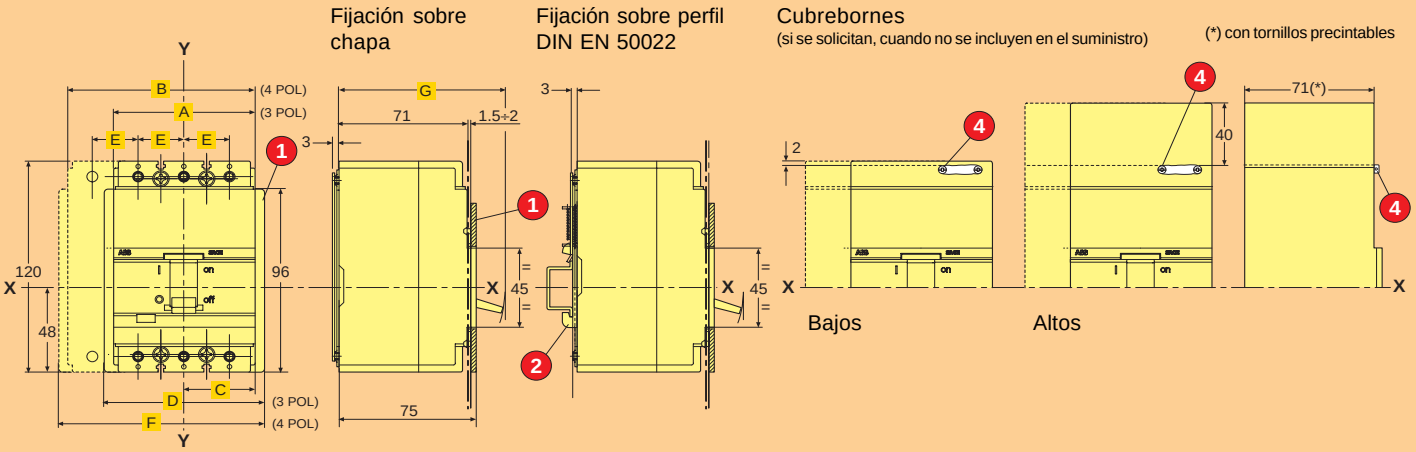
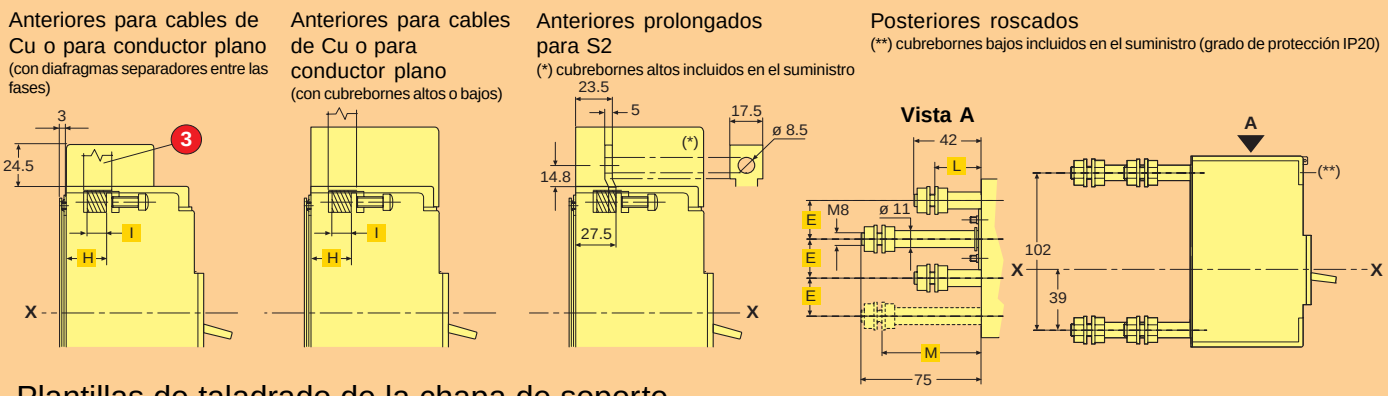
Dimensiones generales SACE S1-S2

Interruptor fijo



Terminales

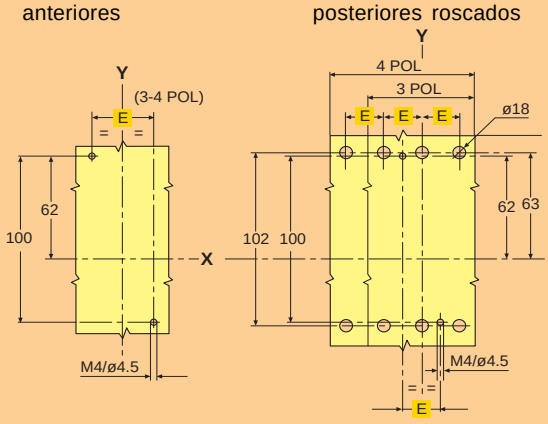


Plantillas de taladrado de la chapa de soporte

(espesor mínimo de la chapa: 3 mm)

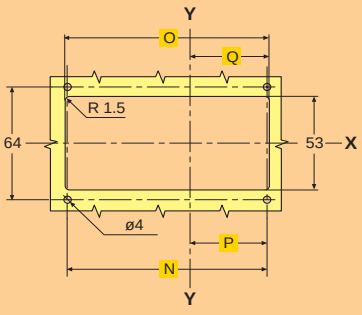
Para terminales anteriores

Para terminales posteriores roscados



Plantilla de taladrado de la puerta de la celda y fijación del marco

(espesor de la chapa 1.5 - 2 mm)



Leyenda

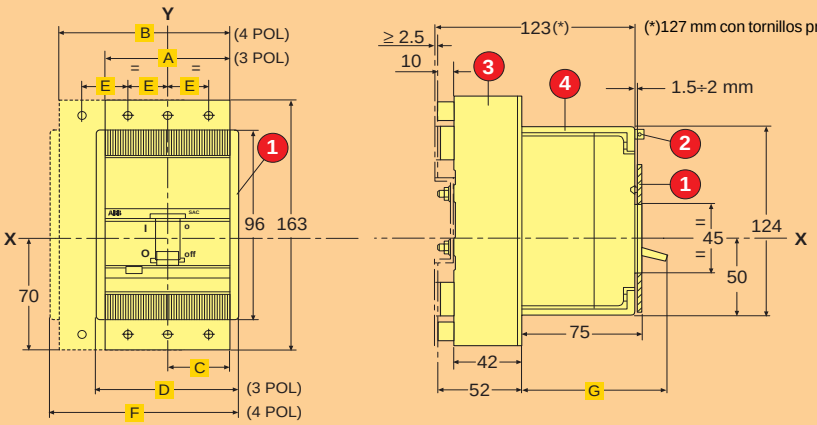
1. Marco para la puerta de la celda
2. Brida para fijación interruptor sobre perfil DIN (si se solicita)
3. Diafragma separador
4. Tornillos precintables

VSIS0501

	A	B	C	D	E	F	G	H	I	L	M	N 3 Pol	N 4 Pol	O 3 Pol	O 4 Pol	P	Q
S1	78	103	39	91	25	116	91	25.5	10.5x11	29	62	83.5	108.5	85	111	42	43
S2	90	120	45	103	30	133	93	27.5	12.5x12.5	27	60	95.5	125.5	98	128	48	49

Interruptor enchufable

Partes fijas montadas sobre chapa o sobre perfil
(cubrebornes para parte móvil con IP20 siempre incluidos en el suministro)

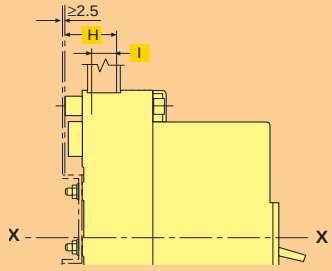


Leyenda

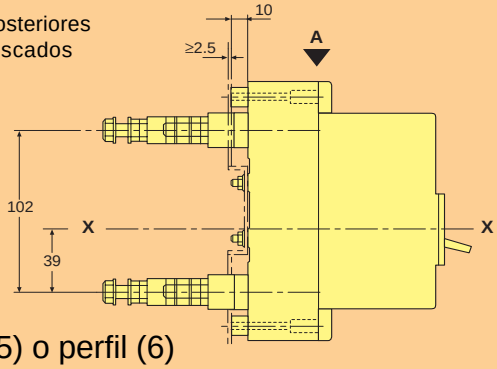
1. Marco para la puerta de la celda
2. Tornillos precintables
3. Parte fija
4. Parte móvil con cubrebornes

Terminales

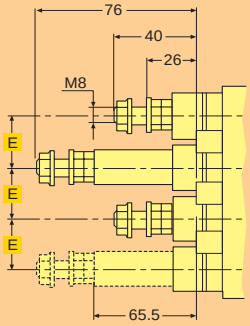
Anteriores



Posteriores roscados



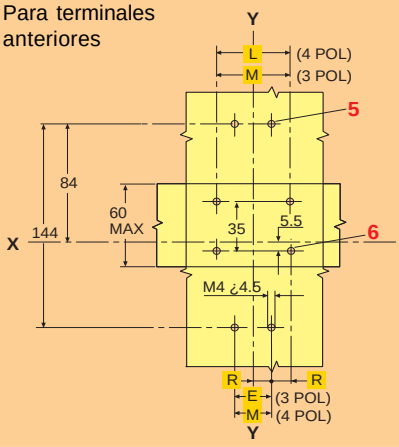
Vista A



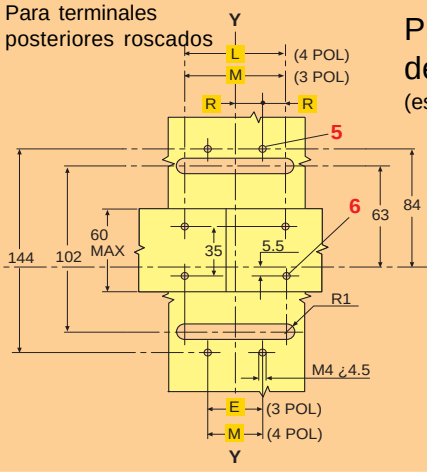
Plantilla de taladrado de soporte (5) o perfil (6)

(espesor mínimo de la chapa: 2.5 mm)

Para terminales anteriores

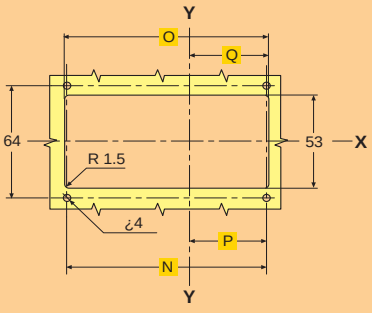


Para terminales posteriores roscados



Plantilla de taladrado de la puerta de la celda y fijación del marco

(espesor de la chapa 1.5 - 2 mm)



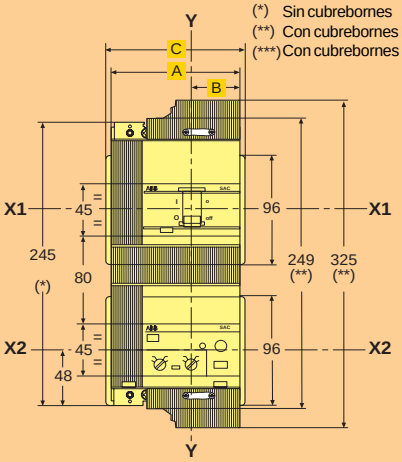
VSIS0502

	A	B	C	D	E	F	G	H	I	L	M	N 3 Pol	N 4 Pol	O 3 Pol	O 4 Pol	P	Q	R
S1	78	103	39	91	25	116	91	28	10.5x11	75	50	83.5	108.5	86	111	42	43	12.5
S2	90	120	45	103	30	133	93	28	12.5x12.5	90	60	95.5	125.5	98	128	48	49	15

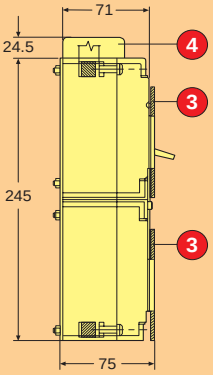
Dimensiones generales SACE S1-S2

Interruptor automático con relé diferencial SACE RC211-RC212

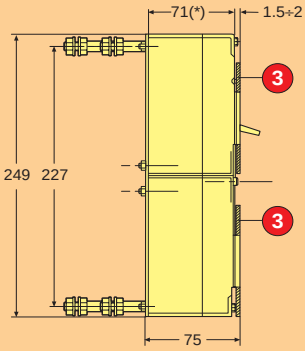
Montaje sobrepuesto (Fijación sobre chapa)



Terminales anteriores para cables de Cu o para conductor plano
(cubrebornes altos si se solicitan)

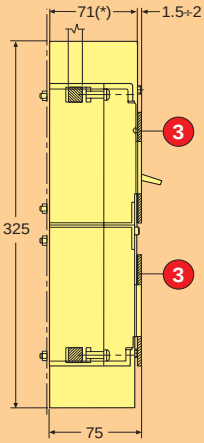


Terminales posteriores roscados
(cubrebornes bajos incluidos en el suministro)



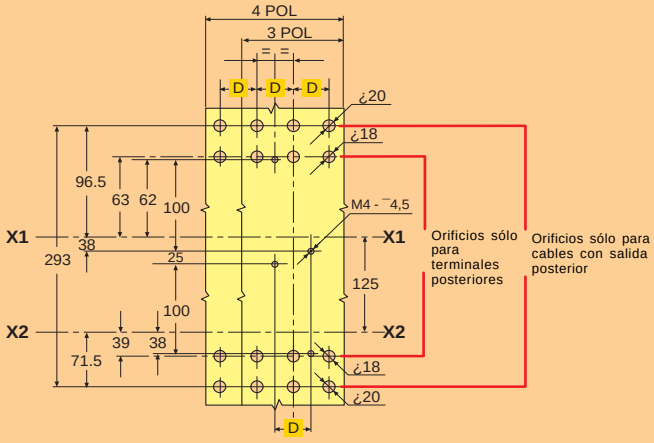
(*) 75 con tornillos precintables

Ejecución con cubrebornes altos: cables de salida anterior o posterior



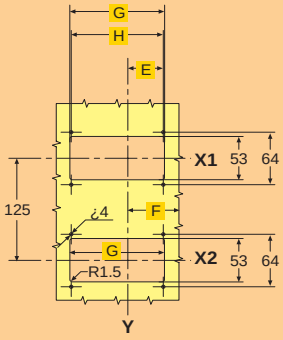
Plantilla de taladrado de la chapa de soporte

(espesor mínimo de la chapa: 3 mm)

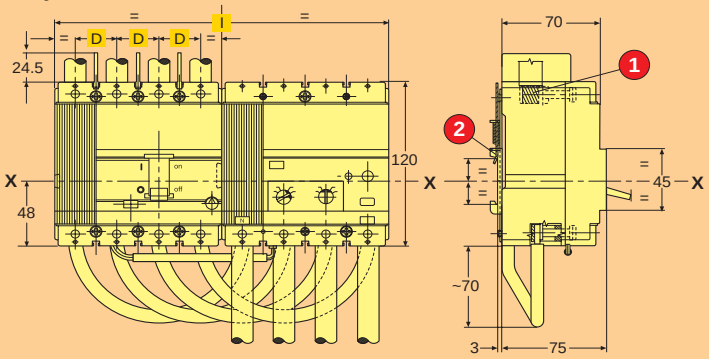


Plantilla de taladrado de la puerta de la celda y fijación del marco

(espesor de la chapa: 1.5 - 2 mm)



Montaje colateral



Leyenda

1. Terminales anteriores para cable y para conductor plano
2. Brida para fijación sobre perfil DIN EN 50022
3. Marco para la puerta de la celda
4. Diafragma separador

Nota
Para las dimensiones de los terminales ver las diferentes ejecuciones

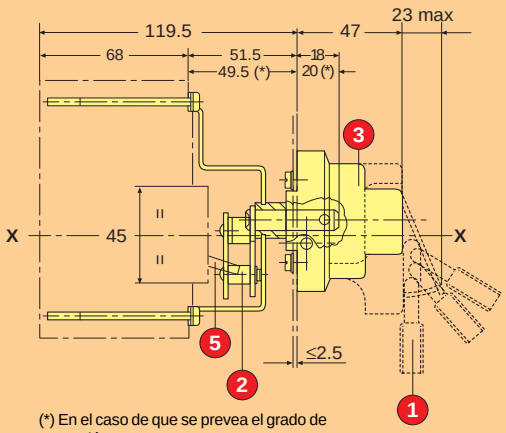
VSIS0503

	A	B	C	D	E	F	G	H	I
S1 - RC211/RC212	103	39	116	25	43	41.7	111	108.5	206
S2 - RC211/RC212	120	45	133	30	49	47.7	128	125.5	240

Accesorios

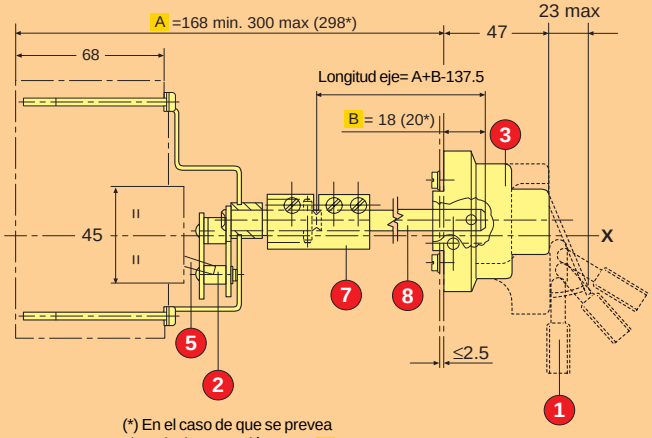
Mando giratorio en la puerta de la celda para interruptor fijo o enchufable

Con distancia fija

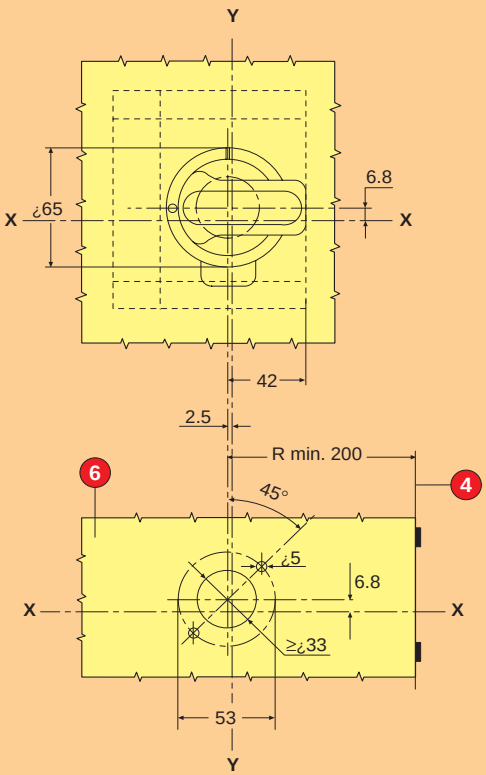


(*) En el caso de que se prevea el grado de protección IP54

Con distancia regulable



(*) En el caso de que se prevea el grado de protección IP54 A = 298 B = 20



Leyenda

1. Bloqueo por candados en posición abierta (máx. 3 candados ø 6 a cargo del cliente)
2. Grupo de transmisión
3. Grupo manija
4. Radio mínimo de rotación para fulcro de la puerta de la celda
5. Palanca de maniobra interruptor
6. Taladrado de la puerta de la celda
7. Junta
8. Eje

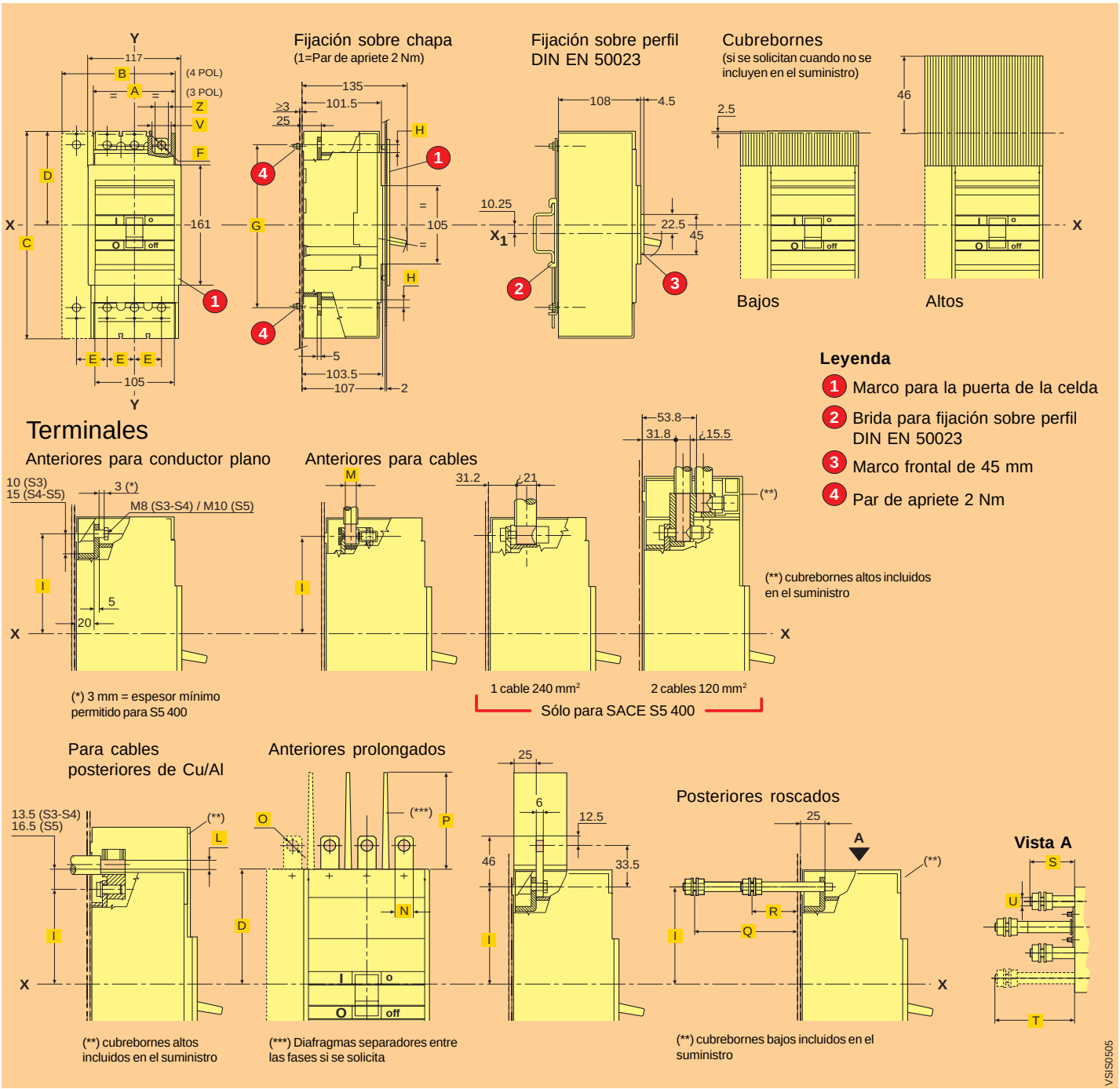
Nota

Para los taladrados de fijación del interruptor ver las diferentes ejecuciones

VSIS0504

Dimensiones generales SACE S3-S4-S5

Interruptor fijo

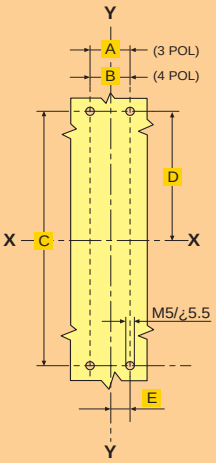


	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R	S	T	U	V	Z
S3	105	140	170	87.25	35	¿8	143	10	73.75	¿16	18x18	20	¿8.5	83	81.5	36.5	55	100	M12	24	17.5
S4	105	140	254	125.25	35	¿8	218	11	107.25	¿16	18x18	20	¿8.5	83	81.5	36.5	55	100	M12	24	17.5
S5	140	183.75	254	125.25	43.75	¿10	218	12	107.25	¿21	24x24	25	¿11	100.5	86.5	39.5	62	108	M16	31	19.5

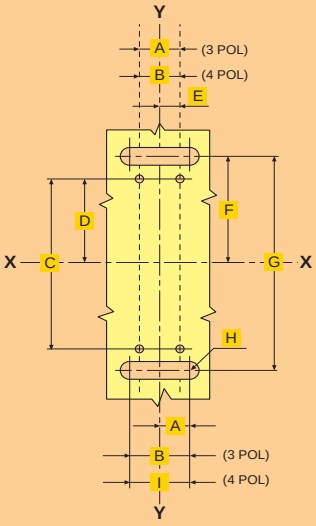
Sujeciones para interruptor fijo

Plantilla de taladrado de la chapa de soporte
(espesor mínimo de la chapa: 3 mm)

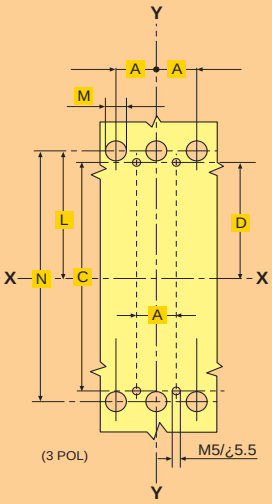
Para terminales:
Anteriores para conductor plano,
Anteriores prolongados,
Anteriores para cables

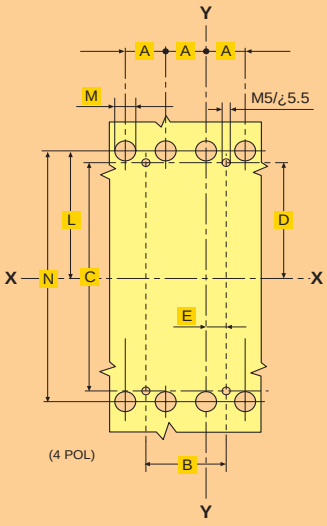


Para terminales para cables posteriores de Cu/Al

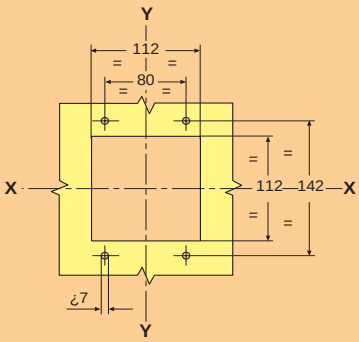


Para terminales posteriores roscados





Plantilla de taladrado de la puerta de la celda y fijación del marco
(espesor de la chapa: 2 mm)



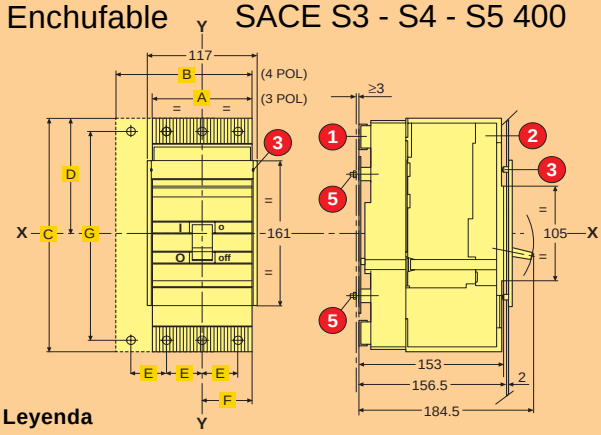
VSIS0506

	A	B	C	D	E	F	G	H	I	L	M	N
S3	35	70	139	71.75	17.5	94.75	185	R15	105	73.75	¿24	143
S4	35	70	214	105.25	17.5	128.25	260	R15	105	107.25	¿24	218
S5	43.75	87.5	214	105.25	22	134.25	272	R20	131.25	107.25	¿30	218

Dimensiones generales SACE S3-S4-S5

Interruptor enchufable - interruptor extraíble

Enchufable SACE S3 - S4 - S5 400



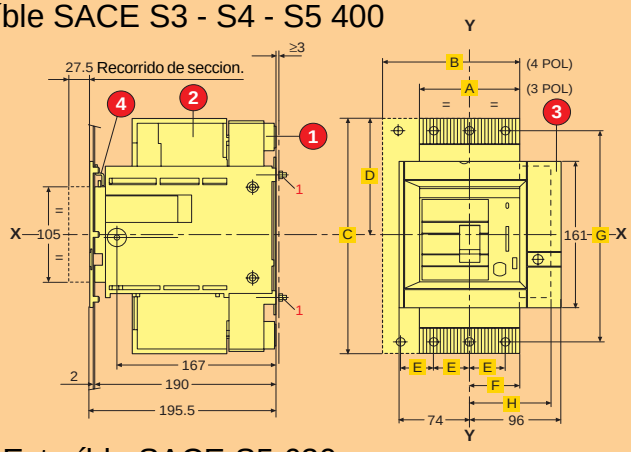
Leyenda

1. Parte fija
2. Parte móvil con cubrebornes con grado de protección IP20
3. Marco para la puerta de la celda (incluido en el suministro)
4. Bloqueo para la puerta de la celda (si se solicita)
5. Par de apriete: 1,1 Nm (S3/S4) - 2 Nm (S5)

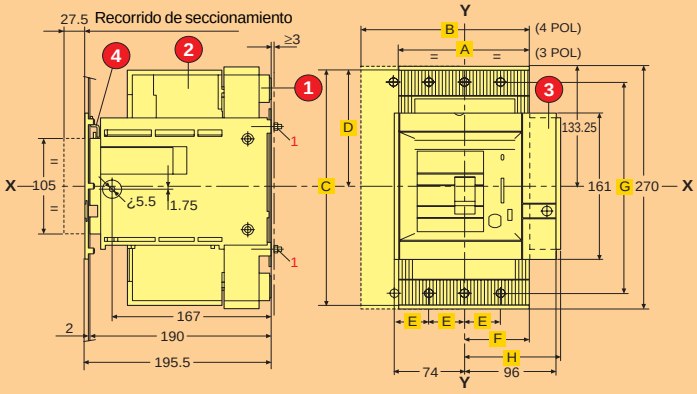
Nota

El interruptor extraíble se tiene que dotar con uno de los siguientes accesorios:
– frente para mando de palanca
– mando giratorio
– mando a motor

Extraíble SACE S3 - S4 - S5 400

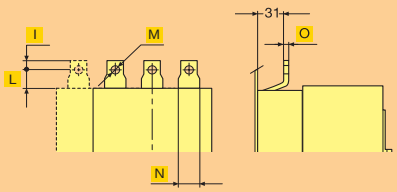


Extraíble SACE S5 630

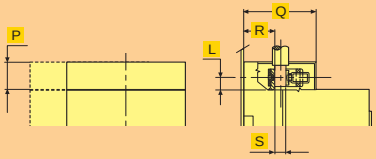


Terminales

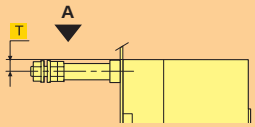
Anteriores para conductor plano (fino a 400 A)



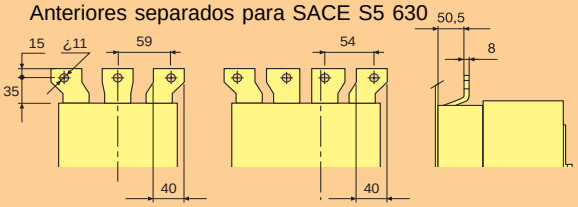
Anteriores para cables (hasta 400 A)



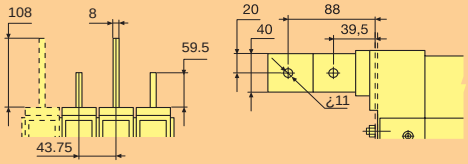
Posteriores roscados



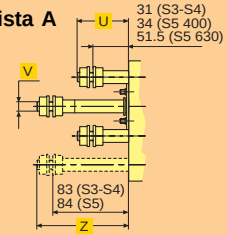
Anteriores separados para SACE S5 630



Posteriores en pletina verticales para SACE S5 630



Vista A



VSIS0507

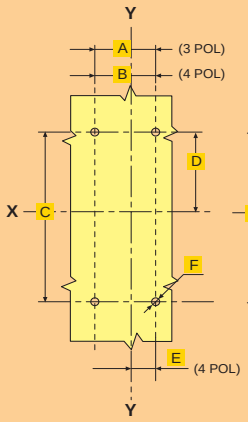
	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R	S	T	U	V	Z
S3	105	140	175	89.75	35	52.5	143	84	10	17.5	¿8.2	20	5	37.5	79.5	36	18x18	16	48	M12	100
S4	105	140	259	127.75	35	52.5	218	84	10	13	¿8.2	20	5	37.5	79.5	36	18x18	20.5	48	M12	100
S5 400	140	183.75	259	127.75	43.75	70	218	101.5	14	23	¿10.2	25	6	47.5	91.5	37	24x24	20.5	58	M16	108
S5 630	140	183.75	259	127.75	43.75	70	218	101.5	14	25	¿10.2	25	6	55.75	91.5	37	24x24	24	80	M24x2	143

Sujeciones para interruptor enchufable - interruptor extraíble

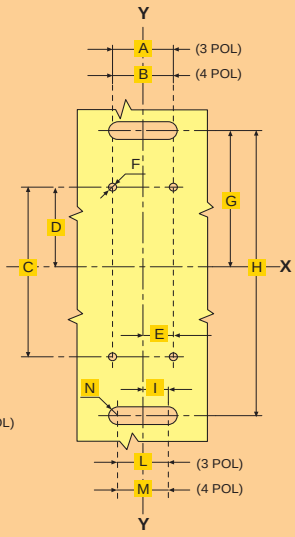
Plantilla de taladrado de la chapa de soporte
(espesor mínimo de la chapa: 3 mm)

SACE S3 - S4 - S5 400

Para terminales:
Anteriores para conductor plano,
Anteriores para cables

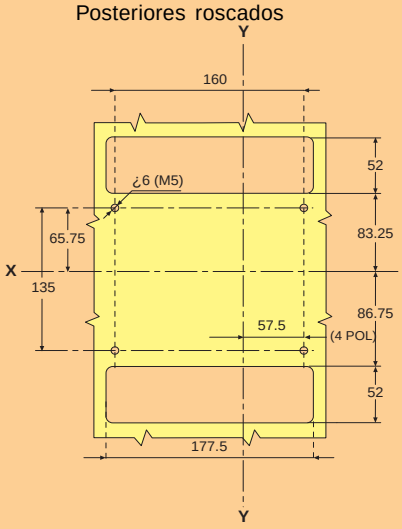


Para terminales posteriores roscados

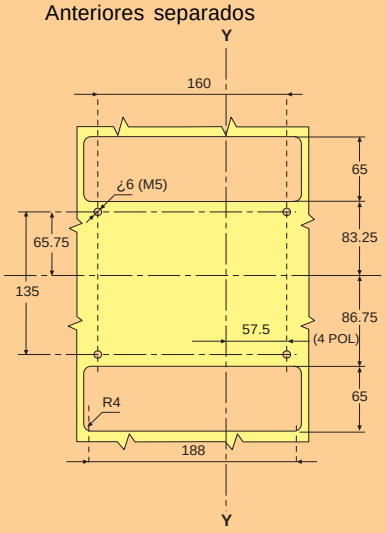


SACE S5 630

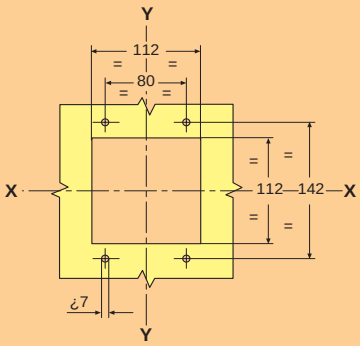
Para terminales:
Posteriores en pletina verticales,
Posteriores roscados

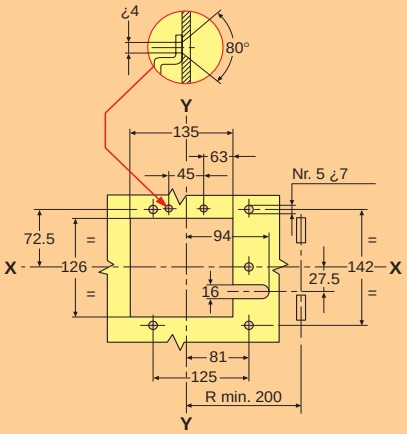


Para terminales:
Anteriores
Anteriores para cables de Cu
Anteriores separados



Plantilla de taladrado de la puerta de la celda y fijación del marco
(thickness of sheet metal: 2 mm)





Para Interruptor enchufable

Para interruptor extraíble

VSIS0508

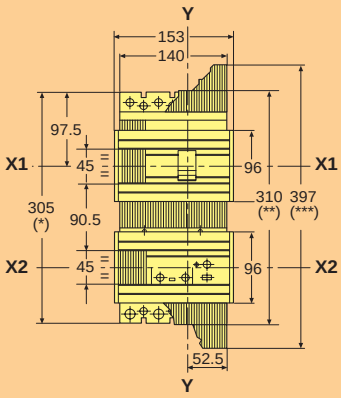
	A	B	C	D	E	F	G	H	I	L	M	N
S3	70	105	100	52.25	25	M4-¿5	73.75	143	35	70	105	R14
S4	82	117	135	65.75	41	M4-¿5	107.25	218	35	70	105	R14
S5 400	115	160	135	65.75	58	M5-¿6	107.25	218	43.75	87.5	131.25	R18

Dimensiones generales SACE S3-S4-S5

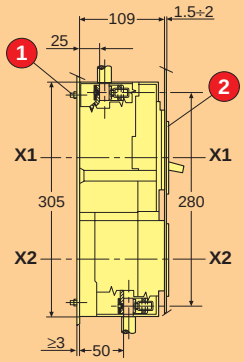
Interruptor automático SACE S3 con relé diferencial SACE RC211/3 - RC212/3

Montaje sobrepuesto (Fijación sobre chapa)

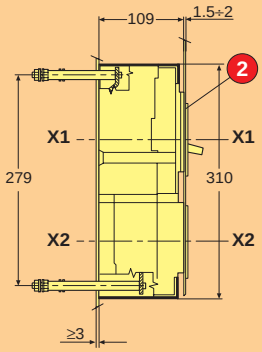
(*) Sin cubrebornes
(**) con cubrebornes bajos
(***) con cubrebornes altos



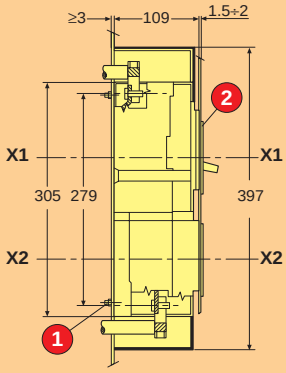
Terminales anteriores para cable
(cubrebornes si se solicitan)



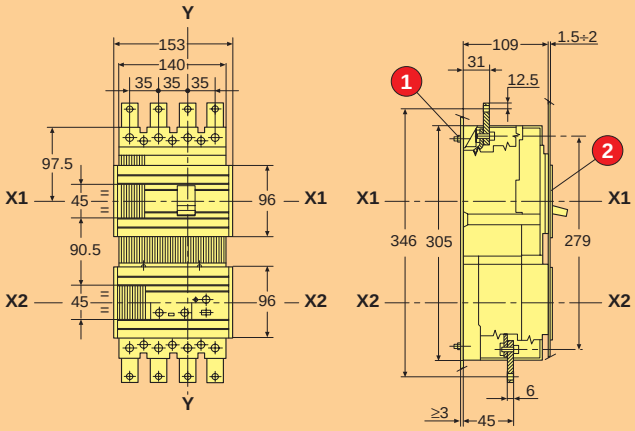
Terminales posteriores
(cubrebornes bajos incluidos en el suministro)



Terminales para cables posteriores de Cu/Al
(cubrebornes altos incluidos en el suministro)



Ejecución con terminales anteriores prolongados

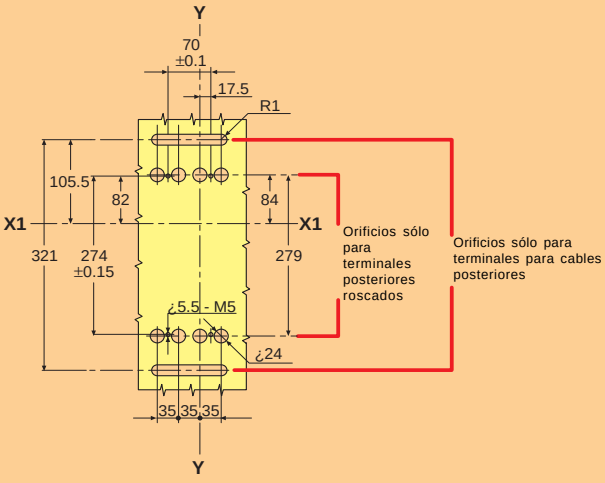


Nota
Para las dimensiones de los terminales ver las diferentes ejecuciones

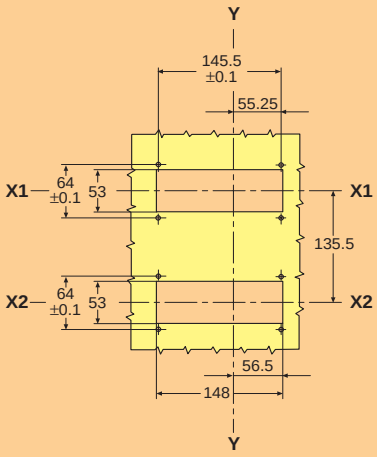
Leyenda

1. Par de apriete 2 Nm
2. Marco para la puerta de la celda

Plantilla de taladrado de la chapa de soporte
(espesor mínimo de la chapa: 3 mm)



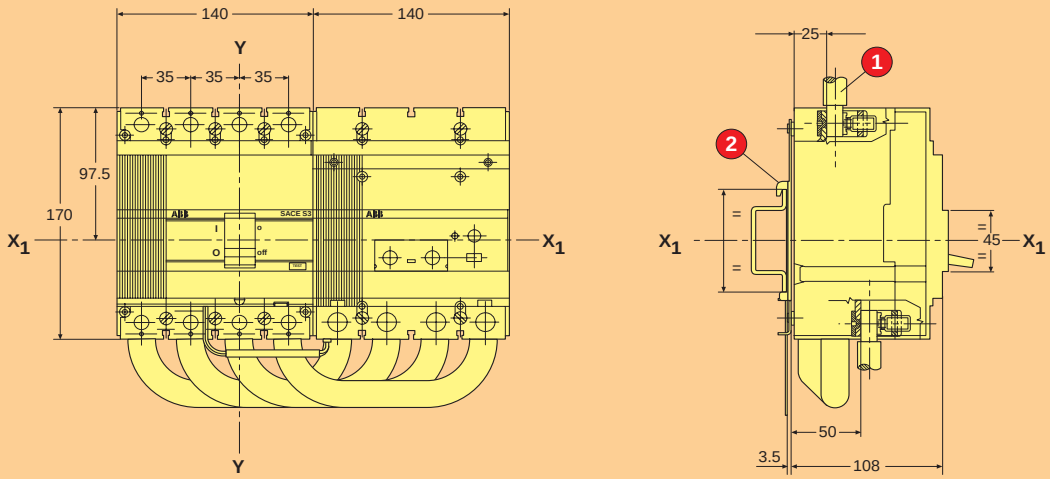
Plantilla de taladrado de la puerta de la celda y fijación del marco
(espesor de la chapa 1.5 - 2 mm)



VSIS0509

Interruptor automático SACE S3 con relé diferencial SACE RC211/3 - RC212/3

Montaje colateral



Leyenda

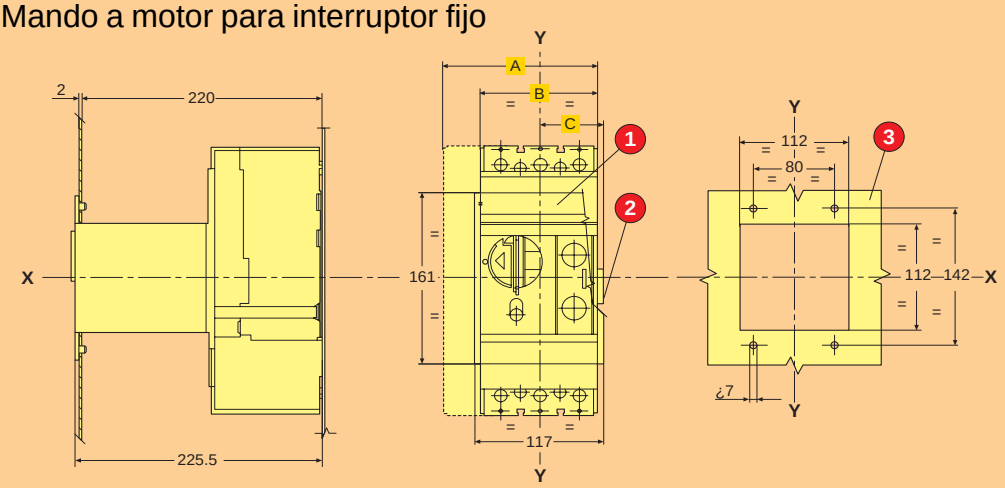
1. Terminales anteriores para cable
2. Brida de fijación sobre perfil DIN EN 50023

VSIS0510

Dimensiones generales SACE S3-S4-S5

Accesorios

Mando a motor para interruptor fijo



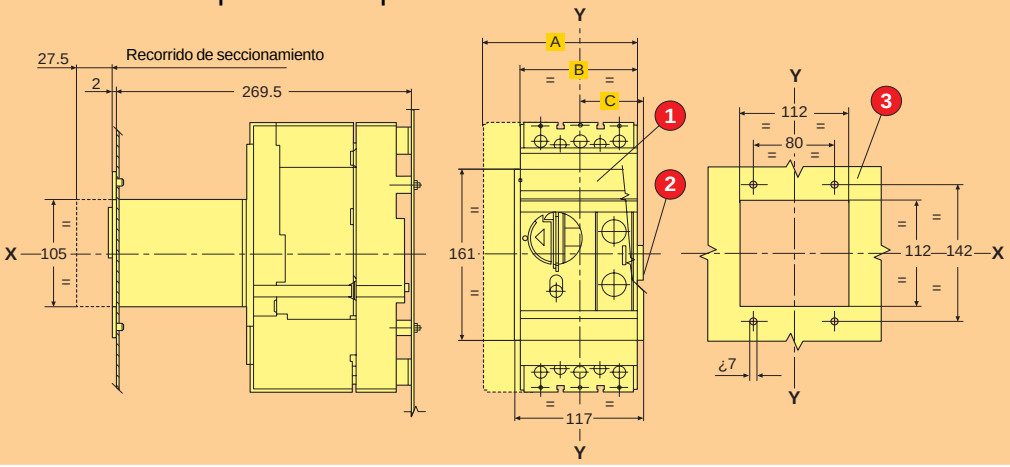
Leyenda

1. Marco para la puerta de la celda (incluido en el suministro)
2. Dimensiones generales con conectores
3. Taladrado de la puerta de la celda

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

	A	B	C
S3-S4	140	105	58
S5	183.75	140	75.5

Mando a motor para interruptor enchufable



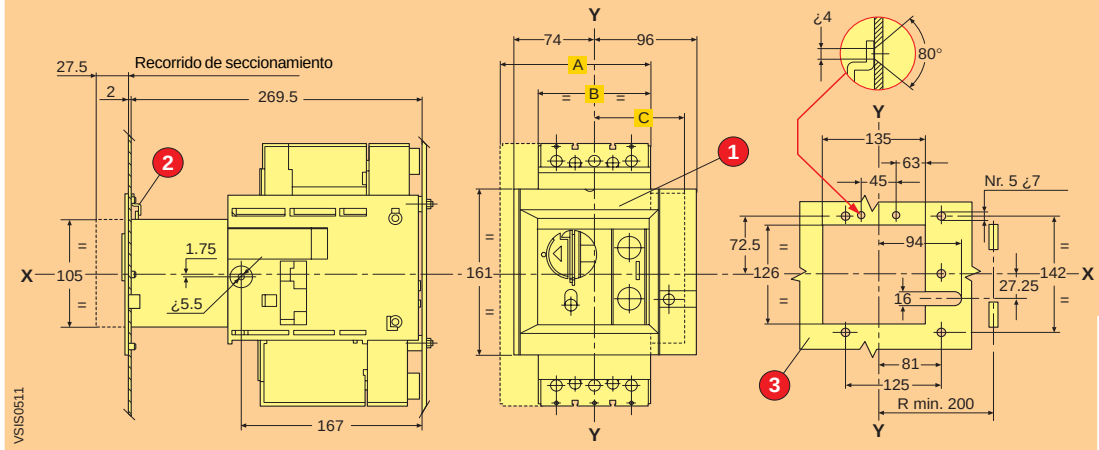
Leyenda

1. Marco para la puerta de la celda (incluido en el suministro)
2. Dimensiones generales con conectores
3. Taladrado de la puerta de la celda

Nota
Para los taladrados de fijación del interruptor ver las diferentes ejecuciones

	A	B	C
S3-S4	140	105	58
S5	183.75	140	75.5

Mando a motor para interruptor extraíble



Leyenda

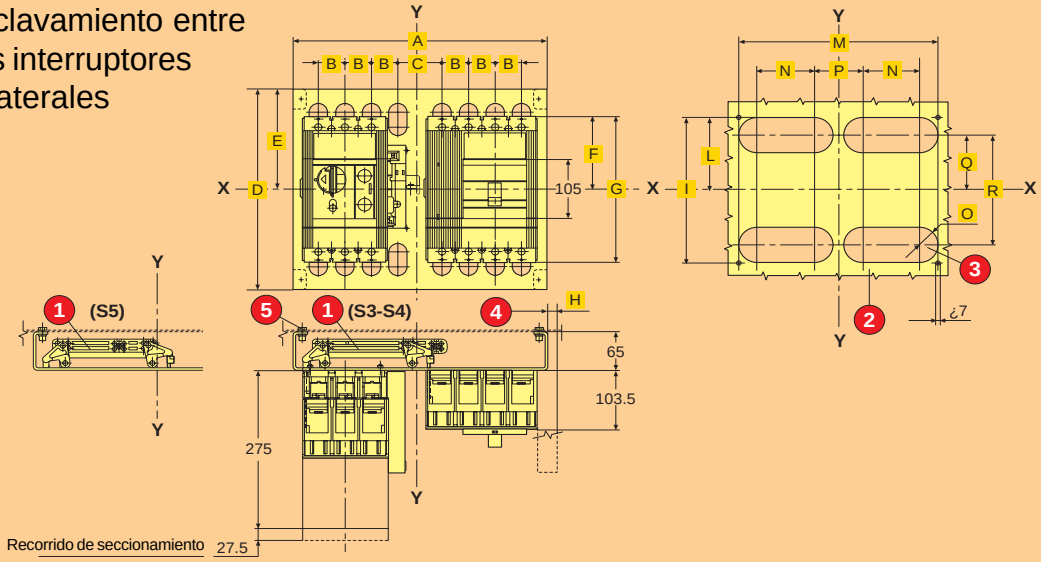
1. Marco para la puerta de la celda (incluido en el suministro)
2. Bloqueo de la puerta de la celda (si se solicita)
3. Taladrado de la puerta de la celda

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

	A	B	C
S3-S4	140	105	84
S5	183.75	140	101.5

Accesorios

Enclavamiento entre dos interruptores colaterales



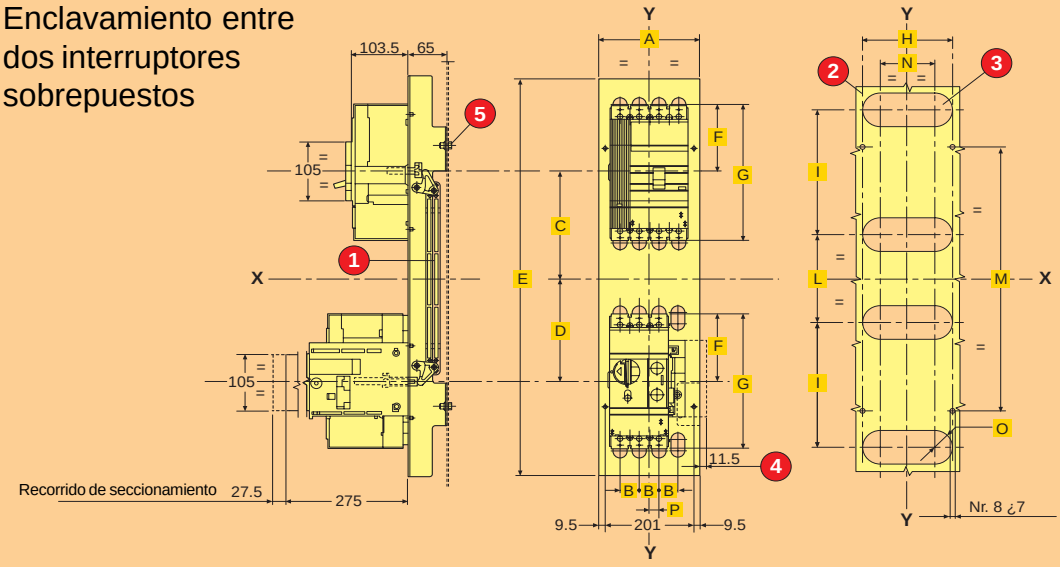
Leyenda

1. Dispositivo de enclavamiento
2. Plantilla para el taladrado de fijación de los interruptores en la chapal
3. Plantilla de taladrado para todas las ejecuciones con terminales posteriores
4. Dimensiones generales con ejecución extraíble tetrapolar montada a la derecha
5. Par de apriete 3,7 Nm

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
S3	350	35	66	265	135	87.3	170	12	227.5	116	324	95	R30	76	80.5	155
S4	350	35	66	350	173.5	125.3	254	12	315	156	324	95	R30	76	113.5	230
S5	430	43.75	83.5	350	173.5	125.3	254	16	315	156	402.5	115.5	R37.5	99.5	117	237.5

Enclavamiento entre dos interruptores sobrepuestos



Leyenda

1. Dispositivo de enclavamiento
2. Plantilla para el taladrado de fijación de los interruptores en la chapa
3. Plantilla de taladrado para todas las ejecuciones con terminales posteriores
4. Dimensiones generales con ejecución extraíble tetrapolar
5. Par de apriete 3,7 Nm

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

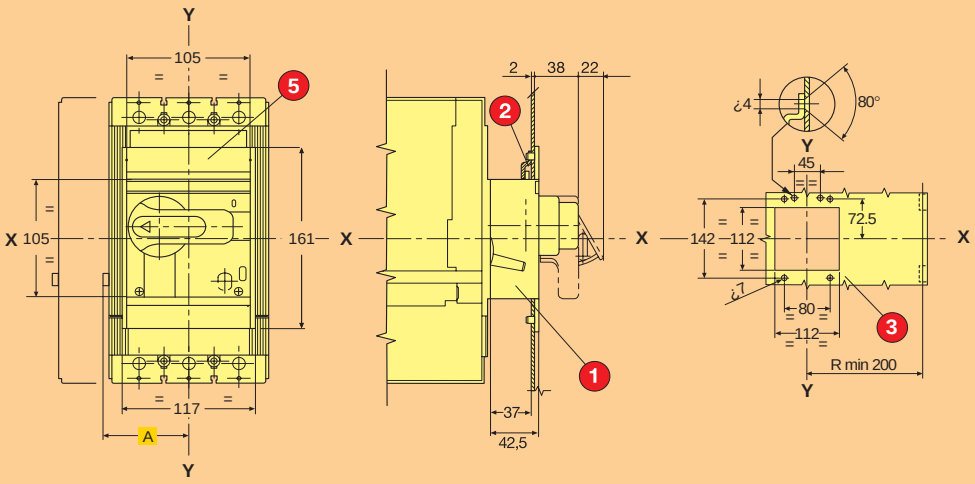
VSIS0512

	A	B	C	D	E	F	G	H	I	L	M	N	O	P
S3	180	35	152.5	157.5	578	87.5	170	157.5	227.5	82.5	350	95	R30	17.5
S4	180	35	198.5	195.5	750	125.3	254	157.5	230	164	490	95	R30	17.5
S5	220	43.75	198.5	195.5	750	125.3	254	201	237.5	156.5	490	115.5	R37.5	20

Dimensiones generales SACE S3-S4-S5

Accesorios

Mando giratorio en el interruptor fijo o enchufable



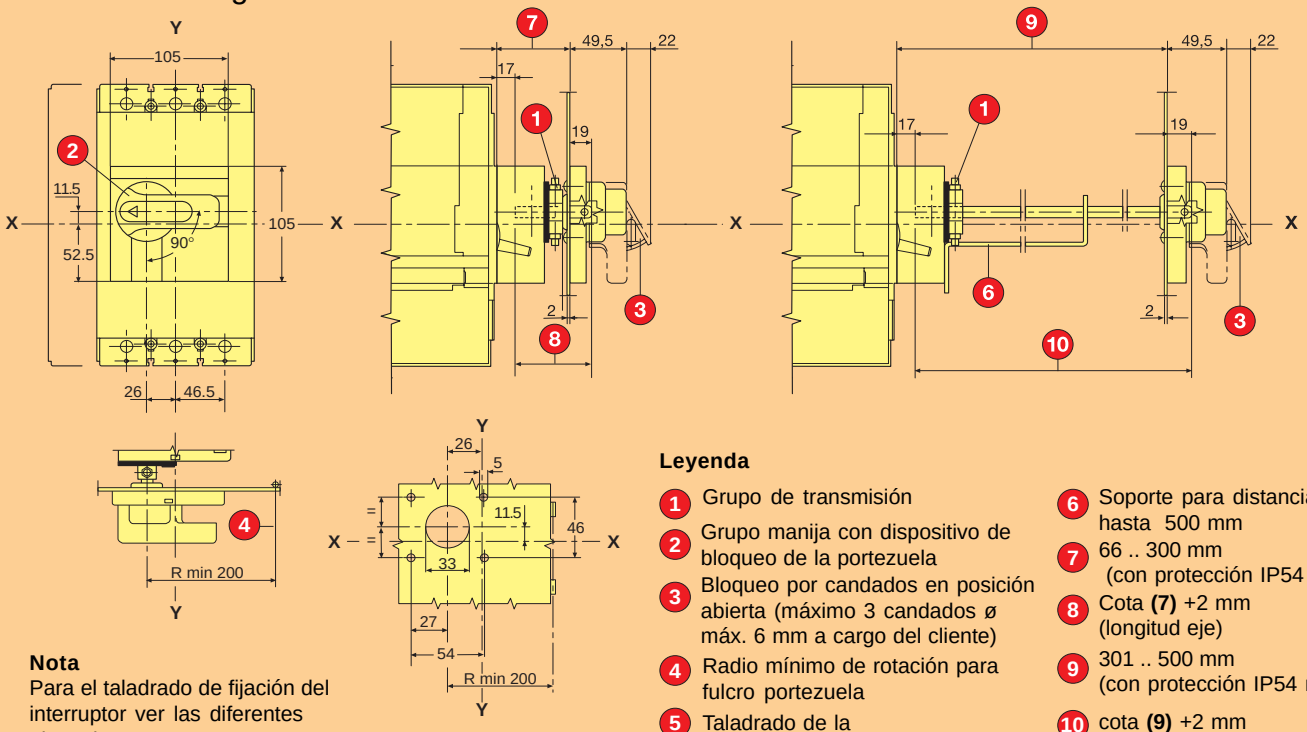
Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

Leyenda

1. Mando giratorio
2. Bloqueo para la puerta de la celda (si se solicita)
3. Taladrado de la puerta de la celda
4. Dimensiones generales para conector con contacto anticipado M.T.
5. Marco para la puerta de la celda (incluido en el suministro)

	A (4)
S3-S4 III	58
S3-S4 IV	93
S5 III	75.5
S5 IV	119.25

Mando giratorio en la puerta de la celda para interruptor fijo o enchufable con distancia regulable



Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

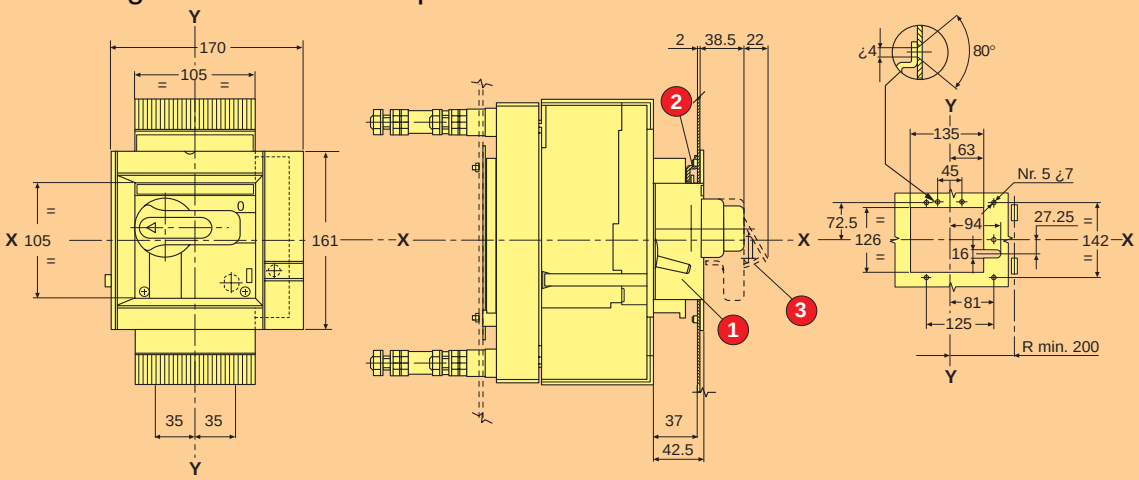
Leyenda

1. Grupo de transmisión
2. Grupo manija con dispositivo de bloqueo de la portezuela
3. Bloqueo por candados en posición abierta (máximo 3 candados ø máx. 6 mm a cargo del cliente)
4. Radio mínimo de rotación para fulcro portezuela
5. Taladrado de la portezuela
6. Soporte para distancia hasta 500 mm
7. 66 .. 300 mm (con protección IP54 mín. 90)
8. Cota **(7)** +2 mm (longitud eje)
9. 301 .. 500 mm (con protección IP54 mín. 325)
10. cota **(9)** +2 mm (longitud eje)

VSIS0513

Accesorios

Mando giratorio en el interruptor extraíble

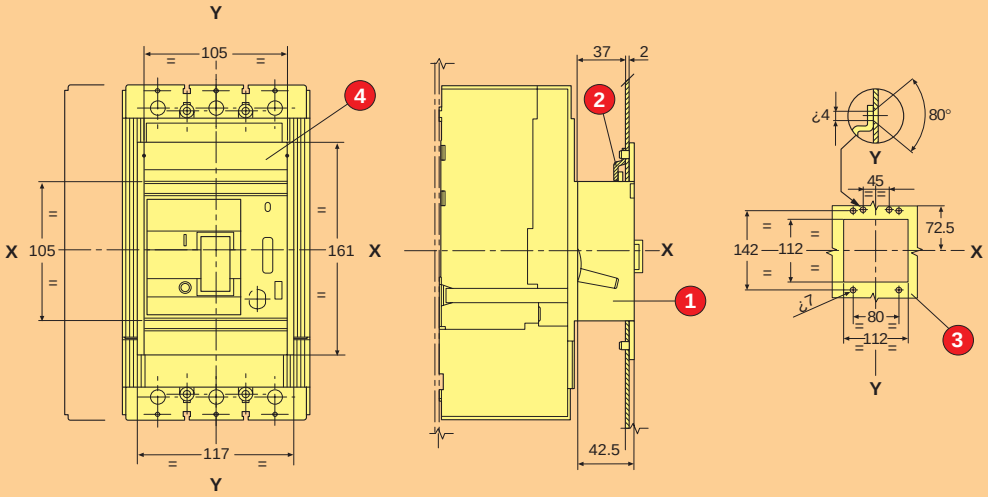


Leyenda

1. Mando giratorio en el interruptor
2. Bloqueo para la puerta de la celda (si se solicita)
3. Bloqueo por candados en posición abierta (máximo 3 candados ø máx. 6 mm a cargo del cliente)

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

Frente para mando a palanca

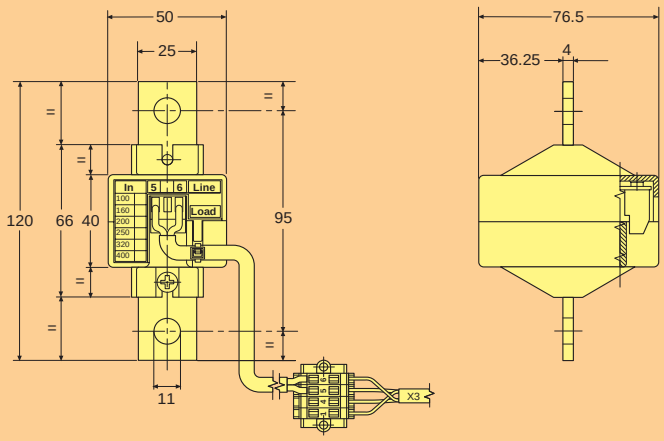


Leyenda

1. Frente para mando a palanca
2. Bloqueo para la puerta de la celda (si se solicita)
3. Taladrado de la puerta de la celda
4. Marco para la puerta de la celda (incluido en el suministro)

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

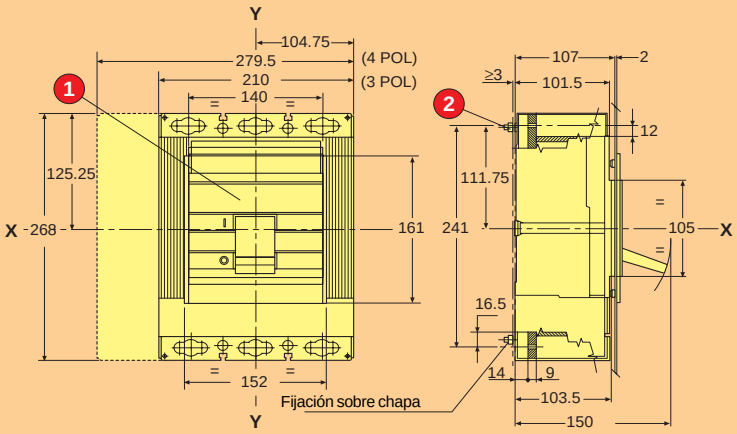
Neutro exterior para interruptores SACE S4-S5



VSIS0514

Dimensiones generales SACE S6

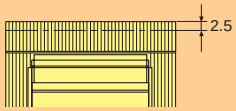
Interruptor fijo



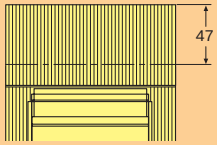
Cubrebornes

(si se solicitan, cuando no se incluyen en el suministro)

Bajos



Altos

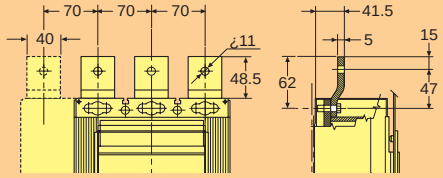


Leyenda

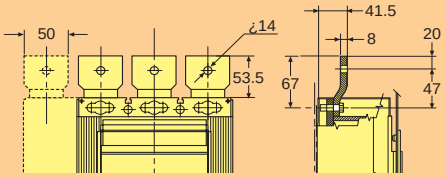
1. Marco para la puerta de la celda (incluido en el suministro)
2. Par de apriete 2 Nm

Terminales

Anteriores prolongados

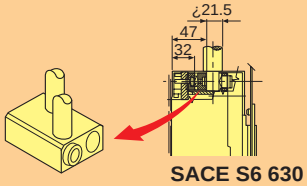


S6 630

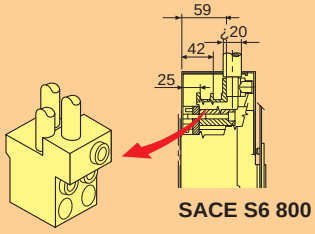


S6 800

Anteriores para cables de Cu/Al
(cubrebornes altos IP20 incluidos en el suministro para S6 800)

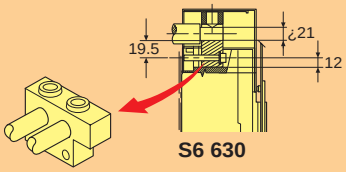


SACE S6 630

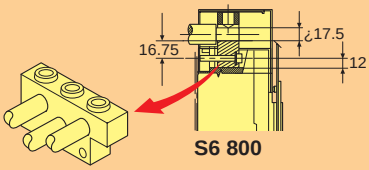


SACE S6 800

Para cables posteriores de Cu/Al
(cubrebornes altos IP20 incluidos en el suministro)

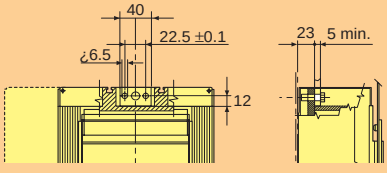


S6 630



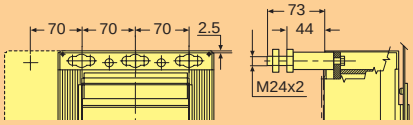
S6 800

Anteriores



SACE S6 630 - S6 800

Posteriores roscados
(cubrebornes bajos incluidos en el suministro)



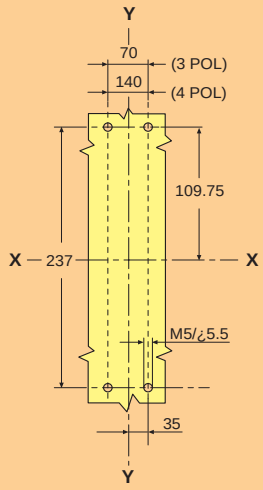
SACE S6 630 - S6 800

VSIS0515

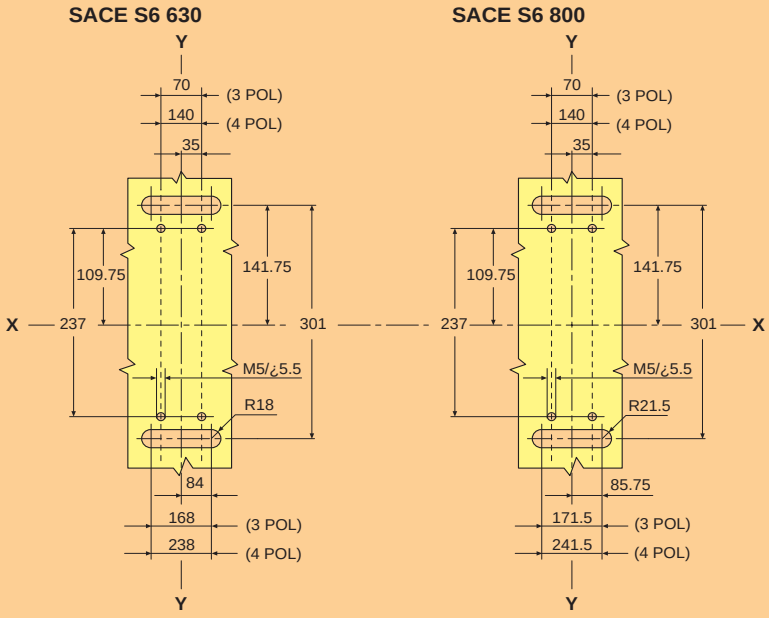
Fijaciones interruptor fijo

Plantilla de taladrado de la chapa de soporte (espesor mínimo de la chapa: 3 mm)

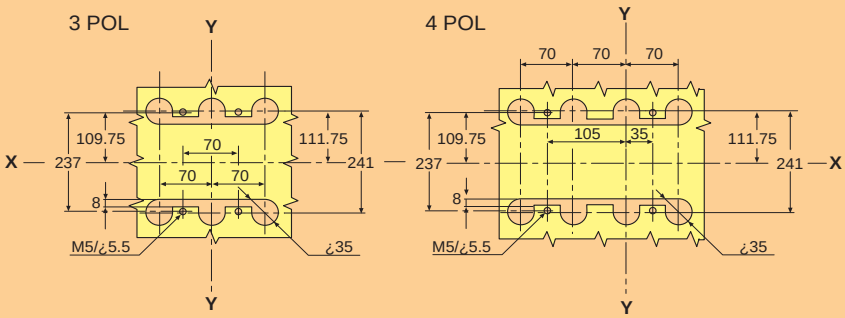
Para terminales:
Anteriores para conductor plano
Anteriores prolongados
Anteriores para cables



Para terminales para cables posteriores de Cu/Al

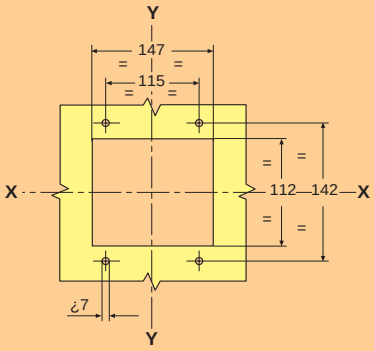


Para terminales posteriores roscados



Plantilla de taladrado de la puerta de la celda y fijación del marco

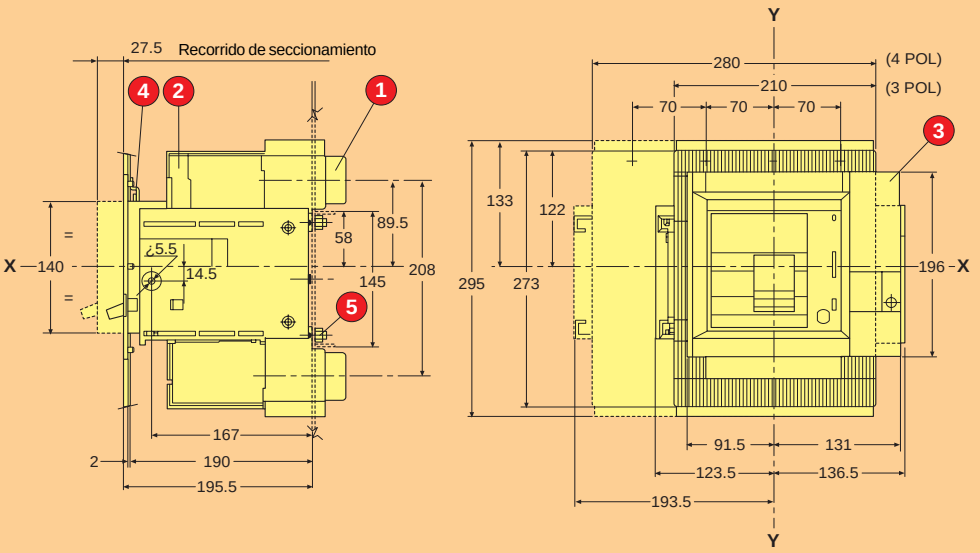
(espesor de la chapa: 2 mm)



VSIS0516

Dimensiones generales SACE S6

Interruptor extraíble

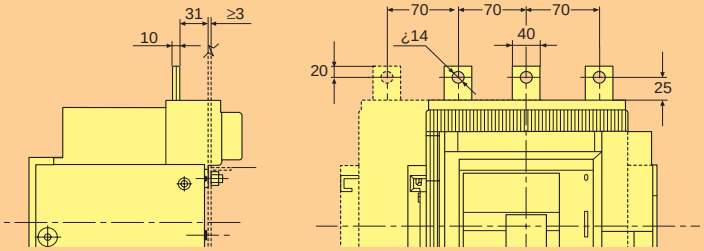


Leyenda

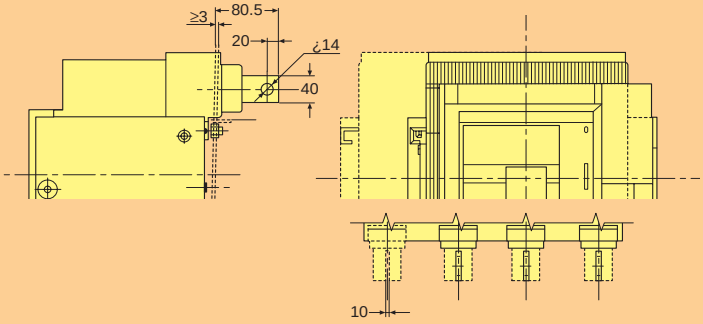
1. Parte fija
2. Parte móvil
3. Marco para la puerta de la celda (incluido en el suministro)
4. Bloqueo para la puerta de la celda (si se solicita)
5. Par de apriete 9 Nm

Terminales

Anteriores para SACE S6 630, S6 800



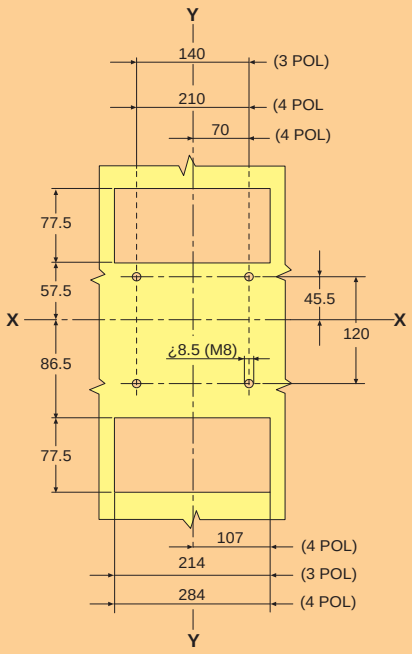
Posteriores en pletina horizontales o verticales para SACE S6 630, S6 800



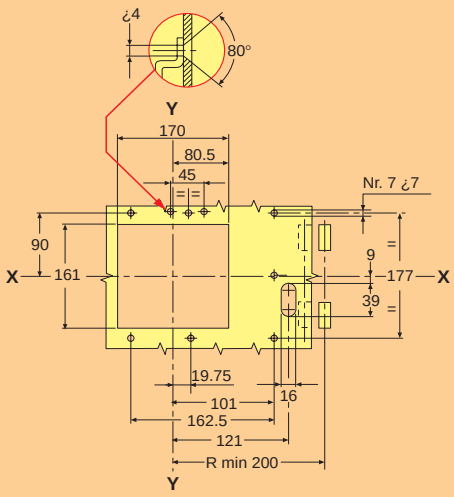
VSIS0517

Sujeciones para interruptor extraíble

Plantilla de taladrado de la chapa de soporte (espesor mínimo de la chapa: 3 mm)



Plantilla de taladrado de la puerta de la celda y fijación del marco (espesor de la chapa: 2 mm)

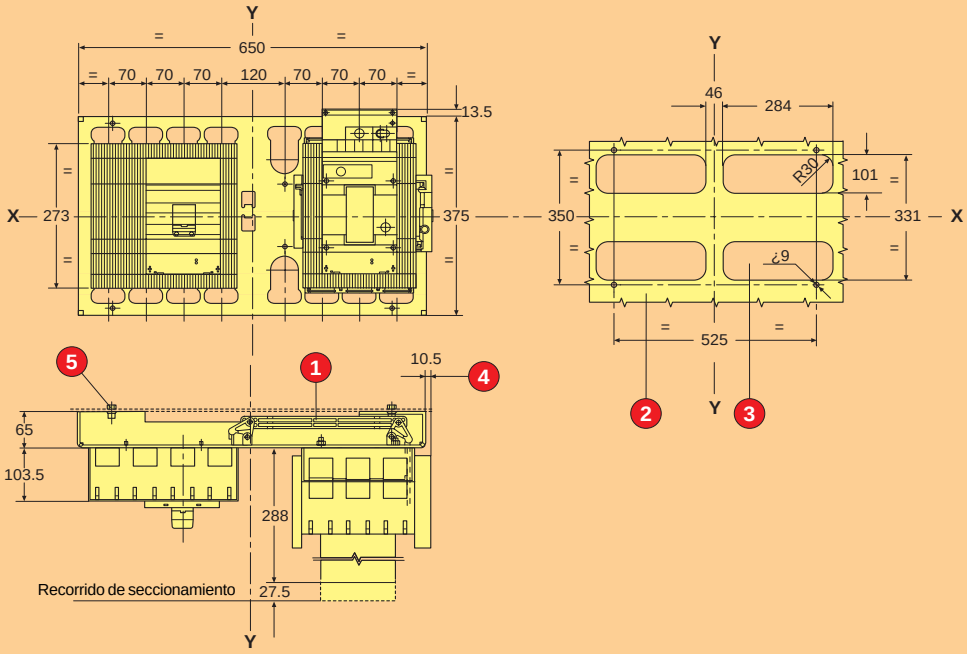


VSIS0518

Dimensiones generales SACE S6

Accesorios

Enclavamiento entre dos interruptores colaterales

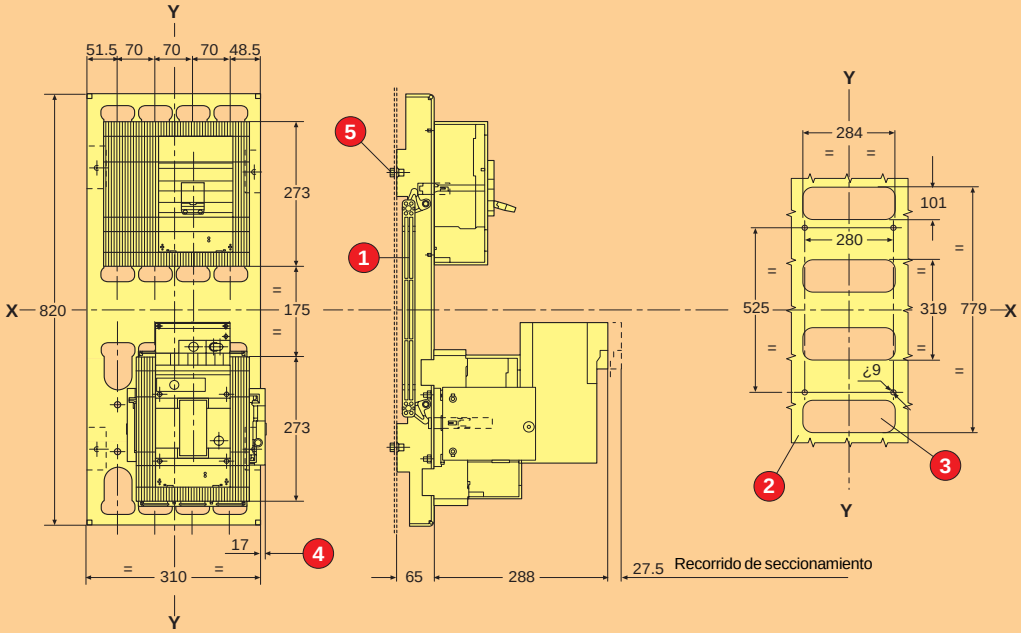


Leyenda

1. Dispositivo de enclavamiento
2. Plantilla para el taladrado de fijación de los interruptores en la chapa
3. Plantilla de taladrado para todas las ejecuciones con terminales posteriores
4. Dimensiones generales con ejecución extraíble montada a la derecha
5. Par de apriete 9 Nm

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

Enclavamiento entre dos interruptores sobrepuestos



Leyenda

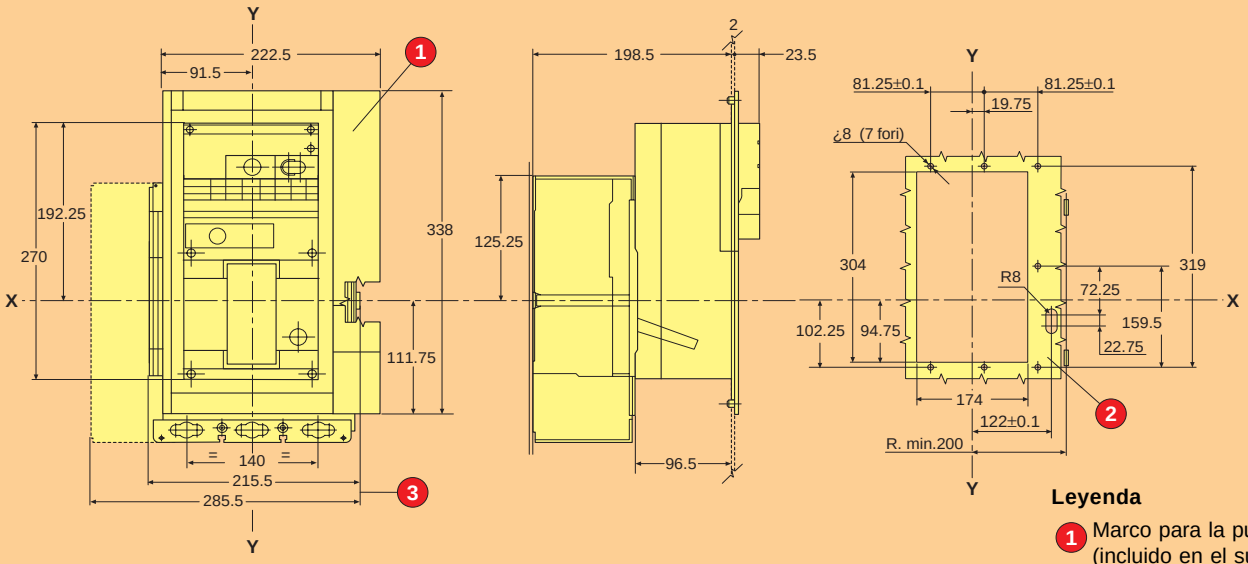
1. Dispositivo de enclavamiento
2. Plantilla para el taladrado de fijación de los interruptores en la chapa
3. Plantilla de taladrado para todas las ejecuciones con terminales posteriores
4. Dimensiones generales con ejecución extraíble montada en la parte inferior
5. Par de apriete 9 Nm

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

VSIS0519

Accesorios

Mando a motor para interruptor fijo

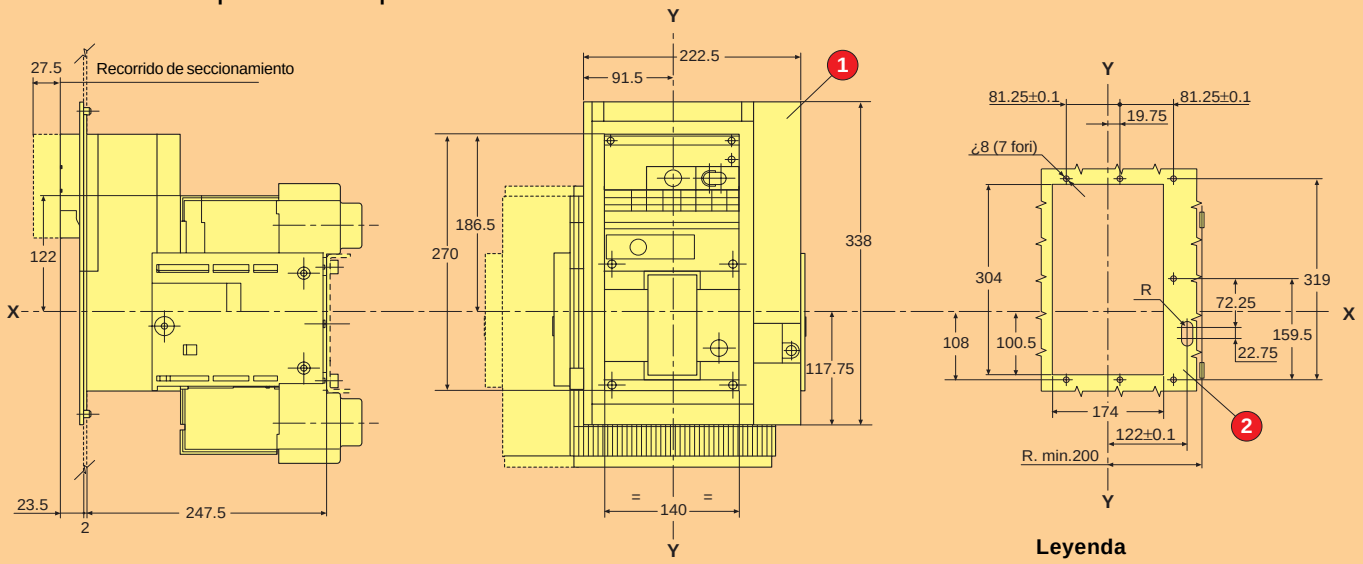


Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

Leyenda

1. Marco para la puerta de la celda (incluido en el suministro)
2. Plantilla para el taladrado de la puerta de la celda
3. Dimensiones generales con conectores

Mando a motor para interruptor extraíble



Leyenda

1. Marco para la puerta de la celda (incluido en el suministro)
2. Plantilla para el taladrado de la puerta de la celda

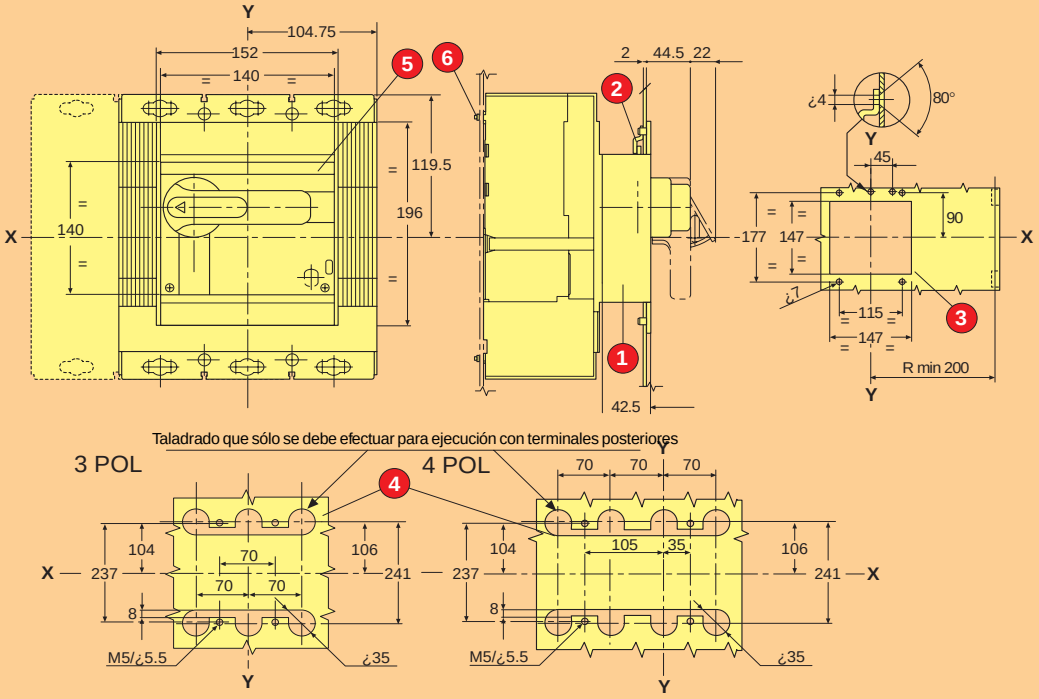
Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

VSIS0520

Dimensiones generales SACE S6

Accesorios

Mando giratorio en el interruptor fijo

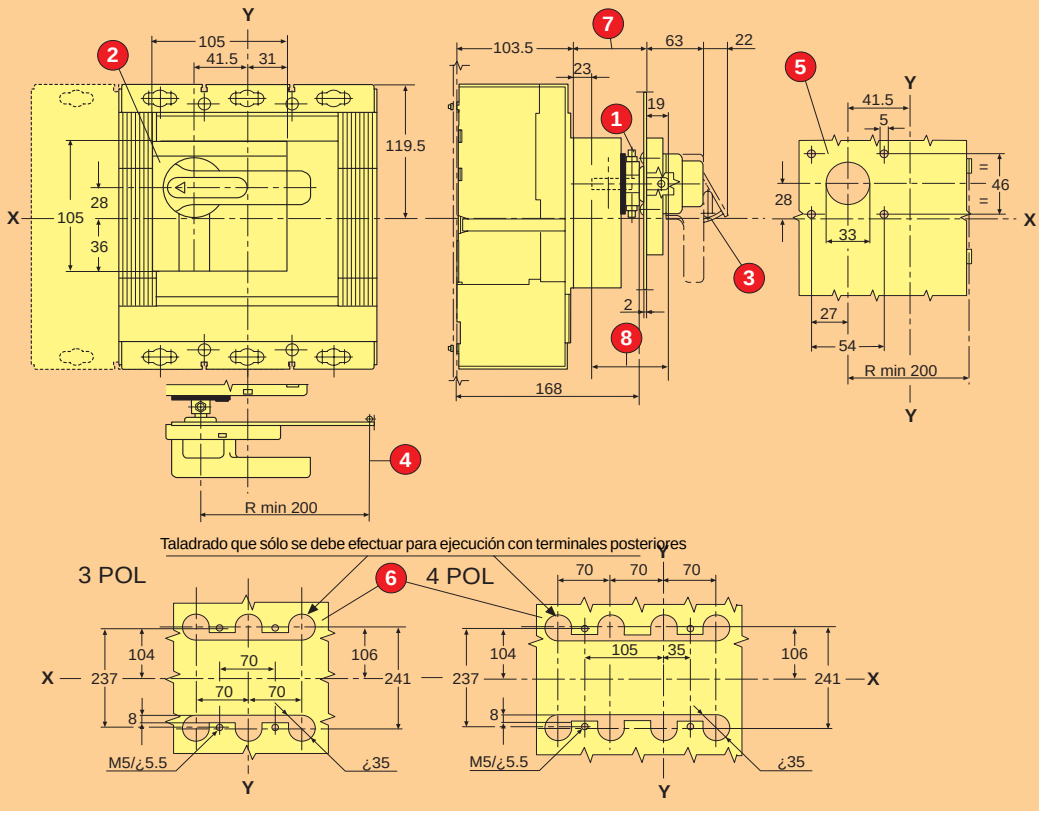


Leyenda

1. Mando giratorio en el interruptor
2. Bloqueo para la puerta de la celda (si se solicita)
3. Taladrado de la puerta de la celda
4. Plantilla de taladrado de fijación del interruptor en la chapa
5. Marco para la puerta de la celda (incluido en el suministro)
6. Par de apriete 2 Nm

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

Mando giratorio en la puerta de la celda para interruptor fijo a distancia regulable



Leyenda

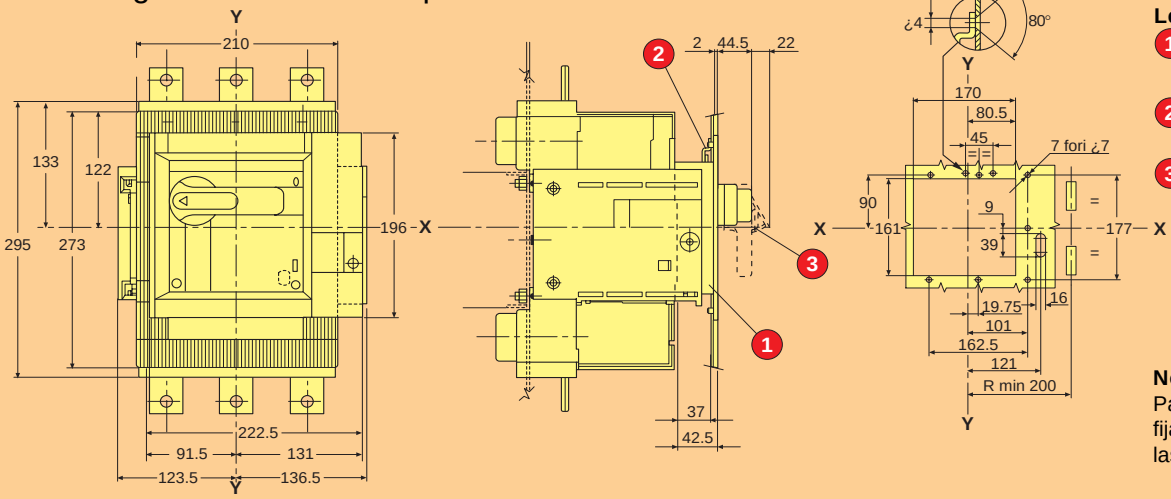
1. Grupo de transmisión
2. Grupo manija con dispositivo bloqueo de la portezuela
3. Dispositivo de bloqueo por candados (máximo 3 candados ø máx. 6 mm a cargo del cliente sólo en posición de interruptor abierto)
4. Radio mínimo de rotación para fulcro de la portezuela
5. Plantilla de taladrado de la puerta de la celda
6. Plantilla para el taladrado de fijación del interruptor en la chapa 7,72 .. 506 mm (con protección IP54 mín. 96)
7. 72..506 mm (con protección IP54 mín. 96)
8. Cota **(7)** -4 mm (longitud eje)

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

VSIS0521

Accesorios

Mando giratorio en el interruptor extraíble

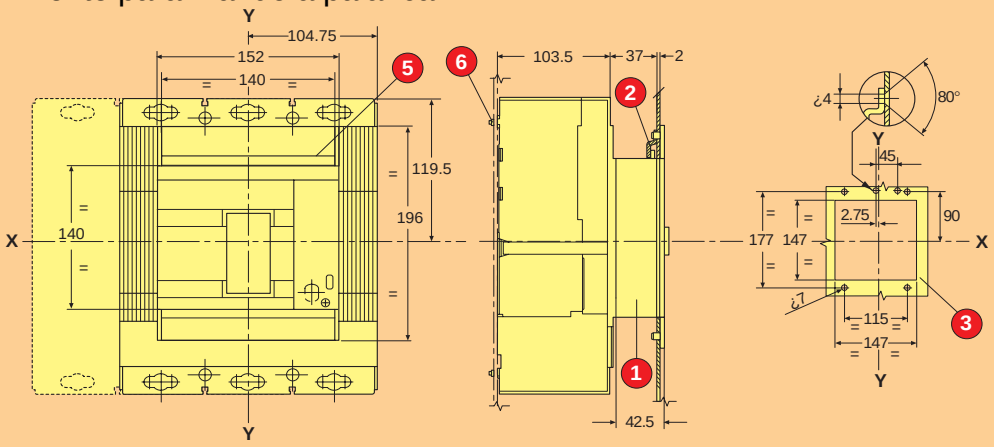


Leyenda

1. Mando giratorio en el interruptor
2. Bloqueo para la puerta de la celda (si se solicita)
3. Bloqueo por candados en posición abierta (máximo 3 candados o máx. 6 mm a cargo del cliente)

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

Frente para mando a palanca

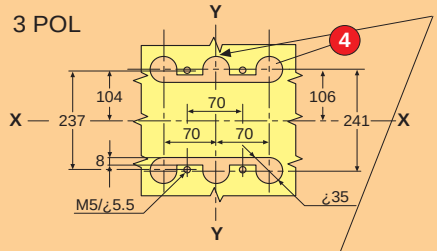


Leyenda

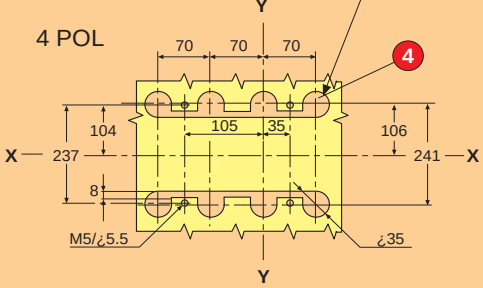
1. Mando giratorio en el interruptor
2. Bloqueo para la puerta de la celda (si se solicita)
3. Taladrado de la puerta de la celda
4. Plantilla de taladrado de fijación del interruptor en la chapa
5. Marco para la puerta de la celda (incluido en el suministro)
6. Par de apriete 2 Nm

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

3 POL

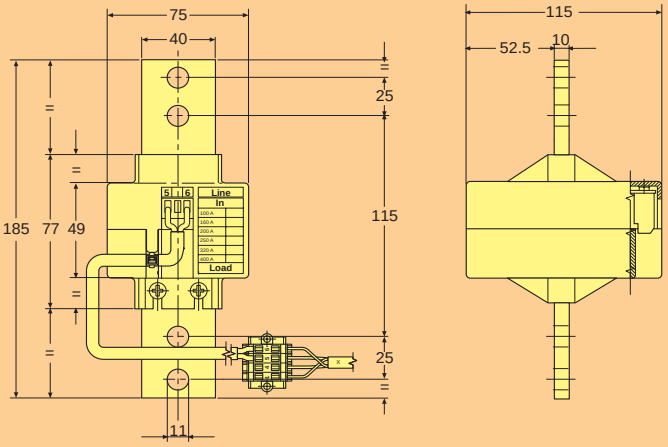


4 POL



Taladrado que sólo se debe efectuar para ejecución con terminales posteriores

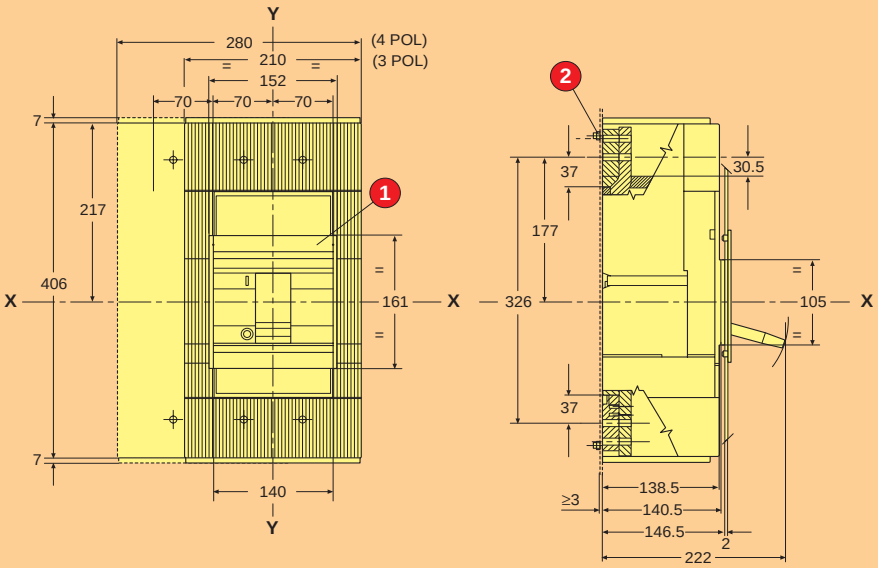
Neutro exterior



VSIS0522

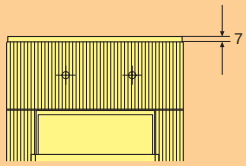
Dimensiones generales SACE S7

Interruptor fijo



Cubrebornes

Bajos

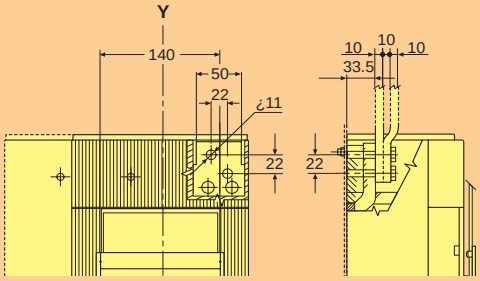


Leyenda

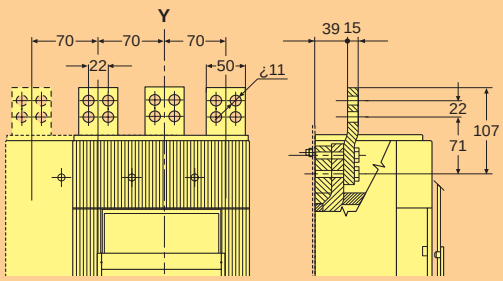
1. Marco para la puerta de la celda (incluido en el suministro)
2. Par de apriete 2 Nm

Terminales

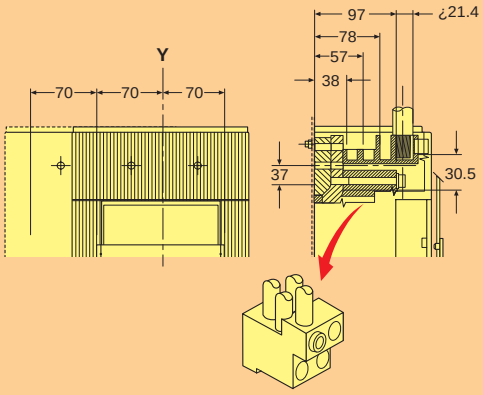
Anteriores



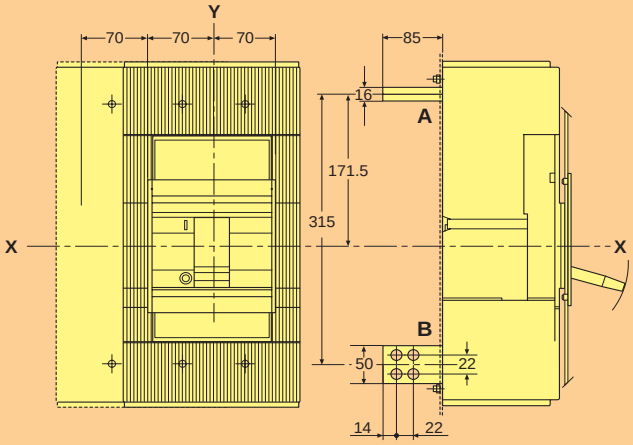
Anteriores prolongados



Anteriores para cables de Cu/Al para S7 1250



Posteriores en pletina horizontales o verticales



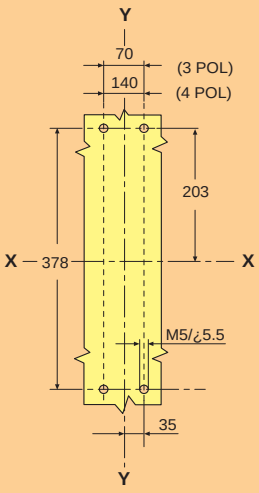
A = montaje horizontal
B = montaje vertical

VSIS0523

Fijaciones interruptor fijo

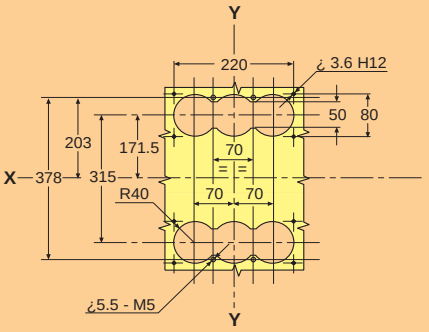
Plantilla de taladrado de la chapa de soporte (espesor mínimo de la chapa: 3 mm)

Para terminales:
Anteriores
Anteriores prolongados
Anteriores para cables de Cu/Al

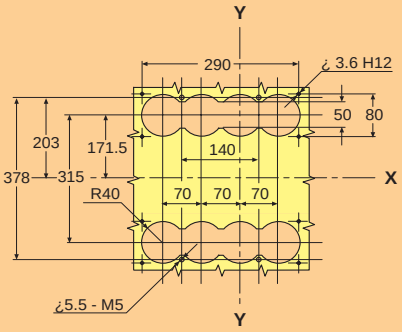


Para terminales posteriores en pletina

3 POL

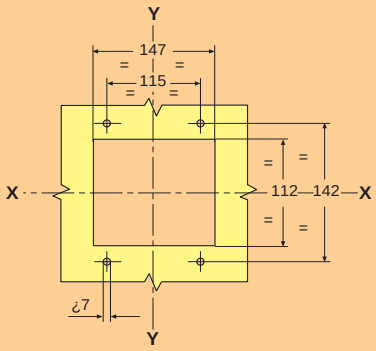


4 POL



Plantilla de taladrado de la puerta de la celda y fijación del marco

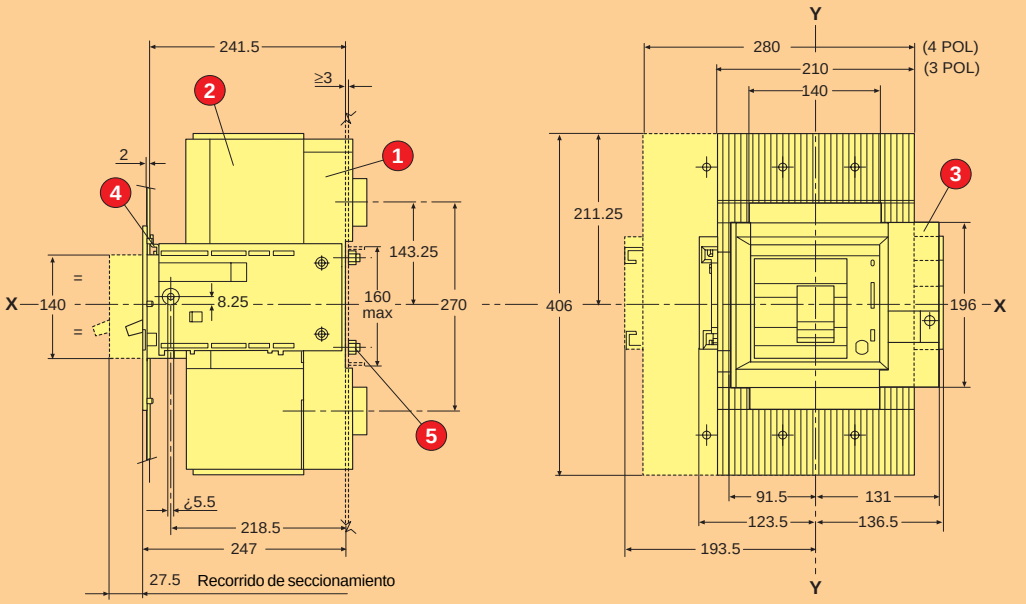
(thickness of sheet metal: 2 mm)



VSIS0524

Dimensiones generales SACE S7

Interruptor extraíble

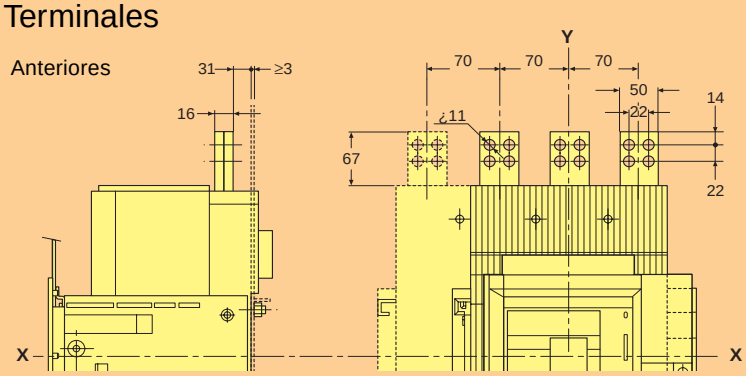


Leyenda

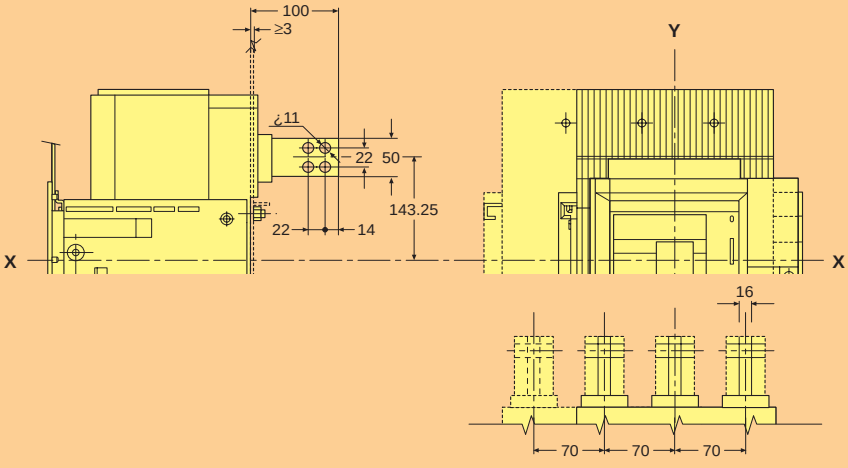
1. Parte fija
2. Parte móvil
3. Marco para la puerta de la celda (incluido en el suministro)
4. Bloqueo para la puerta de la celda (si se solicita)
5. Par de apriete 9 Nm

Terminales

Anteriores



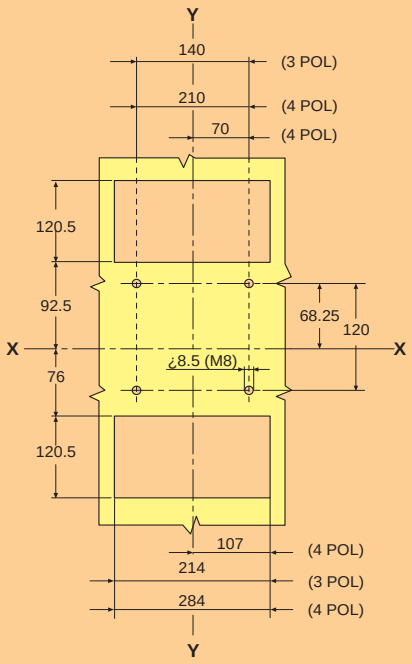
Posteriores en pletina horizontales o verticales



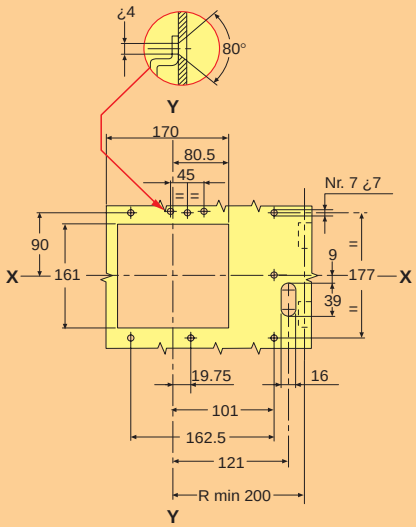
VSIS0525

Fijaciones interruptor extraíble

Plantilla de taladrado de la chapa o perfil de soporte (Espesor mínimo de la chapa: 3 mm)



Plantilla de taladrado de la puerta de la celda y fijación del marco (espesor de la chapa: 2 mm)

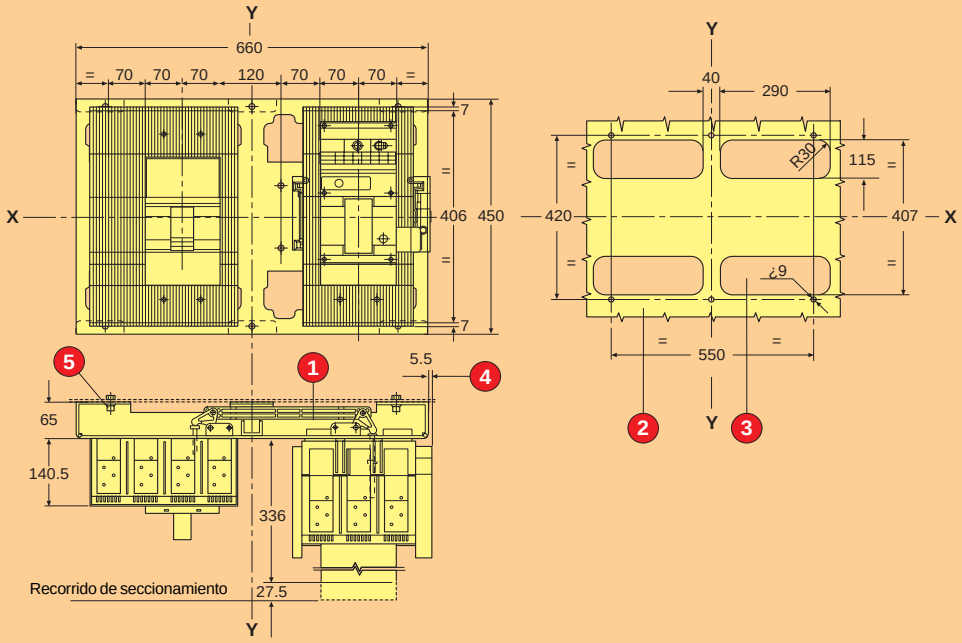


VSIS0526

Dimensiones generales SACE S7

Accesorios

Enclavamiento entre dos interruptores colaterales

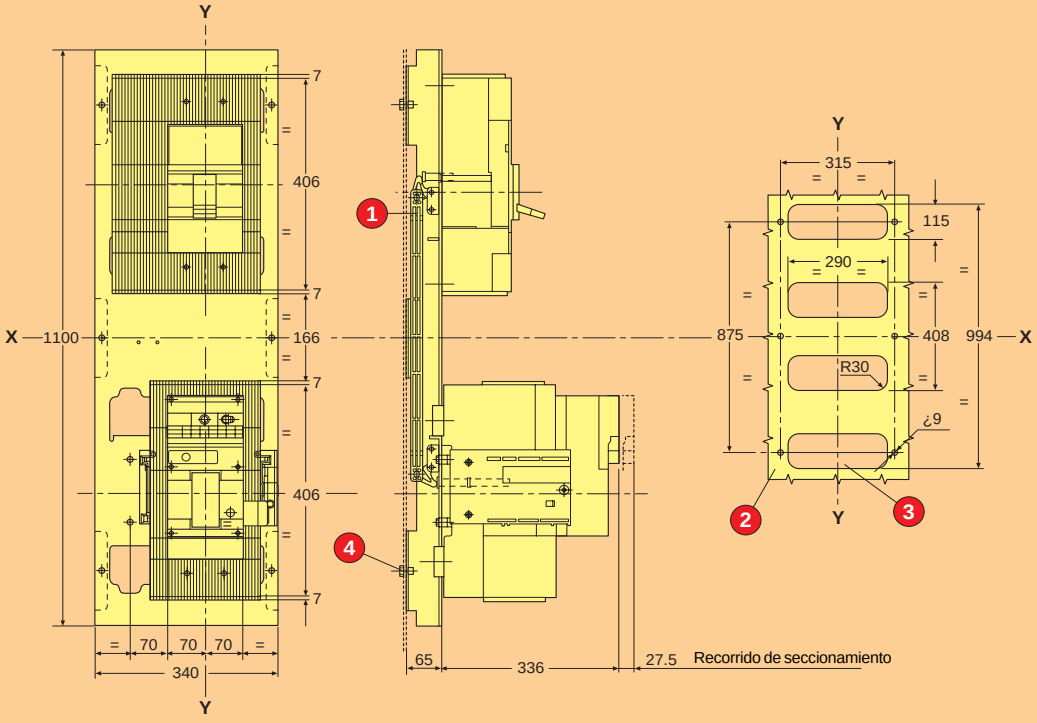


Leyenda

1. Dispositivo de enclavamiento
2. Plantilla para el taladrado de fijación del interruptor en la chapa
3. Plantilla de taladrado para todas las ejecuciones con terminales posteriores
4. Dimensiones generales con ejecución extraíble montada a la derecha
5. Par de apriete 9 Nm

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

Enclavamiento entre dos interruptores sobrepuestos



Leyenda

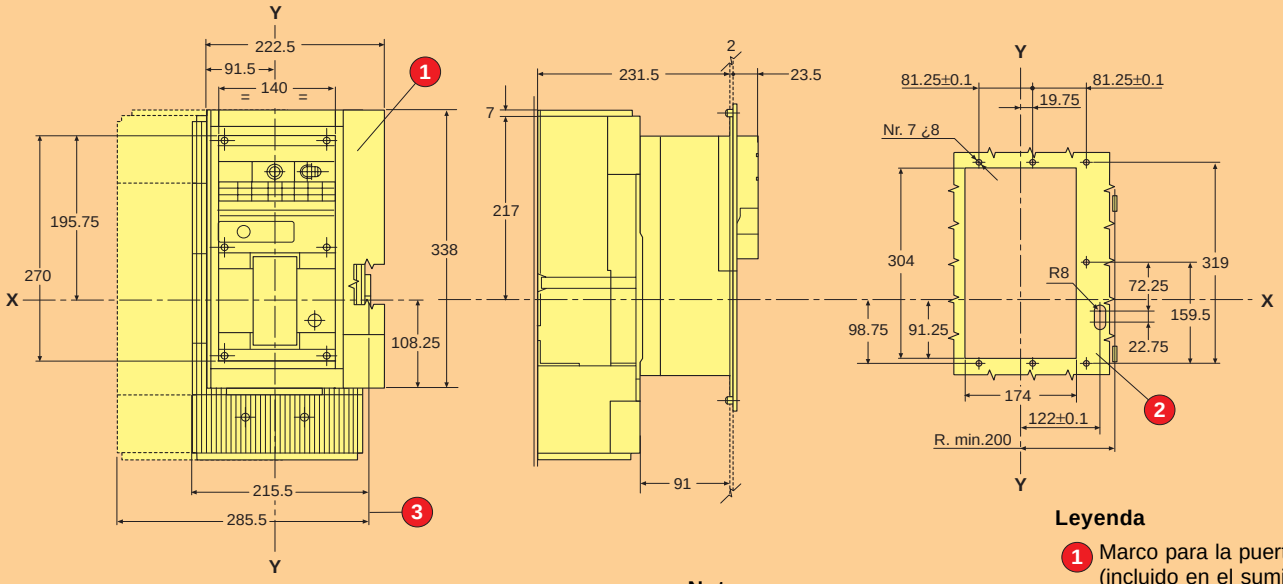
1. Dispositivo de enclavamiento
2. Plantilla para el taladrado de fijación del interruptor en la chapa
3. Plantilla de taladrado para todas las ejecuciones con terminales posteriores
4. Par de apriete 9 Nm

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

VSIS0527

Accesorios

Mando a motor para interruptor fijo

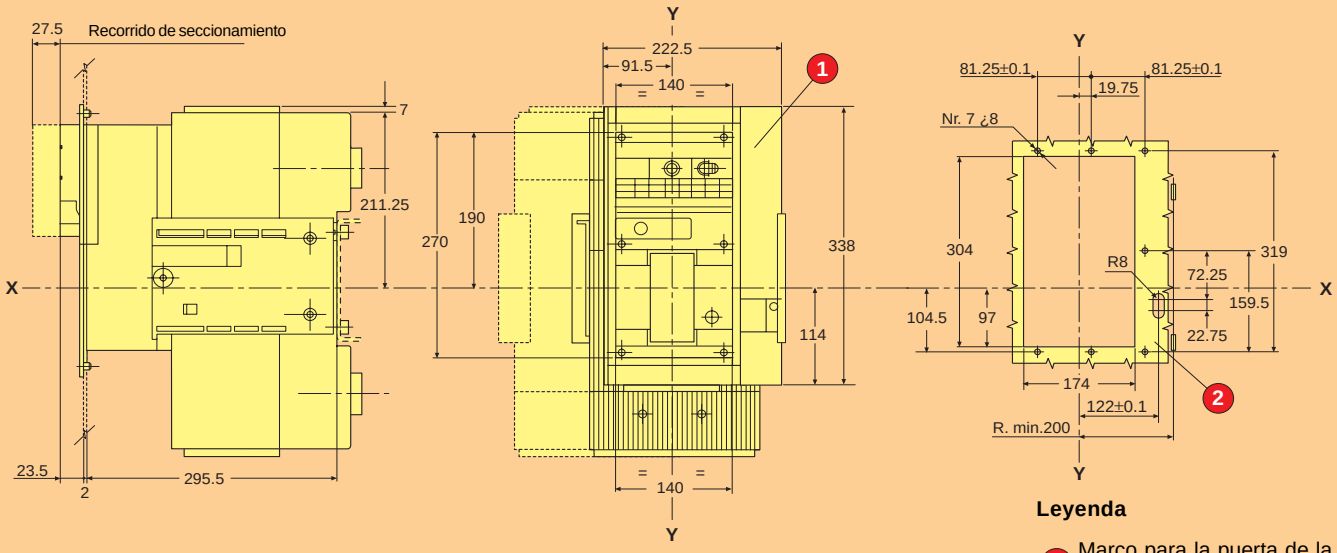


Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

Leyenda

1. Marco para la puerta de la celda (incluido en el suministro)
2. Plantilla para el taladrado de la puerta de la celda
3. Dimensiones generales con conectores

Mando a motor para interruptor extraíble



Leyenda

1. Marco para la puerta de la celda (incluido en el suministro)
2. Plantilla para el taladrado de la puerta de la celda

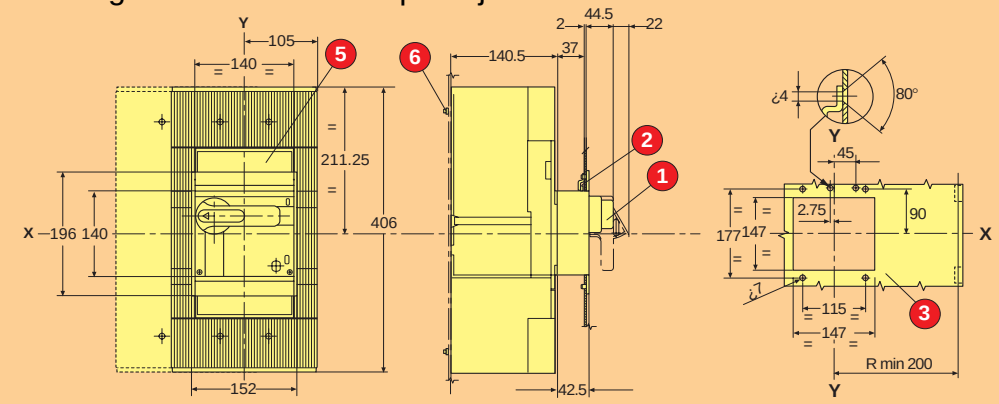
Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

VSIS0528

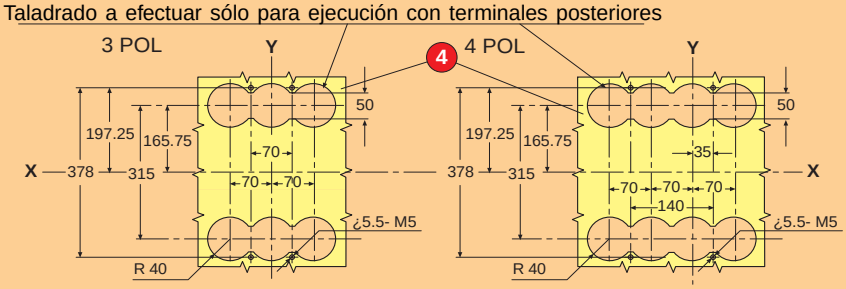
Dimensiones generales SACE S7

Accesorios

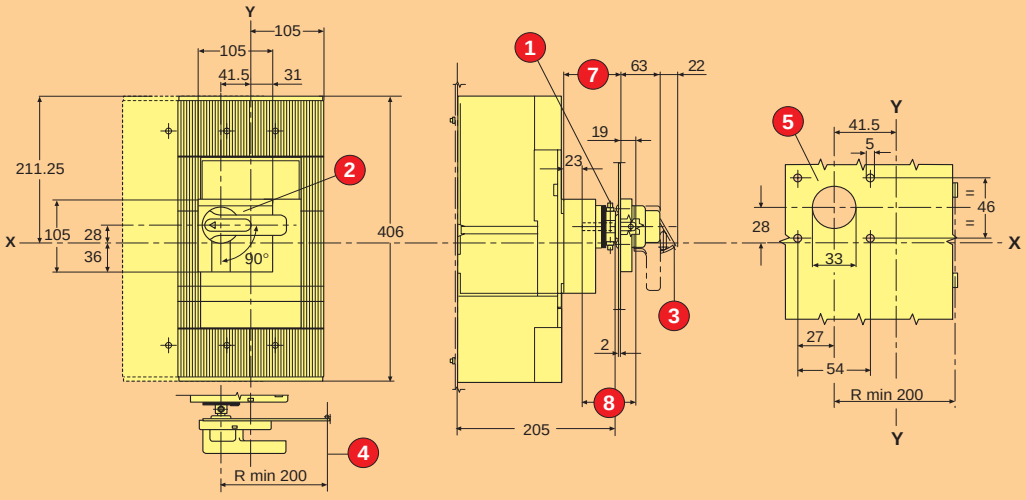
Mando giratorio en el interruptor fijo



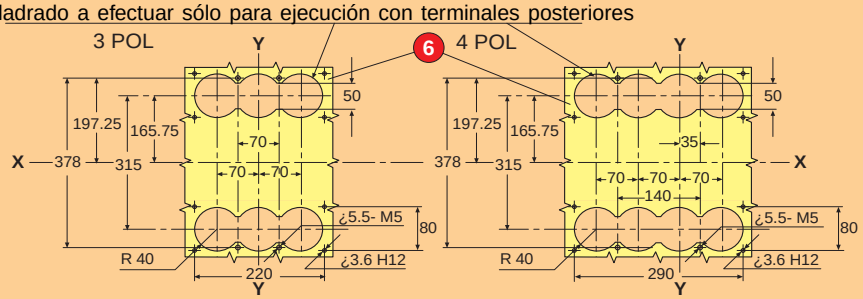
Taladrado a efectuar sólo para ejecución con terminales posteriores



Mando giratorio en la puerta de la celda para interruptor fijo



Taladrado a efectuar sólo para ejecución con terminales posteriores



Leyenda

1. Mando giratorio en el interruptor
2. Bloqueo para la puerta de la celda (si se solicita)
3. Taladrado de la puerta de la celda
4. Plantilla de taladrado de fijación del interruptor en la chapa
5. Marco para la puerta de la celda (incluido en el suministro)
6. Par de apriete 2 Nm

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

Leyenda

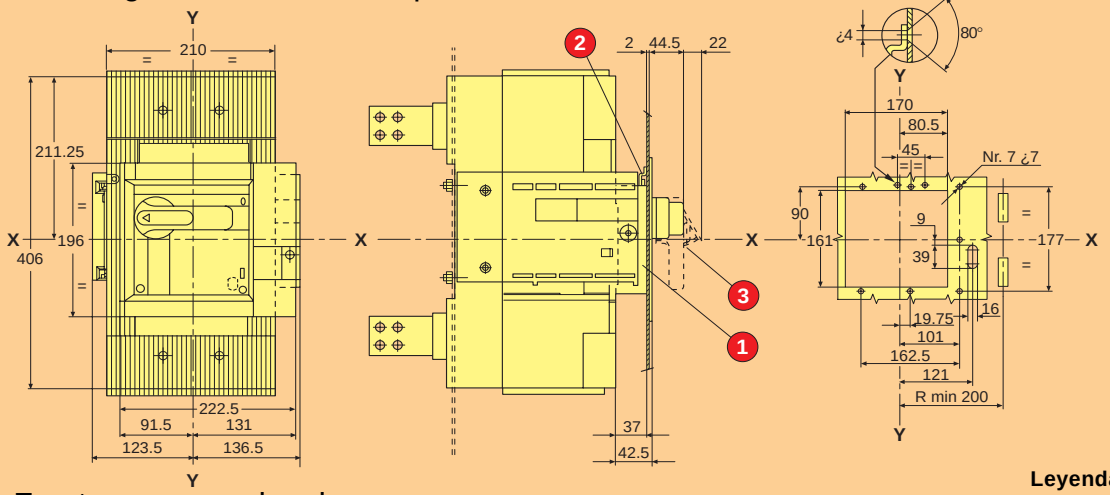
1. Grupo de transmisión
2. Grupo manija con dispositivo de bloqueo de la portezuela
3. Dispositivo de bloqueo por candados (máximo 3 candados ø máx. 6 mm a cargo del cliente sólo en posición de interruptor abierto)
4. Radio mínimo de rotación para fulcro portezuela
5. Plantilla de taladrado de la puerta de la celda
6. Plantilla para el taladrado de fijación del interruptor en la chapa
7. 72 .. 506 mm (con protección IP54 mín. 96)
8. Cota **(7)** - 4 mm (longitud eje)

Nota
Para las dimensiones generales de los interruptores ver las diferentes ejecuciones

VSIS0529

Accesorios

Mando giratorio en el interruptor extraíble

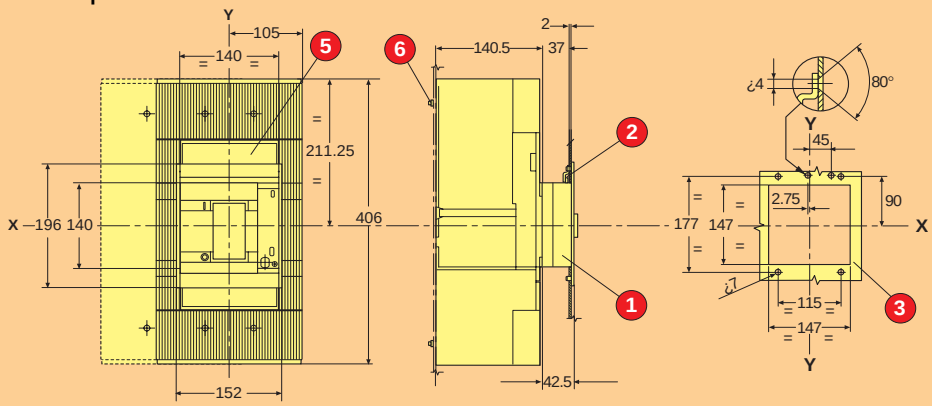


Leyenda

1. Mando giratorio en el interruptor
2. Bloqueo para la puerta de la celda (si se solicita)
3. Bloqueo por candados en posición abierta (máximo 3 candados ø máx. 6 mm a cargo del cliente)

Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

Frente para mando a leva

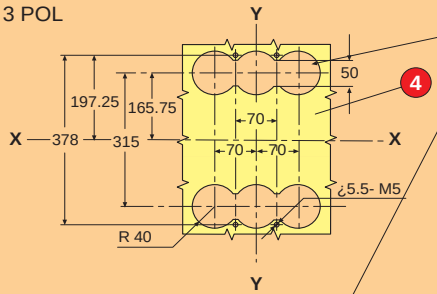


Leyenda

1. Frente para mando a palanca
2. Bloqueo para la puerta de la celda (si se solicita)
3. Taladrado de la puerta de la celda
4. Plantilla de taladrado de fijación del interruptor en la chapa
5. Marco para la puerta de la celda (incluido en el suministro)
6. Par de apriete 2 Nm

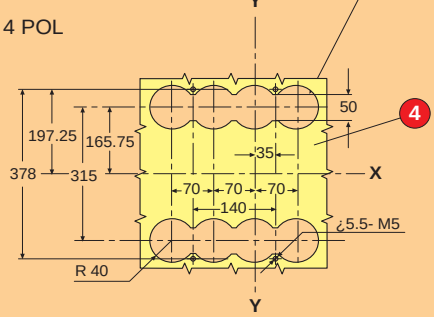
Nota
Para el taladrado de fijación del interruptor ver las diferentes ejecuciones

3 POL

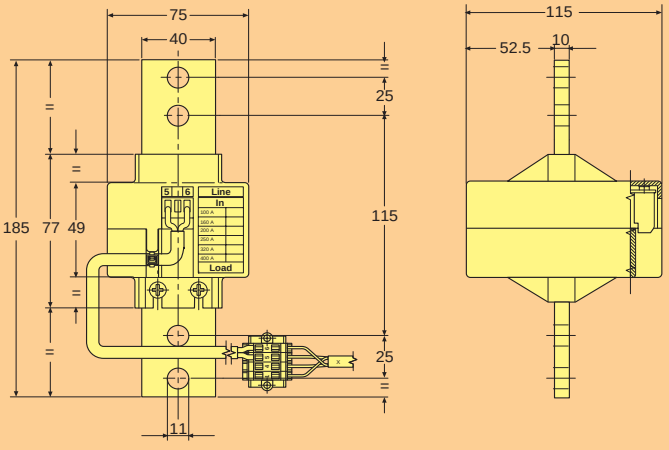


Taladrado a efectuar sólo para ejecución con terminales posteriores

4 POL



Neutro exterior



VSIS0530

Distancias de respeto

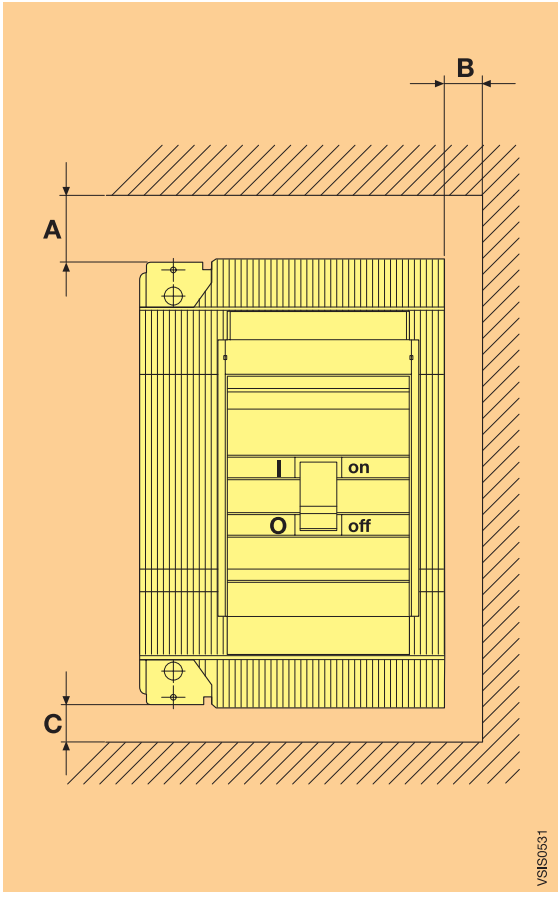
Distancias de respeto

– entre el interruptor y la pared superior (A)
– entre el interruptor y la pared lateral (B)
– entre el interruptor y la pared inferior (C)
con pared de masa o pared de masa protegida con hoja aislante.

Distancias de aislamiento para la instalación en cubículo metálico

	Pared de masa			
Interruptor	**A** ($U_b \geq 415V$)	**A**(*) ($U_b \geq 440V$)	**B**	**C**
	[mm]	[mm]	[mm]	[mm]
S1	25	50	20	20
S2	25	50	20	20
S3	35	100	25	20
S4	35	100	25	20
S5	35	100	25	20
S6	35	100	25	20
S7	50	100	30	20

(*) son las cotas válidas para las tensiones de ejercicio > 440V y para los interruptores con poder de corte de nivel L.



Distancias de aislamiento para instalación en cubículo aislado

	Pared aislada		
Interruptor	**A**	**B**	**C**
	[mm]	[mm]	[mm]
S1	25	0	20
S2	25	0	20
S3	35	0	25
S4	35	0	25
S5	35	0	25
S6	35	10	25
S7	50	10	30

Las dimensiones indicadas son válidas con tensiones de ejercicio Ub hasta 690 V.
Las distancias de respeto se deben añadir a las dimensiones generales máximas de los interruptores en las diferentes ejecuciones, incluidos los terminales.

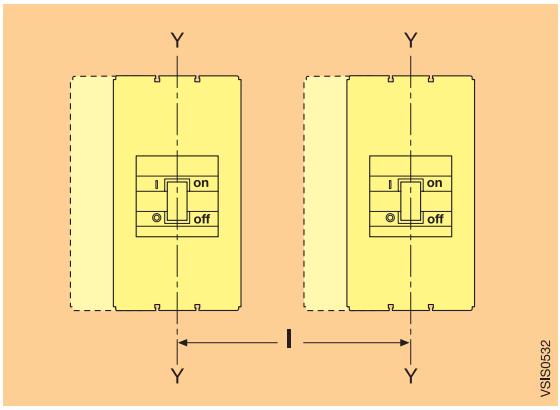
Entreejees mínimo entre dos interruptores colaterales o sobrepuestos

Para el montaje colateral o sobrepuesto controlar que las barras o los cables de conexión no reduzcan las distancias de aislamiento en línea de aire.

Entreejes mínimo para interruptores colaterales

	Anchura del interruptor [mm]		I [mm]	
Interruptor	**3p**	**4p**	**3p**	**4p**
S1	78	103	**78/93**(*)	**103/118**(*)
S2	90	120	**90/105**(*)	**120/135**(*)
S3	105	140	**105/119**(*)	**140**
S4	105	140	**105/119**(*)	**140**
S5	140	184	**140**	**185**
S6	210	280	**210**	**280**
S7	210	280	**210**	**280**

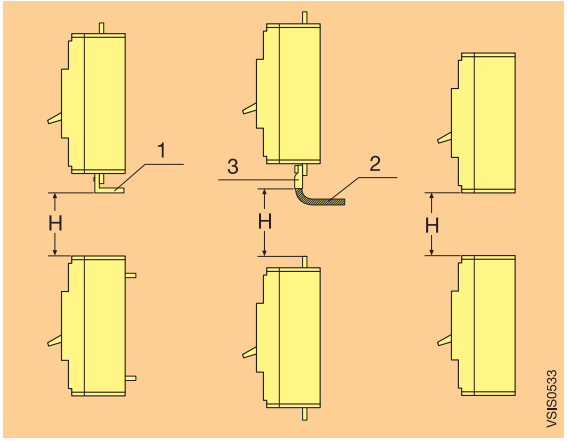
(*) son las cotas de respeto referidas a los interruptores dotados con marco para la puerta de la celda o de salidas laterales de los conductores.



Los entreejes se refieren al montaje de interruptores fijos y enchufables. Para el montaje de los interruptores extraíbles SACE S3, S4, S5, S6 y S7, ver las dimensiones generales de un perfil metálico de sostén que se debe colocar entre las guías de las partes fijas de lo dos interruptores contiguos.

Entreejes mínimo para interruptores sobrepuestos

	H
Interruptor	[mm]
S1	60
S2	90
S3	140
S4	140
S5	140
S6	180
S7	180



1 Conexión no aislada
2 Cable aislado
3 Terminal para cable

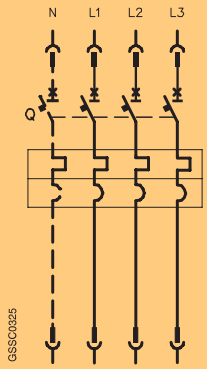
Esquemas eléctricos.
Estado de funcionamiento representado

El esquema se representa en las siguientes condiciones:
– interruptor en ejecución fija enchufable o extraíble (en función del tipo de interruptor), abierto e insertado
– circuitos sin tensión
– relés no intervenidos
– mando a motor con resortes cargados (para interruptores S6-S7).

El interruptor sólo está dotado con las aplicaciones especificadas en la confirmación de pedido de ABB SACE. Para redactar el pedido, consultar el presente catálogo.

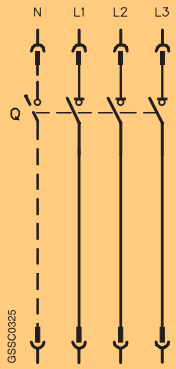
SACE S1-S2-S3-S5-S6

Interruptor tripolar o tetrapolar con relé termomagnético



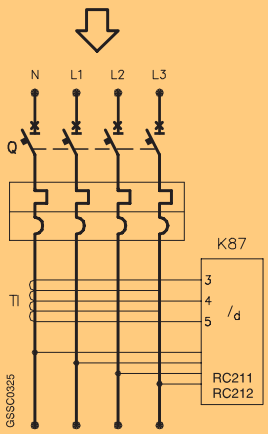
SACE S3D-S6D-S7D

Interruptor de maniobra-seccionador tripolar o tetrapolar

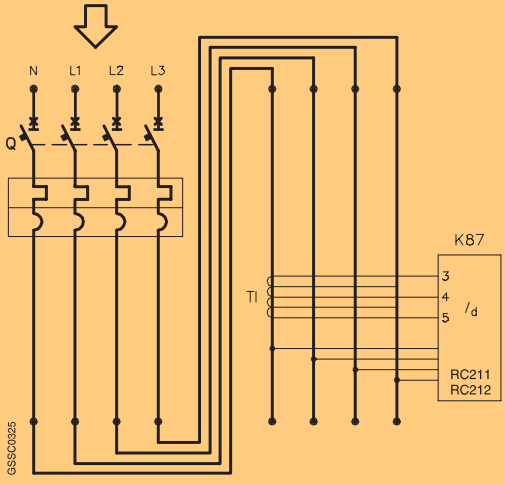


SACE S1-S2-S3

Interruptor tetrapolar en ejecución fija con relé diferencial en la parte inferior SACE RC211 o RC212

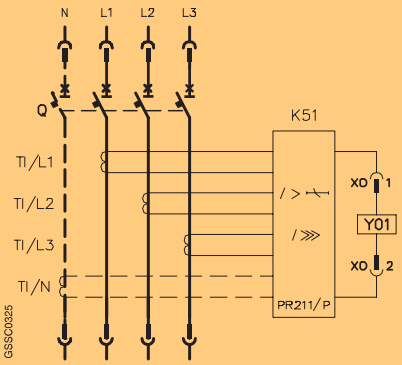


Interruptor tetrapolar en ejecución fija con relé diferencial colateral SACE RC211 o RC212

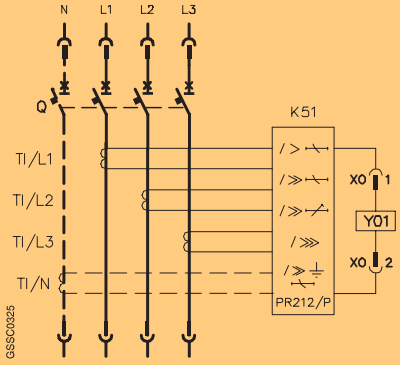


SACE S4-S5-S6-S7

Interruptor tripolar o tetrapolar con relé con microprocesador SACE PR211

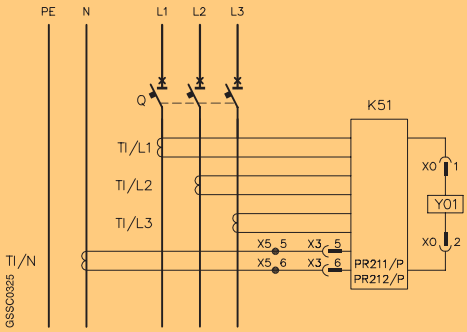


Interruptor tripolar o tetrapolar con relé con microprocesador SACE PR212



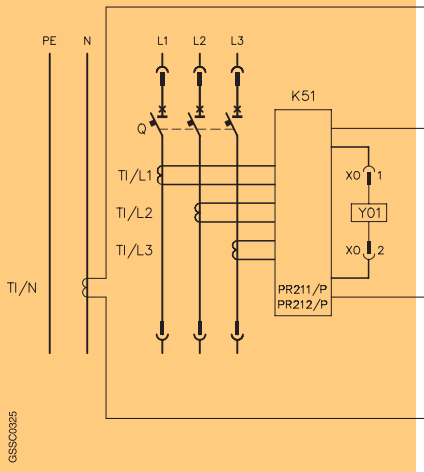
SACE S4-S5-S6-S7

Interruptor tripolar en ejecución fija con transformador de corriente en conductor neutro exterior al interruptor

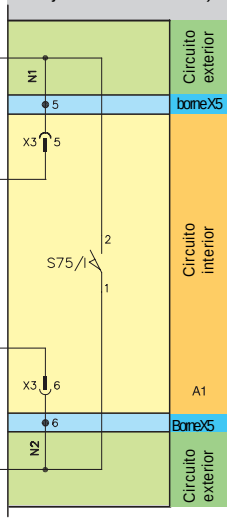


N.B. En el caso de interruptor en ejecución fija con transformador de corriente en conductor neutro exterior al interruptor, cuando se desea remover el interruptor es necesario cortocircuitar los bornes del transformador T/N.

Interruptor tripolar en ejecución enchufable o extraíble con transformador de corriente en conductor neutro exterior al interruptor

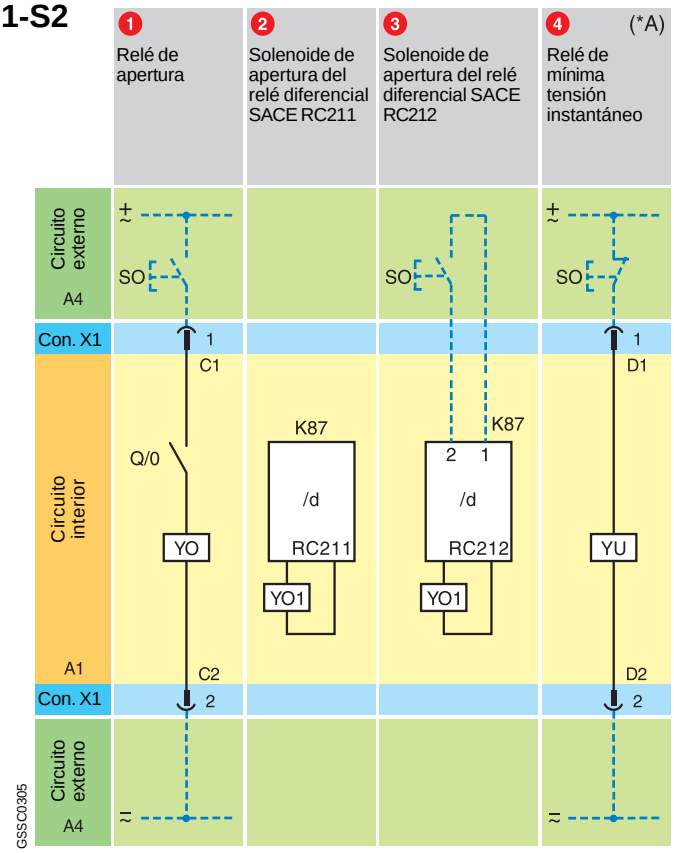


20 Circuito del transformador de corriente en conductor neutro exterior al interruptor (para interruptor en ejecución extraíble)

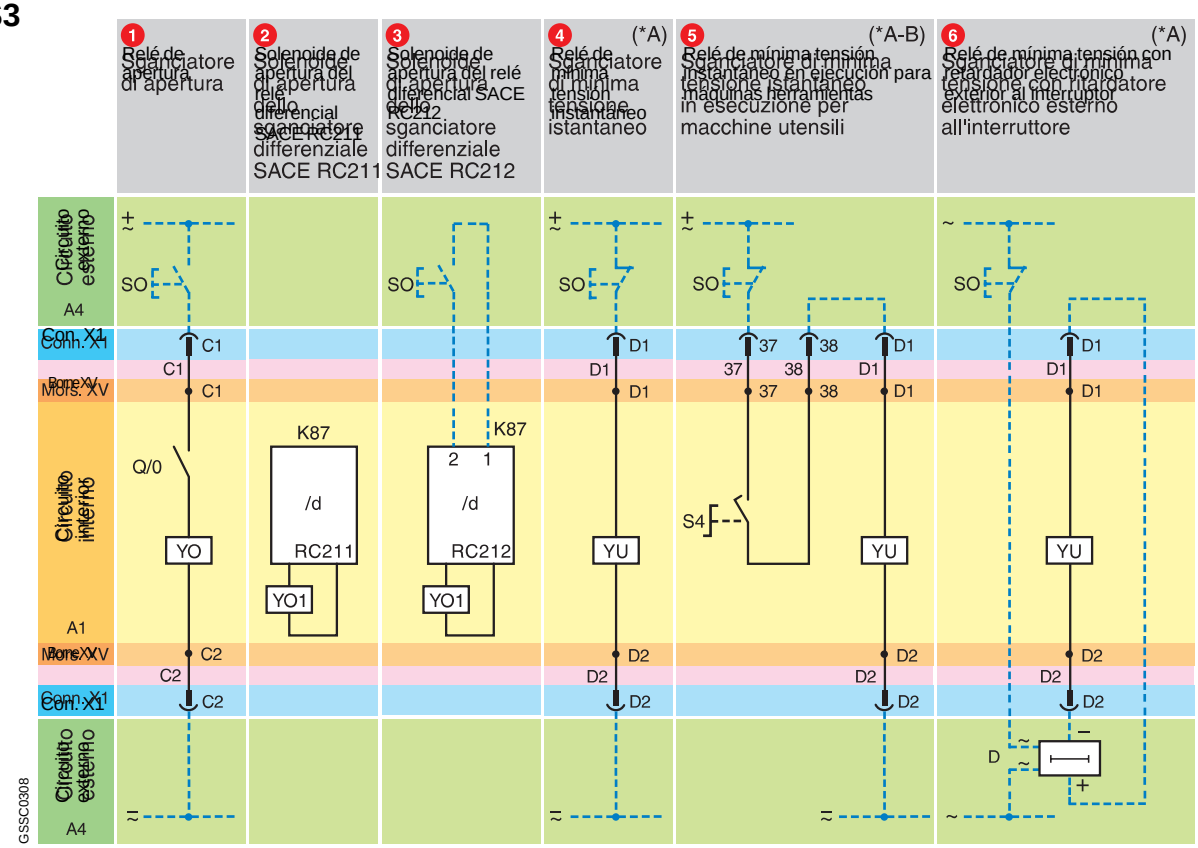


Relés de servicio

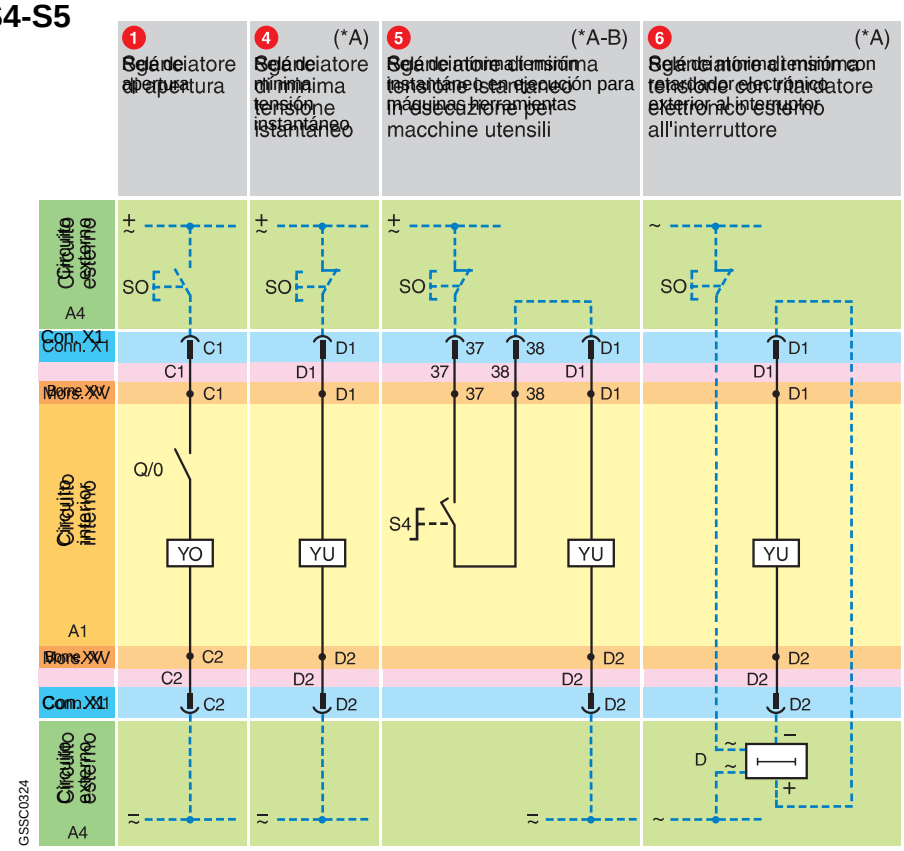
SACE S1-S2



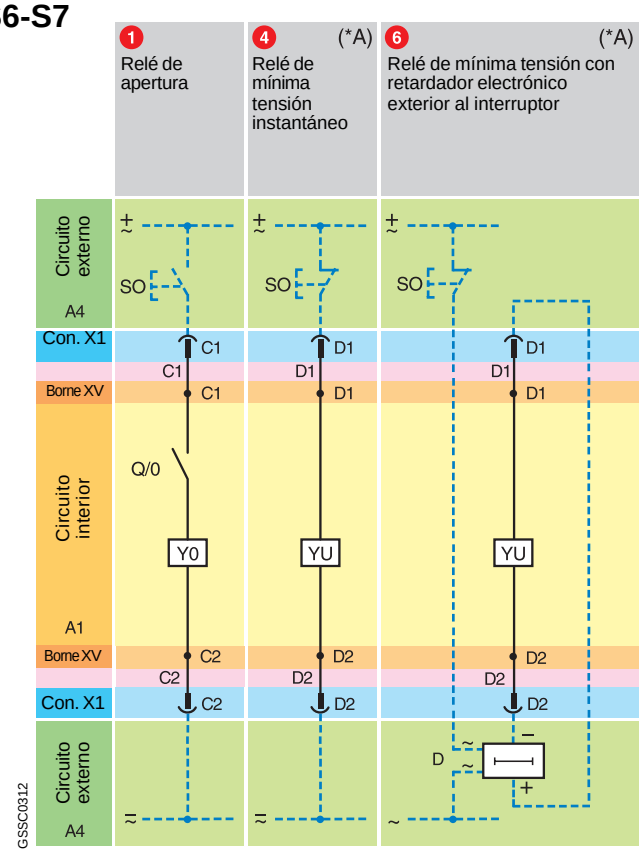
SACE S3



SACE S4-S5



SACE S6-S7



Incompatibilidad

No se pueden suministrar simultáneamente en el mismo interruptor los circuitos indicados con las siguientes figuras:

1 - 4 - 5 - 6 2 - 3

Disponibilidad

Para interruptores S1 - S2 los conectores X1 y X2 sólo se suministran si se solicitan

Notas

(*A) El relé de mínima tensión se suministra para alimentación derivada antes del interruptor o procedente de una fuente independiente: se permite el cierre del interruptor sólo con el relé excitado (el bloqueo del cierre se efectúa mecánicamente).

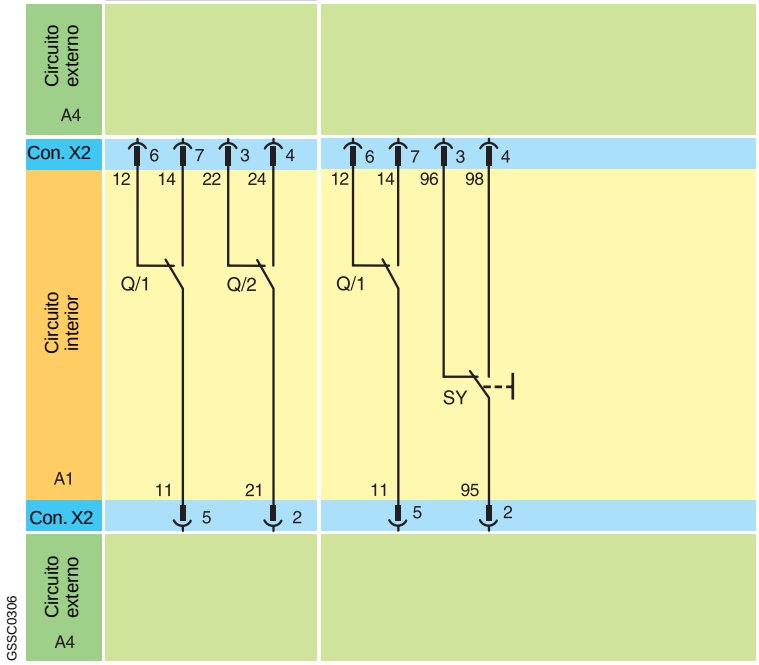
(*B) El contacto S4 representado en la fig. 5 abre el circuito con el interruptor abierto y los vuelve a cerrar cuando se realiza un mando de cierre manual mediante el mando giratorio, según lo establecido en las normativas correspondientes a las máquinas herramienta (el cierre no se efectúa si el relé de mínima tensión no se encuentra alimentado).

Contactos auxiliares

SACE S1-S2

11 Dos contactos de intercambio para la señalización eléctrica de interruptor abierto o cerrado

12 Un contacto de intercambio para la señalización eléctrica de interruptor abierto o cerrado y un contacto de intercambio para la señalización eléctrica de interruptor abierto para la intervención de los relés termomagnéticos YO, YO1, YU (posición de disparo)

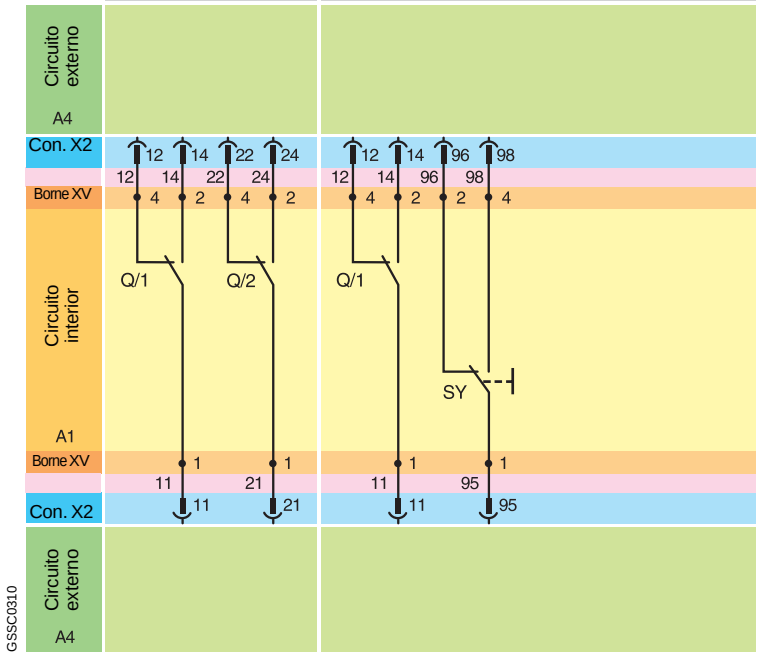


GSSC0306

SACE S3-S4-S5-S6-S7

11 Dos contactos de intercambio para la señalización eléctrica de interruptor abierto o cerrado

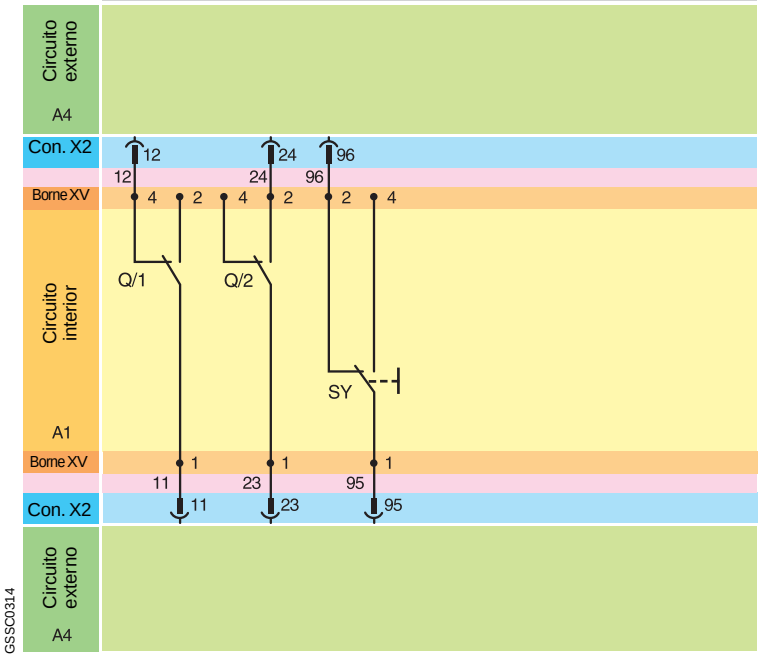
12 Un contacto de intercambio para la señalización eléctrica de interruptor abierto o cerrado y un contacto de intercambio para la señalización eléctrica de interruptor abierto para la intervención de los relés termomagnéticos YO, YO1, YU (posición de disparo)



GSSC0310

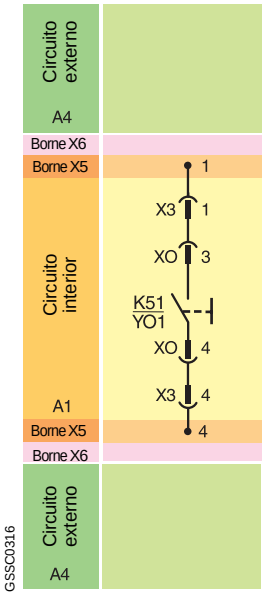
SACE S6-S7

13
Un contacto para la señalización eléctrica de interruptor abierto, un contacto de intercambio para la señalización eléctrica de interruptor cerrado y un contacto para la señalización eléctrica de interruptor no abierto para la intervención de los relés termomagnéticos YO, YO1, YU (posición de no disparado) que se tiene que utilizar, por ejemplo, para el consenso indicado en la fig. 8



SACE S4-S5-S6-S7

41 (*C)
Contacto para la señalización de relé YO1 intervenido



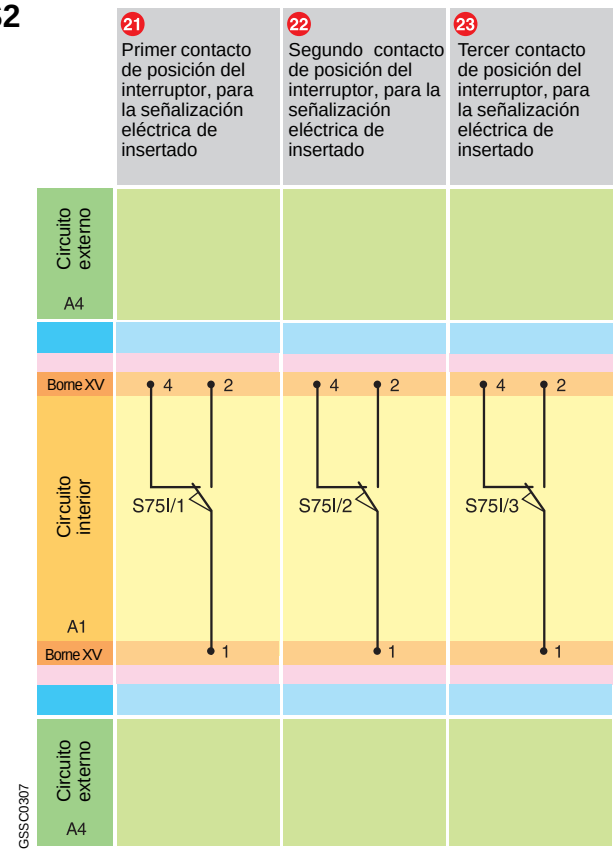
Incompatibilidad
No se pueden suministrar simultáneamente en el mismo interruptor los circuitos indicados con las siguientes figuras:
11-12-13 41-42-43-44

Disponibilidad
Para interruptores S1 - S2 los conectores X1 y X2 sólo se suministran si se solicitan.

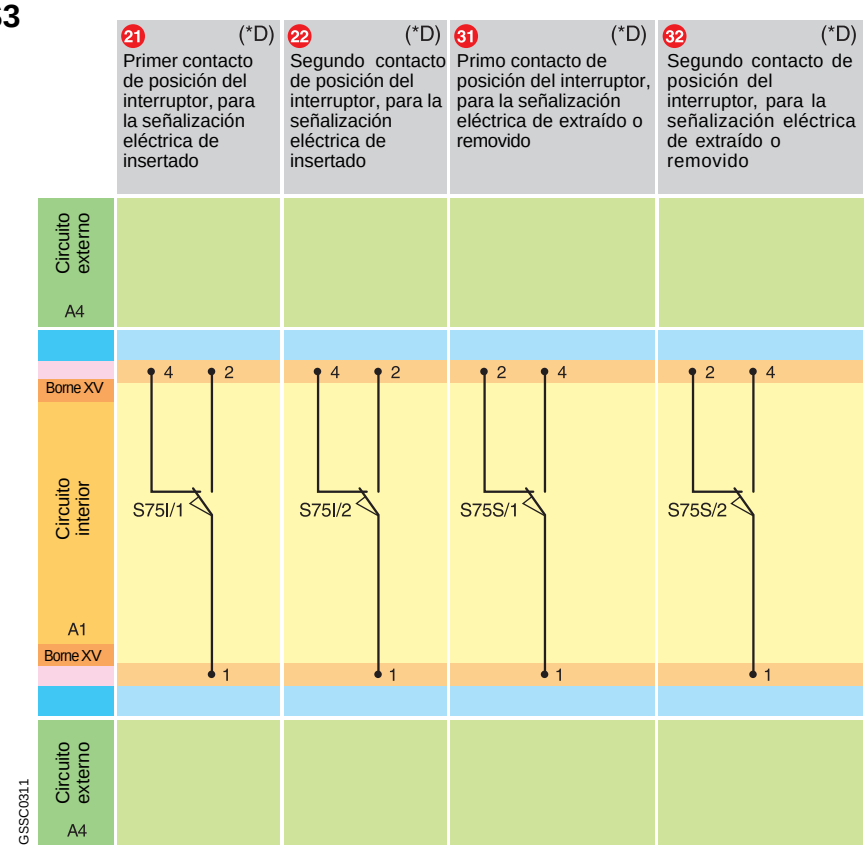
Notas
(*C) el contacto para la señalización eléctrica de relé con microprocesador de sobreintensidad, representado en la fig. 41, posee las siguientes características eléctricas:
– tensión nominal = 24 V
– poder de corte (carga resistiva = 3 W/VA
– corriente máxima interrumpida = 0,5 A
Para S4-S5 sólo se encuentra disponible con relé PR212/P.

Contactos de posición

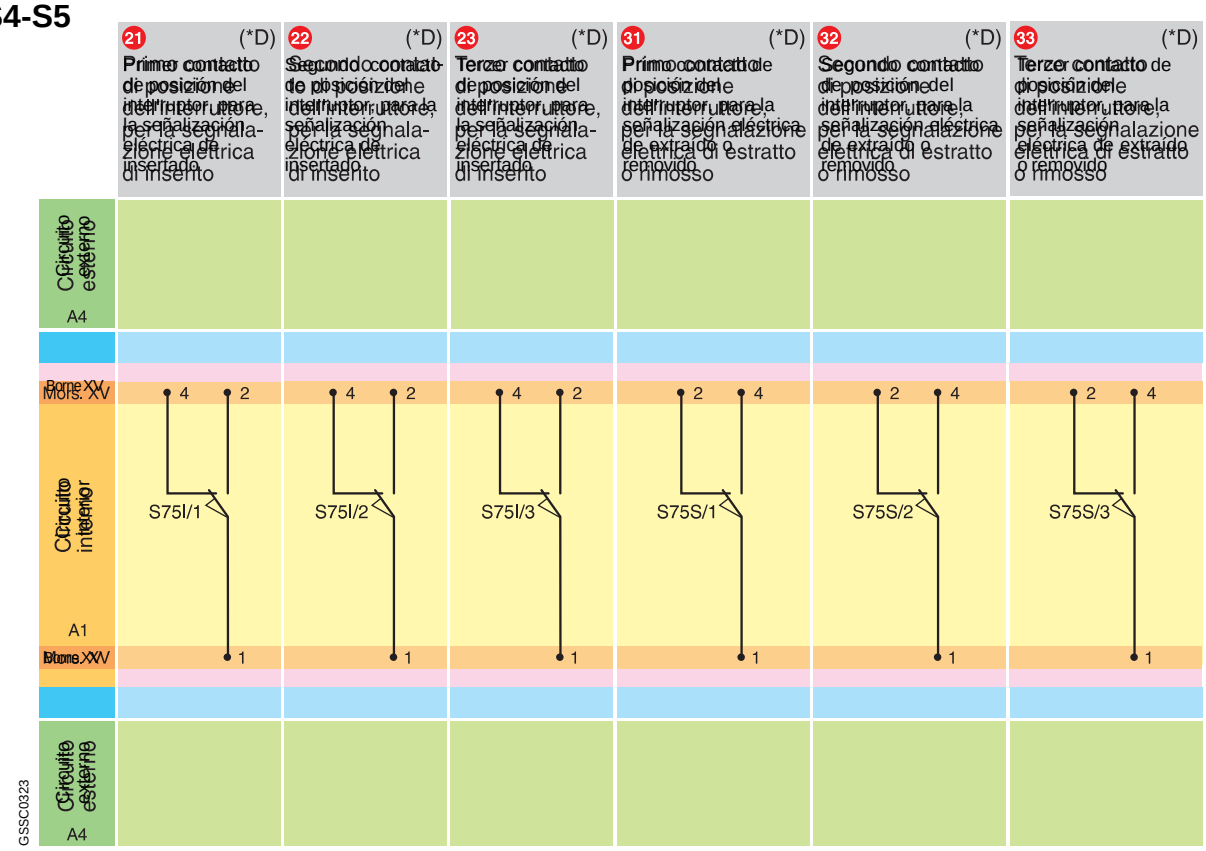
SACE S2



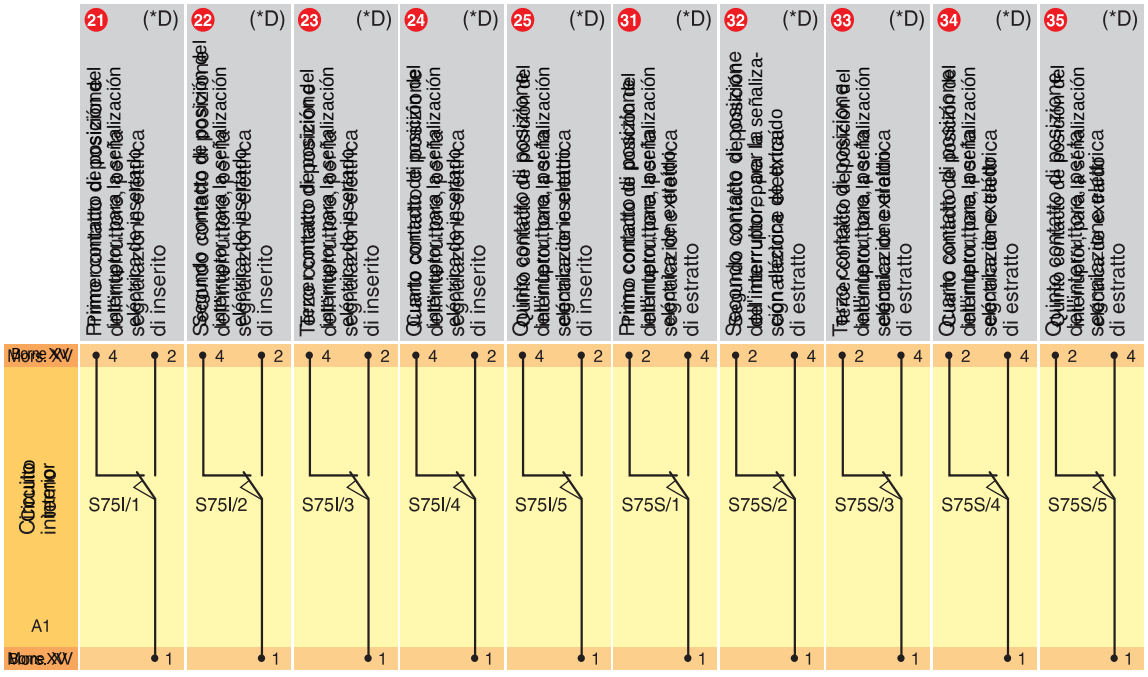
SACE S3



SACE S4-S5



SACE S6-S7



Incompatibilidad

No se pueden suministrar simultáneamente en el mismo interruptor los circuitos indicados con las siguientes figuras:

20 - 21 - 31 22 - 32
23 - 33 24 - 34
25 - 35

Notas

(*D) El interruptor se puede dotar con contactos de posición S75I y S75S en cualquier combinación, con un máximo de

- 2 contactos en total para S3
- 3 contactos en total para S4, S5
- 5 contactos en total para S6, S7

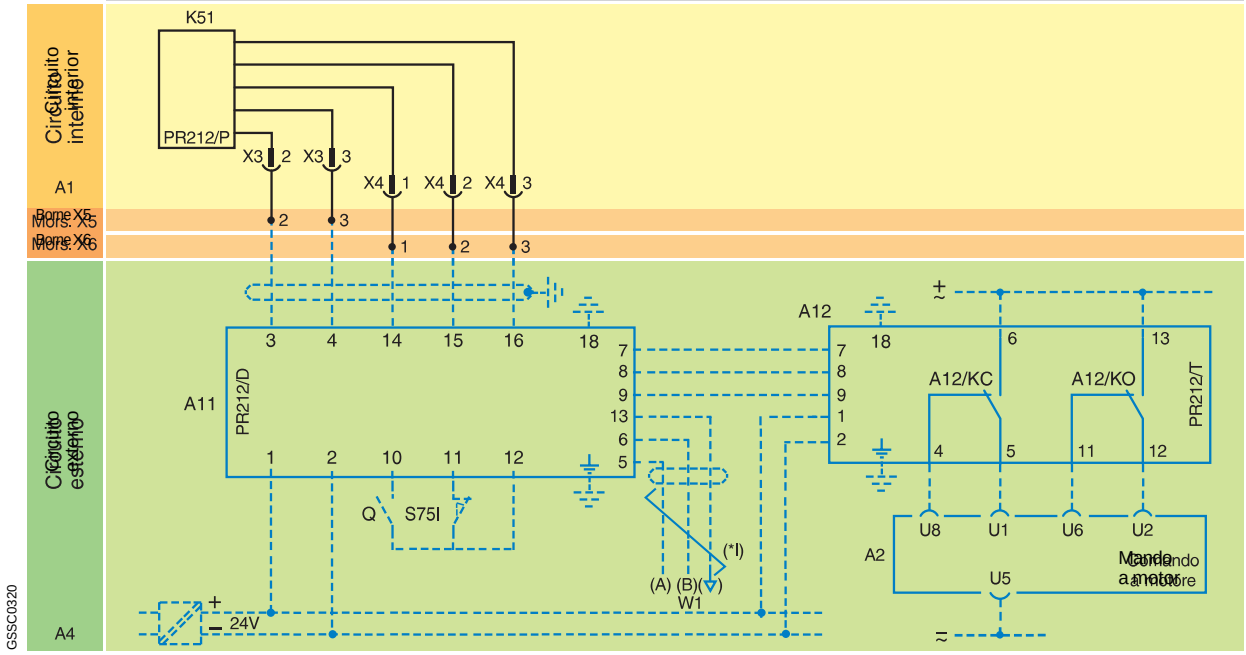
Circuitos auxiliares de los relés de sobreintensidad con microprocesador

SACE S4-S5

42

(*E-I)

Circuitos auxiliares del relé con microprocesador PR212/P conectado con la unidad de diálogo PR212/D, exterior al interruptor.
También se indican las conexiones con la unidad de actuación PR212/T, exterior al interruptor.

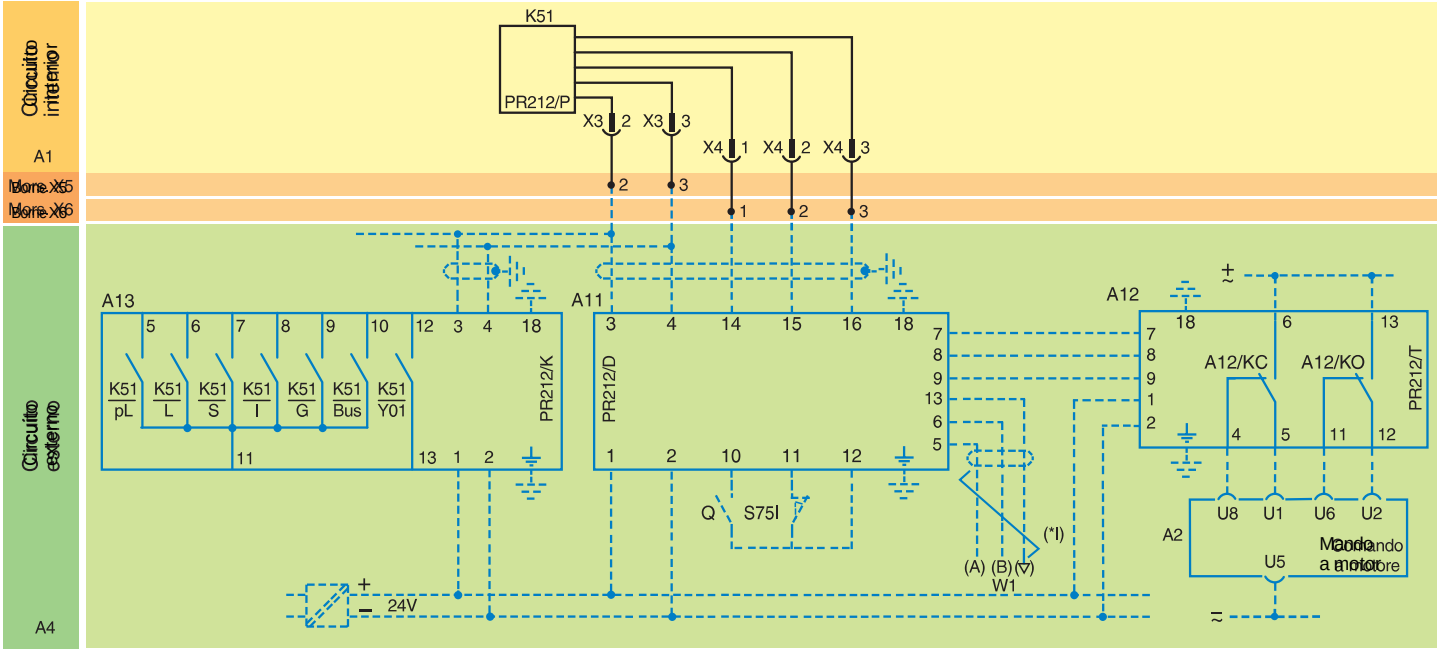


SACE S4-S5

43

(*E-I)

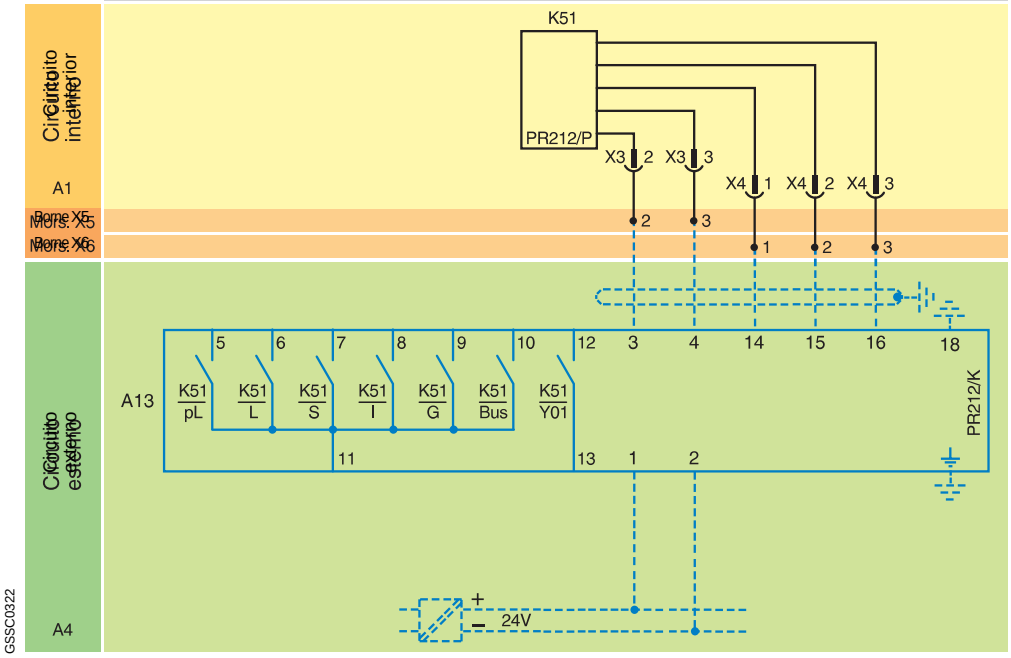
Circuitos auxiliares del relé con microprocesador PR212/P conectado con la unidad de diálogo PR212/D, y de señalización PR212/K exteriores al interruptor (*E).
También se indican las conexiones con la unidad de actuación PR212/T, exterior al interruptor.



SACE S4-S5

44 (*E-H)

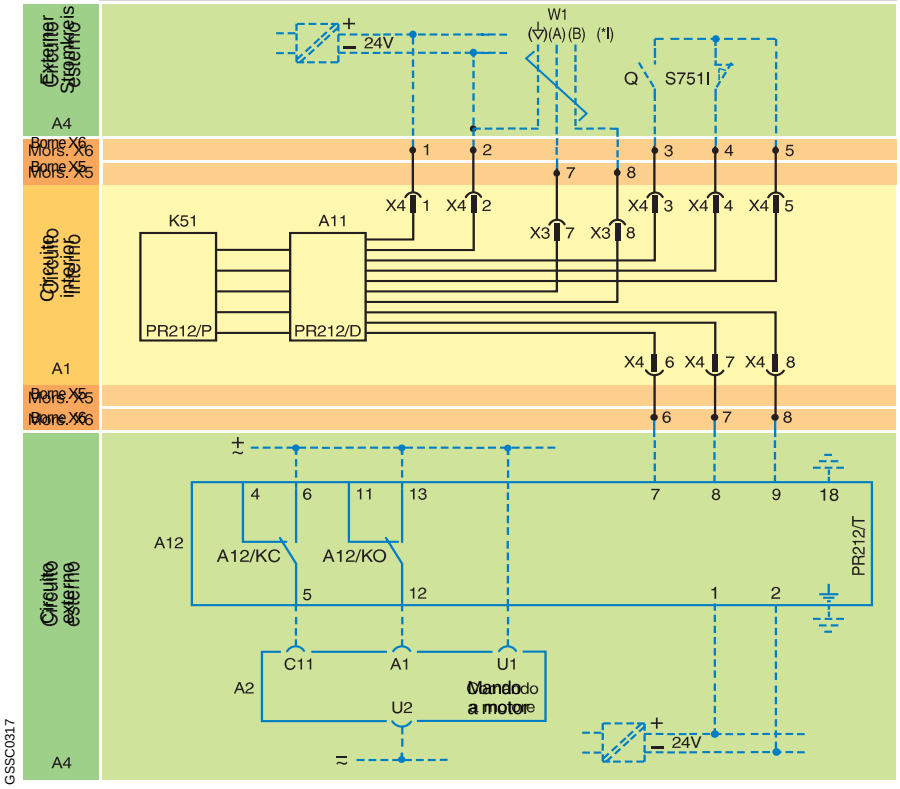
Circuiti ausiliari del relè con microprocessore tipo PR212/P dotato con unità di dialogo, collegato con l'unità di segnalazione tipo PR212/K, esterna all'interruttore



SACE S6-S7

45 (*E-I)

Circuiti ausiliari del relè con microprocessore PR212/P dotato con unità di dialogo PR212/D (*E). Sono indicati anche i collegamenti con l'unità di attuazione PR212/T, esterna all'interruttore



Incompatibilidad

No se pueden suministrar simultáneamente en el mismo interruptor los circuitos indicados con las siguientes figuras:

41 - 42 - 43 - 44
45 - 46 - 47

Notas

(*E) Conectar uno de los contactos auxiliares Q indicados en las fig. 11-12 y uno de los contactos de posición S75I indicados en la fig. 21-22-23-24-25 en el modo representado en las figuras fig. 42-43 para S4, S5 y en el modo representado en las figuras 45, 46 para S6, S7.

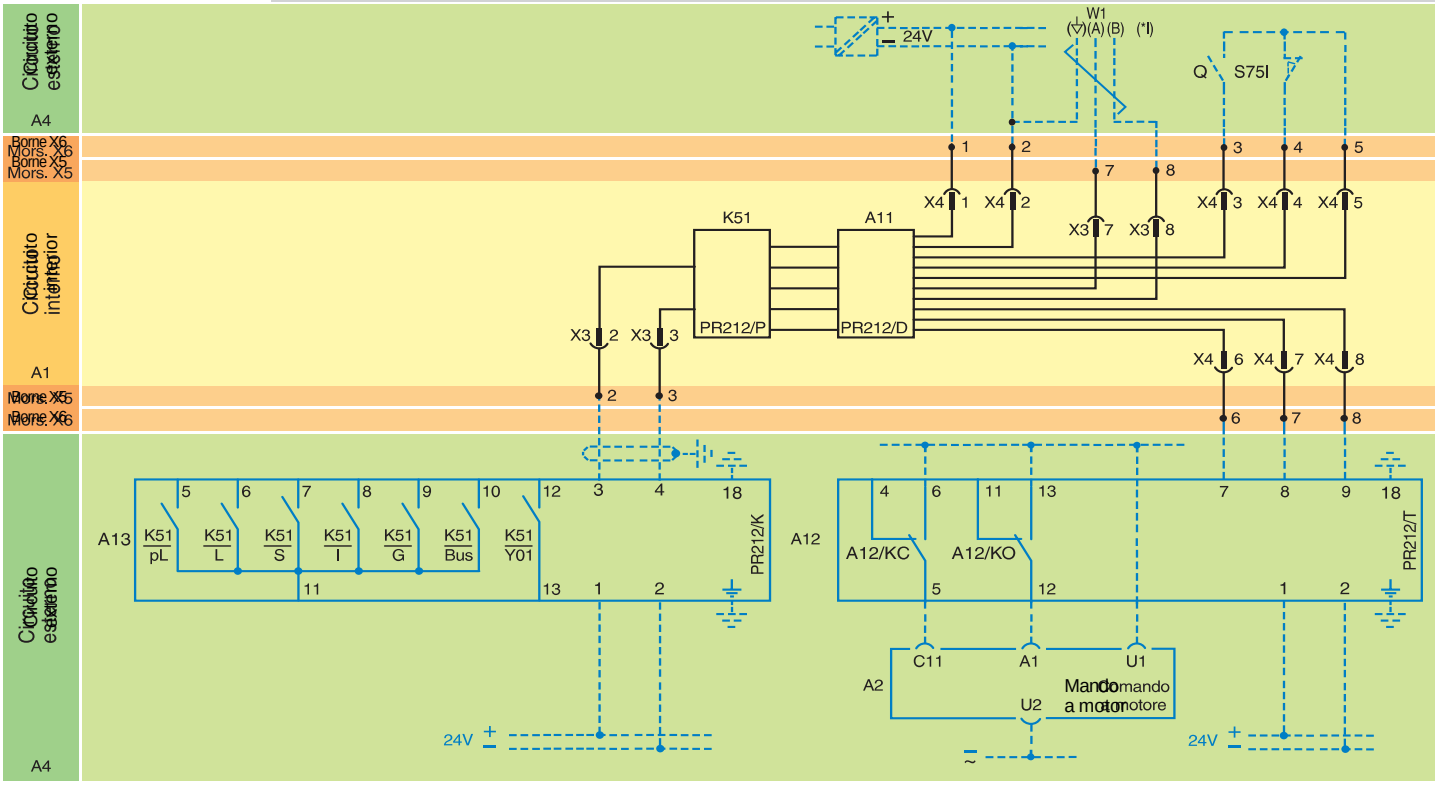
(*I) Para la conexión de la línea serial EIA RS485 véanse los siguientes documentos:
- ejemplos de distribución de la comunicación serial EIA RS485=401517
- prescripciones para la instalación del cable para la comunicación en serie EIA RS485=601823

Circuitos auxiliares de los relés de sobreintensidad con microprocesador

SACE S6-S7

46 Circuitos auxiliares del relé con microprocesador PR212/P dotado con unidad de diálogo PR212/D y conectado a la unidad de señalización PR212/K exterior al interruptor
Circuiti ausiliari dello sganciatore a microprocessore PR212/P corredato dell'unità di dialogo PR212/D e collegato con l'unità di segnalazione PR212/K esterna all'interruttore (*E)
Tambien se indican las conexiones con las unidades de actuación PR212/T, exterior al interruptor
Sono indicati anche i collegamenti con l'unità di attuazione PR212/T, esterna all'interruttore

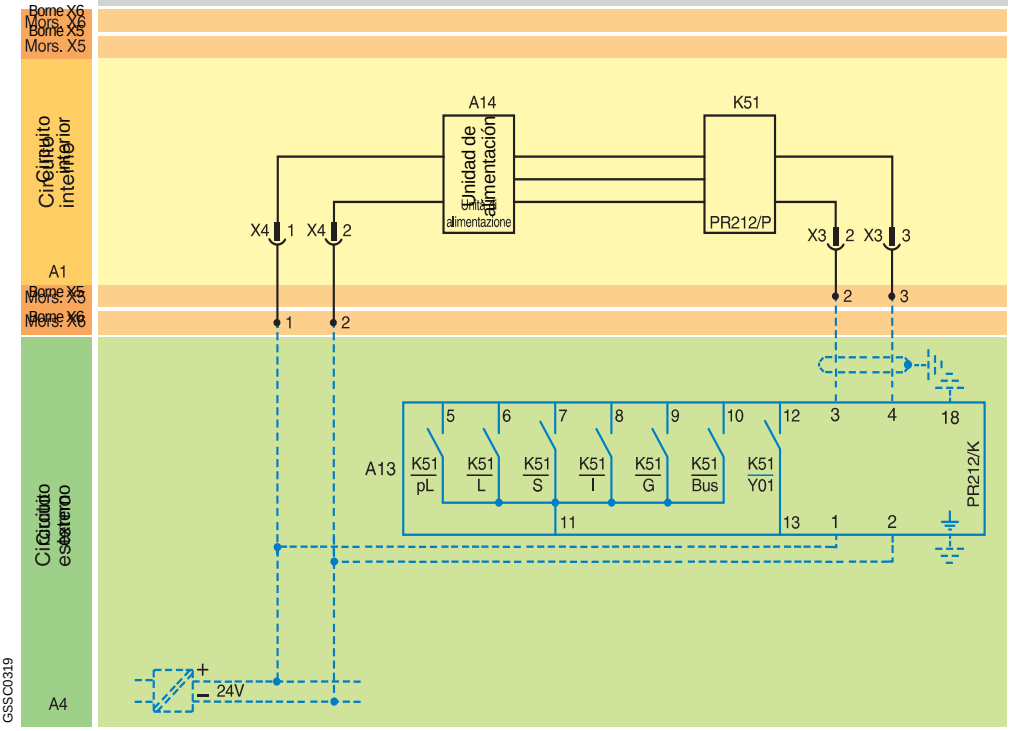
(*E-I)



SACE S6-S7

47 Circuitos auxiliares del relé con microprocesador PR212/P no dotado con unidad de diálogo, conectado a la unidad de señalización PR212/K exterior al interruptor y a la unidad de alimentación SD-S2
Circuiti ausiliari dello sganciatore a microprocessore PR212/P non corredato dell'unità di dialogo, collegato con l'unità di segnalazione PR212/K, esterna all'interruttore, e all'unità di alimentazione SD - S2, interna all'interruttore

(*H)



Incompatibilidad

No se pueden suministrar simultáneamente en el mismo interruptor los circuitos indicados con las siguientes figuras:

45 - 46 - 47

Notas

(*E) Conectar uno de los contactos auxiliares Q indicados en las fig. 11-12 y uno de los contactos de posición S75I indicados en la fig. 21-22-23-24-25 en el modo representado en las figuras fig. 42-43

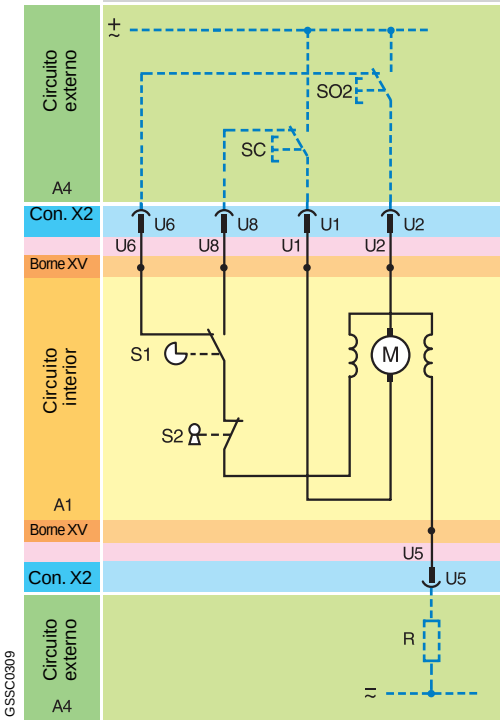
(*I) Para la conexión de la línea serial EIA RS485 véanse los siguientes documentos:

- ejemplos de distribución de la comunicación serial 401517
- prescripciones para la instalación del cable para la comunicación en serie EIA RS485=601823

Mandos a motor

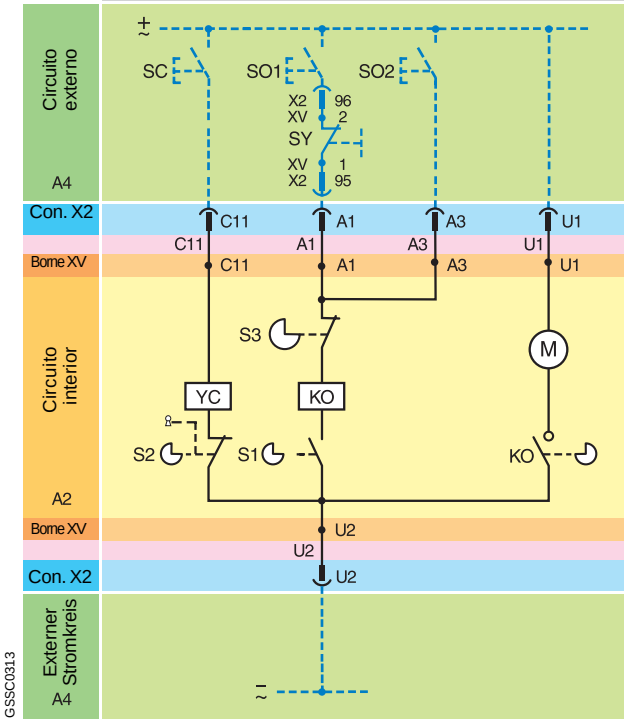
SACE S3-S4-S5

7 Mando a motor de acción directa

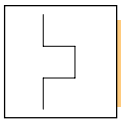


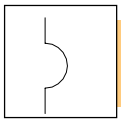
SACE S6-S7

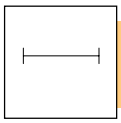
8 Mando a motor de acumulación de energía

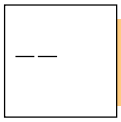


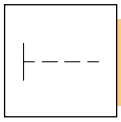
Signos gráficos para esquemas eléctricos (Normas IEC 617 y CEI 3-14...3-26)

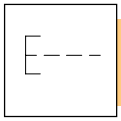

Efecto térmico

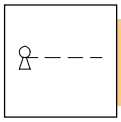

Efecto electromagnético

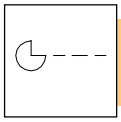

Temporización

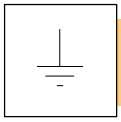

Conexión mecánica

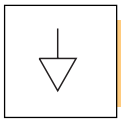

Mando mecánico manual (caso general)

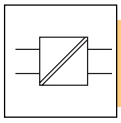

Mando con pulsador

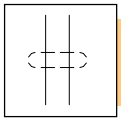

Mando de llave

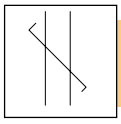

Mando de palanca

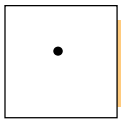

Tierra (signo general)

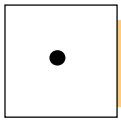

Equipotencialidad

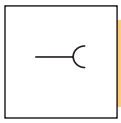

Convertidor separado galvánicamente

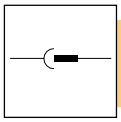

Conductores de cable protegido (ejemplo: dos conductores)

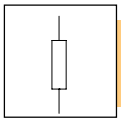

Conductores o cables con cordón (ejemplo: dos conductores)

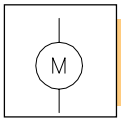

Conexiones de conductores


Terminal o borne

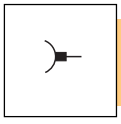

Clavija (hembra) o polo de una clavija

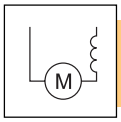

Clavija y toma (macho y hembra)


Resistor (signo general)

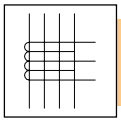


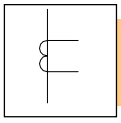
Motor (signo general)

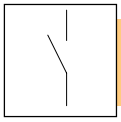

Escobilla

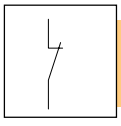


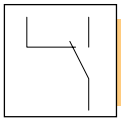
Motor con excitación serial

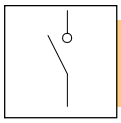

Transformador de corriente con circuito principal formado por 4 conductores pasantes y con circuito secundario enrollado, con toma.

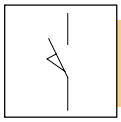

Transformador de corriente

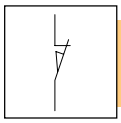

Contacto de cierre

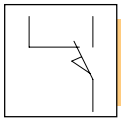

Contacto de apertura

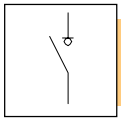

Contacto de intercambio con interrupción momentánea

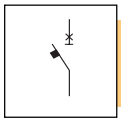

Contacto de cierre con posición mantenida

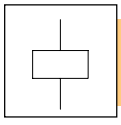

Contacto de posición de cierre (fin de carrera)

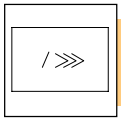

Contacto de posición de una toma apertura (fin de carrera)

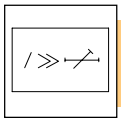

Contacto de posición de intercambio con interrupción momentánea (final de carrera)

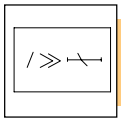

Interruptor de maniobra - seccionador

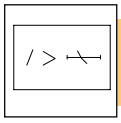

Interruptor de potencia seccionador con apertura automática

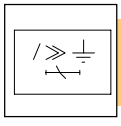

Bobina de mando (signo general)

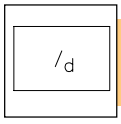

Relé de sobreintensidad instantáneo


Relé de sobreintensidad con característica de retardo de tiempo corto regulable


Relé de sobreintensidad con característica de retardo de tiempo corto inverso


Relé de sobreintensidad con característica a tiempo largo inverso


Relé de sobreintensidad para defecto a tierra con característica de retardo con tiempo corto inverso



Relé de corriente diferencial

Leyenda

● = Número de figura del esquema
* = Véase la nota indicada por la letra
A1 = Aplicaciones del interruptor
A2 = Aplicaciones de mando a motor
A4 = Aparatos y conexiones indicativas para mando y señalización exteriores del interruptor
A11 = Unidad de diálogo tipo PR212/D, para la conexión con un sistema de gestión centralizada
A12 = Unidad de actuación tipo PR212/T, con relé auxiliares para la ejecución de los comandos procedentes de la unidad de diálogo
A12/KC = Mando de cierre de la unidad de actuación
A12/KO = Mando de apertura de la unidad de actuación
A13 = Unidad de señalización tipo PR212/K, con relé auxiliares para la señalización eléctrica de las funciones de protección con microprocesador de sobreintensidad
A14 = Unidad de alimentación
D = Retardador electrónico de mínima tensión (exterior al interruptor)
K51 = Relé con microprocesador de sobreintensidad tipo PR211 o PR212/P, con las siguientes funciones de protección:
- L contra sobrecarga con tiempo de intervención largo inverso
- S contra cortocircuito con tiempo de intervención corto inverso o independiente (disponible sólo con relé PR212/P)
- I contra cortocircuito con tiempo de intervención instantáneo
- G contra defecto a tierra con tiempo de intervención corto inverso (sólo disponible con relé PR212/P)

K51/Bus = Señalización eléctrica de alarma para defecto en la comunicación interior
K51/G = Señalización eléctrica de alarma para función de protección G en la zona de actuación
K51/I2 = Señalización eléctrica de alarma para función de protección I en la zona de actuación
K51/L = Señalización eléctrica de alarma para función de protección L en la zona de actuación
K51/pL = Señalización eléctrica de función de protección L en la zona de prealarma
K51/S = Señalización eléctrica de alarma para función de protección S en la zona de actuación
K51/YO1 = Señalización eléctrica de alarma para relé YO1 intervenido debido a sobreintensidad (Fig. 46-47) o incluso para 'trip test' (Fig. 41)
K87 = Relé diferencial tipo RC211 o RC212 (para interruptores S1-S2-S3)
KO = Para S3-S4-S5: relé auxiliar de apertura.
Para S6-S7: relé de apertura y carga de los resortes con contacto de cierre con posición mantenida, liberado por una palanca del mando a motor cuando el interruptor alcanza la posición de abierto y los resortes de cierre se han cargado
M = Para S3-S4-S5: motor con excitación en serie para la apertura y el cierre del interruptor.
Para S6-S7: motor para la apertura del interruptor y la carga de los resortes de cierre del interruptor
Q = Interruptor principal
Q/0 .. 2 = Contactos auxiliares del interruptor
R = Resistor exterior al interruptor suministrado para las tensiones de alimentación de los motores superiores a 220V
S1 = Para S3-S4-S5: contacto de posición accionado por una palanca del interruptor
Para S6-S7: contacto activado por la palanca del mando a motor: se cierra cuando el interruptor alcanza la posición de cerrado y se abre cuando el interruptor alcanza la posición de abierto (no conmuta cuando el interruptor llega a la posición de disparo)
S2 = Para S3-S4-S5: contacto de seguridad activado por:
- bloqueo a llave (si se encuentra presente)
- bloqueo por candados
- llave hexagonal de mando local.

Para S6-S7: contacto activado por la palanca del mando a motor: se abre cuando el motor alcanza la posición de cerrado y se cierra cuando el interruptor alcanza la posición de abierto (no conmuta cuando el interruptor llega a la posición de disparo). El contacto también se acciona mediante el dispositivo de bloqueo a llave (si se encuentra presente)
S3 = Contacto activado por la leva del mando a motor: se abre tras el cierre del contacto KO y se cierra cuando el interruptor alcanza la posición de abierto (no conmuta cuando el interruptor llega a la posición de disparo)
S4 = Contacto accionado por el mando giratorio del interruptor (véase nota B)
S75I/1..5 = Contactos para la señalización eléctrica de interruptor en posición de insertado (previsto sólo con interruptores en ejecución enchufable o extraíble (véase nota D)
S75S/1..5 = Contactos para la señalización eléctrica de interruptor en posición de removido y extraído (sólo previstos para interruptores con ejecución enchufable o extraíble (véase nota D)
SC = Pulsador o contacto para el cierre del interruptor. Para interruptores S3-S4-S5 el mando debe poseer una duración no inferior a 100 ms
SO = Pulsador o contacto para la apertura del interruptor
SO1, S02 = Pulsadores o contactos para la apertura del interruptor. Para interruptores S3-S4-S5 el mando tiene que poseer una duración superior a 100 ms (véase "Instrucciones para el restablecimiento del interruptor tras la intervención de los relés")
SY = Contacto para la señalización eléctrica de interruptor abierto para intervención de los relés termomagnéticos, YO, YO1, YU (posición de disparo)
TI = Transformador de corriente toroidal
TI/L1 = Transformador de corriente situado en la fase L1
TI/L2 = Transformador de corriente situado en la fase L2
TI/L3 = Transformador de corriente situado en la fase L3

Notas

TI/N = Transformador de corriente ubicado en el neutro
W1 = Interfaz serial con el sistema de control (interfaz EIA RS485)
X1, X2 = Conectores para los circuitos auxiliares del interruptor. Para interruptores S1-S2 sólo se suministran si se solicita.
X3, X4 = Conectores para los circuitos del relé con microprocesador de sobreintensidad (en el caso de interruptores en ejecución enchufable o extraíble, la extracción de los conectores se efectúa al mismo tiempo que la del interruptor)
X5, X6 = Placa de bornes de entrega de los circuitos del relé con microprocesador de sobreintensidad
XO = Conector para el solenoide de apertura YO1
XV = Placa de bornes de las aplicaciones
YC = Relé de cierre
YO = Relé de apertura
YO1 = Solenoide de apertura del relé diferencial tipo RC211 o RC212 (para S1-S2-S3) y del relé de sobreintensidad (para S4 .. S7)
YU = Relé de mínima tensión (véase nota B)

Instrucciones para el restablecimiento del interruptor tras la intervención de los relés

El interruptor se puede abrir no solamente con el mando a motor sino también mediante la intervención de los siguientes relés:
– sobreintensidad
– mínima tensión
– apertura
con la consiguiente apertura del contacto SY (si se encuentra previsto) en serie al relé KO.
En caso de disparo, para cerrar el interruptor hay que efectuar el restablecimiento mediante una apertura manual o eléctrica. Al terminar la operación, se vuelve a cerrar el contacto SY. La elección del tipo de restablecimiento depende de las exigencias del proyecto y de las condiciones de servicio. Se pueden sugerir las siguientes hipótesis:

1) Restablecimiento exclusivamente manual

El mando eléctrico de apertura (contacto SO1) tiene que conectarse en serie al contacto SY. La apertura (para S3-S4-S5 realizada mediante el relé auxiliar KO) no es posible hasta que el interruptor se encuentra en la posición de disparado. Para restablecer el interruptor hay que accionar la correspondiente palanca hasta que el interruptor pasa a la posición de abierto y los resortes de cierre se cargan completamente.

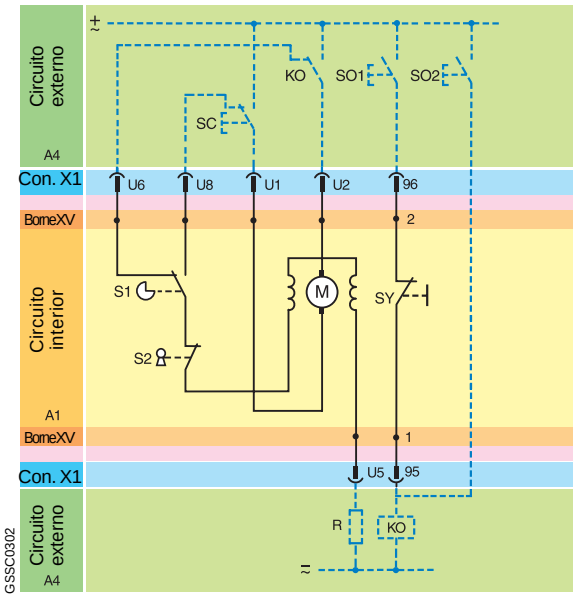
2) Restablecimiento eléctrico con intervención del operador

El mando eléctrico de apertura normal (contacto SO1) tiene que conectarse en serie al contacto SY.
Se ha previsto otro mando de apertura (contacto SO2), conectado directamente en serie al relé KO para S3-S4-S5 o conectado directamente al polo A3 del conector X2 para S6-S7, que tiene que estar controlado, por ejemplo con un pulsador de llave, y que pueda utilizarse solamente si la información recibida por el responsable del puesto de control permite excluir que el disparo sea debido a un cortocircuito o bien las causas del mismo han sido eliminadas

3) Restablecimiento eléctrico permitido siempre

El mando eléctrico de apertura (contacto SO2) está conectado directamente en serie al relé KO para S3-S4-S5 o está conectado directamente al polo A3 del conector X2 (para S6-S7) y, por lo tanto, siempre está permitido.
Ejemplo de empleo: restablecimiento automático del interruptor inmediatamente después de la intervención de los relés.
N.B. Si se encuentra presente el relé de sobreintensidad, es necesario identificar las causas que han provocado el disparo del interruptor para evitar un nuevo cierre en condiciones de cortocircuito.

En todos los casos, siempre es posible efectuar el restablecimiento manual.



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Low voltage moulded-case circuit-breakers for motor protection

SACE Isomax S

Annex to SACE Isomax S technical catalogue 649240

690 V • 3-1000 A • 35-200 kA (380/415 V)

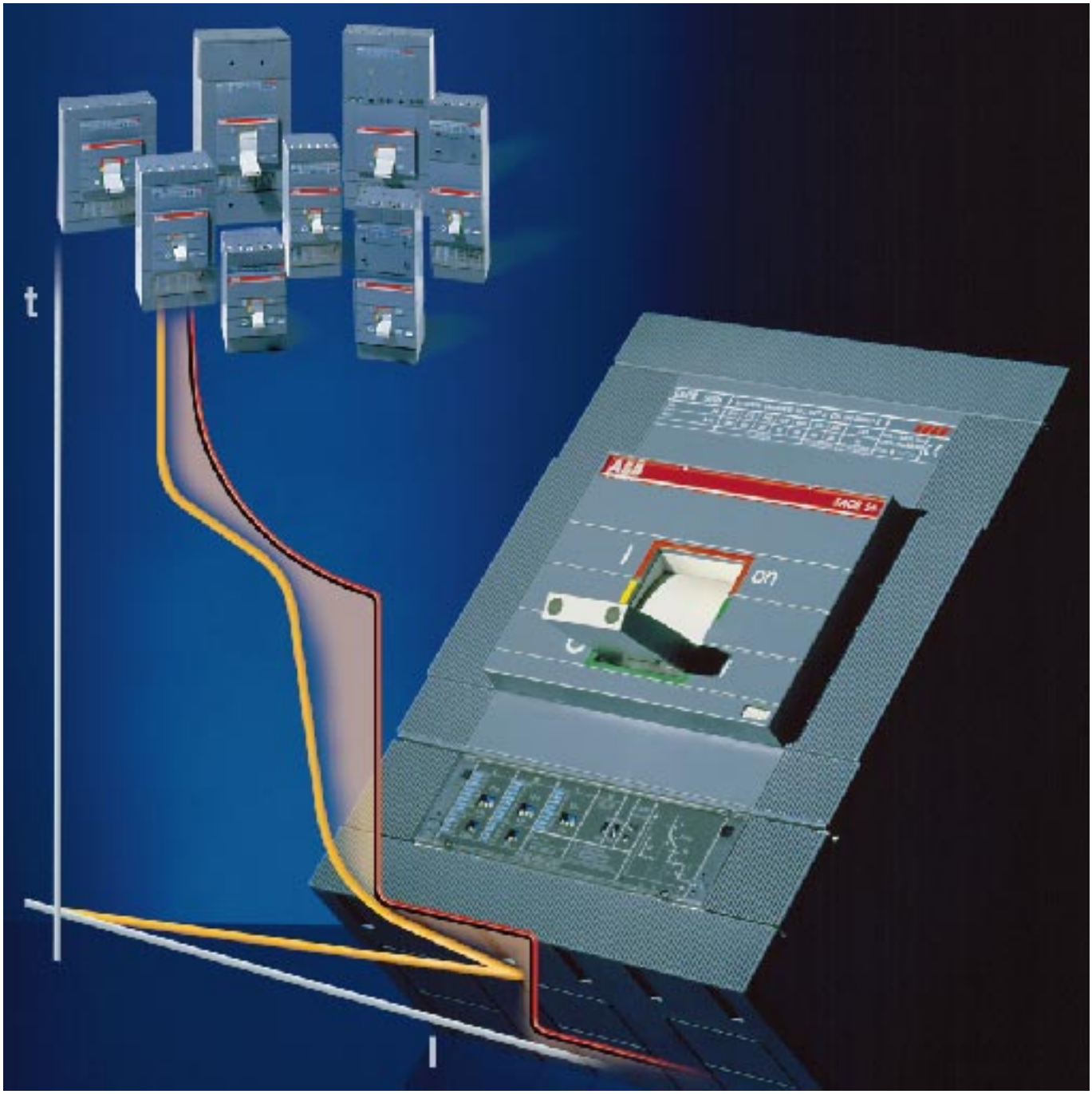

ABB SACE L.V.

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Note

For more detailed information about the SACE Isomax S moulded-case circuit-breakers and relative accessories, and also for the specific let-through energy and current-limiting curves and overall dimensions, please refer to the corresponding types of circuit-breakers described in the following technical catalogues:

code 649240: "SACE Isomax S low voltage moulded-case circuit-breakers"
code 649294: "SACE Isomax S low voltage current-limiting moulded-case circuit-breakers" (Annex to 649240).

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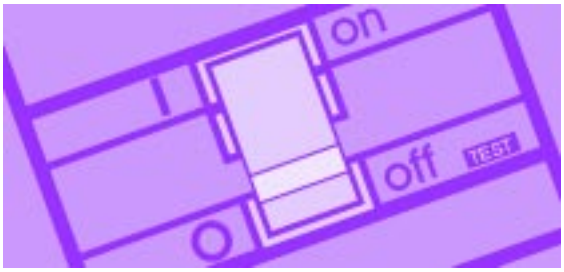
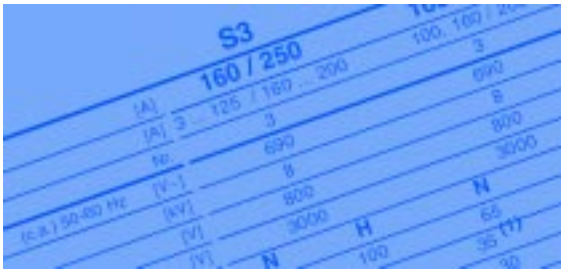


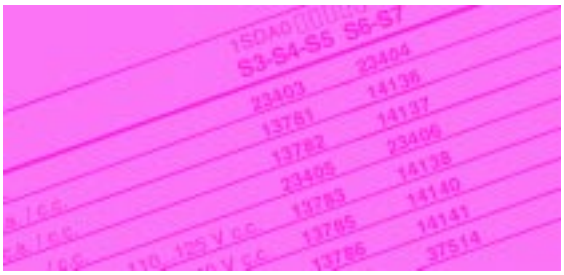
Presentation



Main characteristics

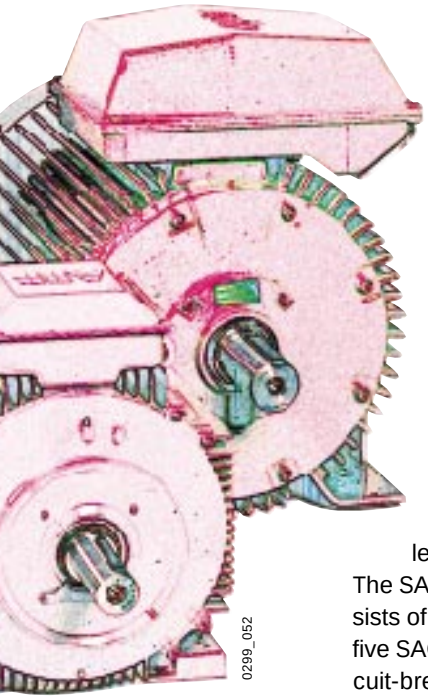
Characteristic curves

Circuit-breaker applications and circuit diagrams



Ordering codes

SACE Isomax S Motor Protection. The protection functions are completed



Modern and rational solutions for motor protection

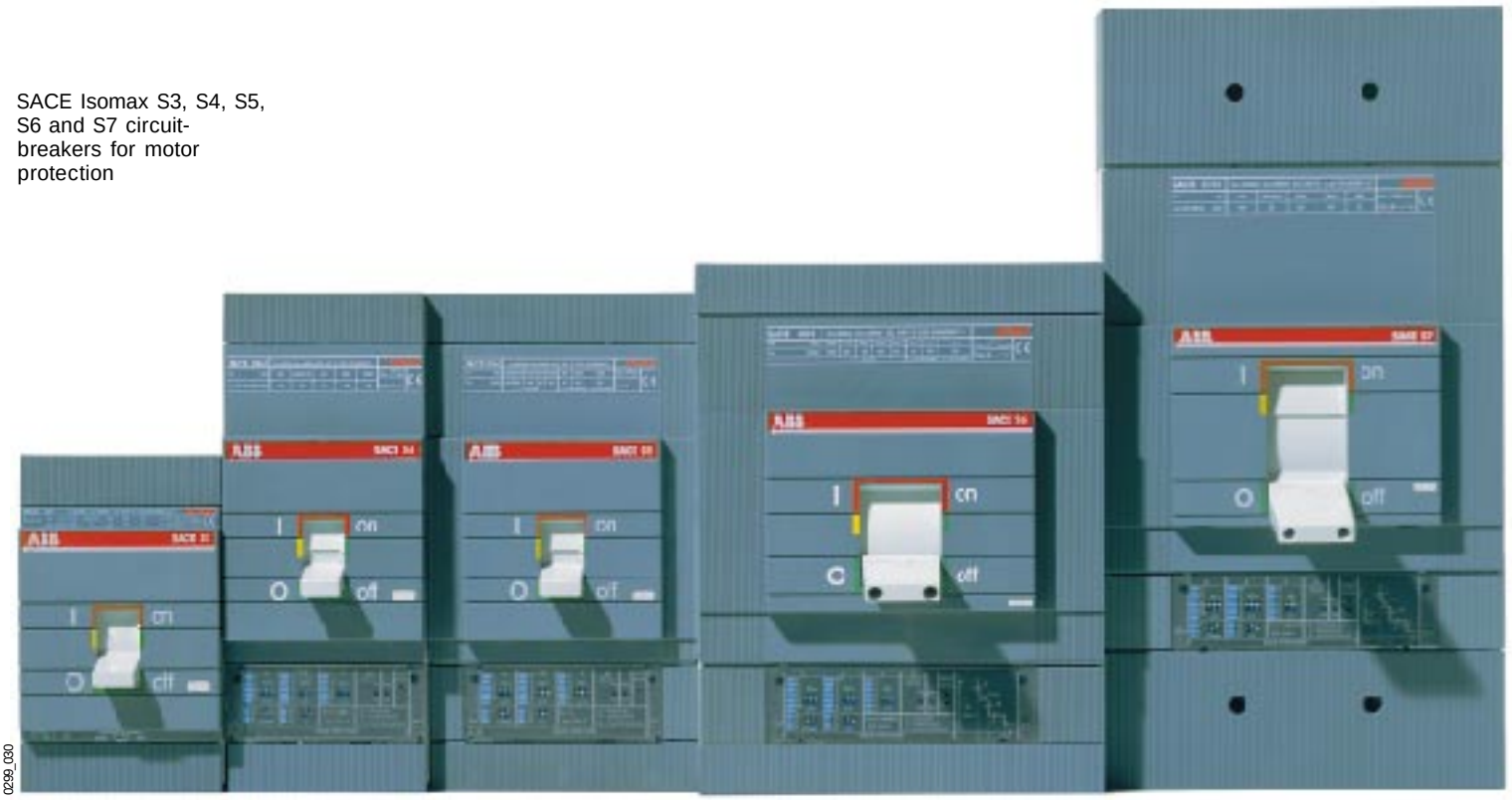
Within the sphere of SACE Isomax S low voltage moulded-case circuit-breakers, there is a range which stands out and fulfils the technical requirements regarding motor starting and protection in particular.
The result of the most advanced research in the field of electrical installation control, the range of SACE Isomax S “Motor Protection” circuit-breakers offers high performances with particularly limited overall dimensions, flexibility, practical usage and simple installation, all combined with an extremely high level of technology.
The SACE Isomax S series for motor protection consists of eight models:
five SACE S3N-H, S4N-H, S5N-H, S6N-H, S7S-H circuit-breakers, with rated currents from 3 A to 1000 A and breaking capacities from 35 to 65 kA (at 380/415 V a.c.) and three SACE S3X, S4X and S6X current-limiting circuit-breakers, with rated currents from 3 A to 630 A and breaking capacity from 200 kA (at 380/415 V a.c.).

Selection of a circuit-breaker suitable for motor protection is fundamental in adding value to the functionality and efficiency of the motor: just think of the increased useful life of a well-protected motor, of the easy and rapid resetting following a trip, of the lower costs due to machine stoppage and of the almost total safety level of the operating personnel.

From classic motor protection to electronic microprocessor-based protection

SACE Isomax S3N-H 160/250 circuit-breakers and the relative S3X 125/200 current-limiting circuit-breakers are fitted with an instantaneous adjustable

SACE Isomax S3, S4, S5, S6 and S7 circuit-breakers for motor protection



0299_017

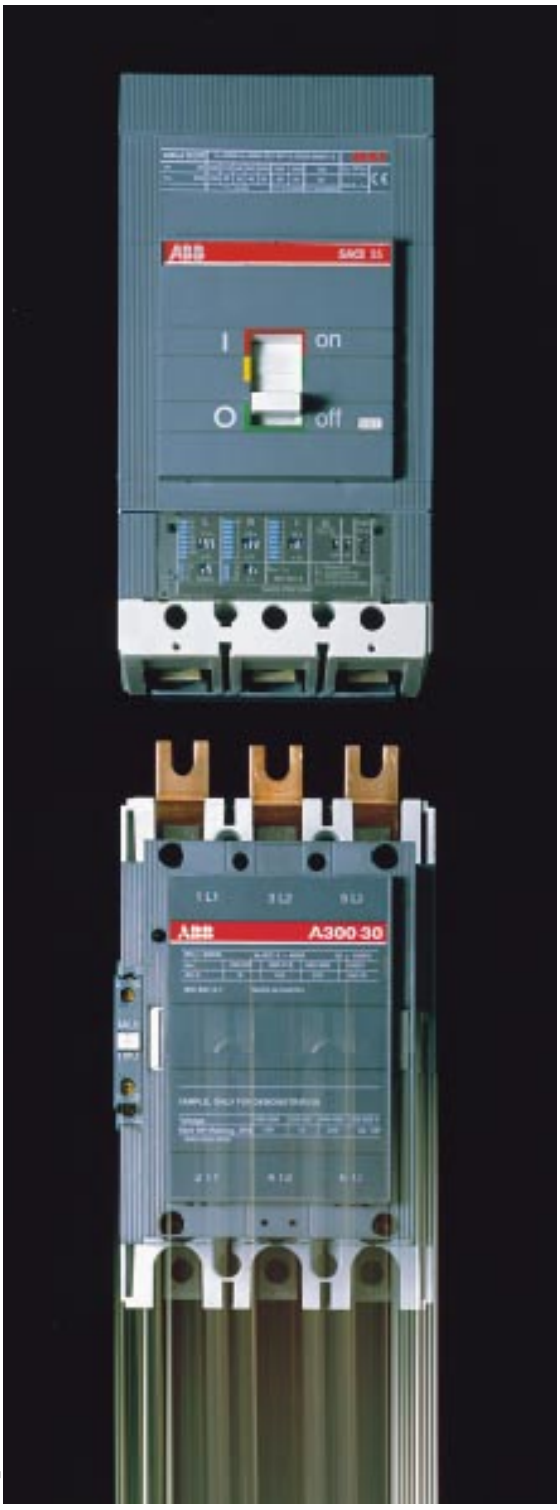
magnetic only release which, used in combination with a thermal relay and with a contactor, ensures motor switching and protection in the traditional way. SACE Isomax S4N-H 160/250, S5N-H 400, S6N-H 800, S7H 1250 circuit-breakers and the relative current-limiting S4X 250 and S6X 400/630 circuit-breakers ensure motor protection by means of the SACE PR212/MP electronic release (ABB SACE L.V. International Patent), which activates protection against overload, against rotor blockage, against short-circuit and against missing and/or unbalanced phase. The circuit-breakers are used in combination with a contactor for motor switching. The calculation algorithms conditioning their operation are memorised in the release microprocessors, checked in the ABB SACE L.V. laboratories. The principle is based on measurement of the effective current value according to sampling criteria, reconstruction and measurement of the signal, appropriate for the different fault conditions which can occur.

0299_029

SACE Isomax S6X, S4X and S3X current-limiting circuit-breakers for motor protection

Coordinated solutions with the ABB system

The range of SACE Isomax S moulded-case circuit-breakers for motor protection is perfectly co-ordinated with the new line of ABB contactors. The latter, defined as A-Line, together with the line of overload thermal relays and SACE Isomax S moulded-case circuit-breakers, are the basis for the new generation of pieces of apparatus specially designed to ensure a system of products which can be integrated according to the required applications. All this not only has the aim of continuously improving its products, but above all of providing design engineers, installers and end users with the best solutions in terms of performance and reliability combined with simplicity of the system.



0299_049

Apart from the classic circuit-breaker-contactor-thermal relay combination, the SACE Isomax S circuit-breakers for motor protection, starting from model S4, are combined with just the contactor (example of composition between S5H and PR212/MP and series A300-30 contactor)

In particular, the SACE Isomax S circuit-breakers and the “A” series contactors provide a very special solution with regard to compactness, having the same width and design characteristics, thereby saving space, assembly material, installation time and relative cabling.
The circuit-breaker-contactor group enhances this feature even further with the SACE PR212/MP electronic overcurrent release which, inside the SACE Isomax S circuit-breakers, allows an extremely compact protected starter to be constructed, implementing the overload protection in compliance with IEC Standard 947-4-1.

0299_047

SACE Isomax S moulded-case circuit-breakers and the new A series contactors share the same width and depth and have been designed to make up a single compact unit

Compliance with Standards. Approvals

Safety recognised internationally and protection of the environment

The SACE Isomax S circuit-breakers for motor protection with electronic microprocessor-based releases comply with the IEC 947-1, IEC 947-2, IEC 947-4-1, IEC 1000, EN 55081 and EN 55082 International Standards.

The ABB SACE Quality System complies with the International ISO 9001 Standard and to the equivalent EN ISO 9001 European Standards and the UNI EN ISO 9001 Italian Standards. The certifying Organisation is the Italian Shipping Register (RINA- QUACER). ABB SACE has obtained its third re-confirmation of qualification.

The ABB SACE L.V. Test Room is accredited by SINAL. The apparatus complies with the prescriptions for on-board installations and is approved by major Shipping Registers, such as LLOYD'S REGISTER OF SHIPPING, GERMANISCHER LLOYD, BUREAU VERITAS, RINA, and DET NORSKE VERITAS.

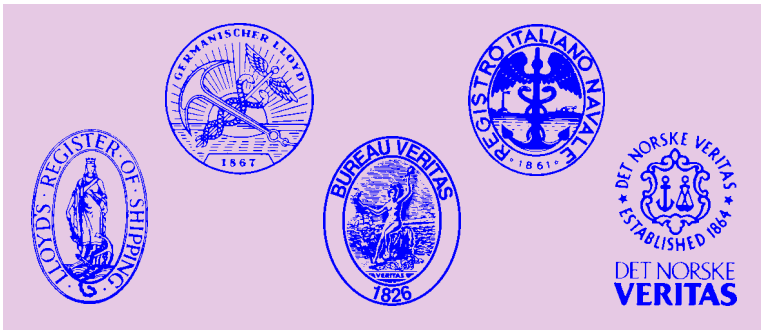
The attention paid to protecting the environment is another important priority for ABB SACE, and, thanks to the use of new production systems carried out with an eye to ecology, this has allowed a reduction of more than 20% in raw materials and processing waste during construction of the circuit-breakers.

CSIS9099

CSIS9098

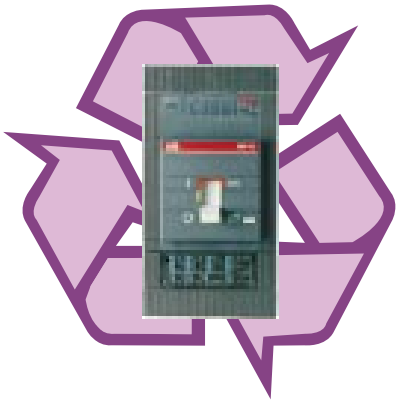
Selection of materials, processes and packaging has been made by optimising the real environmental impact of the product and by using recyclable materials.

The prizes obtained by ABB SACE L.V. at the Forum Design in Hannover and at Electtro in Paris bear testimony to the attention which has always been given to man and respect for ergonomic criteria.



INDUSTRIE FORUM DESIGN HANNOVER

The SACE Isomax S series has been studied respecting the most advanced ergonomic criteria: this is testified by the prize awarded with the IF seal to the circuit-breakers at the Forum Design in Hannover 1997.



ISO 9001

CSIS9099

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SACE Isomax S - Motor Protection circuit-breakers

Rated uninterrupted current, **Iu**			[A]	**160 / 250**	
Rated service current, **In**			[A]	3 ... 125 / 160 ... 200	
Number of poles			Nr.	3	
Rated service voltage, **Ue**		(AC) 50-60 Hz	[V~]	690	
Rated impulse withstand voltage, **Uimp**			[kV]	8	
Rated insulation voltage, **Ui**			[V]	800	
Test voltage at industrial frequency for 1 minute			[V]	3000	
Rated limit short-circuit breaking capacity, **Icu**				**N**	**H**
	(AC) 50-60 Hz	220/230 V~	[kA]	65	100
	(AC) 50-60 Hz	**380/415 V~**	**[kA]**	35 (1)	65
	(AC) 50-60 Hz	440 V~	[kA]	30	50
	(AC) 50-60 Hz	500 V~	[kA]	25	40
	(AC) 50-60 Hz	690 V~	[kA]	14	18
Rated duty short-circuit breaking capacity, **Ics** (2)			%Icu	100%	75%
Rated short-circuit making capacity (415 V~), **Icm**			[kA]	74	143
Tripping time (440 V~ / Icu)			[ms]	8	7
Isolation behaviour				■	■
Reference standards				IEC 947-2	
Releases	magnetic only	adjustable (4 ... 12 Ith)		■	
	microprocessor-based	PR212/MP (LRIU)		—	
Terminals (3)	Fixed (F)			F-EF-ES-FC Cu-FC CuAl-R-RC	
	Plug-in (P)			EF-FC Cu-R	
	Withdrawable (W) (4)			EF-FC Cu-R	
Fixing on rail DIN EN 50023				■	
Mechanical life		No. operations / Operations per hour	No.	25000/120	
Basic dimensions	Fixed (F)	Width	[mm]	105	
		Depth	[mm]	103.5	
		Height	[mm]	170	
Weights	Fixed (F)		[kg]	2.6	
	Plug-in (P)		[kg]	3.1	
	Withdrawable (W)		[kg]	3.5	

Notes

1) The breaking capacity is certified to 36 kA
2) The percentage Ics performance of circuit-breakers S3, S4, S5, S6 is 25% lower at 690V AC.
3) Please see pages 14-15 if you require further information on the types of terminals.
4) Withdrawable circuit-breakers must be fitted with the front flange for the operating lever mechanism or the accessories which are an alternative to it such as the rotary handle operating mechanism or motor operator.

MP0012

S4

MP0010

S5

MP0011

S6

MP0013

S7

160 / 250		400		800		1250	
100, 160 / 200		320		630		1000	
3		3		3		3	
690		690		690		690	
8		8		8		8	
800		800		800		800	
3000		3000		3000		3000	
N	**H**	**N**	**H**	**N**	**H**	**S**	**H**
65	100	65	100	65	100	85	100
35 (1)	65	35 (1)	65	35 (1)	65	50	65
30	50	30	50	30	50	40	55
25	40	25	40	25	40	35	45
18	22	20	25	20	25	20	25
100%		100%		100%		100%	75%
74	143	74	143	74	143	105	143
7		7		8		20	
■		■		■		■	
IEC 947-2 / IEC 947-4-1		IEC 947-2 / IEC 947-4-1		IEC 947-2 / IEC 947-4-1		IEC 947-2 / IEC 947-4-1	
—		—		—		—	
■		■		■		■	
F-EF-ES-FC Cu-FC CuAl-R-RC		F-EF-ES-FC Cu-FC CuAl-R-RC		F-EF-FC CuAl-R-RC		F-EF-FC CuAl-HR-VR	
EF-FC Cu-R		EF-FC Cu-R		—		—	
EF-FC Cu-R		EF-FC Cu-R		EF-HR-VR		EF-HR-VR	
■		■		—		—	
20000/120		20000/120		20000/120		10000/120	
105		140		210		210	
103.5		103.5		103.5		138.5	
254		254		268		406	
4		5		9.5		17	
4.5		6.1		—		—	
4.9		6.4		12.1		21.8	

SACE Isomax S - Motor Protection current-limiting circuit-breakers

Rated uninterrupted current, **Iu**			[A]
Rated service current, **In**			[A]
Number of poles			Nr.
Rated service voltage, **Ue**		(AC) 50-60 Hz	[V~]
Rated impulse withstand voltage, **Uimp**			[kV]
Rated insulation voltage, **Ui**			[V]
Test voltage at industrial frequency for 1 minute			[V]
Rated limit short-circuit breaking capacity, **Icu**			
	(AC) 50-60 Hz	220/230 V~	[kA]
	(AC) 50-60 Hz	**380/415 V~**	**[kA]**
	(AC) 50-60 Hz	440 V~	[kA]
	(AC) 50-60 Hz	500 V~	[kA]
	(AC) 50-60 Hz	690 V~	[kA]
Rated duty short-circuit breaking capacity, **Ics** (1)			%Icu
Rated short-circuit making capacity (415 V~), **Icm**			[kA]
Tripping time (440 V~ / Icu)			[ms]
Isolation behaviour			
Reference standards			
Releases	magnetic only	adjustable (4 ... 12 Ith)	
	microprocessor-based	PR212/MP (LRIU)	
Terminals (3)	Fixed (F)		
	Plug-in (P)		
	Withdrawable (W) (4)		
Fixing on rail DIN EN 50023			
Mechanical life		No. operations / Operations per hour	No.
Basic dimensions	Fixed (F)	Width	[mm]
		Depth	[mm]
		Height	[mm]
Weights	Fixed (F)		[kg]
	Plug-in (P)		[kg]
	Withdrawable (W)		[kg]

Notes

1) The value of Ics is 25% lower at 500/690 V (excluding S3X with setting R 32).
2) For S3X with setting R 32, Icu (690 V~) = 50 kA and Ics = 100%Icu.
3) Please see pages 14-15 if you require further information on the types of terminals.
4) Withdrawable circuit-breakers must be fitted with the front flange for the operating lever mechanism or the accessories which are an alternative to it such as the rotary handle operating mechanism or motor operator.

S3

S4

S6

125 / 200	**250**	**400 / 630**
3 ... 125 / 125 ... 200	100, 160, 200	320 / 400, 630
3	3	3
690	690	690
8	8	8
800	800	800
3000	3000	3000
X	**X**	**X**
300	300	300
200	**200**	**200**
180	180	180
150	150	150
75 (2)	**75**	**75**
100%	100%	100%
440	440	440
3.5	3.5	3.5
■	■	■
IEC 947-2	IEC 947-2 / IEC 947-4-1	IEC 947-2 / IEC 947-4-1
■	—	—
—	■	■
F - EF - ES - FC Cu - FC CuAl - R - RC	F - EF - ES - FC Cu - FC CuAl - R - RC	F - EF - FC CuAl - R - RC
EF - R	EF - R	—
EF - R	EF - R	EF - HR - VR
■	—	—
25000 / 120	20000 / 120	20000 / 120
105	105	210
103.5	103.5	103.5
255	339	406
3.6	5	15
6.3	8.2	–
7.1	9	25.4

Overcurrent releases

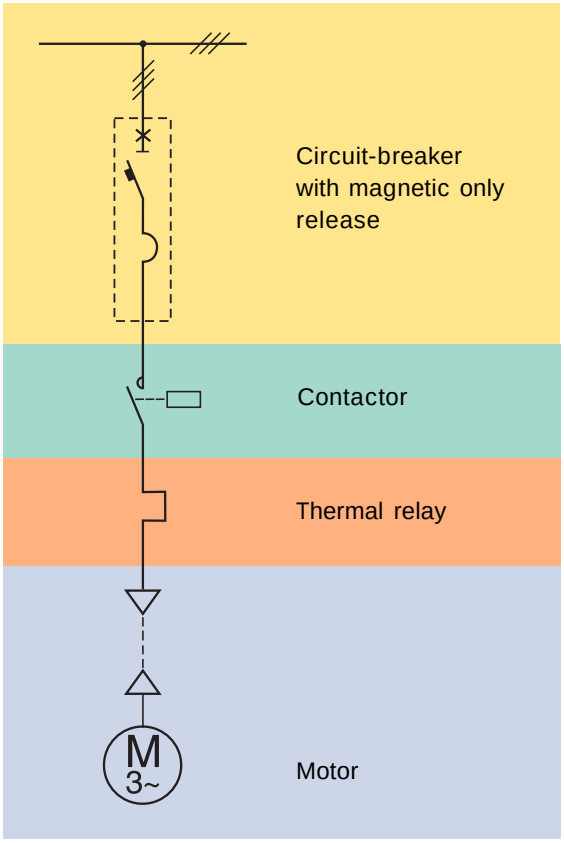
Magnetic only overcurrent releases

The SACE Isomax S3N-H 160/250 and S3X 125/200 circuit-breakers are fitted with magnetic only adjustable releases for protection against short-circuit. These circuit-breakers must be used in combination with a thermal relay (for protection against overload and against missing or unbalanced phase) and with a contactor, to form a device for motor switching and protection.

The circuit-breaker-thermal relay-contactor group takes the name of protected starter.

The circuit-breaker can be used for a range of release setting currents from 3 A to 200 A according to the table shown below.

The magnetic trip current is adjustable with a variable parametrisation range - continuous - from 4 to 12 times the rated In setting current.

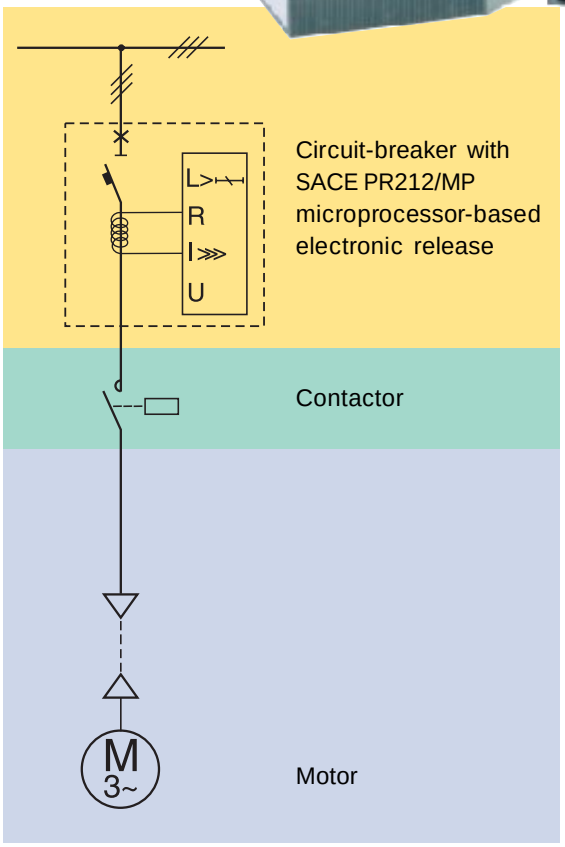


Magnetic only adjustable overcurrent releases

Circuit-breaker					Phases L1 - L2 - L3	
S3N 160	S3H 160	S3N 250 S3H 250	S3X 125	S3X 200	Setting [A]	Magnetic adjustment [A] Im = 4 ... 12 x Ith
■			■		R 3	12 ... 36
■			■		R 5	20 ... 60
■			■		R 10	40 ... 120
■			■		R 25	100 ... 300
■	■		■		R 50	200 ... 600
■	■		■		R 100	400 ... 1200
■	■		■	■	R 125	500 ... 1500
		■		■	R 160	640 ... 1920
		■		■	R 200	800 ... 2400

SACE PR212/MP microprocessor-based electronic releases

SACE Isomax S4N-H 160/250, S5N-H 400, S6N-H 800, S7S-H 1250 and S4X 250 and S6X 400/630 circuit-breakers are fitted with SACE PR212/MP electronic releases constructed using microprocessor-based electronic technology. This allows functions which ensure high trip precision, extreme reliability and insensitivity to variations in external temperature to be obtained. The SACE Isomax S circuit-breaker fitted with the PR212/MP release (complying with the IEC 947-4-1 International Standards regarding motor protection), is used together with a contactor for switching the motor. The microprocessor-based electronic releases are self-supplied and consist of three current transformers, the SACE PR212/MP protection unit and an opening solenoid which acts directly on the operating mechanism group of the circuit-breaker. The current transformers, housed inside the release unit, provide the energy and signal required for correct operation of the protection.
The release is temperature-compensated and is sensitive to the lack of phase according to Table IV of the 947-4-1 7.2.1.5.2 Standard.



SACE PR212/MP microprocessor-based electronic overcurrent releases for motor protection

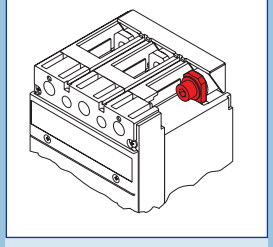
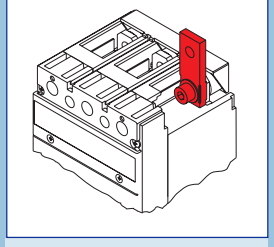
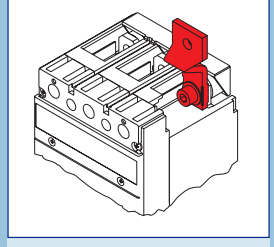
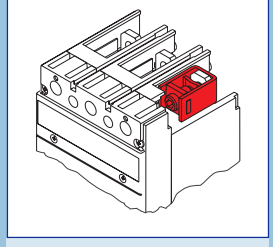
Circuit-breaker								Rated current of release In [A]	Phases L1 - L2 - L3			
S4N160 S4H160	S4N250 S4H250	S5N 400 S5H 400	S6N 800 S6H 800	S7S 1250 S7H 1250	S4X 250	S6X 400	S6X 630		L I1 [A]	R I5 [A]	I I3 [A]	U Iu [A]
■					■			100	50 ... 100		600 ... 1300	
■					■			160	80 ... 160		960 ... 2080	
	■				■			200	100 ... 200		1200 ... 2600	
		■				■		320	160 ... 320	3 ... 10 x I1	1920 ... 4160	0,4 x I1
							■	400	200 ... 400		2400 ... 5200	
			■				■	630	315 ... 630		3780 ... 8190	
				■				1000	500 ... 1000		6000 ... 13000	

L = Protection function against overload with relative setting current (**I1** = 0,5-0.6-0.7-0.8-0.85-0.9-0.95-1 x In - **Class** = 10A, 10, 20, 30)
R = Protection function against rotor block with relative current and setting time (**I5** = 3-4-5-6-7-8-10 x I1 - **t5** = 1-4-7-10 s)
I = Protection function against short-circuit with relative setting current (**I3** = 6-7-8-9-10-11-12-13 x In)
U = Protection function against phase loss or unbalance of a phase with relative current and setting time (**Iu** = 0.4 x I1 - **t** = 4 s)

Basic version and conversion kits

SACE Isomax S circuit-breakers for motor protection are always supplied in the three-pole fixed version with front terminals (basic version).
By means of additional kits, other versions with different types of terminals, summarised in the table below, can be constructed.
Still by means of special conversion kits, the plug-in and withdrawable versions of the circuit-breakers can be constructed.

For different types of terminals and versions, application of the terminal covers which are part of the standard circuit-breaker supply is foreseen. In particular, the moving parts of plug-in or withdrawable circuit-breakers are always complete with terminal covers.
For the version with front terminals, the terminal covers are supplied with separation partitions between the phases.

		F	EF	ES	FC Cu
					
		front	extended front	spreaded extended front	front for Cu cables
SACE S3N-H **SACE S4N-H** **SACE S5N-H**	fixed (F)	□ ↑↓	■ ↑↓	■ (5)	■ ↑↓ (2)+(5)
	plug-in (P)		□		■ (5)
	withdraw. (W)		□		■ (5)
SACE S6N-H	fixed (F)	□ ↑↓	■ ↑↓		
	withdraw. (W)		□		
SACE S7S-H	fixed (F)	□ ↓	■ ↓		
	withdraw. (W)		□		
SACE S3X **SACE S4X**	fixed (F)	□ ↑↓	■ ↑↓	■ (5)	■ ↑↓
	plug-in (P)		□		
	withdraw. (W)		□		
SACE S6X	fixed (F)	□ ↑↓	■ ↑↓		
	withdraw. (W)		□ (1)		

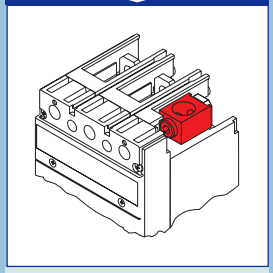
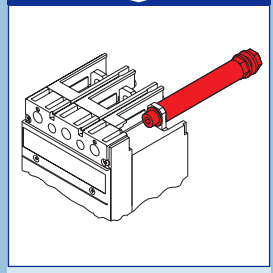
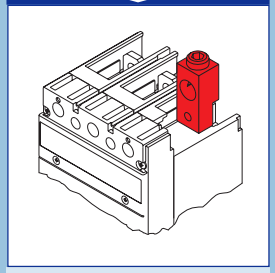
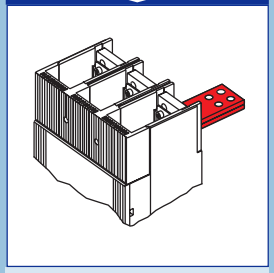
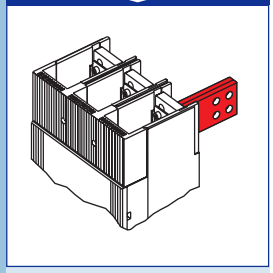
□ = standard version; ■ = version on request; ↑ = high terminal covers (on request); ↓ = low terminal covers (on request)

GSIL9111

GSIL9112

GSIL9113

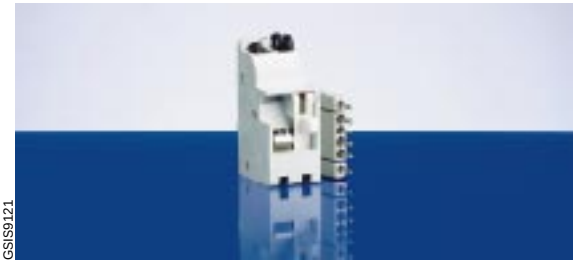
	F FIXED	P PLUG-IN	W WITHDRAWABLE
SACE S3 N-H-X	■	■	■
SACE S4 N-H-X	■	■	■
SACE S5 N-H	■	■	■
SACE S6 N-H-X	■	—	■
SACE S7 S-H	■	—	■

FC CuAl	R	RC	HR	VR
				
front for Cu/Al cables	threaded rear	rear for Cu/Al cables	horizontal flat bar rear	vertical flat bar rear
■ ↑↓ (3)+(5)	■ (5)	■ (5)		
	■			
	■			
■ ↑ (4)+(5)	■ (5)	■ (5)		
			■	■
■ ↓			■ (5)	■ (5)
			■	■
■ ↑ (3)+(5)	■ (5)	■ (5)		
	■			
	■			
■ ↑ (4)+(5)	■ (5)	■ (5)		
			■	■

(1) The extended front terminals can only be fitted on the bottom of the fixed part of the withdrawable S6X circuit-breaker.
(2) For S5 630 A only
(3) For S5 400 A version with two cables of 120 mm²
(4) For S6 800 A only
(5) Terminal covers already included in the supplied

Accessories

The completeness of the range and the possibility of adding accessories to the circuit-breakers for motor protection is ensured by a wide range of accessories to satisfy all requirements.
Below, some of the main accessories which characterise the SACE Isomax S series are listed.
For further information, please consult the SACE Isomax S technical catalogue, code 649240.


GSIS9121

Auxiliary contacts

These carry out electrical signalling of the state of operation of the circuit-breaker: Open - Closed - Release trip.

GSIS9045

Shunt opening release

This allows circuit-breaker opening by means of an electric control. Operation is ensured for an auxiliary power supply voltage between 70% and 110% of the rated voltage value of the power supply Un, both in a.c. and in d.c.

GSIS9052

Motor operator

With direct action (for S3, S4 and S5 circuit-breakers) and with stored energy (for S6 and S7 circuit-breakers).
The opening, closing and resetting commands are operated by the motor which acts directly on the circuit-breaker lever.

GSIS9047

Instantaneous or time-delayed undervoltage release

This opens the circuit-breaker when the power supply voltage to the release is missing, or for drops to minimum values of 0.7 x Un with a trip range of 0.7 to 0.35 x Un.
The undervoltage release can be combined with a time-delay device with external electronic power supply which allows circuit-breaker opening to be delayed in the case of a drop in or missing voltage of the release power supply itself, according to fixed delays of 0.5 - 1 - 2 - 3 s, so as to prevent unwarranted trips caused by temporary malfunctions.

GSIS9055

Rotary handle operating mechanism

This is used to facilitate circuit-breaker operation thanks to its ergonomic handle. It is always fitted with a padlock in the open position, which prevents closure of the circuit-breaker. The lock hole can take up to 3 padlocks (not supplied) with a stem diameter of 6 mm.

CSIS9057

Key lock

Different versions with different keys for each circuit-breaker or with the same keys for groups of circuit-breakers are available.

PSIS9646

Insulating terminal covers

To prevent accidental contact with live parts, bottom terminal covers (for all the circuit-breakers, with IP30 degree of protection) and top terminal covers (for all the circuit-breakers, with IP40 degree of protection) are available. The degrees of protection indicated are valid for circuit-breakers installed in switch-boards. To prevent their removal, screws which can be sealed with lead can be supplied.

PSEM9070

SACE TT1 test unit

This is a pocket unit which allows checking of the SACE PR212/MP electronic release trip for S4-S5-S6 and S7 circuit-breakers. The positive outcome of the test makes the circuit-breaker open.

Construction characteristics

Construction characteristics

The SACE Isomax S series for motor protection has been designed with features which allow all those who operate on the circuit-breakers (installers, operators and maintenance personnel) to work in complete safety thanks to some special characteristics, such as:

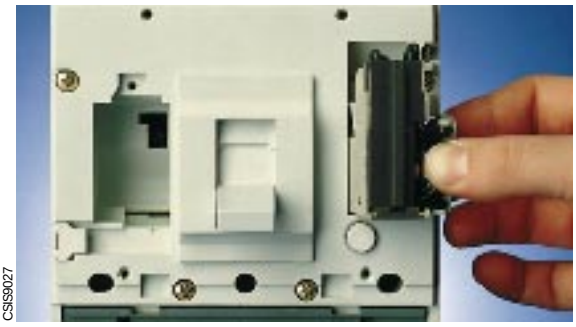
– double insulation, with increased safety in managing and inspecting installations
– positive operation, which ensures safe and reliable visual signals
– easy inspection, with reduction of maintenance times
– electromagnetic compatibility, in compliance with the IEC 947-2 Annex F International Standards
– resistance to vibrations of mechanical type or due to electromagnetic effect, in compliance with the IEC 68-2-6 International Standards and to the strict regulations of the most important classification Organisations and Shipping Registers
– assembly in different installation positions without variation in the rated characteristics
– operation possible with ambient temperatures between -25 °C and + 70°C
– installation at altitudes up to 2000 m without alterations to the rated performances

CSIS9028

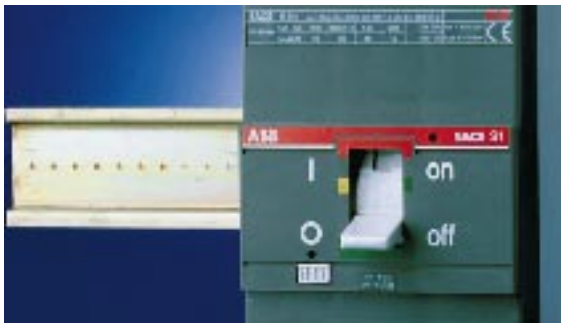
Positive operation

CSIS9029

Easy inspection


CSIS9027

Double insulation



CSIS9033

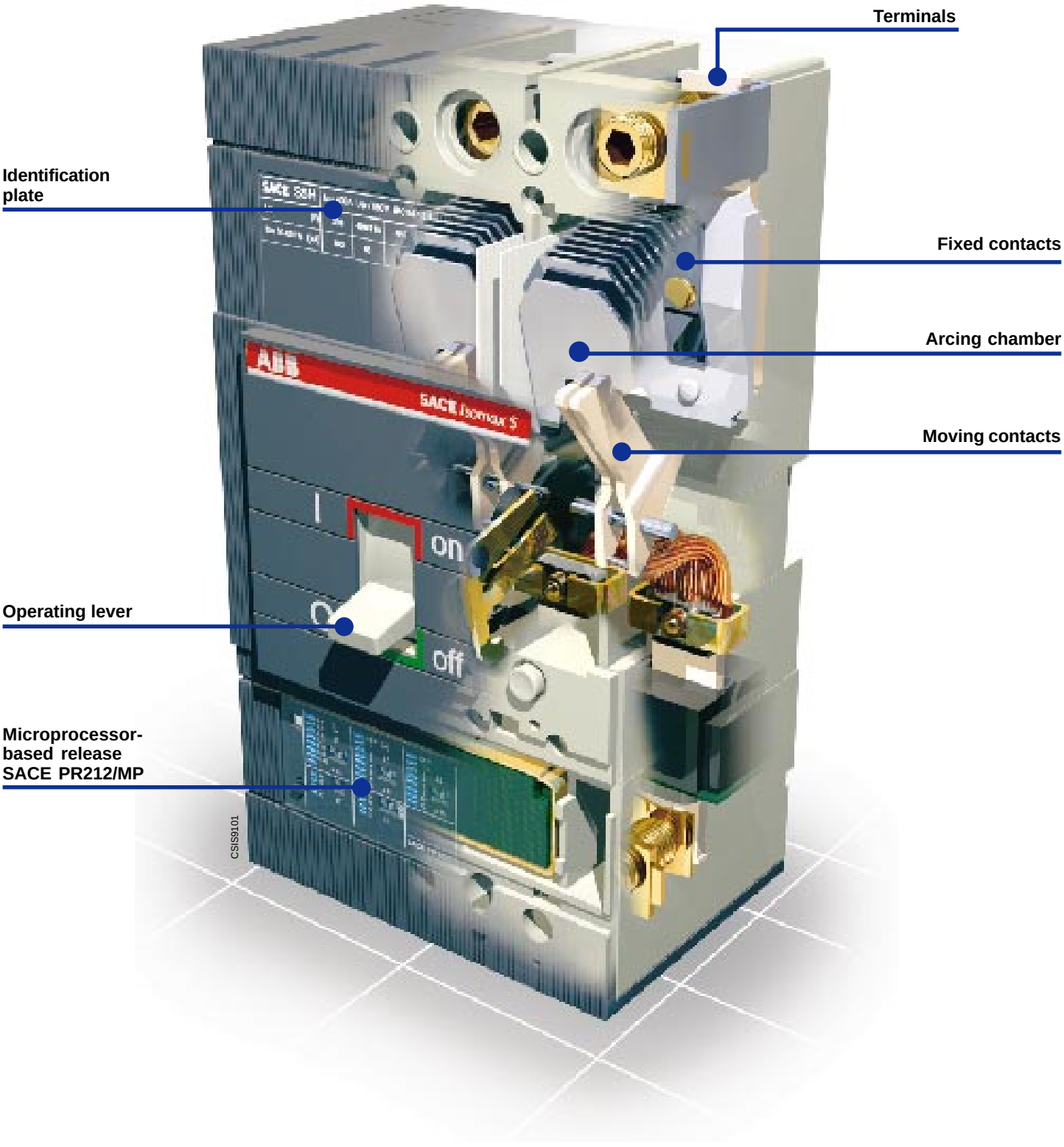
DIN rail

CSIS9111

Resistance to vibrations

CSIS9035

Installation positions


Terminals
Identification plate
Fixed contacts
Arcing chamber
Moving contacts
Operating lever
Microprocessor-based release SACE PR212/MP
ABB
SACE Isomax S
I
on
O
off
CSIS9101

Protection functions and parametrisations of the SACE PR212/MP release

Function L
Protection against overload

Function L protects the motor against undesired overloads according to the indications and classes defined in the IEC 947-4-1 Standards.
The protection is based on a pre-defined thermal model (ABB SACE L.V. International Patent) which, by simulating overtemperatures of copper and iron inside the motor, allows precise safeguarding of the machine.
The protection intervenes when the preset overtemperature is reached.
The trip time is fixed by selecting the trip class defined by the above-mentioned Standards.
The function is temperature-compensated and sensitive to the missing/unbalanced phase according to the IEC 947-4-1 Standard.

Parametrisation of protection L

I1 = 0.5 - 0.6 - 0.7 - 0.8 - 0.85 - 0.9 - 0.95 - 1 x In
where I1 is the rated service current of the circuit-breaker which must be the same or higher than that of the motor to be protected (I1 ≥ Ie) and In is the rated current of the current transformers.
t1 = 4 - 8 - 16 - 24 s
where t1 is the trip at 7.2 x I1 cold

Class 10A - 10 - 20 - 30
are the motor starting classes which determine the trip times for overload according to the IEC 947-4-1 4.7.3 Standards Table II.

Tolerances: according to IEC 947-4-1 Standard.

Function R
Protection against rotor block

The R function protects the motor against any rotor blockage during operation.
This protection is automatically disabled for the whole motor starting phase and is then re-activated.
The protection protects right from low current increases (from 3 times the I1 circuit-breaker service current) and can also be disabled.
Both the current level to be tripped as well as the delay in tripping can be selected.
The protection intervenes when at least one of the phase currents exceeds the preset value and remains above that threshold for the t5 time set.

Parametrisation of protection R

I5 = OFF - 3 - 4 - 5 - 6 - 7- 8 - 10 x I1
where I5 is the current at which the rotor is considered to be blocked and I1 is the rated service current of the circuit-breaker selected for function L.

t5 = 1 - 4 - 7 - 10 s
where t5 is the preset time threshold above which the release trips.

Tolerances: ± 10% (tripping threshold tolerances)
± 20% (trip time tolerances)

Function I
Protection against short-circuit

This protection function intervenes in the case of a short-circuit between phase and phase. It is sufficient for a single phase to exceed the threshold set to cause immediate opening of the circuit-breaker (the protection cannot be excluded).
The trip current can be adjusted up to 13 times the rated current of the release, whereas the time is fixed.
To prevent unwarranted trips during starting, the protection recognises whether the motor to be protected is in the starting phase or whether there is a short-circuit.
This is to allow starting under completely safe conditions.

Parametrisation of protection I

I3 = 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 x In
where I3 is the instantaneous trip current for short-circuit and In is the rated current of the current transformers.

To prevent unwarrented trips during the motor inrush phase, instantaneous tripping of protection I takes place at 1.5 x I3 (for I3 ≤ 9 x In), whereas for higher values (I3 > 9 x In), tripping takes place at 13.5 x In.

Tolerances: ± 20% (tripping threshold tolerances)
± 20% (trip time tolerances)

Function U

Protection against loss and/or unbalance of a phase

Function U can be used in those cases where particularly precise control is needed regarding loss and/or unbalance phase currents. This function can be excluded and intervenes if the effective value of one or two currents drops below the level of 0.4 of the current I1 set with function L and remains there for more than 4 seconds.

Parametrisation of protection U

On, (with I6 = 0.4 x I1 and t6 = 4 s).

Off, in the off position, the release remains sensitive to the loss of phase according to the IEC 947-4-1 Standard, modifying the trip curve for protection L.

Tolerances: ± 20% (tripping threshold tolerances)
± 20% (trip time tolerances)

Selection of the release parametrisation method

By means of the microswitch located on the front, the release can be fitted for parametrisation:

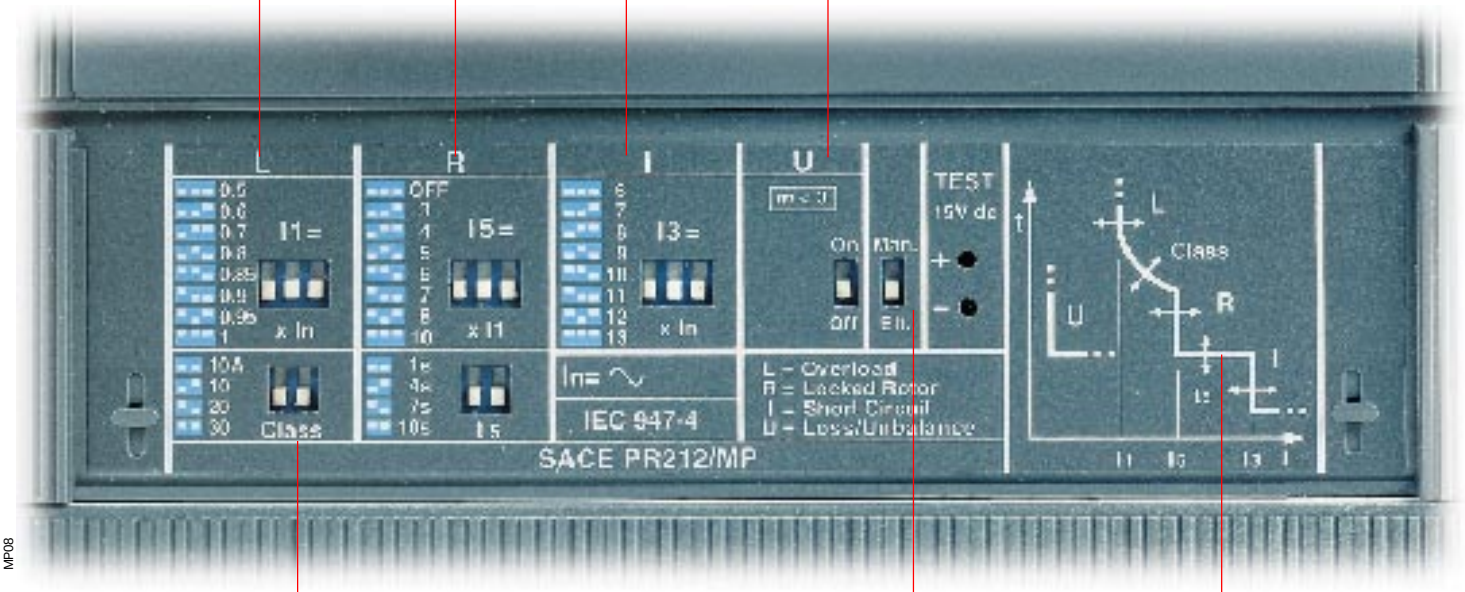
- **Man.** (manual), thresholds and times are adjusted by using the microswitches on the front of the release
- **Elt.** (electronic), stored in a non-volatile memory and predefined by ABB SACE L.V.

Protection L
against motor overload

Protection R
against blocked rotor

Protection I
against instantaneous short-circuit

Protection U
against loss and/or unbalanced phase



MP08

Class
motor starting class according to IEC 947-4-1 Standards

Man. / Elt.
release parametrisation methods

typical trip curve of a circuit-breaker for motor protection

Protection functions and parametrisations of the SACE PR212/MP release

Summary of the parametrisations of the SACE PR212/MP release

Protection function	Parametrisations
L Cannot be excluded	**I1 = 0,5-0,6-0,7-0,8-0,85-0,9-0,95-1 x In** **Class 10A, 10, 20, 30** Trip at 7,2 x **I1** cold, 4 - 8 - 16 - 24 [s]
R Can be excluded	**I5 = 3-4-5-6-7-8-10 x I1 OFF** **t5 = 1 - 4 - 7 - 1 0 [s]**
I Cannot be excluded	**I3 = 6-7-8-9-10-11-12-13 x In**
U Can be excluded	**ON I6 = 0,4 x I1 and t6 = 4s** **OFF**

Characteristics of the SACE PR212/MP microprocessor-based electronic release

Overloading capacity	**2 x In continuously, 7,2 x In for 35 s at 45 °C**
Operating temperature	**– 25 °C ... + 70 °C**
Maximum percentage of relative humidity	**90%**
Rated operating frequency	**45 - 66 Hz, able to measure harmonics up to 550 Hz**
Current measurement method	**true effective value up to 3 x In (functions L, R, U)**
	peak value for values higher than 3 x In (functions L, R, U)
	peak value for function I
Electromagnetic compatibility	**in compliance with Standard: IEC 947-2 Annex F**
Electrostatic discharges	**in compliance with Standard: IEC 1000-4-2**
Radiated electromagnetic field	**in compliance with Standard: IEC 1000-4-3**
Short-time transients	**in compliance with Standard: IEC 1000-4-4**
Mean Time Between Failure (MTBF)	**15 years (at 45 °C)**

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Characteristic curves

Use of the trip curves of circuit-breakers with SACE PR212/MP electronic release 24

Trip curves of circuit-breakers with SACE PR212/MP electronic release 25

Trip curves of circuit-breakers with magnetic only overcurrent release 30

Note

For the current-limiting and specific let-through energy curves of SACE S3, S4, S5, S6 and S7 circuit-breakers for motor protection, please refer to what is indicated in the catalogue on SACE Isomax S "Low voltage moulded-case circuit-breakers" (code 649240) and in the Annex "Low voltage current-limiting circuit-breakers" (code 649294), for the corresponding types of circuit-breakers.

Trip curves of circuit-breakers with SACE PR212/MP electronic release

Use of the trip curves of circuit-breakers with SACE PR212/MP electronic release

For correct parameter setting of the SACE PR212/MP electronic release, it may be useful to compare the overall circuit-breaker curve with the motor starting curve.
For this purpose, with the protection function graphics shown on the following pages, it is possible to draw the overall curve required for the circuit-breaker fitted with SACE PR212/MP release simply and immediately.

N.B. For function L, as for all the other functions, make sure you place a glossy tracing sheet over the curve so that the times on the axis of the co-ordinates coincide.

- **Function L (cannot be excluded) - Protection against overload**

  To protect the motor against any overloads, as a first step it is necessary to adjust function L to a current **I1** higher than or equal to the rated current of the motor Ie: **I1 ≥ Ie**.
  For example, if Ie = 135 A, an S4H160 circuit-breaker can be selected with In = 160 A and the following adjustment carried out: I1 = 0.85 x In = 136 A.
  The second step is to select the trip class according to the motor starting time **ta**. For a motor with a start-up overload of 6 seconds, class 10 can be selected, with a trip time of 8s at 7.2 x I1.
  To trace the curve correctly on the glossy sheet, according to **I/In**, simply place the glossy sheet over the graph of function L so that I/In = 0.85 (on the glossy sheet) corresponds to I/I1 = 1 (on the graph) and draw the curve relative to class 10.

- **Function R (can be excluded) - Protection against rotor blockage**

  Protection against rotor blockage can be set both with regard to the trip current **I5** = 3 ... 10xI1 (in this case I5 = 3 ... 10 x 0.85 x 160), and with regard to the trip time **t5**.
  To trace the curve correctly on the glossy sheet, simply place the glossy sheet over the graph of function R so that I/In = I1/In (on the glossy sheet) corresponds to I/I1 = 1 (on the graph). In this case I/In = I1/In = 0.85, and draw the desired curve.

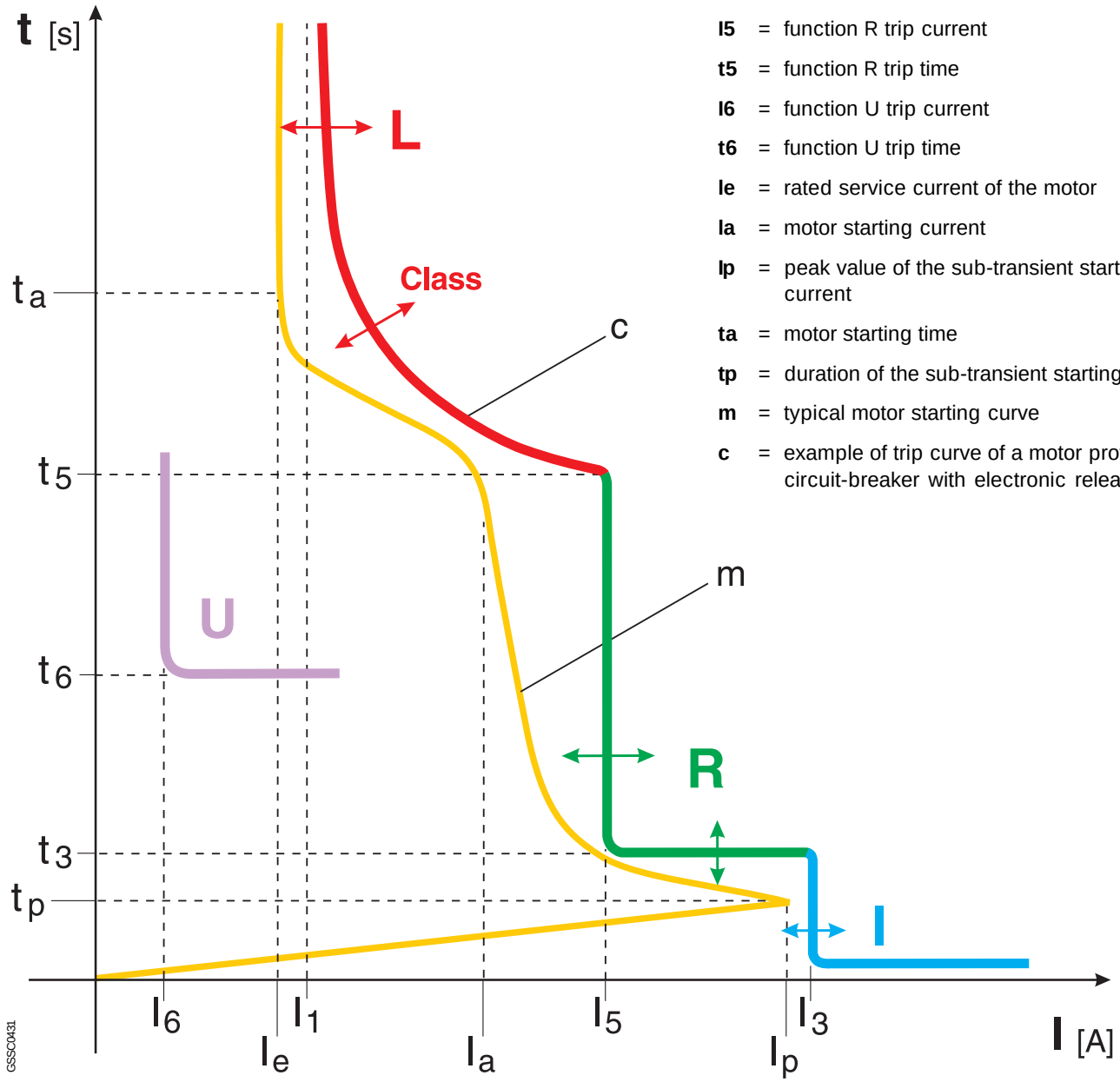
- **Function I (cannot be excluded) - Protection against short-circuit**

  This protection function against short-circuit recognises whether the motor is in the starting phase, thereby avoiding unwarranted trips; the trip threshold can be set from 6 x In to 13 x In.
  To trace the curve correctly on the glossy sheet, simply place the glossy sheet over the graph of function I so that I/In = 1 (on the glossy sheet) corresponds to I/In = 1 (on the graph) and draw the desired curve.

- **Function U (can be excluded) - Protection against loss and/or unbalance of a phase**

  Protection against loss or unbalance of a phase, if set to ON, intervenes when one or two phases have a current lower than 0.4xI1 (0.4 x 0.85 x In = 0.4 x 0.85 x 160 A = 54.4 A in this case).
  To trace the curve correctly on the glossy sheet, simply place the glossy sheet over the graph of function U so that I/In = I1/In (on the glossy sheet) corresponds to I/I1 = 1 (on the graph). In this case I/In = I1/In = 0.85, and draw the desired curve.

Typical operating characteristic of an asynchronous motor

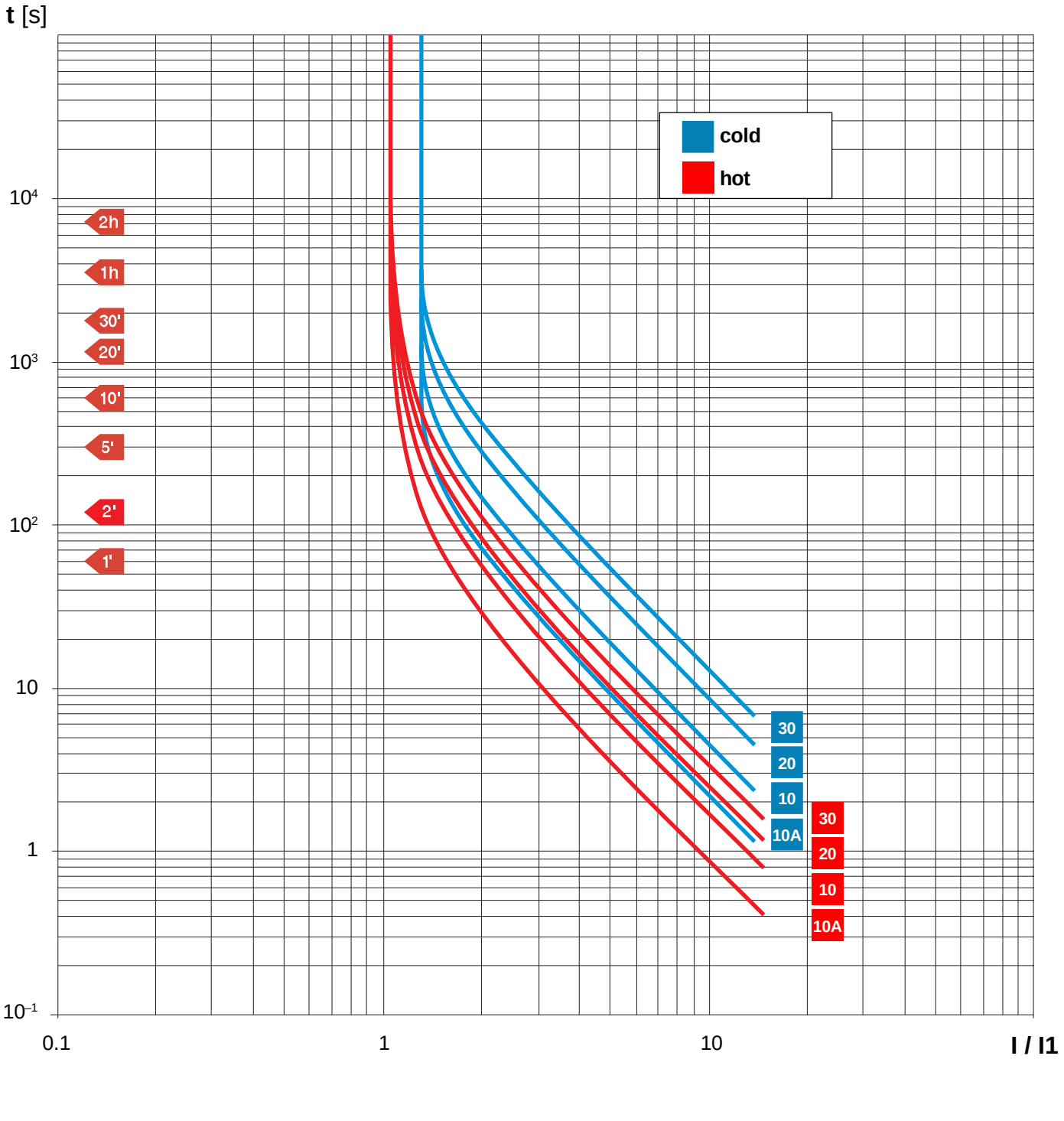


I1 = function L trip current
I3 = function I trip current
I5 = function R trip current
t5 = function R trip time
I6 = function U trip current
t6 = function U trip time
Ie = rated service current of the motor
Ia = motor starting current
Ip = peak value of the sub-transient starting current
ta = motor starting time
tp = duration of the sub-transient starting phase
m = typical motor starting curve
c = example of trip curve of a motor protection circuit-breaker with electronic release

Trip curves of circuit-breakers with electronic overcurrent release SACE PR212/MP

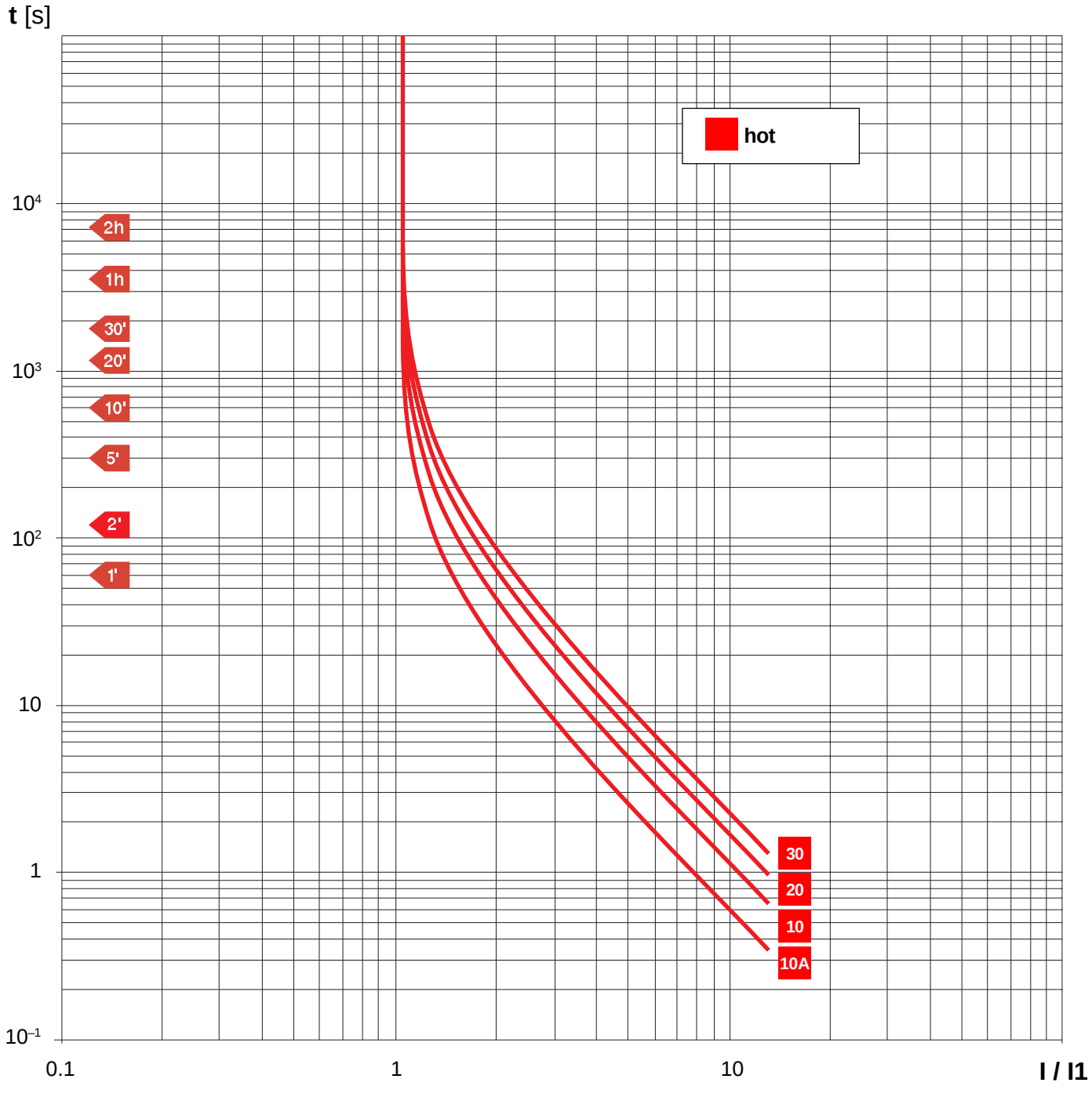
SACE S4, S5, S6, S7

SACE PR212/MP - Function L (hot and cold trip)



SACE S4, S5, S6, S7

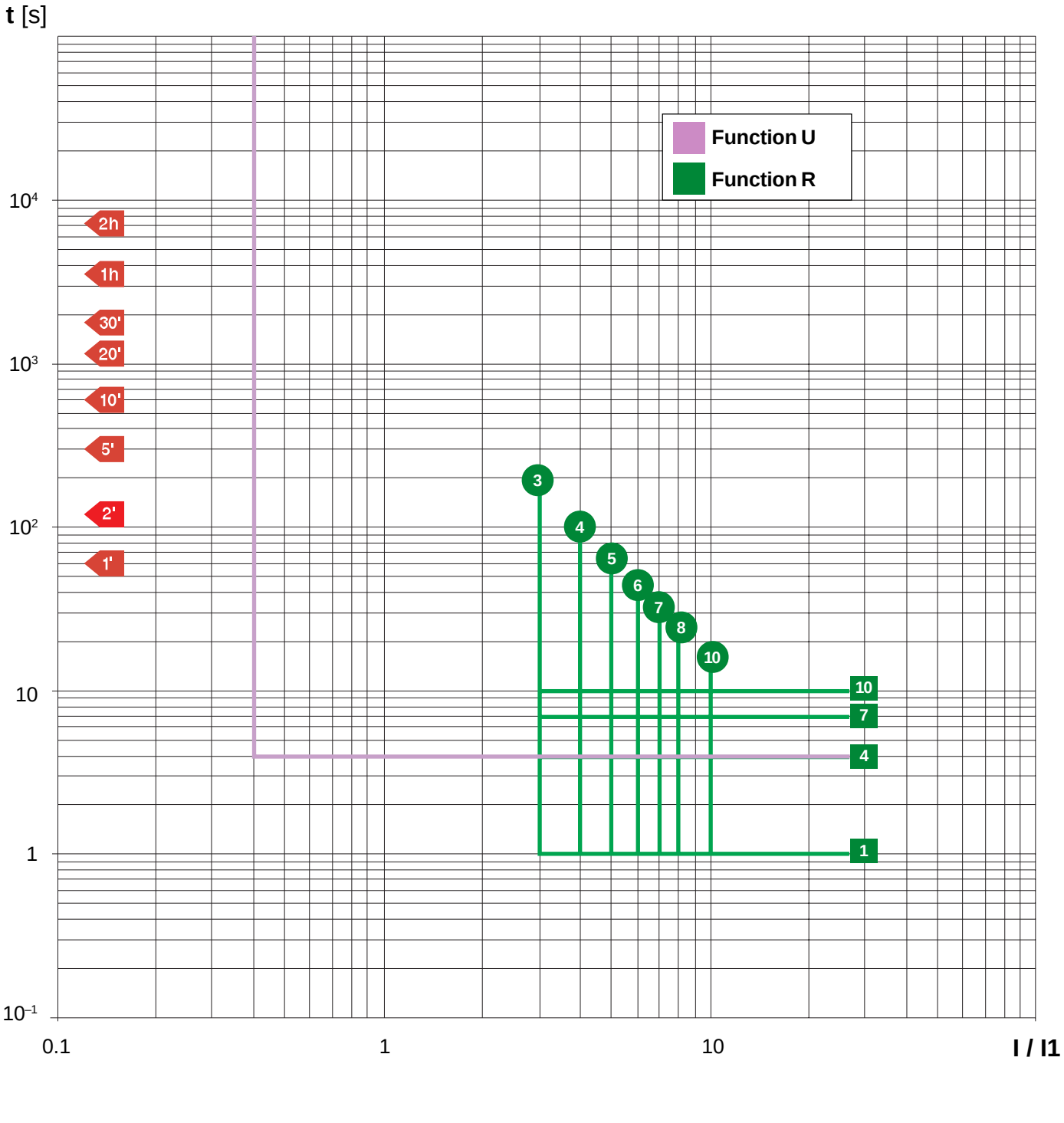
SACE PR212/MP - Function L (hot trip with 1 or 2 phases supplied)



Trip curves of circuit-breakers with electronic overcurrent release SACE PR212/MP

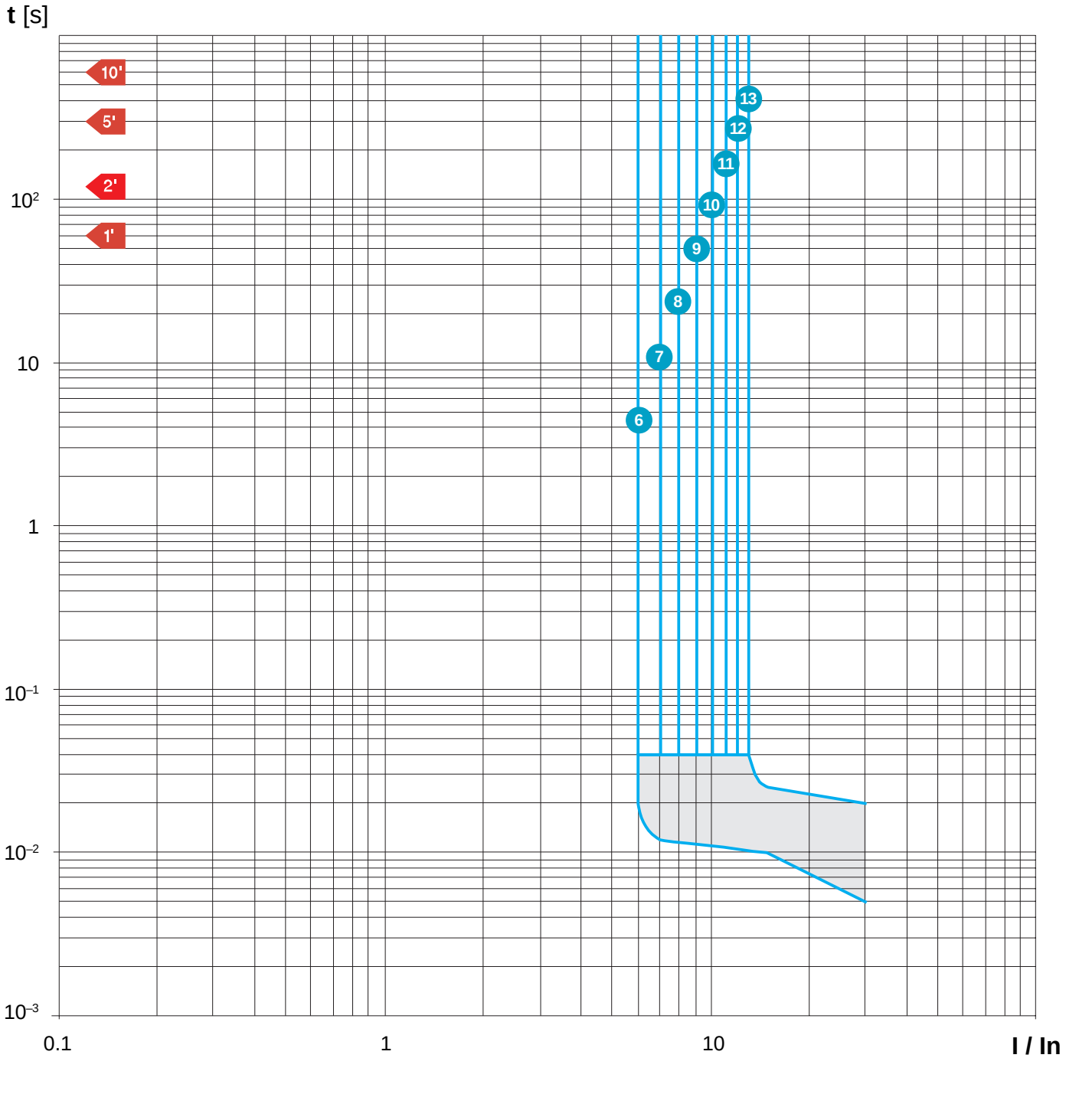
SACE S4, S5, S6, S7

SACE PR212/MP - Functions R - U



SACE S4, S5, S6, S7

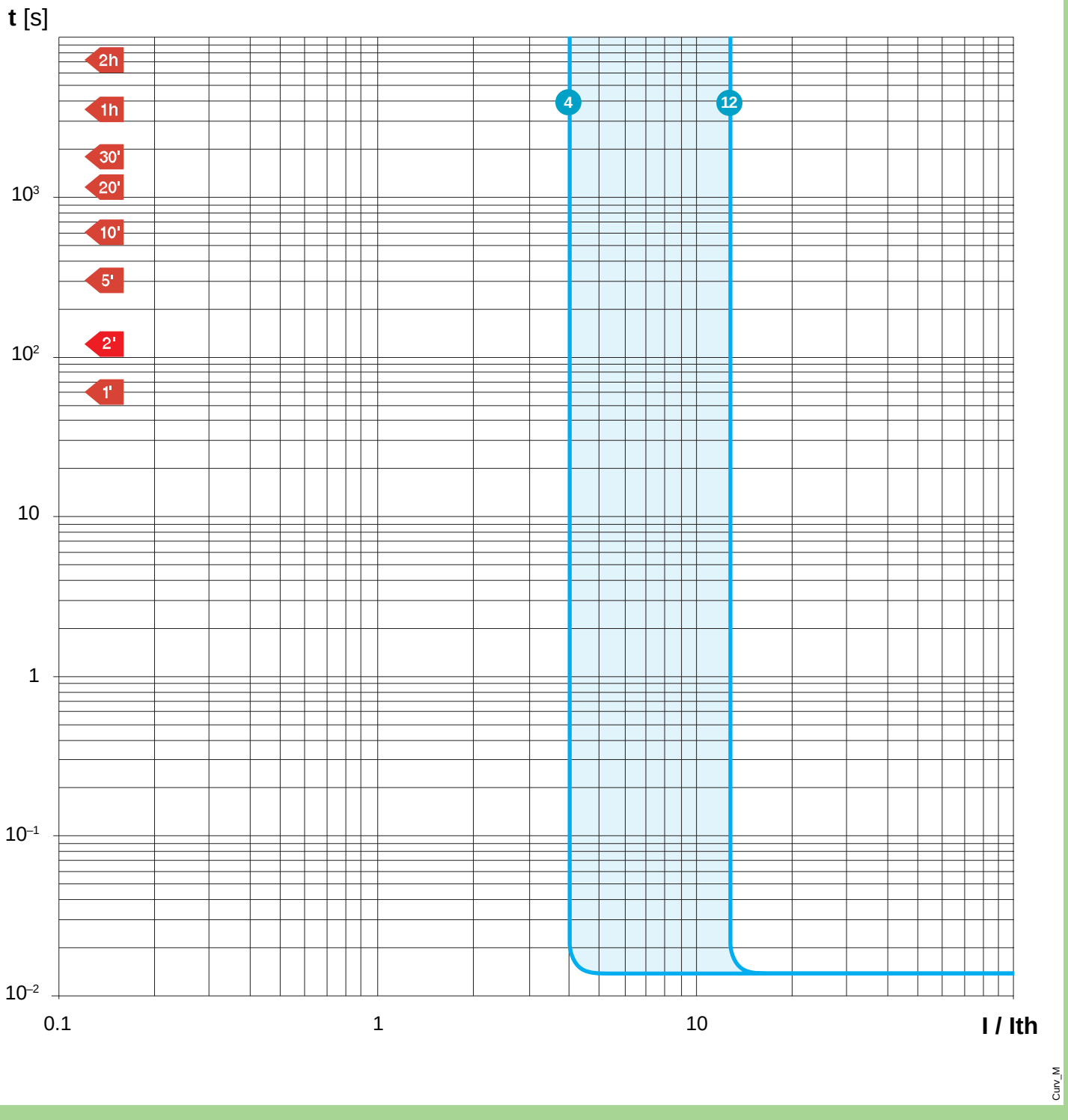
SACE PR212/MP - Function I



Trip curves of circuit-breakers with magnetic only overcurrent release

SACE S3

Function I - Adjustable magnetic only release - Magnetic trip threshold



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Circuit-breaker applications

Protection, starting and switching of three-phase asynchronous motors

Three-phase asynchronous motors, for low and high powers, are widely used in all sectors. Starting, switching and protection are fundamental operations for correct use of the motor.

The traditional system used for this purpose foresees three different devices: a circuit-breaker for protection against short-circuit, a thermal relay for protection against overload and a contactor for switching. Everything must necessarily take into account the problems which arise during starting.

Naturally, different factors must be taken into consideration in selecting these devices, such as:

– the power of the motor
– the starting diagram: direct, with gear inversion, star-delta, with reactances, or with static feeder
– the type of motor: with cage rotor or with wound rotor
– the fault current at the point of the network where the motor is installed.

The SACE S3H 160 circuit-breaker fitted with an adjustable magnetic only release fulfils these requirements in the most classic way, since it is used combined with a thermal relay for protection against overload and missing phase and a contactor for switching.

ABB SACE has constructed the SACE PR212/MP electronic microprocessor-based release which integrates the protection functions against short-circuit and overload in a single product, thanks to the precision and reliability of its electronics.

Other specific functions for motor protection, such as protection against rotor blockage and against missing and unbalanced phase, are built into the product itself, which is therefore a compact, reliable and complete protection system.

The table shows three different starter diagrams and, for each of these, the functions carried out by the various devices.

	diagram A	diagram B	diagram C *
Protection against short-circuit	SACE Isomax S circuit-breaker with magnetic only release (S3) or with PR211-I electronic release (S4...S7)	SACE Isomax S circuit-breaker with SACE PR212/MP electronic release for motor protection	SACE Isomax S circuit-breaker with SACE PR212/MP electronic release for motor protection
Protection against overload	Thermal relay		
Switching	Contactor	Contactor	
Typical use	Installations where a high number of operations is foreseen. They are characterised by powers which are not high and stoppages are not allowed in case of fault	Installations where a high number of operations is foreseen. They are characterised by powers which are not high and stoppages are not allowed in case of fault	Special applications, such as large motors with a limited number of operations

* Special version in category AC-3, please ask ABB SACE L.V.

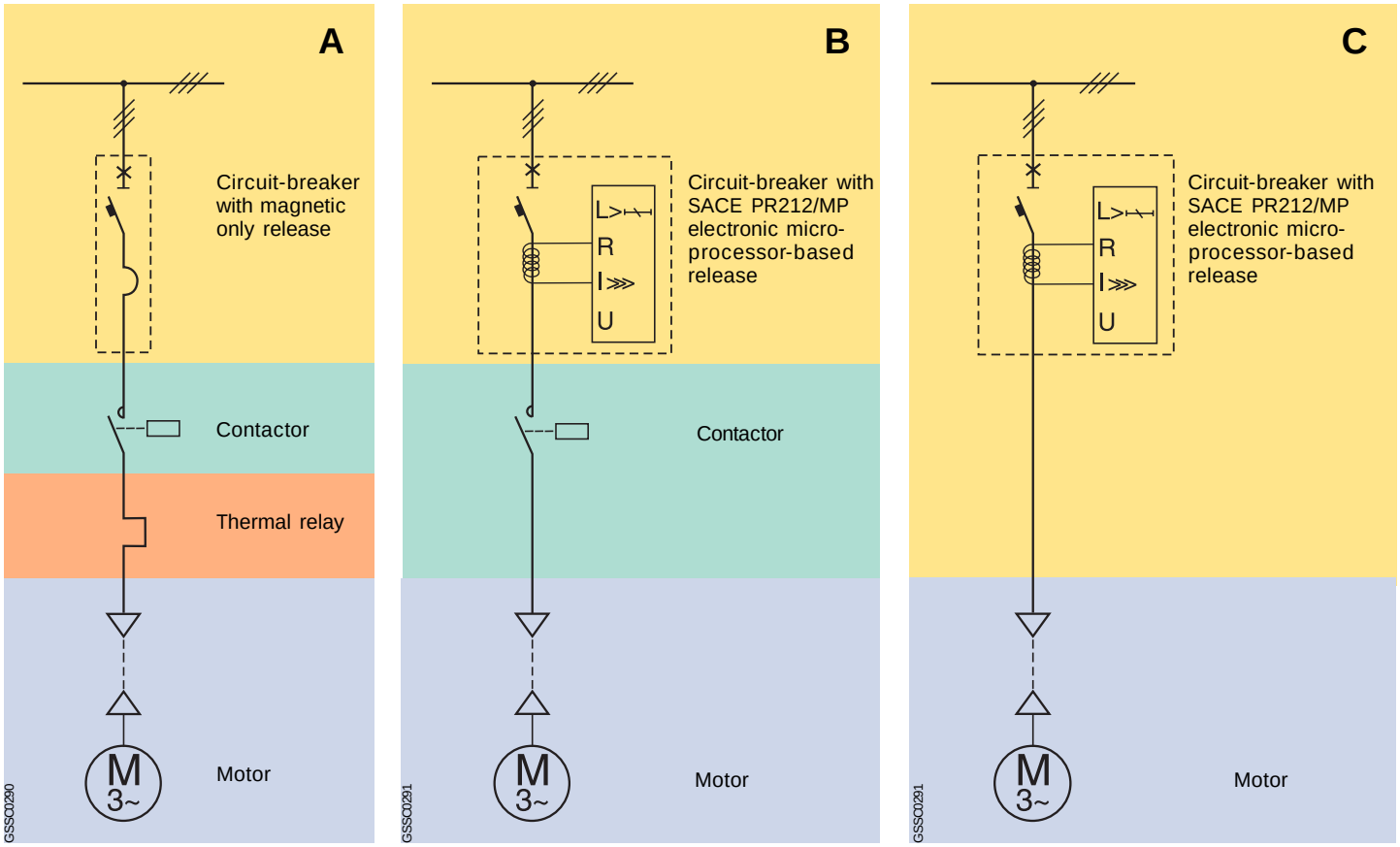
Standards

The International Standard regarding motor protection is the IEC 947-4 Standard.
This foresees trip fields within which a device must intervene to ensure maximum safety during starting and use of the motor.

The Standard defines 4 Classes of intervention which define the starting time of the motor.
The SACE PR212/MP release allows selection of the most suitable class according to the trip times shown in the table, thereby obtaining 4 levels of co-ordination: from normal starting to heavy starting.

Class	Trip according to IEC 947-4-1 Standards				PR212/MP trip
compensated relay (*)	1.05 x I1	1.2 x I1	1.5 x I1	7.2 x I1	at 7.2 x I1
10A	> 2 hours	< 2 hours	< 120 s	2 ... 10 s	4 s
10	> 2 hours	< 2 hours	< 240 s	4 ... 10 s	8 s
20	> 2 hours	< 2 hours	< 480 s	6 ... 20 s	16 s
30	> 2 hours	< 2 hours	< 720 s	9 ... 30 s	24 s

(*) Trip at 1.0 x I1 for uncompensated thermal relay



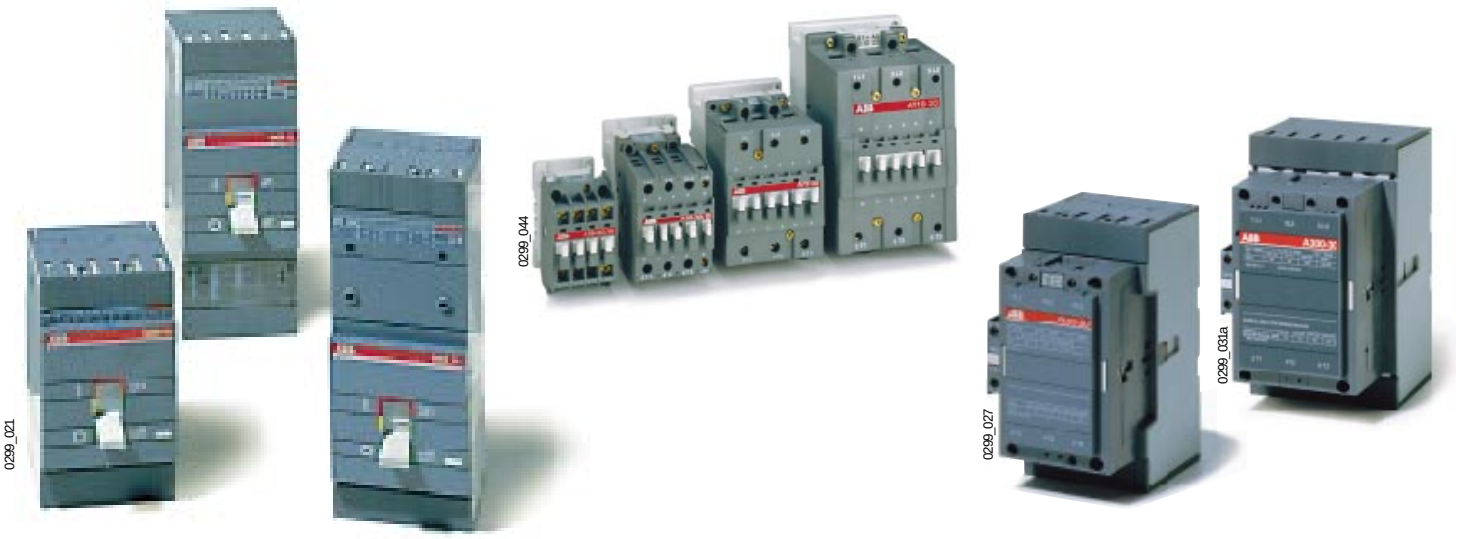
Coordination tables according to IEC 947-4-1 Standards

ABB SACE L.V. proposes a complete range of co-ordination tables to facilitate selection of SACE Isomax S circuit-breakers in relation to the co-ordination requirements with the other devices of the starter (in compliance with the IEC 947-4-1 Standards).
Each table is defined on the basis of an ambient temperature of 40°C. For higher ambient temperatures, a reduction factor of the following components must be applied:

- *For moulded-case circuit-breakers, 0.85 x In when the ambient temperature is 60°C*
- *For thermal overload relays, 0.9 when the ambient temperature is 70°C. There is no reduction factor up to 55°C.*

To facilitate reading, the following parameters are also indicated:

- ***Ie**, rated motor current*
- ***Pn**, rated motor power*
- ***In**, rated circuit-breaker current*
- ***I1**, adjustment current of the protection against overload*
- ***I3**, adjustment current of the protection against short-circuit*
- ***Imax**, maximum testing current, of the protected starter, foreseen by the standard.*



400 V - 50 Hz - 35 kA

Normal and heavy-duty direct starting (Class: 10A, 10, 20, 30), type 2

MOTOR		MCCB SACE Isomax S					CONTACTOR	GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	adjustment I1 [A]	I3 [A]	adjustment I3 [A]	type	Imax [A]
30	56	S4N160 - PR212/MP	100	50 ... 100	600	600-1300	A145	100
37	68	S4N160 - PR212/MP	100	50 ... 100	700	600-1300	A145	100
45	83	S4N160 - PR212/MP	100	50 ... 100	900	600-1300	A145	100
55	98	S4N160 - PR212/MP	160	80 ... 160	1120	960-2080	A145	145
75	135	S4N160 - PR212/MP	160	80 ... 160	1440	960-2080	A145	145
90	158	S4N250 - PR212/MP	200	100 ... 200	1800	1200-2600	A210	200
110	193	S5N400 - PR212/MP	320	160 ... 320	2240	1920-4160	A210	210
132	232	S5N400 - PR212/MP	320	160 ... 320	2560	1920-4160	EH370	320
160	282	S5N400 - PR212/MP	320	160 ... 320	2880	1920-4160	EH370	320
200	349	S6N800 - PR212/MP	630	315 ... 630	3780	3780-8190	EH370	400
250	430	S6N800 - PR212/MP	630	315 ... 630	5040	3780-8190	EH550	550
290	520	S6N800 - PR212/MP	630	315 ... 630	5670	3780-8190	EH550	550
315	545	S6N800 - PR212/MP	630	315 ... 630	5670	3780-8190	EH700	630
355	610	S6N800 - PR212/MP	630	315 ... 630	5670	3780-8190	EH700	630

400 V - 50 Hz - 50 kA

Normal and heavy-duty direct starting (Class: 10A, 10, 20, 30), type 2

MOTOR		MCCB SACE Isomax S					CONTACTOR	GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	adjustment I1 [A]	I3 [A]	adjustment I3 [A]	type	Imax [A]
30	56	S4H160 - PR212/MP	100	50 ... 100	600	600-1300	A145	100
37	68	S4H160 - PR212/MP	100	50 ... 100	700	600-1300	A145	100
45	83	S4H160 - PR212/MP	100	50 ... 100	900	600-1300	A145	100
55	98	S4H160 - PR212/MP	160	80 ... 160	1120	960-2080	A145	145
75	135	S4H160 - PR212/MP	160	80 ... 160	1440	960-2080	A145	145
90	158	S4H250 - PR212/MP	200	100 ... 200	1800	1200-2600	A210	200
110	193	S5H400 - PR212/MP	320	160 ... 320	2240	1920-4160	A210	210
132	232	S5H400 - PR212/MP	320	160 ... 320	2560	1920-4160	EH370	320
160	282	S5H400 - PR212/MP	320	160 ... 320	2880	1920-4160	EH370	320
200	349	S6H800 - PR212/MP	630	315 ... 630	3780	3780-8190	EH370	400
250	430	S6H800 - PR212/MP	630	315 ... 630	5040	3780-8190	EH550	550
290	520	S6H800 - PR212/MP	630	315 ... 630	5670	3780-8190	EH550	550
315	545	S6H800 - PR212/MP	630	315 ... 630	5670	3780-8190	EH700	630
355	610	S6H800 - PR212/MP	630	315 ... 630	5670	3780-8190	EH700	630

440 V - 50 Hz - 50 kA

Normal and heavy-duty direct starting (Class: 10A, 10, 20, 30), type 2

MOTOR		MCCB SACE Isomax S					CONTACTOR	GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	adjustment I1 [A]	I3 [A]	adjustment I3 [A]	type	Imax [A]
30	52	S4H160 - PR212/MP	100	50 ... 100	600	600-1300	A145	100
37	63	S4H160 - PR212/MP	100	50 ... 100	700	600-1300	A145	100
45	75	S4H160 - PR212/MP	100	50 ... 100	800	600-1300	A145	100
55	90	S4H160 - PR212/MP	160	80 ... 160	960	960-2080	A145	145
75	120	S4H160 - PR212/MP	160	80 ... 160	1280	960-2080	A145	145
90	147	S4H250 - PR212/MP	200	100 ... 200	1600	1200-2600	A210	200
110	177	S4H250 - PR212/MP	200	100 ... 200	1800	1200-2600	A210	200
132	212	S5H400 - PR212/MP	320	160 ... 320	2240	1920-4160	A300	300
160	260	S5H400 - PR212/MP	320	160 ... 320	2880	1920-4160	EH370	320
200	320	S6H800 - PR212/MP	630	315 ... 630	3780	3780-8190	EH370	370
250	370	S6H800 - PR212/MP	630	315 ... 630	4410	3780-8190	EH550	550
290	436	S6H800 - PR212/MP	630	315 ... 630	5040	3780-8190	EH550	550
315	500	S6H800 - PR212/MP	630	315 ... 630	5040	3780-8190	EH550	550
355	549	S6H800 - PR212/MP	630	315 ... 630	5670	3780-8190	EH700	630

Coordination tables according to IEC 947-4-1 Standards

500 V - 50 Hz - 50 kA

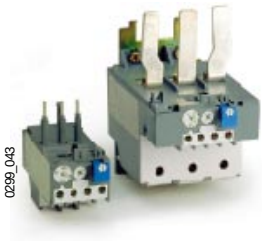
Normal and heavy-duty direct starting (Class: 10A, 10, 20, 30), type 2

MOTOR		MCCB SACE Isomax S					CONTACTOR	GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	adjustment I1 [A]	I3 [A]	adjustment I3 [A]	type	Imax [A]
30	45	S4X250 - PR212/MP	100	50 ... 100	600	600-1300	A145	100
37	56	S4X250 - PR212/MP	100	50 ... 100	600	600-1300	A145	100
45	67	S4X250 - PR212/MP	100	50 ... 100	700	600-1300	A145	100
55	82	S4X250 - PR212/MP	100	50 ... 100	800	600-1300	A145	100
75	110	S4X250 - PR212/MP	160	80 ... 160	1280	960-2080	A145	145
90	132	S4X250 - PR212/MP	160	80 ... 160	1440	960-2080	A145	145
110	158	S4X250 - PR212/MP	200	100 ... 200	1800	1200-2600	A210	200
132	192	S6X400 - PR212/MP	320	160 ... 320	2240	1920-4160	A210	210
160	230	S6X400 - PR212/MP	320	160 ... 320	2560	1920-4160	EH370	320
200	279	S6X400 - PR212/MP	320	160 ... 320	2880	1920-4160	EH370	320
250	335	S6X630 - PR212/MP	400	200 ... 400	3600	2400-5200	EH370	370
290	395	S6X630 - PR212/MP	630	315 ... 630	4410	3780-8190	EH550	550
315	415	S6X630 - PR212/MP	630	315 ... 630	4410	3780-8190	EH550	550
355	451	S6X630 - PR212/MP	630	315 ... 630	5040	3780-8190	EH700	630

690 V - 50 Hz - 50 kA

Normal and heavy-duty direct starting (Class: 10A, 10, 20, 30), type 2

MOTOR		MCCB SACE Isomax S					CONTACTOR	GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	adjustment I1 [A]	I3 [A]	adjustment I3 [A]	type	Imax [A]
45	49	S4X250 - PR212/MP	100	50 ... 100	600	600-1300	A145	100
55	60	S4X250 - PR212/MP	100	50 ... 100	600	600-1300	A145	100
75	80	S4X250 - PR212/MP	100	50 ... 100	900	600-1300	A145	100
90	95	S4X250 - PR212/MP	160	80 ... 160	1120	960-2080	A145	120
110	115	S4X250 - PR212/MP	160	80 ... 160	1280	960-2080	A185	160
132	139	S4X250 - PR212/MP	160	80 ... 160	1440	960-2080	A210	160
160	167	S4X250 - PR212/MP	200	100 ... 200	1800	1200-2600	A210	200
200	202	S6X400 - PR212/MP	320	160 ... 320	2240	1920-4160	EH370	320
250	242	S6X400 - PR212/MP	320	160 ... 320	2560	1920-4160	EH370	320
290	301	S6X400 - PR212/MP	320	160 ... 320	2880	1920-4160	EH370	320
315	313	S6X630 - PR212/MP	400	200 ... 400	3200	2400-5200	EH370	370
355	370	S6X630 - PR212/MP	400	200 ... 400	3600	2400-5200	EH370	370



400 V - 50 Hz - 35 kA

Normal direct starting (Class: 10A), type 2

MOTOR		MCCB SACE Isomax S				CONTACTOR	THERMAL RELAY		GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	I3 [A]	adjustment I3 [A]	Type	Type	adjustment [A]	Imax [A]
37	68	S3N160	100	1050	400-1200	A95	TA80DU80	60 ... 80	80
45	83	S3N160	125	1250	500-1500	A95	TA110DU90	66 ... 90	90
55	98	S3N250	160	1500	640-1920	A110	TA110DU110	80 ... 110	110
75	135	S3N250	200	2150	800-2400	A145	T200DU150	110 ... 150	145
90	158	S3N250	200	2400	800-2400	A185	T200DU175	130 ... 175	175

400 V - 50 Hz - 50 kA

Normal direct starting (Class: 10A), type 2

MOTOR		MCCB SACE Isomax S				CONTACTOR	THERMAL RELAY		GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	I3 [A]	adjustment I3 [A]	Type	Type	adjustment [A]	Imax [A]
37	68	S3H160	100	1050	400-1200	A95	TA80DU80	60 ... 80	80
45	83	S3H160	125	1250	500-1500	A95	TA110DU90	66 ... 90	90
55	98	S3H250	160	1500	640-1920	A110	TA110DU110	80 ... 110	110
75	135	S3H250	200	2150	800-2400	A145	T200DU150	110 ... 150	145
90	158	S3H250	200	2400	800-2400	A185	T200DU175	130 ... 175	175

440 V - 50 Hz - 50 kA

Normal direct starting (Class: 10A), type 2

MOTOR		MCCB SACE Isomax S				CONTACTOR	THERMAL RELAY		GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	I3 [A]	adjustment I3 [A]	Type	Type	adjustment [A]	Imax [A]
37	63	S3H160	100	950	400-1200	A95	TA80DU80	60 ... 80	80
45	75	S3H160	100	1150	400-1200	A95	TA110DU90	65 ... 90	90
55	90	S3H160	125	1400	500-1500	A110	TA110DU110	80 ... 110	110
75	120	S3H250	160	1920	640-1920	A145	T200DU135	100 ... 135	135
90	147	S3H250	200	2300	800-2400	A185	T200DU175	130 ... 175	175

Coordination tables according to IEC 947-4-1 Standards

500 V - 50 Hz - 50 kA

Normal direct starting (Class: 10A), type 2

MOTOR		MCCB SACE Isomax S				CONTACTOR	THERMAL RELAY		GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	I3 [A]	adjustment I3 [A]	Type	Type	adjustment [A]	Imax [A]
18,5	29	S3X125	50	450	200-600	A95	TA80DU42	29 ... 42	42
22	34	S3X125	50	550	200-600	A95	TA80DU42	29 ... 42	42
30	45	S3X125	100	700	400-1200	A95	TA80DU52	36 ... 52	52
37	56	S3X125	100	850	400-1200	A95	TA80DU63	45 ... 63	63
45	67	S3X125	100	1050	400-1200	A95	TA80DU80	60 ... 80	80
55	82	S3X125	125	1250	500-1500	A110	TA110DU90	66 ... 90	90
75	110	S3X200	160	1700	640-1920	A145	T200DU135	100 ... 135	135
90	132	S3X200	200	2050	800-2400	A145	T200DU150	110 ... 150	145
110	158	S3X200	200	2400	800-2400	A185	T200DU175	130 ... 175	170

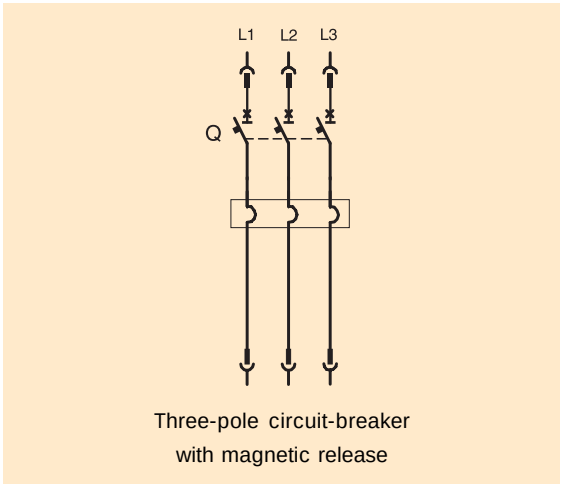
690 V - 50 Hz - 50 kA

Normal direct starting (Class: 10A), type 2

MOTOR		MCCB SACE Isomax S				CONTACTOR	THERMAL RELAY		GROUP
Power, Pn [kW]	Current, Ie [A]	Type	In [A]	I3 [A]	adjustment I3 [A]	Type	Type	adjustment [A]	Imax [A]
37	41	S3X125	100	620	400-1200	A145	TA75DU52	36 ... 52	52
45	49	S3X125	100	740	400-1200	A145	TA75DU63	45 ... 63	63
55	60	S3X125	100	920	400-1200	A145	TA75DU63	45 ... 63	63
75	80	S3X125	125	1250	500-1500	A145	T200DU110	80 ... 110	110
90	95	S3X125	125	1450	500-1500	A145	T200DU110	80 ... 110	110
110	115	S3X200	160	1750	640-1920	A145	T200DU150	110 ... 150	120
132	139	S3X200	200	2100	800-2400	A185	T200DU150	110 ... 150	150

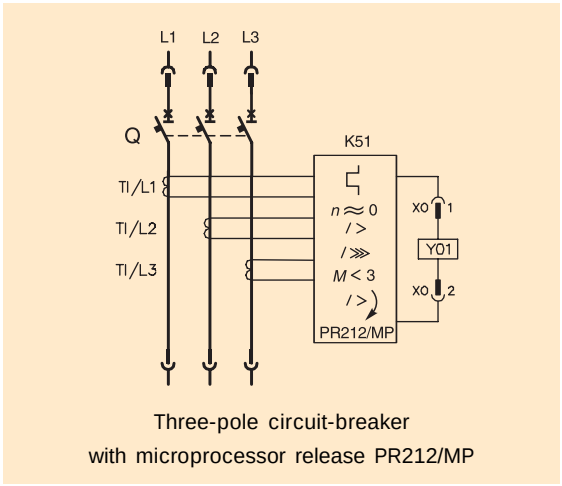
Circuit diagrams.
Operating status shown

The circuit is shown in open and fixed version circuit-breaker.



GSSC0428

Three-pole circuit-breaker
with magnetic release



GSSC0429

Three-pole circuit-breaker
with microprocessor release PR212/MP

Graphic symbols (Standards IEC 617 and CEI 3-14 … 3-26)

Thermal effect	Current transformer	Locked-rotor detection relay operating by current sensing
Electromagnetic effect	Circuit-breaker-disconnector with automatic release	Phase-failure detection relay in a three-phase system
Mechanical connection (link)	Operating device (general symbol)	Instantaneous overcurrent or rate-of-rise relay
Plug and socket (male and female)	Thermal relay	Phase-balance current relay

Key

K51 = PR212/MP microprocessor-based overcurrent release with the following protection functions:
- L against overload (thermal protection)
- R against rotor block
- I against short-circuit
- U against phase loss or unbalance of a phase

Q = Main switch
TI/L1 = Current transformer located on phase L1
TI/L2 = Current transformer located on phase L2
TI/L3 = Current transformer located on phase L3
XO = Connector for the opening solenoid YO1
YO1 = Opening solenoid for the overcurrent release

CONTENTS

Ordering codes

SACE Isomax S3N-H circuit-breakers 42

SACE Isomax S4N-H, S5N-H circuit-breakers 43

SACE Isomax S6N-H, S7S-H circuit-breakers 44

SACE Isomax S3X-S4X-S6X circuit-breakers 45

Accessories 46

Ordering codes

SACE Isomax S3 circuit-breaker

F = FIXED

MP0014

S3N 160

I_u (40 °C) = 160 A • I_{cu} (415 V) = 35 kA

Magnetic only release		I_m	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S3**N** 160 F **F**	R 3	12 ... 36A	**47782**
S3**N** 160 F **F**	R 5	20 ... 60A	**47783**
S3**N** 160 F **F**	R 10	40 ... 120A	**47784**
S3**N** 160 F **F**	R 25	100 ... 300A	**47785**
S3**N** 160 F **F**	R 50	200 ... 600A	**47786**
S3**N** 160 F **F**	R 100	400 ... 1200A	**47787**
S3**N** 160 F **F**	R 125	500 ... 1500A	**47788**

S3H 160

I_u (40 °C) = 160 A • I_{cu} (415 V) = 65 kA

Magnetic only release		I_m	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S3**H** 160 F **F**	R 50	200 ... 600A	**45185**
S3**H** 160 F **F**	R 100	400 ... 1200A	**45186**
S3**H** 160 F **F**	R 125	500 ... 1500A	**45187**

F = FIXED

MP0014

S3N 250

I_u (40 °C) = 250 A • I_{cu} (415 V) = 35 kA

Magnetic only release		I_m	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S3**N** 250 F **F**	R 160	640 ... 1920A	**48651**
S3**N** 250 F **F**	R 200	800 ... 2400A	**48654**

S3H 250

I_u (40 °C) = 250 A • I_{cu} (415 V) = 65 kA

Magnetic only release		I_m	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S3**H** 250 F **F**	R 160	640 ... 1920A	**48657**
S3**H** 250 F **F**	R 200	800 ... 2400A	**48658**

Note

All the SACE Isomax S circuit-breakers for motor protection are available in the fixed, three-pole version. The plug-in and withdrawable versions are taken from the corresponding fixed version by means of special conversion kits indicated on page 50.

Ordering codes

SACE Isomax S4-S5 circuit-breakers

F = FIXED

MP0012

S4N 160

I_u (40 °C) = 160 A • I_{cu} (415 V) = 35 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S4**N** 160 F **F**	In = 100A	LRIU	**50139**
S4**N** 160 F **F**	In = 160A	LRIU	**50140**

S4H 160

I_u (40 °C) = 160 A • I_{cu} (415 V) = 65 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S4**H** 160 F **F**	In = 100A	LRIU	**45049**
S4**H** 160 F **F**	In = 160A	LRIU	**45050**

S4N 250

I_u (40 °C) = 250 A • I_{cu} (415 V) = 35 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S4**N** 250 F **F**	In = 200A	LRIU	**50141**

S4H 250

I_u (40 °C) = 250 A • I_{cu} (415 V) = 65 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S4**H** 250 F **F**	In = 200A	LRIU	**48662**

F = FIXED

MP0010

S5N 400

I_u (40 °C) = 400 A • I_{cu} (415 V) = 35 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S5N 400 F **F**	In = 320A	LRIU	**50142**

S5H 400

I_u (40 °C) = 400 A • I_{cu} (415 V) = 65 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S5H 400 F **F**	In = 320A	LRIU	**45051**

Note

All the SACE Isomax S circuit-breakers for motor protection are available in the fixed, three-pole version. The plug-in and withdrawable versions are taken from the corresponding fixed version by means of special conversion kits indicated on page 50.

Ordering codes

SACE Isomax S6 - S7 circuit-breakers

F = FIXED

MP0011

S6N 800

I_u (40 °C) = 800 A • I_{cu} (415 V) = 35 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S6N 800 F **F**	In = 630A	LRIU	**50143**

S6H 800

I_u (40 °C) = 800 A • I_{cu} (415 V) = 65 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S6H 800 F **F**	In = 630A	LRIU	**45052**

F = FIXED

MP0013

S7S 1250

I_u (40 °C) = 1250 A • I_{cu} (415 V) = 50 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S7S 1250 F **F**	In = 1000A	LRIU	**50144**

S7H 1250

I_u (40 °C) = 1250 A • I_{cu} (415 V) = 65 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 **3 poles**
F = Front terminals			
S7H 1250 F **F**	In = 1000A	LRIU	**45053**

Note

All the SACE Isomax S circuit-breakers for motor protection are available in the fixed, three-pole version. The withdrawable versions are taken from the corresponding fixed version by means of special conversion kits indicated on page 50.

Ordering codes

SACE Isomax S3X - S4X - S6X current-limiting circuit-breakers

F = FIXED

0299_024

S3X 125

I_u (40 °C) = 125 A • I_{cu} (415 V) = 200 kA

Magnetic only release		I_m	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S3**X** 125 F **F**	R 3	12 ... 36A	**45384**
S3**X** 125 F **F**	R 5	20 ... 60A	**45385**
S3**X** 125 F **F**	R 10	40 ... 120A	**45386**
S3**X** 125 F **F**	R 25	100 ... 300A	**45387**
S3**X** 125 F **F**	R 50	200 ... 600A	**45388**
S3**X** 125 F **F**	R 100	400 ... 1200A	**45389**
S3**X** 125 F **F**	R 125	500 ... 1500A	**45390**

S3X 200

I_u (40 °C) = 200 A • I_{cu} (415 V) = 200 kA

Magnetic only release		I_m	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S3**X** 200 F **F**	R 125	500 ... 1500A	**46135**
S3**X** 200 F **F**	R 160	640 ... 1920A	**48659**
S3**X** 200 F **F**	R 200	800 ... 2400A	**48660**

F = FIXED

0299_023

S4X 250

I_u (40 °C) = 250 A • I_{cu} (415 V) = 200 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S4**X** 250 F **F**	In = 100A	LRIU	**46590**
S4**X** 250 F **F**	In = 160A	LRIU	**46591**
S4**X** 250 F **F**	In = 200A	LRIU	**48661**

F = FIXED

0299_022

S6X 400

I_u (40 °C) = 400 A • I_{cu} (415 V) = 200 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S6X 400 F **F**	In = 320A	LRIU	**47780**

S6X 630

I_u (40 °C) = 630 A • I_{cu} (415 V) = 200 kA

Microprocessor-based release		PR212/MP	code 1SDA0 □□□□□ R1 3 poles
F = Front terminals			
S6X 630 F **F**	In = 400A	LRIU	**47781**
S6H 630 F **F**	In = 630A	LRIU	**48663**

Note

All the SACE Isomax S circuit-breakers for motor protection are available in the fixed, three-pole version. The plug-in and withdrawable versions are taken from the corresponding fixed version by means of special conversion kits indicated on page 50.

Ordering codes

SACE Isomax S accessories

CSIS9034

Auxiliary releases

Shunt opening releases

Type	code 1SDA0 □□□□□ R1 S3-S4-S5	S6-S7
12 V DC	**23403**	**23404**
24 V AC / DC	**13781**	**14136**
48 V AC / DC	**13782**	**14137**
60 V AC / DC	**23405**	**23406**
110...120 V AC - 110...125 V DC	**13783**	**14138**
220...240 V AC - 220...250 V DC	**13785**	**14140**
380...400 V AC	**13786**	**14141**
480 V AC	**37512**	**37514**

GSIS9033

Undervoltage releases

Type	code 1SDA0 □□□□□ R1 S3-S4-S5	S6-S7
24 V AC	**13842**	**14188**
48 V AC	**13843**	**14189**
60 V AC	**23346**	**23347**
110...127 V AC	**13844**	**14190**
220...250 V AC	**13846**	**14192**
380...440 V AC	**13847**	**14193**
480 V AC	**37513**	**37515**
24 V DC	**13833**	**14179**
48 V DC	**13835**	**14181**
60 V DC	**13836**	**14182**
110...125 V DC	**13838**	**14184**
220...250 V DC	**13839**	**14185**

PSIS9661

Time-lag undervoltage releases

Type	code 1SDA0 □□□□□ R1 S3-S4-S5	S6-S7
110 - 220 V AC (release + time-lag device)	**13840**	**14186**

PSIS9634

Connectors for auxiliary releases

Type	code 1SDA0 □□□□□ R1 S3-S4-S5-S6	S7
for fixed circuit-breaker - L=1m	**13865**	**14209**
for fixed circuit-breaker - L=2m	**37523**	
for plug-in or withdrawable circuit-breaker - L=1m	**13866**	**14210**
extension for testing auxiliary circuits with the circuit-breaker racked out	**25552**	**25552**

Ordering codes

SACE Isomax S accessories

PSIS9630

Electrical signalling

Auxiliary contacts

Type	code 1SDA0□□□□□ R1 S3-S4-S5	S6-S7
2 open/closed change-over contacts	**13856**	**23366**
1 open/closed change-over contact and 1 tripped release signal	**13575**	**23332**
2 open/closed change-over contacts and 1 tripped release signal		**25773**

Auxiliary contacts for digital signals

Type	code 1SDA0□□□□□ R1 S3-S4-S5	S6-S7
2 open/closed change-over contacts	**25544**	**25774**
1 open/closed change-over contact and 1 tripped release signal	**25545**	**25775**
2 open/closed change-over contacts and 1 tripped release signal		**25776**

PSIS9631

Accept contacts and connectors

Type	code 1SDA0□□□□□ R1 S3-S4-S5-S6	S7
accept contact and connector for undervoltage release	**25551**	**48106**

Connectors for auxiliary contacts

Type	code 1SDA0□□□□□ R1 S3-S4-S5-S6	S7
for fixed circuit-breaker - L=1m	**13863**	**14207**
for fixed circuit-breaker - L=2m	**37522**	
for plug-in or withdrawable circuit-breaker - L=1m	**13864**	**14208**
extension for testing auxiliary circuits with the circuit-breaker racked out	**25553**	**25553**

PSIS9632

Motor operating mechanism

Direct action

Type	code 1SDA0□□□□□ R1 S3-S4-S5
24 V DC	**13873**
48...60 V DC	**13874**
100...127 V AC - 100...125 V DC	**13875**
220...240 V AC - 220...250 V DC	**13876**
380 V AC	**13877**

PSIS9633

Stored energy

Type	code 1SDA0□□□□□ R1 S6	S7
24 V DC	**14029**	**14214**
48 V DC	**14030**	**14215**
60 V DC	**23348**	**23350**
110 V AC / DC	**23349**	**23351**
120...127 V AC / DC	**14031**	**14216**
220...250 V AC / DC	**14032**	**14217**
380 V AC	**14033**	**14218**

PSIS9629

Connectors for motor operating mechanism and auxiliary contacts

Type	code 1SDA0□□□□□ R1 S3-S4-S5-S6	S7
for fixed circuit-breaker - L=1m	**13857**	**14203**
for fixed circuit-breaker - L=2m	**37524**	
for plug-in or withdrawable circuit-breaker - L=1m	**13858**	**14204**
extension for testing auxiliary circuits with the circuit-breaker racked out	**25554**	**25554**

Ordering codes

SACE Isomax S accessories

PSIS9635

Operating mechanism and locks

Direct-mounted rotary-handle operating mechanism

Type	code 1SDA0 □□□□□ R1		
	S3-S4-S5	**S6**	**S7**
for fixed/plug-in circuit breakers	**13867**	**14026**	**14211**
for withdrawable circuit breakers	**13868**	**14027**	**14212**
emergency for fixed or withdrawable circuit-breakers	**13870**		

PSIS9636

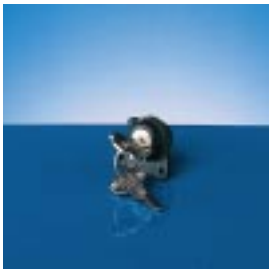
Rotary handle operating mechanism with transmission

Type	code 1SDA0 □□□□□ R1		
	S3-S4-S5	**S6**	**S7**
compartment door, adjustable depth (L_{max}= 300 mm) for fixed or plug-in	**13869**		
compartment door, adjustable depth (L_{max}= 500 mm) for fixed or withdrawable		**14028**	**14213**
compartment door, emergency, adjustable depth (L_{max}= 300 mm) for fixed or plug-in	**13871**		
compartment door, emergency, adjustable depth (L_{max}= 500 mm) for fixed		**46569**	**46572**
remote transmission rod with adjustable depth (L_{max}= 500 mm)	**25427**		

PSIS9637

Front flange for operating lever mechanism

Type	code 1SDA0 □□□□□ R1		
	S3-S4-S5	**S6**	**S7**
for fixed or plug-in	**13889**	**14035**	**14227**
for withdrawable	**13890**	**14036**	**14228**


PSIS9645

Key lock for locking in the open position

Type	code 1SDA0 □□□□□ R1	
	S3-S4-S5	**S6-S7**
for motor operating mechanism - a different key for each circuit-breaker	**13883**	**13885**
for motor operating mechanism - the same key for sets of circuit-breakers	**13884**	**13886**
for motor operating mechanism against manual operation (a different key for each circuit-breaker)		**36245**
for front flange / rotary handle - a different key for each circuit-breaker	**13881**	**13881**
for front flange / rotary handle - the same key for sets of circuit-breakers	**13882**	**13882**

PSIS9640

Locks

Type	model	code 1SDA0 □□□□□ R1
Compartment door lock for front flange for locks / rotary handle oper. mech.	S3-S4-S5-S6-S7	**13880**
Tamper-proof lock for thermal releases	S3	**25548**

Mechanical interlock across two circuit-breakers

Type	model	code 1SDA0 □□□□□ R1
for horizontal installation (excluded ES terminals)	S3	**23330**
for horizontal installation (excluded ES terminals)	S4	**13690**
for horizontal installation (excluded ES terminals)	S5	**13861**
for horizontal installation (excluded ES terminals)	S6	**14204**
for horizontal installation (excluded ES terminals)	S7	**14205**
for vertical installation (excluded current-limiting circuit-breakers)	S3	**23331**
for vertical installation (excluded current-limiting circuit-breakers)	S4	**13691**
for vertical installation	S5	**13862**
for vertical installation (excluded current-limiting circuit-breakers)	S6	**14025**
for vertical installation	S7	**14206**

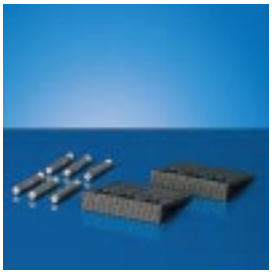
Ordering codes

SACE Isomax S accessories

GSIS9663

PSIS9641

GSIS9642


PSIS9643

PSIS9632

Connection terminals

Type	code 1SDA0 □□□□□ R1 3 pieces	 6 pieces
EF = Extended front terminals		
S3-S4	**23353**	**13596**
S5	**23367**	**13706**
S6 (excluded S6X)	**23383**	**13954**
S6X (for current-limiting circuit-breaker only)	**23379**	**13920**
S7	**23399**	**14079**
ES = Spreaded extended front terminals		
S3X-S4X (for current-limiting circuit-breaker only)	**46517**	**46515**
FC Cu = Front terminals for copper cables		
S3-S4	**23354**	**13598**
S5	**23368**	**13708**
FC CuAl = Front terminals for copper - aluminium cables		
S3-S4 (for 160A - 1x95 mm^2 only)	**23356**	**13602**
S3-S4 (for 250A - 1x150 mm^2 only)	**23357**	**20293**
S5 (2x120 mm^2)	**25766**	**23295**
S5 (1x240 mm^2)	**23370**	**13910**
S6 (3x185 mm^2)	**23384**	**13956**
S7 (4x240 mm^2)	**23387**	**14081**
R = Threaded rear terminals		
S3-S4	**23352**	**13606**
S5	**23372**	**13714**
S6	**23382**	**13960**
HR/VR = Horizontal or vertical flat-bar rear terminals		
S7	**23400**	**14083**
RC = Rear terminals for copper or aluminium cables		
S3-S4 (1x120 mm^2)	**23358**	**13604**
S5 (1x240 mm^2)	**23371**	**13712**
S6 (2x150 mm^2)	**23381**	**13924**

Insulating terminal covers

Type	code 1SDA0 □□□□□ R1 3 poles
high for fixed	
S3-S4	**13695**
S5	**13897**
S6	**14040**
low for fixed and moving part of plug-in or withdrawable	
S3-S4	**13693**
S5	**13895**
S6	**14038**
S7	**23324**
high for fixed parts of plug-in or withdrawable circuit-breakers	
S3-S4	**13697**
S5	**13899**

Screws for sealing terminal covers

Type	code 1SDA0 □□□□□ R1
S3-S4-S5-S6-S7	**13699**

Ordering codes

SACE Isomax S accessories

PSIS9647

Accessories for microprocessor-based overcurrent release

Type	model	code 1SDA0 □□□□□ R1
SACE TT1 test unit	S4-S5-S6-S7	**37121**
X3 connector for tripped release signal (*), fixed circuit-breaker	S4-S5-S6-S7	**13702**
X3 connector for tripped release signal (*), plug-in or withdrawable circuit-breaker	S4-S5-S6-S7	**13703**

(*) The input for the neutral protection is not available.

GSIS9651

Conversion kits

Kit for converting from fixed circuit-breaker to moving part of plug-in circuit-breaker

Type	code 1SDA0 □□□□□ R1 **3poles**
S3 - S4 (excluded current-limiting circuit-breakers)	**13608**
S5	**13716**
for S3X only (*)	**46519**
for S4X only (*)	**46511**

GSIS9652

Kit for converting from fixed circuit-breaker to moving part of withdrawable circuit-breaker

Type	code 1SDA0 □□□□□ R1 **3 poli**
S3 - S4 (excluded current-limiting circuit-breakers)	**13610**
S5	**13718**
S6 (excluded current-limiting circuit-breaker)	**13962**
S7	**23299**
for S3X only (*)	**46521**
for S4X only (*)	**46514**
for S6X only (*)	**47619**

(*) Notes for current-limiting circuit-breakers

– The contact isolators on the fixed parts of S3-S4 circuit-breakers (plug-in and withdrawable versions) have been modified (during 1997) to make them suitable for the moving parts of S3X-S4X current-limiting circuit-breakers.
The "new" contact isolators are supplied in the conversion kit for S3X-S4X models (used for converting them into moving parts). The operation is simple to perform and can be carried out by the user with the help of the instructions supplied. It enables one to maintain the compatibility of S3X-S4X models and S3-S4 fixed parts that are already stored in the warehouse or installed.
The modification is not required on S3X or S4X current-limiting circuit-breakers that are supplied complete with fixed parts or on fixed parts purchased after February 1998.
The contact isolators can be supplied as spare parts if required.

– The existing fixed parts for S3-S4 circuit-breakers are not compatible with current-limiting apparatus if they are fitted with front terminals for copper cables FC Cu.

Accessories for fixed part of plug-in or withdrawable circuit-breakers

Rails

Type	code 1SDA0 □□□□□ R1	
	S3-S4	**S5**
Rail for preparing the fixed part of a plug-in circuit-breaker for use as the fixed part of a withdrawable circuit-breaker	**13692**	**13892**

GSIS9655

Terminals for the fixed parts of plug-in or withdrawable circuit-breakers

Type	code 1SDA0 □□□□□ R1
	3 pieces
EF = Extended front terminals	
S3-S4	**13650**
S5	**13759**
S6 (they can only be fitted on the bottom for current-limiting circuit-breaker)	**13984**
S7	**14108**
FC Cu = Terminali anteriori per cavi in rame	
S3-S4 (excluded current-limiting circuit-breakers)	**13652**
S5	**13761**
R = Threaded rear terminals	
S3-S4	**13654**
S5	**13763**
HR = Horizontal flat-bar rear terminals	
S6	**13986**
S7	**14110**
VR = Vertical flat-bar rear terminals	
S6	**13988**
S7	**14112**

PSIS9654

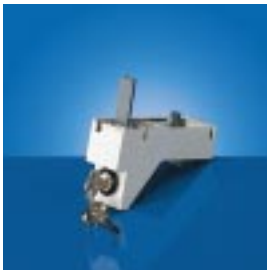
Position contacts

Type	code 1SDA0 □□□□□ R1
	S3-S4-S5-S6-S7
contacts for signalling circuit-breaker racked out	**13859**
contacts for signalling circuit-breaker racked out for digital signals	**25546**
contacts for signalling circuit-breaker racked in	**13860**
contacts for signalling circuit-breaker racked in for digital signals	**25547**

PSIS9656

Lock for fixed part of withdrawable circuit-breakers

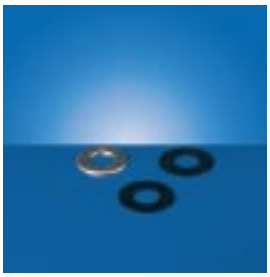
Type	code 1SDA0 □□□□□ R1
	S3-S4-S5-S6-S7
key lock for locking in racked in / out position - different key for each c.b.	**25434**
key lock for locking in racked in / out position - same key for sets of c.bs.	**25435**
padlock device	**13872**


PSIS9664

Ordering codes

SACE Isomax S accessories

Installation accessories


PSIS9657

Bracket for mounting on DIN rail

Type	code 1SDA0 □□□□□ R1 **3 poli**
For DIN rail DIN EN 50023 (complete with DIN front flange H=45 mm)	
S3	**13576**
S4	**13700**
S5	**13901**

IP54 protection

Type	code 1SDA0 □□□□□ R1 **S3-S4-S6-S7**
for adjustable-depth rotary handle operating mechanism on door	**13891**

PSIS9660

Residual-current relay for switchboard

SACE RCQ

Type	code 1SDA0 □□□□□ R1 **S3-S4-S5-S6-S7**
release and closed toroid - diameter 60 mm	**37388**
release and closed toroid - diameter 110 mm	**37389**
release and opening toroid - diameter 110 mm	**37390**
release and opening toroid - diameter 180 mm	**37391**
release and opening toroid - diameter 230 mm	**37392**
release only	**37393**
closed toroid only - diameter 60 mm	**37394**
closed toroid only - diameter 110 mm	**37395**
opening toroid only - diameter 110 mm	**37396**
opening toroid only - diameter 180 mm	**37397**
opening toroid only - diameter 230 mm	**37398**

Due to possible developments of standards as well as of materials, the characteristics and dimensions specified in the present catalogue may only be considered binding after confirmation by ABB SACE L.V.

ITSLV 649284/011 en 04/99

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Julio '99

SACE Isomax S
La serie más importante de interruptores en caja moldeada

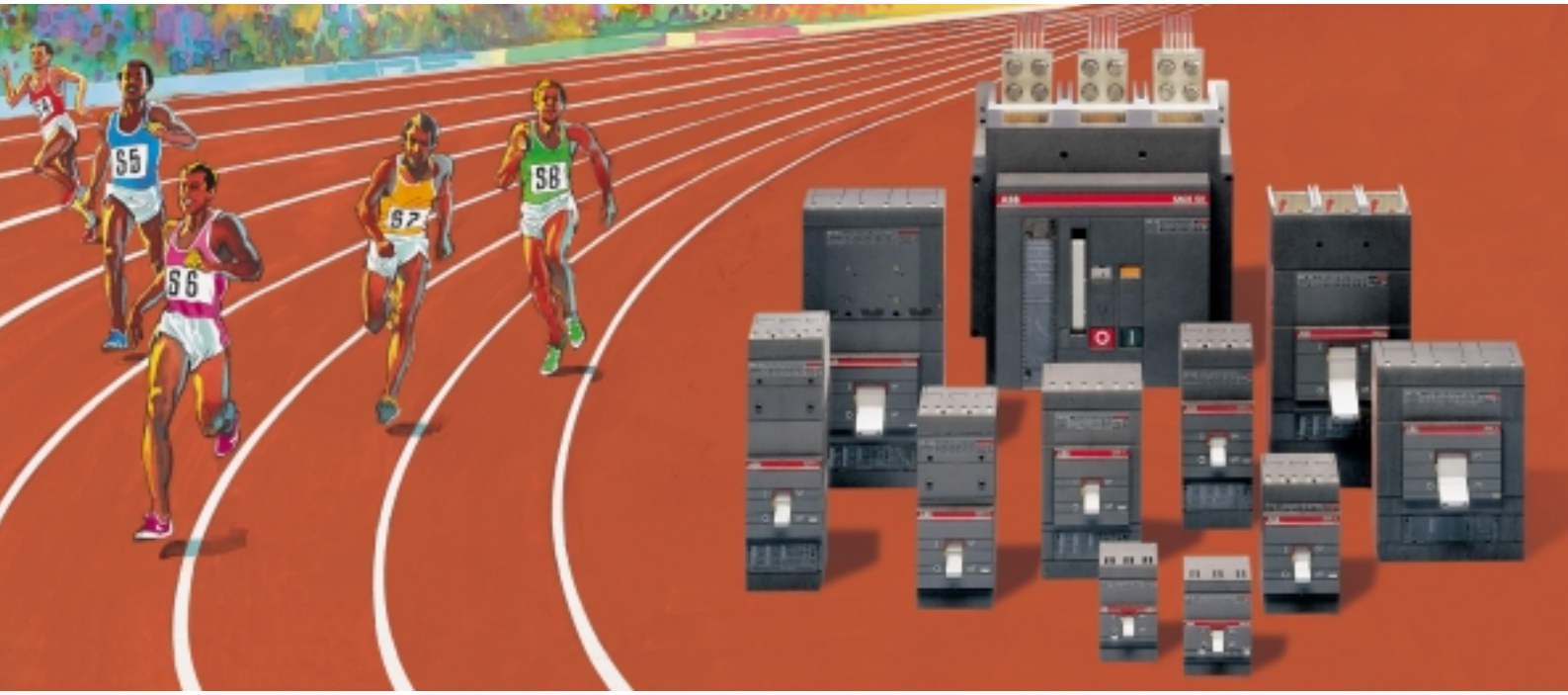


ABB SACE L.V.

Una única serie de interruptores en caja moldeada permite infinitas soluciones

Los interruptores en caja moldeada para baja tensión SACE Isomax S satisfacen una amplia variedad de aplicaciones, que abarca de las pequeñas instalaciones a las grandes plantas industriales de distribución de energía eléctrica. Innovación, tecnología y calidad siempre fueron los principios rectores para el desarrollo de los productos de ABB SACE L.V., y hoy encuentran su máxima expresión en la serie SACE Isomax S, que se presenta con una gama de soluciones aún más exhaustiva, configurando la oferta más completa en el ámbito de los interruptores con caja moldeada.
La serie SACE Isomax S se presenta con ocho modelos de base que, según una lógica modular, se transforman en distintas versiones para formar varias gamas, respondiendo de modo específico y completo a las necesidades de todo tipo de instalación. Están disponibles interruptores para la distribución en corriente alterna o continua, interruptores limitadores de corriente, para protección de motores, de maniobra-seccionadores y diferenciales. A todas estas gamas, que cumplen las normas internacionales IEC 947-2 y EN 60947-2, se suman los interruptores automáticos, para protección de motores y de maniobra-seccionadores, conformes a las normas UL489 y CSA C22.2, gracias a la homologación obtenida de Underwriters Laboratories.

Otra ventaja de la serie es la homogeneidad del suministro: las dimensiones, modalidades de instalación y posibilidades de equipamiento son iguales, independientemente del tipo de gama en el cual se coloque el interruptor, con notables ventajas para el usuario.
La constante evolución de estos productos, que viene ampliando la oferta de SACE Isomax S sin cesar, no se detiene y ofrece numerosas propuestas nuevas.

S2X, por fuera, es idéntico a los S2B/N/S; conserva sus dimensiones, sistemas de fijación y posibilidades de equipamiento y personalización. Gracias a soluciones técnicas particulares, como el doble corte por polo, ofrece unas prestaciones excepcionales en lo que respecta a poder de corte y capacidad de limitación de la corriente de defecto y de la energía específica pasante. La versión S2X 80, con relé sólo magnético 13xIth, está particularmente indicada para la protección de motores, mientras que la versión S2X 100, con relé termomagnético regulable, puede utilizarse en cualquier ámbito donde también se precise una protección contra sobrecargas.

Los interruptores S4 a S7 están equipados con el relé electrónico PR212/MP, específicamente proyectado para el arranque y la protección de los motores. Estos dispositivos aseguran una salvaguardia completa y avanzada, y permiten realizar coordinaciones optimizadas que redundan en cuantiosos ahorros de tiempo, espacio y dinero.

La nueva gama para aplicaciones a 1000 V con corriente alterna extiende aún más los límites de aplicación de los interruptores en caja moldeada, y sintetiza cabalmente la continua evolución de la serie SACE Isomax S y la elevada calidad técnica que la distingue.

El nuevo mando con solenoide para S1-S2 perfecciona la maniobra a distancia de toda la gama SACE Isomax S. Disponible en varias tensiones de alimentación y en dos versiones distintas (para montaje frontal o adosado al interruptor), ofrece una elevada velocidad de maniobra y puede utilizarse para la gestión centralizada de la instalación, así como para la conmutación entre red de servicio y de emergencia.

Interruptores automáticos
IEC 947-2

				SACE Isomax S1		SACE Isomax S2			SACE Isomax S3		
Corriente permanente asignada, **Iu**			[A]	125		160			160 - 250		
Polos			N°.	3-4		3-4			3-4		
Tensión asignada de empleo, **Ue**		(c.a.) 50-60 Hz	[V~]	500		690			690		
		(c.c.)	[V–]	250		500			750		
Tensión asignada soportada a impulso, **Uimp**			[kV]	6		6			8		
Tensión asignada de aislamiento, **Ui**			[V]	500		690			800		
Tensión de ensayo a frequencia industrial 1 minuto			[V]	3000		3000			3000		
Poder asignado de corte último en cortocircuito, **Icu**				B	N	B	N	S	N	H	L
	(c.a.) 50-60 Hz	220/230 V~	[kA]	25	40	25	50	65	65	100	170
	(c.a.) 50-60 Hz	**380/415 V~**	[kA]	**16**	**25**	**16**	**35** (1)	**50**	**35** (1)	**65**	**85**
	(c.a.) 50-60 Hz	440 V~	[kA]	10	16	10	20	25	30	50	65
	(c.a.) 50-60 Hz	500 V~	[kA]	8	12	8	12	15	25	40	50
	(c.a.) 50-60 Hz	690 V~	[kA]	—	—	6	8	10	14	18	20 (5)
	(c.c.)	250 V – (2 polos en serie)	[kA]	16	25	16	35	50	35	65	85
	(c.c.)	500 V – (2 polos en serie)	[kA]	—	—	—	—	—	35	50	65
	(c.c.)	500 V – (3 polos en serie)	[kA]	—	—	16	35	50	—	—	—
	(c.c.)	750 V – (3 polos en serie)	[kA]	—	—	—	—	—	20	35	50
Poder asignado de corte de servicio en cortocircuito, **Ics** (2)			[%Icu]	50%	50%	100%	75%	75%	100%	75%	75%
Poder asignado de cierre en cortocircuito (415 V~), **Icm**			[kA]	32	52,5	32	74	105	74	143	187
Tiempo de apertura (415 V~)			[ms]	8	6	8	7	6	8	7	6
Corriente asignada de corta duración admisible durante 1 s, **Icw**			[kA]								
Categoría de empleo (EN 60947-2)				A		A			A		
Aptitud al seccionamiento				■		■			■		
IEC 947-2, EN 60947-2				■		■			■		
Relés	termomagnéticos	T fijo, M fijo 5Ith		■	■						
		T fijo, M fijo 10Ith		■	■						
		T regulable, M fijo 3Ith							■	■	
		T regulable, M fijo 5Ith				■	■		■	■	■
		T regulable, M fijo 10Ith				■	■	■	■	■	■
		T regulable, M regulable									
	sólo magnéticos	M fijo			■	■	■	■	■	■	■
	con microprocesador	PR211/P (I - LI)									
		PR212/P (LSI - LSIG)									
	Intercambiabilidad										
Versiónes											
Terminals(6)	fijo			FC - R		EF - FC - FC CuAl - R			F - EF - ES - FC - FC CuAl - RC - R		
	enchufable			FC - R		FC - R			EF - FC - R		
	extraíble (3)			—		—			EF - FC - R		
Fijación a perfil DIN				DIN EN 50022		DIN EN 50022			DIN EN 50023		
Durabilidad mecánica	[N° maniobras/operaciones por hora]			25000 / 240		25000 / 240			25000 / 120		
Durabilidad eléctrica (a 415 V~)	[N° maniobras/operaciones por hora]			8000 / 120		8000 / 120			10000 (160A) - 8000 (250A) / 120		
Dimensiones básicas fijo		3 / 4 polos	A [mm]	78 / 103		90 / 120			105 / 140		
			P [mm]	70		70			103,5		
			H [mm]	120		120			170		
Peso	fijo	3 / 4 polos	[kg]	0,9 / 1,2		1,1 / 1,5			2,6 / 3,5		
	enchufable	3 / 4 polos	[kg]	1 / 1,4		1,3 / 1,7			3,1 / 4,1		
	extraíble	3 / 4 polos	[kg]	—		—			3,5 / 4,5		

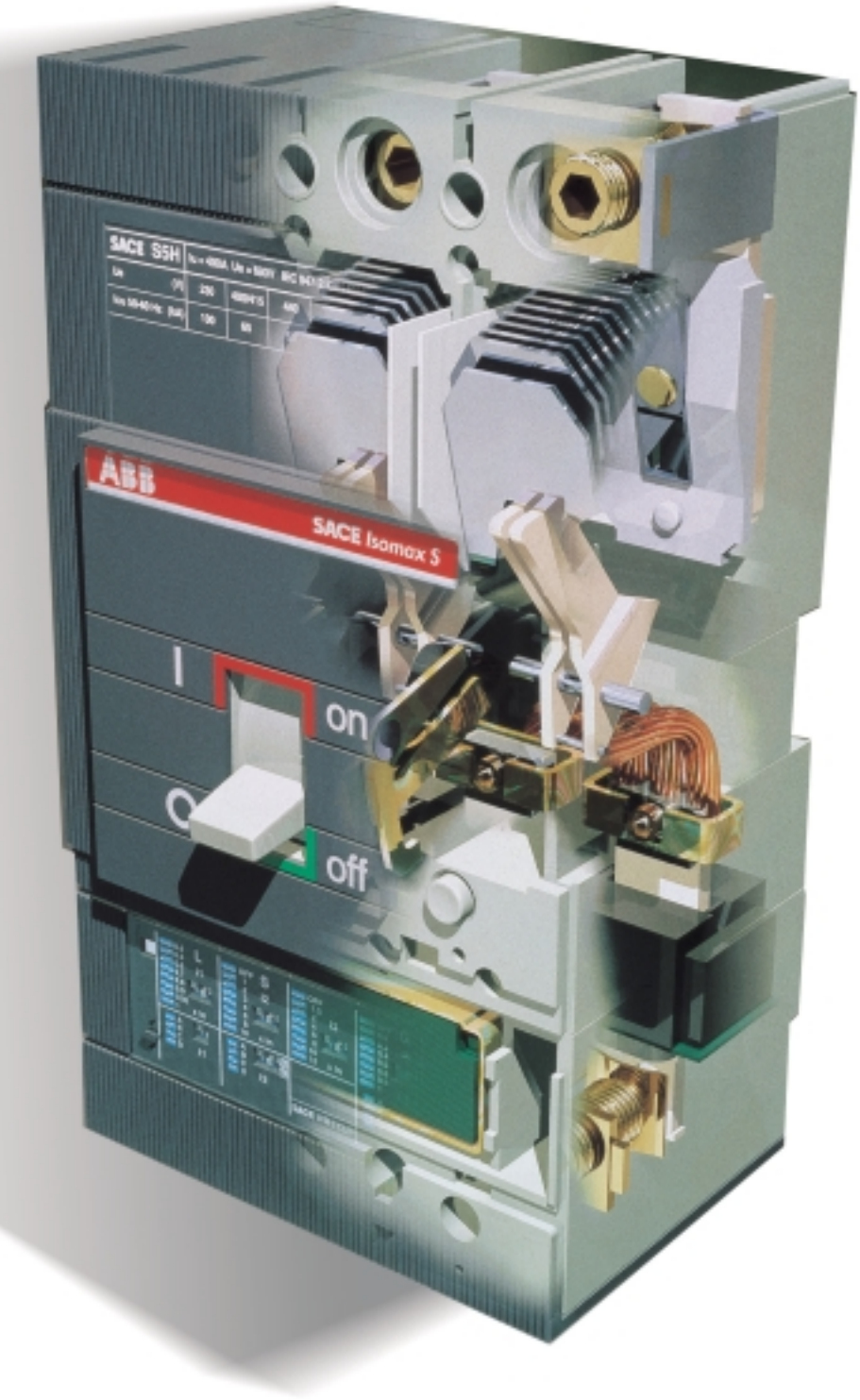
Notas

1) Todas las versiones con Icu=35 kA están certificadas para 36 kA.
2) Para interruptores S3 N/H/L, S4 N/H/L, S5 N/H y S6 N/S/H, la prestación porcentual de Ics a 690 V se reduce un 25%.
3) Los interruptores en versión extraíble se suministran con el frontal para mando por palanca o con los accesorios alternativos a éste como, por ejemplo, el mando giratorio o el mando a motor.
4) Para el interruptor S5, la versión enchufable se encuentra disponible solamente para la corriente asignada permanente de 400 A (S5 N/H/L 400)
5) El interruptor SACE S3 con poder de corte L a 690 V sólo se puede alimentar por la parte superior.

SACE Isomax S4			SACE Isomax S5			SACE Isomax S6				SACE Isomax S7			SACE Isomax S8	
160 - 250			400 - 630			630 - 800				1250 - 1600			2000-2500-3200	
3-4			3-4			3-4				3-4			3-4	
690			690			690				690			690	
—			750			750				—			—	
8			8			8				8			8	
800			800			800				800			690	
3000			3000			3000				3000			2500	
N	H	L	N	H	L	N	S	H	L	S	H	L	H	V
65	100	200	65	100	200	65	85	100	200	85	100	200	85	120
35 (1)	**65**	**100**	**35** (1)	**65**	**100**	**35** (1)	**50**	**65**	**100**	**50**	**65**	**100**	**85**	**120**
30	50	80	30	50	80	30	45	50	80	40	55	80	70	100
25	40	65	25	40	65	25	35	40	65	35	45	70	50	70
18	22	30	20	25	30	20	22	25	30	20	25	35	40	50
—	—	—	35	65	100	35	50	65	100	—	—	—	—	—
—	—	—	35	50	65	20	35	50	65	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	20	35	50	16	20	35	50	—	—	—	—	—
100%	100%	75%	100%	100%	75%	100%	100%	100%	75%	100%	75%	50%	50%	50%
74	143	220	74	143	220	74	105	143	220	105	143	220	187	264
8	7	6	8	7	6	10	9	8	7	22	22	22	20	20
			5 (400 A)			7,6 (630 A) - 10 (800 A)				15 (1250 A) - 20 (1600 A)			35	
A			B (400 A) - A (630 A)			B				B			B	
■			■			■				■			■	
■			■			■				■			■	
			■	■	■	■	■	■	■					
■	■	■	■	■	■	■	■	■	■	■	■	■		
■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	■			■			■				■			
F - EF - ES - FC - FC CuAl - RC - R			F-ES-FC-EF/FC CuAl/RC (400A)			F - EF - FC CuAl - RC - R				F-EF -FC CuAl (1250A) -HR -VR			F (2000-2500A)-VR	
EF - FC -R			EF - FC -R (4)			—				—				
EF - FC -R			EF(400)-ES -FC(400)-R-VR (630A)			EF - HR - VR				EF - HR - VR			—	
DIN EN 50023			DIN EN 50023			—				—			—	
20000 / 120			20000 / 120			20000 / 120				10000 / 120			10000/20	
10000 (160A) - 8000 (250A) / 120			7000 (400A) - 5000 (630A) / 60			7000 (630A) - 5000 (800A) / 60				7000(1250A)-5000(1600A) / 20			2500 (2500A)/20 -1500 (3200)/10	
105 / 140			140 / 184			210 / 280				210 / 280			406/556	
103,5			103,5			103,5				138,5			242	
254			254			268				406			400	
4 / 5,3			5 / 7			9,5 / 12				17 / 22			57/76	
4,5 / 5,9			6,1 / 8,4			—				—			—	
4,9 / 6,3			6,4 / 8,7			12,1 / 15,1				21,8 / 29,2			—	

6) F Terminales anteriores
EF Terminales anteriores prolongados
ES Terminales anteriores prolongados separados
FC Terminales anteriores para cables de cobre
FC CuAl Terminales anteriores para cables de cobre/aluminio
R Terminales posteriores con perno roscado
RC Terminales posteriores para cables de cobre y aluminio
HR Terminales posteriores horizontales
VR Terminales posteriores verticales

Modularidad y prestaciones IEC 947-2. Una serie completa y coordinada



La gama de interruptores automáticos de caja moldeada SACE Isomax S conformes a la normativa IEC 947-2, se articula en ocho tamaños básicos con corrientes permanentes asignadas de 125 a 3200 A y poder de corte de 16 a 120 kA (380/415 V).
La selección del modelo permite identificar de manera fácil e inmediata las características eléctricas fundamentales; y la selección del relé de sobreintensidad, el tipo de aplicación.

Utilización en corriente alterna
Para la protección de circuitos en corriente alterna están disponibles los interruptores automáticos SACE S1, S2 y S3 equipados con relés termomagnéticos y los interruptores automáticos SACE S4, S5, S6, S7 y S8 equipados con relés con microprocesador SACE PR211/P y PR212/P. Están caracterizados por un campo de aplicación de 10 a 3200 A y por una tensión asignada de 690 V.

Utilización en corriente continua
Los interruptores automáticos SACE S1, S2, S3, S5 y S6 equipados con relés termomagnéticos se utilizan para la protección de circuitos en corriente continua, con un campo de aplicación

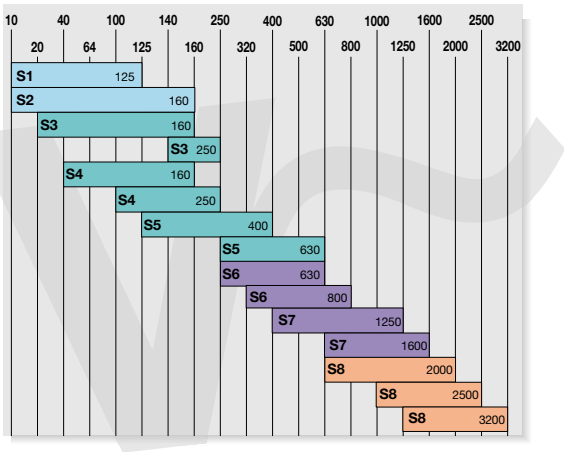
Gama de 1000V en c.a.

Corriente permanente asignada, Iu		[A]
Nº de polos		
Tensión asignada de servicio, Ue (c.a.) 50-60Hz		[V]
Tensión asignada soportada a impulso, Uimp		[kV]
Tensión asignada de aislamiento, Ui		[V]
Tensión de prueba a frecuencia industrial por 1 min		
Poder asignado de corte último en cortocircuito, Icu		
(c.a.) 50-60 Hz 1000 V		[kA]
Poder asignado de cierre en cortocircuito (1000 Vca)		[kA]
Tiempo de apertura (1000 Vca)		[ms]
Corriente asignada de corta duración admisible per 1 s, Icw		[kA]
Categoría de empleo (EN 60947-2)		
Aptitud para el seccionamiento		
IEC 947-2, EN 60947-2		
Relés termomagnéticos T regulable, M fijo 10 Ith		
Relés con microprocesador PR211/P (I-LI)		
Relés con microprocesador PR212/P (LSI-LSIG)		
Versiones		
Terminales		
Fijación sobre perfil DIN		
Durabilidad mecánica	[Nº maniobras / operaciones por hora]	
Dimensiones	A	[mm]
	P	[mm]
	H	[mm]
Pesos		[kg]

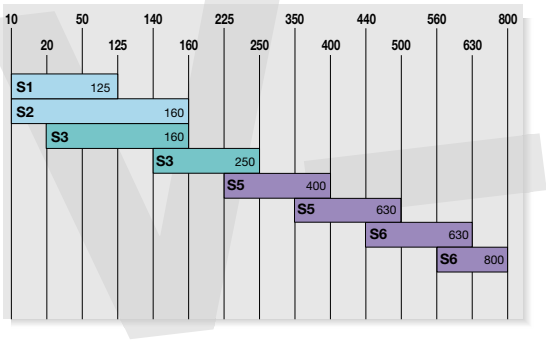
de 10 a 800A.
Con dos polos en serie, los interruptores automáticos SACE Isomax S se pueden utilizar con unas tensiones asignadas de 250 y 500 V y poderes de corte hasta 100 kA (250 V c.c.) y 65 kA (500 V c.c.); mientras que, con los interruptores automáticos SACE S3, S5 y S6 con 3 polos en serie, se puede alcanzar una tensión asignada de 750 V y poderes de corte hasta 50 kA.

Protección de generadores
Para la protección de los generadores, cuyas corrientes de defecto son extremadamente bajas (en el orden de 3 veces la corriente asignada), a la disponibilidad de los relés electrónicos S4 a S7 se suma ahora el modelo S3, con protección termomagnética dedicada, corriente térmica regulable Ith = 0,7…1 x In y umbral magnético fijo Im = 3 x In.

Gama hasta 1000 V
En el ámbito de los interruptores en caja moldeada y abiertos, ABB SACE L.V. propone una novedad con las gamas específicas de interruptores automáticos para aplicaciones en corriente alterna de hasta 1000 V. Los sectores típicos de empleo son las instalaciones en minas, túneles viarios o ferroviarios, tracción y usos industriales en general. Los interruptores están disponibles en versión tripolar, con relés termomagnéticos regulables o electrónicos, y tienen las mismas dimensiones que las versiones estándares. Pueden combinarse con los principales accesorios disponibles para la serie Isomax.



Campo de aplicación de los interruptores automáticos en corriente alterna



Campo de aplicación de los interruptores automáticos en corriente continua

Seguridad y funcionalidad
El doble aislamiento, el bloqueo de la puerta de la celda del cuadro, la extracción con la puerta cerrada son algunas de las características que permiten trabajar con plena seguridad a los operarios y que mejoran la funcionalidad de los aparatos instalados en el cuadro. Además, con la introducción de la tecnología electrónica digital SACE Isomax S se ha podido añadir, a las tradicionales funciones de protección propias de los relés termomagnéticos, otras funciones como la protección contra cortocircuito selectiva, la protección contra defectos a tierra, el control y la comunicación.

SACE Isomax S3	SACE Isomax S4	SACE Isomax S6	SACE Isomax S3X	SACE Isomax S4X	SACE Isomax S6X
160	160-250	630-800	125	250	630
3	3	3	3	3	3
1000	1000	1000	1000	1000	1000
8	8	8	8	8	8
1000	1000	1000	1000	1000	1000
3000	3000	3000	3000	3000	3000
L	L	L	X	X	X
6	8	12	30	30	30
9,2	13,6	24	63	63	63
20	30	30	10	20	25
		7,6 (630 A) - 10 (800 A)			
A	A	B	A	A	A
■	■	■	■	■	■
■	■	■	■	■	■
■			■		
	■ (sólo LI)	■ (sólo LI)		■ (sólo LI)	■ (sólo LI)
	■	■		■	■
F	F	F	F	F	F
F	F	F	F	F	F
DIN EN 50023	DIN EN 50023		DIN EN 50023	DIN EN 50023	
25000/120	20000/120	20000/120	25000/120	20000/120	20000/120
105	105	210	105	105	210
103,5	103,5	103,5	103,5	103,5	103,5
170	254	268	255	339	406
2,6	4	9,5	3,6	5	15

Interruptores automàticos en caja moldeada limitadores de corriente IEC 947-2. Potencia y velocidad.

Los interruptores automáticos SACE S2X 100, S3X, S4X y S6X constituyen la gama de interruptores automáticos de caja moldeada SACE Isomax S limitadores de corriente para aplicaciones de 1 a 630 A.
El interruptor automático limitador sirve para "limitar" al máximo la energía específica pasante en caso de cortocircuito y salvaguardar, así, la integridad de los circuitos y de los aparatos situados aguas abajo. El sistema de corte permite interrumpir con extrema rapidez corrientes de cortocircuito con valores elevados; además, gracias a la configuración especial del sistema, permite limitar los valores de cresta de las corrientes de defecto a valores sensiblemente inferiores a los de las corrientes de cortocircuito previstas en el punto de instalación. La rapidez de apertura reduce las solicitaciones electrodinámicas que se producen en los interruptores situados aguas abajo en caso de defecto. Se encuentran disponibles en ejecución fija, enchufable o extraíble y se pueden utilizar todos los accesorios de los correspondientes interruptores automáticos.

Aplicaciones
Están indicados para todos los tipos de instalaciones (civiles, industriales, terciario) así como en los equipamientos a bordo de naves, minas, plataformas petrolíferas y, en general, donde se puedan producir corrientes de cortocircuito de fuerte intensidad, hasta 200 kA a 380/415 V c.a. debido a las elevadas potencias de los transformadores y generadores. Se pueden utilizar como interruptores automáticos generales colocados aguas abajo de la fuente de alimentación y en instalaciones en las que la continuidad de servicio no es un requisito fundamental y se prevé la protección de acompañamiento (back-up) que permite el uso aguas abajo de interruptores con poder de corte inferior a la corriente de cortocircuito prevista en el punto de instalación.

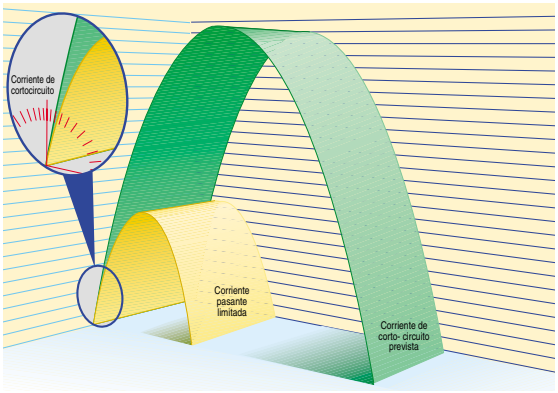
Tensión de servicio y poder de corte
Los interruptores automáticos limitadores de corriente SACE Isomax S son conformes a las normas IEC 947-2. Se caracterizan por una tensión asignada de servicio Ue de 690 V c.a. y el poder asignado de corte último en cortocircuito Iu es de 200 kA a 380/415 V c.a., de 75 kA a 690 V c.a. para S3X, S4X, S6X y de 70 kA a 440 V para S2X 100.
También se pueden realizar protecciones selectivas a pesar de los reducidos tiempos de corte en caso de cortocircuito.

Aptitud al seccionamiento

En la posición de abierto, el interruptor automático garantiza el seccionamiento del circuito en conformidad con la norma IEC 947-2. Las distancias de aislamiento redundantes garantizan la ausencia de corrientes de fuga y tensión de ensayo dieléctrico a posibles sobretensiones entre entrada y salida.

Dimensiones reducidas

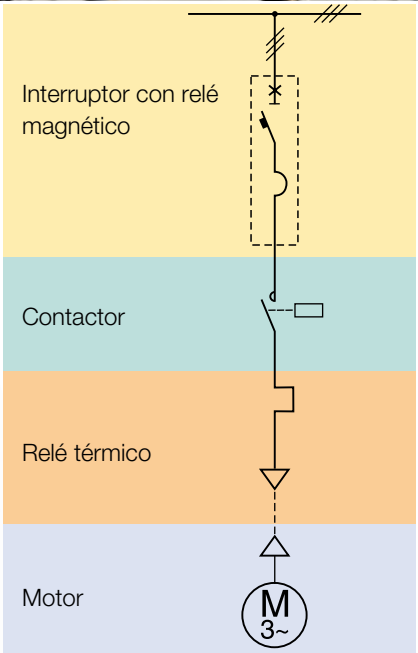
La unificación de la profundidad de los interruptores (en 70 mm para S2X 100 y 103,5 mm para S3X, S4X y S6X), la estandarización de las alturas y la ulterior reducción de las anchuras respecto a la de la gama SACE Limitor facilitan la instalación en cuadros y permiten normalizar las estructuras de soporte.



			SACE Isomax S2X 100	SACE Isomax S3X	SACE Isomax S4X	SACE Isomax S6X
Corriente permanente asignada, Iu		[A]	100	125-200	250	400-630
Nº de polos			3-4	3-4	3-4	3-4
Tensión asignada de servicio, Ue (c.a.) 50-60Hz		[V]	690	690	690	690
Tensión asignada soportada a impulso, Uimp		[kV]	6	8	8	8
Tensión asignada de aislamiento, Ui		[V]	690	800	800	800
Tensión de prueba a frecuencia industrial 1 minuto			3000	3000	3000	3000
Poder asignado de corte último en cortocircuito, Icu			X	X	X	X
	(c.a.) 50-60 Hz 220/230 V	[kA]	100	300	300	300
	(c.a.) 50-60 Hz 380/415 V	[kA]	70	200	200	200
	(c.a.) 50-60 Hz 440 V	[kA]	70	180	180	180
	(c.a.) 50-60 Hz 500 V	[kA]	50	150	150	150
	(c.a.) 50-60 Hz 690 V	[kA]	10	75 (1)	75	75
Poder asignado de corte de servicio en cortocircuito, Ics (2)		[%Icu]	75%	100%	100%	100%
Poder asignado de cierre en cortocircuito (415 V), Icm		[kA]	154	440	440	440
Tiempo de apertura (415V)		[ms]	3,5	3,5	3,5	3,5
Categoría de empleo (según EN 60947-2)			A	A	A	A
Aptitud al seccionamiento			■	■	■	■
IEC 947-2, EN 60947-2			■	■	■	■
Relés termomagnéticos M fijo 10 Ith, T regulable			■	■		
Relés con microprocesador PR211/P (I-LI)					■	■
Relés con microprocesador PR212/P (LSI-LSIG)					■	■
Intercambiabilidad					■	
Versiones			F-P	F-P-W	F-P-W	F-W
Terminales	Fijo		EF - FC - FC (CuAl) - R	F - EF - ES - FC - FC (CuAl) - RC - R	F - EF - ES - FC - FC (CuAl) - RC - R	F - EF - FC (CuAl) - RC - R
	Enchufable		FC-R	EF - R	EF - R	-
	Extraíble		-	EF - R	EF - R	EF - HR - VR
Fijación sobre perfil DIN			DIN EN 50022	DIN EN 50023	DIN EN 50023	-
Durabilidad mecánica [Nº maniobras/operaciones hora]			25000/240	25000/120	20000/120	20000/120
Durabilidad eléctrica (a 415 V) [Nº maniobras/operaciones hora]			8000/120	10000(125A)-8000(200A)/120	8000 / 120	7000 / 60
Dimensiones básicas fijo 3/4 polos						
	A	[mm]	90/120	105/140	105/140	210/280
	P	[mm]	70	103,5	103,5	103,5
	H	[mm]	120	255	339	406
Pesos	Fijo 3/4 polos	[kg]	1,1/1,5	3,6 / 4,8	5 / 7	15 / 20
	Enchufable 3/4 polos	[kg]	1,3/1,7	6,3 / 8,7	8,2 / 10,7	-
	Extraíble 3/4 polos	[kg]	-	7,1 / 9,5	9 / 11,5	24,5 / 33,8

(1) Para S3X con regulación R 32, Icu (690 V~) = 50 kA y Ics = 100%Icu. (2) El valor de Ics a 500/690 V para S3X, S4X y S6X se reduce un 25%.

Interruptores automáticos para protección de motores IEC 947-4. Protección a la medida de su motor



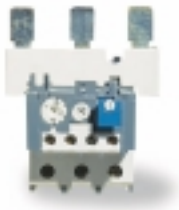
Protección y arranque de los motores asíncronos trifásicos

El arranque, la maniobra y la protección de los motores asíncronos trifásicos son operaciones fundamentales para su uso correcto. El sistema tradicional que se emplea para este fin comprende tres dispositivos: un interruptor para la protección contra cortocircuitos, un relé térmico para protección contra sobrecargas y falta o desequilibrio de fase, y un contactor para maniobrar el motor. El conjunto debe ser capaz de afrontar adecuadamente los problemas que surgen a la hora del arranque.
En particular, para elegir estos dispositivos deben tenerse en cuenta diversos factores, como:
- potencia del motor
- esquema de arranque
- tipo de motor (con rotor de jaula o devanado)
- corriente de defecto en el punto de la red

			S2X 80	S3			S3X	S4		
Corriente permanente asignada, Iu		[A]	80	160 / 250			125 / 200	160 / 250		
Corriente asignada de servicio, In		[A]	1...80	3...125 / 160...200			3... 125 / 125...200	100, 160 / 250		
Nº de polos			3	3			3	3		
Tensión asignada de servicio, Ue (c.a.) 50-60Hz		[V]	690	690			690	690		
Tensión asignada soportada a impulso, Uimp		[kV]	6	8			8	8		
Tensión asignada de aislamiento, Ui		[V]	690	800			800	800		
Tensión de prueba a frecuencia industrial 1 minuto			3000	3000			3000	3000		
Poder asignado de corte último en cortocircuito, Icu			X	N	H	L	X	N	H	L
	(c.a.) 50-60 Hz 220/230 V	[kA]	100	65	100	170	300	65	100	200
	(c.a.) 50-60 Hz 380/415 V	[kA]	70	35[1]	65	85	200	35[1]	65	100
	(c.a.) 50-60 Hz 440 V	[kA]	70	30	50	65	180	30	50	80
	(c.a.) 50-60 Hz 500 V	[kA]	50	25	40	50	150	25	40	65
	(c.a.) 50-60 Hz 690 V	[kA]	10	14	18	20	75	18	22	30
Poder asignado de corte de servicio en cortocircuito, Ics[2]		[%Icu]	75%	100%	75%	75%	100%	100%	100%	75%
Poder asignado de cierre en cortocircuito (415 V), Icm		[kA]	154	74	143	187	440	74	143	220
Tiempo de apertura (415V)		[ms]	3,5	8	7	6	3,5	8	7	6
Categoría de empleo (según EN 60947-2)			A	A			A	A		
Aptitud al seccionamiento			■	■			■	■		
IEC 947-2, EN 60947-2			■	■			■	■		
Relés sólo magnético fijo (13xIn)			■	-			-	-		
Relés sólo magnético regulable 4...12xIn			-	■			■	-		
Relés con microprocesador PR211/P (I)			-	-			-	■		
Intercambiabilidad			-	-			-	■		
Versiones			F-P	F - P - W			F - P - W	F - P - W		
Terminales	Fijo (F)		EF - FC - FC CuAl -R	F - EF - ES - FC - FC CuAl - RC - R			F - EF - ES - FC - FC CuAl - R - RC	F - EF - ES - FC - FC CuAl - R - RC		
	Enchufable (P)		FC-R	EF-FC-R			EF-R	EF-FC-R		
	Extraíble (W)		-	EF-FC-R			EF-R	EF-FC-R		
Fijación sobre perfil DIN			DIN EN 50022	DIN EN 50023			DIN EN 50023	DIN EN 50023		
Durabilidad mecánica [Nº maniobras/operaciones hora]			25000/240	25000/120			25000/120	20000/120		
Dimensiones básicas Fijo, 3 polos A		[mm]	90	105			105	105		
	P	[mm]	70	103,5			103,5	103,5		
	H	[mm]	120	170			255	254		
Pesos	Fijo 3 polos	[kg]	1,1	2,6			3,6	4		
	Enchufable 3 polos	[kg]	1,3	3,1			6,3	4,5		
	Extraíble 3 polos	[kg]	-	3,5			7,1	4,9		

[1] Todas las versiones con Icu=35 kA están certificadas para 36 kA.

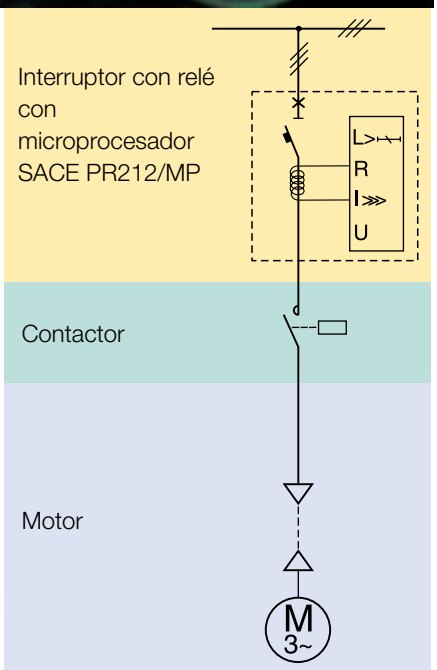
[2] Para interruptores S3 N/H/L, S4 N/H/L, S5 N/H y S6 N/S/H, la prestación porcentual de Ics a 690 V se reduce un 25%.



donde está instalado el motor.
ABB SACE L.V. propone una amplia gama de interruptores que, implementando exclusivamente la protección contra cortocircuitos, son idóneos para el uso dentro de arrancadores protegidos de tipo tradicional.
El nuevo SACE S2X 80, con la protección magnética fija 13 veces superior a la corriente asignada de servicio, es un interruptor extremadamente compacto y dotado de prestaciones excepcionales en lo que respecta a poder de corte y limitación de la energía específica pasante.
Muy fácil y rápido de instalar, tiene las mismas posibilidades de equipamiento y personalización que los interruptores S2B/N/S. Puede utilizarse en un vasto campo de arranques, de 0,37 kW a 37 kW y de 400 V-50 kA hasta 690 V-50 kA.
Los interruptores automáticos SACE S3N/H/L 160/250 y el interruptor limitador de corriente S3X 125/200 llevan montado un relé sólo magnético, regulable de 4 a 12 veces la corriente asignada de servicio. Cubren coordinaciones de 37 a 132 kW y, gracias a la elevada flexibilidad que les confiere el amplio rango de regulación del umbral magnético, aseguran la mejor protección para el motor.
Los SACE S4 160/250, S5 400/630, S6 630/800 y S7 1250/1600, con los diversos niveles de poder de corte N-S-H-L, así como los limitadores de corriente S4X y S6X, pueden equiparse con el relé electrónico con microprocesador PR211/P (I). Se utilizan principalmente en motores de elevada potencia y, gracias a la protección contra cortocircuitos regulable de 1,5 a 12 veces, permiten elegir el valor de intervención ideal para cada tipo de motor.

S4X	S5			S6				S6X	S7		
250	400 / 630			630 / 800				400 / 630	1250 / 1600		
100, 160, 250	320, 400 / 630			630 / 800				320, 400 / 630	1000, 1250 / 1600		
3	3			3				3	3		
690	690			690				690	690		
8	8			8				8	8		
800	800			800				800	800		
3000	3000			3000				3000	3000		
X	N	H	L	N	S	H	L	X	S	H	L
300	65	100	200	65	85	100	200	300	85	100	200
200	35(1)	65	100	35(1)	50	65	100	200	50	65	100
180	30	50	80	30	45	50	80	180	40	55	80
150	25	40	65	25	35	40	65	150	35	45	70
75	20	25	30	20	22	25	30	75	20	25	35
100%	100%	100%	75%	100%	100%	100%	75%	100%	100%	75%	50%
440	74	143	220	74	105	143	220	440	105	143	220%
3,5	8	7	6	10	9	8	7	3,5	22	22	22
A	B(400A) A(630A)			B				A	B		
■	■			■				■	■		
■	■			■				■	■		
-	-			-				-	-		
-	-			-				-	-		
■	■			■				■	■		
■	■			■				■	■		
F -P - W	F - P(400A) - W			F - W				F - W	F - W		
F - EF - ES - FC - FC CuAl - R - RC	F - EF - ES - FC - FC CuAl - R - RC(400A)			F-EF-FC CuAl-R-RC				F-EF-FC CuAl-R-RC	F-EF-FC CuAl(125A)-HR-VR		
EF-R	EF-FC-R			-				-	-		
EF-R	EF-FC-R - VR (630A)			EF-HR-VR				EF-VR-HR	EF-VR-HR		
DIN EN 50023	DIN EN 50023			-				-	-		
20000/120	20000/120			20000/120				20000/120	10000/120		
105	140			210				210	210		
103,5	103,5			103,5				103,5	138,5		
339	254			268				406	406		
5	5			9,5				15	17		
8,2	6,1			-				-	-		
9	6,4			12,1				25,4	21,8		

Relés electrónicos SACE PR212/MP IEC 947-4. La evolución de la protección de motores



Los interruptores SACE Isomax S4N-H-L 160/250, S5N-H-L 400, S6N-H-L 800, S7S-H-L, S4X 250 y S6X 400/630 pueden equiparse con relés electrónicos SACE PR212/MP, realizados con tecnología de microprocesador. Esto permite, por una parte, obtener funciones que garantizan una elevada precisión de intervención, extrema fiabilidad e insensibilidad a los agentes externos; y, por la otra, implementar nuevas y sofisticadas protecciones que, integradas en el interruptor, constituyen una solución tecnológicamente avanzada para el arranque y la protección de motores.
SACE PR212/MP es tan sofisticado en su proyecto como sencillo e inmediato en el uso. Las diversas curvas de funciones, con múltiples regulaciones en umbrales y tiempos, permiten trazar una curva general de intervención realmente próxima a la curva de arranque del motor, optimizando la protección.

			S4			S5			S6			S7		
Corriente permanente asignada, Iu		[A]	160 /250			400			800			1250		
Corriente asignada de servicio, In		[A]	100, 160 / 200			320			630			1000		
Nº de polos			3			3			3			3		
Tensión asignada de servicio, Ue (c.a.) 50-60Hz		[V]	690			690			690			690		
Tensión asignada soportada a impulso, Uimp		[kV]	8			8			8			8		
Tensión asignada de aislamiento, Ui		[V]	800			800			800			800		
Tensión de prueba a frecuencia industrial 1 minuto			3000			3000			3000			3000		
Poder asignado de corte último en cortocircuito, Icu			N	H	L	N	H	L	N	H	L	S	H	L
	(c.a.) 50-60 Hz 220/230 V	[kA]	65	100	200	65	100	200	65	100	200	85	100	200
	(c.a.) 50-60 Hz 380/415 V	[kA]	35(1)	65	100	35(1)	65	100	35(1)	65	100	50	65	100
	(c.a.) 50-60 Hz 440 V	[kA]	30	50	80	30	50	80	30	50	80	40	55	80
	(c.a.) 50-60 Hz 500 V	[kA]	25	40	65	25	40	65	25	40	65	35	45	70
	(c.a.) 50-60 Hz 690 V	[kA]	18	22	30	20	25	30	20	25	30	20	25	35
Poder asignado de corte de servicio en cortocircuito, Ics (2)		[%Icu]	100%	100%	75%	100%	100%	75%	100%	100%	75%	100%	75%	50%
Poder asignado de cierre en cortocircuito (415 V), Icm		[kA]	74	143	220	74	143	220	74	143	220	105	143	220
Tiempo de apertura (415V)		[ms]	8	7	6	8	7	6	9	8	7		22	
Categoría de empleo (según EN 60947-2)				A			A			B			B	
Aptitud al seccionamiento				■			■			■			■	
IEC 947-2, EN 60947-2 IEC 947-4-1, EN 60947-4-1				■			■			■			■	
Relés con microprocesador PR212/MP (LRIU)				■			■			■			■	
Intercambiabilidad				■			■			■			■	
Versiones				F-P-W			F-P-W			F-W			F-W	
Terminales	Fijo (F)			F-EF-ES-FC-FC CuAl-R-RC			F-EF-ES-FC-FC CuAl-R-RC			F-EF-FC CuAl-R-RC			F-EF-FC CuAl-HR-VR	
	Enchufable (P)			EF-FC-R			EF-FC-R			-			-	
	Extraíble (W)			EF-FC-R			EF-FC-R			EF-HR-VR			EF-HR-VR	
Fijación sobre perfil DIN EN 50023				SI			SI			-			-	
Durabilidad mecánica [Nº maniobras/operaciones hora]				20000/120			20000/120			20000/120			10000/120	
Dimensiones básicas Fijo, 3 polos														
	A	[mm]		105			140			210			210	
	P	[mm]		103,5			103,5			103,5			138,5	
	H	[mm]		254			254			268			406	
Pesos	Fijo 3 polos	[kg]		4			5			9,5			17	
	Enchufable 3 polos	[kg]		4,5			6,1			-			-	
	Extraíble 3 polos	[kg]		4,9			6,4			12,1			21,8	

(1) Todas las versiones con Icu=35 kA están certificadas para 36 kA.

(2) Para interruptores S4 N/H/L, S5 N/H y S6 N/S/H, la prestación porcentual de Ics a 690 V se reduce un 25%.

SOBRECARGA: FUNCIÓN L

Un modelo térmico, almacenado en el microprocesador, permite correlacionar las sobrecorrientes verificadas en la línea de alimentación con los niveles de temperatura alcanzados en el cobre y en el hierro del motor (patente internacional de ABB SACE L.V.). La protección es conforme a las normas internacionales sobre seguridad de motores, IEC947-4-1, y ofrece cuatro clases distintas de arranque: 10A, 10, 20 y 30. Además, está compensada en temperatura y es sensible a la falta o al desequilibrio de fase, según la norma.

ROTOR BLOQUEADO: FUNCIÓN R

La función R protege el motor ante un posible bloqueo del rotor durante el funcionamiento. Esta protección se desactiva automáticamente durante la fase de arranque y después se reactiva. De este modo se evitan intervenciones no deseadas debidas a la corriente de subtransitorio y, al mismo tiempo, se protege el motor y la instalación durante el funcionamiento.

CORTOCIRCUITO: FUNCIÓN I

Esta protección interviene en escasos milisegundos cuando se verifica un cortocircuito. El microprocesador, además, discrimina el arranque, evitando que el interruptor se abra inoportunamente a causa de la corriente de pico (patente internacional de ABB SACE L.V.).

FALTA O DESEQUILIBRIO DE FASE: FUNCIÓN U

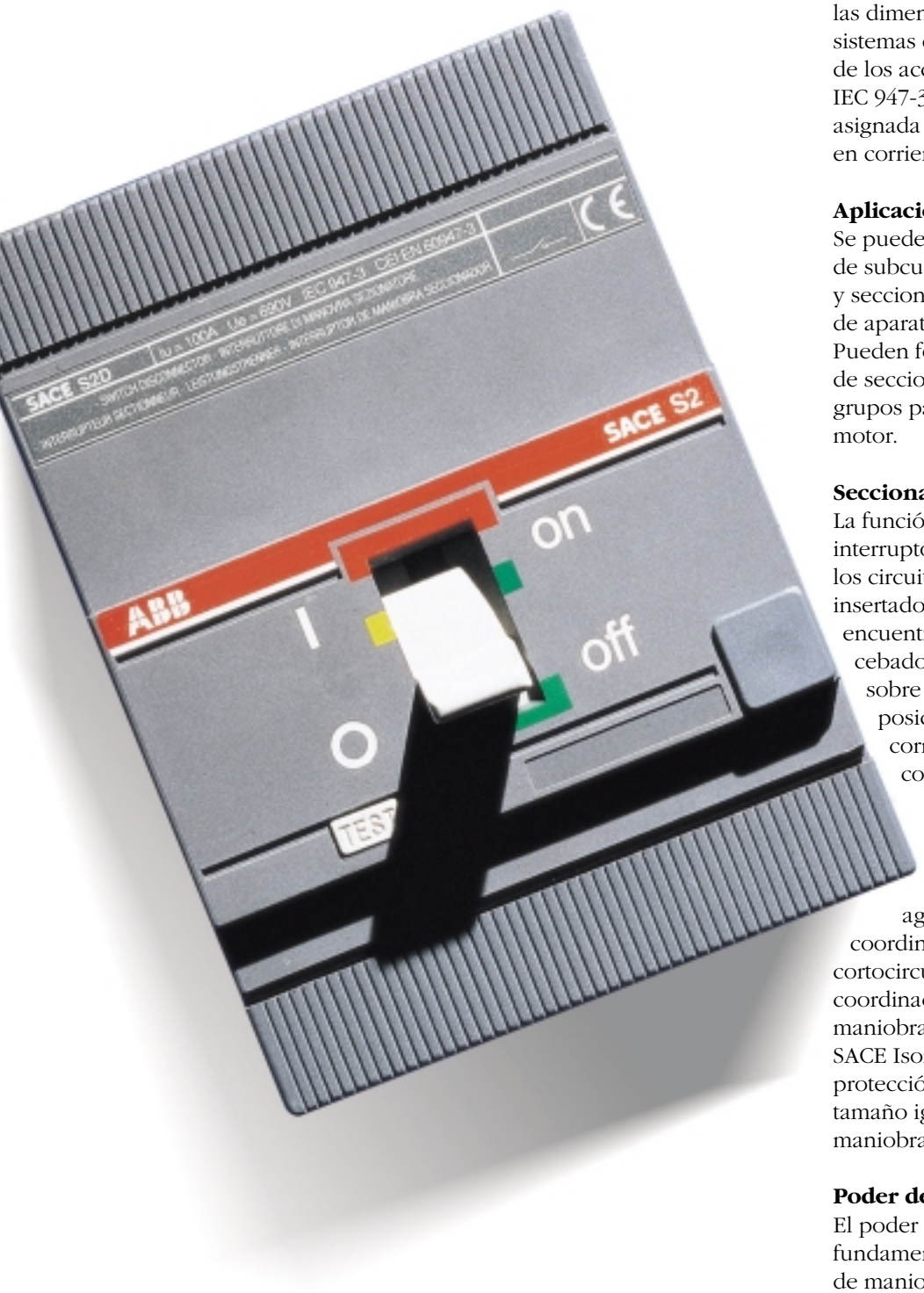
La falta de fase o los desequilibrios de absorción son detectados por el relé electrónico que controla todas las corrientes de fase.
La función U es una protección adicional que se suma a la sensibilidad normal a estos fenómenos, impuesta por la norma y garantizada por la función L. Si la corriente de una o dos fases se hace inferior al umbral prefijado de 0,4 veces la corriente térmica, y permanece así durante más de 4 segundos, el relé se dispara.

Soluciones coordinadas con el sistema ABB
Esta avanzada solución —un arrancador formado por un interruptor SACE Isomax S con PR212/MP y un contactor ABB— ofrece numerosas ventajas además de una perfecta protección del motor. En primer lugar, un notable ahorro de tiempo, espacio y dinero, gracias al hecho de que no hace falta utilizar un relé térmico externo.
Además, la serie SACE Isomax S y la nueva línea de contactores A-Line ABB son la base de una nueva generación de aparatos, específicamente proyectados para componer un sistema de productos perfectamente integrable según las distintas necesidades de aplicación.
El interruptor automático y el contactor tienen las mismas dimensiones en anchura y profundidad, y un sistema de instalación excepcionalmente sencillo y compacto.

S4X	S6X
250	400 / 630
100, 160, 200	320 / 400, 630
3	3
690	690
8	8
800	800
3000	3000
X	X
300	300
200	200
180	180
150	150
75	75
100%	100%
440	440
3,5	3,5
A	A
■	■
■	■
■	■
■	■
F-P-W	F - W
F - EF - ES - FC - FC CuAl - R - RC	F-EF-FC CuAl-R-RC
EF-R	-
EF-R	EF-VR-HR
SI	-
20000/120	20000/120
105	210
103,5	103,5
339	406
5	15
8,2	-
9	25,4

Además de la combinación clásica interruptor-contactor-relé térmico, los interruptores SACE Isomax S para protección de motores, a partir del modelo S4, se combinan sólo con el contactor (ejemplo de composición entre S5H con PR212/MP y contactor serie A modelo A300-30).

Interruptores de maniobra-seccionadores IEC 947-3. Maniobras en plena seguridad



Los interruptores de maniobra-seccionadores derivan de los correspondientes interruptores automáticos, de los que conservan inalteradas las dimensiones generales, las ejecuciones, los sistemas de fijación y la posibilidad de montaje de los accesorios. Son conformes a la norma IEC 947-3. Se caracterizan por una tensión asignada de 690 V en corriente alterna y 750 V en corriente continua.

Aplicaciones
Se pueden utilizar como interruptores generales de subcuadros, como dispositivos de maniobra y seccionamiento para líneas, barras o grupos de aparatos o como acopladores de barras. Pueden formar parte de dispositivos generales de seccionamiento de grupos de máquinas o de grupos para la maniobra y protección de un motor.

Seccionamiento
La función principal que realizan estos interruptores consiste en el seccionamiento de los circuitos en los que se encuentran insertados. Los contactos, una vez abiertos, se encuentran a una distancia que impide el cebado de un arco, respetando las normativas sobre la aptitud al seccionamiento. La posición de la palanca de mando corresponde exactamente a la de los contactos (maniobra positiva).

Protección
Todo interruptor de maniobra-seccionador tiene que estar protegido aguas arriba por un dispositivo coordinado que lo proteja contra los cortocircuitos. La siguiente tabla de coordinación indica para cada interruptor de maniobra-seccionador el interruptor automático SACE Isomax S que puede realizar la función de protección. Se trata siempre de aparatos de tamaño igual o inferior al del interruptor de maniobra-seccionador.

Poder de cierre
El poder de cierre es una prestación de fundamental importancia, ya que un interruptor de maniobra-seccionador tiene que ser capaz de soportar sin destruirse las solicitaciones dinámicas, térmicas y de corriente que pueden manifestarse durante el cierre, hasta las condiciones de cierre con cortocircuito.

			S2D	S3D	S6D	S7D	S8D
Corriente térmica convencional a 60°C Ith		A	125-160	100-160-250-320	400-630-800	1000-1250-1600	2000-2500-3200
Polos		N°	3-4	3-4	3-4	3-4	3-4
Tensión asignada de servicio Ue	c.a. 50-60 Hz	V~	690	690	690	690	690
	c.c.	V-	500	750	750	750	750
Corriente asignada Iu		A	125-160	100-160-250-320	400-630-800	1000-1250-1600	2000-2500-3200
Tensión asignada soportada a impulso, Uimp		kV	6	8	8	8	8
Tensión asignada de aislamiento, Ui		V	690	800	800	800	800
Tensión de prueba a frequencia industrial durante 1 minuto		V	3000	3000	3000	3000	3000
Poder asignado de cierre en cortocircuito (415 V~), Icm		kA	3,1	10	30	52,5	85
Corriente asignada de corta duración admisible durante 1s Icw		kA	2,2	6,5	15	25	40
Aptitud al seccionamiento			■	■	■	■	■
IEC 947-3			■	■	■	■	■
Durabilidad mecánica [n° manovre/ operaz. orarie]			25000/240	25000/120	20000/120	10000/120	10000/20
Versiones-terminales							
	Fija		EF-FC-FC CuAl-R RC-R	F-EF-FC-FC CuAl RC-R	F-EF-FC CuAl RC-R	F-EF-FC CuAl (1250 A) HR-VR	EF (2500A)-R
	Enchufable		FC-R	F-FC-R	-	-	-
	Extraíble		-	F-FC-R	F-HR-VR	F-HR-VR	-
Dimensiones fijo	**3 polos**						
	A	mm	90	105	210	210	406
	P	mm	70	103,5	103,5	138,5	242
	H	mm	120	170	268	406	400
Dimensiones fijo	**4 polos**						
	A	mm	120	140	280	280	556
	P	mm	70	103,5	103,5	138,5	242
	H	mm	120	170	268	406	400
Peso	3P	kg	1,1	2,6	9,5	17	57
	4P	kg	1,5	3,5	12	22	76

Coordinación con los interruptores automáticos

Poder de corte (kA) de las combinaciones entre interruptores automáticos y interruptores de maniobra-seccionadores

Tipo	S2D 125	S2D 160	S3D 100	S3D 160	S3D 250	S3D 320	S6D 400	S6D 630	S6D 800	S7D 1000	S7D 1250	S7D 1600	S8D 2000	S8D 2500	S8D 3200
S1 B	16		16												
S1 N	25		25												
S2 B	16	16	16	16											
S2 N	35	35	35	35											
S2S	50	50	50	50											
S3 N			35	35	35	35									
S3 H			65	65	65	65									
S5 N							35	35	35						
S5H							65	65	65						
S6 N							35	35	35						
S6 S							50	50	50						
S6 H							65	65	65						
S7 S										50	50	50			
S7 H										65	65	65			
S8 H													85	85	85
S8 V													120	120	120

Resistencia en posición de cerrado

Identifica la capacidad de mantener la posición de cerrado para sobrecorrientes de corta duración. Se trata de un parámetro significativo que califica las prestaciones de estos aparatos.

Relés diferenciales. Una unión coordinada

Los interruptores automáticos diferenciales combinan en un único aparato la función de protección contra sobreintensidades y la función diferencial; actúan tanto debido a sobrecarga / cortocircuito como por fuga de corriente a tierra.
Los interruptores diferenciales “puros” que se obtienen con los interruptores de maniobra-seccionadores, sólo son sensibles a la corriente de defecto a tierra
Permiten el control continuo del estado de aislamiento de la instalación asegurando una protección eficaz contra los riesgos de incendio y explosión y, en los casos con dispositivos con IDn ≤ 30 mA, asegurando la protección de las personas contra los contactos directos e indirectos como integración de las medidas obligatorias previstas por las normativas y las prescripciones de prevención de los accidentes.

Relé diferencial polarizado SACE RC210
Para los interruptores SACE S1 está disponible el relé diferencial polarizado SACE RC210/1 para el montaje colateral sobre perfil DIN

50022, en las versiones adecuadas para corrientes diferenciales alternas senoidales (AC), con umbrales de actuación por defecto diferencial de 300 mA y 500 mA, corrientes asignadas permanentes de 63 A y 125 A y tensiones de funcionamiento hasta 500 V.
El relé diferencial polarizado está disponible como bloque a instalar colateralmente en la parte derecha del interruptor y actúa directamente en el dispositivo de disparo. Está dotado con un pulsador de prueba para el control periódico del relé.

Relés diferenciales SACE RC211 y RC212
Los relés diferenciales SACE RC211 y RC212 se pueden montar en posición colateral o inferior tanto en los interruptores automáticos SACE Isomax S1, S2 y S3 como en los interruptores de maniobra-seccionadores SACE S3D. Han sido realizados con tecnología electrónica-analógica. No requieren alimentación auxiliar ya que se alimentan directamente mediante la red a través del interruptor y el funcionamiento está garantizado incluso con una sola fase en tensión y en presencia de corrientes unidireccionales pulsantes con componentes continuas. Un pulsador de prueba permite controlar las condiciones de funcionamiento del relé diferencial.
Los relés diferenciales han sido realizados en conformidad con la norma IEC 947-2 apéndice B, IEC 255-4 e IEC 1000 para la protección contra los disparos intempestivos, IEC 755 para la insensibilidad a las componentes continuas de corriente.
Los relés SACE RC211 y SACE RC212 actúan directamente en el interruptor mediante un solenoide de apertura suministrado con el relé que se tiene que alojar en el correspondiente hueco localizado en la zona del tercer polo.

Relé diferencial de cuadro SACE RCQ
Está aconsejado para el uso en presencia de corrientes de defecto a tierra exclusivamente alternas, para corrientes alternas y/o pulsantes con componentes continuas y para realizar la selectividad diferencial. Se puede combinar con todos los interruptores SACE Isomax S, se instala en los cuadros con toroidal separado para montar exteriormente en los conductores de la línea.
Particularmente indicado para las aplicaciones en las que se desee efectuar un sistema de protección diferencial coordinado con los diferentes niveles de distribución, desde el cuadro principal al servicio final.

			RC210	RC211	RC212	RCQ
Tecnología			polarizado	electrónico	electrónico	electrónico
Montaje			colateral	colateral- inferior	colateral- inferior	celda cuadro
Actuación			directa	con solenoide	con solenoide	con solenoide
Tensión de funcionamiento	c.a.	[V~]	hasta 500	220 ÷ 500	50 ÷ 500	hasta 500
	c.c.	[V–]				48 ÷ 125
Campo de funcionamiento del test		[V]	230 ÷ 500	220 ÷ 500	50 ÷ 500	80 ÷ 500 c.a. 48 ÷ 125 c.c.
Umbrales de actuación IΔn		[A]	0.3 - 0.5	0.03 - 0.1 - 0.3	0.03-0.1-0.3-0.5-3	0.03...30
Tiempos de actuación		[s]	istantáneo	istantáneo	0-0.1-0.25-0.5-1-1.5	0-0.1-0.2-0.3-0.5-0.7-1-2-3-5
Corriente asignada de servicio		[A]	hasta 125	hasta 250	hasta 250	hasta 2000
Tipo AC sólo para corriente alterna			■	■	■	■
Tipo A para corriente alterna, pulsante			—	■	■	■
Tipo selectivo			—	—	■	■
Señalización de actuación			—	■	■	■
Indicación de prealarma			—	—	■	■
Dimensiones A x H x P			103 x120 x 70	120 x 120 x 70	140 x 170 x 108	96x 96 x 131.5
Entrada para apertura a distancia			—	—	■	■

Interruptores según normas UL/CSA. La calidad a la conquista del nuevo mundo

Moulded Case Circuit Breakers

Circuit breaker type			S1	S3 150			S3 225			
Maximum frame continuous rated current 40 °C		[A]	100	150			225			
Poles			3	2 - 3			2 - 3			
Rated operational voltage 50-60 Hz		[V]	277/480	600			240 (B); 480 (N/H/L)			
	d.c. (3 poles in series)	[V]		600			500			
Test voltage (1min.) 50-60 Hz		[V]	3000	3000			3000			
UL/CSA short-circuit interrupting capacity		[kA rms]	N	N	H	L	B	N	H	L
	240 Vac		50	65	100	150	150	65	100	150
	480 Vac		14(for R15) / 20(for R20-R100)	25	50	85	-	25	50	65
	600 Vac		-	14	14	25	-	-	-	-
	500 Vdc (2 poles in series)		-	35	50	65	50	20	35	50
	600 Vdc (3 poles in series)		-	20	35	50	-	-	-	-
Overcurrent trip relays										
Thermal-magnetic			■	■			■			
Microprocessor based			-	-			-			
Interchangeability			-	-			-			
Fixed Version - Dimensions	H	[in/mm]	4,72 / 120	6,70 / 170			6,70 / 170			
	W	[in/mm]	3,07 / 78	4,13 / 105			4,13 / 105			
	D	[in/mm]	2,75 / 70	4,07 / 103,5			4,07 / 103,5			
Mechanical duration		[op./ frequency]	25000 / 240	25000 / 120			25000 /120			
Weights (fixed - 3P)		[lbs.]	2,42	6,75			6,75			

En el campo de los interruptores automáticos en caja moldeada SACE Isomax S, conformes a las normas UL489 y CSA22.2, la oferta SACE Isomax S incluye tres gamas; una de interruptores automáticos para la distribución de potencia, equipados con relés termomagnéticos o electrónicos, otra de interruptores automáticos con relés solo magnéticos (Motor Control Protection – MCP) para protección de motores, y la tercera de interruptores de maniobra (Moulded Case Switch – MCS) para utilizar como seccionadores o dispositivos de maniobra para líneas, barras o partes de instalaciones.
La propuesta de SACE Isomax S aprobada según normas UL/CSA se completa con la introducción de tres nuevos modelos. De esta manera aumentan las posibilidades para los clientes que trabajan en mercados sujetos a estas normas, teniendo a su disposición una gama entera de interruptores en caja moldeada con corrientes asignadas que van de 100 a 2500 A y poderes de corte, a 480 V c.a., que pueden alcanzar los 100kA.
La presentación del modelo S1, además de ampliar el campo de corrientes asignadas hacia valores más bajos, permite satisfacer todas las aplicaciones típicas de la subdistribución de potencia, que exigen interruptores de tamaño reducido pero con gran versatilidad de equipamiento e instalación.
Las opciones se incrementan también con la introducción de nuevas características para S3, Iu = 225 A, con tres niveles de poder de corte (N/H/L), hasta unos valores de tensión de servicio Ue = 480 V c.a. y 500 V c.c.

Por último, cabe destacar la novedad representada por el interruptor S8 según norma UL/CSA, que extiende la gama hacia los valores mayores de corrientes asignadas. Isomax S8V 1600, 2000 y 2500 pueden instalarse inmediatamente después de las fuentes de alimentación en sistemas de baja tensión, y son idóneos para funcionar con seguridad en las más severas condiciones de uso imperantes en las instalaciones modernas. Las elevadas prestaciones, amplia flexibilidad de equipamiento, facilidad de coordinación con los dispositivos montados en puntos posteriores de la línea y la posibilidad de limitar la profundidad de los cuadros gracias al tamaño pequeño del interruptor hacen de Isomax S8 una solución particularmente ventajosa.

S4			S5			S6			S7	S8
250			400			800			1200	1600-2000-2500
2 - 3			2 - 3			2 - 3			2 - 3	3
600			600			600			600	600
-			600			600			-	-
3000			3000			3000			3000	3000
N	H	L	N	H	L	N	H	L	H	V
65	150	200	65	150	200	65	150	200	100	120
25	65	100	35	65	100	50	65	100	65	100
18	22	35	22	22	35	25	35	42	50	85
-	-	-	35	50	65	35	50	65	-	-
-	-	-	20	35	50	20	35	50	-	-
-			■			■			-	-
■			■			■			■	■
■			■			■			■	■
10,00 / 254			10,00 / 254 (300A); 13,62 / 346 (400A)			14,25 / 268			16 / 406	15,75 / 400
4,13 / 105			5,51 / 140			8,27 / 210			8,27 / 210	15,98 / 406
4,07 / 103,5			4,07 / 103,5			4,07 / 103,5			5,45 / 138.5	9,25 / 235
20000 / 120			20000 / 120			20000 / 120			10000 / 120	10000 / 20
8,8			11			22			37,5	135

Motor Control protection - MCP

	S3 L		S4 N/H/L			S5 N/H/L			S6 N/H/L			S7 H	S8 V
Poles	3		3			3			3			3	3
Trip Unit													
Adjustable magnetic only (4...12xIn)	■												
PR211/P - I			■			■			■			■	■
Rating [A]	3...25	50...150	100-250			400	400	400	600-800	600-800	600-800	1000-1200	1600-2000-2500
	L	L	N	H	L	N	H	L	N	H	L	H	V
Interrupting capacity													
240 V a.c.	50	150	65	150	200	65	150	200	65	150	200	100	120
480 V a.c.	25	85	25	65	100	35	65	100	50	65	100	65	100
600 V a.c.	10	25	18	22	35	22	22	35	25	35	42	50	85
500 V d.c.	65 (1)	65	-	-	-	-	-	-	-	-	-	-	-
600 V d.c.	50 (1)	50	-	-	-	-	-	-	-	-	-	-	-

(1) Performance available only for the 25 A rating version

Moulded Case Switches - MCS

Type		S3H-D 225	S3H-D 150	S4H-D	S5H-D	S6H-D	S7H-D	S8V-D
Rating	[A]	225	150	250	400	800	1200	2500
Poles		3	3	3	3	3	3	3
Magnetic trip	[A]	2250	1500	3000	5000	10000	20000	35000
Rated voltage								
(a.c.) 50-60 Hz	[V~]	480	600	600	600	600	600	600
(d.c.) 3 poles in series	[V–]	500	600	600	600	600	600	600

Soluciones inteligentes para una gama completa y personalizada

Modularidad y compacidad

Reduce las dimensiones de los cuadros eléctricos

La modularidad con la que se han concebido las gamas de los interruptores automáticos, de los limitadores de corriente, de los interruptores de maniobra-seccionadores y de los interruptores para protección de motores, facilita la instalación en el interior de las celdas.
Gracias al uso de nuevos materiales y a un estudiado proyecto de los diferentes modelos, los interruptores SACE Isomax S permiten reducir las dimensiones de los cuadros eléctricos:
• a igualdad de prestaciones, los volúmenes ocupados por los interruptores se reducen hasta el 50% con respecto a la serie precedente;
• toda la gama, articulada en ocho modelos y realizada con sólo cuatro profundidades (70 mm para S1 y S2; 103,5 mm para S3 ... S6; 138,5 mm para S7; 242 mm para S8), permite la normalización de las estructuras de soporte, la estandarización de los cuadros y la instalación en estructuras prefabricadas;
• el frontal, normalizado para grupos de interruptores (45 mm para S1 ... S5; 105 mm para S3 ... S7), permite la combinación de los diferentes modelos gracias a la misma ventana del cuadro;
• la homogeneidad dimensional, las posibilidades de conexión gracias a la variedad de terminales disponibles facilita las conexiones mediante sistemas de barras o conexiones con cable.

Cualquier posición de instalación

Máxima flexibilidad durante la elaboración del proyecto y el montaje

Los interruptores automáticos SACE Isomax S se pueden instalar tanto en posición horizontal como vertical, sin que esto perjudique sus prestaciones.
La alimentación se puede efectuar mediante los terminales superiores o los inferiores.
El montaje se puede efectuar en la placa de fondo del cuadro o, hasta el modelo S5, sobre perfil DIN.

Grado de protección

Protección asegurada contra los contactos directos accidentales

El grado de protección de los interruptores en ejecución fija, enchufable o extraíble es de IP20. IP30 para los interruptores instalados en el cuadro.
Si se añade un mando giratorio reenviado, montado en la puerta de la celda, se alcanza el grado de protección IP54. Las partes fijas de los interruptores enchufables o extraíbles presentan, hacia el frente, un grado de protección IP20.

Nuevo sistema de corte

Limita la presencia y la peligrosidad del arco

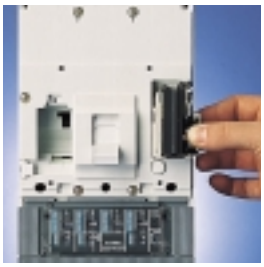
El corte de la corriente se efectúa favoreciendo la sinergia de tres factores que intervienen en la extinción del arco en el menor tiempo posible. Dichos elementos son:
• la velocidad de apertura de los contactos, aumentada gracias a un nuevo sistema cinemático que abre los contactos instantáneamente;
• la acción dinámica de soplado ejecutada en el arco por el campo magnético;
• la estructura de la cámara de arco.
Gracias a la considerable contención del tiempo de apertura, el interruptor automático limita drásticamente el valor de la energía específica pasante salvaguardando los aparatos, los servicios y los conductores situados aguas abajo.

Maniobra positiva

Garantiza las señalizaciones correctas

Los estados de “abierto” y “cerrado” están indicados por la posición asumida por la palanca de maniobra. La posición intermedia indica la apertura por la actuación de los relés. En todos los casos, las señalizaciones mecánicas corresponden siempre a las posiciones reales de los contactos móviles del interruptor.
El mecanismo de mando del interruptor es del tipo con disparo libre independiente de la presión sobre la palanca y de la velocidad de la operación.

Doble aislamiento



Segregación entre los circuitos de potencia y los circuitos auxiliares

Todos los interruptores, a partir del modelo S3, han sido realizados con la técnica del doble aislamiento.
La ubicación de cada accesorio eléctrico está completamente segregada del circuito de potencia; de esta manera, se evita todo riesgo de contacto con las partes activas y se aumentan, así, las condiciones de seguridad del operador en la gestión y la inspección de las instalaciones.
Entre las partes activas interiores, el interruptor presenta, además, un aislamiento redundante tanto por el espesor de los materiales como por las distancias, superiores a las requeridas por las normas IEC y conforme a lo previsto por la práctica americana.

Extracción con la puerta cerrada

Máxima seguridad para el operador y posibilidad de efectuar cuadros a prueba de arco interno

Este sistema, presente por primera vez en una serie de interruptores automáticos de caja moldeada, a partir del modelo S3, permite la inserción y la extracción del interruptor con la puerta de la celda cerrada.
Esta característica aumenta la seguridad del operador y permite realizar cuadros de baja tensión a prueba de arco interno.
La extracción sólo se puede efectuar con el interruptor automático abierto, utilizando una manivela de extracción suministrada con el interruptor en ejecución extraíble.

Mantenimiento fácil y seguro

Reduce los tiempos de mantenimiento y garantiza la seguridad

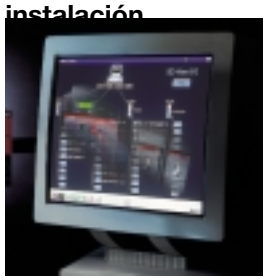
Con el interruptor fuera de servicio es posible controlar directamente el estado de las piezas interiores y de los componentes activos del interruptor. Las cámaras de arco y los contactos fijos y móviles son accesibles tras quitar simplemente la tapa del interruptor.
Esta operación, facilitada por el número limitado de componentes, reduce los tiempos de mantenimiento y garantiza un nivel superior de seguridad.

Conformidad con las normas

Normas, homologaciones, certificados y sistemas de calidad empresariales

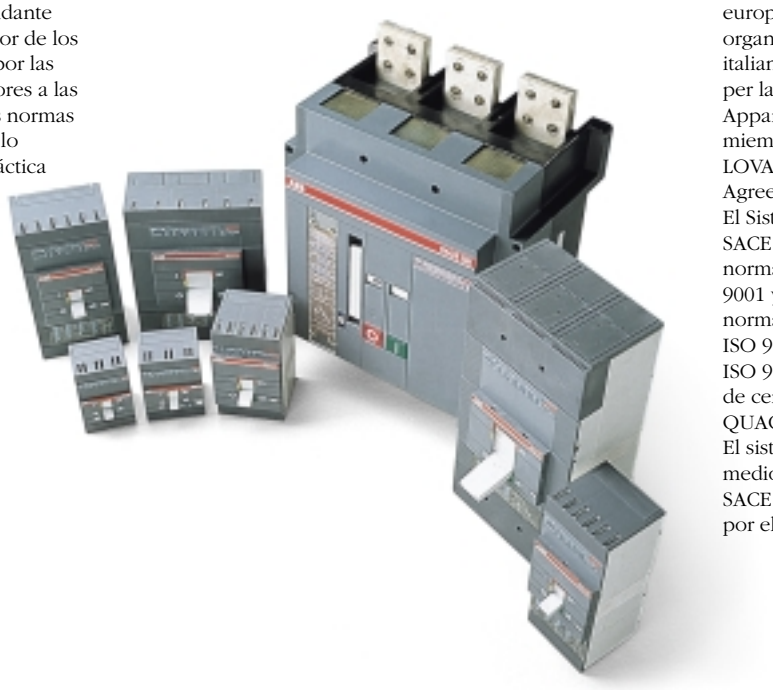
Los interruptores SACE Isomax S y sus accesorios responden a la normas internacionales IEC 947-2, EN 60947-2 (armonizadas en 17 países del CENELEC), UNE EN 60947-2 e IEC 1000 y son conformes a las directivas comunitarias de "Baja Tensión" (LVD) nº 73/23 EEC y de "Compatibilidad electromagnética" (EMC) nº 89/336 EEC.
Los certificados de conformidad del producto con las normas anteriormente citadas, son expedidos, según la establecido por la norma europea EN 45011, por el organismo de certificación italiano ACAE (Associazione per la Certificazione delle Apparecchiature Elettriche), miembro de la organización LOVAG (Low Voltage Agreement Group).
El Sistema Calidad de ABB SACE L.V. es conforme a la norma internacional ISO 9001 y a las equivalentes normativas europeas EN ISO 9001 e italianas UNI EN ISO 9001. El tercer instituto de certificación es el RINA-QUACER.
El sistema de gestión del medio ambiente de ABB SACE L.V. está certificado por el RINA.

La electrónica al servicio de la instalación



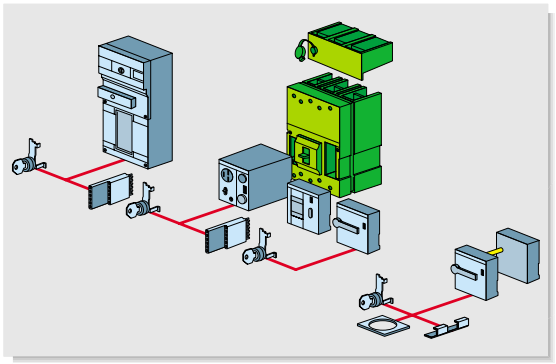
Fiabilidad, precisión e integración en los sistemas de supervisión

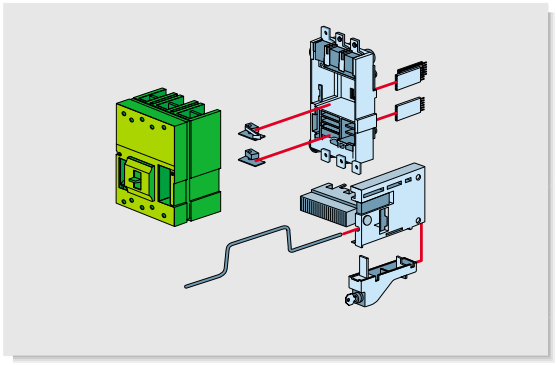
Los relés con microprocesador están caracterizados por la precisión y la fiabilidad derivadas de una atenta realización del proyecto de los componentes y de los algoritmos que realizan las funciones de protección.
La electrónica digital ha permitido realizar funciones como el control y la comunicación para permitir la plena integración de los interruptores en las lógicas de gestión de los sistemas de supervisión y control.
ABB SACE L.V., a la vanguardia en los sistemas de supervisión y control de las instalaciones eléctricas más complejas, propone también la solución más adecuada a las pequeñas instalaciones: el sistema SD-View 810 que, estudiado expresamente para la pequeña y mediana industria, se puede utilizar en un ordenador personal sin ningún tipo de aprendizaje especial.
Aprovechando al máximo la funcionalidad de los relés con microprocesador, SD-View puede dialogar con todos los interruptores ABB SACE L.V., permitiendo controlar el estado de la instalación mediante la memorización continua de los datos, la detección del estado de los interruptores y la señalización de anomalías y los defectos. Al mismo tiempo, permite programar al operador los parámetros de protección y las características de actuación.

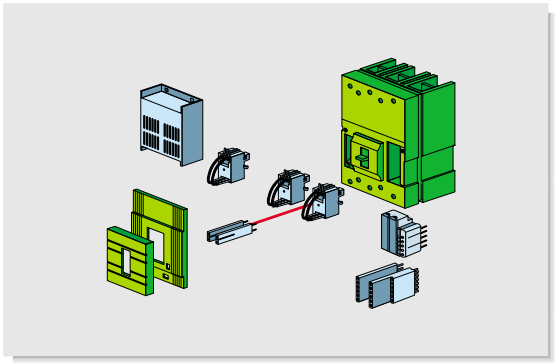


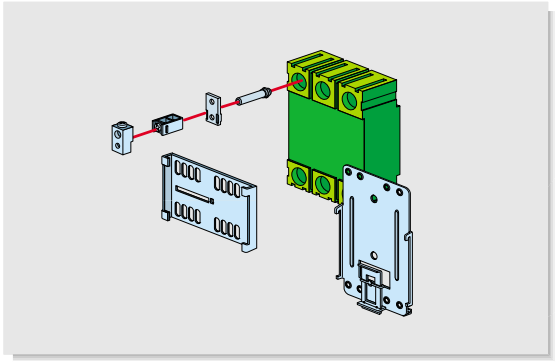
Una gama completa de accesorios. Máxima libertad de personalización

Para la serie SACE Isomax S, la homogeneidad del suministro se traduce en la gran variedad de accesorios unificados por grupos de interruptores.
Los accesorios son los mismos para todas las gamas y se pueden montar sin quitar la tapa del interruptor. Esto permite adaptaciones “in situ” in provocar interrupciones del servicio.
seguridad del personal queda garantizada en las las condiciones gracias al aislamiento de sede de los accesorios con relación a las ezas bajo tensión.









Commande par poignée rotative

Permite una maniobra de apertura y cierre del interruptor más fácil.
Está preparado para un bloqueo por candados (de serie), con posibilidad de montar el bloqueo a llave y el bloqueo de la puerta de la celda (de serie para SACE S1 y S2).

Relé de apertura

Permite la apertura a distancia del interruptor.

Relé de mínima tensión

Provoca la apertura del interruptor en caso de una sensible disminución o falta de tensión de alimentación.
También se encuentra disponible en versión retardada.

Mando con motor

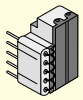
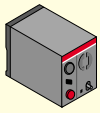
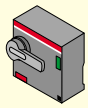
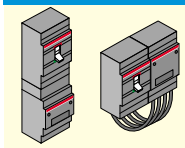
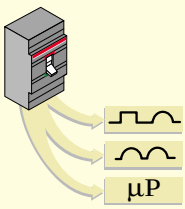
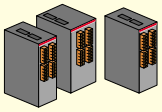
Permite abrir y cerrar el interruptor a distancia.
También es posible aplicar el bloqueo con llave. Se realiza en la versión con solenoide para S1 y S2 de acción directa para los interruptores SACE S3, S4 y S5, y en la de acumulación de energía para los interruptores SACE S6 y S7.

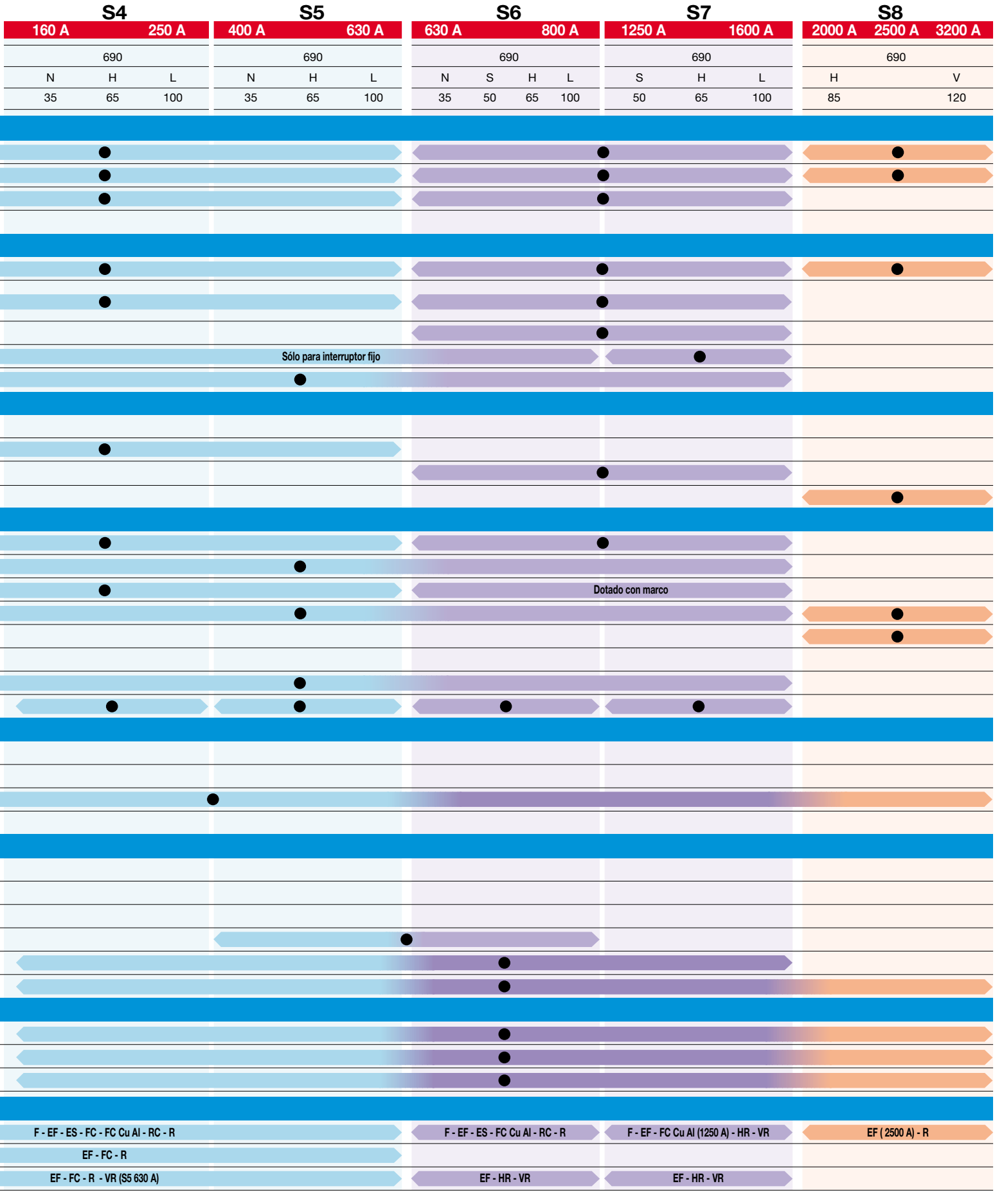
Unidad de diálogo y unidad de señalización

Permite la comunicación bidireccional con los sistemas de gestión y control de la instalación eléctrica.
Siempre se combina con:
• la unidad de actuación para la apertura y el cierre del interruptor desde el sistema de gestión.
Se puede completar con:
• la unidad de señalización para la visualización de las informaciones proporcionadas por el relé con microprocesador.

Contactos auxiliares y de posición

Indican la señalización de
• interruptor abierto - cerrado;
• interruptor abierto por la actuación de los relés;
• interruptor insertado - extraído.
Se encuentran disponibles con contactos conmutados.

	S1		S2			S3		
	125 A		160 A			160 A		250 A
Tensión asignada Ue 50/60 Hz V~	500		690			690		
Nivel de prestación	B	N	B	N	S	N	H	L
Icu kA (380 / 415 V~) 50-60 Hz	16	25	16	35	50	35	65	85
Relés de servicio								
Relés de apertura	●		●					
Relés de mínima tensión	●		●					
Relés de mínima tensión en versión retardada								
Señalizaciones électricas								
Contacto conmutado Abierto/Cerrado	●		●					
								
1 Wechsler AUS/EIN + 1 Wechsler für Ausgelöst-Anzeige	●		●					
1 abierto + 1 cerrado + 1 abierto para señalar la actuación del relé								
Contacto auxiliar avanzado para relé de mínima tensión						●		
Contacto de señalización interruptor Insertado/Extraído			●	●	●	●		
Mando a motor								
								
Mando a motor	●		●					
Mando a motor de acción directa						●		
Mando a motor de acumulación de energía								
Motorreductor para la carga automática de los resortes de cierre								
Mandos y bloqueos								
								
Mando giratorio	●		●					
Protección IP54 para mando giratorio	●		●					
Frontal para mando por palanca						●		
Bloqueo a llave en posición abierto	●		●					
Bloqueo por candados para palanca de maniobra	●		●					
Bloqueo antimanipulación del relé termomagnético			●	●	●	●		
Bloqueo de la puerta de la celda	●		●					
Enclavamiento mecánico entre dos interruptores colaterales o sobrepuestos							●	
Relés differenciales electronicos								
								
Montaje en la parte inferior	RC 211/1 - RC 212/1		RC 211/2 - RC 212/2			RC 211/3 - RC 212/3		
Montaje colateral	RC 210/1 - RC 211/1 - RC 212/1		RC 211/2 - RC 212/2			RC 211/3 - RC 212/3		
Toroidal y relé RCQ	●		●			●		
Relé de sobreintensidad								
								
Térmico fijo / Magnético fijo	●							
Térmico regulable / Magnético fijo			●	●	●	●		
Sólo Magnético	●		●	●	●	●		
Térmico regulable / Magnético regulable								
Microprocesador PR211/P								
Microprocesador PR212/P								
Accesorios para relés con microprocesador								
								
Unidad de visualización PR212/K								
Unidad de diálogo PR212/D								
Unidad de actuación PR212/T								
Terminales								
Para interruptor fijo	FC - R		EF - FC - FC Cu Al -R					
Para interruptor enchufable	FC		FC - R					
Para interruptor extraíble								


S4
160 A
250 A
690
N
H
L
35
65
100
S5
400 A
630 A
690
N
H
L
35
65
100
S6
630 A
800 A
690
N
S
H
L
35
50
65
100
S7
1250 A
1600 A
690
S
H
L
50
65
100
S8
2000 A
2500 A
3200 A
690
H
V
85
120
Sólo para interruptor fijo
Dotado con marco
F - EF - ES - FC - FC Cu Al - RC - R
EF - FC - R
EF - FC - R - VR (S5 630 A)
F - EF - ES - FC Cu Al - RC - R
EF - HR - VR
F - EF - FC Cu Al (1250 A) - HR - VR
EF - HR - VR
EF (2500 A) - R

Software y reglas. Instrumentos de selección y proyectación

Para la elaboración de los proyectos y el dimensionamiento de las instalaciones eléctricas se encuentran disponibles tres instrumentos de trabajo muy útiles (software, el kit de reglas y la guía para la selección de aparamenta de baja tensión) que facilitan los cálculos, aseguran la conformidad del equipo con las normativas y disminuyen los riesgos de error.
Cada CD-Rom incluye los tres productos software principales desarrollados por ABB SACE L.V. y ABB Elettrocondutture llamados: D.O.C., C.A.T.s y DMB/Win.
El D.O.C. (Design Optimization & Compulation) es un sistema de dimensionamiento optimizado para instalaciones industriales de baja tensión y puede sugerir las soluciones proyectuales más correctas correspondientes a los cables, barras y dispositivos de protección.
Permite al proyectista desarrollar rápidamente una documentación para el proyecto clara y completa, conforme con las recientes normativas.
El C.A.T.s. (Computer Aided Technical selection) es un catálogo electrónico y un instrumento técnico de ayuda durante la selección y accesoriamento de cada interruptor.
Mediante un recorrido guiado es posible seleccionar, configurar y solicitar el aparato más indicado a las exigencias de instalación.
El paquete software DMB permite efectuar de manera automática y veloz los presupuestos y la configuración de los cuadros de distribución de las series ArTu y PC de ABB Turati, utilizando principalmente equipos y materiales ABB.
Además, el paquete es perfectamente compatible con las aplicaciones AutoCAD (DMBLT3 y DMBCAD 3.0) específicamente desarrolladas por ABB para el diseño de cuadros y de esquemas eléctricos unifilares.
Cuatro reglas de distintos colores, que constituyen el kit ABB, ayudan a efectuar rápidamente los cálculos de dimensionamiento de la instalación eléctrica.
Es posible efectuar:
- Dimensionamiento de los cables y cálculo de las corrientes de cortocircuito (regla amarilla).
- Verificación de las protecciones contra los contactos indirectos y los cortocircuitos de los cables (regla naranja).
- Coordinación selectiva y de acompañamiento (regla verde).
- Dimensionamiento de las líneas de motor y salidas de los transformadores (regla azul).
Los métodos de cálculo y los datos indicados en las reglas han sido tomados de las vigentes Normas UNE, IEC y NFC y de la práctica en el sector.
La Guja para la selección de aparamenta de baja tensión permite el calculo de la instalación y la optimización técnica y económica en la selección de la aparamenta.
Constituye una herramienta de consulta práctica e imprescindible para proyectistas e instaladores.

SACE Isomax S. Tecnología, innovación y calidad

Usuario. Prestaciones elevadas, fiabilidad, dedicadas a los usuarios

Sería suficiente la historia de ABB SACE L.V., caracterizada por un desarrollo tecnológico continuo, unas soluciones innovadoras y unas selecciones fáciles para las exigencias de las personas que utilizan interruptores automáticos, para servir de referencia en la elección de productos efectivamente válidos.
Sin embargo, para el usuario no es suficiente. Siempre busca lo mejor, lo fiable y lo más seguro.
Ponerse en la óptica del usuario es una estrategia que, durante años, ha permitido a ABB SACE L.V. mejorar continuamente, armonizando las nuevas soluciones técnicas con las exigencias de los usuarios, que exigen a los interruptores automáticos un elevado grado de fiabilidad en el tiempo y, cuando es necesario, la posibilidad de sustituir las piezas averiadas y una especial compatibilidad de las prestaciones de protección con las exigencias, más o menos críticas, de la aplicación.

Proyectista. Más soluciones integradas para cualquier exigencia

Para el proyectista es importante contar con interruptores automáticos que respondan perfectamente a las normativas técnicas internacionales y capaces de efectuar, de manera fiable, cualquier tipo de prestación en los niveles más elevados.
Un proyecto es el fruto de un análisis atento del problema y de la puesta en práctica de ideas originales, basadas en un concreto equilibro de factores concernientes a la funcionalidad, la seguridad, la fiabilidad a lo largo del tiempo y el mantenimiento.
La serie de interruptores automáticos SACE Isomax S ofrece al profesional las soluciones de dimensionamiento, coordinación y flexibilidad de uso que le permiten realizar un proyecto profesional, seleccionando gamas y soluciones para los circuitos concebidas para ser integradas en un sistema completo, satisfaciendo todas las exigencias de instalación y las normativas vigentes.

Encarcado del mantenimiento. Mantenimiento fácil y seguro

Como establecen las normativas y directivas europeas más recientes, el mantenimiento es un factor indispensable en cualquier tipo de instalación.
Los interruptores automáticos SACE Isomax S permiten la inserción de accesorios desde el frente.
En las versiones enchufables y extraíbles se pueden insertar y extraer de la parte fija con gran facilidad.
La disponibilidad de accesorios por grupos de interruptores permite una gestión sencilla y económica de las piezas de recambio necesarias. La racionalidad de fabricación así como la modularidad del diseño permiten intervenciones de sustitución que, a menudo, no requieren especiales adaptaciones ni tan siquiera al pasar de un tipo de interruptor a otro como, por ejemplo, de un interruptor automático a uno limitador.

Instalador y cuadrista. Facilidad de instalación para cualquier instalación

La calidad de los accesorios suministrados con los interruptores automáticos SACE Isomax S; el estudio esmerado antes de la realización del producto, la calidad de la documentación técnica de soporte que ABB SACE L.V. pone a disposición de los instaladores y cuadristas. Estos y otros factores tienen un papel determinante para hacer de un interruptor automático un producto de uso sencillo que se pueda ensamblar, conectar y verificar con facilidad.
La profesionalidad de los instaladores y cuadristas encuentra en la serie de interruptores automáticos SACE Isomax S un partner también profesional ya que se puede gestionar con los máximos niveles de flexibilidad e integración y porque ha sido concebida para garantizar la realización de las soluciones de instalación más avanzadas y simples.

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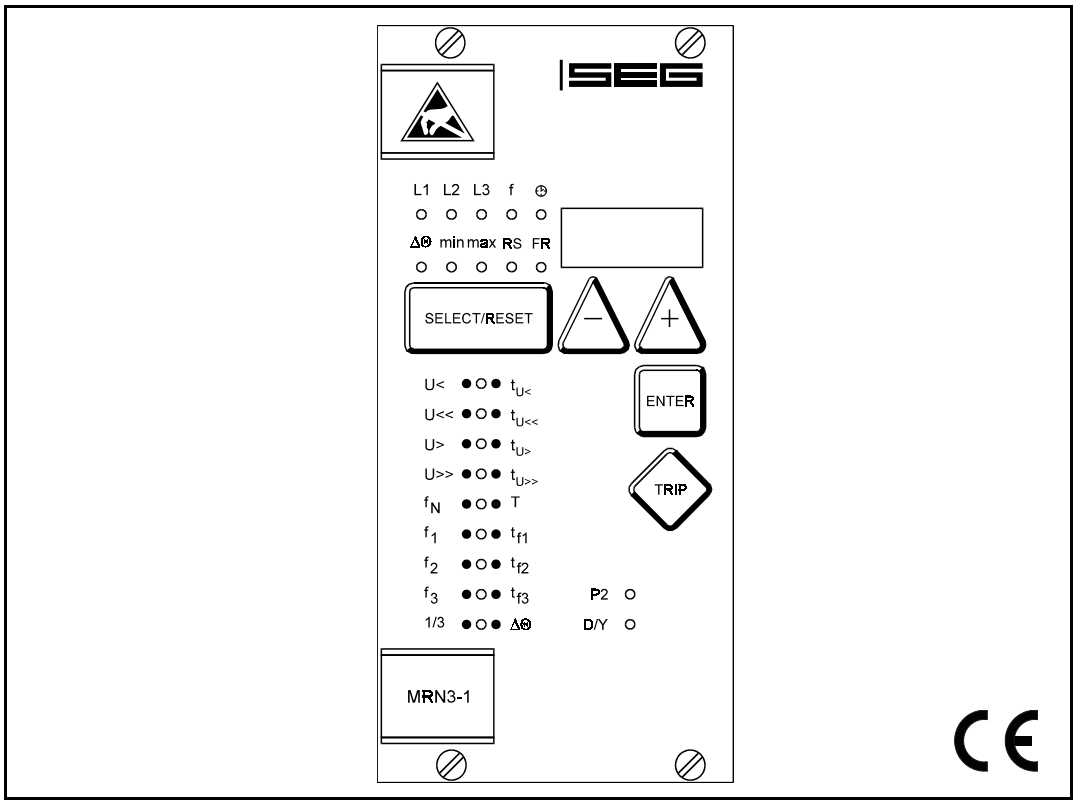
MRN3 - Mains decoupling relay



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1 Introduction and application

The *MRN3* is a universal mains decoupling device and covers the protection requirements from VDEW and most other utilities for the mains parallel operation of power stations.

- Over/ and undervoltage protection,
- over/ and underfrequency protection,
- extremely fast decoupling of generator in case of mains failure (*MRN3-1*) or
- rate of change of frequency df/dt (*MRN3-2*)

Because of combination of three protectional functions in one device the *MRN3* is a very compact mains decoupling device. Compared to the standardly used single devices it has a very good price/performance ratio.

For applications where the single protection functions are required SEG can offer the single *MR*-relays as follows:

- *MRU3-1* four step independent over-/ and undervoltage protection (also used for generator earth fault protection).
- *MRU3-2* two step independent over-/ and undervoltage protection with evaluation of the symmetrical voltage components.
- *MRF3* four step independent over/ and underfrequency protection and two step frequency gradient supervision df/dt.
- *MRG2* generator mains monitor / vector surge detection.

Important:
For additional common data of all *MR*-relays please refer to technical description "*MR* - Digital Multifunctional Relays".

2 Features and characteristics

- Microprocessor technology with watchdog,
- effective analog low pass filter for suppressing harmonics when measuring frequency and vector surge,
- digital filtering of the measured values by using discrete Fourier analysis to suppress higher harmonics and d.c. components induced by faults or system operations,
- integrated functions for voltage, frequency and vector surge in one device as well as single voltage, frequency and vector surge devices,
- two parameter sets,
- voltage supervision each with two step under-/ and overvoltage detection,
- frequency supervision with three step under-/ or overfrequency (user setting),
- completely independent time settings for voltage and frequency supervision,
- adjustable voltage threshold value for blocking frequency and vector surge measuring,
- display of all measuring values and setting parameters for normal operation as well as tripping via a alphanumerical display and LEDs,
- display of measuring values as primary quantities
- Storage of trip values and switching-off time (t_{CBFP}) of 5 fault occurences (fail-safe of voltage),
- recording of up to eight fault occurences with time stamp
- for blocking the individual functions by the external blocking input, parameters can be set according to requirement,
- user configurable vector surge measurement 1-of-3 or 3-of-3,
- reliable vector surge measuring by exact calculation algorithm,
- suppression of indication after an activation (LED flash),
- free assignment for output relays,
- display of date and time,
- in complience with VDE 0435, part 303 and IEC 255,
- serial data exchange via RS485 interface possible; alternatively with SEG RS485 Pro-Open Data Protocol or Modbus Protocol.

3 Design

3.1 Connections

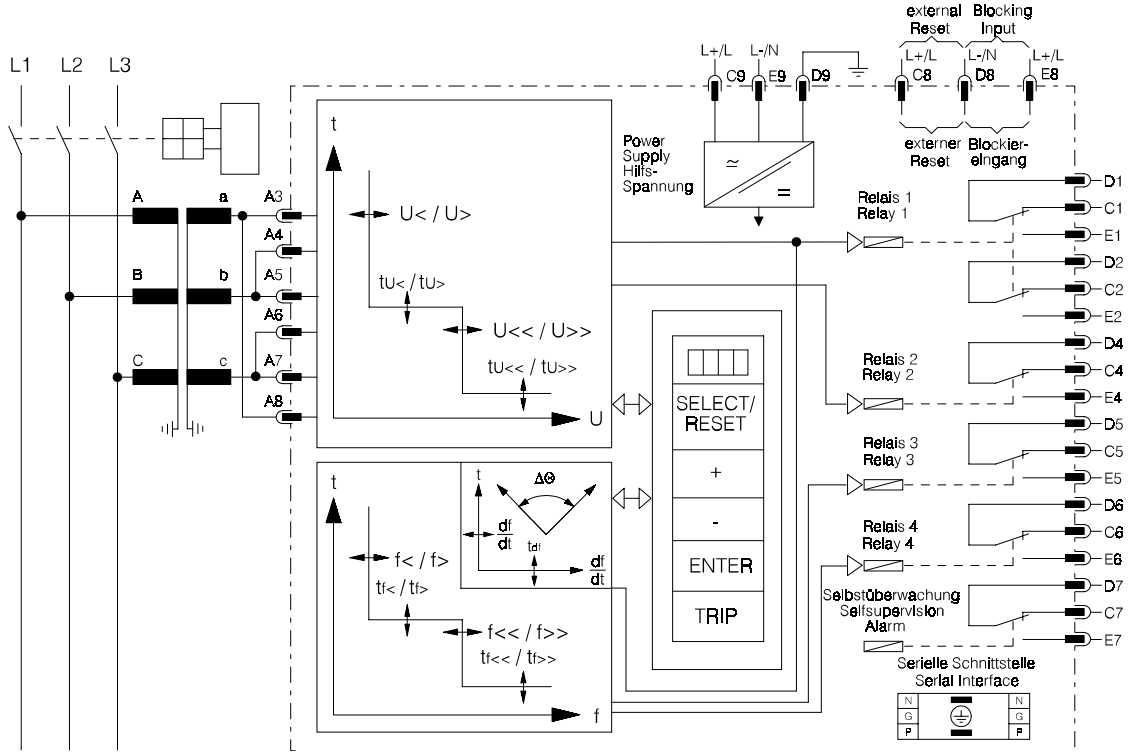


Figure 3.1: Connection diagram MRN3-1 and MRN3-2

3.1.1 Analog input circuits

The analog input voltages are galvanically decoupled by the input transformers of the device, then filtered and finally fed to the analog digital converter. The measuring circuits can be applied in star or delta connection (refer to chapter 4.3.1).

3.1.2 Blocking input

The blocking function can be set according to requirement. By applying the auxiliary voltage to D8/E8, the previously set relay functions are blocked (refer to 4.8 and 5.7.1).

3.1.3 Reset input

Please refer to chapter 5.9.1.

3.1.4 Output relays

The *MRN3* is equipped with 5 output relays. Apart from the relay for self-supervision, all protective functions can be optionally assigned:

- Relay 1: C1, D1, E1 and C2, D2, E2
- Relay 2: C3, D3, E3 and C4, D4, E4
- Relay 3: C5, D5, E5
- Relay 4: C6, D6, E6
- Relay 5: Signal self-supervision (internal failure of the unit) C7, D7, E7

All trip and alarm relays are working current relays, the relay for self supervision is an idle current relay.

3.1.5 Fault recorder

The *MRN3* has a fault value recorder which records the measured analog values as instantaneous values.
The instantaneous values

U_{L1}; U_{L2}; U_{L3} for star connection
or U_{12}; U_{23}; U_{21} for delta connection

are scanned at a raster of 1.25 ms (at 50 Hz) and 1.041 ms (at 60 Hz) and saved in a cyclic buffer. It is possible to store 1 - 8 fault occurences with a total recording time of 16 s (with 50 Hz) and 13.33 s (with 60 Hz) per channel.

Storage division

Independent of the recording time, the entire storage capacity can be divided into several cases of disturbance with a shorter recording time each. In addition, the deletion behaviour of the fault recorder can be influenced.

No writing over

If 2, 4 or 8 recordings are chosen, the complete memory is divided into the relevant number of partial segments. If this max. number of fault event has been exceeded, the fault recorder block any further recordings in order to prevent that the stored data are written over. After the data have been read and deleted, the recorder to ready again for further action.

Writing over

If 1, 3 or 7 recordings are chosen, the relevant number of partial segments is reserved in the complete memory. If the memory is full, a new recording will always write over the oldest one.

The memory part of the fault recorder is designed as circulating storage. In this example 7 fault records can be stored (written over).

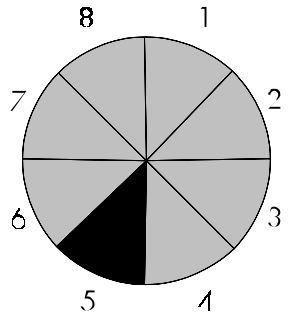


Figure 3.2: Division of the memory into 8 segments, for example

Memory space 6 to 4 is occupied.
Memory space 5 is currently being written in

Since memory spaces 6, 7 and 8 are occupied, this example shows that the memory has been assigned more than eight recordings. This means that No. 6 is the oldest fault recording and No. 4 the most recent one.

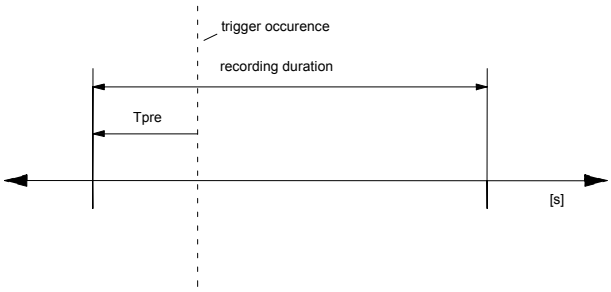


Figure 3.3: Basic set-up of the fault recorder

Each memory segment has a specified storage time which permits setting of a time prior to the trigger event.

Via the interface RS485 the data can be read and processed by means of a PC (HTL/PL-Soft4). The data is graphically edited and displayed. Binary tracks are recorded as well, e.g. activation and trip.

3.2 Parameter settings

System parameters

Parameter settings	*MRN3-1*	*MRN3-2*
U_{prim}/U_{sek}	X	X
Δ/Y	X	X
fN	X	X
P2/FR	X	X
LED-Flash	X	X

Table 3.1: System parameters

Protection parameters

Setting parameter	*MRN3-1*	*MRN3-2*
U<	X	X
$t_{U<}$	X	X
U<<	X	X
$t_{U<<}$	X	X
U>	X	X
$t_{U>}$	X	X
U>>	X	X
$t_{U>>}$	X	X
T	X	X
f_1	X	X
t_{f1}	X	X
f_2	X	X
t_{f2}	X	X
f_3	X	X
t_{f3}	X	X
df		X
dt		X
1/3	X	
ΔΘ	X	
U_B<	X	X
RS485/Slave	X	X
Baud-Rate*	X	X
Parity-Check*	X	X

Table 3.2: Protection parameters
*only Modbus

Blocking functions

Parameter settings	*MRN3-1*	*MRN3-2*
U<	X	X
U<<	X	X
U>	X	X
U>>	X	X
f1	X	X
f2	X	X
f3	X	X
Δθ	X	
df/dt		X

Table 3.3: Blocking functions

Parameters for the fault recorder

Parameter setting	*MRN3-1*	*MRN3-2*
Number of fault events	X	X
Trigger events	X	X
Pre-Triggerzeit T_{pre}	X	X

Table 3.4: Parameters for the fault recorder

Additional functions

Parameter settings	*MRN3-1*	*MRN3-2*
Ralay assignment	X	X
Fault recorder	X	X

Table 3.5: Additional functions

Date and time

Parameter settings		*MRN3-1*	*MRN3-2*
Year	Y = 99	X	X
Month	M = 03	X	X
Day	D = 16	X	X
hour	h = 07	X	X
minute	m = 29	X	X
second	s = 56	X	X

Table 3.6: Date and time

The window for parameter setting is located behind the measured value display. The parameter window can be accessed via the <SELECT/RESET> key.

3.3 LEDs

All LEDs (except LED RS, min. and max.) are two-coloured. The LEDs on the left side, next to the alpha-numerical display light up green during measuring and red after tripping.

The LEDs below the push button <SELECT/RESET> are lit green during setting and inquiry procedure of the setting values which are printed on the left side next to the LEDs. The LEDs will light up red after parametrizing of the setting values next to their right side.

The LED marked with letters RS lights up during setting of the slave address of the device for serial data communication.

The LED marked with the letters FR is alight while the fault recorder is being adjusted.

3.4 Front plate

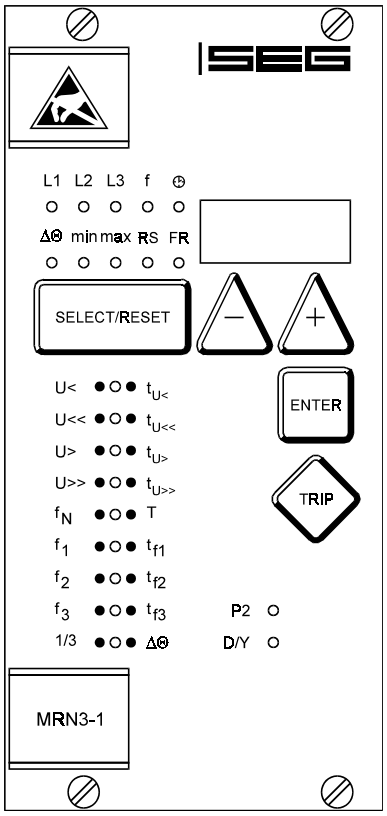


Figure 3.4: Front plate MRN3-1

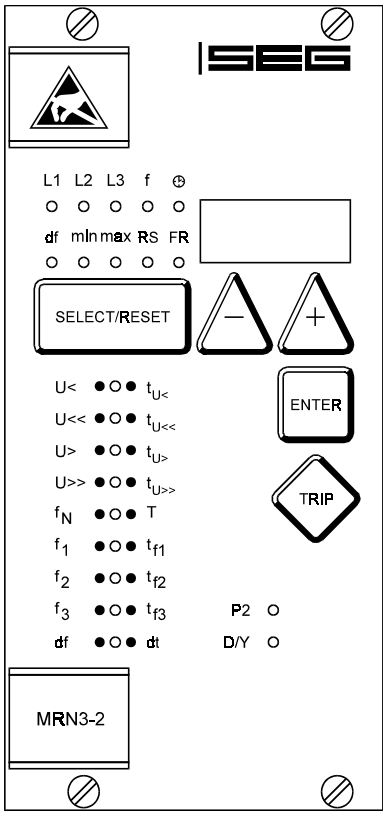


Figure 3.5: Front plate MRN3-2

4 Working principle

4.1 Analog circuits

The input voltages are galvanically insulated by the input transformers. The noise signals caused by inductive and capacitive coupling are supressed by an analog R-C filter circuit.

The analog voltage signals are fed to the A/D-converter of the microprocessor and transformed to digital signals through Sample- and Hold- circuits. The analog signals are sampled with a sampling frequency of 16 x f_N, namely, a sampling rate of 1.25 ms for every measuring quantity, at 50 Hz.

4.2 Digital circuits

The essential part of the *MRN3* relay is a powerful microcontroller. All of the operations, from the analog digital conversion to the relay trip decision, are carried out by the microcontroller digitally. The relay program is located in an EPROM (Electrically-Programmable-Read-Only-Memory). With this program the CPU of the microcontroller calculates the three phase voltage in order to detect a possible fault situation in the protected object.

For the calculation of the voltage value an efficient digital filter based on the Fourier Transformation (DFFT - Discrete Fast Fourier Transformation) is applied to suppress high frequency harmonics and d.c. components caused by fault-induced transients or other system disturbances. The microprocessor continuously compares the measured values with the preset thresholds stored in the parameter memory (EEPROM). If a fault occures an alarm is given and after the set tripping delay has elapsed, the corresponding trip relay is activated.

The relay setting values for all parameters are stored in a parameter memory (EEPROM - Electrically Erasable Programmable Read Only Memory), so that the actual relay settings cannot be lost, even if the power supply is interrupted.
The microprocessor is supervised by a built-in "watchdog" timer. In case of a failure the watchdog timer resets the microprocessor and gives an alarm signal via the output relay "self supervision".

4.3 Voltage supervision

The voltage element of *MRN3* has the application in protection of generators, consumers and other electrical equipment against over-/and undervoltage.
The relay is equipped with a two step independent three-phase overvoltage (U>, U>>) and undervoltage (U<, U<<) function with completely separate time and voltage settings.
In delta connection the phase-to-phase voltages and in star connection the phase-to-neutral voltages are continuously compared with the preset thresholds.

For the overvoltage supervision the highest, for the undervoltage supervision of the lowest voltage of the three phases are decisive for energizing.

4.3.1 Selection of star or delta connection

All connections of the input voltage transformers are led to screw terminals. The nominal voltage of the device is equal to the nominal voltage of the input transformers. Dependent on the application the input transformers can be connected in either delta or star. The connection for the phase-to-phase voltage is the delta connection. In star connection the measuring voltage is reduced by $1/\sqrt{3}$. During parameter setting the connection configuration either Y or Δ has to be adjusted.

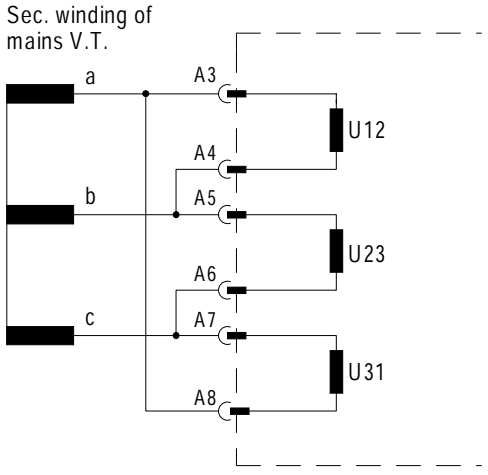


Figure 4.1: Input v.t.s in delta connection (Δ)

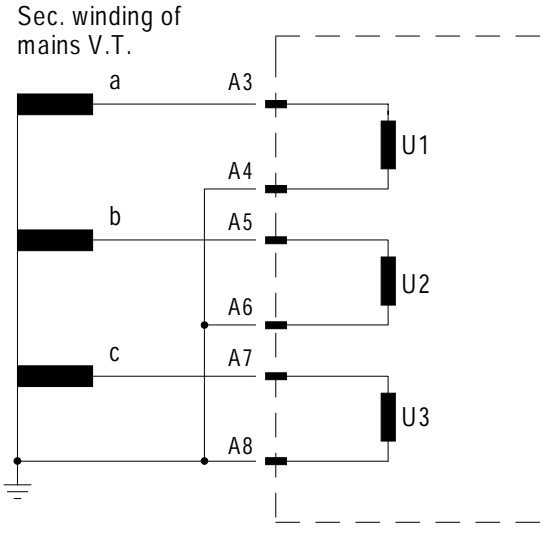


Figure 4.2: Input v.t.s in star connection (Y)

4.4 Principle of frequency supervision

The frequency element of *MRN3* protects electrical generators, consumers or electrical operating equipment in general against over- or underfrequency.
The relay has independent three frequency elements f_1 - f_3 with a free choice of parameters, with separate adjustable pickup values and delay times.

The measuring principle of the frequency supervision is based in general on the time measurement of complete cycles, whereby a new measurement is started at each voltage zero passage. The influence of harmonics on the measuring result is thus minimized.

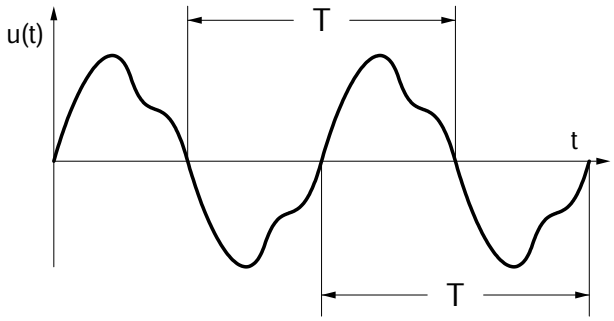


Figure 4.3: Determination of cycle duration by means of zero passages.

In order to avoid false tripping during occurence of interference voltages and phase shifts the relay works with an adjustable measuring repetition. (refer to chapter 5.4.2)

Frequency tripping is sometimes not desired by low measured voltages which for instance occur during alternator acceleration. All frequency supervision functions can be blocked with the aid of an adjustable voltage threshold U_B in case the measured voltages value is below this value.

4.5 Measuring of frequency gradient (*MRN3-2*)

Electrical generators running in parallel with the mains, e.g. industrial internal power supply plants, should be separated from the mains when failure in the intrasystem occurs for the following reasons:

- It must be prevented that the electrical generators are damaged when mains voltage recovering asynchrone, e.g. after a short interruption.
- The industrial internal power supply must be maintained.

A reliable criterion of detecting mains failure is the measurement of the rate of change of frequency df/dt. Precondition for this is a load flow via the mains coupling point. At mains failure the load flow changing then spontaneously leads to an increasing or decreasing frequency. At active power deficit of the internal power station a linear drop of the frequency occurs and a linear increase occurs at power excess. Typical frequency gradients during application of "mains decoupling" are in the range of 0.5 Hz/s up to over 2 Hz/s. The *MRN3* detects the instantaneous frequency gradient df/dt of each mains voltage period in an interval of one half period each. Through multiple evaluation of the frequency gradient in sequence the continuity of the directional change (sign of the frequency gradient) is determined. Because of this special measuring procedure a high safety in tripping and thus a high stabilty against transient processes, e.g. switching procedure are reached. The total switching off time at mains failure is between 60 ms and 80 ms depending on the setting.

4.6 Vector surge supervision (*MRN3-1*)

The vector surge supervision protects synchronous generators in mains parallel operation due to very fast decoupling in case of mains failure. Very dangerous are mains auto reclosings for synchronous generators. The mains voltage returning after 300 ms can hit the generator in asynchronous position. A very fast decoupling is also necessary in case of long time mains failures. Generally there are two different applications:

a) Only mains parallel operation no single operation:
In this application the vector surge supervision protects the generator by tripping the generator circuit breaker in case of mains failure.

b) Mains parallel operation and single operation:
For this application the vector surge supervision trips the mains circuit breaker. Here it is insured that the gen.-set is not blocked when it is required as the emergency set.

A very fast decoupling in case of mains failures for synchronous generators is known as very difficult. Voltage supervision units cannot be used because the synchronous alternator as well as the consumer impedance support the decreasing voltage.

For this the mains voltage drops only after some 100 ms below the pickup threshold of voltage supervision relays and therefore a safe detection of mains auto reclosings is not possible with this kind of relay.

Frequency relays are partial unsuitable because only a highly loaded generator decreases its speed within 100 ms. Current relays detect a fault only when short-circuit type currents exist, but cannot avoid their development. Power relays are able to pickup within 200 ms, but they cannot prevent power to rise to short-circuit values too. Since power changes are also caused by sudden loaded alternators, the use of power relays can be problematic.

Whereas the *MRN3-1* detects mains failures within 60 ms without the restrictions described above because they are specially designed for applications where very fast decoupling from the mains is required.

Adding the operating time of a circuit breaker or contactor, the total disconnection time remains below 150 ms. Basic requirement for tripping of the generator/mains monitor is a change in load of more than 15 - 20% of the rated load. Slow changes of the system frequency, for instance at regulating processes (adjustment of speed regulator) do not cause the relay to trip.

Trippings can also be caused by short-circuits within the grid, because a voltage vector surge higher than the preset value can occur. The magnitude of the voltage vector surge depends on the distance between the short-circuit and the generator. This function is also of advantage to the Power Utility Company because the mains short-circuit capacity and consequently the energy feeding the short-circuit is limited.

To prevent a possible false tripping the vector surge measuring can be blocked at a set low input voltage (refer to 5.4.7). The undervoltage lockout acts faster then the vector surge measurement.

Vector surge tripping is blocked by a phase loss so that a VT fault (e.g. faulty VTs fuse) does not cause false tripping.
When switching on the aux. voltage or measuring voltage , the vector surge supervision is blocked for 5 s (refer to chapter 4.8).

Note:
In order to avoid any adverse interference voltage effects, for instance from contactors or relays, which may cause overfunctions, *MRN3-1* should be connected separately to the busbar.

4.6.1 Measuring principle of vector surge supervision

When a synchronous generator is loaded, a rotor displacement angle is build between the terminal voltage (mains voltage U1) and the synchronous internal voltage (Up). Therefore a voltage is difference ΔU is built between Up and U1 (Fig. 4.4).

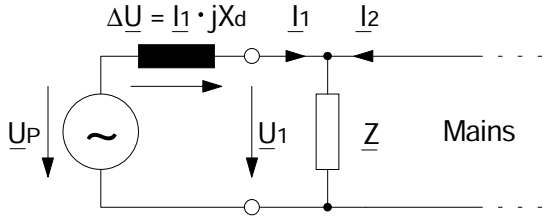


Figure 4.4: Equivalent circuit at synchronous generator in parallel with the mains

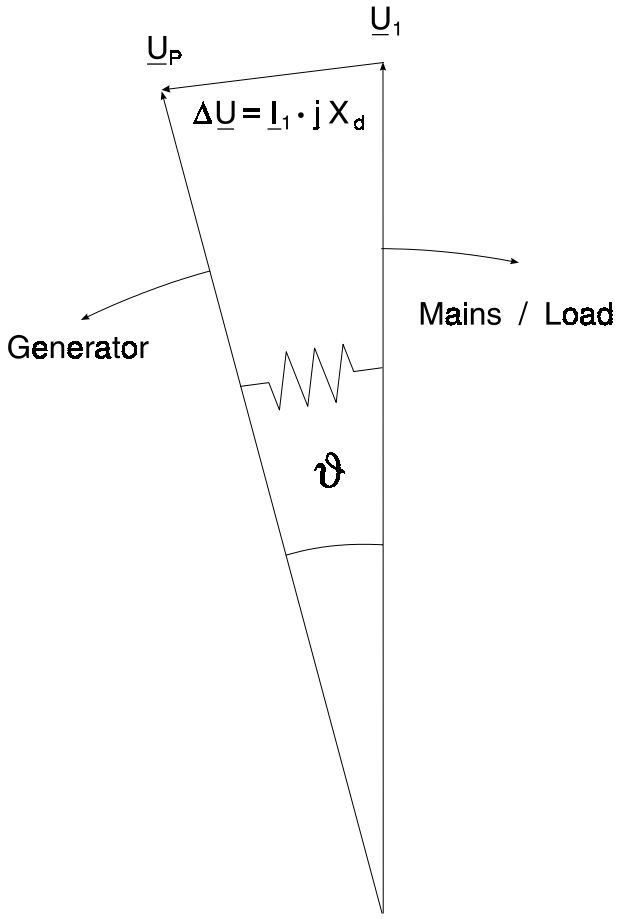


Figure 4.5: Voltage vectors at mains parallel operation

The rotor displacement angle ϑ between stator and rotor is depending of the mechanical moving torque of the generator shaft. The mechanical shaft power is balanced with the electrical feeded mains power, and therefore the synchronous speed keeps constant (Fig. 4.5).

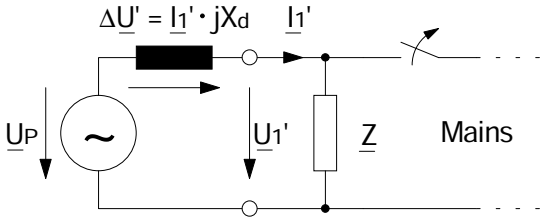


Figure 4.6: Equivalent circuit at mains failure

In case of mains failure or auto reclosing the generator suddenly feeds a very high consumer load. The rotor displacement angle is decreased repeatedly and the voltage vector $\underline{U}_1$ changes its direction ($\underline{U}_1$') (Fig. 4.6 and 4.7).

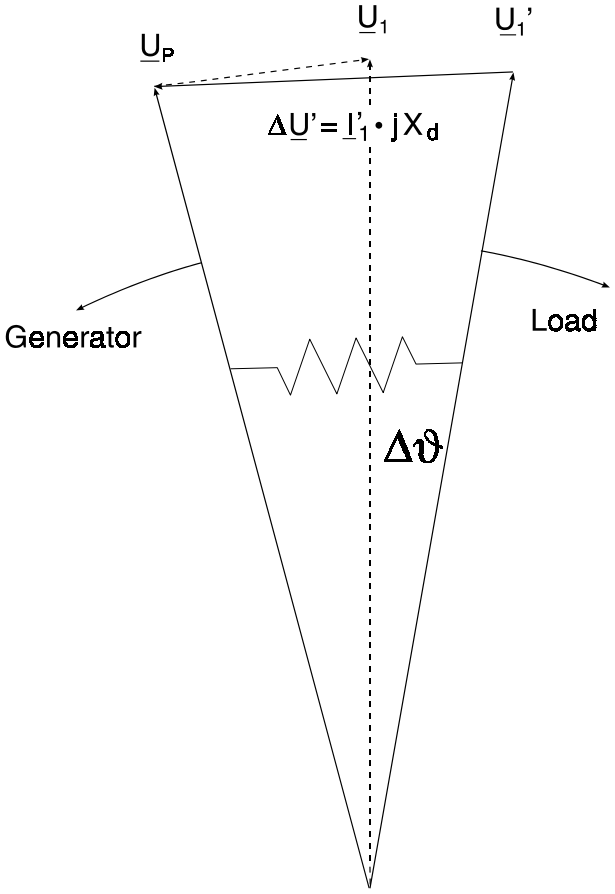


Figure 4.7: Voltage vectors at mains failure

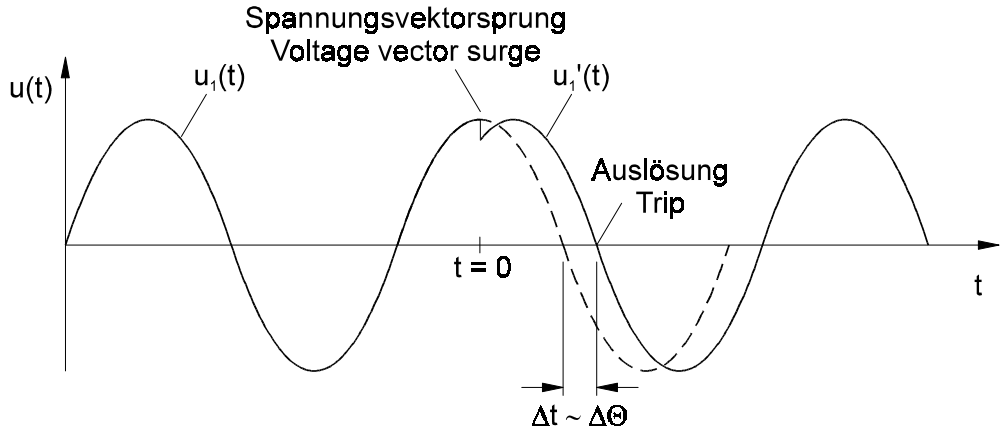


Figure 4.8: Voltage vector surge

As shown in the voltage/time diagram the instantaneous value of the voltage jumps to another value and the phase position changes. This is named phase or vector surge.

The *MRN3-1* measures the cycle duration. A new measuring is started at each voltage zero passage. The measured cycle duration is internally compared with a quartz stable reference time and from this the deviation of the cycle duration of the voltage signal is ascertained. In case of a vector surge as shown in fig. 4.8, the zero passage occurs either earlier or later. The established deviation of the cycle duration is in compliance with the vector surge angle.
If the vector surge angle exceeds the set value, the relay trips immediately.

Tripping of the vector surge is blocked in case of loss of one or more phases of the measuring voltage.

Tripping logic for vector surge measurement:

The vector surge function of the *MRN3-1* supervises vector surges in all three phases at the same time. Tripping of the relay can be adjusted for an one phase vector surge (more sensitive measurement). For this the parameter 1/3 has to be set to "1Ph". When the parameter 1/3 is set to "3Ph", tripping of the vector surge element occurs only if the vector surge angle exceeds the set value in all three phases at the same time.

Application hint

Although the vector surge relay guarantees very fast and reliable detection of mains failures under nearly all operational conditions of mains parallel running alternators, the following borderline cases have to be considered accordingly:

a) None or only insignificant change of power flow at the utility connection point during mains failures.

This can occure during peak lopping operation or in CHP stations (Combined Heat and Power) where the power flow between power station and the public grid may be very low. For detection of a vector surge at parallel running alternators, the load change must be at least 15 - 20% of the rated power. If the active load at the utility connection point is regulated to a minimal value and a high resistance mains failure occurs, then there are no vector surge nor power and frequency changes and the mains failure is not detected.

This can only happen if the public grid is disconnected near the power station and so the alternators are not additionally loaded by any consumers. At distant mains failures the synchronous alternators are abruptly loaded by remaining consumers which leads directly to a vector surge and so mains failure detection is guaranteed.
If such a situation occurs the following has to be taken into account:

In case of an undetected mains failure, i.e. with the mains coupling C.B. closed, the vector surge relay reacts upon the first load change causing a vector surge and trips the mains C.B.

For detecting high resistance mains failures a minimum current relay with an adjustable trip delay can be used. A trip delay is needed to allow regulating actions where the current may reach "zero" at the utility connection point. At high resistance mains failures, the mains coupling C.B. is tripped by the minimum current relay after the time delay.

To prevent asynchronous switching on, an automatic reclosing of the public grid should be not possible during this time delay.

A further measure could be, that the load regulation at the utility connection point guarantees a minimum power flow of 15 - 20% of rated power.

b) Short circuit type loading of the alternators at distant mains failures

At any distant mains failure, the remaining consumers cause sudden short circuit type loading of the power station generators. The vector surge relay detects the mains failure in about 60 ms and switches off the mains coupling C.B. The total switch off time is about 100 - 150 ms. If the generators are provided with an extremely fast short circuit protection e.g. able to detect di/dt, the alternators might be switched off unselectively by the generator C.B., which is not desireable because the power supply for the station is endangered and later on synchronized changeover to the mains is only possible after manual reset of the overcurrent protection.

To avoid such a situation, the alternator C.B.s must have a delayed short circuit protection. The time delay must be long enough so that mains decoupling by the vector surge relay is guaranteed.

4.7 Voltage threshold value for frequency measuring

At low measuring voltages, e.g. during generator start-up, frequency and vector surge or df/dt-measuring is perhaps not desired.

By means of the adjustable voltage threshold value $U_B<$, functions f_1 - f_3, df/dt or $\Delta\Theta$ are blocked if the measured voltage falls below the set value.

4.8 Blocking function

No.	Dynamic Behaviour	U</<<	U>/>>	f_1, f_2, f_3	$\Delta\Theta$	df/dt
1	voltage to external blocking input is applied	free programmable	free programmable	free programmable	free programmable	free programmable
2	blocking input is released	released instantaneously	released instantaneously	released after 1 s	released after 5 s	released after 5 s
3	supply voltage is switched on	blocked for 200 ms	blocked for 200 ms	blocked for 1 s	blocked for 1 s	blocked for 1 s
4	3ph measuring volt. is suddenly applied	released	released	blocked for 1 s	blocked for 5 s	blocked for 5 s
5	one or several measuring voltages are switched off suddenly (phase failure)	released	released	blocked	blocked	blocked
6	measuring voltage smaller $U_B<$ (adjustable voltage threshold value)	released	released	blocked	blocked	blocked

*Table 4.1: Dynamic behaviour of **MRN3** functions*

Blocking function set in compliance with requirements:

The *MRN3* has an external blocking input. By applying the auxiliary voltage to input D8/E8, the requested protection functions of the relay are blocked (refer to 5.7.1).

5 Operation and setting

5.1 Display

Function	Display shows	Pressed pushbutton	Corresponding LED	Type of relay
Normal operation	|SEG			all types
Measured operating values	Actual measured value Min. and max. values of voltage, frequency and vector surge	<SELECT/RESET> one time for each value	L1, L2, L3, f, min, max ΔΘ df	 MRN3-1 MRN3-2
Transformer ratio of the CT's	(SEK) 1.01 – 6500 = prim	<SELECT/RESET><+><->	L1, L2, L3	
Setting values: star/delta connection	Y/DELT	<SELECT/RESET><+><->	Δ/Y	
Parameter switch/ext. Trigger for FR	SET1, SET2, B_S2, R_S2, B_FR, R_FR, S2_FR	<SELECT/RESET><+><->	P2	
Switch-over LED flash No LED flash	FLSH NOFL	<SELECT/RESET><+><->		
undervoltage (low set) tripping delay of low set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U< $t_{U<}$	
undervoltage (high set) tripping delay of high set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U<< $t_{U<<}$	
overvoltage (low set) tripping delay of low set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U> $t_{U>}$	
overvoltage (high set) tripping delay of high set element	setting value in volt setting value in seconds	<SELECT/RESET><+><-> one time for each value	U>> $t_{U>>}$	
rated frequency	setting value in Hz	<SELECT/RESET><+><->	f_N	
frequency measuring repitition	setting value	<SELECT/RESET><+><->	T	
frequency element f_1 tripping delay of frequency element f_1	setting value in Hz setting value in seconds	<SELECT/RESET><+><-> one time for each value	f_1 t_{f1}	
frequency element f_2 tripping delay of frequency element f_2	setting value in Hz setting value in seconds	<SELECT/RESET><+><-> one time for each value	f_2 t_{f2}	
frequency element f_3 tripping delay of frequency element f_3	setting value in Hz setting value in seconds	<SELECT/RESET><+><-> one time for each value	f_3 t_{f3}	
1-of-3/3-of-3 measurement	1Ph/3Ph	<SELECT/RESET><+><->	1/3	MRN3-1
threshold for vector surge	setting value in degree	<SELECT/RESET><+><->	ΔΘ	MRN3-1
setting value df/dt measuring repitition df/dt	setting value in Hz/s setting value in periods	<SELECT/RESET><+><-> one time for each value	df dt	MRN3-2
Blocking	EXIT	<+> until max. setting value	LED of blocked parameter	
Undervoltage blocking of frequency and vector surge measuring (df/dt for *MRN3-2*)	setting value in Volt	<SELECT/RESET><+><->	f, ΔΘ, df	
Slave address of serial interface	1 - 32	<SELECT/RESET><+><->	RS	
Baud-Rate [1]	1200-9600	<SELECT/RESET> <+><->	RS	
Parity-Check [1]	even odd no	<SELECT/RESET> <+><->	RS	
Recorded fault data: star–connection: U1, U2, U3	tripping values in Volt	<SELECT/RESET><+><-> one time for each phase	L1, L2, L3, U<, U<<, U>, U>>	
delta-connection: U12, U23, U31	tripping values in Volt	<SELECT/RESET><+><-> one time for each phase	L1, L2, L3 U<, U<<, U>, U>>	
frequency	tripping values in Hz	<SELECT/RESET><+><-> one time for each phase	f, f1, f2, f3	
rate of change of frequency	tripping value in Hz/s	<SELECT/RESET><+><->	df	MRN3-2
vector surge	tripping value in degree	<SELECT/RESET><+><-> one time for each phase	ΔΘ + L1, L2 or L3	MRN3-1
Delete failure memory	wait	<-> <SELECT/RESET>		

[1] only Modbus

Function	Display shows	Pressed pushbutton	Corresponding LED	Type of relay
Enquiry failure memory	FLT1; FLT2.....	<-><+>	L1, L2, L3, U<, U<<, U>, U>>, f, Ddf/dt, ΔΘ	
Save parameter?	SAV?	<ENTER>		
Save parameter!	SAV!	<ENTER> for about 3 s		
Trigger signal for the fault recorder	TEST, P_UP, A_PI, TRIP	<SELECT/RESET> <+><->	FR	
Number of fault occurences	S = 2, S = 4, S = 8	<SELECT/RESET> <+><->	FR	
Display of date and time	Y = 99, M = 10, D = 1, h = 12, m = 2, s = 12	<SELECT/RESET> <+><->	◷	
Software version	First part (e.g. D02-) Sec. part (e.g. 6.01)	<TRIP> one time for each part		
Manual trip	TRI?	<TRIP> three times		
Inquire password	PSW?	<SELECT/RESET>/ <+>/<->/<ENTER>		
Relay tripped	TRIP	<TRIP> or fault tripping		
Secret password input	XXXX	<SELECT/RESET>/ <+>/<->/<ENTER>		
System reset	|SEG	<SELECT/RESET> for about 3 s		

Table 5.1: Possible indication messages on the display

5.2 Setting procedure

In this paragraph the settings for all relay parameters are described in detail. For parameter setting a password has to be entered first (please refer to 4.4 of description "*MR*-Digital Multifunctional Relays").

5.3 Systemparameter

5.3.1 Display of residual voltage U_E as primary quantity (U_{prim}/U_{sec})

The residual voltage can be shown as primary measuring value. For this parameter the transformation ratio of the VT has to be set accordingly. If the parameter is set to "sek", the measuring value is shown as rated secondary voltage.

Example:
The voltage transformer used is of 10 kV/100 V. The transformation ratio is 100 and this value has to be set accordingly. If still the rated secondary voltage should be shown, the parameter is to be set to 1.

5.3.2 Δ/Y – Switch over

Depending on the mains voltage conditions, the input voltage transformers can be operated in delta or Y connection. Change-overs are effected via the <+> and the <-> keys and stored with <ENTER>.

5.3.3 Setting of nominal frequency

For proper functioning it is necessary to first adjust the rated frequency (50 oder 60 Hz).

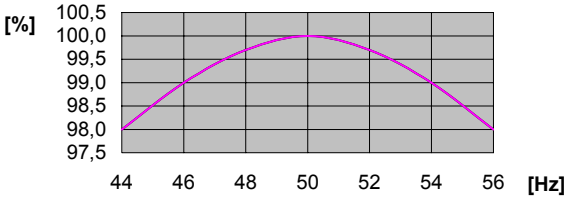
For this a distinction has to be made between the settings v = 50 Hz / f = 50 Hz or v = 60 Hz / f = 60 Hz
The difference lies in the method of voltage measuring. With the setting "v" = 50/60 Hz voltage measuring is independent of the existing frequency. This means, the voltage value can be correctly measured between 30 Hz and 80 Hz without adverse effects from the frequency.

With the setting "f" = 50/60 Hz the measured voltage value is influenced by the frequency. (see Table 5.2)

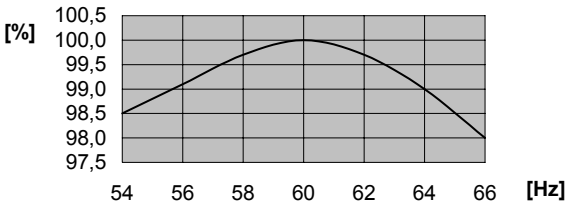
This difference in settings is required for the fault recorder. If the fault recorder is to be used, the setting must be f = 50 Hz or f = 60 Hz.
The different designations "f" or "v" have no influence on any of the other functions.

All frequency functions are determined by setting the nominal frequency, i.e. whether the set frequency thresholds are evaluated as over- or underfrequency (see also chapter 5.4.4). Also the cycle duration (20 ms at 50 Hz and 16.67 ms at 60 Hz) derives from this setting which determines the minimum tripping delay for frequency elements f_1 - f_3 with an adjustable multiplier (see also chapter 5.4.5).
During setting of the nominal frequency a value in Hz is shown on the display.

Declination of measuring value at 50Hz



Declination of measuring value at 60Hz



Setting	v = 50	f = 50	v = 60	f = 60
Rated frequency	50 Hz	50 Hz	60 Hz	60 Hz
Influence on voltage measurement	none	0.5..1%/Hz (see table 5.2)	none	0.5..1%/Hz (see table 5.2)
Fault recorder	Recording distorted**	Recording correct***	Recording distorted**	Recording correct***
Influence on all other functions	none	none	none	none

Table 5.2: Deviation of measured value at 50 or 60 Hz

* Setting is important for differentiation between over- and underfrequency
** Sample rate is variably adjusted to the momentarily measured frequency. 16 samples are always measured in one period.
*** Sample rate setting is fixed to 50 Hz or 60 Hz. 16 samples per 20 ms or 16.67 ms are always measured.

5.3.4 Display of the activation storage (FLSH/NOFL)

If after an activation the existing current drops again below the pickup value, e.g. U<, without a trip has been initiated, LED U< signals that an activation has occured by flashing fast. The LED keeps flashing until it is reset again (push button <RESET>). Flashing can be suppressed when the parameter is set to NOFL.

5.3.5 Parameterswitch/external trigger for the fault recorder

By means of the parameter-change-over switches it is possible to activate two different parameter sets. Switching over of the parameter sets can either be done by means of software or via the external inputs RESET or blocking input. Alternatively, the external inputs can be used for Reset or blocking and for the triggering of the fault recorder.

Software-parameter	Blocking input used as	RESET input used as
SET1	Blocking input	RESET input
SET2	Blocking input	RESET input
B_S2	Parameter switch	RESET input
R_S2	Blocking input	Parameter switch
B_FR	External triggering of the fault recorder	Reset input
R_FR	Blocking input	External triggerung of the fault recorder
S2_FR	Parameter switch	External triggerung of the fault recorder

With the settings SET1 or SET2 the parameter set is activated by software. Terminals C8/D8 and D8/E8 are then available as external reset input or blocking input.

With the setting B_S2 the blocking input (D8, E8) is used as parameter-set change-over switch. With the setting R_S2 the reset input (D8, E8) is used as parameter-set change-over switch. With the setting B_FR the fault recorder is activated immediately by using the blocking input. On the front plate the LED FR will then light up for the duration of the recording. With the setting R_FR the fault recorder is activated via the reset input. With the setting S2_FR parameter set 2 can be activated via the blocking input and/or the fault recorder via the reset input. The relevant function is then activated by applying the auxiliary voltage to one of the external inputs.

With the setting R_FR the fault recorder is activated via the reset input. With the setting S2_FR parameter set 2 can be activated via the blocking input and/or the fault recorder via the reset input.
The relevant function is then activated by applying the auxiliary voltage to one of the external inputs.

Important note:
When functioning as parameter change over facility, the external input RESET is not available for resetting. When using the external input BLOCKING the protection functions must be deactivated by software blocking separately (refer to chapter 5.7.1).

5.4 Protection parameters

5.4.1 Parameter setting of over- and undervoltage supervision

The setting procedure is guided by two coloured LEDs. During setting of the voltage thresholds the LEDs U<, U<<, U> and U>> are lit green. During setting of the trip delays $t_{U>}$, $t_{U>>}$, $t_{U<}$ and $t_{U<<}$ the according LEDs light up red.

Thresholds of the voltage supervision

During setting of the threshold U>, U>>, U< and U<< the displays shows the voltages directly in volt. The thresholds can be changed by the <+> <-> push buttons and stored with <ENTER>.

The undervoltage supervision (U< and U<<) as well as the overvoltage supervision (U> and U>>) can be deactivated by setting the threshold to "EXIT".

Tripping delay of voltage supervision

During setting of the tripping delays $t_{U<}$, $t_{U<<}$, $t_{U>}$ and $t_{U>>}$ the display shows the value directly in seconds. The tripping delay is changed via the push button <+> and <-> in the range of 0,04 s to 50 s and can be stored with the push button <ENTER>.
When setting the tripping delay to "EXIT" the value is infinit meaning only warning, no tripping.

5.4.2 Number of measuring repetitions (T) for frequency functions

In order to avoid false tripping of the unit at short voltage drops of the system voltage or interference voltages, *MRN3* works with an adjustable measuring repetition. When the instantaneous frequency measuring value exceeds (at overfrequency) or falls below (at underfrequency) the set reference value, the counter is incremented, otherwise the counter is decremented down to the minimum value of 0. Only when the counter exceeds the value adjusted at T, alarm is given and after the tripping delay of the frequency element has elapsed the tripping command is given.
The setting range for T is between 2 - 99.

Recommendation for setting:
For short tripping times, e.g. for machine protection or for mains decoupling T should be set in the range from 2 - 5.
At precision measurements, e.g. exact measurement of the system frequency a setting of T in the range from 5 - 10 is recommended.

5.4.3 Threshold of frequency supervision

The frequency supervision of *MRN3* has three frequency elements independent from each other. Acc. to setting the pickup value above or below the nominal frequency, these elements can be used for over- or under frequency supervision.

Dependent on the preset nominal frequency f_N the pickup values from 30 Hz up to 70 Hz at f_N = 50 Hz and from 40 Hz to 80 Hz at f_N = 60 Hz can be set. During setting of the pickup values f_1 - f_3 the display shows the values in Hz. A value of for instance 49,8 Hz is indicated with "4980".

The function of the individual frequency elements can be deactivated by setting the pickup values to "EXIT". The setting value "EXIT" corresponds to the rated frequency.

5.4.4 Tripping delays for the frequency elements

Tripping delays t_{f1} - t_{f3} of the four frequency elements can be set independently from $t_{f1\,min}$ - 50 s. The minimum tripping delay $t_{f1\,min}$ of the relay depends upon the number of set measuring repetitions T (periods) and amounts to:

T	$t_{f\,min}$
2....49	(T+1)·20 ms
50....69	(T - 49)·50 ms + 1 s
70....99	(T - 69)·100 ms + 2 s

When setting the tripping delay to "EXIT" by pressing push button <+> up to the maximum setting value, the corresponding tripping relay is blocked. Pickup of the frequency element is however displayed on the front plate by the corresponding LED, an assigned alarm relay is also activated. This setting applies to 50 Hz and 60 Hz.

5.4.5 Parameter setting of vector surge supervision (*MRN3-1*)

Both the vector surge angle ΔΘ as well as the tripping logic concerning the vector surge have to be adjusted for a vector surge supervision.
If the tripping logic is set to 1-of-3 (= "1Ph" on the display), the relay trips as soon as the measured vector surge angle has exceeded the set value ΔΘ in one of the three phases. This is the more sensitive adjustment when compared with the three phase tripping logic 3-of-3 (= "3Ph" on the display), where tripping occurs only if the vector surge angle exceeds the set value in all three phases.

We recommend to choose the one phase tripping logic "1Ph". Only if this adjustment is too sensitive, adjustment "3Ph" should be used.

The recommended setting of the vector surge angle ΔΘ in a low impedance mains is 4 - 6 degrees. This setting is sufficient in most cases, because low impedance mains do not have a vector surge greater than this value. In case of an auto reclosing, this value is exceeded. In high impedance mains the setting should be 10° to 12° to avoid failure tripping when switching on or switching off big consumer loads.

The vector surge function of this device can be checked as follows:

a) Generator in isolated operation: Switching off and on of loads (approx. 20% of the nominal generator capacity) must trip the relay. Later in normal isolated operation the tripping of the relay is inhibited.

b) In mains parallel operation switching on and switching off of consumer loads and controlling the governor of the prime mover should not trip the relay.

If possible the test described under a) and b) should be double checked by a real auto reclosing.

Threshold for the vector surge supervision

When the pickup value of the vector surge supervision is set, a value in angular degree is indicated at the display. The pickup value requested can be adjusted by pushbuttons <+> and <-> in the range of 2° to 22°. LED ΔΘ lights up red during this procedure.

5.4.6 Parameter setting of frequency gradient (*MRN3-2*)

The pickup value of frequency gradient (parameter df) can be set between 0.2 to 10 Hz/s. The number of measuring repetitions (parameter dt) can be set between 2 - 64 cycles. This parameter defines the number of df/dt measurements, which have to exceed the set value, before tripping.

Setting information:
The power difference after mains failure causes a change in frequency, which can approximately be calculated as follows:

$$\frac{df}{dt} = -\frac{f_N}{T_A} \cdot \Delta P$$

with
f_N = rated frequency in Hz
T_A = starting time at rated torque
ΔP = per unit power deficit with reference to the rated active power of the generator

If the inertia time constant is known and a power difference given, the frequency gradient can be estimated by the a.m. equation. At a supposed power difference of 20% and an inertia time constant of 10 s, the frequency gradient is 1 Hz/s.

To prevent false trippings at loading, deloading or failure signals, we would recommend a setting value for dt of minimum 4 cycles.

5.4.7 Voltage threshold value for frequency and vector surge measuring (df/dt at *MRN3-2*)

Correct frequency measuring or vector surge measuring cannot be obtained if the system voltage is very low, for instance during generator start up or voltage failure. False tripping of the *MRN3* in such cases is prevented by an adjustable voltage threshold U_B. If the system voltage is below this threshold, these functions of the relay are blocked.
During adjustment of U_B< LEDs f and ΔΘ or df light up in the upper display part.

5.4.8 Adjustment of the slave address

By pressing push buttons <+> and <-> the slave address can be set in the range of 1 - 32. During this adjustment the LED RS lights up.

5.4.9 Setting of Baud-rate (applies for Modbus Protocol only)

Different transmission rates (Baud rate) can be set for data transmission via Modbus Protocol.
The rate can be changed by push buttons <+> and <-> and saved by pressing <ENTER>.

5.4.10 Setting of parity (applies for Modbus Protocol only)

The following three parity settings are possible :

- "even" = even
- "odd" = odd
- "no" = no parity check

The setting can be changed by push buttons <+> and <-> and saved by pressing <ENTER>.

5.5 Adjustment of the fault recorder

The *MRI3* is equipped with a fault recorder (see chapter 3.7). Three parameters can be determined.

5.5.1 Number of the fault recordings

The max. recording time is 16 s at 50 Hz or 13.33 s at 60 Hz.
The number of max. recordings requested has to be determined in advance. There is a choice of (1)* 2, (3)* 4 or (7)* 8 recordings and dependent on this the duration of the individual fault recordings is defined, i.e.

(1)* 2 recordings for a duration of 8 s (with 50 Hz) (6.66 s with 60 Hz)
(3)* 4 recordings for a duration of 4 s (with 50 Hz) (3.33 s with 60 Hz)
(7)* 8 recordings for a duration of 2 s (with 50 Hz) (1,66 s with 60 Hz)
* is written over when a new trigger signal arrives

Caution:
If the fault recorder is used, the frequency should be set to f = 50 Hz or f = 60 Hz (see chapter 5.3.3).

5.5.2 Adjustment of trigger occurences

There is a choice between four different occurences:

P_UP (PickUP)	Storage is initiated after recognition of a general activation.
TRIP	Storage is initiated after a trip has occured.
A_PI (After Pickup)	Storage is initiated after the last activation threshold was fallen short of.
TEST	Storing is activated by simultaneous actuation of the keys <+> and <->. During the recording time the display shows "Test".

5.5.3 Pre-trigger time (T_{pre})

By the time T_{pre} it is determined which period of time prior to the trigger occurence should be stored as well. It is possible to adjust a time between 0.05s and the max. recording interval (2, 4 and 8s). With keys <+> and <-> the values can be changed and with <ENTER> be saved.

5.6 Adjustment of the clock

When adjusting the date and time, LED ◷ lights up.
The adjustment method is as follows:

Date :	Year	Y=00
	Month	M=00
	Day	D=00
Time :	Hour	h=00
	Minute	m=00
	Second	s=00

The clock starts with the set date and time as soon as the supply voltage is switched on. The time is safeguarded against short-term voltage failures (min. 6 minutes).

Note:
The window for parameter setting is located behind the measured value display. The parameter window can be accessed via the <SELECT/RESET> key.

5.7 Additional functions

5.7.1 Setting procedure for blocking the protection functions

The blocking function of the *MRN3* can be set according to requirement. By applying the aux. voltage to D8/E8, the functions chosen by the user are blocked. Setting of the parameter should be done as follows:

- When pressing push buttons <ENTER> and <TRIP> at the same time, message "BLOC" is displayed (i.e. the respective function is blocked) or "NO_B" (i.e. the respective function is not blocked). The LED allocated to the first protection function U< lights red.
- By pressing push buttons <+> <-> the value displayed can be changed.
- The changed value is stored by pressing <ENTER> and entering the password.
- By pressing the <SELECT/RESET> push button, any further protection function which can be blocked is displayed.
- Thereafter the menu is left by pressing <SELECT/RESET> again.
- If the <SELECT/RESET> key is actuated again, the blocking menu is left and the assignment mode is accessed^.

Function	Description	Display	LED
U<	Undervoltage step 1	BLOC	red
U<<	Undervoltage step 2	BLOC	red
U>	Overvoltage step 1	NO_B	red
U>>	Overvoltage step 2	NO_B	red
f1	Frequency step 1	BLOC	red
f2	Frequency step 2	BLOC	rec
f3	Frequenzstufe 3	NO_B	red
ΔΘ	Vector surge	BLOC	red
df/dt	Frequency changing rate	BLOC	red

Table 5.3: Blockadefunktion für twei Parametersätze

Assignment of the output relays:
Unit *MRN3* has five output relays. The fifth output relay is provided as permanent alarm relay for self supervision is normally on. Output relays 1 - 4 are normally off and can be assigned as alarm or tripping relays to the voltage functions which can either be done by using the push buttons on the front plate or via serial interface RS485. The assignment of the output relays is similar to the setting of parameters, however, only in the assignment mode. The assignment mode can be reached only via the blocking mode.
By pressing push button <SELECT/RESET> in blocking mode again, the assignment mode is selected.

The relays are assigned as follows: LEDs U<, U<<, U> and U>>, f1, f2, f3 are two-coloured and light up green when the output relays are assigned as alarm relays and $t_{U<}$, $t_{U<<}$, $t_{U<}$, $t_{U<<}$, tf1, tf2, tf3 df/dt and ΔΘ red as tripping relays.

Definition:
Alarm relays are activated at pickup.
Tripping relays are only activated after elapse of the tripping delay.

After the assignment mode has been activated, first LED U< lights up green. Now one or several of the four output relays can be assigned to under voltage element U< as alarm relays. At the same time the selected alarm relays for under voltage element 1 are indicated on the display. Indication "1_ _ _" means that output relay 1 is assigned to this under voltage element. When the display shows "_ _ _ _", no alarm relay is assigned to this under voltage element. The assignment of output relays 1 - 4 to the current elements can be changed by pressing <+> and <-> push buttons. The selected assignment can be stored by pressing push button <ENTER> and subsequent input of the password. By pressing push button <SELECT/RESET>, LED U< lights up red. The output relays can now be assigned to this voltage element as tripping relays.

Relays 1 - 4 are selected in the same way as described before. By repeatedly pressing of the <SELECT/RESET> push button and assignment of the relays all elements can be assigned separately to the relays. The assignment mode can be terminated at any time by pressing the <SELECT/RESET> push button for some time (abt. 3 s).

Note:
- The function of jumper J2 described in general description "MR Digital Multifunctional Relays" does not apply for *MRN3*. For relays without assignment mode this jumper is used for parameter setting of alarm relays (activation at pickup or tripping).

A form is attached to this description where the setting requested by the customer can be filled-in. This form is prepared for telefax transmission and can be used for your own reference as well as for telephone queries.

Relay function		Output relays				Display-	Corresponding
		1	2	3	4	Indication	LED
U<	alarm		X			_ 2 _ _	U<; green
tU<	tripping	X				1 _ _ _	tU< red
U<<	alarm		X			_ 2 _ _	U<< green
tU<<	tripping	X				1 _ _ _	tU<< red
U>	alarm		X			_ 2 _ _	U> green
tU>	tripping	X				1 _ _ _	tU> red
U>>	alarm		X			_ 2 _ _	U>> green
tU>>	tripping	X				1 _ _ _	tU>> red
f1	alarm			X		_ _ 3 _	f1 green
tf1	tripping	X				1 _ _ _	tf1 red
f2	alarm			X		_ _ 3 _	f2 green
tf2	tripping	X				1 _ _ _	tf2 red
f3	alarm			X		_ _ 3 _	f3 green
tf3	tripping	X				1 _ _ _	tf3 red
$\Delta\Theta$	tripping				X	_ _ _ 4	$\Delta\Theta$ red
df/dt	tripping				X	_ _ _ 4	df/dt red

Tabelle 5.4: Example of assignment matrix of the output relay (default settings).

5.8 Indication of measuring values

5.8.1 Measuring indication

In normal operation the following measuring values can be displayed.

Voltages (LED L1, L2, L3 green)
- In star connection all phase-to-neutral voltages
- In delta connection all phase-to-phase voltages

Frequency (LED f green *MRN3-1*)
Vector surge (LED $\Delta\Theta$ green)
Frequency gradient df/dt (LED df green; *MRN3-2*)

Min. and max. values prior to the last reset:
- Frequency (LED f + min or f + max)
- Vector surge (LED $\Delta\Theta$ + min or $\Delta\Theta$ + max)
- Frequency gradient (LED df + min or df + max)

5.8.2 Min./Max.- values

The *MRN3* offers a minimum/maximum storage each for the measuring values of the vector surge as well as the frequency gradient. These min./max. values are mainly used to appraise the system quality. Always the highest and lowest values of each cycle are measured and stored until the next reset.

Min./max. frequency measuring:
The *MRN3* ascertains the actual frequency from each cycle of the system voltage. These measuring values are entered into the min./max. storage. The latest entered min./max. values replace the previously stored values.

Dependent on the adjustment of dt and tripping delay, it is possible that the stored min./max. values are higher than the tripping threshold without causing a trip. The reason for this is storage of instantaneous values.

Min./Max. measuring of the frequency gradient:
The procedure described above applies also to storage of min./max. values of df/dt measurement. Since each instantaneous df/dt value is stored, high values can occur which, however, do not cause any tripping.

This can for instance happen during switching procedures where high positive and negative df/dt values occur, but they do not cause any tripping due to the special measuring method.

Min./max. vector surge measuring :
The procedure described above applies also to storage of min./max. values of vector surge measuring. Since each instantaneous $\Delta\Theta$ value is stored, also here high values are possible which, however, do not cause any tripping.

These min./max. measurements are of great advantage for long-time analysis of the grid quality.

As to operation :
After each reset (ref. 5.9.1) the min./max. storages are cleared. As from this instant there is no time limit for the min./max. storage until the next reset.
By repeatedly pressing the <SELECT/RESET> push button, the measuring values of the min./max. storage can be queried. The respective LEDs light up at the same time; e.g. during minimum frequency is displayed, LEDs "f" and "min" light up.

5.8.3 Unit of the measuring values displayed

The measuring values can optionally be shown in the display as a multiple of the "sec" rated value (x In) or as primary current (A). According to this the units of the display change as follows:

Indication as	Range	Unit
sec. voltage	000V – 999V	V
primary voltage	.000 – 999V	V
	1K00 – 9K99	KV
	10K0 – 99K9	KV
	100K – 999K	KV
	1M00 – 3M00	MV

Table 5.5: Units of the display

5.8.4 Indication of fault data

All faults detected by the relay are indicated on the front plate optically. For this purpose, the four LEDs (L1, L2, L3, f) and the four function LEDs (U<, U<<, U>, U>>, f1, f2, f3, $\Delta\Theta$ und df/dt) are equipped at *MRN3*. Not only fault messages are transmitted, the display also indicates the tripped protection function. If, for example an overcurrent occurs, first the respective phase LED will light up. LED I> lights up at the same time. After tripping the LEDs are lit permanently.

5.9 Fault memory

When the relay is energized or is energized or trips, all fault data and times are stored in a non-volatile memory manner. The *MRN3* is provided with a fault value recorder for max. five fault occurrences. In the event of additional trippings always the oldest data set is written over.

For fault indication not only the trip values are recorded but also the status of LEDs. Fault values are indicated when push buttons <-> or <+> are pressed during normal measuring value indication.

- Normal measuring values are selected by pressing the <SELECT/RESET> button.
- When then the <-> button is pressed, the latest fault data set is shown. By repeated pressing the <-> button the last but one fault data set is shown etc. For indication of fault data sets abbreviations FLT1, FLT2, FLT3, ... are displayed (FLT1 means the latest fault data set recorded). At the same time the parameter set active at the occurence is shown.
- By pressing <SELECT/RESET> the fault measuring values can be scrolled.
- By pressing <+> it can be scrolled back to a more recent fault data set. At first FLT8, FLT7, ... are always displayed.When fault recording is indicated (FLT1 etc), the LEDs flash in compliance with the stored trip information, i.e. those LEDs which showed a continuous light when the fault occured are now blinking blinking to indicate that it is not a current fault. LEDs which were blinking blinking during trip conditions, (element had picked up) just briefly flash.
- If the relay is still in trip condition and not yet reset (TRIP is still displayed), no measuring values can be shown.
- To delete the trip store, the push button combination <SELECT/RESET> and <->, has to be pressed for about 3s. The display shows "wait".

Recorded fault data:

Measuring	Displayed value	Corresponding LED
Voltage	L1; L2; L3; L1/L2; L2/L3; L3/L1	L1; L2; L3
Frequency	f; f min f max	f; min; max
Frequency changing rate	df	df
Vektorsprung	$\Delta\Theta$	$\Delta\Theta$
Time stamp		
Date:	Y = 99	🕒
	M = 03	🕒
	D = 10	🕒
Time:	h = 17	🕒
	m = 21	🕒
	s = 14	🕒

5.9.1 Reset

All relays have the following three possibilities to reset the display of the unit as well as the output relay at jumper position J3=ON.

Manual Reset
- Pressing the push button <SELECT/RESET> for some time (about 3 s)

Electrical Reset
- Through applying auxiliary voltage to C8/D8

Software Reset
- The software reset has the same effect as the <SELECT/RESET> push button (see also communication protocol of RS485 interface)

The display can only be reset when the pickup is not present anymore (otherwise "TRIP" remains in display).

During resetting of the display the parameters are not affected.

5.9.2 Erasure of fault storage

To delete the trip store, the push button combination <SELECT/RESET> and <->, has to be pressed for about 3s. The display shows "wait".

6 Relay testing and commissioning

The following test instructions should help to verify the protection relay performance before or during commissioning of the protection system. To avoid a relay damage and to ensure a correct relay operation, be sure that:

- The auxiliary power supply rating corresponds to the auxiliary voltage on site.
- The rated frequency and rated voltage of the relay correspond to the plant data on site.
- The voltage transformer circuits are connected to the relay correctly.
- All signal circuits and output relay circuits are connected correctly.

6.1 Power-On

NOTE!
Prior to switch on the auxiliary power supply, be sure that the auxiliary supply voltage corresponds to the rated data on the type plate.

Switch on the auxiliary power supply to the relay and check that the message "ISEG" appears on the display and the self supervision alarm relay (watchdog) is energized (Contact terminals D7 and E7 closed).
It may happen that the relay is tripped because of under- voltage condition after power-on. (The message "TRIP" on the display and LED L1, L2, L3 and U< light up red). An undervoltage condition has been detected after power-on, because no input voltages are applied to the relay. In this case:

- Press the push button <ENTER>, thus entering into the setting mode. Now set the parameters U< and U<< to "EXIT" to block the undervoltage functions. After that, press the <SELECT/RESET> for app. 3 s to reset the LEDs and "TRIP" message.
- The undervoltage tripping after power on can also be eliminated by applying three phase rated voltages after power-on and reset the LED and "TRIP" message.
- Apply auxiliary voltage to the external blocking input (Terminals E8/D8) to inhibit the undervoltage functions (refer to 6.5) and press the <SELECT/RESET> for app. 3 s to reset the LEDs and "TRIP" message.

6.2 Testing the output relays

NOTE!
Prior to commencing this test, interrupt the trip circuit to the circuit breaker if tripping is not desired.

By pressing the push button <TRIP> once, the display shows the first part of the software version of the relay (e.g. „D08-"). By pressing the push button <TRIP> twice, the display shows the second part of the software version of the relay (e.g. „4.01". The software version should be quoted in all correspondence. Pressing the <TRIP> button once more, the display shows "PSW?". Please enter the correct password to proceed with the test. The message "TRI?" will follow. Confirm this message by pressing the push button <TRIP> again. All output relays should then be activated and the self supervision alarm relay (watchdog) be deenergized one after another with a time interval of 1 second. Thereafter, reset all output relays back to their normal positions by pressing the push button <SELECT/RESET>.

6.3 Checking the set values

By repeatedly pressing the push button <SELECT>, all relay set values may be checked. Set value modification can be done with the push button <+><-> and <ENTER>. For detailed information about that, please refer to chapter 4.3 of the description "MR – Digital multifunctional relays".

As relay input energizing quantities, three phase voltages should be applied to *MRN3* relay input circuits. Depending on the system conditions and the voltage transformer used, three voltages can be connected to the relay input circuits with either star or delta connection. In case of a star connection the phase-to-neutral voltage will be applied to the voltage input circuits, while the phase-to-phase voltages will be connected to the voltage input circuits in case of a delta connection. The voltage input connection must be set as a parameter, and should correspond with the actual voltage input connection:

Star connection:	Phase-to-neutral voltages will be measured and evaluated.
Delta connection:	Phase-to-phase voltages will be measured and evaluated.

6.4 Secondary injection test

6.4.1 Test equipment

- Voltmeter and frequency meter with class 1 or better,
- auxiliary power supply with the voltage corresponding to the rated data on the type plate,
- three-phase voltage supply unit with frequency regulation (Voltage: adjustable from 0 to 2 x U_N; Frequency: adjustable from 40 - 70 Hz),
- timer to measure the operating time (Accuracy class ±10 ms),
- switching device and
- Test leads and tools

6.5 Example of test circuit

For testing of the *MRN3* relay, a three phase voltage source with adjustable voltage and frequency is required. Figure 6.1 shows an example of a three-phase test circuit energizing the *MRN3* relay during test. The three phase voltages are applied to the relay in Y-connection.

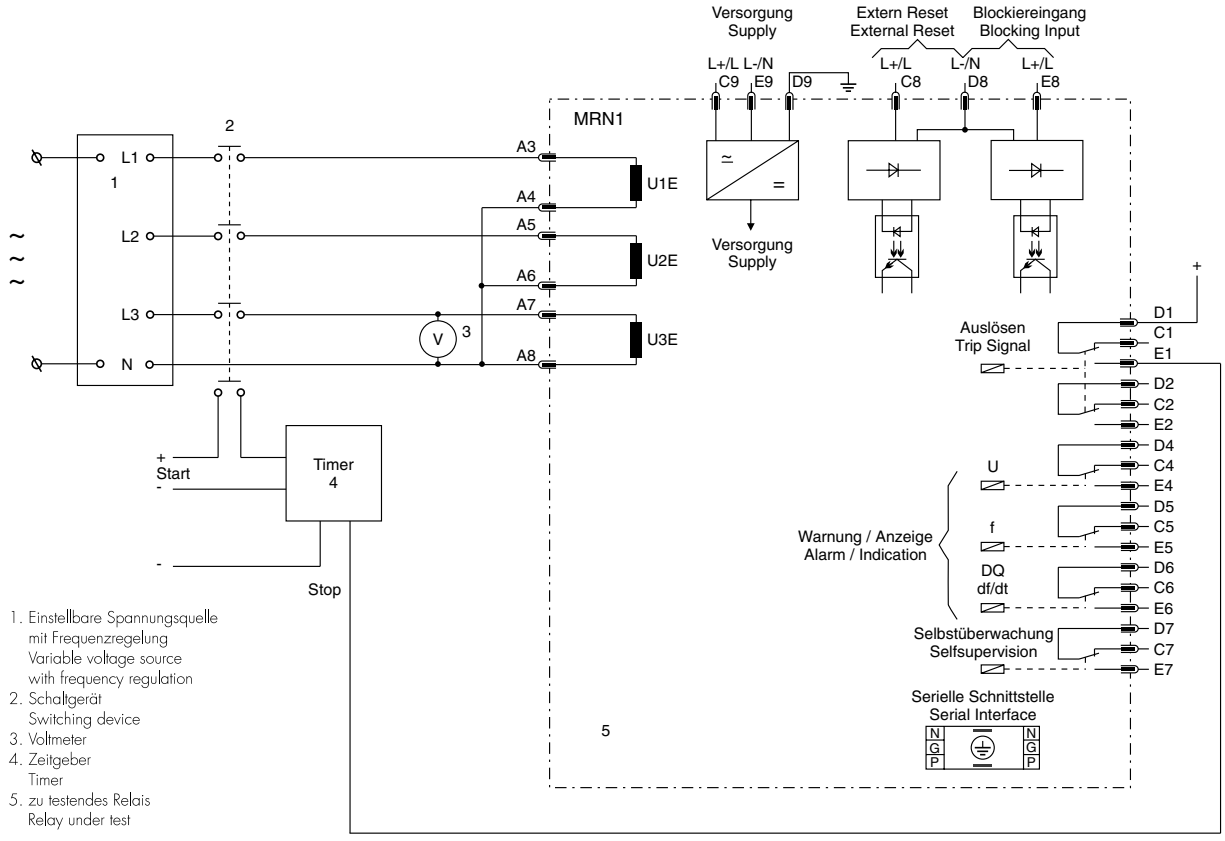


Figure 6.1: Test circuit

For testing the vector surge function of the relay, a test circuit which can produce phase angle change (vector surge) is required to simulate mains failures (please refer to chapter 6.5.6).

For testing the df/dt function of the relay, a special test equipment is required, which produces a constant rate of change of frequency.

6.5.1 Checking the input circuits and measuring functions

Apply three voltages of rated value to the voltage input circuits (terminals A3 - A8) of the relay. Check the measured voltages, frequency and vector surge on the display by pressing the push button <SELECT/RESET> repeatedly. The displayed measuring voltages (shown in Volt) are dependent on the wiring of the input voltage converters and the set transformation ratio.

The voltages are indicated on the display in volts.
At Y-connection:
- Phase-to-neutral voltages: LED L1, L2, L3

At Delta-connection:
- Phase-to-phase voltages: LED L1+L2, L2+L3, L3+L1

The frequency is indicated on the display in Hz: LED f (system frequency = 50.01Hz, Indication = 5001)
The vector surge is indicated on the display in degrees (for *MRN3-1*): LED $\Delta\Theta$ (Indication $\Delta\Theta$ in °)
The rate of change of frequency (LED df) is indicated on the display in Hz/s (for *MRN3-2*)

Change the voltages around the rated value and check the measured voltages on the display.
Change the system frequency around the rated frequency and check the measured frequency on the display.

Compare the voltage and frequency on display with the signal on voltmeter and frequency meter. The deviation for the voltage must not exceed 1% and for frequency <0.01 Hz.

By using an RMS-metering instrument, a greater deviation may be observed if the test voltage contains harmonics. Because the *MRN3* relay measures only the fundamental component of the input signals, the harmonics will be rejected by the internal DFFT-digital filter. Whereas the RMS-metering instrument measures the RMS-value of the input signals.

6.5.2 Checking the operating and reset ting values of the over/undervoltage functions

Note:
When the measuring voltage is connected or disconnected, vector surge tripping or df/dt tripping can occur. In order to ensure a trouble-free test procedure, the vector surge function or df/dt function of the relay have to be blocked before tests are started.

Apply three voltages with the rated value and gradually increase (decrease) the voltages until the relay starts, i.e. at the moment when the LED U> (or U<) lights up or the voltage alarm output relay (contact terminals D4/E4) is activated. Read the operating voltage indicated by the voltmeter. The deviation must not exceed 1% of the set operating value.

Furthermore, gradually decrease (increase) the voltages until the relay resets, i.e. the voltage alarm output relay is disengaged. Check that the dropout to pickup ratio for voltage is greater than 0.97 (for overvoltage function) or smaller than 1.03 (for undervoltage).

6.5.3 Checking the relay operating time of the over/undervoltage functions

To check the relay's operating time, a timer must be connected to the trip output relay contact (Contact terminals D1/E1). The timer should be started simultaneously with the voltage change from sound condition to a faulty condition and stopped by the trip relay contact. The operating time measured by timer should have a deviation about 3% of the set value or <20 ms.

6.5.4 Checking the operating and reset ting values of the over/underfrequency functions

Note:
Due to frequency changes, vector surge tripping or df/dt - tripping can occur during frequency tests. In order to ensure a trouble-free test procedure, the vector surge function or df/dt function of the relay have to be blocked before tests are started.
During frequency tests, each of the frequency elements should be tested separately. This makes it necessary that the other frequency elements of the relay have to be blocked by setting the frequency pickup values f_1 - f_3 to "EXIT". For testing the pickup and dropout to pickup values, the test frequency has to be increased (decreased) until the relay is engergized. This is indicated by lighting up of LEDs f_1 - f_3.
When comparing the values displayed with those of the frequency meter, the deviation must not exceed 0.01 Hz. The dropout to pickup values are ascertained by increasing (decreasing) the test frequency slowly until the output relay releases.
The dropout to pickup value for overfrequency must be >0.99, and for underfrequency <1.01.

6.5.5 Checking the relay operating time of the over/underfrequency functions

The operating time of the over/underfrequency functions can be tested in the similar manner as in chapter 6.5.3 for over/undervoltage functions.

6.5.6 Checking the vector surge function

With the help of an advanced relay test equipment a phase shift (vector surge) on the voltage signal can be obtained to test the vector surge function of *MRN3* relay. If there is no such testing facility available, a very simple simulation circuit may be used to test the vector surge function of the relay with a sufficient accuracy. Figure 6.2 shows the possibility to simulate a phase shift by means of a RC circuit. Closing or opening the switch S1 causes the phase angle of the input voltage to change depending on the adjustable resistor R.

The phase angle obtained may be calculated with the following formula and is almost independent on the test voltages.
In case of a 3-phase vector surge, the angle $\Delta\Theta$ can be calculated with the following formula if the parameters R_0, R and C are known:

$$\Delta\Theta = \text{arctg}\frac{1}{R_0 \cdot \omega \cdot C} - \text{arctg}\frac{1}{(R_0 + R) \cdot \omega \cdot C}$$

Example: R_0 = 1 Ohm, R = 363 Ohm, C = 3 µF

then: $\Delta\Theta \cong 19°$

Usually the voltage source impedance R_0 is negligible, hence R_0 may be assumed zero. Thus, the value of R may be calculated using the following simplified formula:

$$\Delta\Theta = 90° - \text{arctg}\ \frac{1}{R \cdot \omega \cdot C}$$

Note!
Using the above test circuit with single-phase vector surge, the resulting measured angle $\Delta\Theta$ is about half the value of $\Delta\Theta$ calculated for a 3-phase vector surge.
To make tripping possible during a one phase test procedure, the vector surge tripping has to be set to "1Ph".

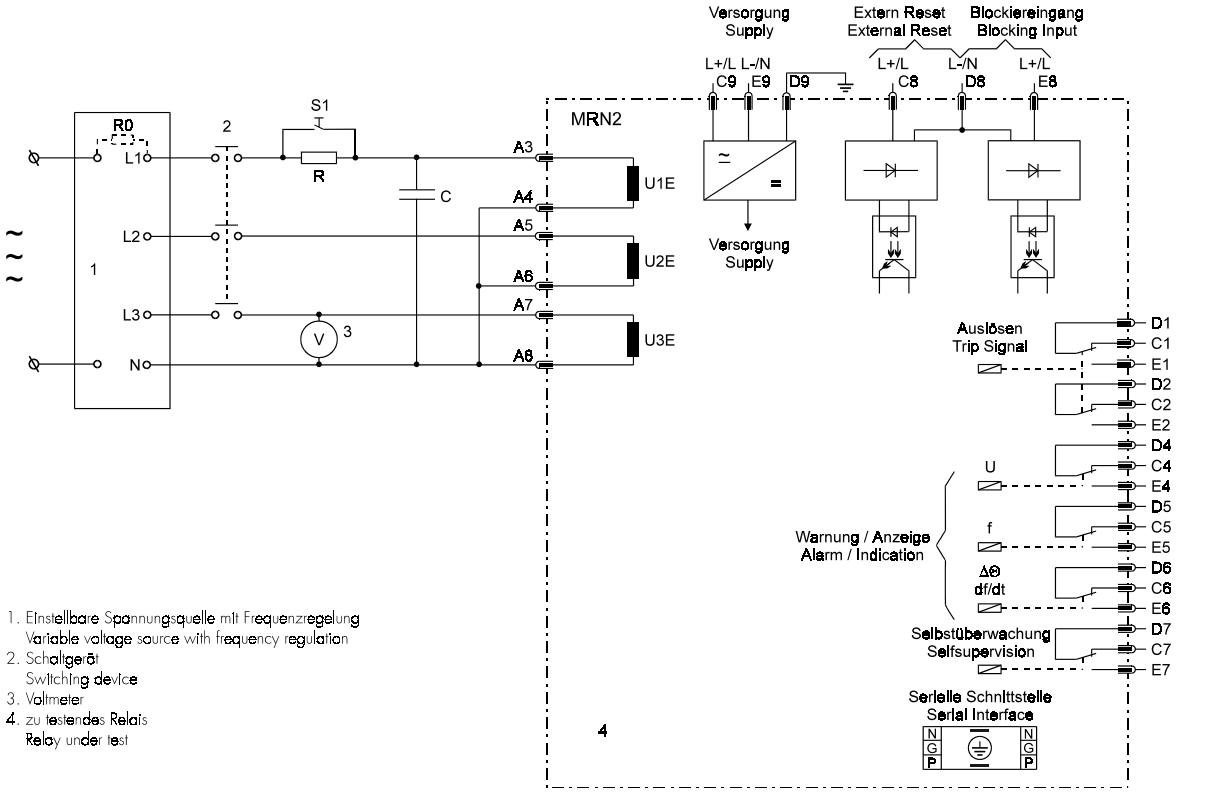


Figure 6.2: Test circuit for the vector surge function

6.5.7 Checking the external blocking and reset functions

The external blocking input is free programmable by the user.
To test the blocking function apply auxiliary supply voltage to the external blocking input of the relay (terminals E8/D8). Inject a test voltage which could cause tripping for the testes functions. Observe that there is no trip and alarm for those functions.

Remove the auxiliary supply voltage from the blocking input. Apply test voltages to trip the relay (message „TRIP" on the display). Return the test voltages to the sound condition and apply auxiliary supply voltage to the external reset input of the relay (terminals C8/D8). The display and LED indications should be reset immediately.

6.6 Primary injection test

Generally, a primary injection test could be carried out in the similar manner as the secondary injection test described above. With the difference that the protected power system should be, in this case, connected to the installed relays under test „on line", and the test voltages should be injected to the relay through the voltage transformers with the primary side energized. Since the cost and potential hazards are very high for such a test, primary injection tests are usually limited to very important protective relays in the power system.

Because of its powerful combined indicating and measuring functions, the *MRN3* relay may be tested in the manner of a primary injection test without extra expenditure and time consumption.

In actual service, for example, the measured voltage and frequency values on the *MRN3* relay display may be compared phase by phase with the concerned indications of the instruments of the switchboard to verify that the relay works and measures correctly.

6.7 Maintenance

Maintenance testing is generally done on site at regular intervals. These intervals vary among users depending on many factors: e.g. the type of protective relays employed; the importance of the primary equipment being protected; the user's past experience with the relay, etc.

For electromechanical or static relays, maintenance testing will be performed at least once a year according to the experiences. For digital relays like *MRN3*, this interval can be substantially longer. This is because:

- The *MRN3* relays are equipped with very wide self-supervision functions, so that many faults in the relay can be detected and signalised during service. Important: The self-supervision output relay must be connected to a central alarm panel!
- The combined measuring functions of *MRN3* relays enable supervision the relay functions during service.
- The combined TRIP test function of the *MRN3* relay allows to test the relay output circuits.

A testing interval of two years for maintenance will, therefore, be recommended.
During a maintenance test, the relay functions including the operating values and relay tripping times should be tested.

7 Technical data

7.1 Measuring input circuits

Rated data:	Nominal voltage U_N	100 V, 230 V, 400 V
	Nominal frequency f_N	40 - 70 Hz
Power consumption in voltage circuit:	<1 VA	
Thermal rating:	continuously	2 x U_N
Undervoltage lockout for frequency and vector surge measurement:	U< adjustable (5%...100% U_N)	

7.2 Common data

Dropout to pickup ratio:	for U>/U>> : >97%;	for U</U<< : <103%
	for f>/f>> : >99.98%;	for f</f<< : <100.02%
Dropout time:	60 ms	
Time lag error class index E:	±10 ms	
Minimum operating time:	40 ms	
Max. allowed interruption of the auxiliarxy supply without a facting the function of the device:	50 ms	
Influences on voltage measuring:		
Aux. voltage:	in the range 0.8 <U_H/U_{HN} <1.2 no additional influences to be measured	
Frequency:	in the range 0.8 <f / f_N <1.4 (for f_N = 50 Hz) <0.15% / Hz	
Harmonics:	up to 20% of the 3rd harmonic <0.1% per percent of the 3rd harmonic	
	up to 20% of the 5th harmonic <0.05% per percent of the 5th harmonic	
Influences on frequency measuring:		
Aux. voltage:	in the range <0.8 U_N/U_{HN} <1.2 no additional influences to be measured	
Frequency:	no influences	
Influences on delay time:	no additional influences to be measured	
GL-Approbation:	98776-96HH	
Bureau Veritas Approbation:	2650 6807 A00 H	

7.3 Setting ranges and steps

Function	Para-meter	Setting range	Steps	Tolerance
Transformer ratio	U_{prim}/U_{sek}	(SEC) 1.01...6500	0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 5.0; 10; 20; 50	
Rated frequency	f_N	f = 50 Hz / f = 60 Hz		
Switch group	Δ/Y	Δ = Delta/Y = Stern		
Switch over	P2/FR	SET1/SET2/B_S2/R_S2/B_FR/R_FR/ S2_FR		
LED blinking at pick-up		FLSH/NOFL		
U</<<	U</<<	U_N = 100 V: 2...200 V (EXIT) U_N = 230 V: 2...460 V (EXIT) U_N = 400 V: 4...800 V (EXIT) 0.04...50 s (EXIT)	 1 V 1 V 2 V 0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0 s	 ± 1 % of set value or < 0.3% U_N ±1% or ±15 ms
U>/>>	U>/>> $t_{U>}$ $t_{U>>}$	U_N = 100 V: 2...200 V (EXIT) U_N = 230 V: 2...460 V (EXIT) U_N = 400 V: 4...800 V (EXIT) 0,04...50 s (EXIT)	 1 V 1 V 2 V 0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0 s	 ±1% of set value or <0,3% U_N ±1% or ±15 ms
Frequency measuring repetition	T	2...99 (Cycles)	1	
Frequency element 1 - 3	f_1 - f_3 t_{f1} - t_{f3}	30...49.99; EXIT; 50.01...70 Hz[1] 40...59.99; EXIT; 60.01...80 Hz[2] $t_{f,min}$[3]...50 s; EXIT	0.1; 0.01 Hz 0.01; 0.02; 0.05; 0.1; 0.2; 0.5; 1.0; 2.0 s	0.005 Hz ±1% or ±20 ms
df/dt-Step df/dt-Measuring repetition	df dt	0,2...10 Hz/s (EXIT) 2...64 Periods	0.1; 0.2; 0.5 Hz/s 1	0.1 Hz/s
ΔΘ	ΔΘ	2°...22° (EXIT)	1°	±1°
Vector surge logic	1/3	1Ph / 3Ph		
Voltage theshold for frequency measuring	U_B (LED 'f'+ ΔΘ/df)	U_N = 100 V: 5...100 V U_N = 230 V: 12...230 V U_N = 400 V: 20...400 V	 1 V 1 V 2 V	 ±1% of set value or <0.3% U_N

Table 7.1: Setting ranges and steps

[1] At 50 Hz rated frequency
[2] At 60 Hz rated frequency
[3] $t_{f,min}$ min. time delay; $t_{f,min}$ = (T+1) x 20 ms
[4] only Modbus

7.3.1 Interface parameter

Function	Parameter	Modbus-Protocol	RS485 Open Data Protocol
RS	Slave-Address	1 - 32	1 - 32
RS	Baud-Rate*	1200, 2400, 4800, 9600	9600 (fixed)
RS	Parity*	even, odd, no	"even Parity" (fixed)

Table 7.1: Interface parameter

*only Modbus Protocol

7.3.2 Parameters for the fault recorder

Function	Parameter	Adjustment example
FR	Number of recordings	(1)* 2 x 8 s; (3)* 4 x 4 s; (7)* 8 x 2 s (with 50 Hz) (1)* 2 x 6.66 s, (3)* 4 x 3.33 s, (7)* 8 x 1.66 s (60 Hz)
FR	Saving of the recording at the occurence	P_UP; TRIP; A_PI; TEST
FR	Pre-trigger-time	0.05 s – 8.00 s

Table 7.2: Parameters for the fault recorder

* is written over when a new trigger signal arrives

7.4 Output relays

Relay type	Trip relays / change-over contacts	Alarm relays / change-over contacts
MRN3	2/2	3/1

Table 7.3: Output relays

8 Order form

Mains decoupling relay ***MRN3-***					
with voltage-, frequency and vector surge supervision		**1**			
Voltage, frequency and df/dt-supervision		**2**			
Rated voltage	100 V		**1**		
	230 V		**2**		
	400 V		**4**		
Housing (12TE)	19"-rack			**A**	
	Flush mounting			**D**	
RS485	Alternatively with Modbus Protocol				**-M**

Technical data subject to change without notice!

Setting list *MRN3*

Project: _____ SEG job.-no.: _____

Function group: = _____ Location: + _____ Relay code: - _____

Relay functions: _____ Password: _____

Setting of the parameters

System parameter

Function		Unit	Relay type *MRN3-1*	*MRN3-2*	Default settings Set 1/Set 2	Actual settings Set 1/Set 2
U_{prim}/U_{sek}	Voltage transformer ratio		X	X	SEK	
Δ/Y	Input voltage correction dependent on the connection of the input transformer		X	X	Y	
f_N	Rated frequency	Hz	X	X	v = 50 Hz	
LED Flash	Display of the activation storage		X	X	FLSH	
P2	2 parameter sets/ext. Trigger for FR		X	X	SET1	

Protection parameter

Function		Unit	Default settings	Actual settings
			Set 1 / Set 2	Set 1 / Set 2
U<	pickup value for undervoltage element (low set)	V	90/210/360*	
t_U<	tripping delay for undervoltage element	s	0.04	
U<<	pickup value for undervoltage element (high set)	V	80/190/320*	
t_U<<	tripping delay for undervoltage element	s	0.04	
U>	pickup value for overvoltage element (low set)	V	110/250/440*	
t_U>	tripping delay for overvoltage element	s	0.04	
U>>	pickup value for overvoltage element (high set)	V	120/270/480*	
t_U>>	tripping delay for overvoltage element	s	0.04	
T	frequency measuring repetition in periods	cycles	4	
f_1	pickup value for frequency element 1	Hz	4800	
t_{f1}	tripping delay for frequency element 1	s	0.1	
f_2	pickup value for frequency element 2	Hz	4900	
t_{f2}	tripping delay for frequency element 2	s	0.1	
f_3	pickup value for frequency element 3	Hz	5100	
t_{f3}	tripping delay for frequency element 3	s	0.1	
df	pickup value for rate of frequency (dt/dt) in	Hz/s	EXIT	
dt	measuring repetition for df/dt	periods	4	
1/3	vector surge tripping logic		1PH	
ΔΘ	pickup value for vector surge	°	2.0	
U_B<	voltage threshold value for frequency and vector surge measuring (or df/dt)	V	10/23/40*	
RS	Slave address of the serial interface		1	
RS**	Baud-Rate		9600	
RS**	Parity-Check		even	

* thresholds dependent on rated voltage 100 V / 230 V / 400 V
** only Modbus

Fault recorder

Function		Unit	Default settings	Actual settings
FR	Number of recordings		4	
FR	Saving of the recording at the occurrence		TRIP	
FR	Time prior to trigger impulse	s	0.05	
🕒	Year setting	year	Y=00	
🕒	Month setting	month	M=00	
🕒	Day setting	day	D=00	
🕒	Setting of the hour	hour	h=00	
🕒	Setting of the minute	minute	m=00	
🕒	Setting of the setting	second	s=00	

Blocking function

	Default settings				Actual settings			
	Blocking		Not blocking		Blocking		Not blocking	
Parameter set	Set 1	Set 2	Set 1	Set 2	Set 1	Set 2	Set 1	Set 2
U<	X		X					
U<<	X		X					
U>		X		X				
U>>		X		X				
f1	X		X					
f2	X		X					
f3		X		X				
ΔΘ	X		X					
df/dt	X		X					

Assignment of the output relays

Function	Relay 1		Relay 2		Relay 3		Relay 4	
	Default settings	Actual settings	Default settings	Actual settings	Default settings	Actual settings	Default settings	Actual settings
U< alarm			X					
$t_{U<}$ tripping	X							
U<< alarm			X					
$t_{U<<}$ tripping	X							
U> alarm			X					
$t_{U>}$ tripping	X							
U>> alarm			X					
$t_{U>>}$ tripping	X							
f1 alarm					X			
tf1 tripping	X							
f2 alarm					X			
tf2 tripping	X							
f3 alarm					X			
tf3 tripping	X							
ΔΘ tripping							X	
df/dt tripping							X	

Setting of code jumpers

Code jumper	J1		J2		J3	
	Default settings	Actual settings	Default settings	Actual settings	Default settings	Actual settings
Plugged						
Not plugged	X		No function		X	

Code jumper	Low/High-range for Reset input		Low/High-range for blockage input	
	Default settings	Actual settings	Default settings	Actual settings
Low=plugged	X		X	
High=not plugged				

All settings must be checked at site and should the occasion arise, adjusted to the object/item to be protected.

This technical manual is valid for
software version number: D01-8.08 (*MRN3-1*)
D04-8.08 (*MRN3-2)*

Modbus version number: D51-1.13 (*MRN3-1*)
D54-1.13 (*MRN3-2)*

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The thyristor blocks are controlled by Mita-Teknik's connection module WP2060 and perform a precise and soft connection between the wind turbine generator and the power supply grid.

- Must be mounted with sufficient cooling.
- The thyristor blocks are protected against overheating by the connection module.
- A specially developed circuit protects the thyristors from overloading.
- Part no.: Please see table next page

THYRISTOR BLOCK

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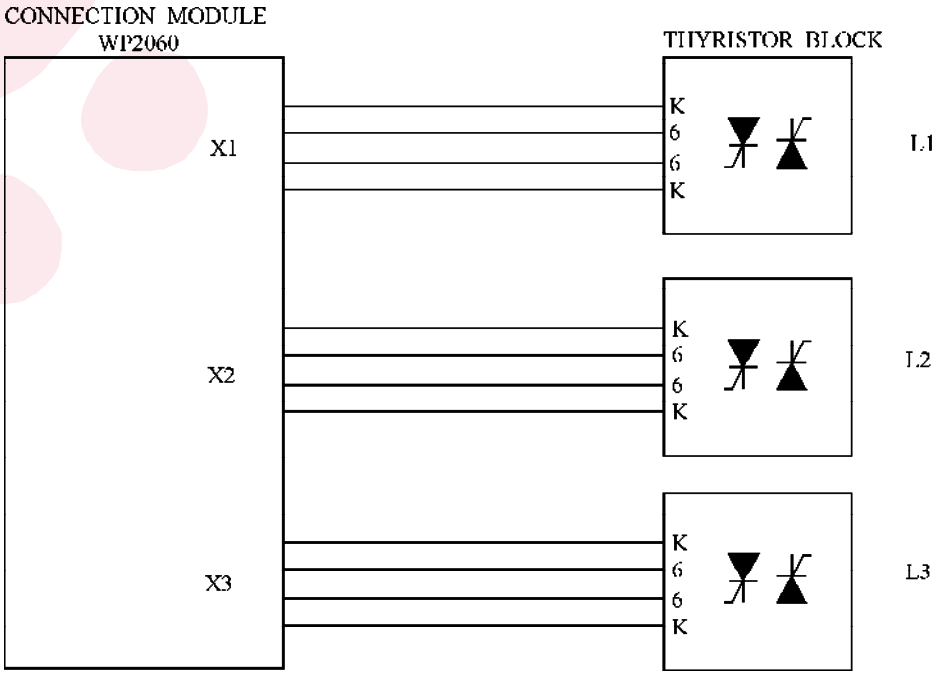

TECHNICAL DATA				
Type	**Generator**	**I 20 seconds**	**I 10 seconds**	**U**
MCC95	60/80kW	170A	190A	400V
MCC162	120kW	280A	320A	400V
MCC250	200kW	450A	500A	400V
MCC310	250kW	550A	620A	400V
SKKT210	400kW	475A	550A	690V
TT430	600kW	730A	930A	690V

DIMENSIONS AND PART NOS.					
Type	**Generator**	**Length cm**	**Width cm**	**Height cm**	**Part No.**
MCC95	60/80kW/400V	24.5	18.6	12.6	9724110
MCC162	120kW/400V	24.5	18.6	12.6	9724120
MCC250	200kW/400V	24.5	18.6	12.6	9724200
MCC310	250kW/400V	24.5	18.6	12.6	9724250
SKKT210	400kW/690V (M93)	24.5	18.6	12.6	9726400
	400kW/690V (M92)	24.5	18.6	12.6	9726401
TT430	600kW/690V (vent.)	17.6	21.8	23.0	9726600
	without ventilator	17.6	21.8	23.0	972660001

THYRISTOR BLOCK

Mita-Teknik a/s

Controls for wind turbines
- we make a difference

- a reliable and complete concept

w i n d

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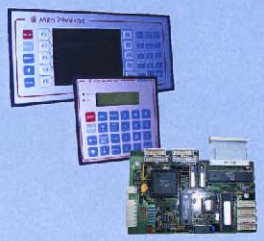
Power Panels

Mita-Teknik's standard concept can be modified to fit any requirements. We customise power panels according to international standards.

Controllers

The WP3000 and the WP3100 control units are designed to control all types of wind turbines. Graphical displays can be connected by choice. Also a large number of extension circuit boards can be built in.



Grid Connection

The WP4060 grid connection module ensures safe grid connection without grid disturbances.

Accessories

Mita-Teknik delivers a number of accessories for intelligent surveillance - like sensors for detecting vibrations, wind speed, wind direction etc.

Weather and Grid Station

The Weather Station is equipped with an IC1000 control unit and is used for surveillance and data collection of wind direction, wind speed, temperature, and air pressure.

The Grid Station is equipped with a WP3000 control unit and is used for monitoring and surveying of Substations (High voltage).

Wind Turbine Control Software

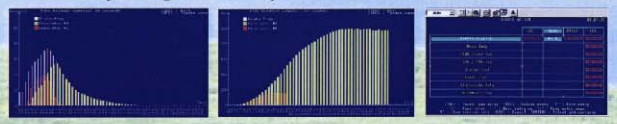
Mita-Teknik has a unique experience in developing wind turbine control software. Our programmers specialize in software which optimizes availability and production in each wind turbine. We have created an outstanding system for wind turbine analysis regarding fault analysis, turbine optimization and prototype running-in.

Management System

Direct connection to wind turbines is established through our Windows management system. This complete management system gives access to advanced statistics and on-line data.

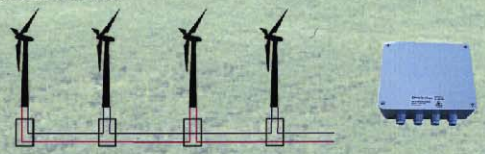
Service System

The system features are among other things downloading of programs, parameter settings and transfer of statistical data. Furthermore the Service System enables detailed stop and operation analysis in order to improve the wind turbine availability and profitability.



Communication

Mita-Teknik ensures a reliable data communication both using fibre optic convertion equipment and the public telephone network.



Training

Mita-Teknik offers customized training. This assures fast and efficient understanding of the software whether it concerns wind turbine control software, service software or management system.

Information

Hot-line service and follow-up characterises Mita-Teknik.
For further information about our wind power concept or Mita in general don't hesitate to contact our sales department or visit us at our homepage...

www.mita-teknik.com

WP3000 Controller

- Intelligent controller for all types of wind turbines
- All control functions are integrated
- Advanced data collection and storage
- Flexible design to meet customer requirements
- Integrated realtime grid measurement
- Easily expandable
- Remote firmware up-date

Description

The WP3000 controller has been specially designed to control wind turbines - from stall to pitch with variable and non-variable speed. The WP3000 controller ensures optimal operation, active security and advanced data collection.

Hardware

Integrated I/O and COM-ports
The compact design of the WP3000 controller makes it noise immune and perfect for building-in with other components. Easily expandable with different extension interfaces. User-friendly design for error detection.

Integrated realtime grid measurement
Fast reaction towards grid disturbances/drops.

HMI text and graphics
Access to data in the turbine is possible using the text/graphic display or a laptop.

Internal turbine network
Possibility of constructing an internal network with more controllers from Mita.

Park network
Prepared for wind park configurations from small to large wind parks.
MNET and ARCNET

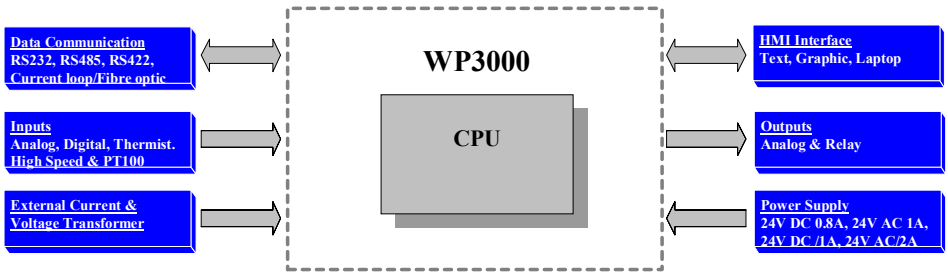
Software and Statistics

State based programme structure.
Integration of all operation functions and feedback.
The programming is undertaken in language “C” and can be uploaded via modem.

Access to the turbine
Remote access for/to parametrization and surveillance of the turbine.
Parameter and stored data are protected by passwords.

Storage of statistics
Life time statistics of standard data - such as availability, production, and consumption - daily, monthly and yearly.
Log/oscilloscope functions for advanced error detection.
100 line lists of status, events, access and alarm call.

Build-up



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WP3000 Controller

Technical data

Supply Voltage 1	
Nominal	24 V AC
Allowed range	21.6 to 26.4 V AC
Current Consumption 1	
Typical	0.8 A AC
Maximum	2 A AC
Supply Voltage 2	
Nominal	24 V DC
Allowed range	21.6 to 26.4 V DC
Current Consumption 2	
Typical	0.2 A DC
Maximum	0.8 A DC
Supply Voltage 3	
Nominal	24 V DC
Allowed range	21.6 to 26.4 V DC
Current Consumption 3	
Typical	1 A DC
Maximum	1 A DC
Power Consumption	
Typical	48 W
Maximum	92 W
Frequency	50/60 Hz +/-5%
Digital Input	
No. of points	43
Number of groups	6
Points per group	5 groups of 8 points/ 1 group of 3 points
Isolation	Optocoupler
Nominal voltage	24 V DC
Signal “1”	15 to 30 V DC
Signal “0”	0 to 5 V DC
Input current/signal “1”	25 mA max.
Input impedance	1200Ω
High Speed Input	
No. of points	4
Number of groups	2
Points per group	1 group of 3 points/ 1 group of 1 point
Isolation	Optocoupler
Nominal voltage	24 VDC
Signal “1”	15 to 30 V DC
Signal “0”	0 to 5 V DC
Input current/signal “1”	25 mA max.
Input impedance	1200Ω
Input frequency	0.01-10000 Hz
Thermistor Input	
No. of points	4
Number of groups	1
Points per group	4
Isolation	Optocoupler
Signal “1”	>3300Ω
Signal “0”	<1000Ω
Input current/signal “1”	1.6 mA max.
Digital Output	
No. of points	24
Number of groups	9
Points per group	5 groups of 4 points/ 4 groups of 1 point

Digital Output(cont.)	
Isolation	Relay contact
Digital Output	
Operation voltage	24-250 V AC 24-250 V DC
Rated current per point	8 A
Rated voltage per point	250 V
Rated breaking capacity	1250 VA
Max per group	5 x 15 A/4 x 8 A
Grid Measurement Input	
No. of current inputs	3
Current input range	1000mA RMS, + 10%
Current input impedance	2.5Ω
No. of voltage inputs	3
Voltage input range	18 V RMS, + 30%
Voltage input impedance	33 kΩ
Resolution	12 bit
Accuracy	1 % of full scale
Sample speed	128 x grid frequency
Analog Input	
No. of points	4
Number of groups	4
Points per group	1
Isolation	Optocoupler
Input configuration	Jumper
Input voltage	0 to 5 V
Input voltage	0 to 10 V
Input current	0 to 20 mA
Resolution	10 bit
Accuracy	0.5 % of full scale
PT100 Input	
No. of points	11
Number of groups	11
Points per group	1
Isolation	Optocoupler
Input impedance	> 6kΩ
Resolution	10 bit
Accuracy	0.5% of full scale
Range for group	-30- 211C°
Analog Output	
No. of points	2
Number of groups	2
Points per group	1
Isolation	Optocoupler
Output voltage	0 to 10 V
Output current	0 to 20 mA
Resolution	8 bit
Accuracy	0.4% of full scale
Ports for Optional Serial Communication Cards	
No. of ports	3
Communication speed	3 x (2400-61400 BAUD)
Communication interfaces:	RS232 RS485 RS422 M-NET Optical

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Mita-Teknik a/s

WP3000 Controller

Technical data

Port for RS232 Communication Cards	
No. of ports	1
Communication speed	2400-38400 BAUD
Max. cable length	30 m.
Recommended	3 x 0.25 w/shield
Connector	9-pin Sub D connector
Permissible Ambient Conditions	
Operation temperature	-20 to 50°C
Transportation/Storage temp	-20 to 75°C
Max. relative humidity	95% at 40°C

Permissible Ambient Conditions (cont.)	
Max. operation height	1000 m. above sea level (2000m. according to agreement
Construction	
Dimensions (WxHxD)	370 x 310 x 100 mm
Weight	4 Kg
Degree of protection	IP40
Standards	EN50082-2 (CE) EN61000-6-2 (CE) EN61000-4-5 (CE)

Ordering data

WP3000 Controller (more types)	P/N.: 9723000xx
Accessories	
Displays	
WP3050 Graphical Display (more types)	P/N.: 9723050xx
WP3059 LCD Display (more types)	P/N.: 9723059xx
Cable for WP3059 Display 1m.	P/N.: 977001001
Cable for WP3059 Display 2.1 m.	P/N.: 977001002
Extensions Boards	
WP3023 13 Digital Input & 8 Digital Output Interf. (more types)	P/N.: 9723023xx
WP3030 Grid DSP Surveillance Interface	P/N.: 9723030
WP3031 2 COM Interf.	P/N.: 9723031
WP3032 ARCNET	P/N.: 9723032xx
WP3033 Multi I/O Interf.	P/N.: 9723033
WP3034 4x Analog Input	P/N.: 972303402
WP3035 4x Analog Output (more types)	P/N.: 9723035xx
WP3042 RS485 Interface	P/N.: 9723042
WP3043 20mA Current Loop Interface	P/N.: 9723043
WP3044 Plastfibre 1000µ	P/N.: 9723044
WP3045 Network Interf. Optic fibre 62.5µ	P/N.: 972304501
WP3046 RS232 Interf.+5V.	P/N.: 9723046
WP3047 RS422 Interf.	P/N.: 9723047
WP3048 Network Interf. Optic fibre 50/62.5µ	P/N.: 972304801

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WP3045 Fibre Optic Interface

- The WP3045 interface is compatible with all IC/WP-Controllers up to WP3100
- High flexibility
- Easy expansion of control units
- Plug-and-play installation
- Optimal lightning protection
- Adjustable baudrate

Description

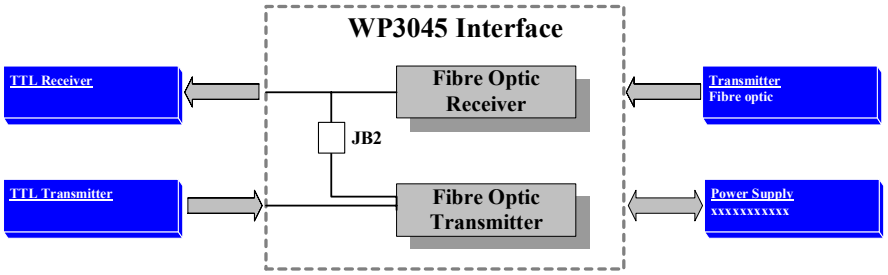
The WP3045 is a standard optical fibre communication card used for safe serial communication. The card is a plug-and-play card which can be used in IC500, IC1000, WP1000, IC3000, WP3000 and WP3100 controllers.

The WP3045 can be used for internal machine communication and/or for network communication between more controllers/machines. The card uses 62.5µ glass optic fibre cable which provide the optimal lightning and overvoltage protection and make the card suitable for industrial use. The baud rate is flexible and can be set in the controller.

62.5µ optic fibre cable is suitable for fast communication over short and long distances, termination of the cable must be handled by professionals.

The maximum distance is calculated based on a power budget for the communication network. Please contact Mita-Teknik A/S for further information.

Build-up



JB1 JUMPER SELECTABLE POWER:
0. STANDARD POWER
1. HIGH POWER
JB2 JUMPER SELECTABLE LOOP FUNCTION:
0. NO LOOP (PARK MASTER)
1. LOOP (PARK SLAVE)

Technical data

Supply Voltage	
Nominal	5 V DC
Allowed range	4.8 to 5.2 V DC
Current Consumption	
Typical	100 mA
Maximum	150 mA
Power Consumption	
Typical	500 mW
Maximum	780 mW
Port for Serial Optical Communication	
Communication speed	0-1.000.000 BAUD

Port for Serial Optical Communication (cont.)	
Wave length	820 nm
Transmission length based on 8 connections in network	
Min./typical 50µ/125µ with 2.7 dB/km	0/1777 m
Min./typical 62.5µ/125µ with 3.2 dB/km	1000/3188 m
Optical Power Budget	
Min./typical 50µ/125µ	4.2/9.6 dB
Min./typical 62.5/125µ	8/15 dB

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WP3045 Fibre Optic Interface

Technical data

Peak Output Power	
measured on 1 m. cable	
Min./typical 50µ/125µ	- 19.8 dBm
Min./typical 62.5/125µ	- 16.0 dBm
Min./typical 100/140µ	- 10.5 dBm
Min. 200 µm PCS	- 6.2 dBm
High Power JB1 mounted	
Extra optic power	1 dBm
Minimum Input Sensivity (HFBR2404)	
Typical/maximum	-25.4/-24.0 dBm
Connector	ST

Permissible Ambient Conditions	
Operation temperature	0 to 70 °C
Transportation /Storage temp.	-40 to 85 °C
Max. relative humidity	95% at 25 °C
Max. operation height	3000 m. above sea level
Construction	
Dimensions (WxHxD)	110 x 15 x 40 mm
Weight	0.050 Kg
Standards	EN50081-2 (CE)
	EN61000-6-2 (CE)
	EN61000-4-5 (Surge)

Ordering data

WP3045 Fibre Optic Interface (more types)	P/N.: 9723045x

Accessories

Which distance pieces, mounting plates, flat cables and screws you have to use depends on which expansion you

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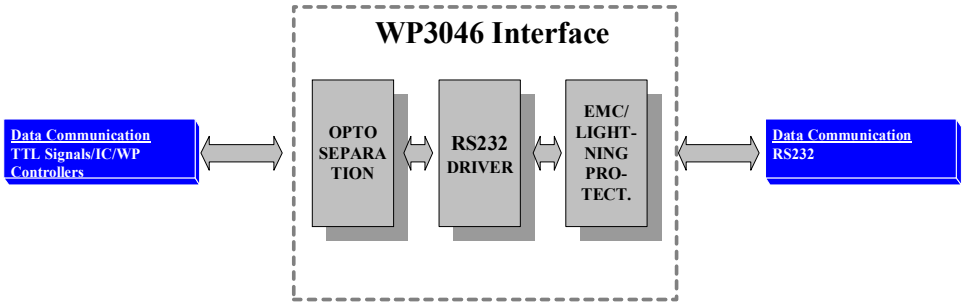
WP3046 RS232 Interface

- The WP3046 interface is compatible with all IC/WP-Controllers up to WP3100
- High flexibility
- Easy expansion of control units
- Plug-and-play installation
- Onboard lightning protection
- Adjustable baudrate

Description

The WP3046 is a standard RS232 communication card used for safe serial communication. The card is a plug-and-play card which can be used in IC500, IC1000, WP1000, IC3000, WP3000 and WP3100 controllers.
The WP3046 can be used for internal machine communication and/or for network communication between more controllers/machines.
The card has an on board lightning and overvoltage protection which make the card suitable for industrial use. The baudrate is flexible and can be set in the controller.
If the distance exceed 30 m, we recommend to convert the signal into optical fibre

Build-up



Technical data

Supply Voltage	
Nominal	5 V DC
Allowed range	4.8 to 5.2 V DC
Current Consumption	
Typical	25 mA
Maximum	30 mA
Power Consumption	
Typical	125 mW
Maximum	155 mW
Port for RS232 Communication	
Communication speed	0-250.000 BAUD
Cable length	30 m.
Recommended cable type	3 x 0.25 w/shield
Connector	9-pin male sub D connector
Permissible Ambient Conditions	
Operation temperature	0 to 70 °C
Transportation /Storage temp.	-40 to 85 °C
Max. relative humidity	95% at 25 °C
Max. operation height	3000 m. above sea level
Construction	
Dimensions (WxHxD)	110 x 15 x 40 mm
Weight	0.040 Kg
Standards	EN50081-2 (CE) EN61000-6-2 (CE)

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WP3046 RS232 Interface

Ordering data

WP3046 RS232 Interface	P/N.: 9723046

Accessories

Which distance pieces, mounting plates, flat cables and screws you have to use depends on which expansion you

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WP3059 Display

- 4-line Text Display for IC/WP-Controllers
- Quick survey of functions and data in the wind turbine
- Userfriendly menu structure
- Designed for easy mounting

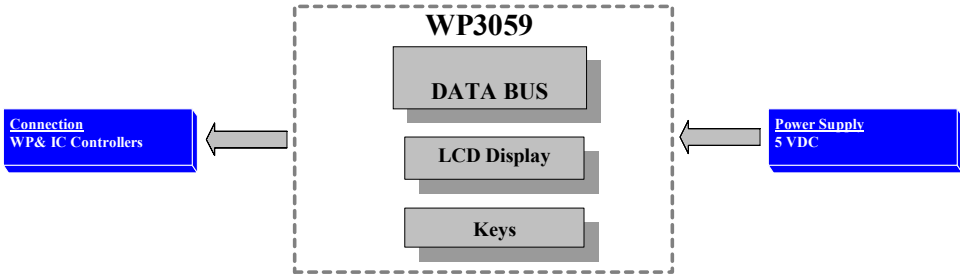
Description

The WP3059 Text Display is used with our IC/WP-control- lers and gives access to the turbine.

Features
LCD-display with four 20-character lines.
The display background light is automatically regulated according to the contrast.
The module emits a sound when a key is pressed.

Access to the turbine
Local access to parametri-zation and surveillancethe turbine.
Parameter and stored data are protected by passwords.

Build-up



Technical data

Supply Voltage	
Nominal	5 V DC
Allowed range	4.75 to 5.25 V DC
Current consumption	
Typical	240 mA
Maximum	400 mA
Power consumption	
Typical	1.2 W
Maximum	2.1 W
Permissible ambient conditions	
Operation temperature	0 to 50°C
Transportation/Storage temp.	-20 to 60°C

Permissible ambient conditions	
Max. relative humidity	95% at 40°C
Max. operation height	3000 m. above sea level
Construction	
Dimensions (WxHxD)	144 x 144 x 65 mm
Weight	0.410 Kg
Degree of Protection	IP40
Standards	EN50081-2 (CE) EN61000-6-2 (CE) EN61000-4-5 (CE)

Ordering data

WP3059 Display (Standard)	P/N.: 9723059

Accessories	
Extra mounting fittings	P/N.: 8351000
Cable, 1m.	P/N.: 977001001
Cable, 2 m.	P/N.: 977001002

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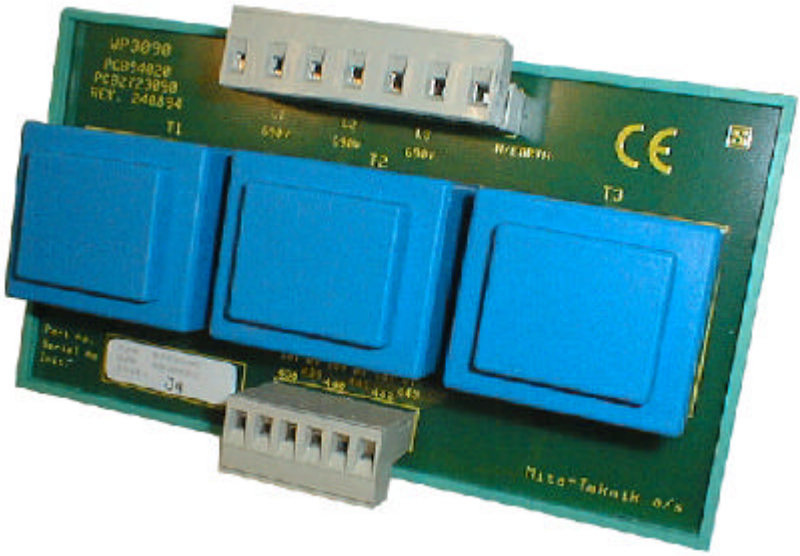

The WP3090 instrument trafo interface is an instrument trafo interface module which is used for measuring the 3-phased grid voltage on 690/400V systems.

- DIN-rail mounting.
- The WP3090 (Part no. 9723090) is produced in accordance with the demands in the DS/ EN ISO 9001-standard and is EMC tested according to EN50082-2 and EN50081-2.

INSTRUMENT TRAFO INTERF ACE WP3090

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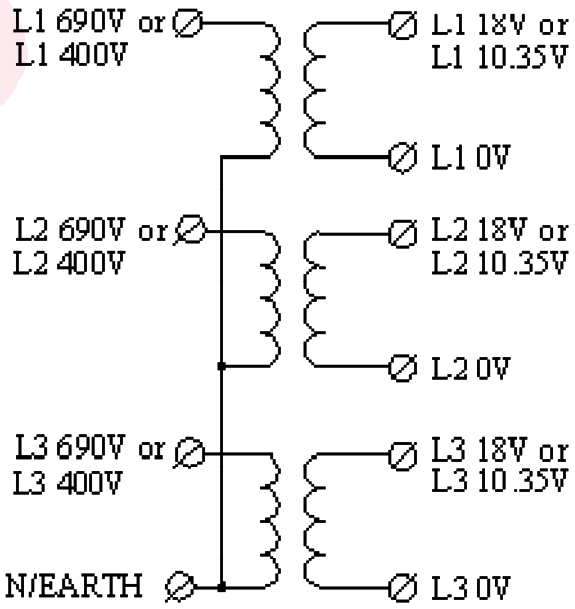
Fax:+45 86 65 92 90
<mail@mita-teknik.com>



TECHNICAL DATA		MIN.	MAX.	
Transformation ratio 690V	R_{LOAD}=3K3 R_{LOAD}=33K2	22.1 : 1 21.9 : 1	22.3 : 1 22.1 : 1	
Accuracy class			1	
Phase shift			0.6	°
Input voltage L/690V-N		0	480	V AC
Temperature		-20	+60	°C
Weight			600	g
Height Width Depth			56 150 85	mm mm mm

INSTRUMENT TRAFO INTERF ACE WP3090

WP4060 Connection Module

- The WP4060 connection module is used for soft connection of generators to the grid
- Contimuous safety test correct thyristor sequence
- Surveillance of too high temeprature on thryristors with bimetal sensor
- For 1- and 2 generator systems
- Possibility of throughout logging of all relevant data
- Download of log data through the IC/WP controllers

Description

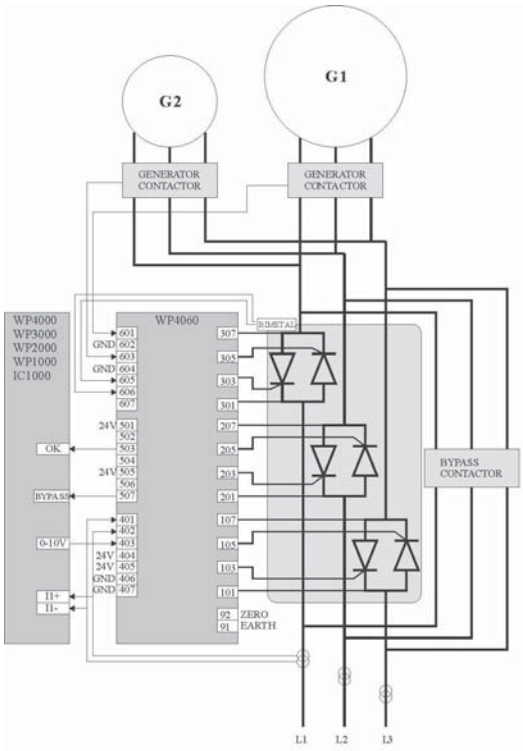
The WP4060 connection module is used for soft connection of wind turbine genrators to the grid.
The Cos.phi circuit of the WP4060 ensures effective current control before, during and after the synchronous point.
The connection current is chosen as a parameter on the control unit.

The thyristors can be connected during low production. The parameters for the opening of the thyristors are set on the control unit.
The WP4060 has a built-in DELTA PHI circuit, which measures whether the generator receive or transmits power.

The module has a built-in phase detecting circuit, which prevents connection if the phase sequence is un correct.
Soft connection of generators with either “6-wire cable” or “3-wire cable connection”. With real time auto detector

The WP4060 can replace our former connection module, WP2060, if the DELTA PHI function is de-activated.

Build-up



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Mita-Teknik a/s

WP4060 Connection Module

Technical data

Supply Voltage	
Nominal	24 V DC
Allowed range	20.4 to 30.2 V DC
Current Consumption	
Typical	0.20 A
Maximum	1.85 A
Feedback Signal from Current Transformer	
Maximum	3.6 V AC
Control Signal for full Opening of Thyristors	
Minimum	9.5 V DC
Maximum	10 V DC
Grid	
Voltage	200-690 V AC
Frequency	40 to 70 Hz
Creep stress	max. 4000 Vrms
Trigging Pulse Time	
Minimum	8
Maximum	40
Pause Time	max. 80 µs
Pulse Current	min. 1.0 A
di/dt (rise time for current)	min. 2 A/µs
Digital Output	
No. of points	3
Number of groups	2
Points per group	2 groups of 1 point 1 group of 1 point
Isolation	Relay contact
Operation voltage	24-250 V AC 24-250 V DC
Rated current per point	8 A
Rated voltage per point	250 V
Rated breaking capacity	1250 VA
Max per group	1x 10 A/1x 8 A

Analog Input	
No. of points	1
Number of groups	1
Points per group	1
Input voltage	0 to 10 V
Input current	0 to 20 mA
Resolution	8 bit
Bus Ports for Optional Communication Cards	
No. of ports	1
Communication interfaces	RS232 RS485 RS422 M-NET Optical
Permissible Ambient Conditions	
Operation temperature	-20 to 60°C
Transportation/Storage temp.	-40 to 85 °C
Max. relative humidity	95% at 40°C
Max. operation height	1000 m. above sea level (2000 m. according to agreement)
Construction	
Dimensions (WxHxD)	310 x 203 x 78 mm
Weight	1.2 Kg
Standards	EN50081-2 (CE) EN61000-6-2 (CE) EN61000-4-5 (CE)

Ordering data

WP4060 Connection Module (more types)	P/N.: 9724060xx

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NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
60034-1

Edition 10.2

1999-08

Edition 10:1996 consolidée par les amendements 1:1997 et 2:1999
Edition 10:1996 consolidated with amendments 1:1997 and 2:1999

Machines électriques tournantes –

Partie 1:
Caractéristiques assignées et caractéristiques de fonctionnement

Rotating electrical machines –

Part 1:
Rating and performance

Numéro de référence
Reference number
CEI/IEC 60034-1:1996+A1:1997+A2:1999

Numéros des publications

Depuis le 1er janvier 1997, les publications de la CEI sont numérotées à partir de 60000.

Publications consolidées

Les versions consolidées de certaines publications de la CEI incorporant les amendements sont disponibles. Par exemple, les numéros d'édition 1.0, 1.1 et 1.2 indiquent respectivement la publication de base, la publication de base incorporant l'amendement 1, et la publication de base incorporant les amendements 1 et 2.

Validité de la présente publication

Le contenu technique des publications de la CEI est constamment revu par la CEI afin qu'il reflète l'état actuel de la technique.

Des renseignements relatifs à la date de reconfirmation de la publication sont disponibles dans le Catalogue de la CEI.

Les renseignements relatifs à des questions à l'étude et des travaux en cours entrepris par le comité technique qui a établi cette publication, ainsi que la liste des publications établies, se trouvent dans les documents ci-dessous:

- **«Site web» de la CEI***
- **Catalogue des publications de la CEI**
  Publié annuellement et mis à jour régulièrement
  (Catalogue en ligne)*
- **Bulletin de la CEI**
  Disponible à la fois au «site web» de la CEI* et comme périodique imprimé

Terminologie, symboles graphiques et littéraux

En ce qui concerne la terminologie générale, le lecteur se reportera à la CEI 60050: *Vocabulaire Electrotechnique International* (VEI).

Pour les symboles graphiques, les symboles littéraux et les signes d'usage général approuvés par la CEI, le lecteur consultera la CEI 60027: *Symboles littéraux à utiliser en électrotechnique,* la CEI 60417: S*ymboles graphiques utilisables sur le matériel. Index, relevé et compilation des feuilles individuelles,* et la CEI 60617: *Symboles graphiques pour schémas.*

* Voir adresse «site web» sur la page de titre.

Numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series.

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Consolidated versions of some IEC publications including amendments are available. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Validity of this publication

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology.

Information relating to the date of the reconfirmation of the publication is available in the IEC catalogue.

Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is to be found at the following IEC sources:

- **IEC web site***
- **Catalogue of IEC publications**
  Published yearly with regular updates
  (On-line catalogue)*
- **IEC Bulletin**
  Available both at the IEC web site* and as a printed periodical

Terminology, graphical and letter symbols

For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams.*

* See web site address on title page.

NORME INTERNATIONALE

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CEI
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1999-08

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Edition 10:1996 consolidated with amendments 1:1997 and 2:1999

Machines électriques tournantes –

Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement

Rotating electrical machines –

Part 1: Rating and performance

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
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For price, see current catalogue

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INTRODUCTION

En 1991, le CE 2 a décidé de rédiger la CEI 60034-1 pour en grouper les prescriptions en un ordre plus logique. Le résultat en est la dixième édition qui a maintenant priorité sur la neuvième édition.

Il n'y a pas de différence entre les prescriptions de la dixième édition et celles de la neuvième édition (incluant son amendement 1) et il est prévu qu'à court terme, d'autres amendements porteront simultanément sur la neuvième et la dixième édition.

La neuvième édition sera retirée d'ici moins de deux ans. Cela laissera le temps nécessaire à la mise à jour de toute autre norme se référant à des articles particuliers de la CEI 60034-1 et permettra aux utilisateurs de la norme de faire les changements qu'ils jugeront nécessaires dans leur propre documentation.

Pour faciliter ce changement, les références croisées (dans les deux sens) sont données en annexe B.

INTRODUCTION

In 1991, TC2 decided to edit IEC 60034-1 to group the requirements in a more logical order. The result is edition 10 which now takes precedence over edition 9.

There is no difference between the technical requirements of edition 10 and of edition 9 (including amendment number 1) and it is intended that in the short term any further amendments will be introduced simultaneously in edition 9 and edition 10.

Edition 9 will be withdrawn within two years. This will allow time for the updating of any other standards which refer to specific clauses of IEC 60034-1 and for users of the standard to make such changes as they judge necessary in their own documentation.

To facilitate these processes, cross-references (both ways) are listed in annex B.

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

_____

MACHINES ÉLECTRIQUES TOURNANTES –

Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement

AVANT-PROPOS

1) La CEI (Commission Electrotechnique Internationale) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de la CEI). La CEI a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, la CEI, entre autres activités, publie des Normes Internationales. Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec la CEI, participent également aux travaux. La CEI collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.

2) Les décisions ou accords officiels de la CEI concernant les questions techniques, représentent, dans la mesure du possible un accord international sur les sujets étudiés, étant donné que les Comités nationaux intéressés sont représentés dans chaque comité d'études.

3) Les documents produits se présentent sous la forme de recommandations internationales. Ils sont publiés comme normes, rapports techniques ou guides et agréés comme tels par les Comités nationaux.

4) Dans le but d'encourager l'unification internationale, les Comités nationaux de la CEI s'engagent à appliquer de façon transparente, dans toute la mesure possible, les Normes internationales de la CEI dans leurs normes nationales et régionales. Toute divergence entre la norme de la CEI et la norme nationale ou régionale correspondante doit être indiquée en termes clairs dans cette dernière.

5) La CEI n'a fixé aucune procédure concernant le marquage comme indication d'approbation et sa responsabilité n'est pas engagée quand un matériel est déclaré conforme à l'une de ses normes.

6) L'attention est attirée sur le fait que certains des éléments de la présente Norme internationale peuvent faire l'objet de droits de propriété intellectuelle ou de droits analogues. La CEI ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de propriété et de ne pas avoir signalé leur existence.

La Norme internationale CEI 60034-1 a été établie par le comité d'études 2 de la CEI: Machines tournantes.

La présente version consolidée de la CEI 60034-1 est issue de la dixième édition (1996) [documents 2/933/FDIS et 2/969/RVD], de son amendement 1 (1997) [documents 2/956/FDIS et 2/984/RVD] et de son amendement 2 (1999) [documents 2/1031+1055+1056/FDIS et 2/1058+1070+1071/RVD].

Elle porte le numéro d'édition 10.2.

Une ligne verticale dans la marge indique où la publication de base a été modifiée par les amendements 1 et 2.

Les annexes A et B sont données uniquement à titre d'information.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International standard IEC 60034-1 has been prepared by IEC technical committee 2: Rotating machinery.

This consolidated version of IEC 60034-1 is based on the tenth edition (1996) [documents 2/933/FDIS and 2/969/RVD], its amendment 1 (1997) [documents 2/956/FDIS and 2/984/RVD] and amendment 2 (1999) [documents 2/1031+1055+1056/FDIS and 2/1058+1070+1071/RVD].

It bears the edition number 10.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

Annexes A and B are for information only.

MACHINES ÉLECTRIQUES TOURNANTES –

Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement

Section 1: Généralités

1.1 Domaine d'application

La présente norme est applicable à toutes les machines électriques tournantes à l'exception de celles qui font l'objet d'autres normes de la CEI, par exemple la CEI 60349.

Les machines comprises dans le domaine d'application de la présente norme peuvent également être soumises à des prescriptions nouvelles, modifiées ou complémentaires figurant dans d'autres publications – par exemple, la CEI 60079 et la CEI 60092.

NOTE S'il est nécessaire de modifier certains articles de la présente norme afin de permettre des applications spéciales, par exemple pour les matériels soumis à des rayonnements ou les matériels aérospatiaux, tous les autres articles restent valables, pour autant qu'ils ne soient pas en contradiction avec ces spécifications particulières.

1.2 Références normatives

Les documents normatifs suivants contiennent des dispositions qui, par suite de la référence qui y est faite, constituent des dispositions valables pour la présente partie de la CEI 60034. Au moment de la publication, les éditions indiquées étaient en vigueur. Tout document normatif est sujet à révision et les parties prenantes aux accords fondés sur la présente partie de la CEI 60034 sont invitées à rechercher la possibilité d'appliquer les éditions les plus récentes des documents normatifs indiqués ci-après. Les membres de la CEI et de l'ISO possèdent le registre des Normes internationales en vigueur.

CEI 60027-1:1992, *Symboles littéraux à utiliser en électrotechnique – Partie 1: Généralités*

CEI 60027-4:1985, *Symboles littéraux à utiliser en électrotechnique – Partie 4: Symboles des grandeurs relatives aux machines électriques tournantes*

CEI 60034-2:1972, *Machines électriques tournantes – Partie 2: Méthodes pour la détermination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines électriques de traction)*

CEI 60034-3:1988, *Machines électriques tournantes – Partie 3: Règles spécifiques pour les turbomachines synchrones*

CEI 60034-5:1991, *Machines électriques tournantes – Partie 5: Classification des degrés de protection procurés par les enveloppes des machines électriques tournantes (code IP)*

CEI 60034-6:1991, *Machines électriques tournantes – Partie 6: Modes de refroidissement (code IC)*

CEI 60034-12:1980, *Machines électriques tournantes – Partie 12: Caractéristiques de démarrage des moteurs triphasés à induction à cage à une seule vitesse pour des tensions d'alimentation inférieures ou égales à 660 V*

ROTATING ELECTRICAL MACHINES –

Part 1: Rating and performance

Section 1: General

1.1 Scope

This standard is applicable to all rotating electrical machines except those covered by other IEC standards – for example, IEC 60349.

Machines within the scope of this standard may also be subject to superseding, modifying or additional requirements in other publications – for example, IEC 60079, and IEC 60092.

NOTE If particular clauses of this standard are modified to meet special applications, for example machines subject to radioactivity or machines for aerospace, all other clauses apply in so far as they are compatible.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60034. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60027-1:1992, *Letter symbols to be used in electrical technology – Part 1: General*

IEC 60027-4:1985, *Letter symbols to be used in electrical technology – Part 4: Symbols for quantities to be used for rotating electrical machines*

IEC 60034-2:1972, *Rotating electrical machines – Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)*

IEC 60034-3:1988, *Rotating electrical machines – Part 3: Specific requirements for turbine-type synchronous machines*

IEC 60034-5:1991, *Rotating electrical machines – Part 5: Classification of degrees of protection provided by enclosures of rotating electrical machines (IP code)*

IEC 60034-6:1991, *Rotating electrical machines – Part 6: Methods of cooling (IC code)*

IEC 60034-12:1980, *Rotating electrical machines – Part 12: Starting performance of single-speed three-phase cage induction motors for voltages up to and including 660 V*

CEI 60034-15:1995, *Machines électriques tournantes – Partie 15: Niveaux de tension de tenue au choc des machines tournantes à courant alternatif à bobines stator préformées*

CEI 60034-17:1992, *Machines électriques tournantes – Partie 17: Guide d'application des moteurs à induction à cage alimentés par convertisseurs*

CEI 60038:1983, *Tensions normales de la CEI*

CEI 60050(411):1996, *Vocabulaire Electrotechnique International (VEI) – Chapitre 411: Machines tournantes*

CEI 60060, *Techniques des essais à haute tension*

CEI 60060-1:1989, *Techniques des essais à haute tension – Partie 1: Définitions et prescriptions générales relatives aux essais*

CEI 60072, *Dimensions et séries de puissances des machines électriques tournantes*

CEI 60085:1984, *Evaluation et classification thermiques de l'isolation électrique*

CEI 60204-1:1992, *Equipement électrique des machines industrielles – Partie 1: Règles générales*

CEI 60279:1969, *Mesure de la résistance des enroulements d'une machine à courant alternatif en fonctionnement sous tension alternative*

CEI 60364-4-41:1992, *Installations électriques des bâtiments – Partie 4: Protection pour assurer la sécurité – Chapitre 41: Protection contre les chocs électriques*

CEI 60445:1988, *Identification des bornes de matériels et des extrémités de certains conducteurs désignés et règles générales pour un système alphanumérique*

CEI 60449:1973, *Domaines de tensions des installations électriques des bâtiments*

CEI 60971:1989, *Convertisseurs à semi-conducteurs – Code d'identification pour montages convertisseurs*

CEI 61293:1994, *Marquage des matériels électriques avec des caractéristiques assignées relatives à l'alimentation électrique – Prescriptions de sécurité*

CISPR 11:1990, *Limites et méthodes de mesure des caractéristiques de perturbations électromagnétiques des appareils industriels, scientifiques et médicaux (ISM) à fréquence radioélectrique*

CISPR 14:1993, *Limites et méthodes de mesure des perturbations radioélectriques produites par les appareils électrodomestiques ou analogues comportant des moteurs ou des dispositifs thermiques, par les outils et par les appareils électriques analogues*

CISPR 16, *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques*

ISO 497:1973, *Guide pour le choix des séries de nombres normaux et des séries comportant des valeurs plus arrondies de nombres normaux.*

IEC 60034-15:1995, *Rotating electrical machines – Part 15: Impulse voltage withstand levels of rotating a.c. machines with form-wound stator coils*

IEC 60034-17:1992, *Rotating electrical machines – Part 17: Guide for the application of cage induction motors when fed from converters*

IEC 60038:1983, *IEC standard voltages*

IEC 60050(411):1996, *International Electrotechnical Vocabulary (IEV) – Chapter 411: Rotating machines*

IEC 60060, *High-voltage test techniques*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60072, *Dimensions and output series for rotating electrical machines*

IEC 60085:1984, *Thermal evaluation and classification of electrical insulation*

IEC 60204-1:1992, *Electrical equipment of industrial machines – Part 1: General requirements*

IEC 60279:1969, *Measurement of the winding resistance of an a.c. machine during operation at alternating voltage*

IEC 60364-4-41:1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*

IEC 60445:1988, *Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

IEC 60449:1973, *Voltage bands for electrical installations of buildings*

IEC 60971:1989, *Semiconductor convertors. Identification code for convertor connections*

IEC 61293:1994, *Marking of electrical equipment with ratings related to electrical supply – Safety requirements*

CISPR 11:1990, *Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment*

CISPR 14:1993, *Limits and methods of measurement radio disturbance characteristics of electrical motor-operated and thermal appliances for household and similar purposes, electric tools and electric apparatus*

CISPR 16: *Specification for radio disturbance and immunity measuring apparatus and methods*

ISO 497:1973, *Guide to the choice of series of preferred numbers and series containing more rounded values of preferred numbers*

Section 2: Définitions

Pour les besoins de la présente Norme internationale, les définitions de la CEI 60050(411) s'appliquent ainsi que les définitions ci-après.

Pour des définitions autres que celles de 2.17 à 2.22 concernant les modes et les fluides de refroidissement, se référer à la CEI 60034-6.

Au sens de la présente norme, le terme «accord» signifie «accord entre le constructeur et l'acheteur».

2.1
valeur assignée
valeur d'une grandeur fixée, généralement par le constructeur, pour un fonctionnement spécifié d'une machine [VEI 411-51-23]

NOTE La tension assignée ou plage de tensions assignées est la tension assignée ou plage de tensions assignées entre phases aux bornes.

2.2
caractéristiques assignées
ensemble des valeurs assignées et des conditions de fonctionnement [VEI 411-51-24]

2.3
puissance assignée
valeur de la puissance incluse dans les caractéristiques assignées

2.4
charge
ensemble des valeurs des grandeurs électriques et mécaniques qui caractérisent les exigences imposées à une machine tournante par un circuit électrique ou un dispositif mécanique, à un instant donné [VEI 411-51-01]

2.5
fonctionnement à vide
état de fonctionnement d'une machine tournant à puissance nulle (mais les autres conditions étant les conditions normales de fonctionnement) [VEI 411-51-02 modifié]

2.6
pleine charge
charge amenant une machine à fonctionner à ses caractéristiques assignées [VEI 411-51-10]

2.7
valeur de pleine charge
valeur d'une grandeur pour une machine fonctionnant à pleine charge [VEI 411-51-11]

NOTE Cette notion est applicable à la puissance, au couple, au courant, à la vitesse, etc.

2.8
repos
absence complète de tout mouvement et de toute alimentation électrique ou de tout entraînement mécanique [VEI 411-51-03]

Section 2: Definitions

For the purpose of this International Standard, the definitions in IEC 60050(411) and the following definitions apply.

For definitions, other than those in 2.17 to 2.22, concerning cooling and coolants, reference should be made to IEC 60034-6.

For the purpose of this standard, the term 'agreement' means 'agreement between the manufacturer and purchaser'.

2.1
rated value
a quantity value assigned, generally by a manufacturer, for a specified operating condition of a machine [IEV 411-51-23]

NOTE The rated voltage or voltage range is the rated voltage or voltage range between lines at the terminals.

2.2
rating
the set of rated values and operating conditions [IEV 411-51-24]

2.3
rated output
the value of the output included in the rating

2.4
load
all the values of the electrical and mechanical quantities that signify the demand made on a rotating machine by an electrical circuit or a mechanism at a given instant [IEV 411-51-01]

2.5
no-load (operation)
the state of a machine rotating with zero output power (but under otherwise normal operating conditions) [IEV 411-51-02, modified]

2.6
full load
the load which causes a machine to operate at its rating [IEV 411-51-10]

2.7
full load value
a quantity value for a machine operating at full load. [IEV 411-51-11]

NOTE This concept applies to power, torque, current, speed, etc.

2.8
rest and de-energized
the complete absence of all movement and of all electrical supply or mechanical drive
[IEV 411-51-03]

2.9
service
stipulation de la charge (des charges) à laquelle (auxquelles) la machine est soumise, y compris, le cas échéant, les périodes de démarrage, de freinage électrique, de fonctionnement à vide et de repos, ainsi que leurs durées et leur ordre de succession dans le temps [VEI 411-51-06]

2.10
service type
service continu, temporaire ou périodique comprenant une ou plusieurs charges qui restent constantes pendant la durée spécifiée ou service non périodique pendant lequel généralement la charge et la vitesse varient dans la plage de fonctionnement admissible [VEI 411-51-13]

2.11
facteur de marche
rapport entre la période de fonctionnement en charge, y compris le démarrage et le freinage électrique, à la durée du cycle de service, exprimé en pourcentage [VEI 411-51-09]

2.12
couple à rotor bloqué
couple mesuré le plus faible que développe le moteur sur son bout d'arbre d'entraînement, quand son rotor est maintenu bloqué quelle que soit sa position angulaire et qu'il est alimenté à tension et fréquence assignées [VEI 411-48-06]

2.13
courant à rotor bloqué
valeur efficace la plus élevée du courant en régime établi, absorbé par le moteur lorsqu'il est alimenté aux tension et fréquence assignées et que son rotor est maintenu bloqué quelle que soit sa position angulaire [VEI 411-48-16]

2.14
couple minimal pendant le démarrage (d'un moteur à courant alternatif)
valeur la plus faible du couple asynchrone en régime établi, que le moteur développe entre la vitesse nulle et la vitesse qui correspond au couple maximal (couple de décrochage) lorsque le moteur est alimenté à la tension et à la fréquence assignées

Cette définition ne s'applique pas au cas de moteurs asynchrones dont le couple décroît continuellement lorsque la vitesse augmente.

NOTE En plus des couples asynchrones en régime établi, il existe, à des vitesses spécifiques, des couples harmoniques synchrones qui sont fonction de l'angle de charge du rotor.

A de telles vitesses, le couple d'accélération peut être négatif pour certains angles de charge du rotor.

L'expérience et le calcul montrent que c'est une condition de fonctionnement instable et qu'en conséquence les couples harmoniques synchrones n'empêchent pas l'accélération du moteur et sont exclus de cette définition.

2.15
couple maximal (couple de décrochage) (d'un moteur à courant alternatif)
valeur maximale en régime établi du couple asynchrone que le moteur développe sans chute brutale de vitesse, lorsqu'il est alimenté à tension et fréquence assignées

Cette définition ne s'applique pas au cas des moteurs asynchrones dont le couple décroît continuellement lorsque la vitesse augmente.

2.16
couple de décrochage synchrone (d'un moteur)
couple le plus élevé que développe un moteur synchrone à sa température de fonctionnement et à la vitesse de synchronisme, à tension, fréquence et excitation assignées

2.9
duty
the statement of the load(s) to which the machine is subjected, including, if applicable, starting, electric braking, no-load and rest and de-energized periods, and including their durations and sequence in time [IEV 411-51-06]

2.10
duty type
a continuous, short-time or periodic duty, comprising one or more loads remaining constant for the duration specified, or a non-periodic duty in which generally load and speed vary within the permissible operating range [IEV 411-51-13]

2.11
cyclic duration factor
the ratio between the period of loading, including starting and electric braking, and the duration of the duty cycle, expressed as a percentage [IEV 411-51-09]

2.12
locked-rotor torque
the smallest measured torque the motor develops at its shaft and with the rotor locked, over all its angular positions at rated voltage and frequency [IEV 411-48-06]

2.13
locked rotor current
the greatest steady-state r.m.s. current taken from the line with the motor held at rest, over all angular positions of its rotor, at rated voltage and frequency [IEV 411-48-16]

2.14
pull-up torque (of an a.c. motor)
the smallest value of the steady-state asynchronous torque which the motor develops between zero speed and the speed which corresponds to the breakdown torque, when the motor is supplied at the rated voltage and frequency

This definition does not apply to those asynchronous motors of which the torque continually decreases with increase in speed.

NOTE In addition to the steady-state asynchronous torques, harmonic synchronous torques, which are a function of rotor load angle, will be present at specific speeds.

At such speeds the accelerating torque may be negative for some rotor load angles.

Experience and calculation show this to be an unstable operating condition and therefore harmonic synchronous torques do not prevent motor acceleration and are excluded from this definition.

2.15
breakdown torque (of an a.c. motor)
the maximum value of the steady-state asynchronous torque which the motor develops without an abrupt drop in speed, when the motor is supplied at the rated voltage and frequency

This definition does not apply to those asynchronous motors of which the torque continually decreases with increase in speed.

2.16
pull-out torque (of a synchronous motor)
the maximum torque which the synchronous motor develops at operating temperature and at synchronous speed with rated voltage, frequency and field current

2.17
refroidissement
opération par laquelle de la chaleur provenant des pertes produites dans une machine est cédée à un fluide de refroidissement primaire qui peut être continûment remplacé ou être lui-même refroidi dans un échangeur de chaleur par un fluide de refroidissement secondaire [VEI 411-44-01]

2.18
fluide de refroidissement
fluide, liquide ou gaz, par l'intermédiaire duquel la chaleur est transférée [VEI 411-44-02]

2.19
fluide de refroidissement primaire
fluide, liquide ou gaz, qui, se trouvant à une température inférieure à celle des pièces de la machine et en contact avec celles-ci, transporte la chaleur cédée par ces pièces [VEI 411-44-03]

2.20
fluide de refroidissement secondaire
fluide, liquide ou gaz, qui, se trouvant à une température inférieure à celle du fluide de refroidissement primaire, transporte la chaleur cédée par ce fluide primaire au moyen d'un échangeur de chaleur ou à travers la surface extérieure de la machine [VEI 411-44-04]

2.21
enroulement à refroidissement direct (refroidissement interne)[1)]
enroulement refroidi principalement par un fluide de refroidissement s'écoulant en contact direct avec la partie refroidie à travers des passages creux, tubes, conduits ou canaux qui, quelle que soit leur orientation, forment partie intégrante de l'enroulement à l'intérieur de l'isolation principale [VEI 411-44-08]

2.22
enroulement à refroidissement indirect[1)]
tout enroulement autre qu'un enroulement à refroidissement direct [VEI 411-4-09]

2.23
isolation supplémentaire
isolation indépendante prévue en plus de l'isolation principale, en vue d'assurer la protection contre les chocs électriques en cas de défaut survenant dans l'isolation principale

2.24
moment d'inertie
somme (intégrale) des produits des masses élémentaires d'un corps par le carré de leurs distances (radiales) par rapport à un axe donné

2.25
équilibre thermique
état atteint lorsque les échauffements des diverses parties de la machine ne varient pas de plus d'un gradient de 2 K par heure [VEI 411-51-08]

NOTE On peut déterminer l'équilibre thermique à partir d'un tracé de l'échauffement en fonction du temps, lorsque les droites entre points pris en début et fin de chacun de deux intervalles de temps raisonnables successifs ont une pente de moins de 2 K par heure.

[1)] Dans tous les cas où «indirect» ou «direct» n'est pas indiqué, il s'agit d'un enroulement à refroidissement indirect.

2.17
cooling
a procedure by means of which heat resulting from losses occurring in a machine is given up to a primary coolant, which may be continuously replaced or may itself be cooled by a secondary coolant in a heat exchanger [IEV 411-44-01]

2.18
coolant
a medium, liquid or gas, by means of which heat is transferred [IEV 411-44-02]

2.19
primary coolant
a medium, liquid or gas, which, being at a lower temperature than a part of a machine and in contact with it, removes heat from that part [IEV 411-44-03]

2.20
secondary coolant
a medium, liquid or gas, which, being at a lower temperature than the primary coolant, removes the heat given up by this primary coolant by means of a heat exchanger or through the external surface of the machine [IEV 411-44-04]

2.21
direct cooled (inner cooled) winding[1)]
a winding mainly cooled by coolant flowing in direct contact with the cooled part through hollow conductors, tubes, ducts or channels which, regardless of their orientation, form an integral part of the winding inside the main insulation [IEV 411-44-08]

2.22
indirect cooled winding[1)]
any winding other than a direct cooled winding [IEV 411-44-09]

2.23
supplementary insulation
an independent insulation applied in addition to the main insulation in order to ensure protection against electric shock in the event of failure of the main insulation

2.24
moment of inertia
the sum (integral) of the products of the mass elements of a body and the squares of their distances (radii) from a given axis

2.25
thermal equilibrium
the state reached when the temperature rises of the several parts of the machine do not vary by more than a gradient of 2 K per hour [IEV 411-51-08]

NOTE Thermal equilibrium may be determined from the time-temperature rise plot when the straight lines between points at the beginning and end of two successive reasonable intervals each have a gradient of less than 2 K per hour.

[1)] In all cases when ‘indirect’ or ‘direct’ is not stated, an indirect cooled winding is implied.

2.26
constante de temps thermique équivalente
constante de temps qui, en remplaçant plusieurs constantes de temps individuelles, détermine approximativement l'évolution de la température dans un enroulement après une variation de courant en échelon

2.27
enroulement enrobé
enroulement complètement enfermé ou noyé dans un isolant moulé [VEI 411-39-06]

2.28
valeur assignée du facteur de forme du courant continu fourni à l'induit d'un moteur à courant continu par un convertisseur statique de puissance
rapport de la valeur efficace maximale admissible du courant $I_{\text{eff.maxN}}$ à sa valeur moyenne I_{moyN} (valeur moyenne intégrée sur une période) aux conditions assignées:

$$k_{\text{fN}} = \frac{I_{\text{eff.maxN}}}{I_{\text{moyN}}}$$

2.29
facteur d'ondulation du courant
rapport de la différence entre la valeur maximale I_{max} et la valeur minimale I_{min} d'un courant ondulé au double de sa valeur moyenne I_{moy} (valeur moyenne intégrée sur une période):

$$q_{\text{i}} = \frac{I_{\text{max}} - I_{\text{min}}}{2 \times I_{\text{moy}}}$$

NOTE Pour de faibles valeurs d'ondulation du courant, le facteur d'ondulation peut être approché par la formule suivante:

$$q_{\text{i}} = \frac{I_{\text{max}} - I_{\text{min}}}{I_{\text{max}} + I_{\text{min}}}$$

La formule ci-dessus peut être utilisée en tant qu'approximation si la valeur calculée résultante de q_{i} est inférieure ou égale à 0,4.

Section 3: Services

3.1 Spécification du service

C'est à l'acheteur qu'incombe la responsabilité de spécifier le service. L'acheteur peut décrire le service par l'une des méthodes suivantes:

a) numériquement, si la charge ne varie pas ou varie de façon connue;

b) graphiquement, par une représentation des grandeurs variables en fonction du temps;

c) en choisissant l'un des services types S1 à S10 qui est au moins aussi sévère que le service prévu.

Le service type peut être désigné par l'abréviation appropriée spécifiée en 3.2, à la suite de la valeur de la charge.

Une formulation du facteur de marche est indiquée sous chaque figure appropriée de service type.

2.26
thermal equivalent time constant
the time constant, replacing several individual time constants, which determines approximately the temperature course in a winding after a step-wise current change

2.27
encapsulated winding
a winding which is completely enclosed or sealed by moulded insulation [IEV 411-39-06]

2.28
rated form factor of direct current supplied to a d.c. motor armature from a static power converter
the ratio of the r.m.s. maximum permissible value of the current $I_{\text{rms, maxN}}$ to its average value I_{avN} (mean value integrated over one period) at rated conditions:

$$k_{\text{fN}} = \frac{I_{\text{rms, maxN}}}{I_{\text{avN}}}$$

2.29
current ripple factor
the ratio of the difference between the maximum value I_{max} and the minimum value I_{min} of an undulating current to two times the average value I_{av} (mean value integrated over one period):

$$q_{\text{i}} = \frac{I_{\text{max}} - I_{\text{min}}}{2 \times I_{\text{av}}}$$

NOTE For small values of current ripple the ripple factor may be approximated by the following expression:

$$q_{\text{i}} = \frac{I_{\text{max}} - I_{\text{min}}}{I_{\text{max}} + I_{\text{min}}}$$

The above expression may be used as an approximation if the resulting calculated value of q_{i} is equal to or less than 0,4.

Section 3: Duty

3.1 Declaration of duty

It is the responsibility of the purchaser to declare the duty. The purchaser may describe the duty by one of the following:

a) numerically, where the load does not vary or where it varies in a known manner;

b) as a time sequence graph of the variable quantities;

c) by selecting one of the duty types S1 to S10 that is no less onerous than the expected duty.

The duty type shall be designated by the appropriate abbreviation, specified in 3.2, written after the value of the load.

An expression for the cyclic duration factor is given in the relevant duty type figure.

Normalement l'acheteur ne peut pas fournir une valeur au moment d'inertie du moteur (J_M) ni à l'espérance de vie thermique en valeur relative (TL), voir annexe A. Ces valeurs sont fournies par le constructeur.

Lorsque l'acheteur ne stipule pas de service, le constructeur doit considérer que le service type S1 (service continu) est applicable.

3.2 Services types

3.2.1 Service type S1 – Service continu

Fonctionnement à charge constante maintenue pendant une durée suffisante pour que la machine atteigne l'équilibre thermique, voir figure 1.

L'abréviation appropriée est S1.

3.2.2 Service type S2 – Service temporaire

Fonctionnement à charge constante pendant un temps déterminé, moindre que celui requis pour atteindre l'équilibre thermique, suivi d'un temps de repos d'une durée suffisante pour rétablir à 2 K près l'égalité de température entre la machine et le fluide de refroidissement, voir figure 2.

L'abréviation appropriée est S2, suivi de la valeur de la durée du service.

Exemple: S2 60 min.

3.2.3 Service type S3 – Service intermittent périodique [2)]

Suite de cycles de service identiques comprenant chacun un temps de fonctionnement à charge constante et un temps de repos, voir figure 3. Dans ce service, le cycle est tel que le courant de démarrage n'affecte pas l'échauffement de façon significative.

L'abréviation appropriée est S3, suivi de la valeur du facteur de marche.

Exemple: S3 25 %.

3.2.4 Service type S4 – Service intermittent périodique à démarrage [2)]

Suite de cycles de service identiques comprenant chacun un temps non négligeable de démarrage, un temps de fonctionnement à charge constante et un temps de repos, voir figure 4.

L'abréviation appropriée est S4, suivi des valeurs du facteur de charge, du moment d'inertie du moteur (J_M) et du moment d'inertie de la charge (J_{ext}), tous deux rapportés à l'arbre du moteur.

Exemple: S4 25 % J_M = 0,15 kg × m² J_{ext} = 0,7 kg × m²

3.2.5 Service type S5 – Service intermittent périodique à freinage électrique [2)]

Suite de cycles de service identiques comprenant chacun un temps de démarrage, un temps de fonctionnement à charge constante, un temps de freinage électrique et un temps de repos, voir figure 5.

[2)] Un service type périodique implique que l'équilibre thermique n'est pas atteint pendant la période de charge.

The purchaser normally cannot provide values for the moment of inertia of the motor (J_M) or the relative thermal life expectancy (TL), see annex A. These values are provided by the manufacturer.

Where the purchaser does not declare a duty, the manufacturer shall assume that duty type S1 (continuous running duty) applies.

3.2 Duty types

3.2.1 Duty type S1 – Continuous running duty

Operation at a constant load maintained for sufficient time to allow the machine to reach thermal equilibrium, see figure 1.

The appropriate abbreviation is S1.

3.2.2 Duty type S2 – Short-time duty

Operation at constant load for a given time, less than that required to reach thermal equilibrium, followed by a time at rest and de-energized, of sufficient duration to re-establish machine temperatures within 2 K of the coolant temperature, see figure 2.

The appropriate abbreviation is S2, followed by an indication of the duration of the duty,

Example: S2 60 min

3.2.3 Duty type S3 – Intermittent periodic duty [2)]

A sequence of identical duty cycles, each including a time of operation at constant load and a time at rest and de-energized, see figure 3. In this duty, the cycle is such that the starting current does not significantly affect the temperature rise.

The appropriate abbreviation is S3, followed by the cyclic duration factor.

Example: S3 25 %

3.2.4 Duty type S4 – Intermittent periodic duty with starting [2)]

A sequence of identical duty cycles, each cycle including a significant starting time, a time of operation at constant load and a time at rest and de-energized, see figure 4.

The appropriate abbreviation is S4, followed by the cyclic duration factor, the moment of inertia of the motor (J_M) and the moment of inertia of the load ($J_{ext)}$, both referred to the motor shaft.

Example: S4 25 % $J_M = 0{,}15\ \text{kg} \times \text{m}^2$ $J_{ext} = 0{,}7\ \text{kg} \times \text{m}^2$

3.2.5 Duty type S5 – Intermittent periodic duty with electric braking [2)]

A sequence of identical duty cycles, each cycle consisting of a starting time, a time of operation at constant load, a time of electric braking and a time at rest and de-energized, see figure 5.

[2)] Periodic duty implies that thermal equilibrium is not reached during the time on load.

L'abréviation appropriée est S5, suivi des valeurs du facteur de marche, du moment d'inertie du moteur (J_M) et du moment d'inertie de la charge (J_{ext}), tous deux rapportés à l'arbre du moteur.

Exemple: S5 25 % $J_M = 0{,}15\ kg \times m^2$ $J_{ext} = 0{,}7\ kg \times m^2$

3.2.6 Service type S6 – Service ininterrompu périodique à charge intermittente [2)]

Suite de cycles de service identiques comprenant chacun un temps de fonctionnement à charge constante et un temps de fonctionnement à vide. Il n'y a pas de temps de repos, voir figure 6.

L'abréviation appropriée est S6, suivi de la valeur du facteur de marche.

Exemple: S6 40 %

3.2.7 Service type S7 – Service ininterrompu périodique à freinage électrique [2)]

Suite de cycles de service identiques comprenant chacun un temps de démarrage, un temps de fonctionnement à charge constante et un temps de freinage électrique. Il n'y a pas de temps de repos, voir figure 7.

L'abréviation appropriée est S7 suivi des valeurs du moment d'inertie du moteur (J_M) et du moment d'inertie de la charge (J_{ext}), tous deux rapportés à l'arbre du moteur.

Exemple: S7 $J_M = 0{,}4\ kg \times m^2$ $J_{ext} = 7{,}5\ kg \times m^2$

3.2.8 Service type S8 – Service ininterrompu périodique à changements liés de charge et de vitesse [2)]

Suite de cycles de service identiques comprenant chacun un temps de fonctionnement à charge constante correspondant à une vitesse de rotation prédéterminée, suivie d'un ou plusieurs temps de fonctionnement à d'autres charges constantes correspondant à différentes vitesses de rotation (réalisées par exemple par changement du nombre de pôles dans le cas des moteurs à induction). Il n'y a pas de temps de repos (voir figure 8).

L'abréviation appropriée est S8 suivi des valeurs du moment d'inertie du moteur (J_M) et du moment d'inertie de la charge (J_{ext}), tous deux rapportés à l'arbre du moteur, de même que de la charge, de la vitesse et du facteur de marche pour chacun des régimes caractérisés par une vitesse.

Exemple: S8 $J_M = 0{,}5\ kg \times m^2$ $J_{ext} = 6\ kg \times m^2$

16 kW	740 min^{-1}	30 %
40 kW	1 460 min^{-1}	30 %
25 kW	980 min^{-1}	40 %

3.2.9 Service type S9 – Service à variations non périodiques de charge et de vitesse

Service dans lequel généralement la charge et la vitesse ont une variation non périodique dans la plage de fonctionnement admissible. Ce service inclut fréquemment des surcharges appliquées qui peuvent être largement supérieures à la charge de référence (voir figure 9).

L'abréviation appropriée est S9.

[2)] Un service type périodique implique que l'équilibre thermique n'est pas atteint pendant la période de charge.

The appropriate abbreviation is S5, followed by the cyclic duration factor, the moment of inertia of the motor (J_M) and the moment of inertia of the load (J_{ext}), both referred to the motor shaft.

Example: S5 25 % $J_M = 0{,}15\ kg \times m^2$ $J_{ext} = 0{,}7\ kg \times m^2$

3.2.6 Duty type S6 – Continuous-operation periodic duty [2)]

A sequence of identical duty cycles, each cycle consisting of a time of operation at constant load and a time of operation at no-load. There is no time at rest and de-energized, see figure 6.

The appropriate abbreviation is S6, followed by the cyclic duration factor.

Example: S6 40 %

3.2.7 Duty type S7 – Continuous-operation periodic duty with electric braking [2)]

A sequence of identical duty cycles, each cycle consisting of a starting time, a time of operation at constant load and a time of electric braking. There is no time at rest and de-energized, see figure 7.

The appropriate abbreviation is S7, followed by the moment of inertia of the motor (J_M) and the moment of inertia of the load (J_{ext}), both referred to the motor shaft.

Example: S7 $J_M = 0{,}4\ kg \times m^2$ $J_{ext} = 7{,}5\ kg \times m^2$

3.2.8 Duty type S8 – Continuous-operation periodic duty with related load/speed changes [2)]

A sequence of identical duty cycles, each cycle consisting of a time of operation at constant load corresponding to a predetermined speed of rotation, followed by one or more times of operation at other constant loads corresponding to different speeds of rotation (carried out, for example, by means of a change in the number of poles in the case of induction motors). There is no time at rest and de-energized (see figure 8).

The appropriate abbreviation is S8, followed by the moment of inertia of the motor (J_M) and the moment of inertia of the load (J_{ext}), both referred to the motor shaft, together with the load, speed and cyclic duration factor for each speed condition.

Example:	S8 $J_M = 0{,}5\ kg \times m^2$	$J_{ext} = 6\ kg \times m^2$	16 kW	740 min^{-1}	30 %
			40 kW	1 460 min^{-1}	30 %
			25 kW	980 min^{-1}	40 %

3.2.9 Duty type S9 – Duty with non-periodic load and speed variations

A duty in which generally load and speed vary non-periodically within the permissible operating range. This duty includes frequently applied overloads that may greatly exceed the reference load (see figure 9).

The appropriate abbreviation is S9.

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2) Periodic duty implies that thermal equilibrium is not reached during the time on load.

Pour ce service type, une charge constante, judicieusement choisie et basée sur le service type S1, est prise comme valeur de référence («P_{ref}» dans la figure 9) pour la notion de surcharge.

3.2.10 Service type S10 – Service avec charges constantes distinctes

Service comprenant au plus quatre valeurs distinctes de charges (ou charges équivalentes), chaque charge étant maintenue pendant une durée suffisante pour permettre à la machine d'atteindre l'équilibre thermique, voir figure 10. La charge minimale pendant un cycle de service peut avoir la valeur zéro (fonctionnement à vide ou temps de repos).

L'abréviation appropriée est S10, suivi des valeurs réduites (p.u.) $p/\Delta t$ pour les différentes charges et leurs durées respectives, et de la valeur réduite (p.u.) TL pour l'espérance de vie thermique relative du système d'isolation. La valeur de référence pour l'espérance de vie thermique est l'espérance de vie thermique aux caractéristiques assignées pour service continu et aux limites admissibles d'échauffement basées sur le service type S1. Pour un temps de repos, la charge doit être indiquée par la lettre r.

Exemple: S10 $p/\Delta t$ = 1,1/0,4; 1/0,3; 0,9/0,2; r/0,1 TL = 0,6

Il convient d'arrondir la valeur de TL au plus proche multiple de 0,05. L'annexe A donne des indications sur la signification de ce paramètre et la détermination de sa valeur.

Pour ce service type, une charge constante, judicieusement choisie et basée sur le service type S1, doit être prise comme valeur de référence («P_{ref}» dans la figure 10) pour les charges distinctes.

NOTE Les valeurs distinctes de charges seront habituellement des charges équivalentes obtenues par intégration en fonction du temps. Il n'est pas nécessaire que chaque cycle de charge soit exactement le même, à condition que chaque charge à l'intérieur d'un cycle soit appliquée pendant une période suffisante pour que l'équilibre thermique soit atteint et que chaque cycle de charge puisse être intégré pour donner la même espérance de vie thermique relative.

Section 4: Caractéristiques assignées

4.1 Attribution des caractéristiques assignées

Les caractéristiques assignées, définies en 2.2, doivent être attribuées par le constructeur. En attribuant les caractéristiques assignées, le constructeur doit choisir l'une des classes de caractéristiques assignées définies de 4.2.1 à 4.2.6. La valeur de la puissance assignée doit être suivie par la désignation d'un service. Si aucune désignation n'est stipulée, les caractéristiques assignées pour service continu sont applicables.

Quand des composants auxiliaires (tels que des inductances, des capacités, etc.) sont insérés par le fabricant en tant qu'éléments de la machine, les valeurs assignées doivent se rapporter aux bornes d'alimentation de l'ensemble complet.

NOTE Cela ne s'applique pas aux transformateurs de puissance connectés entre la machine et l'alimentation.

Une attention spéciale est demandée lors de l'attribution de caractéristiques assignées à des machines alimentées par, ou alimentant, des convertisseurs statiques. La CEI 60034-17 donne des conseils pour le cas des moteurs à induction à cage couverts par la CEI 60034-12.

For this duty type a constant load appropriately selected and based on duty type S1 is taken as the reference value ("P_{ref}" in figure 9) for the overload concept.

3.2.10 Duty type S10 – Duty with discrete constant loads

A duty consisting of not more than four discrete values of load (or equivalent loading), each value being maintained for sufficient time to allow the machine to reach thermal equilibrium, see figure 10. The minimum load within a duty cycle may have the value zero (no-load or rest and de-energized).

The appropriate abbreviation is S10, followed by the p.u. quantities $p/\Delta t$ for the respective load and its duration and the p.u. quantity TL for the relative thermal life expectancy of the insulation system. The reference value for the thermal life expectancy is the thermal life expectancy at rating for continuous running duty and permissible limits of temperature rise based on duty type S1. For a time at rest and de-energized, the load shall be indicated by the letter r.

Example: S10 $p/\Delta t$ = 1,1/0,4; 1/0,3; 0,9/0,2; r/0,1 TL = 0,6

The value of TL should be rounded off to the nearest multiple of 0,05. Advice concerning the significance of this parameter and the derivation of its value is given in annex A.

For this duty type a constant load appropriately selected and based on duty type S1 shall be taken as the reference value ('P_{ref}' in figure 10) for the discrete loads.

NOTE The discrete values of load will usually be equivalent loading based on integration over a period of time. It is not necessary that each load cycle be exactly the same, only that each load within a cycle be maintained for sufficient time for thermal equilibrium to be reached, and that each load cycle be capable of being integrated to give the same relative thermal life expectancy.

Section 4: Rating

4.1 Assignment of rating

The rating, as defined in 2.2, shall be assigned by the manufacturer. In assigning the rating the manufacturer shall select one of the classes of rating defined in 4.2.1 to 4.2.6. The designation of the class of rating shall be written after the rated output. If no designation is stated, rating for continuous running duty applies.

When accessory components (such as reactors, capacitors, etc.) are connected by the manufacturer as part of the machine, the rated values shall refer to the supply terminals of the whole arrangement.

NOTE This does not apply to power transformers connected between the machine and the supply.

Special considerations are required when assigning ratings to machines fed from or supplying static converters. IEC 60034-17 gives guidance for the case of cage induction motors covered in IEC 60034-12.

4.2 Classes de caractéristiques assignées

4.2.1 Caractéristiques assignées pour service continu

Caractéristiques assignées auxquelles la machine peut fonctionner pendant une durée illimitée et conformément aux prescriptions de la présente norme.

Cette classe de caractéristiques assignées correspond au service type S1 et est désignée comme le service type S1.

4.2.2 Caractéristiques assignées pour service temporaire

Caractéristiques assignées auxquelles la machine peut fonctionner pendant une durée limitée, en démarrant à la température ambiante et conformément aux prescriptions de la présente norme.

Cette classe de caractéristiques assignées correspond au service type S2 et est désignée comme le service type S2.

4.2.3 Caractéristiques assignées pour service périodique

Caractéristiques assignées auxquelles la machine peut fonctionner suivant des cycles de service, conformément aux prescriptions de la présente norme.

Cette classe de caractéristiques assignées correspond à l'un des services types périodiques S3 à S8 et est désignée comme le service type correspondant.

Sauf spécifications contraires, la durée d'un cycle de service doit être de 10 min et le facteur de marche doit avoir l'une des valeurs suivantes:

15 %, 25 %, 40 %, 60 %.

4.2.4 Caractéristiques assignées pour service non périodique

Caractéristiques assignées auxquelles la machine peut fonctionner de façon non périodique, conformément aux prescriptions de la présente norme.

Cette classe de caractéristiques assignées correspond au service type non périodique S9 et est désignée comme le service type S9.

4.2.5 Caractéristiques assignées pour service avec charges constantes distinctes

Caractéristiques assignées auxquelles la machine peut fonctionner avec l'association des charges du service type S10, pendant une durée illimitée tout en satisfaisant aux prescriptions de la présente norme. La charge maximale admissible dans un cycle doit prendre en considération tous les éléments de la machine, par exemple le système d'isolation en ce qui concerne la validité de la loi exponentielle pour l'espérance de vie thermique relative, les paliers en ce qui concerne la température, d'autres éléments en ce qui concerne la dilatation thermique. Sauf spécifications dans d'autres normes de la CEI, la charge maximale ne dépassera pas 1,2 fois la valeur de la charge basée sur le service type S1. La charge minimale peut avoir la valeur zéro quand la machine fonctionne à vide ou est au repos. Des informations concernant l'application de cette classe de caractéristiques assignées sont données en annexe A.

Cette classe de caractéristiques assignées correspond au service type S10 et est désignée comme le service type S10.

4.2 Classes of rating

4.2.1 Rating for continuous running duty

A rating at which the machine may be operated for an unlimited period, while complying with the requirements of this standard.

This class of rating corresponds to duty type S1 and is designated as for the duty type S1.

4.2.2 Rating for short-time duty

A rating at which the machine may be operated for a limited period, starting at ambient temperature, while complying with the requirements of this standard.

This class of rating corresponds to duty type S2 and is designated as for the duty type S2.

4.2.3 Rating for periodic duty

A rating at which the machine may be operated on duty cycles, while complying with the requirements of this standard.

This class of rating corresponds to one of the periodic duty types S3 to S8 and is designated as for the corresponding duty type.

Unless otherwise specified, the duration of a duty cycle shall be 10 min and the cyclic duration factor shall be one of the following values:

15 %, 25 %, 40 %, 60 %.

4.2.4 Rating for non-periodic duty

A rating at which the machine may be operated non-periodically while complying with the requirements of this standard.

This class of rating corresponds to the non-periodic duty type S9 and is designated as for the duty type S9.

4.2.5 Rating for duty with discrete constant loads

A rating at which the machine may be operated with the associated loads of duty type S10 for an unlimited period of time while complying with the requirements of this standard. The maximum permissible load within one cycle shall take into consideration all parts of the machine, e.g. the insulation system regarding the validity of the exponential law for the relative thermal life expectancy, bearings with respect to temperature, other parts with respect to thermal expansion. Unless specified in other relevant IEC standards, the maximum load shall not exceed 1,2 times the value of the load based on duty type S1. The minimum load may have the value zero, the machine operating at no-load or being at rest and de-energized. Considerations for the application of this class of rating are given in annex A.

This class of rating corresponds to the duty type S10 and is designated as for the duty type S10.

NOTE D'autres normes appropriées de la CEI peuvent spécifier la charge maximale en termes de limitation de la température (ou d'échauffement) d'enroulement au lieu d'une valeur relative de la charge basée sur le service type S1.

4.2.6 Caractéristiques assignées pour charge équivalente

Caractéristiques assignées auxquelles, à des fins d'essais, la machine peut fonctionner à charge constante jusqu'à ce que l'équilibre thermique soit atteint et qui conduisent au même échauffement de l'enroulement statorique qu'à la fin de l'essai en services type.

NOTE Pour déterminer des caractéristiques assignées du type équivalent, il convient de prendre en compte les charge, vitesse et refroidissement variables du cycle de service.

Le cas échéant, cette classe de caractéristiques assignées est désignée «équ».

4.3 Choix d'une classe de caractéristiques assignées

Une machine construite en vue d'un usage général doit avoir des caractéristiques assignées pour service continu et être capable de fonctionner en service type S1.

Si le service n'a pas été spécifié par l'acheteur, le service type S1 est applicable et les caractéristiques assignées doivent être des caractéristiques assignées pour service continu.

Lorsqu'une machine est prévue pour des caractéristiques assignées pour service temporaire, les caractéristiques assignées doivent être basées sur le service type S2, voir 3.2.2.

Lorsqu'une machine est prévue pour fonctionner à des charges variables ou des charges comprenant un temps de fonctionnement à vide ou des temps pendant lesquelles la machine est à l'état de repos, les caractéristiques assignées doivent être des caractéristiques assignées pour service périodique basées sur un service type choisi parmi les services types S3 à S8, voir 3.2.3 à 3.2.8.

Lorsqu'une machine est prévue pour fonctionner de façon non périodique à des charges variables à des vitesses variables, y compris à des surcharges, les caractéristiques assignées doivent être des caractéristiques assignées pour service non périodique basées sur le service type S9, voir 3.2.9.

Lorsqu'une machine est prévue pour fonctionner à des charges constantes distinctes comprenant des temps de surcharge ou des temps de marche à vide (ou de repos) les caractéristiques assignées doivent être des caractéristiques assignées pour service avec charges constantes distinctes basées sur le service type S10, voir 3.2.10.

4.4 Attribution de la puissance à une classe de caractéristiques assignées

Dans la détermination des caractéristiques assignées:

Pour les services types S1 à S8, la ou les valeurs spécifiées des charges constantes doivent être les puissances assignées; voir 3.2.1 à 3.2.8.

Pour les services types S9 et S10, la valeur de référence de la charge basée sur le service type S1 doit être prise comme puissance assignée, voir 3.2.9 et 3.2.10.

4.5 Puissance assignée

4.5.1 Génératrices à courant continu

La puissance assignée est la puissance aux bornes; elle doit être exprimée en watts (W).

NOTE Other relevant IEC standards may specify the maximum load in terms of limiting winding temperature (or temperature rise) instead of per unit load based on duty type S1.

4.2.6 Rating for equivalent loading

A rating, for test purposes, at which the machine may be operated at constant load until thermal equilibrium is reached and which results in the same stator winding temperature rise as at the end of the test on the specified duty type.

NOTE The determination of an equivalent rating should take account of the varying load, speed and cooling of the duty cycle.

This class of rating, if applied, is designated 'equ'.

4.3 Selection of a class of rating

A machine manufactured for general purpose shall have a rating for continuous running duty and be capable of performing duty type S1.

If the duty has not been specified by the purchaser, duty type S1 applies and the rating assigned shall be a rating for continuous running duty.

When a machine is intended to have a rating for short-time duty, the rating shall be based on duty type S2, see 3.2.2.

When a machine is intended to supply varying loads or loads including a time of no-load or times where the machine will be in a state of rest and de-energized, the rating shall be a rating for periodic duty based on a duty type selected from duty types S3 to S8, see 3.2.3 to 3.2.8.

When a machine is intended non-periodically to supply variable loads at variable speeds, including overloads, the rating shall be a rating for non-periodic duty based on duty type S9, see 3.2.9.

When a machine is intended to supply discrete constant loads including times of overload or times of no-load (or rest and de-energized) the rating shall be a rating with discrete constant loads based on duty type S10, see 3.2.10.

4.4 Allocation of outputs to class of rating

In the determination of the rating:

For duty types S1 to S8, the specified value(s) of the constant load(s) shall be the rated output(s), see 3.2.1 to 3.2.8.

For duty types S9 and S10, the reference value of the load based on duty type S1 shall be taken as the rated output, see 3.2.9 and 3.2.10.

4.5 Rated output

4.5.1 DC generators

The rated output is the output at the terminals and shall be expressed in watts (W).

4.5.2 Alternateurs

La puissance assignée est la puissance électrique apparente aux bornes; elle doit être exprimée en voltampères (VA), complétée par l'indication du facteur de puissance.

Le facteur de puissance assigné des alternateurs synchrones doit être de 0,8 surexcité, sauf spécification contraire de l'acheteur.

4.5.3 Moteurs

La puissance assignée est la puissance mécanique disponible sur l'arbre; elle doit être exprimée en watts (W).

NOTE Il est d'usage dans de nombreux pays d'exprimer aussi la puissance mécanique disponible sur l'arbre en chevaux (1 h.p. est équivalent à 745,7 W; 1 ch est équivalent à 736 W).

4.5.4 Compensateurs synchrones

La puissance assignée est la puissance réactive aux bornes; elle doit être exprimée en voltampères réactifs (var) soit en régime sous-excité soit en régime surexcité.

4.6 Tension assignée

4.6.1 Génératrices de courant continu

Pour les génératrices de courant continu prévues pour fonctionner dans une plage de tensions d'étendue relativement faible, la puissance assignée et le courant assigné doivent, sauf spécification contraire, être applicables à la limite supérieure de la plage de tensions, voir également 6.3.

4.6.2 Alternateurs

Pour les alternateurs prévus pour fonctionner dans une plage de tensions d'étendue relativement faible, la puissance assignée et le facteur de puissance assigné doivent, sauf spécification contraire, être applicables à toute tension de la plage (voir également 6.3).

4.7 Coordination des tensions et des puissances

En pratique on ne construit pas des machines de toutes caractéristiques assignées et de toutes tensions assignées. En général, pour les machines à courant alternatif, en se basant sur des considérations de conception et de fabrication, les tensions assignées préférables supérieures à 1 kV sont indiquées ci-dessus, en fonction des puissances assignées.

Tension assignée kV	**Puissance assignée minimale** kW (ou kVA)
$1{,}0 < U_N \leq 3{,}0$	100
$3{,}0 < U_N \leq 6{,}0$	150
$6{,}0 < U_N \leq 11{,}0$	800
$11{,}0 < U_N \leq 15{,}0$	2 500

4.5.2 AC generators

The rated output is the apparent power at the terminals and shall be expressed in volt-amperes (VA) together with the power factor.

The rated power factor for synchronous generators shall be 0,8 lagging (over-excited), unless otherwise specified by the purchaser.

4.5.3 Motors

The rated output is the mechanical power available at the shaft and shall be expressed in watts (W).

NOTE It is the practice in some countries for the mechanical power available at the shafts of motors to be expressed in horsepower (1 h.p. is equivalent to 745,7 W; 1 ch (cheval or metric horsepower) is equivalent to 736 W).

4.5.4 Synchronous condensers

The rated output is the reactive power at the terminals and shall be expressed in volt-amperes reactive (var) in either leading (under-excited) or lagging (over-excited) conditions.

4.6 Rated voltage

4.6.1 DC generators

For d.c. generators intended to operate over a relatively small range of voltage, the rated output and current shall apply at the highest voltage of the range, unless otherwise specified, see also 6.3.

4.6.2 AC generators

For a.c. generators intended to operate over a relatively small range of voltage, the rated output and power factor shall apply at any voltage within the range, unless otherwise specified (see also 6.3).

4.7 Coordination of voltages and outputs

It is not practical to build machines of all ratings for all rated voltages. In general, for a.c. machines, based on design and manufacturing considerations, preferred voltage ratings above 1 kV in terms of rated output are as follows:

Rated voltage kV	**Minimum rated output** kW (or kVA)
$1{,}0 < U_N \leq 3{,}0$	100
$3{,}0 < U_N \leq 6{,}0$	150
$6{,}0 < U_N \leq 11{,}0$	800
$11{,}0 < U_N \leq 15{,}0$	2 500

4.8 Machines à plus d'un ensemble de caractéristiques assignées

Pour les machines prévues pour plus d'un ensemble de caractéristiques assignées, la machine doit être conforme, à tous points de vue, à la présente norme pour chaque ensemble de caractéristiques assignées.

Pour les moteurs à plusieurs vitesses, des caractéristiques assignées doivent être attribuées pour chaque vitesse.

Quand une grandeur assignée (puissance, tension, vitesse, etc.) peut avoir plusieurs valeurs ou varier constamment entre deux limites, les caractéristiques assignées doivent être attribuées à ces valeurs ou limites. Cette disposition ne s'applique ni aux variations de tension et de fréquence en fonctionnement définies en 6.3, ni au montage étoile-triangle pour le démarrage.

Section 5: Conditions de fonctionnement sur site

5.1 Généralités

Sauf spécifications contraires, les machines doivent être appropriées aux conditions de fonctionnement sur site données ci-dessous. Pour des conditions de fonctionnement sur site différentes de ces valeurs, des corrections sont données en 7.

5.2 Altitude

L'altitude ne doit pas dépasser 1 000 m au-dessus du niveau de la mer.

5.3 Température maximale de l'air ambiant

La température de l'air ambiant ne doit pas dépasser 40 °C.

5.4 Température minimale de l'air ambiant

La température de l'air ambiant ne doit pas être inférieure à –15 °C, quelle que soit la machine.

Pour une machine possédant un des éléments suivants:

a) une puissance assignée supérieure à 3 300 kW (ou kVA) par 1 000 min^{-1};
b) une puissance assignée inférieure à 600 W (ou VA);
c) un collecteur;
d) un palier à coussinet;
e) l'eau comme fluide de refroidissement primaire ou secondaire,

la température minimale de l'air ambiant ne doit pas être inférieure à 0 °C.

5.5 Température de l'eau de refroidissement

La température de l'eau de refroidissement à l'entrée d'une machine ou d'un échangeur de chaleur ne doit pas dépasser +25 °C ou être inférieure à +5 °C.

4.8 Machines with more than one rating

For machines with more than one rating, the machine shall comply with this standard in all respects at each rating.

For multi-speed motors, a rating shall be assigned for each speed.

When a rated quantity (output, voltage, speed, etc.) may assume several values or vary continuously within two limits, the rating shall be stated at these values or limits. This provision does not apply to voltage and frequency variations during operation as defined in 6.3 or to star-delta connections intended for starting.

Section 5: Site operating conditions

5.1 General

Unless otherwise specified machines shall be suitable for the following site operation conditions. For site operating conditions deviating from those values corrections are given in 7.

5.2 Altitude

The altitude shall not exceed 1 000 m above sea-level.

5.3 Maximum ambient air temperature

The ambient air temperature shall not exceed 40 °C.

5.4 Minimum ambient air temperature

The ambient air temperature shall not be less than –15 °C for any machine.

For a machine with any of the following:

a) rated output greater than 3 300 kW (or kVA) per 1 000 min^{-1};
b) rated output less than 600 W (or VA);
c) a commutator;
d) a sleeve bearing;
e) water as a primary or secondary coolant,

the ambient air temperature shall not be less than 0 °C.

5.5 Water coolant temperature

The water coolant temperature at the inlet to a machine or heat exchanger shall not exceed +25 °C nor be less than +5 °C.

5.6 Stockage et transport

Quand des températures inférieures à celles spécifiées en 5.4 sont susceptibles de se produire durant le transport, le stockage ou après installation, l'acheteur doit informer le constructeur et spécifier la température minimale prévue.

5.7 Pureté de l'hydrogène de refroidissement

Les machines refroidies à l'hydrogène doivent être capables de fonctionner à la puissance assignée dans les conditions assignées avec un fluide de refroidissement contenant au moins 95 % d'hydrogène en volume.

NOTE Pour des raisons de sécurité, la teneur en hydrogène devra toujours être maintenue à 90 % ou davantage, en admettant que l'autre gaz entrant dans le mélange soit l'air.

Pour calculer le rendement conformément à la CEI 60034-2, la composition normalisée du mélange gazeux doit être de 98 % d'hydrogène et 2 % d'air en volume, à des valeurs spécifiées de pression et de température du fluide refroidi, sauf accord contraire. Les pertes par ventilation doivent être calculées pour la densité correspondante.

Section 6: Conditions de fonctionnement électriques

6.1 Alimentation électrique

Pour les machines triphasées à courant alternatif, 50 Hz ou 60 Hz, destinées à être directement reliées à un réseau de distribution ou d'utilisation, les tensions assignées doivent être déduites des tensions nominales données dans la CEI 60038.

NOTE Pour les machines à courant alternatif de forte puissance à haute tension, les tensions peuvent être choisies pour l'obtention de caractéristiques de fonctionnement optimales.

Pour les moteurs à courant alternatif alimentés par convertisseurs statiques, ces restrictions sur la tension, la fréquence et la forme d'onde ne sont pas applicables. Dans ce cas le choix des tensions assignées doit se faire par accord.

6.2 Forme et symétrie des tensions et des courants

6.2.1 Moteurs à courant alternatif

6.2.1.1 Les moteurs à courant alternatif ayant parmi leur caractéristiques assignées le fonctionnement sur une alimentation à fréquence fixe, alimentée par un alternateur (localement ou à travers un réseau de distribution) doivent pouvoir fonctionner sous une tension d'alimentation dont le facteur harmonique de tension (HVF) est inférieur ou égal à

0,02 pour les moteurs monophasés et les moteurs triphasés, y compris les moteurs synchrones mais en excluant les moteurs de concept N (voir la CEI 60034-12), sauf déclaration contraire du constructeur.

0,03 pour les moteurs de conception N.

Le HVF doit être calculé à partir de la formule suivante:

$$\mathrm{HVF} = \sqrt{\sum \frac{u_n^2}{n}}$$

où

u_n est la valeur réduite (p.u.) de l'harmonique de tension (par rapport à la tension assignée U_N);

5.6 Storage and transport

When temperatures lower than specified in 5.4 are expected during transportation, storage, or after installation, the purchaser shall inform the manufacturer and specify the expected minimum temperature.

5.7 Purity of hydrogen coolant

Hydrogen cooled machines shall be capable of operating at rated output under rated conditions with a coolant containing not less than 95 % hydrogen by volume.

NOTE For safety reasons, the hydrogen content should at all times be maintained at 90 % or more, it being assumed that the other gas in the mixture is air.

For calculating efficiency in accordance with IEC 60034-2, the standard composition of the gaseous mixture shall be 98 % hydrogen and 2 % air by volume, at the specified values of pressure and temperature of the re-cooled gas, unless otherwise agreed. Windage losses shall be calculated at the corresponding density.

Section 6: Electrical operating conditions

6.1 Electrical supply

For three-phase a.c. machines, 50 Hz or 60 Hz, intended to be directly connected to distribution or utilisation systems, the rated voltages shall be derived from the nominal voltages given in IEC 60038.

NOTE For large high-voltage a.c. machines, the voltages may be selected for optimum performance.

For a.c. motors supplied from static converters these restrictions on voltage, frequency and waveform do not apply. In this case the rated voltages shall be selected by agreement.

6.2 Form and symmetry of voltages and currents

6.2.1 AC motors

6.2.1.1 AC motors rated for use on a power supply of fixed frequency, supplied from an a.c. generator (whether local or via a supply network) shall be suitable for operation on a supply voltage having a harmonic voltage factor (HVF) not exceeding

0,02 for single phase motors and three phase motors, including synchronous motors but excluding motors of design N (see IEC 60034-12), unless the manufacturer declares otherwise.

0,03 for design N motors.

The HVF shall be computed by using the following formula:

$$\mathrm{HVF} = \sqrt{\sum \frac{u_n^2}{n}}$$

where

u_n is the per unit value of the harmonic voltage (referred to rated voltage U_N);

n est le rang de l'harmonique (non divisible par trois dans le cas d'un moteur à courant alternatif triphasé).

Généralement, il suffit de considérer les harmoniques de rang $n \leq 13$.

Les moteurs triphasés à courant alternatif doivent être appropriés au fonctionnement sur un système de tensions dont la composante inverse ne dépasse pas 1 % de la composante directe pendant une longue période, ou 1,5 % pendant une courte période n'excédant pas quelques minutes, et dont la composante homopolaire n'excède pas 1 % de la composante directe.

Si les limites des valeurs du HVF et de la composante inverse et homopolaire se trouvent atteintes simultanément en service à la charge assignée, cela ne doit pas conduire à une température nuisible dans le moteur et il est recommandé que le dépassement d'échauffement ou de température qui en résulte par rapport aux limites spécifiées dans cette norme n'excède pas environ 10 K.

NOTE A proximité de fortes charges monophasées (par exemple fours à induction) et dans les zones rurales, en particulier dans le cas de réseau mixte industriel et domestique, l'alimentation peut être déformée au-delà des limites fixées ci-dessus. Une telle situation nécessite de prendre des dispositions spéciales.

6.2.1.2 Les moteurs à courant alternatif alimentés par convertisseurs statiques doivent supporter un taux supérieur d'harmoniques de la tension d'alimentation; voir la CEI 60034-17 pour le cas des moteurs à cage ouverts par la CEI 60034-12.

NOTE Si la tension d'alimentation est notablement non sinusoïdale, par exemple dans le cas d'alimentation par convertisseur statique, la valeur efficace de la forme d'onde totale et celle de l'onde fondamentale sont toutes deux appropriées lors de la détermination des caractéristiques de fonctionnement d'une machine à courant alternatif.

6.2.2 Alternateurs

Les alternateurs doivent être appropriés à l'alimentation de circuits qui sont pratiquement non-déformants et pratiquement équilibrés, c'est-à-dire, si, alimentés par une tension sinusoïdale, aucune des valeurs instantanées du courant ne diffère de la valeur instantanée correspondante de l'onde fondamentale de plus de 5 % de l'amplitude de cette dernière et si, alimentés par un système de tensions symétrique, ni la composante inverse, ni la composante homopolaire du système de courants ne dépasse 5 % de la composante directe.

Si les limites de déformation et d'équilibre se trouvent atteintes simultanément en service à la charge assignée, cela ne doit pas conduire à une température nuisible dans l'alternateur et il est recommandé que le dépassement d'échauffement ou de température qui en résulte par rapport aux limites spécifiées dans cette norme n'excède pas environ 10 K.

6.2.3 Machines synchrones

Sauf spécification contraire, les machines synchrones triphasées doivent être capables de fonctionner en permanence sur un réseau dissymétrique tel que, aucun des courants de phase de ne dépassant le courant assigné, le rapport de la composante inverse du système de courants (I_2) au courant assigné (I_N) ne dépasse pas les valeurs du tableau 1, et de fonctionner, en cas de défaut à des valeurs du produit de $(I_2/I_N)^2$ par le temps (t) ne dépassant pas les valeurs du tableau 1.

n is the order of harmonic (not divisible by three in the case of three-phase a.c. motors).

Usually it is sufficient to consider harmonic orders $n \leq 13$.

Three-phase a.c. motors shall be suitable for operation on a three-phase voltage system having a negative-sequence component not exceeding 1 % of the positive-sequence component over a long period, or 1,5 % for a short period not exceeding a few minutes, and a zero-sequence component not exceeding 1 % of the positive-sequence component.

Should the limiting values of the HVF and of the negative-sequence and zero-sequence components occur simultaneously in service at the rated load, this shall not lead to any deleterious temperature in the motor and it is recommended that the excess resulting temperature rise or temperature related to the limits specified in this standard should be not more than approximately 10 K.

NOTE In the vicinity of large single-phase loads (e.g. induction furnaces), and in rural areas particularly on mixed industrial and domestic systems, supplies may be distorted beyond the limits set out above. Special arrangements will then be necessary.

6.2.1.2 AC motors supplied from static converters have to tolerate higher harmonic contents of the supply voltage, see IEC 60034-17 for the case of cage motors within the scope of IEC 60034-12.

NOTE When the supply voltage is significantly non-sinusoidal e.g. from static converters, the r.m.s. value of the total waveform and of the fundamental are both relevant in determining the performance of an a.c. machine.

6.2.2 AC generators

AC generators shall be suitable for supplying circuits which are virtually non-deforming and virtually balanced, that is to say, when supplied by a sinusoidal voltage, none of the instantaneous values of the current differ from the corresponding instantaneous value of the fundamental by more than 5 % of the amplitude of the latter, and when supplied by a balanced system of voltages, neither the negative-sequence component nor the zero-sequence component of the system of currents exceeds 5 % of the positive-sequence component.

Should the limits of deformation and balance occur simultaneously in service at the rated load, this shall not lead to any deleterious temperature in the generator and it is recommended that the excess resulting temperature rise or temperature related to the limits specified in this standard should be not more than approximately 10 K.

6.2.3 Synchronous machines

Unless otherwise specified, three-phase synchronous machines shall be capable of operating continuously on an unbalanced system such that, with none of the phase currents exceeding the rated current, the ratio of the negative-sequence component of current (I_2) to the rated current (I_N) does not exceed the values in table 1 and under fault conditions shall be capable of operation with the product of $(I_2/I_N)^2$ and time (t) not exceeding the values in table 1.

Tableau 1 – Conditions de fonctionnement déséquilibrées pour les machines synchrones

Point	Type de machine	Valeur maximale I_2/I_N pour un fonctionnement permanent	Valeur maximale $(I_2/I_N)^2 \times t$ en secondes pour fonctionnement en régime de défaut
	Machines à pôles saillants		
1	Enroulements à refroidissement indirect		
	moteurs	0,1	20
	génératrices	0,08	20
	compensateurs synchrones	0,1	20
2	Enroulements à refroidissement direct (refroidissement interne) au stator et/ou à l'inducteur		
	moteurs	0,08	15
	génératrices	0,05	15
	compensateurs synchrones	0,08	15
	Machines synchrones à rotor lisse		
3	Enroulements rotor à refroidissement indirect		
	par air	0,1	15
	par hydrogène	0,1	10
4	Enroulements rotor à refroidissement direct (refroidissement interne)		
	≤ 350 MVA	0,08	8
	> 350 ≤ 900 MVA	Voir note 1	Voir note 2
	> 900 ≤ 1 250 MVA	Voir note 1	5
	> 1 250 ≤ 1 600 MVA	0,05	5

NOTE 1 Pour ces machines, la valeur I_2/I_N est calculée comme suit:

$$\frac{I_2}{I_N} = 0{,}08 - \frac{S_N - 350}{3 \times 10^4}$$

NOTE 2 Pour ces machines, la valeur $(I_2/I_N)^2 \times t$, en secondes, est calculée comme suit:

$$(I_2/I_N)^2 \times t = 8 - 0{,}005\,45\,(S_N - 350)$$

où (dans les deux notes) S_N est la puissance apparente assignée en mégavoltampères.

6.2.4 Moteurs à courant continu alimentés par convertisseurs statiques de puissance

Dans le cas d'un moteur à courant continu alimenté par un convertisseur statique de puissance, la forme d'ondulation de la tension et du courant influent sur les caractéristiques de fonctionnement de la machine. Les pertes et l'échauffement vont s'accroître et la commutation sera plus difficile qu'avec un moteur à courant continu alimenté par une source de courant continu pur.

Table 1 – Unbalanced operating conditions for synchronous machines

Item	Machine type	Maximum I_2/I_N value for continuous operation	Maximum $(I_2/I_N)^2 \times t$ in seconds for operation under fault conditions
	Salient pole machines		
1	Indirect cooled windings		
	motors	0,1	20
	generators	0,08	20
	synchronous condensers	0,1	20
2	Direct cooled (inner cooled) stator and/or field windings		
	motors	0,08	15
	generators	0,05	15
	synchronous condensers	0,08	15
	Cylindrical rotor synchronous machines		
3	Indirect cooled rotor windings		
	air-cooled	0,1	15
	hydrogen-cooled	0,1	10
4	Direct cooled (inner cooled) rotor windings		
	≤350 MVA	0,08	8
	>350 ≤900 MVA	See note 1	See note 2
	>900 ≤1 250 MVA	See note 1	5
	>1 250 ≤1 600 MVA	0,05	5

NOTE 1 For these machines, the value of I_2/I_N is calculated as follows:

$$\frac{I_2}{I_N} = 0{,}08 - \frac{S_N - 350}{3 \times 10^4}$$

NOTE 2 For these machines, the value of $(I_2/I_N)^2 \times t$, in seconds is calculated as follows:

$$(I_2/I_N)^2 \times t = 8 - 0{,}005\,45\,(S_N - 350)$$

where in the two notes, S_N is the rated apparent power in megavoltamperes.

6.2.4 DC motors supplied from static power converters

In the case of a d.c. motor supplied from a static power converter, the pulsating voltage and current affect the performance of the machine. Losses and temperature rise will increase and the commutation is more difficult compared with a d.c. motor supplied from a pure d.c. power source.

En conséquence, pour les moteurs de puissance assignée supérieure à 5 kW destinés à être alimentés par un convertisseur statique de puissance, il est nécessaire de concevoir leur fonctionnement à partir d'une alimentation spécifiée et, si le constructeur du moteur le juge nécessaire, avec une inductance externe prévue pour réduire l'ondulation.

L'alimentation par convertisseur statique de puissance doit être caractérisée au moyen d'un code d'identification comme suit:

$$[\text{CCC} - U_{\text{aN}} - f - L\ ]$$

où

CCC est le code d'identification de connexion du convertisseur conformément à la CEI 60971;

U_{aN} est constitué de trois ou quatre chiffres indiquant la valeur assignée de la tension alternative aux bornes d'entrée du convertisseur, en volts;

f est constitué de deux chiffres indiquant la fréquence assignée aux bornes d'entrée, en hertz;

L est constitué de un, deux ou trois chiffres indiquant la valeur de l'inductance série à ajouter extérieurement au circuit d'induit du moteur, en millihenrys. Si cette valeur est égale à zéro, elle est omise.

Les moteurs de puissance assignée inférieure à égale à 5 kW, au lieu d'être liés à un type spécifique de convertisseur statique de puissance, peuvent être conçus pour une utilisation avec tout convertisseur statique de puissance, avec ou sans inductance extérieure, pourvu que la valeur assignée du facteur de forme pour lequel le moteur est conçu ne soit pas dépassée et que le niveau d'isolation du circuit d'induit du moteur soit adapté à la valeur assignée de la tension alternative aux bornes d'entrée du convertisseur statique de puissance.

Dans tous les cas, l'ondulation du courant fourni par le convertisseur statique de puissance est présumée être assez faible pour qu'il en résulte un facteur d'ondulation du courant inférieur à 0,1 aux conditions assignées.

6.3 Variations de tension et de fréquence en fonctionnement

Pour les machines à courant alternatif ayant parmi leurs caractéristiques assignées le fonctionnement sur une alimentation à fréquence fixe, alimentée par un alternateur (localement ou à travers un réseau de distribution), les combinaisons des variations de tension et de fréquence sont classées en zone A ou en zone B, conformément à la figure 11 pour les alternateurs et à la figure 12 pour les moteurs.

Pour les machines à courant continu reliées directement à une alimentation à courant continu normalement constante, les zones A et B s'appliquent uniquement aux tensions.

Une machine doit être capable d'assurer sa fonction principale comme spécifié au tableau 2 de façon continue à l'intérieur de la zone A, mais peut ne pas satisfaire complètement à ses caractéristiques de fonctionnement à tension et fréquence assignées (voir le point des caractéristiques assignées sur les figures 11 et 12), et présenter certains écarts. Les échauffements peuvent être supérieurs à ceux à tension et fréquence assignées.

Une machine doit être capable d'assurer sa fonction principale à l'intérieur de la zone B, mais peut présenter des écarts supérieurs à ceux de la zone A par rapport à ses caractéristiques de fonctionnement à tension et fréquence assignées. Les échauffements peuvent être supérieurs à ceux à tension et fréquence assignées et seront très probablement supérieurs à ceux de la zone A. Un fonctionnement prolongé à la périphérie de la zone B n'est pas recommandé.

It is necessary, therefore, for motors with a rated output exceeding 5 kW, intended for supply from a static power converter, to be designed for operation from a specified supply, and, if considered necessary by the motor manufacturer, for an external inductance to be provided for reducing the undulation.

The static power converter supply shall be characterized by means of an identification code, as follows:

$$[\text{CCC} - U_{\text{aN}} - f - L]$$

where

CCC is the identification code for converter connection according to IEC 60971;

U_{aN} consists of three or four digits indicating the rated alternating voltage at the input terminals of the converter, in volts;

f consists of two digits indicating the rated input frequency, in hertz;

L consists of one, two or three digits indicating the series inductance to be added externally to the motor armature circuit, in millihenrys. If this is zero, it is omitted.

Motors with rated output not exceeding 5 kW, instead of being tied to a specific type of static power converter, may be designed for use with any static power converter, with or without external inductance, provided that the rated form factor for which the motor is designed will not be surpassed and that the insulation level of the motor armature circuit is appropriate for the rated alternating voltage at the input terminals of the static power converter.

In all cases, the undulation of the static power converter output current is assumed to be so low as to result in a current ripple factor not higher than 0,1 at rated conditions.

6.3 Voltage and frequency variations during operation

For a.c. machines rated for use on a power supply of fixed frequency supplied from an a.c. generator (whether local or via a supply network), combinations of voltage variation and frequency variation are classified as being either zone A or zone B, in accordance with figure 11 for generators and synchronous condensers, and figure 12 for motors.

For d.c. machines, when directly connected to a normally constant d.c. bus, zones A and B apply only to the voltages.

A machine shall be capable of performing its primary function, as specified in table 2, continuously within zone A, but need not comply fully with its performance at rated voltage and frequency (see rating point in figures 11 and 12), and may exhibit some deviations. Temperature rises may be higher than at rated voltage and frequency.

A machine shall be capable of performing its primary function within zone B, but may exhibit greater deviations from its performance at rated voltage and frequency than in zone A. Temperature rises may be higher than at rated voltage and frequency and most likely will be higher than those in zone A. Extended operation at the perimeter of zone B is not recommended.

NOTE 1 Dans des applications et conditions de fonctionnement pratiques, une machine sera parfois sollicitée pour fonctionner à l'extérieur du périmètre de la zone A. Il est recommandé de limiter de tels écarts en valeur, durée et fréquence d'apparition. Si possible, il convient de prendre des mesures correctives dans un délai raisonnable, par exemple une réduction de puissance. De telles interventions peuvent éviter une réduction de la durée de vie de la machine due aux effets de la température.

NOTE 2 Les limites d'échauffement ou les limites de température conformes à la présente norme sont applicables au point des caractéristiques assignées et peuvent être progressivement dépassées si le point de fonctionnement s'écarte du point des caractéristiques assignées. Pour des conditions aux limites extrêmes de la zone A, les échauffements et températures dépassent habituellement d'environ 10 K les limites spécifiées dans la présente norme.

NOTE 3 Un moteur à courant alternatif ne démarrera à la limite inférieure de tension que si son couple de démarrage est approprié au couple résistant de la charge, mais cela ne constitue pas une exigence du présent article. Pour les caractéristiques de démarrage des moteurs de conception N, voir la CEI 60034-12.

Tableau 2 – Fonctions principales des machines

Point	Type de machine	Fonction principale
1	Alternateur, en excluant le point 5	Puissance assignée apparente (kVA), au facteur de puissance assigné s'il est à commande séparée
2	Moteur à courant alternatif, en excluant les points 3 et 5	Couple assigné (Nm)
3	Moteur synchrone en excluant le point 5	Couple assigné (Nm) avec l'excitation maintenant soit le courant d'excitation assigné, soit le facteur de puissance assigné, lorsque celui-ci peut être commandé séparément
4	Compensateur synchrone, en excluant le point 5	Puissance apparente assignée (kVA) à l'intérieur de la zone applicable à une génératrice sauf accord contraire, voir figure 11
5	Turbo-alternateur de puissance assignée égale ou supérieure à 10 MVA	Voir CEI 60034-3
6	Génératrice à courant continu	Puissance assignée (kW)
7	Moteur à courant continu	Couple assigné (Nm) avec l'excitation d'un moteur shunt maintenant une vitesse assignée, lorsque celle-ci peut-être commandée séparément

6.4 Machines triphasées à courant alternatif fonctionnant sur réseaux isolés

Les machines triphasées à courant alternatif doivent être capables de fonctionner en marche continue avec le neutre à un potentiel proche ou égal à celui de la terre. Elles doivent être aussi capables de fonctionner sur des réseaux isolés ayant une phase au potentiel de la terre pendant des périodes de courtes durées très peu fréquentes, par exemple telles que nécessaires pour affranchir normalement le défaut. S'il est prévu de faire fonctionner la machine en permanence, ou pendant de longues périodes, dans ces conditions, il est indispensable de prévoir une machine spéciale avec le niveau d'isolement approprié.

Si les enroulements n'ont pas une isolation identique côté phase et côté neutre, cela doit être spécifié par le constructeur.

NOTE Il convient que la mise à la terre ou l'interconnexion des points neutres de machines ne soit jamais effectuée sans consultation des constructeurs des machines, à cause des dangers de circulation de courants homopolaires de toutes fréquences dans certaines conditions de fonctionnement et des risques d'incidents mécaniques sur les enroulements lors de défauts entre phase et neutre.

NOTE 1 In practical applications and operating conditions, a machine will sometimes be required to operate outside the perimeter of zone A. Such excursions should be limited in value, duration and frequency of occurrence. Corrective measures should be taken, where practical, within a reasonable time, for example, a reduction in output. Such action may avoid a reduction in machine life from temperature effects.

NOTE 2 The temperature-rise limits or temperature limits in accordance with this standard apply at the rating point and may be progressively exceeded as the operating point moves away from the rating point. For conditions at the extreme boundaries of zone A, the temperature rises and temperatures typically exceed the limits specified in this standard by approximately 10 K.

NOTE 3 An a.c. motor will start at the lower limit of voltage only if its starting torque is adequately matched to the counter-torque of the load, but this is not a requirement of this clause. For starting performance of design N motors, see IEC 60034-12.

Table 2 – Primary functions of machines

Item	Machine type	Primary function
1	AC generator, excluding item 5	Rated apparent power (kVA), at rated power factor where this is separately controllable
2	AC motor, excluding items 3 and 5	Rated torque (Nm)
3	Synchronous motor, excluding item 5	Rated torque (Nm), the excitation maintaining either rated field current or rated power factor, where this is separately controllable
4	Synchronous condenser, excluding item 5	Rated apparent power (kVA) within the zone applicable to a generator, see figure 11, unless otherwise agreed
5	Turbine-type machine, with rated output ≥10 MVA	See IEC 60034-3
6	DC generator	Rated output (kW)
7	DC motor	Rated torque (Nm), the excitation of a shunt motor maintaining rated speed, where this is separately controllable

6.4 Three-phase a.c. machines operating on unearthed systems

Three-phase a.c. machines shall be suitable for continuous operation with the neutral at or near earth potential. They shall also be suitable for operation on unearthed systems with one line at earth potential for infrequent periods of short duration, for example as required for normal fault clearance. If it is intended to run the machine continuously or for prolonged periods in this condition, a machine with a level of insulation suitable for this condition will be required.

If the winding does not have the same insulation at the line and neutral ends, this shall be stated by the manufacturer.

NOTE The earthing or interconnection of the machine's neutral points should not be undertaken without consulting the machine manufacturer because of the danger of zero-sequence components of currents of all frequencies under some operating conditions and the risk of mechanical damage to the windings under line-to-neutral fault conditions.

6.5 Niveaux de tenue en tension (crête et gradient)

Pour les moteurs à courant alternatif, le fabricant doit spécifier une valeur limite pour les crêtes de tension et les gradients de tension, en fonctionnement permanent.

Pour les moteurs à induction à cage couverts par la CEI 60034-12, voir aussi la CEI 60034-17.

Pour les moteurs à courant alternatif à haute tension, voir aussi la CEI 60034-15.

Section 7: Caractéristiques thermiques de fonctionnement et essais thermiques

7.1 Classification thermique

Une classification thermique conforme à la CEI 60085 doit être attribuée aux systèmes d'isolation utilisés dans les machines. La classification des systèmes d'isolation doit s'effectuer au moyen de lettres et non de valeurs de température.

Il est de la responsabilité du constructeur de la machine d'interpréter les résultats obtenus par l'essai d'endurance thermique en fonction du type de la machine et de son application.

NOTE 1 Il est recommandé de ne pas présumer une relation directe entre la classification thermique d'un nouveau système d'isolation et l'aptitude thermique des différents matériaux qui le constituent.

NOTE 2 Il est admis de continuer à utiliser les classifications existantes lorsque celles-ci ont été éprouvées par l'expérience.

7.2 Fluide de refroidissement de référence

Le fluide de refroidissement de référence, pour une méthode donnée de refroidissement, est spécifié dans le tableau 3.

Tableau 3 – Fluide de refroidissement de référence

Point	Fluide de refroidissement primaire	Mode de refroidissement	Fluide de refroidissement secondaire	Tableau n°	Le tableau cité en colonne 4 spécifie des limites à:	Fluide de refroidissement de référence
1	Air	Indirect	Aucun	6	l'échauffement	Air ambiant
2	Air	Indirect	Air	6		
3	Air	Indirect	Eau	6		Fluide de refroidissement à l'entrée dans la machine[1)]
4	Hydrogène	Indirect	Eau	7		
5	Air	Direct	Aucun	11	la température	Air ambiant
6	Air	Direct	Air	11		
7	Air	Direct	Eau	11		Gaz à l'entrée dans la machine ou liquide à l'entrée dans l'enroulement
8	Hydrogène ou liquide	Direct	Eau	11		

[1)] Les caractéristiques assignées d'une machine à refroidissement indirect et à hydroréfrigérant peuvent être attribuées en se servant soit du fluide de refroidissement primaire soit du fluide de refroidissement secondaire comme fluide de refroidissement de référence (voir aussi 9.2 pour l'information à donner sur la plaque signalétique).

6.5 Voltage (peak and gradient) withstand levels

For a.c. motors the manufacturer shall declare a limiting value for the peak voltage and for the voltage gradient in continuous operation.

For cage induction motors within the scope of IEC 60034-12, see also IEC 60034-17.

For high-voltage a.c. motors, see also IEC 60034-15.

Section 7: Thermal performance and tests

7.1 Thermal classification

A thermal classification in accordance with IEC 60085 shall be assigned to the insulation systems used in machines. The classification of the insulation systems shall be by means of letters and not by temperature values.

It is the responsibility of the manufacturer of the machine to interpret the results obtained by thermal endurance testing as appropriate to his machine type and application.

NOTE 1 The thermal classification of a new insulation system should not be assumed to be directly related to the thermal capability of the individual materials used in it.

NOTE 2 The continued use of existing classifications is acceptable where they have been proved by experience.

7.2 Reference coolant

The reference coolant for a given method of cooling the machine is specified in table 3.

Table 3 – Reference coolant

Item	Primary coolant	Method of cooling	Secondary coolant	Table number	Table referred to in column 4 specifies limits of:	Reference coolant
1	Air	Indirect	None	6	Temperature rise	Ambient air
2	Air	Indirect	Air	6		
3	Air	Indirect	Water	6		Coolant at inlet to machine [1)]
4	Hydrogen	Indirect	Water	7		
5	Air	Direct	None	11	Temperature	Ambient air
6	Air	Direct	Air	11		
7	Air	Direct	Water	11		Gas at entry to machine or liquid at entry to the windings
8	Hydrogen or liquid	Direct	Water	11		

[1)] A machine with indirect cooled windings and a water cooled heat exchanger may be rated using either the primary or secondary coolant as the reference coolant (see also 9.2 for information to be given on the rating plate).

Si un troisième fluide de refroidissement est utilisé, les échauffements doivent être mesurés au-dessus de la température du fluide de refroidissement primaire ou secondaire comme spécifié au tableau 3.

NOTE La disposition et le refroidissement d'une machine peuvent être tels que plusieurs points du tableau sont applicables; en ce cas différents fluides de refroidissement de référence peuvent s'appliquer à différents enroulements.

7.3 Conditions des essais thermiques

7.3.1 Alimentation électrique

Pendant l'essai thermique d'un moteur à courant alternatif, le HVF de l'alimentation ne doit pas dépasser 0,015 et la composante inverse du système de tensions doit être inférieure à 0,5 % de la composante directe, l'influence de la composante homopolaire étant éliminée.

Par accord, la composante inverse du système de courants peut être mesurée à la place de la composante inverse du système de tensions. La composante inverse du système de courants ne doit pas excéder 2,5 % de la composante directe.

7.3.2 Température de la machine avant l'essai

Lorsque la température d'un enroulement doit être déterminée d'après l'augmentation de la résistance, la température de l'enroulement, mesurée par thermomètre, lorsque la résistance est mesurée avant l'essai thermique, doit être pratiquement celle du fluide de refroidissement à ce moment.

Lorsqu'une machine doit être essayée à des caractéristiques assignées pour service temporaire (service type S2), sa température au début de l'essai ne doit pas différer de plus de 5 K de la température du fluide de refroidissement.

7.3.3 Température du fluide de refroidissement

L'essai de la machine peut être effectué à toute température disponible du fluide de refroidissement. Voir tableau 10 (pour les enroulements à refroidissement direct) ou tableau 13 (pour les enroulements à refroidissement indirect).

7.3.4 Mesurage de la température du fluide de refroidissement au cours des essais

La valeur à adopter pour la température du fluide de refroidissement pendant un essai doit être la moyenne des lectures effectuées sur les détecteurs de température à intervalles de temps égaux pendant le dernier quart de la durée de l'essai. Pour réduire les erreurs qui peuvent provenir de la lenteur avec laquelle la température des grandes machines suit les variations de la température du fluide de refroidissement, toutes dispositions raisonnables doivent être prises pour réduire ces variations.

7.3.4.1 Machines ouvertes ou machines fermées sans échangeurs de chaleur (refroidies par de l'air ou du gaz environnant)

La température ambiante de l'air ou du gaz doit être mesurée au moyen de plusieurs détecteurs de température répartis autour et à mi-hauteur de la machine, à une distance de 1 m à 2 m de celle-ci. Chaque détecteur doit être à l'abri de toute chaleur rayonnée et des courants d'air.

If a third coolant is used, temperature rise shall be measured above the temperature of the primary or secondary coolant as specified in table 3.

NOTE A machine may be so arranged and cooled that more than one item of table 3 applies, in which case different reference coolants may apply for different windings.

7.3 Conditions for thermal tests

7.3.1 Electrical supply

During thermal testing of an a.c. motor the HVF of the supply shall not exceed 0,015 and the negative-sequence component of the system of voltages shall be less than 0,5 % of the positive-sequence component, the influence of the zero-sequence component being eliminated.

By agreement, the negative-sequence component of the system of currents may be measured instead of the negative-sequence component of the system of voltages. The negative-sequence component of the system of currents shall not exceed 2,5 % of the positive-sequence component.

7.3.2 Temperature of machine before test

If the temperature of a winding is to be determined from the increase of resistance, the temperature of the winding measured by thermometer, when the resistance is measured before the thermal test, shall be practically that of the coolant at the time.

When a machine is to be tested on a short-time rating (duty type S2) its temperature at the beginning of the thermal test shall be within 5 K of the temperature of the coolant.

7.3.3 Temperature of coolant

A machine may be tested at any convenient value of coolant temperature. See table 10 (for indirect cooled windings) or table 13 (for direct cooled windings).

7.3.4 Measurement of coolant temperature during test

The value to be adopted for the temperature of a coolant during a test shall be the mean of the readings of the temperature detectors taken at equal intervals of time during the last quarter of the duration of the test. To reduce errors due to the time lag of the change of temperature of large machines following variations in the temperature of the coolant, all reasonable precautions shall be taken to minimize such variations.

7.3.4.1 Open machines or closed machines without heat exchangers (cooled by surrounding ambient air or gas)

The temperature of the ambient air or gas shall be measured by means of several detectors placed at different points around and halfway up the machine at 1 m to 2 m from it. Each detector shall be protected from radiant heat and draughts.

7.3.4.2 Machines refroidies par de l'air ou du gaz à partir d'une source éloignée à travers des conduits de ventilation et machines à échangeurs de chaleur montés séparément

La température du fluide de refroidissement primaire doit être mesurée à l'entrée dans la machine.

7.3.4.3 Machines fermées à échangeurs de chaleur montés sur la machine ou incorporés

La température du fluide de refroidissement primaire doit être mesurée à l'entrée dans la machine. La température du fluide de refroidissement secondaire doit être mesurée à l'entrée dans l'échangeur de chaleur.

7.4 Echauffement d'un élément de machine

L'échauffement d'un élément de machine, $\Delta\theta$, est la différence entre la température de cet élément, mesurée par la méthode appropriée, conformément à 7.5, et la température du fluide de refroidissement, mesurée conformément à 7.3.4.

Pour la comparaison avec les limites des échauffements (voir tableau 6 ou 7) ou des températures (voir tableau 11), lorsque cela est possible la température doit être mesurée immédiatement avant qu'on arrête la machine à la fin de l'essai thermique, comme cela est défini à l'article 7.7.

Lorsque cela n'est pas possible, par exemple lors du mesurage direct par la méthode de variation de résistance, voir 7.6.2.3.

Pour les machines essayées à leur service périodique réel (services types S3 à S8) la température doit être prise comme étant celle au milieu de la période donnant le plus grand échauffement dans le dernier cycle de fonctionnement (mais voir aussi 7.7.3).

7.5 Méthodes de mesurage de la température

Trois méthodes sont admises pour déterminer les températures des enroulements et des autres éléments:

– méthode par variation de résistance;

– méthode par indicateurs internes de température (IIT);

– méthode par thermomètre.

Les différentes méthodes ne doivent pas être utilisées pour un contrôle mutuel.

7.5.1 Méthode par variation de résistance

La température des enroulements est déterminée à partir de l'augmentation de leur résistance.

7.5.2 Méthode par indicateurs internes de température (IIT)

La température est mesurée au moyen d'indicateurs internes de température (par exemple; thermomètres à résistances, couples thermoélectriques ou thermistances à semi-conducteurs à coefficient de température négatif) introduits dans la machine lors de la construction, en des points qui deviennent inaccessibles lorsque la machine est terminée.

7.3.4.2 Machines cooled by air or gas from a remote source through ventilation ducts and machines with separately mounted heat exchangers

The temperature of the primary coolant shall be measured where it enters the machine.

7.3.4.3 Closed machines with machine-mounted or internal heat exchangers

The temperature of the primary coolant shall be measured where it enters the machine. The temperature of the secondary coolant shall be measured where it enters the heat exchanger.

7.4 Temperature rise of a part of a machine

The temperature rise, $\Delta\theta$, of a part of a machine is the difference between the temperature of that part measured by the appropriate method in accordance with 7.5, and the temperature of the coolant measured in accordance with 7.3.4.

For comparison with the limits of temperature rise (see table 6 or 7) or of temperature (see table 11), when possible, the temperature shall be measured immediately before the machine is shut down at the end of the thermal test, as described in clause 7.7.

When this is not possible, e.g. when using the direct measurement of resistance method, see 7.6.2.3.

For machines tested on actual periodic duty (duty types S3 to S8) the temperature at the end of the test shall be taken as that at the middle of the period causing the greatest heating in the last cycle of operation (but see also 7.7.3).

7.5 Methods of measurement of temperature

Three methods of measuring the temperature of windings and other parts are recognized:

– resistance method;

– embedded temperature detector (ETD) method;

– thermometer method.

Different methods shall not be used as a check upon one another.

7.5.1 Resistance method

The temperature of the windings is determined from the increase of the resistance of the windings.

7.5.2 Embedded temperature detector (ETD) method

The temperature is determined by means of temperature detectors (e.g. resistance thermometers, thermocouples or semi-conductor negative coefficient detectors) built into the machine during construction, at points which are inaccessible after the machine is completed.

7.5.3 Méthode par thermomètre

La température est mesurée au moyen de thermomètres appliqués sur les surfaces accessibles de la machine terminée. Le terme «thermomètre» s'applique non seulement aux thermomètres à réservoir, mais aussi aux couples thermoélectriques et thermomètres à résistance externes. Lorsque des thermomètres à réservoir sont utilisés en des points où il existe un champ magnétique intense, variable ou mobile, des thermomètres à alcool doivent être utilisés de préférence aux thermomètres à mercure.

7.6 Détermination de la température d'enroulement

7.6.1 Choix de la méthode

En général, pour mesurer la température des enroulements d'une machine, la méthode par variation de résistance, conforme à 7.5.1, doit être appliquée (mais voir aussi 7.6.2.3.3).

Pour les enroulements statoriques à courant alternatif des machines de puissance assignée égale ou supérieure à 5 000 kW (ou kVA), la méthode par indicateurs internes de température (IIT) doit être appliquée.

Pour les machines à courant alternatif de puissance assignée inférieure à 5 000 kW (ou kVA) et supérieure à 200 kW (ou kVA), le constructeur doit choisir soit la méthode par variation de résistance, soit la méthode par indicateurs internes de température, sauf accord contraire.

Pour les machines à courant alternatif de puissance assignée inférieure ou égale à 200 kW (ou kVA), le constructeur doit choisir la méthode par variation de résistance, par mesurage direct ou par méthode par superposition, sauf accord contraire (mais voir aussi ci-dessous).

Pour les machines de puissance assignée inférieure ou égale à 600 W (ou VA), si les enroulements ne sont pas uniformes ou si la réalisation des connexions nécessaires entraîne de sévères complications, la température peut être déterminée au moyen de thermomètres. Les limites d'échauffement, conformes au tableau 6, doivent être appliquées.

La méthode par thermomètre est admise dans les cas suivants:

a) Lorsque la détermination de l'échauffement par variation de résistance n'est pas réalisable en pratique, comme par exemple dans le cas des bobines de commutation et enroulements compensateurs de faible résistance et, de façon générale, dans le cas des enroulements de faible résistance, notamment lorsque la résistance des jonctions et connexions représente une proportion importante de la résistance totale.

b) Enroulements en une seule couche, tournants ou fixes.

c) Lors des essais individuels sur machines fabriquées en grande série.

Pour les enroulements statoriques à courant alternatif à un seul faisceau par encoche, la méthode par indicateurs internes de température ne doit pas être utilisée pour vérifier la conformité à la présente norme: la méthode par variation de résistance doit être appliquée.

NOTE Pour vérifier en service la température de tels enroulements, un indicateur interne placé au fond de l'encoche est de peu de valeur du fait qu'il indique principalement la température du fer. Un indicateur placé entre la bobine et la cale d'encoche suit beaucoup plus fidèlement la température de l'enroulement et est donc préférable à des fins de surveillance en fonctionnement. Puisque la température de cet endroit peut être relativement basse, il convient de déterminer par un essai d'échauffement la relation entre la température mesurée à cet endroit et la température mesurée par variation de résistance.

Pour les autres enroulements à un seul faisceau par encoche et pour les développantes, la méthode de mesure de température par IIT ne doit pas être utilisée pour vérifier la conformité à la présente norme.

7.5.3 Thermometer method

The temperature is determined by thermometers applied to accessible surfaces of the completed machine. The term 'thermometer' includes not only bulb-thermometers, but also non-embedded thermocouples and resistance thermometers. When bulb-thermometers are used in places where there is a strong varying or moving magnetic field, alcohol thermometers shall be used in preference to mercury thermometers.

7.6 Determination of winding temperature

7.6.1 Choice of method

In general, for measuring the temperature of the windings of a machine, the resistance method in accordance with 7.5.1 shall be applied (but see also 7.6.2.3.3).

For a.c. stator windings of machines having a rated output of 5 000 kW (or kVA) or more the ETD method shall be used.

For a.c. machines having a rated output less than 5 000 kW (or kVA) but greater than 200 kW (or kVA) the manufacturer shall choose either the resistance or the ETD method, unless otherwise agreed.

For a.c. machines having a rated output less than or equal to 200 kW (or kVA) the manufacturer shall choose the direct measurement version or the superposition version of the resistance method, unless otherwise agreed (but see also below).

For machines having a rated output less than or equal to 600 W (or VA), when the windings are non-uniform or severe complications are involved in making the necessary connections, the temperature may be determined by means of thermometers. Temperature rise limits in accordance with table 6 shall apply.

The thermometer method is recognized in the following cases:

a) When it is not practicable to determine the temperature rise by the resistance method as, for example, with low-resistance commutating coils and compensating windings and, in general, in the case of low-resistance windings, especially when the resistance of joints and connections forms a considerable proportion of the total resistance.
b) Single layer windings, rotating or stationary.
c) During routine tests on machines manufactured in large numbers.

For a.c. stator windings having only one coil-side per slot, the ETD method shall not be used for verifying compliance with this standard: the resistance method shall be used.

NOTE For checking the temperature of such windings in service, an embedded detector at the bottom of the slot is of little value because it gives mainly the temperature of the iron core. A detector placed between the coil and the wedge will follow the temperature of the winding much more closely and is, therefore, better for checks in service. Because the temperature there may be rather low the relation between it and the temperature measured by the resistance method should be determined by a thermal test.

For other windings having one coil-side per slot and for end windings the ETD method shall not be used for verifying compliance with this standard.

Pour les enroulements d'induits à collecteurs et pour les enroulements d'excitation, à l'exception des enroulements d'excitation dans les rotors cylindriques des machines synchrones, la méthode par variation de résistance et la méthode par thermomètre sont admises. La méthode préférée est la méthode par variation de résistance, mais pour les enroulements d'excitation fixes des machines à courant continu à plus d'une couche, la méthode par indicateurs internes de température peut être utilisée.

7.6.2 Détermination par la méthode par variation de résistance

7.6.2.1 Mesurage

L'une des méthodes suivantes doit être utilisée.

7.6.2.1.1 Mesurage direct

Mesurage direct, au début et à la fin de l'essai, en utilisant un instrument ayant une gamme appropriée.

7.6.2.1.2 Mesurage en courant continu de courant et tension

Pour enroulements à courant continu: en mesurant le courant dans l'enroulement et la tension à ses bornes, utilisant des instruments aux gammes appropriées.

Pour enroulements à courant alternatif: en injectant du courant continu dans l'enroulement, en l'absence de tension alternative.

7.6.2.1.3 Méthode par superposition

Sans interruption du courant alternatif de charge, en superposant au courant de charge un courant continu de mesure de faible intensité, selon la CEI 60279.

7.6.2.2 Calcul

L'échauffement $\theta_2 - \theta_a$, peut être obtenu à partir de l'équation

$$\frac{\theta_2 + k}{\theta_1 + k} = \frac{R_2}{R_1}$$

où

θ_1 est la température (°C) de l'enroulement (froid) au moment de la mesure de la résistance initiale;

θ_2 est la température (°C) de l'enroulement à la fin de l'essai;

θ_a est la température (°C) du fluide de refroidissement à la fin de l'essai thermique;

R_1 est la résistance de l'enroulement à la température θ_1 (froid);

R_2 est la résistance de l'enroulement à la fin de l'essai thermique;

k est l'inverse du coefficient de variation de résistivité en fonction de la température à 0 °C du matériau conducteur.

Pour le cuivre k = 235

Pour l'aluminium k = 225 sauf spécification contraire.

Dans la pratique, il est commode de calculer l'échauffement par la formule équivalente suivante:

$$\theta_2 - \theta_a = \frac{R_2 - R_1}{R_1} \times (k + \theta_1) + \theta_1 - \theta_a$$

For windings of armatures having commutators and for field windings, except for field windings in cylindrical rotors of synchronous machines, the resistance method and the thermometer method are recognized. The resistance method is preferred but for stationary field windings of d.c. machines having more than one layer the ETD method may be used.

7.6.2 Determination by resistance method

7.6.2.1 Measurement

One of the following methods shall be used.

7.6.2.1.1 Direct measurement

Direct measurement at the beginning and the end of the test, using an instrument having a suitable range.

7.6.2.1.2 Measurement by d.c. current/voltage

For d.c. windings: by measuring the current in and the voltage across the winding, using instruments having suitable ranges.

For a.c. windings: by injecting direct current into the winding when de-energized.

7.6.2.1.3 Superposition method

Without interruption of the a.c. load current by superimposing on the load current a small d.c. measuring current, in accordance with IEC 60279.

7.6.2.2 Calculation

The temperature rise, $\theta_2 - \theta_a$, may be obtained from the equation:

$$\frac{\theta_2 + k}{\theta_1 + k} = \frac{R_2}{R_1}$$

where

θ_1 is the temperature (°C) of the winding (cold) at the moment of the initial resistance measurement;

θ_2 is the temperature (°C) of the winding at the end of the thermal test;

θ_a is the temperature of the coolant at the end of the thermal test;

R_1 is the resistance of the winding at temperature θ_1 (cold);

R_2 is the resistance of the winding at the end of the thermal test;

k is the reciprocal of the temperature coefficient of resistance at 0 °C of the conductor material.

For copper k = 235

For aluminium k = 225 unless specified otherwise.

For practical purposes, the following alternative formula may be found convenient:

$$\theta_2 - \theta_a = \frac{R_2 - R_1}{R_1} \times (k + \theta_1) + \theta_1 - \theta_a$$

7.6.2.3 Correction pour des mesures relevées après arrêt de la machine

Le mesurage des températures, à la fin de l'essai thermique, par la méthode de variation de résistance exige que la machine arrive rapidement à l'arrêt. Une procédure soigneusement planifiée et un nombre approprié de personnes sont nécessaires.

7.6.2.3.1 Arrêt de la machine en un temps court

Si la lecture initiale par variation de résistance est obtenue dans le délai indiqué au tableau 4, cette lecture doit être adoptée pour la mesure de la température.

Tableau 4 – Délai

Puissance assignée (P_N) kW ou kVA	**Délai après la coupure** s
$P_N \leq 50$	30
$50 < P_N \leq 200$	90
$200 < P_N \leq 5\,000$	120
$5000 < P_N$	Sur accord

7.6.2.3.2 Arrêt de la machine en un temps prolongé

Si la lecture par variation de résistance ne peut être effectuée dans le délai spécifié au tableau 4, elle doit être faite le plus tôt possible mais dans un délai non supérieur à deux fois celui spécifié au tableau 4, et des lectures supplémentaires doivent être effectuées à des intervalles d'environ 1 min, jusqu'au moment où ces lectures commencent à montrer une diminution sensible de leurs valeurs maximales. Une courbe de ces lectures doit être tracée en fonction du temps et extrapolée au délai spécifié dans le tableau ci-dessus pour la puissance assignée de la machine. Il est recommandé de tracer une courbe semi-logarithmique, où la température figure sur l'ordonnée logarithmique. La valeur de la température ainsi obtenue doit être considérée comme la température au moment de l'arrêt de la machine. Si des mesures consécutives montrent une augmentation des températures après l'arrêt, la valeur la plus élevée doit être prise.

Si la lecture initiale par variation de résistance ne peut être effectuée qu'après un délai égal à deux fois le délai spécifié au tableau 4, cette méthode de correction ne doit être utilisée que par accord.

7.6.2.3.3 Enroulements à un faisceau par encoche

Pour les machines à un faisceau par encoche, la méthode par variation de résistance par mesurage direct peut être appliquée si la machine parvient à l'arrêt dans le délai spécifié dans le tableau 4. S'il faut à la machine plus de 90 s pour arriver à l'arrêt après la coupure, la méthode par superposition peut être appliquée s'il y a eu un accord préalable.

7.6.3 Détermination par la méthode par indicateurs internes de température (IIT)

Les indicateurs doivent être convenablement répartis dans l'enroulement de la machine, et le nombre des indicateurs installés ne doit pas être inférieur à six.

On doit s'efforcer, dans toute la mesure compatible avec la sécurité, de placer les indicateurs aux différents points présumés les plus chauds de façon qu'ils soient efficacement protégés d'un contact avec le fluide de refroidissement primaire.

7.6.2.3 Correction for stopping time

The measurement of temperatures at the end of the thermal test by the direct measurement resistance method requires a quick shutdown. A carefully planned procedure and an adequate number of people are required.

7.6.2.3.1 Short stopping time

If the initial resistance reading is obtained within the time interval specified in table 4, that reading shall be accepted for the temperature measurement.

Table 4 – Time interval

Rated output (P_N) kW or kVA	**Time interval after switching off power** s
$P_N \leq 50$	30
$50 < P_N \leq 200$	90
$200 < P_N \leq 5\,000$	120
$5000 < P_N$	By agreement

7.6.2.3.2 Extended stopping time

If a resistance reading cannot be made in the time interval specified in table 4, it shall be made as soon as possible but after not more than twice the interval specified in table 4, and additional readings shall be taken at intervals of approximately 1 min until these readings have begun a distinct decline from their maximum value. A curve of these readings shall be plotted as a function of time and extrapolated to the time interval for the rated output of the machine. A semi-logarithmic plot is recommended where temperature is plotted on the logarithmic scale. The value of temperature thus obtained shall be considered as the temperature at shutdown. If successive measurements show increasing temperatures after shutdown the highest value shall be taken.

If a resistance reading cannot be made until after twice the time interval specified in table 4, this method of correction shall only be used by agreement.

7.6.2.3.3 Windings with one coil-side per slot

For machines with one coil-side per slot the resistance method by direct measurement may be used if the machine comes to rest within the time interval specified in table 4. If the machine takes more that 90 s to come to rest after switching off the power, the superposition method may be used if previously agreed.

7.6.3 Determination by ETD method

The detectors shall be suitable distributed throughout the winding and the number of detectors installed shall not be less than six.

All reasonable efforts, consistent with safety, shall be made to place the detectors at the points where the highest temperatures are likely to occur, in such a manner that they are effectively protected against contact with the primary coolant.

La lecture la plus élevée des éléments IIT doit être utilisée pour déterminer la température de l'enroulement.

NOTE Les éléments IIT ou leurs connexions peuvent présenter un défaut et donner des lectures incorrectes. En conséquence, si une ou plusieurs lectures s'avèrent, après analyse, être erratiques, il convient de les éliminer.

7.6.3.1 Deux faisceaux par encoche ou plus

Les indicateurs de température doivent être placés entre les faisceaux isolés à l'intérieur de l'encoche, aux endroits présumés les plus chauds.

7.6.3.2 Un faisceau par encoche

Les indicateurs doivent être placés entre la cale d'encoche et la partie externe de l'isolation d'enroulement, aux endroits présumés les plus chauds; voir 7.6.1.

7.6.3.3 Développantes

Les indicateurs de température doivent être placés entre deux faisceaux adjacents de développantes, aux endroits présumés les plus chauds. La partie sensible de chaque indicateur doit être en contact étroit avec la surface du faisceau et être efficacement protégée de l'influence du fluide de refroidissement; voir 7.6.1.

7.6.4 Détermination par la méthode du thermomètre

Lorsqu'on utilise un couple thermoélectrique ou thermomètre à résistance externe, il ne doit pas être placé à un point inaccessible à un thermomètre à réservoir.

On doit s'efforcer, autant que cela est compatible avec la sécurité, de placer les thermomètres aux points présumés les plus chauds (par exemple dans les développantes à proximité du circuit magnétique) de façon qu'ils soient efficacement protégés du contact avec le fluide de refroidissement primaire et qu'ils soient en bon contact thermique avec l'enroulement ou autre élément de machine.

Quel que soit le thermomètre, la lecture la plus élevée doit être prise comme valeur de la température de l'enroulement ou de l'élément de machine.

7.7 Durée des essais thermiques

7.7.1 Caractéristiques assignées pour service continu

L'essai doit durer jusqu'à ce que l'équilibre thermique soit atteint.

7.7.2 Caractéristiques assignées pour service temporaire

La durée de l'essai doit être la durée qui est indiquée dans les caractéristiques assignées.

7.7.3 Caractéristiques assignées pour service périodique

Normalement les caractéristiques assignées pour charge équivalente (voir 4.2.6) attribuées par le constructeur doivent être appliquées jusqu'à ce que l'équilibre thermique soit atteint. S'il y a accord pour effectuer un essai au service réel, le cycle de charge spécifié doit être appliqué jusqu'à l'obtention de cycles de température pratiquement identiques. Le critère en est que la droite reliant les points correspondants de deux cycles de charge successifs sur un diagramme de température doit avoir une pente inférieure à 2 K par heure. Si nécessaire, il faut effectuer des mesures à intervalles raisonnables pendant un certain laps de temps.

The highest reading from the ETD elements shall be used to determine the temperature of the winding.

NOTE ETD elements or their connections may fail and give incorrect readings. Therefore, if one or more readings are shown to be erratic, after investigation they should be eliminated.

7.6.3.1 Two or more coil-sides per slot

The detectors shall be located between the insulated coil-sides within the slot in positions at which the highest temperatures are likely to occur.

7.6.3.2 One coil-side per slot

The detectors shall be located between the wedge and the outside of the winding insulation in positions at which the highest temperatures are likely to occur, but see also 7.6.1.

7.6.3.3 End windings

The temperature detectors shall be located between two adjacent coil-sides within the end windings in positions where the highest temperatures are likely to occur. The sensing point of each detector shall be in close contact with the surface of a coil-side and be adequately protected against the influence of the coolant, but see also 7.6.1.

7.6.4 Determination by thermometer method

When a non-embedded thermocouple or a resistance thermometer is used, it shall not be placed at a point inaccessible to a bulb thermometer.

All reasonable efforts, consistent with safety, shall be made to place thermometers at the point, or points where the highest temperatures are likely to occur (e.g. in the end windings close to the core iron) in such a manner that they are effectively protected against contact with the primary coolant and are in good thermal contact with the winding or other part of the machine.

The highest reading from any thermometer shall be taken to be the temperature of the winding or other part of the machine.

7.7 Duration of thermal tests

7.7.1 Rating for continuous running duty

The test shall be continued until thermal equilibrium has been reached.

7.7.2 Rating for short-time duty

The duration of the test shall be the time given in the rating.

7.7.3 Rating for periodic duty

Normally the rating for equivalent loading assigned by the manufacturer (see 4.2.6) shall be applied until thermal equilibrium has been reached. If a test on the actual duty is agreed the load cycle specified shall be applied and continued until practically identical temperature cycles are obtained. The criterion for this shall be that a straight line between the corresponding points of successive duty cycles on a temperature plot has a gradient of less that 2 K per hour. If necessary, measurements shall be taken at reasonable intervals over a period of time.

7.7.4 Caractéristiques assignées pour service non périodique et caractéristiques assignées pour service avec charges constantes distinctes

Les caractéristiques assignées pour charge équivalente (voir 4.2.6), attribuées par le constructeur doivent être appliquées jusqu'à ce que l'équilibre thermique soit atteint.

7.8 Détermination de la constante de temps thermique équivalente des machines pour service type S9

La constante de temps thermique équivalente (avec une ventilation telle qu'en condition normale de fonctionnement) appropriée pour la détermination approchée de l'évolution de la température peut être déterminée à partir de la courbe de refroidissement tracée conformément à 7.6.2.3. La valeur de la constante de temps est égale à 1,44 fois (c'est-à-dire 1/ln2 fois) le délai entre la déconnexion du moteur et le refroidissement à une température correspondant à la moitié de l'échauffement de la machine à pleine charge.

7.9 Mesurage de la température des paliers

L'une ou l'autre des méthodes par thermomètre ou par indicateur interne de température (IIT) est admise.

Le point de mesure doit être placé aussi près que possible de l'un des deux emplacements spécifiés au tableau 5.

Tableau 5 – Points de mesure

Type de palier	Point de mesure	Emplacement du point de mesure
A roulement à billes ou à rouleaux	A	Dans le logement du roulement et à une distance [1] de la bague extérieure du roulement ne dépassant pas 10 mm [2]
	B	Surface extérieure du logement du roulement le plus près possible de la bague extérieure du roulement
A coussinet	A	Dans la zone de pression de la coquille du coussinet [3] et à une distance[1] du film d'huile ne dépassant pas 10 mm [2]
	B	A un autre endroit de la coquille du coussinet

[1] La distance est mesurée à partir du point le plus proche de l'indicateur interne ou du thermomètre.

[2] Dans le cas d'une machine à rotor extérieur, le point A se trouve dans la partie fixe à une distance de la bague intérieure ne dépassant pas 10 mm et le point B se trouve sur la surface extérieure de la partie fixe, aussi près que possible de la bague intérieure.

[3] La coquille du coussinet est la partie supportant le matériau du coussinet qui est pressé et fixé dans le logement. La zone de pression est la portion de circonférence qui supporte la combinaison du poids du rotor et des charges radiales.

Il faut minimiser la résistance thermique entre l'indicateur interne de température et l'objet dont on mesure la température, par exemple, chaque interstice d'air doit être comblé par un produit conducteur de la chaleur.

NOTE Entre les points de mesure A et B comme entre ces points et le point le plus chaud du palier, il existe des différences de température qui dépendent, entre autres, de la dimension du palier. Pour les paliers à coussinets cylindriques emmanchés en force et pour les paliers à roulements à bille ou à rouleaux d'un diamètre intérieur inférieur ou égal à 150 mm, les différences de température qui se produisent entre les points de mesure A et B peuvent être présumées négligeables. Dans le cas des paliers plus grands, la différence de température entre les points de mesure A et B est approximativement 15 K.

7.7.4 Ratings for non-periodic duty and for duty with discrete constant loads

The rating for equivalent loading assigned by the manufacturer (see 4.2.6) shall be applied until thermal equilibrium has been reached.

7.8 Determination of the thermal equivalent time constant for machines of duty type S9

The thermal equivalent time constant with ventilation as in normal operating conditions, suitable for approximate determination of the temperature course, can be determined from the cooling curve plotted in the same manner as in 7.6.2.3. The value of the time constant is 1,44 times (i.e. 1/ln2 times) the time taken by the machine to cool to one-half of the full load temperature rise, after its disconnection from the supply.

7.9 Measurement of bearing temperature

Either the thermometer method or the ETD method may be used.

The measuring point shall be as near as possible to one of the two locations specified in table 5.

Table 5 – Measuring points

Type of bearing	Measuring point	Location of measuring point
Ball or roller	A	In the bearing housing and not more than 10 mm[1)] from the outer ring of the bearing [2)]
	B	Outer surface of the bearing housing as close as possible to the outer ring of the bearing
Sleeve	A	In the pressure zone of the bearing shell[3)] and not more than 10 mm[1)] from the oil-film gap [2)].
	B	Elsewhere in the bearing shell

[1)] The distance is measured to the nearest point of the ETD or thermometer bulb.

[2)] In the case of an 'inside out' machine, point A will be in the stationary part not more than 10 mm from the inner ring and point B on the outer surface of the stationary part as close as possible to the inner ring.

[3)] The bearing shell is the part supporting the bearing material and which is secured in the housing. The pressure zone is the portion of the circumference which supports the combination of rotor weight and radial loads.

The thermal resistance between the temperature detector and the object whose temperature is to be measured shall be minimized; for example, air gaps shall be packed with thermally conducting paste.

NOTE Between the measuring points A and B, as well as between these points and the hottest point of the bearing, there are temperature differences which depend, among other things, on the bearing size. For sleeve bearings with pressed-in bushings and for ball and roller bearings with an inside diameter up to 150 mm, the temperature difference between points A and B may be assumed to be negligible. In the case of larger bearings, the temperature difference between measuring points A and B is approximately 15 K.

7.10 Limites d'échauffement et de température

Des limites sont données pour marche aux conditions de fonctionnement sur site, définies à l'article 5, et aux caractéristiques assignées pour service continu (conditions de référence), suivies par des règles donnant les corrections à ces limites en cas de marche sur site avec d'autres conditions de fonctionnement et avec d'autres caractéristiques assignées. Des règles additionnelles donnent les corrections aux limites pendant l'essai thermique en cas de conditions de fonctionnement au site d'essai différentes de celles au site de fonctionnement.

Les limites sont stipulées par rapport au fluide de refroidissement de référence défini au tableau 3.

Une règle est donnée pour tenir compte de la pureté d'hydrogène.

7.10.1 Enroulements à refroidissement indirect

Les échauffements aux conditions de référence ne doivent pas excéder les limites données au tableau 6 (refroidissement par air) ou au tableau 7 (refroidissement par hydrogène) selon le cas.

Pour des conditions différentes de fonctionnement sur site, pour des caractéristiques assignées autres que celles pour service continu et pour des tensions assignées supérieures à 11 000 V, les limites doivent être corrigées selon le tableau 8. (Voir aussi le tableau 9 pour une limite à la température de fluide de refroidissement qui est présumée dans le tableau 8.)

En cas de lectures par thermomètre effectuées selon 7.6.1, la limite d'échauffement doit être conforme au tableau 6.

Si pour les enroulements à refroidissement indirect par air, les conditions de fonctionnement sur site d'essai diffèrent de celles sur site de fonctionnement, les limites corrigées données au tableau 10 doivent s'appliquer au site d'essai.

Si les limites corrigées données au tableau 10 conduisent à des températures admissibles au site d'essai que le constructeur juge excessives, la méthode d'essai et les limites doivent faire l'objet d'un accord.

Aucune correction pour le site d'essai n'est donnée pour les enroulements à refroidissement indirect par hydrogène car il est très improbable qu'ils soient essayés à pleine charge, ailleurs qu'à leur site de fonctionnement.

7.10 Limits of temperature and of temperature rise

Limits are given for operation under site operating conditions specified in clause 5 and at rating for continuous running duty (reference conditions), followed by rules for the adjustment of those limits when operating at site under other conditions and on other ratings. Further rules give adjustments to the limits during thermal testing when conditions at the test site differ from those at the operating site.

The limits are stated relative to the reference coolant specified in table 3.

A rule is given to allow for the purity of hydrogen coolant.

7.10.1 Indirect cooled windings

Temperature rises under reference conditions shall not exceed the limits given in table 6 (air coolant) or table 7 (hydrogen coolant) as appropriate.

For other operating site conditions, for ratings other than continuous running duty, and for rated voltages greater than 11 000 V, the limits shall be adjusted according to table 8. (See also table 9 for limit on coolant temperature which is assumed in table 8.)

In the case of thermometer readings made in accordance with 7.6.1, the limit of temperature rise shall be according to table 6.

If, for windings indirectly cooled by air, conditions at the test site differ from those at the operating site, the adjusted limits given in table 10 shall apply at the test site.

If the adjusted limits given in table 10 lead to permissible temperatures at the test site which the manufacturer considers to be excessive, the testing procedure and the limits shall be agreed.

No adjustments at the test site are given for windings indirectly cooled by hydrogen, because it is very unlikely that they will be tested at rated load anywhere other than at the operating site.

Tableau 6 – Limites d'échauffement des enroulements à refroidissement indirect par l'air

	Classification thermique	**A**			**E**			**B**			**F**			**H**		
	Méthode de mesure Th = Thermomètre, R = Résistance, IIT = Indicateur interne de température	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K
Point	**Partie de la machine**															
1a)	Enroulements à courant alternatif de machines de puissance supérieure ou égale à 5 000 kW (ou kVA)	–	60	65[1)]	–	–	–	–	80	85[1)]	–	100	105[1)]	–	125	130[1)]
1b)	Enroulements à courant alternatif de machnes de puissance supérieure à 200 kW (ou kVA), mais inférieure à 5 000 kW (ou kVA)	–	60	65[1)]	–	75	–	–	80	90[1)]	–	105	110[1)]	–	125	130[1)]
1c)	Enroulements à courant alternatif de machines de puissance inférieure ou égale à 200 kW (ou kVA) autres que ceux des points 1d) ou 1e)[2)]	–	60	–	–	75	–	–	80	–	–	105	–	–	125	–
1d)	Enroulements à courant alternatif de machines de puissance inférieure à 600 W (ou VA)[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
1e)	Enroulements à courant alternatif de machines qui sont refroidies naturellement, sans ventilateur (IC40) et/ou à enroulements enrobés[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
2	Enroulements d'induit reliés à des collecteurs	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
3	Enroulements d'excitation à courant continu des machines à courant alternatif et à courant continu, autres que ceux du point 4	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
4a)	Enroulements d'excitation à courant continu des machines synchrones à rotor cylindrique, dont un enroulement est logé dans l'encoche, excepté les moteurs synchrones à induction	–	–	–	–	–	–	–	90	–	–	110	–	–	135	–
4b)	Enroulements isolés fixes d'excitation à plus d'une couche des machines à courant continu	50	60	–	65	75	–	70	80	90	85	105	110	105	125	135
4c)	Enroulements d'excitation de faible résistance ayant plus d'une couche des machines à courant alternatif et à courant continu, et enroulements de compensation des machines à courant continu	60	60	–	75	75	–	80	80	–	100	100	–	125	125	–
4d)	Enroulements à une seule couche des machines à courant alternatif et à courant continu avec surfaces exposées nues ou en métal verni[3)]	65	65	–	80	80	–	90	90	–	110	110	–	135	135	–

[1)] Une correction peut être effectuée dans le cas des enroulements à courant alternatif à haute tension (voir point 4 du tableau 8).

[2)] Lors de l'application de la méthode d'essai par superposition à des enroulements de machines de puissance inférieure ou égale à 200 kW (ou kVA) avec des classes thermiques A, B, E et F, les limites des échauffements prévues pour la méthode par variation de résistance peuvent être dépassées de 5 K.

[3)] Comprend également les enroulements à plusieurs couches, à condition que les couches inférieures soient chacune en contact avec le fluide de refroidissement primaire en circulation.

Table 6 – Limits of temperature rise of windings indirectly cooled by air

Thermal classification		A			E			B			F			H		
Method of measurement Th = Thermometer, R = Resistance, ETD = Embedded temperature detector		Th	R	ETD	Th	R	ETD	Th	R	ETD	Th	R	ETD	Th	R	ETD
		K	K	K	K	K	K	K	K	K	K	K	K	K	K	K
Item	**Part of machine**															
1a)	AC windings of machines having outputs of 5 000 kW (or kVA) or more	–	60	65[1)]	–	–	–	–	80	85[1)]	–	100	105[1)]	–	125	130[1)]
1b)	AC windings of machines having outputs above 200 kW (or kVA), but less than 5 000 kW (or kVA)	–	60	65[1)]	–	75	–	–	80	90[1)]	–	105	110[1)]	–	125	130[1)]
1c)	AC windings of machines having outputs of 200 kW (or kVA) or less, other than those in items 1d) or 1e)[2)]	–	60	–	–	75	–	–	80	–	–	105	–	–	125	–
1d)	AC windings of machines having rated outputs of less than 600 W (or VA)[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
1e)	AC windings which are self-cooled without a fan (IC 40) and/or with encapsulated windings[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
2	Windings of armatures having commutators	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
3	Field windings of a.c. and d.c. machines other than those in item 4	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
4a)	Field windings of synchronous machines with cylindrical rotors having a d.c. excitation winding embedded in slots, except synchronous induction motors	–	–	–	–	–	–	–	90	–	–	110	–	–	135	–
4b)	Insulated stationary field windings of d.c. machines having more than one layer	50	60	–	65	75	–	70	80	90	85	105	110	105	125	135
4c)	Low-resistance field windings of a.c. and d.c. machines having more than one layer and compensating windings of d.c. machines	60	60	–	75	75	–	80	80	–	100	100	–	125	125	–
4d)	Single-layer windings of a.c. and d.c. machines with exposed bare or varnished metal surfaces.[3)]	65	65	–	80	80	–	90	90	–	110	110	–	135	135	–

[1)] An adjustment for high-voltage a.c. windings may be applicable to these items, (see item 4 of table 8).

[2)] With the application of the superposition test method to windings of machines rated at 200 kW (or kVA) or less with thermal classes A, B, E and F, the limits of temperature rise given for the resistance method may be exceeded by 5 K.

[3)] Also includes multiple layer windings provided that the under layers are each in contact with the circulating primary coolant.

Tableau 7 – Limites d'échauffement des enroulements à refroidissement indirect par hydrogène

Classification thermique		A		E		B		F	
Méthode de mesure IIT = Indicateur interne de température		Résistance K	IIT K	Résistance K	IIT K	Résistance K	IIT K	Résistance K	IIT K
Point									
1	Enroulements à courant alternatif de machines de puissance égale ou supérieure à 5 000 kW (ou kVA) ou dont la longueur du noyau axial est égale ou supérieure à 1 m								
	Pression absolue d'hydrogène[2] ≤ 150 kPa (1,5 bar)	–	–	–	–	–	85[1]	–	105[1]
	> 150 kPa ≤ 200 kPa (2,0 bar)	–	–	–	–	–	80[1]	–	100[1]
	> 200 kPa ≤ 300 kPa (3,0 bar)	–	–	–	–	–	78[1]	–	98[1]
	> 300 kPa ≤ 400 kPa (4,0 bar)	–	–	–	–	–	73[1]	–	93[1]
	> 400 kPa	–	–	–	–	–	70[1]	–	90[1]
2a)	Enroulements à courant alternatif de machine de puissance inférieure à 5 000 kW (ou KVA) et dont la longueur du noyau axial est inférieure à 1 m	60	65[1]	75	80[1]	80	85[1]	100	105[1]
2b)	Enroulements d'excitation à courant continu des machines à courant alternatif et à courant continu autres que celles des points 3 et 4	80	–	75	–	80	–	105	–
3	Enroulements d'excitation à courant continu des turbo-machines	–	–	–	–	85	–	105	–
4a)	Enroulements d'excitation de faible résistance, à plus d'une couche, et enroulements de compensation	60	–	75	–	80	–	100	–
4b)	Enroulements à une couche avec surfaces exposées nues ou en métal vernis [3]	65	–	80	–	90	–	110	–

[1] Une correction peut être effectuée dans le cas des enroulements à courant alternatif à haute tension (voir point 4 du tableau 8).

[2] Ce point est le seul pour lequel l'échauffement admissible dépend de la pression d'hydrogène.

[3] Comprend également les enroulements d'excitation à plusieurs couches, à condition que les couches inférieures soient chacune en contact avec le fluide de refroidissement primaire en circulation.

Table 7 – Limits of temperature rise of windings indirectly cooled by hydrogen

	Thermal classification	**A**		**E**		**B**		**F**	
	Method of measurement	**Resistance**	**ETD**	**Resistance**	**ETD**	**Resistance**	**ETD**	**Resistance**	**ETD**
	ETD = Embedded temperature detector	K	K	K	K	K	K	K	K
Item									
1	AC windings of machines having outputs of 5 000 kW (or kVA) or more or having a core length of 1 m or more								
	Absolute hydrogen pressure [2] ≤ 150 kPa (1,5 bar)	–	–	–	–	–	85[1]	–	105[1]
	> 150 kPa ≤ 200 kPa (2,0 bar)	–	–	–	–	–	80[1]	–	100[1]
	> 200 kPa ≤ 300 kPa (3,0 bar)	–	–	–	–	–	78[1]	–	98[1]
	> 300 kPa ≤ 400 kPa (4,0 bar)	–	–	–	–	–	73[1]	–	93[1]
	> 400 kPa	–	–	–	–	–	70[1]	–	90[1]
2a)	AC windings of machines having outputs of less than 5 000 kW (or kVA), or having a core length of less than 1 m	60	65[1]	75	80[1]	80	85[1]	100	105[1]
2b)	DC field windings of a.c. and d.c. machines other than those in items 3 and 4	80	–	75	–	80	–	105	–
3	Field windings of turbo type machines having d.c. excitation	–	–	–	–	85	–	105	–
4a)	Low-resistance field windings of more than one layer and compensating windings	60	–	75	–	80	–	100	–
4b)	Single-layer windings with exposed bare or varnished metal surfaces[3]	65	–	80	–	90	–	110	–

[1] An adjustment for high-voltage a.c. windings may be applicable to these items, see table 8 item 4.

[2] This is the only item where the limit of temperature rise is dependant on hydrogen pressure.

[3] Also includes multi-layer field windings provided that the underlayers are each in contact with the circulating primary coolant.

Tableau 8 – Corrections aux limites des échauffements sur le site de fonctionnement des enroulements à refroidissement indirect pour tenir compte de conditions de fonctionnement et de caractéristiques assignées qui ne sont pas les conditions de référence

Point	Conditions de fonctionnement ou caractéristiques assignées		Corrections aux limites d'échauffement ($\Delta\theta$) des tableaux 6 et 7
1	Température maximale de l'air ambiant ou de l'air à l'entrée de la machine (θ_c)	0 °C ≤ θ_c ≤ 40 °C	Peuvent être augmentées par accord, mais cette augmentation ne doit dépasser ni la différence de température entre la température du fluide de refroidissement et 40 °C, ni un maximum de 30 K.
		40 °C < θ_c ≤ 60 °C	Réduites de la différence entre la température du fluide de refroidissement et 40 °C
		θ_c < 0 °C ou θ_c > 60 °C	Par accord
2	Température maximale de l'eau à l'entrée des hydro-réfrigérants (θ_w)	5 °C ≤ θ_w ≤ 25 °C	Augmentées de 10 K et peuvent être augmentées en plus d'une quantité ne dépassant pas la différence de température entre la température de l'eau de refroidissement et 25 °C.
		θ_w > 25 °C	Augmentées de 10 K et diminuées de la différence de température entre la température maximale de l'eau de refroidissement et 25 °C.
3	Altitude (H)	1 000 m < H ≤ 4 000 m et température maximale de l'air ambiant non spécifiée	Pas de correction. On doit admettre que la diminution du pouvoir de refroidissement résultant de l'altitude est compensée par une réduction de la température ambiante maximale au dessous de 40 °C et que les températures totales ne dépasseront en conséquence pas 40 °C plus les échauffements des tableaux 6 et 7[1)]
		H >4 000 m	Par accord
4	Tension assignée (U_N)	11 kV < U_N ≤ 17 kV	$\Delta\theta$, pour les indicateurs internes de température (IIT) doivent être réduites de 1 K par tranche de 1 kV (ou fraction de tranche) à partir de 11 kV jusqu'à 17 kV compris
		U_N > 17 kV	$\Delta\theta$, pour les indicateurs internes de température (IIT) doivent être réduites de 6 K et en plus réduites de 1,5 K par tranche de 1 kV (ou fraction de tranche) au-dessus de 17 kV
5[2)]	Caractéristiques assignées pour service temporaire (S2), avec puissance assignée inférieure à 5 000 kW (kVA)		Augmentées de 10 K
6[2)]	Caractéristiques assignées pour service non périodique (S9)		$\Delta\theta$, peuvent être dépassées pendant de courtes périodes lors du fonctionnement de la machine
7[2)]	Caractéristiques assignées pour service avec charges constantes distinctes (S10)		$\Delta\theta$, peuvent être dépassées pendant des périodes distinctes lors du fonctionnement de la machine.

[1)] En admettant que la réduction nécessaire de la température ambiante est de 1% des limites d'échauffement par tranche de 100 m au-dessus de 1 000 m, la température ambiante maximale présumée du site de fonctionnement, basée sur température ambiante maximale de 40 °C pour des altitudes inférieures ou égales à 1 000 m, sera celle qui est indiquée au tableau 9 (basé sur les limites d'échauffement des points 1b) et 1c) du tableau 6).

[2)] Uniquement pour les enroulements refroidis par air.

Table 8 – Adjustments to limits of temperature rise at the operating site of indirect cooled windings to take account of non-reference operating conditions and ratings

Item	Operating conditions or rating		Adjustment to limit of temperature rise (Δθ) in tables 6 and 7
1	Maximum temperature of ambient air or of the air at inlet to the machine (θ_c)	0 °C ≤ θ_c ≤ 40 °C	May be increased by agreement but this increase shall not exceed either the amount by which the coolant temperature is less than 40 °C, or a maximum of 30 K
		40 °C < θ_c ≤ 60 °C	Reduced by the amount by which the coolant temperature exceeds 40 °C
		θ_c < 0 °C or θ_c > 60 °C	By agreement
2	Maximum temperature of the water at inlet to water-cooled heat exchangers (θ_W)	5 °C ≤ θ_w ≤ 25 °C	Increased by 10 K and may be further increased by an amount not exceeding the amount by which the cooling temperature is less than 25 °C
		θ_w > 25 °C	Increased by 10 K and reduced by the amount by which the maximum cooling water temperature exceeds 25 °C
3	Altitude (H)	1 000 m < H ≤ 4 000 m and maximum ambient air temperature not specified	No adjustment. It shall be assumed that the reduced cooling resulting from altitude is compensated by a reduction of maximum ambient temperature below 40 °C and that the total temperature will therefore not exceed 40 °C plus the table 6 and 7 temperature rises[1)]
		H > 4 000 m	By agreement
4	Rated stator winding voltage (U_N)	11 kV < U_N ≤ 17 kV	Δθ for embedded temperature detectors (ETD) shall be reduced by 1 K for each 1 kV (or part thereof) from 11 kV up to and including 17 kV
		U_N > 17 kV	Δθ for embedded temperature detectors (ETD) shall be reduced by 6 K plus 1,5 K for each 1 kV (or part thereof) above 17 kV
5[2)]	Rating for short-time duty (S2), with rated output less than 5 000 kW (kVA)		Increased by 10 K
6[2)]	Rating for non-periodic duty (S9)		Δθ may be exceeded for short periods during the operation of the machine
7[2)]	Rating for duty with discrete loads (S10)		Δθ may be exceeded for discrete periods during the operation of the machine

[1)] Assuming the necessary decrease in ambient temperature is 1 % of the limiting rises for every 100 m of altitude above 1 000 m, the assumed maximum ambient air temperature at the operating site based on a 40 °C maximum ambient temperature for altitudes less than 1 000 m will be as shown in table 9 (based on the limiting rises for items 1b) and 1c) of table 6).

[2)] For air-cooled windings only.

Tableau 9 – Températures ambiantes maximales présumées

Altitude m	**Classification thermique**				
	A	E	B	F	H
	Température °C				
1000	40	40	40	40	40
2000	34	33	32	30	28
3000	28	26	24	19	15
4000	22	19	16	9	3

7.10.2 Enroulements à refroidissement direct

Les températures aux conditions de référence ne doivent pas excéder les limites données au tableau 11.

Pour des conditions différentes de fonctionnement sur site, les limites doivent être corrigées selon le tableau 12.

Si les conditions de fonctionnement sur site d'essai diffèrent de celles sur site de fonctionnement, les limites corrigées données au tableau 13 doivent s'appliquer au site d'essai.

Si les limites corrigées données au tableau 13 conduisent à des températures au site d'essai que le constructeur considère être excessives, la méthode d'essai et les limites doivent faire l'objet d'un accord.

7.10.3 Corrections pour tenir compte de la pureté de l'hydrogène au cours de l'essai

Pour les enroulements à refroidissement direct ou indirect par hydrogène, aucune correction ne doit être effectuée sur les limites d'échauffement ou de température totale, si la proportion de l'hydrogène est comprise entre 95 % et 100 %.

7.10.4 Enroulements continuellement fermés sur eux-mêmes, circuits magnétiques et tous éléments de structure (à l'exclusion des paliers), qu'ils soient ou non en contact direct avec une isolation

L'échauffement ou la température ne doit pas être préjudiciable à l'isolation de cette partie ou de toute autre partie avoisinante.

7.10.5 Collecteurs et bagues, ouverts ou enfermés, et leurs balais et porte-balais

La température ou l'échauffement de tout collecteur, bague, balai ou porte-balais ne doit pas être préjudiciable à l'isolation de cette partie ou de toute autre partie avoisinante.

La température ou l'échauffement d'un collecteur ou de bagues ne doit pas dépasser le niveau qui permet d'assurer le passage du courant dans toute la plage de fonctionnement, pour la combinaison de la qualité des balais et du matériau du collecteur ou des bagues.

Table 9 – Assumed maximum ambient temperature

Altitude m	Thermal class				
	A	E	B	F	H
	Temperature °C				
1000	40	40	40	40	40
2000	34	33	32	30	28
3000	28	26	24	19	15
4000	22	19	16	9	3

7.10.2 Direct cooled windings

Temperatures under reference conditions shall not exceed the limits given in table 11.

For other operating site conditions the limits shall be adjusted according to table 12.

If conditions at the test site differ from those at the operating site, the adjusted limits given in table 13 shall apply at the test site.

If the adjusted limits given in table 13 lead to temperatures at the test site which the manufacturer considers to be excessive, the testing procedure and the limits shall be agreed.

7.10.3 Adjustments to take account of hydrogen purity on test

For windings directly or indirectly cooled by hydrogen, no adjustment shall be made to limits of temperature rise or of total temperature if the proportion of hydrogen in the coolant is between 95 % and 100 %.

7.10.4 Permanently short-circuited windings, magnetic cores and all structural components (other than bearings) whether or not in contact with insulation

The temperature rise or the temperature shall not be detrimental to the insulation of that part or to any other part adjacent to it.

7.10.5 Commutators and sliprings, open or enclosed and their brushes and brushgear

The temperature rise or temperature of any commutator, slipring, brush or brushgear shall not be detrimental to the insulation of that part or any adjacent part.

The temperature rise or temperature of a commutator or slipring shall not exceed that at which the combination of brush grade and commutator or slipring material can handle the current over the full operating range.

Tableau 10 – Limites corrigées des échauffements sur le site d'essai ($\Delta\theta_T$) des enroulements à refroidissement indirect par air pour tenir compte des conditions de fonctionnement sur le site d'essai

Point	Conditions de fonctionnement sur le site d'essai		Limites corrigées sur le site d'essai $\Delta\theta_T$
1	Différence de température de fluide de refroidissement de référence entre site d'essai (θ_{cT}) et site de fonctionnement (θ_c)	Valeur absolue de ($\theta_c - \theta_{cT}$) ≤ 30 K	$\Delta\theta_T = \Delta\theta$
		Valeur absolue de ($\theta_c - \theta_{cT}$) > 30 K	Par accord
2	Différence d'altitude entre site d'essai (H_T) et site de fonctionnement (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\Delta\theta_T = \Delta\theta\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right)$
		H > 4 000 m ou H_T > 4 000 m	Par accord

1) $\Delta\theta$ est donné au tableau 6 et est corrigé, le cas échéant, conformément au tableau 8.

2) Si l'échauffement doit être mesuré au-dessus de la température de l'eau à son entrée dans le réfrigérant, en toute rigueur il faudrait tenir compte de l'effet de l'altitude sur la différence de température entre l'air et l'eau. Toutefois, pour la plupart des conceptions de réfrigérants, l'effet sera faible, la différence augmentant avec l'altitude au taux d'environ 2 K pour 1 000 m. Si une correction est nécessaire, il convient qu'elle fasse l'objet d'un accord.

Table 10 – Adjusted limits of temperature rise at the test site ($\Delta\theta_T$) for windings indirectly cooled by air to take account of test site operating conditions

Item	Test condition		Adjusted limit at test site $\Delta\theta_T$
1	Difference of reference coolant temperatures of test site (θ_{cT}) and operating site (θ_c)	Absolute value of $(\theta_c - \theta_{cT}) \leq 30$ K	$\Delta\theta_T = \Delta\theta$
		Absolute value of $(\theta_c - \theta_{cT}) > 30$ K	By agreement
2	Difference of altitudes of test site (H_T) and operating site (H)	1 000 m < $H \leq$ 4 000 m $H_T <$ 1 000 m	$\Delta\theta_T = \Delta\theta\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		$H <$ 1 000 m 1 000 m < $H_T \leq$ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		1 000 m < $H \leq$ 4 000 m 1 000 m < $H_T \leq$ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right)$
		$H >$ 4 000 m or $H_T >$ 4 000 m	By agreement

[1] $\Delta\theta$ is given in table 6 and adjusted if necessary in accordance with table 8.

[2] If temperature rise is to be measured above the temperature of the water where it enters the cooler, the effect of altitude on the temperature difference between air and water should strictly be allowed for. However, for most cooler designs, the effect will be small, the difference increasing with increasing altitude at the rate of roughly 2 K per 1 000 m. If an adjustment is necessary, it should be by agreement.

Tableau 11 – Limites des températures des enroulements à refroidissement direct et de leurs fluides de refroidissement

Classification thermique		**B**			**F**		
Méthode de mesure		**Thermomètre** °C	**Résistance** °C	**IIT** °C	**Thermomètre** °C	**Résistance** °C	**IIT** °C
Point	**Partie de la machine**						
1	Fluide de refroidissement à la sortie des enroulements à courant alternatif refroidis directement. Il est préférable d'utiliser ces valeurs, plutôt que celles du point 2, pour la définition des caractéristiques assignées						
1a)	Gaz (air, hydrogène, hélium, etc.)	110	–	–	130	–	–
1b)	Eau	90	–	–	90	–	–
2	Enroulements à courant alternatif						
2a) 2b)	Refroidis par un gaz Refroidis par un liquide	–	–	120[1)]	–	–	145[1)]
3	Enroulements d'excitation des turbo-machines						
3a)	Refroidis par un gaz sortant du rotor par le nombre suivant de zones de sortie [2)]						
	1 et 2	–	100	–	–	115	–
	3 et 4	–	105	–	–	120	–
	6	–	110	–	–	125	–
	8 à 14	–	115	–	–	130	–
	plus de 14	–	120	–	–	135	–
3b)	Refroidis par un liquide	L'observation des températures maximales du fluide de refroidissement spécifiées au point 1b) assure que la température aux points chauds de l'enroulement n'est pas excessive.					
4	Enroulements d'excitation à courant continu des machines à courant alternatif et à courant continu, autres que ceux du point 3						
4a)	Refroidis par un gaz	–	130	–	–	150	–
4b)	Refroidis par un liquide	L'observation des températures maximales du fluide de refroidissement spécifiées au point 1b) assure que la température aux points chauds de l'enroulement n'est pas excessive.					

[1)] Aucune correction n'est à effectuer à ces points dans le cas d'enroulements à courant alternatif à haute tension, voir point n° 2 du tableau 12.

[2)] La ventilation du rotor est caractérisée par le nombre de zones de sorties radiales sur toute la longueur du rotor. Les zones spéciales de sortie de fluide de refroidissement dans les têtes de bobines sont comptées à raison d'une sortie à chaque extrémité. La zone de sortie commune de deux courants dirigés en sens inverse est comptée pour deux zones.

Table 11 – Limits of temperature of directly cooled machines and their coolants

Thermal classification		B			F		
Method of measurement		Thermo-meter °C	Resistance °C	ETD °C	Thermo-meter °C	Resistance °C	ETD °C
Item	Part of the machine						
1	Coolant at the outlet of direct-cooled a.c. windings. These temperatures are preferred to the values given in item 2 as the basis of rating.						
1a)	Gas (air, hydrogen, helium, etc.)	110	–	–	130	–	–
1b)	Water	90	–	–	90	–	–
2	AC windings						
2a) 2b)	Gas cooled Liquid cooled	–	–	120[1)]	–	–	145[1)]
3	Field windings of turbine type machines						
3a)	Cooled by gas leaving the rotor through the following number of outlet regions [2)]						
	1 and 2	–	100	–	–	115	–
	3 and 4	–	105	–	–	120	–
	6	–	110	–	–	125	–
	8 to 14	–	115	–	–	130	–
	above 14	–	120	–	–	135	–
3b)	Liquid cooled	Observance of the maximum coolant temperature given in item 1b) will ensure that the hotspot temperature of the winding is not excessive.					
4	Field windings of a.c. and d.c. machines having d.c. excitation other than in item 3.						
4a)	Gas cooled	–	130	–	–	150	–
4b)	Liquid cooled	Observance of the maximum coolant temperature given in item 1b) will ensure that the hotspot temperature of the winding is not excessive.					

1) No adjustment in the case of high-voltage a.c. windings is applicable to these items, see table 12, item 2.

2) The rotor ventilation is classified by the number of radial outlet regions on the total length of the rotor. Special outlet regions for the coolant of the end windings are included as one outlet for each end. The common outlet region of two axially opposed flows is to be counted as two regions.

Tableau 12 – Corrections aux limites de température sur le site de fonctionnement pour les enroulements à refroidissement direct par air ou hydrogène pour tenir compte de conditions de fonctionnement et de caractéristiques assignées qui ne sont pas les conditions de référence

Point	Conditions de fonctionnement ou caractéristiques assignées		Corrections aux limites de température du tableau 11
1	Température du fluide de refroidissement de référence (θ_c)	0 °C ≤ θ_c ≤ 40 °C	Réduites de la différence entre 40 °C et θ_c. Cependant par accord, une réduction inférieure peut être effectuée, sous réserve que si θ_c < 10 °C, la réduction soit au moins égale à la différence entre 10 °C et θ_c
		40 °C < θ_c ≤ 60 °C	Pas de correction
		θ_c < 0 °C ou θ_c > 60 °C	Par accord
2	Tension assignée de l'enroulement statorique (U_N)	U_N > 11 kV	Pas de correction. Le débit de chaleur passe principalement vers le fluide de refroidissement à l'intérieur des conducteurs et non à travers l'isolation principale de l'enroulement.

Tableau 13 – Limites corrigées de température sur le site d'essai θ_T pour les enroulement à refroidissement direct par air pour tenir compte des conditions de fonctionnement sur le site d'essai

Point	Conditions de fonctionnement sur le site d'essai		Limites corrigées de température sur le site d'essai θ_T
1	Différence de température de fluide de refroidissement entre site d'essai (θ_{cT}) et site de fonctionnement (θ_c)	Valeur absolue de ($\theta_c - \theta_{cT}$) ≤ 30 K	$\theta_T = \theta$
		Valeur absolue de ($\theta_c - \theta_{cT}$) > 30 K	Par accord
2	Différence d'altitude entre site d'essai (H_T) et site de fonctionnement (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\theta_T = (\theta - \theta_c)\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H > 4 000 m ou H_T > 4 000 m	Par accord
NOTE θ est donné au tableau 11 et est corrigé, le cas échéant, conformément au tableau 12.			

Table 12 – Adjustments to limits of temperature at the operating site for windings directly cooled by air or hydrogen to take account of non-reference operating conditions and ratings

Item	Operating condition or rating		Adjustment to limit of temperature in table 11
1	Reference coolant temperature (θ_c)	0 °C ≤ θ_c ≤ 40 °C	Reduction by the amount of the difference between 40 °C and θ_c. However, by agreement, a smaller reduction may be applied, provided that for θ_c < 10 °C the reduction is made at least equal to the difference between 10 °C and θ_c.
		40 °C < θ_c ≤ 60 °C	No adjustment
		θ_c < 0 °C or θ_c > 60 °C	By agreement
2	Rated stator winding voltage (U_N)	U_N > 11 kV	No adjustment The heat flow is mainly towards the coolant inside the conductors and not through the main insulation of the winding.

Table 13 – Adjusted limits of temperature at the test site θ_T for windings directly cooled by air to take account of test site operating conditions

Item	Test condition		Adjusted limit of temperature at test site θ_T
1	Difference of reference coolant temperatures of test site (θ_{cT}) and operating site (θ_c)	Absolute value of ($\theta_c - \theta_{cT}$) ≤ 30 K	$\theta_T = \theta$
		Absolute value of ($\theta_c - \theta_{cT}$) > 30 K	By agreement
2	Difference of altitudes of test site (H_T) and operating site (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\theta_T = (\theta - \theta_c)\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H > 4 000 m or H_T > 4 000 m	By agreement
NOTE θ is given in table 11 and adjusted if necessary in accordance with table 12.			

Section 8: Autres caractéristiques de fonctionnement et essais

8.1 Essais de tension de tenue

Une tension d'essai telle que définie ci–après doit être appliquée entre les enroulements soumis à l'essai et la carcasse de la machine à laquelle sont reliés le circuit magnétique et les enroulements non soumis à l'essai. L'essai ne doit être effectué que sur une machine neuve et terminée, dont toutes les parties sont en place dans des conditions équivalentes aux conditions normales de fonctionnement; il doit être effectué dans l'atelier du constructeur ou après montage sur site. Si un essai d'échauffement est effectué, l'essai de tension de tenue doit être effectué immédiatement après cet essai.

Dans le cas de machines polyphasées de tension assignée supérieure à 1 kV, dont les deux extrémités de chaque phase sont individuellement accessibles, la tension d'essai doit être appliquée entre chaque phase et la carcasse, à laquelle sont reliés le circuit magnétique et les autres phases et enroulements non soumis à l'essai.

Sauf exception ci–dessous, la tension d'essai doit être à fréquence industrielle et de forme pratiquement sinusoïdale. La valeur finale de la tension d'essai doit être conforme au tableau 14. Toutefois, pour les machines de tension assignée égale ou supérieure à 6 kV, lorsque la disponibilité d'une installation d'essai à fréquence industrielle n'existe pas et après accord, l'essai peut être effectué en tension continue, à un niveau égal à 1,7 fois la valeur efficace spécifiée au tableau 14.

NOTE Il est reconnu que, lors d'un essai en tension continue, la distribution de potentiel de surface le long de l'isolation des développantes et les mécanismes de vieillissement sont différents de ceux en tension alternative.

L'essai doit être commencé avec une tension ne dépassant pas la moitié de la pleine tension d'essai. La tension est ensuite augmentée jusqu'à la pleine tension d'essai, d'une manière progressive ou par degrés ne dépassant pas 5 % de la pleine valeur, la durée de l'augmentation de la tension depuis la moitié jusqu'à la pleine valeur n'étant pas inférieure à 10 s. La pleine tension d'essai est alors maintenue pendant 1 min à la valeur spécifiée dans le tableau 14. Il ne doit pas y avoir de défaut (voir la CEI 60060-1) pendant cette séquence.

Lors des essais individuels des machines construites en série de puissance inférieure ou égale à 5 kW (ou kVA), l'essai de 1 min peut être remplacé par un essai d'environ 5 s à la tension normale d'essai spécifiée dans le tableau 14, ou d'environ 1 s à 120 % de la tension normale d'essai du tableau 14, la tension d'essai étant appliquée au moyen de pointes.

L'essai à haute tension effectué à pleine tension sur les enroulements lors de la réception ne doit pas être répété. Si, toutefois, un second essai est effectué sur demande de l'acheteur, après un séchage supplémentaire si cela est jugé nécessaire, la tension d'essai doit être égale à 80 % de la tension spécifiée dans le tableau 14.

Pour les moteurs à courant continu alimentés par convertisseurs statiques de puissance, on doit utiliser, pour déterminer la tension d'essai du tableau 14, la tension continue du moteur ou la valeur efficace de la tension alternative assignée entre phases aux bornes d'entrée du convertisseur statique de puissance, selon la valeur la plus élevée.

Les enroulements entièrement rebobinés doivent être essayés à la pleine valeur prévue pour les machines neuves.

Si un utilisateur et un réparateur ont convenu d'effectuer des essais de tension de tenue dans des cas de rebobinage partiel des enroulements ou de révision d'une machine, il est recommandé de procéder comme suit:

a) Les enroulements partiellement rebobinés sont essayés à 75 % de la tension d'essai prévue pour une machine neuve. Avant l'essai, la partie ancienne de l'enroulement, doit être soigneusement nettoyée et séchée.

Section 8: Other performance and tests

8.1 Withstand voltage test

A test voltage, as specified below, shall be applied between the windings under test and the frame of the machine, with the core and the windings not under test connected to the frame. It shall be applied only to a new and completed machine with all its parts in place under conditions equivalent to normal working conditions and shall be carried out at the manufacturer's works or after erection on site. When a thermal test is carried out, the withstand voltage test shall be carried out immediately after that test.

In the case of polyphase machines with rated voltage above 1 kV having both ends of each phase individually accessible, the test voltage shall be applied between each phase and the frame, with the core and the other phases and windings not under test connected to the frame.

Except as stated below, the test voltage shall be of power frequency and as near as possible to a sine wave form. The final value of the voltage shall be in accordance with table 14. However, for machines with a rated voltage 6 kV or greater, when power frequency equipment is not available, then by agreement a d.c. test may be carried out at a voltage 1,7 times the r.m.s. value given in table 14.

NOTE It is recognized that, during a d.c. test, the surface potential distribution along the end winding insulation and the ageing mechanisms are different from those occurring during an a.c. test.

The test shall be commenced at a voltage not exceeding half of the full test voltage. The voltage shall then be increased to the full value, steadily or in steps of not more than 5 % of the full value, the time allowed for the voltage increase from half to full value being not less than 10 s. The full test voltage shall then be maintained for 1 min in accordance with the value as specified in table 14. There shall be no failure (see IEC 60060-1) during this period.

During the routine testing of quantity produced machines up to 5 kW (or kVA), the 1 min test may be replaced by a test of approximately 5 s at the normal test voltage in table 14 or of approximately 1 s at 120 % of the normal test voltage in table 14, the test voltage being applied by means of prods.

The high-voltage test at full voltage made on the windings on acceptance shall not be repeated. If, however, a second test is made at the request of the purchaser, after further drying if considered necessary, the test voltage shall be 80 % of the voltage specified in table 14.

To determine the test voltage from table 14 for d.c. motors supplied by static power converters, the direct voltage of the motor or the r.m.s. phase-to-phase value of the rated alternating voltage at the input terminals of the static power converter shall be used, whichever is the greater.

Completely rewound windings shall be tested at the full test voltage for new machines.

When a user and a repair contractor have agreed to carry out withstand voltage tests in cases where windings have been partially rewound or in the case of an overhauled machine, the following procedure is recommended:

a) Partially rewound windings are tested at 75 % of the test voltage for a new machine. Before the test, the old part of the winding shall be carefully cleaned and dried.

b) Les machines révisées sont soumises, après nettoyage et séchage, à un essai à une tension égale à 1,5 fois la tension assignée, avec un minimum de 1 000 V si la tension assignée est égale ou supérieure à 100 V et un minimum de 500 V si la tension assignée est inférieure à 100 V.

Tableau 14 – Essais de tension de tenue

Point	Machine ou élément de la machine	Tension d'essai (valeur efficace)
1	Enroulements isolés de machines tournantes de puissance assignée inférieure à 1 kW (ou kVA) et de tension assignée inférieure à 100 V à l'exception de ceux des points 4 à 8	500 V + deux fois la tension assignée
2	Enroulements isolés de machines tournantes de puissance assignée inférieure à 10 000 kW (ou kVA) à l'exception de ceux des points 1 et 4 à 8[2)]	1 000 V + deux fois la tension assignée avec un minimum de 1 500 V[1)]
3	Enroulements isolés de machines tournantes de puissance assignée égale ou supérieure à 10 000 kW (ou kVA) à l'exception de ceux des points 4 à 8[2)]	
	Tension assignée[1)] – inférieure ou égale à 24 000 V – supérieure à 24 000 V	 1 000 V + deux fois la tension assignée Soumis à accord
4	Enroulements d'excitation séparée des machines à courant continu	1 000 V + deux fois la tension assignée maximale d'excitation avec un minimum de 1 500 V
5	Enroulements d'excitation des génératrices synchrones, des moteurs synchrones et des compensateurs synchrones	
5a)	Tension assignée d'excitation – inférieure ou égale à 500 V – supérieure à 500 V	 Dix fois la tension assignée d'excitation avec un minimum de 1 500 V 4 000 V + deux fois la tension assignée d'excitation
5b)	Si la machine est destinée à démarrer avec l'enroulement inducteur court-circuité ou fermé sur une résistance de valeur inférieure à dix fois la résistance de l'enroulement	Dix fois la tension assignée d'excitation avec un minimum de 1 500 V et un maximum de 3 500 V
5c)	Si la machine est destinée à démarrer soit avec l'enroulement inducteur fermé sur une résistance de valeur égale ou supérieure à dix fois la résistance de l'enroulement, soit avec les enroulements d'excitation en circuit ouvert avec ou sans diviseur de champ	1 000 V + deux fois la valeur maximale de la tension efficace qui peut se produire, dans les conditions de démarrage spécifiées, entre les bornes de l'enroulement d'excitation ou, dans le cas d'un enroulement d'excitation sectionné, entre les bornes de toute section, avec un minimum de 1 500 V[3)]
6	Enroulements secondaires (habituellement rotors) des moteurs à induction ou des moteurs à induction synchronisés non court-circuités en permanence (destinés par exemple à démarrer par rhéostats)	
6a)	Pour moteurs non réversibles ou pour moteurs réversibles à partir de l'arrêt seulement	1 000 V + deux fois la tension en circuit ouvert à l'arrêt, mesurée entre les bagues ou les bornes secondaires avec la tension assignée appliquée aux enroulements primaires
6b)	Pour les moteurs qui peuvent être inversés ou freinés en inversant l'alimentation primaire lorsque le moteur est en fonctionnement	1 000 V + quatre fois la tension secondaire en circuit ouvert à l'arrêt comme défini au point 6a)

b) Overhauled machines, after cleaning and drying, are subjected to a test at a voltage equal to 1,5 times the rated voltage, with a minimum of 1 000 V if the rated voltage is equal to or greater than 100 V and a minimum of 500 V if the rated voltage is less than 100 V.

Table 14 – Withstand voltage tests

Item	Machine or part	Test voltage (r.m.s.)
1	Insulated windings of rotating machines of rated output less than 1 kW (or kVA) and of rated voltage less than 100 V with the exception of those in Items 4 to 8	500 V + twice the rated voltage
2	Insulated windings of rotating machines of rated output less than 10 000 kW (or kVA) with the exception of those in Item 1 and Items 4 to 8 [2)]	1 000 V + twice the rated voltage with a minimum of 1500 V[1)]
3	Insulated windings of rotating machines of rated output 10 000 kW (or kVA) or more with the exception of those in Items 4 to 8 [2)] Rated voltage[1)]: - up to and including 24 000 V - above 24 000 V	 1 000 V + twice the rated voltage Subject to agreement
4	Separately excited field windings of d.c. machines	1 000 V + twice the maximum rated circuit voltage with a minimum of 1 500 V
5	Field windings of synchronous generators, synchronous motors and synchronous condensers.	
5a)	Rated field voltage: - up to, and including 500 V, - above 500 V.	 Ten times the rated field voltage with a minimum of 1 500 V 4 000 V + twice the rated field voltage
5b)	When a machine is intended to be started with the field winding short-circuited or connected across a resistance of value less than ten times the resistance of the winding	Ten times the rated field voltage with a minimum of 1 500 V and a maximum of 3 500 V.
5c)	When the machine is intended to be started either with the field winding connected across a resistance of value equal to, or more than, ten times the resistance of the winding, or with the field windings on open circuit with or without a field-dividing switch	1 000 V + twice the maximum value of the r.m.s. voltage, which can occur under the specified starting conditions, between the terminals of the field winding, or in the case of a sectionalized field winding between the terminals of any section, with a minimum of 1 500 V[3)]
6	Secondary (usually rotor) windings of induction motors or synchronous induction motors if not permanently short-circuited (e.g. if intended for rheostatic starting)	
6a)	For non-reversing motors or motors reversible from standstill only	1 000 V + twice the open-circuit standstill voltage as measured between slip-rings or secondary terminals with rated voltage applied to the primary windings
6b)	For motors to be reversed or braked by reversing the primary supply while the motor is running	1 000 V + four times the open-circuit standstill secondary voltage as defined in Item 6a)

Tableau 14 *(fin)*

Point	Machine ou élément de la machine	Tension d'essai (valeur efficace)
7	Excitatrices (sauf exceptions ci-dessous)	Comme les enroulements auxquels elles sont connectées
	Exception 1 – excitatrices des moteurs synchronisés (y compris les moteurs à induction synchrones) lorsqu'elles sont mises à la terre ou déconnectées des enroulements d'excitation pendant le démarrage	1 000 V + deux fois la tension assignée de l'excitatrice avec un minimum de 1500 V
	Exception 2 – enroulement à excitation séparée des excitatrices (voir point 4)	
8	Ensemble de machines et d'appareils électriquement reliés	Il est recommandé d'éviter si possible la répétition des essais des points 1 à 7, mais si l'essai est fait sur un ensemble de machines et d'appareils dont chacun a déjà subi un essai de tension de tenue, la tension d'essai appliquée à un tel ensemble connecté électriquement ne doit pas dépasser 80 % de la tension la plus basse applicable à l'un des éléments individuels de l'ensemble [4)]

[1)] Dans le cas d'enroulements diphasés ayant une borne commune, la tension dans la formule sera la plus haute tension en valeur efficace qui apparaît entre deux bornes quelconques pendant le fonctionnement.

[2)] L'essai diélectrique des machines à isolation graduée fera l'objet d'un accord.

[3)] La tension qui s'établit aux bornes des enroulements d'excitation ou de leurs sections, dans les conditions de démarrage spécifiées, peut être mesurée à une tension d'alimentation réduite appropriée; la tension ainsi mesurée sera augmentée dans le rapport de la tension de démarrage spécifiée à la tension d'alimentation de l'essai.

[4)] Pour les enroulements d'une ou plusieurs machines qui sont reliés ensemble électriquement, la tension à considérer est la tension maximale qui s'établit par rapport à la terre.

8.2 Surintensité occasionnelle

8.2.1 Généralités

La possibilité de surintensité des machines tournantes est donnée afin de coordonner ces machines à des dispositifs de commande et de protection. Des essais pour démontrer ces possibilités ne sont pas une prescription de la présente norme. L'effet d'échauffement dans les enroulements de la machine varie approximativement comme le produit du temps par le carré du courant. Un courant supérieur au courant assigné provoque une élévation de température. Sauf accord contraire, on peut supposer que la machine ne sera mise en fonctionnement à ces surintensités spécifiées que pendant quelques courtes périodes au cours de sa durée de vie. Si une machine à courant alternatif doit être utilisée à la fois comme génératrice et comme moteur, il est recommandé que la surintensité soit l'objet d'un accord.

NOTE Pour les machines synchrones, l'aptitude à fonctionner avec composante inverse de courant en régime de défaut est indiquée en 6.2.3.

8.2.2 Alternateurs

Les alternateurs dont la puissance assignée est inférieure ou égale à 1 200 MVA doivent être capables de supporter un courant égal à 1,5 fois le courant assigné pendant au moins 30 s.

Les alternateurs dont la puissance assignée est supérieure à 1 200 MVA doivent être capables de supporter un courant égal à 1,5 fois le courant assigné pendant une période qui doit faire l'objet d'un accord, mais cette période ne doit pas être inférieure à 15 s.

Table 14 *(concluded)*

Item	Machine or part	Test voltage (r.m.s.)
7	Exciters (except as below)	As for the windings to which they are connected
	Exception 1: Exciters of synchronous motors (including synchronous induction motors) if connected to earth or disconnected from the field windings during starting	1 000 V + twice the rated exciter voltage, with a minimum of 1 500 V
	Exception 2: Separately excited field windings of exciters (see Item 4)	
8	Electrically interconnected machines and apparatus	A repetition of the tests in items 1 to 7 above should be avoided if possible, but if a test is performed on a group of machines and apparatus, each having previously passed its withstand voltage test, the test voltage to be applied to such an electrically connected arrangement shall be 80 % of the lowest test voltage appropriate for any individual piece of the arrangement [4)]

[1)] For two-phase windings having one terminal in common, the voltage in the formula shall be the highest r.m.s. voltage arising between any two terminals during operation.

[2)] High-voltage tests on machines having graded insulation should be the subject of agreement.

[3)] The voltage occurring between the terminals of the field windings, or sections thereof, under the specified starting conditions, may be measured at any convenient reduced supply voltage, and the voltage so measured shall be increased in the ratio of the specified starting supply voltage to the test supply voltage.

[4)] For windings of one or more machines connected together electrically, the voltage to be considered is the maximum voltage that occurs in relation to earth.

8.2 Occasional excess current

8.2.1 General

The excess current capability of rotating machines is given for the purpose of co-ordinating these machines with control and protective devices. Tests to demonstrate these capabilities are not a requirement of this standard. The heating effect in the machine windings varies approximately as the product of the time and the square of the current. A current in excess of the rated current will result in increased temperature. Unless otherwise agreed, it can be assumed that the machine will not be operated at the excess currents specified for more than a few short periods during the lifetime of the machine. When an a.c. machine is to be used as both a generator and a motor, the excess current capability should be the subject of agreement.

NOTE For the capability of synchronous machines concerning the occasional negative-sequence component of current under fault conditions, see 6.2.3.

8.2.2 Generators

AC generators having rated outputs not exceeding 1 200 MVA shall be capable of withstanding a current equal to 1,5 times the rated current for not less than 30 s.

AC generators having rated outputs above 1 200 MVA shall be capable of withstanding a current equal to 1,5 times the rated current for a period which shall be agreed, but this period shall be not less than 15 s.

8.2.3 Moteurs à courant alternatif (sauf les moteurs à collecteur)

Les moteurs triphasés à courant alternatif dont la puissance assignée est inférieure ou égale à 315 kW et dont la tension assignée est inférieure ou égale à 1 kV doivent être capables de supporter un courant égal à 1,5 fois le courant assigné pendant au moins 2 min.

NOTE Pour les moteurs triphasés de puissance assignée supérieure à 315 kW et pour tous les moteurs monophasés, aucune surintensité occasionnelle n'est spécifiée.

8.2.4 Machines à collecteur

Une machine à collecteur doit être capable de supporter, pendant 60 s, 1,5 fois le courant assigné dans la combinaison appropriée des conditions suivantes:

a) vitesse:

1) moteur à courant continu: vitesse la plus élevée à pleine excitation;
2) génératrice à courant continu: vitesse assignée;
3) moteur à collecteur à courant alternatif: vitesse la plus élevée à pleine excitation;

b) tension d'induit: celle correspondant à la vitesse spécifiée.

8.3 Excès momentané de couple des moteurs

8.3.1 Moteurs à induction polyphasés et moteurs à courant continu (sauf les moteurs qui font l'objet de 8.3.2)

Les moteurs doivent, quels que soient leur service et leur réalisation, être capables de supporter, pendant 15 s, sans calage ni changement brusque de vitesse (sous une augmentation graduelle de couple) un excès du couple de 60 % de leur valeur assignée, la tension et la fréquence (moteurs à induction) étant maintenues à leurs valeurs assignées.

NOTE Pour certains moteurs fabriqués conformément à la CEI 60034-12, des couples plus importants sont nécessaires.

Pour les moteurs à courant continu, le couple doit être exprimé en termes de surintensité; voir 8.2.4.

Les moteurs pour service type S9 doivent être capables de supporter momentanément un excès de couple déterminé conformément au service spécifié.

NOTE Pour une détermination approchée des variations de température dues à l'évolution des pertes en fonction du courant, la constante de temps thermique équivalente, déterminée conformément à 7.8, peut être utilisée. De plus, dans le cas d'une machine à collecteur, il convient de prêter attention aux limites de possibilité de commutation.

8.3.2 Moteurs à induction pour applications particulières

Les moteurs destinés à des applications particulières qui exigent un couple élevé (par exemple pour les appareils de levage) doivent faire l'objet d'un accord.

Pour les moteurs à induction à cage spécialement prévus pour assurer au démarrage un courant inférieur à 4,5 fois le courant assigné, l'excès de couple peut être inférieur à 60 % de la valeur indiquée en 8.3.1, mais doit être au moins égal à 50 % de cette valeur.

Dans le cas des moteurs à induction de type spécial ayant des propriétés intrinsèques spéciales de démarrage, par exemple les moteurs destinés au fonctionnement à fréquence variable ou les moteurs à induction alimentés par convertisseurs statiques, la valeur de l'excès de couple doit faire l'objet d'un accord.

8.2.3 AC motors (except commutator motors)

Three-phase a.c. motors having rated outputs not exceeding 315 kW and rated voltages not exceeding 1 kV shall be capable of withstanding a current equal to 1,5 times the rated current for not less than 2 min.

NOTE For three-phase motors having rated outputs above 315 kW and all single-phase motors, no occasional excess current is specified.

8.2.4 Commutator machines

A commutator machine shall be capable of withstanding, for 60 s, 1,5 times rated current under the appropriate combination of conditions as follows:

a) speed:
   1) d.c. motor: highest full-field speed;
   2) d.c. generator: rated speed;
   3) a.c. commutator motor: highest full-field speed;

b) armature voltage: that corresponding to the specified speed;

8.3 Momentary excess torque for motors

8.3.1 Polyphase induction motors and d.c. motors (excluding motors in 8.3.2)

The motors shall, whatever their duty and construction, be capable of withstanding for 15 s, without stalling or abrupt change in speed (under gradual increase of torque), an excess torque of at least 60 % of their rated torque, the voltage and frequency (induction motors) being maintained at their rated value.

NOTE Higher torques are required for some motors manufactured according to IEC 60034-12.

For d.c. motors, the torque shall be expressed in terms of overload current; see 8.2.4.

Motors for duty type S9 shall be capable of withstanding momentarily an excess torque determined according to the duty specified.

NOTE For an approximate determination of the changes in temperature due to the course of the current-related losses, the thermal equivalent time constant, determined according to 7.8 may be used. In addition, in the case of a commutator machine, attention should be given to the limits of commutation capability.

8.3.2 Induction motors for specific applications

Motors intended for specific applications that require a high torque (for example for hoisting) shall be the subject of agreement.

For cage-type induction motors specially designed to ensure a starting current less than 4,5 times the rated current, the excess torque can be below the figure of 60 % given in 8.3.1, but not less than 50 %.

In the case of special types of induction motors with special inherent starting properties, for example motors intended for use at variable frequency or induction motors supplied from static converters, the value of the excess torque shall be the subject of agreement.

8.3.3 Moteurs synchrones polyphasés

Sauf accord contraire, un moteur synchrone polyphasé doit, quel que soit son service, être capable de supporter pendant 15 s, sans perte de synchronisme, l'excès de couple spécifié ci-dessous, l'excitation étant maintenue à la valeur qui correspond à la charge assignée. Dans le cas d'une excitation à réglage automatique, les limites de couple doivent avoir les mêmes valeurs, le dispositif d'excitation fonctionnant dans des conditions normales:

– moteurs asynchrones synchronisés (à rotor bobiné): excès de couple 35 %;
– moteurs synchrones (à rotor cylindrique): excès de couple 35 %;
– moteurs synchrones (à pôles saillants): excès de couple 50 %.

8.3.4 Autres moteurs

L'excès momentané de couple des moteurs monophasés, à collecteur et autres, doit faire l'objet d'un accord.

8.4 Couple minimal pendant le démarrage

Sauf spécification contraire, le couple minimal pendant le démarrage sous pleine tension des moteurs à induction à cage ne doit pas être inférieur aux valeurs suivantes:

Moteurs triphasés à une seule vitesse:

– de puissance inférieure à 100 kW: 0,5 fois le couple assigné et 0,5 fois le couple à rotor bloqué;
– de puissance égale ou supérieure à 100 kW: 0,3 fois le couple assigné et 0,5 fois le couple à rotor bloqué;
– pour les moteurs à induction à cage de tension inférieure ou égale à 690 V, voir aussi la CEI 60034-12.

Moteurs monophasés et moteurs triphasés à plusieurs vitesses: 0,3 fois le couple assigné.

8.5 Vitesse de sécurité en fonctionnement des moteurs à induction à cage

Tous les moteurs triphasés à induction à cage à une seule vitesse ayant une désignation de la carcasse inférieure ou égale à 315 et pour des tensions d'alimentation inférieures ou égales à 690 V doivent être capables de fonctionnement continu sûr à des vitesses inférieures ou égales à la vitesse appropriée du tableau 15 sauf indication différente indiquée sur la plaque signalétique.

8.3.3 Polyphase synchronous motors

Unless otherwise agreed, a polyphase synchronous motor, irrespective of the duty, shall be capable of withstanding an excess torque as specified below for 15 s without falling out of synchronism, the excitation being maintained at the value corresponding to rated load. When automatic excitation is used, the limits of torque shall be the same values with the excitation equipment operating under normal conditions:

– synchronous (wound rotor) induction motors: 35 % excess torque;
– synchronous (cylindrical rotor) motors: 35 % excess torque;
– synchronous (salient pole) motors: 50 % excess torque.

8.3.4 Other motors

The momentary excess torque for single-phase, commutator and other motors shall be the subject of agreement.

8.4 Pull-up torque

Unless otherwise specified, the pull-up torque of cage induction motors under full voltage shall not be less than the following values:

Single-speed three-phase motors:

– for output less than 100 kW: 0,5 times the rated torque and 0,5 times the locked-rotor torque;
– for output equal to or greater than 100 kW: 0,3 times the rated torque and 0,5 times the locked-rotor torque;
– for cage induction motors for voltage up to and including 690 V, see also IEC 60034-12.

Single-phase and multi-speed three-phase motors: 0,3 times the rated torque.

8.5 Safe operating speed of cage induction motors

All three-phase single-speed cage induction motors of frame number up to and including 315 and for voltages up to and including 690 V shall be capable of safe continuous operation at speeds up to the appropriate speed given in table 15 unless otherwise stated on the rating plate.

Tableau 15 – Vitesse maximale de sécurité en fonctionnement (min^{-1}) des moteurs triphasés à induction à cage, à une seule vitesse, pour des tensions d'alimentation inférieures ou égales à 690 V

Désignation de la carcasse	2 pôles	4 pôles	6 pôles
≤ 100	5 200	3 600	2 400
112	5 200	3 600	2 400
132	4 500	2 700	2 400
160	4 500	2 700	2 400
180	4 500	2 700	2 400
200	4 500	2 300	1 800
225	3 600	2 300	1 800
250	3 600	2 300	1 800
280	3 600	2 300	1 800
315	3 600	2 300	1 800

NOTE En cas de fonctionnement à des vitesses supérieures à la vitesse assignée, par exemple en cas d'utilisation avec commande de vitesse réglable, les niveaux de bruit et de vibration augmenteront. Il se peut que l'utilisateur ait besoin d'affiner l'équilibrage du rotor du moteur pour un fonctionnement acceptable au-dessus de la vitesse assignée. La durée de vie des paliers peut être réduite. Il convient de porter attention à la périodicité du regraissage ou à la durée de vie de la graisse.

8.6 Survitesse

Les machines doivent être conçues de façon à supporter les vitesses spécifiées dans le tableau 16.

Un essai de survitesse n'est pas normalement considéré comme nécessaire, mais il peut être effectué si cela a été spécifié et a fait l'objet d'un accord (pour les turbo-alternateurs, voir également la CEI 60034-3). Un essai de survitesse doit être considéré comme satisfaisant si, à la suite de cet essai, on ne constate pas de déformation permanente anormale ni d'autres signes de faiblesse pouvant empêcher la machine de fonctionner normalement et si les enroulements rotoriques satisfont aux essais diélectriques spécifiés. La durée de tout essai de survitesse doit être de 2 min.

En raison d'un affaissement des jantes de rotor feuilletées, des pôles feuilletés maintenus par des cales ou par des boulons, etc., une légère augmentation permanente du diamètre est naturelle et ne doit pas être considérée comme une déformation anormale indiquant que la machine ne se prête pas à un fonctionnement normal.

Pendant les essais de réception d'un alternateur synchrone entraîné par une turbine hydraulique, la machine doit tourner à la vitesse qu'elle peut atteindre avec la protection contre la survitesse en fonction, de façon à permettre de vérifier que l'équilibrage est satisfaisant jusqu'à cette vitesse.

Table 15 – Maximum safe operating speed (min^{-1}) of three-phase single-speed cage induction motors for voltages up to and including 690 V

Frame number	2 pole	4 pole	6 pole
≤ 100	5 200	3 600	2 400
112	5 200	3 600	2 400
132	4 500	2 700	2 400
160	4 500	2 700	2 400
180	4 500	2 700	2 400
200	4 500	2 300	1 800
225	3 600	2 300	1 800
250	3 600	2 300	1 800
280	3 600	2 300	1 800
315	3 600	2 300	1 800

NOTE When operating at speeds above rated speed, for example, when used with adjustable speed controls, noise and vibration levels will increase. The user may require to fine balance of the motor rotor for acceptable operation above rated speed. Bearing life may be reduced. Attention should be paid to the regreasing intervals and the grease service life.

8.6 Overspeed

Machines shall be designed to withstand the speeds specified in table 16.

An overspeed test is not normally considered necessary but can be performed when this is specified and has been agreed. (For turbine-type a.c. generators, see also IEC 60034-3.) An overspeed test shall be considered as satisfactory if no permanent abnormal deformation is apparent subsequently, and no other weakness is detected which would prevent the machine from operating normally, and provided the rotor windings after the test comply with the required dielectric tests. The duration of any overspeed test shall be 2 min.

Due to settling of laminated rotor rims, laminated poles held by wedges or by bolts etc., a minute permanent increase in the diameter is natural, and not to be considered as an abnormal deformation indicating that the machine is not suitable for normal operation.

During commissioning of a hydraulic-turbine driven synchronous generator, the machine shall be driven at the speed it can reach with the overspeed protection operating, so as to ascertain that the balance is satisfactory up to that speed.

Tableau 16 – Survitesses

Point	Type de machines	Prescription de survitesse
1	Machines à courant alternatif Toutes les machines autres que celles qui sont spécifiées ci-après:	 1,2 fois la vitesse assignée maximale
1a)	Alternateurs entraînés par une turbine hydraulique et machines auxiliaires de tous types couplées directement (électriquement ou mécaniquement) à la machine principale	Sauf spécification contraire, vitesse d'emballement du groupe, mais au moins 1,2 fois la vitesse assignée maximale
1b)	Machines pouvant, dans certaines circonstances être entraînées par la charge	Vitesse d'emballement spécifiée du groupe, mais au moins 1,2 fois la vitesse maximale
1c)	Moteurs série et moteurs universels	1,1 fois la vitesse à vide à la tension assignée. Pour les moteurs liés à la charge d'une manière telle qu'ils ne peuvent s'en dissocier accidentellement, l'expression «vitesse à vide» doit être interprétée «vitesse correspondant à la charge la plus faible possible»
1d)	Moteurs triphasés à induction à cage, à une seule vitesse selon l'article 8.5	1,2 fois la vitesse maximale de sécurité en fonctionnement
2	Machines à courant continu	
2a)	Moteurs à excitation shunt ou séparée	1,2 fois la vitesse assignée maximale, ou 1,15 fois la vitesse à vide correspondante la plus grande des deux valeurs
2b)	Moteurs à excitation composée ayant une plage de vitesse inférieure ou égale à 35 %	1,2 fois la vitesse assignée maximale ou 1,15 fois la vitesse à vide correspondante sans toutefois dépasser 1,5 fois la vitesse assignée maximale la plus grande des deux valeurs
2c)	Moteurs à excitation composée ayant une plage de vitesses supérieure à 35 % et moteurs à excitation série	Le constructeur doit attribuer une vitesse maximale de sécurité en fonctionnement qui sera marquée sur la plaque signalétique. La survitesse de ces moteurs sera égale à 1,1 fois cette vitesse maximale de sécurité en fonctionnement. Ce marquage est inutile si la survitesse correspond à 1,1 fois la vitesse à vide à la tension assignée
2d)	Moteurs à excitation par aimant permanent	Survitesse comme spécifiée au point 2a) sauf si le moteur a aussi un enroulement en série; dans ce cas, il doit pouvoir supporter les survitesses spécifiées points 2b) et 2c) selon les cas
2e)	Génératrices	1,2 fois la vitesse assignée

8.7 Courant de court-circuit des machines synchrones

Sauf spécification contraire, la valeur de crête du courant de court-circuit des machines synchrones, comprenant les turbo-machines non couvertes par la CEI 60034-3, dans le cas de court-circuit sur toutes les phases en fonctionnement sous la tension assignée, ne doit pas dépasser 15 fois la valeur de crête ou 21 fois la valeur efficace du courant assigné.

La vérification peut être effectuée par le calcul ou par un essai sous une tension au moins égale à 0,5 fois la tension assignée.

Table 16 – Overspeeds

Item	Machine type	Overspeed
1	AC machines All machines other than those specified below:	 1,2 times the maximum rated speed
1a)	Water-turbine driven generators, and any auxiliary machines connected directly (electrically or mechanically) to the main machine	Unless otherwise specified, the runaway speed of the set but not less than 1,2 times the maximum rated speed
1b)	Machines which may under certain circumstances be driven by the load	The specified runaway speed of the set but not less than 1,2 times the maximum rated speed.
1c)	Series and universal motors	1,1 times the no-load speed at rated voltage. For motors integrally attached to loads that cannot become accidentally disconnected, the words 'no-load speed' shall be interpreted to mean the lightest load condition possible with the load
1d)	Three-phase single-speed cage induction motors according to clause 8.5	1,2 times the maximum safe operating speed
2	DC machines	
2a)	Shunt and separately excited motor	1,2 times the highest rated speed or 1,15 times the corresponding no-load speed, whichever is greater
2b)	Compound excited motors having speed regulation of 35 % or less	1,2 times the higher rated speed or 1,15 times the corresponding no-load speed, whichever is greater but not exceeding 1,5 times the highest rated speed
2c)	Compound excited motors having speed regulation greater than 35 % and series motors	The manufacturer shall assign a maximum safe operating speed which shall be marked on the rating plate. The overspeed for these motors shall be 1,1 times the maximum safe operating speed. The safe operating speed marking is not required on motors that are capable of an overspeed of 1,1 times the no-load speed at rated voltage
2d)	Permanent-magnet excited motors	Overspeed as specified in Item 2a) unless the motor has a series winding and, in such a case, they shall withstand the overspeeds specified in Items 2b) or 2c) as appropriate
2e)	Generators	1,2 times the rated speed

8.7 Short-circuit current for synchronous machines

Unless otherwise specified, the peak value of the short-circuit current for synchronous machines, including turbine-type machines not covered by IEC 60034-3, in the case of short circuit on all phases during operation at rated voltage, shall not exceed 15 times the peak value or 21 times the r.m.s. value of the rated current.

Verification may be carried out by calculation or by means of a test at a voltage of 0,5 times the rated voltage or above.

8.8 Epreuve de tenue au court-circuit des machines synchrones

L'essai de court-circuit triphasé des machines synchrones n'est effectué que sur demande de l'acheteur. Dans ce cas, l'essai doit être effectué sur la machine en marche à vide avec une excitation correspondant, sauf accord contraire, à la tension assignée. L'essai ne doit pas être effectué avec une excitation supérieure à celle qui correspond à 1,05 fois la tension assignée à vide.

L'excitation d'essai ainsi déterminée peut être réduite selon accord pour tenir compte de l'impédance du transformateur qui peut être interposé entre les machines et le réseau. Dans ce dernier cas, il pourra également être accepté que l'essai soit effectué sur le site de fonctionnement avec le dispositif de surexcitation en service. Le court-circuit doit être maintenu pendant 3 s.

L'essai est jugé satisfaisant si aucune déformation nuisible ne se produit et si les prescriptions de l'essai diélectrique par tension appliquée (voir 8.1, tableau 14) sont satisfaites après l'essai de court-circuit. Pour les turbo-machines triphasées, voir CEI 60034-3.

8.9 Essai de commutation pour machines à collecteur

Une machine à courant continu ou à courant alternatif comportant un collecteur doit être capable de fonctionner de la marche à vide à la marche en surintensité ou excès de couple spécifiée aux articles 8.2 et 8.3, sans dommage permanent à la surface du collecteur ou des balais et sans étincelles dangereuses, les balais restant calés dans la même position. Si possible, l'essai de commutation doit être effectué à chaud.

8.10 Facteur harmonique téléphonique (FHT) pour machines synchrones

8.10.1 Généralités

Les prescriptions du présent paragraphe ne s'appliquent qu'aux machines synchrones de puissance assignée égale ou supérieure à 300 kW (ou kVA), destinées à être raccordées à des réseaux fonctionnant à des fréquences nominales de $16^{2}/_{3}$ Hz à 100 Hz inclus en vue de réduire au minimum les interférences entre les lignes de transport et les circuits adjacents.

8.10.2 Limites

Lorsqu'il est vérifié en circuit ouvert à la vitesse et à la tension assignées, le facteur harmonique téléphonique (FHT) de la tension entre bornes de phase, mesuré conformément aux méthodes de 8.10.3 ne doit pas dépasser les valeurs suivantes:

Puissance assignée de la machine	*FHT*
300 kW (ou kVA) < $P_N \leq$ 1000 kW (ou kVA)	5 %
1000 kW (ou kVA) < $P_N \leq$ 5000 kW (ou kVA)	3 %
5000 kW (ou kVA) < P_N	1,5 %

NOTE 1 Il n'est pas spécifié de valeurs limites pour les harmoniques individuels car il est considéré que les machines qui satisfont aux conditions ci-dessus fonctionnent de façon satisfaisante.

NOTE 2 Lorsque la machine synchrone doit être raccordée au réseau de façon inhabituelle (par exemple lorsque le neutre de la machine est mis à la terre et que la machine n'est pas reliée au réseau par l'intermédiaire d'un transformateur), il est recommandé qu'il y ait accord concernant les prescriptions de la forme d'onde.

8.8 Short-circuit withstand test for synchronous machines

The three-phase short-circuit test for synchronous machines shall be carried out only at the request of the purchaser. In this case, the test shall be carriedout on the machine running on no-load with an excitation corresponding to the rated voltage unless otherwise agreed. The test shall not be carriedout with an excitation greater than that corresponding to 1,05 times the rated voltage at no load.

The test excitation, as determined, may be reduced by agreement, in order to take into account the impedance of the transformer which may be placed between the machines and the system. In this latter case, it may also be agreed that the test be made at the operating site with the over-excitation device in operation. The short circuit shall be maintained for 3 s.

The test is considered satisfactory if no harmful deformation occurs and if the requirements of the applied voltage dielectric test (see 8.1, table 14) are met after the short-circuit test. For three-phase turbine-type machines, see IEC 60034-3.

8.9 Commutation test for commutator machines

A d.c. or a.c. commutator machine shall be capable of operating from no-load to operation with the excess current or excess torque, specified in clauses 8.2 and 8.3 respectively, without permanent damage to the surface of the commutator or brushes and without injurious sparking, the brushes remaining in the same set position. If possible, the commutation test shall be performed in warm conditions.

8.10 Telephone harmonic factor (THF) for synchronous machines

8.10.1 General

The requirements of this subclause apply only to synchronous machines having rated outputs of 300 kW (or kVA) or more, intended for connection to power networks operating at nominal frequencies of $16^{2}/_{3}$ Hz to 100 Hz inclusive, with a view to minimizing interference between power lines and adjacent circuits.

8.10.2 Limits

When tested on open-circuit and at rated speed and voltage, the telephone harmonic factor (THF) of the line-to-line terminal voltage as measured according to the methods laid down in 8.10.3 shall not exceed the following values:

Rated output of the machine	*THF*
300 kW (or kVA) < $P_N \leq$ 1 000 kW (or kVA)	5 %
1 000 kW (or kVA) < $P_N \leq$ 5 000 kW (or kVA)	3 %
5 000 kW (or kVA) < P_N	1,5 %

NOTE 1 Limiting values of individual harmonics are not specified as it is considered that machines which meet the above requirements will be operationally satisfactory.

NOTE 2 Where the synchronous machine is to be connected to the system in an unusual manner (e.g., where the star point of the machine is connected to earth and the machine is not linked to the system via a transformer), the waveform requirements should be agreed.

8.10.3 Essais

Les machines synchrones à courant alternatif doivent être soumises à des essais de type ayant pour objet de vérifier leur conformité à 8.10.2. La gamme des fréquences de mesure doit couvrir tous les harmoniques de la fréquence assignée à 5 000 Hz.

On mesure soit le FHT directement à l'aide d'un appareil de mesure associé à un réseau spécialement établi à cet effet, soit chaque harmonique individuel, le FHT étant calculé à partir des valeurs mesurées par la formule suivante:

$$\text{FHT}\ (\%) = \frac{100}{U} \times \sqrt{E_1^2 \times \lambda_1^2 + E_2^2 \times \lambda_2^2 + E_3^2 \times \lambda_3^2 + \ldots\ldots E_n^2 \times \lambda_n^2}$$

où

E_n est la valeur efficace de l'harmonique de rang *n* de la tension entre bornes de phase;

U est la valeur efficace de la tension entre bornes de phase de la machine;

λ_n est le facteur de pondération pour la fréquence correspondant à l'harmonique de rang *n.*

Les valeurs numériques du facteur de pondération pour les différentes fréquences doivent être obtenues à partir du tableau 17; la courbe de la figure 13 peut être utilisée pour faciliter l'interpolation.

8.10.3 Tests

Type tests shall be carried out on a.c. machines to verify compliance with 8.10.2. The range of frequencies measured shall cover all harmonics from rated frequency up to 5 000 Hz.

Either the THF may be measured directly by means of a meter and associated network specially designed for the purpose, or each individual harmonic shall be measured and from the measured values the THF shall be computed using the following formula:

$$\mathrm{THF}\,(\%) = \frac{100}{U} \times \sqrt{E_1^2 \times \lambda_1^2 + E_2^2 \times \lambda_2^2 + E_3^2 \times \lambda_3^2 + \ldots\ldots E_n^2 \times \lambda_n^2}$$

where

E_n is the r.m.s. value of the nth harmonic of the line-to-line terminal voltage;

U is the r.m.s. value of the line-to-line terminal voltage of the machine;

λ_n is the weighting factor for frequency corresponding to the nth harmonic.

Numerical values of the weighting factor for different frequencies shall be obtained from table 17; the curve in figure 13 may be used as an aid to interpolation.

Tableau 17 – Facteurs de pondération

Fréquence Hz	**Facteur de pondération**		**Fréquence** Hz	**Facteur de pondération**
16,66	0,000 001 17		2 050	1,79
50	0,000 044 4		2 100	1,81
100	0,001 12		2 150	1,82
150	0,006 65		2 200	1,84
200	0,023 3		2 250	1,86
250	0,055 6		2 300	1,87
300	0,111		2 350	1,89
350	0,165		2 400	1,90
400	0,242		2 450	1,91
450	0,327		2 500	1,93
500	0,414		2 550	1,93
550	0,505		2 600	1,94
600	0,595		2 650	1,95
650	0,691		2 700	1,96
700	0,790		2 750	1,96
750	0,895		2 800	1,97
800	1,000			
850	1,10		2 850	1,97
900	1,21		2 900	1,97
950	1,32		2 950	1,97
1 000	1,40		3 000	1,97
1 050	1,46		3 100	1,94
1 100	1,47		3 200	1,89
1 150	1,49		3 300	1,83
1 200	1,50		3 400	1,75
1 250	1,53		3 500	1,65
1 300	1,55		3 600	1,51
1 350	1,57		3 700	1,35
1 400	1,58		3 800	1,19
1 450	1,60		3 900	1,04
1 500	1,61		4 000	0,890
1 550	1,63		4 100	0,740
1 600	1,65		4 200	0,610
1 650	1,66		4 300	0,496
1 700	1,68		4 400	0,398
1 750	1,70		4 500	0,316
1 800	1,71		4 600	0,252
1 850	1,72		4 700	0,199
1 900	1,74		4 800	0,158
1 950	1,75		4 900	0,125
2 000	1,77		5 000	0,100

Table 17 – Weighting factors

Frequency Hz	Weighting factor	Frequency Hz	Weighting factor
16,66	0,000 001 17	2 050	1,79
50	0,000 044 4	2 100	1,81
100	0,001 12	2 150	1,82
150	0,006 65	2 200	1,84
200	0,023 3	2 250	1,86
250	0,055 6	2 300	1,87
300	0,111	2 350	1,89
350	0,165	2 400	1,90
400	0,242	2 450	1,91
450	0,327	2 500	1,93
500	0,414	2 550	1,93
550	0,505	2 600	1,94
600	0,595	2 650	1,95
650	0,691	2 700	1,96
700	0,790	2 750	1,96
750	0,895	2 800	1,97
800	1,000		
850	1,10	2 850	1,97
900	1,21	2 900	1,97
950	1,32	2 950	1,97
1 000	1,40	3 000	1,97
1 050	1,46	3 100	1,94
1 100	1,47	3 200	1,89
1 150	1,49	3 300	1,83
1 200	1,50	3 400	1,75
1 250	1,53	3 500	1,65
1 300	1,55	3 600	1,51
1 350	1,57	3 700	1,35
1 400	1,58	3 800	1,19
1 450	1,60	3 900	1,04
1 500	1,61	4 000	0,890
1 550	1,63	4 100	0,740
1 600	1,65	4 200	0,610
1 650	1,66	4 300	0,496
1 700	1,68	4 400	0,398
1 750	1,70	4 500	0,316
1 800	1,71	4 600	0,252
1 850	1,72	4 700	0,199
1 900	1,74	4 800	0,158
1 950	1,75	4 900	0,125
2 000	1,77	5 000	0,100

Section 9: Plaques signalétiques

9.1 Généralités

Toute machine électrique doit être munie d'une ou de plusieurs plaques signalétiques. Les plaques doivent être réalisées dans un matériau durable et être montées de façon sûre.

Les plaques signalétiques doivent de préférence être fixées sur la carcasse de la machine et être placées de façon à être facilement lisibles dans la position d'utilisation déterminée par le type de construction et les dispositions de montage de la machine. Si la machine électrique fait partie de l'équipement ou y est incorporée de telle manière que sa plaque signalétique ne soit pas facilement lisible, le constructeur doit sur demande fournir une seconde plaque à fixer sur l'équipement.

9.2 Marquage

Pour les machines de puissance assignée inférieure ou égale à 750 W (ou VA) et dont les dimensions ne relèvent pas du domaine de la CEI 60072, ainsi que pour les machines incorporées, pour usage spécial, de puissance assignée inférieure ou égale à 3 kW (ou kVA), les indications 1, 2, 11 et 12 doivent au moins figurer comme marquage minimal.

Dans tous les autres cas, la ou les plaques signalétiques doivent porter les indications de la liste ci-après, pour autant qu'elles sont applicables. Il n'est pas nécessaire que toutes les indications figurent sur la même plaque. Les symboles littéraux des unités et grandeurs doivent être conformes à la CEI 60027-1 et à la CEI 60027-4.

Si le constructeur donne plus d'informations, il n'est pas nécessaire de les porter sur la ou les plaques signalétiques.

Les indications sont numérotées pour en faciliter la référence, mais l'ordre dans lequel elles apparaissent sur la ou les plaques signalétiques n'est pas normalisé. Les indications peuvent être combinées de façon convenable.

1) Nom du constructeur ou marque
2) Numéro de série du constructeur ou marque d'identification

   NOTE Une marque d'identification unique peut être utilisée pour identifier chaque élément d'un groupe de machines qui ont fait l'objet de la même conception électrique et mécanique et sont produites en un lot unique utilisant la même technologie.
3) Information permettant d'identifier l'année de fabrication. Celle-ci doit être marquée sur la plaque signalétique ou donnée sur une feuille de données séparée à fournir avec la machine.

   NOTE Si cette information peut être obtenue du constructeur à partir des indications données au point 2, elle peut être omise à la fois de la plaque signalétique et de la feuille de données séparée.
4) Code machine du constructeur
5) Pour les machines à courant alternatif, nombre de phases
6) Référence numérique de la ou des normes de caractéristiques assignées et de caractéristiques de fonctionnement qui sont applicables (CEI 60034-X et/ou norme(s) nationale(s) équivalente(s)). Si CEI 60034 est indiqué, ceci implique la conformité avec toutes les normes correspondantes de la série 34 de la CEI.
7) Degré de protection procuré par les enveloppes (Code IP) conformément à la CEI 60034-5.
8) Classification thermique et limite de température ou d'échauffement (quand elle est inférieure à celle de la classification thermique) et, si nécessaire, méthode de mesure, suivie dans le cas d'une machine à hydroréfrigérant de «P» ou «S», selon que l'échauffement est mesuré par rapport au fluide de refroidissement respectivement primaire ou secondaire; voir l'article 7.2. Cette information, présentée éditorialement avec un trait de fraction oblique, doit être donnée à la fois pour le stator et pour le rotor si leurs classifications thermiques diffèrent.

Section 9: Rating plates

9.1 General

Every electrical machine shall be provided with a rating plate(s). The plates shall be made of durable material and be securely mounted.

The rating plate(s) shall preferably be mounted on the frame of the machine and be located so as to be easily legible in the position of use determined by the type of construction and mounting arrangement of the machine. If the electrical machine is so enclosed or incorporated in the equipment that its rating plate is not easily legible, the manufacturer shall, on request, supply a second plate to be mounted on the equipment.

9.2 Marking

For machines with rated outputs up to and including 750 W (or VA) and dimensions not covered by IEC 60072 and for special-purpose built-in machines with rated outputs up to and including 3 kW (or kVA), items 1, 2, 11 and 12 shall be marked as a minimum.

In all other cases, rating plate(s) shall be durably marked with the items in the following list, as far as they apply. The items need not all be on the same plate. Letter symbols for units and quantities shall be in accordance with IEC 60027-1 and IEC 60027-4.

If the manufacturer gives more information, this need not necessarily be marked on the rating plate(s).

The items are numbered for convenient reference, but the order in which they appear on the rating plate(s) is not standardized. Items may be suitably combined.

1) The manufacturer's name or mark.
2) The manufacturer's serial number, or identification mark.

   NOTE A single identification mark may be used to identify each member of a group of machines which are made to the same electrical and mechanical design and are produced in one batch using the same technology.

3) Information to identify the year of manufacture. This shall be marked on the rating plate or be given on a separate data sheet to be provided with the machine.

   NOTE If this information can be obtained from the manufacturer by quoting the data specified in item 2, it may be omitted from both the rating plate and the separate data sheet.

4) The manufacturer's machine code.
5) For a.c. machines, the number of phases.
6) The number(s) of the rating and performance standard(s) which are applicable (IEC 60034-X and/or equivalent national standard(s)). If IEC 60034 is marked, this implies compliance with all the other relevant standards of the IEC 60034 series.
7) The degree of protection provided by the enclosures (IP code) in accordance with IEC 60034-5.
8) The thermal classification and the limit of temperature or of temperature rise (when lower than that of the thermal classification) and, if necessary, the method of measurement, followed in the case of a machine with a water-cooled heat exchanger by 'P' or 'S', depending on whether the temperature rise is measured above the primary or secondary coolant respectively (see clause 7.2). This information shall be given for both stator and rotor (separated by a slash) when their thermal classifications differ.

9) Classe(s) de caractéristiques assignées de la machine, si celle-ci est conçue pour d'autres caractéristiques que celles pour service continu S1, voir 4.2.

10) Puissance(s) assignée(s) ou plage de puissance assignée.

11) Tension(s) assignée(s) ou plage de tension assignée.

12) Pour les machines à courant alternatif la fréquence assignée ou une plage de fréquence assignée.

Pour les moteurs universels, la fréquence assignée doit être suivie du symbole approprié:

par exemple ~ 50 Hz /⎓ ou c.a. 50 Hz/c.c.

13) Courant(s) assigné(s) ou plage de courant assigné.

14) Vitesse(s) assignée(s) ou plage de vitesse assignée.

15) Pour les machines à courant alternatif triphasé à plus de trois points de connexion, instructions pour le raccordement au moyen d'un schéma ou d'un texte. Ces instructions doivent soit figurer sur une plaque près de la boîte à bornes soit être fournies dans la boîte.

16) Survitesse admissible si différente de celle spécifiée à l'article 8.6,
ou
vitesse maximale de sécurité en fonctionnement si inférieure à celle spécifiée à l'article 8.5.

17) Pour les machines à courant continu à excitation séparée ou à excitation shunt et pour les machines synchrones, tension d'excitation assignée et courant d'excitation assigné.

18) Pour les machines à courant alternatif, facteur(s) de puissance assigné(s).

19) Pour les machines à induction à rotor bobiné, tension entre bagues à circuit ouvert et courant rotorique assignés.

20) Pour les moteurs à courant continu dont l'induit est prévu pour être alimenté par convertisseurs statiques de puissance, code d'identification du convertisseur statique de puissance conformément à la CEI 60971. En variante, pour des moteurs ne dépassant pas 5 kW, facteur de forme assigné et tension alternative assignée aux bornes d'entrée du convertisseur statique de puissance, si celle-ci est supérieure à la tension directe assignée du circuit d'induit du moteur.

21) Température maximale de l'air ambiant, si différente de 40 °C.

Température maximale de l'eau de refroidissement, si différente de 25 °C.

22) Température minimale de l'air ambiant, si différente de celle spécifiée en 5.4.

23) Altitude pour laquelle la machine est conçue (si supérieure à 1000 m au dessus du niveau de la mer).

24) Pour les machines refroidies par hydrogène, pression de l'hydrogène à la puissance assignée.

25) Lorsque spécifié, masse totale approchée de la machine, si supérieure à 30 kg.

26) Pour les machines prévues pour fonctionner dans un seul sens de rotation, sens de rotation, indiqué par une flèche. Il n'est pas nécessaire de placer cette flèche sur la plaque signalétique, mais elle doit être distinguée aisément.

Deux valeurs assignées différentes doivent être indiquées par X/Y et une plage de valeurs assignées doit être indiquée par X–Y (voir la CEI 61293).

Si l'enroulement d'une machine est partiellement ou totalement réparé ou modifié par une autre personne que le constructeur, une plaque supplémentaire doit être prévue pour indiquer le nom du réparateur, l'année de la réparation et les modifications effectuées.

9) The class(es) of rating of the machine if designed for other than rating for continuous running duty S1, see 4.2.

10) The rated output(s) or range of rated outputs.

11) The rated voltage(s) or range of rated voltage.

12) For a.c. machines the rated frequency or range of rated frequency.

    For universal motors, the rated frequency shall be followed by the appropriate symbol:

    e.g. ~ 50 Hz/⎓ or a.c. 50 Hz/d.c.

13) The rated current(s) or range of rated current.

14) The rated speed(s) or range of rated speed.

15) For three-phase a.c. machines with more than three connecting points, connecting instructions by means of a diagram or text. These instructions shall be on a plate mounted near the terminal box or be provided inside the box.

16) The permissible overspeed if other than specified in clause 8.6.

    or

    the maximum safe operating speed if less than in clause 8.5.

17) For d.c. machines with separate excitation or with shunt excitation and for synchronous machines, the rated field voltage and the rated field current.

18) For a.c. machines, the rated power factor(s).

19) For wound-rotor induction machines, the rated open-circuit voltage between slip-rings and the rated slip-ring current.

20) For d.c. motors with armatures intended to be supplied by static power converters, the identification code of the static power converter in accordance with IEC 60971. Alternatively for motors not exceeding 5 kW, the rated form factor and the rated alternating voltage at the input terminals of the static power converter, when this exceeds the rated direct voltage of the motor armature circuit.

21) The maximum ambient air temperature, if other than 40 °C.

    The maximum water coolant temperature, if other than 25 °C.

22) The minimum ambient air temperature if other than specified in 5.4.

23) The altitude for which the machine is designed (if exceeding 1 000 m above sea-level).

24) For hydrogen-cooled machines, the hydrogen pressure at rated output.

25) When specified, the approximate total mass of the machine, if exceeding 30 kg.

26) For machines suitable for operation in only one direction of rotation, the direction of rotation, indicated by an arrow. This arrow need not be on the rating plate, but it shall be easily visible.

Two different rated values shall be indicated by X/Y and a range of rated values shall be indicated by X–Y (see IEC 61293).

If the winding of a machine is partially or totally repaired or changed by other than the manufacturer, an additional plate shall be provided to indicate the repair contractor's name, the year of repair and the changes made.

Section 10: Prescriptions diverses

10.1 Mise à la terre des machines

Les machines doivent comporter des dispositifs permettant de raccorder un conducteur de protection ou un conducteur de terre, de tels dispositifs étant identifiés par le symbole ou la légende appropriés. Cette prescription ne s'applique pas aux machines munies d'une isolation supplémentaire, aux machines de tension assignée inférieure à 50 V en courant alternatif ou 120 V en courant continu (voir CEI 60364-4-41, article 411 et CEI 60449), ni aux machines à installer dans des ensembles à isolation supplémentaire.

Dans le cas des machines de tension assignée supérieure à 50 V en courant alternatif ou 120 V en courant continu, mais ne dépassant pas 1 000 V en courant alternatif ou 1 500 V en courant continu, la borne du conducteur de terre doit être située à proximité des bornes de raccordement des conducteurs de phase, à l'intérieur de la boîte de connexions éventuelle. Les machines de puissance assignée supérieure à 100 kW (ou kVA) doivent également comporter une borne de terre montée sur la carcasse.

Les machines de tension assignée supérieure à 1 000 V en courant alternatif ou 1 500 V en courant continu doivent avoir une borne de terre sur la carcasse, par exemple une languette de fer et, en outre, le cas échéant, un point de connexion à l'intérieur de la boîte de connexions pour raccorder une gaine conductrice de câble.

La borne de terre doit être conçue de manière à assurer une bonne liaison avec le conducteur de terre, sans détérioration du conducteur ou de la borne. Les parties conductrices accessibles qui ne font pas partie du circuit d'utilisation doivent être raccordées les unes aux autres et à la borne de terre, par une liaison électrique de bonne qualité. Si tous les paliers et l'enroulement rotorique d'une machine sont isolés, l'arbre doit être relié électriquement à la borne de terre, à moins d'un accord entre le constructeur et l'acheteur sur d'autres moyens de protection.

Si la boîte de connexions est équipée d'une borne de terre, le conducteur de terre est supposé être du même métal que les conducteurs de phase.

Si une borne de terre est placée sur la carcasse, le conducteur de terre peut, sur accord, être d'un autre métal (en acier par exemple). Dans ce cas, la conception de la borne doit être étudiée en tenant compte de la conductivité de l'âme du conducteur.

La borne de terre doit être conçue pour admettre un conducteur de terre de la section de l'âme conforme au tableau 18 ci-dessous. Si un câble plus gros est utilisé, il est recommandé que sa section se rapproche autant que possible d'une des autres valeurs de ce tableau.

Pour d'autres sections de conducteurs de phase, le conducteur de terre ou de protection doit avoir une section au moins équivalente à:

– celle du conducteur de phase pour des sections inférieures à 25 mm²;
– 25 mm² pour des sections comprises entre 25 mm² et 50 mm²;
– 50 % de celle du conducteur de phase pour des sections supérieures à 50 mm².

La borne de terre doit être identifiée conformément à la CEI 60445.

Section 10 : Miscellaneous requirements

10.1 Earthing of machines

Machines shall be provided with means for connecting a protective conductor or an earth conductor, such means being identified by the appropriate symbol or legend. This requirement does not apply to machines with supplementary insulation, to machines with rated voltages up to and including 50 V a.c. or 120 V d.c. (see IEC 60364-4-41, clause 411 and IEC 60449), or to machines for assembling in apparatus with supplementary insulation.

In the case of machines having rated voltages greater than 50 V a.c. or 120 V d.c., but not exceeding 1 000 V a.c. or 1 500 V d.c., the terminal for the earth conductor shall be situated in the vicinity of the terminals for the line conductors, being placed in the terminal box, if one is provided. Machines having rated outputs in excess of 100 kW (or kVA) shall have in addition an earth terminal fitted on the frame.

Machines for rated voltages greater than 1 000 V a.c. or 1 500 V d.c. shall have an earth terminal on the frame, for example an iron strap, and in addition, a means inside the terminal box for connecting a conducting cable sheath, if any.

The earth terminal shall be designed to ensure a good connection with the earth conductor without any damage to the conductor or terminal. Accessible conducting parts which are not part of the operating circuit shall have a good electrically conducting connection with each other and with the earth terminal. When all bearings and the rotor winding of a machine are insulated, the shaft shall be electrically connected to the earth terminal, unless the manufacturer and the purchaser agree to alternative means of protection.

When an earth terminal is provided in the terminal box, it shall be assumed that the earth conductor is made of the same metal as the live conductors.

When an earth terminal is provided on the frame, the earth conductor may, by agreement, be made of another metal (e.g. steel). In this case, in designing the terminal, proper consideration shall be given to the conductivity of the conductor.

The earth terminal shall be designed to accommodate an earth conductor of cross-sectional area in accordance with table 18. If an earth conductor larger than the size given in the table is used, it is recommended that it should correspond as nearly as possible to one of the other sizes listed.

For other cross-sectional areas of live conductors, the earth or protective conductor shall have a cross-sectional area at least equivalent to:

– that of the live conductor for cross-sectional areas less than 25 mm^2;
– 25 mm^2 for cross-sectional areas between 25 mm^2 and 50 mm^2;
– 50 % of that of the live conductor for cross-sectional areas exceeding 50 mm^2 .

The earth terminal shall be identified in accordance with IEC 60445.

Tableau 18 – Section des conducteurs de terre

Section du conducteur de phase mm²	Section du conducteur de terre ou de protection mm²
4	4
6	6
10	10
16	16
25	25
35	25
50	25
70	35
95	50
120	70
150	70
185	95
240	120
300	150
400	185

10.2 Clavette(s) de bout d'arbre

Quand un bout d'arbre d'une machine est prévu avec une ou plusieurs rainures de clavette, chaque rainure doit être pourvue d'une clavette entière de forme et de longueurs normales.

Table 18 – Cross-sectional areas of earth conductors

Cross-sectional area of the live conductor mm^2	Cross-sectional area of the earth or protective conductor mm^2
4	4
6	6
10	10
16	16
25	25
35	25
50	25
70	35
95	50
120	70
150	70
185	95
240	120
300	150
400	185

10.2 Shaft-end key(s)

When a machine shaft end is provided with one or more keyways, each shall be provided with a full key of normal shape and length.

Section 11: Tolérances

11 Tolérances

Les tolérances doivent être conformes aux spécifications du tableau 19.

Tableau 19 – Nomenclature des tolérances sur les valeurs des grandeurs

Point	Article	Tolérance
1	Rendement η	
1a)	Par sommation des pertes:	
	– machines de puissance inférieure ou égale à 50 kW (ou kVA)	–15 % de $(1 - \eta)$
	– machines de puissance supérieure à 50 kW (ou kVA)	–10 % de $(1 - \eta)$
1b)	Par mesurage des pertes totales	–15 % de $(1 - \eta)$
2	Pertes totales	+10 % des pertes totales
3	Facteur de puissance, cos ϕ, pour les machines à induction	$-1/6\ (1 - \cos\phi)$ Minimum de la valeur absolue 0,02 Maximum de la valeur absolue 0,07
4	Vitesse des moteurs à courant continu (à pleine charge et à la température de fonctionnement)	
4a)	Moteurs à excitation shunt ou séparée	$1000\ P_N/n_N{}^* < 0{,}67$ ± 15 % $0{,}67 \leq 1000\ P_N/n_N < 2{,}5$ ± 10 % $2{,}5 \leq 1000\ P_N/n_N < 10$ ± 7,5 % $10 \leq 1000\ P_N/n_N$ ± 5 %
4b)	Moteurs à excitation série	$1000\ P_N/n_N < 0{,}67$ ± 20 % $0{,}67 \leq 1000\ P_N/n_N < 2{,}5$ ± 15 % $2{,}5 \leq 1000\ P_N/n_N < 10$ ± 10 % $10 \leq 1000\ P_N/n_N$ ± 7,5 %
4c)	Moteurs à excitation composée	Les tolérances sont les mêmes que celles du point 4b) sauf accord contraire
5	Variation de vitesse des moteurs shunt ou à excitation composée à courant continu (entre la charge nulle et la pleine charge)	±20 % de la variation garantie avec un minimum de ±2 % de la vitesse assignée
6	Variation de tension des génératrices à courant continu, à excitation shunt ou séparée, en tout point de la caractéristique	±20 % de la variation garantie en ce point
7	Variation de tension des génératrices à excitation composée (au facteur de puissance assigné dans le cas du courant alternatif)	±20 % de la variation de tension garantie avec un minimum de ±3 % de la tension assignée. (Cette tolérance s'applique à l'écart maximal, à une charge quelconque, entre la tension observée à cette charge et une droite tracée entre les points de la tension garantie à vide et en charge.)

Section 11: Tolerances

11 Tolerances

Tolerances shall be as specified in table 19.

Table 19 – Schedule of tolerances on values of quantities

Item	Quantity	Tolerance
1	Efficiency η	
1a)	By summation of losses:	
	– machines up to and including 50 kW (or kVA)	–15 % of $(1 - \eta)$
	– machines above 50 kW (or kVA)	–10 % of $(1 - \eta)$
1b)	By total loss measurement	–15 % of $(1 - \eta)$
2	Total losses	+10 % of the total losses
3	Power-factor, cos ϕ, for induction machines	–1/6 (1 – cos ϕ) Minimum absolute value 0,02 Maximum absolute value 0,07
4	Speed of d.c. motors (at full load and at working temperature)	
4a)	Shunt and separately excited motors	$1000\ P_N/n_N$* < 0,67 ± 15 % $0,67 \leq 1000\ P_N/n_N < 2,5$ ± 10 % $2,5 \leq 1000\ P_N/n_N < 10$ ± 7,5 % $10 \leq 1000\ P_N/n_N$ ± 5 %
4b)	Series motors	$1000\ P_N/n_N < 0,67$ ± 20 % $0,67 \leq 1000\ P_N/n_N < 2,5$ ± 15 % $2,5 \leq 1000\ P_N/n_N < 10$ ± 10 % $10 \leq 1000\ P_N/n_N$ ± 7,5 %
4c)	Compound excited motors	Tolerances as for item 4b) unless otherwise agreed
5	Variation of speed of d.c. shunt and compound excited motors (from no-load to full load)	±20 % of the guaranteed variation with a minimum of ±2 % of the rated speed
6	Inherent voltage regulation of d.c. generators, shunt or separately excited at any point on the characteristic	±20 % of the guaranteed regulation at that point
7	Inherent voltage regulation of compound excited generators (at the rated power-factor in the case of alternating current)	±20 % of the guaranteed regulation, with a minimum of ±3 % of the rated voltage. (This tolerance applies to the maximum deviation at any load between the observed voltage at that load and a straight line drawn between the points of guaranteed no-load and full-load voltage.)

Tableau 19 *(fin)*

Point	Article	Tolérance
8 a)	Glissement des moteurs à induction (à pleine charge et à la température de fonctionnement)	
	P_N < 1 kW	±30 % du glissement garanti
	P_N ≥ 1 kW	±20 % du glissement garanti
8 b)	Vitesse des moteurs à courant alternatif à collecteur à caractéristiques shunt (à pleine charge et à la température de fonctionnement)	– sur la vitesse la plus élevée: –3 % de la vitesse de synchronisme – sur la vitesse la moins élevée: +3 % de la vitesse de synchronisme
9	Courant à rotor bloqué des moteurs à induction à cage avec tout dispositif de démarrage spécifié	+20 % du courant garanti
10	Couple à rotor bloqué des moteurs à induction à cage	$^{+25}_{-15}$ % du couple garanti (+25 % peut être dépassé sur accord)
11	Couple minimal pendant le démarrage des moteurs à induction à cage	–15 % du couple garanti
12	Couple maximal pendant le démarrage des moteurs à induction (couple de décrochage)	–10 % du couple garanti sous réserve qu'après application de cette tolérance le couple reste égal ou supérieur à 1,6 ou 1,5 fois le couple assigné, voir 8.3.
13	Courant à rotor bloqué des moteurs synchrones	+20 % de la valeur garantie
14	Couple à rotor bloqué des moteurs synchrones	$^{+25}_{-15}$ % de la valeur garantie (+25 % peut être dépassé sur accord)
15	Couple de décrochage des moteurs synchrones	–10 % de la valeur garantie sous réserve qu'après application de cette tolérance le couple reste égal ou supérieur à 1,35 ou 1,5 fois le couple assigné, voir 8.3.3.
16	Valeur de crête du courant de court-circuit d'un alternateur dans des conditions spécifiées	±30 % de la valeur garantie
17	Courant de court-circuit permanent d'un alternateur dans des conditions spécifiées	±15 % de la valeur garantie
18	Moment d'inertie	± 10 % de la valeur garantie

NOTE 1 Lorsqu'une tolérance est spécifiée seulement dans un sens, la valeur n'est pas limitée dans l'autre sens.

NOTE 2 Des garanties ne sont pas nécessairement données sur toutes les grandeurs ou l'une quelconque d'entre celles indiquées dans le présent tableau. Les offres concernant des garanties sujettes à des tolérances devront le stipuler et les tolérances devront être conformes à ce tableau.

NOTE 3 L'attention est attirée sur les différentes interprétations du mot «garantie». Dans certains pays, on fait la différence entre les valeurs garanties et les valeurs caractéristiques ou valeurs déclarées.

NOTE 4 Les tolérances dépendent du rapport de puissance P_N en kW, à la vitesse assignée en min^{-1}.

Table 19 *(concluded)*

Point	Quantity	Tolerance
8 a)	Slip of induction motors (at full load and at working temperature)	
	P_N < 1 kW	±30 % of the guaranteed slip
	P_N ≥ 1 kW	±20 % of the guaranteed slip
8 b)	Speed of a.c. (commutator) motors with shunt characteristics (at full load and at working temperature)	– on the highest speed: –3 % of the synchronous speed – on the lowest speed: +3 % of the synchronous speed
9	Locked rotor current of cage induction motors with any specified starting apparatus	+20 % of the guaranteed current
10	Locked rotor torque of cage induction motors	$^{+25}_{-15}$ % of the guaranteed torque. (+25 % may be exceeded by agreement)
11	Pull-up torque of cage induction motors	–15 % of the guaranteed value
12	Breakdown torque of induction motors	–10 % of the guaranteed torque except that after allowing for this tolerance the torque shall be not less than 1,6 or 1,5 times the rated torque, see 8.3.
13	Locked rotor current of synchronous motors	+ 20 % of the guaranteed value
14	Locked rotor torque of synchronous motors	$^{+25}_{-15}$ % of the guaranteed value (+25 % may be exceeded by agreement)
15	Pull-out torque of synchronous motors	–10 % of the guaranteed value except that after allowing for this tolerance, the torque shall be not less than 1,35 or 1,5 times the rated torque, see 8.3.3.
16	Peak value of short-circuit current of an a.c. generator under specified conditions	±30 % of the guaranteed value
17	Steady short-circuit current of an a.c. generator at specified excitation	±15 % of the guaranteed value
18	Moment of inertia	±10 % of the guaranteed value

NOTE 1 When a tolerance is stated in only one direction, the value is not limited in the other direction.

NOTE 2 It is not intended that guarantees necessarily be given upon all or any of the quantities shown in this table. Tenders including guarantees subject to tolerances should so state, and the tolerances should be in accordance with this table.

NOTE 3 Attention is drawn to the different interpretations of the term "guarantee". In some countries a distinction is drawn between guaranteed values and typical or declared values.

NOTE 4 Tolerances depend on the ratio of rated output P_N, in kW, to rated speed in min^{-1}.

Section 12: Compatibilité électromagnétique (CEM)

12.1 Compatibilité électromagnétique (CEM)

Les prescriptions qui suivent sont applicables aux machines électriques tournantes de tension assignée ne dépassantpas 1 000 V (courant alternatif) ou 1 500 V (courant continu) et sont destinées à fonctionner selon les conditions spécifiées ci-dessous.

Les composants électroniques qui sont montés à l'intérieur de la machine électrique tournante et qui sont destinés pour son fonctionnement (par exemple les systèmes d'excitation tournants) font partie de la machine.

Les prescriptions qui sont applicables à un système d'entraînement final et à ses composants, par exemple un équipement électronique de puissance et de commande, des machines couplées, des appareils de contrôle, etc., qu'ils soient montés à l'intérieur ou à l'extérieur de la machine, sont hors du domaine d'application de cette norme.

Les prescriptions de la section 12 ne s’appliquent pas aux machines dont les caractéristiques de CEM sont notablement modifiées par les capotage et montage finals.

Les limites de la section 6 sont établies pour des conditions de fonctionnement en régime établi. Les régimes transitoires (tels que le démarrage) ne sont pas couverts par le présent article.

12.1.1 Limites d'immunité

Les limites d'immunité des machines à courant alternatif et des machines à courant continu aux variations et aux harmoniques de tension du système connecté, et les limites d'immunité des machines à courant alternatif polyphasées aux déséquilibres du système connecté sont données à la section 6.

12.1.2 Limites d'émission

NOTE Les limites dans les tableaux qui suivant sont tirées du CISPR 11 ou du CISPR 12.

12.1.2.1 Machines à induction

Quand elles sont reliées à un système conformément à la section 6, les machines à induction ne produisent pas de rayonnements perturbateurs supérieurs aux limites

– du tableau 19 pour les machines avec rotors à cage ou avec rotors bobinés munies d'un dispositif de levage des balais et de court-circuit des bagues; ou
– du tableau 20 pour les machines fonctionnant en permanence avec bagues et balais en contact.

Les émissions de conduction sont intrinsèquement bien inférieures aux limites données au tableau 19.

12.1.2.2 Machines synchrones

Quand elles sont reliées à un système conformément à la section 6, les machines synchrones ne produisent pas de rayonnements perturbateurs supérieurs aux limites du tableau 19, pour les machines sans bagues ni balais, ou aux limites du tableau 20 pour les machines avec bagues et balais.

L'émission de conduction à basse fréquence est couverte par 8.9. Les émissions de conduction à fréquences supérieures sont intrinsèquement bien inférieures aux limites données au tableau 19.

Section 12: Electromagnetic compatibility (EMC)

12.1 Electromagnetic compatibility (EMC)

The following requirements apply to rotating electrical machines with a rated voltage not exceeding 1 000 V a.c. or 1 500 V d.c., and which are intended for operation within the conditions specified below.

Electronic components mounted inside the rotating electrical machine and essential for its operation (for example rotating excitation devices) are part of the machine.

Requirements which are applicable to the final drive system and its components, for example power and control electronic equipment, coupled machines, monitoring devices, etc., whether mounted inside or outside the machine, are outside the scope of this standard.

The requirements of section 12 do not apply to machines when the EMC performance is significantly affected by the final enclosure and assembly.

The limitations of section 6 are fixed for steady-state operating conditions. Transients (such as starting) are not covered by this clause.

12.1.1 Immunity limits

The immunity limits of both a.c. and d.c. machines to variations and harmonics of the system voltage, and those of polyphase a.c. machines to unbalances of the connected system, are given in section 6.

12.1.2 Emission limits

NOTE The limits in the tables that follow are taken from CISPR 11 or CISPR 12.

12.1.2.1 Induction machines

When connected to a system according to section 6, induction machines do not produce radiated disturbances higher than the limits in

– table 19 for machines with cage rotors or with wound rotors having brush-lifting and short-circuiting devices; or

– table 20 for machines with continuously running slip-rings.

Conducted emissions are inherently much lower than the limits given in table 19.

12.1.2.2 Synchronous machines

When connected to a system according to section 6, synchronous machines do not radiate disturbances higher than the limits of table 19 for brushless designs or of table 20 for designs with slip-rings.

The conducted low-frequency emission is covered by 8.9. Conducted emissions of higher frequencies are inherently much lower than the limits given in table 19.

Tableau 19 – Limites des perturbations électromagnétiques pour les machines fonctionnant sans balais

	Plages de fréquences	Limites
Rayonnement perturbateur	30 MHz à 230 MHz	30 dB(µV/m) quasi crête, mesuré à 10 m de distance [1)]
	230 MHz à 1 000 MHz	37 dB(µV/m) quasi crête, mesuré à 10 m de distance [1)]
Conduction perturbatrice aux bornes d'alimentation à courant alternatif	0,15 MHz à 0,5 MHz Les limites diminuent proportionnellement avec le logarithme de la fréquence	66 à 56 dB(µV) quasi crête 56 à 46 dB(µV) moyenne
	0,5 MHz à 5 MHz	56 dB(µV) quasi crête 46 dB(µV) moyenne
	5 MHz à 30 MHz	60 dB(µV) quasi crête 50 dB(µV) moyenne
[1)] Peut être mesuré à une distance de 3 m, en augmentant les limites de 10 dB.		

12.1.2.3 Machines à collecteur

Les machines à courant continu, fonctionnant avec une tension lissée et les machines à collecteur à courant alternatif, fonctionnant sur un système conformément à la section 6, ne doivent pas rayonner de perturbations supérieures aux limites du tableau 20.

Les émissions de conduction des machines à collecteur à courant alternatif doivent être inférieures aux limites du tableau 20. Les émissions de conduction des machines à courant continu ne sont pas à considérer car ces machines ne sont pas directement reliées à l'alimentation à courant alternatif.

Tableau 20 – Limites des perturbatins électromagnétiques pour les machines fonctionnant avec balais

	Plages de fréquences	Limites
Rayonnement perturbateur	30 MHz à 230 MHz	30 dB(µV/m) quasi crête, mesuré à 30 m de distance [1)]
	230 MHz à 1 000 MHz	37 dB(µV/m) quasi crête, mesuré à 130 m de distance [1)]
Conduction perturbatrice aux bornes d'alimentation à courant alternatif	0,15 MHz à 0,5 MHz	79 dB(µV) quasi crête 66 dB(µV) moyenne
	0,5 MHz à 30 MHz	73 dB(µV) quasi crête 60 dB(µV) moyenne
[1)] Peut être mesuré à une distance de 10 m en augmentant les limites de 10 dB, ou à une distance de 3 m en augmentant les limites de 20 dB.		

12.1.3 Essais

12.1.3.1 Essais d'immunité

Des essais d'immunité ne sont pas exigés pour démontrer la conformité au présent article.

Table 19 – Electromagnetic disturbance limits for machines operating without brushes

	Frequency range	Limits
Radiated disturbance	30 MHz to 230 MHz	30 dB(μV/m) quasi peak, measured at 10 m distance[1)]
	230 MHz to 1 000 MHz	37 dB(μV/m) quasi peak, measured at 10 m distance[1)]
Conducted disturbance on a.c. supply terminals	0,15 MHz to 0,5 MHz Limits decrease linearly with logarithm frequency	66 to 56 dB(μV) quasi peak 56 to 46 dB(μV) average
	0,5 MHz to 5 MHz	56 dB(μV) quasi peak 46 dB(μV) average
	5 MHz to 30 MHz	60 dB(μV) quasi peak 50 dB(μV) average
[1)] May be measured at 3 m distance using the limits increased by 10 dB.		

12.1.2.3 Commutator machines

DC machines operating on a smooth voltage and a.c. commutator motors operating on a system according to section 6 shall not radiate disturbances which are above the limits of table 20.

Conducted emissions from a.c. commutator machines shall be below the levels of table 20. Conducted emissions from d.c. machines are irrelevant since these machines are not directly connected to the a.c. supply.

Table 20 – Electromagnetic disturbance limits for machines operating with brushes

	Frequency range	Limits
Radiated disturbance	30 MHz to 230 MHz	30 dB(μV/m) quasi peak, measured 30 m distance[1)]
	230 MHz to 1 000 MHz	37 dB(μV/m) quasi peak, measured 30 m distance[1)]
Conducted disturbance on a.c. supply terminals	0,15 MHz to 0,50 MHz	79 dB(μV) quasi peak 66 dB(μV) average
	0,50 MHz to 30 MHz	73 dB(μV) quasi peak 60 dB(μV) average
[1)] May be measured at 10 m distance using the limits increased by 10 dB or measured at 3 m distance using the limits increased by 20 dB.		

12.1.3 Tests

12.1.3.1 Immunity tests

Immunity tests are not required to demonstrate compliance with this clause.

12.1.3.2 Essais d'émission

Pour les machines synchrones de puissance supérieure ou égale à 300 kW (ou kVA), des essais de type d'émission de conduction à basse fréquence doivent être effectués pour vérifier la conformité à 8.9.2.

Pour les machines à collecteur à courant alternatif, des essais de type à vide doivent être effectués afin de vérifier la conformité à 12.1.2.3 pour l'émission de conduction et l'émission de rayonnement.

Pour les machines à collecteur à courant continu, des essais de type à vide ou à charge minimale possible doivent être effectués afin de vérifier la conformité à 12.1.2.3 pour l'émission de rayonnement.

Les essais doivent être conduits suivant le CISPR 11, le CISPR 14 et le CISPR 16, selon le cas.

Aucun autre essai n'est exigé afin de démontrer la conformité au présent article.

NOTE La mesure à vide se justifie par l'influence négligeable de la charge sur l'émission.

Section 13: Sécurité

13.1 Sécurité

Les machines tournantes conformes à la présente norme doivent satisfaire aux exigences de la CEI 60204-1, sauf spécification contraire dans la présente norme, et dans la mesure du possible, elles doivent également être conçues et construites selon la meilleure forme de conception internationalement acceptée, selon l'application.

NOTE Il est de la responsabilité du constructeur ou de l'assembleur de l'équipement incorporant des machines électriques de s'assurer que l'équipement complet est sûr.

Cela peut conduire à prendre en considération des normes de produits applicables telles que:

CEI 60079*: Matériel électrique pour atmosphères gazeuses,*

CEI 60335: *Sécurité des appareils électrodomestiques et analogues;*

et d'autres parties de la CEI 60034 y compris:

CEI 60034,5, CEI 60034-6, CEI 60034-7, CEI 60034-8, CEI 60034-9, CEI 60034-11, CEI 60034-12 et CEI 60034-14.

De plus, il peut être nécessaire de considérer la limitation de la température de surface et des caractéristiques similaires; voir par exemple la CEI 60335-1(1991), article 11: Echauffement.

12.1.3.2 Emission tests

For synchronous machines having outputs of 300 kW (or kVA) or more, type tests for conducted low-frequency emission shall be carried out to verify compliance with 8.9.2.

For a.c. commutator machines, type tests on no-load for conducted and radiated emission shall be carried out to verify compliance with 12.1.2.3.

For d.c. commutator machines, type tests on no-load or minimum possible load for radiated emission shall be carried out to verify compliance with 12.1.2.3.

The tests shall be carried out in accordance with CISPR 11, CISPR 14, and CISPR 16 as applicable.

No other tests are required to demonstrate compliance with this clause.

NOTE The measurement on no-load is justified by the negligible influence of load on the emission.

Section 13: Safety

13.1 Safety

Rotating machines in accordance with this standard shall comply with the requirements of IEC 60204-1 unless otherwise specified in this standard, and be designed and constructed as far as possible in accordance with internationally accepted best design practice, appropriate to the application.

NOTE It is the responsibility of the manufacturer or assembler of equipment incorporating electrical machines as components to ensure that the overall equipment is safe.

This may involve consideration of relevant product standards such as:

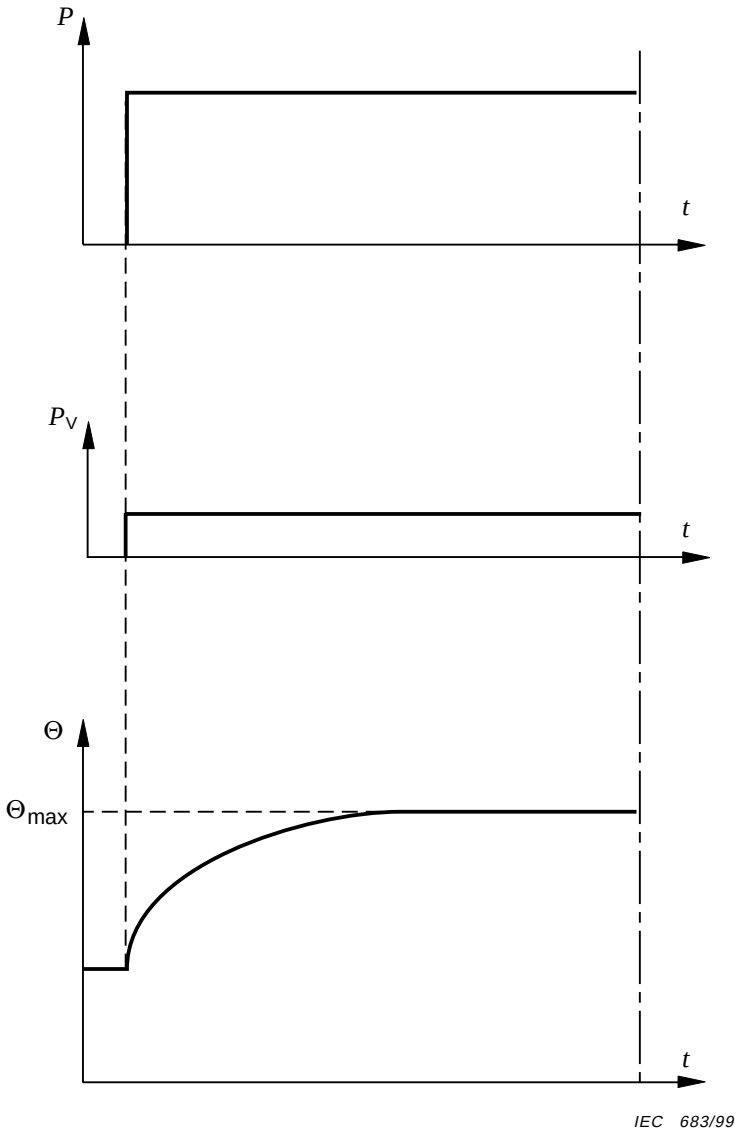
IEC 60079: *Electrical apparatus for explosive gas atmospheres,*

IEC 60335: *Safety of household and similar electrical appliances;*

and other parts of IEC 60034 including:

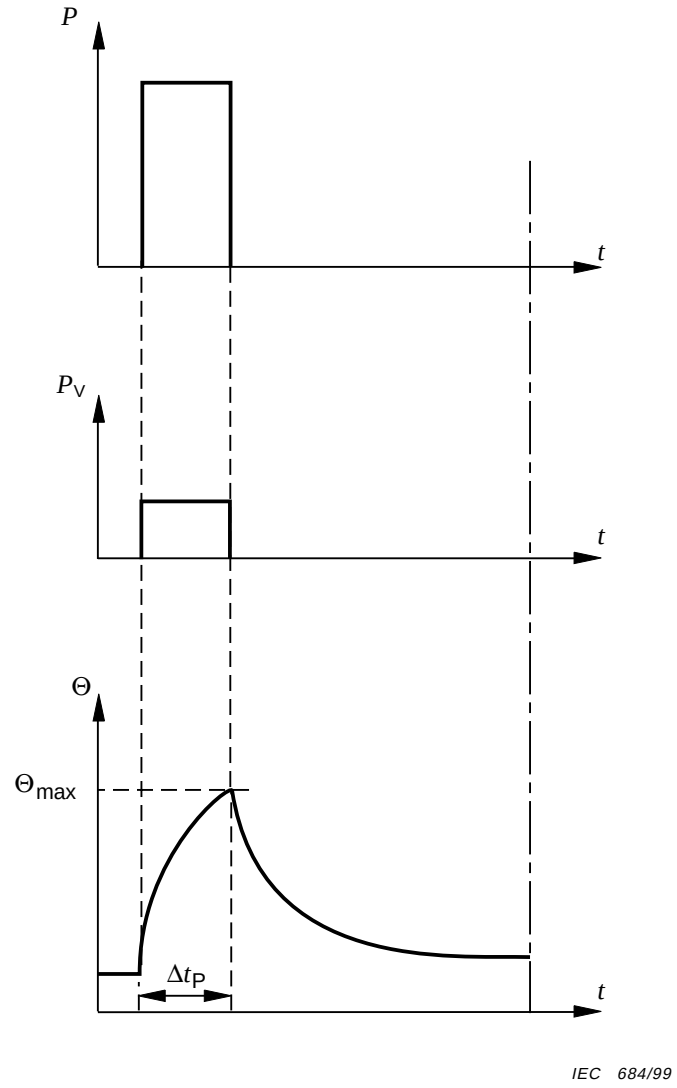
IEC 60034-5, IEC 60034-6, IEC 60034-7, IEC 60034-8, IEC 60034-9, IEC 60034-11, IEC 60034-12 and IEC 60034-14.

In addition, it may be necessary to consider limitation of the surface temperature and similar characteristics; see for example IEC 60335-1 (1991), clause 11: Heating.



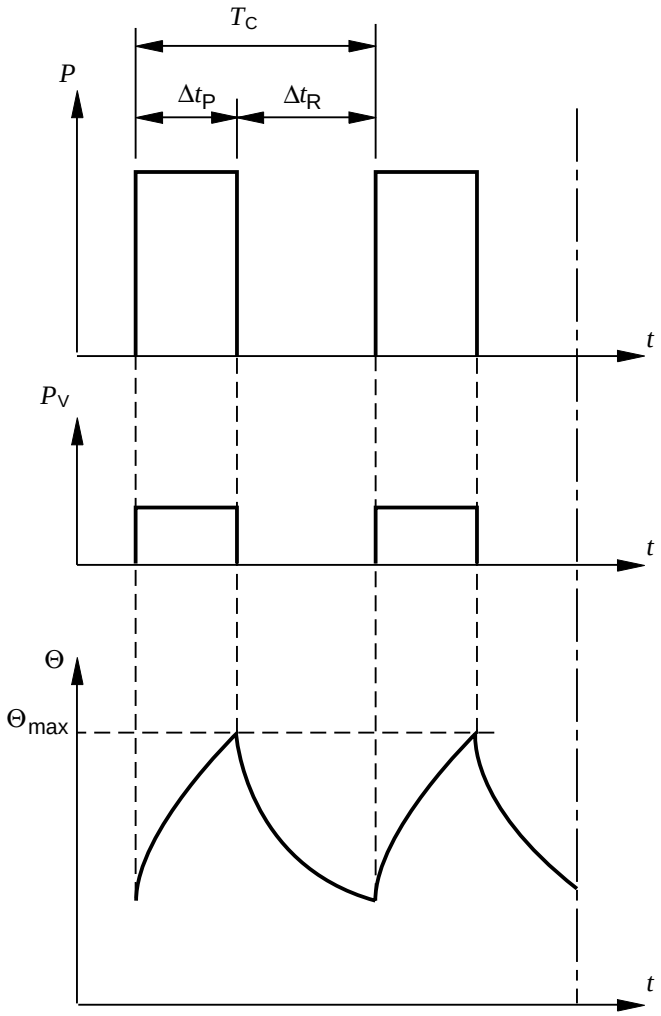
P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
$Θ$	=	température	$Θ$	=	temperature
$Θ_{max}$	=	température maximale atteinte	$Θ_{max}$	=	maximum temperature attained
t	=	temps	t	=	time

Figure 1 – Service continu – Service type S1
Figure 1 – Continuous running duty – Duty type S1



P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load

Figure 2 – Service temporaire – Service type S2
Figure 2 – Short-time duty – Duty type S2

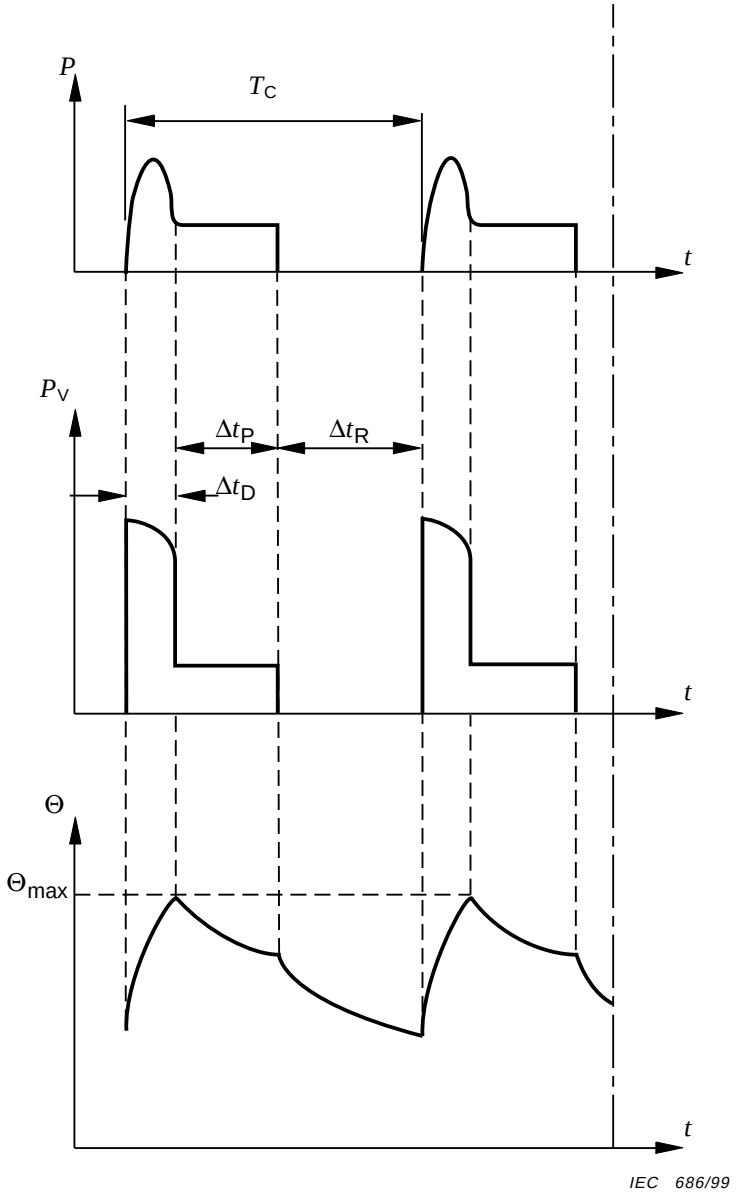


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized

Facteur de marche = Δt_P / T_C

Cyclic duration factor = Δt_P / T_C

Figure 3 – Service intermittent périodique – Service type S3
Figure 3 – Intermittent periodic duty – Duty type S3

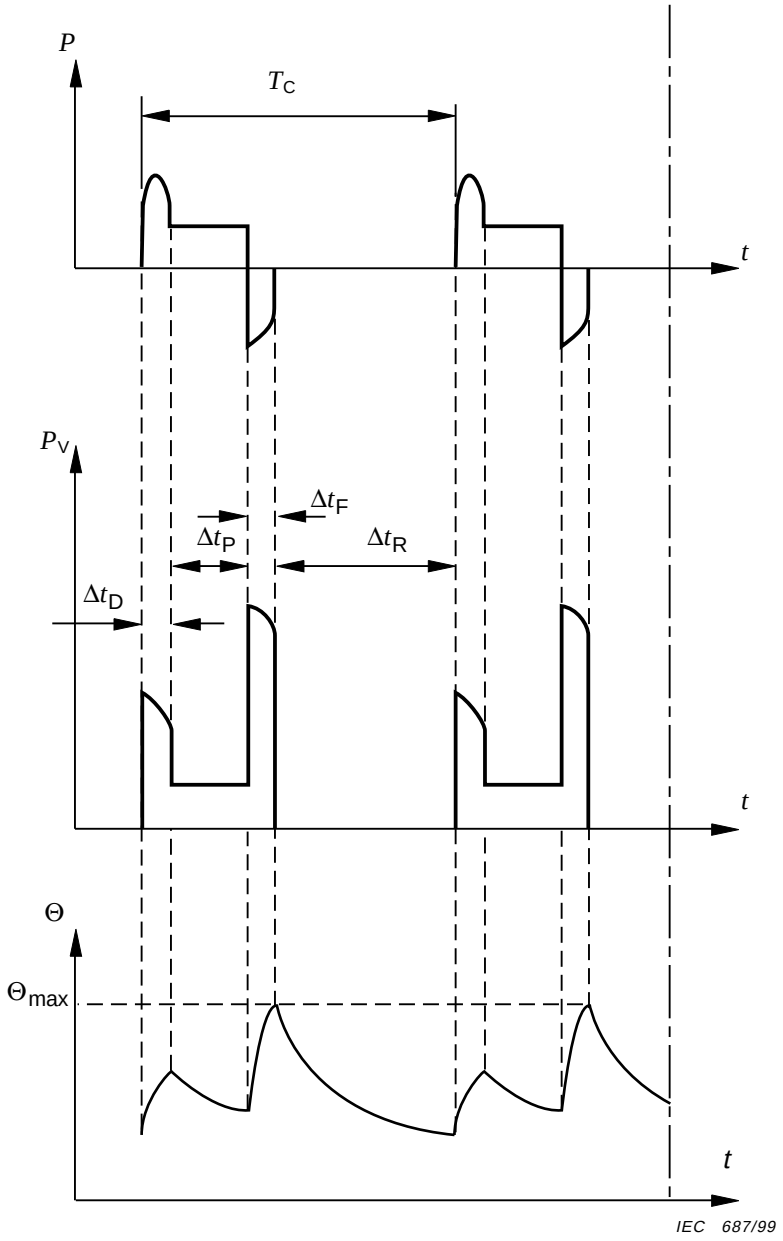


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized

Facteur de marche = $(\Delta t_D + \Delta t_P) / T_C$

Cyclic duration factor = $(\Delta t_D + \Delta t_P) / T_C$

Figure 4 – Service intermittent périodique à démarrage – Service type S4
Figure 4 – Intermittent periodic duty with starting – Duty type S4

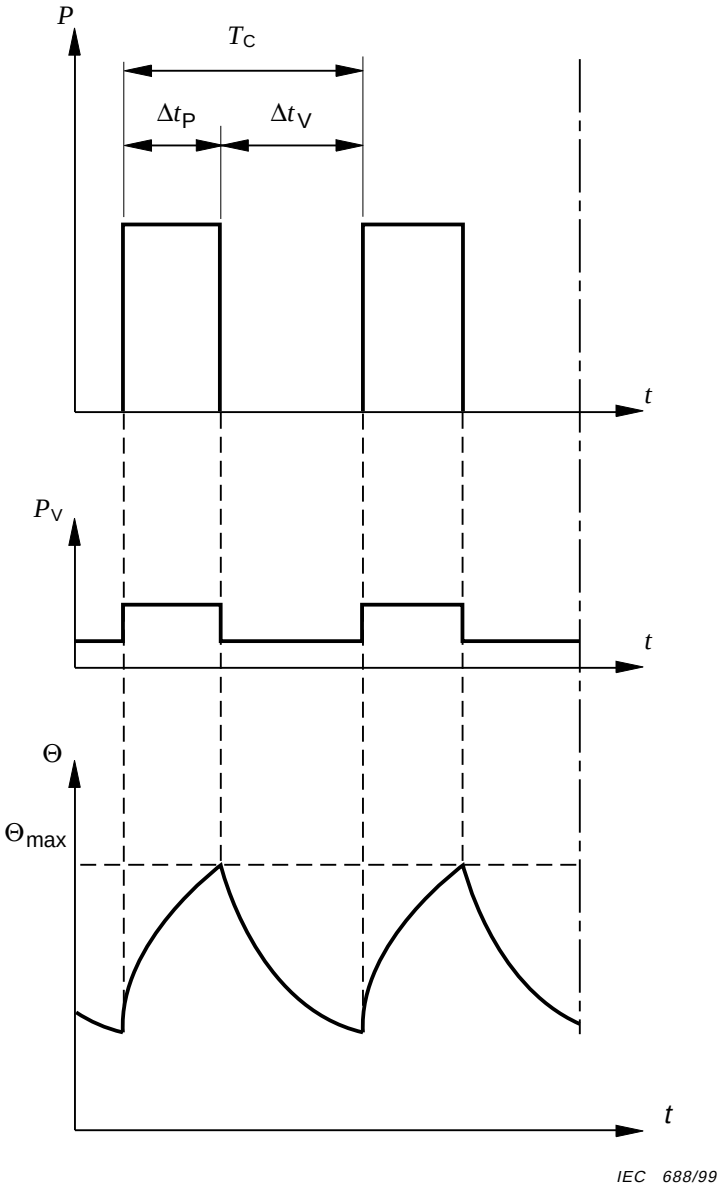


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_F	=	durée de freinage électrique	Δt_F	=	time of electric braking
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized

Facteur de marche = $(\Delta t_D + \Delta t_P + \Delta t_F) / T_C$

Cyclic duration factor = $(\Delta t_D + \Delta t_P + \Delta t_F) / T_C$

Figure 5 – Service intermittent périodique à freinage électrique – Service type S5
Figure 5 – Intermittent periodic duty with electric braking – Duty type S5

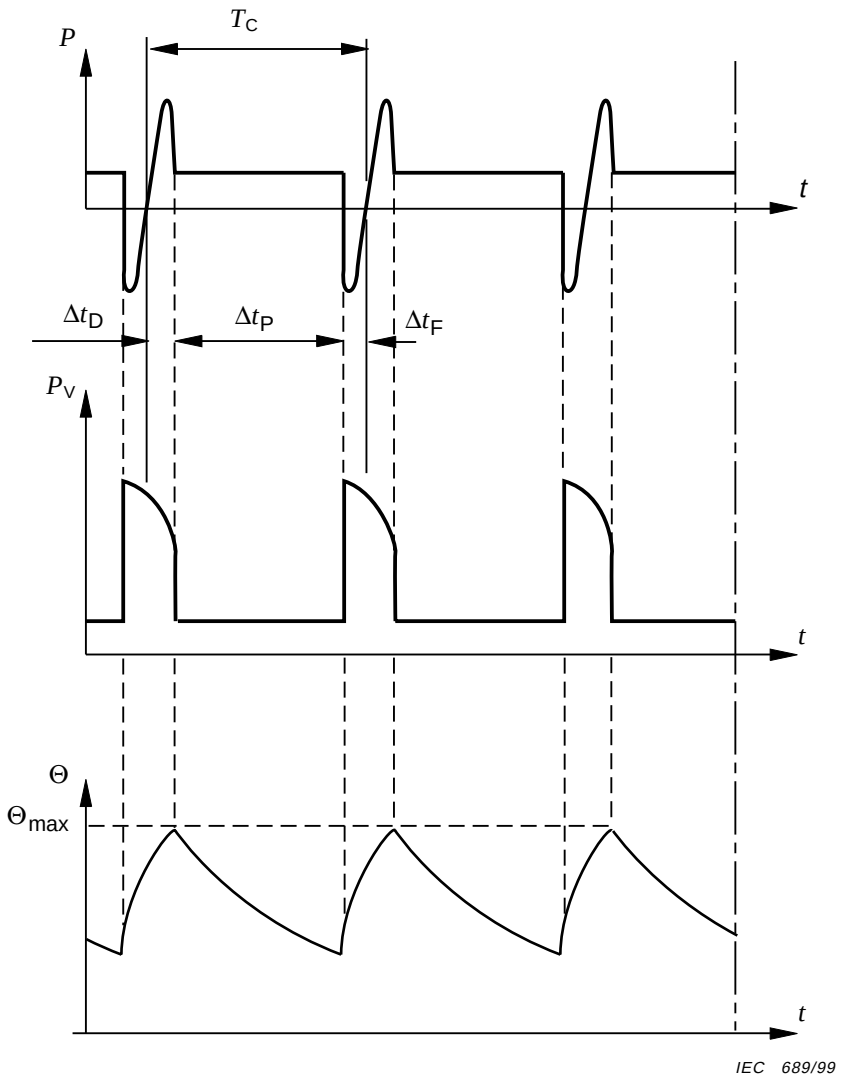


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_V	=	durée de fonctionnement à vide	Δt_V	=	operation time at no-load

Facteur de marche = $\Delta t_P / T_C$

Cyclic duration factor = $\Delta t_P / T_C$

Figure 6 – Service ininterrompu périodique à charge intermittente – Service type S6
Figure 6 – Continuous operation periodic duty – Duty type S6

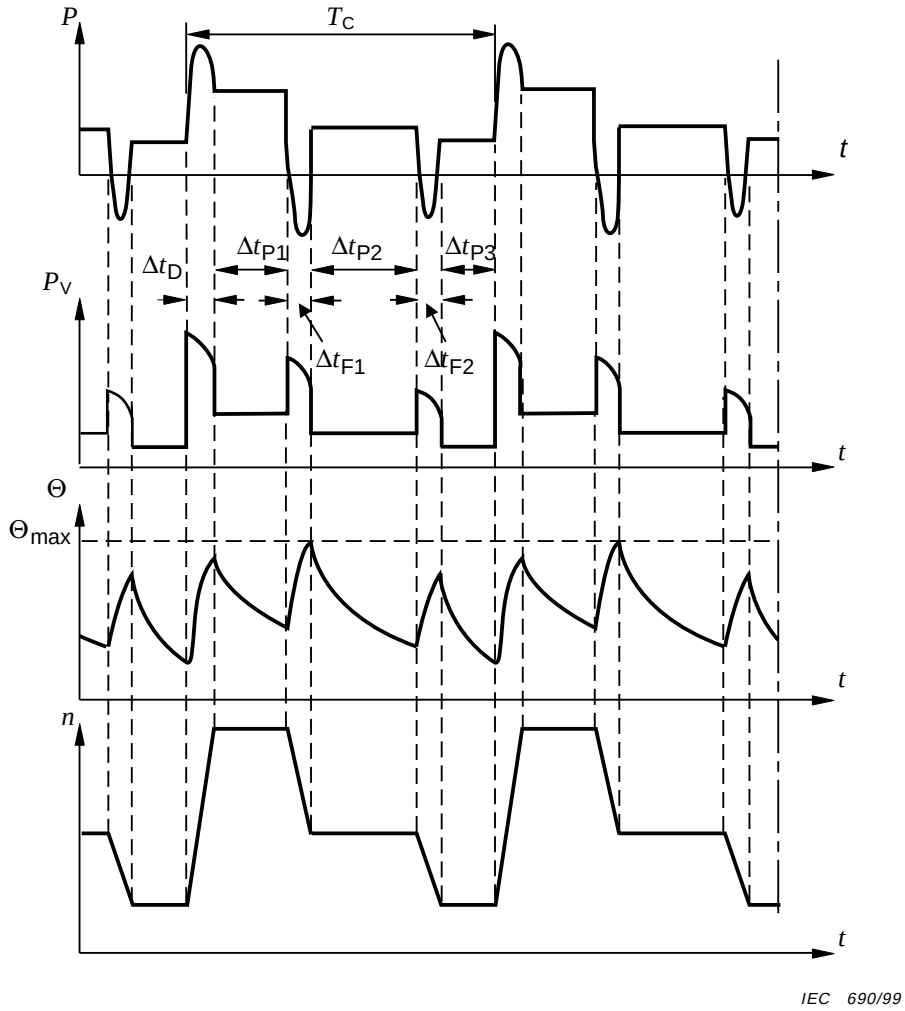


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_F	=	durée de freinage électrique	Δt_F	=	time of electric braking

Facteur de marche = 1

Cyclic duration factor = 1

Figure 7 – Service ininterrompu périodique à freinage électrique – Service type S7
Figure 7 – Continuous operation periodic duty with electric braking – Duty type S7

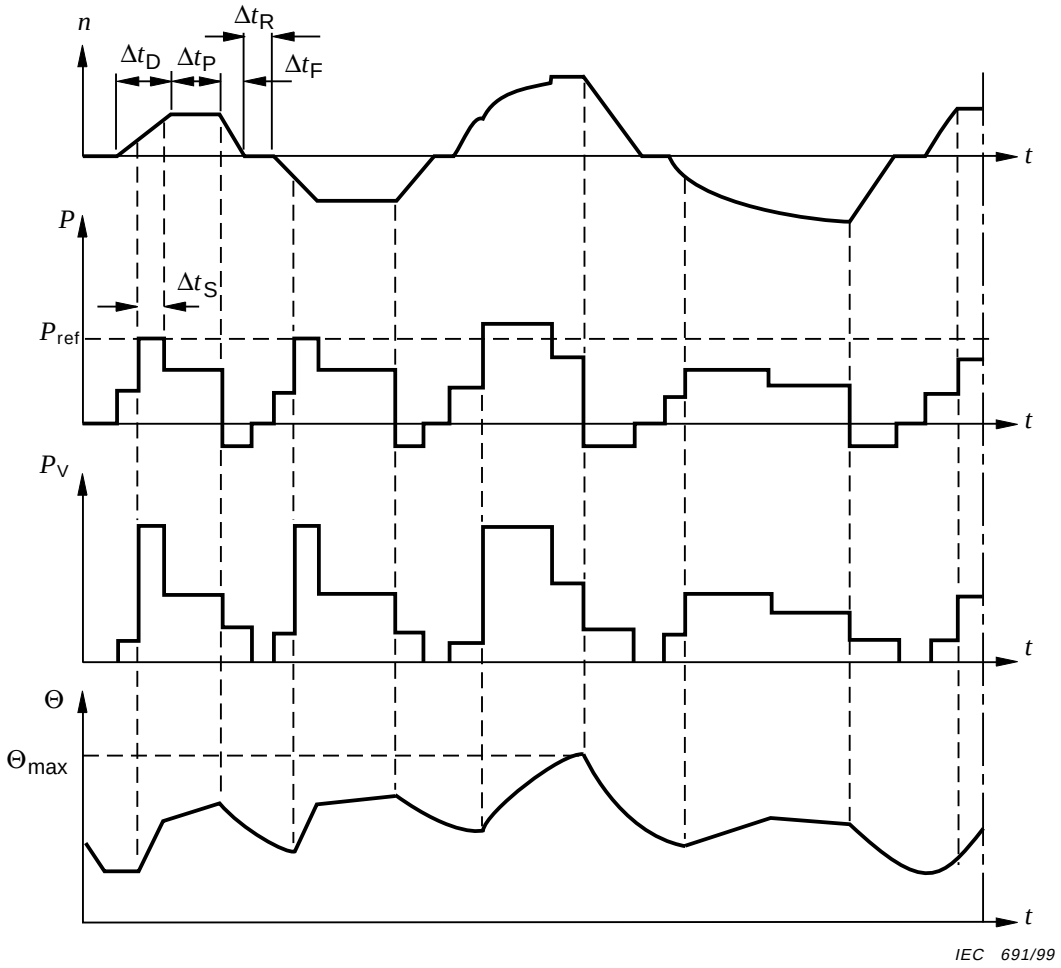


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
n	=	vitesse	n	=	speed
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante (P1, P2, P3)	Δt_P	=	operation time at constant load (P1, P2, P3)
Δt_F	=	durée de freinage électrique (F1, F2)	Δt_F	=	time of electric braking (F1, F2)

Facteur de marche = $(\Delta t_D + \Delta t_{P1}) / T_C$; $(\Delta t_{F1} + \Delta t_{P2}) / T_C$; $(\Delta t_{F2} + \Delta t_{P3}) / T_C$

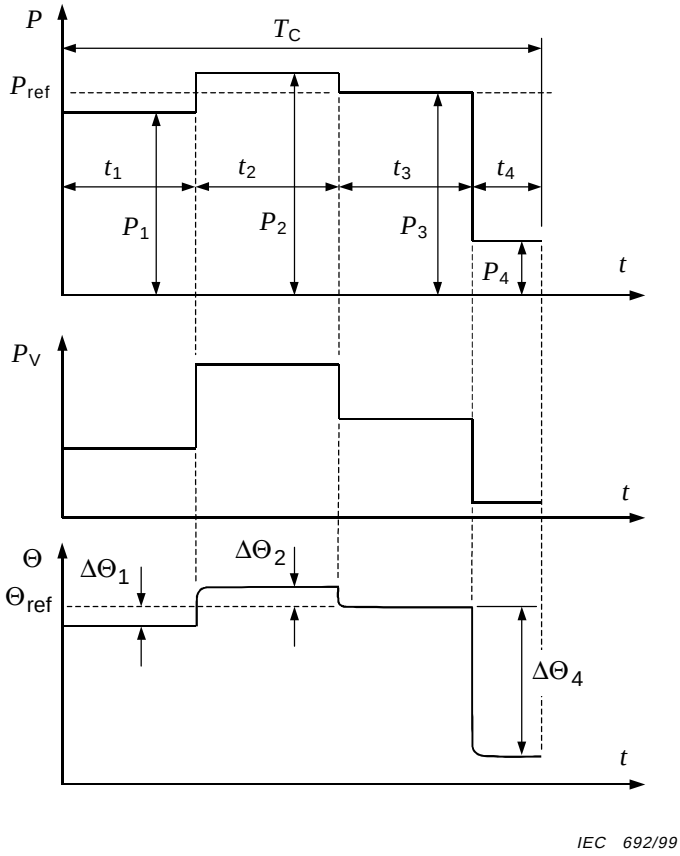
Cyclic duration factor = $(\Delta t_D + \Delta t_{P1}) / T_C$; $(\Delta t_{F1} + \Delta t_{P2}) / T_C$; $(\Delta t_{F2} + \Delta t_{P3}) / T_C$

Figure 8 – Service ininterrompu périodique à changements liés de charge et de vitesse – Service type S8
Figure 8 – Continuous operation periodic duty with related load/speed changes – Duty type S8



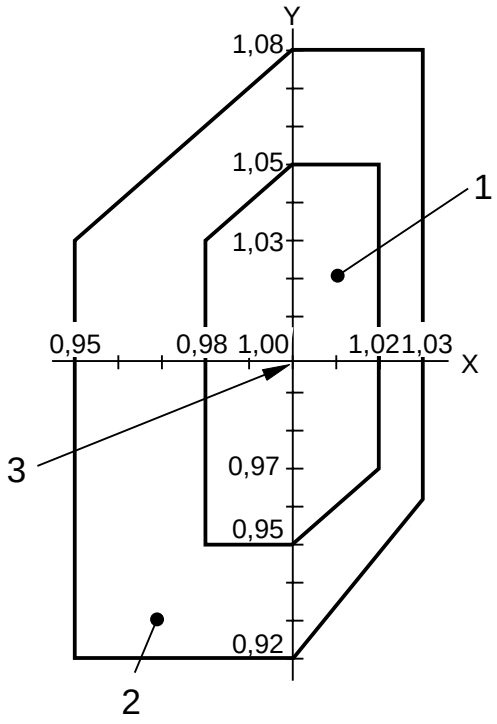
P	=	charge	P	=	load
P_{ref}	=	charge de référence	P_{ref}	=	reference load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
n	=	vitesse	n	=	speed
t	=	temps	t	=	time
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_F	=	durée de freinage électrique	Δt_F	=	time of electric braking
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized
Δt_S	=	durée de fonctionnement en surcharge	Δt_S	=	time under overload

Figure 9 – Service à variations non périodique de charge et de vitesse – Service type S9
Figure 9 – Duty with non-periodic load and speed variations – Duty type S9



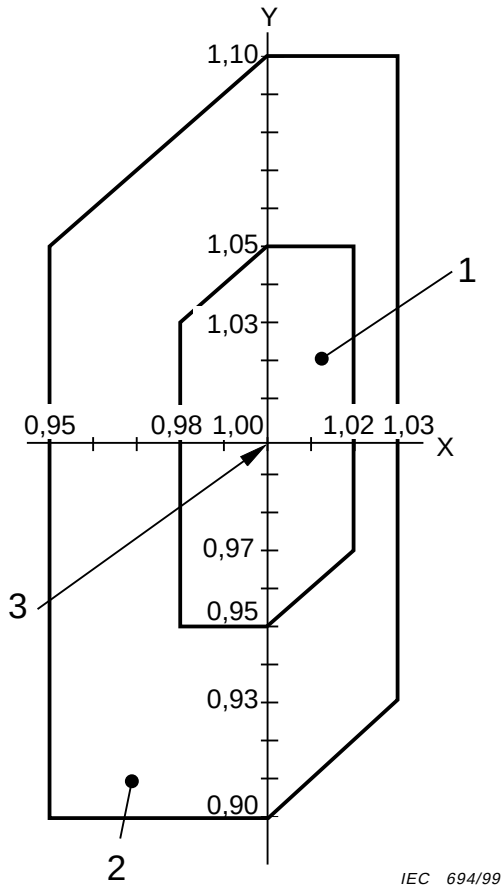
P	=	charge	P	=	load
P_i	=	charge constante pendant un cycle	P_i	=	constant load within a load cycle
P_{ref}	=	charge de référence basée sur le service type S1	P_{ref}	=	reference load based on duty type S1
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{ref}	=	température à la charge de référence basée sur le service type S1	Θ_{ref}	=	temperature at reference load based on duty type S1
t	=	temps	t	=	time
t_i	=	durée d'une charge constante pendant un cycle	t_i	=	time of a constant load within a cycle
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
$\Delta\Theta_i$	=	différence entre l'échauffement de l'enroulement au cours de chacune des charges pendant un cycle et l'échauffement basé sur le service type S1 à la charge référence	$\Delta\Theta_i$	=	difference between the temperature rise of the winding at each of the various loads within one cycle and the temperature rise based on duty cycle S1 with reference load

Figure 10 – Service avec charges constantes distinctes – Service type S10
Figure 10 – Duty with discrete constant loads – Duty type S10



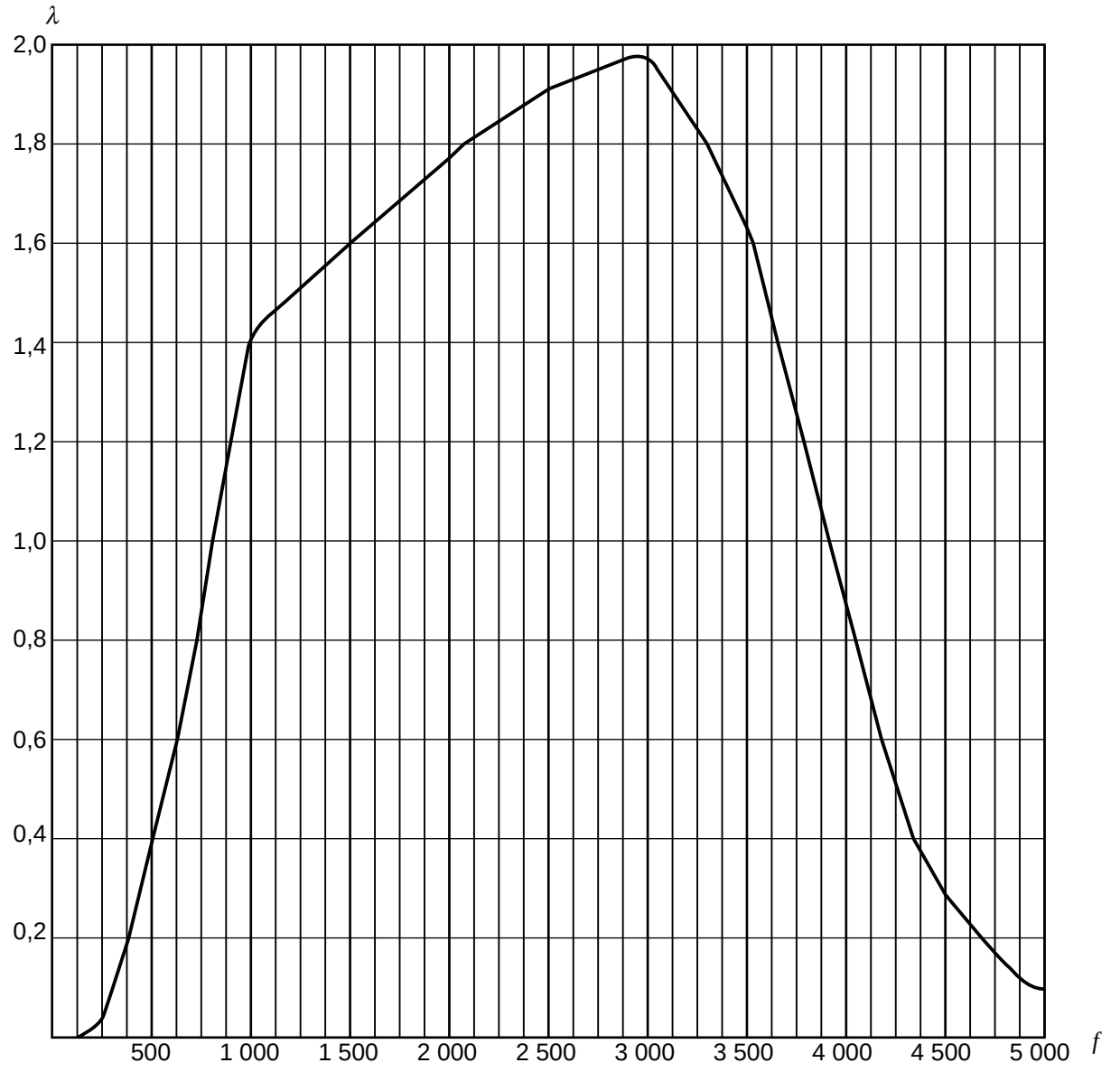
axe X = fréquence p.u.
axe Y = tension p.u.
1 = zone A
2 = zone B (extérieure à zone A)
3 = point des caractéristiques assignées

Figure 11 – Valeurs limites de tension et fréquence pour les alternateurs
Figure 11 – Voltage and frequency limits for generators



X axis = frequency p.u.
Y axis = voltage p.u.
1 = zone A
2 = zone B (outside zone A)
3 = rating point

Figure 12 – Valeurs limites de tension et fréquence pour les moteurs
Figure 12 – Voltage and frequency limits for motors



f	= fréquence Hz	f	= frequency Hz
λ	= facteur de pondération	λ	= weighting factor

Figure 13 – Courbe de pondération pour le calcul de FHT, voir 8.9
Figure 13 – Weighting curve for computing THF, see 8.9

Annexe A
(informative)

Guide pour l'application du service type S10 et pour l'obtention de la valeur relative de l'espérance de vie thermique TL

A.1 La charge de la machine équivaut à tout moment au service type S1 correspondant au paragraphe 3.2.1. Cependant, le cycle de charges peut comprendre d'autres charges que la charge assignée basée sur le service type S1. Un cycle de charges ne peut pas comprendre plus de quatre charges constantes distinctes (voir la figure 10).

A.2 Selon la valeur et la durée des différentes charges dans un cycle, l'espérance de vie relative de la machine basée sur le vieillissement thermique du système d'isolation peut se calculer avec l'équation suivante:

$$\frac{1}{TL} = \sum_{i=1}^{n} \Delta t_i \times 2^{\frac{\Delta\Theta_i}{k}}$$

où

TL est l'espérance de vie thermique en valeur relative par rapport à l'espérance de vie thermique dans le cas du service type S1 à la puissance assignée;

$\Delta\Theta_i$ est la différence entre l'échauffement de l'enroulement au cours des différentes charges dans un cycle et l'échauffement basé sur le service type S1 à la charge de référence;

Δt_i est la durée réduite (p.u.) d'une charge constante dans un cycle de charge;

k est l'augmentation d'échauffement en kelvins qui conduit à une réduction de 50 % de l'espérance de vie thermique du système d'isolation;

n est le nombre des valeurs distinctes de charges ($n \leq 4$).

A.3 La valeur de TL fait partie intégrante de l'identification précise de la classe de caractéristiques assignées.

A.4 La valeur de TL ne peut être déterminée que lorsque, en plus de l'information sur le cycle de charge d'après la figure 10, la valeur k du système d'isolation est connue. Cette valeur k doit être déterminée par expérimentation conformément à la CEI 60034-18 dans toute la plage de température couverte par le cycle de charge selon la figure 10.

A.5 On peut raisonnablement donner la valeur de TL sous la seule forme d'une valeur relative. On peut utiliser cette valeur pour établir approximativement la variation réelle de l'espérance de vie thermique par rapport à celle du service type S1 à la puissance assignée car on peut supposer, en considérant les différentes charges existantes dans un cycle, que les autres effets sur l'espérance de vie de la machine (par exemple contraintes diélectriques, influences du milieu) sont sensiblement les mêmes que ceux dans le cas du service type S1 à la puissance assignée.

A.6 Le constructeur de la machine est responsable de la compilation exacte des différents paramètres servant à déterminer la valeur TL.

Annex A
(informative)

Guidance for the application of duty type S10 and for establishing the value of relative thermal life expectancy TL

A.1 The load of the machine at any moment is equivalent to duty type S1 corresponding to 3.2.1. However, the load cycle may comprise loads other than the rated load based on duty type S1. One load cycle may comprise not more than four discrete constant loads, see figure 10.

A.2 Depending on the value and duration of the different loads within one cycle, the relative life expectancy of the machine based on the thermal ageing of the insulation system can be calculated by the following equation:

$$\frac{1}{TL} = \sum_{i=1}^{n} \Delta t_i \times 2^{\frac{\Delta\Theta_i}{k}}$$

where

TL is the relative thermal life expectancy related to the thermal life expectancy in case of duty type S1 with rated output;

$\Delta\Theta_i$ is the difference between the temperature rise of the winding at each of the various loads within one cycle and the temperature rise based upon duty type S1 with reference load;

Δt_i is the p.u. time of a constant load within a load cycle;

k is the increase in temperature rise in K, which leads to a shortening of the thermal life expectancy of the insulation system by 50 %;

n is the number of discrete values of load ($n \leq 4$).

A.3 The quantity TL is an integral part of the unambiguous identification of the class of rating.

A.4 The value of the quantity TL can be determined only when, in addition to information concerning the load cycle according to figure 10, the value k for the insulation system is known. This value k has to be determined by experiments in conformity with IEC 60034-18 for the whole temperature range within which the load cycle takes place according to figure 10.

A.5 TL can be stated sensibly as a relative value only. This value can be used by approximation to assess the real change in the machine thermal life expectancy as compared to duty type S1 with rated output, because it may be assumed that in consideration of the varying loads existing within a cycle the remaining influences over the lifetime of the machine (e.g. dielectric stress, environmental influences) are approximately the same as in the case of duty type S1 with rated output.

A.6 The manufacturer of the machine is responsible for the correct compilation of the various parameters for determining the value of TL.

Annexe B / Annex B
(informative)

Références croisées entre la neuvième édition (+ amd. 1) et la dixième édition
Cross-references between edition 9 (+ amd 1) and edition 10

NOTE Dans cette annexe, les numéros entre crochets [ ] indiquent les numéros des tableaux.
In this annex, numbers in square brackets [ ] indicate table numbers.

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.....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply).* I am the/a:

purchasing agent ❑
librarian ❑
researcher ❑
design engineer ❑
safety engineer ❑
testing engineer ❑
marketing specialist ❑
other.....

Q3 I work for/in/as a: *(tick all that apply)*

manufacturing ❑
consultant ❑
government ❑
test/certification facility ❑
public utility ❑
education ❑
military ❑
other.....

Q4 This standard will be used for: *(tick all that apply)*

general reference ❑
product research ❑
product design/development ❑
specifications ❑
tenders ❑
quality assessment ❑
certification ❑
technical documentation ❑
thesis ❑
manufacturing ❑
other.....

Q5 This standard meets my needs: *(tick one)*

not at all ❑
nearly ❑
fairly well ❑
exactly ❑

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

standard is out of date ❑
standard is incomplete ❑
standard is too academic ❑
standard is too superficial ❑
title is misleading ❑
I made the wrong choice ❑
other .....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

timeliness.....
quality of writing.....
technical contents.....
logic of arrangement of contents .....
tables, charts, graphs, figures.....
other .....

Q8 I read/use the: *(tick one)*

French text only ❑
English text only ❑
both English and French texts ❑

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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Q1 Veuillez ne mentionner qu'**UNE SEULE NORME** et indiquer son numéro exact: (*ex. 60601-1-1)*

.....

Q2 En tant qu'acheteur de cette norme, quelle est votre fonction?
(cochez tout ce qui convient)
Je suis le/un:

agent d'un service d'achat ❑
bibliothécaire ❑
chercheur ❑
ingénieur concepteur ❑
ingénieur sécurité ❑
ingénieur d'essais ❑
spécialiste en marketing ❑
autre(s).....

Q3 Je travaille:
(cochez tout ce qui convient)

dans l'industrie ❑
comme consultant ❑
pour un gouvernement ❑
pour un organisme d'essais/ certification ❑
dans un service public ❑
dans l'enseignement ❑
comme militaire ❑
autre(s).....

Q4 Cette norme sera utilisée pour/comme
(cochez tout ce qui convient)

ouvrage de référence ❑
une recherche de produit ❑
une étude/développement de produit ❑
des spécifications ❑
des soumissions ❑
une évaluation de la qualité ❑
une certification ❑
une documentation technique ❑
une thèse ❑
la fabrication ❑
autre(s).....

Q5 Cette norme répond-elle à vos besoins:
(une seule réponse)

pas du tout ❑
à peu près ❑
assez bien ❑
parfaitement ❑

Q6 Si vous avez répondu PAS DU TOUT à Q5, c'est pour la/les raison(s) suivantes:
(cochez tout ce qui convient)

la norme a besoin d'être révisée ❑
la norme est incomplète ❑
la norme est trop théorique ❑
la norme est trop superficielle ❑
le titre est équivoque ❑
je n'ai pas fait le bon choix ❑
autre(s) .....

Q7 Veuillez évaluer chacun des critères ci-dessous en utilisant les chiffres
(1) inacceptable,
(2) au-dessous de la moyenne,
(3) moyen,
(4) au-dessus de la moyenne,
(5) exceptionnel,
(6) sans objet

publication en temps opportun .....
qualité de la rédaction.....
contenu technique .....
disposition logique du contenu .....
tableaux, diagrammes, graphiques, figures.....
autre(s) .....

Q8 Je lis/utilise: *(une seule réponse)*

uniquement le texte français ❑
uniquement le texte anglais ❑
les textes anglais et français ❑

Q9 Veuillez nous faire part de vos observations éventuelles sur la CEI:

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.....
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Amendement 2 à la CEI 60034-1, édition 9 (1994)
Amendement 1 à la CEI 60034-1, édition 10 (1996)

Machines électriques tournantes –

Partie 1:
Caractéristiques assignées et caractéristiques de fonctionnement

Amendment 2 to IEC 60034-1, 9th edition (1994)
Amendment 1 to IEC 60034-1, 10th edition (1996)

Rotating electrical machines –

Part 1:
Rating and performance

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Международная Электротехническая Комиссия

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AVANT-PROPOS

Le présent amendement a été établi par le comité d'études 2 de la CEI: Machines tournantes.

Le texte de cet amendement est issu des documents suivants:

FDIS	Rapport de vote
2/956/FDIS	2/984/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cet amendement.

_____

INTRODUCTION

Cet amendement 2 est publié en parallèle avec un amendement équivalent 1 à la CEI 60034-1 (10e édition) de façon que le contenu technique des deux éditions reste le même.

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1.2 *Références normatives*

Insérer, dans la liste existante, les titres des normes suivantes:

CEI 60204-1: 1992, *Equipement électrique des machines industrielles – Partie 1: Règles générales*

CISPR 11: 1990, *Limites et méthodes de mesure des caractéristiques de perturbations électromagnétiques des appareils industriels, scientifiques et médicaux (ISM) à fréquence radioélectrique*

CISPR 14: 1993, *Limites et méthodes de mesure des perturbations radioélectriques produites par les appareils électrodomestiques ou analogues comportant des moteurs ou des dispositifs thermiques, par les outils électriques et par les appareils électriques analogues*

CISPR 16: *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques*

Page 88

18.3 *Surintensité occasionnelle des machines à collecteur*

Remplacer la première phrase de ce paragraphe par la phrase suivante:

Une machine à collecteur doit être capable de supporter, pendant 60 s, 1,5 fois le courant assigné dans la combinaison appropriée des conditions suivantes:

Supprimer le point c).

FOREWORD

This amendment has been prepared by IEC technical committee 2: Rotating machinery.

The text of this amendment is based on the following documents:

FDIS	Report on voting
2/956/FDIS	2/984/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

_____

INTRODUCTION

This amendment 2 is issued in parallel with an equivalent amendment 1 to IEC 60034-1 (tenth edition) in order that the technical content of the two editions remains the same.

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1.2 *Normative references*

Insert, in the existing list, the titles of the following standards:

IEC 60204-1: 1992, *Electrical equipment of industrial machines – Part 1: General requirements*

CISPR 11: 1990, *Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment*

CISPR 14: 1993, *Limits and methods of measurement of radio disturbance characteristics of electrical motor–operated and thermal appliances for household and similar purposes, electric tools and electric apparatus*

CISPR 16: *Specification for radio disturbance and immunity measuring apparatus and methods*

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18.3 *Occasional excess current for commutator machines*

Replace the first sentence of this subclause by the following:

A commutator machine shall be capable of withstanding, for 60 s, 1,5 times rated current under the appropriate combination of conditions as follows:

Delete item c).

19.1 *Moteurs à induction polyphasés et moteurs à courant continu (sauf les moteurs qui font l'objet de 19.2)*

Remplacer le premier alinéa de ce paragraphe par l'alinéa suivant:

Les moteurs doivent, quels que soient leur service et leur réalisation, être capables de supporter, pendant 15 s, sans calage ni changement brusque de vitesse (sous une augmentation graduelle de couple), un excès du couple d'au moins 60 % de leurs valeurs assignées, la tension et la fréquence (moteurs à induction) étant maintenues à leurs valeurs assignées.

NOTE – Pour certains moteurs fabriqués conformément à la CEI 60034-12, des couples plus importants sont nécessaires.

Pour les moteurs à courant continu, le couple doit être exprimé en termes de surintensité; voir 18.3.

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Ajouter les deux nouvelles sections suivantes:

Section 14: Compatibilité électromagnétique (CEM)

32 Compatibilité électromagnétique (CEM)

Les prescriptions qui suivent sont applicables aux machines électriques tournantes de tension assignée ne dépassant pas 1 000 V (courant alternatif) ou 1 500 V (courant continu) et sont destinées à fonctionner selon les conditions spécifiées ci-dessous.

Les composants électroniques qui sont montés à l'intérieur de la machine électrique tournante et qui sont essentiels pour son fonctionnement (par exemple les systèmes d'excitation tournants) font partie de la machine.

Les prescriptions qui sont applicables à un système d'entraînement final et à ses composants, par exemple un équipement électronique de puissance et de commande, des machines couplées, des appareils de contrôle, etc., qu'ils soient montés à l'intérieur ou à l'extérieur de la machine, sont hors du domaine d'application de cette norme.

Les limites de l'article 12 sont établies pour des conditions de fonctionnement en régime établi. Les régimes transitoires (tels que le démarrage) ne sont pas couverts par le présent article.

32.1 *Limites d'immunité*

Les limites d'immunité des machines à courant alternatif et des machines à courant continu aux variations et aux harmoniques de tension du système connecté, et les limites d'immunité des machines à courant alternatif polyphasées aux déséquilibres du système connecté sont données à l'article 12.

32.2 *Limites d'émission*

NOTE – Les limites dans les tableaux qui suivent sont tirées du CISPR 11 ou du CISPR 12.

19.1 *Polyphase induction motors and d.c. motors (excluding motors in 19.2)*

Replace the first paragraph of this subclause by the following:

The motors shall, whatever their duty and construction, be capable of withstanding for 15 s, without stalling or abrupt change in speed (under gradual increase of torque), an excess torque of at least 60 % of their rated torque, the voltage and frequency (induction motors) being maintained at their rated value.

NOTE – Higher torques are required for some motors manufactured according to IEC 60034-12.

For d.c. motors, the torque shall be expressed in terms of overload current; see 18.3.

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Add the following two new sections:

Section 14: Electromagnetic compatibility (EMC)

32 Electromagnetic compatibility (EMC)

The following requirements apply to rotating electrical machines with a rated voltage not exceeding 1 000 V a.c. or 1 500 V d.c., and which are intended for operation within the conditions specified below.

Electronic components mounted inside the rotating electrical machine and essential for its operation (for example rotating excitation devices) are part of the machine.

Requirements which are applicable to the final drive system and its components, for example power and control electronic equipment, coupled machines, monitoring devices etc., whether mounted inside or outside the machine, are outside the scope of this standard.

The limitations of clause 12 are fixed for steady-state operating conditions. Transients (such as starting) are not covered by this clause.

32.1 *Immunity limits*

The immunity limits of both a.c. and d.c. machines to variations and harmonics of the system voltage, and those of polyphase a.c. machines to unbalances of the connected system, are given in clause 12.

32.2 *Emission limits*

NOTE – The limits in the tables that follow are taken from CISPR 11 or CISPR 12.

32.2.1 *Machines à induction*

Quand elles sont reliées à un système conformément à l'article 12, les machines à induction ne produisent pas de rayonnements perturbateurs supérieurs aux limites

– du tableau 11 pour les machines avec rotors à cage ou avec rotors bobinés munies d'un dispositif de levage des balais et de court-circuit des bagues; ou

– du tableau 12 pour les machines fonctionnant en permanence avec bagues et balais en contact.

Les émissions de conduction sont intrinsèquement bien inférieures aux limites données au tableau 11.

32.2.2 *Machines synchrones*

Quand elles sont reliées à un système conformément à l'article 12, les machines synchrones ne produisent pas de rayonnements perturbateurs supérieurs aux limites du tableau 11, pour les machines sans bagues ni balais, ou aux limites du tableau 12, pour les machines avec bagues et balais.

L'émission de conduction à basse fréquence est couverte par la section 11. Les émissions de conduction à fréquences supérieures sont intrinsèquement bien inférieures aux limites données au tableau 11.

Tableau 11 – Limites des perturbations électromagnétiques pour les machines fonctionnant sans balais

	Plages de fréquences	Limites
Rayonnement perturbateur	30 MHz à 230 MHz	30 dB(µV/m) quasi crête, mesuré à 10 m de distance[1)]
	230 MHz à 1 000 MHz	37 dB(µV/m) quasi crête, mesuré à 10 m de distance[1)]
Conduction perturbatrice aux bornes d'alimentation à courant alternatif	0,15 MHz à 0,5 MHz Les limites diminuent proportionnellement avec le logarithme de la fréquence.	66 à 56 dB(µV) quasi crête 56 à 46 dB(µV) moyenne
	0,5 MHz à 5 MHz	56 dB(µV) quasi crête 46 dB(µV) moyenne
	5 MHz à 30 MHz	60 dB(µV) quasi crête 50 dB(µV) moyenne

[1)] Peut être mesuré à une distance de 3 m, en augmentant les limites de 10 dB.

32.2.3 *Machines à collecteur*

Les machines à courant continu, fonctionnant avec une tension lissée et les machines à collecteur à courant alternatif, fonctionnant sur un système conformément à l'article 12, ne doivent pas rayonner de perturbations supérieures aux limites du tableau 12.

32.2.1 *Induction machines*

When connected to a system according to clause 12, induction machines do not produce radiated disturbances higher than the limits in

– table 11 for machines with cage rotors or with wound rotors having brush-lifting and short-circuiting devices; or

– table 12 for machines with continuously running slip-rings.

Conducted emissions are inherently much lower than the limits given in table 11.

32.2.2 *Synchronous machines*

When connected to a system according to clause 12, synchronous machines do not radiate disturbances higher than the limits of table 11 for brushless designs, or of table 12 for designs with slip-rings.

The conducted low-frequency emission is covered by section 11. Conducted emissions of higher frequencies are inherently much lower than the limits given in table 11.

Table 11 – Electromagnetic disturbance limits for machines operating without brushes

	Frequency range	Limits
Radiated disturbance	30 MHz to 230 MHz	30 dB(µV/m) quasi peak, measured at 10 m distance[1)]
	230 MHz to 1 000 MHz	37 dB(µV/m) quasi peak, measured at 10 m distance[1)]
Conducted disturbance on a.c. supply terminals	0,15 MHz to 0,5 MHz Limits decrease linearly with logarithm frequency.	66 to 56 dB(µV) quasi peak 56 to 46 dB(µV) average
	0,5 MHz to 5 MHz	56 dB(µV) quasi peak 46 dB(µV) average
	5 MHz to 30 MHz	60 dB(µV) quasi peak 50 dB(µV) average

[1)] May be measured at 3 m distance using the limits increased by 10 dB.

32.2.3 *Commutator machines*

DC machines operating on a smooth voltage and a.c. commutator motors operating on a system according to clause 12 shall not radiate disturbances which are above the limits of table 12.

Les émissions de conduction des machines à collecteur à courant alternatif doivent être inférieures aux limites du tableau 12. Les émissions de conduction des machines à courant continu ne sont pas à considérer car ces machines ne sont pas directement reliées à l'alimentation à courant alternatif.

Tableau 12 – Limites des perturbations électromagnétiques pour les machines fonctionnant avec balais

	Plages de fréquences	Limites
Rayonnement perturbateur	30 MHz à 230 MHz	30 dB(µV/m) quasi crête, mesuré à 30 m de distance[1)]
	230 MHz à 1 000 MHz	37 dB(µV/m) quasi crête, mesuré à 30 m de distance[1)]
Conduction perturbatrice aux bornes d'alimentation à courant alternatif	0,15 MHz à 0,50 MHz	79 dB(µV) quasi crête 66 dB(µV) moyenne
	0,50 MHz à 30 MHz	73 dB(µV) quasi crête 60 dB(µV) moyenne
[1)] Peut être mesuré à une distance de 10 m en augmentant les limites de 10 dB, ou à une distance de 3 m en augmentant les limites de 20 dB.		

32.3 *Essais*

32.3.1 *Essais d'immunité*

Des essais d'immunité ne sont pas exigés pour démontrer la conformité au présent article.

32.3.2 *Essais d'émission*

Pour les machines synchrones de puissance supérieure ou égale à 300 kW (ou kVA), des essais de type d'émission de conduction à basse fréquence doivent être effectués pour vérifier la conformité à 28.1.

Pour les machines à collecteur à courant alternatif, des essais de type en charge doivent être effectués pour l'émission de conduction et l'émission de rayonnement afin de vérifier la conformité à 32.2.3.

Pour les machines à collecteur à courant continu, des essais de type en charge doivent être effectués pour l'émission de rayonnement afin de vérifier la conformité à 32.2.3.

Les essais doivent être conduits suivant le CISPR 11, le CISPR 14, et le CISPR 16, selon le cas.

Aucun autre essai n'est exigé afin de démontrer la conformité au présent article.

Conducted emissions from a.c. commutator machines shall be below the levels of table 12. Conducted emissions from d.c. machines are irrelevant since these machines are not directly connected to the a.c. supply.

Table 12 – Electromagnetic disturbance limits for machines operating with brushes

	Frequency range	Limits
Radiated disturbance	30 MHz to 230 MHz	30 dB(μV/m) quasi peak, measured 30 m distance[1)]
	230 MHz to 1 000 MHz	37 dB(μV/m) quasi peak, measured 30 m distance[1)]
Conducted disturbance on a.c. supply terminals	0,15 MHz to 0,50 MHz	79 dB(μV) quasi peak 66 dB(μV) average
	0,50 MHz to 30 MHz	73 dB(μV) quasi peak 60 dB(μV) average

1) May be measured at 10 m distance using the limits increased by 10 dB, or measured at 3 m distance using the limits increased by 20 dB.

32.3 *Tests*

32.3.1 *Immunity tests*

Immunity tests are not required to demonstrate compliance with this clause.

32.3.2 *Emission tests*

For synchronous machines having outputs of 300 kW (or kVA) or more, type tests for conducted low-frequency emission shall be carried out to verify compliance with 28.1.

For a.c. commutator machines, type tests on load for conducted and radiated emission shall be carried out to verify compliance with 32.2.3.

For d.c. commutator machines, type tests on load for radiated emission shall be carried out to verify compliance with 32.2.3.

The tests shall be carried out in accordance with CISPR 11, CISPR 14, and CISPR 16 as applicable.

No other tests are required to demonstrate compliance with this clause.

Section 15: Sécurité

33 Sécurité

Les machines tournantes conformes à la présente norme doivent satisfaire aux exigences de la CEI 60204-1, sauf spécification contraire dans la présente norme, et dans la mesure du possible, elles doivent également être conçues et construites selon la meilleure forme de conception internationalement acceptée, selon l'application.

NOTE – Il est de la responsabilité du constructeur ou de l'assembleur de l'équipement incorporant des machines électriques de s'assurer que l'équipement complet est sûr.

Cela peut conduire à prendre en considération des normes de produits applicables telles que:

CEI 60079: *Matériel électrique pour atmosphères gazeuses,*
CEI 60335: *Sécurité des appareils électrodomestiques et analogues;*

et d'autres parties de la CEI 60034 y compris:

CEI 60034-5, CEI 60034-6, CEI 60034-7, CEI 60034-8, CEI 60034-9, CEI 60034-11, CEI 60034-12 et CEI 60034-14.

De plus, il peut être nécessaire de considérer la limitation de la température de surface et des caractéristiques similaires; voir par exemple la CEI 60335-1 (1991), article 11: Echauffement.

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Section 15: Safety

33 Safety

Rotating machines in accordance with this standard shall comply with the requirements of IEC 60204-1 unless otherwise specified in this standard, and be designed and constructed as far as possible in accordance with internationally accepted best design practice, appropriate to the application.

NOTE – It is the responsibility of the manufacturer or assembler of equipment incorporating electrical machines as components to ensure that the overall equipment is safe.

This may involve consideration of relevant product standards such as:

IEC 60079: *Electrical apparatus for explosive gas atmospheres,*
IEC 60335: *Safety of household and similar electrical appliances;*

and other parts of IEC 60034 including:

IEC 60034-5, IEC 60034-6, IEC 60034-7, IEC 60034-8, IEC 60034-9, IEC 60034-11, IEC 60034-12 and IEC 60034-14.

In addition, it may be necessary to consider limitation of the surface temperature and similar characteristics; see for example IEC 60335-1 (1991), clause 11: Heating.

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AVANT-PROPOS

Le présent amendement a été établi par le comité d'études 2 de la CEI: Machines tournantes.

Le texte de cet amendement est issu des documents suivants:

FDIS	Rapport de vote
2/956/FDIS	2/984/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cet amendement.

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INTRODUCTION

Cet amendement 1 est publié en parallèle avec un amendement équivalent 2 à la CEI 60034-1 (9e édition) de façon que le contenu technique des deux éditions reste le même.

Page 12

1.2 *Références normatives*

Insérer, dans la liste existante, les titres des normes suivantes:

CEI 60204-1: 1992, *Equipement électrique des machines industrielles – Partie 1: Règles générales*

CISPR 11: 1990, *Limites et méthodes de mesure des caractéristiques de perturbations électromagnétiques des appareils industriels, scientifiques et médicaux (ISM) à fréquence radioélectrique*

CISPR 14: 1993, *Limites et méthodes de mesure des perturbations radioélectriques produites par les appareils électrodomestiques ou analogues comportant des moteurs ou des dispositifs thermiques, par les outils et par les appareils électriques analogues*

CISPR 16: *Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques*

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8.2.4 *Machines à collecteur*

Remplacer la première phrase de ce paragraphe par la phrase suivante:

Une machine à collecteur doit être capable de supporter, pendant 60 s, 1,5 fois le courant assigné dans la combinaison appropriée des conditions suivantes:

Supprimer le point c).

FOREWORD

This amendment has been prepared by IEC technical committee 2: Rotating machinery.

The text of this amendment is based on the following documents:

FDIS	Report on voting
2/956/FDIS	2/984/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

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INTRODUCTION

This amendment 1 is issued in parallel with an equivalent amendment 2 to IEC 60034-1 (ninth edition) in order that the technical content of the two editions remains the same.

Page 13

1.2 *Normative references*

Insert, in the existing list, the titles of the following standards:

IEC 60204-1: 1992, *Electrical equipment of industrial machines – Part 1: General requirements*

CISPR 11: 1990, *Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment*

CISPR 14: 1993, *Limits and methods of measurement radio disturbance characteristics of electrical motor–operated and thermal appliances for household and similar purposes, electric tools and electric apparatus*

CISPR 16: *Specification for radio disturbance and immunity measuring apparatus and methods*

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8.2.4 *Commutator machines*

Replace the first sentence of this subclause by the following:

A commutator machine shall be capable of withstanding, for 60 s, 1,5 times rated current under the appropriate combination of conditions as follows:

Delete item c).

8.3.1 *Moteurs à induction polyphasés et moteurs à courant continu (sauf les moteurs qui font l'objet de 8.3.2)*

Remplacer le premier alinéa de ce paragraphe par l'alinéa suivant:

Les moteurs doivent, quels que soient leur service et leur réalisation, être capables de supporter, pendant 15 s, sans calage ni changement brusque de vitesse (sous une augmentation graduelle de couple), un excès du couple d'au moins 60 % de leurs valeurs assignées, la tension et la fréquence (moteur à induction) étant maintenues à leurs valeurs assignées.

NOTE – Pour certains moteurs fabriqués conformément à la CEI 60034-12, des couples plus importants sont nécessaires.

Pour les moteurs à courant continu, le couple doit être exprimé en termes de surintensité; voir 8.2.4.

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Ajouter les deux nouvelles sections suivantes:

Section 12: Compatibilité électromagnétique (CEM)

12.1 Compatibilité électromagnétique (CEM)

Les prescriptions qui suivent sont applicables aux machines électriques tournantes de tension assignée ne dépassant pas 1 000 V (courant alternatif) ou 1 500 V (courant continu) et sont destinées à fonctionner selon les conditions spécifiées ci-dessous.

Les composants électroniques qui sont montés à l'intérieur de la machine électrique tournante et qui sont essentiels pour son fonctionnement (par exemple les systèmes d'excitation tournants) font partie de la machine.

Les prescriptions qui sont applicables à un système d'entraînement final et à ses composants, par exemple un équipement électronique de puissance et de commande, des machines couplées, des appareils de contrôle, etc., qu'ils soient montés à l'intérieur ou à l'extérieur de la machine, sont hors du domaine d'application de cette norme.

Les limites de la section 6 sont établies pour des conditions de fonctionnement en régime établi. Les régimes transitoires (tels que le démarrage) ne sont pas couverts par le présent article.

12.1.1 *Limites d'immunité*

Les limites d'immunité des machines à courant alternatif et des machines à courant continu aux variations et aux harmoniques de tension du système connecté, et les limites d'immunité des machines à courant alternatif polyphasées aux déséquilibres du système connecté sont données à la section 6.

12.1.2 *Limites d'émission*

NOTE – Les limites dans les tableaux qui suivent sont tirées du CISPR 11 ou du CISPR 12.

8.3.1 *Polyphase induction motors and d.c. motors (excluding motors in 8.3.2)*

Replace the first paragraph of this subclause by the following:

The motors shall, whatever their duty and construction, be capable of withstanding for 15 s, without stalling or abrupt change in speed (under gradual increase of torque), an excess torque of at least 60 % of their rated torque, the voltage and frequency (induction motors) being maintained at their rated value.

NOTE – Higher torques are required for some motors manufactured according to IEC 60034-12.

For d.c. motors, the torque shall be expressed in terms of overload current; see 8.2.4.

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Add the following two new sections:

Section 12: Electromagnetic compatibility (EMC)

12.1 Electromagnetic compatibility (EMC)

The following requirements apply to rotating electrical machines with a rated voltage not exceeding 1 000 V a.c. or 1 500 V d.c., and which are intended for operation within the conditions specified below.

Electronic components mounted inside the rotating electrical machine and essential for its operation (for example rotating excitation devices) are part of the machine.

Requirements which are applicable to the final drive system and its components, for example power and control electronic equipment, coupled machines, monitoring devices, etc., whether mounted inside or outside the machine, are outside the scope of this standard.

The limitations of section 6 are fixed for steady-state operating conditions. Transients (such as starting) are not covered by this clause.

12.1.1 *Immunity limits*

The immunity limits of both a.c. and d.c. machines to variations and harmonics of the system voltage, and those of polyphase a.c. machines to unbalances of the connected system, are given in section 6.

12.1.2 *Emission limits*

NOTE – The limits in the tables that follow are taken from CISPR 11 or CISPR 12.

12.1.2.1 *Machines à induction*

Quand elles sont reliées à un système conformément à la section 6, les machines à induction ne produisent pas de rayonnements perturbateurs supérieurs aux limites

– du tableau 19 pour les machines avec rotors à cage ou avec rotors bobinés munies d'un dispositif de levage des balais et de court-circuit des bagues; ou

– du tableau 20 pour les machines fonctionnant en permanence avec bagues et balais en contact.

Les émissions de conduction sont intrinsèquement bien inférieures aux limites données au tableau 19.

12.1.2.2 *Machines synchrones*

Quand elles sont reliées à un système conformément à la section 6, les machines synchrones ne produisent pas de rayonnements perturbateurs supérieurs aux limites du tableau 19, pour les machines sans bagues ni balais, ou aux limites du tableau 20, pour les machines avec bagues et balais.

L'émission de conduction à basse fréquence est couverte par 8.9. Les émissions de conduction à fréquences supérieures sont intrinsèquement bien inférieures aux limites données au tableau 19.

Tableau 19 – Limites des perturbations électromagnétiques pour les machines fonctionnant sans balais

	Plages de fréquences	Limites
Rayonnement perturbateur	30 MHz à 230 MHz	30 dB(µV/m) quasi crête, mesuré à 10 m de distance[1)]
	230 MHz à 1 000 MHz	37 dB(µV/m) quasi crête, mesuré à 10 m de distance[1)]
Conduction perturbatrice aux bornes d'alimentation à courant alternatif	0,15 MHz à 0,5 MHz Les limites diminuent proportionnellement avec le logarithme de la fréquence.	66 à 56 dB(µV) quasi crête 56 à 46 dB(µV) moyenne
	0,5 MHz à 5 MHz	56 dB(µV) quasi crête 46 dB(µV) moyenne
	5 MHz à 30 MHz	60 dB(µV) quasi crête 50 dB(µV) moyenne
[1)] Peut être mesuré à une distance de 3 m, en augmentant les limites de 10 dB.		

12.1.2.3 *Machines à collecteur*

Les machines à courant continu, fonctionnant avec une tension lissée et les machines à collecteur à courant alternatif, fonctionnant sur un système conformément à la section 6, ne doivent pas rayonner de perturbations supérieures aux limites du tableau 20.

12.1.2.1 *Induction machines*

When connected to a system according to section 6, induction machines do not produce radiated disturbances higher than the limits in

– table 19 for machines with cage rotors or with wound rotors having brush-lifting and short-circuiting devices; or

– table 20 for machines with continuously running slip-rings.

Conducted emissions are inherently much lower than the limits given in table 19.

12.1.2.2 *Synchronous machines*

When connected to a system according to section 6, synchronous machines do not radiate disturbances higher than the limits of table 19 for brushless designs or of table 20 for designs with slip-rings.

The conducted low-frequency emission is covered by 8.9. Conducted emissions of higher frequencies are inherently much lower than the limits given in table 19.

Table 19 – Electromagnetic disturbance limits for machines operating without brushes

	Frequency range	Limits
Radiated disturbance	30 MHz to 230 MHz	30 dB(μV/m) quasi peak, measured at 10 m distance[1)]
	230 MHz to 1 000 MHz	37 dB(μV/m) quasi peak, measured at 10 m distance[1)]
Conducted disturbance on a.c. supply terminals	0,15 MHz to 0,5 MHz Limits decrease linearly with logarithm frequency.	66 to 56 dB(μV) quasi peak 56 to 46 dB(μV) average
	0,5 MHz to 5 MHz	56 dB(μV) quasi peak 46 dB(μV) average
	5 MHz to 30 MHz	60 dB(μV) quasi peak 50 dB(μV) average

[1)] May be measured at 3 m distance using the limits increased by 10 dB.

12.1.2.3 *Commutator machines*

DC machines operating on a smooth voltage and a.c. commutator motors operating on a system according to section 6 shall not radiate disturbances which are above the limits of table 20.

Les émissions de conduction des machines à collecteur à courant alternatif doivent être inférieures aux limites du tableau 20. Les émissions de conduction des machines à courant continu ne sont pas à considérer car ces machines ne sont pas directement reliées à l'alimentation à courant alternatif.

Tableau 20 – Limites des perturbations électromagnétiques pour les machines fonctionnant avec balais

	Plages de fréquences	Limites
Rayonnement perturbateur	30 MHz à 230 MHz	30 dB(µV/m) quasi crête, mesuré à 30 m de distance[1)]
	230 MHz à 1 000 MHz	37 dB(µV/m) quasi crête, mesuré à 30 m de distance[1)]
Conduction perturbatrice aux bornes d'alimentation à courant alternatif	0,15 MHz à 0,50 MHz	79 dB(µV) quasi crête 66 dB(µV) moyenne
	0,50 MHz à 30 MHz	73 dB(µV) quasi crête 60 dB(µV) moyenne
[1)] Peut être mesuré à une distance de 10 m en augmentant les limites de 10 dB, ou à une distance de 3 m en augmentant les limites de 20 dB.		

12.1.3 *Essais*

12.1.3.1 *Essais d'immunité*

Des essais d'immunité ne sont pas exigés pour démontrer la conformité au présent article.

12.1.3.2 *Essais d'émission*

Pour les machines synchrones de puissance supérieure ou égale à 300 kW (ou kVA), des essais de type d'émission de conduction à basse fréquence doivent être effectués pour vérifier la conformité à 8.9.2.

Pour les machines à collecteur à courant alternatif, des essais de type en charge doivent être effectués pour l'émission de conduction et l'émission de rayonnement afin de vérifier la conformité à 12.1.2.3.

Pour les machines à collecteur à courant continu, des essais de type en charge doivent être effectués pour l'émission de rayonnement afin de vérifier la conformité à 12.1.2.3.

Les essais doivent être conduits suivant le CISPR 11, le CISPR 14 et le CISPR 16, selon le cas.

Aucun autre essai n'est exigé afin de démontrer la conformité au présent article.

Conducted emissions from a.c. commutator machines shall be below the levels of table 20. Conducted emissions from d.c. machines are irrelevant since these machines are not directly connected to the a.c. supply.

Table 20 – Electromagnetic disturbance limits for machines operating with brushes

	Frequency range	Limits
Radiated disturbance	30 MHz to 230 MHz	30 dB(μV/m) quasi peak, measured 30 m distance[1)]
	230 MHz to 1 000 MHz	37 dB(μV/m) quasi peak, measured 30 m distance[1)]
Conducted disturbance on a.c. supply terminals	0,15 MHz to 0,50 MHz	79 dB(μV) quasi peak 66 dB(μV) average
	0,50 MHz to 30 MHz	73 dB(μV) quasi peak 60 dB(μV) average

[1)] May be measured at 10 m distance using the limits increased by 10 dB or measured at 3 m distance using the limits increased by 20 dB.

12.1.3 *Tests*

12.1.3.1 *Immunity tests*

Immunity tests are not required to demonstrate compliance with this clause.

12.1.3.2 *Emission tests*

For synchronous machines having outputs of 300 kW (or kVA) or more, type tests for conducted low-frequency emission shall be carried out to verify compliance with 8.9.2.

For a.c. commutator machines, type tests on load for conducted and radiated emission shall be carried out to verify compliance with 12.1.2.3.

For d.c. commutator machines, type tests on load for radiated emission shall be carried out to verify compliance with 12.1.2.3.

The tests shall be carried out in accordance with CISPR 11, CISPR 14, and CISPR 16 as applicable.

No other tests are required to demonstrate compliance with this clause.

Section 13: Sécurité

13.1 **Sécurité**

Les machines tournantes conformes à la présente norme doivent satisfaire aux exigences de la CEI 60204-1, sauf spécification contraire dans la présente norme, et dans la mesure du possible, elles doivent également être conçues et construites selon la meilleure forme de conception internationalement acceptée, selon l'application.

NOTE – Il est de la responsabilité du constructeur ou de l'assembleur de l'équipement incorporant des machines électriques de s'assurer que l'équipement complet est sûr.

Cela peut conduire à prendre en considération des normes de produits applicables telles que:

CEI 60079: *Matériel électrique pour atmosphères gazeuses,*
CEI 60335: *Sécurité des appareils électrodomestiques et analogues;*

et d'autres parties de la CEI 60034 y compris:

CEI 60034-5, CEI 60034-6, CEI 60034-7, CEI 60034-8, CEI 60034-9, CEI 60034-11, CEI 60034-12 et CEI 60034-14.

De plus, il peut être nécessaire de considérer la limitation de la température de surface et des caractéristiques similaires; voir par exemple la CEI 600335-1 (1991), article 11: Echauffement.

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Annexe B

Ajouter à la liste existante les références croisées suivantes:

Neuvième édition ⟶ Dixième édition

14	12
[11]	[19]
[12]	[20]
15	13

Dixième édition ⟶ Neuvième édition

12	14
[19]	[11]
[20]	[12]
13	15

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Section 13: Safety

13.1 **Safety**

Rotating machines in accordance with this standard shall comply with the requirements of IEC 60204-1 unless otherwise specified in this standard, and be designed and constructed as far as possible in accordance with internationally accepted best design practice, appropriate to the application.

NOTE – It is the responsibility of the manufacturer or assembler of equipment incorporating electrical machines as components to ensure that the overall equipment is safe.

This may involve consideration of relevant product standards such as:

IEC 60079: *Electrical apparatus for explosive gas atmospheres,*
IEC 60335: *Safety of household and similar electrical appliances;*

and other parts of IEC 60034 including:

IEC 60034-5, IEC 60034-6, IEC 60034-7, IEC 60034-8, IEC 60034-9, IEC 60034-11, IEC 60034-12 and IEC 60034-14.

In addition, it may be necessary to consider limitation of the surface temperature and similar characteristics; see for example IEC 60335-1 (1991), clause 11: Heating.

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Annex B

Add to the existing list the following cross references:

Edition 9 ⟶ Edition 10

14	12
[11]	[19]
[12]	[20]
15	13

Edition 10 ⟶ Edition 9

12	14
[19]	[11]
[20]	[12]
13	15

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Publications de la CEI préparées par le Comité d'Etudes n° 2

60034: — Machines électriques tournantes.

60034-1 (1996)	Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement. Amendement 1 (1997).
60034-2 (1972)	Deuxième partie: Méthodes pour la déter-mination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines pour véhicules de traction). Amendement 1 (1995). Amendement 2 (1996).
60034-2A (1974)	Premier complément: Mesure des pertes par la méthode calorimétrique.
60034-3 (1988)	Troisième partie: Règles spécifiques pour les turbo-machines synchrones.
60034-4 (1985)	Quatrième partie: Méthodes pour la détermination à partir d'essais des grandeurs des machines synchrones. Amendement 1 (1995).
60034-5 (1991)	Cinquième partie: Classification des degrés de protection procurés par les enveloppes des machines électriques tournantes (Code IP).
60034-6 (1991)	Partie 6: Modes de refroidissement (Code IC).
60034-7 (1992)	Partie 7: Classification des formes de construction et des dispositions de montage (Code IM).
60034-8 (1972)	Huitième partie: Marques d'extrémités et sens de rotation des machines tournantes. Amendement n° 1 (1990). Amendement 2 (1996).
60034-9 (1990)	Neuvième partie: Limites de bruit. Amendement 1 (1995).
60034-10 (1975)	Dixième partie: Conventions relatives à la description des machines synchrones.
60034-11 (1978)	Onzième partie: Protection thermique incorporée – Chapitre l: Règles concernant la protection des machines électriques tournantes.
60034-11-2 (1984)	Chapitre 2: Détecteurs thermiques et auxiliaires de commande utilisés dans les dispositifs de protection thermique. Modification n° 1 (1990).
60034-11-3 (1984)	Chapitre 3: Règles générales concernant les protecteurs thermiques utilisés dans les dispositifs de protection thermique.
60034-12 (1980)	Douzième partie: Caractéristiques de démarrage des moteurs triphasés à induction à cage à une seule vitesse pour des tensions d'alimentation inférieures ou égales à 660 V. Amendement n° 1 (1992). Amendement 2 (1995).
60034-13 (1980)	Treizième partie: Spécification pour les moteurs auxiliaires pour laminoirs.
60034-14 (1996)	Partie 14: Vibrations mécaniques de certaines machines de hauteur d'axe supérieure ou égale à 56 mm – Mesurage, évaluation et limites de la vibration.
60034-15 (1995)	Partie 15: Niveaux de tension de tenue au choc des machines tournantes à courant alternatif à bobines stator préformées.
60034-16-1 (1991)	Seizième partie: Systèmes d'excitation pour machines synchrones – Chapitre 1: Définitions.

(suite)

IEC publications prepared by Technical Committee No. 2

60034: — Rotating electrical machines.

60034-1 (1996)	Part l: Rating and performance. Amendment 1 (1997).
60034-2 (1972)	Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles). Amendment 1 (1995). Amendment 2 (1996).
60034-2A (1974)	First supplement: Measurement of losses by the calorimetric method.
60034-3 (1988)	Part 3: Specific requirements for turbine-type synchronous machines.
60034-4 (1985)	Part 4: Methods for determining synchronous machine quantities from tests. Amendment 1 (1995).
60034-5 (1991)	Part 5: Classification of degrees of protection provided by enclosures for rotating electrical machines (IP Code).
60034-6 (1991)	Part 6: Methods of cooling (IC Code).
60034-7 (1992)	Part 7: Classification of types of constructions and mounting arrangements (IM Code).
60034-8 (1972)	Part 8: Terminal markings and direction of rotation of rotating machines. Amendment No. 1 (1990). Amendment 2 (1996).
60034-9 (1990)	Part 9: Noise limits. Amendment 1 (1995).
60034-10 (1975)	Part 10: Conventions for description of synchronous machines.
60034-11 (1978)	Part 11: Built-in thermal protection. Chapter l: Rules for protection of rotating electrical machines.
60034-11-2 (1984)	Chapter 2: Thermal detectors and control units used in thermal protection systems. Amendment No. 1 (1990).
60034-11-3 (1984)	Chapter 3: General rules for thermal protectors used in thermal protection systems.
60034-12 (1980)	Part l2: Starting performance of single-speed three-phase cage induction motors for voltages up to and including 660 V. Amendment No. 1 (1992). Amendment 2 (1995).
60034-13 (1980)	Part 13: Specification for mill auxiliary motors.
60034-14 (1996)	Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of the vibration.
60034-15 (1995)	Part 15: Impulse voltage withstand levels of rotating a.c. machines with form-wound stator coils.
60034-16-1 (1991)	Part 16: Excitation systems for synchronous machines – Chapter 1: Definitions.

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 2 *(suite)*

60034-16-2 (1991) Chapitre 2: Modèle pour les études de réseau.

60034-16-3 (1996) Section 3: Performances dynamiques.

60034-17 (1992) Partie 17: Guide d'application des moteurs à induction à cage alimentés par convertisseurs.

60034-18: — Evaluations fonctionnelles des systèmes d'isolation.

60034-18-1 (1992) Section 1: Principes directeurs généraux.
Amendement 1 (1996).

60034-18-21 (1992) Section 21: Procédures d'essai pour enroulements à fils – Evaluation thermique et classification.
Amendement 1 (1994).
Amendement 2 (1996).

60034-18-22 (1996) Section 22: Procédures d'essai pour enroulements à fils – Classification des modifications et des substitutions de composants d'isolation.

60034-18-31 (1992) Section 31: Procédures d'essai pour enroulements préformés – Evaluation thermique et classification des systèmes d'isolation utilisés dans les machines jusqu'à et y compris 50 MVA et 15 kV.
Amendement 1 (1996).

60034-18-32 (1995) Section 32: Procédures d'essai pour enroulements préformés – Evaluation électrique des systèmes d'isolation utilisés dans les machines jusqu'à et y compris 50 MVA et 15 kV.

60034-18-33 (1995) Section 33: Procédures d'essai pour enroulements préformés – Evaluation fonctionnelle à plusieurs facteurs – Endurance sous contrainte thermique et électrique combinée des systèmes d'isolation utilisés dans les machines jusqu'à et y compris 50 MVA et 15 kV.

60034-19 (1995) Partie 19: Méthodes spécifiques d'essai pour machines à courant continu à alimentation conventionnelle ou redressée.

60034-22 (1996) Partie 22: Génératrices à courant alternatif pour moteurs à combustion interne et à pistons.

60072: — Dimensions et séries de puissances des machines électriques tournantes.

60072-1 (1991) Partie 1: Désignation des carcasses entre 56 et 400 et des brides entre 55 et 1 080.

60072-2 (1990) Partie 2: Désignation des carcasses entre 355 et 1 000 et des brides entre 1 180 et 2 360.

60072-3 (1994) Partie 3: Petits moteurs incorporés – Désignation des brides BF10 à BF50.

60136 (1986) Dimensions des balais et porte-balais pour machines électriques.
Amendement 1 (1995).

60276 (1968) Définitions et nomenclature des balais de charbon, des porte-balais, des collecteurs et des bagues.
Modification n° 1 (1987).

60279 (1969) Mesure de la résistance des enroulements d'une machine à courant alternatif en fonctionnement sous tension alternative.

60356 (1971) Dimensions des collecteurs et des bagues.

60413 (1972) Méthodes d'essai pour la mesure des propriétés physiques des matières de balais pour machines électriques.

60560 (1977) Définitions et terminologie des porte-balais de machines électriques.

(suite)

IEC publications prepared by Technical Committee No. 2 *(continued)*

60034-16-2 (1991) Chapter 2: Models for power system studies.

60034-16-3 (1996) Section 3: Dynamic performance

60034-17 (1992) Part 17: Guide for application of cage induction motors when fed from converters.

60034-18: — Functional evaluation of insulation systems.

60034-18-1 (1992) Section 1: General guidelines.
Amendment 1 (1996).

60034-18-21 (1992) Section 21: Test procedures for wire-wound windings – Thermal evaluation and classification
Amendment 1 (1994).
Amendment 2 (1996).

60034-18-22 (1996) Section 22: Test procedures for wire-wound windings – Classification of changes and insulation component substitutions.

60034-18-31 (1992) Section 31: Test procedures for form-wound windings – Thermal evaluation and classification of insulation systems used in machines up to and including 50 MVA and 15 kV.
Amendment 1 (1996).

60034-18-32 (1995) Section 32: Test procedures for form-wound windings – Electrical evaluation of insulation systems used in machines up to and including 50 MVA and 15 kV.

60034-18-33 (1995) Section 33: Test procedures for form-wound windings – Multifactor functional evaluation – Endurance under combined thermal and electrical stresses of insulation systems used in machines up to and including 50 MVA and 15 kV

60034-19 (1995) Part 19: Specific test methods for d.c. machines on conventional and rectifier-fed supplies.

60034-22 (1996) Part 22: AC generators for reciprocating internal combustion (RIC) engine driven generating sets.

60072: — Dimensions and output series for rotating electrical machines.

60072-1 (1991) Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1 080.

60072-2 (1990) Part 2: Frame numbers 355 to 1 000 and flange numbers 1 180 to 2 360.

60072-3 (1994) Part 3: Small built-in motors – Flange numbers BF10 to BF50.

60136 (1986) Dimensions of brushes and brush-holders for elec-trical machinery.
Amendment 1 (1995).

60276 (1968) Definitions and nomenclature for carbon brushes, brush-holders, commutators and slip-rings.
Amendment No. 1 (1987).

60279 (1969) Measurement of the winding resistance of an a.c. machine during operation at alternating voltage.

60356 (1971) Dimensions for commutators and slip-rings.

60413 (1972) Test procedures for determining physical properties of brush materials for electrical machines.

60560 (1977) Definitions and terminology of brush-holders for electrical machines.

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 2 *(suite)*

60681: — Dimensions des moteurs de faible puissance pour applications particulières.

60681-1 (1980) Première partie: Moteurs pour brûleurs à mazout.

60773 (1983) Méthodes d'essai et appareils pour la mesure des propriétés opérationnelles des balais.

60778 (1984) Porte-balais pour bagues, groupe R – exécution RA.

60842 (1988) Guide pour l'application et l'exploitation des machines synchrones à rotor lisse utilisant l'hydrogène comme fluide de refroidissement.

60892 (1987) Effets de tensions déséquilibrées sur les caractéristiques de fonctionnement des moteurs asynchrones triphasés à cage.

60894 (1987) Guide de procédure d'essai pour la mesure de la tangente de l'angle de pertes de bobines et barres d'enroulements des machines.

60991 (1989) Bagues de montage élastiques pour petits moteurs – Dimensions de montage.

61015 (1990) Porte-balais de machines électriques. Guide pour la mesure de la poussée statique appliquée aux balais.

IEC publications prepared by Technical Committee No. 2 *(continued)*

60681: — Dimensions of small power motors for definite purpose application.

60681-1 (1980) Part 1: Oil burner motors.

60773 (1983) Test methods and apparatus for the measurement of the operational characteristics of brushes.

60778 (1984) Brush-holders for slip-rings, Group R – type RA.

60842 (1988) Guide for application and operation of turbine-type synchronous machines using hydrogen as a coolant.

60892 (1987) Effects of unbalanced voltages on the performance of 3-phase cage induction motors.

60894 (1987) Guide for test procedure for the measurement of loss tangent on coils and bars for machine windings.

60991 (1989) Resilient mounting rings for small motors – Mounting dimensions.

61015 (1990) Brush-holders for electrical machines. Guide to the measurement of the static thrust applied to brushes.

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AMENDMENT 2
1999-05

Amendement 2

Machines électriques tournantes –

Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement

Amendment 2

Rotating electrical machines –

Part 1: Rating and performance

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AVANT-PROPOS

Le présent amendement a été établi par le comité d'études 2 de la CEI: Machines tournantes.

Le texte de cet amendement est issu des documents suivants:

FDIS	Rapports de vote
2/1031/FDIS 2/1055/FDIS 2/1056/FDIS	2/1058/RVD 2/1070/RVD 2/1071/RVD

Les rapports de vote indiqués dans le tableau ci-dessus donnent toute information sur le vote ayant abouti à l'approbation de cet amendement.

_____

SOMMAIRE

Page 4

Remplacer le titre de l'article 8.1 par le nouveau titre suivant:

8.1 Essais de tension de tenue

Page 12

1.2 Références normatives

Ajouter à la liste existante les titres des normes suivantes:

CEI 60060, *Techniques des essais à haute tension*

CEI 60060-1:1989, *Techniques des essais à haute tension – Partie 1: Définitions et prescriptions générales relatives aux essais*

CEI 61293:1994, *Marquage des matériels électriques avec des caractéristiques assignées relatives à l'alimentation électrique – Prescriptions de sécurité*

Page 14

2.1 valeur assignée

Ajouter la note suivante:

NOTE – La tension assignée ou plage de tensions assignées est la tension assignée ou plage de tensions assignées entre phases aux bornes.

FOREWORD

This amendment has been prepared by IEC technical committee 2: Rotating machinery.

The text of this amendment is based on the following documents:

FDIS	Reports on voting
2/1031/FDIS 2/1055/FDIS 2/1056/FDIS	2/1058/RVD 2/1070/RVD 2/1071/RVD

Full information on the voting for the approval of this amendment can be found in the reports on voting indicated in the above table.

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CONTENTS

Page 5

Replace the title of clause 8.1 by the following new title:

8.1 Withstand voltage test

Page 13

1.2 Normative references

Insert in the existing list the title of the following standards:

IEC 60060, *High-voltage test techniques*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 61293:1994, *Marking of electrical equipment with ratings related to electrical supply – Safety requirements*

Page 15

2.1 rated value

Add the following note:

NOTE – The rated voltage or voltage range is the rated voltage or voltage range between lines at the terminals.

Page 18

2.25 équilibre thermique

Ajouter la note suivante:

NOTE – On peut déterminer l'équilibre thermique à partir d'un tracé de l'échauffement en fonction du temps, lorsque les droites entre points pris en début et fin de chacun de deux intervalles de temps raisonnables successifs ont une pente de moins de 2 K par heure.

Page 20

3.2 Services types

Supprimer l'alinéa qui suit ce titre.

Page 26

4.1 Attribution des caractéristiques assignées

Remplacer le deuxième alinéa de cet article par le texte suivant:

Quand des composants auxiliaires (tels que des inductances, des capacités, etc.) sont insérés par le fabricant en tant qu'éléments de la machine, les valeurs assignées doivent se rapporter aux bornes d'alimentation de l'ensemble complet.

Page 28

4.2.3 Caractéristiques assignées pour service périodique

Pas de changement dans le texte français.

Page 30

4.2.6 Caractéristiques assignées pour charge équivalente

Remplacer le texte de ce paragraphe par le texte suivant:

Caractéristiques assignées auxquelles, à des fins d'essais, la machine peut fonctionner à charge constante jusqu'à ce que l'équilibre thermique soit atteint et qui conduisent au même échauffement de l'enroulement statorique qu'à la fin de l'essai en services type.

NOTE – Pour déterminer des caractéristiques assignées du type équivalent, il convient de prendre en compte les charge, vitesse et refroidissement variables du cycle de service.

Le cas échéant, cette classe de caractéristiques assignées est désignée «équ».

Page 19

2.25 thermal equilibrium

Add the following note:

NOTE – Thermal equilibrium may be determined from the time-temperature rise plot when the straight lines between points at the beginning and end of two successive reasonable intervals each have a gradient of less than 2 K per hour.

Page 21

3.2 Duty types

Delete the paragraph under this heading.

Page 27

4.1 Assignment of rating

Replace the second paragraph of this clause with the following new paragraph:

When accessory components (such as reactors, capacitors, etc.) are connected by the manufacturer as part of the machine, the rated values shall refer to the supply terminals of the whole arrangement.

Page 29

4.2.3 Rating for periodic duty

Replace the third paragraph of this subclause with the following new paragraph:

Unless otherwise specified, the duration of a duty cycle shall be 10 min and the cyclic duration factor shall be one of the following values:

15 %, 25 %, 40 %, 60 %.

Page 31

4.2.6 Rating for equivalent loading

Replace the text of this subclause with the following new text:

A rating, for test purposes, at which the machine may be operated at constant load until thermal equilibrium is reached and which results in the same stator winding temperature rise as at the end of the test on the specified duty type.

NOTE – The determination of an equivalent rating should take account of the varying load, speed and cooling of the duty cycle.

This class of rating, if applied, is designated 'equ'.

4.5.2 Alternateurs

Remplacer le deuxième alinéa de ce paragraphe par le texte suivant:

Le facteur de puissance assigné des alternateurs synchrones doit être de 0,8 surexcité, sauf spécification contraire de l'acheteur.

Page 32

4.6 Tension assignée

4.6.1 Généralités

Supprimer ce paragraphe et renuméroter les paragraphes 4.6.2 et 4.6.3 en 4.6.1 et 4.6.2 repectivement.

Page 36

6.1 Alimentation électrique

Supprimer le premier alinéa.

Remplacer le deuxième alinéa et la note de cet article par les textes suivants:

Pour les machines triphasées à courant alternatif, 50 Hz ou 60 Hz, destinées à être directement reliées à un réseau de distribution ou d'utilisation, les tensions assignées doivent être déduites des tensions nominales données dans la CEI 60038.

NOTE – Pour les machines à courant alternatif de forte puissance à haute tension, les tensions peuvent être choisies pour l'obtention de caractéristiques de fonctionnement optimales.

Page 40

6.2.4 Moteurs à courant continu alimentés par convertisseurs statiques de puissance

Supprimer la note de ce paragraphe, en page 42.

Page 44

6.4 Machines triphasées à courant alternatif fonctionnant sur réseaux isolés

Remplacer le texte de cet article par le texte suivant:

Les machines triphasées à courant alternatif doivent être capables de fonctionner en marche continue avec le neutre à un potentiel proche ou égal à celui de la terre. Elles doivent être aussi capables de fonctionner sur des réseaux isolés ayant une phase au potentiel de la terre pendant des périodes de courtes durées très peu fréquentes, par exemple telles que nécessaires pour affranchir normalement le défaut. S'il est prévu de faire fonctionner la machine en permanence, ou pendant de longues périodes, dans ces conditions, il est indispensable de prévoir une machine spéciale avec le niveau d'isolement approprié.

4.5.2 AC generators

Replace the second paragraph of this subclause with the following new paragraph:

The rated power factor for synchronous generators shall be 0,8 lagging (over-excited), unless otherwise specified by the purchaser.

Page 33

4.6 Rated voltage

4.6.1 General

Delete this subclause and renumber subclauses 4.6.2 and 4.6.3 as 4.6.1 and 4.6.2, respectively.

Page 37

6.1 Electrical supply

Delete the first paragraph.

Replace the second paragraph and note with the following new paragraph and note:

For three-phase a.c. machines, 50 Hz or 60 Hz, intended to be directly connected to distribution or utilisation systems, the rated voltages shall be derived from the nominal voltages given in IEC 60038.

NOTE – For large high-voltage a.c. machines, the voltages may be selected for optimum performance.

Page 41

6.2.4 DC motors supplied from static power converters

Delete the note of this subclause on page 43.

Page 45

6.4 Three-phase a.c. machines operating on unearthed systems

Replace the existing clause with the following new clause:

Three-phase a.c. machines shall be suitable for continuous operation with the neutral at or near earth potential. They shall also be suitable for operation on unearthed systems with one line at earth potential for infrequent periods of short duration, for example as required for normal fault clearance. If it is intended to run the machine continuously or for prolonged periods in this condition, a machine with a level of insulation suitable for this condition will be required.

Si les enroulements n'ont pas une isolation identique côté phase et côté neutre, cela doit être spécifié par le constructeur.

NOTE – Il convient que la mise à la terre ou l'interconnexion des points neutres de machines ne soit jamais effectuée sans consultation des constructeurs des machines, à cause des dangers de circulation de courants homopolaires de toutes fréquences dans certaines conditions de fonctionnement et des risques d'incidents mécaniques sur les enroulements lors de défauts entre phase et neutre.

Page 50

7.4 Echauffement d'un élément de machine

Remplacer les deuxième et troisième alinéas de cet article par le texte suivant:

Pour la comparaison avec les limites des échauffements (voir tableau 6 ou 7) ou des températures (voir tableau 11), lorsque cela est possible la température doit être mesurée immédiatement avant qu'on arrête la machine à la fin de l'essai thermique, comme cela est défini à l'article 7.7.

Lorsque cela n'est pas possible, par exemple lors du mesurage direct par la méthode de variation de résistance, voir 7.6.2.3.

7.5.3 Méthode par thermomètre

Remplacer le texte de ce paragraphe par le nouveau texte suivant:

La température est mesurée au moyen de thermomètres appliqués sur les surfaces accessibles de la machine terminée. Le terme «thermomètre» s'applique non seulement aux thermomètres à réservoir, mais aussi aux couples thermoélectriques et thermomètres à résistance externes. Lorsque des thermomètres à réservoir sont utilisés en des points où il existe un champ magnétique intense, variable ou mobile, des thermomètres à alcool doivent être utilisés de préférence aux thermomètres à mercure.

Page 52

7.6.1 Choix de la méthode

Supprimer le point d) du sixième alinéa.

Page 58

7.6.4 Détermination par la méthode du thermomètre

Remplacer le texte de ce paragraphe par le nouveau texte suivant:

Lorsqu'on utilise un couple thermoélectrique ou thermomètre à résistance externe, il ne doit pas être placé à un point inaccessible à un thermomètre à réservoir.

On doit s'efforcer, autant que cela est compatible avec la sécurité, de placer les thermomètres aux points présumés les plus chauds (par exemple dans les développantes à proximité du circuit magnétique) de façon qu'ils soient efficacement protégés du contact avec le fluide de refroidissement primaire et qu'ils soient en bon contact thermique avec l'enroulement ou autre élément de machine.

If the winding does not have the same insulation at the line and neutral ends, this shall be stated by the manufacturer.

NOTE – The earthing or interconnection of the machine's neutral points should not be undertaken without consulting the machine manufacturer because of the danger of zero-sequence components of currents of all frequencies under some operating conditions and the risk of mechanical damage to the windings under line-to-neutral fault conditions.

Page 51

7.4 Temperature rise of a part of a machine

Replace the second and third paragraphs of this clause with the following text:

For comparison with the limits of temperature rise (see table 6 or 7) or of temperature (see table 11), when possible, the temperature shall be measured immediately before the machine is shut down at the end of the thermal test, as described in clause 7.7.

When this is not possible, e.g. when using the direct measurement of resistance method, see 7.6.2.3.

7.5.3 Thermometer method

Replace the existing subclause with the following new subclause:

The temperature is determined by thermometers applied to accessible surfaces of the completed machine. The term 'thermometer' includes not only bulb-thermometers, but also non-embedded thermocouples and resistance thermometers. When bulb-thermometers are used in places where there is a strong varying or moving magnetic field, alcohol thermometers shall be used in preference to mercury thermometers.

Page 53

7.6.1 Choice of method

Delete indent d) from the enumeration in the sixth paragraph.

Page 59

7.6.4 Determination by the thermometer method

Replace the existing subclause with the following new subclause:

When a non-embedded thermocouple or a resistance thermometer is used, it shall not be placed at a point inaccessible to a bulb thermometer.

All reasonable efforts, consistent with safety, shall be made to place thermometers at the point, or points where the highest temperatures are likely to occur (e.g. in the end windings close to the core iron) in such a manner that they are effectively protected against contact with the primary coolant and are in good thermal contact with the winding or other part of the machine.

Quel que soit le thermomètre, la lecture la plus élevée doit être prise comme valeur de la température de l'enroulement ou de l'élément de machine.

7.8 Détermination de la constante de temps thermique équivalente des machines pour service type S9

Supprimer la note de cet article, en page 60.

Page 62

7.10.1 Enroulements à refroidissement indirect

Remplacer le troisième alinéa de ce paragraphe, y compris le texte en retrait, par le nouveau texte suivant:

En cas de lectures par thermomètre effectuées selon 7.6.1, la limite d'échauffement doit être conforme au tableau 6.

Page 64

Tableau 6 – Limites d'échauffement des enroulements à refroidissement indirect par l'air

Remplacer le tableau existant par le nouveau tableau suivant:

The highest reading from any thermometer shall be taken to be the temperature of the winding or other part of the machine.

7.8 Determination of the thermal equivalent time constant for machines of duty type S9

Delete the note of this clause on page 61.

Page 63

7.10.1 Indirect cooled windings

Replace the third paragraph of this subclause, including the enumeration with the following new paragraph:

In the case of thermometer readings made in accordance with 7.6.1, the limit of temperature rise shall be according to table 6.

Page 65

Table 6 – Limits of temperature rise of windings indirectly cooled by air

Replace the existing table with the following new table:

Tableau 6 – Limites d'échauffement des enroulements à refroidissement indirect par l'air

	Classification thermique	**A**			**E**			**B**			**F**			**H**		
	Méthode de mesure Th = Thermomètre, R = Résistance, IIT = Indicateur interne de température	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K	**Th** K	**R** K	**IIT** K
Point	**Partie de la machine**															
1a)	Enroulements à courant alternatif de machines de puissance supérieure ou égale à 5 000 kW (ou kVA)	–	60	65[1)]	–	–	–	–	80	85[1)]	–	100	105[1)]	–	125	130[1)]
1b)	Enroulements à courant alternatif de machnes de puissance supérieure à 200 kW (ou kVA), mais inférieure à 5 000 kW (ou kVA)	–	60	65[1)]	–	75	–	–	80	90[1)]	–	105	110[1)]	–	125	130[1)]
1c)	Enroulements à courant alternatif de machines de puissance inférieure ou égale à 200 kW (ou kVA) autres que ceux des points 1d) ou 1e)[2)]	–	60	–	–	75	–	–	80	–	–	105	–	–	125	–
1d)	Enroulements à courant alternatif de machines de puissance inférieure à 600 W (ou VA)[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
1e)	Enroulements à courant alternatif de machines qui sont refroidies naturellement, sans ventilateur (IC40) et/ou à enroulements enrobés[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
2	Enroulements d'induit reliés à des collecteurs	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
3	Enroulements d'excitation à courant continu des machines à courant alternatif et à courant continu, autres que ceux du point 4	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
4a)	Enroulements d'excitation à courant continu des machines synchrones à rotor cylindrique, dont un enroulement est logé dans l'encoche, excepté les moteurs synchrones à induction	–	–	–	–	–	–	–	90	–	–	110	–	–	135	–
4b)	Enroulements isolés fixes d'excitation à plus d'une couche des machines à courant continu	50	60	–	65	75	–	70	80	90	85	105	110	105	125	135
4c)	Enroulements d'excitation de faible résistance ayant plus d'une couche des machines à courant alternatif et à courant continu, et enroulements de compensation des machines à courant continu	60	60	–	75	75	–	80	80	–	100	100	–	125	125	–
4d)	Enroulements à une seule couche des machines à courant alternatif et à courant continu avec surfaces exposées nues ou en métal verni[3)]	65	65	–	80	80	–	90	90	–	110	110	–	135	135	–

[1)] Une correction peut être effectuée dans le cas des enroulements à courant alternatif à haute tension (voir point 4 du tableau 8).

[2)] Lors de l'application de la méthode d'essai par superposition à des enroulements de machines de puissance inférieure ou égale à 200 kW (ou kVA) avec des classes thermiques A, B, E et F, les limites des échauffements prévues pour la méthode par variation de résistance peuvent être dépassées de 5 K.

[3)] Comprend également les enroulements à plusieurs couches, à condition que les couches inférieures soient chacune en contact avec le fluide de refroidissement primaire en circulation.

Table 6 – Limits of temperature rise of windings indirectly cooled by air

Thermal classification		A			E			B			F			H		
Method of measurement Th = Thermometer, R = Resistance, ETD = Embedded temperature detector		Th K	R K	ETD K	Th K	R K	ETD K	Th K	R K	ETD K	Th K	R K	ETD K	Th K	R K	ETD K
Item	**Part of machine**															
1a)	AC windings of machines having outputs of 5 000 kW (or kVA) or more	–	60	65[1)]	–	–	–	–	80	85[1)]	–	100	105[1)]	–	125	130[1)]
1b)	AC windings of machines having outputs above 200 kW (or kVA), but less than 5 000 kW (or kVA)	–	60	65[1)]	–	75	–	–	80	90[1)]	–	105	110[1)]	–	125	130[1)]
1c)	AC windings of machines having outputs of 200 kW (or kVA) or less, other than those in items 1d) or 1e)[2)]	–	60	–	–	75	–	–	80	–	–	105	–	–	125	–
1d)	AC windings of machines having rated outputs of less than 600 W (or VA)[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
1e)	AC windings which are self-cooled without a fan (IC 40) and/or with encapsulated windings[2)]	–	65	–	–	75	–	–	85	–	–	110	–	–	130	–
2	Windings of armatures having commutators	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
3	Field windings of a.c. and d.c. machines other than those in item 4	50	60	–	65	75	–	70	80	–	85	105	–	105	125	–
4a)	Field windings of synchronous machines with cylindrical rotors having a d.c. excitation winding embedded in slots, except synchronous induction motors	–	–	–	–	–	–	–	90	–	–	110	–	–	135	–
4b)	Insulated stationary field windings of d.c. machines having more than one layer	50	60	–	65	75	–	70	80	90	85	105	110	105	125	135
4c)	Low-resistance field windings of a.c. and d.c. machines having more than one layer and compensating windings of d.c. machines	60	60	–	75	75	–	80	80	–	100	100	–	125	125	–
4d)	Single-layer windings of a.c. and d.c. machines with exposed bare or varnished metal surfaces.[3)]	65	65	–	80	80	–	90	90	–	110	110	–	135	135	–

[1)] An adjustment for high-voltage a.c. windings may be applicable to these items, (see item 4 of table 8).

[2)] With the application of the superposition test method to windings of machines rated at 200 kW (or kVA) or less with thermal classes A, B, E and F, the limits of temperature rise given for the resistance method may be exceeded by 5 K.

[3)] Also includes multiple layer windings provided that the under layers are each in contact with the circulating primary coolant.

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Tableau 8

Remplacer les points 1 et 4 du tableau 8 par ce qui suit:

1	Température maximale de l'air ambiant ou de l'air à l'entrée de la machine (θ_c)	0 °C ≤ θ_c ≤ 40 °C	Peuvent être augmentées par accord, mais cette augmentation ne doit dépasser ni la différence de température entre la température du fluide de refroidissement et 40 °C, ni un maximum de 30 K.
		40 °C < θ_c ≤ 60 °C	Réduites de la différence entre la température du fluide de refroidissement et 40 °C
		θ_c < 0 °C ou θ_c > 60 °C	Par accord
4	Tension assignée (U_N)	11 kV < U_N ≤ 17 kV	$\Delta\theta$, pour les indicateurs internes de température (IIT) doivent être réduites de 1 K par tranche (ou fraction de tranche) à partir de 11 kV jusqu'à 17 kV compris
		U_N > 17 kV	$\Delta\theta$, pour les indicateurs internes de température (IIT) doivent être réduites de 6 K et en plus réduites de 1,5 K par tranche (ou fraction de tranche) au-dessus de 17 kV

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Tableau 10

Remplacer le point 2 du tableau 10, par ce qui suit:

2	Différence d'altitude entre site d'essai (H_T) et site de fonctionnement (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\Delta\theta_T = \Delta\theta\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right)$
		H > 4 000 m ou H_T > 4 000 m	Par accord

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Table 8

Replace the text of items 1, 2 and 4 with the following new text:

1	Maximum temperature of ambient air or of the air at inlet to the machine (θ_c)	0 °C ≤ θ_c ≤ 40 °C	May be increased by agreement but this increase shall not exceed either the amount by which the coolant temperature is less than 40 °C, or a maximum of 30 K
		40 °C < θ_c ≤ 60 °C	Reduced by the amount by which the coolant temperature exceeds 40 °C
		θ_c < 0 °C or θ_c > 60 °C	By agreement
2	Maximum temperature of the water at inlet to water-cooled heat exchangers (θ_W)	5 °C ≤ θ_w ≤ 25 °C	Increased by 10 K and may be further increased by an amount not exceeding the amount by which the cooling temperature is less than 25 °C
		θ_w > 25 °C	Increased by 10 K and reduced by the amount by which the maximum cooling water temperature exceeds 25 °C

4	Rated stator winding voltage (U_N)	11 kV < U_N ≤ 17 kV	$\Delta\theta$ for embedded temperature detectors (ETD) shall be reduced by 1 K for each 1 kV (or part thereof) from 11 kV up to and including 17 kV
		U_N > 17 kV	$\Delta\theta$ for embedded temperature detectors (ETD) shall be reduced by 6 K plus 1,5 K for each 1 kV (or part thereof) above 17 kV

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Table 10

Replace the text of item 2 with the following new text:

2	Difference of altitudes of test site (H_T) and operating site (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\Delta\theta_T = \Delta\theta\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right)$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\Delta\theta_T = \Delta\theta\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right)$
		H > 4 000 m or H_T > 4 000 m	By agreement

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Tableau 12

Remplacer le point 1 du tableau 12, par ce qui suit:

1	Température du fluide de refroidissement de référence (θ_c)	0 °C ≤ θ_c ≤ 40 °C	Réduites de la différence entre 40 °C et θ_c. Cependant par accord, une réduction inférieure peut être effectuée, sous réserve que si θ_c < 10 °C, la réduction soit au moins égale à la différence entre 10 °C et θ_c
		40 °C < θ_c ≤ 60 °C	Pas de correction
		θ_c < 0 °C ou θ_c > 60 °C	Par accord

Tableau 13

Remplacer le point 2 du tableau 13 par ce qui suit:

2	Différence d'altitude entre site d'essai (H_T) et site de fonctionnement (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\theta_T = (\theta - \theta_c)\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H > 4 000 m ou H_T > 4 000 m	Par accord

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8.1 Essais diélectriques

Remplacer le titre et le premier alinéa de cet article par ce qui suit:

8.1 Essais de tension de tenue

Une tension d'essai telle que définie ci–après doit être appliquée entre les enroulements soumis à l'essai et la carcasse de la machine à laquelle sont reliés le circuit magnétique et les enroulements non soumis à l'essai. L'essai ne doit être effectué que sur une machine neuve et terminée, dont toutes les parties sont en place dans des conditions équivalentes aux conditions normales de fonctionnement; il doit être effectué dans l'atelier du constructeur ou après montage sur site. Si un essai d'échauffement est effectué, l'essai de tension de tenue doit être effectué immédiatement après cet essai.

Remplacer le troisième alinéa de cet article par le nouveau texte suivant:

Sauf exception ci–dessous, la tension d'essai doit être à fréquence industrielle et de forme pratiquement sinusoïdale. La valeur finale de la tension d'essai doit être conforme au tableau 14. Toutefois, pour les machines de tension assignée égale ou supérieure à 6 kV, lorsque la disponibilité d'une installation d'essai à fréquence industrielle n'existe pas et après accord, l'essai peut être effectué en tension continue, à un niveau égal à 1,7 fois la valeur efficace spécifiée au tableau 14.

NOTE – Il est reconnu que, lors d'un essai en tension continue, la distribution de potentiel de surface le long de l'isolation des développantes et les mécanismes de vieillissement sont différents de ceux en tension alternative.

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Table 12

Replace the text of item 1 with the following new text:

1	Reference coolant temperature (θ_c)	0 °C ≤ θ_c ≤ 40 °C	Reduction by the amount of the difference between 40 °C and θ_c. However, by agreement, a smaller reduction may be applied, provided that for θ_c < 10 °C the reduction is made at least equal to the difference between 10 °C and θ_c.
		40 °C < θ_c ≤ 60 °C	No adjustment
		θ_c < 0 °C or θ_c > 60 °C	By agreement

Table 13

Replace the text of item 2 with the following new text:

2	Difference of altitudes of test site (H_T) and operating site (H)	1 000 m < H ≤ 4 000 m H_T < 1 000 m	$\theta_T = (\theta - \theta_c)\left(1 - \frac{H - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H < 1 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - 1\,000\ \text{m}}{10\,000\ \text{m}}\right) + \theta_{cT}$
		1 000 m < H ≤ 4 000 m 1 000 m < H_T ≤ 4 000 m	$\theta_T = (\theta - \theta_c)\left(1 + \frac{H_T - H}{10\,000\ \text{m}}\right) + \theta_{cT}$
		H > 4 000 m or H_T > 4 000 m	By agreement

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8.1 Dielectric tests

Replace the title and the first paragraph of this clause with the following:

8.1 Withstand voltage test

A test voltage, as specified below, shall be applied between the windings under test and the frame of the machine, with the core and the windings not under test connected to the frame. It shall be applied only to a new and completed machine with all its parts in place under conditions equivalent to normal working conditions and shall be carried out at the manufacturer's works or after erection on site. When a thermal test is carried out, the withstand voltage test shall be carried out immediately after that test.

Replace the third paragraph of this clause with the following new paragraph:

Except as stated below, the test voltage shall be of power frequency and as near as possible to a sine wave form. The final value of the voltage shall be in accordance with table 14. However, for machines with a rated voltage 6 kV or greater, when power frequency equipment is not available, then by agreement a d.c. test may be carried out at a voltage 1,7 times the r.m.s. value given in table 14.

NOTE – It is recognized that, during a d.c. test, the surface potential distribution along the end winding insulation and the ageing mechanisms are different from those occurring during an a.c. test.

Remplacer le quatrième alinéa de cet article par le texte suivant:

L'essai doit être commencé avec une tension ne dépassant pas la moitié de la pleine tension d'essai. La tension est ensuite augmentée jusqu'à la pleine tension d'essai, d'une manière progressive ou par degrés ne dépassant pas 5 % de la pleine valeur, la durée de l'augmentation de la tension depuis la moitié jusqu'à la pleine valeur n'étant pas inférieure à 10 s. La pleine tension d'essai est alors maintenue pendant 1 min à la valeur spécifiée dans le tableau 14. Il ne doit pas y avoir de défaut (voir la CEI 60060-1) pendant cette séquence.

Remplacer le septième alinéa de cet article, y compris la note, par le texte suivant:

Pour les moteurs à courant continu alimentés par convertisseurs statiques de puissance, on doit utiliser, pour déterminer la tension d'essai du tableau 14, la tension continue du moteur ou la valeur efficace de la tension alternative assignée entre phases aux bornes d'entrée du convertisseur statique de puissance, selon la valeur la plus élevée.

Remplacer le neuvième alinéa de cet article par le nouveau texte suivant:

Si un utilisateur et un réparateur ont convenu d'effectuer des essais de tension de tenue dans des cas de rebobinage partiel des enroulements ou de révision d'une machine, il est recommandé de procéder comme suit:

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Tableau 14 – Essais diélectriques

Remplacer le titre du tableau 14 par le nouveau titre suivant:

Tableau 14 – Essais de tension de tenue

Remplacer le point 8 du tableau 14 en page 82, par le nouveau texte suivant:

8	Ensemble de machines et d'appareils électriquement reliés	Il est recommandé d'éviter si possible la répétition des essais des points 1 à 7, mais si l'essai est fait sur un ensemble de machines et d'appareils dont chacun a déjà subi un essai de tension de tenue, la tension d'essai appliquée à un tel ensemble connecté électriquement ne doit pas dépasser 80 % de la tension la plus basse applicable à l'un des éléments individuals de l'ensemble [4)]

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Ajouter le nouvel article suivant:

8.5 Vitesse de sécurité en fonctionnement des moteurs à induction à cage

Tous les moteurs triphasés à induction à cage à une seule vitesse ayant une désignation de la carcasse inférieure ou égale à 315 et pour des tensions d'alimentation inférieures ou égales à 690 V doivent être capables de fonctionnement continu sûr à des vitesses inférieures ou égales à la vitesse appropriée du tableau 15 sauf indication différente indiquée sur la plaque signalétique.

Replace the fourth paragraph of this clause with the following text:

The test shall be commenced at a voltage not exceeding half of the full test voltage. The voltage shall then be increased to the full value, steadily or in steps of not more than 5 % of the full value, the time allowed for the voltage increase from half to full value being not less than 10 s. The full test voltage shall then be maintained for 1 min in accordance with the value as specified in table 14. There shall be no failure (see IEC 60060-1) during this period.

Replace the seventh paragraph of this clause, including the note, with the following new paragraph:

To determine the test voltage from table 14 for d.c. motors supplied by static power converters, the direct voltage of the motor or the r.m.s. phase-to-phase value of the rated alternating voltage at the input terminals of the static power converter shall be used, whichever is the greater.

Replace the ninth paragraph of this clause with the following new paragraph:

When a user and a repair contractor have agreed to carry out withstand voltage tests in cases where windings have been partially rewound or in the case of an overhauled machine, the following procedure is recommended:

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Table 14 – Dielectric tests

Replace the title of this table by the following new title:

Table 14 – Withstand voltage tests

Replace the text of item 8 on page 83 with the following new text:

8	Electrically interconnected machines and apparatus	A repetition of the tests in items 1 to 7 above should be avoided if possible, but if a test is performed on a group of machines and apparatus, each having previously passed its withstand voltage test, the test voltage to be applied to such an electrically connected arrangement shall be 80 % of the lowest test voltage appropriate for any individual piece of the arrangement [4)]

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Add the following new clause:

8.5 Safe operating speed of cage induction motors

All three-phase single-speed cage induction motors of frame number up to and including 315 and for voltages up to and including 690 V shall be capable of safe continuous operation at speeds up to the appropriate speed given in table 15 unless otherwise stated on the rating plate.

Tableau 15 – Vitesse maximale de sécurité en fonctionnement (min^{-1}) des moteurs triphasés à induction à cage, à une seule vitesse, pour des tensions d'alimentation inférieures ou égales à 690 V

Désignation de la carcasse	2 pôles	4 pôles	6 pôles
≤ 100	5 200	3 600	2 400
112	5 200	3 600	2 400
132	4 500	2 700	2 400
160	4 500	2 700	2 400
180	4 500	2 700	2 400
200	4 500	2 300	1 800
225	3 600	2 300	1 800
250	3 600	2 300	1 800
280	3 600	2 300	1 800
315	3 600	2 300	1 800

NOTE – En cas de fonctionnement à des vitesses supérieures à la vitesse assignée, par exemple en cas d'utilisation avec commande de vitesse réglable, les niveaux de bruit et de vibration augmenteront. Il se peut que l'utilisateur ait besoin d'affiner l'équilibrage du rotor du moteur pour un fonctionnement acceptable au-dessus de la vitesse assignée. La durée de vie des paliers peut être réduite. Il convient de porter attention à la périodicité du regraissage ou à la durée de vie de la graisse.

Renuméroter les articles existants 8.5 à 8.9 de 8.6 à 8.10.

Renuméroter les tableaux existants 15 à 18 de 16 à 19.

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Tableau 15 – Survitesses

Remplacer le point 2c) du tableau 15 par le nouveau texte suivant:

2c)	Moteurs à excitation composée ayant une plage de vitesses supérieure à 35 % et moteurs à excitation série	Le constructeur doit attribuer une vitesse maximale de sécurité en fonctionnement qui sera marquée sur la plaque signalétique. La survitesse de ces moteurs sera égale à 1,1 fois cette vitesse maximale de sécurité en fonctionnement. Ce marquage est inutile si la survitesse correspond à 1,1 fois la vitesse à vide à la tension assignée

Ajouter le nouveau point 1d) suivant au tableau 16:

Point	Type de machines	Prescription de survitesse
1d)	Moteurs triphasés à induction à cage, à une seule vitesse selon l'article 8.5	1,2 fois la vitesse maximale de sécurité en fonctionnement

Table 15 – Maximum safe operating speed (min^{-1}) of three-phase single-speed cage induction motors for voltages up to and including 690 V

Frame number	2 pole	4 pole	6 pole
≤ 100	5 200	3 600	2 400
112	5 200	3 600	2 400
132	4 500	2 700	2 400
160	4 500	2 700	2 400
180	4 500	2 700	2 400
200	4 500	2 300	1 800
225	3 600	2 300	1 800
250	3 600	2 300	1 800
280	3 600	2 300	1 800
315	3 600	2 300	1 800

NOTE – When operating at speeds above rated speed, for example, when used with adjustable speed controls, noise and vibration levels will increase. The user may require to fine balance of the motor rotor for acceptable operation above rated speed. Bearing life may be reduced. Attention should be paid to the regreasing intervals and the grease service life.

Renumber the existing clauses 8.5 to 8.9 to 8.6 to 8.10

Renumber the existing tables 15 to 18 to 16 to 19.

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Table 15 – Overspeeds

No change to the English text.

Insert the following new item 1d) to table 16:

Item	Machine type	Overspeed
1d)	Three-phase single-speed cage induction motors according to clause 8.5	1,2 times the maximum safe operating speed

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8.8 Essai de commutation pour machines à collecteur

Remplacer le texte de cet article par le texte suivant:

Une machine à courant continu ou à courant alternatif comportant un collecteur doit être capable de fonctionner de la marche à vide à la marche en surintensité ou excès de couple spécifiée aux articles 8.2 et 8.3, sans dommage permanent à la surface du collecteur ou des balais et sans étincelles dangereuses, les balais restant calés dans la même position. Si possible, l'essai de commutation doit être effectué à chaud.

8.9.1 Généralités

Remplacer le texte de ce paragraphe par le texte suivant:

Les prescriptions du présent paragraphe ne s'appliquent qu'aux machines synchrones de puissance assignée égale ou supérieure à 300 kW (ou kVA), destinées à être raccordées à des réseaux fonctionnant à des fréquences nominales de $16^2/_3$ Hz à 100 Hz inclus en vue de réduire au minimum les interférences entre les lignes de transport et les circuits adjacents.

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8.9.3 Essais

Remplacer le premier alinéa de ce paragraphe par le texte suivant:

Les machines synchrones à courant alternatif doivent être soumises à des essais de type ayant pour objet de vérifier leur conformité à 8.9.2. La gamme des fréquences de mesure doit couvrir tous les harmoniques de la fréquence assignée à 5 000 Hz.

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9.2 Marquage

Remplacer le premier alinéa de cet article par le texte suivant:

Pour les machines de puissance assignée inférieure ou égale à 750 W (ou VA) et dont les dimensions ne relèvent pas du domaine de la CEI 60072, ainsi que pour les machines incorporées, pour usage spécial, de puissance assignée inférieure ou égale à 3 kW (ou kVA), les indications 1, 2, 11 et 12 doivent au moins figurer comme marquage minimal.

Remplacer le point 8) par le texte suivant:

8) Classification thermique et limite de température ou d'échauffement (quand elle est inférieure à celle de la classification thermique) et, si nécessaire, méthode de mesure, suivie dans le cas d'une machine à hydroréfrigérant de «P» ou «S», selon que l'échauffement est mesuré par rapport au fluide de refroidissement respectivement primaire ou secondaire; voir l'article 7.2. Cette information, présentée éditorialement avec un trait de fraction oblique, doit être donnée à la fois pour le stator et pour le rotor si leurs classifications thermiques diffèrent.

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8.8 Commutation test for commutator machines

Replace the text of this clause with the following new text:

A d.c. or a.c. commutator machine shall be capable of operating from no-load to operation with the excess current or excess torque, specified in clauses 8.2 and 8.3 respectively, without permanent damage to the surface of the commutator or brushes and without injurious sparking, the brushes remaining in the same set position. If possible, the commutation test shall be performed in warm conditions.

8.9.1 General

Replace the text of this clause with the following new text:

The requirements of this subclause apply only to synchronous machines having rated outputs of 300 kW (or kVA) or more, intended for connection to power networks operating at nominal frequencies of $16^{2}/_{3}$ Hz to 100 Hz inclusive, with a view to minimizing interference between power lines and adjacent circuits.

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8.9.3 Tests

Replace the first paragraph of this subclause with the following new paragraph:

Type tests shall be carried out on a.c. machines to verify compliance with 8.9.2. The range of frequencies measured shall cover all harmonics from rated frequency up to 5 000 Hz.

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9.2 Marking

Replace the first paragraph of this clause with the following new paragraph:

For machines with rated outputs up to and including 750 W (or VA) and dimensions not covered by IEC 60072 and for special-purpose built-in machines with rated outputs up to and including 3 kW (or kVA), items 1, 2, 11 and 12 shall be marked as a minimum.

Replace the text of item 8) with the following new text:

8) The thermal classification and the limit of temperature or of temperature rise (when lower than that of the thermal classification) and, if necessary, the method of measurement, followed in the case of a machine with a water-cooled heat exchanger by 'P' or 'S', depending on whether the temperature rise is measured above the primary or secondary coolant respectively (see clause 7.2). This information shall be given for both stator and rotor (separated by a slash) when their thermal classification differ.

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Remplacer le texte du point 10) par le nouveau texte suivant:

10) Puissance(s) assignée(s) ou plage de puissance assignée.

Modifer le titre du point 11) comme suit:

11) Tension(s) assignée(s) ou plage de tension assignée.

Supprimer le texte suivant du point 11):

Deux tensions assignées différentes X et Y doivent être indiquées par X/Y et une plage de tensions assignées de X à Y doit être indiquée X – Y.

Remplacer le texte du point 13) par le nouveau texte suivant:

13) Courant(s) assigné(s) ou plage de courant assigné.

Remplacer le texte du point 14) par le nouveau texte suivant:

14) Vitesse(s) assignée(s) ou plage de vitesse assignée.

Remplacer le texte du point 16) par le nouveau texte suivant:

16) Survitesse admissible si différente de celle spécifiée à l'article 8.6,
ou
vitesse maximale de sécurité en fonctionnement si inférieure à celle spécifiée à l'article 8.5.

Ajouter un nouveau cinquième alinéa comme suit:

Deux valeurs assignées différentes doivent être indiquées par X/Y et une plage de valeurs assignées doit être indiquée par X–Y (voir la CEI 61293).

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10.1 Mise à la terre des machines

Remplacer le deuxième alinéa de cet article par le nouveau texte suivant:

Dans le cas des machines de tension assignée supérieure à 50 V en courant alternatif ou 120 V en courant continu, mais ne dépassant pas 1 000 V en courant alternatif ou 1 500 V en courant continu, la borne du conducteur de terre doit être située à proximité des bornes de raccordement des conducteurs de phase, à l'intérieur de la boîte de connexions éventuelle. Les machines de puissance assignée supérieure à 100 kW (ou kVA) doivent également comporter une borne de terre montée sur la carcasse.

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Replace the text of item 10) with the following new text:

10) The rated output(s) or range of rated output.

Delete the following sentence from item 11:

Two different rated voltages X and Y shall be indicated by X/Y and a range of rated voltages from X to Y shall be indicated by X – Y.

Replace the first sentence of item 12) with the following new text

12) For a.c. machines the rated frequency or range of rated frequency.

Replace the text of item 13) with the following new text:

13) The rated current(s) or range of rated current.

Replace the text of item 14) with the following new text:

14) The rated speed(s) or range of rated speed.

Replace item 16 with the following new text:

16) The permissible overspeed if other than specified in clause 8.6,
or
the maximum safe operating speed if less than in clause 8.5.

Add, after the fourth paragraph, the following new paragraph:

Two different rated values shall be indicated by X/Y and a range of rated values shall be indicated by X – Y (see IEC 61293).

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10.1 Earthing of machines

Replace the second paragraph of this clause with the following new paragraph:

In the case of machines having rated voltages greater than 50 V a.c. or 120 V d.c., but not exceeding 1 000 V a.c. or 1 500 V d.c., the terminal for the earth conductor shall be situated in the vicinity of the terminals for the line conductors, being placed in the terminal box, if one is provided. Machines having rated outputs in excess of 100 kW (or kVA) shall have in addition an earth terminal fitted on the frame.

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10.2 Clavette(s) de bout d'arbre

Remplacer le texte de cet article par le nouveau texte suivant:

Quand un bout d'arbre d'une machine est prévu avec une ou plusieurs rainures de clavette, chaque rainure doit être pourvue d'une clavette entière de forme et de longueurs normales.

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Tableau 18 – Nomenclature des tolérances sur les valeurs des grandeurs

Remplacer les points 1, 1a), 1b) et 2 par ce qui suit:

1	Rendement η	
1a)	Par sommation des pertes:	
	– machines de puissance inférieure ou égale à 50 kW (ou kVA)	–15 % de (1 – η)
	– machines de puissance supérieure à 50 kW (ou kVA)	–10 % de (1 – η)
1b)	Par mesurage des pertes totales	–15 % de (1 – η)
2	Pertes totales	+10 % des pertes totales
NOTE 4 – Les tolérances dépendent du rapport de puissance P_N en kW, à la vitesse assignée en min^{-1}.		

Page 108

Remplacer les figures 1 à 13 par les nouvelles figures suivantes:

Page 103

10.2 Shaft-end key(s)

Replace the text of this clause with the following new text:

When a machine shaft end is provided with one or more keyways, each shall be provided with a full key of normal shape and length.

Page 105

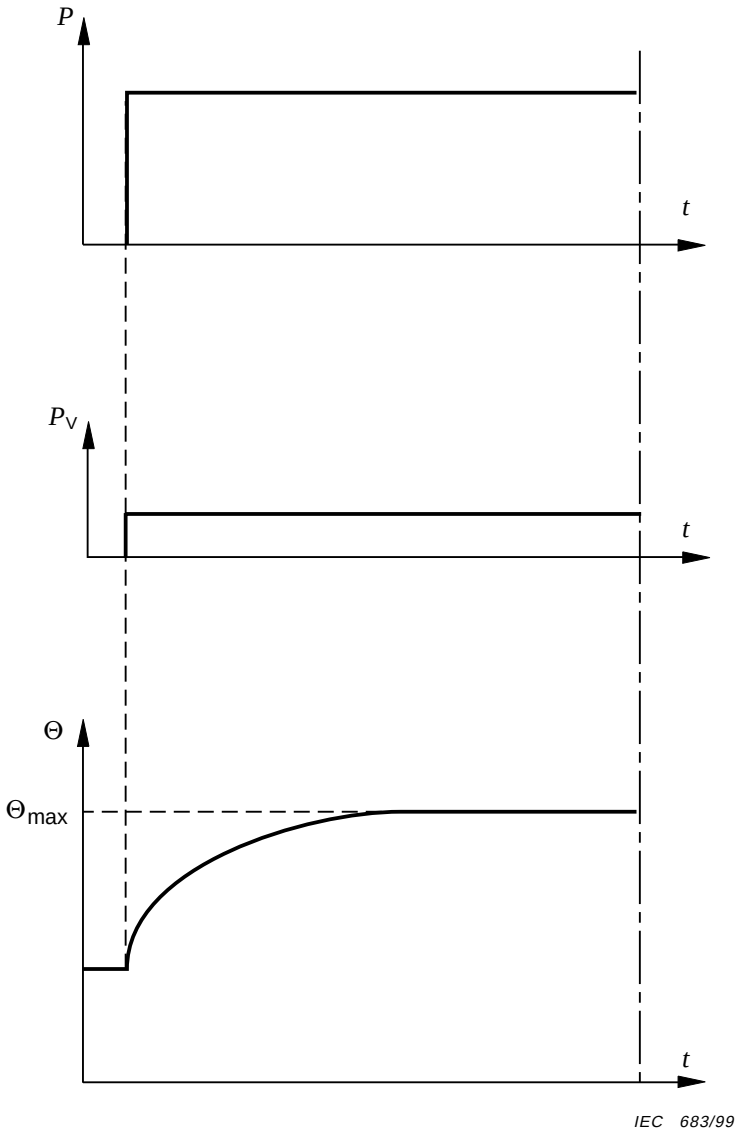
Table 18 – Schedule of tolerances on values of quantities

Replace items 1, 1a), 1b) and 2 of the above table with the following new items:

1	Efficiency η	
1a)	By summation of losses:	
	– machines up to and including 50 kW (or kVA)	–15 % of $(1 - \eta)$
	– machines above 50 kW (or kVA)	–10 % of $(1 - \eta)$
1b)	By total loss measurement	–15 % of $(1 - \eta)$
2	Total losses	+10 % of the total losses
NOTE 4 – Tolerances depend on the ratio of rated output P_N, in kW, to rated speed in min^{-1}.		

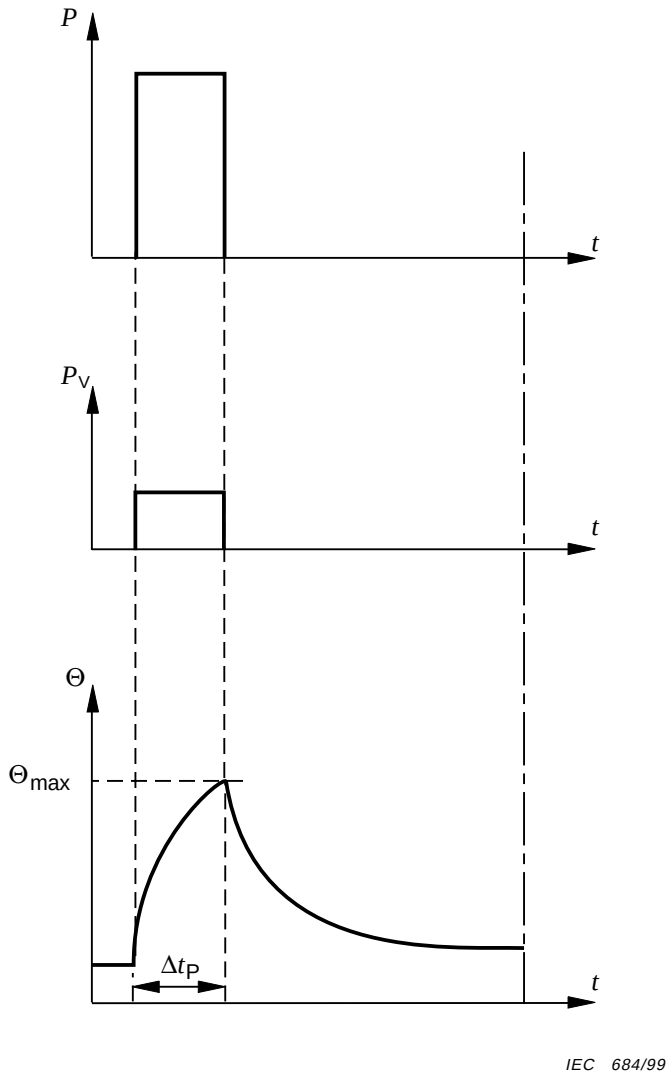
Page 108

Replace the existing figures 1 to 13 by the following new figures.



P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
$Θ$	=	température	$Θ$	=	temperature
$Θ_{max}$	=	température maximale atteinte	$Θ_{max}$	=	maximum temperature attained
t	=	temps	t	=	time

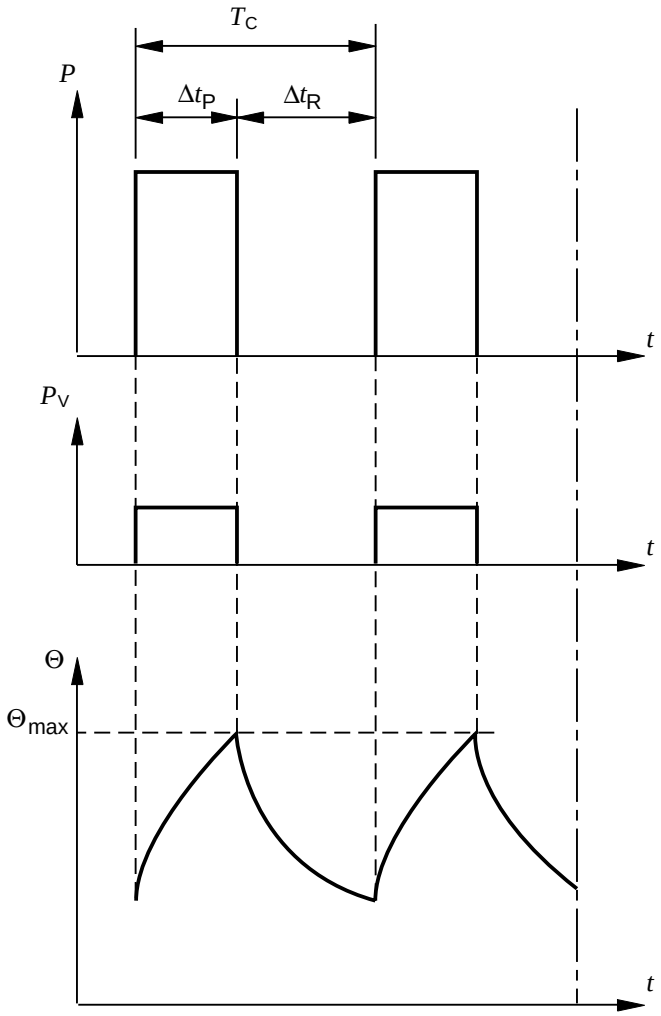
Figure 1 – Service continu – Service type S1
Figure 1 – Continuous running duty – Duty type S1



P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load

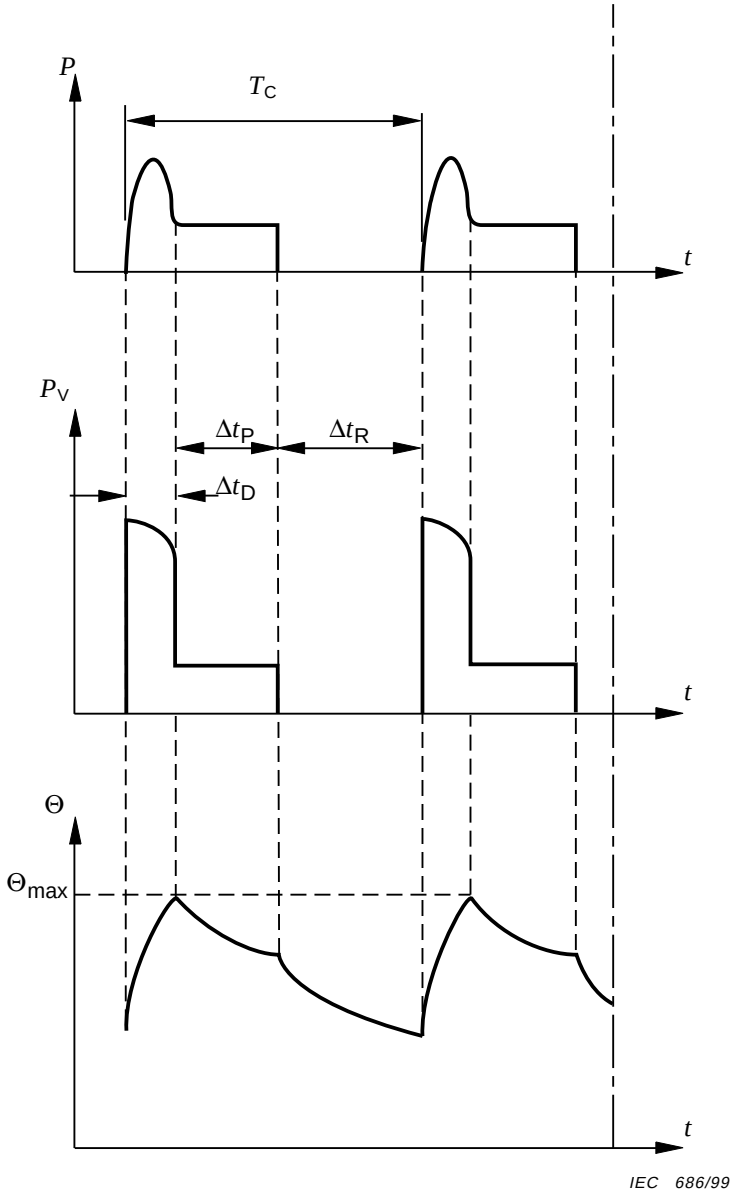
Figure 2 – Service temporaire – Service type S2

Figure 2 – Short-time duty – Duty type S2



P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized
Facteur de marche = Δt_P / T_C			Cyclic duration factor = Δt_P / T_C		

Figure 3 – Service intermittent périodique – Service type S3
Figure 3 – Intermittent periodic duty – Duty type S3

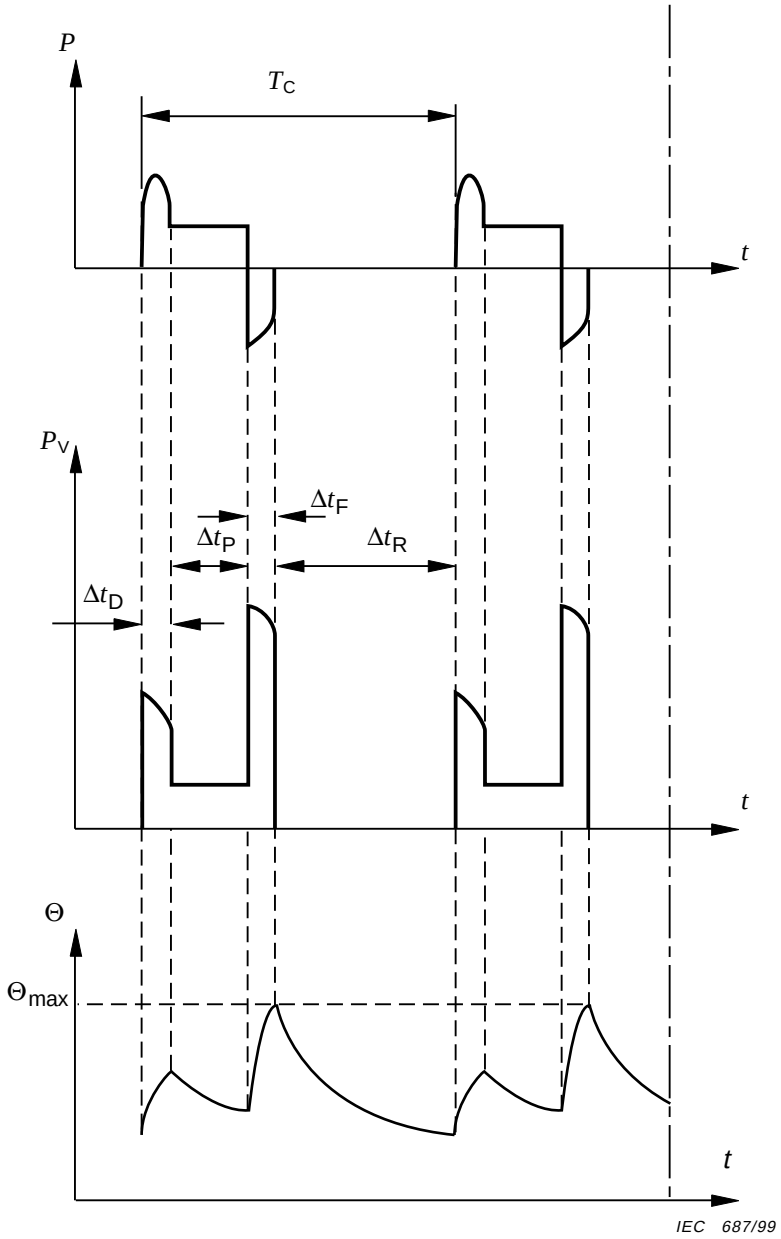


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized

Facteur de marche = $(\Delta t_D + \Delta t_P) / T_C$

Cyclic duration factor = $(\Delta t_D + \Delta t_P) / T_C$

Figure 4 – Service intermittent périodique à démarrage – Service type S4
Figure 4 – Intermittent periodic duty with starting – Duty type S4

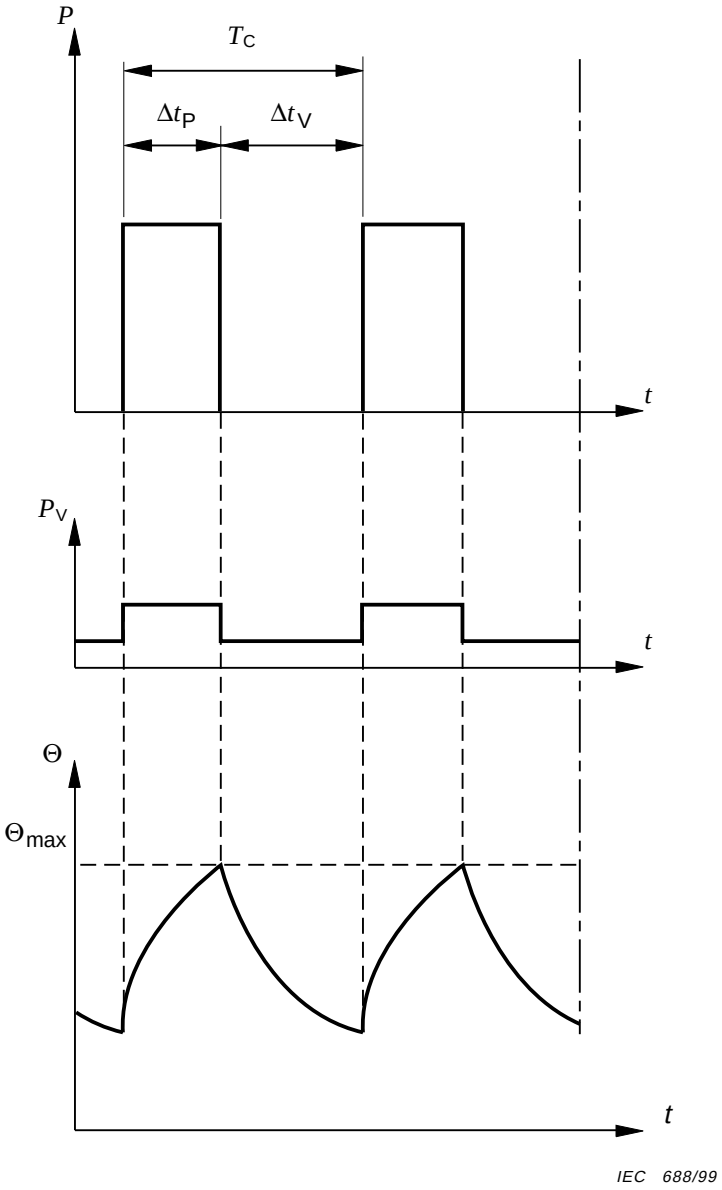


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_F	=	durée de freinage électrique	Δt_F	=	time of electric braking
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized

Facteur de marche = $(\Delta t_D + \Delta t_P + \Delta t_F) / T_C$

Cyclic duration factor = $(\Delta t_D + \Delta t_P + \Delta t_F) / T_C$

Figure 5 – Service intermittent périodique à freinage électrique – Service type S5
Figure 5 – Intermittent periodic duty with electric braking – Duty type S5

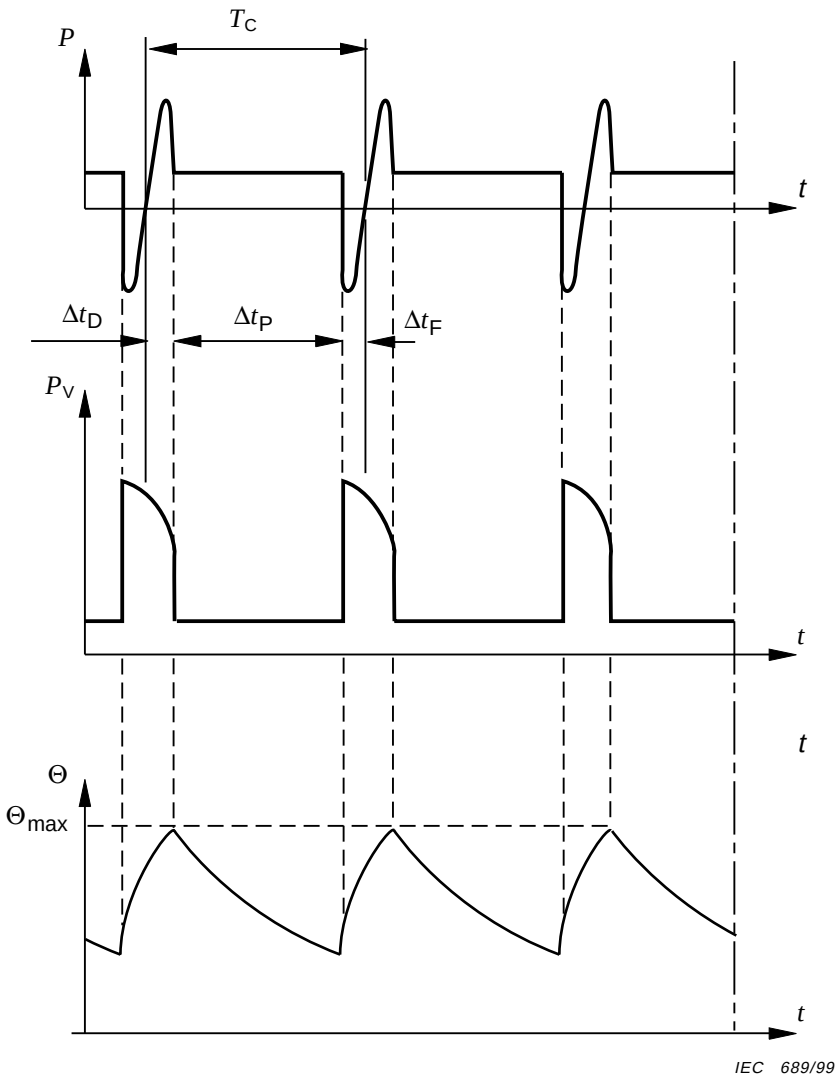


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_V	=	durée de fonctionnement à vide	Δt_V	=	operation time at no-load

Facteur de marche = $\Delta t_P / T_C$

Cyclic duration factor = $\Delta t_P / T_C$

Figure 6 – Service ininterrompu périodique à charge intermittente – Service type S6
Figure 6 – Continuous operation periodic duty – Duty type S6

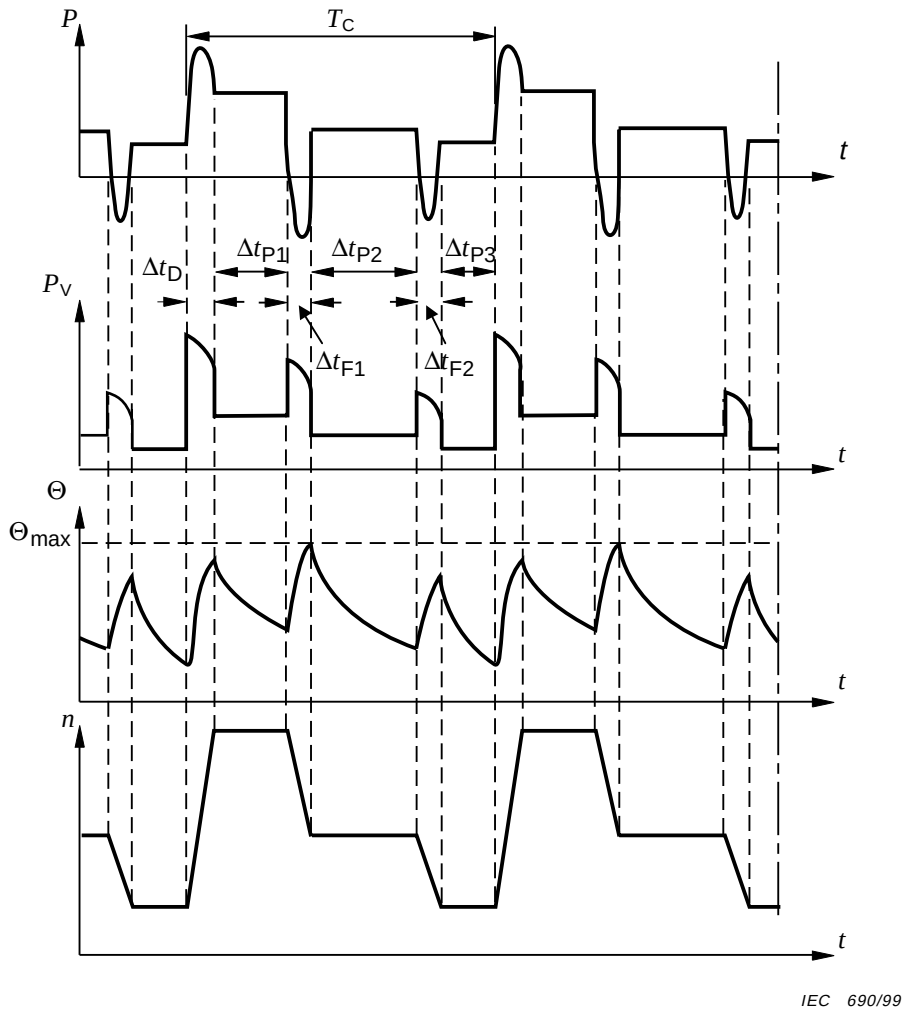


P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_F	=	durée de freinage électrique	Δt_F	=	time of electric braking

Facteur de marche = 1

Cyclic duration factor = 1

Figure 7 – Service ininterrompu périodique à freinage électrique – Service type S7
Figure 7 – Continuous operation periodic duty with electric braking – Duty type S7



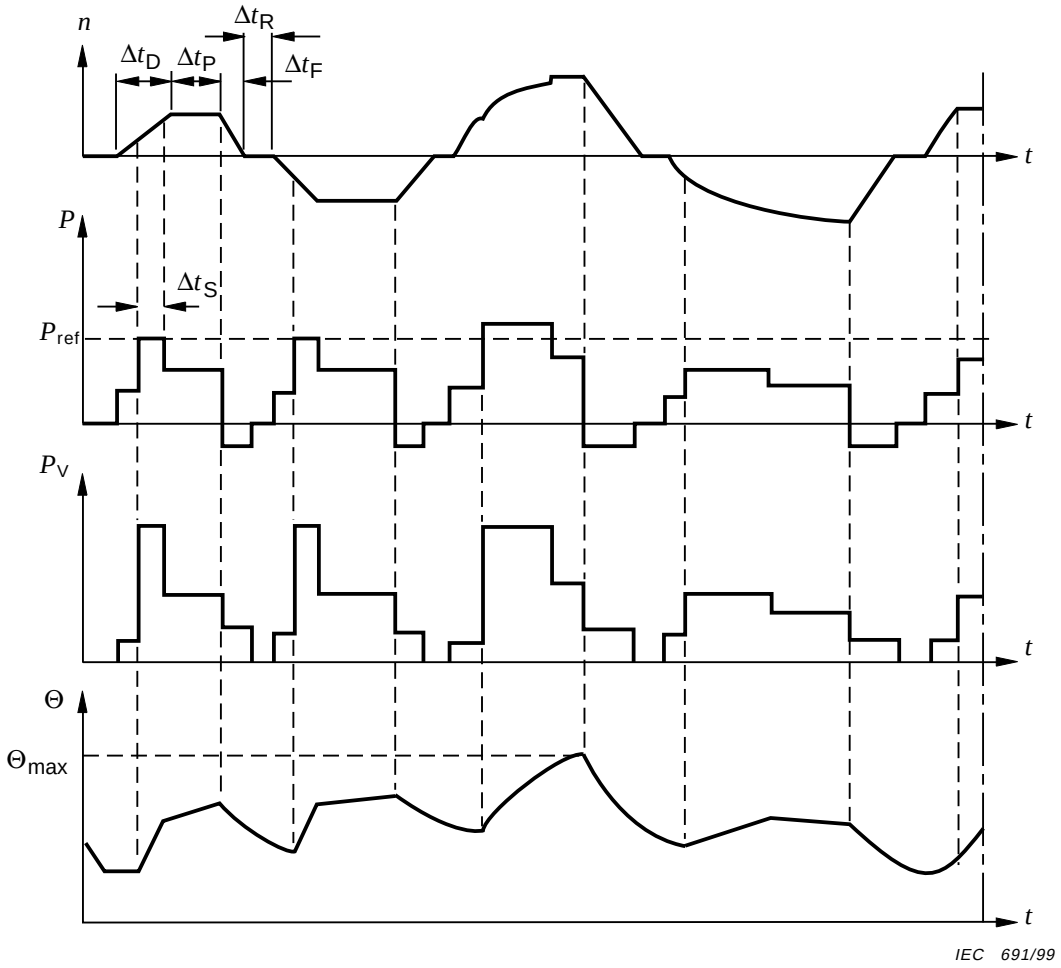
P	=	charge	P	=	load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
n	=	vitesse	n	=	speed
t	=	temps	t	=	time
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante (P1, P2, P3)	Δt_P	=	operation time at constant load (P1, P2, P3)
Δt_F	=	durée de freinage électrique (F1, F2)	Δt_F	=	time of electric braking (F1, F2)

Facteur de marche = $(\Delta t_D + \Delta t_{P1}) / T_C$; $(\Delta t_{F1} + \Delta t_{P2}) / T_C$; $(\Delta t_{F2} + \Delta t_{P3}) / T_C$

Cyclic duration factor = $(\Delta t_D + \Delta t_{P1}) / T_C$; $(\Delta t_{F1} + \Delta t_{P2}) / T_C$; $(\Delta t_{F2} + \Delta t_{P3}) / T_C$

Figure 8 – Service ininterrompu périodique à changements liés de charge et de vitesse – Service type S8

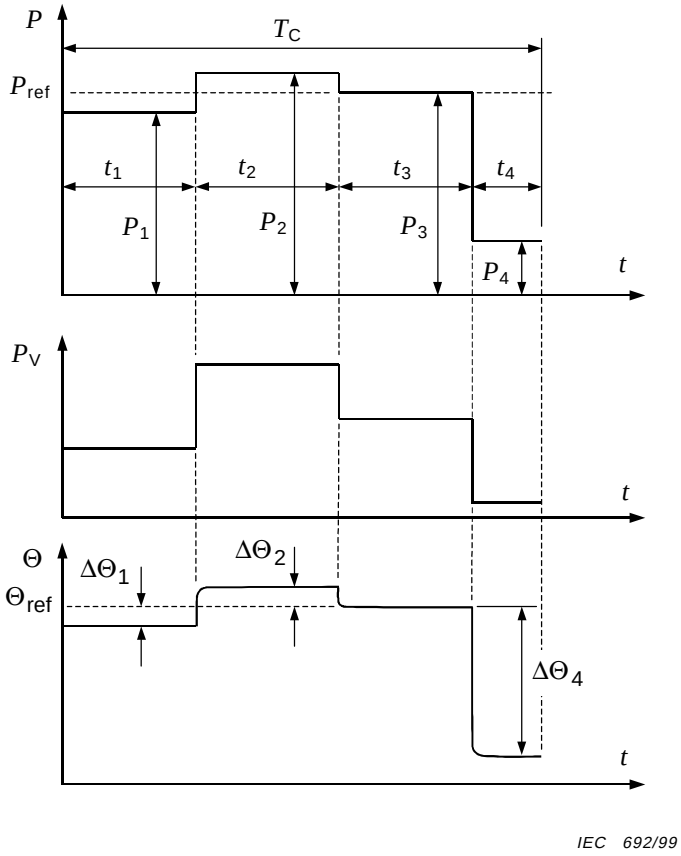
Figure 8 – Continuous operation periodic duty with related load/speed changes – Duty type S8



P	=	charge	P	=	load
P_{ref}	=	charge de référence	P_{ref}	=	reference load
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{max}	=	température maximale atteinte	Θ_{max}	=	maximum temperature attained
n	=	vitesse	n	=	speed
t	=	temps	t	=	time
Δt_D	=	durée de démarrage/accélération	Δt_D	=	starting/accelerating time
Δt_P	=	durée de fonctionnement à charge constante	Δt_P	=	operation time at constant load
Δt_F	=	durée de freinage électrique	Δt_F	=	time of electric braking
Δt_R	=	durée au repos	Δt_R	=	time at rest and de-energized
Δt_S	=	durée de fonctionnement en surcharge	Δt_S	=	time under overload

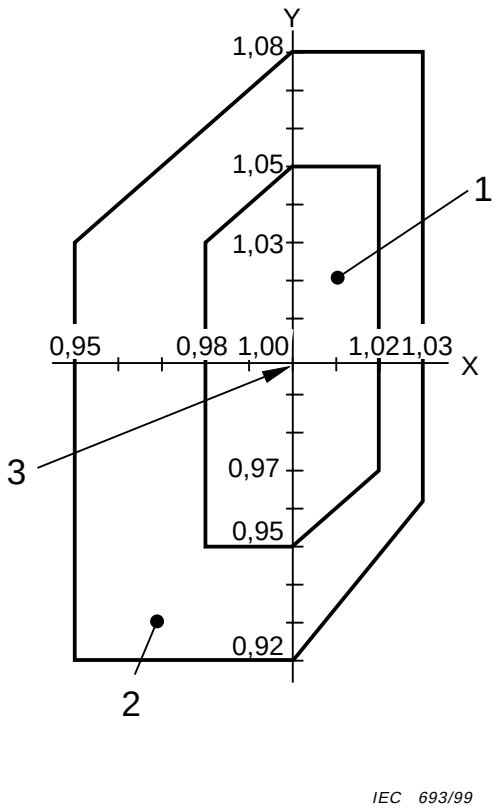
Figure 9 – Service à variations non périodique de charge et de vitesse – Service type S9

Figure 9 – Duty with non-periodic load and speed variations – Duty type S9



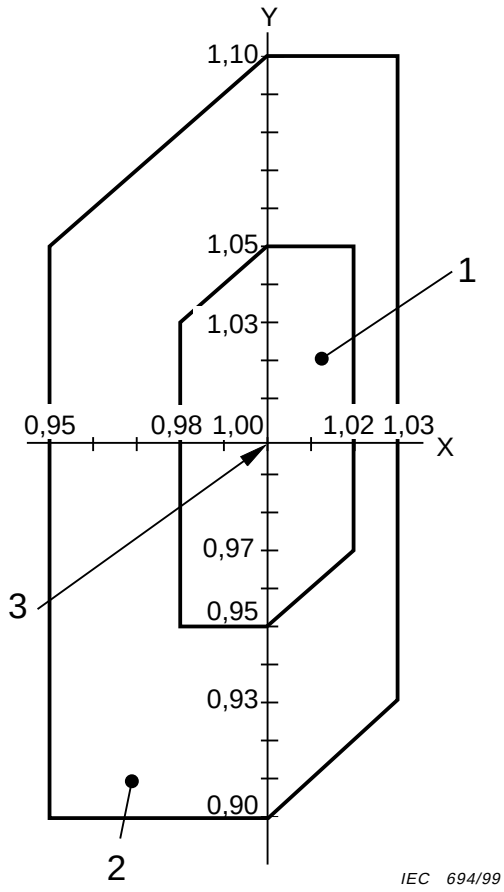
P	=	charge	P	=	load
P_i	=	charge constante pendant un cycle	P_i	=	constant load within a load cycle
P_{ref}	=	charge de référence basée sur le service type S1	P_{ref}	=	reference load based on duty type S1
P_V	=	pertes électriques	P_V	=	electrical losses
Θ	=	température	Θ	=	temperature
Θ_{ref}	=	température à la charge de référence basée sur le service type S1	Θ_{ref}	=	temperature at reference load based on duty type S1
t	=	temps	t	=	time
t_i	=	durée d'une charge constante pendant un cycle	t_i	=	time of a constant load within a cycle
T_C	=	durée d'un cycle	T_C	=	time of one load cycle
$\Delta\Theta_i$	=	différence entre l'échauffement de l'enroulement au cours de chacune des charges pendant un cycle et l'échauffement basé sur le service type S1 à la charge référence	$\Delta\Theta_i$	=	difference between the temperature rise of the winding at each of the various loads within one cycle and the temperature rise based on duty cycle S1 with reference load

Figure 10 – Service avec charges constantes distinctes – Service type S10
Figure 10 – Duty with discrete constant loads – Duty type S10



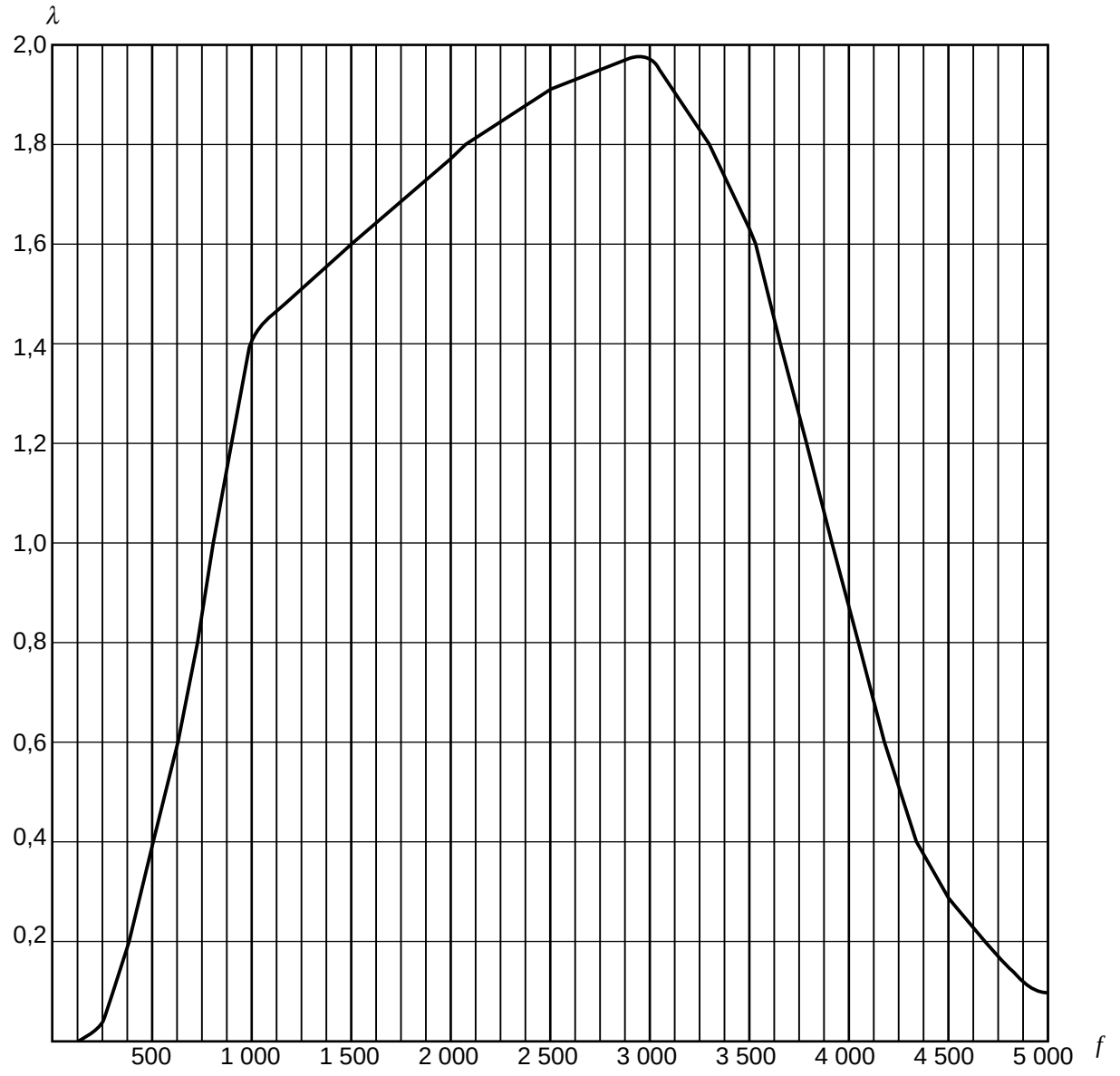
axe X = fréquence p.u.
axe Y = tension p.u.
1 = zone A
2 = zone B (extérieure à zone A)
3 = point des caractéristiques assignées

Figure 11 – Valeurs limites de tension et fréquence pour les alternateurs
Figure 11 – Voltage and frequency limits for generators



X axis = frequency p.u.
Y axis = voltage p.u.
1 = zone A
2 = zone B (outside zone A)
3 = rating point

Figure 12 – Valeurs limites de tension et fréquence pour les moteurs
Figure 12 – Voltage and frequency limits for motors



f = fréquence Hz
λ = facteur de pondération

f = frequency Hz
λ = weighting factor

Figure 13 – Courbe de pondération pour le calcul de FHT, voir 8.9
Figure 13 – Weighting curve for computing THF, see 8.9

Page 14 de l'amendement 1 à la 10e édition

12.1 Compatibilité électromagnétique (CEM)

Ajouter le nouvel alinéa suivant entre le troisième et le quatrième alinéa:

Les prescriptions de la section 12 ne s'appliquent pas aux machines dont les caractéristiques de CEM sont notablement modifiées par les capotage et montage finals.

Page 18 de l'amendement 1 à la 10e édition

12.1.3.2 Essais d'émission

Remplacer les deuxième et troisième alinéas par le nouveau texte suivant:

Pour les machines à collecteur à courant alternatif, des essais de type à vide doivent être effectués afin de vérifier la conformité à 12.1.2.3 pour l'émission de conduction et l'émission de rayonnement.

Pour les machines à collecteur à courant continu, des essais de type à vide ou à charge minimale possible doivent être effectués afin de vérifier la conformité à 12.1.2.3 pour l'émission de rayonnement.

Ajouter à la fin de l'article 12.1 la note suivante:

NOTE – La mesure à vide se justifie par l'influence négligeable de la charge sur l'émission.

_____

Page 15 of amendment 1 to the 10th edition

12.1 Electromagnetic compatibility (EMC)

Add the following new paragraph between the third and fourth paragraph:

The requirements of section 12 do not apply to machines when the EMC performance is significantly affected by the final enclosure and assembly.

Page 19 of amendment 1 to the 10th edition

12.1.3.2 Emission tests

Replace the second and third paragraphs with the following new text:

For a.c. commutator machines, type tests on no-load for conducted and radiated emission shall be carried out to verify compliance with 12.1.2.3.

For d.c. commutator machines, type tests on no-load or minimum possible load for radiated emission shall be carried out to verify compliance with 12.1.2.3.

Add the following note at the end of clause 12.1:

NOTE – The measurement on no-load is justified by the negligible influence of load on the emission.

_____

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1972

Machines électriques tournantes

Partie 2:
Méthodes pour la détermination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines pour véhicules de traction)

Rotating electrical machines

Part 2:
Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)

Numéro de référence
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– la CEI 878: *Symboles graphiques pour équipements électriques en pratique médicale.*

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and for medical electrical equipment,

– IEC 878: *Graphical symbols for electromedical equipment in medical practice.*

The symbols and signs contained in the present publication have either been taken from IEC 27, IEC 417, IEC 617 and/or IEC 878, or have been specifically approved for the purpose of this publication.

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The attention of readers is drawn to the end pages of this publication which list the IEC publications issued by the technical committee which has prepared the present publication.

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

MACHINES ÉLECTRIQUES TOURNANTES

Deuxième partie: Méthodes pour la détermination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines pour véhicules de traction)

PRÉAMBULE

1) Les décisions ou accords officiels de la CEI en ce qui concerne les questions techniques, préparés par des Comités d'Etudes où sont représentés tous les Comités nationaux s'intéressant à ces questions, expriment dans la plus grande mesure possible un accord international sur les sujets examinés.

2) Ces décisions constituent des recommandations internationales et sont agréées comme telles par les Comités nationaux.

3) Dans le but d'encourager cette unification internationale, la CEI exprime le vœu que tous les Comités nationaux ne possédant pas encore de règles nationales, lorsqu'ils préparent ces règles, prennent comme base fondamentale de ces règles les recommandations de la CEI dans la mesure où les conditions nationales le permettent.

4) On reconnaît qu'il est désirable que l'accord international sur ces questions soit suivi d'un effort pour harmoniser les règles nationales de normalisation avec ces recommandations dans la mesure où les conditions nationales le permettent. Les Comités nationaux s'engagent à user de leur influence dans ce but.

PRÉFACE

La présente recommandation a été établie par le Sous-Comité 2D: Pertes et rendement, du Comité d'Etudes N° 2 de la CEI: Machines tournantes. Elle remplace la deuxième édition publiée en 1960.

Elle fait partie d'une série de recommandations traitant des machines électriques tournantes, et dont les autres parties sont:

Première partie: Valeurs nominales et caractéristiques de fonctionnement (Publication 34-1 de la CEI).
Troisième partie: Valeurs nominales et caractéristiques des turbomachines triphasées à 50 Hz (Publication 34-3 de la CEI).
Quatrième partie: Méthodes pour la détermination à partir d'essais des grandeurs des machines synchrones (Publication 34-4 de la CEI).
Cinquième partie: Degrés de protection procurés par les enveloppes des machines tournantes (Publication 34-5 de la CEI).
Sixième partie: Modes de refroidissement des machines tournantes (Publication 34-6 de la CEI).

Les travaux de révision commencèrent lors de la réunion tenue à Tokyo en 1965, et un projet fut discuté lors de la réunion tenue à Londres en 1968. A la suite de cette dernière réunion, un projet définitif fut soumis à l'approbation des Comités nationaux suivant la Règle des Six Mois en novembre 1969.

Les pays suivants se sont prononcés explicitement en faveur de la publication:

Afrique du Sud	Israël
Allemagne	Italie
Australie	Japon
Autriche	Norvège
Belgique	Pays-Bas
Corée (République Démocratique Populaire de)	Pologne
Danemark	Royaume-Uni
Etats-Unis d'Amérique	Suède
Finlande	Suisse
France	Turquie
Hongrie	Union des Républiques Socialistes Soviétiques

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES

Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote this international unification, the IEC expresses the wish that all National Committees having as yet no national rules, when preparing such rules, should use the IEC recommendations as the fundamental basis for these rules in so far as national conditions will permit.

4) The desirability is recognized of extending international agreement on these matters through an endeavour to harmonize national standardization rules with these recommendations in so far as national conditions will permit. The National Committees pledge their influence towards that end.

PREFACE

This Recommendation has been prepared by Sub-Committee 2D, Losses and Efficiency, of IEC Technical Committee No. 2, Rotating Machinery. It supersedes the second edition published in 1960.

It constitutes part of a series of recommendations dealing with rotating electrical machinery, other parts being:

Part 1, Rating and Performance (IEC Publication 34-1).
Part 3, Ratings and Characteristics of Three-phase, 50 Hz Turbine-type Machines (IEC Publication 34-3).
Part 4, Methods for Determining Synchronous Machine Quantities from Tests (IEC Publication 34-4).
Part 5, Degrees of Protection by Enclosures for Rotating Machinery (IEC Publication 34-5).
Part 6, Methods of Cooling Rotating Machinery (IEC Publication 34-6).

Work on the revision started at the meeting held in Tokyo in 1965, and a further draft was discussed at the meeting held in London in 1968. As a result of this latter meeting, a final draft was submitted to the National Committees for approval under the Six Months' Rule in November 1969.

The following countries voted explicitly in favour of publication:

Australia
Austria
Belgium
Denmark
Finland
France
Germany
Hungary
Israel
Italy
Japan
Korea (Democratic People's Republic of)
Netherlands
Norway
Poland
South Africa
Sweden
Switzerland
Turkey
Union of Soviet Socialist Republics
United Kingdom
United States of America

MACHINES ÉLECTRIQUES TOURNANTES

Deuxième partie: Méthodes pour la détermination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines pour véhicules de traction)

SECTION UN — GÉNÉRALITÉS

1. Domaine d'application

La présente recommandation s'applique aux machines à courant continu ainsi qu'aux machines à courant alternatif, synchrones et à induction, de toutes dimensions, qui sont du domaine de la Publication 34-1 de la CEI. Les principes de ces recommandations peuvent toutefois être adoptés pour d'autres types de machines telles que commutatrices, moteurs à collecteurs et moteurs à induction monophasés, pour lesquelles on applique en général d'autres méthodes de détermination des pertes.

2. Objet

La présente recommandation a pour objet de définir les méthodes de détermination du rendement à partir d'essais et également de spécifier les méthodes permettant de déterminer des pertes d'une nature donnée lorsqu'il est nécessaire de les connaître à d'autres fins.

3. Généralités

Les essais doivent être effectués sur une machine en parfait état, tous les couvercles étant montés comme en fonctionnement normal. Les dispositifs de réglage automatique de la tension qui ne font pas partie intégrante de la machine sont mis hors fonction, sauf spécification contraire.

Sauf spécification contraire, les appareils de mesure et leurs accessoires, tels que transformateurs de mesure, shunts et ponts utilisés pendant ces essais, doivent être d'une classe de précision ne dépassant pas 1,0 (Publication 51 de la CEI: Recommandations pour les appareils de mesure électriques indicateurs et leurs accessoires). Les appareils utilisés pour déterminer la résistance en courant continu doivent être d'une classe de précision ne dépassant pas 0,5.

Les appareils de mesure doivent être choisis de façon que la lecture s'effectue sur une zone de l'échelle telle qu'une fraction de division ne corresponde qu'à une faible proportion de la lecture effectuée, et puisse être facilement estimée.

Sur les machines à balais réglables, les balais doivent être placés dans la position correspondant au service nominal spécifié. Pour les mesures à vide, les balais peuvent être placés sur la ligne neutre.

La vitesse de rotation peut être mesurée par une méthode stroboscopique, par un compteur numérique ou par un tachymètre. Pour la mesure du glissement, la vitesse synchrone doit être déterminée à partir de la fréquence d'alimentation au cours de l'essai.

ROTATING ELECTRICAL MACHINES

Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)

SECTION ONE — GENERAL

1. **Scope**

This Recommendation applies to d.c. machines and to a.c. synchronous and induction machines of all sizes within the scope of IEC Publication 34-1. The principles can, however, be applied to other types of machines such as rotary convertors, a.c. commutator motors and single-phase induction motors for which other methods of determining losses are generally used.

2. **Object**

This Recommendation is intended to establish methods of determining efficiencies from tests, and also to specify methods of obtaining particular losses when these are required for other purposes.

3. **General**

Tests shall be conducted on a completely sound machine with all covers fitted in the manner required for normal service, with any devices for automatic voltage regulation not a composite part of the machine itself being made inoperative, unless otherwise agreed.

Measuring instruments and their accessories, such as measuring transformers, shunts and bridges used during the tests, unless otherwise specified, shall have an accuracy class not above 1.0 (IEC Publication 51, Recommendations for Indicating Electrical Measuring Instruments and their Accessories). Instruments for determining d.c. resistance shall be to accuracy class not above 0.5.

Instruments shall be selected to give readings over the effective range such that a fraction of a division is a small percentage of the actual reading and can be easily estimated.

On machines with adjustable brushes, the brushes shall be placed in the position corresponding to the specified rating. For measurements on no-load, the brushes may be placed on the neutral axis.

Speed of rotation may be measured by a stroboscopic method, digital counter or tachometer. When measuring slip, the synchronous speed should be determined from the supply frequency during the test.

Lorsqu'on mesure le rendement global ou la puissance absorbée d'un groupe de machines constitué de deux machines électriques, ou d'une machine et d'un transformateur, ou d'une génératrice et de son moteur d'entraînement, ou d'un moteur et de la machine qu'il entraîne, il n'est pas nécessaire d'indiquer les rendements individuels. Si toutefois ils sont indiqués séparément, ils doivent être considérés comme approximatifs.

3.1 *Liste des symboles*

Ci-dessous, la liste des symboles utilisés dans le texte, avec leur signification:

I = courant
I_l = courant en charge à la tension nominale
I_{lr} = courant primaire principal à tension réduite
I_o = courant à vide à la tension nominale
I_{or} = courant à vide à tension réduite
J = moment d'inertie
n = vitesse nominale, en tours par minute
P_l = puissance absorbée à la tension nominale
P_{lr} = puissance absorbée par l'enroulement primaire à tension réduite
s = glissement
U = tension d'excitation aux bornes du rhéostat principal
U_e = tension totale d'excitation
U_n = tension nominale
U_r = tension réduite pour essai en charge
φ = angle de déphasage en charge à tension nominale
φ_r = angle de déphasage en charge à tension réduite
φ_o = angle de déphasage à vide à tension nominale
φ_{or} = angle de déphasage à vide à tension réduite

4. Définitions

Pour les définitions des termes généraux employés dans la présente recommandation, il convient de se reporter au Vocabulaire Electrotechnique International [Publication 50 de la CEI].

Dans le cadre de la présente recommandation, les définitions suivantes sont applicables:

4.1 *Rendement*

Rapport de la puissance utile à la puissance absorbée, exprimées dans les mêmes unités, et généralement indiqué en pour-cent.

4.2 *Pertes totales*

Différence entre la puissance absorbée et la puissance utile.

4.3 *Essai au frein*

Essai dans lequel la puissance mécanique fournie par une machine fonctionnant en moteur est déterminée par la mesure du couple sur l'arbre au moyen d'un frein ou d'un dynamomètre et par la mesure simultanée de la vitesse de rotation; l'essai peut être également effectué sur une machine fonctionnant en génératrice au moyen d'un dynamomètre pour déterminer la puissance mécanique absorbée.

When the over-all efficiency or the absorbed power is measured for a group of machines comprising two electrical machines, or a machine and a transformer, or a generator and its driving machine, or a motor and its driven machine, there is no need to indicate the individual efficiencies. If, however, these are given separately, they should be regarded as approximate.

3.1 *List of symbols*

A list of symbols used in the draft, with the general meanings attributed to each one, is given below:

I = current
I_l = load current at rated voltage
I_{lr} = main primary current at reduced voltage
I_o = no-load current at rated voltage
I_{or} = no-load current at reduced voltage
J = moment of inertia
n = rated speed, in revolutions per minute
P_l = power absorbed at rated voltage
P_{lr} = power absorbed by main primary winding at reduced voltage
s = slip
U = excitation voltage across terminals of main rheostat
U_e = total excitation voltage
U_n = rated voltage
U_r = reduced voltage for load test
φ = load phase angle at rated voltage
φ_r = load phase angle at reduced voltage
φ_o = no-load phase angle at rated voltage
φ_{or} = no-load phase angle at reduced voltage

4. Definitions

For definitions of general terms used in this Recommendation, reference should be made to the International Electrotechnical Vocabulary [IEC Publication 50].

For the purpose of this Recommendation, the following definitions apply:

4.1 *Efficiency*

The ratio of output to input expressed in the same units and usually given as a percentage.

4.2 *Total loss*

The difference between the input and the output.

4.3 *Braking test*

A test in which the mechanical power output of a machine acting as a motor is determined by the measurement of the shaft torque, by means of a brake or dynamometer, together with the rotational speed. Alternatively, a test performed on a machine acting as a generator, by means of a dynamometer to determine the mechanical power input.

4.4 *Essai avec machine auxiliaire tarée*

Essai dans lequel la puissance mécanique absorbée ou fournie par une machine électrique est calculée à partir de la puissance électrique fournie ou absorbée par une machine auxiliaire tarée accouplée mécaniquement à la machine en essai.

4.5 *Essai en opposition*

Essai dans lequel deux machines identiques sont accouplées mécaniquement, les pertes totales des deux machines étant calculées par différence des puissances électriques que l'une absorbe et que l'autre fournit (voir figure 1, page 54).

4.6 *Essai en opposition avec marche en parallèle sur un réseau*

Essai dans lequel deux machines identiques sont accouplées mécaniquement et connectées toutes deux à un même réseau. Les pertes totales des deux machines sont égales à la puissance fournie par ce réseau (voir figure 2, page 54).

4.7 *Essai de ralentissement*

Essai dans lequel les pertes d'une machine sont calculées à partir du taux de ralentissement de la machine lorsque n'interviennent que ces pertes.

4.8 *Essai calorimétrique*

Essai dans lequel on détermine les pertes de la machine à partir de la quantité de chaleur qu'elles produisent. Les pertes sont calculées à partir du produit de la quantité de réfrigérant par son échauffement, et le cas échéant de la quantité de chaleur dissipée à l'extérieur.

4.9 *Essai à vide*

Essai dans lequel une machine fonctionne en moteur sans fournir de puissance mécanique utile sur l'arbre.

4.10 *Essai à circuit ouvert*

Essai dans lequel une machine fonctionne en génératrice avec ses bornes à circuit ouvert.

4.11 *Essai de court-circuit permanent*

Essai dans lequel une machine fonctionne en génératrice avec ses bornes en court-circuit.

4.12 *Essai au facteur de puissance nul*

Essai à vide effectué sur une machine synchrone surexcitée et fonctionnant à un facteur de puissance très voisin de zéro.

4.4 *Calibrated driving machine test*

A test in which the mechanical input or output of an electrical machine is calculated from the electrical output or input of a calibrated machine mechanically coupled to the machine on test.

4.5 *Mechanical back-to-back test*

A test in which two identical machines are mechanically coupled together, and the total losses of both machines are calculated from the difference between the electrical input to one machine and the electrical output of the other machine (see Figure 1, page 54).

4.6 *Electrical back-to-back test*

A test in which two identical machines are mechanically coupled together, and they are both connected electrically to a power system. The total losses of both machines are taken as the power input drawn from the system (see Figure 2, page 54).

4.7 *Retardation test*

A test in which the losses in a machine are deduced from the rate of deceleration of the machine when only these losses are present.

4.8 *Calorimetric test*

A test in which the losses in a machine are deduced from the heat produced by them. The losses are calculated from the product of the amount of coolant and its temperature rise, and the heat dissipated in the surrounding media.

4.9 *No-load test*

A test in which the machine is run as a motor providing no useful mechanical output from the shaft.

4.10 *Open-circuit test*

A test in which a machine is run as a generator with its terminals open-circuited.

4.11 *Sustained short-circuit test*

A test in which a machine is run as a generator with its terminals short-circuited.

4.12 *Zero power factor test*

A no-load test on a synchronous machine which is over-excited and operates at a power factor very close to zero.

5. **Température de référence**

Sauf spécification contraire, toutes les pertes par effet Joule doivent être ramenées à l'une des températures indiquées ci-après.

Classes A, E et B: 75 °C
Classes F et H: 115 °C

Note. — Il n'est pas nécessaire que la classe réelle d'isolant employée pour l'organe considéré de la machine corresponde aux limites d'échauffement choisies.

SECTION DEUX — MACHINES A COURANT CONTINU

6. **Pertes à comprendre**

Les pertes totales peuvent être considérées comme la somme des pertes suivantes:

6.1 *Pertes dans le circuit d'excitation*

a) Pertes par effet Joule dans les circuits d'excitation en dérivation ou séparés et dans les rhéostats d'excitation.

b) Pertes dans l'excitatrice.

Toutes les pertes dans l'excitatrice lorsque celle-ci, formant partie intégrante d'un ensemble complet, est entraînée mécaniquement par l'arbre principal et est utilisée exclusivement pour l'excitation de la machine, ainsi que les pertes dans le rhéostat d'excitation de cette excitatrice, mais à l'exception des pertes par frottement et par ventilation.

Dans le cas d'une excitation séparée, fournie par des moyens tels que batterie, redresseur ou groupe moteur-générateur, il n'y a pas à tenir compte des pertes dans la source d'excitation ou dans les connexions entre la source et les balais.

Note. — Quand les pertes dans un système d'excitation séparé sont demandées, elles peuvent être indiquées séparément et prises égales à la différence entre le quotient de la puissance d'excitation par le rendement du système d'excitation et la puissance d'excitation.

6.2 *Pertes constantes*

a) Pertes dans le fer et pertes supplémentaires à vide dans les autres parties métalliques.

b) Pertes dues au frottement (paliers et balais) à l'exclusion des pertes dans un système de graissage séparé. Les pertes dans les paliers communs doivent être indiquées séparément, que ces paliers soient fournis ou non avec la machine.

Note. — Si l'on doit indiquer les pertes dans un système de graissage séparé, celles-ci doivent être mentionnées séparément.

5. **Reference temperature**

Unless otherwise specified, all I^2R losses shall be corrected to one of the temperatures given below:

Classes A, E and B: 75 °C
Classes F and H: 115 °C

Note. — The reference temperature need not necessarily correspond with the limits of temperature rise permitted for the actual class of insulation used for a particular part of the machine.

SECTION TWO — D.C. MACHINES

6. **Losses to be included**

The total losses may be taken as the sum of the following component losses:

6.1 *Excitation circuit losses*

a) I^2R losses in shunt or separately excited windings and in the excitation rheostats.

b) Exciter losses.

All the losses in an exciter mechanically driven from the main shaft, which forms part of the complete unit and is used solely for exciting the machine, together with losses in the rheostat in the excitation circuit of such an exciter, but with the exception of friction and windage losses.

In the case of a separate excitation supply such as battery, rectifier or motor generator set, no allowance is made for the losses in the excitation source or in the connections between the source and the brushes.

Note. — When the losses in a separate excitation system are required, these should be listed separately and can be taken as the difference between the excitation power divided by the efficiency of the excitation system, and the excitation power.

6.2 *Constant losses*

a) Losses in active iron, and additional no-load losses in other metal parts.

b) Losses due to friction (bearings and brushes) not including any losses in a separate lubricating system. Losses in common bearings shall be stated separately, whether or not such bearings are supplied with the machine.

Note. — When the losses in a separate lubricating system are required, these should be listed separately.

c) Pertes totales par ventilation dans la machine, y compris la puissance absorbée par les ventilateurs faisant partie intégrante de la machine et par les machines auxiliaires, s'il en existe, faisant partie intégrante de la machine. Les pertes dans les machines auxiliaires telles que les ventilateurs extérieurs, pompes à eau et à huile ne faisant pas partie intégrante de la machine, mais destinées exclusivement à la machine en question, ne doivent être comprises que sur accord.

Note. — Si l'on doit indiquer les pertes dans un système de ventilation séparé, elles doivent être mentionnées séparément, étant donné qu'elles ne font pas partie des pertes de la machine.

6.3 *Pertes en charge*

a) Pertes par effet Joule dans l'induit et dans les enroulements parcourus par le courant d'induit (par exemple enroulements de commutation, de compensation, d'excitation et tous enroulements connectés en série avec l'induit).

b) Pertes électriques dans les balais.

6.4 *Pertes supplémentaires en charge*

a) Pertes supplémentaires en charge dans le fer et les autres parties métalliques autres que les conducteurs.

b) Pertes par courants de Foucault dans les conducteurs d'induit, dues à la pulsation de flux dépendant des courants et à la commutation.

c) Pertes dans les balais, dues à la commutation.

Note. — Ces pertes sont parfois dites pertes supplémentaires, mais ne comprennent pas les pertes supplémentaires à vide mentionnées au paragraphe 6.2 *a*).

7. Détermination du rendement

7.1 *Totalisation des pertes*

Le rendement peut être calculé à partir des pertes totales, considérées comme la somme des pertes déterminées de la façon suivante:

7.1.1 *Pertes par excitation*

Ces pertes sont les suivantes:

7.1.1.1 *Pertes par effet Joule dans l'enroulement d'excitation*

Ces pertes sont calculées par la formule RI^2, dans laquelle R est la résistance de l'enroulement d'excitation en dérivation ou séparée, ramenée à la température de référence, et I le courant d'excitation. Sauf dans le cas *c)* ci-dessous, le courant d'excitation est celui qui correspond à la vitesse nominale et au régime nominal. Dans le cas *c)* ci-dessous, c'est celui qui correspond à la vitesse nominale à vide.

c) The total windage loss in the machine including power absorbed in integral fans and in auxiliary machines, if any, forming an integral part of the machine. The losses in auxiliary machines such as external fans, water and oil pumps not forming an integral part of the machine, but provided exclusively for the machine in question, shall be included only by agreement.

Note. — When the losses in a separate ventilating system are required, they should be listed separately as they are not part of the machine losses.

6.3 *Load losses*

a) I^2R losses in armature, and windings carrying armature current (e.g. commutating, compensating, excitation and series connected windings).

b) Electrical losses in brushes.

6.4 *Additional load losses*

a) Losses introduced by load in active iron, and other metal parts other than the conductors.

b) Eddy current losses in armature conductors caused by current dependent flux pulsation and commutation.

c) Losses in the brushes caused by commutation.

Note. — These losses are sometimes called additional losses, but they do not include the additional no-load losses in Sub-clause 6.2 *a*).

7. Determination of efficiency

7.1 *Summation of losses*

The efficiency can be calculated from the total losses which are assumed to be the summation of the losses obtained in the following manner:

7.1.1 *Excitation losses*

These are:

7.1.1.1 *Excitation winding I^2R losses*

These losses are calculated from the formula I^2R, where R is the resistance of the shunt excitation winding (or separately excited winding), corrected to the reference temperature, and I is the excitation current. Except for case *c)* below, the excitation current shall be that corresponding to rated speed under rated load conditions. For case *c)* below, the excitation current shall be that corresponding to rated speed at no-load.

Si le courant d'excitation ne peut pas être mesuré au cours d'un essai en charge, on admet qu'il est égal:

a) Dans le cas des génératrices à excitation en dérivation ou à excitation séparée avec ou sans pôles de commutation, à 110% du courant d'excitation correspondant à la marche à vide sous une tension égale à la tension nominale majorée de la chute ohmique dans le circuit d'induit (induit, balais, enroulements de commutation, s'il y a lieu, voir aussi paragraphe 7.1.3.2) sous le courant nominal en charge.

b) Dans le cas des génératrices compensées à excitation en dérivation ou à excitation séparée, au courant d'excitation correspondant à la marche à vide sous une tension égale à la tension nominale majorée de la chute ohmique dans le circuit d'induit (induit, balais, enroulements de commutation et de compensation, s'il y a lieu, voir aussi paragraphe 7.1.3.2) sous le courant nominal en charge.

c) Dans le cas des génératrices à excitation compound ajustée, au courant d'excitation correspondant à la marche à vide à la tension nominale.

d) Dans le cas des génératrices à excitation hypercompound ou hypocompound et des types spéciaux de génératrices non couverts par les points *a)* à *c)*, à la valeur convenue entre le constructeur et l'acheteur.

e) Dans le cas des moteurs shunt, au courant d'excitation à vide à la tension nominale.

7.1.1.2 *Pertes dans le rhéostat principal*

Ces pertes sont calculées par la formule RI^2 dans laquelle R est la résistance de la partie du rhéostat en circuit pour le régime considéré et I la valeur du courant d'excitation défini au paragraphe 7.1.1.1 ci-dessus. Elles sont aussi égales au produit IU du courant d'excitation par la fraction U de la tension d'excitation qui doit être absorbée dans le rhéostat.

La somme des pertes, paragraphes 7.1.1.1 et 7.1.1.2, est aussi égale au produit IU_e du courant d'excitation I par la tension totale d'excitation U_e.

Note. — Quand une résistance est reliée en permanence en série dans le circuit d'excitation, elle doit être prise en compte de la même façon que le rhéostat principal.

7.1.1.3 *Pertes dans l'excitatrice*

Note. — Ceci s'applique seulement dans le cas où l'excitatrice est entraînée mécaniquement par l'arbre principal et est utilisée exclusivement pour l'excitation de la machine principale.

Ces pertes comprennent l'excès de la puissance absorbée sur l'arbre par l'excitatrice sur la puissance utile qu'elle fournit à ses bornes* ainsi que les pertes d'excitation de l'excitatrice si celle-ci est excitée par une source séparée.

Si l'excitatrice peut être désaccouplée de la machine principale et essayée séparément, la puissance qu'elle absorbe peut être mesurée par la méthode du moteur taré.

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* La puissance utile aux bornes de l'excitatrice est égale à la somme des pertes, paragraphes 7.1.1.1 et 7.1.1.2, de la machine principale.

If the excitation current cannot be measured during a test on load, it should be taken as:

a) For shunt connected or separately excited generators with or without commutation poles; 110% of the excitation current, corresponding to no-load at a voltage equal to the rated voltage plus ohmic drop in the armature circuit (armature, brushes and commutating windings if any, see also Sub-clause 7.1.3.2) at rated load current.

b) For compensated shunt or separately excited generators: the excitation current corresponding to no-load at a voltage equal to the rated voltage plus the ohmic drop in the armature circuit (armature, brushes, commutating windings and compensating windings, see also Sub-clause 7.1.3.2) at rated load current.

c) For level-compounded generators: the excitation current for the rated no-load voltage.

d) For over-compounded and under-compounded generators, and special types of generator not covered by items *a)* to *c)*: as agreed between manufacturer and purchaser.

e) For shunt wound motors: equal to no-load excitation current corresponding to the rated voltage.

7.1.1.2 *Main rheostat losses*

These losses are calculated from the formula I^2R, where R is the resistance of the part of the rheostat in circuit for the rating considered, and I is the value of the excitation current defined as in Sub-clause 7.1.1.1 above. They are also equal to the product, IU, of the excitation current multiplied by U, the excitation voltage which must be absorbed in the rheostat.

The sum of the losses, Sub-clauses 7.1.1.1 and 7.1.1.2, is also equal to the product IU_e of the excitation current I and the total excitation voltage U_e.

Note. — Where a resistance is permanently connected in series in the excitation circuit it should be dealt with in the same way as the main rheostat.

7.1.1.3 *Exciter losses*

Note. — This applies only to the case where the exciter is mechanically driven from the main shaft and is used solely for exciting the main machine.

These losses include the difference between the power absorbed at the shaft by the exciter and the useful power which it provides at its terminals,* as well as the excitation losses in the exciter if this is excited from a separate source.

If the exciter can be uncoupled from the main machine and tested separately, the power which it absorbs may be measured by using the calibrated-machine method.

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* The useful power at the terminals of the exciter is equal to the sum of the losses, Sub-clauses 7.1.1.1 and 7.1.1.2, of the main machine.

Si elle ne peut pas être désaccouplée de la machine principale, la puissance qu'elle absorbe peut être mesurée soit par la méthode de fonctionnement en moteur à vide, soit par la méthode du moteur taré (article 13), soit par la méthode de ralentissement (article 15), appliquée au groupe complet. Dans ces trois méthodes, la puissance absorbée par l'excitatrice s'obtient par différence entre les pertes totales du groupe mesurées dans des conditions identiques, d'abord avec l'excitatrice en charge, puis avec l'excitatrice non excitée, l'excitation étant fournie par une source indépendante.

Si aucune de ces méthodes n'est applicable, la puissance absorbée par l'excitatrice s'obtient en ajoutant à la puissance mesurée à ses bornes les différentes pertes séparées déterminées comme il est dit à l'article 6. Toutefois, il n'y a pas à tenir compte des pertes mécaniques par frottement et ventilation qui sont mesurées en même temps que celles de la machine principale.

7.1.2 *Pertes indépendantes du courant*

7.1.2.1 *Essai à vide à la tension nominale*

Les pertes constantes se déterminent en faisant fonctionner la machine en moteur à vide sous une tension égale à la tension nominale, la vitesse étant portée à sa valeur nominale par réglage de l'excitation, alimentée de préférence par une source séparée.

La puissance électrique totale absorbée, diminuée des pertes par effet Joule dans l'induit et dans l'enroulement d'excitation ou, s'il y a lieu, de la puissance absorbée par l'excitatrice, donne la somme des pertes constantes.

7.1.2.2 *Essai à circuit ouvert*

Les pertes constantes peuvent être déterminées séparément en entraînant la machine à sa vitesse nominale au moyen d'un moteur taré. La machine est excitée (de préférence par une source indépendante) de façon à fonctionner en génératrice à vide sous une tension égale à sa tension nominale. La puissance qu'elle absorbe sur son arbre, et qui s'obtient à partir de la puissance électrique absorbée par le moteur taré, donne la somme des pertes constantes. En supprimant l'excitation, on obtient de la même façon la somme des pertes par frottement et par ventilation. Les pertes dans le fer peuvent être déterminées séparément en déduisant les pertes mesurées au cours de cet essai de celles mesurées au cours de l'essai à vide précédent. En relevant les balais, on peut déterminer séparément les pertes par frottement des balais en déduisant les pertes mesurées au cours de cet essai de celles mesurées au cours de l'essai précédent sans excitation.

7.1.2.3 *Essai de ralentissement*

Dans les machines à grande inertie, les pertes totales constantes, ainsi que les pertes séparées constantes, peuvent être déterminées par la méthode de ralentissement.

7.1.3 *Pertes dépendant du courant*

Ces pertes sont les suivantes:

If the exciter cannot be uncoupled from the main machine, the power which it absorbs may be measured either by the method of working the main machine as a motor on no-load, or by the calibrated machine method (Clause 13), or by the retardation method (Clause 15), applied to the whole unit. In these three methods, the power absorbed by the exciter is obtained as the difference between the total losses of the unit measured under identical conditions, first with the exciter on-load and secondly with the exciter non-excited, the excitation being supplied by an independent source.

If none of these methods is applicable, the power absorbed by the exciter is obtained by adding to the power, measured at the terminals, the different separate losses determined as under Clause 6. However, mechanical friction and windage losses which are measured at the same time as those of the main machine need not be taken into account.

7.1.2 *Constant losses*

7.1.2.1 *No-load test at rated voltage*

The constant losses shall be determined by running the machine under no-load conditions as a motor with rated voltage applied and with rated speed achieved by adjustment of the excitation, which shall preferably be derived from a separate source.

The total electric power absorbed, less the I^2R losses in the armature and in the excitation winding or, if necessary, less the power absorbed by the exciter, gives the sum of the constant losses.

7.1.2.2 *Open circuit test*

The constant losses can be determined separately by driving the machine at its rated speed by means of a calibrated machine. The machine on test is excited (preferably from an independent source), so as to work as a generator on no-load at a voltage equal to its rated voltage, the power which it absorbs at its shaft, and which can be obtained from the electric power absorbed by the calibrated machine, giving the sum of the constant losses. By removing the excitation, the sum of the friction and windage losses is obtained in the same way. The core losses may be determined separately by subtracting the losses during this test from those measured during the previous no-load test. By lifting the brushes the brush friction loss may be determined separately by subtracting the losses during this test from those measured during the previous, unexcited test.

7.1.2.3 *Retardation test*

In machines with large inertia, the total constant losses, as well as the separate constant losses, can be determined by the retardation method.

7.1.3 *Load losses*

These are:

7.1.3.1 *Pertes par effet Joule dans le circuit d'induit*

Ces pertes sont calculées en partant du courant et des valeurs mesurées des résistances ramenées par le calcul à la température de référence; cependant, lorsque la mesure des résistances est impraticable en raison des très faibles valeurs en jeu, la détermination par le calcul est admise.

Note. — Ces pertes comprennent également celles dans les enroulements de compensation, les enroulements des pôles de commutation et les résistances de shuntage. Dans le cas d'une résistance de shuntage en parallèle avec un enroulement série, les pertes par effet Joule sont déterminées en partant du courant total et de la résistance résultante.

7.1.3.2 *Pertes électriques dans les balais*

On admet que la somme de ces pertes est égale au produit du courant total par une chute de tension déterminée.

La chute de tension admise pour tous les balais d'une même polarité est de 1,0 V pour les balais en carbone ou en graphite, et de 0,3 V pour les balais en carbone métallisé, c'est-à-dire que la chute de tension totale est de 2,0 V pour les balais en carbone ou en graphite, et de 0,6 V pour les balais en carbone métallisé.

7.1.4 *Pertes supplémentaires en charge*

Sauf spécification contraire, on admet que ces pertes varient comme le carré du courant et que leur valeur totale pour le courant nominal maximal est:

Pour les machines non compensées

1% de la puissance nominale absorbée pour les moteurs;
1% de la puissance nominale utile pour les génératrices.

Pour les machines compensées

0,5% de la puissance nominale absorbée pour les moteurs;
0,5% de la puissance nominale utile pour les génératrices.

Pour les machines à vitesse constante, la puissance nominale fournie ou absorbée est la puissance qui serait obtenue pour le courant nominal maximal et la tension nominale maximale.

Pour les moteurs à variation de vitesse par variation de la tension appliquée, la puissance nominale absorbée est définie pour chaque vitesse comme la puissance absorbée lorsque le courant nominal maximal à la vitesse considérée est associé à la tension correspondant à cette vitesse.

Pour les moteurs à vitesse variable compensés ou non, dans lesquels l'augmentation de la vitesse est obtenue par affaiblissement du champ, la puissance nominale absorbée est définie comme la puissance absorbée lorsqu'on associe la tension nominale au courant nominal maximal. Pour les génératrices à vitesse variable, dans lesquelles la tension est maintenue constante par variation du champ, la puissance nominale fournie est définie comme la puissance fournie disponible aux bornes à la tension nominale et au courant nominal maximal. Les pertes supplémentaires à la vitesse correspondant au plein champ sont celles spécifiées ci-dessus. Aux autres vitesses, on peut calculer les pertes supplémentaires en multipliant celles qui correspondent à la vitesse de plein champ par les facteurs de correction donnés au tableau 1, page 22.

7.1.3.1 *Armature circuit* I^2R *losses*

These losses are calculated from the current and the measured resistance, corrected to the reference temperature, except that where resistance measurement is impracticable due to very low resistances, calculation is permissible.

Note. — Under this heading are included compensating windings, commutating pole windings and diverters. In the case of diverters in parallel with a series winding, the I^2R losses should be determined using the total current and the resulting resistance.

7.1.3.2 *Electrical losses in brushes*

The sum of these losses shall be taken as the product of the armature current and a fixed voltage drop.

The voltage drop allowed for all brushes of each polarity shall be 1.0 V for carbon or graphite brushes and 0.3 V for metal-carbon brushes, i.e. a total drop of 2.0 V for carbon or graphite brushes, and 0.6 V for metal-carbon brushes.

7.1.4 *Additional load losses*

Unless otherwise specified, it is assumed that these losses vary as the square of the current. and that their total value at maximum rated current is, for:

Uncompensated machines

1% of the rated input for motors;
1% of the rated output for generators.

Compensated machines

0.5% of the rated input for motors;
0.5% of the rated output for generators.

For constant speed machines, the rated output or input as appropriate is taken as the output or input which would be obtained at maximum rated current and maximum rated voltage.

For variable speed motors where the speed change is obtained by applied voltage, the rated input is defined at each speed as being the input when the maximum rated current at any speed is associated with the applied voltage of the particular speed considered.

For variable speed motors where the increase in speed is obtained by weakening the field, the rated input is defined as being the input when the rated voltage is associated with the maximum rated current. For variable speed generators where the voltage is maintained constant by varying the field, the rated output is defined as being the output which is available at the terminals at rated voltage and maximum rated current. The allowances for additional losses at the speed corresponding to the full field shall be as specified above. The allowances for additional losses at other speeds shall be calculated using the appropriate multiplying factors given in Table 1, page 23.

TABLEAU I

Facteurs de correction pour divers rapports de vitesses

Rapport des vitesses	Facteur de correction
1,5:1	1,4
2 :1	1,7
3 :1	2,5
4 :1	3,2

Le rapport des vitesses figurant à la première colonne du tableau I est le rapport de la vitesse vraie considérée à la vitesse nominale minimale pour service continu.

Pour des rapports de vitesses différents de ceux indiqués dans ce tableau, on déterminera les facteurs de correction appropriés par interpolation.

Note. — Les pertes supplémentaires peuvent être obtenues par un essai en charge ou en opposition, en soustrayant des pertes totales mesurées toutes les autres pertes connues.

7.1.4.1 *Variation des pertes dans le fer due à la charge*

Cette variation est considérée généralement comme négligeable. Sur accord spécial, dans le cas de machines à très basse tension, la somme, paragraphes 6.2 *a)* et 6.4 *a)*, peut être mesurée comme il est indiqué pour les pertes constantes, paragraphe 6.2 *a)*, par l'une ou l'autre des deux méthodes de fonctionnement en moteur à vide ou en génératrice à vide, mais en faisant l'essai, non pas à la tension nominale, mais à cette tension nominale augmentée ou diminuée de la chute de tension dans le circuit de l'induit pour le courant considéré, selon qu'il s'agit d'une génératrice ou d'un moteur.

7.2 *Mesure globale des pertes*

7.2.1 *Essai au frein*

La machine fonctionne dans les conditions nominales de vitesse, de tension et de courant; le rendement est pris égal au rapport de la puissance utile à la puissance absorbée.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

7.2.2 *Essai avec machine auxiliaire tarée* (voir article 13)

La machine fonctionne dans les conditions nominales de vitesse, de tension et de courant; le rendement est pris égal au rapport de la puissance utile à la puissance absorbée.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

TABLE I

Multiplying factors for different speed ratios

Speed ratio	Multiplying factor
1.5:1	1.4
2 :1	1.7
3 :1	2.5
4 :1	3.2

The speed ratio in the first column of Table I shall be taken as the ratio of actual speed under consideration to the minimum rated speed for continuous running.

For speed ratios other than those given in Table I the appropriate multiplying factors can be ascertained by interpolation.

Note. — The additional load loss may be obtained from an input-output test or from a back-to-back test by subtracting from the total measured losses all other known losses.

7.1.4.1 *Change in core loss due to load*

In general, this variation is usually negligible. By special agreement, for very low voltage machines, the sum, Sub-clauses 6.2 *a)* and 6.4 *a)*, may be measured as described for the constant losses in active iron, Sub-clause 6.2 *a)* by one or other of the two methods, by operating as a motor on no-load or as a generator on no-load, but instead of making the test at the rated voltage, the test is made at the rated voltage increased or decreased by the voltage drop in the armature circuit for the current considered, depending on whether the machine is a generator or a motor.

7.2 *Total loss measurement*

7.2.1 *Braking test*

When the machine is run at rated conditions of speed, voltage and current, the efficiency is then taken as the ratio of output to input.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

7.2.2 *Calibrated machine test* (see Clause 13)

When the machine is run at rated conditions of speed, voltage and current, the efficiency is taken as the ratio of output to input.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

7.2.3 *Essai en opposition*

Les machines identiques tournant dans des conditions nominales qui sont pratiquement les mêmes, les pertes sont considérées comme également réparties et le rendement est calculé à partir de la moitié des pertes totales et de la puissance électrique absorbée (dans le cas d'un moteur) ou fournie (dans le cas d'une génératrice).

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

7.2.4 *Essai en opposition avec marche en parallèle sur un réseau* (voir article 16)

Les machines identiques tournant dans des conditions nominales qui sont pratiquement les mêmes, les pertes couvertes par le réseau sont considérées comme également réparties et le rendement est calculé comme indiqué au paragraphe 7.2.3 ci-dessus.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

SECTION TROIS — MACHINES A INDUCTION POLYPHASÉES

8. **Pertes à comprendre**

Les pertes totales peuvent être considérées comme la somme des pertes suivantes:

8.1 *Pertes constantes*

a) Pertes dans le fer et pertes supplémentaires à vide dans les autres parties métalliques.

b) Pertes dues au frottement (paliers et balais s'ils ne sont pas relevés en fonctionnement) à l'exclusion des pertes dans un système de graissage séparé. Les pertes dans les paliers communs doivent être indiquées séparément, que ces paliers soient fournis ou non avec la machine.

Note. — Si l'on doit indiquer les pertes dans un système de graissage séparé, celles-ci doivent être mentionnées séparément.

c) Pertes totales par ventilation dans la machine y compris la puissance absorbée par les ventilateurs faisant partie intégrante de la machine et par les machines auxiliaires, s'il en existe, faisant partie intégrante de la machine. Les pertes dans les machines auxiliaires telles que les ventilateurs extérieurs, pompes à eau et à huile ne faisant pas partie intégrante de la machine, mais destinées exclusivement à la machine en question, ne doivent être comprises que sur accord.

Note. — Si l'on doit indiquer les pertes dans un système de ventilation séparé, elles doivent être mentionnées séparément.

8.2 *Pertes en charge*

a) Pertes par effet Joule dans les enroulements primaires.

b) Pertes par effet Joule dans les enroulements secondaires.

c) Pertes électriques dans les balais (s'il y a lieu).

7.2.3 *Mechanical back-to-back test*

When identical machines are run at essentially the same rated conditions, the losses are assumed to be equally distributed, and the efficiency is calculated from half the total losses and the electrical input (in the case of a motor) or electrical output (in the case of a generator).

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

7.2.4 *Electrical back-to-back test* (see Clause 16)

When identical machines are run at essentially the same rated conditions, the losses supplied from the electrical system are assumed to be equally distributed and the efficiency is calculated as in Sub-clause 7.2.3.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

SECTION THREE — POLYPHASE INDUCTION MACHINES

8. **Losses to be included**

The total losses may be taken as the sum of the following component losses:

8.1 *Constant losses*

a) Losses in active iron, and additional no-load losses in other metal parts.

b) Losses due to friction (bearings and brushes, if not lifted during operation) not including any losses in a separate lubricating system. Losses in common bearings shall be stated separately whether or not such bearings are supplied with the machine.

Note. — When the losses in a separate lubricating system are required these should be listed separately.

c) The total windage loss in the machine, including power absorbed in integral fans, and in auxiliary machines, if any, forming an integral part of the machine. The losses in auxiliary machines such as external fans, water and oil pumps not forming an integral part of the machine, but provided exclusively for the machine in question, shall be included only by agreement.

Note. — When the losses in a separate ventilating system are required they should be listed separately.

8.2 *Load losses*

a) I^2R losses in primary windings.

b) I^2R losses in secondary windings.

c) Electrical losses in brushes (if any).

8.3 *Pertes supplémentaires en charge*

a) Pertes supplémentaires en charge dans le fer et les autres parties métalliques autres que les conducteurs.

b) Pertes par courants de Foucault dans les conducteurs d'enroulements primaires ou secondaires, dues à la pulsation du flux dépendant du courant.

Notes 1. — Les pertes, paragraphes *a)* et *b)*, sont parfois dites pertes supplémentaires, mais ne comprennent pas les pertes supplémentaires à vide mentionnées au paragraphe 8.1 *a)*.

2. — Dans le cas des machines auxiliaires telles que les compensateurs de phase entraînés mécaniquement par l'arbre principal, les pertes doivent être comprises de la même façon que les pertes dans l'excitatrice dans le cas des machines synchrones. Les pertes dans les compensateurs de phase ou appareils de régulation entraînés séparément doivent être indiquées séparément pour le régime nominal de la machine. Ces pertes doivent être déterminées par la méthode normale pour le type d'appareil considéré.

9. Détermination du rendement

9.1 *Totalisation des pertes*

Le rendement peut être calculé à partir des pertes totales, considérées comme la somme des pertes déterminées de la façon suivante:

9.1.1 *Pertes constantes*

9.1.1.1 *Essai à vide à la tension nominale*

La somme des pertes constantes, paragraphes 8.1 *a)*, *b)* et *c)*, se détermine par la méthode du fonctionnement en moteur à vide. La machine est alimentée à sa tension et à sa fréquence nominales. La puissance absorbée, diminuée des pertes par effet Joule dans l'enroulement primaire, donne le total des pertes constantes. Les pertes par effet Joule dans l'enroulement secondaire peuvent être négligées.

9.1.1.2 *Essais avec machine auxiliaire tarée* (voir article 13)

Les pertes constantes peuvent être déterminées séparément en entraînant la machine, séparée du réseau, à sa vitesse nominale au moyen d'un moteur taré (voir paragraphe 9.2.2). Avec les balais en place, s'il y a lieu, la puissance absorbée sur l'arbre par la machine, qui se déduit de la puissance électrique absorbée par le moteur taré, donne le total des pertes, paragraphes 8.1 *b)* et 8.1 *c)*. Avec les balais relevés, s'il y a lieu, on obtient de même la somme des pertes par frottement dans les paliers et des pertes totales par ventilation. Les pertes définies au paragraphe 8.1 *a)* se déduisent des précédentes par différence, à partir de l'essai au paragraphe 9.1.1.1.

9.1.1.3 *Essai à vide à tension variable*

Les pertes définies au paragraphe 8.1 *a)* et la somme des pertes définies au paragraphe 8.1 *b)* et *c)* peuvent être également déterminées séparément en faisant fonctionner la machine en moteur à vide à sa fréquence nominale, mais à des tensions différentes. La puissance absorbée,

8 3 *Additional load losses*

a) Losses introduced by load in active iron and other metal parts other than the conductors.

b) Eddy current losses in primary or secondary winding conductors caused by current dependent flux pulsation.

Notes 1. — Losses, Sub-clause 8.3 *a)* and *b)*, are sometimes called additional losses, but they do not include the additional no-load losses in Sub-clause 8.1 *a)*.

2. — In the case of auxiliary machines such as phase advancers driven mechanically from the main shaft, the losses should be included in the same way as the exciter losses are included for synchronous machines. Losses in separately driven phase advancers or regulating equipment should be given separately for rated operating conditions of the main machine. These losses should be determined by the standard method for the types of apparatus involved.

9. Determination of efficiency

9.1 *Summation of losses*

The efficiency can be calculated from the total losses which are assumed to be the summation of the losses obtained in the following manner:

9.1.1 *Constant losses*

9.1.1.1 *No-load test at rated voltage*

The sum of the constant losses, Sub-clause 8.1 *a), b)* and *c)*, is determined by running the machine as a motor on no-load. The machine is fed at its rated voltage and frequency. The power absorbed, decreased by the I^2R losses in the primary winding, gives the total of the constant losses. The I^2R losses in the secondary winding may be neglected.

9.1.1.2 *Calibrated machine test* (see Clause 13)

The constant losses may be determined separately by driving the machine, disconnected from the network, at its rated speed by means of a calibrated motor (see Sub-clause 9.2.2). With the brushes, if any, in place, the power absorbed at the shaft of the machine, which may be deduced from the electrical power absorbed by the calibrated motor, gives the sum of the losses in Sub-clause 8.1 *b)* and 8.1 *c)*. With the brushes, if any, lifted the sum of the bearing friction losses and the total windage losses is obtained in the same manner. The losses described in Sub-clause 8.1 *a)* may be obtained from the test described in Sub-clause 9.1.1.1 by subtraction.

9.1.1.3 *No-load test at variable voltage*

The losses described in Sub-clause 8.1 *a)* and the sum of the losses described in Sub-clause 8.1 *b)* and *c)* may alternatively be separated by running the machine as a motor at rated frequency but at different voltages. The power absorbed, less the I^2R losses in the primary

diminuée des pertes par effet Joule dans l'enroulement primaire, est reportée sur un diagramme en fonction du carré de la tension. On obtient ainsi, aux faibles saturations, une ligne droite qui peut être extrapolée jusqu'à une valeur nulle de la tension de façon à donner la somme des pertes, paragraphe 8.1 *b)* et *c)*.

Il ne faut pas oublier qu'à très faible tension les pertes reportées sur le diagramme peuvent être élevées en raison de l'augmentation des pertes dans l'enroulement secondaire lorsque le glissement devient important. Cette partie du diagramme doit donc être laissée de côté lors du tracé de la ligne droite.

Si le moteur est démarré avec un enroulement secondaire en court-circuit et avec les balais relevés (ce qui est possible si l'alternateur qui fournit l'alimentation est démarré en même temps que le moteur), les pertes par frottement et les pertes totales par ventilation s'obtiennent par extrapolation à une valeur nulle de la tension comme ci-dessus.

Note. — Pour les moteurs à rotor bobiné, un essai à vide au synchronisme peut être effectué comme pour une machine synchrone, en alimentant deux phases du rotor (ou éventuellement trois) par une excitation en courant continu.

9.1.2 *Pertes dépendant du courant*

9.1.2.1 *Essai en charge*

Les pertes définies au paragraphe 8.2 *a)* sont calculées à partir des résistances des enroulements primaires, mesurées en courant continu et ramenées à la température de référence, et du courant correspondant à la charge à laquelle les pertes sont calculées.

Pour déterminer les pertes définies au paragraphe 8.2 *b)* lorsqu'un essai en charge est fait, les pertes dans l'enroulement secondaire sont prises égales au produit du glissement par la puissance totale transmise à l'enroulement secondaire, c'est-à-dire la puissance absorbée diminuée des pertes dans le fer, paragraphe 8.1 *a)*, et des pertes par effet Joule dans l'enroulement primaire, paragraphe 8.2 *a)*. Cette méthode donne directement la somme des pertes, paragraphes 8.2 *b)* et 8.2 *c)* pour les machines à bagues, et des pertes, paragraphe 8.2 *b)* pour les machines à cage. Elle est la seule applicable pour ce dernier type de machines, où la mesure directe des résistances et du courant de l'enroulement secondaire n'est pas possible. Lorsqu'il est fait usage de cette méthode, le glissement peut être mesuré par une méthode stroboscopique, ou en comptant les battements d'un millivoltmètre à aimant permanent connecté entre deux bagues (pour les moteurs à rotor bobiné), ou aux bornes d'une bobine auxiliaire (pour les moteurs à rotor en court-circuit), ou encore entre les extrémités de l'arbre.

9.1.2.2 *Valeurs calculées*

Pour les moteurs à rotor bobiné, les pertes définies au paragraphe 8.2 *b)* peuvent être calculées à partir des résistances, mesurées en courant continu et ramenées à la température de référence, et du courant secondaire déduit du diagramme du cercle ou d'un circuit équivalent compte tenu du rapport de transformation vrai de la machine. Le type de diagramme du cercle à utiliser doit faire l'objet d'un accord entre constructeur et acheteur.

Pour l'essai en charge, les pertes dans les balais, paragraphe 8.2 *c)*, ne peuvent pas être mesurées directement. Elles sont alors prises égales au produit du courant passant dans les balais par une chute de tension déterminée. La chute de tension dans tous les balais d'une même phase est prise égale à 1,0 V pour les balais en carbone ou en graphite, et à 0,3 V pour les balais en carbone métallisé.

winding, is plotted against the square of the voltage. This, at low values of saturation, will give a straight line which can be extrapolated to zero voltage to give the sum of the losses, Sub-clause 8.1 *b)* and *c)*.

It should be borne in mind that at very low voltages, losses plotted on the diagram may be high because of the increased secondary winding losses with increased slip. When plotting the straight line, those values should not be taken into account.

If the motor is started with a short-circuited secondary winding and the brushes are lifted (which is possible if the supply generator is started at the same time as the motor) the bearing friction and total windage losses are obtained at zero voltage by extrapolation as above.

Note. — For wound rotor motors a synchronous no-load test can be carried out as for synchronous machines with d.c. excitation in two rotor phases (or three if desired).

9.1.2 *Load losses*

9.1.2.1 *Load test*

The losses described in Sub-clause 8.2 *a)* are calculated from the resistance of the primary windings measured using direct current and corrected to the reference temperature, and from the current corresponding to the load at which the losses are being calculated.

To determine the losses in Sub-clause 8.2 *b)* when an on-load test is made, the secondary winding losses are taken to be equal to the product of the slip and the total power transmitted to the secondary winding, i.e. the power absorbed, decreased by the core losses in Sub-clause 8.1 *a)* and the I^2R losses in the primary winding in Sub-clause 8.2 *a)*. This method gives directly the sum of the losses in Sub-clauses 8.2 *b)* and 8.2 *c)* for wound rotor machines, and the losses in Sub-clause 8.2 *b)* for cage machines. For this latter type of machine, this is the only applicable method as it is not possible to measure the resistance and current of the secondary winding directly. When use is made of this method, the slip may be measured by a stroboscopic method or by counting the beats of a permanent-magnet millivoltmeter connected between two rings (for motors with wound secondary windings) or the terminals of an auxiliary coil (for motors with short-circuited secondary windings) or between the ends of the shaft.

9.1.2.2 *Calculated values*

For wound rotor motors, the losses in Sub-clause 8.2 *b)* may be calculated from the resistance measured by direct current and corrected to the reference temperature, and from the secondary current calculated from a circle diagram or equivalent circuit, account being taken of the true transformation ratio of the machine. The type of circle diagram to be used should be agreed between manufacturer and purchaser.

To make an on-load test, the losses in Sub-clause 8.2 *c)* in the brushes cannot be measured directly and these losses shall be taken as the product of the current flowing in the brushes and a fixed voltage drop. The voltage drop in all brushes of the same phase shall be taken as 1.0 V for carbon or graphite brushes, and 0.3 V for metal-carbon brushes.

9.1.2.3 *Essai en charge à tension réduite*

Cette méthode est également applicable aux machines à rotor à cage.

Lorsqu'on réduit la tension en maintenant la vitesse de rotation à une valeur constante, les courants diminuent à peu près proportionnellement à la tension et la puissance à peu près proportionnellement au carré de la tension. Lorsque la tension est réduite à la moitié de sa valeur nominale, les courants sont réduits environ à la moitié et la puissance environ au quart de leur valeur à la tension nominale.

Lorsqu'on applique une charge à un moteur à induction à la tension réduite U_r, on mesure la puissance absorbée P_{lr}, le courant primaire principal I_{lr} et le glissement s ainsi que le courant à vide I_{or} à la même tension réduite U_r et le courant à vide I_o à la tension nominale U_n.

Le vecteur du courant I_l de la charge à la tension nominale s'obtient par construction d'un diagramme vectoriel (figure 3, page 55) de la façon suivante:

Au vecteur du courant I_n, multiplié par le rapport

$$\frac{\text{tension nominale}}{\text{tension réduite}} = \frac{U_n}{U_r}$$

on ajoute le vecteur:

$$\triangle I_o = I_o \sin \varphi_o - I_{or} \left(\frac{U_n}{U_r}\right) \sin \varphi_{or}$$

Le vecteur résultant représente le courant qui s'établirait à la tension nominale U_n pour la puissance absorbée suivante:

$$P_l = P_{lr} \left(\frac{U_n}{U_r}\right)^2$$

à l'aide des valeurs I_l et P_l ainsi déterminées et du glissement s, mesuré à tension réduite, on peut alors calculer les pertes dépendant du courant, comme indiqué au paragraphe 9.1.2.1.

9.1.3 *Pertes supplémentaires en charge*

Sauf spécification contraire, on admet que les pertes définies aux paragraphes 8.3 *a)* et 8.3 *b)* varient comme le carré du courant primaire et que leur valeur totale à pleine charge est égale à 0,5% de la puissance nominale absorbée pour les moteurs et 0,5% de la puissance nominale utile pour les génératrices.

Note. — Pour certains types de petites machines, ces pertes peuvent être supérieures à 0,5% de la puissance nominale. Si, dans un cas particulier, leur valeur présente de l'importance, les pertes doivent être déterminées par la méthode directe de mesure du rendement.

9.2 *Mesure globale des pertes*

9.2.1 *Essai au frein*

La machine tournant dans les conditions nominales de vitesse, tension et courant, le rendement est pris égal au rapport de la puissance utile à la puissance absorbée.

9.1.2.3 *Load test at reduced voltage*

This method is also applicable to cage rotor machines.

When the voltage is reduced, while keeping the rotational speed of the machine constant, the currents diminish approximately in proportion to the voltage, and the power approximately in proportion to the square of the voltage. When the voltage is down to half its rated value, the currents will then be reduced to about one half, and the power to about one quarter, of their values at the rated voltage.

When a load is applied to an induction motor at a reduced voltage U_r, the power absorbed P_{lr}, the main primary current I_{lr} and the slip s are measured, as well as the no-load current I_{or} at the same reduced voltage U_r, and the no-load current I_o at the rated voltage U_n.

The current vector I_l of the load at rated voltage is obtained by constructing a vector diagram (Figure 3, page 55) in the following manner:

To the current vector I_{lr}, multiplied by the ratio

$$\frac{\text{rated voltage}}{\text{reduced voltage}} = \frac{U_n}{U_r}$$

add the vector:

$$\triangle I_o = I_o \sin \varphi_o - I_{or} \left(\frac{U_n}{U_r}\right) \sin \varphi_{or}$$

The resultant vector represents the current which would flow at the rated voltage U_n for the following absorbed power:

$$P_l = P_{lr} \left(\frac{U_n}{U_r}\right)^2$$

By means of the values I_l, P_l, thus determined, and with the slip s measured at reduced voltage, it is then possible to calculate the on-load losses, as indicated in Sub-clause 9.1.2.1.

9.1.3 *Additional load losses*

Unless otherwise specified, it is assumed that the losses specified in Sub-clauses 8.3 *a)* and 8.3 *b)* vary as the square of the primary current and that their total value at full load is equal to 0.5% of the rated input for motors and 0.5% of the rated output for generators.

Note. — For some designs of small machines these losses might be higher than 0.5% of the rated input. If, for a particular case, the value is of importance, the loss should be determined by the direct method of efficiency measurement.

9.2 *Total loss measurement*

9.2.1 *Braking test*

When the machine is run at rated conditions of speed, voltage and current, the efficiency is taken as the ratio of output to input.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

9.2.2 *Essai avec machine auxiliaire tarée* (voir article 13)

La machine tournant dans les conditions nominales de vitesse, tension et courant conformément au paragraphe 13, le rendement est pris égal au rapport de la puissance utile à la puissance absorbée.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

9.2.3 *Essai en opposition*

Les machines identiques tournant dans des conditions nominales qui sont pratiquement les mêmes, les pertes sont considérées comme également réparties et le rendement se calcule à partir de la moitié des pertes totales et de la puissance électrique absorbée. La machine entraînée fonctionne en génératrice asynchrone si on dispose d'une source de puissance réactive magnétisante et si l'on connecte à ses bornes une charge appropriée.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

9.2.4 *Essai en opposition avec marche en parallèle sur un réseau* (voir article 16)

Les machines identiques tournant dans des conditions nominales qui sont pratiquement les mêmes, les pertes couvertes par le réseau sont considérées comme également réparties et le rendement est calculé à partir de la moitié des pertes totales et de la puissance électrique absorbée par l'une des machines.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

Note. — S'il y a lieu d'utiliser une boîte d'engrenages, comme c'est le cas pour les moteurs à induction, il faut déduire les pertes dans celle-ci de la puissance électrique absorbée avant de déterminer les pertes de la machine électrique.

SECTION QUATRE — MACHINES SYNCHRONES

10. **Pertes à comprendre**

Les pertes totales peuvent être considérées comme égales à la somme des pertes suivantes:

10.1 *Pertes constantes*

a) Pertes dans le fer et pertes supplémentaires à vide dans les autres parties métalliques.

b) Pertes dues au frottement (paliers et balais) à l'exclusion des pertes dans un système de graissage séparé. Les pertes dans les paliers communs doivent être indiquées séparément,

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

9.2.2 *Calibrated machine test* (see Clause 13)

When the machine is running in accordance with Clause 13 at rated conditions of speed, voltage and current, the efficiency is then taken as the ratio of output to input.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

9.2.3 *Mechanical back-to-back test*

When identical machines are run at essentially the same rated conditions, the losses are assumed to be equally distributed, and the efficiency is calculated from half the total losses and the electrical input. The driven machine will operate as an induction generator if a source of reactive power is provided, and a suitable load is connected to its terminals.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

9.2.4 *Electrical back-to-back test* (see Clause 16)

When identical machines are run at essentially the same rated conditions, the losses supplied from the electrical system are assumed to be equally distributed and the efficiency is calculated from half the total losses and the electrical input to one machine.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

Note. — Where a gear box is required, as in the case of induction motors, it is necessary for the loss in this to be deducted from the electrical input before determining the losses in the electrical machine.

SECTION FOUR — SYNCHRONOUS MACHINES

10. Losses to be included

The total losses may be taken as the sum of the following component losses:

10.1 *Constant losses*

a) Losses in active iron, and additional no-load losses in other metal parts.

b) Losses due to friction (bearings and brushes), not including any losses in a separate lubricating system. Losses in common bearings shall be stated separately whether or not such

que ces paliers soient fournis ou non avec la machine. Pour les alternateurs hydrauliques et les moteurs synchrones pour pompes d'accumulation, les pertes dans les paliers de butée et, si les paliers de butée sont combinés avec des paliers guides, les pertes totales dans ceux-ci doivent être indiquées séparément. La poussée, la température des paliers et la qualité de l'huile pour lesquelles le chiffre des pertes est applicable doivent également être indiquées.

Note. — Si l'on doit indiquer les pertes dans un système de graissage séparé, elles doivent être mentionnées séparément.

c) Pertes totales par ventilation dans la machine y compris la puissance absorbée par les ventilateurs faisant partie intégrante de la machine et par les machines auxiliaires, s'il en existe, faisant partie intégrante de la machine. Les pertes dans les machines auxiliaires telles que les ventilateurs extérieurs, pompes à eau et à huile ne faisant pas partie intégrante de la machine, mais destinées exclusivement à la machine en question, ne doivent être comprises que sur accord.

Note. — Si l'on doit indiquer les pertes dans un système de ventilation séparé, elles doivent être mentionnées séparément.

10.2 *Pertes en charge*

a) Pertes par effet Joule dans les enroulements primaires.

b) Pertes par effet Joule dans les enroulements de démarrage ou amortisseurs.

Note. — Ces pertes ne présentent d'importance que dans le cas des machines monophasées.

10.3 *Pertes dans le circuit d'excitation*

a) Pertes par effet Joule dans les enroulements et rhéostats d'excitation.

b) Toutes les pertes dans l'excitatrice lorsque celle-ci, formant partie intégrante d'un ensemble complet, est entraînée mécaniquement par l'arbre principal, et est utilisée exclusivement pour l'excitation de la machine, ainsi que les pertes dans le rhéostat d'excitation de cette excitatrice, à l'exception des pertes par frottement et par ventilation.

Les pertes dans les redresseurs tournants et dans les engrenages, courroies ou transmissions analogues entre l'arbre et l'excitatrice doivent être comprises.

Toutes les pertes dans tout appareil d'auto-excitation et de réglage recevant sa puissance du réseau à courant alternatif relié aux bornes de la machine synchrone.

Dans le cas d'une excitation séparée, fournie par des moyens tels que batterie, redresseur ou groupe moteur-générateur, il n'y a pas à tenir compte des pertes dans la source d'excitation ou dans les connexions entre la source et les balais.

c) Pertes électriques dans les balais.

10.4 *Pertes supplémentaires en charge*

a) Pertes supplémentaires dans le fer et les autres parties métalliques autres que les conducteurs.

b) Pertes par courants de Foucault dans les conducteurs de l'enroulement primaire.

bearings are supplied with the machine. For water-driven generators and synchronous motors for pump storage schemes, the losses in thrust bearings, and if the thrust bearings are associated with guide bearings the total losses in those bearings, shall be stated separately. The thrust-load, temperature of the bearings, and type of oil and oil temperature at which the loss values are valid shall also be given.

Note. — When the losses in a separate lubricating system are required these should be listed separately.

c) The total windage loss in the machine including power absorbed in integral fans, and in auxiliary machines, if any, forming an integral part of the machine. The losses in auxiliary machines such as external fans, water and oil pumps not forming an integral part of the machine, but provided exclusively for the machine in question, shall be included only by agreement.

Note. — When the losses in a separate ventilating system are required they should be listed separately.

10.2 *Load losses*

a) I^2R losses in primary windings.

b) I^2R losses in starting or damping windings.

Note. — These are significant only for single-phase machines.

10.3 *Excitation circuit losses*

a) I^2R losses in the excitation windings and in the excitation rheostats.

b) All the losses in an exciter mechanically driven from the main shaft which forms part of the complete unit, and is used solely for exciting the machine, together with losses in the rheostat in the excitation circuit of such an exciter, but with the exception of friction and windage losses.

Losses in rotary rectifiers and in a gear, rope or belt, or similar drive between shaft and exciter should be included.

All the losses in any apparatus for self-excitation and regulation receiving its input from the a.c. supply connected to the terminals of the synchronous machine.

In the case of a separate excitation supply such as a battery, rectifier or motor generator set, no allowance is made for the losses in the excitation source or in the connections between the source and the brushes.

c) The electrical losses in brushes.

10.4 *Additional load losses*

a) Losses introduced by load in active iron and other metal parts other than the conductors.

b) Eddy current losses in primary winding conductors.

11. Détermination du rendement

11.1 *Totalisation des pertes*

Le rendement peut être calculé à partir des pertes totales, considérées comme la somme des pertes déterminées de la façon suivante:

11.1.1 *Pertes dans le circuit d'excitation*

11.1.1.1 *Pertes par effet Joule dans le circuit d'excitation*

Ces pertes sont calculées par la formule RI^2, dans laquelle R est la résistance de l'enroulement d'excitation ramenée à la température de référence, et I la valeur du courant d'excitation pour le régime considéré de la machine, mesurée directement lors d'un essai en charge, ou calculée lorsque cet essai n'est pas possible. Dans ce dernier cas, la méthode de calcul doit faire l'objet d'un accord entre le constructeur et l'acheteur.

11.1.1.2 *Pertes dans le rhéostat principal*

Ces pertes sont calculées par la formule RI^2, en admettant pour R la résistance de la partie du rhéostat en circuit pour le régime considéré et pour I la valeur du courant d'excitation pour le régime considéré de la machine, défini au paragraphe 11.1.1.1 ci-dessus. Elles sont aussi égales au produit IU du courant d'excitation au régime considéré par la tension U aux bornes du rhéostat.

Note. — Quand une résistance est reliée en permanence en série dans le circuit d'excitation, elle doit être prise en compte de la même façon que le rhéostat principal.

11.1.1.3 *Pertes électriques dans les balais*

La somme de ces pertes est prise égale au produit du courant d'excitation au régime considéré par une chute de tension déterminée. Cette chute de tension est fixée, pour tous les balais d'une même polarité, à 1,0 V pour les balais en carbone ou en graphite, et à 0,3 V pour les balais en carbone métallisé, c'est-à-dire que la chute de tension totale est de 2,0 V pour les balais en carbone ou en graphite et de 0,6 V pour les balais en carbone métallisé.

La somme des pertes conformément aux paragraphes 11.1.1.1, 11.1.1.2 et 11.1.1.3, est aussi égale au produit IU_e du courant d'excitation I par la tension totale d'excitation U_e.

11.1.1.4 *Pertes dans l'excitatrice*

Note. — Seulement dans le cas où l'excitatrice est entraînée mécaniquement par l'arbre principal et est utilisée exclusivement pour l'excitation de la machine synchrone.

Ces pertes comprennent l'excès de la puissance absorbée sur l'arbre par l'excitatrice sur la puissance utile qu'elle fournit à ses bornes*, ainsi que les pertes d'excitation de l'excitatrice si elle est elle-même excitée par une source séparée.

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* La puissance utile aux bornes de l'excitatrice est égale à la somme des pertes conformément aux paragraphes 11.1.1.1, 11.1.1.2 et 11.1.1.3, de la machine principale.

11. Determination of efficiency

11.1 *Summation of losses*

The efficiency can be calculated from the total losses which are assumed to be the summation of the losses obtained in the following manner:

11.1.1 *Excitation circuit losses*

11.1.1.1 *Excitation winding* I^2R *losses*

These losses are calculated from the formula I^2R, taking for R the resistance of the excitation winding corrected to the reference temperature, and for I the value of the exciting current for the particular rating of the machine, measured directly during the on-load test or calculated when this test is not possible. Where such a calculation is made, the method to be used is for agreement between manufacturer and purchaser.

11.1.1.2 *Main rheostat losses*

These losses are calculated from the formula I^2R, where R is the resistance of the part of the rheostat in circuit for the rating considered, and I is the value of the exciting current for the rating considered defined as in Sub-clause 11.1.1.1. They are also equal to the product IU of the excitation current at the particular rating, and the voltage U at the terminals of the rheostat.

Note. — Where a resistance is permanently connected in series in the excitation circuit it should be dealt with in the same way as the main rheostat.

11.1.1.3 *Electrical losses in brushes*

The sum of these losses shall be taken as the product of the excitation current at the rating considered and a fixed voltage drop. The voltage drop allowed for all brushes of each polarity shall be 1.0 V for carbon or graphite brushes, and 0.3 V for metal-carbon brushes, i.e. a total drop of 2.0 V for carbon or graphite brushes, and 0.6 V for metal-carbon brushes.

The sum of the losses according to Sub-clauses 11.1.1.1, 11.1.1.2 and 11.1.1.3, is also equal to the product IU_e of the exciting current I and the total excitation voltage U_e.

11.1.1.4 *Exciter losses*

Note. — This applies only to the case where the exciter is mechanically driven from the main shaft and is used solely for exciting the synchronous machine.

These losses include the difference between the power absorbed at the shaft of the exciter and the useful power which it provides at the terminals of the exciter*, and the excitation losses of the exciter if this machine itself is excited by a separate source.

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* The useful power at the terminals of the exciter is equal to the sum of the losses according to Sub-clauses 11.1.1.1, 11.1.1.2 and 11.1.1.3, of the main machine.

Si l'excitatrice peut être désaccouplée de la machine principale et essayée séparément, la puissance qu'elle absorbe peut être mesurée par la méthode du moteur taré.

Si elle ne peut être désaccouplée de la machine principale, la puissance qu'elle absorbe peut être mesurée, soit par la méthode de la machine tarée, soit par la méthode de ralentissement appliquée au groupe complet. Dans ces deux méthodes, la puissance absorbée par l'excitatrice s'obtient par différence entre les pertes totales du groupe mesurées dans des conditions identiques, soit avec l'excitatrice en charge, soit avec l'excitatrice non excitée, l'excitation étant fournie par une source indépendante.

Si aucune de ces méthodes n'est applicable, les pertes séparées doivent être déterminées comme indiqué à l'article 6 pour les machines à courant continu (voir paragraphe 7.1.1.3, dernier paragraphe).

Note. — Le constructeur et l'acheteur doivent se mettre d'accord sur la méthode à utiliser pour déterminer les pertes dans les appareils d'auto-excitation et de réglage de la tension recevant leur puissance du réseau à courant alternatif relié aux bornes de la machine.

11.1.2 *Pertes indépendantes du courant*

11.1.2.1 *Essai au facteur de puissance unité à la tension et à la fréquence nominales*

La somme des pertes constantes est déterminée généralement par la méthode du fonctionnement en moteur à vide. La machine synchrone est alimentée à sa tension nominale et à sa fréquence nominale de manière à fonctionner en moteur à vide. L'excitation est réglée de façon que la machine absorbe le courant minimal. La puissance électrique absorbée, diminuée des pertes Joule dans les enroulements primaires et, s'il y a lieu, de la puissance absorbée par l'excitatrice, donne la somme des pertes indépendantes du courant.

Note. — On peut éviter cette dernière correction en utilisant une source d'excitation séparée.

11.1.2.2 *Essai à circuit ouvert*

La somme des pertes constantes, paragraphes 10.1 *a)*, 10.1 *b)* et 10.1 *c)*, les pertes, paragraphe 10.1 *a)*, et la somme des pertes, paragraphes 10.1 *b)* et 10.1 *c)* peuvent également être déterminées en entraînant la machine à sa vitesse nominale au moyen d'un moteur taré. La machine étant excitée par une source indépendante de façon à fonctionner en alternateur à vide sous une tension égale à sa tension nominale, la puissance qu'elle absorbe sur son arbre, et qui se déduit de la puissance électrique absorbée par le moteur taré, donne la somme des pertes, paragraphes 10.1 *a)*, 10.1 *b)* et 10.1 *c)*. En supprimant l'excitation, on obtient de la même façon la somme des pertes, paragraphes 10.1 *b)* et 10.1 *c)*. Les pertes dans le fer 10.1 *a)* s'en déduisent par différence. Etant donné le petit nombre de balais utilisés sur les machines synchrones, il n'est généralement pas possible de séparer, au moyen d'un essai avec les balais relevés, les pertes par frottement des balais de la somme des autres pertes constantes.

11.1.2.3 *Essai de ralentissement* (voir article 15)

La somme des pertes constantes, paragraphes 10.1 *a)*, 10.1 *b)* et 10.1 *c)*, les pertes, paragraphe 10.1 *a)*, et la somme des pertes, paragraphes 10.1 *b)* et 10.1 *c)*, peuvent être déterminées en utilisant la méthode de ralentissement.

If the exciter can be uncoupled from the main machine and tested separately, the power which it absorbs may be measured by the calibrated machine method.

If the exciter cannot be uncoupled from the main machine, the power which it absorbs may be measured either by the calibrated machine method or by the retardation method applied to the whole unit. In these two methods, the power absorbed by the exciter is obtained as the difference between the total losses of the unit measured under identical conditions, first with the exciter on-load and secondly with the exciter not excited, the excitation being furnished by an independent source.

If none of these methods is applicable, the separate losses should be determined as described under Clause 6 for d.c. machines (see Sub-clause 7.1.1.3, last paragraph).

Note. — The manufacturer and purchaser should agree on the method of determining the losses in apparatus for self-excitation and regulation receiving their input from the a.c. lines connected to the terminals of the machine.

11.1.2 *Constant losses*

11.1.2.1 *Unity power factor test at rated voltage and frequency*

The sum of the constant losses is generally determined by the method of running the machine as a motor on no-load. The synchronous machine is fed at its rated voltage and rated frequency, so as to work as a motor on no-load. The excitation is adjusted so that the machine absorbs the minimum a.c. current. The electrical power absorbed, decreased by the I^2R loss in the primary windings, and, if appropriate, by the power absorbed by the exciter, gives the sum of the constant losses.

Note. — This latter correction may be avoided by the use of a separate source of excitation power.

11.1.2.2 *Open circuit test*

The sum of the constant losses, Sub-clauses 10.1 *a)*, 10.1 *b)* and 10.1 *c)*, the losses Sub-clause 10.1 *a)*, and the sum of the losses, Sub-clauses 10.1 *b)* and 10.1 *c)*, may also be determined by driving the machine at its rated speed by means of a calibrated machine. The machine is excited by an independent source so as to work as a generator with open circuit at a voltage equal to its rated voltage. The power which it absorbs at its shaft, and which may be calculated from the power absorbed from the calibrated motor, gives the sum of the constant losses Sub-clauses 10.1 *a)*, 10.1 *b)* and 10.1 *c)*. By removing the excitation, the sum of the losses, Sub-clauses 10.1 *b)* and 10.1 *c)* is obtained in the same manner. The core losses Sub-clause 10.1 *a)* are obtained by subtraction. Given the small number of brushes used on synchronous machines, it is generally not possible to separate the brush friction losses from the sum of the other constant losses by means of a test with the brushes lifted.

11.1.2.3 *Retardation test* (see Clause 15)

The sum of the constant losses Sub-clauses 10.1 *a)*, 10.1 *b)* and 10.1 *c)*, the losses Sub-clause 10.1 *a)* and the sum of the losses, Sub-clauses 10.1 *b)* and 10.1 *c)* may be determined by using the retardation method

11.1.2.4 *Essai au facteur de puissance unité à tension variable*

Les pertes, paragraphes 10.1 *a)*, 10.1 *b)* et 10.1 *c)*, peuvent être séparées en faisant fonctionner la machine en moteur à sa fréquence nominale, mais à des tensions différentes, comme indiqué au paragraphe 9.1.1.3 de la section trois.

Le facteur de puissance doit être maintenu à la valeur unité par ajustage du courant d'excitation pendant l'essai.

11.1.2.5 *Essai à des densités variables de gaz de refroidissement*

Dans le cas des machines refroidies par un gaz, les pertes totales par ventilation peuvent être séparées des pertes par frottement au moyen d'essais effectués à des densités différentes du gaz de refroidissement.

Note. — Des essais à différentes vitesses sont à l'étude.

11.1.2.6 *Essai calorimétrique* (voir article 17)

Les pertes dans les paliers peuvent être déterminées séparément, quand c'est possible, par la méthode calorimétrique.

Note. — Les essais relatifs aux pertes dans les paliers de butée éventuellement combinés avec des paliers-guides dans les machines à arbre vertical ne doivent être effectués que sur accord.

11.1.3 *Pertes en charge*

Ces pertes sont les suivantes:

— Pertes par effet Joule dans les enroulements d'induit.

— Les pertes par effet Joule dans les enroulements d'induit sont mesurées normalement au cours de l'essai en court-circuit, décrit au paragraphe 11.1.4.

Lorsqu'elles doivent être indiquées séparément, ces pertes sont calculées en partant du courant nominal et de la résistance des enroulements ramenée à la température de référence.

11.1.4 *Pertes supplémentaires en charge*

Sauf spécification contraire, la somme des pertes, paragraphes 10.4 *a)* et 10.4 *b)*, est mesurée par la méthode de l'essai en court-circuit.

La machine à essayer avec son enroulement d'induit mis en court-circuit est entraînée à sa vitesse nominale et excitée de façon que le courant dans l'induit en court-circuit soit égal au courant nominal. La puissance absorbée sur l'arbre, diminuée des pertes mécaniques, paragraphes 10.1 *b)* et 10.1 *c)* ci-dessus, et de la puissance absorbée par l'excitatrice, s'il y a lieu, représente la somme des pertes normales dépendant du courant et des pertes supplémentaires, paragraphes 10.2 et 10.4. Si la réactance de fuite est anormalement élevée, comme dans le cas d'une machine à haute fréquence, on doit également faire une correction pour les pertes dans le

11.1.2.4 *Unity power factor test at variable voltage*

The losses Sub-clauses 10.1 *a)*, 10.1 *b)* and 10.1 *c)* may be separated by running the machine as a motor at rated frequency, but at different voltages as described in Sub-clause 9.1.1.3 of Section Three.

The power factor shall be maintained at unity by adjusting the excitation current during the test.

11.1.2.5 *Variable cooling gas density test*

For machines cooled by a gas at variable pressure, the total windage loss may be separated from the friction losses by tests at different densities of cooling gas.

Note. — Tests at different speeds are under consideration.

11.1.2.6 *Calorimetric test* (see Clause 17)

The bearing losses may be separately determined when possible by using the calorimetric method.

Note. — The determination of losses in thrust bearings, possibly combined with guide bearings, in vertical shaft machines, should only be made by agreement.

11.1.3 *Load losses*

These consist of:

— I^2R loss in primary windings.

— The I^2R loss in primary windings is normally measured during the short-circuit test described in Sub-clause 11.1.4.

When it is to be given separately, the loss is calculated from the rated current and the resistance of the windings corrected to the reference temperature.

11.1.4 *Additional load losses*

Unless otherwise specified, the sum of the losses, Sub-clauses 10.4 *a)* and 10.4 *b)* is measured by means of the short-circuit test method.

The machine to be tested, with its primary winding short-circuited, is driven at its rated speed and so excited that the current in the short-circuited primary winding is equal to the rated current. The power absorbed at the shaft, decreased by the mechanical losses, Sub-clauses 10.1 *b)* and 10.1 *c)*, and the power absorbed by the exciter, if appropriate, presents the sum of the load losses and the additional losses, Sub-clauses 10.2 and 10.4. If the leakage reactance is abnormally high, as for a machine for high frequency, a correction shall also be made for core losses. The load losses vary in different senses as a function of the temperature. The sum of the

fer. Les pertes en charge varient dans des sens différents en fonction de la température. La somme des pertes dépendant du courant et des pertes supplémentaires est supposée indépendante de la température et il n'y a pas à faire de correction pour ramener cette somme à une température de référence.

Note. — Il est reconnu que la somme des pertes, paragraphes 10.4 *a)* et 10.4 *b)*, ainsi déterminée est généralement un peu plus élevée que les pertes existant réellement à pleine charge.

La puissance absorbée sur l'arbre de la machine pendant l'essai en court-circuit peut être mesurée soit par la méthode du moteur taré (article 13), soit par la méthode de ralentissement (article 15).

11.2 *Mesure globale des pertes*

11.2.1 *Essai au frein*

La machine tournant dans les conditions nominales de vitesse, tension et courant, le rendement est pris égal au rapport de la puissance utile à la puissance absorbée.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

11.2.2 *Essai avec machine auxiliaire tarée* (voir article 13)

La machine tournant dans les conditions nominales de vitesse, tension et courant, le rendement est pris égal au rapport de la puissance utile à la puissance absorbée.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

11.2.3 *Essai en opposition*

Les machines identiques tournant dans des conditions nominales qui sont pratiquement les mêmes, les pertes sont considérées comme également réparties et le rendement est calculé à partir de la moitié des pertes totales et de la puissance électrique absorbée.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

11.2.4 *Essai en opposition avec marche en parallèle sur un réseau* (voir article 16)

Les machines identiques tournant dans des conditions nominales qui sont pratiquement les mêmes, les pertes couvertes par le réseau sont considérées comme également réparties et le rendement se calcule comme indiqué au paragraphe 11.2.3 ci-dessus.

L'essai doit être effectué à une température aussi voisine que possible de celle atteinte en fonctionnement à la fin du temps spécifié dans le service nominal. Il n'est pas effectué de correction tenant compte de la variation de résistance des enroulements avec la température.

load losses and additional losses is assumed to be independent of the temperature and no correction is made to a reference temperature.

Note. — It is recognized that the sum of the additional losses, Sub-clauses 10.4 *a)* and 10.4 *b)*, thus determined, is generally a little higher than the losses which actually exist at rated load.

The power absorbed at the shaft of the machine during the short-circuit test may be measured by the calibrated machine method (Clause 13), or by the retardation method (Clause 15).

11.2 *Total loss measurement*

11.2.1 *Braking test*

When the machine is run at rated conditions of speed, voltage and current, the efficiency is taken as the ratio of output to input.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

11.2.2 *Calibrated machine test* (see Clause 13)

When the machine is run at rated conditions of speed, voltage and current, the efficiency is taken as the ratio of output to input.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

11.2.3 *Mechanical back-to-back test*

When identical machines are run at essentially the same rated conditions, the losses are assumed to be equally distributed, and the efficiency is calculated from half the total losses and the electrical input.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

11.2.4 *Electrical back-to-back test* (see Clause 16)

When identical machines are run at essentially the same rated conditions, the losses are assumed to be equally distributed and the efficiency is calculated as in Sub-clause 11.2.3.

The test shall be made as nearly as possible at the temperature attained in operation at the end of the time specified in the rating. No winding temperature correction shall be made.

11.2.5 *Essai au facteur de puissance nul* (voir article 14)

La machine tournant dans les conditions nominales de vitesse, tension et courant, les pertes totales sont équivalentes à la puissance absorbée au cours de l'essai corrigée pour la différence entre les pertes de courant d'excitation effectives et celles en pleine charge.

SECTION CINQ — MÉTHODES D'ESSAIS

12. Généralités

Les essais peuvent être classés dans l'une des trois catégories suivantes:

a) Mesure de la puissance absorbée et de la puissance utile d'une seule machine. Elle implique en général la mesure de la puissance mécanique absorbée ou fournie par la machine.

b) Mesure de la puissance absorbée et de la puissance utile sur deux machines en opposition, par exemple deux machines identiques ou une machine à essayer accouplée à une machine tarée. Ceci a pour but d'éliminer la mesure de la puissance mécanique absorbée ou fournie par la machine.

c) Mesure des pertes réelles dans une machine dans des conditions déterminées.

Ces pertes ne sont pas en général les pertes totales, mais comprennent certaines pertes particulières. La méthode peut toutefois être appliquée pour calculer les pertes totales ou pour calculer des pertes particulières.

Le choix des essais à effectuer dépend des renseignements recherchés, de la précision recherchée, du type et des dimensions de la machine considérée. Lorsqu'on dispose de plusieurs méthodes pour un type donné de machine, la méthode préférentielle est indiquée (voir article 18).

On fait une distinction entre mesures directes et indirectes du rendement.

La mesure directe du rendement consiste à mesurer directement la puissance fournie par la machine et la puissance qu'elle absorbe.

La mesure indirecte du rendement consiste à mesurer les pertes de la machine. En ajoutant ces pertes à la puissance fournie par la machine, on obtient la puissance qu'elle absorbe.

La mesure indirecte du rendement peut être effectuée par les méthodes suivantes:

(i) détermination des pertes séparées en vue de leur sommation;
(ii) détermination des pertes totales.

Note. — Les méthodes de détermination du rendement des machines reposent sur un certain nombre d'hypothèses; il n'est donc pas possible d'établir une comparaison entre les pertes obtenues par mesure directe et celles obtenues par mesure des pertes séparées.

Sauf spécification contraire, le rendement garanti d'une machine est celui qui est basé sur la détermination des pertes séparées, mais lorsqu'on a le choix de la méthode, l'évaluation du rendement doit se baser sur la précision qu'offre la méthode, le rendement et le type de la machine considérée*.

Lorsque le rendement ou les pertes totales sont calculés à partir de la puissance absorbée et de la puissance utile mesurées, toute inexactitude dans ces mesures se traduit directement

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**Note.* — Dans certains pays, un rendement de 90% est pris comme base d'application de la méthode indirecte, tandis que d'autres pays préfèrent une valeur plus faible, par exemple 70%.

11.2.5 *Zero power factor test* (see Clause 14)

When the machine is run at rated conditions of speed, voltage and current, the total losses are equivalent to the absorbed power during the test, corrected for the difference between actual and the full-load exciting current losses.

SECTION FIVE — METHODS OF TEST

12. General

Tests can be grouped in one of the three following categories:

a) Input-output measurement on a single machine. This usually involves the measurement of mechanical power into, or out of a machine.

b) Input and output measurement on two machines connected back-to-back, e.g. two identical machines or a test machine coupled to a calibrated machine. This is done to eliminate the measurement of mechanical power into or out of the machine.

c) Measurement of the actual loss in a machine under a particular condition.

This is not usually the total loss, but comprises certain component losses. The method may, however, be used to calculate the total loss or to calculate a component loss.

The choice of test to be made depends on the information required, the accuracy required, and the type and size of the machine involved. Where alternative methods are available for a particular type of machine, the preferred method is indicated (see Clause 18).

A distinction is made between direct and indirect efficiency measurement.

The direct measurement of efficiency is made by measuring directly the power supplied by the machine and the power absorbed by it.

The indirect measurement of efficiency is made by measuring the losses of the machine. Those losses are added to the power supplied by the machine, thus giving the absorbed power.

The indirect measurement may be carried out by the following methods:

(i) determination of separate losses for summation;
(ii) determination of total losses.

Note. — The methods for determining the efficiency of machines are based on a number of assumptions; it is therefore not possible to make a comparison between the losses obtained by the direct method of measurement and those obtained by the measurement of the separate losses.

Unless otherwise specified, the guaranteed efficiency of a machine is that which is based on the determination of separate losses, but when there is a choice of method, the evaluation of efficiency should be based on the accuracy obtainable from the method, the efficiency and the type of machine involved.*

When the efficiency or total loss is derived from the measured input and output power, any inaccuracy in these measurements appears as a direct error in the efficiency (e.g. with an

**Note.* — In some countries 90% efficiency is accepted as a basis for using the indirect method whereas some other countries prefer a lower value, e.g. 70%.

par une erreur dans le rendement (par exemple, avec une précision de la mesure de la puissance qui n'est pas meilleure que 1%, l'erreur sur le rendement peut être de 2% ou l'erreur sur les pertes totales peut être de 2% de la puissance totale absorbée). Sur les petites machines ou sur les machines de rendement relativement faible (inférieur par exemple à 90%)*, cette méthode peut être tout à fait admissible et représente une méthode d'essais commode pour ces machines. Sur ces machines et sur les autres machines, le rendement peut être obtenu avec une bonne précision par le calcul des pertes à partir des mesures directes.

13. **Méthode du moteur taré**

La machine dont il s'agit de mesurer les pertes est séparée du réseau, désaccouplée de son moteur d'entraînement, s'il y a lieu, et entraînée à sa vitesse nominale par un moteur taré, c'est-à-dire par un moteur électrique dont les pertes ont été déterminées auparavant avec une grande précision, de manière à permettre de déterminer la puissance mécanique qu'il fournit sur son arbre, connaissant la puissance électrique qu'il absorbe et sa vitesse de rotation. La puissance mécanique transmise par le moteur taré à l'arbre de la machine essayée mesure les pertes de cette dernière pour les conditions de fonctionnement dans lesquelles est fait l'essai. Dans cette méthode, la machine essayée peut être à vide, excitée ou non excitée, avec ou sans balais, ou en court-circuit, ce qui permet de séparer certaines catégories de pertes.

En variante, le moteur taré peut être remplacé par un moteur dynamométrique, ou par un moteur quelconque entraînant la machine à essayer par un torsiomètre approprié permettant de connaître le couple transmis à la machine essayée et, par suite, la puissance mécanique absorbée par cette dernière.

Lorsqu'il est fait usage de cette variante, la vitesse de rotation qui intervient directement dans le calcul de la puissance doit être mesurée avec la plus grande précision.

14. **Essai au facteur de puissance nul**

La machine fonctionne en moteur à vide, à la vitesse nominale et à un facteur de puissance voisin du zéro, le courant d'excitation étant réglé de façon que la machine soit parcourue par son courant primaire nominal.

La tension d'alimentation est telle que les pertes magnétiques ont la même valeur qu'en fonctionnement à vide à la tension nominale. La tension d'alimentation est en général prise égale à la tension nominale à moins que ceci ne donne des pertes dans le fer nettement plus élevées qu'à pleine charge. En principe, la puissance réactive doit être positive, c'est-à-dire que la machine est surexcitée, mais si ceci n'est pas possible du fait que la tension de l'excitatrice est insuffisante, l'essai peut être effectué avec absorption de puissance réactive (c'est-à-dire avec la machine sous-excitée).

Note. — La précision de cette méthode dépend de la précision à un faible facteur de puissance des wattmètres utilisés.

15. **Méthode de ralentissement**

Cette méthode est applicable en particulier aux grosses machines synchrones de grande inertie. Elle peut également être appliquée aux machines à courant alternatif à induction et aux machines à courant continu, pour les pertes appropriées de ces machines. Elle consiste

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**Note* — Dans certains pays, un rendement de 90% est pris comme base d'application de la méthode indirecte, tandis que d'autres pays préfèrent une valeur plus faible, par exemple 70%.

accuracy of power measurement not better than 1%, the efficiency can be 2% in error or the total losses can be in error by 2% of the total input power). On small machines or machines with relatively low efficiencies (say below 90%),* this method may be quite acceptable and gives a convenient form of test for such machines. On these and other machines efficiency can be obtained with high accuracy by the calculation of losses from direct measurements.

13. Calibrated machine test

The machine of which the losses are to be measured is separated from the network, uncoupled from its driving motor if necessary, and driven at its rated speed by a calibrated motor, that is by an electric motor of which the losses have been previously determined with great accuracy, such that it is possible to determine the mechanical power which it furnishes at its shaft, knowing the electric power which it absorbs and its speed of rotation. The mechanical power transmitted by the calibrated motor to the shaft of the machine under test is a measure of the losses of this latter machine for the working conditions under which the test is made. In this method, the machine tested may be on no-load, excited or not excited, with or without brushes or short-circuited, which enables categories of losses to be separated.

As an alternative, the calibrated motor may be replaced by a dynamometer or by any other motor driving the machine under test through an appropriate torsionmeter, which enables the torque transmitted to the machine under test to be known, and hence the mechanical power absorbed by this latter machine.

When use is made of this alternative, the speed of rotation, which comes directly into the calculation of the power, must be measured with extreme care.

14. Zero power factor test

The machine operates as a motor at no-load and at rated speed, with a power factor in the neighbourhood of zero, while the excitation current is adjusted so that the machine carries its rated primary current.

The supply voltage is such that the magnetic losses have the same value as in no-load operation at rated voltage. The supply voltage is usually equal to the rated voltage unless this would give an active iron loss appreciably greater than that at full load. In principle, the reactive power should be positive, i.e. over-excited, but when this is impossible because the exciter voltage is not sufficient, the test can be made with absorption of the reactive power (i.e. under-excited).

Note. — The accuracy of this method is dependent upon the accuracy at low power factor of the wattmeters used.

15. Retardation method

This method is particularly applicable to large synchronous machines with considerable inertia. The method may also be used for a.c. induction machines and d.c. machines, using the appropriate losses for such machines. It consists of measuring the retardation time when the

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**Note.* — In some countries 90% efficiency is accepted as a basis for using the indirect method whereas some other countries prefer a lower value, e.g. 70%.

à mesurer le temps employé par la machine pour ralentir, dans différentes conditions, entre deux vitesses prédéterminées, par exemple de 110% à 90% ou de 105% à 95% de la vitesse nominale. Ce temps varie en raison inverse de la valeur moyenne des pertes pendant le même temps.

Cette méthode permet de mesurer les pertes mécaniques (pertes par frottement et pertes totales par ventilation), les pertes dans le fer à différentes excitations et les pertes dues à la charge en court-circuit à différentes excitations.

Pendant l'essai, la machine fonctionne en moteur à vide alimenté par une génératrice pendant une durée suffisante pour que la température des paliers se stabilise. Si les pertes dans les paliers sont garanties pour une certaine température des paliers, l'arrivée d'eau dans le système de refroidissement du palier doit être réglée de façon à permettre d'obtenir la température spécifiée.

La machine en essai est portée à une vitesse suffisamment supérieure à celle à partir de laquelle le temps de ralentissement est mesuré. La machine en essai est ensuite séparée de la machine qui l'alimente et on réalise la valeur de l'excitation et les connexions de l'enroulement primaire nécessaires. Ces manœuvres doivent être faites suffisamment vite pour que le régime établi nécessaire pour l'essai soit réalisé avant que la vitesse de la machine, qui décroît constamment dans cet intervalle de temps, passe par la limite supérieure à partir de laquelle le temps de ralentissement est mesuré.

Dans les essais de ralentissement à vide, l'excitation et la tension statorique sont mesurées à l'instant où la machine passe par sa vitesse nominale. Dans les essais de ralentissement en court-circuit, le courant d'excitation et le courant statorique sont mesurés au même instant. L'essai doit être effectué à plusieurs valeurs d'excitation, les connexions étant ouvertes et en court-circuit.

Le temps entre les deux limites doit être mesuré avec une précision de 2%. L'intervalle entre les deux limites choisies dépend de la précision de la mesure. Une génératrice à aimant permanent ou une excitatrice peuvent être utilisées comme tachymètre; la mesure peut également être réalisée au moyen de dispositifs électroniques.

Pour obtenir la valeur absolue des pertes qui existaient dans les machines pendant l'essai correspondant de ralentissement à vide à l'instant de son passage par la vitesse nominale, on effectue des mesures, la machine fonctionnant en moteur à vide, à la vitesse normale, à un facteur de puissance égal à un et à la même tension que dans l'une des mesures de ralentissement, de préférence à la tension nominale. La puissance absorbée, qui est égale aux pertes, doit être mesurée avec une grande précision.

Lorsque l'on ne connaît pas avec une précision suffisante l'inertie de la machine, on peut la déterminer par un essai de ralentissement dans lequel on connaît les pertes, mesurées par une autre méthode.

On répète la mesure plusieurs fois et on calcule la valeur moyenne. Au lieu d'effectuer plusieurs mesures à la même tension, on peut déterminer plusieurs points à différentes tensions entre 95% et 105% de la tension nominale de façon à obtenir la courbe des pertes *en fonction* de la tension de part et d'autre de sa valeur nominale. Les mesures de ralentissement doivent avoir été effectuées dans le même domaine de tension. On établit alors la relation entre les pertes P et le temps de ralentissement.

Les pertes dans des conditions quelconques (par exemple à vide, en court-circuit, etc.) peuvent être prises égales au produit de la puissance absorbée P, mesurée lors de l'essai ci-dessus, par le rapport du temps de ralentissement de l'essai ci-dessus au temps de ralentissement de l'essai considéré.

machine is slowing down under different conditions between two predetermined speeds, say from 110% to 90% or from 105% to 95% of the rated speed. This time will vary inversely with the average losses during the same time.

The method permits the measurement of the mechanical loss (friction losses and total windage loss), core loss at different excitation and load loss on short-circuit under different excitation.

During the test, the machine is run as a motor at no-load fed from a generator for a sufficient time for the temperature of the bearings to be stabilized. If the bearing losses are guaranteed at a certain temperature of the bearing, the amount of cooling water to the bearing cooling system should be adjusted so that the agreed temperature will be obtained.

The machine on test is accelerated to a speed sufficiently above the speed from which the retardation time is measured. The test machine is then disconnected from its feeding machine and the required value of excitation, and primary winding connections, are established. This should be done with sufficient rapidity for the required steady electrical test conditions to have been reached before the speed of the machine, which is decreasing constantly during this interval, passes through the upper limit from which the retardation time is measured.

In the open-circuit retardation tests, the excitation and the stator voltage are measured as the machine passes through the rated speed. In the short-circuit retardation tests, the excitation current and the stator current are measured at this same instant. The test should be carried out for several values of excitation, with open-circuited and short-circuited connections respectively.

The time between the two limits of speed should be measured within an accuracy of 2%. The interval between the two limits chosen depends on the accuracy of measurement. A permanent magnet generator or an exciter may be used as a tachometer, or measurement may be made with electronic devices.

To obtain the absolute value of the losses, which are present in the machine during the corresponding open-circuit retardation test at the moment of passing through the rated speed, measurements are made with the machine running as a motor at no-load, normal speed and unity power factor, and at the same voltage as used in one of the retardation tests, preferably at normal voltage. The input, i.e. the losses, should be measured with great accuracy.

When the inertia of the machine is not known with sufficient precision, it may be determined by a retardation test with known losses, measured by another method.

The measurement is repeated several times and the average value calculated. Instead of measuring several times at the same voltage, several points can be measured at different voltages in the range of 95% to 105% to obtain a curve of losses *versus* voltage around the rated voltage. Retardation measurements should have been made in the same voltage range. The relation between losses P and retardation time is now established.

The losses at any condition (e.g., at no-load, at short-circuit, etc.) can be calculated as the input value P measured in the above test multiplied by the ratio between the retardation time in the above test and the retardation time in the actual test.

Les pertes mécaniques sont obtenues par un essai de ralentissement sans excitation; les pertes dans le fer sont obtenues à partir des essais à vide par soustraction des pertes mécaniques et les pertes en court-circuit à partir d'un essai de ralentissement en court-circuit par soustraction des pertes mécaniques.

Le moment d'inertie peut se calculer à partir de l'essai de ralentissement par la formule suivante:

$$J \simeq \frac{45600\,Pt}{\delta n^2}$$

où:

$$45600 = \frac{60^2 \times 10^3}{8\pi^2}$$

Le ralentissement se mesure de la vitesse $n\,(1+\delta)$ à la vitesse $n\,(1-\delta)$, n étant la vitesse nominale en tours par minute. Si P est exprimé en kilowatts, l'inertie J s'obtient en kgm², t étant la durée en secondes entre les deux instants où la vitesse est $n\,(1+\delta)$ et $n\,(1-\delta)$ respectivement.

Pendant l'essai de ralentissement, l'excitation de la machine essayée doit de préférence provenir d'une source séparée. On peut toutefois utiliser une excitatrice à accouplement direct si la variation de la vitesse lors du ralentissement est faible, par exemple de 105% à 95%. On doit alors faire une correction appropriée pour les pertes dans le circuit d'excitation en tenant compte également du fait que le courant d'excitation peut différer légèrement entre l'essai de ralentissement et l'essai à vide, bien que la tension reste la même. Il est toutefois nécessaire que l'excitatrice soit en excitation séparée.

Au lieu d'appliquer la méthode à vide pour obtenir la valeur absolue des pertes, on peut appliquer la méthode du moteur auxiliaire taré.

16. **Essai en opposition**

Cette méthode est applicable lorsqu'on dispose de deux machines identiques. Ces machines sont accouplées mécaniquement et couplées électriquement de façon à fonctionner à la vitesse nominale, l'une en moteur et l'autre en génératrice. La température réelle à laquelle sont effectuées les mesures doit être aussi voisine que possible de la température de régime et il n'est pas effectué de correction. Les pertes des machines accouplées sont couvertes soit par un réseau auquel elles sont connectées, soit par un moteur taré d'entraînement, soit par un survolteur, soit encore par une combinaison de ces divers moyens.

La valeur moyenne des courants d'induit est réglée à la valeur nominale; la moyenne de la tension des deux induits est supérieure ou inférieure à la tension nominale d'une valeur égale à la chute de tension, selon que les machines sont fournies pour être employées respectivement comme génératrice ou comme moteur.

Lorsque deux machines à induction sont couplées électriquement, elles doivent être accouplées mécaniquement à l'aide d'un dispositif de réglage de la vitesse, tel qu'une boîte d'engrenages, de façon à assurer la transmission correcte de la puissance. La valeur de la puissance transmise dépend de la différence de vitesse. Le réseau électrique couvrant les pertes des deux machines devra fournir de la puissance réactive magnétisante aux deux machines.

Lorsque deux machines synchrones sont couplées électriquement, elles doivent être accouplées mécaniquement avec un décalage correct entre les angles de phase. La valeur de la puissance transmise dépend du déphasage entre les deux machines.

The mechanical loss is obtained from a retardation test without excitation, the core loss from the open-circuit tests with the mechanical loss subtracted, and the short-circuit loss from a retardation test on short-circuit with the mechanical loss subtracted.

The moment of inertia can be calculated from the retardation test with the equation:

$$J \simeq \frac{45600\ Pt}{\delta n^2}$$

where:

$$45600 = \frac{60^2 \times 10^3}{8\pi^2}$$

The retardation is measured from the speed $n\,(1+\delta)$ to the speed $n\,(1-\delta)$ where n is the rated speed in revolutions per minute. If P is expressed in kilowatts, inertia J is obtained in kgm^2, t being the time in seconds between the two instants where the speed is $n\,(1+\delta)$ and $n\,(1-\delta)$ respectively.

During the retardation test, the excitation on the tested machine should preferably be from a separate source. A directly coupled exciter can, however, be used, if the change in speed during retardation is small, e.g. 105% to 95%. An appropriate correction for the loss in the excitation circuit must then be made taking into account also that the excitation current in the retardation test, and the no-load tests, may be a little different, although the voltage is the same. Separate excitation of the exciter is, however, necessary.

Instead of using the no-load method for obtaining the absolute value of the losses, the calibrated motor method can be used.

16. Electrical back-to-back test

This method is applicable when two identical machines are available. The machines are coupled mechanically and electrically so as to operate at rated speed, one as a motor and the other as a generator. The actual temperature at which the measurements are carried out should be as close as possible to the working temperature and no further correction should be made. The losses of the assembled machines are supplied either by a network to which they are connected, or by a calibrated driving motor, or by a booster, or else by a combination of these various means.

The average value of the armature currents is adjusted to the rated value, the average of the voltage of the two armatures is above or below the rated voltage by an amount equal to the voltage drop, depending on whether the d. c. machines are intended to be used respectively as generators or as motors.

Where two induction machines are electrically connected, they should be mechanically coupled with a speed adjusting device, such as a gear box, to ensure the correct circulation of power. The magnitude of power circulated depends upon the difference in speed. The electrical system supplying the losses to the two machines will be required to provide magnetizing kvar to both machines.

When two synchronous machines are electrically connected, they should be mechanically coupled with a correct angular phase relationship. The magnitude of the power circulated depends upon the difference in phase angle between them.

17. **Essai calorimétrique**

A l'étude.

18. **Indication des essais préférentiels**

18.1 *Machines à courant continu*

L'essai préférentiel des machines à courant continu est celui du paragraphe 7.1 et la méthode préférentielle de calcul du rendement est celle du paragraphe 7.1.2.

18.2 *Machines à induction polyphasées*

L'essai préférentiel des machines à induction polyphasées est celui du paragraphe 9.1 et la méthode préférentielle de détermination des pertes constantes est celle du paragraphe 9.1.1.1.

18.3 *Machines synchrones*

L'essai préférentiel des machines synchrones est celui du paragraphe 11.1 et la méthode préférentielle de détermination des pertes constantes est celle du paragraphe 11.1.2.1.

17. Calorimetric test

Under consideration.

18. Schedule of preferred tests

18.1 *D.C. machines*

The preferred test for d.c. machines is in accordance with Sub-clause 7.1 and the preferred method of calculating the efficiency is in accordance with Sub-clause 7.1.2.

18.2 *Polyphase induction machines*

The preferred test for polyphase induction machines is in accordance with Sub-clause 9.1 and the preferred method of determining the constant losses is in accordance with Sub-clause 9.1.1.1.

18.3 *Synchronous machines*

The preferred test for synchronous machines is in accordance with Sub-clause 11.1 and the preferred method of determining the constant losses is in accordance with Sub-clause 11.1.2.1.

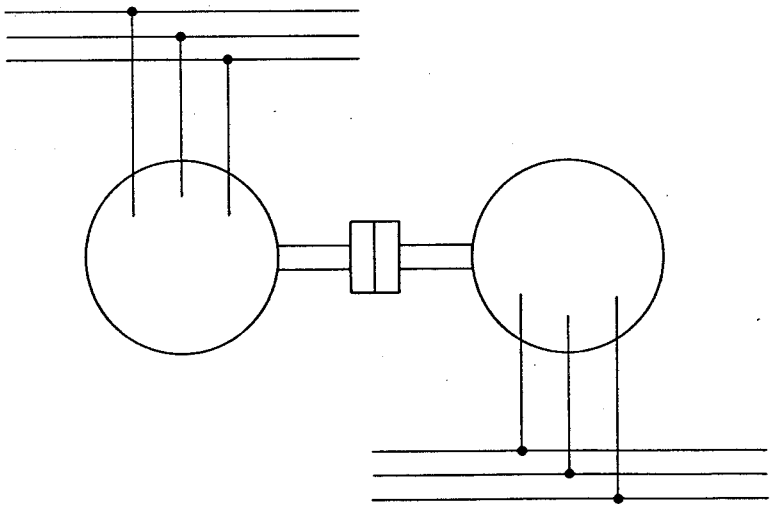

FIG. 1. — Essais en opposition.

Mechanical back-to-back test.

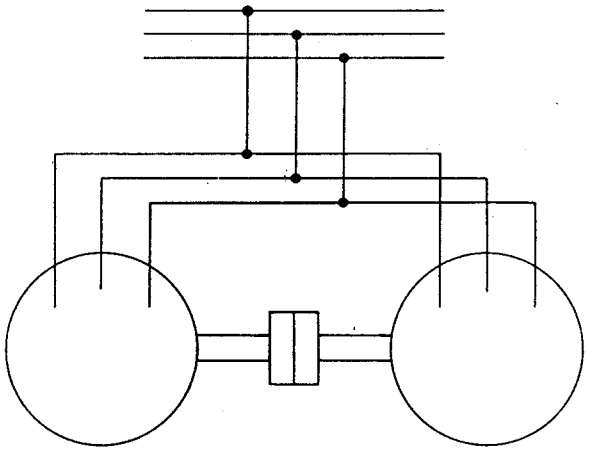

FIG. 2. — Essais en opposition avec marche en parallèle sur un réseau.

Electrical back-to-back test.

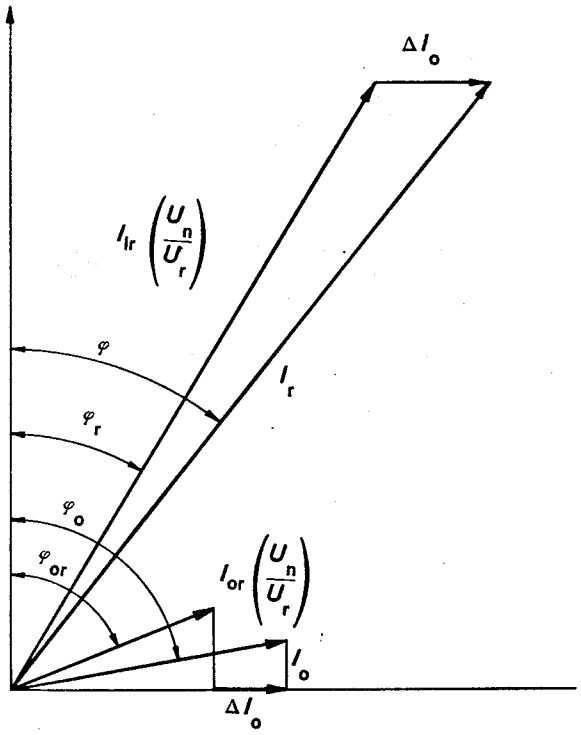

FIG. 3. — Diagramme vectoriel pour obtenir le vecteur du courant en charge I_1 à la tension nominale.

Vector diagram for obtaining vector of load current I_1 at rated voltage.

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(Quatrième édition)

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Troisième partie: Règles spécifiques pour les turbomachines synchrones

IEC Publication 60034-3
(Fourth edition)

Rotating electrical machines –
Part 3: Specific requirements for turbine-type synchronous machines

CORRIGENDUM 1

Page 18

Article 14:

Au lieu de

$$\left(I^2 - I\right)t = 37{,}5 \text{ s}$$

lire

$$\left(I^2 - 1\right)t = 37{,}5 \text{ s}$$

Page 19

Clause 14:

Instead of

$$\left(I^2 - I\right)t = 37{,}5 \text{ s}$$

read

$$\left(I^2 - 1\right)t = 37{,}5 \text{ s}$$

Page 20

Article 16.1:

Dans la première ligne, au lieu de

....dans les articles 18...

lire

....dans les articles 19...

Page 21

Clause 16.1

In the first line, instead of

...in clauses 18...

read

...in clauses 19...

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
34-14

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Machines électriques tournantes –

Partie 14:
Vibrations mécaniques de certaines machines de hauteur d'axe supérieure ou égale à 56 mm – Mesurage, évaluation et limites de la vibration

Rotating electrical machines –

Part 14:
Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of vibration

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- **Annuaire de la CEI**
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- **Catalogue des publications de la CEI**
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En ce qui concerne la terminologie générale, le lecteur se reportera à la CEI 50: *Vocabulaire Electrotechnique International* (VEI), qui se présente sous forme de chapitres séparés traitant chacun d'un sujet défini. Des détails complets sur le VEI peuvent être obtenus sur demande. Voir également le dictionnaire multilingue de la CEI.

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– la CEI 617: *Symboles graphiques pour schémas;*

et pour les appareils électromédicaux,

– la CEI 878: *Symboles graphiques pour équipements électriques en pratique médicale.*

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and for medical electrical equipment,

– IEC 878: *Graphical symbols for electromedical equipment in medical practice.*

The symbols and signs contained in the present publication have either been taken from IEC 27, IEC 417, IEC 617 and/or IEC 878, or have been specifically approved for the purpose of this publication.

IEC publications prepared by the same technical committee

The attention of readers is drawn to the end pages of this publication which list the IEC publications issued by the technical committee which has prepared the present publication.

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
34-14

Deuxième édition
Second edition
1996-11

Machines électriques tournantes –

Partie 14: Vibrations mécaniques de certaines machines de hauteur d'axe supérieure ou égale à 56 mm – Mesurage, évaluation et limites de la vibration

Rotating electrical machines –

Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of vibration

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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MACHINES ÉLECTRIQUES TOURNANTES –

Partie 14: Vibrations mécaniques de certaines machines de hauteur d'axe supérieure ou égale à 56 mm – Mesurage, évaluation et limites de la vibration

AVANT-PROPOS

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La Norme internationale CEI 34-14 a été établie par le comité d'études 2 de la CEI: Machines tournantes.

Cette deuxième édition annule et remplace la première édition, parue en 1982.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
2/940/FDIS	2/970/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

L'annexe A est donnée uniquement à titre d'information.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ROTATING ELECTRICAL MACHINES –

Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of vibration

FOREWORD

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International standard IEC 34-14 has been prepared by IEC technical committee 2: Rotating machinery.

This second edition cancels and replaces the first edition published in 1982.

The text of this standard is based on the following documents:

FDIS	Report on voting
2/940/FDIS	2/970/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annex A is for information only.

MACHINES ÉLECTRIQUES TOURNANTES –

Partie 14: Vibrations mécaniques de certaines machines de hauteur d'axe supérieure ou égale à 56 mm – Mesurage, évaluation et limites de la vibration

1 Domaine d'application et objet

La présente partie de la CEI 34 spécifie les procédures d'essai de vibration et les limites pour certaines machines électriques, dans des conditions spécifiées, sans être couplées à une charge ou à une machine entraînée.

Elle est applicable aux machines à courant continu et aux machines à courant alternatif triphasé de hauteur d'axe supérieure ou égale à 56 mm et de puissance assignée inférieure ou égale à 50 MW, à des vitesses nominales de 600 tr/min jusqu'à et y compris 3 600 tr/min.

Pour les machines verticales et pour les machines à brides, cette norme n'est applicable qu'à celles qui sont mesurées en état de suspension libre.

Cette norme n'est pas applicable aux machines montées sur le site, aux moteurs triphasés à collecteurs, aux machines monophasées, aux machines triphasées alimentées en monophasé, aux générateurs hydrauliques verticaux, aux génératrices à aimant permanent ou aux machines à courant continu à enroulement série.

NOTE – Pour les machines mesurées sur le site, se référer à l'ISO 10816-1 (document de base).

2 Références normatives

Les documents normatifs suivants contiennent des dispositions qui, par suite de la référence qui y est faite, constituent des dispositions valables pour la présente partie de la CEI 34. Au moment de la publication, les éditions indiquées étaient en vigueur. Tout document normatif est sujet à révision et les parties prenantes aux accords fondés sur la présente partie de la CEI 34 sont invitées à rechercher la possibilité d'appliquer les éditions les plus récentes des documents normatifs indiqués ci-après. Les membres de la CEI et de l'ISO possèdent le registre des Normes internationales en vigueur.

CEI 34-1: 1996, *Machines électriques tournantes – Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement*

ISO 2954: 1975, *Vibrations mécaniques des machines tournantes ou alternatives – Spécifications des appareils de mesurage de l'intensité vibratoire*

ISO/DIS 7919-1, *Vibrations mécaniques des machines non alternatives – Mesurages sur les arbres tournants et évaluation – Partie 1: Directives générales*

ISO 8821: 1989, *Vibrations mécaniques – Equilibrage – Conventions relatives aux clavettes d'arbres et aux éléments rapportés*

ROTATING ELECTRICAL MACHINES –

Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of vibration

1 Scope and object

This part of IEC 34 specifies the vibration test procedures and limits for certain electrical machines under specified conditions, when uncoupled from any load or prime mover.

It is applicable to d.c. and three-phase a.c. machines, with shaft heights 56 mm and higher and a rated output up to 50 MW, at nominal speeds from 600 rev/min up to and including 3600 rev/min.

For vertical machines and flange-mounted machines, this standard is only applicable to those machines that are measured in a state of free suspension.

This standard is not applicable to machines mounted *in situ*, three-phase commutator motors, single-phase machines, three-phase machines operated on single-phase systems, vertical water power generators, permanent magnet generators, or series-wound d.c. machines.

NOTE – For machines measured *in situ* refer to ISO 10816-1 (basic document).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 34. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 34 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 34-1: 1996, *Rotating electrical machines – Part 1: Rating and performance*

ISO 2954: 1975, *Mechanical vibration of rotating and reciprocating machinery – Requirements for instruments for measuring vibration severity*

ISO/DIS 7919-1, *Mechanical vibration of non-reciprocating machines – Measurements on rotating shafts and evaluation – Part 1: General guidelines*

ISO 8821: 1989, *Mechanical vibration – Balancing – Shaft and fitment key convention*

ISO 10816-1: 1995, *Vibrations mécaniques – Evaluation des vibrations des machines par mesurage sur les parties non tournantes – Partie 1: Directives générales*

ISO/DIS 10817-1, *Systèmes de mesurage des vibrations des arbres tournants – Partie 1: Capteurs des signaux relatifs et absolus des vibrations radiales produites par les arbres tournants*

3 Définitions

Pour les besoins de la présente norme, les définitions données dans les références normatives ci-dessus s'appliquent.

4 Grandeurs de mesurage

4.1 *Généralités*

Les grandeurs de mesurage sont la vitesse de vibration aux paliers de la machine et le déplacement relatif de la vibration sur l'arbre à l'intérieur ou près des paliers de la machine.

4.2 *Intensité vibratoire*

Le critère à adopter pour la vibration aux paliers de la machine doit être la valeur efficace de la vitesse vibratoire en millimètres par seconde. La valeur la plus élevée déterminée aux points de mesurage prescrits caractérise l'intensité vibratoire de la machine (voir ISO 10816-1).

Les moteurs à induction (spécialement du type bipolaire) présentent fréquemment des vitesses de vibration battant à deux fois la fréquence de glissement. Dans ces cas l'intensité vibratoire doit être déterminée à partir de la relation:

$$v_{\text{eff.}} = \sqrt{\frac{(v_{\max}{}^2 + v_{\min}{}^2)}{2}}$$

où

$v_{\max}$ est la valeur maximale efficace de la vitesse;

$v_{\min}$ la valeur minimale.

4.3 *Vibration relative de l'arbre*

Le critère à adopter pour la vibration relative de l'arbre doit être le déplacement vibratoire $S_{p\text{-}p}$ dans le sens du mesurage (voir ISO/DIS 7919-1).

5 Appareillage de mesurage

L'appareillage de mesurage pour les mesurages d'intensité vibratoire doit satisfaire aux prescriptions de l'ISO 2954.

L'appareillage de mesurage pour les mesurages de la vibration relative de l'arbre doit être conforme aux règles de l'ISO/DIS 10817-1.

ISO 10816-1: 1995, *Mechanical vibration – Evaluation of machine vibration by measurement on non-rotating parts – Part 1: General guidelines*

ISO/DIS 10817-1, *Rotating shaft vibration measuring system – Part 1: Relative and absolute signal sensing of radial vibration from rotating shafts*

3 Definitions

For the purpose of this standard, the definitions in the normative references listed in clause 2 apply.

4 Measurement quantities

4.1 *General*

Measurement quantities are the vibration velocity at the machine bearings and the relative shaft vibration displacement within or near to the machine bearings.

4.2 *Vibration severity*

The criterion for the vibration at the machine bearings shall be the r.m.s. value of the vibration velocity in millimetres per second. The greatest value, determined at the prescribed measurement points, characterizes the vibration severity of the machine (see ISO 10816-1).

Induction motors (especially of two-pole type) frequently show vibration velocities beating at twice slip frequency. In these cases the vibration severity shall be determined from the relationship:

$$v_{\text{r.m.s.}} = \sqrt{\frac{(v_{\text{max}}{}^2 + v_{\text{min}}{}^2)}{2}}$$

where

v_{max} is the maximum r.m.s. velocity value;

v_{min} is the minimum value.

4.3 *Relative shaft vibration*

The criterion adopted for the relative shaft vibration shall be the vibratory displacement $S_{\text{p-p}}$ in the direction of measurement (see ISO/DIS 7919-1).

5 Measurement equipment

Measurement equipment for vibration severity measurements shall comply with the requirements in ISO 2954.

Measurement equipment for relative shaft vibration measurements shall comply with the requirements in ISO/DIS 10817-1.

6 Montage de la machine

La vibration d'une machine électrique est étroitement liée au montage de la machine. Pour permettre une évaluation spécifique de l'équilibrage et des vibrations des machines électriques tournantes, il est nécessaire de mesurer la vibration sur la machine seule, selon des conditions d'essai convenablement définies, de façon à permettre des essais reproductibles et à fournir des mesurages comparables.

6.1 *Suspension libre*

Cet état est obtenu par suspension de la machine à un ressort, ou par montage sur un support élastique (ressorts, caoutchouc, etc.)

La fréquence d'oscillation naturelle du système de suspension et de la machine, dans les six degrés de liberté possibles, doit être inférieure au tiers de la fréquence correspondant à la vitesse de la machine en essai, comme défini en 7.3. L'élasticité nécessaire du système de suspension en fonction de la vitesse nominale peut être déterminée à partir de la figure 1.

6.2 *Montage rigide*

La machine doit être fermement attachée à un sol rigide.

Les vitesses de vibration maximales mesurées selon les directions horizontale et verticale sur les pattes de la machine (ou sur le cadre d'embase près des supports des paliers ou pattes du stator) ne doivent pas excéder 25 % des vitesses maximales qui sont mesurées sur le palier adjacent selon l'une ou l'autre des directions de mesurage.

NOTES

1 La présente règle confirme que les fréquences naturelles horizontale et verticale de l'arrangement d'essai complet ne coïncident pas avec:

a ± 10 % de la fréquence de rotation de la machine;

b ± 5 % de deux fois la fréquence de rotation;

c ± 5 % de une ou deux fois la fréquence électrique de ligne.

2 Le rapport de 25 % exigé entre les vitesses au niveau de la patte et du palier est valable pour une vibration une fois par tour et la vibration avec deux fois la fréquence de ligne si cette dernière est évaluée.

6.3 *Détermination de l'environnement actif*

Les systèmes de support mentionnés en 6.1 et 6.2 sont considérés comme passifs, en admettant que les perturbations externes à la machine sont insignifiantes. Si la vibration de la machine à l'arrêt est supérieure à 25 % de la valeur lorsque la machine est en marche, alors un environnement actif est censé exister et la présente norme ne s'y applique pas (voir ISO 10816-1).

6 Machine mounting

The vibration of an electrical machine is closely linked with the mounting of the machine. To permit evaluation as far as balance and vibration of rotating electrical machines are concerned, it is necessary to measure the vibration on the machine alone, under properly determined test conditions, to enable reproducible tests to be carried out and to provide comparable measurements.

6.1 *Free suspension*

This condition is achieved by suspending the machine on a spring or by mounting on an elastic support (springs, rubber, etc.).

The natural oscillation frequency of the suspension system and machine, in the six possible degrees of freedom, shall be less than 1/3 of the frequency corresponding to the speed of the machine under test, as defined in 7.3. The necessary elasticity of the suspension system, as a function of nominal speed, can be determined from figure 1.

6.2 *Rigid mounting*

The machine shall be clamped firmly to a solid floor.

The maximum vibration velocity measured in the horizontal and vertical directions at the machine feet (or at the base frame near to the bearing pedestals or stator feet) shall not exceed 25 % of the maximum velocity which is measured at the adjacent bearing in either the horizontal or vertical direction.

NOTES

1 This requirement ensures that the horizontal and vertical natural frequencies of the complete test arrangement do not coincide within:

a ± 10 % of the rotational frequency of the machine;

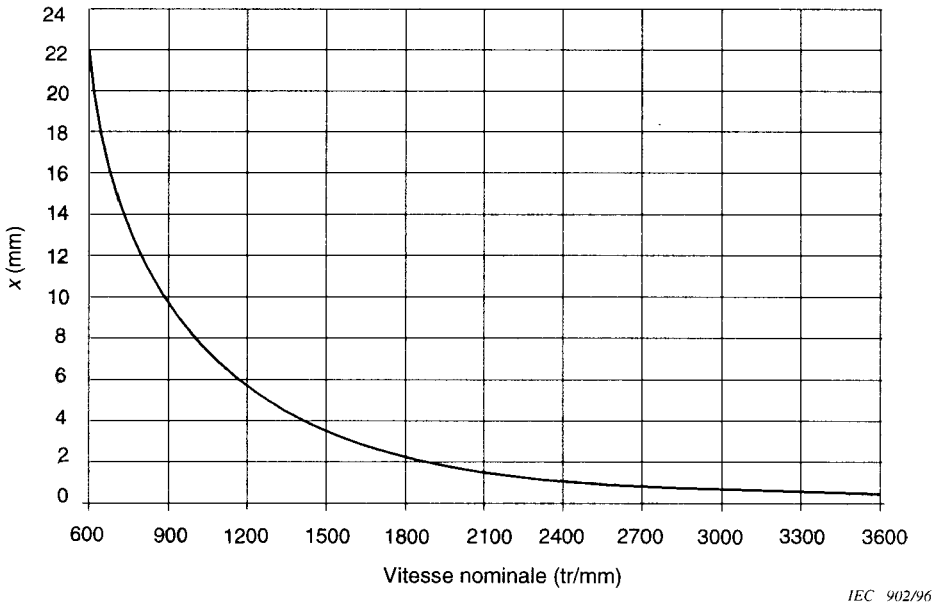
b ± 5 % of two times rotational frequency;

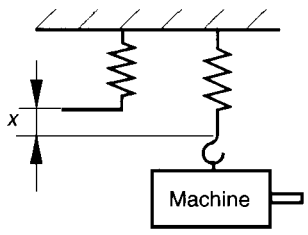
c ± 5 % of one and two times electrical line frequency.

2 The ratio of 25 % of foot to bearing vibration velocities is valid for once per revolution vibration and the vibration at twice line frequency (if the latter is being evaluated).

6.3 *Active environment determination*

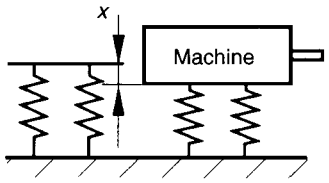
The support systems described in 6.1 and 6.2 are considered passive, admitting insignificant external disturbances to the machine. If the vibration with the machine stationary exceeds 25 % of the value when the machine is running, then an active environment is said to exist and this standard does not apply (see ISO 10816-1).





Suspension à ressort

IEC 903/96

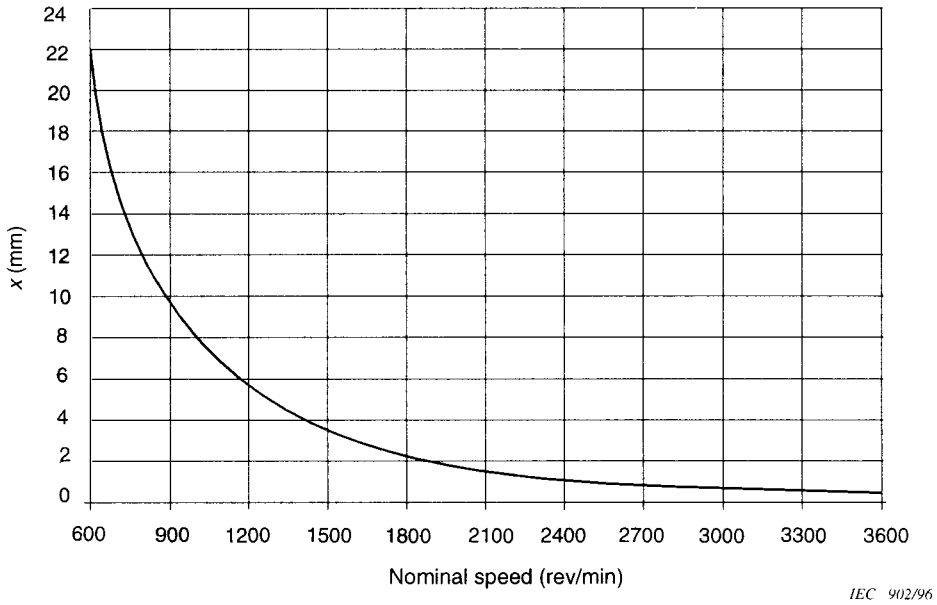


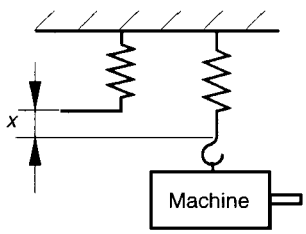
Montage sur un support élastique

IEC 904/96

NOTE – Il convient que la masse effective du support élastique ne soit pas supérieure à 1/10 de celle de la machine, afin de réduire l'influence de la masse et des moments d'inertie de ces éléments sur le niveau de vibration.

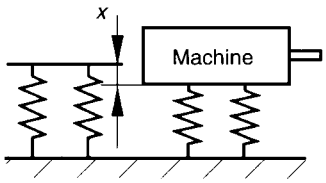
Figure 1 – Déplacement élastique minimal en fonction de la vitesse nominale





Spring suspension

IEC 903/96



Mounting on an elastic support

IEC 904/96

NOTE – To reduce the influence of the mass and the moments of inertia of the suspension system on the vibration level the effective mass of the elastic support should not be greater than 1/10 of that of the machine.

Figure 1 – Minimum elastic displacement as a function of nominal speed

7 Conditions de mesurage

7.1 *Clavette*

Pour l'équilibrage et le mesurage de l'intensité vibratoire des machines équipées d'une rainure de bout d'arbre, la rainure doit être obstruée par une demi-clavette.

NOTE – Une clavette rectangulaire de pleine longueur et de demi-hauteur ou une clavette de demi-longueur et de pleine hauteur (qu'il convient de centrer selon l'axe dans la rainure de la clavette) sont acceptables (voir 3.3 de l'ISO 8821).

7.2 *Points de mesurage*

7.2.1 *Points de mesurage de la vitesse de vibration*

L'emplacement des points de mesurage et les directions auxquelles se rapportent les niveaux de l'intensité vibratoire sont indiqués à la figure 2 pour les machines à flasques paliers et à la figure 4 pour les machines à supports de palier. La figure 3 est applicable aux machines dont les mesurages conformément à la figure 2 ne sont pas possibles sans démontage des éléments.

7.2.2 *Points de mesurage du déplacement relatif de l'arbre*

Des capteurs sans contact doivent être installés à l'intérieur du palier, mesurant directement le déplacement relatif journalier de l'arbre ou bien (si le montage interne n'est pas réalisable) doivent être installés près de la coquille de coussinet. Les positions radiales préférentielles sont celles indiquées en figure 5.

7.3 *Conditions d'essai*

Les machines doivent être essayées à vide, toutes les grandeurs correspondantes étant à leur valeur assignée.

Les machines à courant alternatif doivent être alimentées avec une forme d'onde pratiquement sinusoïdale conformément à 6.2 de la CEI 34-1.

Sauf spécification contraire, l'essai doit être effectué à chaque vitesse assignée ou dans toute la plage des vitesses assignées. Pour chaque essai à une vitesse donnée, les valeurs ne doivent pas être supérieures aux limites correspondantes données dans le tableau 1.

Pour les machines ayant deux sens de rotation, les limites de vibration sont applicables à ces deux sens.

7.4 *Capteur de vibration*

Le contact entre le capteur utilisé pour le mesurage de la vitesse de vibration et la surface de la machine doit être tel que spécifié par le constructeur du capteur et ne doit pas perturber l'état vibratoire de la machine en essai.

Pour cela, il est nécessaire que la masse totale couplée du capteur monté soit inférieure à 1/50 de la masse de la machine.

7 Conditions of measurement

7.1 *Key*

For the balancing and measurement of vibration on machines provided with a shaft extension keyway, the keyway shall be filled with a half key.

NOTE – A full length rectangular key of half height or a half length key of full height (which should be centred axially in the keyway) is acceptable (see 3.3 of ISO 8821).

7.2 *Measurement points*

7.2.1 *Measurement points for vibration velocity*

The location of the measurement points and directions to which the levels of vibration severity apply are shown in figure 2 for machines with end-shield bearings and in figure 4 for machines with pedestal bearings. Figure 3 applies to those machines where measurement positions according to figure 2 are not possible without disassembly of parts.

7.2.2 *Measurement points for relative shaft displacement*

Non-contacting transducers shall be installed inside the bearing, measuring directly the relative shaft journal displacement, or (when inside mounting is not possible) adjacent to the bearing shell. The preferred radial positions are as indicated in figure 5.

7.3 *Test conditions*

Machines shall be tested at no-load with all relevant quantities at their rated value.

AC machines shall be run with a virtually sinusoidal wave form according to 6.2 of IEC 34-1.

Unless otherwise agreed, the test shall be performed at each rated speed or over the whole range of rated speeds. For each tested speed the values shall not exceed the corresponding limit in table 1.

For machines with bidirectional rotation, the vibration limits apply for both directions.

7.4 *Vibration transducer*

The mounting of the transducer used for vibration velocity measurement and the machine surface shall be as specified by the manufacturer of the transducer and shall not disturb the vibratory condition of the machine under test.

For this it is necessary that the total coupled mass of the transducer assembly is less than 1/50 of the mass of the machine.

8 Limites de vibration du logement de palier

8.1 *Limites de l'intensité vibratoire*

Les limites de l'intensité vibratoire des machines à courant continu et des machines triphasées à courant alternatif, de hauteur d'axe égale et supérieure à 56 mm, dans les deux conditions de montage spécifiées à l'article 6 sont spécifiées dans le tableau 1. Les valeurs sont données pour trois niveaux de vibration, N (normal), R (réduit) et S (spécial).

Tableau 1 – Limites d'intensité vibratoire, en mm/s et en valeurs efficaces, pour une hauteur d'axe *H* (mm)

		Machine mesurée en état de suspension libre				Suspension rigide
Niveau de vibration	Vitesse nominale (tr/min)	$56 < H \leq 132$	$132 < H \leq 225$	$225 < H \leq 400$	$H > 400$	$H > 400$
N	600 à 3 600	1,8	2,8	3,5	3,5	2,8
R	600 à 1 800	0,71	1,12	1,8	2,8	1,8
	>1 800 à 3 600	1,12	1,8	2,8	2,8	1,8
S	600 à 1 800	0,45	0,71	1,12		
	>1 800 à 3 600	0,71	1,12	1,8		

NOTES

1 Si aucun niveau n'est spécifié, les machines conformes à la présente norme doivent être de niveau N.

2 Les machines de niveau R sont souvent demandées pour des entraînements de machines-outils. Les machines de niveau S sont utilisées pour entraîner des machines spéciales avec des exigences vibratoires très sévères. Ce niveau n'est applicable qu'aux machines de hauteur d'axe inférieure ou égale à 400 mm.

3 Pour les machines exigeant des valeurs inférieures à celles données dans le tableau 1, il est recommandé de choisir des valeurs de la série 0,45; 0,71; 1,12; 1,8 et 2,8 mm/s.

4 Pour les machines de hauteur d'axe supérieure à 400 mm, les deux méthodes de montage sont applicables. Sauf accord contraire, le choix de la méthode sera effectué par le constructeur.

5 Il est recommandé au constructeur et à l'acheteur de tenir compte du fait que l'instrumentation peut avoir une tolérance de mesurage de ±10 %.

6 Une machine par elle-même bien équilibrée et d'un niveau conforme au tableau peut, après installation sur le site, présenter des vibrations importantes provoquées par diverses raisons, telles qu'une assise mal adaptée, la réaction de la machine entraînée, etc. Des vibrations peuvent également être occasionnées par l'entraînement de pièces présentant une fréquence naturelle d'oscillation très proche de l'excitation en raison d'un faible balourd résiduel de la partie tournante de la machine. Dans de tels cas, il convient d'effectuer des vérifications non seulement sur la machine, mais également sur chaque partie de l'installation.

7 La hauteur d'axe d'une machine sans pattes ou d'une machine avec pattes surélevées, ou de toute machine verticale est à considérer comme étant égale à la hauteur d'axe d'une machine de même carcasse de base mais du type à pattes avec arbre horizontal.

8.2 *Limites de vitesse de vibration à deux fois la fréquence de ligne pour des machines à courant alternatif*

Les machines à deux pôles peuvent présenter des vibrations importantes à deux fois la fréquence de ligne du système d'alimentation. L'évaluation correcte de ces éléments de vibration exige une suspension rigide de la machine qui soit conforme aux prescriptions données en 6.2.

Pour les machines à deux pôles de hauteur d'axe supérieure à 225 mm, l'évaluation ci-dessus doit faire partie d'un essai de type de la machine de base pour établir l'existence d'une vibration importante à deux fois la fréquence de ligne.

8 Limits of bearing housing vibration

8.1 *Limits of vibration severity*

The limit of vibration severity for d.c. and three-phase a.c. machines with shaft heights 56 mm and higher and for the two mounting conditions as specified in clause 6 are specified in table 1. Values are given for three vibration grades: N (normal), R (reduced) and S (special).

Table 1 – Limits of vibration severity in mm/s r.m.s. for the shaft height *H* (mm)

		Machine measured in a state of free suspension				Rigid mounted
Vibration grade	Rated speed rev/min	56 < *H* ≤ 132	132 < *H* ≤ 225	225 < *H* ≤ 400	*H* > 400	*H* > 400
N	600 to 3 600	1,8	2,8	3,5	3,5	2,8
R	600 to 1 800	0,71	1,12	1,8	2,8	1,8
	>1 800 to 3 600	1,12	1,8	2,8	2,8	1,8
S	600 to 1 800	0,45	0,71	1,12		
	>1 800 to 3 600	0,71	1,12	1,8		

NOTES

1 If no grade is specified, machines complying with this standard shall be grade N.

2 Grade R machines are frequently ordered for machine-tool drives. Grade S machines are in use as drives for special machines with extreme vibration requirements. Grade S is applicable only to machines with shaft heights ≤400 mm.

3 For machines requiring values lower than those given in table 1, it is recommended to select values from the series 0,45; 0,71; 1,12; 1,8 and 2,8 mm/s.

4 For machines with H > 400 mm, both methods of mounting are applicable. Unless otherwise agreed, the choice of the method will be made by the manufacturer.

5 Manufacturer and purchaser should take into account that the instrumentation can have a measurement tolerance of ±10 %.

6 A machine, which is well balanced in itself and of a grade conforming with the table, may exhibit large vibrations, when installed *in situ*, arising from various causes, such as unsuitable foundations, reaction of the driven machine, etc. Vibration may also be caused by driving elements with a natural oscillation frequency very close to the excitation due to the small residual unbalance of the rotating masses of the machine. In such cases, checks should be carried out not only on the machine, but also on each element of the installation.

7 The shaft height of a machine without feet, or a machine with raised feet, or any vertical machine is to be taken as the shaft height of a machine in the same basic frame, but of the horizontal shaft, foot-mounting type.

8.2 *Limits of vibration velocity with twice line frequency for a.c. machines*

Two-pole machines may have significant vibration at twice the frequency of the power system. The correct evaluation of these vibration components requires a rigid mounting of the machine which complies with the requirements given in 6.2.

For two-pole machines with shaft heights *H* > 225 mm, the above evaluation shall be part of the basic machine type test to establish the existence of significant twice line frequency vibration.

Les machines de hauteur d'axe supérieure à 225 mm et avec une vibration à deux fois la fréquence de ligne, doivent être essayées avec un montage rigide et ne doivent pas présenter des valeurs supérieures aux valeurs limites du tableau 1 pour les machines de hauteur d'axe supérieure à 400 mm et à montage rigide.

8.3 *Vibration axiale*

L'évaluation de la vibration axiale du palier dépend de la fonction de palier et de la construction du palier.

Dans le cas de paliers de butée, la vibration axiale est corrélée aux pulsations de la poussée qui peuvent endommager la garniture métallique des paliers à douille ou parties des paliers à régule. La vibration axiale de ces paliers doit être évaluée de la même façon qu'une vibration transverse et les valeurs limites du tableau 1 sont applicables.

Si des paliers n'ont pas de limitation axiale par construction, il est permis d'adopter une exigence moins contraignante, soumise à un accord préalable entre le constructeur et l'acheteur.

9 Limites de vibration relative de l'arbre

Les mesurages des vibrations relatives de l'arbre sont seulement recommandées pour les machines deux et quatre pôles à paliers à douilles et de puissance assignée supérieure à 1 000 kW. En conséquence, un accord préalable entre le constructeur et l'utilisateur est nécessaire, quant à l'installation de capteurs de mesurage sur l'arbre.

Si les machines à paliers à douille présentent des dispositions particulières pour le montage des capteurs de mesurage de la vibration de l'arbre, les limites du déplacement relatif de la vibration de l'arbre sont spécifiées dans le tableau 2. Ces limites s'ajoutent à celles exigées à l'article 8.

Tableau 2 – Limites de vibration d'arbre maximale (S_{P-P}) et faux-rond maximal

Niveau de vibration	Nombre de pôles	Déplacement maximal relatif de l'arbre µm	Faux-rond maximal µm
N	2	70	18
	4	90	23
R	2	50	12,5
	4	70	18

NOTES

1 Les machines de niveau de vibration R sont fréquemment demandées pour des entraînements à vitesses élevées dans des installations critiques.

2 Toutes les limites s'appliquent à des machines 50 Hz et 60 Hz.

3 Les limites de déplacement maximal relatif de l'arbre incluent le faux-rond. Pour une définition du faux-rond voir ISO/DIS 7919-1.

Machines having H > 225 mm and twice line frequency vibration, shall be tested with rigid mounting and shall not exceed the values for H > 400 with rigid mounting in table 1.

8.3 *Axial vibration*

The evaluation of axial bearing vibration depends on the bearing function and bearing construction.

In the case of thrust bearings, axial vibration correlates with thrust pulsations which could cause damage to the metal liner of sleeve bearings or to parts of antifriction bearings. Axial vibration of these bearings shall be evaluated in the same manner as transverse vibration and table 1 limits apply.

Where bearings have no axial limiting construction, a less exacting requirement may be acceptable, subject to prior agreement between manufacturer and purchaser.

9 Limits of relative shaft vibration

Relative shaft vibration measurements are recommended only for two- and four-pole machines with sleeve bearings and rated power >1 000 kW and shall be the subject of prior agreement between manufacturer and purchaser with respect to the necessary provisions regarding the installation of shaft measurement transducers.

When machines with sleeve bearings have special provisions for the installation of shaft vibration measurement transducers, the limits for the relative shaft vibration displacement are specified in table 2. These limits are in addition to those required in clause 8.

Table 2 – Limits for the maximum shaft vibration (S_{P-P}) and the maximum run-out

Vibration grade	Number of poles	Maximum relative shaft displacement µm	Maximum run-out µm
N	2	70	18
	4	90	23
R	2	50	12,5
	4	70	18

NOTES

1 Machines with vibration grade R are frequently specified for high-speed drives in critical installations.

2 All limits apply to both 50 Hz and 60 Hz machines.

3 The maximum relative shaft displacement limits include the run-out. For the definition of the run-out (see ISO/DIS 7919-1).

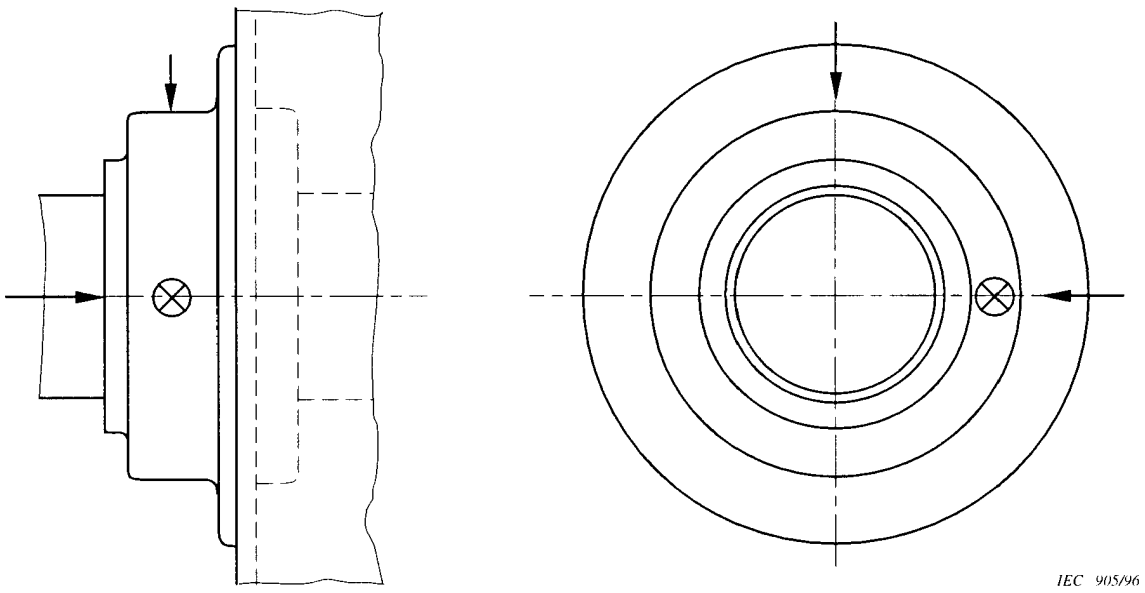


Figure 2 – Points préférentiels de mesurage applicables à une seule ou aux deux extrémités de la machine

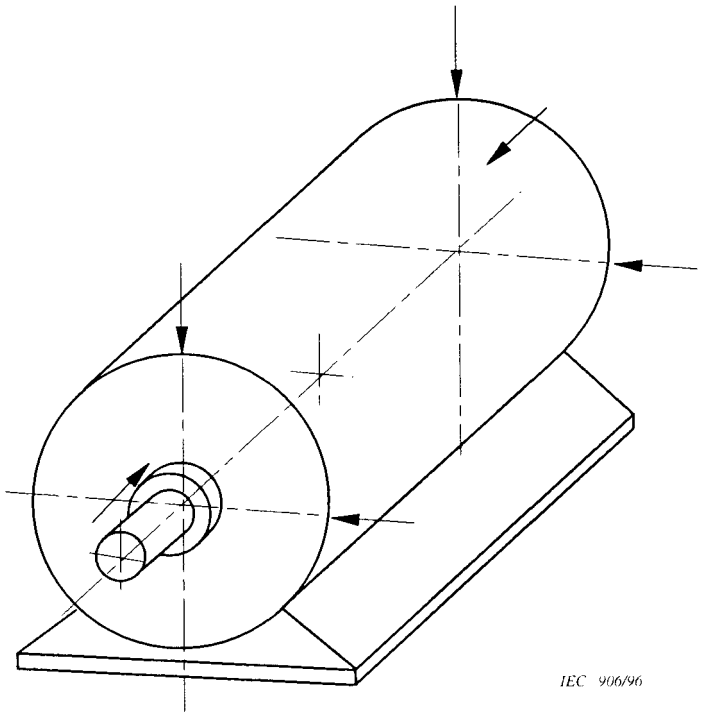


Figure 3 – Points de mesurage pour les extrémités de machines où les mesurages selon la figure 2 ne sont pas possibles sans le démontage des éléments

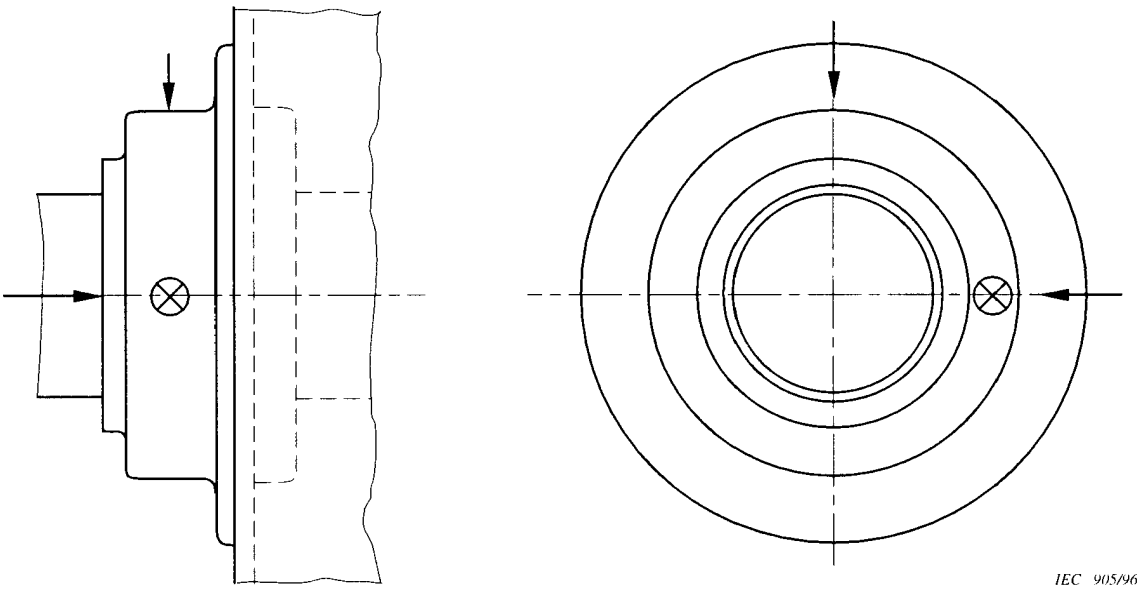


Figure 2 – Preferred points of measurement applicable to one or both ends of the machine

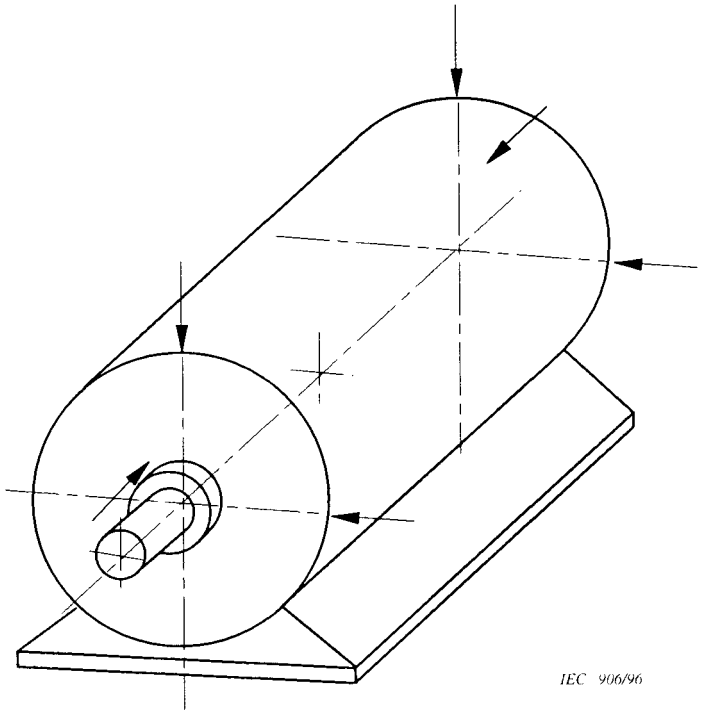


Figure 3 – Measurement points for those ends of machines where measurements according to figure 2 are not possible without disassembly of parts

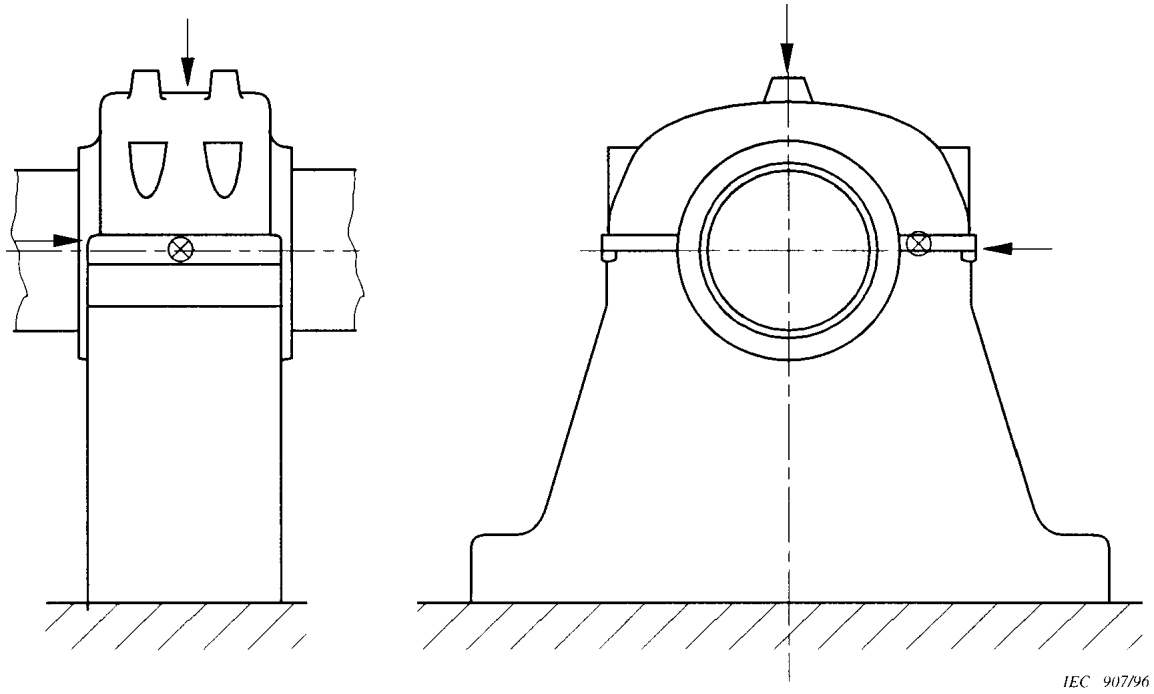


Figure 4 – Points de mesurage pour pied support de palier

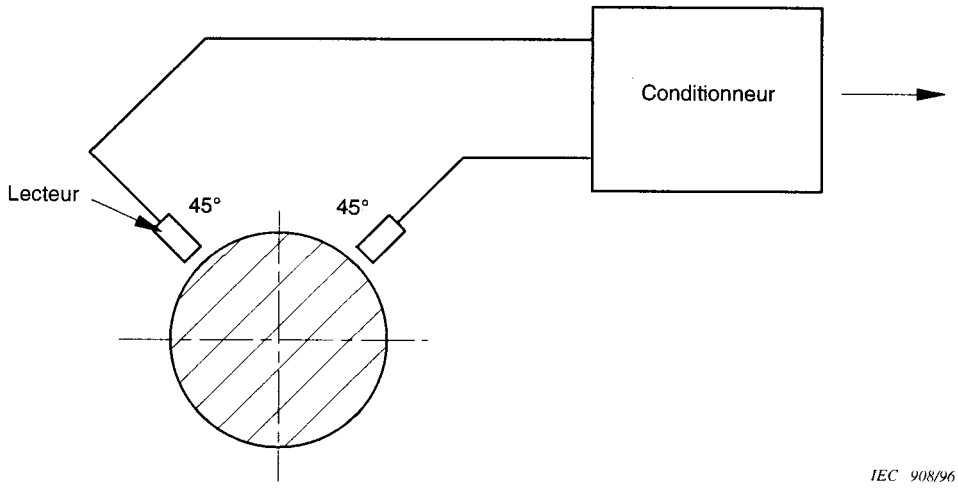


Figure 5 – Installation préférentielle des lecteurs pour le mesurage du déplacement relatif de l'arbre

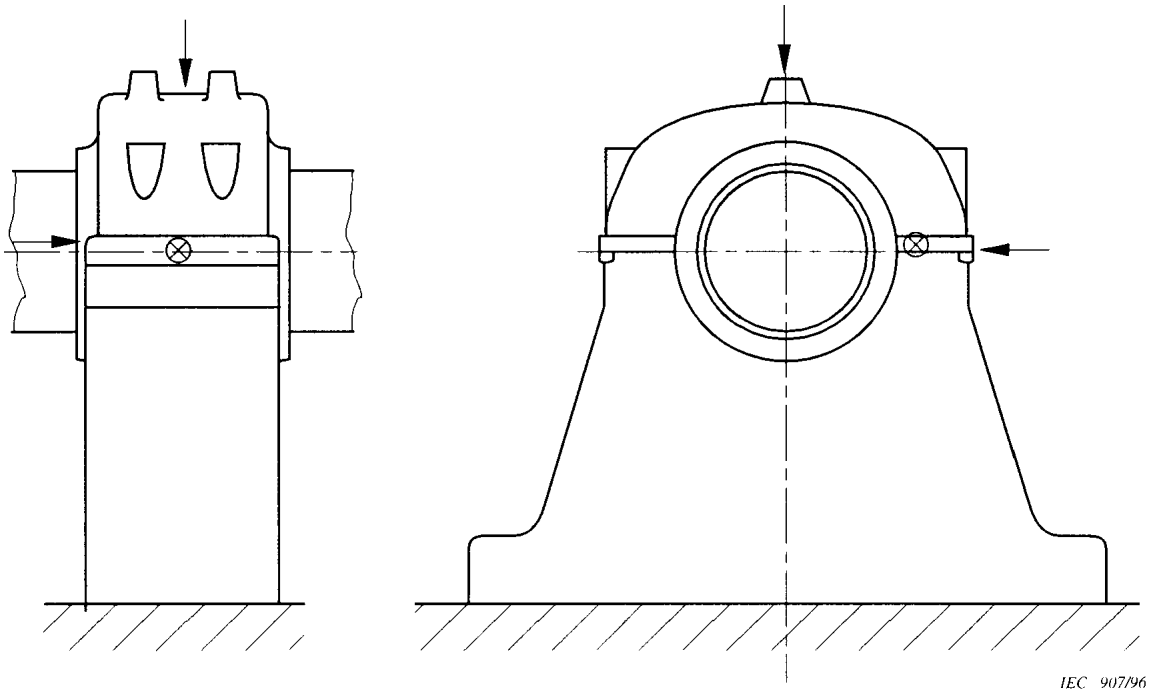


Figure 4 – Measurement points for pedestal bearing

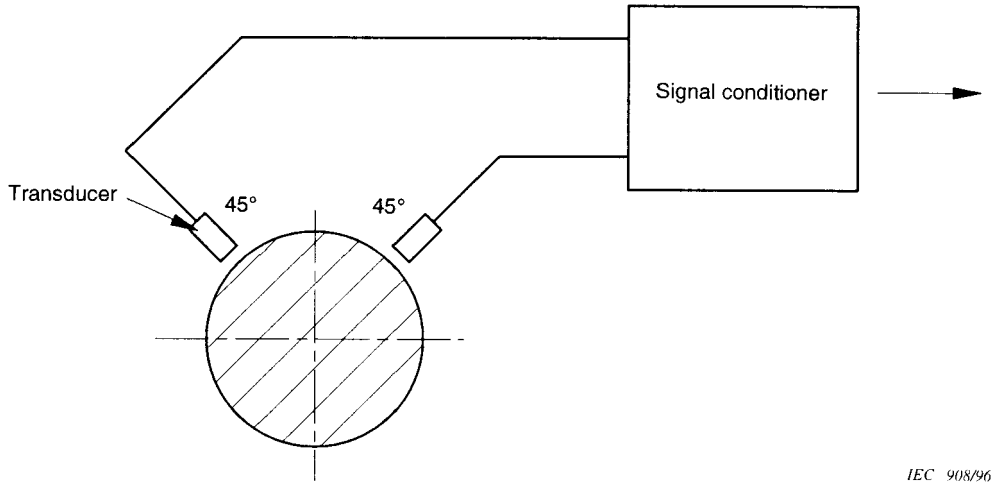


Figure 5 – Preferred circumferential position of transducers for the measurement of relative shaft displacement

Annexe A
(informative)

Bibliographie

ISO/DIS 7919-3, *Vibrations mécaniques des machines non alternatives – Mesurages sur les arbres tournants et évaluation – Partie 3: Directives concernant les machines industrielles couplées*

API standard 541: 1987, *Moteurs à induction à cage, enroulement préformé – 250 HP et plus*

API standard 546: 1990, *Moteurs synchrones sans balai, enroulement préformé – 500 HP et plus*

_____

Annex A
(informative)

Bibliography

ISO/DIS 7919-3, *Mechanical vibration of non-reciprocating machines – Measurements on rotating shafts and evaluation – Part 3: Guidelines for coupled industrial machines*

API Standard 541: 1987, *Form-wound squirrel-cage induction motors 250 horsepower and larger*

API Standard 546: 1990, *Form-wound brushless synchronous motors 500 horsepower and larger*

_____

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We at the IEC want to know how our standards are used once they are published.

The answers to this survey will help us to improve IEC standards and standard related information to meet your future needs

Would you please take a minute to answer the survey on the other side and mail or fax to:

Customer Service Centre (CSC)

International Electrotechnical Commission
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1211 Geneva 20
Switzerland

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Fax to: CSC at +41 22 919 03 00

Thank you for your contribution to the standards making process.

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A Prioritaire

RÉPONSE PAYÉE

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International Electrotechnical Commission
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Case postale 131
1211 GENEVA 20
Switzerland

1.

No. of IEC standard:

.....

2.

Tell us why you have the standard. (check many as apply). I am:

- ☐ the buyer
- ☐ the user
- ☐ a librarian
- ☐ a researcher
- ☐ an engineer
- ☐ a safety expert
- ☐ involved in testing
- ☐ with a government agency
- ☐ in industry
- ☐ other.....

3.

This standard was purchased from?

.....

4.

This standard will be used (check as many as apply):

- ☐ for reference
- ☐ in a standards library
- ☐ to develop a new product
- ☐ to write specifications
- ☐ to use in a tender
- ☐ for educational purposes
- ☐ for a lawsuit
- ☐ for quality assessment
- ☐ for certification
- ☐ for general information
- ☐ for design purposes
- ☐ for testing
- ☐ other.....

5.

This standard will be used in conjunction with (check as many as apply):

- ☐ IEC
- ☐ ISO
- ☐ corporate
- ☐ other (published by.....)
- ☐ other (published by.....)
- ☐ other (published by.....)

6.

This standard meets my needs (check one)

- ☐ not at all
- ☐ almost
- ☐ fairly well
- ☐ exactly

7.

Please rate the standard in the following areas as (1) bad, (2) below average, (3) average, (4) above average, (5) exceptional, (0) not applicable:

- ☐ clearly written
- ☐ logically arranged
- ☐ information given by tables
- ☐ illustrations
- ☐ technical information

8.

I would like to know how I can legally reproduce this standard for:

- ☐ internal use
- ☐ sales information
- ☐ product demonstration
- ☐ other.....

9.

In what medium of standard does your organization maintain most of its standards (check one):

- ☐ paper
- ☐ microfilm/microfiche
- ☐ mag tapes
- ☐ CD-ROM
- ☐ floppy disk
- ☐ on line

9A.

If your organization currently maintains part or all of its standards collection in electronic media please indicate the format(s):

- ☐ raster image
- ☐ full text

10.

In what medium does your organization intend to maintain its standards collection in the future (check all that apply):

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- ☐ microfilm/microfiche
- ☐ mag tape
- ☐ CD-ROM
- ☐ floppy disk
- ☐ on line

10A.

For electronic media which format will be chosen (check one)

- ☐ raster image
- ☐ full text

11.

My organization is in the following sector (e.g. engineering, manufacturing)

.....

12.

Does your organization have a standards library:

- ☐ yes
- ☐ no

13.

If you said yes to 12 then how many volumes:

.....

14.

Which standards organizations published the standards in your library (e.g. ISO, DIN, ANSI, BSI, etc.):

.....

15.

My organization supports the standards-making process (check as many as apply):

- ☐ buying standards
- ☐ using standards
- ☐ membership in standards organization
- ☐ serving on standards development committee
- ☐ other.....

16.

My organization uses (check one)

- ☐ French text only
- ☐ English text only
- ☐ Both English/French text

17.

Other comments:

.....

.....

.....

.....

.....

.....

18.

Please give us information about you and your company

name: .....

job title:.....

company: .....

address:.....

.....

.....

.....

No. employees at your location:.....

turnover/sales:.....

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La CEI se préoccupe de savoir comment ses normes sont accueillies et utilisées.

Les réponses que nous procurera cette enquête nous aideront tout à la fois à améliorer nos normes et les informations qui les concernent afin de toujours mieux répondre à votre attente.

Nous aimerions que vous nous consacriez une petite minute pour remplir le questionnaire joint que nous vous invitons à retourner au:

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1211 Genève 20
Suisse

Télécopie: IEC/CSC +41 22 919 03 00

Nous vous remercions de la contribution que vous voudrez bien apporter ainsi à la Normalisation Internationale

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A Prioritaire

RÉPONSE PAYÉE

SUISSE

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1211 GENÈVE 20
Suisse

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Numéro de la Norme CEI:

.....

2.

Pourquoi possédez-vous cette norme? (plusieurs réponses possibles). Je suis:

- ☐ l'acheteur
- ☐ l'utilisateur
- ☐ bibliothécaire
- ☐ chercheur
- ☐ ingénieur
- ☐ expert en sécurité
- ☐ chargé d'effectuer des essais
- ☐ fonctionnaire d'Etat
- ☐ dans l'industrie
- ☐ autres.....

3.

Où avez-vous acheté cette norme?

.....

4.

Comment cette norme sera-t-elle utilisée? (plusieurs réponses possibles)

- ☐ comme reférence
- ☐ dans une bibliothèque de normes
- ☐ pour développer un produit nouveau
- ☐ pour rédiger des spécifications
- ☐ pour utilisation dans une soumission
- ☐ à des fins éducatives
- ☐ pour un procès
- ☐ pour une évaluation de la qualité
- ☐ pour la certification
- ☐ à titre d'information générale
- ☐ pour une étude de conception
- ☐ pour effectuer des essais
- ☐ autres.....

5.

Cette norme est-elle appelée à être utilisée conjointement avec d'autres normes? Lesquelles? (plusieurs réponses possibles):

- ☐ CEI
- ☐ ISO
- ☐ internes à votre société
- ☐ autre (publiée par).....)
- ☐ autre (publiée par).....)
- ☐ autre (publiée par).....)

6.

Cette norme répond-elle à vos besoins?

- ☐ pas du tout
- ☐ à peu près
- ☐ assez bien
- ☐ parfaitement

7.

Nous vous demandons maintenant de donner une note à chacun des critères ci-dessous (1, mauvais; 2, en-dessous de la moyenne; 3, moyen; 4, au-dessus de la moyenne; 5, exceptionnel; 0, sans objet)

- ☐ clarté de la rédaction
- ☐ logique de la disposition
- ☐ tableaux informatifs
- ☐ illustrations
- ☐ informations techniques

8.

J'aimerais savoir comment je peux reproduire légalement cette norme pour:

- ☐ usage interne
- ☐ des renseignements commerciaux
- ☐ des démonstrations de produit
- ☐ autres .....

9.

Quel support votre société utilise-t-elle pour garder la plupart de ses normes?

- ☐ papier
- ☐ microfilm/microfiche
- ☐ bandes magnétiques
- ☐ CD-ROM
- ☐ disquettes
- ☐ abonnement à un serveur électronique

9A.

Si votre société conserve en totalité ou en partie sa collection de normes sous forme électronique, indiquer le ou les formats:

- ☐ format tramé (ou image balayée ligne par ligne)
- ☐ texte intégral

10.

Sur quels supports votre société prévoit-elle de conserver sa collection de normes à l'avenir (plusieurs réponses possibles):

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- ☐ microfilm/microfiche
- ☐ bandes magnétiques
- ☐ CD-ROM
- ☐ disquettes
- ☐ abonnement à un serveur électronique

10A.

Quel format serait retenu pour un moyen électronique? (une seule réponse)

- ☐ format tramé
- ☐ texte intégral

11.

A quel secteur d'activité appartient votre société? (par ex. ingénierie, fabrication)

.....

12.

Votre société possède-t-elle une bibliothèque de normes?

- ☐ Oui
- ☐ Non

13.

En combien de volumes dans le cas affirmatif?

.....

14.

Quelle organisations de normalisation ont publiées les normes de cette bibliothèque (ISO, DIN, ANSI, BSI, etc.):

.....

15.

Ma société apporte sa contribution à l'élaboration des normes par les moyens suivants (plusieurs réponses possible):

- ☐ en achetant des normes
- ☐ en utilisant des normes
- ☐ en qualité de membre d'organisations de normalisation
- ☐ en qualité de membre de comités de normalisation
- ☐ autres .....

16.

Ma société utilise (une seule réponse)

- ☐ des normes en français seulement
- ☐ des normes en anglais seulement
- ☐ des normes bilingues anglais/français

17.

Autres observations

.....

.....

.....

.....

.....

18.

Pourriez-vous nous donner quelques informations sur vous-mêmes et votre société?

nom .....

fonction.....

nom de la société .....

addresse.....

.....

.....

.....

nombre d'employés.....

chiffre d'affaires:.....

Publications de la CEI préparées par le Comité d'Etudes n° 2

34: — Machines électriques tournantes.

34-1 (1996)	Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement.
34-2 (1972)	Deuxième partie: Méthodes pour la détermination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines pour véhicules de traction). Amendement 1 (1995). Amendement 2 (1996).
34-2A (1974)	Premier complément: Mesure des pertes par la méthode calorimétrique.
34-3 (1988)	Troisième partie: Règles spécifiques pour les turbo-machines synchrones.
34-4 (1985)	Quatrième partie: Méthodes pour la détermination à partir d'essais des grandeurs des machines synchrones. Amendement 1 (1995).
34-5 (1991)	Cinquième partie: Classification des degrés de protection procurés par les enveloppes des machines électriques tournantes (Code IP).
34-6 (1991)	Partie 6: Modes de refroidissement (Code IC).
34-7 (1992)	Partie 7: Classification des formes de construction et des dispositions de montage (Code IM).
34-8 (1972)	Huitième partie: Marques d'extrémités et sens de rotation des machines tournantes. Amendement n° 1 (1990). Amendement 2 (1996).
34-9 (1990)	Neuvième partie: Limites de bruit. Amendement 1 (1995).
34-10 (1975)	Dixième partie: Conventions relatives à la description des machines synchrones.
34-11 (1978)	Onzième partie: Protection thermique incorporée – Chapitre l: Règles concernant la protection des machines électriques tournantes.
34-11-2 (1984)	Chapitre 2: Détecteurs thermiques et auxiliaires de commande utilisés dans les dispositifs de protection thermique. Modification n° 1 (1990).
34-11-3 (1984)	Chapitre 3: Règles générales concernant les protecteurs thermiques utilisés dans les dispositifs de protection thermique.
34-12 (1980)	Douzième partie: Caractéristiques de démarrage des moteurs triphasés à induction à cage à une seule vitesse pour des tensions d'alimentation inférieures ou égales à 660 V. Amendement n° 1 (1992). Amendement 2 (1995).
34-13 (1980)	Treizième partie: Spécification pour les moteurs auxiliaires pour laminoirs.
34-14 (1996)	Partie 14: Vibrations mécaniques de certaines machines de hauteur d'axe supérieure ou égale à 56 mm – Mesurage, évaluation et limites de la vibration.
34-15 (1995)	Partie 15: Niveaux de tension de tenue au choc des machines tournantes à courant alternatif à bobines stator préformées.
34-16-1 (1991)	Seizième partie: Systèmes d'excitation pour machines synchrones – Chapitre 1: Définitions.
34-16-2 (1991)	Chapitre 2: Modèle pour les études de réseau.

(suite)

IEC publications prepared by Technical Committee No. 2

34: — Rotating electrical machines.

34-1 (1996)	Part l: Rating and performance.
34-2 (1972)	Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles). Amendment 1 (1995). Amendment 2 (1996).
34-2A (1974)	First supplement: Measurement of losses by the calorimetric method.
34-3 (1988)	Part 3: Specific requirements for turbine-type synchronous machines.
34-4 (1985)	Part 4: Methods for determining synchronous machine quantities from tests. Amendment 1 (1995).
34-5 (1991)	Part 5: Classification of degrees of protection provided by enclosures for rotating electrical machines (IP Code).
34-6 (1991)	Part 6: Methods of cooling (IC Code).
34-7 (1992)	Part 7: Classification of types of constructions and mounting arrangements (IM Code).
34-8 (1972)	Part 8: Terminal markings and direction of rotation of rotating machines. Amendment No. 1 (1990). Amendment 2 (1996).
34-9 (1990)	Part 9: Noise limits. Amendment 1 (1995).
34-10 (1975)	Part 10: Conventions for description of synchronous machines.
34-11 (1978)	Part 11: Built-in thermal protection. Chapter l: Rules for protection of rotating electrical machines.
34-11-2 (1984)	Chapter 2: Thermal detectors and control units used in thermal protection systems. Amendment No. 1 (1990).
34-11-3 (1984)	Chapter 3: General rules for thermal protectors used in thermal protection systems.
34-12 (1980)	Part l2: Starting performance of single-speed three-phase cage induction motors for voltages up to and including 660 V. Amendment No. 1 (1992). Amendment 2 (1995).
34-13 (1980)	Part 13: Specification for mill auxiliary motors.
34-14 (1996)	Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of the vibration.
34-15 (1995)	Part 15: Impulse voltage withstand levels of rotating a.c. machines with form-wound stator coils.
34-16-1 (1991)	Part 16: Excitation systems for synchronous machines – Chapter 1: Definitions.
34-16-2 (1991)	Chapter 2: Models for power system studies.

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 2 *(suite)*

34-16-3 (1996) Section 3: Performances dynamiques.

34-17 (1992) Partie 17: Guide d'application des moteurs à induction à cage alimentés par convertisseurs.

34-18: — Evaluations fonctionnelles des systèmes d'isolation.

34-18-1 (1992) Section 1: Principes directeurs généraux.
Amendement 1 (1996).

34-18-21 (1992) Section 21: Procédures d'essai pour enroulements à fils – Evaluation thermique et classification.
Amendement 1 (1994).
Amendement 2 (1996).

34-18-22 (1996) Section 22: Procédures d'essai pour enroulements à fils – Classification des modifications et des substitutions de composants d'isolation.

34-18-31 (1992) Section 31: Procédures d'essai pour enroulements préformés – Evaluation thermique et classification des systèmes d'isolation utilisés dans les machines jusqu'à et y compris 50 MVA et 15 kV.
Amendement 1 (1996).

34-18-32 (1995) Section 32: Procédures d'essai pour enroulements préformés – Evaluation électrique des systèmes d'isolation utilisés dans les machines jusqu'à et y compris 50 MVA et 15 kV.

34-18-33 (1995) Section 33: Procédures d'essai pour enroulements préformés – Evaluation fonctionnelle à plusieurs facteurs – Endurance sous contrainte thermique et électrique combinée des systèmes d'isolation utilisés dans les machines jusqu'à et y compris 50 MVA et 15 kV.

34-19 (1995) Partie 19: Méthodes spécifiques d'essai pour machines à courant continu à alimentation conventionnelle ou redressée.

34-22 (1996) Partie 22: Génératrices à courant alternatif pour moteurs à combustion interne et à pistons.

72: — Dimensions et séries de puissances des machines électriques tournantes.

72-1 (1991) Partie 1: Désignation des carcasses entre 56 et 400 et des brides entre 55 et 1 080.

72-2 (1990) Partie 2: Désignation des carcasses entre 355 et 1 000 et des brides entre 1 180 et 2 360.

72-3 (1994) Partie 3: Petits moteurs incorporés – Désignation des brides BF10 à BF50.

136 (1986) Dimensions des balais et porte-balais pour machines électriques.
Amendement 1 (1995).

276 (1968) Définitions et nomenclature des balais de charbon, des porte-balais, des collecteurs et des bagues.
Modification n° 1 (1987).

279 (1969) Mesure de la résistance des enroulements d'une machine à courant alternatif en fonctionnement sous tension alternative.

356 (1971) Dimensions des collecteurs et des bagues.

413 (1972) Méthodes d'essai pour la mesure des propriétés physiques des matières de balais pour machines électriques.

560 (1977) Définitions et terminologie des porte-balais de machines électriques.

681: — Dimensions des moteurs de faible puissance pour applications particulières.

681-1 (1980) Première partie: Moteurs pour brûleurs à mazout.

773 (1983) Méthodes d'essai et appareils pour la mesure des propriétés opérationnelles des balais.

778 (1984) Porte-balais pour bagues, groupe R – exécution RA.

(suite)

IEC publications prepared by Technical Committee No. 2 *(continued)*

34-16-3 (1996) Section 3: Dynamic performance

34-17 (1992) Part 17: Guide for application of cage induction motors when fed from converters.

34-18: — Functional evaluation of insulation systems.

34-18-1 (1992) Section 1: General guidelines.
Amendment 1 (1996).

34-18-21 (1992) Section 21: Test procedures for wire-wound windings – Thermal evaluation and classification.
Amendment 1 (1994).
Amendment 2 (1996).

34-18-22 (1996) Section 22: Test procedures for wire-wound windings – Classification of changes and insulation component substitutions.

34-18-31 (1992) Section 31: Test procedures for form-wound windings – Thermal evaluation and classification of insulation systems used in machines up to and including 50 MVA and 15 kV.
Amendment 1 (1996).

34-18-32 (1995) Section 32: Test procedures for form-wound windings – Electrical evaluation of insulation systems used in machines up to and including 50 MVA and 15 kV

34-18-33 (1995) Section 33: Test procedures for form-wound windings – Multifactor functional evaluation – Endurance under combined thermal and electrical stresses of insulation systems used in machines up to and including 50 MVA and 15 kV

34-19 (1995) Part 19: Specific test methods for d.c. machines on conventional and rectifier-fed supplies.

34-22 (1996) Part 22: AC generators for reciprocating internal combustion (RIC) engine driven generating sets.

72: — Dimensions and output series for rotating electrical machines.

72-1 (1991) Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1 080.

72-2 (1990) Part 2: Frame numbers 355 to 1 000 and flange numbers 1 180 to 2 360.

72-3 (1994) Part 3: Small built-in motors – Flange numbers BF10 to BF50.

136 (1986) Dimensions of brushes and brush-holders for elec-trical machinery.
Amendment 1 (1995).

276 (1968) Definitions and nomenclature for carbon brushes, brush-holders, commutators and slip-rings.
Amendment No. 1 (1987).

279 (1969) Measurement of the winding resistance of an a.c. machine during operation at alternating voltage.

356 (1971) Dimensions for commutators and slip-rings.

413 (1972) Test procedures for determining physical properties of brush materials for electrical machines.

560 (1977) Definitions and terminology of brush-holders for electrical machines.

681: — Dimensions of small power motors for definite purpose application.

681-1 (1980) Part 1: Oil burner motors.

773 (1983) Test methods and apparatus for the measurement of the operational characteristics of brushes.

778 (1984) Brush-holders for slip-rings, Group R – type RA.

(continued)

Publications de la CEI préparées par le Comité d'Etudes n° 2 *(suite)*

842 (1988)	Guide pour l'application et l'exploitation des machines synchrones à rotor lisse utilisant l'hydrogène comme fluide de refroidissement.
892 (1987)	Effets de tensions déséquilibrées sur les caractéristiques de fonctionnement des moteurs asynchrones triphasés à cage.
894 (1987)	Guide de procédure d'essai pour la mesure de la tangente de l'angle de pertes de bobines et barres d'enroulements des machines.
991 (1989)	Bagues de montage élastiques pour petits moteurs – Dimensions de montage.
1015 (1990)	Porte-balais de machines électriques. Guide pour la mesure de la poussée statique appliquée aux balais.

IEC publications prepared by Technical Committee No. 2 *(continued)*

842 (1988)	Guide for application and operation of turbine-type synchronous machines using hydrogen as a coolant.
892 (1987)	Effects of unbalanced voltages on the performance of 3-phase cage induction motors.
894 (1987)	Guide for test procedure for the measurement of loss tangent on coils and bars for machine windings.
991 (1989)	Resilient mounting rings for small motors – Mounting dimensions.
1015 (1990)	Brush-holders for electrical machines. Guide to the measurement of the static thrust applied to brushes.

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Machines électriques tournantes – Charge équivalente et techniques par superposition – Essais indirects pour déterminer l'échauffement

Rotating electrical machines – Equivalent loading and super-position techniques – Indirect testing to determine temperature rise

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

MACHINES ÉLECTRIQUES TOURNANTES – CHARGE ÉQUIVALENTE ET TECHNIQUES PAR SUPERPOSITION – ESSAIS INDIRECTS POUR DÉTERMINER L'ÉCHAUFFEMENT

AVANT-PROPOS

1) La CEI (Commission Électrotechnique Internationale) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de la CEI). La CEI a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, la CEI, entre autres activités, publie des Normes internationales. Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec la CEI, participent également aux travaux. La CEI collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
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4) Dans le but d'encourager l'unification internationale, les Comités nationaux de la CEI s'engagent à appliquer de façon transparente, dans toute la mesure possible, les Normes internationales de la CEI dans leurs normes nationales et régionales. Toute divergence entre la norme de la CEI et la norme nationale ou régionale correspondante doit être indiquée en termes clairs dans cette dernière.
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La Norme internationale CEI 61986 a été établie par le sous-comité 2G: Méthodes et procédures d'essai, du comité d'études 2 de la CEI: Machines tournantes.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
2G/115/FDIS	2G/121/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/CEI, Partie 3.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant 2006. A cette date, la publication sera

- reconduite;
- supprimée;
- remplacée par une édition révisée, ou
- amendée.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES – EQUIVALENT LOADING AND SUPER-POSITION TECHNIQUES – INDIRECT TESTING TO DETERMINE TEMPERATURE RISE

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 61986 has been prepared by subcommittee 2G: Test methods and procedures, of IEC technical committee 2: Rotating machinery.

The text of this standard is based on the following documents:

FDIS	Report on voting
2G/115/FDIS	2G/121/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

MACHINES ÉLECTRIQUES TOURNANTES – CHARGE ÉQUIVALENTE ET TECHNIQUES PAR SUPERPOSITION – ESSAIS INDIRECTS POUR DÉTERMINER L'ÉCHAUFFEMENT

1 Domaine d'application

La présente Norme internationale s'applique aux machines couvertes par la CEI 60034-1 lorsque, pour une raison quelconque, il est impossible de les soumettre à une charge d'une condition spécifique (assignée ou autre). Elle est applicable tant aux moteurs qu'aux génératrices mais ces méthodes ne sont pas appropriées aux machines d'une puissance égale ou inférieure à 1 kW.

La présente norme a pour objet de décrire différents essais en charge indirects destinés à déterminer l'échauffement des machines électriques tournantes, y compris les machines à induction à courant alternatif, les machines synchrones à courant alternatif et les machines à courant continu. Dans certains cas, les méthodes d'essai permettent en outre de mesurer ou d'estimer d'autres paramètres tels que les pertes et les vibrations, mais ces méthodes ne sont pas conçues spécifiquement pour fournir de telles données.

Les méthodes d'essai proposées sont considérées comme équivalentes, le choix dépendant uniquement de l'emplacement, des appareils d'essai, du type de machine et de l'exactitude des résultats d'essai.

La présente norme n'est pas destinée à être interprétée comme une exigence de réaliser un ou tous les essais qu'elle décrit sur une quelconque machine donnée. Les essais particuliers à réaliser font l'objet d'accords spéciaux entre le fabricant et l'acheteur.

Etant donné que les méthodes ne reproduisent qu'approximativement les conditions thermiques des machines observées dans les conditions assignées normales, le fabricant et l'acheteur peuvent convenir de prendre les résultats des mesurages de l'échauffement obtenus lors d'essais réalisés selon ces méthodes comme base pour l'évaluation de l'échauffement de la machine conformément à 7.10 de la CEI 60034-1.

2 Références normatives

Les documents normatifs suivants contiennent des dispositions qui, par suite de la référence qui y est faite, constituent des dispositions valables pour la présente Norme internationale. Pour les références datées, les amendements ultérieurs ou les révisions de ces publications ne s'appliquent pas. Toutefois, les parties prenantes aux accords fondés sur la présente Norme internationale sont invitées à rechercher la possibilité d'appliquer les éditions les plus récentes des documents normatifs indiqués ci-après. Pour les références non datées, la dernière édition du document normatif en référence s'applique. Les membres de la CEI et de l'ISO possèdent le registre des Normes internationales en vigueur.

CEI 60034-1, *Machines électriques tournantes – Partie 1: Caractéristiques assignées et caractéristiques de fonctionnement*

CEI 60034-2, *Machines électriques tournantes – Partie 2: Méthodes pour la détermination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines pour véhicules de traction)*

ROTATING ELECTRICAL MACHINES – EQUIVALENT LOADING AND SUPER-POSITION TECHNIQUES – INDIRECT TESTING TO DETERMINE TEMPERATURE RISE

1 Scope

This International Standard applies to machines covered by IEC 60034-1 when they cannot be loaded to a specific condition (rated or otherwise) for whatever reason. It is applicable to both motors and generators but the methods are not suitable for machines of and below 1 kW.

The object of this standard is to provide descriptions of various indirect load tests, the purpose of which is to determine the temperature rise of rotating electrical machines, including a.c. induction machines, a.c. synchronous machines and d.c. machines. The test methods in some cases provide, in addition, a means of measuring or estimating other parameters such as losses and vibration, but the methods are not designed specifically to provide such data.

The proposed methods of test are considered equivalent, the choice of them relying only on the location, the testing apparatus and the kind of machine, and the test result accuracy.

It is not intended that this standard be interpreted as requiring the carrying out of any or all of the tests described therein on any given machine. The particular tests to be carried out are subject to a special agreement between the manufacturer and the purchaser.

As the methods reproduce only approximately the thermal conditions of the machines which occur under normal rated condition, temperature-rise measurement results achieved from tests with these methods can be taken as the basis for the evaluation of machine heating according to 7.10 of IEC 60034-1 by agreement between the manufacturer and the purchaser.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-2, *Rotating electrical machines – Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)*

3 Symboles et unités

K_{11}, K_{22}, etc.	coefficient de pertes thermiques déterminant l'échauffement du composant 1 dû à des pertes dans le composant 1, etc., K/W
K_{12}, K_{13}, etc.	coefficient de pertes thermiques déterminant l'échauffement du composant 1 dû à des pertes dans le composant 2, etc., K/W
$\Delta\theta$	échauffement, K
θ	température, °C
K	facteur d'inclinaison de la ligne droite qui caractérise la variation de l'échauffement en fonction des pertes, K/W
P	perte, W
I	courant, A
R	résistance, Ω
X_L	réactance de fuite statorique, Ω
V	tension, V
f	fréquence, Hz
ω	pulsation, rad/s
$f_{1,2}$	fréquence principale/auxiliaire, Hz
Δt	intervalle de temps, s
λ	rapport de la tension auxiliaire à la tension principale
F	fréquence de modulation, Hz
δ	amplitude de la modulation de fréquence, Hz
T	couple, Nm
J	moment d'inertie, kgm^2
$\cos\varphi$	facteur de puissance
γ	exactitude de l'essai, %
σ	facteur de correction
Indices	
m, n, o, p	conditions d'essai
1, 2, 3, etc.	composant de machine (par exemple enroulement statorique, enroulement rotorique, fer statorique, etc.)
t	essai
f	excitation
A	ambiant
s	stator
N	valeur assignée
α	surexcité/circuit ouvert
β	sous-excité/court-circuit.
super	essai par superposition
equiv	essai de charge équivalente

3 Symbols and units

K_{11}, K_{22}, etc.	coefficient of heating losses determining the temperature rise of component 1 due to losses in component 1, etc., K/W
K_{12}, K_{13}, etc.	coefficient of heating losses determining the temperature rise of component 1 due to losses in component 2, etc., K/W
$\Delta\theta$	temperature rise, K
θ	temperature, °C
K	slope factor of the straight line characterizing variation of temperature rise with losses, K/W
P	loss, W
I	current, A
R	resistance, Ω
X_L	stator leakage reactance, Ω
V	voltage, V
f	frequency, Hz
ω	angular frequency, rad/s
$f_{1,2}$	main/auxiliary frequency, Hz
Δt	time interval, s
λ	ratio of auxiliary voltage to main voltage
F	modulation frequency, Hz
δ	amplitude of frequency modulation, Hz
T	torque, Nm
J	moment of inertia, kgm^2
cosφ	power factor
γ	test accuracy, %
σ	correction factor
Subscripts	
m, n, o, p	test conditions
1, 2, 3, etc.	machine component (for example, stator winding, rotor winding, stator core, etc.)
t	test
f	field
A	ambient
s	stator
N	rated value
α	overexcited/open-circuit
β	underexcited/short-circuit
super	superposition test
equiv	equivalent load test

4 Exigences générales d'essai

Les paramètres électriques doivent être mesurés de la façon suivante.

a) La classe d'exactitude des appareils de mesure ne doit pas être supérieure à 0,2, à l'exception des wattmètres avec un facteur cosφ inférieur à 0,5 et des fréquencemètres dont la classe d'exactitude peut être de 0,5.

b) L'étendue de mesure des appareils doit être choisie par rapport à des valeurs mesurées supérieures à 30 % de la pleine échelle. Il n'est pas nécessaire de satisfaire à cette exigence pour le mesurage de courant triphasé réalisé au moyen de deux wattmètres, mais les valeurs des courants et des tensions dans les circuits mesurés doivent être d'au moins 20 % des courants et tensions assignés des wattmètres utilisés. L'étendue de mesure des autres appareils de mesure doit être choisie de manière à ne pas augmenter les erreurs de mesure.

c) La forme d'onde et l'asymétrie de la tension d'alimentation aux bornes de la machine doivent être conformes aux exigences de 6.1 à 6.5 de la CEI 60034-1.

d) Chaque courant de ligne doit être mesuré. Si ces courants sont inégaux, la moyenne arithmétique doit être utilisée pour déterminer le point de fonctionnement de la machine.

e) La puissance absorbée d'une machine triphasée peut être mesurée au moyen de deux wattmètres monophasés montés comme pour la méthode des deux wattmètres ou au moyen d'un wattmètre polyphasé ou de trois wattmètres monophasés. La puissance totale relevée sur un wattmètre doit être réduite de la perte par effet Joule dans les circuits de tension ou dans les circuits de courant des appareils selon leur montage, chaque fois que cette perte est une fraction mesurable de la puissance totale. Pour les appareils de mesure numériques, il n'est pas nécessaire de déduire les pertes par effet Joule de la puissance totale relevée sur le wattmètre.

Toutes les grandeurs électriques à mesurer sont, sauf spécification contraire, des valeurs efficaces.

5 Principe des essais par superposition

5.1 Généralités

Les essais par superposition peuvent être appliqués à toute machine à courant continu ou alternatif. La méthode consiste en une série d'essais réalisés dans des conditions de fonctionnement autres qu'à la charge assignée, par exemple à charge réduite, à vide, en court-circuit, à tension réduite, à charge réactive en avant (sous-excitée) ou en retard (surexcitée) de phase.

La méthode permet de déduire l'échauffement des différents composants de la machine à pleine charge. Pour chaque composant, la perte doit être connue pour chaque condition d'essai donnée et à pleine charge. Il convient de réaliser les essais avec des conditions de refroidissement identiques aux conditions en fonctionnement à charge assignée. Un essai de rotor bloqué n'est par conséquent pas approprié puisque la répartition et les amplitudes du flux d'air seraient incorrects.

A l'issue des différents essais individuels, une série d'équations est construite, chaque équation étant du type:

$$\Delta\theta_{1m} = K_{11}P_{1m} + K_{12}P_{2m} + K_{13}P_{3m}$$

où

$\Delta\theta_{1m}$ est l'échauffement mesuré du composant 1 pour l'essai m;

P_{1m}, P_{2m}, etc. est la perte dans le composant 1, 2, etc. pour la condition d'essai m;

K_{11}, K_{12}, etc. sont les coefficients de pertes thermiques déterminant l'échauffement du composant 1 dû aux pertes dans le composant 1 et l'échauffement dans le composant 1 dû aux pertes dans le composant 2, etc.

4 General test requirements

Measurement of the electrical parameters shall be made as follows.

a) The class of accuracy of measuring instruments shall be not greater than 0,2, with the exception of wattmeters with $\cos\varphi$ lower than 0,5 and frequency meters, which may have accuracy class 0,5.

b) The measuring range of the instruments shall be chosen with a view to the measured values being higher than 30 % of the full-scale range. These requirements need not be complied with in the case of the three-phase power measurement by means of two wattmeters, but the currents and voltages in the measured circuits shall be at least 20 % of the rated currents and voltages of the wattmeters being used. The range of the other measuring instruments shall be chosen in such a way that the measuring errors are not increased.

c) The waveform and dissymmetry of the supply voltage at the machine terminals shall be in accordance with the requirements of 6.1 to 6.5 of IEC 60034-1.

d) Each line current shall be measured. If these are unequal, the arithmetic average value shall be used to determine the machine operating point.

e) Power input to a three-phase machine may be measured by two single-phase wattmeters connected as in the two-wattmeter method, or one polyphase wattmeter, or three single-phase wattmeters. The total power read on a wattmeter shall be reduced by the amount of the I^2R loss in the voltage circuits or in the current circuits of the instruments according to their connection whenever this loss is a measurable portion of the total power. There is no need to reduce the total power read on a wattmeter by the amount of the I^2R losses for digital measuring instruments.

All the electrical quantities to be measured are root-mean-square values unless otherwise indicated.

5 Principle of superposition tests

5.1 General

Superposition tests may be applied to any d.c. or a.c. machine. The method comprises a series of tests at operating conditions other than rated load, for example, reduced load, no load, short circuit, reduced voltage, leading (underexcited) or lagging (overexcited) reactive load.

The method allows the full-load temperature rise of various component parts of the machine to be deduced. For each component, the loss shall be known at each particular test condition and at full load. The tests should be undertaken with cooling conditions the same as when operating at rated load. Hence, a locked rotor test will not be suitable as the air-flow distribution and magnitudes will be incorrect.

On completion of the individual tests, a series of equations is constructed, each equation being of the form:

$$\Delta\theta_{1m} = K_{11}P_{1m} + K_{12}P_{2m} + K_{13}P_{3m}$$

where

$\Delta\theta_{1m}$ is the measured temperature rise of component 1 for test m;

P_{1m}, P_{2m} etc. is the loss in component 1, 2, etc. for test condition m;

K_{11}, K_{12}, etc. are the coefficients of heating losses determining the temperature rise of component 1 due to losses in component 1, and the temperature rise of component 1 due to losses in component 2, etc.

Les composants 1, 2 et 3 peuvent par exemple être l'enroulement statorique, le fer statorique et l'enroulement rotorique.

Dans certaines conditions d'essai, des pertes peuvent être égales à zéro et le terme associé disparaît par conséquent dans l'équation. Pour une machine synchrone par exemple, $K_{11}\,P_1$ = 0 à vide et $K_{12}\,P_2$ = 0 en court-circuit.

La méthode est fondée sur le principe selon lequel les coefficients K restent invariables d'un essai à l'autre, en d'autres termes que les conditions de refroidissement restent invariables entre les essais, ce qui implique la même vitesse pour chaque essai. La méthode est également fondée sur le principe de conditions thermiques linéaires de manière à pouvoir additionner les échauffements d'un cas à ceux d'un autre cas. Cette méthode nécessite de connaître pour chaque cas, par calcul ou par mesurage, les pertes dans les composants correspondants avec suffisamment d'exactitude.

Lorsque les essais sont terminés et les équations compilées, les coefficients K peuvent être calculés par simples calculs arithmétiques. Ces coefficients sont ensuite utilisés dans une équation finale avec les pertes pour les conditions à charge assignée afin de calculer l'échauffement du composant 1. Les échauffements à charge assignée des composants 2 et 3 peuvent être calculés de la même manière.

Si l'une quelconque des pertes dépend de la température (par exemple la perte dans le cuivre statorique), la procédure de calcul doit être répétée en utilisant les valeurs de pertes corrigées par rapport à l'échauffement estimé. Il est probablement suffisant de réaliser cette itération une seule fois.

La méthode peut être utilisée pour déterminer l'échauffement de tout composant à n'importe quelle charge si les pertes à cette charge sont connues. Les coefficients de transmission de chaleur (K_{12}, etc.) peuvent être utiles pour d'autres études de modélisation thermique, par exemple pour analyser la réponse au déséquilibre d'alimentation, la réduction de tension, etc.

Pour tous les essais par superposition, des corrections sont nécessaires pour compenser les variations des caractéristiques de fonctionnement de l'échangeur thermique (lorsque la machine en est équipée), dans la mesure où la résistance thermique de l'échangeur dépend entre autres de la perte totale dans chaque essai.

5.2 Echauffement admissible dans les essais par superposition

Lors de la détermination des échauffements des pièces constitutives de la machine au moyen d'essais par superposition, les écarts par rapport aux résultats obtenus lors des essais à charge assignée sont toujours disponibles (voir la présente norme). Dans le cas d'une erreur négative (voir 6.1, 6.2, 7.1, 7.2 et l'article 8), les échauffements admissibles spécifiés dans la CEI 60034-1 doivent être corrigés.

Si l'exactitude γ % pour les résultats obtenus lors des essais par superposition est une valeur négative, les échauffements possibles en fonctionnement à charge assignée sont généralement égaux à:

$$\Delta\theta_N = \Delta\theta_{N\,\text{super}} + \Delta\theta_{N\,\text{super}}\ \frac{|\gamma|}{100}$$

Pour les erreurs négatives, les échauffements admissibles spécifiés dans la CEI 60034-1 doivent par conséquent être multipliés par le facteur de correction σ suivant:

$$\sigma = \frac{1}{1+\dfrac{|\gamma|}{100}}$$

Components 1, 2, and 3 might be, for example, the stator winding, the stator iron, and the rotor winding.

In some test conditions, certain losses may be equal to zero, and hence the related term in the equation disappears. For example, a synchronous machine has $K_{11} P_1$ = 0 at no load and $K_{12} P_2$ = 0 at short circuit.

The method is based on the principle that the coefficients K do not change from test to test, i.e. that the cooling conditions are invariable between tests, which requires the speed to be the same in each test. The method is also based on the principle of the linear thermal conditions so that temperature rises in one case can be added to those for another case. It requires the losses in the relevant component parts to be known sufficiently accurately for each case, either by calculation or measurement.

When the tests have been completed and the equations compiled, then by simple arithmetic the coefficients K can be derived. These are then used in a final equation with the losses for the rated load condition in order to calculate the temperature rise of component 1. By similar means, the temperature rises at rated load of components 2 and 3 can be derived.

If any component loss is temperature dependent (for example, stator copper loss), then the calculation procedure has to be repeated using values for the loss corrected for the estimated temperature rise. It is probably necessary to do this iteration once only.

The method may be used to determine the temperature rise of any component at any load if the losses at that load are known. The heat transfer coefficients (K_{12}, etc.) may be useful in other thermal modelling studies, for example, in analysing the response to supply unbalance, voltage reduction, etc.

In all superposition tests, correction needs to be made for variation in heat exchanger performance (if one is fitted to the machine), as the thermal performance of the heat exchanger will partly depend on the total loss in each test.

5.2 Permissible temperature rise at superposition tests

When determining the temperature rises of the machine design parts at superposition tests, the variations from the results obtained at the rated load test are always available (see this standard). In the case of negative error (see 6.1, 6.2, 7.1, 7.2 and clause 8), the permissible temperature rises given in IEC 60034-1 shall be corrected.

If the accuracy γ % for the results obtained at the superposition tests is a negative value, the possible temperature rises during the operation at the rated load should be equal to:

$$\Delta\theta_N = \Delta\theta_{N\,\text{super}} + \Delta\theta_{N\,\text{super}} \frac{|\gamma|}{100}$$

Consequently, for negative errors, the permissible temperature rises given in IEC 60034-1 shall be multiplied by the correction factor σ, which is as follows:

$$\sigma = \frac{1}{1 + \dfrac{|\gamma|}{100}}$$

6 Méthodes par superposition pour les moteurs à induction

6.1 Méthode de la tension réduite et du courant assigné

Cette méthode consiste en une série de trois essais. Une alimentation à tension variable à la fréquence assignée et une génératrice de charge ou un dispositif de freinage de caractéristiques assignées sensiblement inférieures aux caractéristiques assignées du moteur soumis à l'essai sont nécessaires pour cette méthode. Pour chaque condition, la tension, le courant, les pertes de l'enroulement statorique et l'échauffement de l'enroulement statorique sont mesurés. Les conditions d'essai sont les suivantes.

Essai m: tension réduite en chargeant le moteur au courant assigné, donnant V_{m}, I_{m}, $P_{1\mathrm{m}}$ et $\Delta\theta_{1\mathrm{m}}$

Essai n: même tension réduite mais à vide, donnant V_{n}, I_{n}, $P_{1\mathrm{n}}$ et $\Delta\theta_{1\mathrm{n}}$

Essai o: tension assignée et à vide, donnant V_{o}, I_{o}, $P_{1\mathrm{o}}$ et $\Delta\theta_{1\mathrm{o}}$

Dans ces essais

$\Delta\theta_{1\mathrm{m}}$ est l'échauffement de l'enroulement statorique dû au courant assigné statorique, au courant quasi assigné rotorique et à la perte de tension réduite et à vide dans le fer ainsi qu'aux pertes par frottement et par ventilation;

$\Delta\theta_{1\mathrm{n}}$ est l'échauffement de l'enroulement statorique dû au courant réduit statorique et à la perte de tension réduite dans le fer ainsi qu'aux pertes par frottement et par ventilation;

$\Delta\theta_{1\mathrm{o}}$ est l'échauffement de l'enroulement statorique dû au courant de tension assignée et à vide dans le stator et à la perte de tension assignée dans le fer ainsi qu'aux pertes par frottement et par ventilation.

Il convient de noter que pour les grands moteurs à induction il peut y avoir des cas où l'essai m est impossible à réaliser avec un glissement inférieur au glissement de décrochage; dans ces cas, le fonctionnement au-dessus du glissement de décrochage est une alternative. Pour mesurer l'échauffement de l'enroulement statorique par variation de résistance lorsque la machine est à vide, il convient d'utiliser un moyen pour arrêter rapidement le moteur ou de mesurer la résistance directement sous charge.

Cette méthode suppose que le refroidissement reste inchangé pour chaque essai, ce qui implique que la vitesse reste également virtuellement inchangée.

Il est possible de déterminer la grandeur $\Delta\theta_{1\mathrm{n}}$ avec une exactitude suffisante en utilisant l'équation suivante:

$$\Delta\theta_{1\mathrm{n}} = \Delta\theta_{1\mathrm{o}} P_{1\mathrm{n}} / P_{1\mathrm{o}}$$

L'application de cette relation permet d'économiser un essai thermique complet à tension réduite et à vide comme pour les conditions d'essai n. Il convient, pour des raisons pratiques, d'envisager cette alternative.

L'exactitude de la détermination des échauffements est entre γ = –10 et γ = +6 % pour tous les types et toutes les caractéristiques assignées des machines. Il est préférable d'utiliser cette méthode pour les moteurs à induction à cage pour lesquels l'exactitude peut être estimée à $\gamma = \pm 3$ %.

Les résultats peuvent être analysés au moyen de calculs ou graphiquement de la manière décrite ci-dessous.

6 Superposition methods for induction motors

6.1 Method of reduced voltage and rated current

This method comprises a series of three tests. The method requires a variable-voltage supply at rated frequency and either a loading generator, or braking equipment with the rating much less than the rating of the test motor. For each condition, the voltage, current, stator winding losses, and stator winding temperature rise are measured. The test conditions are as follows:

Test m: reduced voltage, with the motor loaded to give rated current, giving V_{m}, I_{m}, $P_{1\mathrm{m}}$ and $\Delta\theta_{1\mathrm{m}}$

Test n: the same reduced voltage, but on no load, giving V_{n}, I_{n}, $P_{1\mathrm{n}}$ and $\Delta\theta_{1\mathrm{n}}$

Test o: rated voltage on no load, giving V_{o}, I_{o}, $P_{1\mathrm{o}}$ and $\Delta\theta_{1\mathrm{o}}$

In these tests

$\Delta\theta_{1\mathrm{m}}$ is the stator winding temperature rise due to rated stator current, quasi rated rotor current and reduced-voltage no-load iron loss and friction and windage losses;

$\Delta\theta_{1\mathrm{n}}$ is the stator winding temperature rise due to reduced stator current and reduced-voltage iron loss and friction and windage losses;

$\Delta\theta_{1\mathrm{o}}$ is the stator winding temperature rise due to rated-voltage no-load stator current and rated-voltage iron loss and friction and windage losses.

It should be noted that with large induction motors there may be cases when test m is not practicable with a slip below the pull-out slip; in such cases, operation above the pull-out slip is an alternative. To measure the stator winding temperature rise by resistance when the machine is on no load, some means of rapidly stopping the motor should be employed when shutting down the motor, or resistance should be measured direct under load.

The method assumes that the cooling is unchanged for each test, which implies that the speed is also virtually unchanged.

The quantity $\Delta\theta_{1\mathrm{n}}$ can be determined with sufficient accuracy by using the following equation:

$$\Delta\theta_{1\mathrm{n}} = \Delta\theta_{1\mathrm{o}} P_{1\mathrm{n}} / P_{1\mathrm{o}}$$

By applying this relation a complete thermal test at reduced voltage, no load, as for test condition n, can be saved. This should be taken up as an alternative for practical reasons.

The accuracy of determining temperature rises is within $\gamma = -10$ % and $\gamma = +6$ % for all types and ratings of machines. The method is preferable for squirrel-cage induction motors where the accuracy can be estimated within $\gamma = \pm 3$ %.

The results can be analysed either by means of calculation or by the use of a graph, as described below.

6.1.1 Détermination de l'échauffement par la méthode de calcul

La méthode de calcul suppose que l'échauffement de l'enroulement statorique, dans le cas de conducteurs en cuivre, au courant assigné pour toute charge, est une fonction linéaire de la manière suivante:

$$\Delta\theta_1 = \Delta\theta_{1\,p} + K_{11}^{*} P_1$$

où

$\Delta\theta_{1p}$ est l'échauffement théorique du stator qui serait observé à la tension assignée et avec un courant statorique nul (en d'autres termes, l'échauffement dû uniquement à la perte dans le fer et aux pertes par frottement et par ventilation);

P_1 est la perte dans l'enroulement statorique à la charge donnée;

K_{11}^{*} est le coefficient de transfert de chaleur du stator dû à la perte dans l'enroulement statorique, la perte dans l'enroulement rotorique et la perte supplémentaire (voir 8.3 de la CEI 60034-2).

Le coefficient K_{11}^{*} peut être déterminé à partir des essais normaux de 6.1 ci-dessus en utilisant l'expression

$$K_{11}^{*} = \frac{\Delta\theta_{1m} - \Delta\theta_{1n}}{P_{1m} - P_{1n}}$$

en d'autres termes, le rapport de l'augmentation de l'échauffement statorique dû à la variation du courant statorique entre les essais m et n (avec des pertes constantes dans le fer) à l'augmentation des pertes dans le stator dans les deux essais.

L'échauffement théorique du stator dû à la perte dans le fer et aux pertes par frottement et par ventilation $\Delta\theta_{1p}$ peut être déterminé par l'expression:

$$\Delta\theta_{1p} = \Delta\theta_{1o} - K_{11}^{*} P_{1o}$$

en d'autres termes, l'échauffement dû à la perte dans l'enroulement statorique et à la perte dans le fer moins l'échauffement dû à la perte dans l'enroulement statorique.

L'échauffement de l'enroulement statorique, dans le cas de conducteurs en cuivre, au courant assigné et à la tension assignée peut être déterminé de la manière suivante:

$$\Delta\theta_{1N} = \frac{\Delta\theta_{1o} - K_{11}^{*} P_{1o} + K_{11}^{*} P_{1N}(\theta_A)(235 + \theta_{A\,N})/(235 + \theta_A)}{1 - K_{11}^{*} P_{1N}(\theta_A)/(235 + \theta_A)}$$

où

θ_A est la température ambiante à la détermination de $P_{1N}(\theta_A)$;

θ_{AN} est la température ambiante de référence;

235 est le coefficient de température pour les conducteurs en cuivre.

Les échauffements de l'enroulement rotorique et du fer statorique peuvent être déterminés de manière semblable en utilisant les valeurs mesurées des pertes et des échauffements de ces composants pour chaque essai.

6.1.1 Determination of temperature rise by calculation method

The calculation method assumes that the stator winding temperature rise, in the case of copper conductors, at rated current for any load is linearly dependent as follows:

$$\Delta\theta_1 = \Delta\theta_{1\,p} + K_{11}^{*} P_1$$

where

$\Delta\theta_{1p}$ is the theoretical stator temperature rise that would occur at rated voltage and zero stator current (i.e. the rise due to the iron loss and friction and windage loss alone);

P_1 is the stator winding loss at the particular load;

K_{11}^{*} is the coefficient of stator heat transfer due to stator winding loss, rotor winding loss and additional loss (see 8.3 of IEC 60034-2).

The coefficient K_{11}^{*} can be found from the normal tests in 6.1 using the expression

$$K_{11}^{*} = \frac{\Delta\theta_{1m} - \Delta\theta_{1n}}{P_{1m} - P_{1n}}$$

i.e. the ratio of the increase in stator temperature rise due to the change in stator current between tests m and n (with constant iron losses), to the increase in stator losses in the two tests.

The theoretical stator temperature rise due to iron loss and friction and windage loss $\Delta\theta_{1p}$ can be found from the expression:

$$\Delta\theta_{1p} = \Delta\theta_{1o} - K_{11}^{*} P_{1o}$$

i.e. the rise due to stator winding loss and iron loss minus the rise due to the stator winding loss.

The stator winding temperature rise, in the case of copper conductors, at rated current and rated voltage can then be determined as follows:

$$\Delta\theta_{1N} = \frac{\Delta\theta_{1o} - K_{11}^{*} P_{1o} + K_{11}^{*} P_{1N}(\theta_A)(235 + \theta_{A\,N})/(235 + \theta_A)}{1 - K_{11}^{*} P_{1N}(\theta_A)/(235 + \theta_A)}$$

where

θ_A is the ambient temperature at the determination of $P_{1N}(\theta_A)$;

θ_{AN} is the reference ambient temperature;

235 is the temperature coefficient for the conductor material being copper.

The temperature rises of the rotor winding and the stator core can be found in a similar manner, using measured values of losses and temperature rises for these components for each test.

6.1.2 Détermination de l'échauffement par la méthode graphique

La méthode graphique est fondée sur les suppositions suivantes.

a) Les pertes en charge dépendent uniquement du courant et les pertes à vide dépendent uniquement de la tension.

b) Les échauffements peuvent être additionnés, c'est-à-dire que les effets du rayonnement sont négligeables et que les coefficients de transfert de chaleur sont indépendants de la température.

c) La perte en charge vagabonde en fonction de la charge dépend uniquement du courant. Dans la pratique, ces pertes dépendent en partie également de la tension.

Ces suppositions sont fondamentalement les mêmes que celles de la méthode de calcul décrite en 6.1.1 ci-dessus. Un graphique des échauffements mesurés dans les trois essais de 6.1 peut être tracé en fonction du carré du courant statorique comme illustré à la figure 1. Une ligne passant par les deux points à la tension réduite ($\Delta\theta_{1m}$ et $\Delta\theta_{1n}$) et une ligne parallèle passant par $\Delta\theta_{1o}$ peuvent être tracées. L'échauffement à la charge assignée $\Delta\theta_{1N}$ est obtenu comme illustré à la figure 1.

Si les courants statoriques des essais n et o sont suffisamment faibles (et pas trop différents) par rapport au courant assigné, l'échauffement statorique à tension et charge assignées est donné par

$$\Delta\theta_{1N} = \Delta\theta_{1m} + \Delta\theta_{1o} - \Delta\theta_{1n}$$

6.2 Méthode à tension assignée et à courant réduit

Cette méthode consiste en une série de deux essais. Une génératrice de charge ou un dispositif de freinage de caractéristiques assignées inférieures aux caractéristiques assignées du moteur soumis à l'essai est nécessaire pour cette méthode. La méthode de charge peut être la méthode de charge réelle ou une méthode de charge équivalente.

Les échauffements et les courants statoriques sont mesurés dans deux conditions d'essai de la manière suivante.

Essai p: Le moteur est entraîné à une charge réduite et à tension et fréquence assignées et l'échauffement de l'enroulement statorique $\Delta\theta'_{1m}$ et le courant statorique I_1' sont mesurés. Il est souhaitable que I_1' ne soit pas inférieur à 70 % du courant assigné statorique.

Essai o: Le moteur est entraîné à vide à tension et fréquence assignées et l'échauffement $\Delta\theta_{1o}$ et le courant statorique I_o sont mesurés.

L'échauffement à pleine charge est calculé par l'équation:

$$\Delta\theta_{1N} = \frac{\dfrac{\Delta\theta'_{1m} - \Delta\theta_{10}}{I'^2_1 - I^2_0} \times \left(I^2_N \times \dfrac{235 + \theta_{AN}}{235 + \theta_m} - I'^2_1 \right) + \Delta\theta'_{1m}}{1 - \dfrac{\Delta\theta'_{1m} - \Delta\theta_{10}}{I'^2_1 - I^2_0} \times \dfrac{I^2_N}{235 + \theta_m}}$$

où I_N est le courant assigné statorique.

L'exactitude de la détermination des échauffements est de γ = (–5 ± 6) % pour tous les types et toutes les caractéristiques assignées des machines. Il est préférable d'utiliser cette méthode pour les moteurs à induction à rotor bobiné haute tension pour lesquels l'exactitude peut être estimée à γ = ±1 %.

6.1.2 Determination of temperature rise by graphical method

The graphical method is based on the following assumptions.

a) The load losses are dependent solely on current, and the no-load losses are dependent solely on voltage.

b) The temperature rises can be added, i.e. the effect of radiation is negligible, and the heat transfer coefficients are independent of temperature.

c) The load-dependent stray-load loss depends on the current only. In practice, these losses are also partly voltage dependent.

These assumptions are fundamentally the same as those in the calculation method described in 6.1.1 above. A graph can be drawn of the measured temperature rises from the three tests in 6.1 plotted against the square of the stator current as shown in figure 1. A line can be drawn through the two points at the reduced voltage ($\Delta\theta_{1m}$ and $\Delta\theta_{1n}$) and a line parallel to this can be drawn through $\Delta\theta_{1o}$. The temperature rise at rated load $\Delta\theta_{1N}$ is obtained as shown in figure 1.

If the stator currents for tests n and o are sufficiently small (and not too dissimilar) compared with the rated current, then the stator temperature rise at rated voltage rated load is given by

$$\Delta\theta_{1N} = \Delta\theta_{1m} + \Delta\theta_{1o} - \Delta\theta_{1n}$$

6.2 Method of rated voltage and reduced current

This method comprises a series of two tests. The method requires a loading generator or a braking equipment with a rating less than the rating of the test motor. The loading method may be either the actual loading method or equivalent loading method.

Temperature rises and stator currents are measured at two test conditions as follows.

Test p: The motor is driven at a reduced load at rated voltage and frequency and the temperature rise of the stator winding $\Delta\theta'_{1m}$ and stator current I_1' are measured. It is preferable that I_1' is not less than 70 % of rated stator current.

Test o The motor is driven at no-load rated voltage and frequency, and the temperature rise $\Delta\theta_{1o}$ and the stator current I_o are measured.

The full-load temperature rise is calculated from the equation:

$$\Delta\theta_{1N} = \frac{\frac{\Delta\theta'_{1m} - \Delta\theta_{10}}{I'^2_1 - I^2_0} \times \left(I^2_N \times \frac{235 + \theta_{AN}}{235 + \theta_m} - I'^2_1 \right) + \Delta\theta'_{1m}}{1 - \frac{\Delta\theta'_{1m} - \Delta\theta_{10}}{I'^2_1 - I^2_0} \times \frac{I^2_N}{235 + \theta_m}}$$

where I_N is the rated stator current.

The accuracy of determining temperature rises is γ = (–5 ± 6) % for all types and ratings of machines. The method is preferable for high-voltage wound rotor induction motors where the accuracy can be estimated within γ = ±1 %.

6.3 Méthode pour les moteurs à induction à rotor bobiné

La méthode consiste en deux essais réalisés de la manière suivante.

Essai a: Court-circuiter le rotor et faire fonctionner le moteur à vide et à la tension assignée. L'échauffement statorique est principalement déterminé par la perte assignée dans le fer et la perte assignée par frottement et par ventilation.

Essai b: Exciter le rotor, court-circuiter les bornes du stator, faire fonctionner le moteur à la vitesse assignée et corriger le courant rotorique pour obtenir le courant assigné statorique. L'échauffement du stator est principalement déterminé par la perte assignée par effet Joule statorique. La perte dans le fer est faible puisque l'enroulement statorique est court-circuité et que la tension est faible. La perte par frottement et par ventilation est normale.

Les deux échauffements mesurés du stator sont additionnés pour donner l'échauffement qui serait observé à la tension assignée et au courant assigné. L'échauffement calculé du stator sera supérieur à la valeur vraie en raison des faibles effets sur le stator de la perte à vide dans le cuivre dans le premier essai et de la perte par frottement et par ventilation dans le second essai.

Les données d'essai de comparaison destinées à déterminer les échauffements selon cette méthode sont inconnues. Les experts estiment que l'exactitude de cette méthode est de l'ordre de $\gamma = \pm 10$ %.

7 Méthodes par superposition pour machines synchrones

7.1 Méthode de circuit ouvert, de court-circuit et d'excitation nulle

Dans cette méthode, un moteur auxiliaire entraîne la machine synchrone à la vitesse assignée. Les essais sont réalisés aux points de fonctionnement suivants:

Essai m: enroulement d'induit en court-circuit, courant d'excitation réglé pour donner le courant assigné d'induit;

Essai n: enroulement d'induit en circuit ouvert et courant d'excitation réglé pour donner la tension d'induit assignée;

Essai o: enroulement d'induit en circuit ouvert et courant d'excitation nul.

Pour chaque condition, l'échauffement de l'enroulement statorique est déterminé pour donner les valeurs $\Delta\theta_{1m}$, $\Delta\theta_{1n}$ et $\Delta\theta_{1o}$. L'échauffement à la vitesse assignée, à la tension assignée et au courant assigné est déterminé par l'expression

$$\Delta\theta_{1N} = (\Delta\theta_{1m} - \Delta\theta_{1o}) + (\theta_{1n} - \Delta\theta_{1o}) + \Delta\theta_{1o}$$

(c'est-à-dire $(\Delta\theta_{1m} - \Delta\theta_{1o})$ est l'échauffement dû à la perte par effet Joule; $(\Delta\theta_{1n} - \Delta\theta_{1o})$ est l'échauffement dû à la perte dans le fer; $\Delta\theta_{1o}$ est l'échauffement dû aux pertes par frottement et par ventilation).

L'exactitude des échauffements de l'enroulement d'induit des machines synchrones, à l'exception des grands turbo-générateurs synchrones de puissance, est d'environ $\gamma = -10$ % des valeurs réelles.

Il est en même temps possible de déterminer l'échauffement de l'enroulement d'excitation dans les conditions assignées si l'échauffement d'excitation est mesuré pour chacune des trois conditions d'essai. Les échauffements peuvent être déterminés en mesurant la résistance de champ lors de l'arrêt de la machine après chaque essai. Il est possible d'augmenter l'exactitude de cette méthode pour l'excitation en réalisant un quatrième essai soit avec l'enroulement statorique en circuit ouvert et le courant d'excitation réglé sur la valeur assignée donnant une surtension statorique ou avec l'enroulement statorique en court-circuit et le courant d'induit supérieur au courant assigné. L'échauffement mesuré de l'un de ces essais remplace l'échauffement de l'essai n ou de l'essai m. Il convient d'obtenir l'accord du fabricant pour réaliser cet essai car l'enroulement d'induit peut être endommagé.

6.3 Method for wound-rotor induction motors

The method comprises two tests as follows.

Test a: The rotor is short-circuited and the motor is run on no load at rated voltage. The stator temperature rise is primarily determined by the rated iron loss and rated friction and windage loss.

Test b: The rotor is excited, the stator terminals are short-circuited, the motor is driven at rated speed, and the rotor current is adjusted to obtain rated stator current. The stator temperature rise is primarily determined by the rated stator I^2R loss. The iron loss is low as the stator winding is short-circuited and the voltage is low. The friction and windage loss is normal.

The two measured stator temperature rises are added together to give the rise that would occur with rated voltage and rated current. The deduced stator temperature rise will be higher than the true value, due to the small effects on the stator of the no-load stator copper loss in the first test and the friction and windage loss in the second test.

The comparative test data for determining temperature rises by this method are unknown. The experts estimate the accuracy of this method to be within $\gamma = \pm 10$ %.

7 Superposition methods for synchronous machines

7.1 Method of open circuit, short circuit, zero excitation

In this method, the synchronous machine is driven at rated speed by an auxiliary motor. Tests are undertaken at the following operating points:

Test m: armature winding short-circuited, and field current set to give rated armature current;

Test n: armature winding open-circuited, and field current set to give rated armature voltage;

Test o: armature winding open-circuited, and zero field current.

For each condition, the temperature rise of the stator winding is determined to give values $\Delta\theta_{1m}$, $\Delta\theta_{1n}$ and $\Delta\theta_{1o}$. The temperature rise at rated speed, voltage and current is determined from the expression

$$\Delta\theta_{1N} = (\Delta\theta_{1m} - \Delta\theta_{1o}) + (\theta_{1n} - \Delta\theta_{1o}) + \Delta\theta_{1o}$$

(i.e. $(\Delta\theta_{1m} - \Delta\theta_{1o})$ is the rise due to I^2R loss; $(\Delta\theta_{1n} - \Delta\theta_{1o})$ is the rise due to iron loss; $\Delta\theta_{1o}$ is the rise due to friction and windage loss).

The accuracy of temperature rises of the armature winding of synchronous machines, except large power synchronous turbo-generators, are about $\gamma = -10$ % of the actual ones.

At the same time, the temperature rise of the field winding at rated conditions can be determined if the field temperature rise is measured for each of the three test conditions. The temperature rises can be determined by measuring the field resistance on shutdown of the machine after each test. The accuracy of this method for the field is increased if a fourth test is made either with the stator winding open-circuited and the field current set to the rated value giving a stator over-voltage or with the stator winding short-circuited and the armature current greater than the rated current. The measured temperature rise from one of these tests would replace that from test n or from test m respectively. The manufacturer's approval should be obtained for this test as armature winding damage could result.

Il est également possible d'utiliser la machine comme compensateur synchrone au courant assigné d'excitation et à un courant statorique intermédiaire jusqu'à ce que la tension d'excitation soit constante. Le rapport de la tension d'excitation (ajustée par rapport aux effets de contact par balai) au courant d'excitation donne la résistance de champ chaud à partir de laquelle il est possible de calculer l'échauffement d'excitation.

Il est possible d'utiliser une méthode graphique pour obtenir l'échauffement d'excitation à charge assignée si la perte d'excitation, P_{ft}, pour chaque essai est calculée à partir de $I_{ft}{}^2 R_{ft}$, où P_{ft}, I_{ft}, et R_{ft}, sont les valeurs d'essai de la perte, du courant et de la résistance de champ. La courbe de l'échauffement d'excitation en fonction de la perte d'excitation fournie à la figure 2 pour les trois conditions d'essai est approximativement une ligne droite. Une deuxième ligne droite est ensuite tracée qui indique les variations de la perte d'excitation en fonction du courant assigné I_{fN}, lorsque la résistance de champ augmente en fonction de la température par rapport à la valeur à température ambiante. L'intersection des deux lignes donne l'échauffement d'excitation à la charge assignée.

7.2 Méthode de charge à facteur de puissance nul et à circuit ouvert

Dans cette méthode, la machine est à nouveau entraînée à la vitesse assignée par un moteur auxiliaire. Des essais sont réalisés aux points de fonctionnement suivants:

Essai m: courant assigné d'excitation, courant assigné d'induit, facteur de puissance nul, tension réduite aux bornes du stator;

Essai n: stator en circuit ouvert, avec une tension aux bornes égale à la force électromotrice induite par le stator dans l'essai m, en d'autres termes:

$$V_n = V_m + I_m X_L$$

où X_L est la réactance de fuite calculée du stator;

Essai o: stator en circuit ouvert, avec une tension aux bornes égale à la force électromotrice induite à la charge assignée, en d'autres termes

$$V_o = \sqrt{(1 + \sin\phi \times X_L)^2 + (\cos\phi \times X_L)^2 \times I_N}$$

où

$\cos\varphi$ est le facteur de puissance assigné;

V_N est la tension d'induit assignée;

I_N est le courant d'induit assigné.

L'échauffement de l'enroulement statorique est donné par $\Delta\theta_{1N} = \Delta\theta_{1m} - \Delta\theta_{1n} + \Delta\theta_{1o}$ où $\Delta\theta_{1m}$, $\Delta\theta_{1n}$ et $\Delta\theta_{1o}$ sont les échauffements statoriques mesurés respectivement dans les essais m, n et o.

$\Delta\theta_{1m}$ est l'échauffement de l'enroulement d'induit dû au courant assigné d'excitation, au courant assigné d'induit, à la perte par frottement et par ventilation à la vitesse assignée et à la faible perte dans le fer.

$\Delta\theta_{1n}$ est l'échauffement de l'enroulement d'induit dû au courant d'excitation en circuit ouvert, à la tension de phase V_n, à la perte par frottement et par ventilation à la vitesse assignée et à la faible perte dans le fer.

$\Delta\theta_{1o}$ est l'échauffement de l'enroulement d'induit dû au courant d'excitation à la tension de phase en circuit ouvert V_o, à la perte par frottement et par ventilation à la vitesse assignée et à la perte assignée dans le fer.

L'exactitude de l'échauffement obtenu pour l'enroulement d'induit des machines synchrones d'une puissance assignée inférieure ou égale à 500 kVA est de l'ordre de γ = –10 %.

L'échauffement de l'enroulement d'excitation est pris comme la valeur mesurée dans l'essai m.

Alternatively, the machine may be operated as a synchronous condenser at rated field current and at some intermediate stator current until the field voltage is constant. The ratio of the field voltage (adjusted for brush contact effects) to the field current gives the hot field resistance from which the field temperature rise can be calculated.

A graphical method can be used to obtain the field temperature rise at rated load if the field loss, P_{ft}, for each test is calculated from $I_{ft}{}^2 R_{ft}$, where P_{ft}, I_{ft}, and R_{ft}, are the test values of the field loss, current and resistance respectively. The graphical plot of field temperature rise against field loss in figure 2 for the three test conditions approximates a straight line. A second straight line is then plotted, showing the variation of the field loss with rated current I_{fN}, as the field resistance increases with temperature from the value at ambient temperature. The intersection of the two lines gives the temperature rise of the field at rated load.

7.2 Method of zero power factor and open circuit loading

In this method, the machine is again driven at rated speed by an auxiliary motor. Tests are undertaken at the following operating points:

Test m: rated field current, rated armature current, zero power factor, reduced stator terminal voltage;

Test n: stator open-circuited, with terminal voltage equal to stator-induced e.m.f. in test m, i.e.:

$$V_n = V_m + I_m X_L$$

where X_L is the calculated stator leakage reactance;

Test o: stator open-circuited, with terminal voltage equal to induced e.m.f. at rated load, i.e.:

$$V_o = \sqrt{(1 + \sin\phi \times X_L)^2 + (\cos\phi \times X_L)^2 \times I_N}$$

where

$\cos\varphi$ is the rated power factor;

V_N is the rated armature voltage;

I_N is the rated armature current.

The stator winding temperature rise is given by $\Delta\theta_{1N} = \Delta\theta_{1m} - \Delta\theta_{1n} + \Delta\theta_{1o}$ where $\Delta\theta_{1m}$, $\Delta\theta_{1n}$ and $\Delta\theta_{1o}$ are the stator temperature rises measured in tests m, n and o, respectively.

$\Delta\theta_{1m}$ is the armature winding temperature rise due to rated field current, rated armature current, friction and windage loss at rated speed, and low iron loss.

$\Delta\theta_{1n}$ is the armature winding temperature rise due to field current at open-circuit, phase voltage V_n, friction and windage loss at rated speed, and low iron loss.

$\Delta\theta_{1o}$ is the armature winding temperature rise due to field current at open-circuit phase voltage V_o, friction and windage loss at rated speed, and rated iron loss.

The temperature rise accuracy obtained for the armature winding of synchronous machines with rating up to 500 kVA is within $\gamma = -10$ %.

The field winding temperature-rise is taken as the value measured in test m.

8 Méthode par superposition pour les machines à courant continu

La plupart des essais sur de grandes machines à courant continu sont réalisés selon la méthode en opposition. Une seule méthode d'essai indirect est disponible pour les machines à courant continu. Dans cette méthode par superposition, la machine est entraînée à la vitesse assignée par un moteur auxiliaire dont les caractéristiques assignées sont généralement inférieures à 20 % de celles de la machine à soumettre à l'essai. Les essais sont réalisés aux trois points de fonctionnement suivants:

Essai m: Induit en court-circuit et courant d'excitation réglé pour donner le courant d'induit assigné;

Essai n: Induit en circuit ouvert et courant d'excitation réglé pour donner la tension d'induit assignée;

Essai o: Induit en circuit ouvert avec courant d'excitation nul.

Lorsque les deux essais à circuit ouvert sont réalisés sur des machines de puissance assignée inférieure ou égale à 1 000 kW, il convient de relever les balais sauf lorsque la tension statorique est mesurée. Pour les machines de puissance assignée supérieure à 1 000 kW, les balais peuvent rester en place puisque la perte par frottement des balais sera faible par rapport aux autres pertes.

Le troisième essai n'est généralement nécessaire que sur les machines dont le rotor a une vitesse périphérique importante (>30 m/s) et pour lesquelles la perte par ventilation est importante.

Pour chaque condition, l'échauffement de l'enroulement d'induit est déterminé pour donner les valeurs $\Delta\theta_{1m}$, $\Delta\theta_{1n}$ et $\Delta\theta_{1o}$. L'échauffement à la vitesse assignée, à la tension assignée et au courant assigné est déterminé par l'expression

$$\Delta\theta_{1N} = \Delta\theta_{1m} + \Delta\theta_{1n} - \Delta\theta_{1o}$$

(en d'autres termes, l'échauffement est égal à l'échauffement dû aux pertes par effet Joule d'induit et par frottement et par ventilation avec une perte négligeable dans le fer et une perte par effet Joule d'excitation négligeable plus l'échauffement dû à la perte dans le fer et à la perte par frottement et par ventilation avec une perte par effet Joule d'induit nulle et une perte assignée par effet Joule d'excitation, moins l'échauffement dû à la perte par frottement et par ventilation).

Pour l'enroulement d'induit, l'exactitude obtenue est d'environ $\gamma = \pm 10$ %.

9 Principe d'essais de charge équivalente

9.1 Généralités

Contrairement aux concepts à plusieurs essais des méthodes par superposition, un essai de charge équivalente est conçu pour permettre de déterminer l'échauffement d'un composant donné (pratiquement exclusivement l'enroulement statorique) à la charge assignée de manière expérimentale à partir d'un essai unique réalisé dans des conditions différentes de la charge assignée. Le but est de reproduire la distribution des pertes en charge assignée dans le moteur, notamment les pertes dans le composant considéré, dans ces conditions d'essai de charge équivalente. Pour l'enroulement statorique, ceci implique de créer le courant efficace à pleine charge dans l'enroulement.

La charge équivalente est également utilisée dans le cas de machines spéciales à extrémités d'arbre inaccessibles, de machines à haute vitesse ou de machines pour lesquelles l'accouplement des extrémités d'arbre avec la machine de charge nécessite des accouplements spéciaux et onéreux (par exemple des arbres cannelés, etc.).

8 Superposition method for d.c. machines

Most tests on larger d.c. machines are carried out by the back-to-back method. Only one indirect test method is available for d.c. machines. In this superposition method, the d.c. machine is driven at rated speed by an auxiliary motor, whose rating is usually less than 20 % of the machine to be tested. Tests are undertaken at the following three operating points:

Test m: armature short-circuited, and field current set to give rated armature current,

Test n: armature open-circuited, and field current set to give rated armature voltage,

Test o: armature open-circuited, with zero field current.

For the two open-circuit tests on machines rated at and below 1 000 kW, the brushes should be lifted except when the stator voltage is being measured. For machines rated above 1 000 kW, the brushes may be left in place as the brush frictional loss will be small compared with other losses.

The third test is usually only necessary for machines with high rotor surface speed (>30 m/s) where the windage loss is significant.

For each condition, the temperature rise of the armature winding is determined to give values $\Delta\theta_{1m}$, $\Delta\theta_{1n}$ and $\Delta\theta_{1o}$. The temperature rise at rated speed, voltage and current is determined from the expression

$$\Delta\theta_{1N} = \Delta\theta_{1m} + \Delta\theta_{1n} - \Delta\theta_{1o}$$

(i.e. the temperature rise is equal to the rise due to armature I^2R and friction and windage loss with negligible iron loss and negligible field I^2R loss plus the rise due to iron loss and friction and windage loss with zero armature I^2R loss and rated field I^2R loss, minus the rise due to friction and windage loss).

For the armature winding the accuracy obtained is about $\gamma = \pm 10$ %.

9 Principle of equivalent load tests

9.1 General

In contrast with the multi-test concept of the superposition methods, an equivalent load test is designed to allow the temperature rise of the chosen component (almost exclusively the stator winding) at rated load to be determined experimentally from a single test at conditions other than rated load. The intention is to replicate the rated-load loss distribution in the motor, but particularly the loss in the relevant component, at this equivalent load test condition. For the stator winding, this implies creating the effective (r.m.s.) full-load current in the winding.

The equivalent loading is used also in the cases of special machines with inaccessible free shaft ends, high-speed machines or machines where the coupling of the shaft ends with the loading machine requires special and expensive couplings to be made (for example, grooved shaft, etc.).

Pour que l'essai soit profitable, il convient que le matériel utilisé pour l'essai soit sensiblement moins compliqué et moins onéreux que le matériel qui serait nécessaire pour un essai direct à pleine charge. Il convient également que la consommation électrique soit sensiblement moins importante. Il convient dans la mesure du possible de réaliser l'essai avec l'arbre du moteur libre et non accouplé afin de simplifier l'opération et économiser le temps nécessaire à l'alignement de la machine soumise à l'essai avec une charge mécanique ou un moteur d'entraînement.

Les méthodes d'essai décrites dans les articles 10 et 11 permettent d'atteindre ces objectifs à différents niveaux.

9.2 Echauffement admissible lors des essais de charge équivalente.

Lors de la détermination des échauffements des pièces constitutives de la machine au moyen d'essais de charge équivalente, les écarts par rapport aux résultats obtenus lors des essais à charge assignée sont toujours disponibles (voir la présente norme). Dans le cas d'une erreur négative, les échauffements admissibles spécifiés dans la CEI 60034-1 doivent être corrigés.

Si l'exactitude γ % pour les résultats obtenus lors des essais de charge équivalente est une valeur négative, les échauffements possibles en fonctionnement à charge assignée sont généralement égaux à:

$$\Delta\theta_N = \Delta\theta_{N\text{equiv}} + \Delta\theta_{N\text{equiv}} \frac{|\gamma|}{100}$$

Pour les erreurs négatives, les échauffements admissibles spécifiés dans la CEI 60034-1 doivent par conséquent être multipliés par le facteur de correction σ suivant:

$$\sigma = \frac{1}{1 + \frac{|\gamma|}{100}}$$

10 Essais de charge équivalente pour les moteurs à induction

10.1 Essai de court-circuit direct

Le moteur à l'essai est entraîné à la vitesse assignée par une machine auxiliaire et est alimenté par une alimentation à une fréquence d'environ 80 % ou 120 % de la fréquence assignée du moteur. La tension de cette alimentation est ajustée jusqu'à ce que le courant dans le stator du moteur à l'essai soit égal à la valeur assignée. Lorsque la fréquence d'alimentation est d'environ 80 % de la fréquence assignée du moteur, la machine à l'essai fournit une puissance électrique puisqu'elle fonctionne comme une génératrice à induction à glissement négatif. Lorsque la fréquence d'alimentation est d'environ 120 % de la fréquence assignée du moteur, la machine auxiliaire fournit une puissance électrique, puisque le moteur fonctionne comme un moteur à induction à glissement positif.

Par rapport à un essai direct à pleine charge, la perte de fréquence fondamentale par effet Joule du stator reste inchangée, les pertes par frottement et par ventilation restent inchangées, la perte de fréquence fondamentale dans le fer statorique est plus faible, le courant de barre du rotor et les pertes dans le cuivre du rotor ainsi que les pertes de haute fréquence dans le fer des dents du stator sont plus élevées.

For the test to be advantageous, the equipment to be used in the test should be significantly less complex and expensive than that which would be required for a direct full-load test. Also, the demands on the electrical supply should be much less. Ideally, the motor should be tested with a free uncoupled shaft, so that the complexity and time involved in lining up the test machine with a mechanical load or a driving motor is avoided.

The test methods described in clauses 10 and 11 achieve these aims to varying degrees.

9.2 Permissible temperature rise at equivalent load tests

When determining the temperature rises of the machine design parts at equivalent load tests, the variations from the results obtained at the rated load test are always available (see this standard). In the case of negative error, the permissible temperature rises given in IEC 60034-1 shall be corrected.

If the accuracy γ % for the results obtained at the equivalent load tests is a negative value, the possible temperature rises during the operation at the rated load should be equal to

$$\Delta\theta_N = \Delta\theta_{N\text{equiv}} + \Delta\theta_{N\text{equiv}} \frac{|\gamma|}{100}$$

Consequently, for negative errors the permissible temperature rises given in IEC 60034-1 shall be multiplied by the correction factor σ being as follows:

$$\sigma = \frac{1}{1 + \frac{|\gamma|}{100}}$$

10 Equivalent load tests for induction motors

10.1 Forward short-circuit test

The motor under test is driven at rated speed by an auxiliary machine and is fed from a supply with a frequency of about 80 % or about 120 % of the motor rated frequency. The voltage of this supply is adjusted until the current in the test motor stator equals the rated value. When the supply frequency is about 80 % of the motor rated frequency, an electrical output is obtained from the test machine as it operates as an induction generator at negative slip. When the supply frequency is about 120 % of the motor rated frequency, an electrical output is obtained from the auxiliary machine as the motor operates as an induction motor at positive slip.

Compared with a direct full-load test, the stator fundamental-frequency I^2R loss is the same, the friction and windage losses are the same, the fundamental-frequency stator iron loss is lower, and the rotor bar current and rotor copper losses as well as the high-frequency stator-tooth iron losses are higher.

La réduction de la perte de fréquence fondamentale dans le fer n'est généralement pas compensée correctement par l'augmentation de la perte de haute fréquence et il convient par conséquent de compléter l'essai par deux essais à vide à la fréquence d'alimentation assignée, l'un à la tension d'alimentation assignée et l'autre à la tension la plus basse appliquée pendant l'essai de court-circuit direct. La différence entre les échauffements statoriques lors des deux essais à vide est additionnée à l'échauffement mesuré pendant l'essai de court-circuit direct. Afin de déterminer si la perte totale est ou n'est pas égale à la perte qui serait observée lors d'un essai en charge directe, il est nécessaire de mesurer la puissance absorbée et la puissance utile du moteur ou de réaliser des calculs de perte pour les conditions observées dans le moteur pendant l'essai de court-circuit direct.

L'essai peut être appliqué de manière utile aux machines de 60 Hz de toutes caractéristiques assignées lorsque seules des alimentations de 50 Hz sont disponibles et à des machines de 50 Hz de toutes caractéristiques assignées lorsque seules des alimentations de 60 Hz sont disponibles. Il est possible dans ce cas d'obtenir la vitesse correcte de la machine auxiliaire en utilisant une boîte d'engrenages, un entraînement à courant alternatif à vitesse variable ou un moteur à courant continu.

L'exactitude de la détermination des échauffements est de γ = ±10 % pour tous les types et toutes les caractéristiques assignées des machines.

Il est préférable d'utiliser la méthode pour les moteurs à induction à rotor bobiné à basse tension pour lesquels l'exactitude peut être estimée à γ = ±3 %.

En raison de la redistribution des pertes dans les différentes pièces de la machine, il convient de surveiller soigneusement les températures dans toute la machine. Si la température atteint des niveaux excessifs en un quelconque point de la machine, il convient d'interrompre l'essai.

10.2 Méthode de la fréquence modulée

Dans le présent essai, le moteur à induction est alimenté par une source de courant alternatif dont la fréquence est modulée autour d'une valeur moyenne, où

f est la fréquence moyenne (Hz);

δ est l'amplitude de la modulation de fréquence (Hz);

F est la fréquence de modulation (Hz);

Le moteur est soumis à une charge en raison des accélérations et décélérations répétées dues à l'augmentation et à la réduction répétée de la fréquence.

La source de l'alimentation modulée peut être une génératrice à courant alternatif à basse fréquence d'excitation, f_{ex}, où

$$f_{ex} = \delta \times \sin (2\pi F t)$$

La fréquence de la puissance utile de la génératrice, f, est donnée par l'équation:

$$f = f_{rot} + f_{ex}$$

où f_{rot} est la fréquence déterminée par la rotation de l'arbre.

Generally, the reduction in the fundamental frequency iron loss is not adequately offset by the increase in the high-frequency loss, so the test should be supplemented by two no-load tests at rated supply frequency, one at rated supply voltage and the other at the lower voltage applied during the forward short-circuit test. The difference between the stator temperature rises on the two no-load tests is added to the temperature rise measured during the forward short-circuit test. In order to determine whether or not the total loss equals the loss that would occur in a direct-load test, it is necessary to measure the motor input and output powers or undertake loss calculations for the conditions existing in the motor during the forward short-circuit test.

The test can usefully be applied to 60 Hz machines of any rating where only 50 Hz supplies are available and to 50 Hz machines of any rating where only 60 Hz supplies are available. The correct speed of the auxiliary machine in this case could be achieved by using a gearbox, a variable-speed a.c. drive, or a d.c. motor.

The accuracy of determining temperature rises is γ = ±10 % for all types and ratings of machines.

The method is preferable for wound rotor induction motors of low voltage where the accuracy can be estimated within γ = ±3 %.

Due to the significant redistribution of losses in the various component parts of the machine, the temperatures throughout the machine should be carefully monitored. If the temperature becomes excessive at any location, the test should be terminated.

10.2 Modulated frequency method

In this test, the induction motor is fed from an a.c. source, the frequency of which is modulated around a mean value, where

f is the mean frequency (Hz);

δ is the amplitude of frequency modulation (Hz);

F is the modulation frequency (Hz).

The motor is loaded due to the repetitive acceleration and deceleration as the frequency repeatedly increases and then decreases.

The source of the modulated supply can be an a.c. generator with low excitation frequency, f_{ex}, where:

$$f_{ex} = \delta \times \sin(2\pi F t)$$

The generator output frequency, f, is given by the equation:

$$f = f_{rot} + f_{ex}$$

where f_{rot} is the frequency determined by the shaft rotation.

La valeur moyenne du couple est donnée par

$$T_{\text{av}} = 2J \times \delta_{\omega} \times F$$

où:

J = moment d'inertie du moteur

δ_{ω} = amplitude de la variation de pulsation

En supposant une modulation sinusoïdale, la valeur instantanée maximale du couple est donnée par:

$$T_{\text{max}} = \frac{\pi}{2} T_{\text{av}}$$

Il convient que cette valeur soit inférieure au couple de décrochage de sorte que le moteur fonctionne dans la partie stable des caractéristiques de charge.

L'exactitude escomptée est d'environ $\gamma = \pm 10$ %.[1)]

Cette méthode convient tout particulièrement aux moteurs à inertie importante car plus l'inertie est grande moins il est nécessaire que l'amplitude et la fréquence de modulation soient importantes (généralement 1-2 Hz). Pour les moteurs à faible inertie, il peut être nécessaire d'ajouter de l'inertie sous la forme d'un volant.

Le moteur est démarré à la fréquence d'alimentation moyenne, f, et avec l'amplitude et le taux de modulation mis à zéro. L'amplitude et le taux de modulation sont ensuite augmentés jusqu'à ce que le courant statorique soit égal au courant assigné à pleine charge. Le courant d'excitation de la génératrice est ajusté pour donner la tension assignée statorique.

10.3 Injection de courant continu

Dans la présente méthode, le moteur à l'essai est raccordé à une génératrice source à courant alternatif et fonctionne à la tension assignée à vide. Pour cette méthode, il est nécessaire de monter le moteur et la génératrice en étoile et le point neutre doit être accessible tant sur le moteur que sur la génératrice. Une source d'alimentation peut être la génératrice avec un enroulement d'excitation multiphasé symétrique (ou le moteur à induction à rotor bobiné) excité par le courant multiphasé de basse fréquence à variation périodique f_{ex}. Une source de courant continu est ensuite branchée entre les deux points neutres comme illustré à la figure 3. La puissance de courant continu est ajustée jusqu'à ce que la valeur efficace du courant alternatif à vide plus le courant continu d'injection soit égale au courant à pleine charge du moteur. La génératrice source doit fournir la tension assignée et doit être capable de supporter le courant assigné.

Les données d'essai de comparaison destinées à déterminer les échauffements par cette méthode sont inconnues. Les experts estiment que l'exactitude de cette méthode est de l'ordre de $\gamma = \pm 10$ %.

La source de courant continu est à l'origine d'un champ magnétique stationnaire dans l'espace et avec trois fois le nombre de pôles de l'enroulement statorique. Des pertes supplémentaires sont par conséquent observées dans le rotor en raison des courants et des flux qui sont créés par la rotation du rotor.

Les mesurages du courant sont réalisés en utilisant des transformateurs de courant qui relient deux lignes, l'une dans le sens «direct» et l'autre dans le sens «inverse» de manière à annuler le composant de courant continu.

[1)] Si les erreurs de l'opérateur et du matériel de commande et de mesure sont amplifiées.

The average value of torque is given by

$$T_{\text{av}} = 2J \times \delta_{\omega} \times F$$

where

J is the moment of inertia of the motor

δ_{ω} is the amplitude of angular frequency variation

Assuming sinusoidal modulation, the maximum instantaneous value of torque is given by:

$$T_{\text{max}} = \frac{\pi}{2} T_{\text{av}}$$

This maximum value should be below the pull-out torque, so that the motor operates on the stable part of the load characteristic.

The expected accuracy is about $\gamma = \pm 10$ %.[1)]

This method is particularly appropriate for high-inertia motors, because the greater the inertia the smaller the required modulation amplitude and frequency (typically 1-2 Hz). For low-inertia motors, it may be necessary to add inertia in the form of a flywheel.

The motor is started up with the supply of mean frequency, f, and with the modulation amplitude and rate set to zero. Modulation amplitude and rate are then increased until the stator current equals the rated full-load current. The excitation current of the generator is adjusted to give the rated stator voltage.

10.3 DC injection

In this method, the motor under test is connected to an a.c. source generator and operates at rated voltage on no load. The method requires that the motor and generator are star-connected and that the neutral point is accessible on both motor and generator. A power source may be the generator with a symmetrical multiphase excitation winding (or the induction wound-rotor motor) excited by the multiphase current of periodically varying low frequency f_{ex}. A d.c. source is then connected between the two neutral points as shown in figure 3. The d.c. output is adjusted until the r.m.s. value of the a.c. no-load current plus the d.c. injection current equals the full-load current of the motor. The source generator shall provide rated voltage and shall be able to carry rated current.

The comparative test data for determining temperature rises by this method are unknown. The experts estimate the method accuracy to be within $\gamma = \pm 10$ %.

The d.c. source sets up a magnetic field that is stationary in space with three times the number of poles than the stator winding. Hence, extra losses appear in the rotor due to the currents and fluxes that are set up by the rotor rotation.

Current measurements are made using current transformers that link two lines, one in the "forward" direction and one in the "backward" direction so that the d.c. component is cancelled.

[1)] If the errors of the operator and control and measuring equipment are magnified.

10.4 Méthode de fréquence mixte ou de fréquence double

10.4.1 Alimentation statorique

Dans la présente méthode d'essai, le stator du moteur est alimenté simultanément par deux sources à différentes fréquences (figure 4), la source principale et une source auxiliaire. Il est également possible de brancher la génératrice auxiliaire par le biais d'un transformateur triphasé entre la génératrice principale et le moteur (figure 5). Il convient que les séquences de phase de tension de la fréquence principale et de la fréquence auxiliaire soient les mêmes. Le courant, la tension et la vitesse du moteur varient à une fréquence de battement. La génératrice principale fournit une fréquence assignée alors que la génératrice auxiliaire fournit une puissance de fréquence et d'amplitude réglable. La fréquence de la source auxiliaire est généralement égale à environ 80 % ou 120 % de la fréquence assignée et la tension est d'environ 20-30 % de la tension assignée. La fréquence auxiliaire est entre autres choisie de manière à ce que les variations n'empêchent pas une mesure exacte.

Le moteur est d'abord raccordé à l'alimentation principale et démarré à vide. La tension de sortie de la génératrice auxiliaire est augmentée progressivement (et si nécessaire la tension de l'alimentation principale est également ajustée) jusqu'à ce que les conditions suivantes soient atteintes simultanément:

a) la valeur efficace du courant variable du moteur est égale au courant assigné;

b) la valeur efficace de la tension variable du moteur est égale à la tension assignée;

c) la vitesse est égale à la vitesse assignée.

Lorsqu'il est difficile d'ajuster avec précision les valeurs efficaces du courant et de la tension variables du moteur aux valeurs assignées du moteur, il est possible de réaliser l'essai avec un courant et une tension proches de leurs valeurs assignées et à la vitesse assignée en ajustant la puissance absorbée du moteur par rapport aux pertes totales du moteur à la charge assignée.

Pour les moteurs à induction à cage de puissance assignée inférieure ou égale à 315 kW, et pour les moteurs à induction à rotor bobiné basse tension, l'exactitude est de l'ordre de γ = +3 % et γ = –13 %.

Pour les moteurs à induction à rotor bobiné haute tension de puissance assignée inférieure ou égale à 7 000 kW, l'exactitude est d'environ γ = ±3,0 %, mais pour certaines machines à faible niveau d'échauffement, l'erreur peut atteindre γ = +20 %.

Le point de fonctionnement du moteur, lorsque la fréquence de la source principale est de 50 Hz et celle de la source auxiliaire de 40 Hz, peut être déduit des courbes de vitesse/couple et de vitesse/courant pour les fréquences principales et auxiliaires, tel qu'illustré à la figure 6. Le couple positif dû à l'alimentation à 50 Hz (point A) est équilibré par le couple négatif dû à l'alimentation à 40 Hz (point B). Le courant net est principalement déterminé par le courant établi par l'alimentation à 40 Hz (point C) puisque le moteur fonctionne avec un glissement très faible (et ainsi avec un courant très faible) par rapport à l'alimentation à 50 Hz. Lorsque la fréquence de la source principale est de 50 Hz et celle de la source auxiliaire de 60 Hz, le couple positif dû à l'alimentation à 60 Hz est équilibré par le couple négatif dû à l'alimentation à 50 Hz. Le courant net est principalement déterminé par le courant établi par l'alimentation à 60 Hz.

La combinaison des fréquences produit *une* fréquence nette qui varie dans le temps de la manière suivante:

$$f = \frac{f_1 + \lambda^2 \ f_2 + (f_1 + f_2) \cos 2\pi \ (f_1 - f_2)t}{1 + \lambda^2 + 2\lambda \cos 2\pi \ (f_1 - f_2)t}$$

10.4 Mixed-frequency or bi-frequency method

10.4.1 Stator feeding

In this test method, the motor stator is fed simultaneously from two sources at different frequencies (figure 4), the main source and an auxiliary source. The auxiliary generator may alternatively be connected through a three-phase transformer between the main generator and the motor (figure 5). The voltage phase sequences of both main and auxiliary frequency should be the same. The motor current, voltage and speed fluctuate at a beat frequency. The main generator supplies rated frequency, while the auxiliary generator provides an output of adjustable frequency and amplitude. The frequency of the auxiliary source is typically either about 80 % or about 120 % of the rated frequency, and the voltage is about 20-30 % of the rated voltage. The auxiliary frequency is in part chosen so that the fluctuations do not prevent accurate readings.

The motor is first connected to the main supply and run on no load. The output voltage of the auxiliary generator is steadily increased (and if necessary the main supply voltage is adjusted also) until the following conditions are achieved simultaneously:

a) the r.m.s. value of the fluctuating motor current equals the rated current;

b) the r.m.s. value of the fluctuating motor voltage equals the rated voltage;

c) the speed equals the rated speed.

When it is difficult to adjust the r.m.s. values of the fluctuating motor current and voltage to the motor rated values precisely, the test can be performed with current and voltage which are close to their rated values and at rated speed by adjusting the motor input power to the total losses of the motor at rated load.

For squirrel-cage induction motors ratings up to 315 kW and for low-voltage wound-rotor induction motors the accuracy is within γ = +3 % and γ = –13 %.

For high-voltage wound-rotor induction motors rated up to 7 000 kW the accuracy is about γ = ±3,0 %, but, for some machines with a low level of heating, the error can reach γ = +20 %.

The operating point of the motor, when the frequency of the main source is 50 Hz and that of auxiliary source is 40 Hz, can be deduced from the speed/torque and speed/current curves for the main and auxiliary frequencies, as shown in figure 6. The positive torque due to the 50 Hz supply (point A) is balanced by the negative torque due to the 40 Hz supply (point B). The net current is mainly determined by the current set up by the 40 Hz supply (point C), as the motor runs at a very low slip (and hence at a low current) with respect to the 50 Hz supply. When the frequency of the main source is 50 Hz and that of auxiliary source is 60 Hz, the positive torque due to the 60 Hz supply is balanced by the negative torque due to the 50 Hz supply. The net current is mainly determined by the current set up by the 60 Hz supply.

The combination of frequencies results in a net frequency varying with time as follows:

$$f = \frac{f_1 + \lambda^2 \ f_2 + (f_1 + f_2) \cos 2\pi \ (f_1 - f_2)t}{1 + \lambda^2 + 2\lambda \cos 2\pi \ (f_1 - f_2)t}$$

Pour un cas type, les valeurs sont les suivantes:

fréquence de l'alimentation principale f_1 = 50 Hz;

fréquence de l'alimentation auxiliaire f_2 = 40 Hz;

tension auxiliaire/tension principale λ = 0,25.

Dans ce cas, la fréquence nette varie entre 48 Hz et 53,3 Hz, c'est-à-dire $50^{+3,3}_{-2,0}$ Hz et ne varie donc pas de manière symétrique autour de 50 Hz. Il s'agit là d'une différence fondamentale entre la méthode de la fréquence mixte et la méthode de la fréquence modulée décrite en 10.2. Dans cette dernière méthode, la fréquence varie généralement de manière sinusoïdale autour de la fréquence assignée.

10.4.2 Alimentation rotorique

Une autre méthode de fréquence mixte pour les moteurs à induction à rotor bobiné consiste à raccorder la génératrice auxiliaire au circuit du rotor plutôt qu'à celui du stator, tel qu'illustré à la figure 7. La tension et la fréquence auxiliaires sont alors ajustées pour établir le courant assigné statorique ou la perte assignée dans le moteur comme dans la méthode normale d'alimentation statorique. Il convient que la séquence de phase de la source auxiliaire soit telle que le rotor avec le stator en court-circuit tourne dans la même direction que celle de l'alimentation principale raccordée au stator avec le rotor en court-circuit. Il convient que la fréquence auxiliaire soit sensiblement inférieure à la moitié de la fréquence principale.

10.4.3 Niveau de vibration pendant l'essai à fréquence mixte

En raison de la combinaison des fréquences des courants et des champs statoriques (ou rotoriques), le couple d'arbre aura une composante d'oscillation considérable. Les niveaux de vibration auront tendance à être supérieurs à la normale et le risque d'observer une résonance mécanique est augmenté en raison du large spectre d'harmoniques de courant et de flux. Il est souhaitable de surveiller les niveaux de vibration pendant l'essai pour vérifier qu'aucun dommage n'a lieu.

A l'issue de l'essai à fréquence mixte, il est possible de faire marcher le moteur avec seulement l'alimentation principale à la tension assignée et de mesurer rapidement le vrai niveau de vibrations pendant que le moteur est à la température de fonctionnement à pleine charge. Il serait possible de surveiller la température du moteur au moyen d'un thermocouple pour s'assurer que la température est suffisamment proche de la valeur à pleine charge assignée pour être admissible. Si la température devait tomber au-dessous d'un niveau admissible, il serait possible de poursuivre l'essai à fréquence mixte pendant un certain temps.

11 Essai de charge équivalente pour machines synchrones – Facteur de puissance nul

Cette méthode consiste à faire fonctionner la machine comme un compensateur synchrone, avec des valeurs appropriées de courant, de tension et de fréquence statoriques. La machine surexcitée peut être raccordée à une charge constituée de machines synchrones sous-excitées tournant au ralenti. En ajustant l'excitation de la machine à l'essai et celle de sa charge, il est possible de faire varier la tension aux bornes tout en maintenant le courant statorique constant. Dans la mesure où la tension E_p en aval de la réactance de fuite du stator à un facteur de puissance nul surexcité est supérieure à ce qu'elle est avec des facteurs de puissance plus élevés pour la même tension de borne et le même courant statorique, la tension d'essai aux bornes peut être réduite à une valeur qui donne une valeur de E_p identique à celle à la charge assignée. L'échauffement qui en résulte dans le stator peut alors être mesuré et utilisé comme une indication de l'échauffement qui serait observé à la charge assignée.

In a typical case, the values are as follows:

frequency of main supply f_1 = 50 Hz;

frequency of auxiliary supply f_2 = 40 Hz;

auxiliary voltage/main voltage λ = 0,25.

In this case, the net frequency varies between 48 Hz and 53,3 Hz, i.e. $50\,^{+3,3}_{-2,0}$ Hz, and hence does not vary symmetrically around 50 Hz. This is the fundamental difference between this mixed-frequency method and the modulated-frequency method described in 10.2. In the latter method, the frequency generally varies sinusoidally around the rated frequency.

10.4.2 Rotor feeding

An alternative mixed-frequency method for wound-rotor induction motors involves the connection of the auxiliary generator to the rotor circuit rather than to the stator, as shown in figure 7. The auxiliary voltage and frequency are then adjusted in order to establish rated stator current or rated loss in the motor as in the normal stator-feeding method. The phase sequence of the auxiliary source should be such that the rotor rotation with the stator shorted would be in the same direction as that with the main supply connected to the stator with the rotor shorted. The auxiliary frequency should be significantly less than half the main frequency.

10.4.3 Vibration level during the mixed-frequency test

Due to the combination of the frequencies of the stator (or rotor) currents and fields, the shaft torque will have a considerable oscillating component. Vibration levels will tend to be higher than normal, and there is a greater chance of mechanical resonance occurring due to the broad spectrum of current and flux harmonics. It is desirable that vibration levels are monitored during the test to check that damage will not occur.

When the mixed-frequency test has been completed, the motor can then be operated with the main supply only at rated voltage, and the true vibration level can be measured quickly while the motor is at full-load running temperature. The motor temperature could be monitored by thermocouple to ensure that the temperature is acceptably close to the value at rated full load. If the temperature were to fall below an acceptable level, the mixed-frequency test could be re-continued for a while.

11 Equivalent load test for synchronous machines – Zero power factor

This method consists of operating the machine as a synchronous condenser, with appropriate values of stator current, voltage and frequency. The overexcited machine may be connected to a load consisting of idle-running underexcited synchronous machines. By adjustment of the excitation of the machine to be tested and that of its load, the terminal voltage may be varied while the stator current is held constant. Since the voltage E_p behind the stator leakage reactance at zero power factor overexcited is greater than it is at higher power factors for the same terminal voltage and stator current, the test terminal voltage may be reduced to a value which results in a value of E_p which is the same as that at rated load. The resulting stator temperature rise can then be measured and used as an indication of the rise that would occur at rated load.

La perte dans l'enroulement d'excitation s'écarte sensiblement de celle en fonctionnement normal. Il convient par conséquent de corriger l'échauffement d'excitation mesuré par la variation de résistance pour qu'elle corresponde à la perte associée au courant assigné d'excitation. L'échauffement peut être supposé proportionnel à la perte par effet Joule d'excitation de la manière suivante:

$$\Delta\theta_{fN} = \left(\frac{I_{fN}}{I_{ft}}\right)^2 \Delta\theta_{ft} \times \frac{235 + \theta_{AN}}{235 + \Delta\theta_{ft} + \theta_{Ft} - (I_{fN} / I_{ft})^2 \Delta\theta_{ft}}$$

où

I_{fN} est le courant assigné d'excitation;

I_{ft} est le courant d'excitation mesuré;

θ_{AN} est la température ambiante de référence;

θ_{Ft} est la température ambiante mesurée;

$\Delta\theta_{ft}$ est l'échauffement mesuré d'excitation.

Il est possible d'utiliser l'équation simplifiée suivante, moins *précise* et qui néglige la variation de résistance avec la température

$$\Delta\theta_{fN} = (I_{fN}/I_{ft})^2 \, \Delta\theta_{ft}$$

Ce calcul de l'échauffement d'excitation néglige les effets des pertes dans le stator, de surface de rotor et par ventilation.

Lorsqu'il est impossible de négliger l'échauffement de l'enroulement d'excitation dû aux pertes par ventilation, par exemple dans le cas de machines à vitesse périphérique élevée telles que des génératrices de type turbine, l'échauffement de l'enroulement d'excitation doit être déterminé par l'équation suivante:

$$\Delta\theta_{fN} = (I_{fN}/I_{ft})^2 \, (\Delta\theta_{ft} - \Delta\theta_{fw}) + \Delta\theta_{fw}$$

où $\Delta\theta_{fw}$ est l'échauffement de l'enroulement d'excitation mesuré en entraînant la machine à la vitesse assignée avec les enroulements d'induit et d'excitation en circuit ouvert.

Pour les machines dont les caractéristiques assignées ont un facteur de puissance supérieur à 0,9 (et notamment les machines dont les caractéristiques assignées ont un facteur de puissance unité), cette méthode d'essai peut être impossible à réaliser en raison des limites d'échauffement d'excitation. Dans ce cas, l'excitation peut être réglée à la valeur assignée et il convient de réduire la tension aux bornes pour donner le courant assigné statorique. La perte par effet Joule dans le stator est alors égale à la valeur assignée, mais une correction est nécessaire pour compenser l'échauffement du stator par rapport à la réduction de la perte dans le fer dans le stator, même si l'effet est faible puisque les pertes dans le cuivre dominent. Cet essai peut être complété par deux essais à circuit ouvert pour obtenir cette correction:

a) avec l'excitation réglée pour donner la tension réduite aux bornes;

b) avec l'excitation réglée pour donner la tension assignée aux bornes.

L'échauffement statorique est mesuré dans chaque cas et la différence entre les valeurs est ajoutée à la valeur mesurée dans l'essai de charge équivalente.

Il est impossible d'appliquer ces méthodes à des machines à service temporaire puisque ces essais doivent être réalisés suffisamment longtemps pour que les conditions de charge alternative puissent créer un équilibre thermique.

The field winding loss differs considerably from that in normal operation. Hence, the temperature rise of the field measured by change of resistance should be corrected to correspond to the loss associated with the rated field current. The temperature rise may be assumed to be proportional to the field I^2R loss, as follows:

$$\Delta\theta_{fN} = \left(\frac{I_{fN}}{I_{ft}}\right)^2 \Delta\theta_{ft} \times \frac{235 + \theta_{AN}}{235 + \Delta\theta_{ft} + \theta_{Ft} - (I_{fN} / I_{ft})^2 \Delta\theta_{ft}}$$

where

I_{fN} is the rated field current;

I_{ft} is the measured field current;

θ_{AN} is the reference ambient temperature;

θ_{Ft} is the measured ambient temperature;

$\Delta\theta_{ft}$ is the measured field temperature rise.

The following simplified less accurate equation, which neglects the change of resistance with temperature, may be used.

$$\Delta\theta_{fN} = (I_{fN}/I_{ft})^2 \, \Delta\theta_{ft}$$

This derivation of the field temperature rise neglects the effect of stator, rotor-surface and windage losses.

When the temperature rise of field winding due to windage losses cannot be neglected, for example, in the case of high-peripheral-speed machines such as turbine type generators, the temperature rise of field winding shall be determined by the following equation

$$\Delta\theta_{fN} = (I_{fN}/I_{ft})^2 \, (\Delta\theta_{ft} - \Delta\theta_{fw}) + \Delta\theta_{fw}$$

where $\Delta\theta_{fw}$ is the temperature rise of field winding measured by driving the machine at rated speed with open-circuit armature and field windings.

For machines rated at power factors above 0,9 (and particularly those rated at unity power factor), this test method may be impractical because of field heating limits. In this case, the excitation may be set to the rated value, and the terminal voltage should be reduced to give rated stator current. The I^2R loss in the stator will then equal the rated value, but correction is required to compensate the stator temperature rise for reduced iron loss in the stator, even though the effect is small as the copper losses predominate. This test may be supplemented by two open-circuit tests to achieve this correction:

a) with the excitation set to give the reduced terminal voltage;

b) with the excitation set to give the rated terminal voltage.

The stator temperature rise is measured in each case, and the difference between the values is added to the value measured in the equivalent load test.

These methods cannot be applied to short-time rated machines, as the tests have to be applied for a sufficiently long period of time so that the alternating loading conditions can result in thermal equilibrium.

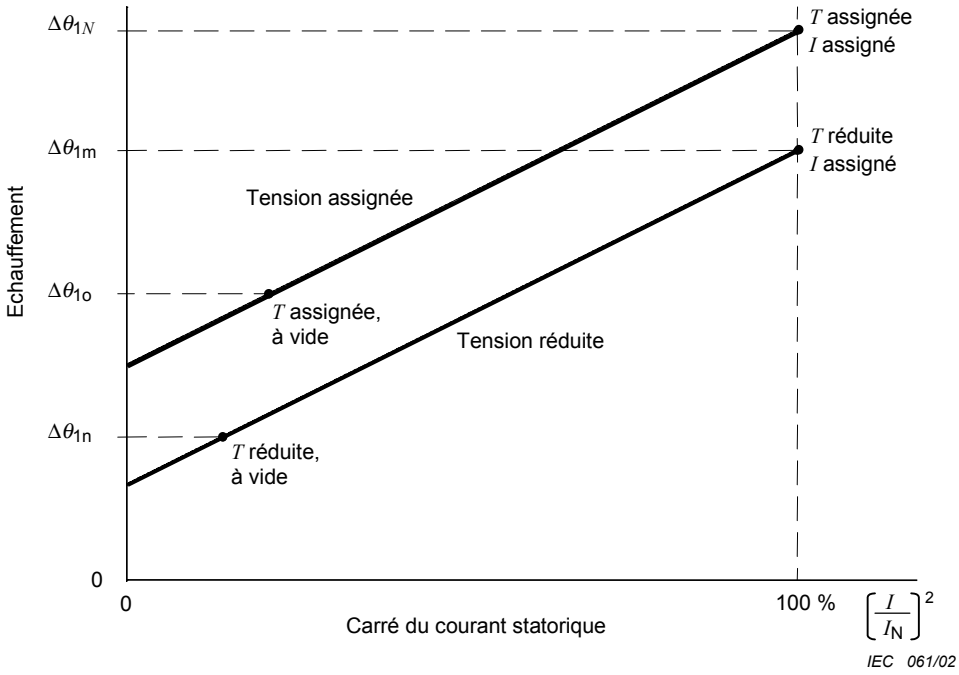


Figure 1 – Méthode par superposition graphique pour moteurs à induction

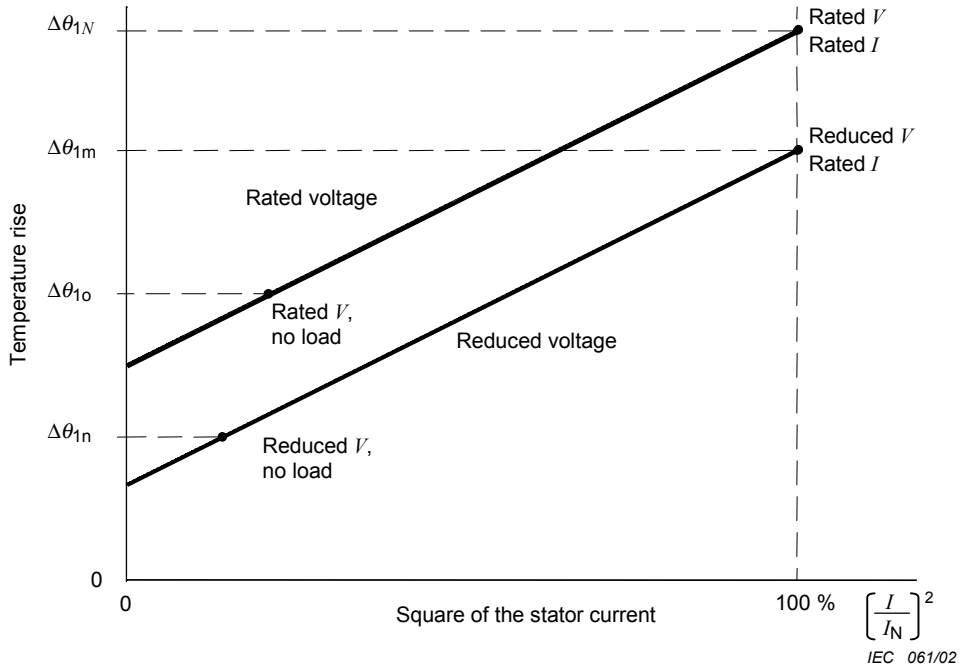
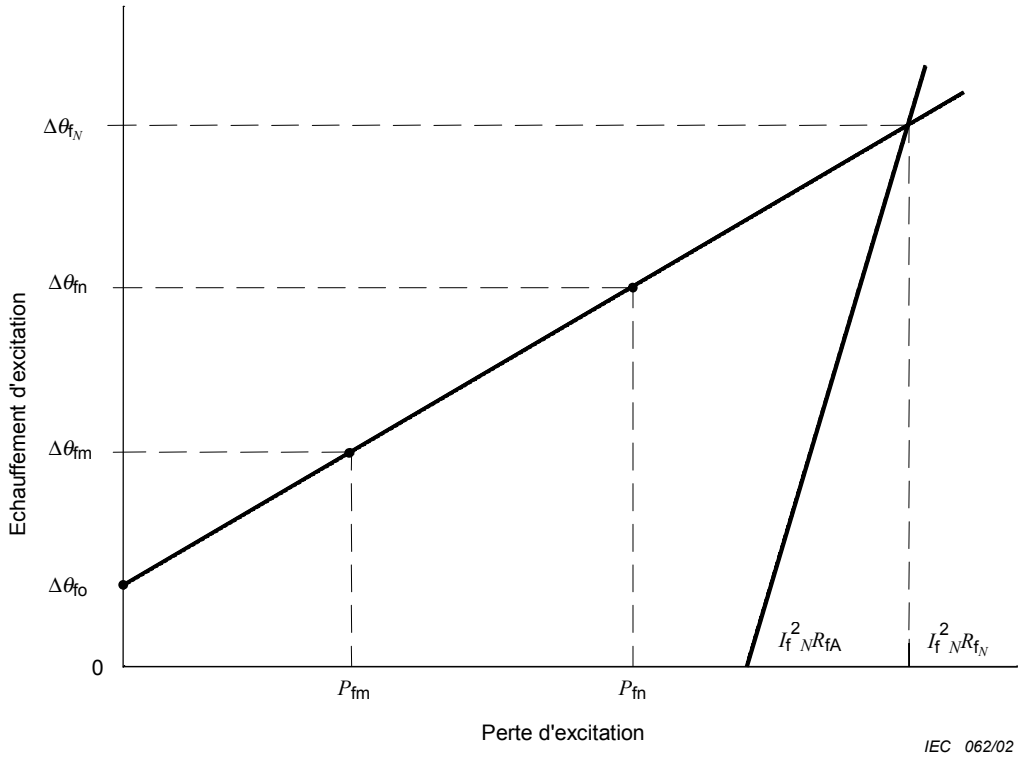


Figure 1 – Graphical superposition method for induction motors



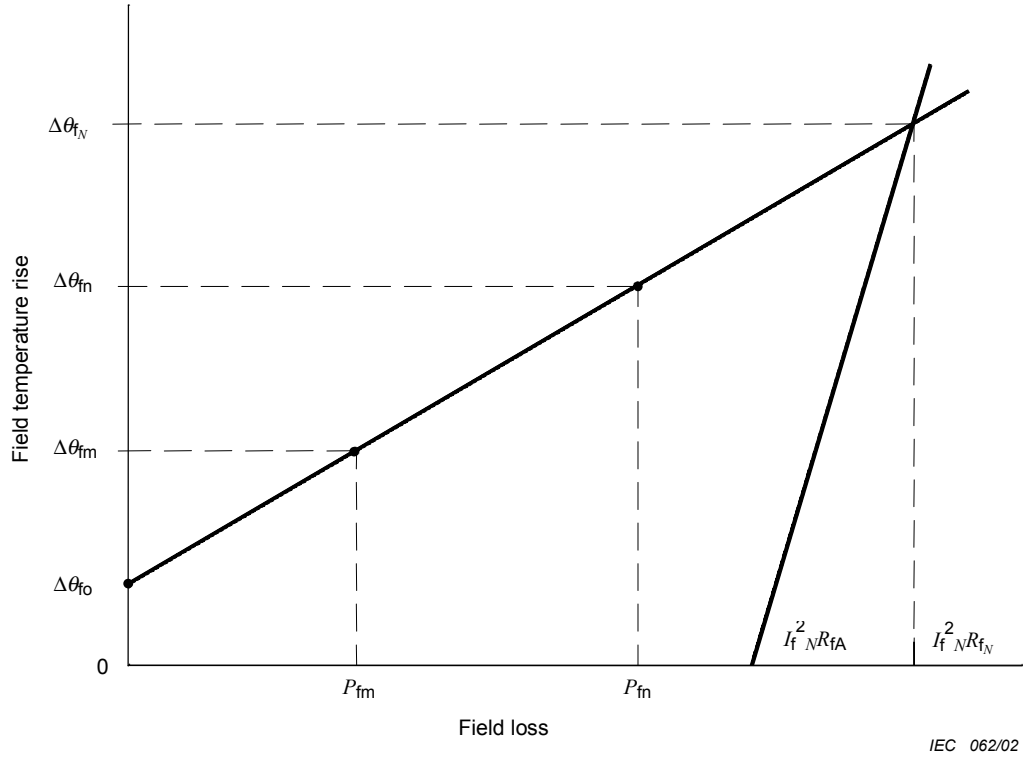
Légende

R_{fA} Résistance de champ à température ambiante

R_{fN} Résistance de champ à charge assignée

I_{fN} Courant assigné rotorique

Figure 2 – Calcul de l'échauffement d'excitation à charge assignée (machines synchrones)



Key

R_{fA} Field resistance at ambient temperature

R_{fN} Field resistance at rated load

I_{fN} Rated rotor current

Figure 2 – Derivation of field temperature rise at rated load (synchronous machines)

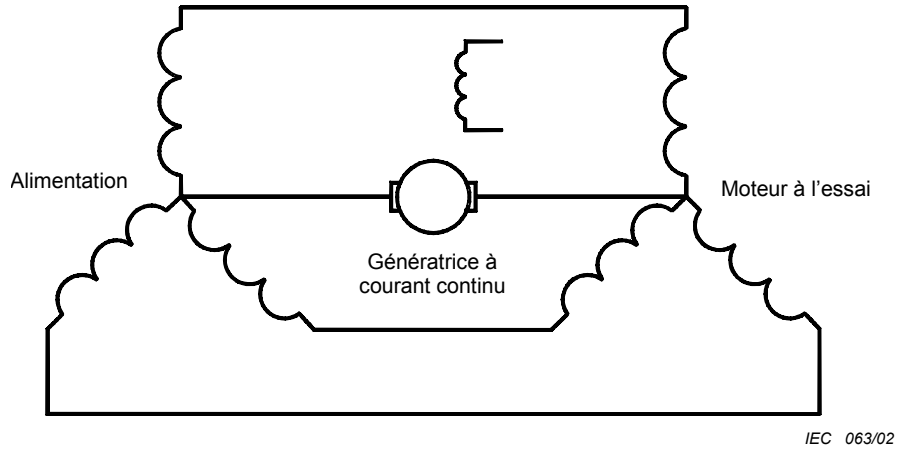


Figure 3 – Circuit d'essai pour essai de charge équivalente à injection de courant continu

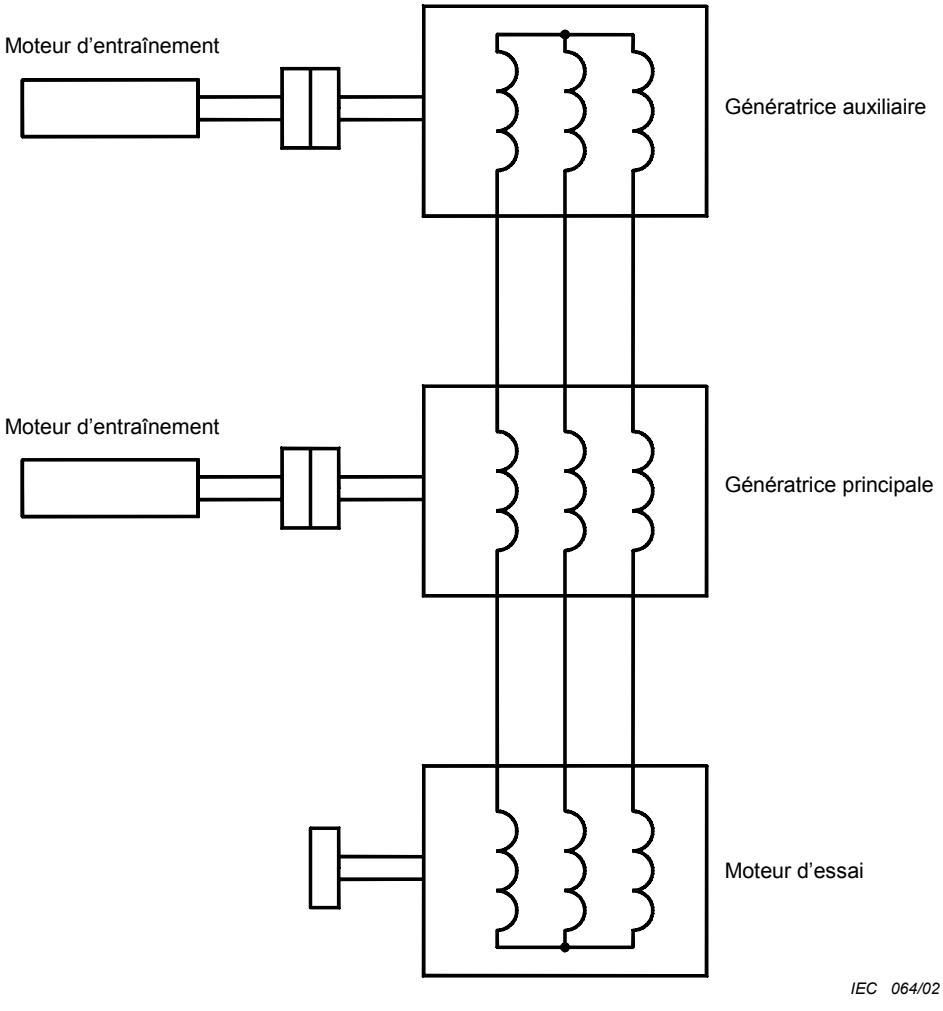


Figure 4 – Essai à fréquence mixte – Génératrices en série

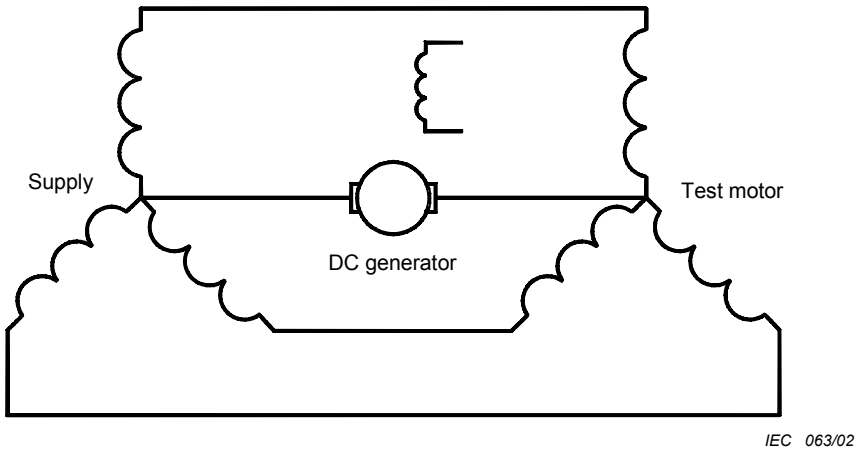


Figure 3 – Test circuit for d.c.-injection equivalent load test

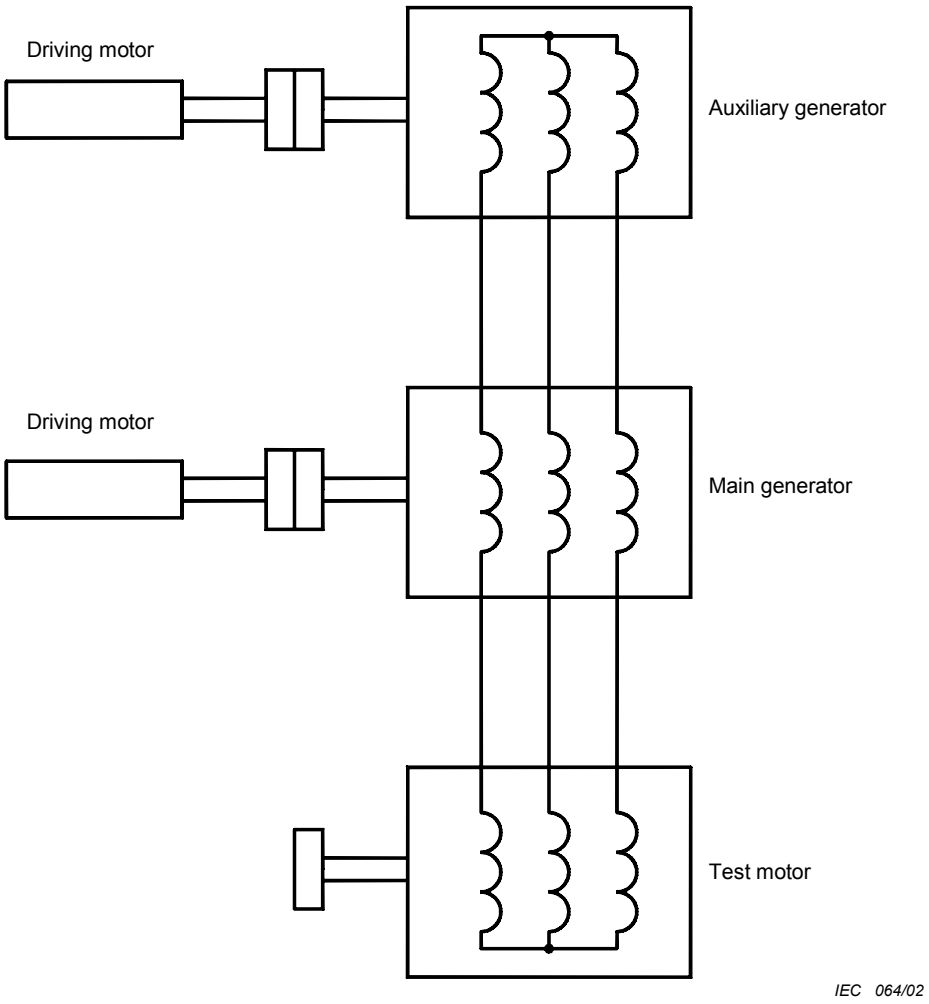


Figure 4 – Mixed-frequency test – Generators in series

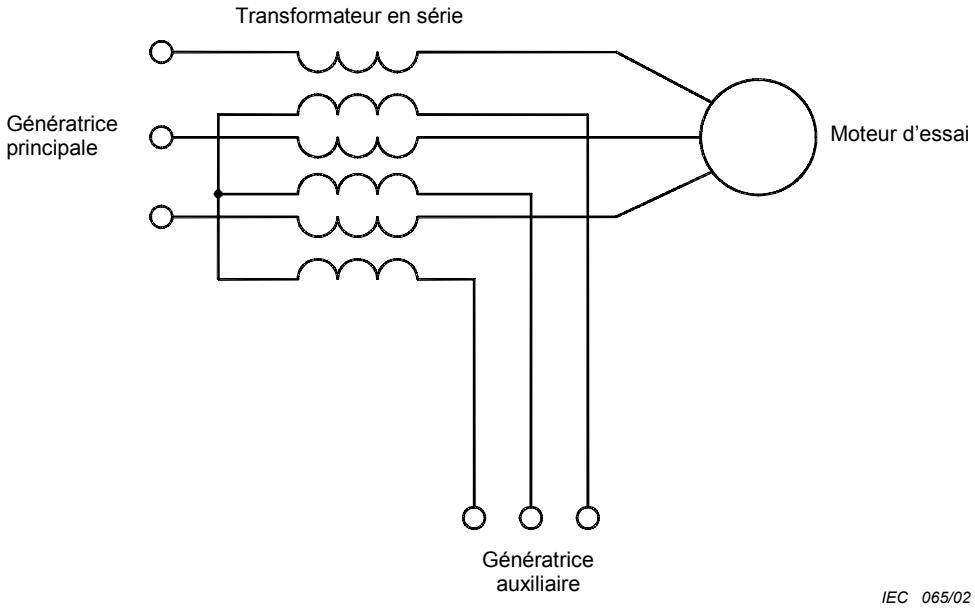


Figure 5 – Essai à fréquence mixte – Transformateur en série

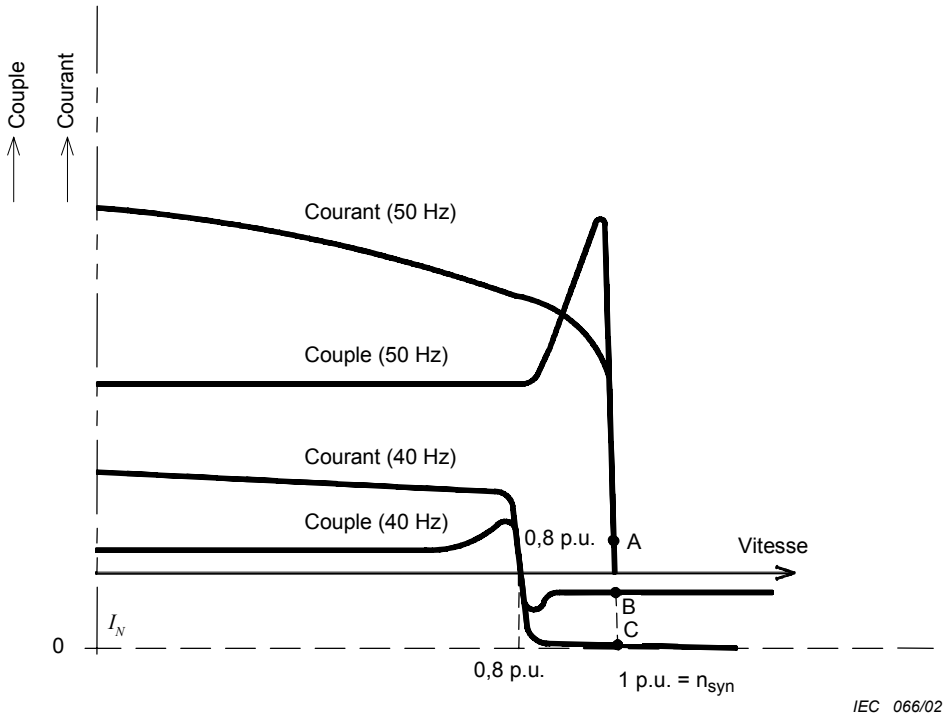


Figure 6 – Combinaison de couple et de courant au point de fonctionnement dans les essais à fréquence mixte

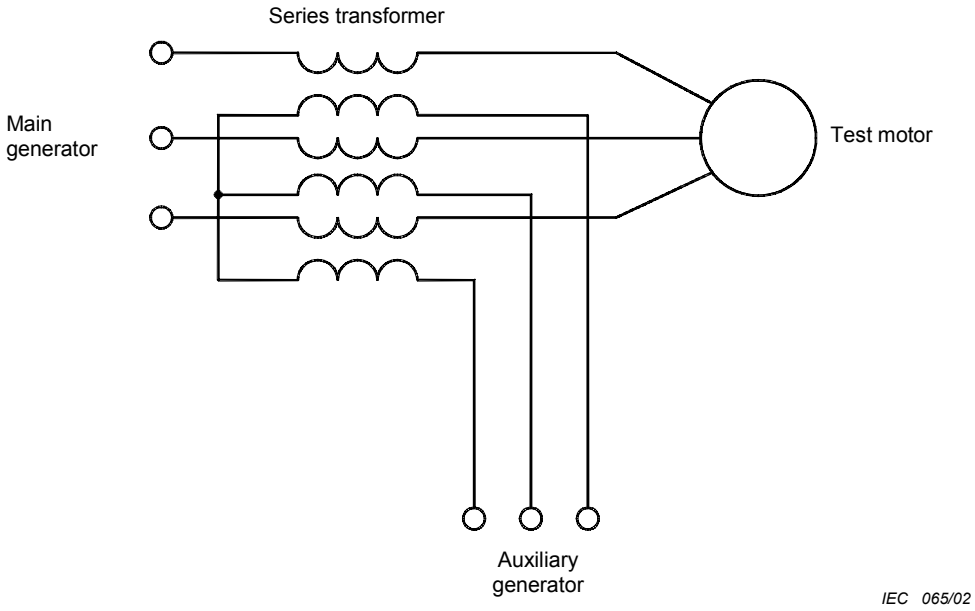


Figure 5 – Mixed-frequency test – Series transformer

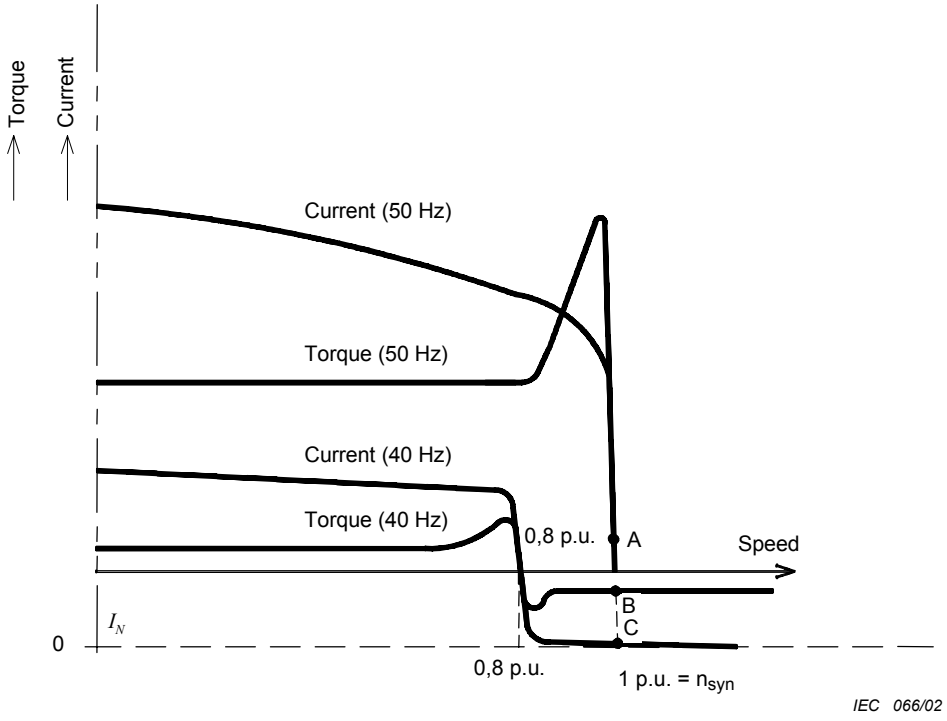


Figure 6 – Combination of torque and current at the operating point in a mixed-frequency test

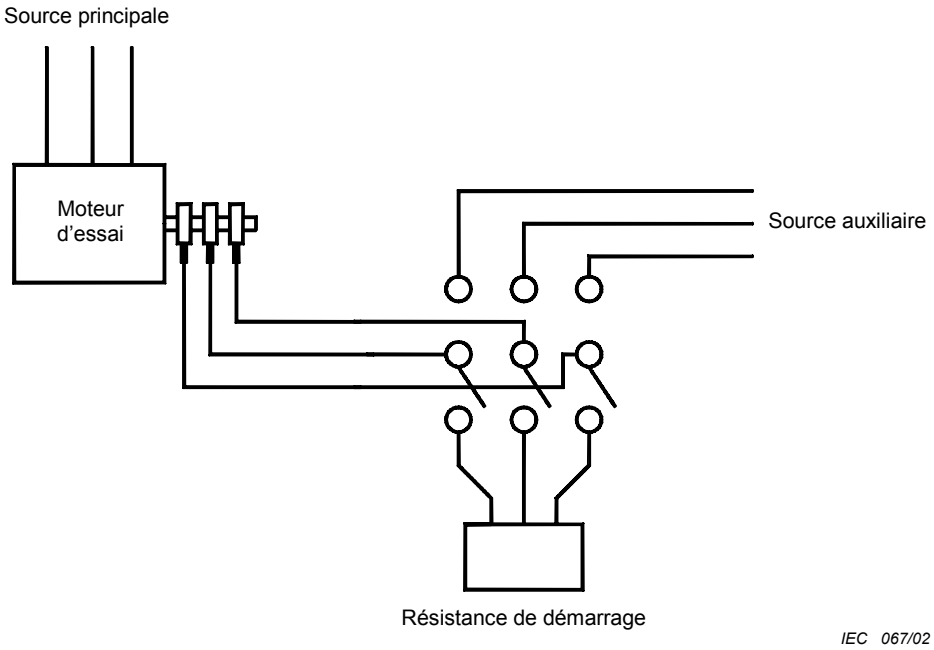


Figure 7 – Méthode d'alimentation rotorique à fréquence mixte

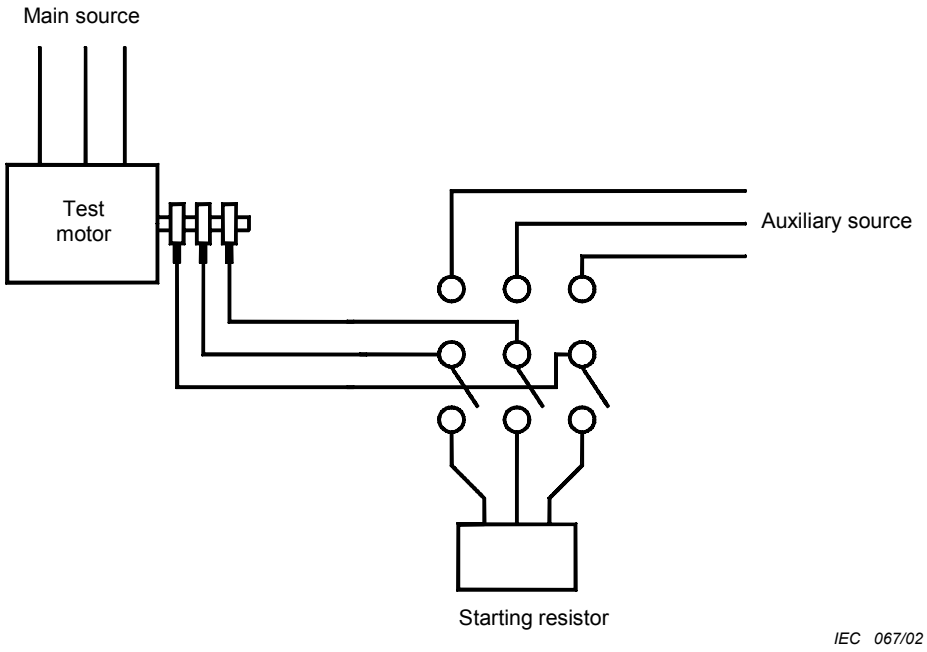


Figure 7 – Rotor-feeding mixed-frequency method

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Mobiltemp SHC 100
Synthetic High Temperature Grease

Product Description

Mobiltemp SHC 100 is a super premium, high temperature, anti-wear grease which combines the unique features of a synthetic base fluid with an organo-clay (non-soap) thickener. The clay thickener provides excellent structural stability at very high temperatures. The wax free nature of the synthetic base fluid, together with its low coefficient of traction compared with mineral oils, provide excellent low temperature lubrication, oxidation stability at high temperatures plus the potential for energy savings through reduced friction and lower torque.

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Based on available toxicological information, it has been determined that this product poses no significant health risk when used and handled properly.

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Thickener Type	-	Organo-Clay
Colour	Visual	Brown
Penetration, Worked	ASTM D217	280
Dropping Point °C	ASTM D2265	260+
Viscosity of Oil, cSt at 40° C	ASTM D445	100
Viscosity of Oil, cSt at 100°C	ASTM D445	14
Emcor Distilled Water Washout Test	IP 220 Mod.	0-0
4-Ball Weld, Scar mm	ASTM D2266	0.5
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Conceptual survey of Generators and Power Electronics for Wind Turbines

L. H. Hansen, L. Helle, F. Blaabjerg, E. Ritchie, S. Munk-Nielsen, H. Bindner, P. Sørensen and B. Bak-Jensen.

Risø National Laboratory, Roskilde, Denmark
December 2001

Abstract

This report presents a survey on generator concepts and power electronic concepts for wind turbines. The report is aimed as a tool for decision-makers and development people with respect to wind turbine manufactures, utilities, and independent system operators as well as manufactures of generators and power electronics.

The survey is focused on the electric development of wind turbines and it yields an overview on:

- State of the art on generators and power electronics.
- Future concepts and technologies within generators and power electronics.
- Market needs in the shape of requirements to the grid connection.

This survey on generator and power electronic concepts was carried out in cooperation between Aalborg University and Risø National Laboratory, in the scope of the joint research programme *Electric Design and Control*.

The report has been reviewed by:

_____	_____
Anca Daniela Hansen	Peter Hauge Madsen

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Preface

The present report is a result of the co-operation between Aalborg University and Risø National Laboratory within the scope of the research programme *Electric Design and Control* (EDS, alias Elektrisk Design og Styring).

The report has as an objective to compile and disseminate some of the knowledge on generators and power electronics for wind turbines, which now is at EDS' disposal. In this work, the following persons have contributed to the report writing:

- Birgitte Bak-Jensen.
- Henrik Bindner.
- Frede Blaabjerg.
- Lars Henrik Hansen.
- Lars Helle.
- Stig Munk-Nielsen.
- Ewen Ritchie.
- Poul Sørensen.

In order to focus the report towards the needs of the wind turbines manufactures a task group consisting of:

- NEG Micon: Niels Vilsbøll.
- Vestas: Michael Kinch.
- ABB: Hans Christian Christensen.
- Siemens: Kim Eskildsen and Ulf Lindhard.

have been asked to contribute to this report by valuable input – in specific on the concept evaluation criteria. Moreover, ABB and Siemens have kindly put pictures and drawings at disposal for this report.

Finally, the four largest wind turbine gearbox manufactures have been asked to supply specific gearbox data. The following two:

- Brook Hansen Transmission
- Lohmann & Solterfoht.

have contributed with data which are used to point out trends on gearboxes.

Frontpage picture has been supplied by Vestas

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Acronyms and abbreviations

AG	Asynchronous Generator
AHF	Active Harmonic Filters
ASVC	Advanced Static Var Compensator
CHP	Combined Heating Power
CUPS	Custom Power Systems
CSC	Current Source Converter
CSI	Current Source Inverter Current Stiff Inverter
DF	Doubly Fed
DPM	Discrete Pulse Modulation
DSFC	Double-Sided with Flux Concentration
DSPMG	Doubly Salient Permanent Magnet Gen.
DVR	Dynamic Voltage Restorer
FACTS	Flexible AC transmission systems
FEM	Finite Element Method
GTO	Gate Turn Off thyristor
HVDC	High Voltage Direct Current
IGBT	Insulated Gate Bipolar Transistor
IGCT	Integrated Gate Commutated Thyristors
IM	Induction Machine
LFPM	Longitudinal Flux Permanent Magnet
MCT	Mos Controlled Thyristors
NCC	Natural Clamped Converter
PCC	Point of Common Coupling
PE	Power Electronic
PMG	Permanent Magnet Generator
PWM	Pulse Width Modulation
SCIG	Squirrel Cage Induction Generator
SG	Synchronous Generator
SR	Switched Reluctance
SRG	Switched Reluctance Generator
SRM	Switched Reluctance Machine
SSSM	Single-Sided with Surface Magnets
STATCOM	Static Synchronous Compensator
SVC	Static Var Compensator
TF	Transversal Flux
TFPM	Transverse Flux Permanent Magnet
UPQC	Unified Power Quality Conditioner
UVC	Unified Voltage Controller
VSI	Voltage Source Inverter Voltage Stiff Inverter
WRSG	Wound Rotor Synchronous Generator

1 Introduction

1.1 Report outline

In recent years, the development in the area of electric machines and power electronics has been vigorous. Due to this development, the authors have a need for a survey on the present state of the art for generators and power electronics and a corresponding state of the art on wind turbines.

The survey presented in this report has the following objectives:

- to document state of the art for generators and power electronics with respect to wind turbines.
- to describe new concepts and technologies for generators and power electronics, which potentially could be used in wind turbines.
- to analyse market needs in terms of demands to the grid connection for wind turbines and wind farms.

The report is structured based on the philosophy sketched in Figure 1. When designing a new wind turbine, a number of function at demands are placed on e.g. the mode of operation etc., which is characteristic for a given wind turbine manufacture. It is foreseen that in the near future, these function at demands will be strongly influenced by customers desires, i.e. towards a more market demand oriented development. Therefore in this report, special emphasis is put on market needs – in particularly needs which shape demands to grid connection. Grid connection demands can be described objectively and simultaneously; they are important factors in the definitions of the function at demands.

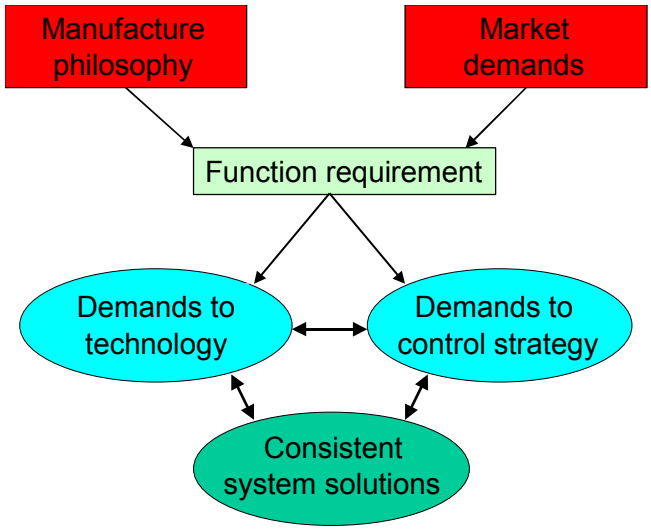


Figure 1.Philosophy of the report structure.

On basis of the function demands, it is a task of the designer to find a suitable technology, which combined with a matching control strategy, yields a consistent system solution. In the succeeding sections, the report presents examples of technological components for wind turbines in the form of concepts generator and power electronics. Control strategies will not be discussed further in this

report, since implementation of this issue typically is specific for each manufacturer, i.e. each has his own characteristic approach.

By nature a large number of consistent system solutions exist. The electrical part of a wind turbine is becoming more and more important. Therefore, it is very important to have this system highly integrated into the overall wind turbine design. Thus, a successor to this report would be one, which describes and analyses consistent system solutions (including aspects of controls), combined with an assessment of these solutions seen in the light of market needs regarding the grid connection demands.

1.2 State of the art

Since the start of modern wind turbine development in 1957, marked by the innovative Gedser wind turbine (200 kW), the main aerodynamic concept has been a horizontal axis, three bladed, downwind wind turbine, connected to a three phase AC-grid. Many different concepts have been developed and tested since. Activities in this field were encouraged by the oil crisis in 1973. Twenty years ago the concept of the Riisager wind turbine (22 kW) initiated a new area. The concept was similar to the innovative Gedser wind turbine, but it was built using inexpensive standard components, e.g. spare parts from cars. It became a success with many private households and it was the kick-off for the Danish wind generator industry.

During the last two decades, the production of wind turbines has grown in size from 20 kW to 2 MW. Many different concepts have been developed and tested. Those, which have been successful, are more or less descendants of the Gedser wind turbine concept. One modification is variable pitch blades. The pitch control concept has been applied during the last fourteen years. Recently, the active stall concept has been utilised. Another modification is in the electric field, where alternative concepts have been introduced. Since 1993, a few manufacturers have replaced the "traditional" asynchronous generator in their wind turbine design by a synchronous generator, while other manufacturers have introduced the asynchronous generator with wound rotor. Electrical developments include the use of advanced power electronics in the wind generator system design, introducing a new control concept, namely variable speed.

Due to the rapid development of power electronics, offering both higher power handling capability and lower price/kW, see e.g. (Thøgersen & Blaabjerg, 2000), the application of power electronics in wind turbines will increase further. Another interesting issue is the efforts, which have been put into research and development of new motor/generator concepts for some years. A comparison of 7 new concepts is presented in (Dubois et al., 2000). Thus, it is evident that the development departments of the wind turbine manufacturers are active analysing and evaluating potential new wind turbine concepts.

The scope of this section is to describe the "state of the art" of wind turbines seen from an electrical point of view, using two approaches. The first approach describes the state of art from a technical point of view, while the second applies a market-based point of view. The following chapters will look deeper into old and new concepts of generators and power electronics.

1.2.1 Concepts and wind turbine configurations

The generator and power electronic configurations most commonly applied in wind turbines are displayed in Figure 2.

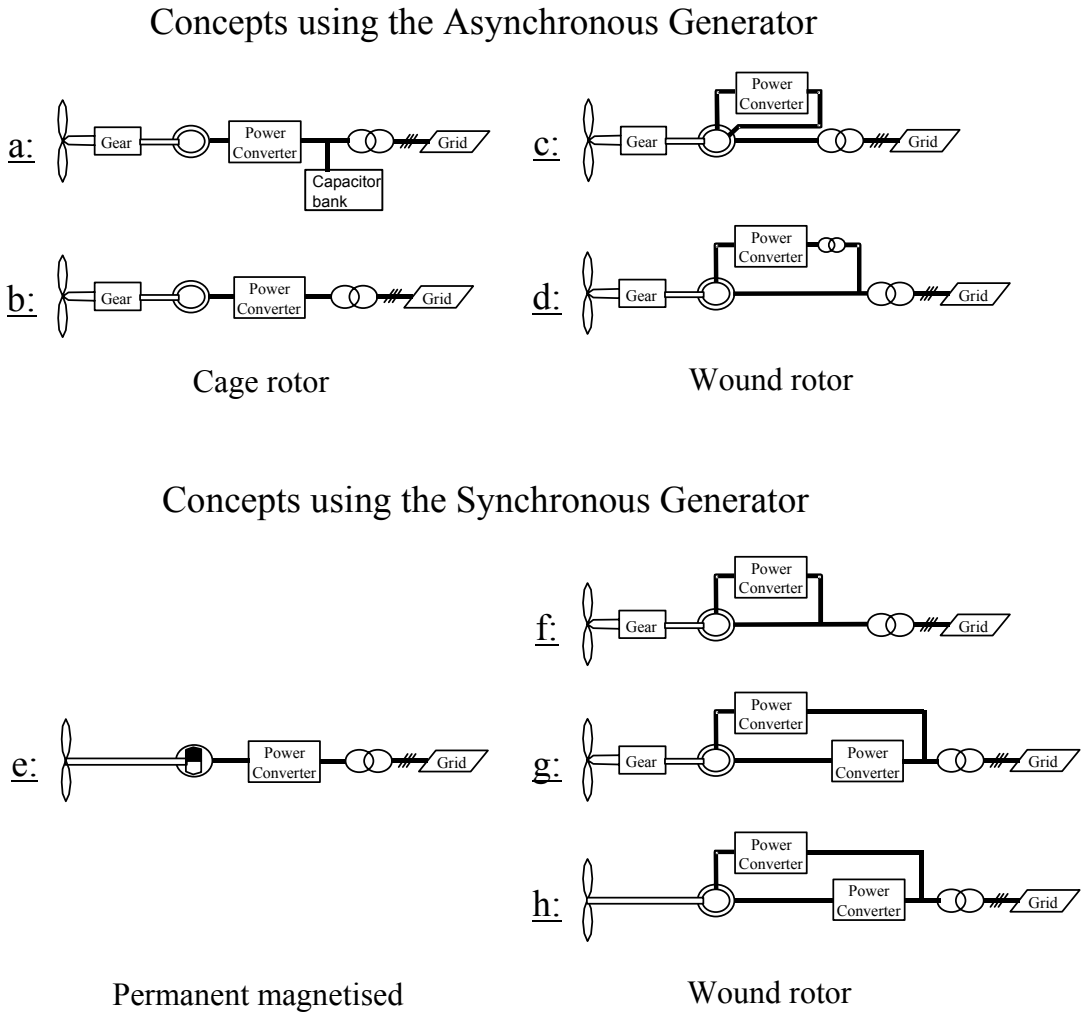


Figure 2. Standard wind turbine configurations using the asynchronous generator (AG) and the synchronous generator (SG). Depending on the particular configuration, the term Power Converter covers different types of power electronic components such as: a soft starter (part a), an external variable rotor resistance (part c), a rectifier (part e – stator connected or part f, g, h – rotor connected) and a frequency converter (part b, d, e, g and h).

The configurations depicted in Figure 2 present an outline of typical electrical topologies used in wind turbines. As listed in Table 1, these seven configurations cover a wide range of the applied power control concepts for wind turbines.

General comments on configurations in Figure 2:

a) This is the "conventional" concept applied by many Danish wind turbine manufacturers during the 1980's and 1990's, i.e. an upwind, stall regulated, three bladed wind turbine concept using an induction generator (cage rotor). During the 1980's this concept was extended with a capacitor bank (for reactive power compensation) and a soft-starter (for smoother grid connection).

Table 1 . The generally applied control concepts for wind turbines (refer to Figure 2*).*

Con-fig.	Power Converter	Multipole or gearbox	Power control features	Comments
A	Soft starter	Gearbox	Stall or active stall	One or two speed machine
B	Frequency converter	Gearbox	Stall or active stall	Variable speed
C	PE converter or passive components	Gearbox	Pitch	Limited variable speed
D	Frequency converter	Gearbox	Pitch	Variable speed (doubly fed generator)
E	Frequency converter	Multipole	Stall, active stall or pitch	Variable speed
F	Rectifier	Gearbox	Stall or pitch	Variable speed
G	Rectifier and frequency converter	Gearbox	Pitch	Variable speed with gearbox
H	Rectifier and frequency converter	Multipole	Pitch	Variable speed without gearbox

b) In this configuration, the capacitor bank and soft-starter are replaced by either a full scale frequency converter or a "low wind" region sized frequency converter – used e.g. by Wind World - where the frequency converter is bypassed (implying fixed speed) and used only for reactive power compensation when the wind speed exceeds the design wind speed. This concept uses a smaller frequency converter (20-30% of nominal generator power) compared to the full-scale concept (approximately 120% of nominal generator power). On the other hand the full-scale concept enables variable speed operation at all wind speeds.

c) This configuration employs a wound rotor and it has been used by Vestas since the mid 1990's – known as OptiSlip. The basic idea of this concept is to control the total rotor resistance using a variable external rotor resistance by means of a power electronic (PE) converter. With the power electronic converter mounted on the rotor shaft, it is possible to control the slip (by controlling the external rotor resistance) over a 10% range. Control of the slip implies control of the power output in the system. (Wallace & Oliver, 1998) describes an alternative concept using passive coponents instead of a PE converter, which also achieves a range of 10% slip variation. However, this concept does not support controllable slip.

d) An other configuration in wind turbines employs a doubly fed induction generator. A frequency converter directly controls the currents in the rotor windings. This enables control of the whole generator output, using a PE converter, rated at 20-30% of nominal generator power. Introduction of this concept is mainly motivated by two reasons: 1) variable speed in a wide speed range compared to the OptiSlip concept and 2) less expensive compared to the full power control concept.

e) A typical application of the full power control configuration is as a power source on sailing boats. A gearless two or three bladed upwind wind turbine using a PMG (typically less than 1kW) is used to charge a battery energy

storage through a rectifier. This configuration is also applied in wind turbines for home wind systems and hybrid systems, i.e. wind turbines larger than 1kW and smaller than approximately 20kW. A future concept – the Windformer – using this configuration has been suggested in year 2000 by ABB, with the following specifications: multipole 3.5MW PMG which together with a diode-rectifier produces 21kV DC. It is proposed to combine this configuration with a HVDC-light based grid.

f) This configuration is not widely used in wind turbines. It is externally excited as shown in the figure using a rectifier (the "Power Converter"). The low utilisation compared to the previous configuration could be due to three reasons: 1) the need for an exciter circuit, 2) the need for slip rings and 3) a more complex wind turbine safely strategy; which makes this configuration less attractive. Note that also internally excited configurations exist.
g) Neither this configuration is widely used in wind turbines. Compared to the previous configuration, this one supports variable speed, if the grid power converter is a four-quadrant frequency converter.
h) In this configuration a multipole wound SG is used. In principle, it is the same as the previous configuration, but due to the multipole generator no gearbox is needed. The wind turbine companies Enercon and Lagerwey are examples of manufacturers using this configuration.

Configuration "a" is the only commonly applied control concept, which does not support variable speed operation. Excluding this configuration for a while, a road map for conversion of mechanical energy into electrical energy may be drawn, as presented in Figure 3. The focus in this figure is the applied generator concept used in the conversion of a mechanical torque input at variable speed to an electrical power output at fixed frequency. Thus, except for configuration "a", the other configurations in Figure 2 (alias Table 1) are classified in the road map.

As it may be observed in Figure 3, the doubly-fed induction generator has two possible implementations, where 1) the rotor is connected to the grid through a small frequency converter or 2) the rotor is connected to an external power conversion unit (PE converter or passive components). The energy coming from the external power conversion unit is dissipated as heat loss – e.g. as in the case of the OptiSlip concept of Vestas. In the last case no slip rings are necessary.

The term "Novel Machines" in Figure 3, is used here to cover e.g. the reluctance machine, the Windformer (from ABB) etc. In the case of the Windformer, the "Large PE converter" is a simple diode bridge and the grid is a HVDC-grid (refer to comments on configuration "e", Figure 2).

Until now, the main focus has been on generators and generator concepts, while power electronics mostly has been referred to by the general terms "Power Converter" or "PE converter", which in this context covers devices like soft starters (and capacitor banks), rectifiers, inverters and frequency converters. Quite a variety of different design philosophies exist, both for rectifiers, inverters and frequency converters. A short introduction is presented below, while a more detailed description is presented in Section 3. A thorough introduction to this subject may be found in (Novotny & Lipo, 1996).

The basic elements for these converters are diodes and electronic switches such as: thyristors, GTO's (gate turn off thyristor), IGCT's (Integrated Gate Commutated Thyristors), BJT's (bipolar junction transistor), MOSFET's (metal oxide semiconductor field effect transistor) or IGBT's (insulated gate bipolar transis-

tor). A comparison of characteristics and ratings for five of these switches is presented in Table 2.

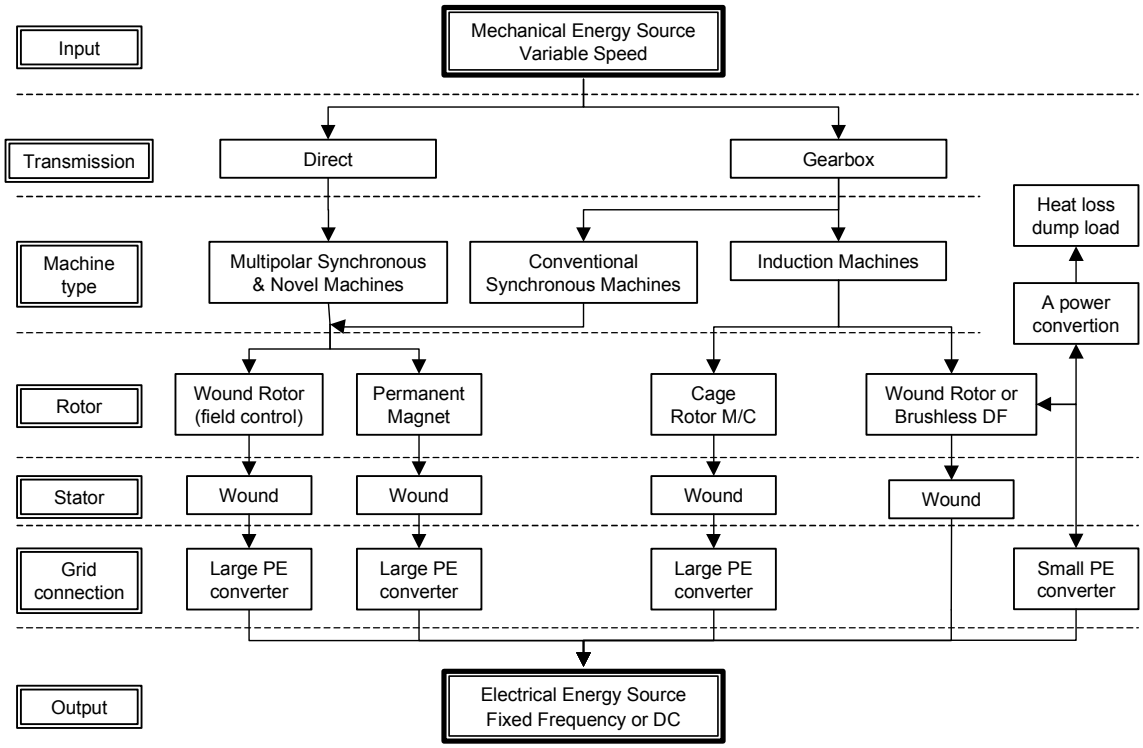


Figure 3. Road map: Conversion process of Mechanical Energy to Electrical Energy using power electronic converter (inspiried by (Wallace & Oliver, 1998)).

Table 2. Maximum ratings and characteristics. Source (Heier, 1998).

Switch type	**GTO**	**IGCT**	**BJT**	**MOSFET**	**IGBT**
Voltage (V)	6000	4500	1200	1000	3300
Current (A)	4000	2000	800	28	2000
Switched-off time (μs)	10-25	2-5	15-25	0.3-0.5	1-4
Pulse bandwidth (kHz)	0.2-1	1-3	0.5-5	5-100	2-20
Drive requirements	High	Low	Medium	Low	Low

In Table 2, voltage, current and output power are maximum ratings. The switch-off time is related to the circuit-commutated recovery time, while the pulse bandwidth defines the operational frequency range.

A traditional AC frequency converter (also called a drive), as seen from the grid, consists of: a rectifier (AC to DC unit), an energy storage, and an inverter (DC to AC with controllable frequency). Talking about motor drives the terms "semiconverter" and "full converter" are used to classify the type of drive. A semiconverter has single quadrant operation (only positive voltage and current rms-values), which utilises motor operation (or acceleration) in the forward direction. A full converter offers two-quadrant operation (i.e. positive/negative voltage and positive current rms-values), which utilises both motor operation in two directions and electrical braking. Since generators feed power back to the grid, it is necessary to use a "dual converter". A full dual converter offers four quadrant operation (i.e. positive/negative voltage and current rms-values), which utilises both motor and generator operation.

Inverters for variable speed operation, may in general be classified in two basic groups: VSI (voltage source inverter) or CSI (current source inverter) and CSC (current source converter). While the VSI creates a relatively well-defined, switched voltage waveform at the terminals of the electrical machine, the CSC produces a switched current waveform. In the case of a VSI, the voltage in the energy storage (the DC bus) is maintained stiff by a large capacitor or a DC source e.g. a battery (voltage source inverter) – while the resulting current is primarily formed by load and speed. In a CSC the opposite is the case, the current in the energy storage (the DC bus) is maintained stiff using a large inductor – while the resulting voltage is primarily formed by load and speed. Thus, VSI and CSI are dual. This duality is further investigated in (Novotny & Lipo, 1996). A diagram of the basic inverter concepts is shown in Figure 4. It must be stressed, that VSI and CSI are quite different concepts.

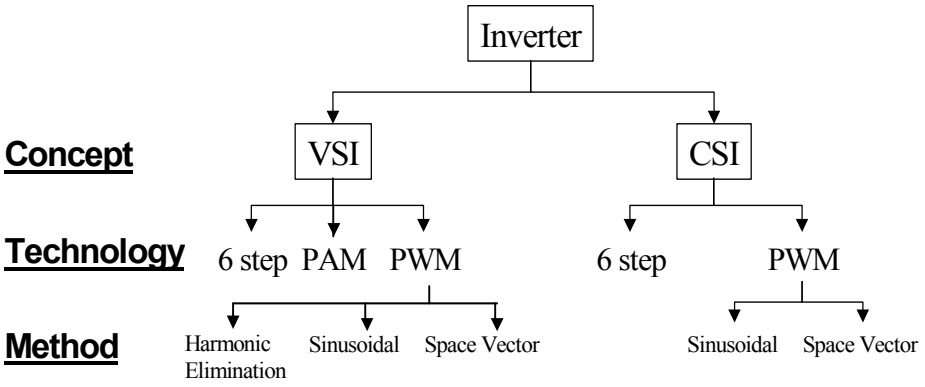


Figure 4. Diagram of basic inverter concepts for adjustable speed in wind turbines.

As indicated in Figure 4, the concepts of VSI and CSI may both be implemented in several ways, e.g. as: 1) six step inverter, 2) pulse amplitude modulated or 3) pulse width modulated inverter. Moreover, the implementation of a PWM inverter for a VSI e.g. may be realised by tree methods: 1) harmonic elimination 2) a "sinusoidal" PWM converter, or 3) a space vector strategy converter. The basic operation of these technologies is described further in Section 3.

A number of different strategies exist to combine a rectifier and an inverter to form a frequency converter. Table 3 serves as a short introduction to five drive topologies applicable for adjustable speed in a wind turbine.

Table 3. Comparison of five AC drives for adjustable speed.

Converter type	**Concept**	**Technology**	**Applicable configuration** (Figure 2)	**Comments**
Back to back	VSI	PWM	b,d,e,f,g and h	Mature technology
Tandem	CSC+VSI	6-step+PWM	b,d,e,g and h	Unproven technology
Matrix	VSI	PWM	b,d,e,f,g and h	Unproven technology
Multilevel	VSI	PWM	b,d,e,f,g and h	Mature technology
Resonant	VSI	PWM	b,c,d,e,f,g,h	Unproven technology

After this brief outline on generator and power electronics it would be appropriate to make a few comments on the grid performance of the various configurations of Figure 2. The performance depends of course on the applied frequency converter technology. In Table 4, some grid performance issues are presented for each configuration.

Table 4. Comments on grid performance of the various configurations in Figure 2 *using 1) a thyristor or 2) a pulse width based frequency converter.*

Con fig.	Voltage control	Reactive power control	Grid demand
a	No	No, reactive power consumer with step-wise compensation	Stiff
b	1) Yes 2) Yes	1) No, reactive power consumer 2) Yes, constant cos(φ) or constant reactive power	1) Stiff 2) Stiff or weak
c	2) Yes	2) Constant cos(φ) or constant reactive power could be made possible	2) Stiff or weak
d	1) Yes 2) Yes	1) No, reactive power consumer 2) Yes, constant cos(φ) or constant reactive power	1) Stiff or weak 2) Stiff or weak
e	1) Yes 2) Yes	1) No, reactive power consumer 2) Yes, constant cos(φ) or constant reactive power	1) Stiff 2) Stiff or weak
f	No	Yes, e.g. constant cos(φ) or constant reactive power	Stiff
g	1) Yes 2) Yes	1) No, reactive power consumer 2) Yes, constant cos(φ) or constant reactive power	1) Stiff 2) Stiff or weak
h	1) Yes 2) Yes	1) No, reactive power consumer 2) Yes, constant cos(φ) or constant reactive power	1) Stiff 2) Stiff or weak

1.2.2 Market aspects

One way of describing the "state of the art" of frequency converters applied to wind turbines is to survey the supply rates of the manufacturers – as presented in Table 5 – and then map the applied concept of each manufacturer with respect to Figure 2 and Table 1. Table 5 ranks the top 10 suppliers (BTM Consults Aps, 2000) with respect to sold MW of converters in 1999.

Table 5. The top-10 list of suppliers in 1999. Source (BTM Consults Aps, 2000).

Top 10 list suppliers	Sold MW 1999	Share in %	Accu. MW 1999	Share in %
1. NEG Micon	761	18.9	3034	21.0
2. Vestas	652	16.2	2530	17.5
3. Gamesa	494	12.3	853	5.9
4. Enercon	488	12.1	1553	10.7
5. Enron (Zond/Tacke)	360	8.9	1153	8.0
6. Bonus	338	8.4	1197	8.3
7. Nordex	306	7.6	638	4.4
8. Made	218	5.4	450	3.1
9. Ecotecnia	59	1.5	136	0.9
10. Dewind	58	1.4	86	0.6
Others	298	7.4	2839	19.6
Total	**4032**	**100**	**14469**	**100**

The applied concept of each manufacturer listed in Table 5 has been evaluated using publicly available data obtained from the Internet. The result is presented in Table 6, where the two largest wind turbines of each top-10 manufacturer have been assessed by their configuration and control concept. As it may be observed from Table 6, there is a trend towards the configuration using a doubly fed, asynchronous generator with variable speed control, combined with variable pitch control. Of the top-10 suppliers, only NEG Micon and Bonus are still using configuration "a" in Figure 2 – the conventional solution – updated with active stall control. All the machines presented in Table 6 are 3 bladed, upwind wind turbines.

Table 6. Applied concept of each manufacturer based on information found on the internet August 8th 2000 concerning the two biggest (alias newest) wind turbines from each manufacture.

Manufacture (top 10 supp.)	**Wind turbine**	**Conf.** Figure 2	**Power control features**	**Comments**
NEG Micon	NM 2000/72	a	Active stall	Two speed
	NM 1500C/64	a	Stall	Two speed
Vestas	V80 – 2 MW	d	Pitch and variable speed	Range: 905 rpm. to 1915 rpm.
	V66 – 1.65 MW	c	Pitch and OptiSlip	Range: 1500 rpm. to 1650 rpm.
Gamesa	G52 – 850 kW	d	Pitch and variable speed	Range: 900 rpm. to 1650 rpm.
	G47 – 660 kW	d	Pitch and variable speed	Range: 1200 rpm. to 1626 rpm.
Enercon	E-66 – 1.8 MW	h	Pitch and variable speed	Gearless. Range: 10 rpm. to 22 rpm.
	E-58 – 1 MW	h	Pitch and variable speed	Gearless. Range: 10 rpm. to 24 rpm.
Enron Wind	1.5s – 1.5 MW	d	Pitch and variable speed	Range: 989 rpm. to 1798 rpm.
	900s – 900 kW	d	Pitch and variable speed	Range: 1000 rpm. to 2000 rpm.
Bonus	2 MW	a	Active stall	Two speed
	1.3 MW	a	Active stall	Two speed
Nordex	N80/2500 kW	d	Pitch and variable speed	Range: 700 rpm. to 1303 rpm.
	N60/1300 kW	a	Stall	Two speed
Made	No technical information was available on the internet			
Ecotecnia	No technical information was available on the internet			
Dewind	D4 – 600 kW	d	Pitch and variable speed	Range: 680 rpm. to 1327 rpm.
	D6 – 1.25 MW	d	Pitch and variable speed	Range: 700 rpm. to 1350 rpm.

The manufacturers applying configuration "d" and "h" all use IGBT based converters. Moreover, manufacturers of configuration "d" use 4 or 6 pole, doubly fed machines.

1 The technical information supplied by some manufactures was in some cases quite limited, which implies that caution should be exercised on some of the indicated configurations.

To obtain an overview of the wind turbine prices, the sales departments of the manufacturers listed in Table 6 were contacted to ascertain the standard price for one machine, on the Danish market (if possible), or alternatively the price on the German market. The result is presented in Table 7. It should be noted that these prices may not be absolutely comparable, since no standard exists on what is to be included in the wind turbine price. E.g. on the German market the step-up transformer is included, while in general it is not on the Danish market. Moreover, service contracts and other optional items may or may not be included. In this connection the price formation on these markets are also different. Nevertheless, the listed prices generally include the wind turbine price (with tubular tower) and installation and start-up costs. Foundation costs are excluded. The hub height is also an optional parameter, which has been selected here to be as close to the rotor diameter as possible.

Table 7. Nominal power, typical rotor diameter, typical hub height and wind turbine prices on the Danish market. The wind turbine price also includes installation and start-up and excludes foundation costs. Data were supplied by the sales departments of the manufacturers.(Year 2000)

Manufacture (top 10 supp.)	Wind turbine	Power kW	Rotor diameter	Hub height meters	Wind turbine price DDK
NEG Micon	NM 2000/72	2000	72	68	12.800.000
	NM 1500C/64	1500	64	60	8.500.000
Vestas	V80	2000	80	78	13.500.000
	V66	1650	66	67	10.000.000
Gamesa	G52	850	52	40-65	No info
	G47	660	47	40-55	No info
Enercon	E-66	1800	70	65	3.120.000*) DM
	E-58	1000	58	70	Not generally available
Enron Wind	1.5s	1500	70.5	80	2.770.000*) DM
	900s	900	55	60	Not yet for sale
Bonus	2 MW	2000	76	70	Not yet for sale
	1.3 MW	1300	62	60	6.800.000
Nordex	N80/2500	2500	80	80	3.750.000*) DM
	N60/1300	1300	60	60	6.600.000
Made	No information was available				
Ecotecnia	No information was available				
Dewind	D6	1250	62	56-91.5	No info
	D4	600	48	40-70	No info

*) This price is valid on the German market.

1.2.3 Trends in wind turbine design

Based on the previous subsection the present "state of the art" large wind turbine may be summarised as a 3-bladed upwind turbine (with tubular tower) using:

- Active stall with a two speed asynchronous generator or
- pitch control combined with variable speed. Moreover, the variable speed concept is mainly realised using configuration "d", i.e. a doubly-fed induction generator with a rotor connected IGBT based frequency converter.
- Only one of the top-10 manufacturers offers a gearless (variable speed) wind turbine.

Meanwhile, it should be mentioned that a number of alternative wind turbine designs exist. Lagerwey uses configuration “h”, but with a 6-phase synchronous generator. Nordic Windpower promotes configuration “a” in a two bladed upwind version. Vergnet also uses configuration “a”, but in a two bladed upwind or downwind version. Scanwind has started to construct a wind turbine using configuration “e” based on the Windformer and a DC grid.

The trend in wind turbine prices is illustrated in Figure 5 and Figure 6, based on the data presented in Table 7. The specific wind turbine price on the Danish market has decreased from 12.000 DKK/kW for 20-30 kW machines down below 6.000 DKK/kW for 450-600 kW machines as reported e.g. in (Hansen & Andersen, 1999). Meanwhile, the Megawatt machines have an increasing specific price as it may be observed in Figure 5. This fact is partly explained by the development in offshore wind turbines, which are generally Megawatt turbines. It seems to be the technical performance, measured as the swept rotor area per nominal power, or the yearly energy production per unit swept rotor area, that is the optimising criterion – rather than the economic performance, measured as the cost per nominal power, or the cost per yearly energy unit production.

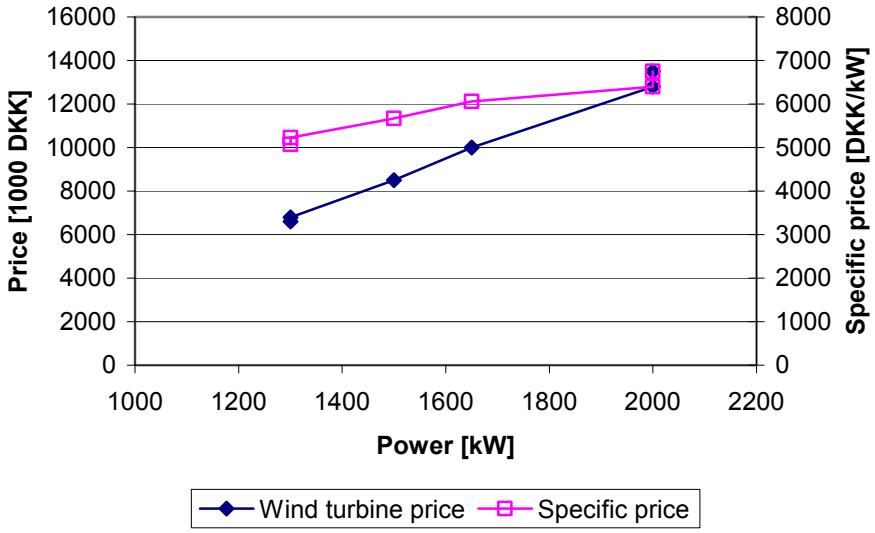


Figure 5. The trend on the Danish market in respect to wind turbine price and specific price (DKK/kW) as a function of wind turbine size.

On the German market, the specific wind turbine price from these limited data is continuously decreasing as shown in Figure 6.

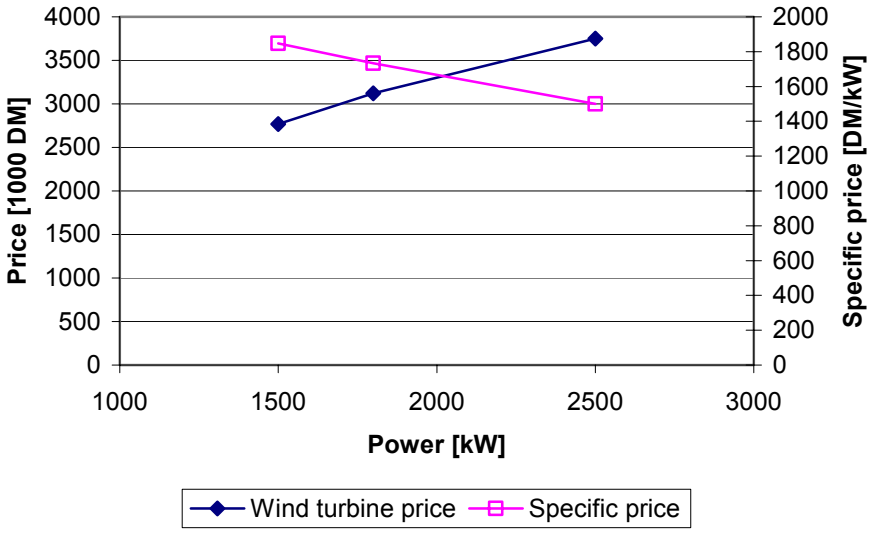


Figure 6. The trend on the German market in respect to wind turbine price and specific price (DKK/kW) as a function of wind turbine size.

The outline of this report is:

Chapter 2 will discuss different generator types, both the standard generators but also new generators, which may be a future solution.

Chapter 3 treats different power electronic concepts, which are possible for controlling the variable speed. It also includes a comparison of some topologies as well as it discusses some wind farm solutions.

In Chapter 4 the grid integration issues are discussed which include discussion of disturbances and standardized grids.

Finally, a summary of the report is done including a list of important research topologies in the area of electrical design and control of wind turbines.

2 Generic Generator Types

Several generic types of generator are possible candidates in wind turbines. Historically, the squirrel cage, induction generator has been frequently applied commercially. A second popular type is the induction generator with wound rotor, while a third is the current excited, synchronous generator. These types have been synchronised directly to the grid, providing a constant speed solution. This confines the choice of generator to a very few types, which exhibit inherently flexible behaviour, notably the induction machines, or where there is an established technology for control, for example, the separately excited synchronous generator.

The generator provides a means of energy conversion between the mechanical torque from the wind rotor turbine, as prime mover, and an electrical load. In this study, the electrical load is confined to the public utility supply grid system. Island operation is not considered, although islanding may be discussed in certain circumstances, e.g. during start-up.

Mechanical connection to the turbine rotor is through the main shaft. The connection may be by direct drive, or using a gearbox. The use of a gearbox allows matching of the generator speed to that of the turbine. This allows some optimisation of generator characteristics, but a disadvantage of the gearbox is that as a mechanical component it is subjected to wear and tear and in some cases has been relatively unreliable.

The ready availability of high power semiconductors for frequency converters has increased the interest in direct coupled, variable speed turbines and generators. The electrical converter thus acts as an electrical gearbox. This system is more flexible than the mechanical gearbox, and the converter may be mounted either in the nacelle, the tower, or elsewhere. Also new option and constraints for generator design are made available by the application of the semiconductor converter, as are new methods for control and protection.

The number of possible options is large. The selection of a final design thus becomes a very complicated process. The objective of this chapter is to illustrate the characteristics of some of the available candidate, generic generator types.

2.1 Criteria for Assessment of Generator Types

Criteria such as weight of active materials, operational characteristics, applicable type of semiconductor power converter, protection considerations, service and maintenance aspects, environmental considerations, and list price are all relevant for the assessment. It may however be difficult to derive some of this information from public literature, and other methods may have to be taken into use.

2.2 The Asynchronous Machine (Induction Machine)

Induction machines may generally be set in two categories, those with squirrel cage, and those with wound rotor. Both categories were considered, as each has some special features to offer. The search term ‘Induction Generator’ produced

an immediate list of some 303 articles, and standards dating from 1990 and later. This was reduced to 133, by rejecting the majority of articles concerning island operation, and studies of the power electronics converter, and control system. The list of 133 is included in the references. Some 15 representative articles have been studied for inclusion in this report.

Induction machines have been proposed as generators in many research articles and are currently the predominant commercial wind turbine generator. Advantages include the asynchronous operation, which allows some flexibility when the wind speed is fluctuating. A major disadvantage is the need for excitation of the magnetic field via the supply terminals. Other applications are also considered in the literature, e.g. Hydroelectric Power Plants (Shibata & Taka, 1990), energy recovery scheme (McQuin, 1989), large steam turbine generator (McQuin, 1989; Hammons et al., 1996; Jiang et al., 1998). An overall description of the function of the Induction Generator is provided in e.g. (Pham, 1991).

2.2.1 Squirrel Cage Induction Generator

The Squirrel Cage Induction Generator (SCIG) is a very popular machine due to its mechanical simplicity and robust construction. The stator winding is connected to the load/excitation source, and is insulated. The rotor is provided with an uninsulated winding, which is very resistant to the effects of possible dirt ingress, and vibration. Maintenance is generally restricted to bearing lubrication only. A major problem is the necessity of obtaining the excitation current from the stator terminals (Shibata & Taka, 1990).

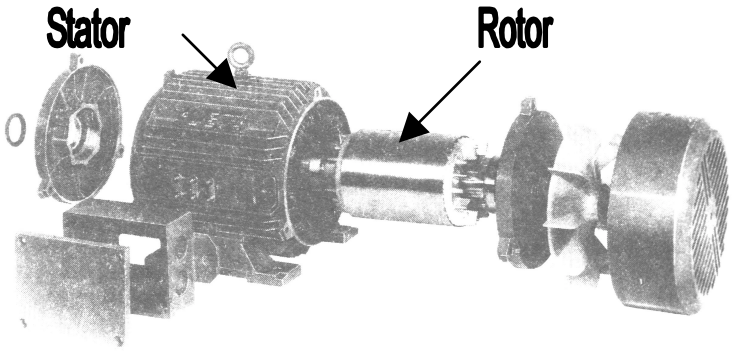


Figure 7. Exploded view of a Squirrel Cage Induction Machine.

Large machines are reported (16 MW (McQuin, 1989)) (several hundred MW (Hammons et al., 1996)). Applying a self-excited start, followed by a fully excited synchronisation, while generation is ensured (McQuin, 1989; Hammons et al., 1996; Jiang et al., 1998), may alleviate voltage dips during start-up. Shaft torques produced under fault conditions, are sometimes very high (Hammons et al., 1996).

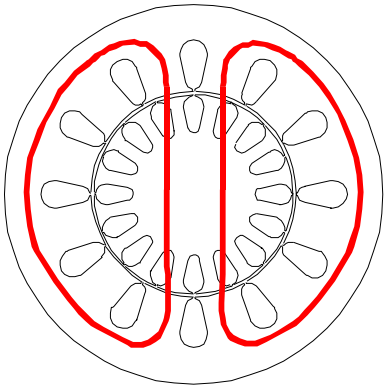


Figure 8. Cross section of a 2-pole squirrel cage induction machine showing main flux path.

Methods of control include full power frequency inverter, fixed capacitor, thyristor and static VAR controller (Abdin & Xu, 1998).

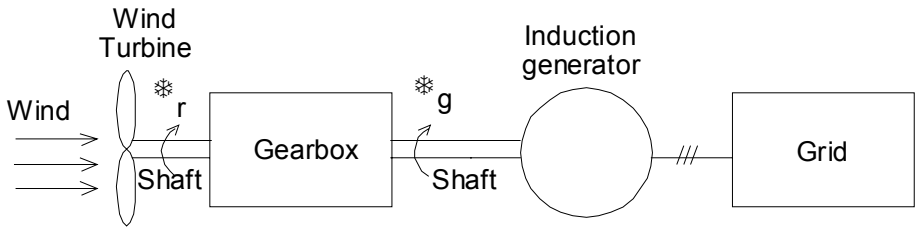


Figure 9. Diagram showing an uncontrolled, grid connected, Squirrel Cage Induction Generator, as a Wind turbine Generator.

At power frequencies, the SCIG is inherently stable, but when connected to a weak grid with an unbalanced, three-phase load, overheating and torque pulsations may occur in the SCIG (Muljadi et al., 1999).

2.2.2 Wound rotor Induction Generator

It has been found useful to apply the wound rotor Induction Machine as a Wind Power Generator. In this case, the rotor is provided with a three-phase insulated winding very similar to that of the stator. The rotating winding may be connected to the stationary supply circuits via a set of slip rings and brushes. This is the traditional manner. An alternative is to use a power electronic converter, which may or may not require slip rings.

The output of the generator may now be controlled, by controlling only the rotor losses. This is very convenient, as the alternative is to control the whole armature power on the stator. With the advent of power electronics it is possible to recover slip energy from the rotor circuit, and add this to the output of the stator. Vestas Wind Systems have made extensive use of this in their 'OptiSlip' system.

Although the inclusion of a wound rotor affords the advantage described above, the wound rotor is inevitably more expensive than a squirrel-cage rotor. The

insulated winding on the rotor may be subject to stresses arising from the rotation and vibration, which may reduce the lifetime of the generator.

2.2.3 Principle of Operation

The Induction Generator is provided with two windings, one on the stator, and one on the rotor. The stator winding of the induction motor has two functions. It provides the excitation or magnetisation, and carries the armature or generated current. The rotor winding carries the armature current only. When AC excitation is present, the magnetic field created rotates at a speed determined jointly by the number of poles in the winding and the frequency of the current, the synchronous speed.

If the rotor rotates at a speed other than the synchronous speed, voltage is generated in the rotor winding at a frequency corresponding to the difference in the two frequencies, known as the slip frequency. This voltage drives the armature current, and provided the rotor speed is faster than the synchronous speed, the machine acts as a generator. The function is thus asynchronous.

2.2.4 Methods of Analysis

The magnetic circuit may be analysed using analytic methods, which are heavily dependent on the availability of test results for machines with the same internal geometry. A more modern method, which has become viable due to the increase in speed of computing, is the Finite Element Method, which may be used to predict the performance of magnetic circuits of which one has no previous experience.

Having solved the magnetic circuit, the machine performance is most conveniently predicted using electric circuit techniques.

For many purposes, the steady state equivalent circuit is adequate for analysis. In other cases, it is necessary to use dynamic simulation of the differential equations (Li & Ching, 1997). Some authors use a version of the step by step method used for analysis of synchronous machines (Hammons et al., 1996), or symmetrical component analysis (Jiang et al., 1998) to simulate dynamic conditions.

Losses are important to know, as they determine the self-heating, hence the machine lifetime, and the energy conversion efficiency. Generally, losses are determined from the steady state equivalent circuit model, or from the loss models.

2.2.5 Operational Characteristics – Normal Duty

In normal duty and directly connected to a stiff AC grid, the Induction Generator is very robust and stable. The slip varies, increasing with increasing load. The major problem is that, due to the magnetising current supplied from the grid to the stator winding, the full load power factor is relatively low. This is to be compared with the fact that most power distribution utilities penalise industrial loads with low power factors. Clearly generation at low power factor cannot be allowed either. When the power factor is too low, connecting capacitors in parallel with the generator may be used to compensate it.

Operating in this manner, the Induction Generator is uncontrolled. Any fluctuations in shaft power are passed on to the net, modified only by the internal im-

pedance of the generator itself. This is to say that the damping is negligible. This is also a situation, which is difficult for the distribution utility to accept.

Some manufacturers seek to improve this situation by adding means of control. Modern power electronics converters have made this technically easier. One solution is to provide an insulated winding on the rotor, controlled by a power electronics converter. In this way, the power handled by the converter is restricted to the rotor power, in some cases the slip power only.

Another solution is to insert a power converter in series with the armature circuit. In this way, full control is obtained over the IG performance, by employing the somewhat cheaper SCIG, but at the cost of a converter capable of handling the full power of the generator.

Both the above controller solutions function well, smoothing the power supplied to the grid. Additional benefits may also be gained in special situations, such as start-up.

2.2.6 Operational Characteristics – Fault Conditions

Should external fault conditions occur, the fault current is reported to be sufficient to trip relays and operate protective relays.

Internal faults are more difficult to determine and isolate. Traditionally, they have been detected by excessive temperature being measured by embedded temperature detectors, or excessive vibrations being measured by accelerometers fitted at strategic positions. These methods detect only faults requiring immediate attention. It would be advantageous to be able to detect incipient faults, to enable maintenance to be planned on the basis of predicted actual necessity rather than predicted estimated necessity.

New methods are being researched and developed, enabled by the improvements to electronics, computing and signal processing techniques, where incipient faults may be detected and identified. The progress of these faults may be charted, and automatic predictions made regarding the seriousness of the fault, and the time remaining until maintenance attention becomes necessary. Such monitoring methods are studied by Aalborg University, Institute of Energy Technology, and Risø's Wind Energy Department, partly funded by the Danish Energy Agency.

2.2.7 Axial Flux Induction Machines

Because of the large numbers of slots on both the stator and the rotor, and the small air-gap, it has not been found practical to propose an axial air-gap induction generator.

2.2.8 Efficiency of Induction Generators as a Function of Load and Speed

The efficiency surface of a typical small induction motor is shown in Figure 10. Efficiency is shown plotted as a function of shaft speed and torque load. This motor was controlled to operate at the maximum efficiency for each working point tested. Scrutiny of this surface reveals that the efficiency may be controlled to give a reasonably flat plateau at a high efficiency for medium to high speeds, and over a wide torque range. However, when the speed drops below a critical level, it becomes impossible to obtain an acceptable efficiency.

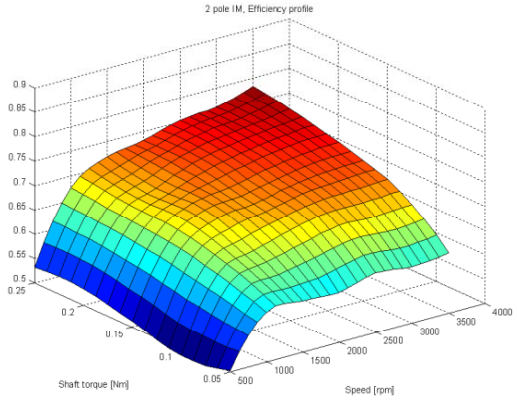


Figure 10. Tested efficiency surface of Induction Motor, controlled to operate at maximum possible efficiency for each working point.

The above figures were obtained by testing a small induction motor. It may be expected that a similar development of the efficiency would apply for a large induction generator, although in this case, the efficiency values would be higher

2.2.9 Well-Established or New Technology

The induction machine is a well-established technology, as is its application as a wind generator, using a gear drive to a generator with a low number of poles.

2.2.10 Gear or Direct Drive Multi-pole

In general, because of the small air-gap, the Induction Machine leakage flux increases to an unacceptable limit for machines with many poles. This causes the difficulty that the machine cannot use the current flowing to generate torque, but only leakage flux. Induction Machines with a large number of poles must be large enough to accommodate a sufficient number of slots per pole per phase, in order to prevent this situation from taking the upper hand. This means that induction machines with many poles will inevitably be oversized in relation to the rated output.

2.3 The Permanent Magnet Generator

Figure 11 shows the cross-section of a typical Permanent Magnet Generator (PMG). The PMG differs from the Induction Generator in that the magnetisation is provided by a Permanent Magnet Pole System on the rotor, instead of taking excitation current from the armature winding terminals, as it is the case with the Induction Generator. This means that the mode of operation is synchronous, as opposed to asynchronous. That is to say, in the PMG, the output frequency bears a fixed relationship to the shaft speed, whereas in the mains connected IG, the frequency is closely related to the network frequency, being related by the slip. These differences will be discussed at length. However, it must be recognised at the outset that the differences have a significant effect on the operating characteristics and performance of the two generator types.

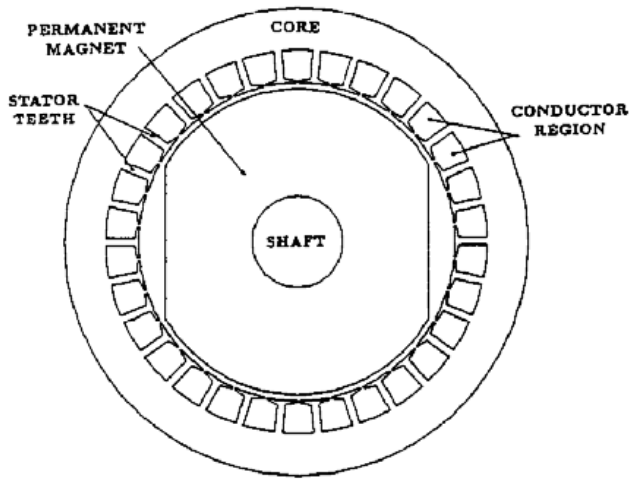


Figure 11. Cross-section of typical conventional Permanent Magnet Generator.

Permanent magnet machines may be set in several categories, those with surface mounted magnets, those with buried magnets, those with damper windings, etc., etc. All categories where data was found were considered, as each has some special features to offer. The search term 'Permanent Magnet Generator' produced an immediate list of some 50 articles, and standards dating from 1990 and later. In view of the small number of articles found, this was not reduced in any way, see Appendix A.2. Some 21 representative articles have actually been studied for this report. Other articles and references found have been included if they came to the notice of the author. This means that some significant articles may have been omitted from consideration. References [8, 9] in Appendix A.2 were ignored, as it concerned a high-speed, 400Hz generator, and cyclo converter. This combination was found interesting, but irrelevant to the case under consideration.

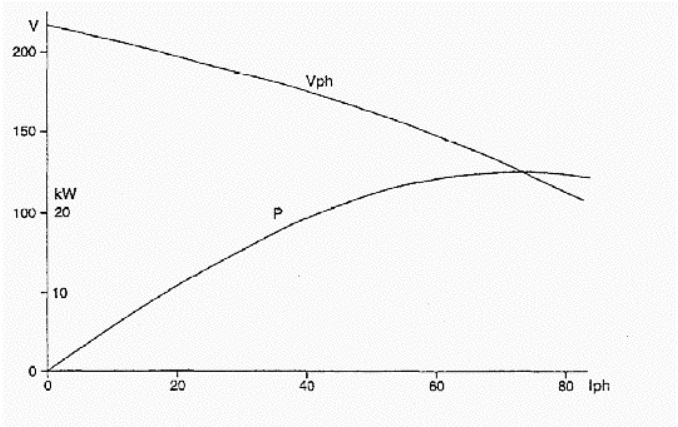


Figure 12. Voltage regulation of 12 pole, outer stator PMG with surface mounted magnets (Mitcham & Grum, 1998).

The PMG has been proposed as wind turbine generator in several research articles. Advantages include self-excitation, which allows operation at high power factor and efficiency. A disadvantage may be the synchronous operation, which causes a very stiff performance in the case of external short circuits, and when the wind speed is unsteady. This may lead to instabilities. Other applications are

also considered in the literature, e.g. animal driven generators (Van Niekerk & Hancke, 1999). An overall description of the function of the PMG was not found in the literature search.

2.3.1 Permanent Magnet Generator

The PMG is proposed as a wind turbine generator due to its property of self-excitation. The stator winding is connected to the load, and is insulated. The rotor is provided with a permanent magnet pole system, which is resistant to the effects of possible dirt ingress. However, the permanent magnets will attract ferromagnetic swarf. They also call for special care when assembling, to avoid damage and accidents to personnel. Maintenance is generally restricted to bearing lubrication only. A major problem is the necessity of maintaining the rotor temperature below the maximum operating temperature of the magnet, which may be limited by the Curie point of the magnetic material, and also by the thermal properties of the binding material in the case of powder metallurgy composites.

Large machines are reported (17 MW motors), but most research papers describing generators consider machines with ratings less than 10 kW. The synchronous nature of the operation causes problems of start, synchronisation, and voltage regulation.

Methods of control include full power frequency inverter, and cyclo-converter. Methods of improving voltage regulation include the application of full voltage, large capacitance capacitors.

2.3.1.1 Voltage Regulation

The main disadvantage of the permanent magnet generator is that it does not readily provide a constant voltage, when the shaft speed and the load current vary, (Mitcham & Grum, 1998). Voltage regulation is the term used to describe the variation of the terminal voltage, as a result of load variations, see Figure 12. In a synchronous machine with a wound field winding this regulation may be compensated by varying the magnetising current. In a 30 W generator, fitted with ferrite magnets, the regulation is reported to be too high (Naoe, 1997). It is also reported as high in an outer rotor, surface-mounted NdFeB 20 kW generator, but may be compensated for in each case, by means of a capacitor connection. Shunt connected capacitors give improved output voltage, when feeding an impedance (Ojo & Cox, 1996), i.e. in island duty. Voltage regulation may also be improved by fitting series capacitors (Naoe, 1995). Acceptable voltage regulation was reported when testing the 'Torus' generator (Chalmers et al., 1996). The synchronous reactance may be a problem, limiting the output of the PMG (Mitcham & Grum, 1998). This comprises mainly armature reaction and slot leakage, if the pole number is high, as would be the case with a many-pole generator, provided with surface mounted magnets of NdFeB or ferrite. Machines provided with soft iron pole shoes, or embedded magnets will also have a significant zigzag reactance.

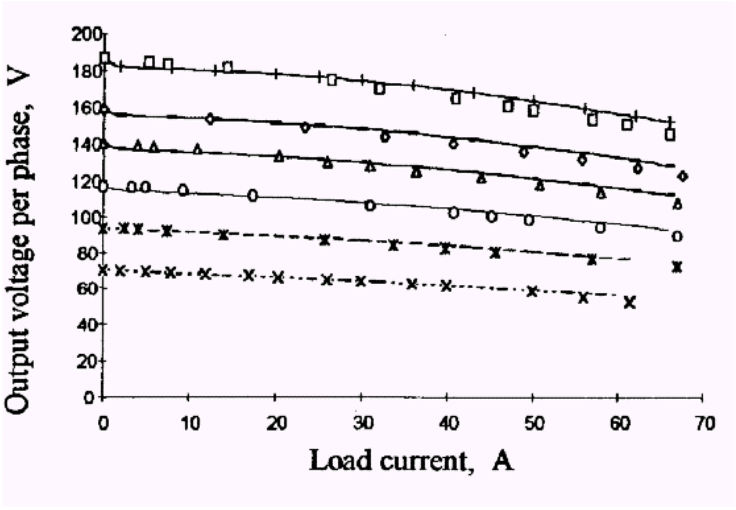


Figure 13 . Regulation of Outer Rotor PMG of (Chen & Nayar, 1998), on resistive load.

At power frequencies, the PMG is usually stable, but the response to fault situations is not well documented and will require some investigation.

2.3.2 Axial Flux Machines

Several authors promote the axial flux design as opposed to the radial flux design. Disadvantages include that it is difficult to manufacture an axial flux machine with a small mechanical air-gap, and that adequate stiffness must be provided in the mechanical design to maintain the air-gap during operation (Chalmers et al., 1996).

2.3.2.1 Torus

The Torus machine, see Figure 14, with a toroidal stator, wound without slots and employing an axial air-gap, has been proposed as a wind turbine generator (Chalmers et al., 1996; Spooner & Chalmers, 1992; Wu et al., 1995). Difficulty with assembly was overcome on a Torus machine. An axial force of 10 kN was experienced, with a 1.5 mm physical air-gap on a 5 kW generator (Chalmers et al., 1996). Use of a machine with a large diameter, a thick winding, and a low, air-gap flux density will reduce axial forces (Chalmers et al., 1996).

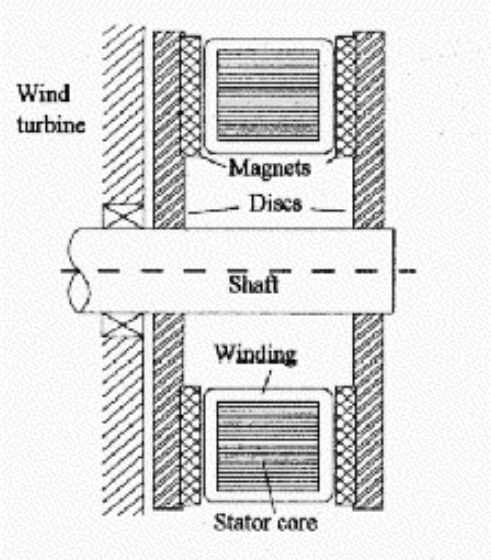


Figure 14. Cross-section of a TORUS generator (Chalmers et al., 1996; Spooner & Chalmers, 1992; Wu et al., 1995).

2.3.3 Hybrid Permanent Magnet machines

2.3.3.1 Doubly salient Permanent Magnet Generator (DSPMG)

The DSPMG in Figure 15 is described in (Sarlioglu & Lipo, 1998). No claims are made as to improvements in performance. It is expected that the DSPMG will improve the performance of an SRMG, by the addition of permanent magnets to bias the magnetic circuit. Alternatively, the performance of a surface mounted PMG is improved by the addition of saliency. This paper focuses on the modelling of the DSPMG, without comparing its performance with other types of generator.

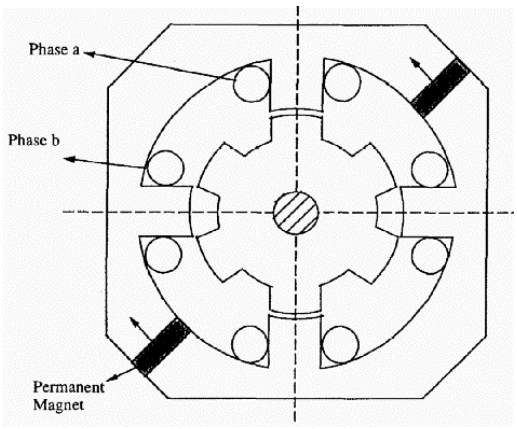


Figure 15. Cross-section of the Doubly Salient Permanent Magnet Generator (Sarlioglu & Lipo, 1998).

2.3.3.2 Axial Flux PMG with salient poles

The hybrid axial flux PMG with salient rotor poles is described in (Muljadi et al., 1998). This is a modular construction, which should make it easy to maintain. Like the transverse flux machines, for this design a complete rotor/stator unit is required for each phase. Poles may be added around the circumference to increase the torque.

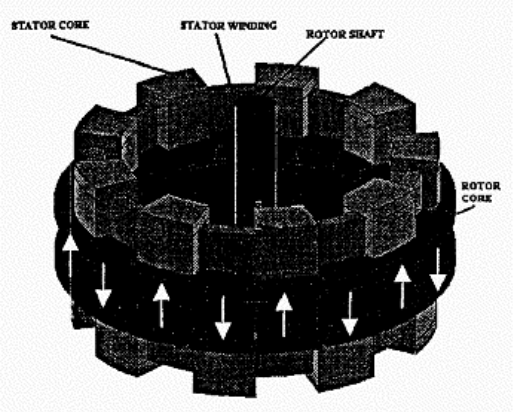


Figure 16. 3D representation of hybrid axial flux PMG with rotor saliency (Muljadi et al., 1998).

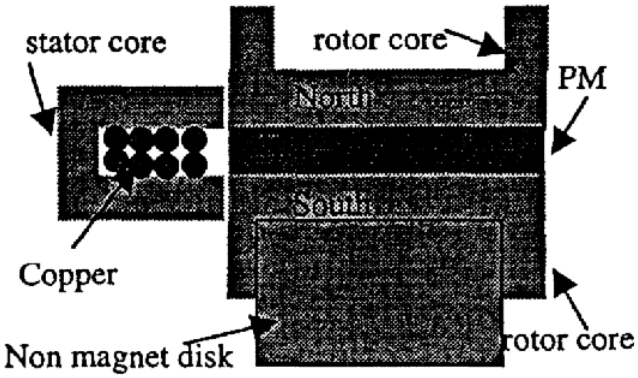


Figure 17. Cross section of hybrid axial flux PMG with rotor saliency (Muljadi et al., 1998).

2.3.4 Methods of Analysis of PMG

Models are reported, which are adjustable to allow for internal and surface mounted magnets, and for the current dependence of flux and inductance (Ojo & Cox, 1996). The model takes no account of current waveform and gives inaccurate results. (Lampola, 2000) reports extensive Finite Element modelling of surface mounted, NdFeB, cylindrical air-gap PMG. This may be supplemented by a linked circuit simulator. In (Polinder & Hoeijmakers, 1997) an analytic method is proposed, to determine the magnetic field distribution in a PMG. This is to ease the numerical problem of optimisation, as opposed to the Finite Element Method. It is also claimed that the method provides insight into the relationship between dimensions and equivalent circuit parameters.

2.3.5 Methods of loading the PMG

To apply the PMG as a wind turbine generator - Figure 18, it should be considered to take advantage of the self-excitation property and allow the machine to operate under variable speed conditions. This would necessitate the use of a line power converter, for the full power to be transmitted. Reasons for this are that variable speed of the PMG will give variable frequency and variable amplitude of the terminal output voltage.

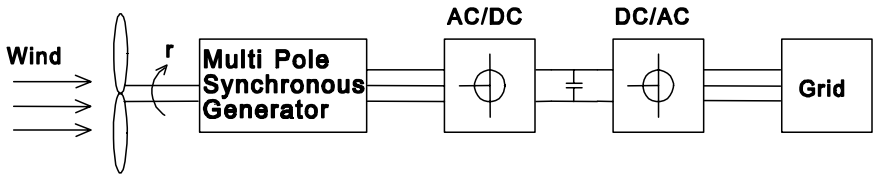


Figure 18. Typical arrangement of Wind turbine driving a PMG, loaded by a Power Converter and the Distibution Grid (Blaabjerg & Mohan, 1999).

Use of a diode bridge rectifier will cause harmonics in the current waveform, giving an exceptionally high peak current in relation to the RMS value of the load (Lampola, 2000). This will cause increased eddy current losses in the rotor, and also the danger of demagnetising the magnets at a relatively small load. This means that the PMG will give less output than it otherwise would, given a sinusoidal current. Additionally, the value of the DC link voltage is directly related to the shaft speed of the PMG. The use of a controlled rectifier allows several advantages. The current may be controlled to be sinusoidal, thus avoiding the above-mentioned problem. The amplitude of the voltage may be controlled to match the grid voltage, independent of shaft speed. Especially, the PMG is more isolated from the grid, making it possible to control fault currents in the PMG, arising from external faults in the grid. The use of the inverter effectively decouples the generator from the grid (Chen & Spooner, 1996). The inverter performance, such as voltage regulation, reactive power control, and power quality, depend mainly on the grid-side inverter. This also removes the need for special starting and synchronising equipment for the PMG. The system may operate at any power angle, without losing synchronism.

2.3.6 Design Considerations

Many authors promote a particular design of generator, where the basic version is possibly the cylindrical air-gap machine, with the stator on the outside and the rotor free to rotate inside it, see Figure 11. The basic magnet design must be NdFeB magnets, surface mounted, see Figure 11 and Figure 12. A problem with this design is that the magnets, which should be maintained at a low temperature, are in the hottest place.

2.3.6.1 Cylindrical air-gap with outer rotor

The outer rotor is proposed, as this gives good cooling conditions for the magnet poles (Chen & Nayar, 1998). An additional advantage is that the magnets are well supported by the drum outside them. For the same air-gap diameter, the outer diameter of the drum may be expected to be less than that of the equivalent outer stator, so a saving may be expected in the materials.

2.3.6.2 Cylindrical air-gap, outer stator

The machine with a cylindrical air-gap and outer stator is the conventional arrangement. It was chosen in (Lampola, 2000) for detailed optimisation studies. The surface mounted magnet, with magnets shaped to suit the radius of the rotor was found to be the best version. Fitting pole shoes was found to be a disadvantage, requiring more machine weight to give the same output, and giving reduced pull-out torque.

2.3.6.3 Modular design using E-cores

(Chen & Spooner, 1995) proposed a modular stator design using E-cores originally designed for the use in transformers, magnetised by ferrite magnets in a flux-amplifying magnetic circuit – see Figure 19. An advantage of this system is claimed to be that the modules may be combined to make a generator having any required number of poles. Tests were performed on a 26-pole unit, but results showing output power related to efficiency are not supplied. (Lampola, 2000) tested a similar arrangement, but with surface mounted NdFeB magnets, and concluded that it was inferior in performance and output/cost to the normal, slotted stator design.

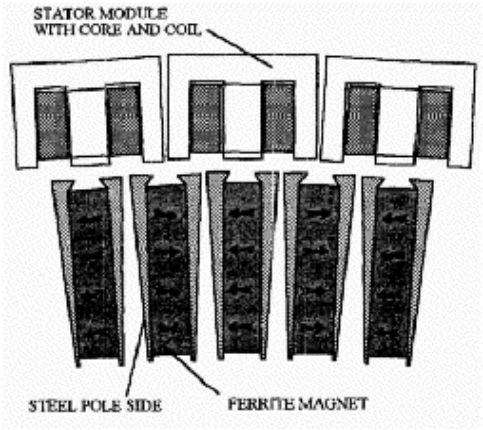


Figure 19. Cross-section of the modular design, using E-cores (Chen & Spooner, 1995).

2.3.6.4 Armature winding design

(Lampola, 2000) found that the conventional distributed winding gave more output from the same machine size than a winding wound around a single tooth.

2.3.6.5 Stator wound without teeth

A 2-pole version is reported, wound without teeth on the stator, (Vyas & Arkadan, 1994), see Figure 20. This was found to yield lower amplitudes of current harmonics on a diode rectifier load, but the total output power was reduced by about 15%.

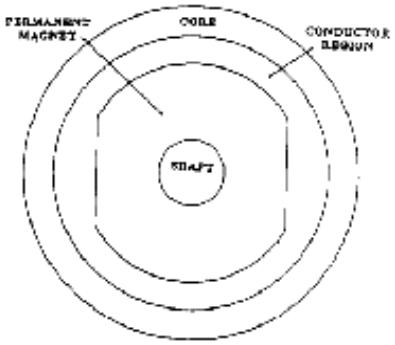


Figure 20. Showing a 2pole design with a toothless stator (Vyas & Arkadan, 1994).

2.3.6.6 Power Angle

(Muljadi et al., 1996) remarks that the power angle for maximum torque, of a PMG, feeding a rectifier, is 45°, instead of the 90°, one would expect of an excited synchronous machine. This means that a PMG will be relatively stiff and susceptible to the effects of sudden fault conditions, compared to the conventional, wound rotor synchronous machine. To obtain the best power characteristics, the DC bus voltage must be changed according to rotor speed. Compensation may be achieved by including a series capacitance in each phase. The DC bus may be used to optimise the output of the wind generator for any working condition.

2.3.7 Experimental Results

2.3.7.1 Efficiency

Efficiency of 83.9% was reported on a 5 kW Torus design (Chalmers et al., 1996). Efficiency of 86% was reported on a 20 kW outer rotor design (Arkadan et al., 1989).

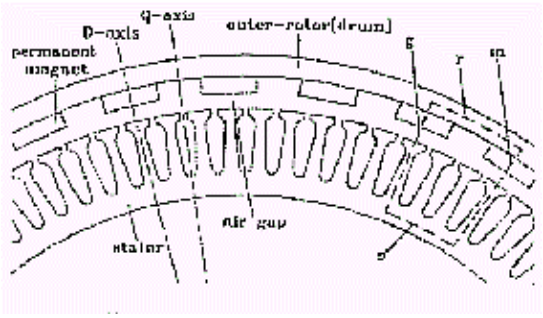


Figure 21. Cross section of PMG with outer rotor (Arkadan et al., 1989).

2.3.7.2 Magnetic Circuit

Efficient use of the magnetic circuit reduces the power to weight ratio (Wang, 1999).

2.3.7.3 Output Power

The fitting of a damper winding can increase the output power by about 4% (Arkadan et al., 1989). The specific power density is claimed to increase with increasing pole number, up to a maximum value (Wang, 1999).

2.3.7.4 Operational Characteristics – Normal Duty

The Permanent Magnet Generator is a form of synchronous machine. As such it will be very stiff in operation if directly connected to the grid. That is to say that all variations of load and power from the turbine must be accommodated at constant shaft speed. This situation is unlikely to produce robust stable operation.

The alternative is to use a power electronic controller between the generator and the grid. To compensate for the cost of the controller, the gearbox may be omitted. It may then be convenient to select a generator with many poles. The use of a full power line converter is expensive, but affords many advantages. E.g. the speed is no longer directly related to the frequency of the grid, energy may be stored locally in the system, as kinetic, electric or magnetic energy, to provide a cushion to even out the effects of wind gusting, etc. Power may be supplied to the grid over a speed range of the shaft.

2.3.7.5 Operational Characteristics – Fault Conditions

On external faults, the Permanent Magnet Generator will easily generate sufficient fault current to activate any type of protection system. The problem is more, if the fault will be cleared before the machine causes serious damage to itself, e.g. in the form of demagnetising the magnets.

Any overheating causing the magnets to achieve the Curie temperature will also cause demagnetisation of the magnets.

2.3.7.6 Efficiency of Permanent Magnet Generators as a Function of Load and Speed

The efficiency surface of a typical small permanent magnet motor is shown in Figure 22. This motor was controlled to operate at the maximum efficiency for each working point tested. Scrutiny of this surface reveals that the efficiency may be controlled to give a reasonably flat plateau at a high efficiency for medium to high torques, and over a wide speed range. However, when the torque drops below a critical level, it becomes impossible to obtain an acceptable efficiency.

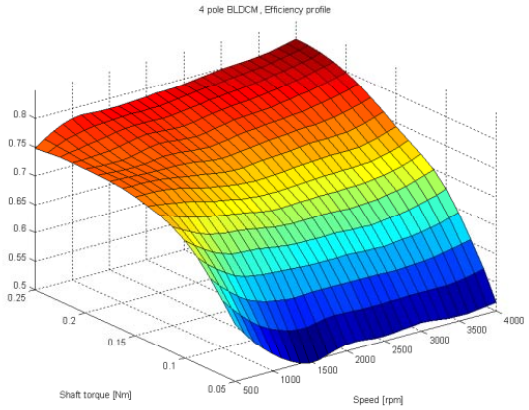


Figure 22. Tested efficiency surface of Permanent Magnet Motor, controlled to operate at maximum possible efficiency for each working point.

The above figures were obtained by testing a small permanent magnet motor. It may be expected that a similar development of the efficiency would apply for a large permanent magnet generator.

2.3.7.7 Well Established or New Technology

The permanent magnet machine is a newer technology than the induction machine, as an application as a wind turbine generator.

2.3.7.8 Gear or Direct Drive Multi-pole

In general, because of the relatively large air-gap, the Permanent magnet Machine leakage flux remains below an acceptable limit for machines with many poles. This means that the machine can use the current flowing to generate torque. Permanent magnet Machines with a large number of poles, may be designed with a reasonably small size compared to the output. This means that permanent magnet machines with many poles will have an acceptable size in relation to the rated output, and may be recommended.

2.3.7.9 One-Off Price

The price of a permanent magnet generator is unknown, as no permanent magnet wind turbine generator is in production. However, the permanent magnet material may be very expensive for NdFeB materials, or reasonably cheap for ferrite materials. The situation is complicated, as a machine provided with NdFeB will need less magnet and other materials than a corresponding machine provided with ferrite magnets. To obtain a reliable estimate, prototypes would have to be designed, built and tested extensively.

2.3.7.10 Other Comments

Acoustic Noise
The Torus machine is reported as having a low level of acoustic noise, (Chalmers et al., 1996).

2.3.8 Conclusion on PMG

The PMG seems attractive as a wind turbine generator. Advantages include self-excitation, high power factor, and high efficiency. Designs have been proposed

in cylindrical and axial flux versions. In the PM machine, efficiency is higher than in the induction machine, as the excitation is provided without energy supply, by the Permanent Magnets. However, permanent magnet materials are expensive in initial purchase, and are difficult to handle in manufacture. Additionally, the use of permanent magnet excitation forces the use of a full power converter, to adjust the frequency of generation to the frequency of transmission. This is an added expense, but the benefits are that generation may be at any speed to suit the current conditions.

The internal voltage generated inside a PMG is directly dependent on the speed. This may be catered for by the power converter, to a certain extent, but the voltage may reach a dangerous level if the speed becomes high enough. Field weakening may be applied, but this requires a special mechanical design of the field system, providing a saliency effect, in addition to extra current being required to reduce the effective magnetic field. This has the effect of reducing the efficiency obtained. Voltage regulation as a function of varying load is a problem, which has received some research attention. Various solutions have been proposed, including the use of a parallel-connected capacitor.

Special attention must be paid to the physical properties of the permanent magnet materials used. Some materials are brittle, others are highly reactive, and rust readily. All magnetic materials are sensitive to temperature. They lose their magnetic qualities at a high temperature, called the Curie Point. This may be in the mid 250˚C, which is critical, as these temperatures may be reached during fault conditions.

The stator of a permanent magnet generator is wound in a similar manner to an Induction Generator, and as such, should present no special problems.

PMG with surface mounted magnets may be designed with a relatively large air-gap. This eases the mechanical problems encountered when building and operating a large generator. On the other hand, surface mounted magnets exacerbate the problems of high voltages at speeds above the base speed.

In general, the efficiency of a PMG may be expected to be relatively high, as long as the torque is high. At low torques, the efficiency will fall off rapidly.

2.3.8.1 Further work

Further work is necessary to determine and study the operating characteristics of the various designs of PMG, and to study and eliminate quasi-periodic oscillations of power angle. At the same time it is important in large scale generators to have the possibility to easily repair broken/destroyed magnets. Otherwise repair cost can be too high.

2.4 The Switched Reluctance Generator

The Switched Reluctance Generator has in the last decades been considered for Wind Power applications, but much of the available literature is focussed on aircraft generators. However, the two applications should have similar requirements, the main differences being a matter of scale. The rotor construction is particularly robust, being without windings. Excitation of the magnetic field is provided by the stator current in the same way as for the Induction Machine. The Switched Reluctance machine in Figure 23 operates on a Vernier principle, making it suitable for low speed operation. A total of 19 articles were located,

dealing with Switched Reluctance Generators, and all 19 have been considered in this discussion.

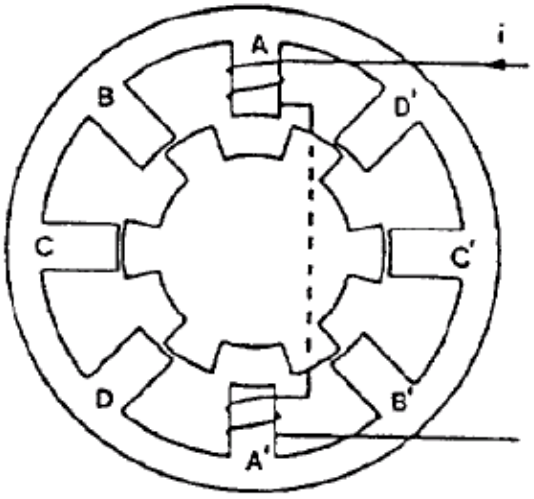


Figure 23. Cross-section of typical Switched Reluctance Generator (Cardenas et al., 1995).

2.4.1 Principle of operation

The SRG is a doubly salient construction, with salient poles on both the stator and the rotor (Mese et al., 2000). Phase windings are wound on the stator poles, each coil being wound around a single pole or tooth. The principle of operation is simple in concept, (Cardenas et al., 1995), but is easier to explain in the motoring mode. If the winding on poles D-D' be energised, the rotor will be pulled clockwise to align with the axis of the magnetic field produced. If now the winding on D-D' is de-energised, and the winding on poles A-A' be energised instead, the rotor will continue to move in the same direction. The machine is now acting as a motor, converting supplied electric energy into mechanical work. Movement in the direction of the torque produced tends to minimise the inductance of the winding (Mese et al., 2000). Generator action may be obtained simply by changing the angular position of the rotor at which current is supplied to the phase winding, to cause generating torque to be produced.

2.4.2 Operational Characteristics – Normal Duty

Generator operation is claimed to be characterised by single pulse operation, rather than chopping, the DC-link voltage being kept constant during operation. By arranging the switching timing to position current pulses where the inductance is decreasing, generating mode may be selected (Husain et al., 1999; Cardenas et al., 1995). The bulk of the generated current is carried by the diodes (Cardenas et al., 1995). The controlled switches mainly provide excitation current (Cardenas et al., 1995).

SRG is interesting for application as an aircraft generator because of its ability to continue operating at reduced output in the presence of faults on the generator itself (Sawata et al., 1997). For the same application, potential instability was reported in (Skvarenina et al., 1997). The SRG is suitable for gearless generation in aircraft applications, because it is capable of high-speed operation (Mitcham & Grum, 1998).

The SRG may be controlled to produce the best efficiency in a given working point (Mese et al., 2000).

Inverter output filtering of SRG current is necessary due to current ripple caused by the commutation (Heglund & Jones, 1997).

In a study (Abouzeid, 1998), the author studies the effects of the variable inductance of the SRG on the load characteristics, and concludes that the inductance/resistance ratio of the load is important to the operation. Otherwise, the SRG is judged to operate in a similar fashion to a separately excited DC generator, if loaded through a rectifier.

The SRG is inherently unstable and requires the firing angles to be adjusted to suit the load exactly (Sawata et al., 1999b). This applies to normal operation and fault conditions. Instability during faults may be controlled by proper detection of the conditions, and control (Sawata et al., 1999a).

A detailed design study (Mueller, 1999) presented an SRG for a 20 kW, 100 rpm wind generator. Torque densities of about 2 – 3.2 were achieved, the best being for a 12/16 design. A converter dimensioned for 80 kVA was predicted. The 12/8 version gives a somewhat lower torque/kg, 2.5, but has a reduced converter requirement, about 55 kVA. The specific torque may be increased, by increasing the iron saturation, at the expense of lower efficiency and increased converter requirement.

A high speed SRG (Ferreira et al., 1995) was successfully controlled, by fixing the turn-on and turn-off angles, and then controlling the output current by turning off both power switches when the current reached the threshold. This system was built and tested for military use. There was no current chopping when generating. Machine efficiency increases with increasing load, while the converter efficiency decreases.

A 30 kW SR-generator has been designed, built and tested (Heglund & Jones, 1997), operating in the speed range of 27,000 to 46,850 rpm. A 25 kW, 250 rpm, 100 Hz, 32/24 SR generator has been designed for a 250 V DC bus (Mitcham & Grum, 1998), the maximum speed was 3100 rpm, yielding 150 kW, 1240 Hz.

2.4.3 Comparison with other types of machine

The SRG is considered inferior to the PM machine, due to its lower power density, and the need for a sophisticated power converter (Mitcham & Grum, 1998). However, the rugged mechanical design and the concentrated coil design are attractive.

2.4.4 Axial Flux Machines

An axial design of 6/2 SRG is reported (Abou-Zaid et al., 1999), with the rating of 300 V, 4 A, where the test results are reported to give a 9% change in voltage, at a 2 A load, for a change of speed from 1500 rpm to 3000 rpm. Changes of load inductance can lead to large changes in output voltage at 2 A load. However, the test results are for voltages around 30 V only, the machine performance at a reasonable rating would be required to be established at a reasonable rating.

2.4.5 Methods for modelling and analysis

The SRG is inherently, extremely non-linear in the magnetic circuit, and in operation. For this reason, Finite Element Analysis is often used as an analysis method (Mese et al., 2000) for the magnetic circuit. Sophisticated simulation of the non-linear electro-mechanical normal duty is required to produce estimates of steady-state performance. Both of these may be effected using in-house software produced by AFEE, (Blaabjerg et al., 1999; Rasmussen et al., 1999).

(Husain et al., 1999) present a general modelling approach for a Switched Reluctance Generator. Modelling and tests were carried out on a 12/8, 250 kW, 22000 rpm machine, operating at 50 V DC. The model was found to be useful for investigating the response of the SRG to fault conditions.

2.4.6 Operational Characteristics – Fault Conditions

Armature phase shorts and open circuits are internal faults, other faults occurring in converters or wiring are external faults (Husain et al., 1999). The SRG investigated was found to continue generating in the presence of single-phase internal faults and converter faults. The excitation required to feed external faults adequately, so that protection equipment would operate as required.

Any generator system must be able to clear load faults by blowing fuses or tripping circuit breakers (Husain et al., 1999). In the case of the SRG, sufficient DC link current must be produced to enable fault clearance by tripping a relay or other fault protection device (Heglund & Jones, 1997). For the SRG tested, the load fault voltage collapsed to 35 V from around 270 V, the phase current was 1400 A, peak value, compared to full-load current of 900 A. (Sawata et al., 1998) found that the 8/8, single phase SRG tested could continue generating in the presence of an internal fault. For certain faults, this was at half capacity only.

2.4.7 Efficiency of the SRG as a Function of Load and Speed

No direct claims to efficiency were found. The SRG may be controlled to produce the best efficiency in a given working point (Mese et al., 2000). The specific torque may be increased, by increasing the iron saturation, at the expense of lower efficiency and increased converter requirement (Mueller, 1999). Many claims have been made that the SR machine should have a higher efficiency than the Induction Machine. This has been shown to be true, if a new design of SRM is compared with a commercial standard IM. However many commercial standard IM's have basic designs which were laid out in the 1950's, with no subsequent changes to lamination geometry. The difference would not be so large, and may even disappear, were the comparison to be made with a completely new design of IM.

Because the SRG is excited from the stator current, as opposed to being excited from a permanent magnet, the controlled best efficiency as a function of torque and speed may be expected to take the same form as for the Induction Motor. This is illustrated by test results obtained on a 100 W induction motor. Note that as the values shown correspond to a 100 W machine, only the form may be interesting here.

2.4.8 Well Established or New Technology

The SRG is a new technology. As a motor, the SRM has attracted a great deal of research interest. However, the number of available commercial suppliers of motors is very small and the even fewer suppliers of SRG are all aiming at the aerospace market, and are building very small, high-speed generators for aircraft duty. It is doubtful whether any real series production of SR machines is currently in manufacture, despite the amount of advertising.

2.4.9 One off Price

The SRG should be reasonably cheap in manufacturing cost, as there are no permanent magnets, and special inter-coil insulation is not required. The air-gap is relatively small, due to the excitation being provided via stator current, which will make the mechanical construction relatively expensive. By using a high number of phases, which will be expensive in wiring and converter costs, an improvement in fault tolerance may be possible.

2.4.10 Gear versus Multi-pole

Due to the Vernier action of the SR machine, it should be easy to manufacture slow running versions. However, the performance characteristics of such a machine are unknown.

2.4.11 Other Comments

(Cardenas et al., 1996) treated a PMG system, and merely mentioned the SRG as a possible solution for further investigation. (Skvarenina et al., 1997) treated the application of a particular commercial graphic modelling language to the solution of problems involving SRG. Only a very simple problem of resistive switching was tested, in order to demonstrate the language. (Wiegele, 1996) treated the detailed design problems of a micro-SRG, considering mostly problems of the impulse-turbine used. (Cardenas et al., 1995) contains a discussion on how to control a DC motor in order to emulate the behaviour of a wind-turbine in the laboratory. (Ke Liu & Striebler, 1998), treated a fuzzy logic controller, suitable for an SRG. (Ferreira & Richter, 1996) treated the subject of channel independence for an SRG feeding two separate bus-bar systems for aircraft use.

2.4.12 Conclusion on SRG

The SRG is a possible candidate for a Wind Turbine Generator. However, the literature is not substantial, and much investigative work remains to be done before the SRG is well prepared for application.

The SRG will require a full power converter in order to function as a grid connected generator, but will otherwise perform in a similar manner to the Induction Generator, as the excitation is provided from the grid.

2.5 The Transverse Flux machine

The Transverse Flux (TF) machine topology is new, but appears to be interesting. The high values of torque per kilogram of active materials reported make it seem very attractive. The transverse flux principle may be applied to a range of machine types, e.g. both permanent magnet and reluctance machines could be made. The machine will inherently behave as the generic type applied, but will

have characteristics, influenced by the TF design. Here, the Transverse Flux Permanent Magnet Machine will be discussed. Most of the researchers have treated motors, but here, we are interested in generators. In principle, the generator is very similar to the motor, except that the windings are subject to severe loads due to short circuits on the generator. This means that the windings need to be strengthened, to cope with the resulting stresses.

2.5.1 Reported machine type designs

Different designs of TFPM will be considered here:

- Double-sided and single-sided.
- Flat magnets and embedded magnets.
- Flux concentrated and not flux concentrated.

In the double-sided design, stator poles are sited on both sides of the rotor and in the single-sided design; only one side is provided with stator poles. Flat magnets are surface mounted magnets and embedded magnets are internal in the rotor structure. Finally, flux concentration means that soft iron pole pieces are fitted to the permanent magnets.

A comparison of several reported TFPM machines was undertaken by Harris, Pajooman and Sharkh, Southampton University (Harris et al., 1997). The various topologies are referred to by the city/university where they were developed;

- Southampton: Single-Sided with Surface Magnets (SSSM)
- Aachen: SSSM with non-conducting stator bridges
- Braunschweig/Newcastle: Double-Sided with Flux Concentration (DSFC)

The findings of this study are that the SSSM machines from Southampton and Aachen can deliver approximately the same torque: circa T_{spec} = 30 kNm/m^3. The DSFC types are superior in specific torque with up to T_{spec} = 52 kNm/m^3. This compares to about 15 kNm/m3 for a standard Induction Motor, and is a dramatic improvement.

According to Harris et al, the larger specific torque of the DSFC machine is caused by the better utilisation of both the stator excited flux and the magnet flux. The power factor of DSFC machines is also higher than SSSM machines - typically 0.53 versus 0.35-0.40. Disadvantages are a more complex and less robust construction - more parts to manufacture and assemble with small tolerances requiring greater accuracy. This construction could be improved by using powder core technology instead of a laminated steel core. Powder metallurgy offers high utilisation of the material and the ability to form and produce complex shapes. This would ease the manufacture and assembly of the motors. However, both material costs and tools will be increased by this solution.

Several attempts have been made to use powdered iron as a direct replacement for laminated steel, but with poor result. According to (Jack et al., 1999) this is because the designs were unsuited for the use of powder cores, where the advantages are three-dimensional flux distribution, lower component count, and, as mentioned, new methods of manufacture and assembly. Hence, designing a wheel motor with powdered core or cores offers new challenges to the designer. To benefit properly from the material, the designer has to have exact knowledge of the material at hand, moulding techniques and assembly methods. Although reported in the literature, the application of powder technology to cores of elec-

tric machines is in its infancy, and requires much more study and material characterisation before application is advisable.

These factors, set limitations for the choice of machine type. The double-sided, transverse-flux, permanent magnet generator seems very attractive for further work, due to its high torque-density and low leakage inductance.

2.5.2 TFPM technology

The TFPM machine has its origins in the SR machine, and it is found to be a promising new design of a linear SR machine. The SR machine is named after its ability to exploit the change in air gap reluctance. This means it produces force by moving according to the maximum inductance of the excited winding. The motion may be rotary or linear, and the rotor may be interior or exterior (Miller, 1989).

In a TFPM machine the flux path in the core back iron is perpendicular (transverse) to the direction of movement – see Figure 24. The opposite, a core back flux path parallel to the direction of movement, is found in the Longitudinal Flux Permanent Magnet machine (LFPM). The LFPM machines are claimed to have inferior performance than the TFPM machines because of their larger rotor mass and difficulties in design, due to unwanted magnetic coupling. All in all LFPM machines do not exhibit results as promising as those of the TFPM machines.

An SR machine consists of a number of separate electromagnets, which are excited in turn. The position of the rotor determines the exact timing of the excitation of each phase. Because of this, the machine will always need to be supplied by a converter and a controller and provided with an accurate position indicator for the rotor position. The excitation of TFPM machine is produced by the permanent magnets instead of by current flowing in rotor windings. The machine must be controlled via current flowing in the stator windings, which like the SR machine must be fed by a converter, preferably a simple converter. The requirement for a simple converter feeding the wheel motors, leads to the proposal of a three-phase motor design. However, a final decision on this point must be the result of a careful study of cost and performance analysis.

The control of the SR machine or TFPM machine is difficult; the air gap flux is non-sinusoidal, and the magnetic circuit of the machine changes continuously and is non-linear when the rotor moves. Also, there is strong local saturation at the edges of the overlapping stator and rotor poles, which means the machine constantly operates in a more or less saturated condition. As a result, the design of a TFPM motor must contain some modelling by use of numerical methods and/or prototyping followed by measurements.

2.5.3 TFPM basic design

The magnetic circuit of the TFPM is complex due to stray flux and the constantly changing saturation of the iron. This means that analytical analysis of the magnetic circuit is difficult. Therefore, numerical methods are attractive. A well-known and documented method is the Finite Element Method (FEM), where the problem is defined inside a boundary and solved by division into small segments with knowledge of the surrounding boundary conditions.

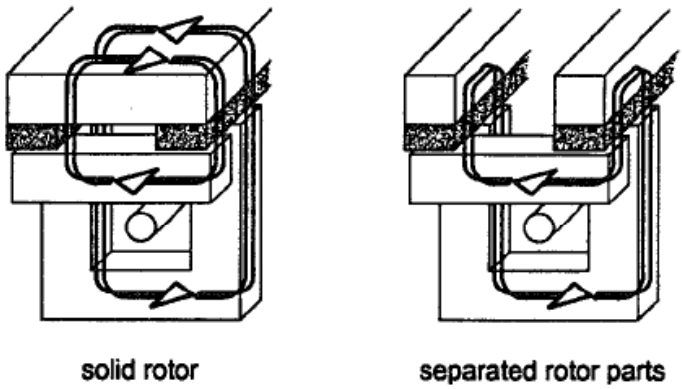


Figure 24. Sketch of the flux path in a transverse flux design. Source (Henneberger & Bork, 1997).

FEM calculations may be used to determine the steady state performance of the non-linear TFPM machine magnetic circuit. According to (Salo et al., 1999) an FEM analysis of only the basic pole-pair will be adequate to determine the traction force and the flux linkage. These are functions of the current and the position of the machine but of course the physical dimensions, the pole number, the air gap length, etc. and the properties of the magnetic material will determine the torque and flux linkage supplied by a pole pair. The torque and inductance for a whole motor may then be found by multiplying by the number of pole pairs of the motor and the number of phases.

The design steps are as follows:

- Decide traction force
- Decide cross-sectional area of pole leg face
- Total mmf is chosen from calculated database or analytical expressions
- Current density is chosen by cooling method. Table in (Hendershot, 1994).

Some dimensional constraints common for SR machines are listed in (Salo et al., 1999):

- Width of the stator poles and the rotor poles is equal
- Distance between two stator poles is equal to the pole width.
- Minimum length of the whole motor is an electric length determined by the number of phases
- Stray flux . 0 and may be ignored in the dimensioning equations
- Pole width is chosen so that it together with the pole length gives the minimum mass of the rotor.

The ultimate *simplicity in design* is obtained with one-pole-pair per phase and then choosing a three, four- or five-phased motor. A three-phase design will lead to a simple converter. The design process uses analysis of the simple basic pole-pair concept.

After determining the basic dimensions i.e. geometric properties, the performance of the magnetic circuit may be predicted by using a numerical method such as FEM. After design and construction of the FEM model, it may be used to calculate the forces on a plane in the air gap. It must be remembered that the steady-state performance represents ideal conditions. Electric, magnetic and friction losses impair the performance of the real machine and should be taken

into account. This must be done using separate calculations, as they are not considered in the FEM environment. When the magnetic design is finished, the weight of materials used may be calculated, and the circuit parameters estimated, to enable system calculations, etc.

2.5.4 Force production and calculation

The linear SR motor produces a traction force when that pole pair which has an increasing inductance in the direction of movement is excited. Force is produced to oppose the change in inductance i.e. to attempt to minimize the field energy in the SR motor, and not by induced current as in the case of induction machines. The mechanism is the same as for the production of reluctance torque in the salient pole synchronous machine. The magnetic flux and the torque producing current must be perpendicular to each other. The magnetic flux must cross the air gap in the normal direction to produce a tangential force component. The magnetic flux is excited by current flowing in the stator winding.

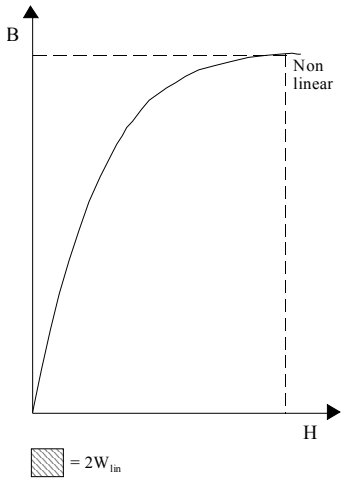


Figure 25. B,H-curve for a ferromagnetic material.

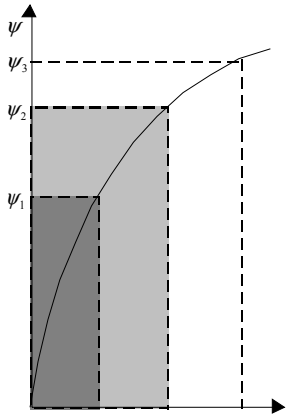


Figure 26. Magnetisation curve for a transverse flux machine.

The magnetic circuit is very complex for analytical calculation due to the effects of stray flux and saturation in the soft iron flux paths. This complex magnetic circuit and the relative unfamiliarity of the construction make it necessary to use a general numerical method for modelling and solution of magnetic problems. A suitable and available method is the Finite Element Method (FEM). After the FEM model is built, and solved, a force determining method is applied to calculate forces on a plane in the air gap. Because the force is strongly dependent on the rotor position, it is necessary to calculate it for a number of different rotor positions and then determine the average traction force. In order to explore saturation effects, the calculations may be repeated with various values of armature current. A suitable modelling tool is Opera-2D a commercially available FEM platform, by Vector Fields Ltd. of Oxford, UK.

The force calculation method used in Opera-2D is the Maxwell Stress Tensor Method. This method is provided for two-dimensional (2D) modelling, because here the closed surface integral is modelled by a line integral around a closed path. This eases the calculation. It is important to note, that the integration path must be completely in air and not pass through elements, which touch the surface of any iron or dielectric. This would give large errors due to abrupt changes flux in the tangential direction in those positions [Opera-2D, pp 3-127]. Another

precaution to take is to draw the integration path, avoiding nodes of the FEM model, preferably in the centre of elements.

2.5.5 Flux linkage calculation

Magnetic flux induced by the armature coil penetrates all the physical objects of the TFPM and thereby creates the armature field of the machine. The flux linkage is an expression of the electrical properties of the motor, and a flux linkage calculation may be used to design the motor windings. However, the flux linkage is strongly dependent on the eddy current losses of the motor cores and the skin effect and proximity effect losses in the windings. Therefore, the flux linkage cannot be accurately determined from a static solution of the motor magnetic circuit. If these losses are very small, their influence on the flux linkage may be neglected and a static magnetic solution used to determine the flux linkages of the motor.

Figure 25 shows the B/H-curve of a non-linear material. The region above the curve is the stored field energy and the region below the curve is the co-energy. The static magnetic field energy and co-energy must be obtained from the FEM solution - like the force performance. The static flux linkages may be calculated by summing their energies and dividing by the current flowing in each calculation when the rotor position is kept constant.

$$\lambda(i,x) = \frac{W_f(i,x) + W_{CO}(i,x)}{i}$$

where i is the armature current and x is the rotor position. A magnetisation curve is plotted for each rotor position, which is changed by altering the size of the air gap in the model.

2.5.6 Conclusion on TFPM Machine

The TFPM machine seems suitable for application as a wind power generator. The nature of its operation is that of a synchronous machine, and it will function in principle in a similar manner to any other permanent magnet machine. It can be made with a very large number of poles, which may make it suitable for direct drive, gearless applications. The TFPM has however, a relatively large leakage inductance. In the reluctance version, this may cause problems that the power factor becomes very low in normal operation, and the short circuit current may be insufficient to trip normal protection. Similar problems exist for the permanent magnet version, but because of the PM, they will not be so severe.

A disadvantage of the TFPM is the large number of individual parts required to produce it, using lamination technology. This may be alleviated, if powder technology becomes viable.

More research study will be required, before it is clear that the TFPM machine is suitable for application as a wind power generator.

2.6 The Wound Rotor Generator

The wound rotor synchronous generator is the workhorse of the electrical power supply industry. As such, it has been described in a multitude of research papers over the years. Both the steady state performance and the fault performance are

well documented. Versions are found with cylindrical rotor, (steam turbine, high speed machines), and with salient poles (diesel driven, and water turbine driven machines). Extremely large machine have been built, up to about 1200 MW. Very slow running machines have been built as water turbine generators. This machine type could be applied as a wind turbine generator, as it could be built with a suitable pole number for direct drive applications, and in suitably large sizes. Enercon and Lagerwey are examples of wind turbine manufacturers that have selected this type of machine.

As a synchronous machine, it is probably most suited for full power control, using a power electronics converter. This would enable variable speed operation. Otherwise, the synchronous machine is strictly fixed speed operation, and is unforgiving if affected by transient and sub-transient loads. The load characteristics may be further controlled, by controlling the magnetising current in the rotor winding.

The operational characteristics should be excellent in all respects, due to the many years of research, design, development and operational experience.

The construction, with an insulated wound rotor makes the machine vulnerable to vibration, which could degrade the rotor insulation. In addition, the rotor current must be supplied, either by using a brushless exciter, and rotating rectifiers, or by using slip rings and brushes. The brushless exciter design adds another rotating winding, and the rotating rectifiers. The slip ring design has the disadvantage of brush losses, and brush wear, requiring maintenance attention. Both of these designs have the potential of regular maintenance and low reliability.

2.6.1 Description

The synchronous machine is usually built with a rotor carrying the field system, provided with a winding excited by DC. The stator carries a three-phase winding quite similar to that of the induction machine. The rotor may have salient poles, or may be cylindrical - Figure 27. Salient poles are more usual in slow speed machines, and may be the most useful version for application to wind turbine generators. The saliency gives added torque, and a stiffer machine operation.

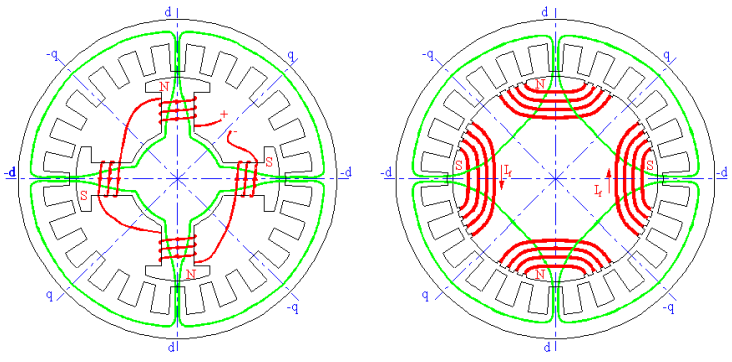


Figure 27. Cross-section diagram of typical salient pole and cylindrical synchronous machines.

Figure 28 illustrates the torque characteristics of salient pole synchronous machine as functions of load angle.

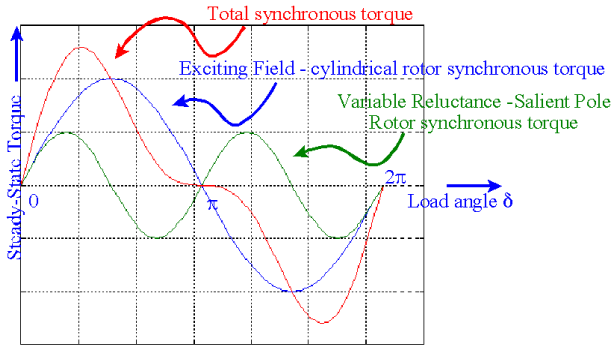


Figure 28. Typical synchronous torque characteristics of salient pole synchronous machine.

Typical low speed synchronous machines are of the salient pole type, with many poles. A typical multi-pole, salient pole, synchronous machine rotor is shown in Figure 29. A typical low-speed, high voltage stator is shown in Figure 30.

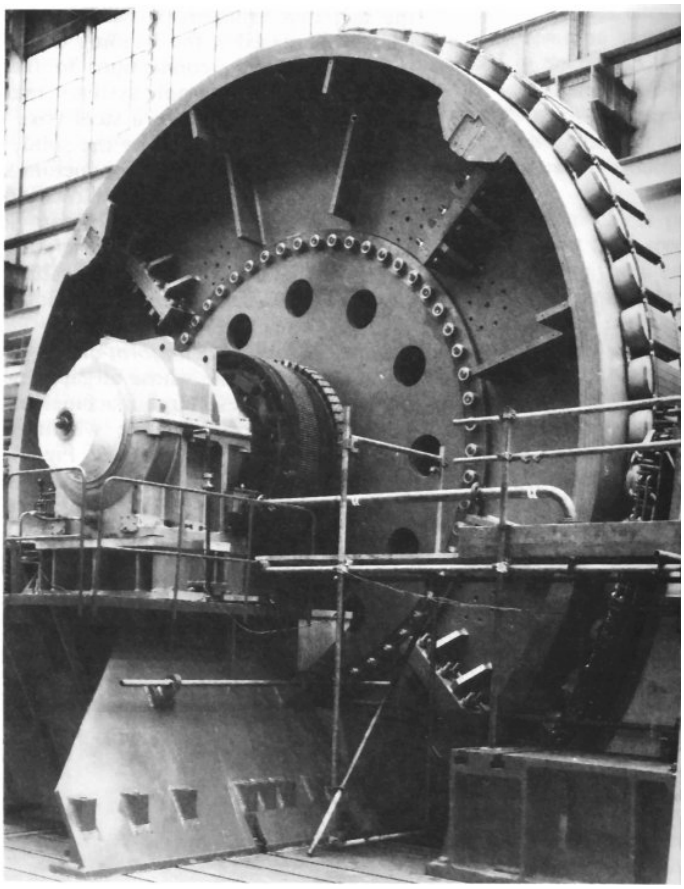


Figure 29. Photograph of a multi-pole, salient pole, synchronous machine rotor.

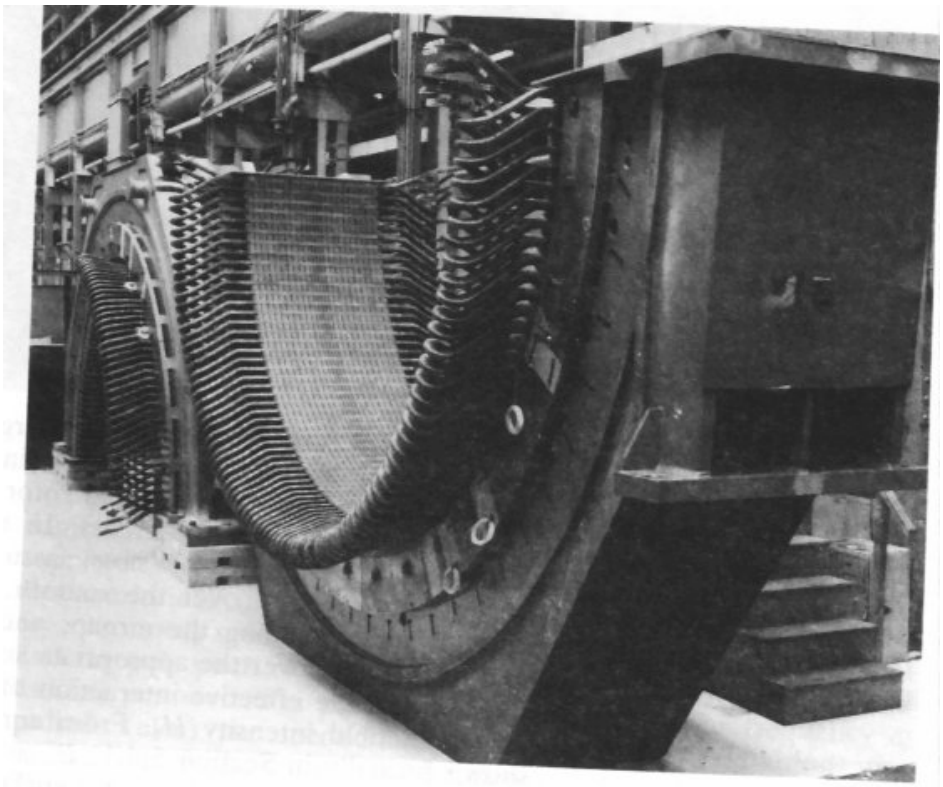


Figure 30. Typical high voltage, low speed, synchronous machine stator with three-phase winding.

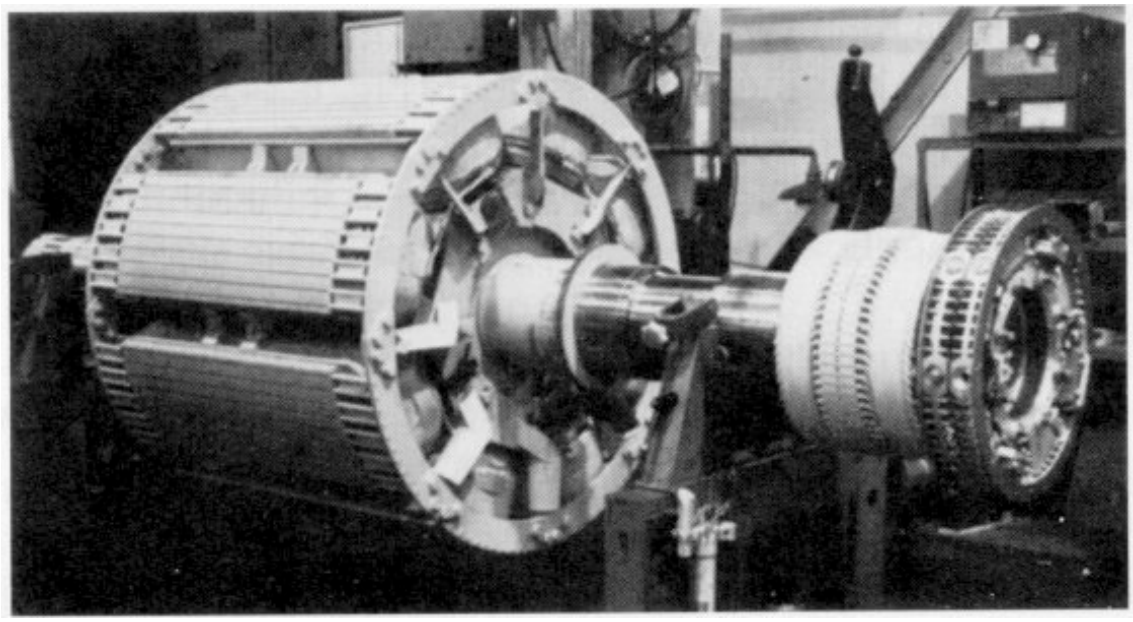


Figure 31. 8 pole, salient pole rotor, fitted with brushless exciter and damper winding.

2.6.2 Operation

To operate as a wind turbine generator, it will be preferable to feed the power through a power electronics converter, carrying the full output power. The system will act as storage for the power fluctuations, which are inevitable with a synchronous generator, driven by an inherently gusting wind. It will also buffer transients coming from the net side, and enable variable speed operation of the wind turbine.

2.6.3 Conclusion on Wound Rotor Synchronous Generator

The Wound Rotor Synchronous Generator is already in application as a wind power generator. The large number of parts and windings probably make it an expensive solution.

It may be supplied in high voltage and industrial voltage versions, and it is widely used as a generator in connection with other forms of prime mover. It may be used, at constant speed, and fixed to the net frequency with consideration of the drive train dependencies and synchronization at start-up. There is a massive amount of research and technical literature. The WRSG may also be applied using a full power inverter, with the option of variable speed operation. In all cases, it is necessary to excite the rotor winding with DC, using slip rings and brushes, or a brush less exciter, employing a rotating rectifier.

2.7 The High Voltage Machine

High voltage machines are manufactured both as synchronous machines and as asynchronous machines. They have been used in applications where high power is needed. They have especially been used for power generation in large power stations, but also for large loads such as large pumps, cement mills and fans. The main motivations for using high voltage machines are the reduction in current, leading to lower copper losses and possible direct connection to the grid without the need for a transformer.

So far only very few wind turbines are provided with high voltage generators. These have been prototype wind turbines, usually designed by utilities or large manufacturers of electric equipment e.g. Tjæreborg 2 MW, applying an induction generator, and Growian 3 MW, applying a doubly fed induction generator. So far, commercially available wind turbines have not applied high voltage machines.

The choice of generator, including the voltage level, should be part of the overall design of the wind farm, from the wind turbine to the point of common coupling of the total wind farm to the grid. Issues that have to be taken into consideration include cost and availability of components, grid connection and control properties, maintenance requirements, required skills of the maintenance workers, safety requirements, etc.

The main motivation for increasing the voltage of the generator is to reduce the current and by that to reduce the copper losses and therefore the amount of heat that has to be dissipated. This can lead to a reduction in the size of the generator and to an increased efficiency of the wind turbine, especially at higher loads. The grid connection and control requirements are the same for the low voltage equivalent generators.

High voltage machines are potentially an interesting alternative for wind turbines from 3 MW and upward. This size limit is mainly due to the high cost of the machine and to the high cost of the auxiliary equipment, such as switchgear. The manufacturing costs may be reduced if a number of wind turbines applying high voltage generators becomes significant. Power electronics are more expensive at these high voltages and there are very few suppliers. The application of high voltage generators means that the requirements regarding safety etc. according to international standards are very different from the requirements applying at low voltage (<1000Vac). These requirements include increased requirements on the level of training of maintenance crew, and different rules of safety. The need for service and maintenance are similar to the equivalent type of system at low voltage. It depends on the type of machine and if gearbox is included, see above.

Recently ABB have announced the WINDFORMER - a high voltage multi-pole permanent magnet synchronous generator, specially developed for application in wind turbines. The WINDFORMER is based on ABB's POWERFORMER concept in which the windings of the stator are made from high voltage cables. This makes a robust construction that is directly connected to the high voltage grid. The utilisation of permanent magnets in a multi-pole rotor also reduces the rotor losses significantly and makes it possible to eliminate the gearbox. The idea of ABB is to combine the WINDFORMER technology with their HVDC-light technology in order to provide a complete concept for the electrical design of not only the wind turbine but of the whole wind farm including the grid connection. The main ideas of the WINDFORMER concept are:

- To provide a simple mechanical construction, without a gearbox, simple power electronics at the wind turbine (diode rectifier) in order to reduce maintenance and increase availability.
- To provide an efficient drive train by having an efficient generator, no gearbox, and a low loss diode rectifier.
- To exploit the features of the HVDC-light technology to have a simple internal grid in the wind farm and to have a high quality grid interface.

ABB is currently testing a prototype of the generator and will later test a complete wind turbine together with Scanwind A/S.

The major disadvantages involved are the cost of the total system and the uncertainty of the long-term performance of the equipment since it uses all new concepts.

2.8 Trends and perspectives

In the previous subsections, the focus has been on technical issues, whereas trends and perspectives are more the subject of this section. The present situation for seven types of generators regarding specific weight and specific price are illustrated in Figure 32 and Figure 33, respectively. These figures present the case of five asynchronous machines – i.e. three cage rotor machines with 4, 6 and 4/6 poles and two slip ring machines 4 and 6 poles, and two synchronous machines 4 and 6 poles, with wound rotor. The two synchronous machines are not relevant for application in wind turbines. They were included solely for comparison purposes. The origin of the data from ABB or Siemens have not been specified, since the purpose of Figure 32 and Figure 33 is to indicate trends rather than to benchmark products from these companies.

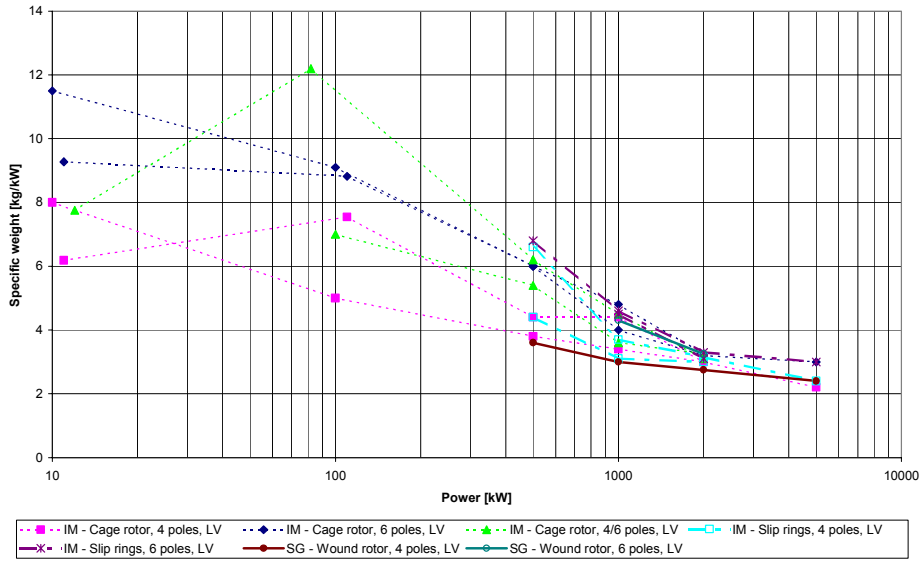


Figure 32. Specific weight for five relevant types of induction generators (IM) and two synchronous generators (SG). Estimated data supplied by ABB and Siemens.

As may be observed in Figure 32, the general trend of specific generator weight approximates to 3 kg/kW in the case of the Megawatt machines. The deviation is quite small in this area.

Regarding the specific price in Figure 33, larger machines may be expected to have an improved price-power ratio. The classical 4-pole cage rotor machine is the most cost efficient of the selected designs, while the slip ring machines turn out to have the poorest price performance.

It should be noted that the machines discussed in Figure 32 and Figure 33 are low voltage machines. The increasing nominal wind turbine power size may lead to application of medium or high voltage machines. This is highly likely, as the machines are getting more compact and the currents are increasing, i.e. higher losses will occur, and higher demands to cooling may be expected.

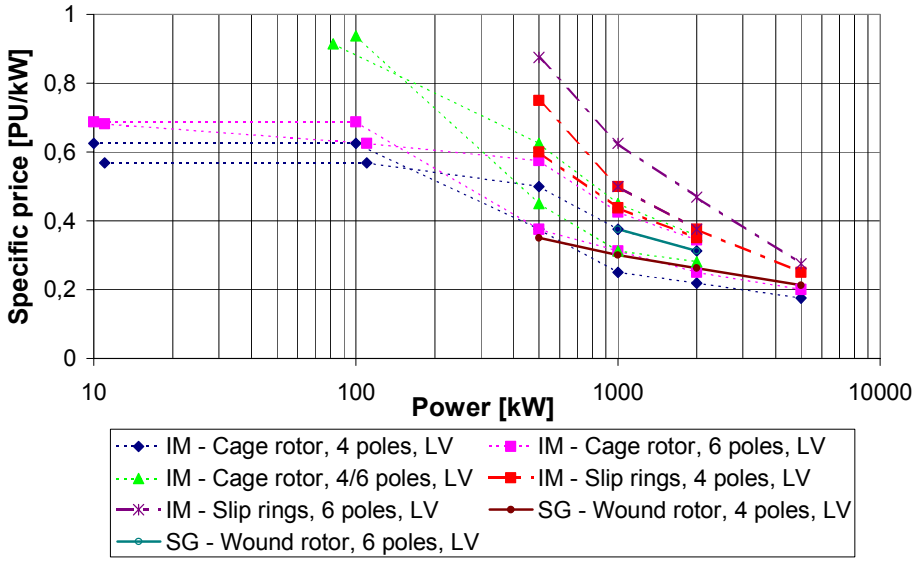


Figure 33. Specific price for five relevant types of induction generators (IM) and two equivalent synchronous generators (SG). Estimated data supplied by ABB and Siemens.

An equivalent analysis of multi-pole machines would be of interest. At present, it seems that this market is quite sensitive, and data is not easy to obtain. Nevertheless, in order to analyse and forecast trends on this aspect a number of gear manufactures have been asked to supply this report with gear data.

Based on the previous analysis of generators, it may be stated that an increasing size will both give a better specific weight and specific price. Therefore, the trend will move against still bigger wind turbines. Further on, consideration on solutions with gear versus without gear becomes still more important because the development in power electronics make it more feasible to use gearless solutions. Important solutions are the synchronous generator with field winding, the switched reluctance generator and the transverse flux machine. Also generators with permanent magnets become still more interesting, due to the lower price of the magnets. It can therefore be recommended that more research is conducted in this area. However, new generator concepts in Mega watt scale are very expensive to prototype. Further on, making a new production line also include huge investments.

More research is also necessary in the classical solutions using power electronics. Especially, it is important to be able to predict the losses in order to keep a high reliability. Related to this it is also at interest to investigate gearboxes and drive train loads using variable speed. The mechanical stress may be reduced using variable speed. The doubly fed induction generator is now widely used but still research is needed in diagnosis, control and even more optimized design in order to reduce the losses to a minimum but also to reduce the overall prices of the generator system. New solutions with a gearbox (low gearing) together with a multi-pole generator may also be an interesting solution both in respect to cost but also in respect to weight.

An indirect way to shed some light on the gear versus gearless machine concept is to take a closer look on the gearbox. The most interesting factor is probably the weight of the gearbox. Data on this parameter is shown in Figure 34. The origin of the data from Brook Hansen Transmission and Lohmann & Solterfoht

is not directly specified, since the purpose of Figure 34 and the following 3 figures it is to indicate trends rather than benchmark products from these companies.

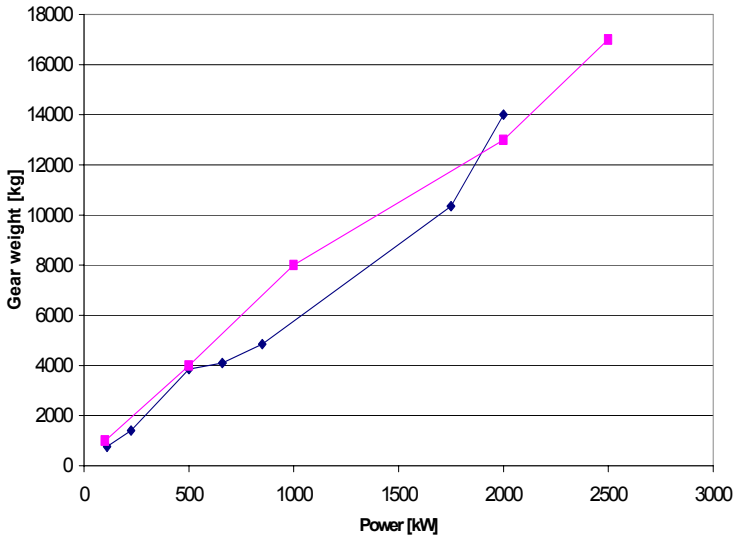


Figure 34: Weight data on gearboxes. Estimated data from Brook Hansen Transmission and Lohmann & Solterfoht.

As it can be observed in Figure 34, the weight of the gearbox is approximately a linear function of the power of the wind turbine. In Figure 35 the specific weight is presented.

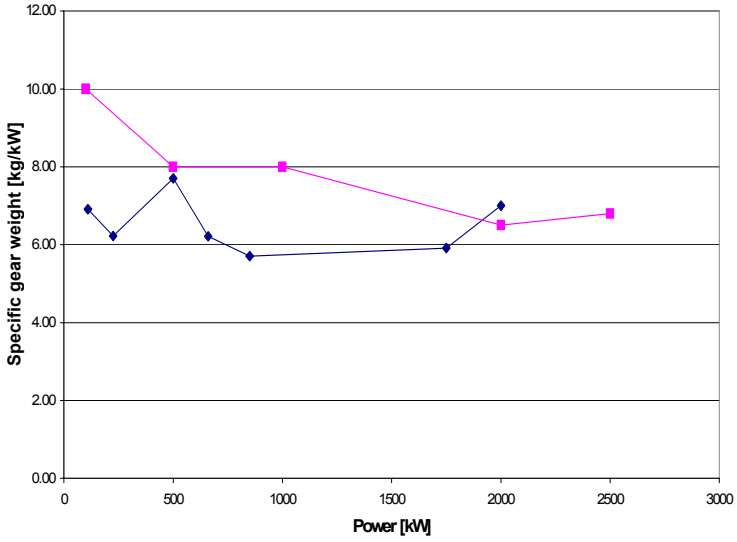


Figure 35: Specific gear weight. Estimated data from Brook Hansen Transmission and Lohmann & Solterfoht.

The trend presented in Figure 35 converges to a specific gear weight of 6-7 kg/kW. The specific weight of the gearbox and e.g. a 4 pole cage rotor machine is approximately 10 kg/kW. The corresponding number of a synchronous multipole generator is in the range of 20-30 kg/kW (Søndergaard & Bindner, 1995). Thus the gearless concept is more than twice as heavy.

Another interesting gearbox parameter is the oil volume. This is shown in Figure 36, based on the same setup as above.

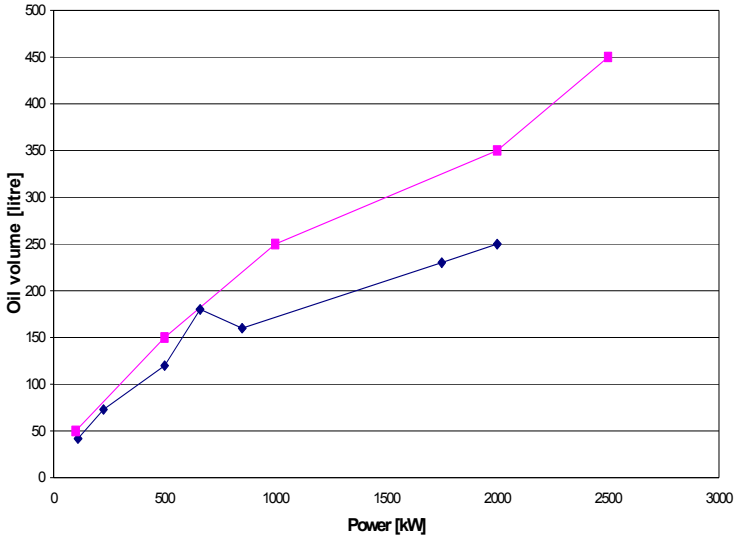


Figure 36: Oil volume of gearboxes. Estimated data from Brook Hansen Transmission and Lohmann & Solterfoht.

The trend in Figure 36 is clear – higher power of course implies more oil. Looking at the specific oil volume a surprising fact is revealed. The specific oil volume decreases exponentially with the power – see Figure 37. This clearly indicates an intensive optimization of the gearbox.

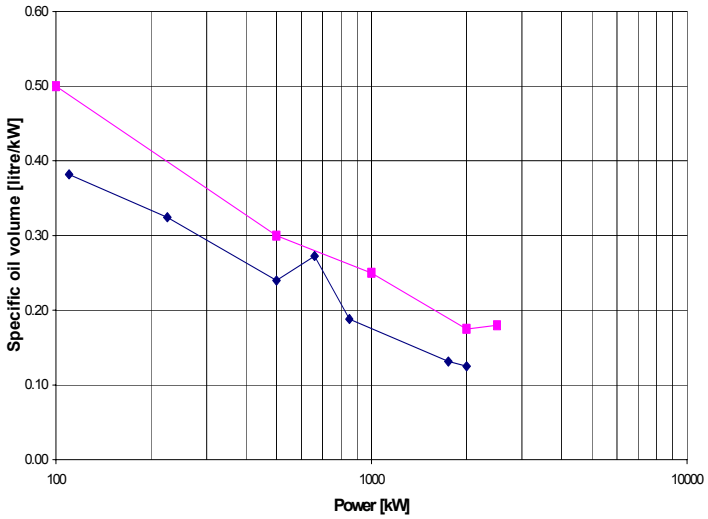


Figure 37: Specific oil volume of gearboxes. Estimated data from Brook Hansen Transmission and Lohmann & Solterfoht.

3 Power Electronic Concepts

Power electronics is a rapidly developing technology. Components are getting higher current and voltage ratings, the power losses decrease and the devices become more reliable. The devices are also very easy to control with a mega scale power amplification. The prices are still going down pr. kVA and power converters are becoming attractive as a mean to improve the performance of a wind turbine. This chapter will discuss the standard power converter topologies from the simplest converters for starting up the turbine to advanced power converter topologies, where the whole power is flowing through the converter. Further, different park solutions using power electronics are also discussed.

3.1 Criteria for concept evaluation

The most common topologies are selected and discussed in respect to advantages and drawbacks. Very advanced power converters, where many extra devices are necessary in order to get a proper operation, are omitted.

3.2 Power converters

Many different power converters can be used in wind turbine applications. In the case of using an induction generator, the power converter has to convert from a fixed voltage and frequency to a variable voltage and frequency. This may be implemented in many different ways, as it will be seen in the next section. Other generator types can demand other complex protection. However, the most used topology so far is a soft-starter, which is used during start up in order to limit the in-rush current and thereby reduce the disturbances to the grid.

3.2.1 Soft starter

The soft starter is a power converter, which has been introduced to fixed speed wind turbines to reduce the transient current during connection or disconnection of the generator to the grid. When the generator speed exceeds the synchronous speed, the soft-starter is connected. Using firing angle control of the thyristors in the soft starter the generator is smoothly connected to the grid over a predefined number of grid periods. An example of connection diagram for the soft-starter with a generator is presented in Figure 34.

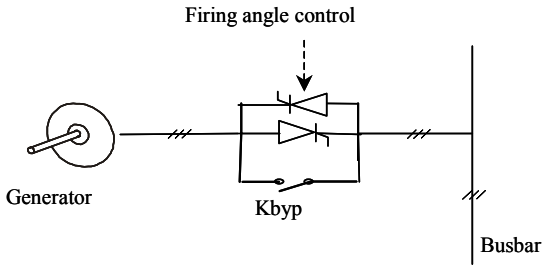


Figure 38. Connection diagram of soft starter with generators.

The commutating devices are two thyristors for each phase. These are connected in anti-parallel. The relationship between the firing angle (α) and the resulting amplification of the soft starter is non-linear and depends additionally on the power factor of the connected element. In the case of a resistive load, α may vary between 0 (full on) and 90 (full off) degrees, in the case of a purely inductive load between 90 (full on) and 180 (full off) degrees. For any power factor between 0 and 90 degrees, α will be somewhere between the limits sketched in Figure 39.

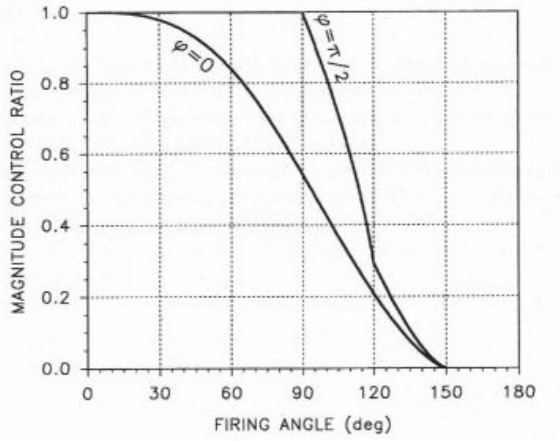


Figure 39. Control characteristic for a fully controlled soft starter.

When the generator is completely connected to the grid a contactor (Kbyp) bypass the soft-starter in order to reduce the losses during normal operation. The soft-starter is very cheap and it is a standard converter in many wind turbines.

3.2.2 Capacitor bank

For the power factor compensation of the reactive power in the generator, AC-capacitor banks are used, as shown in Figure 36. The generators are normally compensated into whole power range. The switching of capacitors is done as a function of the average value of measured reactive power during a certain period.

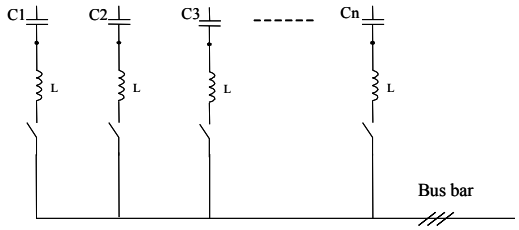


Figure 40. Capacitor bank configuration for power factor compensation in a wind turbine.

The capacitor banks are usually mounted in the bottom of the tower or in the nacelle. In order to reduce the current at connection/disconnection of capacitors a coil (L) can be connected in series. The capacitors may be heavy loaded and damaged in the case of over-voltages to the grid and thereby they may increase the maintenance cost.

3.2.3 Diode rectifier

The diode rectifier is the most common used topology in power electronic applications. For a three-phase system it consists of six diodes. It is shown in Figure 36a.

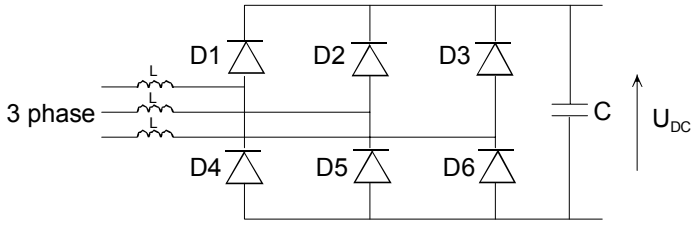


Figure 36a. Diode rectifier for three-phase ac/dc conversion

The diode rectifier can only be used in one quadrant, it is simple and it is not possible to control it. It could be used in some applications with a dc-bus.

3.2.4 The back-to-back PWM-VSI

The back-to-back PWM-VSI is a bi-directional power converter consisting of two conventional PWM-VSI. The topology is shown in Figure 41.

To achieve full control of the grid current, the DC-link voltage must be boosted to a level higher than the amplitude of the grid line-line voltage. The power flow of the grid side converter is controlled in order to keep the DC-link voltage constant, while the control of the generator side is set to suit the magnetization demand and the reference speed. The control of the back-to-back PWM-VSI in the wind turbine application is described in several papers (Bogalecka, 1993), (Knowles-Spittle et al., 1998), (Pena et al., 1996), (Yifan & Longya, 1992), (Yifan & Longya, 1995).

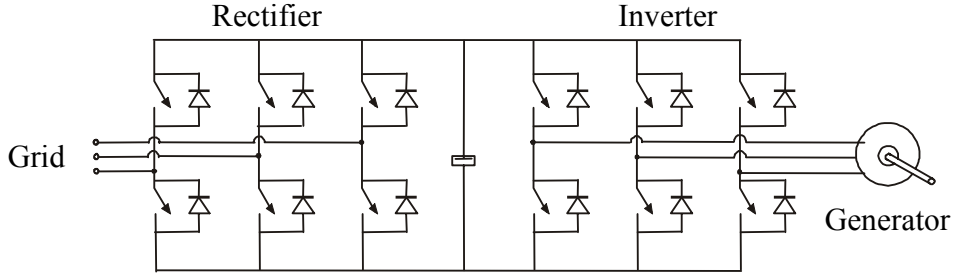


Figure 41. The back-to-back PWM-VSI converter topology.

3.2.4.1 Advantages related to the use of the back-to-back PWM-VSI

The PWM-VSI is the most frequently used three-phase frequency converter. As a consequence of this, the knowledge available in the field is extensive and well established. The literature and the available documentation exceed that for any of the other converters considered in this survey. Furthermore, many manufacturers produce components especially designed for use in this type of converter (e.g., a transistor-pack comprising six bridge coupled transistors and anti paralleled diodes). Due to this, the component costs can be low compared to converters requiring components designed for a niche production.

A technical advantage of the PWM-VSI is the capacitor decoupling between the grid inverter and the generator inverter. Besides affording some protection, this decoupling offers separate control of the two inverters, allowing compensation of asymmetry both on the generator side and on the grid side, independently.

The inclusion of a boost inductance in the DC-link circuit increases the component count, but a positive effect is that the boost inductance reduces the demands on the performance of the grid side harmonic filter, and offers some protection of the converter against abnormal conditions on the grid.

3.2.4.2 Disadvantages of applying the back-to-back PWM-VSI

This section highlights some of the reported disadvantages of the back-to-back PWM-VSI which justify the search for a more suitable alternative converter:

In several papers concerning adjustable speed drives, the presence of the DC-link capacitor is mentioned as a drawback, since it is heavy and bulky, it increases the costs and maybe of most importance, - it reduces the overall lifetime of the system. (Wen-Song & Ying-Yu, 1998); (Kim & Sul, 1993); (Siyoung Kim et al., 1998).

Another important drawback of the back-to-back PWM-VSI is the switching losses. Every commutation in both the grid inverter and the generator inverter between the upper and lower DC-link branch is associated with a hard switching and a natural commutation. Since the back-to-back PWM-VSI consists of two inverters, the switching losses might be even more pronounced. The high switching speed to the grid may also require extra EMI-filters.

To prevent high stresses on the generator insulation and to avoid bearing current problems (Salo & Tuusa, 1999), the voltage gradient may have to be limited by applying an output filter.

3.2.5 Tandem converter

The tandem converter is quite a new topology and a few papers only have treated it up till now ((Marques & Verdelho, 1998); (Trzynadlowski et al., 1998a); (Trzynadlowski et al., 1998b)). However, the idea behind the converter is similar to those presented in ((Zhang et al., 1998b)), where the PWM-VSI is used as an active harmonic filter to compensate harmonic distortion. The topology of the tandem converter is shown in Figure 42.

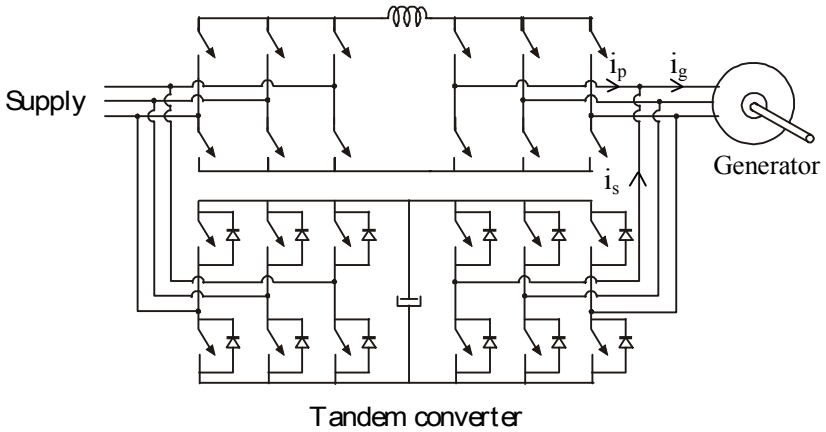


Figure 42. The tandem converter topology used in an induction generator wind turbine system.

The tandem converter consists of a current source converter, CSC, in the following designated the primary converter, and a back-to-back PWM-VSI, designated the secondary converter. Since the tandem converter consists of four controllable inverters, several degrees of freedom exist which enable sinusoidal input and sinusoidal output currents. However, in this context it is believed that the most advantageous control of the inverters is to control the primary converter to operate in square-wave current mode. Here, the switches in the CSC are turned on and off only once per fundamental period of the input- and output current respectively. In square wave current mode, the switches in the primary converter may either be GTO's, or a series connection of an IGBT and a diode.

Unlike the primary converter, the secondary converter has to operate at a high switching frequency, but the switched current is only a small fraction of the total load current. Figure 43 illustrates the current waveform for the primary converter, i_p, the secondary converter, i_s, and the total load current i_l.

In order to achieve full control of the current to/from the back-to-back PWM-VSI, the DC-link voltage is boosted to a level above the grid voltage. As mentioned, the control of the tandem converter is treated in only a few papers. However, the independent control of the CSC and the back-to-back PWM-VSI are both well established, (Mutschler & Meinhardt, 1998); (Nikolic & Jeftenic, 1998); (Salo & Tuusa, 1997); (Salo & Tuusa, 1999).

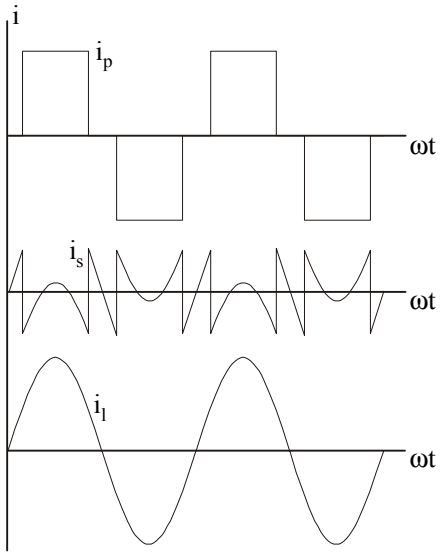


Figure 43. Current waveform for the primary converter, i_p, the secondary converter, is, and the total load current i_l.

3.2.5.1 Advantages in the use of the Tandem Converter

The investigation of new converter topologies is commonly justified by the search for higher converter efficiency. Advantages of the tandem converter are the low switching frequency of the primary converter, and the low level of the switched current in the secondary converter. It is stated that the switching losses of a tandem inverter may be reduced by 70%, (Trzynadlowski et al., 1998a) in comparison with those of an equivalent VSI, and even though the conduction losses are higher for the tandem converter, the overall converter efficiency may be increased.

Compared to the CSI, the voltage across the terminals of the tandem converter contains no voltage spikes since the DC-link capacitor of the secondary converter is always connected between each pair of input- and output lines (Trzynadlowski et al., 1998b).

Concerning the dynamic properties, (Trzynadlowski et al., 1998a) states that the overall performance of the tandem converter is superior to both the CSC and the VSI. This is because current magnitude commands are handled by the voltage source converter, while phase-shift current commands are handled by the current source converter (Zhang et al., 1998b).

Besides the main function, which is to compensate the current distortion introduced by the primary converter, the secondary converter may also act like an active resistor, providing damping of the primary inverter in light load conditions (Zhang et al., 1998b).

3.2.5.2 Disadvantages of using the Tandem Converter

An inherent obstacle to applying the tandem converter is the high number of components and sensors required. This increases the costs and complexity of both hardware and software. The complexity is justified by the redundancy of the system (Trzynadlowski et al., 1998a), however the system is only truly redundant if a reduction in power capability and performance is acceptable.

Since the voltage across the generator terminals is set by the secondary inverter, the voltage stresses at the converter are high. Therefore the demands on the output filter are comparable to those when applying the back-to-back PWM-VSI.

In the system shown in Figure 38, a problem for the tandem converter in comparison with the back-to-back PWM-VSI is the reduced generator voltage. By applying the CSI as the primary converter, only 0.866% of the grid voltage can be utilized. This means that the generator currents (and also the current through the switches) for the tandem converter must be higher in order to achieve the same power.

3.2.6 Matrix converter

Ideally, the matrix converter should be an all silicon solution with no passive components in the power circuit. The ideal conventional matrix converter topology is shown in Figure 44.

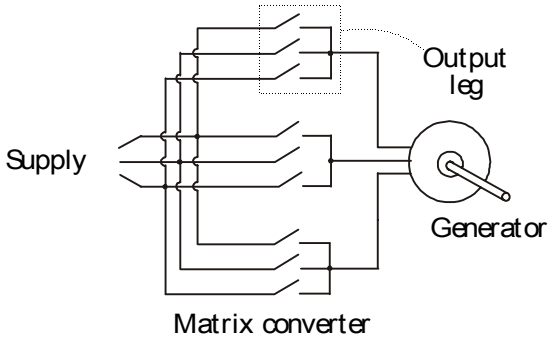


Figure 44. The conventional matrix converter topology.

The basic idea of the matrix converter is that a desired input current (to/from the supply), a desired output voltage and a desired output frequency may be obtained by properly connecting the output terminals of the converter to the input

terminals of the converter. In order to protect the converter, the following two control rules must be complied with: Two (or three) switches in an output leg are never allowed to be on at the same time. All of the three output phases must be connected to an input phase at any instant of time. The actual combination of the switches depends on the modulation strategy.

3.2.6.1 Advantages of using the Matrix Converter

This section summarises some of the advantages of using the matrix converter in the control of an induction wind turbine generator.

For a low output frequency of the converter the thermal stresses of the semiconductors in a conventional inverter are higher than those in a matrix converter. This arises from the fact that the semiconductors in a matrix converter are equally stressed, at least during every period of the grid voltage, while the period for the conventional inverter equals the output frequency. This reduces the thermal design problems for the matrix converter.

Although the matrix converter includes six additional power switches compared to the back-to-back PWM-VSI, the absence of the DC-link capacitor may increase the efficiency and the lifetime for the converter (Schuster, 1998).

Depending on the realization of the bi-directional switches, the switching losses of the matrix inverter may be less than those of the PWM-VSI, because the half of the switchings become natural commutations (soft switchings) (Wheeler & Grant, 1993).

Compared to converters with constant DC-link voltage and only two output levels, the output harmonic content of the matrix converter is lower, due to the fact that the output voltage of the matrix converter is composed of three voltage levels.

3.2.6.2 Disadvantages and problems of the matrix converter

A disadvantage of the matrix converter is the intrinsic limitation of the output voltage. Without entering the over-modulation range, the maximum output voltage of the matrix converter is 0.866 times the input voltage. To achieve the same output power as the back-to-back PWM-VSI, the output current of the matrix converter has to be 1.15 times higher, giving rise to higher conducting losses in the converter (Wheeler & Grant, 1993).

In many of the papers concerning the matrix converter, the unavailability of a true bi-directional switch is mentioned as one of the major obstacles for the propagation of the matrix converter. In the literature, three proposals for realizing a bi-directional switch exists. The diode embedded switch (Neft & Schauder, 1988) which acts like a true bi-directional switch, the common emitter switch and the common collector switch (Beasant et al., 1989). The latter two are able to control the current direction, which is preferable in the phase commutations.

Since real switches do not have infinitesimal switching times (which is not desirable either) the commutation between two input phases constitutes a contradiction between the two basic control rules of the matrix converter. In the literature at least six different commutation strategies are reported, (Beasant et al., 1990); (Burany, 1989); (Jung & Gyu, 1991); (Hey et al., 1995); (Kwon et al., 1998); (Neft & Schauder, 1988). The most simple of the commutation strategies are those reported in (Beasant et al., 1990) and (Neft & Schauder, 1988), but neither of these strategies complies with the basic control rules. The most used

commutation strategies are those reported in (Burany, 1989) and (Kwon et al., 1998). In either of (Burany, 1989) or (Kwon et al., 1998), half of the switchings become soft switchings, thereby reducing the switching losses. The solutions in (Jung & Gyu, 1991) and (Hey et al., 1995) require a more complex hardware structure of the converter.

Due to the absence of the DC-link, there is no decoupling between the input and output of the converter. In ideal terms, this is not a problem but in the case of unbalanced or distorted input voltages, or unbalanced load, the input current and the output voltage also become distorted. Several papers have dealt with the problems of unbalanced input voltages and various solutions have been proposed (Casadei et al., 1994); (Casadei et al., 1995a); (Casadei et al., 1995b); (Casadei et al., 1996); (Enjeti & Wang, 1990); (Nielsen, 1996); (Nielsen et al., 1996); (Oyama et al., 1997); (Zhang et al., 1998a). Each of the solutions has superiorities and drawbacks, and the choice of solution depends on which performance indicator has the highest priority (input disturbance, line losses, controllability of the input power factor etc.).

Finally, the protection of the matrix converter in a fault situation presents a problem. The protection of the matrix converter is treated in (Nielsen, 1996). This protection circuit adds an extra 12 diodes and a DC-link capacitor to the component list, although these components are rated much smaller than the components in the power part of the matrix converter.

3.2.7 Multilevel Converter

Since the development of the neutral-point clamped three-level converter (Nabae et al., 1981), several alternative multilevel converter topologies have been reported in the literature. The general idea behind the multilevel converter technology is to create a sinusoidal voltage from several levels of voltages, typically obtained from capacitor voltage sources. The different proposed multilevel converter topologies can be classified in the following five categories (Lai & Peng, 1996); (Lai & Peng, 1995); (Manjrekar & Venkataramanan, 1996); (Marchesoni & Mazzucchelli, 1993); (Suh et al., 1998):

- Multilevel configurations with diode clamps (Nam et al., 1991); (Sun-Kyoung Lim et al., 1999); (Nabae et al., 1981); (Lixiang & Fahai, 1999).
- Multilevel configurations with bi-directional switch interconnection (Brumsickle et al., 1998); (Nabae et al., 1981).
- Multilevel configurations with flying capacitors (Xiaoming et al., 1999).
- Multilevel configurations with multiple three-phase inverters (Cengelci et al., 1998).
- Multilevel configurations with cascaded single phase H-bridge inverters (Peng et al., 1997).

A common feature of the five different multilevel converter concepts is, that in theory, all the topologies may be constructed to have an arbitrary number of voltage levels, although in practice some topologies are easier to realize than others. The principle of the five topologies is illustrated in Figure 45.

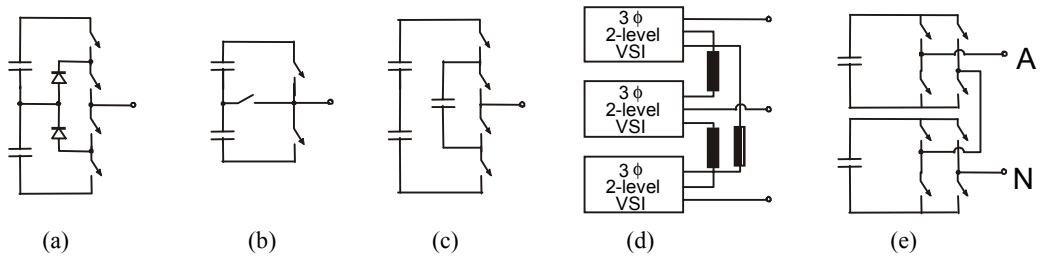


Figure 45. Multilevel topologies. a) One inverter leg of a three-level diode clamped multilevel converter. b) One inverter leg of a three-level multilevel converter with bi-directional switch interconnection. c) One inverter leg of a three level flying capacitor multilevel converter. d) Schematic presentation of a three-level converter consisting of three three-phase inverters. e) One inverter leg of a three-level converter consisting of H-bridge inverters.

Below is a brief comment on the different multi-level converter topologies:

a) Despite the more complex structure, the diode clamped multilevel converter is very similar to the well known back-to-back PWM-VSI. Unlike the multilevel topologies shown in Figure 45d and Figure 45e, the diode clamped multilevel converter may be coupled directly to the grid without transformers. For a converter based on the diode clamped multilevel converter a voltage-balancing problem occurs for levels higher than three, but for a three level converter this is only a minor problem.

b) For a three level structure, the topology of the multilevel converter with bi-directional switch interconnection requires the same number of switches as the diode clamped three-level converter and the three-level flying capacitor converter. However, half of the switches have to block the full DC-link voltage.

c) The topology of the flying capacitor multilevel converter is very similar to that of the diode clamped multilevel converter shown in Figure 45a. In the literature it is stated, that the voltage-balancing problem is relatively easy to solve, compared to the diode clamped converter. The difference in component count between the diode clamped multilevel converter and the flying capacitor multilevel converter is, that two diodes per phase may be substituted by one capacitor.

d) The number of switches (and other components) required realizing a three level converter is very high compared to the concepts a-c, but the converter can be realized from the well-proven VSI technology.

e) The multilevel converter based on multiple H-bridge inverters is heavy, bulky and complex (Nam et al., 1991), and maybe of most importance, - connecting separated DC-sources between two converters in a back-to-back fashion is very difficult because a short circuit will occur when two back-to-back converters are not switching synchronously (Lai & Peng, 1996), (Suh et al., 1998).

3.2.7.1 Advantages in the use of the multilevel converter

Initially, the main purpose of the multilevel converter was to achieve a higher voltage capability of the converters. As the ratings of the components increases

and the switching- and conducting properties improve, the secondary effects of applying multilevel converters become more and more advantageous. In recent papers, the reduced content of harmonics in the input and output voltage is highlighted, together with the reduced EMI (Tolbert & Peng, 1999). The multilevel converter distinguishes itself by being that converter in this survey with the lowest demands to the input filters. (or alternatively reduced number of switchings) (Rodriguez et al., 1999).

The switching losses of the multilevel converter are another feature, which is often accentuated. In (Marchesoni & Mazzucchelli, 1993), it is stated, that for the same harmonic performance the switching frequency can be reduced to 25% of the switching frequency of a two-level converter. Even though the conducting losses are higher for the multilevel converter, it is stated in (Tolbert & Peng, 1999) that the overall efficiency for the diode clamped multilevel converter is higher than the efficiency for a comparable two-level converter. Of course, the truth in this assertion depends on the ratio between the switching losses and the conducting losses.

3.2.7.2 Disadvantages concerning the multilevel converter

The most commonly reported disadvantage of the three level converters with split DC-link is the voltage imbalance between the upper and the lower DC-link capacitor. However, for a three-level converter this problem is not very serious, and the problem in the three-level converter is mainly caused by differences in the real capacitance of each capacitor, inaccuracies in the dead-time implementation or an unbalanced load (Shen & Butterworth, 1997). By a proper modulation control of the switches, the imbalance problem can be solved (Sun-Kyoung Lim et al., 1999). In (Shen & Butterworth, 1997), the voltage balancing problem is solved by hardware, while (Newton & Sumner, 1997) and (Peng et al., 1995) proposed solutions based on modulation control. However, whether the voltage-balancing problem is solved by hardware or software, it is necessary to measure the voltage across the capacitors in the DC-link.

For converters based on the topology in Figure 45a to Figure 45c, another problem is the unequal current stress on the semiconductors. It appears that the upper and lower switches in an inverter branch might be derated compared to the switches in the middle. For an appropriate design of the converter, different devices are required (Lai & Peng, 1996). For the topology in Figure 45b it appears that both the unequal current stress and the unequal voltage stress might constitute a design problem.

From the topologies in Figure 45, it is evident that the number of semiconductors in the conducting path is higher than for the other converters treated in this survey, this might increase the conduction losses of the converter. On the other hand, each of the semiconductors need only block half the total DC-link voltage and for lower voltage ratings, the on-state losses per switch decreases, which to a certain extent might justify the higher number of semiconductors in the conducting path.

3.2.8 Resonant converter

In the efforts towards reducing the switching losses in power converters, several resonant converter topologies have been proposed. A common drawback of these converter topologies is that they suffer from one or more of the following properties.

- Complex hardware structure and complex control.
- High peak voltage in the DC-link and across the load.
- High power flow through the resonant circuit.

The only resonant converter treated in this section is a topology, which does not suffer from the disadvantages mentioned above. The converter topology is termed *Natural Clamped Converter* (NCC). The NCC topology is shown in Figure 46.

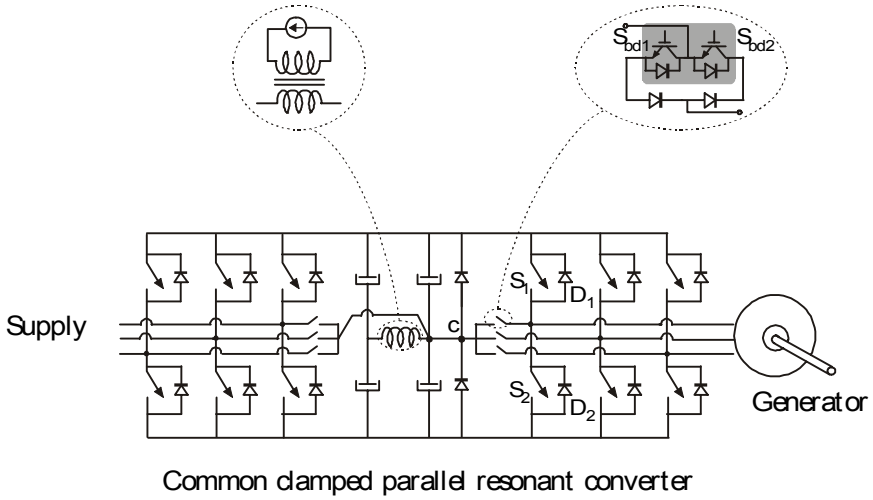


Figure 46. The natural clamped converter topology used in the induction generator wind turbine system.

The NCC consists of the conventional back-to-back PWM-VSI and in addition a circuit to obtain the resonance. To start and to maintain the resonance an inductive energy transfer is used. In order to control the current to/from the supply grid, the DC-link voltage is boosted. Like for the back-to-back PWM-VSI, it is assumed that the voltage is boosted to 800 V. In Figure 46, the boost inductances are shown as a part of the line filter. The used switches in the resonance circuit are bi-directional switches and as in the case of the matrix converter, these have to be built from several discrete devices. The bi-directional switch shown in Figure 46 is made from a standard two-pack transistor module and additional two diodes, but may as well be constructed as a common-emitter, a common-collector or a diode-embedded switch.

3.2.8.1 The commutation process for the NCC.

To explain the operating mode of the NCC, assume that the load current is flowing through diode D_2, resulting from a positive load current. At a given time, the controller demands turn off of S_2. To achieve the commutation, both switches S_{bd1} and S_{bd2} in the bi-directional switch are first turned on when the voltage at point *c* is equal to $u_{DC}/2$. Then S_2 is turned off at zero voltage (and zero current because D_2 was conducting). During the following half period of the resonance, the load current is supplied through S_{bd1} and the voltage across S_1 decreases. When the voltage at point *c* reaches $u_{DC}/2$, the voltage across S_1 is zero. Then, first S_{bd2} is turned off, then S_1 is turned on and finally S_{bd1} may be turned off. The commutation process is depicted in Figure 47.

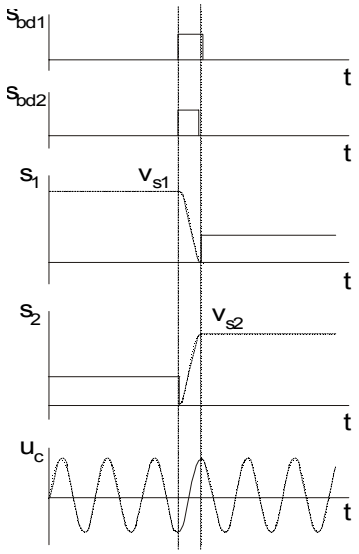


Figure 47. Illustration of the commutation procedure for the NCC.

The NCC is suitable both for discrete pulse modulation (DPM), and pulse width modulation (PWM). Both techniques are described in several papers concerning different resonant converters and a brief survey is given in (Munk-Nielsen, 1997).

3.2.8.2 Advantages in the use of the NCC

Compared to other resonant converters, the NCC possesses the advantageous properties of the different resonant converters while the unsuitable properties are avoided. The advantageous properties of the NCC are: the resonant voltage is clamped and never exceeds the DC-link voltage, the resonant circuit is not in the power part of the converter, and only one resonant circuit is needed for the entire converter.

By inspection of the topology of Figure 46, it appears that the NCC also supports three level operations. This implies however, that the bi-directional switches must be rated for a higher power level. In comparison with the back-to-back PWM-VSI, the main advantage of the NCC is the reduced switching losses, which in applications where the switching losses dominate might increase the overall converter efficiency. Furthermore, due to the lower du/dt, the radiated EMI is reduced, and the demands to the output filter inductance might be reduced. The conduction losses of the NCC are similar to those of the back-to-back PWM-VSI.

The modulation of the NCC may be either PWM or DPM (Direct Pulse Modulation). It may also be possible to use a different modulation strategy in the machine inverter and in the grid inverter. The use of DPM makes the response of the converter very fast, while the use of PWM more or less gives a harmonic spectrum comparable to that of a back-to-back PWM-VSI.

3.2.8.3 Disadvantages of the NCC

Although the complexity is less than the pole commutated resonant converter (Pickert & Johnson, 1998); (Teichmann & Bernet, 1998), the converter is still more complex (hardware and control) than the back-to-back PWM-VSI and several additional components are needed. Furthermore sensors are needed to

detect the zero voltage events and to determine the energy needed to maintain the resonance.

As mentioned above, the use of the DPM technique yields fast response time, but a consequence of the DPM is that the switching harmonics are distributed over a broader spectrum (Dehmlow et al., 1993). The broad switching harmonic spectrum makes the grid filter design procedure a quite difficult task since the harmonics may coincide with the resonant frequency of the filters. However, this increases the complexity of the converter.

The voltage imbalance of the two main capacitors may constitute a problem for the NCC. For every commutation, only one of the main capacitors is discharged. In the case of asymmetrical commutations due to small differences in the switch characteristics, the voltage unbalance has to be compensated actively.

3.2.9 Comparison of the five frequency converters

The five converters presented above: the back-to-back PWM VSI, the tandem converter, the matrix converter, the multilevel converter and the NCC, may be evaluated in terms of their applicability to wind turbine systems. For each converter, a presentation of the topology and the working principles has been presented, combined with a discussion of advantages and disadvantages.

It is evident that the back-to-back converter is highly relevant, as this converter is the one used in wind turbines today. Therefore, this converter type may be used as a reference in a benchmark of the other converter topologies:

- Components and ratings. Considering the number of used components, the matrix converter differs from the other converters, because it consists only of active components in the power part. The back-to-back converter includes a moderate number of passive components, while it has the least number of active components. The latter three converters all include a high number of both active and passive components.
- Auxiliary components. Two converters distinguish themselves, namely the matrix converter and the multilevel converter. The main reason for this statement is that in both the transformer may be omitted, without requiring excessively high voltage ratings for the components. On the other hand, the tandem converter and the NCC both require a greater number of transducers than the other three converters.
- Efficiency. Assessment of the efficiency of the five converters is based on the literature and includes the reported conducting losses and switching losses. The NCC is assessed to have potentially the highest efficiency of the five converters – followed by the multilevel converter and the tandem converter.
- Harmonic performance. Considering the harmonic performance, and the requirements for filters, the multilevel converter shows the best spectra on both the grid side and the generator side. The only converter that really seems to constitute a problem for the filter design is the DPM modulated NCC. Due to a broad switching spectrum, the filter design may be complicated.

- Implementation. Because the back-to-back converter and the multi-level converter are the most used commercial converters of the five, it is believed that these two converters are the least troublesome converters to implement, while the three latter all are quite undiscovered in a commercial sense.

Summarising the findings on the converters presented it is concluded that the back-to-back converter, the matrix converter and the multilevel converter are to be recommended for further studies in different generator topologies.

3.3 Park solutions

Wind power installations with blade angle control and/or power converters are able to control the active power supply to the power system. Moreover, wind power installations with power converters are able also to control the reactive power supply to the power system. The active power control in these wind power installations normally serve to obtain maximum production, and limit the power to avoid only overloading and stress of the wind turbine components, whereas the reactive power control serves to obtain a constant, high power factor, e.g. at unity.

Other types of active control of power plants in the power system contribute to the frequency control by regulation of the active power, and to the voltage control by regulation of the reactive power. Such control capabilities can also be obtained in wind power installations fitted with power converters, but have only been practised in a few cases. The main reason for this is caution because the impact on the stability of the power system becomes a concern when thousands of wind turbines were to regulate the voltage on the local terminals independently. However, in the future such performance is expected from the parks.

For power systems with a large amount of wind energy, the ability of the wind power installations to contribute to the regulation of the voltage and frequency of the power system becomes an important issue, because it influences the ability of the wind power installations to replace other power plants strongly. Thus, both the capacity credit of the wind power installation and the fuel savings at other power plants are influenced by the control capabilities of the wind power installations.

To provide the wind power installations with power system control capabilities and to improve the influence on the power system stability, central power electronic units in large wind farms are a promising technical solution. Central units may be connected to the power system at the wind farm connection point, and consequently could contribute to the control of the voltage and frequency at that point. In this respect, wind farms with central power electronic units can act more like a regular power plant. Also, the application of central units is likely to be the most cost effective way to provide control capabilities for large wind farms.

3.3.1 Reactive power compensation units

Reactive power compensation units are widely used in power systems to provide the reactive power balance and improve the voltage stability. These compensation units are used to supply both inductive and capacitive power. Typically, capacitive power is supplied to compensate for reactive loads while inductive power is supplied to compensate for capacitive consumption in cables.

The most used units to compensate for reactive power in the power systems are either synchronous condensers or shunt capacitors, the latter either with mechanical switches or with thyristor switches, as in Static Var Compensators (SVC). The disadvantage of using shunt capacitors is that the reactive power supplied is proportional to the square of the voltage. Consequently, the reactive power supplied from the capacitors decreases rapidly when the voltage decreases. The reactive power is needed to maintain voltage stability.

STATCOMs or ASVCs are inverters based on forced-commutated switches, i.e. with full, continuous control of the reactive power. The maximum available reactive power from a STATCOM is proportional to the voltage, and consequently the available maximum reactive power decreases more slowly for STATCOMs than SVCs, when the voltage decreases.

The transmission system operator ELTRA in the western half of Denmark has installed a 2×4 MVA ASVC (Stöber et al., 1998) on the 24 MW wind farm at Rejsby Hede, to demonstrate and test this concept. The Rejsby Hede wind farm consists of forty, 600 kW, NEG-Micon wind turbines with directly connected induction generators. The no-load consumption of reactive power in the induction generators is compensated by shunt capacitors on the 700 V level, in the individual wind turbines.

The ASVC at Rejsby Hede compensates for the load-dependent reactive power consumption in the wind farm by a fast, continuous reactive power regulation at the wind farm connection point. Thus, the ASVC runs in the power factor control mode, i.e. controls the power factor to be unity at the wind farm connection point.

The ASVC may in principle also run in a voltage regulation mode, i.e. participate in the voltage regulation on the grid. However, the grid is very strong at the wind farm connection point of the Rejsby Hede wind farm. Therefore, the ASVC has not been designed to participate in the voltage regulation, and it has also not been tested in that mode.

Further issues on these compensation units may be found in Table 10 and Table 11 in the next section.

3.3.2 Power regulation and storage units

The normal power regulation strategy of a wind turbine is designed to combine optimisation of operation and limitation of the power to protect the wind turbine. Overall wind farm regulation of the power to meet the requirements of the grid is not so common, but some examples of voltage dependent power regulation are known. At Cronalaght wind farm in Ireland (Bindner, 1999a), the blade angle control is used to limit the power. At Bockstigen wind farm in Sweden, dump loads and disconnection of wind turbines are used (Lange et al., 1999) as control options.

When wind energy penetration in the power system becomes high, the use of storage units becomes interesting, because the limitation of power required by the power system may lead to substantial loss of available energy from the wind turbines. At the same time, storage units may ensure power delivery from the wind farm, even when the wind speed is low. Consequently, storage units can provide large wind farms with power regulation capabilities, which can enable wind farms to replace, and not just to supplement, other power plants. Besides a

capacity reduction of other power plants, such regulation capabilities may further reduce the requirement for spinning reserve and thus reduce the total fuel costs in the power system. Therefore, the development of storage technologies is very important to the development of wind energy.

When the natural resources are available, pumped storage may be competitive to grid reinforcement today (Bindner, 1999b). However, in many places, pumped storage is not an option. Therefore, the development of batteries, fuel cells and other storage technologies is very important. The main drawback of batteries today is the relatively high cost. An additional cost item for battery storage systems is the conversion from the AC grid to a DC. That cost could be avoided if the batteries were connected to an existing DC voltage, e.g. the DC link in an ASVC, or an HVDC transmission.

3.3.3 HVDC

One of the most widely discussed concepts for grid connection of large (offshore) wind farms is HVDC. This is due to a combination of the rapid development of this technology and the advantages that this technology can give for system operation as well as wind turbine operation.

An HVDC link consists of a minimum of two AC/DC converter stations and a DC cable to link the stations. The latest semiconductor technology development, combined with advanced control of series connected semiconductors has provided modern HVDC transmission systems, like ABBs HVDC Light, with fully controllable converters, based on forced commutated semiconductors.

HVDC technologies are mainly interesting for power transmission over longer distances. The DC cable is less expensive than an AC transmission cable with the same capacity, but the costs of the converter stations make the complete HVDC link more expensive than the corresponding AC link, if the transmission distance is below a certain threshold. The exact threshold distance for HVDC Light today is not public because of commercial interests (Asplund, 2000), but it is very long. Still, the threshold distance is expected to decrease rapidly with the technology development of power electronics, which reduces the cost of the converter stations.

For offshore applications, HVDC links may also be viable when the critical cable length for AC transmission is reached. In that case, a compensation unit is required on the AC transmission system, which is also very costly in the case of offshore transmission.

The world's first HVDC Light installation is operating today on Gotland. It was installed to increase the transmission capacity from the many wind turbines installed in the south of the island to the consumers in the town in the north of the island (Castro, 2000). At the same time, it serves to feed reactive power into the AC grid, particularly to the wind turbines in the south, and to ensure voltage stability. ELTRA has also installed an HVDC Light connection in Tjæreborg to test the use of it for large wind turbines. This is because HVDC Light is a candidate for connection to some of the large offshore wind farms, which are targets in "Energi 21", the Danish government action plan for energy.

Because of the advantages for the power system, HVDC Light will probably be installed for transmission of power over long distance from a number of large wind farms, both offshore and on land. This will open up new possibilities for variable speed control of wind turbines, because the frequency (or frequencies)

of the grid(s) at the wind turbines can be controlled independently of the power system frequency.

The simplest HVDC Light configuration for connection of a wind farm is the group connection shown in Figure 48. The HVDC link is connected to the power system in one end and to the wind farm AC grid in the other end.

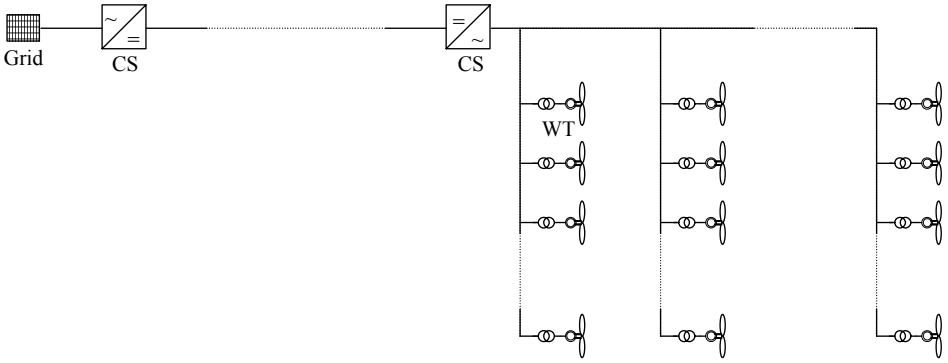


Figure 48. Group connection of a wind farm to an HVDC link.

In principle, all wind turbines designed for connection to AC grid may be connected to the wind farm AC grid in Figure 48, but many of the advantages in using power converters in the wind turbines are reduced. It is therefore most obvious to use wind turbines with directly connected induction generators. With such a concept, the converter at the wind farm will supply the wind turbines with reactive power, and in that way make the wind farm grid more robust to grid faults.

HVDC connection also makes it possible to control the frequency of the wind farm grid in order to improve the aerodynamic efficiency in the same way as for wind turbines with individual power converters. The frequency control must set the frequency as a compromise between the optimum frequency for all the individual wind turbines in the wind farm, because the wind speed and consequently the optimum frequency is different from wind turbine to wind turbine. Therefore, the aerodynamic efficiency is reduced slightly compared to wind turbines with individual power converters.

Another aspect of the group connection concept, which is probably more important is that the common frequency control cannot be used to reduce mechanical loads on the drive train like individual power converters in the wind turbines can. This is important for stall controlled wind turbines and in particular for pitch controlled wind turbines where it may be necessary to have additional speed control of the individual wind turbine, e.g. Optislip.

Another configuration, which appears to have all the technical advantages of wind turbines with individual power converters is shown in Figure 49. The wind turbines are provided with their own AC/DC converter.

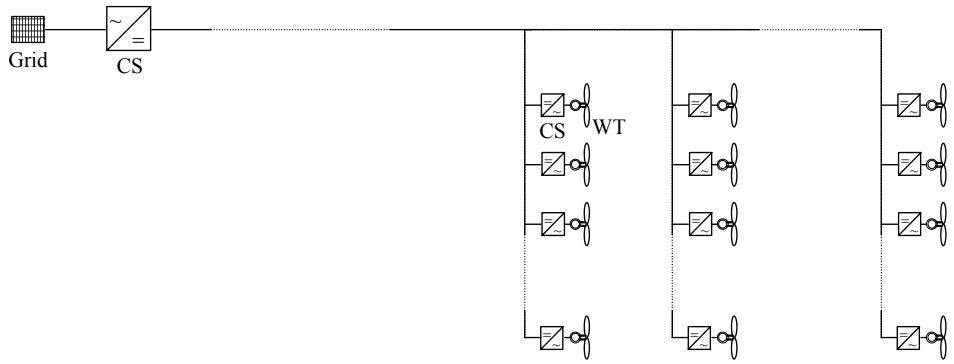


Figure 49. Individual connection of wind turbines to HVDC link.

If the AC/DC converters in the individual wind turbines are based on forced-commutated semiconductors, the frequency and consequently the speed of the wind turbines can be controlled individually. In that case, the frequency control may be used to reduce mechanical loads on the drive train, effectively using the rotor moment of inertia to absorb the fastest fluctuations in the aerodynamic loads.

ABB has proposed a new Windformer concept with individual AC/DC converters as shown in Figure 49, but using diode rectifiers in the converters (Nielsen, 2000). The generators are of synchronous type, because they must provide the magnetic field themselves. ABB proposes a multipole (gearless), high voltage permanent magnet generator, which can be connected directly to the rectifier without a transformer. The wind turbine in the Windformer concept will be pitch controlled.

The Windformer concept removes the ability to use the frequency control to reduce mechanical loads on the drive trains, because the speed control is based on control of the DC voltage at the converter at the power system connection point, which is common for all the wind turbines. The mechanical drive train loads are, however, not so critical for the Windformer concept, because the wind turbines are gearless.

A more critical aspect of the Windformer concept is whether it will be stable with the required blade pitch angles. Both the steady state stability and the dynamic stability must be studied. The system is very complicated, with speed dependent aerodynamic loads and generator AC impedances in the individual wind turbines, and only one common DC voltage, which must be controlled with compromise between all the wind turbines.

3.4 Trends and perspectives

As in Section 2, this final subsection is dedicated to a discussion on trends and perspectives. The rapid development of power electronics, as described in e.g. (Thøgersen & Blaabjerg, 2000), is already reflected in commercial converters. The present situation for two types of converters regarding specific weight and normalised specific price (per unit price) are illustrated in Figure 50 and Figure 51, respectively. The depicted data are related to back-to-back PWM VSI converters using a vector control strategy. The low voltage converters are air cooled, while the medium voltage converters are water-cooled. Again, the origin of data from the ABB or Siemens has not been specified, since the purpose of Figure 50 and Figure 51 is to indicate trends rather than to benchmark products from these companies.

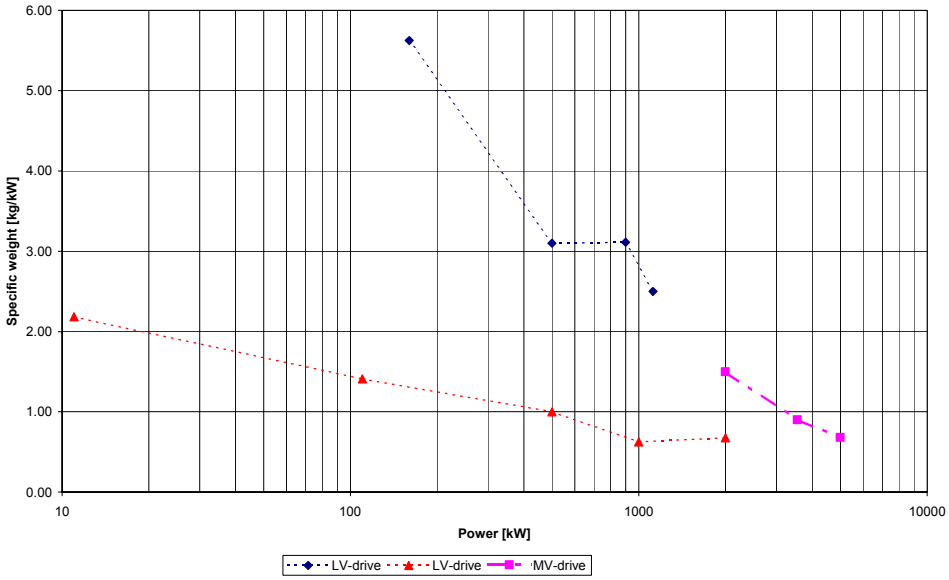


Figure 50. Specific weight of LV and MV converters. Estimated data supplied by ABB and Siemens.

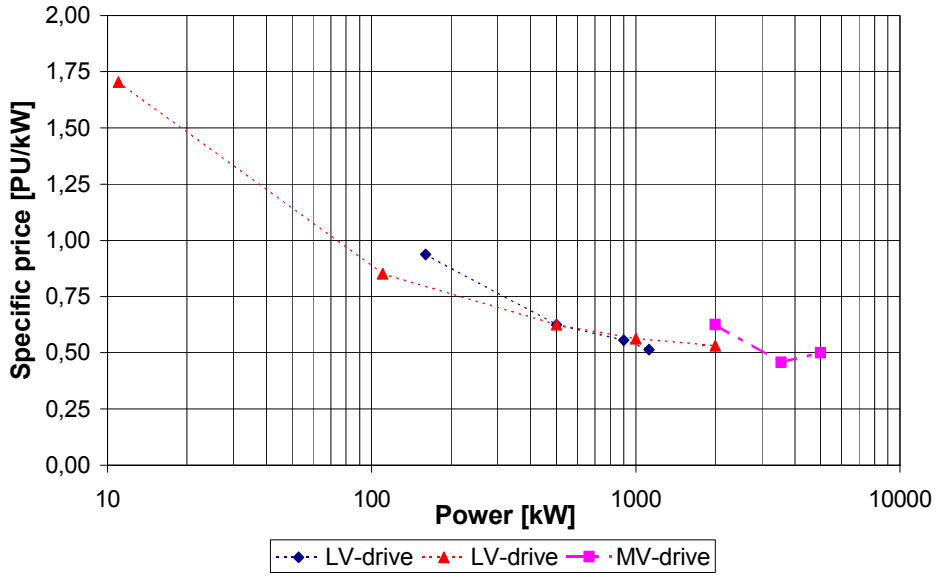


Figure 51. Specific price of LV and MV converters. Estimated data supplied by ABB and Siemens.

In Figure 50, the specific weight of the LV-converters indicates two different implementations, while Figure 51 states that this is not important for the price. The specific weight of the converters in the Megawatt range is approximately half the specific weight of the generators presented in section 2 – and still decreasing. Meanwhile, the specific price of the converters in this area is only twice the specific price of the generators presented.

4 Grid Integration Issues

This section describes the grid integration issues. The first part of this section is generic grid issues. The second part is mainly concerned with the influence of wind turbines on the power quality of the grid. Moreover, power equipment to enhance or control power quality is discussed. The third part presents different types of grids. Each of these standardised grids defines a number of demands and characteristics for a specific wind turbine design. Therefore, each grid presents different market demands. The last part of the chapter focus on integration issues on large amounts of wind power in the power system.

4.1 Grid Generics and Main Focus

A power supply system consists of three main components: 1) power generation units, 2) a grid and 3) loads, which are the customers. The primary aim of a power supply system is to meet the demands for energy imposed by the customers. The function of the grid depends on the size of the power supply system. If the amount of generated, distributed and consumed energy is of considerable size, the grid is divided in a transmission grid (high voltage) and a distribution network (medium and low voltage).

The activities related to "large", deregulated, power supply systems, i.e. generation, transmission and distribution, are in general widely different. Therefore, these activities are (or may be) covered by different supply organisations, e.g. power generation companies, transmission system operators and distribution system operators. The function of the transmission grid is to transmit energy from large power generation plants to the distribution networks, whereas the distribution networks distribute the energy from the transmission grid or from small/local power generation plants to the customers. The main objective of the power generator companies is to produce power at a cost efficient price. Meanwhile the two other organisations have a number of objectives to pursue, which may be summarised by the following goals: to achieve an acceptable level of reliability, quality and safety for the power supply at an economic price – since the price a customer has to pay is determined by the costs of the associated generation, transmission and distribution. Moreover, the transmission system operators are responsible for the overall energy production planning in their own area.

To be able to fulfil the objectives of reliability, quality and safety for the power supply at an economic price, the system operator of the transmission grid has to attend to a number of tasks, e.g.:

- To form and specify Power Station Specifications.
- To plan further development of the transmission grid.
- To contribute to optimal allocation of resources, including balancing of the requirements on various types of plants.
- To ensure the properties essential for the power system operation as regards reliability, power quality and security of supply in the short term as well as in the long run.

On a distribution network level, the same tasks are valid for the system operator of the distribution network.

The key issues for the last task are: power system control and power system specifications. The purpose of power system specifications is to ensure certain abilities and characteristics in the power input for use in the operation and control of the power system. In this way, it becomes possible to operate and control the power system under various load conditions and disturbances. Thus, the main control aspects are power system stability and power quality.

In the rest of the report, focus will be on power quality. Other important issues, which will not be discussed, are various economic items.

4.2 Power Quality and other Demands to Grid Connection

The used term 'Power Quality' is usually considered to include two aspects of power supply, namely Voltage Quality and Supply Reliability (CIGRE WG14-31, 1999). The Voltage Quality part includes different disturbances such as: rapid changes, harmonics, interharmonics, flicker, unbalance and transients, whereas the reliability part involves phenomena with a longer duration, like interruptions, voltage dips and sags, over and under voltages and frequency deviations. Figure 52 gives a simplified view of the characterisation of Power Quality.

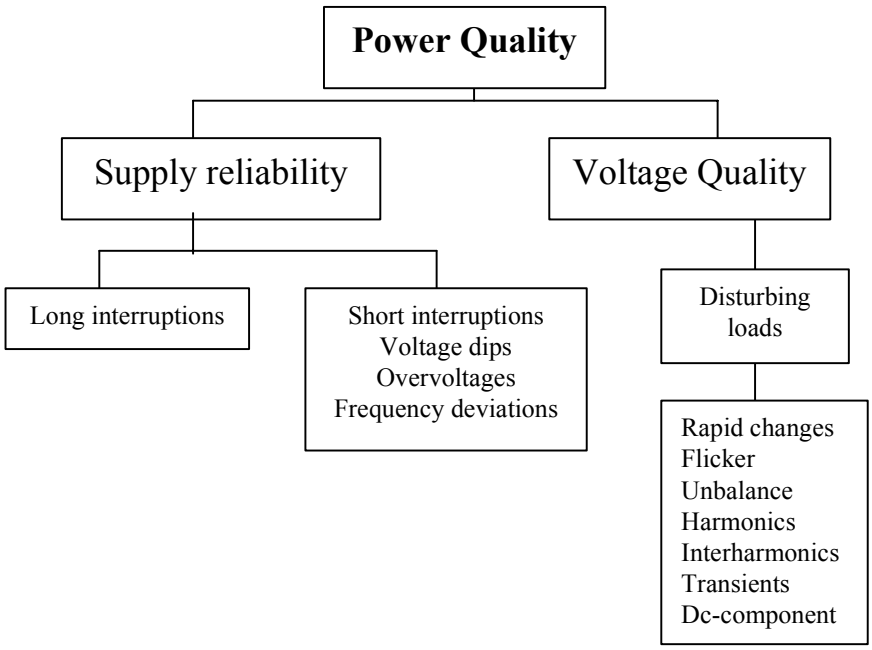


Figure 52. Simplified characterisation of Power Quality.

To give a complete idea of Power Quality, also a third phenomenon may be introduced, i.e. information (Thomsen, 1999). Information about planned outages and information after faults and disturbances, give the customer a better impression of the quality of supply, and of the supplier. So as to complete the term Power Quality a figure like Figure 53 can be drawn.

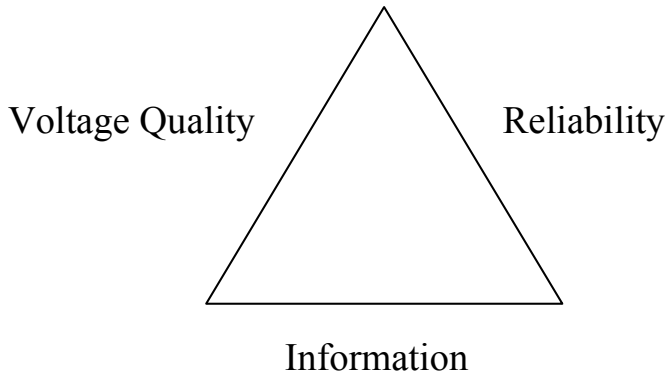


Figure 53. Three important factors for Power Quality.

With the emergence of computers, a high level of automation with sensitive loads and modern communication, reliable electricity supply with a good voltage quality has become a necessity. Electricity is fundamental to economic activity, to the standard of living and quality of life. Over the last ten years the customers perception of reliability has changed. Outage times of a few cumulative hours per year are no longer considered as an characteristic of an extremely reliable supply for an increasing number of sensitive customers, in particular industrial and commercial customers. A few cycles interruption or a voltage reduction to less than 90 % may cause serious problems for industrial customers. The number of voltage dips and swells and their duration becomes more important than the cumulative outage time per year (CIGRE WG14-31, 1999).

The variety of disturbances that may affect customers' equipment are the parameters that describe Voltage Quality and Reliability, and these parameters, and equipment to compensate for their influence, will be described in the following.

4.2.1 Categorisation and characterisation of disturbances in the grid

According to (Dugan et al., 1996) and (Thomsen, 1999) the different disturbances may be classified as in Table 8.

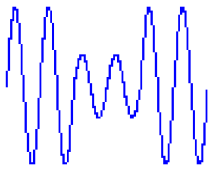
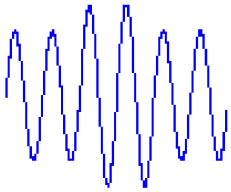
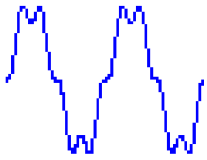
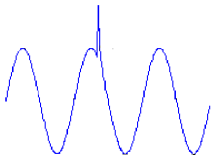
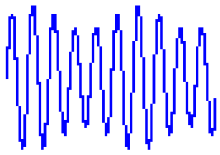
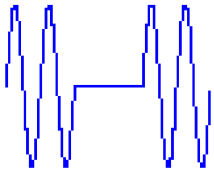
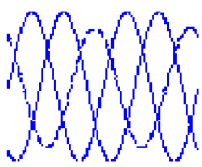
Table 8. Categories and typical characteristics (Low-Voltage grid) for variations in the supply voltage with given voltage quality parameters. EN for chapters in EN 50160 (Thomsen, 1999).

Category	**Typical characteristics**			**Voltage quality parameters**	**EN**
	Spectrum	duration	magnitude		
1.0 Transients					9
1.1 Impulsive	5 ns - 0.1 ms	50 ns - > 1ms	< 6 kV		
1.2 Oscillatory	<5 kHz-5 MHz	5µs – 0.3 ms	0 - 4 pu		
2.0 Short duration variations					
2.1 Interruptions		10 ms - 3 min.	< 1 %	Short duration interruption	6
2.2 Sag		10 ms - 1 min.	1 - 90 %	Voltage sag	5
2.3 Swell		10 ms - 1 min.	110 - 180 %	Voltage swell	8
2.4 Rapid voltage changes		not defined	> +- 5 %	Rapid voltage changes	41
3.0 Long duration variations		stationary	< 106 % > 90 %	Supply voltage	3
3.1 Under voltages		> 1 min.	80 - 90 %		
3.2 Over voltages		> 1 min.	106 - 120 %		
4.0 Voltage unbalance		stationary	0.5 - 2 %	Voltage Unbalance	10
5.0 Curve distortion					
5.1 DC offset	n=0	stationary	0 - 0.1 %		
5.2 Harmonics	n=2 - 40	stationary	0 - 20 %	Harmonics	11
5.3 Interharmonics	0 - 6 kHz	stationary	0 - 2 %	Interharmonics	12
5.4 Notches		stationary			
5.5 Noise	Broadband	stationary	0 - 1 %		
5.6 Signal transmis-sion	< 148 kHz	stationary	0.09	Signal transmis-sion	13
6.0 Voltage - fluctuations	< 25 Hz	intermittent	0.2 - 7% Plt< 1	Voltage Fluctuations (flicker)	4.2
7.0 Net frequency-variations	50 Hz	< 10 s	1 %	Net frequency	1

These categories and the description of the different disturbances in Table 8 are important to classify measurement results and to describe the actual phenomena, which may cause the Power Quality problem. These disturbances are not all new, and the utilities are aware of them. However, they have to take a new look because of the rapidly changing customers' needs and the nature of loads (CIGRE WG14-31, 1999). This may force the utilities to be able to provide value-added options to industrial and commercial customers relating to their specific needs. The way to give some customers better service than others is by using Custom Power equipment to secure better reliability and improved voltage quality.

Another way to categorise the different disturbances is to look at possible causes for each kind of disturbance and to look at the consequences they might give. They are summarised in Table 9.

Table 9. Voltage disturbances their origin and their consequences (Thomsen, 1999; CIGRE WG14-31, 1999).

Disturbance		Origin	Consequences
Voltage sag undervoltage 2.2		Short circuits in the network grid passing or on another radial. Start up of large motors	Disconnection of sensitive loads Fail functions.
Voltage swell Overvoltages 2.3		Earth fault on another phase Shut down of large loads Lightning strike on network structure Incorrect setting in substations	Ageing of insolation Disconnection of equipment May harm equipment with inadequate design margins
Harmonic distortion 5.2-5.3		Nonlinear loads Resonance-phenomena Transformer saturation Notches	Extended heating . Fail function of electronic equipment
Transients 1.1-1.2		Lightning strike Switching event	Insulation failure Reduced lifetime of transformers, motors etc.
Voltage-fluctuations/ flicker 6.0		Arc furnaces Sawmill, crushing mill Welding Wind turbines Start up of large motors	Ageing of insulation Fail functions Flicker
Short duration interruptions 2.1		Direct short circuit Disconnection False tripping Load shedding	Disconnection Disconnection
Unbalanced 4.0		One phase loads Weak connections in the network	Voltage quality for overloaded phase Overload and noise from 3-phase equipment

In Table 9, the distortion caused by DC-offset is not taken into account. This is not considered by IEC. The DC-offset may occur from geomagnetic disturbance or due to the effects of half-wave rectification. Also voltage setting on equipment with iron cores, or short circuits close to the generators can give DC-offset in the voltage. The consequence of a DC-offset is that transformer cores may be biased, so they can saturate in normal operation, leading to heating and loss of transformer life. DC-current can also cause electrolytic erosion of grounding electrodes and other connectors (Dugan et al., 1996).

Also interharmonics are not mentioned in Table 9. Interharmonics are sinusoidal voltages and currents having a frequency that are not an integer multiple of the frequency of the supply voltage. Depending on the source of the interharmonics, they appear as discrete frequencies or as a wideband spectrum. The main source of interharmonics is static frequency converters, cycloconverters and arcing devices. Interharmonics may affect power line carrier signalling, and can induce flicker in display devices such as cathode ray tubes (Dugan et al., 1996).

Finally, power frequency variations are not mentioned in Table 9. The frequency of the power system is directly related to the rotational speed of the generators supplying the network. Frequency variations occur when the dynamic balance between load and generators change, the size and duration depending on the load characteristics and the response of the generation control. Large frequency deviations may be caused by faults on the bulk power transmission system, disconnection of large blocks of load, or a large source of generation going off-line. On modern interconnected power systems, this kind of frequency variation is rare, but the phenomenon may occur on isolated systems.

All the different Power Quality terms are now defined and the origin of the different disturbances is also mentioned. One could also claim that reactive power should be a Power Quality parameter, but in the literature, it is not defined as an independent Power Quality parameter, since the voltage is chosen here as the Power Quality parameter. It may be relevant to take the reactive power into consideration, since the magnitude of the losses in the network and the sizes of transformers and generators may be increased, due to the reactive power in the network. The losses in the network result in large voltage drops, giving rise to poorer Voltage Quality. With the above terms of Power Quality, the effect of the reactive power must be considered under the term voltage fluctuation, and the effect of reactive power must then be compensated with regard to this term (Thomsen, 1999).

4.2.2 Equipment used to enhance the Power Quality.

In this section, the focus will primarily be on the distribution level (up to 60 kV), where equipment used to enhance the Power Quality is called Custom Power Systems (CUPS), as opposed to equipment used on the transmission level, which is called Flexible AC-systems (FACTS). Anyway for some of the apparatus used on the distribution level, corresponding apparatus exists on the transmission level, and this relationship is shown in a later table.

There are many different types of apparatus, which may be used to enhance the Power Quality, and these may be divided into three groups:

- On/off apparatus, switches
- Stepwise controllable apparatus
- Continuously controllable apparatus

4.2.3 On/off apparatus, switches

On/off apparatus is installed typically at industrial or commercial facilities, with a dual, medium voltage supply, to switch between service from one source to the other. Electromechanical switches normally take from 1 to 10 seconds to switch. Such electromechanical switches are too slow to protect sensitive electronic devices, which are sensitive to, for instance, voltage sags and swells. Here solid-state switches based on GTO thyristor technologies are emerging in transfer switch, fault current limiter, and breaker applications (CIGRE WG14-31, 1999). At 600V level and below the Voltage Static Transfer Switch, which uses low voltage power electronic devices, is being used. The use for medium-voltage power electronics for similar applications has evolved in the recent past. In the case of local generation or in case where a transfer between asynchronous sources is needed, solid state breakers may be useful. These are able to interrupt current and they use GTO's or equivalent. Solid state circuit breakers are often used in connection fault current limiters to reduce the fault current, and thereby reduce the voltage sags on the unfaulted system segments.

4.2.4 Stepwise controllable apparatus

Stepwise controllable apparatus may either regulate the voltage by use of an electronic controlled voltage tap changer, or by the use of stepwise-coupled capacitors as in Static Var Compensators or in Thyristor Switched Capacitors. Such apparatus may also be used for compensation of reactive power. In smaller systems, the electronic switches may be replaced by mechanical switches.

4.2.5 Continuously controllable apparatus

This group of apparatus will normally include a voltage source converter, controlled by various control strategies. The connection to the network grid is usually done by use of transformers. New power electronic devices such as Insulated Gate Bipolar Transistors (IGBT), Insulated Gate Commutated Thyristors (IGCT), and MOS controlled Thyristors (MCT) are used in the converters. Depending on the topology used for the converters they are split up into two groups:

1) Shunt converters.
2) Series converters.

The shunt converter injects current into the network at its coupling point. This current injection may then be used to compensate for different disturbances. Typical shunt connected apparatus may be the following: Static Var Compensator SVC, Static Synchronous Compensator (STATCOM) and for harmonic compensation Active Harmonic Filters (AHF).

The series converter injects a voltage with a certain phase lag or lead to the line between the supply and load. The resulting power flow in the circuit where the voltage is injected will be changed, dependent on the resulting voltage and phase-shift across the load. The most frequently used series apparatus is the Dynamic Voltage Restorer (DVR).

Shunt connected compensators are useful for cancelling out disturbances in the network current, whereas the series compensators are useful for cancelling out voltage disturbances at the load side.

The two kinds of apparatus may also be combined. The apparatus is then called a Unified apparatus, for instance a Unified Power Quality Conditioner (UPQC).

Finally, the active compensator may be combined with passive filter elements. Then the apparatus is called hybrid apparatus. Some of the compensators also have an energy storage device connected, to be able to deliver active power, and not only reactive power. In this way also voltage dips and voltage fluctuations may be compensated. Depending on the amount of energy stored, different sizes and duration of the dips can be compensated. On some occasions a shunt apparatus in connection with a series apparatus can replace the energy storage device. A Unified Voltage Controller (UVC) is an example of such an apparatus.

An overview of the different kind of apparatus used at the distribution level (CUPS) and at the transmission level (FACTS) is shown in Table 10.

Table 10. Different CUPS and FACTS apparatus (Thomsen, 1999).

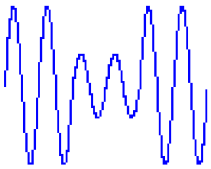
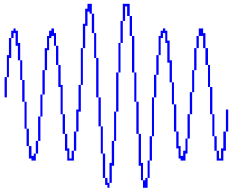
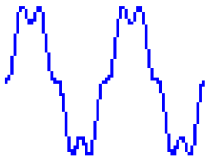
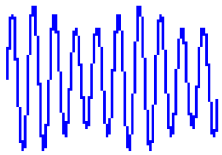
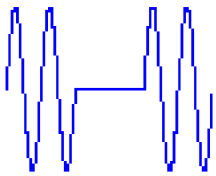
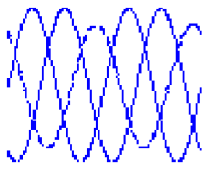
Generation group 1 is the first generation converters and is based on thyristors and current source line- commutated converters

Generation group 2 is second generation converters and is based on self-commutated converters with either GTO's or IGBT's in voltage source converters.

Generation - Group	CUPS	FACTS
1 – shunt		SVC Static Var Compensator
1 – series		TCSC Thyristor Controlled Series Capacitor
On/off apparatus		
1-2 – on/off	SSB Solid State circuit Breaker SSTS Solid State Transfer Switch or STS Static TS BTS Bus Transfer Switch	
1-2 – on/off	FCL Fault Current Limiter	
Stepwise controllable apparatus		
1-2	SVR Static Voltage Regulator SSLTC Solid State Load Tap Changer	
1-2	ASVC Advanced Static Var Compensator AVC Adaptive Var Compensator	
Continuous controllable apparatus		
2 – shunt	STATCOM STATic COMpensator or STATCON STATic CONditioner AHF Active Harmonic Filter	STATCON STATic CONdenser or ASVC Advanced SVC
2 – series	DVR Dynamic Voltage Restorer SABF Series Active Blocking Filter	SSSC Static Synchronous Series Compensator PAR Phase Angle Regulator or PAC Phase Angle Controller
2 – Combined	UPQC Unified Power Quality Conditioner APLC Active Power Line Conditioner UVC Unified Voltage Controller PQM PQ-Manager, Hybrid	UPFC Unified Power Flow Controller

Oscillating transients generated by coupling of capacitors must be eliminated at the generation point by use of coupling resistors or techniques, such as synchronised coupling or passive filters have to be used because of the high frequency (Thomsen, 1999).

Table 11. Compensation apparatus for different disturbances (Thomsen, 1999).

Distortions		Apparatus	Effect
Voltage dip and sags 2.2		StatCom. DVR UPQC	Moderate Good Good
Voltage swell 2.3		StatCom DVR UPQC	Moderate Good Good
Harmonic distortion 5.2 - 5.3		AHF SABF APLC, UPQC	Filtering, good Does not block alone Good, efficient
Voltage-fluctuations 6.0		StatCom □ASVC□ DVR UPQC	Good questionable Best
Short duration inter-ruptions 2.1		StatCom DVR UPQC	UPS -function Hardly, but possible with UPS-function UPS - function
Unbalance 4.0		StatCom DVR UPQC, UVC	Moderate, problematic Good Good, difficult

4.2.6 Measures and indicators

Different types of disturbances have been described in this section. Measurements and indicators are needed to identify the nature of these phenomena. In connection with wind turbines, methods for measurement and assessment of the influence of wind turbines on the power quality are specified in (IEC 61400-21, 2000). This standard includes measures for maximum power, reactive power, voltage fluctuations and harmonics.

The following three measures related to voltage fluctuations and flicker are used:

- Flicker coefficient $c_f(\psi_k,v_a)$ – is used to characterise the flicker emission from the wind turbine in continuous operation e.g. in the PCC (Point of common coupling) without generator couplings. The flicker emission for continuous operation is defined to be:

$$P_{st} = P_{lt} = c_f\left(\psi_k, v_a\right)\frac{S_n}{S_k}$$

  where ψ_k is the grid short circuit angle and v_a is the annual mean wind speed, while S_n denotes the nominal apparent power of the wind turbine and S_k is the apparent short circuit power e.g. in the PCC. According to the standard, $c_f(\psi_k,v_a)$ is given in a table with four values of ψ_k and v_a respectively, and the value in an actual case is obtained by interpolation of ψ_k and v_a.
- Flicker step factor $k_f(\psi_k)$ – is used to characterise the flicker emission from the wind turbine arising from generator switching operations. The short term flicker emission is defined to be:

$$P_{st} = 18\cdot\left(N_{10}\right)^{0.31}\cdot k_f\left(\psi_k\right)\cdot\frac{S_n}{S_k}$$

  where N_{10} is the number of switching operations occurring during ten minutes. The long-term emission is defined to be:

$$P_{lt} = 8\cdot\left(N_{120}\right)^{0.31}\cdot k_f\left(\psi_k\right)\cdot\frac{S_n}{S_k}$$

  where N_{120} is the number of switching operations occurring during 120 minutes.
- Voltage change factor $k_u(\psi_k)$ – is used to characterise the voltage changes, which occur on switching. The relative voltage change in %, d, is defined as:

$$d = 100\cdot k_u\left(\psi_k\right)\cdot\frac{S_n}{S_k}$$

The above formulas for assessment of the influence of a wind turbine on the power quality are valid for a single wind turbine. (IEC 61400-21, 2000) also specifies methods for summation of the effect of wind turbines in a cluster, or a wind farm, taking into account the smoothing effect of the contributions from the individual wind turbines.

Another basic characteristic measure, which has been used in earlier standards, is the cut-in current factor k_i:

$$k_i = \frac{I_{max}}{I_r}$$

where I_{max} denotes the maximum current during one half period and I_r denotes reference current of the wind turbine/farm (both are rms. values). The cut-in current factor is usually used to specify an upper limit for the current at cut-in of a load (passive as well as active). The cut-in current factor k_i has been used to predict the maximum voltage change substituting $k_u(\psi_k)$ in the above equation. However, this method is conservative, because it does not take into account the influence of the impedance angle of the grid. This is particularly relevant for the cut-in of induction generators on grids with high values of short circuit impedance angle, because typically I_{max} is due to reactive power, and therefore $k_i > k_u(\psi_k)$

A widely used technique in signal analysis is to analyse a signal by its Fourier transform. This technique is especially relevant in connection to wind turbines provided with power electronic, due to the harmonics produced by the switching patterns of the applied power electronic device.

The ideal case is a sinusoidal voltage and a sinusoidal current, with a frequency of 50 Hz. In order to be able to describe deviations from the ideal case three different measures have been defined as presented below (Arrillaga et al., 2000):

- Total harmonic voltage distortion is given by:

$$THD_{U\%} = \sqrt{\sum_{h=2}^{40}\left(\frac{U_h}{U_1}\right)^2} \cdot 100\%$$

  where U_h denotes the amplitude of the h'th harmonic. A small THD_U value indicates a signal close to the ideal case. Thus, THD_U is a normalised measure of the harmonic content due to over harmonics up to and including the 40^{th} harmonic.

- Total voltage distortion factor is given by:

$$TDF_{U\%} = \frac{\sqrt{U_{rms}^2 - U_1^2}}{U_1} \cdot 100\%$$

  This includes all kinds of distortion. A small TDF_U value indicates a signal approaching the ideal case. TDF_U can be seen as a normalised measure of the energy of the sinusoidal signal content at frequencies other than 50 Hz.

- The weighted distortion factor is given by:

$$THD_w = \sqrt{\sum_{h=2}^{N}\left(h \cdot \frac{U_h}{U_1}\right)^2}$$

  The weighted distortion factor is dedicated to systems employing shunt capacitors, as it weights the higher frequencies in a manner corresponding to the frequency dependence of the current in a shunt capacitor.

4.3 Standardised Grids

The economic viability of a wind turbine investment is judged e.g. by its pay-back time. The energy production at a given site is a key parameter for this calculation – in other words, the focus is on the power curve of the wind turbine. Here the type of grid and type of wind turbine are of great importance.

In this section, standardised grids are discussed and reviewed. The focus is on how to characterise a particular grid and differentiate between it and other grids. The generic type of a grid will impose certain demands on the grid connection of a wind turbine and/or wind farm. These demands are usually defined at the point of common coupling.

4.3.1 Basic grid properties

A simple way to analyse or to characterise a grid/network is to approximate it by a first order equivalent as shown in Figure 54. If the load Z_l is displaced by a short circuit, the apparent short circuit power may be calculated as:

$$S_k = \sqrt{3} \cdot U_n \cdot I_k$$

in the case of a three phase system.

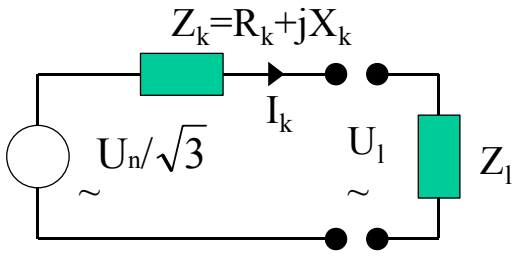


Figure 54. Simple grid equivalent.

A basic characteristic measure of a grid is the short circuit ratio (KR 111, 1998):

$$R_{sc} = \frac{S_k}{S_r}$$

where S_k denotes the short circuit power and S_r the apparent power reference of the wind turbine/farm. This ratio reflects the stiffness of a grid, i.e. a higher value of R_{sc} indicates a stiffer grid. In a sense the short circuit ratio describes the capacity of a grid compared to applied load.

Another characteristic grid measure is the short circuit angle (IEC 61400-21, 2000):

$$\psi_k = \mathrm{Arctan}\left(\frac{X_k}{R_k}\right)$$

where R_k and X_k denote the short circuit resistance and the short circuit reactance of the grid respectively, as indicated in Figure 54.

A simplified description of the load voltage at steady state conditions may be obtained by:

$$U_l = U_n - \frac{R_k \cdot P_l + X_k \cdot Q_l}{U_n}$$

where P_l is the active power production and Q_l the reactive power consumption of the load, respectively. Thus given knowledge of the grid and the load, it is possible to estimate whether or not the load voltage is within specified limits.

4.3.2 Various grid types

One way to describe a grid is by referring to a number of characteristic grid parameters. The first and most important parameters are the voltage level and the kind of source, i.e. either DC or AC. Two other characteristic parameters are the apparent short circuit power and the short circuit angle. Another way is to characterise a grid by certain properties. Examples of terms in use are:

- transmission grid
- distribution grid
- AC or DC grid
- stiff grid
- weak grid
- isolated grid

The first two properties are related to the voltage level. Issues concerning these properties were discussed in Section 4.1.

4.3.2.1 Stiff or weak grid

The properties stiff and weak are more difficult to handle in a short and precise definition. A stiff or a weak grid is not just a stiff or a weak grid, independently, since a grid could be characterised e.g. as frequency stiff and voltage weak. A frequency weak grid would influence the energy production of a fixed speed wind turbine in a less desirable manner. This has been studied in e.g. (Sørensen et al., 2000). Another problem related to the stiff/weak property is that, while a grid with a few connected wind turbines is stiff, the same grid might be characterised as weak at a higher number of connected wind turbines.

In order to assure a proper operating condition for the wind turbine and acceptable reliability and power quality for the grid, recommendations and standards have been developed for connection of wind turbine to the distribution grid. In Denmark, (KR 111, 1998) specifies the requirements for grid connection of wind turbines to the distribution system, based on the characteristics and methods specified in (IEC 61400-21, 2000).

Power quality and other issues related to grid-connected wind turbines are highlighted in a simulation study contained in three reports:

- (Jørgensen et al., 1996) with the focus on steady state voltage conditions. The influence of wind turbines on three different grids is analysed.
- (Sørensen & Kledal, 1996) with the focus on flicker. The flicker impact from both stall regulated and pitch controlled wind turbines is analysed on two different grids.

- (Vikkelsø et al., 1996) with the focus on harmonics and operating conditions of variable speed wind turbines. The distribution of harmonics is analysed for six different configurations of wind turbines on one grid.

If a project aims at installation of a wind power (or any other renewable source) on a weak grid, three options should be considered:

1. Appropriate reactive power compensation etc. of fixed speed wind turbines.
2. Use of wind turbines with controllable power output.
3. Reinforcement of the grid.

Which of these options is the right choice depends on the economics of the three options and the local planning.

4.3.2.2 Isolated grid

An isolated grid is a very ambiguous term. There are no well-defined upper or lower power limits. The term covers a variety of system types, e.g.: wind-diesel, hybrid power, stand-alone etc. The characteristics of an isolated grid are typically equivalent to those of a weak grid. (EN 50160, 1999) is the only identified standard with recommendations for isolated grids.

4.3.3 Off-shore wind farms on the transmission grid

As mentioned in Section 3.3.3, energy planning of the Danish Government has scheduled a number of offshore wind farms. According to the plan, the first two will be ready for operation in 2002 – each rated at 150 MW. By the year 2030, 50 % of the electrical energy consumption in Denmark will be supplied by wind energy.

The Danish power system operators Elkraft System and Eltra are responsible for the integration of these wind farms. Due to their rated power, they will be connected directly to the transmission grid. The specifications for connecting these wind farms are presented (Eltra, 2000).

As usual, specifications for frequencies, voltages, reactive power compensation, voltage quality and fault protection are presented. As a new item, requirements production control has been introduced (Eltra, 2000). Moreover, more stringent stability requirements and requirements for operation during grid faults have been incorporated.

In this context the requirements for production control are of great interest. Referring to (Eltra, 2000), it shall be possible to:

- control the production from the wind farm so that it does not exceed a certain MW-value, i.e. a production limit
- control the production limit by a single central signal
- control individually each wind farm
- have the control to act on the individual wind turbine
- control the production quickly, i.e. a reduction from 100% to below 20% of maximum power in less than two seconds.

Furthermore, high wind speed may not cause all the turbines to stop simultaneously.

These specifications impose new and challenging demands on the art of wind turbine design. As a new task the manufacturers must gain knowledge on how to construct and operate the local wind farm grid. This will imply development of new control strategies for park control, which can take account of the external power production demand, and of internal dispatching of wind turbines.

4.4 Power system integration

So far in the report the focus has been on single wind turbines with their drive train/power conversion system and their internal electrical layout and grid connection. In this section the focus is the integration of large amounts of wind power in a power system and the implications of that on both the wind farm and the rest of the system (transmission, generation, consumption).

In power systems with a high level of wind energy penetration it is necessary to adapt the wind turbines (or the wind farm) and the rest of the power system in order to ensure optimal operation of the combined system. Optimal operation in this context means the lowest operating cost of the complete system as well as maximum utilization of the wind energy.

The fast installation of wind turbine capacity is not the only change with a large impact on the power system. The power system and its organization is currently undergoing rapid changes as a result of both technological development and the political requirement to have a liberalized sector and a more sustainable system.

The technological development takes place in many areas such as micro combined heat and power plants (fuel cells, microturbines etc.) and pv-systems for distributed generation. Also the large development effort in hydrogen and energy storage technologies will have a large impact on the power system in the next 10-15-20 years. In this time frame the information technology will also be widely applied for control and automation of production, transmission and consumption.

Integration of wind energy therefore has to be seen both in the light of the current power system and in view of the opportunities which the future technology will open as it will be developed and implemented.

The fast implementation of wind energy in certain regions results in large regional power systems with very high wind energy penetration levels. This leads to problems for the Transmission System Operator (TSO). These problems include unit commitment, scheduling and dispatch, problems of the controllable power plants, transmission bottlenecks, voltage, angle and transient stability, large power exchanges with neighboring systems, trading problems on the power exchange and other similar problems. These problems off course exist in any power system but the impact from the wind turbines changes many of the well-known problems and therefore requires new solutions to planning, design and operation of the power system.

In order to mitigate these problems it is necessary to view the system as a whole, to exploit the possibilities that already exist in the system and to focus development activities on solutions that combine many different technologies.

Some of the main problems are the voltage control of the system, the need to be able to follow the load and the robustness of the system to faults and trips of both generation and transmission capacity.

As mentioned in Section 3.3, the connection of a wind farm to the grid has a large impact on the voltage at the point of common coupling and in an area close to that. It can also have large impact on the voltage stability due to the reactive power consumption if directly connected induction machines are used in the wind turbines (and there is no extra compensations apart from no-load consumption).

The fluctuating nature of wind power implies that wind power only in a limited way can contribute to the load following capability of the system and since the amount of power produced from more dispatchable sources is reduced there is a trade off between reduction in spinning capacity and the need to be able to cover the load given the fluctuation in the wind power production.

Arguments along the same line are valid regarding the need for the system to be able to pick up load in the case of faults in generators or the grid. In high penetration systems there is a need for the wind turbines (or wind farms) to be able to stay connected during some faults and to find (economic) solutions that enable the system to withstand such perturbations.

Many technical options exist that can be used in combination with wind energy to ease integration and to improve the value of wind energy.

One of the immediate technologies that can be utilized is implementation of wind power production prediction systems [Nielsen et al., 2001], [Giebel et al., 2001]. These have been under development for several years and they have also been installed in load dispatch centers in e.g. Denmark and Ireland, [www.predictor.dk]. The methods that are applied are both statistical and based on physical models like weather forecasts. The systems are used to predict the wind power production that will be fed into the system in the next 24-48 hours and thus to reduce the uncertainty associated with the production. The other types of generation can therefore be committed, scheduled and dispatched in a more economic way. The prediction of wind power production also improves the trading at the power exchange. Both these elements improve the value of wind power in the system.

In order to further improve the integration of wind energy by reducing the power fluctuations the recent development of large-scale power and energy storage has shown much promise. Power and energy storage in the system give many improvements to the way the power system can be operated. These possibilities are also attractive in a general power system perspective and are not linked exclusively to integration of wind power. The four main features are the buffering of energy, the peak shaving ability, the ability to contribute to black start of the grid and the improved utilization of the transmission grid. In this context, the wind power storage systems can reduce or eliminate the short-term fluctuations making it possible to reduce spinning reserve of the system. It will also make it possible to have the wind farms to contribute to the frequency control of the grid and to reduce the stress on the links in and out of the control area.

Until recently the main form of energy storage was lead-acid batteries. However, these batteries are not suited for large-scale storage applications. The main reasons are the investment costs, the maintenance requirements and the limited

and uncertain lifetime of the system, [Drouilhet & Johnson, 1997]. New types of batteries have been developed recently, and some of the most promising types are the so-called redox flow or reversible fuel cell types of storage. These types of batteries have some very desirable features. The first and foremost is the ability to independently size the power and the energy capacity of the storage. This is due to the way the system works. The power exchange happens in a cell stack in which the two electrolytes are flowing separated by a membrane that permit ions to travel from one side to the other. The electrolyte is pumped through the cell stack and is stored in tanks outside the cell stack. The power capacity of the battery is determined by the area of the membrane while the energy capacity is determined by the volume of the tanks (or rather by the volume of the electrolyte stored in the tanks). Further is the self discharge practically zero, the efficiency is high (above 80%) and the lifetime can be very long, [Hawkins, 1998]. The cost of the systems is also relatively competitive even at this stage of development and further reductions are foreseen. Commercial products already exist (from Regenesys Technologies Ltd., UK), [www.regenesys.com]. Vanadium based system are in the final development phase.

In Section 3.3 it was shown how power electronics can be used in combination with wind farms to improve the integration by reducing the impact on voltage level and fluctuations in the grid close to the wind farm. Power electronics can also be installed in central places in the grid in order to improve the capacity of the grid by dynamically controlling the voltage (Flexible AC Transmission Systems, FACTS, such as STATCOMs, DVRs, UPQCs and HVDC). Combined control of these devices will contribute to the improved integration of wind power and it will also improve the utilization of already existing transmission systems.

The predicted development of distributed power production technology will have a large impact on the operation of the system. It can be expected that a very large number of small (5-10kW) systems will be installed in houses for combined power and heat production. There will also in some areas be a rapid increase in the installed capacity of pv-systems as these systems come down in price. This will be in contrast to the trend in wind energy, where the new capacity will be very concentrated in the areas with the highest wind resources. The control of this distributed generation system will be a big challenge, but there will be many control options that eventually could utilize also in the view of integrating wind power. One of the fuels in such a system could be hydrogen.

Utilization of hydrogen also has a large perspective. Hydrogen could be produced by electrolysers that are operated during off-peak hours or in situations with a large wind power production and a low consumption. The hydrogen can then be stored until consumption rises or during peak hours to produce power to the grid. It could also be used, as mentioned above, in a system with micro CHP plants in individual houses or it can be used in transportation. In this way renewable energy can be used to produce fuel and thus contribute to a more sustainable transport sector. The scheduling of the electrolysers can significantly increase the amount of wind energy that can be integrated in the power system.

It is evident from the above, that control of the system is a crucial aspect. If the possibilities mentioned above are to be realized, it is necessary to develop the control technology and the systems, which are used to control the power system. Application of new possibilities coming from the rapid development information technology is a prerequisite if this is to be realized.

5 Summary

This report presents a survey on electrical machines and power electronic concepts for wind turbines as well as the grid integration aspects of them.

The state-of-the-art of wind turbines seen from electrical point of view includes old and new potential concepts of generators and power electronics based on technical aspects and market trends.

The chapter on generator presents the electrical machines used in wind energy conversion and identifies potential new types of machines. Starting with the classical and commercially agreed induction machine in both types, squirrel cage and wound rotor, the report focus in synchronous machines (permanent magnet and wound rotor), switched reluctance machine and transverse flux machine. Another considered candidate is the high voltage machine for power from 3MW and upward. Each machine has advantages and drawbacks.

- The squirrel cage induction machine has a very simple and reliable construction and there are no needs of special maintenance, however it has to be supplied with reactive power via the supply terminals although it.
- The wound rotor induction machine has a weak spot in the presence of the slip rings and brushes, it is more expensive than the squirrel cage machine and requires special maintenance. However, the presence of slip rings makes possible to control from outside the electrical characteristics of the rotor, by means of electric equipment.
- The synchronous machine is very attractive for direct drive applications although involve synchronous operation. The wound rotor machine is vulnerable to vibrations and the slip rings and brushes require special maintenance. The permanent magnet machine eliminates some disadvantages of the wound rotor machine, however it raises problems concerning the temperature and weight of the magnets and the fault capability.
- The switched reluctance machine and the transverse flux machine have not yet implemented in wind energy conversion systems. The switched reluctance machine has the advantages of squirrel cage induction machine regarding the simplicity and robustness of the rotor and it is suitable for low speed operation. However it requires a sophisticated power converter and control.
- The transverse flux machine offers high-values of specific torque and it is suitable for direct drive applications, although it has a large number of individual parts and special methods of manufacturing and assembly.
- Finally, the high-voltage machines manufactured currently as induction and synchronous machine offers a reduction in current, leading to lower copper losses and a possible direct connection to the grid.

The chapter on power electronics deals with two issues: power converter components for wind turbines and power electronic units for wind turbines. The first issue comprises the soft-starter, the capacitor bank, the diode rectifier and five frequency converter topologies (back-to-back PWM-VS converter, tandem converter, matrix converter, multilevel converter and resonant converter). A comparison of these converters is carried out with advantages and drawbacks for each one. As the back-to-back converter is state-of-the-art today in wind turbines it can be used as a reference in a benchmark of the other converter topologies regarding the number of the components and their ratings, the auxiliary components, the efficiency, the harmonic performances and implementation. Nevertheless, the comparison concludes and recommends further studies on

back-to-back converter, the matrix converter and the multilevel converter. Wind farms and wind power plants connected to the grid requires full control of the active- and reactive power transferred with the grid. This demand can be done by means of reactive power compensations units, power regulation and power storage unit. Examples of reactive power compensation units are SVC, ASVC and STACOM inverters. Pitch angle control is a simple and direct example of power regulation as well as dump loads and disconnection of wind turbines. Pumped storage may be an option, although further developments of batteries, fuel cells and other storage technologies must be done. HVDC could be in the future a solution for transmission of power over long distance from a number of wind power plants, both offshore and on-land. This will open new possibilities for variable speed control of wind turbines.

The chapter on grid integration presents two main aspects: power quality and demands to grid connection, and the grid classification. The disturbances in the grid are classified and described using different criteria, as typical characteristics and origin of them, in order to classify measurements results and to describe globally the Power Quality. Then, the apparatus, which may be used to enhance the Power Quality both at the distribution level and transmission level, are presented (on/off apparatus, switches, step-wise controllable apparatus, continuously controllable apparatus). Finally, standardized grids are discussed and reviewed. The focus is on how to characterize a particular grid and differentiate between it and other grids. Each generic type of a grid will impose particularly demands on the grid connection of a wind turbine, wind farm and/or wind power plant.

The report highlights a very important issue. The energy conversion system between the wind turbine and grid has to be treated in an unified way and must satisfy the grid connection demands. Since the electrical machine candidates have advantages and drawbacks as well as the power converters, it is necessary to analysis this assembly based upon some indicators as:

- Overall efficiency.
- Power flow capability.
- Range of speed operation.
- Machine weight.
- Reliability and maintenance.

Trends and further research

At present, the Danish power grid holds more than 2 GW installed wind power as well as small Combined Heat and Power Plants with a capacity of more than 1.5 GW. Both types of plants are independently controlled and do not take part in the voltage and frequency control. Furthermore, a huge expansion of wind power is planned. The power system stability limit in power systems with a high penetration of wind energy is important to identify and to improve in order to obtain the maximum value of the wind energy in the grid system.

The major investment of wind turbines will in the future be done in wind farms with hundreds of MW power capacity. In order to maintain system stability it is important that each wind farm can provide voltage and frequency control by means of power electronic systems. Furthermore, a high penetration of wind power in a power grid structure may test the limits of power stability in the grid system as well as cause power overflow in certain areas.

During the last years the wind turbines have grown in size up to 2 MW and more, and this trend in size up scaling is expected to continue.

Hence, the main challenges related to technology development are then to reduce the technical uncertainties relating to production and durability for future wind energy project all over the world, to maintain the development towards a more optimal, reliable and cost-optimized technology, to improve the power plant characteristics of the wind turbine plants (power regulations shared responsibility for power system stability etc.), develop the wind turbine technology for future applications, e.g. large highly reliable machines for offshore applications in shallow or deep waters, silent, "invisible" machines for distributed installations on land or simple, easily maintained hybrid systems for smaller, isolated communities, and to develop technology that facilitates the integration of a variable energy source into the energy system such as HVDC transmission system, energy storage technologies, power flow control, compensations units (voltage, frequency, power factor, phase imbalance etc) and production forecasting and control of the wind power plants.

Issues discussed in this report are essential for meeting these challenges. In particular the rapid development of power electronics, which offers high power handling capability at lower price per kW, can benefit both the turbine development and the integration of wind farms into the power system. Hence it is expected that the application of power electronics in wind turbine will increase further. As recommendation for further research in this area it can be mentioned:

- Study and analysis of switched reluctance machine for high-power applications in wind turbines;
- Study and analysis of transverse flux machine for high-power applications in wind turbines;
- Study and analysis of double-fed induction machine and converter optimization;
- High-voltage machine design for wind turbines;
- Optimization of back-to-back PWM-VS converter;
- Study and analysis of matrix and multilevel converter for wind turbine application;
- Identification and analysis of new power converter topologies.

As medium term recommendations for research regarding wind farms and/or wind power plants:

- Infrastructure design studies;
- Dynamic interaction between wind farm / wind power plant and grid for:
    - Normal operation;
    - Fault or transient events.
- Control concepts for wind power plant characteristics;
- Energy storage;
- HVDC connection
    - Control concepts;
    - Study of steady-state and dynamic stability.

As long-term research areas it can be mentioned:

- Grid stability;
- System optimization for wind turbine, wind farm and wind power plant;
- Global optimization based on system model;
- Standardization / committee work regarding parks and grid.

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Title and authors

Conceptual survey of Generators and Power Electronics for Wind Turbines

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Abstract (max. 2000 characters)

This report presents a survey on generator concepts and power electronic concepts for wind turbines. The report is aimed as a tool for decision-makers and development people with respect to wind turbine manufactures, utilities, and independent system operators as well as manufactures of generators and power electronics.

The survey is focused on the electric development of wind turbines and it yields an overview on:

- State of the art on generators and power electronics.
- future concepts and technologies within generators and power electronics.
- market needs in the shape of requirements to the grid connection, and
- consistent system solutions, plus an evaluation of these seen in the prospect of market needs.

This survey on of generator and power electronic concepts was carried out in co-operation between Aalborg University and Risø National Laboratory in the scope of the research programme *Electric Design and Control*.

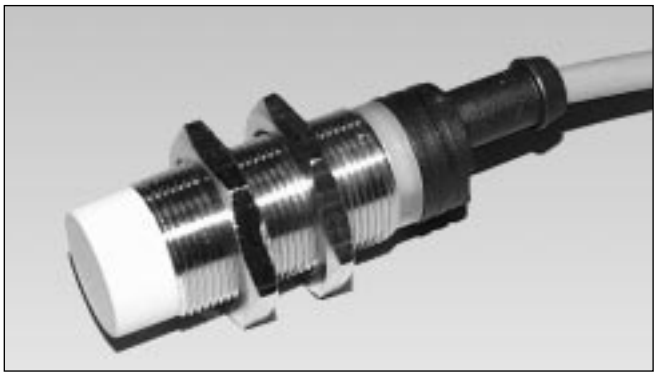
Descriptors INIS/EDB

ELECTRIC GENERATORS; ELECTRICAL EQUIPMENT; POWER TRANSMISSION; REVIEWS; WIND TURBINES

Available on request from Information Service Department, Risø National Laboratory,
(Afdelingen for Informationsservice, Forskningscenter Risø), P.O.Box 49, DK-4000 Roskilde, Denmark.
Telephone (+45) 4677 4004, Telefax (+45) 4677 4013

Proximity Sensors Inductive
Stainless Steel Housing
Types EI, DC, M 18, High Noise Protection

CARLO GAVAZZI



- **Stainless steel housing, cylindrical**
- **Diameter: M 18**
- **Short version**
- **Sensing distance: 8 mm**
- **Power supply: 10 to 40 VDC**
- **Output: Transistor PNP, make switching**
- **Protection: Short-circuit and reverse polarity**
- **LED-indication for output ON**
- **2 m cable**

Product Description

Proximity switch in M18 housing. Short version in standard stainless steel housing. Made after Euronorm EN 50 080. Excellent protection against electromagnetic disturbances.

Ordering Key

EI 1808 PPOS 1531X

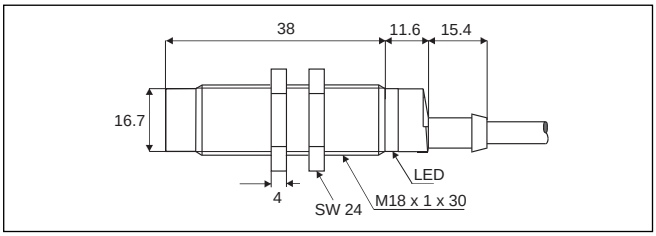
- **Type: Inductive Sensor**
- **Housing diameter (mm)**
- **Rated operating dist. (mm)**
- **Output type**
- **Housing material**
- **Special number**

Type Selection DC Type, Cable

Housing diameter	Body style	Rated operating dist. (S_n)	Ordering no. Transistor PNP Make switching (NO)
M 18	Short	8 mm [1]	**EI 1808 PPOS 1531X**

[1] For non-flush mounting in metal

Dimensions



Specifications

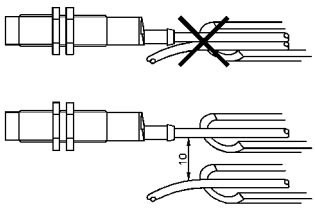
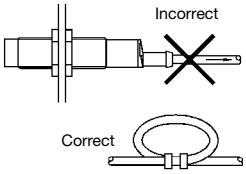
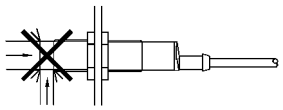
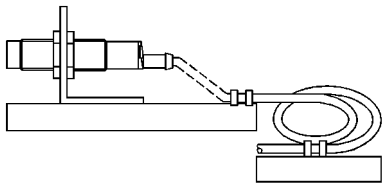
Rated operational volt. (U_e) (U_B)	12 to 36 VDC 10 to 40 VDC (ripple included)
Ripple	≤ 10%
Rated operational current (I_e) Continuous	≤ 200 mA
No-load supply current (I_o)	Output ON: < 6.5 mA Output OFF: < 2.7 mA
Voltage drop (U_d)	≤ 2 VDC at max. load
Protection	Reverse polarity, short-circuit, transients
Transient voltage	≤ 700 V/0.5 J
EMC	Approved according to EN 50 080, EN 50 081
Power ON delay	< 10 ms
Frequency of operating cycles (f)	400 Hz
Indication for output ON	LED, yellow
Assured operating dist. (S_a)	$0 \le S_a \le 0.81\ S_n$
Repeat accuracy (R)	≤ 5%
Hysteresis (H) (Differential travel)	1 to 15% of sensing distance
Effective operating dist. (S_r)	$0.9 \times S_n \le S_r \le 1.1 \times S_n$
Usable operating dist. (S)	$0.9 \times S_r \le S_u \le 1.1 \times S_r$

Ambient temperature	
Operating	-25° to +70°C (-13° to +158°F)
Storage	-30° to +80°C (-22° to +176°F)
Degree of protection	IP 67 (Nema 1, 3, 4, 6, 13)
Housing material	
Body	Stainless steel (1.4301)
Front	Grey thermoplastic polyester
Back	Black polyester
Connection	5 m, 3 x 0.3 mm², grey PVC,oil proof
Weight (cable excluded)	20 g
Tightening torque	27.5 Nm
CE-marking	Yes

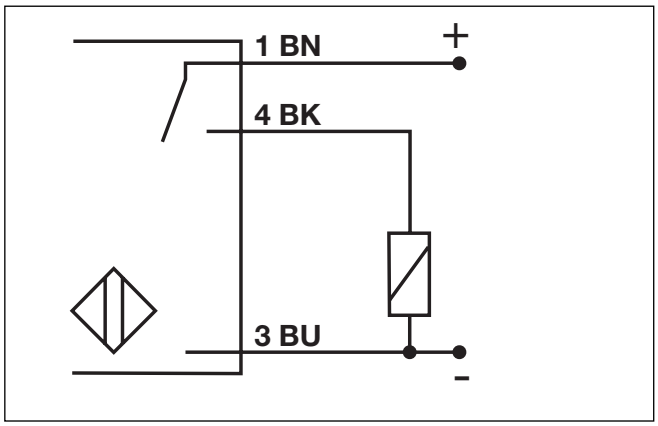
Power Supplies

Power supplies VDC: > SS 130/140.
Power supplies with amplifier relays: > SV 190.

Installation Hints

To avoid interference from inductive voltage/ current peaks, separate the prox. switch power cables from any other power cables, e.g. motor, contactor or solenoid cables	*Relief of cable strain*	*Protection of the sensing face*	*Switch mounted on mobile carrier*
	 The cable should not be pulled	 A proximity switch should not serve as mechanical stop	 Any repetitive flexing of the cable should be avoided

Wiring Diagram



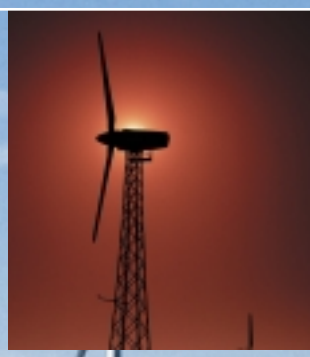
WindCon by SKF

Condition Monitoring System for Wind Turbines

Our Experience - Your Advantage

SKF

All about Performance



In recent years modern wind turbine generators have grown to become true power plants. Plants that create sufficient energy to contribute to our modern way of life and plants that generate a profit for their owners and operators. The energy they deliver is clean and inexhaustible.

To achieve all of this, the giant rotor blades must be kept turning while downtime must be reduced to a minimum.

SKF WindCon System

With the SKF WindCon System a new era of machine and system monitoring has arrived to take wind generated energy to even higher levels of performance and reliability. SKF is a world leader in Condition Monitoring and preventive maintenance systems. Using these experiences, SKF has developed a tailored, reliable monitoring system for the Wind Energy market; called The SKF WindCon System.

The SKF WindCon System enables the operator to:

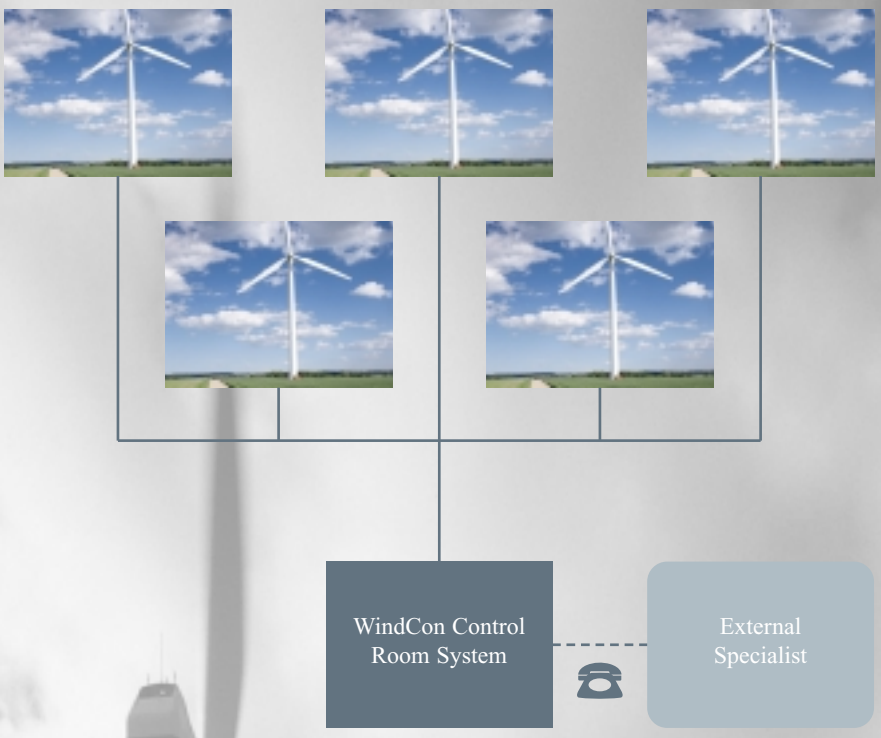
- Improve overall uptime of the wind turbine
- Enhance maintenance timing and efficiency
- Reduce the overall maintenance cost
- Detect small problems before they lead to major breakdowns
- Gather statistical data to investigate component and system trends

The SKF WindCon System provides the operator with the complete overview of the wind energy park and its mechanical condition every day – every hour – every minute.

On present and future offshore installations, the cost of simply getting to the wind turbines will be considerable, and weather conditions may make it impossible to get there during certain seasons. It is therefore of the utmost importance that the necessary measures are planned and carried out when you get there. The SKF WindCon System will equip operators with the knowledge they need in order to maximise every opportunity to carry out normal or urgent maintenance. Also the statistical data provided offers operators and manufacturers a unique possibility to analyse, learn and improve wind turbine uptime and future designs.

SKF

The Reliability Network



The SKF WindCon System is specially developed to meet the tough demands of the offshore wind turbine market, and can of course operate onshore as well.

All of SKF's extensive experience with various Condition Monitoring Applications has been used to create an optimal solution for Wind Energy Monitoring. As a result the key features of the SKF WindCon System are:

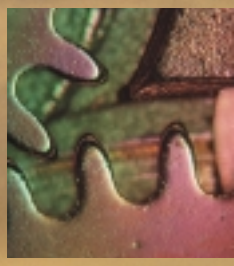
- Robustness
- Flexibility
- Easy-to-use
- State of the art analysis tools
- Experienced support from the global SKF organisation

The system can be divided into three levels:

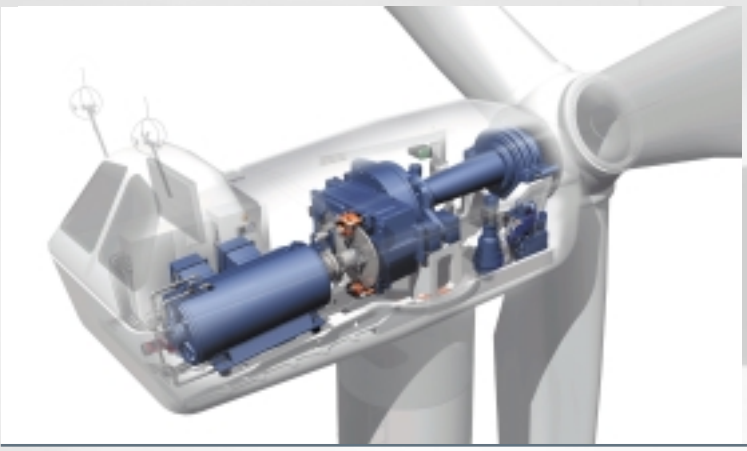
In the nacelle: Every wind turbine is fitted with the Intelligent Monitoring Unit (***i*MU**). The ***i*MU** collects data continuously from accelerometers, displacement sensors, temperature probes or other transducers (up to16 channels). Analyses are made locally, alarms checked, data stored and key data is transmitted to operator control room.

Control Room: The control room can be located anywhere convenient to the wind turbine operator. The software will monitor and store the data from the ***i*MU**'s around the clock. This central unit can be connected to several wind turbines via a TCP/IP network

Specialist hotline: Whenever questions concerning the monitored wind turbines arise, external specialists can access the system via a remote monitoring link. These specialists can be the wind turbine manufacturer or it can be an SKF Reliability Systems expert.



Robust Hardware



The Intelligent Monitoring Unit (***i*MU**) in the nacelle is fully self-supporting and does not make use of any rotating storage medium; data is stored in flash memory. The unit is very robust and fulfils the Heavy Industrial EMC norms and lightning protection requirements (railway requirements have been used as a base).

The ***i*MU** has a unique built-in hardware auto-diagnostic system which continuously checks all sensors, cabling, and electronics for any faults, signal interruption, shortcuts or power failure. Any malfunctions trigger an alarm, and in the case of system power failure the system will automatically restart when the power returns.

The ***i*MU** can be configured remotely using a graphical easy-to-use interface of the ProCon supervisory and analysis system.

The ***i*MU** offers 16 different channels to which multiple measurement points can be connected. Various types of sensors, signal and measurement configurations can be configured via the ProCon software. A typical wind turbine installation can be configured as follows:

- Main bearing 1 channel
- Transmission 4 channels
- Generator 2 channels
- Tachometer 1 channel

In addition other monitoring points may be added, e.g.:

- Tower / structure vibration
- Blade vibration
- Oil temperature
- Oil pressure
- Oil quality
- Generator temperature

SKF

Intelligent
Software

The WindCon control room system-software ProCon is running on a PC equipped with Windows 95/98/2000/NT®. This platform provides a solid foundation for networking and security protection.

All system text may be read in the user's native language. The software can even be adapted to display a customer logo. The ProCon system has Knowledge Based System features built-in which allows automatic root-cause analysis, such as:

- Unbalance
- Alignment error
- Shaft bending
- Failing couplings
- Mechanical looseness
- Faulty/weak foundations
- Bearing condition (Sleeve- and roller bearings)
- Damage on gear wheels
- Electrical problems
- Resonance problems

Based on the experience gained, the features can easily be extended with additional specific features such as Tower Vibration, Blade Vibration etc. Remote access to the system can be achieved through a phone line or the Internet.

SKF Reliability Systems

The business unit SKF Reliability Systems is uniquely equipped to help customers gain significant profits from increased productivity and maintenance-related cost-savings associated with equipment reliability.

SKF's knowledge of rotating equipment begins at the component level and extends to an in-depth understanding of the technologies and activities required to improve manufacturing processes. Our knowledge is based on nearly 100 years of application experience and technical research, while our expertise in condition monitoring adds to our service offering's overall value. This unique blend of capabilities and competences differentiates SKF from any other maintenance/reliability provider in the market.

The span of SKF Reliability Systems' every day tasks vary from mounting a single bearing on to a shaft, to making Integrated Maintenance Solutions (IMS) including commitment towards costumers based on uptime, production, equipment availability etc. Elements of tasks undertaken are:

- Vibration measurements and analysis
- Bearing failure analysis
- Mounting and dismounting services
- Application review and modification
- Customised training

The SKF Reliability Systems Team consists of highly skilled engineers and technicians with experience from almost any type of mechanical application around the world. The global presence enables SKF Reliability Systems to supply you with professional service in a fast and cost effective way no matter where.

The support offered to you by SKF WindCon System can be anything between a traditional hotline service to a complete contract on the monitoring of several wind turbines or parks. The important issue is; you will find the support and the know-how that you need within the SKF organisation – worldwide.

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Revisioni

Le edizioni dei cataloghi che subiscono revisioni, riportano al centro in basso delle pagine che hanno subito delle modifiche, il relativo ultimo indice di revisione. L'elenco delle pagine interessate alle relative revisioni è a pag.224.
L'indice di revisione del catalogo è riportato nella IVa di copertina in basso al centro.

Revisions

For catalogue editions that include revised material, the latest relevant revision index is shown at bottom centre of the modified pages. The list of pages with revisions is shown on page 224. The index of catalogue revisions appears at bottom centre of back cover page.

Änderungen

Der Änderungstatus ist auf jedem Blatt unten, in der Mitte enthalten. Auf Seite 224 ist eine Übersicht der berichtigten Seiten enthalten. Die Änderung des Katalogs ist auf der letztch. Seite des Einbands unten in der Mitte siclitlich.

Révisions

Les éditions des catalogues qui subissent des révisions présentent au centre, du bas des pages ayant subi des modifications, le dernier indice de révision. La liste des pages concernées par les révisions se trouve page 224. L'indice de révision du catalogue se trouve à la IVème page de couverture en bas au centre.

1.0 INTRODUZIONE

In questo catalogo la TRASMITAL BONFIGLIOLI presenta la sua gamma di riduttori epicicloidali modulari serie 300.

Questa serie è stata ampliata ed arricchita di nuove grandezze disponibili, miglioramenti tecnici apportati e dall' estensione della modularità totale fino alle grandezze superiori. Tale caratteristica costruttiva si traduce in una migliore flessibilità produttiva interna, nella possibilità di avere in tempi brevi prodotti nelle grandezze ed esecuzioni richieste, sia direttamente dall'azienda che dalle filiali appartenenti alla organizzazione di vendita BONFIGLIOLI localizzate in numerosi paesi del mondo.

I riduttori sono verificati secondo i seguenti standard:

ISO DP 6336 per gli ingranaggi
ISO 281 per i cuscinetti

1.0 INTRODUCTION

This catalogue presents TRASMITAL BONFIGLIOLI's range of Series 300 modular planetary gearboxes.

The range has been expanded and integrated with new sizes, technical improvements and enhanced modularity right through to the larger sizes. This feature signifies greater flexibility in internal production to ensure quick availability of products in the sizes and types requested either directly from the company or from the many affiliates belonging to the BONFIGLIOLI sales network in various countries around the world.

The gearboxes are tested in conformity with the following stan-dards:

ISO DP 6336 for gears
ISO 281 for bearings

1.0 EINFÜHRUNG

In diesem Katalog stellt die TRASMITAL BONFIGLIOLI seine Angebotsreihe an modularen Planetengetrieben der Serie 300 vor.

Diese Serie wurde weiter ausgebaut und durch neue, nun zur Verfügung stehende Baugrößen bereichert. Darüber hinaus wurden hier technische Verbesserungen angetragen und die Gesamt-modularität bis zu den oberen Baugrößen hin erweitert. Diese Konstruktionsmerkmale lassen sich in eine bessere Flexibilität der internen Produktivität, in die Möglichkeit schnell Produkte in den gewünschten Größen und Ausführungen, sowohl direkt von der Firma selbst, als auch über eine der zahlreichen, zur Organisation der BONFIGLIOLI gehörenden Filialen, die in ebenso zahlreichen und weltweit verbreite- ten Ländern erhalten zu können, übersetzen.

Die Getriebe werden den folgenden Normen gemäß geprüft:

ISO DP 6336 für Zahnräder
ISO 281 für Lager

1.0 INTRODUCTION

Avec ce catalogue TRASMITAL BONFIGLIOLI présente sa gamme de réducteurs épicycloïdaux modulaires série 300.

Elle a été développée et enrichie quant à la disponibilité de nouvelles tailles, l'apport d'améliorations techniques aussi bien qu'à l'extension de la modularité globale jusqu'aux tailles supérieures. Cette caractéristique de construction se traduit dans une flexibilité productive interne plus importante, dans la possibilité d'obtenir, sous de courts délais, les produits ayant les tailles et les exécutions nécessaires, tant de manière directe de l'entreprise, qu'à travers les nombreuses filiales appartenant à l'organisation de vente BONFIGLIOLI, établies dans plusieurs pays du monde.

Les réducteurs sont vérifiés selon les normes suivantes:

ISO DP 6336 pour les engrenages
ISO 281 pour les roulements

2.0 CARATTERISTICHE

La serie 300 è una gamma di riduttori epicicloidali multimpiego azionabili da motori idraulici ed elettrici.
Le caratteristiche di base sono:

- 14 grandezze
- coppie in uscita fino a 540.000 Nm
- potenze trasmissibili fino a 450 kW
- rapporti da 1:3.5 a 3000
- costruzione modulare
- esecuzione:
  - in linea
  - angolare (con primo stadio realizzato con coppia conica Gleason)
- da 1 a 4 stadi di riduzione
- versioni in uscita per montaggio con flangia, con piede, pendolare.
- alberi in uscita: con linguetta, scanalati, femmina scanalati, cavi cilindrici per montaggio pendolare con giunto ad attrito.
- predisposizioni motore in entrata per:
  motori elettrici, secondo IEC forma B5
  motori idraulici dei principali costruttori e secondo SAE J744C
- alberi veloci in entrata
- motoriduttori con:
  - motori elettrici IEC
  - motori idraulici orbitali TRASMITAL MG
- freni idraulici negativi di stazionamento per utilizzo con motori idraulici
- accessori per alberi uscita:
  -flange
  -pignoni
  -barre scanalate
  -giunti ad attrito

Altre caratteristiche costruttive sono:

– elevato rapporto coppia trasmissibile/dimensioni d'ingombro
– elevata capacità a sopportare carichi radiali e assiali sugli alberi di uscita grazie all'utilizzo, sulle versioni H, di cuscinetti a rulli conici
– elevati rendimenti
– collegamenti fra gli organi interni tramite profili scanalati, non utilizzo di linguette
– stadi di riduzione con portaplanetari flottanti per ottenere la massima ripartizione dei carichi fra gli ingranaggi planetari
– carcasse in ghisa sferoidale.

2.0 SPECIFICATIONS

The 300 series consist of a range of multi-purpose planetary gearboxes that can be operated by either hydraulic or electric motors.
Basic features are:

- 14 sizes
- output torque up to 540,000 Nm
- transmissible power up to 450 kW
- ratios from 3.5:1 to 3000:1
- modular design
- versions:
  - in-line
  - right angle (first stage with bevel gear pair Gleason)
- reduction stages ranging from 1 to 4
- with flange-mounted, foot-mounted and shaft-mounted output
- output shafts with keyway, splined, splined hollow shafts, hollow shafts for shaft-mounting with shrink disc
- input adaptors for:
  electric motors to IEC standards design B5
  hydraulic motors by major manufacturers and according to SAE J744C
- high speed shafts
- gearmotors with:
  - electric motors IEC
  - hydraulic orbital motors by TRASMITAL MG
- negative hydraulic parking brakes for operation by hydraulic motors
- output shaft accessories:
  - flanges
  - pinions
  - splined bars
  - shrink discs

More design features:

– high ratio of transmissible torque to overall dimensions
– high radial and axial load capacity of output shafts thanks to tapered roller bearings fitted on the H versions
– high efficiency
– inner parts are connected using grooved sections instead of tabs
– planetary gears of reduction stages mounted to floating holders to ensure maximum load distribution among planetary gears
– housing made of spheroidal cast iron.

2.0 KONSTRUKTIONS-MERKMALE

Die Serie 300 ist eine Reihe an vielseitig einsetzbaren Planetengetrieben, die von Hydraulik- oder Elektromotoren angetrieben werden können.
Ihre Gundmerkmale sind:

- 14 Baugrößen
- Abtriebsdrehmomente bis zu 540.000 Nm
- Antriebsleistungen bis zu 450 kW
- Übersetzungsverhältnisse von 1:3,5 bis 3000
- Modularbauweise
- Ausführung:
  - linear
  - auf Winkel (erste Stufe mit Kegelradpaarung realisiert)
- von 1 bis 4 Untersetzungstufen
- Abtriebsversionen für Montage mit Flansch, mit Fuß, in Aufsteckversion)
- Abtriebswellen: mit Passfeder, Vielkeil, Vielkeilhohlwelle, zylindrischer Hohlwelle für Schrumpfscheibenmontage.
- Vorbereitet für Antriebsmotor:
  Elektromotoren, gemäß IEC Form B5
  Hydraulikmotoren der bedeutensten Hersteller und gemäß SAE J744C
- Schnelle Wellen am Antrieb
- Getriebemotoren mit:
  Elektromotoren IEC
  orbitale Hydraulikmotoren der TRASMITAL MG
- hydraulische Abstellbremsen für Steuerung durch Hydraulikmotoren
- Zubehör für Abtriebswellen:
  - Flanschen
  - Ritzel
  - Keilstäbe
  - Schrumpfscheiben

Andere Konstruktionsmerkmale lassen sich folgendermaßen zusammenfassen:

– hohes übertragbares Drehmoment/Verhältnis zu den Aussenmaßen
– hohe Wirkungsgrade
– Verbindungen zwischen den inneren Organen mittels Nutprofilen, es werden keine Passfedern verwendet
– Untersetzungstufen mit schw immenden Planetenradträger zur Belastungsverteilung auf die Planetenrädern
– Gehäuse aus Sphäroguss.

2.0 CARACTERISTIQUES

La série 300 est une gamme de réducteurs épicycloïdaux polyvalents, qui peuvent être actionnés par des moteurs hydrauliques et électriques.
Les principales caractéristiques sont:

- 14 tailles
- couples en sortie jusqu'à 540.000 Nm
- puissances transmissibles jusqu'à 450 kW
- rapports de 1:3,5 à .3000
- construction modulaire
- exécution:
  - linéaire
  - angulaire (premier étage réalisé avec couple conique)
- de 1 à 4 étages de réduction
- versions en sortie pour assemblage avec bride, patte, ou pendulaire
- arbres de sortie: avec clavette; cannelés; femelle cannelés; creux cylindriques pour assemblage pendulaire avec frette de serrage
- raccordements à l'entrée pour les moteurs suivants:
  moteurs électriques, selon CEI forme B5
- moteurs hydrauliques des marques principales et conformes à SAE J744C
- arbres rapides d'entrée
- motoréducteurs avec :
  - moteurs électriques CEI
  - moteurs hydrauliques orbitaux TRASMITAL MG
- freins hydrauliques négatifs de stationnement pour commande avec moteurs hydrauliques
- accessoires pour arbre de sortie:
  - brides
  - pignons
  - barres cannelées
  - joints d'accouplement à friction

D'autres caractéristiques de construction sont :

– rapport de couple transmissible élevé / dimensions d'encombrement
– capacité élevée à supporter les charges radiales et axiales sur les arbres de sortie, grâce à l'utilisation, sur les versions H., de roulements à rouleaux coniques
– rendements élevé
– raccordements entre les organes intérieurs par le biais de profils cannelés, et non pas de clavettes
– étages de réduction avec porte-planétaires flottants pour obtenir la maxime répartition des charges dans le train d'engrenages épicycloïdaux
– carter en fonte G.S..

3.0 FORME COSTRUTTIVE

3.0 VERSIONS

3.0 BAUFORMEN

3.0 FORMES DE CONSTRUCTION

A ENTRATE / INPUT
EINGANGE / ENTREES

B RIDUZIONI / REDUCTIONS
UNTERSETZUNGEN / TRAINS EPICICLOÏDAUX

A
1 Motore idraulico orbitale MG, con e senza freno.
2 Motore idraulico
3 Predisposizione motore idraulico
4 Coperchio
5 Freno negativo
6 Albero veloce
7 Motore elettrico
8 Predisposizione motore elettrico

B
9 Stadio riduzione angolare
10 Uno stadio di riduzione
11 Due stadi di riduzione
12 Tre stadi di riduzione

C
13 Uscita albero maschio cilindrico o scanalato
14 Uscita rinforzata albero maschio cilindrico o scanalato
15 Uscita con piede di supporto ed albero maschio cilindrico o scanalato.
16 Uscita albero femmina scanalato
17 Uscita albero femmina per giunto ad attrito
18 Uscita albero maschio cilindrico
19 Uscita albero maschio scanalato
20 Uscita albero femmina scanalato
21 Uscita albero femmina per giunto ad attrito
22 Piede di supporto

D
23 Flangia
24 Pignone
25 Manicotto liscio
26 Fondello d'arresto
27 Barra scanalata
28 Giunto ad attrito

A
1 Orbital hydraulic motor MG with/without brake
2 Hydraulic motor
3 Hydraulic motor setting
4 Cover
5 Negative brake
6 Input shaft
7 Electric motor
8 Electric motor setting

B
9 Right angle reduction stage
10 Single reduction stage
11 Two reduction stages
12 Three reduction stages

C
13 Keyed or splined solid shaft output
14 Keyed or splined heavy solid shaft output
15 Output with support bracket and keyed or splined solid shaft
16 Splined hollow shaft output
17 Hollow shaft output for shrink disc
18 Keyed solid shaft output
19 Splined solid shaft output
20 Splined hollow shaft output
21 Hollow shaft output for shrink disc
22 Support bracket

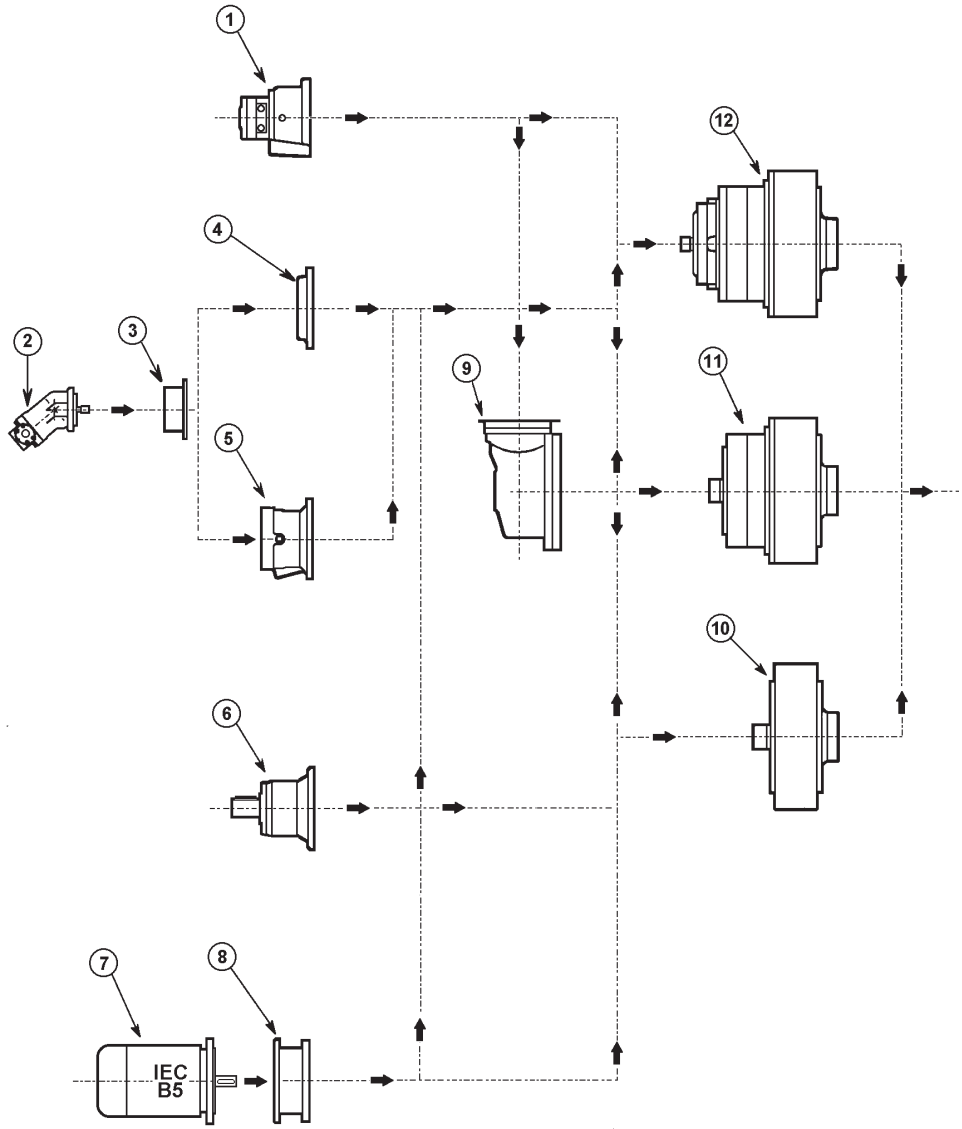
D
23 Flange
24 Pinion
25 Sleeve coupling
26 Stop bottom plate
27 Splined bar
28 Shrink disc

A
1 Orbitaler Motor MG mit und ohne Bremse
2 Hydraulikmotor
3 Anbauvorbereitung für Hydraulikmotor
4 Deckel
5 Negative Bremse
6 Antriebswelle
7 Elektromotor
8 Anbauvorbereitung für Elektromotor

B
9 Winkeluntersetzungsstufe
10 Eine Untersetzungsrufe
11 Zwei Untersetzungsstufen
12 Drei Untersetzungsstufen

C
13 Abtrieb an Einsteckwelle oder Keilwelle
14 Abtrieb an Einsteckwelle oder Verstärkter Abtrieb
15 Abtrieb mit Stützfuß und Einsteckwelle oder Keilwelle
16 Abtrieb an Aufsteckkeilwelle
17 Abtrieb an Aufsteckwelle für Reibekupplung
18 Abtrieb an Einsteckwelle
19 Abtrieb an Keileinsteckwelle
20 Abtrieb an Keilaufsteckwelle
21 Abtrieb an Aufsteckwelle für Reibekupplung
22 Stützfuß

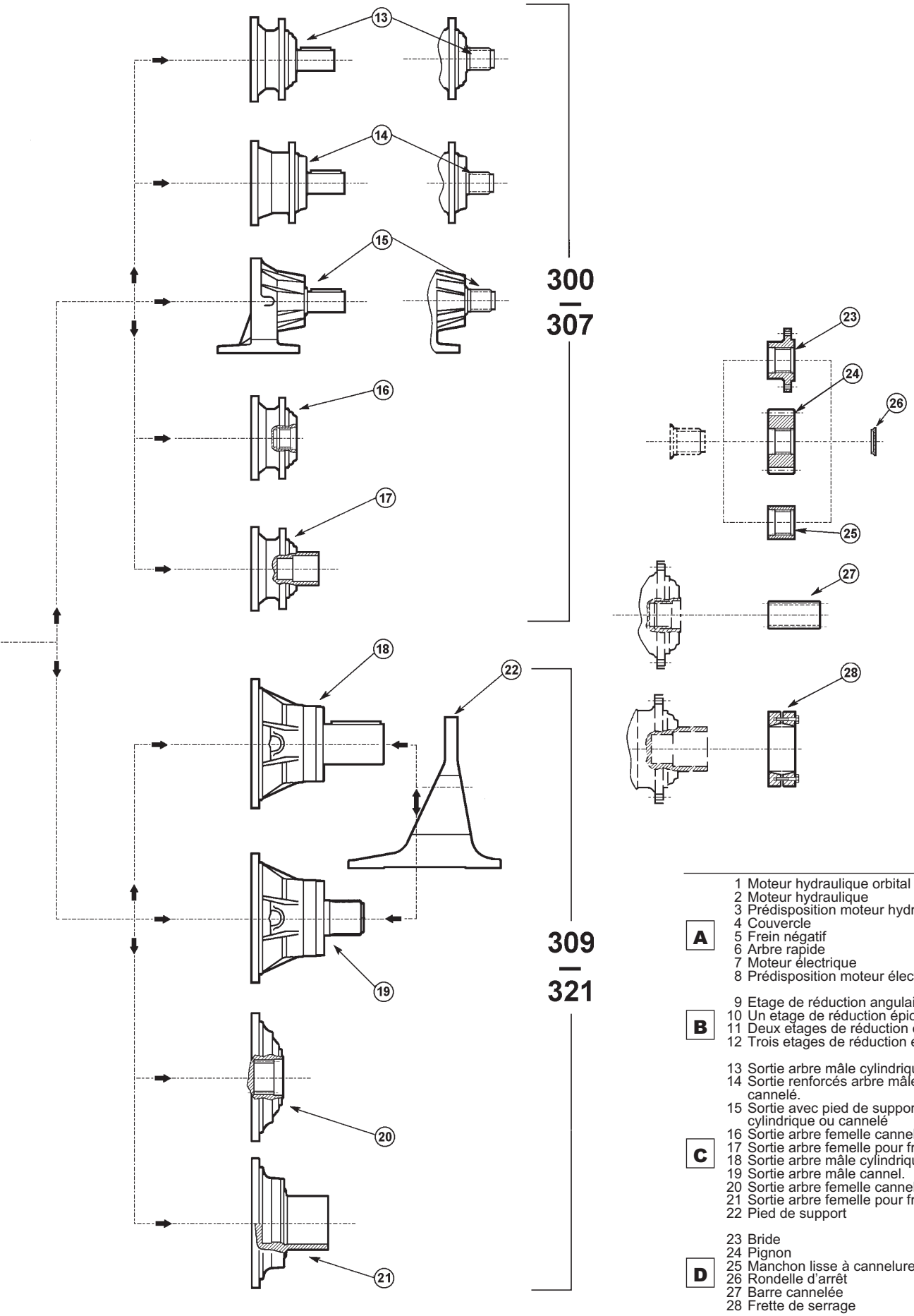
D
23 Flansch
24 Ritzel
25 Nabe
26 Bodenhaltescheibe
27 Vielkeilvollwelle
28 Schrumpfscheibe



3.0 FORME COSTRUTTIVE — 3.0 VERSIONS — 3.0 BAUFORMEN — 3.0 FORMES DE CONSTRUCTION

C USCITE / OUTPUT
ABTRIEB / SORTIES

D ACCESSORI / FITTINGS
ZUBEHÖR / ACCESSOIRES



A
1 Moteur hydraulique orbital MG, avec ou sans frein
2 Moteur hydraulique
3 Prédisposition moteur hydraulique
4 Couvercle
5 Frein négatif
6 Arbre rapide
7 Moteur électrique
8 Prédisposition moteur électrique

B
9 Etage de réduction angulaire
10 Un etage de réduction épicycloidaux
11 Deux etages de réduction épicycloidaux
12 Trois etages de réduction épicycloidaux

C
13 Sortie arbre mâle cylindrique ou cannelé
14 Sortie renforcés arbre mâle cylindrique ou cannelé.
15 Sortie avec pied de support et arbre mâl cylindrique ou cannelé
16 Sortie arbre femelle cannelé
17 Sortie arbre femelle pour frette
18 Sortie arbre mâle cylindrique
19 Sortie arbre mâle cannel.
20 Sortie arbre femelle cannelé
21 Sortie arbre femelle pour frette
22 Pied de support

D
23 Bride
24 Pignon
25 Manchon lisse à cannelure intérieure
26 Rondelle d'arrêt
27 Barre cannelée
28 Frette de serrage

4.0 SIMBOLOGIA E UNITA' DI MISURA — 4.0 SYMBOLS AND UNITS OF MEASURE — 4.0 VERWENDETE SYMBOLE INHEITEN — 2.0 SYMBOLES ET UNITES DE MESURE

Simb. Symb.	U.m. Meßeinh.	Descrizione	Description	Beschreibung	Description
A_{c1}	[N]	Carico assiale di calcolo in entrata riduttore	Calculated thrust load at gearbox input shaft	Axialkräfte auf Getriebe Antriebswelle Berechnungsgrundlage	Charge axiale de calcul à l'entrée du réducteur
A_{c2}	[N]	Carico assiale di calcolo in uscita riduttore	Calculated thrust load at gearbox output shaft	Axialkräfte auf Getriebe Abtriebswelle Berechnungsgrundlage	Charge axiale de calcul à la sortie du réducteur
A_{n1}	[N]	Carico assiale nominale in entrata riduttore	Rated thrust load at gearbox input shaft	Nenn-Axialkräfte auf Getriebe Antriebswelle	Charge axiale nominale à l'entrée du réducteur
A_{n2}	[N]	Carico assiale nominale in uscita riduttore	Rated thrust load at gearbox output shaft	Nenn-Axialkräfte auf Getriebe Abtriebswelle	Charge axiale nominale à la sortie du réducteur
F_h		Fattore di durata per calcolo riduttori	Lifetime factor for gearbox calculation	Lebensdauerfaktor für die Getriebeberechnung	Facteur de durée pour le calcul des reducteurs
F_{h1} , F_{h2}		Fattore di durata per calcolo cuscinetti alberi entrata, uscita	Lifetime factor for bearing shafts calculation	Lebensdauerfaktor für die Berechnung der Ein-undausgangwellenlager	Facteur de durée pour le calcul des roulements sur les arbres d'entrée et sortie
f_{h1}, f_{h2}		Fattore correttivo per carichi sugli alberi	Load corrective factor on shafts	Korrektur faktor für wellenbelastungen	Facteur de correction pour charges sur les arbres
f_m		Fattore di maggiorazione	Increase factor	Überdimensionierungsfaktor	Facteur de majoration
f_s		Fattore di servizio	Service factor	Betriebsfaktor	Facteur de service
f_t		Fattore termico	Thermal factor	Wärmefaktor	Facteur thermique
f_{tp}		Fattore di temperatura	Temperature factor	Temperaturfaktor	Facteur de température
f_v		Fattore di velocità	Speed factor	Drehzahlfaktor	Facteur de vitesse
h	[h]	Durata in ore	Lifetime in hours	Dauer in Stunden	Durée en heures
i		Rapporto di riduzione	Reduction ratio	Übersetzung	Rapport de réduction
K_r		Fattore di sollecitazione del carico radiale	Radial load factor	Belastungsfaktor der Radiallast	Facteur de sollicitation de la charge radiale
I		Rapporto di intermittenza	Intermittence factor	Relative Einschaltdauer	Rapport d'intermittence
M_2	[Nm]	Coppia di riferimento	Reference torque	Bezugsdrehmoment	Couple de référence
Mb	[Nm]	Coppia nominale del freno	Rated brake torque	Nenn-Drehmoment der Bremse	Couple nominal du frein
M_{c2}	[Nm]	Coppia di calcolo in uscita riduttore	Calculated torque at gearbox output	Soll-Drehmoment Abtriebswelle Getriebe	Couple de calcul de sortie réducteur
M_{n2}	[Nm]	Coppia nominale in uscita riduttore	Gearbox rated output torque	Nenn-Drehmoment Abtriebswelle Getriebe	Couple nominal de sortie réducteur
M_{2max}	[Nm]	Coppia massima in uscita riduttore	Gearbox max. output torque	Max-Drehmoment Abtriebswelle Getriebe	Couple max. de sortie réducteur
M_{r1}	[Nm]	Coppia richiesta in entrata al riduttore	Required torque at gearbox input	Erforderliches Drehmoment am Getriebeantrieb	Couple nécessaire à l'entrée du réducteur
M_{r2}	[Nm]	Coppia richiesta in uscita al riduttore	Required torque at gearbox output	Verlangtes Drehmoment Getriebeabtriebswelle	Couple requis à la sortie du réducteur
n_1	[min^{-1}]	Velocità angolare in entrata riduttore	Angular speed at gearbox input	Drehzahl Antriebswelle Getriebe	Vitesse angulaire à l'entrée du réducteur
n_2	[min^{-1}]	Velocità angolare in uscita riduttore	Angular speed at gearbox output	Drehzahl Abtriebswelle Getriebe	Vitesse angulaire à la sortie du réducteur
p	[bar]	Pressione olio idraulico	Hydraulic oil pressure	Druck des Hydrauliköls	Pression huile hydraulique
P_1	[kW]	Potenza max. trasmissibile in entrata riduttore	Max transmissible power at gearbox input	Max übertragene Leistung Antriebswelle Getriebe	Puissance maximum transmissible à l'entrée du réducteur
P_1'	[kW]	Potenza max. trasmessa in entrata riduttore	Transmitted power at gearbox input	Max übertragene Leistung Antriebswelle Getriebe	Puissance maximum transmise à l'entrée du réducteur
P_2	[kW]	Potenza trasmessa in uscita riduttore	Transmitted power at gearbox output	Übertragene Leistung Abtriebswelle Getriebe	Puissance transmise à la sortie du réducteur
P_n	[kW]	Potenza nominale motore	Motor rated power	Nennleistung Motor	Puissance nominale moteur
P_{r1}	[kW]	Potenza richiesta in entrata	Required input power	Verlangte Leistung Antriebswelle	Puissance requise en entrée
P_{r2}	[kW]	Potenza in uscita a n_2 max	Output power at n_2 max	Abtriebsleistung bei n_2 max	Puissance en sortie à n_2 max
P_{r2}'	[kW]	Potenza in uscita a n_2 min	Output power at n_2 min	Abtriebsleistung bei n_2 min	Puissance en sortie à n_2 min
P_s	[kW]	Potenza da smaltire	Excess power	Überleistung	Puissance à éliminer
P_t	[kW]	Potenza termica riduttore	Gearbox thermal capacity	Termische Grenzleistung Getriebe	Puissance thermique réducteur
Q	[l/min]	Portata olio idraulico	Hydraulic flow rate	Durchflußmenge des Hydrauliköls	Débit d'huile hydraulique
R_{c1}	[N]	Carico radiale (di calcolo) in entrata riduttore	Calculated radial load of gearbox input shaft	Radialkräfte auf Antriebswelle Getriebe - Berechnungsgrundlage	Charge radiale de calcul à l'entrée du réducteur
R_{c2}	[N]	Carico radiale (di calcolo) in uscita riduttore	Calculated radial load of gearbox output shaft	Radialkräfte auf Abtriebswelle Getriebe - Berechnungsgrundlage	Charge radiale de calcul à la sortie du réducteur
R_{x1}	[N]	Carico radiale nominale in entrata riduttore ricalcolato rispetto a diversi punti di applicazione del carico	Rated radial load at gearbox input re-calculated with respect to different load application points	Nachrechnung der Nenn-Radialkräfte auf die Antriebswelle des Getriebes bei verschiedenen Angriffspunkten der Kraft	Charge radiale nominale à l'entrée du réducteur recalculée par rapport à différents points d'application de la charge
R_{x2}	[N]	Carico radiale nominale in uscita riduttore ricalcolato rispetto a diversi punti di applicazione del carico	Rated radial load at gearbox output re-calculated with respect to different load application points	Nachrechnung der Nenn-Radialkräfte auf die Abtriebswelle des Getriebes bei verschiedenen Angriffspunkten der Kraft	Charge radiale nominale à la sortie du réducteur recalculée par rapport à différents points d'application de la charge
t_a	[°C]	Temperatura ambiente	Ambient temperature	Umgebungstemperatur	Température ambiante
V	[cm^3]	Cilindrata motore idraulico	Hydraulic motor displacement	Hubraum - Hydraulikmotor	Cylindrée moteur hydraulique
V_c	[cm^3]	Cilindrata motore idraulico (di calcolo)	(Theoretical) Hydraulic motor displacement	Hubraum - Hydraulikmotor (kalkuliert)	Cylindrée moteur hydraulique (de calcul)
X	[mm]	Distanza di applicazione del carico dallo spallamento albero	Load application distance from shaft shoulder	Abstand des Kraftangriffspunktes vom Wellenansatz	Distance d'application de la charge par rapport à l'épaulement de l' arbre
ηd		Rendimento dinamico	Dynamic efficiency	Dinamische Virkungsgrad	Rendement dynamique
Z		Frequenza di avviamento	Frequency of starts	Anlaßfrequenz	Frequence de démarrage

Simbolo riferito ai pesi dei riduttori.

Symbol referring to weight of gearboxes.

Symbol für das Gewicht der Getriebe.

Symbole se référant aux poids des réducteurs.

Le colonne contrassegnate da questo simbolo indicano i numeri di pagina dove sono riportate le dimensioni.

Columns marked with this symbol indicate the reference page showing dimensions.

Die mit diesem Symbol gekennzeichneten Spalten geben die Nummern der Seiten mit den Maßangaben.

Les colonnes portant ce symbole indiquent les numéros de page où sont mentionnées les dimensions.

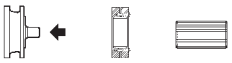
Questo simbolo riporta un numero che rappresenta il numero di pagina di riferimento.

This symbol identifies reference page number.

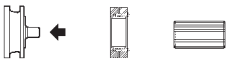
In diesem Symbol wird eine Nummer angegeben, die für die entsprechende Bezugsseite steht.

Cette image comporte un chiffre représentsant le numéro de page de référence.

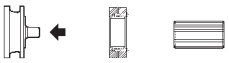
Questi simboli evidenziano il punto di montaggio degli accessori.



These symbols identify the mounting positions of accessories.



Durch diese Symbole werden die Montage punkte für die Zubehörteile hervorgehoben.



Ces images montrent la position de montage des accessoires.

Le parti in nero di questi simboli evidenziano la collocazione delle entrate dei riduttori.

These symbols identify the position of gearbox input (black-filled areas).

Die durch die schwarze Farbe hervorgehobenen Teile, stellen die Antriesseiten der Getriebe dar.

Les parties noires de ces images montrent l’emplacement des entrées des réducteurs.

Il simbolo della chiave associato ad un numero indica la coppia di serraggio delle viti del giunto ad attrito.

The number associated with the wrench symbol indicates the tightening torque for friction coupling screws.

Das an eine Nummer gebundene Schlüsselsymbol steht für den Anzugsmoment der Schrauben der Reibeverbindung.

L’image de la clé associée à un numéro signale le couple de serrage des vis du joint à frottement.

Freno negativo a dischi multipli.

Negative multidisc brake.

Negative Lamellenbremse.

Frein multidisques négatif.

Predisposizione motore idraulico.

Hydraulic motor connection.

Eingangsflansch für Hydraulikmotor.

Adaptation pour moteur hydraulique.

Coperchio per flangiatura in ingresso standard.

Cover for standard input flanging.

Deckel für Antriebsflansche, Standardausführung.

Couvercle pour bridage d’ une entrée standard.

Esecuzione in linea.

Inline units.

Koaxialgetriebe.

Exécution coaxiale.

Esecuzione angolare.

Right angle units.

Winkelgetriebe.

Exécution angulaire.

INFORMAZIONI GENERALI

I paragrafi che seguono riportano una serie di informazioni sugli elementi indispensabili per la scelta e il corretto utilizzo dei motoriduttori.

5.0 COPPIA IN USCITA

5.1 Coppia di riferimento
M_2 [Nm]

E' un valore di coppia in uscita indicativo per una rapida individuazione della classe di prestazione di ogni grandezza base di riduttore.

5.2 Coppia nominale
M_{n2} [Nm]

E' la coppia nominale trasmissibile in uscita dal riduttore con carico continuo uniforme, fattore di servizio f_s=1, per diversi valori fissati del fattore di durata ($n_2 \cdot h$).
I valori di M_{n2} sono verificati secondo i seguenti standard:
ISO DP 6336 per gli ingranaggi
ISO 281 per i cuscinetti.

5.3 Coppia massima
M_{2max} [Nm]

E' il valore di coppia in uscita sopportabile sopportabile dal riduttore in condizioni statiche o fortemente intermittenti.
(Inteso come coppia di punta di carico istantaneo o come coppia di avviamento sotto carico).

5.4 Coppia richiesta
M_{r2} [Nm]

Rappresenta la coppia richiesta dall'applicazione e dovrà sempre essere uguale o inferiore alla coppia in uscita nominale M_{n2} del riduttore scelto.

5.5 Coppia di calcolo
M_{c2} [Nm]

E' il valore di coppia da utilizzare per la selezione del riduttore considerando la coppia richiesta M_{r2} e il fattore di servizio f_s (tab. A3) ed è dato dalla formula:

dove M_{n2} è il valore corrispondente al fattore di durata ($n_2 \cdot h$) caratteristico dell'applicazione.

6.0 POTENZA

6.1 Potenza in entrata
P_1 [kW]

La potenza P_1 indicata nelle tabelle dati tecnici di ogni grandezza di riduttore, è quella trasmissibile in entrata in maniera intermittente o continua alle seguenti condizioni:

Velocità in ingresso	n_1
Durata teorica	1000 h
Fattore di servizio	f_s=1

GENERAL INFORMATION

The following paragraphs contain information on essential elements for selection and correct use of gearmotors.

5.0 OUTPUT TORQUE

5.1 Reference torque
M_2 [Nm]

Indicative output torque to easily establish the performance class for each gearbox basic size.

5.2 Nominal torque
M_{n2} [Nm]

Torque transmitted at output at uniform continuous load, service factor f_s=1 for different fixed values of the life factor ($n_2 \cdot h$).
The M_{n2} values are tested in conformity with the following standars:
ISO DP 6336 for reduction units
ISO 281 for bearings.

5.3 Maximun torque
M_{2max} [Nm

It is the output torque that the reduction unit can withstand in static or highly intermittent conditions. (It is considered as instantaneous load peak torque or starting torque under load).

5.4 Required torque
M_{r2} [Nm]

This is the torque corresponding to application requirements. It must always be equal to or less than rated output torque M_{n2} of the selected gearbox.

5.5 Calculated torque
M_{c2} [Nm]

Torque value to be used for selecting the gearbox, considering required torque M_{r2} and service factor f_s (tab. A3), and is obtained by formula:

where M_{n2} is the value for the specific application taking into consideration the life factor ($n_2 \cdot h$).

6.0 POWER

6.1 Input rated power
P_1 [kW]

Power P_1 indicated in the specification tables for each gearbox size is either the intermittent or continuous power which can be transmitted at the gearbox input under the following conditions:

input speed	n_1
theoretical duration	1000 h
service factor	f_s=1

ALLGEMEINE INFORMATIONEN

Die folgenden Abschnitte enthalten eine Reihe von Informationen über die Aspekte, die im Hinblick auf die Wahl und dem sachgemäßen Betrieb von Getriebemotoren unbedingt zu berücksichtigen sind.

5.0 ABTRIEBSMOMENT

5.1 Bezugsdrehmoment
M_2 [Nm]

Ist ein indikativer Wert eines Abtriebdrehmoments, der ein schnelles Auffinden der Leistungsklasse jeder Getriebegrundbaugröße ermöglicht.

5.2 Nenndrehmoment
M_{n2} [Nm]

Ist das vom Getriebe am Abtrieb übertragbare Nenndrehmoment bei einer gleichmäßigen Dauerbelastung, Betriebsfaktor f_s = 1, für verschiedene festgelegte Werte des Dauerfaktors ($n_2 \cdot h$).
Die Werte M_{n2} werden den folgenden Normen gemäß geprüft:
ISO DP 6336 für Zahnräder
ISO 281 für Lager.

5.3 Maximales Drehmoment
M_{2max} [Nm]

Stellt den Wert des Abtriebdrehmoments dar, mit dem das Getriebe in statischen oder Bedingungen mit häufigen Schaltungen belastet werden kann. (Wird als augenblicklicher Spitzendrehmoment oder als Anlaßdrehmoment unter Last verstanden).

5.4 Verlangtes Drehmoment
M_{r2} [Nm]

Dies ist das von der Anwendung verlangte Drehmoment, das stets kleiner oder gleich dem Nenn-Abtriebsmoment M_{n2} des gewählten Getriebes sein muß.

5.5 Soll-Drehmoment
M_{c2} [Nm]

Ist der Drehmomentenwert, der für die Wahl des getriebemotors unter Berücksichtigung des erforderlichen Drehmoments M_{r2} und des Betriebsfaktors f_s (tab. A3) verwendet wird. Er wird von folgender Formel gegeben:

wo M_{n2} der Wert ist, der dem Dauerfaktor ($n_2 \cdot h$) entspricht, der für die Applikationsart charakteristisch ist.

6.0 LEISTUNG

6.1 Leistung Antriebswelle
P_1 [kW]

P_1 Die in den Tabellen der technischen Daten für jede Getriebegröße angegebene Leistung P_1 entspricht der Leistung, die unter den folgenden Bedingungen im Antrieb kontinuierlich oder im Schaltbetrieb übertragbar ist:

Antriebsdrehzahl	n_1
Theoretische Dauer:	1000 stunden
Betriebsfaktor	f_s=1

INFORMATIONS GENERALES

Les paragraphes qui suivent présentent une série d'informations sur les éléments indispensables pour le choix et l'utilisation correcte des motoréducteurs.

5.0 COUPLE EN SORTIE

5.1 Couple de référence
M_2 [Nm]

Est une valeur de couple en sortie indicative pour une identification rapide de la classe de performance pour chaque taille de base de réducteur.

5.2 Couple nominal
M_{n2} [Nm]

Est le couple nominal transmissible à la sortie du réducteur avec une charge uniforme et continue, facteur de service f_s=1, pour différentes valeurs fixées du facteur de durée ($n_2 \cdot h$).
Les valeurs de Mn2 sont vérifiées selon les normes suivantes:
ISO DP 6336 pour les engrenages
ISO 281 pour les roulements.

5.3 Couple maximal
M_{2max} [Nm]

C'est la valeur de couple en sortie que le réducteur peut supporter dans des conditions statiques ou de forte intermittence (considérée en tant que couple de pointe de charge instantanée ou couple de démarrage en charge).

5.4 Couple requis
M_{r2} [Nm]

Il représente le couple requis par l' application et devra toujours être inférieur ou égal au couple en sortie nominal M_{n2} du réducteur choisi.

5.5 Couple de calcul
M_{c2} [Nm]

C'est la valeur de couple à utiliser pour la sélection du réducteur en considérant le couple requis M_{r2} et le facteur de service f_s (tab. A3); elle résulte de la formule suivante:

$$M_{c2} = M_{r2} \cdot f_s < M_{n2} \qquad (1)$$

où M_{n2} représente la valeur correspondant au facteur de durée ($n_2 \cdot h$) caractéristique de l'application.

6.0 PUISSANCE

6.1 Puissance en entrée
P_1 [kW]

Comme indiqué aux tableaux des données tecniques, pour chaque taille de réducteur, la puissance P_1 est transmissible en entrée de manière intermittente ou continue aux conditions suivantes:

vitesse d'entrée	n_1
durée théorique	1000 heures
facteur de service	f_s=1

Occorre che sia sempre verificata la formula:

Check that the formula here below is always satisfied:

Die folgende Formel muß immer erfüllt werden:

Il faut toujours vérifier la formule suivante:

$$P_1' \cdot fs \leq P_1 \qquad (2)$$

6.2 Potenza in uscita P_2 [kW]

Questo valore rappresenta la potenza trasmessa all'uscita del riduttore. Si può calcolare con le seguenti formule:

6.2 Output power P_2 [kW]

This value is the power transmitted at gearbox output. It can be calculated with the following formulas:

6.2 Leistung Abtriebswelle P_2 [kW]

Dieser Wert repräsentiert die an der Abtriebswelle des Getriebes übertragene Leistung. Dieser Wert kann folgendermaßen berechnet werden:

6.2 Puissance en sortie P_2 [kW]

Cette valeur représente la puissance transmise à la sortie du réducteur. On peut la calculer avec les formules suivantes:

$$P_2 = P_1 \cdot \eta_d \qquad (3)$$

$$P_2 = \frac{M_{r2} \cdot n_2}{9550} \qquad (4)$$

7.0 POTENZA TERMICA P_t [kW]

E' il valore che indica il limite termico del riduttore (riferirsi alle tabelle dei dati tecnici relative alle varie grandezze di riduttori) ed è la potenza trasmissibile in servizio continuo con velocità n_1 in ingresso di 1500 min^{-1} ad una temperatura ambiente di 20°C senza ricorrere ad un raffreddamento ausiliario.
Per un tipo di servizio caratterizzato da una breve durata di funzionamento e da un tempo di sosta sufficientemente lungo da consentire il raffreddamento del gruppo, la potenza termica acquista scarsa rilevanza per cui può non essere tenuta in considerazione.
Con temperatura ambiente diversa da 20°C, con servizio intermittente e con velocità n_1 in ingresso diversa da 1500 min^{-1} è possibile calcolare il valore di P_t in base al fattore termico f_t ed al fattore di velocità f_v riportati nella tabella (A1).
Verificare che sia sempre soddisfatta la relazione.

7.0 THERMAL POWER P_t [kW]

This value indicates the gearbox's thermal capacity (refer to the technical data concerning the gearboxes under consideration) and is the power that can be transmitted under continuous duty at an input speed n_1 of 1500 min^{-1} at an ambient temperature of 20°C without using a supplementary cooling device.
For a duty cycle with short operating periods and sufficiently long pauses to allow the unit to cool, thermal power is not particularly important and therefore it does not need to be taken into consideration.
At an ambient temperature other than 20°C under intermittent duty conditions and with an input speed n1 other than 1500 min^{-1} it is possible to calculate the P_t value according to the thermal factor f_t and the speed factor f_v, shown in table (A1)
Make sure that the following condition is always satisfied.

7.0 THERMISCHE GRENZLEISTUNG P_t [kW]

Dieser Wert gibt die thermische Grenzleistung des Getriebes an (nehmen Sie hierzu Bezug auf die technischen Daten der verschiedenen Getriebegrößen) und die bei einem Dauerbetrieb übertragbaren Leistung bei einer Antriebsdrehzahl n_1 von 1500 min^{-1} bei einer Umgebungstemperatur von 20°C ohne Zusatzkühlung an.
Bei Dauerbetrieb, der durch kurze Betriebszeiten und für die Abkühlung der Baugruppe ausreichend lange Aussetzzeiten gekennzeichnet ist, hat die Wärmegrenzleistung nur geringe Bedeutung und kann deshalb vernachlässigt werden. Bei einer von den 20°C abweichenden Umgebungstemperatur, im Schaltbetrieb und bei einer von 1500 min^{-1} abweichenden Antriebsdrehzahl n_1, kann der Wert P_t unter Zugrundlage des Wärmefaktors f_t und des Drehzahlfaktors f_v, Werte die in der Tabelle (A1) wiedergegeben werden, berechnet werden.
Überprüfen, ob folgendes Verhältnis eingehalten wird.

7.0 PUISSANCE THERMIQUE P_t [kW]

C'est la valeur qui indique la limite thermique du réducteur et c'est la puissance transmissible en service continu avec vitesse n_1 en entrée, de 1500 min^{-1}, à une température ambiante de 20°C sans recourir à un refroidissement auxiliaire.
Pour un type de service caractérisé par une durée de fonctionnement brève et par un temps de pause suffisamment long pour permettre le refroidissement du groupe, la puissance thermique ne revet qu'une faible importance et peut par conséquent,ne pas être prise en considération.
Avec température ambiante autre que 20°C, en service intermittent, et avec vitesse n_1 en entrée autre que 1500 min^{-1}, on peut calculer la valeur de P_t sur la base du facteur thermique f_t et du facteur de vitesse f_v indiqués sur le tableau (A1).
Vérifier que la relation suivante est toujours respectée.

$$P_{r1} \leq P_t \cdot f_t \cdot f_v \qquad (5)$$

(A1)

f_t					
ta max. [°C] ta max. [°C] ta max. [°C] ta maxi. [°C]	Servizio continuo Continuous duty Dauerbetrieb Service continu	Servizio intermittente / Intermittent duty / Aussetzbetrieb / Service intermittent Rapporto di intermittenza % (I) / Cyclic duration factor % (I) Relative Einschaltdauer % (I) / Rapport d'intermittence % (I)			
		80	60	40	20
10	1.2	1.3	1.6	1.8	2
20	1	1.1	1.3	1.5	1.7
30	0.9	1	1.2	1.3	1.5
40	0.7	0.8	0.9	1	1.2
50	0.5	0.6	0.7	0.8	0.9

n_1	f_v
750	1.5
950	1.2
1500	1
2000	0.7

Il rapporto di intermittenza (I)% è dato dal rapporto fra il tempo di funzionamento a carico t_f e il tempo totale ($t_f + t_r$), con t_r = tempo di riposo, espresso in percentuale:

The intermittance factor (I)% is obtained from the ratio between operating time under load t_f and total time ($t_f + t_r$), where rest time t_r, expressed as a percentage:

Die relative Einschaltdauer (I) % ist das Verhältnis aus der Betriebsdauer unter Last t_f und der Gesamtbetriebszeit ($t_f + t_r$), mit t_r= Ruhetemperatur, ausgedrückt in Prozent:

Le rapport d'intermittence (I)% est donné par le rapport entre la durée de fonctionnement en charge t_f et le temps total ($t_f + t_r$) avec t_r = temps de repos, exprimé en pour cent:

$$I = \frac{t_f}{t_f + t_r} \cdot 100 \qquad (6)$$

N.B. I valori di potenza termica indicati nelle tabelle tecniche relative ad ogni grandezza, si riferiscono alle esecuzioni senza freno negativo a dischi multipli.
In caso di applicazioni con freni, interpellare la nostra organizzazione di vendita.

NOTE: The thermal power values indicated in the selection charts for each size apply to the versions without negative multidisc brake.

For the versions fitted with brakes, please contact our sales organization.

MERKE: Die in den technischen Tabellen für jede Baugröße angegebenen Werte der Wärmeleistung, beziehen sich auf die Versionen ohne Mehrfachscheiben- Negativbremse.
Bei Applikationen mit Bremsen, müssen Sie sich erst mit unserem Verkaufsnetz in Verbindung setzen.

N.B. Les valeurs de puissance thermique, indiquées aux tableaux techniques relatifs à chaque taille, concernent des exécutions sans frein négatif multidisque.
En cas d'application avec frein, contacter notre organisation de vente.

8.0 RENDIMENTO

8.1 Rendimento dinamico η_d

E' dato dal rapporto fra la potenza in uscita P_2 e quella in entrata P_1 secondo la relazione:

8.0 EFFICIENCY

8.1 Dynamic efficiency η_d

Obtained from the ratio of output power P_2 to input power P_1 according to the following equation:

8.0 WIRKUNGSGRAD

8.1 Dynamischer Wirkungsgrad η_d

Er ist gegeben durch das Verhältnis der Abtriebsleistung P_2 zur Antriebsleistung P_1:

8.0 RENDEMENT

8.1 Rendement dynamique η_d

Il est donné par le rapport entre la puissance en sortie P_2 et celle en entrée P_1:

$$\eta_d = \frac{P_2}{P_1} \qquad (7)$$

Il suo valore dipende dalla potenza trasmessa, dalla velocità, dal rapporto, dalla temperatura e dalla viscosità dell'olio.
I valori max. di rendimento sono riportati nella tabella (A2) seguente.

Its value is a function of the trasmitted power, the speed, the reduction ratio and oil temperature and viscosity.
The maximum efficiency values are shown in the table (A2) below.

Sein Wert hängt von der übertra genen Leistung, der Drehzahl, dem Übersetzungsverhältnis und der Temperatur, darüber hinaus von der Öltemperatur ab.
Die Werte des max. Wirkungsgrads werden in der in Folge angeführten Tabelle (A2) angegeben.

Sa valeur dépend de la puissance transmise, de la vitesse, du rapport et de la température, ainsi que viscosité, de l'huile.
Les valeurs max. de rendement sont indiquées sur le tableau (A2) suivant.

(A2)

N° stadi / N° stages / Anz. Stufen / Nombre d'étages de réduction			
L1	**L2 - R2**	**L3 - R3**	**L4 - R4**
0.97	0.94	0.91	0.88

9.0 RAPPORTO DI RIDUZIONE i

E il rapporto fra la velocità d'entrata e d'uscita del riduttore.

9.0 REDUCTION RATIO i

This is the ratio of gearbox input speed to gearbox output speed.

9.0 ÜBERSETZUNG i

Ist das Verhältnis zwischen Antriebs- und Abtriebsdrehzahl des Getriebes.

9.0 RAPPORT DE REDUCTION i

Est le rapport entre la vitesse d'entrée et de sortie du réducteur.

$$i = \frac{n_1}{n_2} \qquad (8)$$

10.0 VELOCITÀ ANGOLARE

10.1 Velocità in entrata n_1 [min^{-1}]

E' la velocità del motore di azionamento nel caso in cui questo sia collegato direttamente in asse al riduttore. Oppure quella risultante sempre dal motore e da eventuali rapporti di trasmissione nel caso di azionamento indiretto, ad esempio con cinghie.

La velocità in ingresso non deve mai superare i valori indicati nelle tabelle dati tecnici dei riduttori.

Per funzionamento in continuo in applicazioni industriali è raccomandabile non superare la velocità di 1750 min^{-1}.

10.0 ANGULAR SPEED

10.1 Input speed n_1 [min^{-1}]

Refers to the speed of motor if motor is directly connected to gearbox. In the case of an indirect drive, this value is the speed of the motor divided by the transmission ratio of the indirect drive accessory (belt, chain, etc.).

Input speed should exceed the values indicated in the tables on gearbox technical features.

As for continuous operation in industrial applications, we recommend that speed of 1750 min^{-1} be never exceeded.

10.0 DREHZAHL

10.1 Drehzahl Antriebswelle n_1 [min^{-1}]

Ist die Geschwindigkeit des Antriebsmotors, wenn dieser direkt auf Achse mit dem Getriebe verbunden ist. Kann aber auch die Geschwindigkiet darstellen, die sich immer aus dem Motor und aus eventuellen Übersetzungsverhältnissen im Fall eines indirekten Antriebs ergibt, z.B. bei einem Riemenantrieb.

Die Antriebsgeschwindigkeit darf die in den Tabellen der Getriebe angebenen Werte nie überschreiten.

Bei einem Dauerbetrieb im industriellen Einsatz wird empfohlen, die Geschwindigkeit von 1750 min^{-1} nicht zu überschreiten.

10.0 VITESSE ANGULAIRE

10.1 Vitesse d' entrée n_1 [min^{-1}]

C'est la vitesse du moteur d'entraînement, au cas où celui-ci serait directement accouplé au réducteur de manière axiale. Ou bien la vitesse débouchant toujours du moteur, et des rapports de transmission éventuels, en cas d'entraînement indirect par exemple par courroies.

La vitesse en entrée ne doit jamais dépasser les valeurs indiquées aux tableaux des données techniques des réducteurs.

En cas de fonctionnement en continu pour des applications industrielles, on préconise de ne pas dépasser la vitesse de 750 min^{-1}.

10.2 Velocità in uscita n_2 [min^{-1}]

E' in funzione della velocità in entrata n_1 e del rapporto di riduzione i secondo la relazione:

10.2 Output speed n_2 [min^{-1}]

Calculated from input speed n_1 and transmission ratio i according to the following equation:

10.2 Abtriebsdrehzahl n_2 [min^{-1}]

Sie ist abhängig von der Antriebsdrehzahl n_1 und der Übersetzung i nach folgender Gleichung:

10.2 Vitesse en sortie n_2 [min^{-1}]

Elle varie en fonction de la vitesse d'entrée n_1 et du rapport de reduction i selon l'équation:

$$n_2 = \frac{n_1}{i} \qquad (9)$$

11.0 FATTORE DI SERVIZIO f_s

E' un fattore che definisce il tipo di applicazione. Tiene conto con sufficiente approssimazione della variabilità del carico a cui è sottoposto il riduttore per un determinato tipo di servizio. Tiene conto anche del tipo di azionamento del riduttore, con motore elettrico, idraulico ecc.

La tabella (A3) dà una indicazione per la scelta del fattore di servizio più opportuno in funzione del tipo di applicazione e del tipo di motore di azionamento

11.0 SERVICE FACTOR f_s

Factor depending on the application type. This factor takes into consideration (with sufficient approximation) load variations which the gearbox may undergo for a specific type of duty. It also takes into consideration the selected type of the drive unit, e.g. electric or hydraulic motor and so on.

Table (A3) gives indications for the service factor to be selected according to the application and operation type.

11.0 BETRIEBSFAKTOR f_s

Ist ein Faktor, der die Art der Applikation definiert. Er berücksichtigt, mit einer ausreichenden Annäherung, die Belastungschwankungen, denen das Getriebe bei einer bestimmen Betriebsart unterliegt. Berücksichtigt auch die Antriebsart der Getriebe, d.h. mittels Elektromotor, hydraulischem Motor, usw.

Die Tabelle (A3) gibt einen Anhaltspunkt für die Auswahl des, im Hinblick auf die Applikation und dem Betrieb angemessenen Betriebsfaktors.

11.0 FACTEUR DE SERVICE f_s

C'est un facteur définissant le type d'application. Il prend en compte, avec une approximation satisfaisante, la variabilité de la charge à laquelle le réducteur est soumis, pour un genre de service donné. Il considère également le type d'entraînement du réducteur, avec moteur électrique, hydraulique, etc.

Le tableau (A3) donne une indication pour le choix du facteur de service qui convient davantage au genre d'application et de fonctionnement.

(A3)

Fattori di servizio / Service factors / Betriebsfaktoren / Facteurs de service

Natura del carico Type of load Belastungsart Nature de la charge	Tipo di azionamento Type of drive unit Antriebsart Type d'entrainement	N° avviamenti /h Number of starts/hour Schaltungen/Std. N.bre démarrages/h				
		16	32	63	125	250
Uniforme Uniform load Gleichmäßig Uniforme	Mot, elettrico / Electric motor / Elektromotor / Moteur electrique	1.00	1.10	1.15	1.25	1.40
	Mot. idraulico / Hydraulic motor / Hydraulikmotor / Mot. hydraulique	1.00	1.00	1.10	1.15	1.20
	Mot. endotermico / Endothermic engine / Endotermischer Motor /Moteur endothermique	1.25	—	—	—	—
Variabile con urti moderati Moderate shock load Variable mit mäßigen Stößen Variable avec chocs modérés	Mot, elettrico / Electric motor / Elektromotor / Moteur electrique	1.10	1.15	1.20	1.40	1.60
	Mot. idraulico / Hydraulic motor / Hydraulikmotor / Mot. hydraulique	1.00	1.00	1.10	1.20	1.30
	Mot. endotermico / Endothermic engine / Endotermischer Motor /Moteur endothermique	1.50	—	—	—	—
Variabile con urti forti Heavy shock load Variable mit starken Stößen Variable avec chocs fort	Mot, elettrico / Electric motor / Elektromotor / Moteur electrique	1.20	1.30	1.40	1.60	1.80
	Mot. idraulico / Hydraulic motor / Hydraulikmotor / Mot. hydraulique	1.10	1.20	1.25	1.35	1.50
	Mot. endotermico / Endothermic engine / Endotermischer Motor /Moteur endothermique	2.00	—	—	—	—

12.0 FATTORE DI DURATA (F_{h1}, F_{h2})

E' un fattore derivato dal prodotto della velocità angolare in entrata n_1 o in uscita n_2 per le ore di effettivo funzionamento h, esclusi i tempi di sosta.

12.0 LIFE FACTOR (F_{h1}, F_{h2})

Factor resulting by multiplying angular speed at input (n_1) or output (n_2) by actual operating working hours h, break times excluded.

12.0 DAUERFAKTOR (F_{h1}, F_{h2})

Ist ein vom Ergebnis aus der Drehzahl im Antrieb n_1 oder am Abtrieb n_2 für die effektiven Betriebsstunden h, die Stillstandszeiten ausgenommen, abgeleiteter Faktor.

12.0 FACTEUR DE DUREE (F_{h1}, F_{h2})

C'est un facteur découlant du résultat de la vitesse angulaire en entrée n_1 ou en sortie n_2 multipliée par les heures de service effectif h, le temps d'arrêté tout exclus.

$$F_{h1} = (n_1 \cdot h) \qquad (10)$$

$$F_{h2} = (n_2 \cdot h) \qquad (11)$$

Il fattore di durata è direttamente proporzionale al numero di rotazioni che compie il riduttore nella sua intera durata di servizio.

Life factor is directly proportional to gearbox rpms during the whole duty time

Der Dauerfaktor steht proportional direkt zur Anzahl der Umdrehungen, die das Getriebe in seiner gesamten Betriebsdauer durchläuft.

Le facteur de durée est indirectement proportionnel au nombre de rotations que le réducteur accomplit dans la durée de service globale.

13.0 SCELTA

Per selezionare correttamente un riduttore o un motoriduttore è necessario disporre di alcuni dati fondamentali sintetizzati nella tabella (A4).
Una copia di questa può' essere inviata alla nostra Organizzazione di vendita per la ricerca della selezione del riduttore più' idoneo al tipo di applicazione.

13.0 SELECTION

Some essential data are necessary for a proper gearbox or gearmotor selection as indicated in Table (A4).

Fill in the table and send a copy to our Technical Service Department which will select the most suitable gearbox for your application requirements.

13.0 ANTRIEBSAUSWAHL

Um ein Getriebe oder einen Getriebemotor in korrekter Weise auswählen zu können, muß man über einige grundsätzliche Daten verfügen. Daten, die auf der Tabelle (A4) zusammengefaßt werden.
Eine Kopie dieser Tabelle kann an unsere Verkaufsorganisation gesendet werden, um in dieser Weise gemeinsam die Wahl des für die jeweilige Applikationsart geeignetsten Getriebes treffen zu können.

13.0 SELECTION

Pour le bon choix du réducteur ou du motoréducuteur il faut disposer de certaines données fondamentales, comme résumées au tableau (A4).
Un exemplaire de celui-ci peut être envoyé à notre Organisation de vente, afin de réaliser une sélection de réducteur qui s'adapte le mieux au genre d'application.

(A4)

Tipo di applicazione
Type of application
Anwendung
Type d'application .....

RIDUTTORE / GEARBOX / GETRIEBE / REDUCTEUR

P_{r2} Potenza richiesta in uscita
Required output power
Am Abtrieb erforderliche Leistung
Puissance nécessaire en sortie ..... kW

M_{r2} Coppia richiesta in uscita
Required output torque
Am Abtrieb erforderliches Drehmoment
Couple nécessaire en sortie ..... Nm

n_2 Velocità in uscita
Output speed
Abtriebsdrehzahl
Vitesse en sortie ..... min^{-1}

n_1 Velocità in entrata
Input speed
Antriebsdrehzahl
Vitesse en entrée ..... min^{-1}

R_{c2} Carico radiale su albero in uscita
Radial load on output shaft
Radialkraft auf Abtriebswelle
Charge radiale sur l'arbre de sortie ..... N

X_2 Distanza di applicazione del carico
Load application distance
Abstand des Kraftangriffspunktes
Distance d'application de la charge ..... mm (*)

R_{c1} Carico radiale su albero in entrata
Radial load on input shaft
Radialkraft auf Antriebswelle
Charge radiale sur l'arbre d' entrée ..... N

X_1 Distanza di applicazione del carico
Load application distance
Abstand des Kraftangriffspunktes
Distance d'application de la charge ..... mm (*)

A_{c2} Carico assiale su albero in uscita
Thrust load on output shaft
Axialkraft auf Abtriebswelle
Charge axiale sur l'arbre de sortie ..... N (•)

A_{c1} Carico assiale su albero in entrata
Thrust load on input shaft
Axialkraft auf Antriebswelle
Charge axiale sur l'arbre d' entrée ..... N (•)

h Durata di vita
Requested life time
Lebensdauer
Durée de vie ..... h

t_a Temperatura ambiente
Ambient temperature
Umgebungstemperatur
Température ambiante ..... °C

Esecuzione ☐ In linea ☐ Angolare
Type Linear Right angle
Ausführung In Reihe Auf Winkel
Exécution Linéaire Angulaire

Versione uscita
Output version
Abtriebsversion
Version sortie .....

Accessori
Accessories
Zubehör
Accessoires .....

Posizione di montaggio
Mounting position
Montageposition
Position de montage .....

Tipo di motore e azionamento / Type of motor and drive unit
Typ des Antriebsmotors / Type de moteur et entraînement

☐ Elettrico / Electric / Elektrisch / Electrique
☐ Idraulico / Hydraulic / Hydraulisch / Hydraulique
☐ Altri / Others / Anderer / Autres

MOTORE ELETTRICO / ELECTRIC MOTOR
ELEKTROMOTOR / MOTEUR ELECTRIQUE

Grandezza IEC
IEC size
IEC Baugröße
Taille CEI .....

Pn Potenza nominale
Rated power
Nennleistung
Puissance nominale ..... kW

Tensione di alimentazione
Motor voltage
Nennspannung des Motors
Tension d'alimentation moteur V

N° poli / Number of poles / Anzahl der Pole / N.bre de pôles

Frequenza
Frequency
Frequenz
Fréquence ..... Hz

Fattore di intermittenza in accordo a CEI
Duty type to IEC norms
Relative Einschaltdauer gemäß CEI
Type de service selon CEI S...../.....%

Z Frequenza di avviamento
Starting frequency
Schaltungshäufigkeit
Fréquence de démarrage 1/h

Grado di protezione motore
Motor protection degree
Schutzart des Motors
Degré de protection moteur IP.....

Classe di isolamento
Insulation class
Isolierstoffklasse
Classe d'isolation .....

FRENO SU MOTORE AUTOFRENANTE
BRAKE IN SELF-BRAKING MOTOR
BREMSE AUF SELBSTBREMSENDEM MOTOR
FREIN SUR MOTEUR AUTOFREINE

Tensione di alimentazione freno
Brake voltage
Nennspannung der Bremse
Tension d'alimentation du frein V

M_b Coppia frenante
Brake torque
Bremsmoment
Couple de freinage ..... Nm

MOTORE IDRAULICO / HYDRAULIC MOTOR
HYDRAULIKMOTOR / MOTEUR HYDRAULIQUE

Marca / Brand / Marke / Marque .....

Tipo / Type / Typ / Type .....

V Cilindrata max./min.
Min./max. displacement
Max./min. Hubraum
Cylindrée max/min ..... cm^3

p Pressione max. di esercizio
Max. operating pressure
Max. Betriebsdruck
Pression max. de service ..... bar

Q Portata max. di esercizio
Max. operating flow rate
Max.Ölstrom
Débit max. de service ..... l/min

FRENO IDRAULICO ☐ si/yes/ja/oui ☐ no/non/nein/non
HYDRAULIC BRAKE
HYDRAULISCHE BREMSE
FREIN HYDRAULIQUE

M_b Coppia frenante
Brake torque
Bremsdrehmoment
Couple de freinage ..... Nm

N.B: Tab. (A4)

(*) La distanza X_{1-2} è quella compresa fra il punto di applicazione della forza e la battuta dell'albero (se non indicata, si considererà la forza agente sulla mezzeria della sporgenza dell'albero).

(•) + = compressione
– = trazione

N.B.

I criteri di scelta e i dati tecnici riportati in questo catalogo non sono validi per tutte le applicazioni, come ad esempio impianti di sollevamento, dove il riduttore funziona come organo di sicurezza verso persone e/o cose.
In questi casi la selezione del riduttore deve essere fatta con criteri specifici, ed eventualmente in accordo alle vigenti norme di sicurezza, per cui è necessario interpellare l'Organizzazione di vendita TRASMITAL BONFIGLIOLI.

13.1 Scelta del tipo di riduttore

a) In base al tipo di applicazione definire:
- Fattore di servizio f_s (tab A3)
- La durata di funzionamento richiesta h
- Il tipo di azionamento idraulico, elettrico, altro

b) Con il valore della coppia richiesta in uscita M_{r2}, determinare la coppia di calcolo:

$$M_{c2} = M_{r2} \cdot f_s \qquad (12)$$

c) Con la durata richiesta h e la velocità di uscita n_2 calcolare il fattore di durata:

$$F_{h2} = (n_2 \cdot h) \qquad (13)$$

d) Calcolare il rapporto di riduzione richiesto:

$$i = \frac{n_1}{n_2} \qquad (14)$$

e) Selezionare la grandezza del riduttore che con il rapporto più vicino a quello calcolato soddisfi la seguente condizione:

$$M_{c2} \leq M_{n2} \qquad (15)$$

con / with / mit / avec

$$Fh_2 \leq (n_2 \cdot h) \qquad (16)$$

dove M_{n2} e F_{h2} sono riportati sulle tabelle dati tecnici di ogni grandezza di riduttore.

N.B: Table (A4)

(*) Distance X_{1-2} is between force application point and shaft shoulder (if not indicated the force exerted on the mid-point of the shaft extension will be considered).

(•) + = compression
– = traction

NOTE:

The selection criteria and specifications reported in this catalogue are not valid for any applications, including those where the gearbox is to serve as a safety device preventing injury to persons or damage to objects, as is the case with hoisting equipment.
For these applications, however, the gearbox should be selected following specific criteria and in accordance with any safety rules in force. Fir this reason, we recommend that you seek advice from TRASMITAL BONFIGLIOLI sales organization.

13.1 Gearbox selection

a) Determine the following according to the required application:
- Service factor f_s (tab. A3)
- required gearbox working life h
- required drive unit (hydraulic, electric or others)

b) Define the calculated torque with the required output torque M_{r2}:

$$M_{c2} = M_{r2} \cdot f_s \qquad (12)$$

c) Calculate the life factor with required working life h and output speed n_2.:

$$F_{h2} = (n_2 \cdot h) \qquad (13)$$

d) Calculate the required reduction ratio:

$$i = \frac{n_1}{n_2} \qquad (14)$$

e) Select gearbox size which, having a reduction ratio close to the calculated value, which satisties the following:

$$M_{c2} \leq M_{n2} \qquad (15)$$

con / with / mit / avec

$$Fh_2 \leq (n_2 \cdot h) \qquad (16)$$

where M_{n2} and F_{h2} are indicated in the tables on technical features for each gearbox size.

N.B: Tab. (A4)

(*) Der Abstand X_{1-2} ist der Abstand vom Kraftangriffspunkt zum Wellenansatz (wenn nicht anders angegeben, wird davon ausgegangen, daß die Kraft auf der Mitte des Wellenendes angreift).

(•) + = Druck
– = Zug

MERKE:

Die Auswahlkriterien und die technischen Daten, die in diesem Katalog aufgeführt werden, sind nicht für alle Applikationsarten gültig, wie z.B. an Hebeanlagen, wo das Getriebe die Funktion eines Sicherheitsorgans im Hinblick auf den Personen- und/oder Sachschutz hat.
In diesen Fällen muß die Getriebewahl unter Anwendung spezifischer Kriterien und eventuell in Übereinstimmung mit den Sicherheitsnormen erfolgen. Es ist daher erforderlich, daß Sie sich diesbezüglich mit einer Verkaufsstelle der TRASMITAL BONFIGLIOLI in Verbindung setzen.

13.1 Wahl des Getriebetyps

a) In Basis auf die Applikationsart muß folgendes bestimmt werden:
- Betriebsfaktor f_s (tab. A3)
- Die erforderliche Betriebsdauer h
- Die Antriebsart - hydraulisch, elektrisch, o.a.

b) Mit dem Wert des am Abtrieb M_{r2} erforderlichen Drehmoments das Soll-Drehmoment bestimmen:

$$M_{c2} = M_{r2} \cdot f_s \qquad (12)$$

c) Mit der erforderlichen Dauer h und der Abtriebsdrehzahl n_2, den Dauerfaktor kalkulieren:

$$F_{h2} = (n_2 \cdot h) \qquad (13)$$

d) Das erforderliche Übersetzungsverhältnis kalkulieren:

$$i = \frac{n_1}{n_2} \qquad (14)$$

e) Die Getriebebaugröße, die mit ihrem Übersetzungsverhältnis dem soeben kalkulierten Wert am nächsten kommt und die folgende Bedingung einhält, wählen:

$$M_{c2} \leq M_{n2} \qquad (15)$$

con / with / mit / avec

$$Fh_2 \leq (n_2 \cdot h) \qquad (16)$$

wo M_{n2} und F_{h2} auf den, zu jeder Getriebegröße gehörenden Tabellen der technischen Daten wiedergegeben werden.

N.B: Tab. (A4)

(*) La distance X_{1-2} est celle comprise entre le point d'application de la force et l'épaulement de l'arbre (si non precisée l'on considerera la force agissant au milieu de la saillie de l'arbre).

(•) + = compression
– = traction

N.B.

Les critères de sélection et les données techniques indiqués dans ce catalogue ne sont pas valables pour toutes les applications, telles que les équipements de levage, où le réducteur a fonction d'organe de sécurité vis-à-vis du personnel et des matériels.

Dans ces cas, la sélection du réducteur doit être faite avec des critères spécifiques, et, s'il y a lieu, en conformité avec les règles de sécurité en vigueur; c'est pourquoi il faut consulter l'organisation de vente TRASMITAL BONFIGLIOLI.

13.1 Seléction type de réducteur

a) Sur la base du type d'application il faut définir:
- Facteur de service f_s (tab. A3)
- Durée de fonctionnement nécessaire h
- Type d'entraînement hydraulique, électrique, ou autres.

b) Avec la valeur du couple nécessaire en sortie M_{r2} déterminer le couple de calculation:

$$M_{c2} = M_{r2} \cdot f_s \qquad (12)$$

c) Avec la durée nécessaire h et la vitesse de sortie n_2 calculer le facteur de durée:

$$F_{h2} = (n_2 \cdot h) \qquad (13)$$

d) Calculer le rapport de réduction nécessaire:

$$i = \frac{n_1}{n_2} \qquad (14)$$

e) Sélectionner la taille du réducteur qui, avec le rapport le plus proche à celui calculé, puisse satisfaire à la condition suivante:

$$M_{c2} \leq M_{n2} \qquad (15)$$

con / with / mit / avec

$$Fh_2 \leq (n_2 \cdot h) \qquad (16)$$

où M_{n2} et F_{h2} ont été indiquées aux tableaux de données techniques de chaque taille de réducteur.

Nel caso di applicazioni caratterizzate da variazioni notevoli della coppia richiesta M_{r2} e della velocità n_2 una selezione più appropriata può essere fatta considerando una coppia richiesta equivalente data da:

In case of applications in which the required torque M_{r2} and speed n_2 vary within a wide range, best selection could be an equivalent required torque given by:

Bei Applikationen, die sich durch erhebliche Variationen des erforderlichen Drehmoments M_{r2} und der Drehzahl n_2 kennzeichnen, kann eine angemessenere Lösung unter Berücksichtigung eines erforderlichen gleichwertigen Drehmoments, gefunden werden. Sie wird von folgenden Berechnungen gegeben:

En cas d'applications caractérisées par des variations importantes du couple necessaire M_{r2} et de la vitesse n_2, une seléction appropriée peut être établie en considérant un couple nécessaire équivalent découlant de :

$$M_{r2} = \sqrt[4]{\frac{(n_2 \bullet h)_A \bullet M_A{}^4 + (n_2 \bullet h)_B \bullet M_B{}^4 + (n_2 \bullet h)_C \bullet M_C{}^4 + ...}{(n_2 \bullet h)_A + (n_2 \bullet h)_B + (n_2 \bullet h)_C + ...}} \qquad (17)$$

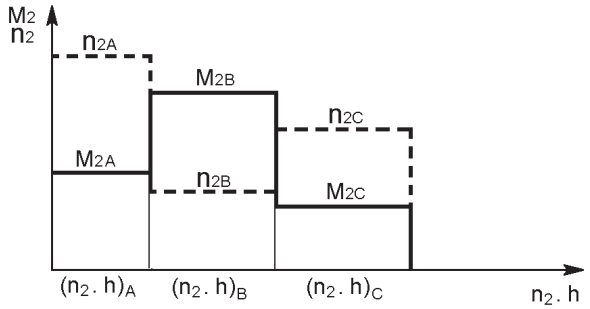
riferita a:

referred to:

bezogen auf:

référé à:

(A5)



e calcolando il fattore di durata Fh con:

and calculating the life factor Fh with:

und durch ein Kalkulieren des Dauerfaktors Fh mit:

en calculant le facteur de durée Fh par:

$$Fh_{calc} = (n_2 \cdot h)_A + (n_2 \cdot h)_B + (n_2 \cdot h)_C + ... \qquad (18)$$

Seguire poi la stessa procedura indicata con d); e).

Then follow the same procedure as specified in d) and e).

Dann die unter d.) und e.) aufgeführte Vorgangsweise befolgen.

Adopter par la suite la même procédure indiquée par d); e).

14.0 **VERIFICHE**

Effettuata la corretta selezione si raccomanda di procedere alle seguenti verifiche:

a) Potenza termica

Assicurarsi che la potenza termica del riduttore, indicata nelle tabelle dati tecnici abbia un valore uguale o maggiore alla potenza richiesta dall'applicazione secondo la relazione (5) a pag. 9, in caso contrario selezionare un riduttore di grandezza superiore oppure provvedere ad applicare un sistema di raffreddamento ausiliario (vedi cap. 45 a pag. 220).

b) Coppia massima

Verificare che la coppia massima (intesa come coppia di punta di carico istantaneo o come coppia di avviamento sotto carico) non superi il valore di M_{2max} ammesso dal riduttore.
(Riferirsi alle tabelle dei dati tecnici relative alle varie grandezze de riduttori).

14.0 **VERIFICATION**

After selecting the drive units, please check the following:

a) Thermal power

Make sure that the thermal power of the gearbox (shown in the tables in the chapters dealing with the gear unit series captioned) is equal to or greater than the the power required by the application according to equation (5) on page 9. If this condition is not respected, select a larger gearbox or apply a forced cooling system (see chap. 45 at a page 220).

b) Maximum torque

Make sure that the maximum torque (considered as instantaneous load peak torque or starting torque under load) does not exceed the M_{2max} value that the gearbox can withstand.
(Refer to the technical data tables concerning the gearboxes sizes.)

14.0 **PRÜFUNGEN**

Nach Wahl des Getriebemotors folgende Prüfungen ausführen:

a) Thermische Grenzleistung

Sicherstellen, daß die Wärme-grenzleistung des Getriebes, die in den Tabellen in den Kapiteln über die betreffenden Getriebeserien angegeben ist, größer oder gleich der verlangten Leistung ist, die von der Anwendung nach Gleichung (5) auf S. 9 verlangt wird. Andernfalls ein größer dimensioniertes Getriebe wählen bzw. ein Zwangskühlsystem vorsehen Siehe Abschnitt 45, Seite 220).

b) Max. Drehmoment

Überprüfen, ob das maximale Drehmoment (als augenblicklicher Spitzendrehmoment oder als Anlaßdrehmoment unter Last verstanden) den seitens des Getriebes zulässigen Wert M_{2max} auch nicht überschreitet. (Nehmen Sie diesbezüglich Bezug auf die Tabelle der rechnischen Daten, welche die verschiedenen Getriebegrößen anführen).

14.0 **VERIFICATIONS**

Après avoir effectué une sélection correcte des motorisations, nous conseillons de proceder aux vérifications suivantes:

a) Puissance thermique

S'assurer que la puissance thermique du réducteur, indiquée dans les tableaux repris dans les chapitres relatifs à la série de réducteurs concernée, ait une valeur supérieure ou égale à la puissance requise par l'application selon l'équation (5) page 9. Dans le cas contraire, sélectionner un réducteur de taille supérieure ou bien prevoir un système de refroidissement forcé (voir par. 45 à page 220).

b) Couple maximum

Vérifier que la couple maximal (considéré en tant que couple de pointe de charge instantanée ou couple de démarrage en charge) ne dépasse pas la valeur de M_{2max} admise par le réducteur (se reporter aux tableaux des données techniques concernant les différentes tailles de réducteurs).

c) Carichi radiali

Verificare che i carichi radiali agenti sugli alberi di entrata e uscita risultino inferiori o uguali a quelli indicati nelle relative tabelle caratteristiche o diagrammi di ogni grandezza di riduttore.

Nel caso in cui la verifica non sia soddisfatta cambiare versione uscita riduttore per quelle grandezze dove è previsto, oppure cambiare grandezza riduttore o sopportare con altri mezzi il carico.

Per effettuare la verifica procedere come segue:

determinare i carichi radiali R_{c1} in entrata e R_{c2} in uscita.

c) Radial loads

Check that radial loads exerted on input and output shafts are lower than or equal to values indicated in the tables on gearbox technical features or charts for each gearbox size.

In case they are grater the indicated value, change either gearbox output version, gearbox size or system bearing arrangement.

To check proceed as follows:

define radial loads R_{c1} at input and R_{c2} at output.

c) Radialkräfte

Überprüfen, ob die auf die Antriebs- und Abtriebswellen einwirkenden Radialkräfte unter den Werten, die in den entsprechenden Tabellen der technischen Eigenschaften oder in den Diagrammen für jede Getriebebauform angegeben werden liegen, oder gleichwertig sind.
Erhält man bei dieser Kontrolle ein negatives Ergebnis muß man die Abtriebsversion des Getriebes für diese Baugrößen, wo diese Möglichkeit vorgesehen ist ändern, die Getriebebaugröße wechseln, oder die Last durch anderweitige Mittel stützen.
Für die Durchführung dieser Kontrolle geht man wie folgt vor: die Radialkräfte R_{c1} am Antrieb und R_{c2} am Abtrieb bestimmen.

c) Charges radiales

Veiller à ce que les charges radiales, appliquées sur les arbres rapides et lents, soient inférieures ou égales aux charges indiquées sur les tableaux caractéristiques ou les diagrammes de chaque taille de réducteur.

Au cas où la vérification serait négative, changer la version de sortie réducteur, pour les tailles qui le prévoient, ou changer la taille du réducteur ou encore supporter la charge par d'autres moyens.

Pour effectuer la vérification procéder comme suit:

déterminer les charges radiales R_{c1} en entrée et R_{c2} en sortie.

$$R_{c1-2} = \frac{2000 \cdot M_{c1-2} \cdot K_2}{d} \qquad (19)$$

dove:

Mc_{1-2} Coppia di calcolo in entrata e uscita (Nm)

d Diametro dell'organo montato sull'albero: (mm) puleggia, ingranaggio, corona per catena

Kr Fattore di sollecitazione per carico radiale con i seguenti valori:

Corona per catena	1
Ingranaggio	1.25
Puleggia per cinghia	1.5-2.5

in which:

Mc_{1-2} Input and output calculated torque (Nm)

d Diameter of the part fitted onto the shaft (mm) pulley, gear or chain crown

Kr Stress factor for radial load with following values

Chain crown	1
Gear	1.25
Belt pulley	1.5-2.5

wo:

Mc_{1-2} Berechnungsdrehmoment im Antrieb und Abtrieb (Nm)

d Durchmesser des auf die Welle montierten Organs (mm) Riemenscheibe, Zahnrad, Kettenkranz

Kr Beanspruchungsfaktor für Radialkraft mit den folgenden Werten:

Kettenkranz	1
Zahnrad	1.25
Riemenscheibe für Riemen	1.5-2.5

où:

Mc_{1-2} Est le couple de calculation en entrée et sortie (Nm)

d Est le diamètre de l'organe monté sur l'arbre: (mm) poulie, engrenage, coronne de chaîne

Kr Est le facteur de contrainte pour charge radiale avec les valeurs suivantes :

Pignon à chaîne	1
Engrenage	1.25
Poulie de courroie	1.5-2.5

Definire la posizione assiale X del carico sull'albero, entrare con tale valore nel diagramma indicante il carico sopportabile dal riduttore R_{x1}, R_{x2} e verificare sia soddisfatta la seguente relazione:

Define the trust load position X onto shaft. Check this value with the chart indicating the load R_{x1} and R_{x2} bearable by the gearbox. Check that the following is satisfied:

Die Axialposition X der an der Welle anliegenden Last definieren und durch einen Vergleich dieses Werts auf dem Diagramm, welches die vom Getriebe R_{x1}, R_{x2} tragbare Last angibt, nachprüfen, ob das folgende Verhältnis gegeben ist:

Définir la position axiale X de la charge sur l'arbre, introduire cette valeur dans le diagramme indiquant la charge supportable par le réducteur R_{x1}, R_{x2} et vérifier que le rapport suivant est respecté:

$$R_{c1-2} \leq Rx_{1-2} \cdot fh \qquad (20)$$

dove fh_{1-2} sono i fattori correttivi carichi radiali e assiali da ricavare in funzione del fattore di durata F_{h1}, F_{h2} richiesto.

where fh_{1-2} the radial and thrust load corrective factor depending on the required life factor F_{h1} and F_{h2}.

wo fh_{1-2} den Korrekturfaktor der Radial und Axialkräfte darstellt, der im Bezug auf den geforderten Dauerfaktor F_{h1}, F_{h2} zu erarbeiten ist.

où fh_{1-2} sont les facteurs de correction des charges radiales et axiales à rechercher en fonction du facteur de durée F_{h1}, F_{h2} nécessaire.

d) Carichi assiali

Provvedere a verificare il carico assiale, quando presente sull'albero di uscita, in maniera analoga alla verifica relativa al carico radiale.

Deve essere soddisfatta la seguente relazione:

d) Thrust loads

Check the thrust load, when exerted onto the output shaft, as specified for the radial load.

The following should be satisfied:

d) Axialkräfte

In einer, der im Hinblick auf die Kontrolle der Radialkräfte analogen Vorgangsweise, die Kontrolle der Axialkraft, falls an der Abtriebswelle anliegend, vornehmen.

Das folgende Verhältnis muß gegeben sein:

d) Charges axiales

Vérifier la charge axiale, si existante sur l'arbre lent, pareillement à la vérification concernant la charge radiale.

La condition suivante doit être respectée :

$$\pm A_{c2} \leq \pm A_{n2} \cdot fh_2 \qquad (21)$$

Quando è presente un carico assiale combinato ad un carico radiale per una opportuna verifica interpellare la nostra Organizzazione di vendita.

When a thrust load is combined with an axial load contact our Sales Dept. for a proper checking procedure.

Ist jedoch eine Axialkraft gemeinsam mit einer Radial-kraft vorhanden, müssen Sie sich für die Prüfung an unsere Verkaufsorganisation wenden.

En cas de charge axiale combinée avec une charge radiale, pour une vérification appropriée consulter notre Organisation de Vente.

15.0 SCELTA DEL MOTORE

Motore elettrico

a) Dalla coppia M_{r2}, conoscendo n_2 e il rendimento dinamico η_d, ricavare la potenza in entrata:

$$P_{r1} = \frac{M_{r2} \cdot n_2}{9550 \cdot \eta_d} \quad [kW] \qquad (22)$$

La tabella (A2) a pag. 10 riporta i valori di rendimento η_d relativi ai vari stadi di riduzione dei riduttori della serie 300.

b) Selezionare nelle tabelle dati tecnici motori una grandezza con potenza nominale tale da soddisfare:

$$P_{r1} \leq P_n \qquad (23)$$

Preferibilmente scegliere motori a 4 poli o superiori.

Se non diversamente indicato, la potenza P_n dei motori riportata a catalogo si riferisce al servizio continuo S1.
Per i motori utilizzati in condizioni diverse da S1, sarà necessario identificare il tipo servizio previsto con riferimento alle Norme CEI 2-3/IEC 34-1.
In particolare, per i servizi da S2 a S8 e per le grandezze motore uguali o inferiori a 132, è possibile ottenere una maggiorazione della potenza rispetto a quella prevista per il servizio continuo, pertanto la condizione da soddisfare sarà:

$$\frac{P_{r1}}{f_m} \leq P_n \qquad (24)$$

Il fattore di maggiorazione f_m è ricavabile dalla tabella (A6).

15.0 HOW TO SELECT THE MOTOR

Electric motor

a) n_2 and dynamic efficiency η_d are known, calculate input power based on torque M_{r2} as follows:

Table (A2) on page 10 reports the values of efficiency η_d related to the different reduction stages of the gearboxes of series 300.

b) Look up the motor selection charts and select a size with such rated power to satisfy this condition:

4-pole motors and over should be preferred.

Unless otherwise specified, power P_n of motors indicated in the catalogue refers to continuous duty S1.
For motors used in conditions other than S1, the type of duty required by reference to CEI 2-3/IEC 34-1 Standards must be mentioned.
For duties from S2 to S8 in particular and for motor frame 132 or smaller, extra power can be obtained with respect to continuous duty power, consequently the following condition must be satisfied:

The increased power factor f_m can be obtained from table (A6).

15.0 WAHL DES MOTOR

Elektromotor

a) Da man n_2 und den dynamischen Wirkungsgrad η_d kennt, kann man aus dem Drehmoment M_{r2} nun die Antriebsleistung errechnen:

Die Tabelle (A2), Seite 10, führt die Werte des Wirkungsgrads η_d im Bezug auf die verschiedenen Untersetzungsstufen der Getriebe der Serie 300 auf.

b) In den Tabellen mit den technischen Motordaten eine Größe mit einer solchen Nennleistung wählen, welche die folgende Anforderung befriedigt:

Vorzugsweise sollten jedoch Motoren mit 4 oder mehr Polen ausgewählt werden.

Wenn nicht anders angegeben, bezieht sich die im Katalog angegebene Leistung P_n der Motoren auf Dauerbetrieb S1. Bei Motoren, die unter anderen Bedingungen als S1 eingesetzt werden, muß die vorgesehen Betriebsart unter Bezug auf die CEI-Normen 2-3/IEC 34-1 bestimmt werden.
Insbesondere kann man für die Betriebsarten S2 bis S8 (und für Motorbaugrößen gleich oder niedriger als 132) eine Überdimensionierung der Leistung, relativ zu der für den Dauerbetrieb vorgesehenen Leistung erhalten; die zu erfüllende Bedingung ist dann:

Der Überdimensionierungs-faktor f_m kann der Tabelle (A6) entnommen werden.

15.0 CHOIX DU MOTEUR

Moteur électrique

a) En connaissance de n_2 et de η_d rendement dynamique, calculer la puissance à l'entrée au couple M_{r2}:

Le tableau (A2) à la page 10 montre les valeurs de rendement η_d concernant les différents étages de réduction des réducteurs série 300.

b) Sélectionner au tableau données techniques des moteurs une taille avec puissance nominale capable de satisfaire à:

Choisir de préférence des moteurs à 4 pôles ou supérieurs.

Sauf indication contraire la puissance P_n des moteurs indiquée dans le catalogue se réfère à un service continu S1.
Pour les moteurs utilisés dans des conditions différentes du service S1, il sera nécessaire d'identifier le type de service prévu en se référant aux normes CEI 2-3/IEC 34-1.
En particulier, pour les services de type S2 à S8 ou pour les tailles de moteurs égales ou superieures à 132 il est possible d'obtenir une majoration de la puissance par rapport à celle prévue pour le service continu. Par conséquent, la condition à satisfaire sera:

Le facteur de majoration f_m peut être obtenu en consultant le tableau (A6).

(A6)

	SERVIZIO / DUTY / BETRIEB / SERVICE						
	S2			**S3***			**S4 - S8**
	Durata del ciclo / Cycle duration [min] Zyklusdauer / Durée du cycle [min]			Rapporto di intermittenza / Cyclic duration factor (I) Relative Einschaltdauer / Rapport d'intermittence (I)			Interpellarci Please contact us Rückfrage Nous contacter
	10	**30**	**60**	**25%**	**40%**	**60%**	
f_m	1.35	1.15	1.05	1.25	1.15	1.1	

* La durata del ciclo dovrà comunque essere uguale o inferiore a 10 minuti; se superiore interpellare la nostra organizzazione di vendita.
Rapporto di intermittenza:

$$I = \frac{t_f}{t_f + t_r} \cdot 100 \qquad (25)$$

t_f = tempo di funzionamento a carico costante
t_r = tempo di riposo

* Cycle duration, in any event, must be 10 minutes or less.If it is longer, please contact our technical service department.

Intermittence ratio:

t_f = operating time at constant load
t_r = rest time

* Die Zyklusdauer muß in jedem Fall kleiner oder gleich 10 min sein; wenn sie darüber liegt, unseren technisch- en Kundendienst zu Rate ziehen.
Relative Einschaltdauer:

t_f = Betriebszeit mit konstanter Belastung
t_r = Aussetzzeit

* La durée du cycle devra être égale ou inférieure à 10 minutes. Si supérieure, contacter notre service technique.

Rapport d'intermittence:

t_f = temps de fonctionnement à charge constante
t_r = temps de repos

Per servizi diversi da S_1, con un numero rilevante di inserzioni/ora si dovrà tener conto di un fattore Z (determinabile con le indicazioni riportate nel capitolo dei motori) il quale definisce il numero massimo di avviamenti specifico per l'applicazione in oggetto.

For duties other than S_1 with considerable number of starts per hour, factor Z must be considered (it is ascertained by using the information in the motors chapter). Factor Z defines the maximum number of starts for the application under consideration.

Bei von dem S_1 abweichenden Betriebsarten mit einer bedeutenden Anzahl an Schaltungen/Stunde muß man den Faktor Z (mittels der, im Kapitel der Motoren angeführten Angaben bestimmbar) berücksichtigen, der eine spezifische max. Anzahl an Anlässen für die betreffende Applikation festlegt.

Pour les services différents de S_1, avec un nombre important d'insertions/heure, il faudra prendre en considération un facteur Z (déterminé à l'aide des informations reportées dans le chapitre des moteurs) qui définit le nombre maximum de démarrages spécifique pour l'application concernée.

Motore idraulico

– In funzione dell'applicazione definire il tipo di motore idraulico scegliendolo dalla tabella (A7) di primo orientamento.

Hydraulic motor

– Determine hydraulic motor type according to the application, choosing from the options given in guidance table (A7).

Hydraulikmotor

– Im Hinblick auf die Applikationsart, muß nun in der Anhaltspunkttabelle (A7) der entsprechende Hydraulikmotor gewählt werden.

Moteur hydraulique

– D'après l'application, définir le type de moteur hydraulique en le choisissant du tableau (A7) de première orientation.

(A7)

Tipo d'impiego Duty Einsatzart Genre d'utilisation	Leggero Light Leicht Léger		Medio Medium Mittel Moyen		Pesante Heavy Schwer Intensif	
Pressione p [bar] Pressure p [bar] Druck p [bar] Pression p [bar]	<175		175 - 200		200 - 450	
Costruzione motori Motor design Motorenbauweise Construction moteur	orbitali orbital orbitale orbitale	a ingranaggi gear motor mit Zahnrädern à engrenages	a pistoni radiali radial piston mit Radialkolben à pistons radiaux	a pistoni assiali axial piston mit Axialkolben à pistons axiaux	a camme cam motor mit Nocken à cames	a pistoni assiali axial piston mit Axialkolben à pistons axiaux
Velocità / Speed Drehzahl / Vitesse	media / mean mittel / moyenne ≤ 700	alta / high hoch / élévée ≤ 3000	media / mean mittel / moyenne ≤ 500	alta / high hoch / élévée ≤ 4000	bassa / low niedrig / faible ≤ 200	media / mean mittel / moyenne ≤ 4000
ηmh	0.80	0.85	0.95	0.93	0.93	0.93
ηv	0.90	0.87	0.95	0.95	0.95	0.95

– Con i dati caratteristici di ingresso del riduttore:
coppia in entrata M_{r1} [Nm]
velocità in entrata n_1 [min^{-1}]
e con la pressione p [bar] ammessa dal circuito idraulico determinare la cilindrata del motore idraulico con la seguente formula:

– Based on the specifications of gearbox input:
input torque M_{r1} [Nm]
input speed n_1 [min^{-1}]
and on allowed pressure p [bar] for the hydraulic circuit, calculate the displacement of the hydraulic motor by formula:

– Anhand der charakteristischen Daten des Getriebeantriebs:
Antriebsdrehmoment M_{r1} [Nm]
Antriebsdrehzahl n_1 [min^{-1}]
und mit dem vom hydraulischen Kreislauf zugelassenen Druckwert p [bar], den Hubraum des Hydraulikmotors, unter Anwendung der folgenden Formel, bestimmen:

– Avec les données caractéristiques à l'entrée du réducteur :
couple en entrée Mr_1 [Nm]
vitesse en entrée n_1[min^{-1}]
et avec la pression p [bar] admise dans le circuit hydraulique, déterminer la cylindrée du moteur hydraulique par la formule: suivante:

$$V_c = \frac{20 \bullet \pi \bullet M_{r1}}{p \bullet \eta mh} \text{ [cm}^3\text{]} \qquad (26)$$

dove ηmh è il rendimento meccanico idraulico del motore (tab. A7).

where ηmh is the hydraulic mechanical efficiency of the motor (tab. A7).

wobei ηmh den mechanisch-hydraulischen Wirkungsgrad des Motors darstellt (tab. A7).

où ηmh représente le rendement mécanique-hydraulique du moteur (tab. A7).

– Selezionare una grandezza di motore che abbia una cilindrata V tale che:

– Select a motor size with displacement V that satisfies the following condition:

– Einen Motor mit einer Baugröße wählen, der über folgenden Hubraum V verfügt:

– Sélectionner une taille de moteur ayant une telle cylindrée V que :

$$V_c \leq V \qquad (27)$$

– Calcolare la portata necessaria per alimentare il motore idraulico

– Calculate the flow required for the hydraulic motor

– Die für die Versorgung des Hydraulikmotors erforderliche Förderleistung berechnen:

– Calculer le débit nécessaire pour alimenter le moteur hydraulique

$$Q_1 = \frac{V \bullet n_1}{\eta_v \bullet 1000} \text{ [l/min]} \qquad (28)$$

dove ηv è il rendimento volumetrico.
Per motori idraulici orbitali di produzione TRASMITAL BONFIGLIOLI consultare il relativo capitolo del presente catalogo.
Per altri tipi di motori idraulici consultare le loro relative documentazioni tecniche.

where ηv is volumetric efficiency.
For hydraulic orbital motors by TRASMITAL BONFIGLIOLI, please see the relevant chapter in this catalogue. For other types of hydraulic motors, see the relevant technical literature.

wo ηv für den volumetrischen Wirkungsgrad steht.
Im Bezug auf die orbitalen Hydraulikmotoren aus der Produktion TRASMITAL BONFIGLIOLI, das entsprechende Kapitel im vorliegenden Katalog konsultieren. Bezüglich anderer Hydraulikmotortypen, verweisen wir auf deren jeweilige Unterlagen.

où ηv représente le rendement volumétrique.
Pour les moteurs hydrauliques orbitaux de production TRASMITAL BONFIGLIOLI, consulter le chapitre correspondant de ce catalogue. Pour d'autres types de moteurs hydrauliques consulter la documentation techniques y rattachée.

16.0 INSTALLAZIONE

E' molto importante per l'affidabilità e il buon funzionamento del riduttore o motoriduttore rispettare alcune norme per la sua corretta installazione.
Le norme qui riportate hanno valore per una prima indicazione per la installazione del riduttore o motoriduttore.
Per provvedere ad una effettiva e corretta installazione attenersi al Manuale di installazione uso e manutenzione dei riduttori della serie 300 fornibile dalla nostra Organizzazione di Vendita.

Riportiamo in breve le norme da seguire:

a) Fissaggio:

- Appoggiare il riduttore a una struttura sufficientemente rigida, con superfici di accoppiamento piane lavorate di macchina utensile.
- Le superfici di accoppiamento, specialmente per riduttori montati con flangia e con alberi in uscita femmina scanalati, devono risultare entro precise tolleranze geometriche (vedi manuale).
- Per alcune grandezze di riduttori, in applicazioni con elevati carichi radiali in uscita, è raccomandato il montaggio a flangia eseguito per utilizzare i doppi diametri di centraggio di cui tali riduttori sono provvisti. Vedi parte "Carichi sugli alberi" per le diverse grandezze di riduttori.
- Verificare che il riduttore sia previsto per la posizione di montaggio richiesta come illustrato nella tabella (A8) a pag. 24.
- Fissare il riduttore con viti di classe di resistenza 8.8 o superiore serrandole ai valori di coppia di serraggio indicati nelle relative tabelle.
  Per coppie massime trasmesse maggiori od uguali al 70% della coppia M_{2max} indicata e con frequenti inversioni del moto, utilizzare viti in classe minima di resistenza 10.9.
  Alcune grandezze di riduttori prevedono oltre il fissaggio con viti, anche spine. Inserire le spine di cui i riduttori sono provvisti, nella struttura sulla quale il riduttore viene installato per una lunghezza almeno pari a 1,5 il valore del loro diametro.

16.0 INSTALLATION

Observing a few rules for correct installation is essential to the reliable and proper operation of the gearbox or gear motor.
The rules set out here are intended as a preliminary guide to selecting gearbox or gear motor.
For effective and proper installation, follow the instructions given in the Installation, use and maintenance manual for the gearboxes of series 300 available from our Sales Organization.

Following is a brief outline of installation rules:

a) Fastening:

- Place gearbox on a surface providing adequate rigidity. Mating surfaces should be machined and flat.
- Mating surfaces must be within definite geometric tolerances (see manual). This is especially true of flange-mounted gearboxes with splined hollow shafts.
- In applications that involve high radial loads at the output end, flange mounting is recommended for some gearbox sizes as this mounting makes use of the double pilot diameters provided on these gearboxes. See section "Loads on shafts" for the different gearbox sizes.
- Make sure the gearbox is suitable for the required mounting position (check with table A8 on page 24).
- Use screws of resistance class 8.8 and over to secure the gearbox. Torque up screws to the figures indicated in the relevant tables.
  With transmitted output torque greater than or equal to 70% of the indicated M2max torque, and with frequent movement reversals, use screws with minimum resistance 10.9.
  Some gearbox sizes can be fastened using either screws or pins. If a pin is used, the length of pin seated in the frame the gearbox is being installed to should be at least 1.5 times pin diameter.

16.0 INSTALLATION

Im Hinblick auf die Zuverlässigkeit und eine gute Betriebsweise des Getriebes oder des Getriebemotors ist es besonders wichtig, für deren korrekten Einbau Kenntnis über einige Richtlinien zu haben.
Die hier in Folge angeführten Normen sind eine erste Anleitung für die Auswahl des Getriebes oder des Getriebemotors.
Um eine effektive und korrekt erfolgte Installation zu erhalten, muß man sich an das Anleitungs- und Instandhaltungshandbuch der Getriebe der Serie 300 halten. Dieses Handbuch ist bei unserer Verkaufsorganisation erhältlich.

Wir möchten Ihnen hier nur kurz die zu befolgenden Normen anführen:

a) Befestigung:

- Das Getriebe auf einer ausreichend starken Stuktur mit flachen und mittels Werkzeugmaschinen bearbeitenen Passungsflächen ablegen.
- Die Passungsflächen, besonders für die mit Flansch und Keilabtriebswellen montierten Getriebe, müssen innerhalb bestimmter geometrischer Toleranzen liegen (siehe Hand -buch).
- Bei einigen Baugrößen, bei Applikationen mit hoher auf dem Abtrieb einwirkender Radialkraft, wird die Montageweise mit Flansch empfohlen, wodurch die doppelten Zentrierdurchmesser, mit denen die Getriebe ausgestattet sind, verwendet werden können. Im Bezug auf die unterschiedlichen Baugrößen der Getriebe, siehe Abschnitt "Auf Wellen einwirkende Kräfte ".
- Unter Bezugnahme auf die Tabelle (A8) prüfen auf Seite 24, ob das Getriebe auch für die erforderliche Montagestellung geeignet ist.
- Das Getriebe mit Schrauben der Widerstandsklasse 8.8 oder einer höheren Klasse befestigen, dabei auf die in den jeweiligen Tabellen angegebenen Anzugsmomente bringen.
  Für zu übertragene Maximaldrehmomente, die höher als 70% des angegebenen Werts M2max oder diesem Prozentsatz gleich kommen und im Fall von häufigen Schaltungen sind Schnecken aus der Klasse der min. Widerstandsgrads 10.9 zu verwenden.
  Einige Getriebebaugrößen sehen ausser der Befestigung durch die Schrauben, auch Stifte vor. Dazu die Stifte, mit denen die Getriebe ausgestattet sind, über eine Länge von mindestens gleich 1,5 des Werts ihres Durchmesser, in die Stuktur einstecken, auf die das Getriebe installiert werden soll.

16.0 INSTALLATION

Il est très important pour la fiabilité et le bon fonctionnement du réducteur ou motoréducteur, de respecter certaines règles pour son installation correcte.
Les règles indiquées n'ont qu'une valeur indicative orientation pour le choix du réducteur ou motoréducteur. Pour effectuer la parfaite installation définitive, respecter les consignes d'installation, utilisation et entretien des réducteurs de la série 300, qui peuvent être livrées par notre Organisation de Vente.

Voici brièvement les règles qu'il faut suivre:

a) Fixation:

- Faire en sorte que le réducteur repose sur un bâti suffisamment rigide avec des surfaces d'accouplement planes et usinées à la machine-outil.
- Les surfaces d'accouplement, spécialement pour les réducteurs avec bride d'assemblage et arbres de sortie femelle cannelés, doivent respecter des tolérances géométriques bien précises (voir catalogue).
- Pour certaines tailles de réducteur, dans des applications avec des charges radiales élevées à la sortie, on préconise un montage avec bride, afin d'utiliser le doubles diamètres de centrage, dont ces réducteurs sont pourvus. Se reporter à la section "Charges sur les arbres" pour les différentes tailles de réducteurs.
- Veiller à ce que le réducteur convienne à la position de montage nécessaire, ainsi qu'au tableau (A8) à la page 24, le montre.
- Fixer le réducteur avec des vis d'un degré de résistance 8.8 ou supérieur en les serrant aux valeurs de couple de serrage indiquées sur les tableaux correspondants.
  Pour des couples maximaux transmis plus importants ou équivalents à 70% du couple M2max indiqué, et en cas d'inversions fréquentes du mouvement, utiliser des vis dans une classe minimale de résistance 10.9.
  Certaines tailles de réducteurs prévoient une fixation tant par vis que par goupilles. Introduire les goupilles, livrées avec les réducteurs, dans le bâti sur lequel le réducteur sera installé pour une longueur au moins égale à 1,5 de la valeur de leur diamètre.

b) Collegamenti

– Fissare gli organi di collegamento in entrata ed uscita al riduttore evitando di battere con martello o equivalenti. Utilizzare per l'inserimento degli organi viti di servizio e i fori filettati presenti negli alberi. Prima di montare gli organi di collegamento avere cura di pulire gli alberi eliminando grassi o protettivi eventualmente presenti.

– Montaggio motori idraulici.
Avere cura nel montaggio dell'O-ring di tenuta fra flangia motore e flangia in ingresso riduttore. Montare il motore idraulico prima di mettere l'olio lubrificante nel riduttore.

– Collegamento freno idraulico.
Utilizzare un circuito idraulico che assicuri l'apertura del freno immediatamente prima della partenza del motoriduttore e la chiusura dopo che questo sia arrestato. Verificare che durante le fasi di motoriduttore fermo la pressione nella linea idraulica di apertura freno sia zero.

– Versi di rotazione.
Nei collegamenti dei motori al circuito elettrico o idraulico in funzione dei loro versi di rotazione, tenere presente che tutti i riduttori, sia in esecuzione in linea che angolare hanno versi di rotazione concordi fra entrata e uscita. Per altre indicazioni relative ai collegamenti di motori elettrici e idraulici vedi le parti specifiche su questo catalogo pag.171.

c) Verniciatura

– Utilizzare vernici compatibili con la vernice di fondo presente sui riduttori, vedi condizioni di fornitura pag.21.
Durante la verniciatura proteggere gli anelli di tenuta presente sugli alberi.
La vernice li può fare essiccare causando perdite d'olio.

b) Connections

– Secure the connection parts to gearbox input and output. Do not tap them with hammers or similar tools. To insert these parts, use the service screws and threaded holes provided on the shafts. Be sure to clean off any grease or protectants from the shafts before fitting any connection parts.

– Fitting hydraulic motors.
Be careful of the O ring between motor flange and gearbox input flange when assembling. Install the hydraulic motor before filling lube oil into the gearbox.

– Connecting the hydraulic brake.
The hydraulic circuit should be such to ensure that brake is released instants before gearbox starts and applied after gearbox has stopped. Check that pressure in the hydraulic line for brake release is at zero whenever gearbox is stopped.

– Direction of rotation
Motors are connected to the suitable electric or hydraulic circuit according to their direction of rotation. When performing these connections, bear in mind that all gearboxes, whether in the in-line or right angle design, have the same direction of rotation both at input and output. For more details of the connection of electric and hydraulic motors, see relevant sections in this catalogue on page 171.

c) Painting

– Use paints compatible with the primer applied to the gearbox, see supply conditions on page 21.
Before painting, protect the seal rings installed on the shafts.
Contact with paint may deteriorate the seals with subsequent oil leakage.

b) Anschlüsse

– Die Anschlußteile zum Getriebeantrieb und -abtrieb befestigen, dabei ein Einklopfen mittels Hammer oder ähnlichen Gegenständen vermeiden. Beim Einführen der Teile sind Serviceschrauben und die auf den Wellen vorhandenen Gewindebohrungen zu verwenden. Vor dem Montieren der Verbindungsteile müssen die Wellen durch eine entsprechende Reinigung von Fett und eventuell vorhandenen Schutzmitteln befreit werden.

– Montage der Hydraulikmotore.
Der Montage des O-Dichtrings zwischen dem Motorflansch und dem Antriebsflansch am Getriebe muß besondere Aufmerksamkeit zugewendet werden. Vor dem Einfüllen des Schmieröls in das Getriebe, ist der Motor zu montieren.

– Anschluß der hydraulischen Bremse Hierbei ist ein Hydraulikkreislauf zu verwenden, der eine unmittelbare Öffnung der Bremse, noch vor dem Anlauf des Getriebemotors und nach dessen Halt, eine Schließung sichern kann. Es ist zu überprüfen, daß während der Phasen, in denen der Getriebemotor stillsteht, der Druck in der hydraulischen Leitung für die Bremsöffnungsfunktion gleich Null ist.

– Drehrichtungen
Die Drehrichtung an der Abtriebswelle ist bei allen Getrieben, sowohl bei linear als auch bei Winkelgetrieben, gleich mit der Eingangsdrehrichtung des Hydro-oder Elektromotors. Im Bezug auf weitere Anleitungen für die Anschlüsse von Elektro- und Hydraulikmotoren, verweisen wir auf die entsprechenden Abschnitte in diesem Katalog. Siehe dazu Seite 171.

c) Lackierung

– Es müssen Lackarten verwendet werden, die mit der bereits am Getriebe verwendeten Grundierung kompatibel sind. Siehe dazu auch die Seite 21 angeführten Lieferbedingungen. Während des Lackiervorgangs sind die auf der Welle angeordneten Dichtringe in angemessener Weise zu schützen.
Der Lack kann zum Austrocknen dieser Ringe führen, was letztendlich zu Ölverlusten führen würde.

b) Raccordements

– Fixer les éléments de raccordement en entrée et en sortie du réducteur. N'utilisez pas de marteaux, ni d'outils afin de frapper. Pour l'introduction des organes, utiliser les vis correspondantes et les trous taraudés existant sur les arbres.
Avant le montage des éléments de raccordement, prendre soin de nettoyer les arbres, en éliminant, si besoin est, les graisses ou agents protecteurs.

– Montage des moteurs hydrauliques.
Prendre soin de monter le joint torique entre la bride moteur et la bride à l'entrée du réducteur. Installer le moteur hydraulique avant de mettre l'huile lubrifiant dans le réducteur.

– Utiliser un circuit hydraulique assurant une ouverture du frein juste avant le démarrage du motoréducteur et une fermeture après sa mise à l'arrêt. Veiller à ce que, lors des phases d'arrêt du motoréducteur, le circuit hydraulique d'ouverture frein soit totalement dépressurisé.

– Sens de rotation.
Lors d'un raccordement de moteurs au circuit électrique ou hydraulique, en fonction de leurs sens de rotation, il faut tenir compte que tous les réducteurs, en exécution alignée aussi bien qu'angulaire, aient des sens de rotation concordants en entrée et en sortie.
Pour d'autres indications concernant les raccordements des moteurs électriques et hydrauliques, voir les sections s'y rattachant de ce catalogue à la page 171.

c) Peinture

– Utiliser des peintures compatibles avec la couche de fond déjà existant sur les réducteurs, se reporter aux conditions de livraison à la page 21.
En cours de peinture, protéger les bagues à lévres des arbres.
La peinture peut les sécher trop et des fuites d'huile peuvent en découler.

d) Lubrificazione

– Prima della messa in funzione riempire il riduttore d'olio lubrificante del tipo raccomandato (vedi lubrificazione a pag.25) fino al raggiungimento del previsto livello verificabile dall'apposito tappo o livello visivo di cui ogni riduttore è provvisto in relazione alla posizione di montaggio stabilita.

d) Lubrication

– Before start-up, fill the gearbox with the recommended lube oil (see lubrication on page .25) up to correct level. Level is checked through the suitable plug or sight glass provided on each gearbox depending on designated mounting position.

d) Schmierung

– Vor der Inbetriebnahme muß das Getriebe solange mit dem empfohlenen Schmieröl (siehe "Schmierung" auf Seite .25) gefüllt werden, bis der vorgesehene Ölpegel erreicht wurde. Dieser Pegel ist über den entsprechenden Verschluß oder über das Schauauge, über welches jedes Getriebe je nach festgelegten Montagestellung verfügt, feeststellbar.

d) Lubrification

– Avant la mise en service, remplir le réducteur avec l'huile lubrifiante conseillée (voir lubrification à la page 25) jusqu'à atteindre le niveau prévu par rapport à la position de montage établie vérifier à travers le bouchon, ou niveau visible, dont chaque réducteur est équipé.

17.0 **MANUTENZIONE**

Controllare il serraggio dei bulloni dopo 50 ore di lavoro.

Effettuare il primo cambio olio circa dopo 100 – 150 ore di lavoro. Successivamente effettuare il cambio ogni 2000 – 3000 ore a seconda degli impieghi o almeno una volta all'anno.

E' buona norma comunque controllare il livello una volta al mese per funzionamento intermittente o più frequentamente per funzionamento in continuo e aggiungere olio se necessario.

17.0 **MAINTENANCE**

Check the tightness of mounting bolts after the initial 50 hours of operation.

Change the oil first after 100 – 150 hours operation.
Subsequently, change the oil every 2000 – 3000 hours operation depending on application.
Alternatively change oil once a year.

Check the oil level in the gearbox every month and top up as necessary

17.0 **WARTUNG**

Schrauben nach 50 Betriebsstunden auf festen Sitz prüfen .

Ersten Ölwechsel nach zirka 100 – 150 Betriebsstunden durchführen. Anschließend alle 2000 - 3000 oder mindestens einmal jährlich einen Ölwechsel durchführen (je nach Einsatzbereich).

Es sollte jedoch bei Aussetzbetrieb einmal monatlich und bei Dauerbetrieb häufiger der Ölstand kontrolliert werden.
Falls notwendig, Öl nachfüllen.

17.0 **ENTRETIEN**

Controler le serrage des vis et boulons, aprés 50 heures de travail.

Effectuer la première vidange du lubrifiant, aprés 100 – 150 heures de travail. Ultérieurement, effectuer une vidange toutes les 2000 – 3000 heures, selont les applications, ou au minimum une fois par an.

Toutefois, il est conseillé de controler le niveau d'huile une fois par mois, en cas de fonctionnement intermittent, plus souvent en cas de service continu, et de faire l'appoint si nécessaire.

18.0 **STOCCAGGIO**

Il corretto stoccaggio dei prodotti ricevuti richiede l'esecuzione delle seguenti attività:

a) Escludere aree all'aperto, zone esposte alle intemperie o con eccessiva umidità.

b) Interporre sempre tra il pavimento ed i prodotti, pianali lignei o di altra natura, atti ad impedire il diretto contatto col suolo.

c) Per periodi di stoccaggio superiori ai 60 giorni, le superfici interessate agli accoppiamenti quali flange, alberi e giunti, devono essere protette con idoneo prodotto antiossidante (Mobilarma 248 od equivalente).

d) Per periodi di stoccaggio previsti superiori ai 6 mesi, i prodotti devono essere oggetto delle seguenti attività:

d1)Ricoprire le parti lavorate esterne e quelle di accoppiamento con grasso atto ad evitare ossidazioni.

d2)Posizionare i riduttori con il tappo di sfiato nella posizione più alta e riempirli di olio.
I riduttori, prima del loro utilizzo, dovranno essere riempiti con la corretta quantità e tipo di lubrificante previsto.

18.0 **STORAGE**

Observe the following instructions to ensure correct storage of delivered products:

a) Do not store outdoors, in areas exposed to weather or with excessive humidity.

b) Always place boards in wood or other material between floor and products, to avoid direct contact with the floor.

c) For storage periods of over 60 days, all machined surfaces such as flanges, shafts and couplings must be protected with a suitable anti-oxidation product (Mobilarma 248 or equivalent product).

d) The following measures must be taken in respect of products for which the expected storage period exceeds 6 months:

d1)Cover outer machined parts and mating parts with grease to avoid oxidation.

d2)Position the gearboxes with the breather plug up and fill them with oil.
Before use, the gearboxes should be filled with the proper amount of lubricant of the recommended type.

18.0 **LAGERUNG**

Die korrekte Lagerung der Antriebe erfordert folgende Vorkehrungen:

a) Die Produkte nicht im Freien lagern und nicht in Räumen, die der Witterung ausgesetzt sind, oder eine hohe Feuchtigkeit aufweisen.

b) Die Produkte nie direkt auf dem Boden, sondern auf Unterlagen aus Holz oder einem anderen Material lagern.

c) Bei Lagerzeiten von mehr als 60 Tagen die Oberflächen für die Verbindung, wie Flansche, Wellen oder Kupplungen mit einem geeigneten Oxidations-schutzmittel behandeln (Mobilarma 248 oder ein äquivalentes Mittel).

d) Bei Lagerzeiten von mehr als 6 Monaten müssen folgende Vorkehrungen getroffen werden:

d1)Die bearbeiteten Außenteile und die Passflächen mit Oxydationschutzfett abdecken.

d2)Die Getriebe mit der Entlüftungsschraube in die oberste Position ausgerichtet montieren, dann mit Öl auffüllen.
Die Getriebe müssen vor ihrem Einsatz mit der richtigen Menge des vorgesehenen Schmiermittels aufgefüllt werden.

18.0 **STOCKAGE**

Un stockage correct des produits reçus nécessite de respecter les règles suivantes:

a) Exclure les zones à ciel ouvert, les zones exposées aux intempéries ou avec humidité excessive.

b) Interposer dans tous les cas entre le plancher et les produits des planches de bois ou des supports d'autre nature empêchant le contact direct avec le sol.

c) Pour les périodes de stockage supérieures à 60 jours, les surfaces concernées par les liaisons telles que les brides, les arbres et les accouplements doivent être protégées avec un produit antioxydant spécial (Mobilarma 248 ou équivalent).

d) Pour les périodes de stockage prévues supérieures à 6 mois, les produits doivent être objet des contrôles suivants:

d1)Recouvrir les parties extérieures usinées et les éléments d'accouplement avec de la graisse contre l'oxydation.

d2)Positionner les réducteurs avec le bouchon reniflard le plus haut possible et les remplir d'huile.
Avant utilisation, les réducteurs doivent être remplis de la quantité et du type de lubrifiant préconisés.

19.0 CONDIZIONI DI FORNITURA

I riduttori vengono forniti come segue:

a) già predisposti per essere installati nella posizione di montaggio come definito in fase di ordine;

b) **senza olio lubrificante ed internamente protetti con un film d'olio usato per il collaudo finale (tipo IP IDEX OIL SAE 10W20)**;

c) verniciati con vernice di fondo antiossidante all'acqua di colore grigio (tipo Idrayon Primer-Ral 7042/C441).
Le superfici di accoppiamento non sono verniciate.
La verniciatura finale è a cura del cliente;

d) collaudati secondo specifiche interne;

e) appositamente imballati;

f) provvisti di dadi e bulloni per montaggio motori elettrici versione IEC o motori idraulici;

19.0 SUPPLY CONDITIONS

Gearboxes are supplied as follows:

a) ready for installation in the mounting position specified on order;

b) **dry; inner parts are protected by a film of the oil used for final testing (type IP IDEX OIL SAE 10W20);**

c) painted with antioxidant water primer in the colour grey (type Idrayon Primer-Ral 7042/C441).
Mating surfaces are not painted.
Final coat is to be applied by the Customer;

d) tested to in-house specifications;

e) suitably packed;

f) complete with mounting nuts and bolts for IEC electric motors or hydraulic motors;

19.0 LIEFERBEDINGUNGEN

Die Getriebe werden wie folgt geliefert.

a) bereits für die Installation in der Einbaulage gemäß Auftrag bereit.

b) **ohne Schmieröl und innen mit einem Öl, das für die Endabnahmeprüfung verwendet wurde, überzogen (Typ IP IDEX OIL SAE 10W20).**

c) mit einer grauen, vor Oxydation durch Wasser schützenden Grundlackierung überzogen (Typ Idrayon Primer Ral 7042/C441).
Die Verbindungsflächen sind nicht lackiert.
Die Endlackierung geht zu Lasten des Kunden.

d) gemäß werksinterner Spezifikationen geprüft.

e) in angemessener Weise verpackt.

f) mit Muttern und Schrauben für die Montage an Elektromotoren der Version IEC oder Hydraulikmotoren ausgestattet.

19.0 CONDITIONS DE LIVRAISON

Les réducteurs sont livrés comme suit:

a) déjà adaptés pour l'installation dans la position d'assemblage définie en cours de commande;

b) **sans huile lubrifiante et protégés à l'intérieur avec un film d'huile utilisée lors de l'essai final (type IP IDEX OIL SAE 10W20);**

c) peints avec une couche de fond de protection antioxydant à l'eau, de coloris gris (type idrayon Primer-Ral 7042/C441).
Les surfaces d'accouplement ne sont pas peintes.
La peinture de finition doit être réalisée par le client;

d) essayés d'après les spécifications internes;

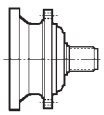
e) dûment emballés;

f) pourvus d'écrous et de boulons pour l'assemblage aux moteurs électriques, version CEI, ou moteurs hydrauliques;

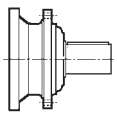
20.0 **DESIGNAZIONE RIDUTTORE** | 20.0 **GEARBOX DESIGNATION** | 20.0 **GETRIEBE-BEZEICHNUNG** | 20.0 **DESIGNATION REDUCTEUR**

3 11 L 2 16.7 HZ

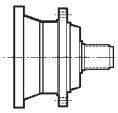
VERSIONE USCITA / OUTPUT VERSION / AUSGANGSVERSION / VERSION EN SORTIE



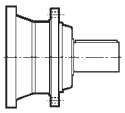
MZ : Albero maschio scanalato
Splined male shaft
Vielkeilwelle
Arbre de sortie cannelè sortant



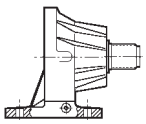
MC : Albero maschio cilindrico
Solid keyed shaft
Zylindrisches Welle
Arbre de sortie cyl. Claveté sortant



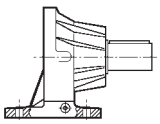
HZ : Albero maschio rinforzato scanalato
Heavy duty splined male shaft
Vielkeilwelle mit Verstärkfer Lagerung
Arbres de sortie cannelé sortant, paliers renforcés



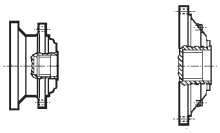
HC : Albero maschio rinforzato cilindrico
Heavy duty solid keyed shaft
Zylindrisches Welle mit Verstärkfer Lagerung
Arbre de sortie cyl. claveté sortant, paliers renforcés



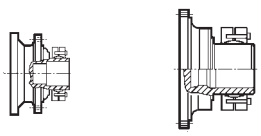
PZ : Base di supporto con albero maschio scanalato
Foot mounted with splined shaft
Fußausführung mit Keilwelle
Base de support avec arbre mâle cannelé



PC : Base di supporto con albero cilindrico
Foot mounted with solid keyed shaft
Fußausführung mit zylindrischer Welle
Base support à pattes avec arbre cyl. clavéte



FZ : Albero femmina scanalato
Hollow splined shaft
Vielkeilhohlwelle
Arbre de sortie creux cannelé



FP : Albero femmina per giunto ad attrito
Hollow shaft for shrink disc
Zylindrische Hohlwelle für Schumpfscheibe
Arbre de sortie creux pour montage par frette

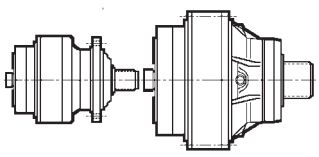
RAPPORTO DI RIDUZIONE / REDUCTION RATIO / ÜBERSETZUNG / RAPPORT DE REDUCTION

Indicare il valore del rapporto (compresi punto e decimali) riportato su pagine dati tecnici
Fill in the value of the transm. ratio (including point and decimals) reported in the selection charts
Den auf den Seiten der technischen Daten angegebenen Wert des Übersetzuns (einschließlich Punkt und Dezimalen) angeben
Indiquer la valeur du rapport (y inclus les chiffres décimaux) citée aux pages des données techniques
Esim. / Ex. / Beispiel / Ex. : 1/5.33 = 5.33 1/44.6 = 44.6 1/131 = 131

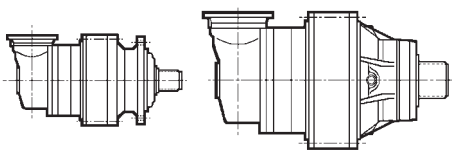
N. STADI DI RIDUZIONE / Nbr. OF REDUCTIONS / ANZAHL DER UNTERSETZ. / NOMBRE DE TRAINS
1 - 2 - 3 - 4

ESECUZIONE / DESIGN / AUSFÜHRUNG / EXECUTION

L = Lineare / In line / Linear / Coaxiale



R = Angolare / Right angle / Rechtwinklig / A renvoi d'angle



GRANDEZZA RIDUTTORE / GEARBOX SIZE / GETRIEBEBAUGRÖSSE / TAILLE REDUCTEUR

00 = 300	30	**06** = 306	70	**11** = 311	110	**19** = 319	150
01 = 301	40	**07** = 307	80	**13** = 313	120	**21** = 321	160
03 = 303	50	**09** = 309	90	**15** = 315	130		
05 = 305	60	**10** = 310	100	**17** = 317	140		

SERIE / SERIES / SERIE / SERIE

20.0 **DESIGNAZIONE / RIDUTTORE** | 20.0 **GEARBOX DESIGNATION** | 20.0 **GETRIEBE-BEZEICHNUNG** | 20.0 **DESIGNATION REDUCTEUR**

6A S5EC A A W0A ... ...

INDICE DI REVISIONE / REVISION NUMBER
REVISIONSANGABE / INDEX DE REVISION

OPZIONI / OPTIONS
OPTIONEN / OPTIONS

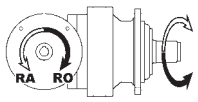
GUARNIZIONI / GASKET / DICHTUNGEN / MATIERE ETANCHE
STANDARD=NITRILBUTADIENE / NITRILBUTADIENE
NITRILBUTADIEN / NITRILEBUTADIENE

PV = VITON

SOLO PER ESECUZIONE ANGOLARE / ONLY FOR RIGHT ANGLE DESIGN
NUR FÜR WINKELAUSFÜHRUNGEN / UNIQUEMENT EN CASE D'EXECUTION D'ANGLE
senso di rotazione in ingresso preferenziale / preferential input direction of rotation
bevorzugte umdrehungsrichtung am antrieb / sense de rotation de preference en entrée

RA = sinistro / Left / Links / Gauche

RO =destro / Right / Rechts / Droit

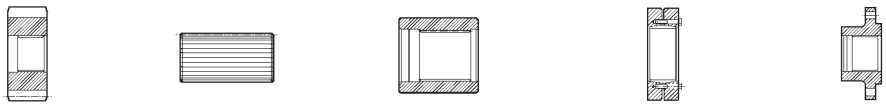


CENTRALINA AUSILIARE DI RAFFREDDAMANTO
SUPPLEMENTARY COOLING SYSTEM
HILFSKÜHLSYSTEM
UNITE' DE REFROIDISSEMENT AUXILAIRE

220

CR1
CR2
CR3

ACCESSORI IN USCITA / OUTPUT FITTINGS
ZUBEHÖR (ABTRIEB) / ACCESSOIRES COTE SORTIE



P... = Pignoni / Pinions / Ritzel / Pignons

B0A = Barra scanalata / Splinedbar / Vlelkeilvollwelle / Barre canneleée

M0A = Manicotto liscio / Sleeve coupling / Nabe / Manchon lisse

G0A = Giunto ad attrito / Shrink disc / Schrumpfscheibe / Frette de serrage

W0A = Flangia / Flange / Flansch / Bride

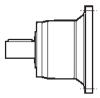
ORIENTAMANTO FLANGIA MOTORE / MOTOR FLANGE ORIENTATION
ORIENTERUNG DER MOTORFLANSCH / ORIENTATION DE LA BRIDE MOTEUR

171

POS. DI MONTAGGIO / MOUNTING POS.
EINBAULAGEN / POS. DE MONTAGE

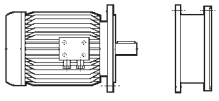
24

ENTRATA / INPUT / EINGANG / ENTREE



Albero veloce
Input keyed shaft
Eingangswelle
Arbre d'entrée cyl. claveté

VO1A = Ø 24
VO1B = Ø 38
VO5B = Ø 48
VO6B = Ø 60
VO7B = Ø 80
V11 B = Ø 80



Predisposizione motore elettrico
Electric motor connection
Motoranbauteile für IEC-Motor
Adaptation pour moteur électrique

P + grandezza motore (**80**,**90**,**100**,**132**,**160**,...)
P + motor size (**80**,**90**,**100**,**132**,**160**,...)
P + Motor Größe (**80**,**90**,**100**,**132**,**160**,...)
P + tailles de moteur (**80**,**90**,**100**,**132**,**160**,...)

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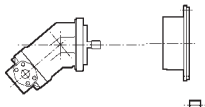


Predisposizione motore idraulico
Hydraulic Motor connection
Motoranbauteile fürHydromotor
Adaptation pour moteur hydraulique

S5AP, COAA, HOBA, ...

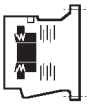
172

Motoriduttore con motore idraulic integrato orbitale MG
Hydraulic motor MG
Hydraulikmotor MG
Moteur hidraulique MG

T4AA

181

SOLO CON IN ENTRATA MOTORE IDRAULICO / ONLY WITH HYDRAULIC MOTOR ADAPTOR
NUR AM HYDRAULIKMOTORANTRIEB / UNIQUEMENT AVEC ENTREE MOTEUR HYDRAULIQUE



Freno idraulico negativo a dischi multipli standard / Standard negative multidisc brake
Standard negative lamellenbremse / Frein multidisque negatif standard

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6 = Grandezza / Type / Typ / Type : **4 - 5 - 6**
A = Jarrumomentti - Braking torque - Bremsmoment - Couple de frenage : **A - B - C**

Freno idraulico negativo a dischi multipli per motore orbitale
Negative multidisc brake for MG hydraulic motor
Negative lamellenbremse für Hydraulikmotor MG
Frein multidisque negatif pour moteur hydraulique MG

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SF = Senza freno / Without brake / Ohne Bremse / Sans frein

21.0 POSIZIONI DI MONTAGGIO

Per la completa definizione della forma costruttiva del motoriduttore o del riduttore selezionato, definire la posizione di montaggio rispetto al suolo secondo la tabella (A8) e l'orientamento dell'angolare.

(A8)

Riduttori in linea ed angolari

21.0 MOUNTING POSITION

For a proper designation of the geared motor or gearbox, mounting position please refer to the table (A8) to determine mounting position and right angle unit arrangement.

Inline and right angle gearboxes

21.0 MONTAGEPOSITIONEN

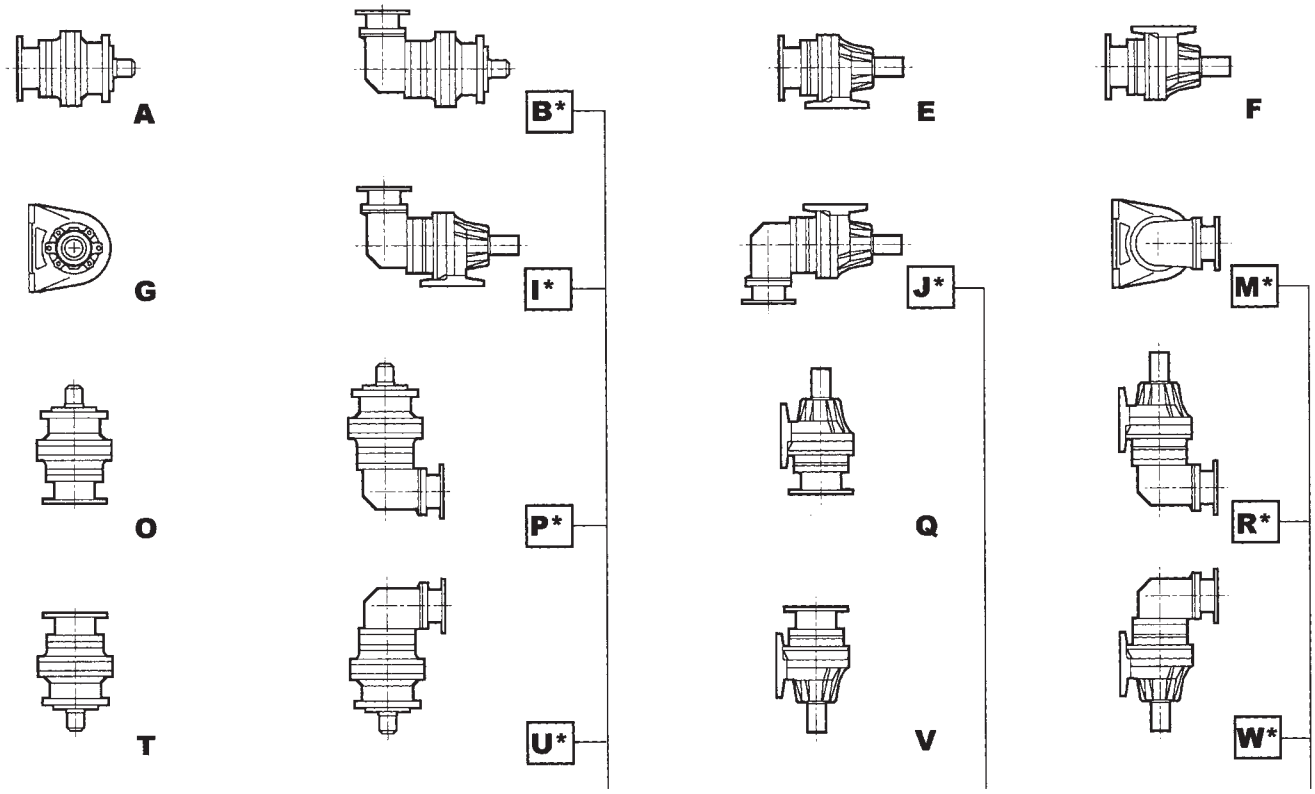
Für die vollständige Definition der Bauform des Getriebemotors oder des gewählten Getriebes ist die Montagestellung gegenüber dem Boden gemaß der Tabelle (A8) und der Ausrichtung des Winkelstücks festzulegen.

Coaxiale und rechtwinklige Untersetzungsgetriebe

21.0 POSITION DE FONCTIONNEMENT

Pour une définition complète de la forme de construction, du motoréducteur ou réducteur sélectionné, préciser la position de montage par rapport au sol, d'après les tableaux (A8) et l'orientation de coude.

Réducteurs coaxiaux et a rénvoi d'angle

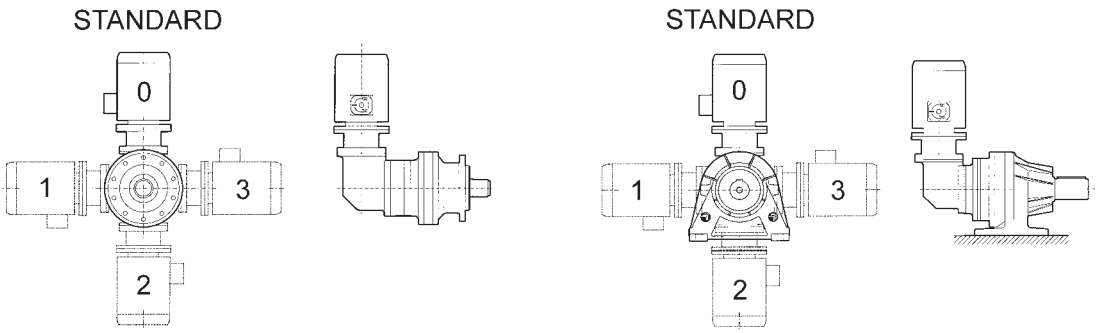


* Per tutti i riduttori con angolare, oltre alla posizione di montaggio, specificarel'orientamento dell'asse dell'ingresso secondo lo schema seguente

* For all gearboxes with right angle unit, in addition to the mounting position, please specify the arrangement of the input axis according to the diagram below.

* Für alle Winkelgetriebe, muß über die Montagestellung hinaus, auch die Ausrichtung der Antriebsachse, dem folgenden Schema gemaß, spezifiziert werden.

* Pour tous les réducteurs avec renvoi d'angle, en plus de la position de montage spécifier l'orientation de l'axe d'entrée suivant le schéma suivant.



22.0 LUBRIFICAZIONE
(prima della messa in funzione)

Tutti i riduttori prevedono una lubrificazione a bagno d'olio. Nelle posizioni di montaggio che prevedono i riduttori con un asse verticale, dove lo sbattimento dell'olio durante il funzionamento non sarebbe sufficente a garantire la corretta lubrificazione dei cuscinetti superiori, vengono adottati adeguati sistemi di lubrificazione.

22.0 LUBRICATION
(prior to start-up)

All gearboxes are oil-bath lubricated. For applications calling for gearboxes with a vertically positioned axis, in which oil coverage during operation would not be sufficient to ensure correct lubrication of upper bearings, suitable life lubrication systems are used.

22.0 SCHMIERUNG
(vor der inbetriebnahme)

Alle Getriebe weisen eine Ölbadschmierung auf. Werden die Getriebe mit vertikaler Achse eingebaut, so daß nicht gewährleistet werden kann, daß das Öl während des Betriebs des Getriebes auch die oberen Lager ordnungsgemäßschmiert, werden entsprechende Dauerschmierungen vorgesehen.

22.0 LUBRIFICATION
(avant mise en route)

Tous réducteurs prevoient une lubrification en bain d'huile. Dans les positions de montage qui prévoient les réducteurs avec axe vertical, où le barbotage de l'huile pendant le fonctionnement serait insuffisant pour garantir une lubrification correcte des paliers supérieurs, l'on adopte des systè-mes appropriés de graissage à vie.

Prima della messa in opera immmettere la giusta quantità di lubrificante scegliendo la viscosità nella tabella (A9). A tal proposito i riduttori sono muniti dei tappi di carico, livello e scarico olio.

Al fine di predisporre il corretto orientamento dei tappi, per una adeguata lubrificazione, chiediamo di precisare sempre la posizione di montaggio desiderata.

Nella tabella (A9) sono riportate le marche più diffuse di lubrificazione con i tipi di oli consigliati per applicazioni normali.

- Per funzionamenti particolari dove sono richiesti speciali requisiti, interpellare il nostro servizio tecnico.
- La temperatura max. del lubrificante in esercizio continuo non deve superare gli 85°C.
- Tutti i riduttori vengono forniti senz'olio, ma predisposti con tappi di carico, scarico e livello.
- La quantità d'olio indicate per i vari tipi di riduttori sono indicative, il riempimento esatto deve essere fatto controllando il livello.
- Nel caso in cui la potenza trasmessa superi quella termica, occorrerà una circolazione d'olio (vedi cap.45 a pag. 220).

Before start-up, fill the gearbox with the correct quantity of oil, selecting the viscosity level as per table (A9). These gearboxes are provided with oil filling, level and drain plugs.
For a proper plug positioning for adequate lubrication, please always specify the required mounting position.

The table (A9) lists the most common brands of lubricant and the types recommended for normal applications.

- Note: For applications with special operating conditions, consult the factory with complete information.
- Oil temperature must not exceed 85°C.
- Units are delivered without oil but with filling, draining and oil level plugs correctly positioned.
- The oil capacities indicated for the various types of unit are indicative only. Check the oil level plug to ensure the correct amount of oil.
- Should transmitted power exceed the thermal capacity of the unit forced lubrication must be provided (see chap.45 at page 220).

Vor der Inbetriebnahme muß die entsprechende Schmiermittelmenge eingefüllt werden. Die hierzu jeweils erforderlichen Viskositätswerte können der Tabelle (A9) entnommen werden. Für diesen Füllvorgang wurden die Getriebe mit Verschlüssen für das Einfüllen, Nachfüllen und den Ablaß des Öls ausgestattet.
Um die Verschlüsse für eine angemessene Schmierung in korrekter Weise auszurichten zu können, empfehlen wir Ihnen, immer die gewünschte Montageposition anzugeben.

In der Tabelle (A9) sind die be-kanntesten Marken von Schmier- mitteln mit den empfohlenen Ölen für normale angeführt Einsatz.

- Im Falle von speziellen Einsatzbereichen, bei denen besondere Anforderungen vonnöten sind, wenden Sie sich bitte an unsere technische Abteilung.
- Die maximale Temperatur des Schmiermittels bei Dauerbetrieb darf 85°C nicht überschreiten.
- Sämtliche Untersetzungsgetriebe werden ohne Öl geliefert, sind und mit einer Ölfüll-Ölablaß-und Ölstandschraube versehen.
- Die für die verschiedenen Typen von Untersetzungsgetrieben angegebenen Füllmengen sind Richtwerte. Die Befüllung erfolgt über die Kontrolle des Ölstandes.
- Sollte die übertragene Leistung die thermische Leistung übersteigen, so wird eine Ölumwälz-ung erforderlich (Siebe Abschmitt 45, Seite 220).

Avant la mise en service, introduire la quantité exacte de lubrifiant choisissant la viscosité du tableau (A9). Les réducteurs sont pourvus à cet effet de bouchon de remplissage, jauge de niveau et élément de vidange huile.
Dans le but de réaliser une mise en place exacte des bouchons, pour une lubrification appropriée, il est conseillé de spécifier toujours la position de montage souhaitée.

Sur le tableau (A9), ont été reportées les marques les plus répandues de lubrifiants avec les types conseillés, pour des applications normales.

- Pour des applications dans des conditions de fonctionnement particuliéres, consulter nos Services Techniques.
- La température maxi du lubrifiant, en fonctionnement continu, ne doit pas dépasser 85°C.
- Tous les réducteurs sont livrés sans huile, mais équipés de bouchons de remplissage, de vidange, et de niveau.
- Les quantités d'huile, précisées pour les divers types de réducteurs, sont indicatives, le remplissage exact devant être effectué en contrôlant le niveau.
- Dans le cas où la puissance transmise dépasserait la puissance thermique, il sera necessaire de prévoir une circulation d'huile (voir par.45 à page 220).

(A9)

	IMPIANTI INDUSTRIALI / INDUSTRIAL PLANTS INDUSTRIEANLAGEN/ INSTALLATIONS INDUSTRIELLES		MACCHINE MOBILI / MOBILE MACHINES BEWEGLICHE MASCHINEN / MACHINES MOBILES	
	norme ISO .. con caratteristiche EP. ISO standard .. E.P. grade ISO-Normen .. E.P.-Merkmalen normes ISO .. avec caractéristiques E.P.		norme SAE .. con caratteristiche API GL5 SAE standard .. API GL5 grade SAE-Normen .. mit API GL5-Merkmalen normes SAE .. avec caractéristiques API GL5	
Temperatura ambiente Ambient temperature Temperaturbereiche Température ambiante	-10°C / +30°C	+20°C / +45°C	-10°C / +30°C	+20°C / +45°C
	ISO VG 150	**ISO VG 220**	**SAE 80W/90**	**SAE 85W/140**
AGIP	BLASIA 150	BLASIA 220	ROTRA MP	ROTRA MP
	BLASIA S150	BLASIA S 220		
ARAL	DEGOL BG 150	DEGOL BG 220	GETRIEBEOL HYP	GETRIEBEOL HYP
BP - MACH	ENERGOL GR XP 150	ENERGOL GR XP 220	HYPOGEAR EP	HYPOGEAR EP
		ERNESYN HTX 220		
CASTROL	ALPHA SP 150	ALPHA SP 220	HYPOY	HYPOY
CHEVRON	EDWN.L. GEAR COMPOUND 150	N.L. GEAR COMPOUND 220	UNIVERSAL GEAR LUBRICANTE	UNIVERSAL GEAR LUBRICANTE
ELF	REDUCTELF SP 150	REDUCTELF SP 220	TRANSELF8	TRANSELF8
ESSO	SPARTAN EP 150	SPARTAN EP 220	GEAR OIL GX	GEAR OIL GX
	GLYCOLUBE 150	GLYCOLUBE 220	PONTONIC MP	PONTONIC MP
FINA	GIRAN 150	GIRAN 220		
I.P.	MELLANA 150	MELLANA 220	PONTIAX HD	PONTIAX HD
	PONTIAX HDS	PONTIAX HDS		
KLÜBER	LAMORA 150	LAMORA 220		
	SYNTHESO D150 EP	SYNTHESO D220 EP		
MOBIL	MOBILGEAR 629	MOBILGEAR 630	MOBILUBE HD	MOBILUBE HD
	SHC 629	SHC 630		
SHELL	OMALA EP 150	OMALA EP 220	SPIRAX HD	SPIRAX HD
	TIVELA OIL WA-SA	TIVELA OIL WB		
TOTAL	CARTER EP 150	CARTER EP 220	TRANSMISSION TM	TRANSMISSION TM

- Temperatura sulla carcassa, questa non deve superare nel punto più caldo i 70-75°C.
- The temperature of the gear case, which should not exceed 70-75°Cat the hottest point.
- Gehäusetemperatur, an der Wârmsten Stelle max. 70-75°C.
- La température sur la carcasse; l'échauffement maximum de celle-ci ne devant pas dépasser les 70-75°C.

Oli a base sintetica
Synthetic oil
Synthetische Öle
Huiles à base synthetique

LUBRIFICAZIONE FRENI
I freni idraulici a dischi multipli hanno lubrificazione unica con il riduttore.

BRAKES LUBRICATION
The hydraulically operated multi-disc brakes are lubricated by the same oil as the gearbox.

BREMSE SCHMIERUNG
Die hydraulischen Lamellenbremsen werden über die Schmierung des Untersetzungsgetriebes geschmiert.

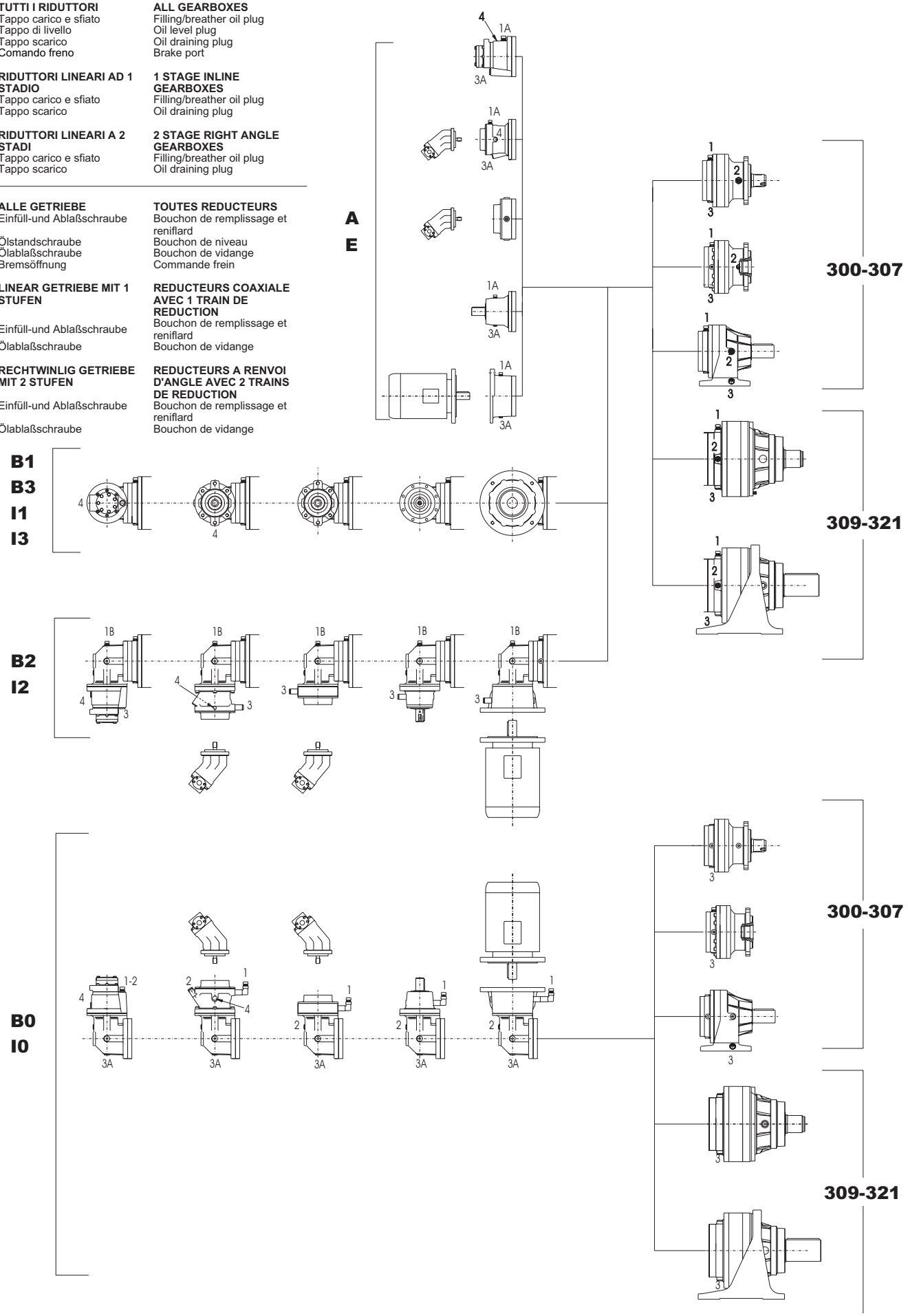
FREINS LUBRIFICATION
Les freins hydrauliques à disques multiples sont lubrifié avec la même huile que les réducteurs.

22.1 **Posizione tappi olio** 22.1 **Plug positions** 22.1 **Position der Schrauben** 22.1 **Positions des bouchons**

(A10)

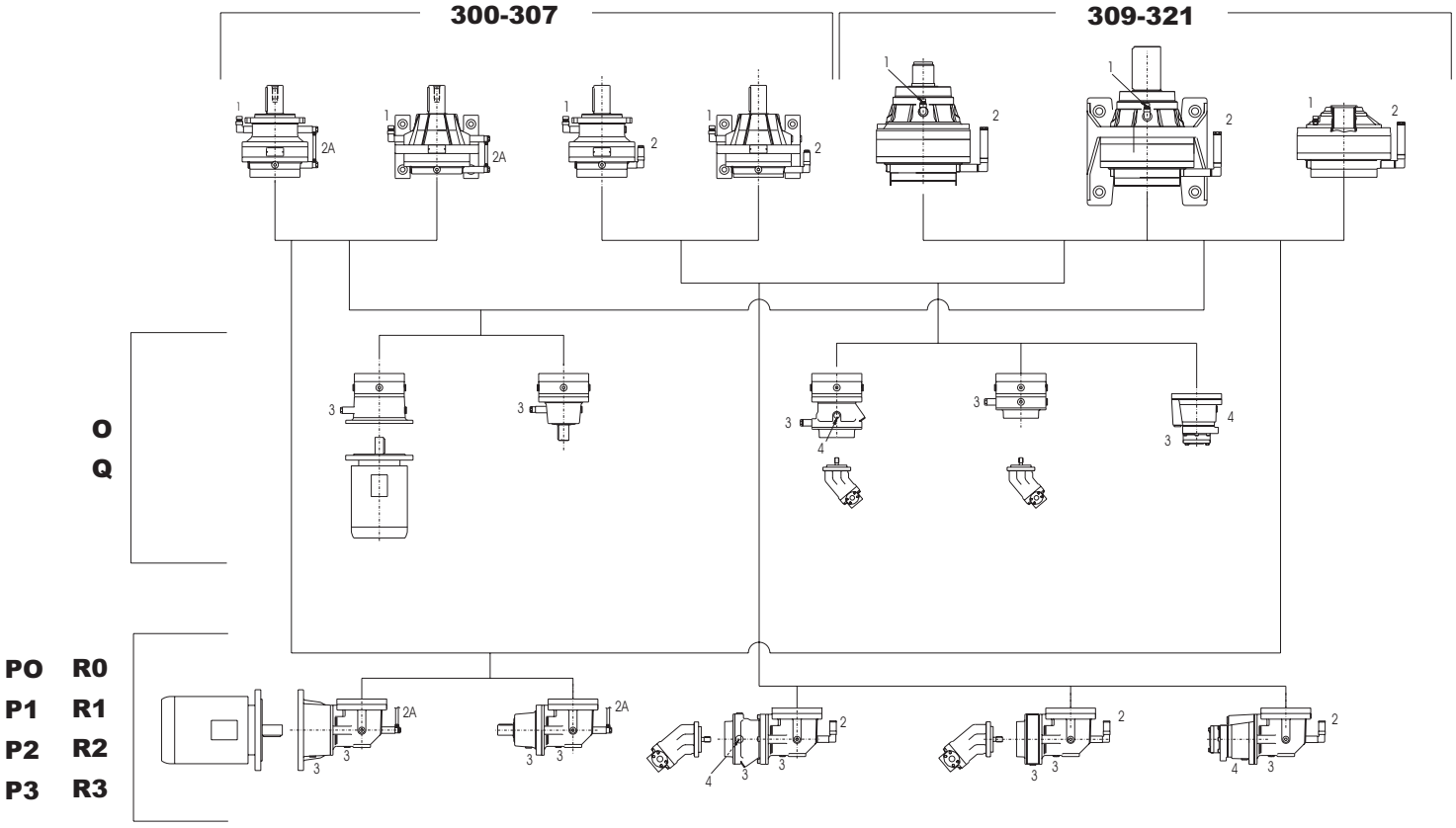
	TUTTI I RIDUTTORI	**ALL GEARBOXES**
1	Tappo carico e sfiato	Filling/breather oil plug
2	Tappo di livello	Oil level plug
3	Tappo scarico	Oil draining plug
4	Comando freno	Brake port
	RIDUTTORI LINEARI AD 1 STADIO	**1 STAGE INLINE GEARBOXES**
1A	Tappo carico e sfiato	Filling/breather oil plug
3A	Tappo scarico	Oil draining plug
	RIDUTTORI LINEARI A 2 STADI	**2 STAGE RIGHT ANGLE GEARBOXES**
1b	Tappo carico e sfiato	Filling/breather oil plug
3A	Tappo scarico	Oil draining plug

	ALLE GETRIEBE	**TOUTES REDUCTEURS**
1	Einfüll-und Ablaßschraube	Bouchon de remplissage et reniflard
2	Ölstandschraube	Bouchon de niveau
3	Ölablaßschraube	Bouchon de vidange
4	Bremsöffnung	Commande frein
	LINEAR GETRIEBE MIT 1 STUFEN	**REDUCTEURS COAXIALE AVEC 1 TRAIN DE REDUCTION**
1A	Einfüll-und Ablaßschraube	Bouchon de remplissage et reniflard
3A	Ölablaßschraube	Bouchon de vidange
	RECHTWINLIG GETRIEBE MIT 2 STUFEN	**REDUCTEURS A RENVOI D'ANGLE AVEC 2 TRAINS DE REDUCTION**
1B	Einfüll-und Ablaßschraube	Bouchon de remplissage et reniflard
3A	Ölablaßschraube	Bouchon de vidange



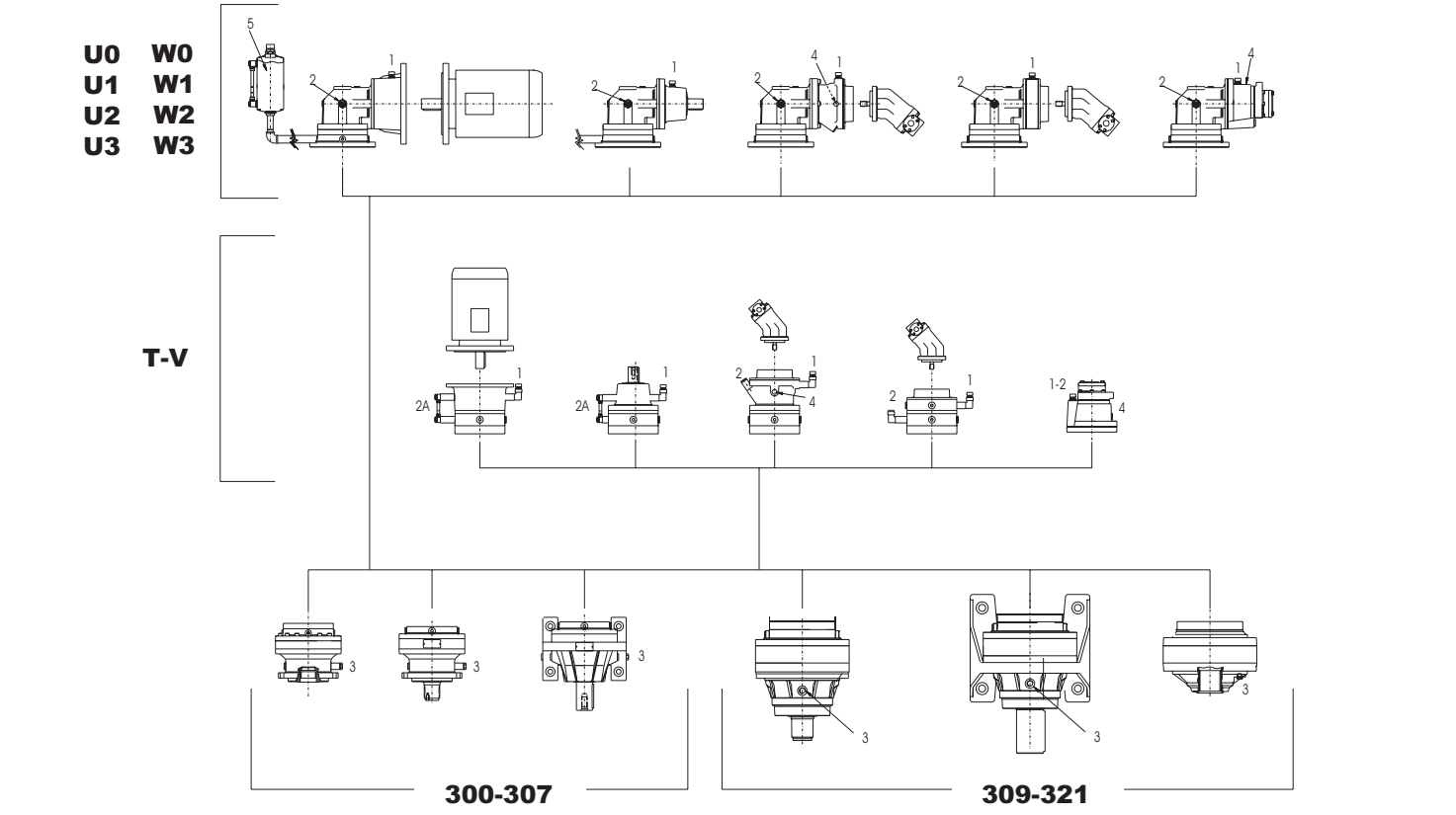
22.1 **Posizione tappi olio** 22.1 **Plug positions** 22.1 **Position der Schrauben** 22.1 **Positions des bouchons**

(A11)



	TUTTI I RIDUTTORI	ALL GEARBOXES	ALLE GETRIEBE	TOUTES REDUCTEURS
1	Tappo carico e sfiato	Filling/breather oil plug	Einfüll-und Ablaßschraube	Bouchon de remplissage et reniflard
2	Tappo di livello	Oil level plug	Ölstandschraube	Bouchon de niveau
2A	Tubo trasparente di livello	Transparent oil level hose	Ölstandschraube	Bouchon de niveau
3	Tappo scarico	Oil draining plug	Ölablaßschraube	Bouchon de vidange
4	Comando freno	Brake port	Bremsöffnung	Commande frein
5	Vaso espansione olio per applicazioni di continuo	Oil tank, for gearboxes in industrial application	Olüberlaufgefaß für Applikationen im Dauerbetriebe	Vase d'expansion pour des applications en service continu

(A12)



22.2 **Quantità olio (l)** 22.2 **Oil quantity (l)** 22.2 **Schmierolmenge (l)** 22.2 **Quantité d'huile**

(A13)

Tipo/Type Typ/Type		Posizione di montaggio Mounting position Einbaulagen Position de montage 24		
		A	**T**	**O**
300	**L1**	0.6	1.0	0.9
	L2	0.9	1.3	1.2
	L3	1.2	1.6	1.5
	L4	1.5	1.9	1.8
301	**L1**	0.8	1.2	1.1
	L2	1.1	1.5	1.4
	L3	1.4	1.8	1.7
	L4	1.7	2.1	2.0
303	**L1**	1.3	2.3	2.0
	L2	1.6	2.6	2.3
	L3	1.9	2.9	2.6
	L4	2.2	3.2	2.9
305	**L1**	1.6	2.6	2.4
	L2	2.1	3.1	2.9
	L3	2.4	3.4	3.2
	L4	2.7	3.7	3.5
306	**L1**	2.5	3.5	3.2
	L2	3.3	4.3	4.0
	L3	3.6	4.6	4.3
	L4	3.9	4.9	4.6
307	**L1**	3.5	5.0	4.5
	L2	4.5	6.0	5.5
	L3	5.0	6.5	6.0
	L4	5.3	6.8	6.3
309	**L1**	4.0	5.5	5.0
	L2	5.0	6.5	6.0
	L3	5.5	7.0	6.5
	L4	5.8	7.3	6.8
310	**L1**	5.0	6.5	6.0
	L2	6.3	7.8	7.3
	L3	7.1	8.6	8.1
	L4	7.4	8.9	8.4
311	**L1**	7.0	12.0	10.0
	L2	9.0	14.0	12.0
	L3	10.0	15.0	13.0
	L4	10.5	15.5	13.5
313	**L1**	9.0	14.0	12.0
	L2	11.5	16.5	14.5
	L3	12.5	17.5	15.5
	L4	13.0	18.0	16.0
315	**L1**	15.0	23	19.0
	L2	19.0	27	23
	L3	21	29	25
	L4	22	30	26
317	**L1**	20	35	30
	L2	26	41	36
	L3	29	44	39
	L4	30	45	40
319	**L1**	25	45	38
	L2	35	55	48
	L3	40	60	53
	L4	43	63	56
321	**L1**	30	50	43
	L2	45	65	58
	L3	51	71	64
	L4	55	75	68

Tipo/Type Typ/Type		Posizione di montaggio Mounting position Einbaulagen Position de montage 24		
		B0	**U***	**P***
300	**R2**	1.2	1.7	1.5
	R3	1.5	2.0	1.8
	R4	1.8	2.3	2.1
301	**R2**	1.6	2.1	1.9
	R3	1.9	2.4	2.2
	R4	2.2	2.7	2.5
303	**R2**	2.2	2.8	2.6
	R3	2.5	3.1	2.9
	R4	2.8	3.4	3.2
305	**R2**	2.5	3.1	2.9
	R3	3.0	3.6	3.4
	R4	3.3	3.9	3.7
306	**R2**	4.0	5.0	4.8
	R3	4.8	5.8	5.6
	R4	5.1	6.1	5.9
307	**R2**	6.0	8.0	7.0
	R3	7.0	9.0	8.0
	R4	7.5	9.5	8.5
309	**R2**	6.5	8.5	7.5
	R3	7.5	9.5	8.5
	R4	8.0	10.0	9.0
310				
	R3	11.0	13.0	12.0
	R4	12.0	14.0	13.0
311	**R2**	14.0	19.0	17.0
	R3	16.0	21	19.0
	R4	17.0	22	20
313	**R2**	16.0	21	19
	R3	19.0	24	22
	R4	20	25	23
315				
	R3	27	35	31
	R4	30	38	34
317				
	R3	38	52	48
	R4	42	56	52

N.B. Le quantità d'olio sono indicative. Verificare l'esatto livello al momento del riempimento tramite l'apposito tappo.

N.B. Oil quantities are indicative. Check actual level after filling through the appropriate plug.

Achtung! Die Angabe bezüglich Ölmenge sind Richtwerte Der Ölstand soll während des Einfüllens anhand des Ölstandstopfens überprüft werden.

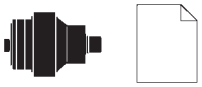
N.B. Les quantités d'huile sont indicatives. Vérifiez la quantité correcte de lubrifiant selon le niveau d'huile.

23.0 **TABELLE DATI TECNICI RIDUTTORI E DIMENSIONI**

23.0 **GEARBOX SELECTION CHARTS AND DIMENSIONS**

23.0 **GETRIEBEAUSWAHL-TABELLEN UND ABMESSUNGEN**

23.0 **TABLEAUX DES CARACTERISTIQUES TECHNIQUES REDUCTEURS ET DIMENSIONS**

GRANDEZZA SIZE BAUGRÖßE TAILLE	M_2 [Nm]		
300	1 000	30	31
301	1 750	40	41
303	2 500	50	51
305	5 000	60	61
306	8 500	70	71
307	12 500	80	81
309	18 500	90	91
310	25 000	100	101
311	35 000	110	111
313	50 000	120	121
315	80 000	130	131
317	150 000	140	141
319	300 000	150	151
321	450 000	160	161

300L

M_2 = 1000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	3.48	700	700	700	650	650	640	20	7.5	2 000	4 000	260	4F
	4.26	1 000	1 000	890	850	760	610	20	7.5	2 000	4 000	330	4H
	5.77	860	730	650	650	650	580	18.2	7.5	2 000	4 000	260	4F
	7.20	700	600	550	550	550	510	12.4	7.5	2 000	4 000	160	4D
L 2	12.1	700	700	700	650	650	640	9.0	7.5	2 000	4 000	100	4B
	14.8	700	700	700	650	650	640	7.3	7.5	2 000	4 000	100	4B
	18.2	1 000	1 000	890	850	760	610	7.8	7.5	2 000	4 000	100	4B
	20.1	700	700	700	650	650	640	5.4	7.5	2 000	4 000	100	4B
	24.6	1 000	1 000	890	850	760	610	5.8	7.5	2 000	4 000	100	4B
	30.7	1 000	1 000	890	850	760	610	4.9	7.5	2 000	4 000	50	4A
	33.3	860	730	650	650	650	580	3.3	7.5	2 000	4 000	50	4A
	41.5	860	730	650	650	650	580	2.8	7.5	2 000	4 000	50	4A
	51.8	700	600	550	550	550	510	1.9	7.5	2 000	4 000	50	4A
L 3	42.1	700	700	700	650	650	640	2.9	7.5	2 000	4 000	50	4A
	51.6	1 000	1 000	890	850	760	610	3.2	7.5	2 000	4 000	50	4A
	63.2	1 000	1 000	890	850	760	610	2.7	7.5	2 000	4 000	50	4A
	69.9	700	700	700	650	650	640	1.7	7.5	2 000	4 000	50	4A
	77.5	1 000	1 000	890	850	760	610	2.2	7.5	2 000	4 000	50	4A
	85.6	1 000	1 000	890	850	760	610	2.0	7.5	2 000	4 000	50	4A
	105	1 000	1 000	890	850	760	610	1.6	7.5	2 000	4 000	50	4A
	116	860	730	650	650	650	580	1.2	7.5	2 000	4 000	50	4A
	131	1 000	1 000	890	850	760	610	1.3	7.5	2 000	4 000	50	4A
	142	1 000	1 000	890	850	760	610	1.2	7.5	2 000	4 000	50	4A
	177	1 000	1 000	890	850	760	610	0.97	7.5	2 000	4 000	50	4A
	192	860	730	650	650	650	580	0.80	7.5	2 000	4 000	50	4A
	221	1 000	1 000	890	850	760	610	0.78	7.5	2 000	4 000	50	4A
	240	860	730	650	650	650	580	0.67	7.5	2 000	4 000	50	4A
	299	860	730	650	650	650	580	0.56	7.5	2 000	4 000	50	4A
	373	700	600	550	550	550	510	0.38	7.5	2 000	4 000	50	4A
L 4	403	860	730	650	650	650	580	0.63	6	2 000	4 000	50	4A
	447	1 000	1 000	890	850	760	610	0.66	6	2 000	4 000	50	4A
	494	1 000	1 000	890	850	760	610	0.60	6	2 000	4 000	50	4A
	558	1 000	1 000	890	850	760	610	0.53	6	2 000	4 000	50	4A
	616	1 000	1 000	890	850	760	610	0.48	6	2 000	4 000	50	4A
	755	1 000	1 000	890	850	760	610	0.39	6	2 000	4 000	50	4A
	819	1 000	1 000	890	850	760	610	0.36	6	2 000	4 000	50	4A
	942	1 000	1 000	890	850	760	610	0.31	6	2 000	4 000	50	4A
	1 022	1 000	1 000	890	850	760	610	0.29	6	2 000	4 000	50	4A
	1 108	860	730	650	650	650	580	0.27	6	2 000	4 000	50	4A
	1 275	1 000	1 000	890	850	760	610	0.23	6	2 000	4 000	50	4A
	1 383	860	730	650	650	650	580	0.21	6	2 000	4 000	50	4A
	1 591	1 000	1 000	890	850	760	610	0.19	6	2 000	4 000	50	4A
	1 725	860	730	650	650	650	580	0.17	6	2 000	4 000	50	4A
	2 153	860	730	650	650	650	580	0.14	6	2 000	4 000	50	4A
	2 687	700	600	550	550	550	510	0.11	6	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

M_2 = 1000 Nm

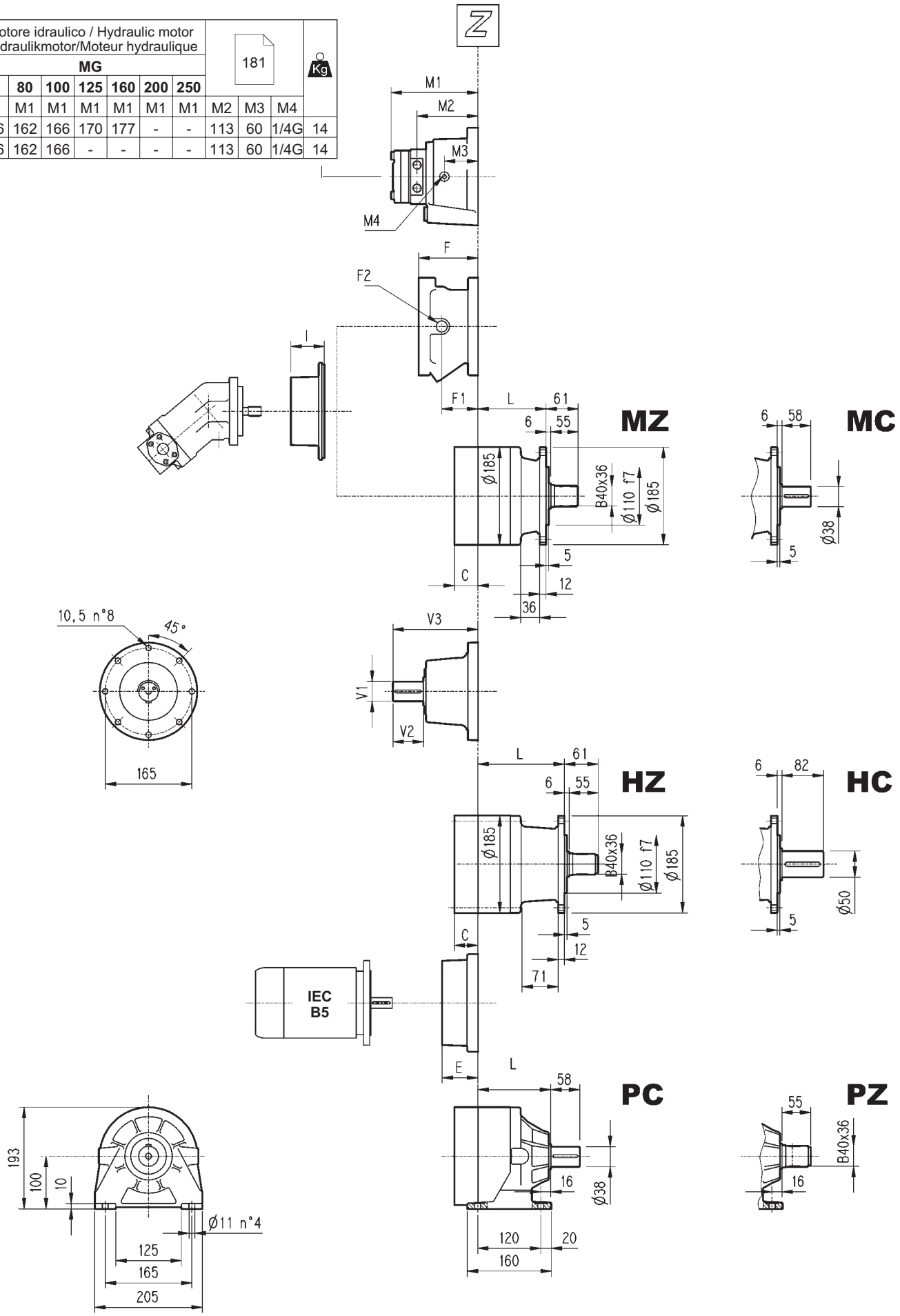
300R

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	7.13	700	700	700	650	650	640	15.0	12	2 000	4 000	160	4D
	8.74	1 000	1 000	890	850	760	610	15.0	12	2 000	4 000	160	4D
	11.8	860	730	650	650	650	580	9.2	12	2 000	4 000	100	4B
	14.8	700	600	550	550	550	510	6.2	12	2 000	4 000	100	4B
R3	24.8	700	700	700	650	650	640	4.7	12	2 000	4 000	50	4A
	30.4	700	700	700	650	650	640	4.0	12	2 000	4 000	50	4A
	37.3	1 000	1 000	890	850	760	610	4.3	12	2 000	4 000	50	4A
	41.2	700	700	700	650	650	640	2.9	12	2 000	4 000	50	4A
	50.4	1 000	1 000	890	850	760	610	3.3	12	2 000	4 000	50	4A
	62.9	1 000	1 000	890	850	760	610	2.7	12	2 000	4 000	50	4A
	68.2	860	730	650	650	650	580	1.9	12	2 000	4 000	50	4A
	85.2	860	730	650	650	650	580	1.6	12	2 000	4 000	50	4A
	106	700	600	550	550	550	510	1.1	12	2 000	4 000	50	4A
R4	86.4	700	700	700	650	650	640	2.4	10	2 000	4 000	50	4A
	106	1 000	1 000	890	850	760	610	2.8	10	2 000	4 000	50	4A
	130	1 000	1 000	890	850	760	610	2.3	10	2 000	4 000	50	4A
	143	700	700	700	650	650	640	1.4	10	2 000	4 000	50	4A
	159	1 000	1 000	890	850	760	610	1.9	10	2 000	4 000	50	4A
	175	1 000	1 000	890	850	760	610	1.7	10	2 000	4 000	50	4A
	215	1 000	1 000	890	850	760	610	1.4	10	2 000	4 000	50	4A
	237	860	730	650	650	650	580	1.1	10	2 000	4 000	50	4A
	268	1 000	1 000	890	850	760	610	1.1	10	2 000	4 000	50	4A
	291	1 000	1 000	890	850	760	610	1.0	10	2 000	4 000	50	4A
	363	1 000	1 000	890	850	760	610	0.81	10	2 000	4 000	50	4A
	394	860	730	650	650	650	580	0.70	10	2 000	4 000	50	4A
	453	1 000	1 000	890	850	760	610	0.65	10	2 000	4 000	50	4A
	491	860	730	650	650	650	580	0.58	10	2 000	4 000	50	4A
	613	860	730	650	650	650	580	0.48	10	2 000	4 000	50	4A
	765	700	600	550	550	550	510	0.33	10	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

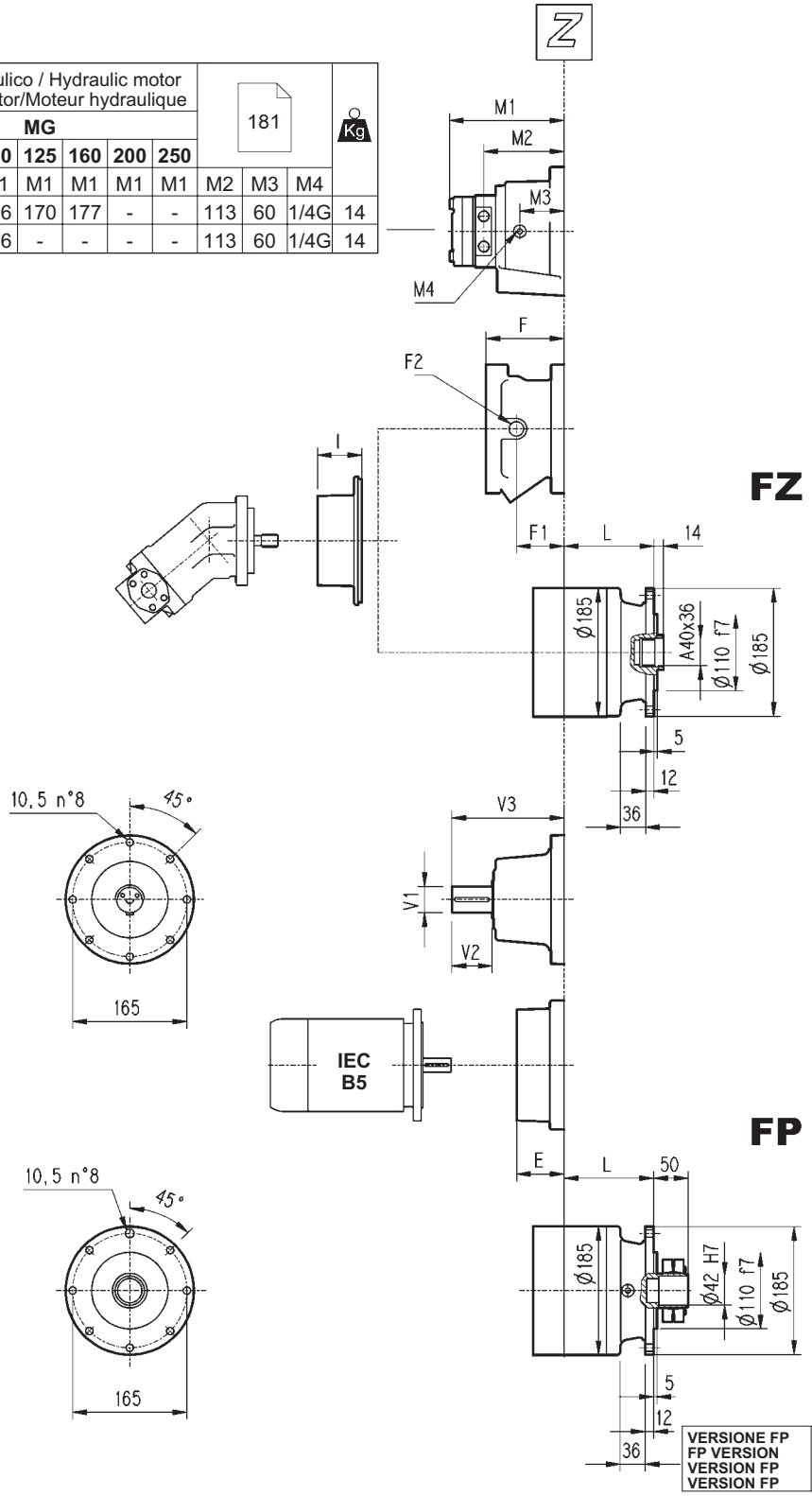
300L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
300L1	156	162	166	170	177	-	-	113	60	1/4G	14
300L2	156	162	166	-	-	-	-	113	60	1/4G	14



300L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
300L1	156	162	166	170	177	-	-	113	60	1/4G	14
300L2	156	162	166	-	-	-	-	113	60	1/4G	14



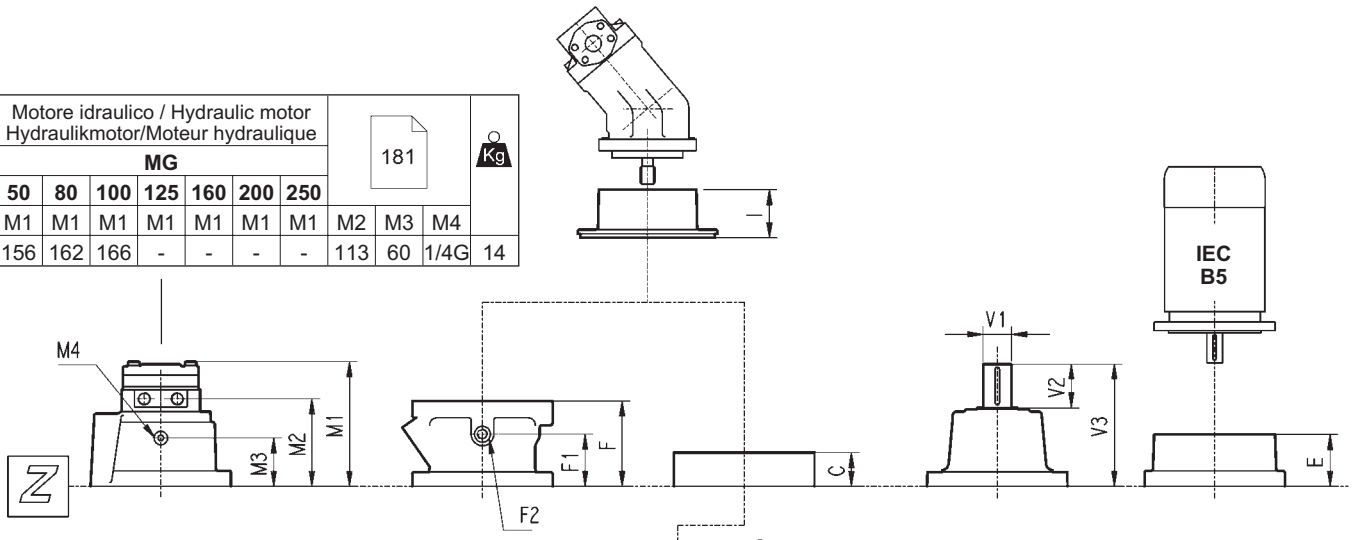
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**1 000 Nm**

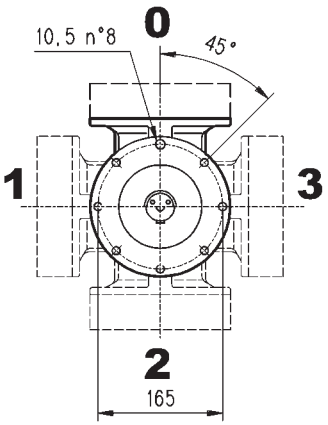
	L				Kg												
	MZ MC	**FZ FP**	**HZ HC**	**PC PZ**	**MZ MC**	**FZ FP**	**HZ HC**	**PC PZ**	**C**	Entrata Input Antrieb Entrée	**I**	**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
300 L1	80	80	115	86	18	16	20	23	37	A	171	105	65	1/4 G	4	A	10
300 L2	133	133	168	139	22	20	24	27	37	A		105	65	1/4 G	4	A	10
300 L3	186	186	221	192	26	24	28	31	37	A		105	65	1/4 G	4	A	10
300 L4	239	239	274	245	30	28	32	35	37	A		105	65	1/4 G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
										IEC 71	**IEC 80**	**IEC 90**	**IEC 100**	**IEC 112**	**IEC 132**			
300 L1	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114			
300 L2	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114			
300 L3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114			
300 L4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114			

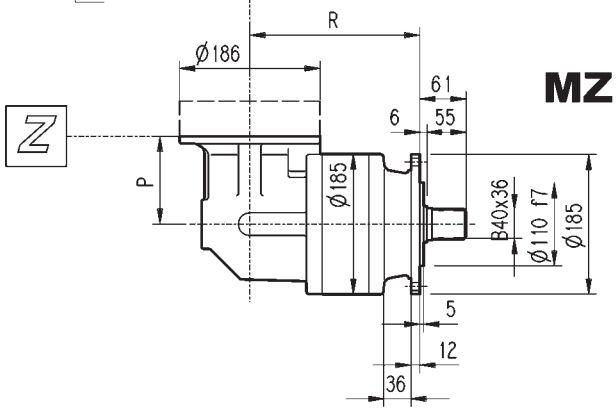
300R

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
300R2	156	162	166	-	-	-	-	113	60	1/4G	14

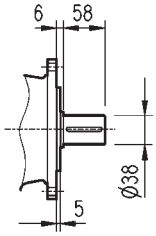




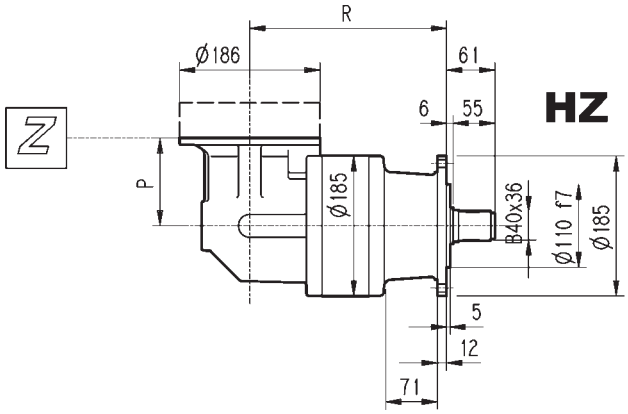
MZ



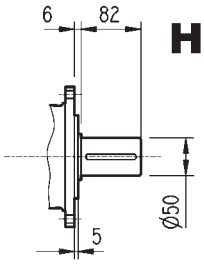
MC

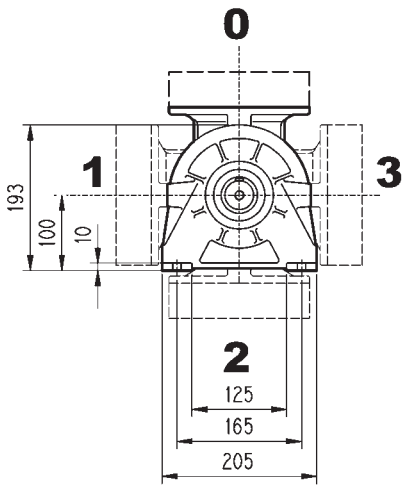


HZ

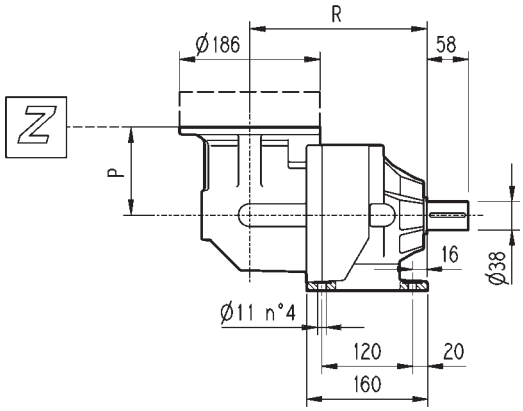


HC

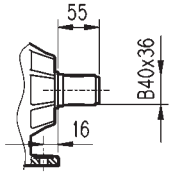




PC

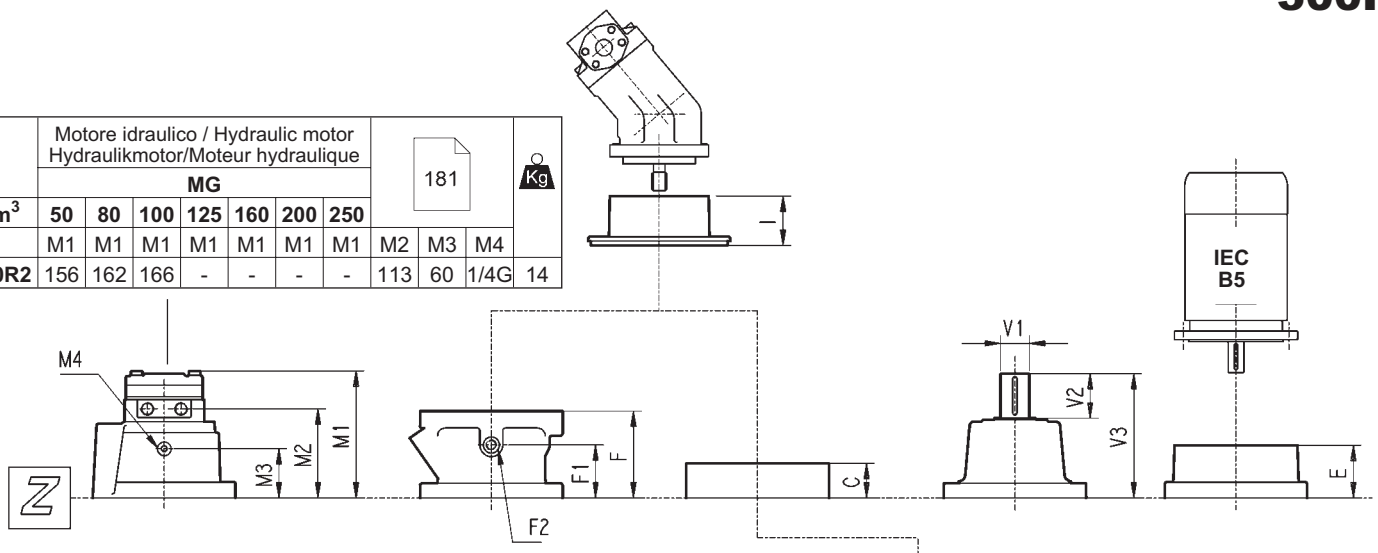


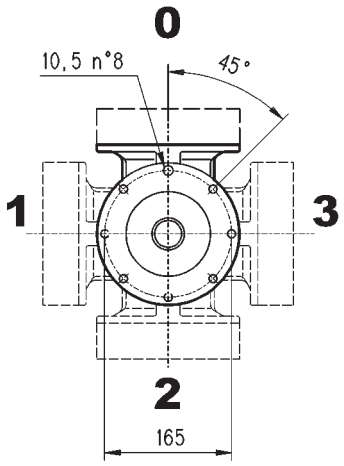
PZ

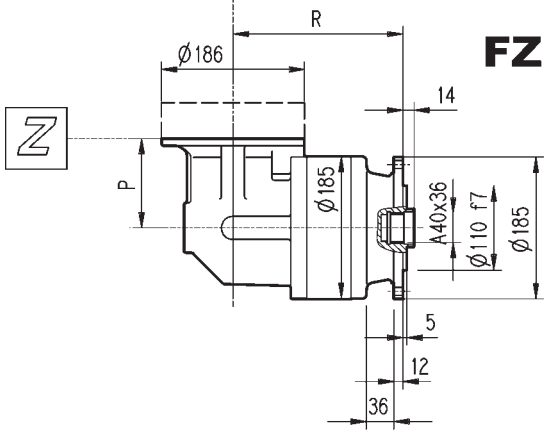


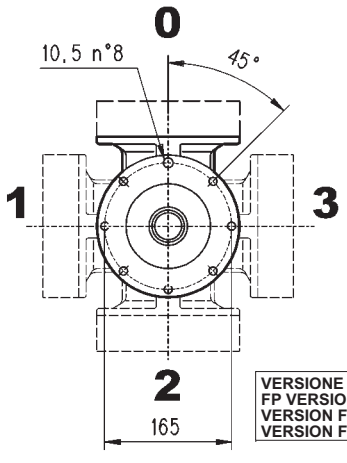
300R

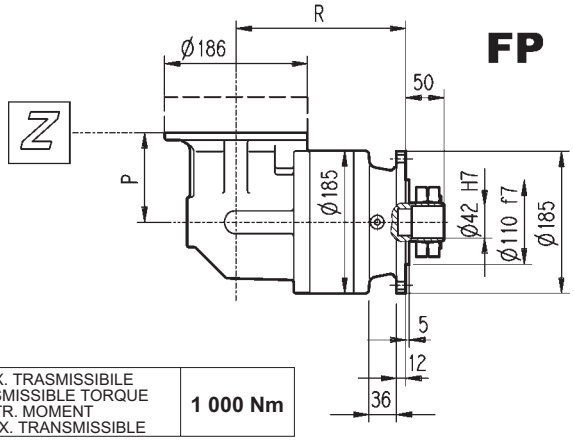
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
300R2	156	162	166	-	-	-	-	113	60	1/4G	14











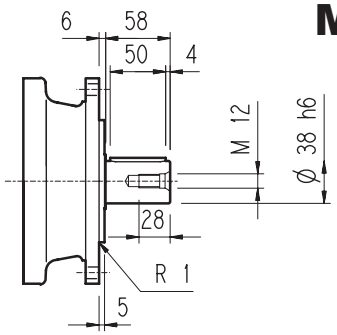
VERSIONE FP FP VERSION VERSION FP VERSION FP	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	1 000 Nm

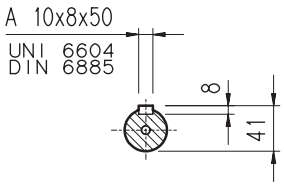
	R				P	Kg				C		I	F	F1	F2			Kg
	MZ MC	FZ FP	HZ HC	PC PZ		MZ MC	FZ FP	HZ HC	PC PZ		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
300 R2	172	172	207	178	122	32	30	34	37	37	A		105	65	1/4 G	4	A	10
300 R3	225	225	260	231	122	36	34	38	41	37	A		105	65	1/4 G	4	A	10
300 R4	278	278	313	284	122	40	38	42	45	37	A	171	105	65	1/4 G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E										
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132				
300 R2	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				
300 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				
300 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				

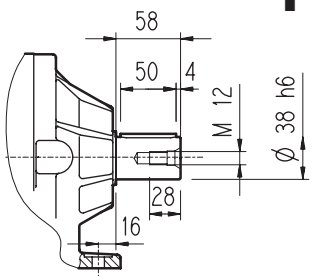
300L - 300R

MC

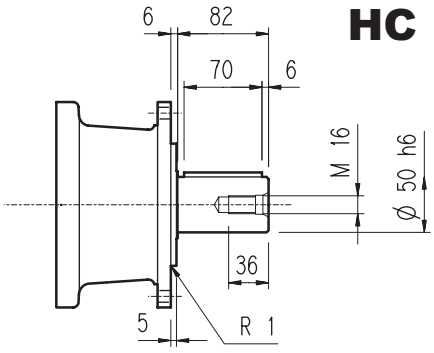


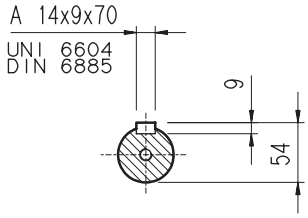


PC

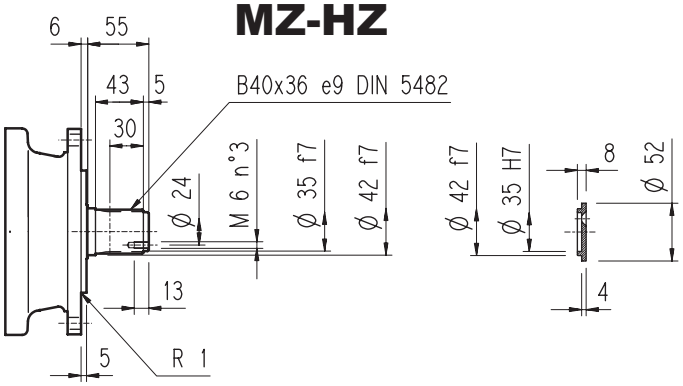


HC

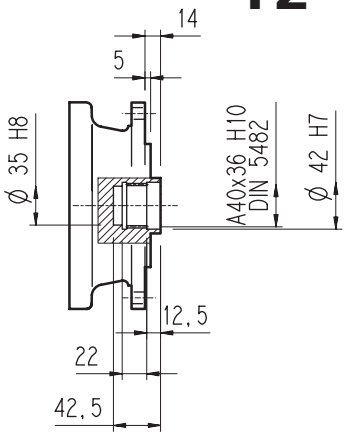




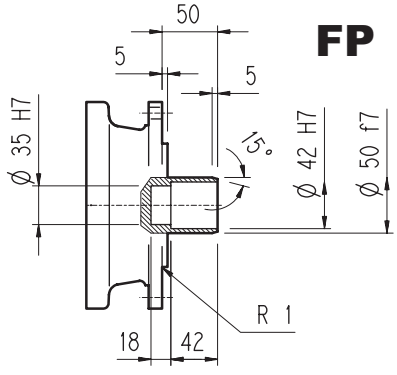
MZ-HZ

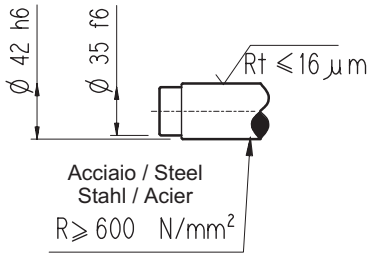


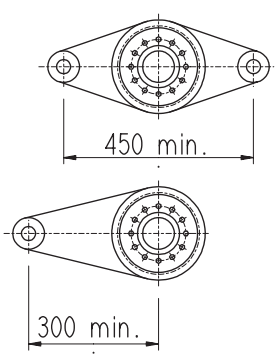
FZ



FP



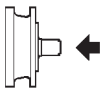


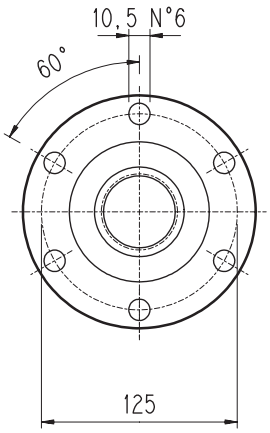


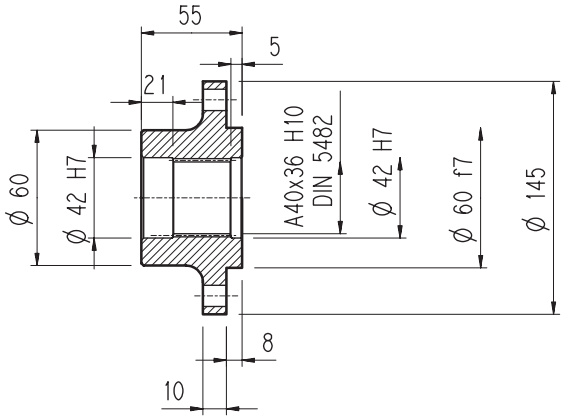
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**1 000 Nm**

300L - 300R
WOA

Flangia / Flange
Flansch / Brides

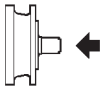




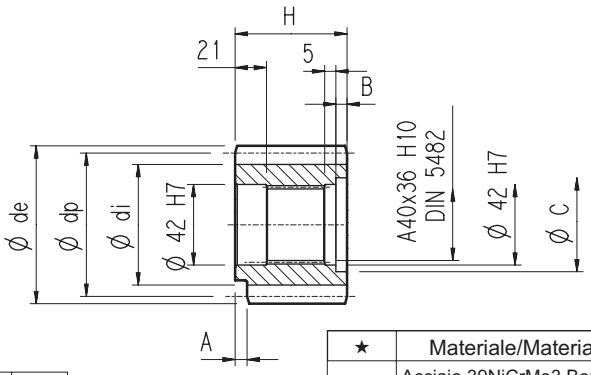


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons



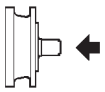
P...



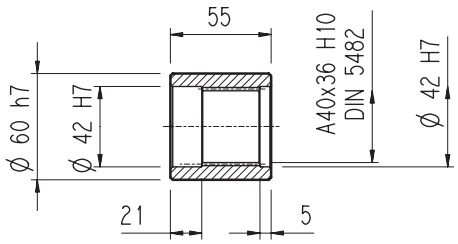
	m	z	x	dp	di	de	H	A	B	C	★
PBE	4.5	14	0.507	63	56	75.5	55	0	0	0	■
PCE	5	14	0.500	70	62.5	84.8	65	0	10	53	■
PDC	6	12	0.250	72	61	84.8	59	14	4	54	■
PDE	6	14	0.500	84	73	99.6	65	0	10	54	■

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

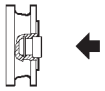


MOA

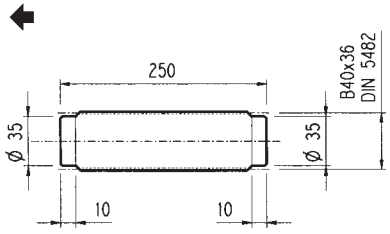


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

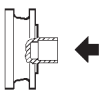


BOA

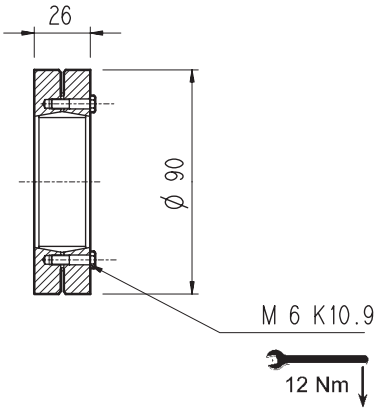


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

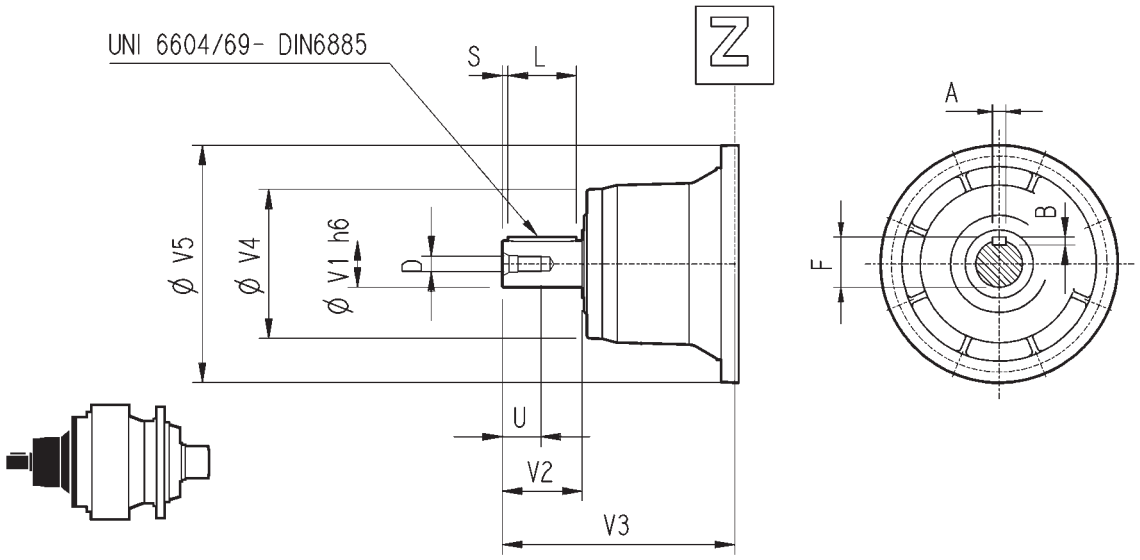


GOA



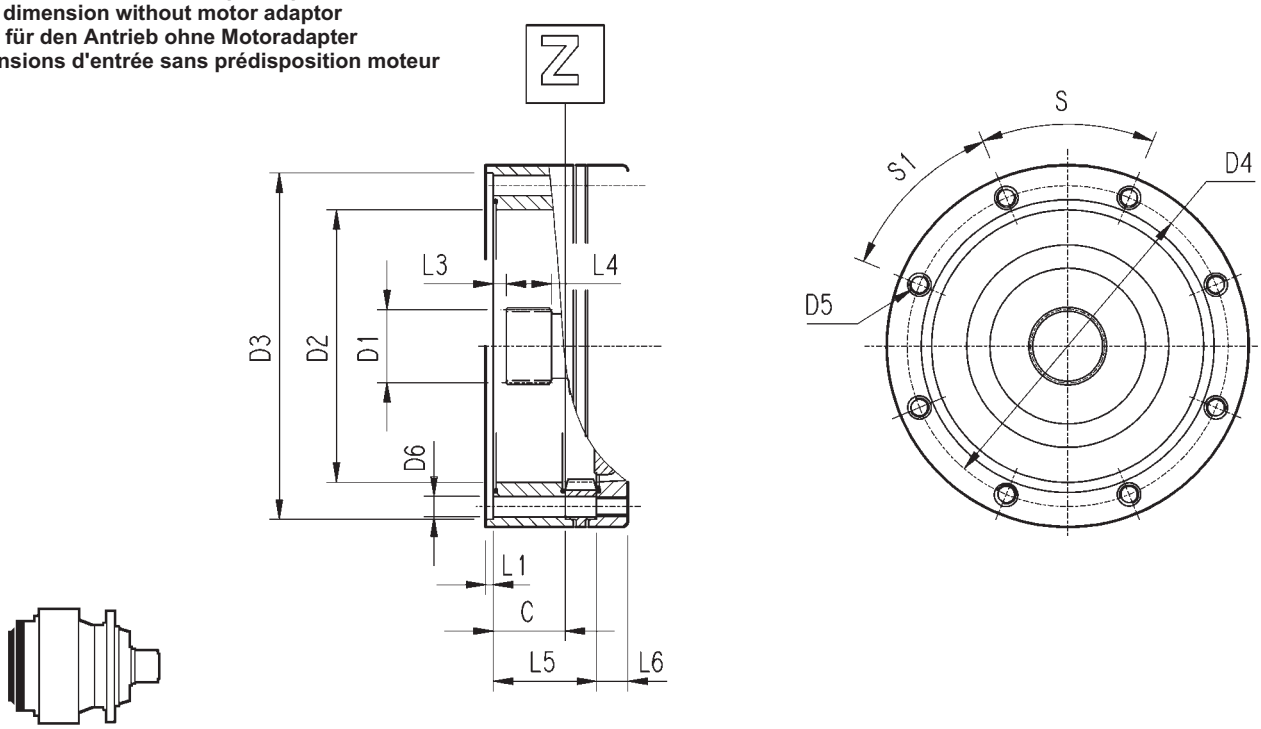
300L - 300R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
300 L1	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
300 L2	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
300 L3	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
300 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
300 R2-R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
300 L1	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	53	18	45°	45°	A
300 L2	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	106	18	45°	45°	A
300 L3	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	159	18	45°	45°	A
300 L4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	212	18	45°	45°	A
300 R2-R3-R4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

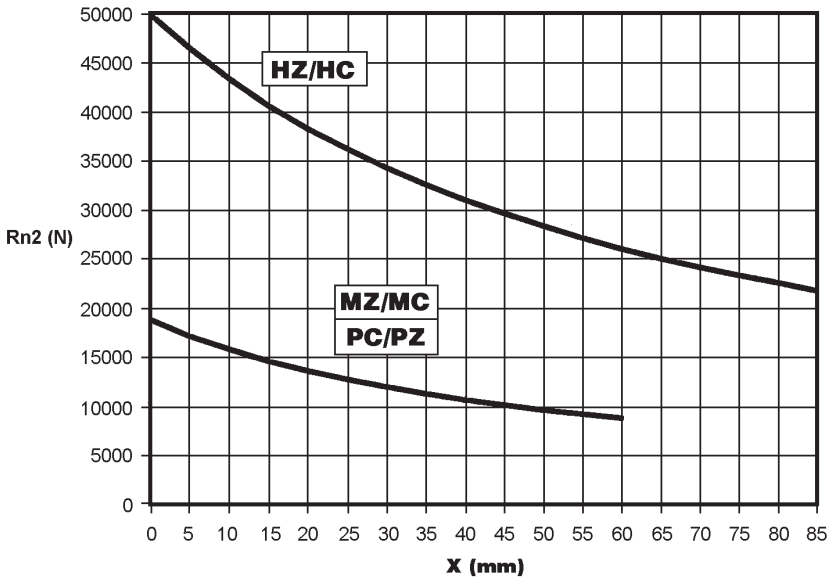
300L - 300R

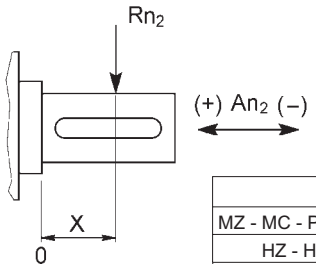
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

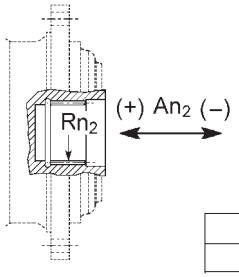
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
MZ - MC - PC - PZ	20 000	15 000
HZ - HC	40 000	40 000



	Rn2	An2 (+/-)
FZ	8 000	8 000

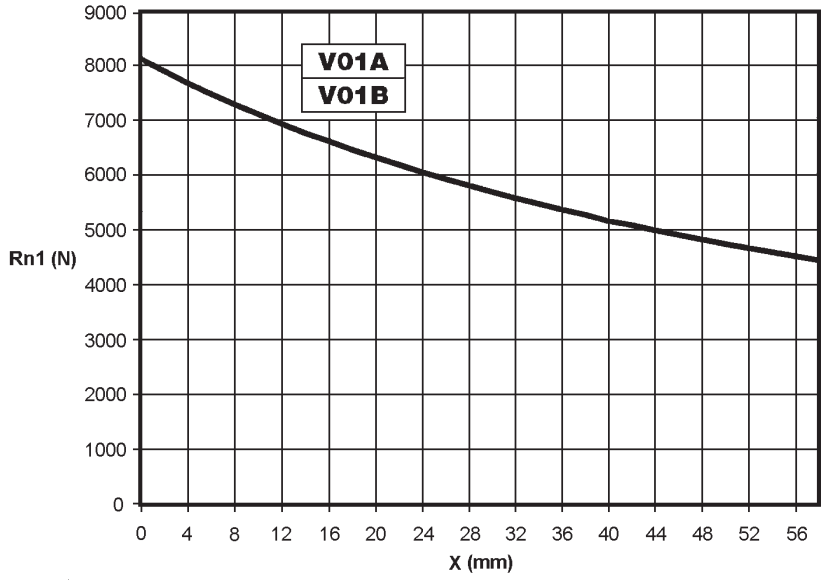
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	MZ-MC-PC-PZ-FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

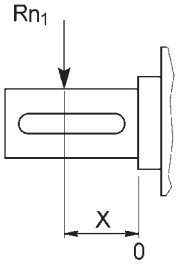
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

301L

M_2 = 1750 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L1	3.48	1 400	1 400	1 400	1 300	1 300	1 100	30	7.5	2 000	4 000	440	4L
	4.26	2 000	2 000	1 750	1 700	1 350	1 100	30	7.5	2 000	4 000	440	4L
	5.77	1 700	1 450	1 300	1 300	1 300	1 050	30	7.5	2 000	4 000	400	4K
	7.20	1 150	1 150	1 150	1 150	1 150	940	26	7.5	2 000	4 000	260	4F
L2	12.1	1 400	1 400	1 400	1 300	1 300	1 100	17.9	7.5	2 000	4 000	160	4D
	14.8	1 400	1 400	1 400	1 300	1 300	1 100	14.6	7.5	2 000	4 000	160	4D
	18.2	2 000	2 000	1 750	1 700	1 350	1 100	15.6	7.5	2 000	4 000	160	4D
	20.1	1 400	1 400	1 400	1 300	1 300	1 100	10.8	7.5	2 000	4 000	160	4D
	24.6	2 000	2 000	1 750	1 700	1 350	1 100	11.7	7.5	2 000	4 000	160	4D
	30.7	2 000	2 000	1 750	1 700	1 350	1 100	9.7	7.5	2 000	4 000	100	4B
	33.3	1 700	1 450	1 300	1 300	1 300	1 050	6.6	7.5	2 000	4 000	100	4B
	41.5	1 700	1 450	1 300	1 300	1 300	1 050	5.5	7.5	2 000	4 000	100	4B
	51.8	1 150	1 150	1 150	1 150	1 150	940	3.7	7.5	2 000	4 000	50	4A
L3	42.1	1 400	1 400	1 400	1 300	1 300	1 100	5.7	7.5	2 000	4 000	50	4A
	51.6	2 000	2 000	1 750	1 700	1 350	1 100	6.6	7.5	2 000	4 000	50	4A
	63.2	2 000	2 000	1 750	1 700	1 350	1 100	5.4	7.5	2 000	4 000	50	4A
	69.9	1 400	1 400	1 400	1 300	1 300	1 100	3.4	7.5	2 000	4 000	50	4A
	77.5	2 000	2 000	1 750	1 700	1 350	1 100	4.4	7.5	2 000	4 000	50	4A
	85.6	2 000	2 000	1 750	1 700	1 350	1 100	4.0	7.5	2 000	4 000	50	4A
	105	2 000	2 000	1 750	1 700	1 350	1 100	3.3	7.5	2 000	4 000	50	4A
	116	1 700	1 450	1 300	1 300	1 300	1 050	2.4	7.5	2 000	4 000	50	4A
	131	2 000	2 000	1 750	1 700	1 350	1 100	2.6	7.5	2 000	4 000	50	4A
	142	2 000	2 000	1 750	1 700	1 350	1 100	2.4	7.5	2 000	4 000	50	4A
	177	2 000	2 000	1 750	1 700	1 350	1 100	1.9	7.5	2 000	4 000	50	4A
	192	1 700	1 450	1 300	1 300	1 300	1 050	1.6	7.5	2 000	4 000	50	4A
	221	2 000	2 000	1 750	1 700	1 350	1 100	1.6	7.5	2 000	4 000	50	4A
	240	1 700	1 450	1 300	1 300	1 300	1 050	1.3	7.5	2 000	4 000	50	4A
	299	1 700	1 450	1 300	1 300	1 300	1 050	1.1	7.5	2 000	4 000	50	4A
	373	1 150	1 150	1 150	1 150	1 150	940	0.53	7.5	2 000	4 000	50	4A
L4	403	1 700	1 450	1 300	1 300	1 300	1 050	1.2	6	2 000	4 000	50	4A
	447	2 000	2 000	1 750	1 700	1 350	1 100	1.3	6	2 000	4 000	50	4A
	494	2 000	2 000	1 750	1 700	1 350	1 100	1.2	6	2 000	4 000	50	4A
	558	2 000	2 000	1 750	1 700	1 350	1 100	1.06	6	2 000	4 000	50	4A
	616	2 000	2 000	1 750	1 700	1 350	1 100	0.96	6	2 000	4 000	50	4A
	755	2 000	2 000	1 750	1 700	1 350	1 100	0.78	6	2 000	4 000	50	4A
	819	2 000	2 000	1 750	1 700	1 350	1 100	0.72	6	2 000	4 000	50	4A
	942	2 000	2 000	1 750	1 700	1 350	1 100	0.63	6	2 000	4 000	50	4A
	1 022	2 000	2 000	1 750	1 700	1 350	1 100	0.58	6	2 000	4 000	50	4A
	1 108	1 700	1 450	1 300	1 300	1 300	1 050	0.53	6	2 000	4 000	50	4A
	1 275	2 000	2 000	1 750	1 700	1 350	1 100	0.46	6	2 000	4 000	50	4A
	1 383	1 700	1 450	1 300	1 300	1 300	1 050	0.43	6	2 000	4 000	50	4A
	1 591	2 000	2 000	1 750	1 700	1 350	1 100	0.37	6	2 000	4 000	50	4A
	1 725	1 700	1 450	1 300	1 300	1 300	1 050	0.34	6	2 000	4 000	50	4A
	2 153	1 700	1 450	1 300	1 300	1 300	1 050	0.27	6	2 000	4 000	50	4A
	2 687	1 150	1 150	1 150	1 150	1 150	940	0.13	6	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

M_2 = 1750 Nm

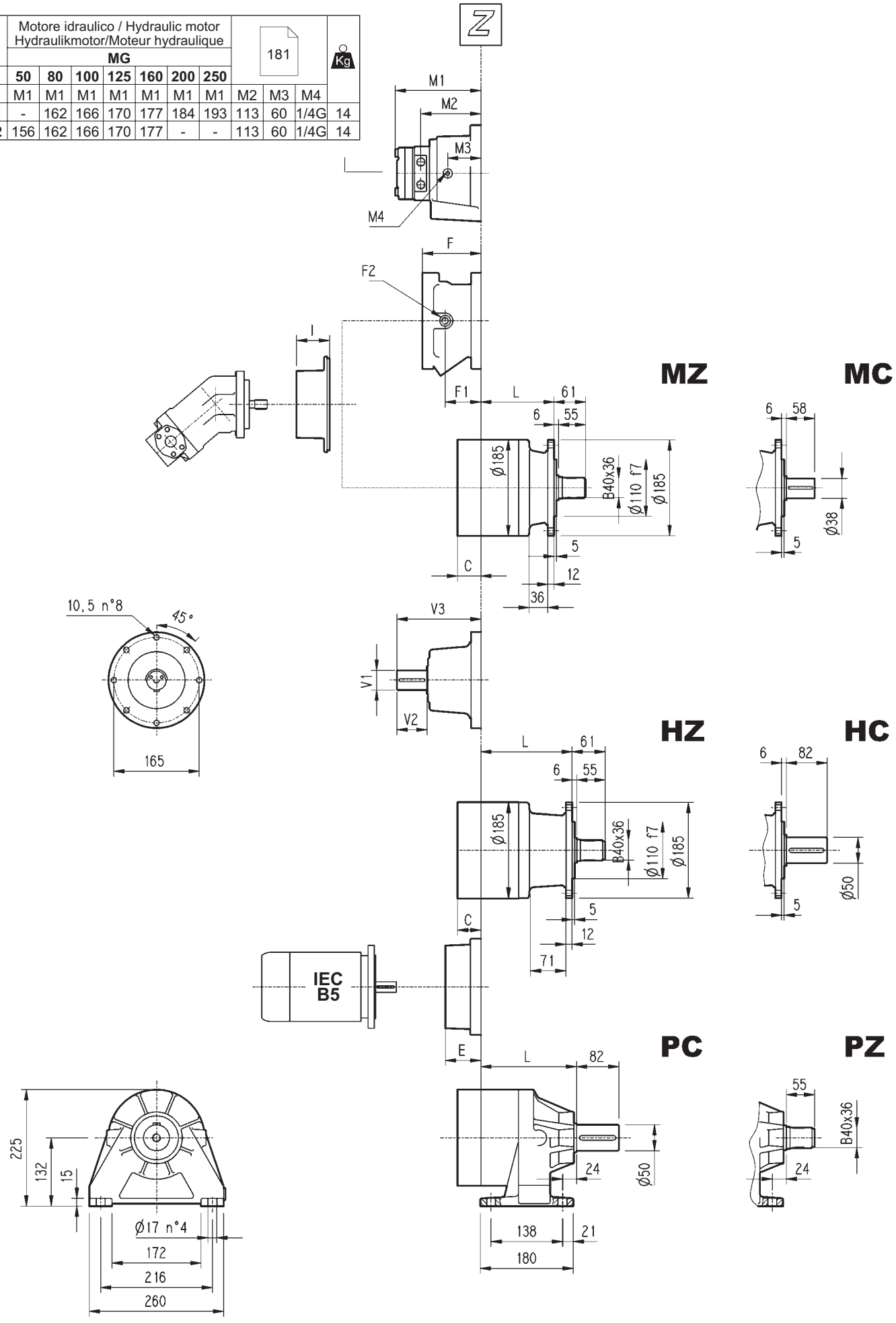
301R

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
	1:	$n_2 \cdot h$ 10 000	$n_2 \cdot h$ 25 000	$n_2 \cdot h$ 50 000	$n_2 \cdot h$ 100 000	$n_2 \cdot h$ 500 000	$n_2 \cdot h$ 1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	7.13	1 200	1 200	1 200	1 200	1 100	0 890	15	12	2 000	4 000	260	4F
	8.74	1 450	1 450	1 450	1 450	1 250	1 050	15	12	2 000	4 000	330	4H
	11.80	1 700	1 450	1 300	1 300	1 300	1 050	15	12	2 000	4 000	260	4F
	14.80	1 150	1 150	1 150	1 150	1 150	940	13	12	2 000	4 000	160	4D
R3	24.8	1 400	1 400	1 400	1 300	1 300	1 100	9.3	12	2 000	4 000	100	4B
	30.4	1 400	1 400	1 400	1 300	1 300	1 100	7.8	12	2 000	4 000	100	4B
	37.3	2 000	2 000	1 750	1 700	1 350	1 100	8.5	12	2 000	4 000	100	4B
	41.2	1 400	1 400	1 400	1 300	1 300	1 100	5.9	12	2 000	4 000	100	4B
	50.4	2 000	2 000	1 750	1 700	1 350	1 100	6.6	12	2 000	4 000	100	4B
	62.9	2 000	2 000	1 750	1 700	1 350	1 100	5.5	12	2 000	4 000	50	4A
	68.2	1 700	1 450	1 300	1 300	1 300	1 050	3.7	12	2 000	4 000	50	4A
	85.2	1 700	1 450	1 300	1 300	1 300	1 050	3.1	12	2 000	4 000	50	4A
	106	1 150	1 150	1 150	1 150	1 150	940	1.9	12	2 000	4 000	50	4A
R4	86.4	1 400	1 400	1 400	1 300	1 300	1 100	4.8	10	2 000	4 000	50	4A
	106	2 000	2 000	1 750	1 700	1 350	1 100	5.5	10	2 000	4 000	50	4A
	130	2 000	2 000	1 750	1 700	1 350	1 100	4.5	10	2 000	4 000	50	4A
	143	1 400	1 400	1 400	1 300	1 300	1 100	2.9	10	2 000	4 000	50	4A
	159	2 000	2 000	1 750	1 700	1 350	1 100	3.7	10	2 000	4 000	50	4A
	175	2 000	2 000	1 750	1 700	1 350	1 100	3.3	10	2 000	4 000	50	4A
	215	2 000	2 000	1 750	1 700	1 350	1 100	2.8	10	2 000	4 000	50	4A
	237	1 700	1 450	1 300	1 300	1 300	1 050	2.1	10	2 000	4 000	50	4A
	268	2 000	2 000	1 750	1 700	1 350	1 100	2.2	10	2 000	4 000	50	4A
	291	2 000	2 000	1 750	1 700	1 350	1 100	2.0	10	2 000	4 000	50	4A
	363	2 000	2 000	1 750	1 700	1 350	1 100	1.6	10	2 000	4 000	50	4A
	394	1 700	1 450	1 300	1 300	1 300	1 050	1.4	10	2 000	4 000	50	4A
	453	2 000	2 000	1 750	1 700	1 350	1 100	1.3	10	2 000	4 000	50	4A
	491	1 700	1 450	1 300	1 300	1 300	1 050	1.1	10	2 000	4 000	50	4A
	613	1 700	1 450	1 300	1 300	1 300	1 050	1.0	10	2 000	4 000	50	4A
	765	1 150	1 150	1 150	1 150	1 150	940	0.44	10	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

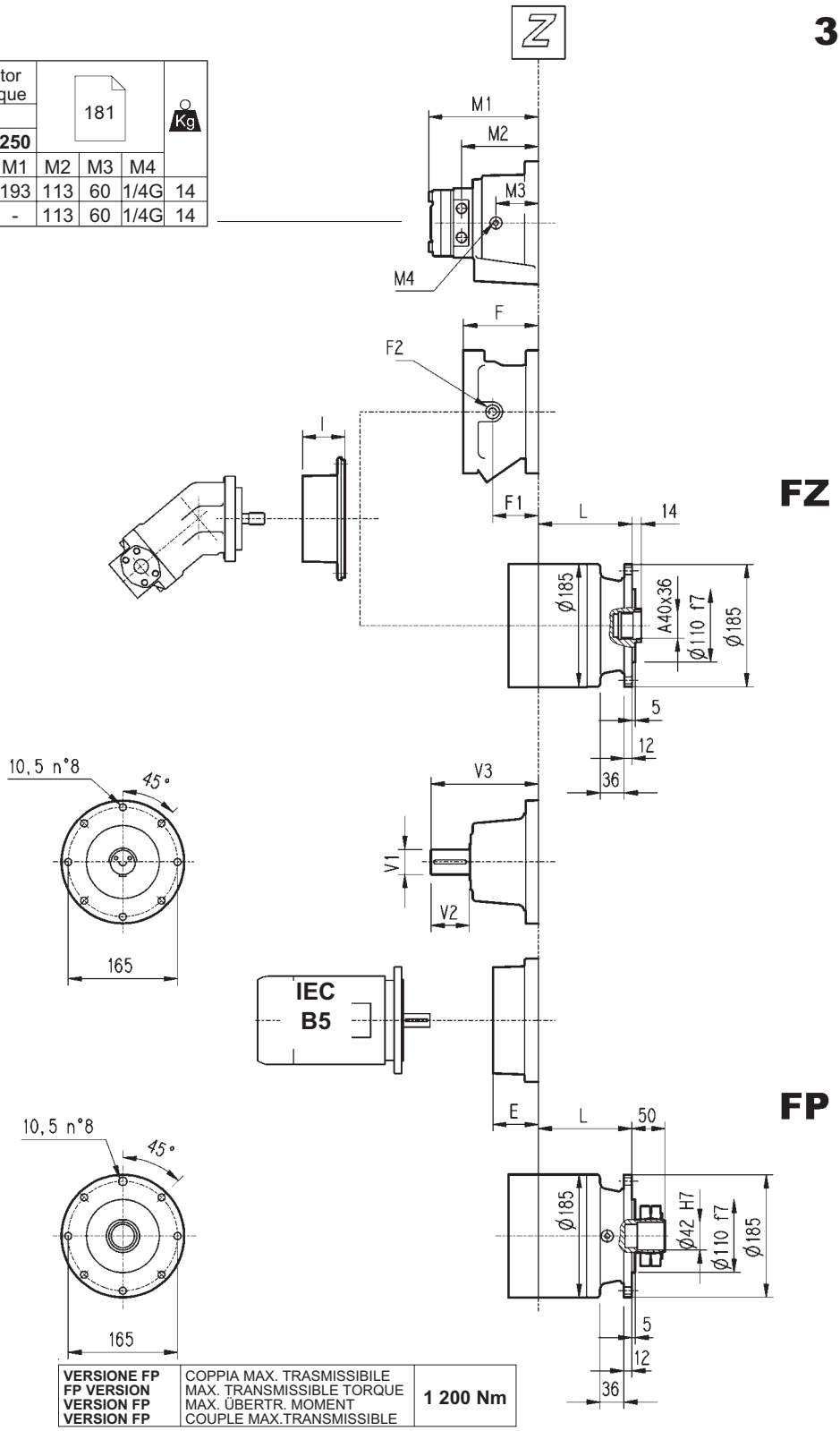
301L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
301L1	-	162	166	170	177	184	193	113	60	1/4G	14
301L2	156	162	166	170	177	-	-	113	60	1/4G	14



301L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
301L1	-	162	166	170	177	184	193	113	60	1/4G	14
301L2	156	162	166	170	177	-	-	113	60	1/4G	14



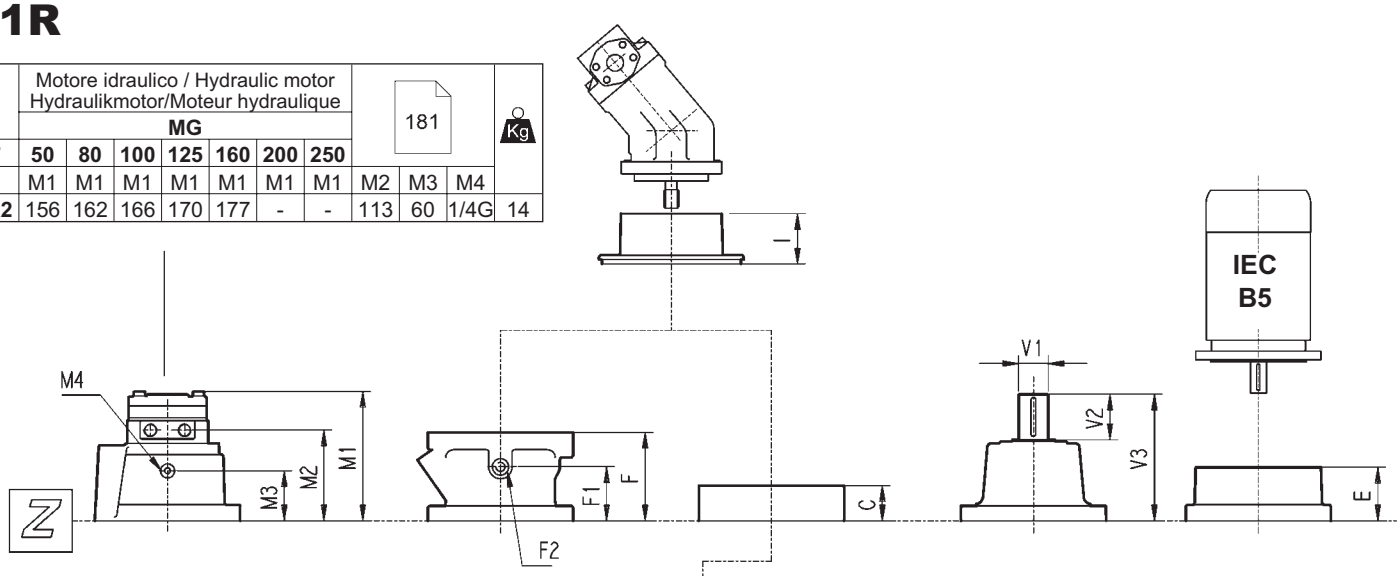
VERSIONE FP FP VERSION VERSION FP VERSION FP	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	1 200 Nm

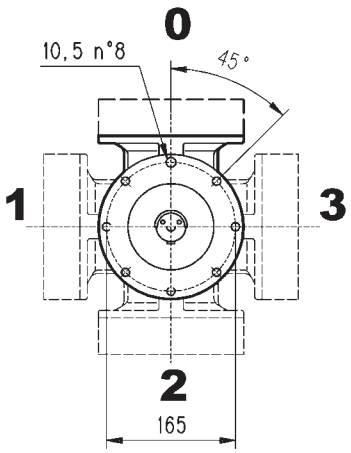
	L				Kg				C	Entrata Input Antrieb Entrée	I	F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
	MZ MC	FZ FP	HZ HC	PC PZ	MZ MC	FZ FP	HZ HC	PC PZ									
301 L1	92	92	127	133	21	19	23	26	37	A	171	105	65	1/4G	4	A	10
301 L2	145	145	180	186	25	23	27	30	37	A		105	65	1/4G	4	A	10
301 L3	198	198	233	239	29	27	31	34	37	A		105	65	1/4G	4	A	10
301 L4	251	251	286	292	33	31	35	38	37	A		105	65	1/4G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
									IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160			
301 L1	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			
301 L2	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			
301 L3	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			
301 L4	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			

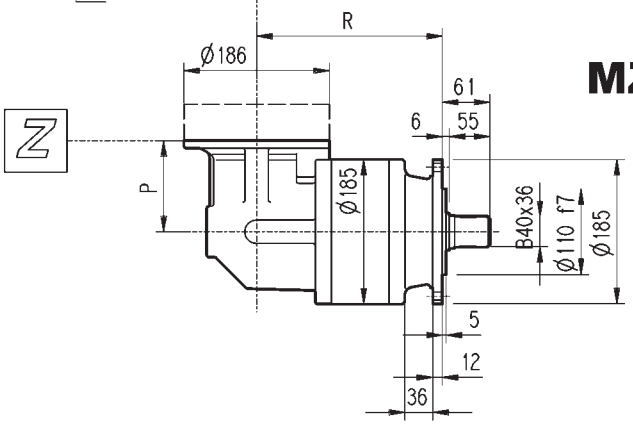
301R

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
301R2	156	162	166	170	177	-	-	113	60	1/4G	14

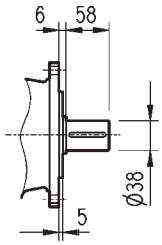




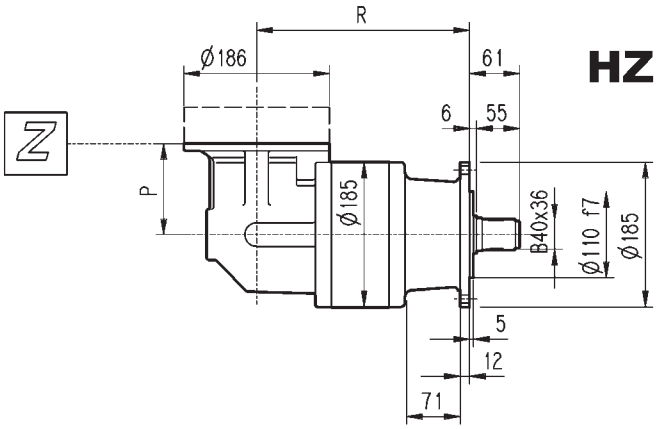
MZ



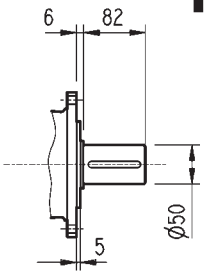
MC

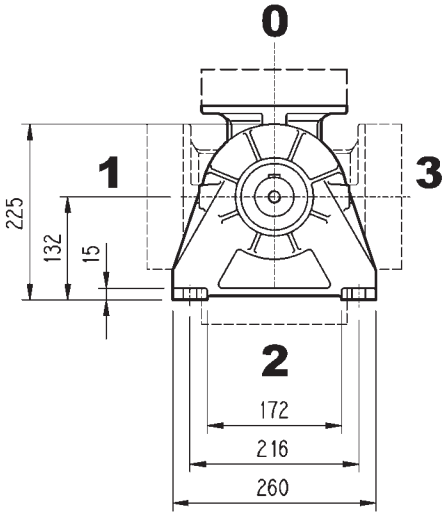


HZ

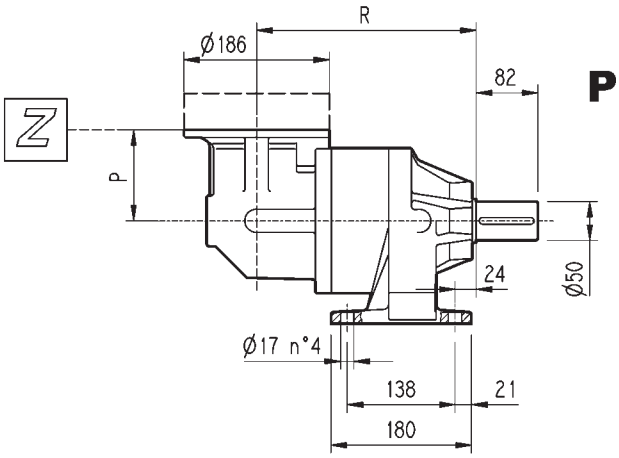


HC

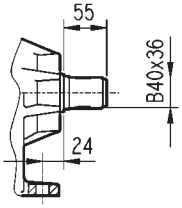




PC

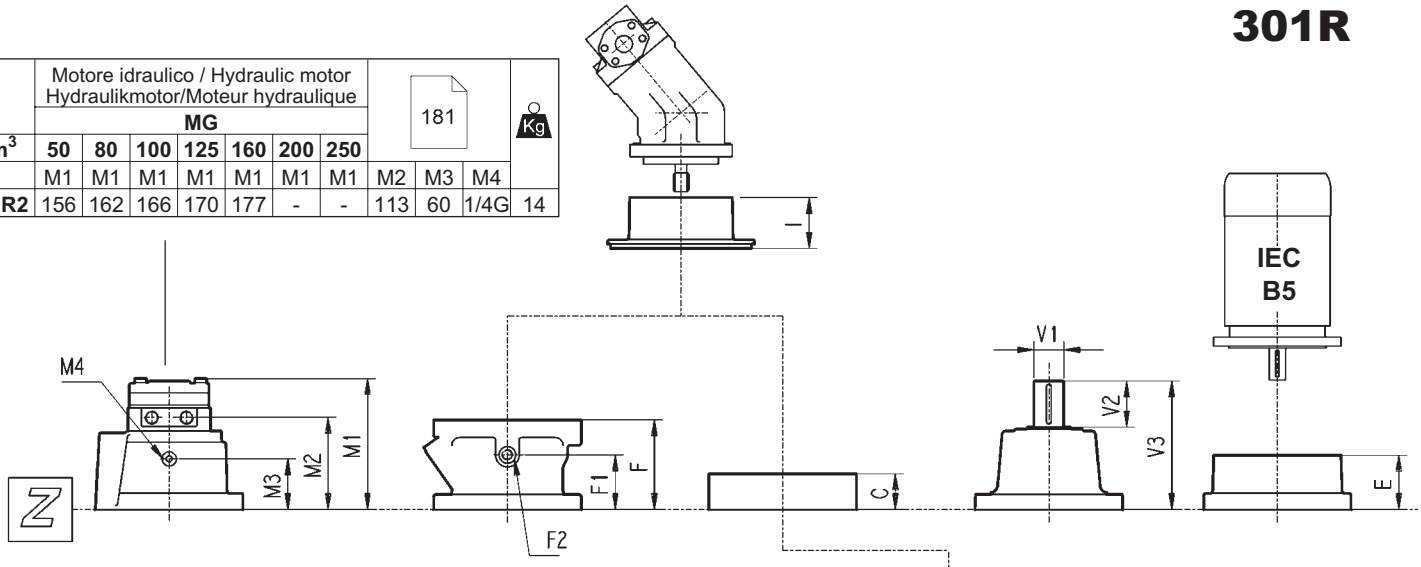


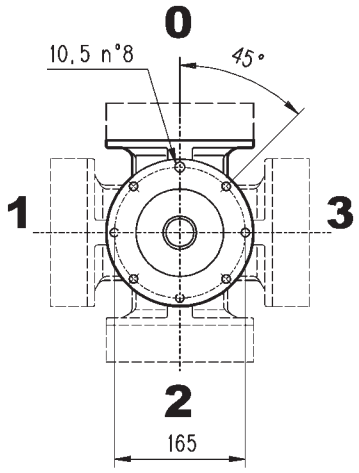
PZ

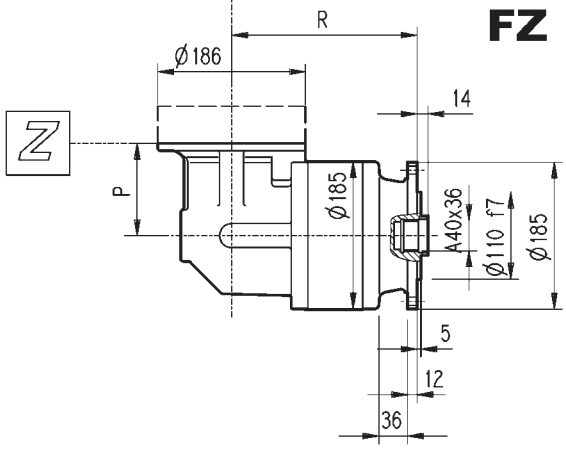


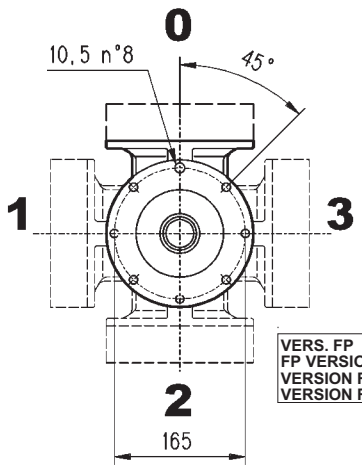
301R

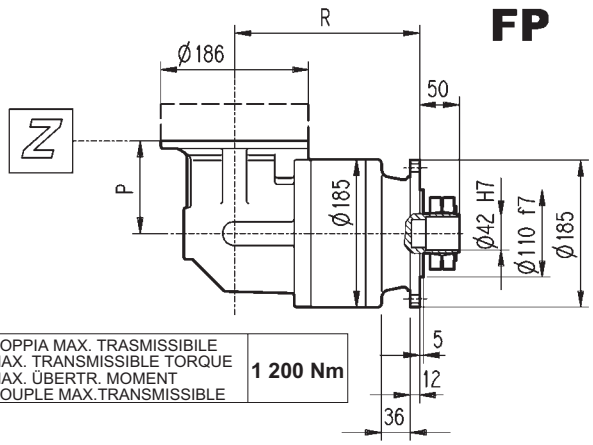
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
301R2	156	162	166	170	177	-	-	113	60	1/4G	14











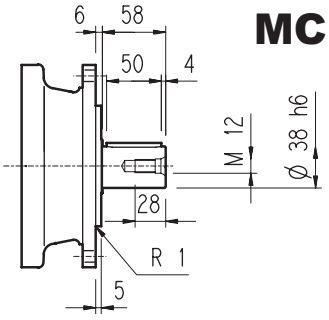
VERS. FP FP VERSION VERSION FP VERSION FP	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE
1 200 Nm	

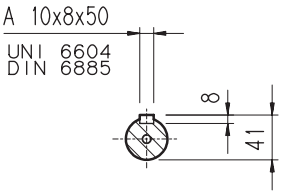
	R				P	Kg				C		I	F	F1	F2			Kg
	MZ MC	FZ FP	HZ HC	PC PZ		MZ MC	FZ FP	HZ HC	PC PZ		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
301 R2	184	184	219	225	122	35	33	37	40	37	A		105	65	1/4G	4	A	10
301 R3	237	237	272	278	122	39	37	41	44	37	A		105	65	1/4G	4	A	10
301 R4	290	290	325	331	122	43	41	45	48	37	A	171	105	65	1/4G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132			
301 R2	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114			
301 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114			
301 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114			

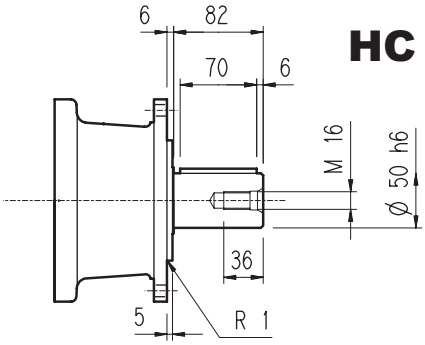
301L - 301R

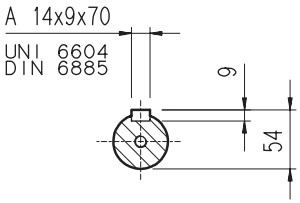
MC





HC





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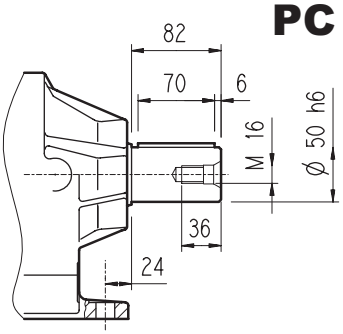
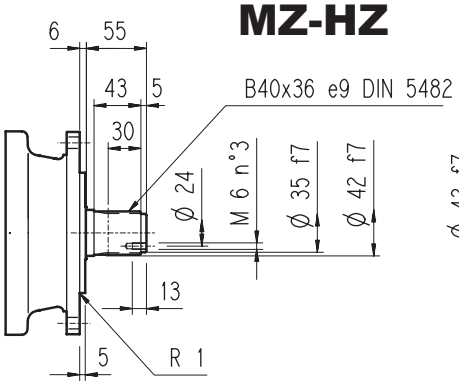
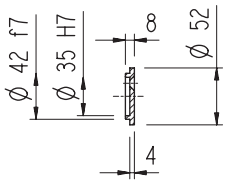
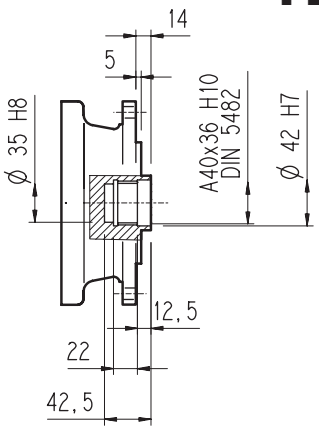


MZ-HZ

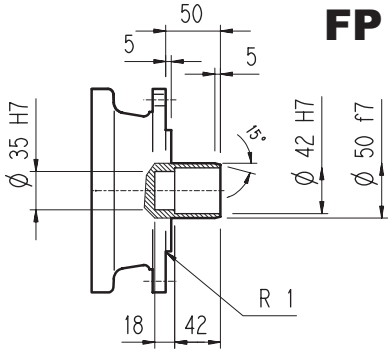


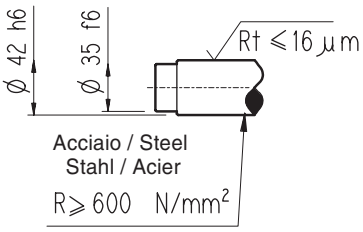


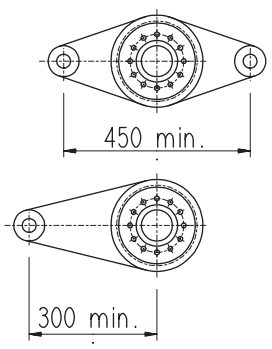
FZ



FP





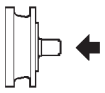


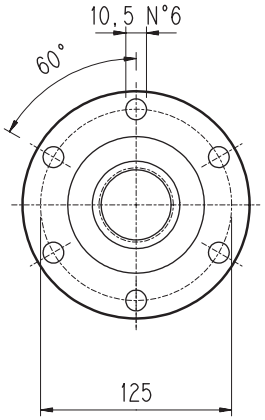
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**1 200 Nm**

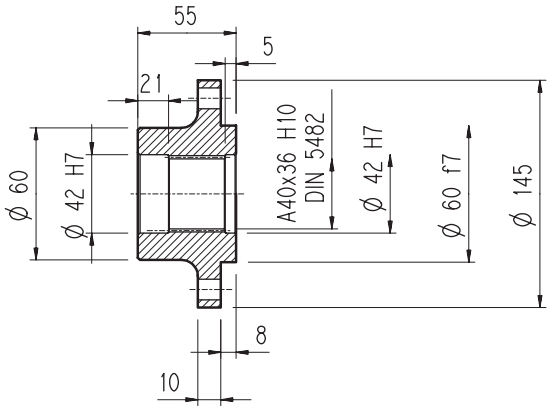
301L - 301R

Flangia / Flange
Flansch / Brides

WOA



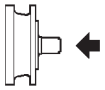


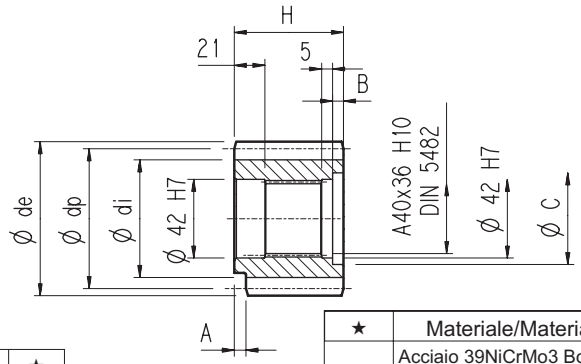


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



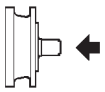


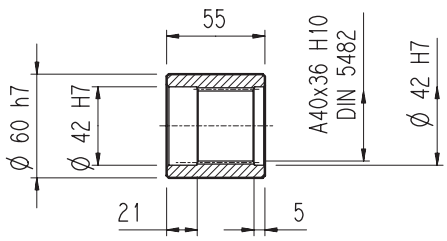
	m	z	x	dp	di	de	H	A	B	C	★
PBE	4.5	14	0.507	63	56	75.5	55	0	0	0	■
PCE	5	14	0.500	70	62.5	84.8	65	0	10	53	■
PDC	6	12	0.250	72	61	84.8	59	14	4	54	■
PDE	6	14	0.500	84	73	99.6	65	0	10	54	■

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

MOA

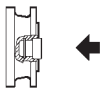


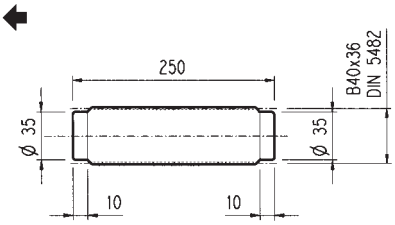


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

BOA

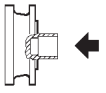


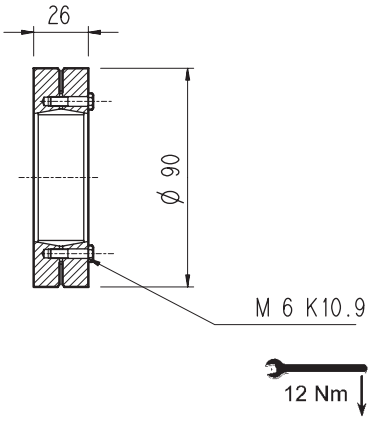


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

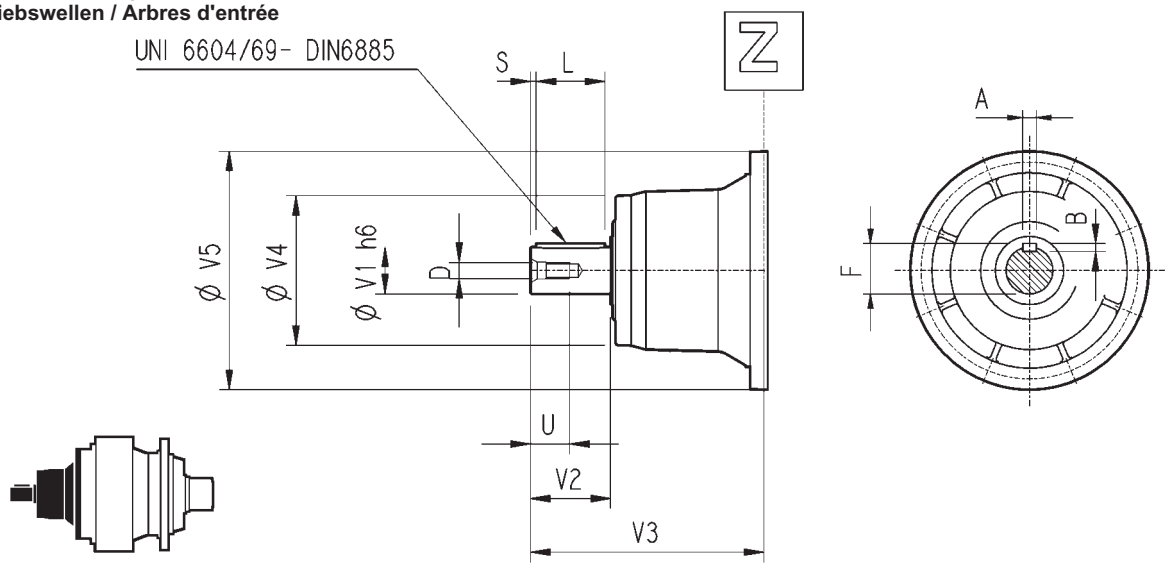
GOA





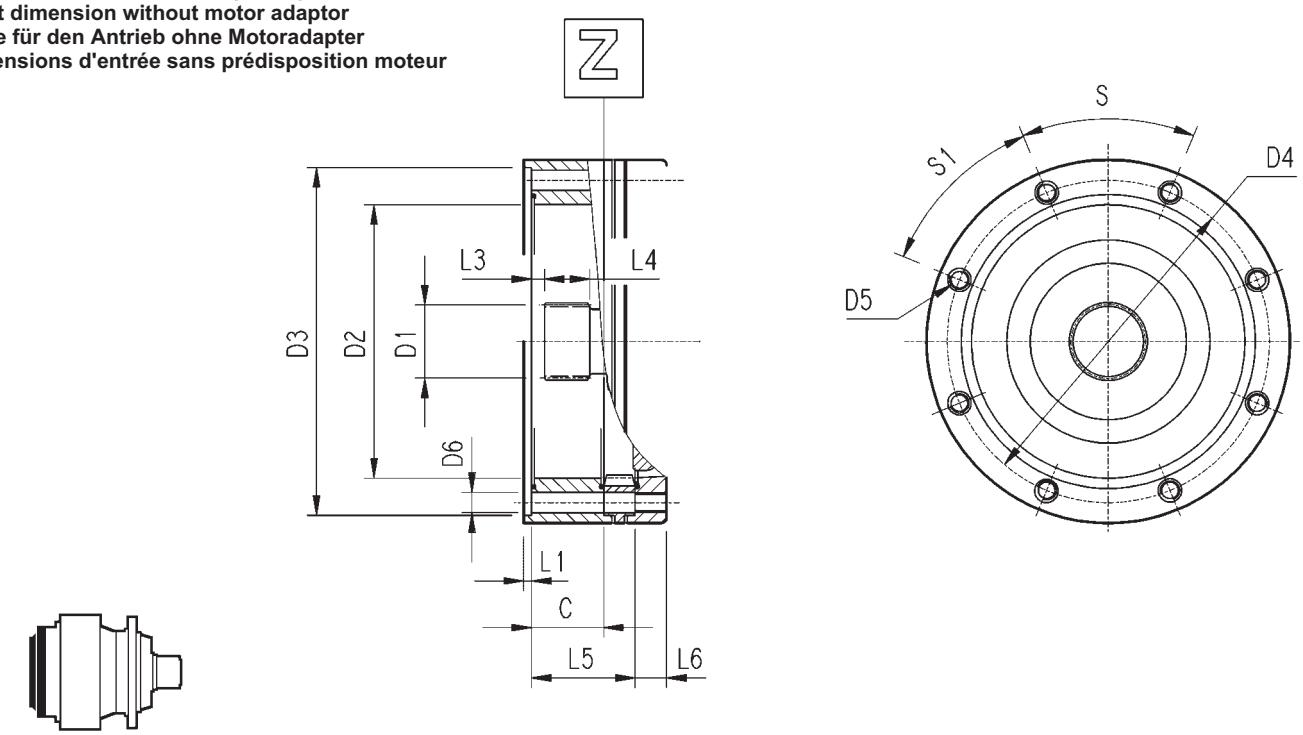
301L - 301R

Algberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
301 L1	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
301 L2	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
301 L3	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
301 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
301 R2-R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



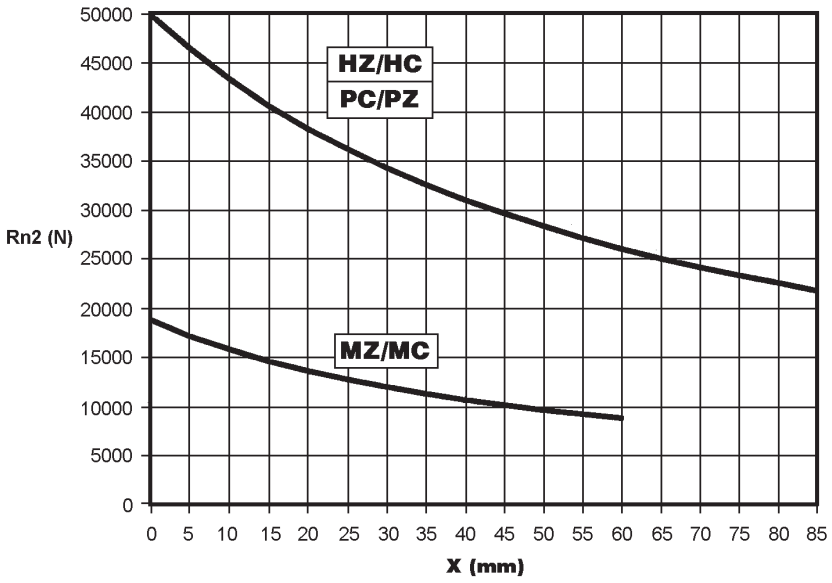
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
301 L1	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	65	18	45°	45°	A
301 L2	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	118	18	45°	45°	A
301 L3	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	171	18	45°	45°	A
301 L4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	224	18	45°	45°	A
301 R2-R3-R4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

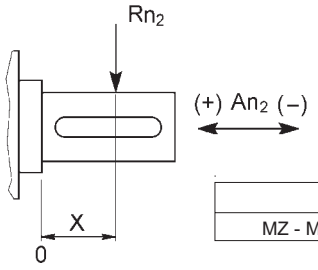
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

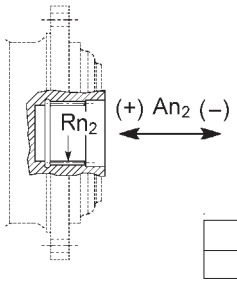
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
MZ - MC	20 000	15 000



	Rn2	An2 (+/-)
FZ	8 000	8 000

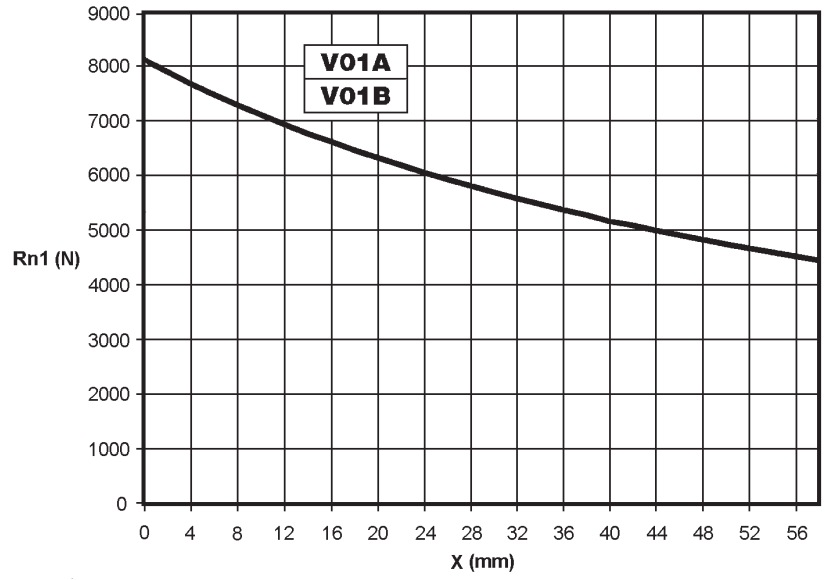
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	MZ - MC - FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

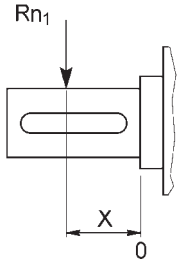
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

303L

M_2 = 2500 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	3.60	2 300	2 200	2 150	2 100	2 100	1 750	40	11	1 800	3 800	800	5G
	4.25	2 900	2 750	2 650	2 600	2 150	1 750	40	11	1 800	3 800	800	5G
	5.33	2 850	2 450	2 200	2 200	2 100	1 700	40	11	1 800	3 800	630	5E
	6.20	2 300	2 000	1 800	1 800	1 750	1 400	40	11	1 800	3 800	500	5C
	7.50	2 000	1 750	1 650	1 650	1 650	1 500	36	11	1 800	3 800	400	5B
L 2	12.5	2 300	2 200	2 150	2 100	1 850	1 500	20	9	2 000	4 000	260	4F
	15.3	2 300	2 200	2 150	2 100	1 800	1 450	20	9	2 000	4 000	260	4F
	18.1	2 900	2 750	2 650	2 600	2 000	1 650	20	9	2 000	4 000	260	4F
	20.8	2 300	2 200	2 150	2 100	1 700	1 400	17.0	9	2 000	4 000	160	4D
	22.7	2 850	2 450	2 200	2 200	2 100	1 700	16.2	9	2 000	4 000	160	4D
	24.5	2 750	2 700	2 650	2 600	1 900	1 550	17.8	9	2 000	4 000	160	4D
	26.4	2 300	2 000	1 800	1 800	1 750	1 400	11.4	9	2 000	4 000	160	4D
	30.8	2 850	2 450	2 200	2 200	2 100	1 700	12.0	9	2 000	4 000	160	4D
	35.8	2 300	2 000	1 800	1 800	1 750	1 400	8.5	9	2 000	4 000	100	4B
	38.4	2 850	2 450	2 200	2 200	2 000	1 600	10.0	9	2 000	4 000	100	4B
	44.6	2 300	2 000	1 800	1 800	1 750	1 400	7.0	9	2 000	4 000	100	4B
	54.0	2 000	1 750	1 650	1 650	1 650	1 500	5.3	7.5	2 000	4 000	50	4A
L 3	43.6	2 300	2 200	2 150	2 100	1 900	1 500	8.6	7.5	2 000	4 000	100	4B
	53.4	2 300	2 200	2 150	2 100	1 800	1 450	7.1	7.5	2 000	4 000	100	4B
	63.1	2 886	2 700	2 650	2 600	2 100	1 700	7.3	7.5	2 000	4 000	100	4B
	72.3	2 300	2 200	2 150	2 100	1 900	1 500	5.3	7.5	2 000	4 000	50	4A
	77.2	2 900	2 750	2 650	2 600	2 000	1 650	6.2	7.5	2 000	4 000	50	4A
	90.2	2 300	2 200	2 150	2 100	1 900	1 500	4.3	7.5	2 000	4 000	50	4A
	105	2 900	2 750	2 650	2 600	2 000	1 650	4.7	7.5	2 000	4 000	50	4A
	113	2 300	2 000	1 800	1 800	1 750	1 400	3.4	7.5	2 000	4 000	50	4A
	124	2 300	2 000	1 800	1 800	1 750	1 400	3.1	7.5	2 000	4 000	50	4A
	141	2 750	2 700	2 650	2 600	1 900	1 550	3.3	7.5	2 000	4 000	50	4A
	152	2 300	2 000	1 800	1 800	1 750	1 400	2.6	7.5	2 000	4 000	50	4A
	164	2 850	2 450	2 200	2 200	2 100	1 700	3.0	7.5	2 000	4 000	50	4A
	178	2 850	2 450	2 200	2 200	2 100	1 700	2.8	7.5	2 000	4 000	50	4A
	190	2 300	2 000	1 800	1 800	1 750	1 400	2.2	7.5	2 000	4 000	50	4A
	220	2 250	2 200	2 250	2 250	1 700	1 400	1.9	7.5	2 000	4 000	50	4A
	258	2 300	2 000	1 800	1 800	1 750	1 400	1.7	7.5	2 000	4 000	50	4A
	276	2 850	2 450	2 200	2 200	2 000	1 600	1.9	7.5	2 000	4 000	50	4A
	312	2 000	1 750	1 650	1 650	1 650	1 500	1.2	7.5	2 000	4 000	50	4A
	389	2 000	1 750	1 650	1 650	1 650	1 500	1.0	7.5	2 000	4 000	50	4A
L 4	413	2 850	2 450	2 200	2 200	2 100	1 700	2.0	6	2 000	4 000	50	4A
	446	2 900	2 750	2 650	2 600	2 000	1 650	2.0	6	2 000	4 000	50	4A
	492	2 750	2 700	2 650	2 600	1 900	1 550	1.6	6	2 000	4 000	50	4A
	556	2 900	2 750	2 650	2 600	2 000	1 650	1.6	6	2 000	4 000	50	4A
	649	2 300	2 200	2 150	2 100	1 850	1 500	1.1	6	2 000	4 000	50	4A
	718	2 300	2 000	1 800	1 800	1 750	1 400	1.1	6	2 000	4 000	50	4A
	816	2 750	2 700	2 650	2 600	1 900	1 550	1.1	6	2 000	4 000	50	4A
	896	2 300	2 000	1 800	1 800	1 750	1 400	0.94	6	2 000	4 000	50	4A
	1 018	2 750	2 700	2 650	2 600	1 900	1 550	0.91	6	2 000	4 000	50	4A
	1 098	2 300	2 000	1 800	1 800	1 750	1 400	0.79	6	2 000	4 000	50	4A
	1 278	2 850	2 450	2 200	2 200	2 100	1 700	0.74	6	2 000	4 000	50	4A
	1 370	2 300	2 000	1 800	1 800	1 750	1 400	0.66	6	2 000	4 000	50	4A
	1 586	2 250	2 250	2 250	2 250	1 700	1 350	0.58	6	2 000	4 000	50	4A
	1 854	2 300	2 000	1 800	1 800	1 750	1 400	0.51	6	2 000	4 000	50	4A
	1 991	2 850	2 450	2 200	2 200	2 000	1 600	0.48	6	2 000	4 000	50	4A
	2 243	2 000	1 750	1 650	1 650	1 650	1 500	0.37	6	2 000	4 000	50	4A
	2 799	2 000	1 750	1 650	1 650	1 650	1 500	0.30	6	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

M_2 = 2500 Nm

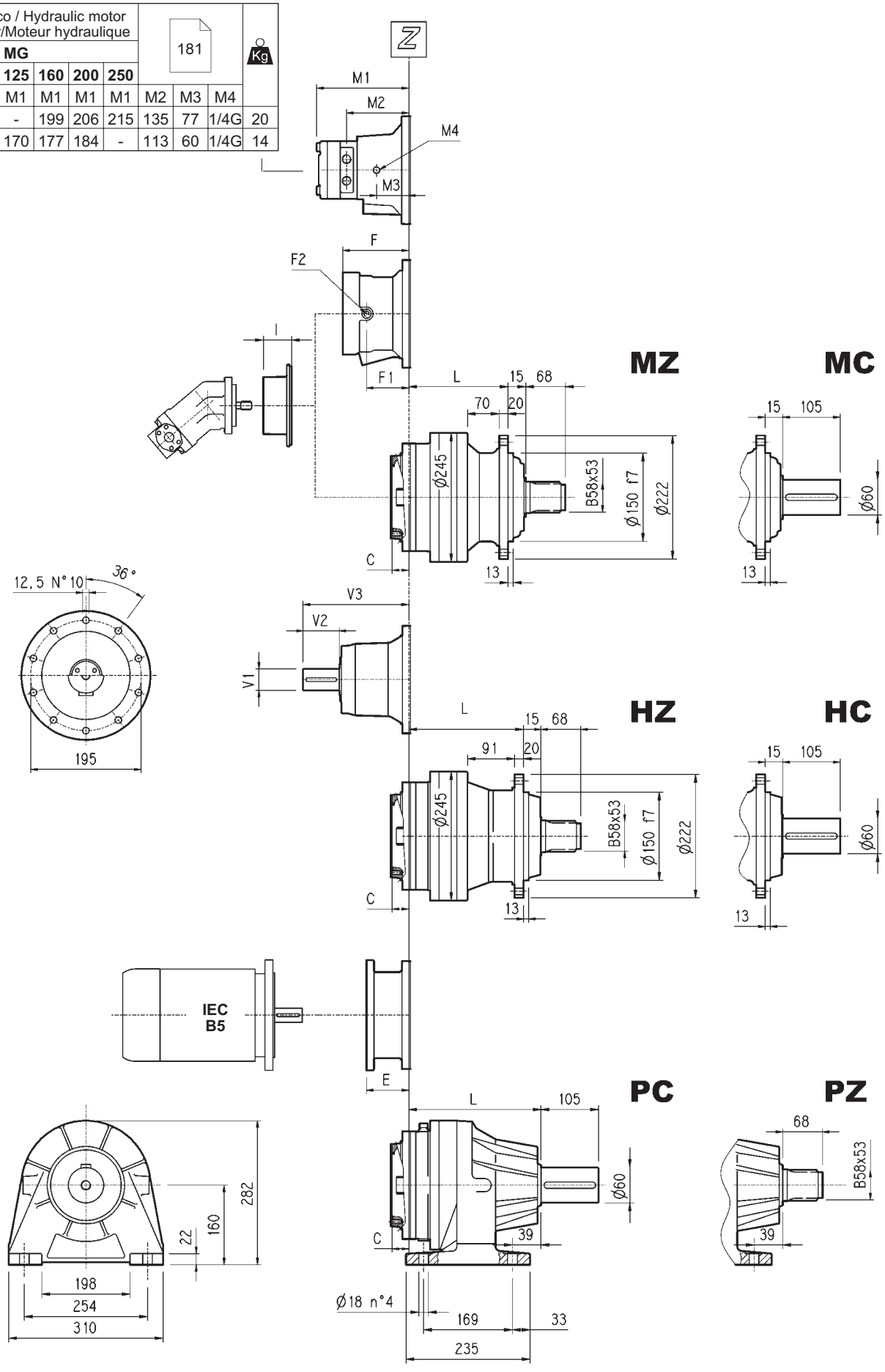
303R

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
	1:	$n_2 \cdot h$ 10 000	$n_2 \cdot h$ 25 000	$n_2 \cdot h$ 50 000	$n_2 \cdot h$ 100 000	$n_2 \cdot h$ 500 000	$n_2 \cdot h$ 1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	9.23	2 300	2 200	2 150	2 100	2 000	1 600	35	18	1 800	3 800	330	4H
	10.9	2 900	2 750	2 650	2 600	2 150	1 750	35	18	1 800	3 800	330	4H
	13.7	2 850	2 450	2 200	2 200	2 100	1 700	27	18	1 800	3 800	260	4F
	15.9	2 300	2 000	1 800	1 800	1 750	1 400	18.9	18	1 800	3 800	260	4F
	19.2	2 000	1 750	1 650	1 650	1 650	1 500	14.3	18	1 800	3 800	160	4D
R3	25.7	2 300	2 200	2 150	2 100	1 850	1 500	14.3	14	2 000	4 000	160	4D
	31.5	2 300	2 200	2 150	2 100	1 800	1 450	11.8	14	2 000	4 000	100	4B
	37.1	2 900	2 750	2 650	2 600	2 000	1 650	12.4	14	2 000	4 000	100	4B
	42.6	2 300	2 200	2 150	2 100	1 700	1 400	8.8	14	2 000	4 000	100	4B
	46.6	2 850	2 450	2 200	2 200	2 100	1 700	8.7	14	2 000	4 000	100	4B
	50.3	2 750	2 700	2 650	2 600	1 900	1 550	9.2	14	2 000	4 000	100	4B
	54.2	2 300	2 000	1 800	1 800	1 750	1 400	6.2	14	2 000	4 000	100	4B
	63.1	2 850	2 450	2 200	2 200	2 100	1 700	6.8	14	2 000	4 000	100	4B
	73.3	2 300	2 000	1 800	1 800	1 750	1 400	4.8	14	2 000	4 000	50	4A
	78.7	2 850	2 450	2 200	2 200	2 000	1 600	5.6	14	2 000	4 000	50	4A
	91.5	2 300	2 000	1 800	1 800	1 750	1 400	4.0	14	2 000	4 000	50	4A
	111	2 000	1 750	1 650	1 650	1 650	1 500	3.0	12	2 000	4 000	50	4A
R4	129	2 850	2 700	2 650	2 600	2 100	1 700	6.1	12	2 000	4 000	50	4A
	148	2 300	2 200	2 150	2 100	1 850	1 500	4.5	12	2 000	4 000	50	4A
	158	2 900	2 750	2 650	2 600	2 000	1 650	5.3	12	2 000	4 000	50	4A
	185	2 300	2 200	2 150	2 100	1 850	1 500	3.6	12	2 000	4 000	50	4A
	214	2 900	2 750	2 650	2 600	2 000	1 650	4.0	12	2 000	4 000	50	4A
	231	2 300	2 000	1 800	1 800	1 750	1 400	2.9	12	2 000	4 000	50	4A
	255	2 300	2 000	1 800	1 800	1 750	1 400	2.7	12	2 000	4 000	50	4A
	290	2 750	2 700	2 650	2 600	1 900	1 550	2.9	12	2 000	4 000	50	4A
	313	2 300	2 000	1 800	1 800	1 750	1 400	2.3	12	2 000	4 000	50	4A
	336	2 850	2 450	2 200	2 200	2 100	1 700	2.5	12	2 000	4 000	50	4A
	364	2 850	2 450	2 200	2 200	2 100	1 700	2.5	12	2 000	4 000	50	4A
	390	2 300	2 000	1 800	1 800	1 750	1 400	1.9	12	2 000	4 000	50	4A
	452	2 250	2 250	2 250	2 250	1 700	1 400	1.6	12	2 000	4 000	50	4A
	528	2 300	2 000	1 800	1 800	1 750	1 400	1.3	12	2 000	4 000	50	4A
	567	2 850	2 450	2 200	2 200	2 000	1 600	1.6	12	2 000	4 000	50	4A
	639	2 000	1 750	1 650	1 650	1 650	1 500	1.1	12	2 000	4 000	50	4A
	797	2 000	1 750	1 650	1 650	1 650	1 500	0.88	12	2 000	4 000	50	4A

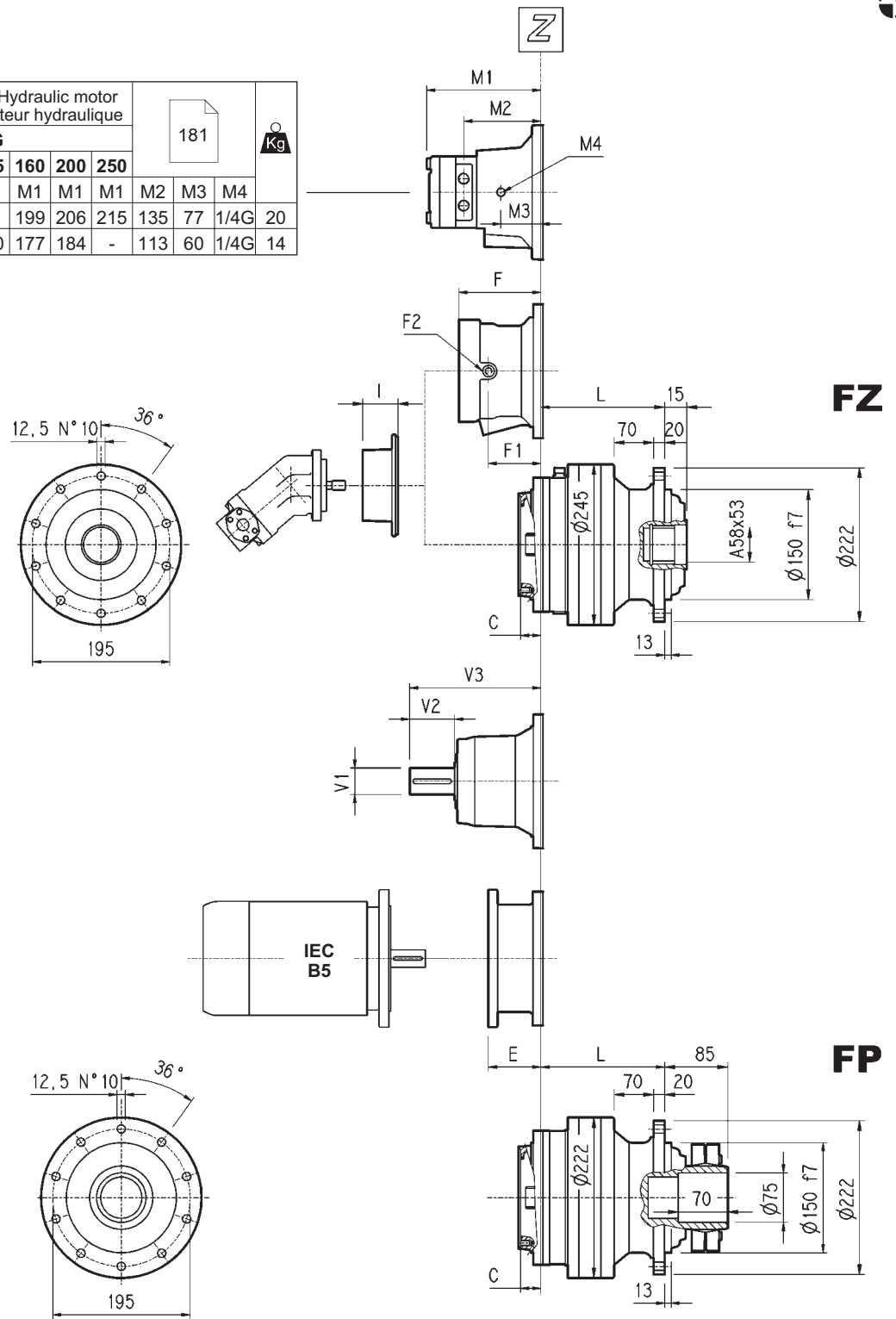
$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

303L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
303L1	-	-	-	-	199	206	215	135	77	1/4G	20
303L2	156	162	166	170	177	184	-	113	60	1/4G	14



	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
303L1	-	-	-	-	199	206	215	135	77	1/4G	20
303L2	156	162	166	170	177	184	-	113	60	1/4G	14



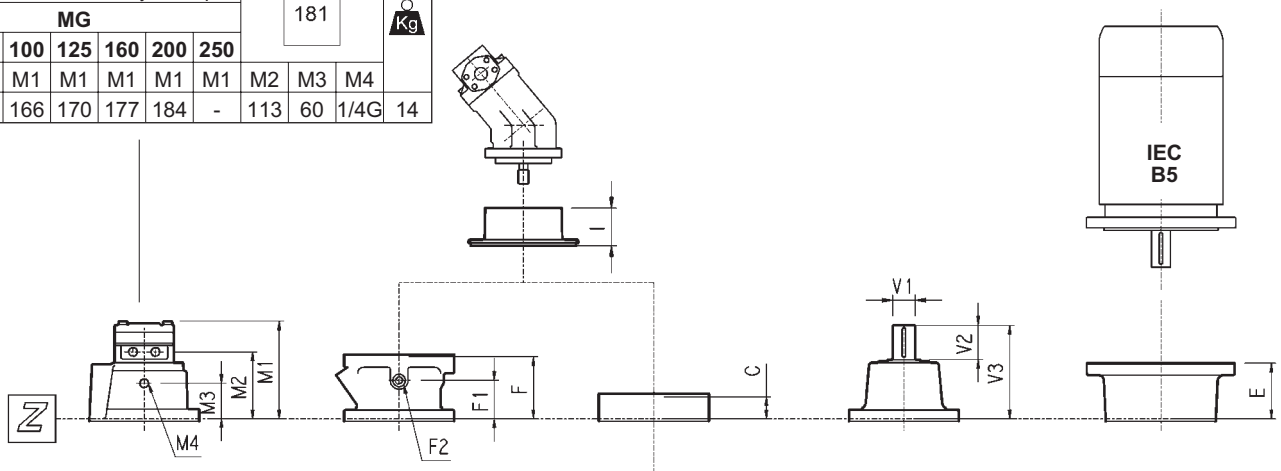
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**2 500 Nm**

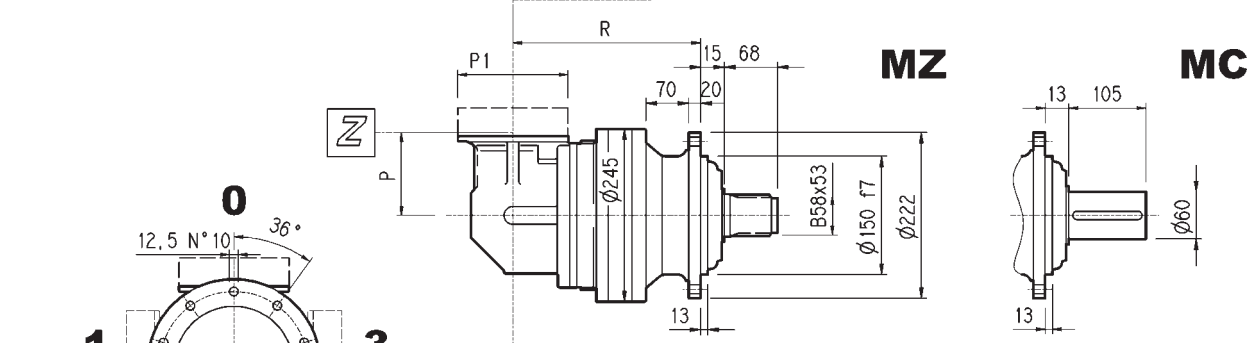
	L				Kg												
	MZ MC	FZ FP	HZ HC	PC PZ	MZ MC	FZ FP	HZ HC	PC PZ	C	Entrata Input Antrieb Entrée	I	F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
303 L1	125	125	150	165	31	31	35	40	37	A		145	95	1/4 G	5	A	16
303 L2	178	178	203	218	35	35	39	44	37	A		105	65	1/4 G	4	A	10
303 L3	231	231	256	271	39	39	43	48	37	A		105	65	1/4 G	4	A	10
303 L4	284	284	309	324	43	43	47	52	37	A	171	105	65	1/4 G	4	A	10

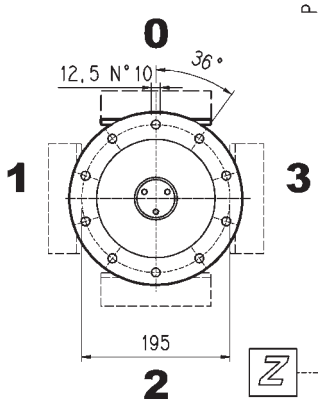
	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
									IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160	IEC 180	IEC 200	
303 L1	48	82	239	15										114	144	144	174	
303 L2	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			
303 L3	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			
303 L4	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			

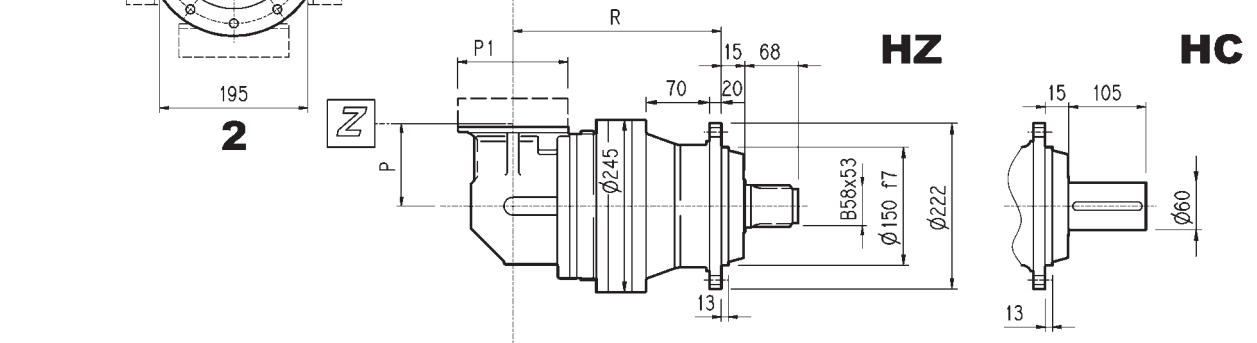
303R

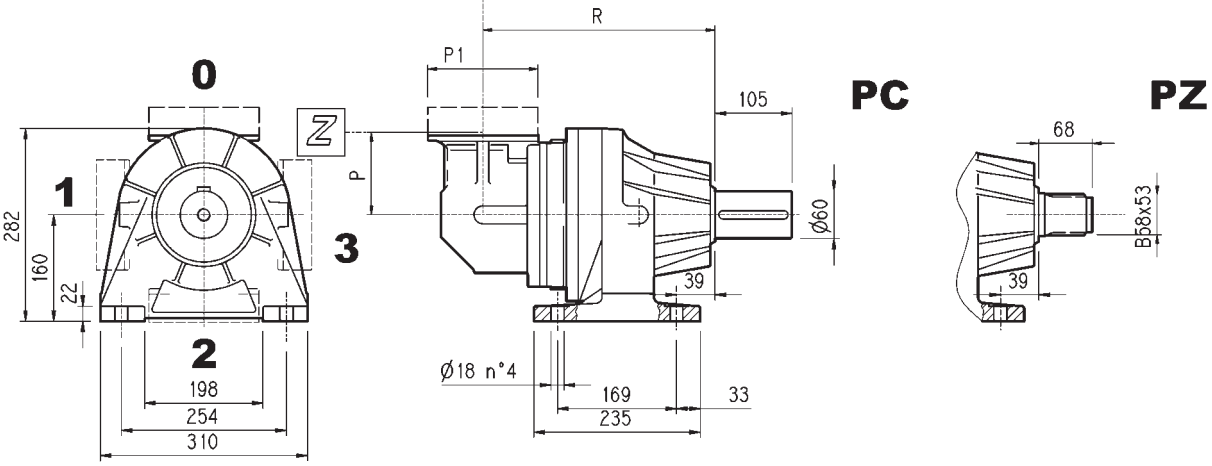
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur Hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
303R2	156	162	166	170	177	184	-	113	60	1/4G	14





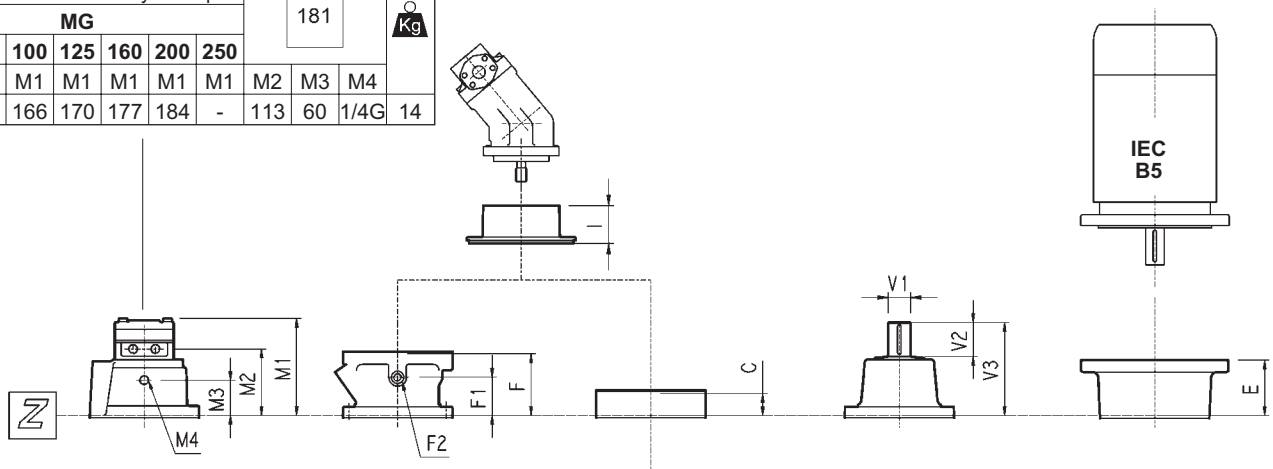


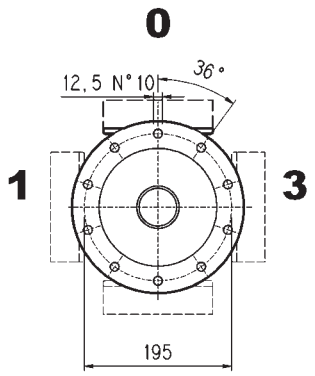


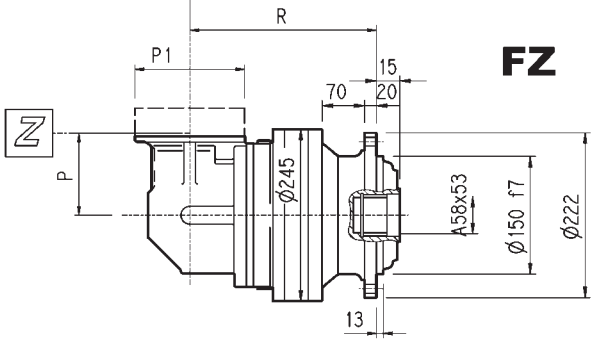


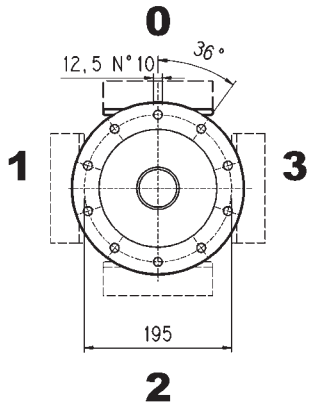
303R

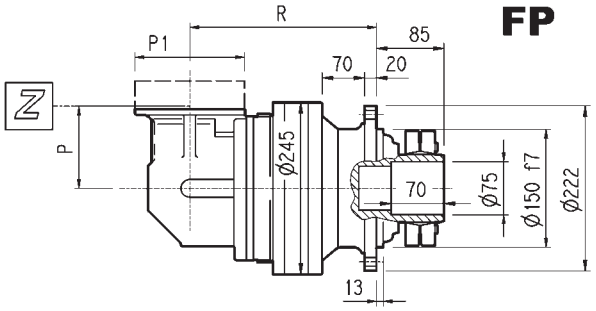
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
303R2	156	162	166	170	177	184	-	113	60	1/4G	14











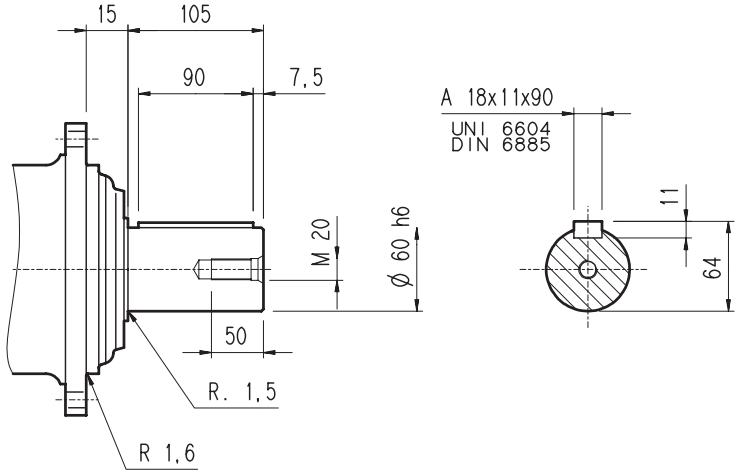
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**2 500 Nm**

	R				P	P1	Kg						I						Kg
	MZ MC	FZ FP	HZ HC	PC PZ			MZ MC	FZ FP	HZ HC	PC PZ	C	Entrata Input Antrieb Entrée		F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	
303 R2	217	217	242	257	140	186	51	51	55	60	37	A		105	65	1/4 G	4	A	10
303 R3	270	270	295	310	122	186	49	49	53	58	37	A		105	65	1/4 G	4	A	10
303 R4	323	323	348	363	122	186	53	53	57	62	37	A	171	105	65	1/4 G	4	A	10

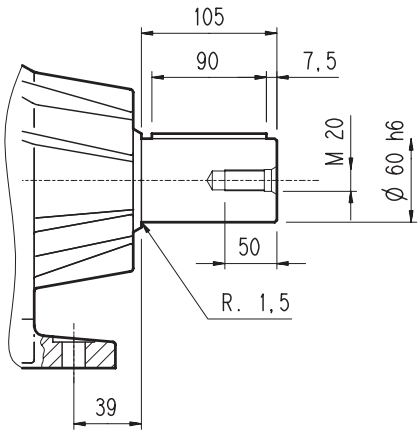
	V1	V2	V3	Kg	V1	V2	V3	Kg	E										
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132				
303 R2	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				
303 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				
303 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				

303L - 303R

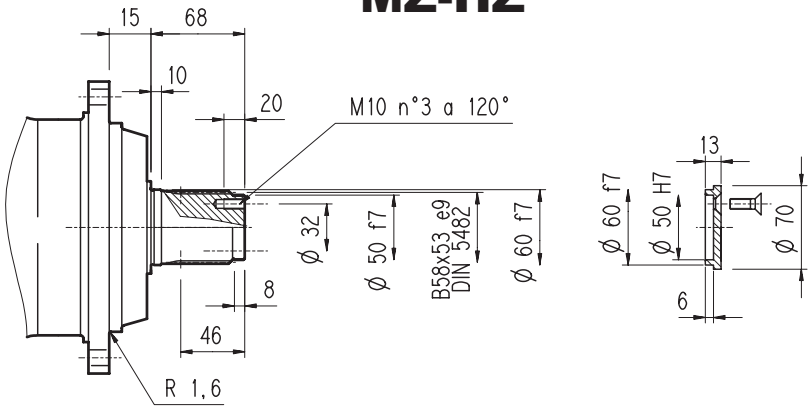
MC-HC



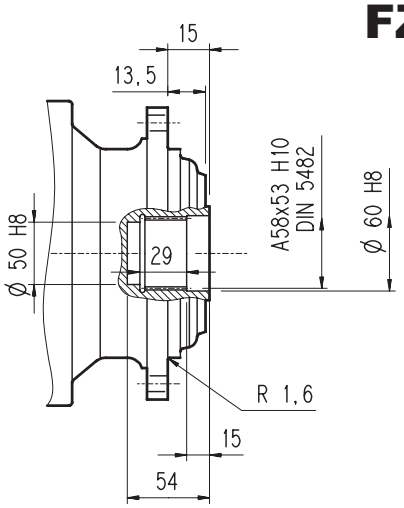
PC



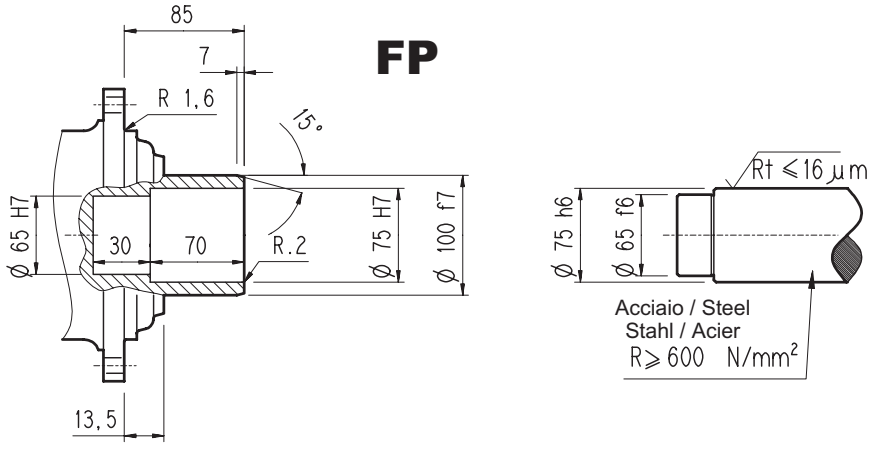
MZ-HZ



FZ



FP

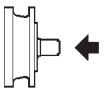


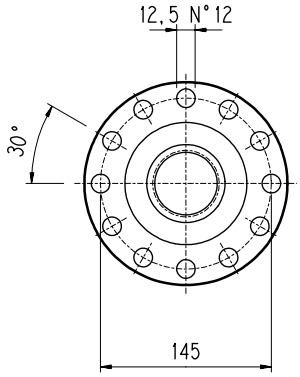
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**2 500 Nm**

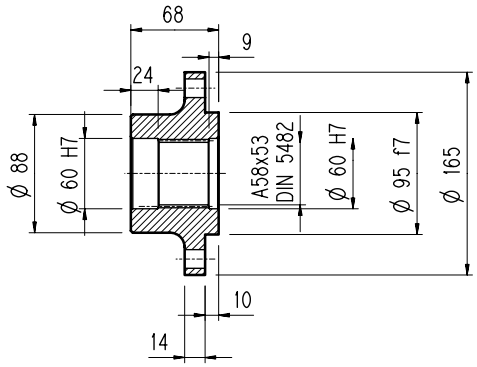
303L - 303R

Flangia / Flange
Flansch / Brides

W0A



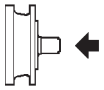




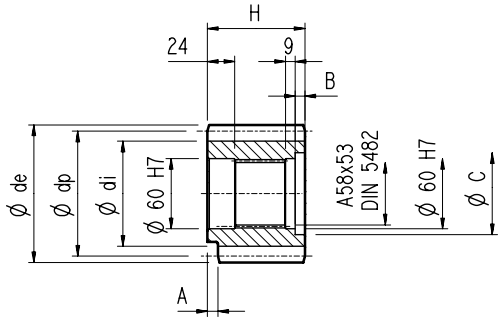
Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



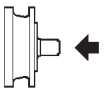
Codice Code	m	z	x	dp	di	de	H	A	B	C	★
PCL1	5	19	0	95	82	104	77	12	9	72	■
PCL2	5	19	0	95	82	104	68	0	0	0	■
PCM	5	20	0	100	87.5	110	68	18	0	0	□
PCP	5	22	0	110	97.5	120	68	18	0	0	□
PDE	6	14	0.500	84	75	99.6	68	0	0	0	■
PDI	6	18	0.500	108	99	123.6	68	0	0	0	■
PDM	6	20	0.500	120	115	140	68	0	0	0	■
PFD	8	13	0.675	104	95	127.6	68	0	0	0	□
PFE1	8	14	0	112	92	126	68	0	0	0	□
PFE2	8	14	0	112	92	126	80	0	12	72	□
PFF	8	15	0	120	100	136	68	0	0	0	■
PFP	8	22	0	176	156	190	77	12	10	71	■
PHG	10	16	0.500	160	145	188	75	0	7	72	■

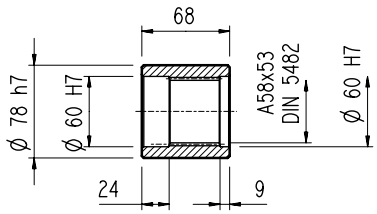


★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

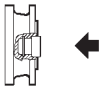


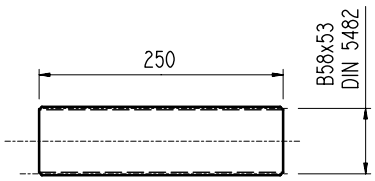


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

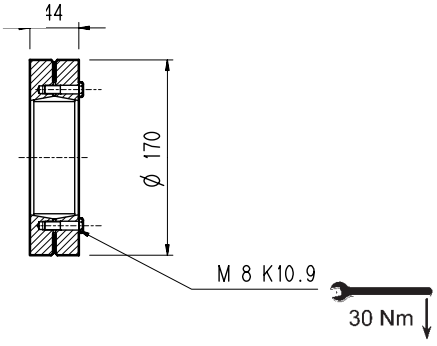




Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

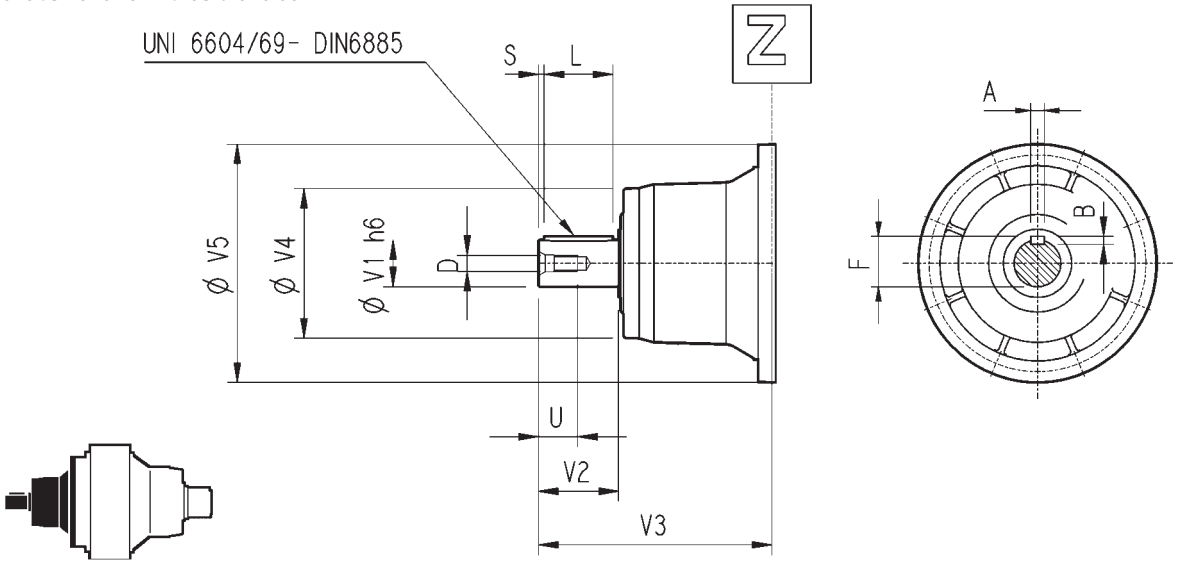
Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

G0A



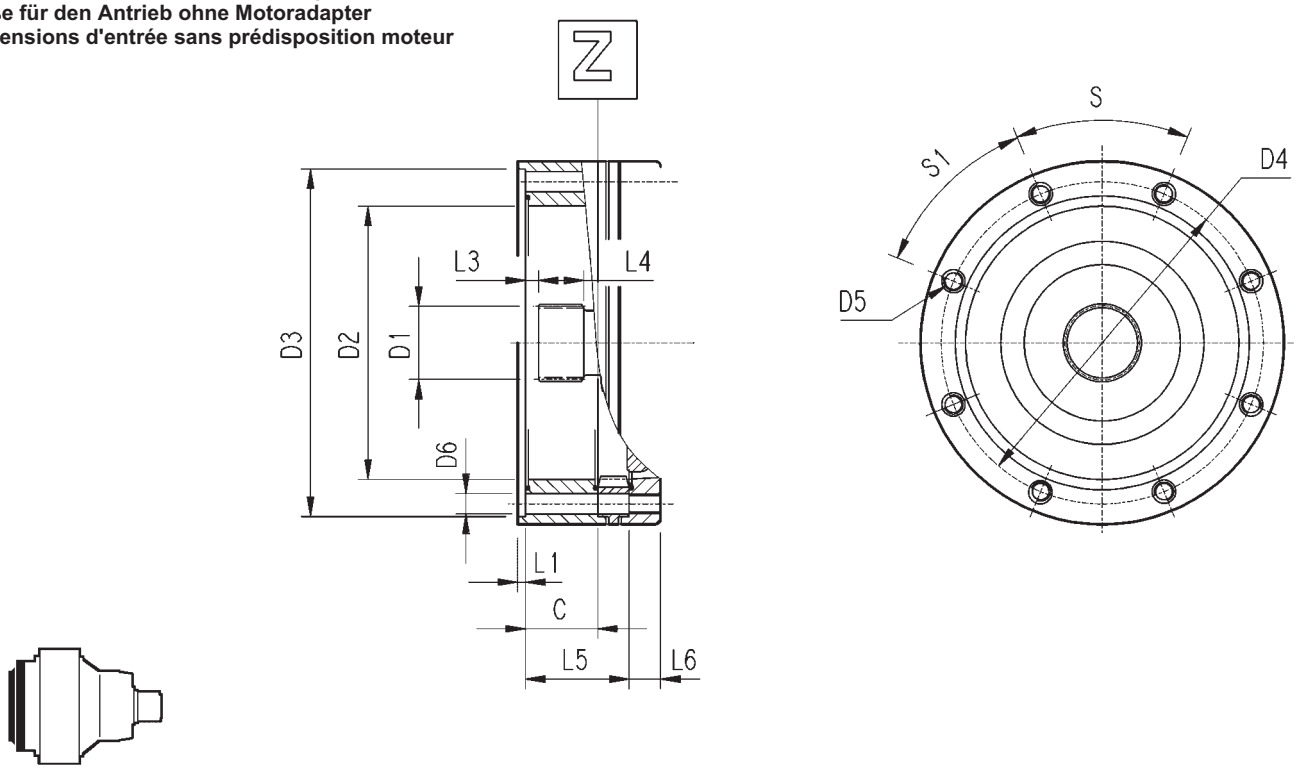
303L - 303R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
303 L1	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
303 L2	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
303 L3	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
303 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
303 R2-R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



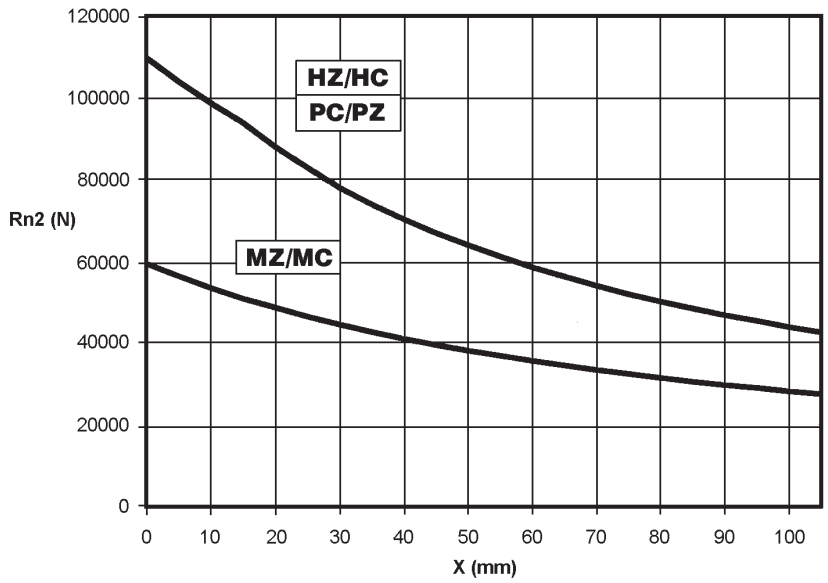
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
303 L1	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A
303 L2	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	53	18	45°	45°	A
303 L3	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	106	18	45°	45°	A
303 L4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	159	18	45°	45°	A
303 R2-R3-R4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

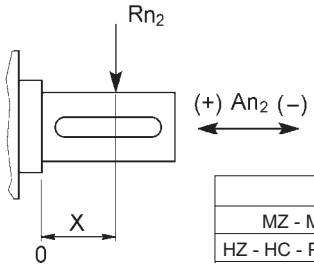
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

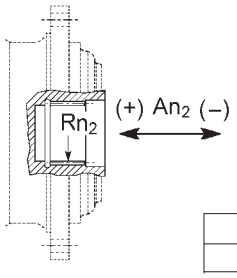
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
MZ - MC	55 000	44 000
HZ - HC - PC - PZ	55 000	44 000



	Rn2	An2 (+/-)
FZ	24 000	25 000

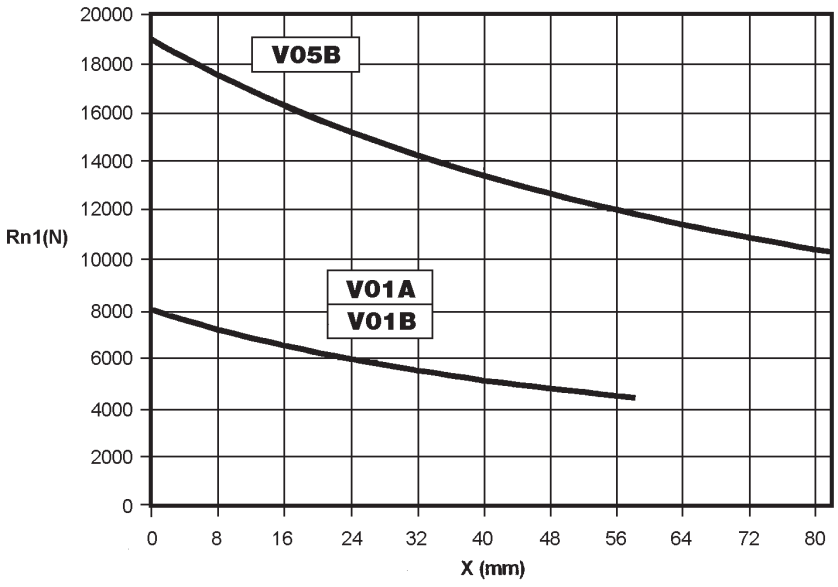
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	**$Fh_2 = n_2 \cdot h$**		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	MZ - MC - FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

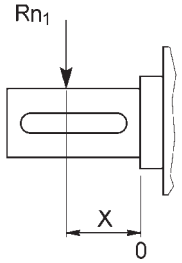
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	**$Fh_1 = n_1 \cdot h$**	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

305L

M_2 = 5000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	3.60	4 700	4 450	4 300	4 200	3 750	3 050	60	13	1 800	3 800	1 000	5K
	4.25	5 800	5 500	5 300	5 200	3 700	3 000	60	13	1 800	3 800	1 000	5K
	5.33	5 600	4 900	4 400	4 400	3 600	2 950	60	13	1 800	3 800	1 000	5K
	6.20	4 600	3 950	3 600	3 600	3 550	2 900	60	13	1 800	3 800	800	5G
	7.50	3 800	3 300	3 100	3 100	3 000	2 400	60	13	1 800	3 800	630	5E
L 2	12.5	4 700	4 450	4 300	4 200	3 250	2 650	30	9	2 000	4 000	400	4K
	15.3	4 700	4 450	4 300	4 200	3 250	2 650	30	9	2 000	4 000	330	4H
	18.1	5 800	5 500	5 300	5 200	3 650	2 950	30	9	2 000	4 000	400	4K
	20.8	4 700	4 450	4 300	4 200	3 100	2 500	30	9	2 000	4 000	260	4F
	22.7	5 600	4 900	4 400	4 400	3 600	2 950	30	9	2 000	4 000	330	4H
	24.5	5 500	5 400	5 300	5 200	3 450	2 800	30	9	2 000	4 000	330	4H
	26.4	4 600	3 950	3 600	3 600	3 550	2 900	23	9	2 000	4 000	260	4F
	30.8	5 600	4 900	4 400	4 400	3 600	2 950	24	9	2 000	4 000	260	4F
	35.8	4 600	3 950	3 600	3 600	3 550	2 900	17.0	9	2 000	4 000	160	4D
	38.4	5 600	4 900	4 400	4 400	3 600	2 900	19.8	9	2 000	4 000	160	4D
	44.6	4 600	3 950	3 600	3 600	3 550	2 900	14.1	9	2 000	4 000	160	4D
	54.0	3 800	3 300	3 100	3 100	3 000	2 400	10.0	9	2 000	4 000	100	4B
L 3	43.6	4 700	4 450	4 300	4 200	3 250	2 650	17.3	7.5	2 000	4 000	160	4D
	53.4	4 700	4 450	4 300	4 200	3 250	2 650	14.3	7.5	2 000	4 000	100	4B
	63.1	5 800	5 350	5 300	5 200	3 650	3 000	14.6	7.5	2 000	4 000	160	4D
	72.3	4 700	4 450	4 300	4 200	3 250	2 650	10.7	7.5	2 000	4 000	100	4B
	77.2	5 800	5 500	5 300	5 200	3 650	2 950	12.5	7.5	2 000	4 000	100	4B
	90.2	4 700	4 450	4 300	4 200	3 250	2 650	8.7	7.5	2 000	4 000	100	4B
	105	5 800	5 500	5 300	5 200	3 650	2 950	9.4	7.5	2 000	4 000	100	4B
	113	4 600	3 950	3 600	3 600	3 550	2 900	6.7	7.5	2 000	4 000	100	4B
	124	4 600	3 950	3 600	3 600	3 550	2 900	6.2	7.5	2 000	4 000	50	4A
	141	5 500	5 350	5 300	5 200	3 450	2 800	6.6	7.5	2 000	4 000	100	4B
	152	4 600	3 950	3 600	3 600	3 550	2 900	5.2	7.5	2 000	4 000	50	4A
	164	5 600	4 900	4 400	4 400	3 600	2 950	6.0	7.5	2 000	4 000	50	4A
	178	5 600	4 900	4 400	4 400	3 600	2 950	5.6	7.5	2 000	4 000	50	4A
	190	4 600	3 950	3 600	3 600	3 550	2 900	4.3	7.5	2 000	4 000	50	4A
	220	4 750	4 750	4 750	4 750	3 050	2 500	3.7	7.5	2 000	4 000	50	4A
	258	4 600	3 950	3 600	3 600	3 550	2 900	3.4	7.5	2 000	4 000	50	4A
	276	5 600	4 900	4 400	4 400	3 600	2 900	3.7	7.5	2 000	4 000	50	4A
	312	3 800	3 300	3 100	3 100	3 000	2 400	2.4	7.5	2 000	4 000	50	4A
	389	3 800	3 300	3 100	3 100	3 000	2 400	2.0	7.5	2 000	4 000	50	4A
L 4	413	5 600	4 900	4 400	4 400	3 600	2 900	4.0	6	2 000	4 000	50	4A
	446	5 800	5 500	5 300	5 200	3 650	2 950	4.0	6	2 000	4 000	50	4A
	492	5 500	5 350	5 300	5 200	3 450	2 800	3.2	6	2 000	4 000	50	4A
	556	5 800	5 500	5 300	5 200	3 650	2 950	3.2	6	2 000	4 000	50	4A
	649	4 700	4 450	4 300	4 200	3 250	2 650	2.2	6	2 000	4 000	50	4A
	718	4 600	3 950	3 600	3 600	3 550	2 900	2.2	6	2 000	4 000	50	4A
	816	5 500	5 350	5 300	5 200	3 450	2 800	2.2	6	2 000	4 000	50	4A
	896	4 600	3 950	3 600	3 600	3 550	2 900	1.9	6	2 000	4 000	50	4A
	1 018	5 500	5 350	5 300	5 200	3 450	2 800	1.7	6	2 000	4 000	50	4A
	1 098	4 600	3 950	3 600	3 600	3 550	2 900	1.6	6	2 000	4 000	50	4A
	1 278	5 600	4 900	4 400	4 400	3 600	2 950	1.4	6	2 000	4 000	50	4A
	1 370	4 600	3 950	3 600	3 600	3 550	2 900	1.3	6	2 000	4 000	50	4A
	1 586	4 750	4 750	4 750	4 750	3 050	2 500	0.88	6	2 000	4 000	50	4A
	1 854	4 600	3 950	3 600	3 600	3 550	2 900	0.96	6	2 000	4 000	50	4A
	1 991	5 600	4 900	4 400	4 400	3 600	2 900	0.88	6	2 000	4 000	50	4A
	2 243	3 800	3 300	3 100	3 100	3 000	2 400	0.71	6	2 000	4 000	50	4A
	2 799	3 800	3 300	3 100	3 100	3 000	2 400	0.59	6	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

M_2 = 5000 Nm

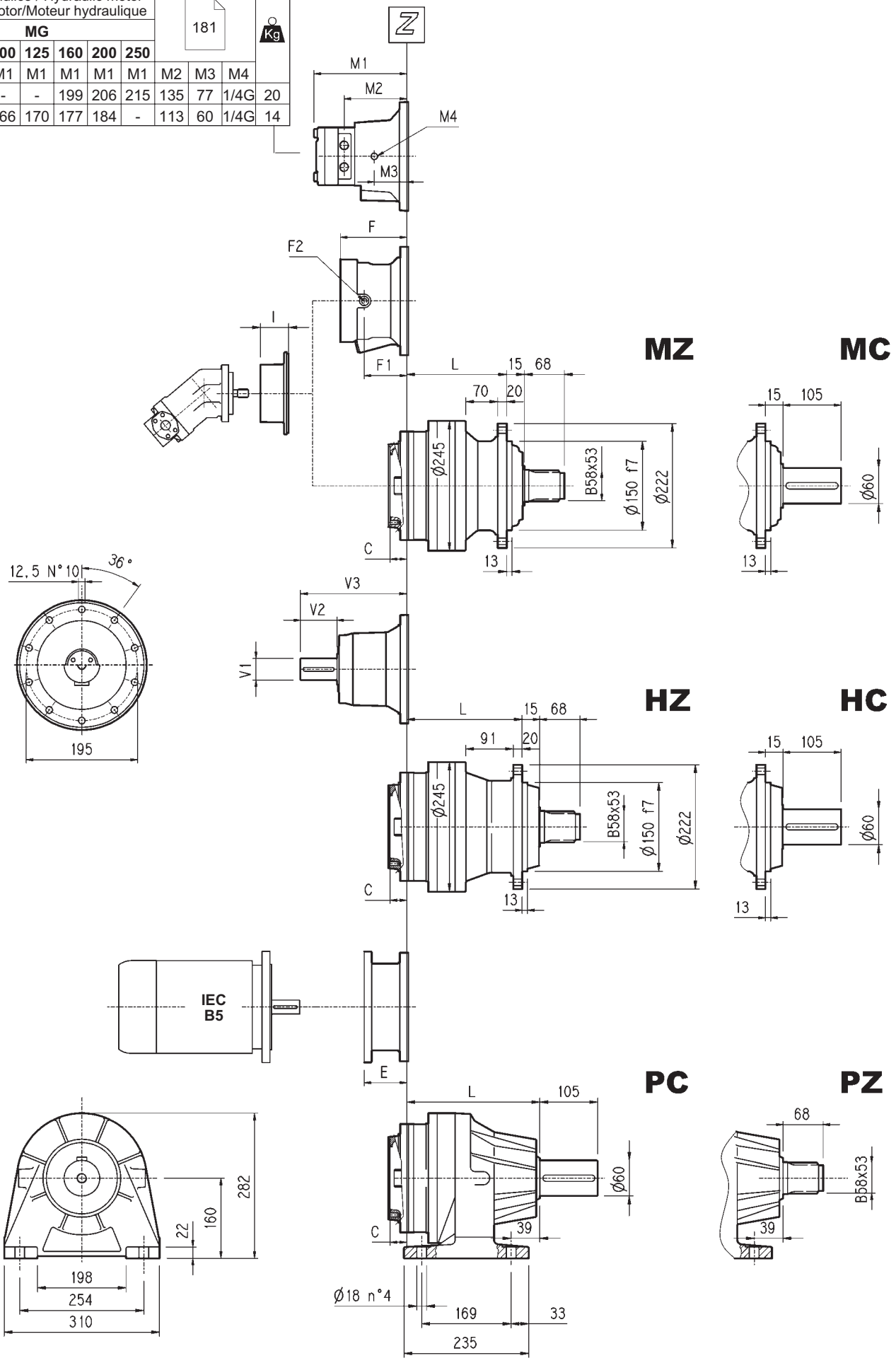
305R

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	9.23	4 650	4 050	3 600	3 200	2 000	1 600	35	18	1 800	3 800	440	4L
	10.9	5 300	4 650	4 150	3 600	2 200	1 800	35	18	1 800	3 800	440	4L
	13.7	5 600	4 900	4 400	4 200	2 600	2 100	35	18	1 800	3 800	440	4L
	15.9	4 600	3 950	3 600	3 600	2 900	2 350	35	18	1 800	3 800	330	4H
	19.2	3 800	3 300	3 100	3 100	3 000	2 400	27	18	1 800	3 800	260	4F
R3	25.7	4 150	4 150	4 150	4 150	2 600	2 100	15.0	14	2 000	4 000	260	4F
	31.5	4 700	4 450	4 300	4 200	3 000	2 450	15.0	14	2 000	4 000	260	4F
	37.1	5 800	5 500	5 300	5 200	3 400	2 750	15.0	14	2 000	4 000	260	4F
	42.6	4 700	4 450	4 300	4 200	3 100	2 500	15.0	14	2 000	4 000	160	4D
	46.6	5 600	4 900	4 400	4 400	3 600	2 950	15.0	14	2 000	4 000	160	4D
	50.3	5 500	5 350	5 300	5 200	3 450	2 800	15.0	14	2 000	4 000	160	4D
	54.2	4 600	3 950	3 600	3 600	3 550	2 900	12.4	14	2 000	4 000	100	4B
	63.1	5 600	4 900	4 400	4 400	3 600	2 950	13.4	14	2 000	4 000	100	4B
	73.3	4 600	3 950	3 600	3 600	3 550	2 900	9.6	14	2 000	4 000	100	4B
	78.7	5 600	4 900	4 400	4 400	3 600	2 900	11.1	14	2 000	4 000	100	4B
	91.5	4 600	3 950	3 600	3 600	3 550	2 900	8.0	14	2 000	4 000	100	4B
	111	3 800	3 300	3 100	3 100	3 000	2 400	5.6	14	2 000	4 000	50	4A
R4	129	5 800	5 400	5 300	5 200	3 650	3 000	12.3	12	2 000	4 000	50	4A
	148	4 700	4 450	4 300	4 200	3 250	2 650	9.1	12	2 000	4 000	50	4A
	158	5 800	5 500	5 300	5 200	3 650	2 950	10.6	12	2 000	4 000	50	4A
	185	4 700	4 450	4 300	4 200	3 250	2 650	7.4	12	2 000	4 000	50	4A
	214	5 800	5 500	5 300	5 200	3 650	2 950	7.9	12	2 000	4 000	50	4A
	231	4 600	3 950	3 600	3 600	3 550	2 900	5.8	12	2 000	4 000	50	4A
	255	4 600	3 950	3 600	3 600	3 550	2 900	5.3	12	2 000	4 000	50	4A
	290	5 500	5 400	5 300	5 200	3 450	2 800	5.7	12	2 000	4 000	50	4A
	313	4 600	3 950	3 600	3 600	3 550	2 900	4.5	12	2 000	4 000	50	4A
	336	5 600	4 900	4 400	4 400	3 600	2 900	4.9	12	2 000	4 000	50	4A
	364	5 600	4 900	4 400	4 400	3 600	2 950	4.8	12	2 000	4 000	50	4A
	390	4 600	3 950	3 600	3 600	3 550	2 900	3.7	12	2 000	4 000	50	4A
	452	4 750	4 750	4 750	4 750	3 050	2 500	3.1	12	2 000	4 000	50	4A
	528	4 600	3 950	3 600	3 600	3 550	2 900	2.5	12	2 000	4 000	50	4A
	567	5 600	4 900	4 400	4 400	3 600	2 900	3.1	12	2 000	4 000	50	4A
	639	3 800	3 300	3 100	3 100	3 000	2 400	2.0	12	2 000	4 000	50	4A
	797	3 800	3 300	3 100	3 100	3 000	2 400	1.7	12	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

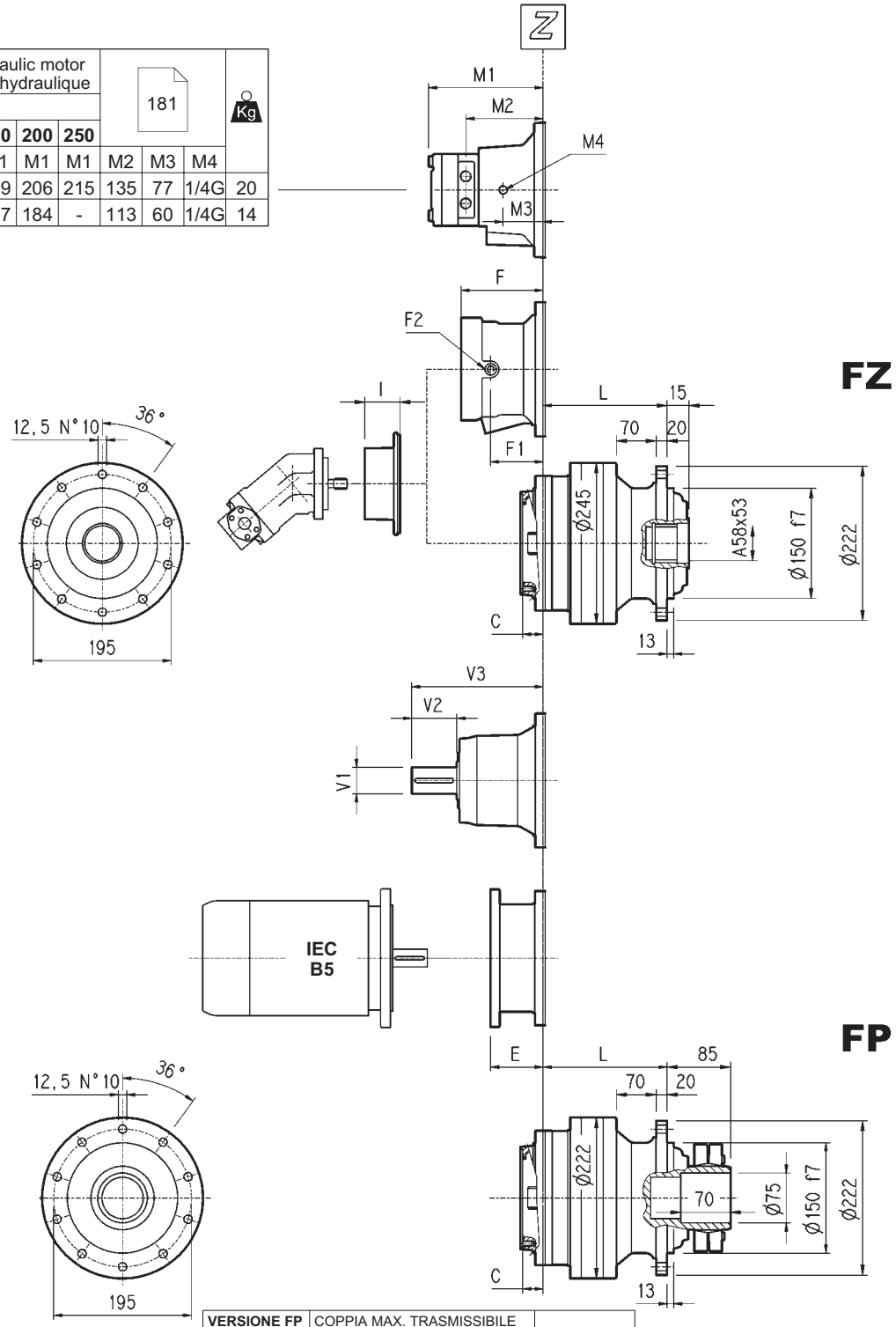
305L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
305L1	-	-	-	-	199	206	215	135	77	1/4G	20
305L2	156	162	166	170	177	184	-	113	60	1/4G	14



305L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
305L1	-	-	-	-	199	206	215	135	77	1/4G	20
305L2	156	162	166	170	177	184	-	113	60	1/4G	14



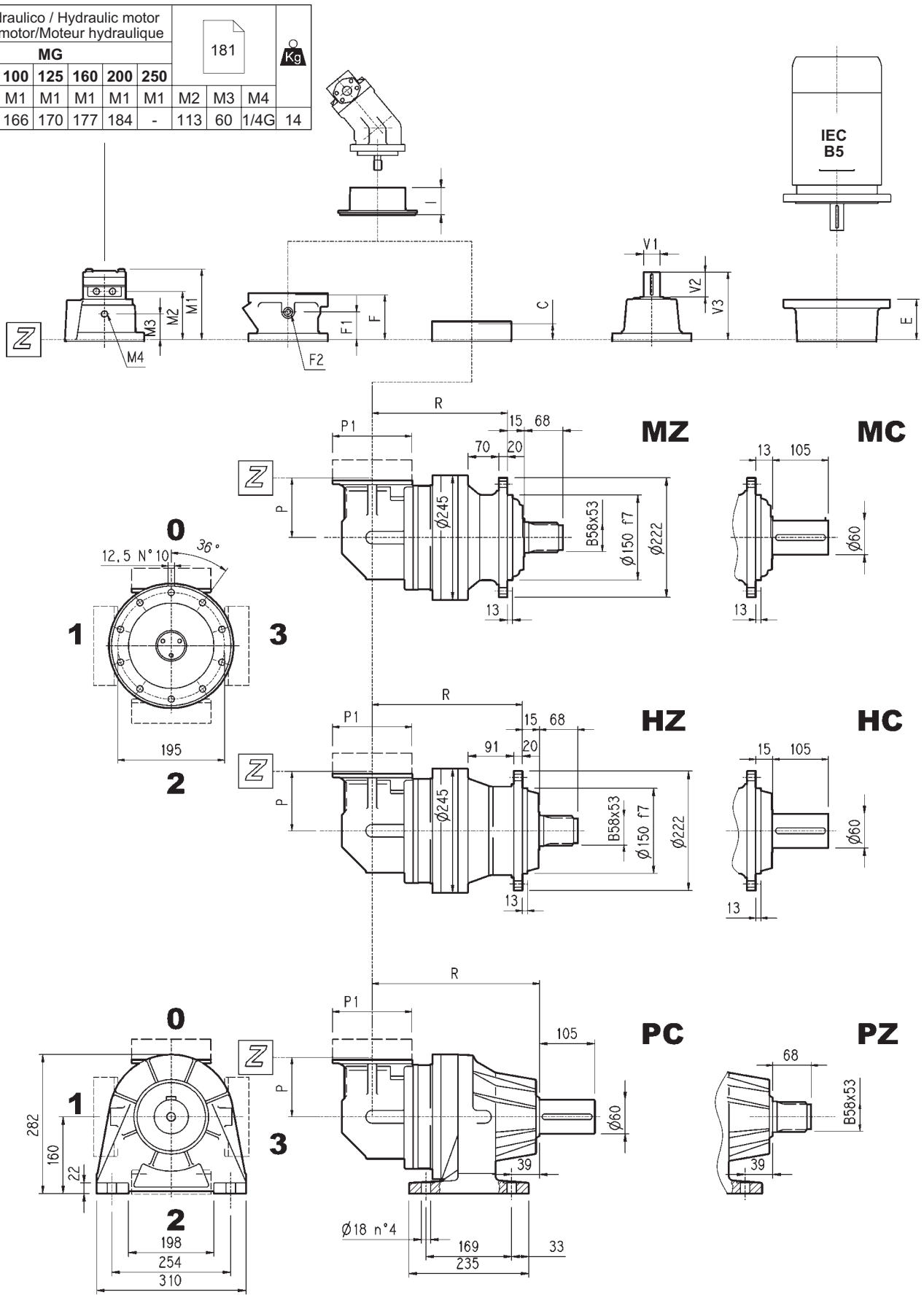
VERSIONE FP FP VERSION VERSION FP VERSION FP	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	5 000 Nm

	L				Kg													
	MZ MC	FZ FP	HZ HC	PC PZ	MZ MC	FZ FP	HZ HC	PC PZ	C	Entrata Input Antrieb Entrée	I	F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
305 L1	143	143	168	183	36	36	40	45	37	A		145	95	1/4 G	5	A	16
305 L2	208	208	233	248	43	43	47	52	37	A		105	65	1/4 G	4	A	10
305 L3	261	261	286	301	47	47	51	56	37	A		105	65	1/4 G	4	A	10
305 L4	314	314	339	354	51	51	55	60	37	A	171	105	65	1/4 G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
									IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160	IEC 180	IEC 200	
305 L1	48	82	239	15										114	144	144	174	
305 L2	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			
305 L3	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			
305 L4	24	36	137.5	6	38	58	158	7	65	84	84	94	94	114	144			

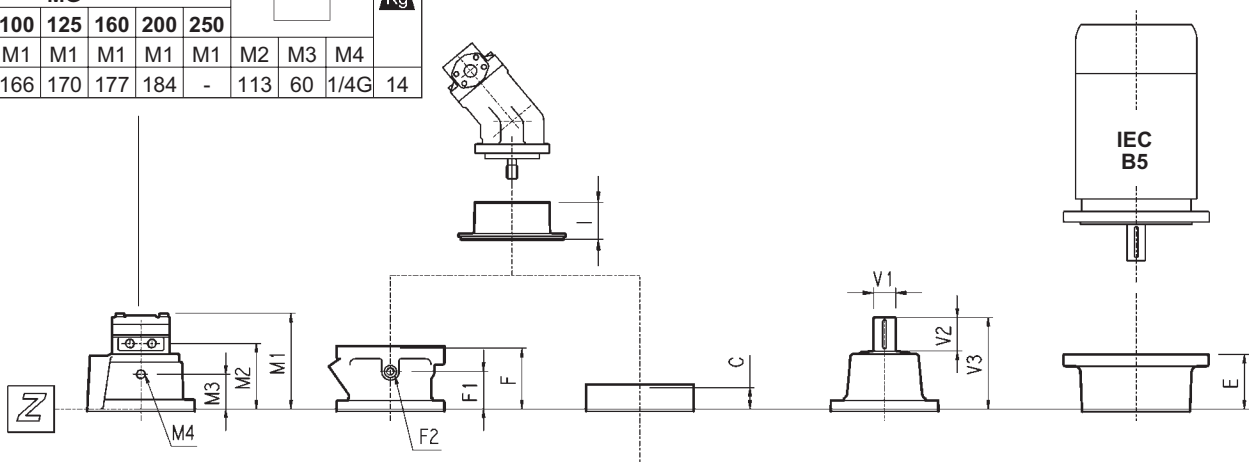
305R

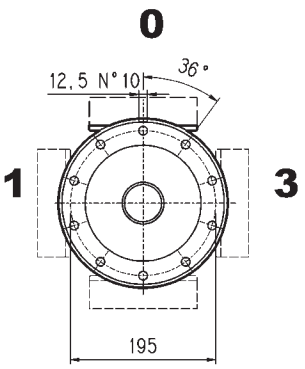
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
305R2	156	162	166	170	177	184	-	113	60	1/4G	14

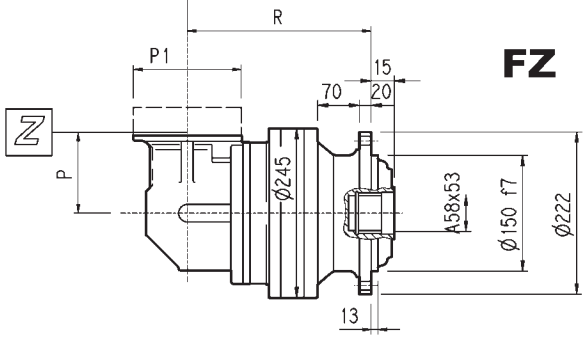


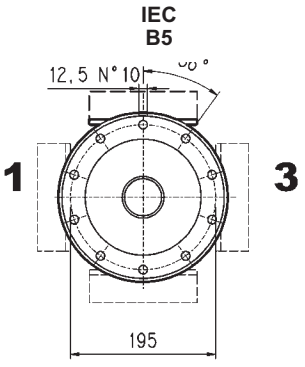
305R

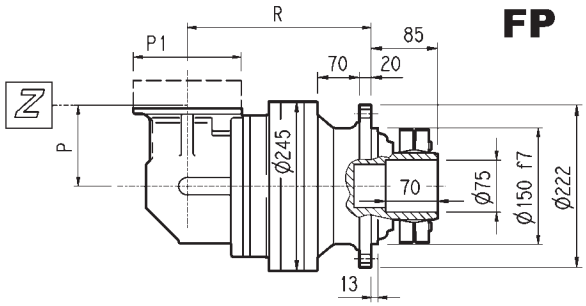
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
305R2	156	162	166	170	177	184	-	113	60	1/4G	14











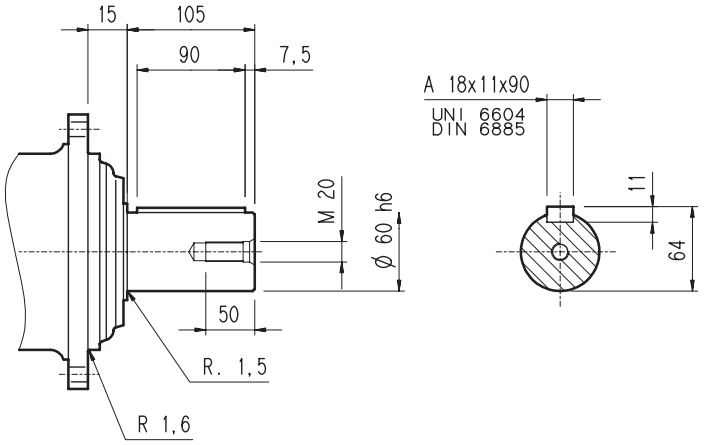
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**5 000 Nm**

	R				P	P1	Kg				C	Entrata Input Antrieb Entrée	I	F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
	MZ MC	FZ FP	HZ HC	PC PZ			MZ MC	FZ FP	HZ HC	PC PZ									
305 R2	235	235	260	275	140	186	56	56	60	65	37	A		105	65	1/4 G	4	A	10
305 R3	300	300	325	340	122	186	57	57	61	66	37	A		105	65	1/4 G	4	A	10
305 R4	353	353	378	393	122	186	61	61	65	70	37	A	171	105	65	1/4 G	4	A	10

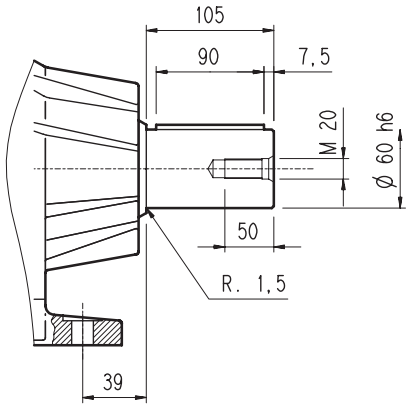
	V1	V2	V3	Kg	V1	V2	V3	Kg	E										
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132				
305 R2	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				
305 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				
305 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114				

305L - 305R

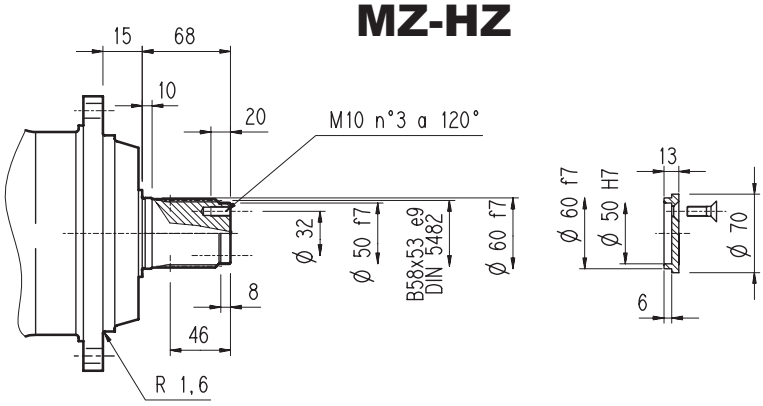
MC-HC



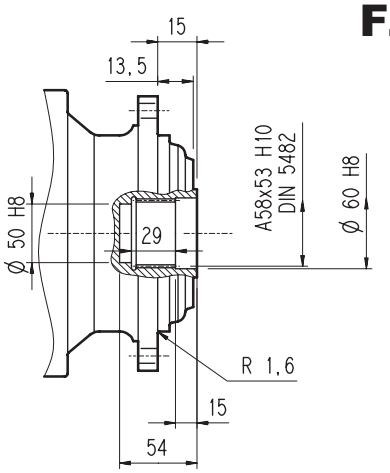
PC



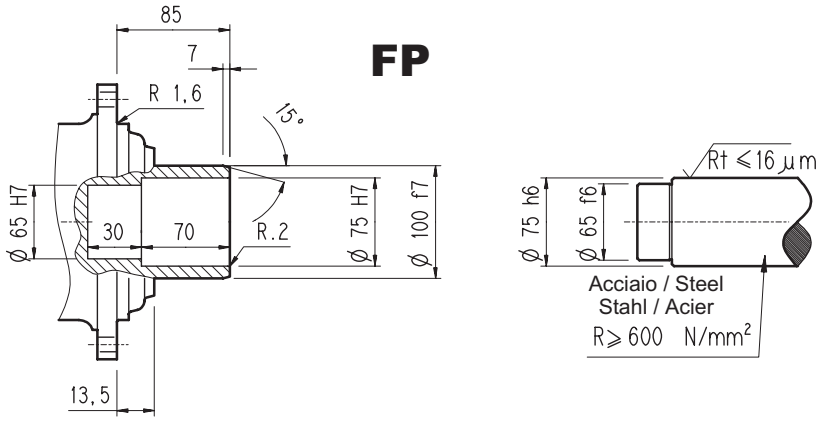
MZ-HZ

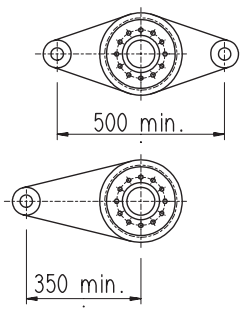


FZ



FP



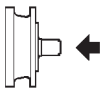


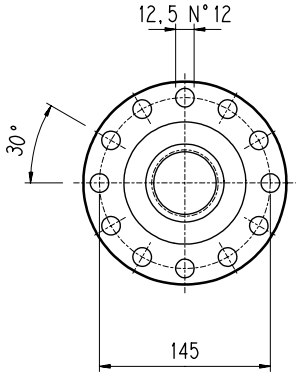
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**5 000 Nm**

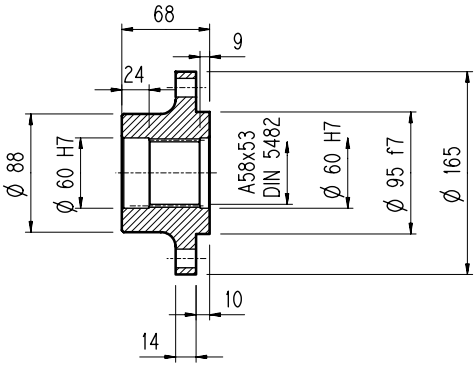
305L - 305R

Flangia / Flange
Flansch / Brides

W0A



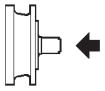


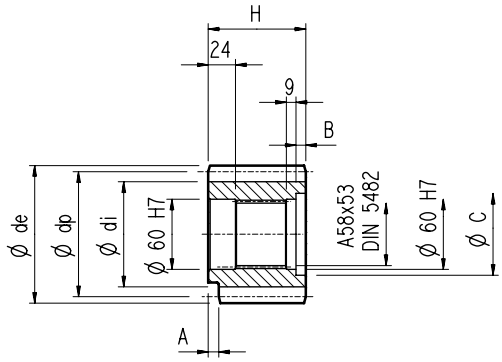


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



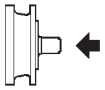


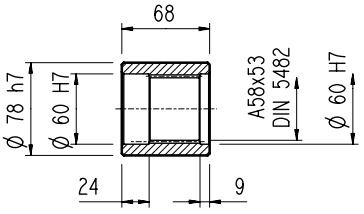
Codice Code	m	z	x	dp	di	de	H	A	B	C	★
PCL1	5	19	0	95	82	104	77	12	9	72	■
PCL2	5	19	0	95	82	104	68	0	0	0	■
PCM	5	20	0	100	87.5	110	68	18	0	0	□
PCP	5	22	0	110	97.5	120	68	18	0	0	□
PDE	6	14	0.500	84	75	99.6	68	0	0	0	■
PDI	6	18	0.500	108	99	123.6	68	0	0	0	■
PDM	6	20	0.500	120	115	140	68	0	0	0	■
PFD	8	13	0.675	104	95	127.6	68	0	0	0	□
PFE1	8	14	0	112	92	126	68	0	0	0	□
PFE2	8	14	0	112	92	126	80	0	12	72	□
PFF	8	15	0	120	100	136	68	0	0	0	■
PFP	8	22	0	176	156	190	77	12	10	71	■
PHG	10	16	0.500	160	145	188	75	0	7	72	■

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

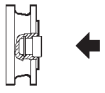


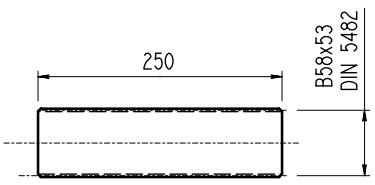


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

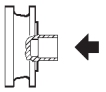


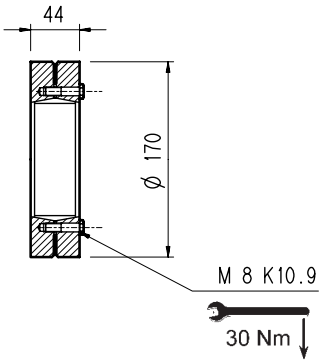


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

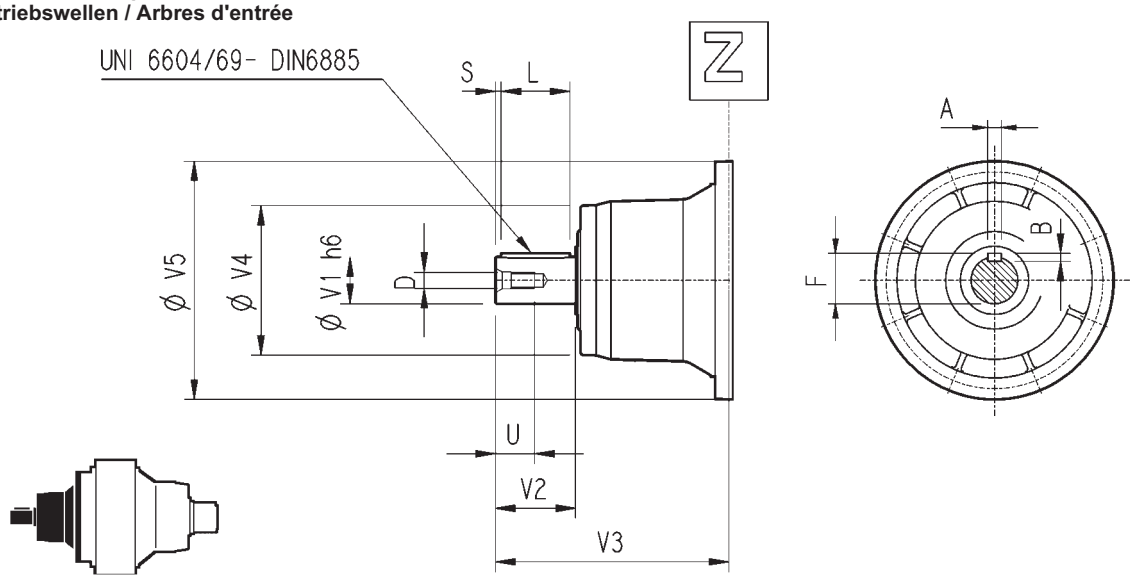
G0A





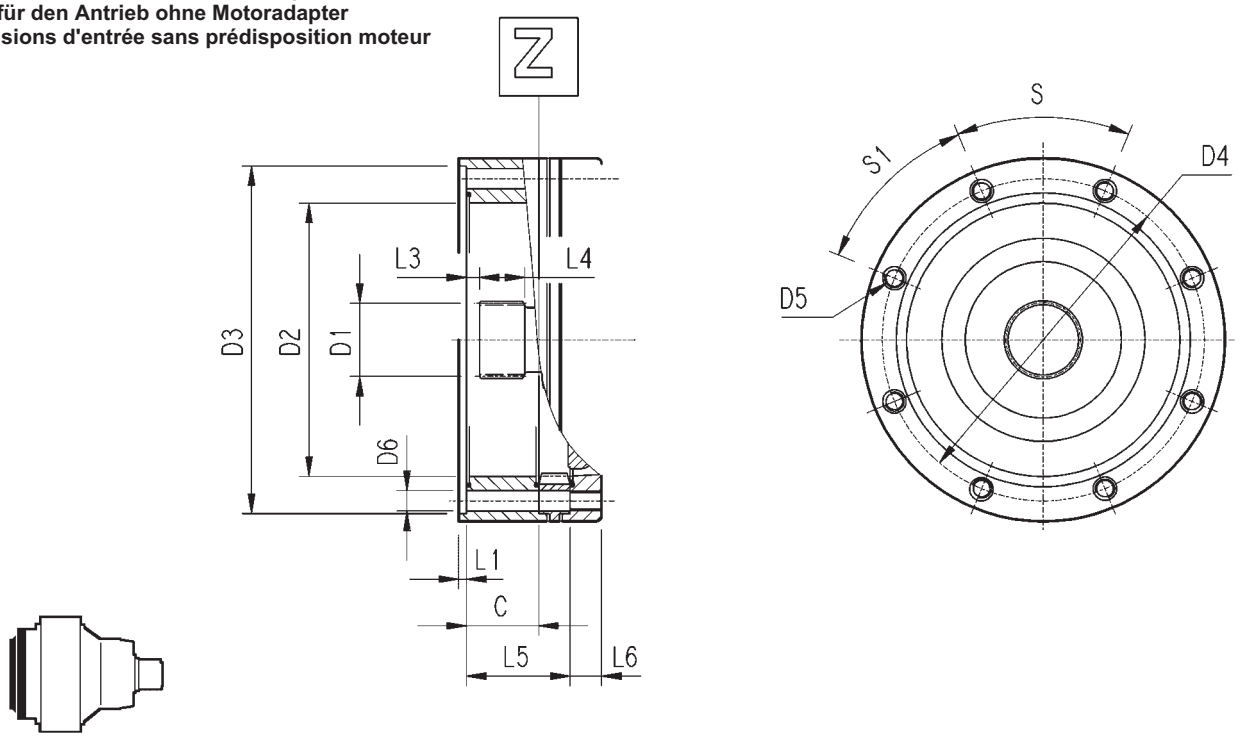
305L - 305R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
305 L1	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
305 L2	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
305 L3	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
305 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
305 R2-R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



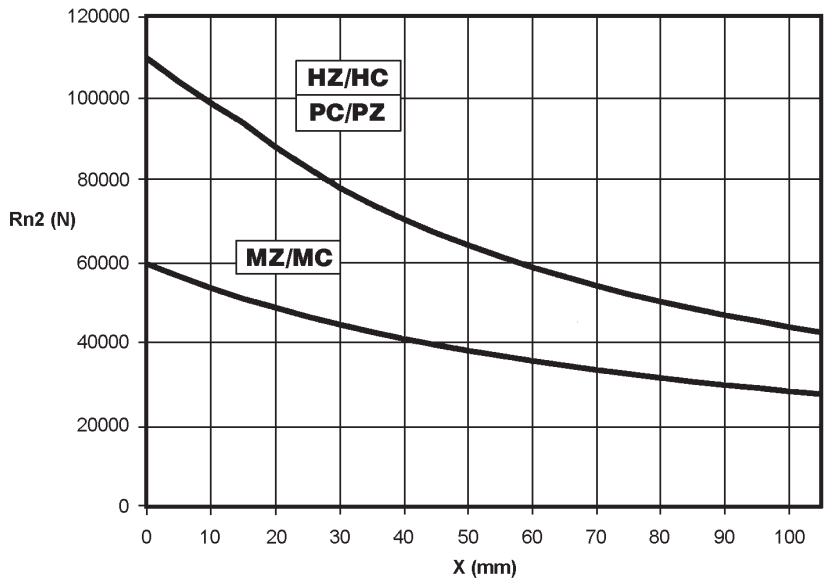
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
305 L1	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A
305 L2	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	65	18	45°	45°	A
305 L3	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	118	18	45°	45°	A
305 L4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	171	18	45°	45°	A
305 R2-R3-R4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

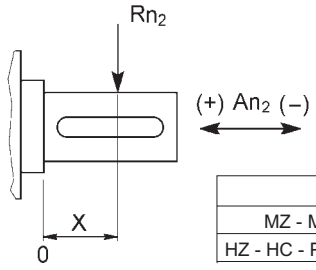
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

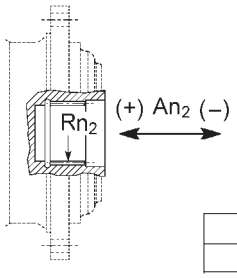
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An_2 (+)	An_2 (-)
MZ - MC	55 000	44 000
HZ - HC - PC - PZ	55 000	44 000



	Rn_2	An_2 (+/-)
FZ	24 000	25000

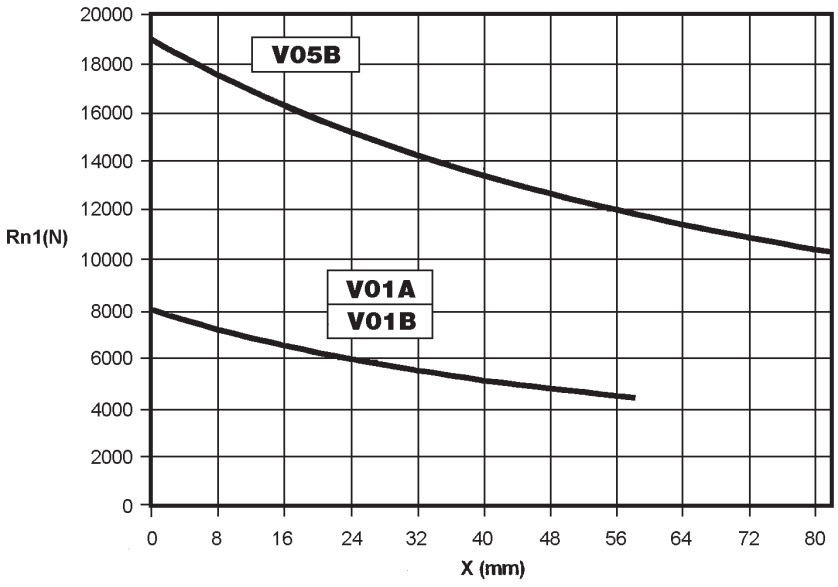
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	MZ - MC - FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

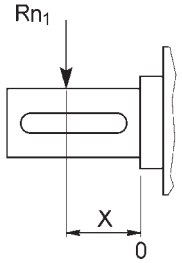
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

306L

M_2 = 8500 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	3.60	8 300	7 900	7 700	7 500	6 700	5 400	75	18	1 500	3 000	2 600	6K
	4.25	10 000	9 600	9 400	9 300	6 000	4 850	75	18	1 500	3 000	2 600	6K
	5.33	9 500	8 500	7 800	7 800	5 700	4 600	75	18	1 500	3 000	2 100	6G
	6.20	8 500	7 200	6 500	6 500	5 700	4 650	75	18	1 500	3 000	1 500	6E
	7.50	7 000	5 900	5 500	5 500	4 700	3 850	75	18	1 500	3 000	1 100	6C
L 2	13.0	7 600	7 300	7 300	7 300	5 100	4 150	40	13	1 800	3 800	800	5G
	15.3	8 300	7 900	7 700	7 500	5 100	4 150	40	13	1 800	3 800	800	5G
	18.1	10 000	9 600	9 400	9 300	5 800	4 700	40	13	1 800	3 800	630	5E
	22.7	9 300	9 100	9 100	9 100	5 700	4 600	40	13	1 800	3 800	500	5C
	26.4	7 500	7 400	7 400	7 400	4 650	3 750	40	13	1 800	3 800	400	5B
	28.4	9 500	8 500	7 800	7 800	5 700	4 600	40	13	1 800	3 800	400	5B
	33.1	9 300	8 500	7 800	7 800	5 400	4 400	40	13	1 800	3 800	400	5B
	38.4	8 500	7 200	6 500	6 500	5 750	4 650	29	13	1 800	3 800	400	5B
	46.5	8 500	7 200	6 500	6 500	5 750	4 650	25	13	1 800	3 800	400	5B
	56.3	7 000	5 900	5 500	5 500	4 700	3 850	17.3	13	1 800	3 800	400	5B
L 3	45.1	7 600	7 300	7 300	7 200	4 450	3 600	20.0	7.5	2 000	4 000	260	4F
	53.2	8 300	7 900	7 700	7 500	5 000	4 050	20.0	7.5	2 000	4 000	260	4F
	65.2	8 300	7 900	7 700	7 500	4 800	3 900	20.0	7.5	2 000	4 000	160	4D
	77.0	10 000	9 600	9 400	8 700	5 400	4 400	20.0	7.5	2 000	4 000	160	4D
	81.9	8 100	7 700	7 700	7 500	5 000	4 100	16.2	7.5	2 000	4 000	160	4D
	88.3	8 900	8 700	8 700	7 400	4 550	3 700	17.0	7.5	2 000	4 000	160	4D
	104	10 000	9 600	9 400	8 300	5 100	4 150	16.3	7.5	2 000	4 000	160	4D
	112	7 500	7 400	7 400	7 400	4 600	3 750	11.4	7.5	2 000	4 000	160	4D
	121	9 500	8 500	7 800	7 800	5 700	4 600	13.1	7.5	2 000	4 000	100	4B
	141	9 300	8 500	7 800	7 800	5 400	4 400	11.4	7.5	2 000	4 000	100	4B
	152	7 500	7 400	7 400	7 400	4 650	3 750	8.5	7.5	2 000	4 000	100	4B
	184	6 800	6 800	6 800	6 800	4 850	3 950	6.4	7.5	2 000	4 000	100	4B
	205	9 500	8 500	7 800	7 800	5 700	4 600	8.3	7.5	2 000	4 000	100	4B
	222	8 500	7 200	6 500	6 500	5 700	4 650	7.1	7.5	2 000	4 000	50	4A
	238	9 300	8 500	7 800	7 800	5 400	4 400	7.0	7.5	2 000	4 000	50	4A
	268	7 000	5 900	5 500	5 500	4 700	3 850	5.0	7.5	2 000	4 000	50	4A
	288	7 000	5 900	5 500	5 500	4 700	3 850	4.7	7.5	2 000	4 000	50	4A
	325	7 000	5 900	5 500	5 500	4 700	3 850	4.3	7.5	2 000	4 000	50	4A
	405	7 000	5 900	5 500	5 500	4 700	3 850	3.6	7.5	2 000	4 000	50	4A
L 4	444	10 000	9 600	9 400	8 300	5 100	4 150	6.8	6	2 000	4 000	50	4A
	509	8 900	8 700	8 700	7 400	4 550	3 700	5.3	6	2 000	4 000	50	4A
	589	9 500	8 500	7 800	7 800	5 700	4 600	4.7	6	2 000	4 000	50	4A
	636	8 900	8 700	8 700	7 400	4 550	3 700	4.3	6	2 000	4 000	50	4A
	700	9 500	8 500	7 800	7 800	5 700	4 600	4.3	6	2 000	4 000	50	4A
	809	7 500	7 400	7 400	7 400	4 650	3 750	3.3	6	2 000	4 000	50	4A
	877	7 500	7 400	7 400	7 400	4 650	3 750	3.1	6	2 000	4 000	50	4A
	1 015	9 300	8 500	7 800	7 800	5 400	4 400	3.0	6	2 000	4 000	50	4A
	1 095	7 500	7 400	7 400	7 400	4 650	3 750	2.6	6	2 000	4 000	50	4A
	1 279	8 500	7 200	6 500	6 500	5 700	4 650	2.4	6	2 000	4 000	50	4A
	1 475	9 500	8 500	7 800	7 800	5 700	4 600	2.0	6	2 000	4 000	50	4A
	1 597	8 500	7 200	6 500	6 500	5 700	4 650	1.9	6	2 000	4 000	50	4A
	1 872	7 000	5 900	5 500	5 500	4 700	3 850	1.6	6	2 000	4 000	50	4A
	2 074	7 000	5 900	5 500	5 500	4 700	3 850	1.5	6	2 000	4 000	50	4A
	2 337	7 000	5 900	5 500	5 500	4 700	3 850	1.3	6	2 000	4 000	50	4A
	2 916	7 000	5 900	5 500	5 500	4 700	3 850	1.0	6	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

M_2 = 8500 Nm

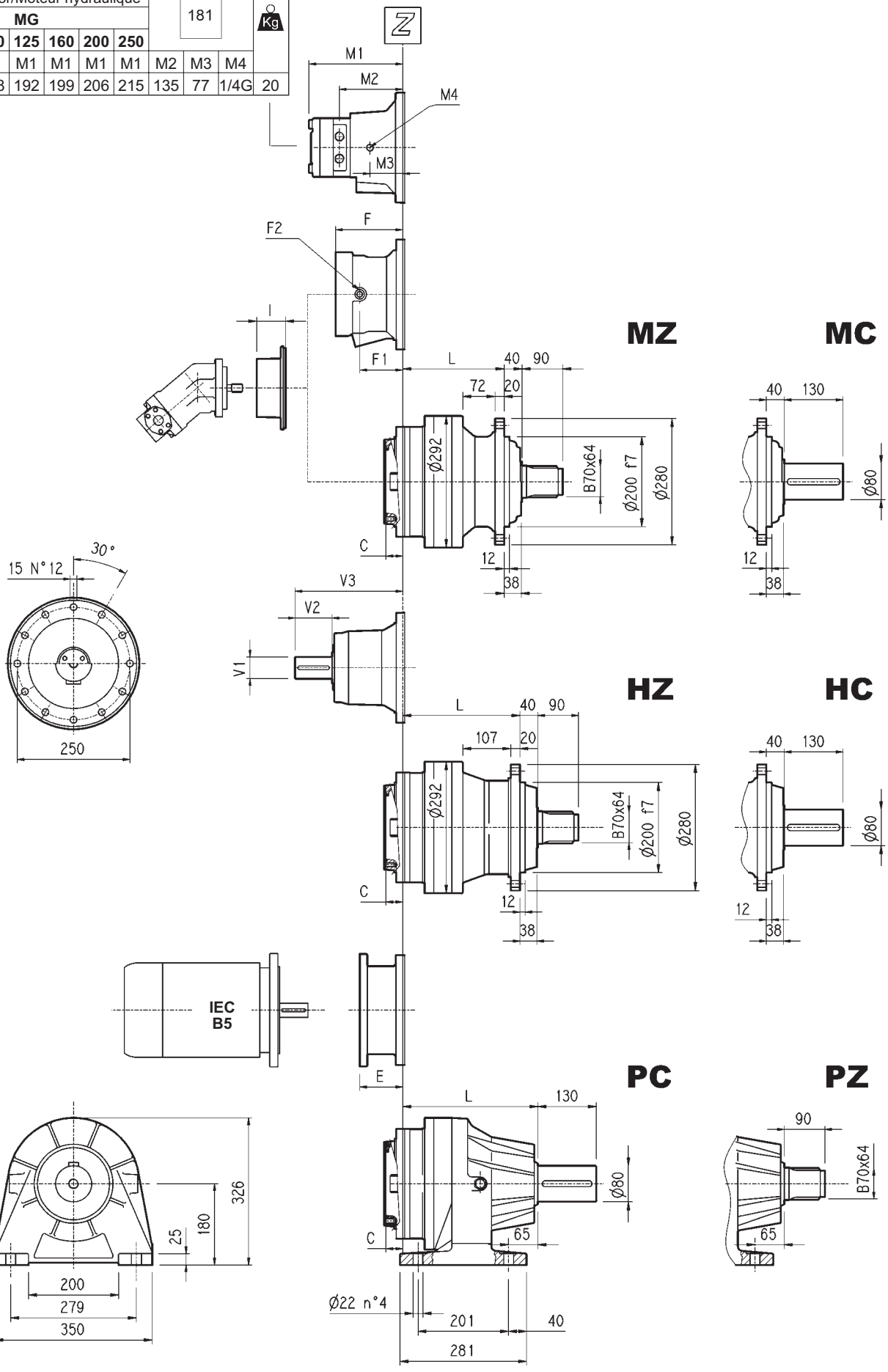
306R

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	9.23	4 650	4 050	3 600	3 200	2 000	1 600	35	18	1 800	3 800	440	4L
	10.89	5 300	4 650	4 150	3 600	2 200	1 800	35	18	1 800	3 800	440	4L
	13.67	6 500	5 600	5 100	4 200	2 600	2 100	35	18	1 800	3 800	440	4L
	15.89	7 300	6 400	5 700	4 700	2 900	2 350	35	18	1 800	3 800	440	4L
	19.22	7 000	5 900	5 500	5 400	3 300	2 700	35	18	1 800	3 800	400	4K
R3	33.2	7 600	7 300	7 300	7 300	4 700	3 800	35	14	2 000	4 000	260	4F
	39.2	8 300	7 900	7 700	7 500	5 100	4 150	34	14	2 000	4 000	260	4F
	46.3	10 000	9 600	9 400	9 300	5 800	4 700	35	14	2 000	4 000	260	4F
	58.1	9 300	9 100	9 100	9 100	5 700	4 600	27	14	2 000	4 000	260	4F
	67.5	7 500	7 400	7 400	7 400	4 600	3 750	19	14	2 000	4 000	260	4F
	72.9	9 500	8 500	7 800	7 800	5 700	4 600	21	14	2 000	4 000	160	4D
	84.7	9 300	8 500	7 800	7 800	5 400	4 400	18	14	2 000	4 000	160	4D
	98.5	8 500	7 200	6 500	6 500	5 700	4 650	14	14	2 000	4 000	100	4B
	119	8 500	7 200	6 500	6 500	5 700	4 650	11.8	14	2 000	4 000	100	4B
	144	7 000	5 900	5 500	5 500	4 700	3 850	8.3	14	2 000	4 000	100	4B
R4	158	10 000	9 600	9 400	8 800	5 400	4 400	15.0	12	2 000	4 000	100	4B
	168	8 100	7 700	7 700	7 500	5 000	4 100	14.0	12	2 000	4 000	100	4B
	181	8 900	8 700	8 700	7 400	4 550	3 700	14.4	12	2 000	4 000	100	4B
	214	10 000	9 600	9 400	8 300	5 100	4 150	13.8	12	2 000	4 000	50	4A
	230	7 500	7 400	7 400	7 400	4 650	3 750	9.5	12	2 000	4 000	50	4A
	249	9 500	8 500	7 800	7 800	5 700	4 600	11.3	12	2 000	4 000	50	4A
	289	9 300	8 500	7 800	7 800	5 400	4 400	9.5	12	2 000	4 000	50	4A
	312	7 500	7 400	7 400	7 400	4 650	3 750	7.3	12	2 000	4 000	50	4A
	377	6 800	6 800	6 800	6 800	4 850	3 950	5.5	12	2 000	4 000	50	4A
	420	9 500	8 500	7 800	7 800	5 700	4 600	7.1	12	2 000	4 000	50	4A
	455	8 500	7 200	6 500	6 500	5 700	4 650	6.2	12	2 000	4 000	50	4A
	488	9 300	8 500	7 800	7 800	5 400	4 400	6.1	12	2 000	4 000	50	4A
	550	7 000	5 900	5 500	5 500	4 700	3 850	4.4	12	2 000	4 000	50	4A
	590	7 000	5 900	5 500	5 500	4 700	3 850	3.5	12	2 000	4 000	50	4A
	665	7 000	5 900	5 500	5 500	4 700	3 850	3.7	12	2 000	4 000	50	4A
	830	7 000	5 900	5 500	5 500	4 700	3 850	3.1	12	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

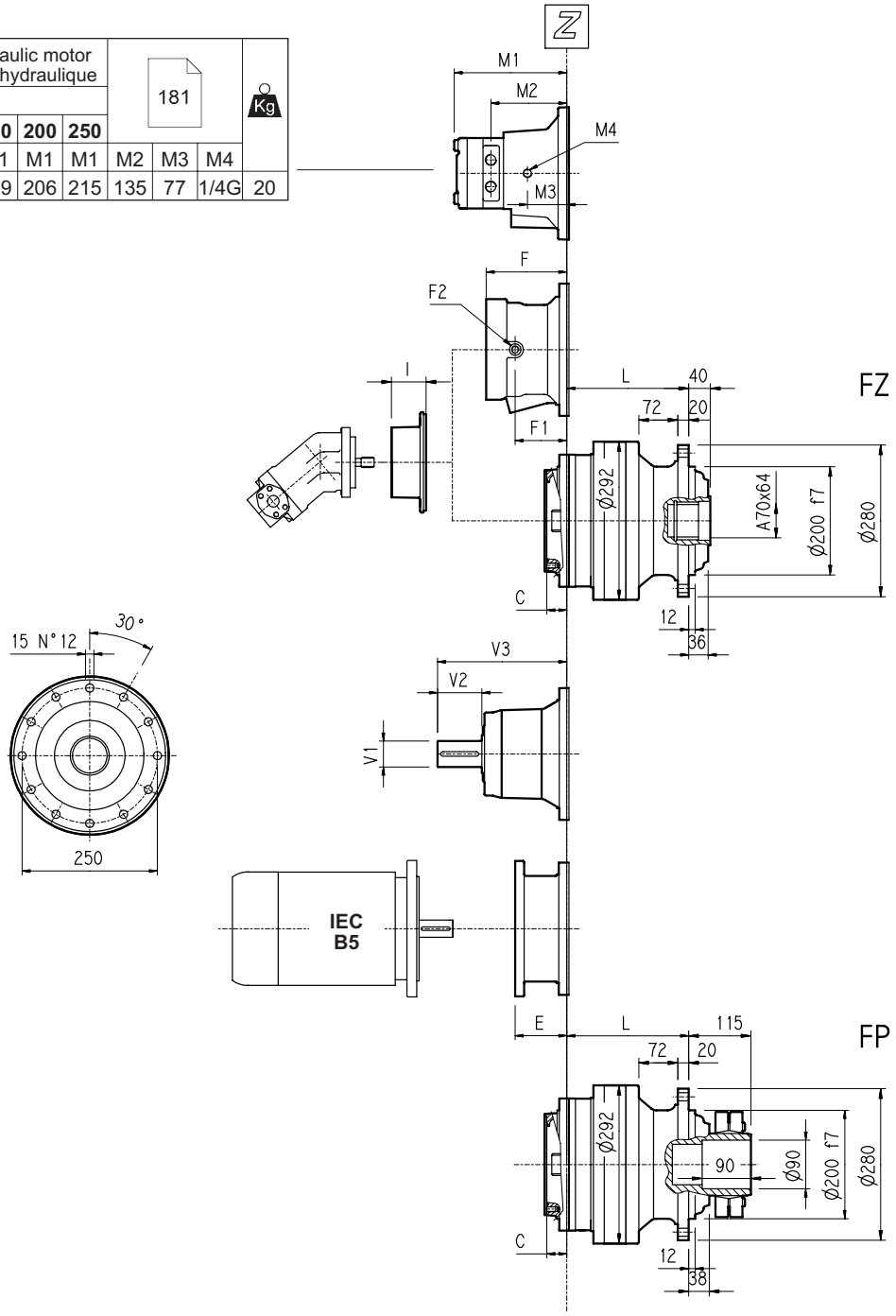
306L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique										
	MG							181			Kg
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
306L2	-	184	188	192	199	206	215	135	77	1/4G	20



306L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
306L2	-	184	188	192	199	206	215	135	77	1/4G	20



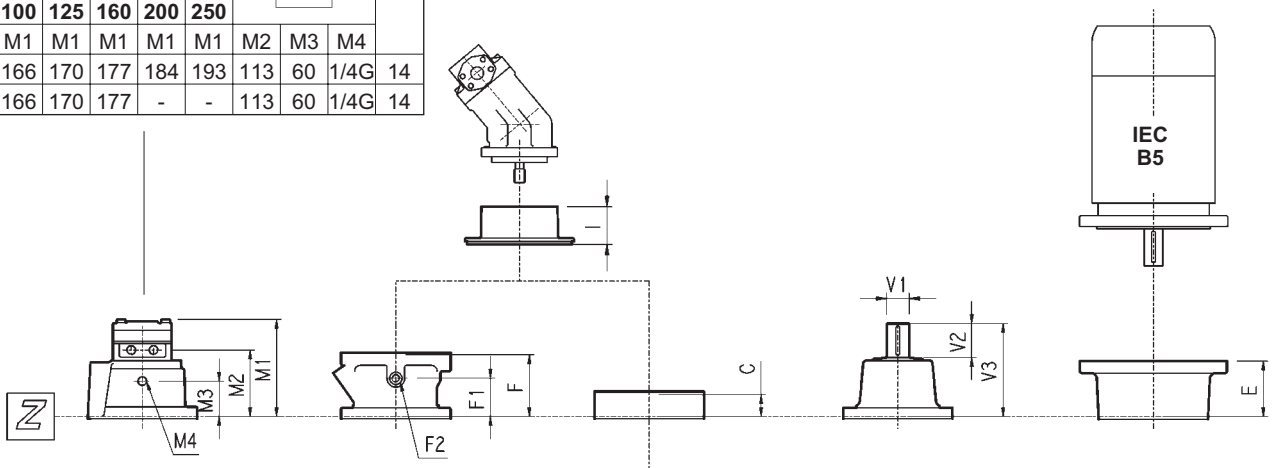
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**8 500 Nm**

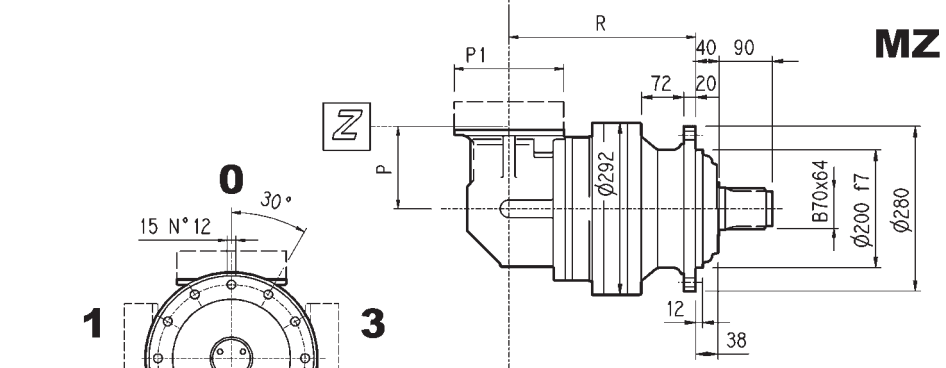
	L				Kg													Kg
	MZ MC	FZ FP	HZ HC	PC PZ	MZ MC	FZ FP	HZ HC	PC PZ	C	Entrata Input Antrieb Entrée	I	F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	
306 L1	160	160	195	235	65	65	70	80	45	B		195	147	1/4 G	6	B	28
306 L2	225	225	260	300	74	74	79	89	37	A		145	95	1/4 G	5	A	16
306 L3	278	278	313	353	78	78	83	93	37	A		105	65	1/4 G	4	A	10
306 L4	331	331	366	406	82	82	87	97	37	A	171	105	65	1/4 G	4	A	10

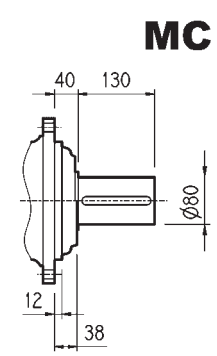
	V1	V2	V3	Kg	V1	V2	V3	Kg	E											
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160	IEC 180	IEC 200	IEC 225	IEC 250
306 L1	60	105	307	23												152	152	182	212	193
306 L2	48	82	239	15											114	144	144	174		
306 L3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				
306 L4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				

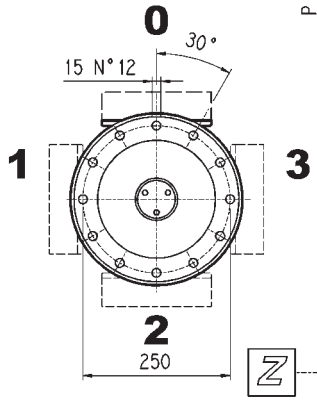
306R

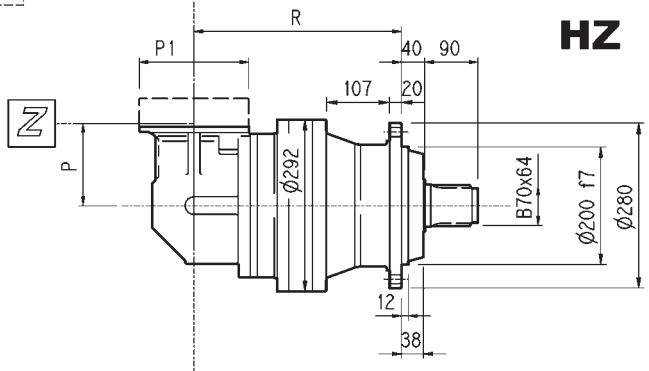
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
306R2	-	162	166	170	177	184	193	113	60	1/4G	14
306R3	156	162	166	170	177	-	-	113	60	1/4G	14

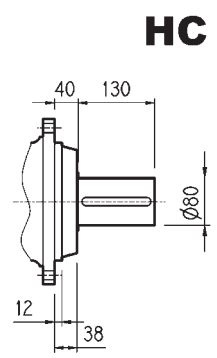


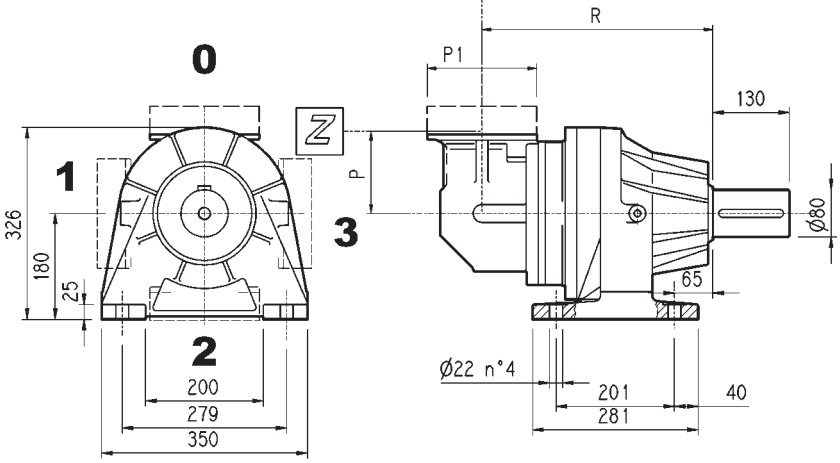


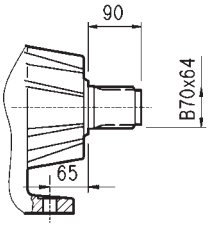






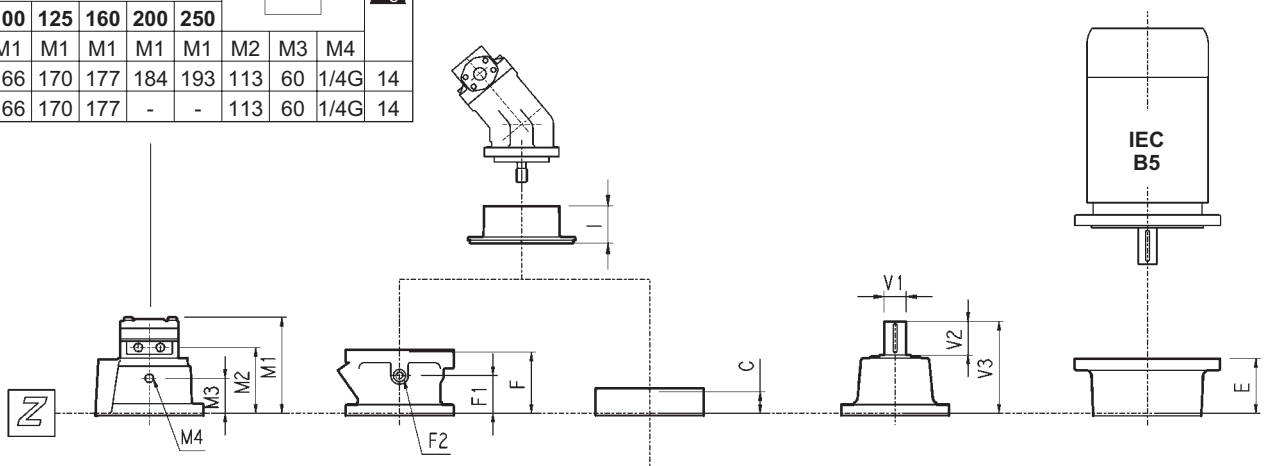


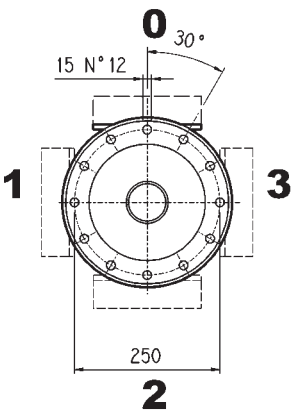


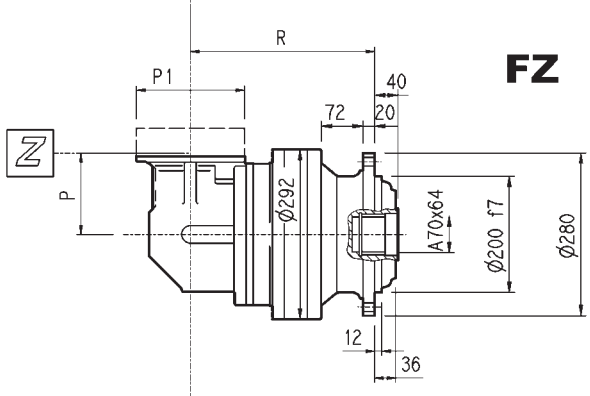


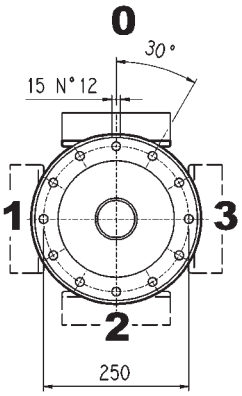
306R

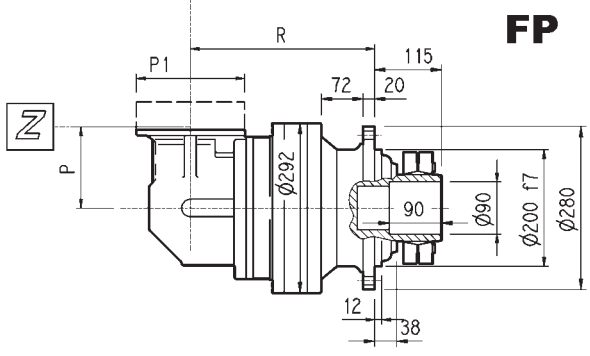
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
306R2	-	162	166	170	177	184	193	113	60	1/4G	14
306R3	156	162	166	170	177	-	-	113	60	1/4G	14











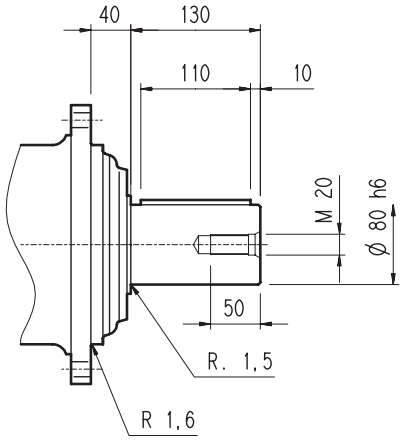
VERSIONE FP FP VERSION VERSION FP VERSION FP	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	8 500 Nm

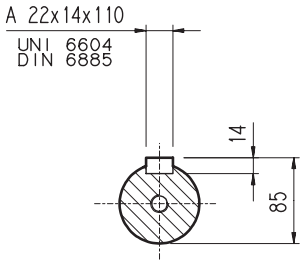
	R				P	P1	Kg				C	Entrata Input Antrieb Entrée	I	F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
	MZ MC	FZ FP	HZ HC	PC PZ			MZ MC	FZ FP	HZ HC	PC PZ									
306 R2	297	297	332	372	140	186	89	89	94	104	37	A		105	65	1/4 G	4	A	10
306 R3	317	317	352	392	140	186	85	85	90	100	37	A		105	65	1/4 G	4	A	10
306 R4	370	370	405	445	122	186	79	79	84	94	37	A	171	105	65	1/4 G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160		
306 R2	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		
306 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		
306 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		

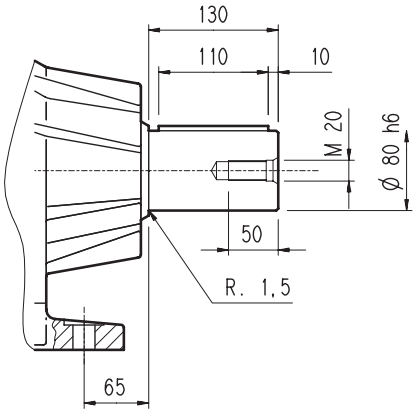
306L - 306R

MC-HC

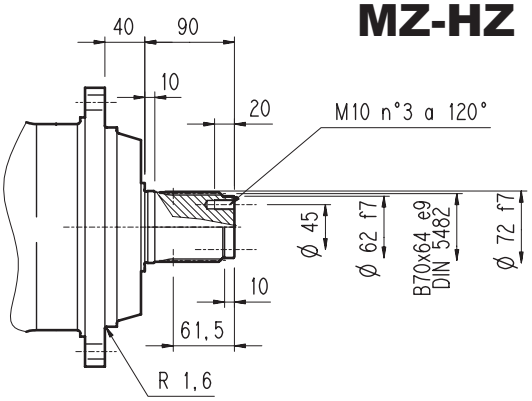


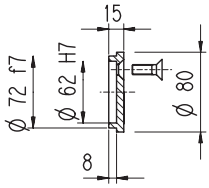


PC

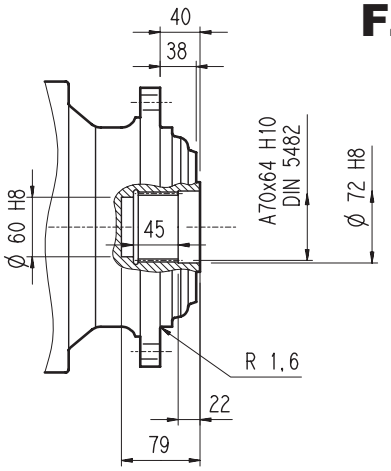


MZ-HZ

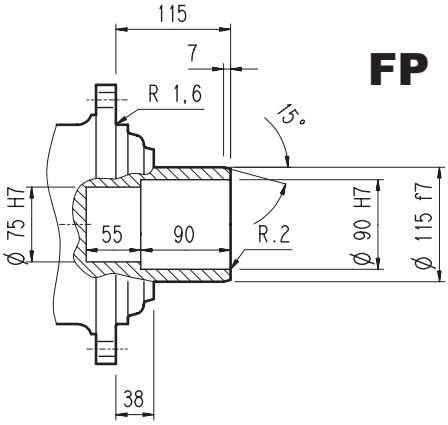


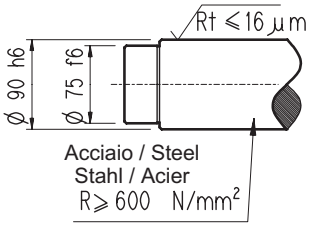


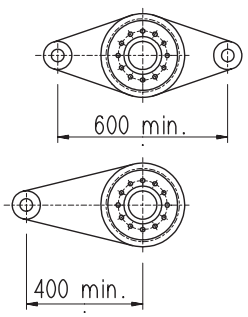
FZ



FP





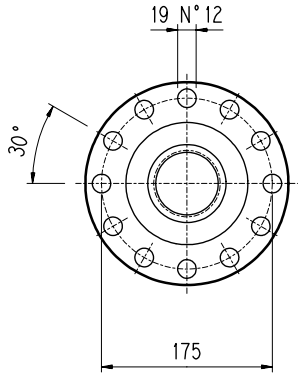


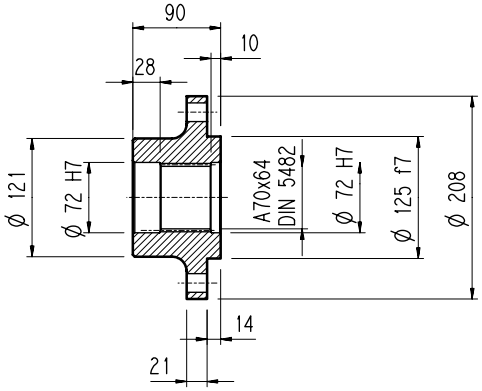
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**8 500 Nm**

306L - 306R

Flangia / Flange
Flansch / Brides

W0A

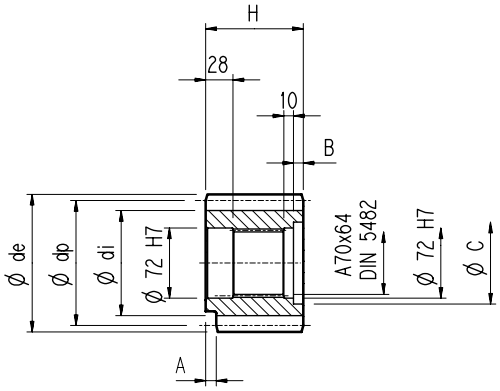




Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...

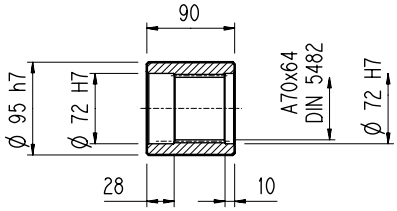


Codice Code	m	z	x	dp	di	de	H	A	B	C	★
PFF1	8	15	0	120	100	134	90	0	0	0	■
PFF2	8	15	0.500	120	108	141	90	0	0	0	■
PHB	10	11	0.500	110	95	136	90	10	0	0	■
PHC1	10	12	0.450	120	104	145	90	0	0	0	■
PHC2	10	12	0.320	120	100	144.2	90	0	0	0	■
PHC3	10	12	0.350	120	101	144	90	0	0	0	■
PHD1	10	13	0.950	130	124	165	90	0	0	0	■
PHD2	10	13	0.500	130	115	159	90	0	0	0	■
PHE1	10	14	0	140	115	160	90	0	0	0	■
PHE2	10	14	0.500	140	125	166	90	0	0	0	❑
PHF	10	15	0	150	127	167	90	24	0	0	■
PHH	10	17	0.480	170	154	197.5	90	10	0	0	■
PHM	10	20	0	200	175	220	90	10	0	0	❑

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
❑	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

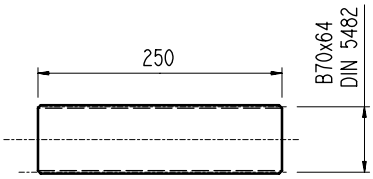
M0A



Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

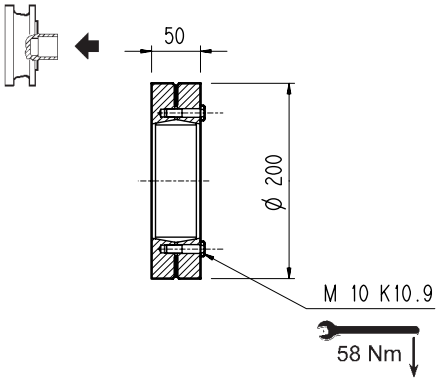
B0A



Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

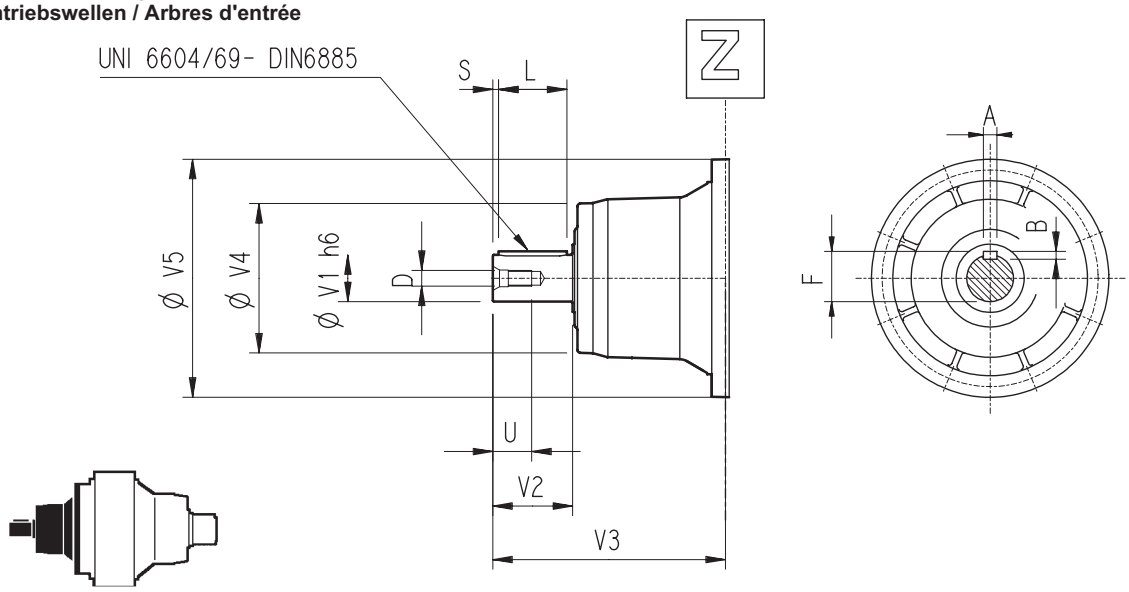
Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

G0A



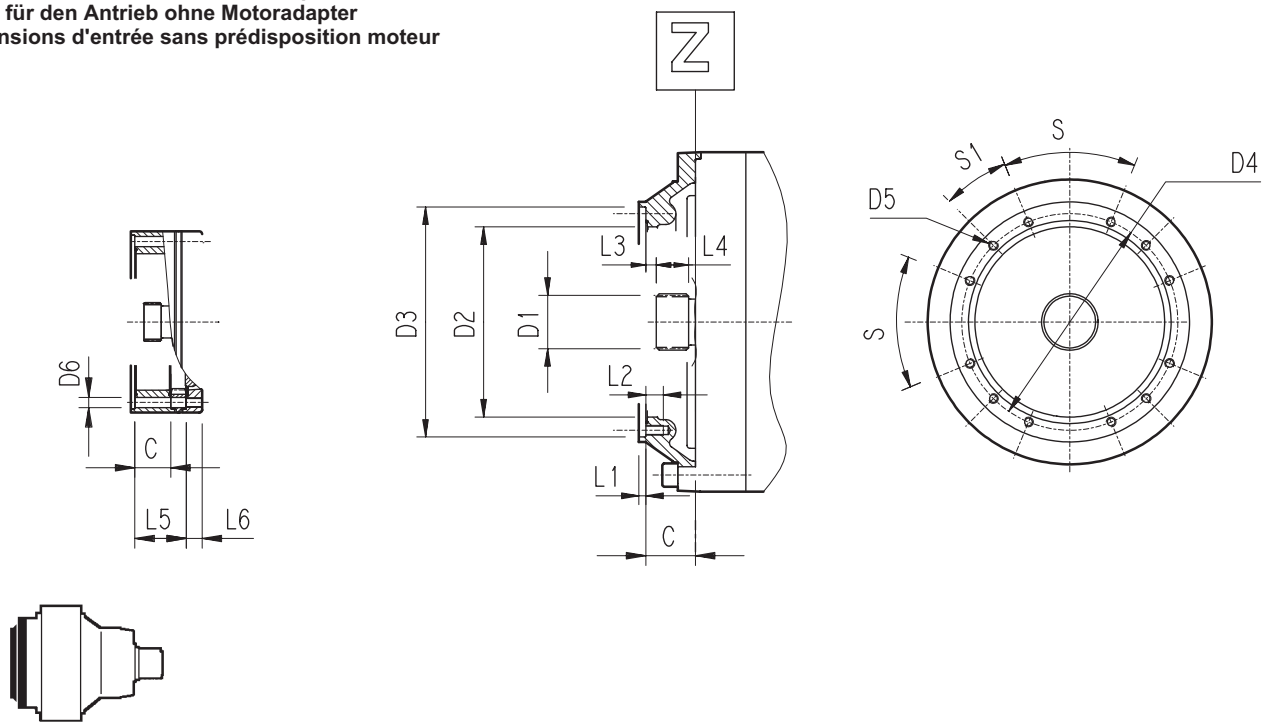
306L - 306R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
306 L1	V06B	60	105	307	155	292	18	11	64	90	7.5	M16	40
306 L2	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
306 L3	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
306 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
306 R2-R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



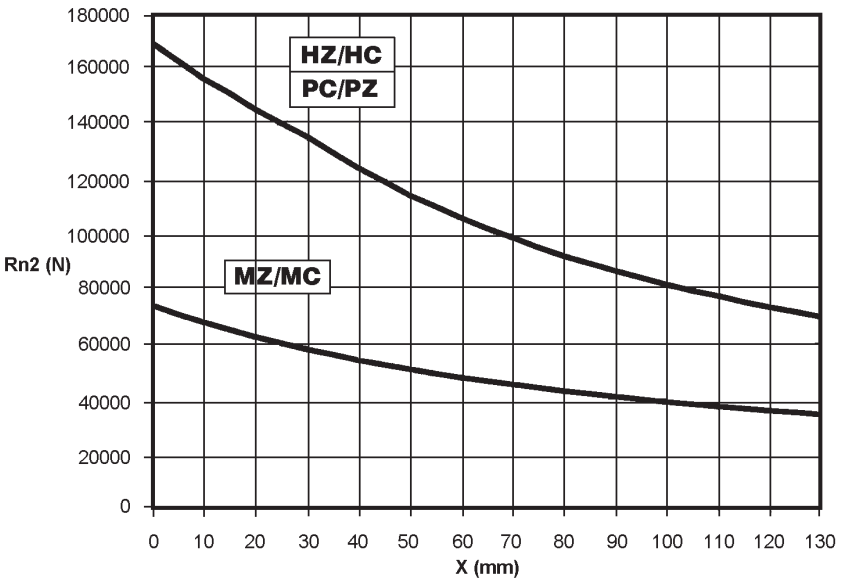
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
306 L1	45	58x53 DIN5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
306 L2	37	40x36 DIN5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
306 L3	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	53	18	45°	45°	A
306 L4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	106	18	45°	45°	A
306 R2-R3-R4	37	40x36 DIN5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

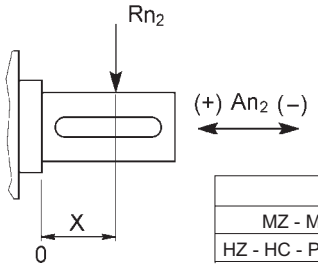
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

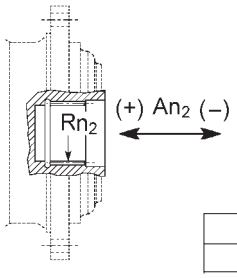
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
MZ - MC	70 000	44 000
HZ - HC - PC - PZ	120 000	60 000



	Rn2	An2 (+/-)
FZ	35 000	35 000

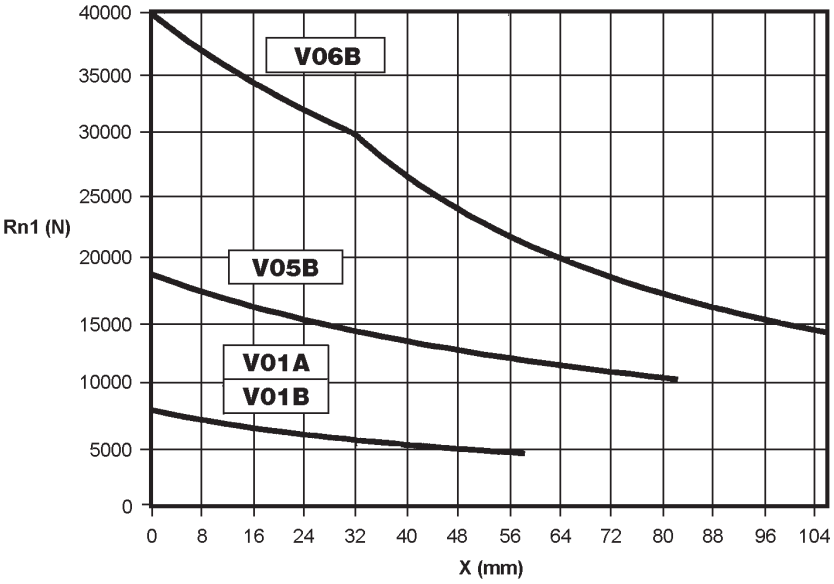
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	MZ - MC - FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

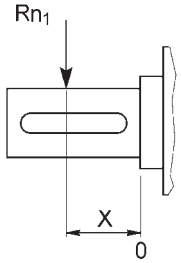
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

307L

M_2 = 12500 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	3.43	9 000	9 000	9 000	9 000	8 000	6 500	100	22	1 500	2 500	3 200	6L
	4.09	15 000	13 800	12 900	12 500	7 900	6 400	100	22	1 500	2 500	3 200	6L
	5.25	14 000	12 000	10 700	10 500	7 700	6 200	100	22	1 500	2 500	3 200	6L
	6.23	11 000	9 600	8 700	8 700	7 700	6 200	100	22	1 500	2 500	2 100	6G
L 2	12.3	9 000	9 000	9 000	9 000	8 000	6 500	60	18	1 800	3 800	1 000	5K
	14.7	15 000	13 800	12 900	12 500	7 900	6 400	60	18	1 800	3 800	800	5G
	17.4	15 000	13 800	12 900	12 500	7 900	6 400	60	18	1 800	3 800	1 000	5K
	21.8	15 000	13 800	12 900	12 500	7 900	6 400	60	18	1 800	3 800	800	5G
	25.4	14 500	13 800	12 900	12 500	7 900	6 400	60	18	1 800	3 800	630	5E
	28.0	14 000	12 000	10 700	10 500	7 700	6 200	60	18	1 800	3 800	500	5C
	30.7	12 300	12 300	12 300	12 300	7 800	6 300	60	18	1 800	3 800	500	5C
	32.6	14 000	12 000	10 700	10 500	7 700	6 200	56	18	1 800	3 800	500	5C
	38.6	11 000	9 600	8 700	8 700	7 700	6 200	39	18	1 800	3 800	400	5B
	46.7	11 000	9 600	8 700	8 700	7 700	6 200	33	18	1 800	3 800	400	5B
L 3	51.3	15 000	13 800	12 900	12 500	7 900	6 400	30	11	2 000	4 000	330	4H
	60.5	15 000	13 800	12 900	12 500	7 900	6 400	30	11	2 000	4 000	330	4H
	74.1	15 000	13 800	12 900	12 500	7 900	6 400	30	11	2 000	4 000	260	4F
	80.6	14 000	12 000	10 700	10 500	7 700	6 200	27	11	2 000	4 000	260	4F
	93.0	15 000	13 800	12 900	12 500	7 900	6 400	26	11	2 000	4 000	260	4F
	100	15 000	13 800	12 900	12 500	7 900	6 400	25	11	2 000	4 000	260	4F
	113	14 000	12 000	10 700	10 500	7 700	6 200	20	11	2 000	4 000	160	4D
	126	15 000	13 800	12 900	12 500	7 900	6 400	20	11	2 000	4 000	160	4D
	139	14 000	12 000	10 700	10 500	7 700	6 200	17.1	11	2 000	4 000	160	4D
	153	11 000	9 600	8 700	8 700	7 700	6 200	12.3	11	2 000	4 000	160	4D
	162	14 000	12 000	10 700	10 500	7 700	6 200	15.1	11	2 000	4 000	100	4B
	177	12 300	12 300	12 300	12 300	7 800	6 300	12.0	11	2 000	4 000	100	4B
	202	14 000	12 000	10 700	10 500	7 700	6 200	11.9	11	2 000	4 000	100	4B
	223	11 000	9 600	8 700	8 700	7 700	6 200	9.0	11	2 000	4 000	100	4B
	239	11 000	9 600	8 700	8 700	7 700	6 200	8.5	11	2 000	4 000	50	4A
	284	14 000	12 000	10 700	10 500	7 700	6 200	9.3	11	2 000	4 000	50	4A
	336	11 000	9 600	8 700	8 700	7 700	6 200	6.4	11	2 000	4 000	50	4A
L 4	349	15 000	13 800	12 900	12 500	7 900	6 400	12.9	7.5	2 000	4 000	50	4A
	406	14 000	12 000	10 700	10 500	7 700	6 200	10.2	7.5	2 000	4 000	50	4A
	465	14 000	12 000	10 700	10 500	7 700	6 200	9.7	7.5	2 000	4 000	50	4A
	509	15 000	13 800	12 900	12 500	7 900	6 400	8.4	7.5	2 000	4 000	50	4A
	579	15 000	13 800	12 900	12 500	7 900	6 400	7.8	7.5	2 000	4 000	50	4A
	654	14 000	12 000	10 700	10 500	7 700	6 200	6.9	7.5	2 000	4 000	50	4A
	722	15 000	13 800	12 900	12 500	7 900	6 400	6.2	7.5	2 000	4 000	50	4A
	801	14 000	12 000	10 700	10 500	7 700	6 200	5.6	7.5	2 000	4 000	50	4A
	906	15 000	13 800	12 900	12 500	7 900	6 400	5.0	7.5	2 000	4 000	50	4A
	999	14 000	12 000	10 700	10 500	7 700	6 200	4.5	7.5	2 000	4 000	50	4A
	1 149	11 000	9 600	8 700	8 700	7 700	6 200	3.6	7.5	2 000	4 000	50	4A
	1 274	12 300	12 300	12 300	12 300	7 800	6 300	3.5	7.5	2 000	4 000	50	4A
	1 380	11 000	9 600	8 700	8 700	7 700	6 200	3.1	7.5	2 000	4 000	50	4A
	1 605	11 000	9 600	8 700	8 700	7 700	6 200	2.7	7.5	2 000	4 000	50	4A
	1 723	11 000	9 600	8 700	8 700	7 700	6 200	2.5	7.5	2 000	4 000	50	4A
	2 041	14 000	12 000	10 700	10 500	7 700	6 200	2.2	7.5	2 000	4 000	50	4A
	2 423	11 000	9 600	8 700	8 700	7 700	6 200	1.9	7.5	2 000	4 000		

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

M_2 = 12500 Nm

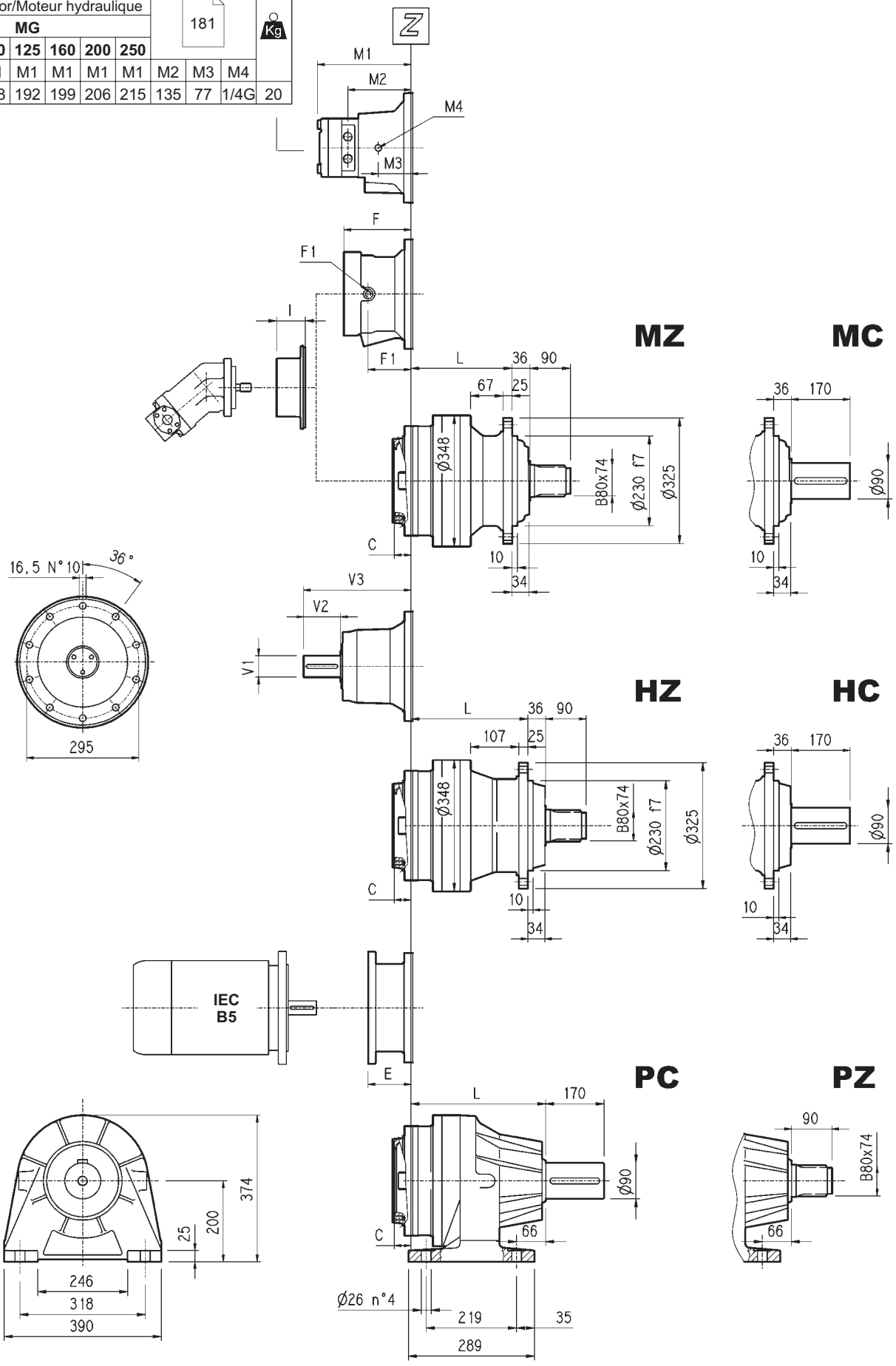
307R

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	13.0	9 000	8 500	7 600	6 800	5 300	4 250	85	35	1 800	3 800	1 000	5K
	15.5	11 400	9 800	8 800	7 900	5 900	4 850	85	35	1 800	3 800	1 000	5K
	19.8	14 000	12 000	10 700	9 700	7 100	5 700	85	35	1 800	3 800	800	5G
	23.5	11 000	9 600	8 700	8 700	7 700	6 200	62	35	1 800	3 800	500	5C
R3	31.6	9 000	9 000	9 000	7 400	4 550	3 700	35	20	2 000	4 000	400	4K
	37.7	14 800	12 600	10 300	8 300	5 100	4 150	35	20	2 000	4 000	440	4L
	44.6	15 000	13 800	11 500	9 400	5 800	4 700	35	20	2 000	4 000	400	4K
	55.9	15 000	13 800	12 900	11 000	6 800	5 500	35	20	2 000	4 000	330	4H
	65.0	14 500	13 800	12 900	12 200	7 500	6 100	35	20	2 000	4 000	260	4F
	71.8	14 000	12 000	10 700	10 500	7 700	6 200	30	20	2 000	4 000	260	4F
	78.6	12 300	12 300	12 300	12 300	7 800	6 300	27	20	2 000	4 000	260	4F
	83.4	14 000	12 000	10 700	10 500	7 700	6 200	26	20	2 000	4 000	260	4F
	99.0	11 000	9 600	8 700	8 700	7 700	6 200	17.9	20	2 000	4 000	160	4D
	120	11 000	9 600	8 700	8 700	7 700	6 200	15.3	20	2 000	4 000	160	4D
R4	152	15 000	13 800	12 900	12 500	7 900	6 400	15.0	14	2 000	4 000	100	4B
	165	14 000	12 000	10 700	10 500	7 700	6 200	15.0	14	2 000	4 000	100	4B
	191	15 000	13 800	12 900	12 500	7 900	6 400	15.0	14	2 000	4 000	100	4B
	206	15 000	13 800	12 900	12 500	7 900	6 400	15.0	14	2 000	4 000	100	4B
	232	14 000	12 000	10 700	10 500	7 700	6 200	15.0	14	2 000	4 000	100	4B
	258	15 000	13 800	12 900	12 500	7 900	6 400	15.0	14	2 000	4 000	100	4B
	284	14 000	12 000	10 700	10 500	7 700	6 200	14.9	14	2 000	4 000	100	4B
	313	11 000	9 600	8 700	8 700	7 700	6 200	10.8	14	2 000	4 000	50	4A
	331	14 000	12 000	10 700	10 500	7 700	6 200	13.1	14	2 000	4 000	50	4A
	344	14 000	12 000	10 700	10 500	7 700	6 200	12.7	14	2 000	4 000	50	4A
	363	12 300	12 300	12 300	12 300	7 800	6 300	10.4	14	2 000	4 000	50	4A
	413	14 000	12 000	10 700	10 500	7 700	6 200	10.9	14	2 000	4 000	50	4A
	457	11 000	9 600	8 700	8 700	7 700	6 200	7.8	14	2 000	4 000	50	4A
	490	11 000	9 600	8 700	8 700	7 700	6 200	7.4	14	2 000	4 000	50	4A
	581	14 000	12 000	10 700	10 500	7 700	6 200	7.8	14	2 000	4 000	50	4A
	690	11 000	9 600	8 700	8 700	7 700	6 200	7.4	14	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

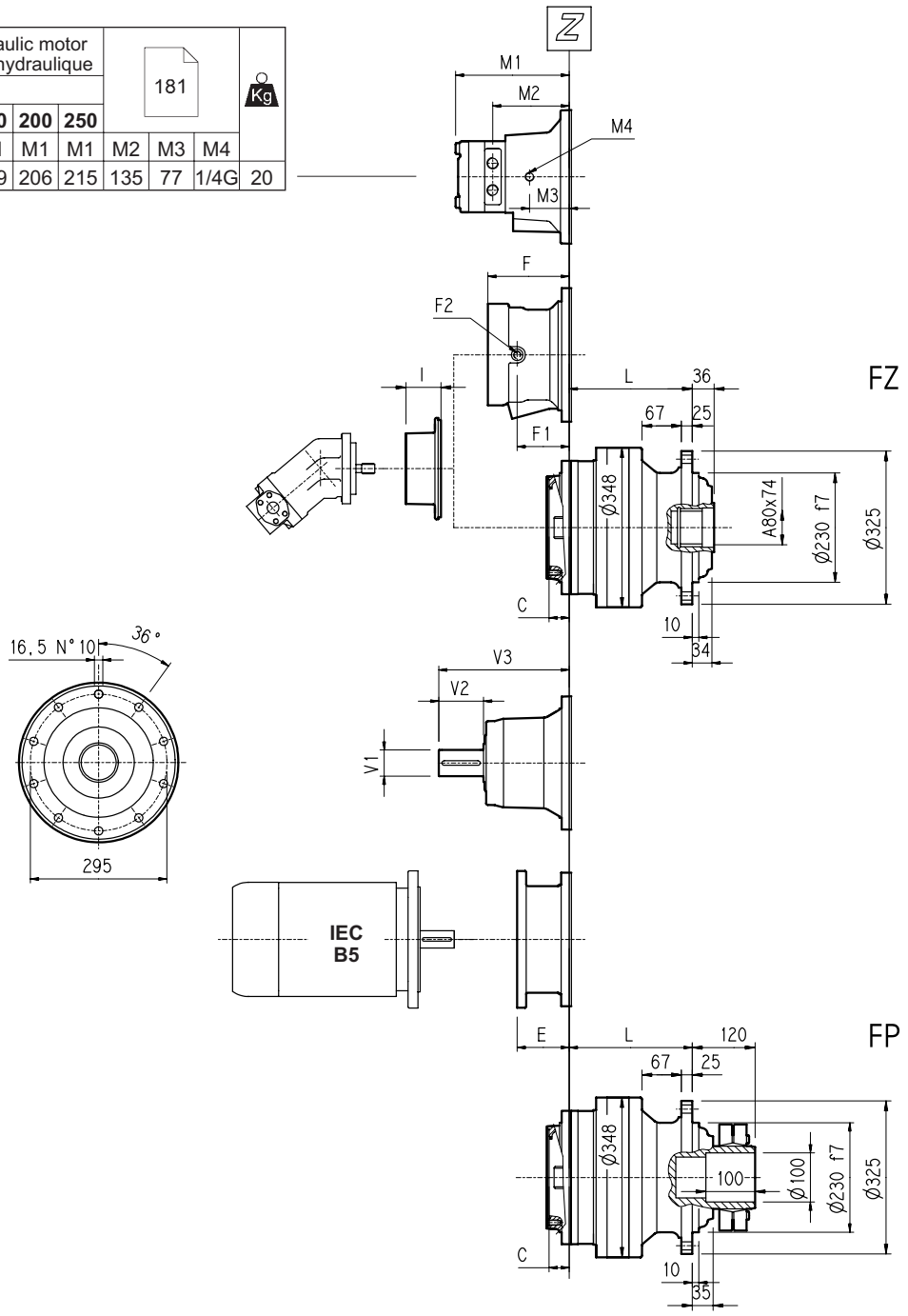
307L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
307L2	-	-	188	192	199	206	215	135	77	1/4G	20



307L

	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
307L2	-	-	188	192	199	206	215	135	77	1/4G	20



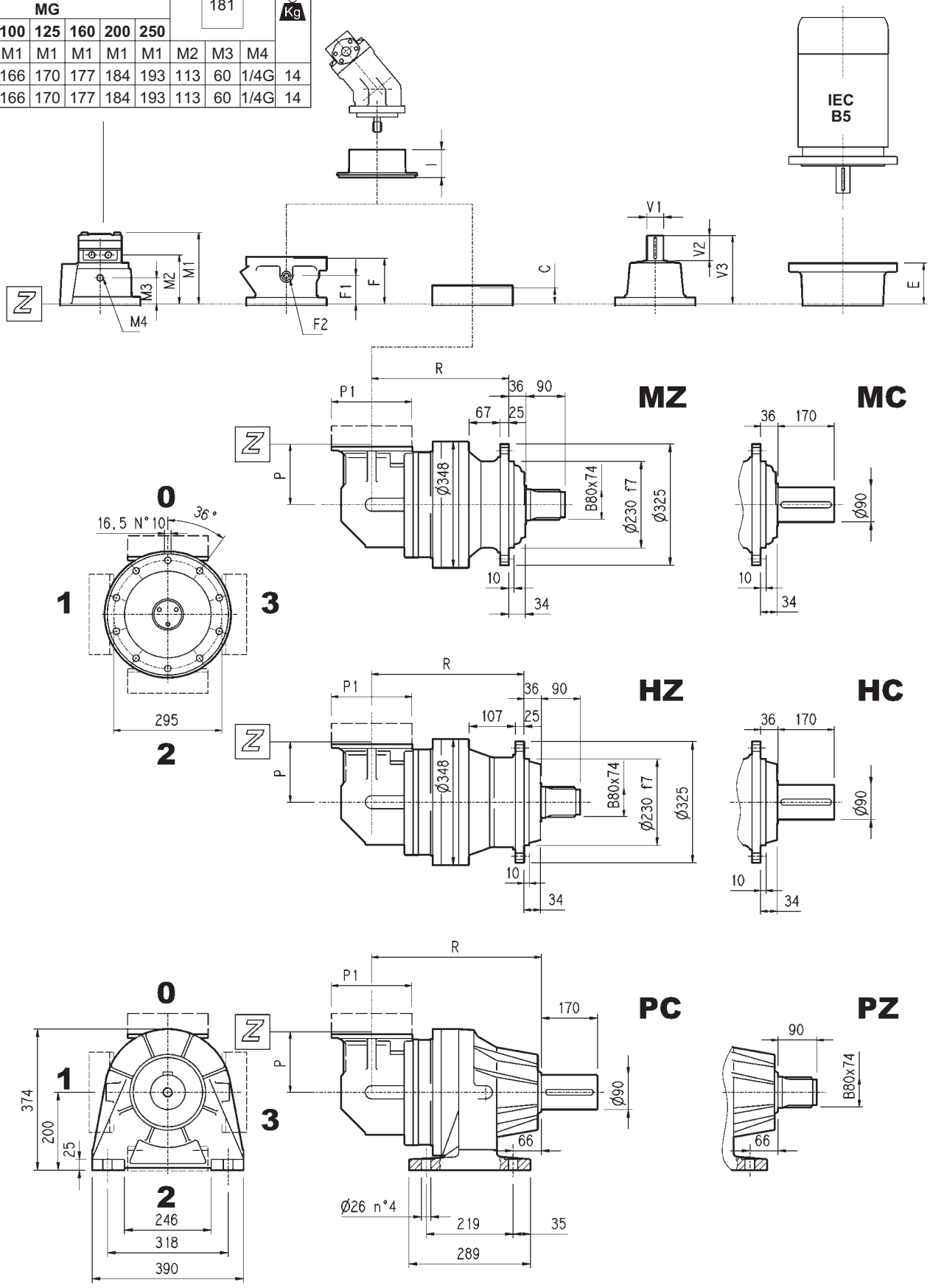
VERSIONE FP FP VERSION VERSION FP VERSION FP	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	12 500 Nm

	L				Kg				C		I	F	F1	F2	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
	MZ MC	FZ FP	HZ HC	PC PZ	MZ MC	FZ FP	HZ HC	PC PZ		Entrata Input Antrieb Entrée							
307 L1	165	165	210	246	95	85	105	120	51	B		201	153	1/4 G	6	B	28
307 L2	254	254	299	335	107	97	117	132	37	A		145	95	1/4 G	5	A	16
307 L3	319	319	364	400	114	104	124	139	37	A		105	65	1/4 G	4	A	10
307 L4	372	372	417	453	118	108	128	143	37	A	171	105	65	1/4 G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E											
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160	IEC 180	IEC 200	IEC 225	IEC 250
307 L1	80	130	315	35	60	105	313	28									195	186	216	215
307 L2	48	82	239	15											114	144	144	174		
307 L3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				
307 L4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				

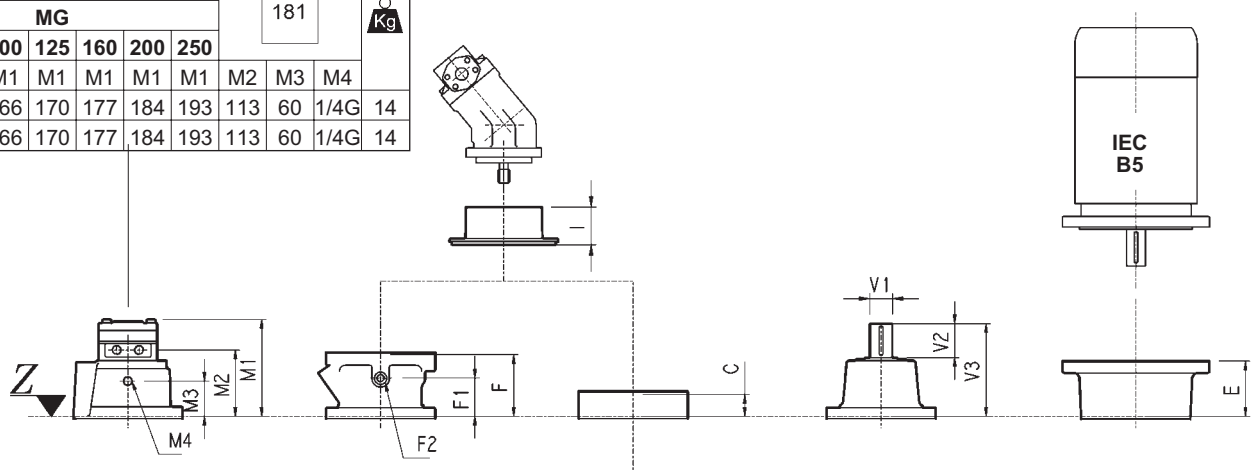
307R

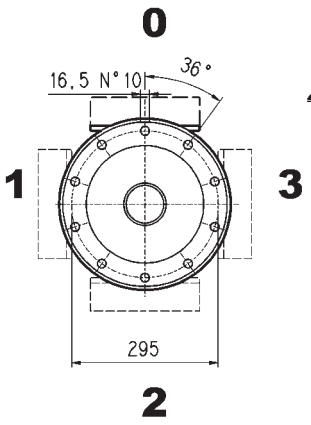
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm³	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
307R2	-	-	166	170	177	184	193	113	60	1/4G	14
307R3	-	162	166	170	177	184	193	113	60	1/4G	14

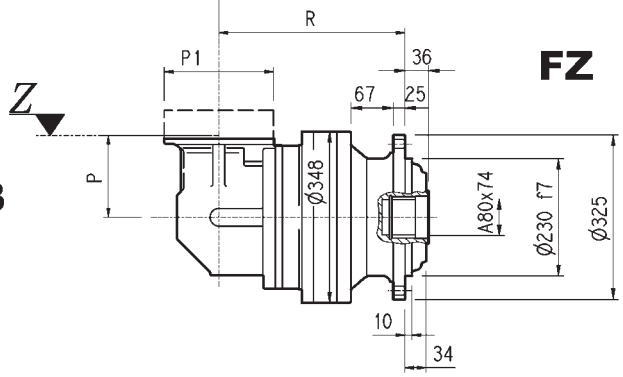


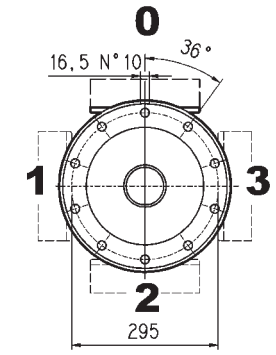
307R

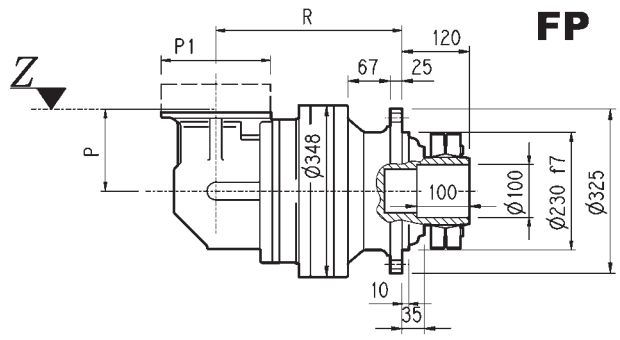
	Motore idraulico / Hydraulic motor Hydraulikmotor/Moteur hydraulique							181			Kg
	MG										
cm^3	50	80	100	125	160	200	250				
	M1	M1	M1	M1	M1	M1	M1	M2	M3	M4	
307R2	-	-	166	170	177	184	193	113	60	1/4G	14
307R3	-	162	166	170	177	184	193	113	60	1/4G	14











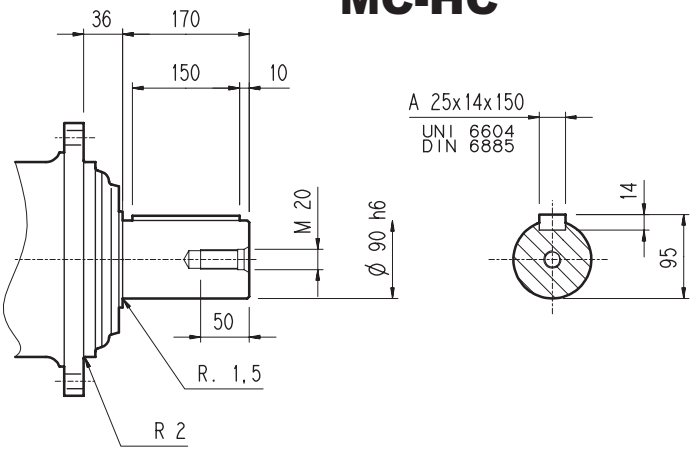
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**12 500 Nm**

	R				P	P1	Kg				C		I	F	F1	F2			Kg
	MZ MC	FZ FP	HZ HC	PC PZ			MZ MC	FZ FP	HZ HC	PC PZ		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
307 R2	284	284	329	365	225	245	145	135	155	170	37	A		145	95	1/4 G	5	A	16
307 R3	346	346	391	427	140	186	127	117	137	152	37	A		105	65	1/4 G	4	A	10
307 R4	411	411	456	492	122	186	128	118	138	153	37	A	171	105	65	1/4 G	4	A	10

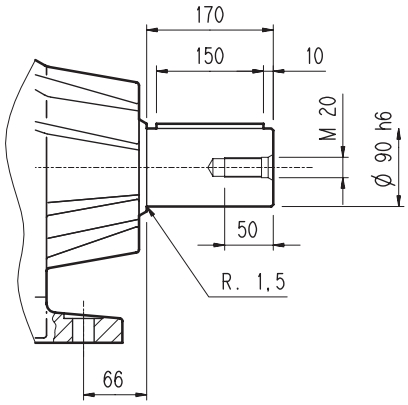
	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160	IEC 180	IEC 200
307 R2	48	82	239	15											114	144	144	174
307 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		
307 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		

307L - 307R

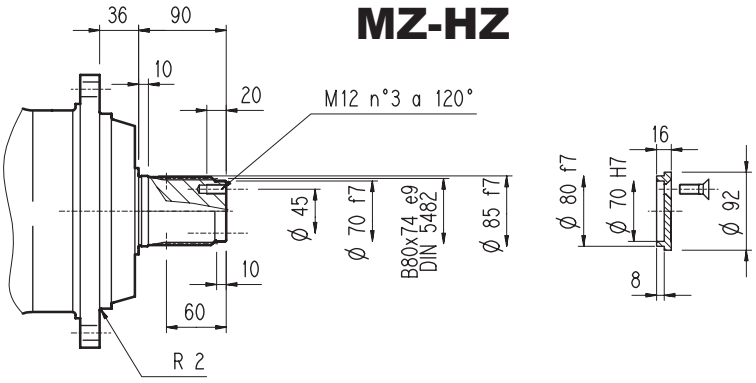
MC-HC



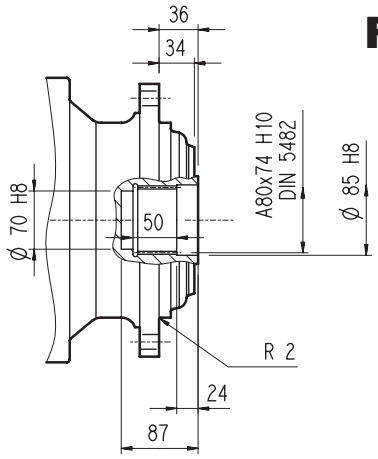
PC



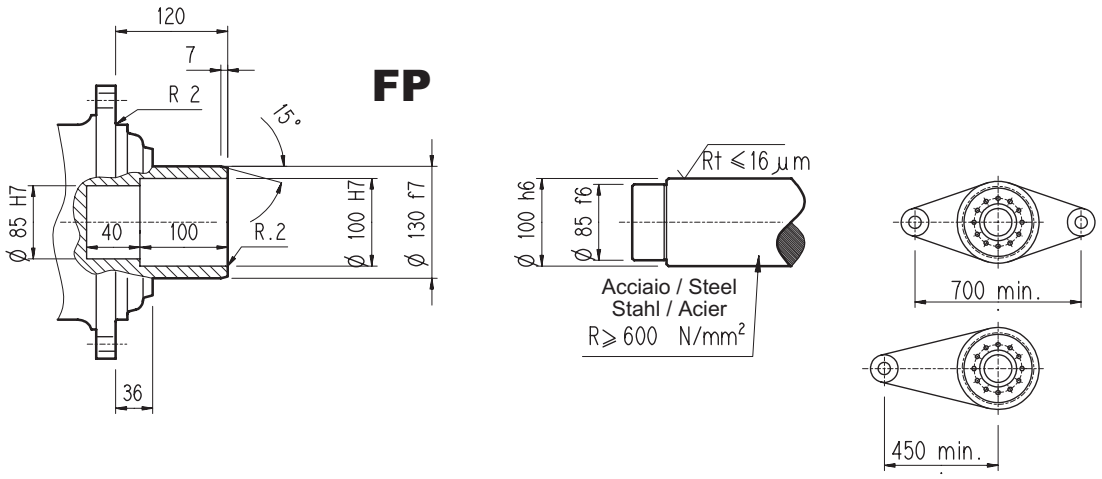
MZ-HZ



FZ



FP

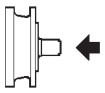


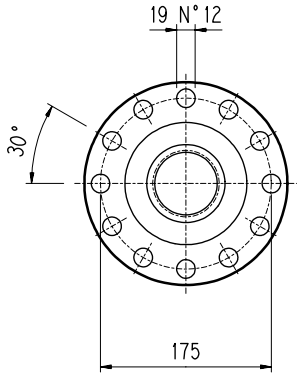
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**12 500 Nm**

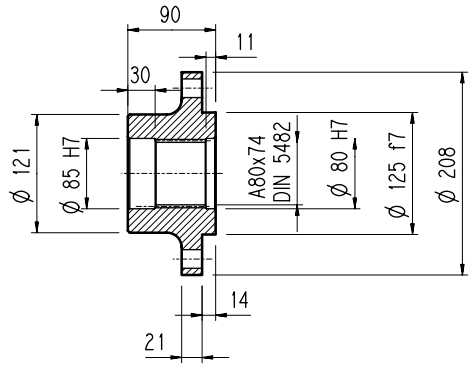
307L - 307R

Flangia / Flange
Flansch / Brides

W0A



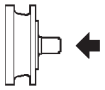


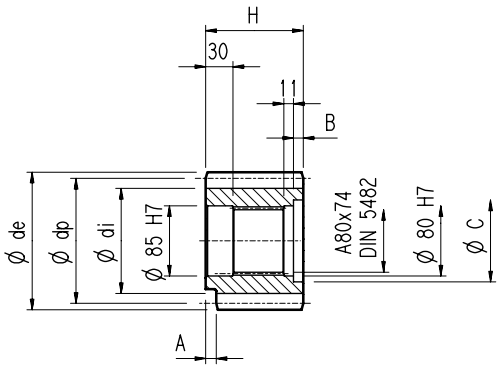


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



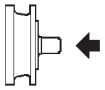


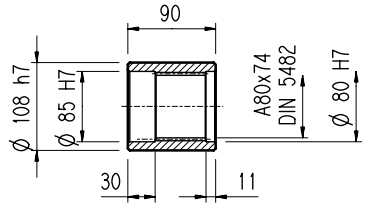
	m	z	x	dp	di	de	H	A	B	C	☆
PFG	8	16	0.500	128	117	149.5	90	0	0	0	□
PHC	10	12	0.450	120	104	145	90	0	0	0	□
PHE	10	14	0.320	140	121	162.5	116	13	26	95	□
PHF	10	15	0.150	150	130	171.5	107	20	17	100	□
PHG	10	16	0.500	160	145	186	90	0	0	0	■
PHH1	10	17	0	170	145	190	90	0	0	0	■
PHH2	10	17	0.500	170	154	198	90	0	0	0	■
PLD	12	13	0.500	156	138	192	102	0	12	95	□
PLE	12	14	0.500	168	150	199.2	90	0	0	0	□
PLI	12	18	0.500	216	198	249.6	107	7	17	95	□
PLT	12	26	0	312	282	336	90	10	0	0	■

☆	Materiale/Material/Material/Màterial
□	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
■	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

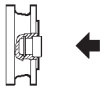


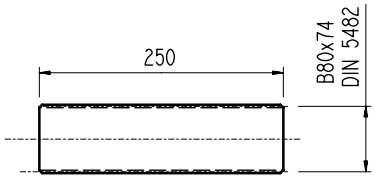


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

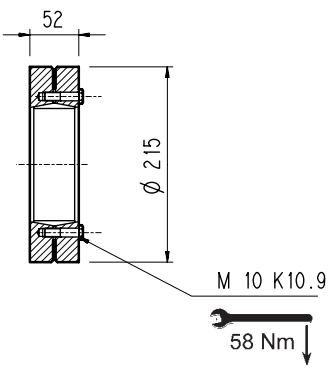




Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

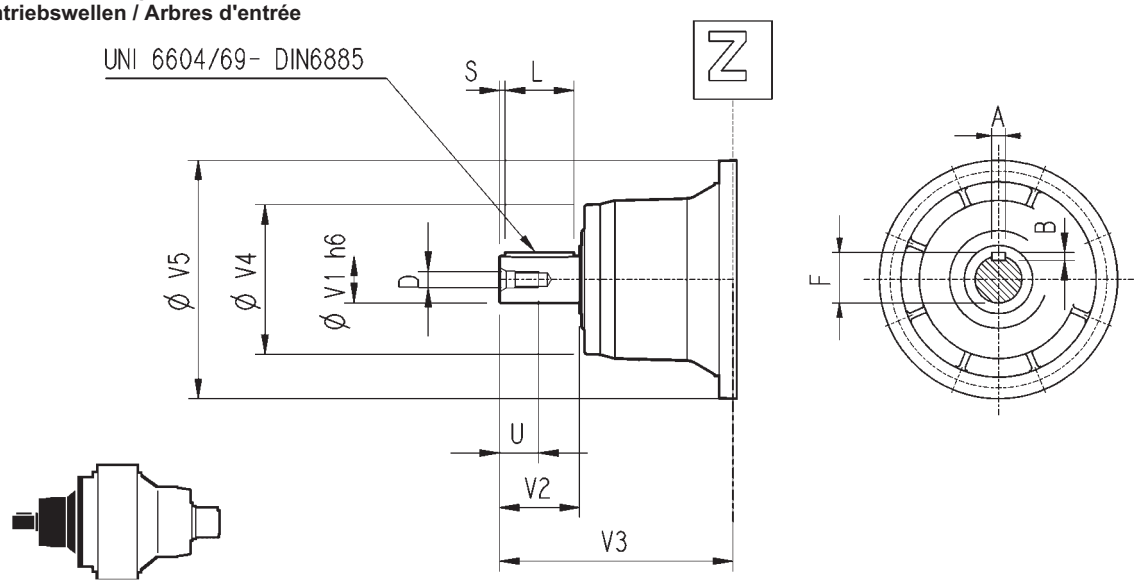
Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

G0A



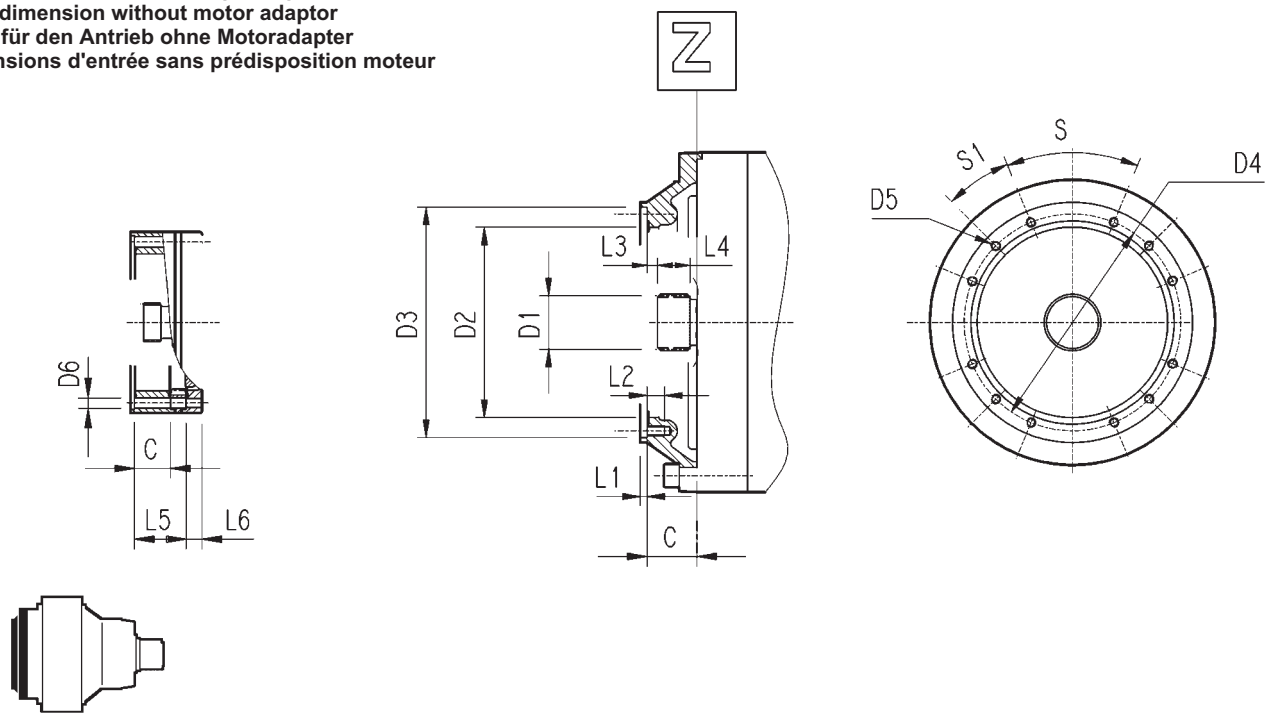
307L - 307R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
307 L1	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
307 L2	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
307 L3	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
307 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
307 R2	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
307 R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



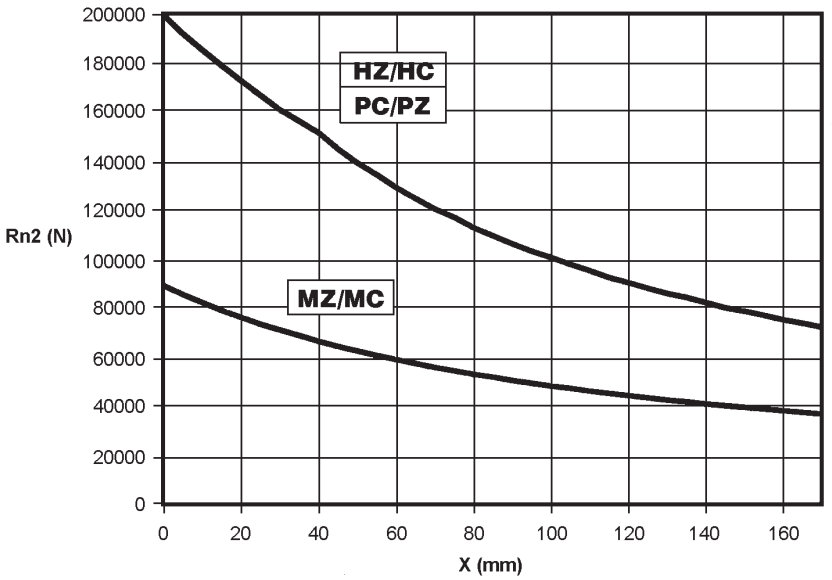
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
307 L1	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
307 L2	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
307 L3	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	0	9	18	65	18	45°	45°	A
307 L4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	0	9	18	118	18	45°	45°	A
307 R2	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A
307 R3-R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

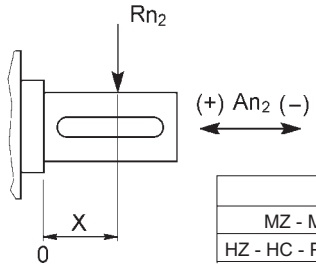
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

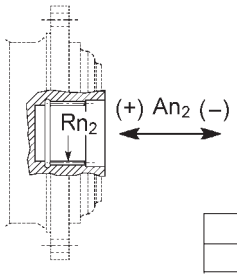
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
MZ - MC	90 000	50 000
HZ - HC - PC - PZ	160 000	80 000



	Rn2	An2 (+/-)
FZ	45 000	45 000

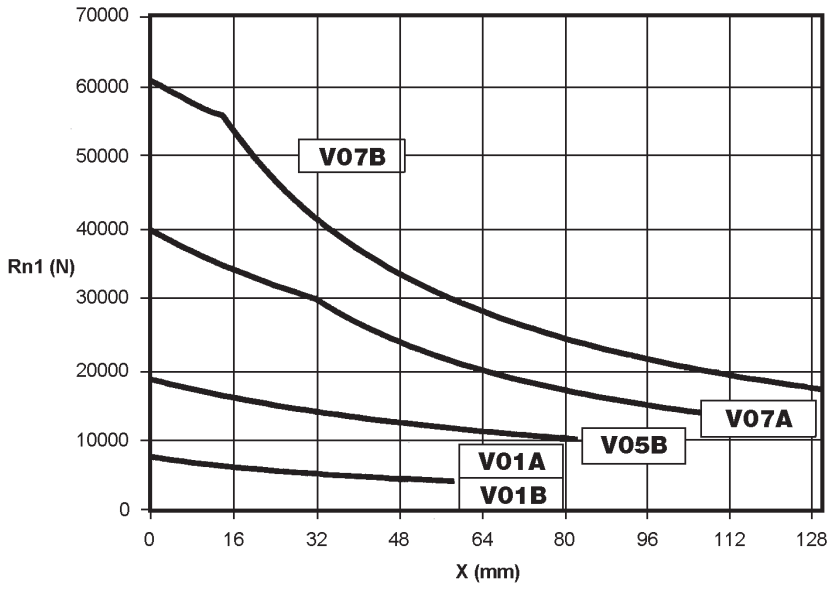
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	MZ - MC - FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

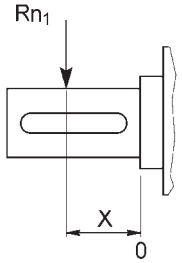
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

309L

M_2 = 18500 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	3.43	13 000	13 000	13 000	13 000	11 200	9 100	130	25	1 500	2 000	3 200	6L
	4.09	22 500	20 600	19 000	16 800	10 400	8 400	130	25	1 500	2 000	3 200	6L
	5.25	21 000	18 100	16 200	16 000	10 700	8 700	130	25	1 500	2 000	3 200	6L
	6.23	17 000	14 400	13 000	13 000	10 400	8 500	130	25	1 500	2 000	3 200	6L
L 2	12.3	13 000	13 000	13 000	13 000	8 700	7 000	60	18	1 800	3 800	1 000	5K
	14.7	17 200	16 700	16 700	13 800	8 500	6 900	60	18	1 800	3 800	1 000	5K
	17.4	21 300	20 600	19 000	15 600	9 600	7 800	60	18	1 800	3 800	1 000	5K
	21.8	18 000	17 500	17 500	15 200	9 400	7 600	60	18	1 800	3 800	1 000	5K
	25.4	14 500	14 300	14 300	14 300	9 200	7 500	60	18	1 800	3 800	800	5G
	28.0	21 000	18 100	16 200	16 000	10 700	8 700	60	18	1 800	3 800	800	5G
	30.7	12 300	12 300	12 300	12 300	7 800	6 300	60	18	1 800	3 800	630	5E
	32.6	18 300	18 100	16 200	16 000	10 700	8 700	60	18	1 800	3 800	630	5E
	38.6	17 000	14 400	13 000	13 000	10 400	8 500	57	18	1 800	3 800	500	5C
	46.7	17 000	14 400	13 000	13 000	10 400	8 500	49	18	1 800	3 800	400	5B
L 3	51.3	17 200	16 700	16 700	13 800	8 500	6 900	30	11	2 000	4 000	400	4K
	60.5	21 300	20 600	19 000	15 500	9 500	7 700	30	11	2 000	4 000	400	4K
	74.1	21 300	20 600	19 000	15 500	9 500	7 700	30	11	2 000	4 000	260	4F
	80.6	21 000	18 100	16 200	16 000	10 000	8 200	30	11	2 000	4 000	260	4F
	93.0	18 000	17 500	17 500	15 200	9 400	7 600	30	11	2 000	4 000	260	4F
	100	21 300	20 600	18 000	14 600	9 000	7 300	30	11	2 000	4 000	260	4F
	113	18 300	18 100	16 200	16 000	10 700	8 700	28	11	2 000	4 000	260	4F
	126	18 000	17 500	17 500	15 200	9 400	7 600	24	11	2 000	4 000	260	4F
	139	18 300	18 100	16 200	16 000	10 700	8 700	23	11	2 000	4 000	160	4D
	162	21 000	18 100	16 200	16 000	10 700	8 700	23	11	2 000	4 000	160	4D
	177	12 300	12 300	12 300	12 300	7 800	6 300	12.0	11	2 000	4 000	160	4D
	199	17 000	14 400	13 000	13 000	10 400	8 500	15.5	11	2 000	4 000	100	4B
	223	17 000	14 400	13 000	13 000	10 400	8 500	14.1	11	2 000	4 000	100	4B
	239	17 000	14 400	13 000	13 000	10 400	8 500	13.3	11	2 000	4 000	100	4B
	284	15 800	15 800	15 800	15 000	9 200	7 500	10.0	11	2 000	4 000	100	4B
	336	17 000	14 400	13 000	13 000	10 400	8 500	10.0	11	2 000	4 000	100	4B
L 4	349	21 300	20 600	19 000	15 500	9 500	7 700	18.0	7.5	2 000	4 000	100	4B
	411	13 000	13 000	13 000	11 500	7 100	5 800	9.4	7.5	2 000	4 000	50	4A
	465	21 000	18 100	16 200	16 000	10 000	8 200	14.3	7.5	2 000	4 000	50	4A
	513	13 000	13 000	13 000	11 500	7 100	5 800	7.5	7.5	2 000	4 000	50	4A
	579	21 300	20 600	18 000	14 600	9 000	7 300	10.9	7.5	2 000	4 000	50	4A
	654	18 300	18 100	16 200	16 000	10 700	8 700	9.5	7.5	2 000	4 000	50	4A
	722	21 300	20 600	18 000	14 600	9 000	7 300	8.7	7.5	2 000	4 000	50	4A
	801	18 300	18 100	16 200	16 000	10 700	8 700	8.0	7.5	2 000	4 000	50	4A
	906	18 000	17 500	17 500	15 200	9 400	7 600	7.1	7.5	2 000	4 000	50	4A
	999	18 300	18 100	16 200	16 000	10 700	8 700	6.6	7.5	2 000	4 000	50	4A
	1 149	17 000	14 400	13 000	13 000	10 400	8 500	5.6	7.5	2 000	4 000	50	4A
	1 274	12 300	12 300	12 300	12 300	7 800	6 300	3.6	7.5	2 000	4 000	50	4A
	1 380	17 000	14 400	13 000	13 000	10 400	8 500	4.8	7.5	2 000	4 000	50	4A
	1 605	17 000	14 400	13 000	13 000	10 400	8 500	4.1	7.5	2 000	4 000	50	4A
	1 723	17 000	14 400	13 000	13 000	10 400	8 500	3.9	7.5	2 000	4 000	50	4A
	2 041	15 800	15 800	15 800	15 000	9 200	7 500	3.0	7.5	2 000	4 000	50	4A
	2 423	17 000	14 400	13 000	13 000	10 400	8 500	2.7	7.5	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

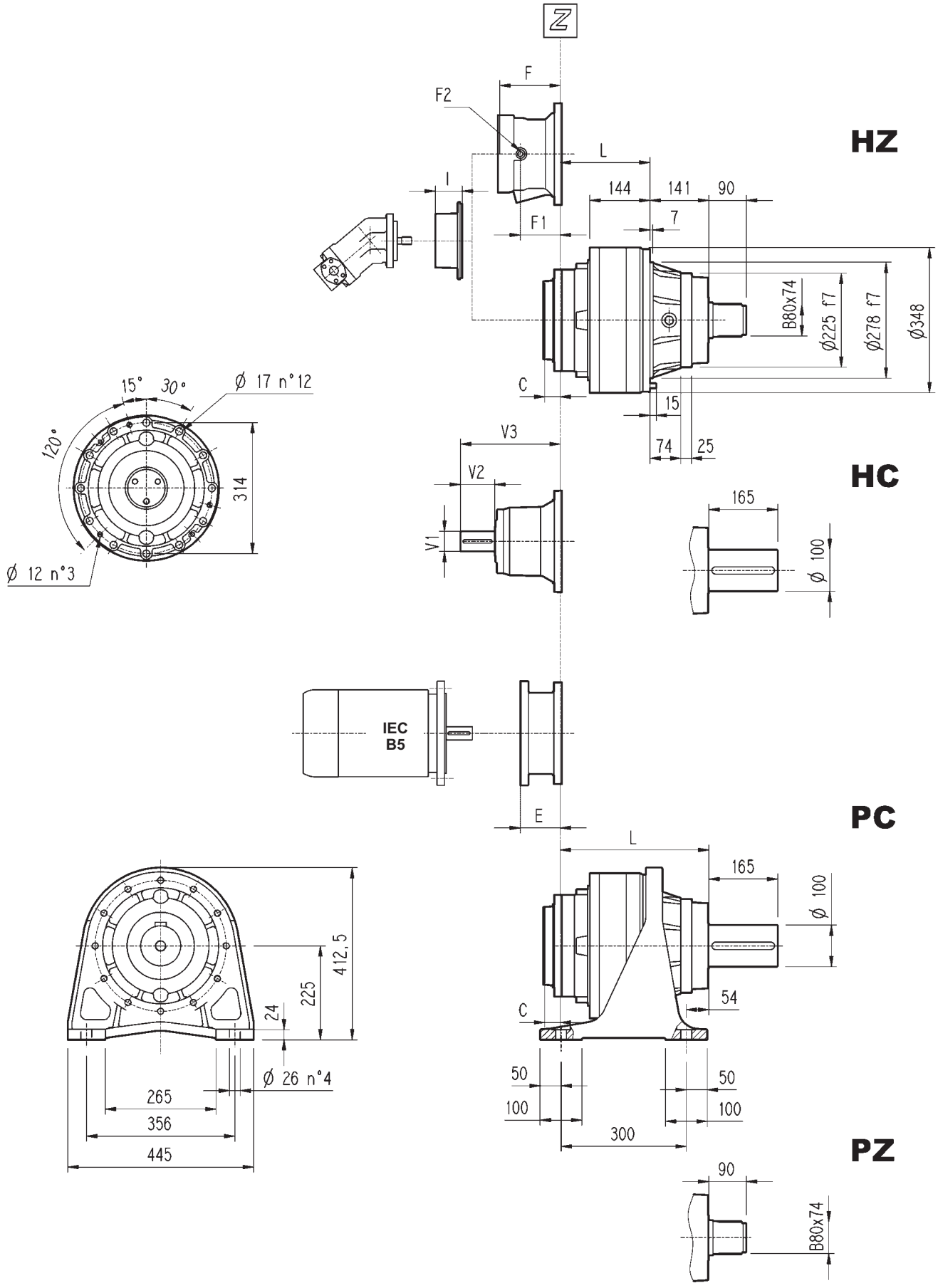
M_2 = 18500 Nm

309R

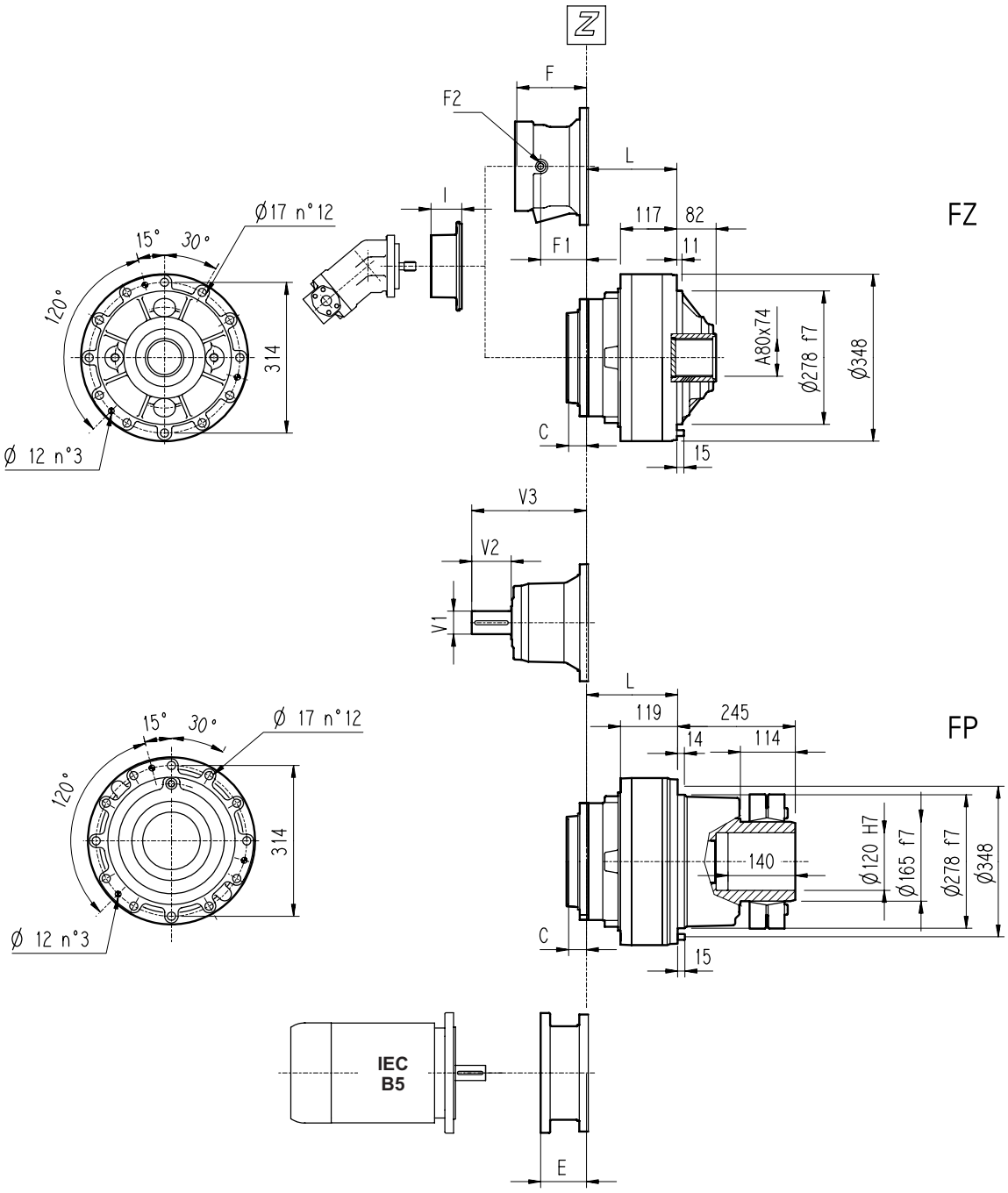
	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	13.0	9 800	8 500	7 600	6 800	5 300	4 300	85	35	1 800	3 800	1 000	5K
	15.5	11 400	9 800	8 800	7 900	5 900	4 800	85	35	1 800	3 800	1 000	5K
	19.8	14 000	12 100	10 800	9 700	7 100	5 700	85	35	1 800	3 800	1 000	5K
	23.5	16 200	14 000	12 500	11 200	8 000	6 500	85	35	1 800	3 800	800	5G
R3	31.6	12 800	11 000	9 100	7 400	4 550	3 700	35	20	2 000	4 000	440	4L
	37.7	14 800	12 600	10 300	8 300	5 100	4 200	35	20	2 000	4 000	440	4L
	44.6	17 100	14 100	11 500	9 400	5 800	4 700	35	20	2 000	4 000	400	4K
	55.9	18 000	16 600	13 500	11 000	6 800	5 500	35	20	2 000	4 000	400	4K
	65.0	14 500	14 300	14 300	12 200	7 500	6 100	35	20	2 000	4 000	260	4F
	71.8	21 000	18 100	16 100	13 100	8 100	6 500	35	20	2 000	4 000	330	4H
	78.6	12 300	12 300	12 300	12 300	7 800	6 300	27	20	2 000	4 000	260	4F
	83.4	18 300	18 100	16 200	14 500	9 000	7 300	35	20	2 000	4 000	260	4F
	99.0	17 000	14 400	13 000	13 000	10 100	8 200	27	20	2 000	4 000	260	4F
	120	17 000	14 400	13 000	13 000	10 400	8 500	23	20	2 000	4 000	160	4D
R4	152	21 300	20 600	18 000	14 600	9 000	7 300	15.0	14	2 000	4 000	160	4D
	165	21 000	18 100	16 200	15 100	9 300	7 500	15.0	14	2 000	4 000	160	4D
	191	18 000	17 500	17 500	15 200	9 400	7 600	15.0	14	2 000	4 000	160	4D
	206	21 300	20 600	18 000	14 600	9 000	7 300	15.0	14	2 000	4 000	160	4D
	232	18 300	18 100	16 200	16 000	10 700	8 700	15.0	14	2 000	4 000	100	4B
	258	18 000	17 500	17 500	15 200	9 400	7 600	15.0	14	2 000	4 000	100	4B
	284	18 300	18 100	16 200	16 000	10 700	8 700	15.0	14	2 000	4 000	100	4B
	313	17 000	14 400	13 000	13 000	10 400	8 500	15.0	14	2 000	4 000	100	4B
	331	21 000	18 100	16 200	16 000	10 700	8 700	15.0	14	2 000	4 000	100	4B
	344	15 800	15 800	15 800	15 000	9 200	7 500	13.6	14	2 000	4 000	100	4B
	363	12 300	12 300	12 300	12 300	7 800	6 300	10.4	14	2 000	4 000	100	4B
	413	21 000	18 100	16 200	16 000	10 700	8 700	15.0	14	2 000	4 000	100	4B
	457	17 000	14 400	13 000	13 000	10 400	8 500	12.3	14	2 000	4 000	50	4A
	490	17 000	14 400	13 000	13 000	10 400	8 500	11.6	14	2 000	4 000	50	4A
	581	15 800	15 800	15 800	15 000	9 200	7 500	8.7	14	2 000	4 000	50	4A
	690	17 000	14 400	13 000	13 000	10 400	8 500	8.7	14	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

309L


Z
F
F2
L
I
144
141
90
7
F1
B80x74
Ø225 f7
Ø278 f7
Ø348
C
15
74
25
HZ
15°
30°
120°
Ø 17 n°12
314
Ø 12 n°3
V3
V2
V1
165
Ø 100
HC
IEC
B5
E
L
165
Ø 100
54
C
50
100
50
100
300
PC
412,5
225
24
Ø 26 n°4
265
356
445
90
B80x74
PZ

309L

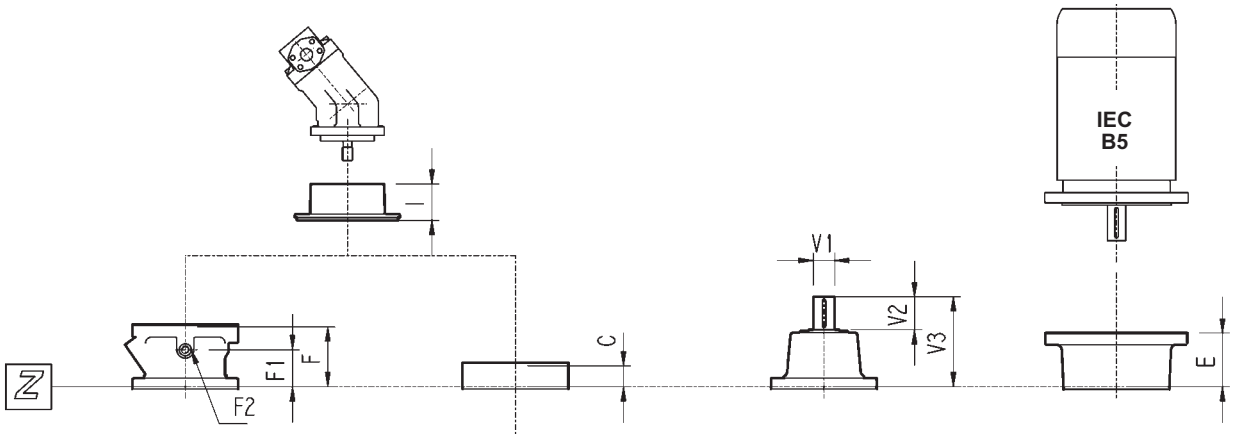


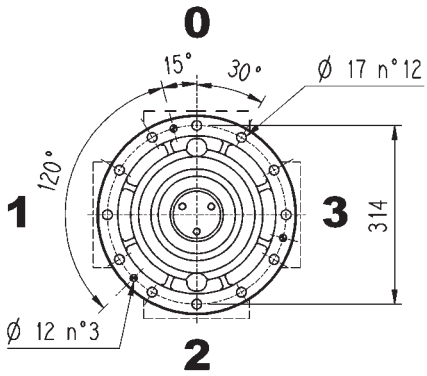
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**22 000 Nm**

	L				Kg												
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée	**I**	**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
309 L1	126	267	99	101	115	130	95	100	51	B		201	153	1/4 G	6	B	28
309 L2	215	356	188	190	127	142	107	112	37	A		145	95	1/4 G	5	A	16
309 L3	280	421	253	255	134	149	114	119	37	A		105	65	1/4 G	4	A	10
309 L4	333	474	306	308	138	153	118	123	37	A	171	105	65	1/4 G	4	A	10

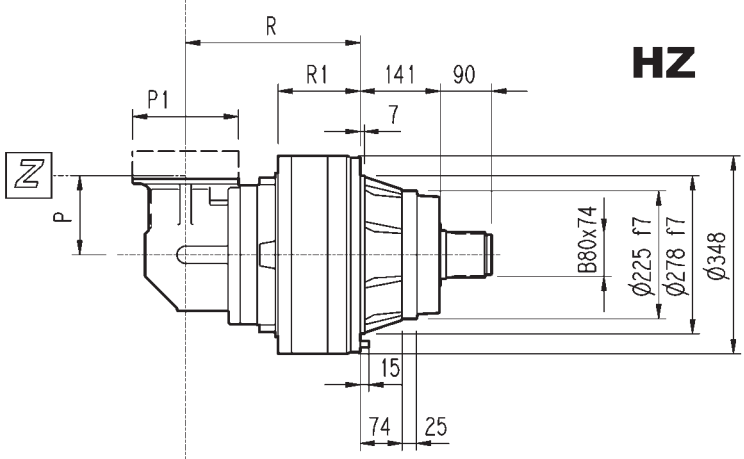
	V1	V2	V3	Kg	V1	V2	V3	Kg	E											
										IEC 71	**IEC 80**	**IEC 90**	**IEC 100**	**IEC 112**	**IEC 132**	**IEC 160**	**IEC 180**	**IEC 200**	**IEC 225**	**IEC 250**
309 L1	80	130	315	35	60	105	313	28									195	186	216	215
309 L2	48	82	239	15											114	144	144	174		
309 L3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				
309 L4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				

309R

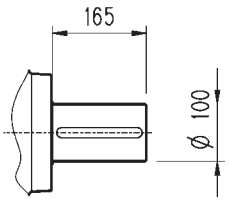


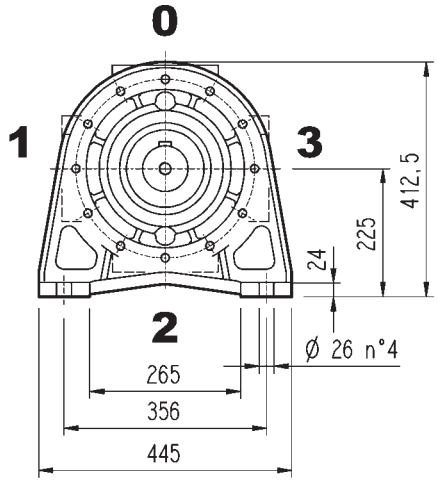


HZ

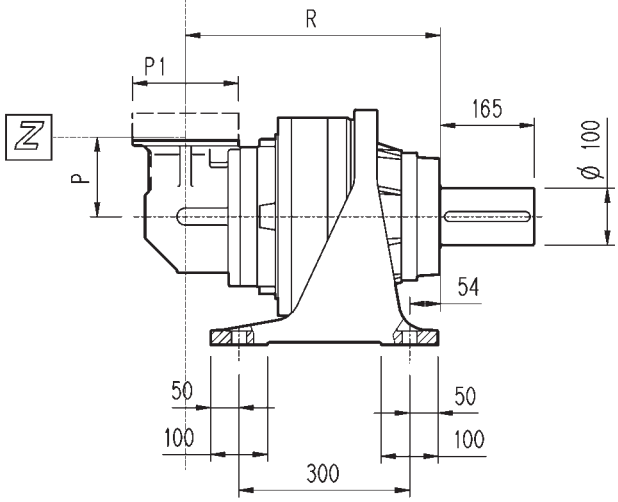


HC

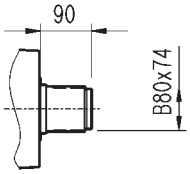




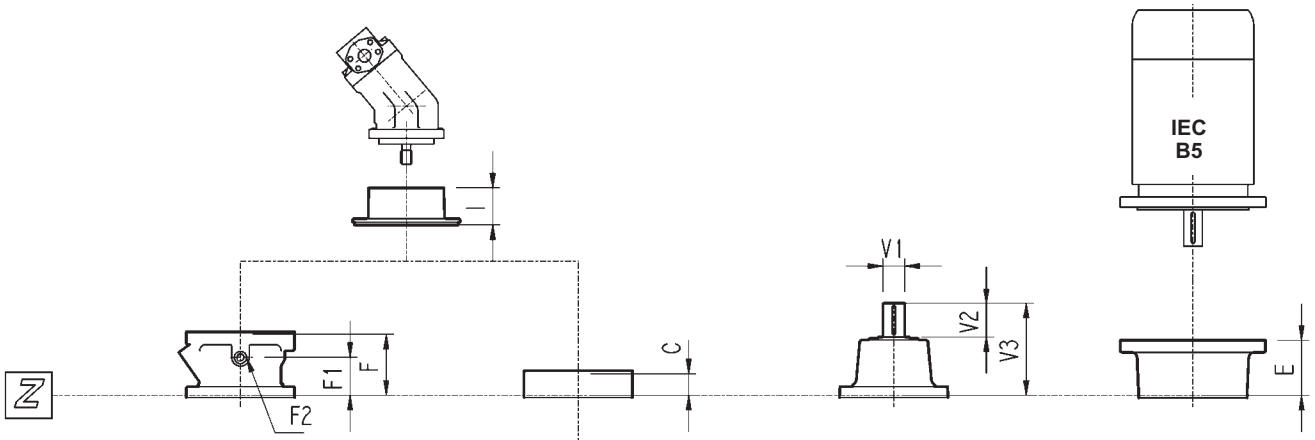
PC

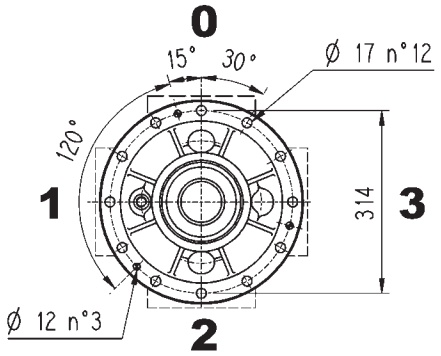


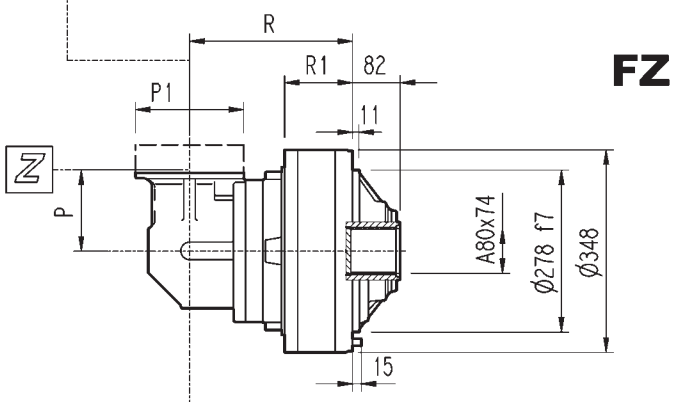
PZ

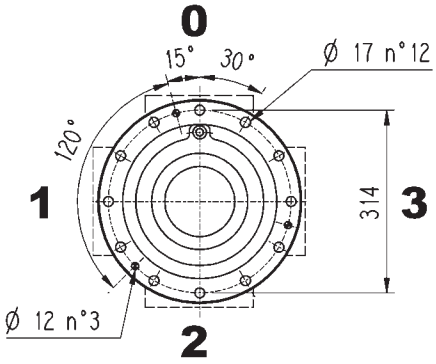


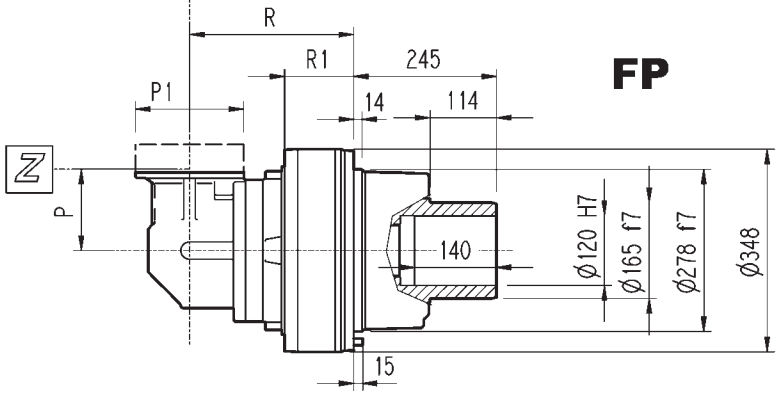
309R











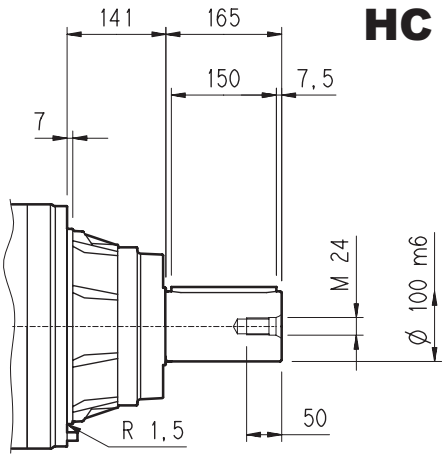
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE
22 000 Nm	

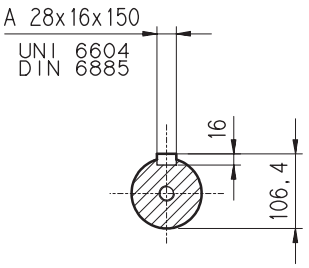
	R				R1			P	P1	Kg				C		I	F	F1	F2			Kg
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**FZ**	**FP**			**HZ HC**	**PC PZ**	**FZ**	**FP**		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
309 R2	245	386	218	220	168	141	143	225	245	165	180	145	150	37	A		145	95	1/4 G	5	A	16
309 R3	307	448	280	282	144	117	119	140	186	147	162	127	132	37	A		105	65	1/4 G	4	A	10
309 R4	372	513	345	347	144	117	119	122	186	148	163	128	133	37	A	171	105	65	1/4 G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
										IEC 71	**IEC 80**	**IEC 90**	**IEC 100**	**IEC 112**	**IEC 132**	**IEC 160**	**IEC 180**	**IEC 200**
309 R2	48	82	239	15											114	144	144	174
309 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		
309 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		

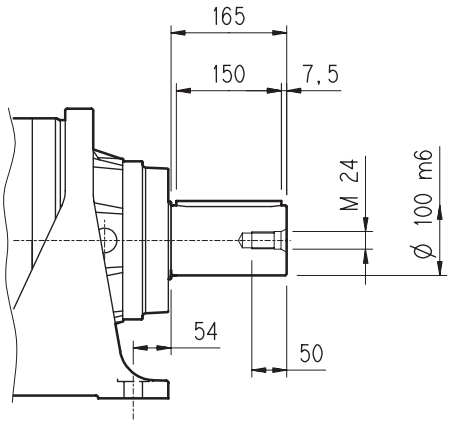
309L - 309R

HC

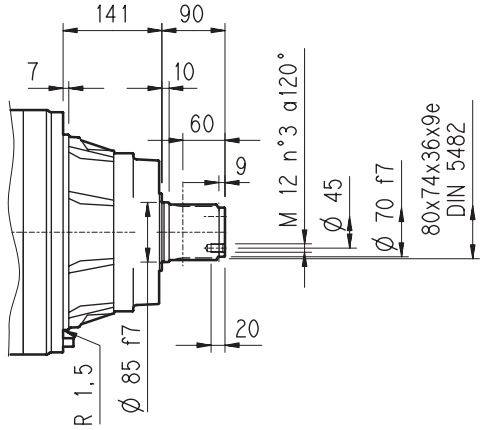


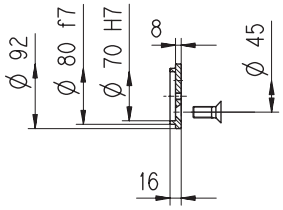


PC

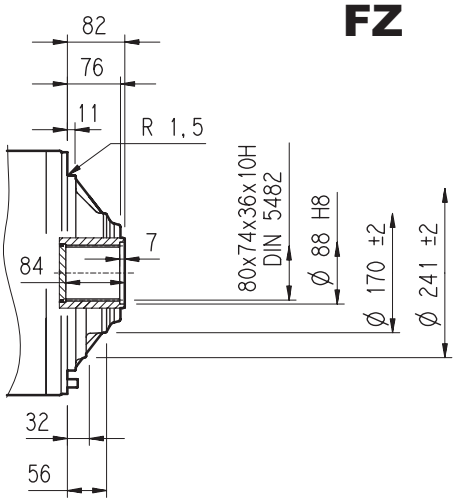


HZ

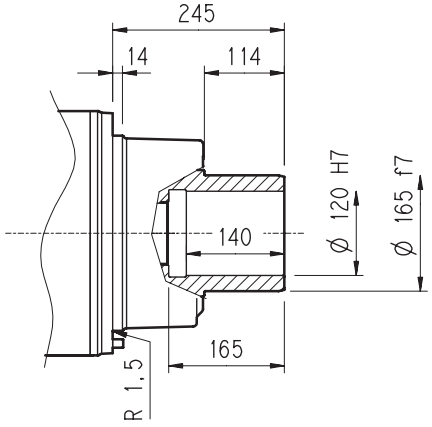


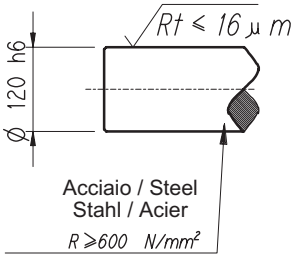


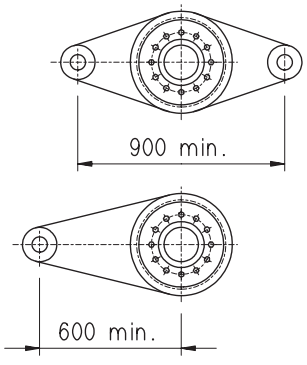
FZ



FP





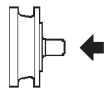


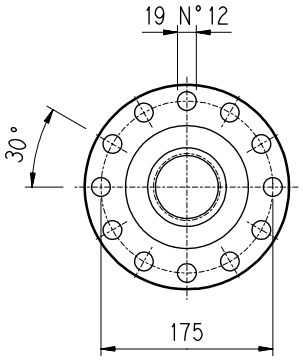
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**22 000 Nm**

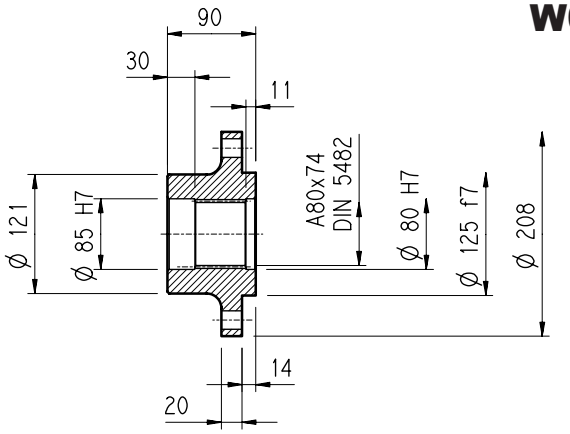
309L - 309R

Flangia / Flange
Flansch / Brides

W0A



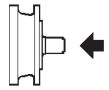


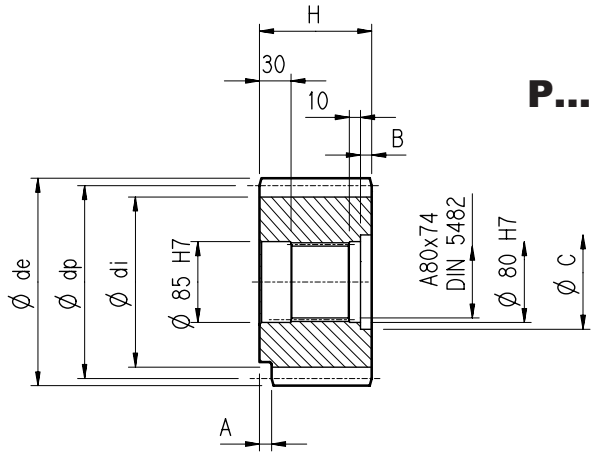


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



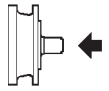


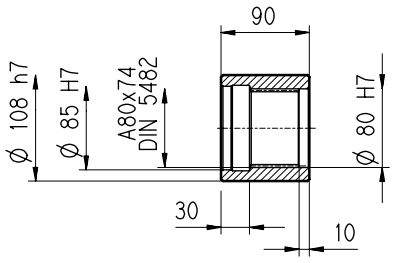
	m	z	x	dp	di	de	H	A	B	C	★
PFG	8	16	0.500	128	117	149.5	90	0	0	0	■
PHC	10	12	0.450	120	104	145	90	0	0	0	■
PHE	10	14	0.320	140	121	162.5	116	13	26	95	■
PHF	10	15	0.150	150	130	171.5	107	20	17	100	■
PHG	10	16	0.500	160	145	186	90	0	0	0	□
PHH1	10	17	0	170	145	190	90	0	0	0	□
PHH2	10	17	0.500	170	154	198	90	0	0	0	□
PLD	12	13	0.500	156	138	192	102	0	12	95	■
PLE	12	14	0.500	168	150	199.2	90	0	0	0	■
PLI	12	18	0.500	216	198	249.6	107	7	17	95	■
PLT	12	26	0	312	282	336	90	10	0	0	□

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

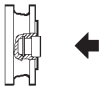


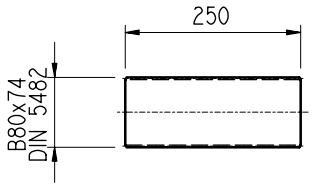


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

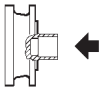


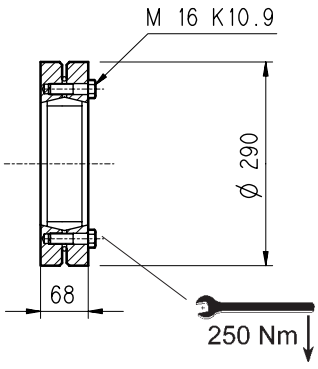


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

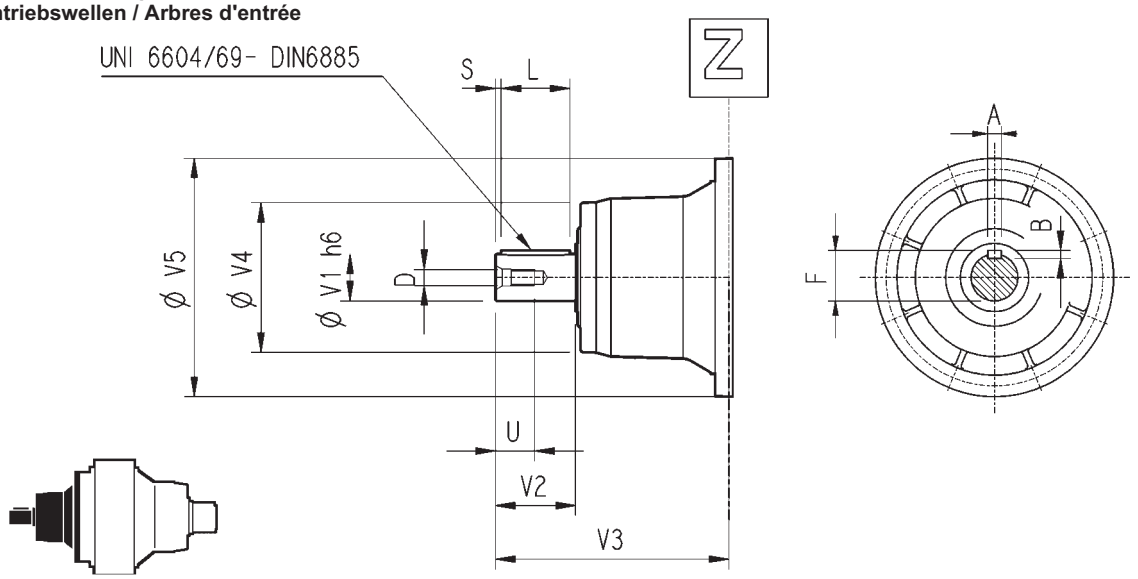
G0A





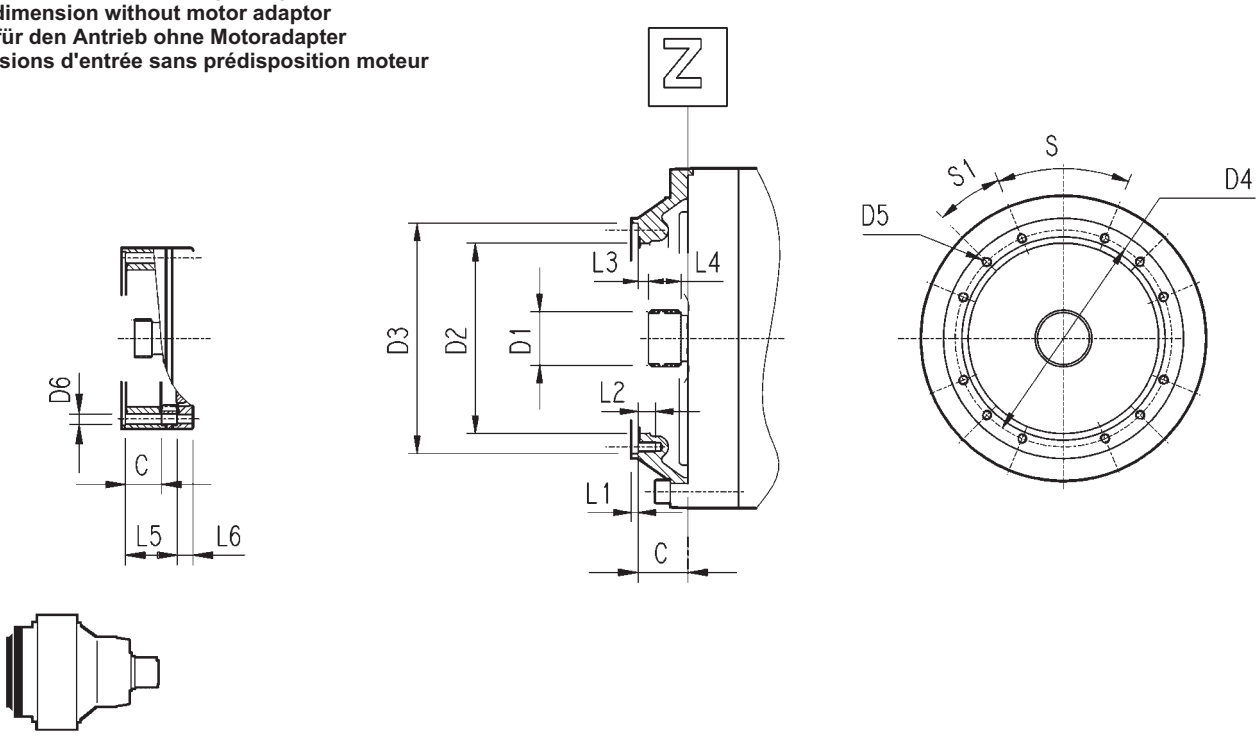
309L - 309R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
309 L1	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
309 L2	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
309 L3	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
309 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
309 R2	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
309 R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



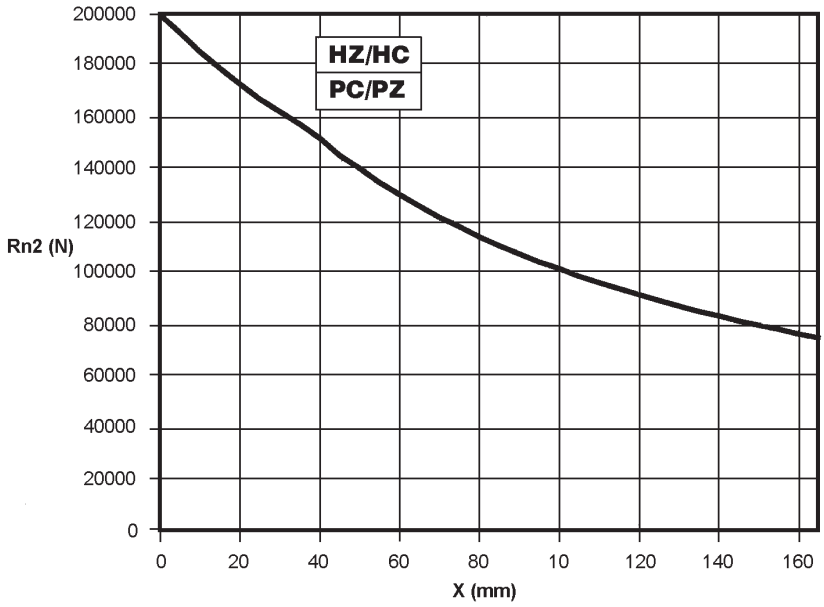
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
309 L1	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
309 L2	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
309 L3	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	0	9	18	65	18	45°	45°	A
309 L4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	0	9	18	118	18	45°	45°	A
309 R2	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A
309 R3-R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

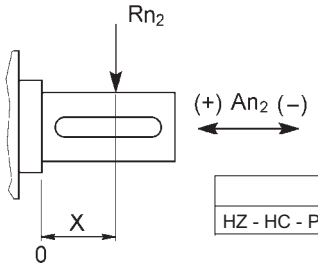
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

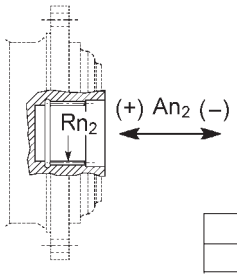
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC - PC - PZ	160 000	80 000



	Rn2	An2 (+/-)
FZ	36 000	37 000

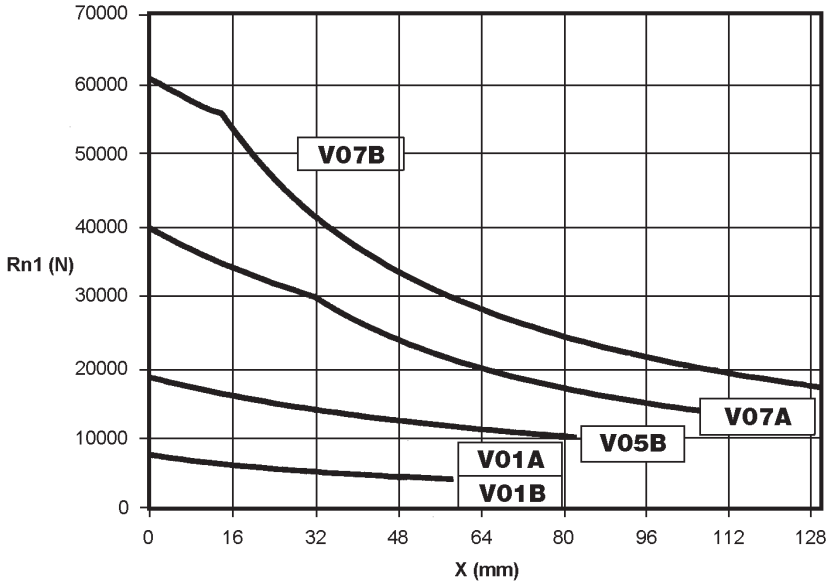
		$Fh_2 = n_2 \cdot h$	10 000	25 000	50 000	100 000	500 000	1 000 000
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	fh_2	FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

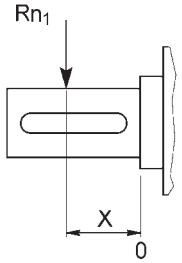
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





		$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

310L

M_2 = 25000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	4.09	30 000	30 000	26 200	21 300	13 100	10 700	150	35	1 000	1 500		
	5.25	29 500	25 400	22 700	20 500	12 700	10 300	150	35	1 000	1 500		
	6.23	26 000	21 200	18 100	17 800	12 600	10 200	150	35	1 000	1 500		
L 2	14.7	30 000	29 800	26 200	21 300	13 100	10 700	75	22	1 500	3 000	2 100	6G
	17.4	30 000	30 000	26 200	21 300	13 100	10 700	75	22	1 500	3 000	2 100	6G
	21.8	30 000	30 000	26 200	21 300	13 100	10 700	75	22	1 500	3 000	1 500	6E
	25.4	26 100	25 800	25 800	21 300	13 100	10 700	75	22	1 500	3 000	1 500	6E
	28.0	29 500	25 400	22 700	20 500	12 700	10 300	75	22	1 500	3 000	1 500	6E
	30.7	21 800	21 800	21 800	19 900	12 300	10 000	75	22	1 500	3 000	1 050	
	32.6	29 500	25 400	22 700	20 500	12 700	10 300	75	22	1 500	3 000	1 050	
	38.6	26 000	21 200	18 100	17 800	12 600	10 200	75	22	1 500	3 000	850	6B
	46.7	26 000	21 200	18 100	17 800	12 600	10 200	71	22	1 500	3 000	850	6B
L 3	53.0	29 100	29 100	26 200	21 300	13 100	10 700	40	18	1 800	3 800	630	5E
	62.6	30 000	29 800	26 200	21 300	13 100	10 700	40	18	1 800	3 800	630	5E
	73.9	30 000	30 000	26 200	21 300	13 100	10 700	40	18	1 800	3 800	500	5C
	80.3	29 500	25 400	22 700	20 500	12 700	10 300	40	18	1 800	3 800	400	5B
	91.3	24 900	24 900	21 400	17 400	10 700	8 700	40	18	1 800	3 800	400	5B
	101	29 500	25 400	22 700	20 500	12 700	10 300	40	18	1 800	3 800	400	5B
	110	22 900	22 900	22 500	18 300	11 300	9 200	36	18	1 800	3 800	400	5B
	119	29 500	25 400	22 700	20 500	12 700	10 300	40	18	1 800	3 800	400	5B
	130	27 000	27 000	25 300	20 500	12 700	10 300	36	18	1 800	3 800	400	5B
	142	29 300	25 400	22 700	20 500	12 700	10 300	35	18	1 800	3 800	400	5B
	164	30 000	30 000	26 200	21 300	13 100	10 700	32	18	1 800	3 800	400	5B
	177	26 000	21 200	18 100	17 800	12 600	10 200	26	18	1 800	3 800	400	5B
	202	29 500	25 400	22 700	20 500	12 700	10 300	26	18	1 800	3 800	400	5B
	230	21 800	21 800	21 800	19 900	12 300	10 000	17.3	18	1 800	3 800	400	5B
	249	26 000	21 200	18 100	17 800	12 600	10 200	20	18	1 800	3 800	400	5B
	295	28 000	25 400	22 700	20 500	12 700	10 300	17.3	18	1 800	3 800	400	5B
	350	26 000	21 200	18 100	17 800	12 600	10 200	14.7	18	1 800	3 800	400	5B
L 4	389	24 900	24 900	21 400	17 400	10 700	8 700	18.9	11	2 000	4 000	100	4B
	451	30 000	25 700	20 900	16 900	10 500	8 500	19.7	11	2 000	4 000	100	4B
	507	29 500	25 400	22 700	20 500	12 700	10 300	17.5	11	2 000	4 000	100	4B
	556	27 000	27 000	25 300	20 500	12 700	10 300	14.4	11	2 000	4 000	50	4A
	637	22 900	22 900	22 500	18 300	11 300	9 200	10.6	11	2 000	4 000	50	4A
	726	29 500	25 400	22 700	20 500	12 700	10 300	12.2	11	2 000	4 000	50	4A
	818	29 300	25 400	22 700	20 500	12 700	10 300	10.6	11	2 000	4 000	50	4A
	939	27 000	27 000	25 300	20 500	12 700	10 300	8.5	11	2 000	4 000	50	4A
	1 021	29 300	25 400	22 700	20 500	12 700	10 300	8.5	11	2 000	4 000	50	4A
	1 164	29 500	25 400	22 700	20 500	12 700	10 300	7.6	11	2 000	4 000	50	4A
	1 259	28 000	25 400	22 700	20 500	12 700	10 300	7.0	11	2 000	4 000	50	4A
	1 438	26 000	21 200	18 100	17 800	12 600	10 200	6.2	11	2 000	4 000	50	4A
	1 657	21 800	21 800	21 800	19 900	12 300	10 000	5.4	11	2 000	4 000	50	4A
	1 794	26 000	21 200	18 100	17 800	12 600	10 200	4.9	11	2 000	4 000	50	4A
	2 022	26 000	21 200	18 100	17 800	12 600	10 200	4.4	11	2 000	4 000	50	4A
	2 523	26 000	21 200	18 100	17 800	12 600	10 200	3.5	11	2 000	4 000	50	4A

$$M_{2max} = 1.2 \cdot M_{n2} \quad (n_2 \cdot h = 10\,000)$$

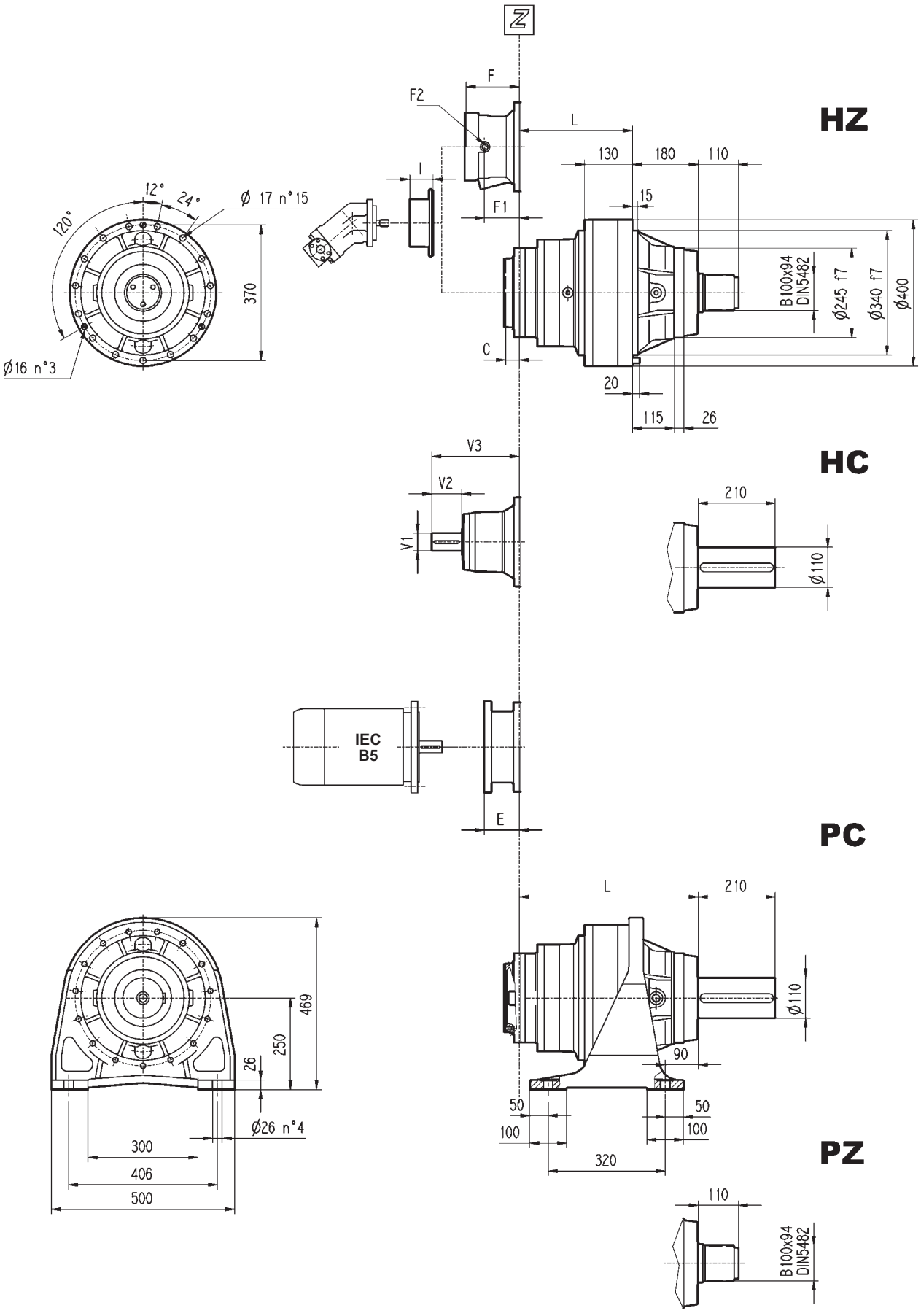
M_2 = 25000 Nm

310R

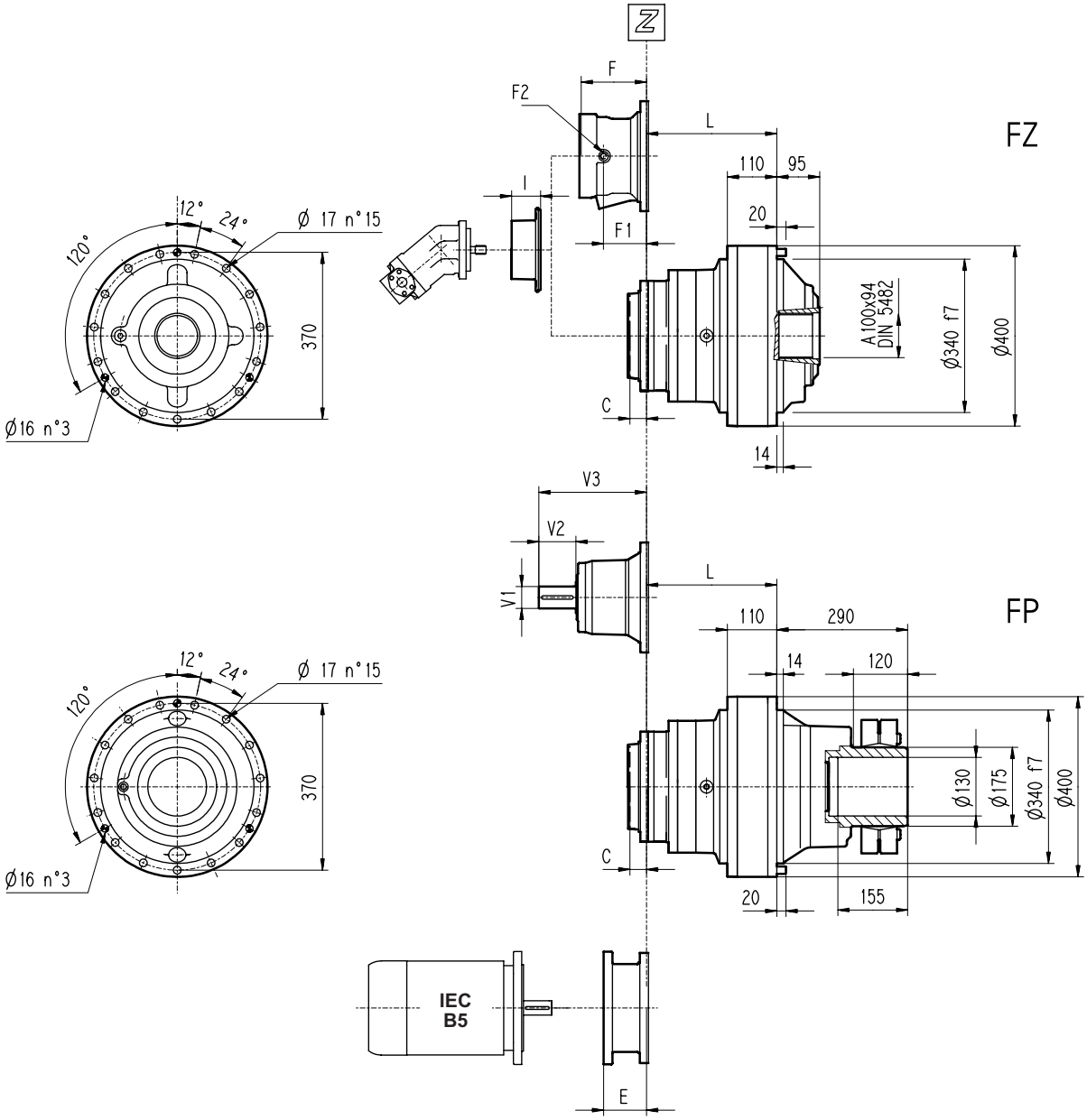
i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2												
R3	37.7	14 800	12 600	10 300	8 300	5 100	4 150	35	20	1 800	3 800	440	4L
	44.6	17 100	14 200	11 500	9 400	5 800	4 700	35	20	1 800	3 800	440	4L
	55.9	20 700	16 600	13 500	11 000	6 800	5 500	35	20	1 800	3 800	400	4K
	65.0	23 500	18 500	15 000	12 200	7 500	6 100	35	20	1 800	3 800	400	4K
	71.8	25 500	19 800	16 100	13 100	8 100	6 500	35	20	1 800	3 800	400	4K
	78.6	21 800	21 100	17 100	13 900	8 600	7 000	35	20	1 800	3 800	330	4H
	83.4	28 900	22 000	17 900	14 500	9 000	7 300	35	20	1 800	3 800	400	4K
	99.0	26 000	21 200	18 100	16 400	10 100	8 200	35	20	1 800	3 800	330	4H
	120	26 000	21 200	18 100	17 800	11 500	9 400	35	20	1 800	3 800	260	4F
R4	136	29 100	29 100	24 400	19 800	12 200	9 900	35	14	2 000	4 000	260	4F
	160	30 000	29 800	26 200	21 300	13 100	10 700	35	14	2 000	4 000	260	4F
	189	30 000	30 000	26 200	21 300	13 100	10 700	35	14	2 000	4 000	260	4F
	206	29 500	25 400	22 700	20 500	12 700	10 300	35	14	2 000	4 000	160	4D
	234	24 900	24 900	21 400	17 400	10 700	8 700	32	14	2 000	4 000	160	4D
	258	29 500	25 400	22 700	20 500	12 700	10 300	34	14	2 000	4 000	160	4D
	283	22 900	22 900	22 500	18 300	11 300	9 200	24	14	2 000	4 000	100	4B
	305	29 500	25 400	22 700	20 500	12 700	10 300	29	14	2 000	4 000	100	4B
	334	27 000	27 000	25 300	20 500	12 700	10 300	24	14	2 000	4 000	100	4B
	363	29 300	25 400	22 700	20 500	12 700	10 300	24	14	2 000	4 000	100	4B
	419	30 000	30 000	26 200	21 300	13 100	10 700	21	14	2 000	4 000	100	4B
	454	26 000	21 200	18 100	17 800	12 600	10 200	19.4	14	2 000	4 000	100	4B
	517	29 500	25 400	22 700	20 500	12 700	10 300	17.2	14	2 000	4 000	100	4B
	590	21 800	21 800	21 800	19 900	12 300	10 000	12.6	14	2 000	4 000	50	4A
	639	26 000	21 200	18 100	17 800	12 600	10 200	13.9	14	2 000	4 000	50	4A
	757	28 000	25 400	22 700	20 500	12 700	10 300	11.7	14	2 000	4 000	50	4A
	898	26 000	21 200	18 100	17 800	12 600	10 200	9.9	14	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

310L


Z
F
F2
L
130
180
110
I
F1
15
HZ
12°
24°
Ø 17 n°15
120°
370
Ø16 n°3
B100x94 DIN5482
Ø245 f7
Ø340 f7
Ø400
C
20
115
26
V3
V2
V1
HC
210
Ø110
IEC B5
E
PC
L
210
Ø110
90
50
50
100
100
320
469
250
26
Ø26 n°4
300
406
500
PZ
110
B100x94 DIN5482

310L

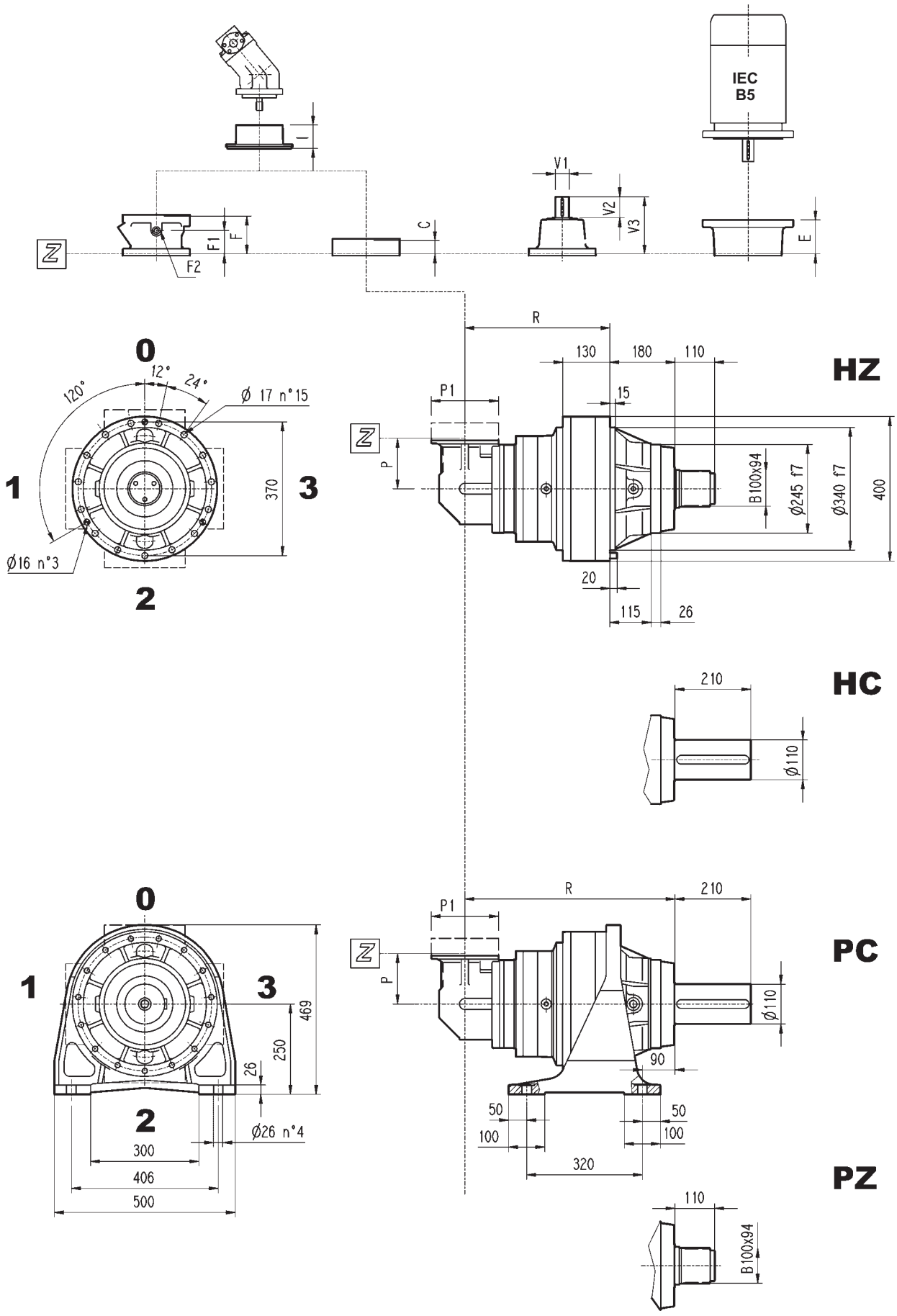


VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE	**30 000 Nm**

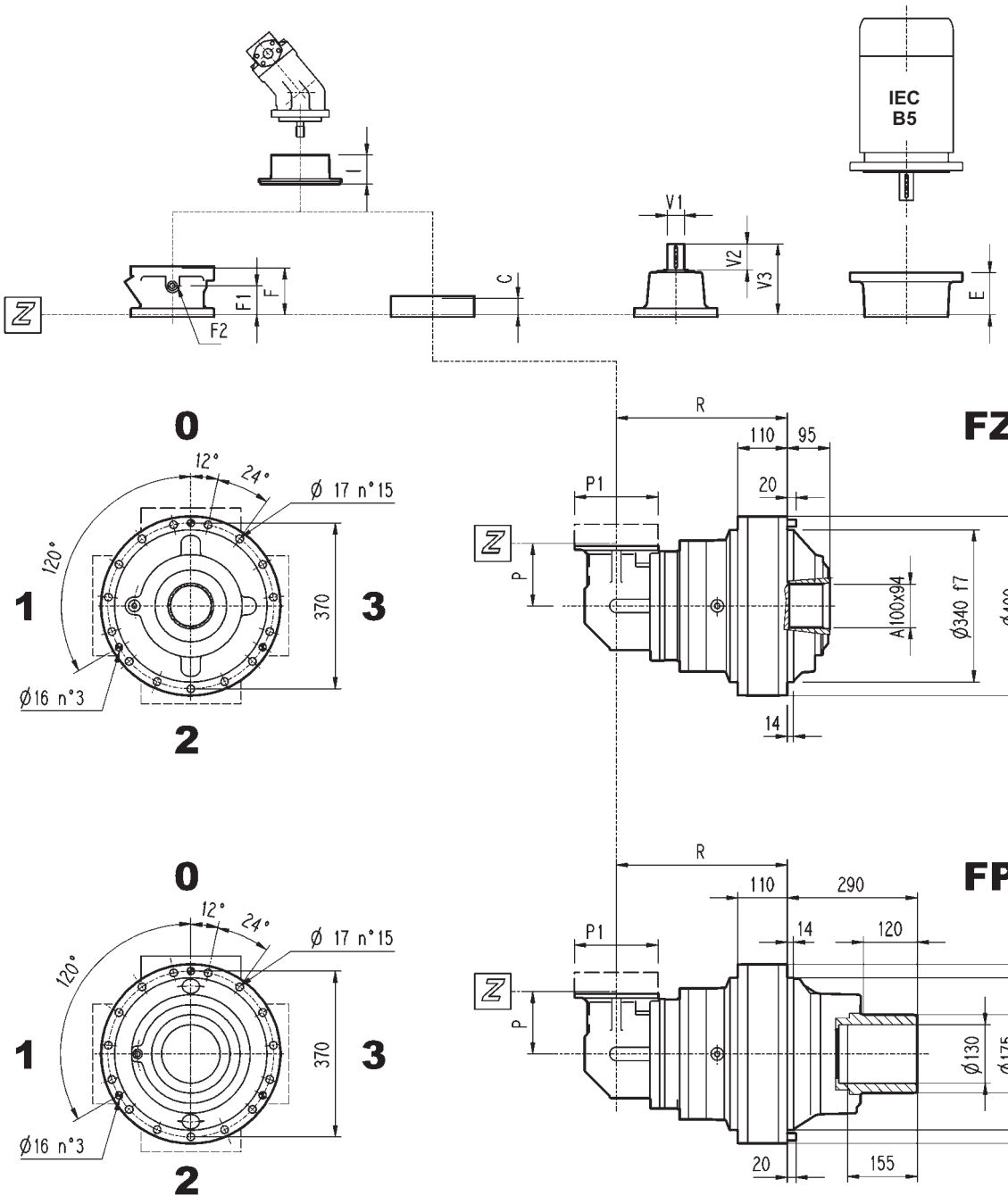
	L				Kg													
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée	**I**	**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
310 L1	108	288	88	88	135	155	110	115	88	C							
310 L2	244	424	224	224	165	185	140	145	45	B		195	147	1/4 G	6	B	28
310 L3	309	489	289	289	174	194	149	154	37	A		145	95	1/4 G	5	A	16
310 L4	362	542	342	342	178	198	153	158	37	A	171	105	65	1/4 G	4	A	10

	V1	V2	V3	Kg	V1	V2	V3	Kg	E											
										IEC 71	**IEC 80**	**IEC 90**	**IEC 100**	**IEC 112**	**IEC 132**	**IEC 160**	**IEC 180**	**IEC 200**	**IEC 225**	**IEC 250**
310 L1																				
310 L2	60	105	307	23													152	182	212	193
310 L3	48	82	239	15											114	144	144	174		
310 L4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				

310R


IEC
B5
V1
V2
V3
I
C
E
F
F1
F2
Z
0
1
2
3
12°
24°
120°
Ø 17 n°15
Ø16 n°3
370
R
130
180
110
15
P1
P
B100x94
Ø245 f7
Ø340 f7
400
20
115
26
HZ
210
Ø110
HC
469
250
26
Ø26 n°4
300
406
500
90
50
100
320
PC
PZ

310R



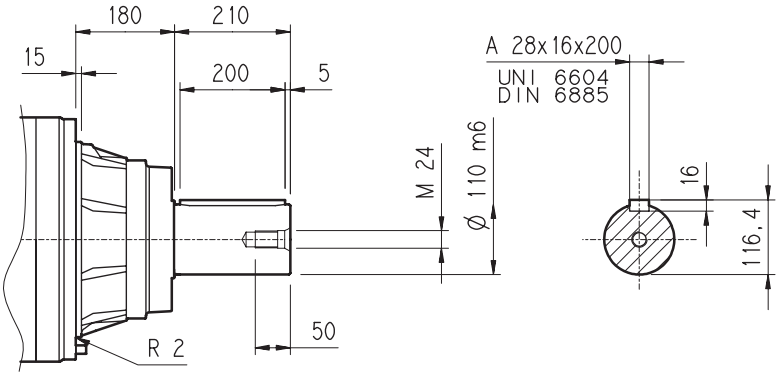
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX.TRANSMISSIBLE
30 000 Nm	

	R				P	P1	Kg				C		I	F	F1	F2			Kg
	HZ HC	PC PZ	FZ	FP			HZ HC	PC PZ	FZ	FP		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
310 R2																			
310 R3	381	561	361	361	140	186	189	209	164	169	37	A		105	65	1/4 G	4	A	10
310 R4	401	581	381	381	140	186	194	214	169	174	37	A	171	105	65	1/4 G	4	A	10

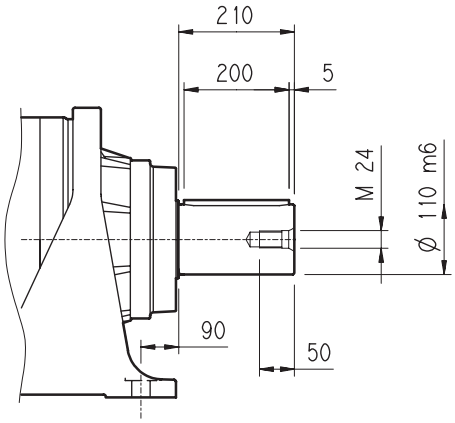
	V1	V2	V3	Kg	V1	V2	V3	Kg	E										
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160			
310 R2																			
310 R3	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144			
310 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144			

310L - 310R

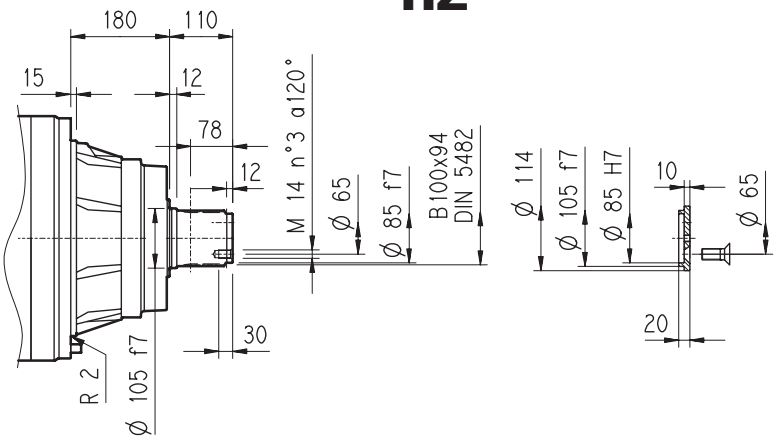
HC



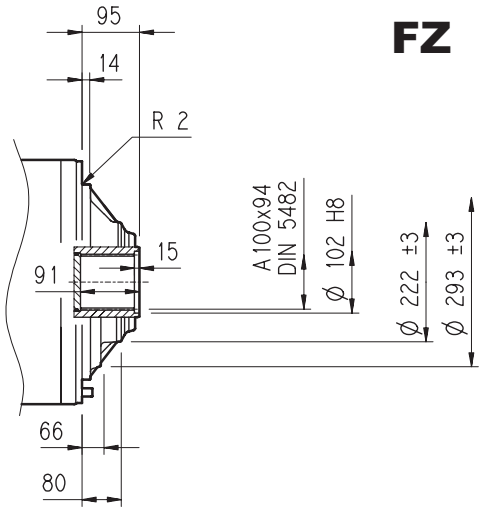
PC



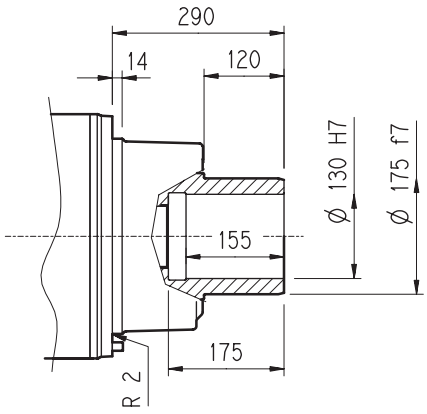
HZ

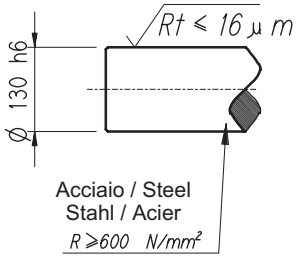


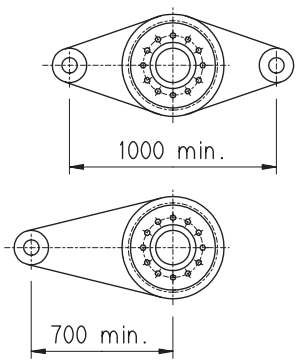
FZ



FP





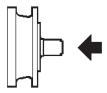


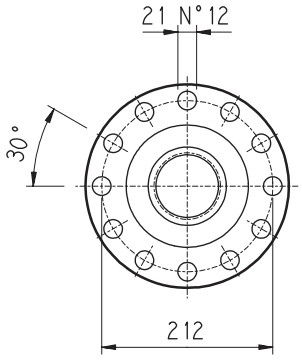
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**30 000 Nm**

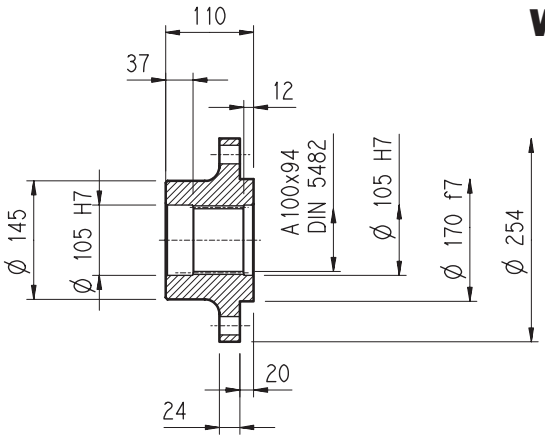
310L - 310R

Flangia / Flange
Flansch / Brides

W0A



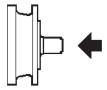


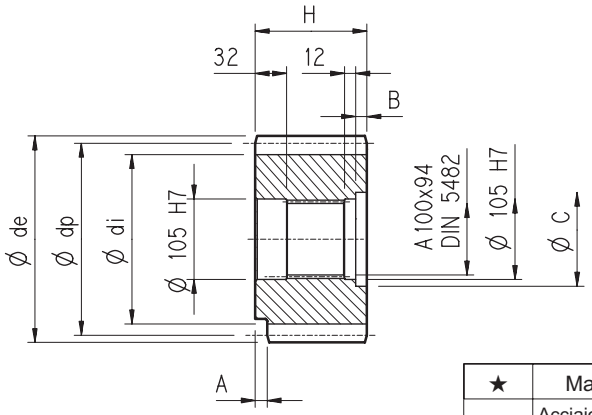


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



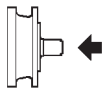


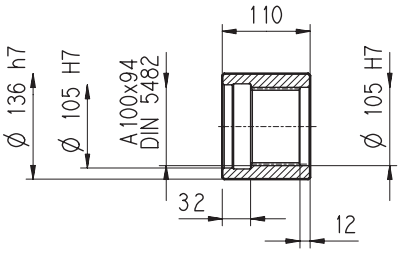
	m	z	x	dp	di	de	H	A	B	C	★
PLQ	12	23	0	276	246	300	110	0	0	0	□
PPD	16	13	0.500	208	184	252.5	145	0	35	116	■
PPF	16	15	0.450	240	215	280	125	0	15	120	□

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

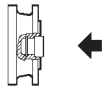


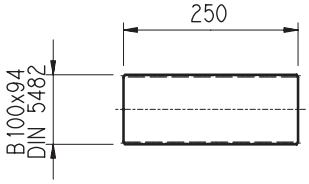


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

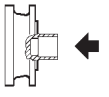


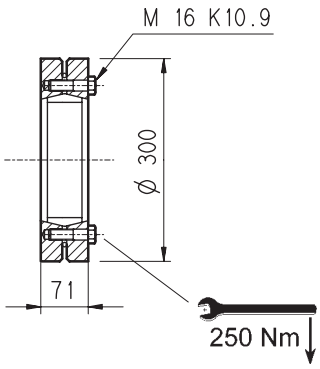


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

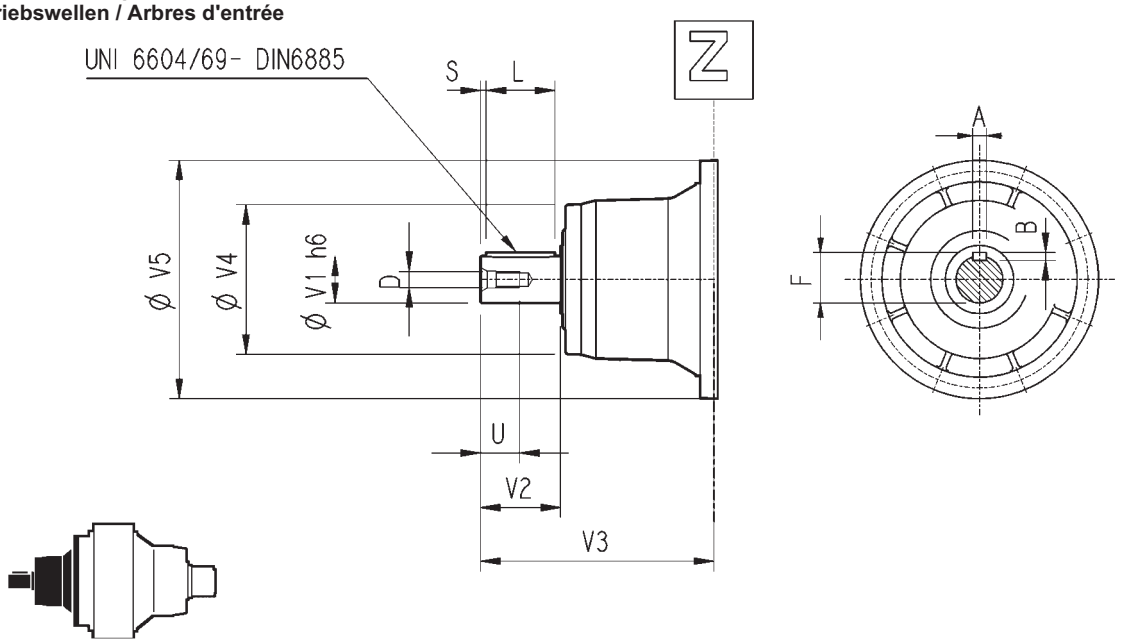
G0A





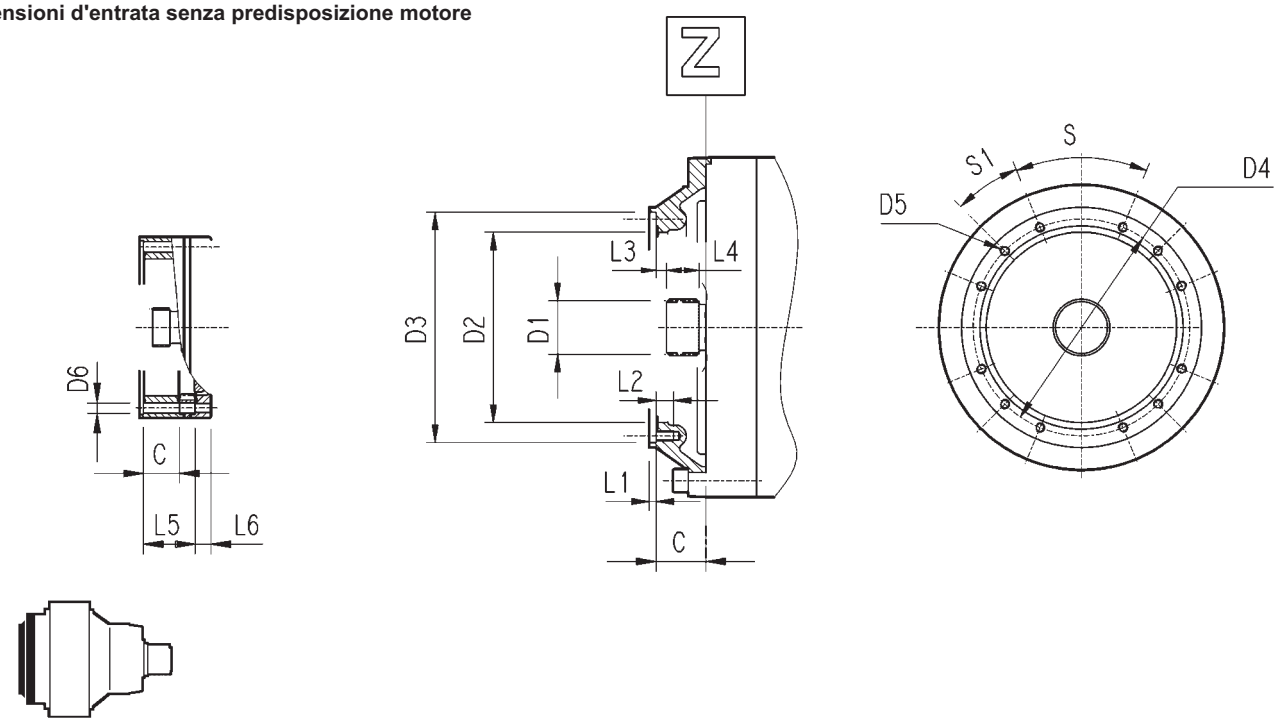
310L - 310R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
310 L2	V06B	60	105	307	155	292	18	11	64	90	7.5	M16	40
310 L3	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
310 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
310 R3-R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore



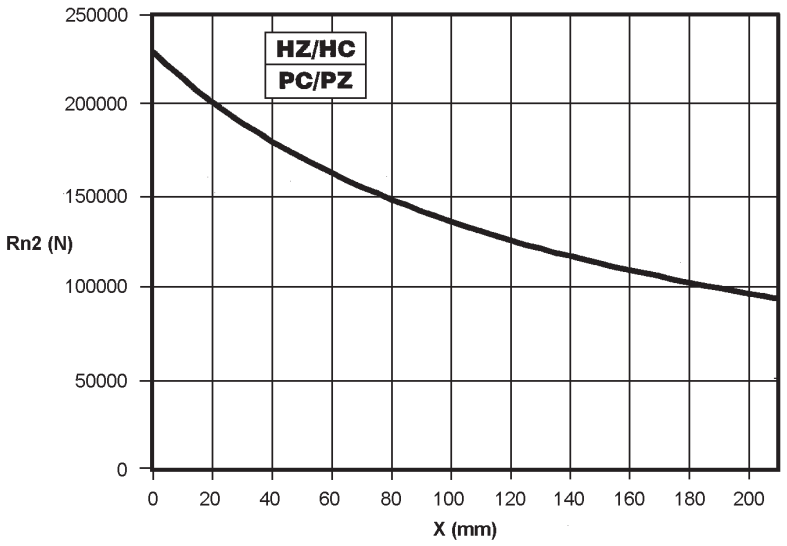
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
310 L1	88	70x64 DIN 5482	200	282 H7	266	M12 n°12	/	4	22	11	32	/	/	45°	45°	C
310 L2	45	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
310 L3	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
310 L4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	0	9	18	53	18	45°	45°	A
310 R3-R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

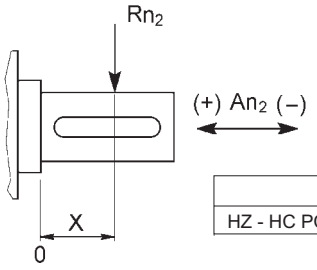
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

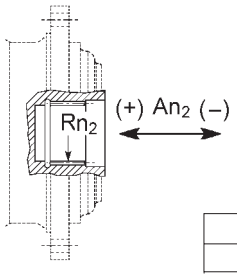
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC PC - PZ	170 000	100 000



	Rn2	An2 (+/-)
FZ	65 000	52 000

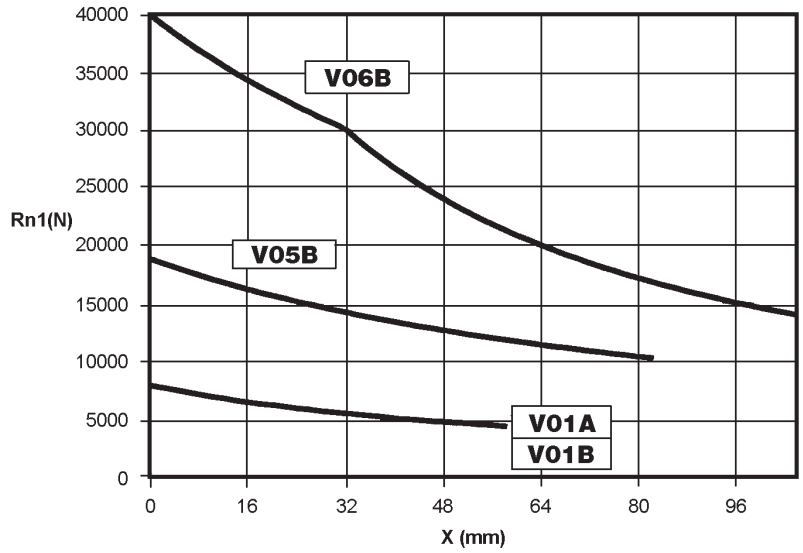
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres		**$Fh_2 = n_2 \cdot h$**	10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

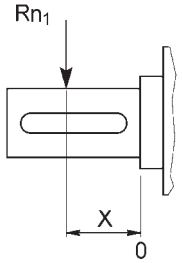
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	**$Fh_1 = n_1 \cdot h$**	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

311L

M_2 = 35000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	4.09	45 000	45 000	37 400	30 300	18 700	15 200	180	40	750	1 000		
	5.25	43 000	36 500	32 300	32 000	19 700	16 000	180	40	750	1 000		
	6.23	34 000	29 500	27 000	27 000	18 600	15 100	180	40	750	1 000		
L 2	14.0	35 700	35 700	35 700	30 300	18 700	15 200	100	26	1 500	2 500	3 200	6L
	16.7	45 000	45 000	37 400	30 300	18 700	15 200	100	26	1 500	2 500	3 200	6L
	18.0	43 000	36 500	32 300	32 000	19 700	16 000	100	26	1 500	2 500	2 600	6K
	21.5	44 100	41 700	37 400	30 300	18 700	15 200	100	26	1 500	2 500	2 100	6G
	25.5	35 200	34 500	34 500	30 300	18 700	15 200	100	26	1 500	2 500	1 500	6E
	27.6	43 000	36 500	32 300	32 000	19 700	16 000	100	26	1 500	2 500	2 100	6G
	32.7	43 000	36 500	32 300	32 000	19 700	16 000	100	26	1 500	2 500	1 500	6E
	38.8	34 000	29 500	27 000	27 000	18 600	15 100	100	26	1 500	2 500	850	6B
L 3	50.5	35 700	35 700	35 700	30 300	18 700	15 200	60	18	1 800	3 800	800	5G
	60.2	45 000	45 000	37 400	30 300	18 700	15 200	60	18	1 800	3 800	800	5G
	71.1	45 000	45 000	37 400	30 300	18 700	15 200	60	18	1 800	3 800	800	5G
	77.3	44 100	41 700	37 400	30 300	18 700	15 200	60	18	1 800	3 800	800	5G
	87.0	35 700	35 700	35 700	30 300	18 700	15 200	60	18	1 800	3 800	500	5C
	104	45 000	45 000	37 400	30 300	18 700	15 200	60	18	1 800	3 800	500	5C
	115	44 100	41 700	37 400	30 300	18 700	15 200	60	18	1 800	3 800	400	5B
	126	45 000	45 000	37 400	30 300	18 700	15 200	60	18	1 800	3 800	400	5B
	133	44 100	41 700	37 400	30 300	18 700	15 200	56	18	1 800	3 800	400	5B
	147	43 000	36 500	32 300	32 000	19 700	16 000	50	18	1 800	3 800	400	5B
	161	44 100	41 700	37 400	30 300	18 700	15 200	48	18	1 800	3 800	400	5B
	171	43 000	36 500	32 300	32 000	19 700	16 000	44	18	1 800	3 800	400	5B
	191	35 200	34 500	34 500	30 300	18 700	15 200	33	18	1 800	3 800	400	5B
	203	43 000	36 500	32 300	32 000	19 700	16 000	38	18	1 800	3 800	400	5B
	245	43 000	36 500	32 300	32 000	19 700	16 000	32	18	1 800	3 800	400	5B
	291	34 000	29 500	27 000	27 000	18 600	15 100	22	18	1 800	3 800	400	5B
L 4	348	45 000	45 000	37 400	30 300	18 700	15 200	30	11	2 000	4 000	160	4D
	410	45 000	45 000	37 400	30 300	18 700	15 200	30	11	2 000	4 000	160	4D
	512	45 000	45 000	37 400	30 300	18 700	15 200	26	11	2 000	4 000	100	4B
	568	44 100	41 700	37 400	30 300	18 700	15 200	23	11	2 000	4 000	100	4B
	626	35 700	35 700	35 700	30 300	18 700	15 200	16.9	11	2 000	4 000	100	4B
	724	45 000	45 000	37 400	30 300	18 700	15 200	18.4	11	2 000	4 000	100	4B
	825	44 100	41 700	37 400	30 300	18 700	15 200	16.1	11	2 000	4 000	100	4B
	904	45 000	45 000	37 400	30 300	18 700	15 200	14.7	11	2 000	4 000	50	4A
	986	43 000	36 500	32 300	32 000	19 700	16 000	13.5	11	2 000	4 000	50	4A
	1 103	35 200	34 500	34 500	30 300	18 700	15 200	11.8	11	2 000	4 000	50	4A
	1 230	43 000	36 500	32 300	32 000	19 700	16 000	10.8	11	2 000	4 000	50	4A
	1 415	43 000	36 500	32 300	32 000	19 700	16 000	9.4	11	2 000	4 000	50	4A
	1 680	34 000	29 500	27 000	27 000	18 600	15 100	7.9	11	2 000	4 000	50	4A
	1 766	43 000	36 500	32 300	32 000	19 700	16 000	7.5	11	2 000	4 000	50	4A
	2 096	34 000	29 500	27 000	27 000	18 600	15 100	6.3	11	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

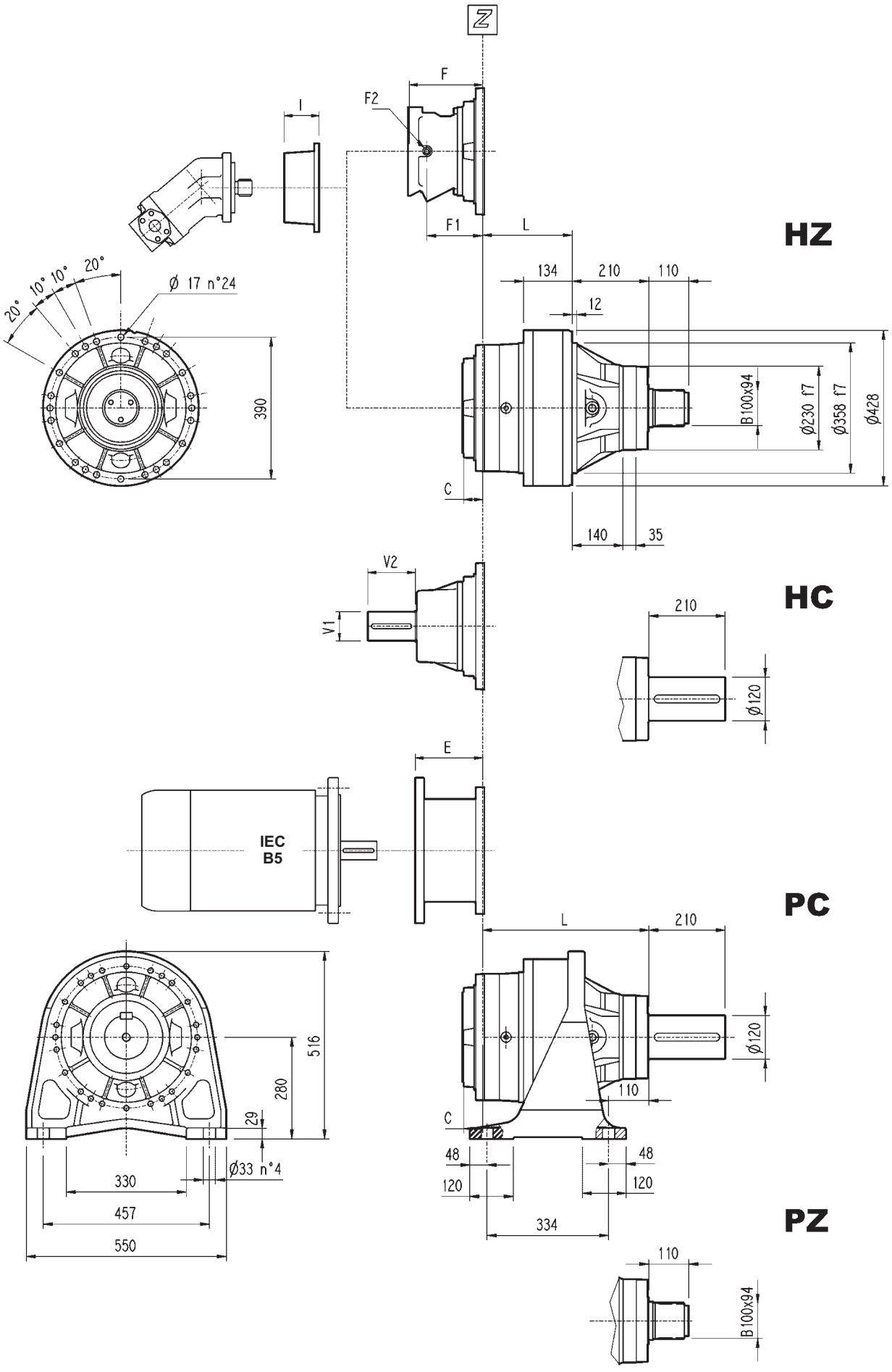
M_2 = 35000 Nm

311R

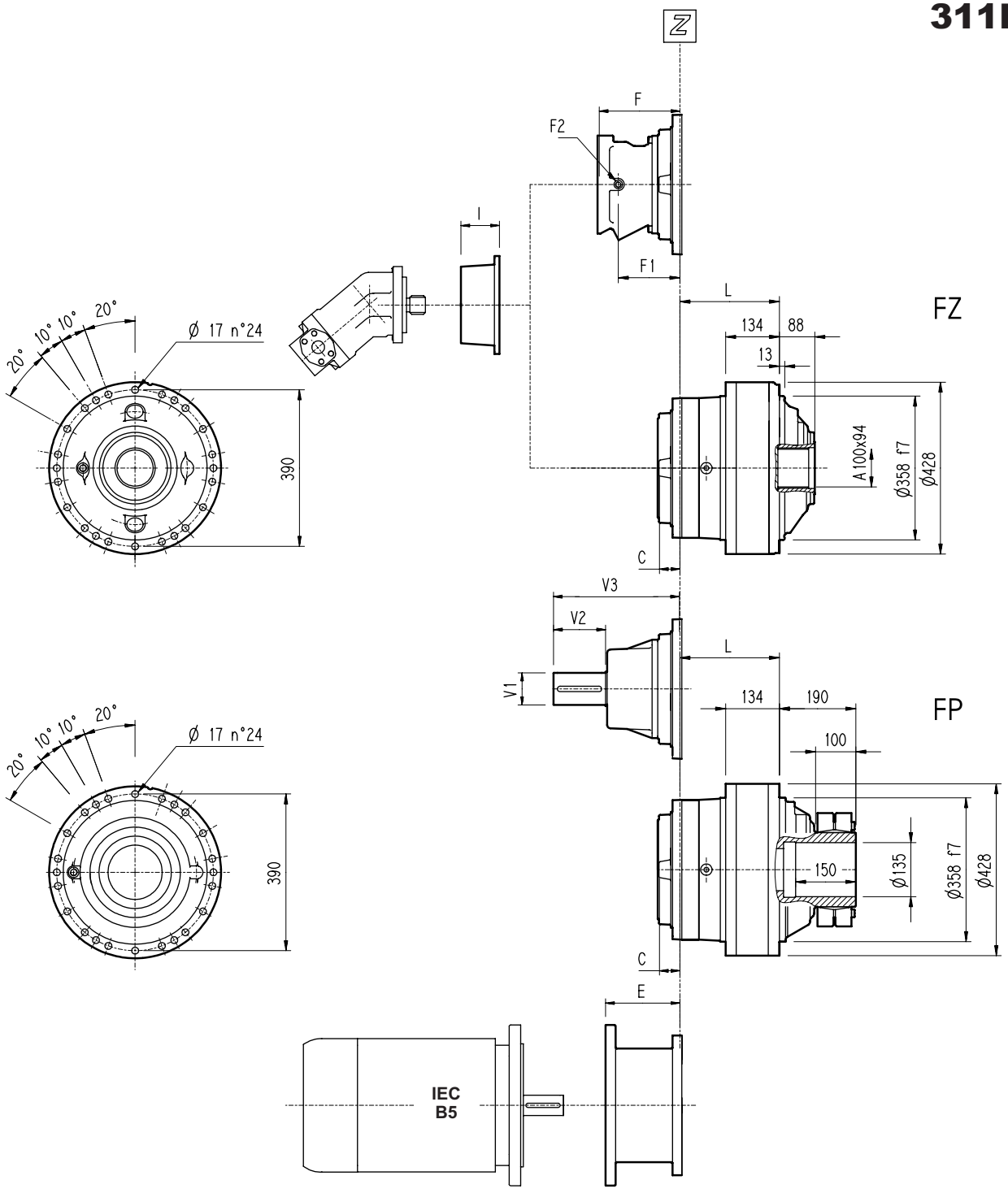
	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	17.7	14 800	14 300	14 300	14 300	9 600	7 800	135	75	1 800	3 800	1 000	5K
	22.8	18 300	18 300	18 300	18 300	11 500	9 300	135	75	1 800	3 800	1 000	5K
	27.0	21 800	21 800	21 800	21 000	12 900	10 500	135	75	1 800	3 800	1 000	5K
R3	53.0	31 100	26 800	24 000	22 100	13 700	11 100	85	40	2 000	4 000	800	5G
	63.2	36 000	31 100	28 000	25 000	15 500	12 600	85	40	2 000	4 000	800	5G
	68.0	38 300	33 100	30 100	26 400	16 300	13 200	85	40	2 000	4 000	630	5E
	81.1	44 100	38 400	36 000	29 800	18 400	14 900	85	40	2 000	4 000	630	5E
	96.3	35 200	34 500	34 500	30 300	18 700	15 200	62	40	2 000	4 000	500	5C
	104	43 000	36 500	32 300	32 000	19 700	16 000	67	40	2 000	4 000	500	5C
	124	43 000	36 500	32 300	32 000	19 700	16 000	58	40	2 000	4 000	400	5B
	147	34 000	29 500	27 000	27 000	18 600	15 100	40	40	2 000	4 000	400	5B
R4	154	43 200	32 800	26 700	21 700	13 400	10 900	35	22	2 000	4 000	330	4H
	182	45 000	36 900	29 900	24 300	15 000	12 200	35	22	2 000	4 000	330	4H
	198	44 100	39 100	31 700	25 800	15 900	12 900	35	22	2 000	4 000	260	4F
	223	35 700	35 700	34 500	28 000	17 300	14 000	35	22	2 000	4 000	260	4F
	266	45 000	45 000	37 300	30 300	18 700	15 200	35	22	2 000	4 000	260	4F
	294	44 100	41 700	37 300	30 300	18 700	15 200	35	22	2 000	4 000	160	4D
	322	45 000	45 000	37 300	30 300	18 700	15 200	35	22	2 000	4 000	160	4D
	341	44 100	41 700	37 300	30 300	18 700	15 200	35	22	2 000	4 000	160	4D
	377	43 000	36 500	32 300	32 000	19 700	16 000	33	22	2 000	4 000	160	4D
	413	44 100	41 700	37 300	30 300	18 700	15 200	32	22	2 000	4 000	160	4D
	438	43 000	36 500	32 300	32 000	19 700	16 000	30	22	2 000	4 000	160	4D
	490	35 200	34 500	34 500	30 300	18 700	15 200	24	22	2 000	4 000	100	4B
	520	43 000	36 500	32 300	32 000	19 700	16 000	24	22	2 000	4 000	100	4B
	629	43 000	36 500	32 300	32 000	19 700	16 000	21	22	2 000	4 000	100	4B
	746	34 000	29 500	27 000	27 000	18 600	15 100	16	22	2 000	4 000	100	4B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

311L


Z
F
F2
I
F1
L
HZ
134
210
110
12
20°
10°
10°
20°
Ø 17 n°24
390
B100x94
Ø230 f7
Ø358 f7
Ø428
C
140
35
V2
V1
HC
210
Ø120
E
IEC
B5
PC
L
210
516
280
29
Ø33 n°4
330
457
550
Ø120
110
C
48
48
120
120
334
PZ
110
B100x94

311L

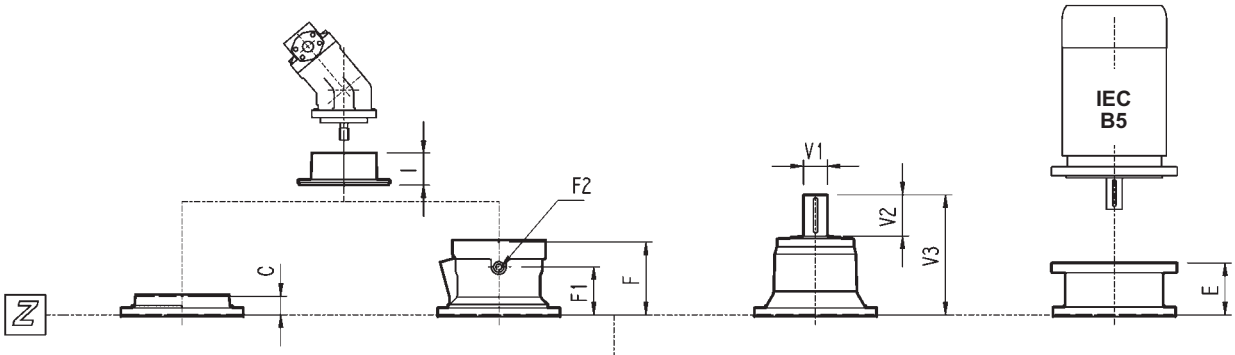


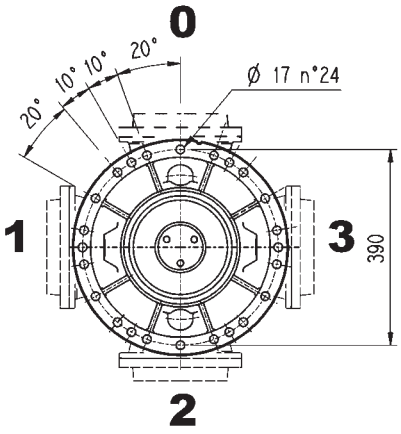
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**36 000 Nm**

	L				Kg												
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée	**I**	**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
311 L1	115	325	115	115	180	250	160	170	81	D							
311 L2	248	458	248	248	225	295	205	215	51	B		201	153	1/4 G	6	B	28
311 L3	337	547	337	337	237	307	217	227	37	A		145	95	1/4 G	5	A	16
311 L4	402	612	402	402	244	314	224	234	37	A	171	105	65	1/4 G	4	A	10

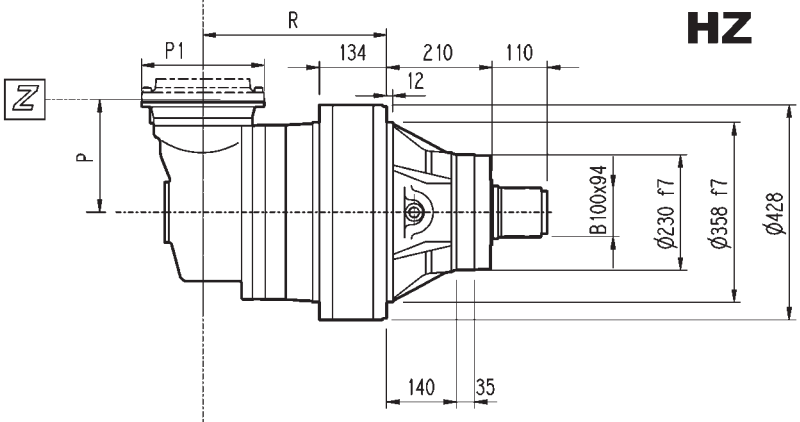
									E											
	V1	**V2**	**V3**	Kg	**V1**	**V2**	**V3**	Kg		**IEC 71**	**IEC 80**	**IEC 90**	**IEC 100**	**IEC 112**	**IEC 132**	**IEC 160**	**IEC 180**	**IEC 200**	**IEC 225**	**IEC 250**
311 L1	80	130	348	55																
311 L2	80	130	315	35	60	105	313	28									195	186	216	215
311 L3	48	82	239	15											114	144	144	174		
311 L4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				

311R

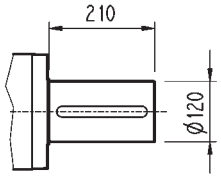


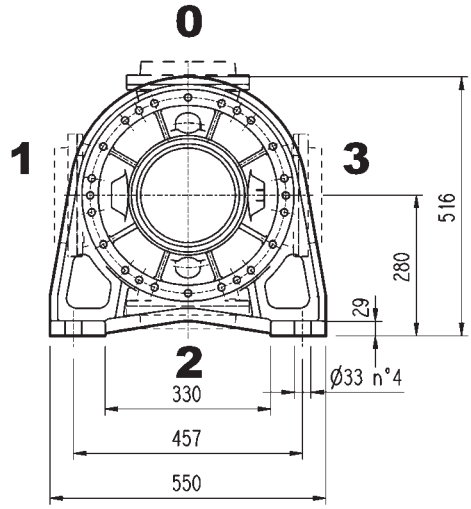


HZ

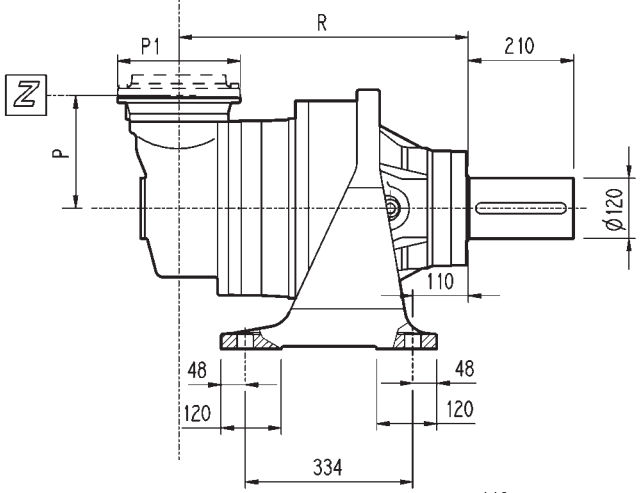


HC

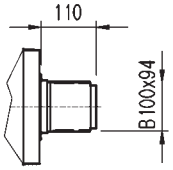




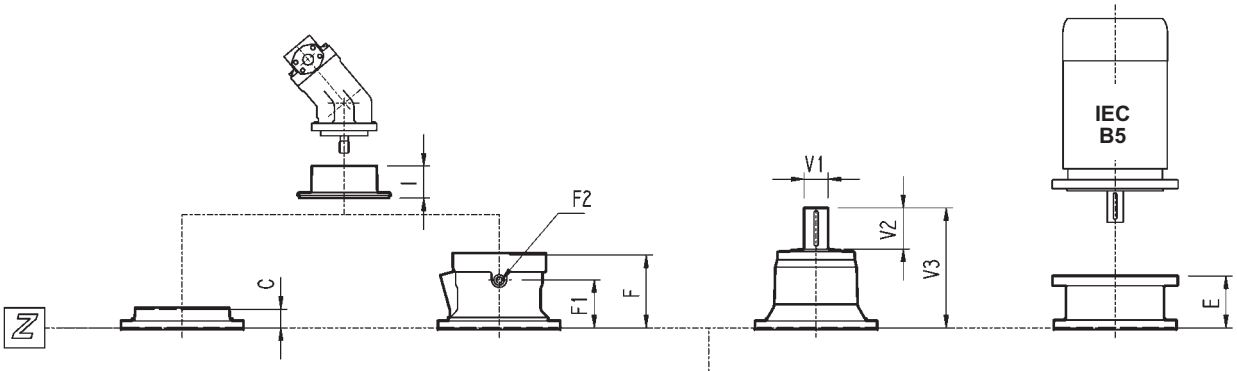
PC

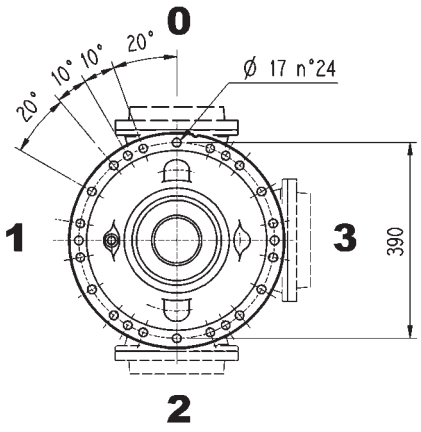


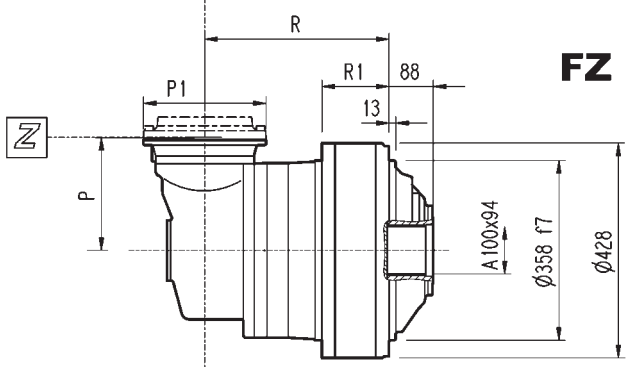
PZ

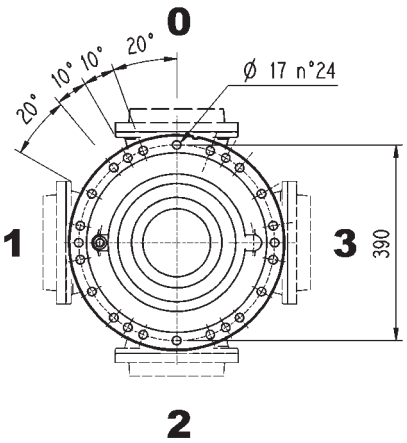


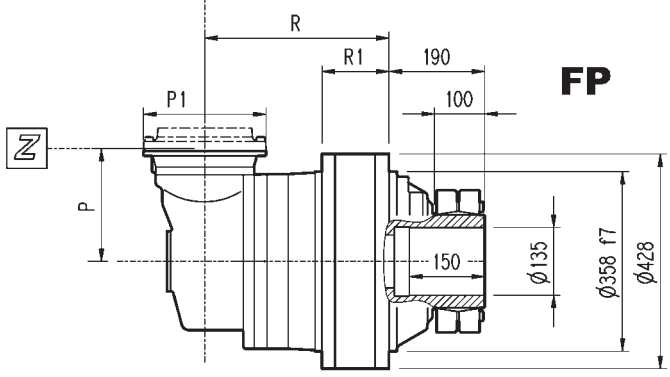
311R











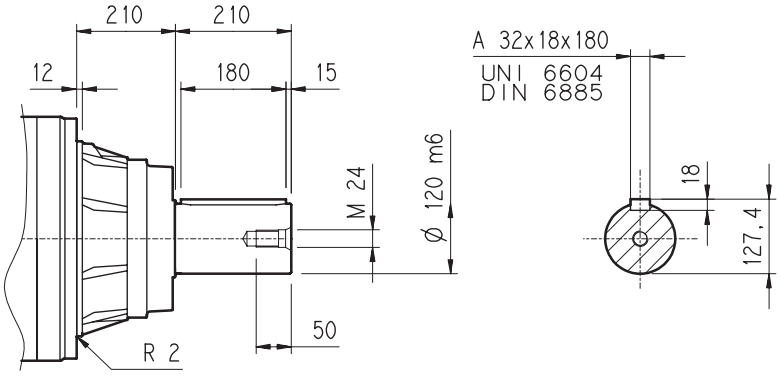
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**36 000 Nm**

	R				R1			P	P1	Kg				C		I	F	F1	F2			Kg
	HZ HC	PC PZ	FZ	FP	HZ HC	FZ	FP			HZ HC	PC PZ	FZ	FP		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
311 R2	340	550	340	340	134	154	154	330	245	290	360	270	280	37	A		145	95	1/4 G	5	A	16
311 R3	367	577	367	367	134	134	134	225	245	275	345	255	265	37	A		145	95	1/4 G	5	A	16
311 R4	429	639	429	429	134	134	134	140	186	257	327	237	247	37	A	171	105	65	1/4 G	4	A	10

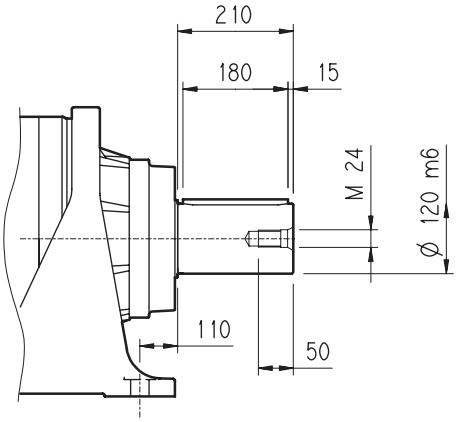
	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160	IEC 180	IEC 200
311 R2	48	82	239	15											114	144	144	174
311 R3	48	82	239	15											114	144	144	174
311 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		

311L - 311R

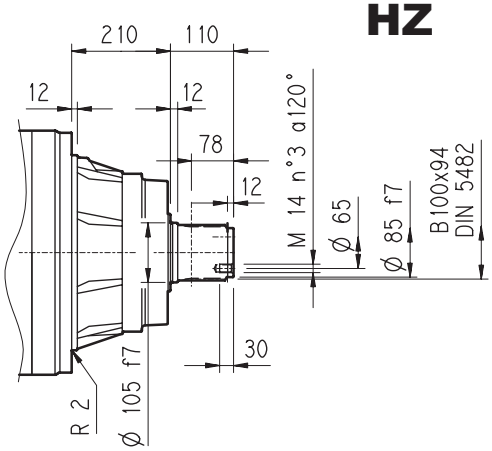
HC

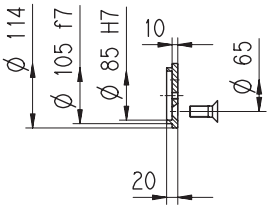


PC

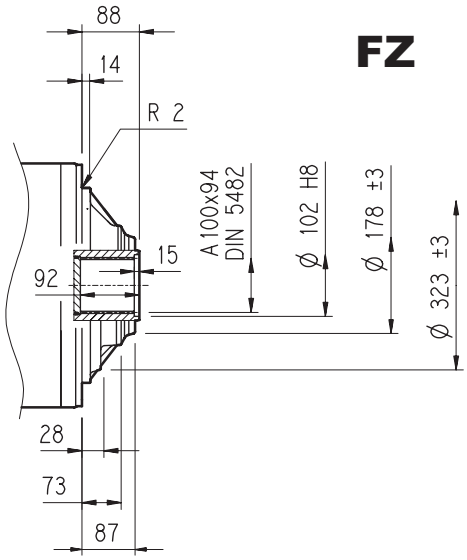


HZ

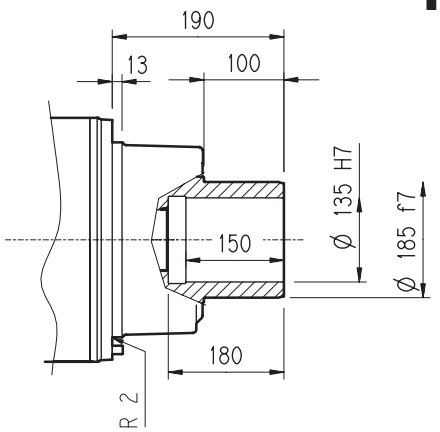


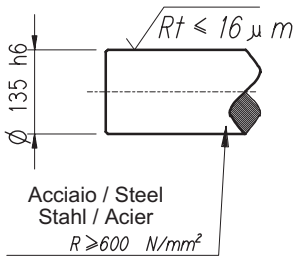


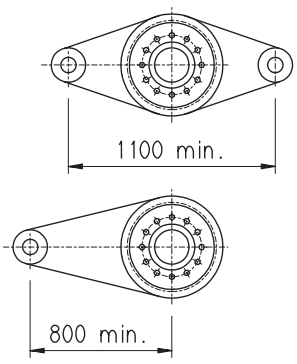
FZ



FP





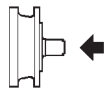


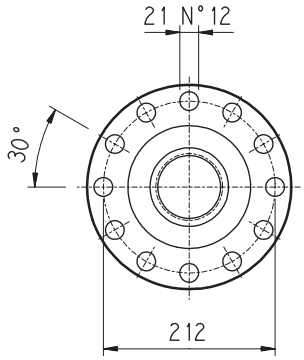
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**36 000 Nm**

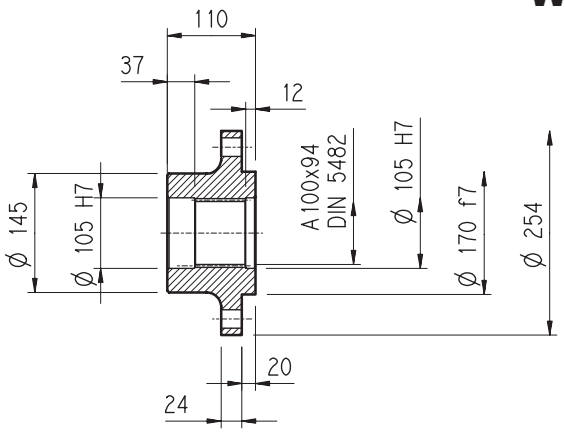
311L - 311R

Flangia / Flange
Flansch / Brides

W0A



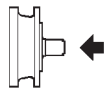


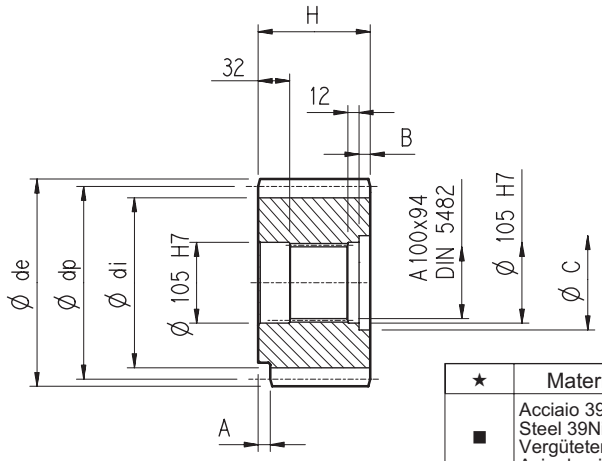


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



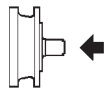


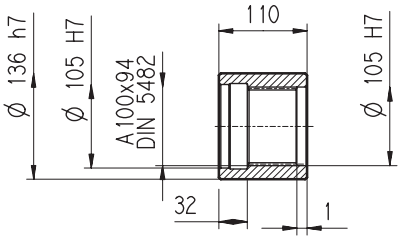
	m	z	x	dp	di	de	H	A	B	C	★
PLQ	12	23	0	276	246	300	110	0	0	0	□
PPD	16	13	0.500	208	184	252.5	145	0	35	116	■
PPF	16	15	0.450	240	215	280	125	0	15	120	□

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

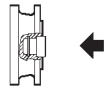


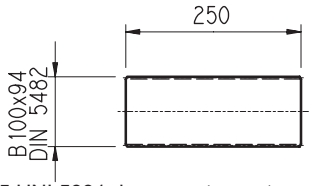


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

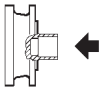


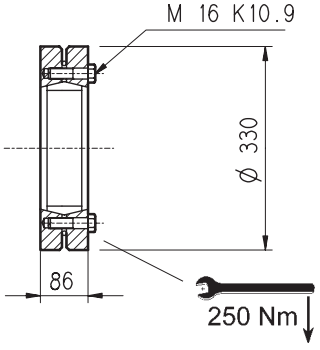


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

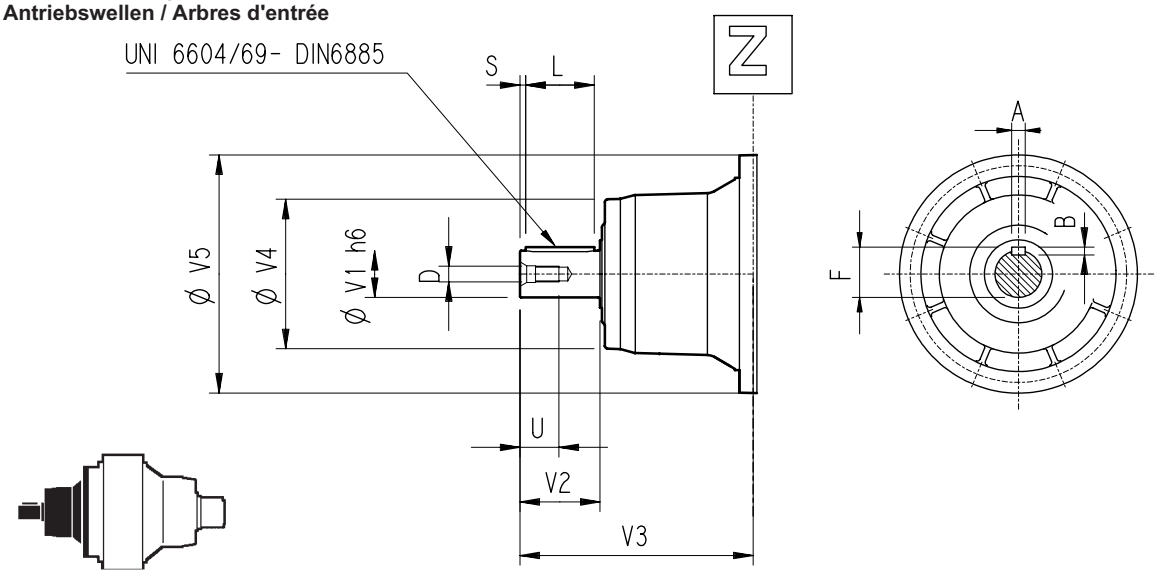
G0A





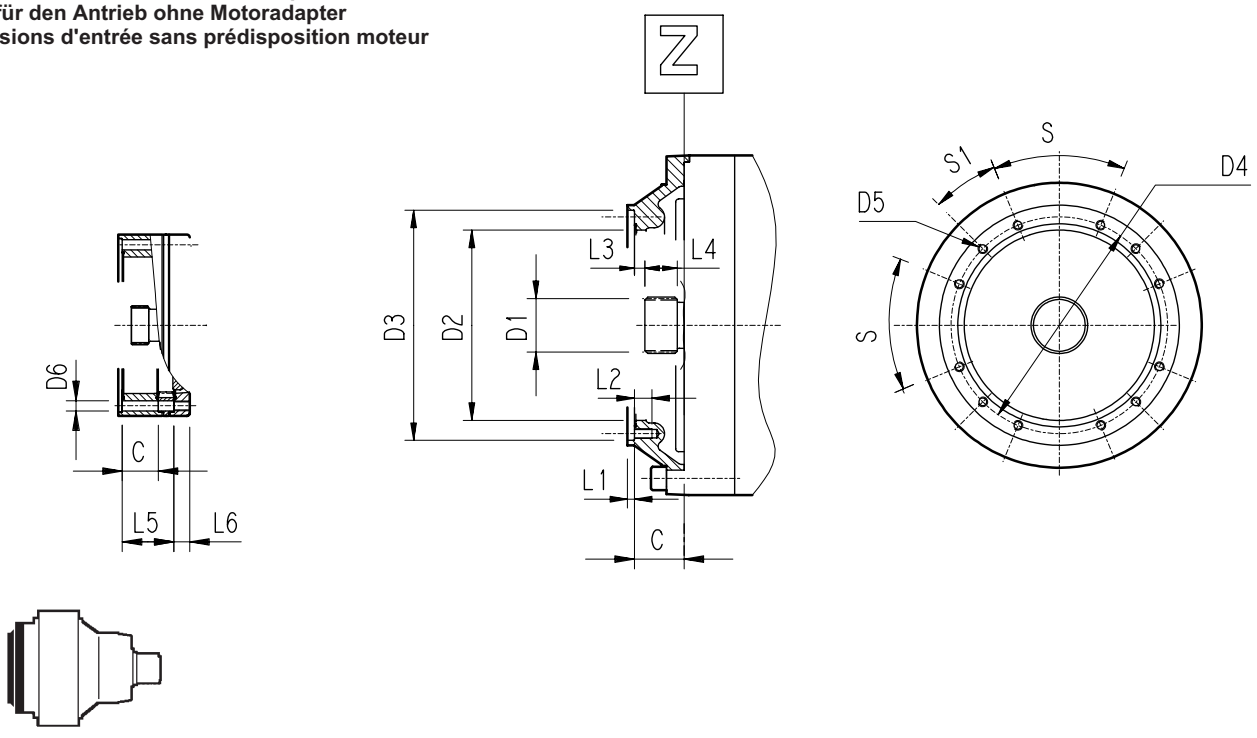
311L - 311R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
311 L1	V11B	80	130	345	200	428	22	14	85	110	10	M16	40
311 L2	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
311 L3	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
311 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
311 R2-R3	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
311 R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



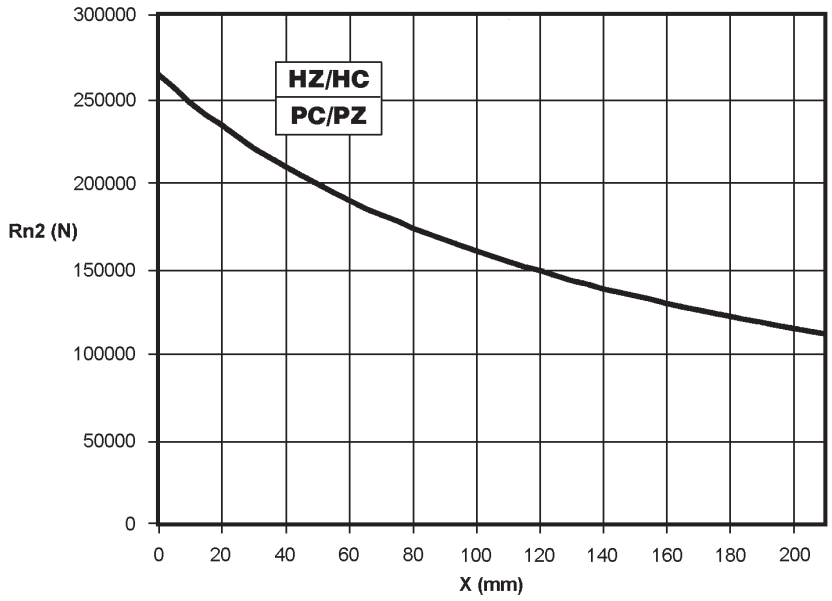
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
311 L1	81	80x74 DIN 5482	270	335 H7	314	M16 n°8	/	5	30	8.5	40	/	/	60°	30°	D
311 L2	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
311 L3	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
311 L4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	0	9	18	65	18	45°	45°	A
311 R2 - R3	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A
311 R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

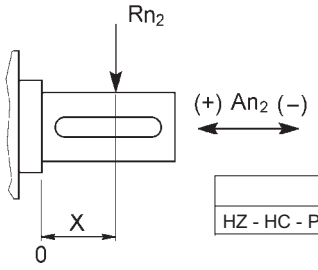
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

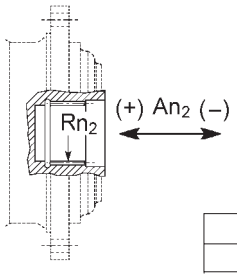
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC - PC - PZ	200 000	140 000



	Rn2	An2 (+/-)
FZ	65 000	60 000

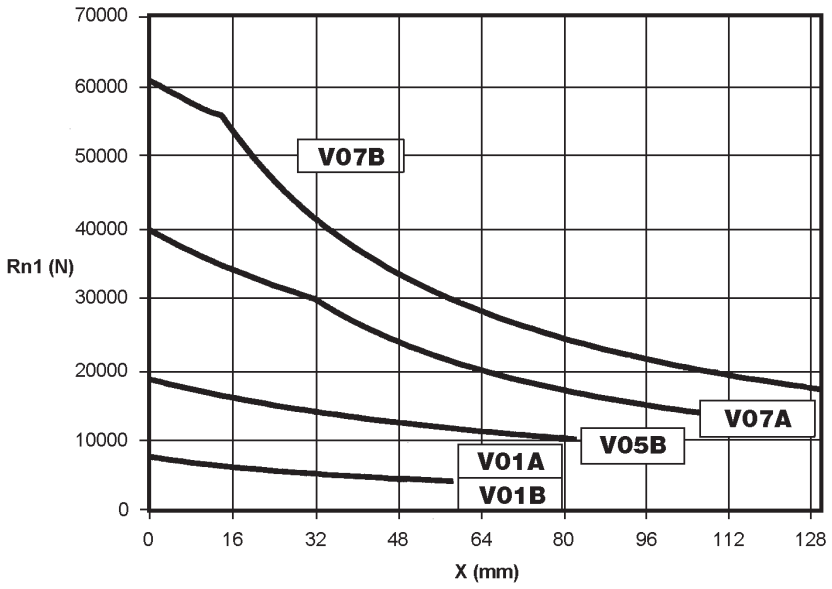
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

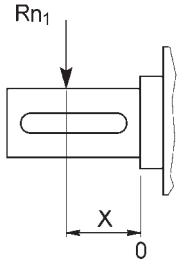
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

313L

M_2 = 50000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	4.14	55 000	55 000	55 000	46 000	28 400	23 000	200	45	500	800		
	5.40	55 000	48 200	45 000	45 000	27 800	22 600	200	45	500	800		
	6.50	49 000	42 400	39 000	39 000	27 800	22 500	200	45	500	800		
L 2	14.2	52 000	52 000	52 000	46 000	28 400	23 000	130	30	1 500	2 000	3 200	6L
	16.9	55 000	55 000	54 000	44 200	27 300	22 100	130	30	1 500	2 000	3 200	6L
	18.5	55 000	48 200	45 000	45 000	27 800	22 600	130	30	1 500	2 000	3 200	6L
	21.8	55 000	55 000	55 000	45 400	28 000	22 800	130	30	1 500	2 000	2 600	6K
	25.8	53 000	52 000	52 000	44 300	27 400	22 200	130	30	1 500	2 000	2 100	6G
	28.4	55 000	48 200	45 000	45 000	27 800	22 600	130	30	1 500	2 000	2 100	6G
	33.6	55 000	48 200	45 000	45 000	27 800	22 600	130	30	1 500	2 000	2 100	6G
	40.5	49 000	42 400	39 000	39 000	27 700	22 500	130	30	1 500	2 000	1 500	6E
L 3	51.1	52 000	52 000	45 400	36 900	22 800	18 500	60	18	1 800	3 800	1 000	5K
	61.0	55 000	55 000	51 000	41 700	25 700	20 900	60	18	1 800	3 800	1 000	5K
	72.0	55 000	55 000	50 000	40 800	25 200	20 500	60	18	1 800	3 800	1 000	5K
	78.3	55 000	55 000	55 000	45 400	28 000	22 800	60	18	1 800	3 800	1 000	5K
	92.4	55 000	55 000	55 000	45 400	28 000	22 800	60	18	1 800	3 800	800	5G
	110	53 000	52 000	52 000	44 300	27 400	22 200	60	18	1 800	3 800	500	5C
	120	55 000	48 200	45 000	45 000	27 800	22 600	60	18	1 800	3 800	500	5C
	135	55 000	55 000	55 000	45 400	28 000	22 800	60	18	1 800	3 800	500	5C
	151	55 000	48 200	45 000	45 000	27 800	22 600	60	18	1 800	3 800	400	5B
	163	55 000	55 000	48 400	39 300	24 200	19 700	58	18	1 800	3 800	400	5B
	176	55 000	48 200	45 000	45 000	27 800	22 600	55	18	1 800	3 800	400	5B
	194	53 000	52 000	52 000	44 300	27 300	22 200	49	18	1 800	3 800	400	5B
	209	55 000	48 200	45 000	45 000	27 800	22 600	48	18	1 800	3 800	400	5B
	252	55 000	48 200	45 000	45 000	27 800	22 600	40	18	1 800	3 800	400	5B
	304	49 000	42 400	39 000	39 000	27 700	22 500	31	18	1 800	3 800	400	5B
L 4	352	55 000	51 800	42 100	34 200	21 100	17 100	30	11	2 000	4 000	160	4D
	394	55 000	55 000	55 000	45 400	28 000	22 800	30	11	2 000	4 000	160	4D
	452	55 000	55 000	50 000	40 700	25 100	20 400	30	11	2 000	4 000	160	4D
	514	55 000	48 200	45 000	45 000	27 800	22 600	30	11	2 000	4 000	160	4D
	564	55 000	55 000	44 300	36 000	22 200	18 000	29	11	2 000	4 000	160	4D
	633	52 800	52 000	52 000	44 300	27 400	22 200	26	11	2 000	4 000	100	4B
	695	55 000	48 200	45 000	45 000	27 800	22 600	26	11	2 000	4 000	100	4B
	790	52 800	52 000	52 000	44 300	27 400	22 200	21	11	2 000	4 000	100	4B
	889	55 000	48 200	45 000	45 000	27 800	22 600	20	11	2 000	4 000	100	4B
	1 014	55 000	48 200	45 000	45 000	27 800	22 600	17	11	2 000	4 000	100	4B
	1 117	52 800	52 000	52 000	44 300	27 300	22 200	15	11	2 000	4 000	50	4A
	1 266	55 000	48 200	45 000	45 000	27 800	22 600	14	11	2 000	4 000	50	4A
	1 394	52 800	52 000	52 000	44 300	27 300	22 200	12	11	2 000	4 000	50	4A
	1 502	55 000	48 200	45 000	45 000	27 800	22 600	12	11	2 000	4 000	50	4A
	1 817	55 000	48 200	45 000	45 000	27 800	22 600	10	11	2 000	4 000	50	4A
	2 187	49 000	42 400	39 000	39 000	27 700	22 500	8	11	2 000	4 000	50	4A

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

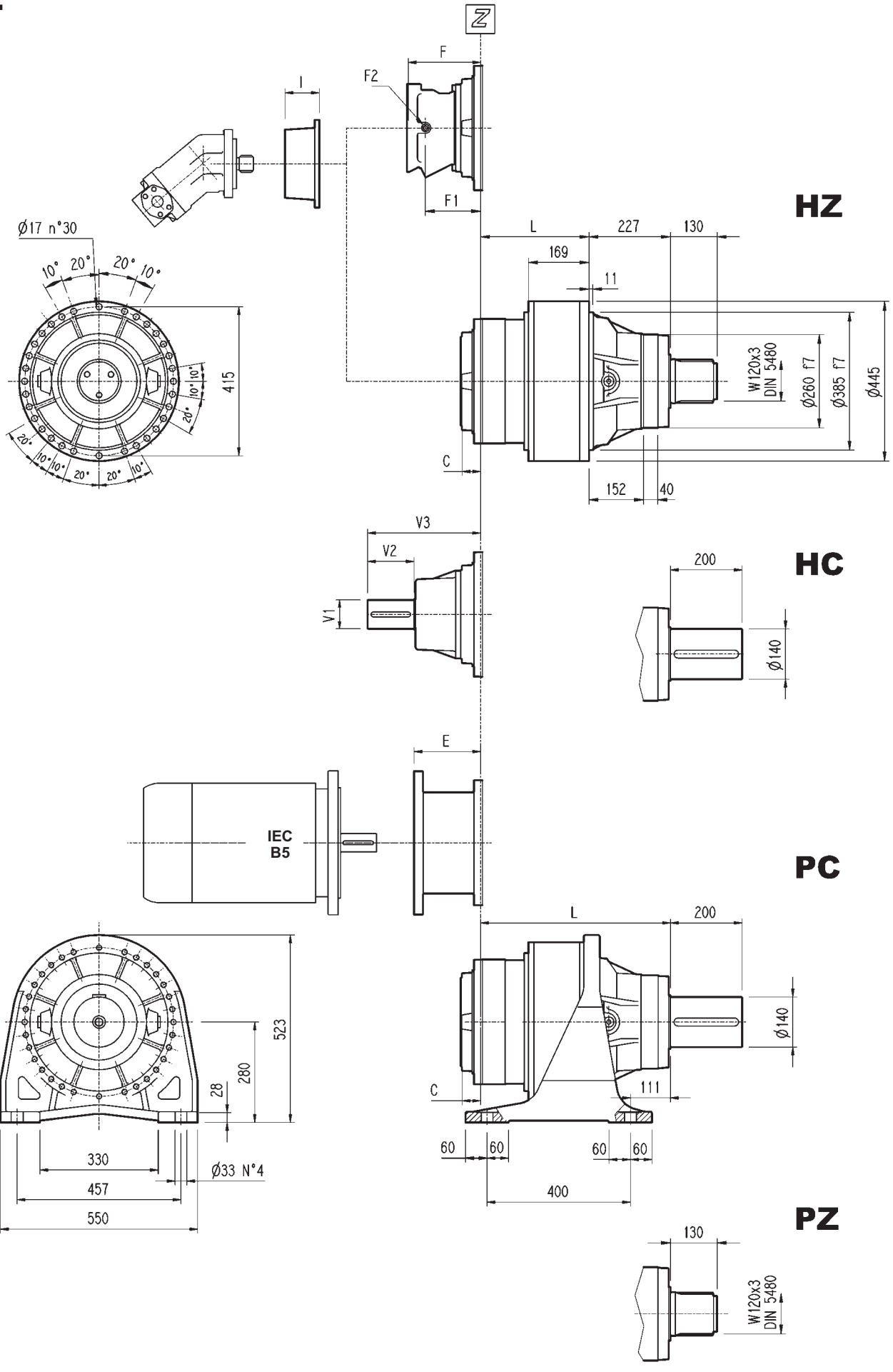
M_2 = 50000 Nm

313R

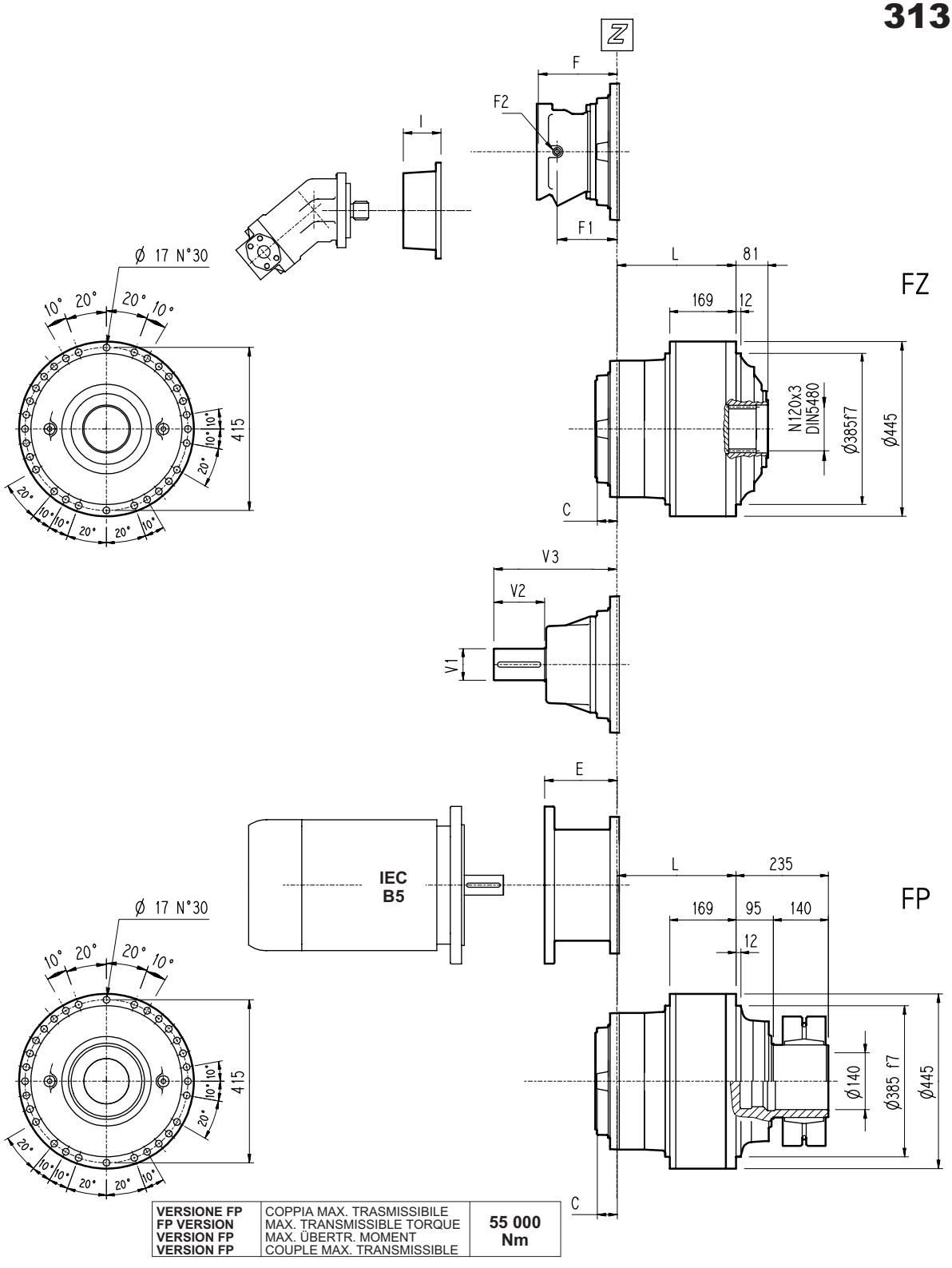
	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2	18,0	15 000	14 500	14 500	14 500	9 700	7 900	90	75	1 500	2 000	1 000	5K
	23,4	18 900	18 900	18 900	18 900	11 700	9 500	90	75	1 500	2 000	1 000	5K
	28,2	22 700	22 700	22 700	21 600	13 300	10 800	90	75	1 500	2 000	1 000	5K
R3	53,7	31 400	27 100	24 200	22 300	13 800	11 200	85	40	1 800	3 800	800	5G
	64,0	36 400	31 400	28 400	25 300	15 600	12 700	85	40	1 800	3 800	800	5G
	69,9	39 200	33 900	31 000	26 900	16 600	13 500	85	40	1 800	3 800	800	5G
	82,2	44 900	38 800	36 400	30 100	18 600	15 100	85	40	1 800	3 800	630	5E
	97,5	52 000	44 800	41 800	33 900	20 900	17 000	85	40	1 800	3 800	630	5E
	107	55 000	48 200	44 600	36 200	22 300	18 200	84	40	1 800	3 800	630	5E
	127	55 000	48 200	45 000	40 800	25 200	20 500	73	40	1 800	3 800	500	5C
	153	49 000	42 400	39 000	39 000	27 700	22 500	55	40	1 800	3 800	400	5B
R4	185	49 000	37 200	30 200	24 500	15 100	12 300	35	22	2 000	4 000	330	4H
	201	52 000	39 400	32 000	26 000	16 100	13 000	35	22	2 000	4 000	330	4H
	237	55 000	44 300	36 000	29 200	18 000	14 600	35	22	2 000	4 000	260	4F
	281	53 000	49 900	40 600	32 900	20 300	16 500	35	22	2 000	4 000	260	4F
	309	55 000	48 200	43 300	35 200	21 700	17 600	35	22	2 000	4 000	260	4F
	346	55 000	55 000	46 900	38 100	23 500	19 100	35	22	2 000	4 000	260	4F
	387	55 000	48 200	45 000	41 200	25 400	20 700	35	22	2 000	4 000	160	4D
	418	55 000	55 000	46 900	38 100	23 500	19 100	35	22	2 000	4 000	160	4D
	450	55 000	48 200	45 000	45 000	27 800	22 600	35	22	2 000	4 000	160	4D
	496	53 000	52 000	52 200	44 300	27 300	22 200	33	22	2 000	4 000	160	4D
	535	55 000	48 200	45 000	45 000	27 800	22 600	33	22	2 000	4 000	160	4D
	647	55 000	48 200	45 000	45 000	27 800	22 600	27	22	2 000	4 000	100	4B
	778	49 000	42 400	39 000	39 000	27 700	22 500	22	22	2 000	4 000	100	4B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

313L


Z
F
F2
I
F1
HZ
Ø17 n°30
10° 20° 20° 10°
415
L
227
130
169
11
W120x3
DIN 5480
Ø260 f7
Ø385 f7
Ø445
C
152
40
V3
V2
V1
HC
200
Ø140
E
IEC
B5
PC
L
200
Ø140
C
111
60
60
60
60
400
523
280
28
330
457
550
Ø33 N°4
PZ
130
W120x3
DIN 5480

313L

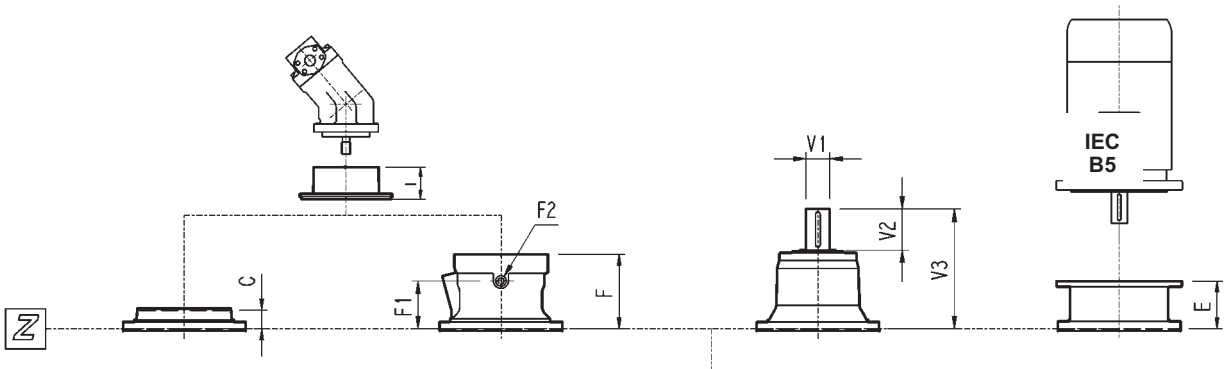


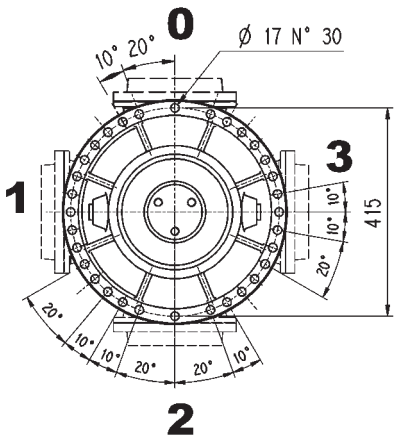
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE
55 000 Nm	

	L				Kg				C		I	F	F1	F2			Kg
	HZ HC	PC PZ	FZ	FP	HZ HC	PC PZ	FZ	FP		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
313 L1	154	381	154	154	230	320	200	200	76	D							
313 L2	304	531	304	304	290	380	260	280	51	B		201	153	1/4 G	6	B	28
313 L3	393	620	393	393	302	392	272	292	37	A		145	95	1/4 G	5	A	16
313 L4	458	685	458	458	309	399	279	299	37	A	171	105	65	1/4 G	4	A	10

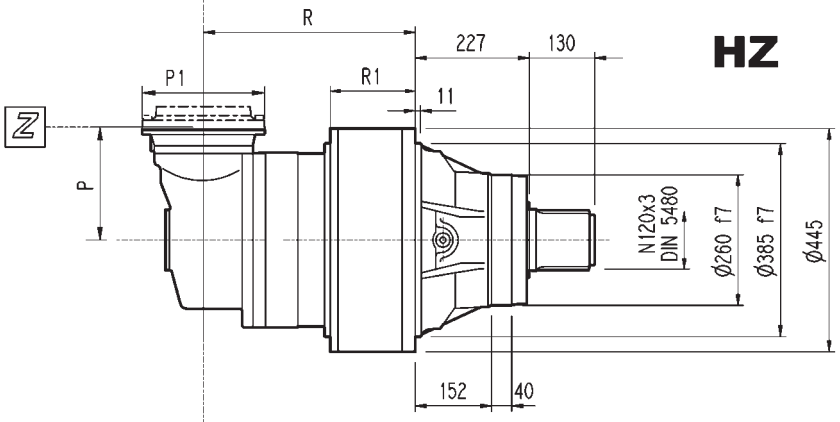
	V1	V2	V3	Kg	V1	V2	V3	Kg	E											
										IEC 71	IEC 80	IEC 90	IEC 100	IEC 112	IEC 132	IEC 160	IEC 180	IEC 200	IEC 225	IEC 250
313 L1	80	130	348	55																
313 L2	80	130	315	35	60	105	313	28									195	186	216	215
313 L3	48	82	239	15											114	144	144	174		
313 L4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144				

313R

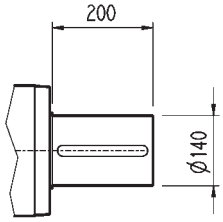




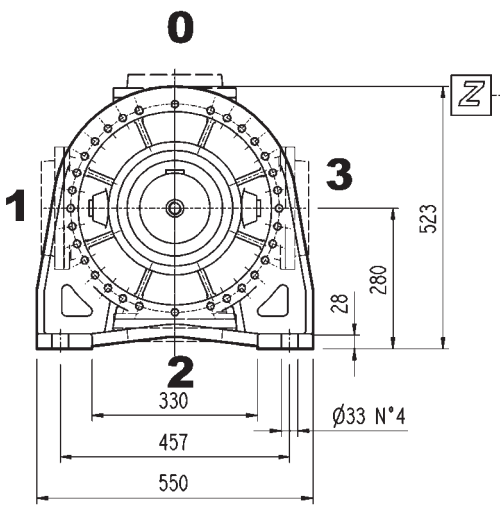
HZ

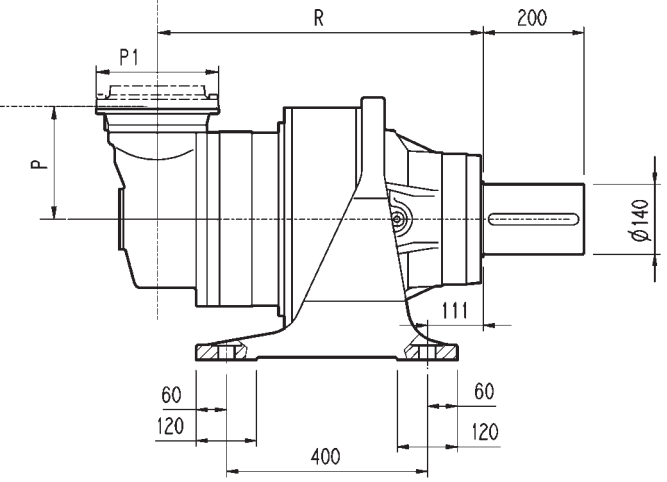


HC

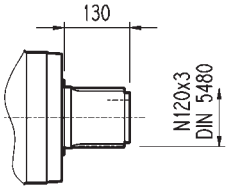


PC

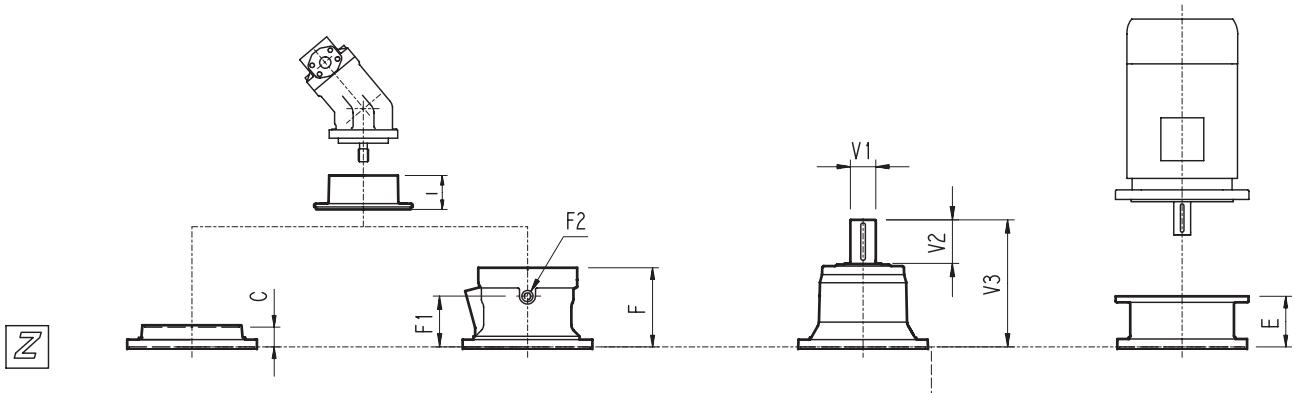


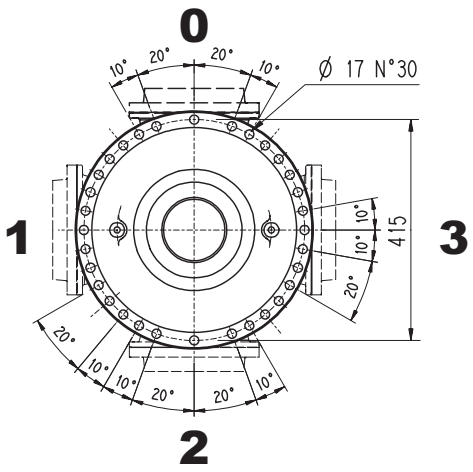


PZ

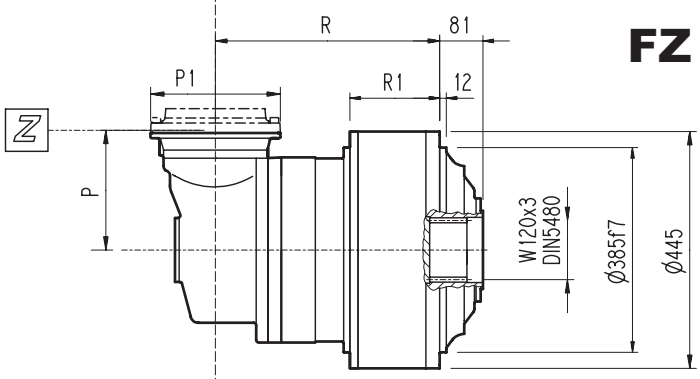


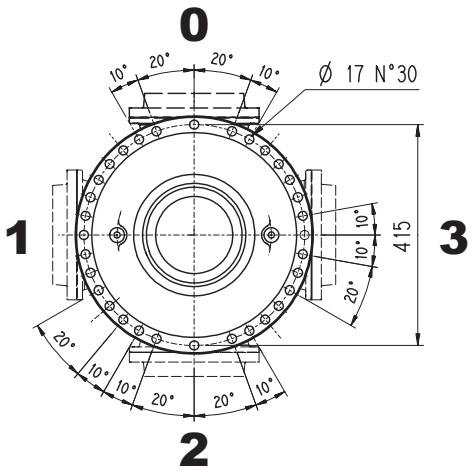
313R



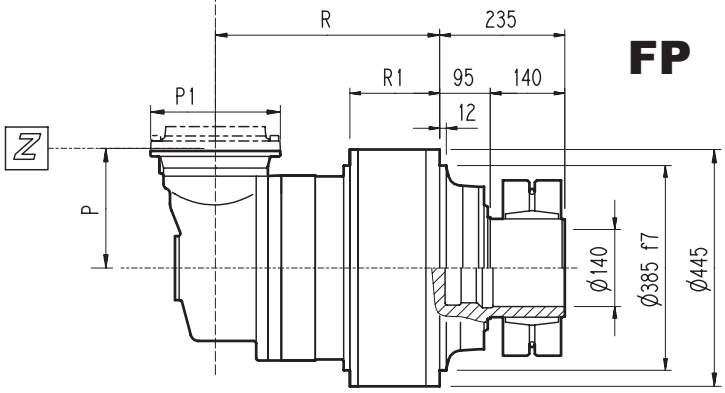


FZ





FP



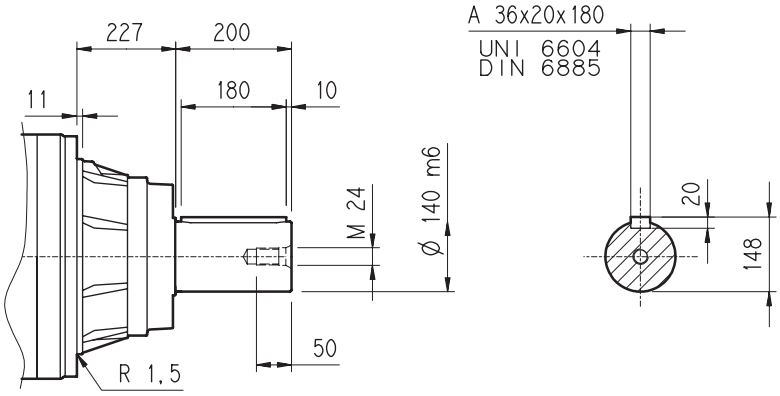
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**55 000 Nm**

	R				R1			P	P1	Kg						I						Kg
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**FZ**	**FP**			**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée		**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	
313 R2	384	611	384	384	199	199	199	330	245	340	430	310	330	37	A		145	95	1/4 G	5	A	16
313 R3	423	650	423	423	169	169	169	225	245	340	430	310	330	37	A		145	95	1/4 G	5	A	16
313 R4	485	712	485	485	169	169	169	140	186	322	412	292	312	37	A	171	105	65	1/4 G	4	A	10

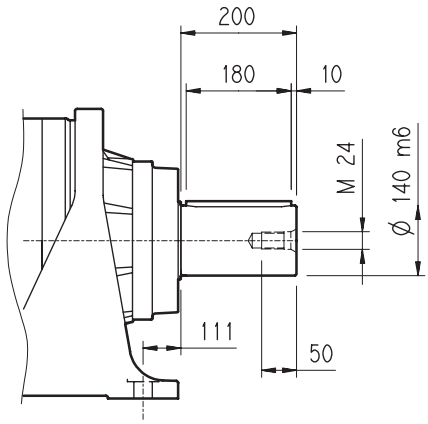
	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
										IEC 71	**IEC 80**	**IEC 90**	**IEC 100**	**IEC 112**	**IEC 132**	**IEC 160**	**IEC 180**	**IEC 200**
313 R2	48	82	239	15											114	144	144	174
313 R3	48	82	239	15											114	144	144	174
313 R4	24	36	137.5	6	38	58	158	7		65	84	84	94	94	114	144		

313L - 313R

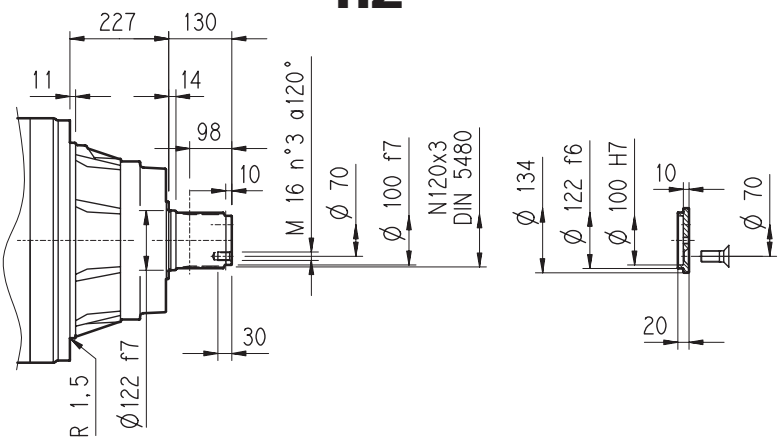
HC



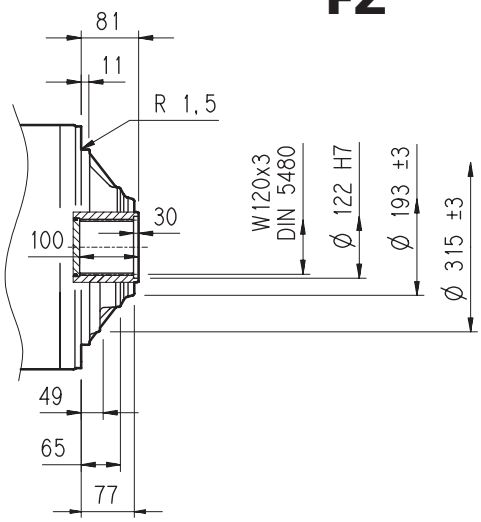
PC



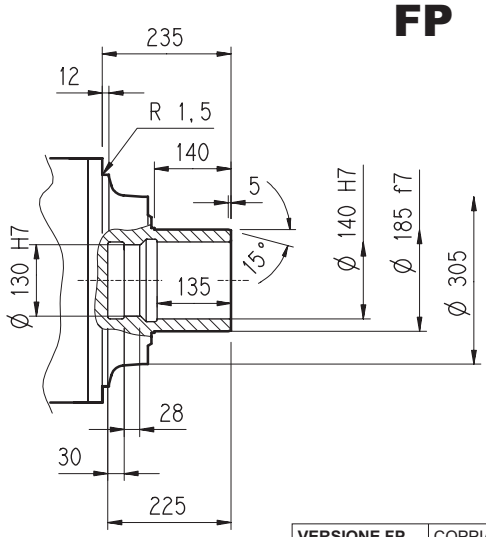
HZ

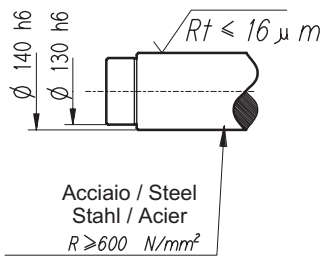


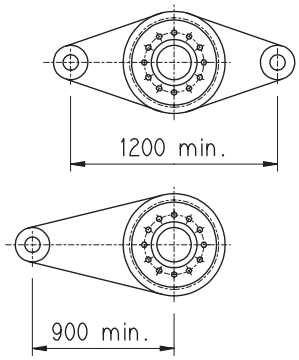
FZ



FP





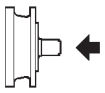


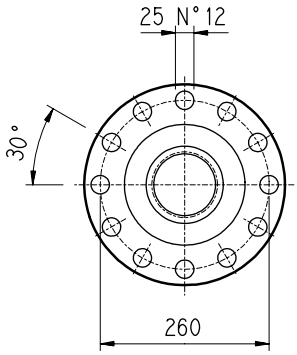
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**55 000 Nm**

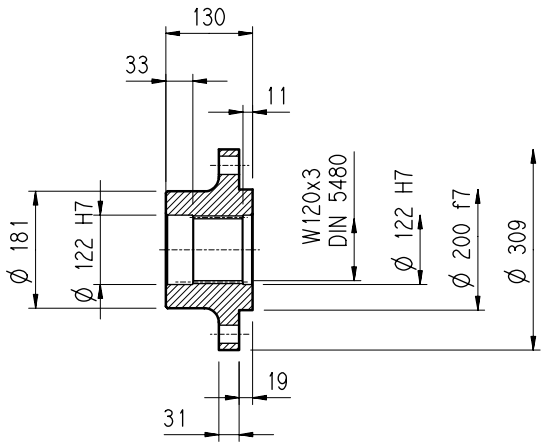
313L - 313R

Flangia / Flange
Flansch / Brides

W0A



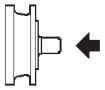


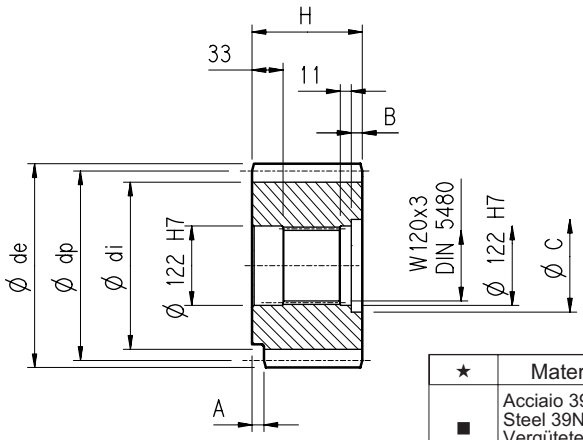


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



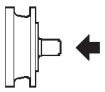


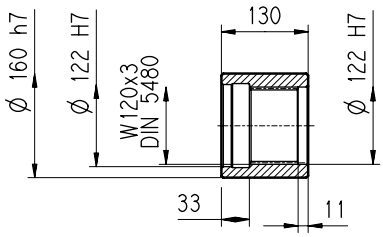
	m	z	x	dp	di	de	H	A	B	C	★
PPH	16	17	0.500	272	247	315	135	0	5	136	■
PRI	18	18	0.333	324	294	365	140	0	10	140	■

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

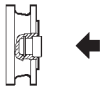


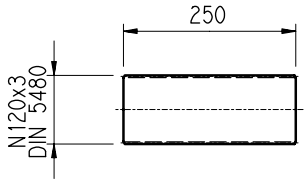


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

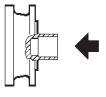


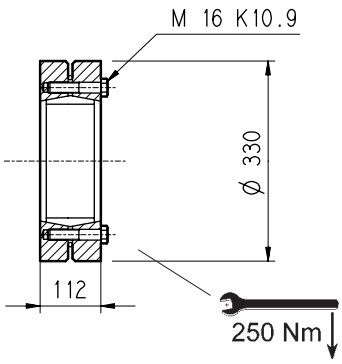


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

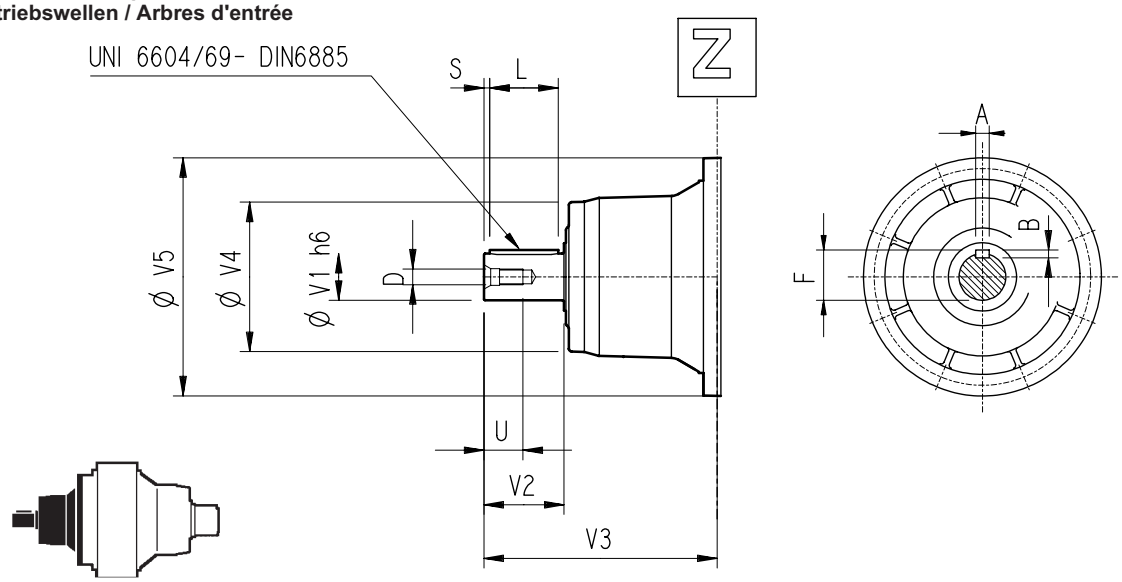
G0A





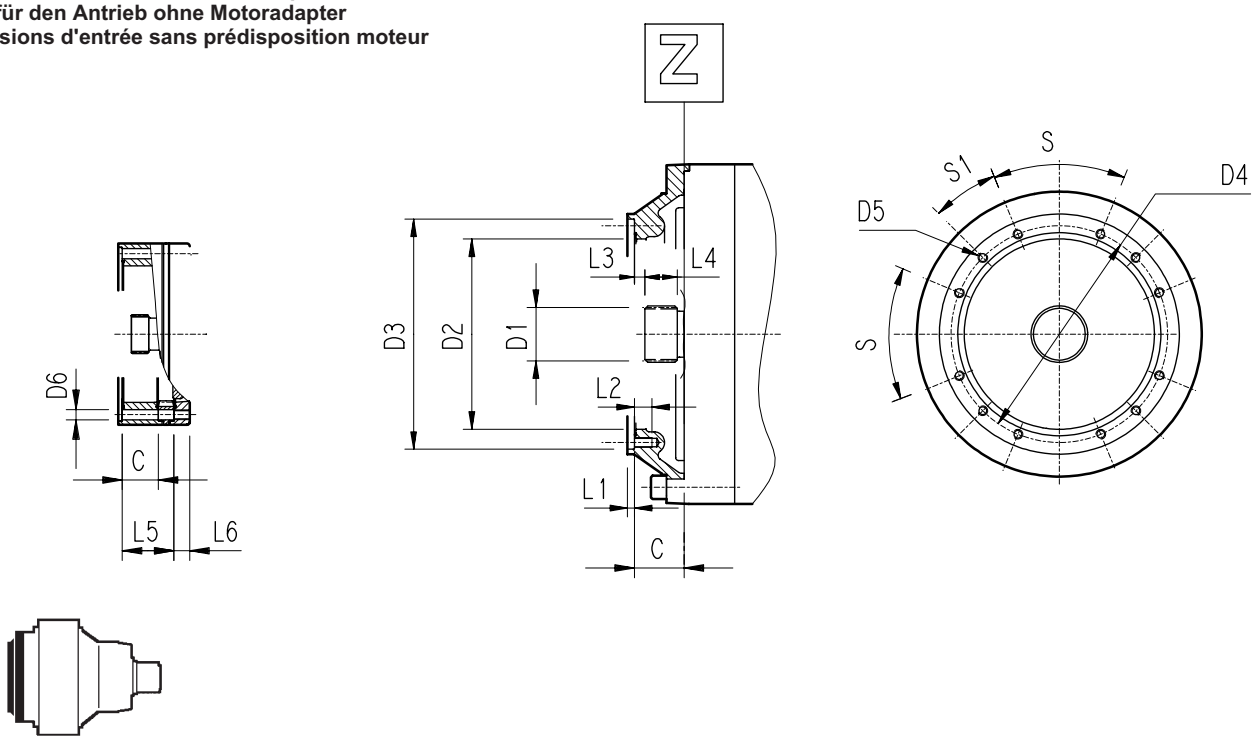
313L - 313R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
313 L1	V11B	80	130	345	200	428	22	14	85	110	10	M16	40
313 L2	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
313 L3	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
313 L4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32
313 R2-R3	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
313 R4	V01A	24	36	137.5	120	186	8	7	27	30	3	M8	20
	V01B	38	58	158	120	186	10	8	41	50	4	M12	32

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



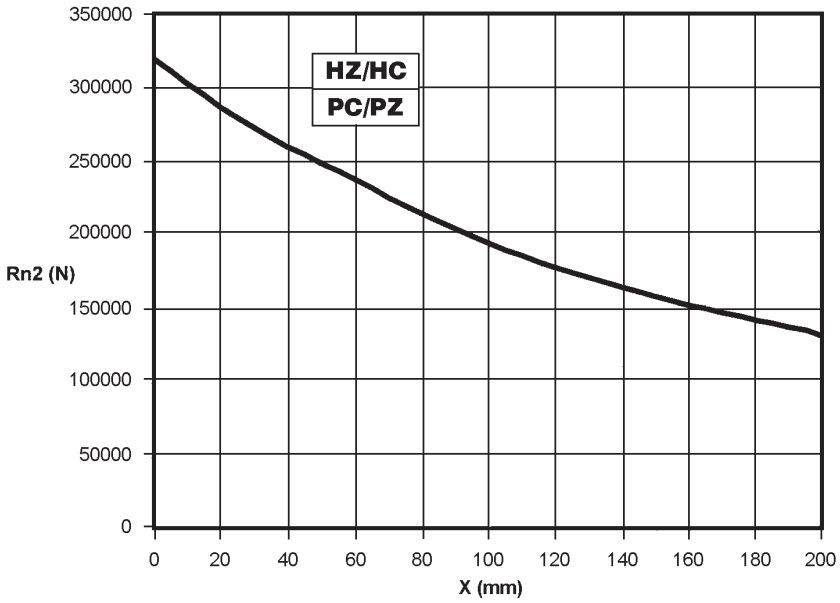
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
313 L1	75	80x74 DIN 5482	270	335 H7	314	M16 n°8	/	5	30	9.5	40	/	/	60°	30°	D
313 L2	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
313 L3	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
313 L4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	0	9	18	65	18	45°	45°	A
313 R2-R3	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A
313 R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	/	9	18	37	18	45°	45°	A

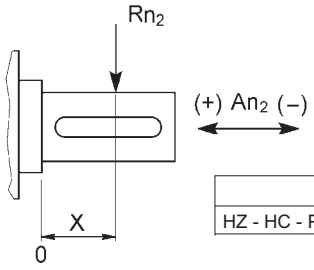
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

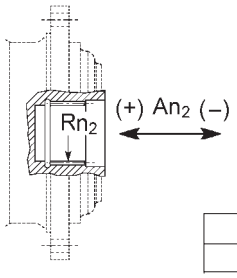
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC - PC - PZ	250 000	160 000



	Rn2	An2 (+/-)
FZ	80 000	75 000

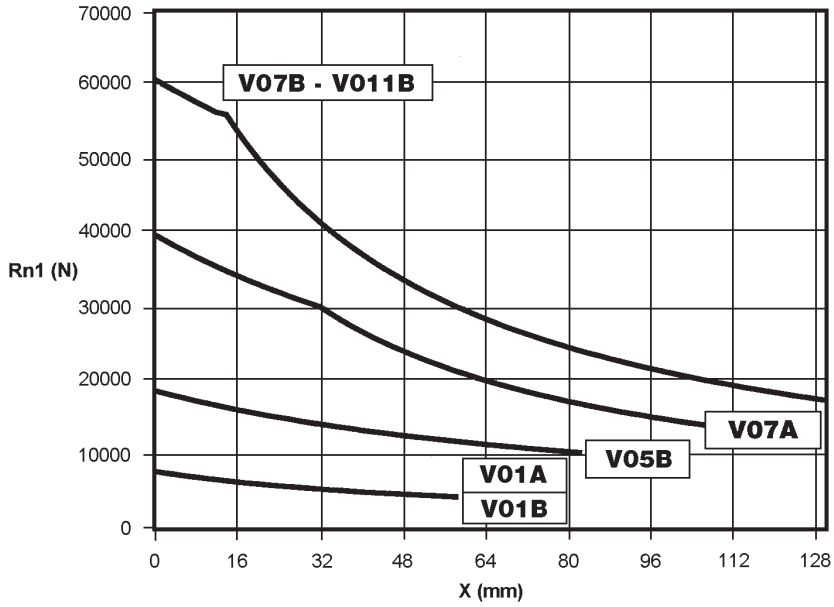
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

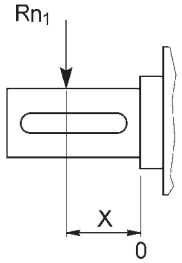
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

315L

M_2 = 80000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	4.09	105 000	100 000	97 000	85 000	53 000	42 800	260	60	350	500		
	5.25	99 000	87 000	79 000	78 000	49 000	39 700	260	60	350	500		
	6.23	80 000	70 000	65 000	65 000	41 000	33 300	260	60	350	500		
L 2	16.7	105 000	100 000	97 000	79 000	48 700	39 600	180	45	750	1 000		
	21.5	105 000	100 000	97 000	83 000	51 000	41 700	180	45	750	1 000		
	25.5	105 000	100 000	97 000	78 000	48 400	39 400	180	45	750	1 000		
	27.6	99 000	87 000	79 000	78 000	48 800	39 700	180	45	750	1 000		
	32.7	99 000	87 000	79 000	78 000	48 800	39 700	180	45	750	1 000		
	38.8	80 000	70 000	65 000	65 000	41 000	33 300	157	45	750	1 000		
L 3	57.4	105 000	100 000	97 000	79 000	48 700	39 600	100	30	1 500	2 500	2 600	6K
	68.5	105 000	100 000	97 000	79 000	48 700	39 600	100	30	1 500	2 500	2 100	6G
	87.9	105 000	100 000	97 000	79 000	48 700	39 600	100	30	1 500	2 500	1 500	6E
	104	105 000	100 000	97 000	79 000	48 700	39 600	100	30	1 500	2 500	1 100	6C
	134	105 000	100 000	97 000	83 000	51 000	41 700	100	30	1 500	2 500	850	6B
	159	105 000	100 000	97 000	78 000	48 400	39 400	100	30	1 500	2 500	850	6B
	172	99 000	87 000	79 000	78 000	48 800	39 700	100	30	1 500	2 500	850	6B
	204	99 000	87 000	79 000	78 000	48 800	39 700	87	30	1 500	2 500	850	6B
	242	80 000	70 000	65 000	65 000	41 000	33 300	61	30	1 500	2 500	850	6B
L 4	291	105 000	100 000	97 000	79 000	48 700	39 600	60	18	1 800	3 800	400	5B
	356	105 000	100 000	97 000	79 000	48 700	39 600	60	18	1 800	3 800	400	5B
	424	105 000	100 000	97 000	79 000	48 700	39 600	59	18	1 800	3 800	400	5B
	469	105 000	100 000	97 000	79 000	48 700	39 600	53	18	1 800	3 800	400	5B
	513	105 000	100 000	97 000	79 000	48 700	39 600	48	18	1 800	3 800	400	5B
	569	105 000	100 000	97 000	83 000	51 000	41 700	44	18	1 800	3 800	400	5B
	647	105 000	100 000	97 000	79 000	48 700	39 600	38	18	1 800	3 800	400	5B
	714	105 000	100 000	97 000	83 000	51 000	41 700	35	18	1 800	3 800	400	5B
	830	105 000	100 000	97 000	83 000	51 000	41 700	30	18	1 800	3 800	400	5B
	916	99 000	87 000	79 000	78 000	48 800	39 700	27	18	1 800	3 800	400	5B
	1 004	105 000	100 000	97 000	83 000	51 000	41 700	25	18	1 800	3 800	400	5B
	1 087	99 000	87 000	79 000	78 000	48 800	39 700	23	18	1 800	3 800	400	5B
	1 264	99 000	87 000	79 000	78 000	48 800	39 700	19.7	18	1 800	3 800	400	5B
	1 500	80 000	70 000	65 000	65 000	41 000	33 300	16.6	18	1 800	3 800	400	5B
	1 814	80 000	70 000	65 000	65 000	41 000	33 300	13.7	18	1 800	3 800	400	5B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

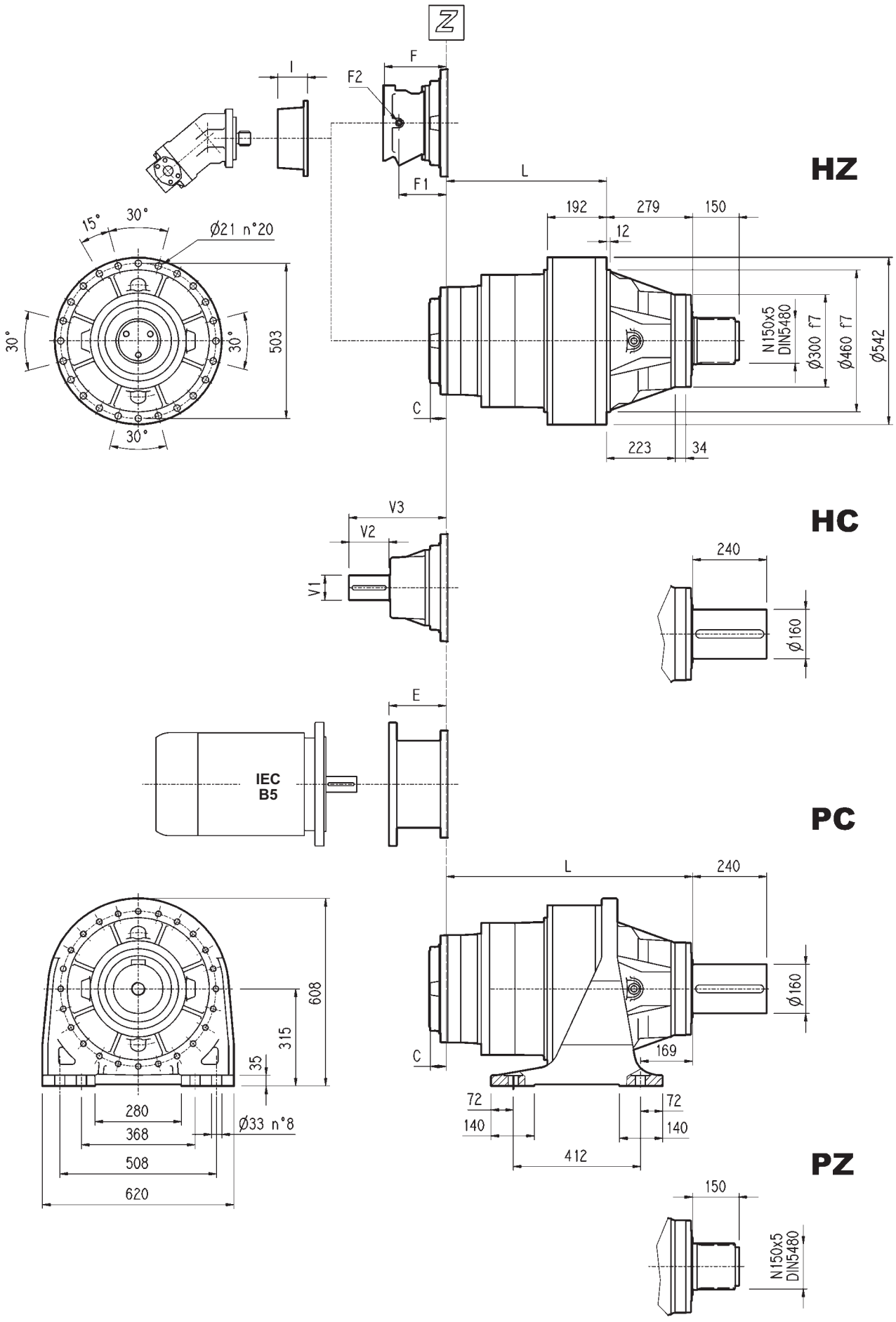
M_2 = 80000 Nm

315R

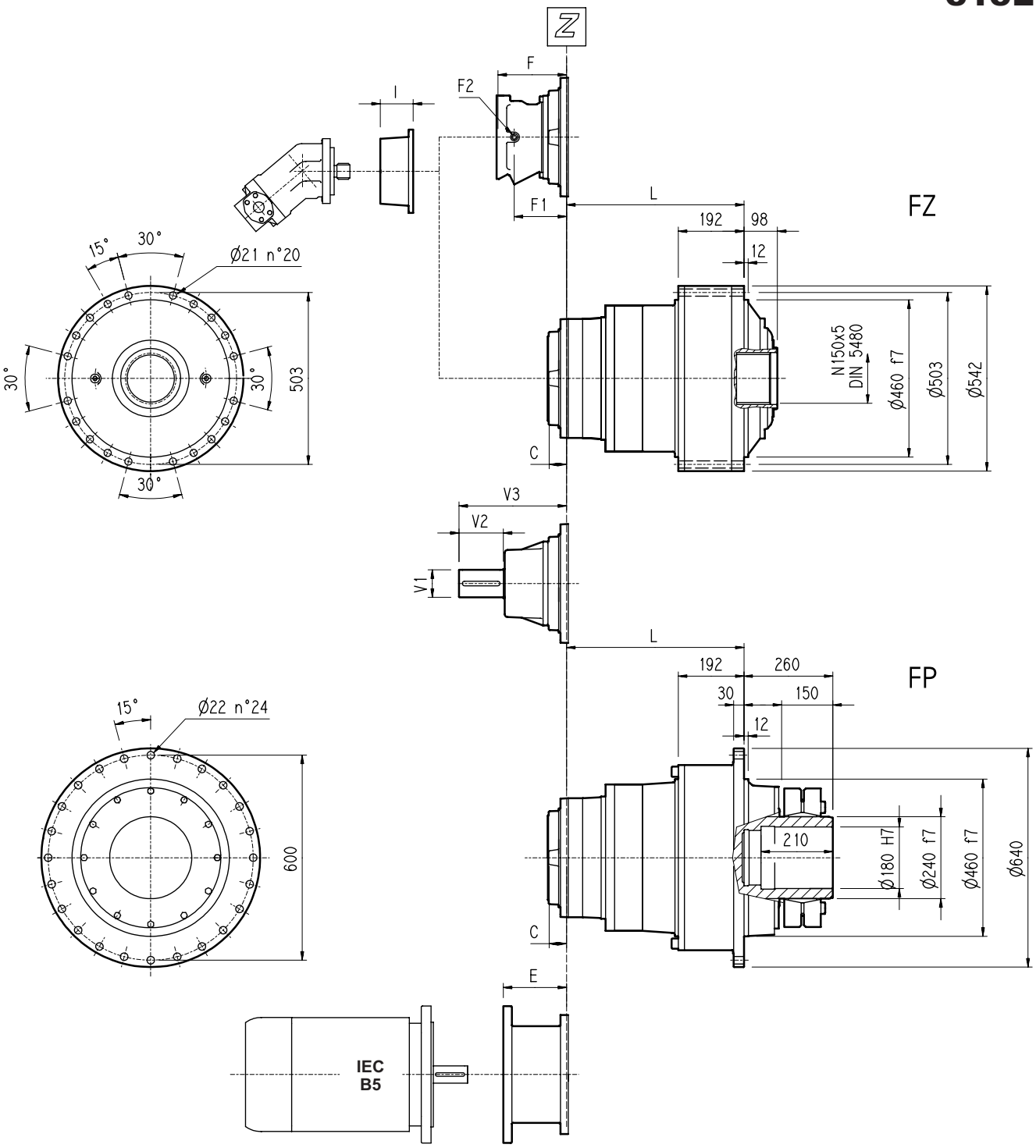
	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2													
R3	72.5	57 000	57 000	50 000	40 600	25 100	20 300	135	75	1 500	2 500	1 000	5K
	93.1	73 000	73 000	60 000	48 300	29 800	24 200	135	75	1 500	2 500	1 000	5K
	110	86 000	83 000	67 000	55 000	33 600	27 300	135	75	1 500	2 500	1 000	5K
	119	93 000	87 000	71 000	58 000	35 500	28 900	135	75	1 500	2 500	1 000	5K
	142	99 000	87 000	79 000	65 000	40 000	32 500	119	75	1 500	2 500	800	5G
	168	80 000	70 000	65 000	65 000	41 000	33 300	83	75	1 500	2 500	500	5C
R4	217	98 000	87 000	71 000	58 000	35 500	28 900	90	40	1 800	3 800	500	5C
	259	105 000	99 000	80 000	65 000	40 200	32 600	90	40	1 800	3 800	500	5C
	332	105 000	100 000	95 000	78 000	47 900	38 900	75	40	1 800	3 800	400	5B
	394	105 000	100 000	97 000	79 000	48 700	39 600	63	40	1 800	3 800	400	5B
	506	105 000	100 000	97 000	83 000	51 000	41 700	49	40	1 800	3 800	400	5B
	600	105 000	100 000	97 000	78 000	48 400	39 300	41	40	1 800	3 800	400	5B
	649	99 000	87 000	79 000	78 000	48 800	39 700	38	40	1 800	3 800	400	5B
	770	99 000	87 000	79 000	78 000	48 800	39 700	32	40	1 800	3 800	400	5B
	914	80 000	70 000	65 000	65 000	41 000	33 300	26	40	1 800	3 800	400	5B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

315L


Z
I
F
F2
F1
L
HZ
192
279
150
12
15°
30°
Ø21 n°20
30°
30°
30°
503
N150x5
DIN5480
Ø300 f7
Ø460 f7
Ø542
C
223
34
V3
V2
V1
HC
240
Ø160
E
IEC
B5
PC
L
240
608
315
35
Ø160
C
169
280
368
508
620
Ø33 n°8
72
140
72
140
412
PZ
150
N150x5
DIN5480

315L

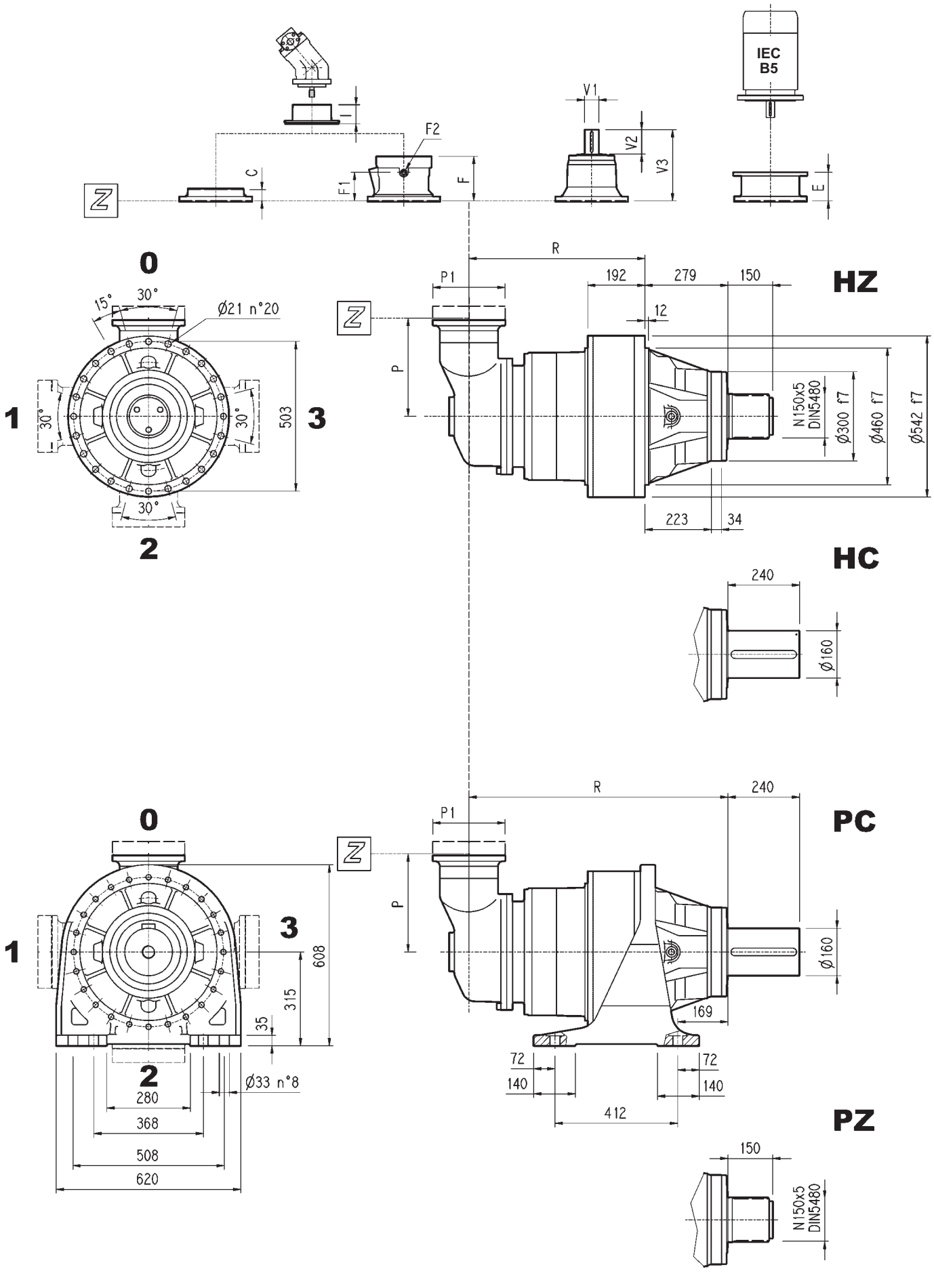


VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE
100 000 Nm	

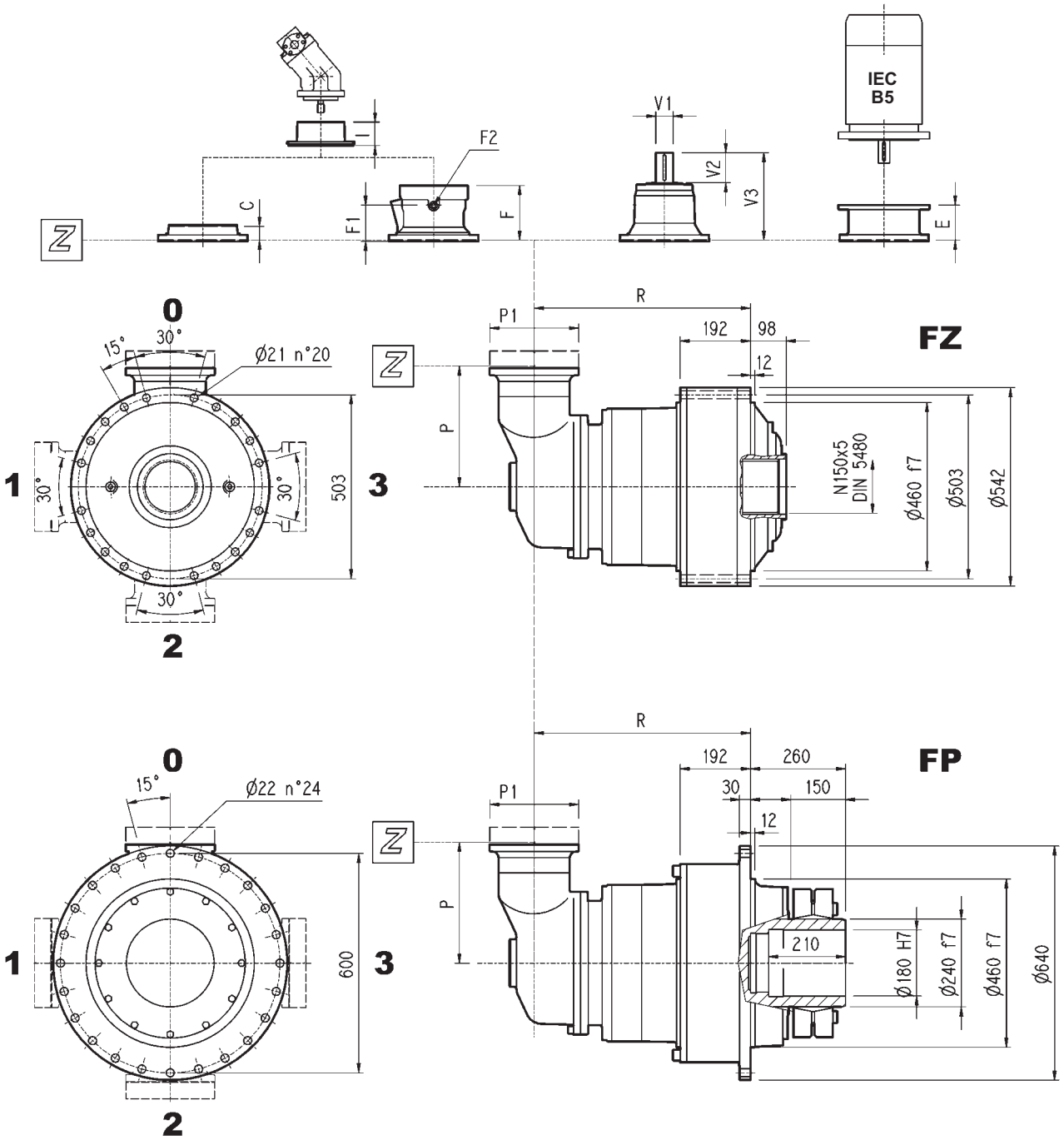
	L				Kg												
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée	**I**	**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
315 L1	174	453	174	174	370	500	280	330	116	E							
315 L2	386	665	386	386	455	585	365	415	81	D		232	185	1/4 G	6	B	35
315 L3	519	798	519	519	500	630	410	460	51	B		201	153	1/4 G	6	B	28
315 L4	608	887	608	608	512	642	422	472	37	A	171	145	95	1/4 G	5	A	16

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
															IEC 132	**IEC 160**	**IEC 180**	**IEC 200**	**IEC 225**	**IEC 250**
315 L1																				
315 L2	80	130	348	35																
315 L3	80	130	315	35	60	105	313	28									195	186	216	215
315 L4	48	82	239	15											114	144	144	174		

315R


IEC B5
V1
V2
V3
F2
F1
F
C
E
Z
0
1
2
3
15°
30°
Ø21 n°20
503
R
P1
192
279
150
12
P
HZ
N150x5 DIN5480
Ø300 f7
Ø460 f7
Ø542 f7
223
34
HC
240
Ø160
PC
608
315
35
Ø33 n°8
280
368
508
620
169
72
140
412
PZ
N150x5 DIN5480

315R



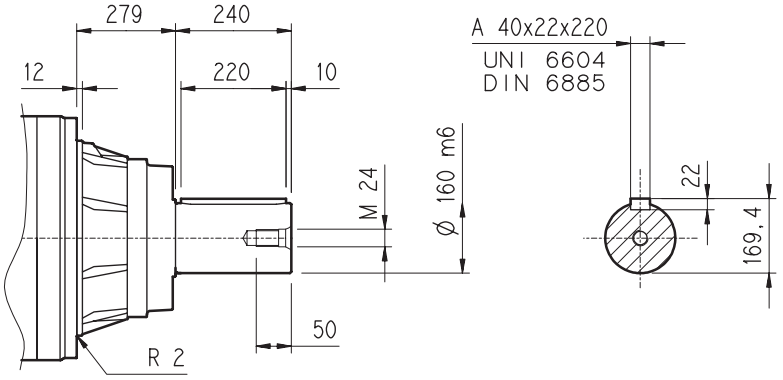
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**100 000 Nm**

	R				P	P1	Kg				C		I	F	F1	F2			Kg
	HZ HC	PC PZ	FZ	FP			HC HZ	PC PZ	FZ	FP		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
315 R2																			
315 R3	611	890	611	611	330	245	565	695	475	525	37	A		145	95	1/4 G	5	A	16
315 R4	638	917	638	638	225	245	550	680	460	510	37	A	171	145	95	1/4 G	5	A	16

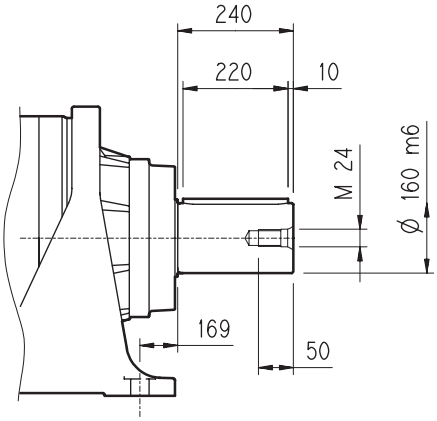
	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
															IEC 132	IEC 160	IEC 180	IEC 200	
315 R2																			
315 R3	48	82	239	15											114	144	144	174	
315 R4	48	82	239	15											114	144	144	174	

315L - 315R

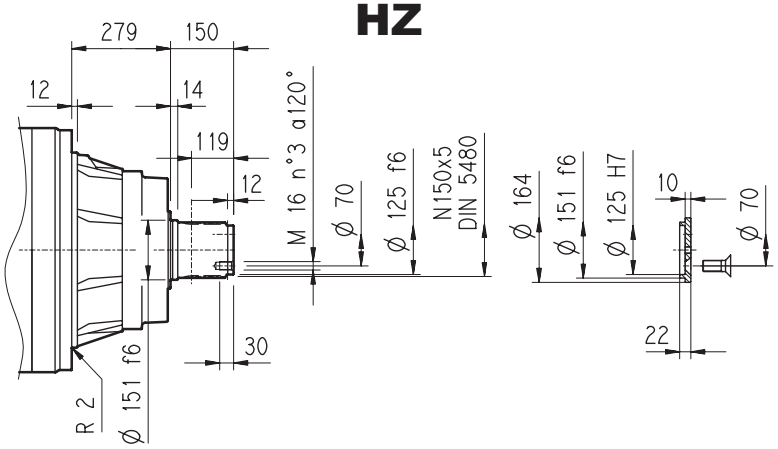
HC



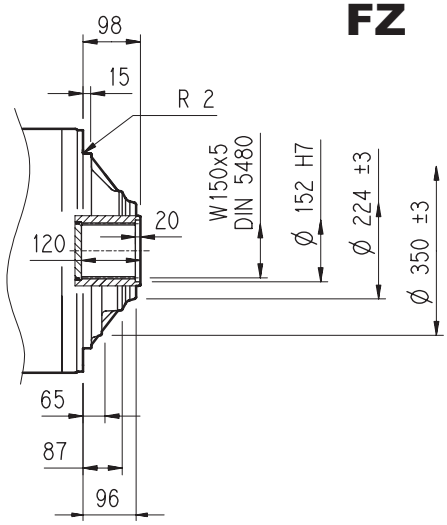
PC



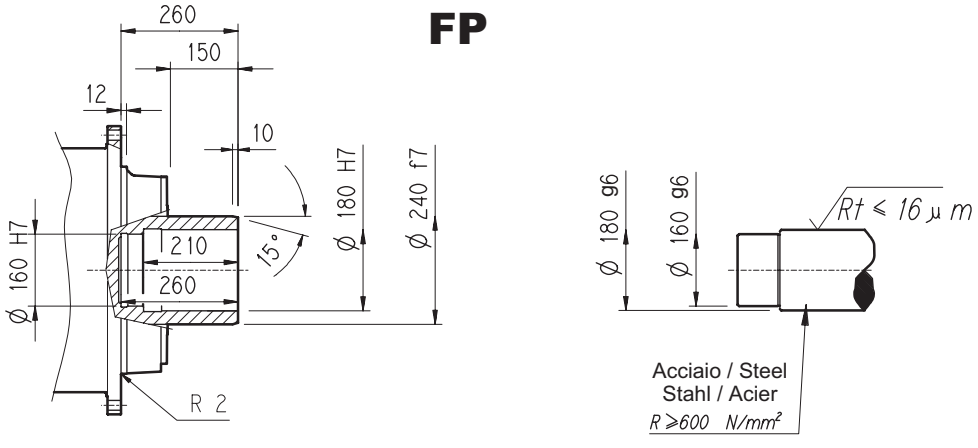
HZ



FZ



FP

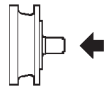


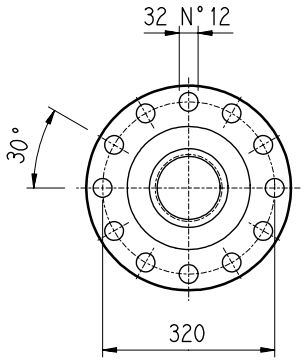
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**100 000 Nm**

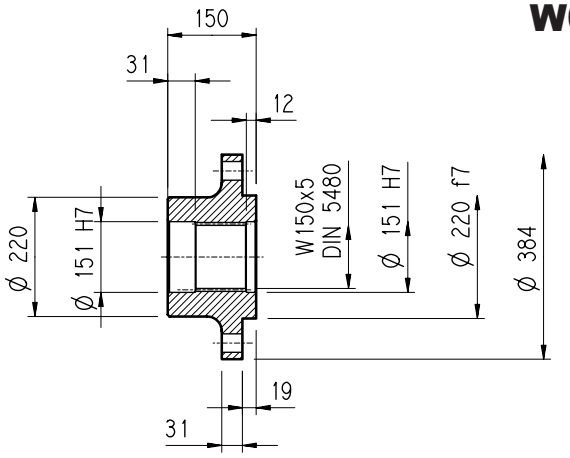
315L - 315R

Flangia / Flange
Flansch / Brides

W0A



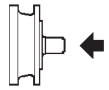


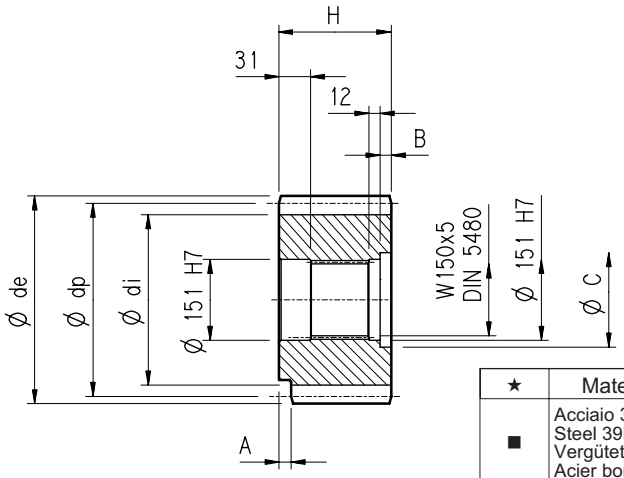


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Pignoni per rotazione / Output pinions
Ritzel / Pignons

P...



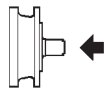


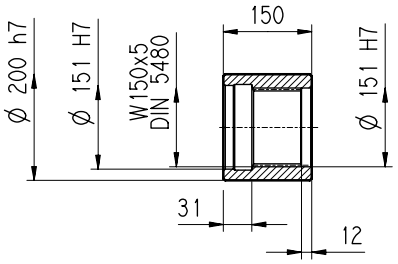
	m	z	x	dp	di	de	H	A	B	C	★
PRG1	18	16	0.500	288	261	342	160	0	10	166	□
PRG2	18	16	0.617	288	271	339	150	30	0	0	■

★	Materiale/Material/Material/Màterial
■	Acciaio 39NiCrMo3 Bonificato Steel 39NiCrMo3 hardened and tempered Vergüteter Stahl 39NiCrMo3 Acier bonifiè 39NiCrMo3
□	Acciaio 18NiCrMo5 Cementato e temprato Steel 18NiCrMo5 Case hardened Einsatzstahl 18NiCrMo5 Einsatzgehärtet Acier cementè et temprè 18NiCrMo5

Manicotti lisci / Sleeve couplings
Naben / Manchons lisses a cannelure interieure

M0A

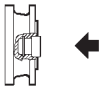


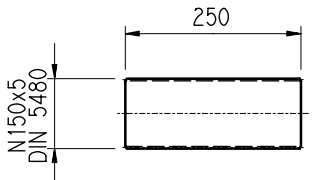


Materiale : Acciaio 16CrNi4
Material : Steel 16CrNi4
Material : Stahl 16CrNi4
Màterial : Acier 16CrNi4

Barre scanalate / Splined bars
Vielkeilwellen / Barre cannelée

B0A

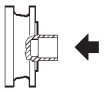


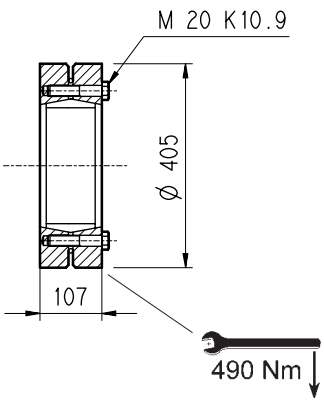


Mat. acciaio 18NiCrMo5 UNI 5331 da cementare e temprare 50-55 HRC
Case hardening steel 18NiCrMo5 UNI 5331
must be case hardened 50-55 HRC
Material: Einsatzstahl 18NiCrMo5 UNI 5331
muss einsatzgehärtet werden 50-55 HRC
Acier 18 NiCrMo5 UNI 5331 doit être cémenté trempé 50-55 HRC

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

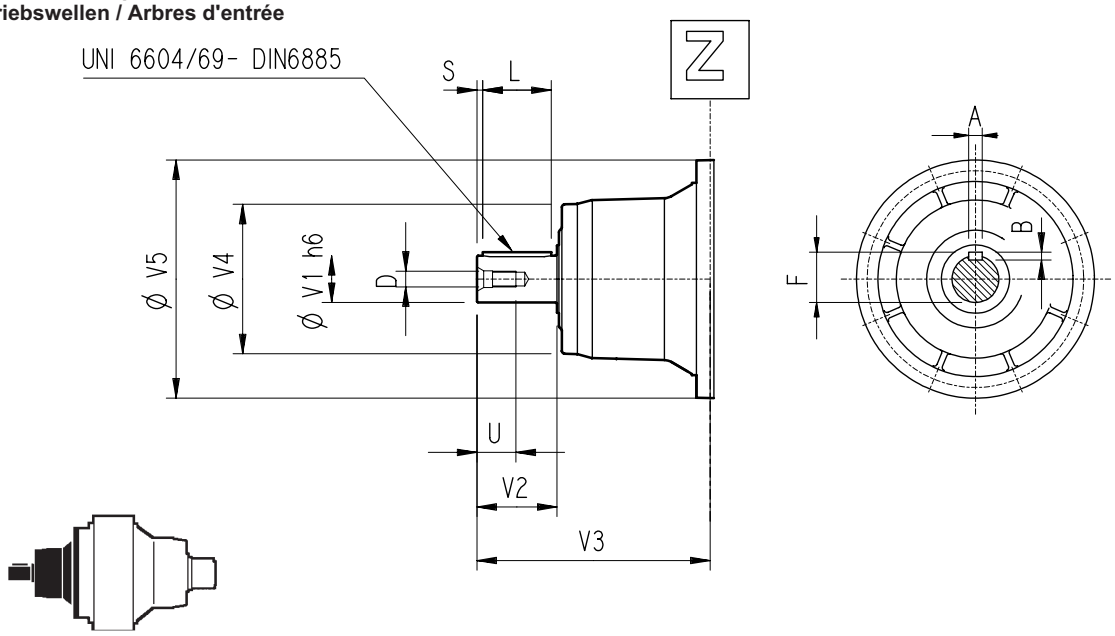
G0A





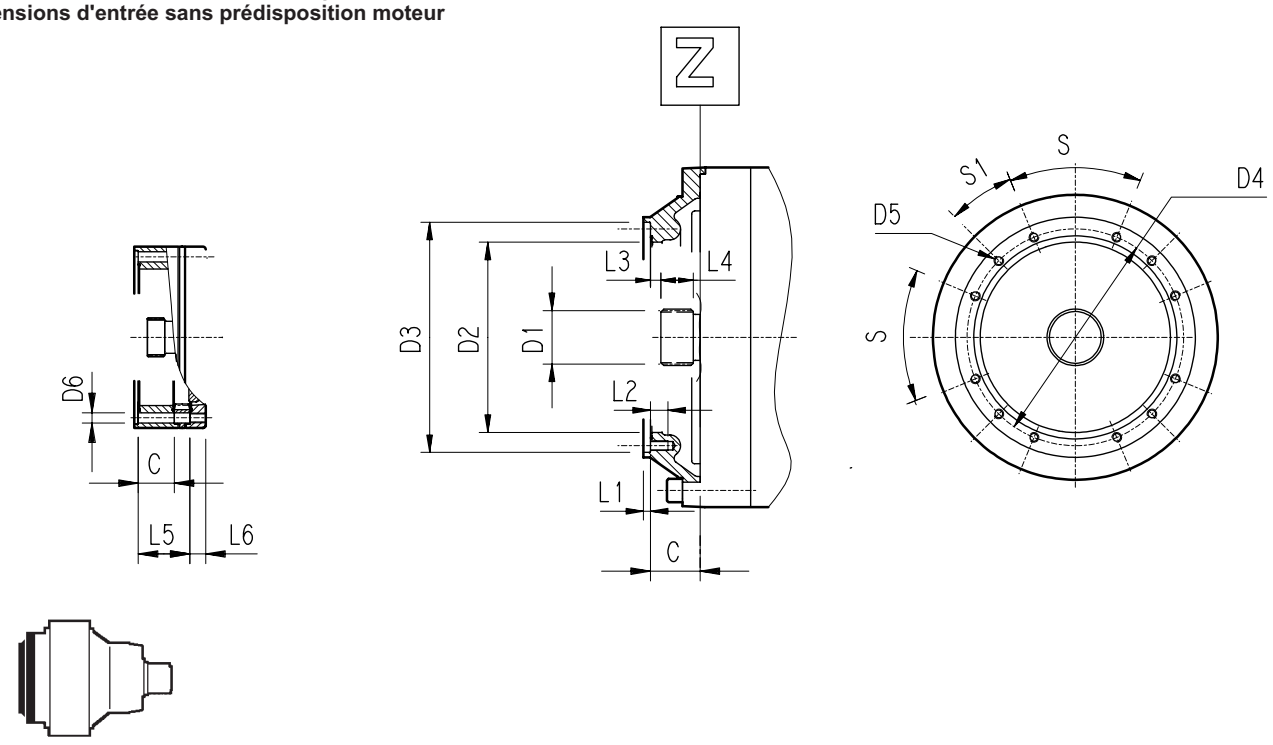
315L - 315R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
315 L2	V11B	80	130	345	200	428	22	14	85	110	10	M16	40
315 L3	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
315 L4	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
315 R3-R4	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



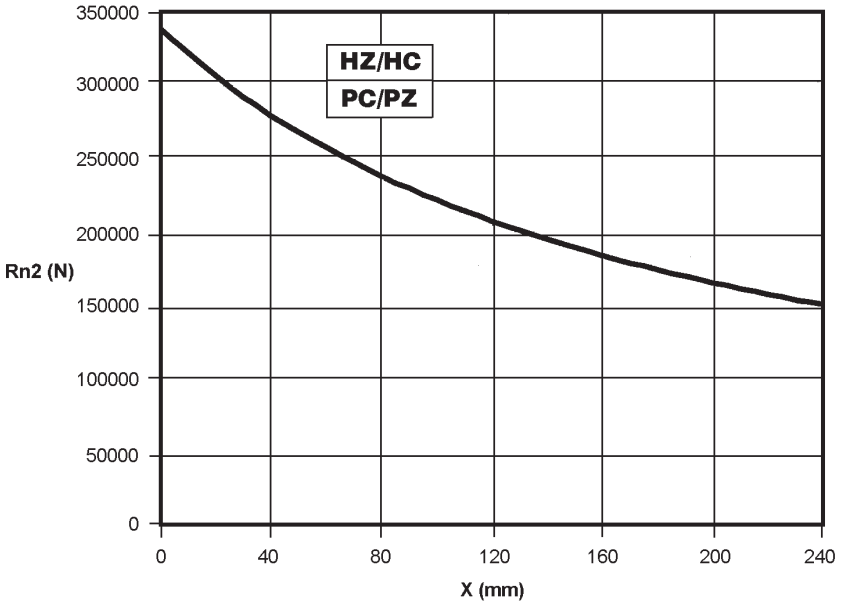
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
315 L1	116	100x94 DIN 5482	340	412 H7	390	M16 n°18	/	7	30	8	55	/	/	20°	20°	E
315 L2	81	80x74 DIN 5482	270	335 H7	314	M16 n°8	/	5	30	8.5	40	/	/	60°	30°	D
315 L3	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
315 L4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
315 R2-R3-R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A

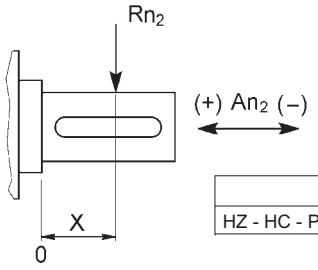
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

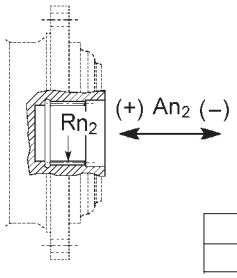
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC - PC - PZ	280 000	210 000



	Rn2	An2 (+/-)
FZ	90 000	90 000

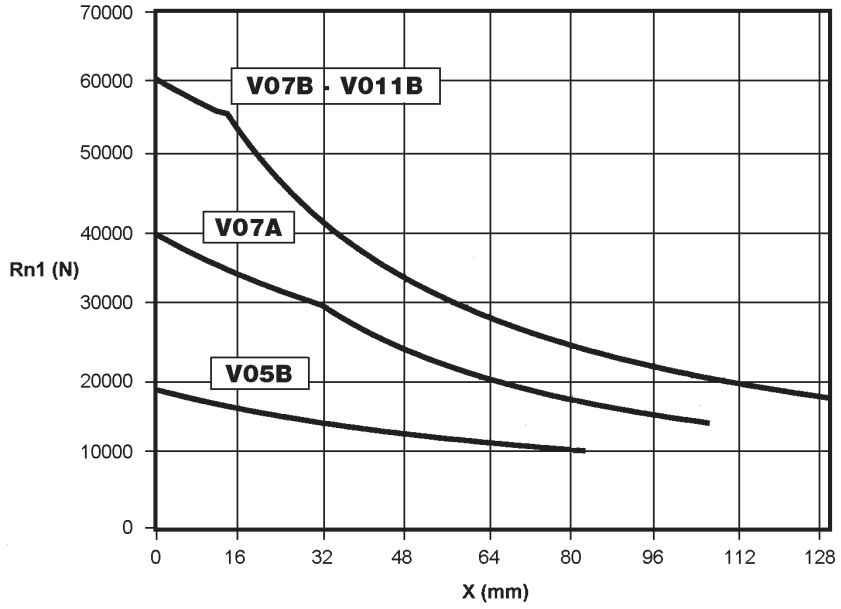
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

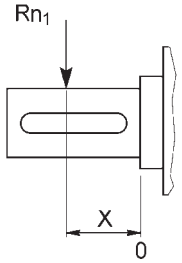
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

317L

M_2 = 150000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L 1	4,09	180 000	180 000	166 000	135 000	83 000	67 000	300	85	200	300		
	5,25	170 000	153 000	141 000	130 000	80 000	65 000	300	85	200	300		
	6,23	145 000	126 000	115 000	115 000	78 000	64 000	300	85	200	300		
L 2	16,9	180 000	180 000	147 000	120 000	74 000	60 000	200	55	500	800		
	22,1	179 000	177 000	144 000	117 000	72 000	59 000	200	55	500	800		
	26,6	155 000	155 000	144 000	117 000	72 000	59 000	200	55	500	800		
	28,4	170 000	153 000	141 000	130 000	80 000	65 000	200	55	500	800		
	34,1	170 000	153 000	141 000	130 000	80 000	65 000	200	55	500	800		
	40,5	145 000	126 000	115 000	115 000	78 000	64 000	200	55	500	800		
L 3	58,1	180 000	180 000	147 000	120 000	74 000	60 000	130	35	1 400	2 000	3 200	6L
	69,3	180 000	174 000	141 000	115 000	71 000	58 000	130	35	1 400	2 000	3 200	6L
	89,0	180 000	179 000	145 000	118 000	73 000	59 000	130	35	1 400	2 000	2 600	6K
	106	180 000	174 000	142 000	115 000	71 000	58 000	130	35	1 400	2 000	2 100	6G
	116	179 000	177 000	144 000	117 000	72 000	59 000	130	35	1 400	2 000	1 500	6E
	138	179 000	177 000	144 000	117 000	72 000	59 000	130	35	1 400	2 000	1 500	6E
	166	155 000	155 000	144 000	117 000	72 000	59 000	130	35	1 400	2 000	1 100	6C
	179	170 000	153 000	141 000	130 000	80 000	65 000	130	35	1 400	2 000	1 100	6C
	213	170 000	153 000	141 000	130 000	80 000	65 000	130	35	1 400	2 000	850	6B
	252	145 000	126 000	115 000	115 000	78 000	63 800	115	35	1 400	2 000	850	6B
L 4	310	180 000	139 000	113 000	92 000	57 000	46 000	60	18	1 800	3 800	630	5E
	360	180 000	137 000	112 000	90 000	56 000	45 000	60	18	1 800	3 800	500	5C
	449	180 000	175 000	142 000	115 000	71 000	58 000	60	18	1 800	3 800	500	5C
	493	179 000	177 000	144 000	117 000	72 000	59 000	60	18	1 800	3 800	400	5B
	552	180 000	179 000	145 000	118 000	73 000	59 000	60	18	1 800	3 800	400	5B
	619	179 000	177 000	144 000	117 000	72 000	59 000	60	18	1 800	3 800	400	5B
	719	179 000	177 000	144 000	117 000	72 000	59 000	59	18	1 800	3 800	400	5B
	792	180 000	175 000	142 000	115 000	71 000	58 000	54	18	1 800	3 800	400	5B
	904	170 000	153 000	141 000	130 000	80 000	65 000	47	18	1 800	3 800	400	5B
	1 032	179 000	177 000	144 000	117 000	72 000	59 000	41	18	1 800	3 800	400	5B
	1 134	170 000	153 000	141 000	130 000	80 000	65 000	38	18	1 800	3 800	400	5B
	1 318	170 000	153 000	141 000	130 000	80 000	65 000	32	18	1 800	3 800	400	5B
	1 595	170 000	153 000	141 000	130 000	80 000	65 000	27	18	1 800	3 800	400	5B
	1 893	145 000	126 000	115 000	115 000	78 000	64 000	22	18	1 800	3 800	400	5B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

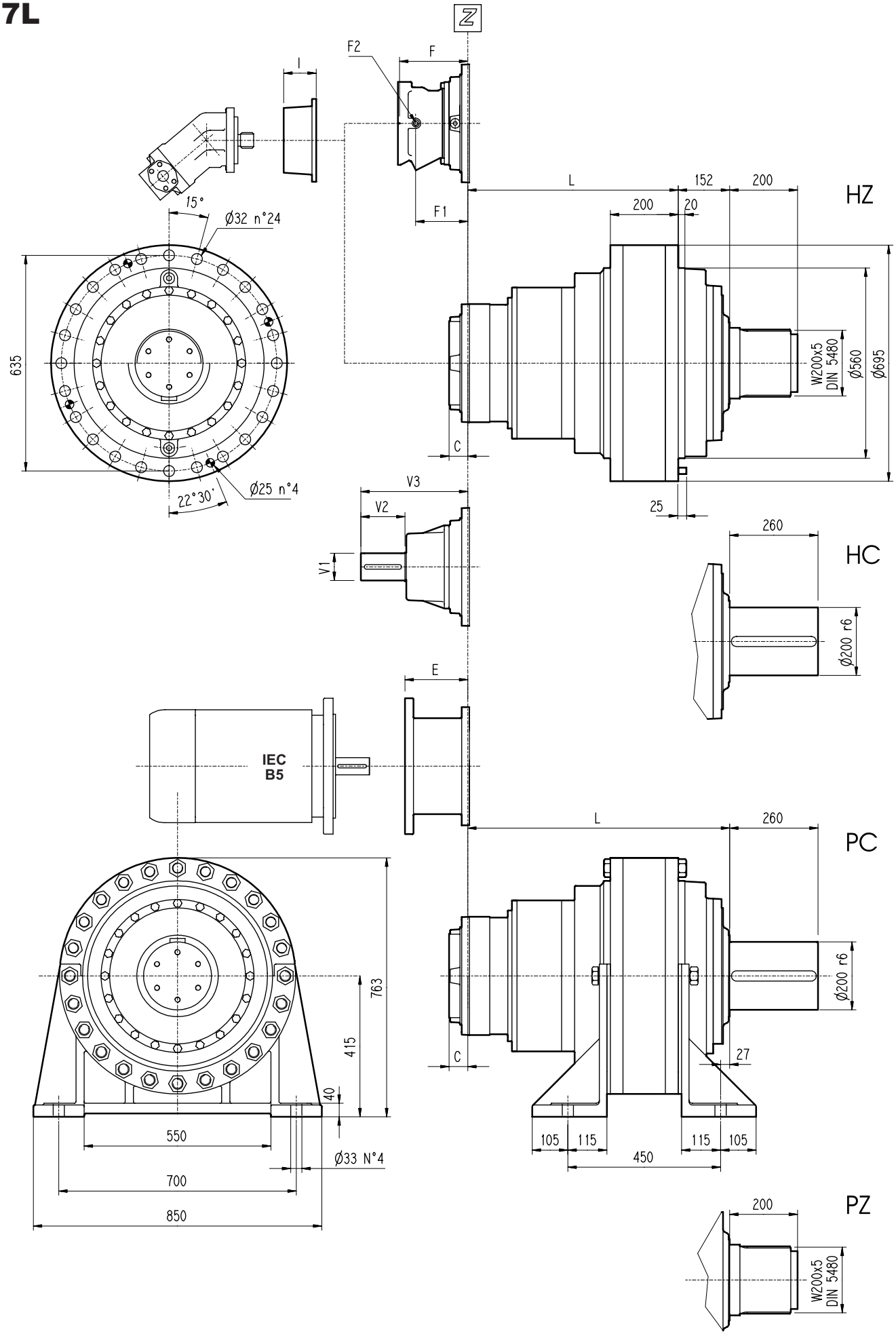
M_2 = 150000 Nm

317R

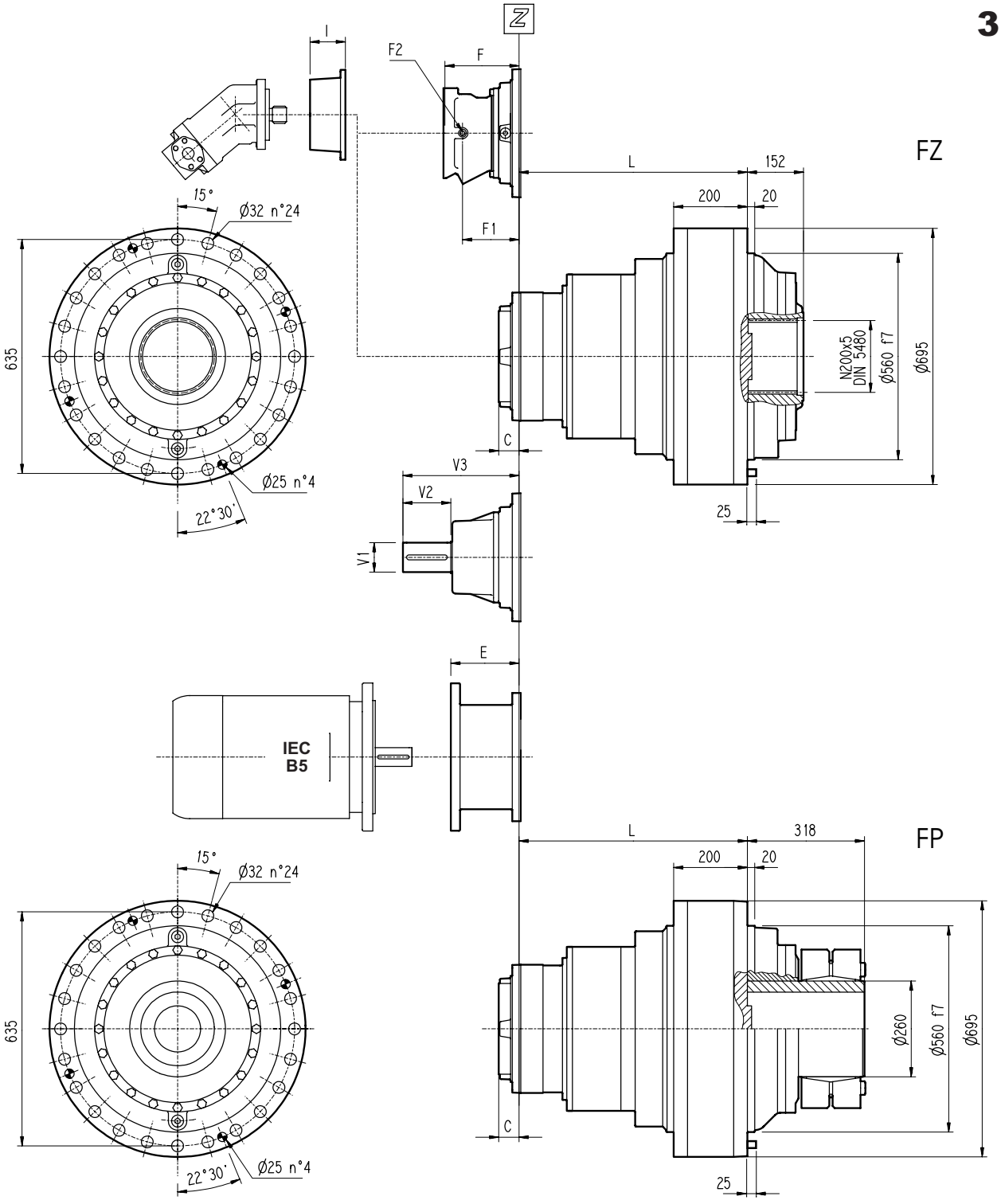
	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2													
R3	73,4	57 000	57 000	50 000	41 000	25 300	20 500	90	90	1 400	2 000		
	95,7	75 000	75 000	61 000	49 300	30 400	24 700	90	90	1 400	2 000		
	115	90 000	85 000	69 000	56 000	34 600	28 100	90	90	1 400	2 000		
	123	96 000	89 000	72 000	59 000	37 000	30 000	90	90	1 400	2 000		
	148	116 000	101 000	82 000	67 000	42 000	34 000	90	90	1 400	2 000		
	176	137 000	114 000	93 000	75 000	46 500	37 800	90	90	1 400	2 000		
R4	220	99 000	88 000	71 000	58 000	35 800	29 100	90	30	1 800	3 800	500	5C
	262	115 000	100 000	81 000	66 000	40 500	32 900	90	30	1 800	3 800	500	5C
	336	145 000	119 000	96 000	78 000	48 300	39 200	90	30	1 800	3 800	500	5C
	399	172 000	134 000	109 000	88 000	54 000	44 200	90	30	1 800	3 800	500	5C
	438	179 000	143 000	116 000	94 000	58 000	47 200	90	30	1 800	3 800	500	5C
	520	179 000	161 000	131 000	106 000	66 000	53 000	82	30	1 800	3 800	400	5B
	626	155 000	155 000	144 000	117 000	72 000	59 000	68	30	1 800	3 800	400	5B
	677	170 000	153 000	141 000	123 000	74 000	59 000	63	30	1 800	3 800	400	5B
	803	170 000	153 000	141 000	138 000	83 000	77 000	53	30	1 800	3 800	400	5B
	953	145 000	126 000	115 000	115 000	78 000	64 000	45	30	1 800	3 800	400	5B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

317L


Z
F2
F
I
F1
L
152
200
200
20
HZ
15°
Ø32 n°24
635
W200x5
DIN 5480
Ø560
Ø695
C
V3
V2
V1
25
260
HC
Ø200 r6
E
IEC
B5
L
260
PC
Ø200 r6
763
415
40
C
27
550
700
850
Ø33 N°4
105
115
115
105
450
22°30'
Ø25 n°4
200
PZ
W200x5
DIN 5480

317L

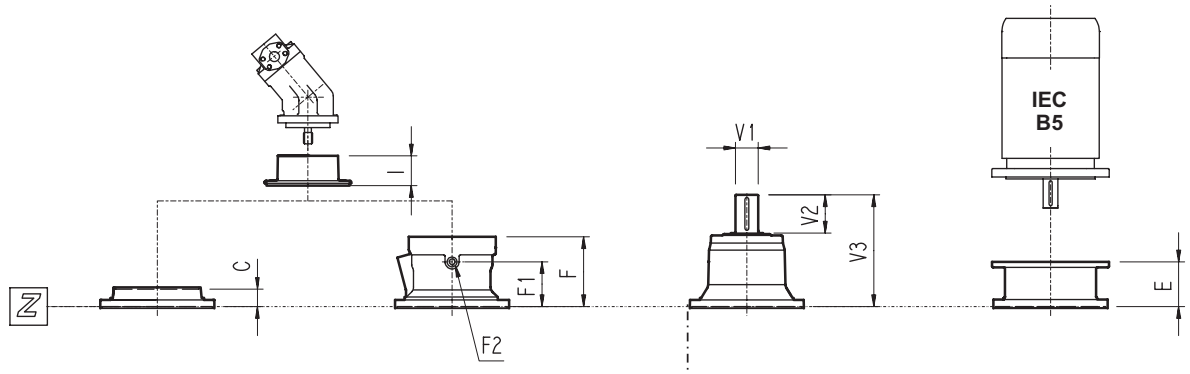


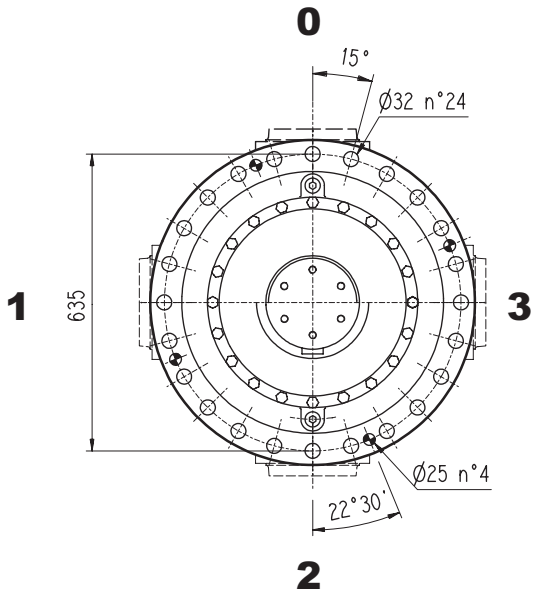
VERSIONE FP/FP VERSION **VERSION FP/VERSION FP**	COPPIA MAX. TRASMISS./MAX. TRANSMISS. TORQUE MAX. ÜBERTR. MOMENT/COUPLE MAX. TRANSMISSIBLE	**140 000 Nm**

	L				Kg													
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée	**I**	**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
317 L1	163	315	163	163	800	950	750	800	181	F							
317 L2	472	624	472	472	930	1 080	880	930	75	D							
317 L3	621	773	621	621	990	1 140	940	990	51	B		201	153	1/4 G	6	B	28
317 L4	710	862	710	710	1 002	1 152	952	1 002	37	A	171	145	95	1/4 G	5	A	16

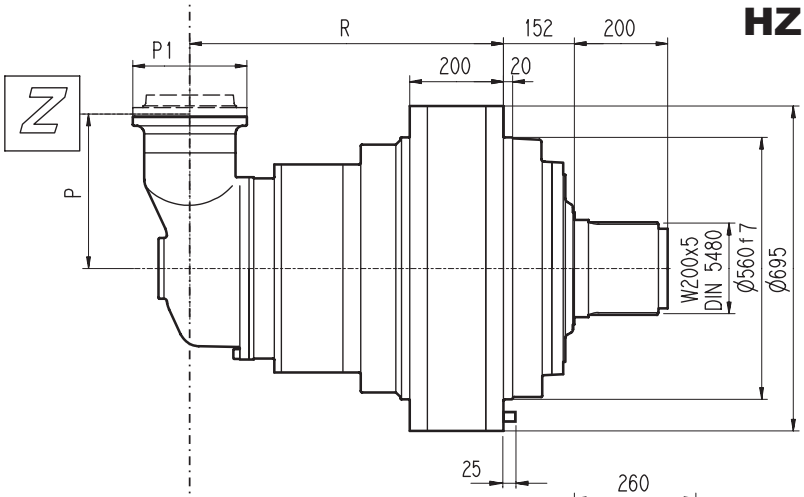
	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
															IEC 132	**IEC 160**	**IEC 180**	**IEC 200**	**IEC 225**	**IEC 250**
317 L1																				
317 L2	80	130	348	35																
317 L3	80	130	315	35	60	105	313	28									195	186	216	215
317 L4	48	82	239	15											114	144	144	174		

317R

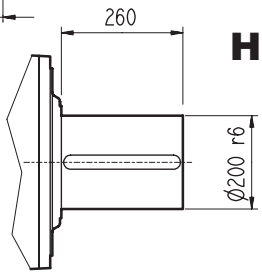


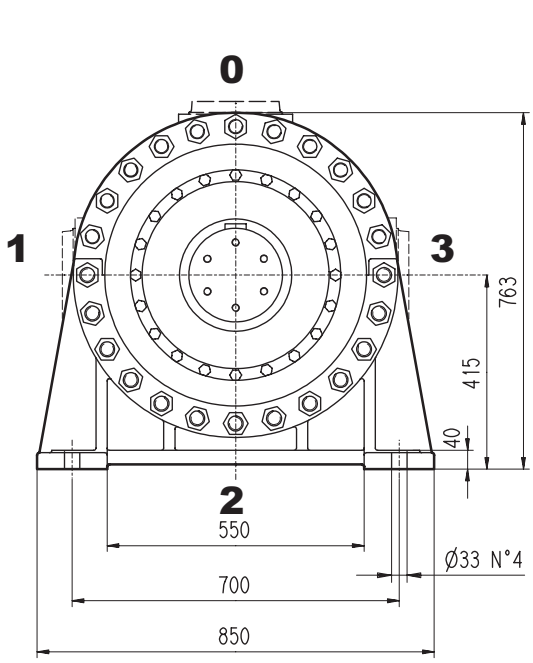


HZ

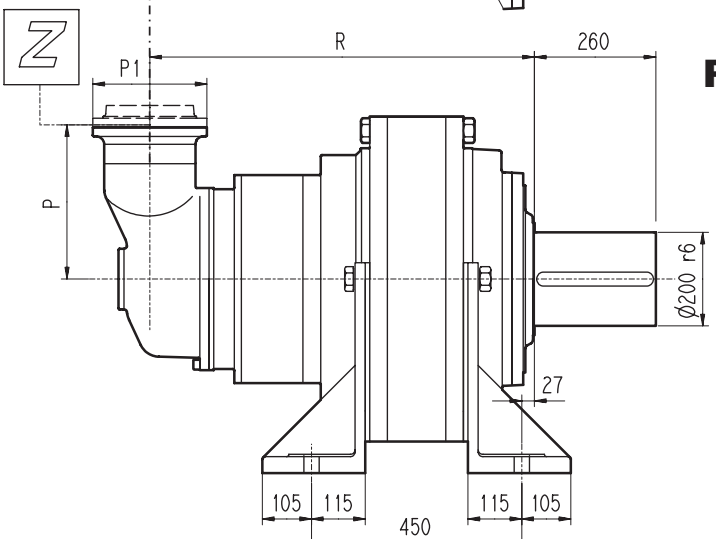


HC

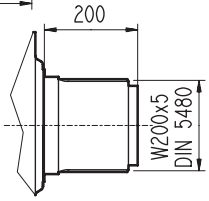




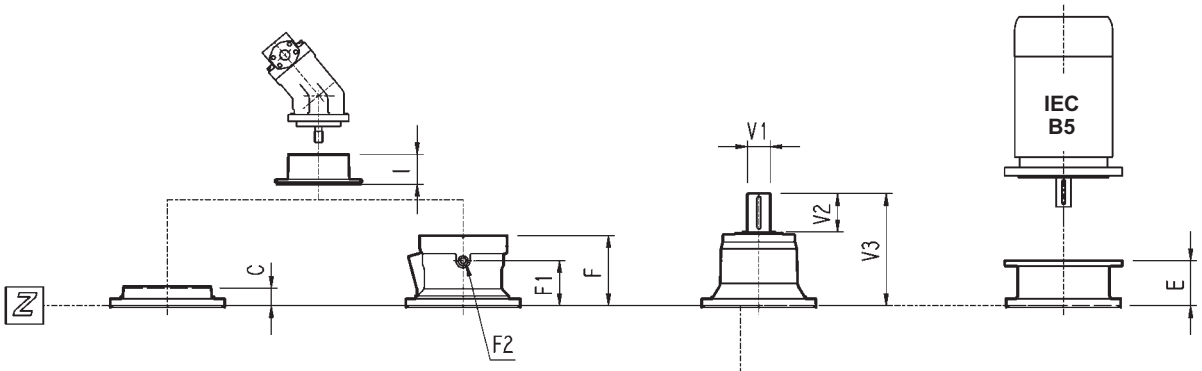
PC

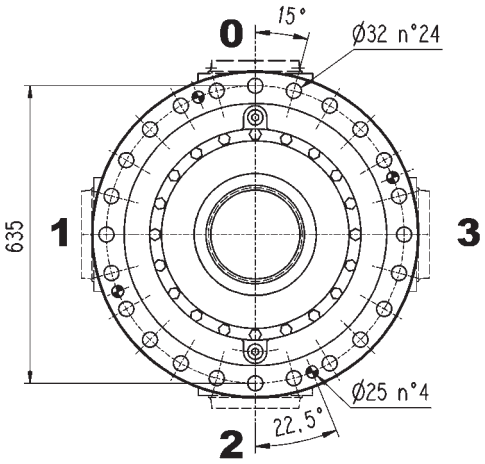


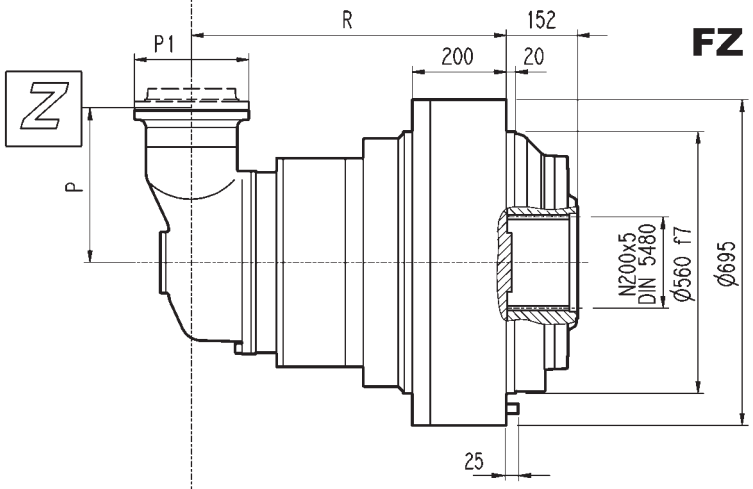
PZ

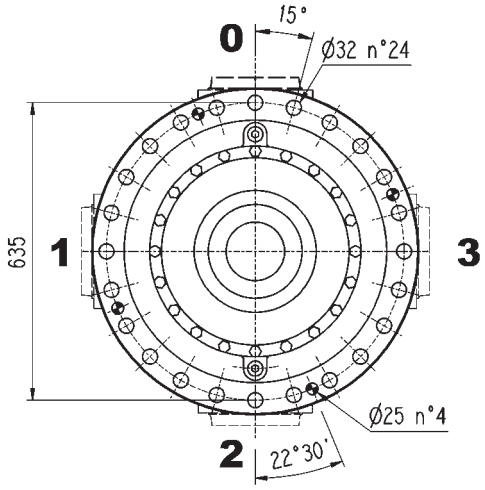


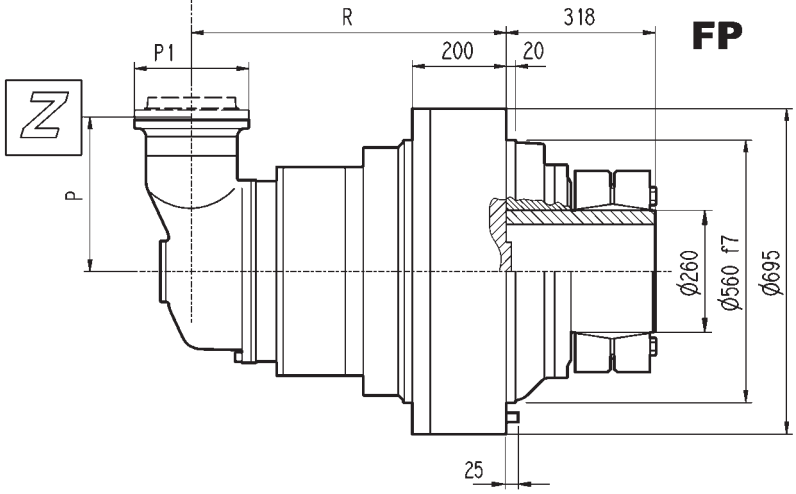
317R









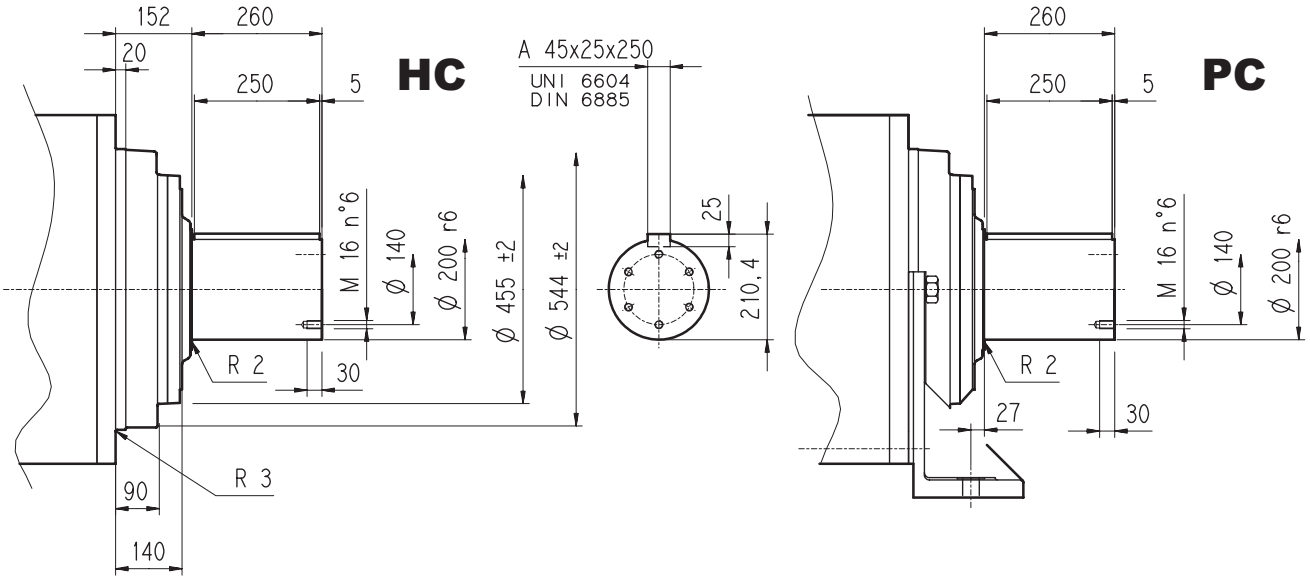


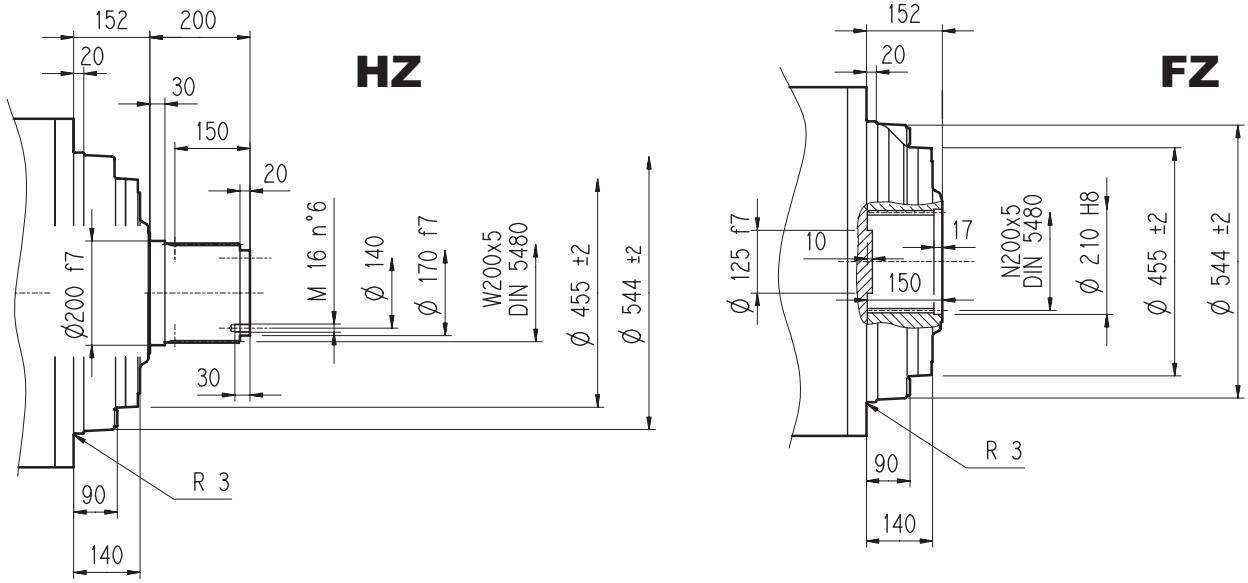
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE
140 000 Nm	

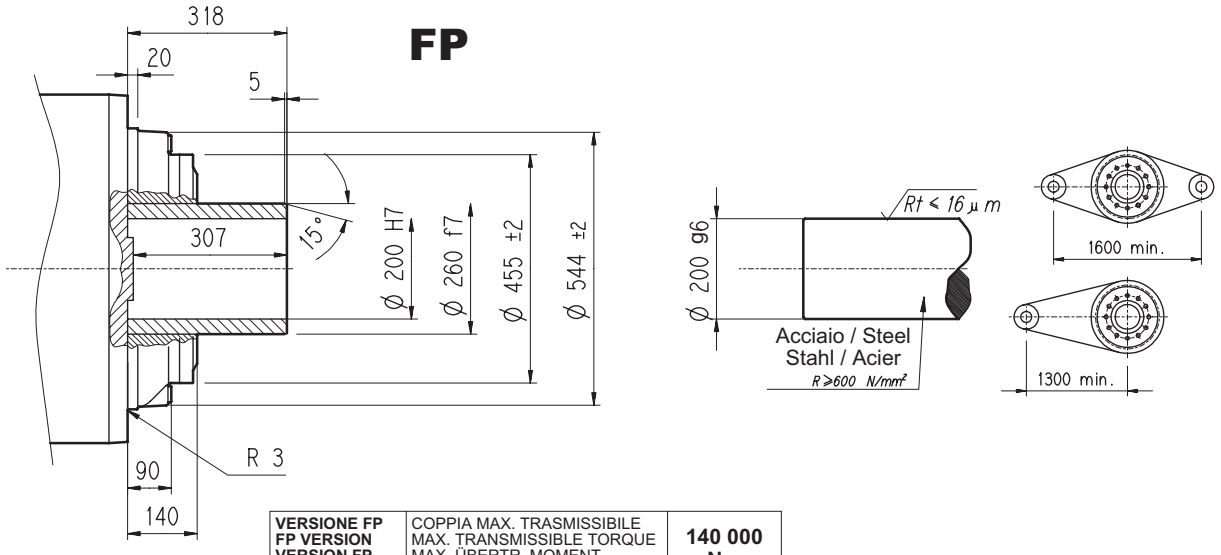
	R				P	P1	Kg				C		I	F	F1	F2			Kg
	HZ HC	**PC PZ**	**FZ**	**FP**			**HZ HC**	**PC PZ**	**FZ**	**FP**		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
317 R2																			
317 R3	701	853	701	701	330	245	1 040	1 190	990	1 040	37	A		145	95	1/4 G	5	A	16
317 R4	740	892	740	740	225	245	1 040	1 190	990	1 040	37	A	171	145	95	1/4 G	5	A	16

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
															IEC 132	**IEC 160**	**IEC 180**	**IEC 200**	
317 R2																			
317 R3	48	82	239	15											114	144	144	174	
317 R4	48	82	239	15											114	144	144	174	

317L - 317R



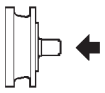




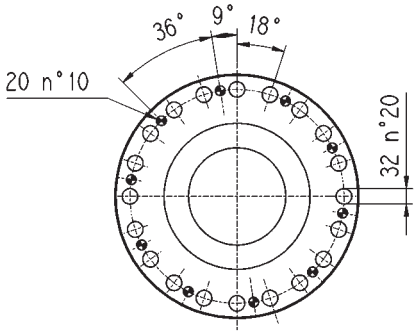
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**140 000 Nm**

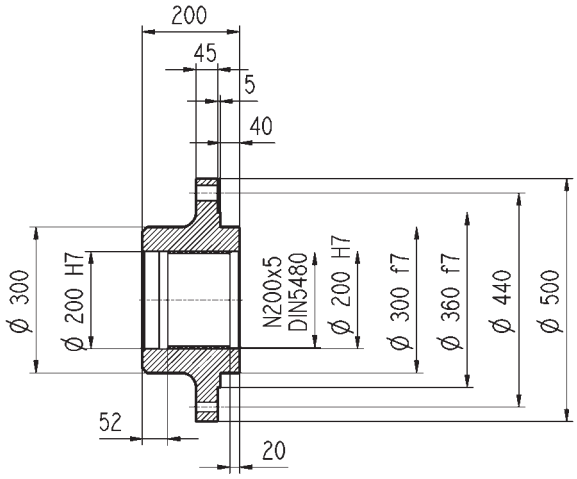
317L - 317R

Flangia / Flange
Flansch / Brides



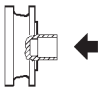
W0A



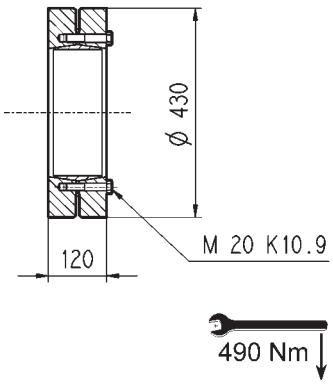


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

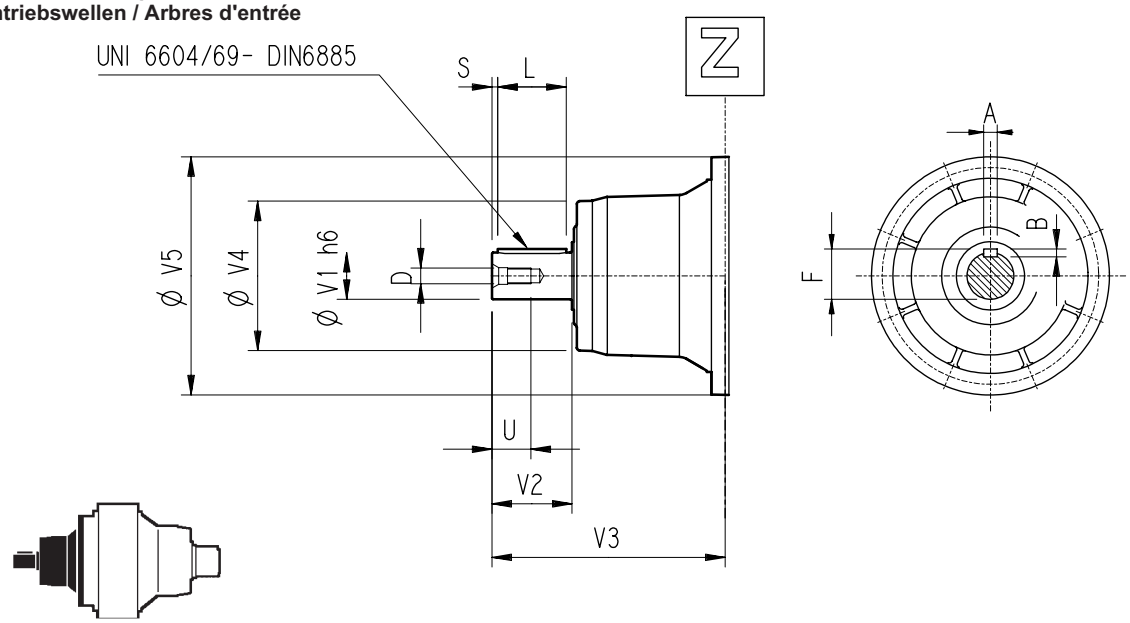


G0A



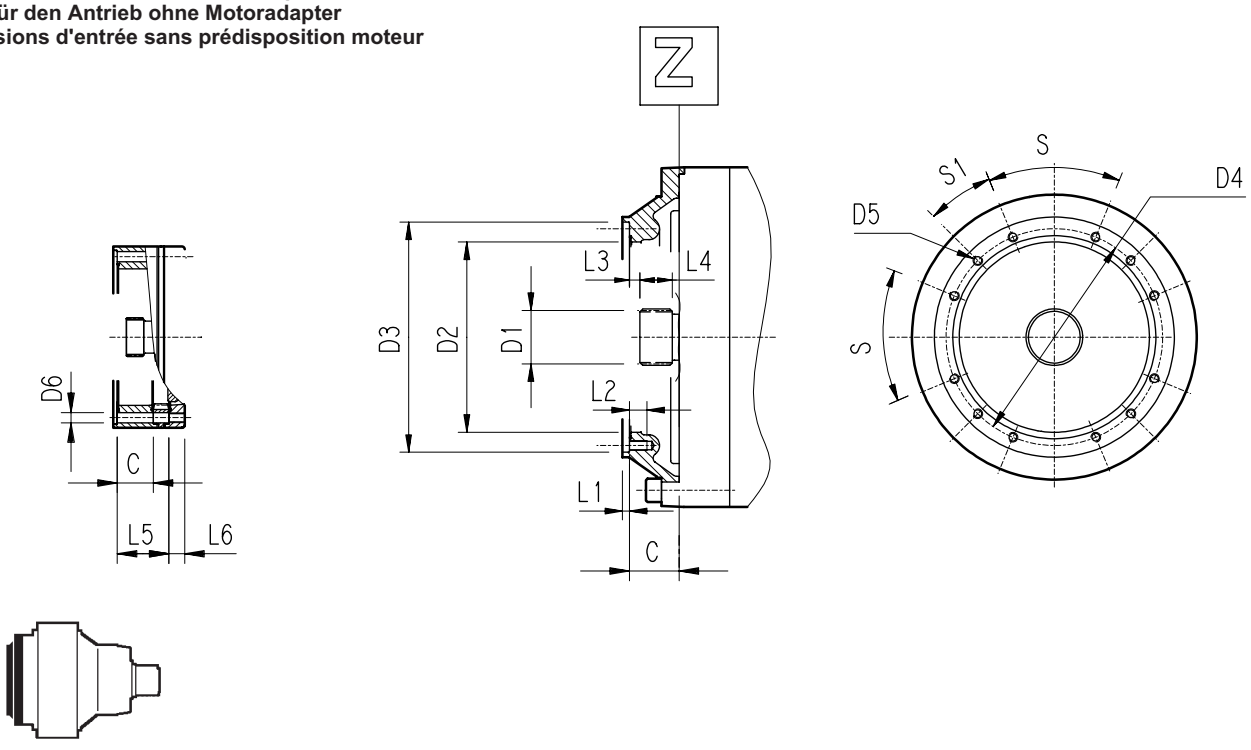
317L - 317R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
317 L2	V11B	80	130	345	200	428	22	14	85	110	10	M16	40
317 L3	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
317 L4	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40
317 R3-R4	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



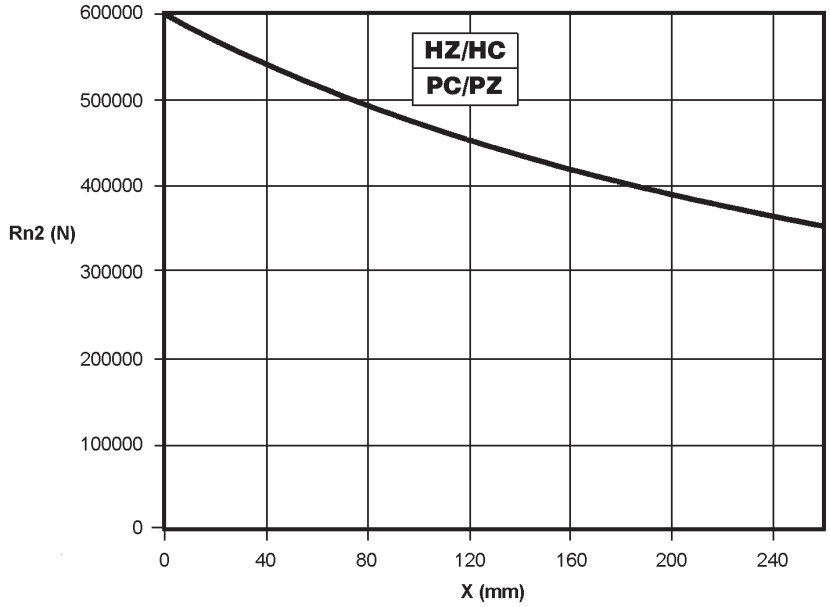
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
317 L1	181	120x3 DIN 5480	365	390 f7	415	M16 n°18	/	4	30	3	65	/	/	20°	20°	F
317 L2	75	80x74 DIN 5482	270	335 H7	314	M16 n°8	/	5	30	9.5	40	/	/	60°	30°	D
317 L3	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
317 L4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	0	4	18	9	18	0	0	45°	45°	A
317 R2-R3-R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A

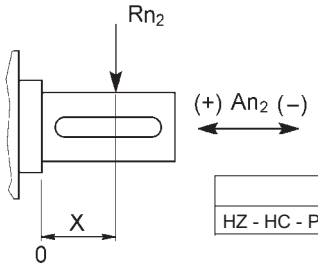
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

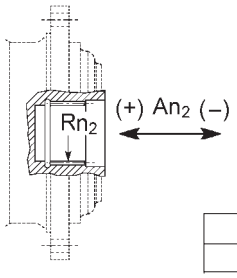
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC - PC - PZ	360 000	300 000



	Rn2	An2 (+/-)
FZ	150 000	150 000

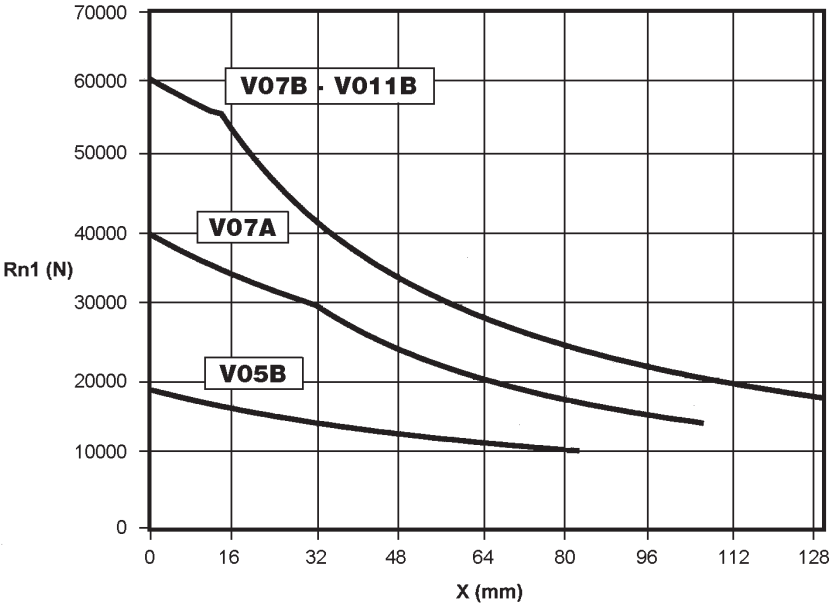
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

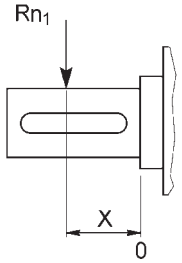
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

319L

M_2 = 300000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L1	4.88	350 000	348 000	308 000	250 000	154 000	125 000	380	115	200	300		
	5.77	340 000	292 000	260 000	248 000	153 000	124 000	380	115	200	300		
L2	19.9	350 000	348 000	308 000	250 000	154 000	125 000	250	70	350	500		
	23.6	340 000	291 000	260 000	248 000	153 000	124 000	250	70	350	500		
	25.6	350 000	348 000	286 000	233 000	144 000	117 000	250	70	350	500		
	30.4	307 000	296 000	241 000	196 000	121 000	98 000	250	70	350	500		
	35.9	340 000	292 000	260 000	220 000	136 000	110 000	250	70	350	500		
L3	81.6	350 000	348 000	286 000	232 000	143 000	116 000	180	50	750	1 000		
	105	350 000	348 000	301 000	245 000	151 000	123 000	180	50	750	1 000		
	124	350 000	348 000	284 000	231 000	142 000	116 000	180	50	750	1 000	3 200	6L
	134	350 000	348 000	286 000	233 000	144 000	117 000	180	50	750	1 000	2 600	6K
	159	340 000	292 000	260 000	248 000	153 000	124 000	180	50	750	1 000	2 600	6K
	189	307 000	296 000	241 000	196 000	121 000	98 000	157	50	750	1 000	2 100	6G
	224	340 000	292 000	260 000	220 000	136 000	110 000	134	50	750	1 000	2 100	6G
L4	334	350 000	348 000	286 000	232 000	143 000	116 000	100	30	1 500	2 500	1 100	6C
	428	350 000	348 000	286 000	232 000	143 000	116 000	100	30	1 500	2 500	850	6B
	508	350 000	348 000	286 000	232 000	143 000	116 000	100	30	1 500	2 500	850	6B
	550	350 000	348 000	301 000	245 000	151 000	123 000	100	30	1 500	2 500	850	6B
	652	350 000	348 000	301 000	245 000	151 000	123 000	95	30	1 500	2 500	850	6B
	705	350 000	348 000	286 000	233 000	144 000	117 000	88	30	1 500	2 500	850	6B
	837	350 000	348 000	286 000	233 000	144 000	117 000	74	30	1 500	2 500	850	6B
	916	340 000	292 000	260 000	220 000	136 000	110 000	68	30	1 500	2 500	850	6B
	991	340 000	292 000	260 000	248 000	153 000	124 000	63	30	1 500	2 500	850	6B
	1 179	307 000	296 000	241 000	196 000	121 000	98 000	53	30	1 500	2 500	850	6B
	1 396	340 000	292 000	260 000	220 000	136 000	110 000	44	30	1 500	2 500	850	6B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

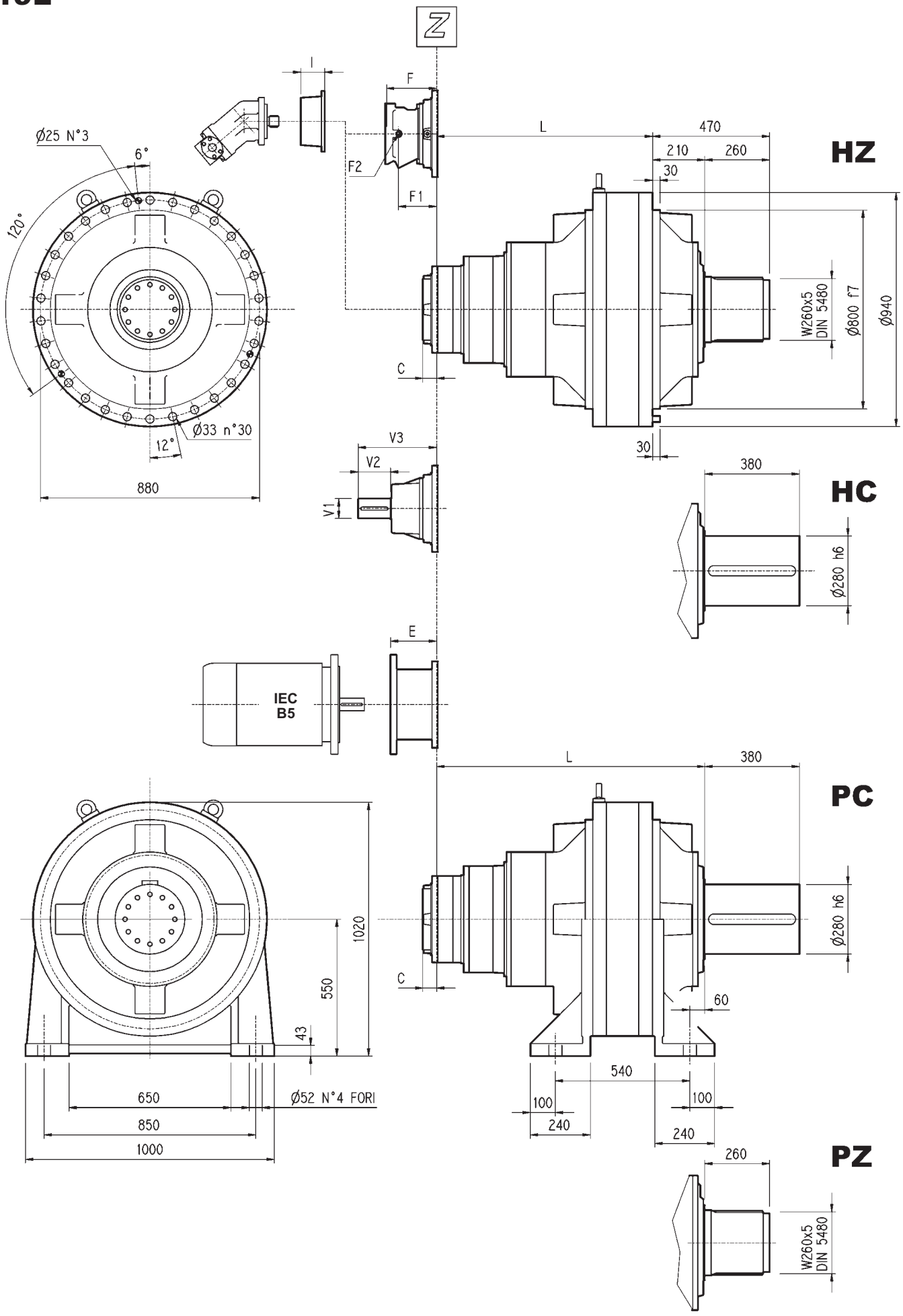
M_2 = 300000 Nm

319R

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2													
R3													
R4	354	238 000	181 000	147 000	119 000	74 000	60 000	135	90	1 500	2 500	800	5G
	454	284 000	215 000	175 000	142 000	88 000	71 000	135	90	1 500	2 500	800	5G
	538	320 000	243 000	197 000	160 000	99 000	80 000	115	90	1 500	2 500	800	5G
	582	338 000	257 000	208 000	169 000	104 000	85 000	107	90	1 500	2 500	630	5E
	689	340 000	289 000	234 000	190 000	118 000	95 000	90	90	1 500	2 500	630	5E
	820	307 000	296 000	241 000	196 000	121 000	98 000	76	90	1 500	2 500	500	5C
	971	340 000	292 000	260 000	222 000	137 000	111 000	65	90	1 500	2 500	500	5C

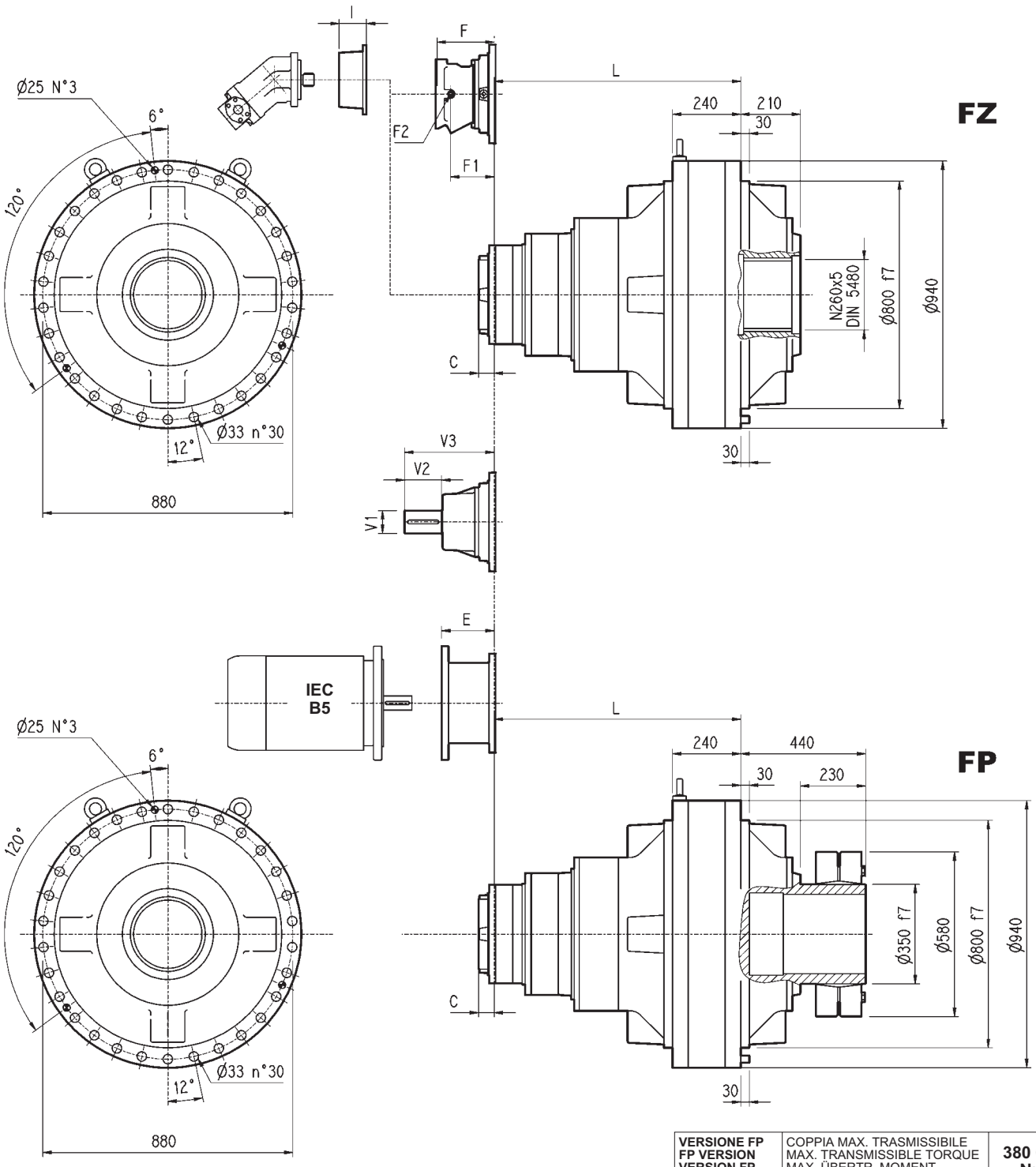
$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

319L


Z
I
F
F2
F1
L
470
210
260
30
HZ
Ø25 N°3
6°
120°
Ø33 n°30
12°
880
W260x5
DIN 5480
Ø800 f7
Ø940
C
30
V3
V2
V1
380
HC
Ø280 h6
E
IEC
B5
L
380
PC
Ø280 h6
C
60
540
100
100
240
240
1020
550
43
650
850
1000
Ø52 N°4 FORI
260
PZ
W260x5
DIN 5480

319L

Z

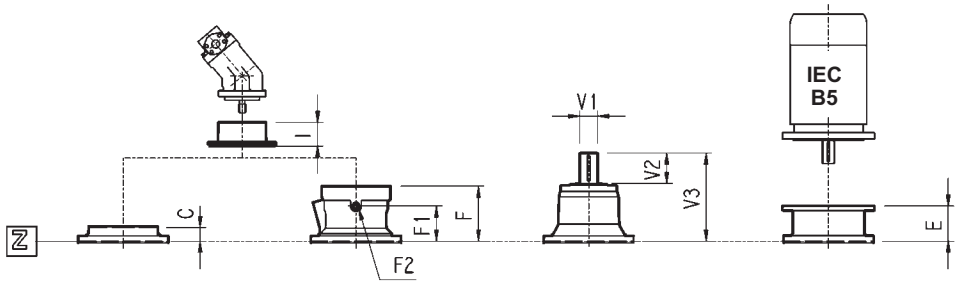


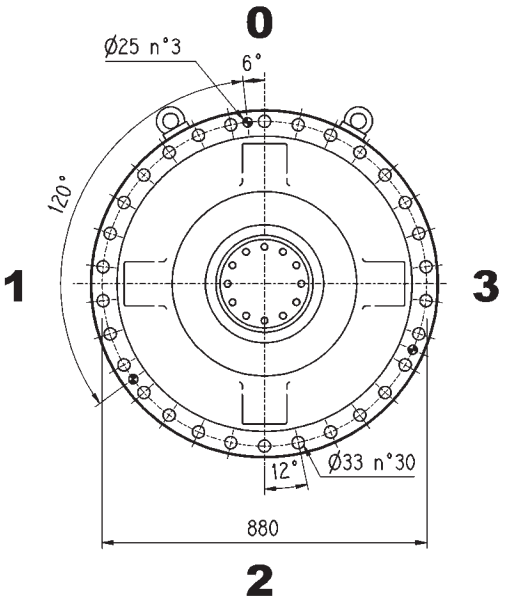
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**380 000 Nm**

	L				Kg						I	F	F1	F2			Kg
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
319 L1	185	395	185	185	1 800	2 100	1 700	1 700	245								
319 L2	568	778	568	568	2 050	2 350	1 950	1 950	116	E							
319 L3	780	990	780	780	2 135	2 435	2 035	2 035	81	D		232	185	1/4 G	6	B	28
319 L4	913	1 123	913	913	2 180	2 480	2 080	2 080	51	B	171	201	153	1/4 G	6	B	28

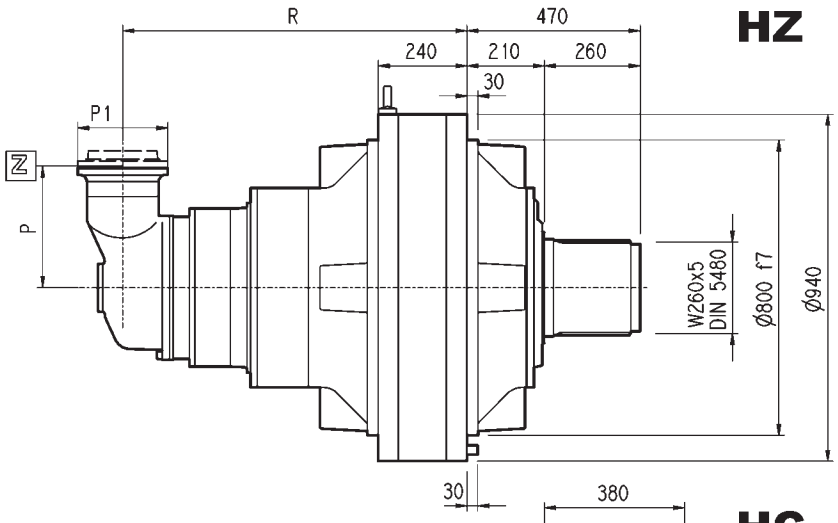
	V1	V2	V3	Kg	V1	V2	V3	Kg	E								IEC 180	IEC 200	IEC 225	IEC 250
319 L1																				
319 L2																				
319 L3	80	130	345	35																
319 L4	80	130	315	35	60	105	313	28									195	186	216	215

319R

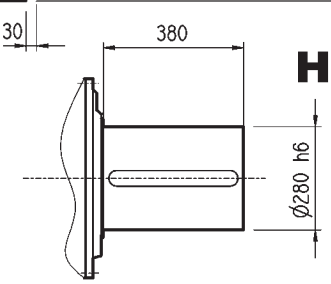


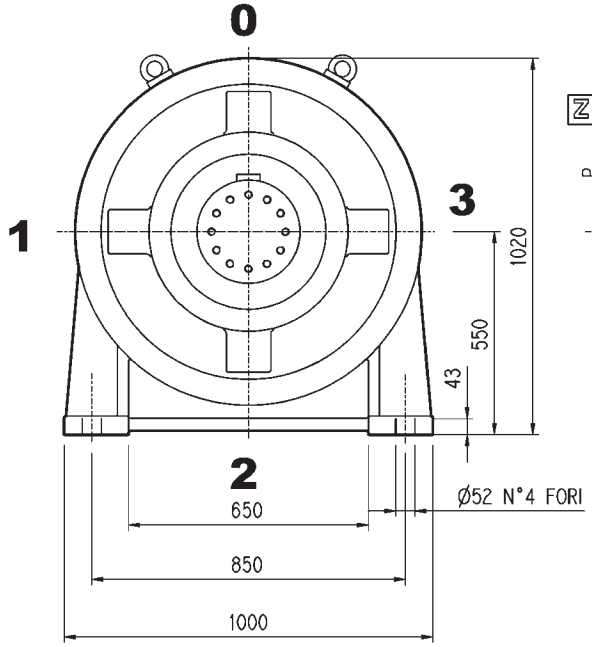


HZ

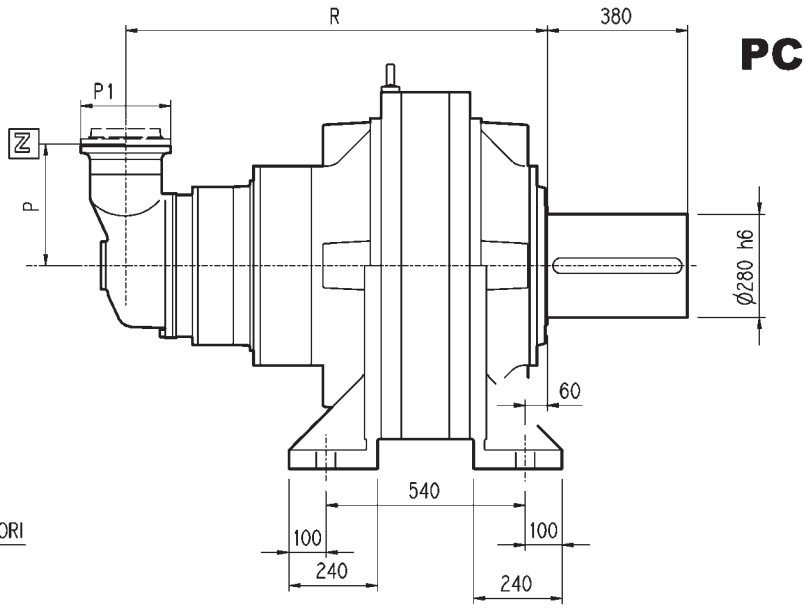


HC

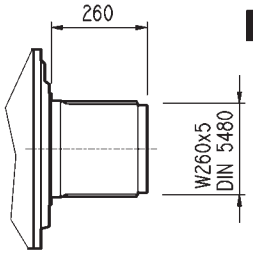




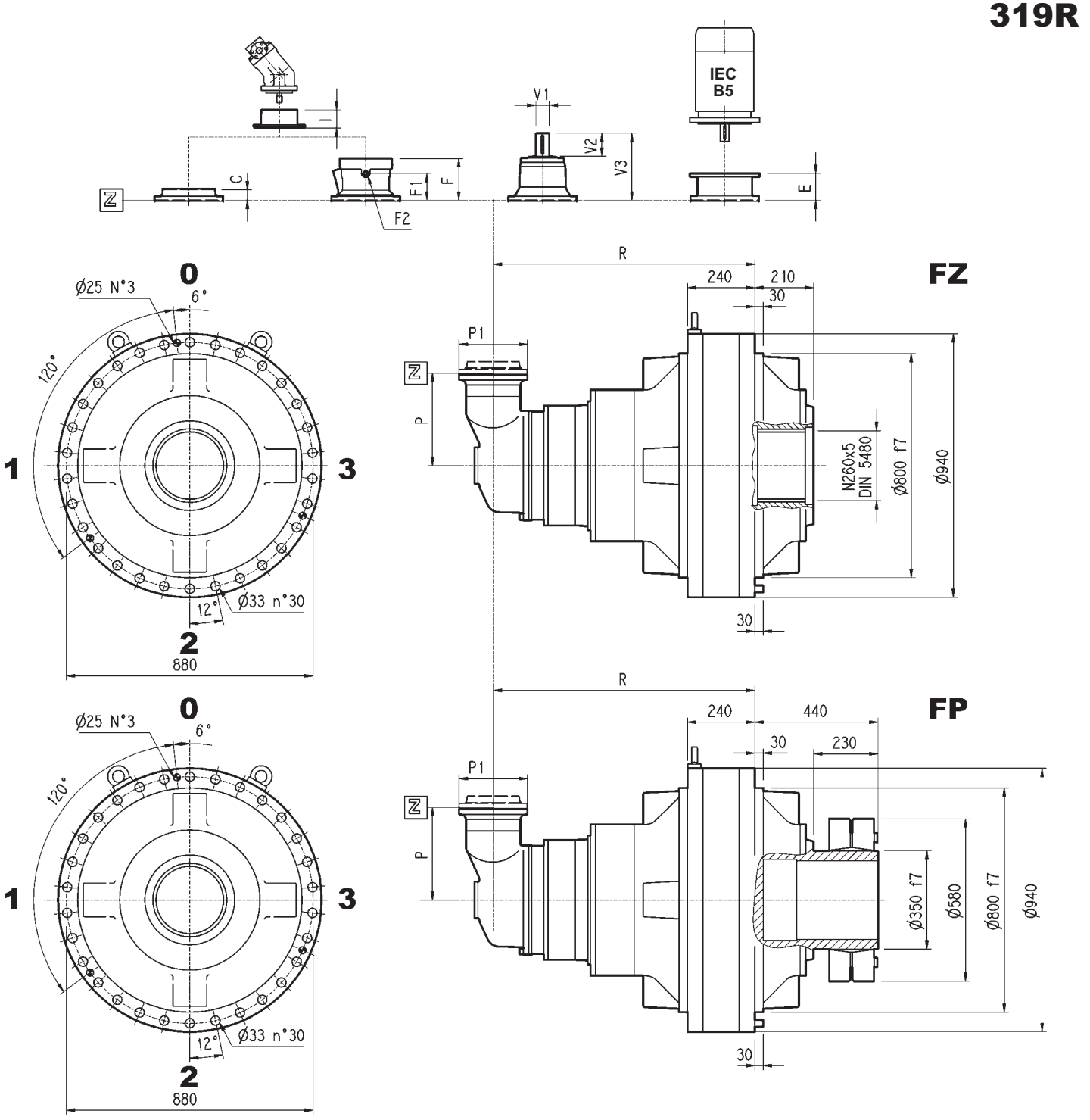
PC



PZ



319R

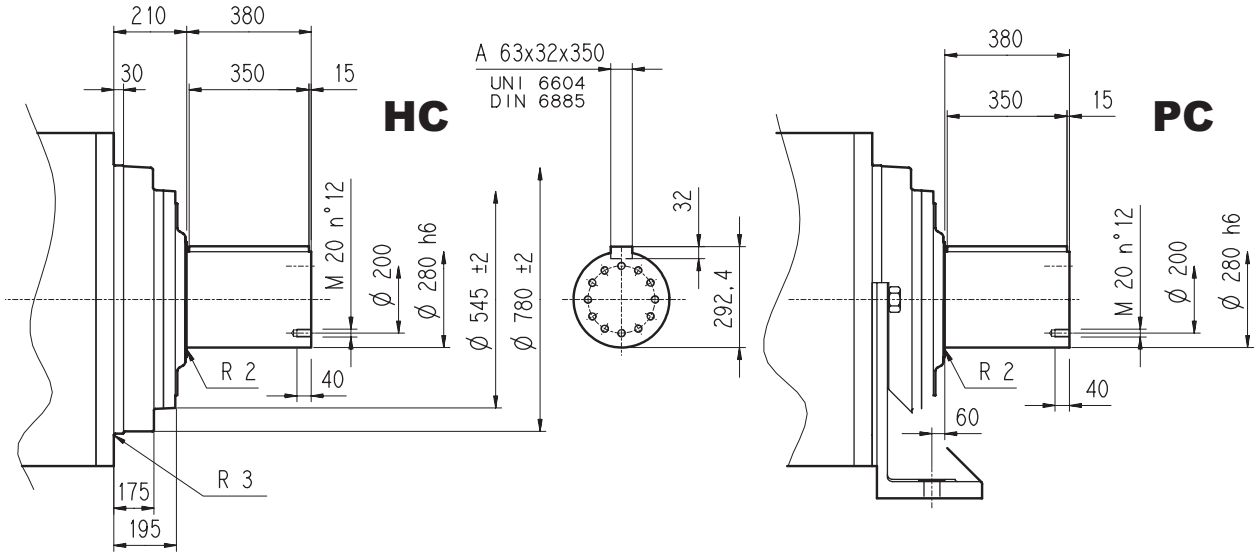


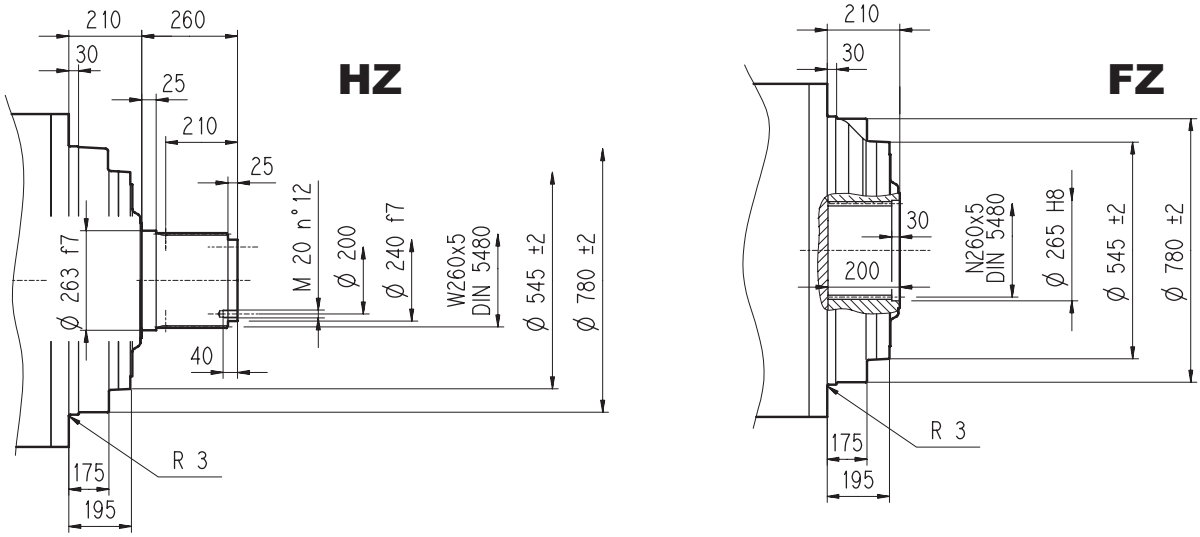
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**380 000 Nm**

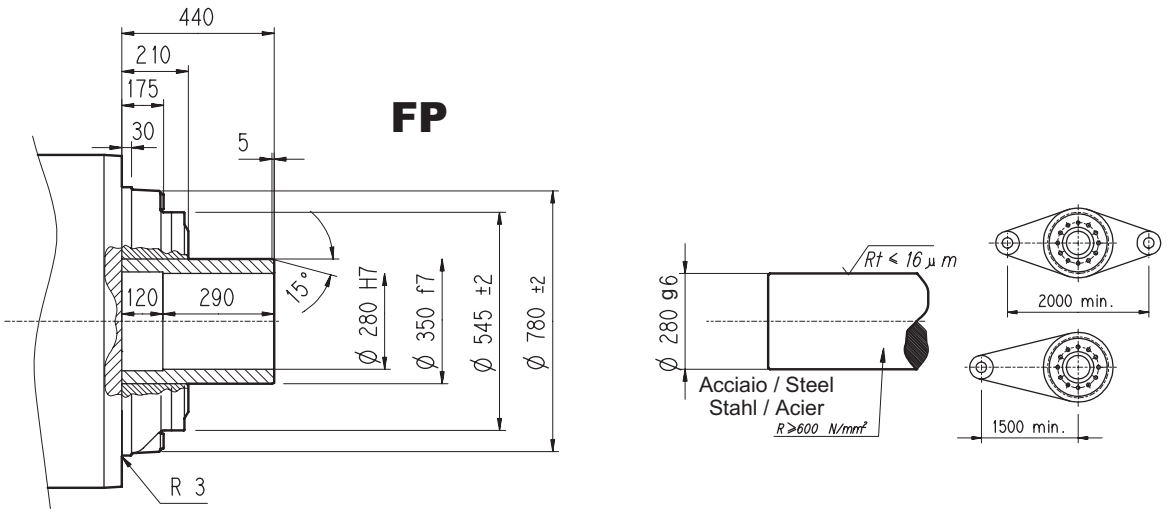
	R				P	P1	Kg				C		I	F	F1	F2			Kg
	HZ HC	PC PZ	FZ	FP			HZ HC	PC PZ	FZ	FP		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
319 R2																			
319 R3																			
319 R4	1 005	1 205	1 005	1 005	330	245	2 245	2 545	2 145	2 145	37	A	171	145	95	1/4 G	5	A	16

	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
															IEC 132	IEC 160	IEC 180	IEC 200	
319 R2																			
319 R3																			
319 R4	48	82	239	15											114	144	144	174	

319L - 319R



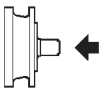




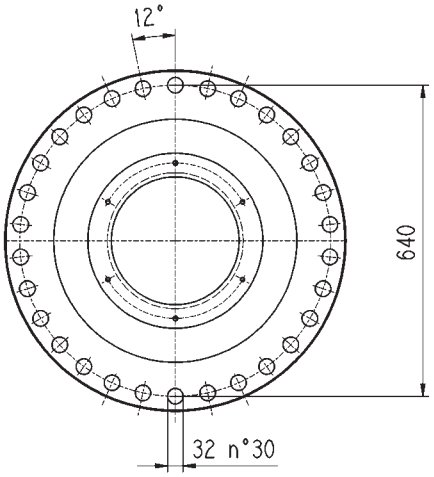
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**380 000 Nm**

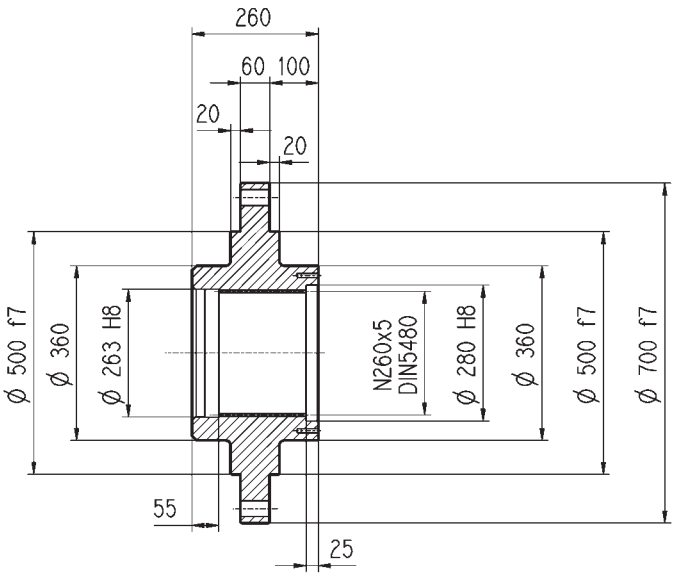
319L - 319R

Flangia / Flange
Flansch / Brides



W0A

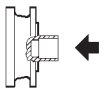


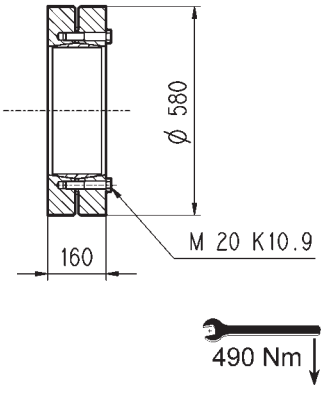


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Màterial : Acier C40

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

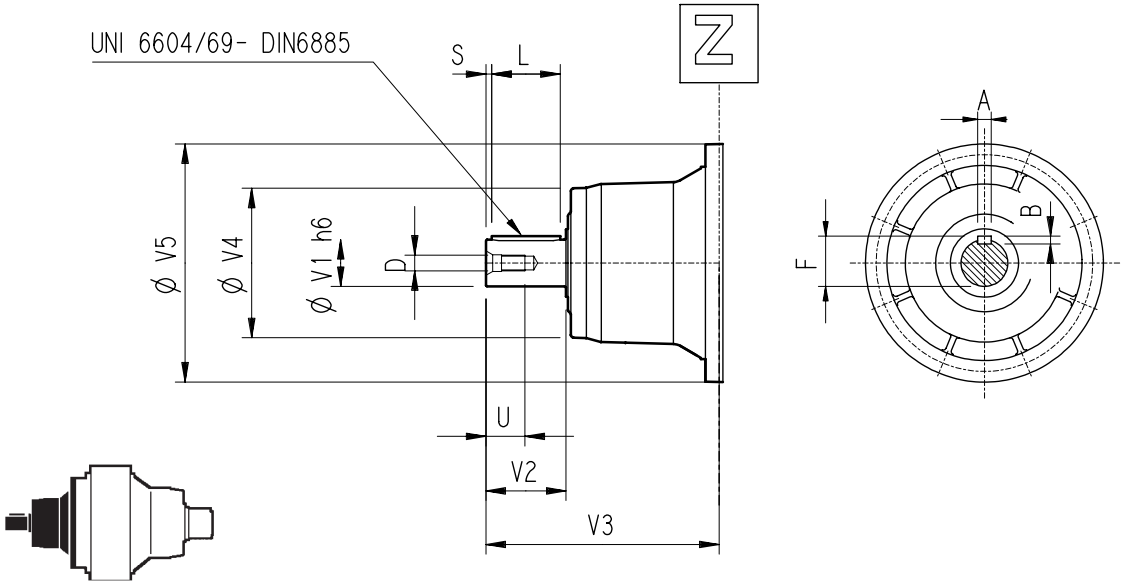
G0A





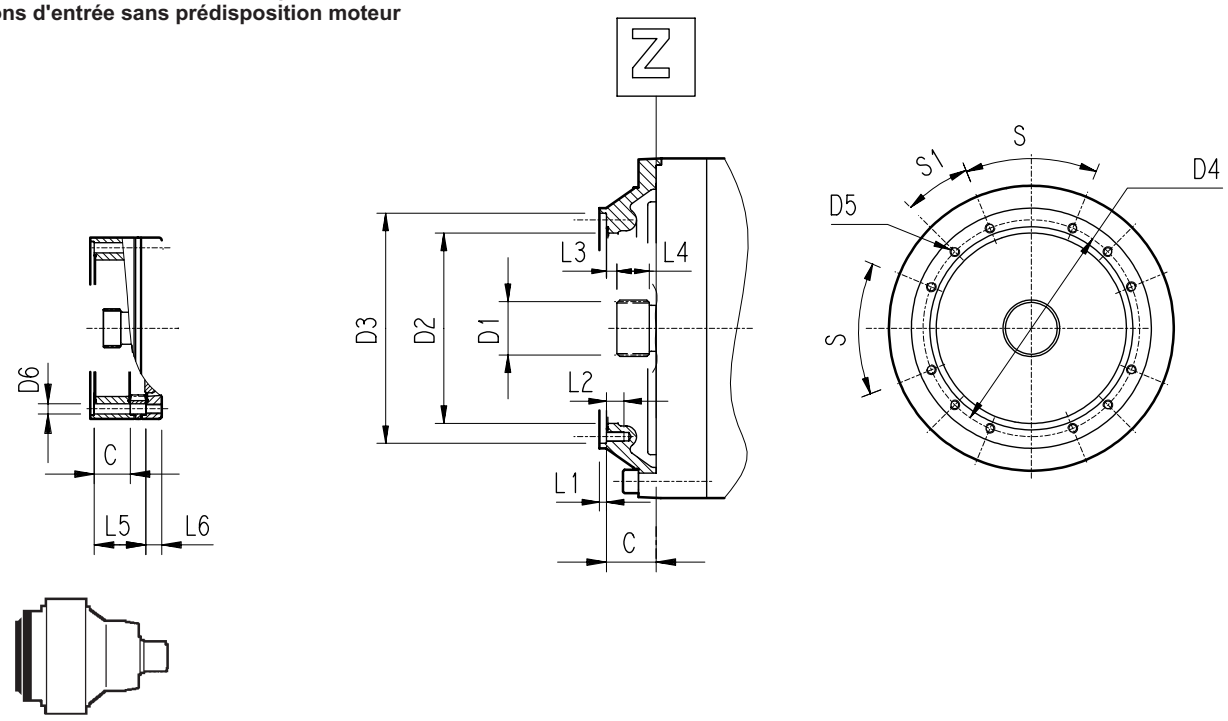
319L - 319R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
319 L3	V11B	80	130	345	200	428	22	14	85	110	10	M16	40
319 L4	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
319 R4	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



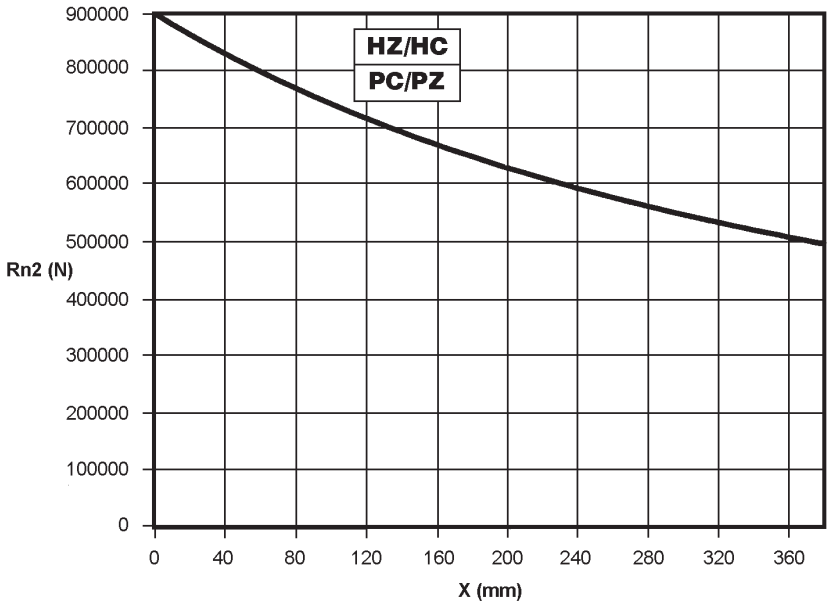
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
319 L1																
319 L2	116	100x94 DIN 5482	340	412 H7	390	M16 n°18	/	7	30	8	55	/	/	20°	20°	E
319 L3	81	80x74 DIN 5482	270	335 H7	314	M16 n°8	/	5	30	8.5	40	/	/	60°	30°	D
319 L4	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
319 R2-R3-R4	37	40x36 DIN 5482	140	178 H7	165	M12 n°8	11	4	18	9	18	0	0	45°	45°	A

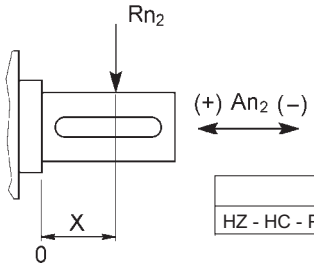
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

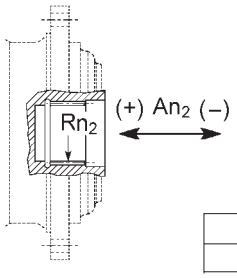
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC - PC - PZ	500 000	450 000



	Rn2	An2 (+/-)
FZ	200 000	200 000

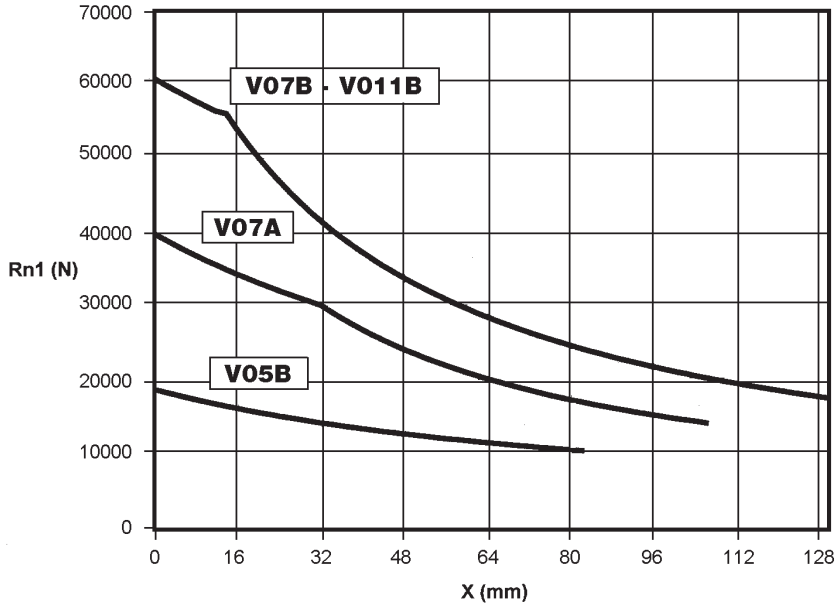
	$Fh_2 = n_2 \cdot h$	10 000	25 000	50 000	100 000	500 000	1 000 000
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	fh_2 FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
	HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

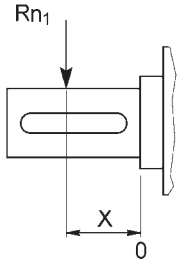
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

321L

M_2 = 450000 Nm

	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
L1	4.44	540 000	466 000	415 000	337 000	208 000	169 000	540	115	200	300		
L2	18.2	540 000	466 000	415 000	337 000	208 000	169 000	350	95	200	300		
	23.3	540 000	460 000	410 000	335 000	210 000	172 000	350	95	200	300		
	27.7	498 000	466 000	415 000	337 000	208 000	169 000	350	95	200	300		
L3	75.3	540 000	466 000	406 000	329 000	203 000	165 000	200	60	500	800		
	98.2	540 000	466 000	397 000	322 000	199 000	162 000	200	60	500	800		
	118	540 000	466 000	396 000	322 000	199 000	161 000	200	60	500	800		
	126	540 000	460 000	410 000	335 000	210 000	172 000	200	60	500	800		
	152	540 000	460 000	410 000	335 000	210 000	172 000	200	60	500	800		
	180	498 000	466 000	415 000	337 000	208 000	169 000	180	60	500	800		
L4	258	540 000	466 000	406 000	329 000	203 000	165 000	130	35	1 400	2 000	2 100	6G
	308	540 000	466 000	390 000	316 000	195 000	159 000	130	35	1 400	2 000	2 100	6G
	395	540 000	466 000	401 000	325 000	201 000	163 000	130	35	1 400	2 000	2 100	6G
	469	540 000	466 000	391 000	318 000	196 000	159 000	130	35	1 400	2 000	1 500	6E
	515	540 000	466 000	397 000	322 000	199 000	162 000	130	35	1 400	2 000	1 500	6E
	612	540 000	466 000	397 000	322 000	199 000	162 000	130	35	1 400	2 000	1 100	6C
	736	540 000	466 000	396 000	322 000	199 000	161 000	130	35	1 400	2 000	850	6B
	796	540 000	460 000	410 000	335 000	210 000	172 000	123	35	1 400	2 000	850	6B
	945	540 000	460 000	410 000	335 000	210 000	172 000	103	35	1 400	2 000	850	6B
	1 122	498 000	466 000	415 000	337 000	208 000	169 000	87	35	1 400	2 000	850	6B

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

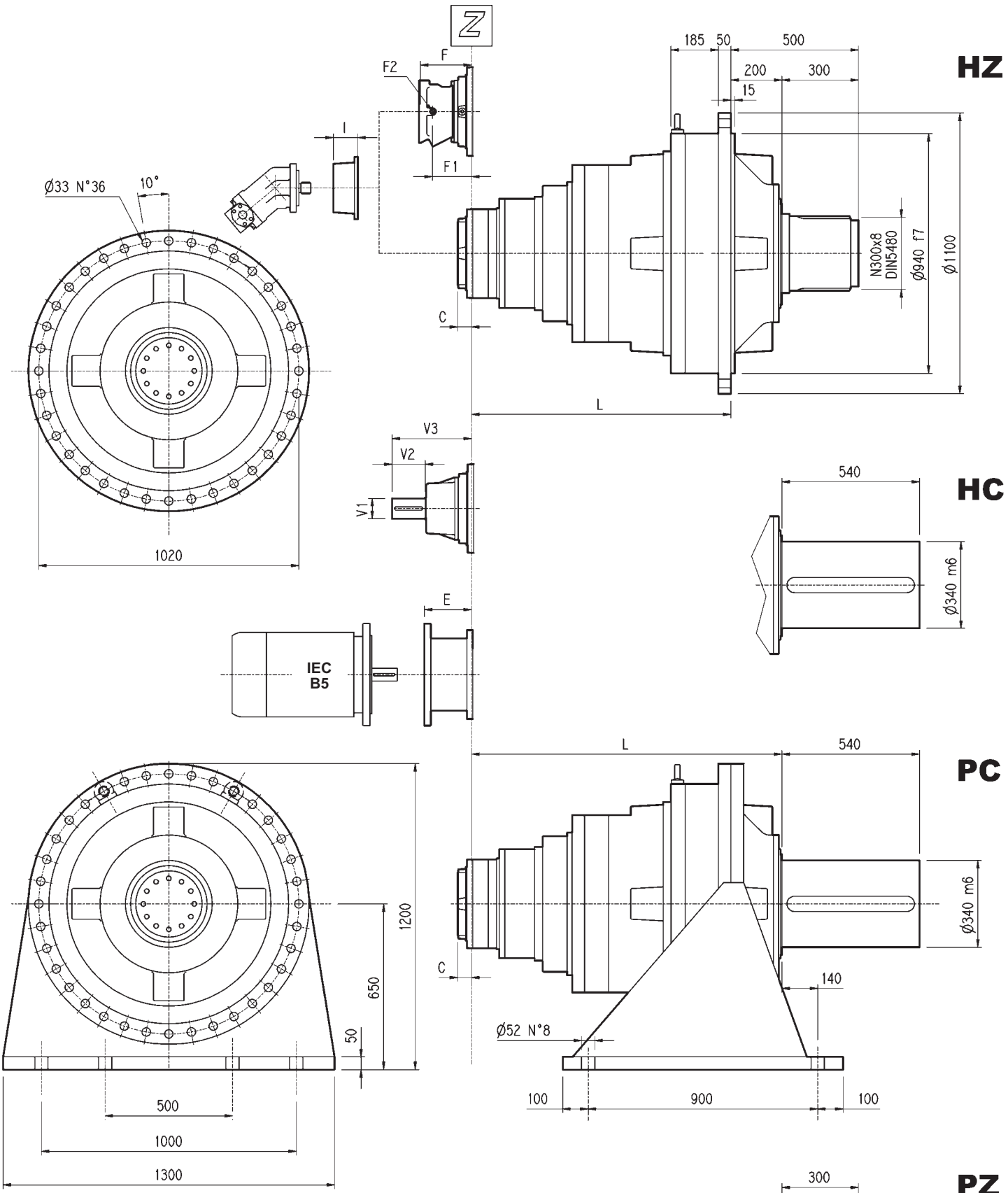
M_2 = 450000 Nm

321R

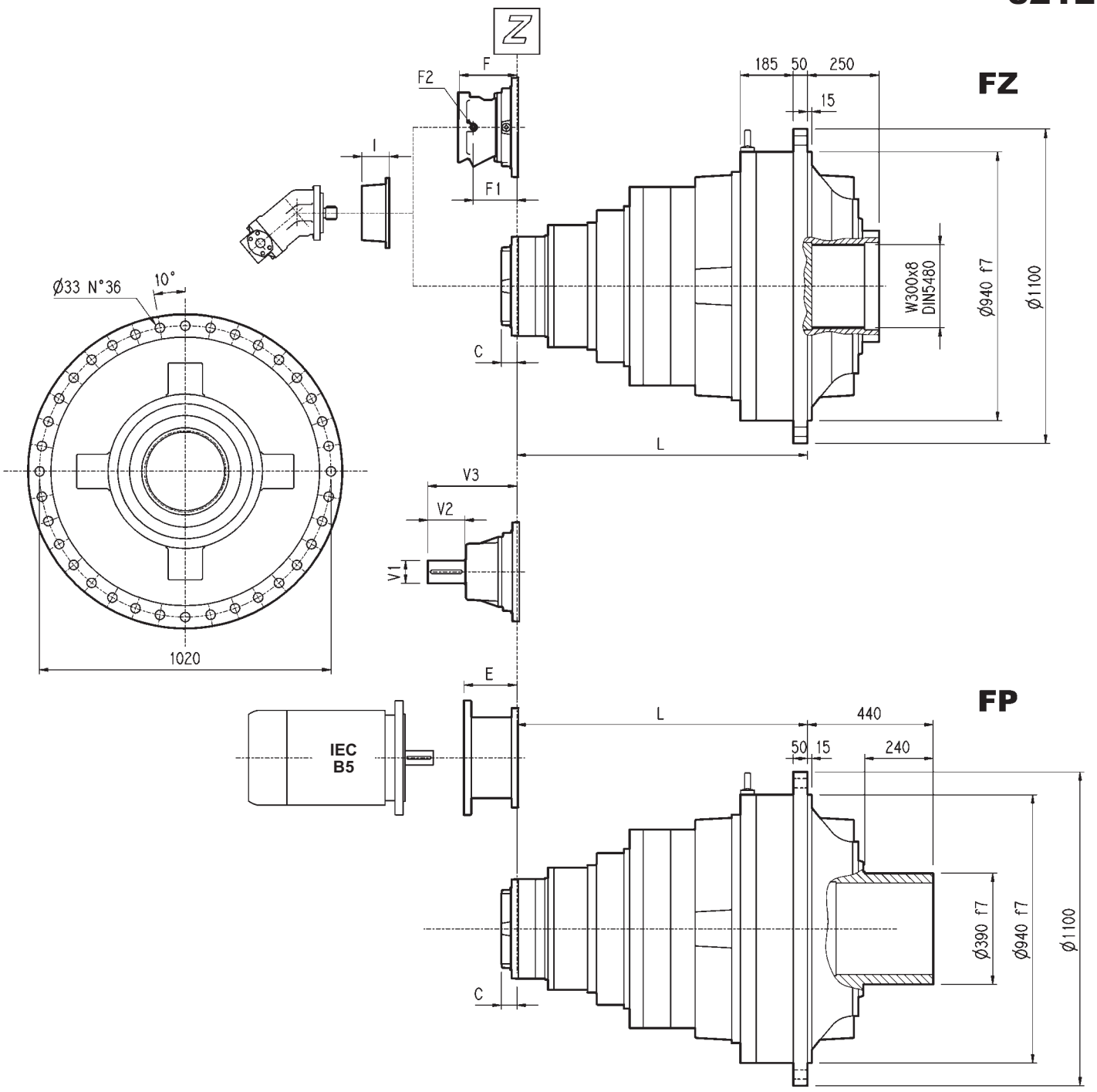
	i	M_{n2} [Nm]						P_1	Pt	n_1	n_{1max}	M_b	
		$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$	$n_2 \cdot h$						
	1:	10 000	25 000	50 000	100 000	500 000	1 000 000	[kW]	[kW]	[min^{-1}]	[min^{-1}]	[Nm]	
R2													
R3													
R4	326	225 000	171 000	139 000	113 000	70 000	57 000	135	90	1 400	2 000	800	5G
	425	270 000	206 000	167 000	136 000	84 000	68 000	135	90	1 400	2 000	800	5G
	512	309 000	234 000	190 000	155 000	95 000	78 000	135	90	1 400	2 000	800	5G
	546	324 000	247 000	202 000	164 000	102 000	83 000	135	90	1 400	2 000	800	5G
	657	369 000	282 000	230 000	187 000	117 000	95 000	135	90	1 400	2 000	800	5G
	780	414 000	315 000	256 000	208 000	128 000	104 000	125	90	1 400	2 000	800	5G

$M_{2max} = 1.2 \cdot M_{n2}$ ($n_2 \cdot h = 10\,000$)

321L


Z
F
F2
F1
I
Ø33 N°36
10°
1020
C
185
50
500
200
300
15
N300x8 DIN5480
Ø940 f7
Ø1100
L
HZ
V3
V2
V1
540
Ø340 m6
HC
E
IEC B5
L
540
PC
Ø340 m6
C
140
Ø52 N°8
100
900
100
1200
650
50
500
1000
1300
300
N300x8 DIN5480
PZ

321L

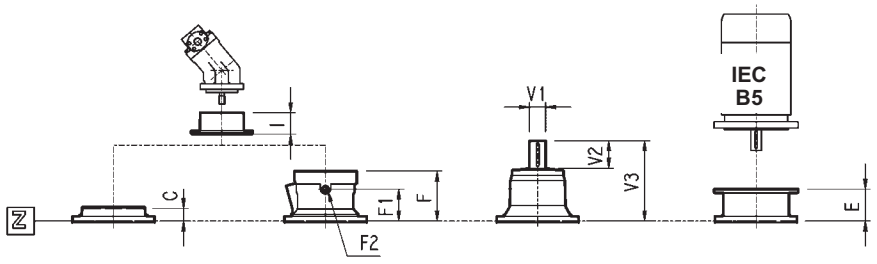


VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**600 000 Nm**

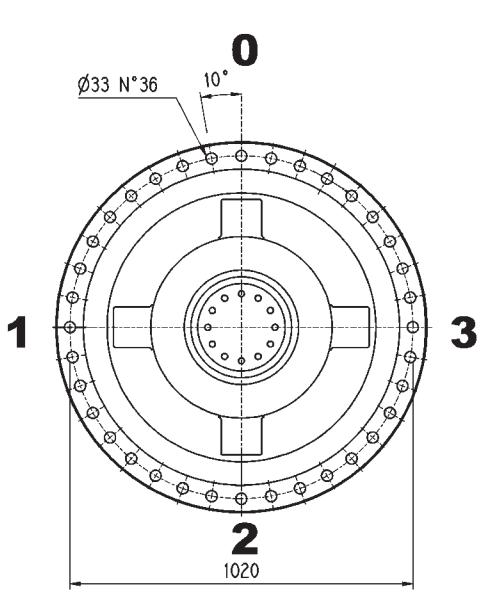
	L				Kg													
	HZ HC	**PC PZ**	**FZ**	**FP**	**HZ HC**	**PC PZ**	**FZ**	**FP**	**C**	Entrata Input Antrieb Entrée	**I**	**F**	**F1**	**F2**	Tipo Type Typ Type	Entrata Input Antrieb Entrée	Kg
321 L1																	
321 L2	595	795	595	595	2 700	3 000	2 600	2 600	181	F							
321 L3	904	1 104	904	904	2 820	3 120	2 720	2 720	75	D							
321 L4	1 053	1 253	1 053	1053	2 880	3 180	2 780	2 780	51	B	171	201	153	1/4 G	6	B	28

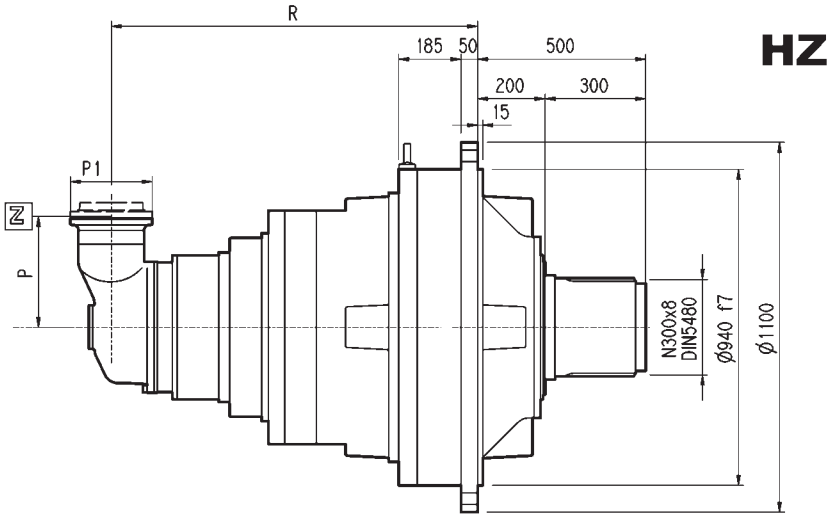
									E									
	V1	**V2**	**V3**	Kg	**V1**	**V2**	**V3**	Kg									**IEC 180**	**IEC 200**	**IEC 225**	**IEC 250**
321 L1																				
321 L2																				
321 L3	80	130	345	35																
321 L4	80	130	315	35	60	105	313	28									195	186	216	215

321R

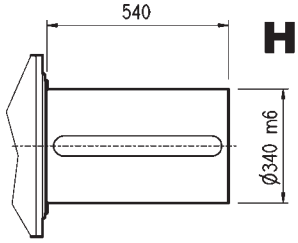


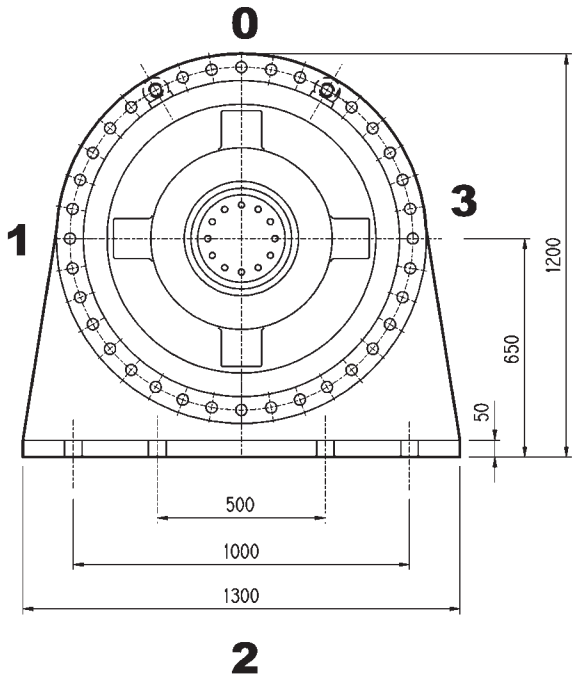
HZ



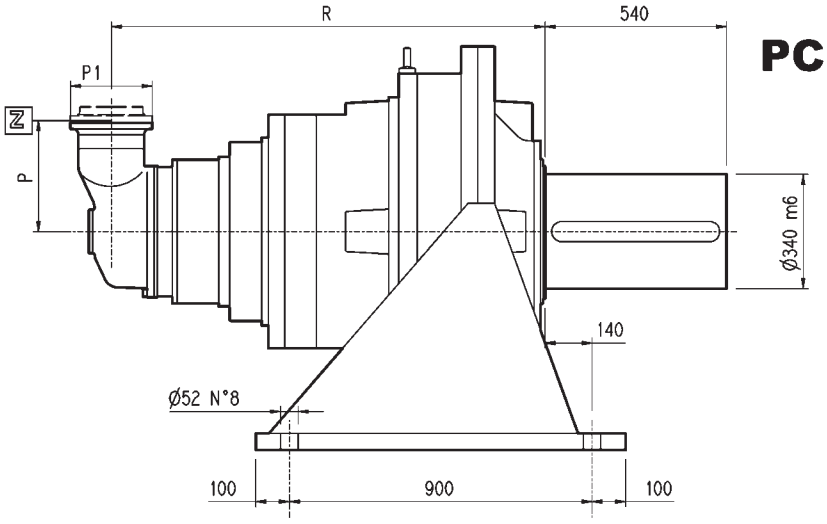


HC

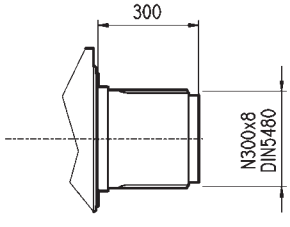




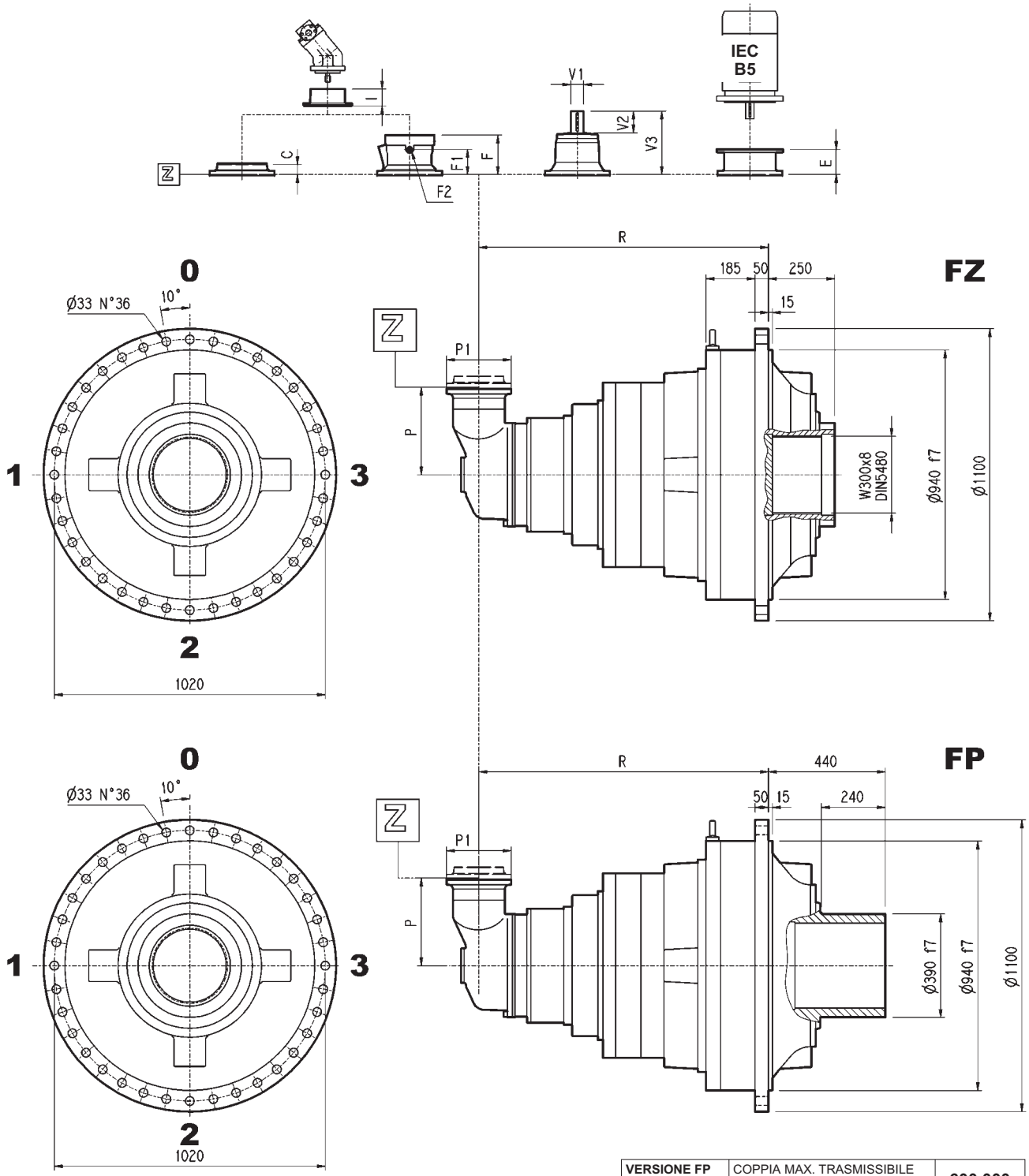
PC



PZ



321R



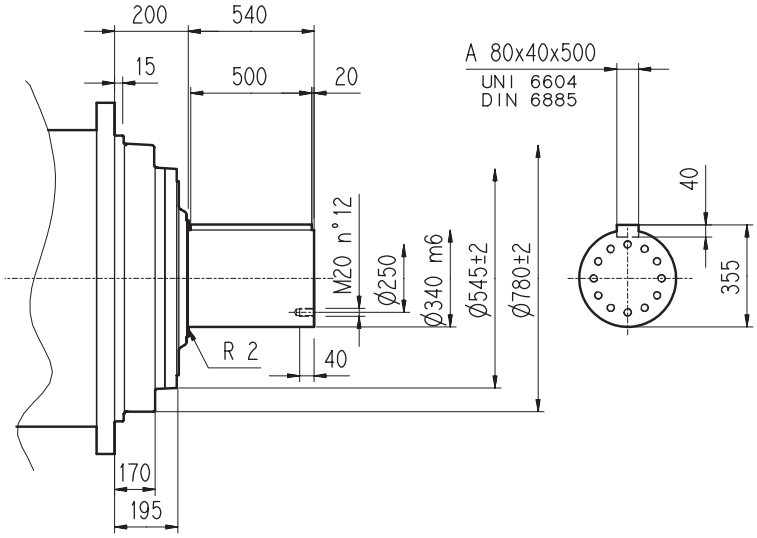
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**600 000 Nm**

	R				P	P1	Kg				C		I	F	F1	F2			Kg
	HZ HC	PC PZ	FZ	FP			HZ HC	PC PZ	FZ	FP		Entrata Input Antrieb Entrée					Tipo Type Typ Type	Entrata Input Antrieb Entrée	
321 R2																			
321 R3																			
321 R4	1 134	1 334	1 134	1 134	330	245	2 930	3 230	2 830	2 830	37	A	171	145	95	1/4 G	5	A	16

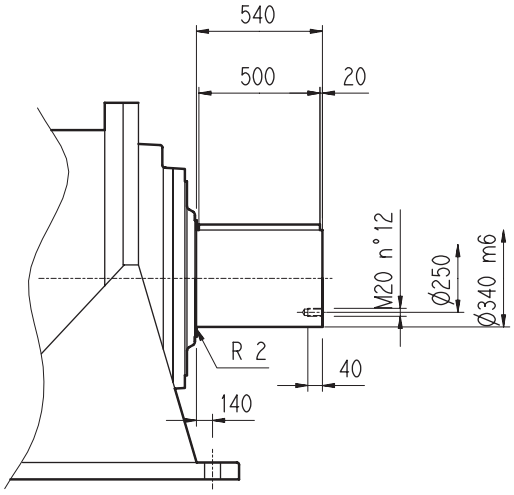
	V1	V2	V3	Kg	V1	V2	V3	Kg	E									
															IEC 132	IEC 160	IEC 180	IEC 200	
321 R2																			
321 R3																			
321 R4	48	82	239	15											114	144	144	174	

321L - 321R

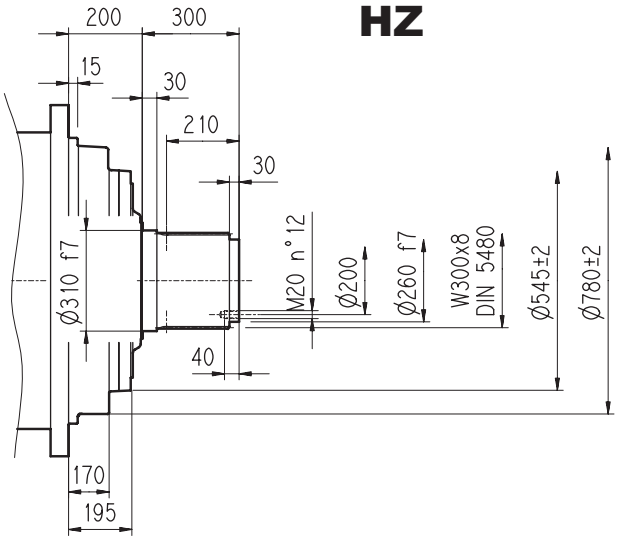
HC



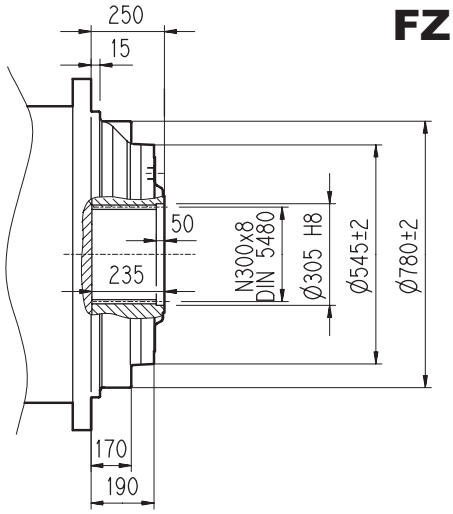
PC



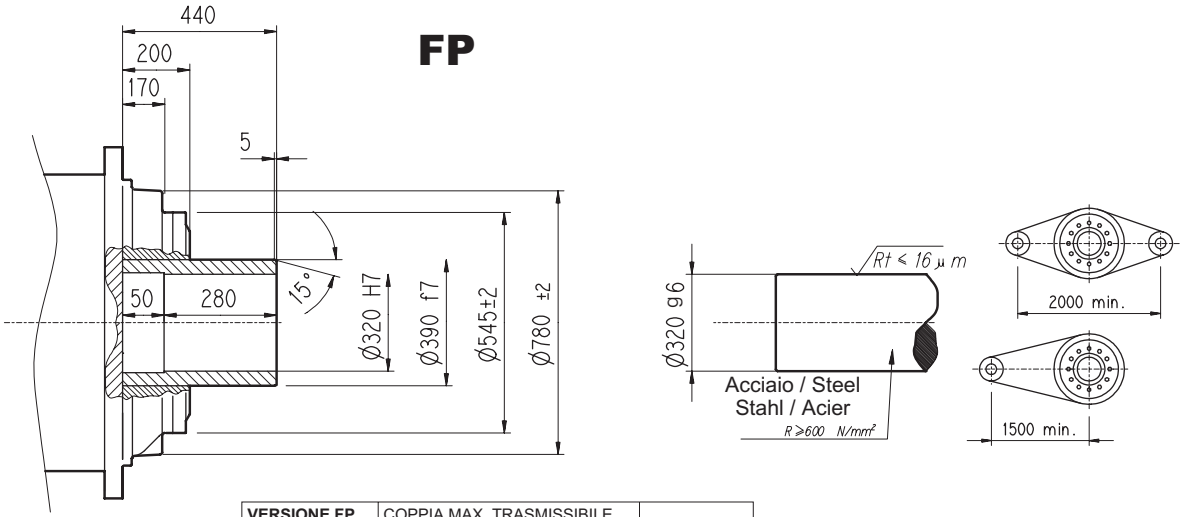
HZ



FZ



FP

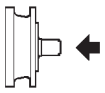


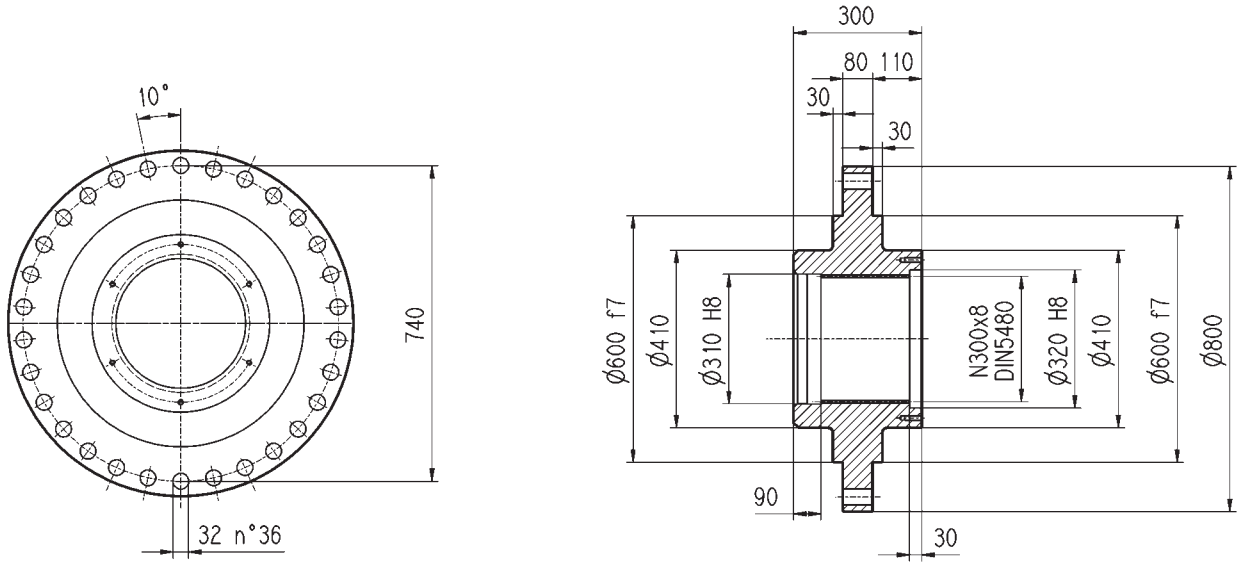
VERSIONE FP **FP VERSION** **VERSION FP** **VERSION FP**	COPPIA MAX. TRASMISSIBILE MAX. TRANSMISSIBLE TORQUE MAX. ÜBERTR. MOMENT COUPLE MAX. TRANSMISSIBLE	**600 000 Nm**

321L - 321R

Flangia / Flange
Flansch / Brides

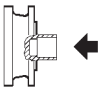
W0A



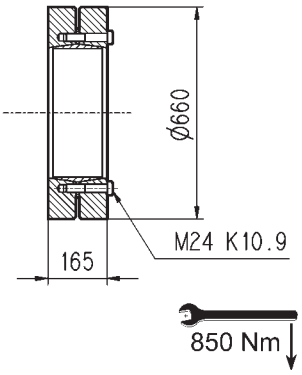


Materiale : Acciaio C40
Material : Steel C40
Material : Stahl C40
Matèrial : Acier C40

Giunto ad attrito / Shrink disc
Schrumpfscheibe / Frette de serrage

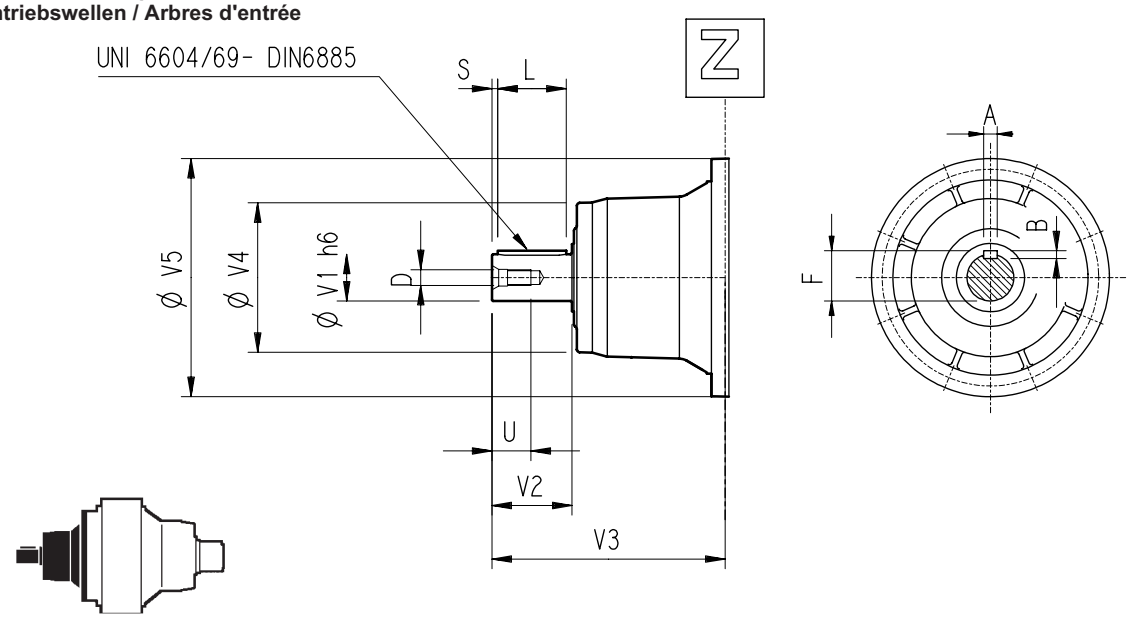


G0A



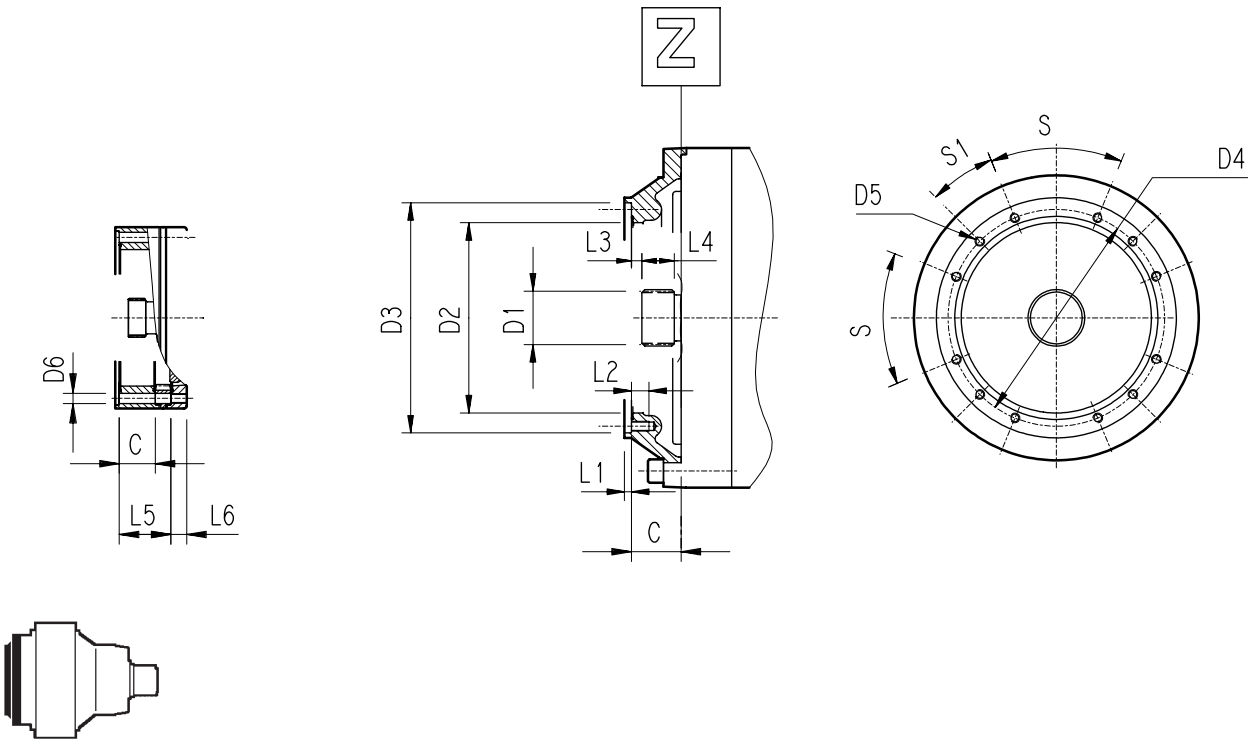
321L - 321R

Alberi veloci / Input shaft
Antriebswellen / Arbres d'entrée



	CODE	V1	V2	V3	V4	V5	A	B	F	L	S	D	U
321 L3	V11B	80	130	345	200	428	22	14	85	110	10	M16	40
321 L4	V07B	80	130	315	200	345	22	14	85	110	10	M16	40
	V07A	60	105	313	155	345	18	11	64	90	7.5	M16	40
321 R4	V05B	48	82	239	155	245	14	9	51.5	70	6	M16	40

Dimensioni d'entrata senza predisposizione motore
Input dimension without motor adaptor
Maße für den Antrieb ohne Motoradapter
Dimensions d'entrée sans prédisposition moteur



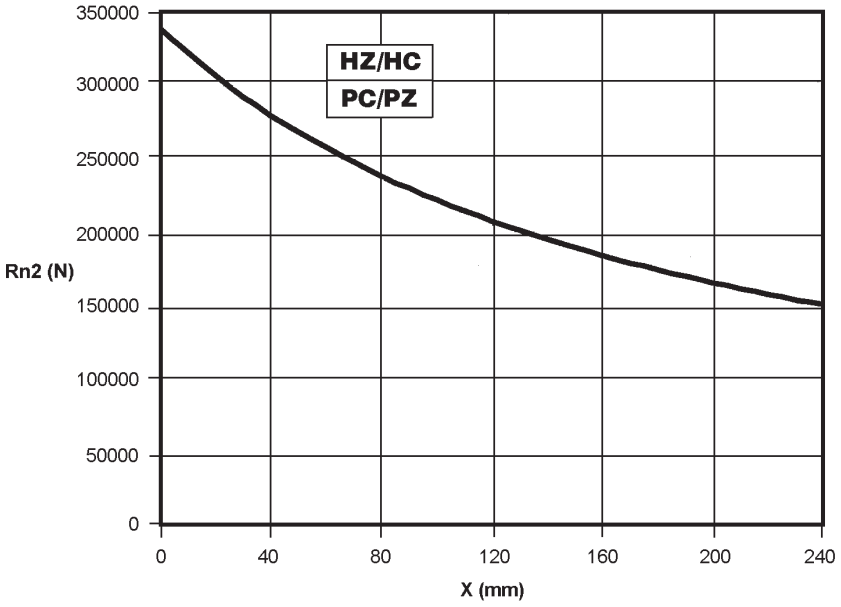
	C	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6	S	S1	Entrata Input Antrieb Entrée
321 L1																
321 L2	181	120x3 DIN 5480	365	390 f7	415	M16 n°18	/	4	30	3	65	/	/	20°	20°	F
321 L3	75	80x74 DIN 5482	270	335 H7	314	M16 n°8	/	5	30	9.5	40	/	/	60°	30°	D
321 L4	51	58x53 DIN 5482	195	236 H7	222	M10 n°12	/	4	18	11	22	/	/	45°	22.5°	B
321 R2-R3-R4	37	40x36 DIN 5482	140	178 H7	165	M10 n°8	11	4	18	9	18	0	0	45°	45°	A

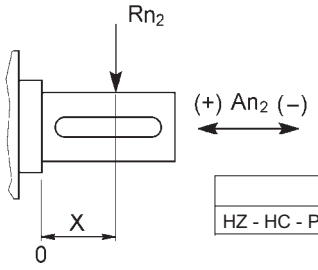
Carichi radiali ed assiali ammissibili sull'albero lento per un valore di $Fh_2 : n_2 \cdot h = 10\,000$

Permissible radial and axial loads on output shaft with Fh_2 $n_2 \cdot h = 10\,000$

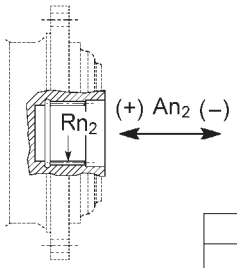
An der Ausgangswelle zulässige Radiallasten und Axialkräfte für einen Wert von Fh_2 $n_2 \cdot h = 10\,000$

Charges radiales et axiales admises sur l'arbre lent pour une valeur de $Fh_2 : n_2 \cdot h = 10\,000$





	An2 (+)	An2 (-)
HZ - HC - PC - PZ	180 000	240 000



	Rn2	An2 (+/-)
FZ	120000 0	180 000

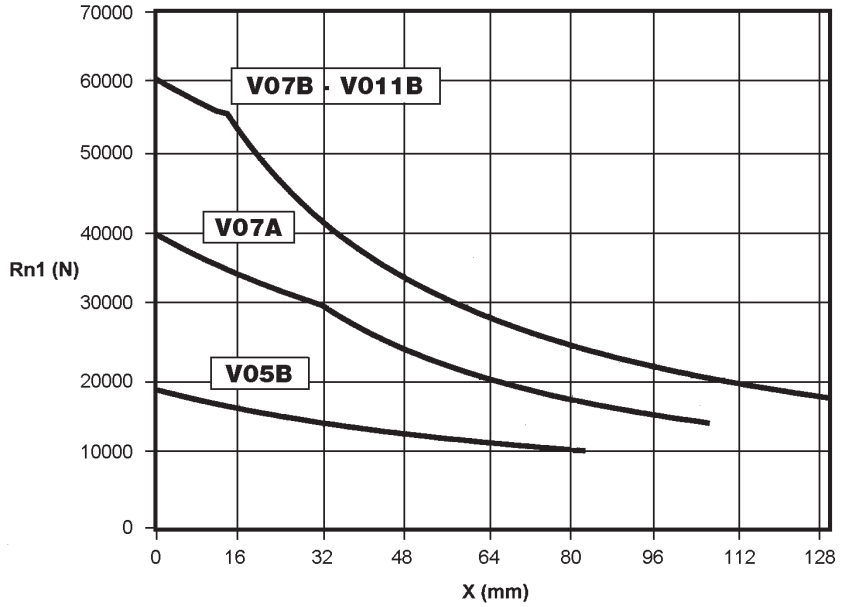
Fattore fh_2 correttivo per carichi sugli alberi Load corrective factor fh_2 on shafts Korrektionsfaktor fh_2 für wellenbelastungen Facteur de corretion fh_2 pour charges sur les arbres	$Fh_2 = n_2 \cdot h$		10 000	25 000	50 000	100 000	500 000	1 000 000
	fh_2	FZ	**1**	**0.74**	**0.58**	**0.46**	**0.27**	**0.21**
		HZ - HC - PC - PZ	**1**	**0.76**	**0.61**	**0.50**	**0.31**	**0.25**

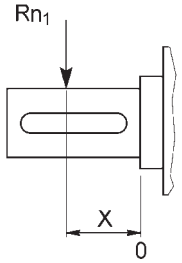
Carichi radiali ammissibili sull'albero veloce per un valore di Fh_1 $n_1 \cdot h = 250\,000$

Permissible radial loads on input shaft with $Fh_1 : n_1 \cdot h = 250\,000$

An der Antriebswelle zulässige Radiallasten für einen Wert von $Fh_1 : n_1 \cdot h = 250\,000$

Charges radiales admises sur l'arbre d'entrée pour une valeur de $Fh_1 : n_1 \cdot h = 250\,000$





Fattore fh_1 correttivo per carichi sugli alberi Load corrective factor fh_1 on shafts Korrektionsfaktor fh_1 für wellenbelastungen Facteur de corretion fh_1 pour charges sur les arbres	$Fh_1 = n_1 \cdot h$	250 000	500 000	1 000 000	2 000 000	5 000 000	10 000 000
	fh_1	**1**	**0.79**	**0.63**	**0.50**	**0.37**	**0.29**

24.0 FRENI IDRAULICI NEGATIVI A DISCHI MULTIPLI

DESCRIZIONE

Sono freni statici di sicurezza, in quanto l'azione frenante è sviluppata quando la pressione idraulica di comando è nulla, mentre quando questa raggiunge i valori minimi per lo sbloccaggio, l'azione frenante cessa. Applicati in entrata ai riduttori, costituiscono un gruppo unico e compatto con essi. Si adottano in tutte quelle applicazioni dove è assolutamente necessario arrestare e tenere bloccata la trasmissione anche sotto l'azione di coppie esterne.

Applicabili in:

- argani
- rotazione torrette
- freni di parcheggio su macchine semoventi
- applicazioni industriali

24.0 NEGATIVE MULTIDISC BRAKE

DESCRIPTION

TRASMITAL's fail-safe parking brake is an oil immersed multidisc unit on the input side of the gearbox. The brake is operated when ther is no hydraulic pressure and is released when the minimum release pressure is applied.
Use of parking brake is necessary whenever the driven system must be kept at standstill even under external forces and/or torques.

Applications:

- winches
- slewing drives
- parking brake on mobile equipment
- general industrial applications

24.0 HYDRAULISCH BELÜFTETE LAMELLEN-BREMSEN

BESCHREIBUNG

Hierbei handelt es sich um Sicherheits- und Haltebremsen, bei denen die Bremswirkung eintritt, wenn der hydraulische Regeldruck gleich Null ist. Sobald der min. Öffnungsdruck erreicht wird, täßt die Bremswirkung nach. Die Bremse wird am Getriebeeingang angebracht und bildet zusammen mit dem Getriebe eine kompakte Einheit. Eine Bremse sollte dann vorgesehen werden, wenn ein Anhalten des Getriebes unbedingt notwendig ist auch bei äußerer Drehmomenteinwirkung.

Einsatzfälle:

- Winden
- Drehwerke
- als Parkbremse bei Fahrzeugen
- Industrieanwendungen

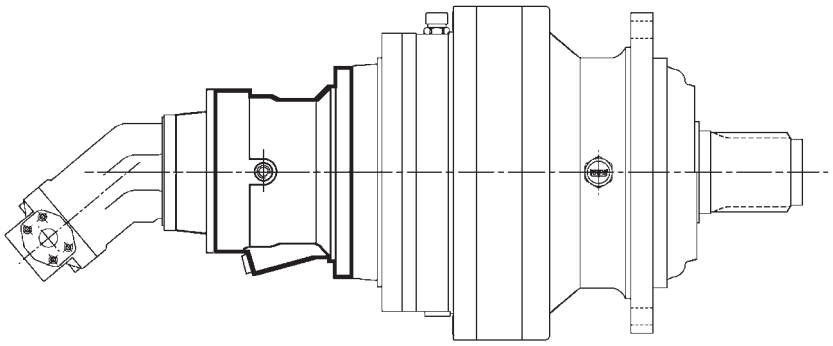
24.0 FREINS HYDRAULIQUES NEGATIFS

DESCRIPTION

Il s'agit de freins de sécurité dans la mesure oú l'action de freinage intervient lorsque la pression de commande est nulle, et à l'inverse lorsqu'elle atteint une valeur minimum pour le déblocage, l'action de freinage cesse. Appliqués à l'entrée des réducteurs, ils constituent, ensemble, un groupe unique et compact. Ils s'adaptent dans toutes les applications oú il est absolument nécessaire d'arrêter et de maintenir bloquée la transmission, même sous l'action de couples extérieurs.

Applications:

- Treuils
- Rotation tourelles
- Freins de parking sur équipements mobiles
- Applications industrielles



(A14)

DATI TECNICI FRENI / BRAKE TECHNICAL DATA
TECHNISCHE DATEN BREMSEN / CARACTERISTIQUES TECHNIQUES

		Tipo/Type/Typ/Type																	
		4.							5.					6.					
		A	B	D	F	H	K	L	B	C	E	G	K	B	C	E	G	K	L
Coppia frenante statica Mb Static braking torque Mb Statische bremsmoment Mb Couplè de freinage statique Mb	Nm (10%	50	100	160	260	330	400	440	400	500	630	800	1000	850	1100	1500	2100	2600	3200
Pressione minima apertura Min. opening pressure Min. Öffnungsdruck Pression minime d'ouverture	bar	10	20	30	20	25	30	34	20	27	20	26	32	14	19	25	19	24	29
Pressione massima comando Max. operating pressure Max. Druck Pression maxi de commande	bar	320																	
Volume d'olio per comando apertura freno Oil volume for brake release Ölmenge zum öffnen bremse Volume d'huile pour commande ouverture frein	cm^3	6.65	6.65	6.65	6.65	6.65	6.65	6.65	13.96	13.96	13.96	13.96	13.96	37.2	37.2	37.2	37.2	37.2	37.2

25.0 ENTRATE PER MOTORI IDRAULICI

Tutte le grandezze sono predisponibili in ingresso per motori idraulici.
I tipi di predisposizioni disponibili sono indicati nelle pagine seguenti.
Gli orientamenti standard (A) delle flange attacco motore, sono indicati negli schemi seguenti, considerando il punto di vista dal lato ingresso sul riduttore.

25.0 INPUTS FOR HYDRAULIC MOTORS

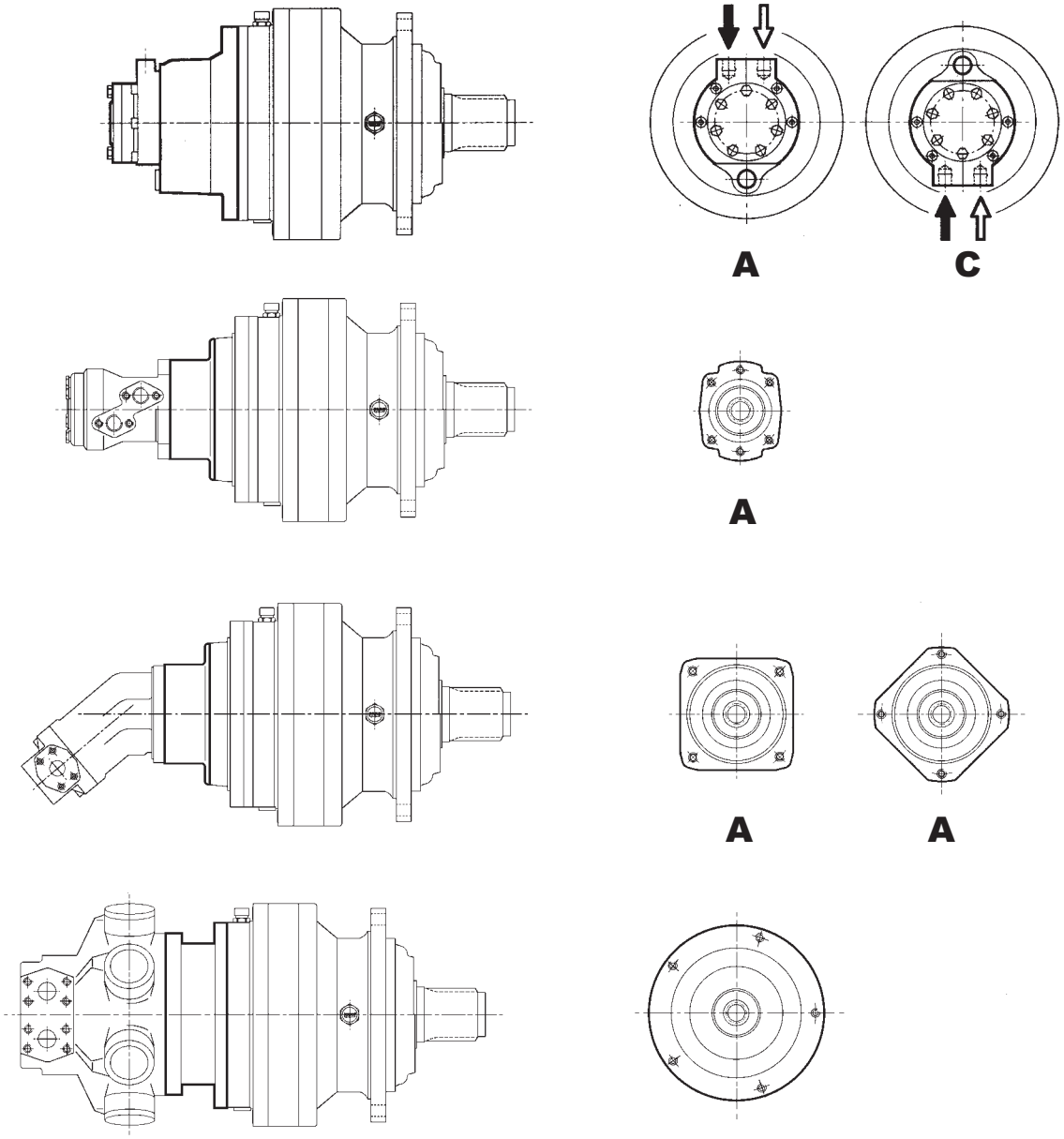
All sizes can be supplied with hydraulic motor input flanges.
The available motor adaptors are shown in the following pages.
The standard orientations (A) of the motor flanges are shown in the following scheme, taking into consideration the input side of the gearbox.

25.0 ANTRIEBE FÜR HYDRAULISCHE MOTOREN

Alle Baugrößen sind vorbereitet für den Antrieb hydraulischer Motoren.
Die Anbaumöglichkeiten sind auf den folgenden Seiten angegeben.
Die Standardorientierungen (A) der Motorflanschen werden in dem folgenden Schema angegeben, bei Ansicht auf die Eintriebsseite des Getriebes.

25.0 ENTREES POUR MOTEURS HYDRAULIQUES

Toutes les tailles sont prevues à l'entrée pour accouplement moteurs hydrauliques.
Les types de prédispositions disponibles sont indiqués dans les page suivantes.
Les orientations standard (A) des brides accouplement moteur sont indiquées ci-dessous, en considerant le point de vue du côté entrée sur le réducteur.



Codici indicativi degli altri orientamenti:

B: + 90° (senso orario)
C: + 180° (senso orario)
D: + 270° (senso orario)

Identification codes of other arrangements:

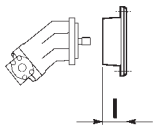
B: + 90° (clockwise)
C: + 180° (clockwise)
D: + 270° (clockwise)

Anhaltsnummern der anderweitigen Ausrichtungsmöglichkeiten:

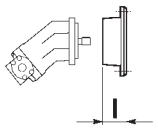
B: + 90° (im Uhrzeigersinn)
C: + 180° (im Uhrzeigersinn)
D: + 270° (im Uhrzeigersinn)

Codes indicatifs des autres orientations:

B: + 90° (sens horaire)
C: + 180° (sens horaire)
D: + 270° (sens horaire)



		SAE Standard J744c												
		SAE A 16/32 9T	SAE A ø15.875	SAE B 16/32 13T	SAE B ø22.2	SAE BB 16/32 15T	SAE BB ø25.4	SAE C 12/24 14T	SAE C ø31.7	SAE CC 12/24 17T	SAE CC ø38.1	SAE D 8/16 13T	SAE E 8/16 13T	
	CODICE / CODE	S5AM	S5AN	S5BA	S5BB	S5BM	S5BN	S5CA	S5CB	S5CP	S5CQ	S5DA	S5EA	
											I			
300	**L1-L2-L3-L4**	42	42	52	52	52	52	64	64	80	80	81		
	R2-R3-R4	42	42	52	52	52	52	64	64	80	80	81		
301	**L1-L2-L3-L4**	42	42	52	52	52	52	64	64	80	80	81		
	R2-R3-R4	42	42	52	52	52	52	64	64	80	80	81		
303	**L1**	42	42	52	52	52	52	64	64	80	80	81		
	L2-L3-L4	42	42	52	52	52	52	64	64	80	80	81		
	R2-R3-R4	42	42	52	52	52	52	64	64	80	80	81		
305	**L1**	42	42	52	52	52	52	64	64	80	80	81		
	L2-L3-L4	42	42	52	52	52	52	64	64	80	80	81		
	R2-R3-R4	42	42	52	52	52	52	64	64	80	80	81		
306	**L1**											101	113	
	L2	42	42	52	52	52	52	64	64	80	80	81		
	L3-L4	42	42	52	52	52	52	64	64	80	80	81		
	R2-R3-R4	42	42	52	52	52	52	64	64	80	80	81		
307	**L1**											101	113	
	L2	42	42	52	52	52	52	64	64	80	80	81		
	L3-L4	42	42	52	52	52	52	64	64	80	80	81		
	R2	42	42	52	52	52	52	64	64	80	80	81		
	R3-R4	42	42	52	52	52	52	64	64	80	80	81		
309	**L1**											101	113	
	L2	42	42	52	52	52	52	64	64	80	80	81		
	L3-L4	42	42	52	52	52	52	64	64	80	80	81		
	R2	42	42	52	52	52	52	64	64	80	80	81		
	R3-R4	42	42	52	52	52	52	64	64	80	80	81		
310	**L1**													
	L2											101	113	
	L3	42	42	52	52	52	52	64	64	80	80	81		
	L4	42	42	52	52	52	52	64	64	80	80	81		
	R3-R4	42	42	52	52	52	52	64	64	80	80	81		
311	**L1**													
	L2											101	113	
	L3	42	42	52	52	52	52	64	64	80	80	81		
	L4	42	42	52	52	52	52	64	64	80	80	81		
	R2-R3	42	42	52	52	52	52	64	64	80	80	81		
	R4	42	42	52	52	52	52	64	64	80	80	81		
313	**L1**													
	L2											101	113	
	L3	42	42	52	52	52	52	64	64	80	80	81		
	L4	42	42	52	52	52	52	64	64	80	80	81		
	R2-R3	42	42	52	52	52	52	64	64	80	80	81		
	R4	42	42	52	52	52	52	64	64	80	80	81		
315	**L1**													
	L2													
	L3											101	113	
	L4	42	42	52	52	52	52	64	64	80	80	81		
	R3-R4	42	42	52	52	52	52	64	64	80	80	81		
317	**L1**													
	L2													
	L3											101	113	
	L4	42	42	52	52	52	52	64	64	80	80	81		
	R3-R4	42	42	52	52	52	52	64	64	80	80	81		
319	**L1**													
	L2													
	L3													
	L4											101	113	
	R4	42	42	52	52	52	52	64	64	80	80	81		
321	**L1**													
	L2													
	L3													
	L4											101	113	
	R4	42	42	52	52	52	52	64	64	80	80	81		



		AXIAL PUMP	CALZONI								CHAR-LYNN (EATON)								
		M2-M2R-M2R1 24/50 16/32 z12	MR190 N z8	MR300 N z8	MRP300 N z8	MR450 N z8	MR700 N z8	MR1100 N z8	MR1800 N z10	MR2800 N z10	SERIE 2000 SAE A 1" 6B	SERIE 2000 SAE A ø25,4	SERIE 2000 SAE A ø32	SERIE 2000 SAE A 12/24 z14	SERIE 2000 BEARINGLESS 12/24 z12	SERIE 4000 SAE B ø31,75	SERIE 4000 SAE C 12/24 z17	SERIE 6000 SAE C ø38,1	SERIE 6000 SAE C 12/24 z17
	CODICE / CODE	S5BA	C0AA	C0AD	C0BL	C0AG	C0AL	C0AP	C0AS	C0AV	S5AQ	S5AS	D0AG	D0AH	E2AA	S5BP	S5CP	S5CQ	S5CP
										I									
300	**L1-L2-L3-L4**	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2-R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
301	**L1-L2-L3-L4**	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2-R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
303	**L1**	52	64	78	78						42	42	64	64	52	68	80	80	80
	L2-L3-L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2-R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
305	**L1**	52	64	78	78						42	42	64	64	52	68	80	80	80
	L2-L3-L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2-R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
306	**L1**					98	102	133											
	L2	52	64	78	78						42	42	64	64	52	68	80	80	80
	L3-L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2-R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
307	**L1**					98	102	133											
	L2	52	64	78	78						42	42	64	64	52	68	80	80	80
	L3-L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2	52	64	78	78						42	42	64	64	52	68	80	80	80
	R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
309	**L1**					98	102	133											
	L2	52	64	78	78						42	42	64	64	52	68	80	80	80
	L3-L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2	52	64	78	78						42	42	64	64	52	68	80	80	80
	R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
310	**L1**					143	147	178											
	L2					98	102	133											
	L3	52	64	78	78						42	42	64	64	52	68	80	80	80
	L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
311	**L1**						130	130	165	200									
	L2					98	102	133											
	L3	52	64	78	78						42	42	64	64	52	68	80	80	80
	L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2-R3	52	64	78	78						42	42	64	64	52	68	80	80	80
	R4	52	64	78	78						42	42	64	64	52	68	80	80	80
313	**L1**						130	130	165	200									
	L2					98	102	133											
	L3	52	64	78	78						42	42	64	64	52	68	80	80	80
	L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R2-R3	52	64	78	78						42	42	64	64	52	68	80	80	80
	R4	52	64	78	78						42	42	64	64	52	68	80	80	80
315	**L1**																		
	L2						130	130	165	200									
	L3					98	102	133											
	L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
317	**L1**																		
	L2						130	130	165	200									
	L3					98	102	133											
	L4	52	64	78	78						42	42	64	64	52	68	80	80	80
	R3-R4	52	64	78	78						42	42	64	64	52	68	80	80	80
319	**L1**																		
	L2																		
	L3						130	130	165	200									
	L4					98	102	133											
	R4	52	64	78	78						42	42	64	64	52	68	80	80	
321	**L1**																		
	L2																		
	L3						130	130	165	200									
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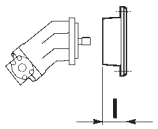

		DANFOSS									DENISON Hydraulics							
		OMP-OMR 50/315 ø25	OMP-OMR 50/315 SAE 1" 6B	OMS 80/315 ø32	OMS 80/315 12/24 z14	OMSS 80/315 12/24 z12	OMT 160/400 ø40	OMT 160/400 12/24 z17	OMTS160/400 12/24 z16	OMVS315/800 10/20 z16	M6-M7-M8 *3** 12/24 z14	M11-M14 *3** 8/16 z13	M3 B 16/32 z9	M4C-M4SC 16/32 z13	M4D-M4SD 12/24 z14	M4DC-M4SDC 12/24 z14	M4E-M4SE 12/24 z14	M5BS 16/32 z13	
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300	L1-L2-L3-L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2-R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
301	L1-L2-L3-L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2-R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
303	L1	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	L2-L3-L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2-R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
305	L1	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	L2-L3-L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2-R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
306	L1									70		113							
	L2	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	L3-L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2-R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
307	L1									70		113							
	L2	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	L3-L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
309	L1									70		113							
	L2	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	L3-L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
310	L1									115		158							
	L2									70		113							
	L3	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
311	L1																		
	L2									70		113							
	L3	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2-R3	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
313	L1																		
	L2									70		113							
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	L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R2-R3	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
315	L1																		
	L2																		
	L3									70		113							
	L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
317	L1																		
	L2																		
	L3									70		113							
	L4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
	R3-R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
319	L1																		
	L2																		
	L3																		
	L4									70		113							
	R4	42	42	64	64	37	112	112	57		64		42	52	64	64	64	52	
321	L1																		
	L2																		
	L3																		
	L4									70		113							
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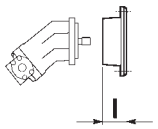
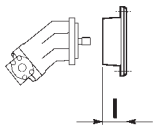


		DINAMIC OIL		LINE								
		AH-BH200 z6	CH-DH350 z8	MMF 43 16/32 z15	MMF 63 12/24 z14	HMF 35-02 16/32 z15	HMF 50-02 16/32 z21	HMF-HMV 75-02 16/32 z21	HMF-HMV 105-02 16/32 z23	HMF-HMV 135/02 16/32 z27	BMF-BMV 186 50x2 z24	
	CODICE / CODE	D2AA	D2AB	S5BM	S5CA	S5BM	S5CE	S5CE	S5CD	I5DC	I5AF	
											I	
300	L1-L2-L3-L4	64		52	64	52	64	64	64	81		
	R2-R3-R4	64		52	64	52	64	64	64	81		
301	L1-L2-L3-L4	64		52	64	52	64	64	64	81		
	R2-R3-R4	64		52	64	52	64	64	64	81		
303	L1	64		52	64	52	64	64	64	81		
	L2-L3-L4	64		52	64	52	64	64	64	81		
	R2-R3-R4	64		52	64	52	64	64	64	81		
305	L1	64		52	64	52	64	64	64	81		
	L2-L3-L4	64		52	64	52	64	64	64	81		
	R2-R3-R4	64		52	64	52	64	64	64	81		
306	L1		98							101	121	
	L2	64		52	64	52	64	64	64	81		
	L3-L4	64		52	64	52	64	64	64	81		
	R2-R3-R4	64		52	64	52	64	64	64	81		
307	L1		98							101	121	
	L2	64		52	64	52	64	64	64	81		
	L3-L4	64		52	64	52	64	64	64	81		
	R2	64		52	64	52	64	64	64	81		
	R3-R4	64		52	64	52	64	64	64	81		
309	L1		98							101	121	
	L2	64		52	64	52	64	64	64	81		
	L3-L4	64		52	64	52	64	64	64	81		
	R2	64		52	64	52	64	64	64	81		
	R3-R4	64		52	64	52	64	64	64	81		
310	L1		143							146	166	
	L2		98							101	121	
	L3	64		52	64	52	64	64	64	81		
	L4	64		52	64	52	64	64	64	81		
	R3-R4	64		52	64	52	64	64	64	81		
311	L1											
	L2		98							101	121	
	L3	64		52	64	52	64	64	64	81		
	L4	64		52	64	52	64	64	64	81		
	R2-R3	64		52	64	52	64	64	64	81		
	R4	64		52	64	52	64	64	64	81		
313	L1											
	L2		98							101	121	
	L3	64		52	64	52	64	64	64	81		
	L4	64		52	64	52	64	64	64	81		
	R2-R3	64		52	64	52	64	64	64	81		
	R4	64		52	64	52	64	64	64	81		
315	L1											
	L2											
	L3		98							101	121	
	L4	64		52	64	52	64	64	64	81		
	R3-R4	64		52	64	52	64	64	64	81		
317	L1											
	L2											
	L3		98							101	121	
	L4	64		52	64	52	64	64	64	81		
	R3-R4	64		52	64	52	64	64	64	81		
319	L1											
	L2											
	L3											
	L4		98							101	121	
	R4	64		52	64	52	64	64	64	81		
321	L1											
	L2											
	L3											
	L4		98							101	121	
	R4	64		52	64	52	64	64	64	81		



		HYDROMATIK																
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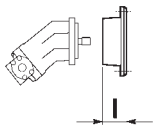
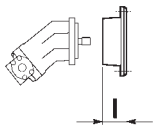
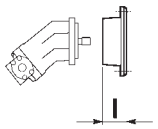
	CODICE / CODE	H0AA	H0AE	H0AH	H0AI	H0BA	H0BC	H0BG	H0BI	H0CA	H0CC	H0CE	H0CG	H0CI	H0DA	H0DE	S5BM	
										I								
300	L1-L2-L3-L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2-R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
301	L1-L2-L3-L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2-R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
303	L1	42	52	52	64	64	64	75	75	101	101		101				52	
	L2-L3-L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2-R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
305	L1	42	52	52	64	64	64	75	75	101	101		101				52	
	L2-L3-L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2-R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
306	L1											101	101	101	113	113		
	L2	42	52	52	64	64	64	75	75	101	101		101				52	
	L3-L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2-R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
307	L1											101	101	101	113	113		
	L2	42	52	52	64	64	64	75	75	101	101		101				52	
	L3-L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2	42	52	52	64	64	64	75	75	101	101		101				52	
	R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
309	L1											101	101	101	113	113		
	L2	42	52	52	64	64	64	75	75	101	101		101				52	
	L3-L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2	42	52	52	64	64	64	75	75	101	101		101				52	
	R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
310	L1											146	146	146	158	158		
	L2											101	101	101	113	113		
	L3	42	52	52	64	64	64	75	75	101	101		101				52	
	L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
311	L1																	
	L2											101	101	101	113	113		
	L3	42	52	52	64	64	64	75	75	101	101		101				52	
	L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2-R3	42	52	52	64	64	64	75	75	101	101		101				52	
	R4	42	52	52	64	64	64	75	75	101	101		101				52	
313	L1																	
	L2											101	101	101	113	113		
	L3	42	52	52	64	64	64	75	75	101	101		101				52	
	L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R2-R3	42	52	52	64	64	64	75	75	101	101		101				52	
	R4	42	52	52	64	64	64	75	75	101	101		101				52	
315	L1																	
	L2																	
	L3											101	101	101	113	113		
	L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
317	L1																	
	L2																	
	L3											101	101	101	113	113		
	L4	42	52	52	64	64	64	75	75	101	101		101				52	
	R3-R4	42	52	52	64	64	64	75	75	101	101		101				52	
319	L1																	
	L2																	
	L3																	
	L4											101	101	101	113	113		
	R4	42	52	52	64	64	64	75	75	101	101		101				52	
321	L1																	
	L2																	
	L3																	
	L4											101	101	101	113	113		
	R4	42	52	52	64	64	64	75	75	101	101		101				52	



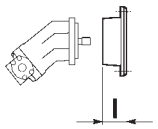
		OILDRIVE				OLIOSTIP		SAI								
		HGL-HGT 50/400 ø25	HGL-HGT 50/400 SAE 1" 6B	HGL-HGT 50/400 ø25,4	HGL-HGT 50/400 25x22 z14	RMF200-300 z8	RMF400-600 z8	M05 UNI221	M1 UNI221	M1/P1/S1 35x2 z16	M2 UNI220	M2-M3 UNI220	M4 UNI221	M5 UNI221	L7 N80x3 z25	
	CODICE / CODE	S5AP	S5AQ	S5AS	S5AT	M5FB	M5FC	S2BA	S2AB	S2CE	S2AF-A	S2AF-B	S2AS	S2BF	S2BH	
										I						
300	L1-L2-L3-L4	42	42	42	42	78		73	37	57	78					
	R2-R3-R4	42	42	42	42	78		73	37	57	78					
301	L1-L2-L3-L4	42	42	42	42	78		73	37	57	78					
	R2-R3-R4	42	42	42	42	78		73	37	57	78					
303	L1	42	42	42	42	78		73	37	57	78					
	L2-L3-L4	42	42	42	42	78		73	37	57	78					
	R2-R3-R4	42	42	42	42	78		73	37	57	78					
305	L1	42	42	42	42	78		73	37	57	78					
	L2-L3-L4	42	42	42	42	78		73	37	57	78					
	R2-R3-R4	42	42	42	42	78		73	37	57	78					
306	L1	42	42	42	42	78		73	74			98	98	105		
	L2	42	42	42	42	78		73	37	57	78					
	L3-L4	42	42	42	42	78		73	37	57	78					
	R2-R3-R4	42	42	42	42	78		73	37	57	78					
307	L1						103		74			98	98	105		
	L2	42	42	42	42	78		73	37	57	78					
	L3-L4	42	42	42	42	78		73	37	57	78					
	R2	42	42	42	42	78		73	37	57	78					
	R3-R4	42	42	42	42	78		73	37	57	78					
309	L1						103		74			98	98	105		
	L2	42	42	42	42	78		73	37	57	78					
	L3-L4	42	42	42	42	78		73	37	57	78					
	R2	42	42	42	42	78		73	37	57	78					
	R3-R4	42	42	42	42	78		73	37	57	78					
310	L1						148		119			143	143	150		
	L2						103		74			98	98	105		
	L3	42	42	42	42	78		73	37	57	78					
	L4	42	42	42	42	78		73	37	57	78					
	R3-R4	42	42	42	42	78		73	37	57	78					
311	L1											135		142	90	
	L2						103		74			98	98	105		
	L3	42	42	42	42	78		73	37	57	78					
	L4	42	42	42	42	78		73	37	57	78					
	R2-R3	42	42	42	42	78		73	37	57	78					
	R4	42	42	42	42	78		73	37	57	78					
313	L1											135		142	90	
	L2						103		74			98	98	105		
	L3	42	42	42	42	78		73	37	57	78					
	L4	42	42	42	42	78		73	37	57	78					
	R2-R3	42	42	42	42	78		73	37	57	78					
	R4	42	42	42	42	78		73	37	57	78					
315	L1															
	L2											135		142	90	
	L3						103		74			98	98	105		
	L4	42	42	42	42	78		73	37	57	78					
	R3-R4	42	42	42	42	78		73	37	57	78					
317	L1															
	L2											135		142	90	
	L3						103		74			98	98	105		
	L4	42	42	42	42	78		73	37	57	78					
	R3-R4	42	42	42	42	78		73	37	57	78					
319	L1															
	L2															
	L3											135		142	90	
	L4						103		74			98	98	105		
	R4	42	42	42	42	78		73	37	57	78					
321	L1															
	L2															
	L3											135		142	90	
	L4						103		74			98	98	105		
	R4	42	42	42	42	78		73	37	57	78					



		KAWASAKI STAFFA			SAUER SUNSTRAND														
		B030 z17	B045 z17	HM (HD)B150 HM (HD)B200 5/10 z16	OMF-SMF-OMV-SMV 1-038 16/32 z13	SMF 2/033-052-070 16/32 z21	SMF 2/089 16/32 z23	SMF 2/119 16/32 z27	SMF 2/166-227 16/32 z27	SMF 4/023 16/32 z13	SMF 4/046 16/32 z15	90 M055 16/32 z21	90 M075-M100 16/32 z23	90 M130 16/32 z27	51 V 060 12/24 Z14	51 V 080 12/24 z14	51 V 110 8/16 z13	51 V 160 8/16 z13	51 V 250 8/16 z15
	CODICE / CODE	S1AB	S1AC	S1AL	S5BA	S5CE	S5CD	S5DC	S5EC	S4BA	S5BM	S5CE	S5CD	S5DC	S5CA	S5CA	S5DA	S5DA	S5ED
											I								
300	**L1-L2-L3-L4**				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2-R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
301	**L1-L2-L3-L4**				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2-R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
303	**L1**				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L2-L3-L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2-R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
305	**L1**				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L2-L3-L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2-R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
306	**L1**	135	140					101	113					101			101	101	113
	L2				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L3-L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2-R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
307	**L1**	135	140					101	113					101			101	101	113
	L2				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L3-L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
309	**L1**	135	140					101	113					101			101	101	113
	L2				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L3-L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
310	**L1**	180	185					146	158					146			146	146	158
	L2	135	140					101	113					101			101	101	
	L3				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
311	**L1**			187															
	L2	135	140					101	113					101			101	101	113
	L3				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2-R3				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
313	**L1**			187															
	L2	135	140					101	113					101			101	101	113
	L3				52	64	64	81		52	52	64	64	81	64	64	81	81	
	L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R2-R3				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
315	**L1**																		
	L2			187															
	L3	135	140					101	113					101			101	101	113
	L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
317	**L1**																		
	L2			187															
	L3	135	140					101	113					101			101	101	113
	L4				52	64	64	81		52	52	64	64	81	64	64	81	81	
	R3-R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
319	**L1**																		
	L2																		
	L3			187															
	L4	135	140					101	113					101			101	101	113
	R4				52	64	64	81		52	52	64	64	81	64	64	81	81	
321	**L1**																		
	L2																		
	L3			187															
	L4	135	140					101						101			101	101	113
	R4				52	64	64	81		52	52	64	64	81	64	64	81	81	



		TRW-TORQMOTOR					VICKERS						WHITE			
		MAG 04-32 SAE 1" 6B	MAF 06-40 SAE 12 6B	MAB 06-32 SAE 1" 6B	MAB 06-32 SAE A ø25	MAE 10-68 SAE 1" 6B	MFE 19 16/32 z15	25M**A11 16/32 z13	35-45 M**A11 12/24 Z14	50 M**A11 8/16 z13	HS 02-15 SAE A ø25	HS 02-15 SAE A 1"6B	RS 08-24 SAE A ø25	RS 08-24 SAE A 1"6B	REO 06-45 SAE A 1"6B	
	CODICE / CODE	S5AQ	S5AQ	S5AQ	S5AP	S5AQ	S5BM	S5BA	S5CA	S5DA	S5AP	S5AQ	S5AP	S5AQ	S5AP	
										I						
300	**L1-L2-L3-L4**	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2-R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
301	**L1-L2-L3-L4**	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2-R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
303	**L1**	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L2-L3-L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2-R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
305	**L1**	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L2-L3-L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2-R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
306	**L1**									101						
	L2	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L3-L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2-R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
307	**L1**									101						
	L2	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L3-L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
309	**L1**									101						
	L2	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L3-L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
310	**L1**									146						
	L2									101	42	42	42	42	42	
	L3	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
311	**L1**															
	L2									101						
	L3	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2-R3	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
313	**L1**															
	L2									101						
	L3	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R2-R3	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
315	**L1**															
	L2															
	L3									101						
	L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
317	**L1**															
	L2															
	L3									101						
	L4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
	R3-R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
319	**L1**															
	L2															
	L3															
	L4									101						
	R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	
321	**L1**															
	L2															
	L3															
	L4									101						
	R4	42	42	42	42	42	52	52	64	81	42	42	42	42	42	



		VOAC																
		F11-5 CK ø18	F11-10 CK ø20	F11-19 CK ø25	F11-19 CD 25x1,25 z18	F12-30 MF1*D 30x2 z14	F12-40 MF1*D 32x2 z14	F12-60 MF1*D 35x2 z16	F12-80 MF1*D 40x2 z18	F12-110 MF1*D 45x z21	F11-150/250 S*S 8/16 z13	V12 060 I*D 35x2 Z16	V12 060 S*S 12/24 Z14	V12 080 N*D 40x2 z18	V12 080 S*S 12/24 z14	V12 110 I*D 45x2 z21	V12 110 S*S 8/16 z13	V12 160 S*S 8/16 z13
	CODICE / CODE	V0AA	V0AC	V0AE	V0AG	H0AE	H0AI	H0BC	H0BG	H0CA	S5DA	H0BC	S5CA	H0BG	S5CA	H0CA	S5DA	S5DA
											I							
300	L1-L2-L3-L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2-R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
301	L1-L2-L3-L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2-R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
303	L1	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L2-L3-L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2-R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
305	L1	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L2-L3-L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2-R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
306	L1										101						101	101
	L2	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L3-L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2-R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
307	L1										101						101	101
	L2	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L3-L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
309	L1										101						101	101
	L2	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L3-L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
310	L1										146						146	146
	L2										101						101	101
	L3	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
311	L1																	
	L2										101						101	101
	L3	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2-R3	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
313	L1																	
	L2										101						101	101
	L3	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R2-R3	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
315	L1																	
	L2																	
	L3										101						101	101
	L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
317	L1																	
	L2																	
	L3										101						101	101
	L4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
	R3-R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
319	L1																	
	L2																	
	L3																	
	L4										101						101	101
	R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81
321	L1																	
	L2																	
	L3																	
	L4										101						101	101
	R4	64	52	53	53	52	64	64	75	101	81	64	64	75	64	101	81	81

26.0 MOTORI IDRAULICI

Presentazione

I riduttori serie 300 sono fornibili completi di motori idraulici MG prodotti dalla TRASMITAL BONFIGLIOLI

Le forme e dimensioni di tali motori sono definiti per ottenere la massima integrazione con il riduttore ottenendo cosi motoriduttori con ottime caratteristiche di compattezza ed economicità.

26.0 HYDRAULIC MOTORS

General features

Gearboxes belonging to the series 300 can be supplied complete with MG hydraulic motors man-ufactured by TRASMITAL BONFIGLIOLI.

These motors were designed to provide compact and energy efficient gearmotors.

26.0 HYDRAULIKMOTOREN

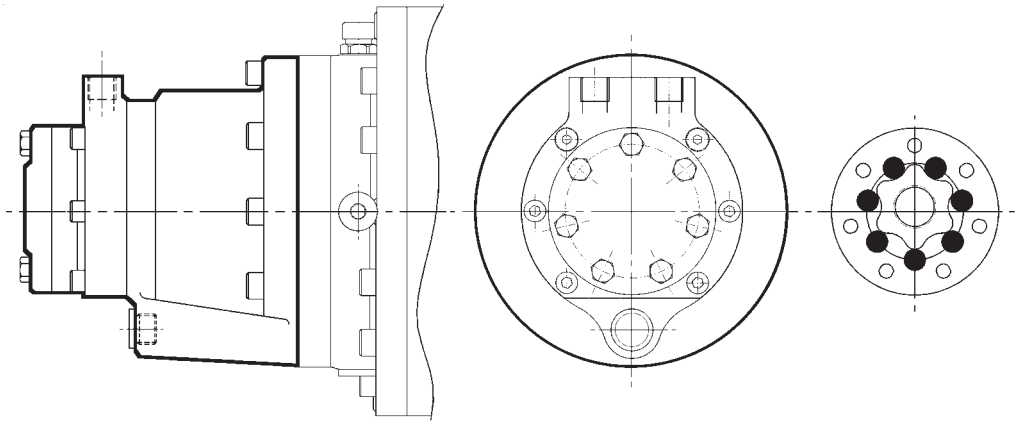
Vorstellung

Die Getriebe der Serie 300 können komplett mit den von der TRASMITAL BONFIGLIOLI hergestellten MG-Hydraulikmotoren geliefert werden. Diese integrierten Hydraulikmotore sind eine optimale Lösung in Bezug auf Kompaktheit und Wirtschaftlichkeit.

26.0 MOTEURS HYDRAULIQUES

Présentation

Les réducteurs série 300 peuvent être livrés équipés de moteurs hydrauliques MG fabriqués par TRASMITAL BONFIGLIOLI.
Les formes et les dimensions de ces moteurs sont établies dans le but d'obtenir une intégration optimale avec le réducteur, pour aboutir à des motoréducteurs avec des caractéristiques de compacité et rentabilité excellentes.



Motori idraulici MG

Caratteristiche costruttive:

- Sistema orbitale, con rulli fra rotore e statore GEROLER®
- Distributore sull'albero d'uscita.
- Cilindrate da 50 a 250 cm^3
- Pressione max 175 bar
- Portata max 48 lt/min
- Rendimenti elevati
- Possibilità di avere il freno idraulico nella stessa dimensione d'ingombro
- Comando freno interno direttamente dal motore, senza la necessità di valvole e circuiti esterni

MG hydraulic motors

Design characteristics:

- Orbit system with GEROLER® rollers between rotor and stator
- Distributor on output shaft
- Displacements from 50 to 250 cm^3
- Max. pressure 175 bar
- Max. flow rate 48 lt/min
- High efficiency
- Hydraulic brake can be included in the motor overall dimensions
- Inner brake directly controlled by the motor with no valves or outer circuits required

Hydraulikmotoren MG

Baumerkmale:

- Orbitalsystem, mit Rollen zwischen Rotor und Stator GEROLER®
- Wegeventil auf Abtriebswelle
- Hubraum von 50 bis 250 cm^3
- Max. Druck 175 bar
- Max. Förderleistung 48 lt/min
- Höhere Wirkungsgrade
- Möglichkeit, eine hydraulische Bremse bei gleichen Abmessungen zu integrieren
- Bremssteuerung erfolgt intern direkt über den Motor, ohne einen Einsatz von Ventilen und äußeren Kreisläufen

Moteurs hydrauliques MG

Caractéristiques de construction:

- Système orbital, avec rouleaux entre rotor et stator GEROLER®
- Distributeur sur l'arbre lent
- Cylindrées 50 à 250 cm^3
- Pression max. 175 bar
- Débit max. 48 l/min.
- Rendements élevés.
- Possibilité d'obtenir le frein hydraulique avec les mêmes dimensions d'encombrement.
- Frein intérieur commandé directement par le moteur, sans l'exigence de clapets ni de circuits extérieurs

27.0 SIMBOLOGIA E UNITA' DI MISURA

27.0 SYMBOLS AND UNITS OF MEASURE

27.0 VERWENDETE SYMBOLE

27.0 SYMBOLES ET UNITES

Simb. Symb.	U.m. Meßeinh.	Descrizione	Description	Beschreibung	Description
V	[cm^3]	Cilindrata	Rot.displacement	Umdr. Hubraum	Tour cylindrée
p	[bar]	Pressione	Pressure	Druck	Pression
pA,pB	[bar]	Pressione sugli attacchi A e B	Pressure in A and B connections	Druck an den Anschlüssen A und B	Pression sur les raccords A et B
Q	[l/min]	Portata	Flow rate	Durchflußleistung	Débit
η_t		Rendimento totale	Efficiency	Wirkungsgrad	Rendement
η**mh**		Rendimento meccanico - idraulico	Hydraulic-mechanical efficiency	Mechanischer-hydraulischer Wirkungsgrad	Rendement mécanique-hydraulique
η**v**		Rendimento volumetrico	Volumetric efficiency	Volumetrischer Wirkungsgrad	Rendement volumétrique
n	[min^{-1}]	Velocità angolare	Angular speed	Drehzahl	Vitesse angulaire
M	[Nm]	Coppia effettiva all'albero motore	Actual torque onto the motor shaft	Effektives Drehmoment an der Welle	Couple réel sur l'arbre
cont		Valore generico, continuo nel tempo	General value, for continuous duty	Allgemeiner Wert, in der Zeit kontinuierlich	Valeur générale, continue dans le temps
int		Valore generico, intermittente nel tempo	General value, intermittent duty	Allgemeiner Wert, in der Zeit intermittierend	Valeur générale, intermittente dans le temps

28.0 CARATTERISTICHE TECNICHE

28.1 Cilindrata V [cm^3]

E' il volume geometrico generato ad ogni giro, corrispondente al volume teorico di olio idraulico necessario per fare ruotare l'albero motore di un giro.

28.2 Pressione p [bar]

E' la pressione idraulica a cui viene sottoposto il motore nel suo funzionamento.

28.3 Portata Q [l / min]

E' il flusso di olio idraulico che attraversa il motore nel suo funzionamento.

28.4 Rendimento totale η_t

E' il rendimento totale del motore idraulico dato dal prodotto:

28.5 Rendimento meccanico-idraulico ηmh

Rappresenta il rapporto fra coppia effettiva e coppia teorica all'albero motore.
Dipende dalle perdite interne dovute ad attriti meccanici e perdite di pressione del fluido idraulico, è dato dalla formula:

28.0 TECHNICAL FEATURES

28.1 Displacement V [cm^3]

Geometrical volume produced as a result of each motor rotation corresponding to the theoretical volume of hydraulic oil necessary for a rotation of the driving shaft.

28.2 Pressure p [bar]

Hydraulic pressure applied to the motor when running.

28.3 Flow rate Q [l / min]

Hydraulic oil flow through the motor when running.

28.4 Efficiency η_t

Total efficiency of the hydraulic motor given by:

28.5 Mechanical-hydraulic efficiency ηmh

This is the ratio of actual torque to theoretical torque at the driving shaft.
Value depending on inner losses due to mechanical friction as well as hydraulic fluid pressure losses, calculated as follows:

28.0 TECHNISCHE EIGENSCHAFTEN

28.1 Hubraum V [cm^3]

Ist das geometrische Volumen, welches bei jeder Umdrehung gerzeugt wird und dem theoretischen Volumen des Hydrauliköls, welches für eine Umdrehung der Antriebswelle erforderlich ist, entspricht.

28.2 Druck p [bar]

Ist der hydraulische Druck, dem der Motor während seines Betriebs unterliegt.

28.3 Förderleistung Q [l / min]

Ist der Fluß des Hydrauliköls, der den Motor während dessen Betriebs durchquert.

28.4 Wirkungsgrad η_t

Ist der Gesamtwirkungsgrad des hydraulischen Motors, der sich aus der folgenden Formel ergibt:

28.5 Mechanischer-hydraulischer Wirkungsgrad ηmh

Ist das Verhältnis zwischen effektivem und theoretischem Drehmoment an der Antriebswelle.
Hängt von den, durch mechanische Reibung erzeugten Verlusten und Druckverlusten der Hydraulikflüssigkeit ab und ergibt sich aus der folgenden Formel:

28.0 CARACTERISTIQUES TECHNIQUES

28.1 Cylindrée V [cm^3]

Il s'agit du volume géométrique créé à chaque tour, correspondant au volume théorique en huile hydraulique nécessaire pour faire avancer l'arbre moteur d'un tour.

28.2 Pression p [bar]

Il s'agit de la pression hydraulique à laquelle le moteur en service est soumis.

28.3 Débit Q [l / min]

Il s'agit de l'écoulement d'huile hydraulique traversant le moteur en service.

28.4 Rendement η_t

Il s'agit du rendement total du moteur hydraulique découlant du produit de:

$$\eta_t = \eta mh \cdot \eta v \qquad (29)$$

28.5 Rendement mécanique-hydraulique ηmh

Représente le rapport entre couple efficace et couple Théorique à l'arbre moteur.
Dépend des pertes intérieures dues à des frottements mécaniques et chutes de pression du fluide hydraulique, il découle de la formule:

$$\eta mh = \frac{2\pi \cdot 10 \cdot M}{(pA - pB) \cdot V} \qquad (30)$$

28.6 **Rendimento volumetrico** ηv

Rappresenta il rapporto fra velocità effettiva e velocità teorica del motore.
Dipende dal trafilamento interno del motore fra i volumi in alta e bassa pressione, è dato dalla formula:

28.6 **Hydraulic efficiency** ηv

This is the ratio of motor actual speed to motor theoretical speed.

Value depending on the motor inner blow-by between high and low pressure volumes. This value is given by the following formula:

28.6 **Volumetrischer Wirkungsgrad** ηv

Ist das Verhältnis zwischen effektiver und theoretischer Drehzahl des Motors.
Hängt von den inneren Verlusten des Motors zwischen den Volumen im Hoch- und Niederdruck ab. Er ergibt sich aus der folgenden Formel:

28.6 **Rendement volumétrique** ηv

Répresente le rapport entre vitesse réelle et vitesse théorique du moteur.
Dépend du débordement à l'intérieur du moteur entre les volumes de haute et basse pression; il découle la formule:

$$\eta v = \frac{n \bullet V}{Q \bullet 1000} \qquad (31)$$

28.7 **Velocità angolare n** [min^{-1}]

E' la velocità di rotazione del motore idraulico, è dato dalla formula:

28.7 **Angular speed n** [min^{-1}]

Hydraulic motor rotation speed. Value resulting from the following formula:

28.7 **Drehzahl n** [min^{-1}]

Ist die Drehgeschwindigkeit des Hydraulikmotors und wird von der folgenden Formel gegeben:

28.7 **Vitesse angulaire n** [min^{-1}]

Est la vitesse de rotation du moteur hydraulique, elle est le résultat de la formule :

$$n = \frac{Q \bullet 1000}{V} \bullet \eta v \qquad (32)$$

28.8 **Coppia M** [Nm]

E' la coppia effettiva che riesce a trasmettere il motore idraulico, è data dalla formula:

28.8 **Torque M** [Nm]

Actual torque transmitted by the hydraulic motor. Value given by the following formula:

28.8 **Drehmoment M** [Nm]

Tatsächliches Drehmoment des Hydraulikmotors ergibt sich aus folgender Formel:

28.8 **Couple M** [Nm]

Est le couple effectif que le moteur hydraulique est en mesure de transmettre; il découle de la formule :

$$M = \frac{(p\,A - p\,B) \bullet V}{2\pi \bullet 10} \bullet \eta mh \qquad (33)$$

29.0 **DESIGNAZIONE** 29.0 **DESIGNATION** 29.0 **BEZEICHNUNG** 29.0 **DESIGNATION**

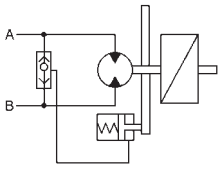
MG - 160 ZA I 2 C - P01 S N

GUARNIZIONI / SEALS
DICHTUNGEN / JOINTS D'ETANCHEITE

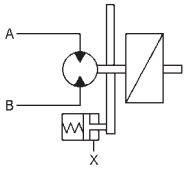
N = **standard, mescola nitrilbutadiene**
standard, nbr rubber
Standard, Nitrilbutadien
standard, nitrilbutadiene

COMANDO FRENO / BRAKE PILOT
BREMSSTEUERUNG / COMMANDE FREIN

P = **interno, diretto dal motore**
(solo con attacchi B02)
internal, direct through the motor
(with B02 ports only)
intern, direkt vom motor
(nur mit anschlüssen B02)
interieur, directement du moteur
(seulement avec orifices B02)



S = **non predisposto, occorre circuito esterno**
(solo con attacchi P01)
not connected, external piping necessary
(with P01 ports only)
nicht vorgesehen, ausserer kreislauf erforderlich
(nur mit anschlüssen P01)
non pas predispose, il faut circuit exteieur
(seulement avec orifices P01)



ATTACCHI / PORTS / ANSCHLÜSSE / RACCORDS

P01 = **porte di alimentazione direttamente sul corpo motore**
(solo esecuzione S)
oil ports on motor housing direct
(S execution only)
Arbeitsanschlüsse direkt auf demgehause
(nur ausführung S)
orifices d'alimentation sur le carter
(seulement execution S)

B02 = **porte di alimentazione con valvola selettrice comando freno**
(solo esecuzione P)
oil ports with valve brake pilot
(P execution only)
Arbeitsanschlüsse mit bremssteuerventil
(nur ausführung P)
orifices d'alimentation avec valve commande frein
(seulement execution P)

PROGRESSIVO DI MODIFICA / PROGRESSIVE MODIFICATION
LAUFANDE ÄNDERUNGEN / PROGRESSIF DES MODIFICATIONS

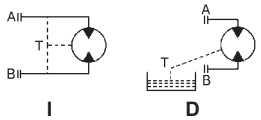
SERIE COSTRUTTIVA / CONSTRUCTION SERIES / BAUSERIE / SERIE CONSTRUCTIF

2

DRENAGGIO / DRAIN / LECKÖLANSCHLUSS / DRAINAGE

I = Interno / internal / intern / interieur

D = Esterno / external / extern / exterieur



ESECUZIONE ALBERO / SHAFT EXECUTION / WELLENVERSION / ARBRE VERSION

CILINDRATA / DISPLACEMENT / HUBRAUM / CYLINDREE

050	(49.2 cm^3)
080	(81.9 cm^3)
100	(101.6 cm^3)
125	(126.2 cm^3)
160	(162.2 cm^3)
200	(201.6 cm^3)
250	(252.4 cm^3)

TIPO / TYPE / TYP / TYPE

30.0 SCELTA

La cilindrata V del motore idraulico deve essere scelta insieme al riduttore.

Nota la coppia di uscita da trasmettere dal riduttore M_{r2} e la sua velocità n_2 si procede come segue:

- Fissare il valore della pressione di comando del motore pA-pB ≤ 175 bar.
- Calcolare il valore della cilindrata equivalente Veq del motoriduttore con la formula:

30.0 DISPLACEMENT SELECTION

Displacement V of the hydraulic motor should be selected together with the gearbox.

Once the output torque and speed n_2 for the gearbox Mr_2 is known, proceed as follows:

- Define the control pressure value pA-pB ≤ 175 bar for the motor.
- Calculate the gearbox displacement value called Veq with the following formula:

30.0 AUSWAHL

Die Auswahl des Hubraums V des Hydraulikmotors muß gemeinsam mit der Getriebewahl getroffen werden.

Ist das vom Getriebe M_{r2} zu übertragende Abtriebsdrehmoment und die entsprechende Drehzahl n_2 bekannt, geht man folgendermaßen vor:

- Den Wert des Steuerdrucks des Motors pA-pB ≤ 175 bar festlegen.
- Den Wert des gleichwertigen Hubraums Veq des Getriebemotors unter Anwendung der folgenden Formel berechnen:

30.0 CHOIX

Le choix de la cylindrée V du moteur hydraulique doit s'accompagner au choix du réducteur.

Une fois qu'on a établi le couple de sortie à transmettre par le réducteur M_{r2} et sa vitesse n_2, il faut procéder comme suit:

- Fixer la valeur de pression de commande du moteur pA-pB ≤ 175 bar.
- Calculer la valeur de la cylindrée équivalente Veq du motoréducteur par la formule:

$$Veq = \frac{2\pi \bullet 10 \bullet M_{r2}}{(pA - pB) \bullet \eta mh \bullet \eta d} \ [cm^3] \qquad (34)$$

dove per ηmh fissare inizialmente 0,85;

η_d: rendimento dinamico riduttore fissare 0.94.

- Calcolare il valore della portata Q necessaria per alimentare il motore idraulico con la formula:

where ηmh, for example, is equal to 0.85;

η_d: gearbox dynamic efficiency, consider 0.94.

- Calculate the value for flow rate Q, necessary for feeding the hydraulic motor, with the following formula:

wo für ηmh, z.B. 0,85 festgelegt werden muß;

η_d: dynamischen Wirkungsgrad des Getriebes auf 0.94 festlegen.

- Den Wert der für die Versorgung des Hydraulikmotors erforderlichen Förderleistung Q, unter Anwendung der folgenden Formel, kalkulieren:

pour ηmh, on peut fixer par ex. 0,85;

η_d: rendement dynamique réducteur fixer 0.94.

- Calculer la valeur du débit Q, nécessaire pour alimenter le moteur hydraulique, avec la formule :

$$Q = \frac{n_2 \bullet Veq}{1000 \bullet \eta v} \ [l/min] \qquad (35)$$

dove per ηv fissare inizialmente 0,90.

- In base alle prestazioni richieste M_{r2} ed n_2 scegliere la grandezza del riduttore (vedi a pag. 29).
- Entrare nel diagramma (A15) del motoriduttore con il valore di cilindrata equivalente v_{eq} e scegliere contemporaneamente:
  - il motore che soddisfi le condizioni di p int e Q richieste.
  - Il valore indicativo di i, tenendo presente che questo venga ottenuto con il minimo numero di stadi di riduzione, così da ottenere un motoriduttore con il costo più basso e con dimensioni compatte.

  Con il valore di M_2 ed il valore indicativo di i, procedere alla selezione ed alla verifica del riduttore secondo quanto indicato nel cap. 14.

where ηv, for example is equal to 0.90.

- Select the gearbox size with M_{r2}. See gearbox selection on page 29.
- Look up the diagram (A15) for the gearmotor with equivalent displacement value v_{eq} and select:
  - a motor that fulfils the p int. and Q requirements and at the same time
  - the indicative value of reduction ratio i. Please consider that ratio should be obtained with as few reduction stages as possible, to save on gearmotor costs and contain dimensions.

  Once you have determined the value of M_2 and the indicative value of i, select the gearbox and check your selection as indicated in chapt. 14.

wo für ηv, z.B. 0,90 festgelegt werden muß.

- Die Baugröße des Getriebes mit M_{r2} wählen. Siehe dazu "Wahl des Getriebes" auf Seite 29.
- Das Diagramm (A15) des Getriebemotors mit äquivalentem Hubraumwert v_{eq} zur Hand nehmen und gleichzeitig folgendes wählen:
  - denjenigen Motor, der die Bedingungen des geforderten p int. und Q int. erfüllt.
  - den Anhaltswert des Untersetzungsverhältnis i, wobei berücksichtigt werden muß, daß dieser mit einer Mindestzahl an Untersetzungsstufen verwirklicht wird, um so den kostengünstigsten Getriebemotor in einem kompakten Maß zu erhalten.

  Mit dem Wert M_2 und dem Anhaltswert i, kann man nun die entsprechende Wahl treffen und das Getriebe gemäß der Angaben im Kap.14 überprüfen.

ou pour ηv il faut fixer par exemple 0,90.

- Choisir la taille du réducteur avec M_{r2}. Se reporter à la sélection du réducteur à la page 29.
- Entrer dans le diagramme (A15) du motoréducteur avec la valeur de cylindrée équivalente Veq et choisir parallèlement:
  - le moteur satisfaisant aux conditions de p. int. et Q int nécessaires;
  - la valeur indicative du rapport de réduction I, compte tenu que cela est réalisé avec un nombre d'étages de réduction minimum, de manière à obtenir un réducteur ayant un coût aussi bas que possible et une dimension compacte.

  Avec la valeur de M_2 et la valeur indicative de i, procéder à la sélection et à la vérification du réducteur suivant les indications du chapitre14.

31.0 VERIFICHE

Verificare poi che i valori di pressione, portata, rendimenti trovino corrispondenza con quelli riportati sulla Tab. (A16) dei dati tecnici motori.

31.0 CHECKING

Check that pressure, efficiency and flow rate values correspond with values indicated in Table (A16) on motor technical features.

31.0 ÜBERPRÜFUNGEN

Daraufhin ist zu überprüfen, ob die Werte des Drucks, der Förderleistung, der Wirkungsgrade, mit den auf der Tabelle der technischen Motordaten (A16) eingetra genen Werten übereinstimmen.

31.0 VERIFICATIONS

Vérifier ensuite que les valeurs de pression, débit, rendements correspondent aux indications du Tableau (A16) des données techniques moteurs.

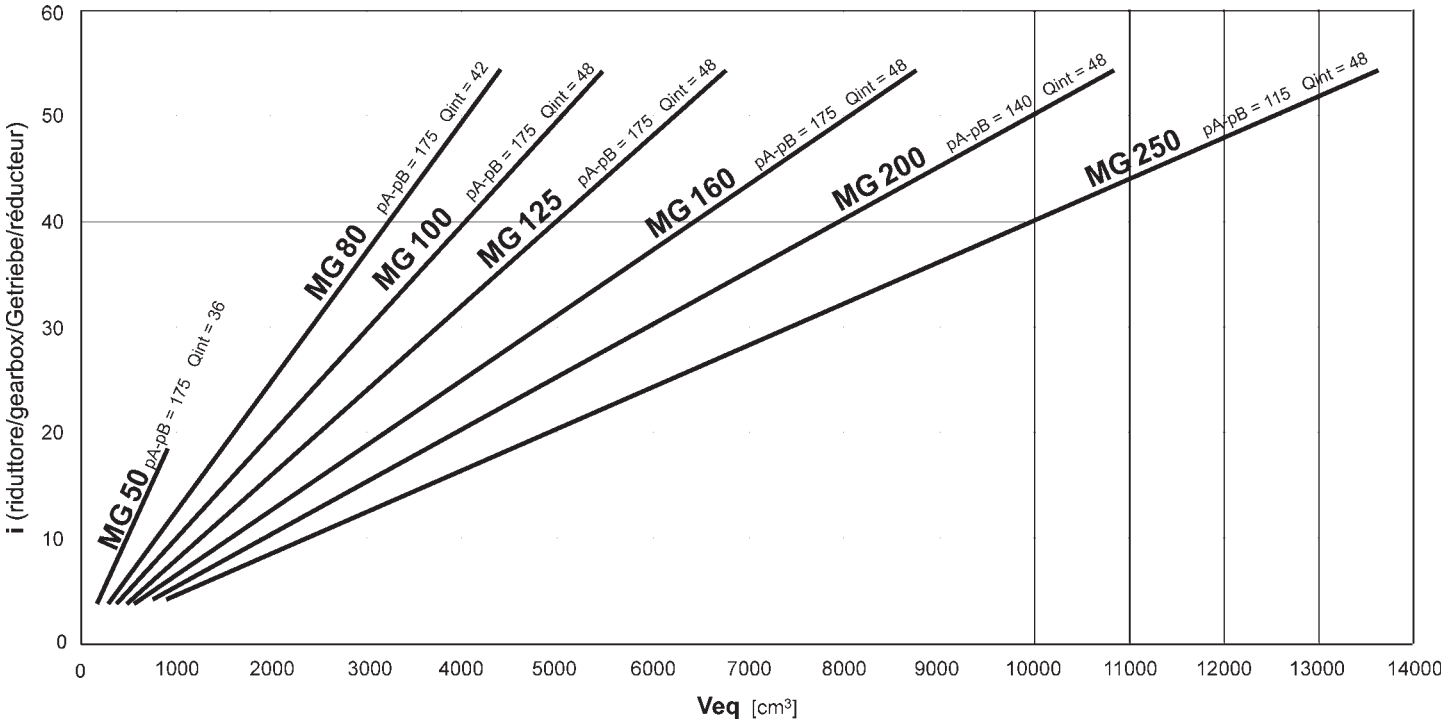
32.0 DATI TECNICI MOTORI MG

32.0 TECHNICAL DATA MG MOTORS

32.0 MG MOTORAUSWAHL-TABELLEN

32.0 CARACTERISTIQUES TECHNIQUES MOTEURS MG

(A15)



(A16)

					MG 50	MG 80	MG 100	MG 125	MG 160	MG 200	MG 250
Cilindrata	Displacement	Hubraum	Cilindrée	[cm^3]	49.2	81.9	101.6	126.2	162.2	201.6	252.4
pmax alimentazione	Suction pmax	pmax Speisung	pmax alimentation	[bar]	175	175	175	175	175	140	140
pA-pB continuo	pA-pB continuous	pA-pB kontinuierlich	pA-pB continu	[bar]	140	140	140	140	130	110	90
pA-pB int. 1)	pA-pB int. 1)	pA-pB Schaltbetrieb 1)	pA-pB int. 1)	[bar]	175	175	175	175	175	140	115
pA-pB picco 2)	pA-pB peak 2)	pA-pB Spitze 2)	pA-pB de crête 2)	[bar]	200	200	200	200	200	170	140
Portata continuo	Flow rate, continuous	Kont. Durchflußleistung	Débit continu	[l/min]	30	35	40	40	40	40	40
Portata int. 1)	Flow rate int. 1)	Durchflußleistung- Schalt. 1)	Débit int. 1)	[l/min]	36	42	48	48	48	48	48
Coppia cont.	Cont. torque	Kontinuierliches Drehmoment	Couple cont.	[Nm]	98	157	190	236	279	289	296
Coppia int. 1)	Int. torque 1)	Drehmoment - Schalt. 1)	Couple int. 1)	[Nm]	122	196	238	295	375	368	379
Coppia picco 2)	Peak torque 2)	Spitzendrehmoment 2)	Couple crête 2)	[Nm]	139	224	272	237	429	447	461
Velocità cont.	Cont. speed	Kont. Drehzahl	Vitesse cont.	[min^{-1}]	567	402	374	301	237	190	152
Velocità int. 1)	Int. speed 1)	Drehzahl - Schaltbetrieb 1)	Vitesse int. 1)	[min^{-1}]	680	477	439	361	284	229	183
Velocità min.	Min. speed	Min. Drehzahl	Vitesse min.	[min^{-1}]	12	12	12	11	10	8	8
Potenza cont.	Cont. power	Kont. Leistung	Puissance cont.	[kW]	5.7	6.6	7.4	7.4	6.9	5.7	4.7
Potenza int. 1)	Int. power 1)	Leistung-Schaltbetrieb 1)	Puissance int. 1)	[kW]	6.5	7.0	8.0	8.0	7.0	6.5	5.0

1) Valore intermittente: i valori in tabella si intendono per un massimo del 10% ogni minuto.

2) Valore di picco: i valori in tabella si intendono per un massimo del 1% ogni minuto.

1) Intermittent duty value: the values in the table are referred to 10% every minute maximum.

2) Peak value: the values in the table are referred to 1% every minute maximum.

1) Wert im Schaltbetrieb: die in der Tabelle aufgeführten Werte beziehen sich auf einen Maximalwert von 10% pro Minute.
2) Spitzenwert: die auf der Tabelle aufgeführten Werte beziehen sich auf einen Maximalwert von 1% pro Minute.

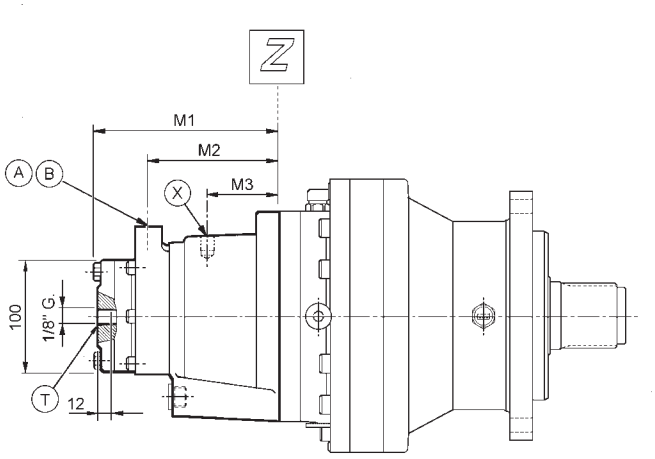
1) Valeur intermittente: les valeurs du tableau s'entendent pour un maximum de 10% toutes les minutes.
2) Valeur de crête: les valeurs du tableau s'entendent pour un maximum de 1% toutes les minutes.

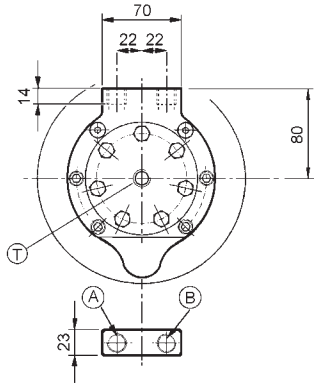
(A17)

		MG 50				MG 80				MG 100				MG 125				MG 160				MG 200				MG 250			
	P	Q l/min				Q l/min				Q l/min				Q l/min				Q l/min				Q l/min				Q l/min			
	bar	5	10	20	30	10	20	30	35	10	20	30	40	10	20	30	40	10	20	30	40	10	20	30	40	10	20	30	40
ηmh	50	82	80	78	77	81	78	75	73	80	75	71	70	80	75	71	70	80	76	71	69	79	74	71	69	78	74	70	68
	80	86	84	82	79	84	81	77	75	82	77	74	72	82	77	74	72	82	77	73	70	81	75	72	69	81	75	71	68
	110	88	86	84	82	85	83	81	79	83	80	76	74	83	80	76	74	83	78	75	72	82	77	74	70	82	77	72	70
	140	89	88	86	84	86	84	82	80	84	82	77	75	84	82	77	75	82	80	76	74	81	78	75	73				
	170	88	88	87	86	85	85	83	81	82	80	78	76	82	80	78	76	82	79	77	75								
ηv	50	90	92	93	93	91	92	94	94	93	94	95	95	93	94	95	95	93	94	95	96	93	94	95	96	93	94	95	96
	80	89	90	92	93	89	90	91	93	91	93	94	95	91	94	94	95	91	94	95	95	91	94	94	95	91	94	94	95
	110	88	89	90	92	87	89	90	92	90	92	93	94	90	91	92	94	90	91	92	94	90	91	92	94	90	91	92	94
	140	85	88	89	90	85	89	90	90	85	90	91	92	86	87	90	91	87	88	90	91	87	88	91	93				
	170	81	84	88	89	81	94	88	89	82	85	89	90	83	85	89	91	84	85	89	92								

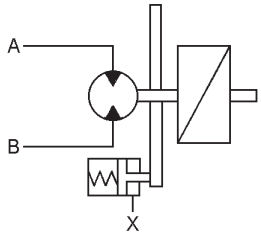
33.0 **DIMENSIONI MOTORI MG** | 33.0 **DIMENSIONS MG MOTORS** | 33.0 **ABMESSUNGEN MOTOREN MG** | 33.0 **DIMENSIONS MOTEURS MG**

MG-***ZA**-P01S

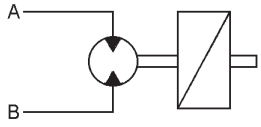




Con freno / with brake
mit Bremse / avec frein

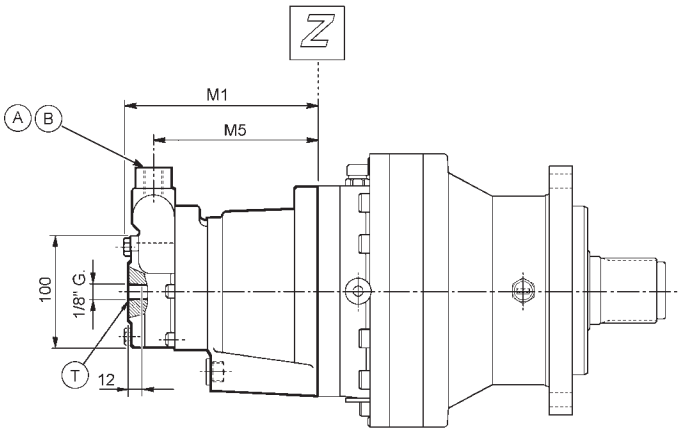


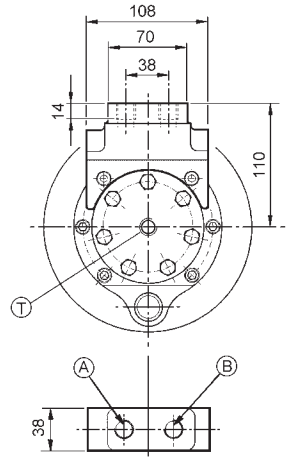
Senza freno / without brake
ohne Bremse / sans frein



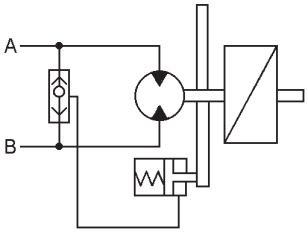
ATTACCHI / PORTS
ANSCHLUSSE / RACCORDS
A - B = 3/8" G 19TPI
T = 1/8" G 28TPI
X = 1/4 G 19TPI

MG-***ZA**-B02P





Con freno / with brake
mit Bremse / avec frein



Riduttore applicabile Suitable gearbox Anbaugetriebe Réducteur appliquable	Motore / Motor / Motor / Moteur							Esecuzione / Execution Ausführung / Exécution		
	MG 50	**MG 80**	**MG 100**	**MG 125**	**MG 160**	**MG 200**	**MG 250**	**P01S**		**B02P**
	M1							M2	M3	M5
300 L1 - L2 - R2	156	162	166	170	177			113	60	143
301 L1 - L2 - R2	156	162	166	170	177	184	193	113	60	143
303 L1					199	206	215	135	77	165
303 L2 - R2	156	162	166	170	177	184	193	113	60	143
305 L1					199	206	215	135	77	165
305 L2 - R2	156	162	166	170	177	184	193	113	60	143
306 L2					199	206	215	135	77	165
306 R2 - R3	156	162	166	170	177	184	193	113	60	143
307 L2					199	206	215	135	77	165
307 R2 - R3	156	162	166	170	177	184	193	113	60	143

34.0 DATI TECNICI FRENI PER MOTORI MG

34.0 TECHNICAL DATA-BRAKES FOR MG MOTORS

34.0 TECHNISCHE DATEN-BREMSEN FÜR MG-MOTOREN

34.0 DONNEE TECHNIQUES FREINS DE MOTEURS MG

(A18)

		Freno/Brake/Bremse/Frein TYPE 3.				Freno/Brake/Bremse/Frein TYPE 4.			
		3E	**3I**	**3L**	**3N**	**4K**	**4N**	**4R**	**4U**
Coppia frenante Mf Brake torque Mf Bremsmoment Mf Couple de freinage Mf	[Nm]	**120**	**200**	**280**	**350**	**260**	**320**	**430**	**620**
Pressione minima apertura Min. opening pressure Min. öffnungsdruck Pression minimale ouverture	[bar]	16	28	28	35	25	30	24	34
Pressione massima di comando Max. operating pressure Max. steuerdruck Pression maximale de commande	[bar]	200							
Volume d'olio per comando apertura freno Oil volume for brake release Ölvolumen für öffnungssteuerung Volume d'huile pour commande ouverture	[cc]	6.43	6.43	6.43	6.43	6.65	6.65	6.65	6.65

(A19)

Riduttore applicabile Suitable gearbox Anbaugetriebe Réducteur appliquable	Motore / Motor / Motor / Moteur													
	MG 50		**MG 80**		**MG 100**		**MG 125**		**MG 160**		**MG 200**		**MG 250**	
	Mf [Nm]		Mf [Nm]		Mf [Nm]		Mf [Nm]		Mf [Nm]		Mf [Nm]		Mf [Nm]	
300 L1 - L2	120	**3E**	200	**3I**	280	**3L**	350	**3N**	350	**3N**				
300 R2	120	**3E**	200	**3I**	280	**3L**								
301 L1 - L2			200	**3I**	280	**3L**	350	**3N**	350	**3N**	350	**3N**	350	**3N**
301 R2	120	**3E**	200	**3I**	280	**3L**	350	**3N**	350	**3N**				
303 L1									430	**4R**	430	**4R**	430	**4R**
303 L2	120	**3E**	200	**3I**	280	**3L**	350	**3N**	350	**3N**	350	**3N**		
303 R2	120	**3E**	200	**3I**	280	**3L**	350	**3N**	350	**3N**	350	**3N**		
305 L1									430	**4R**	430	**4R**	430	**4R**
305 L2	120	**3E**	200	**3I**	280	**3L**	350	**3N**	350	**3N**	350	**3N**		
305 R2	120	**3E**	200	**3I**	280	**3L**	350	**3N**	350	**3N**	350	**3N**		
306 L2			260	**4K**	260	**4K**	320	**4R**	430	**4R**	430	**4R**	430	**4R**
306 R2 - R3			200	**3I**	280	**3L**	350	**3N**	350	**3N**	350	**3N**		
307 L2					260	**4K**	320	**4R**	430	**4R**	430	**4R**	430	**4R**
307 R2 - R3			200	**3I**	280	**3L**	350	**3N**	350	**3N**	350	**3N**	350	**3N**

35.0 INSTALLAZIONE

In aggiunta alle norme relative alla installazione del riduttore, vedi pag. 18, è raccomandato seguire le seguenti norme per l' installazione del motore idraulico.

a) Collegamento al circuito idraulico

I motori possono essere collegati sia a circuiti del tipo chiuso che aperto.
Nel caso di circuito aperto la elettrovalvola o distributore di comando può essere sia di tipo a centro chiuso che aperto.

35.0 INSTALLATION

Further to standards on gearbox installation, refer to page 18, comply with the following hydraulic motor installation instructions:

a) Connection to the hydraulic circuit

Motors can be connected either to closed or open circuits.
In case of an open circuit, solenoid valve or control distributor can be of the closed or open center type.

35.0 INSTALLATION

Zusätzlich zu den Normen für die Vorgangsweise bei der Installation des jeweiligen Getriebes, siehe Seite 18, wird empfohlen, die auch folgenden Anweisungen für die Installation des Hydraulikmotors zu befolgen.

a) Anschluß an den hydraulischen Kreislauf

Die Motoren können, sowohl an geschlossene, als auch an offene Kreisläufe verwendet werden.
Handelt es sich um einen offenen Kreislauf kann das Elektroventil oder das Steuerwegeventil, sowohl vom Typ mit geschlossener Mitte, als auch mit offener Mitte sein.

35.0 INSTALLATION

En plus des règles concernant l'installation du réducteur, voir page 18, on préconise de suivre les instructions ci-dessous pour l'installation du moteur hydraulique.

a) Raccordement au circuit hydraulique

Les moteurs peuvent être raccordés à des circuits de type fermé aussi bien qu'ouvert.
En cas de circuit ouvert, l'électrovanne, ou distributeur de commande, peut être de type tant à centre fermé qu'ouvert.

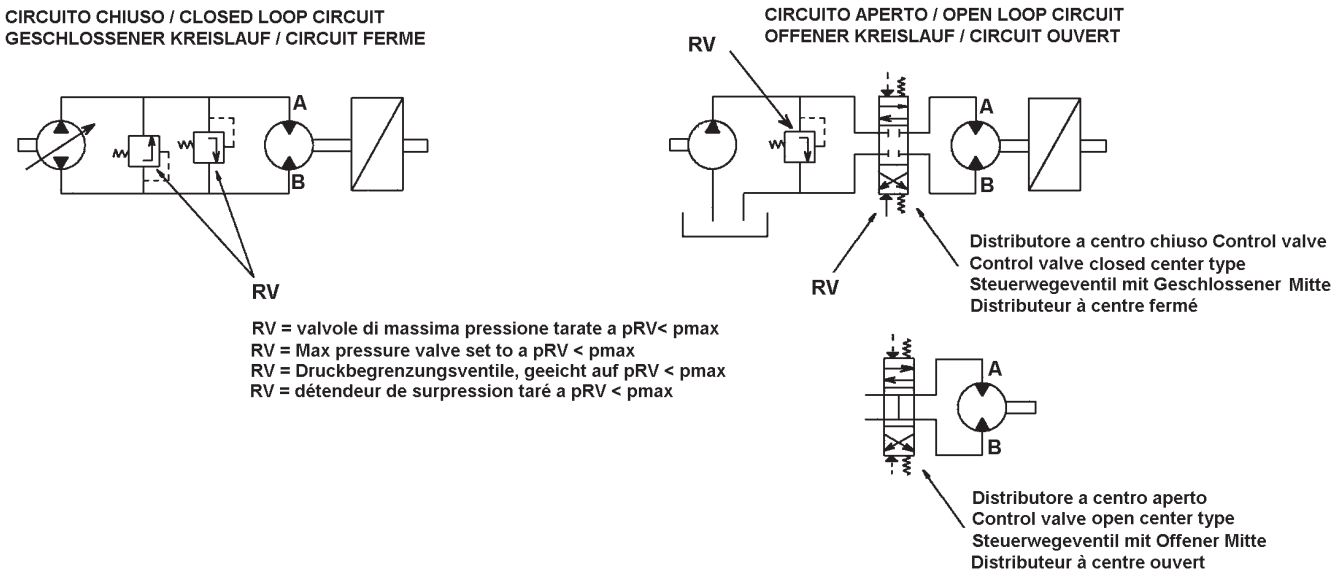
Occorre che nel ramo del circuito corrispondente alla mandata del motore idraulico sia sempre montata una valvola di massima pressione tarata ad un valore non superiore al valore p_{int} ammesso sul motore idraulico. Vedi schemi idraulici (A20).

The hydraulic motor delivery side should always have a max. pressure valve set to a value not exceeding the p_{int} value allowed for the hydraulic motor. See hydraulic diagrams (A20).

Es ist erforderlich, daß am Zweig des Kreislaufs, gegenüber der Druckleitung des Hydraulikmotors immer ein Druckbegrenzungsventil montiert ist, welches auf einen Wert geeicht ist, der den am Hydraulikmotor zulässigen Wert von p_{int} nicht überschreitet. Siehe Hydraulikpläne (A20).

Il y a lieu que la portion de circuit, correspondant à l'alimentation du moteur hydraulique, soit toujours équipée d'un détendeur de surpression taré à une valeur pas supérieure à p_{int} maximale admise sur le moteur hydraulique. Voir schémas hydrauliques (A20).

(A20)



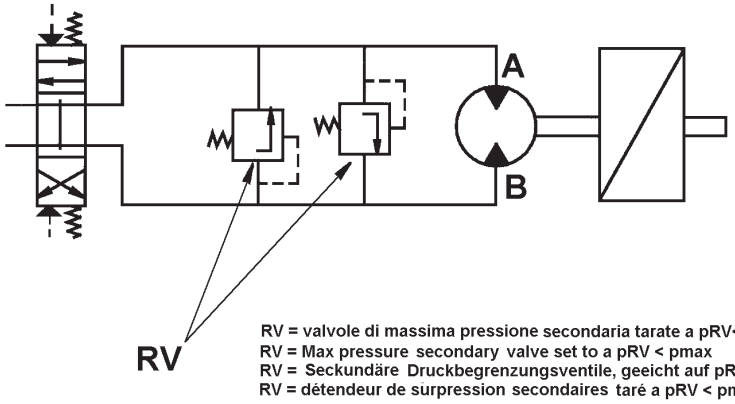
Nel caso in cui questo non sia possibile in quanto il circuito deve comandare altri azionamenti a pressione più' elevata e/o nel caso cui si abbia un distributore a centro chiuso ed il motore aziona organi ad elevato momento d'inerzia occorre montare valvole di massima pressione secondarie il più' vicino possibile al motore.
Vedi schema (A21).

If not possible, because the circuits control other devices needing a higher pressure and/or a closed center control valve is fitted and the motor controls parts with a high moment of inertia, max. pressure secondary valves should be as close as possible to the motor.
See diagram (A21).

Ist dies nicht möglich, weil der Kreislauf noch andere, unter höheren Druck stehende Antriebe steuern muß und/oder in dem Fall, daß kein Wegeventil mit geschlossener Mitte zur Verfügung steht und der Motor Organe mit einem erhöhten Trägheitsmoment antreibt, muß man so nahe wie möglich am Motor sekundäre Druckbegrenzungsvenitle montieren. Siehe Schema (A21).

Si cela n'est pas possible, du fait que le circuit doit commander d'autres entraînements, ayant une pression plus élevée, et/ou qu'il y a un distributeur à centre fermé et le moteur actionne des organes, ayant un moment d'inertie élevé, il faut monter des détendeurs de surpression secondaires, le plus près du moteur.
Voir schéma (A21).

(A21)



b) Collegamento foro di drenaggio T

In esecuzione standard i motori vengono forniti senza foro di drenaggio. In questo caso il motore è provvisto di drenaggio interno. Questo soddisfa la maggioranza delle applicazioni dove il funzionamento è intermittente e la pressione media di comando è inferiore al 50% della pressione sopportabile dal motore.
Quando il funzionamento è in continuo o intermittente con una percentuale di funzionamento maggiore del 50% e la pressione media di comando è superiore al 50% della pressione, occorre richiedere il motore in esecuzione con drenaggio esterno e collegare il foro di drenaggio T al serbatoio.

b) Connection of drain hole T

Standard motors are supplied with no drain hole. In this case, the motor has an internal drain system.
This meets most application requirements with intermittent duty and average control pressure under 50% of the max. pressure bearable by the motor.
In continuous or intermittent duty with operation percentage over 50% and average control pressure over 50% of the max. pressure, motor should be ordered in the external drain version and the drain hole T should be connected to the tank.

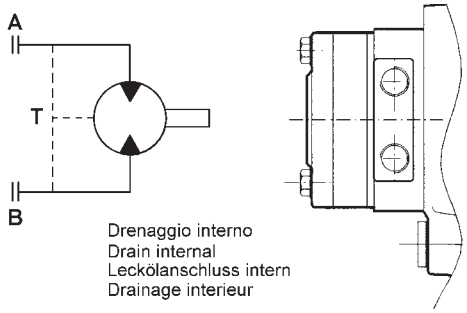
b) Anschlüsse an der Drainagebohrung T

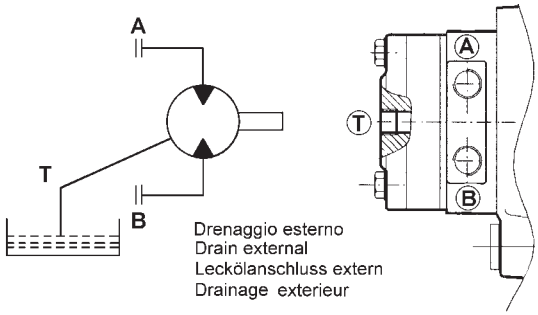
In der Standardausführung werden die Motoren ohne Drainagebohrung geliefert. Diese Lösung reicht bei den meisten Applikationsfällen, bei denen ein Schaltbetrieb verwendet wird und der mittlere Steuerdruck unter den 50% des max. vom Motor tragbaren Drucks liegt, aus.
Handelt es sich um einen Dauer- oder einen Schaltbetrieb mit einem Betriebsprozentsatz über 50% und der mittlere Steuerdruck liegt über 50% des Drucks, muß man eine Motorausführung mit einer Außendrainage anfordern und die Drainagebohrung T dann mit dem Tank verbinden.

b) Raccordement orifige de purge T

L'exécution standard des moteurs ne prévoit pas d'orifice de purge.
Dans ce cas le moteur est dépourvu de purge intérieure.
Cela satisfait à la plupart des applications où le fonctionnement est intermittent et la pression moyenne de commande est inférieure à 50% de la pression maximale admise pour le moteur .
Si le fonctionnement est continu ou intermittent, avec un pourcentage de fonctionnement supérieur à 50% et la pression moyenne de commande est supérieure à 50% de la pression, il faut commander le moteur dans la variante avec purge extérieure et raccorder l'orifice de purge T au réservoir.

(A22)





c) Comando freno

Nel caso in cui il motoriduttore sia dotato di freno, il motore può essere in due esecuzioni: B02P oppure P01S.
Nella esecuzione B02P, il comando del freno è interno, diretto dal motore.
Nella esecuzione P01S, occorre un ramo ausiliario per il comando del freno.
Vedere lo schema seguente (A23).

c) Brake control

For gearmotors equipped with brakes, there are two motor versions available, i.e. the B02P or P01S executions.
In the B02P version, the motor has an in-built, direct brake control system.
In the P01S version, an auxiliary branching is required to control the brake.
See the following diagram (A23).

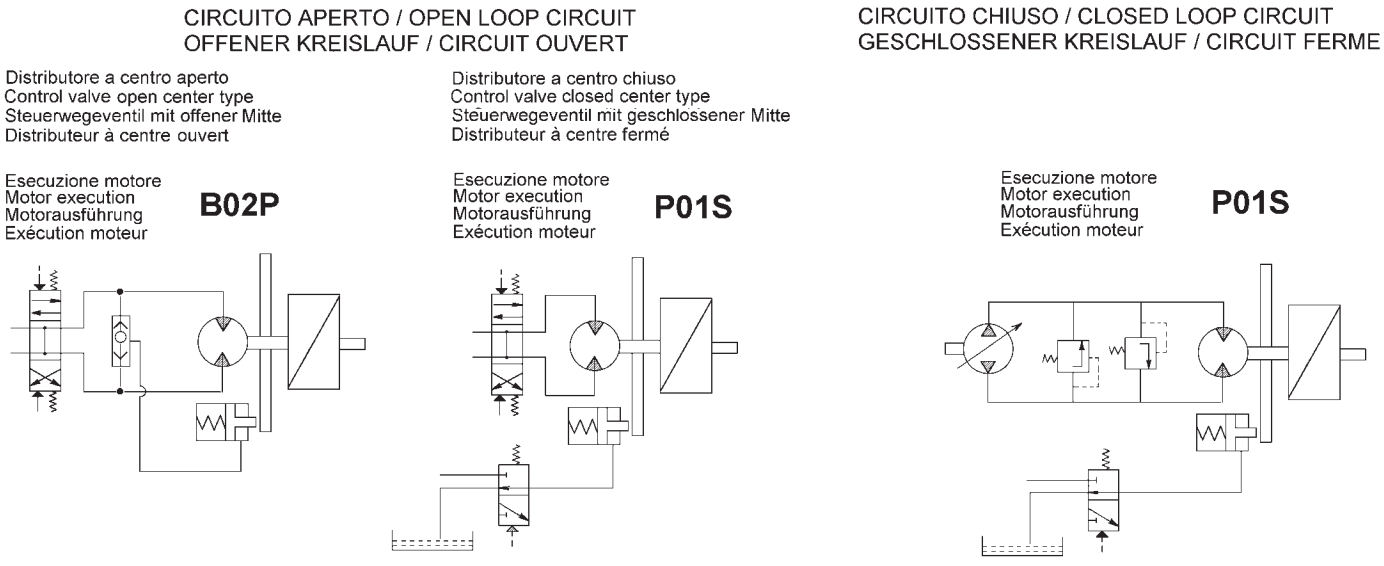
c) Bremssteuerung

Ist der Getriebemotor mit einer Bremse ausgestattet, können zwei Motorausführungen verwendet werden: B02P oder P01S.
Bei der Ausführung B02P liegt die Bremssteuerung im Inneren und wird vom Motor gesteuert.
Bei der Ausführung P01S ist für die Bremssteuerung eine Hilfsüberzweigung erforderlich.
Siehe dazu folgendes Schema (A23).

c) Commande frein

Au cas où le motoréducteur serait équipé de frein, le moteur pourra avoir deux exécutions: B02P ou P01S.
Dans l'exécution B02P, la commande du frein est à l'intérieur, derrière le moteur.
Dans l'exécution P01S, il faut disposer d'une branche auxiliaire pour la commande du frein. Voir schéma suivant (A23).

(A23)



d) Tipo olio idraulico

E' raccomandato l'uso di olio idraulico minerale con viscosità ISO VG 46 (46 Cst a t = 40°C).
E' raccomandabile che la temperatura dell'olio sia compresa fra +30 °C e + 70 °C.

d) Hydraulic oil

Use hydraulic mineral oil with viscosity ISO VG 46 (46 Cst at t = 40°C).
It is recommended the oil temperature should be between +30°C and +70°C.

d) Hydrauliköltyp

Es wird der Einsatz von Mineralhydrauliköl mit einem Viskositätsgrad ISO VG 46 (46 Cst bei t = 40°C) empfohlen.
Die Öltemperatur sollte zwischen +30°C und +70°C liegen.

d) Type d'huile hydraulique

On préconise d'utiliser de l'huile hydraulique minérale avec viscosité ISO VG 46 (46 Cst à t = 40°C).
On préconise que le domaine de température de l'huile soit compris entre +30 °C et + 70 °C.

e) Filtraggio

Per assicurare un funzionamento affidabile del motore ed una sua durata è estremamente importante che il circuito idraulico sia dotato di filtro con capacità filtrante tale da assicurare un grado di pulizia dell'olio secondo grado:

grado 9 NAS 1638
grado 6 SAE
grado 18/15 SO DIS 4406

e) Oil filtering

For reliable motor operation and long life, it is important that the hydraulic circuit has a filter for a proper oil filtering according to the following degree:

degree 9 NAS 1638
degree 6 SAE
degree 18/15 SO DIS 4406

e) Filtrierung

Um einen zuverlässigen Betrieb des Motors und eine lange Lebensdauer zu gewährleisten, ist es besonders wichtig, daß der hydraulische Kreislauf mit einem Filter ausgestattet ist, der eine Filtrierleistung bieten, die einen Ölreinigungsgrad gemäß folgender Angaben sichert Grad:

Grad 9 NAS 1638
Grad 6 SAE
Grad 18/15 SO DIS 4406

e) Filtrage

Pour assurer un fonctionnement fiable du moteur, ainsi que sa longévité, il est extrêmement important que le circuit hydraulique soit équipé de filtre, ayant une capacité de filtration en mesure d'assurer un niveau de propreté de l'huile conforme aux degres suivants:

degré 9 NAS 1638
degré 6 SAE
degré 18/15 SO DIS 4406

36.0 **MOTORI ELETTRICI** 36.0 **ELECTRIC MOTORS** 36.0 **ELEKTROMOTOREN** 36.0 **MOTEURS ELECTRIQUE**

36.1 Simbologia e unità di misura / Symbols and units of measure / Verwendete symbole undinheiten / Symboles et unites de mesure

Simb. Symb.	U.m. Einheit	Descrizione	Description	Beschreibung	Description
cosφ		Fattore di potenza	Power factor	Leistungsfaktor	Facteur de puissance
η	–	Rendimento motore	Motor efficiency	Wirkungsgrad Motor	Rendement moteur
$\mathbf{f_m}$	–	Fattore di maggiorazione	Power increase factor	Überdimensionierungsfaktor	Facteur de majoration
$\mathbf{f_t}$	–	Fattore termico	Thermal factor	Wärmefaktor	Facteur thermique
I	–	Grado di intermittenza	Cyclic duration factor	relative Einschaltdauer	Degré d'intermittence
In	[A]	Corrente nominale del motore	Motor rated current	Nennstrom des Motors	Courant nominal du moteur
Ia	[A]	Corrente di spunto del motore	Motor starting current	Anlaufstrom des Motors	Courant de démarrage du moteur
$\mathbf{J_c}$	[Kgm^2]	Momento di inerzia delle masse esterne	Moment of inertia of external masses	Trägheitsmoment der externen Masse	Moment d'inertie des masses extérieures
$\mathbf{J_m}$	[Kgm^2]	Momento di inerzia del motore	Motor moment of inertia	Trägheitsmoment des Motors	Moment d'inertie du moteur
$\mathbf{K_c}$	–	Fattore di coppia	Torque factor	Drehmomentfaktor	Facteur de couple
$\mathbf{K_d}$	–	Fattore di carico	Load factor	Lastfaktor	Facteur de charge
$\mathbf{K_J}$	–	Fattore di inerzia	Inertia factor	Trägheitsfaktor	Facteur d'inertie
Ma	[Nm]	Coppia di accelerazione media motore	Motor mean acceleration torque	Mittleres Beschleunigungsmoment des Motors	Couple d'accélération moyen moteur
Mb	[Nm]	Coppia nominale del freno	Brake rated torque	Nenndrehmoment der Bremse	Couple nominal du frein
Mn	[Nm]	Coppia nominale motore	Motor rated torque	Nenndrehmoment des Motors	Couple nominal du moteur
$\mathbf{M_L}$	[Nm]	Coppia resistente media durante l' avviamento	Starting mean load torque	Mittleres Gegenmoment beim Anlaufen	Couple résistant moyen pendant le démarrage
Ms	[Nm]	Coppia di spunto motore	Motor locked rotor torque	Anlaufdrehmoment des Motors	Couple de démarrage moteur
n	[min^{-1}]	Velocità angolare motore	Motor angular speed	Motordrehzahl	Vitesse angulaire moteur
Pb	[W]	Potenza assorbita dal freno a 20°C	Brake power absorbed at 20°C	Aufnahme der Bremse bei 20°C	Absorption du frein à 20°C
Pn	[kW]	Potenza nominale motore	Motor rated power	Nennleistung des Motors	Puissance nominale moteur
Pr	[kW]	Potenza richiesta a regime di velocità	Required power at full speed	Von der Anwendung verlangte Leistung	Puissance demandée en régime de vitesse
$\mathbf{t_1}$	[ms]	Tempo di rilascio freno	Brake release reaction time	Ansprechzeit der Bremse	Temps de réaction déblocage frein
$\mathbf{t_{1s}}$	[ms]	Tempo di rilascio freno con sovraeccitazione	Brake release reaction time with over-excitation	Ansprechzeit der Bremse mit Schnellerregung	Temps de réaction déblocage frein avec surexcitation
$\mathbf{t_2}$	[ms]	Ritardo di frenatura	Braking reaction time	Einfallzeit der Bremse	Temps de réaction freinage
$\mathbf{t_{2c}}$	[ms]	Ritardo di frenatura con interruzione della c.c.	Braking reaction time with d.c. line interruption	Einfallzeit der Bremse bei gleichstromseitiger Schaltung	Temps de réaction freinage avec interruption du c.c.
$\mathbf{t_a}$	[°C]	Temperatura ambiente	Ambient temperature	Umgebungstemperatur	Température ambiante
$\mathbf{t_f}$	[s]	Tempo di funzionamento a carico costante	Operating time at constant load	Betriebszeit mit konstanter Last	Temps de fonctionnement à charge constante
$\mathbf{t_r}$	[s]	Tempo di riposo	Rest time	Aussetzzeit	Temps de repos
W	[J]	Energia dissipata dal freno tra due regolazioni del traferro successive	Brake dissipated energy between two consecutive air-gap adjustments	Bremsenergie bis zu Nachstellreife	Energie dissipée par le frein entre deux réglages successifs de l'entrefer
$\mathbf{W_{max}}$	[J]	Energia massima per frenata	Maximum energy each braking operation	Maximale Energie pro Bremsung	Energie maximum par freinage
$\mathbf{Z_0}$	[1/h]	Numero di avviamenti a vuoto con I = 50%	Number of permitted motor no-load starts (I = 50%)	Zulässige Schalthäufigkeit des Motors ohne Last (I = 50%)	Nombre de démarrages à vide admissible du moteur (I = 50%)
Z	[1/h]	Numero di avviamenti ammissibile del motore	Number of permitted motor starts	Zulässige Schalthäufigkeit des Motors	Nombre de démarrages admissible du moteur

37.0 CARATTERISTICHE GENERALI

37.1 Programma di produzione

I motori elettrici asincroni trifase del programma di produzione della BONFIGLIOLI RIDUTTORI sono previsti nelle forme costruttive base IMB5, IMB14 e loro derivate con le seguenti polarità: 4, 6.
Nel presente catalogo sono evidenziate inoltre le caratteristiche tecniche dei motori in versione integrata.

37.2 Normative

I motori descritti in questo catalogo sono costruiti in accordo alle Norme ed unificazioni applicabili evidenziate nella tabella (A24).

37.0 GENERAL CHARACTERISTICS

37.1 Production range

The asynchronous three-phase electric motors of BONFIGLIOLI RIDUTTORI's production, are available in basic designs IMB5 and IMB14 and derived versions, with the following polarities: 4, 6.
The technical characteristics of compact version motors are also supplied in this chapter.

37.2 Standards

The motors described in this catalogue are manufactured to the applicable standards shown in table (A24).

37.0 ALLGEMEINE EIGENSCHAFTEN

37.1 Produktprogramm

Die Dreiphasen-Asynchronmotoren aus dem Produktprogramm von BONFIGLIOLI RIDUTTORI gibt es in den Grundbauformen IMB5, IMB14 und deren Ableitungen mit folgenden Polzahlen: 4, 6.
Im vorliegenden Katalog sind außerdem die technischen Eigenschaften der Motoren in Kompaktausführung hervorgehoben.

37.2 Normen

Die in diesem Katalog beschriebenen Motoren sind in Übereinstimmung mit den in der Tabelle (A24) angegebenen einschlägigen Normen und Vereinheitlichungsrichtlinien konstruiert worden.

37.0 CARACTERISTIQUES GENERALES

37.1 Programme de production

Les moteurs électriques asynchrones triphasés du programme de production de BONFIGLIOLI RIDUTTORI sont prévus dans les formes de construction de base IMB5, IMB14 et leur dérivés avec les polarités suivantes: 4, 6.
Dans le présent catalogue sont également mises en évidence les caractéristiques techniques des moteurs en version compacte.

37.2 Réglementations

Les moteurs décrits dans ce catalogue sont construits en accord avec les Normes et standardisations applicables mises en évidence dans le tableau (A24).

(A24)

Titolo / Title / Titel / Titre	CEI	IEC
Prescrizioni generali per macchine elettroniche rotanti General requirements for rotating electrical machines Allgemeine Vorschriften für umlaufende elektrische Maschinen Prescriptions générales pour machines électriques tournantes	CEI 2 - 3	IEC 34 - 1/83
Marcatura dei terminali e senso di rotazione per macchine elettriche rotanti Terminal markings and direction of rotation of rotating machines Kennzeichnung der Anschlußklemmen und Drehrichtung von umlaufenden elektrischen Maschinen Définitions des bornes et sens de rotation pour machines électriques tournantes	CEI 2 - 8	IEC 34 - 8
Metodi di raffreddamento delle macchine elettriche Methods of cooling for electrical machines Verfahren zur Kühlung von elektrischen Maschinen Méthodes de refroidissement des machines électriques	CEI 2 - 7	IEC 34 - 6
Dimensioni e potenze nominali per macchine elettriche rotanti Dimensions and output ratings for rotating electrical machines Auslegung der Nennleistung von umlaufenden elektrischen Maschinen Dimensions, puissances nominales pour machines électriques tournantes	UNEL 13113 - 71 13117 - 71 13118 - 71	IEC 72
Classificazione dei gradi di protezione delle macchine elettriche rotanti Classification of degree of protection provided by enclosures for rotating machines Klassifizierung der Schutzart von umlaufenden elektrischen Maschinen Classification des degrés de protection des machines électriques tournantes	CEI 2 - 16	IEC 34 - 5
Limiti di rumorosità Noise limits Geräuschgrenzwerte Limites de bruit	CEI 2 - 24	IEC 34 - 9
Sigle di designazione delle forme costruttive e dei tipi di installazione Classification of type of construction and mounting arrangements Abkürzungen zur Kennzeichnung der Bauform und der Einbaulagen Sigles de dénomination des formes de construction et des types d'installation	CEI 2 - 14	IEC 34 - 7
Tensione nominale per i sistemi di distribuzione pubblica dell'energia elettrica a bassa tensione Rated voltage for low voltage mains power. Nennspannung für öffentliche NS-Stromverteilungssysteme Tension nominale pour les systèmes de distribution publique de l'énergie électrique en basse tension	CEI 18 - 6	IEC 38
Grado di vibrazione delle macchine elettriche Vibration level of electric machines. Schwingstärke bei elektrischen Maschinen Degré de vibration des machines électriques	CEI 2 - 23	IEC 34 - 14

I motori corrispondono inoltre alle Norme straniere adeguate alle IEC 34-1 e riportate nella tabella (A25).

The motors also comply with foreign standards adapted to IEC 34-1 as shown in table (A25).

Die Motoren entsprechen außerdem den an die IEC-Norm 34-1 angepaßten ausländischen Normen, die in Tabelle (A25) genannt werden.

En outre, les moteurs correspon-dent aux Normes étrangères adaptées aux IEC 34-1 indiquées dans le tableau (A25).

(A25)

DIN VDE 0530	Germania	Germany	Deutschland	Allemagne
BS5000 / BS4999	Gran Bretagna	Great Britain	Großbritannien	Grande Bretagne
AS 1359	Australia	Australia	Australien	Australie
CSA C22.2 N° 100	Canada	Canada	Kanada	Canada
NBNC 51 - 101	Belgio	Belgium	Belgien	Belgique
NEK - IEC 34	Norvegia	Norway	Norwegen	Norvège
NF C 51	Francia	France	Frankreich	France
OEVE M 10	Austria	Austria	Österreich	Autriche
SEV 3009	Svizzera	Switzerland	Schweiz	Suisse
NEN 3173	Paesi Bassi	Netherlands	Niederlande	Pays Bas
SS 426 01 01	Svezia	Sweden	Schweden	Suède

I motori gr. 63-132, M4-M3 costruiti in accordo alle Norme Canadesi sono certificati CSA, vengono forniti con targhetta speciale CSA e sono previsti con ingresso cavi NPT secondo CSA STANDARD C22-2 N° 0.5
Dimensioni e caratteristiche a richiesta.

The motors size 63-132, M4-M3, manufactured according to the Canadian Rules are CSA certified, are supplied with special CSA name plate and are equipped with NPT cable input according to CSA STANDARD C22-2 Nr. 0.5
Dimensions and features upon request.

Die gemäß den Canada Richtlinien hergestellten Motoren gr. 63-132, M4-M3 sind CSA bescheinigt, werden mit CSA Sondernamenschild geliefert und sind mit NPT Kabeleintritt gemäß CSA STANDARD C22-2 NR. 0.5 ausgestattet.
Abmessungen un Eigenschaften auf Anfrage.

Les moteurs type 63-132, M4-M3 construits selon les Normes Canadiennes, sont certifiés CSA et sont fournis avec des plaquesmarques spéciales CSA; il sont prévus pour entrée de câbles NPT selon CSA STANDARD C22-2 N° 0.5
Dimensions et carattéristiques sur demande.

Direttive CEE 73/23 (LVD) e CEE 89/336 (EMC).

I motori delle serie BN sono corrispondenti ai requisiti delle Direttive CEE 73/23 (Direttiva Bassa Tensione) e CEE 89/336 (Direttiva Compatibilità Elettromagnetica) e provvisti in targa della marcatura CE.

Directives EEC 73/23 (LVD) and EEC 89/336 (EMC).

Motors of the BN series comply with requirements of Directive EEC 73/23 (Low Voltage Directive) and EEC 89/336 (Electromagnetic Compatibility Directive) and bear the CE mark.

Richtlinie EWG 73/23 (LVD) und EWG 89/336 (EMC).

Die motoren der Serie BN entsprechen den Anforderungen der Richtlinie EWG 73/23 (Richtlinie - Niedrigspannung) und der Richtlinie 89/336 (Richtlinie - elektromagnetische Kompaktibilität) und verfügen über das CE-Zeichen.

Directive CEE 73/23 (LVD) et CEE 89/336 (EMC).

Les moteurs de la série BN répondent aux conditions requises par les Directives CEE 73/23 (Directive Basse Tension) et CEE 89/336 (Directive compatibilité Electromagnétique), la marque CE est présente sur la plaquette signalétique.

In particolare per quanto riguarda la Direttiva EMC, la costruzione risulta in accordo alle Norme:

BN	EN 50081-1
	EN 50082-2
BN-FA	EN 50081-1
	EN 50082-2
BN-FD	EN 50081-2
	EN 50082-2

In particular, as far as Directive EMC is concerned, they are manufactured in compliance with the following standard:

BN	EN 50081-1
	EN 50082-2
BN-FA	EN 50081-1
	EN 50082-2
BN-FD	EN 50081-2
	EN 50082-2

IN Hinblick auf die Richtlinie EMC, stimmt die Konstruktion insbesonder mit den folgenden Normen überein:

BN	EN 50081-1
	EN 50082-2
BN-FA	EN 50081-1
	EN 50082-2
BN-FD	EN 50081-2
	EN 50082-2

Plus particulièrement, en ce qui concerne la Directive EMC, la fabrication répond aux Normes:

BN	EN 50081-1
	EN 50082-2
BN-FA	EN 50081-1
	EN 50082-2
BN-FD	EN 50081-2
	EN 50082-2

Se è richiesta la conformità alla Norma EN 50081-1, i motori con freno FD devono essere corredati di opportuno filtro capacitivo in ingresso al raddrizzatore (opzione CF).
I motori risultano inoltre conformi a quanto previsto dalle Norme IEC 204-1 "Equipaggiamento elettrico delle macchine".

If compliance with standard EN 50081-1 is required, motors with brake FD must have a capacitive filter at rectifier inlet (option CF).
Furthermore, motors are in compliance with requirements of Standard IEC 204-1 "Electric equipment of machines".

Wird auch die Übereinstimmung mit der Norm EN 50081-1 verlangt, müssen die Motoren mit einer FD-Bremse am Eingang zum Gleichrichter (Option CF) mit einem angemessenen kapazitiven Filter ausgestattet werden.
Die Motoren resultieren darüber hinaus als mit den Normen IEC 204-1 "Elektrische Ausrüstung der Maschinen" konform.

Si la comformité à la Norme EN 50081-1 est nécessaire, les moteurs avec frein FD doivent être équipés de filtre capacitif à l'entrée du redresseur (option CF).
De plus, les moteurs sont conformes aux normes IEC 204-1 "Equipment électrique des machines".

37.3 **Tolleranze**

Secondo le Norme sono ammesse le tolleranze indicate nella tabella (A26) sulle grandezze garantite.

37.3 **Tolerances**

According to Standards, the tolerances shown in table (A26) referring to guaranteed sizes, are permitted.

37.3 **Toleranzen**

Die Normen lassen die in Tabelle (A26) genannten Toleranzen bei den garantierten Größen zu.

37.3 **Tolérances**

Selon les Normes, les tolérances indiquées dans le tableau (A26) sont admises sur les tailles garanties.

(A26)

$-0.15\ (1 - \eta)$ $P \leq 50kW$	Rendimento	Efficiency	Wirkungsgrad	Rendement
$-(1 - \cos\varphi)/6$ min. 0.02 max. 0.07	Fattore di potenza	Power factor	Leistungsfaktor	Facteur de puissance
±20% *	Scorrimento	Slip	Schlupf	Glissement
+20%	Corrente a rotore bloccato	Locked rotor current	Strom bei blockiertem Läufer	Courant à rotor bloqué
-15% ÷ +25%	Coppia a rotore bloccato	Locked rotor torque	Drehmoment bei blockiertem Läufer	Couple à rotor bloqué
-10%	Coppia max	Max. torque	Max. Drehmoment	Couple max

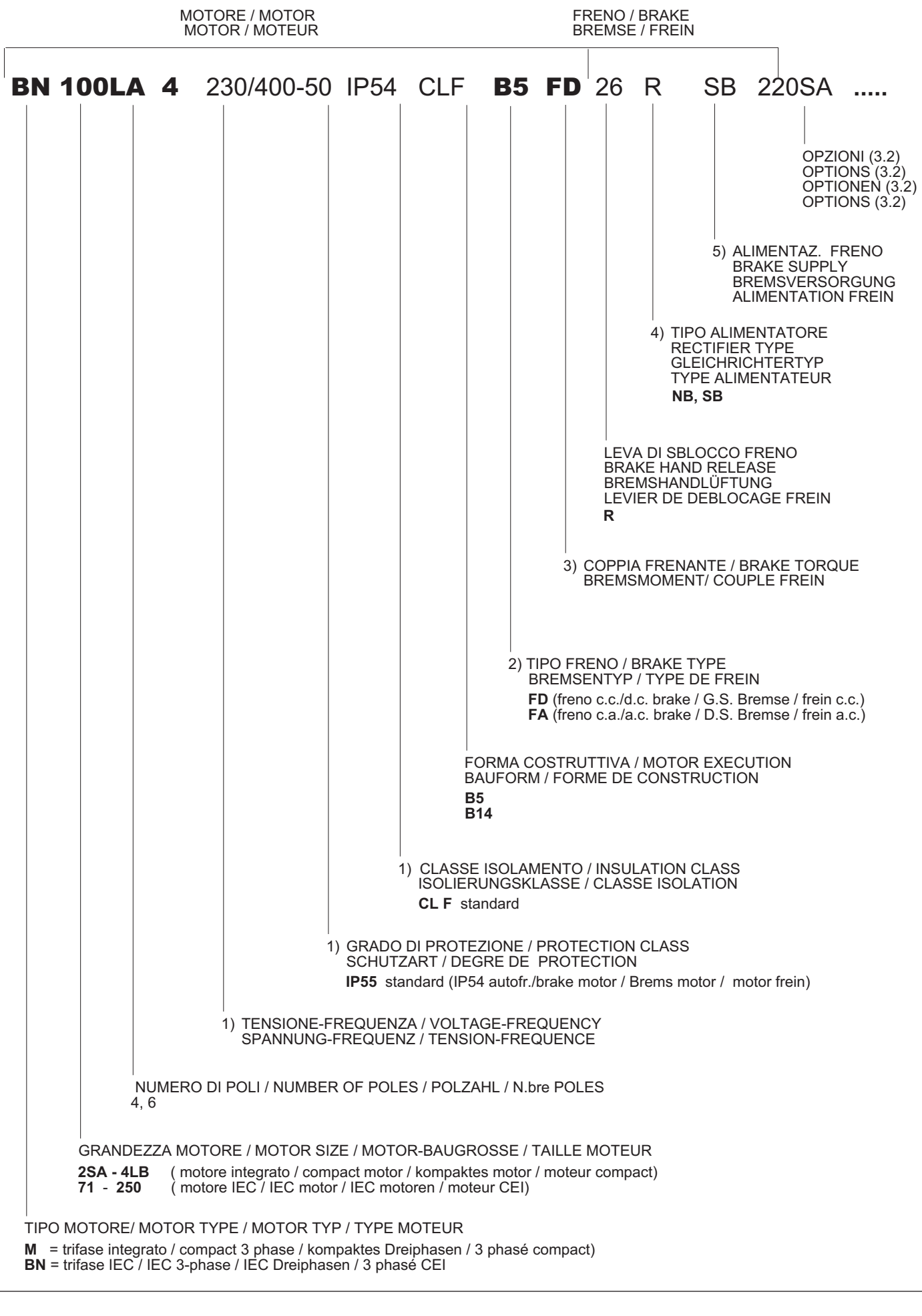
* ± 30% per motori con Pn < 1 kW

* ± 30% for motors with Pn < 1 kW

* ± 30% für Motoren mit Pn < 1 kW

* ± 30% pour moteurs avec Pn < 1 kW

38.0 **DESIGNAZIONE MOTORE** | 38.0 **MOTOR DESIGNATION** | 38.0 **MOTOR-BEZEICHNUNG** | 38.0 **DESIGNATION MOTEUR**



38.1 Note motori

1)
- TENSIONE - FREQUENZA
Da indicare sempre. Tensioni standard come descritto al par. 30.5.1.

- GRADO DI PROTEZIONE
Protezione IP56 (IP55 per autofrenanti) a richiesta.

- CLASSE DI ISOLAMENTO
Classi di isolamento H a richiesta.

2) TIPO DI FRENO
Disponibile, a richiesta, freno FA (freno c.a.).
Se non specificato il freno è omesso.

3) COPPIA FRENANTE
Valori standard come riportato nelle tabelle dati motore.
Altre coppie a richiesta (vedi tab. C23 - tipo FD, per tipo FA veditab. C27).

4) TIPO DI ALIMENTATORE
Da indicare solo per freni FD.
A richiesta, per i freni FD02, FD03, FD53, FD04, FD14, FD05, FD15, può essere fornito il raddrizzatore SB.

5) ALIMENTAZIONE FRENO

Freni tipo FD
Tensione alimentazione come descritto al parag. 6.2.
Per alimentazione freno separata indicare:
a) il valore di tensione richiesto seguito da **SA** (p.e. 290SA);
b) nel caso di alimentazione diretta del freno in c.c. indicare il valore di tensione seguito da **SD** (p.e. 24SD); in questo caso il raddrizzatore è escluso dalla fornitura.
Freni tipo FA
Tensione alimentazione come descritto al par. 30.6.3.
Per alimentazione freno separata indicare il valore di tensione seguito da **SA** (p.e. 290SA).

Se non specificati espressamente, i dati previsti nei campi sopra indicati saranno assunti corrispondenti alla versione standard a catalogo.

38.1 Notes on motors

1)
- VOLTAGE - FREQUENCY
To be always specified when special voltages are required. Standard voltage as per par. 30.5.1.

- PROTECTION CLASS
IP56 protection class upon request (IP55 for brake motors).

- INSULATION CLASS
Isolation class H upon request.

2) BRAKE TYPE
FA brake (a.c. brake) also available on request.
Brake omitted if brake type not specified.

3) BRAKE TORQUE
Standard values as in the motor data table.
Upon requiest are available other torques (for FD type see table C23, for FA type see table C27)

4) RECTIFIER TYPE
To be indicated only for brakes type FD.
Upon request for brakes FD02, FD03, FD53, FD04, FD14, FD05, FD15, the rectifier SB can be supplied.

5) BRAKE SUPPLY

Brakes type FD.
Power supply as described at paragraph 6.2.
For external power supply, it must be stated:
a) the voltage value required followed by **SA** (e.g. 290SA);
b) in case of direct power supply of d.c. brake, state the voltage value followed by **SD** (e.g. 24SD); in this case the rectifier will be not supplied.
Brakes type FA.
Power supply as described at paragraph 30.6.3.
For external power supply, state the voltage value followed by **SA** (e.g. 290SA).

If not specified, the data as above will be understood as the ones corresponding to the standard catalogue version.

38.1 Anmerkungen zu den Motoren

1)
-SPANNUNG - FREQUENZ
Ist immer anzugeben. Standardspannungen wie in Abschnitt 30.5.1 beschrieben

- SCHUTZART
Auf Anfrage IP56 (IP55 für Bremsmotoren) lieferbar.

-ISOLIERSTOFFKLASSE
Isolierstoffklasse H auf Anfrage lieferbar.

2) BREMSENTYP
Lieferbar auf Anfrage auch Bremse FA (Drehstrombremse).
Wenn nicht anders angegeben, fehlt die Bremse.

3) BREMSMOMENT
Standardwerte können aus den Datenblättern entnommen werden.
Andere Momente sind auf Anfrage verfügbar für Typ FD (siehe Tabelle C23, für Typ FA, siehe Tabelle C27).

4) GLEICHRICHTERTYP
Ist nur für Bremse Typ FD anzugeben.
Auf Anfrage für Bremsen Typ FD02, FD03, FD53, FD04, FD14, FD05, FD15, kann das Gleichrichtertyp SB geliefert werden.

5) BREMSSPANNUNGS-VERSORGUNG
Bremstyp FD.
Spannungsversorgung ist im Abschnitt 6.2 angegeben.
Für getrennte Spannungsversorgung, sind anzugeben:
a) den angefragten Spannungswert, gefolgt von **SA** (z.B. 290SA);
b) im Fall von direkten Spannungsversorgung von G.S.-Bremsen, muß man den Spannungswert gefolgt von **SD** angeben(z.B. 24SD); in diesem Fall erfolgt die Lieferung ohne Gleichrichter.
Bremstyp FA.
Spannungsversorgung ist im Abschnitt 30.6.3.
Für getrennte Spannungsversorgung, muß man den Spannungswert gefolgt von **SA** angeben(z.B. 290SA).

Wenn nicht angegeben, werden die obengenannten Daten als Standardausführung wie im Katalog verstanden.

38.1 Remarques moteurs

1)
- TENSION - FREQUENCE
A préciser dans tous les cas quand des tensions ou fréquences sont demandées. Tensions standard comme indiqué au par. 30.5.1.

- DEGRE DE PROTECTION
Protection IP56 (IP55 pour moteurs freins) sur demande.

- CLASSE D'ISOLATION
Classes d'isolation H sur demande.

2) TYPE DE FREIN
Frein FA (frein c.a.) egalement disponible, sur demande.
Si non spécifié, le frein est omis.

3) COUPLE DE FREINAGE
Valeurs standard comme indiqué dans les tableaux des caractéristiques moteurs.
Couples différents sur demande (voir tableau C23, type FD, pour type FA voir tableau C27).

4) TYPE D'ALIMENTATEUR
A préciser seulement pour type FD.Sur demande, pour les freins FD02, FD03, FD53, FD04, FD14, FD05, FD15, il est possible de fournir le redresseur SB.

5) ALIMENTATION DU FREIN

Freins type FD
Tension d'alimentation comme définie au paragraphe 6.2.
Pour une alimentation separée du frein, indiquer:
a) la valeur de tension requise suivie de **SA** (ex. 280SA);
b) dans le cas d'une alimentation directe du frein en courant continue indiquer la valeur de tension à la suite de **SD** (EX. 24 SD); dans ce cas le redresseur est exclu de la fourniture.
Frein type FA
tension d'alimentation comme définie au paragraphe 30.6.3.
Pour une alimentation du frein separée indiquer la valeur de tension à la suite de **SA** (ex. 290SA).

En l'absence de précision, les caracteristiques prévues dans le domaine ci-dessus indiqué seront celles prévues du catalogue pour la version standard.

30.3.2 Opzioni motori

AA, AC, AD
Posizione angolare leva di blocco freno rispetto alla posizione morsettiera visto lato ventola.
Posizione standard = 90° orari
AA = 0°, AC = 180°, AD = 90° antiorari.

CF
Filtro capacitivo (solo per freni FD).

D3
No. 3 sonde bimetalliche (in accordo alle classe di isolamento).

E3
No. 3 Termistori PTC (in accordo alla classe di isolamento).

E6
No. 3 Termistori di intervento in accordo alla classe di isolamento + No. 3 termistori di allarme in accordo alla classe inferiore a quella di isolamento (es: F + B o H + F).

F1
Volano per avviamento progressivo (escluso BN160 - BN280.

H1
Riscaldatori anticondensa.
Alimentazione standard 230V ± 10%.

30.3.2 Motor options

AA, AC, AD
Angular position of the brake release lever with respect to the terminal box position loocking from fan side.
Standard position = 90° clockwise.
AA = 0°, AC = 180°, AD = 90° counterclockwise.

CF
Capacitive filter (only for brake FD).

D3
No. 3 bimetallic thermostates (according to the insulation class).

E3
No. 3 thermistors PTC (according to the insulation class).

E6
No.3 switching thermistors according to the insulation class + No. 3 alarm thermistors according to the the class lower than the insulation class (f.e.: F+B or H+F).

F1
Flywheel for soft start (excluding BN160 - BN 280).

H1
Anti-condensate heaters.
Standard voltage 230V ± 10%.

30.3.2 Optionen Motoren

AA, AC, AD
Geben die Lage des Bremslüfterhebels zum Klemmenkasten an. Standard ist 90° im Uhrzeigersinn beim Ansehen der Lüfterradseite.
AA = 0°, AC = 180°, AD=90° entgegen dem Uhrzeigersinn.

CF
Kapazitiver Filter (nur für Bremse FD).

D3
3 Bimetallfühler (gemäß der Isolierstoffklasse).

E3
3 Kaltleiterthermistoren PTC (gemäß der Isolierstoffklasse).

E6
3 Thermistoren wie für E3 gemäß Isolierstoffklasse + 3 Thermistoren zur Alarmmeldung. Ansprechtemperatur entspricht der nächst niedrigen Isolierstoffklasse (z.B.: F+B oder H+F).

F1
Schwungrad zum sanften Anfahren (schließt BN160 - BN280).

H1
Wicklungsheizung.
Standardspannung 230 V ± 10%.

30.3.2 Options moteurs

AA, AC, AD
Position angulaire du levier de déblocage du frein par rapport à la position de la boîte à borne en regardant du côté du ventilateur.
Position standard = 90° sens horaire.
AA = 0°, AC = 180°, AD = 90° sens anti-horaire.

CF
Filtre capacitif (seulement pour frein FD).

D3
3 sondes bimétalliques (selon les classes d'isolation.

E3
3 thérmistances PTC (selon les classes d'isolation).

E6
3 thérmistances d'intervention selon les classes d'isolation + 3 thérmistances d'alarme selon la classe inférieure à celle d'isolation (ex. F+B ou H+F).

F1
Volant pour démarrage progressif (exclue BN160 - BN280)

H1
Réchauffeurs anticondensation.
Alimentation standard 230 V ± 10%.

M3
Morsettiera a 9 morsetti (Escluso gr. 71).

PN
Potenza a 60 Hz corrispondente alla potenza normallizzata a 50 Hz.

PS
Doppia estremità d'albero (esclude opzione RC e U1).

PT
Motore standard 220/380 - 50 Hz alimentato a 220/380 - 60 Hz (con declassamento di coppia).

RC
Tettuccio parapioggia (esclude opzione PS).

RV
Bilanciamento rotore in grado di vibrazione R.

TP
Tropicalizzazione.

U1
Servoventilazione (esclude opzione PS).

M3
Terminal box: 9 terminals. (Sizes 71 excluded).

PN
60 Hz power corresponding to the normalised 50 Hz power.

PS
Double shaft extension (excluding RC and U1 options).

PT
Standard motor 220/380V - 50 Hz supplied at 220/380V - 60 Hz (with torque derating).

RC
Rain canopy (excluding option PS).

RV
Rotor balancing in vibration class R.

TP
Tropicalization.

U1
Servoventilation (excluding option PS).

M3
Klemmkasten mit 9 Klemmen. (Mit Ausnahme von Baugröße 71).

PN
Die 60 Hz- Leistung wird an 50 Hz Normleistung angegliechen.

PS
Zweites Wellenende (schließt die Optionen RC und U1 aus).

PT
Der standardmäßig an 220/380V - 50 Hz zu betreibenden Motor wird mit der Leistung bei 220/380V- 60 Hz getrieben.

RC
Schutzdach (schließt Option PS aus).

RV
Läufer in Vibrationsgrad R ausgewuchtet.

TP
Tropenfestigkeit.

U1
Fremdbelüftung (schließt Option PS aus).

M3
Boîte à bornes (9 bornes). (Exclu taille 71).

PN
Puissance à 60 Hz correspondante à la puissance normalisée à 50 Hz.

PS
Double extrémité d'arbre (à l'exclusion de l'option RC et U1).

PT
Moteur standard 220/380- 50 Hz alimenté à 220/380 - 60 Hz (avec déclassement de couple).

RC
Capot de protection antipluie (exclu option PS).

RV
Equilibrage rotor avec degré de vibration R.

TP
Tropicalisation.

U1
Servo-ventilateur (option PS exclue).

39.0 CARATTERISTICHE MECCANICHE

39.1 FORME COSTRUTTIVE

I motori serie IEC sono previsti nelle forme costruttive indicate in tabella (C4) secondo le Norme CEI 2-14/ IEC 34-7.

Le forme costruttive sono le seguenti:

IM B5 (base)
IM V1, IM V3 (derivate)

I motori in forma costruttiva IM B5 possono essere installati nelle posizioni IM V1 e IM V3.
In questi casi, sulla targa del motore sarà indicata la forma costruttiva base IM B5.
Nelle forme costruttive dove il motore assume una posizione verticale con albero in basso, si consiglia di richiedere l'esecuzione con tettuccio parapioggia (da prevedere sempre nel caso di motori autofrenanti).
Tale esecuzione, prevista nelle opzioni, va richiesta espressamente in fase di ordine in quanto non è prevista nella versione base.

39.0 MECHANICAL CHARACTERISTICS

39.1 VERSIONS

IEC motors are available in the design versions indicated in table (C4) in line with Standards CEI 2-14/IEC 34-7.

The design range comprises:

IM B5 (basic)
IM V1, IM V3 (derived)

IM B5 design motors can be installed in positions IM V1 and IM V3.
In such cases, the basic design IM B5 is indicated on the motor name plate.
In design versions with a vertically located motor and shaft downwards, it is recommended to request the rain canopy (always necessary for brake motors). This facility, included in the options, should be specified when ordering as it is not part of the basic version.

39.0 MECHANISCHE EIGENSCHAFTEN

39.1 BAUFORMEN

Die Motoren der Serie IEC weisen die in der Abbildung (C4) angegebene Bauform gemäß den Normen CEI 2-14/IEC 34-7 auf.

Die Bauformen sind:

IM B5 (Grundmodell)
IM V1, IM V3 (Ableitungen)

Die Motoren mit der Bauform IM B5 können mit den Einbaulagen IM V1 und IM V3 eingebaut werden.
In diesen Fällen ist auf dem Leistungsschild des Motors die Bauform IM B5 angegeben.
Bei Bauformen mit vertikaler Lage des Motors und nach unten gerichteter Welle wird die Aus-führung mit Regenschutzabdeckung empfohlen (bei Brems- motoren stets vorzusehen). Dieses wahlweise Zubehör muß ausdrücklich zum Zeitpunkt der Bestellung verlangt werden, da es bei der Grundausführung nicht vorgesehen ist.

39.0 CARACTERISTIQUES MECANIQUES

39.1 FORMES DE CONSTRUCTION

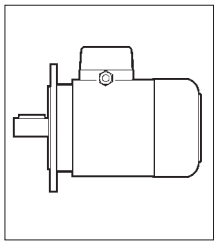
Les moteurs série IEC sont prévus dans les formes de construction indiquées sur le tableau (C4) selon les normes CEI 2-14/IEC 34-7.

Les formes de construction sont les suivantes:

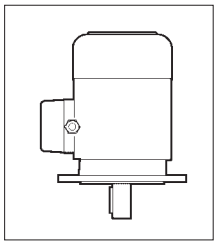
IM B5 (base)
IM V1, IM V3 (dérivées)

Les moteurs en forme de construction IM B5 peuvent être installés dans les positions IM V1 et IM V3.
Dans ces cas, la forme de construction base IM B5 sera indiquée sur la plaque du moteur. Dans les formes de construction où le moteur présente une position verticale avec arbre vers le bas, nous conseillons de demander l'exécution avec capot de protection contre la pluie (à prévoir toujours dans le cas de moteurs freins).
Cette exécution, prévue dans les options, doit être expressément demandée en phase de commande étant donné qu'elle n'est pas prévue dans la version de base.

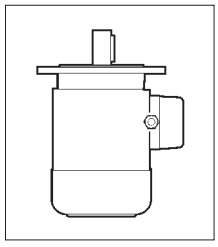
(A27)



IM B5



IM V1



IM V3

39.2 Grado di protezione

I motori sono previsti nella soluzione standard con un grado di protezione IP55 (IP54 per autofrenante) in accordo alle Norme CEI 2-16 / IEC 34-5.
Su richiesta possono essere forniti con grado di protezione aumentato IP56 (IP55 per autofrenante).
Per installazione all'aperto i motori debbono essere protetti dall'irraggiamento diretto e, nel caso di montaggio in posizione verticale con l'albero in basso, è necessario prevedere il tettuccio di protezione.

39.3 Ventilazione

I motori sono raffreddati mediante ventilazione esterna (IC 411 secondo CEI 2-7 / IEC 34-6) e sono provvisti di ventola radiale in plastica che funziona in entrambi i sensi di rotazione.
L'installazione deve assicurare una distanza minima dalla calotta copriventola alla parete in modo da non avere impedimenti all'ingresso aria e permettere la possibilità di eseguire l'opportuna manutenzione del motore e, se previsto, del freno.
Su richiesta è possibile prevedere una ventilazione forzata indipendente (IC 416). Questa soluzione consente di aumentare il fattore di utilizzo del motore nel caso di alimentazione da inverter e funzionamento a giri ridotti (vedi par. 30.7.3 per maggiori dettagli).

39.4 Senso di rotazione

E' possibile il funzionamento di entrambi i sensi di rotazione.
Con collegamento dei morsetti U1,V1,W1 alle fasi di linea L1,L2,L3 si ha rotazione oraria vista dal lato accoppiamento, mentre la marcia antioraria si ottiene scambiando fra loro due fasi.

39.5 Rumorosità

I valori di rumorosità, rilevati secondo il metodo previsto dalle Norme ISO 1680, sono contenuti entro i livelli massimi previsti dalle Norme CEI 2-24 / IEC 34-9.

39.6 Vibrazioni ed equilibratura

Tutti i motori sono equilibrati con mezza linguetta e rientrano nei limiti di intensità di vibrazione previsti dalle Norme CEI 2-23 / IEC 34-14.
Per particolari esigenze di silenziosità potrà essere previsto, a richiesta, un'esecuzione antivibrante in grado ridotto (R).
La tabella (A28) riporta i valori della velocità efficace di vibrazione per equilibratura normale (N) e ridotta (R).

39.2 Protection class

Motors are supplied standard with IP55 protection class (IP54 for brake motors) to CEI standards 2-16 / IEC 34-5.
On request, motors can be supplied with a higher protection class IP56 (IP55 for brake motors).
For outdoor installation, motors must be protected from direct sunlight and if mounted vertically with shaft downwards, the rain canopy must be provided.

39.3 Ventilation

The motors are cooled by external ventilation (IC 411 to CEI 2-7 / IEC 34-6) and are equipped with a plastic fan working in both directions.
The motors must be installed allowing sufficient space between fan cowl and nearest wall to ensure free air intake and allow access for maintenance on motor and brake, if supplied.
Independent, forced air ventilation (IC 416) can be supplied on request.
This solution enables to increase the motor duty factor when driven by an inverter and operating at reduced speed (for further details, refer to paragraph 30.7.3)

39.4 Direction of rotation

Rotation is possible in both directions. If terminals U1, V1, and W1 are connected to line phases L1,L2 and L3, clockwise rotation (looking from drive end) is obtained. For counterclockwise rotation, switch two phases.

39.5 Noise

Noise levels, measured using the method prescribed by ISO 1680 Standards, are within the maximum levels specified by Standards CEI 2-24 / IEC 34-9.

39.6 Vibrations and balancing

All rotors are balanced with half key and fall within the vibration class N, as specified by Standard CEI 2-23 / IEC 34-14.
If a particular low noise level is required, upon requeset, a reduced degree antivibration version (R) is available.
Table (A28) shows the effective vibration speed values for standard (N) and reduced (R) balancing.

39.2 Schutzart

Die Motoren verfügen in der Standardausführung gemäß den Normen CEI 2-16 und IEC 34-5 über die Schutzart IP55 (IP54 bei Bremsmotoren).
Auf Wunsch können sie auch mit Schutzart IP56 (IP55 für Brems-motoren) geliefert werden.
Bei Installation im Freien müssen die Motoren vor direkter Sonneneinstrahlung geschützt und, wenn bei vertikaler Einbaulage und Welle nach unten, mit einer Schutzabdeckung versehen werden.

39.3 Lüftung

Die Motoren sind eigenbelüftet (IC 411 gemäß CEI 2-7 / IEC 34-6) und verfügen über ein Radiallüfterrad aus Kunststoff, das in beiden Drehrichtungen arbeiten kann.
Bei der Installation muß sichergestellt werden, daß die Lüfterrad-abdeckung soweit von der Wand entfernt ist, daß der Lufteintritt nicht behindert wird, und daß der Motor und (falls vorhanden) die Bremse problemlos gewartet werden können.
Auf Wunsch können die Motoren mit Fremdbelüftung geliefert werden (IC 416). Diese Lösung ermöglicht das Motorbetriebsfaktor zu erhöhen, wenn vom Frequenzumrichter gesteuert und zu niedrigen Geschwindigkeit betrieben (siehe Abschnitt 30.7.3 für weitere Informationen).

39.4 Drehrichtung

Der Betrieb in beiden Drehrichtungen ist möglich.
Schließt man die Klemmen U1, V1, W1 an die Phasen L1, L2, L3 an, dreht sich der Motor im Uhrzeigersinn (von der Verbindungsseite her betrachtet); die Drehung im Gegenuhrzeigersinn erhält man, indem man zwei Phasen vertauscht.

39.5 Geräuschpegel

Die mit der von der ISO-Norm 1680 vorgesehenen Methoden gemessenen Lärmstärkewerte liegen innerhalb der gemäß den Normen CEI 2-24 und IEC 34-9 zulässigen Höchstgrenzen.

39.6 Schwingungen und Ausgleich

Alle Rotoren werden durch einen halben Federkeil ausgeglichen und fallen somit unter die, von den Normen CEI 2-23 / IEC 34-14 vorgesehenen Scwingungsgradgrenzen.
Bei besonderen Anforderungen an die Laufruhe kann auf Anfrage eine schwingungsdämpfende Ausführung in der reduzierten Klasse (R) geliefert werden.
Die tabelle (A28) führt die Effektivwerte der Schwingungsgeschwindigkeit für einen normalen (N) und reduzierten (R) Ausgleich auf.

39.2 Degré de protection

Les moteurs sont prévus dans la version standard avec un degré de protection IP55 (IP54 pour moteur frein) conformément aux normes CEI 2-16 / IEC 34-5.
Sur demande, ils peuvent être fournis avec un degré de protection supérieur IP56 (IP55 pour moteurs freins). Pour l'installation à ciel ouvert, les moteurs doivent être protégés du rayonnement direct et dans le cas de montage en position verticale, avec l'arbre en bas, il est nécessaire de prévoir un capot de protection.

39.3 Ventilation

Les moteurs sont refroidis à l'aide d'une ventilation extérieure (IC 411 selon CEI 2-7, IEC 34-6) et sont dotés d'un ventilateur à ailettes en plastique qui fonctionne dans les deux sens de rotation.
L'installation doit assurer une distance minimum entre le capot de protection du ventilateur et la paroi afin de permettre une bonne circulation de l'air et rendre plus aisé l'entretien du moteur et si prévu, du frein.
Sur demande, il est possible de prévoir une ventilation forcée indépendante (IC 416).
Cette solution permet d'augmenter le facteur d'utilisation du moteur en cas d'alimentation, via un variateur de fréquence, et pour un fonctionnement à faible vitesse (voir paragraphe 30.7.3 pour plus de détails).

39.4 Sens de rotation

Un fonctionnement dans les deux sens de rotation est possible. Avec raccordement des bornes U1, V1,W1 aux phases de ligne L1, L2,L3, on a la rotation dans le sens des aiguilles d'une montre vue du côté liaison alors que le sens inverse s'obtient en intervertissant les deux phases entre elles.

39.5 Niveau de bruit

Les valeurs relevées selon la méthode prévue par les normes ISO 1680 sont situées sous les niveaux maximums prévus par les normes CEI 2-24 / IEC 34-9.

39.6 Vibrations et équilibrage

Tous les rotors sont équilibrès avec une demi languette et rentrent dans les limites d'intensité de vibration prévues par les Normes CEI 2-23 / IEC 34/14.
En cas d'exigences particulière concernat le niveau de bruit, sur demande, il est possible de réaliser une exécution anti-vibrante, de degré réduit (R).

Le tableau (A28) indique les valeurs de la vitesse efficace de vibration pour un équilibrage normal (N) et rèpduit (R).

(A28)

Grado di vibrazione Vibration degree Schwingungsklasse Degré de vibration	Velocità di rotazione n (min^{-1}) Rotation speed n (min^{-1}) Drehungsgeschwindigkeit n (min^{-1}) Vitesse de rotation n (min^{-1})	Limiti della velocità di vibrazione (mm/s) Limits of the vibration velocity (mm/s) Grenzen der Schwingungsgeschwindigkeit (mm/s) Limites de la vitesse de vibration (mm/s)		
		71 - 132	**160 - 225**	**250 - 180**
N	600 - 1800 >1800 - 3600	1.8 1.8	1.8 2.8	2.8 4.5
R	600 - 1800 >1800 - 3600	0.71 1.12	1.12 1.8	1.8 2.8

I valori si riferiscono a misure con motore liberamente sospeso e funzionamento a vuoto.

Values refer to measures with freely suspended motor and void-operation.

Die Werte beziehen sich auf die Abmessungen mit stehendem Motor, ohne Getriebe und Leerlauf.

Les valeurs se réfèrent à des mesures avec moteur librement suspendu et fonctionnement à vide.

39.7 **Tolleranze dimensionali**

L'estremità d'albero, la linguetta e la flangia hanno dimensioni e tolleranze secondo CEI-UNEL 13502, CEI-UNEL 13501, IEC 72.
Le estremità d'albero sono provviste di foro filettato in testa secondo UNI 3221, DIN 332.
I motori vengono forniti con linguetta inserita.
La tabella (A29) riporta le tolleranze relative ai componenti dei motori elettrici BONFIGLIOLI RIDUTTORI.

39.7 **Tolerances**

Dimensions and tolerances of shaft ends, keys and flanges are according to CEI-UNEL 13502, CEI-UNEL 13501, IEC 72.
The shaft ends are supplied with tapped hole on the head according to UNI 3221, DIN 332.
The motors are supplied with key.
Table (A29) shows tolerances for components of BONFIGLIOLI RIDUTTORI electric motors.

39.7 **Toleranzen**

Die Wellenende-,Feder-und Flanschabmessungen und -toleranzen sind gemäß CEI-UNEL 13502, CEI-UNEL 13501, IEC 72.
Die Wellenenden sind mit Gewindebohrung auf den Kopf gemäß UNI 3221, DIN 332 geliefert.
Die Motoren werden mit Federkeil geliefert.
Die Tabelle (A29) zeigt die Toleranzen der Komponenten der Elektromotoren von BONFIGLIOLI RIDUTTORI.

39.7 **Tolérances**

Le bout d'arbre, la clavette et la bride ont les dimensions et les tolérances selon CEI-UNEL 13502, CEI-UNEL 13501, IEC 72.
Les bouts d'arbre sont prévus avec trous taraudés selon UNI 3221, DIN 332.
Les moteurs sont fournis avec clavette montée.
Le tableau (A29) présente les tolérances relatives aux composants des moteurs électriques BONFIGLIOLI RIDUTTORI.

(A29)

Componenti / Components / Komponenten / Composants	Dimensioni / Dimensions Abmessungen / Dimensions		Tolleranza / Tolerance Toleranz / Tolérance
Estremità albero / Shaft extension / Wellenende / Extrémité arbre	**D - DA**	ø 14 – 28	**j6**
		ø 38 – 48	**k6**
		ø 55 – 100	**m6**
Linguetta / Key / Federkeil / Clavette	**F - FA**		**h9**
Flangia / Flange / Flansch / Bride	**N**	< ø 250	**j6**
		≥ ø 250	**h6**

39.8 **Morsettiera motore**

La scatola coprimorsettiera è prevista di serie con un bocchettone pressacavo. La morsettiera principale è a sei morsetti per collegamento con capicorda. All'interno della scatola è previsto un morsetto per il conduttore di protezione.
Le dimensioni dei perni di attacco sono riportate nella tabella (A30).
Nel caso di motori autofrenanti, il raddrizzatore per l'alimentazione del freno è fissato all'interno della scatola e provvisto di adeguati morsetti di collegamento.
Eseguire i collegamenti secondo gli schemi riportati all'interno della scatola coprimorsetti o nei manuali d'uso.

39.8 **Motor terminal box**

The terminal box is provided as standard with one cable gland.
The main terminal board has six terminals for connection to the lead-in wire.
A terminal for the protective conductor is provided inside the box.
Terminals dimensions are listed in table (A30).
For brake motors, the brake rectifier is fitted inside the box and has adequate connecting terminals.
All connections must be carried out according to the diagrams inside the terminal box or in the instruction manuals.

39.8 **Motorklemmenkasten**

Der Klemmkasten verfügt serienmäßig über eine Kabeldurch-führung. Die Hauptklemmleiste hat 6 Klemmen für den Anschluß mit Kabelschuhen. Im Innern des Klemmenkasten befindet sich eine Klemme für den Schutzleiter.
Die Abmessungen der Auschüsse sind in Tabelle (A30) angegeben.
Bei den Bremsmotoren befindet sich auch der mit den erforderlichen Anschlußklemmen ausgestattete Gleichrichter für die Stromversorgung der Bremse im Klemmenkasten.
Die Anschlüße müssen gemäß den Diagrammen im Klemmkasten oder in den Betriebsanwiesungen durchgeführt werden.

39.8 **Bornier moteur**

Le couvercle du bornier est prévu de série avec un presseétoupe de fixation du câble. Le bornier principal prevoit six bornes pour raccordement avec cosses. Dans le boîtier se trouve une borne pour le conducteur de protection. Les dimensions des axes de fixation sont reportées dans le tableau (A30).
Dans le cas de moteurs freins, le redresseur pour l'alimentation du frein est fixé à l'intérieur du boîtier et est doté de bornes spéciales de raccordement.
Effectuer les connexions selon les schémas indiqués à l'intérieur du bornier, ou dans les manuels d'utilisation.

(A30)

Tipo / Motor type / Motortyp / Moteur type		Avviamento / Starting Start / Démarrage	Numero morsetti / Number of terminals Klemmenanzahl / Nombre bornes	Filettatura perni di attacco / Terminal threads Gewinde der Verbindungszapfen / Filetage axe de fixation
BN 71	**—**	diretto direct direkt direct	6	M4
BN 80 - 90	**M2.**			M4
BN 100 - 112	**M3.**			M5
BN 132	**M4.**			M5
BN 160	**—**			M6

39.9 Ingresso cavi

Nell'esecuzione standard, l'ingresso dei cavi è previsto secondo le dimensioni e le disposizioni indicate nella tabella (A31):

39.9 Cable entry

In the standard version, cable entry is provided according to the dimensions and locations shown in table (A31):

39.9 Kabeldurchführung

Bei der Standardausführung ist die Kabeldurchführung wie in Tabelle (A31) angegeben angeordnet und dimensioniert:

39.9 Entrée câbles

Dans l'exécution standard, l'entrée des câbles est prévue selon les dimensions et les dispositions indiquées dans le tableau (A31):

(A31)

Tipo / Motor type Motortyp / Moteur type		Ingresso cavi / Cable entry / Kabeldurchführung / Entrée câbles		Diam. max. cavo allacciabile [mm] Max.cable diam. allowed Max. zulässiger Kabeldurchmesser Diam. maxi. câble
BN 71	**M1.**	2 x Pg13.5	1 bocchettone + 3 tappi filettati (2 fori per lato) 1 cable gland + 3 threaded plugs (2 holes on each side) 1 Durchführung + 3 Schraubdeckel (2Bohrung pro Seite) 1 presse-étoupe + 3 bouchons filetés (2 trous par côté)	12
BN 80 - 90	**M2.**	2 x Pg16	1 bocchettone + 1 tappo filettato 1 cable gland + 1 threaded plug 1 Durchführung + 1 Schraubdeckel 1 presse-étoupe + 1 bouchon fileté	15
BN 100 - 112	**M3.**	4 x Pg16		15
BN 132	**M4.**	4 x Pg21		19

39.10 Cuscinetti

I cuscinetti previsti sono del tipo radiale a sfere con lubrificazione permanente precaricati assialmente.
I tipi utilizzati sono indicati nelle tabella (A32). La durata nominale a fatica L_{10h} dei cuscinetti, in assenza di carichi esterni applicati è superiore a 40.000 ore calcolata secondo ISO 281.

39.10 Bearings

Life lubricated radial ball-bearings are supplied.
The types in use are indicated in table (A32).
Fatigue life of bearings L_{10h}, in the absence of external loads, is in excess of 40,000 hours calculated to ISO 281.

39.10 Lager

Bei den Lagern handelt es sich um Radialkugellager mit Dauerschmierung.
Die verwendeten Typen sind in den Tabelle (A32) angegeben.
Die Lebensdauer der Lager bei einer Beanspruchung L_{10h} ist, sofern keine externen Kräfte wirken, über 40.000 Stunden (Berechnung gemäß ISO 281).

39.10 Roulements

Les roulements prévus sont du type radial à billes avec lubrification permanente.
Les types utilisés sont indiqués dans les tableau (A32).
La résistance à la déformation L_{10h} des roulements en absence de charges extérieures appliquées est supérieure à 40.000 heures calculée selon ISO 281.

(A32)

Tipo / Motor type Motortyp / Moteur type	Cuscinetti / Bearings / Lager / Roulements		
	Lato comando / Shaft output Wellenseite / Sortie arbre	Lato opposto comando / Fan side Lüfterseite / Côté ventilateur	
		Motore normale / Normal motor normaler Motor / Moteur normal	Motore autofrenante / Brake motor Bremsmotor / Moteur frein
BN 71	6202 - 2Z - C3	6202 - 2Z - C3	6202 - 2RS - C3
BN 80	6204 - 2Z - C3	6204 - 2Z - C3	6204 - 2RS - C3
BN 90	6205 - 2Z - C3	6205 - 2Z - C3	6305 - 2RS - C3
BN 100	6206 - 2Z - C3	6206 - 2Z - C3	6206 - 2RS - C3
BN 112	6306 - 2Z - C3	6306 - 2Z - C3	6306 - 2RS - C3
BN 132	6308 - 2Z - C3	6308 - 2Z - C3	6308 - 2RS - C3
BN 160	6309 - 2Z - C3	6309 - 2Z - C3	6309 - 2RS - C3

40.0 CARATTERISTICHE ELETTRICHE

40.1 Tensione

I motori a una velocità di grandezza inferiore a 160 e i motori da M2 a M4 sono previsti nell'esecuzione normale per tensione nominale 230V Δ / 400V Y, 50 Hz con tolleranza di tensione ± 10% (escluso i tipi M3LC4 e M3LC6).
Per i tipi 160 - 280 la tensione standard è 400 Δ / 690 Y 50 Hz ± 10%.
I motori sono quindi adatti per funzionamento sulla rete di distribuzione europea con tensione in accordo alla pubblicazione IEC 38 (Eurotensione).

40.0 ELECTRIC CHARACTERISTICS

40.1 Voltage

Single polarity motors of IEC are provided in the normal version for voltage values 230V Δ /400V Y, 50 Hz with voltage tolerance of ± 10% (not including types M3LC4 and M3LC6).
Standard voltage for types 160 - 280 is 400Δ / 690 Y 50 Hz ± 10%.
Therefore motors are right to operate on the European voltage distribution net according to IEC 38 (Eurovoltage).

40.0 ELEKTRISCHE EIGENSCHAFTEN

40.1 Spannung

Die eintourigen Motoren müssen in der Standardausführung mit einer Spannung von 230 V Δ / 400 V Y, 50 Hz mit einer Toleranz von ± 10% gespeist werden (Type M3LC4 und M3LC6 ausgenommen).
Für die Typen 160 - 280 die Standardspannung folgende 400 Δ / 690 Y 50 ± 10%.
Darüber hinaus sind die Motoren geeignet für Spannungsbereiche gemäß IEC38 (Eurospannung) zu arbeiten.

40.0 CARACTERISTIQUES ELECTRIQUES

40.1 Tension

Les moteurs à polarité unique de taille CEI sont prévus dans l'exécution normale pour tension 230V Δ / 400V Y, 50 Hz avec tolérance de tension ± 10% (sauf les types M3CL4 et M3LC6).
Pour les types 160 - 280 la tension standard est 400 Δ / 690 Y 50 Hz ± 10%.
Les moteurs sont donc adaptés pour un fonctionnement sur le reseau électrique Européen avec tension en accord aux publications CEI 38 (Tension Européenne).

In targa sono indicati oltre alla tensione nominale i campi di funzionamento consentiti p.e.:
220 - 240V Δ
380 - 415V Y, 50 Hz.
In accordo alle Norme CEI 2-3, IEC 34-1 i motori possono funzionare alle tensioni sopra indicate con tolleranza del ± 5%.
Per funzionamento ai limiti di tolleranza la temperatura può superare di 10 K il limite previsto dalla classe di isolamento adottata.
In targa vengono indicati inoltre i valori corrispondenti al funzionamento a 60 Hz (p.e. 460Y, 60 Hz) ed il relativo campo di tensione:
440 - 480VY, 60 Hz.

(esclusi autofrenanti FD)

Per i motori autofrenanti con freno tipo FD le tensioni standard sono:
- grandezze 71 - 132, M2 - M4
220V - 240V Δ
380V - 415V Y, 50 Hz
con tensione di alimentazione freno 230V ± 10%.
- grandezze 160 - 280
380 - 415V Δ ,50 Hz
con tensione di alimentazione freno 400V ± 10%.

La tabella (A33) riporta le tensioni previste per i motori.

The plate indicates the rated voltage and the allowed operating fields as well, e.g.:
220-240V Δ
380-415V Y/50 Hz.
According to rules CEI 2-3, IEC 34-1 the motors can operate with the above mentioned voltages with tolerances of ± 5%.
For running at the tolerance limits, the temperature can exceed of 10 K the limit foreseen by the insulation class used.
Moreover on the name plate are indicated the values corresponding to the 60 Hz operating (i.e. 460 Y, 60 Hz) and the relevant voltage field, 440 - 480VY, 60 Hz.

(brake FD excluded)

Standard voltages for brake motors with brake type FD are the following:
- size 71 - 132, M2 - M4
220V - 240V Δ
380V - 415V Y, 50 Hz
with a brake power supply of 230V ± 10%.
- size 160 - 280
380V - 415V Δ ,50 Hz
with a brake power supply of 400V ± 10%.

Table (A33) indicates relevant motor voltages.

Auf dem Schild werden über die Nennspannung hinaus, auch die zulässigen Ansprechbereiche angegeben, z.B.:
220-240V Δ
380-415V Y/50 Hz.
Gemäß den Normen CEI 2-3, IEC 34-1 können die Motoren auf die oben genannten Spannungen mit Toleranzen von ± 5% arbeiten.
Bei Betrieb an den Spannungsgrenzen, kann die Temperatur bis zum 10K die für die verwendeten Isolierstoffklasse angegebenen Grenze überschreiten.
Darüber hinaus wird auf den Typensschild die dem 60 Hz-Betrieb entsprechenden Werte angegeben (d.h. 460 Y, 60 Hz) und das entsprechende Spannungsfeld, 440-480VY, 60 Hz.

(ausschließlich die selbstbremseden Versionen FD).

Für die selbstbremsenden Motoren mit dem Bremsetyp FD sind die Standardspannungen die folgende: - Baugrößen 71 - 132, M2 - M4
220V - 240V Δ
380V - 415V Y /50 Hz
mit Bremsspannungsversorgung von 230V ± 10%.
- Baugrößen 160 - 280
380V - 415V Y/50 Hz
mit Bremsspannungsversorgung von 400V ± 10%.

Die tabelle (A33) fürth die für die Motoren vorgesehenen Spannungen auf.

Outre la tension nominale, les plages de fonctionnement permises sont indiquées sur la plaquette signalètique, à savoir:
220-240V Δ
380-415V Y/50 Hz.
Selon les normes CEI 2-3, IEC 34-1 les moteurs peuvent fonctionner aux tension indiquées ci-dessus avec une tolérance de ± 5%.
Pour un fonctionnement à la limite de tolérance, la température peut dépasser les 10K, la limite prevue de la classe d'isolation choisie.
Sur la plaque marque sont de plus indiqués les valeurs correspondantes au fonctionnement en 60 Hz (ex.460Y, 60 Hz) et la relative plage de tension:
440 - 480VY, 60 Hz.

(à l'exclusion autofreinants FD)

En ce qui concerne les moteurs autofreinants avec frein de type FD, les tensions standard sont les suivantes:
- tailles 71 - 132, M2 - M4
220V - 240V Δ
380V - 415V Y /50 Hz
avec tension d'alimentation du frein 230V ± 10%.
- taille 160 - 280
380V - 415V Y /50 Hz
avec tension d'alimentation du frein 400V ± 10%.

La tableau (A33) indique les tensions prévues pour les moteurs.

(A33)

Motore / Motor / Motor / Moteur	Tensione / Voltage (± 10%) Spannung / Tension	Esecuzione avvolgimento / Winding type Wicklungsart / Exécution bobinage
71 - 132	230 Δ / 400Y, 50 Hz. 460Y 60Hz	Standard
160 -280	400 Δ / 690Y 50Hz 460 Δ 60 Hz	Standard
100 - 132	400 Δ / 690Y 50Hz 460 Δ 60 Hz	A richiesta

Nella tabella (A34) sono indicati i vari tipi di collegamenti previsti per i motori in funzione della polarità.

In the table (A34) are to be found the several connection types foreseen for motors.

Auf die Tabelle (A34) werden die verschiedenen für die Motoren vorgesehenen Anschlußtypen angegeben.

Dans le tableau (A34) sont indiqués les differents types de connexion prevus pour les moteurs.

(A34)

Motore / Motor / Motor / Moteur	Poli / Pole / Polig / Pôles	Collegamento avvolgimento / Winding connection Wicklungsanschlußß / Connexion du bobinage
71 - 280	4, 6	Δ / Y

I motori a singola polarità richiesti con tensione nel campo 200≤V≤346V sono realizzati con avvolgimento collegato a triangolo (p.e. richiesto 200V, esecuzione 200Δ/346Y V); per i tipi 71 - 132, M1 - M4 con tensioni V≥346V il collegamento è a stella (p.e. 400V, fornito 230Δ/400Y V), mentre per le grandezze 160 - 250, l'esecuzione standard e' a triangolo (p.e. richiesto 400V, fornito 400Δ/690Y V).

Per l'alimentazione dell'eventuale freno fare riferimento ai paragrafi 41.2 e 41.3

Single poles motors, with voltage 200≤V≤346V have delta-connected windings (e.g. 200V required, 200Δ/346Y V supplied). Motor size 71-132, M1 - M4 with voltage V≥346V have a connection of the star type (e.g. 400V required, 200Δ/346Y V supplied), whereas motor sizes 160 - 250 has a standard delta connection (e.g. 400V required, 400Δ/690Y V supplied).

As for brake power supply, refer to paragraph 41.2 and 41.3

Die einpoligen Motoren, die mit einer Spannung im Bereich von 200≤V≤346V angefordert werden, werden mit einer Wicklung mit Dreiecksschaltung verwirklicht (werden z.B. 200V gefordert, erhäit man die Ausführung 200Δ/346Y V); für die Typen 71-132, M1 - M4 mit Spannungen V≥346V hat man eine Sternschaltung (z.B. 400V, geliefert wird 230Δ/400Y V), während die Standardausführung für die Baugrößen 160 - 250, die Dreiecksschaltung ist (z.B. 400V gefordert, geliefert wird 400Δ/690Y V).

Für die Versorgung der eventuell vorhandenen Bremse, ist Bezug auf den Par. 41.2 und 41.3.

Les moteurs à simple polarité avec tension comprise dans la plage 200V-346V sont réalisés avec un bobinage braché en triangle (ex.requis 200V, execution 200Δ/346Y V; pour les types 71-132, M1-M4, avec des tension V≥346V le branchement est en étoille (ex. 400V, fourni 230Δ/400Y V)tandis que pour la tailles 160 - 250, l'exécution standard set en triangle (ex. 400V, fourni 400Δ/690Y V).

En ce qui concerne l'alimentation de léventuel frein, se référer au paragraphe 41.2 et 41.3

40.2 **Frequenza**

I motori ad una velocità nell'esecuzione standard riportano in targa oltre alle tensioni del funzionamento a 50 Hz il campo di tensione 440 - 480V 60 Hz (escluso motori autofrenanti con freno FD) con potenza aumentata di circa il 20%
La potenza di targa dei motori a 60Hz corrisponde a quanto riportato nella tabella (A35) seguente:

40.2 **Frequency**

In the name plate of single poles motors, standard version, besides the operating voltages at 50 Hz is also stated the voltage field 440 - 480V 60 Hz (except for brake motors with brake type FD) with an increased power of about 20%.
The power in the name plate of 60 Hz motors corresponds to the following table (A35):

40.2 **Frequenz**

Bei eintourigen Motoren in der Standardausführung wird außer den 50 Hz-Betriebsspannungen auch den Spannungsfeld 440 - 480V 60 Hz angegeben (mit Ausnahme von Bremsmotoren mit Bremsentyp FD) mit einer erhöhten Leistung von ungefähr 20%.
Die Leistung auf das Namenschild von 60 Hz-Motoren entspricht den Daten aus der folgenden Tabelle (A35):

40.2 **Fréquence**

Les moteurs à une vitesse en exécution standard reportent sur la plaque marque en plus des tension du fonctionnement à 50 Hz la plage de tension 440 - 480V 60 Hz (moteurs freins avec frein FD exclus) avec puissance augmentée de 20% env.
La puissance sur la plaque marque des moteurs à 60 Hz correspond à celle indiquée au tableau (A35) suivant:

(A35)

Motore / Motor Motoren / Moteur	4 poli / pole polig / pôles kW	6 poli / pole polig / pôles kW
63A	0.14	0.10
63B	0.21	0.14
71A	0.30	0.21
71B	0.45	0.30
80A	0.65	0.45
80B	0.90	0.65
90S	1.3	0.9
90SA	–	–
90L	–	1.3
90LA	1.8	–
100L	–	–
100LA	2.5	1.8
100LB	3.5	2.2
112M	–	–
	4.7	2.5
132S	6.5	3.5
132SA	–	–
132SB	–	–
132M	–	–
132MA	8.7	4.6
132MB	11	6.5

Motore / Motor Motoren / Moteur	4 poli / pole polig / pôles kW	6 poli / pole polig / pôles kW
160M	13	8.6
160MA	–	–
160MB	–	–
160 L	18	13
180M	22*	–
180L	26	18
200L	36	–
200LA	–	22
200LB	–	26
225S	45	–
225M	55	36
250M	65	45

Se la potenza richiesta a 60 Hz corrisponde alla potenza normalizzata a 50 Hz specificare in designazione l'opzione PN.
I motori avvolti per frequenza 50 Hz possono essere utilizzati in reti a 60 Hz secondo quanto riportato in tabella (A36).

If the required 60 Hz power corresponds to the normalized 50 Hz power, when designing it is necessary to specify the option PN.
Motors with windings suitable for 50 Hz can be used with 60 Hz supply nets according to the values shown in table (A36).

Wenn die angefragte 60 Hz-Leistung der normierten 50 Hz-Leistung entspricht, geben bei der Bezeichnung das Option PN an.
Die Motoren mit einer Wicklung für eine Frequenz von 50 Hz können entsprechend den Angaben von Tabelle (A36) an Netze mit 60 Hz angeschlossen werden.

Si la puissance requise à 60 Hz correspond à la puissance normalisée à 50 Hz on devra indiquer l'option PN.
Les moteurs bobinés pour fréquence 50 Hz peuvent être utilisés sur réseau à 60 Hz selon les indications du tableau (A36).

(A36)

Fattori di correzione dei valori a 50 Hz / Correction factors for 50Hz values Korrektionsfaktoren für 50 Hz-Werte / Facteurs de correction des valeurs à 50 Hz				
Tensione a 50 Hz Voltage at 50 Hz Spannung mit 50 Hz Tension à 50 Hz	Tensione a 60 Hz Voltage at 60 Hz Spannung mit 60 Hz Tension à 60 Hz	Potenza a 60 Hz Power at 60 Hz Leistung mit 60 Hz Puissance à 60 Hz	Coppia a 60 Hz Ma/Mn, Ms/Mn Torque at 60 Hz Ma/Mn, Ms/Mn Drehmoment mit 60Hz Ma/Mn,Ms/Mn Couple à 60 Hz Ma/Mn, Ms/Mn	Velocità a 60 Hz Speed at 60 Hz Drehzahl bei 60 Hz Vitesse à 60 Hz
V	V *	1	0.8	1.15
V	1,2 V **	1.2	1	1.2

* Escluso motori autofrenanti FA
** Escluso motori autofrenanti FD.

***** Not including brake motors FA.
** Not including brake motors FD.

***** Bremsmotoren FA ausgenommen.
** Bremsmotoren FD ausgenommen.

***** Moteurs frein FA exclus.
** Moteurs frein FD exclus

Per i motori con alimentazione da rete 220/380V 60 Hz e potenza relativa a 50 Hz, possono essere impiegati i motori normali (escluso motori a doppia polarità ed autofrenanti FA) accettando sovratemperature superiori e applicando i declassamenti riportati in tabella (A36); specificare in ordine l'opzione PT.

For motors with net power supply 220/380V 60 Hz and relevant 50 Hz power, standard motors can be used (except for double polarity motors and FA brake motors) accepting higher temperatures rises and applying the derating values as in table (A36); when ordering the option PT must be specified.

Für die Motoren mit Netzspannungsversorgung 220/380V 60 Hz und entsprechende 50 Hz-Leistung können die Standardmoto-ren verwendet werden (mit Ausnahme von polumschaltbaren Motoren und Bremsmotoren Typ FA), unter Annahme von höheren Temperatursteigerungen und bei Anwendung von der auf die Tabelle (A36) angegebenen Deklassierungen; bei der Bestellung muß das Option PT angegeben werden.

Pour les moteurs alimentés sur le réseau 220/380 60 Hz avec puissance correspondante à 50 Hz, des moteurs normaux peuvent être employés (moteurs à deux polarités et freins FA exclus) en acceptant des élévations de température supérieures et en appliquant les déclassements indiqués au tableau (A36); on devra indiquer l'option PT à la commande.

40.3 **Potenza nominale**

Le tabelle dei dati tecnici del catalogo riportano le caratteristiche funzionali a 50 Hz in condizioni ambientali standard secondo le Norme CEI 2-3 / IEC 34-1 (temperatura 40 °C e altitudine <1000 m s.l.m.).
I motori possono essere impiegati ad altitudini superiori e temperature comprese tra 40 °C e 60 °C applicando i declassamenti di potenza indicati nelle tabelle (A37) e (A38).

40.3 **Rated power**

The catalogue selection charts show technical data at 50 Hz under standard environmental conditions to CEI 2-3 / IEC 34-1 Standards (ambient temperature 40 °C and altitude <1000 m a.s.l.).

The motors can be used at higher altitudes and in the temperature range 40°C - 60°C by applying the derating factors indicated in tables (A37) and (A38).

40.3 **Nennleistung**

Die Betriebsdatentabellen des Katalogs enthalten die technischen Daten bei einer Frequenz von 50 Hz bei normalen Umgebungsbedingungen gemäß den Normen CEI 2-3 und IEC 34-1 (Temperatur 40°C und Höhe <1000 m ü.d.M.). Die Motoren können in größeren Höhen und bei Temperaturen zwischen 40°C und 60°C betrieben werden, wenn man die in den Tabellen (A37) und (A38) angegebenen Rückstufungen anwendet.

40.3 **Puissance nominale**

Les tableaux fonctionnels du catalogue présentent les caractéristiques techniques à 50 Hz dans des conditions ambiantes standard selon les normes CEI 2-3, IEC 34-1 (température 40°C et altitude <1000 m).
Les moteurs peuvent être employés à des altitudes supérieures et à des températures comprises entre 40°C et 60°C en appliquant les déclassements de puissance indiqués dans les tableaux (A37) et (A38).

(A37)

Temperatura ambiente / Ambient temperature / Umgebungstemperatur / Température ambiante(°C)	**40**	**45**	**50**	**55**	**60**
Potenza ammissibile in % della potenza nominale / Permitted power as a % of rated power Zulässige Leistung in % der Nennleistung / Puissance admissible en % de la puissance nominale	100	95	90	85	80

(A38)

Altitudine s.l.m. /Altitude a.s.l. / Höhe ü.d.M. / Altitude (m)	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**
Potenza ammissibile in % della potenza nominale / Permitted power as a % of rated power Zulässige Leistung in % der Nennleistung / Puissance admissible en % de la puissance nominal.	100	96	93	90	85	80	77

I coefficienti di potenza per variazione d'altitudine si riferiscono a temperatura ambiente compresa tra 30 e 40 °C.
Quando è richiesto un declassamento del motore superiore al 15%, contattare il ns. servizio tecnico.

The power coefficients for altitude variation refer to an ambient temperature between 30 and 40°C.
When is required a motor derating higher than 15%, contact our customers'assistance department.

Die Leistungskoeffizienten zur Höheänderung beziehen sich auf einer Umweltstemperatur zwischen 30 und 40°C.
Wenn eine Motordeklassierung höher als 15% gefragt ist, wir bitten um Rückfrage.

Les coefficients de puissance pour une variation d'altitude se réfènt à une température ambiente comprise entre 30° et 40 °C. Si un déclassement du moteur supérieur à 15% est requis, on devra contacter notre service technique.

40.4 Classe d'isolamento

I motori descritti in questo catalogo impiegano materiali isolanti (filo smaltato, isolanti di superfice, tipo d'impregnazione) in classe F o H.
L'accurata scelta dei componenti del sistema isolante consente l'impiego dei motori in climi tropicali ed in presenza di vibrazioni normali.
Per applicazioni in presenza di forti aggressivi chimici o elevata umidità contattare il ns. servizio tecnico.

40.4 Insulation class

The motors described in this catalogue use insulating materials (painted wire, surface insulation treatments, impregnation type) to Class F or H.
An accurate selection of insulation material allows use of motors in tropical climates at normal vibration level.
For applications in environments pervaded by very aggressive chemical elements or with high humidity, contact our technical service department.

40.4 Isolierstoffklasse

Die in diesem Katalog beschriebenen Motoren sind mit Isolierstoffen (Emaildraht, Oberflächenisolierungen, Typ der Imprägnierung) der Klasse F oder H.
Die sorgfältige Wahl der Komponenten des Isoliersystems gestattet den Betrieb der Motoren auch in tropischen Klimazonen.
Für Anwendungen in aggressiven oder abrasive Umgebungen oder mit hoher Luftfeuchte (90%) unseren Technischen Kundendienst zu Rate ziehen.

40.4 Classe d'isolation

Les moteurs décrits dans ce catalogue utilisent des matériaux isolants (fil émaillé, isolants de surface, type d'imprégnation) en classe F ou H.
Le choix soigné des composants du système d'isolation permet d'utiliser les moteurs dans des climats tropicaux et en présence de vibrations normales.
Pour les applications en présence de fortes agressions chimiques et de degré d'humidité élevé, contacter notre service technique.

40.5 Tipo di servizio

Se non indicato diversamente,la potenza dei motori riportata a catalogo si riferisce al servizio continuo S1.
Per i motori utilizzati in condizioni diverse da S1 sarà necessario identificare il tipo di servizio previsto con riferimento alle Norme CEI 2-3 / IEC 34-1.
In particolare, per i servizi S2 ed S3, è possibile ottenere una maggiorazione della potenza termica rispetto a quella prevista per il servizio continuo secondo quanto indicato nella tabella (A39) valida per motori ad una velocità. Per motori a doppia polarità interpellare il nostro servizio tecnico.

40.5 Type of duty

Unless otherwise indicated, the power of motors specified in the catalogue refers to continuous duty S1.
For motors used under conditions other than S1, the type of duty required must be specified with reference to CEI 2-3/IEC 34-1 Standards.
In particular, for duties S2 and S3, power can be increased with respect to continuous duty power according to data in table (A39) applicable to single speed motors. For double polarity motors, contact our technical service department.

40.5 Betriebsart

Sofern nicht anders angegeben, bezieht sich die im Katalog angegebene Motorleistung auf den Dauerbetrieb S1.
Bei den Motoren, die für eine andere Betriebsart als S1 vorgesehen sind, muß man die Betriebsart unter Bezugnahme auf die Normen CEI 2-3/IEC 34-1 identifizieren.
Insbesondere kann man für die Betriebsarten S2 und S3 nach der für Motoren mit einer Drehzahl. Gültigen Tabelle (A39) eine Überdimensionierung der Leistung für den Dauerbetrieb im Vergleich zur vorgesehenen Betriebsart erreichen. Für polumschaltbaren Motoren, bitte Rückfrage.

40.5 Type de service

Sauf indication contraire, la puissance des moteurs reportée dans le catalogue se réfère au service continu S1.
Pour les moteurs utilisés dans des conditions différentes de S1, il sera nécessaire d'identifier le type de service prévu en se réferant aux normes CEI 2-3/IEC34-1.
En particulier, pour les services S2 et S3, il est possible d'obtenir une majoration de la puissance par rapport à celle prévue pour le service continu selon ce qui est indiqué dans le tableau (A39) valable pour les moteurs à une vitesse. Pour les moteurs à double polarité, contacter notre service technique.

(A39)

	Servizio / Duty / Betriebsart / Service						
	S2			S3 *			S4 - S9
	Durata del ciclo (min) Cycle duration (min) Zyklusdauer (min) Durée du cycle (min)			Rapporto di intermittenza (I) Cyclic duration factor (I) Relative Einschaltdauer (I) Rapport d'intermittence (I)			Interpellarci Please contact us Rückfrage Nous contacter
	10	30	60	25%	40%	60%	
f_m	1.35	1.15	1.05	1.25	1.15	1.1	

* La durata del ciclo dovrà comunque essere uguale o inferiore a 10 minuti; se superiore interpellare il nostro servizio tecnico.

Rapporto di intermittenza:

$$I = \frac{t_f}{t_f + t_r} \cdot 100 \qquad (1)$$

t_f = tempo di funzionamento a carico costante
t_r = tempo di riposo

Servizio di durata limitata S2

Caratterizzato da un funzionamento a carico costante per un periodo di tempo limitato, inferiore a quello richiesto per raggiungere l'equilibrio termico, seguito da un periodo di riposo di durata sufficiente a ristabilire, nel motore, la temperatura ambiente.

Servizio intermittente periodico S3:

Caratterizzato da una sequenza di cicli di funzionamento identici, ciascuno comprendente un periodo di funzionamento a carico costante ed un periodo di riposo. In questo servizio, la corrente di avviamento non influenza la sovratemperatura in modo significativo.

* Cycle duration must, in any event, be equal to or less than 10 minutes; if this time is exceeded, please contact our technical service department.

Intermittence ratio:

$$.I = \frac{t_f}{t_f + t_r} \cdot 100 \qquad (1)$$

t_f = operating time at constant load
t_r = rest time

Limited duration duty S2

This type of duty is characterized by operation at constant load for a limited time, which is shorter than the time required to reach thermal equilibrium, followed by a rest period of sufficient duration to re-establish ambient temperature in the motor.

Periodical intermittent duty S3:

This type of duty is characterized by a sequence of identical operation cycles, each including a constant load operation period and a rest period.
For this type of duty, the starting current does not significantly influence overtemperature.

* Die Zyklusdauer muß in jedem Fall kleiner oder gleich 10 Minuten sein. Wenn sie darüber liegt, unseren Technischen Kundendienst zu Rate ziehen.

Relative Einschaltdauer:

$$I = \frac{t_f}{t_f + t_r} \cdot 100 \qquad (1)$$

t_f = Betriebszeit mit konstanter Last
t_r = Aussetzzeit

Kurzzeitbetrieb S2

Betrieb mit konstanter Last für eine begrenzte Zeit, die unter der Zeit liegt, die zum Erreichen des thermischen Gleichgewichts benötigt wird, gefolgt von einer Aussetzzeit, die so lang ist, daß der Motor wieder auf die Umgebungstemperatur abkühlen kann.

Periodische Einschaltsdauer S3:

Betrieb mit aufeinanderfolgenden identischen Betriebszyklen, die alle einen kurzzeitigen Betrieb mit konstanter Belastung und eine Aussetzzeit einschließen.
Bei dieser Betriebsart beeinflußt der Anlaufstrom die Übertemperatur nicht in signifikanter Weise.

* La durée du cycle devra être inférieure ou égale à 10 minutes. Si supérieure, contacter notre service technique.

Rapport d'intermittence:

$$I = \frac{t_f}{t_f + t_r} \cdot 100 \qquad (1)$$

t_f = temps de fonctionnement à charge constante
t_r = temps de repos

Service de durée limitée S2

Caractérisé par un fonctionnement à charge constante pour une période de temps limitée, inférieure à celle necessaire pour atteindre l'équilibre thermique, suivie par une période de repos de durée suffisante pour rétablir, dans le moteur, la température ambiante.

Service intermittent périodique S3

Caractérisé par une séquence de cycles de fonctionnement identiques, comprenant chacun une période de fonctionnement à charge constante et une période de repos. Dans ce service, le courant de démarrage n'influence pas l'excès de température de façon significative.

40.6 Frequenza massima di avviamento Z

Nelle tabelle dei dati tecnici motori è indicata la max frequenza di inserzione a vuoto Z_0 con I = 50% riferita alla versione autofrenante. Questo valore definisce il numero max di avviamenti orari a vuoto che il motore può sopportare senza superare la max temperatura ammessa dalla classe di isolamento F.

Nel caso pratico di motore accoppiato ad un carico esterno con potenza assorbita P_r, massa inerziale J_c e coppia resistente media durante l'avviamento M_L, il numero di avviamenti ammissibile si può calcolare in modo approssimato con la seguente formula:

$$Z = \frac{Z_0 \cdot K_c \cdot K_d}{K_J} \qquad (2)$$

dove:

$K_J = \frac{J_m + J_c}{J_m}$ = fattore di inerzia

$K_c = \frac{M_a - M_L}{M_a}$ = fattore di coppia

K_d = fattore di carico vedi tabella (A40)

40.6 Maximum starting frequency Z

The motor selection charts include the max. no-load starting frequency Z_0 with intermittence of I=50% referred to the brake version. This number defines the maximum number of no-load starts acceptable to the motor without exceeding the maximum temperature permitted according to insulation class F.

To give a practical example, a motor coupled to an external load with absorbed power P_r, moment of inertia of masses J_c and load torque during start M_L, the number of permitted starts can be calculated approximately using the following formula:

$$Z = \frac{Z_0 \cdot K_c \cdot K_d}{K_J} \qquad (2)$$

where:

$K_J = \frac{J_m + J_c}{J_m}$ =inertia factor

$K_c = \frac{M_a - M_L}{M_a}$ = torque factor

K_d = load factor see table (A40)

40.6 Maximale Schaltungshäufigkeit Z

In den Tabellen mit den Technischen Daten der Motoren ist die maximale Schaltungshäufigkeit im Leerlauf Z_0 bei relativer Einschaltdauer I = 50% bezüglich auf die Bremsausführung. Dieser Wert definiert die maximale Anzahl von Anfahrten im Leerlauf pro Stunde, die der Motor ertragen kann, ohne die durch die Isolierstoffklasse F festgelegte maximal zulässige Temperatur zu überschreiten.
Im praktischen Fall eines mit einer externen Last verbundenen Motors mit einer Leistungsauf-nahme von P_r, Trägheitsmasse J_c und mittlerem Gegenmoment während des Anfahrens von M_L kann die zulässige Anzahl Anfahrten mit folgender Formel approximativ berechnet werden:

$$Z = \frac{Z_0 \cdot K_c \cdot K_d}{K_J} \qquad (2)$$

wobei gilt:

$K_J = \frac{J_m + J_c}{J_m}$ = Trägheitsfaktor

$K_c = \frac{M_a - M_L}{M_a}$ =Drehmomentsfaktor

K_d = Lastfaktor siehe Tabelle (A40)

40.6 Fréquence maximum de démarrage Z

Dans les tableaux des caractéristiques techniques des moteurs se trouve la fréquence maximum d'insertion à vide Z_0 avec intermittence I = 50% référée à la version frein. Cette valeur définit un nombre maximum de démarrages horaires à vide que le moteur peut supporter sans dépasser la température maximum admise par la classe d'isolation F.

Dans le cas pratique de moteur accouplé à une charge extérieure avec puissance absorbée P_r, masse inertielle J_c et couple résistant moyen pendant le démarrage M_L, le nombre de démarrages admissible peut se calculer de façon approximative avec la formule suivante:

$$Z = \frac{Z_0 \cdot K_c \cdot K_d}{K_J} \qquad (2)$$

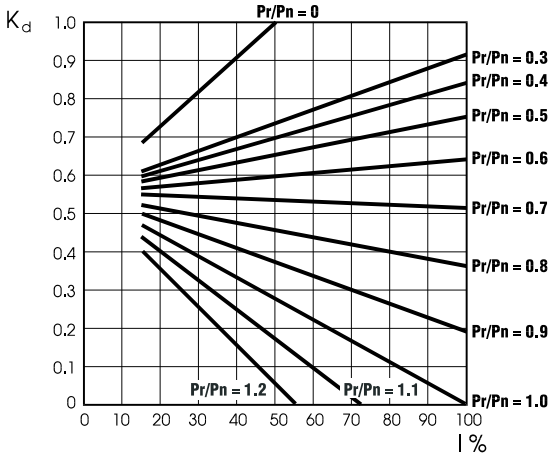
où:

$K_J = \frac{J_m + J_c}{J_m}$ = facteur d'inertie

$K_c = \frac{M_a - M_L}{M_a}$ = facteur de couple

K_d = facteur de charge voir tableau (A40)

(A40)



Con il numero di avviamenti così ottenuto si dovrà in seguito verificare che il massimo lavoro di frenatura sia compatibile con la capacità termica del freno W_{max} indicata nelle tabelle (A47-A51).

Having thus obtained the number of starts, next you must check that the maximum braking work is compatible with the brake's thermal capacity W_{max} indicated under tables (A47-A51).

Auf Grundlage der so berechneten Anzahl Schaltungen muß man dann prüfen, ob die maximale Bremsarbeit mit der Wärmegrenzleistung der Bremse W_{max} kompatibel ist, die in die Tabellen (A47-A51) angegeben ist.

Avec le nombre de démarrages ainsi obtenu, il faudra ensuite vérifier que le travail maximum de freinage soit compatible avec la capacité thermique du frein W_{max} indiquée dans le tableaux (A47-A51).

41.0 MOTORI ASINCRONI AUTOFRENANTI

Generalità

L'esecuzione autofrenante prevede l'impiego di freni a pressione di molle alimentati in c.c. (tipo BN71 - 160FD) o in c.a. (tipo BN71 - 132FA).

41.0 BRAKE MOTORS

General information

The brake version foresees the use of d.c. (type BN71 - 160FD) or a.c. (type BN71 - 132FA) spring pressure brakes.

41.0 BREMSMOTOREN

Allgemeines

Bei Bremsmotoren sind als Bremse Federdruckbremse vorgesehen, die mit Gleichstrom (Typ BN71 - 160FD) oder mit Drehstrom (Typ BN71 - 132FA) geliefert werden.

41.0 MOTEURS ASYNCHRONES FREINS

Généralités

L'exécution avec frein prevoit l'utilisation de freins à pression de ressort alimentés en c.c. (type BN71 - 160FD) ou en c.a. (type BN71 - 132FA).

Il freno funziona secondo il principio di sicurezza, ossia interviene in seguito all'azione delle molle quando il motore viene disinserito oppure in mancanza di tensione.
Le caratteristiche elettriche e meccaniche (escluso dimensioni d'ingombro) corrispondono a quelle dei motori trifasi.

Le caratteristiche salienti sono:

- Coppie frenanti dimensionate sulla coppia nominale del motore e regolabili modificando il tipo e/o il numero di molle (freni FD) o agendo sui grani di compressione delle molle (tipo FA).
- Disco freno con doppia guarnizione d'attrito (materiale a bassa usura privo di amianto).
- Leva di sblocco meccanico con ritorno automatico per le operazioni manuali (a richiesta).
- Elemento elastico di compensazione per assorbire le vibrazioni meccaniche durante la rotazione.
- Protezione antipolvere (6,7) ed anello V-ring (5) sull'albero motore come illustrato nella tabella (C19).
- Trattamento anticorrosivo di tutte le superfici del freno.
- Isolamento bobina toroidale in classe F.

The brake operates according to a safety concept: it is activated by the springs when the motor is switched off or in the event of power failure.
The electric and mechanical characteristics (excepting overall dimensions) are as for three-phase motors.

Main characteristics:

- Braking torques settled according to motor rated torque and adjustable by modifying type and/or quantity of springs.
- Brake disk with double friction lining (low wear, asbestos-free material).
- Mechanical hand release lever with self re-engaging facility for manual operations (on request).
- Compensation spring to absorb mechanical.
- Dust protection (6,7) and V-ring (5) on motor shaft (IP 55 on request), table (C19).
- Anti-corrosion treatment on all brake surfaces.
- Toroidal coil insulated to class F.

Die Bremse arbeitet nach dem Prinzip der Sicherheitsbremse, d.h. sie greift nach Betätigung der Federn ein, wenn der Motor ausgeschaltet wird, bzw. wenn der Strom ausfällt. Die elektrischen und mechanischen Eigenschaften (mit Ausnahme der Außenmaße) entsprechen denen von Drehstrommotoren.

Die wichtigsten Eigenschaften sind:

- Bremsmomente ausgelegt in Abhängigkeit vom Nenndrehmoment des Motors; regulierbar durch Modifikation der Art oder der Anzahl der Federn.
- Bremsscheibe mit doppeltem Bremsbelag (Material mit geringem Verschleiß und ohne Asbest).
- Hebel zum mechanischen Lösen der Bremse mit automatischer Rückstellung fürmanuelle Aktivitäten (auf Anfrage).
- Elastisches Ausgleichselement für die Aufnahme der mechanischen Schwingungen während der Drehung.
- Staubschutz (6,7) und V-Ring (5) auf der Antriebswelle (IP55 auf Wunsch), Abbildung (C19).
- Korrosionbeständige Oberflächenbehandlung aller Oberflächen der Bremse.
- Isolierung der Ringspule der Klasse F.

Le frein fonctionne selon le principe de sécurité c'est-à-dire qu'il intervient à la suite de l'action des ressorts lorsque le moteur est deconnectéou bein en l'absence de tension.
Les caractéristiques électriques et mécaniques (sauf dimensions d'encombrement) correspondent à celles des moteurs triphasés.

Les principales caractéristiques sont:

- couples de freinage dimensionnés en fonction du couple nominal du moteur et réglables en modifiant le type et/ou le nombre des ressorts.
- Disque de frein avec double garniturer de friction (matériau à faible usure sans amiante).
- Levier de déblocage mécanique avec retour automatique pour les opérations manuelles (sur demande).
- Elément élastique de compensation pour absorber les vibrations mécaniques durant la rotation.
- Protection anti-poussière (6,7) et bague V-ring (5) sur l'arbre moteur (IP 55 sur demande), tableau (C19).
- Traitement anticorrosion de toutes les surfaces du frein.
- Isolation bobine torique en classe F.

41.1 **Freno**

Costruzione e funzionamento

La costruzione prevista sullo scudo posteriore del motore come illustrato nelle tabelle (C18) (C19) è costituita da:

1 elettromagnete che contiene la bobina toroidale fissato con tre viti allo scudo lato ventola del motore; tre molle di precarico realizzano il posizionamento assiale

2 ancora mobile con smusso per alloggiamento della guaina parapolvere

3 disco freno libero assialmente e collegato all'albero del mozzo trascinatore

4 molle di spinta dell' ancora mobile
s

In caso di mancanza di tensione, l' ancora mobile, spinta dalle molle del freno, blocca il disco freno tra la superficie dell'ancora stessa e lo scudo motore.

Quando la bobina viene eccitata, l'attrazione magnetica dell'àncora mobile vince la reazione elastica delle molle e sblocca il freno.

41.1 **Brake**

Construction and operation

Installed on motor rear shield as shown in tables (C18) and (C19) and consisting of:

1 electro-magnet containing the toroidal coil, secured with three screws on the rear shield fan side; three preloaded springs ensure axial positioning.

2 mobile armature plate preset for dust protection elements assembly.

3 axially independent brake disk connected to the shaft by the trailinghub

4 braking springs

In case of a power cut, as the armature plate is pushed by the brake springs, it engages the brake disk between the armature plate surface and the motor shield.

When the coil is energized, the mobile armature plate magnetic attraction overcomes the elastic reaction of the springs thus releasing the brake.

41.1 **Bremse**

Konstruktionsform und Funktionsweise

Anordnung auf dem hinteren Schild des Motors wie in den Abbildungen (C18) und (C19) angegeben. Konstruktion aus:

1 Elektromagnet, der die Ringspule enthält und mit drei Schrauben am Schild auf der Lüfterradseite des Motors befestigt ist; drei Federn zum Vorspannen sorgen für die axiale Positionierung.

2 Beweglicher Anker mit Fase für die Aufnahme der Staubschutzdichtung.

3 Axial frei bewegliche Bremsscheibe, die an der Welle mit der Mitnehmernabe befestigt ist.

4 Schubfedern des beweglichen Ankers.

Bei fehlender Spannung blockiert der bewegliche Anker, der von den Bremsfedern geschoben wird, die Bremsscheibe zwischen der Oberfläche des Ankers selbst und dem Motorschild.

Wenn die Spule versorgt wird, wird die magnetische Kraft des beweglichen Ankers die elastische Reaktion der Federn winnen und wird die Bremseauflösen.

41.1 **Frein**

Construction et fonctionnement

Construction prévue sur le couvercle postérieur du moteur comme illustré dans les tableaux (C18) et (C19)et constituée par:

1 électro-aimant contenant la bobine torique, fixé avec trois vis au couvercle côté ventilateur du moteur. Trois ressorts de précharge réalisent le positionnement axial.

2 armature mobile avec chanfrein pour logement de la gaine de protection contre la poussière.

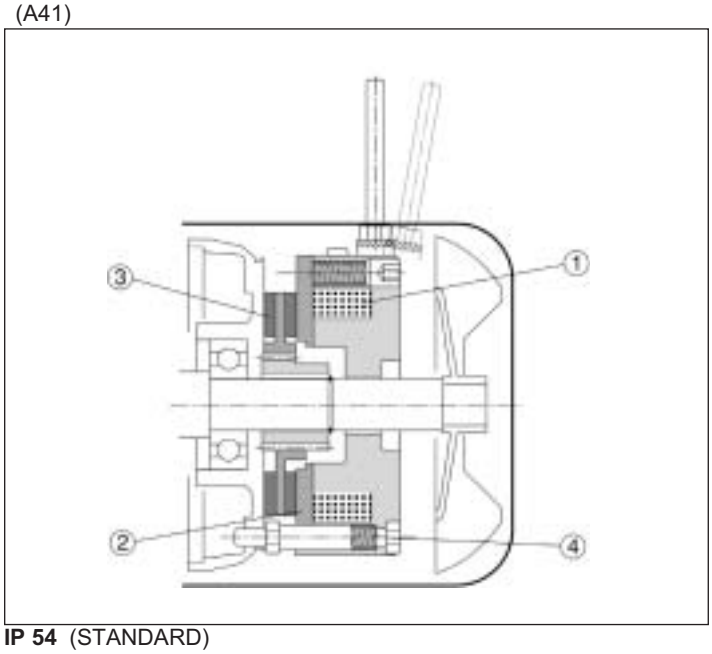
3 disque de frein libre axialement, relié à l'arbre par le moyeu d'entraînement.

4 ressorts de poussée de l'armature mobile.

En cas d'absence de tension, l'armature mobile, poussée par les ressorts du frein, bloque le disque du frein entre la surface de l'armature et le couvercle moteur.

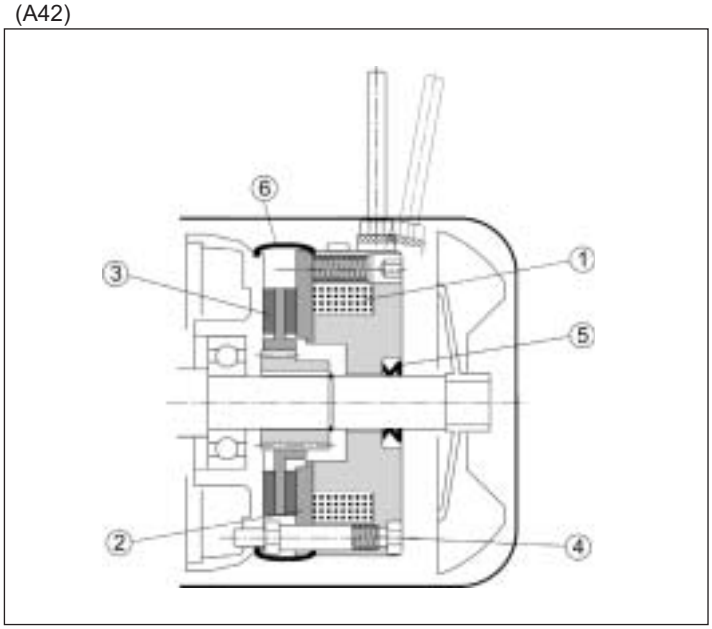
Lorsque la bobine est excitée, l'attraction magnétique de l'armature mobile compense l'action des ressorts et débloque le frein.

(A41)



IP 54 (STANDARD)

(A42)



IP 55 (OPTIONAL)

41.2 **Freno tipo FD**

Alimentazione freno

L'alimentazione della bobina freno in c.c. è prevista per mezzo di opportuno raddrizzatore.
Il raddrizzatore nell'esecuzione base è fissato alla scatola coprimorsetti e già collegato alla bobina del freno.
La tensione del raddrizzatore-bobina freno è coordinata all'alimentazione motore (tensione di fase o stellata del motore) e, per motori ad una velocità, il collegamento alla morsettiera motore è realizzato in fabbrica. In questo caso la tensione del freno può essere omessa.
La tensione standard è 230 V ± 10% 50/60 Hz.
Il raddrizzatore è del tipo a diodi a semplice semionda (Vc.c. = 0,45 Vc.a.).
Per i freni FD02, FD03, FD53, FD04, FD14, FD05, FD15, è previsto di serie il raddrizzatore tipo NB (disponibile a richiesta il tipo SB), tensione max. d'impiego 500 V c.a.
Per i freni FD55, FD56, FD06, FD06S, FD07 è previsto di serie il raddrizzatore tipo SB a controllo elettronico dell'eccitazione (tensione d'impiego 200 V < V < 440 V c.a. Quest' ultima soluzione, che consente tempi di sblocco del freno ridotti, è realizzata sovraeccitando l'elettromagnete nei primi istanti d'inserzione passando poi alla tensione nominale a distacco freno avvenuto.

L'impiego del raddrizzatore tipo SB è sempre da prevedere nei casi di:

a) elevato numero di interventi orari

b) tempi di sblocco freno ridotti

c) elevate sollecitazioni termiche del freno.

Per la protezione del raddrizzatore, della bobina e dei contatti contro le sovratensioni di manovra, sono previsti di serie dei varistori.

41.2 **FD brake**

Brake power supply

All motors have a rectifier secured to the terminal box and connected to brake coil.
Rectifier-brake coil voltage is combined with motor power supply (phase voltage) and for single speed motors, the connection to the motor terminal box is carried out at the factory.
Standard voltage is 230 V ± 10% 50/60Hz for sizes 71-132 and 400 V ± 10% for size 160.
A diode, single half-wave rectifier is used (V.d.c. = 0.45 V.a.c.).

The NB rectifier (SB available on request) is a standard device for brakes FD02, FD03, FD53, FD04, FD14, FD05 and FD15; the maximum operating voltage is 500V a.c..
The SB rectifier type with electronic energizing control is a standard device for brakes FD55, FD56, FD06, FD06S and FD07; the operating voltage is 200V < V < 440V a.c.
This solution, ensuring rapid brake release, entails over-energizing the electro-magnet for a few moments at power-up, and changing to rated voltage after brake release.

The SB rectifier should always be used in the following situations:

a) high number of starts/stops

b) short brake release times

c) high temperature generated on brake.

Varistors are used to protect rectifier, coil and contacts against excess voltage during operation.

41.2 **Bremstyp FD**

Stromversorgung der Bremse

Der Motor ist stets mit einem Gleichrichter ausgestattet, der im Klemmkasten befestigt und mit der Spule der Bremse verbunden ist.
Die Spannung der Bremsengleichrichterspule ist mit Motorversorgung (Sternspannung des Motors) und bei hohen Geschwindigkeits motoren wird der Anschluß dem Motorklemmkasten in der Fabrik durchgeführt. In diesem Fall kann die Bremsspannung wegfallen. Die Standardspannung ist 230 V ± 10% - 50/60 Hz für die Baugröße 71-132 und für Baugröße 160 ist 400 V ± 10%.
Der Gleichrichter ist in Einwegschaltung ausgeführt (V Gleichstrom: 0.45 V Wechselstrom).
Bei den Bremsen vom Typ FD02, FD03, FD53, FD04, FD14, FD05 und FD15 ist serienmäßig ein Gleichrichter vom Typ NB vorgesehen (auf Wunsch Typ SB lieferbar); die max. Betriebsspannung ist 500V W.S.
Bei den Bremsen vom Typ FD55, FD56, FD06, FD06S und FD07 ist serienmäßig ein Gleichrichter vom Typ SB mit elektronischer Schnellerregung vorgesehen; die Betriebsspannung ist 200V < V < 440V W.S.
Diese Lösung, die sehr kurze Ansprechzeiten der Bremse erlaubt, wird verwirklicht, indem der Elektromagnet in der ersten Einschaltphase übererregt wird und nach erfolgter Öffnung der Bremse nur noch mit Nennspannung gespeist wird.
Die Verwendung des Gleich-richters vom Typ SB ist in folgenden Fällen stets vorzusehen:

a) hohe Schalthäufigkeit;

b) kurze Bremsansprechzeiten;

c) hohe thermische Belastung der Bremse.

Zum Schutz des Gleichrichters, der Spule und der Kontakte zum Schutz von Schaltüberspannungen sind einige Varistoren vorge-

41.2 **Freins type FD**

Alimentation frein

Le moteur est toujours doté d'un redresseur fixé dans la boîte à borne et relié à la bobine du frein.
La tension du redresseur-bobine frein est coordonnée à l'alimentation moteur (tension de phase ou en étoile du moteur). Pour moteur mono-vitesse, le raccordement à la boîte à borne est réalisé en usine. Dans ce cas, la tension du frein peut être omise. La tension standard est de 230 V ± 10% 50/60 Hz por la taille 71-132 et 400 V ± 10% pour la taille 160.
Le redresseur est du type à diodes à mono alternance (Vcc = 0.45 Vca).
Pour les freins FD02, FD03, FD53, FD04, FD14, FD05, FD15, le redresseur type NB est prévu en série (le type SB est disponible sur demande), tension maxi d'utilisation 500V en courant alternatif.
Pour les freins, FD55, FD56, FD06, FD06S, FD07, le redresseur type SB à contrôle électronique de l'excitation (tension d'utilisation 200V < V < 440V en courant alternatif) est prévu en série.
Cette solution, qui permet des durées de déblocage du frein réduites, est réalisée en surexcitant l'électro-aimant dans les premiers instants d'insertion, en passant ensuite à la tension nominale lorsque le déblocage du frein est intervenu.
L'emploi du redresseur type SB est toujours à prévoir dans les cas de:

a) nombre élevé d'interventions horaires

b) temps de déblocage frein réduits

c) contraintes thermiques élevées du frein.

Pour la protection du redresseur, de la bobine et des contacts contre les surtensions de manoeuvre, des varistors sont prévus en série.

Collegamenti

Per i motori a semplice polarità in esecuzione normale il collegamento del raddrizzatore alla morsettiera motore viene eseguito in fabbrica.
Per i motori a 2 velocità e per alimentazione freno separata prevedere il collegamento al raddrizzatore secondo la tensione freno indicata nella targhetta motore.

Le tabelle (A43), (A44), (A45), (C23) riportano gli schemi di collegamento del freno.

Wiring

For single polarity motors, connection of the rectifier to terminal-box is carried out in-house.
For 2-speed motors and for separate brake supply, the brake voltage indicated on the motor name plate shall be used.

The brake wiring diagrams are shown in tables (A43), (A44), (A45), and (C23).

Anschlüsse

Bei eintourigen Motoren wird der Gleichrichter werkseitigim Motorklemmkasten angeschlossen.
Bei den polumschaltbaren Motoren mit separater Stromversorgung der Bremse ist der Anschluß entsprechend der auf dem Motorleistungsschild angegeben Nennspannung vorzusehen.

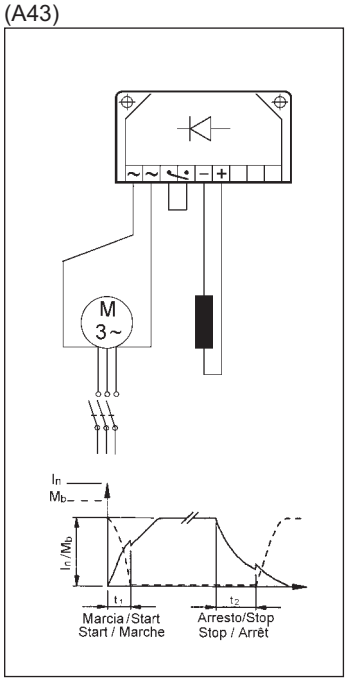
Die Abbildungen (A43), (A44), (A45) und (C23) zeigen die Pläne für den Anschluß der Bremse.

Branchements

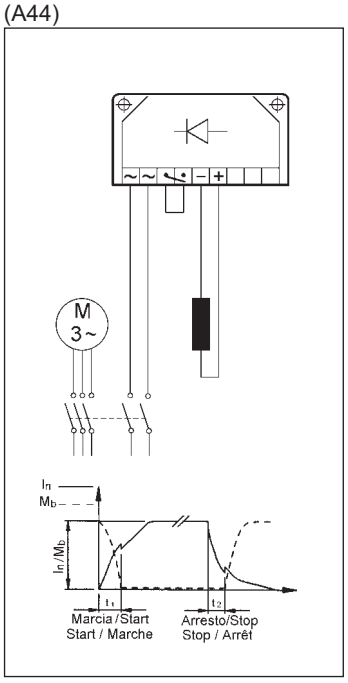
Pour les moteurs à simple polarité, le branchement du redresseur au bornier moteur est réalisé en usine.
Pour les moteurs à deux vitesses et pour l'alimentation frein séparée, prévoir le branchement selon la tension indiquée sur la plaque d'identification moteur.

Les tableaux (A43), (A44), (A45), (C23) présentent les schémas de branchement du frein.

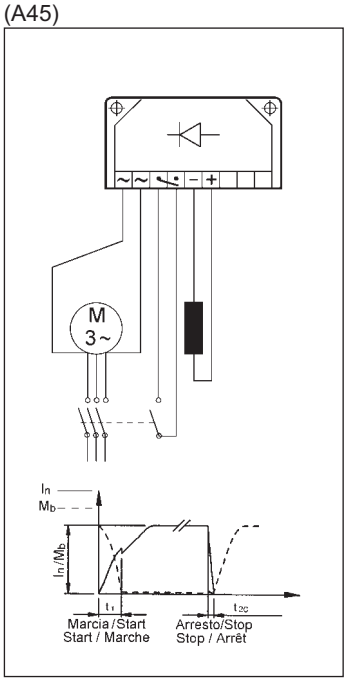
(A43)



(A44)



(A45)



(A46)

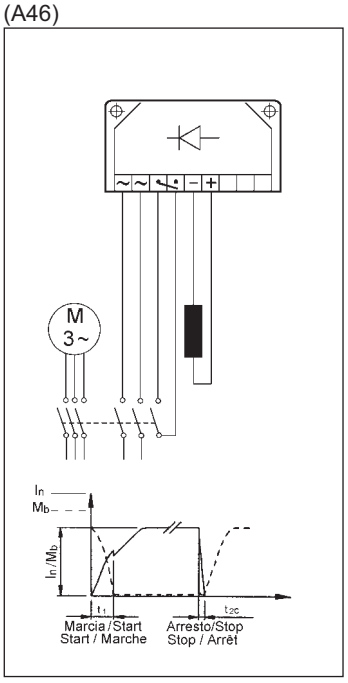


Tabella (A43)

Alimentazione freno dai morsetti motore ed interruzione lato c.a..
Tempo di arresto t_2 ritardato e funzione delle costanti di tempo del motore. Da prevedere quando non sono richieste particolari prestazioni sui tempi d'intervento.

Table (A43)

Brake supply from motor terminals and a.c. line interruption.
Long stop time t_2 and function of motor time constants. Use in the absence of any particular braking time performance specifications.

Abbildung (A43)

Bremsenspeisung über Motorenklemmen und Unterbrechung des Wechselstromkreises.
Stoppzeit t_2 mit Verzögerung ist abhängig von der Zeitkonstanten des Motors. Vorzusehen, wenn keine besonderen Anforderungen an die Ansprechzeiten gestellt werden.

Tableau (A43)

Alimentation et interruption bobine frein côté c.a.
Temps d'arrêt t_2 retardé et fonction des constantes de temps du moteur. A prévoir lorsque qu'aucune performance particulière sur les temps d'intervention n'est demandée.

Tabella (A44)

Bobina freno con alimentazione separata ed interruzione lato c.a.
Tempo di arresto normale ed indipendente dal motore.
Si realizzano i tempi di arresto t_2 indicati nella tabella (A47).

Table (A44)

Brake coil with separate power supply, plus a.c. line interruption.
Normal stopping time, independent of motor.
Stopping times t_2 are indicated in table (A47).

Abbildung (A44)

Unabhängie Bremsenspeisung und Unterbrechung des Wechselstromkreises.
Normale Stoppzeit unabhängig vom Motor.
Es gelten die Stoppzeiten t_2, die in der Tabelle (A47) angegeben sind.

Tableau (A44)

Bobine frein avec alimentation séparée et interruption côté c.a.
Temps d'arrêt normal et indépendant du moteur.
On obtient les temps d'arrêt t_2 indiqués dans le tableau (A47).

Tabella (A45)

Bobina freno con alimentazione dai morsetti motore ed interruzione lato c.a. e c.c.
Tempo di arresto ridotto secondo i valori t_{2c} indicati in tabella (A47).

Table (A45)

Brake coil with power supply from motor terminals and power interruption on both a.c. and d.c. lines.
Rapid stopping to t_{2c} values shown in table (A47)

Abbildung (A45)

Bremsenspeisung über Motorenklemmen und Unterbrechung des Wechselstrom- und des Gleichstromkreises.
Verkürzte Stoppzeiten entsprechend den in Tabelle (A47) angegebenen Werten t_{2c}.

Tableau (A45)

Bobine frein avec alimentation à partir des bornes moteurs et interruption côté c.a et c.c.
Temps d'arrêt réduit selon les valeurs t_{2c} indiquées dans le tableau (A47).

Tabella (A46)

Bobina freno con alimentazione separata ed interruzione lato c.a. e c.c.
Tempo di arresto ridotto secondo i valori t_{2c} indicati in tabella (A47).

Table (A46)

Brake coil with separate power supply, plus power interruption on both a.c. and d.c. lines.
Rapid stopping to t_{2c} values in table (A47).

Abbildung (A46)

Unabhängige Bremsenspeisung und Unterbrechung des Wechselstrom und des Gleichstromkreises.
Verkürzte Stoppzeiten entsprechend den in die Tabelle (A47) angegebenen Werten t_{2c}.

Tableau (A46)

Bobine frein avec alimentation séparée et interruption côté c.a. et c.c.
Temps d'arrêt réduit selon les valeurs t_{2c} indiquées en tableau (A47).

Dati tecnici freni FD

Nella tabella (A47) sono riportati i dati tecnici dei freni tipo FD.

FD brake technical specifications

Technical specifications of FD brakes are shown in table (A47).

Technische Daten der Bremsen FD

In Tabelle (A47) sind die Technischen Daten der Bremsen vom Typ FD angegeben.

Caractéristiques techniques freins FD

Le tableau (A47) présente les données techniques des freins type FD.

(A47)

Freno / Brake / Bremse / Frein	Motore / Motor / Motors / Moteur	Coppia frenante Mb [Nm] / Brake torque Mb [Nm] / Bremsmoment Mb [Nm] / Couple de freinage Mb [Nm] n° molle/springs/Feder/ressorts 6	4	2	Rilascio / Release / Ansprechzeit / Déblocage NB t_1 [ms]	SB t1s [ms]	Frenatura / Braking / Bremsung / Freinage t_2 [ms]	t_{2c} [ms]	Wmax [J] 10 c/h	100 c/h	1000 c/h	W [MJ]	P_b [W]
FD03	**BN 71**	5	3.5	1.75	50	20	80	12	7000	1900	230	30	24
FD53		7.5	5	2.5	60	30	80	12					
FD04	**BN 80**	15	10	5	80	35	120	16	10000	3100	350	50	33
FD14	**BN 90S**												
FD05	**BN 90L**	40	26	13	150	65	170	21	18000	4500	500	75	45
FD15	**BN 100**	40	26	13	150	65	170	21					
FD55		55	37	18	—	65	170	23					
FD06S	**BN 112**	60	40	20	—	70	180	23	20000	4800	550	130	55
FD56	**BN 132**	—	75	37	—	90	190	18	29000	7400	800	140	65
FD06		—	100	50	—	100	170	26					
FD07		150	100	50	—	120	250	38	40000	9300	1000	210	65
FD08	**BN 160**	250*	200*	170*	—	140	350	50	60000	14000	1500	300	100

Legenda:

- t_1 = tempo di rilascio del freno con alimentatore a semionda
- t_{1s} = tempo di rilascio del freno con alimentatore con sovraeccitaz.
- t_2 = ritardo di frenatura con interruzione lato c.a. e alimentazione separata
- t_{2c} = ritardo di frenatura con interruzione lato c.a. e c.c. I valori di t_1, t_{1s}, t_2, t_{2c}, indicati nella tabella (C24) sono riferiti al freno tarato alla coppia massima, traferro medio e tensione nominale.
- W_{max} = energia max per frenata
- W = energia di frenatura tra due regolazioni successive
- P_b = potenza assorbita dal freno a 20°C
- Mb = Coppia frenante statica (± 15%)

Key:

- t_1 = brake release time with half-wave rectifier
- t_{1s} = brake release time with over-exciting rectifier
- t_2 = brake engagement time with interruption and separate power supply a.c. line
- t_{2c} = brake engagement time with power interruption on both a.c. and d.c. lines and separate power supply t_1, t_{1s}, t_2 and t_{2c} values indicated in table (C24) refer to maximum torque brake setting, with medium air-gap and at rated voltage.
- W_{max} = max. energy each braking operation
- W = braking energy between two consecutive air-gap adjustments
- P_b = brake power absorbed at 20°C
- Mb = static braking torque (± 15%)

Zeichenerklärung:

- t_1 = Bremsenansprechzeit mit Einwegschaltungsgleirichter
- t_{1s} = Bremsenansprechzeit mit Gleichrichter und mit Überregung
- t_2 = Bremsungzeit mit Unterbrechung W.S. Seite und unabhängige Versogung
- t_{2c} = Bremsungzeit mit Unterbrechung W.S. und G.S. Seite und unabhängige Versogung Die in Tabelle (C24) angegebenen Werte für t_1, t_{1s}, t_2 und t_{2c} beziehen sich auf eine auf das maximale Drehmoment eingestellte Bremse mit mittlerem Luftspalt und bei Nennspannung.
- W_{max} = max Energie pro Bremsung
- W = Bremsenergie zwischen zwei Eistellungen
- P_b = Aufnahme der Bremse bei 20°C
- Mb = Statische Bremsmoment (± 15%)

Légende:

- t_1 = durée de déblocage du frein avec alimentateur mono alternance
- t_{1s} = durée de déblocage du frein avec alimentateur à surexcitation
- t_2 = retard de freinage avec interruption côté c.a et alimentation separée
- t_{2c} = retard de freinage avec interruption côté c.a. et c.c. et alimentation separée. Les valeurs de t_1, t_{1s}, t_2, t_{2c} indiquées dans le tableau (C24) se réfèrent au frein taré au couple maximum, entrefer moyen et tension nominale.
- W_{max} = énergie maxi. par freinage
- W = énergie de freinage entre deux réglages successifs
- P_b = absorption du frein à 20°C
- Mb = Couple freinant statique (± 15%)

*** Nel freno FD08 i valori di coppia frenante Mb sono ottenuti con n.9, n.7 e n.6 molle.**

*** For brake FD08, brake torque values Mb are archieved with no.9, no.7 and no.6 springs.**

*** Bei der Bremse FD08 werden die Bremsmomente Mb durch 9, 7 und 6 Federnerhalten.**

*** En ce qui concerne le frein FD08, les valeurs de couple freinant Mb sont obtenutes avec 9, 7 et 6 ressort.**

Caratteristiche volani per motori autofrenanti FD (F1)

La tabella (A48) indica il peso e l'inerzia dei volani aggiuntivi che possono essere previsti nei motori autofrenanti serie FD senza variazioni dell'ingombro motore.

Fly-wheel characteristics for FD brake motor series (F1)

Table (A48) shows weight and inertia of additional fly-wheels for brakes motors belonging to FD series, being overail dimension unchenged.

Eigenschaften der Schwungräder für Bremsmotoren Typ FD (F1)

Die Tabelle (A48) gibt das Gewicht und das Trägheitsmoment der Zusatzschwungräder an, die auf den selbstbremsenden Motoren der Serie FD ohne eine Änderungen der Motormaße vorgesehen werden können.

Caractéristiques volants pour moteurs freins FD (F1)

Le tableau (A48) indique le poids et l'inertie des volants supplémentaires qui peuvent être prévus sur les moteurs autofreinants série FD sans variations de l'encombrement moteur .

(A48)

Volani per motori autofrenanti serie FD / Fly-wheels for FD brake motors series / Schwungräder für Bremsmotoren Serie FD / Volants pour moteurs freins sèrie FD		
Tipo / Type / Typ / Type	Peso volano [Kg] / Fly-wheel weight [Kg] / Gewicht Schwungrad [Kg] / Poids volant [Kg]	Inerzia volano [Kgm^2] / Fly-wheel inertia [Kgm^2] / Trägheitsmoment Schwungrad [Kgm^2] / Inertie volant [Kgm^2]
BN 71	1.13	0.00135
BN 80	1.67	0.00270
BN 90 S/L	2.51	0.00530
BN 100	3.48	0.00840
BN 112	4.82	0.01483
BN 132 S/M	6.19	0.02580

41.3 **Freno tipo FA**

Alimentazione freno

Nei motori ad una velocità in esecuzione normale, l'alimentazione della bobina freno è derivata direttamente dalla morsettiera motore; in questo caso la tensione del freno può essere ommessa dalla designazione.
Per i motori a doppia polarità e per motori ad una velocità con alimentazione separata è prevista una morsettiera ausiliaria per il collegamento del freno.
Per questa esecuzione il valore di tensione freno dovrà sempre essere indicato in designazione.
La tensione di alimentazione standard è 230 Δ / 400 Y V, 50 Hz.
A richiesta sono disponibili tensioni speciali nel campo 24 - 690V, 50 - 60 Hz.

Collegamenti

Per i motori con alimentazione freno derivata dall'alimentazione motore, i collegamenti alla morsettiera corrispondono a quanto indicato nella tabella (A49)

41.3 **Brake type FA**

Brake power supply

In standard single speed motors, the brake coil power supply comes directly from the motor terminal board, in this case the brake voltage can be omitted in the designation.
For double polarity motors and for single speed motors with separate power supply, an auxiliary terminal board for the brake connection is provided. In this case the brake voltage value must be always indicated in the designation. The standard power supply voltage is 230 Δ /400YV, 50 Hz.
Upon request are available special voltages in the range 24-690V, 50-60 Hz.

Connections

For motors with brake power supply coming from the motor terminal board, the table (A49) are performed.

41.3 **Bremstyp FA**

Stromversorgung der Bremse

In den eintourigen Motoren - Standardausführung - kommt die Stromversorgung der Bremsenspule direkt aus dem Motorklemmkasten; in diesem Fall kann die Bremsversorgung nich in der Bezeichnung angegeben werden.
Für Polumschaltbaren Motoren und für eintourigen Motoren mit Fremdversorgung ist ein Hilfs-klemmkasten für den Bremsenanschluß vorgesehen.
Für solche Ausführung muß der Bremsspannungswert immer in der Bezeichnung angegeben werden.
Die Standardversorgungspannung ist 230 Δ /400YV, 50 Hz.
Auf Anfrage sind Sonderspannungen im Feld 24-690V, 50-60 Hz verfügbar.

Anschlüsse

Für die Motoren mit Stromversorgung der Bremse, die aus der Motorstromversorgung kommt, sind die Anschlüsse des Klemmenkastens aus der Tabelle (A49) zu nehmen.

41.3 **Freins type FA**

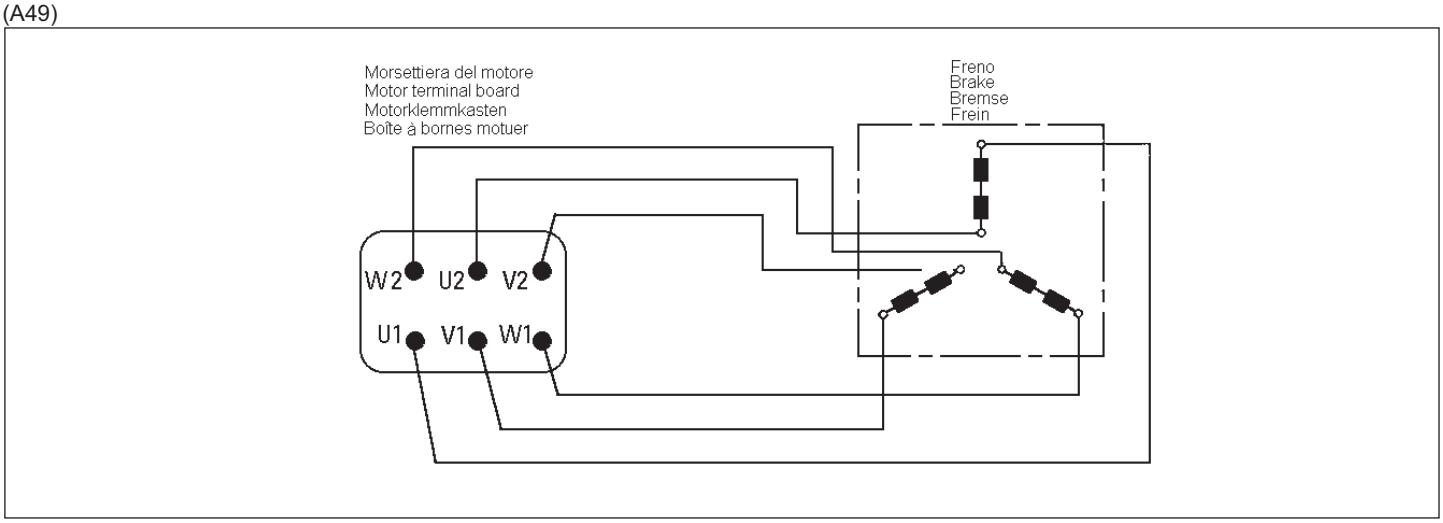
Alimentation frein

Dans les moteurs mono-vitasse en exécution normale, l'alimentation de la bobine du frein est dérivée de la boîte à bornes du moteur. Dans ce cas, il n'est pas nécessaire de signaler la tension du frein en phase de définition.
Pour les moteurs à double polarité et les moteurs à une seule vitesse, avec alimentation séparée, il est prévu une boîte à bornes auxiliaire pour le branchement du frein.
Pour cette exécution, la valeur de la tension du frein devra toujours être indiquée lors de la définition du moteur.
La tension d'alimentation stan-dard est 230 Δ /400YV, 50 Hz.
Les tensions spéciales sont possibles sur demande, dans la plage 24-690V, 50-60 Hz.

Branchements

Pour les moteurs avec alimentation du frein dérivée de l'alimentation moteur, les branchements â la boîte â bornes correspondent aux indications du tableau (A49).

(A49)



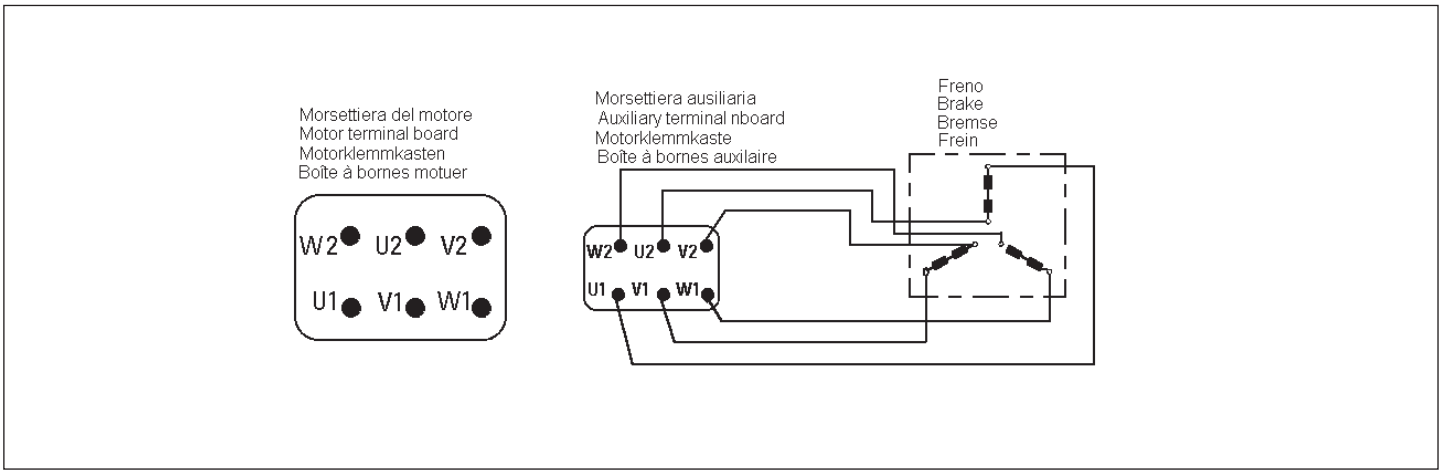
Nel caso di alimentazione separata, le connessioni del freno sono derivate alla morsettiera ausiliaria come indicato in tabella (A50)

In case of separate power supply, the brake connections comes from the auxiliary terminal board as shown in table (A50).

Im Fall von Fremdversorgung kommen die Bremsanschlüsse aus dem Hilfsklemmkasten, wie die Tabelle (A50) zeigt.

Pour les moteurs avec alimentation du frein dèrivèe de l'alimentation moteur, les branchements à la boîte à bornes correspondent aux indications du tableau (A50).

(A50)



Dati tecnici freni FA

Nella tabella (A51) sono riportati i dati tecnici dei freni tipo FA.

FA brakes technical specifications

Technical specifications of FA brakes are shown in table (A51).

Technische Daten der Bremsen FA

In Tabelle (A51) sind die Technischen Daten der Bremsen vom Typ FA angegeben.

Caractéristiques techniques freins FA

Le tableau (A51) présente les données techniques des freins type FA.

(A51)

Freno Brake Bremse Frein	Motore Motor Motor Moteur	Coppia frenante Mb Brake torque Mb Bremsmoment Mb Couple de freinage Mb	Rilascio Release Ansprechzeit Déblocage	Frenatura Braking Bremsung Freinage	Wmax			W	P_b
			t_1	t2c	[J]				
		[Nm]	[ms]	[ms]	10 c/h	100 c/h	1000 c/h	[MJ]	[VA]
FA02	**BN 63**	3.5	4	20	4500	1400	180	15	60
FA03	**BN 71**	7.5	4	40	7000	1900	230	30	80
FA04	**BN 80**	15	6	60	10000	3100	350	50	110
FA14	**BN 90S**								
FA05	**BN 90L**	40	8	90	18000	4500	500	75	250
FA15	**BN 100**								
FA06S	**BN 112**	60	16	120	20000	4800	550	130	470
FA06	**BN 132**	75	16	140	29000	7400	800	140	550
FA07		150	16	180	40000	9300	1000	210	600

Legenda:

Mb = Coppia frenante statica (± 15%)
t_1 = tempo di rilascio freno
t_2 = ritardo di frenatura
I valori di t_1 e t_2, indicati nella tabella (C28) sono riferiti al freno tarato alla coppia nominale, traferro medio e tensione nominale.
W_{max} = energia max di frenata
W = energia di frenatura tra due regolazioni successive
Pb = potenza assorbita dal freno a 20°C

Key:

Mb = Static braking torque (± 15%)
t_1 = brake release time
t_2 = brake engagement time
t_1, and t_2 values indicated in table (C28) refer to nominal torque brake setting, with medium air-gap and at rated voltage.
W_{max} = max. energy each braking operation
W = braking energy between two successive air-gap adjustments
P_b = brake power absorption at 20°C

Zeichenerklärung:

Mb = Statische Bremsmoment (± 15%)
t_1 = Bremsenansprechzeit
t_2 = Bremsungzeit mit Unterbrechung W.S.
Die in Tabelle (C28) angegebenen Werte für t_1, und t_2 beziehen sich auf eine auf das Nenndrehmoment eingestellte Bremse mit mittlerem Luftspalt und bei Nennspannung.
W_{max} = max Energie pro Bremsung
W = Bremsenergie zwischen zwei Einstellungen
P_b = Aufnahme der Bremse bei 20°C

Légende:

Mb = Couple freinant statique (± 15%)
t_1 = durée de déblocage du frein
t_2 = retard de freinage
Les valeurs de t_1, et t_2 indiquées dans le tableau (C28) se réfèrent au frein taré au couple nominale, entrefer moyen et tension nominale.
W_{max} = énergie maxi. par freinage
W = énergie de freinage entre deux réglages successifs
P_b = absorption du frein à 20°C

42.0 ESECUZIONI SPECIALI

30.7.1 Protezioni termiche

Oltre alla protezione garantita dall'interruttore magnetotermico, i motori possono essere provvisti di sonde termiche incorporate per proteggere l'avvolgimento da eccessivo riscaldamento dovuto (p.es.) a scarsa ventilazione o servizio intermittente.
Questa protezione dovrebbe sempre essere prevista per motori servoventilati (IC416).

Sonde termiche a termistori (E3, E6)

Sono dei semiconduttori che presentano una rapida variazione di resistenza in prossimità della temperatura nominale di intervento.
L'andamento della caratteristica R= f (T) è normalizzato dalle Norme DIN 44081, IEC 34-11.

Questi sensori presentano il vantaggio di avere ingombri ridotti, un tempo di risposta molto contenuto e, dato che il funzionamento avviene senza contatti, sono completamente esenti da usura.
In genere vengono impiegati termistori a coefficiente di temperatura positivo denominati anche "resistori a conduttore freddo" PTC.

A differenza delle sonde termiche bimetalliche, non possono intervenire direttamente sulle correnti delle bobine di eccitazione e devono pertanto essere collegati ad una speciale unità di controllo (apparecchio di sgancio) da interfacciare alle connessioni esterne.
Con questa protezione vengono inseriti tre PTC, collegati in serie, nell'avvolgimento con terminali disponibili in morsettiera ausiliaria.

Sonde termiche bimetalliche (D3)

I protettori di questo tipo contengono all'interno di un involucro un disco bimetallico che, raggiunta la temperatura nominale di intervento, commuta i contatti dalla posizione di riposo.
Con la diminuzione della temperatura, il disco e i contatti riprendono automaticamente la posizione di riposo.
Normalmente si impiegano tre sonde bimetalliche in serie con contatti normalmente chiusi e terminali disponibili in una morsettiera ausiliaria.

42.0 SPECIAL EXECUTIONS

40.1 Thermal protective devices

In addition to the standard protection provided by the magneto-thermal cut-out device, motors can be supplied with built-in thermal probes to protect windings against overheating caused, for example, by inadequate ventilation or by an intermittent duty.
This additional protection should always be specified for servo-ventilated motors (IC416).

Thermistors (E3, E6)

These are semi-conductors having rapid resistance variation when they are close to the rated intervention temperature.
Variations of the R = f(T) characteristic are specified under DIN 44081, IEC 34-11 Standards.

These elements have several advantages: compact dimensions, rapid response time and,being contact-free, absolutely no wear.
Positive temperature coefficient thermistors are normally used (also known as PTC "cold conductor resistors").

Contrary to bimetallic thermostates, they cannot directly intervene on currents of energizing coils, and must therefore be connected to a special control unit (triggering apparatus) to be interfaced with the external connections.
Thus protected, three PTCs connected in series are installed in the winding, the terminals of which are located on the auxiliary terminal-board.

Bimetallic thermostates (D3)

These types of protective devices contain a bimetal disk inside a housing. When the rated temperature is reached, the disk switches the contacts from their initial rest position.
As temperature falls, the disk and contacts automatically return to rest position.
Three bimetallic thermostates connected in series are usually employed, with normally closed contacts. The terminals are located on an auxiliary terminalboard.

42.0 SONDERAUSFÜHRUNGEN

40.1 Thermische Schutzeinrichtungen

Abgesehen von den Motorschutzschaltern mit thermischem und elektromagnetischem Auslöser können die Motoren mit integrierten Temperaturfühlern zum Schutz der Wicklung vor Überhitzung z.B. wegen unzureichender Lüftung oder Aussetzbetriebs ausgestattet werden.
Diese Schutzeinrichtung muß bei fremdbelüfteten Motoren stets vorgesehen werden (IC416).

Temperaturfühler und Thermistoren (E3, E6)

Hierbei handelt es sich um Halbleiter, die eine schnelle Änderung des Widerstands in der Nähe der Nennansprechtemperatur zeigen.
Der Verlauf der Kennlinie R = f(T) ist durch die DIN-Normen 44081 und IEC 34-11 festgelegt.

Diese Sensoren haben folgende Vorteile: sie weisen geringe Außenmaße und eine äußerst kurze Ansprechzeit auf und sind vollkommen verschleißfrei, da sie berührungslos arbeiten.

Im allgemeinen werden Thermistoren mit positivem Temperaturkoeffizienten verwendet, die auch als "Kaltleiter" (PTC-Widerstände) bezeichnet werden.
Im Unterschied zu Bimetall-Temperaturfühlern können sie nicht direkt auf die Erregungsströme der Spulen wirken, sondern müssen an eine spezielle Steuereinheit (Auslösegerät) angeschlossen werden, die mit den externen Anschlüssen kompatibel ist.
Mit dieser Schutzeinrichtung werden drei in Reihe geschaltete PTC-Widerstände in die Wicklung eingesetzt, deren Endanschlüsse an einer Zusatzklemmleiste verfügbar sind.

Bimetall-Temperaturfühler (D3)

Diese Schutzeinrichtungen bestehen aus einer Kapsel, in der sich eine Bimetallscheibe befindet, die bei Erreichen der Nennansprechtemperatur anspricht.
Nach Absenkung der Temperatur geht der Schaltkontakt automatisch in Ruhestellung zurück.
Normalerweise werden drei in Reihe geschaltete Bimetallfühler mit Öffnern verwendet, deren Endverschlüsse an einer Zusatzklemmleiste verfügbar sind.

42.0 EXECUTIONS SPECIALES

40.1 Protections thermiques

Outre la protection garantie par l'interrupteur magnétothermique, les moteurs peuvent être équipés de sondes thermiques incorporées pour protéger le bobinage contre une surchauffe excessive due par exemple à une ventilation insuffisante ou un service intermittent.
Cette protection devrait toujours être prévue pour les moteurs servoventilés (IC416).

Sondes thermométriques (E3, E6)

Ce sont des semiconducteurs qui présentent une variation rapide de résistance à proximité de la température nominale d'intervention.
L'évolution de la caractéristique R = f(T) est défini par les Normes DIN 44081, IEC 34-11.

Ces capteurs présentent l'avantage d'avoir des encombrements réduits, un temps de réponse très bref et, du fait que le fonctionnement a lieu sans contact, il sont exempts d'usure.

En général, on utilise des thermistors à coefficient de température positif dénommés également "résistors à conducteur froid" PTC.
Contrairement aux sondes thermiques bimétalliques, ils ne peuvent intervenir directement sur les courants des bobines d'excitation et doivent par conséquent être reliés à une unité spéciale de contrôle (appareil de déconnection) à interfacer aux connexions extérieures.
Avec cette protection, trois sondes, reliées en série, sont insérées dans le bobinage avec extrémités disponibles dans le bornier auxiliaire.

Sondes thermiques bimétalliques (D3)

Les protecteurs de ce type contiennent, dans une enveloppe interne, un disque bimétallique qui, lorsque la température nominale d'intervention est atteinte, commute les contacts de la position de repos.
Avec la diminution de la température, le disque et les contacts reprennent automatiquement la position de repos.
Normalement, on utilise trois sondes bimétalliques en série avec contacts normalement fermés et extrémités disponibles dans un bornier auxiliaire.

42.2 **Riscaldatori anticondensa** (H1)

I motori funzionanti in ambienti molto umidi e/o in presenza di forti escursioni termiche, possono essere equipaggiati con una resistenza anticondensa.
L'alimentazione è prevista da una morsettiera ausiliaria e la tensione standard è 230V c.a. ± 10% monofase; le potenze sono indicate nella tabella (C29).

42.2 **Anti-condensate heaters** (H1)

Motors operating in extremely humid environments and/or at a wide temperature range can be supplied with an anti-condensate heater.
Power is supplied via an auxiliary terminal-board, standard voltage is 230 V.a.c. ± 10% single-phase; power specifications are shown in table (C29).

42.2 **Wicklungsheizung** (H1)

Die Motoren, die in Umgebungen mit hoher Luftfeuchte und der großen Temperaturschwankungen betrieben werden, können mit einem Kondenswasserschutz-Heizelement ausgestattet werden.
Die Stromversorgung wird über eine Zusatzklemmleiste mit einer einphasigen Standardspannung von W.S. 230 V ± 10% bewerkstelligt; die Leistungen sind in Tabelle (C29) angegeben.

42.2 **Réchauffeurs anticondensation** (H1)

Les moteurs fonctionnant dans des milieux très humides et/ou en présence de fortes excursions thermiques, peuvent être équipés de résistance anticondensation.
L'alimentation est prévue par un bornier auxiliaire et la tension standard est de 230V c.a. ± 10% monophasée. Les puissances sont indiquées dans le tableau (C29).

(C29)

Tipo Motor type	Potenza Power [W]	Motortyp Moteur type	Leistung Puissance [W]
BN 80	10	**BN 80**	10
BN 90 - 100	25	**BN 90 - 100**	25
BN 112 - 132	25	**BN 112 - 132**	25
BN 160	50	**BN 160**	50

Importante !
Durante il funzionamento del motore la resistenza anticondensa non deve mai essere inserita.

Important !
While motor is running, the anti-condensate heater must be switched off.

Wichtig!
Während des Betriebs des Motors darf das Heizelement nie eingeschaltet werden.

Important!
Pendant le fonctionnement du moteur, la résistance anti-condensation ne doit jamais être branchée.

42.3 **Servoventilazione(U1)**

A partire dalla grandezza BN71 i motori possono essere forniti con ventilazione assiale indipendente.
Il raffreddamento è realizzato da un ventilatore installato all'interno della calotta copriventola, con alimentazione indipendente
(220/240 V 50/60 Hz per grandezza 71 - 100 ,
230/400 V 50/60 Hz per 112 - 132).
A richiesta può essere applicato un encoder o una dinamo tachimetrica.
La tabella (A53) riporta le variazioni dimensionali (ΔL_1 e ΔL_2) del motore servoventilato.

42.3 **Servo-ventilation** (U1)

Starting from size BN71, the motors can be supplied with independent axial ventilation.
Cooling is by an independently powered fan mounted inside the fan cover
(220V/240V 50/60 Hz for sizes 71 - 100,
230/400 V 50/60 Hz for 112 - 132).

An encoder or tacho-generator can be fitted on request.
Table (A53) shows dimension variations (ΔL_1 and ΔL_2) of the servo-ventilated motor.

42.3 **Fremdbelüftung** (U1)

Ab der Baugrösse BN71 können die Motoren mit einem Fremdlüfter geliefert werden.
Die Kühlung erfolgt durch einen Ventilator, der unter der Lüfterradkappe angeordnet ist und über eine unabhängige Stromversorgung verfügt.
(220/240 V - 50/60 Hz für Größen 71 - 100,
230/400 V - 50/60 Hz für 112 - 132).
Auf Wunsch kann ein Encoder oder ein Tacho-Dynamo installiert werden.
Tabelle (A53) zeigt die Maßänderungen (ΔL_1 und ΔL_2) des fremdbelüfteten Motors.

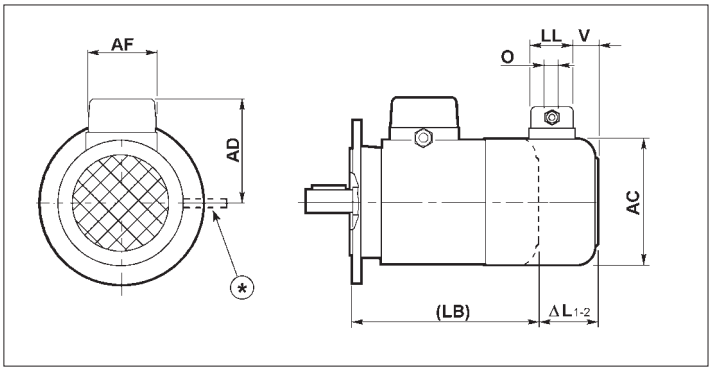
42.3 **Servoventilation** (U1)

A partir de la taille BN71, les moteurs peuvent être équipés d'une ventilation axiale indépendante.
Le refroidissement est réalisé par un ventilateur installé à l'intérieur de la calotte cache-ventilateur, avec alimentation indépendante.
(220/240 V - 50/60 Hz pour taille 71 - 100,
230/400V 50/60 Hz pour 112 - 132).
Sur demande, on peut appliquer un encodeur ou une dynamo tachymétrique.
Le tableau (A53) présente les variations dimensionnelles (ΔL_1 et ΔL_2) du moteur servoventilé.

(A53)

Tipo/Type/Typ/Type	ΔL_1	ΔL_2	AC	AD	AF	LL	V	O
BN 71	91	32	138	112	70	70	36	Pg11
BN 80 / M 2	125	55	156	120	70	70	40	Pg11
BN 90	118	38	176	137	90	90	35	Pg11
M 3S	148	57	195	145	90	90	40	Pg11
BN 100 / M 3L	117	29	195	145	90	90	40	Pg11
BN 112	127	31	219	155	70	70	55	Pg11

(C32)



Legenda:

ΔL_1 = Variazione dimensionale rispetto alla dimensione LB dei motori trifase normali
ΔL_2 = Variazione dimensionale rispetto alla dimensione LB dei motori autofrenanti

* N.B. Nei motori autofrenanti con leva di sblocco, la leva verrà collocata lateralmente.

Per grandezza BN160 interpellare il ns. servizio tecnico

Key:

ΔL_1 = Dimensional variation with respect to dimension LB of normal three-phase motors
ΔL_2 = Dimensional variation with respect to dimension LB of brake motors.

* N.B. In brake motors with a hand release lever, the lever is side located.

Contact our Technical Service Dept. for size BN160.

Zeichenerklärung:

ΔL_1 = Maßänderung im Vergleich zum Maß LB der normalen Drehstrommotoren
ΔL_2= Maßänderung im Vergleich zum Maß LB der Bremsmotoren.

*P.S. bei den Bremsmotoren mit Bremslüfthebel wird der Hebel seitlich angebracht

Im Bezug auf die BN160 bitten wir Sie sich an unseren technischen Kunddendienst zu werden.

Légende:

ΔL_1 = Variation dimensionnelle par rapport à la dimension LB des moteurs triphasés normaux
ΔL_2 = variation dimensionnelle par rapport à la dimension LB des moteurs frein.

*N.B. Pour les moteurs freins avec levier de déblocage, le levier sera placé latéralement.

En ce qui concerne la taille BN160, contacter notre service technique.

42.4 Tettuccio parapioggia (RC)

Questa protezione viene applicata al motore quando esso è montato con albero in basso per proteggerlo dall'ingresso di corpi solidi e dallo stillicidio.
Deve essere richiesta in fase di ordine in quanto non prevista nella versione base.
La tabella (A54) riporta il massimo ingombro del tettuccio parapioggia.

42.4 Rain canopy (RC)

This rain canopy is applied to the motor when mounted with the shaft downwards in order to provide a protection against solid bodies and dripping water.
The rain canopy must be specified when ordering as it is not a supplied item for standard motors. Table (A54) shows the overall dimensions of the rain canopy.

42.4 Schutzdach (RC)

Diese Schutzvorrichtung wird am Motor angebracht, wenn der Motor mit der Welle nach unten montiert wird und von Feststoffen und Tropfwasser geschützt werden muß.
Die Abdeckung muß bei Bestellung angefordert werden, da der Motor in der Standardausführung nicht darüber verfügt. In Tabelle (A54) sind die maximalen Außenmaße der Regenschutzabdeckung angegeben.

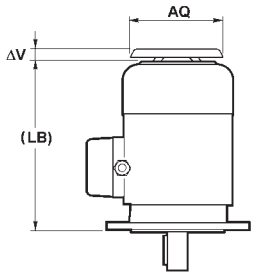
42.4 Capot de protection anti-pluie (RC)

C'est une protection qui est appliquée au moteur lorsque ce dernier est monté avec arbre vers bas pour le proteger contre la pénétration de corps solides ou de la stillation.
Il doit être demandé au moment de la commande étant donné que le moteur standard ne le prevoit pas. Le tableau (A54) présente l'encombrement maximum du capot de protection anti-pluie.

(A54)

Tipo/Type/Typ/Type		AQ	∆ V
BN 71		134	27
BN 80	**M2**	134	25
BN 90		168	30
BN 100	**M3**	168	28
BN 112		211	32
BN 132	**M4**	211	32
BN 160	**M5**	270	36

(A54)



43.0 TABELLE DATI TECNICI
SELECTION CHARTS
AUSWAHLTABELLEN
TABLEAUX CARACTERISTIQUES TECHNIQUES

4 Poli / Pole / Polig / Pôles - 1500 min^{-1} - S1

freno/brake/Bremse/frein FD

Tipo Type Typ Type	Pn	n	Mn	η	cosφ	In	Is/In	Ms/Mn	Ma/Mn	Freno Brake Bremse Frein	Mb max	Zo		Senza freno Without brake Ohne Bremse Sans frein		Con freno With brake mit Bremse Avec frein	
														Jm	Kg	Jm	Kg
	kW	min^{-1}	Nm	%		A (400V)					Nm	NB*	SB* 1/h	(• 10^{-4}) kgm^2	IMB5	(• 10^{-4}) kgm^2	IMB5
BN 71A4	0.25	1375	1.74	65	0.76	0.73	3.2	1.9	1.7	FD03	3.5	7700	11000	5.8	5.1	7.3	7.3
BN 71B4	0.37	1370	2.6	67	0.77	1.04	3.4	2.0	1.8	FD03	5	6000	9400	6.9	5.9	8.4	8.1
BN 80A4	0.55	1400	3.8	72	0.77	1.43	4.1	2.3	2.0	FD04	10	4100	8000	15	8.2	18.0	11.3
BN 80B4	0.75	1400	5.1	75	0.78	1.85	4.9	2.7	2.5	FD04	15	4100	7800	20	9.9	23	13
BN 90S4	1.1	1400	7.5	73	0.77	2.82	4.6	2.6	2.2	FD14	15	4800	8000	21	12.2	24	15.3
BN 90LA4	1.5	1390	10.3	74	0.77	3.8	4.6	2.8	2.4	FD05	26	3400	6000	28	14	33	18.9
BN 90LB4	1.85	1390	12.7	77	0.78	4.4	4.8	2.8	2.5	FD05	26	3200	5900	30	15	35	19.9
BN 100LA4	2.2	1410	14.9	78	0.76	5.4	4.5	2.2	2.0	FD15	40	2600	4700	40	18	46	23
BN 100LB4	3	1410	20	80	0.78	6.9	5.0	2.3	2.2	FD15	40	2400	4400	54	22	59	27
BN 112M4	4	1420	27	82	0.78	9.0	5.4	2.5	2.3	FD06S	60	–	1400	98	30	114	38
BN 132S4	5.5	1440	36	84	0.80	11.0	5.5	2.3	2.2	FD56	75	–	1050	213	43	233	52
BN 132MA4	7.5	1440	50	85	0.81	15.7	5.7	2.5	2.4	FD06	100	–	950	270	51	290	61
BN 132MB4	9.2	1445	61	86	0.81	19.1	5.7	2.5	2.5	FD07	150	–	900	319	58	352	70
BN 160M4	11	1450	72	87	0.81	22.5	5.5	2.2	2.0	FD08	170	–	800	490	85	–	109
BN 160L4	15	1460	98	89	0.82	29.7	5.9	2.3	2.1	FD08	200	–	750	650	102	–	126
BN 180M4	18.5	1470	120	90	0.84	35	6.5	2.5	2.3	–	–	–	–	888	110	–	–
BN 180L4	22	1470	143	90	0.84	42	6.5	2.5	2.3	–	–	–	–	1110	119	–	–
BN 200L4	30	1470	195	91	0.86	55	6.5	2.4	2.1	–	–	–	–	1605	155	–	–
BN 225S4	37	1480	239	91	0.86	68	7.1	2.6	2.4	–	–	–	–	3075	202	–	–
BN 225M4	45	1480	291	91	0.86	83	7.1	2.6	2.4	–	–	–	–	3675	235	–	–
BN 250M4	55	1480	355	92	0.86	100	7.3	2.5	2.3	–	–	–	–	4500	286	–	–

6 Poli / Pole / Polig / Pôles - 1000 min^{-1} - S1

freno/brake/Bremse/frein FD

Tipo Type Typ Type	Pn	n	Mn	η	cosφ	In	Is/In	Ms/Mn	Ma/Mn	Freno Brake Bremse Frein	Mb max	Zo		Senza freno Without brake Ohne Bremse Sans frein		Con freno With brake mit Bremse Avec frein	
														Jm	Kg	Jm	Kg
	kW	min^{-1}	Nm	%		A (400V)					Nm	NB*	SB* 1/h	(• 10^{-4}) kgm^2	IMB5	(• 10^{-4}) kgm^2	IMB5
BN 71A6	0.18	895	1.92	56	0.69	0.67	2.6	1.9	1.7	FD03	5	8100	13500	8.4	5.4	9.9	7.6
BN 71B6	0.25	890	2.7	62	0.71	0.82	2.6	1.9	1.7	FD03	5	7800	13000	10.9	6.7	12.4	8.9
BN 80A6	0.37	910	3.9	68	0.68	1.15	3.2	2.2	2.0	FD04	10	5200	8500	21	8.2	23	11.3
BN 80B6	0.55	920	5.7	70	0.69	1.64	3.9	2.6	2.2	FD04	15	4800	7200	25	11.3	28	14.4
BN 90S6	0.75	900	8.0	69	0.68	2.31	3.3	2.4	2.0	FD14	15	3400	6500	26	13	29	16.1
BN 90L6	1.1	900	11.7	72	0.69	3.20	3.6	2.3	1.9	FD05	26	2700	5000	33	16.2	39	21.1
BN 100LA6	1.5	940	15.2	73	0.72	4.1	4.0	2.1	2.0	FD15	40	1900	4100	82	22	87	27
BN 100LB6	1.85	930	19.0	73	0.73	5.0	4.1	2.0	2.0	FD15	40	1700	3600	95	25	100	30
BN 112M6	2.2	940	22	78	0.73	5.6	4.8	2.2	2.0	FD06S	60	–	2100	168	28	184	37
BN 132S6	3	940	30	79	0.74	7.4	4.8	1.9	1.8	FD56	75	–	1400	216	36	236	45
BN 132MA6	4	945	40	80	0.75	9.6	4.8	2.0	1.8	FD06	100	–	1200	295	44	315	53
BN 132MB6	5.5	945	56	81	0.74	13.2	4.9	2.0	1.9	FD07	150	–	1050	383	56	416	68
BN 160M6	7.5	955	75	87	0.80	15.6	5.5	2.1	1.9	FD08	170	–	900	740	85	835	109
BN 160L6	11	960	109	87	0.78	23	5.5	2.1	1.9	FD08	200	–	800	970	102	1065	126
BN 180L6	15	970	148	87	0.82	30	7.2	2.4	2.4	–	–	–	–	1410	114	–	–
BN 200LA6	18.5	975	181	88	0.83	37	6.8	2.3	2.2	–	–	–	–	2700	145	–	–
BN 200LB6	22	975	216	88	0.84	43	6.8	2.3	2.2	–	–	–	–	3200	160	–	–
BN 225M6	30	980	293	90	0.84	57	6.1	2.4	2.3	–	–	–	–	5400	234	–	–
BN 250M6	37	980	361	91	0.84	70	6.8	2.4	2.2	–	–	–	–	7500	295	–	–

* Raddrizzatore tipo NB o SB * Rectifier type NB or SB * Gleichrichter Typ NB oder SB * Redresseur type NB ou SB

4 Poli / Pole / Polig / Pôles - 1500 min^{-1} - S1

freno/brake/Bremse/frein FA

Tipo Type Typ Type	Pn kW	n min^{-1}	Mn Nm	η %	cosφ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Freno Brake Bremse Frein	Mb max Nm	Z_o 1/h	Senza freno Without brake Ohne Bremse Sans frein Jm ($\cdot 10^{-4}$) kgm^2	Senza freno Kg IMB5	Con freno With brake mit Bremse Avec frein Jm ($\cdot 10^{-4}$) kgm^2	Con freno Kg IMB5
BN 71A4	0.25	1375	1.74	65	0.76	0.73	3.2	1.9	1.7	**FA03**	3.5	11000	5.8	5.1	7.3	7
BN 71B4	0.37	1370	2.6	67	0.77	1.04	3.4	2.0	1.8	**FA03**	5	9400	6.9	5.9	8.4	7.8
BN 80A4	0.55	1400	3.8	72	0.77	1.43	4.1	2.3	2.0	**FA04**	10	8000	15	8.2	18.0	11.3
BN 80B4	0.75	1400	5.1	75	0.78	1.85	4.9	2.7	2.5	**FA04**	15	7800	20	9.9	23	13
BN 90S4	1.1	1400	7.5	73	0.77	2.82	4.6	2.6	2.2	**FA14**	15	8000	21	12.2	24	15.3
BN 90LA4	1.5	1390	10.3	74	0.77	3.8	4.6	2.8	2.4	**FA05**	26	6000	28	14	33	19.6
BN 90LB4	1.85	1390	12.7	77	0.78	4.4	4.8	2.8	2.5	**FA05**	26	5900	30	15	35	21
BN 100LA4	2.2	1410	14.9	78	0.76	5.4	4.5	2.2	2.0	**FA15**	40	4700	40	18	46	24
BN 100LB4	3	1410	20	80	0.78	6.9	5.0	2.3	2.2	**FA15**	40	4400	54	22	59	28
BN 112M4	4	1420	27	82	0.78	9.0	5.4	2.5	2.3	**FA06S**	60	2100	98	30	114	40
BN 132S4	5.5	1440	36	84	0.80	11.0	5.5	2.3	2.2	**FA06**	75	1200	213	43	233	53
BN 132MA4	7.5	1440	50	85	0.81	15.7	5.7	2.5	2.4	**FA07**	100	1000	270	51	290	66
BN 132MB4	9.2	1445	61	86	0.81	19.1	5.7	2.5	2.5	**FA07**	150	900	319	58	352	73

6 Poli / Pole / Polig / Pôles - 1000 min^{-1} - S1

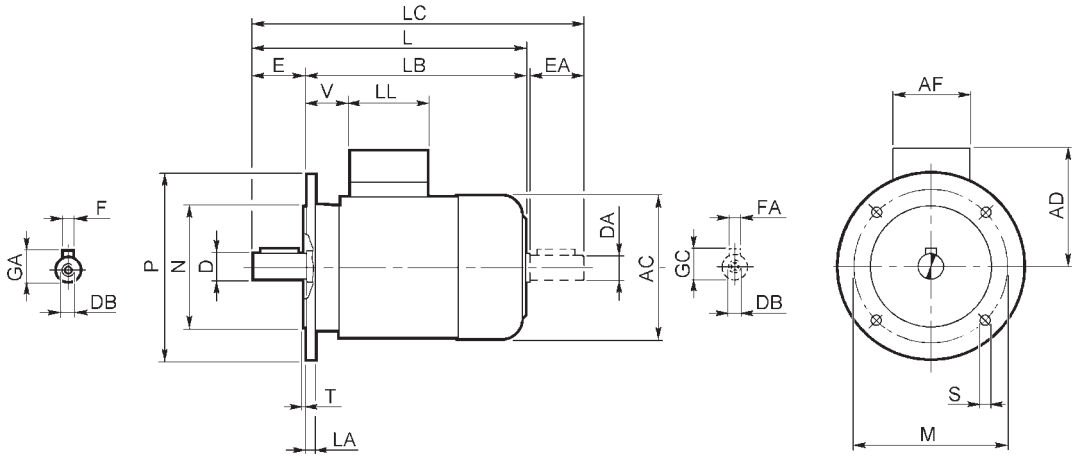
freno/brake/Bremse/frein FA

Tipo Type Typ Type	Pn kW	n min^{-1}	Mn Nm	η %	cosφ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Freno Brake Bremse Frein	Mb max Nm	Z_o 1/h	Senza freno Without brake Ohne Bremse Sans frein Jm ($\cdot 10^{-4}$) kgm^2	Senza freno Kg IMB5	Con freno With brake mit Bremse Avec frein Jm ($\cdot 10^{-4}$) kgm^2	Con freno Kg IMB5
BN 71A6	0.18	895	1.92	56	0.69	0.67	2.6	1.9	1.7	**FA03**	5	13500	8.4	5.4	9.9	7.3
BN 71B6	0.25	890	2.7	62	0.71	0.82	2.6	1.9	1.7	**FA03**	5	13000	10.9	6.7	12.4	8.6
BN 80A6	0.37	910	3.9	68	0.68	1.15	3.2	2.2	2.0	**FA04**	10	8500	21	8.2	23	11.3
BN 80B6	0.55	920	5.7	70	0.69	1.64	3.9	2.6	2.2	**FA04**	15	7200	25	11.3	28	14.4
BN 90S6	0.75	900	8.0	69	0.68	2.31	3.3	2.4	2.0	**FA14**	15	6500	26	13	29	16.1
BN 90L6	1.1	900	11.7	72	0.69	3.20	3.6	2.3	1.9	**FA05**	26	5000	33	16.2	39	22
BN 100LA6	1.5	940	15.2	73	0.72	4.1	4.0	2.1	2.0	**FA15**	40	4100	82	22	87	28
BN 100LB6	1.85	930	19.0	73	0.73	5.0	4.1	2.0	2.0	**FA15**	40	3600	95	25	100	31
BN 112M6	2.2	940	22	78	0.73	5.6	4.8	2.2	2.0	**FA06S**	60	2100	168	28	184	38
BN 132S6	3	940	30	79	0.74	7.4	4.8	1.9	1.8	**FA06**	75	1400	216	36	236	46
BN 132MA6	4	945	40	80	0.75	9.6	4.8	2.0	1.8	**FA07**	100	1200	295	44	315	59
BN 132MB6	5.5	945	56	81	0.74	13.2	4.9	2.0	1.9	**FA07**	150	1050	383	56	416	71

44.0 **DIMENSIONI** 44.0 **DIMENSIONS** 44.0 **ABMESSUNGEN** 44.0 **DIMENSIONS**

BN_B5

(IM B5)



* n. 8 fori a 45°
n. 8 holes 45°
n. 8 Bohrungen 45°
n. 8 trous 45°

Tipo/Type Typ/Type	Flangia / Flange / Flansch / Bride						Motore / Motor / Motor / Moteur								Albero / Shaft / Welle / Arbre				
	P	**N**	**M**	**LA**	T	**S**	AC	L	LB	LC	AD	AF	LL	V	**D** DA	DB	**E** EA	**GA** GC	**F** FA
BN 71	160	110	130	10	3.5	9	138	249	219	281	109	70	70	35	14	M5	30	16	5
BN 80	200	130	165	12	3.5	11	156	273	233	315	124	85	85	37	19	M6	40	21.5	6
BN 90 S	200	130	165	12	3.5	11	176	302	252	354	126	98	98	44	24	M8	50	27	8
BN 90 L	200	130	165	12	3.5	11	176	326	276	378	126	98	98	44	24	M8	50	27	8
BN 100	250	180	215	14	4	14	195	366	306	429	135	98	98	50	28	M10	60	31	8
BN 112	250	180	215	15	4	14	219	385	325	448	150	98	98	52	28	M10	60	31	8
BN 132 S	300	230	265	16	4	14	258	455	375	538	193	118	118	58	38	M12	80	41	10
BN 132 M	300	230	265	16	4	14	258	493	413	576	193	118	118	58	38	M12	80	41	10
BN 160 M	350	250	300	15	5	18	310	596	486	680	235	175	188	77	42(1)	M16	110	45	12
BN 160 L	350	250	300	15	5	18	310	596	486	680	235	175	188	77	42(1)	M16	110	45	12
BN 180 M	350	250	300	15	5	18	320	690	580	824	245	188	188	165	48	M16	110	51.5	14
BN 180 L	350	250	300	15	5	18	320	690	580	824	245	188	188	165	48	M16	110	51.5	14
BN 200 M	400	300	350	15	5	18	360	750	640	905	275	188	188	196	55	M20	110	59	16
BN 200 L	400	300	350	15	5	18	360	750	640	905	275	188	188	196	55	M20	110	59	16
BN 225 S	450	350	400	16	5	18*	400	830	690	985	290	225	225	193	60	M20	140	64	18
BN 225 M4-6	450	350	400	16	5	18*	400	830	690	985	290	225	225	193	60	M20	140	64	18
BN 250 M4-6	550	450	500	18	5	18*	450	905	756	1061	330	225	225	197	65	M20	140	69	18

(1) Per i motori gr. 160 dimensioni della seconda estremità d'albero come BN132.

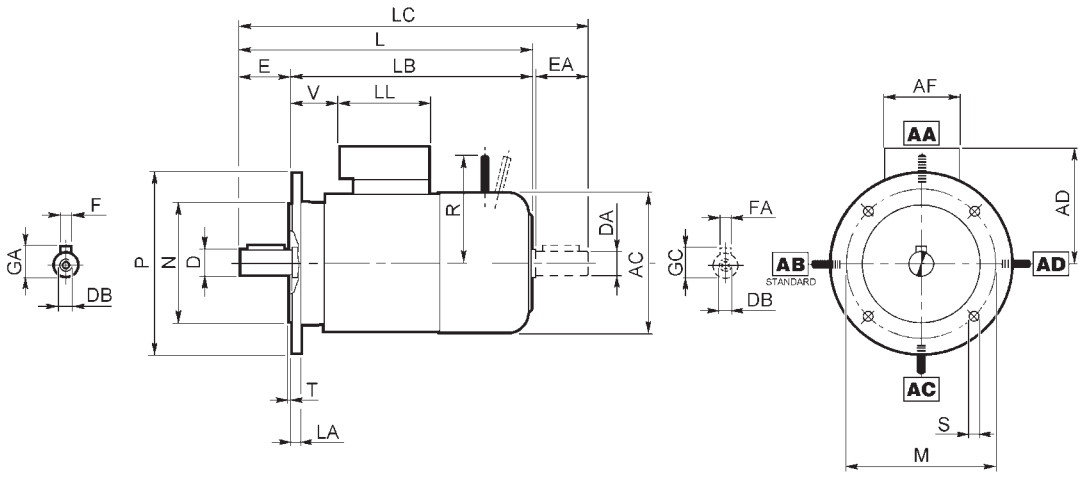
(1) For motor size 160, dimensions of the second shaft end as BN132.

(1) Für Motoren der Baugröße 160, Maße des 2. Wellenendes wie BN132.

(1) Pour les moteurs de taille 160, dimensions par rapport à la 2ème extrémité d'arbre comme BN132.

BN_B5 FD

(IM B5)



Tipo/Type Typ/Type	Flangia / Flange / Flansch / Bride						Motore / Motor / Motor / Moteur									Albero / Shaft / Welle / Arbre				
	P	**N**	**M**	**LA**	T	**S**	AC	L	LB	LC	AD	AF	LL	R	V	**D** DA	DB	**E** EA	**GA** GC	**F** FA
BN 63	140	95	115	10	3	9	124	269	246	294	105	86	130	96	11	11	M4	23	12.5	4
BN 71	160	110	130	10	3.5	9	138	310	280	342	117	86	130	103	23	14	M5	30	16	5
BN 80	200	130	165	12	3.5	11	156	346	306	388	133	102	146	129	27	19	M6	40	21.5	6
BN 90 S	200	130	165	12	3.5	11	176	385	335	437	146	110	165	129	15	24	M8	50	27	8
BN 90 L	200	130	165	12	3.5	11	176	409	359	461	146	110	165	160	39	24	M8	50	27	8
BN 100	250	180	215	14	4	14	195	458	398	521	155	110	165	160	62	28	M10	60	31	8
BN 112	250	180	215	15	4	14	219	484	424	547	170	110	165	199	73	28	M10	60	31	8
BN 132 S	300	230	265	16	4	14	258	565	485	648	193	118	118	204	142	38	M12	80	41	10
BN 132 M	300	230	265	16	4	14	258	603	523	686	193	118	118	204	180	38	M12	80	41	10
BN 160 M	350	250	300	13	5	18.5	310	736	626	820	235	175	188	266	77	42 (1)	M16	110	45	12
BN 160 L	350	250	300	13	5	18.5	310	736	626	820	235	175	188	266	77	42 (1)	M16	110	45	12

(1) Per i motori gr. 160 dimensioni della seconda estremità d'albero come BN132.

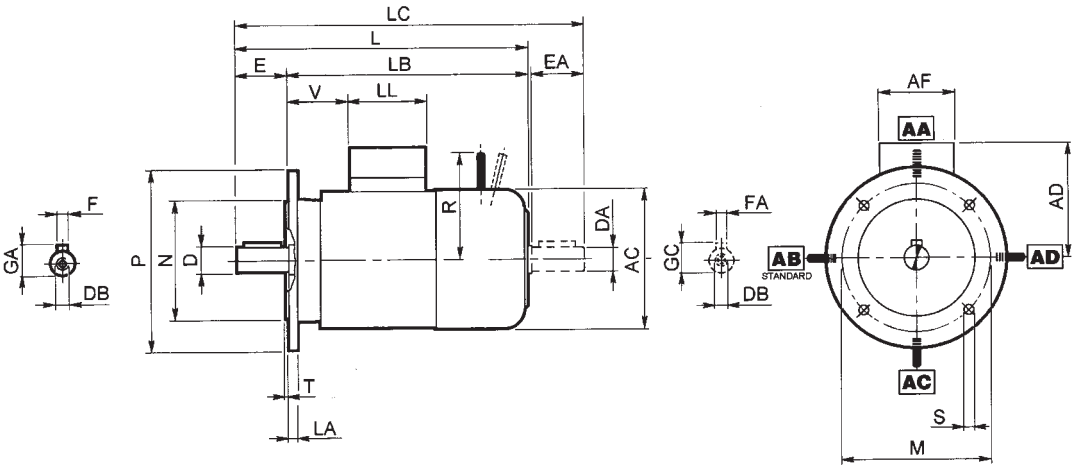
(1) For motor size 160, dimensions of the second shaft end as BN132.

(1) Für Motoren der Baugröße 160, Maße des 2. Wellenendes wie BN132.

(1) Pour les moteurs de taille 160, dimensions par rapport à la 2ème extrémité d'arbre comme BN132.

BN_B5 FA

(IM B5)



Tipo/Type Typ/Type	Flangia / Flange / Flansch / Bride						Motore / Motor / Motor / Moteur									Albero / Shaft / Welle / Arbre				
	P	**N**	**M**	**LA**	T	**S**	AC	L	LB	LC	AD*	AF*	LL*	R	V*	**D** DA	DB	**E** EA	**GA** GC	**F** FA
BN 71	160	110	130	10	3.5	9	138	310	280	342	109	70	70	124	75	14	M5	30	16	5
BN 80	200	130	165	12	3.5	11	156	346	306	388	124	85	85	134	78	19	M6	40	21.5	6
BN 90 S	200	130	165	12	3.5	11	176	385	335	437	126	98	98	134	71	24	M8	50	27	8
BN 90 L	200	130	165	12	3.5	11	176	409	359	461	126	98	98	160	95	24	M8	50	27	8
BN 100	250	180	215	14	4	14	195	458	398	521	135	98	98	160	119	28	M10	60	31	8
BN 112	250	180	215	15	4	14	219	484	424	547	150	98	98	198	128	28	M10	60	31	8
BN 132 S	300	230	265	16	4	14	258	565	485	648	193	118	118	200	142	38	M12	80	41	10
BN 132 M	300	230	265	16	4	14	258	603	523	686	193	118	118	200	180	38	M12	80	41	10

* Se è prevista l'alimentazione separata del freno la morsettiera avrà le dimensioni riportate a pag. 219 (BN_B5FD).

* In case of separate brake power supply, the terminal board will have the same dimensions as at page 219 (BN_B5FD).

* Wenn die Fremdstromversorgung der Bremse vorgesehen ist, wird das Klemmkasten die gleiche Abmessungen wie auf Seite 219 (BN_B5FD).

* En cas d'alimentation séparée du frein, la boîte à bornes aura les dimensions reportées page 219 (BN_B5FD).

45.0 SISTEMI AUSILIARI DI RAFFREDDAMENTO

Qualora la potenza meccanica trasmessa sia superiore a quella termica trasmissibile (vedi tabelle dati tecnici riduttori), è possibile fornire il riduttore corredato di centralina di raffreddamento.

45.0 SUPPLEMENTARY COOLING SYSTEMS

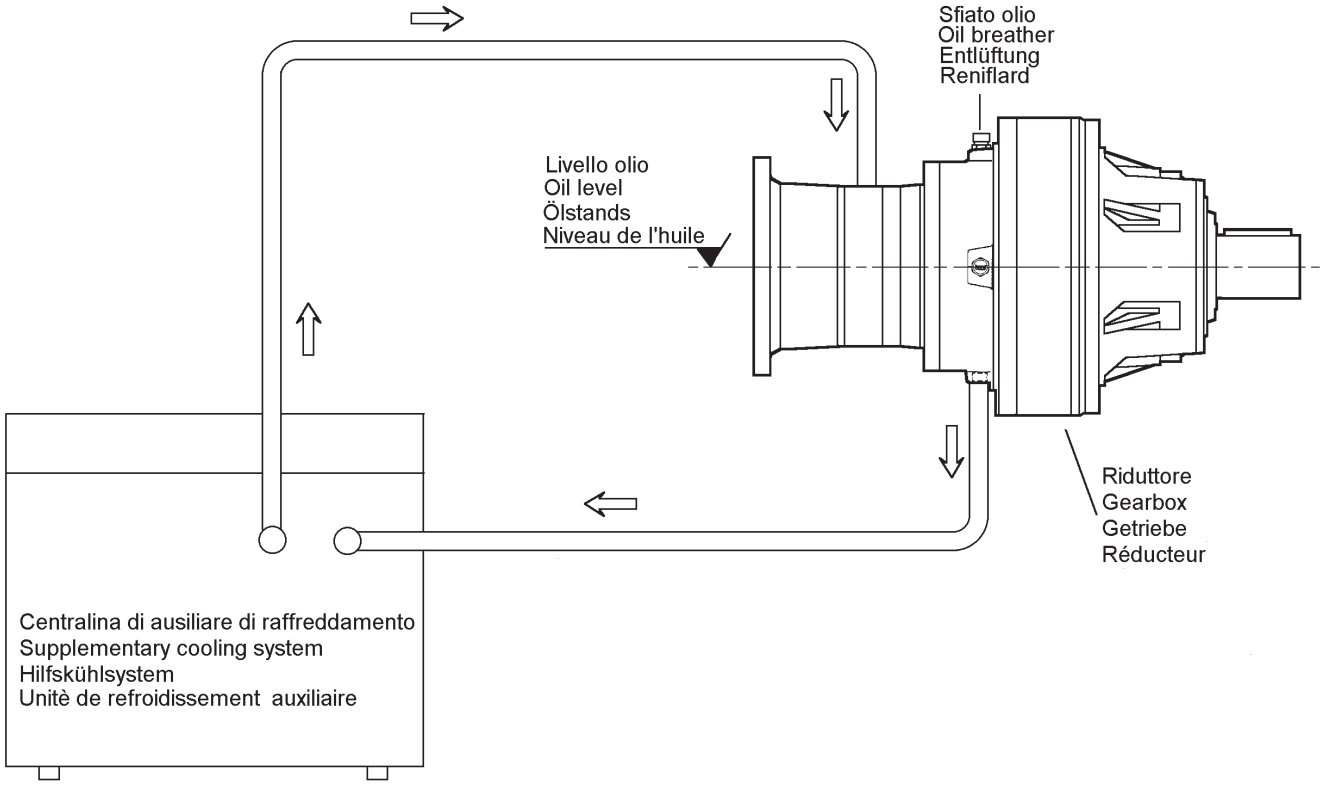
In the event transmitted mechanical power is higher than transmissible thermal power (see tables of gearbox specifications), gearboxes are available complete with a cooling system.

45.0 HILFSKºHLSYSTEME

Sollte die übertragende mechanische Leistung über der übertragbaren Wärmeleistung liegen (siehe Tabelle mit technischen Getriebedaten), ist die Lieferung eines, mit einem Kühlsystem ausgestatteten Get-

45.0 SYSTEMES AUXILIAIRES DE REFROIDISSEMENT

Au cas où la puissance mécanique transmise serait supérieure à celle thermique transmissible (confronter tableaux données techniques réducteurs), il est possible de d'équiper le réducteur d'une unité de refroidis-



Le centraline autonome di raffreddamento sono unità composte da uno scambiatore di calore aria-olio, una motopompa, un filtro dell'olio da raffreddare, un elettroventilatore ed un impianto elettrico comprendente la protezione termica dei motori elettrici.
Caratteristica delle centraline è il basso livello di rumorosità.

These separate cooling systems are made up of an air-oil heat exchanger, a motor pump, a filter for warm oil and an electric system that incorporates an overload cutout for electric motors.
A special feature of these cooling systems is their low noise.

Die autonomen Kühlsysteme sind Einheiten, die sich aus einem Luft-Öl-Wärmeaustauscher, einer Motorpumpe, einem Filter für das zu kühlende Öl, einem Elektroventilator und einer elektrischen Anlage, welche den Wärmeschutz der Elektromotoren enthält, zusammensetzen.

Les unités indépendantes de refroidissement sont des sous-ensembles se composant d'un échangeur de chaleur air/huile, d'une motopompe, d'un filtre pour l'huile à refroidir, d'un électroventilateur et d'un système électrique incluant une protection thermique des moteurs électriques.
Cette unité est caractérisée par un bas niveau de nuisance sonore.

45.1 Dati tecnici

45.1 Technical data

45.1 Technische daten

45.1 Donn¢e techniques

		CR1	CR2	CR3
Potenza assorbita Power absorbtion Leistungsaufn Puissance absorbée	[kW]	0.25	0.63	1
Portata pompa Pumpflow Pumpeausflussmenge Débit de pompe	[l/min]	9	25	40
Portata aria Air flow Luftausflussmenge Débit d'air	[m^3/h]	600	1000	3000
Livello di rumorosità a 1 metro Level of noise at 1 mt. Geräuschpegel Niveau sonore à 1 in1 mètre	[dB(A)]	67	71	76
Peso Weight Gewicht Poids	[Kg]	28	40	63

45.2 **Criteri di scelta**

Nota la potenza da trasmettere P e verificato che questa sia superiore alla potenza termica Pt, calcolare la potenza da smaltire Ps con la formula:

45.2 **Selection criteria**

Power P to be transmitted is known. Once you have determined that it is higher than thermal power Pt, calculate excess power Ps using this formula:

45.2 **Auswahlkriterien**

Hat man einmal die Date der zu übertragenden Leistung P zur Verfügung stehen und überprüft, ob diese über der Wärmeleistung Pt liegt, muß man die Überleistung Ps unter Anwendung der folgenden Formel berechnen:

45.2 **Critères de sélection**

La puissance P à transmettre connue, et une fois vérifié que celle-ci est supérieure à la puissance thermique Pt, calculer la puissance à éliminer Ps par la formule :

$$Ps = 0.1 \cdot (P - Pt) \qquad (38)$$

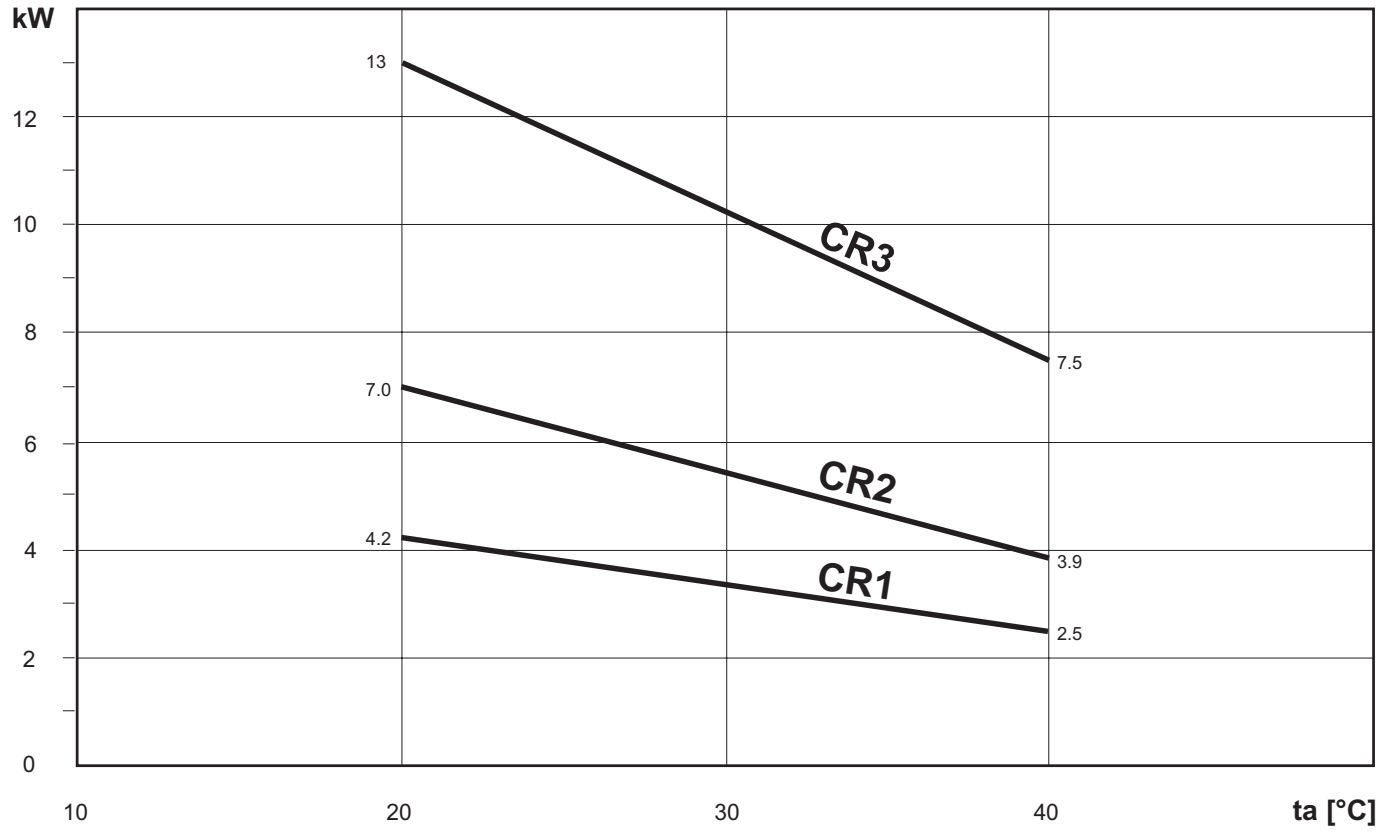
Selezionare la grandezza della centralina sul diagramma (A55) in funzione della temperatura ambiente ta (20° - 40°C).
Verificare che la centralina sia installabile sul riduttore selezionato (vedi tabella A56).
In caso contrario, contattare la ns. rete di vendita.

Select cooling system size in chart (A55) according to ambient temperature ta (20° - 40°C).
Check that the cooling system you have selected will fit the gearbox (see table A56).
If this is not the case, contact our sales organization.

Die Größe des Systems auf dem Diagramm (A55) in Anbetracht der Umgebungstemperatur ta (20° - 40°C) auswählen.
Überprüfen, ob die Zentrale auch auf dem ausgewählten Getriebe installierbar ist (siehe Tabelle A56).
Ist dies nicht der Fall, müssen Sie sich mit unserem Verkaufsnetz in Verbindung setzen.

Sélectionner la taille de l'unité sur le diagramme (A55), se rapportant à la température ambiante (20° - 40°C).
Veiller à ce que l'unité puisse être installée sur le réducteur sélectionné (voir tableau A56).
Vice versa, contacter notre réseau de vente.

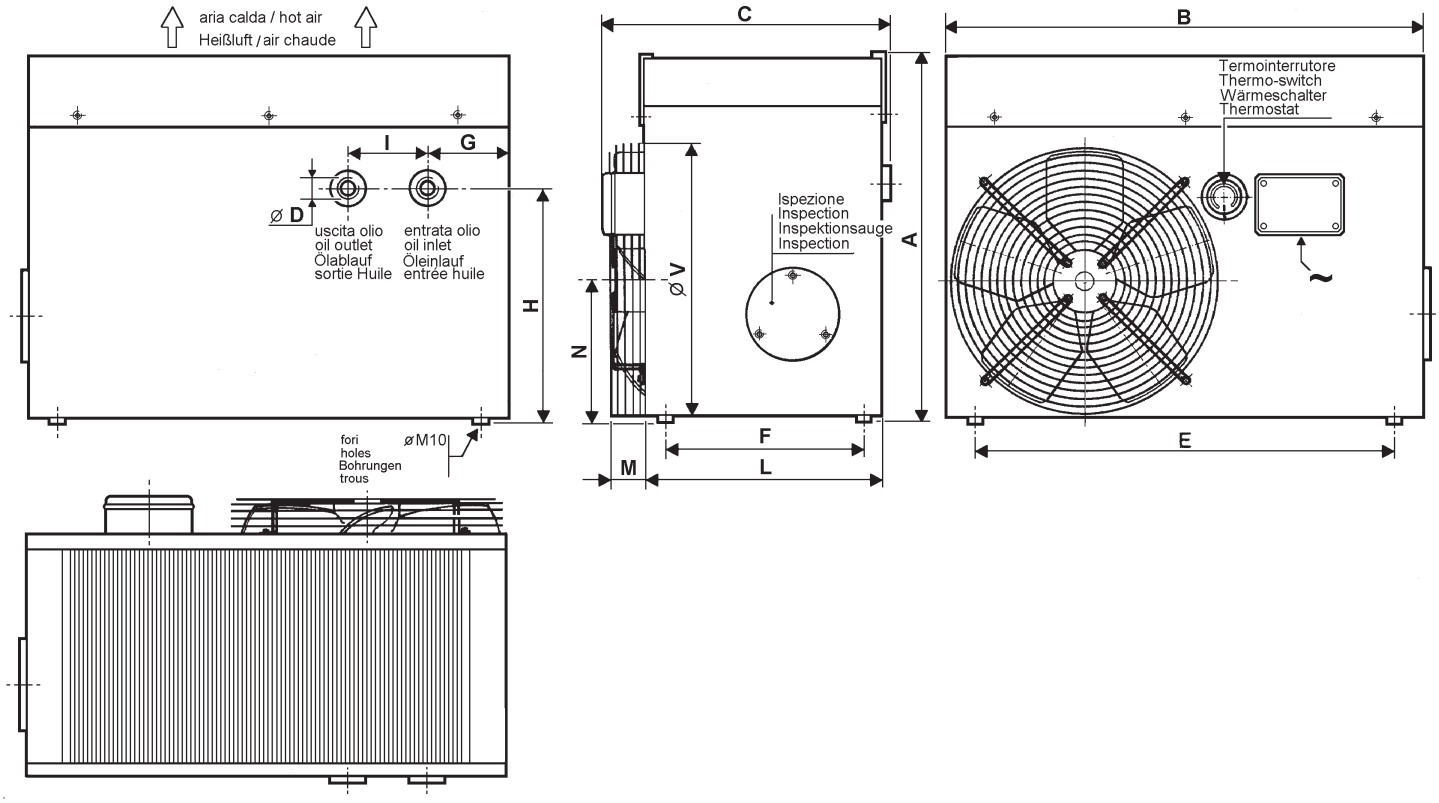
(A55)



(A56)

Riduttore / Gearbox Getriebe / Réducteur	L1	L2	L3	L4	R2	R3	R4
306	CR1	CR1	—	—	—	—	—
307	CR1	CR1	—	—	CR1	—	—
309	CR1	CR1	CR1	—	CR1	—	—
310	CR2	CR1	CR1	—	—	CR1	—
311	CR2	CR1	CR1	—	CR1	CR1	—
313	CR2	CR1	CR1	—	CR1	CR1	—
315	CR3	CR2	CR1	—	CR1	CR1	—
317	CR3	CR2	CR2	CR1	—	—	—
319	CR3	CR2	CR2	CR1	—	—	—
321	CR3	CR2	CR2	CR2	—	—	—

45.3 **Dimensioni** 45.3 **Dimensions** 45.3 **Abmessungen** 45.3 **Dimensions**



	A	B	C	D	E	F	G	H	I	L	M	N	V
CR1	410	490	310	1/2" G	415	190	90	263	80	245	10	158	250
CR2	463	600	365	3/4 “G	530	250	100	296	100	300	45	181	300
CR3	575	760	465	IN = 1”4 OUT = 3/4”4	690	350	100	408	100	400	45	228	400

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Torque Range
8.000 ... 180.000 Nm

Gear Ratios
600 ... 2000

Key Features
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Output shaft: splined or with integral pinion
Rugged construction
High torque capacity
Output shafts supported by heavy duty bearings

Applicable AC motors
Compact motors and brake motors, M series
IEC motors and brake motors, BN series

Main Brake Motor Features
DC and AC type

Main Motor Options
Thermistors and thermostates sensors

Type	Nominal Torque Nm	Peak static Torque Nm
706 T	8.000	15.000
707 T	12.000	25.000
709 T	18.000	30.000
710 T	25.000	50.000
711 T	35.000	80.000
712 T	40.000	90.000
713 T	50.000	100.000
715 T	80.000	140.000
716 T	100.000	180.000

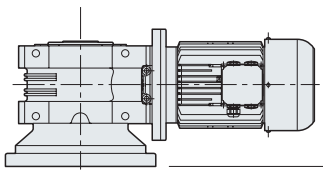
Range of Ratios	Kg
600-2000	100
600-2000	140
600-2000	180
600-2000	250
600-2000	300
600-2000	330
600-2000	450
600-2000	700
600-2000	900

Overall dimensions

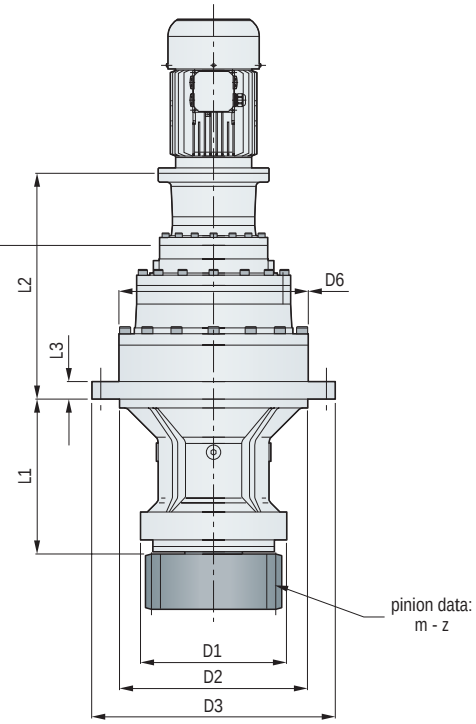
Type	D1	D2	D3	D4	D5	D6	L1	L2	L3
706TF	-	200	280	250	ø 17 n□12	292	38	520	25
706TN	200	250	360	325	ø 17 n□10	292	225	-	25
707TN	230	280	348	314	ø 17 n□12	348	300	360	98
709TN	230	280	348	314	ø 17 n□24	348	300	400	125
710TN	300	425	500	450	ø 22 n□12	400	360	500	40
711TF	-	400	490	445	ø 21 n□24	428	110	700	40
711TN	300	425	500	460	ø 22 n□12	428	350	520	40
712TF	-	400	490	445	ø 21 n□24	428	110	700	40
713TN	340	400	560	510	ø 22 n□24	445	430	630	30
715TN	370	470	640	600	ø 22 n□24	542	470	670	36
716TF	-	555	645	600	ø 28 n□32	542	100	1100	40

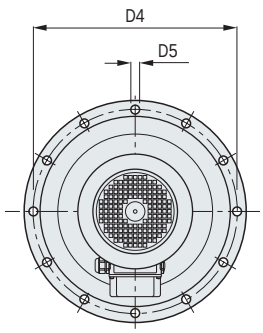
module/number of teeth of pinion: on request

combined version - worm gearbox - planetary gearbox



inline version - planetary gearbox





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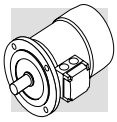

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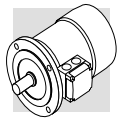
Revisioni
L'indice di revisione del catalogo è riportato a pag. 82.
Nel sito www.bonfiglioli.com sono disponibili i cataloghi con le revisioni aggiornate.

Revisions
Refer to page 82 for the catalogue revision index.
Visit www.bonfiglioli.com to search for catalogues with latest revisions.

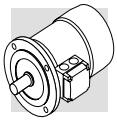
Änderungen
Das Revisionsverzeichnis des Katalogs wird auf Seite 82 wiedergegeben. Auf unserer Website www.bonfiglioli.com werden die Kataloge in ihrer letzten, überarbeiteten Version angeboten.

Révisions
Le sommaire de révision du catalogue est indiqué à la page82.
Sur le site des catalogues avec les dernières révisions sont disponibles.



SIMBOLOGIA E UNITÀ DI MISURA	*SYMBOLS AND UNITS OF MEAUSURE*	VERWENDETE SYMBOLE UND EINHEITEN	*SYMBOLES ET UNITES DE MISURE*

Simb. Symb.	U.m. Einheit	Descrizione	*Description*	Beschreibung	*Description*
$\cos\varphi$	–	Fattore di potenza	*Power factor*	Leistungsfaktor	*Facteur de puissance*
η	–	Rendimento	*Efficiency*	Wirkungsgrad	*Rendement*
f_m	–	Fattore correttivo della potenza	*Power adjusting factor*	Leistungskorrekturfaktor	*Facteur de correction de la puissance*
I	–	Rapporto di intermittenza	*Cyclic duration factor*	Relative Einschaltdauer	*Rapport d'intermittence*
I_N	[A]	Corrente nominale	*Rated current*	Nennstrom	*Courant nominal*
I_S	[A]	Corrente di spunto	*Locked rotor current*	Kurzschlußstrom	*Courant de démarrage*
J_C	[Kgm^2]	Momento di inerzia del carico	*Load moment of inertia*	Massenträgheitsmoment der externen Massen	*Moment d'inertie de la charge*
J_M	[Kgm^2]	Momento di inerzia motore	*Moment of inertia*	Trägheitsmoment	*Moment d'inertie du moteur*
K_c	–	Fattore di coppia	*Torque factor*	Drehmomentfaktor	*Facteur de couple*
K_d	–	Fattore di carico	*Load factor*	Lastfaktor	*Facteur de charge*
K_J	–	Fattore di inerzia	*Inertia factor*	Trägheitsfaktor	*Facteur d'inertie*
M_A	[Nm]	Coppia accelerante media	*Mean breakaway torque*	Losbrechmoment	*Couple d'accélération moyen*
M_B	[Nm]	Coppia frenante	*Brake torque*	Bremsemoment	*Couple du frein*
M_N	[Nm]	Coppia nominale	*Rated torque*	Nennmoment	*Couple nominal*
M_L	[Nm]	Coppia resistente media	*Counter-torque during acceleration*	Lastmoment	*Couple résistant moyen*
M_S	[Nm]	Coppia di spunto	*Starting torque*	Startmoment	*Couple de démarrage*
n	[min^{-1}]	Velocità nominale	*Rated speed*	Nenndrehzahl	*Vitesse nominale*
P_B	[W]	Potenza assorbita dal freno a 20°C	*Power drawn by the brake at 20°C*	Leistungsaufnahme der Bremse bei 20°C	*Puissance absorbée par le frein à 20°C*
P_n	[kW]	Potenza nominale	*Motor rated power*	Nennleistung	*Puissance nominale*
P_r	[kW]	Potenza richiesta	*Required power*	Benötigte Leistung	*Puissance nécessaire*
t_1	[ms]	Ritardo di sblocco del freno con alimentatore a semionda	*Brake response time with one-way rectifier*	Ansprechzeit Bremse mit Einweg-Gleichrichter	*Temps de déblocage du frein avec alimentation à demi-onde*
t_{1s}	[ms]	Tempo di sblocco del freno con alimentatore a controllo elettronico	*Brake response time with electronic-controlled rectifier*	Ansprechzeit Bremse mit elektronisch gesteuertem Gleichrichter	*Temps de déblocage du frein avec alimentation à contrôle électronique*
t_2	[ms]	Ritardo di frenatura con disgiunzione lato c.a.	*Brake reaction time with a.c. disconnect*	Einfallzeit Bremse bei Unterbrechung der Stromversorgung WS	*Retard de freinage avec coupure coté c.a.*
t_{2c}	[ms]	Ritardo di frenatura con disgiunzione circuito c.a. e c.c.	*Brake reaction time with a.c. and d.c. disconnect*	Einfallzeit Bremse bei Unterbrechung der Stromversorgung WS und GS	*Retard de freinage avec coupure coté c.a. et c.c.*
t_a	[°C]	Temperatura ambiente	*Ambient temperature*	Umgebungstemperatur	*Température ambiante*
t_f	[min]	Tempo di funzionamento a carico costante	*Work time at constant load*	Betriebsdauer unter Nennbelastung	*Temps de fonctionnement à charge constante*
t_r	[min]	Tempo di riposo	*Rest time*	Aussetzzeit	*Temps de repos*
W	[J]	Lavoro di frenatura accumulato tra due regolazioni del traferro	*Braking work between service*	Bremsenergie zwichen zwei Einstellungen	*Energie de freinage accumulée entre deux réglages de l'entrefer*
W_{max}	[J]	Energia massima per singola frenatura	*Maximum brake work for each braking*	Max. Bremsarbeit pro Bremsvorgang	*Energie maxi par freinage*
Z	[1/h]	N° di avviamenti ammissibili, a carico	*Permissible starting frequency, loaded*	Schalthäufigkeit Nennbetrieb	*Nombre de démarrages admissibles en charge*
Z_0	[1/h]	N° di avviamenti ammissibili a vuoto (I = 50%)	*Max. permissible no-load starting frequency (I = 50%)*	Max. Schalthäufigkeit im Leerlauf (relative Einschaltdauer I = 50%)	*Nombre de démarrages admissible à vide (I = 50%)*



M1 - PROGRAMMA DI PRODUZIONE

Questo catalogo descrive i motori asincroni trifase in bassa tensione di produzione BONFIGLIOLI RIDUTTORI.
I motori sono del tipo chiuso con ventilazione esterna e rotore a gabbia per l'utilizzo in ambienti industriali.

M1 - PRODUCTION PLANNING

This catalogue discusses low-voltage three-phase asynchronous motors manufactured by BONFIGLIOLI RIDUTTORI.
Motors are the enclosed type with outer fan and cage-type rotor for use in industrial environments.

M1 - PRODUKTIONSPROGRAMM

In diesem Katalog werden die unter Niederspannung arbeitenden asynchronen Drehstrommotoren der Produktion von BONFIGLIOLI RIDUTTORI näher beschrieben. Hierbei handelt es sich um geschlossene Motoren mit Eigenbelüftung und einem Käfigrotor für den industriellen Einsatz.

M1 - PROGRAMME DE PRODUCTION

Ce catalogue décrit les moteurs asynchrones triphasés en basse tension produits par BONFIGLIOLI RIDUTTORI.
Les moteurs sont du type fermé avec ventilation extérieure et rotor à cage pour l'utilisation dans des milieux industriels.

M2 - NORMATIVE

I motori sono costruiti in accordo alle Norme CEI/EN ed IEC applicabili, riportate in tabella.

M2 - REFERENCE STANDARDS

Motors are manufactured in accordance with applicable CEI /EN and IEC standards, listed in the table.

M2 - NORMEN

Die Motoren wurden in entsprechend der Normen CEI /EN und IEC, die in der nachstehenden Tabelle angegeben sind, gefertigt:

M2 - NORMES

Les moteurs sont fabriqués dans le respect des Normes CEI /EN et IEC applicables indiquées dans le tableau.

(01)

Titolo / *Title* / Titel / *Titre*	**CEI**	**IEC**
Prescrizioni generali per macchine elettriche rotanti *General requirements for rotating electrical machines* Allgemeine Vorschriften für umlaufende elektrische Maschinen *Prescriptions générales pour machines électriques tournantes*	**CEI EN 60034-1**	**IEC 60034-1**
Marcatura dei terminali e senso di rotazione per macchine elettriche rotanti *Terminal markings and direction of rotation of rotating machines* Kennzeichnung der Anschlußklemmen und Drehrichtung von umlaufenden elektrischen Maschinen *Définitions des bornes et sens de rotation pour machines électriques tournantes*	**CEI 2-8**	**IEC 60034-8**
Metodi di raffreddamento delle macchine elettriche *Methods of cooling for electrical machines* Verfahren zur Kühlung von elektrischen Maschinen *Méthodes de refroidissement des machines électriques*	**CEI EN 60034-6**	**IEC 60034-6**
Dimensioni e potenze nominali per macchine elettriche rotanti *Dimensions and output ratings for rotating electrical machines* Auslegung der Nennleistung von umlaufenden elektrischen Maschinen *Dimensions, puissances nominales pour machines électriques tournantes*	**EN 50347**	**IEC 60072**
Classificazione dei gradi di protezione delle macchine elettriche rotanti *Classification of degree of protection provided by enclosures for rotating machines* Klassifizierung der Schutzart von umlaufenden elektrischen Maschinen *Classification des degrés de protection des machines électriques tournantes*	**CEI EN 60034-5**	**IEC 60034-5**
Limiti di rumorosità *Noise limits* Geräuschgrenzwerte *Limites de bruit*	**CEI EN 60034-9**	**IEC 60034-9**
Sigle di designazione delle forme costruttive e dei tipi di installazione *Classification of type of construction and mounting arrangements* Abkürzungen zur Kennzeichnung der Bauform und der Einbaulagen *Sigles de dénomination des formes de construction et des types d'installation*	**CEI EN 60034-7**	**IEC 60034-7**
Tensione nominale per i sistemi di distribuzione pubblica dell'energia elettrica a bassa tensione *Rated voltage for low voltage mains power* Nennspannung für öffentliche NS-Stromverteilungssysteme *Tension nominale pour les systèmes de distribution publique de l'énergie électrique en basse tension*	**CEI 8-6**	**IEC 60038**
Grado di vibrazione delle macchine elettriche *Vibration level of electric machines* Schwingstärke bei elektrischen Maschinen *Degré de vibration des machines électriques*	**CEI EN 60034-14**	**IEC 60034-14**

I motori corrispondono inoltre alle Norme straniere elencate qui di seguito:

Motors are also in compliance with the national Standards listed below:

Die Motoren entsprechen darüber hinaus den nachstehend aufgelisteten ausländischen Normen:

Les moteurs correspondent aussi aux Normes étrangères suivantes :

(02)

DIN VDE 0530	Germania	*Germany*	Deutschland	*Allemagne*
BS5000 / BS4999	Gran Bretagna	*Great Britain*	Großbritannien	*Grande Bretagne*
AS 1359	Australia	*Australia*	Australien	*Australie*
NBNC 51-101	Belgio	*Belgium*	Belgien	*Belgique*
NEK - IEC 60034-1	Norvegia	*Norway*	Norwegen	*Norvège*
NF C 51	Francia	*France*	Frankreich	*France*
OEVE M 10	Austria	*Austria*	Österreich	*Autriche*
SEV 3009	Svizzera	*Switzerland*	Schweiz	*Suisse*
NEN 3173	Paesi Bassi	*Netherlands*	Niederlande	*Pays Bas*
SS 426 01 01	Svezia	*Sweden*	Schweden	*Suède*

Direttive CEE 73/23 (LVD) e CEE 89/336 (EMC)

I motori della serie BN sono conformi ai requisiti delle Direttive CEE 73/23 (Direttiva Bassa Tensione) e CEE 89/336 (Direttiva Compatibilità Eletromagnetica), e riportano in targa la marcatura CE. Per quanto riguarda la Direttiva EMC, la costruzione è in accordo alle Norme CEI EN 60034-1 sez. 12, EN 50081, EN 50082.

I motori con freno FD, se corredati dell'opportuno filtro capacitivo in ingresso al raddrizzatore (variante **CF**), rientrano nei limiti di emissione previsti dalla Norma EN 50081- "Compatibilità elettromagnetica - Norma Generica sull'emissione - Parte 1: Ambienti residenziali, commerciali e dell'industria leggera".

I motori soddisfano inoltre le prescrizioni della Norma CEI EN 60204-1 "Equipaggiamento elettrico delle macchine".

È responsabilità del costruttore o dell'assemblatore dell'apparecchiatura che incorpora i motori come componenti garantire la sicurezza e la conformità alle direttive del prodotto finale.

Directives 73/23/ EEC (LVD) and 89/336/ EEC (EMC)

BN motors meet the requirements of Directives 73/23/EEC (Low Voltage Directive) and 89/336/EEC (Electromagnetic Compatibility Directive) and their name plates bear the CE mark. As for the EMC Directive, construction is in accordance with standards CEI EN 60034-1 Sect. 12, EN 50081, EN 50082.

*Motors with FD brakes, when fitted with the suitable capacitive filter at rectifier input (option **CF**), meet the emission limits required by Standard EN 50081-1 "Electromagnetic compatibility - Generic Emission Standard - Part 1: Residential, commercial and light industrial environment".*

Motors also meet the requirements of standard CEI EN 60204-1 "Electrical equipment of machines".

The responsibility for final product safety and compliance with applicable directives rests with the manufacturer or the assembler who incorporate the motors as component parts.

Richtlinien EWG 73/23 (LVD) und EWG 89/336 (EMC)

Die Motoren der Serie BN entsprechen den Anforderungen der Richtlinien EWG 73/23 (Richtlinie - Niederspannung) und CEE 89/336 (Richtlinie – elektromagnetische Kompatibilität) und sind mit dem CE-Zeichen ausgestattet. Im Hinblick auf die Richtlinie EMC entspricht die Konstruktion den Normen CEI EN 60034-1, Abschn. 12, EN 50081, EN 50082.
Die Motoren mit dem Bremstyp FD fallen, falls mit dem entsprechenden kapazitiven Filter am Eingang des Gleichrichters ausgestattet (Option **CF**), unter die Emissionsgrenzwerte, die von der Norm EN 50081-1 " Elektromagnetische Kompatibilität – Allgemeine Norm für Emissionen – Teil 1: Wohngebiete, Handels- und Leichtindustriezonen" vorgesehen werden".
Die Motoren entsprechen darüber hinaus den von der Norm CEI EN 60204-1 "Elektrische Maschinenausstattung" gegebenen Vorschriften.

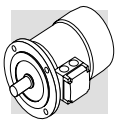
Es liegt in der Verantwortung des Herstellers oder des Monteurs der Anlage, in der die Motoren als Komponenten montiert werden, die Sicherheit und die Übereinstimmung mit den Richtlinien des Endprodukts zu gewährleisten.

Directives CEE 73/23 (LVD) e CEE 89/336 (EMC)

Les moteurs de la série BN sont conformes aux conditions requises par les Directives CEE 73/23 (Directive Basse Tension) et CEE 89/336 (Directive Compatibilité Electromagnétique), et le marquage CE est indiqué sur la plaquette signalétique. En ce qui concerne la Directive EMC, la fabrication répond aux Normes CEI EN 60034-1 Sect. 12, EN 50081, EN 50082.
*Les moteurs avec frein FD, s'ils sont équipés du frein capacitif approprié en entrée du redresseur (option **CF**), rentrent dans les limites d'émission prévues par la Norme EN 50081-1 "Compatibilité électromagnétique - Norme Générique sur l'émission – Partie 1: Milieux résidentiels, commerciaux et de l'industrie légère".*

Les moteurs répondent aussi aux prescriptions de la Norme CEI EN 60204-1 "Equipement électrique des machines".

Le fabricant ou le monteur de la machine qui comprend les moteurs comme composant est responsable et doit se charger de garantir la sécurité et la conformité aux directives du produit final.



M3 - TOLLERANZE

Secondo le Norme CEI EN 60034-1 sono ammesse le tolleranze qui indicate per le grandezze garantite:

M3 - TOLERANCES

Allowed tolerances for guaranteed parameters in accordance with standards CEI EN 60034-1 are indicated in the table below:

M3 - TOLERANZEN

Den Normen CEI EN 60034-1 entsprechend sind für die angegebenen Werte folgende Toleranzen zulässig:

M3 - TOLERANCES

Selon les Normes CEI EN 60034-1 les tolérances indiquées ci-dessous sont admises pour les tailles garanties :

-0.15 (1 - η) P ≤ 50 kW	Rendimento	*Efficiency*	Wirkungsgrad	*Rendement*
-(1 - cosφ) /6 min 0.02 max 0.07	Fattore di potenza	*Power factor*	Leistungsfaktor	*Facteur de puissance*
± 20% (*)	Scorrimento	*Slip*	Schlupf	*Glissement*
+ 20%	Corrente a rotore bloccato	*Locked rotor current*	Strom bei blockiertem Läufer	*Courant à rotor bloqué*
-15% + 25%	Coppia a rotore bloccato	*Locked rotor torque*	Drehmoment bei blockiertem Läufer	*Couple à rotor bloqué*
-10%	Coppia max	*Max. torque*	Max. Drehmoment	*Couple max*

(*) ± 30% per motori con P_n < 1 kW *(*) ± 30% for motors with P_n < 1 kW* (*) ± 30% für Motoren mit P_n < 1 kW *(*) ± 30% pour moteurs avec P_n < 1 kW*

M3.1 - TOLLERANZE GEOMETRICHE

L'estremità d'albero, la linguetta e la flangia hanno dimensioni e tolleranze secondo EN 50347, IEC 60072-1, CEI-UNEL 13501.
Le estremità d'albero sono previste di foro filettato in testa secondo UNI 9321, DIN 332.
I motori sono sempre forniti con linguetta inserita nella sede.
La tabella seguente riporta le tolleranze previste per le diverse parti:

M3.1 - GEOMETRIC TOLERANCES

Dimensions and tolerances of shaft end, key and flange are in accordance with EN 50347, IEC 60072-1, CEI-UNEL 13501.
Shaft ends feature an axial threaded hole in accordance with UNI 3221, DIN 332 and a key inserted in the suitable keyway.
The following table reports the tolerances for the different parts:

M3.1 - GEOMETRISCHE TOLERANZEN

Die Wellenenden, der Federkeil und der Flansch entsprechen im Hinblick auf ihre Maße und Toleranzen den NormenrEN 50347, IEC 60072-1 und CEI-UNEL 13501. Die Wellenenden sind an ihrer Stirnseite mit einer Gewindebohrung gemäß UNI 3221, DIN 332 versehen und werden mit einem in seinen Sitz eingefügten Federkeil geliefert. In der nachstehenden Tabelle werden für die verschiedenen Teile die entsprechenden Toleranzen angegeben:

M3.1 - *TOLERANCES GEOMETRIQUES*

L'extrémité de l'arbre, la clavette et la bride présentent des dimensions et tolérances selon EN 50347, IEC 60072-1, CEI-UNEL 13501. Les extrémités d'arbre sont dotées d'orifice fileté en tête, selon UNI 3221, DIN 332 ainsi que la clavette introduite dans le logement. Le tableau suivant indique les tolérances prévues pour les différentes pièces :

(03)

Componente / *Component* **Komponente / *Composant***	Dimensioni / *Dimensions* Abmessungen / *Dimensions*		Tolleranza / *Tolerance* Toleranz / *Tolérance*
Estremità albero / *Shaft end* Wellenende / *Extrémité arbre*	**D - DA**	∅ 11 - 28	**j6**
		∅ 38 - 48	**k6**
		∅ ≥ 55	**m6**
Linguetta / *Key* Federkeil / *Clavette*	**F - FA**		**h9**
Flangia / *Flange* Flansch / *Bride*	**N**	∅ < 250	**j6**
		∅ ≥ 250	**h6**

M3.2 - RUMOROSITÀ

I valori di rumorosità, rilevati secondo il metodo indicato dalle Norme ISO 1680, sono contenuti entro i livelli massimi previsti dalle Norme CEI EN 60034-9.

M3.2 - NOISE LEVEL

Noise levels measured using the method specified by standard ISO 1680 are within the maximum limits required by standards CEI EN 60034-9.

M3.2 - GERÄUSCHPEGEL

Der Geräuschpegel wurde entsprechend der in der Norm ISO 1680 angegeben Methode gemessen und liegt innerhalb der max. Werte, die von der Norm CEI EN 60034-9 vorgeschrieben werden.

M3.2 - NIVEAU DE BRUIT

Les valeurs du niveau de bruit, mesurées selon la méthode indiquées par les Normes ISO 1680 sont contenues dans les limites maximums prévues par les Normes CEI EN 60034-9.

M4 - SENSO DI ROTAZIONE

È possibile il funzionamento dei motori in entrambi i versi di rotazione. Con collegamento dei morsetti U1, V1, W1 alle fasi di linea L1, L2, L3 si ottiene la rotazione oraria, osservando l'albero dal lato accoppiamento. La marcia antioraria si ottiene scambiando fra loro due fasi.

M4 - ***DIRECTION OF ROTATION***

Motors may operate in both directions of rotation. When the terminals U1, V1, W1 are connected to the line phases L1, L2, L3, the motor will run in a clockwise direction as viewed from the coupling end. Counter clockwise rotation is obtained by swapping two phases.

M4 - DREHRICHTUNG

Die Motoenr können in beiden Drehrichtungen betrieben werden. Schließt man die Klemmen U1, V1, W1 an die Phasen L1, L2, L3 an, dreht sich der Motor, mit Sicht auf die Motorwelle her betrachtet, im Uhrzeigersinn. Eine Drehrichtungsumkehr gegen den Uhrzeigersinn erhält man durch das Wechseln von zwei Phasen.

M4 - SENS DE ROTATION

Le fonctionnement des moteurs dans les deux sens de rotation est possible. Avec raccordement des bornes U1, V1, W1 aux phases de ligne L1, L2, L3 on obtient la rotation dans le sens des aiguilles d'une montre, en observant l'arbre côté accouplement. Intervertir deux des phases pour obtenir la rotation dans le sens inverse des aiguilles d'une montre.

M5 - CUSCINETTI

I cuscinetti previsti sono del tipo radiale a sfere, precaricati assialmente, e dotati di carica di grasso per lubrificazione permanente.
La durata nominale a fatica L_{10h} in assenza di carichi esterni applicati all'albero e montaggio orizzontale è superiore a 40.000 ore.
I tipi utilizzati sono indicati nella tabella seguente:

M5 - BEARINGS

Axially pre-loaded radial ball bearings, lubricated for life with the grease.
Nominal fatigue life L_{10h} ~ 40,000 hours assuming no overhung load on the shaft, and mounting position horizontal.
The types of bearings in use are listed in the table below:

M5 - LAGER

Bei den verwendeten Lagern handelt es sich um axial vorgespannte Radialkugellager mit einer für die Dauerschmierung ausgelegten Fettfüllung.
Der Nennwert der Ermüdungsdauer L_{10h} ohne auf die Welle einwirkenden Kräften und bei horizontaler Montage liegt bei über 40.000 Stunden:

M5 - ROULEMENTS

Les roulements prévus sont du type radial à billes, préchargés du point de vue axial et remplis de graisse pour une lubrification permanente.
La durée nominale à la fatigue L_{10h}, en l'absence de charges externes appliquées à l'arbre et avec un montage horizontal, est supérieure à 40.000 heures :

(04)

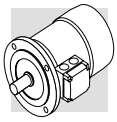
	DE	**NDE**	
	Tutti i motori / *All motors* Alle Motoren / *Tous les moteurs*		**BN_FD; BN_FA**
BN 56	6201 2Z C3	6201 2Z C3	—
BN 63	6201 2Z C3	6201 2Z C3	6201 2RS C3
BN 71	6202 2Z C3	6202 2Z C3	6202 2RS C3
BN 80	6204 2Z C3	6204 2Z C3	6204 2RS C3
BN 90	6205 2Z C3	6205 2Z C3	6205 2RS C3
BN 100	6206 2Z C3	6206 2Z C3	6206 2RS C3
BN 112	6306 2Z C3	6306 2Z C3	6306 2RS C3
BN 132	6308 2Z C3	6308 2Z C3	6308 2RS C3
BN 160MR	6309 2Z C3	6308 2Z C3	6308 2RS C3
BN 160M/L	6309 2Z C3	6309 2Z C3	6309 2RS C3
BN 180M	6310 2Z C3	6309 2Z C3	6309 2RS C3
BN 180L	6310 2Z C3	6310 2Z C3	6310 2RS C3
BN 200L	6312 2Z C3	6310 2Z C3	6310 2RS C3

DE = lato comando
NDE = lato opposto comando

DE *= drive end*
NDE *= non drive end*

DE = Wellenseite
NDE = Lüfterseite

DE *= sortie arbre*
NDE *= côté ventilateur*



M6 - OPERATIVITÀ STANDARD

M6.1 - TENSIONE

I motori a singola polarità sono previsti, nell'esecuzione standard, per tensione nominale 230/400V Δ/Y (o 400/690 V Δ/Y per le grandezze da BN160 e BN 200) 50 Hz con tolleranza ± 10% (Eurotensione).
I motori sono idonei per funzionamento sulla rete di distribuzione europea con tensione in accordo alla pubblicazione IEC 60038.
In targa sono indicati oltre alla tensione nominale, i campi di funzionamento consentiti, p.e. 220-240V Δ /380-415V Y, 50 Hz.
In accordo alla Norma CEI EN 60034-1, i motori possono funzionare alle tensioni sopra indicate con tolleranza del ± 5% (Zona A).
Per funzionamento ai limiti della tolleranza la temperatura può superare di 10 K il limite previsto dalla classe di isolamento adottata.

M6 - STANDARD OPERATION

M6.1 - VOLTAGE

Standard single-speed motors are designed to operate from a rated voltage 230/400V Δ/Y (or 400/690V Δ/Y for frame sizes BN 160 through BN 200) 50 Hz, with ± 10% tolerance (Eurovoltage).
Motors are suitable for operation with European power mains with voltage in accordance with publication IEC 60038.
Besides rated voltage, the name plate reports allowed operating ranges, e.g. 220-240V Δ /380-415V Y, 50Hz. In accordance with standard CEI EN 60034-1, motors may operate at the above mentioned voltages with ± 5% tolerance (Zone A).
In operation at tolerance limits, temperature may exceed the temperature limit required by the adopted insulation class by 10 K.

M6 - STANDARDVERSORGUNG

M6.1 - SPANNUNG

Die einpoligen Motoren sind in der Standardausführung für eine Nennspannung von 230/400V Δ/Y (oder 400/690V Δ/Y für die Baugrößen von BN 160 bis BN 200) 50 Hz, mit einer Toleranz ± 10% (Euro-Spannung) ausgelegt.
Diese Motoren eignen sich für einen Betrieb im Europäischen Versorgungsnetz mit einer Spannung, die den in der Veröffentlichung IEC 60038 angegebenen Werten entspricht. Auf dem Typenschild werden über die Nennspannung hinaus, auch die zulässigen Toleranzbereiche angegeben, z.B. 220-240V Δ /380-415V Y, 50 Hz. In Übereinstimmung mit der Norm CEI EN 60034-1 können die Motoren unter den o.g. Spannungswerten mit einer Toleranz von ± 5% (Bereich A) arbeiten. Bei einem Betrieb an den Toleranzgrenzen kann die Temperatur die vorgesehene Isolationsklasse um 10 K überschreiten.

M6 - CONDITIONES OPERATIVES

M6.1 - TENSION

Les moteurs à simple polarité sont prévus, dans l'exécution standard, pour une tension nominale de 230/400V Δ/Y (ou 400/690V Δ/Y pour les tailles de BN 160 à BN 200) 50 Hz, avec une tolérance de ± 10% (Eurotension). Les moteurs sont adaptés pour fonctionner sur le réseau de distribution européen avec une tension correspondant aux indications de la norme CEI 60038.
Sur la plaque signalétique sont indiquées, outre la tension nominale, les plages de fonctionnement autorisées, par ex. 220-240V Δ /380-415V Y, 50 Hz. En accord avec la norme CEI EN 60034-1, les moteurs peuvent fonctionner aux tensions susmentionnées avec une tolérance de ± 5% (Zone A). Pour un fonctionnement aux limites de la tolérance, la température peut dépasser de 10 K la limite prévue pour la classe d'isolation adoptée.

(05)

	V_{mot} ± 10% 3 ~		Esecuzione *Configuration* Ausführung *Execution*
BN 56 ... BN 132	230/400 V Δ /Y 460 V Y	50 Hz 60 Hz	Standard
BN 160 ... BN 200	400/690 V Δ /Y 460 V Δ	50 Hz 60 Hz	Standard
BN 100 ... BN 132	400/690 V Δ /Y 460 V Δ	50 Hz 60 Hz	A richiesta, senza sovrapprezzo *At request, carries no extra charge* Auf Anfrage, ohne Aufpreis *Sur demande, sans majoration de prix*

I motori a doppia polartà sono previsti per alimentazione standard 400V / 50 Hz; tolleranze applicabili secondo CEI EN 60034-1.
Nella tabella (06) sono indicati i collegamenti previsti in funzione della polarità:

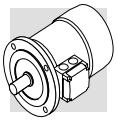
Switch-pole motors are designed to operate from 400V - 50 Hz standard power supply. Applicable tolerances are in accordance with standard CEI EN 60034-1. The table (06) reports the required connections depending on the number of poles:

Die polumschaltbaren Motoren sind für eine Standardversorgung von 400V – 50 Hz ausgelegt; Toleranzen gelten gemäß CEI EN 60034-1. In der Tabelle (06) werden in Abhängigkeit von den jeweiligen Polzahlen die Wicklungsanschlüsse angegeben:

Les moteurs à double polarité sont prévus pour une alimentation standard 400V – 50 Hz ; tolérances applicables selon la norme CEI EN 60034-1. Les branchements prévus en fonction de la polarité sont indiqués sur le tableau (06) :

(06)

	Poli *Number of poles* Polzahl *Nombre de poles*	Collegamento avvolgimento *Winding connection* Wicklungsanschluß *Connexion du bobinage*
BN 63 … BN 200	2,4,6,8	Δ /Y
	2/4, 4/8	Δ / YY (Dahlander)
	2/6, 2/8, 2/12, 4/6	Y / Y (due avvolgimenti *Two windings* Zwei wicklungen *Deux bobinage*)



M6.2 - FREQUENZA

I motori della serie BN sono previsti per essere normalmente utilizzati su reti a 50 Hz o 60 Hz.

M6.2 - FREQUENCY

The motors of the BN series may operate under 50 or 60 Hz supply.

M6.2 - FREQUENZ

Die Motoren der Serie BN können mit 50 Hz oder 60 Hz betrieben werden.

M6.2 - FREQUENCE

Les moteurs de la série BN peuvent être normalement utilisés sur des réseaux en 50 Hz ou 60 Hz.

M6.3 - TEMPERATURA AMBIENTE

Le tabelle dati tecnici del catalogo riportano le caratteristiche funzionali a 50Hz, per le condizioni di installazione previste dalle Norme CEI EN 60034-1 (temperatura compresa tra -15 °C e +40 °C ed altitudine ≤ 1000 m s.l.m.).
I motori possono essere impiegati con temperature comprese tra 40 °C e 60 °C applicando i declassamenti di potenza indicati nella tabella (07):

M6.3 - AMBIENT TEMPERATURE

Catalog rating charts report operating characteristics at 50 Hz, under installation conditions as specified by standards CEI EN 60034-1 (temperature between -15 °C and + 40 °C and altitude above sea level ≤ 1000 m).
Motors may be used at ambient temperatures between 40°C and 60°C as long as the derating factors listed in the table (07) are applied:

M6.3 - UMGEBUNGSTEMPERATUR

Die im Katalog enthaltenen Tabellen geben die Betriebsdaten bei 50 Hz für die Einbaubedingungen gemäß den Normen CEI EN 60034-1 (Temperatur zwischen -15 °C und + 40 °C und Höhe ≤ 1000 m ü. M.) an.
Die Motoren können auch bei Temperaturen zwischen 40°C und 60°C eingesetzt werden, in diesem Fall müssen jedoch die in der Tabelle (07) angegebenen Leistungsreduzierungen beachtet werden:

M6.3 - TEMPERATURE AMBIANTE

Les tableaux des caractéristiques techniques du catalogue indiquent les caractéristiques de fonctionnement à 50 Hz, pour les conditions d'installation prévues par les normes CEI EN 60034-1 (température comprise entre -15 °C et + 40 °C à une altitude de ≤ 1000 m). Les moteurs peuvent être utilisés à des températures comprises entre 40°C et 60°C en appliquant les déclassements de puissance indiqués dans le tableau (07) :

(07)

Temperatura ambiente / *Ambient temperature* Umgebungstemperatur / *Température ambiante* [°C]	40°	45°	50°	55°	60°
Potenza ammissibile in % della potenza nominale *Permitted power as a % of rated power* Zulässige Leistung in % der Nennleistung *Puissance admissible en % de la puissance nominale*	100%	95%	90%	85%	80%

Quando è richiesto un declassamento del motore superiore al 15%, contattare il ns. Servizio Tecnico.

When the applicable derating factor for the motor exceeds 15%, please contact our Technical Service Dept.

Ist eine Rückstufung des Motors von mehr als 15% erforderlich, setzen sie sich bitte mit unserem Technischen Kundendienst in Verbindung.

En cas de nécessité d'un déclassement du moteur supérieur à 15%, contacter notre Service Technique.

M7 - FUNZIONAMENTO A 60 Hz

I motori della serie BN possono essere normalmente utilizzati anche su reti a 60 Hz.
Ad esclusione dei motori autofrenanti in c.c., tipo BN_FD, nella targa dei motori, oltre alle tensioni a 50 Hz, sono riportati i valori corrispondenti al funzionamento a 460 V - 60Hz, ed il relativo campo di tensione 440-480V.

M7 - 60 Hz OPERATION

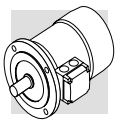
BN motors may also operate with 60 Hz power mains.
Except for DC brake motors type BN_FD, motor name plate reports 50 Hz voltage ratings, as well as the values for operation at 460 V - 60Hz and the corresponding voltage range 440-480V.

M7 - BETRIEB BEI A 60 Hz

Die Motoren der Serie BN können normalerweise auch in Stromnetzen mit 60 Hz Frequenz eingesetzt werden.
Mit Ausnahme der Bremsmotoren mit Gleichstromes vom Typ BN_FD, werden auf dem Typenschild der Motoren über die Angabe der Spannungen bei 50 Hz auch die Werte angegeben, die einem Betrieb bei 460 V - 60Hz entsprechen. Darüber hinaus kann man diesem Schild den entsprechenden Spannungsbereich 440-480V entnehmen.

M7 - FONCTIONNEMENT A 60 Hz

Les moteurs de la série BN peuvent aussi être normalement utilisés sur des réseaux à 60 Hz.
A l'exception des moteurs frein en c.c., type BN_FD, sur la plaque signalétique des moteurs, outre la tension à 50 Hz, sont indiqués les valeurs correspondant au fonctionnement à 460 V - 60Hz ainsi que la plage de tension relative 440-480V.



In corrispondenza dell' alimentazione 460V-60 Hz la targa del motore riporta valori di potenza aumentata di circa il 20% (non applicabile ai motori autofrenanti con freno in c.c., tipo BN_FD). La potenza nominale di targa, a 60 Hz, è quella riportata nella tabella (08) seguente:

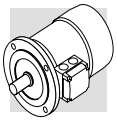
For 460V-60 Hz power supply, the power ratings reported in the motor name plate are about 20% higher (does not apply to DC brake motors type BN_FD). Name plate rated power for operation with 60 Hz power mains is as reported in the table below (08):

Bei einer Spannungsversorgung mit 460V-60 Hz werden auf dem Typenschild etwa 20% höhere Leistungswerte angegeben (gilt nicht für die Bremsmotoren mit Gleichstrombremse vom Typ BN_FD). Der nachstehenden Tabelle (08) können Sie die auf dem Typenschild angegebene Nennleistung bei 60 Hz entnehmen:

En face de l'alimentation 460V-60 Hz la plaque signalétique du moteur indiquent les valeurs de puissance majorée d'environ 20% (non applicable aux moteurs frein avec frein en c.c., type BN_FD). La puissance nominale indiquée sur la plaque, à 60 Hz, est celle figurant dans le tableau (08) suivant :

(08)

	Pn [kW]			
	2p	4p	6p	8p
56A	—	0.07	—	—
56B	—	0.10	—	—
63A	0.21	0.14	0.10	—
63B	0.30	0.21	0.14	—
63C	0.45	0.30	—	—
71A	0.45	0.30	0.21	0.10
71B	0.65	0.45	0.30	0.14
71C	0.90	0.65	0.45	—
80A	0.90	0.65	0.45	0.21
80B	1.30	0.90	0.65	0.30
80C	1.80	1.3	0.90	—
90S	—	1.3	0.90	0.45
90SA	1.8	—	—	—
90SB	2.2	—	—	—
90L	2.5	—	1.3	0.65
90LA	—	1.8	—	—
90LB	—	2.2	—	—
100L	3.5	—	—	—
100LA	—	2.5	1.8	0.85
100LB	4.7	3.5	2.2	1.3
112M	4.7	4.7	2.5	1.8
132S	—	6.5	3.5	2.5
132SA	6.5	—	—	—
132SB	8.7	—	—	—
132M	11	—	—	3.5
132MA	—	8.7	4.6	—
132MB	—	11	6.5	—
160MR	12.5	12.5	—	—
160MB	17.5	—	—	—
160M	—	—	8.6	—
160L	21.5	17.5	12.6	—
180M	24.5	21.5	—	—
180L	—	25.3	17.5	—
200L	34	34	22	—



Per i motori a doppia polarità con frequenza di alimentazione 60Hz l'incremento di potenza previsto, rispetto a quanto riportato nelle tabelle dati tecnici a 50 Hz, è circa del 15%.
I motori ad una velocità con avvolgimento standard, se utilizzati su reti a 60 Hz e tensioni come riportato in tabella (09), presentano variazioni delle grandezze principali come nel seguito descritto:

For switch-pole motors operating with 60 Hz input frequency, the power increase factor over 50 Hz ratings is in the order of 15%.
Key parameter variations for single-pole motors with standard winding operating with 60 Hz power mains at the voltage ratings reported in the table (09) are reported below (variations expressed as percentages):

Für die polumschaltbaren Motoren mit einer Spannungsversorgung von 60 Hz beträgt die Leistungserhöhung im Vergleich zu den Angaben in der Tabelle der sich auf 50 Hz beziehenden technischen Daten ungefähr 15%.
Für die einpoligen Motoren mit Standardwicklung die in Versorgungsnetzen mit 60 Hz und mit Spannungen gemäß Tabelle (09) eingesetzt werden, gelten die folgenden Werte:

Pour les moteurs à double polarité avec fréquence d'alimentation 60 Hz l'augmentation de puissance prévue, par rapport aux indications des tableaux des caractéristiques techniques à 50 Hz, est d'environ 15%.
Les moteurs à une vitesse avec bobinage standard, lorsqu'ils sont utilisés sur des réseaux à 60 Hz et des tensions comme indiqué dans le tableau (09), présentent des variations des valeurs principales en pourcentage comme indiqué ci-dessous :

(09)

50 Hz	**60 Hz**			
V	**V**	**Pn**	**Mn, Ma/Mn**	**n [min^{-1}]**
230/400 Δ /Y	220 - 240 Δ 380 - 415 Y	1	0.83	1.2
400/690 V Δ /Y	380 - 415 Δ			
230/400 V Δ /Y	265 - 280 Δ 440 - 480 Y	1.15	1	1.2
400/690 V Δ /Y	440 - 480 Δ			
230/400 V Δ /Y	265 - 280 440 - 480 Y	1.15	1	1.2
400/690 V Δ /Y	440 - 480 Δ			

I freni, se presenti, dovranno sempre essere alimentati come riportato in targa.

Brakes, if fitted, must always be supplied as specified on the name plate.

Die Bremsen, falls vorhanden, müssen immer wie gezeicht auf dem Typenschild versorgt werden.

Si présents, les freins doivent toujours être alimentés indiquée sur la plaque signalétique.

PN

L'opzione consente di avere sulla targa del motore il valore di potenza normalizzata a 50 Hz, anche quando è specificata l'alimentazione a 60 Hz.

With this option, motor name plate includes 50 Hz normalized power information even when motor is designated for operation with 60 Hz power mains.

Diese Option ermöglicht es auf dem Typenschild des Motors den Wert der auf 50 Hz genormten Leistung angeben zu können, auch wenn eine Spannungsversorgung bei 60 Hz erfolgt.

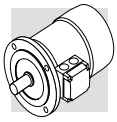
L'option permet d'avoir sur la plaque signalétique du moteur la valeur de puissance normalisée à 50 Hz, même lorsque l'alimentation à 60 Hz est spécifiée.

Per alimentazioni a 60 Hz con le tensioni 230/460V e 575V l'opzione PN viene applicata di default.

For 60 Hz supplies along with voltages 230/460V and 575V the PN option is applied by default.

Die Option PN ist immer dabei mit 60 Hz und Spannungsversorgung 230/460V und 575V 60 Hz.

Pour alimentations à 60 Hz avec tensions 230/460V et 575V l'option PN est appliqué de default.



M7.1 - MOTORI PER USA E CANADA

M7.1 - MOTORS FOR USA AND CANADA

M7.1 - MOTOREN FÜR DIE USA UND KANADA

M7.1 - MOTEURS POUR ETATS-UNIS ET CANADA

CUS

I motori da BN 56 a BN 200 sono disponibili in esecuzione NEMA Design C (per le caratteristiche elettriche), certificata in conformità alle norme CSA (Canadian Standard) C22.2 N° 100 e UL (Underwriters Laboratory) UL 1004 con targhetta riportante il marchio:

BN motor's sizes 56 through 200, are available in NEMA Design C configuration (concerning electrical characteristics), certified to CSA (Canadian Standard) C22.2 No. 100 and UL (Underwriters Laboratory) UL 1004. Through the option CUS the name plate is " cCSAus" marked:

Die Motoren BN 56...BN 200 sind in der Ausführung NEMA, Design C (aufgrund der elektrischen Eigenschaften), den Normen CSA (Canadian Standard) C22.2 Nr. 100 und UL (Underwriters Laboratory) UL 1004 gemäß zertifiziert und mit einem Typenschild mit:

Les moteurs BN 56...BN 200 sont disponibles en exécution NEMA Design C (pour les caractéristiques électriques), certifiée conforme aux normes CSA (Canadian Standard) C22.2 N° 100 et UL (Underwriters Laboratory) UL 1004 avec plaque signalétique indiquant la marque :

C US

(tensione ≤ 600V).

(voltage ≤ 600V)

Zeichen (Spannung ≤ 600V) versehen.

(tension ≤ 600V).

Le tensioni delle reti di distribuzione americane e le corrispondenti tensioni nominali da specificare per il motore sono indicate nella tabella seguente:

US power mains voltages and the corresponding rated voltages to be specified for the motor are indicated in the following table:

Die Spannungen der amerikanischen Verteilernetze und die entsprechenden Nennspannungen, die bei der Bestellung der Motore angegeben werden müssen, können der folgenden Tabelle entnommen werden:

Les tensions des réseaux de distribution américains ainsi que les tensions nominales à spécifier pour le moteur sont indiquées dans le tableau suivant :

(10)

Frequenza *Frequency* Frequenz *Fréquence*	Tensione di rete *Mains voltage* Netzspannung *Tension de réseau*	Tensione nominale motore *Motor rated voltage* Nennspannung des Motors *Tension nominale moteur*
60 Hz	208 V	**200 V**
	240 V	**230 V**
	480 V	**460 V**
	600 V	**575 V**

I motori con tensione nominale 230/460V 60Hz sono previsti di serie con collegamento YY/Y e morsettiera a 9 terminali.
Per i motori autofrenanti con freno in c.c. tipo BN_FD l'alimentazione del raddrizzatore è da morsettiera motore con tensione 230V a.c. monofase.
Per i motori autofrenanti **l'alimentazione del freno** è così predisposta:

Motors with rated voltage 230/460V 60Hz are supplied with YY/Y connection and 9-stud terminal box from standard.
For DC brake motors type BN_FD, the rectifier is connected to a single-phase 230 VAC supply voltage in the motor terminal box.
***Brake power supply** for brake motors is as follows:*

Die Motoren mit einer Nennspannung von 230/460V 60 Hz sind serienmäßig mit einer Verbindung YY/Y und einer 9-Pin-Klemmenleiste ausgestattet. Für Bremsmotoren mit Gleichstrombremse vom Typ BN_FD erfolgt die Versorgung des Gleichrichters über den Motorklemmenkasten mit einer Spannung von 230V (einphasiger Wechselstrom). Bei Bremsmotoren stellt sich die **Versorgung der Bremse** wie folgt dar:

*Les moteurs avec tension nominale 230/460V 60Hz sont prévus de série avec raccordement YY/Y et boîte à bornes à 9 bornes.Pour les moteurs frein avec frein en c.c. type BN_FD , l'alimentation du redresseur provient de la boîte à bornes moteur avec une tension 230V c.a. monophasée. Pour les moteurs frein **l'alimentation du frein** est la suivante :*

(11)

BN_FD		**BN_FA ; BN_BA**	Specificare: *Power supply:* Bitte angeben: *Spécifier* :
Da morsettiera motore *Connected to terminal box* Vom Motorklemmenkasten *Depuis boîte à bornes moteur* 1~ 230 V a.c.		Alimentazione separata *Separate power supply* *Fremdversorgung* *Alimentation séparée* 230 V Δ - 60 Hz	**230SA**
		Alimentazione separata *Separate power supply* Fremdversorgung *Alimentation séparée* 460 V Y - 60 Hz	**460SA**

M8 - ALIMENTAZIONE DA INVERTER

I motori elettrici della serie BN possono essere utilizzati con alimentazione da inverter PWM e tensione nominale all'ingresso del convertitore fino a 500 V.
Il sistema isolante adottato sui motori di serie prevede l'isolamento di fase con separatori, l'utilizzo di filo smaltato in grado 2 e resine d'impregnazione in classe H (limite di tenuta all'impulso di tensione 1600V picco-picco e fronte di salita t_s > 0.1 µs ai morsetti motore).
Le caratteristiche tipiche coppia/velocità in servizio S1 per motore con frequenza base f_b = 50 Hz sono riportate nella tabella seguente.
Per frequenze di funzionamento inferiori a circa 30 Hz, a causa della diminuzione della ventilazione, i motori standard autoventilati (IC 411) devono essere opportunamente declassati in coppia o, in alternativa, devono essere provvisti di ventilatore con alimentazione separata (vedi par. M12).
Per frequenze maggiori alla frequenza base, raggiunto il valore massimo di tensione di uscita dell'inverter, il motore lavora in un campo di funzionamento a potenza costante, con coppia all'albero che si riduce ca. con il rapporto (f/f_b).
Poiché la coppia massima del motore decresce ca. con $(f/f_b)^2$, il margine di sovraccarico ammesso dovrà essere progressivamente ridotto.

M8 - INVERTER CONTROL

The BN type electric motors are suitable for PWM inverter control with rated voltage at transformer input up to 500 V.
The insulating system adopted on standard motors uses phase insulation with separators, grade 2 enamelled wire and impregnation resins in class H (maximum voltage pulse 1600 V peak-to-peak and rise edge t_s > 0.1 µs at motor terminals).
Typical torque/speed characteristics for S1 duty for motors operating with basic frequency f_b= 50 Hz is are reported in the table below.
Operating at the frequencies below 30 Hz impair ventilation efficiency, standard motors with incorporated fan (IC 411) require either a corresponding torque reduction or, alternately, a fan with separate power supply. (See par M12)
For frequencies greater than basic frequency, once inverter maximum output voltage has been reached, the motor will be working in a steady power operation range, with shaft torque decreasing approximately with ratio (f/f_b).
As motor maximum torque decreases approximately with $(f/f_b)^2$, the permitted overload reserve will have to be reduced gradually.

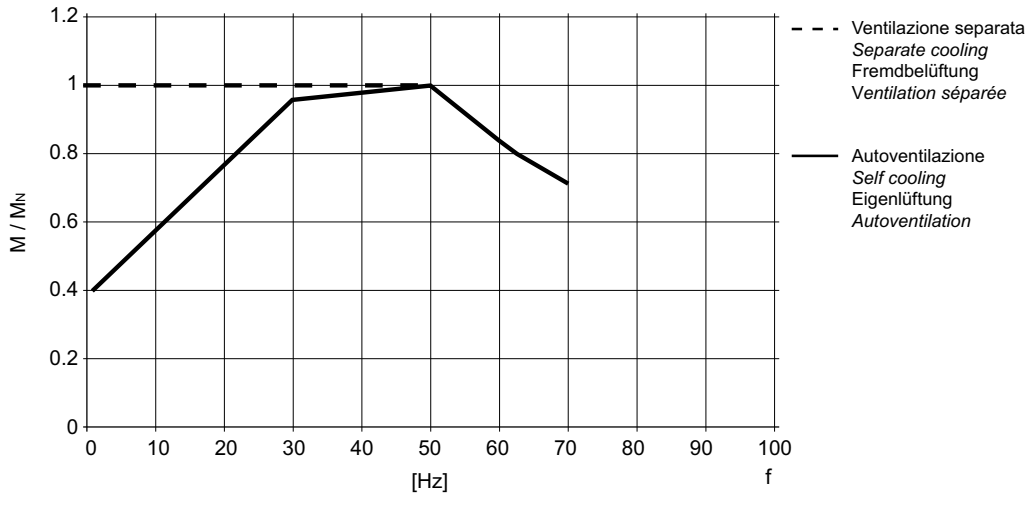
M8 - FREQUENZUMRICHTER-BETRIEB

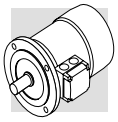
Die Elektromotoren der Serie BN können mit einem Frequenzumrichter und einer Nennspannung am Eingang des Umrichters bis zu 500 V versorgt werden.
Die Motoren haben eine Phasentrennung über Wicklungstrenner, Emaildraht der Klasse 2 mit Imprägnierharzen der Klasse H vor (Widerstandsgrenze gegen einen Spannungsimpuls von 1600 V und Anstiegsrampe t_s > 0.1 µs an den Motorklemmen).
Die typischen Merkmale Drehmoment/Drehzahl in der Betriebsart S1 für Motoren mit einer Eckfrequenz von f_b= 50 Hz werden in der nachstehenden Tabelle angegeben. Bei Frequenzen von unter 30 Hz liegenden Betriebsfrequenzen müssen die eigenbelüfteten Standardmotoren (IC 411) aufgrund ihrer geringeren Kühlwirkung in ihrem Drehmoment zurückgestuft oder, alternativ, mit einem Fremdlüfter ausgestattet werden (siehe Par. M12).
Wenn der Motor oberhalb der Eckfrequenz betrieben wird, arbeitet er im Feldschwächebereich. In diesem Bereich konstanter Leistung fällt das Drehmoment des Motors ungefähr um das Verhältnis (f/f_b) ab. Da die maximale Motordrehzahl sich mit ungefähr $(f/_{fb})^2$ verringert, muss die zulässige Belastungsgrenze in progressiv reduziert werden.

M8 - ALIMENTATION PAR VARIATEUR

Les moteurs électriques de la série BN peuvent être utilisés avec alimentation par variateur PWM, et tension nominale en entrée du convertisseur jusqu'à 500V. Le système isolant adopté sur les moteurs de série prévoit l'isolation de phase avec séparateurs, l'utilisation de fil émaillé niveau 2 et résines d'imprégnation de classe H (limite de maintien à l'impulsion de tension 1600V pic-pic et front de montée t_s > 0.1µs aux bornes moteur).
Les caractéristiques typiques couple/vitesse en service S1 pour moteur avec fréquence de base f_b = 50 Hz sont indiquées dans le tableau suivant. Pour des fréquences de fonctionnement inférieures à environ 30 Hz, à cause de la diminution de la ventilation, les moteurs standards autoventilés (IC411) doivent être opportunément déclassés au niveau du couple ou, en alternative, doivent être équipés de ventilateur avec alimentation séparée (voir paragraphe M12).
Pour des fréquences supérieures à la fréquence de base, une fois la valeur maximale de tension de sortie du variateur atteinte, le moteur fonctionne dans une plage de fonctionnement à puissance constante, avec un couple à l'arbre qui se réduit approximativement dans le rapport ($f/_{fb}$). Etant donné que le couple maximum du moteur diminue approximativement en relation avec $(f/_{fb})^2$, la marge de surcharge admise devra être progressivement réduite.

(12)





Per funzionamento oltre la frequenza nominale, la velocità limite meccanica dei motori è riportata nella tabella qui di seguito:

The following table reports the mechanical speed limit for motors operating above rated frequency:

Für Anwendungen, bei denen der Motor oberhalb der Eckfrequenz betrieben wird, finden sie die mechanische Drehzahlgrenzen in der folgenden Tabelle:

En cas de fonctionnement au-delà de la fréquence nominale, la vitesse limite mécanique des moteurs est indiquée dans le tableau suivant :

(13)

	n [min^{-1}]		
	2P	**4P**	**6P/8P**
BN 56...BN 100	5200	4000	3000
BN 112	5200	4000	3000
BN 132...BN 160MR	4500	4000	3000
BN 160M...BN 180M	4500	4000	3000
BN 180L...BN 200L	4500	3600	3000

A velocità superiori alla nominale i motori presentano maggiori vibrazioni meccaniche e rumorosità di ventilazione; è consigliabile, per queste applicazioni, un bilanciamento del rotore in grado R - opzione **RV** - ed eventualmente il ventilatore con alimentazione separata - opzioni **U1** o **U2**.
Sia il servoventilatore, sia il freno elettromagnetico, devono sempre essere alimentati direttamente dalla rete.

*Motors operating above rated speed show an increased tendency for mechanical vibration and fan noise. When this is the case, rotor balancing in grade R - option **RV** - and possibly a fan with separate power supply - options **U1** or **U2** - should be specified.*
Both servo-fan and electromagnetic brake require direct connection to mains power supply.

Bei Drehzahlen oberhalb der Nenndrehzahlen weisen die Motoren stärkere mechanische Schwingungen und Llüftungergeräusche auf: In diesen Fällen wird das Auswuchten des Rotors im Grad R – Option **RV** – und eventuell die Installation eines Fremdlüfters– Option **U1** oder **U2** - empfohlen. Sowohl der Fremdlüfter als auch die elektromagnetische Bremse müssen bei Frequenzumrichterbetrieb auf Grund der abfallenden Versorgungsspannung immer direkt über das Stromnetz versorgt werden.

*A des vitesses supérieures à la vitesse nominale, les moteurs présentent plus de vibrations mécaniques et de bruit de ventilation ; pour ces applications, il est conseillé d'effectuer un équilibrage du rotor en niveau R - option **RV** - et de monter éventuellement un ventilateur avec alimentation séparée – options **U1** ou **U2**.*
Le servoventilateur ainsi que le frein électromagnétique doivent toujours être alimentés directement par le réseau.

M9 - TIPO DI SERVIZIO

Se non indicato diversamente, la potenza dei motori riportata a catalogo si riferisce al servizio continuo S1.
Per i motori utilizzati in condizioni diverse da S1 sarà necessario identificare il tipo di servizio previsto con riferimento alle Norme CEI EN 60034-1.
In particolare per servizi S2 ed S3 è possibile ottenere una maggiorazione della potenza rispetto a quella prevista per il servizio continuo secondo quanto indicato nella tabella che segue, valida per i motori a singola polarità.
Per le maggiorazioni applicabili a motori a doppia polarità consultare preferibilmente il Servizio Tecnico Bonfiglioli.

M9 - TYPE OF DUTY

Unless otherwise specified, catalogue motor power refers to continuous duty S1.
Any operating conditions other than S1 duty must be identified in accordance with duty cycle definitions laid down in standards CEI EN 60034-1.
For duty cycles S2 and S3, the power increase co-efficient reported in the following table may be used. Please note that the table provided below applies to single-speed motors.
Please contact Bonfiglioli Engineering for the power increase coefficients applicable to switch-pole motors.

M9 - BETRIEBSARTEN

Sofern nicht anderweitig angegeben, beziehen sich die im Katalog angegebene Motorleistungen auf den Dauerbetrieb S1. Bei Motoren, die unter Bedingungen eingesetzt werden, die nicht mit S1 übereinstimmen, muss die entsprechende Betriebsart unter Bezugnahme auf die Normen CEI EN 60034-1 festgelegt werden. Insbesondere kann man, für die Betriebsarten S2 und S3, durch Anwendung der in der nachstehenden Tabelle angeführten Koeffizienten der für den Dauerbetrieb vorgesehenen Leistung gegenüber eine Leistungssteigerung erzielen. Diese Tabelle gilt für einpolige Motoren. Für die polumschaltbaren Motoren sollte man sich im Hinblick auf den Leistungssteigerung, mit unserem Technischen Kundendienst in Verbindung setzen.

M9 - TYPE DE SERVICE

Sauf indication contraire, la puissance des moteurs indiquée dans le catalogue se réfère au service continu type S1.
Pour les moteurs utilisés dans des conditions différentes de S1, il est nécessaire d'identifier le type de service en se référant aux Normes CEI EN 60034-1.
Plus particulièrement, pour les types de service S2 et S3 il est possible d'obtenir une majoration de la puissance par rapport à celle prévue pour le service continu, en appliquant les coefficients indiqués dans le tableau suivant, valable pour les moteurs à simple polarité. En ce qui concerne les majorations applicables aux moteurs à double polarité, il est préférable de contacter le Service Technique Bonfiglioli.

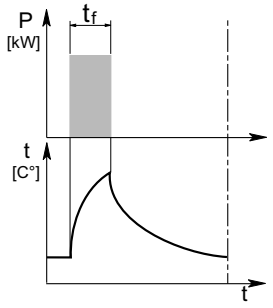
S2

Funzionamento a carico costante per un periodo di tempo limitato, inferiore a quello richiesto per raggiungere l'equilibrio termico, seguito da un periodo di riposo di durata sufficiente a ristabilire nel motore la temperatura ambiente.

Operation under steady loading for a limited period of time (less than the time taken to achieve thermal balance), followed by a period of time at rest long enough for engine to cool down to ambient temperature.

Betrieb mit konstanter Last für eine begrenzte Dauer, die unter der Zeit liegt, die für das Erreichen des thermischen Gleichgewichts erforderlich ist, gefolgt von einer Aussetzzeit mit einer Dauer, die für das erneute Erreichen der Umgebungstemperatur im Motor erforderlich ist.

Fonctionnement à charge constante pendant une période de temps limitée, inférieure à celle nécessaire pour atteindre l'équilibre thermique, suivie par une période de repos de durée suffisante pour rétablir la température ambiante dans le moteur.



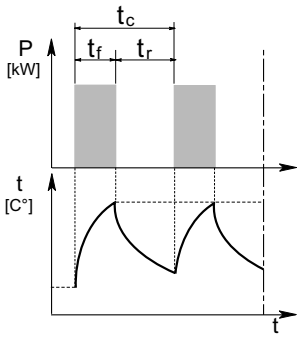
S3

Sequenza di cicli di funzionamento identici, ciascuno comprendente un periodo di funzionamento a carico costante ed un periodo di riposo.
In questo tipo di servizio la corrente d'avviamento non influenza la sovratemperatura in modo significativo.

A sequence of identical operation cycles, each including operation under steady loading followed by some time at rest. In this type of duty, starting current has no significant effect on overtemperature.

Betriebsweise mit identischen Betriebszyklen, von denen jeder Zyklus eine Betriebsdauer mit konstanter Last und eine Aussetzzeit einschliesst. Bei dieser Betriebsart beeinflußt der Anlaufstrom die Übertemperatur in keinerlei ausschlaggebender Weise.

Séquence de cycles de fonctionnement identiques, comprenant chacun une période de fonctionnement à charge constante et une période de repos. Dans ce type de service, le courant de démarrage n'influence pas l'excès de température de façon significative.



(14)

Tipo di Servizio *Type of duty* Betriebsart *Type de service*		Potenza ammissibile in p.u. della potenza in S1 *Permitted power in p.u. of S1 power* Zulässige Leistung in % der Leistung bei S1 *Puissance admissible en p.u. de la puissance en S1*
	Durata / *Duration* / Dauer / *Durée*	
S2	10 min	1.35
	30 min	1.15
	60 min	1.05
	Rapporto di intermittenza *Intermittence* / Schaltverhältnis *Rapport d'intermittence* (**I**)	
S3	25 %	1.25
	40 %	1.15
	60 %	1.10
S4 … S9	Interpellarci / *Contact us / Setzen Sie sich mit uns in Verbindung / Nous contacter*	

$$I = \frac{t_f}{t_f + t_r} 100$$

t_f = tempo di funzionamento sotto carico

t_r = tempo di riposo

La durata del ciclo dovrà essere ≤ 10 min. Per durate superiori interpellarci.

t_f = *work time under constant load*

t_r = *rest time*

Cycle duration must be up to 10 min. Please contact us when cycle duration exceeds this limit.

t_f = Betriebszeit mit konstanter Last

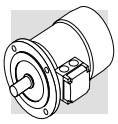
t_r = Aussetzzeit

Die Zyklusdauer muss ≤ 10 min. betragen. Falls der Zyklus länger sein sollte, setzen Sie sich bitte mit unserem Kundendienst in Verbindung.

t_f = *temps de fonctionnement à charge constante*

t_r = *temps de repos*

La durée du cycle devra être ≤ 10 min. Pour des durées supérieures, nous contacter.



M10 - MORSETTIERA MOTORE

La morsettiera principale è a 6 morsetti per collegamento con capicorda (esecuzione a 9 morsetti per tensioni americane "dual voltage" - vedi par. M7.1).
All'interno della scatola coprimorsetti è previsto il morsetto di terra per il collegamento del conduttore di protezione.
Le dimensioni dei terminali sono riportati nella tabella (15).
Per l'alimentazione del freno vedi par. M25 (freno FD), M26 + M27 (freno FA e BA).
Nei motori in forma costruttiva IM B3 la scatola coprimorsetti è posta in alto (posizione opposta ai piedi).
Eseguire i collegamenti elettrici secondo gli schemi riportati all'interno della scatola coprimorsettiera o nei manuali d'uso.

M10 - TERMINAL BOX

The main terminal box has 6 terminals for connection to lead-in wires (9-terminal version is supplied for "dual voltage" US voltage ratings - see M7.1)
The ground terminal for earth lead connection is housed in the terminal box.
Terminal sizes are listed in the table (15).
For brake power supply, please read par. M25 (brake FD), M26 + M27 (brake FA and BA).
In motor design IM B3, the terminal box is top mounted (side opposite to feet).
Please refer to the wiring diagrams reported inside the terminal box, or in the operating instructions, for correct wiring.

M10 - MOTORKLEMMENKASTEN

Der Klemmenkasten hat ein Klemmbrett mit 6 Klemmen für einen Anschluss über Kabelschuhe (für die amerikanischen Spannungswerte "dual voltage" sind 9 Klemmen vorgesehen – siehe M7.1. Im Inneren des Klemmenkastens ist ein Erdungsanschluß für den Anschluss des Schutzleiters vorgesehen. Die Abmessungen der Anschlüsse werden in der Tabelle (15) angegeben. Für Informationen über die Bremsversorgung verweisen wir an dieser Stelle auf den Par. M25 (Bremstyp FD), M26 + M27 (Bremstyp FA und BA). Bei Motoren in der Bauform IM B3 ist der Klemmenkasten oben angeordnet (den Füßen entgegengesetzt).
Die elektrischen Anschlüsse müssen entsprechend den Schaltplänen, die sich im Inneren des Klemmenkästen befinden oder in den Betriebsanleitungen zu finden sind, vorgenommen werden.

M10 - BORNIER MOTEUR

Le bornier principal est de type à 6 bornes pour raccordement avec cosses (exécution à 9 bornes pour les tensions américaines "dual voltage" – voir M7.1).
A l'intérieur du couvercle du bornier se trouve la borne de terre pour le raccordement du conducteur de protection.
Les dimensions des bornes sont indiquées dans le tableau (15). Pour l'alimentation du frein, voir par. M25 (frein FD), M26 + M27 (frein FA et BA).
Sur les moteurs de forme de construction IM B3 la boîte à bornes est située en haut (à l'opposé des pieds).
Effectuer les branchements électriques selon les schémas indiqués à l'intérieur du couvercle de la boîte à bornes ou dans les manuels d'instructions.

(15)

	N° terminali *No. of terminals* *Klemmen* *N° bornes*	Filettatura terminali *Terminal threads* Gewinde *Filetage bornes*	Sezione max. del conduttore mm^2 *Wire max cross section area sq mm^2* Max. leiter-querschnitt mm^2 *Section max du conducteur mm^2*
BN 56 ... BN 90	6	M4	2.5
BN 100 ... BN 160MR	6	M5	6
BN 160M ... BN 180M	6	M6	16
BN 180L ... BN 200L	6	M8	25

M10.1 - INGRESSO CAVI

Nell'esecuzione standard l'ingresso dei cavi di alimentazione è previsto per pressacavo metrici in accordo alla Norma CEI EN 50262. Dimensioni e disposizioni come indicato nelle tabelle che seguono.

M10.1 - CABLE GLAND HOLES

Standard cable gland holes accommodate metric-size cable glands in accordance with standard CEI EN 50262. Dimensions and locations are as shown in the following tables.

M10.1 - KABELDURCHFÜHRUNG

In der Standardversion ist die Ein- bzw. Durchführung der Kabel in Übereinstimmung mit der Norm CEI EN 50262 über metrische Kabelführungen vorgesehen. Maße und Anordnung werden in den folgenden Tabellen angegeben.

M10.1 - ENTREE CABLES

Dans l'exécution standard, l'entrée des câbles d'alimentation est prévue pour des serre-câbles métriques, en accord avec la Norme CEI EN 50262. Dimensions et dispositions comme indiqué dans les tab. suivantes.

(16)

Motori flangiati (IM B5, IM B14) / *Flanged motors (IM B5, IM B14)* Flanschmotoren (IM B5, IM B14) / *Moteurs à bride (IM B5, IM B14)*			
	N° ingresso cavi e dimensione *No. & size of cable gland holes* Kabeleingänge und masse *Nb entrees câbles et dimensions*		∅ Max. cavo [mm] *Wire max ∅ [mm]* Max. ∅ kabel [mm] *∅ Max câble [mm]*
BN 56 ... BN 63	2 x M 20 x 1.5	1 foro per lato *1 Hole on each side* 1 Bohrung pro Seite *1 Orifice par côté*	13
BN 71 ... BN 90	2 x M 25 x 1.5		17
BN 100	2 x M 32 x 1.5 2 x M 25 x 1.5	2 fori per lato *2 Holes on each side* 2 Bohrungen pro Seite *2 Orifices par côté*	21 17
BN 112	4 x M 25 x 1.5		17
BN 132 ... BN 160MR	4 x M 32 x 1.5		21
BN 160M ... BN 200L	2 x M 40 x 1.5	Orientabili 4 x 90° *Pivoting, 4 x 90°* Orientierbar 4 x 90° *Orientables 4 x 90°*	28

(17)

Motori con piedi (IM B3 e derivati) / *Footed motors (IM B3 and derived designs)* Motoren in Fußausführung (IM B3 und davon abgeleitete Versionen) *Moteurs avec pieds (IM B3 et dérivés)*			
	N° ingresso cavi e dimensione *no. & size of cable gland holes* Kabeleingänge und masse *nb entrees câbles et dimensions*		Diametro max. cavo [mm] *max wire diametre ∅ [mm]* Max. ∅ kabel [mm] *∅ max câble [mm]*
BN 63	2 x M 16 x 1.5	1 foro per lato *1 hole on each side* 1 Bohrung pro Seite *1 orifice par côté*	10
BN 71 ... BN 80	2 x M 20 x 1.5		13
BN 90	2 x M 25 x 1.5		17
BN 100 ... BN 112	4 x M 25 x 1.5	2 fori per lato *2 holes on each side* 2 Bohrungen pro Seite *2 orifices par côté*	17
BN 132	4 x M 32 x 1.5		21

M11 - FORME COSTRUTTIVE

I motori sono previsti nelle forme costruttive IM B3, IM B5, IM B14 e derivate in accordo alla Norma CEI EN 60034-7, come indicato nella tabella seguente.

M11 - DESIGN VERSIONS

Motors are available in the design versions IM B3, IM B5, IM B14 and derived versions in accordance with standard CEI EN 60034-7, as outlined in the table below.

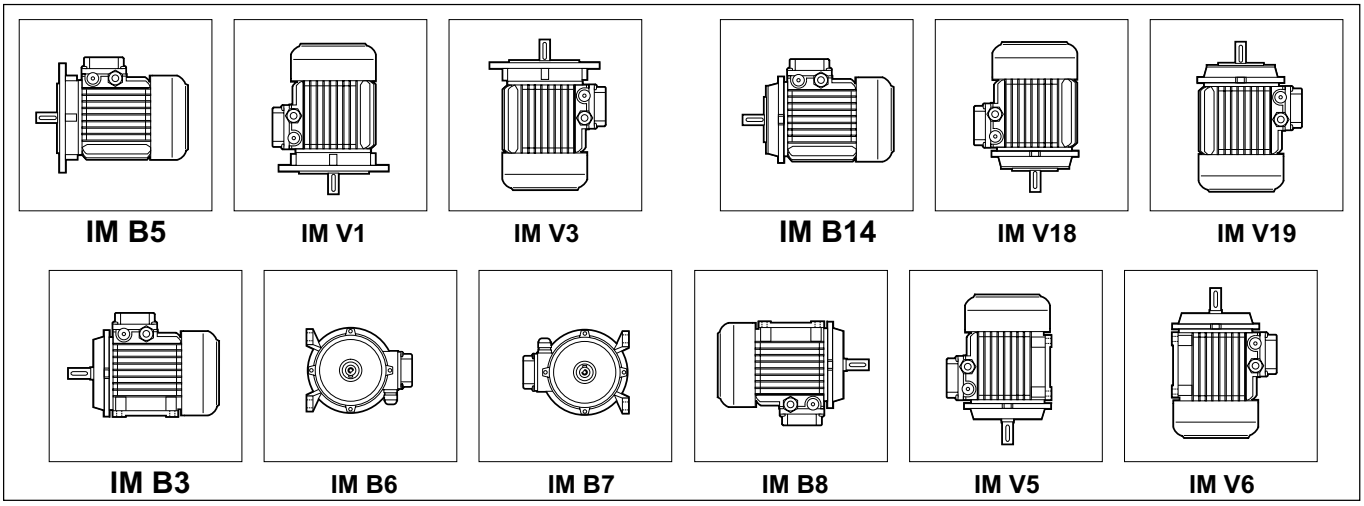
M11 - BAUFORMEN

Die Motoren sind in den Bauformen IM B3, IM B5, IM B14 und abgeleitete Versionen erhältlich und wurden in Übereinstimmung mit der Norm CEI EN 60034-7, entsprechend den Angaben in der nachstehenden Tabelle, realisiert.

M11 - FORMES DE CONSTRUCTION

Les moteurs sont disponibles dans les formes de construction IM B3, IM B5, IM B14 et dérivées, en accord avec la Norme CEI EN 60034-7, comme indiqué dans le tableau suivant.

(18)



I motori, targati esclusivamente nella forma costruttiva base, possono essere installati anche nelle forme costruttive derivate, come illustrato nella tabella seguente:

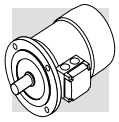
Motors in the derived design versions may also be installed as outlined in the table below. however, note that motor name plate will report the corresponding basic design version:

Die Motoren werden auf dem Typenschild in der Einbaulage B3 angegeben, sie können aber auch in den anderen, in der nachfolgenden Tabelle angegebenen Bauformen montiert werden:

Les moteurs, marqués exclusivement dans la forme de construction de base, peuvent aussi être installés dans les formes de construction dérivées, comme indiqué dans le tableau suivant :

(19)

Forma costruttiva base ***Basic design version*** **Gundbauform** ***Forme de construction de base***	**Forma costruttiva derivata / *Derived design version* Andere Einbaulagen / Forme de construction dérivée**				
IM B3	IM B6	IM B7	IM B8	IM V5	IM V6
IM B5	IM V1	IM V3			
IM B14	IM V18	IM V19			



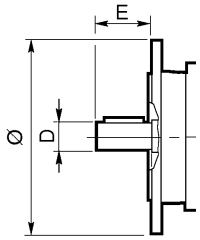
Nelle installazioni con l'albero rivolto verso il basso è consigliabile specificare l'opzione **RC** - tettuccio parapioggia**,** vedi par. M23 in particolar modo nel caso di motore autofrenante.
I motori in forma flangiata possono essere forniti con dimensioni di accoppiamento ridotte, corrispondenti alle forme costruttive B5R o B14R, con dimensioni dettagliate nella tabella seguente:

*If motor is to be installed with the shaft pointing downwards, the rain canopy option **RC** – see par. M23 is recommended, especially where a brake motor is used.*
Flange output motors are also available with reduced coupling dimensions corresponding to design versions B5R or B14R. Dimensions are indicated in the table below:

Bei Anwendungen mit senkrecht unten zeigender Welle, wird empfohlen, den Motor mit der Option **RC** – Schutzdach, siehe M23 zu bestellen, insbesondere dann, wenn es sich um einen Bremsmotor handelt. Die Motoren mit Flansch können mit reduzierten Wellen- und Flanschmaßen geliefert werden, die den Bauformen B5R oder B14R entsprechen und folgende Maße aufweisen:

*En ce qui concerne les installations avec arbre dirigé vers le bas, il est conseillé de spécifier l'option **RC** – capot antipluie, voir par. M23 plus particulièrement en cas de moteur frein. Les moteurs avec bride peuvent être fournis avec des dimensions d'accouplement réduites, correspondant aux formes de construction B5R ou B14R, avec les dimensions détaillées dans le tableau suivant :*

(20)



	BN 71	BN 80	BN 90	BN 100	BN 112	BN 132
B5R (1)	11 x 23 - ∅ 140	14 x 30 - ∅ 160	19 x 40 - ∅ 200	24 x 50 - ∅ 200	24 x 50 - ∅ 200	28 x 60 - ∅ 250
B14R (2)	11 x 23 - ∅ 90	14 x 30 - ∅ 105	19 x 40 - ∅ 120	24 x 50 - ∅ 140	—	—

(1) Flangia con fori passanti
(2) Flangia con fori filettati

(1) Flange with through holes
(2) Flange with tapped holes

(1)Flanschen mit durchgehenden Bohrungeni
(2) Flansch mit Gewindebohrungen

(1) Bride avec orifices passants
(2)Bride avec orifices filetés

M12 - VENTILAZIONE

I motori sono raffreddati mediante ventilazione esterna (IC 411 secondo CEI EN 60034-6) e sono provvisti di ventola radiale in plastica, funzionante in entrambi i versi di rotazione.
L'installazione dovrà assicurare una distanza minima della calotta copriventola dalla parete più vicina, in modo da non creare impedimento alla circolazione dell'aria, oltre che permettere l'esecuzione della manutenzione ordinaria del motore e, se presente, del freno.
Su richiesta, a partire dalla grandezza BN 71, i motori possono essere forniti con ventilazione forzata ad alimentazione indipendente. Il raffreddamento è realizzato per mezzo di un ventilatore assiale con alimentazione indipendente, montato sulla calotta copriventola (metodo di raffreddamento IC 416).

M12 - VENTILATION

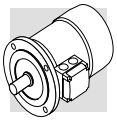
Motors are cooled by external ventilation systems (IC 411 in accordance with CEI EN 60034-6) and are equipped with a plastic radial fan running in both directions of rotation.
Installation must take into account a minimum distance of the fan cover from the nearest wall so as to ensure unobstructed air circulation. This also facilitates routine maintenance operations for motor and brake (if fitted).
At request, motor frame sizes BN 71 and larger may be equipped with forced ventilation with independent power supply. Motor is cooled by an axial ventilator mounted on the fan cover using an independent power supply (cooling method IC 416).

M12 - KÜHLUNG

Die Motoren werden mittels Eigenbelüftung gekühlt (IC 411 gemäß CEI EN 60034-6) und sind mit einem Radiallüfterrad aus Kunststoff ausgestattet, das in beide Richtungen drehen kann. Bei der Montage des Motors muss darauf geachtet werden, das zwischen Lüfterhaube und dem nächsten Bauteil eine Mindestabstand einzuhalten, damit die Luftzirkulation nicht beeinträchtigt werden kann. Dieser Abstand ist ebenso für die regelmäßige Instandhaltung des Motors und, falls vorhanden, der Bremse erforderlich. Ab der Baugröße BN 71 können die Motoren auf Anfrage mit einem unabhängig gespeisten Fremdlüfter geliefert werden. Die Kühlung erfolgt hier durch einen Axialventilator, der an Stelle der Standardlüfterhaube (Kühlmethode IC 416) montiert wird.

M12 - VENTILATION

Les moteurs sont refroidis par ventilation externe (IC 411 selon CEI EN 60034-6) et sont équipés de ventilateur radial en plastique fonctionnant dans les deux sens de rotation.
L'installation doit garantir une distance minimum du capot cache-ventilateur par rapport au mur le plus proche de façon à ne pas créer d'empêchement à la circulation de l'air ainsi que pour permettre les interventions d'entretien ordinaire du moteur et, si présent, du frein. Sur demande, à partir de la taille BN 71, les moteurs peuvent être fournis avec ventilation forcée à alimentation indépendante. Le refroidissement est réalisé au moyen d'un ventilateur axial avec alimentation indépendante monté sur le capot cache-ventilateur (méthode de refroidissement IC 416).



Questa esecuzione è utilizzata in caso di alimentazione del motore tramite inverter allo scopo di estendere il campo di funzionamento a coppia costante anche a bassa velocità, o quando per lo stesso sono richieste elevate frequenze di avviamento.
Da questa opzione sono esclusi i motori autofrenanti tipo BN_BA e motori con doppia sporgenza d'albero (opzione PS).

This design is adopted on inverter-controlled motors in order to extend torque-control operating range to include low speeds, or when the motor is to perform a large number of starts per hour.
This option is not compatible with brake motors type BN_BA and motors with double-extended shaft (option PS).

Diese Ausführung sollte eingestzt werden, falls der Motor über einen Frequenzumrichterbetrieben wird, so dass der Motor bei konstantem Drehmoment auch bei niedrige Drehzahlen oder bei hohen Anlauffrequenzen. eingesetzt werden kann.
Von dieser Option ausgeschlossen sind die Bremsmotoren BN_BA und Motoren mit zweitem Wellenende (Option PS).

Cette exécution est utilisée en cas d'alimentation du moteur par variateur dans le but d'étendre aussi la plage de fonctionnement à couple constant aux faibles vitesses ou lorsque des fréquences de démarrage élevées sont nécessaire à celui-ci.
Les moteurs frein type BN_BA et les moteurs avec arbre sortant des deux côtés (option PS) sont exclus de cette option.

Tabella dati di alimentazione elettrica ***Power supply chart***

Tabelle – Daten der Stromversorgung ***Tableau caractéristiques de l'alimentation électrique***

(21)

BN **U1**	**V a.c.** ± 10%	**Hz**	**P** [W]	**I** [A]
BN 71	1 ~ 230	50 / 60	22	0.14
BN 80			22	0.14
BN 90			40	0.25
BN 100			50	0.25
BN 112	3 ~ 230Δ / 400Y		50	0.26 / 0.15
BN 132 ... BN 160MR			110	0.38 / 0.22
BN 160M ... BN 180M		50	180	1.25 / 0.72
BN 180L ... BN 200L			250	1.51 / 0.87

(22)

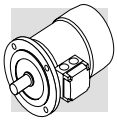
BN **U2**	**V a.c.** ± 10%	**Hz**	**P** [W]	**I** [A]
BN 71	1 ~ 230	50 / 60	22	0.14
BN 80			22	0.14
BN 90			40	0.25
BN 100	3 ~ 230Δ / 400Y		40	0.24 / 0.14
BN 112			50	0.26 / 0.15
BN 132 ... BN 160MR			110	0.38 / 0.22

Per la variante sono disponibili due esecuzioni alternative, denominate **U1** e **U2**, aventi lo stesso ingombro in senso longitudinale. Per entrambe le esecuzioni, la maggiore lunghezza della calotta copriventola (Δ **L**) è riportata nella tabella che segue. Dimensioni complessive ricavabili dalle tavole dimensionali dei motori.

*Variant is available in two alternative executions named **U1** and **U2**, featuring the same overall length. The largest length of fan cover (Δ **L**) for each configuration is reported in the following table. For overall dimensions, please see the dimension tables of motors.*

Für diese Optionsind als Alternative zwei Ausführungen verfügbar: **U1** und **U2** mit dem gleichen Längsmaßen. Für beide Ausführungen wird die Verlängerung der Lüfterhaube (Δ **L**) in der nachstehenden Tabelle wiedergegeben. Die Gesamtmaße der Motoren können den Tabellen mit den Motormaßen entnommen werden.

*Pour la variante sont disponibles deux exécutions alternatives, dénommées **U1** et **U2**, ayant le même encombrement dans le sens longitudinal. Pour les deux exécutions, la majoration de la longueur du capot cache-ventilateur (Δ **L**) est indiquée dans le tableau suivant. Dimensions totales à calculer d'après les planches de dimensions des moteurs.*



Lunghezza aggiuntiva per motori con ventilazione indipendente

Extra length for motors with independent cooling

Zusätzliche Länge für Motoren mit unabhängiger Luftkühlung

Majoration longueur pour moteurs avec ventilation forcée à alimentation indèpendante

(23)

	ΔL_1 [mm]	ΔL_2 [mm]
BN 71	93	32
BN 80	127	55
BN 90	131	48
BN 100	119	28
BN 112	130	31
BN 132 ... BN 160MR	161	51
BN 160M ... BN 180M	184	184
BN 180L ... BN 200L	184	184

Δ L_1 = variazione dimensionale rispetto alla lunghezza LB del motore standard corrispondente.

Δ L_2 = variazione dimensionale rispetto alla lunghezza LB del motore autofrenante corrispondente.

Δ L_1 = *dimension variation compared to length LB of the corresponding standard motor.*

Δ L_2 = *dimension variation compared to length LB of the corresponding brake motor.*

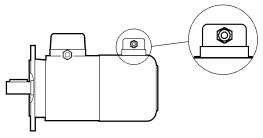
Δ L_1 = = Maßänderung gegenüber Maß LB des entsprechenden Standardmotors.

Δ L_2 = Maßänderung gegenüber Maß LB des entsprechenden Bremsmotors.

Δ L_1 = *variation de dimension par rapport à la cote LB du moteur standard correspondant.*

Δ L_2 = *variation de dimension par rapport à la cote LB du moteur frein correspondant.*

U1



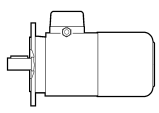
Terminali di alimentazione del ventilatore in scatola morsetti separata. Nei motori autofrenanti grandezza BN 71...BN 160MR, con variante **U1**, la leva di sblocco non è collocabile nella posizione AA (vedi par. M24.1).

Terminals of the independent fan motor are housed in a separate terminal box. The hand release cannot be located in the AA position for brake motors size BN71...BN160MR that feature the U1 type forced cooling, as described at section M24.1.

Versorgungsanschlüsse des Ventilators im Zusatzklemmenkasten. Bei den Bremsmotoren in der Baugröße BN 71...BN 160MR, mit Variante **U1** kann der Bremslüfthebel nicht in der Position AA (siehe Par. M24.1) angeordnet werden.

*Bornes d'alimentation du ventilateur dans une boîte à bornes séparée. Pour les moteurs frein taille BN 71...BN 160MR, avec variante **U1**, le levier de déblocage ne peut être installé en position AA (voir par. M24.1).*

U2



Terminali di alimentazione del ventilatore nella scatola morsettiera principale del motore.

L'opzione non è applicabile ai motori BN 160M...BN 200L.

Terminals of the fan motor are located in the main terminal box.

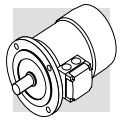
The U2 option does not apply to motors BN 160M…BN 200L.

Versorgungsanschlüsse des Ventilators im Hauptklemmenkasten des Motors.

Die Option kann nicht an den Motoren BN 160M…BN 200L geliefert werden.

Bornes d'alimentation du ventilateur dans la boîte à bornes principale du moteur.

L'option n'est pas applicable aux moteurs BN 160M…BN 200L.



M13 - DESIGNAZIONE MOTORE | ***M13 - MOTOR DESIGNATION*** | **M13 - MOTORBEZEICHNUNG** | ***M13 - DESIGNATION MOTEUR***

MOTORE / *MOTOR*
MOTOR / *MOTEUR*

FRENO / *BRAKE*
BREMSE / *FREIN*

BN 63B 4 230/400-50 IP55 CLF **B5** **FD** 3.5 R NB 220SA ...

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OPTIONS
21

ALIMENTAZIONE FRENO
BRAKE SUPPLY
BREMSVERSORGUNG
ALIMENTATION FREIN
34

TIPO RADDRIZZATORE AC/DC
RECTIFIER TYPE
GLEICHRICHTERTYP
TYPE ALIMENTATEUR
39

LEVA DI SBLOCCO FRENO
BRAKE HAND RELEASE
BREMSENTHANDLÜFTUNG
LEVIER DE DEBLOCAGE FREIN
32

COPPIA FRENANTE/ *BRAKE TORQUE*
BREMSMOMENT / *COUPLE FREIN*
40 45 49

TIPO FRENO / *BRAKE TYPE* / BREMSENTYP / *TYPE DE FREIN*
37 43 47

FORMA COSTRUTTIVA / *MOTOR EXECUTION*
BAUFORM / FORME DE CONSTRUCTION
16

CLASSE ISOLAMENTO / *INSULATION CLASS*
ISOLIERUNGSKLASSE / *CLASSE ISOLATION*
24

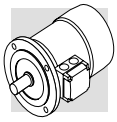
GRADO DI PROTEZIONE / *DEGREE OF PROTECTION*
SCHUTZART / *DEGRE DE PROTECTION*
22

TENSIONE-FREQUENZA / *VOLTAGE-FREQUENCY*
SPANNUNG-FREQUENZ / *TENSION-FREQUENCE*
7

NUMERO DI POLI / *NUMBER OF POLES* / POLZAHL / *N.bre POLES*
2, 4, 6, 8, 2/4, 2/6, 2/8, 2/12, 4/6, 4/8
51

GRANDEZZA MOTORE / *MOTOR SIZE* / MOTOR-BAUGROSSE / *TAILLE MOTEUR*
56 - 200L
51

BN



M14 - VARIANTI E OPZIONI *M14 - VARIANTS AND OPTIONS* M14 - OPTIONEN *M14 - VARIANTES ET OPTIONS*

VARIANTI *VARIANTS* OPTIONEN *VARIANTES*

Descrizione *Description* Beschreibung *Description*		Default *Default* Standard *Par défaut*	Opzione *Option* Option *Option*		
Tensione-frequenza *Voltage-frequency* Spannung-Frequenz *Tension-fréquence*		230/400-50			7
Grado di protezione *Protection class* Schutzart *Degré de protection*	**BN**	IP 55	IP 56		22
	BN_FD **BN_FA**	IP 54	IP 55		
	BN_BA	IP 55	-		
Classe di isolamento *Insulation class* Isolierstoffklasse *Classe d'isolation*		CL F	CLH		24
Forma costruttiva *Design version* Bauform *Forme de construction*		**B5**	**B14**	**B3**	16

OPZIONI *OPTIONS* OPTIONEN *OPTIONS*

Descrizione / *Description* Beschreibung / *Description*	Valori / *Catalogue numbers* Werte */ Valeurs*			
Protezioni termiche *Thermal protective devices* Thermische Wicklungsschutz *Protections thermiques*	**D3**	**E3**		25
Potenza normalizzata a 50 Hz *50 Hz normalized power* Auf 50 Hz genormte Leistung *Puissance normalisée à 50 Hz*	**PN**			10
Dispositivi di retroazione *Feedback devices* Signalrückführungen (Drehgeber) *Dispositifs de rétroaction*	**EN1**	**EN2**	**EN3**	27
Riscaldatori anticondensa *Anti-condensate heaters* Wicklungsheizung *Réchauffeurs anticondensation*	**H1**			28
Tropicalizzazione avvolgimenti *Tropicalized windings* Tropenschutz der Motorwicklungen *Tropicalisation bobinages*	**TP**			28
Doppia estremità d'albero *Double-extended shaft* Zweites Wellenende *Arbre à double extrémité*	**PS**			28
Equilibratura rotore in grado R *Rotor balancing grade R* Rotorauswuchtung mit Grad R *Equilibrage rotor en degré R*	**RV**			29
Protezioni meccaniche esterne *External mechanical protections* Schutzdächer *Protections mécaniques extérieures*	**RC**	**TC**		30
Ventilazione forzata *Forced ventilation* Fremdlüfter *Ventilation forcée*	**U1**	**U2**		19
Esecuzione certificata *Certification* Zertifizierte Ausführung *Exécution certifiée* C US	**CUS**			11

OPZIONI COLLEGATE AL FRENO | ***BRAKE-RELATED OPTIONS*** | **BREMSEOPTIONEN** | ***OPTIONS CONCERNANT LE FREIN***

Descrizione *Description* Beschreibung / *Description*	Valori / *Catalogue numbers* *Werte / Valeurs*				Pagina
Coppia frenante *Brake torque* Bremsmoment *Couple de freinage*	Riferirsi al particolare tipo di freno *Refer to brake type* Bezug auf den entsprechenden Bremstyp nehmen *Se référer au type de frein particulier*				40 45 49
Leva di sblocco manuale *Manual release lever* Manueller Bremslüfthebel *Clevier de déblocage manuel*	**R**	**RM**			32
Orientamento leva di sblocco *Release lever orientation* Orientierungdes Bremslösehebel *Orientation levier de déblocage*	**AB**	**AA**	**AC**	**AD**	
Alimentatore freno d.c. *DC brake rectifier* Stromversorgung der Bremse *Disp. d'alimentation c.c.*	**NB**	**NBR**	**SB**	**SBR**	39
Volano per avviamento *progressivo* *Soft-start flywheel* Schwungrad für Sanftanlauf *Volant pour démarrage progressif*	**F1**				36
Filtro capacitivo *Capacitive filter* Kapazitiver Filter *Filtre capacitif*	**CF**				36
Alimentazione freno separata (*) *Brake separate power supply (*)* Separate Bremsversorgung (*) *Alimentation frein séparée (*)*	**...SA**	**...SD**			34

(*) Completare con il valore di tensione.

(*) Specify voltage.

(*) Spannungswert eintragen.

(*) Compléter avec la valeur de tension.

Valori pre-impostati di default.

Default values.

Standardwerte bei Lieferung falls nicht anders spezifiziert.

Valeurs prédéfinies par défaut.

M15 - GRADO DI PROTEZIONE | ***M15 - DEGREE OF PROTECTION*** | **M15 - SCHUTZART** | ***M15 - DEGRE DE PROTECTION***

IP...

Nella loro esecuzione standard (non autofrenante) i motori tipo BN sono caratterizzati dal grado di protezione IP55, a richiesta è disponibile la protezione aumentata IP56.
I motori autofrenanti tipo BN_FD e BN_FA sono protetti in grado IP54 e, opzionalmente, in IP55.
La tabella sottostante riassume la disponibilità dei vari gradi di protezione.
Indipendentemente dal grado di protezione specificato, per installazione all'aperto i motori devono essere protetti dall' irraggiamento diretto e, nel caso di installazione con l'albero rivolto verso il basso, è necessario specificare ulteriormente il tettuccio di protezione contro l'ingresso di acqua e di corpi solidi (opzione **RC**).

Standard BN motors (where standard means other than brake motors) are manufactured in protection class IP55. A higher protection class IP56 is available at request. Brake motors type BN_FD and BN_FA are in protection class IP54 or IP55 (at request).
Brake motors BN_BA are only available in protection class IP55. The following table provides an overview of available protection classes.
*Regardless of the protection class specified on order, motors to be installed outdoors require protection against direct sunlight and in addition – when they are to be installed with the shaft pointing downwards – a rain canopy to keep out water and solid bodies (option **RC**).*

In der Standardausführung (ohne Bremse) werden die Motoren vom Typ BN in Schutzart IP55 ausgeliefert. Auf Anfrage können sie mit einer auf IP56 erhöhten Schutzart geliefert werden. Die Bremsmotoren vom Typ BN_FD und BN_FA verfügen über die Schutzart IP54 und können Optional in IP55 geliefert werden. Die Bremsmotoren vom Typ BN_BA sind nur in der Schutzart IP55 lieferbar. In der nachstehenden Tabelle werden die jeweiligs zur Verfügung stehenden Schutzarten zusammengefasst. Unabhängig von der spezifischen Schutzart müssen die im Freien installierten Motoren vor direkten Strahlungen geschützt werden. Im Fall einer senkrechten Montage, in der die Welle nach unten gerichtet ist, sollte darüber hinaus das Schutzdach bestellt werden, das vor dem Eindringen von Wasser und festen Fremdkörpern schützt (Option **RC**).

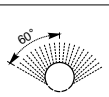
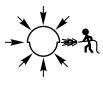
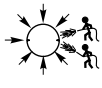
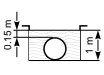
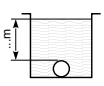
*Dans l'exécution standard (non frein), les moteurs type BN sont caractérisés par le degré de protection IP55. Sur demande, la protection majorée IP56 est aussi disponible. Les moteurs frein type BN_FD et BN_FA sont protégés en degré IP54 et, en option, en IP55. Les moteurs frein type BN_BA sont disponibles uniquement avec degré de protection IP55. Le tableau ci-dessous résume la disponibilité des différents degrés de protection. Indépendamment du degré de protection spécifié, en cas d'installation en plein air, les moteurs doivent être protégés des rayons directs du soleil et, en cas d'installation avec arbre dirigé vers le bas, il est nécessaire de spécifier ultérieurement le capot de protection contre la pénétration de l'eau et des corps solides (option **RC**).*

(24)

	IP 54	IP 55	IP 56
BN	⛔	di serie / *standard* serienmäßig / *de série*	a richiesta / *at request* auf Anfrage / *sur demande*
BN_FD **BN_FA**	di serie / *standard* serienmäßig / *de série*	a richiesta / *at request* auf Anfrage / *sur demande*	⛔
BN_BA	⛔	di serie / *standard* serienmäßig / *de série*	⛔

IP **5** **5**

0		Non protetto *Noi protected* Nicht geschützt *Non protégé*
1		Protetto contro corpi solidi estranei di ϕ 50 mm *Protected against extraneous solid bodies having ϕ 50 mm* Geschützt gegen feste Fremdkörper mit ϕ 50 mm *Protégé contre les corps solides étrangers de ϕ 50 mm*
2		Protetto contro corpi solidi estranei di ϕ 12.5 mm *Protected against extraneous solid bodies having ϕ 12.5 mm* Geschützt gegen feste Fremdkörper mit ϕ 12,5 mm *Protégé contre les corps solides étrangers de ϕ 12.5 mm*
3		Protetto contro corpi solidi estranei di ϕ 2.5 mm *Protected against extraneous solid bodies having ϕ 2.5 mm* Geschützt gegen feste Fremdkörper mit ϕ 2,5 mm *Protégé contre les corps solides étrangers de ϕ 2.5 mm*
4		Protetto contro corpi solidi estranei di ϕ 1.0 mm *Protected against extraneous solid bodies having ϕ 1.0 mm* Geschützt gegen feste Fremdkörper mit ϕ 1,0 mm *Protégé contre les corps solides étrangers de ϕ 1.0 mm*
5		Protetto contro la polvere *Protected against dust* Staubgeschützt *Protégé contre la poussière*

0		Non protetto *Not protected* Nicht geschützt *Non protégé*
1		Protetto contro la caduta verticale di gocce d'acqua *Protected against vertical water drips* Geschützt gegen senkrecht einfallendes Tropfwasser *Protégé contre la chute verticale de gouttes d'eau*
2		Protetto contro la caduta verticale di gocce d'acqua con un'inclinazione fino a 15° Protected against vertical water drips inclined up to 15° Geschützt gegen senkrecht einfallendes Tropfwasser bei Neigung bis 15° *Protégé contre la chute verticale de gouttes d'eau avec inclinaison jusqu'à 15°*
3		Protetto contro la pioggia *Protected against rain* Regenwassergeschützt *Protégé contre la pluie*
4		Protetto contro gli spruzzi d'acqua da tutte le direzioni *Protected against water splashes* Spritzwassergeschützt *Protégé contre les éclaboussures d'eau*
5		Protetto contro i getti d'acqua *Protected against jets of water* Wasserstrahlgeschützt *Protégé contre les jets d'eau*
6		Protetto contro getti d'acqua a pressione *Protected against powerful jets of water* Gegen starke Wasserstrahlen geschützt *Protégé contre les jets d'eau puissants*
7		Protetto contro gli effetti dell'immersione temporanea *Protected against the effects of temporary immersion* Kurzzeitig wasserdicht *Protégé contre les effets de l'immersion temporaire*
8		Protetto contro gli effetti dell'immersione continua *Protected against the effects of continuous immersion* Nachhaltig wasserdicht *Protégé contre les effets de l'immersion continue*

M16 - CLASSE DI ISOLAMENTO ***M16 - INSULATION CLASS*** **M16 - ISOLATIONSKLASSE** ***M16 - CLASSES D'ISOLATION***

CLF

I motori di produzione Bonfiglioli impiegano, di serie, materiali isolanti (filo smaltato, isolanti, resine d'impregnazione) in classe **F**.

*Bonfiglioli motors use class **F** insulating materials (enamelled wire, insulators, impregnation resins) as compare to the standard motor.*

Die Motoren von Bonfiglioli sind serienmäßig mit Isolierstoffen (Emaildraht, Isolierstoffen, Imprägnierharzen) der Klasse **F** ausgestattet.

*De série, les moteurs fabriqués par Bonfiglioli utilisent des matériaux isolants (fil émaillé, isolants, résines d'imprégnation) en classe **F**.*

In genere, per i motori in esecuzione standard la sovratemperatura dell'avvolgimento statore è contenuta entro il limite di 80 K, corrispondente alla sovratemperatura di classe B.
L'accurata scelta dei componenti del sistema isolante consente l'impiego dei motori anche in climi tropicali ed in presenza di vibrazioni normali.

In standard motors, stator windings over temperature normally stays below the 80 K limit corresponding to class B over temperature.
A careful selection of insulating components makes the motors compatible with tropical climates and normal vibration.

Allgemein hält sich die Übertemperatur der Motoren in der Standardausführung innerhalb des Grenzwerts von 80 K, der einer Übertemperatur der Klasse B entspricht. Die sorgfältig Wahl der Komponenten des Isoliersystem gestatten den Einsatz dieser Motoren auch unter tropischen Klimabedingungen und bei Vorliegen normaler Schwingungen.

En général, pour les moteurs en exécution standard, l'échauffement de l'enroulement du stator se situe dans la limite de 80 K, correspondant à un échauffement de classe B.
Le choix soigné des composants du système d'isolation permet d'utiliser également les moteurs dans des climats tropicaux et en présence de vibrations normales.

Per applicazioni in presenza di sostanze chimiche aggressive o di elevata umidità, è consigliabile contattare il Servizio Tecnico Bonfiglioli per la selezione del prodotto più idoneo.

For applications involving the presence of aggressive chemicals or high humidity, contact Bonfiglioli Engineering for assistance with product selection.

Für den Einsatz in in der Nähe aggressiv wirkenden chemischen Substanzen oder bei hoher Luftfeuchtigkeit, wird empfohlen sich zur Wahl eines passendes Produktes mit unserem Technischen Kundendienst in Verbindung zu setzen.

Pour des applications en présence de substances chimiques agressives, ou d'humidité élevée, il est conseillé de contacter le Service Technique Bonfiglioli pour sélectionner le produit le plus adapté.

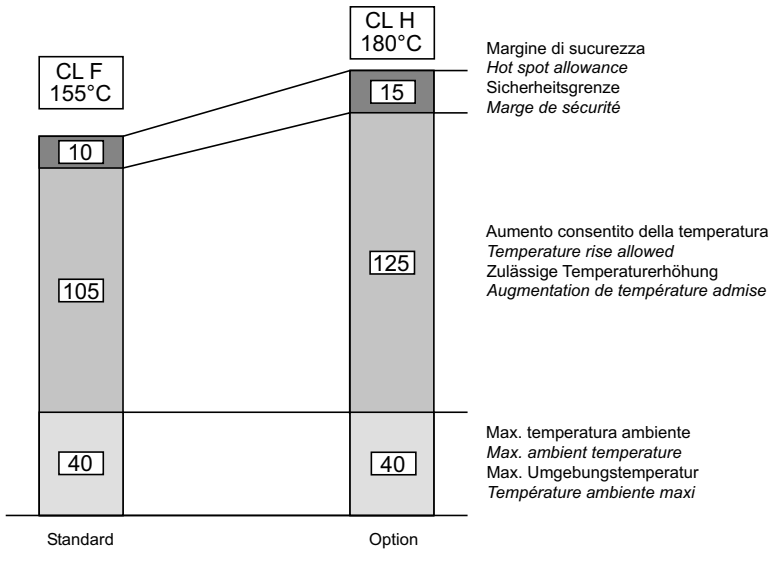
CLH

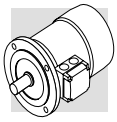
Su richiesta può venire specificata la classe di isolamento **H**.

*Motors manufactured in insulation class **H** are available at request.*

Auf Anfrage können sie auch in der Klasse **H** geliefert werden.

Sur demande, la classe d'isolation H peut être spécifiée.





M17- PROTEZIONI TERMICHE

Oltre alla protezione garantita dall'interruttore magnetotermico, i motori possono essere provvisti di sonde termiche incorporate per proteggere l'avvolgimento da eccessivo riscaldamento dovuto alla scarsa ventilazione o servizio intermittente. Una protezione aggiuntiva di questo tipo dovrebbe sempre essere specificata per i motori dotati di ventilazione separata. Le varianti a disposizione sono:

M17- THERMAL PROTECTIVE DEVICES

The standard thermal cut out fitted to motors may be supplemented by incorporating thermistors or thermostats to protect winding from overheating due to poor ventilation or intermittent duty.
Such additional protection is highly recommended for motors with separate ventilation. Available variants are as follows:

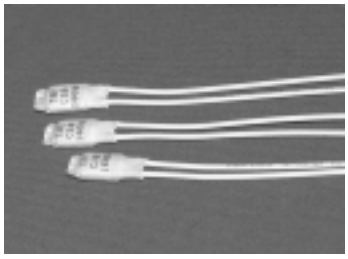
M17- THERMISCHE WICKLUNGSSCHUTZEINRICHTUNGEN

Abgesehen vom durch den Magnetwärmeschalter garantierten Schutz können die Motoren mit integrierten. Temperaturfühler ausgestattet werden, die die Wicklung vor Überhitzung aufgrund einer unzureichenden Lüftung oder eines Aussetzbetriebs sichern. Ein solcher zusätzlicher Schutz sollte bei Motoren mit Fremdlüftung immer verwendet werden. Die verfügbaren Optionen sind:

M17- PROTECTIONS THERMIQUES

Outre la protection garantie par le thermocontact moteur, les moteurs peuvent être équipés de sondes thermiques incorporées pour protéger le bobinage contre une surchauffe excessive due à une faible ventilation ou un service intermittent.
Ce type de protection supplémentaire devrait toujours être prévue pour les moteurs dotés de ventilation séparée. Les variantes à disposition sont les suivantes :

D3



n° 3 sonde bimetalliche negli avvolgimenti con temperatura 150 °C
3 Bi-metallic thermostats in the windings, 150 °C temperature
3 Bimetallfühler in den Wicklungen mit einer Ansprechtemperatur von 150 °C
n° 3 sondes bimétalliques dans les bobinages avec température de 150 °C

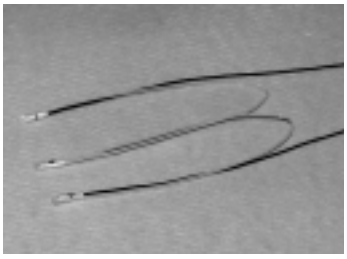
I protettori di questo tipo contengono all'interno di un involucro un disco bimetallico che, raggiunta la temperatura nominale di intervento, commuta i contatti dalla posizione di riposo.
Con la diminuzione della temperatura, il disco e i contatti riprendono automaticamente la posizione di riposo.
Normalmente si impiegano tre sonde bimetalliche in serie con contatti normalmente chiusi e terminali disponibili in una morsettiera ausiliaria.

Bimetallic thermostats consist of a bimetallic disc mounted inside a casing. Upon reaching the preset operating temperature, the disc operates the contacts causing them to disengage from the rest position.
As temperature decreases, disc and contacts return to the rest position.
Normally, three bimetallic thermostats connected in series with normally closed contacts and an auxiliary terminal board are used.

Diese Schutzeinrichtungen enthalten in einer Kaspel eine Bimetallscheibe, die bei Erreichen der Nennansprechtemperatur die Kontakte aus ihrer Ruhestellung heraus schaltet. Bei abnehmender Temperatur nehmen die Scheibe und die Kontakte automatisch wieder ihre Ruhestellung ein. Normalerweise werden diese drei Bimetallfühler bei normal geschlossenen Kontakten und auf einer Hilfsklemmenleiste verfügbaren Anschlüsse in Reihe geschaltet.

Les protecteurs de ce type contiennent, dans une enveloppe interne, un disque bimétallique qui, lorsque la température nominale d'intervention est atteinte, commute les contacts de la position de repos.
Avec la diminution de la température, le disque et les contacts reprennent automatiquement la position de repos.
Normalement, on utilise trois sondes bimétalliques en série avec contacts normalement fermés et extrémités disponibles dans une boîte à bornes auxiliaire.

E3



n° 3 termistori PTC negli avvolgimenti, con temperatura 150 °C
3 PTC thermistors in the windings, 150 °C temperature
3 PTC-Thermistoren in den Wicklungen mit einer Ansprechtemperatur 150 °C
3 thermistors PTC dans les bobinages, avec température de 150 °C

I termistori sono semiconduttori che presentano una rapida variazione di resistenza in prossimità della temperatura nominale d'intervento. In genere sono impiegati termistori a coefficiente di temperatura positivo, anche conosciuti con la sigla PTC.

Thermistors are semiconductors that exhibit a rapid resistance change when approaching a preset switch temperature. Normally, positive temperature coefficient (PTC) thermistors are used.

Bei diesen Thermistoren handelt es sich um Halbleiter, die eine schnelle Änderung des Widerstands kurz vor der Nennansprechtemperatur aufweisen. Im allgemeinen werden Thermistoren mit positivem Temperaturkoeffizienten verwendet, die auch unter der Bezeichnung PTC bekannt sind.

Les thermistors sont des semi-conducteurs qui présentent une variation rapide de résistance à proximité de la température nominale d'intervention. En général, on utilise des thermistors à coefficient de température positif, connus aussi sous le sigle PTC.

Questi sensori presentano il vantaggio di avere ingombri ridotti, un tempo di risposta molto contenuto e la totale assenza di usura. A differenza delle sonde termiche bimetalliche i termistori non possono comandare direttamente i relais e devono pertanto essere collegati ad una particolare apparecchiatura di sgancio.
I terminali di 3 PTC collegati in serie, sono disponibili in una morsettiera ausiliaria.

These sensors offer such advantages as a compact, space-efficient design, very low response time and totally wear-free operation.
Unlike bi-metallic thermostats, thermistors do not operate the relays directly and need to be connected to a special release device for this purpose.
The terminals for three PTC thermistors connected in series are available in an auxiliary terminal board.

Diese Sensoren haben den Vorteil kleiner Abmessungen, einer stark eingehaltenen Ansprechzeit und weisen keinerlei Verschleißerscheinungen auf.
Im Unterschied zu Bimetall-Temperaturfühlern können diese Thermistoren die Relais nicht direkt schalten und müssen daher an ein spezielles Auslösegerät angeschlossen werden.
Die Anschlüsse der 3 in Reihe geschalteten PTC-Thermistoren sind an einer Zusatzklemmleiste verfügbar.

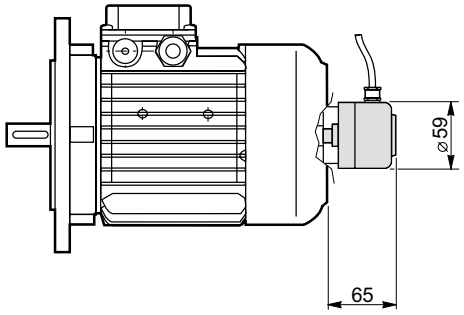
Ces capteurs présentent l'avantage d'être de dimensions réduites, leur temps de réponse est très limité et l'absence d'usure est totale.
A la différence des sondes thermiques bimétalliques, les thermistors ne peuvent pas commander directement les relais, par conséquent, ils doivent être branchés à un appareil de déclenchement particulier.
Les extrémités de 3 PTC reliés en série sont disponibles dans une boîte à bornes auxiliaire.

M18 - DISPOSITIVI DI RETROAZIONE

M18 - FEEDBACK UNITS

M18 - ENCODER / INKREMENTALGEBER

M18 - DISPOSITIFS DE RETROACTION



BN 71...BN 200

I motori possono essere dotati di tre diversi tipi di encoder, qui di seguito descritti.

Il montaggio dell'encoder esclude le esecuzioni con doppia estremità d'albero (PS) e tettuccio di protezione (RC, TC). Il dispositivo non è applicabile ai motori con freno tipo BA.

Motors may be combined with three different types of encoders to achieve feedback circuits.

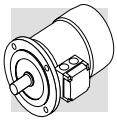
Configurations with double-extended shaft (PS) and rain canopy (RC, TC) are not compatible with encoder installation. Also not compatible are motors equipped with BA brakes.

Die Motoren mit drei unterschiedlichen Encodertypen ausgestattet werden.

Nachstehend finden Sie die entsprechenden Beschreibungen. Die Montage des Encoders schließt die Version mit zweitem Wellenende (PS) und Schutzdach (RC, TC) aus. Die Vorrichtung kann an Motoren mit Bremse vom Typ BA nicht angebaut werden.

Les moteurs peuvent être dotés de trois types de codeurs différents, décrits ci-après.

Le montage du codeur exclu les exécutions avec arbre à double extrémité (PS) et le capot de protection (RC, TC). Le dispositif n'est pas applicable aux moteurs avec frein type BA.



EN1

Encoder incrementale, V_{IN}= 5 V, uscita line-driver RS 422.

Incremental encoder, V_{IN}= 5 V, line-driver output RS 422.

Inkremental-Encoder, V_{IN}= 5 V, Ausgang "line-driver" RS 422.

Codeur incrémental, V_{IN}= 5 V, sortie line-driver RS 422.

EN2

Encoder incrementale, V_{IN}=10-30 V, uscita line driver RS 422.

Incremental encoder, V_{IN}= 10-30 V, line-driver output RS 422.

Inkremental-Encoder, V_{IN}=10-30 V, Ausgang "line-driver" RS 422.

Codeur incrémental, V_{IN}=10-30 V, sortie line-driver RS 422.

EN3

Encoder incrementale, V_{IN}=12-30 V, uscita push-pull 12-30 V.

Incremental encoder, V_{IN}= 12-30 V, push-pull output 12-30 V.

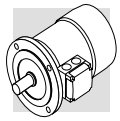
Inkremental-Encoder, V_{IN}=12-30 V, Ausgang "push-pull" 12-30 V.

Codeur incrémental, V_{IN}=12-30 V, sortie push-pull 12-30 V.

Tabella dati tecnici — ***Specifications*** — **Technische Daten** — ***Tableau des caractéristiques techniques***

(25)

		EN1	EN2	EN3
Interfaccia *Interface* Schnittstelle *Interface*		RS 422	RS 422	push-pull
Tensione alimentazione *Power supply voltage* Versorgungsspannung *Tension d'alimentation*	[V]	4...6	10...30	12...30
Tensione di uscita *Output voltage* Ausgangsspannung *Tension de sortie*	[V]	5	5	12...30
Corrente di esercizio senza carico *No-load operating current* Betriebsstrom ohne Belastung *Courant d'utilisation sans charge*	[mA]	120	100	100
N° impulsi per giro *No. of pulses per revolution* Impulse pro Drehung *Nobre d'impulsions par tour*		1024		
n° segnali *No. of signals* Signale *Nobre de signaux*		6 (A,B,C + Segnali invertiti / + *Inverted signals* Invertierte Signale / Signaux inversés)		
Max. frequenza di uscita *Max. output frequency* Max. Ausgangsfrequenz *Fréquence max. de sortie*	[kHz]	300	300	200
Max. velocità *Max. speed* Max. Drehzahl *Vitesse max.*	[min^{-1}]	6000 (9000 min^{-1} per 10 s) *6000 (9000 rpm for 10 s*) 6000 (9000 min^{-1} pour 10 s) *6000 (9000 min^{-1} für 10 Sek.)*		
Campo di temperatura *Temperature range* Temperaturbereich *Plage de température*	[°C]	-20 ... +70		
Grado di protezione *Protection class* Schutzgrad *Degré de protection*		IP 65		



M19 - RISCALDATORI ANTICONDENSA

I motori funzionanti in ambienti molto umidi e/o in presenza di forti escursioni termiche, possono essere equipaggiati con una resistenza anticondensa.
L'alimentazione monofase è prevista da morsettiera ausiliaria posta nella scatola principale.

M19 - ANTI-CONDENSATION HEATERS

Where an application involves high humidity or extreme temperature fluctuation, motors may be equipped with an anti-condensate heater. A single-phase power supply is available in the auxiliary terminal board inside the main terminal box.

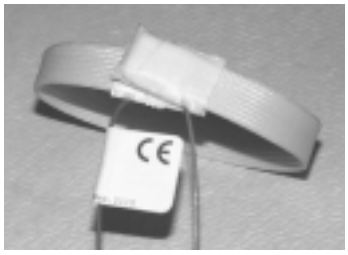
M19 - WICKLUNGSHEIZUNG

Die Motoren, die in besonders feuchten Umgebungen und/oder unter starken Temperaturschwankungen eingesetzt werden, können mit einem Heizelement als Kondenswasserschutz ausgestattet werden. Die einphasige Versorgung erfolgt über eine Zusatzklemmenleiste, die sich im Klemmenkasten befindet.

M19 - RECHAUFFEURS ANTICONDENSATION

Les moteurs fonctionnants dans des milieux très humides et/ou en présence de fortes plages thermiques peuvent être équipés d'une résistance anticondensation.
L'alimentation monophasée est prévue par l'intermédiaire d'une boîte à bornes auxiliaire située dans la boîte principale.

H1



	H1
	1~ 230V ± 10% **P [W]**
BN 56 … BN 80	10
BN 90 … BN 160MR	25
BN 160M … BN 180M	50
BN 180L … BN 200L	65

Durante il funzionamento del motore la resistenza anticondensa non deve mai essere alimentata.

Always remove power supply to the anti-condensate heater before operating the motor.

Während des Motorbetriebs darf die Wicklungsheizung nie gespeist werden.

Durant le fonctionnement du moteur, la résistance anticondensation ne doit jamais être alimentée.

M20 - TROPICALIZZAZIONE

TP

Su richiesta, mediante la specifica dell'opzione **TP**, gli avvolgimenti del motore ottengono una protezione aggiuntiva che li rende idonei al funzionamento in condizioni di elevata temperatura e umidità.

M20 - TROPICALIZATION

*When option **TP** is specified, motor windings receive additional protection for operation in high humidity and temperature conditions.*

M20 - TROPENSCHUTZ

Wird die Option **TP** bestellt, wird die Motorwicklung mit einem zusätzlichen Schutz ausgestattet, der ihren Einsatz unter hohen Temperaturen und starker Feuchtigkeit ermöglicht.

M20 - TROPICALISATION

*Sur demande, en spécifiant l'option **TP**, les bobinages du moteur obtiennent une protection supplémentaire qui les rend apte au fonctionnement dans des conditions de température et d'humidité élevées.*

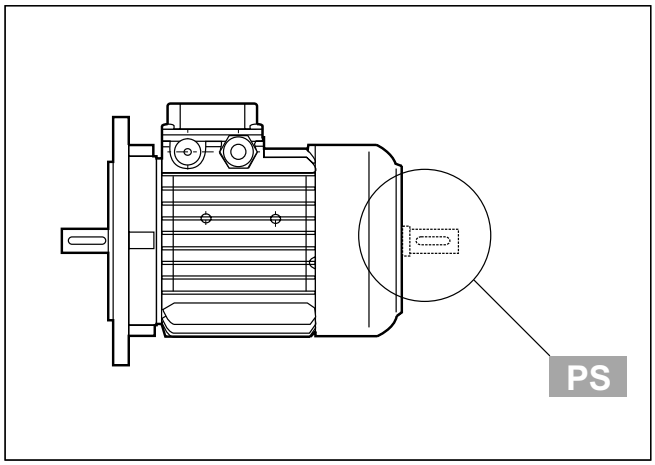
M21 - ESECUZIONI ALBERO

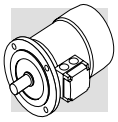
PS

M21 - ROTOR SHAFT CONFIGURATIONS

M21 - OPTIONEN DER ROTORWELLE

M21 - EXECUTIONS ARBRE ROTOR





Seconda estremità d'albero

L'opzione esclude le varianti RC, TC, U1, U2, EN1, EN2, EN3 – non applicabile ai motori con freno tipo BA.
Le dimensioni sono reperibili nelle tavole dimensionali dei motori.

Second shaft extension

This option is not compatible with variants RC, TC, U1, U2, EN1, EN2, EN3 – and is not feasible on motors equipped with BA brake.
For shaft dimensions please see motor dimensions tables.

Zweites Wellenende

Diese Option schließt die Optionen RC, TC, U1, U2, EN1, EN2, EN3 aus – sie kann nicht außerdem nicht an Motoren, die mit einer Bremse vom Typ BA ausgestattet sind, angebaut werden.
Die entsprechenden Maße können den Maßtabellen der Motoren entnommen werden.

Arbre à double extrémité

L'option exclut les variantes RC, TC, U1, U2, EN1, EN2, EN3 – non applicables aux moteurs avec frein type BA.
Les dimensions figurent sur les planches de dimensions des moteurs.

M22 - EQUILIBRATURA ROTORE

I motori sono equilibrati dinamicamente con mezza linguetta e rientrano nel grado di vibrazione **N**, secondo la Norma CEI EN 60034-14.

M22 - ROTOR BALANCING

*Motors are dynamically balanced with a half key and fall within vibration class **N** in accordance with standard CEI EN 60034-14.*

M22 - ROTORAUSWUCHTUNG

Die Motoren werden dynamisch durch das Einsetzen eines halben Federkeils ausgewuchtet und fallen der Norm CEI EN 60034-14 gemäß unter die Einstufung **N** des Schwingungsgrads.

M22 - *EQUILIBRAGE DU ROTOR*

*Les moteurs sont équilibrés du point de vue dynamique avec une demi-clavette et rentrent dans le degré de vibration **N**, selon la norme CEI EN 60034-14.*

RV

Per esigenze di particolare silenziosità è disponibile l'esecuzione opzionale **RV** che garantisce vibrazioni ridotte, secondo il grado **R**.
La tabella sottostante riporta i valori della velocità efficace di vibrazione per equilibratura normale (N) e in grado R.

*Where low noise is a priority requirement, the option **RV** ensures reduced vibration in accordance with vibration class **R**.*
The table below reports effective velocity of vibration for normal (N) and R grade balancing.

Sollte eine besondere Laufruhe gefordert werden, steht als Option **RV** eine Ausführung mit reduziertem Schwingverhalten nach Grad **R**, zur Verfügung.
Die folgende Tabelle gibt die Werte der effektive Schwingungen für das normale Auswuchten (N) und im Grad R an.

*En cas d'exigence particulière de faible niveau de bruit, l'exécution **RV** est disponible en option, elle garantit des vibrations réduites, de degré **R**.*
Le tableau ci-dessous indique les valeurs de la vitesse efficace de vibration pour un équilibrage normal (N) et en degré R.

(26)

Grado di vibrazione *Vibration class* Schwingungsklasse *Degrée de vibration*	Velocità di rotazione *Synchronous speed* Drehungsgeschwindikeit *Viitesse de rotation* n [min^{-1}]	Limiti della velocità di vibrazione *Limits of the vibration velocity* Grenzen der Schwingungsgeschwindikeit *Limites de la vitesse de vibration* (mm/s)	
		63 < H ≤ 132	**132 < H ≤ 200**
N	600 < n < 3600	1.8	2.8
R	600 < n < 1800	0.71	1.12
	1800 < n < 3600	1.12	1.8

I valori si riferiscono a misure con motore liberatamente sospeso e funzionamento a vuoto; tolleranza ±10%.

Values are obtained from measurements on freely suspended motor during no-load operation; tolerance ± 10%.

Diese Werte beziehen sich auf einem frei hängenden und sich im Leerbetrieb befindlichen Motor; Toleranz ± 10%.

Les valeurs se réfèrent à des mesures avec moteur librement suspendu et fonctionnement à vide, tolérance ± 10%.

M23 - PROTEZIONI MECCANICHE ESTERNE

M23 - EXTERNAL MECHANICAL PROTECTIONS

M23 - MECHANISCHE SCHUTZVORRICHTUNGEN

M23 - PROTECTIONS MECANIQUES EXTERIEURES

RC

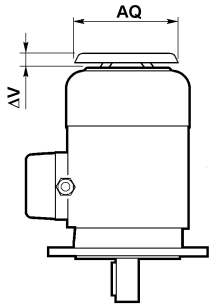
Il dispositivo parapioggia, che è raccomandato quando il motore è montato verticalmente con l'albero verso il basso, serve a proteggere il motore stesso dall'ingresso di corpi solidi e dallo stillicidio. Le dimensioni aggiuntive sono indicate nella tabella (27).
Il tettuccio esclude le varianti PS, EN1, EN2, EN3 e non è applicabile ai motori con freno tipo BA.

The rain canopy protects the motor from dripping and avoids the ingress of solid matter. It is recommended when motor is installed in a vertical position with the shaft pointing downwards.
Relevant dimensions are indicated in the table (27).
The rain canopy is not compatible with variants PS, EN1, EN2, EN3 and will not fit motors equipped with a BA brake.

Ein Regenschutzdach, dessen Montage empfohlen wird, wenn der Motor senkrecht mit einer nach unten gerichteten Welle montiert wird. Es dient dem Schutz des Motors vor dem Eindringen von festen Fremdkörpern und Tropfwasser. Die Dimensionen werden in der Tabelle (27) angegeben. Das Schutzdach schließt die Möglichkeit der Optionen PS, EN1, EN2, EN3 aus und kann bei Bremsmotoren vom Typ BN_BA nicht montiert werden.

Le capot de protection antipluie est recommandé lorsque le moteur est monté verticalement avec l'arbre vers le bas, il sert à protéger le moteur contre l'introduction de corps solides et le suintement. Les dimensions à ajouter sont indiquées dans le tableau (27).
Le capot antipluie exclue les variantes PS, EN1, EN2, EN3 et n'est pas applicable aux moteurs avec frein type BA.

(27)

	AQ	**∆ V**	
BN 63	118	24	
BN 71	134	27	
BN 80	134	25	
BN 90	168	30	
BN 100	168	28	
BN 112	211	32	
BN 132 ... BN 160MR	211	32	
BN 160M ... BN 180M	270	36	
BN 180L ... BN 200L	310	36	

TC

La variante del tettuccio tipo TC è da specificare quando il motore è installato in ambienti dell'industria tessile, dove sono presenti filamenti che potrebbero ostruire la griglia del copriventola, impedendo il regolare flusso dell'aria di raffreddamento.
L'opzione esclude le varianti EN1, EN2, EN3 e non è applicabile ai motori con freno tipo BA.

L'ingombro complessivo è lo stesso del tettuccio tipo RC.

Option TC is a rain canopy variant for textile industry environments, where lint may obstruct the fan grid and prevent a regular flow of cooling air.
This option is not compatible with variants EN1, EN2, EN3 and will not fit motors equipped with a BA brake.

Overall dimensions are the same as rain canopy type RC.

Bei dieser Option handelt es sich um ein Schutzdachs mit einem Textilnetz, dessen Einsatz empfohlen wird wenn der Motor in Bereichen der Textilindustrie installiert wird, in denen Stofffusseln das Lüfterradgitter verstopfen und so einen ausreichenden Kühlluftfluss verhindern könnten. Diese Option schließt die Möglichkeit der Optionen EN1, EN2, EN3 aus und kann bei Bremsemotoren vom Typ BN_BA nicht montiert werden.

Die Gesamtmaße entsprechen denen des Schutzdachs vom Typ RC.

La variante du capot type TC est à spécifier lorsque le moteur est installé dans des sites de l'industrie textile, où sont présents des filaments qui pourraient obstruer la grille du cache-ventilateur et empêcher le flux régulier de l'air de refroidissement. L'option exclue les variantes EN1, EN2, EN3 et n'est pas applicable aux moteurs avec frein type BA.

L'encombrement total est identique à celui du capot type RC.

M24 - MOTORI ASINCRONI AUTOFRENANTI

Funzionamento

L'esecuzione autofrenante prevede l'impiego di freni a pressione di molle alimentati in c.c. (tipo FD) o in c.a. (tipo FA, BA).
Tutti i freni funzionano secondo il principio di sicurezza, ossia intervengono in seguito alla pressione esercitata dalle molle, in mancanza di alimentazione.

M24 - ASYNCHRONOUS BRAKE MOTORS

Operation

Versions with incorporated brake use spring-applied DC (FD option) or AC (FA, BA options) brakes.
All brakes are designed to provide fail-safe operation, meaning that they are applied by spring-action in the event of power failure.

M24 - DREHSTROMBREMS-MOTOREN

Betriebsweise

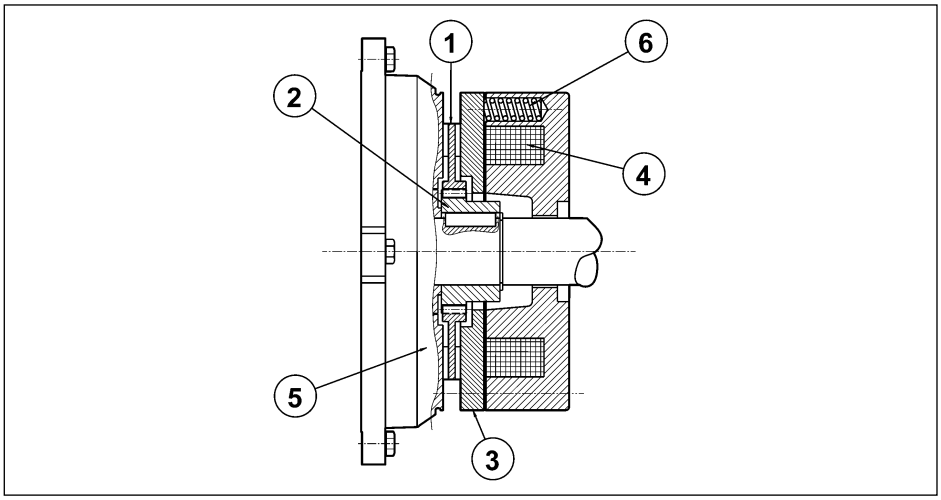
Die selbstbremsende Ausführung der Motoren sieht den Einsatz von Federdruckbremsen vor, die mit Gleichstrom (Typ FD) oder mit Wechselstrom (Typ FA, BA) gespeist werden. Alle Bremsen arbeiten gemäß dem Sicherheitsprinzip, d.h. sie greifen, im Fall eines Stromausfalls in Folge eines auf die Feder ausgeübten Drucks ein.

M24 - MOTEURS FREIN ASYNCHRONES

Fonctionnement

L'exécution avec frein prévoit l'utilisation de freins à pression de ressorts alimentés en c.c. (type FD) ou en c.a. (type FA, BA). Tous les freins fonctionnent selon le principe de sécurité, c'est-à-dire qu'ils interviennent suite à la pression exercée par les ressorts, en cas de coupure d'alimentation.

(28)



Legenda:
① disco
② mozzo
③ áncora mobile
④ bobina
⑤ scudo NDE motore
⑥ molle

Key:
① *brake disc*
② *disc carrier*
③ *pressure plate*
④ *brake coil*
⑤ *motor NDE shield*
⑥ *brake springs*

Zeichenerklärung:
① Brems scheibe
② Nabe
③ Bewgliher Anker
④ Ringspule
⑤ Motorschild
⑥ Schußfedern

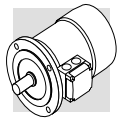
Légende:
① *disque*
② *moyeu d'entraînement*
③ *disque de freinage*
④ *flasque-frein*
⑤ *flasque arrière*
⑥ *ressort de frein*

In mancanza di tensione, l'ancora mobile spinta dalle molle di pressione blocca il disco freno tra la superficie dell'ancora stessa e lo scudo motore impedendo la rotazione dell'albero. Quando la bobina viene eccitata, l'attrazione magnetica esercitata sull'ancora mobile vince la reazione elastica delle molle e libera il disco freno, e conseguentemente l'albero motore con esso solidale.

When voltage is interrupted, pressure springs push the armature plate against the brake disc. The disc becomes trapped between the armature plate and motor shield and stops the shaft from rotation. When the coil is energized, a magnetic field strong enough to overcome spring action attracts the armature plate, so that the brake disc – which is integral with the motor shaft – is released.

Wenn die Spannungsversorgung abfällt, sorgt der bewegliche, von den Druckfedern geschobene Anker für die Blockierung der Bremsscheibe zwischen der Ankerfläche und dem Motorschild und blockiert damit den Rotor Wird die Spule erregt, kommt es durch den magnetischen auf den beweglichen Anker wirkenden Anzug zur Überwindung der elastischen Federkraft und zum Lösen der Bremsscheibe, wodurch der rotor wieder freigegeben wird.

En cas de coupure de courant, l'armature mobile, poussée par les ressorts, bloque le disque de frein entre la surface de l'armature et le bouclier moteur en empêchant la rotation de l'arbre. Lorsque la bobine est excitée, l'attraction magnétique exercée sur l'armature mobile annule la réaction élastique des ressorts et libère le disque de frein, et par conséquent l'arbre moteur, qui est solidaire.



Caratteristiche generali:

- Coppie frenanti elevate (generalmente $M_b \cong 2\ M_n$) e regolabili
- Disco freno con anima in acciaio a doppia guarnizione d'attrito (materiale a bassa usura, senza amianto)
- Cava esagonale sull'albero motore, lato ventola (N.D.E.), per rotazione manuale (non prevista quando sono presenti le opzioni PS, RC, TC, U1, U2, EN1, EN2, EN3)
- Sblocco meccanico manuale (opzioni **R** e **RM** per BN_FD, BN_FA).
- Trattamento anticorrosivo di tutte la superfici del freno
- Isolamento in classe F

Most significant features:

- *High braking torques (normally $M_b \cong 2\ M_n$) braking torque adjustment*
- *Steel brake disc with double friction lining (low-wear, asbestos-free lining)*
- *Hexagonal seat on motor shaft fan end (N.D.E.) for manual rotation (not compatible with options PS, RC, TC, U1, U2, EN1, EN2, EN3)*
- *Manual release lever (options **R** and **RM** for BN_FD, BN_FA).*
- *Corrosion-proof treatment on all brake surfaces*
- *Insulation class F*

Allgemeine Eigenschaften:

- Hohe und regulierbare Bremsmomente (allgemein $M_b \cong 2\ M_n$).
- Bremsscheibe mit Stahlkern und doppeltem Bremsbelag (Material mit geringem Verschleiß, asbestfrei).
- Sechskant hinten an der Motorwelle, auf Lüfterradseite (N.D.E.), für eine manuelle Drehung des Rotors mit einem Inbusschlüssel. (nicht lieferbar, wenn die Optionen PS, RC, TC, U1, U2, EN1, EN2, EN3) bestellt wurden.
- Manuell zu betätigende, mechanische Bremslüftvorrichtung (Optionen **R** und **RM** für BN_FD, BN_FA).
- Korrionsschutzbehandlung an allen Flächen der Bremse.
- Isolierung in Klasse F.

Caractéristiques générales:

- *Couples de freinage élevés (généralement $M_b \cong 2\ M_n$) et réglables.*
- *Disque de frein avec structure en acier à double garniture de frottement (matière à faible usure, sans amiante).*
- *Empreinte hexagonale sur l'arbre moteur, côté ventilateur (N.D.E.), pour la rotation manuelle (non prévue en cas de présence des options PS, RC, TC, U1, U2, EN1, EN2, EN3).*
- *Déblocage mécanique manuel (options **R** et **RM** pour BN_FD, BN_FA).*
- *Traitement anticorrosion sur toute la surface du frein.*
- *Isolation en classe F.*

M24.1 - LEVA SBLOCCO FRENO

I freni a pressione di molle tipo **FD** e **FA** possono essere dotati opzionalmente di dispositivi per lo sblocco manuale del freno, normalmente utilizzati per condurre interventi di manutenzione sulle parti di macchina, o dell'impianto, comandate dal motore.

M24.1 - BRAKE RELEASE SYSTEMS

*Spring-applied brakes type **FD** and **FA** may be equipped with optional manual release devices. These are typically used for manually releasing the brake before servicing any machine or plant parts operated by the motor.*

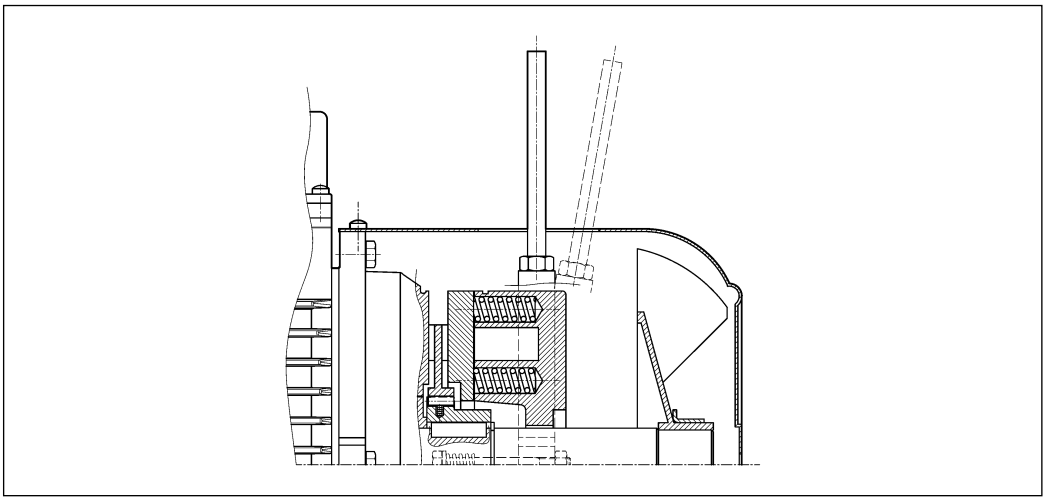
M24.1 - BREMSLÜFTHEBEL

Die Federdruckbremsen vom Typ **FD** und **FA** können Optional mit Bremslüfthebeln geliefert werden, die ein manuelles Lüften der Bremse ermöglichen. Diese Lüftungseinrichtungen können bei Instandhaltungsarbeiten an vom Motor betriebenen Maschinen- oder Anlagenteilen verwendet werden.

M24.1 - SYSTEMES DE DEBLOCAGE FREIN

*Les freins à pression de ressorts type **FD** et **FA** peuvent, en option, être dotés de dispositifs de déblocage manuel du frein, normalement utilisés pour effectuer des interventions d'entretien sur les composants de la machine, ou de l'installation commandée par le moteur.*

R



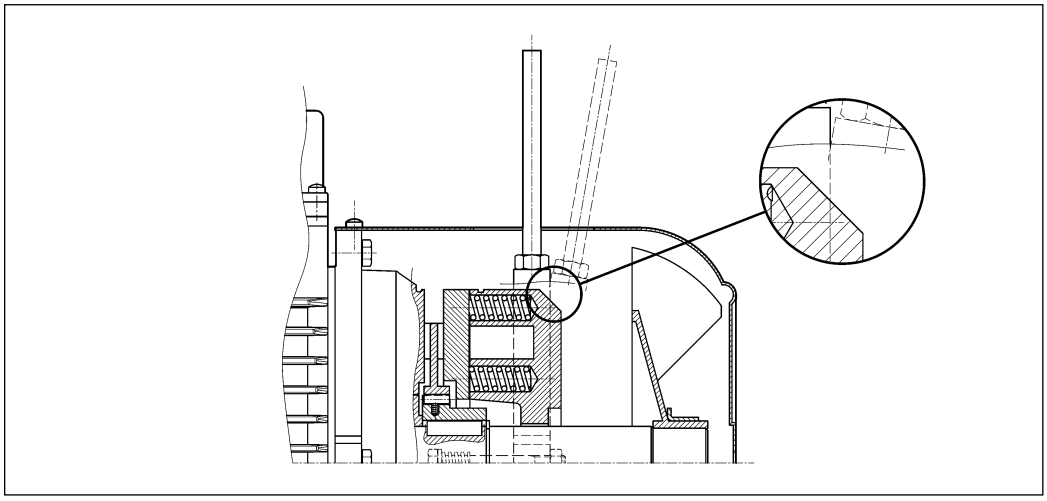
La leva di sblocco è dotata di ritorno automatico, tramite dispositivo a molla.

A return spring brings the release lever back in the original position.

Bremslüfthebel mit automatischer Rückstellung durch Federkraft.

Le levier de déblocage est doté de retour automatique, au moyen d'un dispositif à ressort.

RM



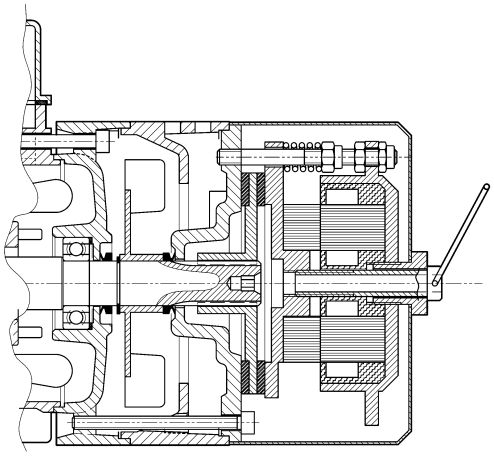
La leva di sblocco può essere temporaneamente bloccata in posizione di rilascio del freno, avvitando la stessa fino ad impegnarne l'estremità in un risalto del corpo del freno. La disponibilità dei sistemi di sblocco freno è diversa per i vari tipi di motore, ed è descritta dalla tabella seguente:

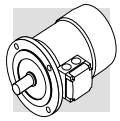
The release lever may be locked in the "release" position by tightening the lever until lever end becomes engaged with a brake housing projection. There are different brake release systems available for the various types of motors as indicated in the table below:

Der Bremslüfthebel kann zeitweise in der Bremslüftposition arretiert werden, indem man ihn so lange einschraubt, bis die Bremse arretiert ist. Für die unterschiedlichen Motortypen sind ebenso verschiedene Bremslüftsysteme verfügbar, die Sie der folgenden Tabelle entnehmen können:

Le levier de déblocage peut être temporairement bloqué en position de déblocage du frein en le vissant jusqu'à engager l'extrémité dans une saillie du corps du frein. La disponibilité des systèmes de déblocage du frein est différente en fonction des types de moteur et figure dans le tableau suivant :

(29)

	R	RM
BN_FD	63 ≤ H ≤ 200	63 ≤ H ≤ 160MR
BN_FA	63 ≤ H ≤ 132	⛔
BN_BA		di serie *std. supply* serienmäßig *de série*



Orientamento della leva di sblocco

Per entrambe le opzioni **R** e **RM**, la leva di sblocco del freno viene collocata, se non diversamente specificato, con orientamento di 90° in senso orario, rispetto alla posizione della morsettiera - riferimento [AB] nel disegno sottostante.
Orientamenti alternativi, tipo [**AA**], [**AC**] e [**AD**] possono essere richiesti citandone la relativa specifica:

Release lever orientation

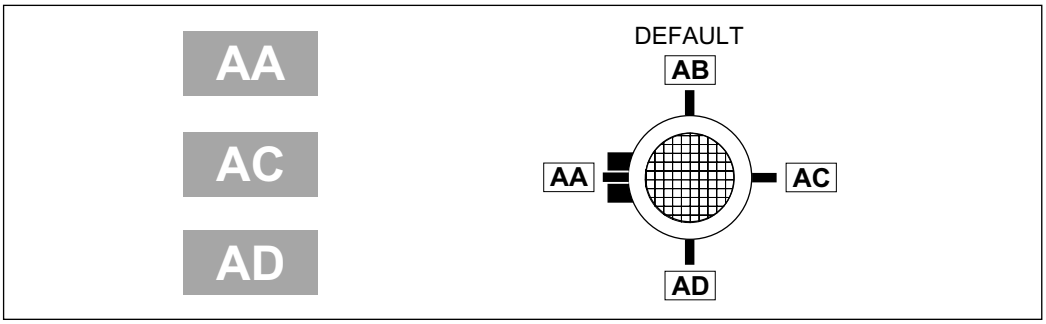
*Unless otherwise specified, the release lever is located 90° away from the terminal box – identified by letters [AB] in the diagram below – in a clockwise direction on both options **R** and **RM**.*
*Alternative lever positions [**AA**], [**AC**] and [**AD**] are also possible when the corresponding option is specified:*

Ausrichtung des Bremslüfthebels

Bei beiden Optionen, **R** und **RM**, wird der Bremslüfthebel, falls nicht anderweitig festgelegt, um 90° im Uhrzeigersinn zur Position des Klemmenkastens montiert (Position [AB] in der nachfolgenden Zeichnung).
Andere Positionen: **AA** (0° zum Klemmenkasten), **AC** (180° zum Klemmenkasten) oder **AD** (270° zum Klemmenkasten, im Uhrzeigersinn vom Lüfter aus gesehen) können unter Angabe der entsprechenden Spezifikation bestellt werden:

Orientation du levier de déblocage

*Pour les deux options **R** et **RM**, le levier de déblocage du frein est positionné, sauf spécification contraire, avec une orientation de 90° dans le sens des aiguilles d'une montre par rapport à la position de la boîte à bornes - référence [AB] sur le dessin ci-dessous.*
*Des orientations différentes, type [**AA**], [**AC**] et [**AD**] peuvent être demandées à condition de préciser la position correspondante :*



M24.2 - ALIMENTAZIONE SEPARATA DEL FRENO

M24.2 - SEPARATE BRAKE SUPPLY

M24.2 - BREMSE MIT SEPARATER SPANNUNGSVERSORGUNG

M24.2 - ALIMENTATION FREIN SEPAREE

...SA

La bobina del freno è alimentata da linea separata e indipendente dall'alimentazione del motore.
Il valore di tensione alla bobina deve essere specificato, es. 230SA.
L'opzione è applicabile ai motori con freno tipo FD, FA e BA.

The brake coil is directly fed through an independent line, separately from the motor.
In this case the rated voltage for the coil must be specified, e.g. 230SA.
The option is applicable to all motors with brake type FD, FA and BA.

Die Bremsspule wird, unabhaengig vom Motor, durch einen separaten Anschluss gespeist.
In diesem Fall muss Betriebsspannung fuer die spule spezifiziert werden, z.b. 230SA.
Die Option ist verfuegbar für alle Motoren mit Bremstyp FD, FA und BA.

La bobine du frein est alimentée par une ligne séparée et indépendante de l'alimentation du moteur.
La valeur de tension à la bobine doit être spécifiée, ex. 230SA.
L'option est applicable aux moteurs avec frein type FD, FA et BA.

...SD

La bobina del freno tipo FD è alimentata direttamente con corrente continua e l'alimentatore NON è fornito.
Il valore di tensione alla bobina deve essere specificato, es. 24SD.

The brake coil is directly fed with DC current and the rectifier is out of the scope for supply.
The rated voltage for the coil must be specified, e.g. 24SD.

Die Bremsspule wird direkt mit Gleichspannung gespeist. Der Gleichrichter ist nicht im Lieferimfang enthalten.
Die Betriebsspannung für die Spule muss spezifiziert werden, z.b. 24SD.

La bobine du frein type FD est alimentée directement avec courant continu et l'alimentateur n'est pas fourni.
La valeur de tension à la bobine doit être spécifiée, es. 24SD.

M24.3 - FREQUENZA MASSIMA D'AVVIAMENTO

Nelle tabelle dei dati tecnici, per ogni tipo di freno, è indicata la massima frequenza di inserzione a vuoto Z_0, con intermittenza I = 50%.
Questo valore definisce il nume-

M24.3 - MAXIMUM STARTS PER HOUR

For all types of Brakes the rating charts reports the maximum number of starts per hour under no-load conditions Z_o with cyclic duration factor I = 50 % .
This parameter gives the num-

M24.3 - MAX. SCHALTHÄUFIGKEIT

In den Tabellen, in denen die technischen Daten enthalten sind, wird für jeden Bremstyp die maximal Schalthäufigkeit im Leerbetrieb Z_o mit einer Einschaltdauer I = 50 % angege-

M24.3 - FREQUENCE MAXIMUM DE DEMARRAGE

Les tableaux des caractéristiques techniques indiquent, pour chaque type de frein, la fréquence maximum d'enclenchement à vide Z_o, avec intermittence I = 50 %. Cette valeur dé-

ro di avviamenti orari a vuoto che il motore può sopportare senza superare la temperatura ammessa dalla classe di isolamento F.
Nel caso pratico di motore accoppiato ad un carico esterno con potenza assorbita P_r, massa inerziale J_c e coppia resistente media durante l'avviamento M_L, il numero di avviamenti ammissibile si può calcolare con la seguente formula:

ber of starts per hour under no-load conditions a motor can withstand without exceeding the temperature limit permitted for insulation class F.
Assuming an application involving an overhung load applied to the motor with absorbed power P_r, inertial mass J_C and starting mean load torque M_L, the number of starts allowed is calculated by the following formula:

ben. Dieser Wert legt die Anzahl der Schaltungen im Leerbetrieb pro Stunde fest, denen der Motor standhalten kann, ohne dabei die von der Isolierstoffklasse F zulässige Temperatur zu überschreiten. Im praktischen Fall eines an eine externe Last gekoppelten Motors mit einer Leistungsaufnahme P_r, Trägheitsmasse J_C und einem durchschnittlichen Gegendrehmoment während des Anlaufs M_L, kann die Anzahl der zulässigen Schaltungen anhand der nachstehenden Formel berechnet werden:

finit le nombre de démarrages horaires à vide que le moteur peut supporter sans dépasser la température admise par la classe d'isolation F.
Dans le cas pratique d'un moteur accouplé à une charge extérieure avec puissance absorbée P_r, masse inertielle J_C et couple résistant moyen durant le démarrage M_L, il est possible de calculer le nombre de démarrages admissibles avec la formule suivante :

$$Z = \frac{Z_0 \; K_c \; K_d}{K_J}$$

dove:

$K_J = \frac{J_m + J_c}{J_m}$ = fattore di inerzia

$K_c = \frac{M_a - M_L}{M_a}$ = fattore di coppia

K_d fattore di carico vedi tabella:

where

$K_J = \frac{J_m + J_c}{J_m}$ = *inertia factor*

$K_c = \frac{M_a - M_L}{M_a}$ = *torque factor*

K_d = *load factor see table:*

wobei gilt:

$K_J = \frac{J_m + J_c}{J_m}$ = Trägheitsfaktor

$K_c = \frac{M_a - M_L}{M_a}$ = Drehmomentsfaktor

K_d = Lastfaktor siehe Tabelle:

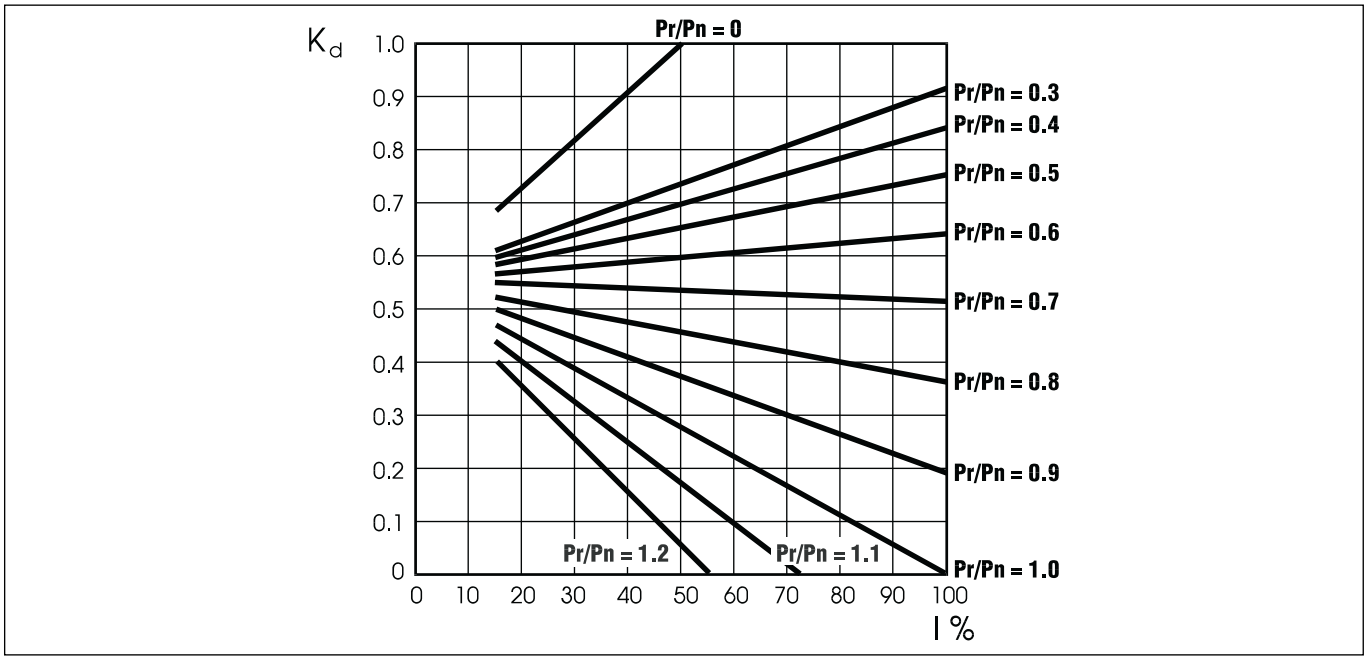
où

$K_J = \frac{J_m + J_c}{J_m}$ = *facteur d'inertie*

$K_c = \frac{M_a - M_L}{M_a}$ = *facteur de couple*

K_d = *facteur de charge voir tableau*

(30)



Con il numero di avviamenti così ottenuto si dovrà in seguito verificare che il massimo lavoro di frenatura sia compatibile con la capacità termica del freno W_{max}.

The resulting number of starts must be double-checked against maximum braking effort, which must be compatible with brake thermal capacity W_{max}.

Auf Grundlage der berechneten Anzahl der Schaltungen muss man prüfen, ob die maximale Bremsleistung mit der angegebenen thermischen Leistung der Bremse W_{max} übereinstimmt.

Avec le nombre de démarrages ainsi obtenu, il est ensuite nécessaire de vérifier que l'action maximum de freinage est compatible avec la capacité thermique du frein W_{max}.

M24.4 - AVVIAMENTO PROGRESSIVO

M24.4 - SOFT-START / STOP

M24.4 - SANFTANLAUF / STOP

M24.4 - DEMARRAGE/ARRET PROGRESSIF

F1

Per applicazioni che richiedono progressività nelle fasi di avvio e di arresto è disponibile un volano – opzione **F1** – la cui inerzia aggiuntiva assorbe energia cinetica durante l'avviamento e la restituisce in frenatura, rendendo i transitori più progressivi e graduali.
Il volano è disponibile per i motori autofrenanti del tipo BN_FD, con caratteristiche specifiche dettagliate nella tabella che segue:

*An optional flywheel – option **F1** – is available for applications requiring soft starting or stopping. The flywheel's added inertia uses up kinetic energy during starting and returns it back during braking, thus catering for more progressive and gradual shock loads.*
The optional flywheel is available for brake motors type BN_FD, with specific characteristics as detailed in the table below:

Für Anwendungen, bei denen einer sanfte Anlauf- und Stop erforderlich ist, steht als – Option **F1** – ein Schwungrad zur Verfügung, dessen zusätzliches Trägheitsmoment während der Anlaufphase kinetische Energie aufnimmt, die in der Abbremsphase wieder abgegeben wird. Dadurch erfolgen die Übergangsphasen progressiver und sanfter. Das Schwungrad ist für die Bremsmotoren vom Typ BN_FD in den nachstehend aufgeführten spezifischen Details verfügbar:

*Pour les applications nécessitant une progressivité au cours des phases de démarrage et d'arrêt, un volant – option **F1** – est disponible ; son inertie supplémentaire absorbe l'énergie cinétique durant le démarrage et la restitue au moment du freinage, rendant ainsi les phases transitoires plus progressives et graduelles: Le volant est disponible pour les moteurs frein du type BN_FD, ses caractéristiques spécifiques détaillées sont indiquées dans le tableau suivant :*

(31)

Volano per avviamento progressivo / *Flywheel for soft starting* / Schwungräder für Sanftanlauf *Volant pour demarrage/arret progressif*		
BN_FD	Peso del volano *Flywheel weight* Gewicht Schwungrad *Poids du volant* [Kg]	Inerzia volano *Flywheel inertia* Trägheitsmoment des Schwungrad *Inertie du volant* J_v [Kg m^2]
BN 63	0.69	0.00063
BN 71	1.13	0.00135
BN 80	1.67	0.00270
BN 90	2.51	0.00530
BN 100	3.48	0.00840
BN 112	4.82	0.01483
BN 132	6.19	0.02580

Per le esigenze di particolari applicazioni, ad es. traslazioni, che richiedano regolazioni micrometriche della coppia frenante è disponibile una serie di motori autofrenanti, denominata BN_FM, dettagliata nel catalogo cod. 1134 R1, sviluppato per le motorizzazioni dei carriponte. Consultare per questo il Servizio Tecnico Bonfiglioli.

For special applications that require a fine adjustment of braking torque, as is the case with track drives, a specific brake motor type BN_FM is available. This type of product has been developed for bridge crane drives and is described in detail in catalogue no. 1134 R1. Please contact Bonfiglioli Engineering for more details.

Für besondere Anwendungen, z.B. Transfers, die fein abgestufte Einstellungen des Bremsmoments erfordern, ist eine Reihe an Bremsmotoren verfügbar (BN_FM) und die detailliert im Katalog Art.-Nr. 1134 R1 beschrieben werden. Dieser Katalog ist für die Antriebe von Laufkränen entwickelt wurde. Wenden Sie sich diesbezüglich bitte an unseren Technischen Kundendienst.

En cas d'exigences d'applications particulières, par ex. translations, qui nécessitent des réglages micrométriques du couple de freinage, une série de moteurs frein est disponible, dénommée BN_FM, détaillée dans le catalogue réf. 1134 R1, conçue pour les motorisations des ponts roulants. Dans ce cas, consulter le Service Bonfiglioli.

M24.5 - FILTRO CAPACITIVO

M24.5 - CAPACITIVE FILTER

M24.5 - KAPAZITIVER FILTER

M24.5 - FILTRE CAPACITIF

CF

Per i soli motori autofrenanti in corrente continua, tipo BN_FD, è disponibile in opzione il filtro capacitivo. Se corredati dell'opportuno filtro capacitivo a monte del raddrizzatore (opzione CF) i motori rientrano nelimiti di emissione previsti dalla Norma EN 50081-1 "Compatibilità elettromagnetica - Norma Generica sull'emissione – Parte 1: Ambienti residenziali, commerciali e dell'industria leggera".

An optional capacitive filter is available for DC brake motors type BN_FD only.
When the suitable capacitive filter is installed upstream of the rectifier (option CF), motors comply with the emission limits required by standard EN 50081-1 "Electromagnetic Compatibility – Generic Emission Standard – Part 1: Residential, commercial and light industrial environment".

Nur bei den Bremsmotoren mit Gleichstrombremse vom Typ BN_FD, ist die Option eines kapazitiven Filters vorgesehen. Wird dieser Filter vor dem Gleichrichter (Option CF) installiert, fallen die Motoren in die von der Norm EN 50081-1 "Elektromagnetische Kompatibilität – Allgemeine Norm zur Emission – Teil 1: Wohngebiete, Handels- und Leichtindustriezonen " vorgesehenen Emissionsgrenzen.

Un filtre capacitif en option est disponible uniquement pour les moteurs frein en courant continu type BN_FD. S'ils sont équipés du filtre capacitif approprié en amont du redresseur (option CF), les moteurs rentrent dans les limites d'émission prévues par la Norme EN 50081-1 "Compatibilité électromagnétique - Norme Générique sur l'émission – Partie 1: Milieux résidentiels, commerciaux et de l'industrie légère".

M25 - MOTORI AUTOFRENANTI IN C.C.,TIPO BN_ FD

M25 - DC BRAKE MOTORS TYPE BN_ FD

M25 - WECHSELSTROMBREMS-MOTOREN MIT G.S.– BREMSE TYP BN_ FD

M25 - MOTEURS FREIN EN C.C.,TYPE BN_ FD

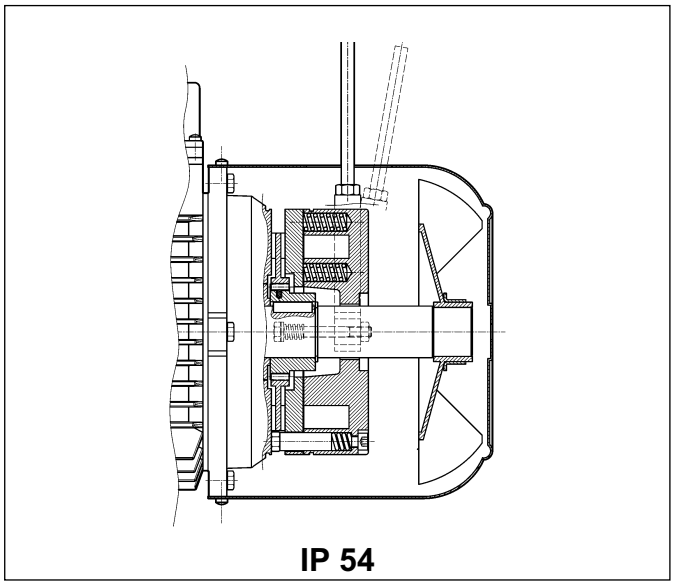
- Grandezze: BN 63 ... BN200L

***- Frame sizes**: BN 63 ... BN200L*

- Baugrößen: BN 63 ... BN 200L

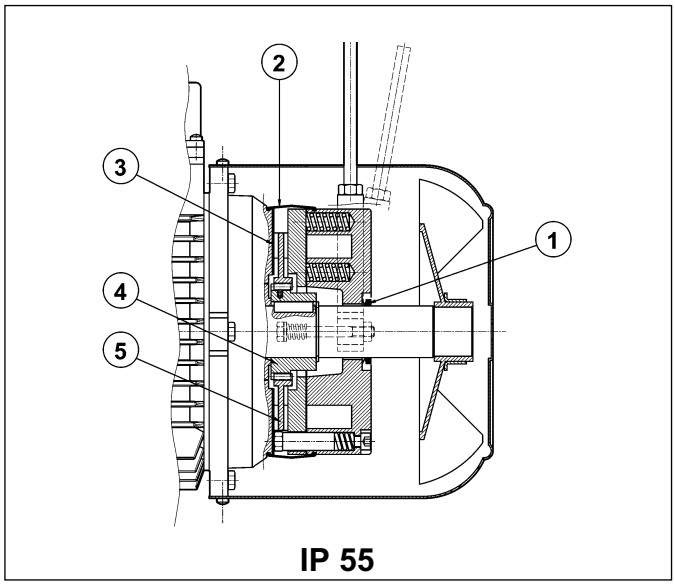
***- Tailles** : BN 63 ... BN200L*

(32)



IP 54

(33)



IP 55

Freno elettromagnetico con bobina toroidale in corrente continua fissato con viti allo scudo motore; le molle di precarico realizzano il posizionamento assiale del corpo magnete. Il disco freno è scorrevole sul mozzo trascinatore in acciaio calettato sull'albero e previsto di molla antivibrazione. I motori sono forniti con freno tarato in fabbrica al valore di coppia riportato nelle tabelle dati tecnici; la coppia frenante può essere regolata modificando il tipo e/o il numero delle molle. A richiesta, i motori possono essere previsti di leva per lo sblocco manuale con ritorno automatico (**R**) o con mantenimento della posizione di rilascio freno (**RM**); per la posizione angolare della leva di sblocco vedi descrizione della relativa variante alla pag. 32. Il freno FD garantisce elevate prestazioni dinamiche e bassa rumorosità; le caratteristiche d'intervento del freno in corrente continua possono essere ottimizzate in funzione dell'applicazione, utilizzando i vari tipi di alimentatore disponibili e/o realizzando l'opportuno cablaggio.

Direct current toroidal-coil electromagnetic brake bolted onto motor shield. Preloading springs provide axial positioning of magnet body.
Brake disc slides axially on steel hub shrunk onto motor shaft with anti-vibration spring.
Brake torque factory setting is indicated in the corresponding motor rating charts. Braking torque may be modified by changing the type and/or number of springs.
*At request, motors may be equipped with manual release lever with automatic return (**R**) or system for holding brake in the released position (**RM**).*
See variant at page 32 for available release lever locations.
FD brakes ensure excellent dynamic performance with low noise. DC brake operating characteristics may be optimized to meet application requirements by choosing from the various rectifier/power supply and wiring connection options available.

Elektromagnetische Bremse mit Ringwicklungsspule für Gleichstromspannung, die mittels Schrauben am hinteren Motorschild befestigt ist. Die Federn sorgen für die axiale Ausrichtung des Magnetkörpers. Die Bremsscheibe gleitet axial auf der Mitnehmernabe aus Stahl, die über eine Paßfeder mit der Motorwelle verbunden und mit einer Schwingungsdämpfung ausgestattet ist. Die Motoren werden vom Hersteller auf den in der Tabelle der technischen Daten angegebenen Bremsmoment eingestellt; das Bremsmoment kann durch das Ändern des Typs und/oder der Anzahl der Federn reguliert werden. Auf Anfrage können die Motoren mit einem Bremslüfthebel für die manuelle Lüftung der Bremse mit selbstständiger Rückstellung (**R**) ohne Arretierung oder mit arretierbarem Lüfterhebel (**RM**) geliefert werden. Die Fesstlegung der Position des Bremslüfthebel in Abhängigkeit von der Klemmkastenlage erfolgt durch die Option auf Seite 32.
Die Bremse vom Typ FD garantiert hohe dynamische Leistungen und niedrige Laufgeräusche. Die Ansprecheigenschaften der Bremse unter Gleichstrom können in Abhängigkeit zur jeweiligen Anwendung durch den Einsatz der verschiedenen verfügbaren Gleichrichter oder durch eine entsprechenden Anschluß der Bremse optimiert werden.

*Frein électromagnétique avec bobine toroïdale en courant continu, fixé avec des vis au bouclier moteur ; les ressorts de précharge réalisent le positionnement axial de la bobine. Le disque frein coulisse de façon axiale sur le moyeu d'entraînement en acier calé sur l'arbre et doté de ressort antivibration. Les moteurs sont fournis avec frein préréglé en usine à la valeur de couple indiquée dans les tableaux des caractéristiques techniques ; le couple de freinage peut être réglé en modifiant le type et/ou le nombre de ressorts. Sur demande, les moteurs peuvent être équipés de levier pour le déblocage manuel avec retour automatique (**R**) ou avec maintien de la position de déblocage frein (**RM**); pour la position angulaire du levier de déblocage, voir description de la variante correspondante à la page 32.*
Le frein FD garantit des performances dynamiques élevées et un faible niveau de bruit ; les caractéristiques d'intervention du frein en courant continu peuvent être optimisées en fonction de l'application en utilisant les différents types de dispositifs d'alimentation disponibles et/ou en réalisant un câblage approprié.

- Grado di protezione

L'esecuzione standard prevede il grado di protezione IP54.
In opzione il motore autofrenante tipo FD viene fornito con grado di protezione **IP 55**, prevedendo le seguenti varianti costruttive:

① anello V-ring posizionato sull'albero motore N.D.E.
② fascia di protezione in gomma
③ anello in acciaio inox interposto tra scudo motore e disco freno
④ mozzo trascinatore in acciaio inox
⑤ disco freno in acciaio inox

- Degree of protection

Standard protection is IP54.
*Brake motor FD is also available in protection **IP 55**, which mandates the following variants:*

① *V-ring at N.D.E. of motor shaft*
② *dust and water-proof rubber boot*
③ *stainless steel ring placed between motor shield and brake disc*
④ *stainless steel hub*
⑤ *stainless steel brake disc*

- Schutzart

Die Standardausführung ist Schutzart IP54 vor.
Optional kann der Bremsmotor vom Typ FD in der Schutzart **IP 55** geliefert werden, wobei sind folgende Komponenten eingesetzt werden:

① V-Ring an der Motorwelle N.D.E.
② Schutzring aus Gummi
③ Ring aus rostfreiem Stah zwischen Motorschild und Bremsscheibe
④ Mitnehmernabe aus rostfreiem Stahl
⑤ Bremsscheibe aus rostfreiem ahl

- Degré de protection

L'exécution standard prévoit le degré de protection IP54.
En option, le moteur frein type FD est fourni avec degré de protection IP 55, en prévoyant les variantes de construction suivantes :

① *bague V-ring positionnées sur l'arbre moteur N.D.E.*
② *bande de protection en caotchouc*
③ *bague en acier inox interposée entre le bouclier moteur et le disque de frein*
④ *moyeu d'entraînement en acier inox*
⑤ *disque frein en acier inox*

- Alimentazione freno FD

L'alimentazione della bobina freno in c.c. è prevista per mezzo di opportuno raddrizzatore montato all'interno della scatola coprimorsetti e già cablato alla bobina del freno.
Per motori a singola polarità è inoltre previsto di serie il collegamento del raddrizzatore alla morsettiera motore.
Indipendentemente dalla frequenza di rete, la tensione standard di alimentazione del raddrizzatore V_B ha il valore indicato nella tabella qui di seguito:

- FD brake power supply

A rectifier accommodated inside the terminal box feeds the DC brake coil. Wiring- connection across rectifier and brake coil is performed at the factory.
On all single-pole motors, rectifier is connected to the motor terminal board.
Rectifier standard power supply voltage V_B is as indicated in the following table, regardless of mains frequency:

- Spannungsversorgung der Bremse FD

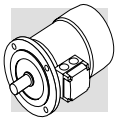
Die Versorgung der Gleichstrombremsspule erfolgt über einen Gleichrichter im Klemmenkasten der bei Lieferung, wenn nicht anders bestellt, bereits mit der Bremsspule verkabelt ist.
Bei den einpoligen Motoren ist serienmäßig der Anschluss des Gleichrichters an die Motorsspannung vorgesehen. Unabhängig von der Netzfrequenz erfolgt die Versorgung des Gleichrichters V_B über die in der nachstehenden Tabelle angegebenen Standardspannung:

- Alimentation frein FD

L'alimentation de la bobine de frein en c.c. est prévue au moyen d'un redresseur approprié monté à l'intérieur de la boîte à bornes et déjà câblé à la bobine de frein.
De plus, pour les moteurs à simple polarité, le raccordement du redresseur au bornier moteur est prévu de série.
Indépendamment de la fréquence du réseau, la tension standard d'alimentation du redresseur V_B correspond à la valeur indiquée dans le tableau ci-dessous :

(34)

2, 4, 6 P				**1 speed**
	BN_FD V_{mot} ± 10% 3 ~	V_B ± 10% 1 ~	alimentazione freno da morsettiera *brake connected to terminal board power supply* Bremsversorgung über die Motorspannung *Alimentation frein depuis boîte à bornes*	alimentazione separata *separate power supply* Separate Versorgung *Alimentation séparée*
BN 63…BN 132	230/400 V – 50 Hz	230 V	standard	specificare **V_B SA** o **V_B SD** *specify **V_B SA** or **V_B SD*** **V_B SA** oder **V_B SD** angeben *spécifier **V_B SA** ou **V_B SD***
BN 160…BN 200	400/690 V – 50 Hz	400 V	standard	specificare **V_B SA** o **V_B SD** *specify **V_B SA** or **V_B SD*** **V_B SA** oder **V_B SD** angeben *spécifier **V_B SA** ou **V_B SD***



Per i motori a doppia polarità l'alimentazione standard del freno è da linea separata con tensione d'ingresso al raddrizzatore V_B come indicato in tabella:

Switch-pole motors feature a separate power supply line for the brake with rectifier input voltage V_B as indicated in the table:

Die polumschaltbaren Motoren müssen immer mit separater Bremsversorgungsspannung betrieben werden, deshalb erfolgt die Lieferung standardmäßig ohne Anschluß der Bremse an die Motorspannung, da diese mit einer am Eingang des Gleichrichters V_B anliegenden Spannung versorgt werden muß, entsprechend Werte in der nachstehenden Tabelle:

Pour les moteurs à double polarité, l'alimentation standard du frein dérive d'une ligne séparée avec tension d'entrée aredresseur V_B comme indiqué dans le tableau :

(35)

2/4, 2/6, 2/8, 2/12, 4/6, 4/8 P				**2 speed**
	BN_FD		alimentazione freno da morsettiera *brake powered via terminal board* Bremsversorgung über die Motorspannung *Alimentation frein depuis boîte à bornes*	alimentazione separata *separate power supply* Separate Versorging *Alimentation séparée*
	V_{mot} ± 10% 3 ~	V_B ± 10% 1 ~		
BN 63…BN 132	400 V – 50 Hz	230 V	⛔	specificare **V_B SA** o **V_B SD** *specify **V_B SA** or **V_B SD*** **V_B SA** oder **V_B SD** angeben *spécifier **V_B SA** ou **V_B SD***

Il raddrizzatore è del tipo a diodi a semionda (Vc.c ≈ 0,45 x Vc.a.) ed è disponibile nelle versioni **NB**, **SB**, **NBR** e **SBR**, come dettagliato nella tabella seguente:

*The diode half-wave rectifier (VDC ≈ 0,45 x VAC) is available in versions **NB**, **SB**, **NBR** e **SBR**, as detailed in the table below:*

Bei dem Gleichrichter handelt es sich um einen Typ mit Halbwellendioden (Vc.c ≈ 0,45 Vc.a.). Er ist in den Versionen **NB**, **SB**, **NBR** und **SBR**, gemäß den Details in der nachstehenden Tabelle, verfügbar:

*Le redresseur est du type à diodes à demi-onde (Vc.c ≈ 0,45 x Vc.a.) et il est disponible dans les versions **NB**, **SB**, **NBR** et **SBR**, comme indiqué de façon détaillée dans le tableau suivant :*

(36)

	Freno *Brake* Bremse Ffrein	**Raddrizzatore** ***Rectifier*** **Gleichrichter** ***Redresseur***	
		standard	A richiesta At request Auf Anfrage *Sur demande*
BN 63	FD 02	**NB**	**SB, SBR, NBR**
BN 71	FD 03 FD 53		
BN 80	FD 04		
BN 90S	FD 14		
BN 90L	FD 05		
BN 100	FD 15		
BN 112	FD 06S	**SB**	**SBR**
BN 132 - 160MR	FD 56 FD 06 FD 07		
BN 160L - BN 180M	FD 08		
BN 180L - BN 200M	FD 09		

Il raddrizzatore **SB** a controllo elettronico dell'eccitazione, riduce i tempi di sblocco del freno sovreccitando l'elettromagnete nei primi istanti d'inserzione, per passare poi al normale funzionamento a semionda a distacco del freno avvenuto.

*Rectifier **SB** with electronic energizing control over-energizes the electromagnet upon power-up to cut brake release response time and then switches to normal half-wave operation once the brake has been released.*

Der Gleichrichter **SB** mit elektronischer Kontrolle der Erregung reduziert die Bremslösezeiten, indem er die Bremsspule in den ersten Momenten der Einschaltung übermäig erregt, um dann, nach erfolgter Bremslösung, in die normale Halbwellenfunktion umzuschalten.

*Le redresseur **SB** à contrôle électronique de l'excitation réduit les temps de déblocage du frein en surexcitant l'électro-aimant durant les premiers instants d'enclenchement pour passer ensuite au fonctionnement normal à demi-onde une fois le frein désactivé.*

L'impiego del raddrizzatore tipo **SB** è sempre da prevedere nei casi di:

- elevato numero di interventi orari
- tempi di sblocco freno ridotti
- elevate sollecitazioni termiche del freno.

Per applicazioni dove è richiesto un rapido rilascio del freno sono disponibili a richiesta i raddrizzatori **NBR** o **SBR**.
Questi raddrizzatori completano i tipi **NB** e **SB**, integrando nel circuito elettronico un interruttore statico che interviene diseccitando rapidamente il freno in caso di mancanza di tensione.
Questa soluzione consente di ridurre i tempi di rilascio del freno evitando ulteriori cablaggi e contatti esterni.
Per il migliore utilizzo dei raddrizzatori **NBR** e **SBR** è richiesta l'alimentazione separata del freno.
Tensioni disponibili: 230V ± 10%, 400V ± 10%, 50/60 Hz.

*Use of the **SB** rectifier is mandatory in the event of:*

- *high number of operations per hour*
- *reduced brake release response time*
- *brake is exposed to extreme thermal stress.*

*Rectifiers **NBR** or **SBR** are available for applications requiring quick brake release response.*
*These rectifiers complement the **NB** and **SB** types as their electronic circuit incorporates a static switch that de-energizes the brake quickly in the event voltage is missing.*
This arrangement ensures short brake release response time with no need for additional external wiring and contacts.
*Optimum performance of rectifiers **NBR** and **SBR** is achieved with separate brake power supply.*
Available voltages: 230V ± 10%, 400V ± 10%, 50/60 Hz.

Der Einsatz eines Gleichrichters vom Typ **SB** wird in folgenden Fällen empfohlen:

- hohe Anzahl von Schaltungen pro Stunde
- schnelle Bremsansprechzeiten
- starke thermische Beanspruchungen der Bremse.

Für die Anwendungen, bei denen eine schnelle Ansprechzeit der Bremse gefordert wird, können auf Anfrage die Gleichrichter **NBR** oder **SBR** geliefert werden. Diese Gleichrichter erweitern die Funktion der Typen **NB** und **SB**, indem in dem elektronischen Schaltkreis ein statischen Schalter integriert ist, durch dessen Auslösen die Bremse im Fall eines Spannungsausfalls schnell abgeregt wird. Diese Lösung ermöglicht eine Verringerung der Ansprechzeiten der Bremse, wodurch weitere Schaltungen und externe Sensoren vermieden werden können. Im Hinblick auf einen besseren Einsatz der Gleichrichter **NBR** und **SBR** ist bei der Bremse eine separate Versorgung erforderlich.
Verfügbare Spannungen: 230V ± 10%, 400V ± 10%, 50/60 Hz.

*L'utilisation du redresseur type **SB** doit toujours être prévue dans les cas suivants:*

- *nombre d'interventions horaires élevé*
- *temps de déblocage frein réduits*
- *sollicitations thermiques du frein élevées.*

*Pour les applications nécessitant un déblocage rapide du frein, sur demande les redresseurs **NBR** ou **SBR** sont disponibles.*
*Ces redresseurs complètent les types **NB** et **SB**, en intégrant dans le circuit électronique un interrupteur statique qui intervient en désexcitant rapidement le frein en cas de coupure de tension.*
Cette solution permet de réduire les temps de déblocage du frein en évitant d'autres câblages et contacts extérieurs.
*Pour une meilleure utilisation des redresseurs **NBR** et **SBR** l'alimentation séparée du frein est nécessaire.*
Tensions disponibles : 230V ± 10%, 400V ± 10%, 50/60 Hz.

- Dati tecnici freni FD

Nella tabella sottostante sono riportati i dati tecnici dei freni in c.c. tipo FD.

- FD brake technical specifications

The table below reports the technical specifications of DC brakes FD.

- Technische Daten - Bremstyp FD

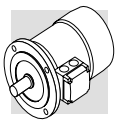
In der nachstehenden Tabelle werden die technischen Daten der Gleichstrombremsen vom Typ FD angegeben.

- Caractéristiques techniques freins FD

Le tableau suivant indique les caractéristiques techniques des freins en c.c. type FD.

(37)

Freno *Brake* Bremse *Frein*	Coppia frenante M_b *Brake torque M_b* Bremsmoment M_b *Couple de freinage M_b* [Nm] n° molle / *no. of springs* Feder / *ressorts*			Rilascio *Release* Ansprechzeit *Déblocage*		Frenatura *Braking* Bremszeit *Freinage*		Wmax per frenata *Wmax per brake operation* Wmax pro Bremsung *Wmax par freinage* [J]			W	P
	6	**4**	**2**	t_1 [ms]	t_{1s} [ms]	t_2 [ms]	t_{2c} [ms]	10 c/h	100 c/h	1000 c/h	[MJ]	[W]
FD 02	—	3.5	1.75	30	15	80	9	4500	1400	180	15	17
FD 03	5	3.5	1.75	50	20	100	12	7000	1900	230	25	24
FD 53	7.5	5	2.5	60	30	100	12					
FD 04	15	10	5	80	35	140	15	10000	3100	350	30	33
FD 14												
FD 05	40	26	13	150	65	170	20	18000	4500	500	50	45
FD 15	40	26	13	150	65	170	20					
FD 55	55	37	18	—	65	170	20					
FD 06S	60	40	20	—	80	220	25	20000	4800	550	70	55
FD 56	—	75	37	—	90	150	20	29000	7400	800	80	65
FD 06	—	100	50	—	100	150	20					
FD 07	150	100	50	—	120	200	25	40000	9300	1000	130	65
FD 08 *	250	200	170	—	140	350	30	60000	14000	1500	230	100
FD 09 **	400	300	200	—	200	450	40	70000	15000	1700	230	120



* valori di coppia frenante ottenuti con n° 9,7,6 molle rispettivamente

** valori di coppia frenante ottenuti con n° 12,9,6 molle rispettivamente

* *brake torque values obtained with 9, 7 and 6 springs, respectively*

** brake torque values obtained with 12, 9 and 6 springs, respectively

* Werte, der durch den Einsatz von jeweils 9, 7, 6 Federn erreichten Bremsmomente

** Werte, der durch den Einsatz von jeweils 12, 9, 6 Federn erreichten Bremsmomente

* *valeurs de couple de freinage obtenues respectivement avec n° 9, 7, 6 ressorts*

** *valeurs de couple de freinage obtenues respectivement avec n° 12, 9, 6 ressorts*

Legenda:

t_1 = tempo di rilascio del freno con alimentatore a semionda

t_{1s} = tempo di rilascio del freno con alimentatore con sovraeccitaz.

t_2 = ritardo di frenatura con interruzione lato c.a. e alimentazione separata

t_{2c} = ritardo di frenatura con interruzione lato c.a. e c.c. I valori di t_1, t_{1s}, t_2, t_{2c}, indicati nella tabella (37) sono riferiti al freno tarato alla coppia massima, traferro medio e tensione nominale.

W_{max} = energia max per frenata

W = energia di frenatura tra due regolazioni successive

P_b = potenza assorbita dal freno a 20°C

M_b = coppia frenante statica (± 15%)

c/h = avviamenti orari

Key:

t_1 = *brake release time with half-wave rectifier*

t_{1s} = *brake release time with over-energizing rectifier*

t_2 = *brake engagement time with AC line interruption and separate power supply*

t_{2c} = *brake engagement time with AC and DC line interruption – Values for t_1, t_{1s}, t_2, t_{2c} indicated in the tab. (37) are referred to brake set at maximum torque, medium air gap and rated voltage*

W_{max} = *max energy per brake operation*

W = *braking energy between two successive air gap adjustments*

P_b = brake power absorption at 20 °C

M_b = *static braking torque (± 15%)*

c/h = *starts per hour*

Legende:

t_1 = Ansprechzeit der Bremse mit Halbwellengleichrichter

t_{1s} = Ansprechzeit der Bremse mit elektronisch gesteuerten Erregungsgleichrichter

t_2 = Bremsverzögerung mit Unterbrechung auf Wechselstromseite und Fremdversorgung

t_{2c} = Bremsverzögerung mit Unterbrechung auf Wechselstrom- und Gleichstromseite – Die in der Tab. (37) angegebenen Werte t_1, t_{1s}, t_2, t_{2c}, beziehen sich auf eine auf das max. Bremsmoment geeichte Bremse, mit mittlerem Luftspalt und Nennspannung.

W_{max} = max. Energie pro Bremsung

W = Bremsenergie zwischen zwei Einstellungen des Luftspalts

P_b = bei 20° C von der Bremse aufgenommene Leistung (50 Hz)

M_b = statisches Bremsmoment (± 15%)

c/h = Schaltungen pro stunde

Légende:

t_1 = *temps de déblocage du frein avec dispositif d'alimentation à demi-onde*

t_{1s} = *temps de déblocage du frein avec dispositif d'alimentation à contrôle électronique de l'excitation*

t_2 = *retard de freinage avec interruption côté c.a. et alimentation séparée*

t_{2c} = *retard de freinage avec interruption côté c.c.Les valeurs de t_1, t_{1s}, t_2, t_{2c}, indiquées dans le tab. (37) se réfèrent au frein étalonné au couple maximal, entrefer moyen et tension nominale.*

W_{max} = *énergie max. par freinage*

W = *énergie de freinage entre deux réglages successifs de l'entrefer*

P_b = *puissance absorbée par le frein à 20 °C*

M_b = *couple de freinage statique (± 15%)*

c/h = *démarrages horaires*

- Collegamenti freno FD

I motori standard ad una velocità sono forniti con il collegamento del raddrizzatore alla morsettiera motore già realizzato in fabbrica.

Per motori a 2 velocità, e dove è richiesta l'alimentazione del freno separata, prevedere il collegamento al raddrizzatore in accordo alla tensione freno V_B indicata nella targhetta del motore.

Data la natura induttiva del carico, per il comando del freno e per l'interruzione lato corrente continua devono essere utilizzati contatti con categoria d'impiego AC-3 secondo IEC 60947-4-1.

- FD brake connections

On standard single-pole motors, the rectifier is connected to the motor terminal board at the factory.

For switch-pole motors and where a separate brake power supply is required, connection to rectifier must comply with brake voltage V_B stated in motor name plate.

Because the load is of the inductive type, brake control and DC line interruption must use contacts from the usage class AC-3 to IEC 60947-4-1.

- Anschlüsse - Bremstyp FD

Die einpoligen Motoren werden vom Werk ab mit an die Motorspannung angeschlossenem Gleichrichters geliefert. Für die polumschaltbaren Motoren, und Bremse mit separater Versorgung, wird in Übereinstimmung mit der auf dem Typenschild des Motors angegebenen Bremsspannung V_B der Anschluss an den Gleichrichter vorgesehen.

Da es sich bei der Bremsleistung um eine induktive Kraft handelt, müssen gemäß IEC 60947-4-1 für die Steuerung der Bremse und die Unterbrechung der Gleichstromseite Kontakte der Kategorie AC-3 verwendet werden.

- Raccordements frein FD

Les moteurs standard à une vitesse sont fournis avec le raccordement du redresseur au bornier moteur déjà réalisé en usine.

Pour les moteurs à 2 vitesses, et lorsqu'une alimentation séparée du frein est requise, prévoir le raccordement au redresseur conformément à la tension frein V_B indiquée sur la plaque signalétique du moteur.

Etant donné la nature inductive de la charge, pour la commande du frein et l'interruption côté courant continu, il est nécessaire d'utiliser des contacts avec catégorie d'utilisation AC-3 selon la norme IEC 60947-4-1.

Tabella (38) - Alimentazione freno dai morsetti motore ed interruzione lato a.c.
Tempo di arresto t_2 ritardato e funzione delle costanti di tempo del motore.
Da prevedere quando sono richiesti avviamenti/arresti progressivi.

Tabella (39) – Bobina freno con alimentazione separata ed interruzione lato c.a.
Tempo di arresto normale ed indipendente dal motore.

Table (38) – Brake power supply from motor terminals and AC line interruption.
Delayed stop time t_2 and function of motor time constants.
Mandatory when soft-start/stops are required.

Table (39) – Brake coil with separate power supply and AC line interruption
Normal stop time independent of motor.

Tabelle (38) – Bremsversorgung über die Motorspannung und Unterbrechung der Wechselstromseite. Verzögerter und von den Zeitkonstanten des Motors abhängige Haltezeit t_2. Vorzusehen, wenn progressive Starts/Stopps erforderlich sind.

Tabelle (39) – Bremsspule mit separater Spannungsversorgung und Unterbrechung der Wechselstromseite. Normale und vom Motor unabhängige Stoppzeiten.

Tableau (38) - Alimentation frein depuis bornes moteur et interruption côté c.a.
Temps d'arrêt t_2 retardé et fonction des constantes de temps du moteur.
A prévoir lorsque des démarrages/arrêts progressifs sont requis.

Tableau (39) - Bobine de frein avec alimentation séparée et interrupteur côté c.a.
Temps d'arrêt normal et indépendant du moteur.

Tabella (40) – Bobina freno con alimentazione dai morsetti motore ed interruzione lato c.a. e c.c.
Arresto rapido con i tempi d'intervento t_{2c}.

Table (40) – Brake coil power supply from motor terminals and AC/DC line interruption.
Quick stop with operation times t_{2c}.

Tabelle (40) – Bremsspule mit Versorgung über die Motorspannung und Unterbrechung der Gleich- und der Wechselstromseite. Schneller Stopp mit angegebenen Ansprechzeiten t_{2c}.

Tableau (40) - Bobine de frein avec alimentation depuis les bornes moteur et interruption côté c.a. et c.c.
Arrêt rapide avec les temps d'intervention t_{2c}.

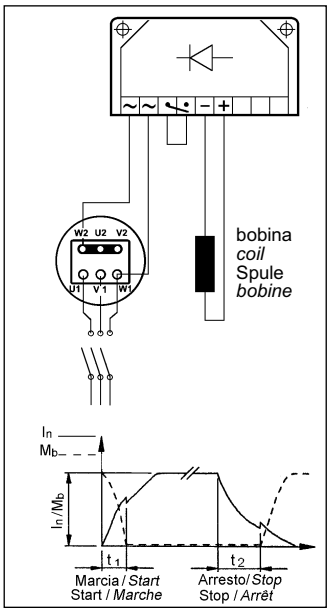
Tabella (41) – Bobina freno con alimentazione separata ed interruzione lato c.a. e c.c.
Tempo di arresto ridotto secondo i valori t_{2c}.

Table (41) – Brake coil with separate power supply and AC/DC line interruption.
Stop time decreases by values t_{2c}.

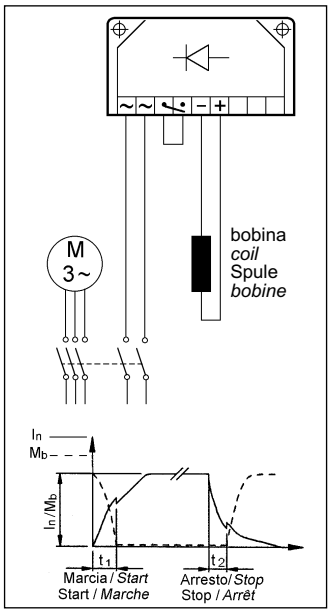
Tabelle (41) – Bremsspule mit separater Spannungsvversorgung und Unterbrechung der Gleich-und der Wechselstromseite.
Reduzierte Stoppzeiten angegebenen Werte t_{2c}.

Tableau (41) - Bobine de frein avec alimentation séparée et interruption côté c.a. et c.c. Temps d'arrêt réduit selon les valeurs t_{2c}.

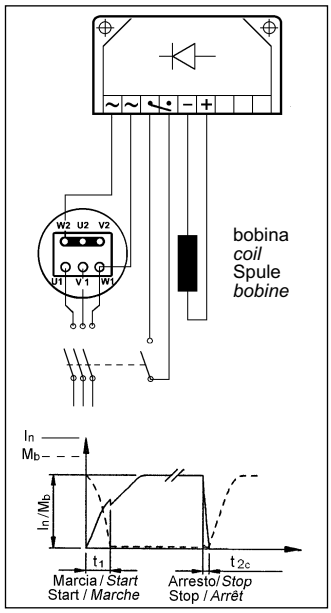
(38)



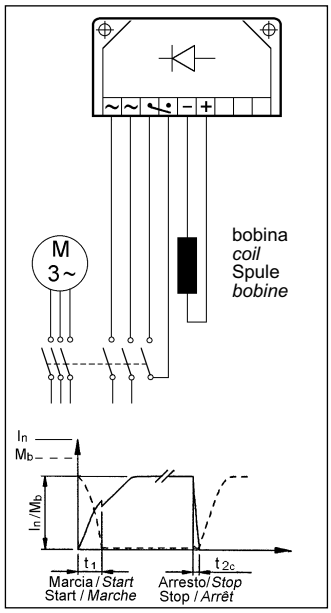
(39)



(40)



(41)



Le tabelle da (38) a (41) riportano gli schemi tipici di collegamento per alimentazione 400 V, motori 230/400V collegati a stella e freno 230 V.

Tables (38) through (41) show the typical connection diagrams for 400 V power supply, star-connected 230/400V motors and 230 V brake.

In den Tabellen (38) bis (41) werden die typischen Schaltungen für Versorgung mit 400 V, Motoren 230/400V mit Sternschaltung und einer Bremsspannung von 230 V wiedergegeben.

Les tableaux de (38) à (41) indiquent les schémas typiques de branchement pour une alimentation de 400 V, moteurs 230/400V raccordés en étoile et frein 230 V.

M26 - MOTORI AUTOFRENANTI IN C.A. TIPO BN_ FA

M26 - AC BRAKE MOTORS TYPE BN_FA

M26 - WECHSELSTROMBREMS-MOTOREN MIT W.S.–BREMSE TYP BN_ FA

M26 - MOTEURS FREIN EN C.A. TYPE BN_FA

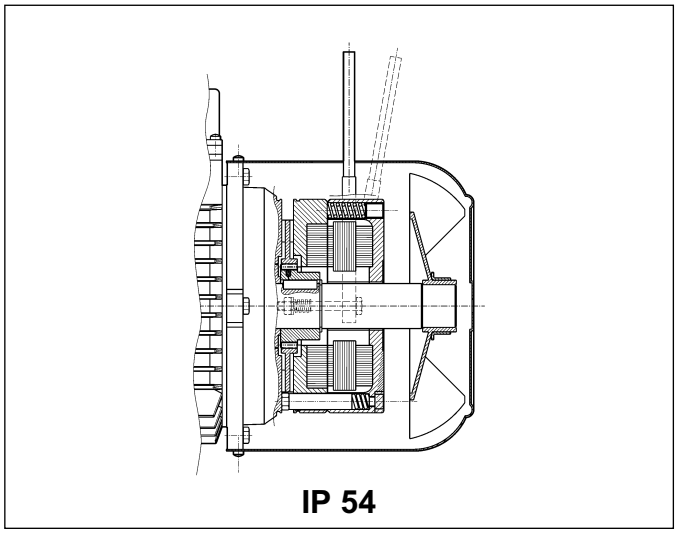
- Grandezze: BN 63 ... BN 180M

- Frame sizes: BN 63 ... BN 180M

- Baugrößen: BN 63 ... BN 180M

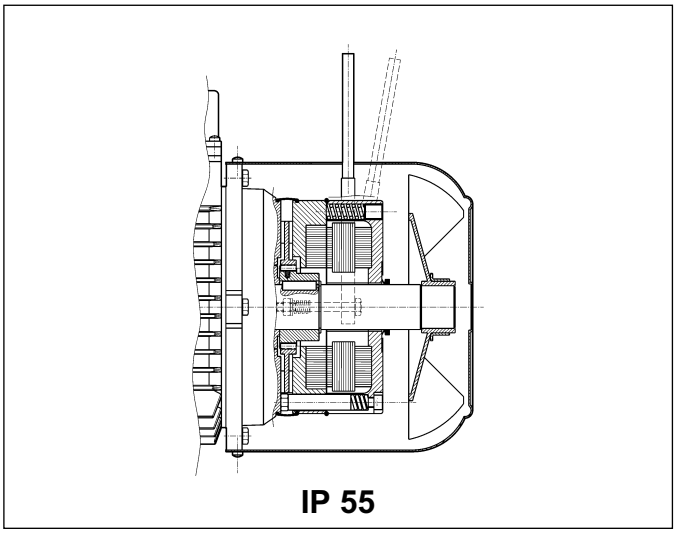
Tailles*: BN 63 ... BN 180M*

(42)



IP 54

(43)



IP 55

Freno elettromagnetico con alimentazione in **corrente alternata** trifase, fissato con viti allo scudo motore; le molle di precarico realizzano il posizionamento assiale del corpo magnete.
Il disco freno è scorrevole assialmente sul mozzo trascinatore in acciaio calettato sull'albero e previsto di molla antivibrazione.
La coppia frenante è preimpostata in fabbrica su valori che sono indicati nelle tabelle dati tecnici dei relativi motori.
L'azione del freno è inoltre modulabile, regolando con continuità la coppia frenante, tramite le viti che realizzano il precarico delle molle; il campo di regolazione della coppia è: 30% $M_{bMAX} < M_b < M_{bMAX}$ (M_{bMAX} è il momento frenante max riportato in tab. (46).
Il freno tipo FA presenta dinamiche molto elevate che lo rendono idoneo in applicazioni dove sono richieste frequenze di avviamento elevate con tempi d'intervento molto rapidi.
A richiesta, i motori possono essere previsti di leva per lo sblocco manuale con ritorno automatico (R). Per la specifica della posizione angolare della leva vedi relativa variante alla pag. 34.

*Electromagnetic brake operates from three-phase **alternated current** power supply and is bolted onto conveyor shield. Preloading springs provide axial positioning of magnet body.*
Steel brake disc slides axially on steel hub shrunk onto motor shaft with anti-vibration spring.
Brake torque factory setting is indicated in the corresponding motor rating charts.
Spring preloading screws provide stepless braking torque adjustment. Torque adjustment range is 30% $M_{bMAX} < Mb < M_{bMAX}$ (where M_{bMAX} is maximum braking torque as shown in tab. (46).
Thanks to their high dynamic characteristics, FA brakes are ideal for heavy-duty applications as well as applications requiring frequent stop/starts and very fast response time.
Motors may be equipped with manual release lever with automatic return (R) at request. See variants at page 34 for available lever locations.

Elektomagnetische Bremse mit **Drehstromversorgung**, die mittels Schrauben am hinteren Motorschild befestigt ist. Die Federn sorgen dabei für die axiale Ausrichtung des Magnetkörpers. Die Bremsscheibe (Stahl) gleitet axial auf dem sich auf dem Rotor befindlichen Mitnehmer, der über eine Paßfeder mit Motorwelle verbunden und mit einer Schwingungsdämpffeder ausgestattet ist. as Bremsmoment wird auf das entsprechende Motormoment eingestellt (siehe Tabelle der technischen Daten der entsprechenden Motoren). Das Bremsmoment ist stufenlos durch über die Schrauben die die Federvorspannung einstellbar. Der Einstellbereich beträgt 30% $Mb_{MAX} < Mb < Mb_{MAX}$ (Mb_{MAX} steht für den max. Bremsmoment, der in der Tab (46) angegeben wird). Die Bremse vom Typ FA zeichnet sich durch ihre hohen Dynamik aus, weshalb sie für Anwendungen geeignet sind, in denen hohe Schaltfrequenzen und schnelle Ansprechzeiten gefordert werden.
Auf Anfrage können die Motoren mit einem Lüfterhebel für die manuelle Lüftung der Bremse mit automatischer Rückstellung (R) geliefert werden. Die Angabe der Montageposition erfolgt über die Angabe der Option auf Seite 34.

*Frein électromagnétique avec alimentation en **courant alternatif** triphasé, fixé avec des vis au bouclier ; les ressorts de précharge réalisent le positionnement axial de la bobine.*
Le disque frein coulisse de façon axiale sur le moyeu d'entraînement en acier, calé sur l'arbre et doté de ressort antivibration.
Le couple de freinage est préréglé en usine aux valeurs qui sont indiquées dans les tableaux des caractéristiques techniques des moteurs correspondants. De plus, l'action du frein est modulable, en réglant le couple de freinage en continu au moyen des vis qui réalisent la précharge des ressorts ; la plage de réglage du couple est de 30% $M_{bMAX} < Mb < M_{bMAX}$ (M_{bMAX} est le couple de freinage maximum indiqué dans le tab. (46).
Le frein type FA présente des caractéristiques dynamiques très élevées, il est donc adapté pour des applications nécessitant des fréquences de démarrage élevées et des temps d'intervention très rapides.
Sur demande, les moteurs peuvent être prévus avec levier pour le déblocage manuel avec retour automatique (R). Pour la spécification de la position angulaire du levier, voir variante page 34.

- Grado di protezione

L'esecuzione standard prevede il grado di protezione IP54.

In opzione, il motore autofrenante BN_FA viene fornito con grado di protezione **IP 55** prevedendo le seguenti varianti costruttive:

- anello V-ring posizionato sull'albero motore N.D.E.
- fascia di protezione in gomma
- anello o-ring

- Degree of protection

Standard protection is IP54.

*Brake motor BN_FA is also available in protection **IP 55**, which mandates the following variants:*

- V-ring at N.D.E. of motor shaft

- rubber boot

- O-ring

- Schutzart

Die Standardausführung ist Schutzart IP54 vor.

Optional kann der Bremsmotor BN_FA auch in der Schutzart IP 55 geliefert werden, was durch die folgenden zusätzlichen Bauteile erreicht wird:

- V-Ring an der Motorwelle N.D.E.
- Schutzring aus Gummi
- O-Ring

- Degré de protection

L'exécution standard prévoit le degré de protection IP54.
*En option, le moteur frein BN_FA est fourni avec degré de protection **IP 55**, les variations de construction suivantes sont prévues :*

- bague V-ring positionné sur l'arbre moteur N.D.E.

- bande de protection en caoutchouc

- joint torique

- Alimentazione freno FA

Nei motori a singola polarità l'alimentazione della bobina freno è derivata direttamente dalla morsettiera motore e la tensione del freno quindi coincide con la tensione del motore. In questo caso la tensione del freno può essere omessa dalla designazione.

Per i motori a doppia polarità, e per i motori con alimentazione separata del freno, è presente una morsettiera ausiliaria con 6 terminali per il collegamento alla linea del freno. In entrambi i casi il valore di tensione del freno dovrà essere specificato in designazione.
Nella tabella seguente sono riportate le condizioni di alimentazione standard del freno in c.a. per i motori a singola e doppia polarità:

- FA brake power supply

In single-pole motors, power supply is brought to the brake coil direct from the motor terminal box. As a result, brake voltage and motor voltage are the same. In this case, brake voltage indication may be omitted in the designation.

Switch-pole motors and motors with separate brake power supply feature an auxiliary terminal board with 6 terminals for connection to brake line. In both cases, brake voltage indication in the designation is mandatory.

The following table reports standard AC brake power supply ratings for single- and switch-pole motors:

- Stromversorgung - Bremstyp FA

Bei den einpoligen Motoren wird die Versorgung der Bremsspule direkt vom Motorklemmenkasten abgenommen, das bedeutet, dass die Spannung der Bremse mit der Motorspannung übereinstimmt. In diesem Fall braucht die Bremsenspannung nicht extra angegeben werden.

Für die polumschaltbaren Motoren und für eine separate Bremsversorgung ist eine Hilfsklemmenleiste mit 6 Anschlüssen vorgesehen, die einen Anschluß der Bremse ermöglichen. In beiden Fällen muss die Bremspannung in der Bestellung angegeben werden.
In der nachstehenden Tabelle werden für die einpoligen und die polumschaltbaren Motoren die Standardspannungen der Wechselstrombremsen angegeben:

- Alimentation frein FA

Sur les moteurs à simple polarité, l'alimentation de la bobine frein dérive directement du bornier moteur, par conséquent, la tension du frein coïncide avec la tension du moteur. Dans ce cas, la tension du frein peut être omise de la désignation.

Pour les moteurs à double polarité et les moteurs avec alimentation séparée du frein, une boîte à bornes auxiliaire avec 6 bornes pour le raccordement à la ligne du frein, est présente. Dans les deux cas, la valeur de tension du frein doit être spécifiée dans la désignation.
Le tableau suivant indique les conditions d'alimentation standard du frein en c.a. pour les moteurs à simple et double polarité :

(44)

Motori a singola polarità ***Single-speed motors*** **Einpolige Motoren** ***Moteurs à simple polarité***	**BN 63 ... BN 132**	**BN 160 ... BN 180 M**
	230Δ / 400Y V ±10% – 50 Hz	400Δ / 690Y V ±10% – 50 Hz
	265Δ / 460Y V ±10% - 60 Hz	460Δ V – 60 Hz

(45)

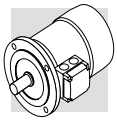
Motori a doppia polarità (alimentazione da linea separata) ***Switch-speed motors*** *(separate power supply line*) **Polumschaltbare Motoren** (separate Versorgung) ***Moteurs à double polarité*** *(alimentation depuis ligne séparée)*	**BN 63 ... BN 132**
	230Δ / 400Y V ±10% – 50 Hz
	460Y V – 60 Hz

Su richiesta, sono disponibili tensioni speciali, nel campo 24…690 V, 50... 60 Hz.

Special voltages in the 24…690 V, 50... 60 Hz range are available at request.

Auf Anfrage können Sonderspannungen von 24…690 V, 50... 60 Hz geliefert werden.

Sur demande, des tensions spéciales sont disponibles dans la plage 24…690 V, 50... 60 Hz.



- Dati tecnici freni FA | ***- FA brake technical specifications*** | **- Technische Daten der Bremsen vom Typ FA** | ***- Caractéristiques techniques freins FA***

(46)

Freno *Brake* Bremse *Frein*	Coppia frenante M_b *Brake torque M_b* Bremsmoment M_b *Couple de freinage M_b* [Nm]	Rilascio *Release* Ansprechzeit *Déblocage* t_1 [ms]	Frenatura *Braking* Bremszeit *Freinage* t_2 [ms]	W max [J] 10 c/h	W max [J] 100 c/h	W max [J] 1000 c/h	W [MJ]	Pb [VA]
FA 02	3.5	4	20	4500	1400	180	15	60
FA 03	7.5	4	40	7000	1900	230	25	80
FA 04	15	6	60	10000	3100	350	30	110
FA 14								
FA 05	40	8	90	18000	4500	500	50	250
FA 15								
FA 06S	60	16	120	20000	4800	550	70	470
FA 06	75	16	140	29000	7400	800	80	550
FA 07	150	16	180	40000	9300	1000	130	600
FA 08	250	20	200	60000	14000	1500	230	1200

Legenda:

- M_b = max coppia frenante statica (± 15%)
- t_1 = tempo di rilascio del freno
- t_2 = ritardo di frenatura
- W_{max} = energia max per frenata (capacità termica del freno)
- W = energia di frenatura tra due regolazioni successive del traferro
- P_b = potenza assorbita dal freno a 20°C (50 Hz)
- c/h = avviamenti orari

Key:

- M_b = *max static braking torque (15%)*
- t_1 = *brake release time*
- t_2 = *brake engagement time*
- W_{max} = *max energy per brake operation (brake thermal capacity)*
- W = *braking energy between two successive air gap adjustments*
- P_b = *brake power absorption at 20° (50 Hz)*
- c/h = *starts per hour*

Legende:

- M_b = statisches max. Bremsmoment (± 15%)
- t_1 = Bremsenansprechzeit
- t_2 = Bremsverzögerung
- W_{max} = max. Energie pro Bremsung (Wärmeleistung der Bremse)
- W = Bremsenergie zwischen zwei Einstellungen des Luftspalts
- P_b = bei 20° von der Bremse aufgenommene Leistung (50 Hz)
- c/h = Schaltungen pro Stunde

Légende:

- M_b = *couple de freinage statique max (15%)*
- t_1 = *temps de déblocage frein*
- t_2 = *retard de freinage*
- W_{max} = *énergie max par freinage (capacité thermique du frein)*
- *W* = *énergie de freinage entre deux réglages successifs de l'entrefer*
- P_b = *puissance absorbée par le frein à 20° (50 Hz)*
- c/h = *démarrages horaires*

N.B.

I valori di t_1 e t_2 riportati in tabella sono riferiti al freno tarato alla coppia nominale, traferro medio e tensione nominale.

NOTE

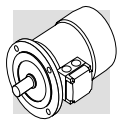
Values t_1 and t_2 in the table refer to a brake set at rated torque, medium air gap and rated voltage.

HINWEIS:

Die in der Tabelle angegebenen Werte t_1 und t_2 beziehen sich auf eine Bremse, die auf das Nenndrehmoment, einen mittleren Luftspalt und die Standardspannung eingestellt ist.

N.B.

Les valeurs de t_1 et t_2 indiquées dans le tableau se réfèrent au frein étalonné au couple nominal, entrefer moyen et tension nominale.



- Collegamenti freno FA

Per i motori con alimentazione del freno derivata direttamente dall'alimentazione motore i collegamenti alla morsettiera corrispondono a quanto riportato nello schema (47):

- FA brake connections

The diagram (47) shows the required connections to terminal box when brake is to be connected directly to motor power supply:

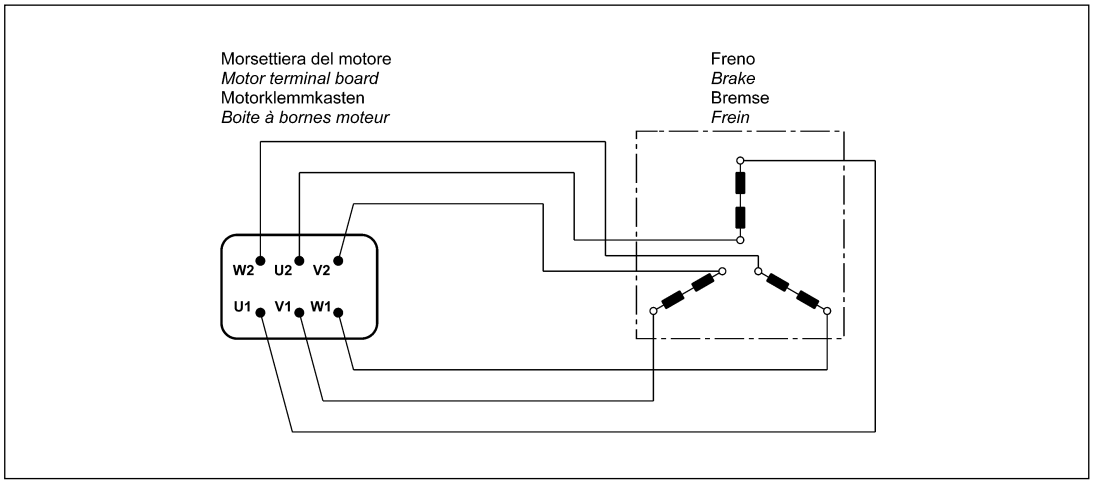
- Abschlüsse - Bremstyp FA

Bei den Motoren mit direkter Bremsspannungsversorgung müssen die Anschlüsse im Klemmenkasten entsprechend den Angaben im Schema (47) angeschlossen werden:

- Raccordements frein FA

Pour les moteurs avec alimentation du frein dérivant directement de l'alimentation moteur, les raccordements à la boîte à bornes correspondent aux indications du schéma (47) :

(47)



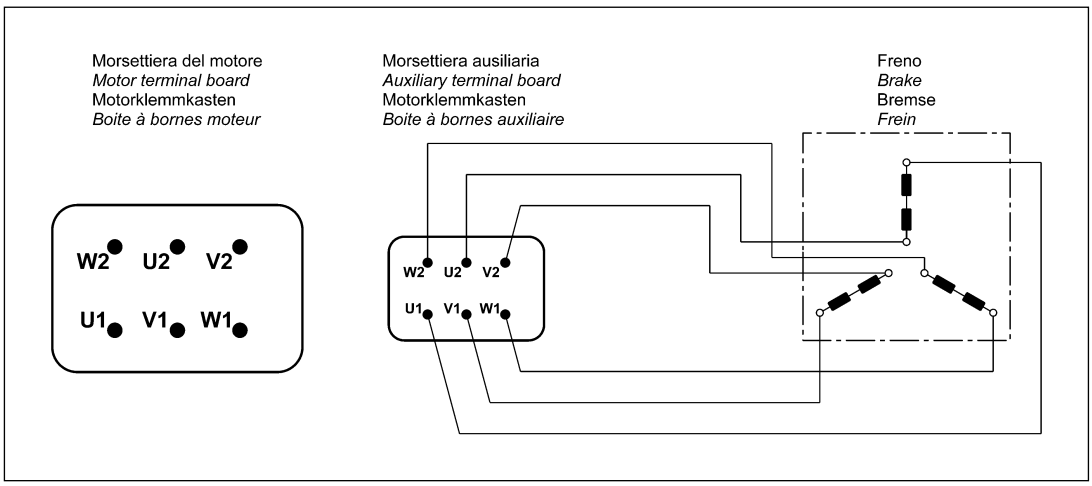
Per i motori a doppia polarità e, quando richiesto, per i motori ad una velocità con alimentazione da linea separata è prevista una morsettiera ausiliaria a 6 morsetti per il collegamento del freno; in questa esecuzione i motori prevedono la scatola coprimorsetti maggiorata. Vedi schema (48):

Switch-pole motors and, at request, single-pole motors with separate power supply line are equipped with an auxiliary terminal board with 6 terminals for brake connection. In this version, motors feature a larger terminal box. See diagram (48):

Bei den polumschaltbaren Motoren und, auf Anfrage, auch bei den einpoligen Motoren mit separater Bremsversorgung ist für den Anschluss der Bremse ein Hilfsklemmenkasten mit 6 Klemmen vorgesehen. In diesen Ausführungen haben die Motoren einen größeren Klemmenkasten. Siehe Schema (48):

Pour les moteurs à double polarité et, lorsque cela est requis, pour les moteurs à une vitesse avec alimentation depuis ligne séparée, une boîte à bornes auxiliaire à 6 bornes est prévue pour le raccordement du frein ; dans cette exécution les moteurs prévoient un couvercle bornier majoré. Voir schéma (48) :

(48)



M27 - MOTORI AUTOFRENANTI IN C.A. TIPO BN_ BA

M27 - AC BRAKE MOTORS TYPE BN_BA

M27 - WECHSELSTROMBREMS-MOTOREN MIT W.S.–BREMSE TYP BN_ BA

M27 - MOTEURS FREIN EN C.A. TYPE BN_BA

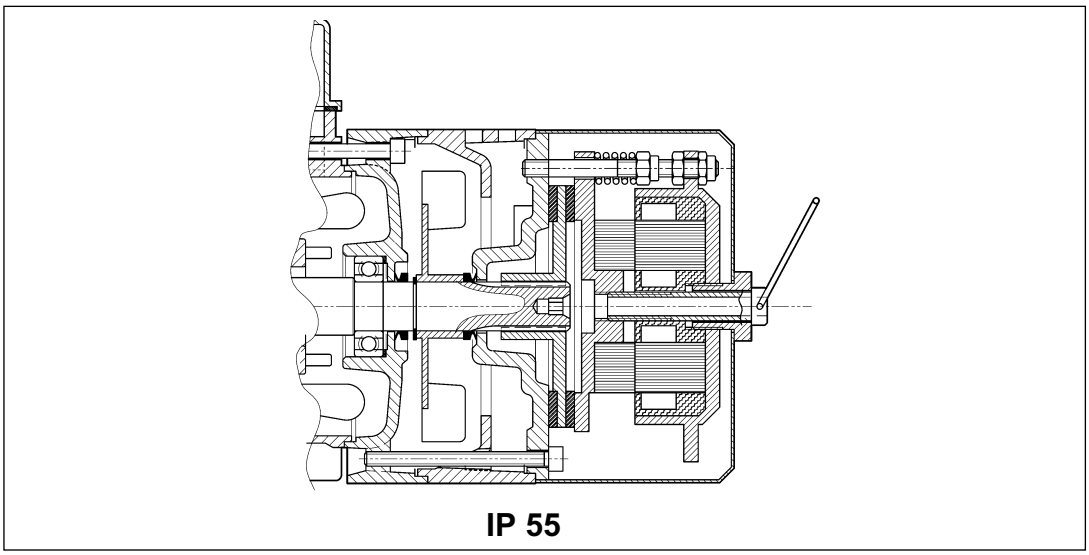
- Grandezze: BN 63 ... BN 132M

***- Frame sizes**: BN 63 ... BN 132M*

- Baugrößen: BN 63 ... BN 132M

***- Tailles** : BN 63 ... BN 132M*

(49)



IP 55

Freno elettromagnetico con alimentazione in **corrente alternata** trifase, fissato con viti allo scudo convogliatore.
Disco freno in acciaio scorrevole assialmente sull'albero motore scanalato (mozzo trascinatore in acciaio calettato sull'albero per grandezza 132).
I motori sono forniti con freno tarato alla massima coppia. La coppia freno è regolabile con continuità agendo sulle viti di compressione delle molle; il campo di regolazione consentito è 30% $M_{bMAX} < M_b < M_{bMAX}$ (M_{bMAX} è il momento frenante max riportato in tab. (52).
Di serie i motori sono forniti completi di vite per lo sblocco manuale del freno, con mantenimento della posizione di rilascio per consentire la rotazione dell'albero motore.
La vite di sblocco deve essere smontata dopo l'utilizzo per assicurare il corretto funzionamento del freno ed evitare situazioni potenzialmente pericolose.
Il freno BA, oltre alle elevate caratteristiche dinamiche tipiche dei freni in corrente alternata, presenta una costruzione robusta con energia di frenatura aumentata che lo rendono particolarmente idoneo a servizi pesanti oltre che in applicazioni dove sono richieste frequenze di manovra elevate e tempi d'intervento molto rapidi.

*Electromagnetic brake operates from three-phase **alternated current** power supply and is bolted onto conveyor shield.*
Steel brake disc slides axially on splined motor shaft (steel drive hub is shrunk onto shaft on frame size 132).
Factory setting is maximum brake torque.
Step less braking torque adjustment by screws which compress the brake springs. Allowed adjustment range is 30% $M_{bMAX} < M_b < M_{bMAX}$ (M_{bMAX} is maximum braking torque as shown in tab. (52).
Motors are supplied complete with manual brake release screw as standard. Screw may be locked in the release position to allow for motor shaft rotation.
The brake release screw must be removed after use to ensure proper brake operation and avoid potentially dangerous conditions.
In addition to the high dynamic characteristics typical of AC brakes, a sturdy design and increased braking energy make the BA brake ideal for heavy-duty applications as well as applications requiring frequent stop/starts and very fast response time.

Elektomagnetische Bremse mit Drehstromversorgung, die mittels Schrauben am Motorschild des Motors befestigt ist. Die Bremsscheibe (Stahl) gleitet axial auf der Rotorwelle (bei Baugröße 132 über einem auf die Welle aufgezogenem Mitnehmer aus Stahl). Die Motoren werden mit einer auf das maximale Drehmoment des Motors eingestellten Bremse geliefert. Das Bremsdrehmoment ist durch Betätigen der Federdruckschrauben stufenlos regelbar. Der zulässige Einstellbereich beträgt 30% $M_{bMAX} < M_b < M_{bMAX}$ (M_{bMAX} steht für den max. Bremsmoment, das in der Tab. (52) angegeben wird.
Die Motoren werden serienmäßig mit einer Schraube zur manuelle Bremslüftung geliefert; die arretierbar ist, um ein Drehen der Motorwelle zu ermöglichen.
Diese Schraube muss im Betrieb des Motors wieder abmontiert werden, damit die korrekte Funktion der Bremse gesichert ist Die Bremse vom Typ BA zeichnet sich durch ihre dynamischen Eigenschaften und die robuste Bauweise aus, durch die sie eine erhöhte Bremsenergie abzugeben kann. Diese Bremstypen eignen sich besonders für einen Einsatz unter harten Bedingungen und überall dort, wo häufige Schaltfrequenzen und schnelle Ansprechzeiten gefordert werden.

*Frein électromagnétique avec alimentation en **courant alternatif** triphasé, fixé avec des vis au bouclier.*
Disque frein en acier coulissant de façon axiale sur l'arbre moteur rainuré (moyeu d'entraînement en acier calé sur l'arbre pour la taille 132).
Les moteurs sont fournis avec frein étalonné au couple maximal. Le couple de freinage est réglable en continu en intervenant sur les vis de compression des ressorts ; la plage de réglage autorisé est de 30% $M_{bMAX} < M_b < M_{bMAX}$ (M_{bMAX} étant le couple de freinage maximum indiqué dans le tab. (52).
De série, les moteurs sont fournis avec vis de déblocage manuel du frein, avec maintien de la position de relâchement afin de permettre la rotation de l'arbre moteur.
La vis de déblocage doit être démontée après utilisation afin de garantir le fonctionnement correct du frein et d'éviter les situations potentiellement dangereuses. Le frein BA, outre les caractéristiques dynamiques élevées typiques des freins en courant alternatif, est de fabrication robuste avec énergie de freinage majorée, ce qui le rend particulièrement adapté pour les services difficiles ainsi que pour les applications nécessitant des fréquences de manœuvre élevées et des temps d'intervention très rapides.

- Grado di protezione

È disponibile un'unica esecuzione, con grado di protezione IP55.

- Degree of protection

Only available with degree of protection IP55.

- Schutzart

Es ist eine nur die Ausführung in Schutzklasse IP55 verfügbar.

- Degré de protection

Il est disponible en une exécution unique, avec degré de protection IP55.

- Alimentazione freno BA

Nei motori a singola polarità l'alimentazione della bobina freno è derivata direttamente dalla morsettiera motore e la tensione del freno quindi coincide con la tensione del motore. In questo caso la tensione del freno può essere omessa dalla designazione.
Per i motori a doppia polarità, e per i motori con alimentazione separata del freno, è presente una morsettiera ausiliaria con 6 terminali per il collegamento alla linea del freno. In entrambi i casi il valore di tensione del freno dovrà essere specificato in designazione.
Nella tabella seguente sono riportate le condizioni di alimentazione standard del freno in c.a. per i motori a singola e doppia polarità:

- BA brake power supply

In single-pole motors, power supply is brought to the brake coil direct from the motor terminal box. As a result, brake voltage and motor voltage are the same. In this case, brake voltage indication may be omitted in the designation.
Switch-pole motors and motors with separate brake power supply feature an auxiliary terminal board with 6 terminals for connection to brake line. In both cases, brake voltage indication in the designation is mandatory.
The following table reports standard AC brake power supply ratings for single- and switch-pole motors:

- Stromversorgung - Bremstyp BA

Bei den einpoligen Motoren wird die Versorgung der Bremsspule direkt vom Motorklemmenkasten abgezweigt, das bedeutet also, dass die Spannung der Bremse mit der Motorspannung übereinstimmt. In diesem Fall braucht die Bremsenspannung nicht extra angegeben werden. Für polumschaltbaren Motoren und für eine separate Bremsversorgung ist eine Hilfsklemmenleiste mit 6 Anschlüssen vorgesehen, die einen Anschluss der Bremse ermöglichen. In beiden Fällen muss die Bremsspannung bei der Bestellung angegeben werden.
In der nachstehenden Tabelle werden für die einpoligen und die polumschaltbaren Motoren die Standardversorgung der Wechselstrombremsen angegeben.

- Alimentation frein BA

Sur les moteurs à simple polarité, l'alimentation de la bobine frein dérive directement du bornier moteur, par conséquent, la tension du frein coïncide avec la tension du moteur. Dans ce cas, la tension du frein peut être omise de la désignation.
Pour les moteurs à double polarité et les moteurs avec alimentation séparée du frein, un boîte à bornes auxiliaire avec 6 bornes pour le raccordement au réseau du frein, est présente. Dans les deux cas, la valeur de tension du frein doit être spécifiée dans la désignation.
Le tableau suivant indique les conditions d'alimentation standard du frein en c.a. pour les moteurs à simple et double polarité :

(50)

Motori a singola polarità ***Single-speed motors*** **Einpolige Motoren** ***Moteurs à simple polarité***	**BN 63 ... BN 132**
	230Δ / 400Y V ± 10% – 50 Hz
	265Δ / 460Y ± 10% - 60 Hz

(51)

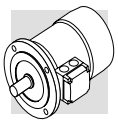
Motori a doppia polarità (alimentazione da linea separata) ***Switch-pole motors*** *(separate power supply line*) **Polumschaltbare Motoren** (separate Versorgung) ***Moteurs à double polarité*** *(alimentation depuis ligne séparée)*	**BN 63 ... BN 132**
	230Δ / 400Y V ± 10% – 50 Hz
	460Y – 60 Hz

Se non diversamente specificato, l'alimentazione standard del freno è 230Δ /400Y V - 50 Hz.
Su richiesta, sono disponibili tensioni speciali, nel campo 24…690 V, 50... 60 Hz.

Unless otherwise specified, standard brake power supply is 230Δ /400Y V - 50 Hz.
Special voltages in the 24…690 V, 50... 60 Hz range are available at request.

Falls nicht anderweitig angegeben, beträgt die Standardversorgung der Bremse 230Δ /400Y V - 50 Hz.
Auf Anfrage können Sonderspannungen von 24…690 V, 50... 60 Hz geliefert werden.

Sauf spécification contraire, l'alimentation standard du frein est 230Δ /400Y V - 50 Hz.
Sur demande, des tensions spéciales sont disponibles dans la plage 24…690 V, 50... 60 Hz.



- Dati tecnici freni BA

Nella tabella sottostante sono riportati i dati tecnici dei freni in c.a., tipo BA.

- BA brake technical specifications

The table below reports the technical specifications for AC brakes type BA.

- Technische Daten der Bremsen vom Typ BA

In der nachstehenden Tabelle werden die technischen Daten der Wechselstrombremsen vom Typ BA angegeben:

- Caractéristiques techniques freins BA

Le tableau ci-dessous indique les caractéristiques techniques des freins en c.a., type BA.

(52)

Freno *Brake* Bremse *Frein*	Coppia frenante M_b *Brake torque M_b* Bremsmoment M_b *Couple de freinage M_b* [Nm]	Rilascio *Release* Ansprechzeit *Déblocage* t_1 [ms]	Frenatura *Braking* Bremszeit *Freinage* t_2 [ms]	W max [J] 10 c/h	W max [J] 100 c/h	W max [J] 1000 c/h	W [MJ]	Pb [VA]
BA 60	5	5	20	4000	1500	180	30	60
BA 70	8	6	25	7000	2700	300	60	75
BA 80	18	6	25	10000	3100	350	80	110
BA 90	35	8	35	13000	3600	400	88	185
BA 100	50	8	35	18000	4500	500	112	225
BA 110	75	8	35	28000	6800	750	132	270
BA 140	150	15	60	60000	14000	1500	240	530

Legenda:

- M_b = max coppia frenante statica (± 15%)
- t_1 = tempo di rilascio del freno
- t_2 = ritardo di frenatura
- W_{max} = energia max per frenata (capacità termica del freno)
- W = energia di frenatura tra due regolazioni successive del traferro
- P_b = potenza assorbita dal freno a 20°C (50 Hz)
- c/h = avviamenti orari

Legenda:

- M_b = *max static braking torque (15%)*
- t_1 = *brake release response time*
- t_2 = *brake engagement time*
- W_{max} = *max energy per brake operation (brake thermal capacity)*
- W = *braking energy between two successive air gap adjustments*
- P_b = *brake power absorption at 20° (50 Hz)*
- c/h = *starts per hour*

Legende:

- M_b = statisches max. Bremsmoment (± 15%)
- t_1 = Bremsenansprechzeit
- t_2 = Bremsverzögerung
- W_{max} = max. Energie pro Bremsung (Wärmeleistung der Bremse)
- W = Bremsenergie zwischen zwei Einstellungen des Luftspalts
- P_b = bei 20° von der Bremse aufgenommene Leistung (50 Hz)
- c/h = Schaltungen pro stunde

Légende:

- M_b = *couple de freinage statique max (15%)*
- t_1 = *temps de déblocage frein*
- t_2 = *retard de freinage*
- W_{max} = *énergie max par freinage (capacité thermique du frein)*
- W = *énergie de freinage entre deux réglages successifs de l'entrefer*
- P_b = *puissance absorbée par le frein à 20° (50 Hz)*
- c/h = *démarrages horaires*

N.B.

I valori di t_1 e t_2 riportati in tabella sono riferiti al freno tarato alla coppia nominale, traferro medio e tensione nominale.

NOTE :

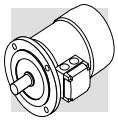
Values t_1 and t_2 in the table refer to a brake set at rated torque, medium air gap and rated voltage.

HINWEIS:

Die in der Tabelle angegebenen Werte t_1 und t_2 beziehen sich auf eine Bremse, die auf das Nenndrehmoment, einen mittleren Luftspalt und die Standardspannung eingestellt ist.

N.B.

Les valeurs de t_1 et t_2 indiquées dans le tableau se réfèrent au frein étalonné au couple nominal, entrefer moyen et tension nominale.



- Collegamenti freno BA

Per i motori con alimentazione del freno derivata direttamente dall'alimentazione motore i collegamenti alla morsettiera corrispondono a quanto riportato nello schema (53):

- BA brake connections

The diagram (53) shows the required connections to terminal box when brake is to be connected directly to motor power supply:

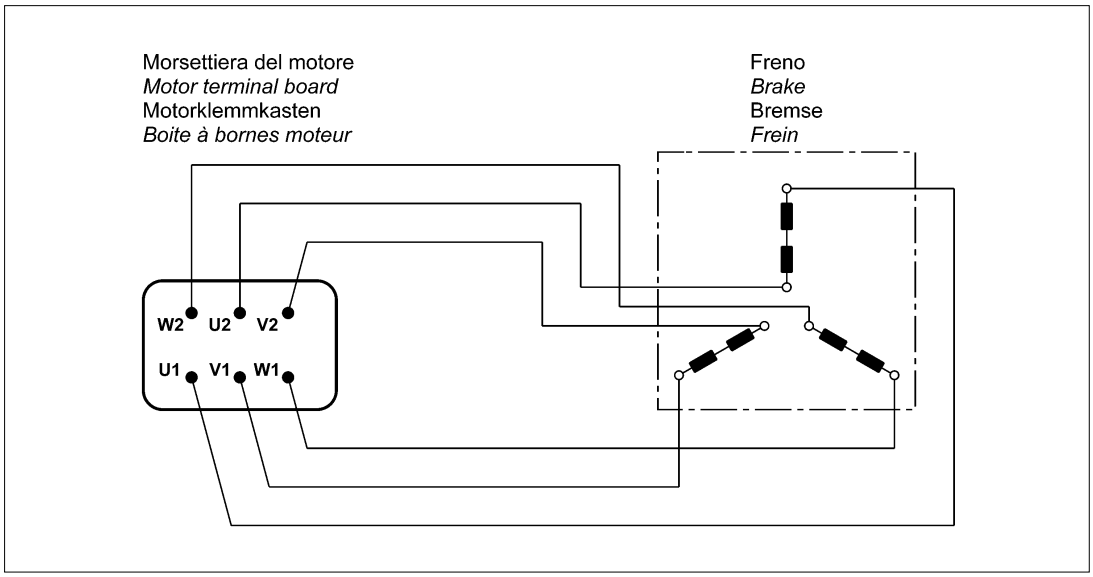
- Anschlüsse - Bremstyp BA

Bei den Motoren mit einer direkt von der Motorspannung gespeisten Bremsversorgung müssen die Bremsen entsprechend der Angaben im Schema (53) angeschlossen werden:

- Raccordements frein BA

Pour les moteurs avec alimentation du frein dérivant directement de l'alimentation moteur, les raccordements à la boîte à bornes correspondent aux indications du schéma (53) :

(53)



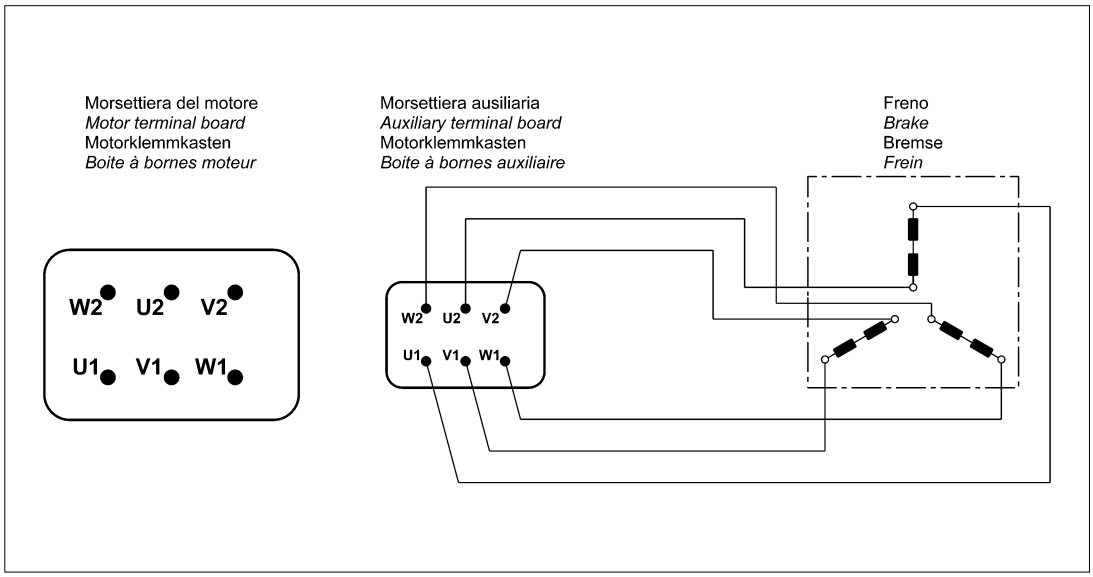
Per i motori a doppia polarità e, quando richiesto, per i motori ad una velocità con alimentazione da linea separata è prevista una morsettiera ausiliaria a 6 morsetti per il collegamento del freno; in questa esecuzione i motori prevedono la scatola coprimorsetti maggiorata. Vedi schema (54):

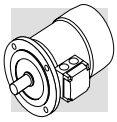
Switch-pole motors and, at request, single-pole motors with separate power supply line are equipped with an auxiliary terminal board with 6 terminals for brake connection. In this version, motors feature a larger terminal box. See diagram (54):

Bei den polumschaltbaren Motoren und, auf Anfrage, auch bei den eintpoligen Motoren mit separater Bremsversorgung ist für den Anschluss der Bremse ein Hilfsklemmenkasten mit 6 Klemmen vorgesehen. In dieser Ausführungen haben die Motoren einen größeren Klemmenkasten. Siehe Schema (54):

Pour les moteurs à double polarité et, lorsque cela est requis, pour les moteurs à une vitesse avec alimentation depuis ligne séparée, une boîte à bornes auxiliaire à 6 bornes est prévue pour le raccordement du frein ; dans cette exécution les moteurs prévoient un couvercle bornier majoré. Voir schéma (54) :

(54)

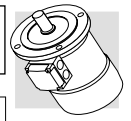




2 P

3000 min^{-1} - S1

50 Hz



Pn kW		n min^{-1}	Mn Nm	η %	cos φ	In A (400 V)	Is / In	Ms / Mn	Ma / Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.18	**BN 63A 2**	2700	0.64	53	0.78	0.63	3.0	2.1	2	2.0	3.5
0.25	**BN 63B 2**	2700	0.88	62	0.78	0.75	3.3	2.3	2.3	2.3	3.9
0.37	**BN 63C 2**	2750	1.29	64	0.79	1.06	3.9	2.6	2.6	3.3	5.1
0.37	**BN 71A 2**	2810	1.26	70	0.78	0.98	4.8	2.8	2.6	3.5	5.4
0.55	**BN 71B 2**	2810	1.87	73	0.77	1.41	5.0	2.9	2.8	4.1	6.2
0.75	**BN 71C 2**	2800	2.6	74	0.77	1.90	5.1	3.1	2.8	5.0	7.3
0.75	**BN 80A 2**	2800	2.6	74	0.78	1.88	4.8	2.6	2.2	7.8	8.6
1.1	**BN 80B 2**	2800	3.8	76	0.77	2.71	4.8	2.8	2.4	9.0	9.5
1.5	**BN 80C 2**	2800	5.1	80	0.81	3.3	4.9	2.7	2.4	11.4	11.3
1.5	**BN 90SA 2**	2870	5.0	78	0.78	3.6	5.9	2.7	2.6	12.5	12.3
1.85	**BN 90SB 2**	2880	6.1	79	0.79	4.3	6.2	2.9	2.6	16.7	14
2.2	**BN 90L 2**	2880	7.3	79	0.79	5.1	6.3	2.9	2.7	16.7	14
3	**BN 100L 2**	2860	10.0	80	0.80	6.8	5.7	2.6	2.2	31	20
4	**BN 100LB 2**	2870	13.3	82	0.81	8.7	5.9	2.7	2.5	39	23
4	**BN 112M 2**	2900	13.2	83	0.84	8.3	6.9	3	2.9	57	28
5.5	**BN 132SA 2**	2890	18.2	83	0.85	11.3	6	2.6	2.2	101	35
7.5	**BN 132SB 2**	2900	25	84	0.86	15.0	6.4	2.6	2.2	145	42
9.2	**BN 132M 2**	2900	30	86	0.87	17.7	6.9	2.8	2.3	178	53
11	**BN 160MR 2**	2910	36	87	0.86	21	7.0	2.9	2.5	210	65
15	**BN 160MB 2**	2930	49	88	0.86	29	7.1	2.6	2.3	340	84
18.5	**BN 160L 2**	2930	60	89	0.86	35	7.6	2.7	2.3	420	97
22	**BN 180M 2**	2930	72	89	0.87	41	7.8	2.6	2.4	490	109
30	**BN 200LA 2**	2960	97	90	0.88	55	7.9	2.7	2.9	770	140

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} Kgm^2	IM B5 Kg
FD 02	1.75	3900	4800	2.6	5.2
FD 02	1.75	3900	4800	3.0	5.6
FD 02	3.5	3600	4500	3.9	6.8
FD 03	3.5	3000	4100	4.6	8.1
FD 03	5	2900	4200	5.3	8.9
FD 03	5	1900	3300	6.1	10
FD 04	5	1700	3200	9.4	12.5
FD 04	10	1500	3000	10.6	13.4
FD 04	15	1300	2600	13.0	15.2
FD 14	15	900	2200	14.1	16.5
FD 14	15	900	2200	18.3	18.2
FD 05	26	900	2200	21	20
FD 15	26	700	1600	35	26
FD 15	40	450	900	43	29
FD 06S	40	—	950	66	39
FD 06	50	—	600	112	48
FD 06	50	—	550	154	55
FD 56	75	—	430	189	66

freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 02	1.75	4800	2.6	5.0
FA 02	1.75	4800	3.0	5.4
FA 02	3.5	4500	3.9	6.6
FA 03	3.5	4200	4.6	7.8
FA 03	5	4200	5.3	8.6
FA 03	5	3600	6.1	9.7
FA 04	5	3200	9.4	12.4
FA 04	10	3000	10.6	13.3
FA 04	15	2600	13.0	15.1
FA 14	15	2200	14.1	16.4
FA 14	15	2200	18.3	18.1
FA 05	26	2200	21	20.7
FA 15	26	1600	35	27
FA 15	40	1000	43	30
FA 06S	40	950	66	40
FA 06	50	600	112	49
FA 06	50	550	154	56
FA 06	75	430	189	67

BA

Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 60	5	3500	4.0	5.8
BA 60	5	3600	4.3	6.2
BA 60	5	3500	5.3	7.4
BA 70	8	3500	5.5	9.3
BA 70	8	3600	6.1	10.1
BA 70	8	3200	7.0	11.2
BA 80	18	2800	10.8	13.9
BA 80	18	2700	12.0	14.8
BA 80	18	2400	14.4	16.6
BA 90	35	1600	19.5	19.6
BA 90	35	1700	23.7	21.3
BA 90	35	1700	24	21.3
BA 100	50	1300	43	30
BA 100	50	850	51	33
BA 110	75	850	73	41
BA 140	150	500	151	67
BA 140	150	450	195	74
BA 140	150	400	228	85

4 P — 1500 min^{-1} - S1 — 50 Hz

Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.06	**BN 56A**	**4**	1350	0.42	47	0.62	0.30	2.6	2.3	2.0	1.5	3.1
0.09	**BN 56B**	**4**	1350	0.64	52	0.62	0.40	2.6	2.5	2.4	1.5	3.1
0.12	**BN 63A**	**4**	1310	0.88	51	0.68	0.50	2.6	1.9	1.8	2.0	3.5
0.18	**BN 63B**	**4**	1320	1.30	53	0.68	0.72	2.6	2.2	2.0	2.3	3.9
0.25	**BN 63C**	**4**	1320	1.81	60	0.69	0.87	2.7	2.1	1.9	3.3	5.1
0.25	**BN 71A**	**4**	1375	1.74	62	0.77	0.76	3.3	1.9	1.7	5.8	5.1
0.37	**BN 71B**	**4**	1370	2.6	65	0.77	1.07	3.7	2.0	1.9	6.9	5.9
0.55	**BN 71C**	**4**	1380	3.8	69	0.74	1.55	4.1	2.3	2.3	9.1	7.3
0.55	**BN 80A**	**4**	1390	3.8	72	0.77	1.43	4.1	2.3	2.0	15	8.2
0.75	**BN 80B**	**4**	1400	5.1	75	0.78	1.85	4.9	2.7	2.5	20	9.9
1.1	**BN 80C**	**4**	1400	7.5	75	0.79	2.68	5.1	2.8	2.5	25	11.3
1.1	**BN 90S**	**4**	1400	7.5	73	0.77	2.82	4.6	2.6	2.2	21	12.2
1.5	**BN 90LA**	**4**	1410	10.2	77	0.77	3.7	5.3	2.8	2.4	28	13.6
1.85	**BN 90LB**	**4**	1400	12.6	77	0.78	4.4	5.2	2.8	2.6	30	15.1
2.2	**BN 100LA**	**4**	1410	14.9	78	0.76	5.4	4.5	2.2	2.0	40	18.3
3	**BN 100LB**	**4**	1410	20	80	0.78	6.9	5	2.3	2.2	54	22
4	**BN 112M**	**4**	1420	27	83	0.78	8.9	5.6	2.7	2.5	98	30
5.5	**BN 132S**	**4**	1440	36	84	0.80	11.8	5.5	2.3	2.2	213	44
7.5	**BN 132MA**	**4**	1440	50	85	0.81	15.7	5.7	2.5	2.4	270	53
9.2	**BN 132MB**	**4**	1440	61	86	0.81	19.1	5.9	2.7	2.5	319	59
11	**BN 160MR**	**4**	1440	73	87	0.82	22.3	5.9	2.7	2.5	360	70
15	**BN 160L**	**4**	1460	98	89	0.82	29.7	5.9	2.3	2.1	650	99
18.5	**BN 180M**	**4**	1460	121	89	0.81	37.0	6.2	2.6	2.5	790	115
22	**BN 180L**	**4**	1465	143	89	0.82	45	6.5	2.5	2.5	1250	135
30	**BN 200L**	**4**	1465	196	90	0.83	58	7.1	2.7	2.8	1650	157

freno c.c. / *d.c. brake* — G.S.-bremse / *frein c.c.*

FD

Mod	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} Kgm^2	IM B5 Kg
FD 02	1.75	10000	13000	2.6	5.2
FD 02	3.5	10000	13000	3.0	5.6
FD 02	3.5	7800	10000	3.9	6.8
FD 03	3.5	7700	11000	6.9	7.8
FD 03	5.0	6000	9400	8.0	8.6
FD 53	7.5	4300	8700	10.2	10
FD 04	10	4100	8000	16.6	12.1
FD 04	15	4100	7800	22	13.8
FD 04	15	2600	5300	27	15.2
FD 14	15	4800	8000	23	16.4
FD 05	26	3400	6000	32	19.6
FD 05	26	3200	5900	34	21.1
FD 15	40	2600	4700	44	25
FD 15	40	2400	4400	58	28
FD 06S	60	—	1400	107	40
FD 56	75	—	1050	223	57
FD 06	100	—	950	280	66
FD 07	150	—	900	342	75
FD 07	150	—	850	382	86
FD 08	200	—	750	725	129
FD 08	250	—	700	865	145
FD 09	300	—	400	1450	175
FD 09	400	—	300	1850	197

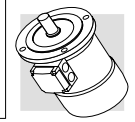
freno c.a. / *a.c. brake* — W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 02	1.75	13000	2.6	5.0
FA 02	3.5	13000	3.0	5.4
FA 02	3.5	10000	3.9	6.6
FA 03	3.5	11000	6.9	7.5
FA 03	5.0	9400	8.0	8.3
FA 03	7.5	8700	10.2	9.7
FA 04	10	8000	16.6	12.0
FA 04	15	7800	22	13.7
FA 04	15	5300	27	15.1
FA 14	15	8000	23	16.3
FA 05	26	6000	32	20.3
FA 05	26	5900	34	21.8
FA 15	40	4700	44	25
FA 15	40	4400	58	29
FA 06S	60	2100	107	42
FA 06	75	1200	223	58
FA 07	100	1000	280	71
FA 07	150	900	342	77
FA 07	150	850	382	88
FA 08	200	750	710	128
FA 08	250	700	850	144

BA

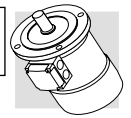
Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 60	5	9000	4.0	5.8
BA 60	5	9000	4.3	6.2
BA 60	5	8500	5.3	7.4
BA 70	8	9700	7.8	9.0
BA 70	8	8500	8.9	9.8
BA 70	8	8000	11.1	11.2
BA 80	18	7400	18	13.5
BA 80	18	7400	23	15.2
BA 80	18	5100	28	16.6
BA 90	35	6500	28	19.5
BA 90	35	5400	35	21
BA 90	35	5400	37	22
BA 100	50	4000	52	29
BA 100	50	3800	66	32
BA 110	75	2000	114	43
BA 140	150	1200	263	76
BA 140	150	1000	320	85
BA 140	150	900	369	91



6 P

1000 min^{-1} - S1

50 Hz



Pn kW		n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.09	**BN 63A 6**	880	0.98	41	0.53	0.60	2.1	2.1	1.8	3.4	4.6
0.12	**BN 63B 6**	870	1.32	45	0.60	0.64	2.1	1.9	1.7	3.7	4.9
0.18	**BN 71A 6**	900	1.91	56	0.69	0.67	2.6	1.9	1.7	8.4	5.5
0.25	**BN 71B 6**	900	2.7	62	0.71	0.82	2.6	1.9	1.7	10.9	6.7
0.37	**BN 71C 6**	910	3.9	66	0.69	1.17	3	2.4	2.0	12.9	7.7
0.37	**BN 80A 6**	910	3.9	68	0.68	1.15	3.2	2.2	2.0	21	9.9
0.55	**BN 80B 6**	920	5.7	70	0.69	1.64	3.9	2.6	2.2	25	11.3
0.75	**BN 80C 6**	920	7.8	70	0.65	2.38	3.8	2.5	2.2	28	12.2
0.75	**BN 90S 6**	920	7.8	69	0.68	2.31	3.8	2.4	2.2	26	12.6
1.1	**BN 90L 6**	920	11.4	72	0.69	3.2	3.9	2.3	2.0	33	15
1.5	**BN 100LA 6**	940	15.2	73	0.72	4.1	4	2.1	2.0	82	22
1.85	**BN 100LB 6**	930	19.0	75	0.73	4.9	4.5	2.1	2.0	95	24
2.2	**BN 112M 6**	940	22	78	0.73	5.6	4.8	2.2	2.0	168	32
3	**BN 132S 6**	940	30	76	0.76	7.5	4.8	1.9	1.8	216	36
4	**BN 132MA 6**	950	40	78	0.77	9.6	5.5	2.0	1.8	295	45
5.5	**BN 132MB 6**	945	56	80	0.78	12.7	5.9	2.1	1.9	383	56
7.5	**BN 160M 6**	955	75	84	0.81	15.9	5.9	2.2	2.0	740	83
11	**BN 160L 6**	960	109	87	0.81	22.5	6.5	2.5	2.3	970	103
15	**BN 180L 6**	970	148	88	0.82	30	6.2	2.0	2.4	1550	130
18.5	**BN 200LA 6**	960	184	88	0.81	37	5.9	2.0	2.3	1700	145

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} kgm^2	IM B5 Kg
FD 02	3.5	9000	14000	4.0	6.3
FD 02	3.5	9000	14000	4.3	6.6
FD 03	5.0	8100	13500	9.5	8.2
FD 03	5.0	7800	13000	12	9.4
FD 53	7.5	5100	9500	14	10.4
FD 04	10	5200	8500	23	13.8
FD 04	15	4800	7200	27	15.2
FD 04	15	3400	6400	30	16.1
FD 14	15	3400	6500	28	16.8
FD 05	26	2700	5000	37	21
FD 15	40	1900	4100	86	28
FD 15	40	1700	3600	99	30
FD 06S	60	—	2100	177	42
FD 56	75	—	1400	226	49
FD 06	100	—	1200	305	58
FD 07	150	—	1050	406	72
FD 08	170	—	900	815	112
FD 08	200	—	800	1045	133
FD 09	300	—	600	1750	170
FD 09	400	—	450	1900	185

freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 02	3.5	14000	4.0	6.1
FA 02	3.5	14000	4.3	6.4
FA 03	5.0	13500	9.5	7.9
FA 03	5.0	13000	12	9.1
FA 03	7.5	9500	14	10.1
FA 04	10	8500	23	13.7
FA 04	15	7200	27	15.1
FA 04	15	6400	30	16.0
FA 14	15	6500	28	16.7
FA 05	26	5000	37	22
FA 15	40	4100	86	29
FA 15	40	3600	99	31
FA 06S	60	2100	177	44
FA 06	75	1400	226	50
FA 07	100	1200	318	63
FA 07	150	1050	406	74
FA 08	170	900	815	113
FA 08	200	800	1045	133

BA

Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 60	5	12000	5.4	6.9
BA 60	5	12000	5.7	7.2
BA 70	8	12300	10.4	9.4
BA 70	8	12000	12.9	10.6
BA 70	8	8900	14.9	11.6
BA 80	18	8000	24	15.2
BA 80	18	6800	28	16.6
BA 80	18	6100	31	17.5
BA 90	35	5500	33	19.9
BA 90	35	4600	40	22
BA 100	50	3800	94	32
BA 100	50	3400	107	34
BA 110	75	2000	184	45
BA 140	150	1200	266	68
BA 140	150	1050	345	77
BA 140	150	1000	433	88

8 P — 750 min^{-1} - S1 — 50 Hz

Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.09	**BN 71A**	**8**	680	1.26	47	0.59	0.47	2.3	2.4	2.3	10.9	6.7
0.12	**BN 71B**	**8**	680	1.69	51	0.59	0.58	2.1	2.3	2.2	12.9	7.7
0.18	**BN 80A**	**8**	690	2.49	51	0.60	0.85	2.4	2.2	2.2	15	8.2
0.25	**BN 80B**	**8**	680	3.51	54	0.63	1.06	2.4	2.0	1.9	20	9.9
0.37	**BN 90S**	**8**	675	5.2	58	0.60	1.53	2.6	2.3	2.1	26	12.6
0.55	**BN 90L**	**8**	670	7.8	62	0.60	2.13	2.6	2.2	2.0	33	15
0.75	**BN 100LA**	**8**	700	10.2	68	0.63	2.53	3.4	1.9	1.7	82	22
1.1	**BN 100LB**	**8**	700	15.0	68	0.64	3.65	3.2	1.7	1.7	95	24
1.5	**BN 112M**	**8**	710	20.2	71	0.66	4.6	3.7	1.8	1.9	168	32
2.2	**BN 132S**	**8**	710	29.6	75	0.66	6.4	3.8	1.8	2.0	295	45
3	**BN 132MA**	**8**	710	40.4	76	0.69	8.3	3.9	1.6	1.8	370	53

freno c.c. / *d.c. brake* G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} kgm^2	IM B5 Kg
FD 03	3.5	9000	16000	12.0	9.4
FD 03	5.0	9000	16000	14.0	10.4
FD 04	5.0	6500	11000	16.6	12.1
FD 04	10.0	6000	10000	22	13.8
FD 14	15.0	4800	7500	28	16.8
FD 05	26	4000	6400	37	21
FD 15	26	2800	4800	86	28
FD 15	40	2500	4000	99	30
FD 06S	60	—	3000	177	42
FD 56	75	—	2300	305	58
FD 06	100	—	1900	394	69

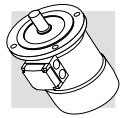
freno c.a. / *a.c. brake* W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 03	3.5	16000	12.0	9.1
FA 03	5.0	16000	14.0	10.1
FA 04	5.0	11000	16.6	12.0
FA 04	10.0	10000	23	13.7
FA 14	15.0	7500	28	16.7
FA 05	26	6400	37	22
FA 15	26	4800	86	29
FA 15	40	4000	99	31
FA 06S	60	3000	177	44
FA 06	75	2300	305	56
FA 07	100	1900	406	74

BA

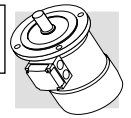
Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 70	8.0	14000	12.9	10.6
BA 70	8.0	14000	14.9	11.6
BA 80	18.0	10000	—	—
BA 80	18.0	9500	24	15.2
BA 90	35	6800	33	19.9
BA 90	35	6000	40	22
BA 100	50	4500	94	32
BA 100	50	3700	107	34
BA 110	75	2700	184	45
BA 140	150	2000	345	77
BA 140	150	1700	433	88



2/4 P

3000/1500 min^{-1} - S1

50 Hz



Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.20	**BN 63B**	**2**	2700	0.71	55	0.82	0.64	3.5	2.1	1.9	2.9	4.4
0.15		**4**	1350	1.06	49	0.67	0.66	2.6	1.8	1.7		
0.28	**BN 71A**	**2**	2700	0.99	56	0.82	0.88	2.9	1.9	1.7	4.7	4.4
0.20		**4**	1370	1.39	59	0.72	0.68	3.1	1.8	1.7		
0.37	**BN 71B**	**2**	2740	1.29	56	0.82	1.16	3.5	1.8	1.8	5.8	5.1
0.25		**4**	1390	1.72	60	0.73	0.82	3.3	2.0	1.9		
0.45	**BN 71C**	**2**	2780	1.55	63	0.85	1.21	3.8	1.8	1.8	6.9	5.9
0.30		**4**	1400	2.0	63	0.73	0.94	3.6	2.0	1.9		
0.55	**BN 80A**	**2**	2800	1.9	63	0.85	1.48	3.9	1.7	1.7	15	8.2
0.37		**4**	1400	2.5	67	0.79	1.01	4.1	1.8	1.9		
0.75	**BN 80B**	**2**	2780	2.6	65	0.85	1.96	3.8	1.9	1.8	20	9.9
0.55		**4**	1400	3.8	68	0.81	1.44	3.9	1.7	1.7		
1.1	**BN 90S**	**2**	2790	3.8	71	0.82	2.73	4.7	2.3	2.0	21	12.2
0.75		**4**	1390	5.2	66	0.79	2.08	4.6	2.4	2.2		
1.5	**BN 90L**	**2**	2780	5.2	70	0.85	3.64	4.5	2.4	2.1	28	14.0
1.1		**4**	1390	7.6	73	0.81	2.69	4.7	2.5	2.2		
2.2	**BN 100LA**	**2**	2800	7.5	72	0.85	5.2	4.5	2.0	1.9	40	18.3
1.5		**4**	1410	10.2	73	0.79	3.8	4.7	2.0	2.0		
3.5	**BN 100LB**	**2**	2850	11.7	80	0.84	7.5	5.4	2.2	2.1	61	25
2.5		**4**	1420	16.8	82	0.80	5.5	5.2	2.2	2.2		
4	**BN 112M**	**2**	2880	13.3	79	0.83	8.8	6.1	2.4	2.0	98	30
3.3		**4**	1420	22.2	80	0.80	7.4	5.1	2.1	2.0		
5.5	**BN 132S**	**2**	2890	18.2	80	0.87	11.4	5.9	2.4	2.0	213	44
4.4		**4**	1440	29	82	0.84	9.2	5.3	2.2	2.0		
7.5	**BN 132MA**	**2**	2900	25	82	0.87	15.2	6.5	2.4	2.0	270	53
6		**4**	1430	40	84	0.85	12.1	5.8	2.3	2.1		
9.2	**BN 132MB**	**2**	2920	30	83	0.86	18.6	6.0	2.6	2.2	319	59
7.3		**4**	1440	48	85	0.85	14.6	5.5	2.3	2.1		

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} kgm^2	IM B5 Kg
FD 02	3.5	2200	2600	3.5	6.1
		4000	5100		
FD 03	3.5	2100	2400	5.8	7.1
		3800	4800		
FD 03	5	1400	2100	6.9	7.8
		2900	4200		
FD 03	5	1400	2100	8.0	8.6
		2900	4200		
FD 04	5	1600	2300	16.6	12.1
		3000	4000		
FD 04	10	1400	1600	22	13.8
		2700	3600		
FD 14	10	1500	1600	23	16.4
		2300	2800		
FD 05	26	1050	1200	32	20
		1600	2000		
FD 15	26	600	900	44	25
		1300	2300		
FD 15	40	500	900	65	31
		1000	2100		
FD 06S	60	—	700	107	40
		—	1200		
FD 56	75	—	350	223	57
		—	900		
FD 06	100	—	350	280	66
		—	900		
FD 07	150	—	300	342	75
		—	800		

freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 02	3.5	2600	3.5	5.9
		5100		
FA 03	3.5	2400	5.8	6.8
		4800		
FA 03	5	2100	6.9	7.5
		4200		
FA 03	5	2100	8.0	8.3
		4200		
FA 04	5	2300	16.6	12.0
		4000		
FA 04	10	1600	22	13.7
		3600		
FA 14	10	1600	23	16.3
		2800		
FA 05	26	1200	32	21
		2000		
FA 15	26	900	44	25
		2300		
FA 15	40	900	65	32
		2100		
FA 06S	60	700	107	42
		1200		
FA 06	75	350	223	58
		900		
FA 07	100	350	293	71
		900		
FA 07	150	300	342	77
		800		

BA

Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 60	5	2000	4.9	6.7
		4000		
BA 70	8	2100	5.6	8.3
		4200		
BA 70	8	1800	7.8	9.0
		3600		
BA 70	8	1800	8.9	9.8
		3600		
BA 80	18	2100	18	13.5
		3700		
BA 80	18	1500	22	15.2
		3300		
BA 90	35	1300	28	19.5
		2300		
BA 90	35	1100	35	21
		1800		
BA 100	50	750	51	29
		1900		
BA 100	50	750	72	35
		1800		
BA 110	75	600	114	43
		1100		
BA 140	150	300	263	76
		750		
BA 140	150	300	320	85
		800		
BA 140	150	300	369	91
		750		

2/6 P

3000/1000 min^{-1} - S3 60/40%

50 Hz

Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.25	**BN 71A**	**2**	2850	0.84	60	0.82	0.73	4.3	1.9	1.8	6.9	5.9
0.08		**6**	910	0.84	43	0.70	0.38	2.1	1.4	1.5		
0.37	**BN 71B**	**2**	2880	1.23	62	0.80	1.08	4.4	1.9	1.8	9.1	7.3
0.12		**6**	900	1.27	44	0.73	0.54	2.4	1.4	1.5		
0.55	**BN 80A**	**2**	2800	1.88	63	0.86	1.47	4.5	1.9	1.7	20	9.9
0.18		**6**	930	1.85	52	0.65	0.77	3.3	2	1.9		
0.75	**BN 80B**	**2**	2800	2.6	66	0.87	1.89	4.3	1.8	1.6	25	11.3
0.25		**6**	930	2.6	54	0.67	1.00	3.2	1.7	1.8		
1.1	**BN 90L**	**2**	2860	3.7	67	0.84	2.82	4.7	2.1	1.9	28	14.0
0.37		**6**	920	3.8	59	0.71	1.27	3.3	1.6	1.6		
1.5	**BN 100LA**	**2**	2880	5.0	73	0.84	3.53	5.1	1.9	2.0	40	18.3
0.55		**6**	940	5.6	64	0.67	1.85	3.5	1.7	1.8		
2.2	**BN 100LB**	**2**	2900	7.2	77	0.85	4.9	5.9	2.0	2.0	61	25
0.75		**6**	950	7.5	67	0.64	2.5	3.3	1.9	1.8		
3	**BN 112M**	**2**	2900	9.9	78	0.87	6.4	6.3	2.0	2.1	98	30
1.1		**6**	950	11.1	72	0.64	3.4	3.9	1.8	1.8		
4.5	**BN 132S**	**2**	2910	14.8	78	0.84	9.9	5.8	1.9	1.8	213	44
1.5		**6**	960	14.9	74	0.67	4.4	4.2	1.9	2.0		
5.5	**BN 132M**	**2**	2920	18.0	78	0.87	11.7	6.2	2.1	1.9	270	53
2.2		**6**	960	22	77	0.71	5.8	4.3	2.1	2.0		

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} kgm^2	IM B5 Kg
FD 03	1.75	1500	1700	8.0	8.6
		10000	13000		
FD 03	3.5	1000	1300	10.2	10.0
		9000	11000		
FD 04	5	1500	1800	22	13.8
		4100	6300		
FD 04	5	1700	1900	27	15.2
		3800	6000		
FD 05	13	1400	1600	32	20
		3400	5200		
FD 15	13	1000	1200	44	24
		2900	4000		
FD 15	26	700	900	65	31
		2100	3000		
FD 06S	40	—	1000	107	40
		—	2600		
FD 56	37	—	500	223	57
		—	2100		
FD 56	50	—	400	280	66
		—	1900		

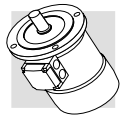
freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 03	2.5	1700	8.0	8.3
		13000		
FA 03	3.5	1300	10.2	9.7
		11000		
FA 04	5	1800	22	13.7
		6300		
FA 04	5	1900	27	15.1
		6000		
FA 05	13	1600	32	21
		5200		
FA 15	13	1200	44	25
		4000		
FA 15	26	900	65	32
		3000		
FA 06S	40	1000	107	32
		2600		
FA 06	37	500	223	58
		2100		
FA 06	50	400	280	67
		1900		

BA

Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 70	8	1500	8.9	9.8
		11000		
BA 70	8	1200	11.1	11.2
		10000		
BA 80	18	1700	23	15.2
		6000		
BA 80	18	1800	28	16.6
		5600		
BA 90	35	1500	35	21
		4700		
BA 100	50	1050	51	29
		3500		
BA 100	50	800	72	36
		2700		
BA 110	75	930	114	43
		2400		
BA 140	150	400	263	76
		1700		
BA 140	150	350	320	85
		1600		



2/8 P

3000/750 min^{-1} - S3 60/40%

50 Hz

Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.25	**BN 71A**	**2**	2790	0.86	61	0.87	0.68	3.9	1.8	1.9	10.9	6.7
0.06		**8**	680	0.84	31	0.61	0.46	2	1.8	1.9		
0.37	**BN 71B**	**2**	2800	1.26	63	0.86	0.99	3.9	1.8	1.9	12.9	7.7
0.09		**8**	670	1.28	34	0.75	0.51	1.8	1.4	1.5		
0.55	**BN 80A**	**2**	2830	1.86	66	0.86	1.40	4.4	2.1	2.0	20	9.9
0.13		**8**	690	1.80	41	0.64	0.72	2.3	1.6	1.7		
0.75	**BN 80B**	**2**	2800	2.6	68	0.88	1.81	4.6	2.1	2.0	25	11.3
0.18		**8**	690	2.5	43	0.66	0.92	2.3	1.6	1.7		
1.1	**BN 90L**	**2**	2830	3.7	63	0.84	3.00	4.5	2.1	1.9	28	14
0.28		**8**	690	3.9	48	0.63	1.34	2.4	1.8	1.9		
1.5	**BN 100LA**	**2**	2880	5.0	69	0.85	3.69	4.7	1.9	1.8	40	18.3
0.37		**8**	690	5.1	46	0.63	1.84	2.1	1.6	1.6		
2.4	**BN 100LB**	**2**	2900	7.9	75	0.82	5.6	5.4	2.1	2.0	61	25
0.55		**8**	700	7.5	54	0.58	2.5	2.6	1.8	1.8		
3	**BN 112M**	**2**	2900	9.9	76	0.87	6.5	6.3	2.1	1.9	98	30
0.75		**8**	690	10.4	60	0.65	2.8	2.5	1.6	1.6		
4	**BN 132S**	**2**	2870	13.3	73	0.84	9.4	5.6	2.3	2.4	213	44
1		**8**	690	13.8	66	0.62	3.5	2.9	1.9	1.8		
5.5	**BN 132M**	**2**	2870	18.3	75	0.84	12.6	6.1	2.4	2.5	270	53
1.5		**8**	690	21	68	0.63	5.1	2.9	1.9	1.9		

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} kgm^2	IM B5 Kg
FD 03	1.75	1300	1400	12	9.4
		10000	13000		
FD 03	3.5	1200	1300	14	10.4
		9500	13000		
FD 04	5	1500	1800	22	13.8
		5600	8000		
FD 04	10	1700	1900	27	15.2
		4800	7300		
FD 05	13	1400	1600	32	20
		3400	5100		
FD 15	13	1000	1200	44	25
		3300	5000		
FD 15	26	550	700	65	31
		2000	3500		
FD 06S	40	—	900	107	40
		—	2900		
FD 56	37	—	500	223	57
		—	3500		
FD 06	50	—	400	280	66
		—	2400		

freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 03	2.5	1400	12	9.1
		13000		
FA 03	3.5	1300	14	10.1
		13000		
FA 04	5	1800	22	13.7
		8000		
FA 04	10	1900	27	15.1
		7300		
FA 05	13	1600	32	21
		5100		
FA 15	13	1200	44	25
		5000		
FA 15	26	700	65	32
		3500		
FA 06S	40	900	107	42
		2900		
FA 06	37	500	223	58
		3500		
FA 06	50	400	280	67
		2400		

BA

Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 70	8	1300	12.9	10.6
		12000		
BA 70	8	1200	14.9	11.6
		12000		
BA 80	18	1700	23	15.2
		7500		
BA 80	18	1800	28	16.6
		7000		
BA 90	35	1400	35	21
		4500		
BA 100	50	1000	52	29
		4200		
BA 100	50	600	72	36
		3100		
BA 110	75	800	114	43
		2700		
BA 140	150	400	263	76
		3000		
BA 140	150	350	320	85
		2100		

2/12 P

3000/500 min^{-1} - S3 60/40%

50 Hz

Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.55	**BN 80B**	**2**	2820	1.86	64	0.89	1.39	4.2	1.6	1.7	25	11.3
0.09		**12**	430	2.0	30	0.63	0.69	1.8	1.9	1.8		
0.75	**BN 90L**	**2**	2790	2.6	56	0.89	2.17	4.2	1.8	1.7	26	12.6
0.12		**12**	430	2.7	26	0.63	1.06	1.7	1.4	1.6		
1.1	**BN 100LA**	**2**	2850	3.7	65	0.85	2.87	4.5	1.6	1.8	40	18.3
0.18		**12**	430	4.0	26	0.54	1.85	1.5	1.3	1.5		
1.5	**BN 100LB**	**2**	2900	4.9	67	0.86	3.76	5.6	1.9	1.9	54	22
0.25		**12**	440	5.4	36	0.46	2.18	1.8	1.7	1.8		
2	**BN 112M**	**2**	2900	6.6	74	0.88	4.43	6.5	2.1	2	98	30
0.3		**12**	460	6.2	46	0.43	2.19	2	2.1	2		
3	**BN 132S**	**2**	2920	9.8	74	0.87	6.7	6.8	2.3	1.9	213	44
0.5		**12**	470	10.2	51	0.43	3.3	2	1.7	1.6		
4	**BN 132M**	**2**	2920	13.1	75	0.89	8.6	5.9	2.4	2.3	270	53
0.7		**12**	460	14.5	53	0.44	4.3	1.9	1.7	1.6		

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} kgm^2	IM B5 Kg
FD 04	5	1000	1300	27	15.2
		8000	12000		
FD 05	13	1000	1150	30	18.6
		4600	6300		
FD 15	13	700	900	44	25
		4000	6000		
FD 15	13	700	900	58	28
		3800	5000		
FD 06S	20	—	800	107	40
		—	3400		
FD 56	37	—	450	223	57
		—	3000		
FD 56	37	—	400	280	66
		—	2800		

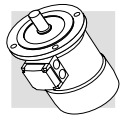
freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 04	5	1300	27	15.1
		12000		
FA 05	13	1150	30	19.3
		6300		
FA 15	13	900	44	25
		6000		
FA 15	13	900	58	29
		5000		
FA 06S	20	800	107	42
		3400		
FA 06	37	450	223	58
		3000		
FA 06	37	400	280	67
		2800		

BA

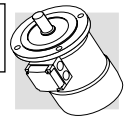
Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 80	18	1200	28	16.6
		11000		
BA 90	35	1050	33	19.9
		5700		
BA 100	50	750	52	29
		5000		
BA 100	50	800	66	32
		4300		
BA 110	75	750	114	43
		3200		
BA 140	150	380	263	76
		2500		
BA 140	150	350	320	85
		2500		



4/6 P

1500/1000 min^{-1} - S1

50 Hz



Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.22	**BN 71B**	**4**	1410	1.5	64	0.74	0.67	3.9	1.8	1.9	9.1	7.3
0.13		**6**	920	1.4	43	0.67	0.65	2.3	1.6	1.7		
0.30	**BN 80A**	**4**	1410	2.0	61	0.82	0.87	3.5	1.3	1.5	15	8.2
0.20		**6**	930	2.1	54	0.66	0.81	3.2	1.9	2.0		
0.40	**BN 80B**	**4**	1430	2.7	63	0.75	1.22	3.9	1.8	1.8	20	9.9
0.26		**6**	930	2.7	55	0.70	0.97	2.7	1.5	1.6		
0.55	**BN 90S**	**4**	1420	3.7	70	0.78	1.45	4.5	2.0	1.9	21	12.2
0.33		**6**	930	3.4	62	0.70	1.10	3.7	2.3	2.0		
0.75	**BN 90L**	**4**	1420	5.0	74	0.78	1.88	4.3	1.9	1.8	28	14
0.45		**6**	920	4.7	66	0.71	1.39	3.3	2.0	1.9		
1.1	**BN 100LA**	**4**	1450	7.2	74	0.79	2.72	5.0	1.7	1.9	82	22
0.8		**6**	950	8.0	65	0.69	2.57	4.1	1.9	2.1		
1.5	**BN 100LB**	**4**	1450	9.9	75	0.79	3.65	5.1	1.7	1.9	95	25
1.1		**6**	950	11.1	72	0.68	3.24	4.3	2.0	2.1		
2.3	**BN 112M**	**4**	1450	15.2	75	0.78	5.7	5.2	1.8	1.9	168	32
1.5		**6**	960	14.9	73	0.72	4.1	4.9	2.0	2.0		
3.1	**BN 132S**	**4**	1460	20	83	0.83	6.5	5.9	2.1	2.0	213	44
2		**6**	960	20	77	0.75	4.9	4.5	2.1	2.1		
4.2	**BN 132MA**	**4**	1460	27	84	0.82	8.8	5.9	2.1	2.2	270	53
2.6		**6**	960	26	79	0.72	6.6	4.3	2.0	2.0		

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h NB	Z_o 1/h SB	Jm x 10^{-4} kgm^2	IM B5 Kg
FD 03	3.5	2500	3500	10.2	10
		5000	9000		
FD 04	5	2500	3100	16.6	12.1
		4000	6000		
FD 04	10	1800	2300	22	13.8
		3600	5500		
FD 14	10	1500	2100	23	16.1
		2500	4100		
FD 05	13	1400	2000	32	20
		2300	3600		
FD 15	26	1400	2000	86	28
		2100	3300		
FD 15	26	1300	1800	99	31
		2000	3000		
FD 06S	40	—	1600	177	42
		—	2400		
FD 56	37	—	1200	223	57
		—	1900		
FD 06	50	—	900	280	66
		—	1500		

freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 03	3.5	3500	10.2	9.7
		9000		
FA 04	5	3100	16.6	12.0
		6000		
FA 04	10	2300	22	13.7
		5500		
FA 14	10	2100	23	16.3
		4100		
FA 05	13	2000	32	21
		3600		
FA 15	26	2000	86	29
		3300		
FA 15	26	1800	99	32
		3000		
FA 06S	40	1600	177	44
		2400		
FA 06	37	1200	223	58
		1900		
FA 06	50	900	280	67
		1500		

BA

Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 70	8	3200	11.1	11.2
		8200		
BA 80	18	2800	18	13.5
		5500		
BA 80	18	2200	23	15.2
		5200		
BA 90	35	1700	28	19.5
		3300		
BA 90	35	1800	35	21
		3300		
BA 100	50	1800	94	32
		3000		
BA 100	50	1600	107	34
		2800		
BA 110	75	1500	184	45
		2300		
BA 140	150	1000	263	76
		1600		
BA 140	150	800	320	85
		1300		

4/8 P

1500/750 min^{-1} - S1

50 Hz

Pn kW			n min^{-1}	Mn Nm	η %	cos φ	In A (400V)	Is/In	Ms/Mn	Ma/Mn	Jm x 10^{-4} kgm^2	IM B5 Kg
0.37	**BN 80A**	**4**	1400	2.5	63	0.82	1.03	3.3	1.4	1.4	15	8.2
0.18		**8**	690	2.5	44	0.60	0.98	2.2	1.5	1.6		
0.55	**BN 80B**	**4**	1390	3.8	65	0.86	1.42	3.8	1.7	1.6	20	9.9
0.30		**8**	670	4.3	49	0.65	1.36	2.3	1.7	1.8		
0.65	**BN 90S**	**4**	1390	4.5	73	0.85	1.51	4.0	1.9	1.9	28	13.6
0.35		**8**	690	4.8	49	0.57	1.81	2.5	2.1	2.2		
0.9	**BN 90L**	**4**	1370	6.3	73	0.87	2.05	3.8	1.8	1.8	30	15.1
0.5		**8**	670	7.1	57	0.62	2.04	2.4	2.1	2		
1.3	**BN 100LA**	**4**	1420	8.7	72	0.83	3.14	4.3	1.7	1.8	82	22
0.7		**8**	700	9.6	58	0.64	2.72	2.8	1.8	1.8		
1.8	**BN 100LB**	**4**	1420	12.1	69	0.87	4.3	4.2	1.6	1.7	95	25
0.9		**8**	700	12.3	62	0.63	3.3	3.2	1.7	1.8		
2.2	**BN 112M**	**4**	1440	14.6	77	0.85	4.9	5.3	1.8	1.8	168	32
1.2		**8**	710	16.1	70	0.63	3.9	3.3	1.9	1.8		
3.6	**BN 132S**	**4**	1440	24	80	0.82	7.9	6.5	2.1	1.9	295	45
1.8		**8**	720	24	72	0.55	6.6	4.6	1.9	2		
4.6	**BN 132M**	**4**	1450	30	81	0.83	9.9	6.5	2.2	1.9	383	56
2.3		**8**	720	31	73	0.54	8.4	4.4	2.3	2		

freno c.c. / *d.c. brake*
G.S.-bremse / *frein c.c.*

FD

Mod.	Mb Nm	Z_o 1/h		Jm x 10^{-4} kgm^2	IM B5 Kg
FD 04	10	2300	3500	16.6	12.1
		4500	7000		
FD 04	10	2200	2900	22	13.8
		4200	6500		
FD 14	15	2300	2800	30	17.8
		3500	6000		
FD 05	26	1700	2100	34	21
		2500	4200		
FD 15	40	1300	1700	86	28
		2000	3400		
FD 15	40	1200	1700	99	31
		1600	2600		
FD 06S	60	—	1200	177	42
		—	2000		
FD 56	75	—	1000	305	58
		—	1400		
FD 06	100	—	1000	393	69
		—	1300		

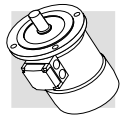
freno c.a. / *a.c. brake*
W.S.-bremse / *frein c.a.*

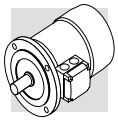
FA

Mod.	Mb Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
FA 04	10	3500	16.6	12.0
		7000		
FA 04	10	2900	22	13.7
		6500		
FA 14	15	2800	30	17.7
		6000		
FA 05	26	2100	34	22
		4200		
FA 15	40	1700	86	29
		3400		
FA 15	40	1700	99	32
		2600		
FA 06S	60	1200	177	43
		2000		
FA 06	75	1000	305	59
		1400		
FA 07	100	1000	406	74
		1300		

BA

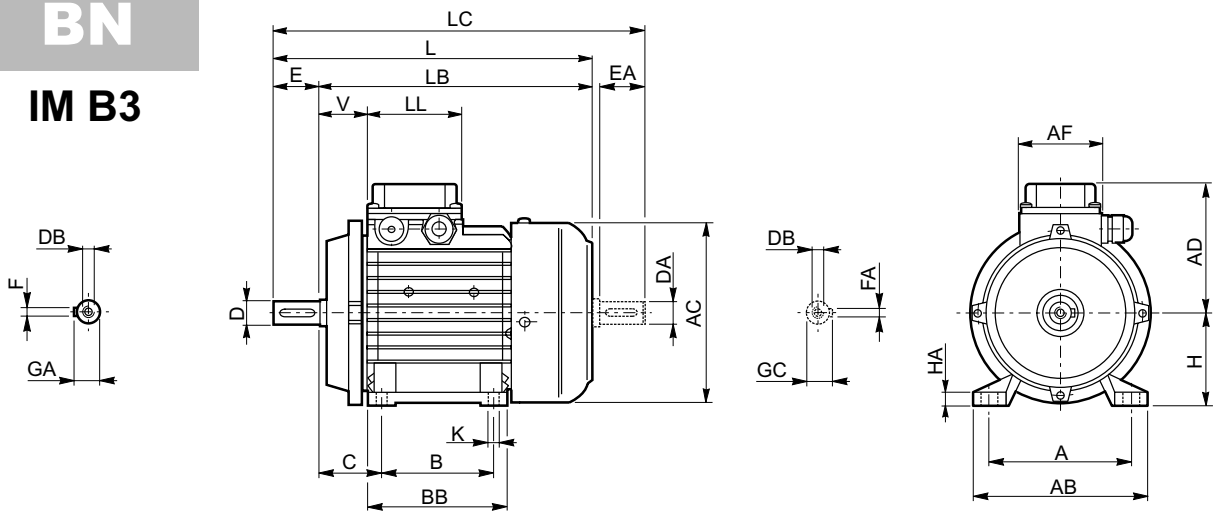
Mod.	Mb max Nm	Z_o 1/h	Jm x 10^{-4} kgm^2	IM B5 Kg
BA 80	18	3200	18	13.5
		6500		
BA 80	18	2500	23	15.2
		5600		
BA 90	35	2400	35	21
		5100		
BA 90	35	1900	37	22
		3800		
BA 100	50	1500	94	32
		3100		
BA 100	50	1500	107	34
		2400		
BA 110	75	1100	184	45
		1900		
BA 140	150	900	345	77
		1200		
BA 140	150	900	433	88
		1200		



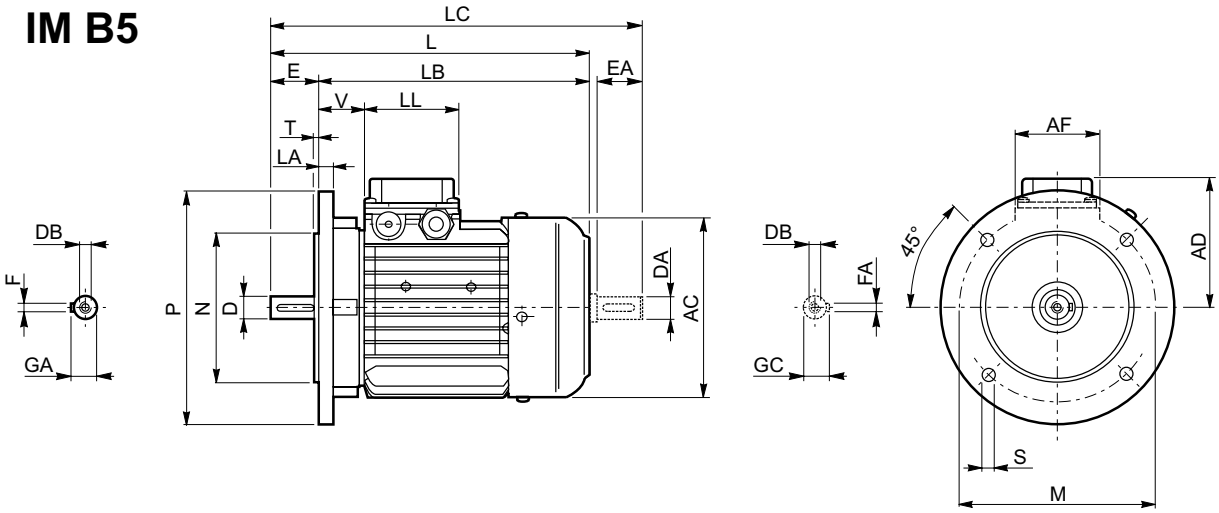


BN

IM B3



IM B5



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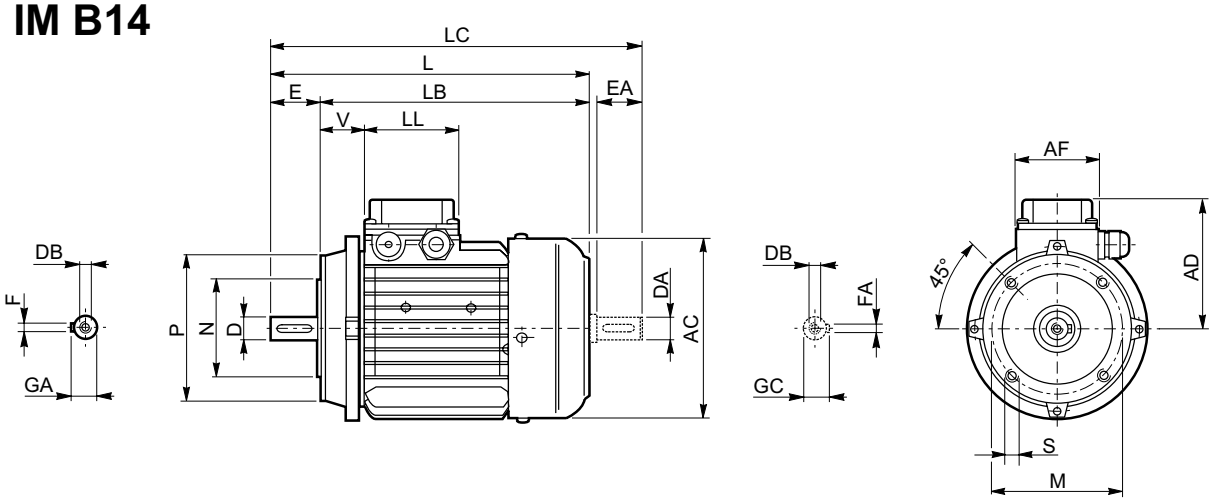
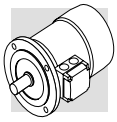




M29 - DIMENSIONI ***M29- DIMENSIONS*** **M29 - ABMESSUNGEN** ***M29 - DIMENSIONS***

BN (IM B3)	Albero / *Shaft* / Welle / *Arbre*					Cassa / *Frame* / Gehäuse / *Carcasse*						Motore / *Motor* / Motor / *Moteur*									
	D DA	E EA	DB	GA GC	F FA	B	A	HA	BB	AB	K	C	H	AC	L	LB	LC	AD	AF	LL	V
BN 63	11	23	M4	12.5	4	80	100	7	96	120	7	40	63	121	212	189	237	92	74	80	30
BN 71	14	30	M5	16	5	90	112	8	112	135	7	45	71	138	249	219	281	105	74	80	35
BN 80	19	40	M6	21.5	6	100	125	9.5	124	153	10	50	80	156	273	233	315	115	74	80	38
BN 90S	24	50	M8	27	8	100	140	13	130	174	10	56	90	176	302	252	354	133	98	98	44
BN 90L	24	50	M8	27	8	125	140	13	155	174	10	56	90	176	326	276	379	133	98	98	44
BN 100	28	60	M10	31	8	140	160	14	175	192	12	63	100	195	366	306	429	142	98	98	50
BN 112	28	60	M10	31	8	140	190	14	175	224	12	70	112	219	385	325	448	157	98	98	52
BN 132S	38	80	M12	41	10	140	216	16	180	250	12	89	132	258	455	375	538	193	118	118	58
BN 132M	38	80	M12	41	10	178	216	16	218	250	12	89	132	258	493	413	576	193	118	118	58

BN (IM B5)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*						Motore / *Motor* / Motor / *Moteur*							
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	LA	AC	L	LB	LC	AD	AF	LL	V
BN 56	9	20	M3	10.2	3	100	80	120	7	3	8	110	185	165	207	91	74	80	34
BN 63	11	23	M4	12.5	4	115	95	140	9.5	3	10	121	207	184	232	95	74	80	26
BN 71	14	30	M5	16	5	130	110	160	9.5	3	10	138	249	219	281	108	74	80	37
BN 80	19	40	M6	21.5	6	165	130	200	11.5	3.5	11.5	156	274	234	315	119	74	80	38
BN 90 S	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	326	276	378	133	98	98	44
BN 90 L	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	326	276	378	133	98	98	44
BN 100	28	60	M10	31	8	215	180	250	14	4	14	195	367	307	429	142	98	98	50
BN 112	28	60	M10	31	8	215	180	250	14	4	15	219	385	325	448	157	98	98	52
BN 132 S	38	80	M12	41	10	265	230	300	14	4	16	258	455	375	538	193	118	118	58
BN 132 M	38	80	M12	41	10	265	230	300	14	4	16	258	493	413	576	193	118	118	58
BN 160 MR	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	258	562	452	645	193	118	118	218
BN 160 M	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	310	596	486	680	245	187	187	51
BN 160 L	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	310	596	486	680	245	187	187	51
BN 180 M	48 38 (1)	110 110 (1)	M16 M12 (1)	51.5 41 (1)	14 10 (1)	300	250	350	18.5	5	15	310	640	530	724	245	187	187	51
BN 180 L	48 42 (1)	110 110 (1)	M16 M16 (1)	51.5 45 (1)	14 12 (1)	300	250	350	18.5	5	18	348	708	598	823	261	187	187	52
BN 200 L	55 42 (1)	110 110 (1)	M20 M16 (1)	59 45 (1)	16 12 (1)	350	300	400	18.5	5	18	348	722	612	837	261	187	187	66

BN (IM B14)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*					Motore / *Motor* / Motor / *Moteur*							
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	AC	L	LB	LC	AD	AF	LL	V
BN 56	9	20	M3	10.2	3	65	50	80	M5	2.5	110	185	165	207	91	74	80	34
BN 63	11	23	M4	12.5	4	75	60	90	M5	2.5	121	207	184	232	95	74	80	26
BN 71	14	30	M5	16	5	85	70	105	M6	2.5	138	249	219	281	108	74	80	37
BN 80	19	40	M6	21.5	6	100	80	120	M6	3	156	274	234	315	119	74	80	38
BN 90 S	24	50	M8	27	8	115	95	140	M8	3	176	326	276	378	133	98	98	44
BN 90 L	24	50	M8	27	8	115	95	140	M8	3	176	326	276	378	133	98	98	44
BN 100	28	60	M10	31	8	130	110	160	M8	3.5	195	366	306	429	142	98	98	50
BN 112	28	60	M10	31	8	130	110	160	M8	3.5	219	385	325	448	157	98	98	52
BN 132 S	38	80	M12	41	10	165	130	200	M10	4	258	455	375	538	193	118	118	58
BN 132 M	38	80	M12	41	10	165	130	200	M10	4	258	493	413	576	193	118	118	58

N.B.:

1) Queste dimensioni sono riferite alla seconda estremità d'albero

NOTE:

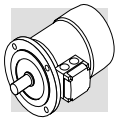
1) These values refer to the rear shaft end.

HINWEIS:

1) Diese Maße betreffen das zweite Wellenende.

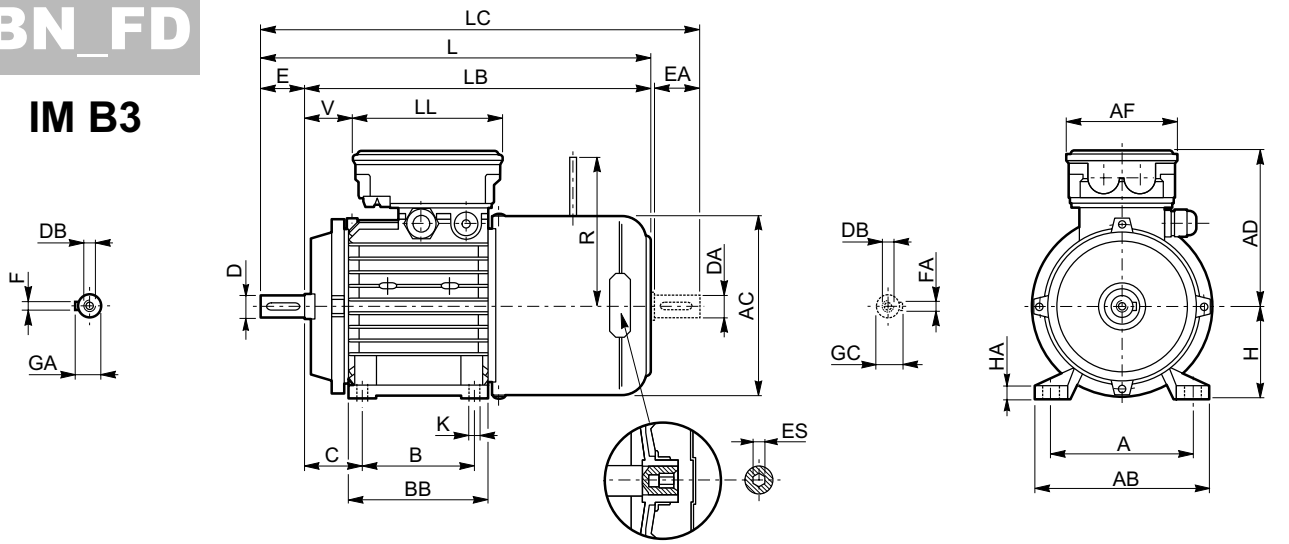
REMARQUE :

1) Ces dimensions se réfèrent à la deuxième extrémité de l'arbre.

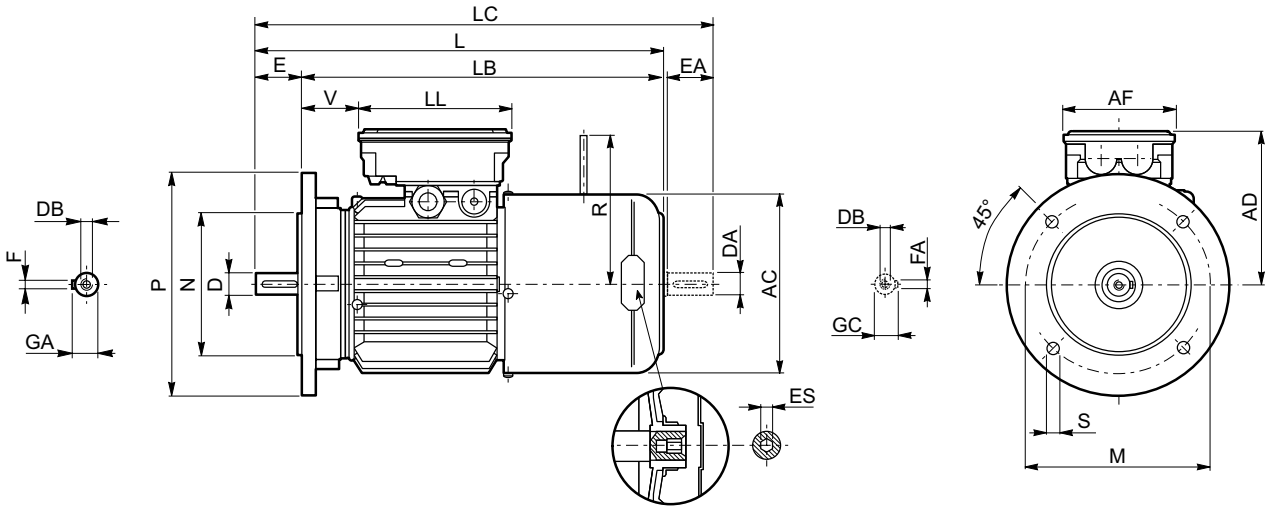


BN_FD

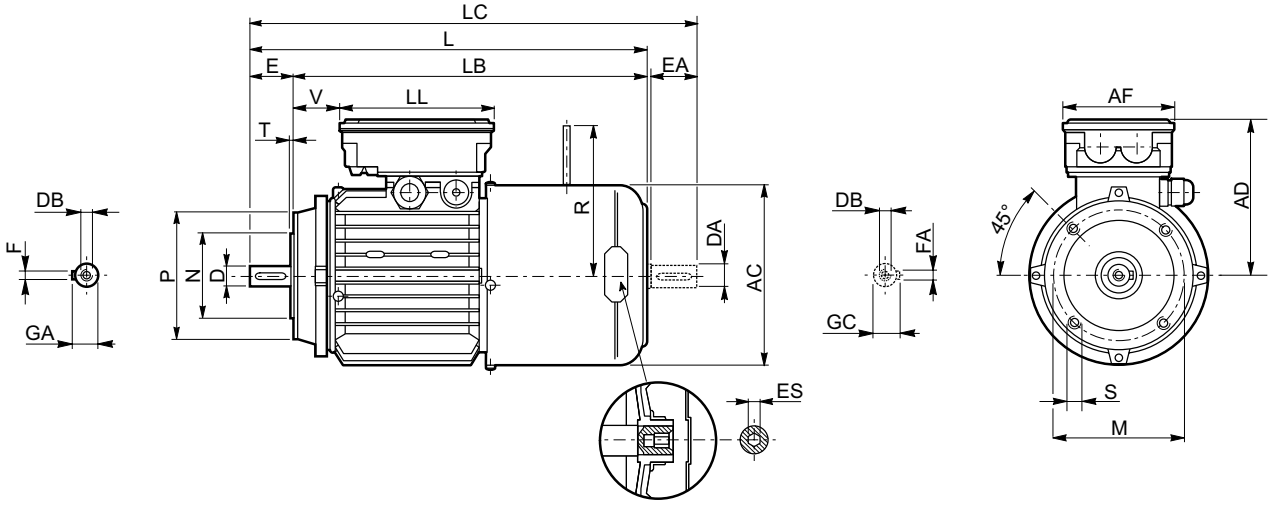
IM B3

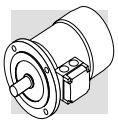


IM B5



IM B14





BN_FD (IM B3)	Albero / *Shaft* / Welle / *Arbre*					Cassa / *Frame* / Gehäuse / *Carcasse*						Motore / *Motor* / Motor / *Moteur*											
	D DA	E EA	DB	GA GC	F FA	B	A	HA	BB	AB	K	C	H	AC	L	LB	LC	AD	AF	LL	V	R	ES
BN 63	11	23	M4	12.5	4	80	100	7	96	120	7	40	63	121	269	246	294	119	98	133	51	96	5
BN 71	14	30	M5	16	5	90	112	8	112	135	7	45	71	138	310	280	342	132	98	133	30	103	5
BN 80	19	40	M6	21.5	6	100	125	9.5	124	153	10	50	80	156	346	306	388	143	98	133	41	129	5
BN 90S	24	50	M8	27	8	100	140	13	130	174	10	56	90	176	385	335	437	146	110	165	15	129	6
BN 90L	24	50	M8	27	8	125	140	13	155	174	10	56	90	176	409	359	461	146	110	165	39	160	6
BN 100	28	60	M10	31	8	140	160	14	175	192	12	63	100	195	458	398	521	155	110	165	62	160	6
BN 112	28	60	M10	31	8	140	190	14	175	224	12	70	112	219	484	424	547	170	110	165	73	199	6
BN 132S	38	80	M12	41	10	140	216	16	180	250	12	89	132	258	565	485	648	193	118	118	142	204 (2)	6
BN 132M	38	80	M12	41	10	178	216	16	218	250	12	89	132	258	603	523	686	193	118	118	180	204 (2)	6

BN_FD (IM B5)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*						Motore / *Motor* / Motor / *Moteur*									
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	LA	AC	L	LB	LC	AD	AF	LL	V	R	ES
BN 63	11	23	M4	12.5	4	115	95	140	9.5	3	10	121	272	249	297	119	98	133	14	96	5
BN 71	14	30	M5	16	5	130	110	160	9.5	3.5	10	138	310	280	342	132	98	133	30	103	5
BN 80	19	40	M6	21.5	6	165	130	200	11.5	3.5	11.5	156	346	306	388	143	98	133	41	129	5
BN 90 S	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	409	359	461	146	110	165	39	129	6
BN 90 L	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	409	359	461	146	110	165	39	160	6
BN 100	28	60	M10	31	8	215	180	250	14	4	14	195	458	398	521	155	110	165	62	160	6
BN 112	28	60	M10	31	8	215	180	250	14	4	15	219	484	424	547	170	110	165	73	199	6
BN 132 S	38	80	M12	41	10	265	230	300	14	4	16	258	565	485	648	193	118	118	142	204 (2)	6
BN 132 M	38	80	M12	41	10	265	230	300	14	4	16	258	603	523	686	193	118	118	180	204 (2)	6
BN 160 MR	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	258	672	562	755	193	118	118	218	226	6
BN 160 M	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	310	736	626	820	245	187	187	51	266	—
BN 160 L	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	310	736	626	820	245	187	187	51	266	—
BN 180 M	48 38 (1)	110 110 (1)	M16 M12 (1)	51.5 41 (1)	14 10 (1)	300	250	350	18.5	5	15	310	780	670	864	245	187	187	51	266	—
BN 180 L	48 42 (1)	110 110 (1)	M16 M16 (1)	51.5 45 (1)	14 12 (1)	300	250	350	18.5	5	18	348	866	756	981	261	187	187	52	305	—
BN 200 L	55 42 (1)	110 110 (1)	M20 M16 (1)	59 45 (1)	16 12 (1)	350	300	400	18.5	5	18	348	878	768	993	261	187	187	64	305	—

BN_FD (IM B14)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*					Motore / *Motor* / Motor / *Moteur*									
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	AC	L	LB	LC	AD	AF	LL	V	R	ES
BN 63	11	23	M4	12.5	4	75	60	90	M5	2.5	121	272	249	297	119	98	133	14	96	5
BN 71	14	30	M5	16	5	85	70	105	M6	2.5	138	310	280	342	132	98	133	30	103	5
BN 80	19	40	M6	21.5	6	100	80	120	M6	3	156	346	306	388	143	98	133	41	129	5
BN 90 S	24	50	M8	27	8	115	95	140	M8	3	176	409	359	461	146	110	165	39	129	6
BN 90 L	24	50	M8	27	8	115	95	140	M8	3	176	409	359	461	146	110	165	39	160	6
BN 100	28	60	M10	31	8	130	110	160	M8	3.5	195	458	398	521	155	110	165	62	160	6
BN 112	28	60	M10	31	8	130	110	160	M8	3.5	219	484	424	547	170	110	165	73	199	6
BN 132 S	38	80	M12	41	10	165	130	200	M10	4	258	565	485	648	193	118	118	142	204 (2)	6
BN 132 M	38	80	M12	41	10	165	130	200	M10	4	258	603	523	686	193	118	118	180	204 (2)	6

N.B.:

1) Queste dimensioni sono riferite alla seconda estremità d'albero.
2) Per freno FD07 quota R=226

L'esagono ES non è presente con l'opzione PS

NOTE:

1) These values refer to the rear shaft end.
2) For FD07 brake value R=226

ES hexagon is not supplied with PS option

HINWEIS:

1) Diese Maße betreffen das zweite Wellenende
2) Für Bremse FD07, Maß R=226

Der Sechskant ES ist bei der Option PS nicht vorhanden.

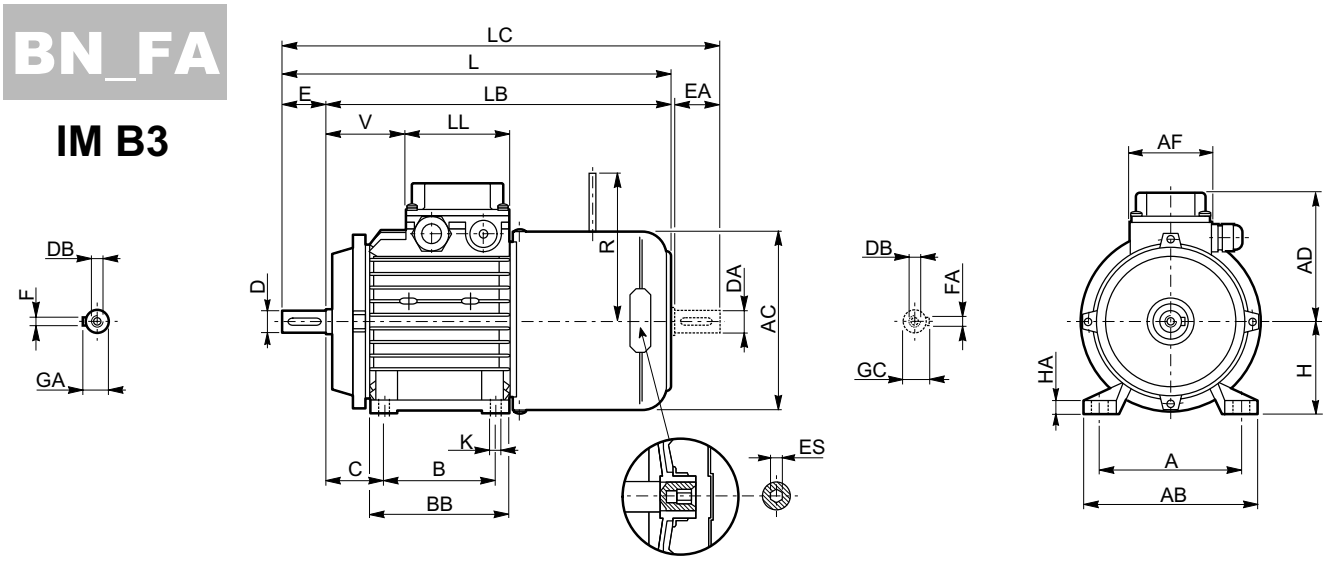
REMARQUE :

1) Ces dimensions se réfèrent à la deuxième extrémité de l'arbre
2) Pour frein FD07 valeur R=226

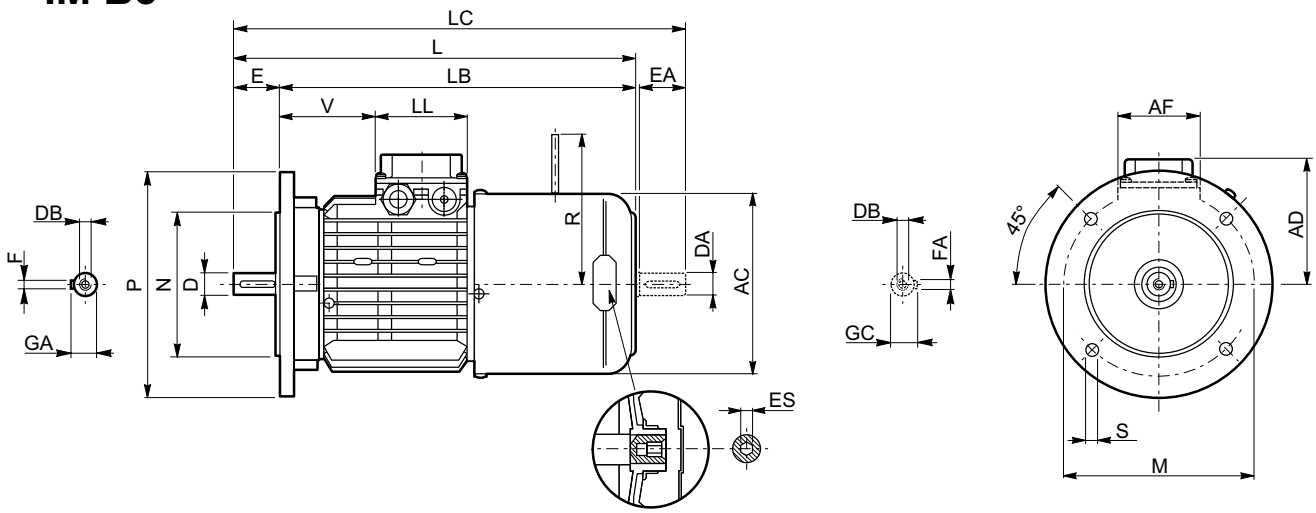
L'hexagone ES n'est pas disponible avec l'option PS

BN_FA

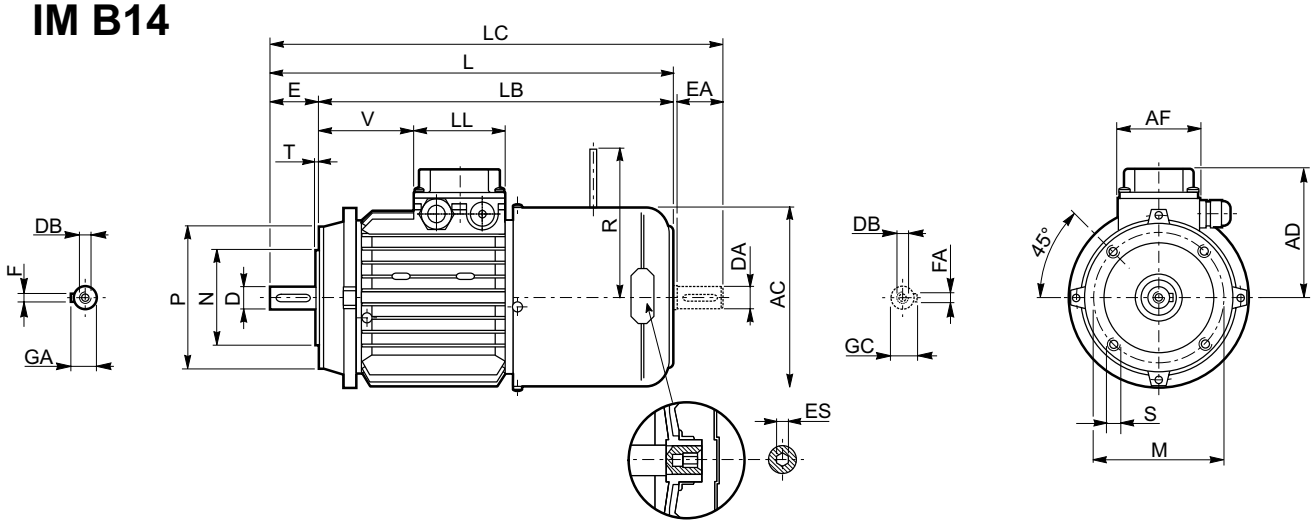
IM B3

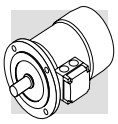


IM B5



IM B14





BN_FA (IM B3)	Albero / *Shaft* / Welle / *Arbre*					Cassa / *Frame* / Gehäuse / *Carcasse*						Motore / *Motor* / Motor / *Moteur*											
	D DA	E EA	DB	GA GC	F FA	B	A	HA	BB	AB	K	C	H	AC	L	LB	LC	AD	AF	LL	V	R	ES
BN 63	11	23	M4	12.5	4	80	100	7	96	120	7	40	63	121	269	246	294	92	74	80	51	116	5
BN 71	14	30	M5	16	5	90	112	8	112	135	7	45	71	138	310	280	342	105	74	80	68	124	5
BN 80	19	40	M6	21.5	6	100	125	9.5	124	153	10	50	80	156	346	306	388	115	74	80	83	134	5
BN 90S	24	50	M8	27	8	100	140	13	130	174	10	56	90	176	385	335	437	133	98	98	71	134	6
BN 90L	24	50	M8	27	8	125	140	13	155	174	10	56	90	176	409	359	461	133	98	98	95	160	6
BN 100	28	60	M10	31	8	140	160	14	175	192	12	63	100	195	458	398	521	142	98	98	119	160	6
BN 112	28	60	M10	31	8	140	190	14	175	224	12	70	112	219	484	424	547	157	98	98	142	198	6
BN 132S	38	80	M12	41	10	140	216	16	180	250	12	89	132	258	565	485	648	193	118	118	180	200 (2)	6
BN 132M	38	80	M12	41	10	178	216	16	218	250	12	89	132	258	603	523	686	193	118	118	180	200 (2)	6

BN_FA (IM B5)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*						Motore / *Motor* / Motor / *Moteur*									
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	LA	AC	L	LB	LC	AD	AF	LL	V	R	ES
BN 63	11	23	M4	12.5	4	115	95	140	9.5	3	10	121	272	249	297	95	74	80	26	116	5
BN 71	14	30	M5	16	5	130	110	160	9.5	3.5	10	138	310	280	342	108	74	80	68	124	5
BN 80	19	40	M6	21.5	6	165	130	200	11.5	3.5	11.5	156	346	306	388	119	74	80	83	134	5
BN 90 S	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	409	359	461	133	98	98	95	134	6
BN 90 L	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	409	359	461	133	98	98	95	160	6
BN 100	28	60	M10	31	8	215	180	250	14	4	14	195	458	398	521	142	98	98	119	160	6
BN 112	28	60	M10	31	8	215	180	250	14	4	15	219	484	424	547	157	98	98	128	198	6
BN 132 S	38	80	M12	41	10	265	230	300	14	4	16	258	565	485	648	193	118	118	142	200 (2)	6
BN 132 M	38	80	M12	41	10	265	230	300	14	4	16	258	603	523	686	193	118	118	180	200 (2)	6
BN 160 MR	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	258	672	562	755	193	118	118	218	217	6
BN 160 M	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	310	736	626	820	245	187	187	51	247	—
BN 160 L	42 38 (1)	110 80 (1)	M16 M12 (1)	45 41 (1)	12 10 (1)	300	250	350	18.5	5	15	310	736	626	820	245	187	187	51	247	—
BN 180 M	48 38 (1)	110 80 (1)	M16 M12 (1)	51.5 41 (1)	14 10 (1)	300	250	350	18.5	5	15	310	780	670	864	245	187	187	51	247	—

BN_FA (IM B14)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*					Motore / *Motor* / Motor / *Moteur*									
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	AC	L	LB	LC	AD	AF	LL	V	R	ES
BN 63	11	23	M4	12.5	4	75	60	90	M5	2.5	121	272	249	119	95	74	80	26	116	5
BN 71	14	30	M5	16	5	85	70	105	M6	2.5	138	310	280	342	108	74	80	68	124	5
BN 80	19	40	M6	21.5	6	100	80	120	M6	3	156	346	306	388	119	74	80	83	134	5
BN 90 S	24	50	M8	27	8	115	95	140	M8	3	176	409	359	461	133	98	98	95	134	6
BN 90 L	24	50	M8	27	8	115	95	140	M8	3	176	409	359	461	133	98	98	95	160	6
BN 100	28	60	M10	31	8	130	110	160	M8	3.5	195	458	398	521	142	98	98	119	160	6
BN 112	28	60	M10	31	8	130	110	160	M8	3.5	219	484	424	547	157	98	98	128	198	6
BN 132 S	38	80	M12	41	10	165	130	200	M10	4	258	565	485	648	193	118	118	142	200 (2)	6
BN 132 M	38	80	M12	41	10	165	130	200	M10	4	258	603	523	686	193	118	118	180	200 (2)	6

N.B.:

1) Queste dimensioni sono riferite alla seconda estremità d'albero.
2) Per freno FD07 quota R=226

Per la versione BN..FA le dimensioni della scatola morsettiera AD, AF, LL, V sono uguali al tipo BN..FD.

L'esagono ES non è presente con l'opzione PS.

NOTE:

1) These values refer to the rear shaft end.
2) For FD07 brake value R=226

For motors type BN..FA, the terminal box sizes AD, AF, LL, V are the same as for BN..FD.

ES hexagon is not supplied with PS option.

HINWEIS:

1) Diese Maße betreffen das zweite Wellenende
2) Für Bremse FD07, Maß R=226

Bei der Motor typ BN..FA sind die Maße des Klemmenkastens AD, AF, LL, V denen der Version BN..FD gleich.

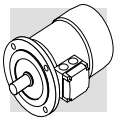
Der Sechskant ES ist bei der Option PS nicht vorhanden.

REMARQUE :

1) Ces dimensions se réfèrent à la deuxième extrémité de l'arbre
2) Pour frein FD07 valeur R=226

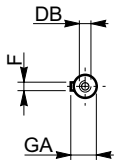
Pour moteurs type BN..FA les dimensions de la boîte à bornes AD, AF, LL, V sont les mêmes de BN..FD.

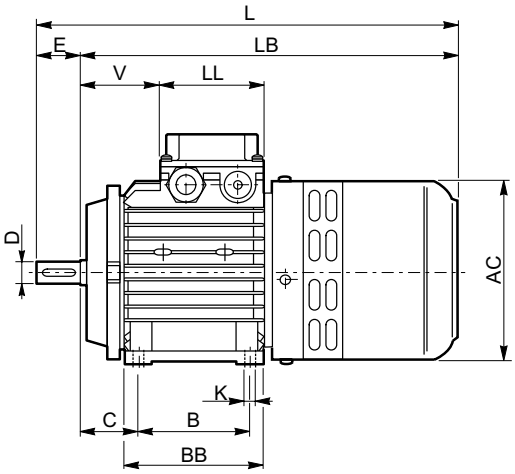
L'hexagone ES n'est pas disponible avec l'option PS.

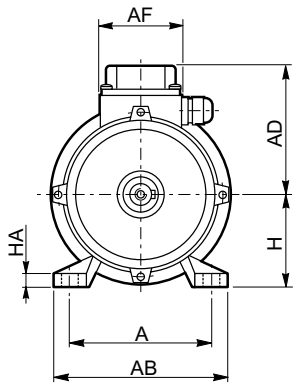


BN_BA

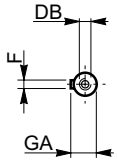
IM B3

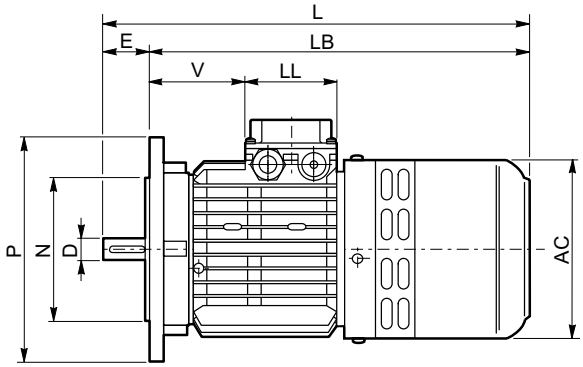


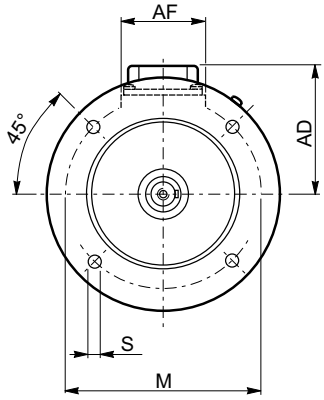




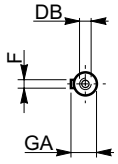
IM B5

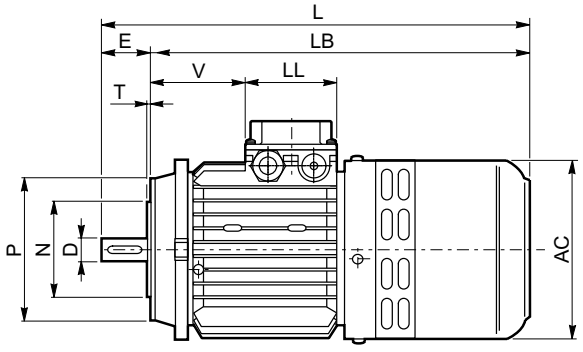


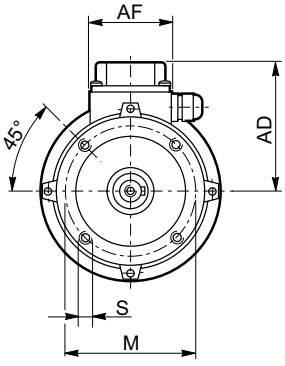


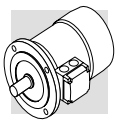


IM B14









BN_BA (IM B3)	Albero / *Shaft* / Welle / *Arbre*					Cassa / *Frame* / Gehäuse / *Carcasse*						Motore / *Motor* / Motor / *Moteur*									
	D DA	E EA	DB	GA GC	F FA	B	A	HA	BB	AB	K	C	H	AC	L	LB	LC	AD	AF	LL	V
BN 71	14	30	M5	16	5	90	112	8	112	135	7	45	71	138	327	298	342	108	74	80	68
BN 80	19	40	M6	21.5	6	100	125	9.5	124	153	10	50	80	156	372	332	388	119	74	80	83
BN 90S	24	50	M8	27	8	100	140	13	130	174	10	56	90	176	400	350	437	133	98	98	71
BN 90L	24	50	M8	27	8	125	140	13	155	174	10	56	90	176	425	375	461	133	98	98	95
BN 100	28	60	M10	31	8	140	160	14	175	192	12	63	100	195	477	417	521	142	98	98	119
BN 112	28	60	M10	31	8	140	190	14	175	224	12	70	112	219	500	440	547	157	98	98	128
BN 132S	38	80	M12	41	10	140	216	16	180	250	12	89	132	258	600	520	648	193	118	118	142
BN 132M	38	80	M12	41	10	178	216	16	218	250	12	89	132	258	638	558	686	193	118	118	180

BN_BA (IM B5)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*						Motore / *Motor* / Motor / *Moteur*						
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	LA	AC	L	LB	AD	AF	LL	V
BN63	11	23	M4	12.5	4	115	95	140	9.5	3	10	124	298	275	95	74	80	28
BN 71	14	30	M5	16	5	130	110	160	9.5	3.5	10	138	327	297	108	74	80	68
BN 80	19	40	M6	21.5	6	165	130	200	11.5	3.5	11.5	156	372	332	119	74	80	83
BN 90 S	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	425	375	133	98	98	95
BN 90 L	24	50	M8	27	8	165	130	200	11.5	3.5	11.5	176	425	375	133	98	98	95
BN 100	28	60	M10	31	8	215	180	250	14	4	14	195	477	417	142	98	98	119
BN 112	28	60	M10	31	8	215	180	250	14	4	15	219	500	440	157	98	98	128
BN 132 S	38	80	M12	41	10	265	230	300	14	4	16	258	600	520	193	118	118	142
BN 132 M	38	80	M12	41	10	265	230	300	14	4	16	258	638	558	193	118	118	180

BN_BA (IM B14)	Albero / *Shaft* / Welle / *Arbre*					Flangia / *Flange* / Flansch / *Bride*					Motore / *Motor* / Motor / *Moteur*						
	D DA	E EA	DB	GA GC	F FA	M	N	P	S	T	AC	L	LB	AD	AF	LL	V
BN 63	11	23	M4	12.5	4	75	60	90	M5	2.5	124	298	275	95	74	80	28
BN 71	14	30	M5	16	5	85	70	105	M6	2.5	138	327	297	108	74	80	68
BN 80	19	40	M6	21.5	6	100	80	120	M6	3	156	372	332	119	74	80	83
BN 90 S	24	50	M8	27	8	115	95	140	M8	3	176	425	375	133	98	98	95
BN 90 L	24	50	M8	27	8	115	95	140	M8	3	176	425	375	133	98	98	95
BN 100	28	60	M10	31	8	130	110	160	M8	3.5	195	477	417	142	98	98	119
BN 112	28	60	M10	31	8	130	110	160	M8	3.5	219	500	440	157	98	98	128
BN 132 S	38	80	M12	41	10	165	130	200	M10	4	258	600	520	193	118	118	142
BN 132 M	38	80	M12	41	10	165	130	200	M10	4	258	638	558	193	118	118	180

N.B.:

Per la versione BN..BA le dimensioni della scatola morsettiera AD, AF, LL, V sono uguali al BN..FD.

NOTE:

For motors type BN..BA, the terminal box sizes AD, AF, LL, V are the same as for BN..FD.

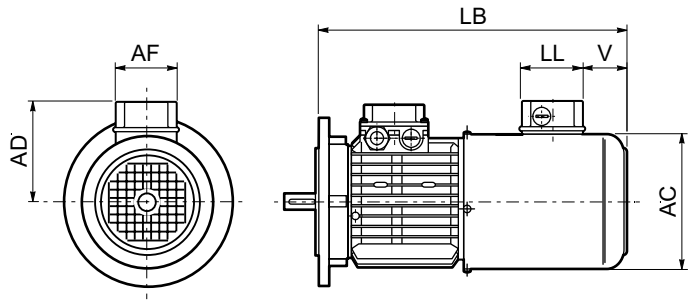
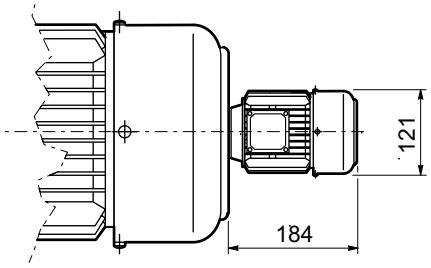
HINWEIS:

Bei der Motor typ BN..BA sind die Maße des Klemmenkastens AD, AF, LL, V denen der Version BN..FD gleich.

REMARQUE :

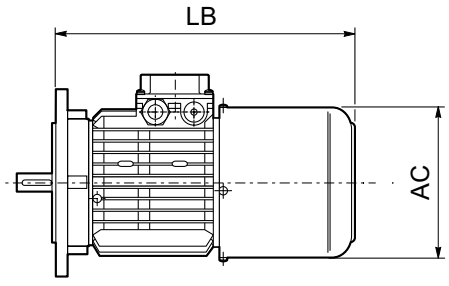
Pour moteurs type BN..BA les dimensions de la boîte à bornes AD, AF, LL, V sont les mêmes de BN..FD.

U1 BN, BN_FD, BN_FA

BN71…BN160MR	BN160…BN200L
	

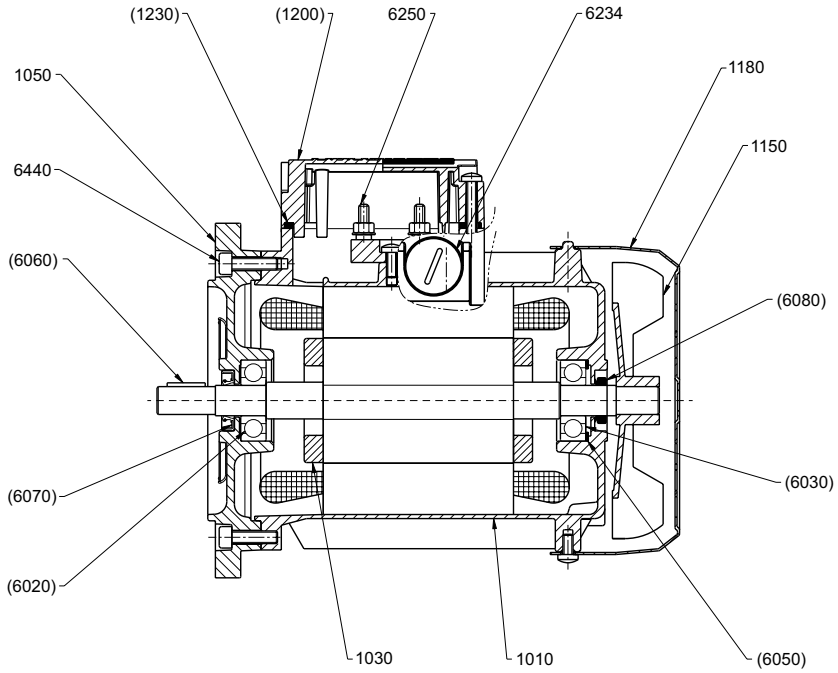
	LB	AC	AD	AF	LL	V
BN71	312	138	112	70	70	36
BN80	361	156	120	70	70	40
BN90S / BN90L	407	176	131	70	70	45
BN100	426	195	145	90	90	40
BN112	455	219	155	70	70	55
BN132S	536	258	174	70	70	87
BN132M	574	258	174	70	70	87
BN160MR	613	258	174	70	70	87

U2 BN, BN_FD, BN_FA

BN71…BN160MR


	LB	AC
BN71	312	138
BN80	361	156
BN90S / BN90L	407	176
BN100	426	195
BN112	455	219
BN132S	536	258
BN132M	574	258
BN160MR	613	258

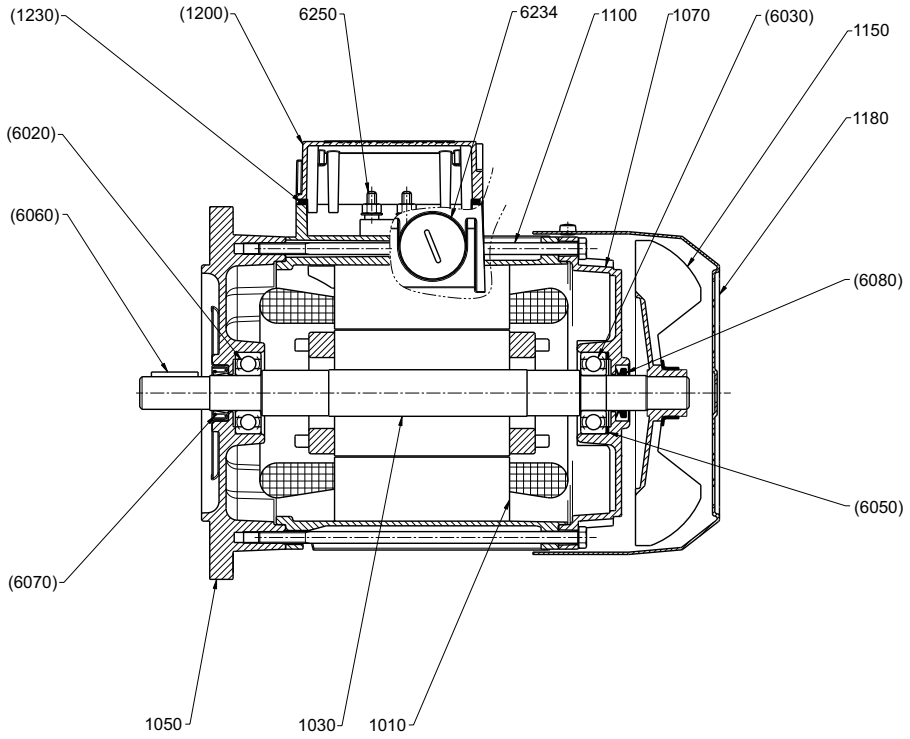
BN 63



kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5/IM B14)	*Mounting flange (IM B5/IM B14)*	Flansch (IM B5/IM B14)	*Bride (IM B5/IM B14)*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione scatola coprimorsettiera	*Terminal box gasket*	Klemmenkastendeckeldichtung	*Joint de la boîte a bornes*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6440	Vite serraggio flangia	*Bolt*	Schraube	*Vis*
KSA	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*

(####) Disponibile SOLO in kit | *(####) Only available as a complete kit* | (####) Nür lieferbar als Kit | *(####) Disponible seulement en kit*

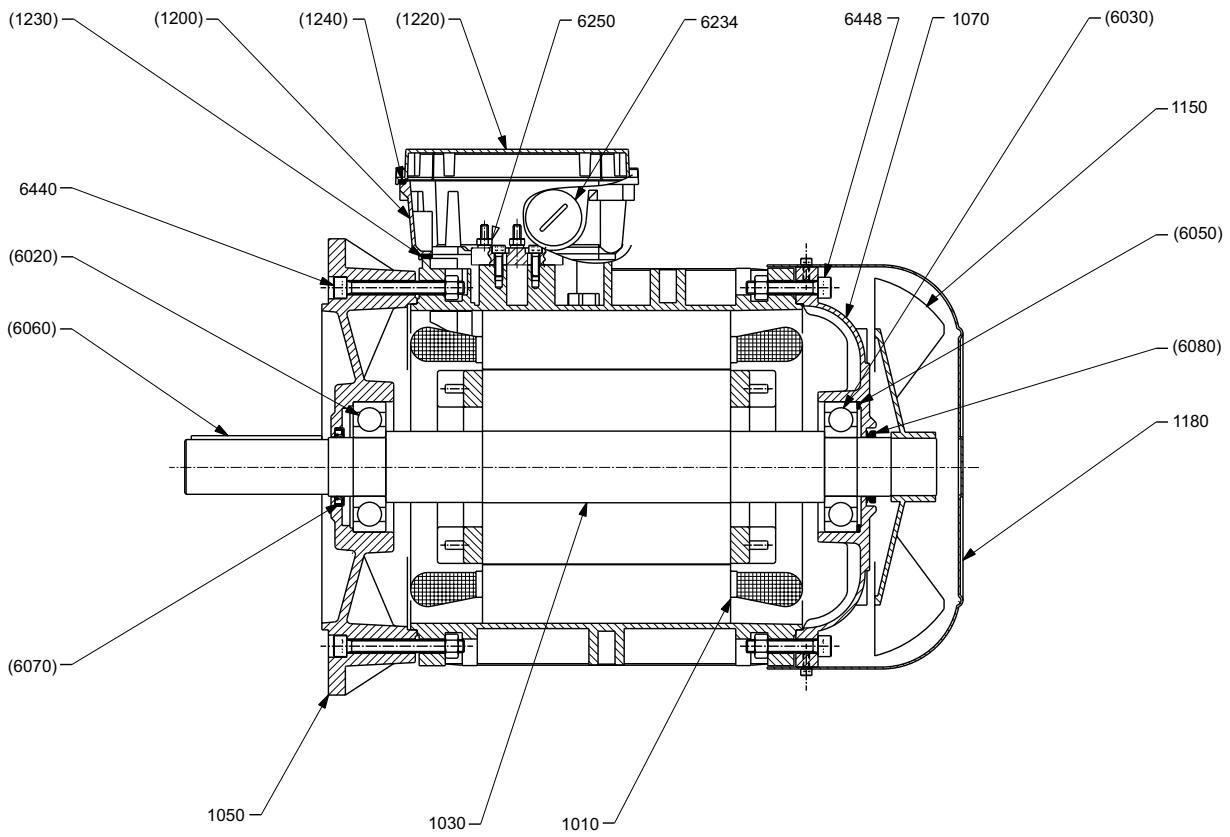
BN 71...BN 160MR



Kit	rif.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange (B5/B14)*	Flansch (B5/B14)	*Bride (B5/B14)*
	1070	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie-rods*	Zuganker	*Entretoises*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione scatola coprimorsettiera	*Terminal box gasket*	Klemmenkastendeckeldichtung	*Joint de la boîte a bornes*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
KSA	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

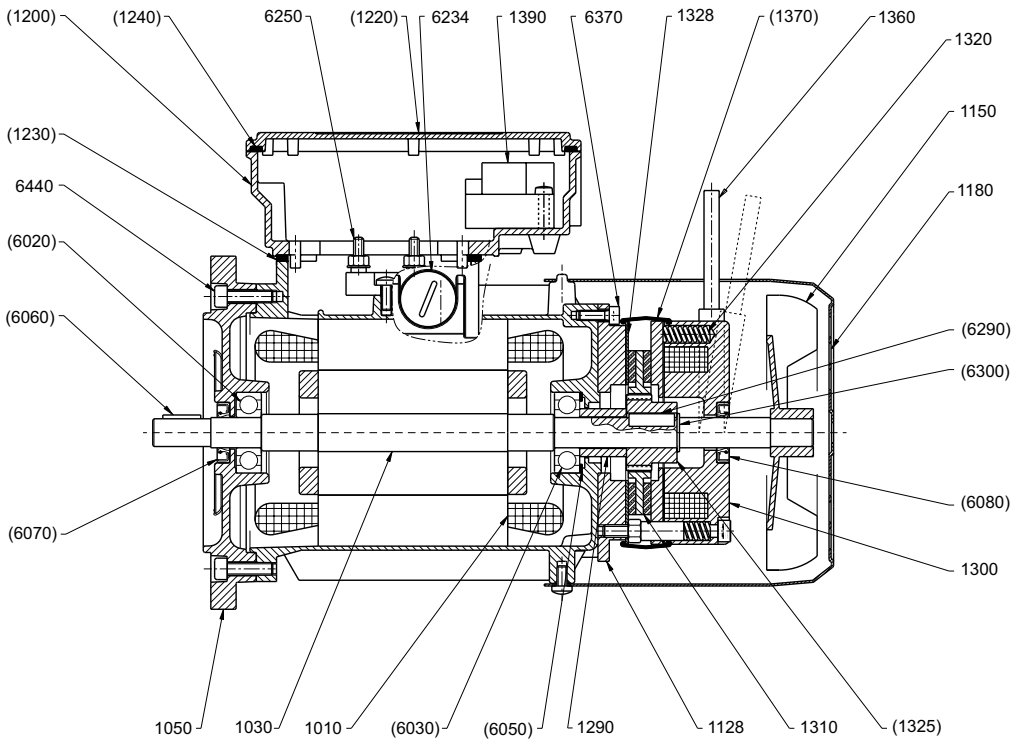
BN 160M...BN 200



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5)	*Mounting flange (IM B5)*	Flansch (IM B5)	*Bride (IM B5)*
	1070	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione scatola coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio coprimors.	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle boîte a bornes*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte a bornes*
	6440	Viti flangia	*DE flange bolts*	Flanschschrauben	*Vis bride*
	6448	Viti scudo NDE	*NDE shield bolts*	Motorschildschrauben	*Vis bouclier NDE*
KSA	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

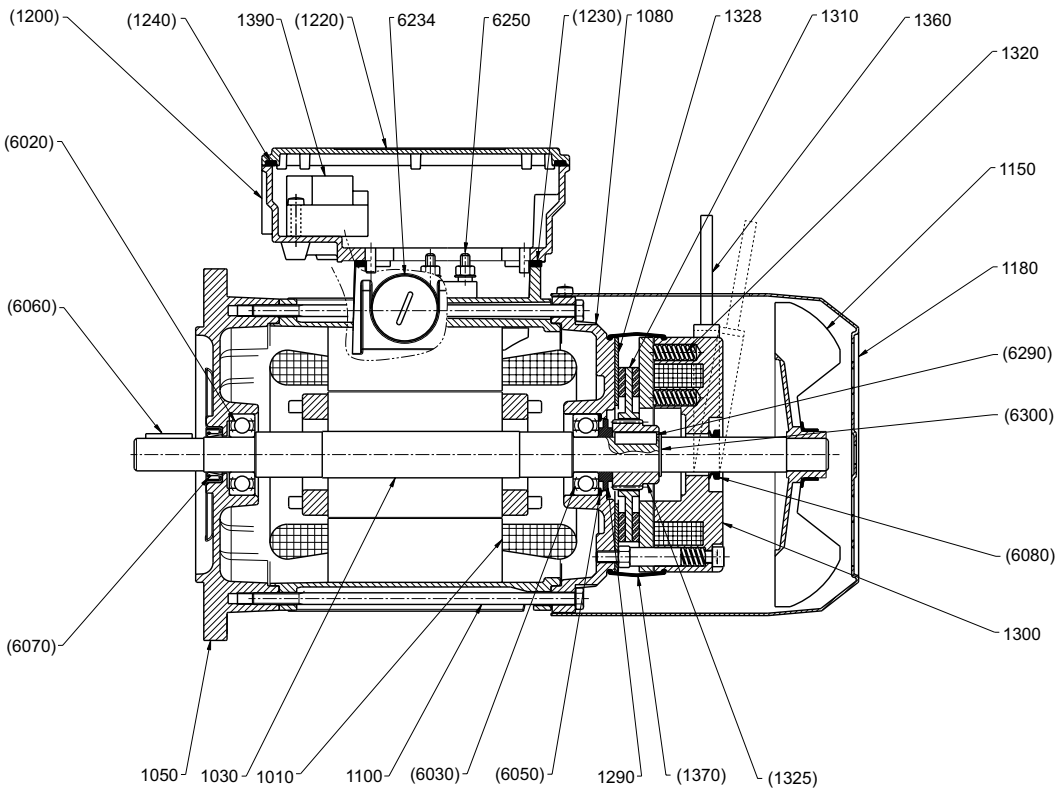
BN 63_FD



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange (B5/B14)*	Flansch (B5/B14)	*Bride (B5/B14)*
	1128	Anello attacco freno	*Brake holding plate*	Bremslagerschild	*Anneau attelage frein*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
KSM	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	1300	Freno in c.c. tipo FD	*d.c. brake type FD*	Gleichstrombremse Typ FD	*Frein c.c. type FD*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1360	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1390	Alimentatore ac/dc	*ac/dc rectifier*	Gleichrichter	*Redresseur c.a./c.c.*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6370	Viti fissaggio anello attacco freno	*Bolts*	Schraube	*Vis*
	6440	Viti fissaggio flangia	*Bolts*	Schraube	*Vis*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

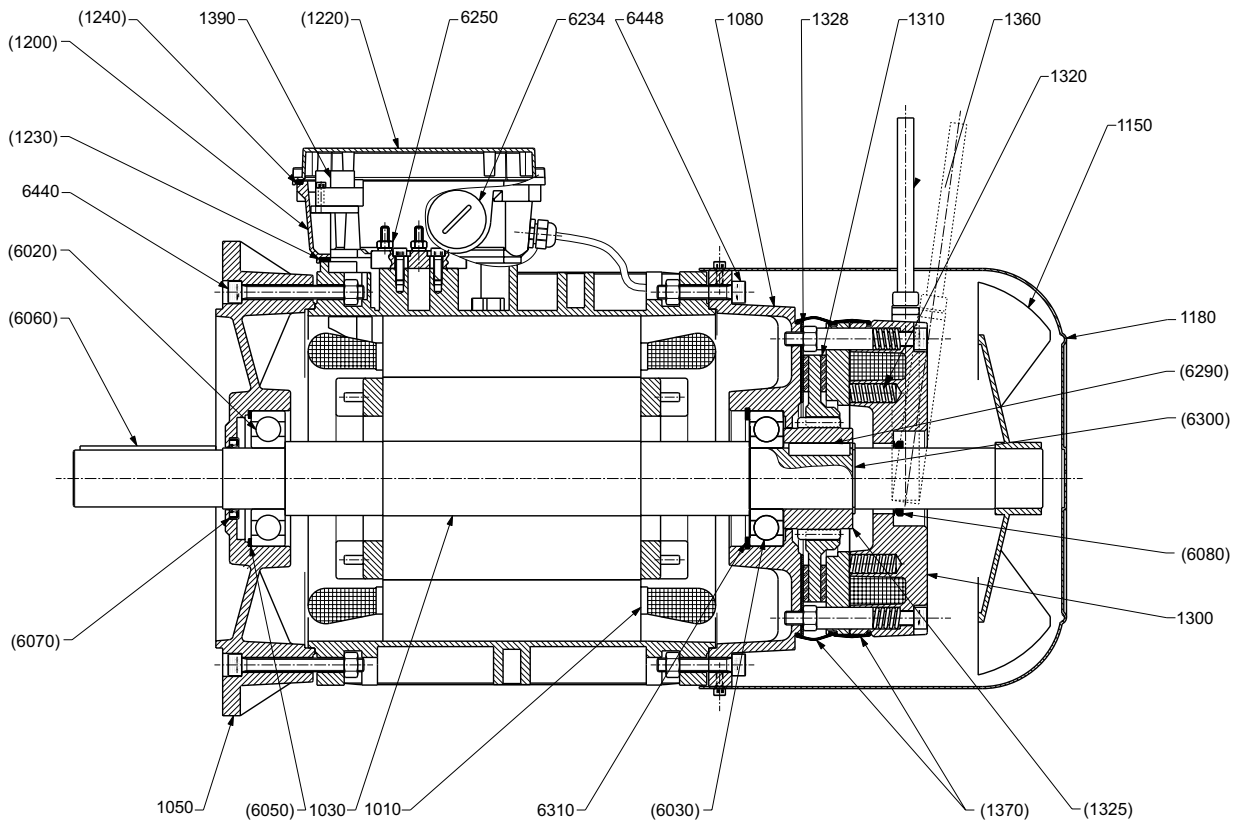
BN 71_FD...BN 160MR_FD



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange*	Flansch (B5/B14)	*Bride (B5/B14)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie-rods*	Zuganker	*Entretoises*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
KSM	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	1300	Freno in c.c. tipo FD	*d.c. brake type FD*	Gleichstrombremse Typ FD	*Frein c.c. type FD*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1360	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1390	Alimentatore ac/dc	*ac/dc rectifier*	Gleichrichter	*Redresseur c.a./c.c.*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

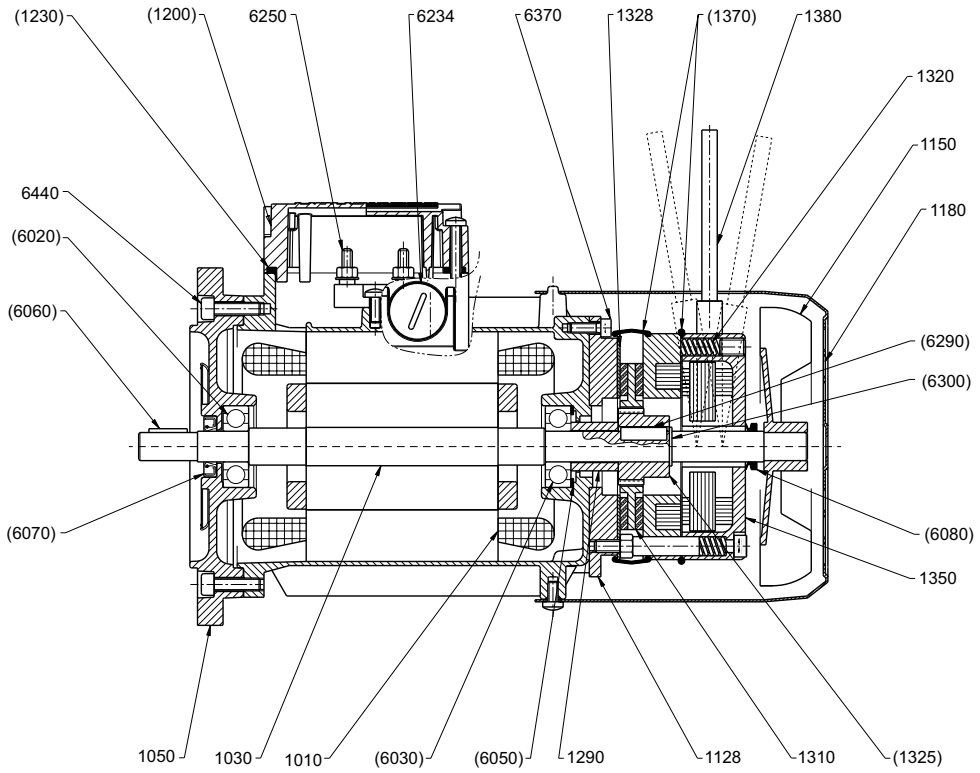
BN 160_FD...BN 200L_FD



kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5)	*Mounting flange (IM B5)*	Flansch (IM B5)	*Bride (IM B5)*
	1080	Scudo NDE	*Rear shield (NDE)*	Lagerschild Nichtantriebsseite	*Bouchier*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
KSM	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1300	Freno in c.c. tipo FD	*d.c. brake type FD*	Gleichstrombremse Typ FD	*Frein c.c. type FD*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1360	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1390	Alimentatore ac/dc	*ac/dc rectifier*	Gleichrichter	*Redresseur c.a./c.c.*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6310	Anello elastico	*Circlip*	Seegerring	*Seeger*
	6440	Viti serraggio flangia	*Bolts DE*	Scraube	*Vis*
	6448	Viti serraggio scudo NDE	*Bolts NDE*	Schraube	*Vis*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

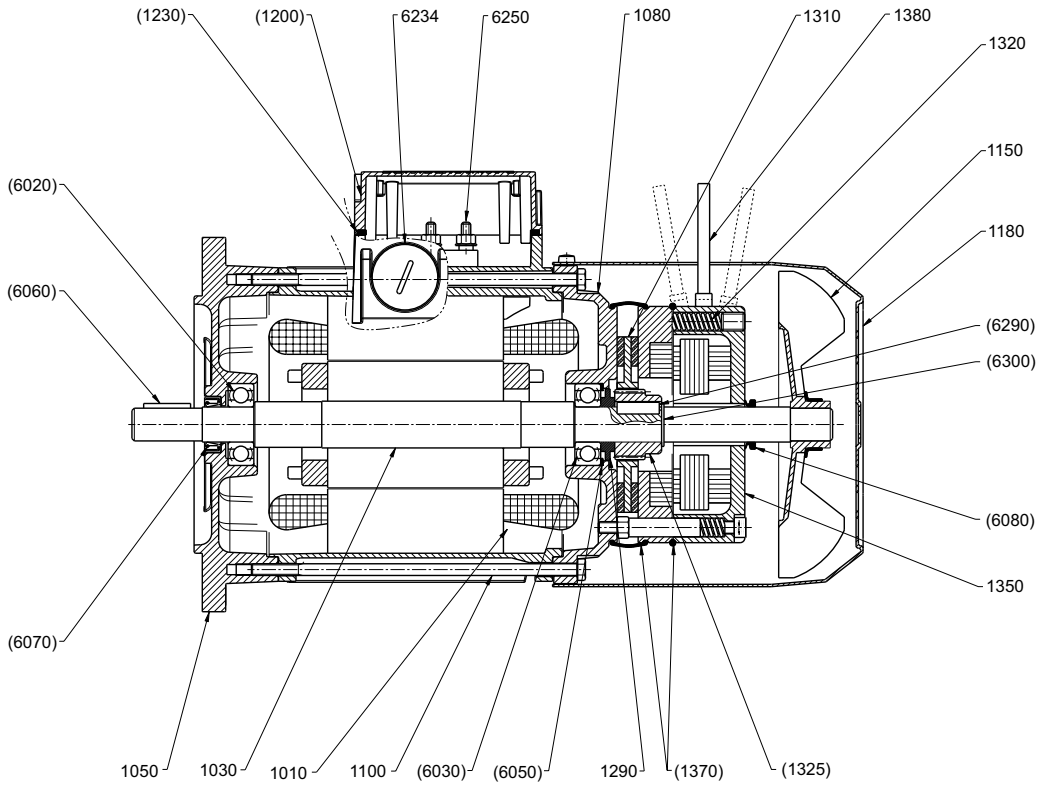
BN 63_FA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange (B5/B14)*	Flansch (B5/B14)	*Bride (B5/B14)*
	1128	Anello attacco freno	*Brake holding plate*	Bremslagerschild	*Anneau attelage frein*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1350	Freno in c.a. tipo FA	*a.c. brake type FA*	Wechselstrombremse Typ FA	*Frein c.a. type FA*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1380	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6370	Viti fissaggio anello attacco freno	*Bolts*	Schraube	*Vis*
	6440	Viti fissaggio flangia	*Bolts*	Schraube	*Vis*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

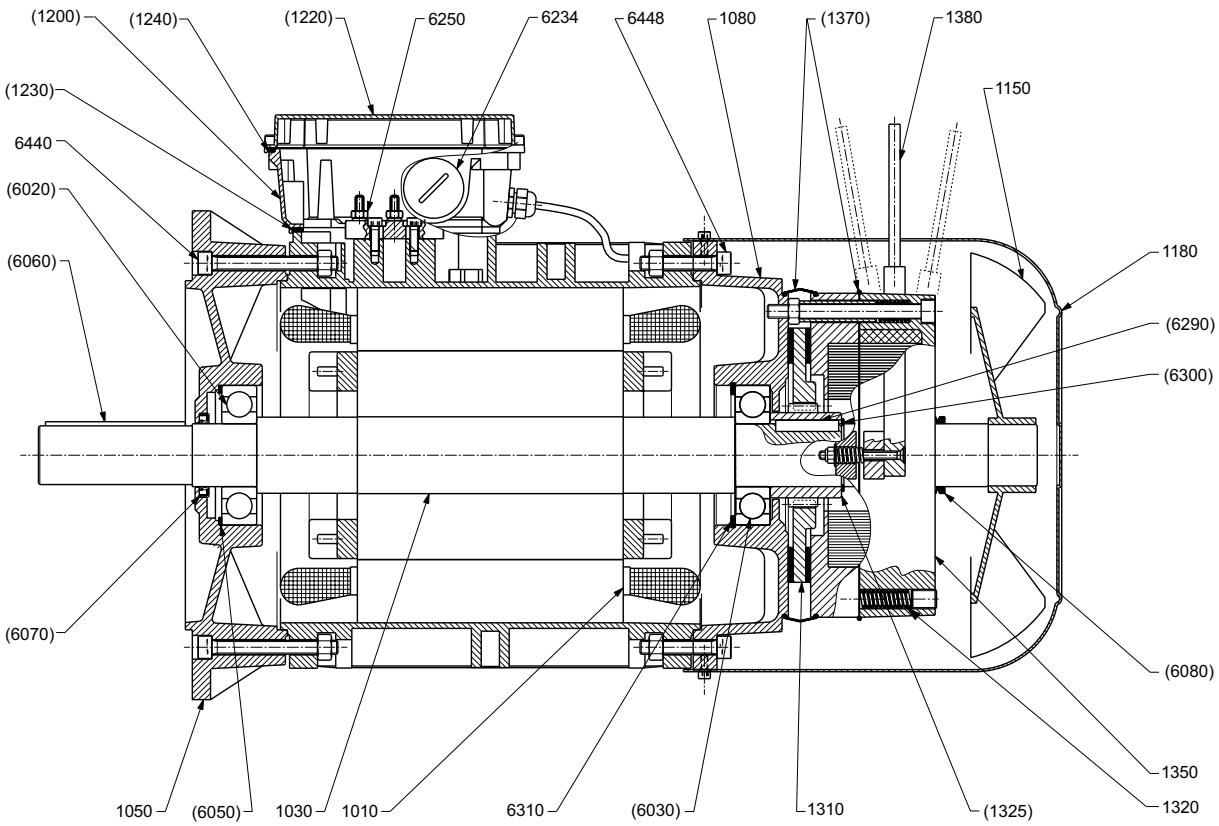
BN 71_FA...BN 160MR_FA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange*	Flansch (B5/B14)	*Bride (B5/B14)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie-rods*	Zuganker	*Entretoises*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cowl*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzstück	*Entretoise*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1350	Freno in c.a. tipo FA	*a.c. brake type FA*	Drehstrombremse Typ FA	*Frein c.a. type FA*
KPF	(1370)	Set guarnizioni freno (IP55)	*Brake seal kit (IP55)*	Gummiring (IP55)	*Set bagues de frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1380	Leva di sblocco	*Hand release lever*	Handlüfterhebel	*Levier déblocage*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

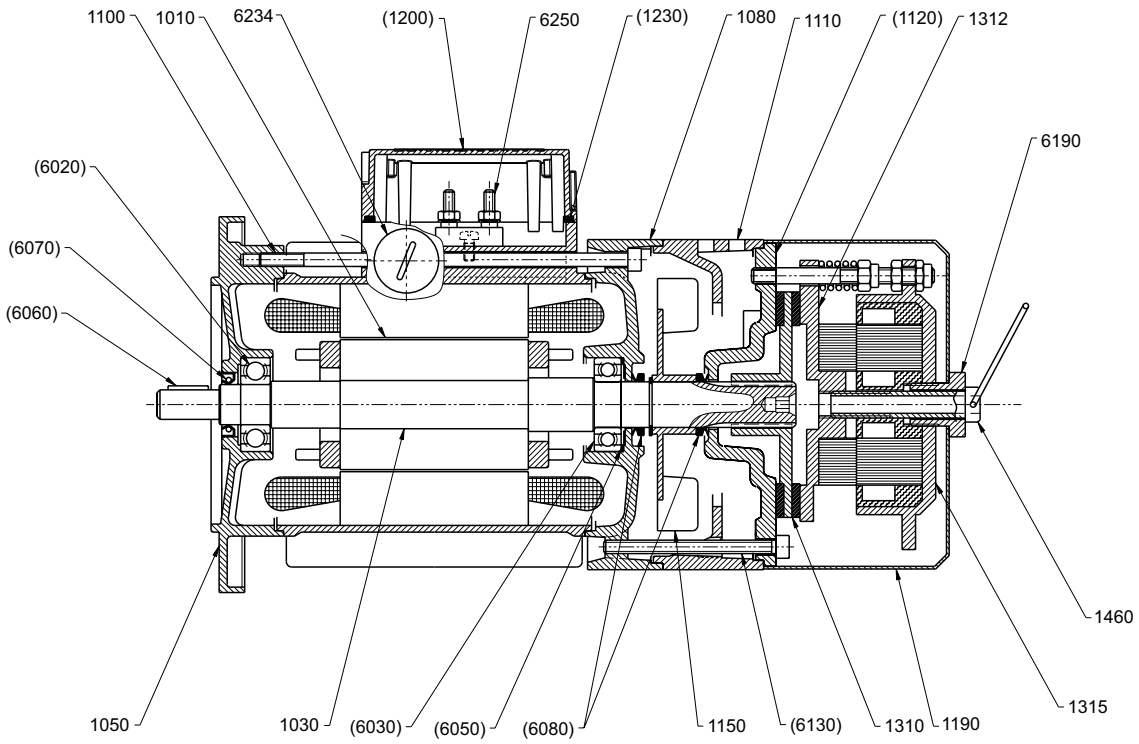
BN 160_FA...BN 180M_FA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5)	*Mounting flange (IM B5)*	Flansch (IM B5)	*Bride (IM B5)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cowl*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1220)	Coperchio scatola morsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle de la boîte a bornes*
KSM	(1230)	Guarnizione scatola morsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio morsettiera	*Terminal box lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1350	Freno in c.a. tipo FA	*a.c. brake type FA*	Drehstrombremse Typ FA	*Frein c.a. type FA*
KPF	(1370)	Set guarnizioni freno (IP55)	*Brake seal kit (IP55)*	Gummiring (IP55)	*Set bagues de frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1380	Leva di sblocco	*Hand release lever*	Handlüfterhebel	*Levier déblocage*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Elastic ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6310	Anello elastico	*Circlip*	Seegerring	*Seeger*
	6440	Viti serraggio flangia	*Bolt DE*	Schraube	*Vis*
	6448	Viti serraggio scudo NDE	*Bolt NDE*	Schraube	*Vis*

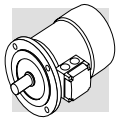
(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en*

BN 63_BA...BN132_BA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange*	Flansch (B5/B14)	*Bride (B5/B14)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie rods*	Zuganker	*Entretoises*
	1110	Convogliatore	*Fan cowling*	Lüftungsbohrung	*Convoyeur*
KSF	(1120)	Anello attacco freno	*Brake holding plate*	Bremshalterung	*Bague d'attaque frein*
	(6130)	Viti	*Bolts*	Schrauben	*Vis*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1190	Cuffia protezione freno	*Brake guard*	Bremshaube	*Guarde de protection frein*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1312	Ancora mobile	*Armature plate*	Beweglicher Anker	*Armature mobile*
	1315	Freno in c.a. tipo BA	*a.c. brake type BA*	Drehstrombremse Typ BA	*Frein c.a. type BA*
	1460	Vite di sblocco freno	*Brake release*	Bremslüftungsschraube	*Vis déblocage frein*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*
	6190	Vite forata	*Nut screw*	Mutter	*Vis percé*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*



R5				
	Descrizione	***Description***	**Beschreibung**	***Description***
10	Aggiunti dettagli su applicabilità opzione PN.	*Details added on applicability of the PN option.*	Detailangaben bei Eignung der PN-Option.	*Rajoutés détails sur applicabilité de l' option PN.*
34	Inserita la descrizione delle opzioni per l'alimentazione separata del freno.	*Description of the options available for the separate brake supply.*	Beschreibung der für separate Bremsansteuerung verfügbaren Optionen.	*Insérée la description des options pour l'alimentation séparée du frein.*
69	Corrette le dimensioni del motore tipo BN63_BA.	*Corrected dimensions of enclosure for brakemotor type BN63_BA.*	Korrigierte Abmessungen des Bremsmotors Type BN63_BA.	*Corrigées les dimensions du moteur frein type BN63_BA.*

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Shell

Bonfiglioli Riduttori recommends SHELL lubricants

COD. BC0020 R5

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Revisioni
Le edizioni dei cataloghi che subiscono revisioni, riportano al centro in basso delle pagine che hanno subito delle modifiche, il relativo ultimo indice di revisione. L'elenco delle pagine interessate alle relative revisioni è a pag.40.
L'indice di revisione del catalogo è riportato nella IVa di copertina in basso al centro.

Revisions
For catalogue editions that include revised material, the latest relevant revision index is shown at bottom centre of the modified pages. The list of pages with revisions is shown on page 40. The index of catalogue revisions appears at bottom centre of back cover page.

Änderungen
Der Änderungstatus ist auf jedem Blatt unten, in der Mitte enthalten. Auf Seite 40 ist eine Übersicht der berichtigten Seiten enthalten. Die Änderung des Katalogs ist auf der letztch. Seite des Einbands unten in der Mitte sichtlich.

Révisions
Les éditions des catalogues qui subissent des révisions présentent au centre, du bas des pages ayant subi des modifications, le dernier indice de révision. La liste des pages concernées par les révisions se trouve page 40. L'indice de révision du catalogue se trouve à la IVème page de couverture en bas au centre.

Il Gruppo Bonfiglioli, sensibile ai problemi dell'ambiente e all'ecologia, ha realizzato le pagine di questo catalogo in carta raciclata.

Bonfiglioli Group, in its commitment to environment to environmental preservation, have printed these pages on recycled paper.

Die Gruppe Bonfiglioli denkt umweltbewußt: Vorliegender Katalog ist auf Altpapier gedruckt.

Le Groupe Bonfiglioli, sensible aux problèmes de préservation de l'environnement, a imprimé ce catalogue sur du papier recyclé.

1 - CONDIZIONI DI FORNITURA

I riduttori vengono forniti come segue:

a) già predisposti per essere installati nella posizione di montaggio come definito in fase di ordine;

b) **senza olio lubrificante ed internamente protetti con un film d'olio usato per il collaudo finale (tipo SHELL ENSIS OIL N);**

c) verniciati con vernice di fondo antiossidante all'acqua di colore grigio (tipo Idrayon Primer-Ral 7042/C441).
Le superfici di accoppiamento non sono verniciate.
La verniciatura finale è a cura del cliente;

d) collaudati secondo specifiche interne;

e) appositamente imballati;

f) provvisti di dadi e bulloni per montaggio motori elettrici versione IEC;

g) già provvisti di lubrificante per quelli a lubrificazione permanente.

1 - SUPPLY CONDITIONS

Gearboxes are supplied as follows:

a) ready for installation in the mounting position specified on order;

*b) **dry; inner parts are protected by a film of the oil used for final testing (type SHELL ENSIS OIL N);***

c) painted with antioxidant water primer in the colour grey (type Idrayon Primer-Ral 7042/C441).
Mating surfaces are not painted.
Final coat is to be applied by the Customer;

d) tested to in-house specifications;

e) suitably packed;

f) complete with mounting nuts and bolts for IEC electric motors;

g) life-lubed gearboxes are factory filled with oil.

1 - LIEFERBEDINGUNGEN

Die Getriebe werden folgendermaßen geliefert:

a) bereits für die Installation in der Einbaulage gemäß Auftrag bereit;

b) **ohne Schmieröl und innen mit einem Öl, das für die Endabnahmeprüfung verwendet wurde, überzogen (Typ SHELL ENSIS OIL N);**

c) mit einer grauen, vor Oxydation durch Wasser schützenden Grundlackierung überzogen (Typ Idrayon Primer Ral 7042/C441).
Die Verbindungsflächen sind nicht lackiert.
Die Endlackierung geht zu Lasten des Kunden;

d) gemäß werksinterner Spezifikationen geprüft;

e) in angemessener Weise verpackt;

f) mit Muttern und Schrauben für die Montage an Elektromotoren der Version IEC;

g) die mit Dauerschmierung, bereits mit Schmiermittel ausgestattet.

1 - CONDITIONS DE LIVRAISON

Les réducteurs sont livrés comme suit:

a) déjà adaptés pour l'installation dans la position d'assemblage définie en cours de commande;

*b) **sans huile lubrifiante et protégés à l'intérieur avec un film d'huile utilisée lors de l'essai final (type SHELL ENSIS OIL N);***

c) peints avec une couche de fond de protection antioxydant à l'eau, de coloris gris (type idrayon Primer-Ral 7042/C441).
Les surfaces d'accouplement ne sont pas peintes.
La peinture de finition doit être réalisée par le client;

d) essayés d'après les spécifications internes;

e) dûment emballés;

f) pourvus d'écrous et de boulons pour l'assemblage aux moteurs électriques, version CEI;

g) déjà pourvus de lubrifiant pour ceux à lubrification permanente.

TRASPORTO

Durante il trasporto è norma trattare i riduttori come merce delicata per evitare danni.
Durante i trasporti interni dei riduttori sballati, evitare che questi prendano urti per non danneggiare parti esterne delicate.

SHIPMENT

Always handle gearboxes as fragile goods during shipment.
When moving unpacked gearboxes inside your factory, ensure that they are not subjected to impacts which could damage delicate external components and surfaces.

TRANSPORT

Während dem Transport empfiehlt es sich, die Getriebe mit Sorgfalt und Vorsicht zu behandeln, um Schäden zu vermeiden.
Beim werksinternen Transport der schon ausgepackten Getriebe sollte vermieden werden, dass diese Schläge oder Stösse erleiden, welche empfindliche äussere Teile beschädigen könnten.

TRANSPORT

Durant le transport, il est nécessaire de traiter les réducteurs comme des produits délicats, afin d'éviter tout dommage.
Durant les transports internes des réducteurs déballés, éviter que ces derniers ne subissent des chocs pour ne pas endommager les parties externes sensibles.

STOCCAGGIO

Il corretto stoccaggio dei prodotti ricevuti richiede l'esecuzione delle seguenti attività:

a) Escludere aree all'aperto, zone esposte alle intemperie o con eccessiva umidità;

b) Interporre sempre tra il pavimento ed i prodotti, pianali lignei o di altra natura, atti ad impedire il diretto contatto col suolo;

c) Per periodi di stoccaggio superiori ai 60 giorni, le superfici interessate agli accoppiamenti quali flange, alberi e giunti, devono essere protette con idoneo prodotto antiossidante (SHELL ENSIS FLUID SDC od equivalente);

d) Per periodi di stoccaggio previsti superiori ai 6 mesi, i prodotti devono essere oggetto delle seguenti attività:

d1) Ricoprire le parti lavorate esterne e quelle di accoppiamento con grasso atto ad evitare ossidazioni;

d2) Posizionare i riduttori con il tappo di sfiato nella posizione più alta e riempirli di olio ad eccezione di quelli con lubrificazione permanente .
I riduttori, prima del loro utilizzo, dovranno essere riempiti con la corretta quantità e tipo di lubrificante previsto (vedi pag.35-36)

STORAGE

Observe the following instructions to ensure correct storage of delivered products:

a) Do not store outdoors, in areas exposed to weather or with excessive humidity;

b) Always place boards in wood or other material between floor and products, to avoid direct contact with the floor;

c) For storage periods of over 60 days, all machined surfaces such as flanges, shafts and couplings must be protected with a suitable antioxidation product (SHELL ENSIS FLUID SDC or equivalent product);

d) The following measures must be taken in respect of products for which the expected storage period exceeds 6 months:

d1) Cover outer machined parts and mating parts with grease to avoid oxidation;

d2) Position the gearboxes with the breather plug up and fill them with oil (this does not apply to life-lubed gearboxes).
Before use, the gearboxes should be filled with the proper amount of lubricant of the recommended type (page 35-36).

LAGERUNG

Die korrekte Lagerung der Antriebe erfordert folgende Vorkehrungen:

a) Die Produkte nicht im Freien lagern und nicht in Räumen, die der Witterung ausgesetzt sind, oder eine hohe Feuchtigkeit aufweisen;

b) Die Produkte nie direkt auf dem Boden, sondern auf Unterlagen aus Holz oder einem anderen Material lagern;

c) Bei Lagerzeiten von mehr als 60 Tagen die Oberflächen für die Verbindung, wie Flansche, Wellen oder Kupplungen mit einem geeigneten Oxidationsschutzmittel behandeln (SHELL ENSIS FLUID SDC oder ein äquivalentes Mittel);

d) Bei Lagerzeiten von mehr als 6 Monaten müssen folgende Vorkehrungen getroffen werden:

d1) Die bearbeiteten Außenteile und die Passflächen mit Oxydationschutzfett abdecken;

d2) Die Getriebe mit der Entlüftungsschraube in der obersten Position ausgerichtet aufstellen und, die mit Dauerschmierung ausgestatteten Getriebe ausgenommen, mit Öl füllen.
Die Getriebe müssen vor ihrem Einsatz mit der richtigen Menge des vorgesehenen Schmiermittels aufgefüllt werden (Seite 35-36).

STOCKAGE

Un stockage correct des produits reçus nécessite de respecter les règles suivantes:

a) Exclure les zones à ciel ouvert, les zones exposées aux intempéries ou avec humidité excessive;

b) Interposer dans tous les cas entre le plancher et les produits des planches de bois ou des supports d'autre nature empêchant le contact direct avec le sol;

c) Pour les périodes de stockage supérieures à 60 jours, les surfaces concernées par les liaisons telles que les brides, les arbres et les accouplements doivent être protégées avec un produit antioxydant spécial (SHELL ENSIS FLUID SDC ou équivalent);

d) Pour les périodes de stockage prévues supérieures à 6 mois, les produits doivent être objet des contrôles suivants:

d1) Recouvrir les parties extérieures usinées et les éléments d'accouplement avec de la graisse contre l'oxydation;

d2) Positionner les réducteurs avec le bouchon reniflard le plus haut possible et les remplir d'huile, à l'exception de ceux à lubrification permanente.
Avant utilisation, les réducteurs doivent être remplis de la quantité et du type de lubrifiant préconisés (page 35-36).

2 - NORME PER L'INSTALLAZIONE

Prima dell'installazione del riduttore controllare che questo sia nella esecuzione prevista per la posizione di montaggio.

2 - INSTALLATION

Check that the gearbox is the right model and type before starting installation.

2 - INSTALLATION

Vor Installation des Getriebes kontrollieren, daß die gelierferte Ausführung für die gewünschte Einbaulage vorgesehen ist.

2 - INSTRUCTIONS D'INSTALLATION

Avant installation du réducteur s'assurer que celui-ci soit prédisposé pour sa position de montage.

POSIZIONI DI MONTAGGIO Serie 300L - 300R

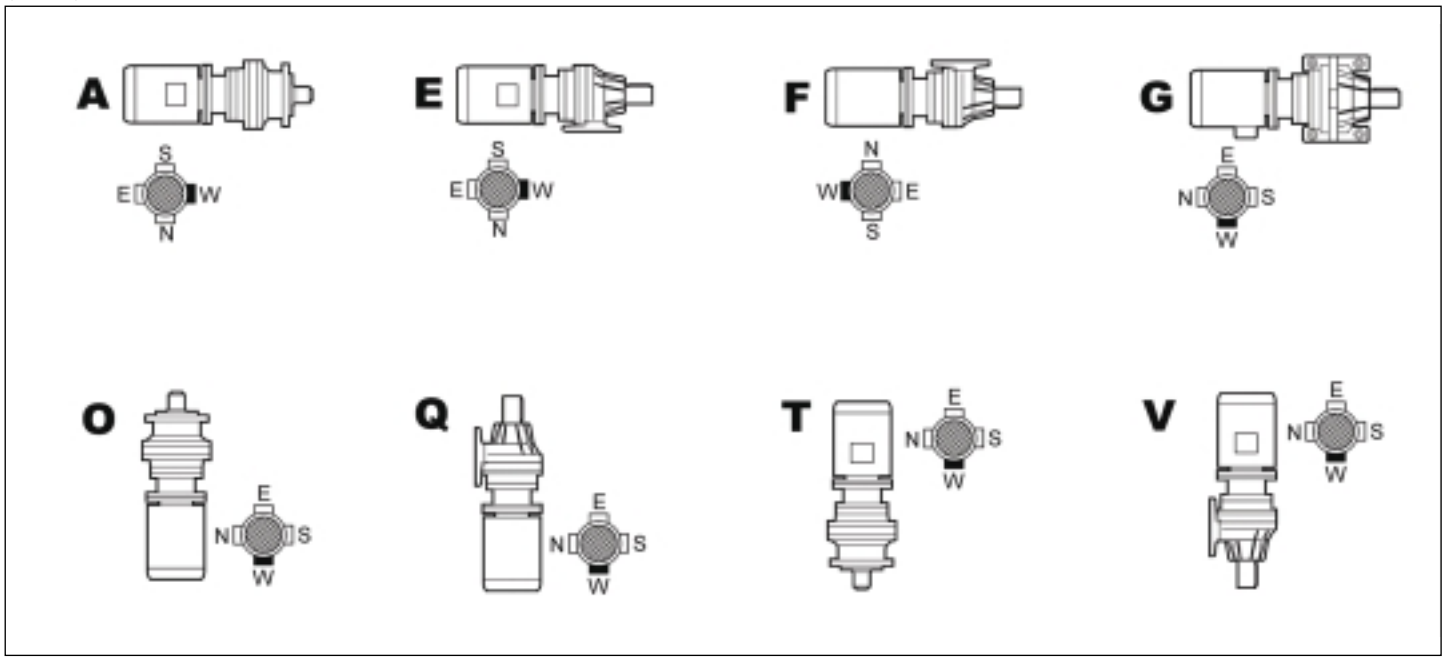
MOUNTING POSITION 300L - 300R Series

MONTAGEPOSITIONEN Serie 300L - 300R

POSITION DE FONCTIONNEMENT Série 300L - 300R

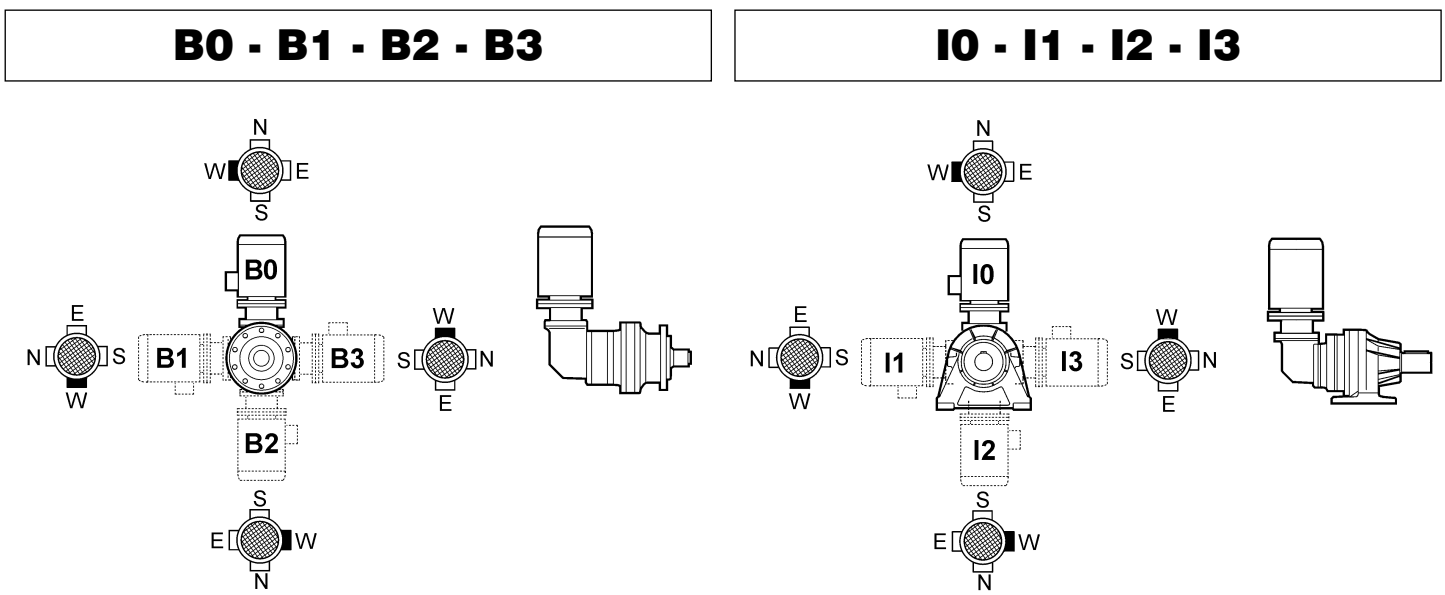
Riduttori in linea — ***Inline gearboxes*** — **Coaxiale Untersetzungsgetriebe** — ***Réducteurs coaxiaux***

(FIG.1)



Riduttori angolari — ***Right angle gearboxes*** — **Rechtwinklige Untersetzungsgetriebe** — ***Réducteurs a rénvoi d'angle***

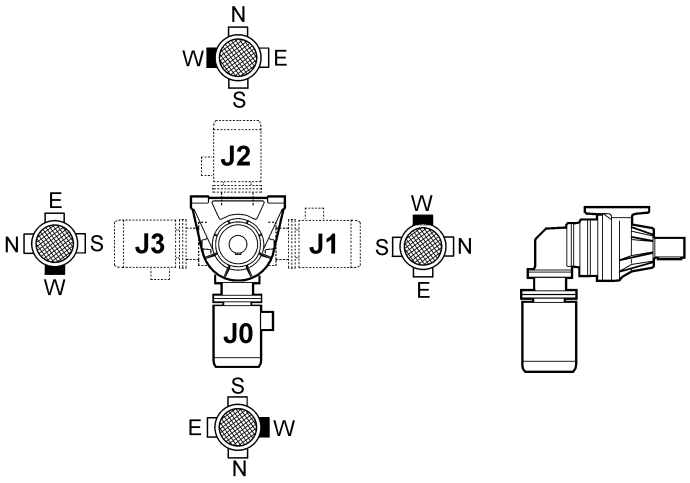
(FIG.2)



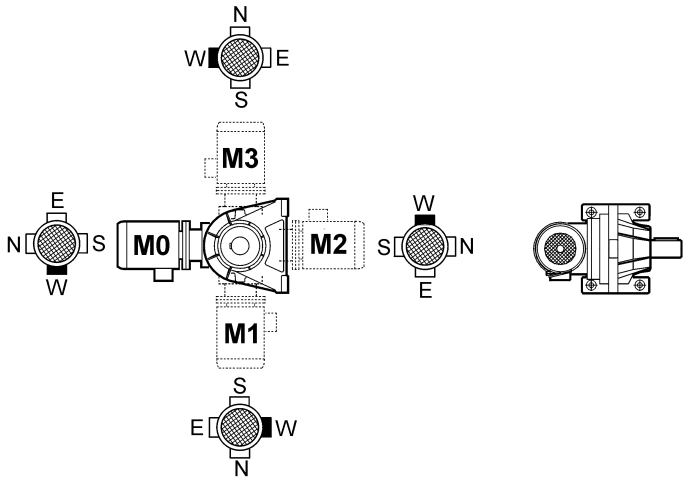
POSIZIONI DI MONTAGGIO Serie 300L - 300R | ***MOUNTING POSITION 300L - 300R Series*** | **MONTAGEPOSITIONEN Serie 300L - 300R** | ***POSITION DE FONCTIONNEMENT Série 300L - 300R***

(FIG.3)

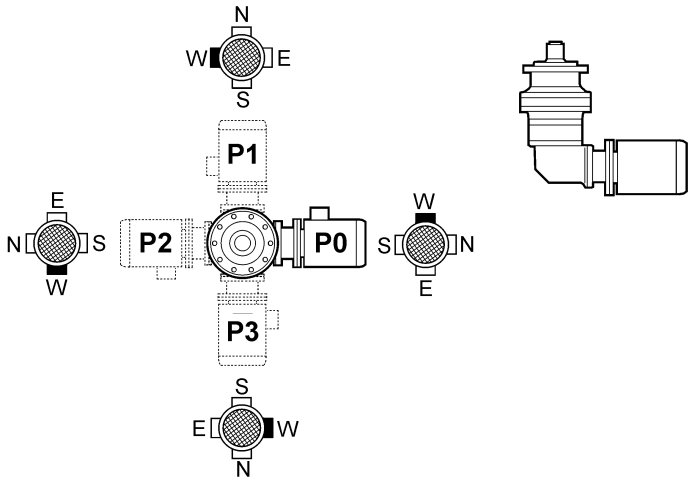
J0 - J1 - J2 - J3



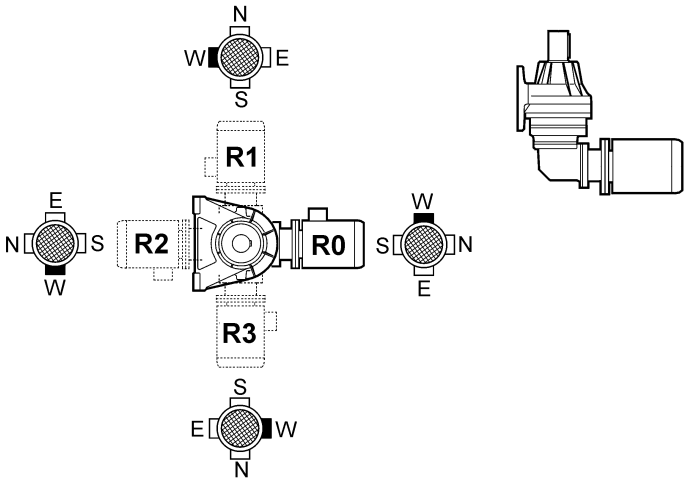
M0 - M1 - M2 - M3



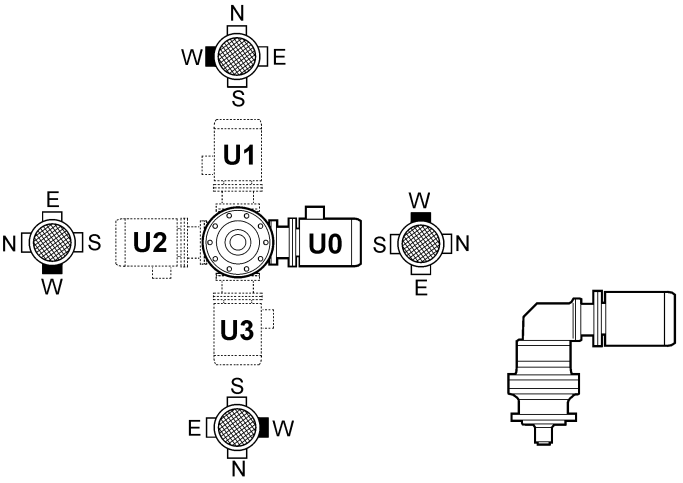
P0 - P1 - P2 - P3



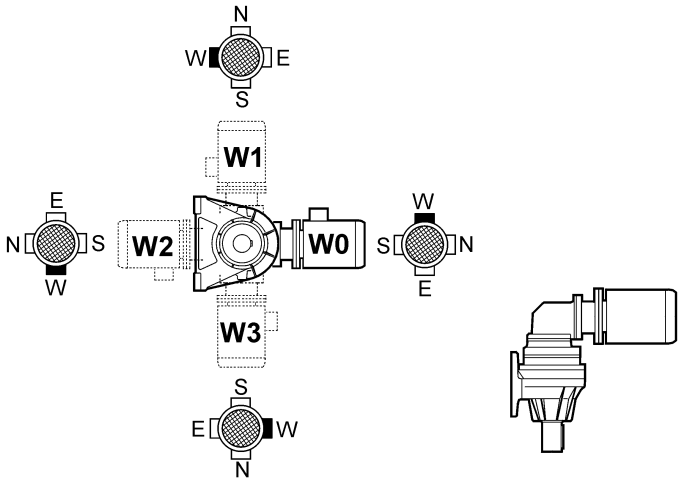
R0 - R1 - R2 - R3



U0 - U1 - U2 - U3



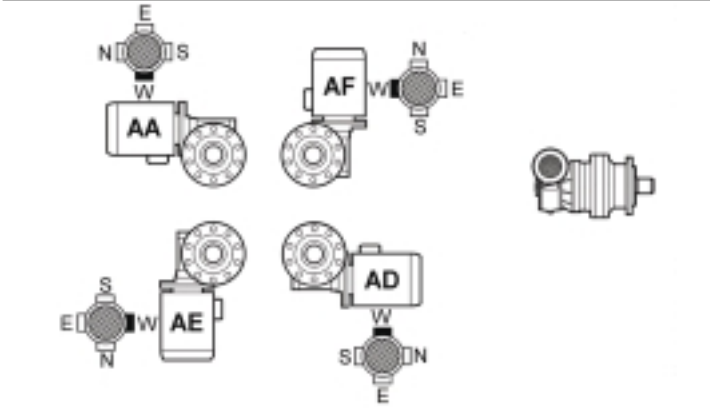
W0 - W1 - W2 - W3



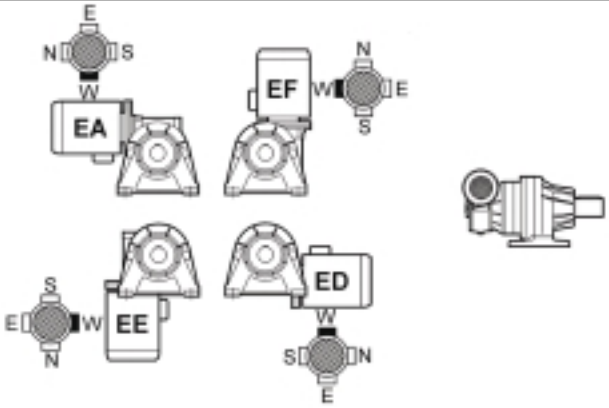
POSIZIONI DI MONTAGGIO Serie 3/VF | ***MOUNTING POSITION 3/VF Series*** | **MONTAGEPOSITIONEN Serie 3/VF** | ***POSITION DE FONCTIONNEMENT Série 3/VF***

(FIG.4)

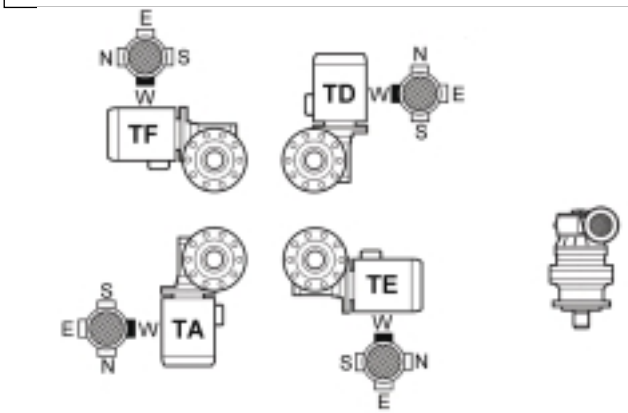
AA - AE - AF - AD



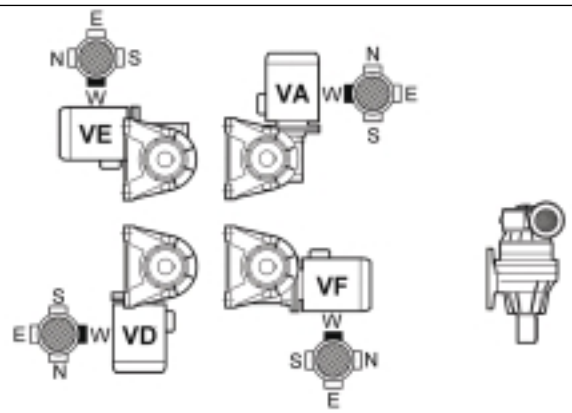
EA - EE - EF - ED



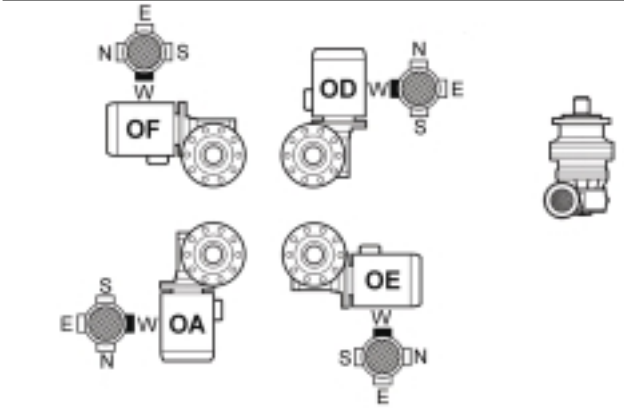
TA - TE - TF - TD



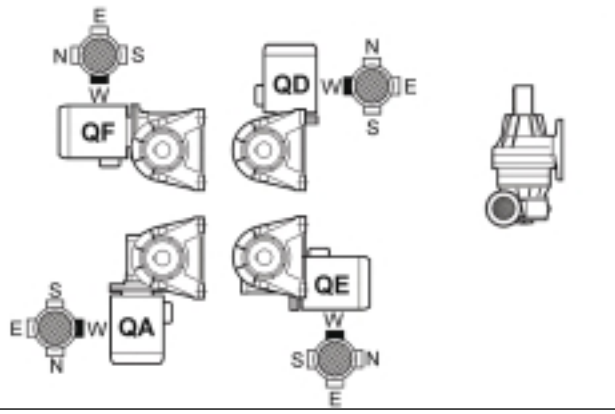
VA - VE - VF - VD



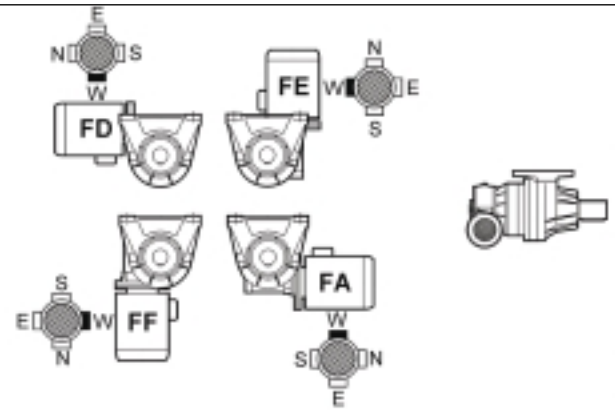
OA - OE - OF - OD



QA - QE - QF - QD



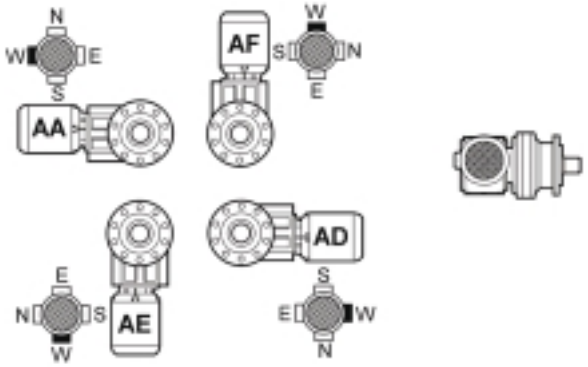
FA - FE - FF - FD



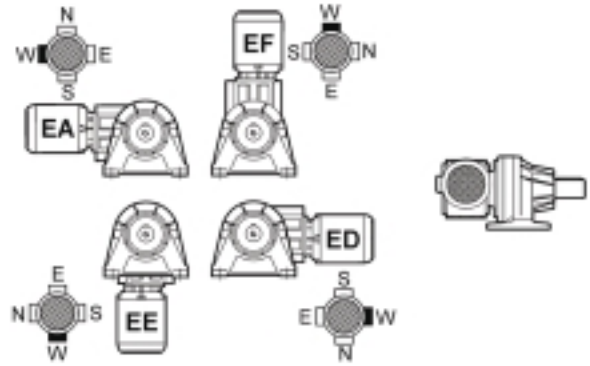
POSIZIONI DI MONTAGGIO Serie 3/A | ***MOUNTING POSITION 3/A Series*** | **MONTAGEPOSITIONEN Serie 3/A** | ***POSITION DE FONCTIONNEMENT Série 3/A***

(FIG.5)

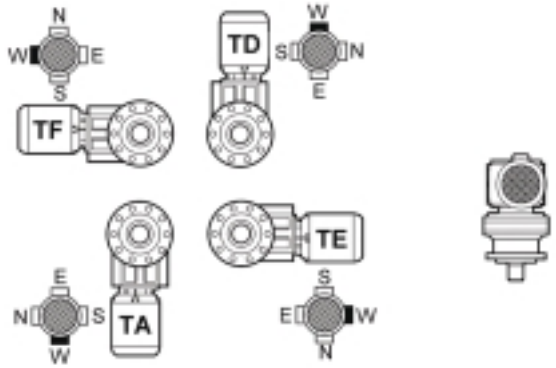
AA - AE - AF - AD



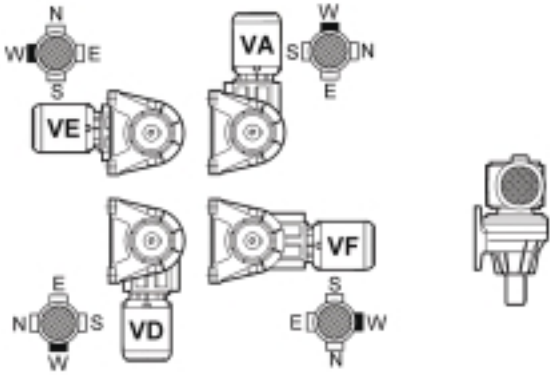
EA - EE - EF - ED



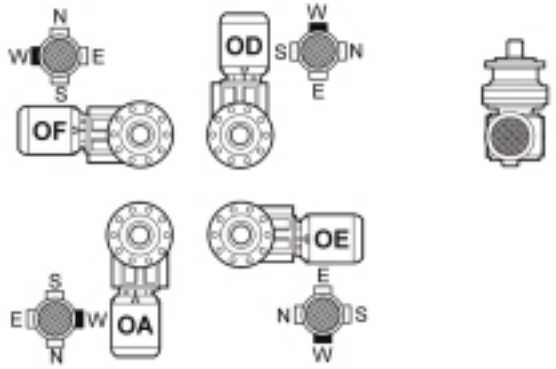
TA - TE - TF - TD



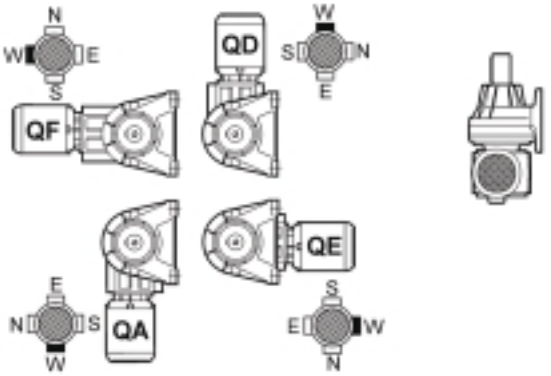
VA - VE - VF - VD



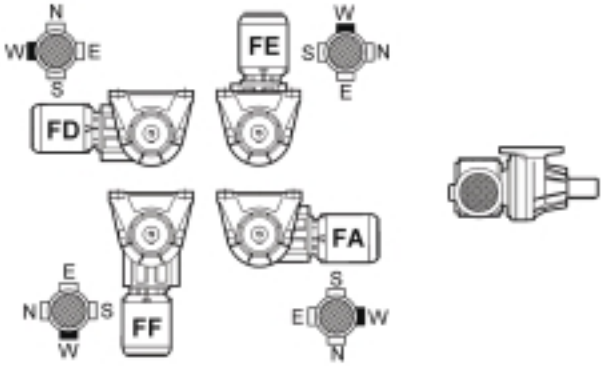
OA - OE - OF - OD



QA - QE - QF - QD



FA - FE - FF - FD



FORME COSTRUTTIVE — *VERSIONS* — BAUFORMEN — *FORMES DE CONSTRUCTION*

A **ENTRATE / *INPUT* ANTRIEB / *ENTREES***

B **RIDUZIONI / *REDUCTIONS* UNTERSETZUNGEN / *TRAINS EPICICLOÏDAUX***

A
1 Motore elettrico compatto
2 Motore elettrico IEC
3 Predisposizione motore elettrico
4 Albero veloce

B
5 Stadio riduzione angolare
6 Uno stadio di riduzione epicicloidale
7 Due o più stadi di riduzione epicicloidale
8 Stadio di riduzione epicicloidale combinato con riduttore a vite senza fine
9 Stadio di riduzione epicicoidale combinato con riduttore ad assi ortogonali

C
10 Uscita albero maschio cilindrico o scanalato
11 Uscita con piede di supporto ed albero maschio cilindrico o scanalato
12 Uscita con flangia o piede di supporto e albero cilindrico maggiorato
13 Uscita albero femmina scanalato
14 Uscita albero femmina per giunto ad attrito
15 Uscita albero maschio cilindrico
6 Uscita albero maschio scanalato
17 Uscita albero femmina scanalato
18 Uscita albero femmina per giunto ad attrito
19 Piede di supporto
20 Uscita rinforzata con albero cilindrico per agitatori / miscelatori

D
21 Flangia
22 Pignone
23 Manicotto liscio
24 Fondello d'arresto
25 Barra scanalata
26 Giunto ad attrito

A
1 Compact electric motor
2 IEC electric motor
3 Adapter for electric motor
4 Input shaft

B
5 Right-angle reduction stage
6 Single planetary reduction stage
7 Two or more planetary reduction stages
8 Planetary reduction stage
9 Planetary reduction stage combined with helical bevel gear unit

C
10 Parallel or splined solid shaft output
11 Parallel or splined solid shaft output featuring integral foot mount
12 Flanged or foot-mount output with oversized solid shaft
13 Splined hollow shaft output
14 Hollow shaft output for shrink disc
15 Parallel solid shaft output
16 Splined solid shaft output
17 Splined hollow shaft output
18 Hollow shaft output for shrink disc
19 Foot mount
20 Reinforced output with parallel shaft for stirrers and mixers

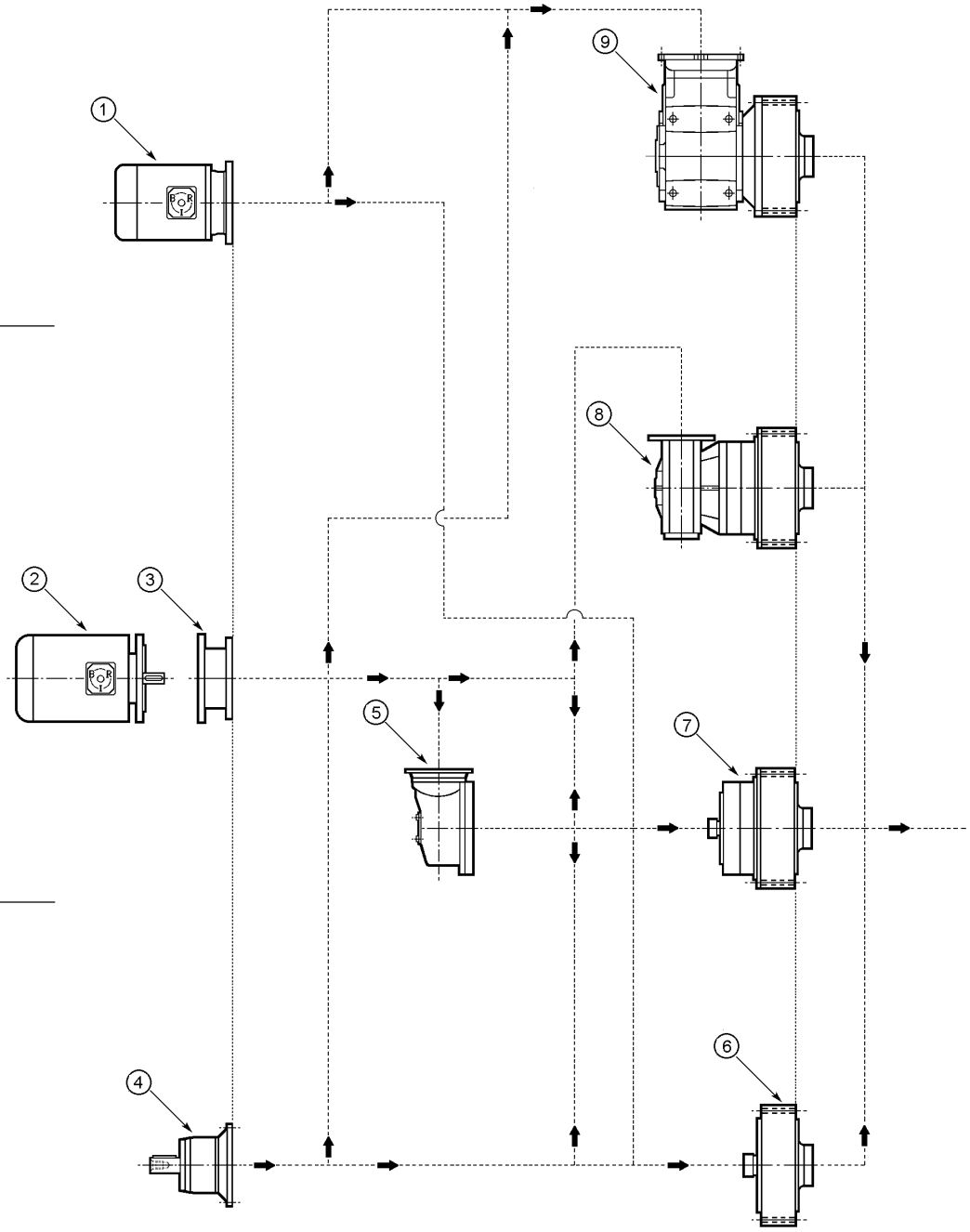
D
21 Flange
22 Pinion
23 Sleeve coupling
24 Stop bottom plate
25 Splined bar
26 Shrink disc

A
1 Kompakter Elektromotor
2 IEC-Elektromotor
3 Vorbereitung für Elektromotor
4 Antriebswelle

B
5 Winkelübersetzungsstufe
6 Eine Planetenübersetzungsstufe
7 Zwei oder mehr Planetenübersetzungsstufen
8 Planentenübersetzungsstufe kombiniert mit Schneckengetriebe
9 Planentenübersetzungsstufe kombiniert mit Kegelradgetriebe

C
10 Abtrieb mit Einsteck- oder Keilwelle
11 Abtrieb mit Stützfuß und Einsteckwelle oder keilwelle
12 Abtrieb mit Flansch oder Stützfuß und vergrößerter Einsteckwelle
13 Abtrieb mit Keilaufsteckwelle
14 Abtrieb mit Aufsteckwelle für Schrumpfscheibe
15 Abtrieb mit zylindrischer Einsteckwelle
16 Abtrieb mit Keileinsteckwelle
17 Abtrieb mit Keilaufsteckwelle
18 Abtrieb mit Aufsteckwelle für Schrumpfscheibe
19 Stützfuß
20 Verstärkter Abtrieb mit zylindrischer Welle für Rührwerke und Mischer

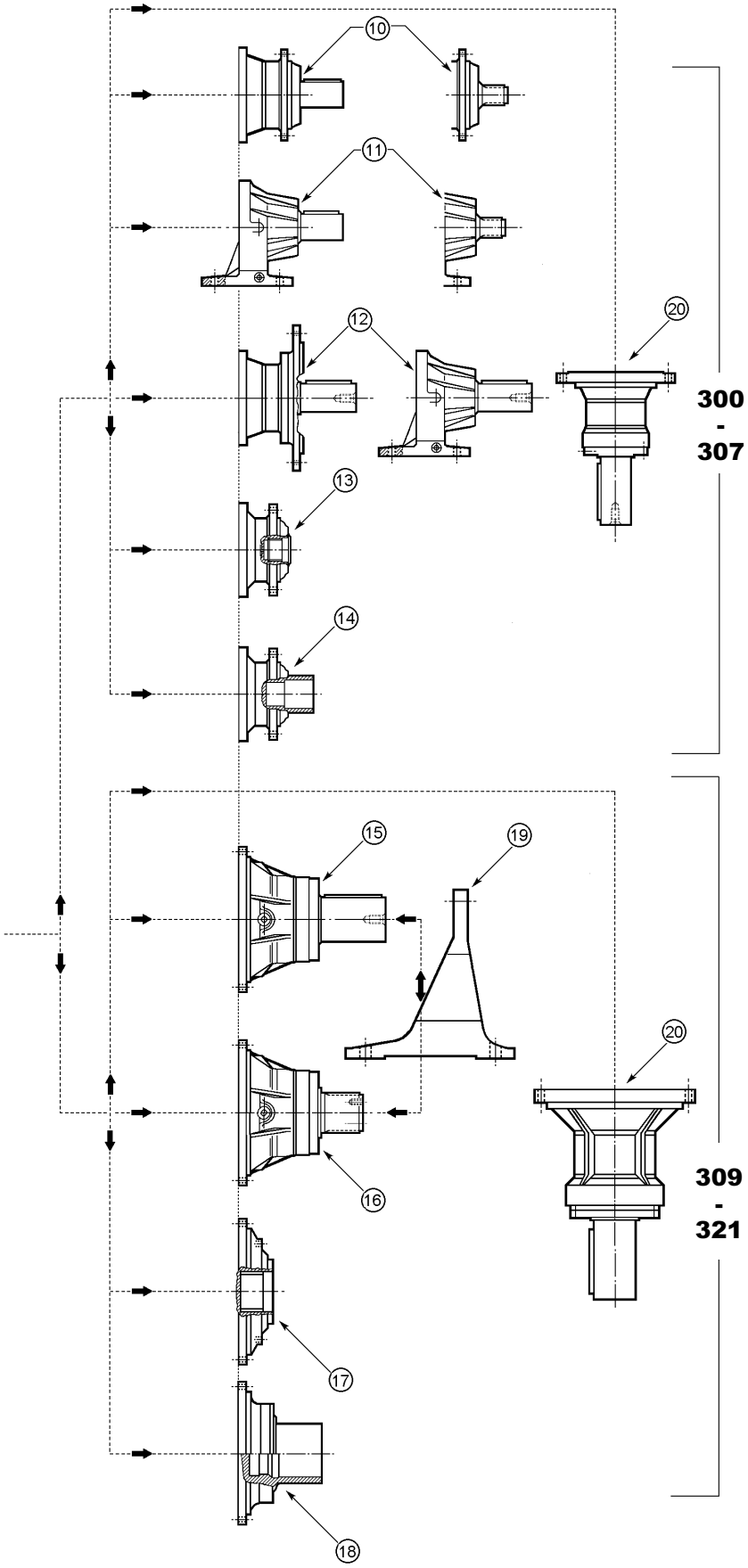
D
21 Flansch
22 Ritzel
23 Nabe
24 Bodenklemmscheibe
25 Keilvollwelle
26 Schrumpfscheibe

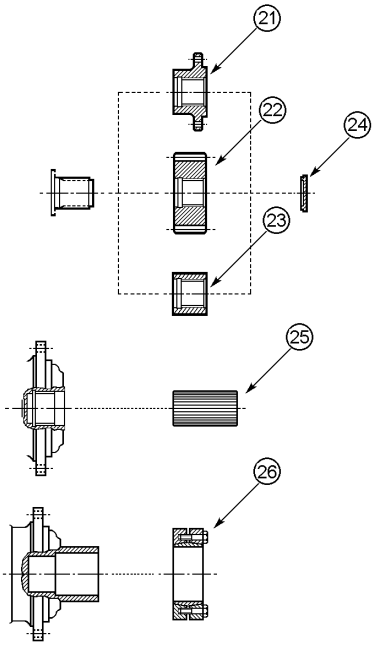


FORME COSTRUTTIVE — ***VERSIONS*** — **BAUFORMEN** — ***FORMES DE CONSTRUCTION***

A **ENTRATE / *INPUT* ANTRIEB / *ENTREES***

B **RIDUZIONI / *REDUCTIONS* UNTERSETZUNGEN / *TRAINS EPICICLOÏDAUX***





A
- *1 Moteur électrique compact*
- *2 Moteur électrique IEC*
- *3 Prédisposition moteur électrique*
- *4 Arbre rapide*

B
- *5 Etage de réduction angulaire*
- *6 Un étage de réduction épicycloïdal*
- *7 Deux ou plusieurs étages de réduction épicycloïdaux*
- *8 Etage de réduction épicycloïdal combiné avec réducteur à vis sans fin*
- *9 Etage de réduction épicycloïdal combiné avec réducteur à axes orthogonaux*

C
- *10 Sortie arbre mâle cylindrique ou cannelé*
- *11 Sortie avec patte de support et arbre mâle cylindrique ou cannelé*
- *12 Sortie avec bride ou patte de support et arbre cylindrique majoré*
- *13 Sortie arbre femelle cannelé*
- *14 Sortie arbre femelle joint à frottement*
- *15 Sortie arbre mâle cylindrique*
- *16 Sortie arbre mâle cannelé*
- *17 Sortie arbre femelle cannelé*
- *18 Sortie arbre femelle joint à frottement*
- *19 Patte de support*
- *20 Sortie renforcée avec arbre cylindrique pour agitateurs et mélangeurs*

D
- *21 Bride*
- *22 Pignon*
- *23 Manchon lisse*
- *24 Fond de butée*
- *25 Barre cannelée*
- *26 Joint à frottement*

ESECUZIONE RIDUTTORI SERIE 300

- ESECUZIONE CON FLANGIA
- ESECUZIONE CON PIEDE
- ESECUZIONE PENDOLARE

300 SERIES GEARBOX MOUNTINGS

- *FLANGE MOUNTING*
- *FOOT MOUNTING*
- *PENDULAR MOUNTING*

AUSFÜHRUNG GETRIEBE SERIE 300

- AUSFÜHRUNG MIT FLANSCH
- AUSFÜHRUNG MIT FUß
- PENDELAUSFÜHRUNG

EXECUTION REDUCTEURS SERIE 300

- *EXECUTION AVEC BRIDE*
- *EXECUTION A PATTES*
- *EXECUTION PENDULAIRE*

ESECUZIONE CON FLANGIA

Ricavare, sulla macchina o impianto su cui vengono installati, le controflange di accoppiamento.
Queste dovranno avere la superficie di accoppiamento con la flangia del riduttore piana e lavorata di macchina utensile. Collegare l'albero d'uscita all'organo da comandare secondo le indicazioni dei disegni seguenti (FIG. 8) e (FIG.9).
Per i centraggi attenersi a quanto segue:

GRANDEZZE FINO AL 307:
esecuzione con albero maschio: vedi disegno (FIG.10).

FLANGE MOUNTING

Prepare the counter-flanges on the machine or plant to which the gearbox is to be applied. The mating surfaces used for gearbox mounting must be perfectly flat and machine finished.
Refer to drawings (FIG.8) and (FIG.9) to match the output shaft to the device to be operated.
Refer to the drawings below to ensure correct centering of the gearboxes:

SIZES UP TO 307:
Refer to drawing (FIG.10) for solid shaft coupling.

AUSFÜHRUNG MIT FLANSCH

Die entsprechenden Gegenflansche an der Maschine oder Anlage, an der das Getriebe eingebaut werden soll, vorbereiten.
Die Kontaktflächen mit dem Getriebeflansch müssen perfekt eben und mit Werkzeugmaschinen bearbeitet sein.
Die Abtriebswelle, den auf den nachstehenden Zeichnung (Abb.8) und (Abb.9) gegebenen Angaben gemäß, an das zu steuernde Organ schließen.
Für die genaue Zentrierung

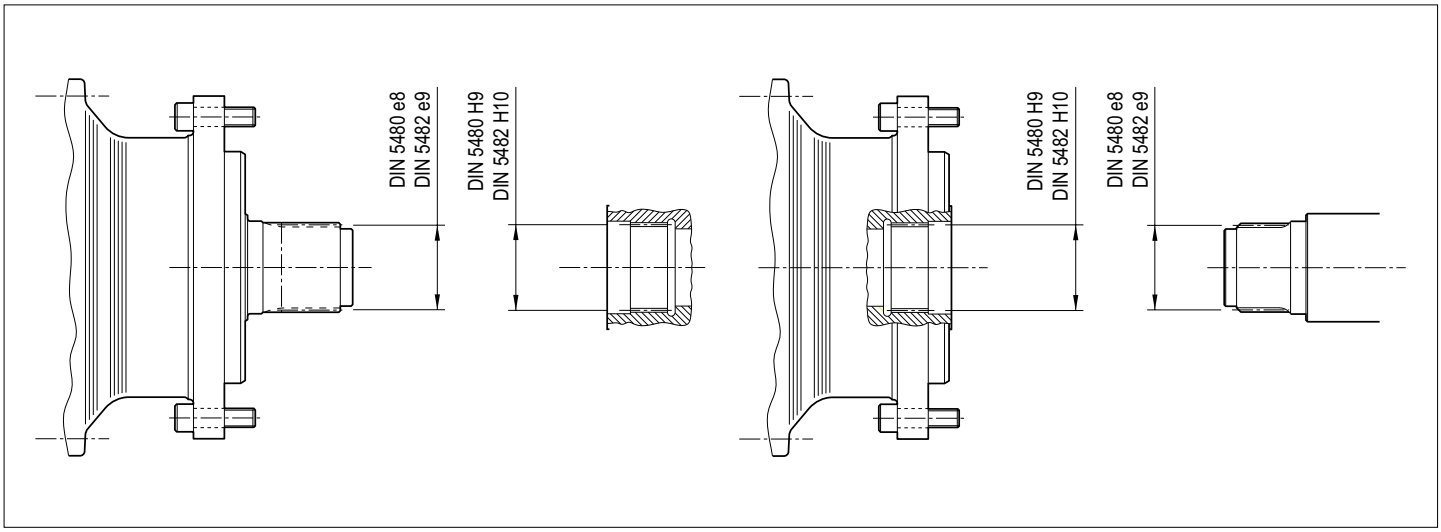
GRÖSSEN BIS 307:
Version mit Innenwelle: siehe Zeichnung (Abb.10)

EXECUTION AVEC BRIDE

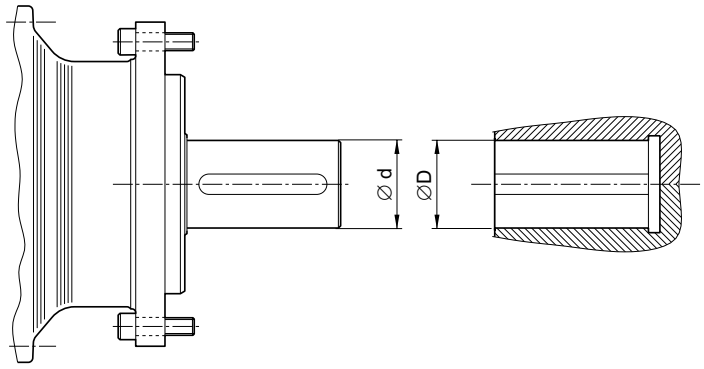
Repérer les contre-brides de couplage sur la machine ou l'installation existante.
Celles-ci devront avoir une surface de couplage avec la bride du réducteur plane et usinée.
Relier l'arbre de sortie à l'organe qui doit être commandé suivant les indications sur les plans (Figure 8) et (Figure 9).
Pour les centrages, respecter les indications suivantes:

GRANDEURS JUSQU'À 307:
execution avec arbre male: se référer au plan (Figure 10)

(FIG.8)



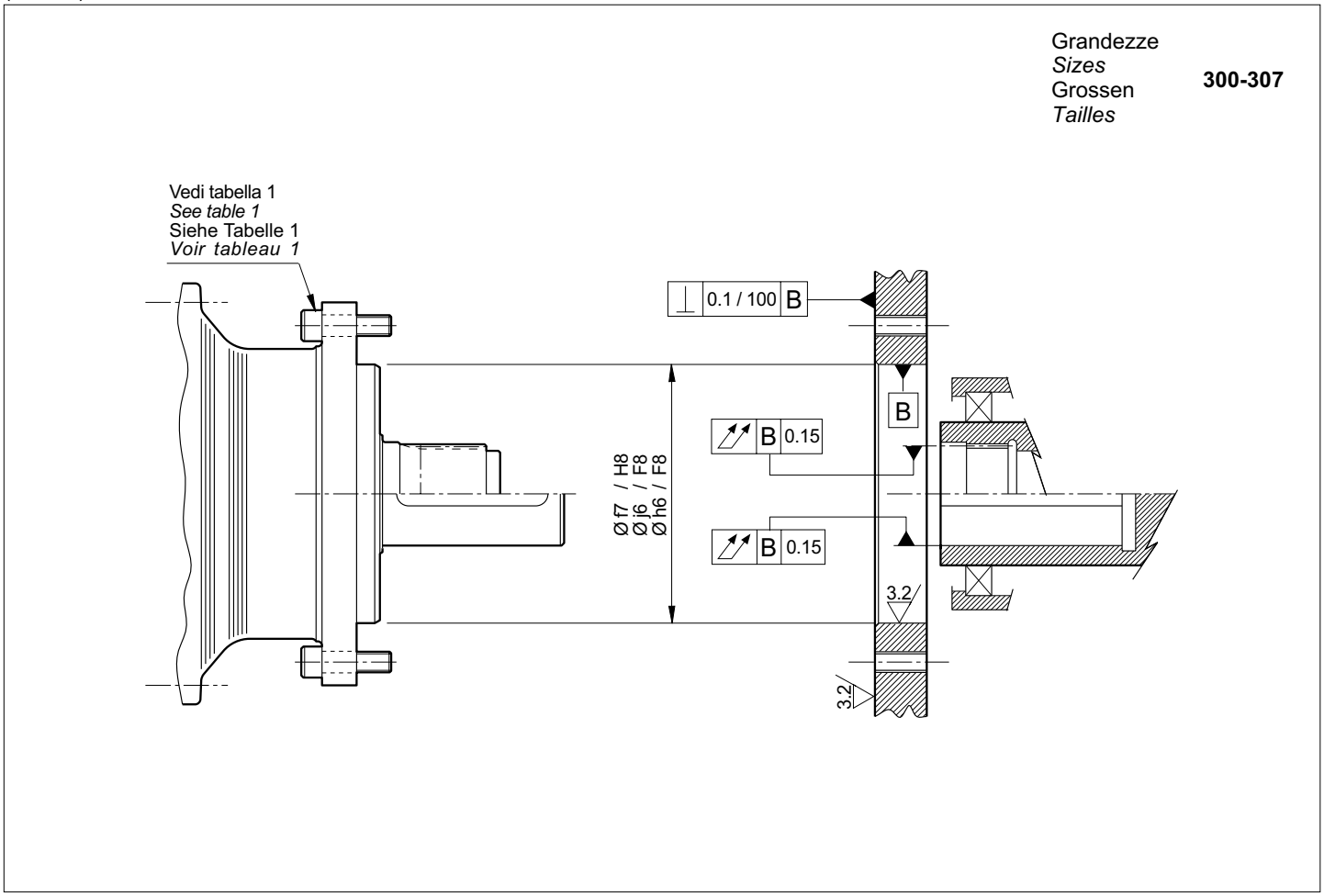
(FIG.9)



Tolleranze consigliate /*Recommended tolerances*
Empfohlene Toleranzen / *Tolérances admises*

Accoppiamento libero *Loose coupling* Freie Passung *Accouplement libre*		Accoppiamento con interferenza *Coupling with interference* Passung mit Interferenz *Accouplement avec interférence*	
Albero pieno *Solid shaft* Vollwelle *Arbre plein*	Albero cavo *Hollow shaft* Hohlwelle *Arbre creux*	Albero pieno *Solid shaft* Vollwelle *Arbre plein*	Albero cavo *Hollow shaft* Hohlwelle *Arbre creux*
Ø d h6	Ø D G7	Ø d h6	Ø D P7
Ø d k6	Ø D F7	Ø d k6	Ø D M7
Ø d m6	Ø D F7	Ø d m6	Ø D K7
Ø d r6	Ø D E7	Ø d r6	Ø D H7

(FIG.10)



GRANDEZZE DAL 309 IN POI CON USCITA ALBERO MASCHIO

Questi riduttori sono provvisti di due diametri di centraggio.
Per le flange di accoppiamento è sufficiente un solo centraggio quando sull'albero in uscita non vi sono carichi radiali o comunque questi sono inferiori al 60% dei carichi ammessi.
Per carichi superiori prevedere la flangia di accoppiamento con tutti e due i diametri di centraggio.
Nel caso in cui il riduttore debba trasmettere coppie elevate con urti ed inversioni del senso di rotazione occorre eseguire sulla controflangia fori per le spine.
Al momento della installazione fare avanzare nella controflangia le spine già montate sul riduttore di una misura pari al loro diametro.
Vedi disegno (FIG.11).

SIZES FROM 309 UPWARDS, WITH MALE OUTPUT SHAFT

These gearboxes have two alignment rings of different diameter. If the output shaft is not subject to radial load, or if radial load is below 60% maximum allowable, only one alignment ring needs to be fitted to the counter-flange. For higher loads, the counter-flange must hold both rings firmly. If the gearbox has to transmit high torque or is subjected to loads with impact or direction changes, dowel holes must also be drilled in the counter-flange.
The dowels provided on the gearbox flanges should enter the holes in the counter-flanges by a length equivalent to their diameter.
See drawing (FIG.11).

GRÖSSEN VON 309 AUFWÄRTS MIT EINFÜHRWELLE

Diese Getriebe sind mit zwei Zentrierdurchmessern ausgestattet. Für die Verbindungsflanschs genügt eine einzige Zentrierung, wenn an der Abtriebswelle keine Radialbelastungen vorliegen oder wenn sie weniger als 60% der zulässigen Belastungen betragen.
Für höhere Belastungen den Verbindungsflansch mit beiden Zentrierdurchmessern vorbereiten.
Falls das Getriebe hohe Drehmomente übertragen muss, mit Schlägen und Umkehrungen der Drehrichtung, sollten auf dem Gegenflansch Bohrungen für Stift angebracht werden. Bei der Installation die am Getriebe schon angebrachten Stift um ein Mass in den Gegenflansch einführen, das ihrem Durchmesser entspricht.
Siehe Zeichnung (Abb.11).

TAILLES 309 ET AU-DELA, AVEC ARBRE DE SORTIE MÂLE

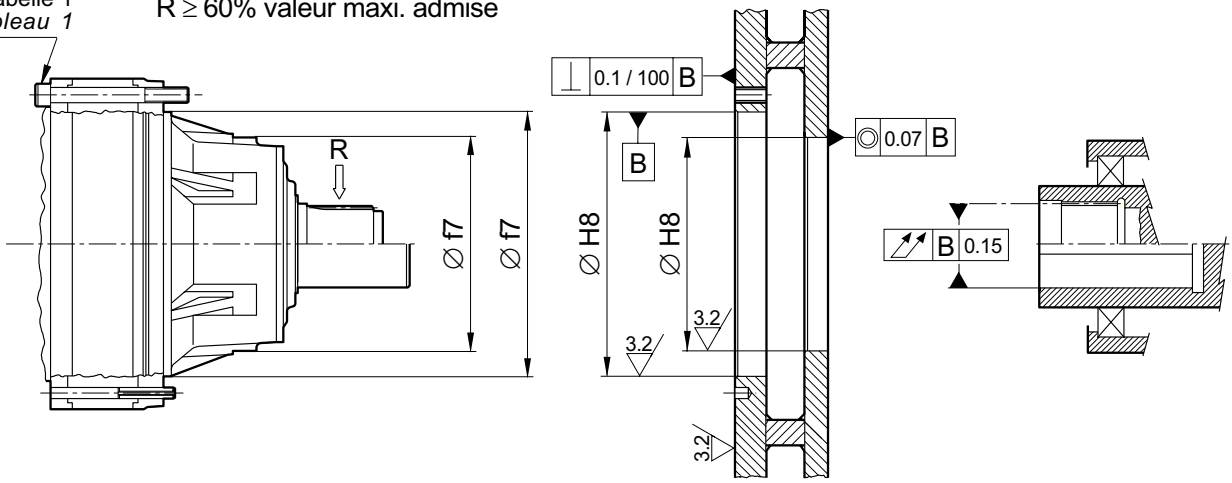
Ces réducteurs sont prévus avec deux diamètres de centrage. Pour les brides da fixation, un seul centrage est suffisant, quand l'arbre de sortie n'est soumis à aucune charge radiale, ou lorsque celle-ci est inférieure à 60% de la valeur des charges maximum admissibles.
Pour des chaerges supérieures, il est nécessaire de prévoir la bride de fixation avec les deux diametrès de centrage. Lorsque le réducteur est soumis à des couples élevés avec chocs, et inversions du sens de rotation, il est nécessaire d'effectuer, sur la bride de fixation, des trous pour recevoir des goupilles.
Au moment de l'installation, faire avancer, dans la bride recevant le réducteur, les goupilles dèjà montées, d'une longueur équivalente à leur diamètre.
Voir plan (Figure 11).

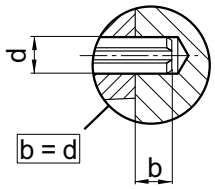
(FIG.11)

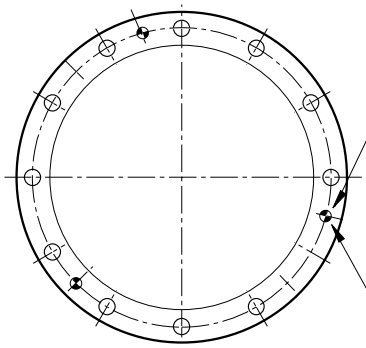
Grandezze
Sizes
Grossen
Tailles
309-321

CARICO RADIALE / *RADIAL LOAD*
RADIALKRAFT / *CHARGE RADIALE*
R ≥ 60% valore massimo consentito
R ≥ 60% max admissible
R ≥ 60% max. zulässiger Wert
R ≥ 60% valeur maxi. admise

Vedi tabella 1
See table 1
Siehe Tabelle 1
Voir tableau 1





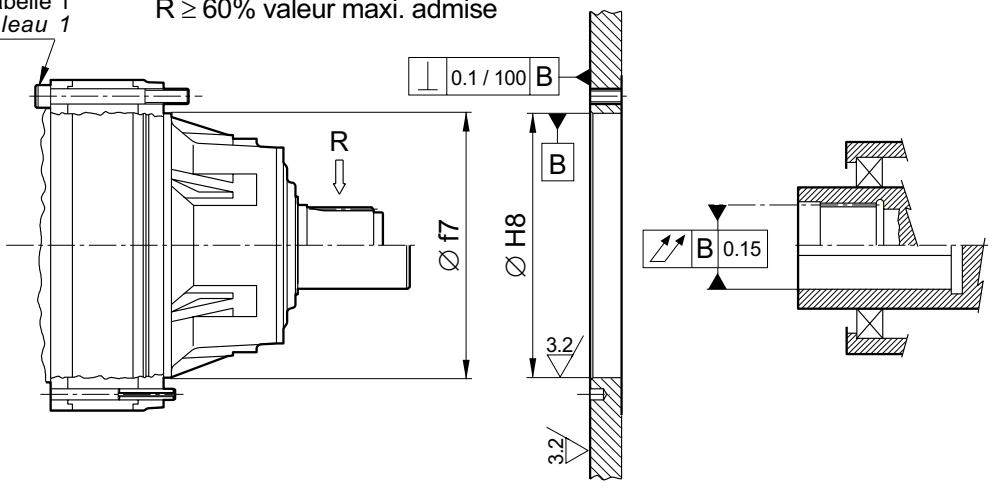


Per spina elastica di 309, 310 e 315
For elastic pin of 317 and 319.
Für Spannstift von 309, 310 und 315
Pour goupille élastique de 309, 310 et 315
Ø0.20 B

Per spina cilindrica di 317 e 319
For cylindrical pin of 317 and 319.
Für Zylinderstift von 317 und 319
Pour goupille cylindrique de 317 et 319
Ø0.05 B

CARICO RADIALE / *RADIAL LOAD*
RADIALKRAFT / *CHARGE RADIALE*
R ≥ 60% valore massimo consentito
R ≥ 60% max admissible
R ≥ 60% max. zulässiger Wert
R ≥ 60% valeur maxi. admise

Vedi tabella 1
See table 1
Siehe Tabelle 1
Voir tableau 1



ESECUZIONE CON ALBERO FEMMINA SCANALATO

Assicurare l'allineamento fra riduttore e albero condotto e che quest'ultimo non subisca flessioni durante l'esercizio. Vedi disegno (FIG.12).

SPLINED FEMALE SHAFT MOUNTING

Make sure that the gearbox is perfectly aligned with the driven shaft, and also check that the driven shaft is not subject to flexure during rotation.
See drawing (FIG.12).

AUSFÜHRUNG MIT NUTAUFNAHMEWELLLE

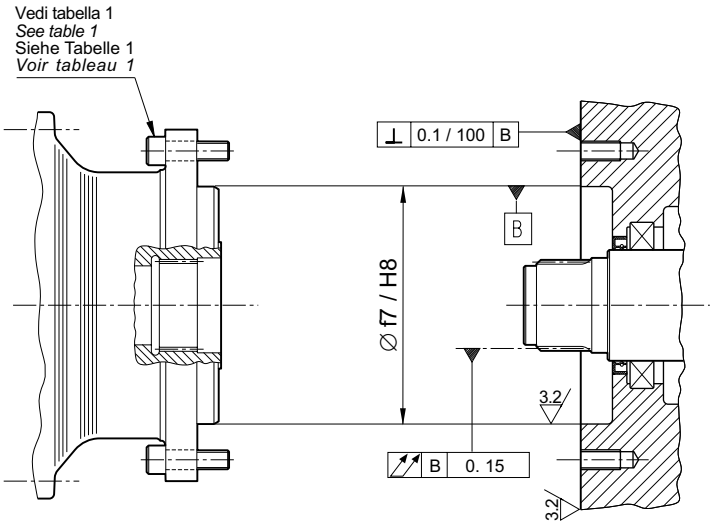
Die Flucht zwischen Getriebe und Abtriebswelle herstellen und sicherstellen, dass letztere während dem Betrieb keinen Biegungen ausgesetzt ist. Siehe Zeichnung (Abb.12).

EXECUTION AVEC ARBRE FEMELLE CANNELÉ

S'assurer de l'alignement entre le réducteur et l'arbre entraîné, et vérifier que ce dernier ne subisse aucune flexion durant le fonctionnement.
Voir plan (Figure 12).

(FIG.12)

Grandezze
Sizes
Grossen
Tailles
300-321



VITI DI FISSAGGIO RIDUTTORI FLANGIATI

FIXING SCREWS OF FLANGE MOUNTING

BEFESTIGUNGSCHRAUBEN VON GETRIEBEN MIT FLANSCHAUSFÜHRUNG

VIS DE FIXATION REDUCTEURS A BRIDE

		300	301	303	305	306	307
Vite/*Screws*/Schraube/*Vis*		M10	M10	M12	M12	M14	M16
Quantità/*Quantity*/Menge/*Quantité*		8	8	10	10	12	10
Classe/*Class*/Klasse/*Classe*		8.8	8.8	8.8	8.8	8.8	8.8
Coppia di serraggio/*Tightening torque* Anzugsmoment/*Couple de serrage*	Nm	50	50	85	85	135	200

		309	310	311	313	315	317	319	321
Vite/*Screws*/Schraube/*Vis*		M16	M16	M16	M20	M20	M30	M30	M30
Quantità/*Quantity*/Menge/*Quantité*		12	15	24	30	20	24	30	36
Classe/*Class*/Klasse/*Classe*		8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Coppia di serraggio/*Tightening torque* Anzugsmoment/*Couple de serrage*	Nm	200	200	200	400	400	1400	1400	1400

Per coppie massime trasmesse maggiori o uguali al 70% della coppia con M_{2max} indicata e con frequenti inversioni del moto, utilizzare viti in classe minima di resistenza 10.9.

With transmitted output torque greater than or equal to 70% of the indicated M_{2max} torque, and with frequent movement reversals, use screws with minimum resistance 10.9.

Für zu übertragene Maximaldrehmomente, die höher als 70% des angegebenen Werts M_{2max} oder diesem Prozentsatz gleich kommen und im Fall von häufigen Schaltungen sind Schrauben aus der Klasse der min. Widerstandsgrads 10.9 zu verwenden.

Puor des couples maximaux transmis plus importants ou équivalents à 70% du couple M_{2max} indiqué, et en cas d'inversions fréquentes du mouvement, utiliser des vis dans une classe minimale de résistance 10.9.

ESECUZIONE CON PIEDI DI SUPPORTO

Il fissaggio di questi riduttori deve avvenire su una base sufficientemente rigida, lavorata di macchina utensile con un errore massimo di planarità non superiore a 0,2 mm/100mm.
Vedi disegno (FIG.13).

FOOT MOUNTING

Make sure that the mounting base is sufficiently rigid. Bases must be machined to a maximum flatness tolerance of 0.2mm/100mm.
See drawing (FIG.13).

AUSFÜHRUNG MIT STANDFÜSSEN

Diese Getriebe sollten auf einer ausreichend starren und mit Werkzeugmaschinen bearbeiteten Grundlage befestigt werden, wobei der maximal zulässige Ebenheitsfehler nicht grösser als 0,2 mm/100 mm sein darf.
Siehe Zeichnung (Abb.13).

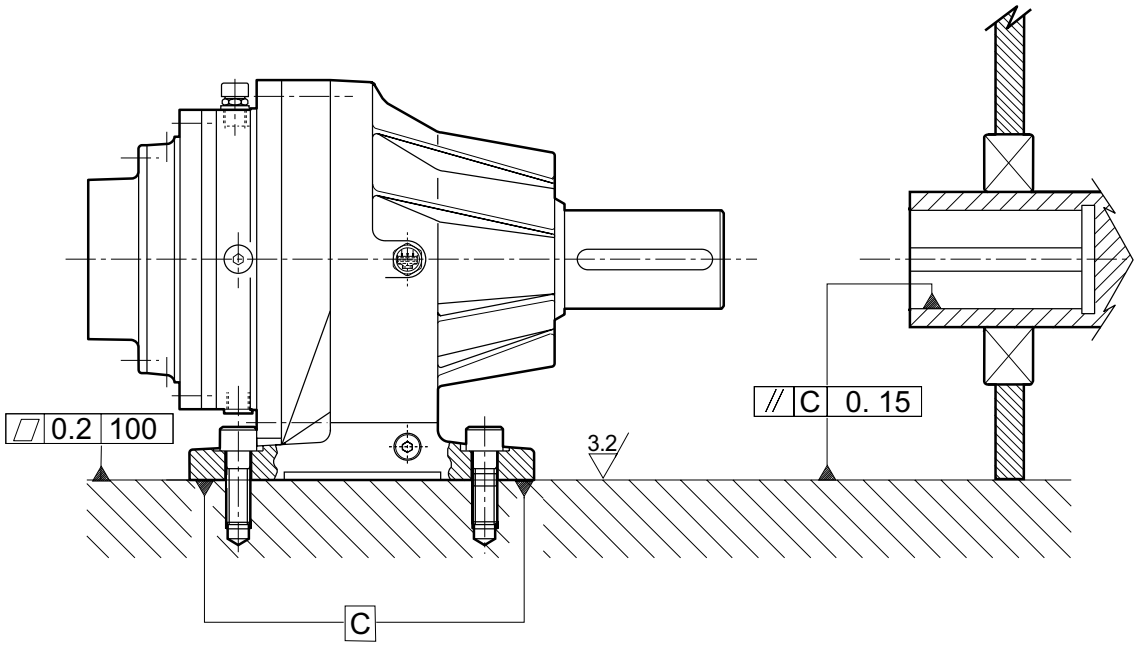
EXECUTION AVEC CARTER A PATTES

La fixation de ces réducteurs doit s'effectuer sur un châssis suffisamment rigide, usiné sur machine-outil avec une erreur maximum de planéité ne dépassant pas 0,2 mm/100 mm.
Voir plan (Figure 13).

(FIG.13)

Grandezze
Sizes
Grossen
Tailles

300-321



VERSIONE PENDOLARE

Fissare il braccio di reazione con viti classe minima di resistenza 8,8 serrate ad una coppia corrispondente al 70% del loro carico di snervamento.
Pulire e sgrassare le superfici degli alberi di accoppiamento sia interna del riduttore che quella esterna dell'albero da accoppiare.
Montare il giunto sull'albero del riduttore dopo aver leggermente lubrificato la sua superficie esterna. Serrare leggermente un primo gruppo di 3 viti, posizionate secondo i vertici di un triangolo equilatero (esempio: le viti pos. 1-5-9 del disegno FIG.15). Accoppiare il riduttore sull'albero da azionare.
Serrare le viti gradualmente (secondo lo schema del triangolo equilatero) procedendo in senso circolare, effettuando più passaggi affinchè tutte le viti siano serrate alla coppia specificata in tabella 2, a seconda del tipo di giunto/riduttore.
Vedi disegno (FIG.14)

N.B. : non serrare in sequenza viti diametralmente opposte.

SHAFT MOUNTING DESIGN

Secure the torque arm with fixing bolts rated at least class 8.8, torqued to 70% of their yield stress.
Clean and degrease the mating surfaces of the gear unit output bore and the driven machine pivot.
Fit the coupling onto the gear unit hollow shaft after having lubricated the shaft external surface.
Lightly tighten the first 3 screws that are placed following the vertexes of an equilateral triangle (for instance: screw pos. 1-5-9 on drawing FIG.15). Match the gearbox to the shaft to be activated.

Follow the equilateral triangle scheme and keep tightening the screws in a circular sequence until you reach the torque specified in table 2 - according to the type of joint-gearbox. See drawing (FIG.14)

NOTE: do not follow a sequence when tightening opposite screws.

AUFSTECKMONTAGE

Die Achsstrebe mit Spannschrauben mit Mindestfestigkeitsklasse 8,8 und mit einem Anzugsmoment von 70% ihrer Biegegrenze befestigen.
Die Oberflächen der Kupplungswellen im und außerhalb des Getriebes reinigen und entfetten.
Die Kupplung an der Getriebewelle nach einer leichten Schmierung ihrer externen Oberfläche anbauen.Eine erste Gruppe aus 3 Schrauben anziehen, diese den Spitzen eines Dreiecks mit gleichlangen Seiten entsprechend anordnen (Beispiel: die Schrauben Pos. 1-5-9 der Zeichnung Abb.15). Das Getriebe auf die anzutreibende Welle passen.
Die Schrauben graduell und in mehreren Gängen anziehen, bis alle auf den Anzugsmoment, der in der Tabelle 2 angegeben wird und der sich dem Typ von Kupplung/Getriebe entsprechend ändert, festgestellt sind. Siehe Zeichnung (Abb.14).

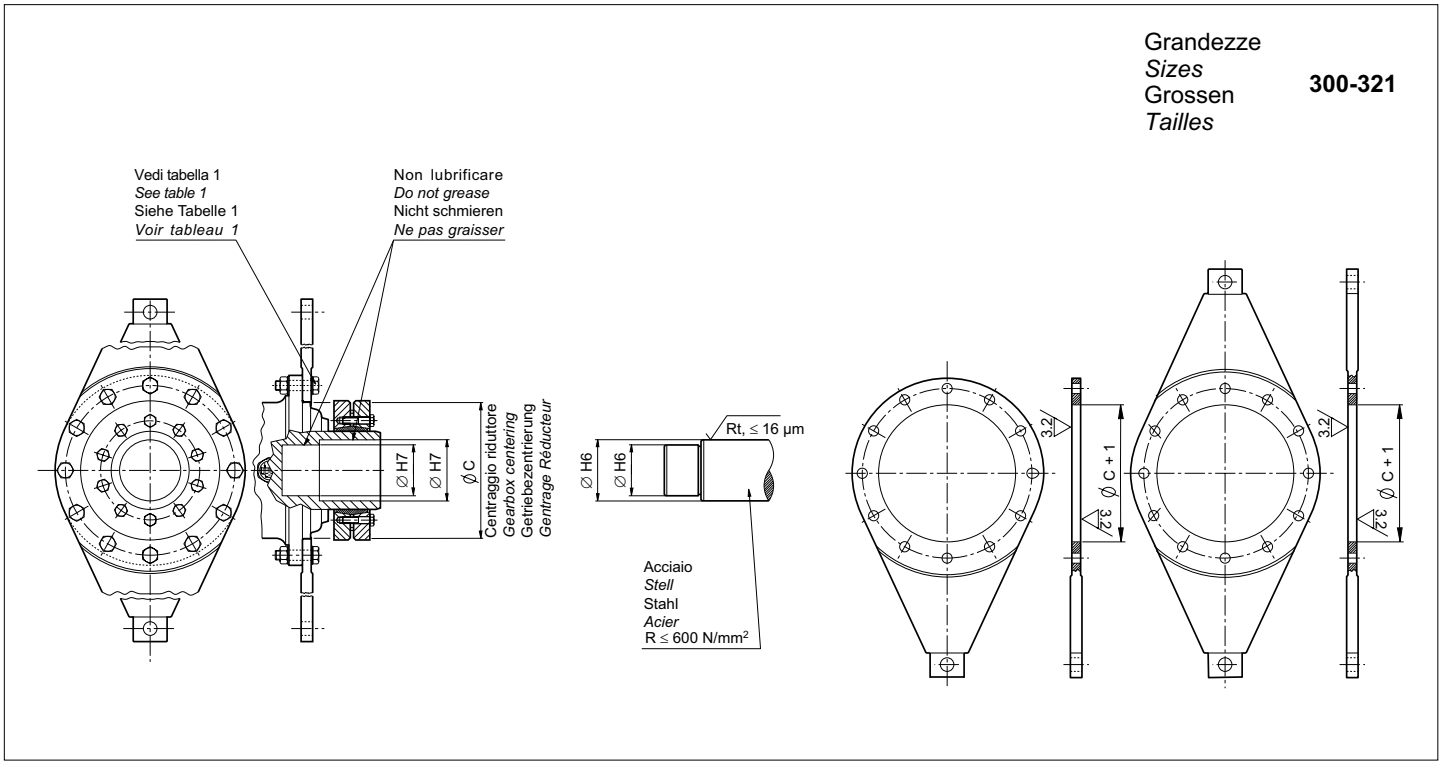
HINWEIS: Diametral gegenüberliegende Schrauben nicht befestigen.

VERSION MONTAGE FLOTTANT

Fixer le bras de réaction avec des vis de résistance classe minimum 8,8 vissées à un couple de serrage correspondant à 70% de leur charge d'élasticité.
Nettoyer et dégraisser les surfages des arbres d'accouplement, aussi bien celles intèrieures du réducteur que cells extérieures de l'arbre à accoupler.
Monter le joint sur l'arbre du réducteur après en avoir légèrement lubrifié la surface extérieure.
Serrer légèrement un premier groupe de 3 vis positionnées selon les sommets d'un triangle équilatéral (exemple : les vis pos. 1-5-9 du plan Figure 15). Accoupler le réducteur à l'arbre qui doit être actionné.
Serrer les vis en phases successives (selon le schéma du triangle équilatéral) suivant un ordre circulaire et continuer le serrage jusqu'à atteindre le couple spécifié dans le tableau 2, selon le type de joint/réducteur. Se référer au plan (Figure 14).

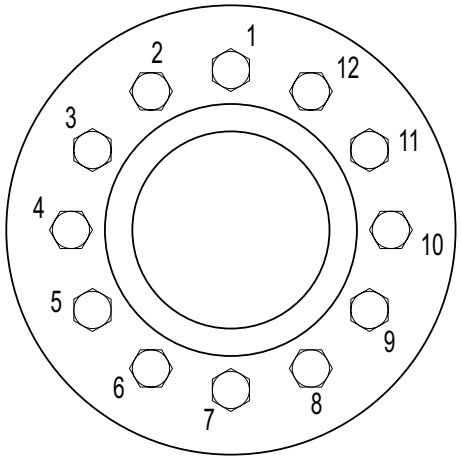
Remarque: ne pas serrer en séquence des vis diamétralement opposées.

(FIG.14)



(FIG.15)

Grandezze
Sizes
Grossen
Tailles
300-321



Viti per giunti ad attrito ***Screws for shrink disks*** **Schrauben für Reibkupplungen** ***Vis pour joints sous friction***

Riduttore-giunto/*Gearbox-joint* **Getriebe-Kupplung/*Réducteur-joint***		**300**	**301**	**303**	**305**	**306**	**307**
Vite/*Screw*/Schraube/*Vis*		M6	M6	M8	M8	M10	M10
Quantità/*Quantity*/Mange/*Quantité*		8	8	12	12	9	12
Classe/*Class*/Klasse/*Classe*		10.9	10.9	10.9	10.9	10.9	10.9
Coppia di serraggio/*Tightening torque* **Anzugsmoment/*Couple de serrage***	Nm	12	12	30	30	58	58

Riduttore-giunto/*Gearbox-joint* **Getriebe-Kupplung/*Réducteur-joint***		**309**	**310**	**311**	**313**	**315**	**317**	**319**	**321**
Vite/*Screw*/Schraube/*Vis*		M16	M16	M16	M16	M20	M20	M20	M24
Quantità/*Quantity*/Mange/*Quantité*		8	8	10	10	12	14	24	21
Classe/*Class*/Klasse/*Classe*		10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
Coppia di serraggio/*Tightening torque* **Anzugsmoment/*Couple de serrage***	Nm	250	250	250	250	490	490	490	840

3 - COLLEGAMENTI

- Fissare gli organi di collegamento in entrata ed uscita al riduttore o motoriduttore evitando di battere con martello o equivalenti. Utilizzare per l'inserimento degli organi le viti di servizio e i fori filettati presenti negli alberi. Prima di montare gli organi di collegamento avere cura di pulire gli alberi eliminando grassi o protettivi eventualmente presenti.

3 - CONNECTIONS

- *Secure the connection parts to gearbox or gearmotor input and output. Do not tap them with hammers or similar tools. To insert these parts, use the service screws and threaded holes provided on the shafts. Be sure to clean off any grease or protectants from the shafts before fitting any connection parts.*

3 - ANSCHLÜSSE

- Die Anschlußteile im An-und Abtrieb des Getriebes oder des Getriebemotors befestigen, dabei ist ein Einklopfen dieser unter Anwendung eines Hammers oder anderer gleicharti- ger Instrumente zu vermeiden. Zum Einführen der Teile die Serviceschrauben und die Gewindebohrungen der Wellen verwenden. Vor der Montage der Verbindungsteile, die Wellen sorgfältig von Fett oder eventuell vorhandenen Schutzmitteln reinigen.

3 - RACCORDEMENTS

- *Fixer les éléments de raccordement en entrée et en sortie du réducteur ou du motoréducteur en évitant de frapper avec un marteau ou autre. Pour l'introduction des organes, utiliser les vis appropriées et les orifices filetés présents sur les arbres. Avant de monter les éléments de raccordement, nettoyer les arbres en éliminant les graisses ou produits de protection éventuellement présents.*

- Versi di rotazione.
  Al momento del collegamento verificare con l'aiuto delle seguenti illustrazioni il verso di rotazione degli alberi a seconda di ciò che si ha in ingresso.

- *Direction of rotation*
  When couplings the output shaft, refer to the following diagrams to ensure that the direction of rotation is correct for the input.

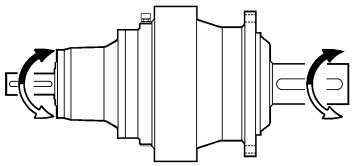
- Drehrichtung
  Beim Anschluss mit Hilfe der nachfolgenden Darstellungen die korrekte Drehrichtung je nach Drehrichtung am Antrieb prüfen.

- *Sens de rotation.*
  Lors de la liaisons'assurer à l'aide des illustrations des arbres en fonction de ce dont on dispose en entrée.

(FIG.16)

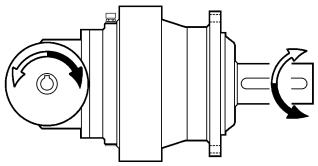
3..L

In linea
In line
Linear
Coaxiale



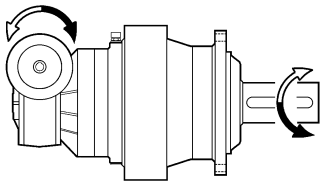
3..R

Angolare
Right angle
Rechtwinklig
A renvoi d'angle



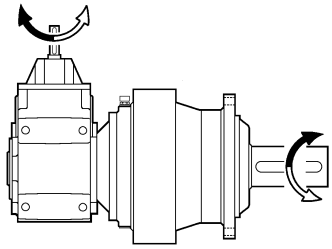
3/VF

Combinato con riduttori a vite senza fine
Combined with worm gear unit
Kombiniert mit Schneckengetrieben
Combiné avec réducteurs à vis sans fin



3/A

Combinato con riduttori ad assi ortogonali
Combined with helical bevel gear unit
Kombiniert mit Kegelradgetrieben
Combiné avec réducteurs à axes orthogonaux



NOTA:

Non usare martelli od altri organi meccanici per forzare l'inserimento di giunti, flange od altro.

NOTE:

Never use hammers or other mechanical means to force disks, flanges, etc. into place.

ANMERKUNG:

Keine Hämmer oder sonstige mechanischen Organe benutzen, um das Einsetzen bzw. die Verbindung von Kupplungen, Flanschen oder sonstigem zu erzwingen.

NOTA:

Ne pas utiliser de marteau ou d'autres organes mécaniques pour permettre l'introduction d'accouplements, de brides, ou autres.

Pulire gli alberi dai protettivi prima di accoppiare l'organo da collegare. Spalmare un velo di grasso per favorire il montaggio.

Clean all protective coatings off shafts before coupling units together. Apply a thin smear of grease to facilitate assembly.

Die Wellen von den Schutzmitteln reinigen, bevor die Verbindungen hergestellt werden. Eine dünne Schicht Fett auftragen, um die Montage zu vereinfachen.

Nettoyer les arbres des vernis de protection, avant de monter l'organe à accoupler. Enduire les pièces d'un voile de graisse pour favoriser le montage.

COLLEGAMENTI IN ENTRATA

Collegamento al motore elettrico

Pulire zone di centraggio ed il giunto di collegamento albero motore; applicare sul giunto un velo di grasso per facilitare il montaggio, inserire il motore e serrare le viti di assemblaggio con la flangia motore.
Usare sempre viti con classe di resistenza minima 8,8.

INPUT COUPLINGS

Connection to electric motor

Clean the mating surfaces and the motor shaft coupling. Smear the coupling with a thin coating of grease to facilitate assembly. Fit the motor and tighten the securing bolts to the motor flange. Always use bolts of minimum resistance class 8.8.

ANSCHLÜSSE AM EINGANG

Anschluss an den Elektromotor

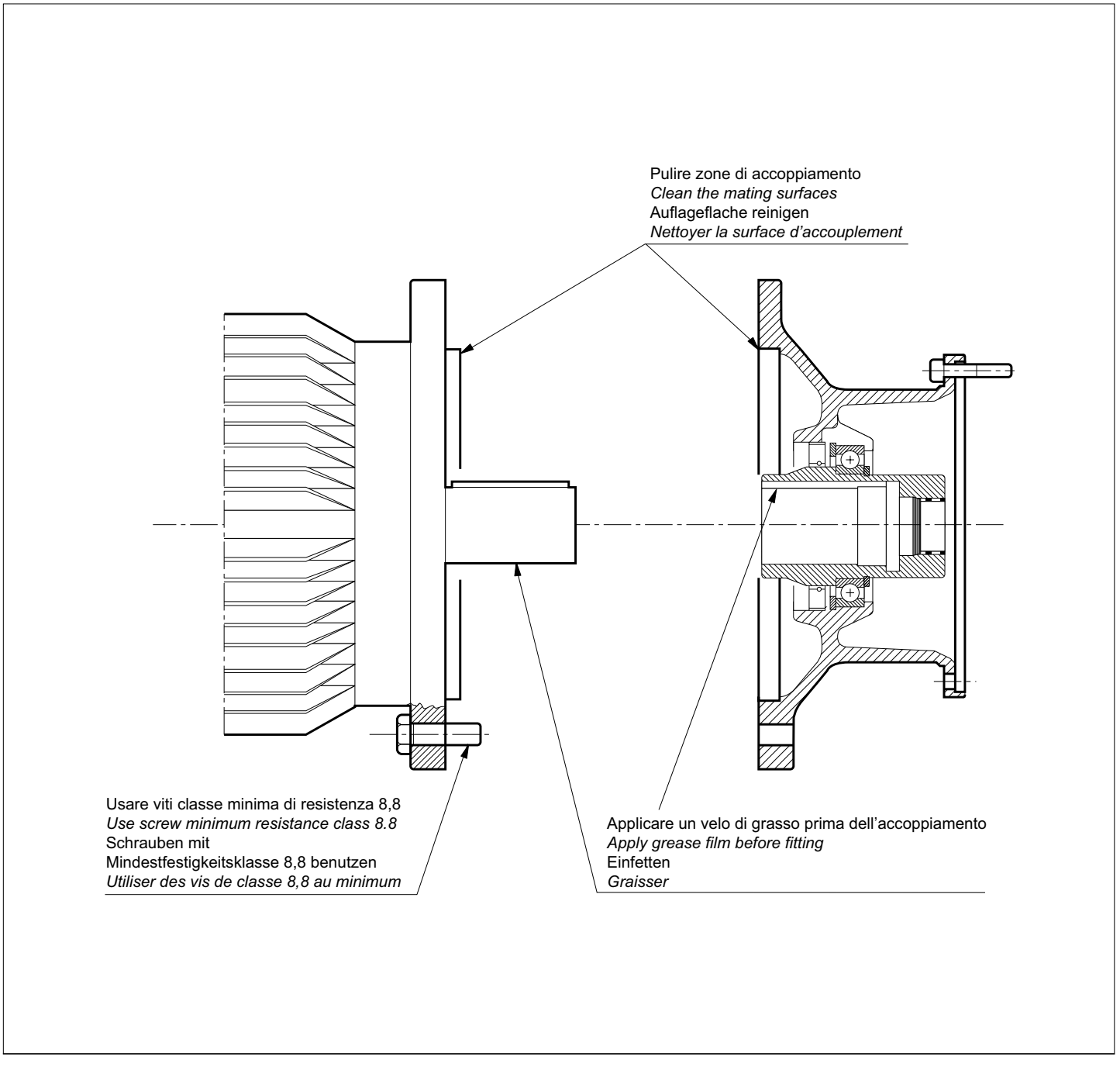
Die Bereiche für die Zentrierung und die Verbindungskupplung der Motorwelle reinigen. Auf der Kupplung eine dünne Schicht Fett auftragen, um die Montage zu vereinfachen. Den Motor einsetzen und die Schrauben zur Verbindung mit dem Motorflansch anziehen.
Stets Schrauben mit Mindest-Festigkeitsklasse 8,8 benutzen.

LIAISON EN ENTREE

Liaison au moteur électrique

Nettoyer les zones de centrage, et l'accouplement de liaison à l'arbre moteur.
Appliquer, sur le manchon d'accouplement, un voile de graisse pour faciliter le montage, insérer le moteur et serrer les vis de fixation avec la bride moteur.
Utiliser toujours des vis de classe 8,8 au minimum.

(FIG.17)



COLLEGAMENTI IN ENTRATA

INPUT COUPLINGS

ANSCHLÜSSE AM EINGANG

LIAISON EN ENTREE

Collegamento al motore elettrico

In caso di motori di elevata potenza usare motori in esecuzione B3-B5 opportunamente sopportati.

Connection to electric motor

With high power motors always use suitably supported B3-B5 mountings.

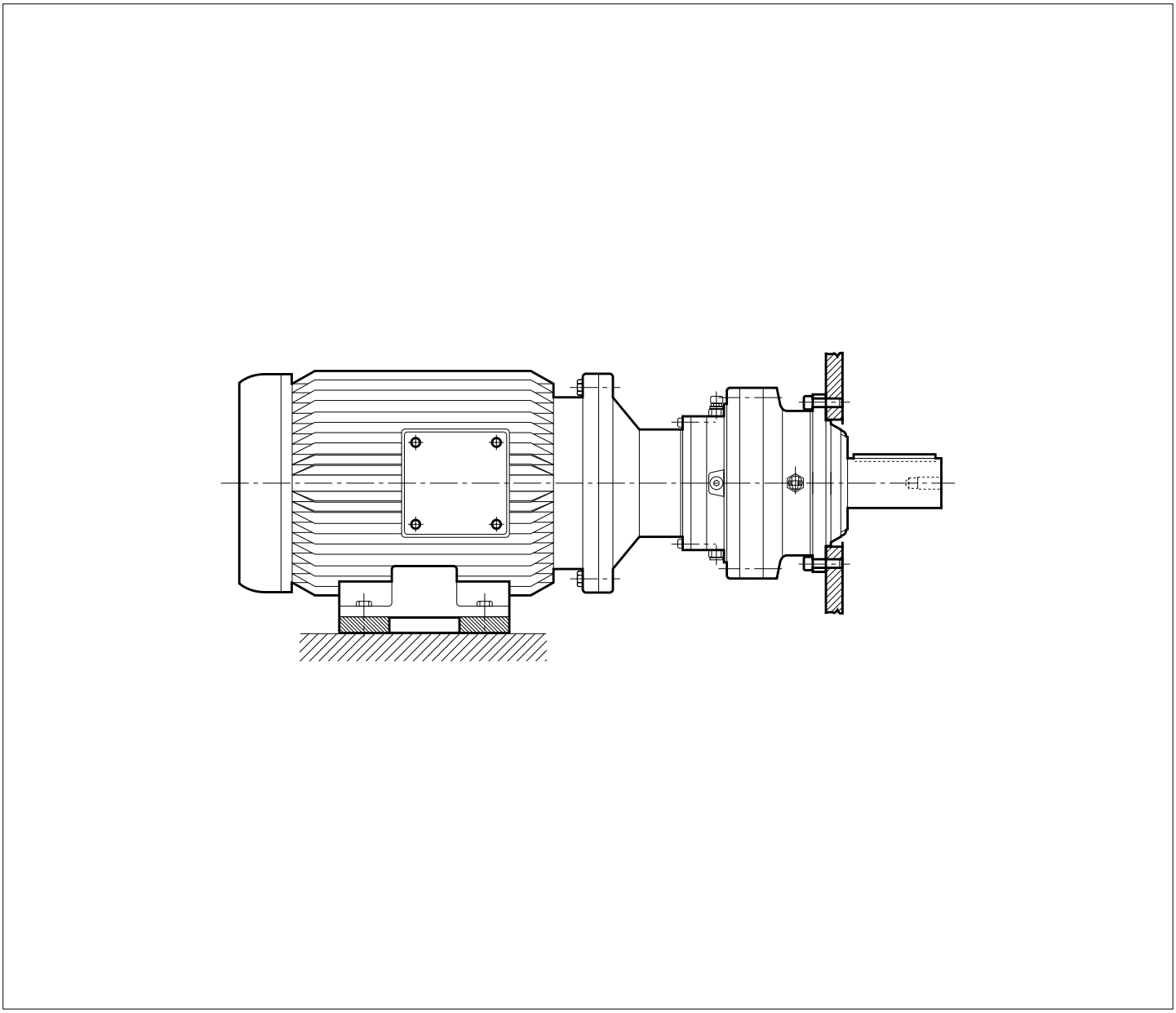
Anschluss an den Elektromotor

Bei Motoren mit hoher Leistung sind Motoren in Ausführung B3-B5 anzuwenden, die gut gelagert sind.

Liaison au moteur électrique

En cas d'utilisation de moteurs de puissance élevée, prévoir ces derniers en exécution B3-B5 supportés en conséquence.

(FIG.18)



Nota: i motori devono essere sempre perfettamente allineati sia in caso di accoppiamento tra albero motore e albero in ingresso tramite giunto sia soprattutto in caso di accoppiamento diretto.
Una posizione errata può causare danni ai cuscinetti, sia del motore che della predisposizione motore.

Note: *Ensure that the motors are perfectly aligned. This is important wehen joints are used between the motor shaft and the input shaft, and even more so in cases of direct coupling.*
Incorrect alignment can cause damage to both motor and input side bearings.

Anmerkung: die Motoren müssen stets gut gefluchtet sein, sowohl bei Verbindung von Motorwelle und Getriebe-Antriebswelle als auch insbesondere bei direkter Verbindung.
Eine falsche Position kann zu Schäden an den Lagern des Motors als auch der Motorvorbereitung führen.

Remarque: *Les moteurs doivent toujours être parfaitement alignés en cas de couplage entre arbre moteur et arbre d'entrée par l'intermédiaire d'un accouplement surtout en cas de couplage direct.*
Une position erronée peut endommager les roulements du moteur ou de la prédisposition moteur.

COLLEGAMENTO ALL'ALBERO VELOCE

Pulire prima di accoppiare gli organi.
In caso di montaggio pulegge per trasmissioni a cinghia, gli alberi devono essere paralleli e le pulegge devono essere allineate.
Non tendere la cinghia più del necessario in quanto una eccessiva tensione può causare danni ai cuscinetti.

HIGH SPEED SHAFT COUPLINGS

Clean all units prior to assembly.
When fitting belt driven pulleys, make sure that the shafts are perfectly parallel and that the pulleys themselves are aligned with each other.
Avoid over tensioning the belts since excess tension can cause bearing failure.

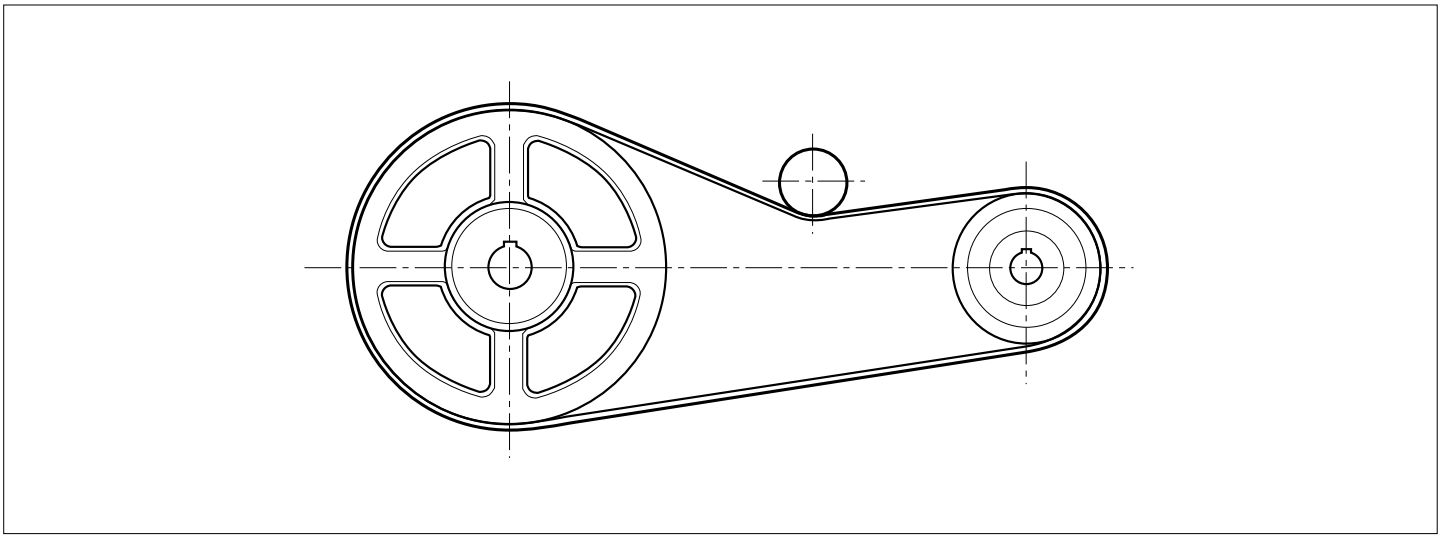
VERBINDUNG AN DIE ANTRIEBSWELLE

Die Organe vor Anschluß reinigen.
Bei Montage von Riemenscheiben müssen die Wellen parallel stehen und die Riemenscheiben gut gefluchtet sein.
Den Riemen nicht übermässing spannen, da ein zu hohe Spannung zu Schäden an den Lagern führen kann.

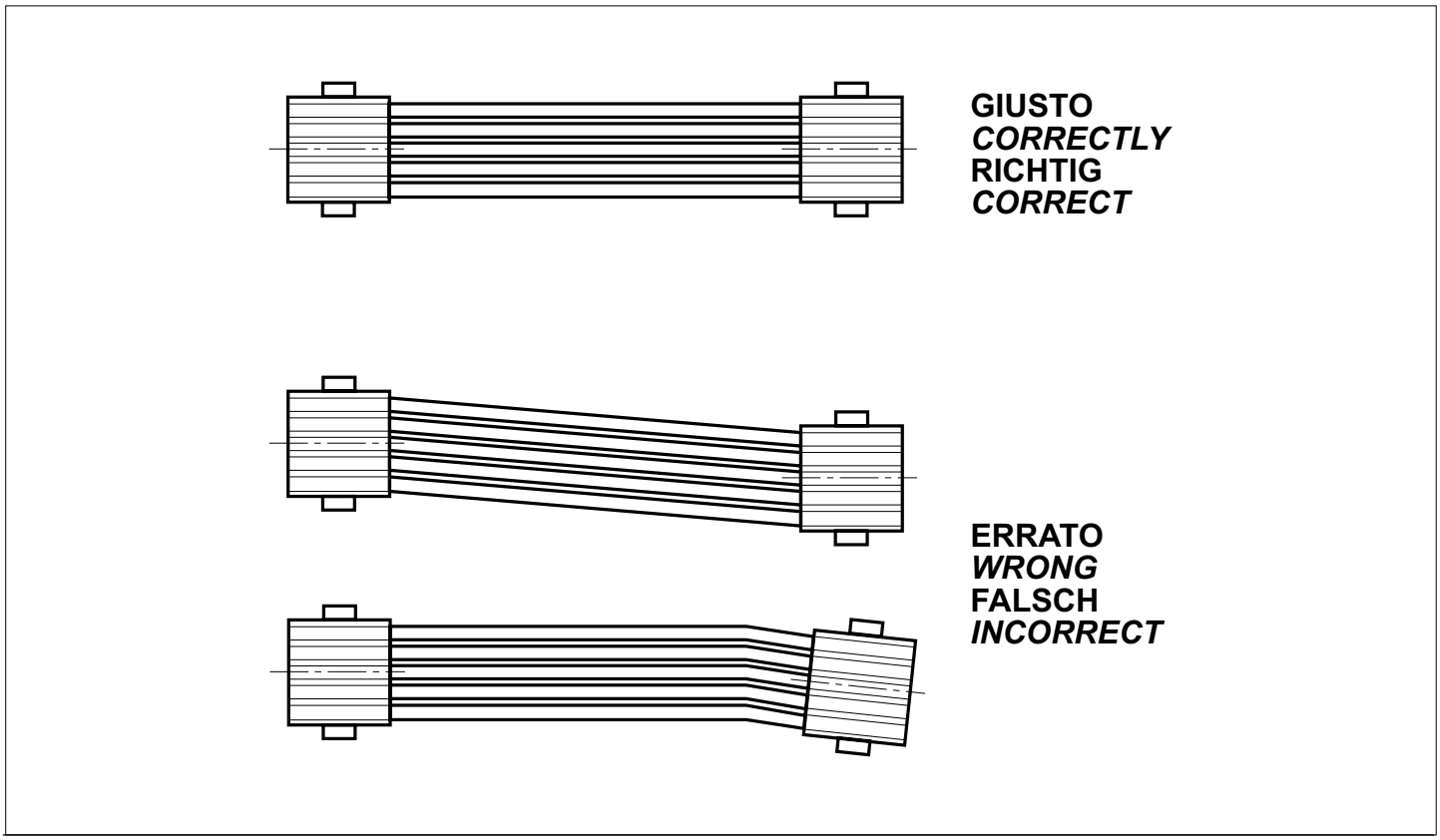
LIAISON A L'ARBRE RAPIDE

Procéder au nettoyage, avant d'accoupler les organes.
En cas de montage de poulies de transmission à courroie, les arbres doivent être parallèles et les poulies alignées.
Ne pas tendre la courroie plus que nécessaire car une tension excessive peut entraîner des dommages aux roulements.

(FIG.19)



(FIG.20)



COLLEGAMENTO AL MOTORE IDRAULICO

Togliere il cappellotto di protezione.
Le predisposizioni per motori idraulici sono di due tipi:

a) Versione con O-ring di tenuta olio fra flangia motore e riduttore (FIG. 21).

b) Versione con anello di tenuta già montato sul giunto di collegamento (FIG.22).

Nel caso a) montare l'O-ring che assicura la tenuta fra riduttore e motore avendo cura di mantenerlo nella propria sede e di non rovinarlo.

HYDRAULIC MOTOR COUPLINGS

Remove the protective cap.
Two types of hydraulic motor couplings are possible:

a) With O ring seal between motor flange and gearbox. (FIG.21)

b) With seal incorporated in motor joint. (FIG 22)

With type a) connections, fit the O ring seal between the gearbox and motor making sure that it fits snugly in its seat and is not damaged.

ANSCHLUß AN HYDRAULIKMOTOR

Die Schutzkappe entfernen.
Es bestehen zwei Arten Vorbereitung für den Anschluß von Hydraulikmotoren:

a) Ausführung mit O-Dichtring für Öl zwschen Motorflansch und Getriebe. (Abb. 21)

b) Ausführung mit schon montiertem Dichtring an der Verbindungskupplung. (Abb. 22)

Im Fall a) den O-Ring montieren, der für die Abdichtung zwischen Getriebe und Motor sorgt, hierbei darauf achten, dass er gut in seinen Sitz eingesetzt und nicht beschädigt wird.

LIAISON AU MOTEUR HYDRAULIQUE

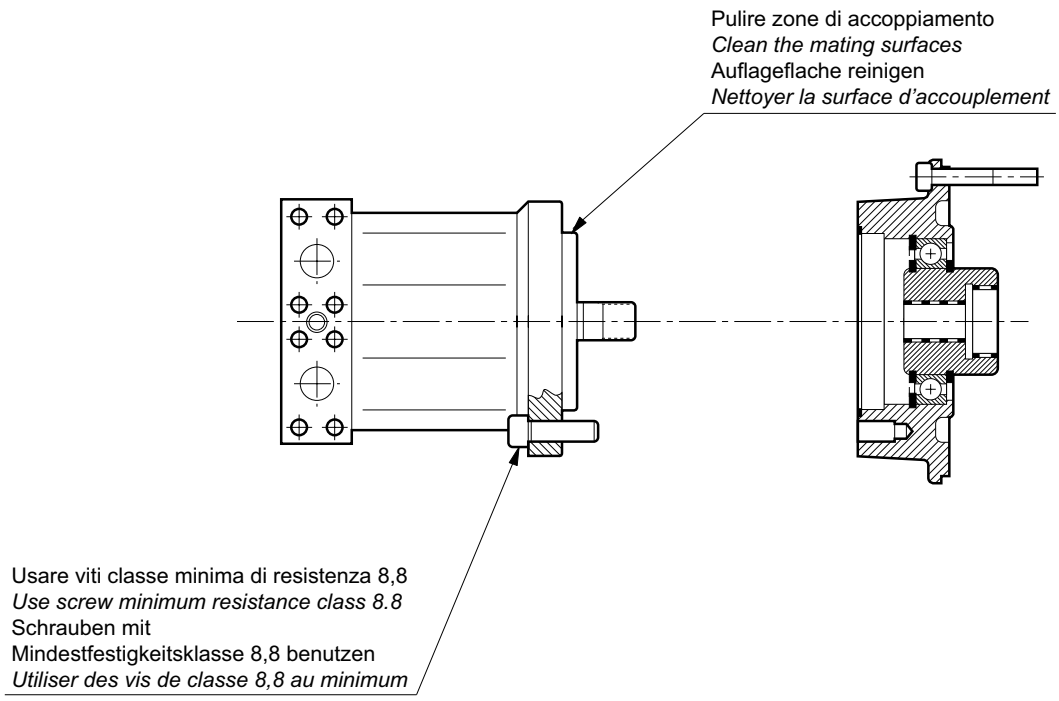
Enlever le capuchon de protection.
Les prédispositions pour moteurs hydrauliques sont de deux types:

a) Version avec joint d'étanchéïté O-ring entre bride moteur et réducteur. (Figure21)

b) Version avec bague d'étanchéïté déjà montée sur le manchon de liaison. (Figure 22)

Dans le cas a) monter le joint O-ring qui assure l'étanchéïté entre réducteur et moteur en prenant soin de le maintenir dans son logement et de ne pas le blesser.

(FIG.21)



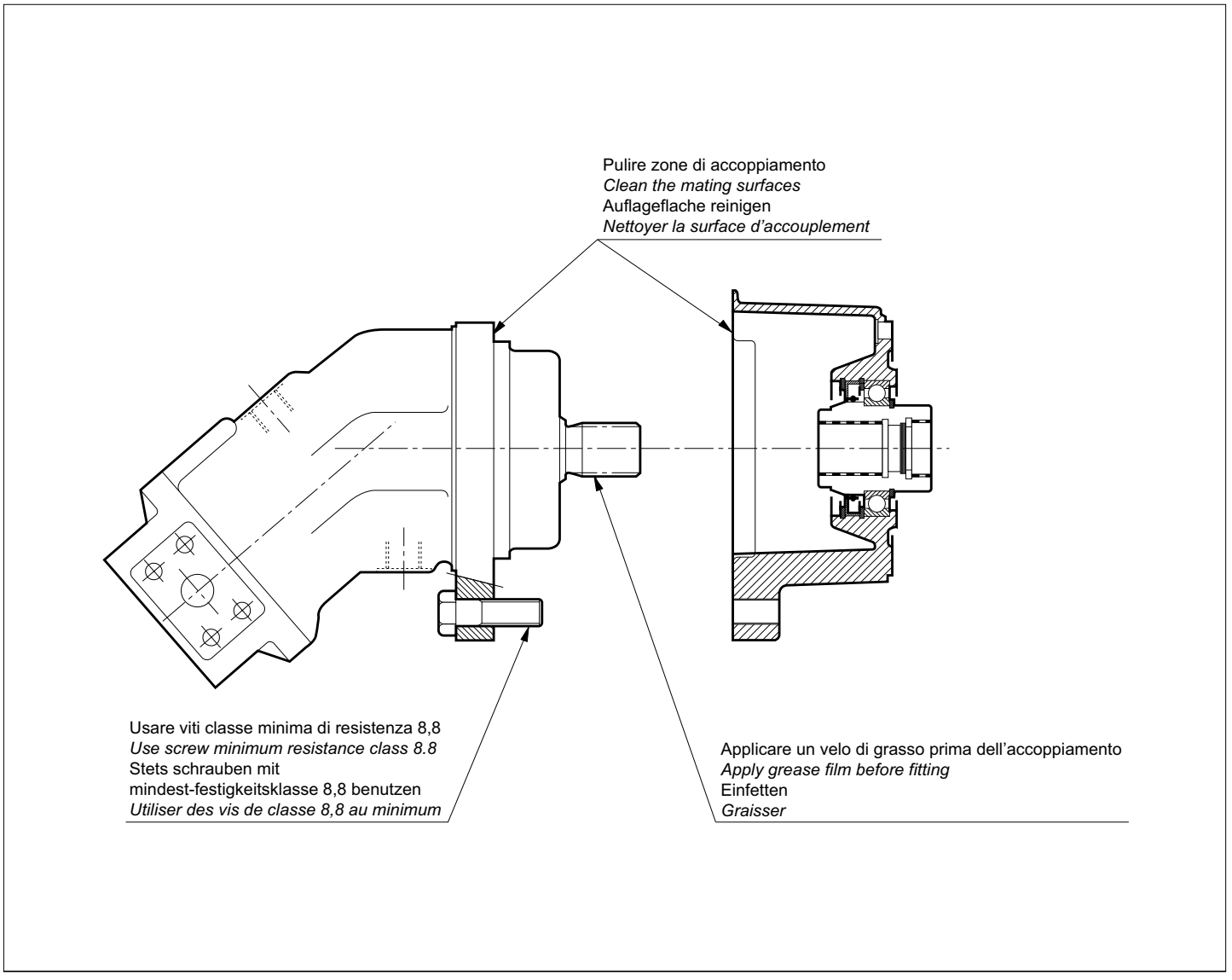
Nel caso b) non occorre far nulla per assicurare la tenuta dell'olio in quanto questa è già effettuata sul giunto motore, applicare solo un velo di grasso sull'albero motore.
In ambedue i casi pulire le zone di centraggio ed il giunto dove va inserito il motore, inserire il motore e serrare le viti di assemblaggio con la flangia.
Usare sempre viti con classe di resistenza minima 8,8.

With type b) connections, no specific action is required to ensure oil-tight operation since the seal is incorporated in the motor casing.
Apply a thin smear of grease to the motor shaft to facilitate assembly.
For both types of coupling, clean all mating surfaces couplings first. Fit the motor and tighten the flange securing bolts.
Always use bolts of minimum resistance class 8.8.

Im Fall b) ist es nicht notwendig, die gute Abdichtung sicherzustellen, da dies schon von der Motorkupplung gewährleistet wird. Man sollte jedoch etwas Fett auf die Motorwelle streichen. In beiden Fällen die Zentrierbereiche und Kupplung zum Anschluss des Motors gut reinigen.
Den Motor einsetzen, die Schrauben zur Befestigung mit dem Flansch anziehen.
Stets Schrauben mit Mindest-Festigkeitsklasse 8,8 benutzen.

Dans le cas b) il n'y a rien à faire pour assurer l'étanchéïté dans la mesure où celle-ci est déjà effectuée sur le manchon de liaison au moteur.
Appliquer seulement un voile de graisse sur l'arbre moteur.
Dans les deux cas nettoyer les zones de centrage et le manchon qui reçoit le moteur, monter le moteur et serrer les vis de liaison avec la bride.
Toujours utiliser des vis de classe minimum 8,8.

(FIG.22)



COLLEGAMENTO AL FRENO

Per riduttori predisposti per motori idraulici e completi di freno, collegarsi all'atto della installazione con un apposito tubo del circuito idraulico al foro di comando previsto sul corpo freno.

BRAKE COUPLINGS

With gearboxes designed for coupling to a hydraulic motor and pre-fitted with a hydraulic brake, simply connect the hydraulic circuit to the delivery hole on the brake body when assembling the units.

ANSCHLUß AN DIE BREMSE

Für Getriebe, die zur Montage mit Hydraulikmotoren vorbereitet und komplett mit Bremse ausgestattet sind, ist bei Installation mit einem eigens vorgesehenen Schlauch des Hydrauliksystems die Verbindung mit der Bohrung auf dem Bremskörper herzustellen.

CONNEXION DU FREIN

Pour les réducteurs prédisposés pour moteurs hydrauliques et équipés de frein, relier au moment de l'installation le raccord approprié du circuit hydraulique au trou de commande prévu sur le carter du frein.

Avviamento

Pressione minima tale da garantire apertura freno (vedi tabella) inferiore 320 bar.

Start-up

Regulate to the minimum pressure which will release the brake (see table).
This must be below 320 bar.

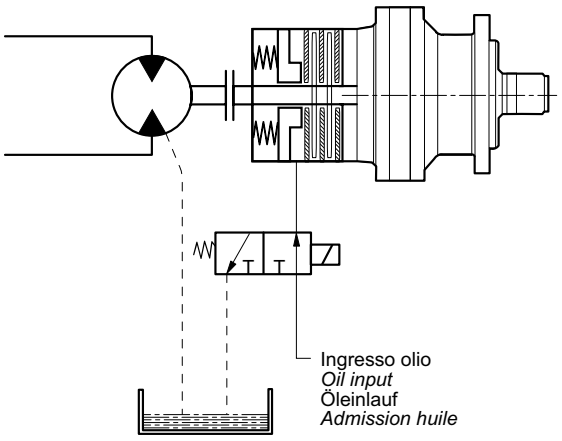
Start

Der Mindestdruck muß so sein, daß die Öffnung der Bremse gewährleistet wird (siehe Tabelle).
Unter 320 bar.

Démarrage

Pression minimum pour permettre l'ouverture du frein (voir tableau).
Inférieure à 320 bars.

(FIG.23)



DATI TECNICI — *TECHNICAL DATA* — TECHNISCHE DATEN — *DONNEES TECHNIQUES*

Freno tipo - *Brake type* / **BremseTyp - *Frein type***		**4...**							**5...**					**6...**					
		A	**B**	**D**	**F**	**H**	**K**	**L**	**B**	**C**	**E**	**G**	**K**	**B**	**C**	**E**	**G**	**K**	**L**
Coppia frenante *Braking torque* Bremsmoment *Couple de freinage*	Ms daNm	5	10	16	26	33	40	44	40	50	63	80	100	85	110	150	210	260	320
Pess. min. apertura *Min. release presure* Min. Öffnungsdruck *Press. min. ouverture*	bar	10	20	30	20	25	30	33	20	27	20	25	32	14	19	25	19	24	28
Pressione max *Max. pressure* Max. Druck *Press. max.*	bar	320																	
Peso *Weight* Gewicht *Poids*	Kg	10							18					35					

NOTA: La coppia statica Ms è la max che può esercitare il freno. – In condizioni dinamiche la coppia frenante è inferiore. – I valori effettivi di Ms possono variare da –5% a +15% rispetto a quelli indicati in tabella.

NOTE: The values for Ms given above are valid when circuit pressure is 0. If ther is any back-pressure in the circuit, contact our technical assistance depatment. Allow for a varation of –5% to +10% in above values. Braking torque is reduced in dynamic operating condition.

ANMERKUNG: Der statische Bremsmoment Ms ist der max. Wert, den die Bremse ausüben kann.-In dynamischem Zustand ist der Bremsmoment geringer.- Die effektiven Werte von Ms können von -5% bis +15% von den in der Tabelle angegebenen abweichen.

REMARQUE: le couple statique Ms est le cuople max. que le frein peut exercer. En conditions dynamiques le couple de freinage est inférieur.
Les valeurs effectives de Ms peuvent varier de -5% à +15% par rapport aux valeurs indiquées sur le tableau.

INSTALLAZIONE MOTORIDUTTORE

Nei casi in cui venga fornito il gruppo motoriduttore completo, per l'installazione di sua macchina attenersi alle indicazioni fornite precedentemente.
Per i collegamenti idraulici od elettrici si forniscono a titolo di esempio due tipologie di schemi ai quali ci si può attenere in via generica in quanto ogni impianto ha le sue esigenze che devono essere valutate di volta in volta dal costruttore.

INSTALLATION OF GEARMOTORS

If a complete gearmotor is supplied, follow the instructions given above for installation to any machine or plant.
Two sample diagrams are provided for generic hydraulic and electrical connections. Each individual installation will, of course, have its own specific requirements which must be catered for.

INSTALLATION GETRIEBE-MOTOR

Sollte die komplette Gruppe Getriebemotor gelierfet werden, dann sind zur Installation an der Maschine die vorher gemachten Angaben zu befolgen.
Für die hydraulischen oder elektrischen Anschlüsse werdwn als Beispiele zwei Schemen angeführt, an die man sich in grossen Zügen halten kann. Jede Anlage bringt jedoch spezifische Anforderungen mit sich, die von Fall zu Fall vom Hersteller bewertet werden müssen.

INSTALLATION MOTOREDUCTEUR

Dans de nombreux cas TRASMITAL fournit le groupe motoréducteur complet.
Pour son installation il convient dans tous les cas de respecter les indications susmentionnées. Pour les branchements hydrauliques ou électriques il est fourni à titre d'exemple deux types de schémas auxquels on peut se référer d'une façon générale, car chaque installation a ses exigences qui doivent être évaluées à chaque fois par le constructeur.

INSTALLAZIONE MOTORIDUTTORE

Con motore elettrico.

Vedere schemi qui di seguito.

INSTALLATION OF GEARMOTORS

With electric motors.

See generic diagrams to follow.

INSTALLATION GETRIEBEMOTOR

Mit Elektromotor.

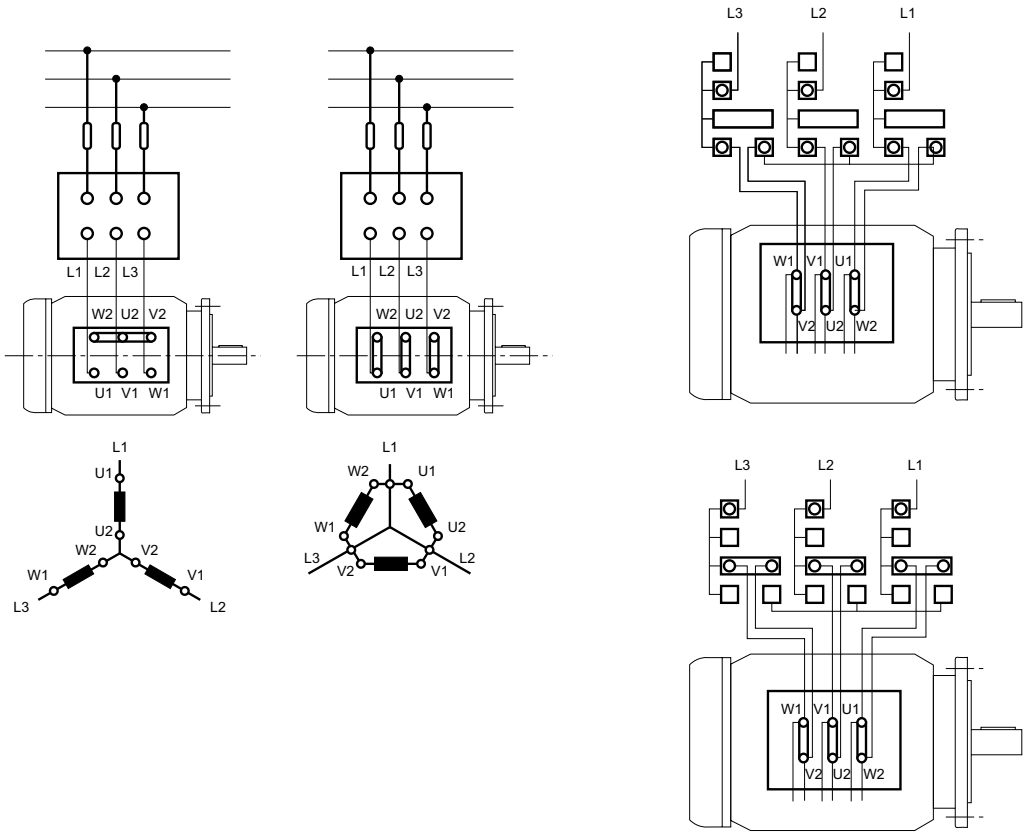
Siehe folgendes Diagramm.

INSTALLATION MOTOREDUCTEUR

Avec moteur électrique.

Voir schémas suivants.

(FIG.24)



INSTALLAZIONE MOTORIDUTTORE

- Con motore idraulico TRASMITAL MG.

In aggiunta alle norme relative alla installazione del riduttore, è raccomandato seguire le seguenti norme per l' installazione del motore idraulico.

INSTALLATION OF GEARMOTORS

- With hydraulic motor TRASMITAL MG.

Further to standards on gearbox installation, comply with the following hydraulic motor installation instructions:

INSTALLATION GETRIEBE-MOTOR

- Mit Hydraulikmotor TRASMITAL MG

Zusätzlich zu den Normen für die Vorgangsweise bei der Installation des jeweiligen Getriebes, wird empfohlen, die auch folgenden Anweisungen für die Installation des Hydraulikmotors zu befolgen.

INSTALLATION MOTOREDUCTEUR

- Avec moteur hydraulique TRASMITAL MG

En plus des règles concernant l'installation du réducteur, on préconise de suivre les instructions ci-dessous pour l'installation du moteur hydraulique.

a) Collegamento al circuito idraulico

I motori possono essere collegati sia a circuiti del tipo chiuso che aperto.
Nel caso di circuito aperto la elettrovalvola o distributore di comando può essere sia di tipo a centro chiuso che aperto.
Occorre che nel ramo del circuito corrispondente alla mandata del motore idraulico sia sempre montata una valvola di massima pressione tarata ad un valore non superiore al valore p_{int} ammesso sul motore idraulico. Vedi schemi idraulici (FIG.25).

a) Connection to the hydraulic circuit

Motors can be connected either to closed or open circuits.
In case of an open circuit, solenoid valve or control distributor can be of the closed or open center type.
The hydraulic motor delivery side should always have a max. pressure valve set to a value not exceeding the p_{int} value allowed for the hydraulic motor. See hydraulic diagrams (FIG.25).

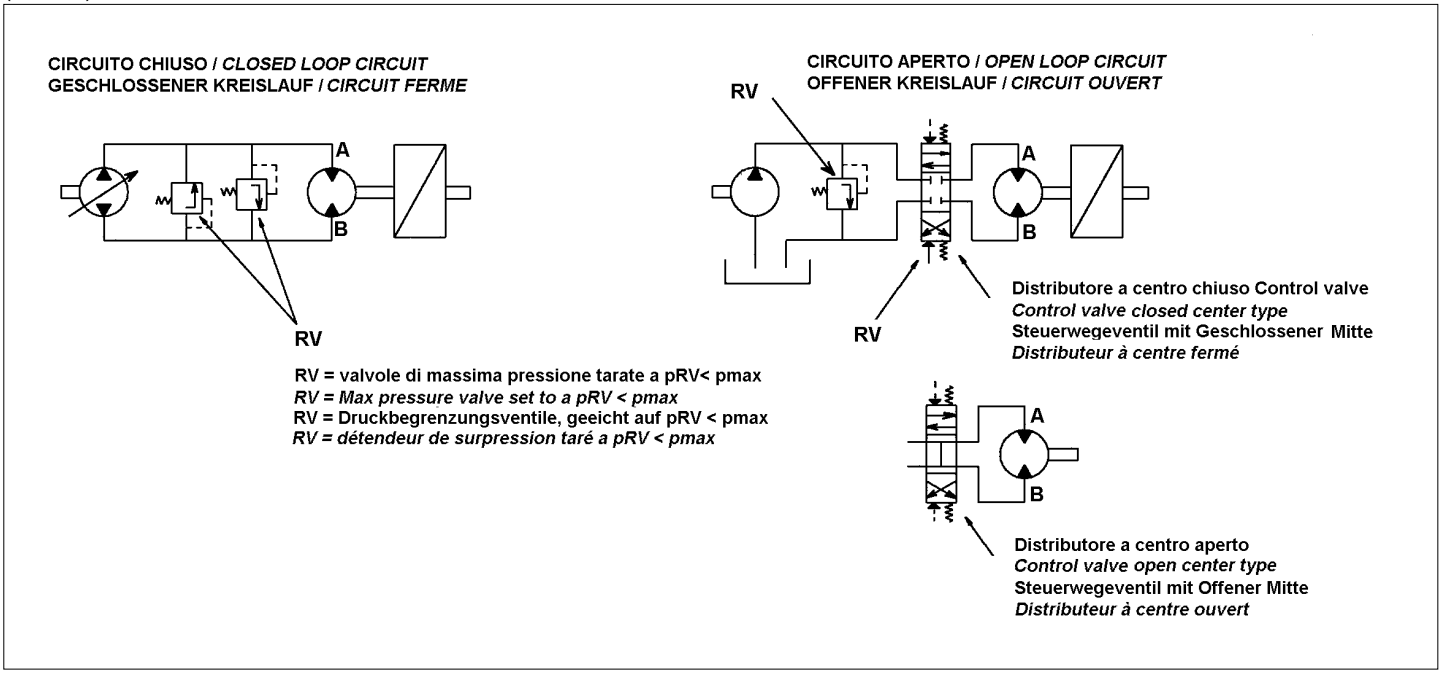
a) Anschluß an den hydraulischen Kreislauf

Die Motoren können, sowohl an geschlossene, als auch an offene Kreisläufe verwendet werden.
Handelt es sich um einen offenen Kreislauf kann das Elektroventil oder das Steuerwegeventil, sowohl vom Typ mit geschlossener Mitte, als auch mit offener Mitte sein.
Es ist erforderlich, daß am Zweig des Kreislaufs, gegenüber der Druckleitung des Hydraulikmotors immer ein Druckbegrenzungsventil montiert ist, welches auf einen Wert geeicht ist, der den am Hydraulikmotor zulässigen Wert von p_{int} nicht überschreitet. Siehe Hydraulikpläne (Abb.25).

a) Raccordement au circuit hydraulique

Les moteurs peuvent être raccordés à des circuits de type fermé aussi bien qu'ouvert.
En cas de circuit ouvert, l'électrovanne, ou distributeur de commande, peut être de type tant à centre fermé qu'ouvert.
Il y a lieu que la portion de circuit, correspondant à l'alimentation du moteur hydraulique, soit toujours équipée d'un détendeur de surpression taré à une valeur pas supérieure à p_{int} maximale admise sur le moteur hydraulique. Voir schémas hydrauliques (Figure25).

(FIG.25)



Nel caso in cui questo non sia possibile in quanto il circuito deve comandare altri azionamenti a pressione più' elevata e/o nel caso cui si abbia un distributore a centro chiuso ed il motore aziona organi ad

If not possible, because the circuits control other devices needing a higher pressure and/or a closed center control valve is fitted and the motor controls parts with a high moment of inertia, max. pressure

Ist dies nicht möglich, weil der Kreislauf noch andere, unter höheren Druck stehende Antriebe steuern muß und/oder in dem Fall, daß kein Wegeventil mit geschlossener Mitte zur Verfügung steht und der

Si cela n'est pas possible, du fait que le circuit doit commander d'autres entraînements, ayant une pression plus élevée, et/ou qu'il y a un distributeur à centre fermé et le moteur actionne des orga-

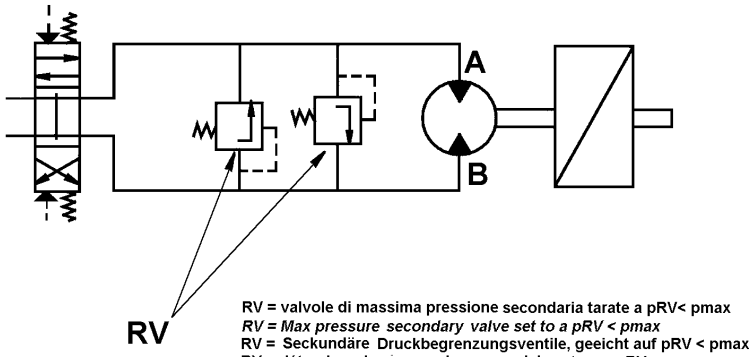
elevato momento d'inerzia occorre montare valvole di massima pressione secondarie il più' vicino possibile al motore. Vedi schema (FIG.26).

secondary valves should be as close as possible to the motor.
See diagram (FIG.26).

Motor Organe mit einem erhöhten Trägheitsmoment antreibt, muß man so nahe wie möglich am Motor sekundäre Druckbegrenzungsventile montieren. Siehe Schema (Abb.26).

nes, ayant un moment d'inertie élevé, il faut monter des détendeurs de surpression secondaires, le plus près du moteur.
Voir schéma (Figure 26).

(FIG.26)



b) Collegamento foro di drenaggio T

In esecuzione standard i motori vengono forniti senza foro di drenaggio. In questo caso il motore è provvisto di drenaggio interno. Questo soddisfa la maggioranza delle applicazioni dove il funzionamento è intermittente e la pressione media di comando è inferiore al 50% della pressione sopportabile dal motore.
Quando il funzionamento è in continuo o intermittente con una percentuale di funzionamento maggiore del 50% e la pressione media di comando è superiore al 50% della pressione, occorre richiedere il motore in esecuzione con drenaggio esterno e collegare il foro di drenaggio T al serbatoio.

b) Connection of drain hole T

Standard motors are supplied with no drain hole. In this case, the motor has an internal drain system.
This meets most application requirements with intermittent duty and average control pressure under 50% of the max. pressure bearable by the motor.
In continuous or intermittent duty with operation percentage over 50% and average control pressure over 50% of the max. pressure, motor should be ordered in the external drain version and the drain hole T should be connected to the tank.

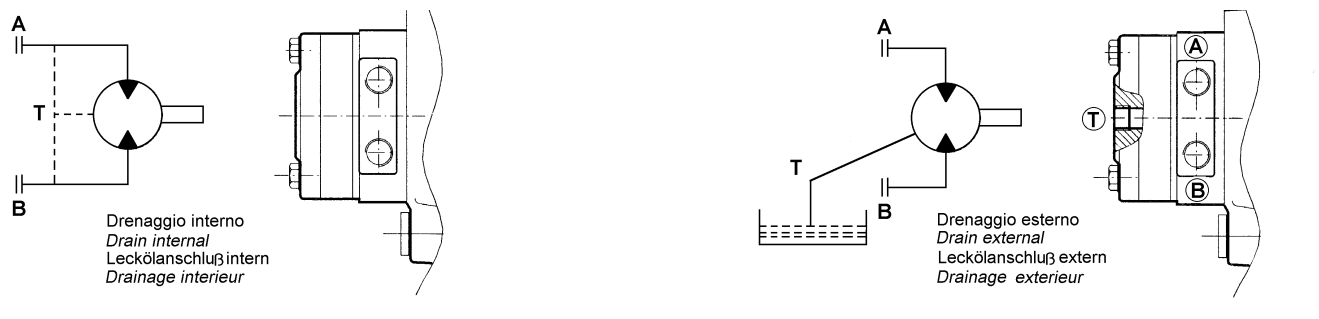
b) Anschlüsse an der Drainagebohrung T

In der Standardausführung werden die Motoren ohne Drainagebohrung geliefert. Diese Lösung reicht bei den meisten Applikationsfällen, bei denen ein Schaltbetrieb verwendet wird und der mittlere Steuerdruck unter den 50% des max. vom Motor tragbaren Drucks liegt, aus.
Handelt es sich um einen Dauer- oder einen Schaltbetrieb mit einem Betriebsprozentsatz über 50% und der mittlere Steuerdruck liegt über 50% des Drucks, muß man eine Motorausführung mit einer Außendrainage anfordern und die Drainagebohrung T dann mit dem Tank verbinden.

b) Raccordement orifige de purge T

L'exécution standard des moteurs ne prévoit pas d'orifice de purge.
Dans ce cas le moteur est dépourvu de purge intérieure.
Cela satisfait à la plupart des applications où le fonctionnement est intermittent et la pression moyenne de commande est inférieure à 50% de la pression maximale admise pour le moteur .
Si le fonctionnement est continu ou intermittent, avec un pourcentage de fonctionnement supérieur à 50% et la pression moyenne de commande est supérieure à 50% de la pression, il faut commander le moteur dans la variante avec purge extérieure et raccorder l'orifice de purge T au réservoir.

(FIG.27)



c) Comando freno

Nel caso in cui il motoriduttore sia dotato di freno, il motore può essere in due esecuzioni: B02P oppure P01S.
Nella esecuzione B02P, il comando del freno è interno, diretto dal motore.
Nella esecuzione P01S, occorre un ramo ausiliario per il comando del freno.
Vedere lo schema seguente (FIG.28).

c) Brake control

For gearmotors equipped with brakes, there are two motor versions available, i.e. the B02P or P01S executions.
In the B02P version, the motor has an in-built, direct brake control system.
In the P01S version, an auxiliary branching is required to control the brake.
See the following diagram (FIG.28).

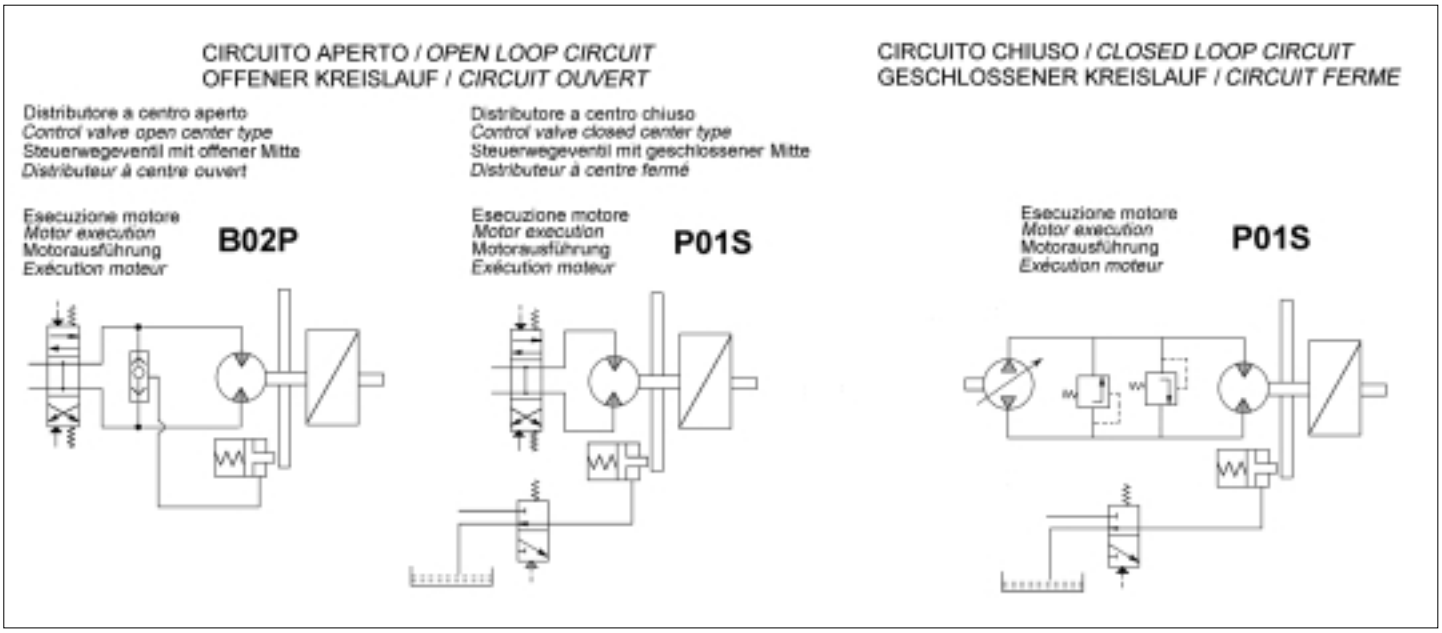
c) Bremssteuerung

Ist der Getriebemotor mit einer Bremse ausgestattet, können zwei Motorausführungen verwendet werden: B02P oder P01S.
Bei der Ausführung B02P liegt die Bremssteuerung im Inneren und wird vom Motor gesteuert. Bei der Ausführung P01S ist für die Bremssteuerung eine Hilfsüberzweigung erforderlich.
Siehe dazu folgendes Schema (Abb.28).

c) Commande frein

Au cas où le motoréducteur serait équipé de frein, le moteur pourra avoir deux exécutions: B02P ou P01S.
Dans l'exécution B02P, la commande du frein est à l'intérieur, derrière le moteur.
Dans l'exécution P01S, il faut disposer d'une branche auxiliaire pour la commande du frein. Voir schéma suivant (Figure 28).

(FIG.28)



d) Tipo olio idraulico

E' raccomandato l'uso di olio idraulico minerale con viscosità ISO VG 46 (46 Cst a t = 40°C).
E' raccomandabile che la temperatura dell'olio sia compresa fra +30 °C e + 70 °C.

d) Hydraulic oil

Use hydraulic mineral oil with viscosity ISO VG 46 (46 Cst at t = 40°C).
It is recommended the oil temperature should be between +30°C and +70°C.

d) Hydrauliköltyp

Es wird der Einsatz von Mineralhydrauliköl mit einem Viskositätsgrad ISO VG 46 (46 Cst bei t = 40°C) empfohlen.
Die Öltemperatur sollte zwischen +30°C und +70°C liegen.

d) Type d'huile hydraulique

On préconise d'utiliser de l'huile hydraulique minérale avec viscosité ISO VG 46 (46 Cst à t = 40°C).
On préconise que le domaine de température de l'huile soit compris entre +30 °C et + 70 °C.

e) Filtraggio

Per assicurare un funzionamento affidabile del motore ed una sua durata è estremamente importante che il circuito idraulico sia dotato di filtro con capacità filtrante tale da assicurare un grado di pulizia dell'olio secondo grado:

e) Oil filtering

For reliable motor operation and long life, it is important that the hydraulic circuit has a filter for a proper oil filtering according to the following degree:

e) Filtrierung

Um einen zuverlässigen Betrieb des Motors und eine lange Lebensdauer zu gewährleisten, ist es besonders wichtig, daß der hydraulische Kreislauf mit einem Filter ausgestattet ist, der eine Filtrierleistung bieten, die einen Ölreinigungsgrad gemäß folgender Angaben sichert Grad:

e) Filtrage

Pour assurer un fonctionnement fiable du moteur, ainsi que sa longévité, il est extrêmement important que le circuit hydraulique soit équipé de filtre, ayant une capacité de filtration en mesure d'assurer un niveau de propreté de l'huile conforme aux degres suivants:

grado 9 NAS 1638	*degree 9 NAS 1638*	Grad 9 NAS 1638	*degré 9 NAS 1638*
grado 6 SAE	*degree 6 SAE*	Grad 6 SAE	*degré 6 SAE*
grado 18/15 SO DIS 4406	*degree 18/15 SO DIS 4406*	Grad 18/15 SO DIS 4406	*degré 18/15 SO DIS 4406*

- Con motore idraulico

Con motore idraulico tutti i motori devono essere riempiti col fluido idraulico prima della messa in esercizio e durante il montaggio nell'impianto.
Posizionare il foro di drenaggio nella posizione più alta per fare il riempimento.
Fare attenzione a che le tubazioni siano dislocate in modo da evitare che il corpo del motore si svuoti per non avere inclusioni di aria che potrebbero causare difficoltà di aspirazione nelle pompe.

- With hydraulic motors

All hydraulic motors must be filled with hydraulic fluid prior to installation and start-up.
Turn the drain hole upwards to fill the motor.
Make sure that the hydraulic hoses are arranged so that they do not drain the motor, and so that air pockets do not form, causing pump suction malfunctions during operation.

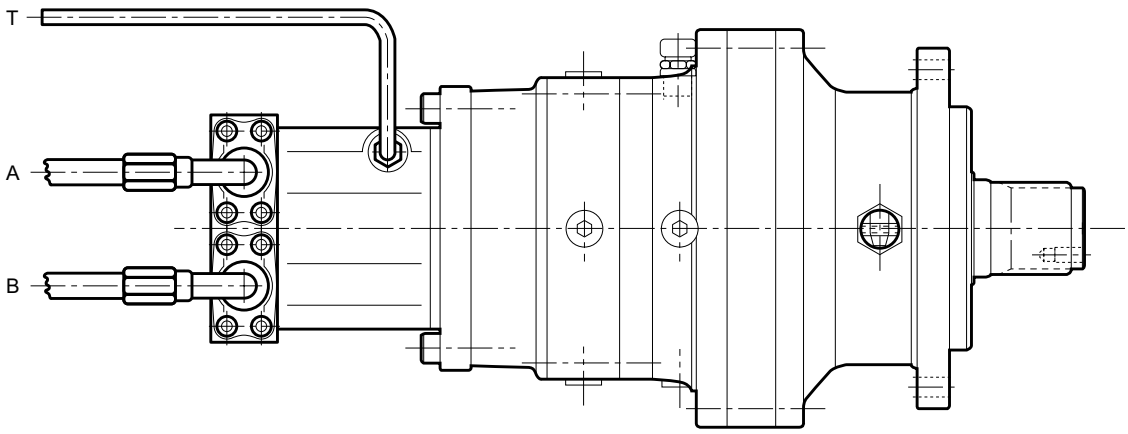
- Mit Hydraulikmotor

Mit Hydraulikmotor müssen alle Motoren vor Inbetriebnahme bei Montage der Anlage mit Hydrauliköl gefüllt werden.
Die Ablassbohrung in de höchste Stellung bringen, um zu füllen.
Darauf achten, daß die Leitungen so angeordnet sind, dass eine Entleerung des Motorgehäuses vermieden wird, um Luftblasen zu vermeiden, die zu Schwierigkeiten beim Ansaugen der Pumpen führen könnten.

- Avec moteur hydraulique

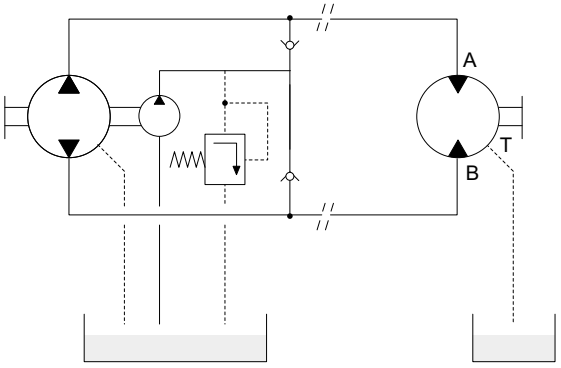
Tous les moteurs doivent être remplis avec du fluide hydraulique avant la mise en fonction et pendant le montage dans l'installation.
Positionner le trou de drainage dans la position la plus haute pour effecteur le remplissage.
Faire attention que les tubes soient déconnectés de façon à éviter que le corps moteur se vide pour ne pas avoir d'introduction d'air qui pourrai causer des difficultés d'aspiration dans les pompes.

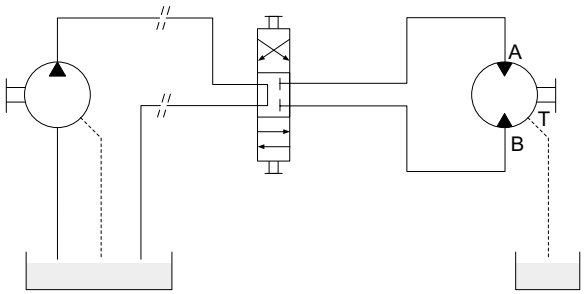
(FIG.29)



A - B = Rami di alimentazione
Port of alimentation
Arbeitsanschlusse
Orifice d'alimentation

T = Drenaggio
Draining
Leckolanschlusse
Orifice de vidange





4 - LUBRIFICAZIONE (prima della messa in funzione)

La lubrificazione è normale in bagno d'olio. A seconda dell'applicazione se in impianto fisso o su macchina mobile attenersi alle seguenti tabelle:

1) Macchine mobili: oli a norme SAE 80 W/90 con caratteristiche API GL5.

2) Impianti industriali: oli a norme ISO VG 150 con caratteristiche E.P.

Nella tabella seguente sono riportati le marche più diffuse di lubrificanti con i tipi di oli consigliati per applicazioni normali.

4 - LUBRICATION (prior to start-up)

Standard lubrication is oilbath. Respect the specifications given below for fixed and mobile machines:

1) Mobile machinery: SAE 80W/90 olis with API GL5 properties

2) Industrial machinery: ISO VG 150 oils with E.P. properties

The following table lists the most common brands of lubricant and the types recommended for normal applications.

4 - SCHMIERUNG (Von Inbetriebnahme)

Die Schmierung erfolgt normal im Ölbad.
Je nach Einsatz, d.h. Festanlage oder bewegliche Maschine, sollte man sich an folgende Tabellen halten:

1) Bewegliche Maschinen: Öl gem. Norm SAE 80 W/90 mit Eigenschaften API GL5

2) Industrieanlagen: Öl gem. Norm ISO VG 150 mit Eigenschaften E.P.

In der nachfolgenden Tabelle sind die üblichsten Schmiermittelmarken aufgeführt, mit Angabe der empfohlenen Ölsorten für normalen Einsatz.

4 - LUBRIFICATION (avant la mise en route)

La lubrification normale s'effectue en bain d'huile.
Selon l'application, installation fixe ou équipement mobile, se reporter aux tableaux suivants:

1) Machines mobiles: Huiles aux normes SAE VG 150 avec caractéristiques API GL5.

2) Installations industrielles: Huiles aux normes ISO VG 150 avec caractéristiques E.P.

Sur le tableau suivant on a reporté les marques les plus répandues de lubrifiants avec les types d'huile conseillés pour des applications normales.

	IMPIANTI INDUSTRIALI / *INDUSTRIAL PLANTS* INDUSTRIEANLAGEN / *INSTALLATIONS INDUSTRIELLES*		MACCHINE MOBILI / *MOBILE MACHINES* BEWEGLICHE MASCHINEN / *MACHINES MOBILES*	
	norme ISO .. con caratteristiche E.P. *ISO standard .. E.P. grade* ISO-Normen .. E.P.-Merkmalen *normes ISO .. avec caractéristiques E.P.*		norme SAE .. con caratteristiche API GL5 *SAE standard .. API GL5 grade* SAE-Normen .. mit API GL5-Merkmalen *normes SAE .. avec caractéristiques API GL5*	
Temperatura ambiente *Ambient temperature* Temperaturbereiche *Température ambiante*	-10°C / +30°C	+20°C / +45°C	-10°C / +30°C	+20°C / +45°C
	ISO VG 150	ISO VG 220	SAE 80W/90	SAE 85W/140
AGIP	BLASIA 150	BLASIA 220	ROTRA MP	ROTRA MP
	BLASIA S150	BLASIA S 220		
ARAL	DEGOL BG 150	DEGOL BG 220	GETRIEBEOL HYP	GETRIEBEOL HYP
BP - MACH	ENERGOL GR XP 150	ENERGOL GR XP 220	HYPOGEAR EP	HYPOGEAR EP
		ERNESYN HTX 220		
CASTROL	ALPHA SP 150	ALPHA SP 220	HYPOY	HYPOY
CHEVRON	EDWN.L. GEAR COMPOUND 150	N.L. GEAR COMPOUND 220	UNIVERSAL GEAR LUBRICANTE	UNIVERSAL GEAR LUBRICANTE
ELF	REDUCTELF SP 150	REDUCTELF SP 220	TRANSELF8	TRANSELF8
ESSO	SPARTAN EP 150	SPARTAN EP 220	GEAR OIL GX	GEAR OIL GX
	GLYCOLUBE 150	GLYCOLUBE 220	PONTONIC MP	PONTONIC MP
FINA	GIRAN 150	GIRAN 220		
I.P.	MELLANA 150	MELLANA 220	PONTIAX HD	PONTIAX HD
	PONTIAX HDS	PONTIAX HDS		
KLÜBER	LAMORA 150	LAMORA 220		
	SYNTHESO D150 EP	SYNTHESO D220 EP		
MOBIL	MOBILGEAR 629	MOBILGEAR 630	MOBILUBE HD	MOBILUBE HD
	SHC 629	SHC 630		
SHELL	OMALA EP 150	OMALA EP 220	SPIRAX HD	SPIRAX HD
	TIVELA OIL WA-SA	TIVELA OIL WB		
TOTAL	CARTER EP 150	CARTER EP 220	TRANSMISSION TM	TRANSMISSION TM

— **Temperatura sulla carcassa, questa non deve superare nel punto più caldo i 70-75°C**

— ***The temperature of the gear case, which should not exceed 70-75°Cat the hottest point.***

— **Gehäusetemperatur, an der Wärmsten Stelle max. 70-75°C.**

— ***La température sur la carcasse; l'échauffement maximum de celle-ci ne devant pas dépasser les 70-75°C.***

Oli a base sintetica | ***Synthetic oil*** | **Synthetische Öle** | ***Huiles à base synthetique***

LUBRIFICAZIONE FRENI

I freni idraulici a dischi multipli hanno lubrificazione unica con il riduttore.

BRAKES LUBRICATION

The hydraulically operated multidisc brakes are lubricated by the same oil as the gearbox.

BREMSE SCHMIERUNG

Die hydraulischen Lamellenbremsen werden über die Schmierung des Untersetzungsgetriebes geschmiert.

FREINS LUBRIFICATION

Les freins hydrauliques à disques multiples sont lubrifié avec la même huile que les réducteurs.

STADIO RIDUZIONE A VITE SENZA FINE (3/VF) / *WORM REDUCTION MODULE (3/VF)* SCHNECKENÜBERSETZUNGSSTUFE (3/VF) / *ETAGE DE REDUCTION A VIS SANS FIN (3/VF)* STADIO RIDUZIONE AD ASSI ORTOGONALI (3/A) / *HELICAL BEVEL REDUCTION MODULE (3/A)* KEGELRADÜBERSETZUNGSSTUFE (3/A) / *ETAGE DE REDUCTION A AXES ORTHOGONAUX (3/A)*				
Tipo di carico / *Type of Load* Art der Belastung / *Type de charge*	0 °C / +20 °C		+20 °C / +40 °C	
	Olio minerale *Mineral oil* Mineralöl *Huile minérale* **ISO VG**	Olio sintetico *Synthetic oil* Syntheseöl *Huile synthétique* **ISO VG**	Olio minerale *Mineral oil* Mineralöl *Huile minérale* **ISO VG**	Olio sintetico *Synthetic oil* Syntheseöl *Huile synthétique* **ISO VG**
Carico leggero / *Light load* / Leicht / *Charge légère*	150	150	220	220
Carico medio / *Medium load* / Normal / *Charge moyenne*	150	150	320	220
Carico pesante / *Heavy load* / Schwer / *Charge lourde*	220	220	460	320

Per applicazioni particolari come temperature particolarmente elevate, requisiti di non infiammabilità dell'olio, ecc. interpellare l'Ufficio tecnico TRASMITAL.

For particular applications like: high temperature running conditions, noninflammable oil, etc. contact Trasmital Technical Departements.

Für speziellle Einsatzbedingungen, wie sehr hohe Temperaturen, Notwendigkeit der Verwendung von nicht entflammbarem Öl, usw. setzen Sie sich bitte mit dem technischen Büro von Trasmital in Verbindung.

Dans le cas d'applications particulières avec des températures élevées...où la non inflammabilité de l'huile est requise,...etc., contacter le service technique TRASMITAL.

La temperatura massima dell'olio in esercizio continuo non deve comunque superare gli 85°C.

Maximum operating oil temperature must never exceed 85° C.

Die maximale Öltemperatur darf im Dauerbetrieb 85°C nicht überschreiten.

La température maximum de l'huile en fonctionnement continu ne doit de toute façon pas dépasser 85°C.

RIEMPIMENTO

I riduttori vengono forniti senza olio lubrificante.

Tutti i riduttori sono provvisti dei tappi di carico, livello, sfiato e scarico olio.
Per effettuare il riempimento olio occorre avere il riduttore nella esatta posizione di funzionamento, svitare il tappo di carico olio e riempire fino al livello la cui posizione dipende dal tipo di montaggio: orizzontale o verticale.
Per lo scarico svitare il tappo di scarico magnetico e lasciare defluire l'olio.
Per agevolare l'operazione sarebbe meglio che l'olio fosse ancora caldo e che si sia smontato anche un tappo posizionato in alto nel riduttore per avere una circolazione di aria.

NOTA: per i riduttori con freno, la lubrificazione del freno è comune a quella del riduttore.

FILLING

Gearboxes are supplied without oil.

All gearboxes are equipped with filler, lever, breather, and drain plugs. To fill the gearbox secure it in its exact working position, unscrew the oil filler plug, and add oil until it is visible in the level window. The position of the window will obviously depend on whether the unit is mounted horizontally or vertically.
To drain, remove the magnetic drain plug and drain off oil. If possible, drain while the oil is hot and remove the filler plug from the top of the gearbox to give optimum oil flow.

Note: In gearboxes with brakes, brake lubrication is provided by the gearbox lubricant.

EINFÜLLEN

Die Getriebe werden ohne Schmieröl ausgeliefert.

Alle Getriebe sind mit Füllstopfen, Füllstandanzeige, Entlüftung und Ölablass ausgestattet.
Zum Einfüllen des Öls muss sich das Getriebe in der genauen Betriebsposition befinden, dann den Nachfüllstopfen lösen und bis zum korrekten Füllstand auffüllen, der von der Einbaulage abhängt: senkrecht oder waagerecht. Zum Ablassen des Öl den magnetischen Ablassstopfen entfernen und das Öl abfliessen lassen.
Dieser Vorgang ist einfacher, wenn das Öl noch warm ist und bei abgeschraubtem Nachfüllstopfen, damit die Luft besser nachfliesst.

Anmerkung: Für Getriebe mit Bremse, entspricht die Schmierung der Bremse auf jeden Fall der Getriebeschmierung.

REMPLISSAGE

Les réducteurs sont livrés sans huile de lubrification.

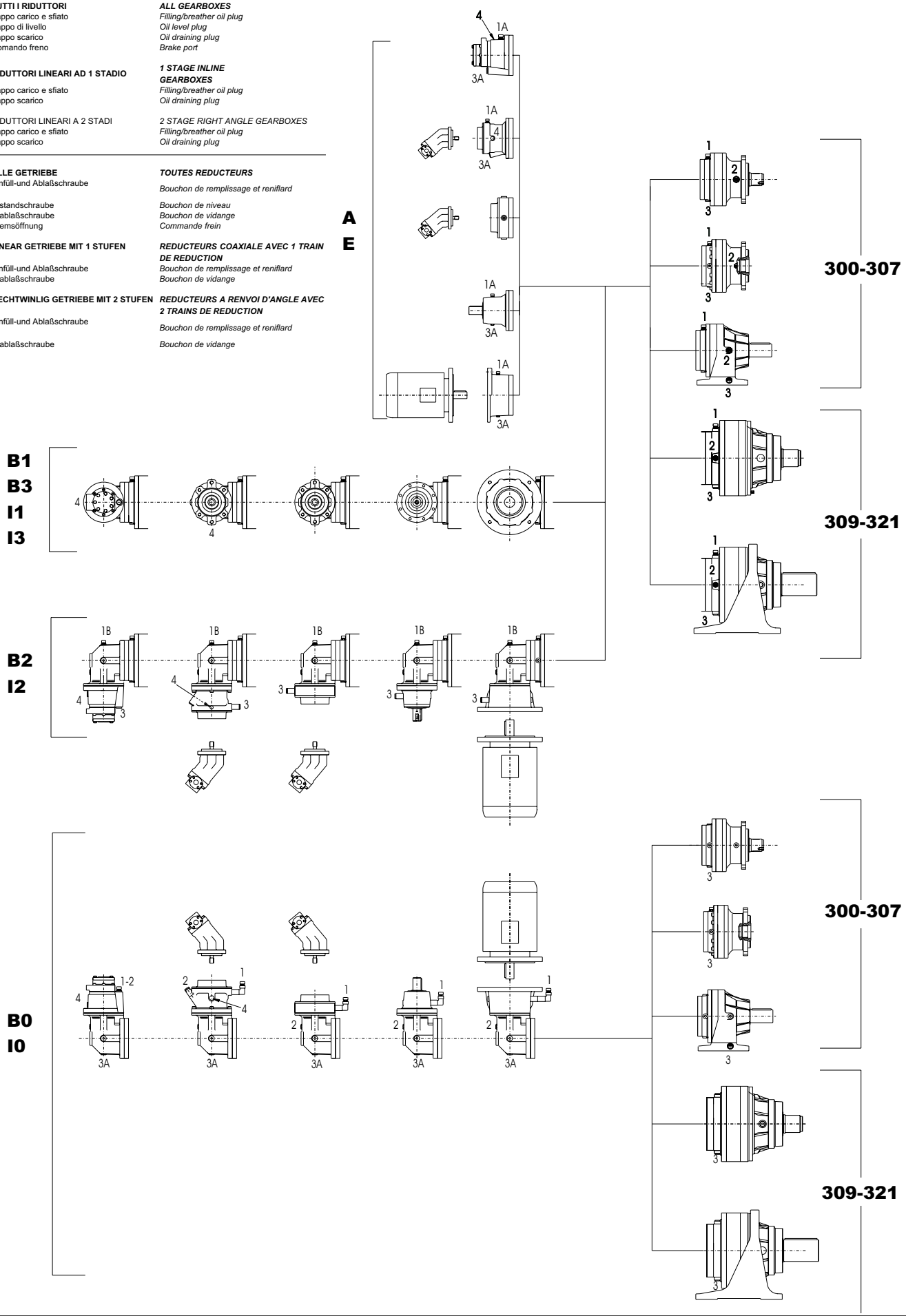
Tous les réducteurs sont équipés de bouchons de remplissage, niveau, reniflard et vidange d'huile.
Pour effectuer le remplissage d'huile il faut présenter le réducteur dans la position exacte de fonctionnement, dévisser le bouchon de remplissage d'huile et remplir jusqu'au niveau dépendant du type de montage: horizontal ou vertical.
Pour la vidange dévisser le bouchon magnétique de vidange et laisser couler l'huile.
Pour faciliter l'opération il est préférable que l'huile soit encore chaude et qu'un autre bouchon positionné en hauteur soit ôté pour permettre une circulation d'air.

NOTA: Pour les réducteurs équipés de frein, la lubrification de ce dernier est commune avec celle du réducteur.

POSIZIONE TAPPI OLIO *PLUG POSITIONS* POSITION DER SCHRAUBEN *POSITIONS DES BOUCHONS*

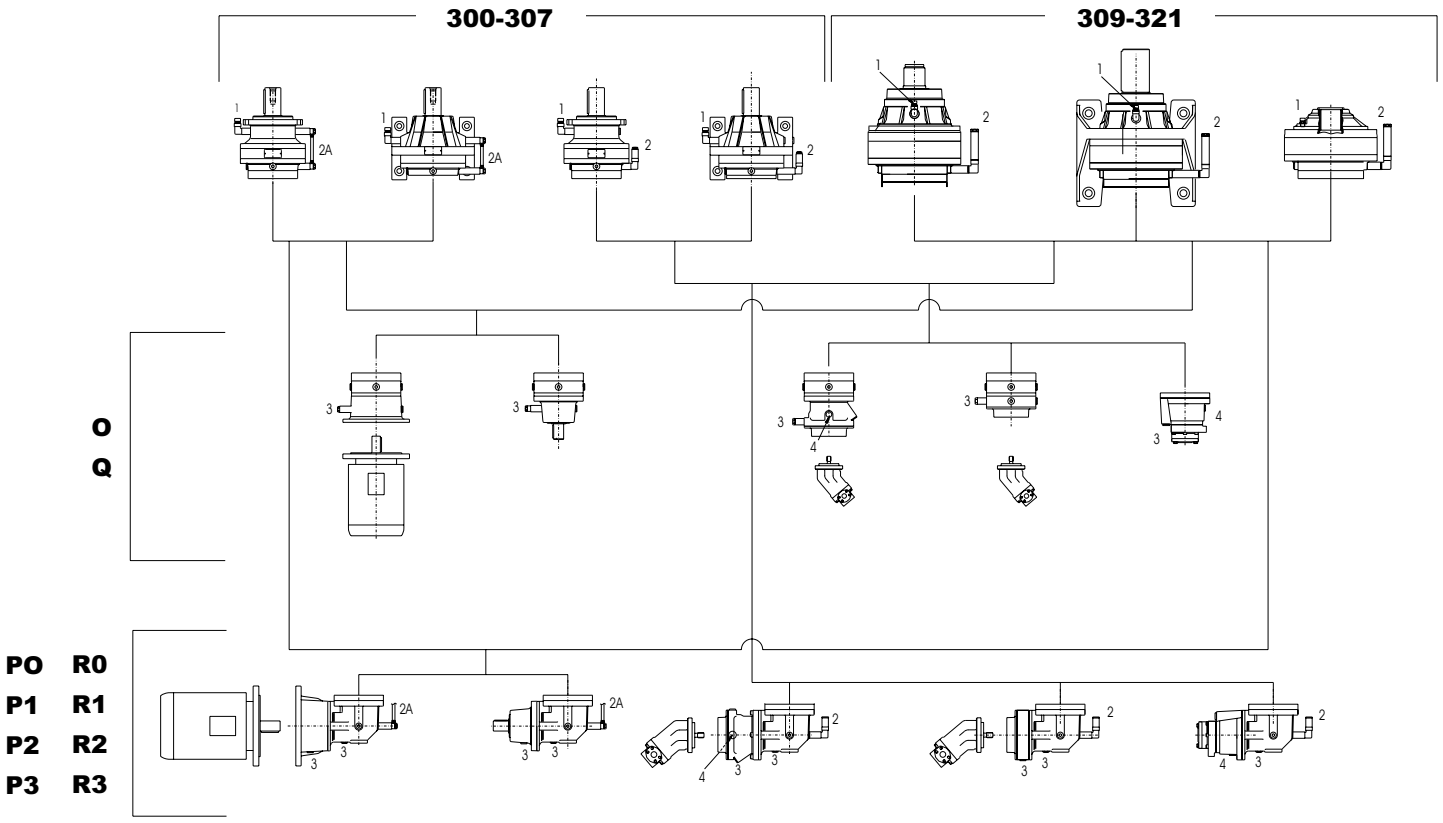
(FIG.32)

	TUTTI I RIDUTTORI	***ALL GEARBOXES***
1	Tappo carico e sfiato	*Filling/breather oil plug*
2	Tappo di livello	*Oil level plug*
3	Tappo scarico	*Oil draining plug*
4	Comando freno	*Brake port*
	RIDUTTORI LINEARI AD 1 STADIO	***1 STAGE INLINE GEARBOXES***
1A	Tappo carico e sfiato	*Filling/breather oil plug*
3A	Tappo scarico	*Oil draining plug*
	RIDUTTORI LINEARI A 2 STADI	*2 STAGE RIGHT ANGLE GEARBOXES*
1b	Tappo carico e sfiato	*Filling/breather oil plug*
3A	Tappo scarico	*Oil draining plug*
	ALLE GETRIEBE	***TOUTES REDUCTEURS***
1	Einfüll-und Ablaßschraube	*Bouchon de remplissage et reniflard*
2	Ölstandschraube	*Bouchon de niveau*
3	Ölablaßschraube	*Bouchon de vidange*
4	Bremsöffnung	*Commande frein*
	LINEAR GETRIEBE MIT 1 STUFEN	***REDUCTEURS COAXIALE AVEC 1 TRAIN DE REDUCTION***
1A	Einfüll-und Ablaßschraube	*Bouchon de remplissage et reniflard*
3A	Ölablaßschraube	*Bouchon de vidange*
	RECHTWINLIG GETRIEBE MIT 2 STUFEN	***REDUCTEURS A RENVOI D'ANGLE AVEC 2 TRAINS DE REDUCTION***
1B	Einfüll-und Ablaßschraube	*Bouchon de remplissage et reniflard*
3A	Ölablaßschraube	*Bouchon de vidange*



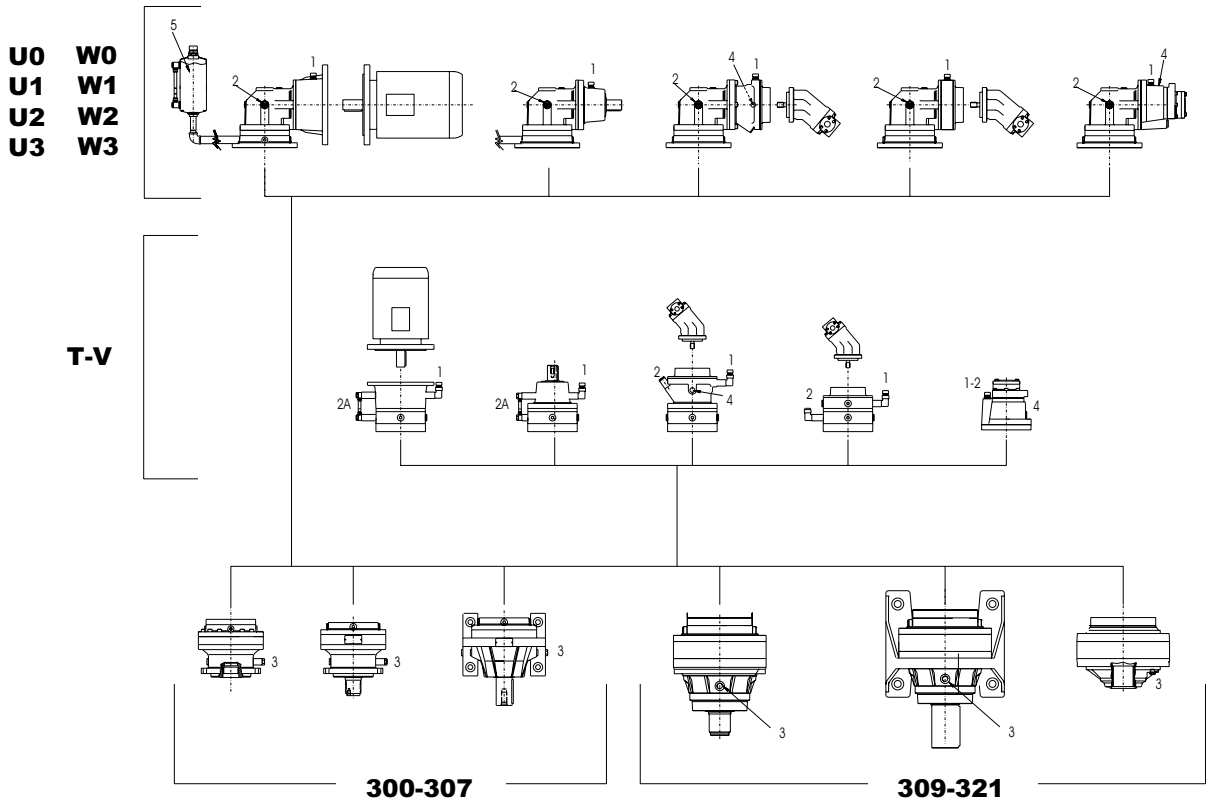
POSIZIONE TAPPI OLIO *PLUG POSITIONS* POSITION DER SCHRAUBEN *POSITIONS DES BOUCHONS*

(FIG.33)



	TUTTI I RIDUTTORI	*ALL GEARBOXES*	ALLE GETRIEBE	*TOUTES REDUCTEURS*
1	Tappo carico e sfiato	*Filling/breather oil plug*	Einfüll-und Ablaßschraube	*Bouchon de remplissage et reniflard*
2	Tappo di livello	*Oil level plug*	Ölstandschraube	*Bouchon de niveau*
2A	Tubo trasparente di livello	*Transparent oil level hose*	Ölstandschraube	*Bouchon de niveau*
3	Tappo scarico	*Oil draining plug*	Ölablaßschraube	*Bouchon de vidange*
4	Comando freno	*Brake port*	Bremsöffnung	*Commande frein*

(FIG.34)



POSIZIONE TAPPI OLIO Serie 3/VF

PLUG POSITIONS 3/VF Series

POSITION DER SCHRAUBEN Serie 3/VF

POSITIONS DES BOUCHONS Série 3/VF

(FIG.35) **A -E**

TUTTI I RIDUTTORI (stadi epicicloidali)
1 Tappo carico e sfiato
2 Tappo di livello
3 Tappo scarico

(stadio a vite senza fine)
1V Tappo carico e sfiato
2V Tappo di livello
3V Tappo scarico

ALL GEARBOXES (planetary stages)
1 *Filling/breather oil plug*
2 *Oil level plug*
3 *Oil draining plug*

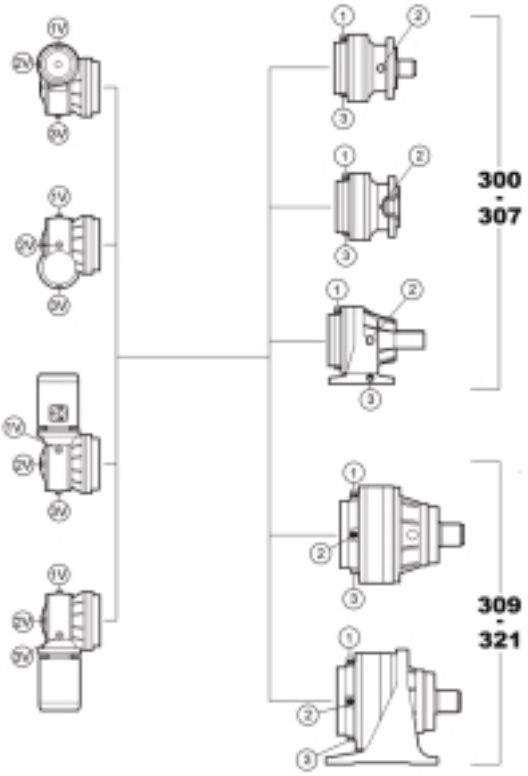
(worm reduction module)
1V *Filling/breather oil plug*
2V *Oil level plug*
3V *Oil draining plug*

ALLE GETRIEBE (Planetenstufen)
1 Einfüll-und Ablaßschraube
2 Ölstandschraube
3 Ölablaßschraube

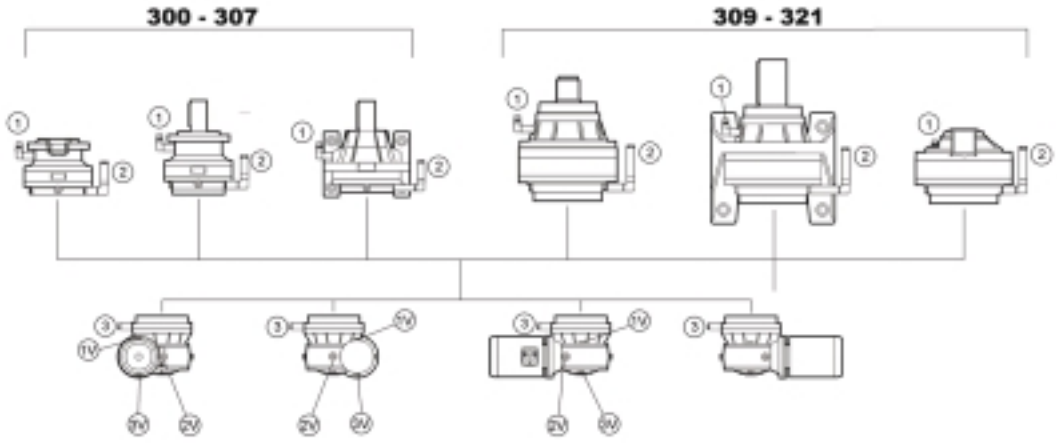
(Schneckenübersetzungsstufe)
1V Einfüll-und Ablaßschraube
2V Ölstandschraube
3V Ölablaßschraube

TOUTES REDUCTEURS (étages épicycloidaux)
1 *Bouchon de remplissage et reniflard*
2 *Bouchon de niveau*
3 *Bouchon de vidange*

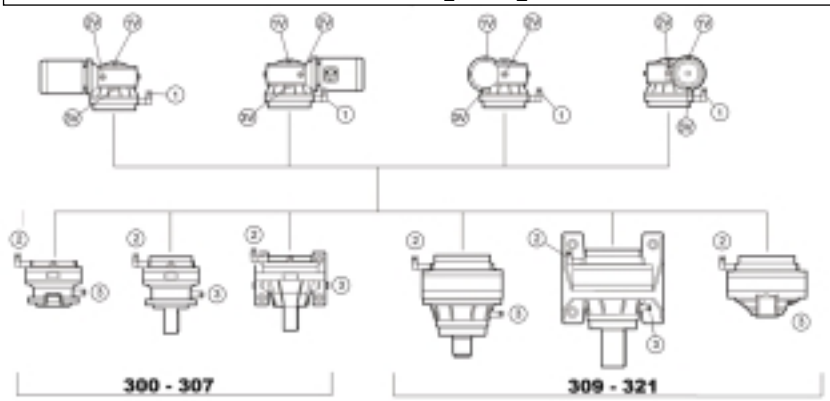
(étage de réduction à vis sans fin)
1V *Bouchon de remplissage et reniflard*
3V *Bouchon de niveau*
3V *Bouchon de vidange*



(FIG.36) **O - Q**



(FIG.37) **T - V**



POSIZIONE TAPPI OLIO Serie 3/A — *PLUG POSITIONS 3/A Series* — POSITION DER SCHRAUBEN Serie 3/A — *POSITIONS DES BOUCHONS Série 3/A*

(FIG.38) **A -E**

TUTTI I RIDUTTORI
(stadi epicicloidali)
1 Tappo carico e sfiato
2 Tappo di livello
3 Tappo scarico

(stadio a vite senza fine)
1A Tappo carico e sfiato
2A Tappo di livello
3A Tappo scarico

ALL GEARBOXES
(planetary stages)
1 *Filling/breather oil plug*
2 *Oil level plug*
3 *Oil draining plug*

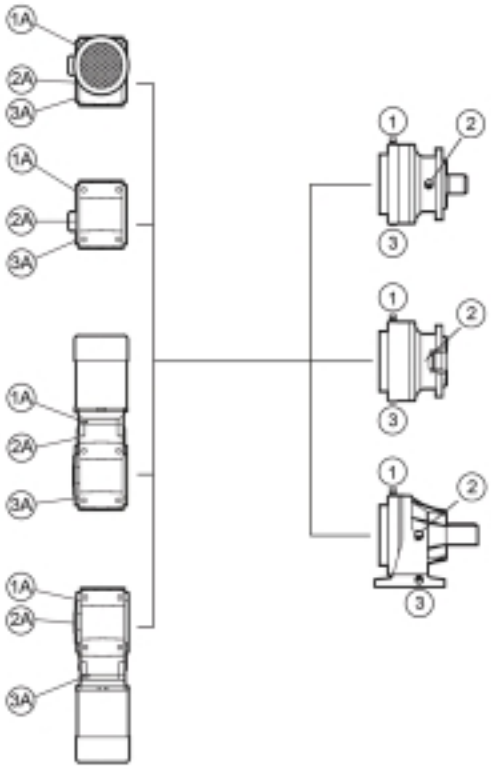
(worm reduction module)
1A *Filling/breather oil plug*
2A *Oil level plug*
3A *Oil draining plug*

ALLE GETRIEBE
(Planetenstufen)
1 Einfüll-und Ablaßschraube
2 Ölstandschraube
3 Ölablaßschraube

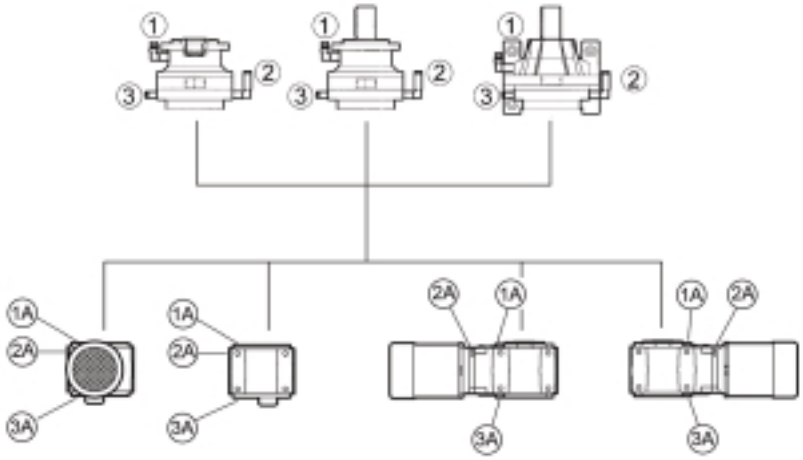
(Schneckenübersetzungsstufe)
1A Einfüll-und Ablaßschraube
2A Ölstandschraube
3A Ölablaßschraube

TOUTES REDUCTEURS
(étages épicycloidaux)
1 *Bouchon de remplissage et reniflard*
2 *Bouchon de niveau*
3 *Bouchon de vidange*

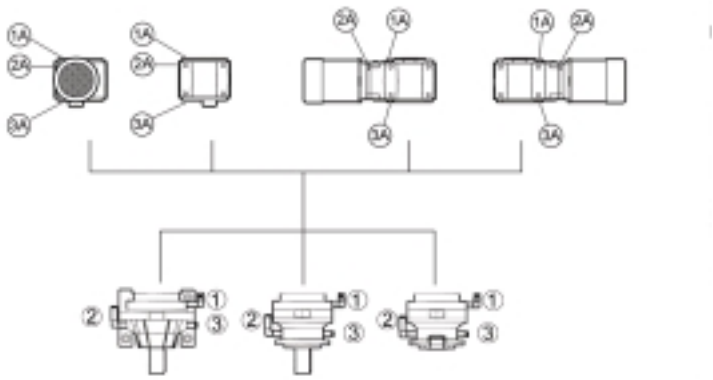
(étage de réduction à vis sans fin)
1A *Bouchon de remplissage et reniflard*
3A *Bouchon de niveau*
3A *Bouchon de vidange*



(FIG.39) **O - Q**



(FIG.40) **T - V**



QUANTITÀ OLIO (l) Serie 3_L e 3_R

OIL QUANTITY (l) 3_L and 3_R Series

SCHMIEROLMENGE (l) Serie 3_L und 3_R

QUANTITÉ D'HUILE (l) Série 3_L et 3_R

Tipo/*Type* Typ/*Type*		3_L			
		Posizione di montaggio *Mounting position* Einbaulagen *Position de montage* 4			VK
		A	T	O	T
300	L1	0.6	1.0	0.9	
	L2	0.9	1.3	1.2	
	L3	1.2	1.6	1.5	
	L4	1.5	1.9	1.8	
301	L1	0.8	1.2	1.1	
	L2	1.1	1.5	1.4	
	L3	1.4	1.8	1.7	
	L4	1.7	2.1	2.0	
303	L1	1.3	2.3	2.0	2.8
	L2	1.6	2.6	2.3	3.1
	L3	1.9	2.9	2.6	3.4
	L4	2.2	3.2	2.9	3.7
305	L1	1.6	2.6	2.4	3.1
	L2	2.1	3.1	2.9	3.6
	L3	2.4	3.4	3.2	3.9
	L4	2.7	3.7	3.5	4.2
306	L1	2.5	3.5	3.2	4.5
	L2	3.3	4.3	4.0	5.3
	L3	3.6	4.6	4.3	5.6
	L4	3.9	4.9	4.6	5.9
307	L1	3.5	5.0	4.5	6.0
	L2	4.5	6.0	5.5	7.0
	L3	5.0	6.5	6.0	7.5
	L4	5.3	6.8	6.3	7.8
309	L1	4.0	5.5	5.0	6.5
	L2	5.0	6.5	6.0	7.5
	L3	5.5	7.0	6.5	8.0
	L4	5.8	7.3	6.8	8.3
310	L1	5.0	6.5	6.0	8.5
	L2	6.3	7.8	7.3	9.8
	L3	7.1	8.6	8.1	10.6
	L4	7.4	8.9	8.4	10.9
311	L1	7.0	12.0	10.0	14.0
	L2	9.0	14.0	12.0	16.0
	L3	10.0	15.0	13.0	17.0
	L4	10.5	15.5	13.5	18.0
313	L1	9.0	14.0	12.0	16.0
	L2	11.5	16.5	14.5	19.0
	L3	12.5	17.5	15.5	20
	L4	13.0	18.0	16.0	21
315	L1	15.0	23	19.0	26
	L2	19.0	27	23	30
	L3	21	29	25	32
	L4	22	30	26	33
317	L1	20	35	30	
	L2	26	41	36	
	L3	29	44	39	
	L4	30	45	40	
319	L1	25	45	38	
	L2	35	55	48	
	L3	40	60	53	
	L4	43	63	56	
321	L1	30	50	43	
	L2	45	65	58	
	L3	51	71	64	
	L4	55	75	68	

Tipo/*Type* Typ/*Type*		3_R			
		Posizione di montaggio *Mounting position* Einbaulagen *Position de montage* 4			VK
		BO	U	P	U
300	R2	1.2	1.7	1.5	
	R3	1.5	2.0	1.8	
	R4	1.8	2.3	2.1	
301	R2	1.6	2.1	1.9	
	R3	1.9	2.4	2.2	
	R4	2.2	2.7	2.5	
303	R2	2.2	2.8	2.6	3.3
	R3	2.5	3.1	2.9	3.6
	R4	2.8	3.4	3.2	3.9
305	R2	2.5	3.1	2.9	3.6
	R3	3.0	3.6	3.4	4.1
	R4	3.3	3.9	3.7	4.4
306	R2	4.0	5.0	4.8	6.0
	R3	4.8	5.8	5.6	6.8
	R4	5.1	6.1	5.9	7.1
307	R2	6.0	8.0	7.0	9.0
	R3	7.0	9.0	8.0	10.0
	R4	7.5	9.5	8.5	10.5
309	R2	6.5	8.5	7.5	9.5
	R3	7.5	9.5	8.5	10.5
	R4	8.0	10.0	9.0	11.0
310	R3	11.0	13.0	12.0	15.0
	R4	12.0	14.0	13.0	16.0
311	R2	14.0	19.0	17.0	21
	R3	16.0	21	19.0	23
	R4	17.0	22	20	24
313	R2	16.0	21	19	23
	R3	19.0	24	22	26
	R4	20	25	23	28
315	R3	27	35	31	38
	R4	30	38	34	41
317	R3	38	52	48	
	R4	42	56	52	

N.B. Le quantità d'olio sono indicative. Verificare l'esatto livello al momento del riempimento tramite l'apposito tappo.

N.B. Oil quantities are indicative. Check actual level after filling through the appropriate plug.

Achtung! Die Angabe bezüglich Ölmenge sind Richtwerte Der Ölstand soll während des Einfüllens anhand des Ölstandstopfens überprüft werden.

N.B. Les quantités d'huile sont indicatives. Vérifiez la quantité correcte de lubrificant selon le niveau d'huile.

QUANTITÀ OLIO (l) Serie 3/VF - 3/A — ***OIL QUANTITY (l) 3/VF - 3/A Series*** — **SCHMIEROLMENGE (l) Serie 3/VF - 3/A** — ***QUANTITÉ D'HUILE (l) Série 3/VF - 3/A***

Tipo *Type* Typ *Type*	Entrata *Input* Eingang *Entrée*	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*											
		AA-EA-FD	(B3)	**AF-EF-FE**	(V6)	**AE-EE-FF**	(V5)	**AD-ED-FA**	(B8)	**TA-TE-TF-TD-VA-VC-VF-IO**	(B6)	**OA-OE-OF-OD-QA-QE-QF-QD**	(B7)
3/VF 00L3	HS - P	0.90	0.12	0.90	0.12	0.90	0.12	0.90	0.12	1.30	0.12	1.20	0.12
3/VF 01L3		1.10		1.10		1.10		1.10		1.50		1.40	
3/VF 03L3		1.60	0.32	1.60	0.32	1.60	0.32	1.60	0.32	2.60	0.32	2.30	0.32
3/VF 05L3		2.10	0.50	2.10	0.50	2.10	0.50	2.10	0.50	3.10	0.50	2.90	0.50
3/VF 06L3		3.30	0.87	3.30	0.87	3.30	0.87	3.30	0.87	4.30	0.87	4.00	0.87
3/VF 10L4		7.10		7.10		7.10		7.10		8.60		8.10	
3/VF 07L3	HS	4.50	2.80	4.50	2.60	4.50	2.60	4.50	1.70	6.00	1.90	5.50	1.90
3/VF 11L4	P	10.00	2.40	10.0	2.60	10.00	2.60	10.00	1.70	15.00	1.90	13.00	1.90
3/VF 13L4		12.50		12.5		12.50		12.50		17.50		15.50	
3/VF 09L3	HS	5.00	4.50	5.00	3.90	5.00	3.90	5.00	3.00	6.50	3.50	6.00	3.50
3/VF 10L3	P	6.30	4.30	6.30	3.90	6.30	3.90	6.30	3.00	7.80	3.50	7.30	3.50
3/VF 15L4		21		21		21		21		29		25	
3/VF 11L3	HS	9.00	9.60	9.00	6.70	9.00	6.70	9.00	5.00	14.00	5.50	12.00	5.50
3/VF 13L3	P	11.50	7.80	11.50	6.70	11.50	6.70	11.50	5.00	16.50	5.50	14.50	5.50
3/VF 17L4		29		29		29		29		44		39	
3/VF 15L3	HS	19.00	15.00	19.00	8.90	19.00	9.40	19.00	7.50	27	9.50	23	9.50
3/VF 19L4	P	40	11.00	40	8.90	40	9.40	40	7.50	60	9.50	53	9.50
3/VF 17L3	HS	26	28	26	16.80	26	17.50	26	10.70	41	17.00	36	17.00
3/VF 21L4	P	51	23	51	16.80	51	17.50	51	10.70	71	17.00	64	17.00

Stadi epicicloidali / *planetary stages* / Planetenstufen / *étages épicycloidaux*

Stadio di riduzione a vite senza fine / *worm reduction module* / Schneckenübersetzungsstufe / *étage de réduction à vis sans fin*

Tipo *Type* Typ *Type*	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*												
	AA-EA-FD	(B3)	**TA-TE-TF-TD-VA-VC-VF-IO**	(B6)	**OA-OE-OF-OD-QA-QE-QF-QD**	(B7)	**AD-ED-FA**	(B8)	**AF-EF-FE**	(VA)	**AE-EE-FF**	(VB)
3/A 00L2	0.60	1.30	1.00	1.30	0.90	1.30	0.60	1.30	0.60	1.30	0.60	1.30
3/A 01L2	0.80	2.15	1.20	2.15	1.10	2.15	0.80	2.15	0.80	2.15	0.80	2.15
3/A 03L2	1.30	2.95	2.30	2.95	2.00	2.95	1.30	2.95	1.30	2.95	1.30	2.95
3/A 05L2	1.60	3.50	2.60	3.50	2.40	3.50	1.60	3.50	1.60	5.60	1.60	3.50
3/A 06L2	2.50	4.60	3.50	7.60	3.20	4.20	2.50	7.90	2.50	11.10	2.50	8.50
3/A 07L2	3.50	6.80	5.00	7.70	4.50	12.20	3.50	14.40	3.50	17.90	3.50	13.80

Stadio epicicloidale / *planetary stage* / Planetenstufe / *étage épicycloidal*

Stadio di riduzione ad assi ortogonali / *Helical bevel reduction module* / Kegelradübersetzungsstufe / *étage de réduction à axes orthogonaux*

Lubrificazione permanente — *Life lubricated* — Dauerschmierung — *Lubrification permanente*

NOTA: nei riduttori e motoriduttori combinati la lubrificazione degli stadi epicicloidali è separata da quella dei riduttori a vite senza fine (3/VF) o ortogonali (3/A).

NOTE: Combined gearboxes and gearmotors feature separate lubrication for planetary stages and for worm gearboxes (3/VF) or helical bevel units (3/A).

MERKE: Bei den kombinierten Getrieben oder Getriebemotoren ist die Schmierung der Planetenstufen von denen der Schneckengetriebe (3/VF) oder Kegelradgetriebe (3/A) getrennt.

REMARQUE: Sur les réducteurs et motoréducteurs combinés, la lubrificationdes étages épicycloïdaux est séparée de celle des réducteurs à vis sans fin (3/VF) ou orthogonaux (3/A).

5 - MESSA IN FUNZIONE

Prima di avviare il riduttore controllare:

- Esatto posizionamento tappi olio.
- Tappo sfiato che non sia ostruito da sporcizia o vernice. La sua chiusura provoca sovrapressione all'interno del riduttore con conseguente espulsione degli anelli di tenuta.
- Avviare il riduttore possibilmente senza carico e quando è possibile a bassa velocità.
- Verificare che il funzionamento sia regolare ed in assenza di eccessiva rumorosità.

Dopo le prime ore di esercizio verificare:

- Temperatura sulla carcassa, questa non deve superare nel punto più caldo i 70-75°C.
- Esatto serraggio viti.

5 - START-UP

Before starting the gearbox, check the exact position of the oil plug and check that the breather is not blocked by dirt or paint.

If the breather is blocked, pressure can build up inside the gearbox and blow out the seal rings.

If possible, start up the gearbox without load and at low speed.

Check that the gearbox runs smoothly and does not generate excessive noise;

After the first few hours operation, check the temperature of the gearbox casing.

At its hottest point it should not exceed 70°-75°C.

Also check that all bolts are tight.

5 - INBETRIEBNAHME

Von Inbetriebnahme des Getriebes folgendes kontrollieren:

- Korrekte Position des Ölstopfens.
- Entlüftungsstopfen darf nicht von Schmutz oder Lack verstopft sein.Ist er geschlossen, dann führt dies zu Überdruck im Getriebe und die Dichtringe lösen sich.
- Das Getriebe möglichstohne Last und, falls möglich, mitgeringer Geschwindigkeitanfahren.
- Kontrollieren, ob der Betrieb gleichmässig und ohne Störgeräusche erfolgt.

Nach den ersten Betriebsstunden:

- Temperatur am Gehäuseprüfen: sie darf an der heissesten Stelle 70-75°C nicht überschreiten.
- Prüfen ob alle Schrauben gut angezogen sind.

5 - MISE EN ROUTE

Avant la mise en route, vérifier:

- *La position exacte des bouchons.*
- *Que le bouchon reniflard ne soit pas obstrué par des impurités ou de la peinture. Son obstruction provoque une surpression à l'intérieur du réducteur avec pour conséquence l'extrusion des bagues d'étanchéïté.*
- *Procéder au démarrage du réducteur si possible à vide et éventuellement à basse vitesse.*
- *Vérifier que le fonctionnement est normal et sans-bruit excessif.*

Après les premières heures de fonctionnement, vérifier:

- *La température sur le carter - celle-ci ne doit pas dépasser au point le plus chaud 70-75°C.*
- *Le bon serrage des vis.*

6 - MANUTENZIONE

In condizioni di normale esercizio il riduttore non necessita di manutenzione.
Sono solo da effettuare le normali verifiche di livello e cambio olio come segue:

Cambio olio

Effettuare il primo cambio olio circa dopo 100÷150 ore di lavoro.
Successivamente effettuare il cambio ogni 2000÷3000 ore a seconda degli impieghi o almeno una volta all'anno.
È buona norma comunque controllare il livello una volta al mese per funzionamento intermittente, più frequentemente per funzionamento in continuo e aggiungere olio se necessario.

Nota: è sempre opportuno procedere al cambio degli anelli di tenuta, quando:

- l'anello di tenuta viene smontato;
- quando si fa una revisione del riduttore;
- riposizionare l'anello di tenuta in modo che il labbro di tenuta del nuovo anello non lavori sulla stessa pista di scorrimento dell'anello precedente.

Nota: se il riduttore dovesse rimanere fermo per lunghi periodi si consiglia di riempirlo completamente di olio che sarà riportato al giusto livello quando questo verrà rimesso in esercizio.

6 - MAINTENANCE

Gearboxes are virtually maintenance free under normal operating conditions. The only periodic operations required are checks on oil level and oil changes as follows:

Oil Changes

Change the oil first after 100-150 hours operation.
Subsequently, change the oil only every 2000-3000 hours operation depending on application. Alternatively change oil once a year.
Check the oil level in the gearbox every month and top up as necessary.

***Note:** We recommend that you also change the oil seals on the following occasions:*

- *whenever the seal rings are removed;*
- *whenever the gearbox is serviced/reconditioned;*
- *at least once a year with electric motor drives.*

When fitting new seals, avoid locating the lip of the new seal in exactly the same place as that of the old seal.

***Note:** Fill a gearbox completely with oil before any long idle period. Drain to the normal level prior to re-starting operation.*

6 - WARTUNG

Unter normalen Betriebsbedingungen berdaf das Getriebe keiner Wartung. Nur der Ölstand sollte regelmässig geprüft und das Öl muss gewechselt werden:

Ölwechsel

Den ersten Ölwechsel nach ca. 100-150 Betriebsstunden vornehmen, dann alle 2000 bis 300 Betriebsstunden je nach Einsatz, oder mindestens einmal im Jahr. Es empfiehlt sich, die Ölstand einmal im Monat zu kontrollieren und, falls nötig, nachfüllen.

Anmerkung: Es ist stets empfehlenswert, die Dichtringe auszutauschen, wenn:

- der Dichtring ausgebaut wird
- wenn das Getriebe überholt wird
- bei Antrieb mit Elektromotor mindestens einmal jährlich.

Den Dichtring so einsetzen, daß die Dichtlippe des neuen Rings nicht an der gleichen Stelle ansetzt, wie jene des alten Rings.

Anmerkung: Sollte das Getriebe über längere Zeiträume stehen, dann wird empfohlen, es vollständing mit Öl zu füllen und den korrekten Füllstand erst bei erneuter Inbetriebnahme wiederherzustellen.

6 - ENTRETIEN

Dans les conditions normales d'utilisation le réducteur ne nécessite pas d'entretien. Seul sont à effectuer les contrôles habituels de niveau et la vidange de l'huile comme suit:

Vidange d'huile

Effectuer la première vidange après 100/150 heurs de travail environ.
Puis successivement toutes les 2000-3000 heurs selon le type d'utilisation ou au minimum une fois l'an.
Il est toutefois conseillé de contrôler le niveau une fois par mois et faire l'appoint d'huile si nécessaire.

***Remarque:** Il est toujours opportun de procéder au changement des joints d'étanchéité, lorsque:*

- *Le joint a été démonté.*
- *On procède à une révision du réducteur.*

Replacer le nouveau joint de façon que les bords ne travaillent pas sur la même piste de glissement que le joint précédent.

***Remarque:** Si par nécessité le reducteur devait rester arrêté pour de longues périodes, il est conseillé de remplir complètement d'huile.*
La mise à niveau sera effectuée lors de la remise en route du réducteur.

PRECARICO E MOMENTO DI SERRAGGIO PER VITI CON FILETTATURA ISO A PASSO GROSSO

Il precarico è stato calcolato pari al 70% del carico di snervamento minimo. Il momento torcente è stato calcolato impiegando la formula (39) del manuale Junker & Blume, ed attribuendo al coefficiente di attrito µges il valore medio ges 0,14.

PRELOADING AND TIGHTENING TORQUE FOR ISO STD. PITCH SCREWS

Preloading has been calculated at 70% of the vizls point. Formula (39) of the Junker and Blume's handbook has been used to calculate the torque, and a mean value of µges 0,14 has been given to friction coefficent µges.

BEANSPRUCHBARKEIT UND ANZUGSMOMENT DER SCHRAUBEN MIT HOHER GEWINDESTEIGUNG GEM.ISO

Die Beanspruchbarkeitswerte betragen 70% der min. Bruchbelastung. Das Anzugsmoment wurde gem Formel 39 des Junker und Blume Manuels errechnet unter Berücksichtigung eines Reribungskoeffizienten von µ ges.-0,14 (Mittelwert).

PRÉCHARGE ET COUPLE DE SERRAGE POUR VIS À FILETAGE ISO PAS GROS.

La précharge a été calculée à 70% de la charge minimum de rupture. Le moment de torsion a été calculé par la formule (39) du manuel Junker et Blume, en attribuant au coefficient de frottement µ ges la valeur moyenne 0,14.

Ø nom. vite *Ø nom. screw* Ø Güte klasse *Diam. nom. vis*	Precarico max V (daN) *Max preloading V (daN)* Beanspruchbarkeit max. (daN) *Précharge max V (daN)*			Momento max Ma (daNm) *Max torque Ma (daNm)* Anzugsmoment max (daNm) *Couple max Ma (daNm)*		
	8.8 8 G	**10.9 10 K**	**12.9 12 K**	**8.8 8 G**	**10.9 10 K**	**12.9 12 K**
M 4x0,7	394	554	665	0,31	0,43	0,52
M 5x0,8	635	895	1070	0,60	0,84	1,01
M 6x1	902	1270	1520	1,03	1,46	1,75
M 8x1,25	1640	2310	2770	2,48	3,49	4,19
M 10x1,5	2600	3660	4380	4,97	7,0	8,37
M 12x1,75	3780	5320	6380	8,46	11,9	14,30
M 14x2	5160	7250	8700	13,46	18,92	22,70
M 16x2	7020	9900	11000	20,40	28,80	34,60
M 18x2,5	8600	12100	14500	28,40	40,0	48,0
M 20x2,5	11000	15540	18500	39,6	55,60	66,60
M 22x2,5	13600	19100	22900	53	74,5	90
M 24x3	15900	22300	26700	70	98	117
M 27x3	20600	28900	34700	101	142	170
M 30x3,5	26000	36000	44000	142	200	235

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R_0

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Leggere attentamente

Read carefully

Aufmerksam lesen

Lire attentivement

Rischio di folgorazione

Electrical hazard

Fulgurationsgefahr

Risque d'électrocution

Revisioni
L'indice di revisione del catalogo è riportato a pag. 80.
Al sito www.bonfiglioli.com sono disponibili i cataloghi con le revisioni aggiornate.

Revisions
Refer to page 80 for the catalogue revision index.
Visit www.bonfiglioli.com to search for catalogues with latest revision index.

Änderungen
Das Revisionsverzeichnis des Katalogs wird auf Seite 80 wiedergegeben.
Auf unserer Website www.bonfiglioli.com werden die Kataloge in ihrer letzten, überarbeiteten Version angeboten.

Révisions
Le sommaire de révision du catalogue est indiqué à la page 80.
Sur le site des catalogues avec les dernières révisions sont disponibles.

ISTRUZIONI DI SICUREZZA

Le seguenti istruzioni di sicurezza fanno riferimento in via principale all'utilizzo di motoriduttori. Tenere in considerazione le istruzioni di sicurezza supplementari riportate nelle singole sezioni di questo manuale istruzioni. I conduttori di tensione e gli organi in movimento di macchine elettriche possono provocare gravi lesioni o la morte. L'installazione, il collegamento e la messa in funzione, unitamente agli interventi di manutenzione e riparazione, devono essere effettuati esclusivamente da personale specializzato tenendo in considerazione quanto di seguito riportato:

- le presenti istruzioni
- i segnali di avvertimento e le etichette istruzioni sull'unità motore / riduttore
- tutte le documentazioni di progettazione, le istruzioni di messa in funzione e gli schemi tecnici
- le regolamentazioni e i requisiti specifici del sistema
- le normative nazionali/regionali vigenti (normative di sicurezza/antinfortunistiche)

Uso previsto

Questi motori elettrici sono destinati all'uso in sistemi industriali. Essi sono conformi alle normative e alle regolamentazioni vigenti e rispettano le disposizioni della Direttiva Bassa Tensione 73/23/CEE. I dati tecnici, come pure le condizioni ammesse sul luogo, sono indicati sulla targhetta identificativa della macchina e nel presente manuale istruzioni. Le informazioni ivi riportate devono essere rispettate!

SAFETY INSTRUCTIONS

The following safety instructions relate primarly to the use of geared motors. Please consider the additional safety instructions in the individual sections of these operating instructions. Voltage conductors and movable parts of electrical machines can cause serious or fatal injury. Installation, connection, commissioning as well as maintenance and repair work may only be carried out by qualified specialists, taking into account:

- *these instructions*
- *the warning and instructions labels on the motor / gear unit*
- *all other project planning documentation, commissioning instructions and schematic diagrams*
- *the system specific regulations and requirements*
- *the current national / regional regulations (safety / accident prevention regulations)*

Intended use

These electrical motors are intended for industrial systems. They conform to the valid standards and regulations and meet the requirements of the Low Voltage Directive 73/23/EEC. Technical data as well as permitted conditions on site can be found on the nameplate and in these operating instructions. These details must be observed!

SICHERHEITSANWEISUNGEN

Die nachstehenden Sicherheitsanweisungen beziehen sich hauptsächlich auf den Einsatz der Getriebemotoren. Dabei sind jedoch auch die zusätzlichen, in den einzelnen Abschnitten dieses Anleitungshandbuchs enthaltenen Sicherheitsanweisungen zu berücksichtigen. Die Spannungsleiter und die sich in Bewegung befindlichen Organe an elektrischen Maschinen können schwere Verletzungen verursachen oder gar tödliche Gefahren in sich bergen. Die Installation, der Anschluss und die Inbetriebsetzung, ebenso wie die Instandhaltungs- und Reparatureingriffe, dürfen ausschließlich nur von Fachpersonal durchgeführt werden, dass folgendes berücksichtigen muss:

- die vorliegenden Anleitungen
- die Warnhinweise und die Angaben auf den an der Einheit Motor / Getriebe angebrachten Anweisungsetiketten
- alle Projektdokumente, die Anleitungen für die Inbetriebsetzung und die technischen Pläne
- die spezifischen Regeln und Anforderungen des Systems
- die sich in Kraft befindlichen nationalen/regionalen Richtlinien (Sicherheits-/Unfallschutznormen)

Vorgesehener Einsatz

Diese Elektromotoren sind für den Einsatz an industriellen Systemen bestimmt. Sie entsprechen den gültigen Richtlinien und Regelungen und der Niederspannungsrichtlinie EWG/73/23. Die technischen Daten, ebenso wie die zulässigen Bedingungen vor Ort, werden auf den Typenschild der Maschine und in der vorliegenden Anleitung angegeben. Die hier enthaltenen Informationen müssen eingehalten werden!

INSTRUCTION DE SÉCURITÉ

Les instructions de sécurité suivantes se réfèrent principalement à l'utilisation des motoréducteurs.

Considérer les instructions de sécurité supplémentaires indiquées dans les chapitres de ce manuel d'instructions. Les conducteurs de tension et les organes en mouvement des machines électriques peuvent provoquer de graves lésions, voire même être mortels. L'installation, le branchement et la mise en service, ainsi que les interventions d'entretien et de réparation, doivent être effectués exclusivement par du personnel qualifié, dans le respect des indications suivantes:

- *les présentes instructions*
- *les signaux d'avertissement et les autocollants d'instructions présents sur l'unité moteur/réducteur*
- *tous les documents de conception, les instructions de mise en service et les schémas techniques*
- *les réglementations et les conditions requises spécifiques du système*
- *les normes nationales/régionales en vigueur (normes de sécurité/de prévention des accidents)*

Utilisation prévue

Ces moteurs électriques sont destinés à être utilisés dans des systèmes industriels. Ils sont conformes aux normes et réglementations en vigueur et respectent les dispositions de la Directive Basse Tension 73/23/CEE. Les caractéristiques techniques ainsi que les conditions admises sur le site sont indiquées sur la plaquette signalétique de la machine et dans ce manuel d'instructions. Il est indispensable de respecter les informations qui y sont indiquées !

1.0 IDENTIFICAZIONE

Tutti i riduttori, motoriduttori e motori sono muniti di una targhetta dalla quale potranno essere rilevati i dati necessari alla loro identificazione.
Nella tabella sono indicate le tre tipologie di targhe di identificazione utilizzate per le varie configurazioni.

1.0 IDENTIFICATION

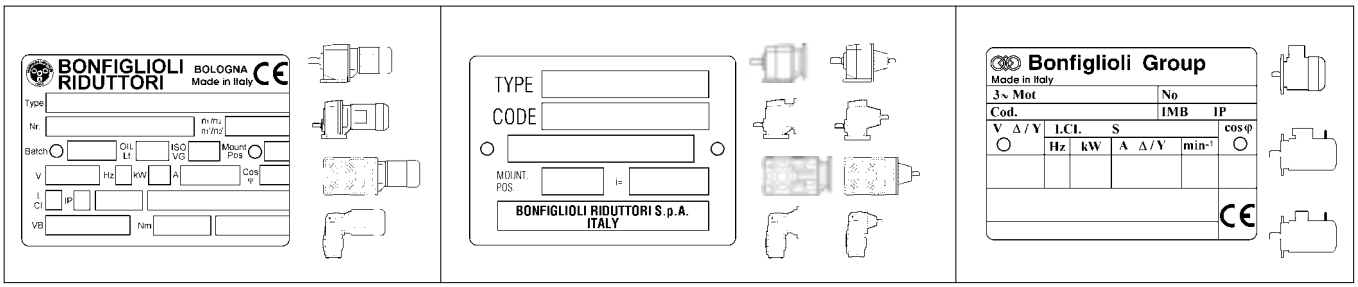
All gearboxes, gearmotors, and motors carry a nameplate with data to be used for their identification.
Table shows the three types of name plates used for the various configurations.

1.0 IDENTIFIKATION

Alle Getriebe, Getriebemotoren und Motoren sind mit einem Namensschild ausgerüstet, auf dem die technischen Daten, die für ihre Identifikation ausschlaggebend sind, abgelesen werden können. In der Tabelle sind die drei Schildertypen aufgeführt, die zur Identifikation der verschiedenen Konfigurationen dienen.

1.0 IDENTIFICATION

Tous les réducteurs, motoréducteurs et moteurs sont munis d'une plaque sur laquelle figurent les données nécessaires à leur identification.
Dans le tableau sont indiqués les trois types de plaques signalétiques utilisées pour les différentes configurations.



2.0 RICHIESTA RICAMBI

La tabella indica i dati che è indispensabile fornire in fase di richiesta ricambi per poter effettuare una corretta identificazione del prodotto e di conseguenza una sollecita risposta alla richiesta stessa.
In funzione delle particolari tecniche di montaggio dei componenti utilizzate dalla BONFIGLIOLI RI- DUTTORI atte a ottimizzare le prestazioni dei riduttori e motoriduttori si consiglia, dove previsto, l'acquis- to dei kit di montaggio.

2.0 SPARE PARTS ORDER

Table indicates the data that must be supplied when placing a spare part order so that the product may be correctly identified and the order processed promptly.
Due to the assembly techniques for components used by BONFIGLIO- LI RIDUTTORI to optimise the performance of gearboxes and gearmotors, we recommend the purchase (where applicable) of the mounting kits.

2.0 BESTELLUNG VON ERSATZTEILEN

In der Tabelle sind die Daten aufgelistet, die bei der Bestellung von Ersatzteilen unbedingt angegeben werden müssen, damit die Teile richtig identifiziert werden und die Bestellung schneller folgen kann.
Wegen der speziellen Montagetechniken der Komponenten, die bei BONFIGLIOLI RIDUTTORI angewendet werden und die zu einer Verbesserung der Leistungen der Getriebe und Getriebemotoren führen, empfehlen wir, wenn möglich die Ausrüstungselemente zu kaufen.

2.0 DEMANDE DE PIECES DETACHEES

Le tableau indique les données qu'il est indispensable de fournir pour toute commande de pièces détachées, ceci pour permettre l'identification correcte du produit et, par conséquent, une livraison dans les meilleurs délais. Du fait des techniques particulières de montage des composants utilisées par BONFIGLIOLI RIDUTTORI à même d'optimiser les performances de réducteurs et motoréducteurs, nous vous conseillons dans la mesure du possible l'achat des kits.

Identificazione prodotto	***Product information***	**Produktbeschreibung**	***Identification produit***
Type/Mot. :		Nr./Code :	
Batch/N° :		Nm :	

Identificazione parti	***Parts identification***	**Beschreibung der Teile**	***Identification des composants***
N.	Denominazione / *Description* / Benennung / *Dénomination*		Q.tà / *Q.ty* / Menge / *Q.té*

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3.0 LAYOUT GENERALE

La tabella sottostante illustra lo schema generale di collegamento dei vari moduli con l'indicazione dei paragrafi in cui sono riportate le sezioni e le liste dei componenti.

3.0 GENERAL LAYOUT

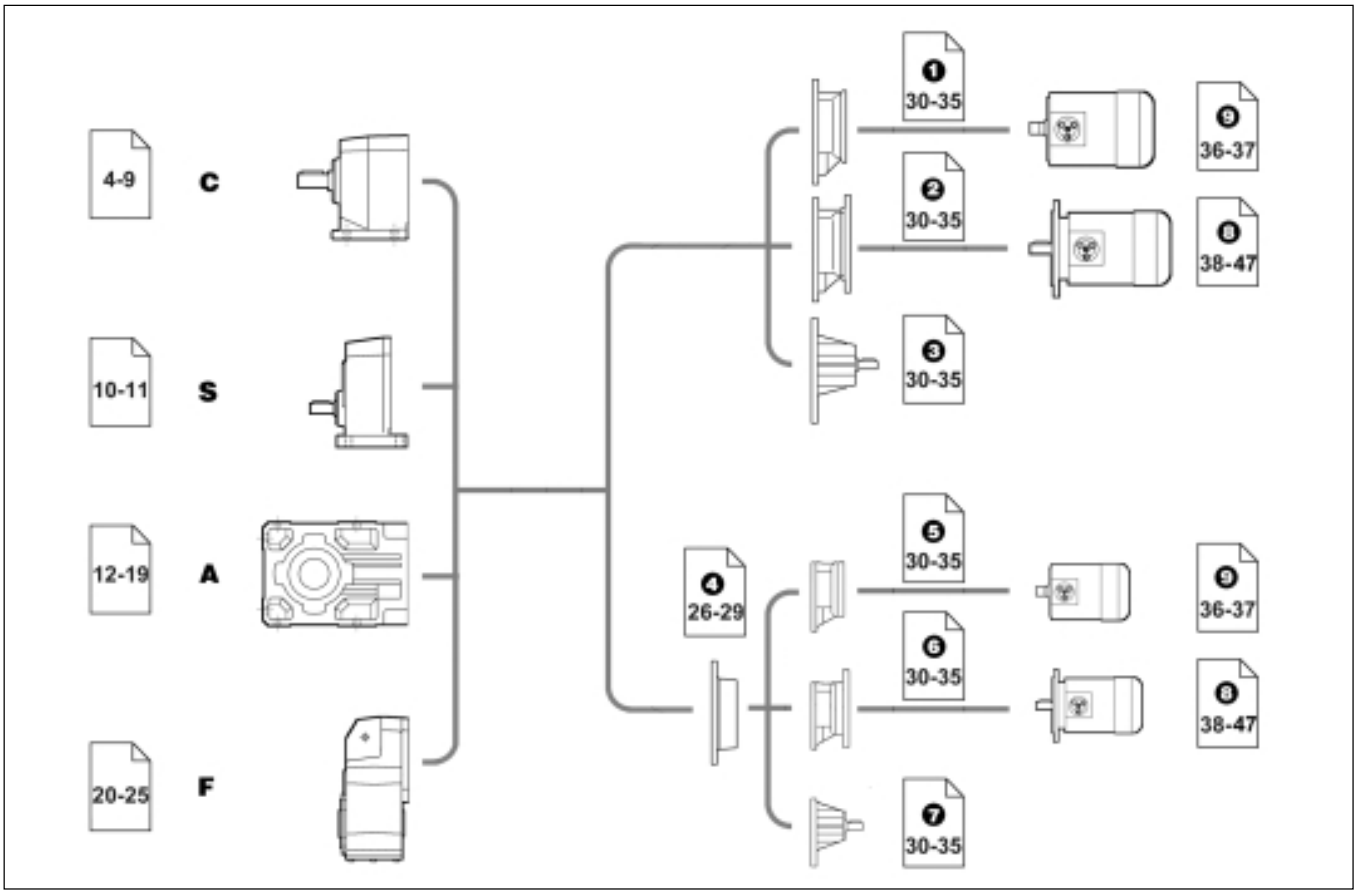
Table below shows the general layout for the various modules and indicates the paragraphs in which the cross-sectional drawings and parts lists are given.

3.0 ALLGEMEINES LAYOUT

Die Tabelle zeigt das Gesamtschema zum Zusammenbau der verschiedenen Baueinheiten und verweist auf die Abschnitte, in denen die einzelnen Untergruppen und Komponentenlisten aufgeführt sind.

3.0 SCHEMA D'IMPLANTATION

Le tableau présente le schéma général d'accouplement des différents modules, avec l'indication des paragraphes où sont fournies les sections et les nomenclatures des composants.



Legenda:

C Modulo uscita C
S Modulo uscita S
A Modulo uscita A
F Modulo uscita F

❶ Modulo S	(2 stadi)	
❷ Modulo P (IEC)	(2 stadi)	
❸ Modulo HS	(2 stadi)	
❹ Modulo addizionale	(3 stadi)	
❺ Modulo S	(3 stadi)	
❻ Modulo P (IEC)	(3 stadi)	
❼ Modulo HS	(3 stadi)	
❽ Motore IEC		
❾ Motore M		

Key:

C Output module C
S Output module S
A Output module A
F Output module F

❶ *S Module*	*(2 stages)*	
❷ *P Module (IEC)*	*(2 stages)*	
❸ *HS module*	*(2 stages)*	
❹ *Additional module*	*(3 stages)*	
❺ *Module S*	*(3 stages)*	
❻ *P Module (IEC)*	*(3 stages)*	
❼ *HS module*	*(3 stages)*	
❽ *IEC motor*		
❾ *M motor*		

Zeichenerklärung:

C Abtriebseinheit C
S Abtriebseinheit S
A Abtriebseinheit A
F Abtriebseinheit F

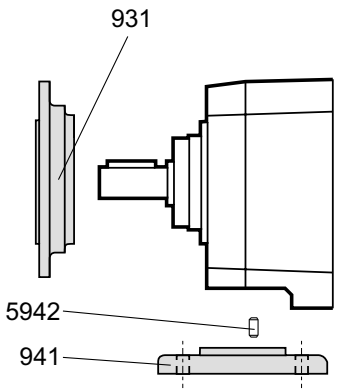
❶ S Baueinheit	(2 Stufen)	
❷ P Baueinheit (IEC)	(2 Stufen)	
❸ HS Baueinheit	(2 Stufen)	
❹ Zusatzbaueinheit	(3 Stufen)	
❺ S Baueinheit	(3 Stufen)	
❻ P Baueinheit (IEC)	(3 Stufen)	
❼ HS Baueinheit	(3 Stufen)	
❽ IEC Motor		
❾ M Motor		

Legende:

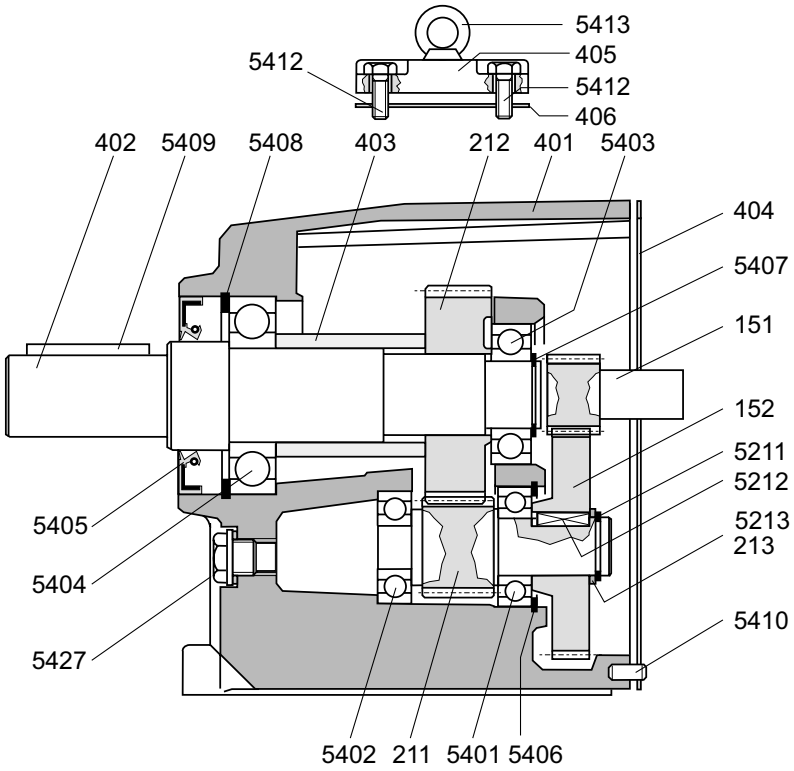
C Module de sortie C
S Module de sortie S
A Module de sortie A
F Module de sortie F

❶ *Module S*	*(2 étages)*	
❷ *Module P (IEC)*	*(2 étages)*	
❸ *Module HS*	*(2 étages)*	
❹ *Module additionnel*	*(3 étages)*	
❺ *Module S*	*(3 étages)*	
❻ *Module P (CEI)*	*(3 étages)*	
❼ *Module HS*	*(3 étages)*	
❽ *Moteur normalisé CEI*		
❾ *Moteur M*		

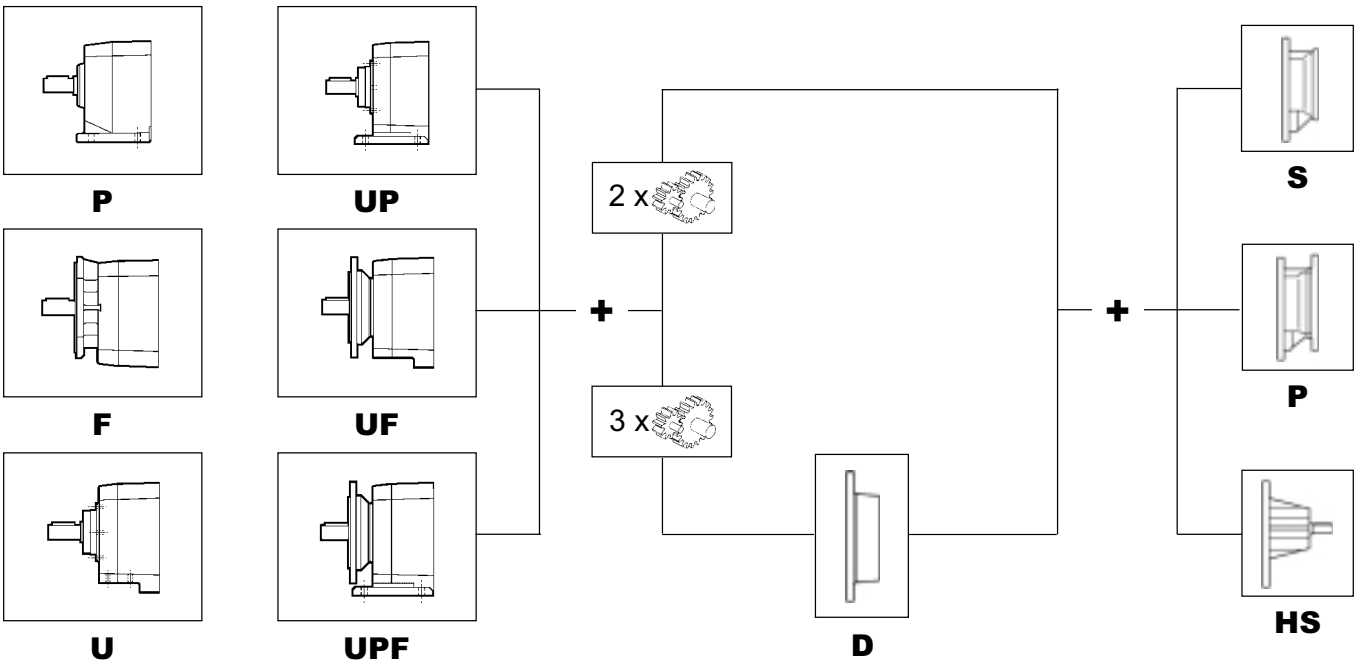
C10 ... C60



UF - UP - UPF

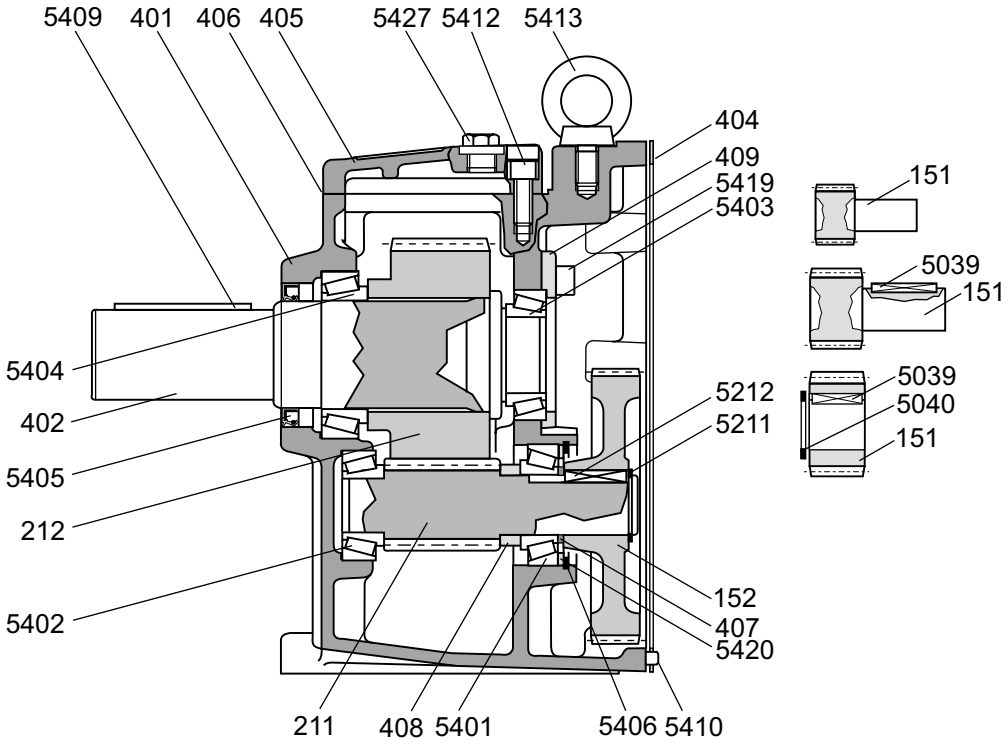


P - F - U

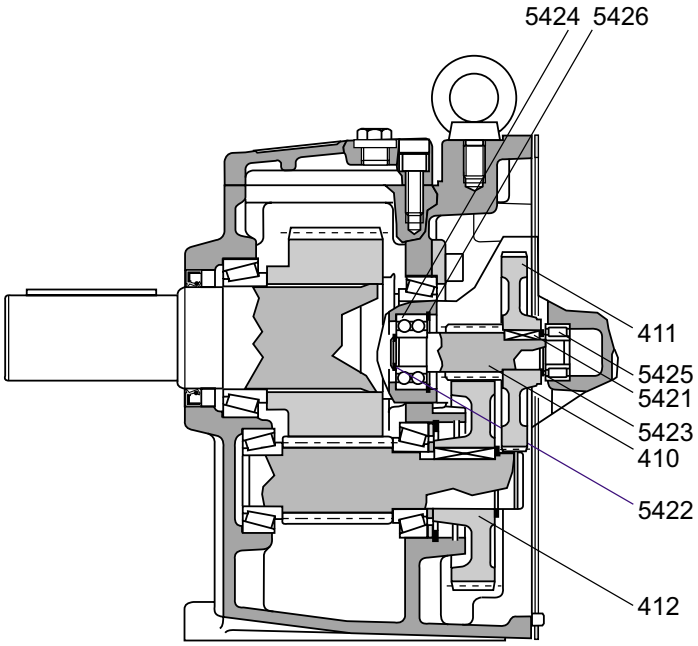


C_	ref.				
P - F- U - UP - UF - UPF					
10 - 20 - 30 40 - 50 - 60	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1ª riduzione	*1st red. gearwheel*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	211	Pignone lento	*Pinion shaft*	Abtriebsritzel	*Pignon à la sortie*
	212	Corona lenta	*Gear*	Abtriebszahnrad	*Couronne à la sortie*
	401	Cassa	*Gear case*	Gehäuse	*Carter*
	402	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	403	Distanziale	*Spacer*	Distanzring	*Entretoise*
	404	Guarnizione	*Gasket*	Dichtung	*Joint*
	5211	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5212	Linguetta	*Key*	Paßteder	*Clavette*
	5401	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5402	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5403	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5404	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5405	Anello di tenuta	*Seal ring*	Simmerring	*Bague d'étanchéité*
	5406	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5407	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5408	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5409	Linguetta	*Key*	Paßteder	*Clavette*
	5410	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
20 - 30	213	Ralla pignone lento	*Washer*	Scheibe des Abtriebsritzel	*Butée pignon à la sortie*
40	5213	Ralla pignone lento	*Washer*	Scheibe des Abtriebsritzel	*Butée pignon à la sortie*
60	405	Coperchio ispezione	*Inspection cover*	Inspektionsdeckel	*Couvercle d'inspection*
	406	Guarnizione	*Gasket*	Dichtung	*Joint*
	5412	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5413	Golfare	*Eyebolt*	Ösenschraube	*Cheville à oeille*
	5427	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
UF - UPF					
10 - 20 - 30 40 - 50 - 60	931	Flangia	*Bolted flange*	Flansch	*Bride*
UP - UPF					
10 - 20 - 30 40 - 50 - 60	941	Piedi riportati	*Bolted flange*	Eingesetzte Füße	*Pattes rapportées*
	5942	Spina cilindrica piede	*Dowel pin*	Zylinderstift des Fußes	*Goupille cylindrique patte*

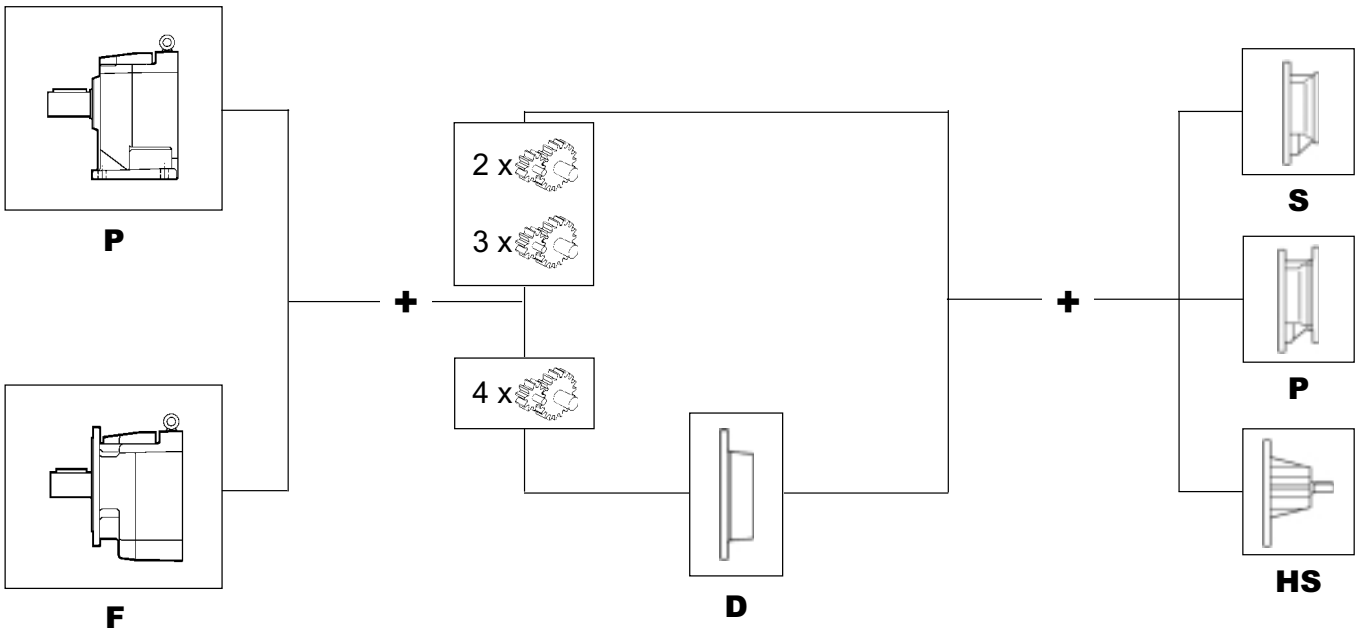
C702 - C802



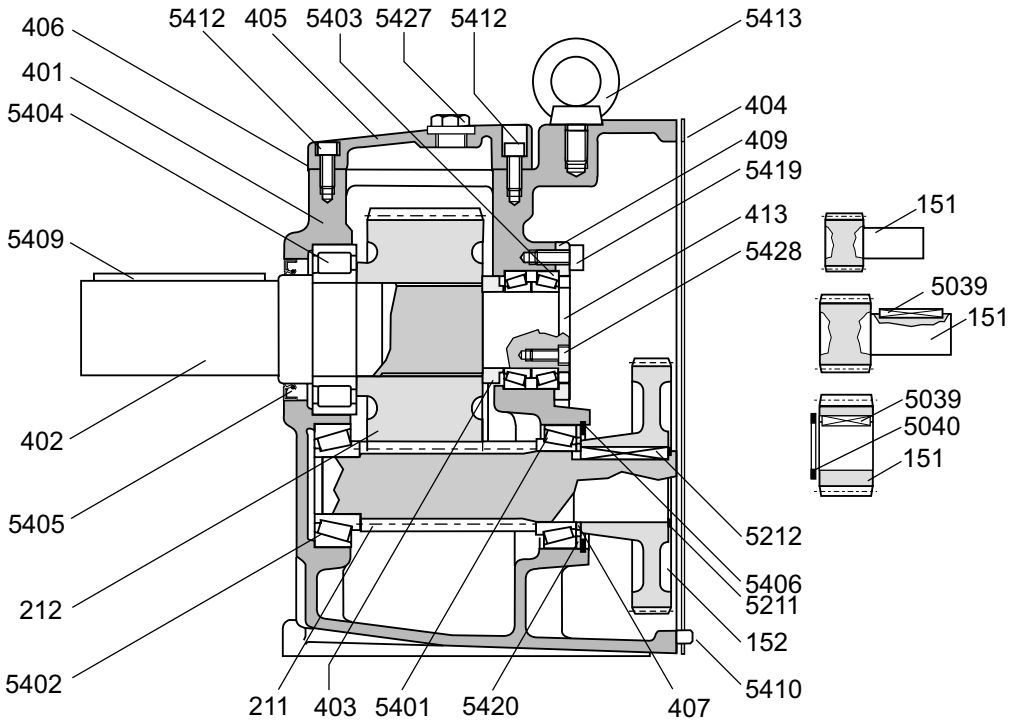
C703 - C803
C704 - C804



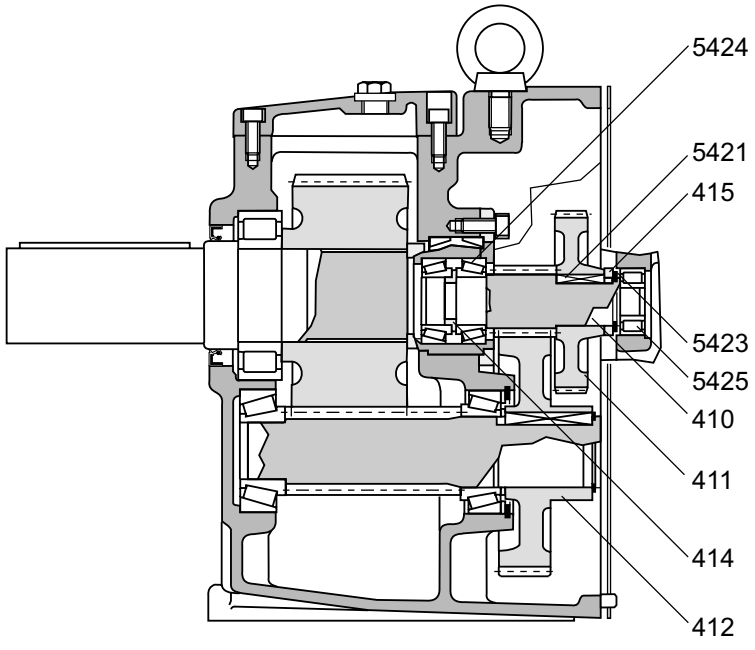
C_	ref.				
	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	211	Pignone lento	*Pinion shaft*	Abtriebsritzel	*Pignon à la sortie*
	212	Corona lenta	*Gear*	Abtriebszahnrad	*Couronne à la sortie*
	401	Cassa	*Gear case*	Gehäuse	*Carter*
	402	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	404	Guarnizione	*Gasket*	Dichtung	*Joint*
	405	Coperchio ispezione	*Inspection cover*	Inspektionsdeckel	*Couvercle d'inspection*
	406	Guarnizione	*Gasket*	Dichtung	*Joint*
	407	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	5211	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5212	Linguetta	*Key*	Paßfeder	*Clavette*
702 - 802	5401	Cuscinetto	*Bearing*	Kugellager	*Roulement*
703 - 803	5402	Cuscinetto	*Bearing*	Kugellager	*Roulement*
704 - 804	5403	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5404	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5405	Anello di tenuta	*Seal ring*	Simmerring	*Bague d'étanchéité*
	5406	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5409	Linguetta	*Key*	Paßteder	*Clavette*
	5410	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
	5413	Golfare	*Eyebolt*	Ösenschraube	*Cheville à oeillet*
	5419	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5420	Ralla pignone lento	*Washer*	Scheibe des Abtriebsritzel	*Butée pignon à la sortie*
	5427	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5039	Linguetta	*Key*	Paßfeder	*Clavette*
	5040	Anello seeger	*Circlip*	Seegerring	*Seeger*
702 - 802	152	Corona 1ª riduzione	*1st red. gearwheel*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	408	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
702 - 802	409	Anello per cuscinetto	*Bearing ring*	Ring für Lager	*Bague pour roulement*
703 - 803	5412	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	410	Pignone	*Pinion*	Ritzel	*Pignon*
	411	Corona	*Gear*	Zahnrad	*Couronne*
	412	Corona	*Gear*	Zahnrad	*Couronne*
	5421	Linguetta	*Key*	Paßfeder	*Clavette*
703 - 803	5422	Seeger	*Circlip*	Seegerring	*Seeger*
704 - 804	5423	Seeger	*Circlip*	Seegerring	*Seeger*
	5424	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5425	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5426	Seeger	*Circlip*	Seegerring	*Seeger*



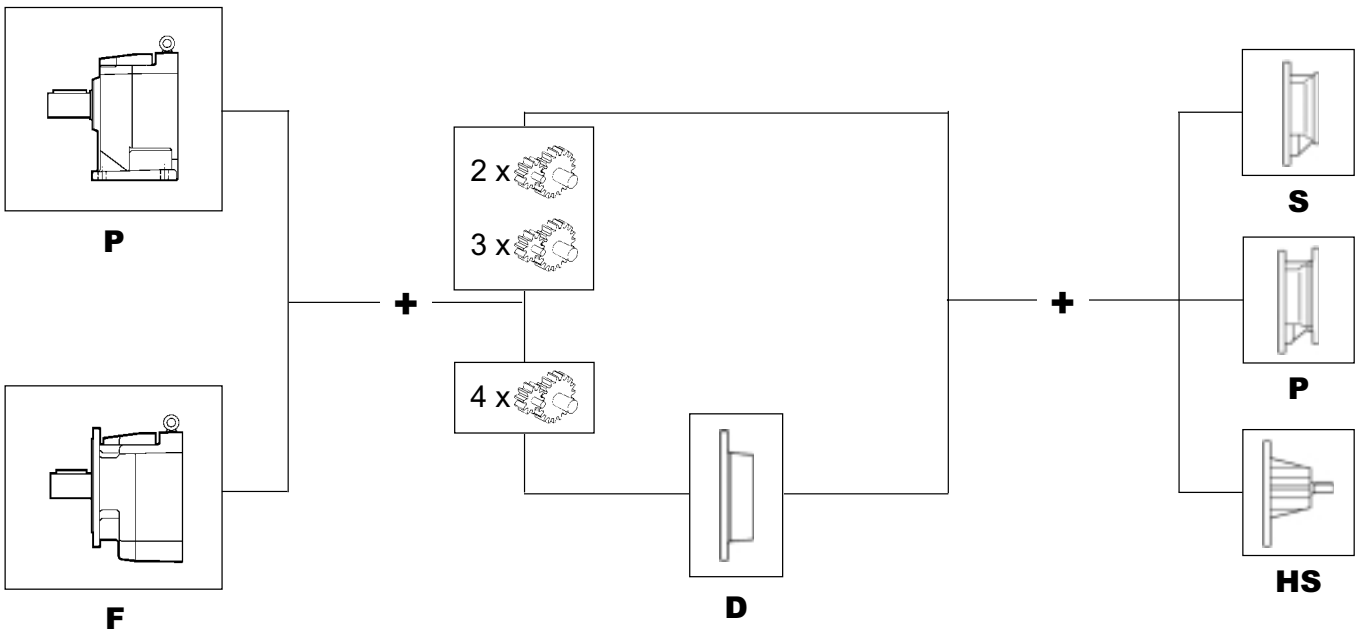
C902 - C1002



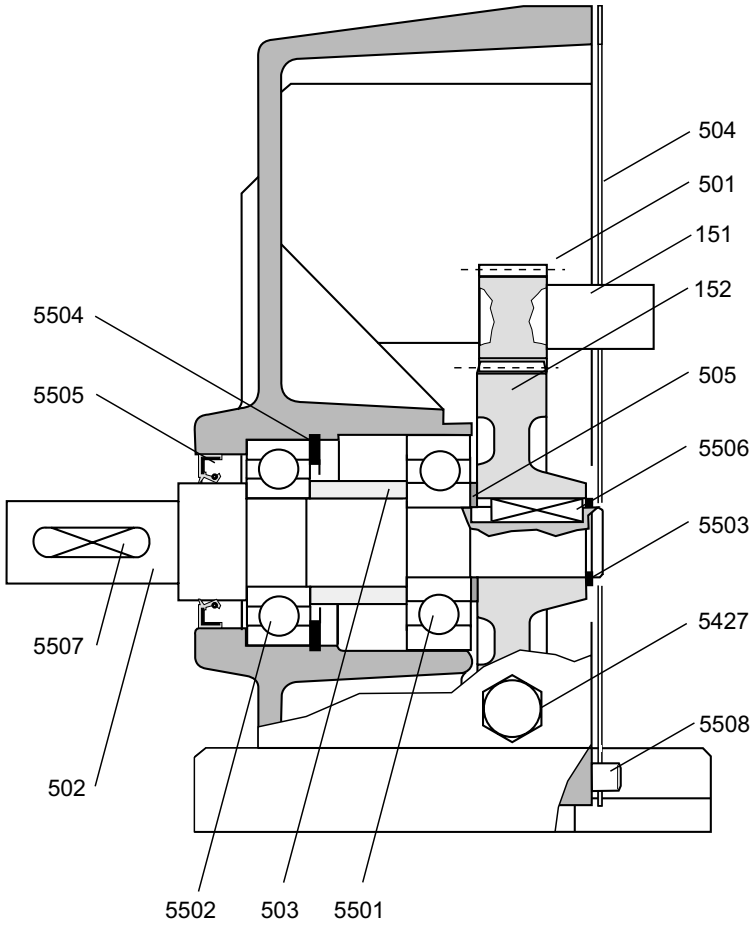
C903 - C1003
C904 - C1004

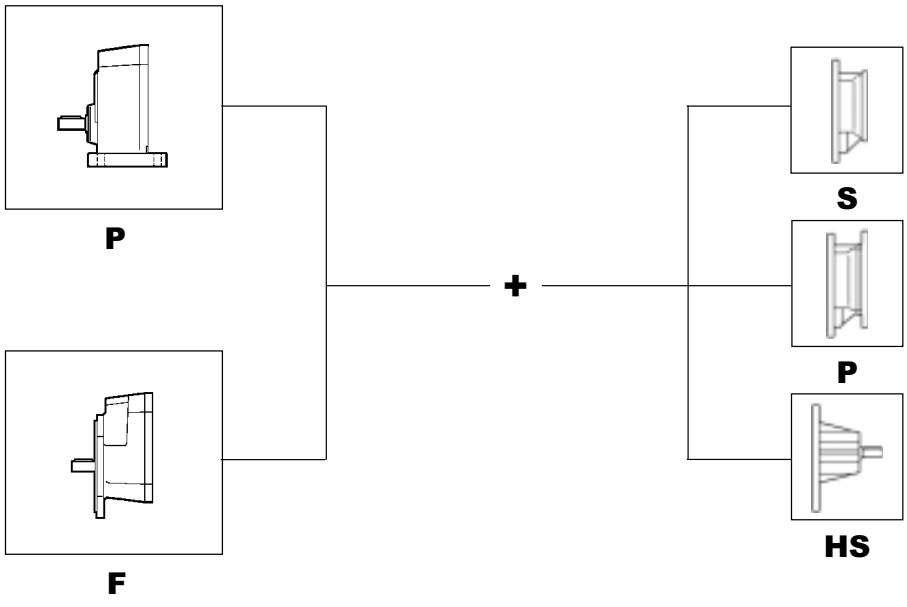


C_	ref.				
	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	211	Pignone lento	*Pinion shaft*	Abtriebsritzel	*Pignon à la sortie*
	212	Corona lenta	*Gear*	Abtriebszahnrad	*Couronne à la sortie*
	401	Cassa	*Gear housing*	Gehäuse	*Carter*
	402	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	403	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	404	Guarnizione	*Gasket*	Dichtung	*Joint*
	405	Coperchio ispezione	*Inspection cover*	Inspektionsdeckel	*Couvercle d'inspection*
	406	Guarnizione	*Gasket*	Dichtung	*Joint*
	407	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	413	Rondella	*Washer*	Unterlegscheibe	*Rondelle*
	5211	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5212	Linguetta	*Key*	Paßfeder	*Clavette*
902 - 1002	5401	Cuscinetto	*Bearing*	Kugellager	*Roulement*
903 - 1003	5402	Cuscinetto	*Bearing*	Kugellager	*Roulement*
904 - 1004	5403	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5404	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5405	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5406	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5409	Linguetta	*Key*	Paßteder	*Clavette*
	5410	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
	5412	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5413	Golfare	*Eyebolt*	Ösenschraube	*Cheville à oeillet*
	5420	Ralla pignone lento	*Washer*	Scheibe des Abtriebsritzel	*Butée pignon à la sortie*
	5427	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5428	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5039	Linguetta	*Key*	Paßfeder	*Clavette*
	5040	Anello seeger	*Circlip*	Seegerring	*Seeger*
902 - 1002	152	Corona 1ª riduzione	*1st red. gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
902 - 1002	409	Anello per cuscinetto	*Bearing ring*	Ring für Lager	*Bague pour roulement*
903 - 1003	5419	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	410	Pignone	*Pinion*	Ritzel	*Pignon*
	411	Corona	*Gear*	Zahnrad	*Couronne*
	412	Corona	*Gear*	Zahnrad	*Couronne*
	414	Boccola	*Bushing*	Buchse	*Douille*
903 - 1003	415	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
904 - 1004	5421	Linguetta	*Key*	Paßfeder	*Clavette*
	5423	Seeger	*Circlip*	Seegerring	*Seeger*
	5424	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5425	Cuscinetto	*Bearing*	Kugellager	*Roulement*



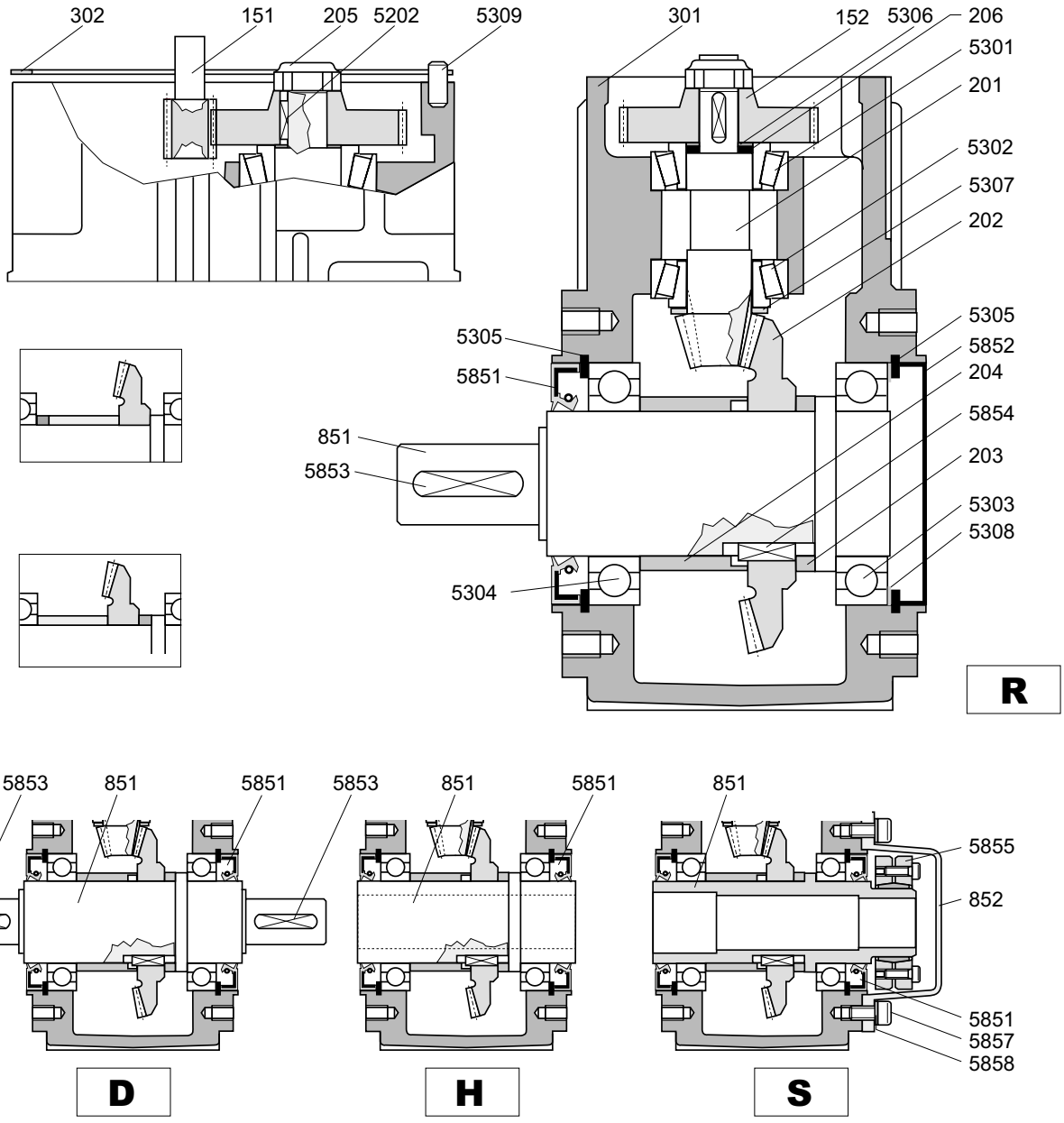
S101 ... S501


504
501
151
152
5504
505
5505
5506
5503
5427
5507
5508
502
5502
503
5501

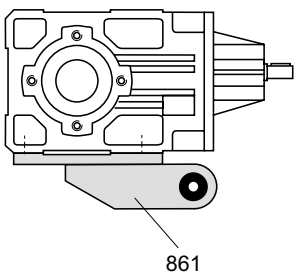

P
F
+
S
P
HS

S_	ref.				
	151	Pignone 1[a] riduzione	*Pinion shaft*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1[a] riduzione	*Gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	501	Cassa	*Gear case*	Gehäuse	*Carter*
	502	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	503	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	504	Guarnizione	*Gasket*	Dichtung	*Joint*
	505	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
101 - 501	5501	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5502	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5503	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5504	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5505	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5506	Linguetta	*Key*	Paßteder	*Clavette*
	5507	Linguetta	*Key*	Paßfeder	*Clavette*
	5508	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
501	5427	Tappo olio	*Oil plug*	Ölstopfen	*Bouchon d'huile*

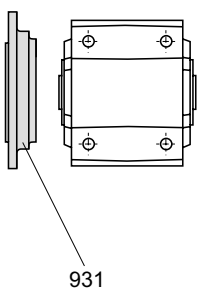
A10 ... A41



Accessori *Accessories* Zubehörteile *Accessoires*

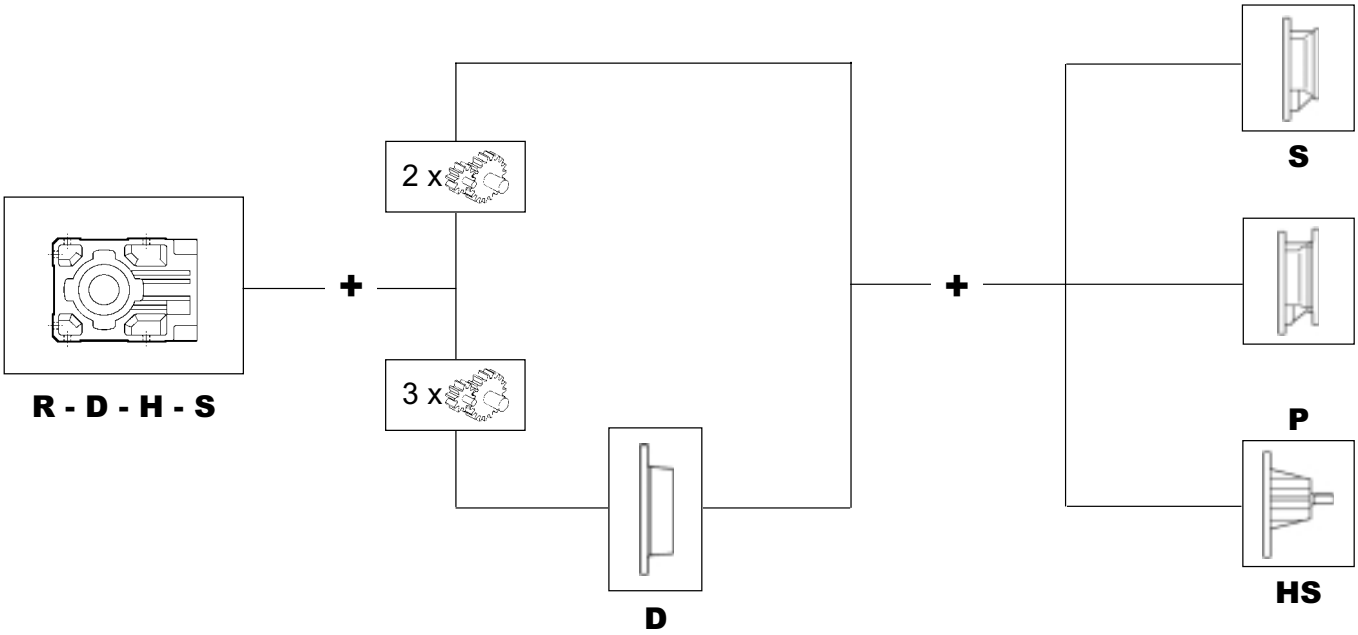


R - D - H - S

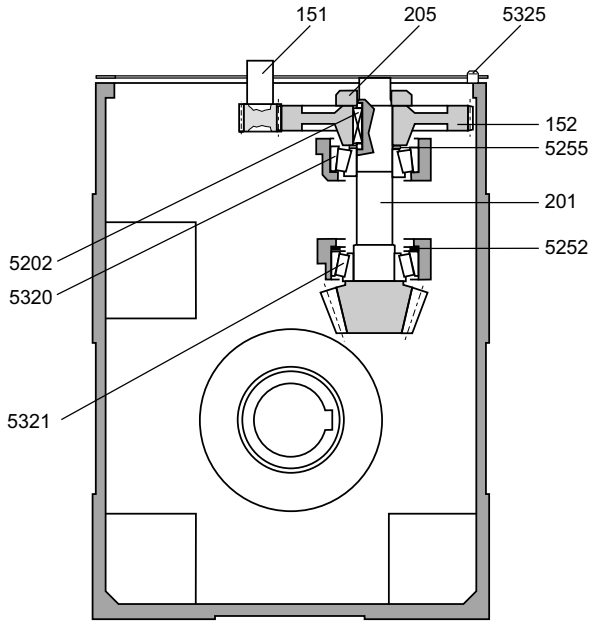


RF - DF - HF

A_	ref.				
R - D - H - S					
10 - 20 30 - 41	151	Pignone 1ª riduzione	*Pinion shaft*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1ª riduzione	*Gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	201	Pignone conico	*Bevel pinion*	Kegelrad	*Pignon conique*
	202	Corona conica	*Bevel gear*	Kegelkranz	*Couronne conique*
	203	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	204	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	205	Ghiera	*Ring nut*	Wellenmutter	*Frette*
	301	Cassa	*Gear housing*	Gehäuse	*Carter*
	302	Guarnizione	*Gasket*	Dichtung	*Joint*
	851	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	5202	Linguetta	*Key*	Paßfeder	*Clavette*
	5301	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5302	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5303	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5304	Cuscinetto	*Bearing*	Kugellagerr	*Roulement*
	5305	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5307	Ralla pignone conico	*Bevel pinion washer*	Scheibe der Kegelritzels	*Butée pignon conique*
	5308	Ralla albero lento	*Output shaft washer*	Scheibe der Abtriebswelle	*Butée arbre lent*
	5309	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylyndrique*
	5851	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
10 - 20 - 30	5306	Ralla corona 1ª riduzione	*Washer*	Scheibe der 1. stufe Zahnrad	*Butée couronne 1ère réd.*
30 - 41	5854	Linguetta corona conica	*Key*	Paßfeder des Kegelzahnrades	*Clavette couronne conique*
41	206	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
R					
10 - 20 - 30 - 41	5852	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
R - D					
10 - 20 - 30 - 41	5853	Linguetta albero lento	*Output shaft key*	Paßfeder der Abtriebswelle	*Clavette arbre lent*
S					
10 - 20 - 30 - 41	852	Protezione	*Safety cover*	Schutzvorrichtung	*Protection*
	5855	Calettatore	*Shrink disc*	Schrumpfscheibe	*Frette de serrage*
	5857	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5858	Rosetta zigrinata	*Knurled washer*	Rändelscheibe	*Rondelle moletée*
RF - DF - HF					
10 - 20 - 30 - 41	931	Flangia	*Flange*	Flansch	*Bride*
R - D - H - S					
10 - 20 - 30 - 41	861	Kit braccio di reazione	*Torque arm kit*	Ausrüstung für Drehmomentstütze	*Kit bras de réaction*

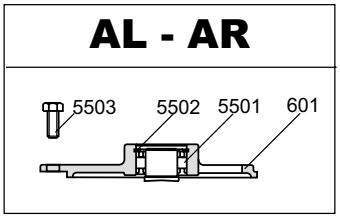


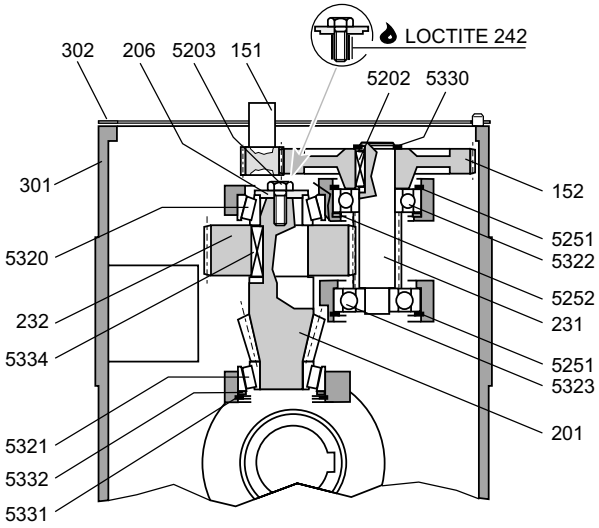
A502

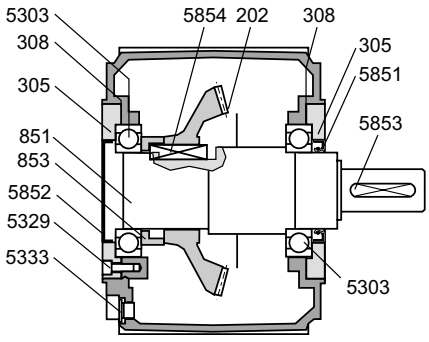


A503 - A504

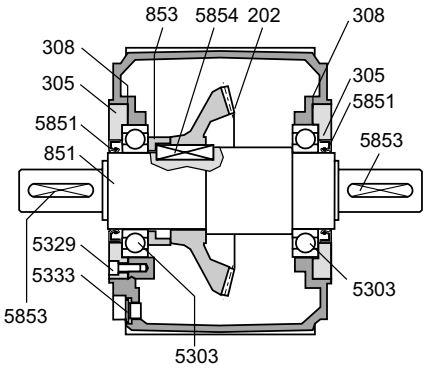
AL - AR







R



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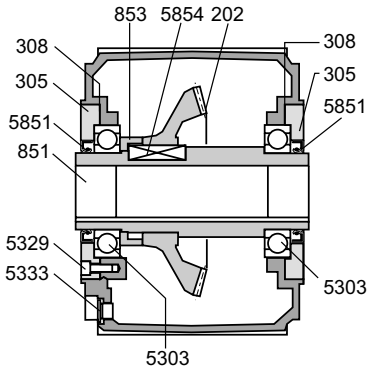
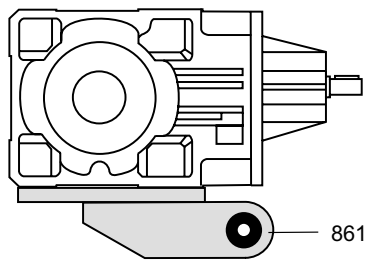
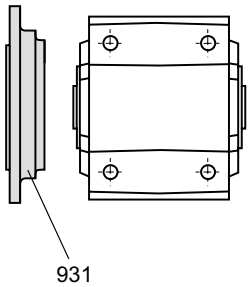


H

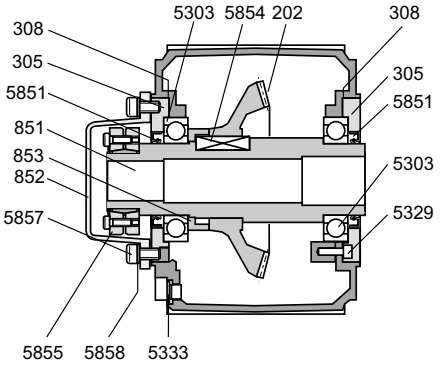
Accessori / *Accessories* / Zubehörteile / *Accessoires*



R - D - H - S

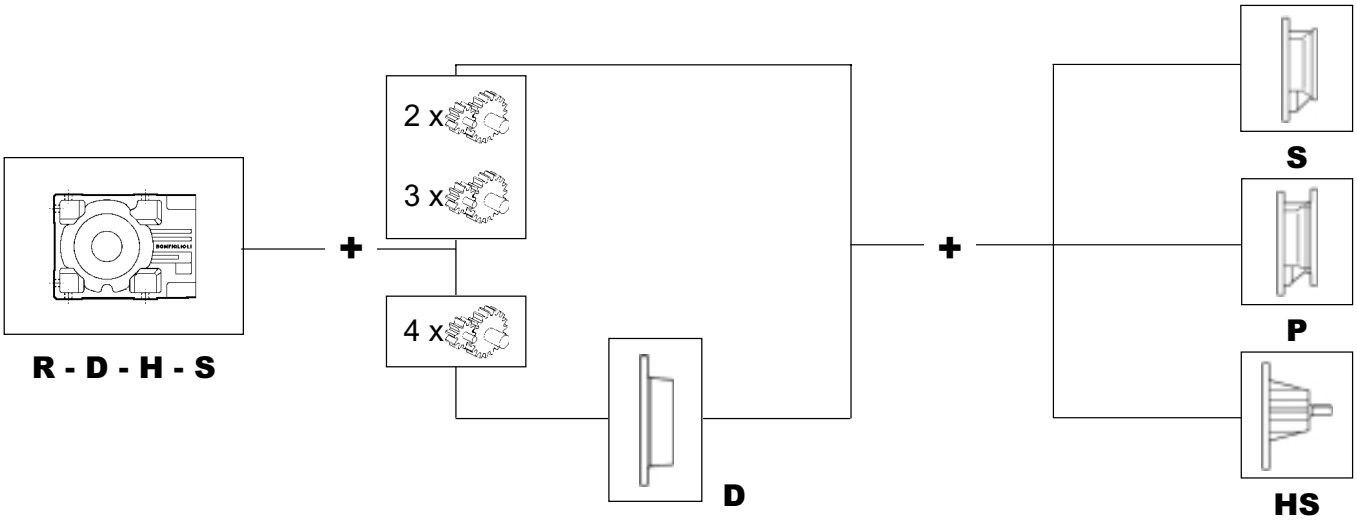


RF - DF - HF

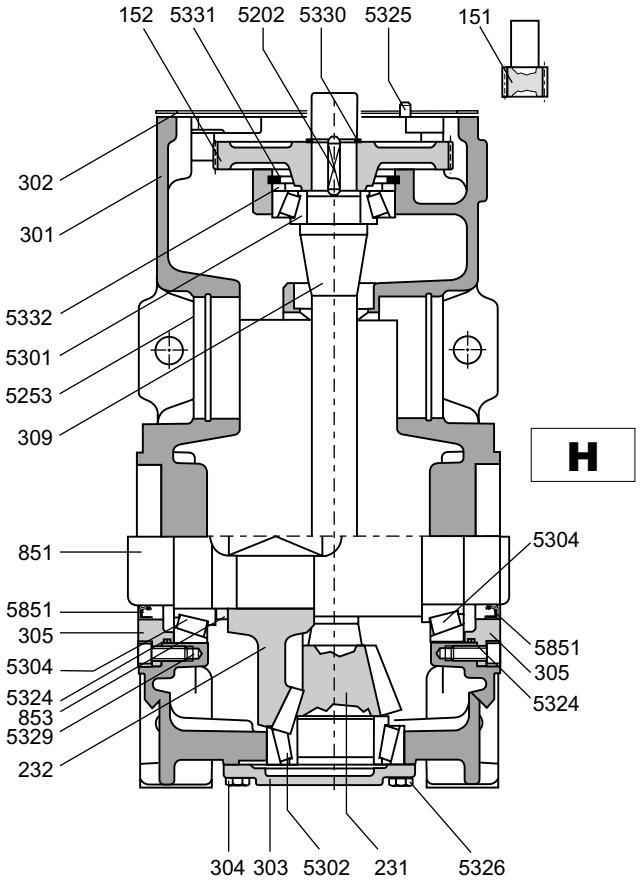


S

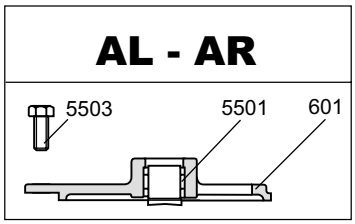
A_	ref.				
R - D - H - S					
	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona veloce	*1st red. gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	201	Pignone conico	*Bevel pinion*	Kegelrad	*Pignon conique*
	202	Corona conica	*Bevel gear*	Kegelkranz	*Couronne conique*
	301	Cassa	*Gear housing*	Gehäuse	*Carter*
	302	Guarnizione	*Gasket*	Dichtung	*Joint*
	305	Cappellotto	*Cap*	Deckel	*Capuchon*
	308	Guarnizione	*Gasket*	Dichtung	*Joint*
502	851	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
503	853	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
504	5202	Linguetta	*Key*	Paßfeder	*Clavette*
	5303	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5320	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5321	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5325	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylyndrique*
	5329	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5333	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5851	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5854	Linguetta corona conica	*Key*	Paßfeder des Kegelzahnrades	*Clavette couronne conique*
	205	Ghiera	*Ring nut*	Wellenmutter	*Frette*
502	5252	Ralla	*Washer*	Scheibe	*Butée*
	5255	Ralla	*Washer*	Scheibe	*Butée*
	206	Ralla	*Washer*	Wellenmutter	*Frette*
	231	Pignone 2ª riduzione	*2nd red. pinion*	Ritzel 2. Stufe	*Pignon 2ère réd.*
	232	Corona 2ª riduzione	*2nd red. gear*	Zahnrad 2. Stufe	*Couronne 2ère réd.*
	5203	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5251	Anello seeger	*Circlip*	Seegerring	*Seeger*
503 - 504	5252	Ralla	*Washer*	Scheibe	*Butée*
	5322	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5323	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5330	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5331	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5332	Ralla	*Washer*	Scheibe	*Butée*
	5334	Linguetta	*Key*	Paßfeder	*Clavette*
R					
502 - 503 - 504	5852	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
R - D					
502 - 503 - 504	5853	Linguetta albero lento	*Output shaft key*	Paßfeder der Abtriebswelle	*Clavette arbre lent*
S					
	852	Protezione	*Safety cover*	Schutzvorrichtung	*Protection*
502 - 503 - 504	5855	Calettatore	*Shrink disc*	Schrumpfscheibe	*Frette de serrage*
	5857	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5858	Rosetta zigrinata	*Knurled washer*	Rändelscheibe	*Rondelle moletée*
URF - UDF - UHF					
502 - 503 - 504	931	Flangia	*Flange*	Flansch	*Bride*
R - D - H - S					
502 - 503 - 504	861	Kit braccio di reazione	*Torque arm kit*	Ausrüstung für Drehmomentstütze	*Kit bras de réaction*
AL- AR					
	601	Supporto antiretro	*Anti-run-back support*	Halter für Rückzugsperre	*Support anti-retrait*
503 - 504	5501	Ruota libera	*Free wheel*	Freilauf	*Roue libre*
	5502	Anello seeger	*Circlip*	Seegerring	*Seegerr*
	5503	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*

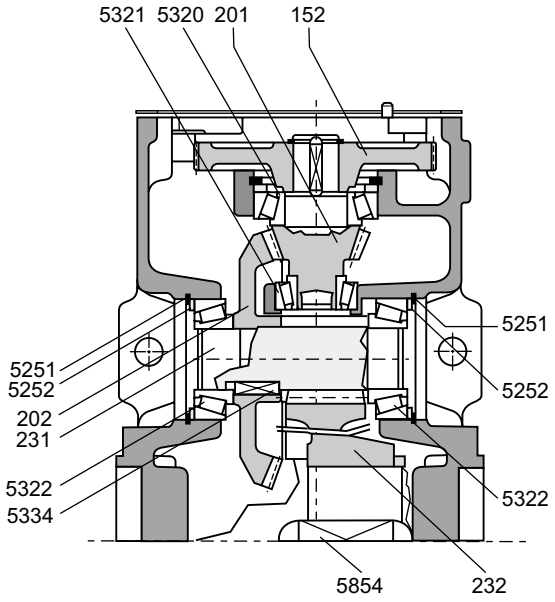


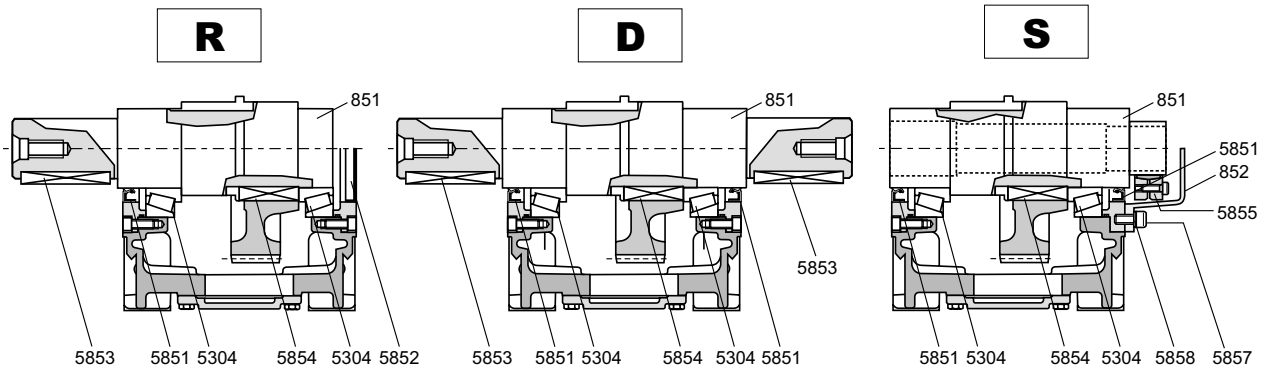
A602



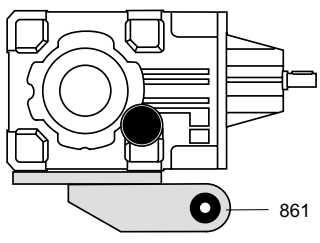
A603 - A604



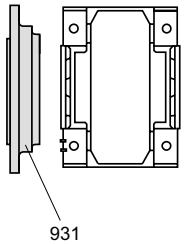




Accessori / *Accessories* / Zubehörteile / *Accessoires*

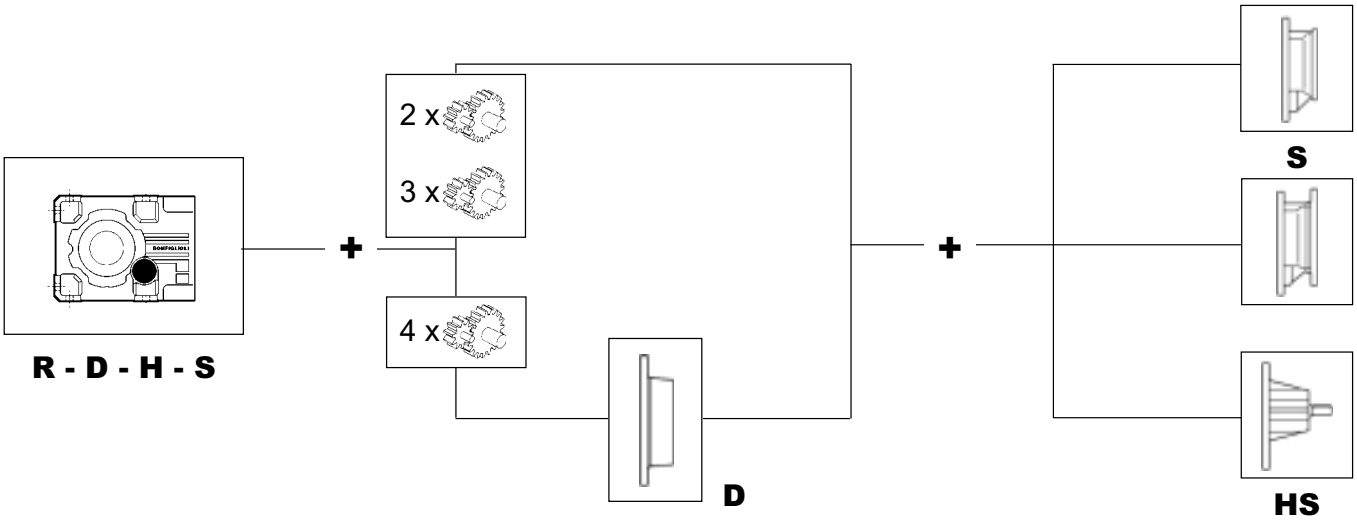


R - D - H - S

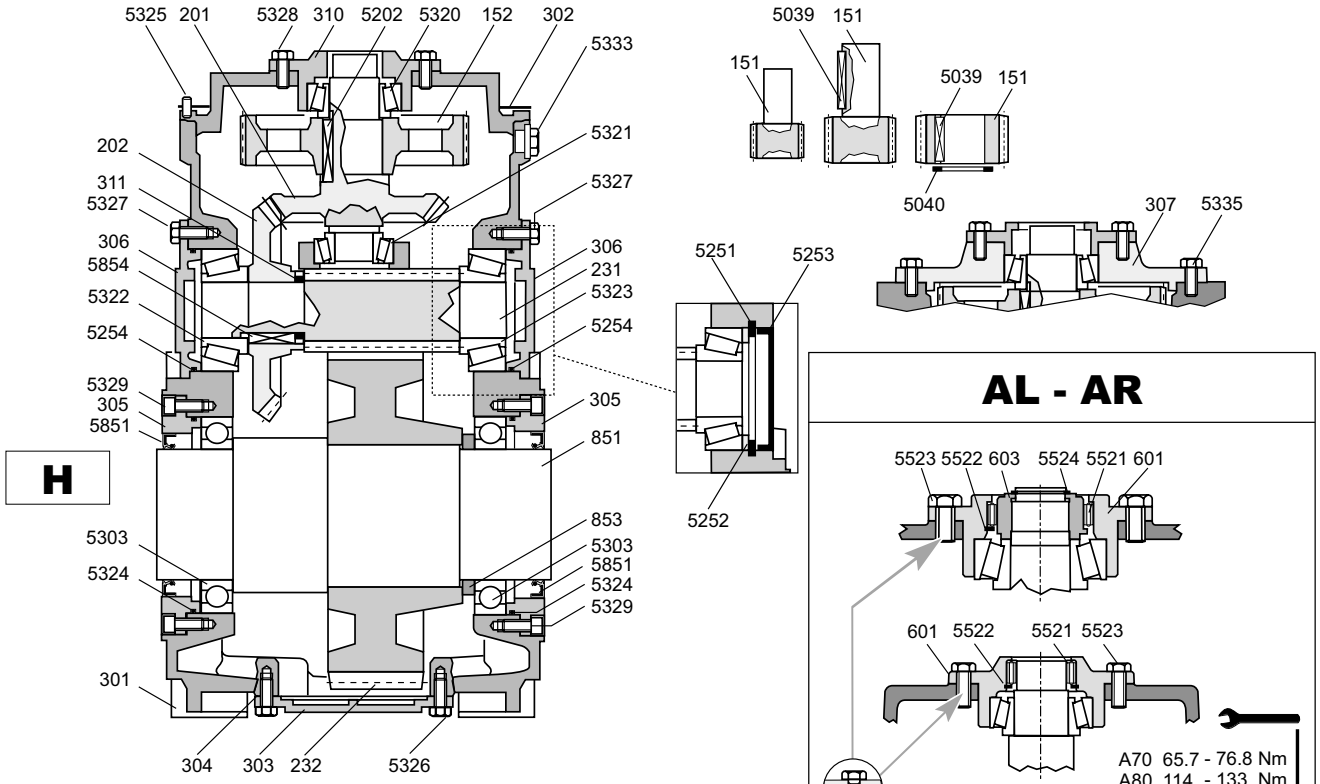


RF - DF - HF

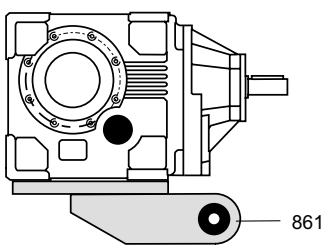
A_	ref.				
R - D - H - S					
602-603-604	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1ª riduzione	*1st red. gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	301	Cassa	*Gear housing*	Gehäuse	*Carter*
	302	Guarnizione	*Gasket*	Dichtung	*Joint*
	303	Coperchio di chiusura	*Cover*	Schlußdeckel	*Couvercle de fermeture*
	304	Guarnizione	*Gasket*	Dichtung	*Joint*
	305	Cappellotto	*Cap*	Deckel	*Capuchon*
	851	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	5202	Linguetta	*Key*	Paßfeder	*Clavette*
	5253	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
	5304	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5324	Anello O-Ring	*O-Ring seal*	O-Ring	*Bague O-ring*
	5325	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
	5326	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5329	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5330	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5331	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5332	Ralla	*Washer*	Scheibe	*Capuchon*
	5851	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5854	Linguetta	*Key*	Paßfeder	*Clavette*
602	231	Pignone conico	*Bevel pinion*	Kegelrad	*Pignon conique*
	232	Corona conica	*Bevel gear*	Kegelkranz	*Couronne conique*
	309	Alb. inserto	*Module shaft*	Modulwelle	*Arbre module*
	853	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	5301	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5302	Cuscinetto	*Bearing*	Kugellager	*Roulement*
603 - 604	201	Pignone conico	*Bevel pinion*	Kegelrad	*Pignon conique*
	202	Corona conica	*Bevel gear*	Kegelkranz	*Couronne conique*
	231	Pignone lento	*Output pinion*	Abtriebsritze	*Pignon à la sortie*
	232	Corona lenta	*Output gear*	Abtriebszahnrad	*Couronne á la sortie*
	5251	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5252	Ralla	*Washer*	Scheibe	*Butée*
	5320	Cuscinetto	*Bearing*	Kugellagerr	*Roulement*
	5321	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5322	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5334	Linguetta	*Key*	Paßfeder	*Clavette*
R					
602 - 603 - 604	5852	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
R - D					
602 - 603 - 604	5853	Linguetta albero lento	*Output shaft key*	Paßfeder der Abtriebswelle	*Clavette arbre lent*
S					
602 - 603 - 604	852	Protezione	*Safety cover*	Schutzvorrichtung	*Protection*
	5855	Calettatore	*Shrink disc*	Schrumpfscheibe	*Frette de serrage*
	5857	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5858	Rosetta zigrinata	*Knurled washer*	Rändelscheibe	*Rondelle moletée*
RF - DF - HF					
602 - 603 - 604	931	Flangia	*Flange*	Flansch	*Bride*
R - D - H - S					
602 - 603 - 604	861	Kit braccio di reazione	*Torque arm kit*	Ausrüstung für Drehmomentstütze	*Kit bras de réaction*
AL - AR					
603 - 604	601	Supporto antiretro	*Anti-run-back support*	Halter für Rückzugsperre	*Douille antiretrait*
	5501	Ruota libera	*Free wheel*	Freilauf	*Roue libre*
	5503	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*



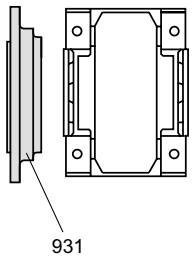
A70 ... A90



Accessori / *Accessories* / Zubehörteile / *Accessoires*

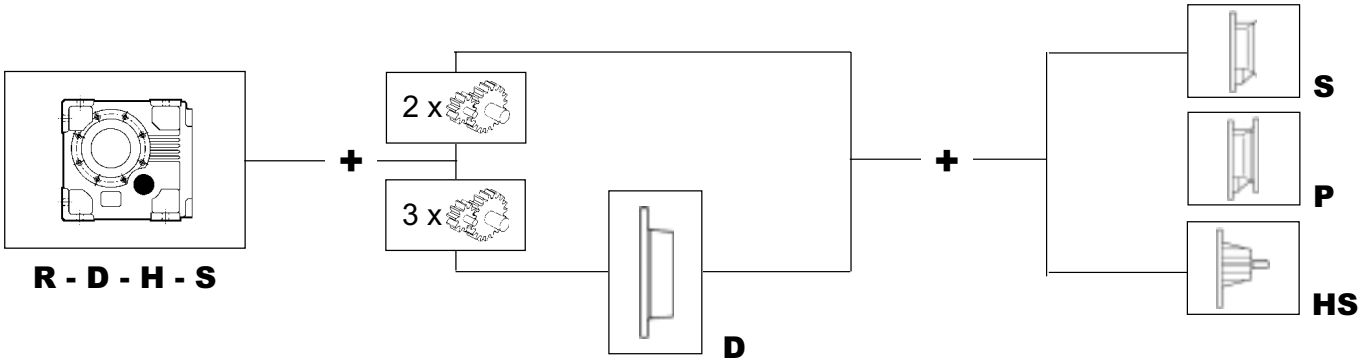


R - D - H - S

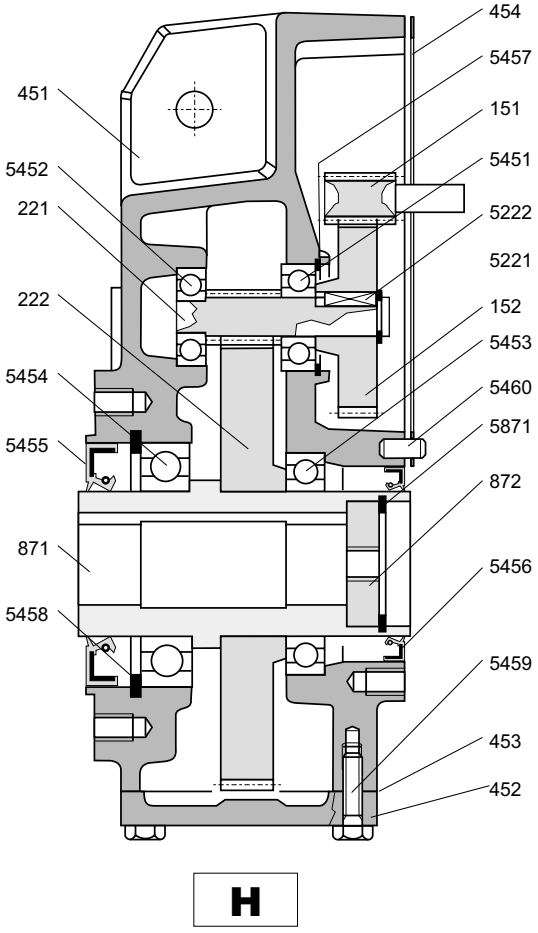


RF - DF - HF

A_	ref.				
R - D - H - S					
70-80-90	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1ª riduzione	*1st red. gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	201	Pignone conico	*Bevel pinion*	Kegelrad	*Pignon conique*
	202	Corona conica	*Bevel gear*	Kegelkranz	*Couronne conique*
	231	Pignone lento	*Output pinion*	Abtriebsritzel	*Pignon à la sortie*
	232	Corona lenta	*Output gear*	Abtriebszahnrad	*Couronne à la sortie*
	301	Cassa	*Gear housing*	Gehäuse	*Carter*
	302	Guarnizione	*Gasket*	Dichtung	*Joint*
	303	Coperchio di chiusura	*Cover*	Schlußdeckel	*Couvercle de fermeture*
	304	Guarnizione	*Gasket*	Dichtung	*Joint*
	305	Cappellotto alb. lento	*Cover*	Deckel	*Capuchon*
	310	Supporto cuscinetto	*Bearing support*	Lageraufnahme	*Support roulement*
	311	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	851	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	5039	Linguetta	*Key*	Paßfeder	*Clavette*
	5040	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5202	Linguetta	*Key*	Paßfeder	*Clavette*
	5320	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5321	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5322	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5323	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5324	Anello O-Ring	*O-Ring seal*	O-Ring	*Bague O-ring*
	5325	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
	5326	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5328	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5329	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5333	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5851	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5854	Linguetta	*Key*	Paßfeder	*Clavette*
70	5251	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5252	Ralla	*Washer*	Scheibe	*Butée*
	5253	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
80 - 90	306	Cappellotto chiuso	*Cover*	Geschlossener Deckel	*Capuchon fermé*
	307	Supporto interno	*Internal support*	Innerer Halter	*Support interne*
	5254	Anello O-Ring	*O-Ring seal*	O-Ring	*Bague O-ring*
	5327	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5335	Vite supporto cuscinetto	*Bearing support acrew*	Schraube für Lagerauf	*Vis de support roulement*
H					
70 - 80 - 90	5303	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	853	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
R					
70 - 80 - 90	5304	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5853	Linguetta albero lento	*Output shaft key*	Paßfeder der Abtriebswelle	*Clavette arbre lent*
	5852	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
D					
70 - 80 - 90	5304	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5853	Linguetta albero lento	*Key output shaft*	Paßfeder der Abtriebswelle	*Clavette arbre lent*
S					
70 - 80 - 90	852	Protezione	*Guard*	Schutzvorrichtung	*Protection*
	853	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	5303	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5855	Calettatore	*Shrink disc*	Schrumpfscheibe	*Frette de serrage*
	5857	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5858	Rosetta zigrinata	*Knurled washer*	Rändelscheibe	*Rondelle moletée*
RF - DF - HF - SF					
70 - 80 - 90	931	Flangia	*Flange*	Flansch	*Bride*
R - D - H - S					
70 - 80 - 90	861	Kit braccio di reazione	*Torque arm kit*	Ausrüstung für Drehmomentstütze	*Kit bras de réaction*
AL - AR					
80	601	Supporto antiretro	*Anti-run-back support*	Halter für Rückzugsperre	*Support anti-retrait*
	5521	Ruota libera	*Free wheel*	Freilauf	*Roue libre*
	5523	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
70 - 90	601	Supporto antiretro	*Anti-run-back support*	Halter für Rückzugsperre	*Support anti-retrait*
	603	Boccola per antiretro	*Anti-run-back spacer ring*	Buchse für Rücklaufsicherung	*Douille antiretrait*
	5521	Ruota libera	*Free wheel*	Freilauf	*Roue libre*
	5522	Anello Seeger	*Circlip*	Seegerring	*Seeger*
	5523	Vite di fissaggio	*Fixing screw*	Befestigungschraube	*Vis de fixation*
	5524	Anello Seeger	*Circlip*	Seegerring	*Seeger*



F10 - F20



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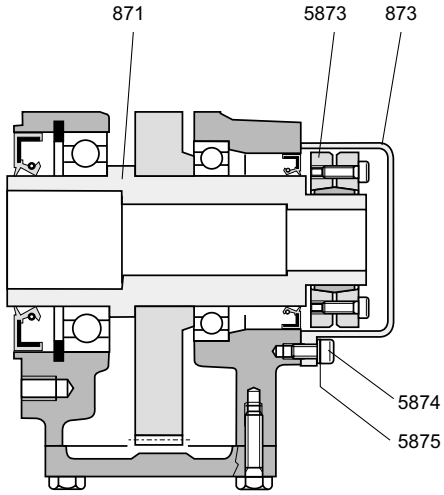

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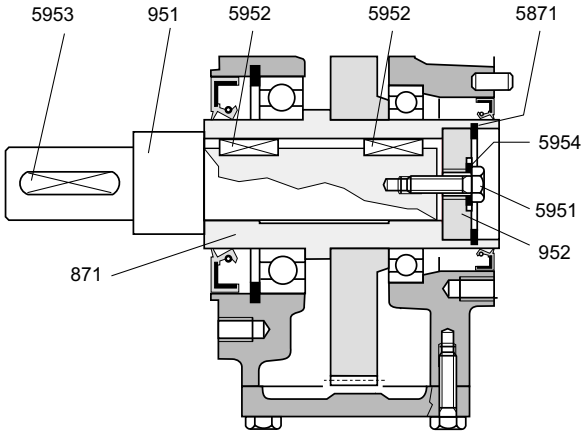

R

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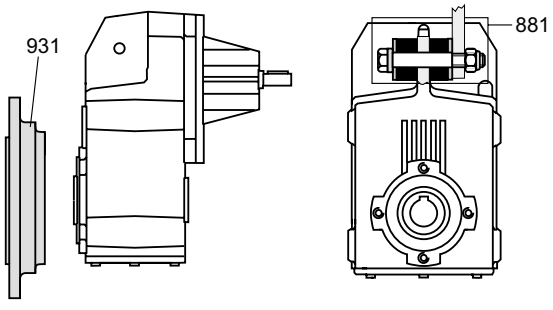
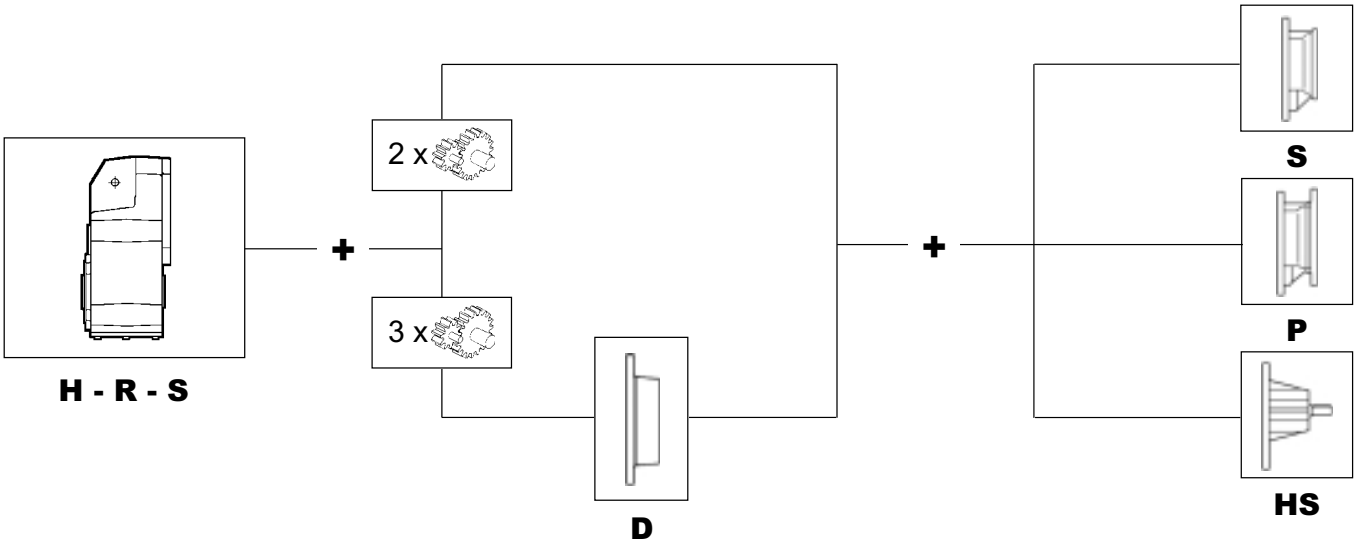
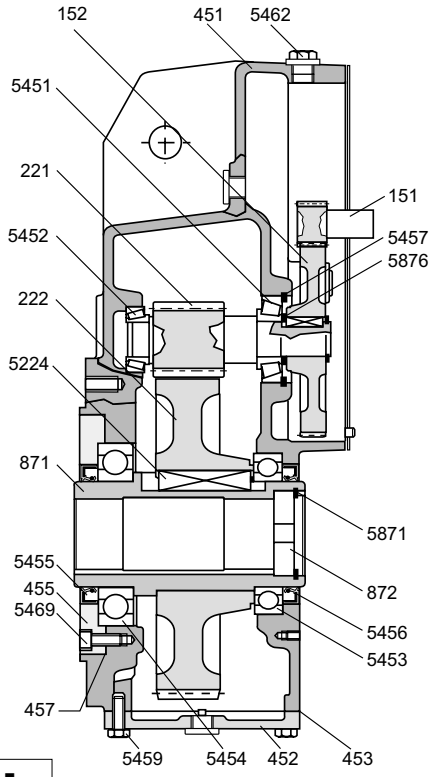


HF - SF - RF **H - S - R**

F_	ref.				
H - S - R					
10 - 20	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1ª riduzione	*1st red. gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	221	Pignone lento	*Output pinion*	Abtriebsritzel	*Pignon à la sortie*
	222	Corona lenta	*Output gear*	Abtriebszahnrad	*Couronne à la sortie*
	451	Cassa	*Gear housing*	Gehäuse	*Carter*
	452	Coperchio di chiusura	*Cover*	Schlußdeckel	*Couvercle de fermeture*
	453	Guarnizione coperchio	*Gasket*	Dichtung	*Joint couvercle*
	454	Guarnizione cassa	*Gasket*	Dichtung	*Joint carter*
	871	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	5221	Anello seeger	*Seeger*	Seegerring	*Seeger*
	5222	Linguetta	*Key*	Paßfeder	*Clavette*
	5451	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5452	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5453	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5454	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5455	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5456	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5457	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5458	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5459	Vite di fissaggio coperchio	*Bolt*	Deckel -Befestigungsschraube	*Vis de fixation couvercle*
	5460	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
H					
10 - 20	872	Ralla albero lento	*Assembly ring*	Scheibe der abtriebswelle	*Boutée arbre lent*
	5871	Anello seeger	*Circlip*	Seegerring	*Seeger*
R					
10 - 20	951	Albero lento	*Output shaft*	Abtriebswelle	*Arbre lent*
	952	Ralla albero lento	*Assembly ring*	Scheibe der Abtriebswelle	*Boutée arbre lent*
	5871	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5951	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5952	Linguetta	*Key*	Paßfeder	*Clavette*
	5953	Linguetta	*Key*	Paßfeder	*Clavette*
	5954	Rosetta	*Washer*	Scheibe	*Rondelle*
S					
10 - 20	873	Protezione	*Safety cover*	Schutzvorrichtung	*Protection*
	5873	Calettatore	*Shrink disc*	Schrumpfscheibe	*Frette de serrage*
	5874	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5875	Rosetta zigrinata	*Knurled washer*	Rändelscheibe	*Roundelle muletée*
HF - SF - RF					
10 - 20	931	Flangia	*Flange*	Flansch	*Bride*
H - S - R					
10 - 20	881	Kit di fissaggio con boccola antivibrante	*Anti-vibration kit*	Dämpfungskit	*Kit de fixation pour bras de réaction avec butée en caoutchouc*

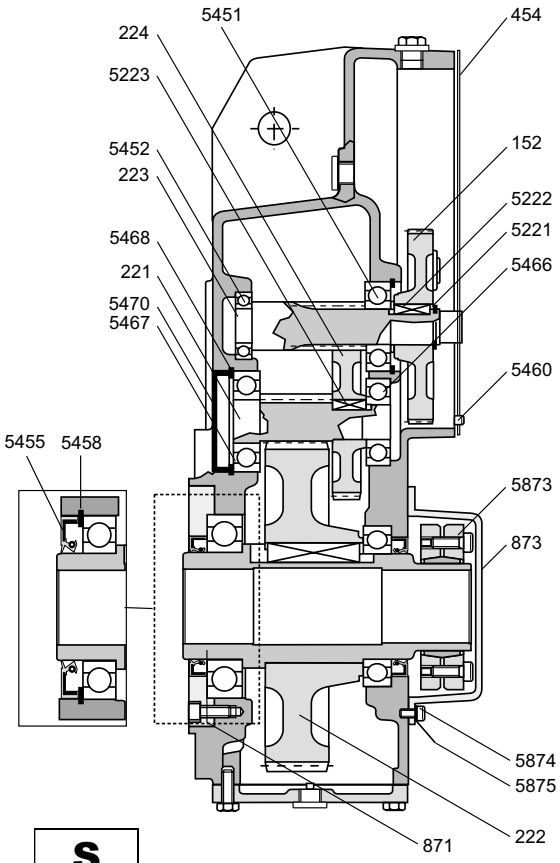


F302 - F402 - F502



H

F303 - F403 - F503
F304 - F404 - F504



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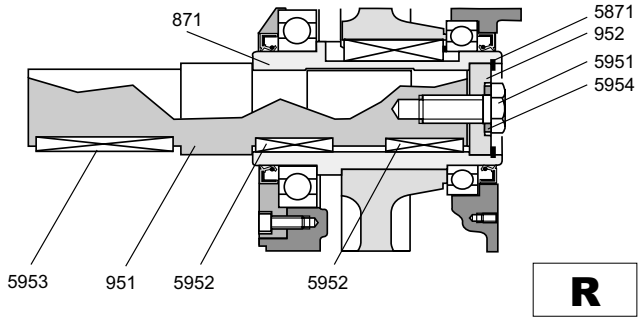
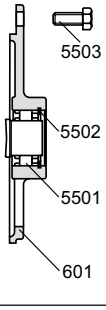


R

AL - AR



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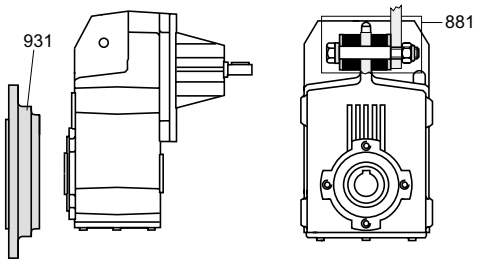
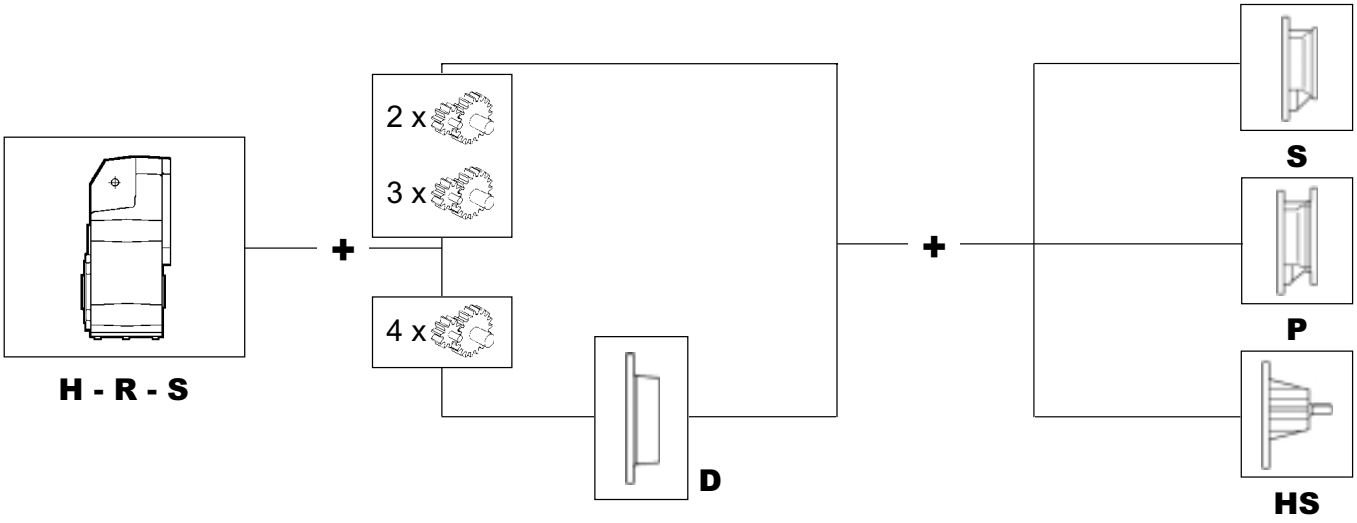
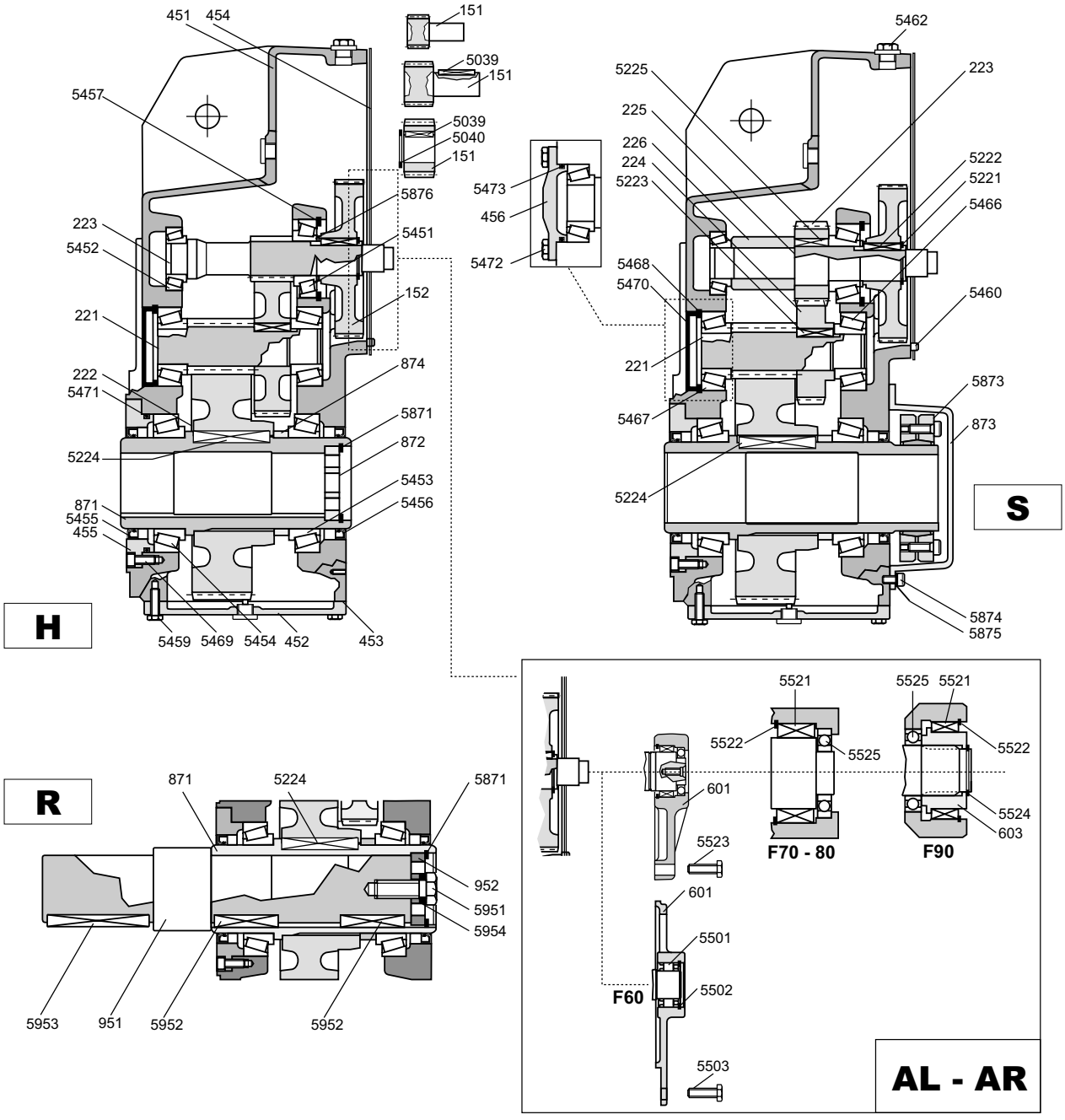


HF - SF - RF **H - S - R**

F_	ref.				
H - S - R					
30 - 40 - 50	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1ª riduzione	*1st red. gear*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	221	Pignone lento	*Output pinion*	Abtriebsritzel	*Pignon à la sortie*
	222	Corona lenta	*Output gear*	Abtrie2szahnrad	*Couronne à la sortie*
303 - 403 - 503	223	Pignone 2ª rid.	*2nd red. pinion*	Ritzel 1. Stufe	*Pignon 2ère réd.*
304 - 404 - 504	224	Corona 2ª rid.	*2nd red. gearwheel*	Zahnrad 2. Stufe	*Couronne 2ère réd.*
30 - 40 - 50	451	Cassa	*Gear housing*	Gehäuse	*Carter*
	452	Coperchio di chiusura	*Cover*	Schlußdeckel	*Couvercle de fermeture*
	453	Guarnizione coperchio	*Gasket*	Dichtung	*Joint couvercle*
	454	Guarnizione cassa	*Gasket*	Dichtung	*Joint carter*
	871	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	5221	Anello seeger	*Seeger*	Seegerring	*Seeger*
	5222	Linguetta	*Key*	Paßfeder	*Clavette*
	5223	Linguetta	*Key*	Paßfeder	*Clavette*
	5224	Linguetta	*Key*	Paßfeder	*Clavette*
	5451	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5452	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5453	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5454	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5455	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5456	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5457	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5459	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
30 - 40	5458	Anello seeger	*Circlip*	Seegerring	*Seeger*
30 - 40 - 50	5460	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
303 - 403 - 503	5466	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5467	Cuscinetto	*Bearing*	Kugellager	*Roulement*
304 - 404 - 504	5468	Anello seeger	*Circlip*	Seegerring	*Seegerc*
	5470	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
30 - 40 - 50	5876	Ralla	*Washer*	Scheibe	*Butée*
40 - 50	5462	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
50	455	Cappellotto	*Cap*	Deckel	*Capuchon*
	457	Guarnizione	*Gasket*	Dichtung	*Joint*
	5469	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
H					
30 - 40 - 50	872	Ralla albero lento	*Assembly ring*	Scheibe der abtriebswelle	*Boutée arbre lent*
	5871	Anello seeger	*Circlip*	Seegerring	*Seeger*
R					
30 - 40 - 50	951	Albero lento	*Output shaft*	Abtriebswelle	*Arbre lent*
	952	Rondella albero lento	*Assembly ring*	Scheibe der Abtriebswelle	*Boutée arbre lent*
	5871	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5951	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5952	Linguetta	*Key*	Paßfeder	*Clavette*
	5953	Linguetta	*Key*	Paßfeder	*Clavette*
	5954	Rosetta	*Washer*	Scheibe	*Rondelle*
S					
30 - 40 - 50	873	Protezione calettatore	*Safety cover*	Schutzvorrichtung	*Protection*
	5873	Calettatore	*Shrink disc*	Schrumpfscheibe	*Frette de serrage*
	5874	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5875	Rosetta zigrinata	*Knurled washer*	Rändelscheibe	*Rondelle moletée*
HF - SF - RF					
30 - 40 - 50	931	Flangia	*Flange*	Flansch	*Bride*
H - S - R					
30 - 40 - 50	881	Kit di fissaggio con boccola antivibrante	*Anti-vibration kit*	Dämpfungskit	*Kit de fixation pour bras de réaction avec butée en caoutchouc*
AL - AR					
503 - 504	601	Supporto antiretro	*Anti-run-back support*	Halter für Rückzugsperre	*Douille antiretrait*
	5501	Ruota libera	*Free wheel*	Freilauf	*Roue libre*
	5502	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5503	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*



F60 … F90



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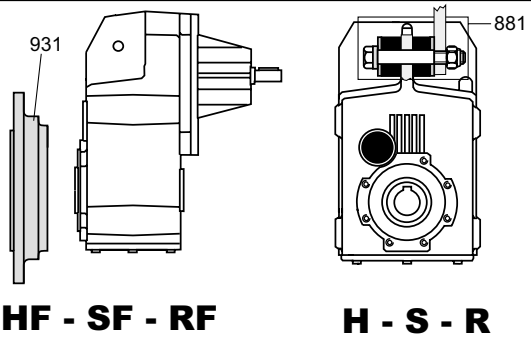
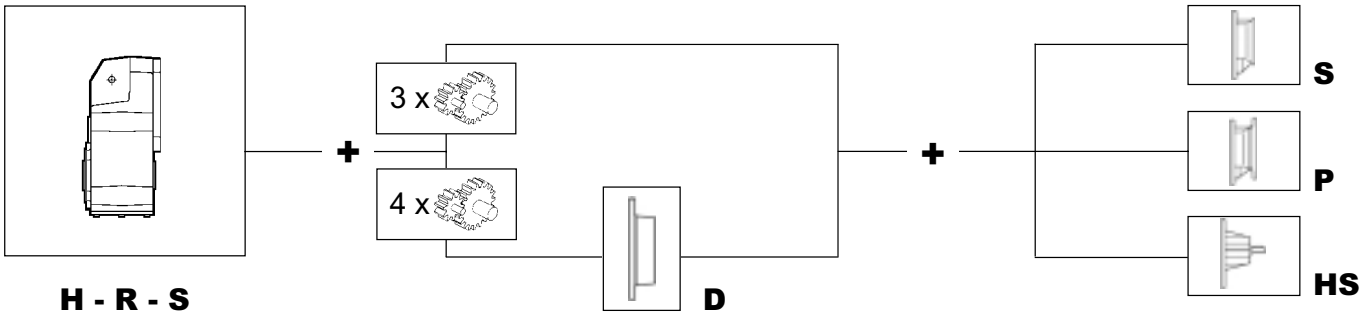


F_	ref.				
			H - S - R		
60 - 70 - 80 - 90	151	Pignone 1ª riduzione	*1st red. pinion*	Ritzel 1. Stufe	*Pignon 1ère réd.*
	152	Corona 1ª riduzione	*1st red. gearwheel*	Zahnrad 1. Stufe	*Couronne 1ère réd.*
	221	Pignone lento	*Output pinion*	Abtriebsritzel	*Pignon à la sortie*
	222	Corona lenta	*Output gear*	Abtriebszahnrad	*Couronne à la sortie*
	223	Pignone 2a rid.	*2nd red. pinion*	Ritzel 2. Stufe	*Pignon 2ère réd.*
	224	Corona 2a rid.	*2nd red. gear*	Zahnrad 2. Stufe	*Couronne 2ère réd.*
	451	Cassa	*Gear housing*	Gehäuse	*Carter*
	452	Coperchio di chiusura	*Cover*	Schlußdeckel	*Couvercle de fermeture*
	453	Guarnizione coperchio	*Gasket*	Dichtung	*Joint couvercle*
	454	Guarnizione cassa	*Gasket*	Dichtung	*Joint carter*
	455	Cappellotto	*Cap*	Deckel	*Capuchon*
	871	Albero lento	*Output shaft*	Abtriebswelle	*Arbre de sortie*
	874	Distanziale	*Spacer ring*	Distanzring	*Entretois*
	5221	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5222	Linguetta	*Key*	Paßfeder	*Clavette*
	5223	Linguetta	*Key*	Paßfeder	*Clavette*
	5451	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5452	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5453	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5454	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5455	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5456	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5457	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5459	Vite di fissaggio coperchio	*Bolt*	Deckel -Befestigungsschraube	*Vis de fixation couvercle*
	5460	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
	5462	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5466	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5467	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5469	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5471	Anello O-Ring	*O-ring seal*	O-Ring	*Bague O-ring*
60	5224	Linguetta	*Key*	Paßfeder	*Clavette*
60 - 70	5468	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5470	Cappellotto in gomma	*Rubber cap*	Gummideckel	*Capuchon en caoutchouc*
60 - 70 - 90	225	Albero inserto	*Shaft*	Modulwelle	*Arbre module*
	226	Distanziale	*Spacer*	Distanzring	*Entretois*
	5225	Linguetta	*Key*	Paßfeder	*Clavette*
70 - 80 - 90	5039	Linguetta	*Key*	Paßfeder	*Clavette*
	5040	Anello seeger	*Circlip*	Seegerring	*Seeger*
80	5876	Ralla	*Washer*	Scheibe	*Butée*
80 - 90	456	Cappellotto chiuso	*Cap cover*	Geschlossener Deckel	*Capuchon fermé*
	5472	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5473	Anello O-Ring	*O-ring seal*	O-Ring	*Bague O-ring*
			H		
60 - 70 - 80 - 90	872	Ralla albero lento	*Assembly ring*	Scheibe der abtriebswelle	*Boutée arbre lent*
	5871	Anello seeger	*Circlip*	Seegerring	*Seeger*
			R		
60 - 70 - 80 - 90	951	Albero lento	*Output shaft*	Abtriebswelle	*Arbre lent*
	952	Rondella albero lento	*Washer*	Scheibe der Abtriebswelle	*Boutée arbre lent*
	5871	Anello seeger	*Circlip*	Segerring	*Seeger*
	5951	Vite di fissaggio	*Screw*	Befestigungsschraube	*Vis de fixation*
	5952	Linguetta	*Key*	Paßfeder	*Clavette*
	5953	Linguetta	*Key*	Paßfeder	*Clavette*
	5954	Rosetta	*Washer*	Scheibe	*Rondelle*
			S		
60 - 70 - 80 - 90	873	Protezione calettatore	*Safety cover*	Schutzvorrichtung	*Protection*
	5873	Calettatore	*Shrink disc*	Schrumpfscheibe	*Frette de serrage*
	5874	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5875	Rosetta zigrinata	*Knurled washer*	Rändelscheibe	*Rondelle moletée*
			HF - SF - RF		
60- 70 - 80 - 90	931	Flangia	*Flange*	Flansch	*Bride*
			H - S - R		
60 - 70 - 80 - 90	881	Kit di fissaggio con boccola antivibrante	*Anti-vibration kit*	Dämpfungskit	*Kit de fixation pour bras de réaction avec butée en caoutchouc*
			AL - AR		
60	601	Supporto antiretro	*Anti-run-back support*	Halter für Rückzugsperre	*Douille antiretrait*
	5501	Ruota libera	*Free wheel*	Freilauf	*Roue libre*
	5502	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5503	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
70 - 80 - 90	601	Supporto antiretro	*Anti-run-back support*	Halter für Rückzugsperre	*Support anti-retrait*
	5521	Ruota libera	*Free wheel*	Freilauf	*Roue libre*
	5522	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5523	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5525	Cuscinetto	*Bearing*	Kugellager	*Roulement*
90	603	Boccola per antiretro	*Anti-run-back bushing*	Buchse für Rückzugsperre	*Douille antiretrait*
	5524	Anello seeger	*Circlip*	Seegerring	*Seeger*



8.0 MODULO ADDIZIONALE

Il modulo addizionale viene interposto fra il modulo uscita del riduttore (C, A, F) e uno dei moduli entrata (paragrafo 9.0).

8.0 ADDITIONAL GEAR MODULE

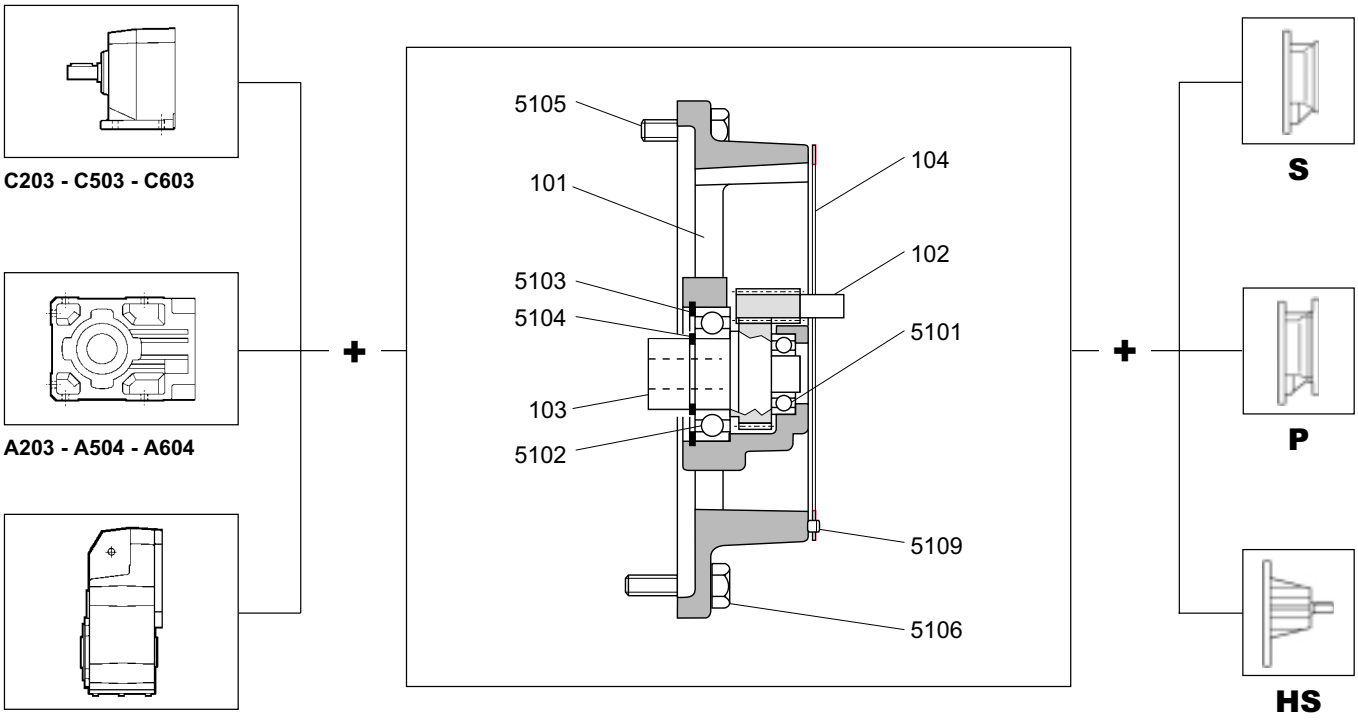
The additional module is assembled between the output module of the gearbox (C, A, F) and one of the input modules (section 9.0).

8.0 ZUSÄTZLICHE BAUEINHEIT

Die zusätzliche Baueinheit mit wird zwischen die Ausgangseinheit des Getriebes (C, A, F) und eine der Baueinheiten mit (siehe Abschnitt 9.0) eingefügt.

8.0 MODULE ADDITIONNEL

Le module additionnel est interposé entre le module de sortie du réducteur (C, A, F) et un des modules d'entrée (paragraphe 9.0).



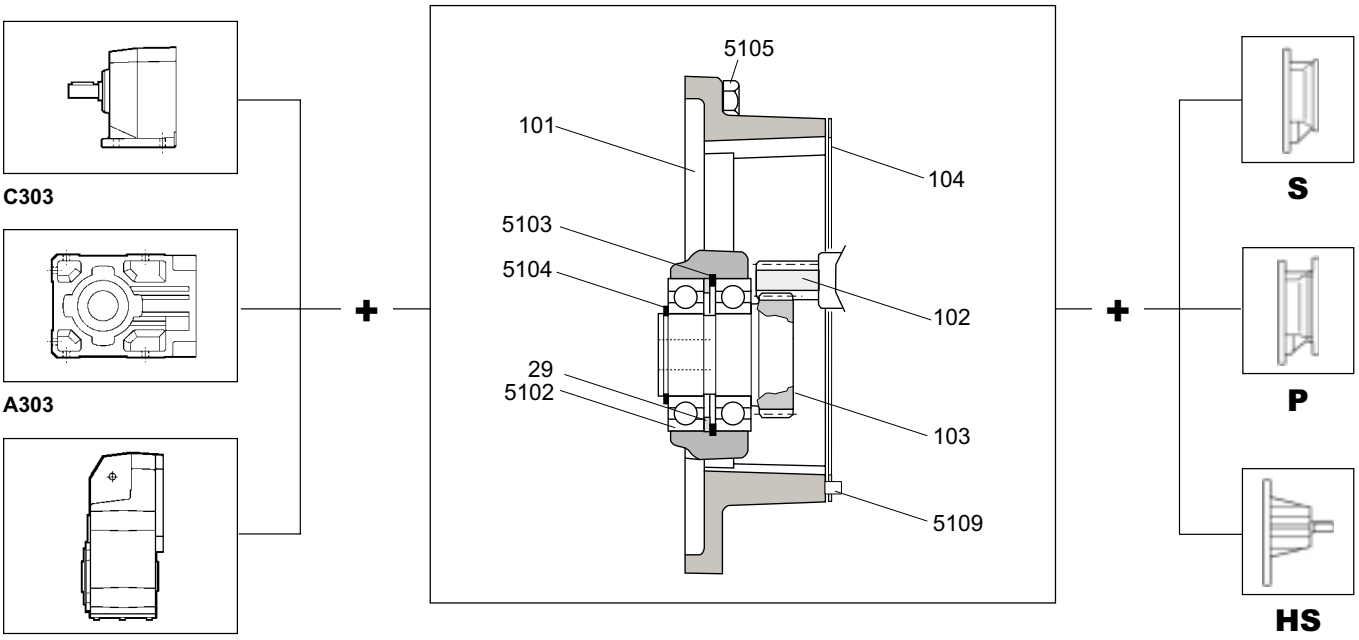
Quando le entrate S,P,HS devono essere fissate alle casse o ai moduli addizionali, le viti di fissaggio, nel caso in cui si trovino in corrispondenza di fori passanti devono avere il trattamento "DRILOC" sul filetto. Se non è possibile reperirle, è indispensabile effettuare un'efficace sigillatura applicando un adeguato prodotto (Loctite 574) sul filetto all'atto del montaggio.

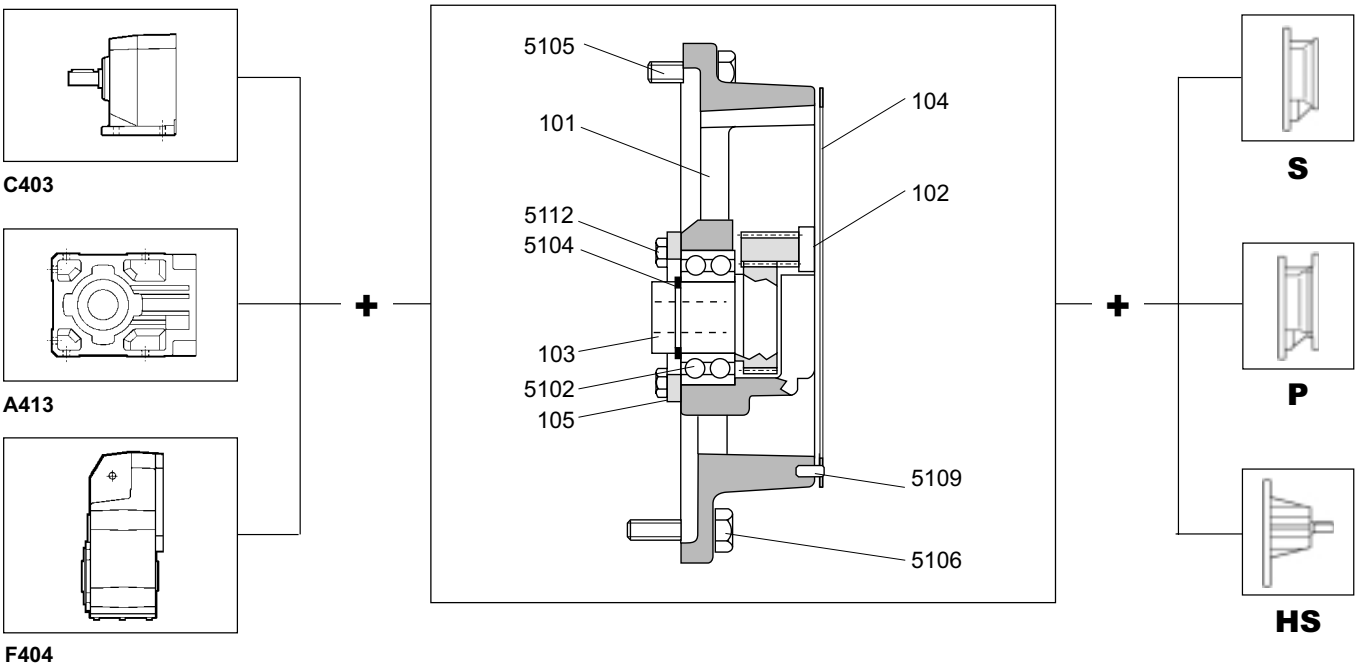
S (integr. motor), P (IEC motor interface), or HS (free shaft) input kits are to be fitted onto the main gear housings or to the additional gear module. Should fasteners engage into through holes, the threads of the forner must be "DRILOC" treated for sealing purposes. If such screws are not available locally, we recommend to apply Loctite 574, or an equivalent product, on the threads before connecting the parts.

Sollten die Antriebe S,P,HS an den Gehäusen oder den zusätzlichen Einheiten befestigt werden, muß auf die Gewinde der Schrauben 5002, 5027, und 5047, falls sie in den durchgehenden Bohrungen angeordnet sein sollten, "DRILOC" aufgetragen werden. Sollte dieses Mittel nicht erhältlich sein, muß bei der Montage durch das Auftragen eines geeigneiten Produkts (Loctite 574) auf das Gewinde, eine haltbare Sicherung gewährleistet werden.

Lorsque les entrée S,P,HS doivent être fixées aux carters ou aux modules additionnels, les vis de fixation, lorsq'elles se trouvent en face des orifices passants, doivent être traitées avec "DRILOC" au niveau du filetage. Si ce produit nìest pas disponible, au moment du montage, il est indispensable d'effectuer un scellement efficace en appliquant un produit spécifique (Loctite 574) sur le filetage.

C_, A_, F_	ref.				
20 - 50 - 60	101	Modulo addizionale	*Gear housing*	Zusatzbaueinheit	*Module additionnel*
	102	Pignone modulo addizionale	*Pinion shaft*	Ritzel für Zusatzbaueinheit	*Pignon module additionnel*
	103	Corona modulo addizionale	*Gear*	Zahnrad für Zusatzbaueinheit	*Couronne module additionnel*
	104	Guarnizione	*Gasket*	Dichtung	*Bague d'étanchéité*
	5101	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5102	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5103	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5104	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5105	Vite di fissaggio	*Fixing Screw*	Befestigungsschraube	*Vis de fixation*
	5106	Vite di fissaggio	*Fixing Screw*	Befestigungsschraube	*Vis de fixation*
	5109	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*





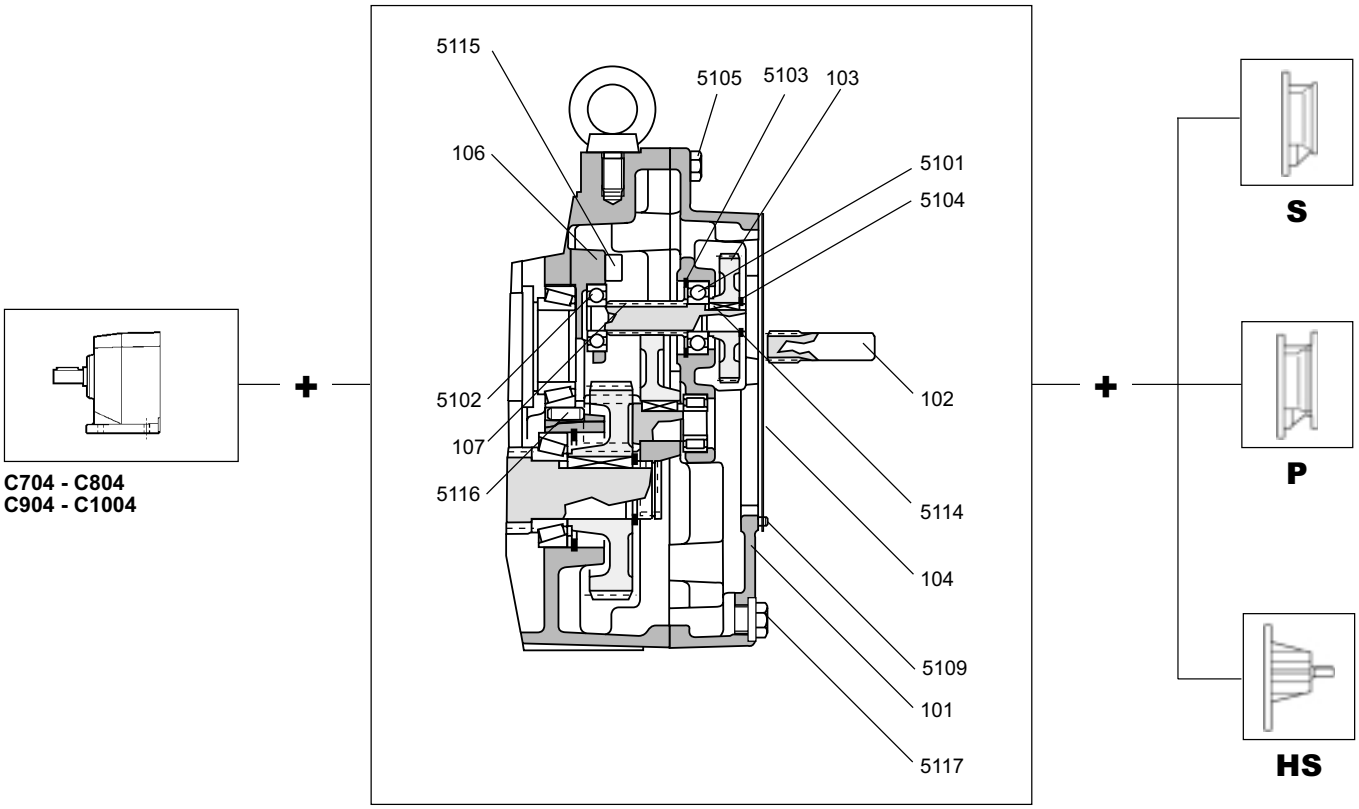
C_, A_, F_	ref.				
30 - 40	101	Modulo addizionale	*Gear housing*	Zusatzbaueinheit	*Module additionnel*
	102	Pignone modulo addizionale	*Pinion shaft*	Ritzel für Zusatzbaueinheit	*Pignon module additionnel*
	103	Corona modulo addizionale	*Gear*	Zahnrad für Zusatzbaueinheit	*Couronne module additionnel*
	104	Guarnizione	*Gasket*	Dichtung	*Bague d'étanchéité*
	5102	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5104	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5105	Vite di fissaggio	*Fixing Screw*	Befestigungsschraube	*Vis de fixation*
	5109	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
30	5103	Anello seeger	*Circlip*	Seegerring	*Seeger*
	29	Ralla	*Washer*	Scheibe	*Butée*
40	105	Anello di chiusura	*Closing ring*	Schlußring	*Bague de fermeture*
	5106	Vite di fissaggio	*Fixing Screw*	Befestigungsschraube	*Vis de fixation*
	5112	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*

Il modulo addizionale viene interposto fra il modulo uscita del riduttore (C, A, F) e uno dei moduli entrata (paragrafo 9.0).

The additional module is fitted between the output module of the gearbox (C, A, F) and one of the input modules (section 9.0).

Die zusätzliche Baueinheit mit wird zwischen die Ausgangseinheit des Getriebes (C, A, F) und eine der Baueinheiten mit (siehe Abschnitt 9.0) eingefügt.

Le module additionnel est interposé entre le module de sortie du réducteur (C, A, F) et un des modules d'entrée (paragraphe 9.0).



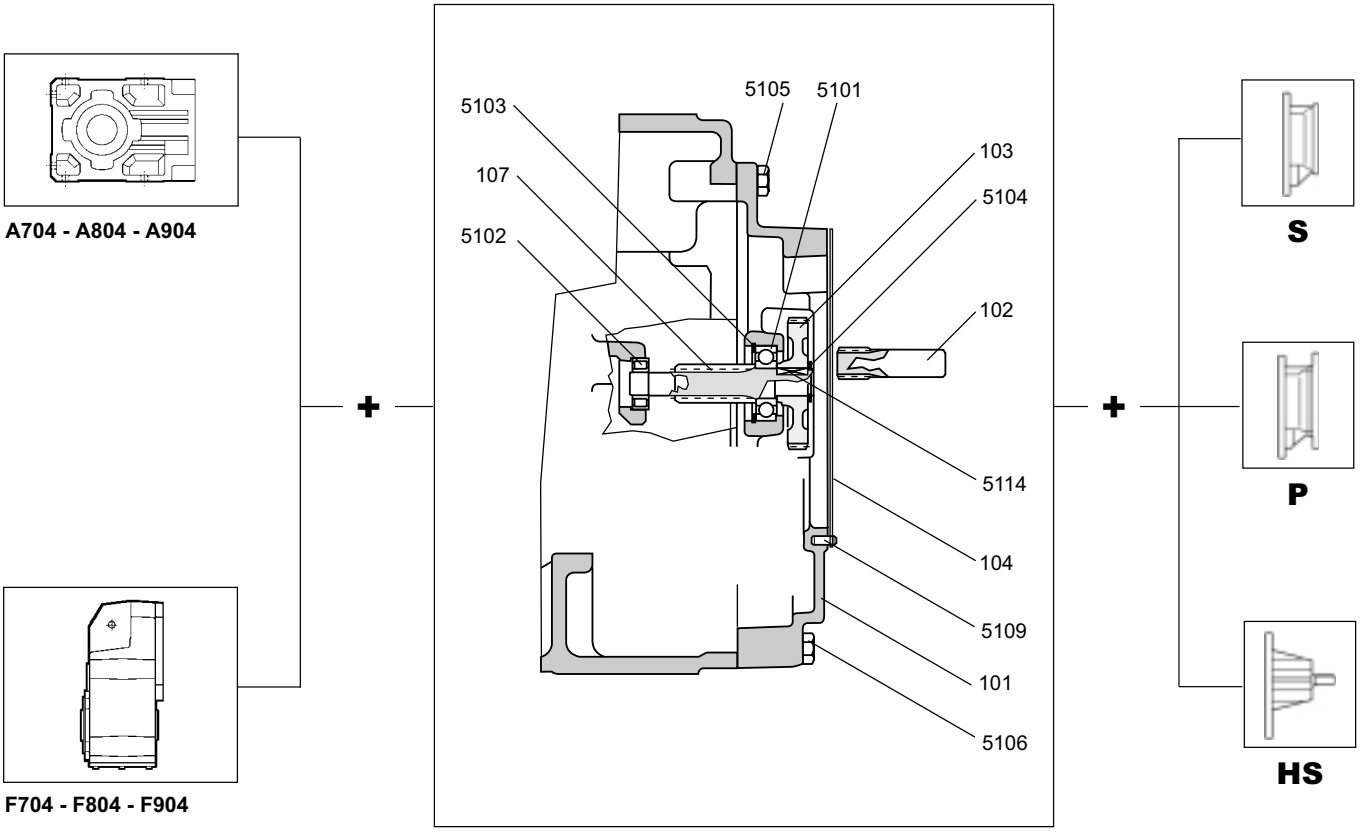
Quando le entrate S,P,HS devono essere fissate alle casse o ai moduli addizionali, le viti di fissaggio, nel caso in cui si trovino in corrispondenza di fori passanti devono avere il trattamento "DRILOC" sul filetto. Se non è possibile reperirle, è indispensabile effettuare un'efficace sigillatura applicando un adeguato prodotto (Loctite 574) sul filetto all'atto del montaggio.

S (integr. motor), P (IEC motor interface), or HS (free shaft) input kits are to be fitted onto the main gear housings or to the additional gear module. Should fasteners engage into through holes, the threads of the forner must be "DRILOC" treated for sealing purposes. If such screws are not available locally, we recommend to apply Loctite 574, or an equivalent product, on the threads before connecting the parts.

Sollten die Antriebe S,P,HS an den Gehäusen oder den zusätzlichen Einheiten befestigt werden, muß auf die Gewinde der Schrauben 5002, 5027, und 5047, falls sie in den durchgehenden Bohrungen angeordnet sein sollten, "DRILOC" aufgetragen werden. Sollte dieses Mittel nicht erhältlich sein, muß bei der Montage durch das Auftragen eines geeigneten Produkts (Loctite 574) auf das Gewinde, eine haltbare Sicherung gewährleistet werden.

Lorsque les entrée S,P,HS doivent être fixées aux carters ou aux modules additionnels, les vis de fixation, lorsq'elles se trouvent en face des orifices passants, doivent être traitées avec "DRILOC" au niveau du filetage. Si ce produit niest pas disponible, au moment du montage, il est indispensable d'effectuer un scellement efficace en appliquant un produit spécifique (Loctite 574) sur le filetage.

C_	ref.				
70 - 80 90 - 100	101	Modulo addizionale	*Gear housing*	Zusatzbaueinheit	*Module additionnel*
	102	Pignone modulo addizionale	*Pinion shaft*	Ritzel für Zusatzbaueinheit	*Pignon module additionnel*
	103	Corona modulo addizionale	*Gear*	Zahnrad für Zusatzbaueinheit	*Couronne module additionnel*
	104	Guarnizione	*Gasket*	Dichtung	*Bague d'étanchéité*
	106	Supporto cuscinetto	*Bearing support*	Lageraufnahme	*Support roulement*
	107	Pignone 1° mod.D	*Pinion shaft*	Ritzel 1 Mod. D	*Pignon 1 mod. D*
	5101	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5102	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5103	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5104	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5105	Vite di fissaggio	*Fixing Screw*	Befestigungsschraube	*Vis de fixation*
	5109	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
	5114	Linguetta	*Key*	Paßfeder	*Clavette*
	5115	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5117	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
70 - 80	5116	Spina elastica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*



Quando le entrate S,P,HS devono essere fissate alle casse o ai moduli addizionali, le viti di fissaggio, nel caso in cui si trovino in corrispondenza di fori passanti devono avere il trattamento "DRILOC" sul filetto. Se non è possibile reperirle, è indispensabile effettuare un'efficace sigillatura applicando un adeguato prodotto (Loctite 574) sul filetto all'atto del montaggio.

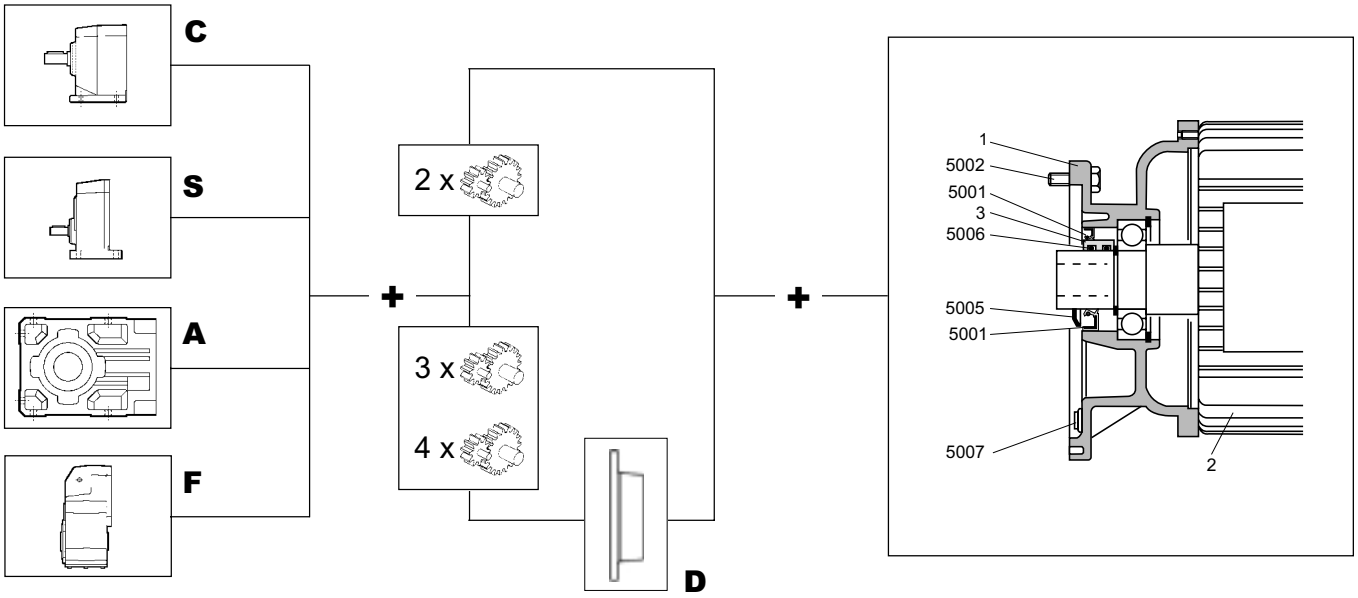
S (integr. motor), P (IEC motor interface), or HS (free shaft) input kits are to be fitted onto the main gear housings or to the additional gear module. Should fasteners engage into through holes, the threads of the forner must be "DRILOC" treated for sealing purposes. If such screws are not available locally, we recommend to apply Loctite 574, or an equivalent product, on the threads before connecting the parts.

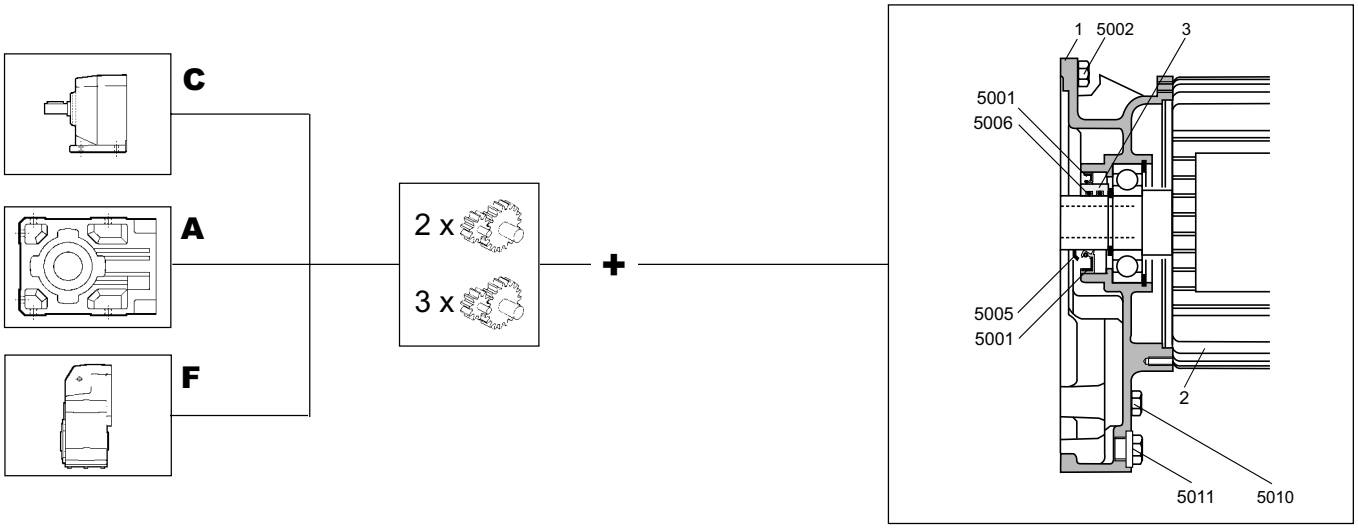
Sollten die Antriebe S,P,HS an den Gehäusen oder den zusätzlichen Einheiten befestigt werden, muß auf die Gewinde der Schrauben 5002, 5027, und 5047, falls sie in den durchgehenden Bohrungen angeordnet sein sollten, "DRILOC" aufgetragen werden. Sollte dieses Mittel nicht erhältlich sein, muß bei der Montage durch das Auftragen eines geeigneten Produkts (Loctite 574) auf das Gewinde, eine haltbare Sicherung gewährleistet werden.

Lorsque les entrée S,P,HS doivent être fixées aux carters ou aux modules additionnels, les vis de fixation, lorsq'elles se trouvent en face des orifices passants, doivent être traitées avec "DRILOC" au niveau du filetage. Si ce produit nìest pas disponible, au moment du montage, il est indispensable d'effectuer un scellement efficace en appliquant un produit spécifique (Loctite 574) sur le filetage.

A_, F_	ref.				
70 - 80 - 90	101	Modulo addizionale	*Gear housing*	Zusatzbaueinheit	*Module additionnel*
	102	Pignone modulo addizionale	*Pinion shaft*	Ritzel für Zusatzbaueinheit	*Pignon module additionnel*
	103	Corona modulo addizionale	*Gear*	Zahnrad für Zusatzbaueinheit	*Couronne module additionnel*
	104	Guarnizione	*Gasket*	Dichtung	*Bague d'étanchéité*
	106	Supporto cuscinetto	*Bearing support*	Lageraufnahme	*Support roulement*
	107	Pignone 1° mod.D	*Pinion shaft*	Ritzel 1 Mod. D	*Pignon 1 mod. D*
	5101	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5102	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5103	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5104	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5105	Vite di fissaggio	*Fixing Screw*	Befestigungsschraube	*Vis de fixation*
	5106	Vite di fissaggio	*Fixing Screw*	Befestigungsschraube	*Vis de fixation*
	5109	Spina cilindrica	*Dowel pin*	Zylinderstift	*Goupille cylindrique*
	5114	Linguetta	*Key*	Paßfeder	*Clavette*

9.0 MODULO ENTRATA S — *9.0 S INPUT MODULE* — 9.0 ANTRIEBSEINHEIT S — *9.0 MODULE ENTREE S*





Quando le entrate S,P,HS devono essere fissate alle casse o ai moduli addizionali, le viti di fissaggio, nel caso in cui si trovino in corrispondenza di fori passanti devono avere il trattamento "DRILOC" sul filetto. Se non è possibile reperirle, è indispensabile effettuare un'efficace sigillatura applicando un adeguato prodotto (Loctite 574) sul filetto all'atto del montaggio.

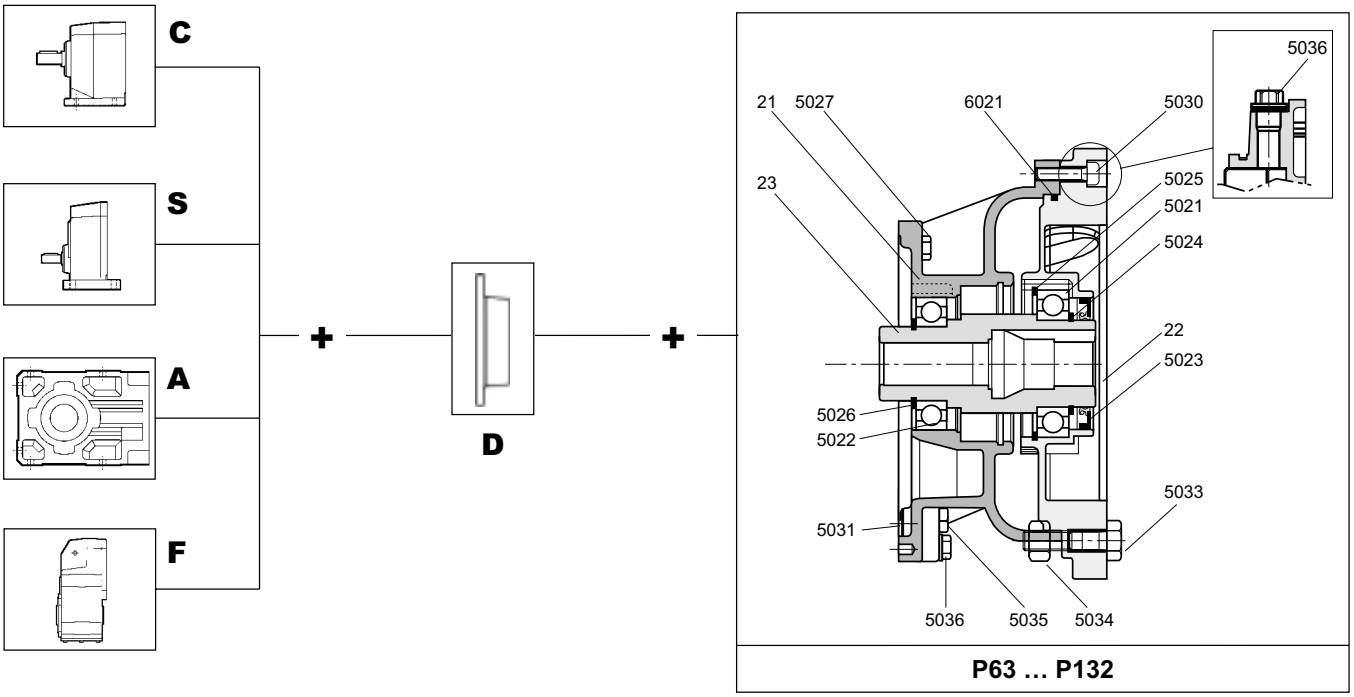
S (integr. motor), P (IEC motor interface), or HS (free shaft) input kits are to be fitted onto the main gear housings or to the additional gear module. Should fasteners engage into through holes, the threads of the forner must be "DRILOC" treated for sealing purposes. If such screws are not available locally, we recommend to apply Loctite 574, or an equivalent product, on the threads before connecting the parts.

Sollten die Antriebe S,P,HS an den Gehäusen oder den zusätzlichen Einheiten befestigt werden, muß auf die Gewinde der Schrauben 5002, 5027, und 5047, falls sie in den durchgehenden Bohrungen angeordnet sein sollten, "DRILOC" aufgetragen werden. Sollte dieses Mittel nicht erhältlich sein, muß bei der Montage durch das Auftragen eines geeigneten Produkts (Loctite 574) auf das Gewinde, eine haltbare Sicherung gewährleistet werden.

Lorsque les entrée S,P,HS doivent être fixées aux carters ou aux modules additionnels, les vis de fixation, lorsq'elles se trouvent en face des orifices passants, doivent être traitées avec "DRILOC" au niveau du filetage. Si ce produit nìest pas disponible, au moment du montage, il est indispensable d'effectuer un scellement efficace en appliquant un produit spécifique (Loctite 574) sur le filetage.

S_ (C_, A_, S_, F_)	ref.				
M1 - M2 - M3 - M4 - M5	1	Flangia motore compatto	*Compact motor flange*	Flansch des kompakten Motors	*Bride moteur compact*
	2	Motore compatto	*Compact motor*	Kompakter Motor	*Moteur compact*
	3	Boccola per anello di tenuta	*Oil seal bushing*	Buchse für Dichtungsringe	*Douille pour joint d'étanchéité*
	5001	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5002	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5005	Gamma seals	*Gamma ring*	Gamma - Ring	*Déflecteur*
	5007	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
M3 - M4 - M5	5006	Anello O-ring	*O-ring seal*	O-Ring	*Bague O-ring*
M2 - M3 - M4 - M5	5010	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5011	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*

9.1 MODULO ENTRATA P — *9.1 P INPUT MODULE* — 9.1 ANTRIEBSEINHEIT P — *9.1 MODULE ENTREE P*



Quando le entrate S,P,HS devono essere fissate alle casse o ai moduli addizionali, le viti di fissaggio, nel caso in cui si trovino in corrispondenza di fori passanti devono avere il trattamento "DRILOC" sul filetto. Se non è possibile reperirle, è indispensabile effettuare un'efficace sigillatura applicando un adeguato prodotto (Loctite 574) sul filetto all'atto del montaggio.

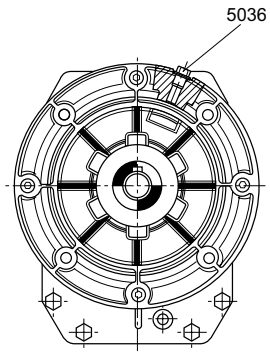
S (integr. motor), P (IEC motor interface), or HS (free shaft) input kits are to be fitted onto the main gear housings or to the additional gear module. Should fasteners engage into through holes, the threads of the forner must be "DRILOC" treated for sealing purposes. If such screws are not available locally, we recommend to apply Loctite 574, or an equivalent product, on the threads before connecting the parts.

Sollten die Antriebe S,P,HS an den Gehäusen oder den zusätzlichen Einheiten befestigt werden, muß auf die Gewinde der Schrauben 5002, 5027, und 5047, falls sie in den durchgehenden Bohrungen angeordnet sein sollten, "DRILOC" aufgetragen werden. Sollte dieses Mittel nicht erhältlich sein, muß bei der Montage durch das Auftragen eines geeigneten Produkts (Loctite 574) auf das Gewinde, eine haltbare Sicherung gewährleistet werden.

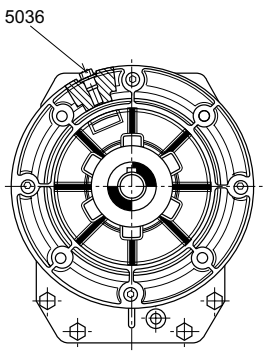
Lorsque les entrée S,P,HS doivent être fixées aux carters ou aux modules additionnels, les vis de fixation, lorsq'elles se trouvent en face des orifices passants, doivent être traitées avec "DRILOC" au niveau du filetage. Si ce produit nìest pas disponible, au moment du montage, il est indispensable d'effectuer un scellement efficace en appliquant un produit spécifique (Loctite 574) sur le filetage.

P_ (C_, S_, A_, F_)	ref.				
	21	Flangia motore	*Main flange*	Motorflansch	*Bride moteur*
	22	Controflangia IEC	*IEC interface*	IEC-Flansch	*Bride*
	23	Albero veloce	*Input shaft*	Antriebswelle	*Arbre rapide*
	5021	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5022	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5023	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5024	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5025	Anello seeger	*Circlip*	Seegerring	*Seeger*
P63 … P132	5026	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5027	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5030	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5031	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5033	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5034	Dado	*Nut*	Mutter	*Ecrou*
	5035	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5036	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5040	Anello Seeger	*Circlip*	Seegerring	*Seeger*

Posizione tappo olio su flangia attacco motore | ***Breather plug location onto motor mounting flange*** | **Position der Ölschraube am Motoranschlussflansch** | ***Position bouchon d'huile sur bride de fixation moteur***

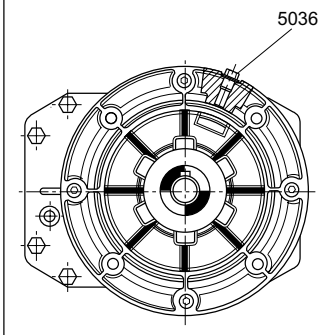


P63 ... P112

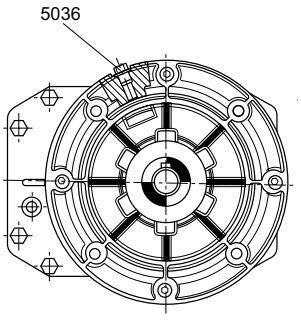


P132

Tipo - *Type* Typ - *Type*	Posizioni di montaggio - *Mounting Positions* Einbaulagen - *Positions de montage*
A	B3 - VA - VB
C (P-UP-UPF)	B3 - V5 - V6
C (F-UF-U)	B5 - V1 - V3
F	H1 - H5 - H6
S (P)	B3 - V5 - V6
S (F)	B5 - V1 - V3

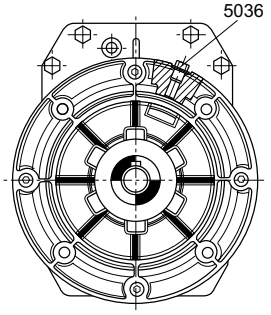


P 63 ... P112

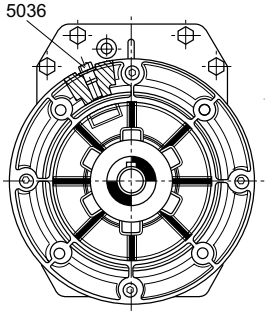


P132

Tipo - Type Typ - *Type*	Posizioni di montaggio - *Mounting Positions* Einbaulagen - *Positions de montage*
A	B7
C (P-UP-UPF)	B7
F	H3
S (P)	B7
S (F)	B53

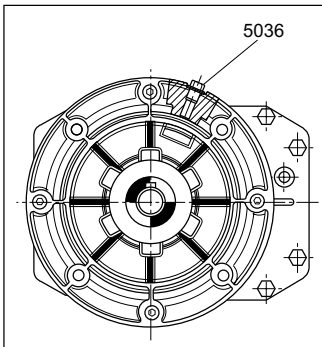


P63 ... P112

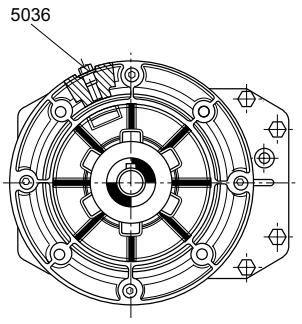


P132

Tipo - *Type* Typ - *Type*	Posizioni di montaggio - *Mounting Positions* Einbaulagen - *Positions de montage*
A	B8
C (P-UP-UPF)	B8
F	H2
S (P)	B8
S (F)	B52



P63 ... P112



P132

Tipo - *Type* Typ - *Type*	Posizioni di montaggio - *Mounting Positions* Einbaulagen - *Positions de montage*
A	B6
C (P-UP-UPF)	B6
F	H4
S (P)	B6
S (F)	B51

Note:

Sostituire il tappo chiuso con il tappo di sfiato fornito a corredo nei seguenti casi:

Note:

Replace the closed plug with the breather plug supplied in the following cases:

Hinweis:

Den mitgelieferten Ablassverschluss-stopfen in den folgenden Fällen verwenden:

Remarques:

Remplacer le bouchon fermé par le bouchon de vidange livré en dotation dans les cas suivants :

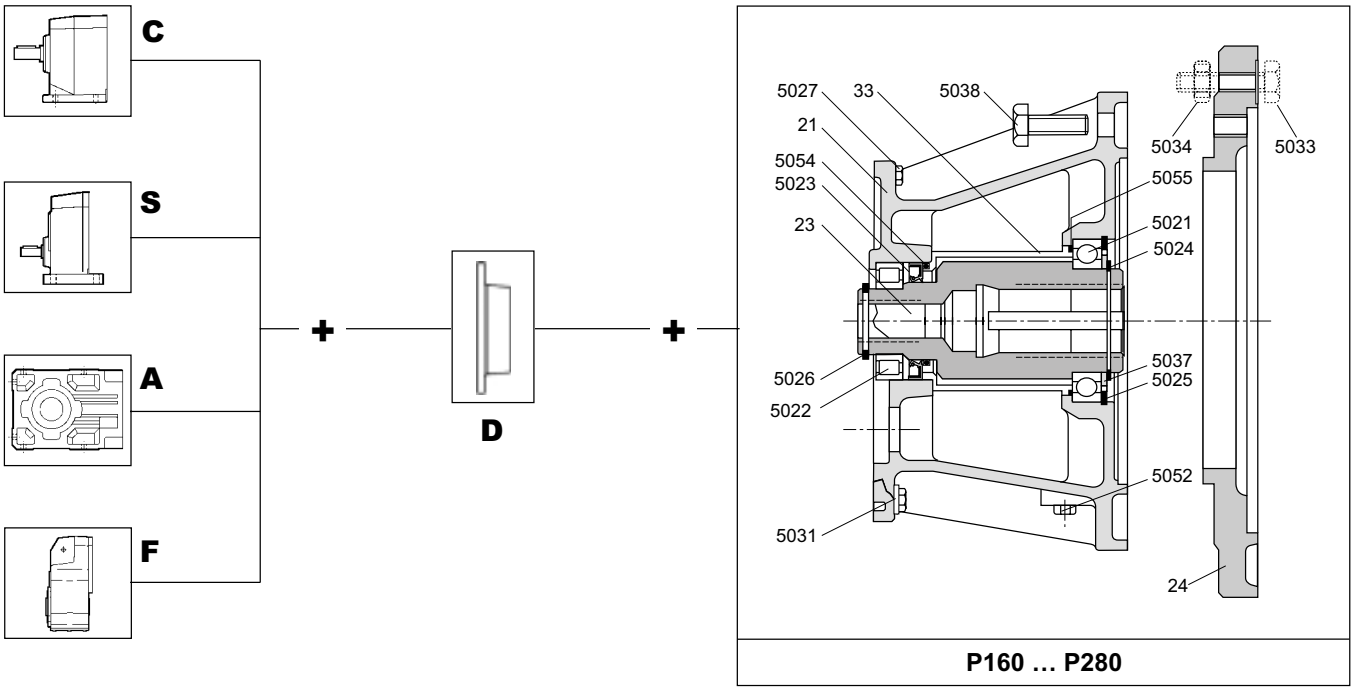
Tipo - *Type* - Typ - *Type*	Posizioni di montaggio - *Mounting Positions* Einbaulagen - *Positions de montage*
A 102, A 202-A 203, A 302-A 303	B3 - B8 - B6 - B7 - VA
A 403, A 504, A 604, A 704, A 804, A 904	VA
C 102, C 202-C 203, C 302-C 303, C 402-C 403, C 502-C 503	B3 - B8 - B6 - B7 - V5 - V1 - B5 - B51 - B52 - B53
C 603, C 704, C 804, C 904, C 1004	V5 - V1
F 102, F 202-F 203, F 302-F 303-F 304	H1 - H3 - H4 - H5
F 404, F 504, F 604, F 704, F 804, F 904	H5
S 101, S 201, S 301, S 401	B3 - B6 - B7 - B8 - V5 - B5 - B52 - V1 - B51 - B53
S 501	V1 - V5

In tutti gli altri casi mantenere il tappo chiuso.

In all the other cases leave the closed plug into position.

In allen anderen Fällen, den Verschluss geschlossen lassen.

Dans les autres cas, garder le bouchon fermé.



P160 … P280

Quando le entrate S,P,HS devono essere fissate alle casse o ai moduli addizionali, le viti di fissaggio, nel caso in cui si trovino in corrispondenza di fori passanti devono avere il trattamento "DRILOC" sul filetto. Se non è possibile reperirle, è indispensabile effettuare un'efficace sigillatura applicando un adeguato prodotto (Loctite 574) sul filetto all'atto del montaggio.

S (integr. motor), P (IEC motor interface), or HS (free shaft) input kits are to be fitted onto the main gear housings or to the additional gear module. Should fasteners engage into through holes, the threads of the former must be "DRILOC" treated for sealing purposes. If such screws are not available locally, we recommend to apply Loctite 574, or an equivalent product, on the threads before connecting the parts.

Sollten die Antriebe S,P,HS an den Gehäusen oder den zusätzlichen Einheiten befestigt werden, muß auf die Gewinde der Schrauben 5002, 5027, und 5047, falls sie in den durchgehenden Bohrungen angeordnet sein sollten, "DRILOC" aufgetragen werden. Sollte dieses Mittel nicht erhältlich sein, muß bei der Montage durch das Auftragen eines geeigneten Produkts (Loctite 574) auf das Gewinde, eine haltbare Sicherung gewährleistet werden.

Lorsque les entrée S,P,HS doivent être fixées aux carters ou aux modules additionnels, les vis de fixation, lprsq'elles se trouvent en face des orifices passants, doivent être traitées avec "DRILOC" au niveau du filetage. Si ce produit nìest pas disponible, au moment du montage, il est indispensable d'effectuer un scellement efficace en appliquant un produit spécifique (Loctite 574) sur le filetage.

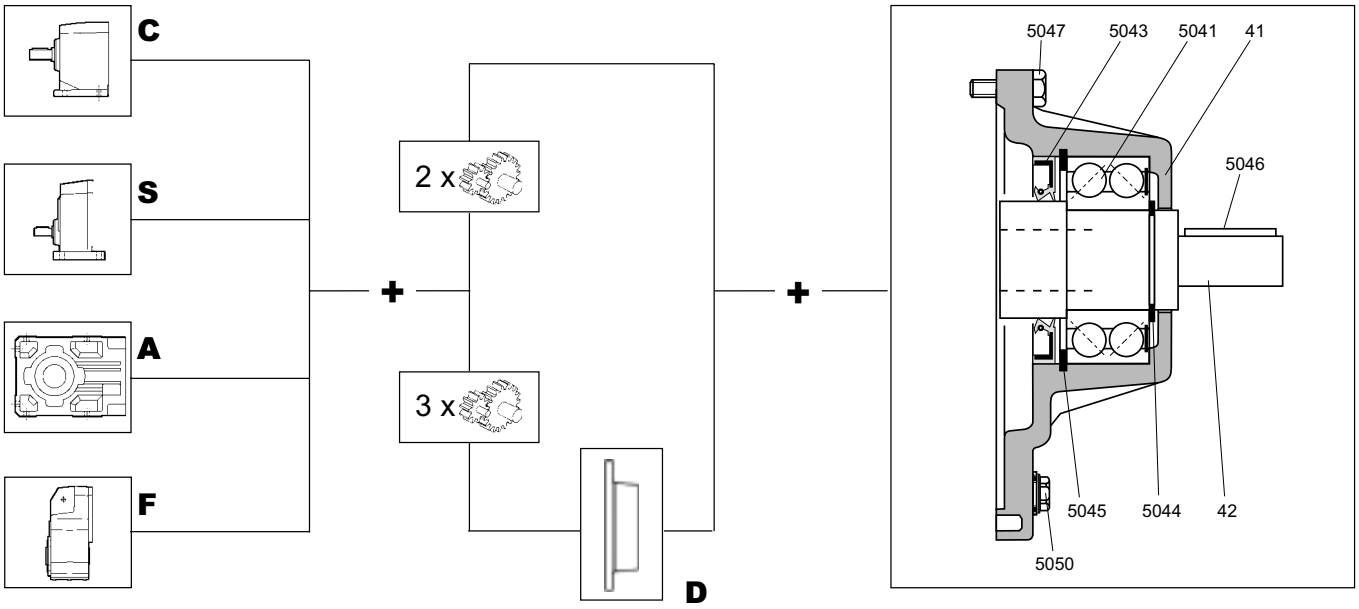
P_ (C_, S_, A_, F_)	ref.				
P160 … P280	21	Flangia motore	*Main motor flange*	Motorflansch	*Bride moteur*
	23	Albero veloce	*Input shaft*	Antriebswelle	*Arbre d'entrée*
P200 - P250 - P280	24	Controflangia IEC	*IEC interface*	Flansch	*Bride*
P160 … P280	5021	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5022	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5023	Anello di tenuta	*Oil seal*	Simmgerring	*Bague d'étanchéité*
	5024	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5025	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5026	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5027	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5031	Tappo olio	*Oil plug*	Ölverschlub	*Bouchon d'huile*
	5033	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5034	Dado	*Nut*	Mutter	*Ecrou*
P160 - P180	5037	Ralla	*Washer*	Scheibe	*Butée*
P200 - P250 - P280	5038	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
P160 … P280	5035	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5036	Tappo olio	*Oil plug*	Ölverschlub	*Bouchon d'huile*
	5040	Anello seeger	*Circlip*	Seegerring	*Seeger*
P160 … P250(*)	33	Boccola	*Bushing*	Buchse	*Douille*
	5052	Tappo olio	*Oil plug*	Ölverschlub	*Bouchon d'huile*
	5054	Anello O-ring	*O-ring seal*	O-ring	*Bague O-ring*
	5055	Anello O-ring	*O-ring seal*	O-ring	*Bague O-ring*

(*) Solo per installazioni con motore disposto in verticale.

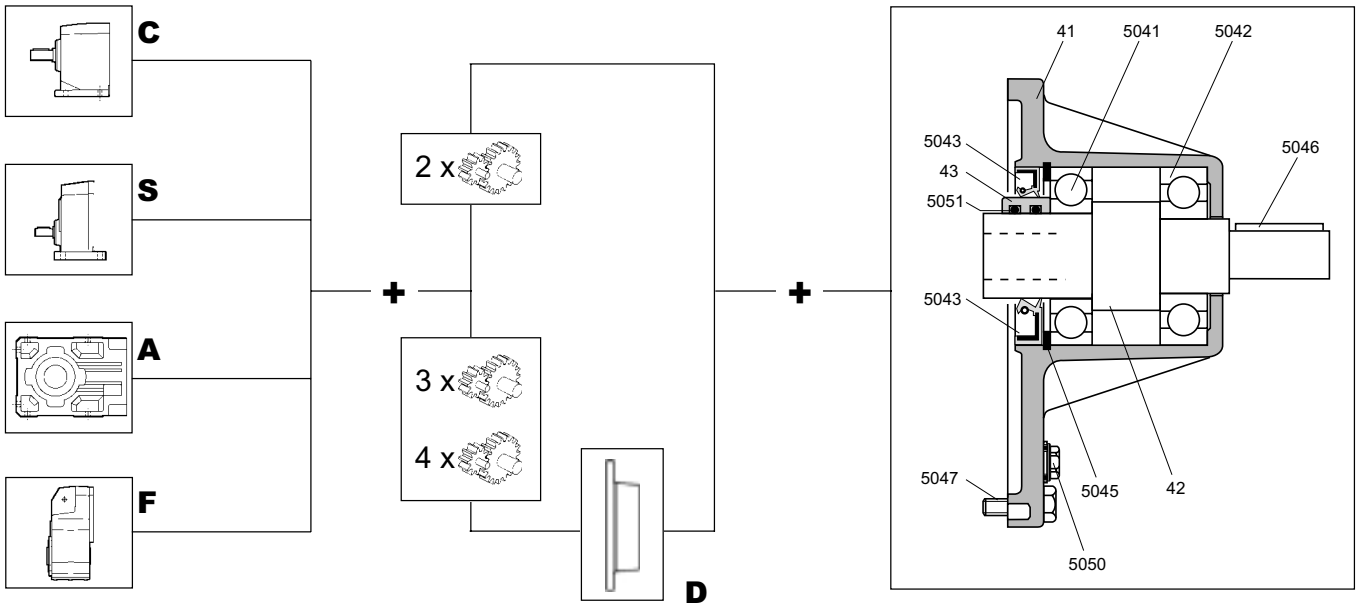
(*) *Only for mounting positions with motor sitting vertically.*

(*) nur für Installationen mit senkrecht ausgerichtetem Motor

(*) *Uniquement pour les installations équipées de moteur en position verticale*



HS_	ref.				
	41	Coperchio	*Cover*	Deckel	*Couvercle*
C102 - 203 - 303	42	Albero veloce	*Input shaft*	Antriebswelle	*Arbre d'entrée*
	5041	Cuscinetto	*Bearing*	Kugellager	*Roulement*
S101	5043	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5045	Anello seeger	*Circlip*	Seegerring	*Seeger*
A102 - 203 - 303	5046	Linguetta	*Key*	Paßfeder	*Clavette*
	5047	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
F102 - 203 - 304	5044	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5050	Tappo olio	*Oil plug*	Ölverschlub	*Bouchon d'huile*



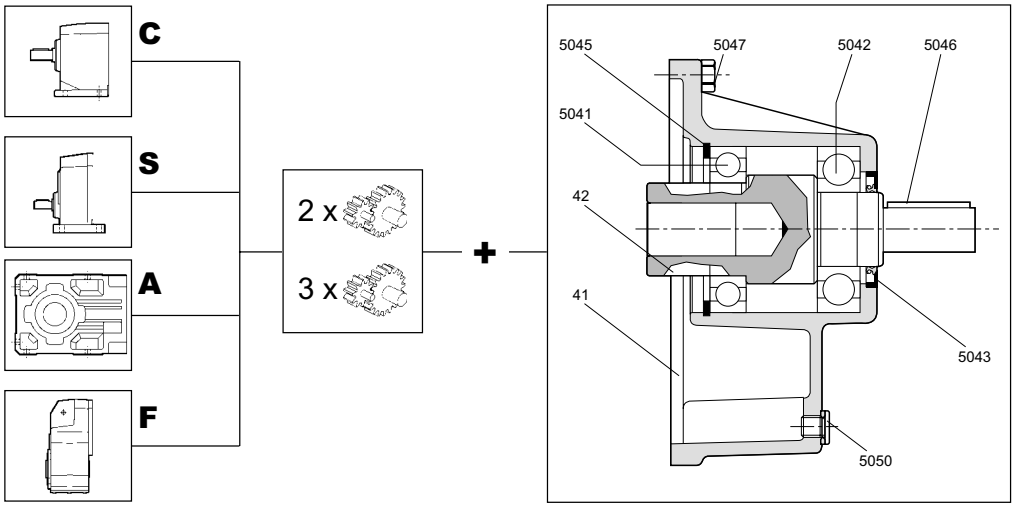
HS_	ref.				
	41	Coperchio	*Cover*	Deckel	*Couvercle*
	42	Albero veloce	*Input shaft*	Antriebswelle	*Arbre d'entrée*
C202 - 302 - 402 - 502	43	Boccola per anello di tenuta	*Oilseal sleeve*	Buchse für Dichtungsringe	*Douille pour joint d'étanchéité*
	5041	Cuscinetto	*Bearing*	Kugellager	*Roulement*
S201 - 301 - 401 - 501	5042	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5043	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
A202 - 302 - 412 - 502 - 503	5045	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5046	Linguetta	*Key*	Paßfeder	*Clavette*
F202 - 302 - 303 - 402 403 - 502 - 503	5047	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5044	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5050	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5051	Anello O-ring	*O-ring seal*	O-Ring	*Bague O-ring*

Quando le entrate S,P,HS devono essere fissate alle casse o ai moduli addizionali, le viti di fissaggio, nel caso in cui si trovino in corrispondenza di fori passanti devono avere il trattamento "DRILOC" sul filetto. Se non è possibile reperirle, è indispensabile effettuare un'efficace sigillatura applicando un adeguato prodotto (Loctite 574) sul filetto all'atto del montaggio.

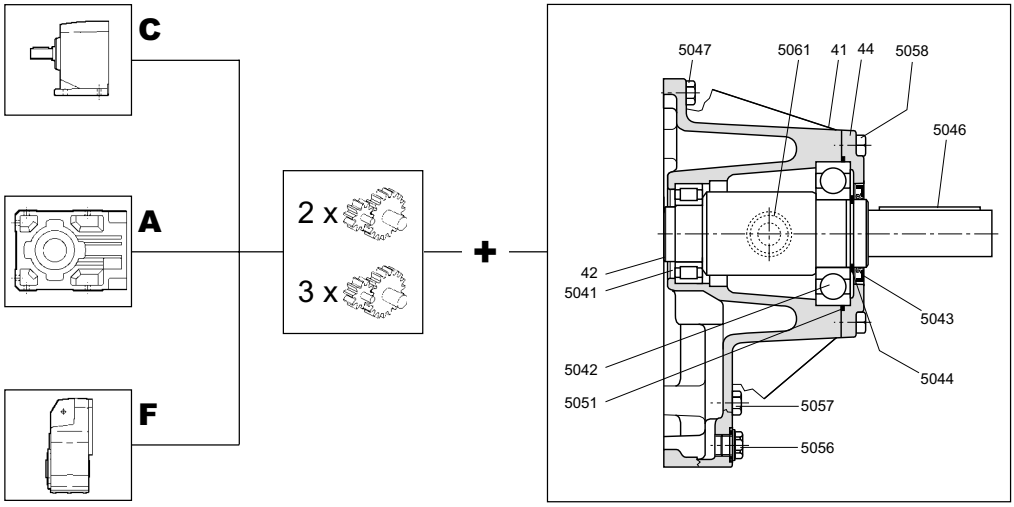
S (integr. motor), P (IEC motor interface), or HS (free shaft) input kits are to be fitted onto the main gear housings or to the additional gear module. Should fasteners engage into through holes, the threads of the forner must be "DRILOC" treated for sealing purposes. If such screws are not available locally, we recommend to apply Loctite 574, or an equivalent product, on the threads before connecting the parts.

Sollten die Antriebe S,P,HS an den Gehäusen oder den zusätzlichen Einheiten befestigt werden, muß auf die Gewinde der Schrauben 5002, 5027, und 5047, falls sie in den durchgehenden Bohrungen angeordnet sein sollten, "DRILOC" aufgetragen werden. Sollte dieses Mittel nicht erhältlich sein, muß bei der Montage durch das Auftragen eines geeigneiten Produkts (Loctite 574) auf das Gewinde, eine haltbare Sicherung gewährleistet werden.

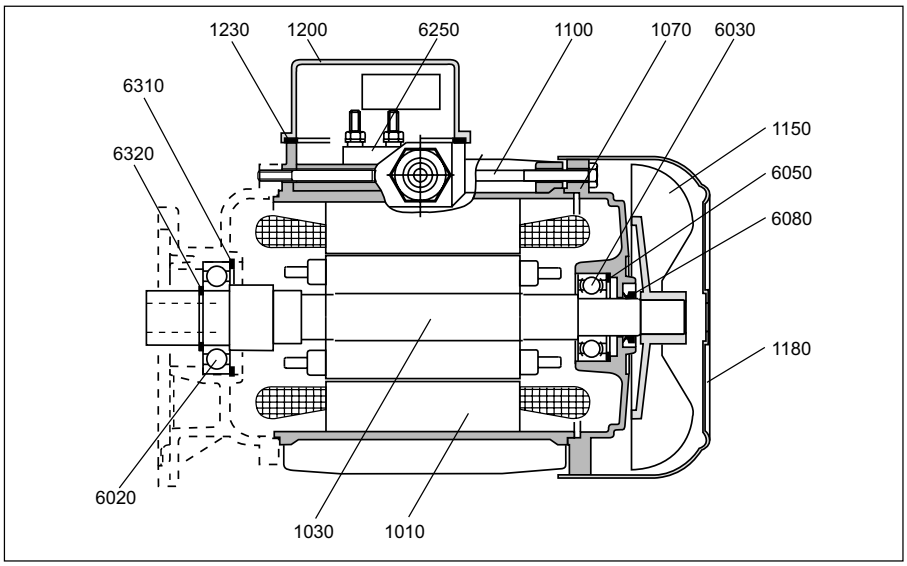
Lorsque les entrée S,P,HS doivent être fixées aux carters ou aux modules additionnels, les vis de fixation, lorsq'elles se trouvent en face des orifices passants, doivent être traitées avec "DRILOC" au niveau du filetage. Si ce produit niest pas disponible, au moment du montage, il est indispensable d'effectuer un scellement efficace en appliquant un produit spécifique (Loctite 574) sur le filetage.



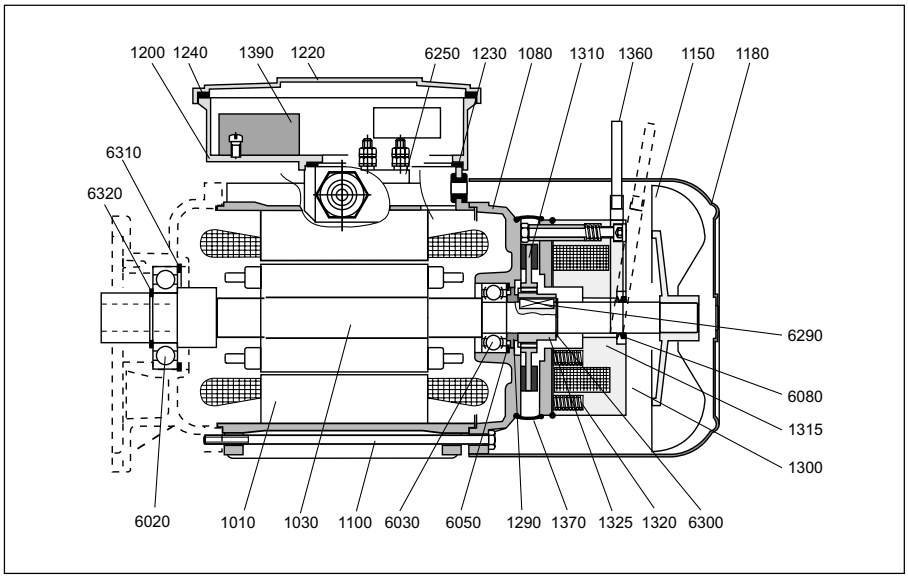
HS_	ref.				
	41	Coperchio	*Cover*	Deckel	*Couvercle*
	42	Albero veloce	*Input shaft*	Antriebswelle	*Arbre d'entrée*
	5041	Cuscinetto	*Bearing*	Kugellager	*Roulement*
C602	5042	Cuscinetto	*Bearing*	Kugellager	*Roulement*
A602 - 603	5043	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
F603	5045	Anello seeger	*Circlip*	Seegerring	*Seeger*
	5046	Linguetta	*Key*	Paßfeder	*Clavette*
	5047	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5050	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*



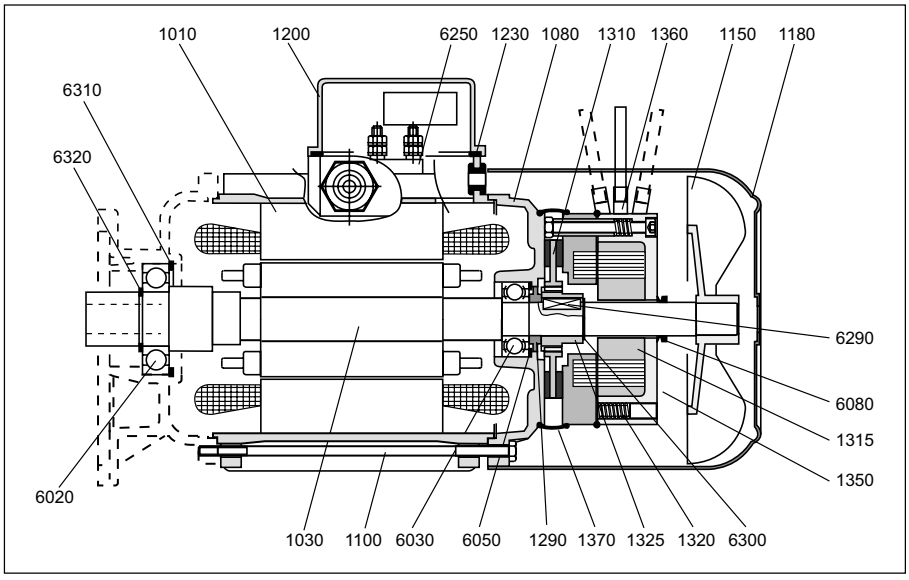
HS_	ref.				
	41	Coperchio	*Cover*	Deckel	*Couvercle*
	42	Albero veloce	*Input shaft*	Antriebswelle	*Arbre d'entrée*
	44	Cappellotto	*Cap*	Deckel	*Capuchon*
	5041	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	5042	Cuscinetto	*Bearing*	Kugellager	*Roulement*
C702 - 703 - 802 - 803 902 - 903 - 1002 - 1003	5043	Anello di tenuta	*Oil seal*	Simmerring	*Bague d'étanchéité*
	5044	Anello seeger	*Circlip*	Seegerring	*Seeger*
A703 - 803 - 903	5046	Linguetta	*Key*	Paßfeder	*Clavette*
	5047	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
F703 - 803 - 903	5051	Anello O-ring	*O-ring seal*	O-ring	*Bague O-ring*
	5056	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5057	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*
	5058	Vite di fissaggio	*Fixing screw*	Befestigungsschraube	*Vis de fixation*
	5061	Tappo olio	*Oil plug*	Ölverschluß	*Bouchon d'huile*



Motore M
M motor
M Motor
Moteur M



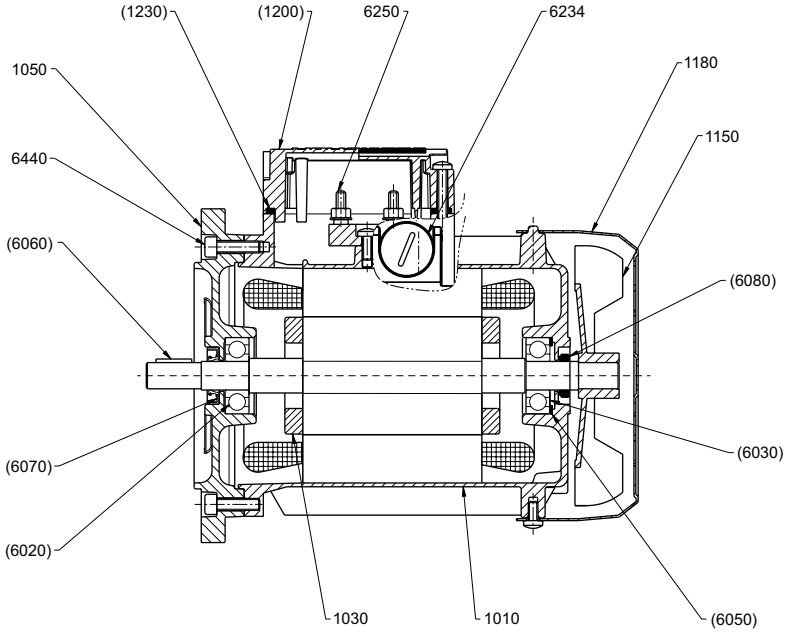
Motore M_FD
M_FD motor
M_FD Motor
Moteur M_FD



Motore M_FA
M_FA motor
M_FA Motor
Moteur M_FA

M	ref.				
M M_FD M_FA	1010	Statore completo	*Stator*	Stator	*Stator*
	1030	Rotore completo	*Rotor*	Läufer	*Rotor*
	1100	Tiranti	*Tie-rods*	Zugbolzen	*Entretoises*
	1150	Ventola	*Fan*	Lüfterrad	*Ventilateur*
	1180	Copriventola	*Fan cowl*	Lüfterraddeckel	*Couvre - ventilateur*
	1200	Scatola coprimorsettiera	*Terminal box lid*	Klemmkastendeckel	*Boîte à bornes*
	1230	Guarnizione scat. coprimors.	*Terminal box seal*	Klemmkastendeckeldichtung	*Joint de la boîte à bornes*
	6020	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	6030	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	6050	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	6080	Anello V-RING	*V-ring*	V-Ring	*Bague V-ring*
	6250	Morsettiera	*Terminal board*	Klemmkasten	*Boîte à bornes*
	6310	Anello seeger	*Circlip*	Seegerring	*Seeger*
	6320	Anello seeger	*Circlip*	Seegerring	*Seeger*
M	1070	Scudo NDE	*NDE shield*	Schild	*Bouclier*
M_FD M_FA	1080	Scudo per mot. autofrenante	*Shield for brake motor*	Schild für Bremsmotor	*Bouclier pour moteur frein*
	1290	Distanziale	*Spacer ring*	Distanzstück	*Entretoise*
	1360	Leva di sblocco	*Hand release lever kit*	Kit Handlüfterhebel	*Kit levier déblocage*
	1370	Protezione freno	*Brake seal kit*	Kit Bremsdichtungen	*Kit bagues frein*
	6290	Linguetta (mozzo freno)	*Key (brake hub)*	Paßfeder (Bremsenabe)	*Clavette (moyeu frein)*
	6300	Anello seeger	*Circlip*	Seegerring	*Seeger*
M_FD	1220	Coperchio scat.coprimorsett.	*Terminal box lid*	Klemmkastendeckel	*Couvercle boîte à bornes*
	1240	Guarniz. coperchio coprim.	*Terminal box seal*	Klemmkastendeckeldichtung	*Joint du couvercle de la boîte à bornes*
	1300	Freno tipo FD c.c.	*d.c. Brake type FD*	Bremstyp FD G.S.	*Frein type FD c.c.*
	1390	Raddrizzatore	*a.c./d.c. Rectifier*	Gleichrichter	*Redresseur*
M_FA	1350	Freno tipo FA c.a.	*a.c. Brake type FA*	Bremstyp FA D.S.	*Frein type FA c.a.*

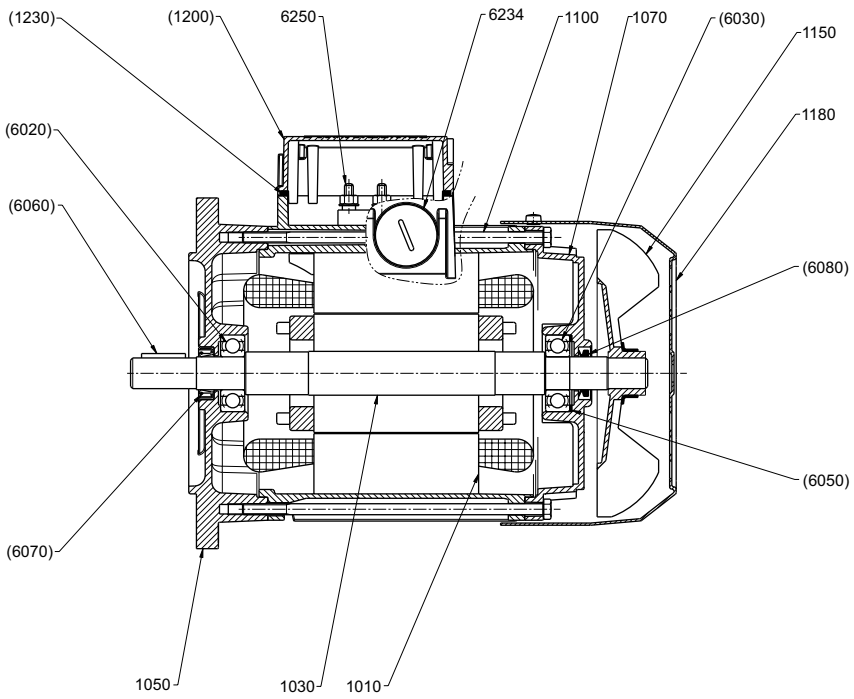
BN 63



kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5/IM B14)	*Mounting flange (IM B5/IM B14)*	Flansch (IM B5/IM B14)	*Bride (IM B5/IM B14)*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione scatola coprimorsettiera	*Terminal box gasket*	Klemmenkastendeckeldichtung	*Joint de la boîte a bornes*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6440	Vite serraggio flangia	*Bolt*	Schraube	*Vis*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*

(####) Disponibile SOLO in kit *(####) Only available as a complete kit* (####) Nür lieferbar als Kit *(####) Disponible seulement en kit*

BN 71...BN 160MR



Kit	rif.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange (B5/B14)*	Flansch (B5/B14)	*Bride (B5/B14)*
	1070	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie-rods*	Zuganker	*Entretoises*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione scatola coprimorsettiera	*Terminal box gasket*	Klemmenkastendeckeldichtung	*Joint de la boîte a bornes*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
KSA	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*

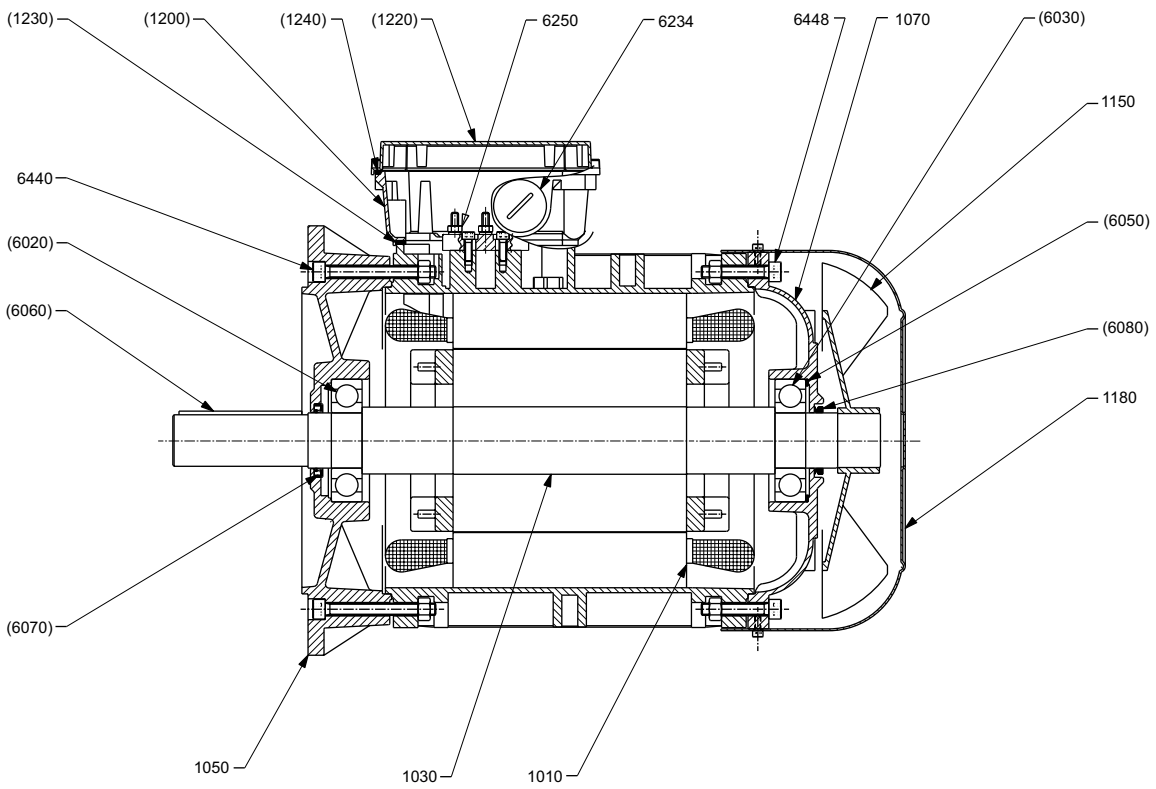
(####) Disponibile SOLO in kit

(####) Only available as a complete kit

(####) Nür lieferbar als Kit

(####) Disponible seulement en kit

BN 160M...BN 200



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5)	*Mounting flange (IM B5)*	Flansch (IM B5)	*Bride (IM B5)*
	1070	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione scatola coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio coprimors.	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle boîte a bornes*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte a bornes*
	6440	Viti flangia	*DE flange bolts*	Flanschschrauben	*Vis bride*
	6448	Viti scudo NDE	*NDE shield bolts*	Motorschildschrauben	*Vis bouclier NDE*
KSA	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*

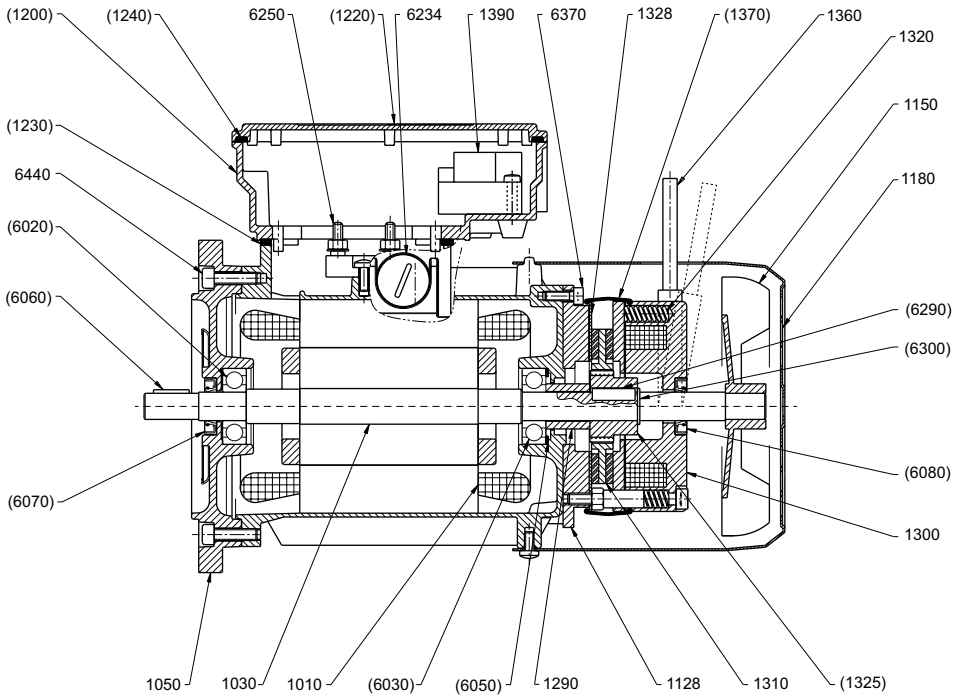
(####) Disponibile SOLO in kit

(####) Only available as a complete kit

(####) Nür lieferbar als Kit

(####) Disponible seulement en kit

BN 63_FD



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange (B5/B14)*	Flansch (B5/B14)	*Bride (B5/B14)*
	1128	Anello attacco freno	*Brake holding plate*	Bremslagerschild	*Anneau attelage frein*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
KSM	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	1300	Freno in c.c. tipo FD	*d.c. brake type FD*	Gleichstrombremse Typ FD	*Frein c.c. type FD*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1360	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1390	Alimentatore ac/dc	*ac/dc rectifier*	Gleichrichter	*Redresseur c.a./c.c.*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6370	Viti fissaggio anello attacco freno	*Bolts*	Schraube	*Vis*
	6440	Viti fissaggio flangia	*Bolts*	Schraube	*Vis*

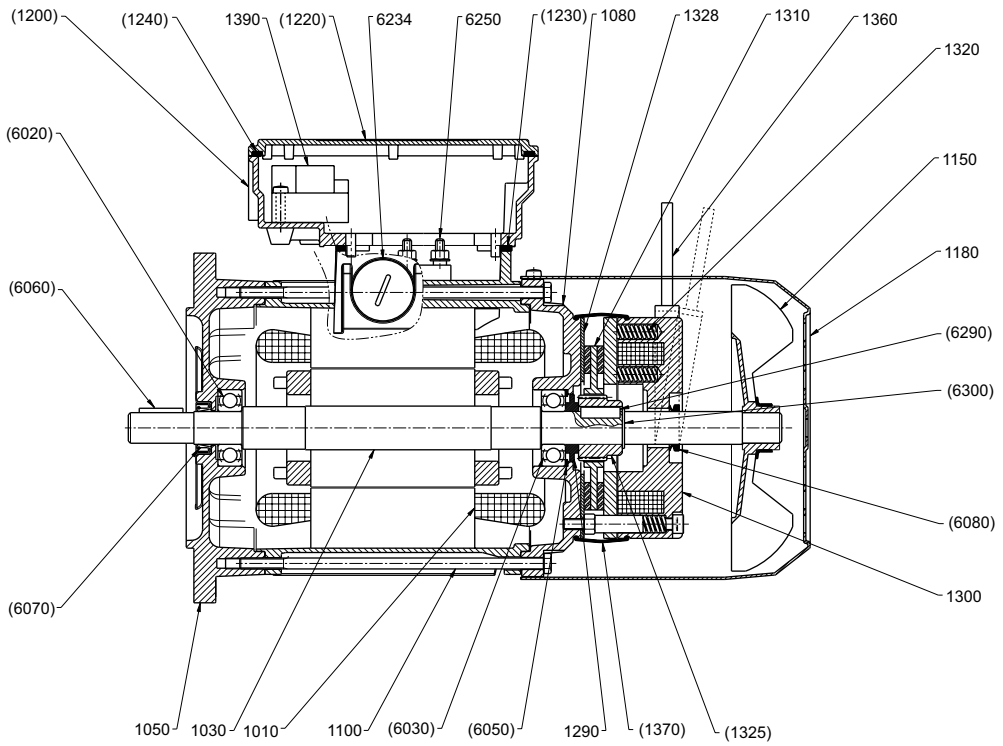
(####) Disponibile SOLO in kit

(####) Only available as a complete kit

(####) Nür lieferbar als Kit

(####) Disponible seulement en kit

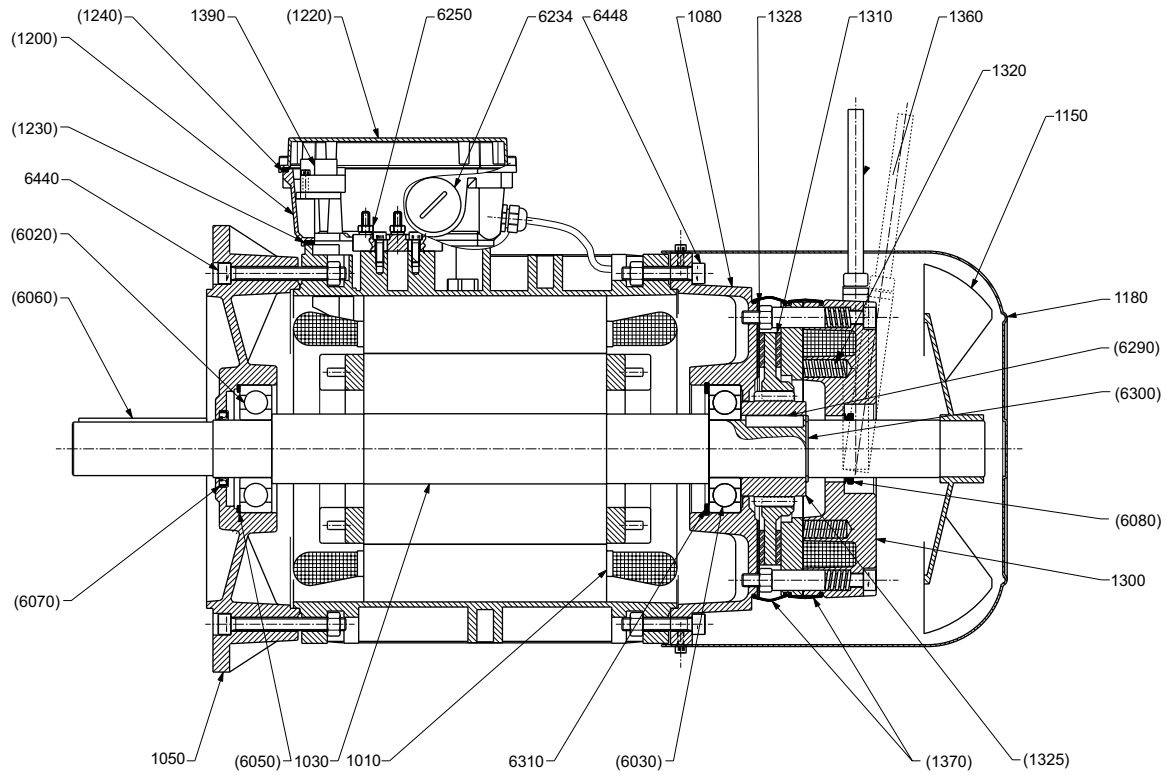
BN 71_FD...BN 160MR_FD



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange*	Flansch (B5/B14)	*Bride (B5/B14)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie-rods*	Zuganker	*Entretoises*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
KSM	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	1300	Freno in c.c. tipo FD	*d.c. brake type FD*	Gleichstrombremse Typ FD	*Frein c.c. type FD*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1360	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1390	Alimentatore ac/dc	*ac/dc rectifier*	Gleichrichter	*Redresseur c.a./c.c.*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*

(####) Disponibile SOLO in kit — *(####) Only available as a complete kit* — (####) Nür lieferbar als Kit — *(####) Disponible seulement en kit*

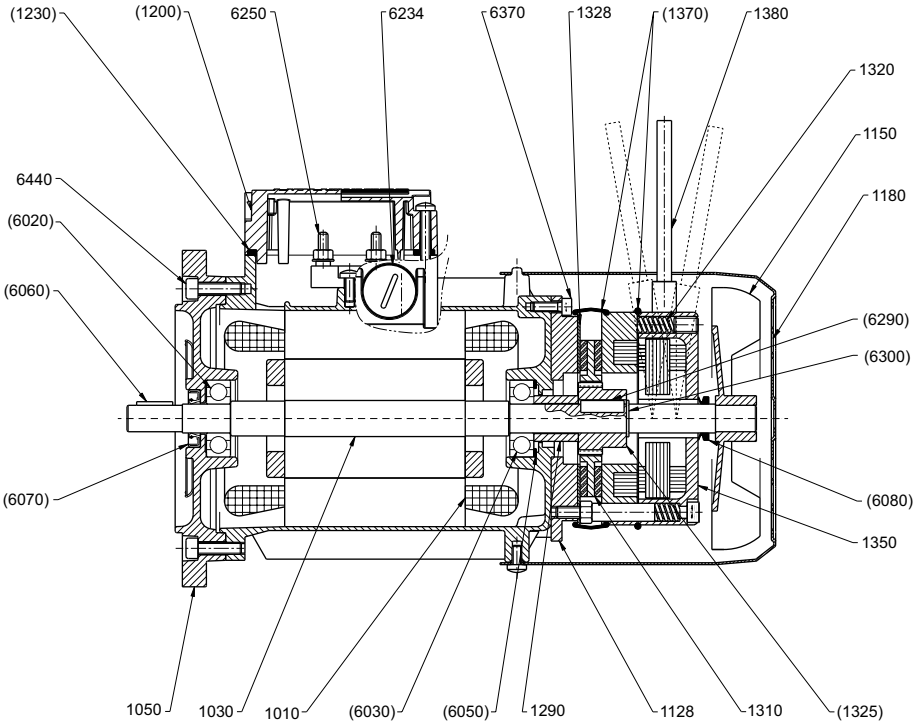
BN 160_FD...BN 200L_FD



kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5)	*Mounting flange (IM B5)*	Flansch (IM B5)	*Bride (IM B5)*
	1080	Scudo NDE	*Rear shield (NDE)*	Lagerschild Nichtantriebsseite	*Bouchier*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
KSM	(1220)	Coperchio coprimorsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio	*Lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1300	Freno in c.c. tipo FD	*d.c. brake type FD*	Gleichstrombremse Typ FD	*Frein c.c. type FD*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1360	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1390	Alimentatore ac/dc	*ac/dc rectifier*	Gleichrichter	*Redresseur c.a./c.c.*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6310	Anello elastico	*Circlip*	Seegerring	*Seeger*
	6440	Viti serraggio flangia	*Bolts DE*	Scraube	*Vis*
	6448	Viti serraggio scudo NDE	*Bolts NDE*	Schraube	*Vis*

(####) Disponibile SOLO in kit — *(####) Only available as a complete kit* — (####) Nür lieferbar als Kit — *(####) Disponible seulement en kit*

BN 63_FA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange (B5/B14)*	Flansch (B5/B14)	*Bride (B5/B14)*
	1128	Anello attacco freno	*Brake holding plate*	Bremslagerschild	*Anneau attelage frein*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cover*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzring	*Entretoise*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1328	Anello in acciaio inox (IP55)	*Stainless steel disc (IP55)*	Anlaufscheibe INOX (IP55)	*Bague en acier inox (IP55)*
	1350	Freno in c.a. tipo FA	*a.c. brake type FA*	Wechselstrombremse Typ FA	*Frein c.a. type FA*
KPF	(1370)	Guarnizione freno (IP55)	*Grommet (IP55)*	Gummiring (IP55)	*Bague frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1380	Leva di sblocco	*Hand release lever*	Handlüfthebel	*Levier déblocage*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Kompensationsring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6370	Viti fissaggio anello attacco freno	*Bolts*	Schraube	*Vis*
	6440	Viti fissaggio flangia	*Bolts*	Schraube	*Vis*

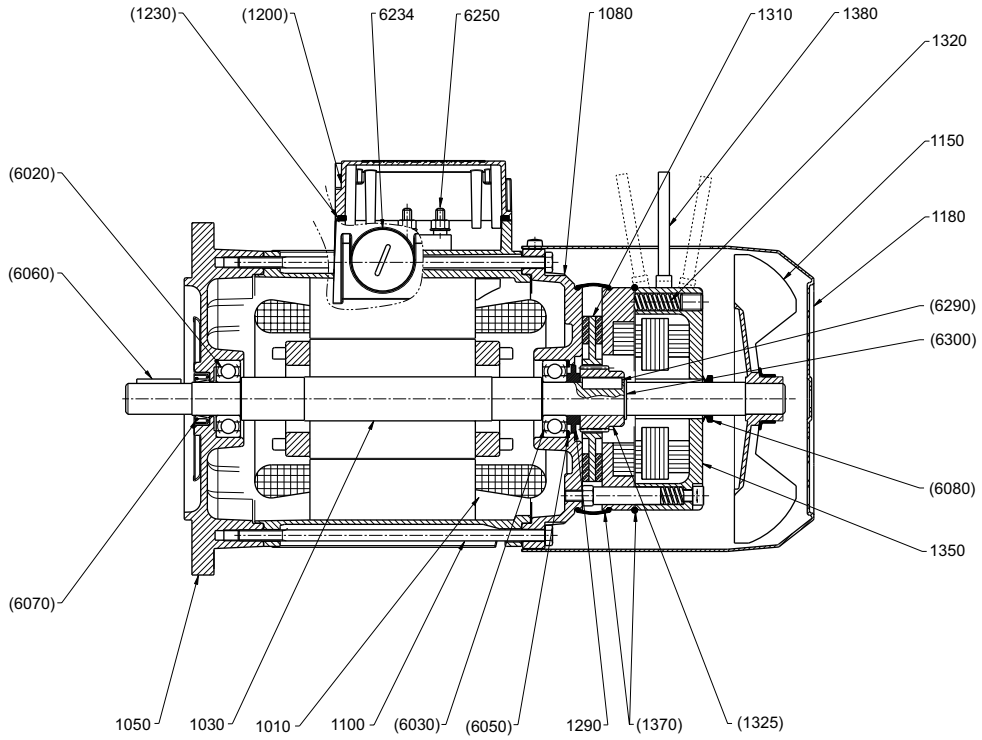
(####) Disponibile SOLO in kit

(####) Only available as a complete kit

(####) Nür lieferbar als Kit

(####) Disponible seulement en kit

BN 71_FA...BN 160MR_FA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange*	Flansch (B5/B14)	*Bride (B5/B14)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie-rods*	Zuganker	*Entretoises*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cowl*	Lüfterhaube	*Couvre ventilateur*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	1290	Distanziale	*Spacer ring*	Distanzstück	*Entretoise*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1350	Freno in c.a. tipo FA	*a.c. brake type FA*	Drehstrombremse Typ FA	*Frein c.a. type FA*
KPF	(1370)	Set guarnizioni freno (IP55)	*Brake seal kit (IP55)*	Gummiring (IP55)	*Set bagues de frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1380	Leva di sblocco	*Hand release lever*	Handlüfterhebel	*Levier déblocage*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*

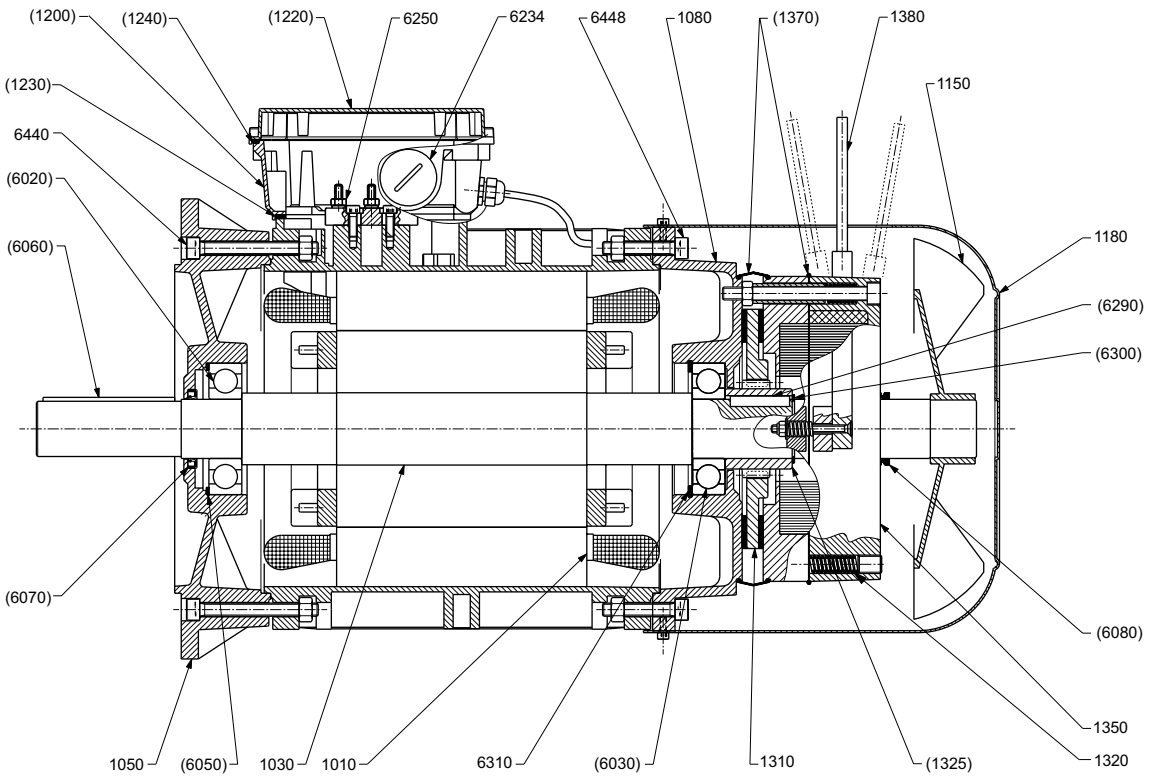
(####) Disponibile SOLO in kit

(####) Only available as a complete kit

(####) Nür lieferbar als Kit

(####) Disponible seulement en kit

BN 160_FA...BN 180M_FA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (IM B5)	*Mounting flange (IM B5)*	Flansch (IM B5)	*Bride (IM B5)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1180	Copriventola	*Fan cowl*	Lüfterhaube	*Couvre ventilateur*
	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
KSM	(1220)	Coperchio scatola morsettiera	*Terminal box lid*	Klemmenkastendeckel	*Couvercle de la boîte a bornes*
	(1230)	Guarnizione scatola morsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	(1240)	Guarnizione coperchio morsettiera	*Terminal box lid gasket*	Klemmenkastendeckeldichtung	*Joint couvercle de la boîte a bornes*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1320	Molle di pressione	*Brake springs*	Bremsfedern	*Ressorts frein*
	(1325)	Mozzo freno	*Brake hub*	Nabe	*Moyeu frein*
KTF	(6290)	Linguetta mozzo freno	*Key (brake hub)*	Paßfeder (Nabe)	*Clavette (moyeu frein)*
	(6300)	Anello elastico	*Circlip*	Seegerring	*Seeger*
	1350	Freno in c.a. tipo FA	*a.c. brake type FA*	Drehstrombremse Typ FA	*Frein c.a. type FA*
KPF	(1370)	Set guarnizioni freno (IP55)	*Brake seal kit (IP55)*	Gummiring (IP55)	*Set bagues de frein (IP55)*
	(6080)	Anello V-ring (IP55)	*V-ring (IP55)*	V-ring (IP55)	*Bague V-ring (IP55)*
	1380	Leva di sblocco	*Hand release lever*	Handlüfterhebel	*Levier déblocage*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Elastic ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*
	6310	Anello elastico	*Circlip*	Seegerring	*Seeger*
	6440	Viti serraggio flangia	*Bolt DE*	Schraube	*Vis*
	6448	Viti serraggio scudo NDE	*Bolt NDE*	Schraube	*Vis*

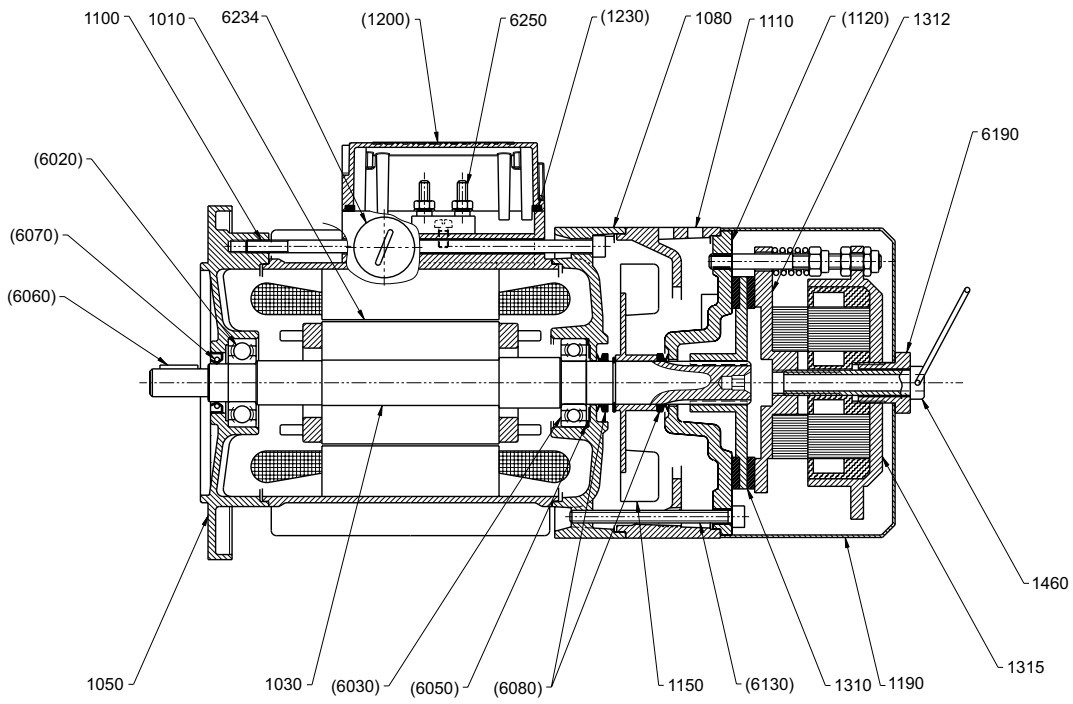
(####) Disponibile SOLO in kit

(####) Only available as a complete kit

(####) Nür lieferbar als Kit

(####) Disponible seulement en kit

BN 63_BA...BN132_BA



Kit	ref.				
	1010	Statore completo	*Stator winding complete*	Stator	*Stator*
	1030	Rotore completo	*Rotor shaft*	Läufer komplett	*Rotor*
	1050	Flangia (B5/B14)	*Mounting flange*	Flansch (B5/B14)	*Bride (B5/B14)*
	1080	Scudo NDE	*Rear shield*	Lagerschild Nichtantriebsseite	*Bouchier*
	1100	Tiranti	*Tie rods*	Zuganker	*Entretoises*
	1110	Convogliatore	*Fan cowling*	Lüftungsbohrung	*Convoyeur*
KSF	(1120)	Anello attacco freno	*Brake holding plate*	Bremshalterung	*Bague d'attaque frein*
	(6130)	Viti	*Bolts*	Schrauben	*Vis*
	1150	Ventola	*Fan*	Lüfter	*Ventilateur*
	1190	Cuffia protezione freno	*Brake guard*	Bremshaube	*Guarde de protection frein*
KSM	(1200)	Scatola coprimorsettiera	*Terminal box*	Klemmenkasten	*Boîte a bornes*
	(1230)	Guarnizione coprimorsettiera	*Terminal box gasket*	Klemmenkastendichtung	*Joint de la boîte a bornes*
	1310	Disco freno	*Brake disc*	Bremsscheibe	*Disc frein*
	1312	Ancora mobile	*Armature plate*	Beweglicher Anker	*Armature mobile*
	1315	Freno in c.a. tipo BA	*a.c. brake type BA*	Drehstrombremse Typ BA	*Frein c.a. type BA*
	1460	Vite di sblocco freno	*Brake release*	Bremslüftungsschraube	*Vis déblocage frein*
	(6020)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
	(6030)	Cuscinetto	*Bearing*	Kugellager	*Roulement*
KSA	(6050)	Anello di compensazione	*Compensation ring*	Federring	*Bague de compensation*
	(6060)	Linguetta	*Key*	Paßfeder	*Clavette*
	(6070)	Anello di tenuta	*Seal ring*	Dichtring	*Bague d'étanchéité*
	(6080)	Anello V-ring	*V-ring*	V-ring	*Bague V-ring*
	6190	Vite forata	*Nut screw*	Mutter	*Vis percé*
	6234	Riduzione filettata M/Pg	*Metric/Pg adapter*	Reduzierstück M/Pg	*Reduction filet à pas Metrique/Pg*
	6250	Morsettiera	*Terminal board*	Klemmenplatte	*Boîte à bornes*

(####) Disponibile SOLO in kit

(####) Only available as a complete kit

(####) Nür lieferbar als Kit

(####) Disponible seulement en kit

10.2 **OPZIONI MOTORI ELETTRICI:**

Antiritorno

10.2 ***ELECTRIC MOTOR OPTIONS:***

Back stop

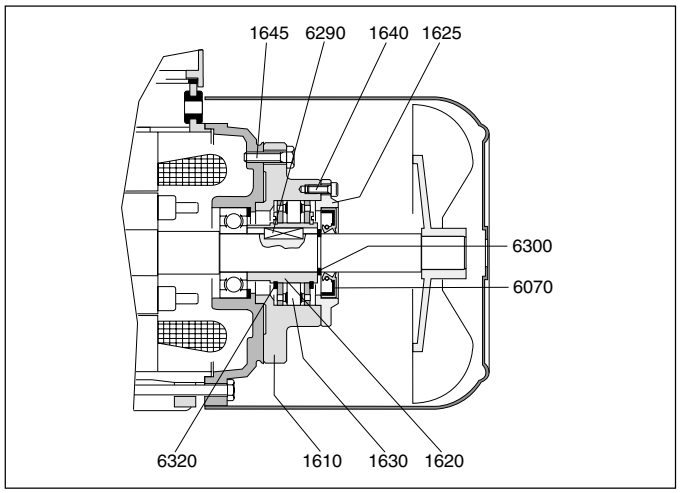
10.2 **BETRIEBSMÖGLICHKEITEN DER ELEKTROMOTOREN:**

Rücklaufsperre

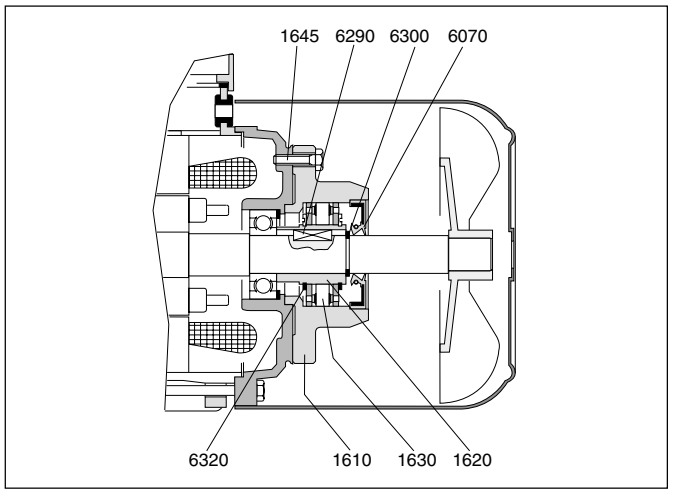
10.2 ***OPTIONS MOTEURS ELECTRIQUES:***

Anti- retour

Motore / *Motor* / Motor / *Moteur* **M1, M2**

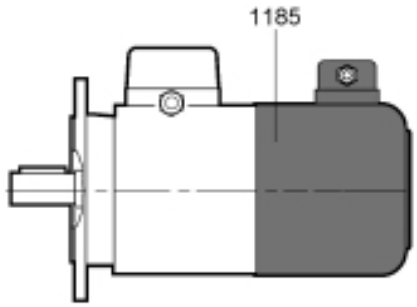


Motore / *Motor* / Motor / *Moteur* **M3, M4**

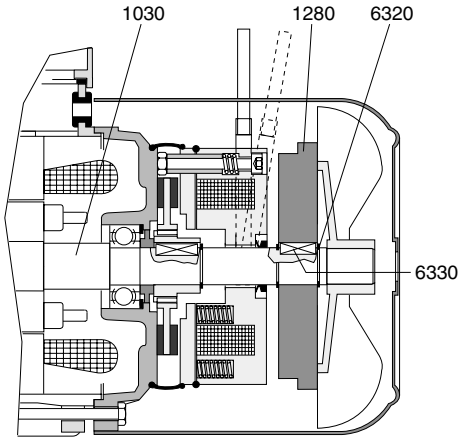


M	ref.				
M1, M2, M3, M4	1610	Boccola esterna	*Backstop housing*	Außenbuchse	*Douille externe*
	1620	Boccola interna	*Bushing*	Innenbuchse	*Douille interne*
	1630	Ruota libera	*Free wheel*	Freies Rad	*Roue libre*
	1645	Vite di fissaggio	*Screw*	Befestigungsschraube	*Vis de fixation*
	6070	Anello di tenuta	*Oil seal*	Dichtungsring	*Joint d'étanchéité*
	6290	Linguetta	*Key*	Paßfeder	*Clavette*
	6300	Seeger	*Circlip*	Seegerring	*Seeger*
	6320	Seeger	*Circlip*	Seegerring	*Seeger*
M1, M2	1625	Cappellotto	*Cap*	Deckel	*Capuchon*
	1640	Vite di fissaggio	*Screw*	Befestigungsschraube	*Vis de fixation*

Servoventilatore
Servo-ventilation
Servoventilator
Servo-vetilateur



Volano
Flywheel
Schwungrad
Volant



M - BN	ref.				
Servoventilatore / *Servo-ventilation* / Servoventilator / *Servo - ventilateur*					
M, BN	1185	Servoventilatore	*Servo-ventilation*	Servoventilator	*Servo - ventilateur*
Volano / *Flywheel* / Schwungrad / *Volant*					
M_FD BN_FD	1030	Albero motore	*Rotor shaft*	Motorwelle	*Arbre moteur*
	1280	Volano	*Flywheel*	Schwungrad	*Volant*
	6320	Seeger	*Circlip*	Seegerring	*Seeger*
	6330	Linguetta	*Key*	Paßfeder	*Clavette*

11.0 LUBRIFICAZIONE

Un sistema misto bagno d'olio-sbattimento garantisce di regola la lubrificazione dei riduttori.
Per alcune posizioni di montaggio, generalmente caratterizzate da uno dei due assi verticali, opportune precauzioni vengono adottate al fine di garantire una adeguata lubrificazione anche agli organi più sfavoriti.

In alcune grandezze di riduttore il particolare lubrificante adottato, cosìddetto "long life" non richiede alcuna sostituzione per tutto l'arco di vita del riduttore stesso il quale pertanto viene fornito privo dei tappi di carico, scarico e livello.
Il primo riempimento viene effettuato da tutti gli stabilimenti Bonfiglioli esclusivamente con lubrificanti sintetici di marca **SHELL**.

Funzionamenti a temperature ambiente ta comprese fra -15 °C e +50°C sono in questo caso ammessi. Per temperature inferiori a -15 °C consigliamo di contattare il ns. Servizio Tecnico.

Riduttori delle taglie superiori sono invece forniti "a secco" e sarà pertanto cura dell'utilizzatore riempirli di lubrificante prima della messa in opera.A questo scopo tali riduttori sono provvisti di tappi di carico, scarico e livello disposti in funzione della posizione di moantaggio specificata in fase di ordinativo (illustrata nella specifica sezione di catalogo).

A garanzia di un funzionamento ottimale Bonfiglioli consiglia di eseguire il primo ed i successivi riempimenti ricorrendo sempre alle elevate prestazioni dei lubrificanti **SHELL**.

Confezioni da 4 l di Shell Tivela Oil SC 320 sono disponibili e possono essere ordinate presso la rete di vendita Bonfiglioli.

11.0 LUBRICATION

Lubrication of gear units is usually provided through a combination of oil bath and oil-splash patterns.
For some mounting positions, typically those featuring a vertical shaft, provisions are made to guarantee lubrication of even the least favourably located drive components.

Smallest gear units are filled in at the factory with a "long life" poliglycol-based lubricant, virtually maintenance-free and thus not requiring oil changes all throughout the operating life of the gearbox. In such a case gear units do not feature oil fill, level and drain plugs.
*Original filling is provided by all Bonfiglioli assembly facilities exclusively with synthetic-base **SHELL** oil.*

Under these conditions operation at ambient temperatures in the range of -15 °C to +50 °C is allowed. Should the unit operate at temperatures well below -15 °C please contact Bonfiglioli's Technical Service for specific directions.

Larger size units are instead supplied dry and it will be the customer care to fill them with lubricant prior to putting them into operation. Consequently such units feature oil plugs properly located according to the particular mounting position specified at the ordering stage (coding shown in the specific catalogue section).

*For a long lasting and trouble-free operation Bonfiglioli recommends that the first fill as well as following replacements are only made using **SHELL** lubricants.*

4 l cans of Shell Tivela Oil SC 320 are available and can be sourced through Bonfiglioli Riduttori's sales network.

11.0 SCHMIERUNG

Normalerweise sorgt ein kombiniertes System aus Ölbad-Ölumlauf für die Gewährleistung der Schmierung der Getriebe.
In einigen Montagepositionen, die im Allgemeinen von einer der beiden senkrechten Achsen gegeben wird, werden, um auch an den ungünstig liegenden Organen eine geeignete Schmierung zu gewährleisten entsprechende Vorsichtsmaßnahmen getroffen.

Bei einigen Getriebegrößen muß das verwendete Schmiermittel, das sogenannte "Long-Life"-Schmiermittel, während der gesamten Lebensdauer des Getriebes nicht mehr gewechselt werden. Aus diesem Grund werden sie auch ohne jeglichen Einfüll- sowie Ablaßverschluß und ohne Pegelanzeige geliefert. Die Füllung erfolgt direkt in den Bonfiglioli-Werken, dabei werden ausschließlich nur synthetische Schmiermittel der Marke **SHELL** verwendet.

In diesem Fall ist der Getriebeeinsatz unter Umgebungstemperaturen zwischen –15°C und +50°C zulässig. Bei Temperaturen unter –15°C empfehlen wir, sich mit unserem Technischen Kundendienst abzustimmen.

Die größeren Getriebe werden "trocken" geliefert, d.h. der Anwender muß vor der Inbetriebnahme das entsprechende Schmiermittel zugeben. Zu diesem Zweck sind diese Getriebe mit Einfüll- sowie Ablaßschrauben und mit einer Pegelanzeige ausgestattet, die der, bei der Auftragsgebung angegebenen Montageposition (im entsprechenden Abschnitt des Katalogs angegeben) entsprechend angeordnet sind.

Um den optimalen Betrieb gewährleisten zu können, empfiehlt die Bonfiglioli sowohl die Erstbefüllung als auch die nachfolgenden Füllungen mit den stark belastungsfähigen Schmiermitteln der **SHELL** vorzunehmen.

Die 4-Liter-Behälter des "Shell Tivela Oil SC 320" können bei den Verkaufsstellen der Bonfiglioli angefordert werden.

11.0 LUBRIFICATION

Normalement, un système mixte bain d'huile-barbotage garantit la lubrification des réducteurs.
Pour certaines positions de montage, généralement caractérisées par un des deux axes verticaux, des précautions opportunes sont adoptées afin de garantir une lubrification adéquate, même des organes les plus mal placés.

Sur certaines tailles de réducteur, le lubrifiant particulier adopté, de type " ong life", ne nécessite aucun remplacement au cours de la durée de vie du réducteur, par conséquent, ce dernier est fourni sans bouchon de remplissage, de vidange et de niveau.
*Le premier remplissage est effectué par tous les établissements Bonfiglioli, exclusivement avec des lubrifiants synthétiques de marque **SHELL**.*

Dans ce cas, des fonctionnements à des températures ambiantes comprises entre –15°C et + 50°C sont admis. En cas de températures inférieures à –15°C, il est conseillé de contacter notre service technique.

Au contraire, les réducteurs de tailles supérieures sont fournis " à sec", par conséquent, l'utilisateur doit se charger de les remplir avec du lubrifiant avant leur mise en service.
Dans ce but, ces réducteurs sont équipés de bouchon de remplissage, de vidange et de contrôle du niveau situés en fonction de la position de montage spécifiée au moment de la commande (voir chapitre spécifique dans le catalogue).

*Afin de garantir un fonctionnement optimal, nous vous conseillons d'effectuer le premier remplissage, ainsi que les suivants, en utilisant toujours des lubrifiants **SHELL**, dont les performances sont élevées.*

Des bidons de 4 l de Shell Tivela Oil SC 320 sont disponibles et peuvent être commandés dans les points du réseau de vente Bonfiglioli.

Lubrificante di fornitura originale Bonfiglioli Riduttori / *Original Bonfiglioli's supply* Schmiermittel der Orginalfüllung – Bonfiglioli Riduttori / *Lubrifiants de fourniture originale Bonfiglioli Riduttori*	
Riduttori ad ingranaggi elicoidali / *Helical and bevel helical gear unit* Stirnradgetriebe und Kegelradgetriebe / *Réducteurs à engrenages hélicoïdaux*	**SHELL Tivela Oil SC 320**

Qualora il lubrificante sintetico, preferibile per le superiori prestazioni, non sia disponibile localmente è consentito, **solo per i riduttori ad ingranaggi elicoidali e non per i riduttori a vite senza fine**, l'uso di lubrificante a base minerale. In questo caso suggeriamo l'uso di **SHELL Omala 220**.

*Should the synthetic lubricant option, preferred performancewise, not be available locally it is allowed, **for helical and bevel helical units only, NOT for worm units**, the use of a mineral-base oil. In this case **SHELL Omala 220** must be considered as the preferred option.*

Sollte das bei höheren Leistungsausbringungen empfohlene synthetische Schmiermittel vor Ort nicht verfügbar sein, kann, **nur für die Stirnradgetriebe, Kegelradgetriebe und auf keinen Fall für die Schneckengetriebe**, auch ein Schmiermittel auf Mineralbasis verwendet werden. In diesem Fall empfehlen wir den Einsatz von **SHELL Omala 220**.

*Si le lubrifiant synthétique, préférable pour ses performances supérieures, n'est pas disponible sur place, il est possible **uniquement en ce que concerne les réducteurs à engrenages hélicoïdaux et non les réducteurs à vis sans fin**, d'utiliser un lubrifiant à base minérale. Dans ce cas, nous conseillons d'utiliser **SHELL Omala 220**.*

Bonfiglioli infine raccomanda che, qualora il lubrificante venga scelto al di fuori del tipo SHELL consigliato, questo sia di composizione equivalente in merito alla natura sintetica e alla viscosità, inoltre sia dotato degli opportuni additivi con funzione antischiuma.

Bonfiglioli finally recommends that should the oil type be selected outside the recommended SHELL range the same is at least of equivalent composition as to the synthetic base and viscosity index besides including the appropriate anti-foam additives.

Die Bonfiglioli weist letztendlich darauf hin, daß falls man ein von den empfohlenen SHELL-Typen abweichendes Schmiermittel wählen sollte, daß dieses in bezug auf seine synthetische Herkunft und Viskosität gleichwertig zusammengesetzt und darüber hinaus über geeignete Schaumschutzstoffe verfügen sollte.

Enfin, en cas de choix autre que le type SHELL conseillé, nous vous recommandons de choisir un lubrifiant équivalent, tant du point de vue de la nature synthétique que de la viscosité, de plus, sa composition doit comprendre des additifs anti-mousse appropriés.

11.1 LUBRIFICAZIONE RIDUTTORI SERIE C

11.1 LUBRICATION OF HELICAL UNITS, C SERIES

11.1 SERIE C GETRIEBES SCHMIERUNG

11.1 LUBRIFICATION REDUCTEURS SERIE C

I riduttori dal tipo C102 al tipo C403 compreso, sono forniti con lubrificazione permanente ad olio sintetico e non necessitano di alcuna manutenzione.
Gli altri tipi sono predisposti per la lubrificazione ad olio e pertanto dotati dei tappi di carico, livello e scarico olio (tabelle S71 e S72); sarà cura dell'utente immettere il lubrificante avvalendosi delle quantità (litri) indicate in tabella (S70).
Evidenziamo però che tali quantità sono indicative, pertanto l'esatto livello dovrà essere valutato osservandolo dall'apposita spia (con il riduttore già installato nella corretta posizione di montaggio).

Gearboxes from C102 to C403 are life lubricated with synthetic oil and do not require any maintenance.
The remaining types are designed for oil lubrication and therefore have oil filling, level and drain plugs (tables S71 and S72);
users should fill the units with oil, consulting table (S70), with the correct quantity (litres).
However, it must be underlined that these quantities are only guidelines, therefore users should check the correct level through the oil level plug (when the gearbox is installed in its correct mounting position).

Die Getriebe von Typ C102 bis Typ C403 werden mit Dauerschmierung mit Syntheseöl geliefert und sind wartungsfrei.
Die anderen sind für die Ölschmierung vorgerüstet und verfügen daher über einen Einfüllverschluß, Ölstands-und Öl-ablaßschrauben (Tabelle S71 und S72). Das Öl muß vom Kunden in der in Tabelle (S70) angegebenen Menge (Liter) eingefüllt werden. Wir weisen jedoch darauf hin, daß es sich bei diesen Angaben nur um Richtwerte handelt und daher der tatsächlich Ölbedarf durch das Schauglas geprüft werden muß (das Getriebe muß sich hierzu schon in seiner endgültigen Einbaulage befinden).

Les réducteurs du type C102 au type C403 compris sont fournis avec lubrification permanente à l' huile synthétique et n'ont besoin d'aucun entretien.
Les autres types sont prédisposés pour la lubrification à l'huile et par conséquent dotés de bouchons de remplissage, niveau et vidange d'huile (tableau S71 et S72); l'utilisateur devra introduire le lubrifiant en se conformant aux quantités (litres) indiqués sur le tableau (S70).
Ces quantités sont toutefois indicatives et le niveau exact devra être contrôlé par le voyant spécial (avec le réducteur déjà installé dans la position correcte de montage).

Quantità di lubrificante [l] — *Oil quantity [l]* — Schmiermittelmenge [l] — *Quantité de lubrifiant [l]*

(S70a)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*																							
	P						UP - UPF						F						U - UF					
	B3	B6	B7	B8	V5	V6	B3	B6	B7	B8	V5	V6	B5	B51	B53	B52	V1	V3	B5	B51	B53	B52	V1	V3
C102 S-HS	0.52	0.52	0.52	0.52	0.52	0.52	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
C102 P63/71	0.52	0.52	0.52	0.52	0.52	0.72°	0.47	0.47	0.47	0.47	0.47	0.67°	0.47	0.47	0.47	0.47	0.47	0.67°	0.47	0.47	0.47	0.47	0.47	0.67°
C102 P80/112	0.52	0.52	0.52	0.52	0.52	0.82°	0.47	0.47	0.47	0.47	0.47	0.77°	0.47	0.47	0.47	0.47	0.47	0.77°	0.47	0.47	0.47	0.47	0.47	0.77°
C202 S-HS	0.85	0.85	0.85	0.85	0.85	0.85	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
C202 P63/71	0.85	0.85	0.85	0.85	0.85	1.05°	0.80	0.80	0.80	0.80	0.80	1.00°	0.80	0.80	0.80	0.80	0.80	1.00°	0.80	0.80	0.80	0.80	0.80	1.00°
C202 P80/112	0.85	0.85	0.85	0.85	0.85	1.15°	0.80	0.80	0.80	0.80	0.80	1.10°	0.80	0.80	0.80	0.80	0.80	1.10°	0.80	0.80	0.80	0.80	0.80	1.10°
C203 S-HS	1.30	1.30	1.30	1.30	1.30	1.30	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
C203 P63/71	1.30	1.30	1.30	1.30	1.30	1.5°	1.25	1.25	1.25	1.25	1.25	1.45°	1.25	1.25	1.25	1.25	1.25	1.45°	1.25	1.25	1.25	1.25	1.25	1.45°
C203 P80/112	1.30	1.30	1.30	1.30	1.30	1.6°	1.25	1.25	1.25	1.25	1.25	1.55°	1.25	1.25	1.25	1.25	1.25	1.55°	1.25	1.25	1.25	1.25	1.25	1.55°
C302 S-HS-P63/112	1.50	1.50	1.50	1.50	1.50	1.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
C303 S-HS-P63/112	1.80	1.80	1.80	1.80	1.80	1.80	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78

(S70b)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*																							
	P						UP - UPF						F						U - UF					
	B3	B6	B7	B8	V5	V6	B3	B6	B7	B8	V5	V6	B5	B51	B53	B52	V1	V3	B5	B51	B53	B52	V1	V3
C402 S-HS-(P63...112)	2.80	2.80	2.80	2.80	2.80	2.80	2.15	2.15	2.15	2.15	2.25	2.15	2.80	2.80	2.80	2.80	2.65	2.80	2.15	2.15	2.15	2.15	2.25	2.15
C402 P132°	3.80	3.80	3.80	3.80	2.80	4.40	3.00	3.00	3.00	3.00	2.25	3.80	3.40	3.40	3.40	3.40	2.65	4.20	3.00	3.00	3.00	3.00	2.25	3.80
C403 S-HS-(P63...112)	3.60	3.60	3.60	3.60	3.60	3.60	2.95	2.95	2.95	2.95	2.95	2.95	3.35	3.35	3.35	3.35	3.35	3.35	2.95	2.95	2.95	2.95	2.95	2.95
***C502** S-HS-(P63...112-160/180)	3.40	4.20	2.50	4.30	4.30	3.60	2.60	3.40	1.90	3.60	3.00	2.20	3.00	3.30	2.20	3.90	4.30	2.80	2.60	3.40	1.90	3.60	3.00	2.20
***C502** P132°	4.40	4.40	3.50	5.30	4.50	5.40	3.60	4.40	2.90	4.60	3.20	4.00	4.00	4.30	3.20	4.90	4.50	4.60	3.60	4.40	2.90	4.60	3.20	4.00
***C503** S-HS-(P63...112)	4.00	3.50	3.50	4.90	6.40	4.00	3.20	3.00	2.90	4.10	5.10	3.10	3.60	3.30	3.10	4.50	5.70	3.90	3.20	3.00	2.90	4.10	5.10	3.10
***C602** S-HS-(P63...112-160/180)	4.10	3.90	4.20	4.70	6.10	4.60	2.50	3.00	3.40	4.60	4.40	3.90	3.70	3.50	3.70	4.30	5.50	4.50	2.50	3.00	3.40	4.60	4.40	3.90
***C603** P132°	5.10	4.90	5.20	5.70	6.30	6.40	3.50	4.00	4.40	5.60	4.60	5.70	4.70	4.50	4.70	5.30	5.70	6.30	3.50	4.00	4.40	5.60	4.60	5.70
***C603** S-HS-(P63...112-160/180)	5.00	4.70	4.50	4.20	7.70	5.50	3.10	3.60	3.80	3.70	6.20	4.90	4.70	4.30	4.10	4.20	7.30	5.80	3.10	3.60	3.80	3.70	6.20	4.90
***C702 - C703**	6.50	8.50	8.50	7.50	10.5	7.50	—	—	—	—	—	—	—	6.50	—	—	10.5	7.50	6.50	—	—	—	10.5	7.50
***C704**	6.50	8.50	8.50	7.50	10.5	7.50	—	—	—	—	—	—	—	6.50	—	—	10.5	7.50	6.50	—	—	—	10.5	7.50
***C802 - C803**	10.6	14.1	14.1	12.6	17.5	12.6	—	—	—	—	—	—	—	10.6	—	—	17.5	12.6	10.6	—	—	—	17.5	12.6
***C804**	10.6	14.1	14.1	12.6	17.5	12.6	—	—	—	—	—	—	—	10.6	—	—	17.5	12.6	10.6	—	—	—	17.5	12.6
***C902 - C903**	18.7	25.0	25.0	22.1	30.8	22.1	—	—	—	—	—	—	—	18.7	—	—	30.8	22.1	18.7	—	—	—	30.8	22.1
***C904**	18.7	25.0	25.0	22.1	30.8	22.1	—	—	—	—	—	—	—	18.7	—	—	30.8	22.1	18.7	—	—	—	30.8	22.1
***C1002 - C1003**	27.4	36.7	36.7	32.5	45.2	32.5	—	—	—	—	—	—	—	27.4	—	—	45.2	32.5	27.4	—	—	—	45.2	32.5

Lubrificazione permanente

* = La quantità è indicativa. Controllare il riempimento attraverso il relativo vetro spia.

° = Il riempiemento parziale o totale deve essere effettuato dal foro presente sulla flangia P

Life lubricated

* = *Quantity is indicative. Check filling through the sight glass.*

° = *The oil must be fitted through the hole located on the motor flange.*

Dauerschmierung

* = Bei der angegebenen Menge handelt es sich um einen Anhaltswert. Den Füsstand über das entsprechendeKontrollglaskontrollieren.

° = Ein teilweise oder vollkommene Füllung muss über die Bohrung am Flaschn erfolgen.

Lubrification permanente

* = *In allen anderen Fällen, den Verschluss geschlossen lassen.*

° = *Le remplissage partiel ou total doit s'effectuer au moyen de l'orifice positionné sur la bride.*

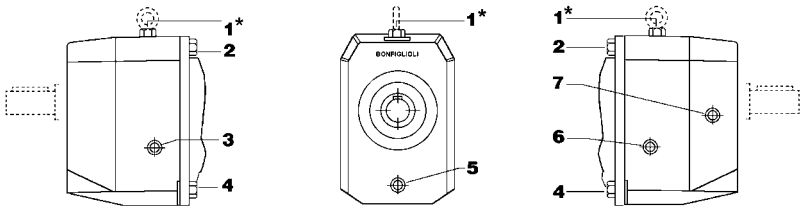
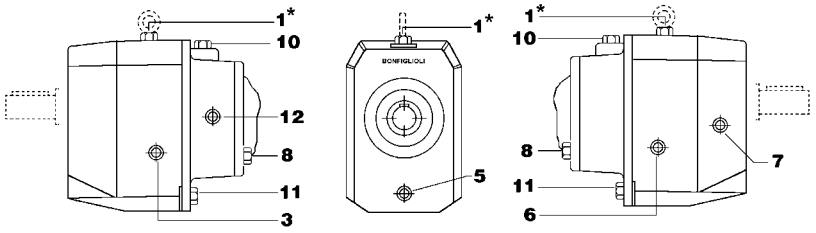
Posizione dei tappi di carico, scarico e livello olio

Positions of oil filling, level and drain plugs.

Anordnung des Einfüllv, Ölstands- und Ölablaßschrauben.

Position des bouchons de remplissage, niveau et vidange d'huile.

(S71)

C102 C202 C302 C402 C502 C602 C702 C703 C802 C803 C902 C903 C1002 C1003	
C203 C303 C403 C503 C603 C704 C804 C904 C1004	

* Nel tipo C60_ i riduttori sono forniti con un golfare al posto del tappo n.1. In fase di installazione, il golfare dovrà essere rimosso e sostituito con il tappo allegato.

** Gear units type C60_ are supplied with an eyebolt in lieu of plug ref. 1. After the unit is installed, remove the eyebolt and replace it with the plug provided.*

* Die Getriebetypen C60_ werden mit einer Ösenschraube anstelle der Schraube 1 geliefert. Bei der Montage muß die ÖsenSchraube entfernt und durch den mitgelieferten Verschluß ersetzt werden.

** Dans les types C60_ les réducteurs sont équipés d'un anneau à la place du bouchon n.1. En phase d'installation, l' anneau devra être enlevé et remplacé par le bouchon annexé.*

Dimensioni e collocazione dei tappi di carico, scarico e livello olio.

Dimensions and location of oil filling, level and drain plugs.

Abmessungen und Anordnung des Einfüll, Ölstands-und Ölablaßschrauben.

Dimensions et emplacement des bouchons de remplissage, de vidange et niveau d'huile.

(S72a)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*																							
	P - UP - UPF																							
	B3				**B6**				**B7**				**B8**				**V6**			
	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132
C102	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C202	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C203	4	T (1/4")	4	T (1/4")	8	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C302	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C303	4	T (1/4")	4	T (1/4")	8	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C402	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C403	4	T (1/4")	4	T (1/4")	8	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C502	2	CF (3/8")	2	C (3/8")	3	S (3/8")	3	S (3/8")	3	CF (3/8")	3	C (3/8")	2	S (3/8")	2	S (3/8")	4	S (3/8")	4	S (3/8")
	4	S (3/8")	4	S (3/8")	4	L (3/8")	4	L (3/8")	4	L (3/8")	4	L (3/8")	6	L (3/8")	6	L (3/8")	3	L (3/8")	3	L (3/8")
	7	L (3/8")	7	L (3/8")	7	CF (3/8")	6	C (3/8")	6	S (3/8")	6	S (3/8")	4	CF (3/8")	4	C (3/8")	7	CF (3/8")	7	CF (3/8")
			13	F*			13	F*			13	F*			13	F*				
C503	7	L (3/8")	7	L (3/8")	3	S (3/8")	3	S (3/8")	3	CF (3/8")	3	C (3/8")	6	L (3/8")	6	L (3/8")	3	L (3/8")	3	L (3/8")
	10	CF (3/8")	10	C (3/8")	7	CF (3/8")	7	C (3/8")	6	S (3/8")	6	S (3/8")	10	S (3/8")	10	S (3/8")	7	CF (3/8")	7	CF (3/8")
	11	S (3/8")	11	S (3/8")	11	L (3/8")	11	L (3/8")	11	L (3/8")	11	L (3/8")	11	CF (3/8")	11	C (3/8")	4	S (1/4")	4	S (1/4")
			13	F*			13	F*			13	F*			13	F*				
C602	1	CF (M14)	1	C (M14)	1	L (M14)	1	L (M14)	1	L (M14)	1	L (M14)	1	S (M14)	1	S (M14)	1	L (M14)	1	L (M14)
	3	L (1/2")	3	L (1/2")	3	S (1/2")	3	S (1/2")	3	CF (1/2")	3	C (1/2")	5	CF (1/2")	5	C (1/2")	4	S (3/8")	4	S (3/8")
	5	S (1/2")	5	S (1/2")	6	CF (1/2")	6	C (1/2")	6	S (1/2")	6	S (1/2")	6	L (3/8")	6	L (3/8")	5	CF (1/2")	5	CF (1/2")
			13	F*			13	F*			13	F*			13	F*				
C603	1	CF (M14)	1	C (M14)	1	L (M14)	1	L (M14)	1	L (M14)	1	L (M14)	1	S (M14)	1	S (M14)	1	L (M14)	1	L (M14)
	5	S (1/2")	5	S (1/2")	3	S (1/2")	3	S (1/2")	3	CF (1/2")	3	C (1/2")	5	CF (1/2")	5	C (1/2")	5	CF (1/2")	5	CF (1/2")
	12	L (3/8")	12	L (3/8")	6	CF (1/2")	6	C (1/2")	6	S (1/2")	6	S (1/2")	12	L (3/8")	12	L (3/8")	4	S (1/4")	4	S (1/4")
			13	F*			13	F*			13	F*			13	F*				
C702	1	CF (1/2")	1	CF (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	S (1/2")	1	S (1/2")	1	L (1/2")	1	L (1/2")
C703	3	L (1/2")	3	L (1/2")	3	S (1/2")	3	S (1/2")	3	S (1/2")	3	S (1/2")	3	L (1/2")	3	L (1/2")	4	S (1/2")	4	S (1/2")
	4	S (1/2")	4	S (1/2")	7	CF (1/2")	7	CF (1/2")	7	CF (1/2")	7	CF (1/2")	4	CF (1/2")	4	CF (1/2")	7	CF (1/2")	7	CF (1/2")
C704	1	CF (1/2")	1	CF (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	S (1/2")	1	S (1/2")	1	L (1/2")	1	L (1/2")
	11	S (1/2")	11	S (1/2")	3	S (1/2")	3	S (1/2")	3	CF (1/2")	3	CF (1/2")	11	CF (1/2")	11	CF (1/2")	7	CF (1/2")	7	CF (1/2")
	3	L (1/2")	3	L (1/2")	7	CF (1/2")	7	CF (1/2")	7	S (1/2")	7	S (1/2")	3	L (1/2")	3	L (1/2")	11	S (1/2")	11	S (1/2")
C802	1	CF (1/2")	1	CF (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	S (1/2")	1	S (1/2")	3	L (1/2")	3	L (1/2")
C803	3	S (1/2")	3	S (1/2")	3	S (1/2")	3	S (1/2")	3	CF (1/2")	3	CF (1/2")	3	L (1/2")	3	L (1/2")	4	S (1/2")	4	S (1/2")
	4	L (1/2")	4	L (1/2")	7	CF (1/2")	7	CF (1/2")	7	S (1/2")	7	S (1/2")	4	CF (1/2")	4	CF (1/2")	7	CF (1/2")	7	CF (1/2")
C804	1	CF (1/2")	1	CF (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	S (1/2")	1	S (1/2")	3	L (1/2")	3	L (1/2")
	11	S (1/2")	11	S (1/2")	3	S (1/2")	3	S (1/2")	3	CF (1/2")	3	CF (1/2")	11	CF (1/2")	11	CF (1/2")	7	CF (1/2")	7	CF (1/2")
	3	L (1/2")	3	L (1/2")	7	CF (1/2")	7	CF (1/2")	7	S (1/2")	7	S (1/2")	3	L (1/2")	3	L (1/2")	11	S (1/2")	11	S (1/2")
C902	1	CF (1/2")	1	CF (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	S (1/2")	1	S (1/2")	1	L (1/2")	1	L (1/2")
C903	3	S (1/2")	3	S (1/2")	3	S (1/2")	3	S (1/2")	3	CF (1/2")	3	CF (1/2")	3	L (1/2")	3	L (1/2")	4	S (1/2")	4	S (1/2")
	4	L (1/2")	4	L (1/2")	7	CF (1/2")	7	CF (1/2")	7	S (1/2")	7	S (1/2")	4	CF (1/2")	4	CF (1/2")	7	CF (1/2")	7	CF (1/2")
C904	1	CF (1/2")	1	CF (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	L (1/2")	1	S (1/2")	1	S (1/2")	1	L (1/2")	1	L (1/2")
	11	S (1/2")	11	S (1/2")	3	S (1/2")	3	S (1/2")	3	CF (1/2")	3	CF (1/2")	11	CF (1/2")	11	CF (1/2")	7	CF (1/2")	7	CF (1/2")
	3	L (1/2")	3	L (1/2")	7	CF (1/2")	7	CF (1/2")	7	S (1/2")	7	S (1/2")	3	L (1/2")	3	L (1/2")	11	S (1/2")	11	S (1/2")
C1002	1	CF (1")	1	CF (1")	1	L (1")	1	L (1")	1	L (1")	1	L (1")	1	S (1")	1	S (1")	1	L (1")	1	L (1")
C1003	3	S (1")	3	S (1")	3	S (1")	3	S (1")	3	CF (1")	3	CF (1")	3	L (1")	3	L (1")	4	S (1")	4	S (1")
	4	L (1")	4	L (1")	7	CF (1")	7	CF (1")	7	S (1")	7	Z (1")	4	CF (1")	4	CF (1")	7	CF (1")	7	CF (1")
C1004	1	CF (1")	1	CF (1")	1	L (1")	1	L (1")	1	L (1")	1	L (1")	1	S (1")	1	S (1")	1	L (1")	1	L (1")
	11	S (1")	11	S (1")	3	S (1")	3	S (1")	3	CF (1")	3	CF (1")	11	CF (1")	11	CF (1")	7	CF (1")	7	CF (1")
	3	L (1")	3	CF (1")	7	CF (1")	7	CF (1")	7	S (1")	7	S (1")	3	L (1")	3	L (1")	11	S (1")	11	S (1")

(S72b)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*																			
	F - U - UF																			
	B5				**B51**				**B53**				**B52**				**V3**			
	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132
C102	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C202	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C203	4	T (1/4")	4	T (1/4")	8	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C302	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*
C303	4	T (1/4")	4	T (1/4")	8	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")	4	T (1/4")
			13	F*			13	F*			13	F*			13	F*			13	T*

(S72c)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*																							
	F - U - UF																							
	B5				B51				B53				B52				V3							
	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132	•	S-HS-P	•	P≤132				
C402	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")				
			13	**F***			**13**	**F***			**13**	**F***			**13**	**F***			**13**	**F***				
C403	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")	**4**	**T** (1/4")				
			13	**F***			**13**	**F***			**13**	**F***	**13**		**13**	**F***			**13**	**F***				
C502	**2**	**CF** (3/8")	**2**	**C** (3/8")	**3**	**S** (3/8")	**3**	**S** (3/8")	**3**	**CF** (3/8")	**3**	**C** (3/8")	**2**	**S** (3/8")	**2**	**S** (3/8")	**4**	**S** (3/8")	**4**	**S** (3/8")				
	4	**S** (3/8")	**4**	**S** (3/8")	**4**	**L** (3/8")	**4**	**L** (3/8")	**4**	**L** (3/8")	**4**	**L** (3/8")	**6**	**L** (3/8")	**6**	**L** (3/8")	**3**	**L** (3/8")	**3**	**L** (3/8")				
	7	**L** (3/8")	**7**	**L** (3/8")	**7**	**CF** (3/8")	**6**	**C** (3/8")	**6**	**S** (3/8")	**6**	**S** (3/8")	**4**	**CF** (3/8")	**4**	**C** (3/8")	**7**	**CF** (3/8")	**7**	**CF** (3/8")				
			13	**F***			**13**	**F***			**13**	**F***			**13**	**F***								
C503	**7**	**L** (3/8")	**7**	**L** (3/8")	**3**	**S** (3/8")	**3**	**S** (3/8")	**3**	**CF** (3/8")	**3**	**C** (3/8")	**6**	**L** (3/8")	**6**	**L** (3/8")	**3**	**L** (3/8")	**3**	**L** (3/8")				
	10	**CF** (3/8")	**10**	**C** (3/8")	**7**	**CF** (3/8")	**7**	**C** (3/8")	**6**	**S** (3/8")	**6**	**S** (3/8")	**10**	**S** (3/8")	**10**	**S** (3/8")	**7**	**CF** (3/8")	**7**	**CF** (3/8")				
	11	**S** (3/8")	**11**	**S** (3/8")	**11**	**L** (3/8")	**11**	**L** (3/8")	**11**	**L** (3/8")	**11**	**L** (3/8")	**11**	**CF** (3/8")	**11**	**C** (3/8")	**4**	**S** (1/4")	**4**	**S** (1/4")				
			13	**F***			**13**	**F***			**13**	**F***			**13**	**F***								
C602	**1**	**CF** (M14)	**1**	**C** (M14)	**1**	**L** (M14)	**1**	**L** (M14)	**1**	**L** (M14)	**1**	**L** (M14)	**1**	**S** (M14)	**1**	**S** (M14)	**1**	**L** (M14)	**1**	**L** (M14)				
	3	**L** (1/2")	**3**	**L** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**C** (1/2")	**5**	**CF** (1/2")	**5**	**C** (1/2")	**4**	**S** (3/8")	**4**	**S** (3/8")				
	5	**S** (1/2")	**5**	**S** (1/2")	**6**	**CF** (1/2")	**6**	**C** (1/2")	**6**	**S** (1/2")	**6**	**S** (1/2")	**6**	**L** (3/8")	**6**	**L** (3/8")	**5**	**CF** (1/2")	**5**	**CF** (1/2")				
			13	**F***			**13**	**F***			**13**	**F***			**13**	**F***								
C603	**1**	**CF** (M14)	**1**	**C** (M14)	**1**	**L** (M14)	**1**	**L** (M14)	**1**	**L** (M14)	**1**	**L** (M14)	**1**	**S** (M14)	**1**	**S** (M14)	**1**	**L** (M14)	**1**	**L** (M14)				
	5	**S** (1/2")	**5**	**S** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**C** (1/2")	**5**	**CF** (1/2")	**5**	**C** (1/2")	**5**	**CF** (1/2")	**5**	**CF** (1/2")				
	12	**L** (3/8")	**12**	**L** (3/8")	**6**	**CF** (1/2")	**6**	**C** (1/2")	**6**	**S** (1/2")	**6**	**S** (1/2")	**12**	**L** (3/8")	**12**	**L** (3/8")	**4**	**S** (1/4")	**4**	**S** (1/4")				
			13	**F***			**13**	**F***			**13**	**F***			**13**	**F***								
C702 **C703**	**1**	**CF** (1/2")	**1**	**CF** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**S** (1/2")	**1**	**S** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")				
	3	**L** (1/2")	**3**	**L** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**CF** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")				
	4	**S** (1/2")	**4**	**S** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**S** (1/2")	**7**	**S** (1/2")	**21**	**CF** (1/2")	**21**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")				
C704	**1**	**CF** (1/2")	**1**	**CF** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**S** (1/2")	**1**	**S** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")				
	11	**S** (1/2")	**11**	**S** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**CF** (1/2")	**11**	**CF** (1/2")	**11**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")				
	3	**L** (1/2")	**3**	**L** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**S** (1/2")	**7**	**S** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")	**11**	**S** (1/2")	**11**	**S** (1/2")				
C802 **C803**	**1**	**CF** (1/2")	**1**	**CF** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**S** (1/2")	**1**	**S** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")				
	3	**L** (1/2")	**3**	**L** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**CF** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")				
	4	**S** (1/2")	**4**	**S** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**S** (1/2")	**7**	**S** (1/2")	**21**	**CF** (1/2")	**21**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")				
C804	**1**	**CF** (1/2")	**1**	**CF** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**S** (1/2")	**1**	**S** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")				
	11	**S** (1/2")	**11**	**S** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**CF** (1/2")	**11**	**CF** (1/2")	**11**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")				
	3	**L** (1/2")	**3**	**L** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**S** (1/2")	**7**	**S** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")	**11**	**S** (1/2")	**11**	**S** (1/2")				
C902 **C903**	**1**	**CF** (1/2")	**1**	**CF** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**S** (1/2")	**1**	**S** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")				
	3	**L** (1/2")	**3**	**L** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**CF** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")				
	4	**S** (1/2")	**4**	**S** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**S** (1/2")	**7**	**S** (1/2")	**21**	**CF** (1/2")	**21**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")				
C904	**1**	**CF** (1/2")	**1**	**CF** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")	**1**	**S** (1/2")	**1**	**S** (1/2")	**1**	**L** (1/2")	**1**	**L** (1/2")				
	11	**S** (1/2")	**11**	**S** (1/2")	**3**	**S** (1/2")	**3**	**S** (1/2")	**3**	**CF** (1/2")	**3**	**CF** (1/2")	**11**	**CF** (1/2")	**11**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")				
	3	**L** (1/2")	**3**	**L** (1/2")	**7**	**CF** (1/2")	**7**	**CF** (1/2")	**7**	**S** (1/2")	**7**	**S** (1/2")	**3**	**L** (1/2")	**3**	**L** (1/2")	**11**	**S** (1/2")	**11**	**S** (1/2")				
C1002 **C1003**	**1**	**CF** (1")	**1**	**CF** (1")	**1**	**L** (1")	**1**	**L** (1")	**1**	**L** (1")	**1**	**L** (1")	**1**	**S** (1")	**1**	**S** (1")	**1**	**L** (1")	**1**	**L** (1")				
	3	**L** (1")	**3**	**L** (1")	**3**	**S** (1")	**3**	**S** (1")	**3**	**CF** (1")	**3**	**CF** (1")	**3**	**L** (1")	**3**	**L** (1")	**4**	**S** (1")	**4**	**S** (1")				
	4	**S** (1")	**4**	**S** (1")	**7**	**CF** (1")	**7**	**CF** (1")	**7**	**S** (1")	**7**	**S** (1")	**21**	**CF** (1")	**21**	**CF** (1")	**7**	**CF** (1")	**7**	**CF** (1")				
C1004	**1**	**CF** (1")	**1**	**CF** (1")	**1**	**L** (1")	**1**	**L** (1")	**1**	**L** (1")	**1**	**L** (1")	**1**	**S** (1")	**1**	**S** (1")	**1**	**L** (1")	**1**	**L** (1")				
	11	**S** (1")	**11**	**S** (1")	**3**	**S** (1")	**3**	**S** (1")	**3**	**CF** (1")	**3**	**CF** (1")	**11**	**CF** (1")	**11**	**CF** (1")	**7**	**CF** (1")	**7**	**CF** (1")				
	3	**L** (1")	**3**	**L** (1")	**7**	**CF** (1")	**7**	**CF** (1")	**7**	**S** (1")	**7**	**S** (1")	**3**	**L** (1")	**3**	**L** (1")	**11**	**S** (1")	**11**	**S** (1")				

Legenda:

C Tappo di sfiato
F Tappo di carico
L Tappo di livello
S Tappo di scarico
T Tappo chiuso
A Tappo livello con asta
p Prolunga

Key:

C *Vented plug*
F *Fill plug*
L *Level plug*
S *Drain plug*
T *Closed plug*
A *Dipstick*
p *Extension*

Zeichenerklärung:

C Einfüll- und Ablaßschrauber
F Einfüllschraube
L Ölstandsschraube
S Ölablaßschraube
T geschlossene Schraube
A Verschluss mit Pegelstab
p Verlängerung

Légende:

C *Bouchon de remplissage/évent*
F *Goulotte de remplissage*
L *Bouchon de niveau*
S *Bouchon de vidange*
T *Bouchon fermé*
A *Bouchon de niveau avec tige*
p *Rallonge*

* P 63, P 71, P 80, P 90 1/8" GAS
P 100, P 112 1/4" GAS
P 132 3/8" GAS

• Numero di riferimento delle posizioni dei tappi di carico, scarico e livello olio come da tabella (S71).

• Reference number for positions of oil filling, level and drain plugs as shown in table (S71).

• Bezugsnummer der Positionen des Einfüll Ölstands-und Ölablaßschrauben (Siehe TabelleS71).

• Numéro de référence des positions des bouchons de remplissage, vidange et niveau d'huile comme d'après tableau (S71).

Posizioni dimontaggio e orientamento morsettiera

Per i riduttori C50 - C100, dalle posizioni standard B3 e B5 è possibile ottenere le altre (B6,B7,B8,V5 e V1) disponendo i tappi come indicato nelle tabelle (S72a) e (S72b) provvedendo ad immettere la corretta quantità di lubrificante riportata in tabella (S70b) relativa alla nuova posizione scelta.

Mounting position and terminal box angular position

The B6, B7, B8, V5 and V1 mounting positions of gear units C50 through C100 can be obtained from the original B3 and B5 arrangemets by re-locating the oil plugs, as indicated in tables (S72a) and (S72b) and adjusting the relevant oil quantity, as per table (S70b).

Einbaulagen und lage des klemmenkastens

Von den Standardpositionen B3 und B5 gelangt man zu den anderen Positionen (B6, B7, B8, V5 und V1), indem man die Verschlußschrauben wie in den Tabellen, (S72a) und (S72b) angegeben anordnet.

Positions de montage et orientation boite a borne

A partir des positions standard B3 et B5, il est possible d'obtenir les autres (B6, B7, B8, V5 et V1) en disposant les bouchons comme indiqué sur les tableaux (S72a) et (S72b).

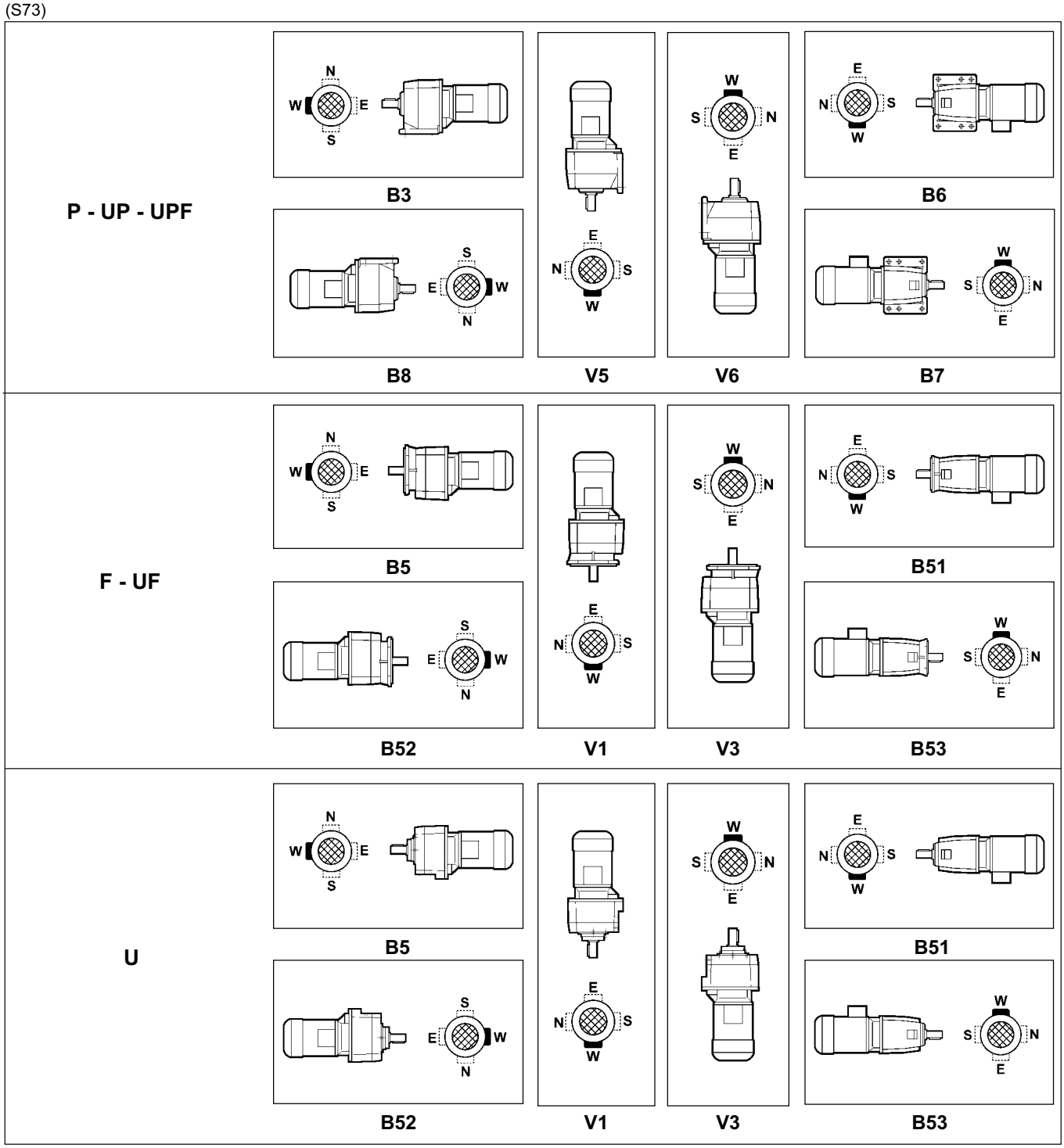
Fanno eccezione a questa regola le posizioni V3 e V6 (per i riduttori suddetti) le quali dovranno obbligatoriamente essere richieste nella corretta configurazione alla BONFIGLIOLI RIDUTTORI in quanto è indispensabile schermare alcune parti interne.
Gli orientamenti delle morsettiere dei motori sono identificati osservando il motore dal lato ventola; l'orientamento standard è evidenziato in nero **(W)** come indicato nella tabella (S73).

Positions V3 and V6 (for sizes C50 - C100) are an exception to this rule. These must be ordered to BONFIGLIOLI RIDUTTORI in their correct configuration as some internal parts require separate lubrication activities.
Orientation of motor terminal boxes can be determined by observing the motor from the fan side; standard orientation is highlighted in black ***(W)*** *as in table (S73).*

Von dieser Regel aus-genommen sind die Anordnungen V3 und V6 (für die Typen C50 - C100), die obligatorisch mit der gewünschten Konfiguration bei BONFIGLIOLI RIDUTTORI bestellt werden müssen, da einige innere Bauteile zusätzlich abgeschirmt werden müssen.
Die Angaben zur Lage des Klemmenkastens beziehen sich auf das von der Lüfterseite her betrachtete Getriebe. Die Standardorientierung ist schwarz hervorgehoben **(W)**, wie in Abbildung (S73) angegeben.

Les positions V3 et V6 (pour les types C50- C100) ne suivent pas cette règle. Elles devront obligatoirement être demandées dans la configuration correcte à BONFIGLIOLI RIDUTTORI étant donné qu'il est indispensable de proteger certaines parties intérieures.
Les orientations des boîtes à bornes des moteurs sont définies en regardant le moteur du côté ventilateur. L'orientation standard est indiquée en noir ***(W)*** *comme d'après le tableau (S73).*

(S73)



11.2 LUBRIFICAZIONE RIDUTTORI SERIE S

I riduttori dal tipo S101 al tipo S401 compreso, sono forniti con lubrificazione permanente ad olio sintetico e non necessitano di sostituzioni periodiche del lubrificante.
Il tipo S501 è predisposto per la lubrificazione ad olio e pertanto dotato dei tappi di carico, livello e scarico olio (tabelle S74 e S75); sarà cura dell'utente immettere il lubrificante avvalendosi delle quantità (litri) indicate in tabella (S76).
Evidenziamo però che tali quantità sono indicative, pertanto l'esatto livello dovrà essere valutato osservandolo dall'apposita spia (con il riduttore già installato nella corretta posizione di montaggio).

11.2 LUBRICATION OF SINGLE REDUCTION UNITS, S SERIES

Gearboxes from S101 to S401 are life lubricated with synthetic oil and do not require any periodical oil changes.
The remaining type S501 is designed for oil lubrication and therefore has filling, level and drain plugs (tables S74 and S75); users should fill the units with oil, consulting table (S76), with the correct quantity (litres).
However, it must be underlined that these quantities are only guidelines, therefore users should check the correct level through the oil level plug (when the gearbox is installed in its correct mounting position).

11.2 SERIE S GETRIEBES SCHMIERUNG

Die Getriebe von Typ S101 bis Typ S401 werden mit Dauerschmierung mit Syntheseöl geliefert und sind wartungsfrei.
Die anderen sind für die Ölschmierung vorgerüstet und verfügen daher über einen Einfüllverschluß, Ölstands-und Ölablaßschrauben (Tabelle S74 und S75). Das Öl muß vom Kunden in der in Tabelle (S76) angegebenen Menge (Liter) eingefüllt werden.
Wir weisen jedoch darauf hin, daß es sich bei diesen Angaben nur um Richtwerte handelt und daher der tatsächlich Ölbedarf durch das Schauglas geprüft werden muß (das Getriebe muß sich hierzu schon in seiner endgültigen Einbaulage befinden).

11.2 LUBRIFICATION REDUCTEURS SERIE S

Les réducteurs du type S101 au type S401 compris sont fournis avec lubrification permanente à l' huile synthétique et n'ont besoin d'aucun entretien.
Le type S501 est prédisposé pour la lubrification à l'huile et par conséquent doté de bouchons de remplissage, niveau et vidange d'huile (tableau S74 et S75); l'utilisateur devra introduire le lubrifiant en se conformant aux quantités (litres) indiqués sur le tableau (S76).
Ces quantités sont toutefois indicatives et le niveau exact devra être contrôlé par le voyant spécial (avec le réducteur déjà installé dans la position correcte de montage).

Dimensioni e collocazione dei tappi di carico, scarico e livello olio.

Dimensions and location of oil filling, level and drain plugs.

Abmessungen und Anordnung des Einfüll, Ölstands-und Ölablaßschrauben.

Dimensions et emplacement des bouchons de remplissage, de vidange et niveau d'huile.

(S74)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*																							
	P												**F**											
	•	**B3**	•	**B6**	•	**B7**	•	**B8**	•	**V5**	•	**V6**	•	**B5**	•	**B51**	•	**B52**	•	**B53**	•	**V1**	•	**V3**
S101	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")
S201	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")
S301	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")
S401	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")	**3**	**T** (1/4")
	1	**C** (3/8")	**2**	**S** (3/8")	**2**	**C** (3/8")	**1**	**S** (3/8")	**1**	**C** (3/8")	**1**	**S** (3/8")	**1**	**C** (3/8")	**2**	**S** (3/8")	**1**	**C** (3/8")	**2**	**S** (3/8")	**1**	**C** (3/8")	**1**	**S** (3/8")
S501	**3**	**S** (3/8")	**3**	**L** (3/8")	**3**	**L** (3/8")	**5**	**L** (3/8")	**4**	**L** (3/8")	**4**	**L** (3/8")	**3**	**S** (3/8")	**3**	**L** (3/8")	**5**	**L** (3/8")	**3**	**L** (3/8")	**4**	**L** (3/8")	**4**	**L** (3/8")
	2	**L** (3/8")	**4**	**C** (3/8")	**4**	**S** (3/8")	**3**	**C** (3/8")	**5**	**S** (3/8")	**5**	**C** (3/8")	**2**	**L** (3/8")	**4**	**C** (3/8")	**3**	**S** (3/8")	**4**	**C** (3/8")	**5**	**S** (3/8")	**5**	**C** (3/8")

Legenda:

C Tappo di carico/sfiato
L Tappo di livello
S Tappo di scarico
T Tappo chiuso

Key:

C *Filling/breather plug*
L *Level plug*
S *Drain plug*
T *Closed plug*

Zeichenerklärung:

C Einfüll- und Ablaßschrauber
L Ölstandsschraube
S Ölablaßschraube
T geschlossene Schraube

Légende:

C *Bouchon de remplissage/évent*
L *Bouchon de niveau*
S *Bouchon de vidange*
T *Bouchon fermé*

• Numero di riferimento delle posizioni dei tappi di carico, scarico e livello olio come da tabella (S75)

• Reference number for positions of oil filling, level and drain plugs as shown in table (S75).

• Bezugsnummer der Positionen des Einfüll Ölstands-und Ölablaßschrauben (Siehe TabelleS75).

• Numéro de référence des positions des bouchons de remplissage, vidange et niveau d'huile comme d'après tableau (S75).

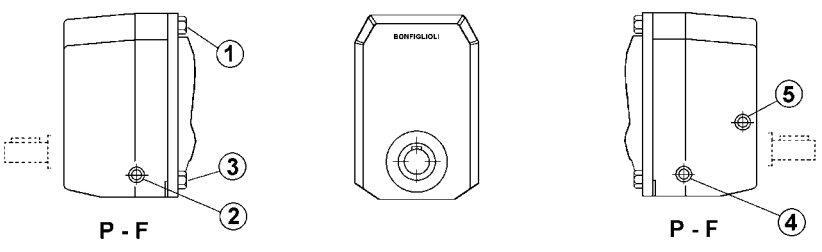
Posizione dei tappi di carico, scarico e livello olio

Positions of oil filling, level and drain plugs.

Anordnung des Einfüllv, Ölstands- und Ölablaßschrauben.

Position des bouchons de remplissage, niveau et vidange d'huile.

(S75)

S101 **S201** **S301** **S401** **S501**	

Quantità di lubrificante [l] *Oil quantity [l]* Schmiermittelmenge [l] *Quantité de lubrifiant [l]*

(S76)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*											
	P						**F**					
	B3	**B6**	**B7**	**B8**	**V5**	**V6**	**B5**	**B51**	**B53**	**B52**	**V1**	**V3**
S101 **S-HS**	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
S101 **P63...112°**	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
S201 **S-HS**	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
S201 **P63...112°**	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
S301 **S-HS**	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
S301 **P63...112°**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S401 **S-HS**	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
S401 **P63...112°**	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
S401 **P132°**	2.60	2.60	2.60	2.60	2.60	3.20	2.60	2.60	2.60	2.60	2.60	3.20
***S501** **S-HS**	1.20	2.70	1.85	3.20	2.70	2.00	1.30	3.10	2.60	1.50	3.00	2.00
***S501** **P63...112-160/180**	1.40	2.90	2.05	3.40	2.90	2.40	1.50	3.20	2.80	1.70	3.20	2.20
***S501** **P132°**	2.20	3.70	2.85	4.20	3.70	3.70	2.30	4.10	3.70	2.50	4.00	3.70

Lubrificazione permanente

* = La quantità è indicativa. Controllare il riempimento attraverso il relativo vetro spia.

° = Il riempiemento parziale o totale deve essere effettuato dal foro presente sulla flangia P

Life lubricated

* = *Quantity is indicative. Check filling through the sight glass.*

° = *Fill the gear unit through the hole located on the motor flange.*

Dauerschmierung

* = Bei der angegebenen Menge handelt es sich um einen Anhaltswert. Den Füsstand über das entsprechende Kontrollglas kontrollieren.

° = Ein teilweise oder vollkommene Füllung muss über die Bohrung am Flaschn erfolgen.

Lubrification permanente

* = *La quantité est citée seulement à titre indicatif. Contrôler le remplissage par le hublot de visite correspondant.*

° = *Le remplissage partiel ou total doit s'effectuer au moyen de l'orifice positionné sur la bride.*

Posizioni di montaggio e orientamento morsettiera

Per il riduttore S501 dalle posizioni standard B3 e B5 è possibile ottenere le altre (B6,B7,B8,V5 e V1) disponendo i tappi come indicato nelle tabelle (S74) e (S75) e provvedendo all'aggiunta di un quantitativo di olio tale da rispettare le indicazioni della tabella (S76) per la nuova posizione di montaggio.

Fanno eccezione a questa regola le posizioni V3 e V6 (per il tipo S501) le quali dovranno obbligatoriamente essere richieste nella corretta configurazione a BONFIGLIOLI RIDUTTORI in quanto è indispensabile schermare alcune parti interne.

Mounting position and terminal box position

The B6, B7, B8, V5 and V1 mounting positions of model S501 can be obtained from the base mounting positions B3 and B5, by re-locating the oil plugs, as indicated in the table (S74) and (S75). Oil quantity must be adjusted as per table (S76).

Mounting positions V3 and V6 instead must be specified at the time of ordering, as specific arrangemets are made at the factory.

Einbaulagen und lage des klemmenkastens

Von den Standardpositionen B3 und B5 (S501) gelangt man zu den anderen Positionen (B6, B7, B8, V5 und V1), indem man die Verschlußschrauben wie in den Tabellen (S74) und (S75) angegeben anordnet.

Von dieser Regel aus-genommen sind die Anordnungen V3 und V6 (für die Type S501), die obligatorisch mit der gewünschten Konfiguration bei BONFIGLIOLI RIDUTTORI bestellt werden müssen, da einige innere Bauteile zusätzlich abgeschirmt werden müssen.

Positions de montage et orientation boite a borne

Pour le réducteurs S501à partir des positions standard B3 et B5, il est possible d'obtenir les autres (B6, B7, B8, V5 et V1) en disposant les bouchons comme indiqué sur les tableaux (S74) et (S75).

Les positions V3 et V6 (pour les type S501) ne suivent pas cette règle. Elles devront obligatoirement être demandées dans la configuration correcte à BONFIGLIOLI RIDUTTORI étant donné qu'il est indispensable de proteger certaines parties intérieures.

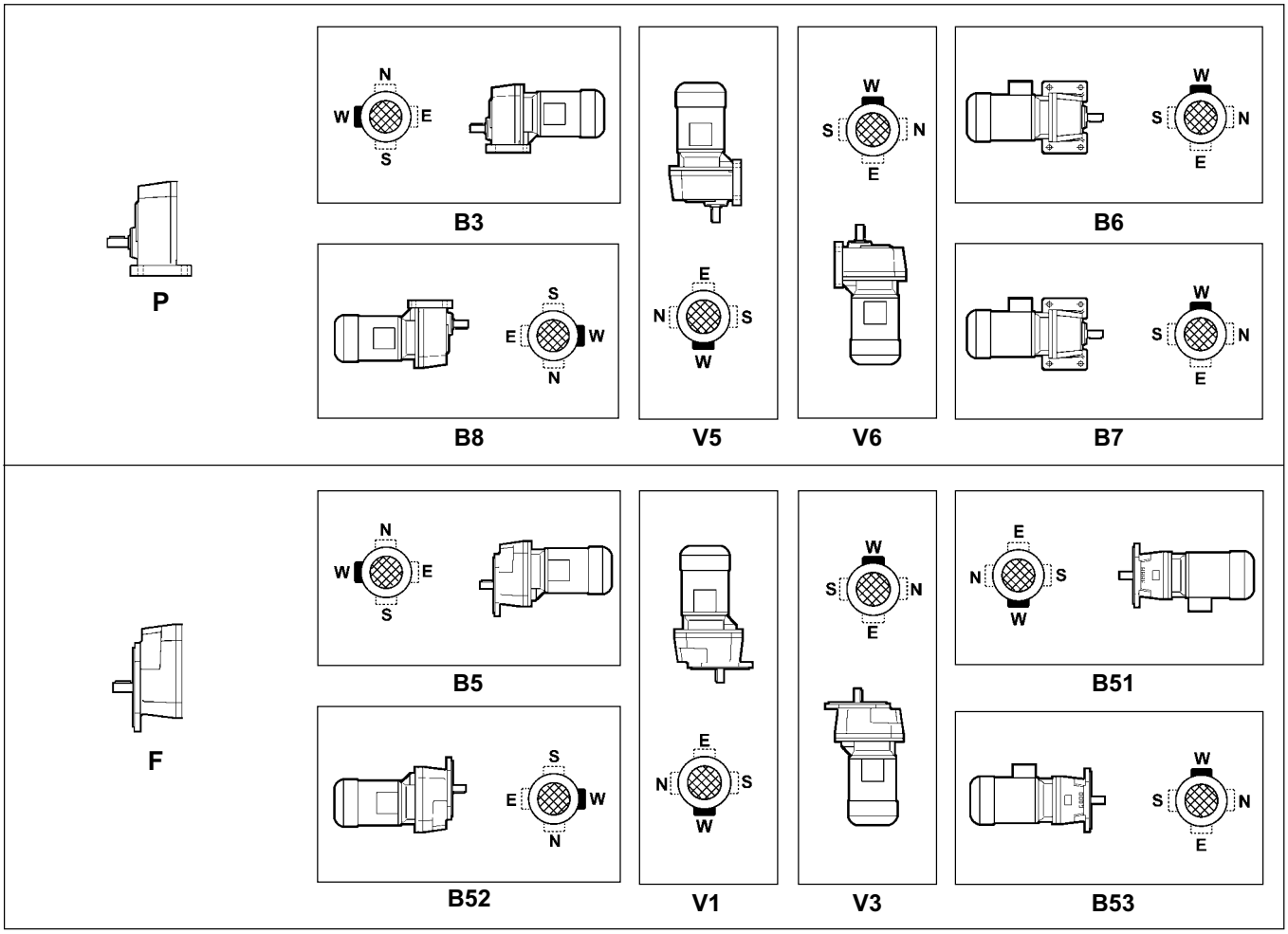
Gli orientamenti delle morsettiere dei motori sono identificati osservando il motore dal lato ventola; l'orientamento standard è evidenziato in nero **(W)** come indicato nella tabella (S77).

*Orientation of motor terminal boxes can be ascertained by observing the motor from the fan side; standard orientation is highlighted in black **(W)** in table (S77).*

Die Angaben zur Lage des Klemmenkastens beziehen sich auf das von der Lüfterseite her betrachtete Getriebe. Die Standardorientierung ist schwarz hervorgehoben **(W)**, wie in Abbildung (S77) angegeben.

*Les orientations des boîtes à bornes des moteurs sont définies en regardant le moteur du côté ventilateur. L'orientation standard est indiquée en noir **(W)** comme d'après le tableau (S77).*

(S77)



11.3 LUBRIFICAZIONE RIDUTTORI SERIE A

I riduttori dal tipo A102 al tipo A303 compreso, sono forniti con lubrificazione permanente ad olio sintetico e non necessitano di alcuna manutenzione.
Gli altri tipi sono predisposti per la lubrificazione ad olio e pertanto dotati dei tappi di carico, livello e scarico olio (tabelle S78 e S79); sarà cura dell'utente immettere il lubrificante avvalendosi delle quantità (litri) indicate in tabella (S80).
Evidenziamo però che tali quantità sono indicative, pertanto l'esatto livello dovrà essere valutato osservandolo dall'apposita spia (con il riduttore già installato nella corretta posizione di montaggio).

11.3 LUBRICATION OF BEVEL HELICAL UNITS, A SERIES

Gearboxes from A102 to A303 are life lubricated with synthetic oil and do not require periodical oil change.
The remaining types are designed for oil lubrication and therefore have oil filling, level and drain plugs (tables S78 and S79); users should fill the units with oil, consulting table (S80), with the correct quantity (litres).
However, it must be underlined that these quantities are only indicative, therefore users should check the correct level through the oil level plug (when the gearbox is installed in the actual mounting position).

11.3 SERIE A GETRIEBES SCHMIERUNG

Die Getriebe von Typ A102 bis Typ A303 werden mit Dauerschmierung mit Syntheseöl geliefert und sind wartungsfrei.
Die anderen sind für die Ölschmierung vorgerüstet und verfügen daher über einen Einfüllverschluß, Ölstands-und Öl-ablaß- schrauben (Tabelle S78 und S79). Das Öl muß vom Kunden in der in Tabelle (S80) angegebenen Menge (Liter) eingefüllt werden. Wir weisen jedoch darauf hin, daß es sich bei diesen Angaben nur um Richtwerte handelt und daher der tatsächlich Ölbedarf durch das Schauglas geprüft werden muß (das Getriebe muß sich hierzu schon in seiner endgültigen Einbaulage befinden).

11.3 LUBRIFICATION REDUCTEURS SERIE A

Les réducteurs du type A102 au type A303 compris sont fournis avec lubrification permanente à l'huile synthétique et n'ont besoin d'aucun entretien.
Les autres types sont prédisposés pour la lubrification à l'huile et par conséquent dotés de bouchons de remplissage, niveau et vidange d'huile (tableau S78 et S79); l'utilisateur devra introduire le lubrifiant en se conformant aux quantités (litres) indiqués sur le tableau (S80).
Ces quantités sont toutefois indicatives et le niveau exact devra être contrôlé par le voyant spécial (avec le réducteur déjà installé dans la position correcte de montage).

Dimensioni e collocazione dei tappi di carico, scarico e livello olio.

Dimensions and location of oil filling, level and drain plugs.

Abmessungen und Anordnung des Einfüll, Ölstands-und Ölablaßschrauben.

Dimensions et emplacement des bouchons de remplissage, de vidange et niveau d'huile.

(S78)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*											
	R - D - H - S											
	•	**B3**	•	**B6**	•	**B7**	•	**B8**	•	**V5**	•	**V6**
A102	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")
A202	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")
A203	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")
A302	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")	**5**	**T** (1/4")
A303	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")	**8**	**T** (1/4")
A412	**4**	**C** (3/8")	**4**	**C** (3/8")	**3**	**C** (3/8")	**3**	**S** (3/8")	**5**	**C** (3/8")	**1**	**S** (3/8")
	2	**L** (3/8")	**4**	**L** (3/8")	**3**	**L** (3/8")	**1**	**L** (3/8")	**2**	**L** (3/8")	**3**	**L** (3/8")
	3	**S** (3/8")	**3**	**S** (3/8")	**4**	**S** (3/8")	**4**	**C** (3/8")	**1**	**S** (3/8")	**5**	**C** (3/8")
A413	**4**	**C** (3/8")	**4**	**C** (3/8")	**3**	**C** (3/8")	**3**	**S** (3/8")	**8**	**C** (3/8")	**1**	**S** (3/8")
	2	**L** (3/8")	**4**	**L** (3/8")	**3**	**L** (3/8")	**1**	**L** (3/8")	**8**	**L** (3/8")	**3**	**L** (3/8")
	3	**S** (3/8")	**3**	**S** (3/8")	**4**	**S** (3/8")	**4**	**C** (3/8")	**1**	**S** (3/8")	**8**	**C** (3/8")
A502 A503	**14**	**C** (3/8")	**7**	**C** (3/8")	**14**	**C** (3/8")	**3**	**C** (3/8")	**5**	**C** (3/8")	**7**	**C** (1/4")
	2	**L** (3/8")	**5**	**L** (3/8")	**5**	**L** (3/8")	**2**	**L** (3/8")	**5**	**L** (3/8")	**3**	**L** (3/8")
	3	**S** (3/8")	**3**	**S** (3/8")	**7**	**S** (3/8")	**14**	**S** (3/8")	**7**	**S** (3/8")	**5**	**S** (3/8")
A504	**14**	**C** (3/8")	**7**	**C** (3/8")	**14**	**C** (3/8")	**3**	**C** (3/8")	**8**	**C** (1/4")	**7**	**C** (3/8")
	7	**L** (3/8")	**8**	**L** (1/4")	**8**	**L** (1/4")	**2**	**L** (3/8")	**10**	**L** (3/8")	**3**	**L** (3/8")
	3	**S** (3/8")	**3**	**S** (3/8")	**7**	**S** (3/8")	**14**	**S** (3/8")	**7**	**S** (3/8")	**8**	**S** (1/4")
A602 A603	**4**	**C** (1/2")	**4**	**C** (1/2")	**1**	**C** (1/2")	**3**	**C** (1/2")	**5**	**C** (3/8")	**1**	**C** (1/2")
	2	**L** (1/2")	**5**	**L** (3/8")	**5**	**L** (3/8")	**2**	**L** (1/2")	**2**	**L** (1/2")	**3**	**L** (1/2")
	3	**S** (1/2")	**1**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**5**	**S** (3/8")
A604	**4**	**C** (1/2")	**4**	**C** (1/2")	**1**	**C** (1/2")	**3**	**C** (1/2")	**8**	**C** (1/4")	**1**	**C** (1/2")
	12	**L** (3/8")	**8**	**L** (1/4")	**8**	**L** (1/4")	**2**	**L** (1/2")	**12**	**L** (3/8")	**3**	**L** (1/2")
	3	**S** (1/2")	**1**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**8**	**S** (1/4")
A703	**4**	**C** (1/2")	**4**	**C** (1/2")	**3**	**C** (1/2")	**3**	**C** (1/2")	**5**	**C** (1/2")	**1**	**C** (1/2")
	2	**L** (1/2")	**5**	**L** (1/2")	**5**	**L** (1/2")	**1**	**L** (1/2")	**2**	**L** (1/2")	**3**	**L** (1/2")
	3	**S** (1/2")	**3**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**5**	**S** (1/2")
A704	**4**	**C** (1/2")	**4**	**C** (1/2")	**3**	**C** (1/2")	**3**	**C** (1/2")	**11**	**C** (1/2")	**1**	**C** (1/2")
	2	**L** (1/2")	**11**	**L** (1/2")	**11**	**L** (1/2")	**1**	**L** (1/2")	**11**	**L** (1/2")	**3**	**L** (1/2")
	3	**S** (1/2")	**3**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**11**	**S** (1/2")
A803	**4**	**C** (1/2")	**4**	**C** (1/2")	**3**	**C** (1/2")	**3**	**C** (1/2")	**5**	**C** (1/2")	**1**	**C** (1/2")
	2	**L** (1/2")	**5**	**L** (1/2")	**5**	**L** (1/2")	**1**	**L** (1/2")	**2**	**L** (1/2")	**3**	**L** (1/2")
	3	**S** (1/2")	**3**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**5**	**S** (1/2")
A804	**4**	**C** (1/2")	**4**	**C** (1/2")	**3**	**C** (1/2")	**3**	**C** (1/2")	**11**	**C** (1/2")	**1**	**C** (1/2")
	2	**L** (1/2")	**11**	**L** (1/2")	**11**	**L** (1/2")	**1**	**L** (1/2")	**11**	**L** (1/2")	**3**	**L** (1/2")
	3	**S** (1/2")	**3**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**11**	**S** (1/2")
A903	**4**	**C** (1/2")	**4**	**C** (1/2")	**3**	**C** (1/2")	**3**	**C** (1/2")	**5**	**C** (1/2")	**1**	**C** (1/2")
	2	**L** (1/2")	**5**	**L** (1/2")	**5**	**L** (1/2")	**1**	**L** (1/2")	**2**	**L** (1/2")	**3**	**L** (1/2")
	3	**S** (1/2")	**3**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**5**	**S** (1/2")
A904	**4**	**C** (1/2")	**4**	**C** (1/2")	**3**	**C** (1/2")	**3**	**C** (1/2")	**11**	**C** (1/2")	**1**	**C** (1/2")
	2	**L** (1/2")	**11**	**L** (1/2")	**11**	**L** (1/2")	**1**	**L** (1/2")	**11**	**L** (1/2")	**3**	**L** (1/2")
	3	**S** (1/2")	**3**	**S** (1/2")	**4**	**S** (1/2")	**4**	**S** (1/2")	**1**	**S** (1/2")	**11**	**S** (1/2")

Legenda:

C Tappo di carico/sfiato
L Tappo di livello
S Tappo di scarico
T Tappo chiuso

Key:

C *Filling/breather plug*
L *Level plug*
S *Drain plug*
T *Closed plug*

Zeichenerklärung:

C Einfüll- und Ablaßschrauber
L Ölstandsschraube
S Ölablaßschraube
T geschlossene Schraube

Légende:

C *Bouchon de remplissage/évent*
L *Bouchon de niveau*
S *Bouchon de vidange*
T *Bouchon fermé*

• Numero di riferimento delle posizioni dei tappi come da tabella (S79).

• *Reference number for positions of plugs as shown in table (S79).*

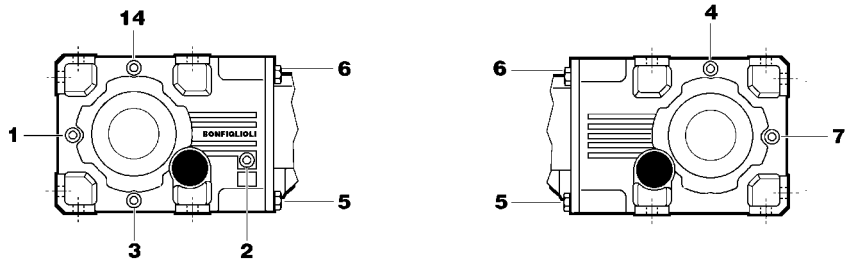
• Bezugsnummer der Positionen der Schrauben (Siehe Tabelle S79).

• *N.bre de référence des positions des bouchons comme d'après tableau (S79).*

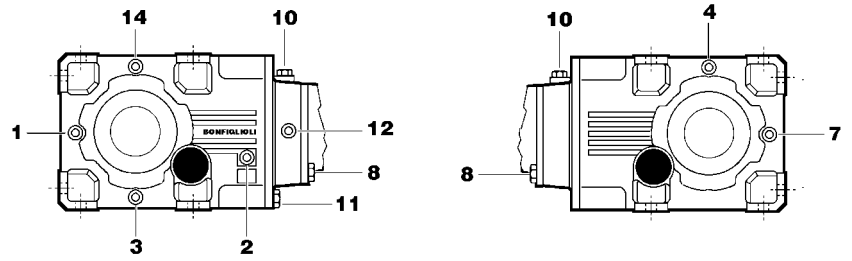
Posizione dei tappi di carico, scarico e livello olio — *Positions of oil filling, level and drain plugs.* — Anordnung des Einfüll-, Ölstands- und Ölablaßschrauben. — *Position des bouchons de remplissage, niveau et vidange d'huile.*

(S79)

A102 A202 A302 A412 A502 A503 A602 A603 A703 A803 A903



A203 A303 A413 A504 A604 A704 A804 A904



Quantità di lubrificante [l] — *Oil quantity [l]* — Schmiermittelmenge [l] — *Quantité de lubrifiant [l]*

(S80)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*					
	B3	**B6**	**B7**	**B8**	**VA**	**VB**
A102 S-HS-(P63...P112)	1.4	1.4	1.4	1.4	1.4	1.4
A202 S-HS-(P63...P112)	2.3	2.3	2.3	2.3	2.3	2.3
A203 S-HS-(P63...P112)	2.6	2.6	2.6	2.6	2.6	2.6
A302 S-HS-(P63...P112)	3.2	3.2	3.2	3.2	3.2	3.2
A303 S-HS-(P63...P112)	3.6	3.6	3.6	3.6	3.6	3.6
***A412** S-HS-(P63...P112)	3.5	3.6	3.6	4.2	5.0	3.5
***A412** P132°	4.5	4.6	4.6	5.2	5.3	5.2
***A413** S-HS-(P63...P112)	4.0	4.0	4.0	4.7	6.1	3.9
***A502 - A503** S-HS-(P63...P112-P160...P180)	4.6	7.6	4.2	7.9	11	8.5
***A502 - A503** P132°	5.6	8.6	5.2	8.9	11	10
***A504** S-HS-(P63...P112)	6.3	8.2	5.3	8.3	13	9.1
***A602** S-HS-(P63...P112-P160...P180)	6.8	7.7	12	14	18	14
***A602 - A603** P132°	6.8	8.6	11	15	18	15
***A603** S-HS-(P80...112-P160...P180)	6.8	7.7	12	14	18	14
***A604** S-HS-(P80...P112)	7.2	11	7.4	16	19	14
***A703** S-HS-(P80...P200)	10	14	10	15	20	14
***A704** S-HS-(P63...P132)	13	14	10	15	23	14
***A803** S-HS-(P80...P225)	15	22	15	26	35	22
***A804** S-HS-(P63...P132)	20	22	15	26	35	22
***A903** S-HS-(P80...P250)	31	35	37	44	66	39
***A904** S-HS-(P63...P180)	41	35	37	44	73	39

Lubrificazione permanente.
* = La quantità è indicativa. Controllare il riempimento attraverso il relativo vetro spia.
° = Il riempiemento parziale o totale deve essere effettuato dal foro presente sulla flangia P.

Life lubricated.
* = *Quantity is indicative. Check filling through the sight glass.*
° = *Fill the gear unit through the hole located on the motor flange.*

Dauerschmierung.
* = Bei der angegebenen Menge handelt es sich um einen Anhaltswert. Den Füsstand über das entsprechende Kontrollglas kontrollieren.
° = Ein teilweise oder vollkommene Füllung muss über die Bohrung am Flaschn erfolgen.

Lubrification permanente.
* = *La quantité est citée seulement à titre indicatif. Contrôler le remplissage par le hublot de visite correspondant.*
° = *Le remplissage partiel ou total doit s'effectuer au moyen de l'orifice positionné sur la bride.*

Posizioni di montaggio e orientamento morsettiera

Gli orientamenti delle morsettiere dei motori sono identificati osservando il motore dal lato ventola; l'orientamento standard è evidenziato in nero **(W)** come indicato nella tabella (S81).

Mounting position and terminal box orientation

*Orientation of motor terminal boxes can be ascertained by observing the motor from the fan side; standard orientation is shown in black **(W)** as in table (S81).*

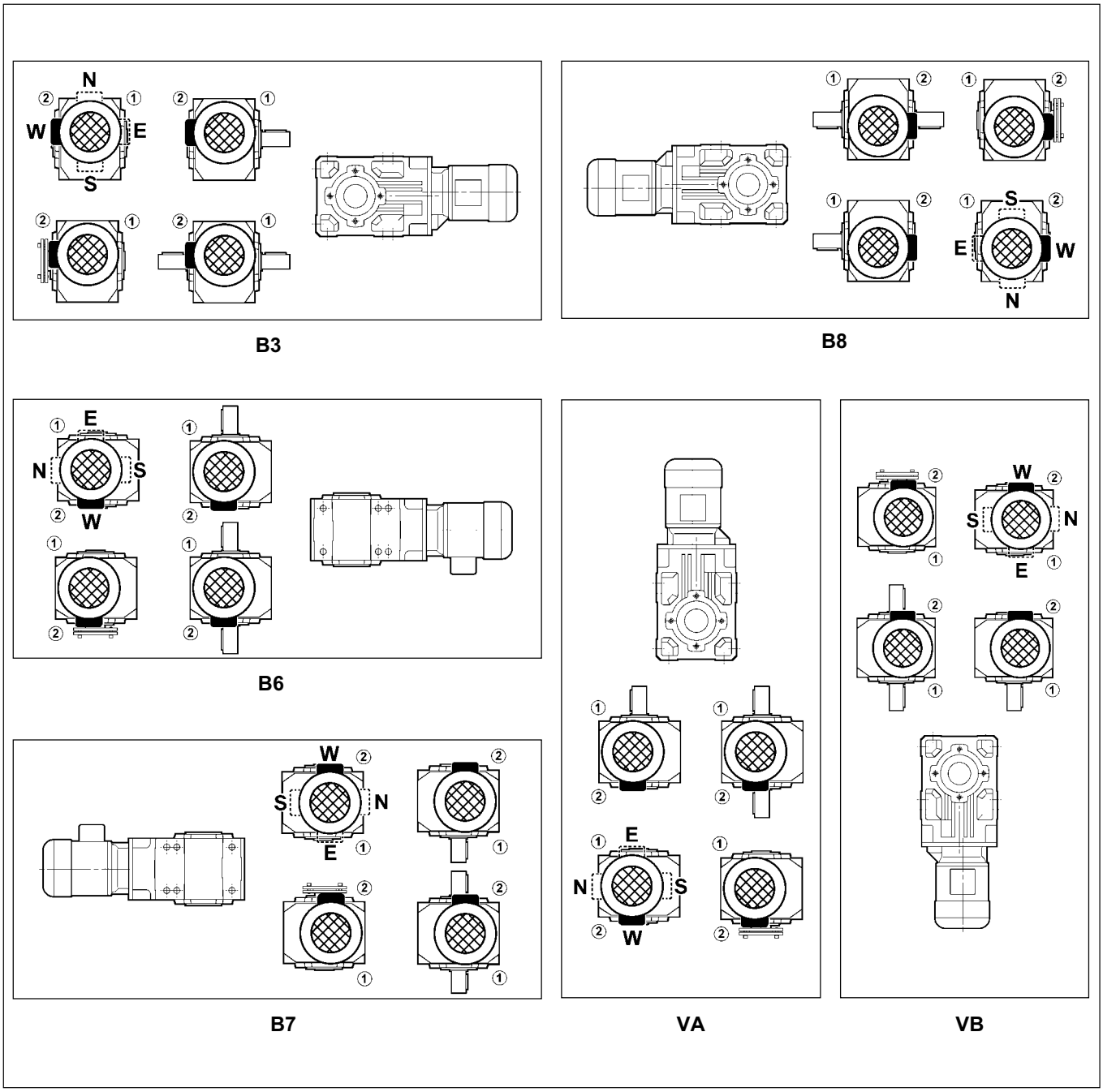
Einbaulagen und lage des klemmenkastens

Die Angaben zur Lage des Klemmenkastens beziehen sich auf das von der Lüfterseite her betrachtete Getriebe. Die Standardorientierung ist schwarz hervorgehoben **(W)**, wie in Abbildung (S81) angegeben.

Positions de montage et orientation boite a borne

*Les orientations des boîtes à bornes des moteurs sont définies en regardant le moteur du côté ventilateur. L'orientation standard est indiquée en noir **(W)** comme d'après le tableau (S81).*

(S81)



① ② Posizione flangia / *Flange position* / Flanschlage / *Position bride*

11.4 LUBRIFICAZIONE RIDUTTORI SERIE F

I riduttori dal tipo F102 al tipo F304 compreso, sono forniti con lubrificazione permanente ad olio sintetico e non necessitano di alcuna manutenzione.
Gli altri tipi sono predisposti per la lubrificazione ad olio e pertanto dotati dei tappi di carico, livello e scarico olio (tabelle S82 e S83); sarà cura dell'utente immettere il lubrificante avvalendosi delle quantità (litri) indicate in tabella (S84).
Evidenziamo però che tali quantità sono indicative, pertanto l'esatto livello dovrà essere valutato osservandolo dall'apposita spia (con il riduttore già installato nella corretta posizione di montaggio).

11.4 LUBRICATION OF SHAFT MOUNTED UNITS, F SERIES

Gearboxes from F102 to F304 are life lubricated with synthetic oil and do not require any periodical oil change.
The remaining types are designed for oil lubrication and therefore have oil filling, level and drain plugs (tables S82 and S83); users should fill the units with oil, consulting table (S84), with the correct quantity (litres).
However, it must be underlined that these quantities are only indicative, therefore users should check the correct level through the oil level plug (when the gearbox is installed in its actual mounting position).

11.4 SERIE F GETRIEBES SCHMIERUNG

Die Getriebe von Typ F102 bis Typ F304 werden mit Dauerschmierung mit Syntheseöl geliefert und sind wartungsfrei.
Die anderen sind für die Ölschmierung vorgerüstet und verfügen daher über einen Einfüllverschluß, Ölstands-und Öl-ablaß- schrauben (Tabelle S82 und S83). Das Öl muß vom Kunden in der in Tabelle (S84) angegebenen Menge (Liter) eingefüllt werden. Wir weisen jedoch darauf hin, daß es sich bei diesen Angaben nur um Richtwerte handelt und daher der tatsächlich Ölbedarf durch das Schauglas geprüft werden muß (das Getriebe muß sich hierzu schon in seiner endgültigen Einbaulage befinden).

11.4 LUBRIFICATION REDUCTEURS SERIE F

Les réducteurs du type F102 au type F304 compris sont fournis avec lubrification permanente à l'huile synthétique et n'ont besoin d'aucun entretien.
Les autres types sont prédisposés pour la lubrification à l'huile et par conséquent dotés de bouchons de remplissage, niveau et vidange d'huile (tableau S82 et S83); l'utilisateur devra introduire le lubrifiant en se conformant aux quantités (litres) indiqués sur le tableau (S84).
Ces quantités sont toutefois indicatives et le niveau exact devra être contrôlé par le voyant spécial (avec le réducteur déjà installé dans la position correcte de montage).

Dimensioni e collocazione dei tappi di carico, scarico e livello olio.

Dimensions and location of oil filling, level and drain plugs.

Abmessungen und Anordnung des Einfüll, Ölstands-und Öl-ablaßschrauben.

Dimensions et emplacement des bouchons de remplissage, de vidange et niveau d'huile.

(S82)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*																							
	H - S - R																							
	•	**H1**		•	**H2**		•	**H3**		•	**H4**		•	**H5**		•	**H6**	
F102	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")
F202	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")
F203	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")
F302 - F303	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")	**5**	**T**	(1/4")
F304	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")	**8**	**T**	(1/4")
F402 F403	**4**	**C**	(3/8")	**4**	**C**	(3/8")	**3**	**C**	(3/8")	**3**	**S**	(3/8")	**5**	**C**	(3/8")	**1**	**S**	(3/8")
	2	**L**	(3/8")	**4**	**L**	(3/8")	**3**	**L**	(3/8")	**1**	**L**	(3/8")	**2**	**L**	(3/8")	**3**	**L**	(3/8")
	3	**S**	(3/8")	**3**	**S**	(3/8")	**4**	**S**	(3/8")	**4**	**C**	(3/8")	**1**	**S**	(3/8")	**5**	**C**	(3/8")
F404	**4**	**C**	(3/8")	**4**	**C**	(3/8")	**3**	**C**	(3/8")	**3**	**S**	(3/8")	**8**	**C**	(3/8")	**1**	**S**	(3/8")
	2	**L**	(3/8")	**4**	**L**	(3/8")	**3**	**L**	(3/8")	**1**	**L**	(3/8")	**8**	**L**	(3/8")	**3**	**L**	(3/8")
	3	**S**	(3/8")	**3**	**S**	(3/8")	**4**	**S**	(3/8")	**4**	**C**	(3/8")	**1**	**S**	(3/8")	**8**	**C**	(3/8")
F502 F503	**14**	**C**	(3/8")	**7**	**C**	(3/8")	**14**	**C**	(3/8")	**3**	**C**	(3/8")	**5**	**C**	(3/8")	**7**	**C**	(1/4")
	2	**L**	(3/8")	**5**	**L**	(3/8")	**5**	**L**	(3/8")	**2**	**L**	(3/8")	**5**	**L**	(3/8")	**3**	**L**	(3/8")
	3	**S**	(3/8")	**3**	**S**	(3/8")	**7**	**S**	(3/8")	**14**	**S**	(3/8")	**7**	**S**	(3/8")	**5**	**S**	(3/8")
F504	**14**	**C**	(3/8")	**7**	**C**	(3/8")	**14**	**C**	(3/8")	**3**	**C**	(3/8")	**8**	**C**	(1/4")	**7**	**C**	(3/8")
	7	**L**	(3/8")	**8**	**L**	(1/4")	**8**	**L**	(1/4")	**2**	**L**	(3/8")	**10**	**L**	(3/8")	**3**	**L**	(3/8")
	3	**S**	(3/8")	**3**	**S**	(3/8")	**7**	**S**	(3/8")	**14**	**S**	(3/8")	**7**	**S**	(3/8")	**8**	**S**	(1/4")
F603	**4**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**3**	**C**	(1/2")	**5**	**C**	(3/8")	**1**	**C**	(1/2")
	2	**L**	(1/2")	**5**	**L**	(3/8")	**5**	**L**	(3/8")	**2**	**L**	(1/2")	**2**	**L**	(1/2")	**3**	**L**	(1/2")
	3	**S**	(1/2")	**1**	**S**	(1/2")	**4**	**S**	(1/2")	**4**	**S**	(1/2")	**1**	**S**	(1/2")	**5**	**S**	(3/8")
F604	**4**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**3**	**C**	(1/2")	**8**	**C**	(1/4")	**1**	**C**	(1/2")
	12	**L**	(3/8")	**8**	**L**	(1/4")	**8**	**L**	(1/4")	**2**	**L**	(1/2")	**12**	**L**	(3/8")	**3**	**L**	(1/2")
	3	**S**	(1/2")	**1**	**S**	(1/2")	**4**	**S**	(1/2")	**4**	**S**	(1/2")	**1**	**S**	(1/2")	**8**	**S**	(1/4")
F703	**3**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**2**	**C**	(1/2")	**5**	**C**	(1/2")	**1**	**C**	(1/2")
	1	**L**	(1/2")	**2**	**L**	(1/2")	**4**	**L**	(1/2")	**3**	**L**	(1/2")	**3**	**L**	(1/2")	**4**	**L**	(1/2")
	4	**S**	(1/2")	**3**	**S**	(1/2")	**2**	**S**	(1/2")	**1**	**S**	(1/2")	**2**	**S**	(1/2")	**5**	**S**	(1/2")
F704	**3**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**2**	**C**	(1/2")	**11**	**C**	(1/2")	**2**	**C**	(1/2")
	1	**L**	(1/2")	**2**	**L**	(1/2")	**4**	**L**	(1/2")	**3**	**L**	(1/2")	**11**	**L**	(1/2")	**4**	**L**	(1/2")
	4	**S**	(1/2")	**3**	**S**	(1/2")	**2**	**S**	(1/2")	**1**	**S**	(1/2")	**2**	**S**	(1/2")	**11**	**S**	(1/2")
F803	**3**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**2**	**C**	(1/2")	**5**	**C**	(1/2")	**1**	**C**	(1/2")
	1	**L**	(1/2")	**2**	**L**	(1/2")	**4**	**L**	(1/2")	**3**	**L**	(1/2")	**3**	**L**	(1/2")	**4**	**L**	(1/2")
	4	**S**	(1/2")	**3**	**S**	(1/2")	**2**	**S**	(1/2")	**1**	**S**	(1/2")	**2**	**S**	(1/2")	**5**	**S**	(1/2")
F804	**3**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**2**	**C**	(1/2")	**11**	**C**	(1/2")	**2**	**C**	(1/2")
	1	**L**	(1/2")	**2**	**L**	(1/2")	**4**	**L**	(1/2")	**3**	**L**	(1/2")	**11**	**L**	(1/2")	**4**	**L**	(1/2")
	4	**S**	(1/2")	**3**	**S**	(1/2")	**2**	**S**	(1/2")	**1**	**S**	(1/2")	**2**	**S**	(1/2")	**11**	**S**	(1/2")
F903	**3**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**2**	**C**	(1/2")	**5**	**C**	(1/2")	**1**	**C**	(1/2")
	1	**L**	(1/2")	**2**	**L**	(1/2")	**4**	**L**	(1/2")	**3**	**L**	(1/2")	**3**	**L**	(1/2")	**4**	**L**	(1/2")
	4	**S**	(1/2")	**3**	**S**	(1/2")	**2**	**S**	(1/2")	**1**	**S**	(1/2")	**2**	**S**	(1/2")	**5**	**S**	(1/2")
F904	**3**	**C**	(1/2")	**4**	**C**	(1/2")	**1**	**C**	(1/2")	**2**	**C**	(1/2")	**11**	**C**	(1/2")	**2**	**C**	(1/2")
	1	**L**	(1/2")	**2**	**L**	(1/2")	**4**	**L**	(1/2")	**3**	**L**	(1/2")	**11**	**L**	(1/2")	**4**	**L**	(1/2")
	4	**S**	(1/2")	**3**	**S**	(1/2")	**2**	**S**	(1/2")	**1**	**S**	(1/2")	**2**	**S**	(1/2")	**11**	**S**	(1/2")

Legenda:

C Tappo di carico/sfiato
L Tappo di livello
S Tappo di scarico
T Tappo chiuso

• Numero di riferimento delle posizioni dei tappi come da tabella (S83)

Key:

C *Filling/breather plug*
L *Level plug*
S *Drain plug*
T *Closed plug*

• *Reference number for positions of plugs as shown in table (S83).*

Zeichenerklärung:

C Einfüll- und Ablaßschrauber
L Ölstandsschraube
S Ölablaßschraube
T geschlossene Schraube

• Bezugsnummer der Positionen der Schrauben (Siehe Tabellea S83).

Légende:

C *Bouchon de remplissage/évent*
L *Bouchon de niveau*
S *Bouchon de vidange*
T *Bouchon fermé*

• *N.bre de référence des positions des bouchons comme d'après tableau (S83).*

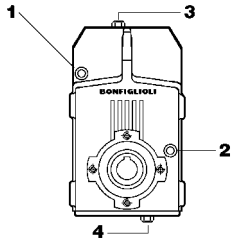
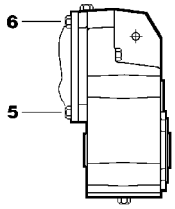
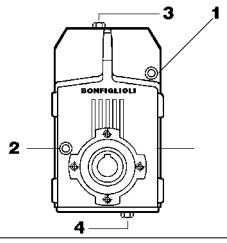
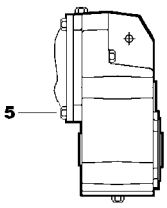
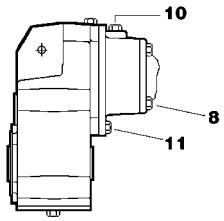
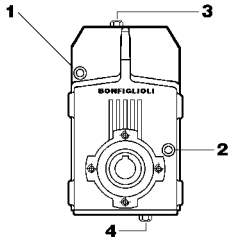
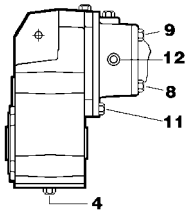
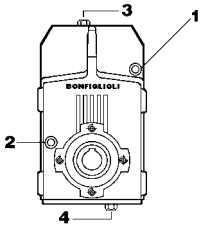
Posizione dei tappi di carico, scarico e livello olio

Positions of oil filling, level and drain plugs.

Anordnung des Einfüll-, Ölstands- und Ölablaßschrauben.

Position des bouchons de remplissage, niveau et vidange d'huile.

(S83)

F102 **F202** **F302-F303** **F402-F403** **F502-F503**			**F603** **F703** **F803** **F903**		
F203 **F304** **F404** **F504**			**F604** **F704** **F804** **F904**		

Quantità di lubrificante [l]

Oil quantity [l]

Schmiermittelmenge [l]

Quantité de lubrifiant [l]

(S84)

	Posizioni di montaggio / *Mounting positions* / Einbaulagen / *Positions de montage*					
	H - S - R					
	H1	**H2**	**H3**	**H4**	**H5**	**H6**
F102 S-HS-(P63...112)	1.43	1.43	1.43	1.43	1.43	1.43
F202 S-HS-(P63...112)	2.00	2.00	2.00	2.00	2.00	2.00
F203 S-HS-(P63...112)	2.40	2.40	2.40	2.40	2.40	2.40
F302 - F303 S-HS-(P63...112)	2.85	2.10	1.50	2.10	2.85	2.85
F304 S-HS-(P63...112)	3.34	2.40	1.65	2.35	3.15	3.34
***F402 - F403** S-HS-(P63...112)	4.95	3.90	4.00	3.10	5.05	4.00
***F402 - F403** P132°	5.95	4.90	5.00	4.10	6.05	5.70
***F404** S-HS-(P63...112)	5.25	4.30	4.30	3.30	5.45	4.40
***F502 - F503** S-HS-(P63...112-160/180)	9.20	6.65	7.60	4.70	9.20	6.70
***F502 - F503** P132°	10.2	7.65	8.60	5.70	10.2	8.50
***F504** S-HS-(P63...112)	9.70	7.35	8.10	5.05	9.90	7.40
***F603** S-HS-(P63...112-160/180)	13.6	10.3	7.40	10.2	14.2	10.2
***F603** P132°	14.6	11.3	8.40	11.2	15.2	12.0
***F604** S-HS-(P63...112)	14.5	11.5	8.00	11.1	15.4	11.4
F703	23.0	20.0	10.0	16.0	23.0	19.0
F704	23.0	20.0	10.0	16.0	27.0	19.0
F803	40	33	15.0	56	42	30.0
F804	40	33	15.0	56	46	30.0
F903	70	59	32	49	76	55
F904	70	59	32	49	83	55

Lubrificazione permanente

* = La quantità è indicativa. Controllare il riempimento attraverso il relativo vetro spia.

° = Il riempiemento parziale o totale deve essere effettuato dal foro presente sulla flangia P

Life lubricated

* = *Quantity is indicative. Check filling through the sight glass.*

° = *Fill the gear unit through the hole located on the motor flange.*

Dauerschmierung

* = Bei der angegebenen Menge handelt es sich um einen Anhaltswert. Den Füsstand über das entsprechendeKontrollglaskontrollieren.

° = Ein teilweise oder vollkommene Füllung muss über die Bohrung am Flaschn erfolgen.

Lubrification permanente

* = *La quantité est citée seulement à titre indicatif. Contrôler le remplissage par le hublot de visite correspondant.*

° = *Le remplissage partiel ou total doit s'effectuer au moyen de l'orifice positionné sur la bride.*

Posizioni di montaggio e orientamento morsettiera

Nella tabella (S85) sono riportate le posizioni di montaggio dei riduttori Serie F.
Gli orientamenti delle morsettiere dei motori sono identificati osservando il motore dal lato ventola; l'orientamento standard è evidenziato in nero **(W)**.

Mounting position and terminal box orientation

Table (S85) shows the mounting positions for Series F gearboxes.
*Orientation of motor terminal boxes can be determined by observing the motor from the fan side; standard orientation is highlighted in black **(W)**.*

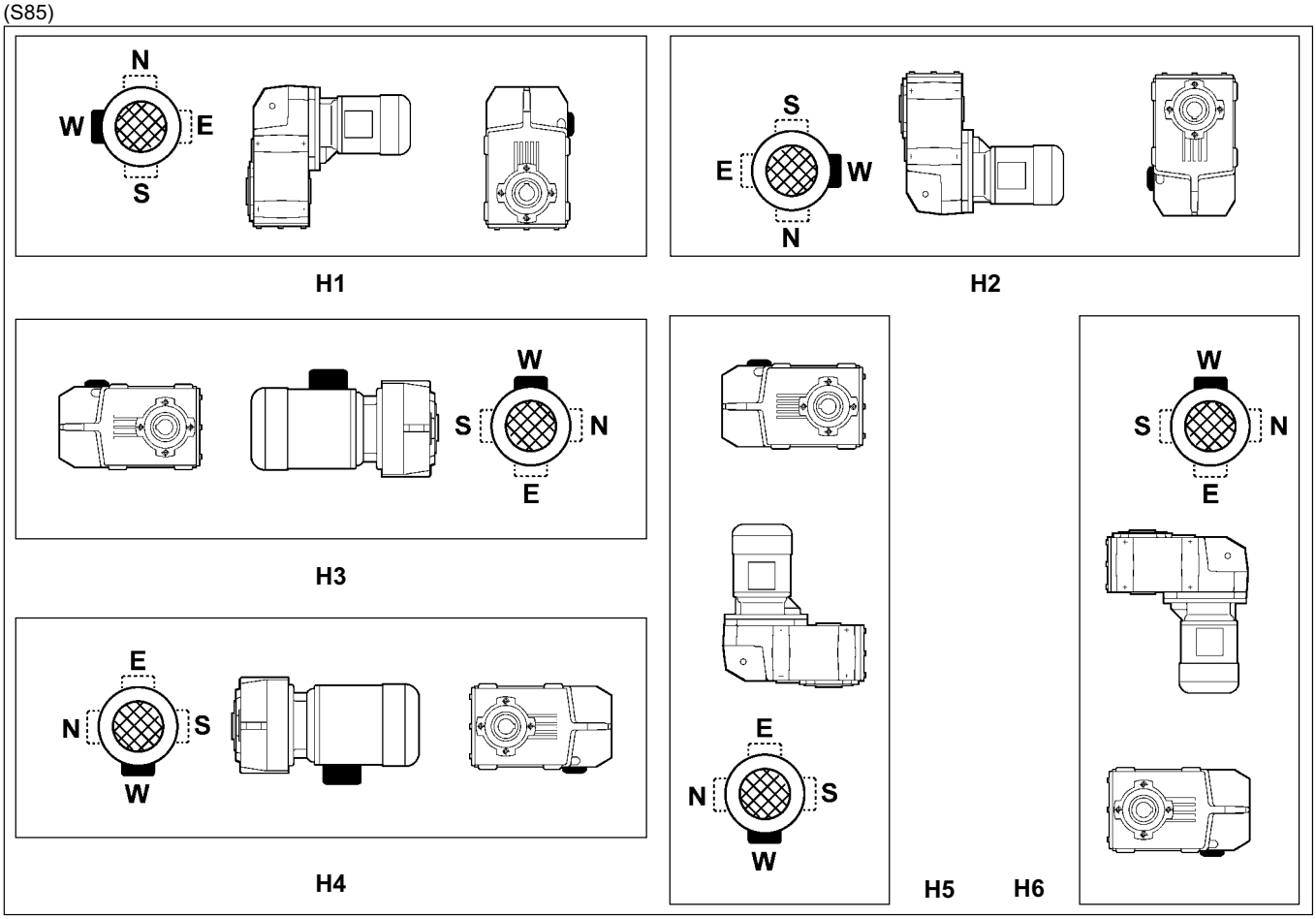
Einbaulagen und lage des klemmenkastens

Auf Tabelle (S85) sind die Einbaulagen der Getriebe der Serie F ersichtlich.
Die Angaben zur Lage des Klemmenkastens beziehen sich auf das von der Lüfterseite her betrachtete Getriebe. Die Standardorientierung ist schwarz hervorgehoben **(W)**.

Positions de montage et orientation boite a borne

Le tableau (S85) indique les positions de montage des réducteurs Série F.
*Les orientations des boîtes à bornes des moteurs sont définies en regardant le moteur du côté ventilateur. L'orientation standard est indiquée en noir **(W)**.*

(S85)



12.0 INFORMAZIONI GENERALI RIDUTTORI

Avvertenze per l'operatore.
Per effettuare una corretta installazione e per prevenire eventuali situazioni di pericolo, è necessario acquisire la conoscenza delle modalità di utilizzo riportate nel presente manuale prima dell'installazione e della messa in moto.
Il presente manuale potrà essere aggiornato con l'integrazione di altri prodotti e di eventuali ulteriori indicazioni. Le pagine che subiranno delle variazioni rispetto all'edizione precedente verranno segnalate con gli appositi indici di modifica (R).

Riduttori di velocità
Si intende per riduttore solo la parte meccanica composta da una cassa e dagli ingranaggi di qualsiasi tipo in essa contenuti. Il sistema indicato non presenta pericoli fino a che ad esso non sarà applicata una motorizzazione; in tal caso dovranno essere previste protezioni sulle parti rotanti accessibili.
Per quanto concerne i motori e la parte elettrica relativa, si rimanda al paragrafo (13.0) motori elettrici.

12.0 GENERAL INFORMATION ON GEARBOXES

Operator warnings.
For correct installation and prevention of hazardous conditions, it is necessary to know the methods of operation described in this manual before installation and start-up.
This manual may be updated with the addition of other products and possible additional instructions.
Revised pages will be marked in the index of revisions (R).

Gearboxes
The gearbox is understood to mean only the mechanical part composed of a box containing any type of gears. This system presents no hazard until a drive is attached to it, and in this case guards must be provided for accessible moving parts.
With regard to motors and the relative electrical part, see section (13.0) Electric motors.

12.0 ALLGEMEINE INFORMATIONEN ÜBER DIE GETRIEBE

Warnung an den Betriebsmann.
Im Hinblick auf eine einwandfreie Installation und auf die Vermeidung von gefährlichen Situationen muß man dieses Handbuch aufmerksam lesen und so die notwendigen Kenntnisse erwerben, bevor mit der Installation und Inbetriebnahme begonnen wird.
Dieses Handbuch könnte in Zukunft durch Hinzufügen weiterer Produkte und eventueller weiterer Anweisungen erweitert werden.
Die abgeänderten Seiten werden dann mit einem speziellen Zeichen versehen (R).

Getriebe
Unter einem Getriebe verstehen wir nur den mechanischen Teil, der aus einem Gehäuse und Zahnrädern irgendwelcher Art besteht. Das gezeigte System birgt keine Gefahren, bevor es motorisiert wird, danach müssen vom Kunden auf den zuganglichen Teilen, die sich bewegen, Schutzvorrichtungen gemäß den Sicherheitsgesetzen angebracht werden. Bezüglich Motoren und der entsprechenden Elektrik siehe Abschnitt 13.0, elektrische Motoren.

12.0 INFORMATIONS GENERALES SUR LES REDUCTEURS

Instructions pour l'opérateur.
Pour effectuer une installation correcte et pour éviter tout danger, il est nécessaire d'acquérir la connaissance des modalités d'utilisation exposées dans le présent manuel avant l'installation et la mise en service.
Le présent manuel pourra être mis à jour par l'adjonction d'autres produits et d'indications supplémentaires.
Les pages qui seront l'objet de variations par rapport à l'édition précédente seront signalées par l'indice de modification (R).

Réducteurs de vitesse
Par réducteur de vitesse, il faut entendre uniquement la pièce mécanique composée d'une caisse et des engrenages qu'elle contient. Le système indiqué ne présente pas de dangers tant qu'on ne lui applique pas de motorisation. Dans ce cas, le client devra prévoir des protections sur les parties en mouvement accessibles, selon les normes de sécurité en vigueur dans son Pays.
En ce qui concerne les moteurs et la partie électrique correspondante, on se rapportera au paragraphe (13.0) Moteurs électriques.

Condizioni di fornitura

I riduttori vengono forniti da BONFIGLIOLI RIDUTTORI S.p.A. previo superamento delle attività di controllo previste nella documentazione applicabile del proprio sistema di qualità UNI EN ISO 9001, collaudati e già predisposti per essere installati nella posizione di montaggio come definito in fase di ordine del cliente e confermato dalla BONFIGLIOLI RIDUTTORI S.p.A.
Il ricevente avrà cura che i prodotti siano soggetti a trasporto e movimentazione utilizzando mezzi e attenzioni tali da assicurare il mantenimento dello stato delle condizioni fornite dalla BONFIGLIOLI RIDUTTORI S.p.A. all'atto della consegna.
Per quanto riguarda le caratteristiche di progetto si dovrà fare riferimento al catalogo o alla descrizione contenuta nell' ordine del cliente e confermato dalla BONFIGLIOLI RIDUTTORI S.p.A.

Conditions of supply

Gearboxes are supplied by BONFIGLIOLI RIDUTTORI S.p.A. after they have passed the controls provided in the applicable documentation for the Company's quality control system UNI EN ISO 9001, inspected and prepared for installation in the mounting position that was specified in the customer's order and confirmed by BONFIGLIOLI RIDUTTORI S.p.A.
The customer must transport and handle the products by appropriate means and with suitable care in order to keep them in the state in which they are supplied by BONFIGLIOLI RIDUTTORI S.p.A. at the time of delivery.
With respect to unit specifications, refer to the catalogue or to the description in the customer's order as confirmed by BONFIGLIOLI RIDUTTORI S.p.A.

Lieferbedingungen

BONFIGLIOLI RIDUTTORI S.p.A. liefert die Getriebe nach erfolgter Prüfung - gemäß den Unterlagen, die diese Kontrollen für ihr Qualitätssystem UNI EN ISO 9001 vorschreiben. Die Getriebe sind bereits kontrolliert und zur Installation in der Enbaulage bereit, die der Kunde bei Erteilung des Auftrags bestimmt und die BONFIGLIOLI RIDUTTORI S.p.A. danach bestätigt hatte.
Der Empfänger muß bedenken, daß die Produkte transportiert werden sollen und muß deshalb geeignete Transportmittel wählen sowie Vorsichtsmaßnahmen treffen, damit diese bei ihm so ankommen, wie sie BONFIGLIOLI RIDUTTORI S.p.A ausgeliefert hat.
Bezüglich der Projekteigenschaften muß man den Katalog und die Beschreibungen beachten, die im Auftrag des Kunden enthalten sind und die BONFIGLIOLI RIDUTTORI S.p.A. bestätigt hatte.

Conditions de fourniture

Les réducteurs sont fournis par BONFIGLIOLI RIDUTTORI S.p.A. à l'issue des contrôles de la documentation prévus par son système de la qualité UNI EN ISO 9001, testés et déjà prêts pour l'installation dans la position de montage définie dans la commande du client confirmée par BONFIGLIOLI RIDUTTORI S.p.A.
Le client veillera à ce que le transport et la manutention des produits se fassent de façon à assurer le maintien des conditions fournies par BONFIGLIOLI RIDUTTORI S.p.A. au moment de la livraison.
En ce qui concerne les caractéristiques de projet, on se rapportera au catalogue ou à la description figurant dans la commande du client confirmée par BONFIGLIOLI RIDUTTORI S.p.A.

Ricevimento, trasporto e movimentazione.

Al ricevimento del riduttore controllare che non abbia subito danni durante il trasporto ed eventualmente segnalarli allo spedizioniere. Controllare inoltre che le caratteristiche riportate in targa corrispondano a quanto richiesto in ordine e confermato da BONFIGLIOLI RIDUTTORI S.p.A.
I riduttori vengono consegnati imballati in contenitori di cartone.
In alcuni casi, gli imballi di maggiori dimensioni sono riempiti con dei materiali atti a compensare gli spazi vuoti rispettando la stabilità e le dimensioni dei riduttori.
Tutti gli elementi di imballaggio dovranno essere raccolti e smaltiti o riciclati secondo le norme vigenti nel proprio Paese.
Gli imballi contenenti più riduttori sono normalmente applicati a bancali in legno per facilitarne la movimentazione tramite carrelli elevatori o transpallets.
I riduttori possono essere movimentati individualmente sollevandoli con fasce o cinghie (se il peso lo richiede) applicate agli alberi entrata e uscita.
I riduttori di potenza medio alta sono provvisti di un golfare di sollevamento.

Gli alberi dei riduttori sono muniti di protezioni di sicurezza in plastica. Queste protezioni dovranno essere rimosse prima dell'installazione seguendo le norme di sicurezza e prevenzione in vigore nel paese del destinatario.
Successivamente, queste protezioni dovranno essere recuperate ed eliminate secondo le norme in vigore nel proprio paese.

Receipt, transport, and handling

Upon receipt of the gearbox, check that it was not damaged during transport; if damage is noted, inform the carrier immediately. In addition, check that the characteristics stated on the plate conform to those ordered and confirmed by BONFIGLIOLI RIDUTTORI S.p.A.
The gearboxes are delivered packed in cardboard cartons.
In some cases, larger cartons may be filled with polyurethane foam.
All packing parts must be collected and disposed of or recycled according to current regulations in the customer's country.
Cartons containing more than one gearbox are usually attached to wooden boards to facilitate handling by forklifts or transpallets.
Gearboxes may be handled individually by lifting them with belts or chains (if required due to weight) attached to input and output shafts.
Medium-high power gearboxes are equipped with an eyebolt for lifting.

Gear shafts are provided with plastic guards, which must be removed before installation, collected, and disposed of according to safety regulations in customer's country.

Warenempfang, Transport, Auf- und Abladung

Bei Eintreffen des Getriebes kontrolliere man, ob es beim Transport eventuell beschädigt worden ist. Ist dies der Fall, muß die Speditionsfirma sofort benachrichtigt werden. Zudem muß kontrolliert werden, ob die Eigenschaften, die auf dem Schild angegeben sind, denjenigen entsprechen, die im Auftrag verlangt und von BONFIGLIOLI RIDUTTORI S.p.A bestätigt wurden.
Die Getriebe werden in Kartonbehälter oder anders wie im Vertrag vorgesehen verpackt ausgeliefert.
In einigen Fällen werden größere Verpackungen mit geeigneten Materialen zur Kompensation der leeren Räumen unter Einhaltung der Stabilität und Erhaltung des Inhalts aufgefüllt.
Alle Verpackungselemente müssen nach den im betreffenden Land gültigen Vorschriften entsorgt oder recycelt werden.
Verpackungen, die mehrere Getriebe enthalten, werden normalerweise auf Holzverschlägen fixiert, dies vereinfacht ihren Transport auf Hubkarren oder Handgabelhubwagen.
Die Getriebe können individuell umplaziert werden, indem man sie, falls dies wegen ihres Gewichts notwendig ist, mit Riemen oder Bändern, die an die Eingangs - und Ausgangswellen befestigt sind, anhebt.
Getriebe mit mittel - höherer Leistung weisen eine Ösenschraube auf.

Die Wellen der Getriebe weisen einen Plastikschutz auf. Dieser Schutz muß vor der Installation entfernt und entsorgt werden, unter Einhaltung der Sicherheits und Verhütungsrechtinien gemäß des Gesetres.
Die Sammlung und Entsorgung der Schutzvorrichtungen muß vom Kunde erfolgen, der gemäß den gültigem Gesetzem in seinem Land wirken wird.

Réception, transport et manutention

A la réception du réducteur, contrôler qu'il n'a pas été abîmé pendant le transport. Le cas échéant, signaler les détériorations au transporteur. Contrôler également que les caractéristiques figurant sur la plaque signalétique correspondent bien à ce qui a été demandé dans la commande et confirmé par BONFIGLIOLI RIDUTTORI S.p.A.
Les réducteurs sont livrés emballés dans des emballages en carton ou autre prévu dans le contrat .
Dans certains cas, les emballages de dimensions plus grandes sont remplis avec des matériels aptes à compenser les espaces vides en respectant la stabilité et la dimension des réducteurs.
Tous les éléments d'emballage devront être récupérés et éliminés ou recyclés suivant les normes en vigueur dans le pays du destinataire.
Les emballages contenant plusieurs réducteurs sont normalement appliqués sur des palettes en bois pour faciliter la manutention au moyen de chariots élévateurs ou de transpalettes.
Les réducteurs peuvent être déplacés individuellement en les soulevant avec des bandes ou des courroies (si le poids le nécessite) appliquées aux arbres d'entrée et de sortie.
Les réducteurs de puissance moyenne ou haute sont dotés d'une cheville à oeillet.

Les arbres des réducteurs sont dotés de protections de securité en plastique. Ces protections devront être enlevées avant l'installation suivant les normes de securité et prévention en vigueur dans le pays du destinataire.
Ensuite, ces protections seront récuperées et éliminées du destinataire suivant les normes en vigueur dans son pays.

12.1 STOCCAGGIO

Il corretto stoccaggio dei prodotti ricevuti richiede l'esecuzione delle seguenti attività:

a) Escludere aree all'aperto, zone esposte alle intemperie o con eccessiva umidità.

b) Interporre sempre tra il pavimento ed i prodotti, pianali lignei o di altra natura, atti ad impedire il diretto contatto col suolo.

c) Per periodi di stoccaggio superiori ai 60 giorni, le superfici interessate agli accoppiamenti quali flange, alberi e giunti, devono essere protette con idoneo prodotto antiossidante (Mobilarma 248 od equivalente).

d) Per periodi di stoccaggio previsti superiori ai 6 mesi, i prodotti devono essere oggetto delle seguenti attività:
d1)
I prodotti forniti con lubrificazione permanente dovranno avere le parti lavorate esterne e quelle di accoppiamento ricoperte di grasso atto ad evitare ossidazioni.
d2)
I prodotti forniti privi di lubrificante, oltre alle attività descritte al punto d1), dovranno essere posizionati con il tappo di sfiato nella posizione più alta e riempiti di olio.
I riduttori, prima del loro utilizzo, dovranno essere riempiti con la corretta quantità e tipo di lubrificante previsto.

12.1 STORAGE

Observe the following instructions to ensure correct storage of delivered products:

a) Do not store outdoors, in areas exposed to weather or with excessive humidity.

b) Always place boards in wood or other material between floor and products, to avoid direct contact with the floor.

c) For storage periods of over 60 days, all machined surfaces such as flanges, shafts and couplings must be protected with a suitable anti-oxidation product (Mobilarma 248 or equivalent product).

d) The following measures must be taken in respect of products for which the expected storage period exceeds 6 months:
d1)
For life lubricated products, the external machined and coupled parts must be greased to prevent oxidation.
d2)
In addition to the measures at point d1), products supplied without oil must be positioned with the breather plug high up, and be filled with oil.
Before using the gearboxes, restore the correct quantity of recommended oil.

12.1 LAGERUNG

Die korrekte Lagerung der Antriebe erfordert folgende Vorkehrungen:

a) Die Produkte nicht im Freien lagern und nicht in Räumen, die der Witterung ausgesetzt sind, oder eine hohe Feuchtigkeit aufweisen.

b) Die Produkte nie direkt auf dem Boden, sondern auf Unterlagen aus Holz oder einem anderen Material lagern.

c) Bei Lagerzeiten von mehr als 60 Tagen die Oberflächen für die Verbindung, wie Flansche, Wellen oder Kupplungen mit einem geeigneten Oxidations-schutzmittel behandeln (Mobilarma 248 oder ein äquivalentes Mittel).

d) Bei Lagerzeiten von mehr als 6 Monaten müssen folgende Vorkehrungen getroffen werden:
d1)
Bei den Produkten mit Dauerschmierung müssen die maschinell bearbeiteten Außenseiten und die Verbindungsflächen mit Fett vor Oxidation geschützt werden.
d2)
Die Produkte ohne Schmiermittel müssen wie unter Punkt d1) behandelt werden und außerdem mit nach oben gerichteter Entlüftungsschraube gelagert und mit Öl gefüllt werden.
Die Getriebe müssen vor ihrer Verwendung mit der angegebenen Menge des vorgesehenen Schmiermittels gefüllt werden.

12.1 STOCKAGE

Un correct stockage des produits reçus nécessite de respecter les règles suivantes:

a) Exclure les zones à ciel ouvert, les zones exposées aux intempéries ou avec humidité excessive.

b) Interposer dans tous les cas entre le plancher et les produits des planches de bois ou des supports d'autre nature empêchant le contact direct avec le sol.

c) Pour les périodes de stockage supérieures à 60 jours, les surfaces concernées par les liaisons telles que les brides, les arbres et les accouplements doivent être protégées avec un produit antioxydant spécial (Mobilarma 248 ou équivalent).

d) Pour les périodes de stockage prévues supérieures à 6 mois, les produits doivent être objet des contrôles suivants:
d1)
les produits fournis avec lubrification permanente devront avoir les parties externes usinées ainsi que celles de liaison recouvertes de graisse pour éviter les oxydations. d2)
les produits fournis sans lubrifiant, outre les opérations décrites au point d1), devront être positionnés avec le bouchon reniflard dans la position la plus haute et remplis d'huile.
Les réducteurs, avant d'être utilisés, devront être remplis avec la juste quantité et type de lubrifiant prévu.

12.2 INSTALLAZIONE E MESSA IN SERVIZIO

E' molto importante, per l'installazione del riduttore, attenersi alle seguenti norme:

Rimuovere le eventuali protezioni in plastica presenti sugli alberi secondo le indicazioni riportate nel paragrafo.

Nei riduttori C602 e C603 rimuovere il golfare di sollevamento sostituendolo con il tappo allegato.

Rimuovere eventuali protettivi con solventi seguendo le norme in vigore nel paese del destinatario.

Evitare che il solvente venga a contatto con il labbro degli anelli di tenuta.

Assicurarsi che il fissaggio del riduttore sia stabile onde evitare qualsiasi vibrazione e sia effettuato su piani lavorati.

Installare (se si prevedono urti, sovraccarichi prolungati o possibili bloccaggi) giunti idraulici, frizioni, limitatori di coppia, ecc.

12.2 INSTALLATION AND COMMISSIONING

The following installation instructions for gearboxes must be observed:

Remove any plastic guards from the shafts according to paragraph.

On gearboxes C602 and C603, remove the eyebolt supplied for lifting and replace it with the plug provided.

Remove any protective coatings with solvents according to customer's country rules.

Do not let the solvent be in touch with oilseal lips.

Make sure that the gearbox is correctly secured and is fitted onto a machined surface to avoid vibrations.

(If shocks, overloading, or the possibility of locking are expected), install hydraulic couplings, clutches, torque limiters, etc.

12.2 INSTALLATION

Für die Installation des Getriebes ist es äußerst wichtig, daß folgende Normen beachtet werden:

Eventuell vorhandenen Plastikschutz von den Wellen entfernen, gemaß Abschnitt.

Bei den Getrieben C602 und C603 die Ösenschraube entfernen und durch den mitgelieferten Stöpsel ersetzen.

Eventuell vorhandene rastbeseitigenden Schutzschichten mit einem zulässigen Lösemittel gemäß Landgesetzen entfernen.

Es muß unbedingt vermieden werden, daß Lösemittel mit den Lippen der Dichtungsringe in Kontakt kommt.

Sicherstellen, daß die Befestigung des Getriebes stabil ist, damit keine Schwingungen entstehen und daß es auf einer bearbeiteten Fläche ohne Positioniertreiben zu liegen kommt.

(Wenn es voraussichtlich zu Stößen, längerdauernden Überlasten oder zu Blockierungen kommen kann) sind entsprechende Schutzelemente wie hydraulische Kupplungen, Rutschkupplungen usw. zu installieren.

12.2 INSTALLATION

Il est très important, pour l'installation du réducteur, de se conformer aux règles suivantes:

Enlever les éventuelles protections en plastique présentes sur les arbres selon les indications au point.

Sur les réducteurs C602 et C603, enlever la cheville à oeillet de levage en la remplaçant par le bouchon joint.

Enlever les éventuelles produits de protection antioxydants au moyen de solvants suivant les normes en vigueur dans le pays du destinataire.

Le solvant ne doit pas entrer en contact avec la lèvre des bagues d'étanchéité.

S'assurer que la fixation du réducteur soit stable afin d'éviter toute vibration et soit sur des surfaces ousinées sans aucun forcement de positionnement.

Installer (en cas de chocs, de surcharges prolongées ou de blocages) des accouplements hydrauliques, des embrayages, des limiteurs de couple, etc.

Nei riduttori ad assi ortogonali serie A è opportuno valutare attentamente il tipo di fissaggio desiderato per effettuare una installazione corretta.

Negli schemi indicati in tabella (S86) vengono riportati i 3 casi possibili per l'installazione dei riduttori serie A alla struttura della macchina da operare.
Per ognuno di questi casi riportiamo nella tabella (S87) le dimensioni delle viti a testa esagonale da utilizzare.
Inoltre, per una facile installazione, suggeriamo di utilizzare il tipo di chiave mostrato in tabella (S86).

With bevel helical units, A series, make sure that the type of fastening to be used will provide correct installation.

Schemes in table (S86) show the 3 possible installation cases for A gear units to the machine frame.
For each of these circumstances , table (S87) indicates exagonal head screw sizes to be used.
Besides, in order to operate an easy installation , we suggest to use a wrench of the type shown in table (S86).

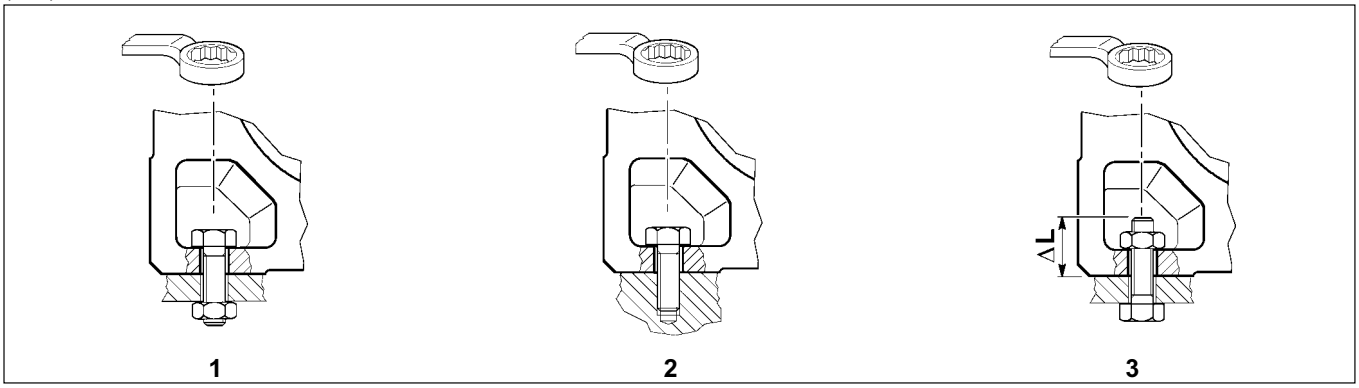
Vor allem bei den Parallelwellengetrieben der Serie A muß aufmerksam geprüft werden, welche Fixierungsart für eine fachmännische Installation wünschenswert ist.

In Tabelle (S86) sind die 3 Anbaumöglichteiten des Getriebes Typ A an die zu betreibende Maschine dargestellt.
Für jeden dieser Fällen sind in der Tabelle (S87) die Abmessungen der zu verwendenden Sechskantschrauben angegeben. Im übrigen schlagen wir zwechs einfachen Anbaus vor, den Schlüsseltyp wie in Tabelle (S86) zu verwenden.

Sur les réducteurs à arbres orthogonaux série A, il convient d'évaluer attentivement le type de fixation souhaité pour effectuer une installation correcte.

Dans les schèmas indiqués dans le tableau (S86) l'on a indiqué 3 cas possibles pour le montage des réducteurs type A à la structure de la machine.
Pour tous ces cas l'on doit se référer pour les dimensions des vis à tête hexagonales à employer, au tableau (S87).
Pour un montage plus soigneux nous conseillons l'emploi du type de clé indiquée au tableau (S86).

(S86)



(S87)

	Tipo vite / *Screw type* / Schraubentyp / *Type de vis*					Tipo vite / *Screw type* / Schraubentyp / *Type de vis*			
	1	2	3	ΔL (mm)		1	2	3	ΔL (mm)
A10	M8 x 25	M8 x 20	M8 x...	20	**A60**	M16 x 50	M16 x 45	M16 x...	40
A20	M8 x 25	M8 x 20	M8 x...	20	**A70**	M20 x 60	M20 x 55	M20 x...	45
A30	M10 x 30	M10 x 25	M10 x...	25	**A80**	M24 x 70	M24 x 65	M24 x...	55
A41	M12 x 35	M12 x 30	M12 x...	30	**A90**	M24 x 90	M24 x 80	M24 x...	65
A50	M14 x 45	M14 x 40	M14 x...	35					

Se i riduttori verranno riverniciati, si dovranno proteggere i piani lavorati e il bordo esterno degli anelli di tenuta per evitare che la vernice ne essichi la gomma, pregiudicando la tenuta del paraolio stesso. Si consiglia inoltre di proteggere il foro dell'eventuale tappo di sfiato per evitarne l'occlusione, la targa di identificazione e il tappo di livello olio (dove previsto).
Le superfici di contatto dovranno essere pulite e trattate con adeguati protettivi prima del montaggio, onde evitare l'ossidazione e il conseguente bloccaggio delle parti.
Gli organi che vanno calettati sugli alberi di uscita del riduttore devono essere lavorati con tolleranza ISO H7 per evitare accoppiamenti troppo bloccati che, in fase di montaggio potrebbero danneggiare irreparabilmente il riduttore stesso. Inoltre, per il montaggio e lo smontaggio di tali organi si consiglia l'uso di adeguati tiranti ed estrattori utilizzando il foro filettato posto in testa alle estremità degli alberi.

If the gearboxes are to be paint coated, protect the machined surfaces and the outside face of the oilseals to prevent paint from drying out the rubber and jeopardising the functioning of the seal.
In addition, protect the hole of the breather plug (if present) to prevent clogging, as well as the identification plate and the oil level plug (if present).
Contact surfaces must be cleaned and treated with suitable protective products before mounting to avoid oxidation and, as a result, seizure of parts.
Parts assembled on the gearbox output shafts must be machined to ISO H7 tolerance to prevent interference fits that could damage the gearbox itself during the mounting. Further, to mount or remove such parts, employ suitable pullers or extraction devices using the tapped hole located at the top of the shaft extensions.

Beim Lackieren die bearbeiten Flächen und die Dichtringe schützen, damit der Anstrichstoff nicht den Kunststoff angreift und somit die Dichtigkeit der Ölabdichtungen in Frage gestellt wird.
Es wird zudem empfohlen, die Öffnung der eventuell vorhandenen Entluftungsschraube, sowie das Typenschild und (wenn vorhanden) die Ölstandsschraube zu schutzen, damit es nicht zu Verstopfungen kommt.
Die Berührungsflächen müssen sauber sein und vor der Montage mit einem geeigneten Schutzmittel behandelt werden, um Oxidierung und die daraus folgende Blockierung der Teile zu verhindern.
Die Organe, die mit einer Keilverbindung auf der Abtriebswelle des Getriebes befestigt werden, müssen mit einer Toleranz ISO H7 gearbeitet sein, um allzu fest blockierte Verbindungen zu vermeiden, die eventuell zu einer irreparablen Beschädigung des Getriebes während des Einbaus führen könnten. Außerdem sind beim Ein- und Ausbau dieser Organe geeignete Zugstangen und Abzieher zu verwenden, wobei die Gewindebohrung an den Stirnseiten der Wellen zu verwenden sind.

En phase de peinture, il faudra protéger le plans usinés et le bord extérieur des bagues d'étanchéité pour éviter que la peinture ne dessèche le caoutchouc, ce qui risque de nuire à l'efficacité du joint.
Nous vous conseillons par ailleurs de protéger le trou du bouchon reniflard s'il y en a un, pour éviter qu'il ne se bouche, la plaque signalétique et le bouchon de niveau d'huile (s'il est prévu).
Les surfaces d'accouplement devront être propres et traitées avec des produits de protections appropriés avant le montage afin d'éviter l'oxydation et par suite le blocage des pièces.
Les organes qui sont calés sur les arbres de sortie du réducteur doivent être réalisés avec une tolérance ISO H7 pour éviter les accouplements trop serrés qui, en phase de montage, pourraient endommager irrémédia- blement le réducteur. En outre, pour le montage et le démontage de ces organes, nous conseillons d'utiliser un outillage et des extracteurs appropriés en utilisant le trou taraudé situé en extremité d' arbre.

Non sottoporre gli alberi ad urti che possano danneggiare i cuscinetti interni.

L'accoppiamento all'albero di uscita cavo del riduttore (tolleranza G7) viene normalmente eseguito con perni lavorati con tolleranza h6. Dove il tipo di applicazione lo richieda, si può prevedere un accoppiamento con una leggera interferenza (G7 - j6).

Avoid shocks on the shafts: this may damage internal bearings.

Coupling to the gearbox output hollow shaft (G7 tolerance) is usually effected with shafts machined to h6 tolerance. If the type of application requires it, coupling with a slight interference (G7 - j6) is possible.

Die Wellen dürfen nie Stößen ausgesetzt werden, denn diese können die inneren Lager beschädigen.

Die Verbindung mit der Abtriebshohlwelle des Getriebes (Toleranz G7) wird normalerweise mit Zapfen mit Toleranz h6 hergestellt. Wo die Anwendungsart dies verlangt, kann man die Verbindung mit einem leichten Übermaß ausführen (G7 - j6).

Ne pas soumettre les arbres à des chocs pouvant endommager les roulements internes.

L' accouplement à l'arbre de sortie creux du réducteur (tolérance G7) est habituellement réalisé avec des arbres exécutés à la tolérance h6. Lorsque le type d'application le demande, on peut prévoir un accouplement avec une légère interférence (G7 - j6).

ISTRUZIONI PER IL CORRETTO SERRAGGIO DEL CALETTATORE

I riduttori serie A ed F sono disponibili a richiesta con albero lento cavo munito di calettatore (forma costruttiva _S).
E' necessario eseguire le seguenti operazioni per effettuare il montaggio del riduttore sull'albero della macchina da azionare.

1) Svitare le viti di bloccaggio gradualmente e in successione rimuovendo il calettatore
2) Pulire e sgrassare accuratamente le zone di accoppiamento fra albero lento riduttore e albero della macchina da azionare
3) Accoppiare albero condotto e riduttore
4) Montare il calettatore sull'albero del riduttore
5) Avvitare a fondo tutte le viti del calettatore gradualmente e in successione, facendo uso di una chiave dinamometrica. **E' necessario ripetere la sequenza alcune volte al fine di raggiungere la coppia di serraggio Mt indicata in tabella (S87a).**

INSTRUCTIONS FOR FITTING OF SHRINK DISC

Gearboxes of the A and F series are available upon request with hollow output shaft complete with shrink disc (_S version).
To fit the gearbox onto the customer shaft the procedure described here below must be followed.

1) Unscrew the locking bolts progressively and remove the shrink disc
2) Carefully clean and degrease mating surfaces of the hollow shaft and customer shaft
3) Fit the gearbox onto the driven shaft
4) Fit the shrink disc onto the gearbox shaft
5) Tighten all locking bolts of the shrink disc gradually and progressively in circular sequence, using a torque wrench. ***Several sequences are necessary until the specified tightening torque Mt is reached. See tab. (87a) for reference.***

ANLEITUNGEN FÜR DEN KORREKTEN ANZUG DER SCHRUMPFSCHEIBE

Die Getriebe der Serie A und F sind auf Anfrage mit einer Abtriebswelle verfügbar, die mit einer Schrumpfscheibe versehen ist (Version _S). Um ein solches Getriebe auf die Welle der zu betreibenden Maschine montieren zu können, muß man folgendermaßen vorgehen:

1) Die Befestigungsschrauben schrittweise und in entsprechender Reihenfolge lockern und so die Schrumpfscheibe entfernen
2) Die Passbereiche zwischen Abtriebswelle des Getriebes und der Welle der anzutreibenden Maschine säubern und entfetten
3) Die geführte Welle und das Getriebe aneinander passen
4) Die Schrumpfscheibe auf die Getriebewelle montieren
5) Alle Schrauben der Schrumpfscheibe schrittweise und in entsprechender Reihenfolge anziehen. **Diese Sequenz ist mehrmals zu wiederholen, d.h. solange bis der in der Tabelle (87a) angegebene Anzugsmoment Mt erreicht wurde.**

INSTRUCTIONS POUR LE BLOCAGE CORRECT DE LA FRETTE DE SERRAGE

Les réducteurs série A et F sont disponibles sur demande avec un arbre de sortie creux équipé de frette de serrage (version S_).
Il est nécessaire d'exécuter les opérations suivantes pour effectuer le montage du réducteur sur l'arbre de la machine à actionner:

1) Dévisser graduellement et l'une après l'autre les vis de blocage et enlever la frette de serrage
2) Nettoyer et dégraisser soigneusement les zones d'accouplement entre arbre de sortie réducteur et arbre de la machine à actionner
3) Accoupler l'arbre mené et le réducteur
4) Monter la frette de serrage sur l'arbre réducteur
5) Visser à fond graduellement et l'une après l'autre toutes les vis de la frette de serrage. ***Il est nécessaire de répéter la séquence plusieurs fois afin d'atteindre le couple de serrage Mt indiqué dans le Tableau (87a).***

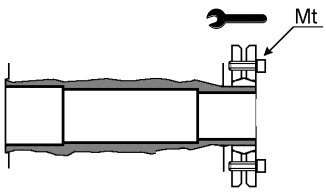
Attenzione! Non usare bisolfuro di molibdeno o altri grassi, causa di notevoli riduzioni del coefficiente d'attrito.

Warning! Do not use molibdenum disolphide or any grease whatsoever because of consequent reduction in the friction coefficient.

Achtung! Niemals Molybdändisulfid oder andere Fettarten verwenden, da sie zu erheblichen Reduzierungen des Reibkoeffizienten führen würden.

Attention! Ne pas utiliser de bisulfure de molybdène ou autres graisses, susceptibles de provoquer d'importantes réductions du coefficient de frottement.

(S87)



	A10	**A20**	**A30**	**A41**	**A50**	**A60**	**A70**	**A80**	**A90**
Mt [Nm]	14.5	14.5	14.5	14.5	35	35	35	69	69
	F10	**F20**	**F30**	**F40**	**F50**	**F60**	**F70**	**F80**	**F90**
Mt [Nm]	8.5	14.5	14.5	14.5	14.5	35	35	69	69

Prima della messa in funzione della macchina, accertarsi che la posizione del livello del lubrificante sia conforme alla posizione di montaggio del riduttore e che la viscosità sia adeguata al tipo del carico come indicato in tabella (S69).

Nei motoriduttori controllare che fra la calotta posteriore del motore ed eventuali carterature delle macchina vi sia lo spazio sufficiente per garantire il regolare afflusso dell'aria per il raffreddamento.

Before starting up the machine, make sure that oil level conforms to the reduction unit mounting position, and that viscosity is suitable for the load involved as indicated in the table (S69).

In gearmotors, check that there is sufficient space to guarantee a regular flow of cooling air between the rear motor cover and any machine frame.

Vor Inbetriebnahme der Maschine sicherstellen, daß die Anordn- ung der Füllstandschraube der Einbaulage entspricht und die Viskosität des Schmiermittels der Belastungsart entspricht, wie dies in Tabelle (S69) angegeben wird.

Bei den Getriebemotoren muß kontrolliert werden, ob zwischen der hinteren Lüfterraddeckel und eventuell vorhandenen Rahmen der Maschine genügend Platz ist, damit die Kühlungsluft gut hineinströmen kann.

Avant la mise en marche de la machine, s'assurer que la position du niveau du lubrifiant soit conforme à la position de montage du réducteur et que la viscosité soit appropriée au type de charge, voir tableau (S69).

Sur les motoréducteurs, contrôler qu'entre la calotte arrière du moteur et les éventuels carters de la machine il y ait assez d'espace pour garantir l'arrivée régulière de l'air pour le refroidissement.

Nelle installazioni all'aperto o in ambienti umidi o corrosivi, si consiglia di adottare tutte le precauzioni necessarie a preservare la funzionalità della macchina nel tempo.

For outdoor installations or in damp or corrosive conditions, use all of the precautions needed to maintain machine operation over an extended period of time.

Bei Installationen im Freien oder in feuchten oder korrosionsfördernden Räumen empfehlen wir, alle notwendigen Vorkehrungen zu treffen, damit der Maschine eine lange Lebensdauer garantiert werden kann.

Dans les installations en extérieur ou dans des milieux humides ou corrosifs, nous vous conseillons d'adopter toutes les précautions nécessaires pour préserver le bon fonctionnement de la machine dans le temps.

Tutte le operazioni descritte dovranno essere eseguite da personale qualificato.

All of the operations described above must be performed by qualified personnel only.

Alle Eingriffe müssen von geschultem Personal vorgenommen werden.

Toutes les opérations décrites devront être effectuées par du personnel qualifié.

12.3 USO E MANUTENZIONE

12.3 USE AND MAINTENANCE

12.3 VERWENDUNG UND INSTADHALTUNG

12.3 UTILISATION ET ENTRETIEN

Nei riduttori previsti con lubrificazione permanente non è necessario ripristinare il livello del lubrificante.
Il o i tappi presenti su questi riduttori dovranno essere del tipo chiuso.

Negli altri riduttori, provvisti dei tappi di carico, livello e scarico si dovrà effettuare un controllo periodico del livello del lubrificante e se necessario ripristinarlo aggiungendo la quantità necessaria.

It is not necessary to top up the oil in gearboxes with permanent lubrication.
The plug seals on these gearboxes must be closed type.

On other gearboxes with filler, level, and drain plugs, check oil level periodically and top up if necessary.

Bei den Getrieben mit einer Dauerschmierung muß kein Schmiermittel nachgefüllt werden.
Der oder die Stöpsel auf diesen Getrieben müssen so gestaltet sein, daß keine Öffnung vorgesehen ist.

Bei den anderen Getrieben, die Einfüll- Ölstand- und Ölablaß- schrauben aufweisen, muß eine periodische Kontrolle des Ölstands durchgeführt werden. Wenn nötig nachfüllen.

Sur les réducteurs à lubrification permanente, il n'est pas nécessaire de remettre à niveau le lubrifiant.
Le ou les bouchon(s) présents sur ces réducteurs devront être du type fermé.

Sur les autres réducteurs, dotés de bouchons de remplissage, niveau et vidange il faudra effectuer un contrôle périodique du niveau de lubrifiant et, si besoin est, le remettre à niveau.

Si raccomanda di non miscelare oli a base minerale con oli sintetici e viceversa.

Never mix mineral oils with synthetic oils and vice versa.

Es wird empfohlen, nie Mineralöle mit synthetischen Ölen (oder umgekehrt!) zu vermischen.

Ne pas mélanger des huiles à base minérale avec des huiles synthétiques et inversement.

La sostituzione del lubrificante potrà essere effettuata indicativamente agli intervalli (h) indicati nella tabella (S88).

Oil change may be performed in the approximate hourly intervals (h) shown in table (S88) below.

Das Schmiermittel wird ungefähr in den in Tabelle (S88) angegebenen Zeitabständen aus gewechselt.

Le renouvellement du lubrifiant devra être effectué indicativement aux échéances (en h) indiquées dans le tableau (S88).

(S88)

Temperatura olio / *Oil temperature* Öltemperatur / *Température huile* [°C]	Intervallo di lubrificazione / *Lubrication interval* Schmierfrist / *Intervalle de lubrification* [h]	
	olio minerale / *mineral oil* Mineralöl / *huile minérale*	olio sintetico / *synthetic oil* Syntheseöl / *huile synthétique*
< 65	8000	25000
65 - 80	4000	15000
80 - 95	2000	12500

Si consiglia di effettuare, sistematicamente, una accurata pulizia esterna del riduttore per rimuovere eventuali sedimenti che limiterebbero la capacità di dissipazione termica.

Nei motoriduttori verificare che la griglia posteriore del motore non sia ostruita da corpi estranei o da polvere.

We advise you to carefully clean the exterior of the gearbox on a regular basis to remove any sediments that might limit heat dissipation.

In gearmotors, check that the grid of the fan cowl is not blocked by foreign bodies or dirt.

Es wird empfohlen, das Getriebe systematisch und sorgfältig außen zu reinigen, damit eventuelle Ablagerungen entfernt werden, die die Wärmeabstrahlung einschränken könnten.

Bei den Getriebemotoren muß kontrolliert werden, ob das hintere Motorengitter nicht durch Fremdkörper oder Staub verstopft ist.

Nous vous conseillons d'effectuer systématiquement un nettoyage externe soigneux du réducteur, pour enlever d'éventuels sédiments, qui limiteraient la capacité de dissipation thermique.

Sur les motoréducteurs, s'assurer que la grille arrière du moteur n'est pas obstruée par des corps étrangers ou de la poussière.

Attenzione!!
Alcuni riduttori, in particolari condizioni ambientali e applicative possono raggiungere temperature di funzionamento superiori a 50 °C sulle parti esterne. Il contatto con tali parti senza l'ausilio di adeguate protezioni può provocare ustioni.
Il controllo del livello del lubrificante e l'eventuale rabbocco devono essere effettuati a macchina ferma e al ripristino delle condizioni della temperatura ambiente.

Warning!!
Under certain ambient and operating conditions, the external parts of certain gearmotors may reach temperatures exceeding 50 °C. Touching such parts without adequate protection may cause injury.
Checking of oil level and any topping up must be performed with the machine stopped and at ambient temperature.

Achtung!!
Einige Getriebe können unter speziellen Umwelt oder Einsatzbedingungen auf den äußeren Teilen Betriebstemperaturen von über 50 °C erreichen. Berührt man diese Teile ohne Körperschutz, kann dies zu Verbrennungen führen.
Die Kontrolle des Ölstandes und das eventuelle Nachfüllen müssen bei stillstehender Maschine erfolgen, nachdem die Getriebetemperatur auf Umgebungstemperatur gefallen ist.

Attention!!
Certains réducteurs, dans des conditions extérieures et d'application particulières, peuvent atteindre des températures de fonctionnement supérieures à 50 °C sur les parties externes. Le contact avec ces parties sans protections appropriées peut provoquer des brûlures.
Le contrôle du niveau de lubrifiant et l'éventuelle mise à niveau doivent être effectués quand la machine est à l'arrêt, une fois rétablies les conditions de température ambiante.

In caso di attività di manutenzione del riduttore, accertarsi che:

– non ci siano nelle vicinanze organi in movimento
– non ci siano carichi sospesi o instabili nelle vicinanze; in caso affermativo provvedere al loro bloccaggio,
– non ci siano sorgenti di calore elevate o fiamme libere nelle vicinanze se si usano solventi per la pulizia esterna,
– l'alimentazione del motore sia staccata.

When performing maintenance on the gearbox, make sure that:

– *there are no moving elements in the nearby*
– *there are no suspended or unstable loads in the vicinity; if there are, secure them*
– *there are no sources of intense heat or open flame in the vicinity if solvents are to be used for external cleaning*
– *power has been disconnected to the motor.*

Bei Wartungsarbeiten am Getriebe kontrolliere man:

– daß keine sich bewegenden Maschinenkomponenten in der Nähe sind,
– daß keine aufgehängten oder unstabilen Lasten in der Nähe sind; falls dies trotzdem der Fall ist, müssen diese blockiert werden,
– daß keine starken Wärmequellen oder freie Flammen in der Nähe sind, falls Lösemittel für die Reinigung der Außenteile verwendet worden ist,
– daß die Stromzufuhr des Motors unterbrochen ist.

Pour l'entretien du réducteur, s'assurer que :

– *il n'y a pas à proximité d'organes en mouvement;*
– *il n'y a pas de charges suspendues ou instables à proximité; si c'est le cas, les bloquer;*
– *il n'y a pas de sources de chaleur élevées ou de flammes libres à proximité si l'on utilise des solvant pour le nettoyage externe;*
– *l'alimentation du moteur est coupée.*

13.0 INFORMAZIONI GENERALI MOTORI ELETTRICI

Campo di applicazione

Le seguenti istruzioni si applicano ai motori elettrici asincroni trifasi prodotti dalla BONFIGLIOLI RIDUTTORI S.p.A. della serie:

- BN
- M
nella versione base.

Esecuzioni costruttive speciali come descritto nei cataloghi e/o nelle relative offerte, applicazioni particolari (p.e. alimentazione da inverter) necessitano di informazioni aggiuntive.
Per i tipi autofrenanti si applicano le istruzioni supplementari riportate nella specifica documentazione.

Informazioni generali sulla sicurezza

I motori elettrici descritti nelle seguenti istruzioni sono previsti per impiego in installazioni industriali e destinate ad essere utilizzate da personale qualificato.

Durante il funzionamento questi motori presentano parti sotto tensione o in movimento e pertanto la rimozione delle necessarie protezioni elettriche e meccaniche, l'uso improprio o la non adeguata manutenzione possono causare gravi danni a persone o cose.

Deve essere assicurato che ogni operazione sui motori venga eseguita da personale qualificato che abbia conoscenza delle istruzioni e dati tecnici relativi al prodotto e sia stato autorizzato dal responsabile della sicurezza all'intervento.

13.0 GENERAL INFORMATION ELECTRIC MOTORS

Field of application

The following instructions apply to the three-phase asynchronous electric motors manufactured by BONFIGLIOLI RIDUTTORI S.p.A., series:

- BN
- M
basic version.

Special versions as described in the catalogues and/or in offers, or special applications (for example, power supply from inverter) will require additional information.
For brake motors, refer to the supplementary instructions, given in the specific documentation.

General safety information

The electric motors described in the following instructions are designed to be used in industrial installations and must be operated by qualified personnel only.

When in operation, motors have live or moving parts. Therefore, removal of necessary electrical or mechanical guards, improper use, or inadequate maintenance may cause serious damage to persons or property.

All interventions on the motors must be performed only by qualified personnel who have thorough knowledge of the instructions and technical data for the product and who have been authorised to perform such intervention by the safety supervisor.

13.0 ALLGEMEINE INFORMATIONEN ÜBER DIE ELEKTROMOTOREN

Verwendungsbereich

Die folgenden Anweisungen betreffen die asynchronen, dreiphasigen Elektromotoren, die von BONFIGLIOLI RIDUTTORI S.p.A. hergestellt wurden und zu folgenden Serien gehören:

- BN
- M
in der Grundausführung.

Für Elektromotoren mit Sonderbauform, wie sie in den Katalogen und/oder Angeboten beschrieben werden, sowie für spezielle Anwendungen (wie z.B. Stromzufuhr aus einem Inverter) sind zusätzliche Informationen notwendig. Für die Bremsmotore müssen die zusätzlichen Anweisungen bezogen werden.

Allgemeine Sicherheitsinformationen

Die in den folgenden Anweisungen beschriebenen Elektromotoren sind für eine Verwendung durch geschultes Personal in Industriebetrieben vorgesehen.

Während ihres Betriebs stehen Teile dieser Motoren unter Spannung oder bewegen sich. Deshalb kann die Entfernung der notwendigen elektrischen oder mechanischen Schutzvorrichtungen, eine nicht sachgerechte Verwendung oder eine falsche Wartung schwere Schäden an Personen und Objekten verursachen.

Es muß unbedingt sichergestellt werden, daß alle Operationen an den Motoren von qualifiziertem Personal vorgenommen werden, das die Anweisungen und technischen Daten des Produktes zur Kenntnis genommen hat und vom Verantwortlichen für Sicherheitsfragen die entsprechende Erlaubnis erhalten hat.

13.0 INFORMATIONS GENERALES MOTEURS ELECTRIQUES

Domaine d'application

Les instructions suivantes s'appliquent aux moteurs électriques asynchrones triphasés produits de BONFIGLIOLI RIDUTTORI S.p.A. de la série :

- BN
- M
dans la version de base.

Les exécutions spéciales décrites dans les catalogues et/ou dans les offres correspondantes ainsi que les applications particulières (alimentation par convertisseur par exemple), requièrent des informations supplémentaires.
Pour les types freins, on se rapportera aux instructions supplémentaires figurant à la documentation relative.

Informations générales concernant la sécurité

Les moteurs électriques décrits dans les instructions suivantes sont prévus pour être employés sur des installations industrielles et doivent être utilisés par du personnel qualifié.

Pendant le fonctionnement, ces moteurs présentent des parties sous tension ou en mouvement. Par conséquent, l'enlèvement des protections électriques et mécaniques, l'utilisation non appropriée ou un mauvais entretien peuvent entraîner de graves dommages corporels ou matériels.

Veiller à ce que chaque opération sur les moteurs soit effectuée par du personnel qualifié connaissant le mode d'emploi et les caractéristiques techniques du produit et ayant reçu l'autorisation du responsable de la sécurité pour l'intervention.

Le presenti istruzioni devono essere integrate con quanto previsto dalle disposizioni legislative vigenti nel luogo di installazione nonchè da quanto prescritto dalle Norme tecniche, specifiche di impianto ed altre regolamentazioni ai fini della sicurezza.

These instructions must be integrated with current legislation in the country of installation, as well as with technical norms and specifications regarding layout and with safety norms.

Diese Anweisungen müssen im Hinblick auf die Sicherheit durch die gesetzlichen Vorschriften, die im betreffenden Land gelten, ergänzt werden, sowie durch die technischen Vorschriften, die Spezifikationen der Anlagen und andere Regelungen.

Ces instructions doivent être complétées par les obligations prévues par les dispositions législatives en vigueur dans l'endroit d'installation, ainsi que par les prescriptions des normes techniques, spécifications d'installation et autres réglementations de sécurité.

Altre informazioni e chiarimenti possono essere richiesti agli uffici commerciali BONFIGLIOLI RIDUTTORI S.p.A.

For additional information and explanations, contact the sales office of BONFIGLIOLI RIDUTTORI S.p.A.

Weitere Informationen und Erklärungen erhalten Sie bei den Handelsvertretungen von BONFIGLIOLI RIDUTTORI S.P.A.

Pour tout autre renseignement, veuillez vous adresser aux services commerciaux de BONFIGLIOLI RIDUTTORI S.p.A.

Condizioni dl fornitura

I motori vengono forniti dalla BONFIGLIOLI RIDUTTORI S.p.A. previo superamento delle attività di controllo previste nella documentazione applicabile nel proprio sistema qualità, collaudati e già predisposti per essere installati.
Il ricevente avrà cura che i prodotti siano soggetti a trasporto e movimentazione utilizzando mezzi e attenzioni tali da assicurare il mantenimento dello stato delle condizioni fornite dalla BONFIGLIOLI RIDUTTORI S.p.A. all'atto della consegna.
Per quanto riguarda le caratteristiche di progetto si dovrà fare riferimento al catalogo o alla descrizione contenuta in ordine del cliente e confermato dalla BONFIGLIOLI RIDUTTORI S.p.A.

Supply conditions

Motors are supplied by BONFIGLIOLI RIDUTTORI S.p.A. after they have passed the controls provided in the applicable documentation for the Company's quality control system, inspected and prepared for installation.
The customer must transport and handle the products by appropriate means and with suitable care in order to keep them in the state in which they are supplied by BONFIGLIOLI RIDUTTORI S.p.A. at the time of delivery.
With respect to product specifications, refer to the catalogue or to the description in the customer's order as confirmed by BONFIGLIOLI RIDUTTORI S.p.A.

Lieferbedingungen

BONFIGLIOLI RIDUTTORI S.p.A. liefert ihre Motoren nach erfolgter Prüfung - gemäß den Unterlagen, die diese Kontrollen für ihr Qualitätssystem vorschreiben. Sie sind bereits kontrolliert und zur Installation bereit.
Der Empfänger muß bedenken, daß die Produkte transportiert werden sollen und muß deshalb geeignete Transportmittel wählen sowie Vorsichtsmaßnahmen treffen, damit diese bei ihm so ankommen, wie sie BONFIGLIOLI RIDUTTORI S.p.A ausgeliefert hat.
Bei den Produkteigenschaften muß man den Katalog und die Beschreibungen beachten, die im Auftrag des Kunden enthalten sind und die BONFIGLIOLI RIDUTTORI S.p.A. bestätigt hatte.

Conditions de fourniture

Les moteurs sont fournis par BONFIGLIOLI RIDUTTORI S.p.A. à l'issue des contrôles de la documentation prévue par son système de la qualité, testés et déjà prêts pour l'installation.
Le client veillera à ce que le transport et la manutention des produits se fassent de façon à assurer le maintien des conditions fournies par BONFIGLIOLI RIDUTTORI S.p.A. au moment de la livraison.
En ce qui concerne les caractéristiques de projet, on se rapportera au catalogue ou à la description figurant dans la commande du client confirmée par BONFIGLIOLI RIDUTTORI S.p.A.

Dato che il motore elettrico non ha una funzione intrinseca per l'utilizzatore finale e viene meccanicamente accoppiato ad altra macchina, sarà responsabilità di chi esegue l'installazione e assemblaggio garantire che vengano presi tutti i provvedimenti necessari alla sicurezza durante il funzionamento.

Since the electric motor does not have an intrinsic function for the final user and is mechanically coupled to another machine, it is the responsibility of the installer and assembler to guarantee that all provisions for safe operation have been taken.

Da der Elektromotor keine eigenleitende Funktion für den Endbenützer hat und mechanisch an eine andere Maschine angeschlossen wird, ist derjenige, der Installation und Zusammenbau vornimmt dafür verantwortlich, daß alle zur Betriebssicherheit notwendigen Maßnahmen getroffen werden.

Etant donné que le moteur électrique n'a pas une fonction intrinsèque pour l'utilisateur final et est accouplé mécaniquement à une autre machine, il appartiendra au responsable de l'installation et de l'assemblage d'adopter toutes les mesures de sécurité nécessaires pendant le fonctionnement.

Ricevimento, trasporto e movimentazione

Al ricevimento del motore controllare che non abbia subito danni durante il trasporto ed eventualmente segnalarli allo spedizioniere. Controllare inoltre che le caratteristiche riportate in targa corrispondano a quanto richiesto in ordine e confermato da BONFIGLIOLI RIDUTTORI S.p.A.
I motori elettrici vengono consegnati imballati in contenitori di cartone.
Tutti gli elementi di imballaggio dovranno essere raccolti e smaltiti o riciclati secondo le norme vigenti nel proprio Paese.
Gli imballi contenenti più motori sono normalmente applicati a bancali in legno per facilitarne la movimentazione tramite carrelli elevatori o transpallets.

Receipt, transport, and handling

Upon receipt of the motor, check that it was not damaged during transport; if damage is noted, inform the carrier immediately. In addition, check that the characteristics stated on the plate conform to those ordered and confirmed by BONFIGLIOLI RIDUTTORI S.p.A.
The motors are delivered packed in cardboard cartons.
All packing parts must be collected and disposed of or recycled according to current regulations in the customer's country.
Cartons containing more than one motor are usually attached to wooden boards to facilitate handling by forklifts or transpallets.

Warenempfang, Transport, Auf - und Abladung

Beim Eintreffen des Motors kontrolliere man, ob er beim Transport eventuell beschädigt worden ist. Ist dies der Fall, muß die Speditionsfirma sofort benachrichtigt werden. Zudem muß kontrolliert werden, ob die Eigenschaften, die auf dem Schild angegeben sind, denjenigen entsprechen, die im Auftrag verlangt und von BONFIGLIOLI RIDUTTORI S.p.A bestätigt wurden. Alle Verpackungselemente müssen eingesammelt und nach den im betreffenden Land gültigen Vorschriften entsorgt oder recyceit werden.
Verpackungen, die mehrere Motoren enthalten, werden normalerweise auf Holzverschlägen fixiert, dies vereinfacht ihren Transport auf Hubkarren oder Handgabelhubwagen.

Réception, transport et manutention

A la réception du moteur, contrôler qu'il n'a pas été abîmé pendant le transport. Le cas échéant, signaler les détériorations au transporteur.
Contrôler également que les caractéristiques figurant sur la plaque signalétique correspondent bien à ce qui a été demandé dans la commande et confirmé par BONFIGLIOLI RIDUTTORI S.p.A.
Les moteurs électriques sont livrés emballés dans des emballages en carton.
Tous les éléments d'emballage devront être récupérés et éliminés ou recyclés suivant les normes en vigueur dans le pays du destinataire.
Les emballages contenant plusieurs moteurs sont normalement appliqués sur des palettes en bois pour faciliter la manutention au moyen de chariots élévateurs ou de transpalettes.

I motori possono essere movimentati individualmente sollevandoli con fasce o cinghie (se il peso lo richiede).
I motori ≥ 100, ≥ M3 sono provvisti di un golfare di sollevamento.
Gli alberi dei motori sono muniti di protezioni di sicurezza in plastica.
Esse dovranno essere rimosse prima dell'installazione seguendo le norme di sicurezza e prevenzione in vigore nel paese del destinatario.
Successivamente, queste protezioni dovranno essere recuperate ed eliminate secondo le norme in vigore nel proprio paese.

Motors may be handled individually by lifting them with belts or chains (if required due to weight) attached to input and output shafts.
Motors ≥ 100, ≥ M3 are fitted with a hoisting eye bolt.
Motor shafts feature plastic safety protections.
They shall be removed before assembly according to the safety standards in force in the country of destination.
These protections shall then be disposed of according to the standards in force in the country considered.

Die Motoren können individuell umpaziert werden, indem man sie, falls dies wegen ihres Gewichts notwendig ist, mit Riemen oder Bändern anhebt.
Die Motoren ≥ 100, ≥ M3, sind mit einer Transportöse ausgestattet.
Die Motorwellen sind mit einem Sicherheitsschutz auf Kunststoff versehen.
Letztere müssen vor der Installation unter Berücksichtigung der im jeweiligen Anwenderland gültigen Sicherheits- und Unfallvorsorgenormen abgenommen werden.
Diese Schutzabdeckungen müssen aufbewahrt und den im jeweiligen Land geltenden Normen gemäß entsorgt werden.

Les moteurs peuvent être déplacés individuellement en les soulevant avec des bandes ou des courroies (si le poids le nécessite).
Les moteurs ≥ 100, ≥ M3 possèdent un piton de levage.
Les arbres des moteurs sont munis de protections de sécurité en plastique.
Avant l'installation il est nécessaire de les démonter selon les normes de sécurité et prévention en vigueur dans le pays du destinataire.
Par la suite, il faut récupérer ces protection et les éliminer de la façon indiquée par les lois en vigueur dans le pays considéré.

I golfari sono adatti per il sollevamento del solo motore.

The eyebolts are suitable for lifting the motor only.

Die Ösenschrauben sind nur für die Anhebung des Motors vorgesehen.

Les chevilles à oeillet sont adaptés uniquement pour le levage du moteur.

Assicurarsi che il motore venga appoggiato in modo stabile e sia impedito il rotolamento nel caso di motori con flangia.

Make sure that the motor rests in a stable manner and will not roll (in the case of motors with flange).

Man kontrolliere, ob der Motor stabil aufgesetzt wird und - im Fall von Motoren mit Flansch - nicht wegrollen kann.

S'assurer que le moteur soit posé de façon stable et qu'ils ne puissent pas rouler en cas de moteurs à bride.

13.1 STOCCAGGIO

Il corretto stoccaggio dei prodotti ricevuti richiede l'esecuzione delle seguenti attività:

a) Escludere aree all'aperto, zone esposte alle intemperie o con eccessiva umidità.

b) Interporre sempre tra il pavimento ed i prodotti, pianali lignei o di altra natura, atti ad impedire il diretto contatto col suolo.

c) Per periodi di stoccaggio superiori ai 60 giorni, le superfici interessate agli accoppiamenti quali flange e alberi, devono essere protette con idoneo prodotto antiossidante (Mobilarma 248 od equivalente).

d) Per periodi di stoccaggio previsti superiori ai 6 mesi, sarà buona norma ruotare periodicamente, ogni 1-2 mesi, il rotore e prevedere misure adeguate di protezione contro la corrosione e l'umidità.

13.1 STORAGE

Observe the following instructions to ensure correct storage of delivered products:

a) Do not store outdoors, in areas exposed to weather or with excessive humidity.

b) Always place boards in wood or other material between floor and products, to avoid direct contact with the floor.

c) For storage periods exceeding 60 days, all coupling surfaces such as flanges and shafts must be protected with a suitable anti-oxidation product (Mobilarma 248 or equivalent).

d) For storage periods exceeding 6 months, it is a good rule to turn the rotor every 1-2 months and to take adequate measures against corrosion and humidity.

13.1 LAGERUNG

Die korrekte Lagerung der Antriebe erfordert folgende Vorkehrungen:

a) Die Produkte nicht im Freien lagern und nicht in Räumen, die der Witterung ausgesetzt sind, oder eine hohe Feuchtigkeit aufweisen.

b) Die Produkte nie direkt auf dem Boden, sondern auf Unterlagen aus Holz oder einem anderen Material lagern.

c) Bei Lagerungen, die länger als 2 Monate dauern, müssen die Oberflächen wie Flansche und Wellen, die an andere Geräte angeschlossen werden, mit einem geeigneten Antioxydierungsmittel (Mobilarma 248 oder ein gleichwertiges Produkt) geschützt werden.

d) Ist eine Lagerung von mehr als 6 Monaten vorgesehen, muß von Zeit zu Zeit, alle 1 - 2 Monate der Läufer gedreht werden, zudem müssen vorbeugende Schutzmaßnahmen gegen Rost und Feuchtigkeit getroffen werden.

13.1 STOCKAGE

Un correct stockage des produits reçus nécessite de respecter les règles suivantes:

a) Exclure les zones à ciel ouvert, les zones exposées aux intempéries ou avec humidité excessive.

b) Interposer dans tous les cas entre le plancher et les produits des planches de bois ou des supports d'autre nature empêchant le contact direct avec le sol.

c) Pour des périodes de stockage supérieures à 60 jours, les surfaces d'accouplement (brides et arbres) doivent être protégées au moyen d'un produit antirouille approprié (Mobilarma 248 ou équivalent).

d) Pour des périodes de stockage supérieures à 6 mois, il convient de tourner le rotor périodiquement, tous les mois ou les deux mois, et de prévoir des mesures appropriées de protection contre la rouille et l'humidité.

13.2 INSTALLAZIONE E MESSA IN SERVIZIO

Controllare che le condizioni di alimentazione, montaggio e servizio corrispondano a quanto indicato in targa e descritto nella documentazione tecnica.

È molto importante, per l'installazione del motore, attenersi alle seguenti norme:

13.2 INSTALLATION AND START-UP

Check that power supply, assembly and service conditions comply with the information on the plate and described in the technical documentation.

The following instructions must be observed when installing the motor:

13.2 INSTALLATION UND IBETRIEBSETZUNG

Man kontrolliere, ob die Stromversorgungs-, Montage- und Betriebsbedingungen denjenigen entsprechen, die auf dem Typenschild angegeben sind und den technischen Unterlagen entsprechen.

Bei der Installation des Motors müssen unbedingt folgende Regeln beachtet werden:

13.2 INSTALLATION ET MISE EN SERVICE

S'assurer que les conditions d'alimentation, de montage et de service correspondent bien aux indications figurant sur la plaque signalétique et dans la documentation technique.

Il est important, pour l'installation du moteur, de se conformer aux règles suivantes:

Rimuovere le eventuali protezioni in plastica presenti sugli alberi seguendo le norme di sicurezza e prevenzione in vigore nel paese del destinatario.

Rimuovere eventuali protettivi di protezione antiossidanti per mezzo di solventi seguendo le norme in vigore nel paese del destinatario.

Evitare che il solvente venga a contatto con il labbro degli anelli di tenuta.

Remove any plastic guards from the shafts according to safety regulations in customer's country.

Remove any protective coatings with solvents according to safety regulations in customer's country.

Do not let the solvent be in touch with oilseal lips.

Eventuell vorhandenen Plastikschutz von den Wellen entfernen, unter Einhaltung der Sicherheits und Varhütungsrichtlinien gemaß des Gesetzes.

Anhaftende Schutzschichten mit einem Lösemittel entfernen.

Es muß unbedingt vermieden werden, daß das Lösemittel mit den Lippen der Dichtungsringe in Kontakt kommt.

Enlever les éventuelles protections en plastique présentes sur les arbres suivant les normes de securité et prévention en vigueur dans le pays du destinataire.

Enlever les éventuelles produits de protection antioxidants au moyen de solvants suivant les normes en vigueur dans le pays du destinataire

Le solvant ne doit pas entrer en contact avec la lèvre des bagues d'étanchéité.

Assicurarsi che il motore sia ben ventilato, non vi siano impedimenti alla libera circolazione dell'aria e in generale, che non insorgano situazioni che compromettano il regolare smaltimento del calore.

L'installazione dovrà inoltre consentire l'esecuzione della manutenzione ordinaria del motore e, se previsto, del freno.

Make sure that the motor is well-ventilated, that there is nothing to block the free circulation of air, and that no situation will arise that could block the regular dissipation of heating.

The installation must also allow the ordinary maintenance on the motor and, if provided, of the brake.

Sicherstellen, daß die Lüftung des Motors gut funktioniert und daß die Luft frei strömen kann. Ganz allgemein darf es nicht zu Situationen kommen, die die normale Abkühlung verhindern.

Die Installation muß zudem so erfolgen, daß die normalen Wartungsarbeiten des Motors und, wenn vorgesehen, der Bremse ohne Behinderung vorgenommen werden können.

S'assurer que le moteur est bien aéré, qu'il n'y a pas d'empêchements à la libre circulation de l'air et, en général, qu'il ne se produit pas de situations compromettant la dissipation régulière de la chaleur.

L'installation devra en outre permettre l'entretien ordinaire du moteur et, s'il est prévu, du frein.

Non sottoporre l'albero motore ad urti che possano danneggiare i cuscinetti.

Avoid shocks on the motor shafts: this may damage the bearings.

Die Motorenwelle darf keine Stöße bekommen, denn diese könnten die Lager beschädigen.

Ne pas soumettre l'arbre à des chocs pouvant endommager les roulements.

Nel caso di motori con montaggio verticale ed albero in basso, l'ingresso aria dovrà essere protetto da un tettuccio.

Nelle installazioni all'aperto, proteggere il motore dall'irraggiamento diretto e, se possibile, dalle intemperie.

Accoppiando motori elettrici con flangia IEC B5 o B14 ai riduttori, e prima di introdurre l'albero del motore nell'albero cavo del riduttore stesso, assicurarsi che la linguetta del motore sia perfettamente stabile.
Spalmare su tutta la lunghezza dell'albero del motore appositi componenti (es. Loctite Antiseize 767) per prevenire fenomeni di usura superficiali, meglio conosciuti come “fretting corrosion” o “ polveri rosse”.
Ogni 6 - 12 mesi è opportuno scollegare il motore dal riduttore, pulire la zona di accoppiamento albero/foro e ripristinare la protezione antiusura sopra descritta.

Assicurarsi che il fissaggio del motore sulla flangia del riduttore avvenga in modo stabile per non dare luogo a vibrazioni.

Nel caso che i motori debbano essere verniciati è opportuno proteggere la targa di identificazione.

Nei motori flangiati il centraggio è previsto con tolleranza j6 ≤ 132, h6 ≥160.

In case of motors with vertical assembly and shaft below, fan cover must be protected by a canopy.

In outdoor installations, protect the motor from direct sunlight and, if possible, from inclement weather.

When coupling electric motors with flange IEC B5 or B14 to gearboxes, and before inserting the motor shaft in the hollow shaft of the gearbox, make sure that the motor key is perfectly stable.
Spread a suitable substance (such as Loctite Antiseize 767) over the entire length of the shaft to prevent surface wear, better known as fretting corrosion or red dust.
It is a good rule to disconnect the motor from the gearbox every 6-12 months, clean the shaft/hole coupling zone, and restore the above-described anti-wear conditions.

Make sure that the motor is secured to the gearbox flange in a stable manner and does not cause vibrations.

If the motors must be painted, it is advisable to protect the name plate.

Pilot diameter on flanged motors have a j6 ≤ 132, h6 ≥160 tolerance.

Falls die Motoren vertikal montiert werden und die Welle sich unten befindet, muß der Eingang durch ein Schutzdach geschützt werden.

Bei Installationen im Freien muß der Motor vor direkten Sonnenstrahlen und, wenn möglich, vor Witterungseinflüssen geschützt werden.

Werden Elektromotoren mit IEC B5- oder B14-Flanschen an die Getriebe angeschlossen, ist vor dem Einführen der Motorwelle in die Hohlwelle des Getriebes zu kontrollieren, ob die Feder des Motors völlig stabil ist. Auf die ganze Motorwellenlänge spezielle Produkte streichen (z.B. Loctite Antiseize 767), um eine Oberflächenabnützung zu verhindern - dieses Problem ist vielleicht besser bekannt unter dem Namen “fretting corrosion” oder “roter Staub”.
EAin- bis zweimal pro Jahr muß der Motor vom Getriebe entfernt und die Zone, wo sich Welle und Öffnung berühren, gereinigt werden, dann die eben beschriebene Oberflächenbehandlung wiederholen.

Man kontrolliere, ob der Motor gut am Getriebeflansch fixiert ist, sodaß er nicht vibriert.

Falls die Motoren lackiert werden sollen, empfehlen wir, das Typenschild zu schützen.

Bei Flanschmotoren beträgt die vorgesehene Zentrierungstoleranz j6 ≤ 132, h6 ≥ 160.

Sur les moteurs à montage vertical et avec arbre en bas, l'entrée de l'air doit être protégée par un capot de protection parapluie.

Sur les installations en extérieur, protéger le moteur du rayonnement direct et, si possible, des intempéries.

Pour l'accouplement de moteurs électriques aux réducteurs au moyen d'une bride IEC B5 ou B14, avant d'introduire l'arbre du moteur dans l'arbre creux du réducteur, s'assurer que la clavette du moteur soit parfaitement stable.
Appliquer sur toute la longueur de l'arbre du moteur un produit prévu à cet effet (par exemple, Loctite Antiseize 767), pour empêcher les phénomènes d'usure superficielle, mieux connus sous le nom de “fretting corrosion” ou “poudres rouges”.
Tous les 6-12 mois, il convient de déconnecter le moteur du réducteur, de nettoyer la zone d'accouplement arbre/trou, et d'appliquer de nouveau la protection anti-usure décrite ci- dessus.

S'assurer que la fixation du moteur sur la bride du réducteur se fasse de façon stable, sans possibilité de vibrations.

Si les moteurs doivent être peints, nous vous conseillons de protéger la plaque signalétique.

Sur les moteurs bridés, le centrage est prévu avec une tolérance j6 ≤ 132, h6 ≥160.

Bilanciamento

Il rotore è bilanciato dinamicamente con mezza linguetta.
Il montaggio dell'eventuale organo di trasmissione dovrà avvenire con l'utilizzo di strumenti adeguati e dopo opportuna equilibratura evitando colpi che danneggerebbero i cuscinetti.
Particolare attenzione dovrà essere posta per evitare l'avviamento del motore senza avere fissato opportunamente la linguetta non utilizzata (motori con due estremità d'albero).

Balancing

The rotor is dynamically balanced with full key.
The assembly of an external transmission must be performed with adeaquate instruments after suitable balancing, avoiding knocks which could damage the bearings.
Be especially careful not to rotate the motor without having properly secured the key not being used (motors with two shaft ends).

Auswuchtung

Der Läufer wird dynamisch mit der Feder ausgewuchtet.
Die Montage der eventuell notwendigen Antriebskomponente muß unter Verwendung geeigneter Instrumente und erst nach der Auswuchtung erfolgen, dabei darf es nicht zu Stößen kommen, die die Lager beschädigen könnten.
Man muß speziell aufpassen, daß der Motor sich nicht dreht, ohne daß die nicht benützte Feder richtig fixiert worden ist (Motoren mit Doppelwellenenden).

Equilibrage

Le rotor est équilibré dynamiquement avec une clavette entière.
Le montage de l'éventuel organe de transmission devra se faire au moyen d'instruments appropriés et après équilibrage, en évitant les coups qui pourraient abîmer les roulements.
Veiller en particulier à éviter la rotation du moteur sans avoir fixé la clavette non utilisée (moteurs avec deux extrémités d'arbre).

Adottare le misure adeguate per prevenire il contatto accidentale con parti nude in tensione o in movimento.

Adopt adequate measures to avoid accidental contact with exposed live or moving parts.

Es müssen entsprechenden Maßnahmen getroffen werden, um zufälligen Kontakt spannungstragender oder rotierender Teile mit Personen zu verhinden.

Adopter les mesures appropriées pour empêcher le contact accidentel avec des parties vives sous tension ou en mouvement.

Dovrebbe inoltre essere evitato il contatto con la cassa motore dato che nel normale funzionamento la temperatura può raggiungere valori superiori a 50 °C.

Avoid contact with the motor case, since the temperature under normal operating conditions may exceed 50 °C.

Zudem sollte der Kontakt mit dem Motorengehäuse vermieden werden, da bei normalem Betrieb die Temperatur auf über 50° C steigen kann.

Eviter également le contact avec la carcasse du moteurs : en fonctionnement normal, la température peut atteindre des valeurs supérieures à 50 °C.

Prova dI isolamento

Prima della messa in servizio o dopo lunghi periodi di giacenza a magazzino (o fermata), controllare la resistenza di isolamento verso massa con Megger da 500V in c.c. Il valore misurato a temperatura di +25 °C per avvolgimenti nuovi ed in buone condizioni deve essere superiore a 10 MΩ. Nel caso in cui questo valore non sia raggiunto è necessario l'essiccamento in forno per eliminare l'umidità presente.

Insulation test

Before start-up, or after long storage (or idle) periods, check insulation resistance to mass with Megger at 500V DC.
The level measured at 25 °C for new windings in good condition should exceed 10 MΩ.
If this level is not reached, oven drying will be required to eliminate humidity.

Isolationstest

Vor der Inbetriebsetzung oder nach langen Ruhepausen kontrolliere man mit einem 500 V-Megger mit Gleichstrom den Isolationswiderstand gegenüber der Erdung. Der Wert, der bei einer Temperatur von + 25 °C (für neue Wicklungen) und unter guten Bedingungen gemessen wird, muß mehr als 10 MΩ betragen. Wird dieser Wert nicht erreicht, muß die Feuchtigkeit durch Trocknen im Ofen eliminiert werden.

Test d'isolation

Avant la mise en service ou après de longues périodes de stockage (ou d'arrêt), contrôler la résistance d'isolation vers la masse au moyen d'un Megger 500 Vcc.
La valeur mesurée à une température de +25 °C pour des enroulements neufs et en bon état doit être supérieure à 10 MΩ.
Si ce n'est pas le cas, sécher au four pour éliminer l'humidité.

Collegamento elettrico

Utilizzare cavi di alimentazione di sezione adeguata alla corrente assorbita ed idonei alle condizioni di installazione previste evitando eccessivi riscaldamenti e/o cadute di tensione. Il collegamento in morsettiera deve essere eseguito secondo gli schemi riportati nella tabella (S89) o come indicato nelle istruzioni all'interno della scatola coprimorsetti utilizzando le apposite piastrine, dadi e rondelle. Eseguire la messa a terra secondo le disposizioni vigenti prima di procedere alla connessione alla rete.
Oltre ai morsetti principali, la scatola coprimorsettiera può contenere le connessioni per le protezioni termiche, dei riscaldatori anticondensa o del freno.
Eseguire le connessioni secondo gli schemi contenuti all'interno della scatola morsetti verificando il tipo di sonda installato (termistore o bimetallo).

Per le connessioni al freno vedi istruzioni supplementari.

Electrical connection

Use power cables with suitable section for absorbed current and for installation conditions, avoiding excessive heating and/or voltage drops. Connection at the terminal board must be performed according to the diagrams shown in table (S89) or according to the instructions contained in the terminal box, using the appropriate plates, nuts, and washers. Earth according to current norms before connecting to the mains.
In addition to the main terminals, the terminal box may contain thermal protection, anti-condensation heaters, and brake connections.
Make the connections according to the diagrams contained in the terminal box. Check the type of thermal protection installed (thermistor or bimetallic).

See the supplemental instructions for connections to the brake.

Elektrischer Anschluß

Der Querschnitt der Stromkabel muß der aufgenommenen Strommenge entsprechen und sich für die vorgesehenen Installationsbedingungen eignen. Allzu hohe Erwärmungen und/oder Spannungs- abfälle müssen verhindert werden. Der Anschluß an das Klemmenbrett erfolgt unter Beachtung der Tabelle (S89) oder der Anweisungen, die im Deckel des Klemmenbrettgehäuses angegeben werden. Dabei werden die dazu vorgesehenen Plättchen, Muttern und Rondellen verwendet. Die Erdung erfolgt entsprechend den im betreffenden Land geltenden Vorschriften, und erst danach wird der Netzanschluß vorgenommen. Außer den Hauptklemmen kann das Klemmenbrettdeckgehäuse Anschlüsse für den Wärmeschutz, die Heizgeräte zur Verhütung von Kondenswasser oder die Bremse enthalten.
Die Anschlüsse müssen nach den Zeichnungen, die sich im Innern des Klemmenbrettgehäuses befinden, vorgenommen werden, wobei man kontrollieren muß, welcher Schutzschalte installiert worden ist (Thermistor oder Bimetall).

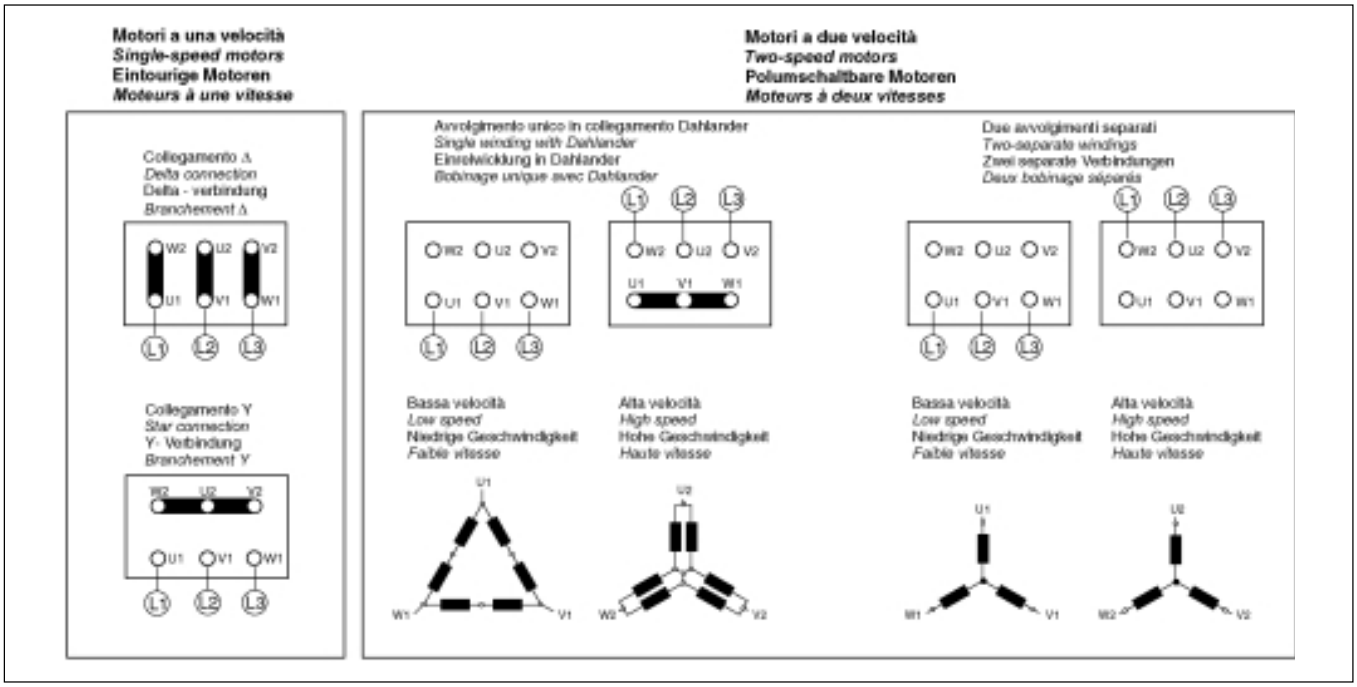
Für die Anschlüsse an die Bremse beachte man die zusätzlichen Anweisungen.

Branchement électrique

Utiliser des câbles d'alimentation d'une section appropriée au courant absorbé et adaptés aux conditions d'installation prévues, en évitant les surchauffages excessives ou les chutes de tension. Le branchement au bornier doit être effectué selon les schémas figurant au tableau (S89) ou de la façon indiquée dans les instructions fournies à l'intérieur de la boîte à bornes, en utilisant les platines, les écrous et le rondelles appropriés.
Effectuer la mise à la terre selon les dispositions en vigueur avant de procéder à la connexion au réseau.
En plus des bornes principales, la boîte à bornes peut contenir les connexions pour les protections thermiques, des réchauffeurs anticondensation ou du frein.
Effectuer les connexions selon les schémas figurant à l'intérieur de la boîte à bornes, en vérifiant le type de sonde installée (thermistor ou bimétal).

Pour les connexions au frein, voir instructions supplémentaires.

(S89)



L'alimentazione delle scaldiglie deve essere separata e deve sempre essere esclusa durante il funzionamento del motore.

Power for the heaters must be separate and must always be disconnected when the motor is running.

Die Stromzufuhr der Heizvorrichtungen muß getrennt erfolgen und bei funktionierendem Motor immer ausgeschaltet sein.

L'alimentation des réchauffeurs doit être séparée et doit toujours être désactivée pendant le fonctionnement du moteur.

Chiudere il coperchio interponendo la guarnizione, avvitare correttamente il bocchettone e la sua vite premicavo e chiudere le aperture d'ingresso non utilizzate.
Nel caso di motori con ventilazione assistita, l'avviamento del motore dovrà avvenire solo con ventilatore in funzione. Per questa applicazione prevedere sempre protezioni

Insert the gasket and close the cover. Carefully tighten the cable entrye and cable gland and close the openings not used.
In the case of motors with servo ventilation, the motor must be started only with the fan running. Always provide incorporated thermal protections for this application. The motors must be equipped with

Deckel schließen, indem man eine Dichtung dazwischenlegt.
Den Stutzen und seine Kabelhalteschraube richtig anschrauben, dann die nicht verwendeten Eingänge schließen. Bei Motoren, die eine Fremdbelüftung aufweisen, darf der Motor nur angelassen werden, wenn die Ventilation in Betrieb ist.

Fermer le couvercle en interposant le joint, visser correctement le bouchon et sa vis presse-étoupe et fermer les ouvertures d'entrée non utilisées.
Pour les moteurs à ventilation assistée, le démarrage du moteur ne doit se faire que lorsque le ventilateur est en fonction. Pour cette application, prévoir toujours des

termiche incorporate. I motori devono essere previsti di adeguate protezioni contro i cortocircuiti, sovraccarichi e sovratensioni di manovra.

adequate protections against short circuits, overloads, and overvoltages.

Für diese Verwendung muß immer ein Wärmeschutz eingebaut sein. Die Motoren müssen angemessene Schutzvorrichtungen gegen Kurz-schluß, Überlastung und übermäßige Spannung beim Manövrieren aufweisen

protections thermiques incorporées. Les moteurs doivent être dotés de protections appropriées contre les courts-circuits, les surcharges ou les surtensions de manoeuvre.

Durante le fermate può essere presente tensione per l'alimentazione delle scaldiglie o del freno. Accertarsi che manchi ogni connessione alla rete.
Si deve inoltre evitare che possano verificarsi riavviamenti automatici tali da creare situazioni pericolose e/o danneggiamenti.

During stops, there may be voltage to feed the heaters or the brake. Make sure that all connections to the mains have been cut.
In addition, be sure to prevent any automatic restarts that could create hazardous and/or destructive situations.

Wenn der Motor nicht in Betrieb ist, kann Spannung für die Wärmer oder für die Bremse vorhanden sein. Man kontrolliere, ob kein Anschluß ans Stromnetz vorhanden ist.
Zudem muß vermieden werden, daß es erneut zu automatischem Motorstart kommt, diese Situation könnte gefährlich sein und/oder Beschädigungen verursachen.

Pendant les arrêts, de la tension peut être présente pour l'alimentation des réchauffeurs ou du frein. S'assurer qu'il n'y a pas de connexion au reseau.
Eviter que ne se produisent des redémarrages automatiques, qui peuvent créer des situations de danger et/ou des dommages.

Senso dl rotazione

Se la rete di alimentazione con sequenza di fase L1, L2, L3 viene collegata ai morsetti U, V, W come indicato nella tabella (S89), il senso di rotazione del motore risulta orario visto dal lato comando. Se vengono scambiati tra loro due terminali qualsiasi, il senso di rotazione risulta antiorario.

Per i motori unidirezionali, sarà prevista una targhetta con indicato il senso di rotazione e la sequenza di fase da applicare (p.e. U, V, W).
Questa indicazione è presente soltanto quando il motore in funzione delle proprie caratteristiche di progetto prevede un unico senso di rotazione (p.e. dispositivo antiritorno installato).
Particolare attenzione dovrà porsi nei casi in cui l'unidirezionalità sia imposta dalle specifiche di macchina o impianto.

Direction of rotation

If the mains with phase sequence L1, L2, L3 is connected to terminals U, V, W as shown at table (S89), the direction of rotation of the motor will be clockwise as seen from the drive end. If any two terminals are switched, the direction of rotation will be counter- clockwise.

For single direction motors, a plate will be provided to indicate the direction of rotation and the phase sequence to be applied (for example, U, V, W).
This indication is present only when the motor, as a function of project characteristics, requires only one direction of rotation (for example, anti run-back device installed).
Pay special attention when single direction status is imposed by machine or plant specifications.

Drehrichtung

Wenn das Stromnetz mit Phasenfolge L1, L2, L3 wie in der Tabelle (S86) gezeigt an die Klemmen U, V, W angeschlossen wird, erfolgt die Drehrichtung des Motors - von der Antriebswellenseite her gesehen - im Uhrzeigersinn. Werden zwei beliebige Kabelenden untereinander vertauscht, ist die Drehrichtung im Gegenuhrzeigersinn.

Für Motoren, die nur eine Drehrichtung haben ist ein Typen- schild vorgesehen, auf dem die richtige Drehrichtung und die Phasenfolge (z.B.: U, V, W) angegeben sind.
Diese Angaben stehen nur auf Motoren, die aufgrund ihrer Bauweise eine einzige Drehrichtung haben (z.B. installierte Rücklaufsperre).
In den Fällen, wo die einzige Drehrichtung durch Eigenheiten der Maschine oder der Anlage bedingt ist, muß speziell vorsichtig vorgegangen werden.

Sens de rotation

Si le réseau d'alimentation avec séquence de phase L1, L2, L3 est relié aux bornes U, V, W de la façon indiquée au tableau (S89), la rotation du moteur se fait dans le sens horaire vu du côté arbre d'entrée. Si l'on intervertit deux bornes quelconques, la rotation se fait dans le sens anti-horaire.

Pour les moteurs unidirectionnels, on prévoira une plaque indiquant le sens de rotation et la séquence de phase à appliquer (par exemple, U, V, W).
Cette indication est présente uniquement quand le moteur, en fonction de ses caractéristiques, prévoit un sens de rotation unique (par exemple, dispositif anti-retour installé).
Faire particulièrement attention si la direction unique est imposée par les spécifications de la machine ou de l'installation.

Avviamento

Prima della messa in servizio si consiglia di eseguire le seguenti operazioni e controlli:

1) verificare che tutte le misure di sicurezza siano applicate;
2) alimentare il motore a vuoto alla tensione nominale;
3) controllare che l'eventuale servoventilatore sia inserito;
4) controllare che il funzionamento sia regolare e senza vibrazioni;
5) in caso di funzionamento soddisfacente applicare il carico controllando i relativi valori di tensione e corrente.

Per i motori autofrenanti vedi istruzioni supplementari.

Commissioning

Perform the following operations and checks before start-up:

1) check that all safety measures have been applied;
2) power up the motor unloaded at rated voltage;
3) check if the servoventilator (if any) is on;
4) check that operation is normal and vibration-free;
5) if operation is satisfactory, apply the load and check voltage, current, and power.

See the supplemental instructions for brake motors.

Anlassen

Bevor der Motor in Betrieb genommen wird, führe man folgende Kontrollen durch:

1) sicherstellen, daß alle Sicherheitsmaßnahmen getroffen worden sind;
2) den Motor bei Leerlauf und Nennspannung laufen lassen,
3) kontrollieren, ob der eventuell vorhandene Servoventilator eingeschaltet ist;
4) kontrollieren, ob der Motor gleichmäßig läuft und nicht vibriert;
5) falls man mit dem Betrieb des Motors zufrieden ist, kann er belastet werden, wobei die Spannungs-, Strom- und Leistungswerte kontrolliert werden müssen.

Für Bremsmotoren beachte man die zusätzlichen Anweisungen.

Démarrage

Avant la mise en service, nous vous conseillons d'effectuer les opérations et les contrôles suivants:

1) vérifier que toutes les mesures de sécurité sont appliquées;
2) alimenter le moteur à vide à la tension nominale;
3) contrôler que l'éventuel servo-ventilateur est bien installé;
4) contrôler que le fonctionnement est régulier et sans vibrations;
5) en cas de fonctionnement satisfaisant, appliquer la charge en contrôlant les valeurs correspondantes de tension, de courant et de puissance.

Pour les moteurs freins, voir informations supplémentaires.

Un funzionamento anomalo quale assorbimento oltre I limiti di targa, riscaldamento eccessivo, rumore, vibrazioni possono causare seri danneggiamenti o condizioni di pericolo. In questi casi interrompere l'alimentazione ed avvertire Il personale preposto alla manutenzione.

Malfunctions such as over current, overheating, noise, or vibrations, may cause serious damage or dangerous conditions. In these cases, cut power and notify maintenance personnel immediately.

Funktioniert der Motor nicht normal, d.h. nimmt er mehr Strom auf, als auf dem Schild angegeben ist, erhitzt er sich übermäßig, macht er zu viel Geräusch oder vibriert er, kann dies zu schweren Beschädigungen oder gefährlichen Situationen führen. In diesen Fällen muß man die Stromzufuhr unterbrechen und das Wartungspersonal benachrichtigen.

Un fonctionnement anormal (absorption au-delà des limites indiquées sur la plaque, réchauffement excessif, bruit, vibrations) peut entraîner des dommages et des dangers. Dans ce cas, couper l'alimentation et avertir le personnel chargé de l' entretien.

13.3 **MANUTENZIONE**

Prima di eseguire qualsiasi intervento il motore, i circuiti ausiliari e/o accessori devono venire correttamente scollegati dalla rete di alimentazione. In particolare:

controllare l'isolamento dalla rete elettrica

prevedere le opportune protezioni da eventuali parti nude in tensione

accertarsi che non si verifichino riavviamenti accidentali.

Si raccomanda di osservare frequentemente il funzionamento del motore e prevedere periodiche ispezioni.
Osservare inoltre quanto previsto nelle istruzioni aggiuntive per i motori con freno.
In generale si consiglia di operare come segue:

1) controllare che il funzionamento sia regolare e gli assorbimenti entro i valori riportati in targa;
2) mantenere il motore pulito e verificare che non vi siano ostruzioni alla ventilazione;
3) controllare le condizioni degli anelli di tenuta sull'albero;
4) controllare che le connessioni elettriche e le viti di fissaggio siano strette;
5) i cuscinetti utilizzati nell'esecuzione standard sono del tipo prelubrificati e non necessitano di manutenzione; è comunque buona norma sostituirli dopo circa 3 anni.

Per le normali ispezioni non è necessario smontare il motore se non per la sostituzione dei cuscinetti. In questo caso le operazioni dovrebbero essere eseguite dal personale specializzato e con strumenti idonei.

13.3 MAINTENANCE

Before any intervention, the motor, auxiliary circuits and/or accessories must be disconnected from the mains. In particular:

check insulation from the electrical mains

provide suitable protections from exposed live parts

make sure to prevent accidental restarts.

Be sure to frequently observe the operation of the motor. Inspect periodically.
In addition, follow the additional instructions for motors with brake.
In general, we advise you to do as follows:

1) check that operation is normal and that absorbed current is within rated limits;
2) keep the motor clean and check that ventilation is not obstructed;
3) check the condition of the seals on the shaft;
4) check that all electrical connections and fastening screws are tight;
5) the bearings used in the standard version are pre-lubricated e seded and do not require maintenance. Nevertheless, it is a good rule to replace them after approximately 3 years.

The motor does not have to be removed for normal inspections unless the bearings need to be replaced. In this case, the operations should be performed by specialised personnel and with appropriate tools.

13.3 **WARTUNG**

Bevor irgendwelche Wartungsarbeiten vorgenommen werden, muß beim Motor, sowie auf den Hilfs- und Nebenkreisen die Stromversorgung fachmännisch unterbrochen werden. Vor allem muß man:

die Isolation des Stromnetzes geeignete Schutzvorrichtungen kontrollieren,

gegegen unbeabrichtigten Kontakt mit spannungstragenden Teilen tragen,

sicherstellen, daß es nicht zu unvorhergesehenen Motorstarts kommt.

Es wird empfohlen, häufig den Betrieb des Motors zu beobachten und von Zeit zu Zeit eine Inspektion durchzuführen.
Bei Motoren mit Bremse beachte man zudem die zusätzlichen Anweisungen.
Im Allgemeinen empfehlen wir, wie folgt vorzugehen:

1) kontrollieren, ob der Motor richtig funktioniert und die Stromaufnahme den Angaben auf dem Typenschild entspricht
2) den Motor sauber halten und regelmäßig nachsehen, ob die Belüftung nicht verstopft ist;
3) die Dichtungsringe auf der Welle regelmäßig kontrollieren;
4) kontrollieren, ob die elektrischen Anschlüsse und die Befestigungsschrauben gut fixiert sind;
5) die Lager, die auf dem Standard modell verwendet wurden, sind vorgeschmiert und wartungsfrei; wir empfehlen aber trotzdem, diese nach zirka 3 Jahren zu ersetzen.

Für normale Inspektionen muß der Motor nicht abmontiert werden, außer wenn die Lager ausgewechselt werden sollen. In diesem Fall sollten die Operationen jedoch von geschultem Personal und mit geeignetem Werkzeug vorgenommen werden.

13.3 ENTRETIEN

Avant toute intervention, le moteur ainsi que les circuits auxiliaires et/ou accessoires doivent être déconnectés du réseau. En particulier:

contrôler l'isolement par rapport au réseau électrique

prévoir des protections appropriées contre les éventuelles parties vives sous tension.

s'assurer qu'il ne puisse pas se produire de redémarrages accidentels

Nous vous recommandons d'observer fréquemment le fonctionnement du moteur et de prévoir des inspections périodiques.
Se conformer aux instructions supplémentaires pour les moteurs à frein.
En général, nous vous conseillons de procéder comme suit:

1) contrôler que le fonctionnement est régulier et que les absorptions sont comprises à l'intérieur des valeurs indiquée sur la plaque;
2) maintenir le moteur propre et vérifier que rien ne gêne la ventilation;
3) contrôler l'état des joints d'étanchéité sur l'arbre;
4) contrôler que les branchements électriques et les vis sont bien serrés;
5) les roulements utilisés dans l'exécution standard sont du type prélubrifié et ne nécessitent aucun entretien. Il convient toutefois de les changer tous les 3 ans environ.

Pour les inspections normales, il n'est pas nécessaire de démonter le moteur, sauf pour le remplacement des roulements. Dans ce cas, les opérations devraient être effectuées par du personnel spécialisé et avec des instruments appropriés.

Motori autofrenanti con freno tipo FD e FA.

Brake motors with brake FD and FA type.

Bremsmotoren Gleichstrombremsung Mod. FD und FA

Moteurs freins avec frein type FD et FA

Regolazione del traferro

Air gap adjustment

Einstellung des Luftspalts

Reglage de l'entrefer

Allentare i dadi 6.

Regolare il traferro T agendo sulle viti 5 portandolo al valore Min. indicato in tabella (S90).

A regolazione ultimata bloccare a fondo i dadi 6 mantenendo in posizione le viti 5.

Il traferro deve essere verificato periodicamente e il suo valore deve essere compreso tra i valori min. e Max. indicati nella tabella (S90).

Unloosen nut No. 6

Set the air gap T to min. value shown in the table (S90) adjusting the screws No. 5.

When reached the air gap value lock the nuts No. 6 keeping the screws in positions No. 5

The air gap value must be checked periodically and the value must be between the min. and max. value shown in the table (S90).

Muttern 6 lösen.

Luftspalt T einstellen, indem man die Schraube 5 dreht, bis sie auf dem kleinsten Wert der Tabelle (S90) sind.

Nach dieser Einstellung die Muttern 6 gut blockieren, wobei die Schrauben 5 in ihrer Position bleiben müssen.

Der Luftspaltwert muß von Zeit zu Zeit kontrolliert werden; die Spaltöffnung muß zwischen dem Mindest- und dem Höchstwert, die in der Tabelle (S90) angegeben sind, liegen.

Desserrer les écrous 6.

Régler l'entrefer T en amenant la vis 5 à la valeur min. indiquée dans le tableau (S90).

Une fois le réglage terminé, bloquer à fond les écrous 6 en maintenant en position les vis 5.

La valeur de l'entrefer doit être vérifiée périodiquement ; elle doit être comprise entre les valeurs min. et max. indiquées dans le tableau (S90).

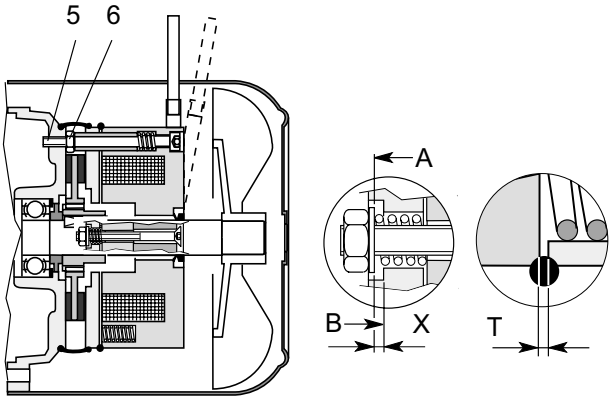
Valori di traferro superiori al valore Max. determinano un aumento della rumorosità e possono impedire lo sbloccaggio del freno.
In presenza della leva di sblocco, l'aumento eccessivo del traferro può portare ad un annullamento della coppia frenante dovuto alla ripresa del gioco dei tiranti della leva di sblocco.
La distanza X (gioco leva) deve essere superiore ai valori indicati in tabella (S90).

Air gap higher than the max. value increase the brake noise and may prevent from brake releasing.
When the brake release lever is fitted, the eccessive air gap may annul the brake torque due to the play in the brake release screw.
Dimension x (lever play) must respect the value shown in the table (S90).

Luftspaltwerte, die höher als der Maximalwert liegen, führen dazu, daß das Bremsgeräusch stärker wird und die Bremse eventuell nicht entsperrt wird.
Ist der Bremsentsperrungshebel vorhanden, kann eine zu starke Öffnung des Luftspaltes dazu führen, daß das Bremsdrehmoment wegen der Wiederaufnahme des Zugstangenspieles des Entsperrungshebels gleich Null wird.
Der Wert X (Hebelspiel) muß den in der Tabelle (S90) angegebenen Werten entsprechen.

Les valeurs d'entrefer supérieures à la valeur max. ont pour effet de rendre le frein plus bruyant, et peuvent en empêcher le déblocage.
En présence du levier de déblocage, l'augmentation excessive de l'entrefer peut entraîner une annulation du couple de freinage, du fait de la reprise du jeu des tirants du levier de déblocage. La dimension X (jeu levier) doit correspondre aux valeurs indiquées dans le tableau (S90).

(S90)



		TIPO DI FRENO / *BRAKE TYPE* BREMSTYP / *TYPE DE FREIN*							
		02FD	**03FD 53FD**	**04FD 14FD**	**05FD 15FD 55FD**	**06SFD**	**06FD 56FD**	**07FD**	**08FD**
T	min.	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5
	Max.	0.4	0.4	0.45	0.45	0.55	0.55	0.6	0.7
X	min	0.6	0.8	1.0	1.0	1.2	1.2	1.2	1.3

		TIPO DI FRENO / *BRAKE TYPE* BREMSTYP / *TYPE DE FREIN*							
		02FA	**03FA**	**04FA 14FA**	**05FA 15FA**	**06SFA**	**06FA**	**07FA**	**08FA**
T	min.	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5
	Max.	0.4	0.4	0.45	0.45	0.55	0.55	0.6	0.8
X	min.	0.6	0.8	1.0	1.0	1.2	1.2	1.2	1.2

T = Traferro (mm) / *Air gap (mm)* / Luftspalt / *Entrefer*

X = Distanza (mm) fra il piano B e il piano della rosetta piana A
X = *Distance (mm) between the surface B and the plan washer surface A*
X = Distanz (mm) zwischen der Fläche B und der Scheibenfläche A
X = *Distance (mm) entre la surface B et la surface de la rondelle A*

Parti di ricambio

Per richiedere eventuali parti di ricambio, precisare il tipo di motore e il codice indicato in targa.
Le parti commerciali unificate sono reperibili direttamente in commercio.

Spare parts

When ordering spare parts, specify the motor type and the code shown on the plate.
Standard commercial parts may be purchased directly on the market.

Ersatzteile

Will man Ersatzteile bestellen, muß die Art des Motors und die auf dem Typenschild angegebene Codenummer angegeben werden.
Die vereinheitlichten handelsüblichen Teile findet man direkt im einschlägigen Handel.

Pièces détachées

Pour commander les pièces détachées, on devra préciser le type de moteur et le code indiqué sur la plaque.
Les pièces commerciales unifiées se trouvent directement dans le commerce.

Manutenzione

In occasione della manutenzione:

- verificare che lo spessore minimo della guarnizione d'attrito non sia inferiore a 1mm;
- verificare il gioco fra disco freno e mozzo trascinatore;
- verificare che non vi sia alcun gioco fra la linguetta e la sua sede sul mozzo;
- verificare che non vi sia alcun gioco fra mozzo trascinatore e albero motore;
- verificare le parti usurate;
- registrare l'intraferro riportandolo al valore iniziale agendo sulle viti e bloccandolo con i dadi.

Maintenance

During maintenance:

- *check that the friction packing minimum thickness is not lower than 1mm;*
- *check that the play between the brake disc and the driving hub is not excessive;*
- *check the absence of play between the tongue and its housing on the hub;*
- *check the absence of play between the driving hub and the driving shaft;*
- *replace the worn parts;*
- *adjust the air-gap, taking it back to its initial value by means of the screws and lock it with the nuts.*

Instandhaltung

Bei der Instandhaltung:

- Prüfen, dass die Mindeststärke des Reibebelags nicht unter 1 mm liegt;
- Das Spiel zwischen Bremsscheibe und Mitnehmernabe prüfen;
- Prüfen, dass keinerlei Spiel zwischen Federkeil und seinem Sitz an der Nabe vorhanden ist;
- Prüfen, dass keinerlei Spiel zwischen Mitnehmernabe und Motorwelle vorhanden ist;
- Die verschlissenen Teile prüfen;
- Den Luftspalt einstellen, ihn dabei durch Betätigen der Schrauben auf den anfänglichen Wert bringen und mit den Muttern feststellen.

Entretien

Lors des opérations d'entretien :

- *Vérifier que l'épaisseur minimum du joint de friction n'est pas inférieure à 1mm ;*
- *vérifier le jeu entre le disque de freinet le moyeu d'entraînement;*
- *vérifier l'absence de jeu entre la clavette et son logement sur le moyeu ;*
- *vérifier l'absence de jeu entre le moyeu d'entraînement et l'arbre moteur ;*
- *vérifier les pièces usées ;*
- *régler l'entrefer : le ramener à sa valeur initiale au moyen des vis et le serrer au moyen des vis.*

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Fax +91(0)44 24780091 / 24781904 - bonfig@vsnl.com

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www.polpack.com.pl - polpack@polpack.com.pl

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Bonfiglioli Riduttori sceglie lubrificanti SHELL

Shell

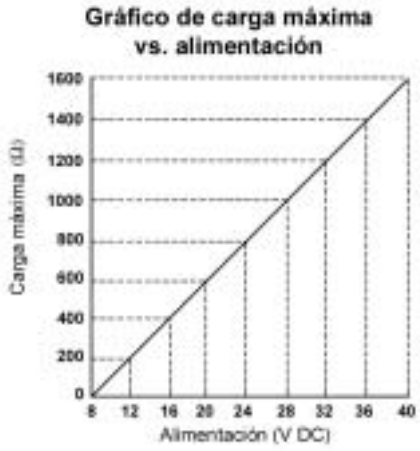
Bonfiglioli Riduttori recommends SHELL lubricants

COD. 1250 R3

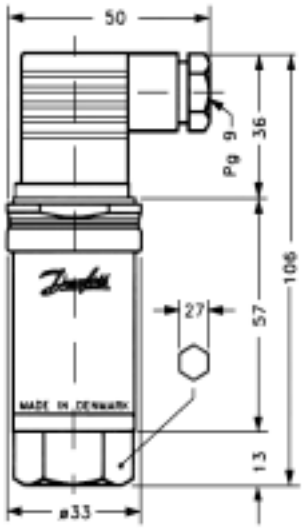
MBS 33

Características

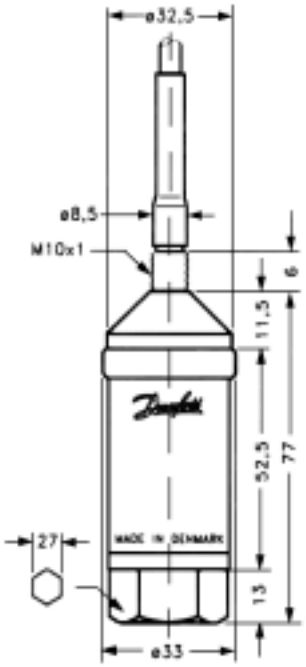
- Diseñado para ambientes industriales exigentes.
- Aprobación CE: cumple con directivas europeas sobre EMC.
- Cubierta y partes de acero inoxidable resistentes al ácido (AISI 316L).
- Calibrado por laser y con compensación de temperatura.
- Señales de salida: 4-20 mA
- Varios rangos de presión.
- Alta precisión.
- Conexión eléctrica a través de plug o cable.
- Presión de referencia: Presión absoluta



Dimensiones



Versión para plug



Versión para cable

MBS 33

Especificaciones Técnicas MBS 33		
Precisión	±0.3% FS (típico)	±1% FS (máx.)
No linealidad		< ±0.2% FS
Tiempo de respuesta		< 4 ms
Rango de señal de salida		4-20 mA
Tensión de alimentación U_B (protección de inversión de polaridad)		10 a 30V DC
Limitación de corriente (señal de salida lineal sobre 1.5 para rango escogido)		28 mA
Máxima resistencia de carga, R_L		$R_L \leq \frac{U_B\text{-}10V}{0.02A}$ (Ω)
Rango de temperatura de operación		-40 a 85º C
Indice de protección	versión con plug	IP 65 - IEC 529
	versión con cable	IP 67 - IEC 529
Material	partes expuestas	DIN 17440- 1.4404 (AISI 316 L)
	cubierta	DIN 17440- 1.4404 (AISI 316 L)
Peso		0.3 Kg

MBS 33 para medida de presión absoluta

Presión Conexión	Rango de Presión (P_e) bar	Presión de Operación max. bar	Presión de ruptura mín. bar	versión con plug Tipo	versión con cable Tipo
DIN 16288 B 6kt G 1/2A	0 - 1	2	300	MBS33-1021-1AB08	MBS33-1021-3AB08
	0 - 1.6	8	300	MBS33-1221-1AB08	MBS33-1221-1AB08
	0 - 2.5	8	300	MBS33-1421-1AB08	MBS33-1221-1AB08
	0 - 4	8	300	MBS33-1621-1AB08	MBS33-1221-1AB08
	0 - 6	8	300	MBS33-1821-1AB08	MBS33-1221-1AB08
	0 -10	8	300	MBS33-2021-1AB08	MBS33-1221-1AB08
	0 -16	20	300	MBS33-2221-1AB08	MBS33-1221-1AB08
	0 -25	20	300	MBS33-2421-1AB08	MBS33-1221-1AB08

MBS 33 para medida de presión manométrica

Conexión de presión	Rango de Presión (P_e) bar	Presión de Operación max. bar	Presión de ruptura mín. bar	Tipo versión con plug	Tipo versión con cable
DIN 16288 B 6kt G 1/2 A	0 - 1	2	50	MBS33-1011-1AB08	MBS33-1011-3AB08
	0 - 1.6	8	50	MBS33-1211-1AB08	MBS33-1211-3AB08
	0 - 2.5	8	50	MBS33-1411-1AB08	MBS33-1411-3AB08
	0 - 4	8	50	MBS33-1611-1AB08	MBS33-1611-3AB08
	0 - 6	20	50	MBS33-1811-1AB08	MBS33-1811-3AB08
	0 - 10	20	50	MBS33-2011-1AB08	MBS33-2011-3AB08
	0 - 16	50	100	MBS33-2211-1AB08	MBS33-2211-3AB08
	0 - 25	50	100	MBS33-2411-1AB08	MBS33-2411-3AB08
	0 - 40	100	300	MBS33-2611-1AB08	MBS33-2611-3AB08
	0 - 60	200	800	MBS33-2811-1AB08	MBS33-2811-3AB08
	0 -100	200	800	MBS33-3011-1AB08	MBS33-3011-3AB08
	0 -160	400	800	MBS33-3211-1AB08	MBS33-3211-3AB08
	0 -250	600	2000	MBS33-3411-1AB08	MBS33-3411-3AB08
	0 -400	600	2000	MBS33-3611-1AB08	MBS33-3611-3AB08
	0 -600	900	2000	MBS33-3811-1AB08	MBS33-3811-3AB08

AVN HYDRAULIK A-S

PROFILE MAGAZINE

AVN HYDRAULIK A-S

In 1933 the founder of the AVN Group, Alfred V. Nielsen, launched his company based on the simple philosophy of "top-notch quality and flexibility to the customer's advantage". Today the AVN Group has branched out in several different directions, but the group's approach has remained unchanged. In order to deliver the best possible product, every single component has to be of the highest quality; and we must meet all the needs and demands of our customers at all times.

AVN Hydraulik A-S represents the biggest production sector within the AVN Group. Since 1978 AVN Hydraulik has been a strong partner for Danish industry, and the company has experienced steady growth in each year of its existence. The experience accumulated with regard to all types of hydraulic systems has helped AVN Hydraulik to become specialists in both individual and all-round hydraulic components and systems.

The fundamental goal of AVN Hydraulik is to meet all challenges and carry out a variety of tasks with regard to the design and development of hydraulic installations. AVN Hydraulik demands a great deal of its own suppliers, and works with some of Europe's leading manufacturers. So the customer can be sure of dealing with the best people in the business.

A MEMBER OF THE AVN GROUP

The AVN Group covers several business areas and employs a highly skilled workforce from a wide variety of specialist backgrounds. Nevertheless, the philosophy is the same everywhere within the Group: "top-notch quality and flexibility to the customer's advantage, no matter what". These days industrial customers have a wide range of delivery requirements, which is why the AVN Group gives top priority to teamwork involving all subsidiary companies. We are able to deliver our products quickly and at a good price, because the structure of the group allows us to optimise every stage in the process.

The AVN Group consists of:

Alfred V. Nielsen A-S
AVN Pneumatik A-S
AVN Elektronik A-S
AVN Hydraulik A-S
The Raben Group

RevisionsGruppen

Slotsgade 38, 3400 Hillerød, Telefon 4822 0800
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Statsautoriserede revisorer

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TELEFON: +45 59 44 02 66
TELEFAX: +45 59 44 14 66

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AVN HYDRAULIK'S DEPARTMENTS

General Manager Jørgen Rose in conversation with an employee.

A long time ago, we discovered the advantage of working closely with our partners without losing close contact with our customers. This is why we have chosen central locations in Denmark, both on Zealand and in Jutland.

AVN Hydraulik's 36 employees in Brøndby and Silkeborg ensure that we are always able to reach our customers anywhere in Denmark very quickly. Both the head office in Brøndby and our brand-new workshop in Silkeborg are equipped with a large warehouse and excellent facilities, including advanced trial facilities and testbeds. We also have suitable equipment for measuring pressure, flow or temperature.

The company values personal and professional contact with the customer very highly. Hydraulic units often form part of a larger whole, and their role is essential for the optimum running of production systems. This is the reason why we have experienced consultants available in Jutland and on Zealand who are always ready to provide expert assistance.

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Dalager 1
DK-2605 Brøndby

Telephone: +45 70 20 04 11
Fax: +45 43 24 55 00

E-mail: avn.hydraulik@avn.dk
Website: www.avn.dk

SILKEBORG

Suensonsvej 14
DK-8600 Silkeborg

Telephone: +45 70 20 04 11
Fax: +45 87 22 81 00

E-mail: avn.hydraulik@avn.dk
Website: www.avn.dk

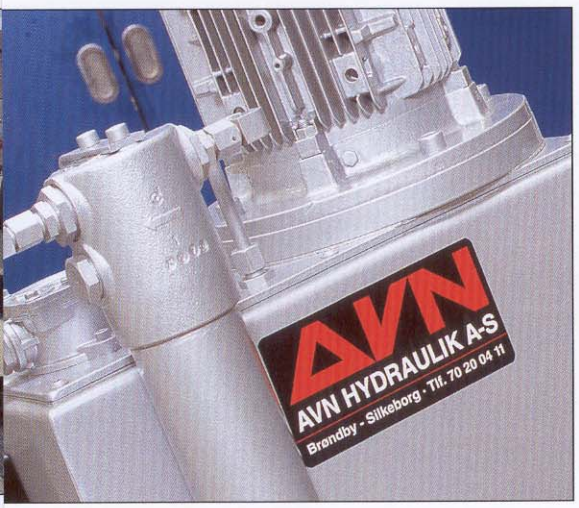
EXPERTISE

AVN Hydraulik has a well-equipped warehouse, but our expertise comprises far more than this.

Nowadays, all work carried out within the field of hydraulics requires a high degree of skill. For instance, when it comes to project planning, designing block systems, systems development, assembly and electronic control systems. And naturally, once they have been concluded our projects come complete with the necessary documentation produced on CAD equipment.

We also rely a great deal on our service department, and our sales department is always ready to provide ready solutions. It could be anything from technical details to good design ideas. AVN Hydraulik's aim is to be able to supply components and systems of high technical and aesthetic quality.

PRODUCTION AT AVN HYDRAULIK A-S

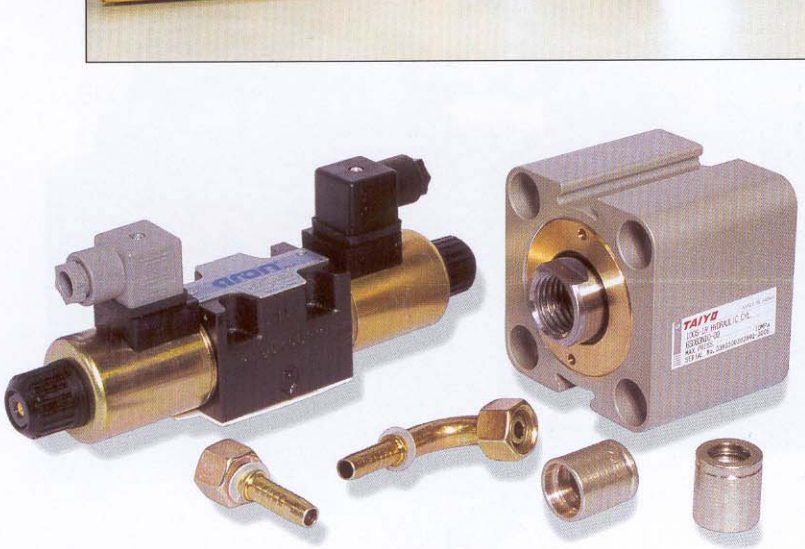


At our workshops our highly qualified staff prepare all the different systems needed, and all the equipment is tested thoroughly before it leaves the building. AVN Hydraulik is able to design and manufacture complete hydraulic power packs, which we produce in accordance with the needs and instructions of our customers. We are able to deliver these power packs on a turnkey basis in the form of complete systems with electronic controls. Our engineers are familiar with all components and systems, so they are highly proficient in ensuring that assembly and commissioning are performed correctly.

Naturally, AVN Hydraulik is able to fulfil all types of requirements, e.g. supplying equipment in particular colours that a customer may wish to work with.

The company is also able to supply all types of hydraulic components, including any specific component parts that the customer may require.

Our expertise also includes the production of hydraulic hoses tailored to meet the customer's requirements.

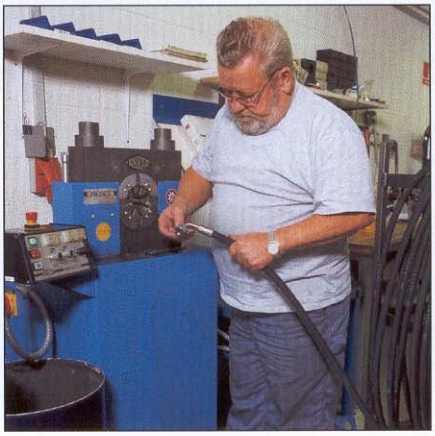


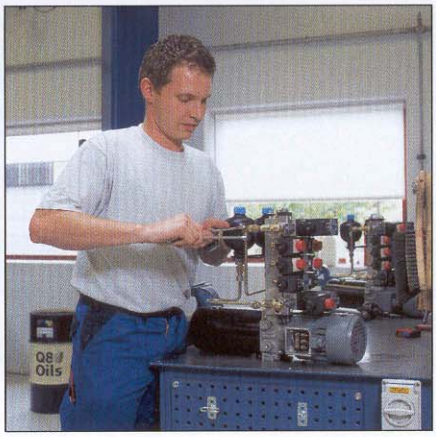
FROM SINGLE COMPONENTS TO ALL-ROUND SYSTEMS

The demand for modern machinery is increasing all the time, so it is crucial to assemble all the functions needed under one roof. The required expertise and tailor-made solutions are also vital factors. This means that the customer can choose a single component or the kind of reliable and carefully thought-out total system that AVN Hydraulik specialises in.

We have detailed knowledge of the total systems that we tailor to suit our customers' requirements, and when supplying them we ensure that they function optimally. Experience shows that the more complete a product is, the more satisfied the customer will be.

AVN invests a great number of resources in developing total systems, and we have gained so much useful experience from earlier projects that our expertise in the field is constantly growing.





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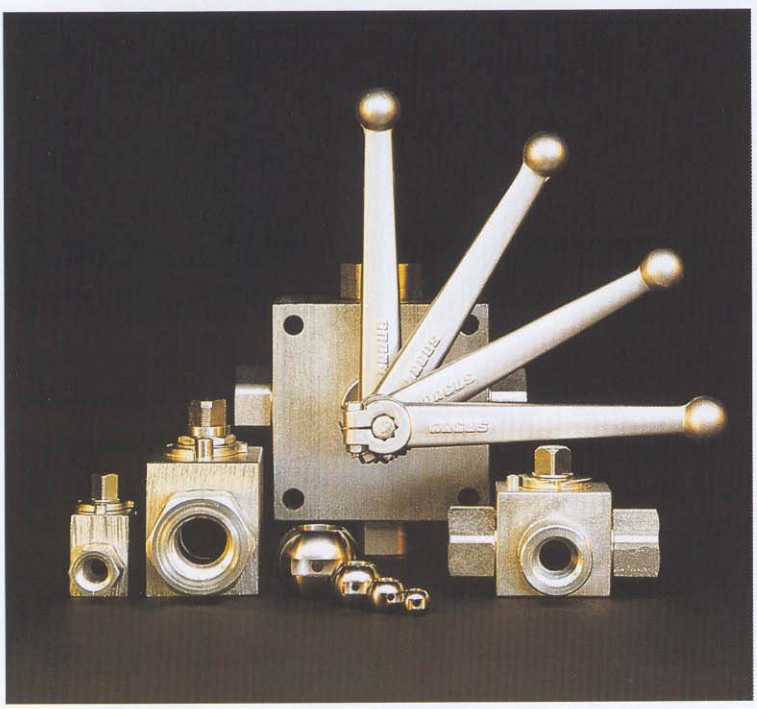

Günstige Drehmomente allein sind kein Grund. Deshalb sind unsere Kugelhähne kompromißlos dicht, absolut wartungsfrei und extrem langlebig. Denn vom europäischen Marktführer für Kugelhähne dürfen Sie mehr erwarten.

ARGUS Fluidtechnik

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A HEALTHY PROFILE

Our objective is simple. We aim to maintain our high level of service so that we can continue to supply our customers with high-quality products. In the future we plan to lead the field in terms of product development in our key areas of concern. This can be achieved by continuously giving further training to our employees. We value our staff very highly, and we prefer to give further training to the people who already work for us so as to ensure that our staff are always familiar with all facets of our production and service process. This means that the customer can always expect to be visited by a qualified engineer or a service-minded salesperson who is ready to provide constructive advice and suggestions.

We are absolutely convinced that it is well-qualified staff who give our company its healthy profile. Good employees help to create new opportunities, enabling us to work together to ensure stability and quality both now and in the future.

SERVICE CONTRACT - A MATTER OF COURSE

When a customer chooses to work with AVN Hydraulik, part of the procedure often involves signing a service contract. This means that the customer can be confident that everything will be carried out exactly in accordance with their own particular operating conditions. The service contract that we offer our customers is a guarantee that equipment will be maintained to a high standard and at the best possible price.

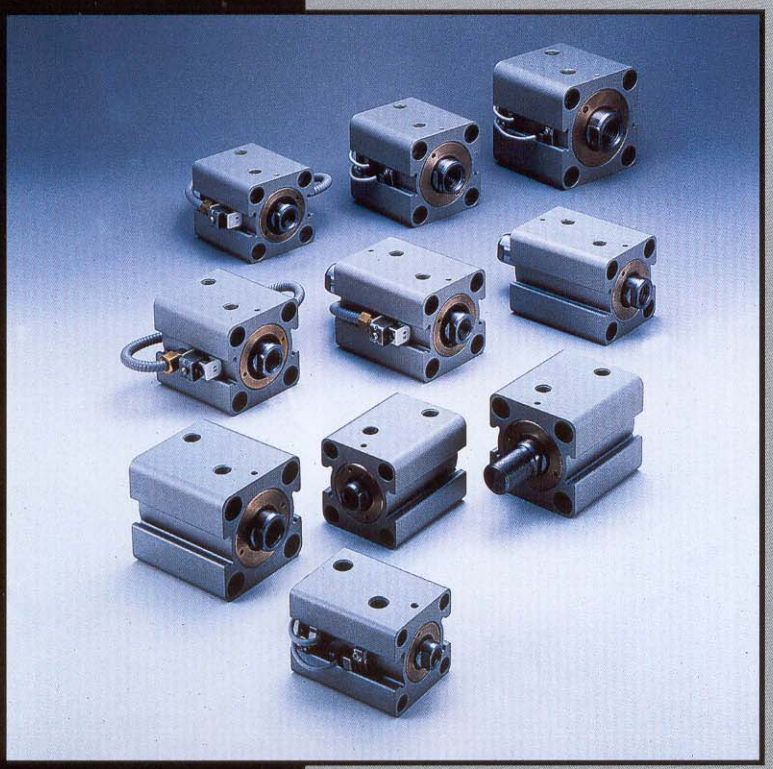
AVN
HYDRAULIK
Systemer - Komponenter
Service - Reparation
AVN HYDRAULIK A-S
Brøndby-Silkeborg
Tlf. 70 20 04 11

Tlf. 70 20 04 11

160S-1 SERIES COMPACT-TYPE HYDRAULIC CYLINDER

OPERATES UP TO
10 MILLION TIMES AT 160 BAR
(BORE 20-80 MM)

1. STANDARD TYPE (STEEL BODY/ BASIC TYPE/FOOT TYPE)
2. SWITCH SET TYPE (STAINLESS STEEL)
3. CUTTING FLUID PROOF TYPE



100S-1 SERIES COMPACT-TYPE HYDRAULIC CYLINDER

OPERATES AT A MAX. OF
160 BAR IMPROVED DURABILITY
AGAINST OPERATING PRESSURE
(BORE 32-80 MM)

1. STANDARD TYPE (ALUMINUM ALLOY)
2. SWITCH SET TYPE (ALUMINUM ALLOY)
3. CUTTING FLUID PROOF TYPE

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CONSULTING

Documentation,
follow-up and advice

Companies responsible for operating conditions in technical areas know how important hydraulic components are in any production process. As a result, they need to be able to rely on their suppliers even after the product has been delivered. This is why AVN Hydraulik invests so much energy in this area of service, including documentation and follow-up on customer premises.

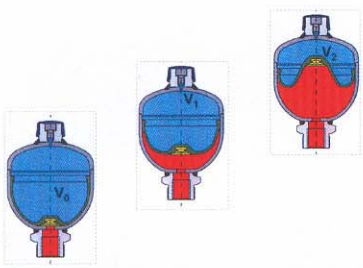
People in charge of a company's production are aware of the value of documentation on machine cards, which we consider to be one of the most important parameters when servicing hydraulic systems. AVN Hydraulik uses the most modern tools in order to ensure that all our projects are well documented. This means that it is always possible to refer back to each part and check everything down to the smallest detail.

Our sales staff have many years' experience, and every day they give advice and perform follow-ups. Because problems are often acute and need to be dealt with speedily, all our engineers have vehicles carrying all the equipment they need so that they can quickly service machinery and carry out repairs on all equipment, irrespective of whether it is our own or someone else's.

A sense of trust between supplier and customer is vital, and AVN Hydraulik is always ready to give advice if problems arise. There is always a qualified engineer on hand ready to answer questions on the telephone.

Our mission is to deliver to our customers competitive products without any defects on time.

Our products:
Diaphragm - and Piston Accumulators as well as Valve technology for hydraulic systems



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Germany
Tel. +49 (26 42) 9 33-285
Fax +49 (26 42) 9 33-299

Freudenberg A member of Freudenberg Dichtungs- und Schwingungstechnik KG

Klinkby Maskinfabrik ApS
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Tlf: 97 83 65 99 Fax: 97 83 60 09
E-mail: km@klinkbymf.dk www.klinkbymf.dk

Din leverandør af hydraulikcylindre

Din underleverandør i spåntagende bearbejdning

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- Metallisering
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- Bygningsrenovering
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MOELLER

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Think future. Switch to green!

*Det er også **ibco**, der i totalentreprise for AVN Hydraulik A-S har opført 2246 m² kontor- og produktionsbygning i Silkeborg samt 1012 m² kontor og værksted for AVN Holding i Brøndby.*

ibco

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AFFILIATED COMPANIES

ALFRED V. NIELSEN A-S

Alfred V. Nielsen A-S have become leaders in the field of pneumatic tools, blind rivet technology and assembly.

Flexibility - Service - Quality
These are just a few of the qualities that we keep in mind as we go about our daily work. In order to live up to these qualities, it is necessary to have an able work force and large supplies of spare parts. We have both these things. Our primary customer groups are companies that work with assembly lines and production within Danish industry.

AVN PNEUMATIK A-S

AVN Pneumatik A-S – who have branches in Brøndby and Silkeborg – market some of the best pneumatic products, forming one of the widest product ranges on the market today.

Numatics pneumatic is the world leader in the area of unsealed magnetic valves, which are noted for their long service life and very high switching speed. Taiyo pneumatic is well known for its handling equipment. And ACE is the world's largest producer of hydraulic industrial shock absorbers.

Our service department can assist with the following:

Maintenance: repair and maintenance of pneumatic equipment along with the controls to match.

Control: assembly of PLC control systems, connection units or purely pneumatic controls.

Special cylinder: in our own in-house cylinder workshop we make pneumatic cylinders to measure, from Ø32 to Ø200, exactly how you want them.

AVN ELEKTRONIK A-S

AVN Elektronik A-S have activities within the fields of positioning, handling and automation. They also supply complete robots including 6-axis and SCARA robots as well as linear systems.

The construction of PLC and PC systems is an important part of AVN Elektronik's production. The main products come from several different producers who all aim to deliver products of a very high quality while maintaining competitive prices.

Warner Electric, which also includes Slo-Syn and Wichita, supply the following: a comprehensive range of auxiliary motors and stepper motors, linear linings, brakes and clutches.
LG Industrial Systems supply the following: PLC systems, operator panels and frequency transformers.

Sankyo Seiki and DENSO Robotics supply various types of robots.

Our technicians and engineers are responsible for the construction of control systems and the design of software (both standard software and software created specifically for the customer).

RABEN VÆRKTØJ A-S

For many generations, the name RABEN has been synonymous with top quality and service in connection with tools supplied to Danish trade and industry.

The RABEN Group markets traditional hand-held tools as well as more advanced equipment, particularly for the metal industry.

In recent years RABEN's range has expanded to include laser cutters, edge presses and punching machines from the world-famous TRUMPF producer.

The company is based in Herlev, and has 45 employees.

RABEN represents leading products such as PFERD, VITEX, TITEX PLUS and HAZET, a total of 14 international high-quality products.

RABEN has been part of the AVN Group since May 2000.

ELEKTROMOTORFABRIK

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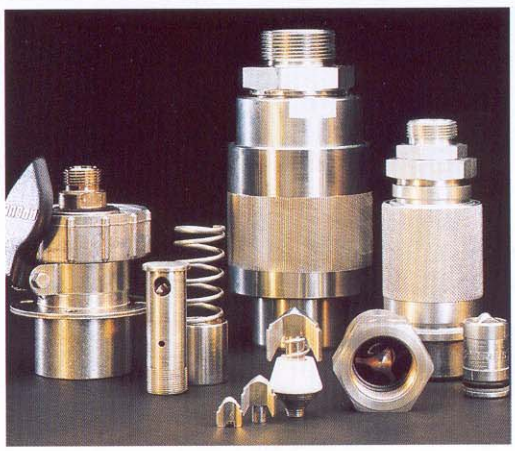
Fremstilling af DCmotorer fra 25-600w - 12-220v efter kundeopgave, i ethvert antal



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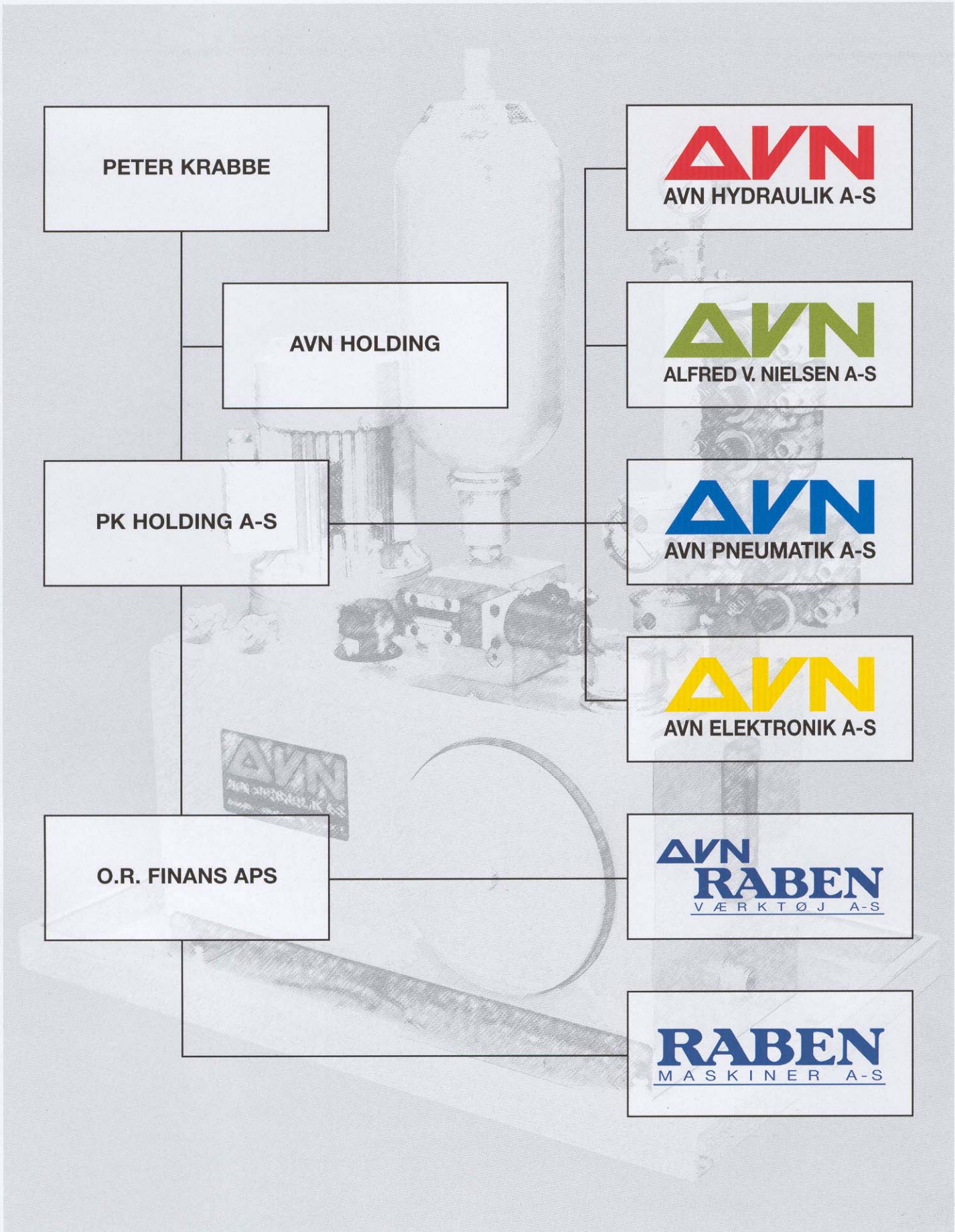
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INTEGRAL

Husets materiale
Normaludførelse - Stål
Andet - Efter opgave

Membranmateriale
Normaludførelse - Perbunan
Andet - Viton-Butyl Epichlorhydrin

Trykmedium
Hydraulikolie iflg. DIN 51524
Andet efter opgave

Specialudførelse efter opgave
til f.eks. levnedsmiddel og

Hydraulik symbol

		Volumen i liter	Max. arbejds-tryk	Max. tryk-svingning	Max. tryk-forhold	Type	Bestillings-nummer	Ca.-mål (Ø x H) mm	Olie-tilslut-ning	Kvælstof-tilslutning
Membran-akkumulator	Elektronstrålesvejst	0,07	250	215	8 :1	D 0,07-250	007-1315-074-611	64 x 117	M 14 x 1,5	M 28 x 1,5
		0,07	500	435	8 :1	D 0,07-500	007-1315-054-811	85 x 105	G 1/4	M 28 x 1,5
		0,32	160	140	8 :1	D 0,32-160	032-1315-014-511	92 x 147	M 16 x 1,5	M 28 x 1,5
		0,5	160	140	8 :1	D 0,5 -160	050-1315-094-511	105 x 160	M 22 x 1,5	M 28 x 1,5
		0,75	180	155	8 :1	D 0,75-180	075-1315-074-611	123 x 175	M 22 x 1,5	M 28 x 1,5
		0,75	250	215	8 :1	D 0,75-250	075-1315-013-611	127 x 184	G 1/2	M 28 x 1,5
		1,0	200	175	8 :1	D 1,0 -200	100-1315-063-611	138 x 191	M 22 x 1,5	M 28 x 1,5
		1,3	50	43	8 :1	D 1,3 - 50	130-1315-024-311	142 x 195	M 22 x 1,5	M 28 x 1,5
		1,4	140	120	8 :1	D 1,4 -140	140-1315-013-511	150 x 205	M 22 x 1,5	M 28 x 1,5
		1,4	250	90	8 :1	D 1,4 -250	140-1315-012-611	157 x 202	G 1/2	M 28 x 1,5
		2,0	100	85	8 :1	D 2,0 -100E	200-1315-013-411	175 x 220	G 1/2	M 28 x 1,5
		3,5	250	98	8 :1	D 3,5 -250	350-1315-042-611	175 x 310	G 3/4	M 28 x 1,5
		5,0	20	17	8 :1	D 5,0 - 20	500-1315-012-211	232 x 276	M 16 x 1,5	Bilventil
		5,0	40	35	8 :1	D 5,0 - 40	500-1315-042-311	220 x 295	G 3/4	M 28 x 1,5
	Skruet	1,5	330	290	8 :1	D 1,5 -330	150-1315-072-711 150-1315-082-711	195 x 205	M 27 x 2 G 3/4	M 28 x 1,5
		2,0	250	200	8 :1	D 2,0 -250	200-1315-032-611	210 x 195	G 1/2	M 28 x 1,5
Blære Akkumulator		4,0	330	230	3,3:1	D 4 -330	400-1315-012-711	170 x 415	G 1 1/4	7/8"-14 UNF-2A
		10,0	330	230	3,3:1	D 10 -330	101-1315-022-711	225 x 545	G 2	7/8"-14 UNF-2A

rev. 0

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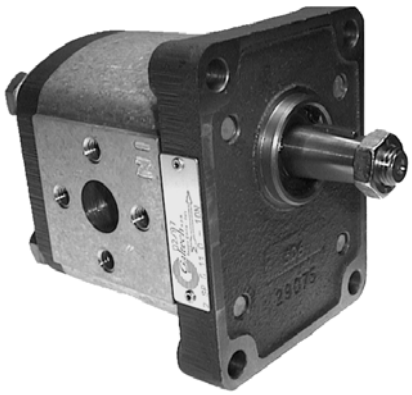
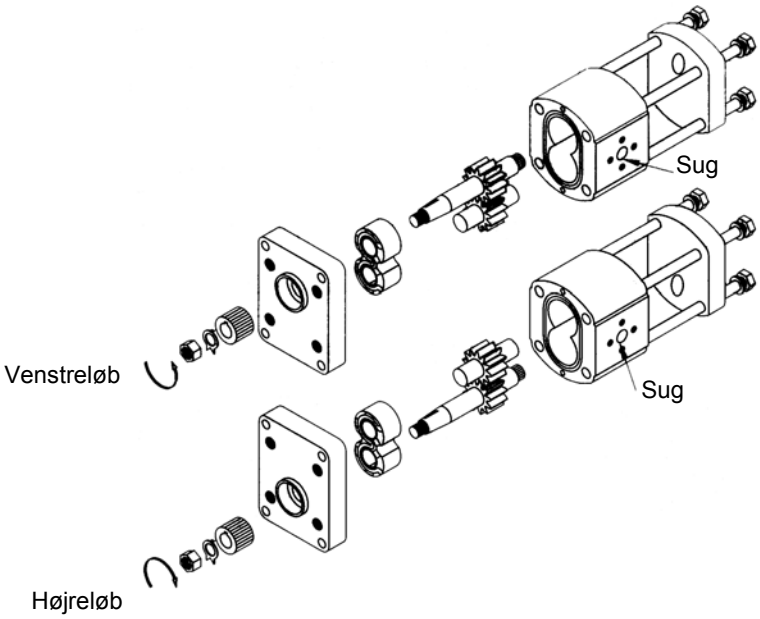


Iotti Strozzi - Galtech tandhjulspumper fås i størrelser fra 1,3 til 120 cm^3/omdr.

De kan fås som venstreløb, højreløb og reversibel. Pumperne er nemme at ændre omløb på, som vist herunder.

Pumperne kan sammenbygges af to eller flere pumper.



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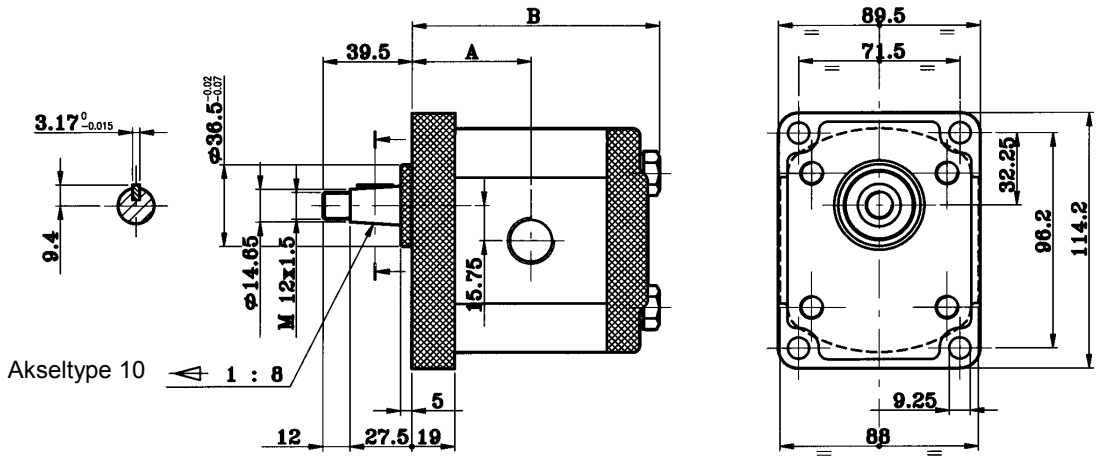

Type	cm³ / omdr.	l/min v/ 1.400 omdr.	Arbejdstryk bar		Max. omdr./min.	Længde mm		Vægt kg
			Kontinuerlig	Max.		A	B	
2 SP G4	4,0	5,6	280	320	4.000	44,4	93,0	3,400
2 SP G6	6,0	8,4	280	320	4.000	46,0	96,3	3,550
2 SP G8	8,5	11,9	280	320	3.500	48,1	100,5	3,700
2 SP G11	11,0	15,4	280	320	3.500	50,2	104,6	3,800
2 SP G14	14,0	19,6	270	290	3.500	52,7	109,6	3,900
2 SP G16	16,5	23,1	230	250	3.500	54,8	113,8	4,050
2 SP G19	19,5	27,3	210	230	3.300	57,3	118,8	4,200
2 SP G22	22,5	31,5	190	210	2.800	59,8	123,8	4,350
2 SP G26	26,0	36,4	170	190	2.500	62,7	129,6	4,500

Bestillingskode

2SP G 14 D –

- 2SP: Pumpetype
- G: Stålflange (fås også i aluminium)
- 14: Volumen cm³ (se tabel)
- D: D = Højreløbende, S = Venstreløbende
- Tilslutningstype: G – N (se gruppe 1)
- Akseltype: 10

Hvis andre udførelser ønskes, spørg da vor salgsafdeling.

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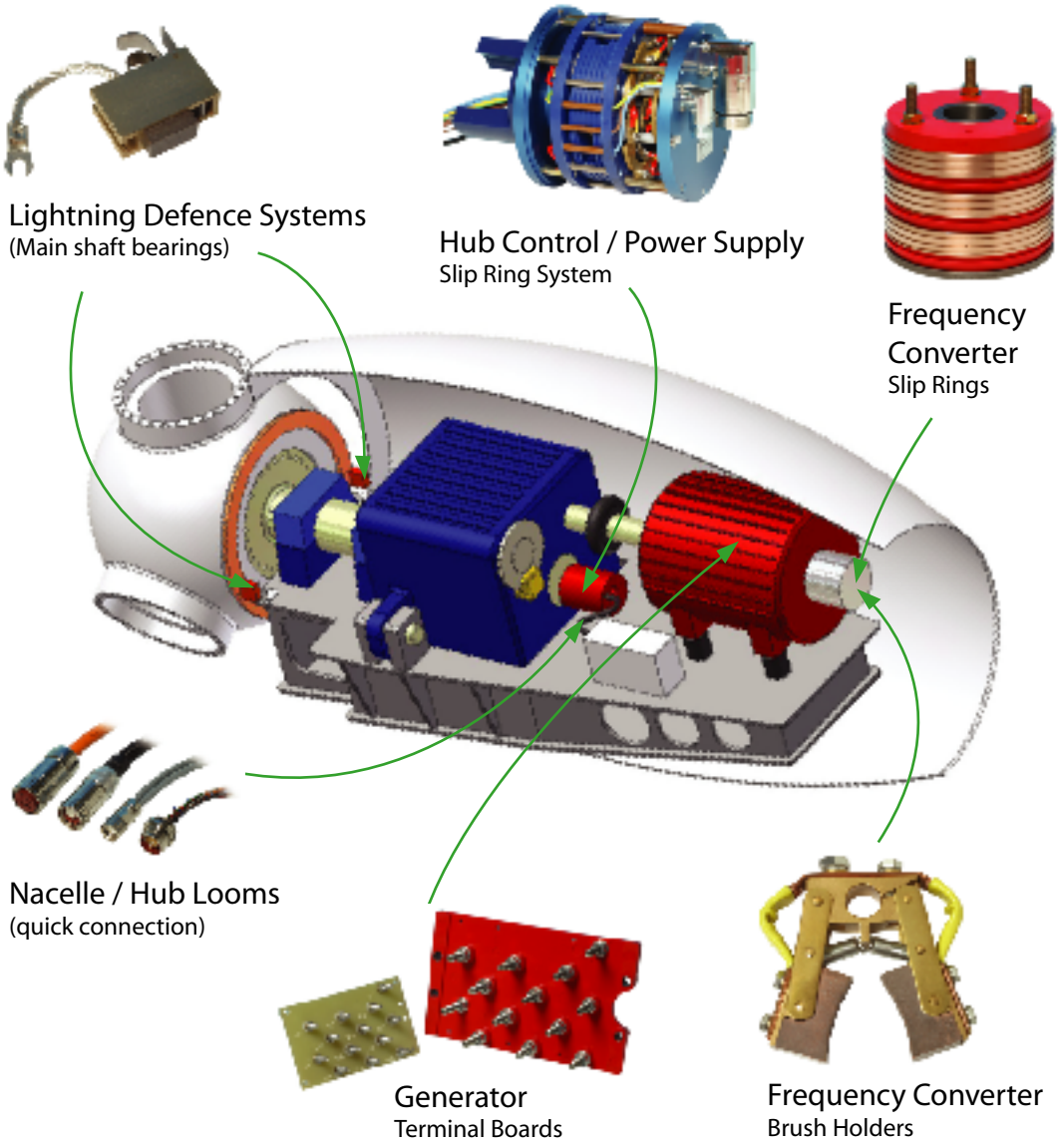

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NEG Micon 750kW Turbine Protocol Document

Revision 2.07

Final version – as implemented on site

Friday, September 28, 2001

Valid for WP3000 controllers on Oak Creek phase I

NOTE: After implementation of this protocol version it will not be possible to use remote software that is using protocol version 1.03. In other words there is no compatibility between protocol version 1.03 and 2.07.

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Specification

Protocol – Asynchronous RS232, ASCII

Baud Rate – 19200

Parameters – 8 data bits, No parity, 1 stop Bit

RS232 Wiring Schematic

RS232 plug into the Controller (Wind Turbine Controller)

9 pole D-Sub Female:

Description	Pin
Rx	2
Tx	3
Gnd	5
RTS	7
CTS	8

Please add wiring between pin 7 and 8
Please do not use other pins, has to be let open.

Please be aware that there is no galvanic isolation (opto-coupler) between the wind turbine processor and the communication channel of the WP3000 controller, meaning the device connected to the communication channel has to provide the galvanic isolation part.

Data Format

Command Packet

Master to WTG

Size byte	Content	Description
1	SOH	Start of heading
3	Wtg Address	1-254; 0 = master; 255 = broadcast
1	Command Character	See Command Character Description
1	GS	Separator
0-12	DATA	Data to WTG
1	ETX	End of text
5	CRC16	Cyclic redundancy check
1	EOT	End of transmission

Command Character Description:

'0' = Information telegram 1

'1' = Status code telegram

'2' = In/out put telegram

'3' = Reset & start

'4' = Stop

'5' = Information telegram 2

'6' = Production info record log

'7' = Set time and date

'8' = Event Telegram

'9' = Surveillance of gearbox

'A' = Power down time and times and event

'B' = Software revision and version

Information Telegram 1

WTG to Master “0”

The event code can be used to check the telegrams 3 and 4 please see the events list.

Byte Position	Size bytes	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	4	Event code	000 if WTG ok, else event code (actual error or warning code)
9	4	RPM	Generator revolution (1sec. Average)
13	2	RPM	Rotor revolution (1sec. average)
15	3	m/s	Windspeed in unit 1/10 m/s (1sec. Average)
18	5	KW	Active production in unit 1/10 kW (1sec. Average)
23	5	KVAr	Reactive consumption/production in unit 1/10 kVAr (1sec. Average)
28	4	P.F.	Cos phi in unit 1/100. –xxx to +xxx (1sec. Average)
32	3	Volt	Phase voltage L1 (1sec. Average)
35	3	Volt	Phase voltage L2 (1sec. Average)
38	3	Volt	Phase voltage L3 (1sec. Average)
41	4	Ampere	Phase Amps. L1 (1sec. average)
45	4	Ampere	Phase Amps. L2 (1sec. average)
49	4	Ampere	Phase Amps. L3 (1sec. Average)
53	3	Hz	Frequency in unit 1/10 Hz
56	3	Pressure	Hydraulic pressure windtips in unit 1 bar (1sec. average)
59	4	Position	Nacelle position in unit degrees
63	1	Status byte	1= turbine on-line, 0= turbine off-line
64	1	GS	Seperator
65	5	CRC16	Cyclic redundancy check
70	1	EOT	End of transmission

Status Code Telegram

WTG to Master “1”

The last 32 status codes in the WP3000.

The definition between an error code and a warning code is:
If the machine is stopped the event is treated as an error code, if the machine is not stopped the event is treated as a warning, ex. “Too low wind”.

Mita supplies Fenway with a list of status codes that can be shown as warnings on the remote system.

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	12	Yymmddhhmmss	Date and time of error
17	1	Status	* if error present, else space
18	4	Code	Status code number
22	12	Yymmddhhmmss	Date and time of error
34	1	Status	* if error present, else space
35	4	Code	Status code number
39	12	Yymmddhhmmss	Date and time of error
51	1	Status	* if error present, else space
52	4	Code	Status code number
56	12	Yymmddhhmmss	Date and time of error
68	1	Status	* if error present, else space
69	4	Code	Status code number
73	12	Yymmddhhmmss	Date and time of error
85	1	Status	* if error present, else space
86	4	Code	Status code number
90	12	Yymmddhhmmss	Date and time of error
102	1	Status	* if error present, else space
103	4	Code	Status code number
107	12	Yymmddhhmmss	Date and time of error
119	1	Status	* if error present, else space
120	4	Code	Status code number
124	12	Yymmddhhmmss	Date and time of error
136	1	Status	* if error present, else space
137	4	Code	Status code number
141	12	Yymmddhhmmss	Date and time of error
153	1	Status	* if error present, else space
154	4	Code	Status code number
158	12	Yymmddhhmmss	Date and time of error
170	1	Status	* if error present, else space
171	4	Code	Status code number
175	12	Yymmddhhmmss	Date and time of error
187	1	Status	* if error present, else space
188	4	Code	Status code number
192	12	Yymmddhhmmss	Date and time of error
204	1	Status	* if error present, else space
205	4	Code	Status code number
209	12	Yymmddhhmmss	Date and time of error
221	1	Status	* if error present, else space
222	4	Code	Status code number
226	12	Yymmddhhmmss	Date and time of error

238	1	Status	* if error present, else space
239	4	Code	Status code number
243	12	Yymmddhhmmss	Date and time of error
255	1	Status	* if error present, else space
256	4	Code	Status code number
260	12	Yymmddhhmmss	Date and time of error
272	1	Status	* if error present, else space
273	4	Code	Status code number
277	12	Yymmddhhmmss	Date and time of warning
289	1	Status	* if warning present, else space
290	4	Code	Status code number
294	12	Yymmddhhmmss	Date and time of warning
306	1	Status	* if warning present, else space
307	4	Code	Status code number
311	12	Yymmddhhmmss	Date and time of warning
323	1	Status	* if warning present, else space
324	4	Code	Status code number
328	12	Yymmddhhmmss	Date and time of warning
340	1	Status	* if warning present, else space
341	4	Code	Status code number
345	12	Yymmddhhmmss	Date and time of warning
357	1	Status	* if warning present, else space
358	4	Code	Status code number
362	12	Yymmddhhmmss	Date and time of warning
374	1	Status	* if warning present, else space
375	4	Code	Status code number
379	12	Yymmddhhmmss	Date and time of warning
391	1	Status	* if warning present, else space
392	4	Code	Status code number
396	12	Yymmddhhmmss	Date and time of warning
408	1	Status	* if warning present, else space
409	4	Code	Status code number
413	12	Yymmddhhmmss	Date and time of warning
425	1	Status	* if warning present, else space
426	4	Code	Status code number
430	12	Yymmddhhmmss	Date and time of warning
442	1	Status	* if warning present, else space
443	4	Code	Status code number
447	12	Yymmddhhmmss	Date and time of warning
459	1	Status	* if warning present, else space
460	4	Code	Status code number
464	12	Yymmddhhmmss	Date and time of warning
476	1	Status	* if warning present, else space
477	4	Code	Status code number
481	12	Yymmddhhmmss	Date and time of warning
493	1	Status	* if warning present, else space
494	4	Code	Status code number
498	12	Yymmddhhmmss	Date and time of warning
510	1	Status	* if warning present, else space
511	4	Code	Status code number
515	12	Yymmddhhmmss	Date and time of warning
527	1	Status	* if warning present, else space
528	4	Code	Status code number
532	12	Yymmddhhmmss	Date and time of warning
544	1	Status	* if warning present, else space
545	4	Code	Status code number

549	1	GS	Separator
550	5	CRC16	Cyclic redundancy check
555	1	EOT	End of transmission

I/O Telegram

WTG to Master (Digital input and output section) “2”
The binary value represented inside the controller, is converted to a HEX-ASCII value before the value is sent

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	1	Bits	Input 1-4
6	1	Bits	Input 5-8
7	1	Bits	Input 9-12
8	1	Bits	Input 13-16
9	1	Bits	Input 17-20
10	1	Bits	Input 21-24
11	1	Bits	Input 25-28
12	1	Bits	Input 29-32
13	1	Bits	Input 33-36
14	1	Bits	Input 37-40
15	1	Bits	Input 41-44
16	1	Bits	Input 45-48
17	1	Bits	Output 1-4
18	1	Bits	Output 5-8
19	1	Bits	Output 9-12
20	1	Bits	Output 13-16
21	1	Bits	Output 17-20
22	1	Bits	Output 21-24
23	1	Bits	Output 25-28 Not in use option
24	1	Bits	Output 29-32 Not in use option
25	1	GS	Separator
26	5	CRC16	Cyclic redundancy check
31	1	EOT	End of transmission

Reset & start

WTG to MASTER “3”

The turbine sends return telegram to the Master.

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	1	GS	Separator
6	5	CRC16	Cyclic redundancy check
11	1	EOT	End of transmission

Command is 3.

Stop

WTG to MASTER “4”

The turbine sends return telegram to the Master.

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	1	GS	Separator
6	5	CRC16	Cyclic redundancy check
11	1	EOT	End of transmission

Command is 4.

Information Telegram 2

WTG to Master ”5”

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	8	Counter	Engagement of hydraulic pump tips
13	6	Time	Time hydraulic pump tips running total in unit 1/10 hours
19	8	Counter	Engagement of hydraulic caliber brake
27	6	Time	Time hydraulic caliber brake running total in unit 1/10 hours
33	8	Counter	Engagement of yaw CW
41	6	Time	Time of yawing CW total in unit 1/10 hours
47	8	Counter	Engagement of yaw CCW
55	6	Time	Time of yawing CCW total in unit 1/10 hours
61	8	Time	Time gear oil pump running total in unit 1/10 hours
69	8	Time	Time nacelle fan running total in unit 1/10 hours
77	8	Time	Time water pump running total in unit 1/10 hours
85	8	kWh	Total production G2 (updated every 3.6 sec.)
93	8	kWh	Total production G1 (updated every 3.6 sec.)
101	8	Counter	Engagement of G2 generator contactor
109	8	Counter	Engagement of G2 generator contactor
117	8	Counter	Engagement braking down, brake program >= B50
125	3	Time	Last braking time in unit 1/10 sec. Until zero RPM
128	4	xxxxx	Not in use 4 byte
132	4	Temp.	Signed gear bearing temperature in unit 1°C. (unaveraged)
136	4	Temp.	Signed gear oil temperature in unit 1°C. (unaveraged)
140	4	Temp.	Signed generator 2 temperature in unit 1°C. (unaveraged)
144	4	Temp.	Signed generator 1 temperature in unit 1°C. (unaveraged)
148	4	Temp.	Signed ambient temperature in unit 1°C. (unaveraged)
152	4	Temp	Signed nacelle temperature in unit 1°C. (unaveraged)
156	1	GS	Separator
157	5	CRC16	Cyclic redundancy check
162	1	EOT	End of transmission

Production info record

WTG to Master ”6”

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	8	KWh	Total netto production in unit 1/10 kW (updated every 3.6 sec.)
13	8	KVAh	Total reactive consumption in unit 1/10 kVAh (updated every 3.6 sec.)
21	8	Time	Total time WTG on grid in unit sec. (updated every 3.6 sec.)
27	8	Meter	Acc. Wind distance in unit 1/10 meters (updated every 1 sec.)
35	8	Time	Total Time with Power On in unit 1/100 hours. (updated every 3.6 sec.)
41	8	Time	Turbine OK Time in unit 1/100 hours. (updated every 3.6 sec.)
47	8	Time	Brake Release Time in unit 1/100 hours. (updated every 3.6 sec.)
53	8	Time	T1 wind counter in unit 1/100 hours. (updated every 3.6 sec.)
59	8	Time	T2 wind counter in unit 1/100 hours. (updated every 3.6 sec.)
65	1	GS	Separator
66	5	CRC16	Cyclic redundancy check
71	1	EOT	End of transmission

T1 wind counter in unit sec. Counts when the wind speed, 10 min. average, is faster than *Start wind and slower than *Stop wind and the mechanical brake is open (output 525 high).

T2 wind counter in unit sec. Counts when the wind speed, 10 min. average, is faster than *Start wind and slower than *Stop wind.

Set time and date

Master to WTG "7"

DATA Description:

The 'Data to WTG' is only used in the 'Set time and date' command. The format is as following:

Size byte	Content	Description
1	SOH	Start of heading
3	Wtg Address	1-254; 0 = master; 255 = broadcast
1	Command Character	See Command Character Description
1	GS	Separator
6	Time	HHMMSS or ****** * = 2A hex
6	Date	YYMMDD or ****** * = 2A hex
1	ETX	End of text
5	CRC16	Cyclic redundancy check
1	EOT	End of transmission

If the data field is ****** in the time and date field the turbine returns the current time and date.

WTG to Master "7". No response if the command is a broadcast

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	6	Time	HHMMSS
11	6	Date	YYMMDD
17	1	GS	Separator
18	5	CRC16	Cyclic redundancy check
23	1	EOT	End of transmission

Event log

WTG to master **"8"**

Byte Position	Size byte	Content	Description
0	1	SOH	Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
Eventlog entry 1			
Eventlog entry 2			
Eventlog entry 3			
.			
.			
.			
Eventlog entry 50			
	1	GS	Separator
	5	CRC16	Cyclic redundancy check
	1	EOT	End of transmission

The fifty events entry in the event log is formatted as follows:
"Date and time stamp" "E or S" "Event no" "Event text" CR LF
The @ is filled with the Character E for an event in the list
The @ is filled with the Character S for a status code in the list

Due to different length of Event log texts there is no fixed length of the event log entry, the single events is separated by a CR and a LF
The total length of the telegram will typically be in the range 2500 – 4000 bytes

Worst case:

Packet size:
<SOH>xxx8(YYMMDDHHMMSS@zzzzabcdefghijklmnopqrst<CR><LF>)*50<GS><crc16><EOT> =
1 + 3+ 1 + (12 + 1+ 4 + 20 + 1 + 1) * 50 + 1 + 5 + 1 = 1962 bytes.

At 19200 baud it will take approximately 1 sec. to transmit the whole package.

Surveillance of gearbox telegram

WTG to Master (Counters for the gearbox suveillance) “9”

Byte Position	Size byte	Content	Description
0	1	SOH	Start of heading Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	6	Time	Short term gear oil hot in unit sec (updated every 3.6 sec)
11	6	Time	Long term gear oil hot in unit sec (updated every 3.6 sec)
17	6	Time	Short term bearing hot in unit sec (updated every 3.6 sec)
23	6	Time	Long term bearing hot in unit sec (updated every 3.6 sec)
29	6	Counter	Short term gear oil hot peak counter
35	6	Counter	Long term gear oil hot peak counter
41	6	Counter	Short term bearing hot peak counter
47	6	Counter	Long term bearing hot peak counter
53	1	GS	Separator
54	5	CRC16	Cyclic redundancy check
59	1	EOT	End of transmission

Power down time and times and event log telegram

WTG to Master “A”

Byte Position	Size byte	Content	Description
0	1	SOH	Start of heading Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	8	Timer	Power down time in seconds
13	8	Counter	Power down times
21	12	yymmddhhmmss	Power down log (last power up) the newest event
33	12	yymmddhhmmss	Power down log (last power down) the newest event
45	12	yymmddhhmmss	Power down log(last power up)
57	12	yymmddhhmmss	Power down log(last power down)
69	12	yymmddhhmmss	Power down log(last power up)
81	12	yymmddhhmmss	Power down log(last power down)
93	12	yymmddhhmmss	Power down log(last power up)
105	12	yymmddhhmmss	Power down log(last power down)
117	12	yymmddhhmmss	Power down log (last power up)
129	12	yymmddhhmmss	Power down log(last power down)
141	12	yymmddhhmmss	Power down log(last power up)
153	12	yymmddhhmmss	Power down log(last power down)
165	12	yymmddhhmmss	Power down log(last power up)
177	12	yymmddhhmmss	Power down log(last power down)
189	12	yymmddhhmmss	Power down log(last power up)
201	12	yymmddhhmmss	Power down log(last power down)
213	12	yymmddhhmmss	Power down log(last power up)
225	12	yymmddhhmmss	Power down log(last power down)
237	12	yymmddhhmmss	Power down log(last power up) the oldest event
249	12	yymmddhhmmss	Power down log(last power down) the oldest event
261	1	GS	Separator
262	5	CRC16	Cyclic redundancy check
267	1	EOT	End of transmission

This log is made in the uninitialized RAM (not cleared at start up). If the WP3033 is removed / disconnected from the WP3000 or the battery is changed in the WP3000 this log is lost. There is a parameter in the WP3000 to clear this log **Reset pwr.down log x* in the Service menu.
The power down times counter will be restored together with the summations in the WP3000.

Software revision and version

WTG to Master “B”

Byte Position	Size byte	Content	Description
0	1	SOH	Start of heading Binary 1
1	3	Wtg Address	Contains leading 0s
4	1	Command Character	Echo command character
5	5	Version	Software version i.e. 96095
10	6	YYMMDD	Date of revision i.e. 010203
16	1	GS	Separator
17	5	CRC16	Cyclic redundancy check
22	1	EOT	End of transmission

Input/output descriptions

Input number	WP3000 Terminal	Description
1	100	Vibration
2	101	Trafo cut out
3	102	Lightning protection
4	103	Available
5	104	MCCB OK
6	105	Cable twisted
7	106	Yaw sensor 1 (CW)
8	107	Yaw sensor 1 (CCW)
9	109	Safety chain
10	110	Wind CCW 1
11	111	Wind CW 1
12	112	Bypass feedback
13	113	Brake free
14	114	WP2060 OK
15	115	WP2060 bypass
16	116	MCCB TRIG
17	118	(H) start/stop
18	119	Gear oil filter
19	120	Hydraulic pressure OK
20	121	Available
21	122	Manual start
22	123	Manual stop
23	124	Manual yaw CW
24	125	Manual yaw CCW
25	127	Compensator capacitor
26	128	External start/stop
27	129	Thermo yaw motor
28	130	Thermo hydraulic pump brake
29	131	Available
30	132	Available
31	133	Thermo gen. water cooling pump
32	134	Thermo gear oil cooling pump
33	136	Available
34	137	Tip (H) service
35	138	Wind CCW 2

Input number	WP3000 Terminal	Description
36	139	Wind CW 2
37	140	Ext. vibration
38	141	Rotor overspeed
39	142	REPO
40	143	Available
41	145	Brake worn out
42	146	Available
43	147	Available
44	148	(Not used
45	151	Thermistor Available
46	152	Thermistor Available
47	153	Thermistor Available
48	154	Thermistor Available

Output number	WP3000 Terminal	Description
1	501	Bypass thyristors
2	502	Generator 1
3	503	Generator 2
4	504	Hydraulic pump brake
5	506	Yaw motor 1 CW
6	507	Yaw motor 1 CCW
7	508	Tip (H) (V) 2
8	509	Tip (H) (P)
9	511	Nacelle cooling fan
10	512	Tip (H) (V) 3
11	513	Water cooling pump
12	514	Gear oil cooling pump
13	516	Capacitor 1
14	517	Capacitor 2
15	518	Capacitor 3
16	519	Capacitor 4
17	521	Capacitor 5
18	522	Fan speed 1
19	523	Fan speed 2
20	524	Infrared heater
21	525	Brake hydraulic valve
22	528	Tip hydraulic valve 1
23	530	Wind vane heat
24	534	Alarm

Output number	WP3000 Terminal	Description
25	-	(Not used)
26	-	(Not used)
27	-	(Not used)
28	-	(Not used)

Addressing Strategy

When turbine does not answer

The response time from the wind turbine controller is less than 100 ms, which means that the handling of the retries has to be defined in the master comm. system.

The timing for the retry depends on how the master system handles the receiving of the characters. If the master system detects that no characters has been received within a delay of 100 ms, the question has to output again. Else if a CRC-16 error is recognized the question has to be output again.

NOTE: The retry handling system must be able to handle the huge Event telegram which in worst case be 2212 bytes (approx 1 sec. at 19200 baud).

CRC-16 Calculation (question)

The CRC16 calculation is calculated from WTG address to the ETX, excl. the ETX.
This routine generates a CRC-16 forward remainder of ASCII characters of 7 bit contained in 8 bit register.
CRCR is a 16 bit register which contains the result dynamically.
CRCP is a 16 bit register which contains the polynomium for the standard X^16 + X^15 + X^2 + 1 = 1 1000 0000 0000 0101 binary.
The first bit is implicitly given in the carry, CRCP = 8005 hex.

CRCRhig = MSB CRCPhig = MSB = 80 hex
CRCRlow = LSB CRCPlow = LSB = 05 hex

Pseudo code for calculation:

Character string
start: SET CRCR = 0

>>>> Char. start: SET COUNTER = 7

SET TEMP = CHARACTER * 2

SET CRCRhig = CRCRhig <XOR> TEMP

>>> shift crcr: SET CRCR = CRCR * 2

IF no carry JUMP count shift >>

SET CRCR = CRCR <xor> CRCP

>> Count shift: SET COUNTER = COUNTER - 1

IF counter not zero JUMP shift crcr >>>

SET CHARACTER = next character

IF no end of string JUMP char. start >>>>

CRC-16 Calculation (answer)

The CRC16 calculation is calculated from WTG address to the GS, excl. the GS.
This routine generates a CRC-16 forward remainder of ASCII characters of 7 bit contained in 8 bit register.
CRCR is a 16 bit register which contains the result dynamically.
CRCP is a 16 bit register which contains the polynomium for the standard X^16 + X^15 + X^2 + 1 = 1 1000 0000 0000 0101 binary.
The first bit is implicitly given in the carry, CRCP = 8005 hex.

CRCRhig = MSB CRCPhig = MSB = 80 hex
CRCRlow = LSB CRCPlow = LSB = 05 hex

Pseudo code for calculation:

Character string
start: SET CRCR = 0

>>>> Char. start: SET COUNTER = 7

SET TEMP = CHARACTER * 2

SET CRCRhig = CRCRhig <XOR> TEMP

>>> shift crcr: SET CRCR = CRCR * 2

IF no carry JUMP count shift >>

SET CRCR = CRCR <xor> CRCP

>> Count shift: SET COUNTER = COUNTER - 1

IF counter not zero JUMP shift crcr >>>

SET CHARACTER = next character

IF no end of string JUMP char. start >>>>

[NM44/750]

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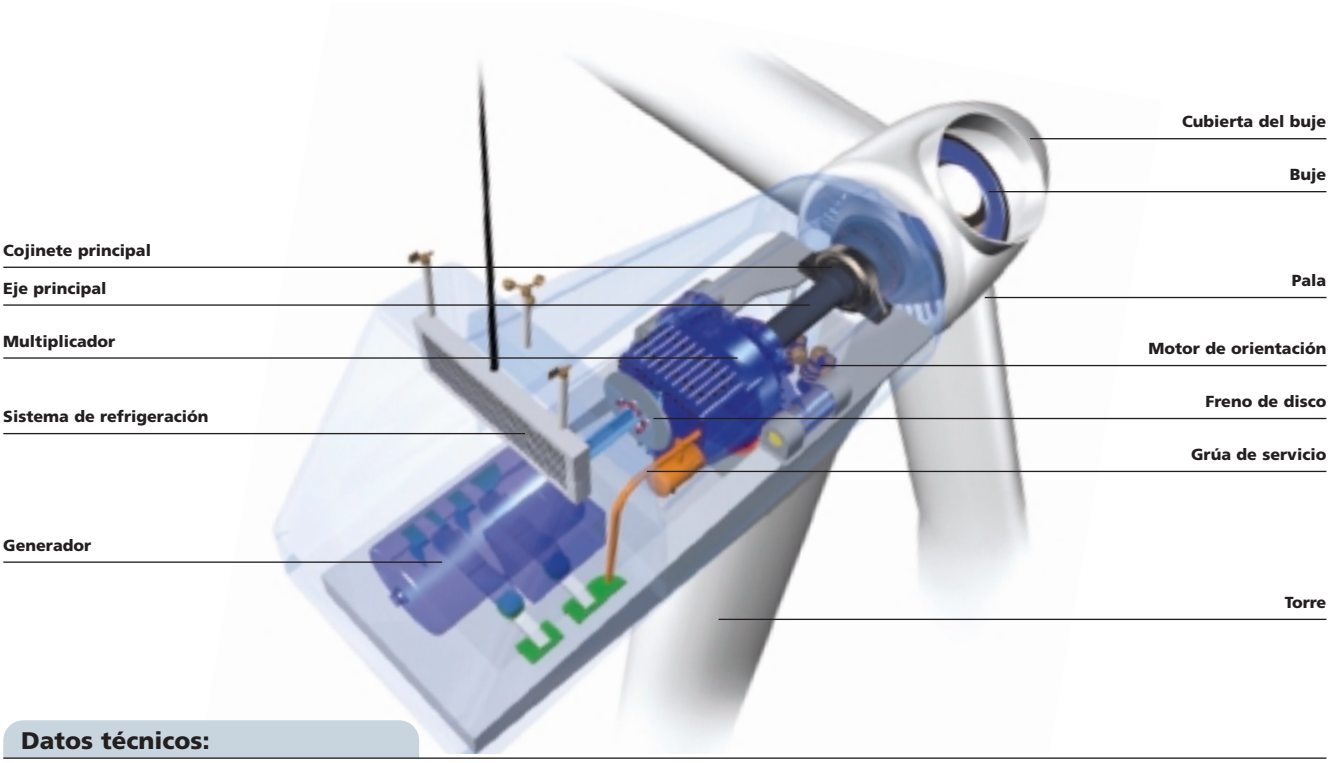


Datos técnicos:

Parámetros de funcionamiento

Potencia máxima:	750 kW
Regulación de potencia:	Paso fijo
Pot. máx. a vel. de viento:	16 m/s
Velocidad de arranque:	4 m/s
Velocidad de parada:	25 m/s

Rotor

Diámetro del rotor:	44 m
Área de barrida por el rotor:	1.520 m^2
Número de palas:	3
Revoluciones del rotor:	27/18 rpm
Posición del rotor:	A barlovento

Sistema de freno

Freno aerodinámico:	Hidráulico, seguro al fallo
Freno de disco:	Hidráulico, seguro al fallo

Multiplicador

Tipo:	Planetario – eje paralelo
Cociente:	1:55.6
Eje principal:	Eje y brida forjados
Cojinete principal:	Cojinete de rodillos esféricos
Refrigeración:	Intercambiador de calor con bomba

Generador

Tipo:	Asíncrono, 4-6 devanados
Voltaje nominal:	690 V
Frecuencia nominal:	50 Hz
Potencia nominal:	750/200 kW
Refrigeración:	Líquida con bomba

Sistema de orientación

Tipo:	Rodamiento de bolas
Frenos:	Frenos por fricción/freno motor
Reductores:	3 engranajes planetarios eléctricos

Torre

Tipo:	Torre cónica de acero pintada
Altura de buje:	Según especificaciones

Regulador

Tipo:	Control por ordenador
Sistema de arranque:	Suave por tiristores
Compensador de reactiva:	Compensación de plena carga
Control remoto:	Por módem

Sensores

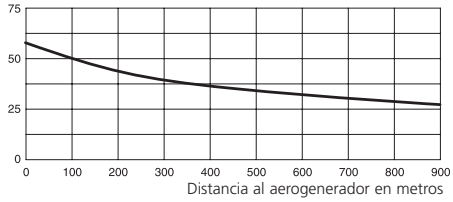
Sensores RPM:	Rotor, generador y sistema de orientación
Sensores de la temperatura:	Multiplicador, generador y regulador
Sensores térmicos:	Interruptor principal y protector de motor
Sensores de vibración:	Góndola, rotor
Meteorología:	Anemómetro, veletas y termómetro
Sistemas hidráulicos:	Presóstatos, transductor de presión

Protección contra rayos

Según la norma:	IEC 1024
Palas:	Receptores en el extremo de la pala
Góndola:	Pararrayos

Nivel de ruido:

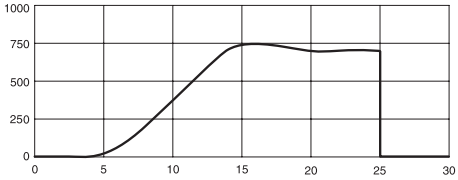
Nivel de ruido dB(A)



Distancia al aerogenerador en metros

Curva de potencia:

kW



Metros por segundo

Debe tenerse en cuenta que los gráficos de potencia están indicados en atmósferas según la norma DIN ISO 2533. Debe tenerse en cuenta que el rotor y la altura de buje han sido aprobados para mercados y clases de vientos específicos. Llámenos para más información.
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STATUS	TEXT	SET DELAY	BRAKE PROGRAM	REPEATED STATUS CODE	ALARM PROGRAM	YAW PROGRAM	RESET PROGRAM	RESET DELAY	REMARKS
0	System OK	0 s	10		0	30	A	10	0 s	
1	Vibration +	1 s	200		1	130	M	25	0 s	
7	Turbine is serviced	0 s	0		1	0	A	10	0 s	
9	Remote stop	1 s	50		1	130	A	10	1 s	
10	Safety chain open	1 s	200		1	240	A	10	1 s	
11	Stop via communica.	0 s	50		1	130	R	10	0 s	
12	dB operation	0 s	0		0	0	A	10	0 s	
13	Manual stop	0,1 s	50		1	50	M	10	0 s	
23	Repeating error	0 s	50		1	240	M	25	0 s	
29	New program	0 s	200		0	240	M	25	0 s	
30	Nacelle temp.	60 s	50	23 4/24h	1	130	A	10	3600 s	
36	Reserve 1 temp.	2 s	50		1	130	A	10	10 s	
38	Alarm call test	0 s	0		1	0	R	1	0 s	
39	Division by zero	0 s	200		1	240	M	25	0 s	
40	Parameter crash	0 s	200		1	240	M	25	0 s	
42	Internal battery low	10 s	0		1	0	M	25	0 s	
43	Internal temp. high	10 s	50		1	50	A	25	60 s	
45	Main ctrl. Supply	0 s	200		1	130	A	10	10 s	
47	Supply 156/157	0 s	200		1	240	A	10	0 s	
48	Supply 248/249	0 s	200		1	240	A	10	0 s	
49	Internal 15V supply	0,5 s	200		1	50	A	10	0 s	
50	Slave watchdog	0 s	200		1	50	A	10	10 s	
51	DSP watchdog	0 s	200		1	50	A	10	10 s	
52	WP3000 watchdog	0 s	200		1	50	A	10	10 s	
54	WP3000 manual reboot	0 s	200		1	50	A	10	10 s	
90	Blade vibration stop	0 s	200		1	130	M	99	0 s	
91	Blade vibr. error	2 s	200	23 3/1h	0	130	A	25	10 m	
96	Sensor error vibra.	2 s	200	23 3/1h	1	240	A	25	10 m	
97	Fast stop	0 s	200		0	240	M	25	0 s	
98	Platform switch	0,02 s	50		1	240	M	25	0 s	
99	Parkmasterstop	0 s	50		0	50	A	80	0 s	
100	Repeated grid error	0 s	50		1	130	M	10	0 s	
102	Phase drop	*1 s	200		0	240	A	80	0 s	

STATUS	TEXT	SET DELAY	BRAKE PROGRAM	REPEATED STATUS CODE	ALARM PROGRAM	YAW PROGRAM	RESET PROGRAM	RESET DELAY	REMARKS
103	Vector surge	0 s	200	100 4/1h	0	240	A	10	10 s	
110	Voltage high	*5 s	50	100 4/1h	0	130	A	10	180 s	
111	Voltage low	*5 s	50	100 4/1h	0	130	A	10	180 s	
120	Frequency high	*0,2 s	50	100 4/1h	0	130	A	10	180 s	
121	Frequency low	*0,2 s	50	100 4/1h	0	130	A	10	180 s	
130	L1-L2-L3 120°	*1 s	50	100 4/1h	0	130	A	10	10 s	
138	Grid param. warning	0 s	0		1	0	A	100	0 s	
139	Grid parameter stop	100 h	50		1	130	M	100	0 s	
200	Outdoor temp. low	10 s	50	23 4/24h	1	130	A	10	600 s	
201	Outdoor temp. high	10 s	50	23 4/24h	1	130	A	10	600 s	
203	Wind > power	*20 s	50	23 4/24h	1	240	A	10	1 m	
206	Ice warning	*15 s	50		0	130	A	80	*15 s	
207	Ice detector error	60 s	50		0	130	A	80	60 s	
221	W.direc.nonidentical	*15 m	50		0	130	R	10	0 s	
223	Wind vane def. R/L	*166,6 m	50	23 4/24h	1	240	A	10	0 s	
227	Anemometer defect	*20 s	50	23 4/24h	1	240	M	10	0 s	
240	Awaiting wind	0 s	50		0	130	A	5	30 s	
250	Wind > max.	*10 s	50		0	130	A	25	*50 m	
251	Wind >> max.	*15 s	50		0	130	A	25	*50 m	
252	Wind>max. & low temp	0 s	50		0	130	A	25	0 s	
300	(G) tacho defect	1 s	50		1	130	M	25	0 s	
301	Cut in overspeed	0 s	50	23 4/24h	1	130	A	10	0 s	
302	(R) tacho defect	1 s	50		1	130	M	25	0 s	
305	Running away	1 s	0		0	0	M	25	0 s	
306	Running away 1	1 s	50		0	130	M	25	0 s	
307	Running away 2	1 s	200		0	130	M	25	0 s	
308	Running away 3	1 s	0		1	0	M	25	0 s	
311	Rotor overspeed	0 s	200		1	130	M	10	0 s	
312	(G) overspeed	0 s	200	23 3/1h	1	130	M	10	0 s	
322	Sensor error rpm	2 s	200		1	240	M	25	0 s	
323	Ext. rotor overspeed	10 s	200		1	130	M	25	0 s	
402	Tip brake press.high	0.5 s	200		1	130	M	25	0 s	
415	Brake pads worn	1 s	0		1	0	M	10	0 s	

STATUS	TEXT	SET DELAY	BRAKE PROGRAM	REPEATED STATUS CODE	ALARM PROGRAM	YAW PROGRAM	RESET PROGRAM	RESET DELAY	REMARKS
416	Replace brake pads	100 h	200		1	130	M	25	0 s	
420	Brakin.time too long	*10 s	210		1	130	M	25	0 s	
421	Brake not released	*4 s	200	23 3/1h	1	130	A	10	0 s	
422	Therm.relay brake(H)	1 s	50		1	130	M	10	0 s	
426	Tip valve	5 s	200		1	50	M	25	0 s	
437	Tip(P) oper.time>max	0 s	200	23 3/1h	1	0	A	10	0 s	
438	Tip (P)starting rate	0 s	0		1	0	M	10	0 s	
442	Tip (H) sensor def.	5 s	200		1	0	A	10	5 s	
444	Tip service switch	1 s	200		1	0	M	10	0 s	
475	Tip (V) Test error	0 s	200		1	50	M	0	0 s	
500	(G)heat error repeat	0 s	50		1	130	M	25	0 s	
501	Power comsumption	10 s	50	23 4/24h	1	130	M	25	0 s	
513	G1 stator temp.	10 s	50	500 1/24h	1	130	A	10	3600 s	
515	G2 stator temp.	10 s	50	500 1/24h	1	130	A	10	3600 s	
525	(G) bypass feedback	0,5 s	50		1	130	A	10	0 s	
530	(G) power too high	10 s	50		1	130	A	25	*50 m	
551	G1 blocked	0 s	0		0	0	A	25	0 s	
568	DB G1>>G2	*60 s	50		1	0	A	0	0 s	
600	Main switch off	1 s	200		1	240	M	25	0 s	
601	Current asymmetry	*0,8 s	50		1	130	M	10	0 s	
602	Lightning prot. def.	1 s	0		1	0	A	10	1 s	
608	Trafo cut off	*5 s	50		1	0	A	10	0 s	
620	WP2060 error	0,2 s	50	23 1/1h	1	130	A	10	0 s	
646	Cut in not allowed	0 s	50		0	130	A	10	0 s	
650	Cut in 0_>G2	0 s	50		1	130	M	10	0 s	
651	Cut in 0_>G1	0 s	50		1	130	M	10	0 s	
652	Cut in G1>G2	0 s	50		1	130	M	10	0 s	
654	Main switch man. out	2 s	200		1	240	M	25	2 s	
660	G1>G2 overspeed	0 s	50		0	0	A	25	0 s	
661	G1>G2 brake time>max	0 s	50		0	0	A	25	0 s	
700	Error by yawing	0 s	50		1	240	M	25	0 s	
701	Rep. error by yawing	0 s	50		1	240	M	25	0 s	
715	Cable autounwind	0,1 s	50		0	70	A	10	0 s	

STATUS	TEXT	SET DELAY	BRAKE PROGRAM	REPEATED STATUS CODE	ALARM PROGRAM	YAW PROGRAM	RESET PROGRAM	RESET DELAY	REMARKS
719	(H)yaw(M)therm.relay	1 s	50		1	240	M	10	0 s	
722	Cable twisted	1 s	50		1	240	M	25	0 s	
730	Yaw sensor defect	20 s	50	701 1/1h	1	240	A	10	0 s	
753	Yaw rim cold	10 s	50		1	240	A	10	60 m	206-208
754	Yaw rim hot	10 s	50		1	240	A	10	60 m	
800	Capacitor feedback	1 s	50	23 1/1h	1	130	A	10	0 s	
904	Therm.(G) cool. pump	1 s	50		1	130	M	10	0 s	
906	Therm. gear oil pump	1 s	50		1	130	M	10	0 s	
1000	Park com.error	0 s	0		1	0	M	25	0 s	
1200	(H) pressure error	2 s	50	23 1/1h	1	130	R	10	0 s	
1213	(H) oper.time > max.	*15 s	50	23 1/1h	1	130	A	10	0 s	
1300	Gear oil filt.choked	*15 m	0		1	0	A	10	0 s	
1307	Gear oil temp.	60 s	50		1	130	M	99	0 s	
1311	Coupling (G) gearbox	*4 s	200		1	240	M	99	0 s	
1317	Gear bearing temp.	60 s	50		1	130	M	99	0 s	
1504	Blade vibr.warning	0 s	0		1	0	M	10	1 h	
1533	WP3033 watchdog	0 s	0		0	0	M	80	0 s	
1554	Invalid parameter	0 s	0		1	0	A	10	0 s	
1578	Stop too long	*600 m	0		1	0	M	25	0 s	

English Text:	*Danish Text:*	*German Text:*
System OK	System OK	System OK

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
0	0 s	10		0	30	A10	0 s

Source: Internal.

Reason: The wind power is error free.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Vibration +	Vibration +	Vibration +

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1	1 s	200		1	130	M25	0 s

Source: No signal on digital input 100.

Reason: Vibrations in the wind turbine.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Turbine is serviced	Møllen under service	WKA in Service

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
7	0 s	0		1	0	A10	0 s

Source:

Reason: Wind power is in service mode

Remarks: When the service mode is entered, the status list and the event list are backed up. When the service mode is left, the status list and the event list are restored.

English Text:	*Danish Text:*	*German Text:*
Remote stop	Fjernstop	Stop Fernbedienung

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
9	1 s	50		1	130	A10	1 s

Source: No signal on input 128.

Reason: The wind turbine is stopped by remote stop.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Safety chain open	Sikkerhedskæde	Sicherheitskette

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
10	1 s	200		1	240	A10	1 s

Source: No signal on digital input 109.

Reason: Safety chain is open.

Remarks: Autoreset when there is a signal on digital input 109.

English Text:	*Danish Text:*	*German Text:*
Stop via communica.	Stop via kommunika.	Stop via Kommunika.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
11	0 s	50		1	130	R10	0 s

Source: Stopped via data communication.

Reason: The wind turbine is stopped. The wind power has received a stop command by data communication.

Remarks:

English Text:	*Danish Text:*	*German Text:*
dB operation	dB drift	dB Betrieb

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
12	0 s	0		0	0	A10	0 s

Source:

Reason: DB operation. Status code is active when turbine is in DB operation

Remarks:

English Text:	*Danish Text:*	*German Text:*
Manual stop	Manuelt stop	Manueller Stop

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
13	0,1 s	50		1	50	M10	0 s

Source: Keyboard <STOP> key pressed or no signal on digital input 123.

Reason: The wind turbine is stopped by manual reset.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Repeating error	Gentagen fejl	Wiederholungsfehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
23	0 s	50		1	240	M25	0 s

Source: One or more status codes are constantly set.

Reason: Another status code has triggered this status code.

Remarks:

English Text:	*Danish Text:*	*German Text:*
New program	Nyt program	Neues Programm

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
29	0 s	200		0	240	M25	0 s

Source: The status code is set if the program is replaced.

Reason: New program.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Nacelle temp.	Møllehattemp.	Gondeltemp.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
30	60 s	50	23 4/24h	1	130	A10	3600 s

Source: Temperature input 225 is higher than *Alarm on HI or below *Alarm on LOW.

Reason: Nacelle temperature is too high or too low.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Reserve 1 temp.	Reserve 1 temp.	Reserve 1 Temp.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
36	2 s	50		1	130	A10	10 s

Source:

Reason: Reserve temp. status code not in use.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Alarm call test	Alarmopkaldstest	Alarmanruftest

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
38	0 s	0		1	0	R1	0 s

Source: The status code is activated when the alarm call test is activated.

Reason: The status code causes an alarm call.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Division by zero	Division med nul	Teilung durch Null

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
39	0 s	200		1	240	M25	0 s

Source: Internal.

Reason: Parameter error.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Parameter crash	Parametre ødelagt	Parameter zerstört

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
40	0 s	200		1	240	M25	0 s

Source:

Reason: Parameter crash due to flat battery. Battery must be replaced and all parameters must be set to default values.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Internal battery low	Interne batteri lav	Int. Batterie nied.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
42	10 s	0		1	0	M25	0 s

Source: Battery in the WP3000 is flat.

Reason: Defective battery. Replace battery.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Internal temp. high	Interne temp. høj	Interne Temp. hoch

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
43	10 s	50		1	50	A25	60 s

Source: Internal temperature in the WP3000 is higher than *Alarm ON.

Reason: Internal temperature in the WP3000 is too high.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Main ctrl. Supply	Main ctrl. Forsyning	Main Rech.Versorgung

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
45	0 s	200		1	130	A10	10 s

Source: Missing supply to the WP3000.

Reason: There has been a voltage drop in the WP3000 main supply which forces the WP3000 to reset.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Supply 156/157	Forsyning 156/157	Versorgung 156/157

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
47	0 s	200		1	240	A10	0 s

Source: Inputs 156 and 157.

Reason: No power on inputs 156 and 157.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Supply 248/249	Forsyning 248/249	Versorgung 248/249

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
48	0 s	200		1	240	A10	0 s

Source: Inputs 248 and 249.

Reason: No power on inputs 248 and 249.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Internal 15V supply	Intern 15V forsyning	Interne 15V Versorg.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
49	0,5 s	200		1	50	A10	0 s

Source: Internal error.

Reason: Internal 15V supply defective. Replace WP3000 PCB.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Slave watchdog	Slave watchdog	Slave Watchdog

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
50	0 s	200		1	50	A10	10 s

Source: Internal error.

Reason: Slave processor is reset. Software error.

Remarks:

English Text:	*Danish Text:*	*German Text:*
DSP watchdog	DSP watchdog	DSP Watchdog

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
51	0 s	200		1	50	A10	10 s

Source: Internal error.

Reason: DSP processor has been reset. Software error.

Remarks:

English Text:	*Danish Text:*	*German Text:*
WP3000 watchdog	WP3000 watchdog	WP3000 Watchdog

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
52	0 s	200		1	50	A10	10 s

Source: Internal error.

Reason: WP3000 has been reset.

Remarks:

English Text:	*Danish Text:*	*German Text:*
WP3000 manual reboot	WP3000 manuel reboot	WP3000 manuel.Reboot

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
54	0 s	200		1	50	A10	10 s

Source: The parameter *REBOOT is set to reboot.

Reason: The WP3000 has been reset manually by the user.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Blade vibration stop	Vingevibration stop	Flügelvibration Stop

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
90	0 s	200		1	130	M99	0 s

Source: Internal calculations.

Reason: Vibration counter > 9.

Remarks: The vibration counter counts one up every time the status code 91 is activated.

English Text:	*Danish Text:*	*German Text:*
Blade vibr. error	Vingevibration fejl	Flügelvibr. Fehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
91	2 s	200	23 3/1h	0	130	A25	10 m

Source: No signal on digital input 140.

Reason: Error message from external vibration watch.

Remarks: Reset when wind speed averaged over 10 m < * and rotor rpm < 5 and generator rpm < 5.

English Text:	*Danish Text:*	*German Text:*
Sensor error vibra.	Sensorfejl vibration	Sensorfehler vibra.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
96	2 s	200	23 3/1h	1	240	A25	10 m

Source: Digital input, terminal 140, pulse train. Low for 0.5 sec. High for 1 sec. etc.

Reason: Error on the vibration sensor of the vibration watch.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Fast stop	Hurtigstop	Schnellstop

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
97	0 s	200		0	240	M25	0 s

Source: The <STOP> key on keyboard is pressed while the brake is activated or digital inputs 123 or 142 are low during braking.

Reason: Emergency stop.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Platform switch	Reposkontakt	Podestkontakt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
98	0,02 s	50		1	240	M25	0 s

Source: No signal on digital input 142.

Reason: Platform switch is open.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Parkmasterstop	Parkmasterstop	Parkmasterstopp

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
99	0 s	50		0	50	A80	0 s

Source: If the command from the park control is sent to stop the turbine, this status code is activated.

Reason: The park control has sent a command to stop the turbine. The status code is reset when the park control sends a start command.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Repeated grid error	Gentagen netfejl	Netzwiederhol.fehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
100	0 s	50		1	130	M10	0 s

Source: Voltage or frequency status codes are constantly set.

Reason: The status codes for voltage low, voltage high or frequency are constantly set.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Phase drop	Faseudfald	KU Abschaltung

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
102	*1 s	200		0	240	A80	0 s

Source: The voltage of L1 or L2 or L3 is below 1/2 of the nominel voltage.

Reason: Grid failure.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Vector surge	Vektorspring	Vektorsprung

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
103	0 s	200	100 4/1h	0	240	A10	10 s

Source: Internal calculations.

Reason: Vector surge > *°.

Remarks: Vector surge is always tested 10 s after cut in of G1 or G2. Vector surge is also tested during free wheeling if *FW vector surge is ON.

English Text:	*Danish Text:*	*German Text:*
Voltage high	Spænding høj	Spannung hoch

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
110	*5 s	50	100 4/1h	0	130	A10	180 s

Source: Grid voltage on one of the phases is higher than *Nom.volt * times *Max voltage.

Reason: Grid voltage is too high.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Voltage low	Spænding lav	Spannung niedrig

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
111	*5 s	50	100 4/1h	0	130	A10	180 s

Source: Grid voltage is below *Nominal voltage * times *Min voltage.

Reason: Grid voltage is too low.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Frequency high	Frekvens høj	Frequenz hoch

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
120	*0,2 s	50	100 4/1h	0	130	A10	180 s

Source: Grid frequency is higher than *Nom Grid frequency times *Max Grid Frequency.

Reason: Grid frequency is too high.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Frequency low	Frekvens lav	Frequenz niedrig

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
121	*0,2 s	50	100 4/1h	0	130	A10	180 s

Source: Grid frequency is below *Nom grid frequency times *Min grid frequency.

Reason: Grid frequency is too low.

Remarks:

English Text:	*Danish Text:*	*German Text:*
L1-L2-L3 120°	L1-L2-L3 120°	L1-L2-L3 120°

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
130	*1 s	50	100 4/1h	0	130	A10	10 s

Source: The phase difference between L1,L2 and L3 is larger or smaller than *L1-L2-L3 120°.

Reason: The phases of L1-L2-L3 differ more than 120°.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Grid param. warning	Netparam. advarsel	Netzparam. Warnung

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
138	0 s	0		1	0	A100	0 s

Source: Change of grid parameter . When grid parameters for voltage and frequency are to be changed, a password must be entered.

Reason: Grid parameter is changed by user.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Grid parameter stop	Netparameter stop	Netzparameter Stop

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
139	100 h	50		1	130	M100	0 s

Source: Grid parameter must be reset by entering a password in *Accept grid parameters.

Reason: The status code 138 has been active for a week causing this parameter to be activated.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Outdoor temp. low	Udetemp. lav	Außentemp. niedrig

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
200	10 s	50	23 4/24h	1	130	A10	600 s

Source: Temperature input 218 is below *Alarm on LOW.

Reason: Outdoor temperature is too low.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Outdoor temp. high	Udetemp. høj	Außentemp. hoch

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
201	10 s	50	23 4/24h	1	130	A10	600 s

Source: Temperature input 218 is higher than *Alaram on HI.

Reason: Outdoor temperature is too high.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Wind > power	Vind > effekt	Wind > Leistung

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
203	*20 s	50	23 4/24h	1	240	A10	1 m

Source: Internal.

Reason: Windspeed is above * and power is below * measured over * time.

Remarks: Wind speed and grid power are averaged over 10 minutes.
Status code starts testing 10 minutes after bypass contactor has been activated.

English Text:	*Danish Text:*	*German Text:*
Ice warning	Overisningsvarsel	Verisungsgefahr

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
206	*15 s	50		0	130	A80	*15 s

Source: Data communication.

Reason: Ice detector status indicates ice warning.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Ice detector error	Isdetektor fejl	Eisdetektor Fehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
207	60 s	50		0	130	A80	60 s

Source: Data communication.

Reason: No data received from the ice detector.

Remarks:

English Text:	*Danish Text:*	*German Text:*
W.direc.nonidentical	Vindretn. uidentisk	W.richt.nicht ident.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
221	*15 m	50		0	130	R10	0 s

Source: Digital inputs 110, 111, 138 and 139.

Reason: The wind direction from wind 1 is nonidentical with wind 2.

Remarks: Is only tested if *Number of anemoscopes is 2 and wind speed averaged over 30 seconds is higher than 5 m/s.

English Text:	*Danish Text:*	*German Text:*
Wind vane def. R/L	Vindfane defekt R/L	Windfahne defekt R/L

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
223	*166,6 m	50	23 4/24h	1	240	A10	0 s

Source: Digital inputs 110 and 111 or digital inputs 138 and 139, all depending on the *Yaw wind vane parameter.

Reason: The anemoscope inputs are constantly active in one direction or no changes in the anemoscope signal.

Remarks: Is only tested when the bypass contactor is ON and the wind speed averaged over 30 seconds is higher than *Start wind speed and the yaw program is 30.

English Text:	*Danish Text:*	*German Text:*
Anemometer defect	Anemometer defekt	Anemometer defekt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
227	*20 s	50	23 4/24h	1	240	M10	0 s

Source: Wind speed is < *Wind < and grid output power > *Power.

Reason: Anemometer is defective.

Remarks: Is only tested when the bypass contactor is ON.

English Text:	*Danish Text:*	*German Text:*
Awaiting wind	Venter på vind	Wartet auf Wind

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
240	0 s	50		0	130	A5	30 s

Source: *Free Wheel is off and wind speed is < *Start wind.

Reason: Awaiting wind.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Wind > max.	Vind > max.	Wind > Max.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
250	*10 s	50		0	130	A25	*50 m

Source: Wind speed averaged over 30 s > * stop wind.

Reason: The wind speed is too high.

Remarks: The wind turbine is reset when wind speed averaged over 10 m < *Wind down wind speed.

English Text:	*Danish Text:*	*German Text:*
Wind >> max.	Vind >> max.	Wind >> Max.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
251	*15 s	50		0	130	A25	*50 m

Source: Wind speed averaged over 1 s > *Stop wind >>.

Reason: The wind speed is too high.

Remarks: The wind turbine is reset when wind speed averaged over 10 m < *Wind down wind speed.

English Text:	*Danish Text:*	*German Text:*
Wind>max. & low temp	Vind>max.& temp. lav	Wind>Max & Temp.nied

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
252	0 s	50		0	130	A25	0 s

Source: Internal.

Reason: The outdoor temp. < -19, measured over 10 min. and the wind speed >* averaged over 10 secs.

Remarks: The status code is reset when zero rpm are reached. When the wind turbine has been brought to stop, it is started and forced to run on G2 until Temp > -20 for 10 min and the wind speed < *.

English Text:	*Danish Text:*	*German Text:*
(G) tacho defect	(G) tacho defekt	(G) Impuls defekt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
300	1 s	50		1	130	M25	0 s

Source: Generator rpm is below 200 rpm while rotor rpm > 5 rpm and brake is free.

Reason: Not enough pulses from the generator.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Cut in overspeed	Indkoblingsoverhast.	Zuschalt.Überdrehz.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
301	0 s	50	23 4/24h	1	130	A10	0 s

Source: Generator rpm > * _>G1 max rpm during cut in of G1 or G2.

Reason: Generator rpm were too high during cut in.

Remarks:

English Text:	*Danish Text:*	*German Text:*
(R) tacho defect	(R) tacho defekt	(R) Impuls defekt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
302	1 s	50		1	130	M25	0 s

Source: Rotor rpm is below 2 rpm while generator rpm >= 600 and brake is free.

Reason: Not enough pulses from the rotor sensor.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Running away	Løbskkørsel	Durchdrehen

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
305	1 s	0		0	0	M25	0 s

Source: Running away warning is selected.

Reason: *Running away is not zero.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Running away 1	Løbskkørsel 1	Durchdrehen 1

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
306	1 s	50		0	130	M25	0 s

Source: Generator rpm > *Max generator rpm or Rotor rpm > *Max rotor.

Reason: Running away 1 is selected and generator or rotor overspeed occur.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Running away 2	Løbskkørsel 2	Durchdrehen 2

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
307	1 s	200		0	130	M25	0 s

Source: Generator rpm > *Max generator rpm or Rotor rpm > *Max rotor.

Reason: Running away 2 is selected.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Running away 3	Løbskkørsel 3	Durchdrehen 3

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
308	1 s	0		1	0	M25	0 s

Source: Generator rpm > *Max generator rpm or Rotor rpm > *Max rotor.

Reason: Running away 3 is selected.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Rotor overspeed	Rotoroverhastighed	Rotorüberdrehzahl

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
311	0 s	200		1	130	M10	0 s

Source: Rotor rpm > *Max rotor.

Reason: Rotor speed is too high.

Remarks: Is only tested if *run away = 0. If *run away > 0, the status codes 306 to 308 are used.

English Text:	*Danish Text:*	*German Text:*
(G) overspeed	(G) overhastighed	(G) Überdrehzahl

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
312	0 s	200	23 3/1h	1	130	M10	0 s

Source: Generator rpm > *Max generator rpm.

Reason: Generator overspeed.

Remarks: Is only tested if *run away = 0. If *run away > 0, the status codes 306 to 308 are used.

English Text:	*Danish Text:*	*German Text:*
Sensor error rpm	Sensorfejl rpm	Sensorfehler rpm

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
322	2 s	200		1	240	M25	0 s

Source: Digital input, terminal 140, pulse train. Low for 0.5 sec. High for 1 sec. etc.

Reason: Error on the rotor sensor of the vibration watch.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Ext. rotor overspeed	Ekst.rotor overhast.	Ext.Rotorubergeschw.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
323	10 s	200		1	130	M25	0 s

Source: Signal on input 141.

Reason: Rotor overspeed message from the external vibration watch.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Tip brake press.high	Tipbremse overtryk	Tipbremse Überdruck

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
402	0.5 s	200		1	130	M25	0 s

Source: Tip pressure is higher than *Tip(H) Max.

Reason: Tip pressure is too high.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Brake pads worn	Bremse slidt	Bremse verschlissen

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
415	1 s	0		1	0	M10	0 s

Source: Signal on digital input 145.

Reason: Warning that the brake is worn out and should be replaced. Status code 416 is set the forth time the brake is activated after the warning.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Replace brake pads	Bremse udskiftes	Bremse erneuern

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
416	100 h	200		1	130	M25	0 s

Source: Status code 415 was active four times during braking. Or status code 415 has been active for 360000 seconds.

Reason: The brake was activated four times since status code 415 was set the first time.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Brakin.time too long	Bremsetid for lang	Bremszeit zu lang

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
420	*10 s	210		1	130	M25	0 s

Source: The time interval from application of the mechanical brake until generator rpm < 400 is longer than *Max brake time.

Reason: Braking time too long.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Brake not released	Bremse ikke frigivet	Bremse nicht offen

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
421	*4 s	200	23 3/1h	1	130	A10	0 s

Source: No signal on digital input 113 after closing of the brake valves.

Reason: Brake is not released whithin *Release brake xx.xs when it should be.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Therm.relay brake(H)	Motorværn bremse(H)	Motorsch. Bremse(H)

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
422	1 s	50		1	130	M10	0 s

Source: No signal on digital input 130.

Reason: Thermo fuse for hydraulics is off.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Tip valve	Tipventil	Tipventil

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
426	5 s	200		1	50	M25	0 s

Source: Tip hydraulic pressure is higher than *Tip (H)(P) ON after opening of the tip valve.

Reason: Tip valve is opened but tip pressure is too high.

Remarks: Status code is not tested when the tip valve is open to reduce pressure.

English Text:	*Danish Text:*	*German Text:*
Tip(P) oper.time>max	Tip(P) drifttid>max	Tip(P)Betr.zeit>Max.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
437	0 s	200	23 3/1h	1	0	A10	0 s

Source: Tip hydraulic pump has been running for more than *Tip(H) /> s. but the tip hydraulic pressure measured in bars is still below *Tip (H)(P) ON.

Reason: Tip hydraulic pressure is too low.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Tip (P)starting rate	Tip (P) starthyp.	Tip (P) Starthäufig.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
438	0 s	0		1	0	M10	0 s

Source: Output 509 is on more often than *Max(H)(P) start /h, measured over *Max(H)(P)/.

Reason: Tip pump was started too often.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Tip (H) sensor def.	Tip (H) føler defekt	Tip (H) sensor def.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
442	5 s	200		1	0	A10	5 s

Source: The tip pressure is lower than -5 bar.

Reason: Tip hydraulic sensor defect.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Tip service switch	Tip servicekontakt	Tip Wartungschalter

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
444	1 s	200		1	0	M10	0 s

Source: No signal on digital input 137.

Reason: Tip service switch is ON. The tip pump is not started while this status code is set.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Tip (V) Test error	Tip (V) Test fejl	Tip (V) Test Fehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
475	0 s	200		1	50	M0	0 s

Source: Internal.

Reason: If the tip pressure is higher than * during test of tip valves, this status code is activated.

Remarks: Only tested during tip valve test.

English Text:	*Danish Text:*	*German Text:*
(G)heat error repeat	(G)gentagen tempfejl	(G)Überhitz.wiederh.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
500	0 s	50		1	130	M25	0 s

Source: Status codes for generator heat is set too often.

Reason: Generator constantly overheated.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Power comsumption	Effektforbrug	Leistungsbezug

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
501	10 s	50	23 4/24h	1	130	M25	0 s

Source: Digital output 501 is on but the turbine consumes more than *Max.Power kW.

Reason: Power consumption is high.

Remarks:

English Text:	*Danish Text:*	*German Text:*
G1 stator temp.	G1 statortemp.	G1 Statortemp.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
513	10 s	50	500 1/24h	1	130	A10	3600 s

Source: Temperature input 209 is higher than *Alarm ON.

Reason: Generator 1 is overheating.

Remarks:

English Text:	*Danish Text:*	*German Text:*
G2 stator temp.	G2 statortemp.	G2 Statortemp.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
515	10 s	50	500 1/24h	1	130	A10	3600 s

Source: Temperature input 203 is higher than *Alarm ON.

Reason: Generator 2 overheating.

Remarks:

English Text:	*Danish Text:*	*German Text:*
(G) bypass feedback	(G) bypass tilbagem.	(G) Bypass Rückmeld.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
525	0,5 s	50		1	130	A10	0 s

Source: No signal on digital input 112 while digital output 501 is on.

Reason: Missing bypass feedback signal.

Remarks:

English Text:	*Danish Text:*	*German Text:*
(G) power too high	(G) overproduktion	(G) Überproduktion

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
530	10 s	50		1	130	A25	*50 m

Source: The output power averaged over 10 min. is higher than *Max.Power kW.

Reason: The output power from the wind turbine is too high.

Remarks: The status code reset delay is counted down when the wind speed averaged over 10 m < *wind down xxx.x m/s. The reset delay parameter is the same used for statuscodes 250 and 251.

English Text:	*Danish Text:*	*German Text:*
G1 blocked	G1 spærret	G1 gesperrt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
551	0 s	0		0	0	A25	0 s

Source: Internal.

Reason: The warning is set when G1 is blocked.

Remarks: The status code is only used to inform the operator that operation will not switch to G1.

English Text:	*Danish Text:*	*German Text:*
DB G1>>G2	DB G1>>G2	DB G1>>G2

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
568	*60 s	50		1	0	A0	0 s

Source:

Reason: If wind speed < *DB G1>>G2 measured over * DB G1>>G2 time, status code is activated.

Remarks: Only tested if DB operation is enabled and time is between *DB start and DB end time.

English Text:	*Danish Text:*	*German Text:*
Main switch off	Hovedafbryder off	Hauptsch. ausgelöst

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
600	1 s	200		1	240	M25	0 s

Source: No signal on digital input 116.

Reason: Main switch is off.

Remarks: Is not activated when *Ice det. xxx = ON.

English Text:	*Danish Text:*	*German Text:*
Current asymmetry	Strømasymmetri	Stromasymmetrie

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
601	*0,8 s	50		1	130	M10	0 s

Source: Internal calculations.

Reason: May be caused by thyristor defect.

Remarks: When the current on one phase differs more than *xxA compared to the average values of the other two phases, testing starts. The status code is activated when the current in one phase differs more than 25% compared to the average values of the other two phases.

English Text:	*Danish Text:*	*German Text:*
Lightning prot. def.	Lynbeskyttelse def.	Blitzschutz defekt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
602	1 s	0		1	0	A10	1 s

Source: No signal on digital input 122.

Reason: Lightning protection diodes are defective.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Trafo cut off	Trafo afbrudt	Trafo unterbrochen

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
608	*5 s	50		1	0	A10	0 s

Source: No signal on digital input 101.

Reason: Power transformer is cut off. After auto reset, the turbine is forced to G2 operation.

Remarks: It is not tested when status code 551 or 47 is active or if terminal 116 and *ICE det. xxx are active.

English Text:	*Danish Text:*	*German Text:*
WP2060 error	WP2060 fejl	WP2060 Fehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
620	0,2 s	50	23 1/1h	1	130	A10	0 s

Source: No signal on digital input 114 during cutting in G1 or G2.

Reason: WP2060 connection module has reported error during operation. Is only tested when contactor G1 or G2 is in.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Cut in not allowed	Indkobl.ikke tilladt	Zuschalt.unzulässig

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
646	0 s	50		0	130	A10	0 s

Source: Data communication. Cut-in acceptance from the master is not received.

Reason: Park control is enabled and the generator rpm are higher than *P G2>G2 max or *P _G1 max rpm and cut in acceptance is not given by the master.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Cut in 0 >G2	Indkobling 0 >G2	Zuschaltung 0 >G2

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
650	0 s	50		1	130	M10	0 s

Source: No signal on digital input 115 after *0_>G2s during cut in of G2.

Reason: Connecting time is too long when the small generator is cut in.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Cut in 0_>G1	Indkobling 0_>G1	Zuschaltung 0_>G1

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
651	0 s	50		1	130	M10	0 s

Source: No signal on digital input 115 after *0_>G1 s during cut in of G1.

Reason: Connecting time is too long when the big generator is cut in.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Cut in G1>G2	Indkobling G1>G2	Zuschaltung G1>G2

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
652	0 s	50		1	130	M10	0 s

Source: No signal on digital input 115 after *G1>G2 s during cut in of the small generator.

Reason: Connecting time for the small generator is too long.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Main switch man. out	Hovedafbr. man. udk.	Hauptschalt. man.aus

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
654	2 s	200		1	240	M25	2 s

Source: Status code 600 is not active and no signal on digital input 104.

Reason: Main circuit braker has manually been set to off.

Remarks:

English Text:	*Danish Text:*	*German Text:*
G1>G2 overspeed	G1>G2 overhastighed	G1>G2 Überdrehzahl

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
660	0 s	50		0	0	A25	0 s

Source: Generator rpm > *G1>G2 (T) max rpm when tip brake is set to operating position.

Reason: Switching from G1 to G2 is performed and the generator rpm is too high when the tip brake is set in operating position.

Remarks: The status code is only checked when *G1>G2 (T) is ON. The status code is automatically reset when the generator rpm is < 100 and the rotor rpm < 5.

English Text:	*Danish Text:*	*German Text:*
G1>G2 brake time>max	G1>G2 bremsetid >Max	G1>G2 Bremszeit >Max

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
661	0 s	50		0	0	A25	0 s

Source: The time from activation of the tip brake during switching from G1 to G2 and generator rpm < *G1>G2 (T) is longer than *G1>G2 (T) max s.

Reason: The time interval from start of switching from G1 until the tip brake is set back to operating position is too long.

Remarks: The status code is only checked when *G1>G2 (T) is ON. The status code is automatically reset when the generator rpm is < 100 and rotor rpm < 5.

English Text:	*Danish Text:*	*German Text:*
Error by yawing	Krøjefejl	Fehler beim Azimut

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
700	0 s	50		1	240	M25	0 s

Source: The computer is yawing CW but the yaw sensor is counting in CCW direction.

Reason: Wrong yawing direction.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Rep. error by yawing	Gentagen krøjefejl	Wiederh.fehl. Azimut

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
701	0 s	50		1	240	M25	0 s

Source: The yaw system is constantly failing.

Reason: Repeated yaw error.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Cable autounwind	Kabel auto udsnoning	Kabel auto entdrillt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
715	0,1 s	50		0	70	A10	0 s

Source: Cable is wound more than three turns. If grid power is higher than *Rewind Power kW measured over *Rev. low-pow s, unwinding is started at four turns.

Reason: Automatic cable unwinding has started. This status code is set when the wind turbine is automatically unwinding the cables.

Remarks:

English Text:	*Danish Text:*	*German Text:*
(H)yaw(M)therm.relay	(H)krøjemotorværn	(H)Azimutmotorschütz

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
719	1 s	50		1	240	M10	0 s

Source: No signal on digital input 129.

Reason: Thermo fuse to yaw motors is off.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Cable twisted	Kabler snoet	Kabel verdrillt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
722	1 s	50		1	240	M25	0 s

Source: No signal on digital input 105.

Reason: The yaw system has turned the nacelle position too far, either CW or CCW.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Yaw sensor defect	Krøjesensor defekt	Azimutsensor defekt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
730	20 s	50	701 1/1h	1	240	A10	0 s

Source: No changing in signals on digital inputs 106 and 107 when digital outputs 506 or 507 are on.

Reason: Yaw system is yawing but the nacelle position is not changing.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Yaw rim cold	Krøjekrans kold	Drehkranz kalt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
753	10 s	50		1	240	A10	60 m

Source: Temperature inputs 206-208.

Reason: Temperature is below *Alarm on low.

Remarks: Autoreset when temperature is below *Alarm off low.

English Text:	*Danish Text:*	*German Text:*
Yaw rim hot	Krøjekrans varm	Drehkranz heiss

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
754	10 s	50		1	240	A10	60 m

Source: Temperature inputs 206-208.

Reason: Yaw rim temperature is > *Alarm on high.

Remarks: Autoreset when temperature is below Alarm off high.

English Text:	*Danish Text:*	*German Text:*
Capacitor feedback	Fasebatt.tilbagemeld	Kondensator Rückmeld

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
800	1 s	50	23 1/1h	1	130	A10	0 s

Source: No signal on digital input 127 when capacitors are cut in.

Reason: One or more capacitors are connected but there is no feedback.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Therm.(G) cool. pump	Term. (G) kølepumpe	Therm.(G) Kühlpumpe

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
904	1 s	50		1	130	M10	0 s

Source: No signal on digital input 133.

Reason: Thermo fuse to generator cooling pump is off.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Therm. gear oil pump	Term. gearoliepumpe	Therm. Getr. Ölpumpe

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
906	1 s	50		1	130	M10	0 s

Source: No signal on digital input 134.

Reason: Thermo fuse to gear oil pump is off.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Park com.error	Park kom.fejl	Park Kom.fehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1000	0 s	0		1	0	M25	0 s

Source: Internal.

Reason: Park communication error. One or more wind turbines in the park do not answer.

Remarks:

English Text:	*Danish Text:*	*German Text:*
(H) pressure error	(H) tryk fejl	(H) Druckfehler

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1200	2 s	50	23 1/1h	1	130	R10	0 s

Source: No signal on digital input 120.

Reason: Error in the hydraulic system.

Remarks:

English Text:	*Danish Text:*	*German Text:*
(H) oper.time > max.	(H) drifttid > max.	(H)Betriebzeit> Max.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1213	*15 s	50	23 1/1h	1	130	A10	0 s

Source: Digital output 504 has been activated for more than *(H)(P) error s..

Reason: Hydraulic pump has been running for too long.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Gear oil filt.choked	Gearolieflt. stoppet	Getr.ölfilt.verstop.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1300	*15 m	0		1	0	A10	0 s

Source: No signal on digital input 119.

Reason: Gear oil filter is choked.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Gear oil temp.	Gearolie temp.	Getriebeöltemp.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1307	60 s	50		1	130	M99	0 s

Source: Temperature input 215 is higher than *Alarm ON 1 min. Or temperature input 215 is higher than *Alarm ON 30 min.

Reason: Gear oil temperature is too high.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Coupling (G) gearbox	Kobling (G)gearkass.	Kupplung (G)Getriebe

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1311	*4 s	200		1	240	M99	0 s

Source: Generator rpm and rotor rpm.

Reason: Generator rpm / rotor rpm <> *Gearratio +/- 2.

Remarks: Not tested when the mechanical brake is activated.

English Text:	*Danish Text:*	*German Text:*
Gear bearing temp.	Gearlejetemp.	Getriebelagertemp.

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1317	60 s	50		1	130	M99	0 s

Source: Temperature input 212 is higher than *Alarm ON.

Reason: Gear bearing is overheated.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Blade vibr.warning	Vingevibr. advarsel	Flügelvibr. Warnung

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1504	0 s	0		1	0	M10	1 h

Source: External vibrations.

Reason: The status code is activated when status code 91 is active.

Remarks:

English Text:	*Danish Text:*	*German Text:*
WP3033 watchdog	WP3033 watchdog	WP3033 Watchdog

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1533	0 s	0		0	0	M80	0 s

Source: Internal calculations.

Reason: The WP3033 controller has reset.

Remarks:

English Text:	*Danish Text:*	*German Text:*
Invalid parameter	Ugyldig parameter	Ungültiger parameter

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1554	0 s	0		1	0	A10	0 s

Source: Internal calculations.

Reason: If (*(Max generator rpm*0.952381) /* (Max rotor rpm * 0.90909) <>(* Gear ratio +/-3) this status code is activated.

Remarks: Gear ratio = Generator rpm / Rotor rpm.
Max Generator rpm = G1 sync.rpm + 5%.
Max Rotor rpm = Rotor G1 sync rpm + 10%.

English Text:	*Danish Text:*	*German Text:*
Stop too long	Stop for længe	Zu lange gestoppt

Status	*Set Delay*	*Brake Program*	*Repeated Status Code*	*Alarm Program*	*Yaw Program*	*Reset Program*	*Reset Delay*
1578	*600 m	0		1	0	M25	0 s

Source: Mechanical brake or tip brake is activated and wind speed > start wind speed.

Reason: The wind turbine has been stopped for too long.

Remarks: No testing, if the turbine is in Service Mode or status codes 13 or 9 is activated.

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The OD 04-1 is an anemoscope used for yaw regulation in connection with Mita-Teknik´s electronics for wind turbines.

- Opto-electronic sensor pick-up action.
- Registers deviations >7° from starting point.
- Magnetically centered.
- Marking point for correct mounting.
- Wind vane with conically shaped wind scoop in varnished stainless steel.
- The casing in PVC.
- Equipped with 12.5 m PVC cable.
- Fastening: External thread M 28 x 2.
- Part.no. 7690215.

ANEMOSCOPE OD04-1

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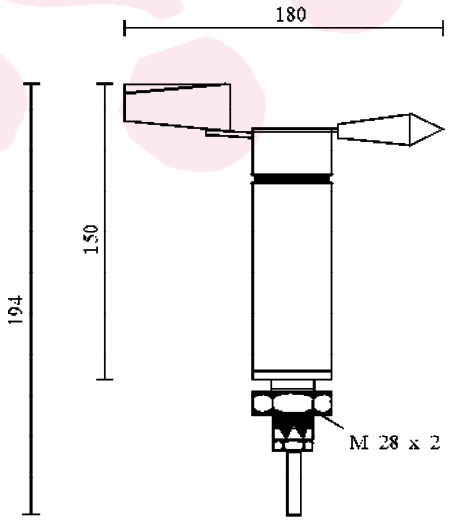

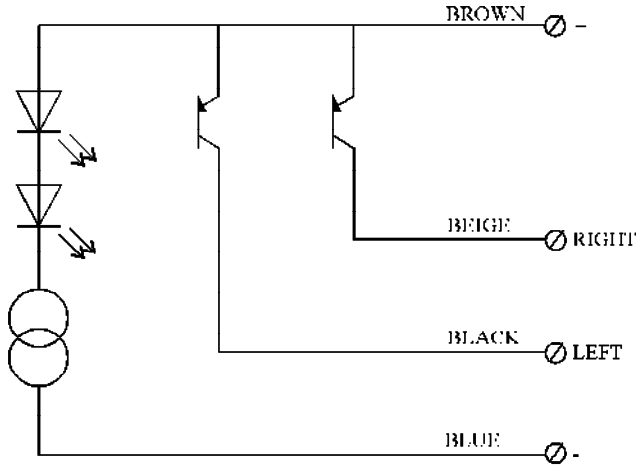

TECHNICAL DATA			
Regulation range	+/-7		°
Hysteresis	3.5		°
Limitation on revolutions	+/-20		°
	MIN.	**MAX.**	
Signal outputs		40	mA
Open collectors PNP		30	VDC
Supply voltage	12	24	VDC
Consumption	20		mA
Temperature, continuous operation	-20	+50	°C
Weight		350	g

ANEMOSCOPE OD04-1

Mita-Teknik a/s

DK-8840 Rødkærsbro
Ph.:+45 86 65 86 00
Fax:+45 86 65 92 90

The OD 05-1H is a relative anemoscope used for yaw regulation in connection with Mita-Teknik's electronics for wind turbines.

- Opto-electronic sensor pick-up action.
- Registers deviations > 7 ° from starting point.
- Magnetically centered.
- Marking point for correct mounting.
- Wind vane with conically shaped wind scoop in varnished stainless steel.
- The casing in PVC.
- Equipped with 12.5 m PVC cable.
- Fastening: External thread M 28 x 2.
- Thermostat controlled heating unit prevents stop caused by icing up.
- Part no. 7690217.

ANEMOSCOPE OD05-1H

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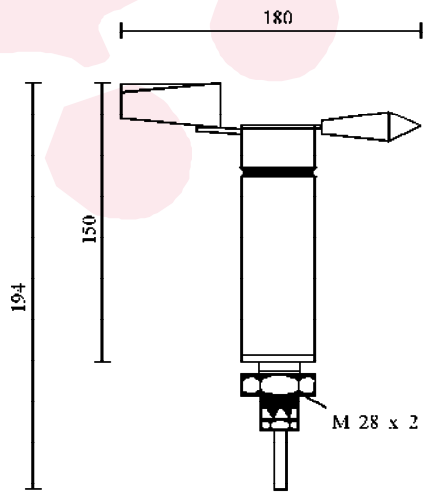
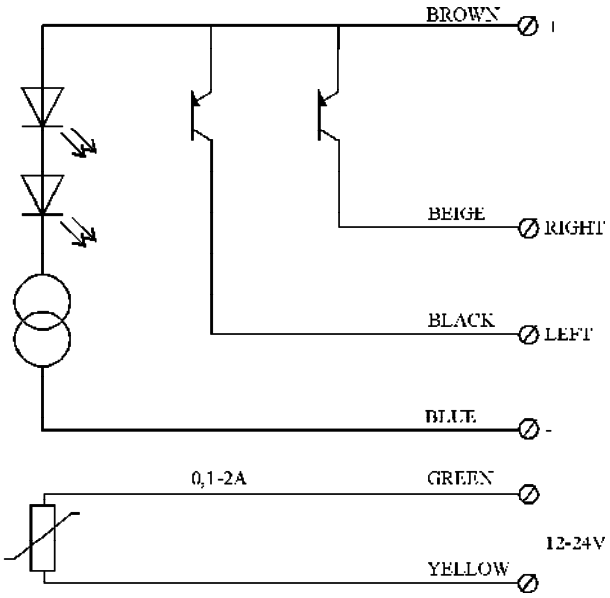
Fax:+45 86 65 92 90





TECHNICAL DATA		MIN.	MAX.	
Heating unit	Supply	12	24	V
	Consumption varies	01	2	A
	Consumption -20 °C	10		W
	+20 °C	5		W
Regulation range		+/-7		°
Hysteresis		3.5		°
Limitation on revolutions		+/-20		°
Signal outputs			40	mA
Open collectors	PNP		30	V DC
Supply voltage		12	24	V DC
Consumption		20		mA
Temperature,	continuous operation	-20	+50	°C
Weight			350	g

ANEMOSCOPE OD05-1H

PT100 Sensor

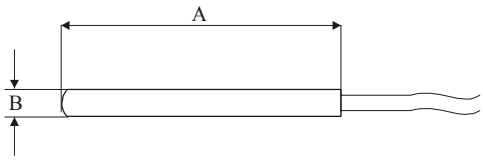
- The PT100 Sensors are used for flexible temperature surveillance
- Easy mounting
- Direct connection to IC/WP-Controllers
- Correction of distance via a 3-core or 4-core system

Description

PT100 is delivered in various mechanical designs for easy mounting at generators, bearings, gear box, or other places in connection with wind turbines.

The sensor compensates for the cable length between the WP or IC control unit and the PT100 sensor so that an accurate temperature measurement is achieved.

Dimensions



Part no.	A	B	Cable length	Cable type
	mm	Ø mm	m	
7631020	100	8	3	GLGLP
7631025	100	8	5	GLGLP
7631028	100	8	10	SHIELDED
7631030	60	6	3	SILICONE
7631032	60	6	5	SILICONE
7631034	60	6	10	SILICONE
7631035	60	6	3	GLGLP
7631037	60	6	5	GLGLP

Technical data

Permissible ambient conditions	
Operation temperature	-40 to 180°C
Transportation/Storage temp.	-50 to 180°C
Max. operation height	2000 m. above sea level
Construction	
Dimensions (WxHxD)	Dependent on the type (see 'Dimensions' of this data sheet)
Weight	Dependent of the type
Standard	IEC 60751

Ordering data

PT100 Sensors (different types) (see 'Dimensions' of this data sheet)	P/N.: 7631020.....37

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The PV 01-2 is an anemometer, used in connection with Mita-Teknik wind turbine electronics for starting and stopping the wind turbine.

- Opto-electronic sensor pickup action.
- Registers wind speed from 2 to 30 m/s.
- The rotor is made of varnished stainless steel.
- The casing in PVC.
- Equipped with 2 m PVC cable.
- Fastening: External thread M 28 x 2.
- Part.no. 7690220

ANEMOMETER PV01-2

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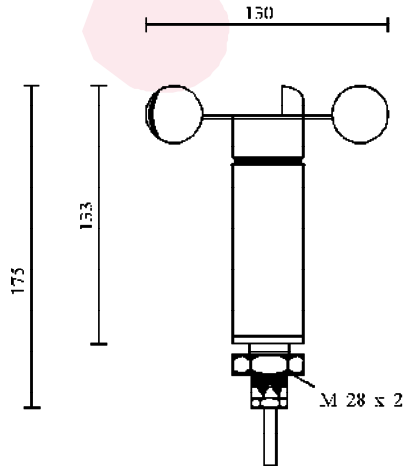
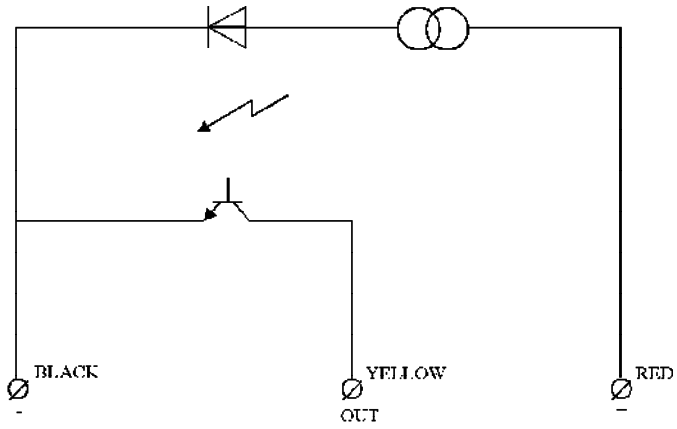




TECHNICAL DATA	MIN.	MAX.	
Measuring range	2	30	m/s
Resolution		10	imp./rpm
Signal output		30	mA
Open collector NPN		30	V DC
Mains voltage	12	24	V DC
Load	20		mA
Temperature	-20	+50	°C
Weight		320	g

ANEMOMETER PV01-2

SIEK-UV1 Pull Switch/Wire

- Pull switch for detection of twisted cables
- Complete set delivered with wire and stop ball
- Part of the safety chain

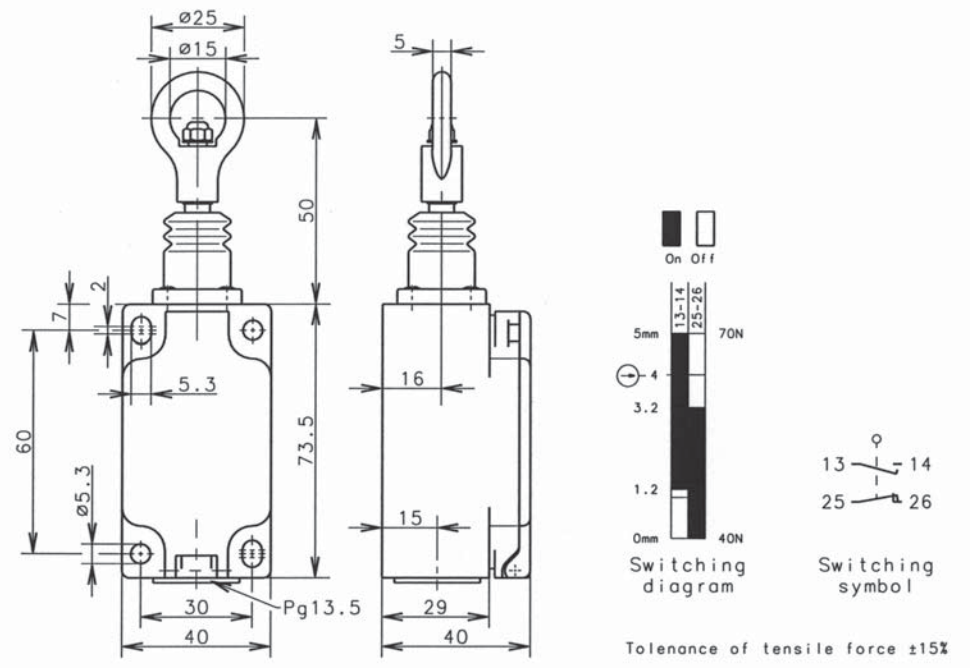
Description

The SIEK_UV1 Pull Switch is used for limiting the number of times the cables are twisted in a wind turbine. Usually the pull switch is mounted as an extra detection.

Normally the software counts the number of CW/CCW via an inductive sensor, if the number is higher than x the cable will be untwisted.
If this measurement fails the pull switch is activated and it signals that the wind turbine must be stopped.
The auxiliary switches are of a positive opening type, thus suitable for safety functions.

The pull switch is often a part of the wind turbine safety chain.
Materials and components are wear resistant and protect the equipment against water and dust.

Dimensions & Mounting



Dimensions all in mm.

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SIEK-UV1 Pull Switch/Wire

Technical data

Digital Output	
No. of points	1 NC and 1 NO
Isolation	Micro switch
Rated current per point	10A
Rated voltage per point	300 VAC
Permissible Ambient Conditions	
Operation temperature	-20 to 60°C
Transportation/Storage temp.	-20 to 85 °C

Construction	
Dimensions (WxHxD)	370 x 310 x 100 mm
Weight	0.350 Kg
Diameter of ball	45 mm
Length of wire	2500 mm
Release pull	80 N
Release point	3.5 mm
Degree of Protection	IP65

Ordering data

SIEK-UV1 Pull Switch with wire	P/N.: 7602520

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AEG

4.1 s

Instrucciones de Servicio

Motores trifásicos con rotor de jaula

Motores trifásicos protegidos contra explosiones

Motores monofásicos

Motores freno trifásicos

10/2001

Aclaraciones sobre las advertencias de seguridad y advertencias adicionales para motores EEx e y EEx n, motores freno, motores monofásicos y generadores

Lea estas Instrucciones de Servicio antes de transportar, montar, poner en marcha, llevar a cabo el mantenimiento o reparar motores industriales y generadores.

Estos símbolos deben llamar su atención sobre las advertencias de seguridad y las advertencias adicionales contenidas en estas Instrucciones de Servicio:

Advertencias de seguridad y garantía:

Advertencias adicionales para motores EEx e y EEx n:

Advertencias de peligro:

Por razones de protección de personas y objetos, todas las advertencias de seguridad y advertencias adicionales para motores EEx e y EEx n indicadas en estas Instrucciones de Servicio deben cumplirse rigurosamente.

Las máquinas de baja tensión tienen piezas rotativas y conductoras peligrosas, así como posiblemente superficies calientes. Todos los trabajos de transporte, montaje, conexión, puesta en marcha, mantenimiento y reparación debe efectuarlos personal técnico cualificado y responsable (observe VDE 0105; IEC 364). La utilización inadecuada puede causar graves daños a personas y objetos.

En caso de requerir más información, debe acudir inmediatamente al fabricante o a un taller autorizado.

Todos los trabajos en las conexiones eléctricas de los motores y generadores sólo pueden ser efectuados por personal cualificado.

Indicaciones generales

Campo de aplicación
Estas Instrucciones de Servicio rigen para motores y generadores asíncronos trifásicos y de corriente alterna de baja tensión con rotor de jaula y ventilación superficial, protección IP 54 e IP 55 según EN 60034 Mayores protecciones están indicadas en la placa de características.

Las máquinas de baja tensión están destinadas a instalaciones industriales. Cumplen con las normas armonizadas DIN VDE 0530/EN 60034. Para su utilización deben observarse eventuales prescripciones especiales. Los motores refrigerados por aire están diseñados para su funcionamiento en altitudes de ≤ 1000 m sobre el nivel del mar a una temperatura ambiente entre -20° C y +40° C. Las excepciones están indicadas en la placa de características.

Observe siempre las desviaciones señaladas en la placa de características. Las condiciones en el lugar de uso deben coincidir con todas las indicaciones de la placa de características.

Las máquinas de baja tensión son componentes de una máquina en el sentido de la directriz 89/393/CEE sobre máquinas. La puesta en marcha está prohibida hasta que se haya comprobado la conformidad del producto final con esta directriz (observe EN 60204-1).

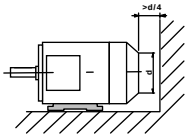
Para los motores en el modo de protección Seguridad aumentada «e» y «n» rigen además las indicaciones de las páginas 22/23.

Transporte
Si se observaran daños una vez entregadas los motores en su destino, éstos deben notificarse inmediatamente a la compañía de transportes; en caso de duda, no deben ponerse en marcha.

Cáncamos de transporte
Utilice siempre el cáncamo de transporte para levantar el motor. No añada ninguna carga adicional al motor; los cáncamos de transporte están diseñados para aguantar únicamente el peso del motor. En caso necesario, utilice medios adecuados.

Seguro de transporte
Los motores con cojinetes de rodillos cilíndricos llevan un seguro de transporte con el fin de evitar daños en sus cojinetes, el cual debe eliminarse antes de poner los motores en marcha. Cierre el orificio de fijación por medio del tapón que se suministra con el motor. El seguro de transporte debe utilizarse también en posteriores transportes del motor.

Ventilación
La distancia entre la entrada de aire del motor y paredes, componentes, etc. debe ser como mínimo 1/4 del diámetro de apertura de entrada de aire. La dirección de la corriente de aire va del lado contrario al accionamiento hacia el lado de accionamiento.
El aire de salida no debe aspirarse nuevamente por el ventilador. Mantenga las aperturas de entrada y salida de aire limpias.



Las formas constructivas con la salida de eje hacia arriba deben estar provistas en el lado de montaje con una cubierta adecuada para evitar que cuerpos extraños puedan caer en el orificio de ventilación. Esta protección no debe afectar la ventilación y no debe aspirarse nuevamente ni el aire de salida, ni el de los grupos adyacentes.

Purgadores para el agua de condensación
Los purgadores para el agua de condensación deben encontrarse también después del montaje en el lugar más bajo del motor. Deben protegerse de la suciedad. Abra los agujeros sólo para la salida del agua y ciérrelos posteriormente.

Sólo deben utilizarse tornillos M6 x 10mm.

Supresión de interferencias
Los motores cumplen los requerimientos del grado de interferencias N según VDE 0875.

Montaje y puesta en marcha

Parte mecánica

Elementos de transmisión

Utilice únicamente acoplamientos elásticos; los acoplamientos rígidos requieren una ejecución especial de los cojinetes.

Sólo deben utilizarse correas que no se carguen electrostáticamente.

Al emplear elementos de transmisión que originen cargas radiales o axiales durante el funcionamiento (p.e. poleas, ruedas dentadas, etc.) debe tenerse cuidado de no sobrepasar las cargas admisibles. Los correspondientes datos están indicados en el catálogo técnico vigente.

Actualmente se equilibran los rotores dinámicamente con media chaveta (según DIN ISO 8821).
«H» o «neutro» significa equilibrado con media chaveta
«F» significa equilibrado con chaveta completa
«N» significa sin chaveta.

El estado de equilibrado del motor está indicado en la parte frontal del eje o en la placa de características. Con ejecución con media chaveta (H), el acoplamiento debe equilibrarse asimismo con media chaveta. Mecanizar la parte sobresaliente de la chaveta.

Quite la protección anticorrosiva con un disolvente adecuado y engrase la salida de eje. Calar y decalar las poleas y acoplamientos únicamente con dispositivos adecuados, véase fig. 1-3, (¡calentar a 80-100° C!) y cubrir con una protección antiadherente. Evite tensiones inadmisibles de las correas (catálogo técnico).

No efectúe de ningún modo el montaje a presión o golpes ya que dañaría los cojinetes.

Quitar directriz

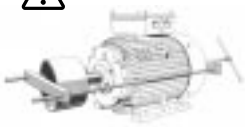


Fig. 1
Calado sin punto de centrado

Fig. 2
Calado con punto de centrado

Fig. 3
Decalado

Base
Observe el apoyo uniforme y la buena fijación de las patas o bridas, así como la alineación exacta con acoplamiento directo.

Todas las patas de fijación deben estar apoyadas en una superficie plana para evitar deformaciones de la carcasa del motor.

Evite resonancias de la base con la frecuencia de giro y doble frecuencia de la red. Gire el rotor a mano a fin de detectar posibles ruidos anormales de rozamiento. Verifique el sentido de giro con la máquina no acoplada (pág. 4 - *Vibraciones en servicio*).

Alineación
Si los motores están conectados a la máquina a accionar por medio de un acoplamiento, ambos ejes deben alinearse axial y radialmente. Los relojes comparadores deben fijarse de forma segura. Las mediciones deben efectuarse en cuatro puntos, cada uno desplazado en 90°, y girando ambos platos de acoplamiento simultáneamente.

Medición en sentido axial (fig. 4)
Iguale las diferencias colocando chapas debajo de las patas del motor. No deben sobrepasarse imprecisiones permanentes de 0,03 mm respecto a un diámetro de 200 mm.

Medición en sentido radial (fig. 5)
Iguale las diferencias desplazando o colocando chapas de forma que no se sobrepasen imprecisiones de 0,03 mm. El ajuste de la holgura axial entre los platos de acoplamiento (medida «E») debe efectuarse según las indicaciones del fabricante de los acoplamientos.

Compruebe la exactitud de alineación con la máquina en caliente.

Medición combinada en sentido axial y radial (fig. 6)
La figura 6 muestra un método relativamente sencillo para combinar ambas mediciones. Los relojes comparadores se insertan en los correspondientes taladros de las pletinas atornilladas o agarradas a los platos de acoplamiento, fijándolos p.e. con tornillos prisioneros.

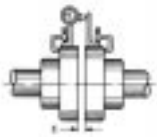


Fig. 4
Medición en sentido axial (desviación angular)

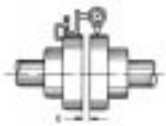


Fig. 5
Medición en sentido radial (desviación entre centros)

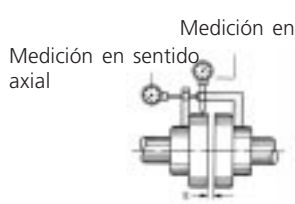


Fig. 6

Vibraciones en servicio
El nivel de vibraciones $V_{eff} \leq 3{,}5$ mm/s ($P_N \leq 15$ kW) ó 4,5 mm/s ($P_N > 15$ kW) de la máquina acoplada no acarrea inconvenientes. Cuando haya diferencias en comparación con el funcionamiento normal, p.e. temperaturas más altas, ruidos, vibraciones, averigüe la causa y consulte en caso necesario al fabricante.

No desconecte los dispositivos de seguridad, tampoco en servicio de prueba. Desconecte la máquina en caso de duda.

Eléctrico

Resistencia del aislamiento
Véase página 8.

Tensión y conexión
La fluctuación admisible entre la tensión nominal y la tensión de la red es de ± 5 %; para la frecuencia nominal se admite ± 2%. Observe las indicaciones de conexión y desviaciones señaladas en la placa de características, así como el diagrama de conexiones en la caja de bornes.

Conexión
Elija cables de conexión de una sección conforme a la intensidad nominal. Las entradas de cable no utilizadas deben cerrarse mediante tapones.

En motores EEx e sólo deben utilizarse entradas de cable y prensaestopas homologados. Los tapones ciegos existentes en las entradas de cable deben eliminarse y sustituirse por insertos de estanqueidad adecuados.

La apertura de entrada de cables es orientable en 90° ó 180°.

Todos los trabajos deberán efectuarse única y exclusivamente por personal cualificado, siempre con la máquina parada, desconectada y previamente asegurada contra una posible puesta en marcha de ésta. Esto rige también para circuitos auxiliares (p.e. resistencias de caldeo). ¡Compruebe que no tenga tensión!

La conexión de los cables de suministro eléctrico debe efectuarse de forma que asegure un contacto permanente y fiable (sin extremos de cables sueltos); utilice el terminal adecuado para los cables de conexión. Los cables de conexión deben fijarse sin tracción mecánica para evitar esfuerzos de tracción de los bornes de conexión.

¡Asegure una buena conexión del conductor de tierra!

Las distancias mínimas de seguridad entre conductores y entre estos y masa no deben sobrepasar los siguientes valores: ≤ 550 V 8 mm; ≤ 750 V 10 mm; ≤ 1100 V 14 mm.

No debe haber cuerpos extraños, suciedad ni humedad en la caja de conexiones. Cierre los orificios de entrada de los cables no utilizados y la caja misma, aislándola del polvo y del agua. Para garantizar el grado de protección deben volver a utilizarse las juntas originales para cerrar la caja de bornes.

Placa de bornes EEx e

Tamaño de motor		80-112	132	160 – 180	200-225	250 – 280
Placa de bornes	Tipo	K85580Ex	K85590Ex	90.60.8	110.70.8	250-280
Tensión asignada máx.	V	750	750	750	750	750
Intensidad asignada máx.	A	10	16	95	146	200
Sección asignada máx.	mm² unifilar	2,5	4	16	35	50
Sección asignada máx.	mm² hilo fino	4	6	25	50	70
Par de apriete ±10%	Nm	1,2	2	6	10	10
Gama de temperatura de aplicación °C		-60°C a 130°C				

Las placas de bornes deben fijarse mediante dos tornillos de fijación con arandelas de seguridad. Se montan en la carcasa o caja de conexiones con protección mínima IP 54. Las cabezas de los tornillos no deben sobrepasar la altura máxima según DIN 912.
La conexión de esta placa de bornes sólo debe efectuarla personal técnico cualificado. Los bornes de abrazadera deben apretarse fuertemente , observándo y cumpliendo los pares de apriete según DIN 46200.
Las dimensiones cumplen con la directriz europea 94/9/CE para aparatos protegidos contra explosiones, así como las normas EN 50014 y EN 50019.
En la parte posterior se hallan grabados la indentificación ATEX y el n° del certificado.

Conecte conductor de tierra aquí.

Para efectuar una prueba sin elementos de accionamiento, asegure la chaveta. En motores con freno, compruebe el buen funcionamiento del freno antes de la puesta en marcha.

Sentido de giro

Normalmente los motores son adecuados para el funcionamiento en ambos sentidos de giro. Las excepciones están indicadas en la placa de características con la correspondiente flecha. Para el sentido de giro requerido, conecte el estator según sigue:

Conexión de L1, L2, L3 a	Sentido de giro visto desde lado accionamiento
U1, V1, W1	hacia la derecha
W1, V1, U1	hacia la izquierda

Comprobación del sentido de giro, véase al lado.

Inversión del sentido de giro:

Modo de arranque y tipo de devanado	*Medida*
Arranque directo y motores de polos conmutables con devanados separados	Intercambiar dos conductores de la red en la regleta de bornes del motor
Arranque Y/Δ y motores conmutables con devanado Dahlander	Intercambiar dos conductores de la red en la alimentación de la combinación del contactor

Comprobación

Para comprobar el sentido de giro, «conecte/desconecte» brevemente el motor correctamente conectado sin estar acoplado.

Arranque en Y/Δ

Para evitar corrientes y momentos transitorios inadmisibles, espere para conmutar a Δ hasta que la intensidad de arranque de la etapa Y se haya atenuado o hasta que la aceleración haya terminado (p.e. conmutación al alcanzar la velocidad nominal).

Protección del motor

Conecte las sondas térmicas semiconductoras al disparador según el esquema de conexiones. El control eventualmente necesario del estado de las sondas térmicas debe hacerse únicamente con ayuda de un puente de medida (máx. 2,5 V).

Para obtener plena protección térmica de los motores, debe instalarse además una protección de sobrecarga térmicamente retardada (fig. 7). Los fusibles frecuentemente sólo protegen la red, pero no el motor.

Para los motores EEx e y EEx n rigen las indicaciones de las páginas 6/7 sobre protección del motor.

Ejemplo
Contactor con relé de máxima intensidad
Protección con termistor y fusible

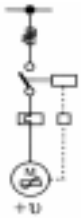


Fig. 7

Mantenimiento

Antes de efectuar cualquier trabajo en el motor o generador, desconéctelo y asegúrese de que no se ponga en marcha nuevamente.

Excepción: El reengrase de los cojinetes en motores con dispositivo de reengrase debe hacerse con el motor en marcha.

¡Atención, peligro de accidentes! ¡Vigile las partes rotatorias!

Limpieza
Los motores deben limpiarse periódicamente en la totalidad del recorrido del aire de refrigeración según el grado de suciedad.

Lubricación de los cojinetes

¡El cumplimiento de los intervalos de reengrase es vital para la seguridad de funcionamiento de los motores!

Mantenimiento de los cojinetes

Rodamientos con engrase permanente
Bajo condiciones normales los motores de 2 polos no necesitan mantenimiento durante 10.000 horas y los motores de mayor número de polos durante 20.000 horas de servicio y como máximo durante 4 años. Limpiar después los cojinetes y sus tapas con bencina o benzol. Si fuera necesario sustituya los cojinetes. Rellenar con grasa la mitad de los huecos entre las pistas y los cuerpos de rodadura así como las cámaras de grasa. Aplicar una capa fina de grasa en los pasos del eje por las tapas y escudos. Los cojinetes cerrados con engrase permanente (cojinetes 2RS y 2Z) no pueden ser lavados ni reengrasados. Han de ser sustituidos.

Utilizar para el desmontaje de los cojinetes tornillos de extracción u otros dispositivos adecuados.

Rodamientos con dispositivo de reengrase y regulador de grasa
La frecuencia de engrase y la cantidad de grasa están indicadas en la placa de características. Después de una docena de reengrases los cojinetes y sus tapas deben limpiarse con bencina o benzol.

La bencina o el benzol utilizado debe envasarse en un recipiente estanco, marcarse con la identificación «Bencina» o «Benzol» y llevarse a un depósito para residuos especiales.

Luego, con la tapa exterior abierta pero la tapa interior atornillada se inyecta grasa a través del engrasador, girando lentamente el rotor hasta que aproximadamente la mitad del hueco entre las pistas y los cuerpos de rodadura quede lleno de grasa.

Si se empleara grasa con otra base jabonosa, asegúrese de limpiar previamente los cojinetes a fondo. Todos los tipos de grasa deben cumplir los siguientes requisitos:

Punto de goteo	*aprox. 190° C*
Contenido en cenizas	*4 %*
Contenido en agua	*0,3 %*

Lubricante
Grasa K 3N según DIN 51825 (a base de litio, resistencia al agua según DIN 51807 parte 1, grado 0 ó 1). Reengrasar solamente con un tipo de grasa similar (p.e. Esso Unirex N 3, Shell-Alvania G 3, Esso-Beacon 3, Klüber HQ 72-102, etc.).

Advertencias adicionales para motores EEx e II y EEx nA II

Generalidades

El empleo de estos motores está sujeto al Reglamento Electrotécnico para Baja Tensión, Instrucción Complementaria MI BT 026 sobre instalaciones eléctricas en áreas con peligro de explosiones.
Al instalar los motores deben cumplirse las condiciones de la MI BT 041.
El grado de peligro de explosiones será determinado únicamente por las autoridades competentes.

Clase de servicio
A no ser que conste otra cosa en el certificado aplicable estos motores sólo deben emplearse para servicio permanente (S1).

Protección del motor

En motores con arranque directo, la conexión de los dispositivos protectores debe asegurar que una vez se disparen, todas las fases de alimentación queden desconectadas.

Dispositivo de protección contra sobreintensidad
Los disparadores o relés retardados en función de la corriente, deben ser ajustados para la corriente nominal del motor. Además deben ser elegidos de forma que los motores queden protegidos térmicamente incluso en caso de cortocircuito (es decir, con el rotor frenado). Esto significa que el tiempo de desconexión no es mayor que el tiempo de calentamiento t_E para la clase de temperatura correspondiente, tomando como tiempo de desconexión el que resulta de la curva característica para la relación I_A/I_N (con 20° C como temperatura inicial).

Los devanados con arranque en estrella deben pro-tegerse de forma que los disparadores o relés estén conectados en serie con las fases del devanado. La selección y el ajuste de los disparadores debe basarse sobre el valor nominal de la corriente de la fase, es decir, 0,58 veces la corriente nominal del motor. Si tal conexión no fuese posible, deben utili-zarse protectores adecuados, p.e. con control de fallo de la fase.

Sensor de temperatura (PTC)
Los sensores para el control de la temperatura de p.e. el devanado del estator, cojinetes, refrigerante, deben conectarse a través de bornes especiales previstos para tal fin en la caja de conexiones principal o a través de varias cajas de conexiones auxiliares.Los sensores de temperatura deben conectarse según el esquema de conexiones vigente. Para la conexión observe las indicaciones en la página 20/21 „Conexión".

Para motores EEx e y EEx n sólo deben utilizarse disparadores homologados por una entidad de ensayo oficial.

Resistencias de caldeo
Potencia de caldeo y tensión de conexión: Véase placa característica del motor. Las resistencias de caldeo deben conectarse a través de bornes especiales en la caja de conexiones principal o a través de una caja de conexiones auxiliar, según el esquema de conexiones vigente. Para la conexión observe las indicaciones en la página 20/21 „Conexión". No conecte las resistencias de caldeo antes de desconectar el motor. Durante el funcionamiento del motor, las resistencias de caldeo deben estar desconectadas.

Arranque en condiciones extremas
Los motores para arranque en condiciones extremas (tiempo de aceleración > 1,7 · tiempo t_E) deben protegerse con un control de aceleración según las indicaciones del certificado de conformidad.

Instrucciones de reparación

Los trabajos de reparación dentro del periodo de garantía requieren la aprobación previa del fabricante.

Generalidades
Recomendamos emplear en las reparaciones únicamente repuestos originales.

Para motores EEx e y EEx n:
Utilice únicamente piezas de repuesto originales.

Trabajos de reparación generales
Pertenecen a éstos todos los trabajos que no afectan a la protección contra explosiones y puedan realizarse sin tener en cuenta las prescripciones sobre instalaciones en áreas con peligro de explosiones:
p.e. renovación de juntas,
reparación o sustitución de ventiladores o directrices,
sustitución de cojinetes,
cambio de la placa de bornes.

Trabajos de reparación especiales
Estos son trabajos que influyen sustancialmente en la protección contra explosiones, p.e. especialmente todas las reparaciones en devanados del rotor o estator. Si estos trabajos no fuesen llevados a cabo por nosotros, los procedimientos adecuados deben verificarse por un experto autorizado.

Toda reparación de este tipo debe indicarse según DIN EN 50019 en una placa de características adicional.

Indicaciones para el almacenamiento

Para los motores almacenados durante un tiempo prolongado antes de su utilización (p.e. motores de reserva) debe observarse lo siguiente:

Lugar de almacenamiento
Asegúrese de que los motores se guarden en un lugar seco, sin polvo y con un mínimo de vibraciones (Veff ≤ 0,2 mm/s) (daños en cojinetes parados). Temperatura ambiente +10° C a +40° C, humedad relativa del aire <50 %.

Seguro de transporte
En los motores con cojinetes de rodillos cilíndricos, asegure el rotor por medio del seguro de transporte para proteger los motores contra la formación de marcas debido a vibraciones. Los motores que se suministran sobre amortiguadores de vibraciones deben almacenarse con éstos puestos.

Si hay poleas, acoplamientos, etc. montados sobre las salidas del eje, monte en lo posible el seguro de transporte y coloque los motores sobre amortiguadores de vibraciones.

⚠ *Utilice siempre el seguro de transporte o los amortiguadores de vibraciones para posterio-res transportes.*

Compruebe antes de la puesta en marcha:

Cojinetes
Antes de la puesta en marcha de un motor almacenado durante tiempo prolongado (más de 4 años), deben comprobarse los cojinetes.

En motores sin dispositivo de reengrase, la grasa debe renovarse o los cojinetes sustituirse lo más tarde después de 2 años de almacenamiento.

⚠ *El más mínimo signo de corrosión reduce considerablemente la vida de los cojinetes. Si los cojinetes no requieren ser sustituidos, engráselos de nuevo.*

⚠ *Para el tipo/cantidad de grasa, véase la placa de características (en el motor) y el capítulo «Lubricación de los cojinetes, Lubricante» en la pág. 6 de estas Instrucciones de Servicio.*

Los motores con dispositivo de reengrase deben reengrasarse lo más tarde después de 2 años con la doble cantidad de grasa que la indicada en la placa de características. Durante este proceso el rotor debe girarse. Si los motores son almacenados durante más de 4 años, la grasa debe ser sustituida.

El rotor debe ser girado mensualmente en aprox. 30 grados para evitar huellas de presión en los cojinetes debidas a la carga estática.

⚠ *Para girar el rotor, afloje, pero no quite el seguro de transporte. Vuelva a apretar éste una vez concluido el proceso de rotación.*

Resistencia del aislamiento

⚠ *Antes de la puesta en marcha mida la resistencia de aislamiento. Con valores ≤ 1kW por voltio de tensión nominal, seque el devanado.*

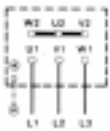
Mida con un inductor de manivela (tensión continua máx. = 630 V) la resistencia del aislamiento de cada fase con relación a tierra, hasta que el valor de medición se mantenga constante. La resistencia del aislamiento en devanados nuevos es > 10 MΩ. Los devanados húmedos muestran valores de resistencia considerablemente inferiores.

Si a temperatura ambiente se midiera menos de 0,5 MΩ, seque el devanado, no debiendo éste sobrepasar una temperatura de 80° C. Secar mediante resistencia de caldeo o calefactor, o aplicar una tensión alterna del 5-6 % de la tensión nominal del motor (conéctese en D) en los bornes U1 y V1 del estator. Repetir la medición. El motor puede ponerse en marcha cuando el valor se halle por encima de 0,5 MΩ.

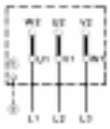
Los valores de la resistencia del aislamiento dependen de la temperatura. Valores orientativos: Al aumentar/reducir la temperatura del devanado en 10K, el valor de la resistencia se duplica/reduce a la mitad.

Esquemas de conexiones

Motores trifásicos con rotor de jaula



Conexión estrella



Conexión triángulo

Conexión al interruptor estrella-triángulo

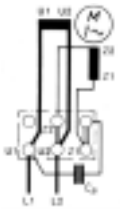
Motores trifásicos de polos conmutables

En conexión Dahlander: En la designación del tipo, el número de polos más alto = velocidad más baja va primero (p.e. AM 250...8/4)

Con 2 devanados separados: En la designación del tipo, el número de polos más bajo = velocidad más alta va primero (p.e. AM 250 ... 4/8).

Para motores de polos conmutables, véanse los esquemas de conexiones incluidos en la caja de conexiones del motor.

Motores monofásicos con rotor de jaula



Marcha a la derecha

Marcha a la izquierda

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4.1/10/2001-GH

Electric Motors

AEG

Technical Catalogue

Low-Voltage Squirrel-Cage Motors IP55

EFF 2

AC Induction Three-Phase Motors 2.1e

2003

LAFERTGROUP

All technical data, outputs, dimensions and weights stated in this catalogue are subject to change without prior notice.

The illustrations are not binding.

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Standard Quality

The strictness of our quality control assures the flawless operation and reliability of our products. That our quality scale fulfils your demands is confirmed by the certificate awarded by the TÜV-CERT Certification body of TÜV Rheinland and the CERMET, a Certification body authorized by SINCERT.

TÜV CERT

CERTIFICATE

The TÜV CERT Certification Body of TÜV Anlagentechnik GmbH

hereby certifies in accordance with TÜV CERT procedures that

AEG Fábrica de Motores, S.A.

Carretera de Castellar, 225

E-08228 Terrassa (Barcelona)

has established and applies a quality system for

Design/development, production and servicing of: Asynchronous electric three-phase and single-phase cage motors for low voltage, frame sizes 56 – 315, to EN/IEC 60034

An audit was performed.

Report No. 78859

Proof has been furnished that the requirements according to

DIN EN ISO 9001:1994

are fulfilled.

The certificate is valid until: June 2003

Certificate Registration No. 00 100 78859

TÜV

SINCERT

CERMET

QUALITY SYSTEM CERTIFICATE

N° 033

THIS IS TO CERTIFY THAT THE QUALITY ASSURANCE SYSTEM OF THE COMPANY

LAFERT S.p.A.

Via Kennedy, 43 - San Donà di Piave VE

ITALY

CONFORME TO THE

ISO 9001-94 STANDARD

FOR THE FOLLOWING PRODUCTS/SERVICES:

THREE-PHASE, MONOPHASE AND SELF-BRAKING ASYNCHRONOUS MOTORS

This certificate consists of 4 pages. The enclosed data sheet supplies details on the field of application. The maintenance of competence of the certification is dependent upon the observance of the agreement stipulated in CERMET.

General Manager

Flaviano Trippetti, Engineer

CERMET - 40068 S. Lazzaro di Savena (BO), Via Aldo Moro 32

CE Marking

Our three-phase induction motors comply with the requirements of the following international standard:

IEC 60034

as well as with the Low Voltage Directive 73/23 (1973), modified by the Directive 93/68 (1993) and the EMC-Directive 89/336.

The above named products comply with the requirements of the EC Directive Machines 89/392. In accordance with this Directive induction motors are components and intended solely for integration into other machines. Commissioning is forbidden until conformity of the end product with this Directive is proved!

The CE symbol was applied for the first time in 1995.

The safety instructions in the Operation Manual of the manufacturer and EN 60204-1 have to be observed.

CEMEP Voluntary Agreement

Motors covered by this agreement are defined as totally enclosed fan-cooled (normally IP 54 or IP 55), three-phase AC squirrel cage induction motors 1.1 to 90 kW, with 2 or 4 poles, rated for 400 V-line, 50 Hz, duty class S1. (Standard design can be interpreted as design N according to EN 60034-12 and HD 231). They are divided in three classes of efficiency levels, defined by 2 values of full load efficiency per output, designated eff1, eff2 and eff3.

All motors with standard rating included in this catalogue comply with efficiency class eff2 and bear the corresponding label on the rating plate. For efficiency data at 50%, 75% and full load, please refer to the electrical data tables.

The motors comply with the relevant standards and regulations, especially:

Title	IEC	EU CENELEC	D DIN/VDE	I CEI/UNEL	GB BS	F NFC	E UNE
Electrical							
General stipulations for electrical machines	60034-1	EN 60034-1	DIN EN 60034-1	CEI EN 60034-1	4999-1 4999-69	51-200 51-111	UNE EN 60034-1
Rotating electrical machines: methods for determining losses and efficiency using tests	60034-2	HD 53 2	DIN EN 60034-2	CEI EN 60034-2	4999-34	51-112	UNE EN 60034-2
Terminal markings and direction of rotation of rotating electrical machines	60034-8	HD 53 8 S4	DIN VDE 0530-8	CEI 2-8	4999-3	51-118	20113-8-96
Starting performance	60034-12	EN 60034-12	DIN EN 60034-12	CEI EN 60034-12	4999-112		UNE EN 60034-12
Standard voltages	60038	HD 472 S1	DIN IEC 60038	CEI 8-6			
Insulating materials	60085		DIN IEC 60085	CEI 15-26			
Mechanical							
Dimensions and output ratings	60072		DIN EN 50347	UNEL 13113			
Mounting dimensions and relationship frame sizes-output ratings, IM B3	60072	HD 231	DIN 42673-1	UNEL 13113	4999-10 51-110	51-105 51-104	20106-1/26 1980
Mounting dimensions and relationship frame sizes-output ratings, IM B5	60072	HD 231	DIN 42677-1	UNEL 13117		20106-2-74	
Mounting dimensions and relationship frame sizes-output ratings, IM B14	60072	HD 231	DIN 42677-1	UNEL 13118	4999-10 51-110	51-105 51-104	20106-2-IC-80
Cylindrical shaft ends for electric motors	60072	HD 231	DIN 748-3	UNEL 13502	4999-10	51-111	
Degrees of protection	60034-5	EN 60034-5	DIN IEC60034-5	CEI EN 60034-5	4999-20	EN60034-5	20111-5
Methods of cooling	60034-6	EN 60034-6	DIN EN 60034-6	CEI EN 60034-6	4999-21		EN 60034-6
Mounting arrangements	60034-7	EN 60034-7	DIN EN 60034-7	CEI EN 60034-7	4999-22	51-117	EN 60034-7
Noise limits	60034-9	EN 60034-9	DIN EN 60034-9	CEI EN 60034-9	4999-51	51-119	EN 60034-9
Mechanical vibration	60034-14	EN60034-14	DIN EN 60034-14	CEI EN 60034-14	4999-50	51-111	EN 60034-14
Mounting flanges			DIN 42948	UNEL 13501			
Tolerances of mounting and shaft extensions			DIN 42955	UNEL 13501/ 13502			
Classification of environmental conditions	600721-2-1		DIN IEC 60721-2-1	CEI 75-1			
Mechanical vibration; balancing	ISO 8821		DIN ISO 8821				

Motors to special regulations:

- Motors to VIK regulations (German Society for Industrial Energy and Power Stations) to VIK recommendation *Technical Requirements April 1999*
- Motors with UL and/or CSA approval (performance data on request)
- Motors with CUL_{US} ($_{C}UR_{US}$) approval

The motors can furthermore be designed according to the stipulations for floating installations of the most important classification societies. For further details see our technical catalogue *Three-phase motors for marine applications.*

The motors are designed for operation at altitudes ≤ 1000 m above sea-level and at ambient temperatures of up to 40° C. Exceptions are indicated on the rating plate.

Permissible temperature rises to various standards

Standard/Regulation	Temperature of coolant	Permissible temperature rise in K (measured by resistance method) Temperature class		
	°C	B	F	H
VDE 0530 part 1	40	80	105	125
International IEC 34-1	40	80	105	125
Britain BS 2613	40	80	105	
Canada CSA	40	80	105	
USA NEMA and ANSI	40	80	105	
Italy CEI	40	80	105	
Sweden SEN	40	80	105	
Norway NEK	40	80	105	
Belgium NBN	40	80	105	
France NF	40	80	105	
Switzerland SEV	40	80	105	
India IS	40	80	-	
Germanischer Lloyd [1]	45	75	90	
American Bureau of Shipping [1]	50	70	95	
Bureau Veritas [1]	45	70	100	
Norske Veritas [1]	45	70	90 [2]	
Lloyds Register [1]	45	70	90	
Registro Italiano Navale [1]	45	70	90	
Korean Register [1]	50	70	90	
China Classification Society [1]	45	75	95	

on request

[1] Classification societies for marine motors

[2] Only with special approval

The motors conform to degree of protection IP 55 to IEC 60034-5. Higher protection on request.

The standard design for horizontal mounting is suitable for indoor and protected outdoor installation, climate group MODERATE (see page 15) (temperature of coolant -20° to +40° C).

For unprotected outdoor installation or severe climatic conditions (moisture category wet, climate group WORLDWIDE, extremely dusty site conditions, aggressive industrial atmosphere, danger of storm rain and coastal climate, danger of attack by termites, etc.), as well as vertical mounting, special protective measures are recommended, such as:

- Protective cowl (for vertical *shaft-down* motors)
- For vertical *shaft-up* motors additional bearing seal and flange drainage
- Special paint finish
- Treatment of winding with protective moisture-proof varnish
- Anti-condensation heating (possibly winding heating)
- Condensation drain holes

The special measures to be applied have to be agreed with the factory once the conditions of installation have been settled.

The corresponding conditions of installation have to be clearly indicated in the order.

Tolerances

For industrial motors to EN 60034-1, certain tolerances must be allowed on guaranteed values, taking into consideration the necessary tolerances for the manufacture of such motors and the materials used. The standard includes the following remarks:

1. It is not intended that guarantees necessarily have to be given for all or any of the items involved. Quotations including guaranteed values subject to tolerances should say so, and the tolerances should be in accordance with the table.
2. Attention is drawn to the different interpretation of the term guarantee. In some countries a distinction is made between guaranteed values and typical or declared values.
3. Where a tolerance is stated in only one direction, the value is not limited in the other direction.

Values for	Tolerance
Efficiency (η) (by indirect determination)	- 0.15 (1 - η) at $P_N \leq 50$ kW - 0.1 (1 - η) at $P_N > 50$ kW
Power factor ($\cos \varphi$)	$\frac{1 - \cos \varphi}{6}$, minimum 0.02, maximum 0.07
Slip (s) (at rated load and at working temperature)	± 20 % of the guaranteed slip at $P_N \geq 1$ kW ± 30 % of the guaranteed slip at $P_N < 1$ kW
Breakaway starting current (I_A) (in the starting circuit envisaged)	+ 20 % of the guaranteed starting current (no lower limit)
Breakaway torque (M_A)	- 15 % and + 25 % of the guaranteed breakaway torque (+ 25 % may be exceeded by agreement)
Pull-up torque (M_S)	- 15 % of the guaranteed value
Pull-out torque (M_K)	- 10 % of the guaranteed value (after allowing for this tolerance, M_K/M_N not less than 1.6)
Moment of inertia (J)	± 10 % of the guaranteed value

Mechanical tolerances

According to IEC 72-1, the following tolerances on mechanical dimensions of electric motors are permitted:

Parameter	Code	Tolerances	
Shaft length	H	- up to 250 - over 250	0,5 mm 1 mm
Diameter of shaft end	D-DA	- from 11 to 28 mm - from 38 to 48 mm - from 55 to 100 mm	j6 k6 m6
Hub key width	F-FA		h9
Flange spigot	N	- up to 132 - over size 132	j6 h6

Note: The holes at the shaft end conform with DIN 332

Degrees of protection

Degrees of protection for mechanical machines are designated in accordance with IEC 60034-5 by the letters **IP** and two characteristic numerals.

First numeral: Protection against contact and ingress of foreign bodies

IP	Description
0	No special protection
1	Protection against solid foreign bodies larger than 50 mm (Example: inadvertent contact with the hand)
2	Protection against solid foreign bodies larger than 12 mm (Example: inadvertent contact with the fingers)
3	Protection against solid foreign bodies larger than 2.5 mm (Example: Wires, tools)
4	Protection against solid foreign bodies larger than 1 mm (Example: Wires, bands)
5	Protection against dust (harmful deposits of dust)
6	Complete protection against dust. Is not described for electrical machines to IEC 34-5.

Second numeral: Protection against ingress of water

IP	Description
0	No special protection
1	Protection against vertically falling water drops (condensation)
2	Protection against dropping water when inclined by up to 15°
3	Protection against waterspray at up to 60° from vertical
4	Protection against water splashed from any direction
5	Protection against water projected by a nozzle from any direction
6	Protection against heavy seas or water projected in powerful jets
7	Protection when submerged between 0.15 and 1 m
8	Protection when continuously submerged in water at conditions agreed between the manufacturer and the user.

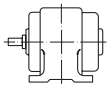
Mounting arrangements

Mounting arrangements for rotating electrical machines are designated according to IEC 60034-7, *Code I* (in brackets Code II).

Our motors are available with the mounting arrangements listed below, depending on design and frame size. Motors with aluminium frame are equipped with removable feet that allow easy change of mounting arrangement.

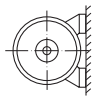
Foot mounting

IM B3 (IM 1001)



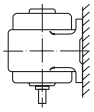
IM B6 (IM 1051) *

IM B7 (IM 1061) *

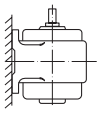


IM B8 (IM 1071) *

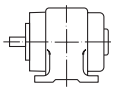
IM V5 (IM 1011) *



IM V6 (IM 1031) *



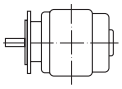
IM B34 (IM 2101)



Flange type C to DIN 42 948 at drive end

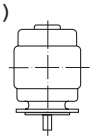
Flange mounting

IM B5 (IM 3001)



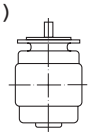
Flange type A to DIN 42 948 at drive end

IM V1 (IM 3011)



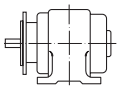
Flange type A to DIN 42 948 at drive end

IM V3 (IM 3031)



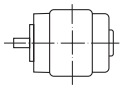
Flange type A to DIN 42 948 at drive end

IM B35 (IM 2001)



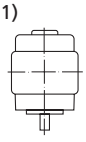
Flange type A to DIN 42 948 at drive end

IM B14 (IM 3601)



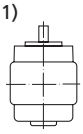
Flange type C to DIN 42 948 at drive end

IM V18 (IM 3611)



Flange type C to DIN 42 948 at drive end

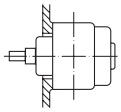
IM V19 (IM 3631)



Flange type C to DIN 42 948 at drive end

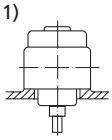
Motors without endshield

IM B9 (IM 9101)



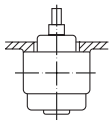
without endshield and without ball bearings on drive end

IM V8 (IM 9111)



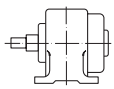
without endshield and without ball bearings on drive end

IM V9 (IM 9131)



without endshield and without ball bearings on drive end

IM B15 (IM 1201)



without endshield and without ball bearings on drive end

* From frame size 225 on request

It is essential to state the desired mounting arrangement when ordering, as the constructive design depends partly on the mounting arrangement.

Terminal boxes

The location of the terminal box in standard design is on top; on the right or on the left are possible.

For motors with mountings IM B6, IM B7, IM B8, IM V5, IM V6 the location of the terminal box is related to an IM B3 mounting.

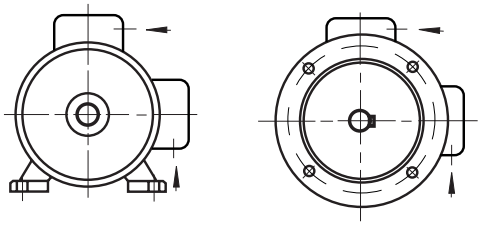
The position of the entry openings can be adjusted to suit the existing connection facilities by turning through 90°. Should special accessories be used (temperature detectors, anti-condensation heating, etc.) please enquire.

For motors in standard design, the cable gland does not belong to our scope of delivery.

For plastic terminal boxes, only plastic glands may be used (shock protection).

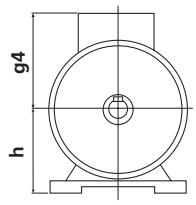
When using screened leads, a metal terminal box is required.

Direction of cable entries

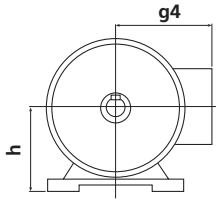


Frame size	Degree of protection	Thread for cable entry [1]		Connection for temperature detector		Max. cable section	Terminal thread	Max. external cable diam.
		Pg	Metric [2]	Pg	Metric	mm²		mm
56 - 71	IP 55	1 x Pg 11 / 1 x Pg 13.5	1 x M16/1 x M20	-	-	2.5	M4	12
80	IP 55	1 x Pg 13.5 / 1 x Pg 16	1 x M25/1 x M20	-	-	2.5	M4	16
90-112	IP 55	1 x Pg 13.5 / 1 x Pg 16	1 x M25/1 x M20	-	-	4	M5	16
132	IP 55	2 x Pg 21	2 x M32	-	-	4	M5	20
160	IP 55	2 x Pg 29	2 x M40	Pg 11	M20	16	M6	28
180	IP 55	2 x Pg 29	2 x M40	Pg 13.5	M20	35	M8	28
200	IP 55	2 x Pg 36	2 x M50	Pg 16	M25	35	M8	34
225	IP 55	2 x Pg 36	2 x M50	Pg 16	M25	50	M10	34
250 - 280	IP 55	2 x Pg 42	2 x M63	Pg 16	M25	50	M10	40
315	IP 55	2 x Pg 48 [3]	2 x M63 [3]	2 x Pg 16	M25	185	M12	48

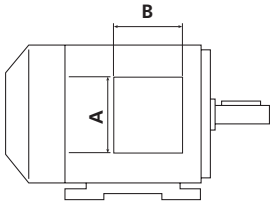
[1] Pg thread to DIN 40 430
[2] Pitch 1.5
[3] Terminal box with unscrewable cable entry plate



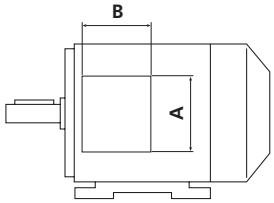
Terminal box on top



Terminal box at the side



left [1]



right

Frame size h	g4	A	B	Design	Material
Standard design					
56	98	91	93	Z	K
63	103	91	93	Z	K
71	112	91	93	Z	K
80 [2]	129	111	116	Z	K
90 [2]	138	111	116	Z	K
100 [2]	145	111	116	Z	K
112 [2]	161	111	116	Z	K
132	198	133	133	Z	AL
160	246	149	149	Z	AL
180	266	204	180	Z	SB
200	341	258	265	Z	SB
225	360	258	265	Z	SB
250	390	258	265	Z	SB
280	423	258	265	Z	SB
315	515	400	285	Z	GG

Frame size h	g4	A	B	Design	Material
Special design					
56	100	94	94	Z	Al
63	105	94	94	Z	Al
71	114	94	94	Z	Al
80	139	110	110	Z	Al
90	148	110	110	Z	Al
100	155	110	110	Z	Al
112	171	110	110	Z	Al
132	205	143	143	Z	GG
160	250	168	168	Z	GG
180	285	209	220	Z	GG
200	310	241	246	Z	GG
225	334	272	254	Z	GG
250	375	272	254	Z	GG
280	409	272	254	Z	GG
Special design gland cover					
56	64	70	70	E	K
63	69	70	70	E	K
71	78	70	70	E	K
80	125 [3]	91	91	E	Al
90	137 [3]	91	91	E	Al
100	141 [3]	91	91	E	Al
112	154 [3]	91	91	E	Al
132	183	111	111	E	GG
160	225	130	130	E	GG
180	250 [3]	144	144	E	GG
200	280 [3]	172	172	E	GG
225	285 [3]	172	172	E	GG
250	340	208	208	E	GG
280	375	208	208	E	GG

[1] On frame size 56-71 the terminal box is supplied displaced towards the non-drive end
[2] For metric thread, increase g4 by 6mm
[3] Maximum height with screw joint

Design: E = Single part
Z = Two parts

Material: K = Plastics
SB = Sheet steel
AL = Aluminium
GG = Cast iron

Materials

Motor parts	Frame size	Material
Stator frame	56 - 200	Aluminium alloy
	132 - 180	Cast iron (optional)
	225 - 315	Cast iron
Endshield	56 - 112	Aluminium alloy
	132 - 315	Cast iron
Flanged endshield	56 - 112	Aluminium alloy
	132 - 315	Cast iron
Fan cover	56 - 71	Sheet steel
	80 - 112	Plastics
	80 - 112	Sheet steel (optional)
	132 - 315	Sheet steel
Fan	56-315	Plastics
Terminal box	56 - 112	Plastics
	56 - 112	Aluminium alloy (optional)
	132 - 160	Aluminium alloy
	180 - 280 + 315SY	Sheet steel
	315	Cast iron

Paint finish

Normal finish

Suitable for climate group **Moderate** to DIN 600 721-2-1, e.g. indoor and outdoor installation
for short periods: up to 100 % rel. humidity at temperatures up to +30° C
continuously: up to 85 % rel. humidity at temperatures up to +25° C

Special finish K1

Suitable for climate group **Worldwide** to DIN 600 721-2-1, e.g. outdoor installation in corrosive chemical and marine atmospheres
for short periods: up to 100 % rel. humidity at temperatures up to +35° C
continuously: up to 98 % rel. humidity at temperatures up to +30° C

Special finishes (on request)

- Special finish K2 (additional treatment of internal motor parts)
- Special paint for exposure to the action of alkalis
- Special finishes to customers' requirements

Bearings

Classification of bearings (standard design) [1]
Ball bearings to ISO15 (DIN 625)

Frame size	No. of poles	Drive end	Non-drive end
56	2 + 4	6201-2Z	6201-2Z
63	2 + 4	6202-2Z	6202-2Z
71	2 - 8	6202-2Z	6202-2Z
80	2 - 8	6204-2Z C3	6204-2Z C3
90	2 - 8	6205-2Z C3	6205-2Z C3
100	2 - 8	6206-2Z C3	6206-2Z C3
112	2 - 8	6306-2Z C3	6306-2Z C3
132	2 - 8	6208-2Z C3	6208-2Z C3

Frame size	No. of poles	Drive end	Non-drive end
160 [2]	2 - 8	6209-2Z C3	6209-2Z C3
180	2 - 8	6210-2Z C3	6210-2Z C3
200	2 - 8	6212-2Z C3	6212-2Z C3
225	2 - 8	6213-Z C3	6213-Z C3
250	2 - 8	6214 C3	6214 C3
280	2 - 8	6216 C3	6216 C3
315	2	6316 C3	6316 C3
	4 - 8	6319 C3	6319 C3
315SY	4 - 8	6319 C3	6316 C3

[1] In frame sizes 132 to 280 bearings type 63 also possible at drive and non-drive end (preferably locating bearing non-drive end), or bearings NU 3 at drive end in frame sizes 160 to 280 (only locating bearing at non-drive end).

[2] IM B14 bearing drive end 6309-2Z C3

Bearing arrangement (AM, AMV)

Frame size	Bearing drive end	Bearing non-drive end	Spring-loaded
56 - 112	Non-locating bearing	Non-locating bearing	Non-drive end
132 - 280	Locating bearing	Non-locating bearing	Non-drive end
315	Non-locating bearing	Locating bearing	Drive end

Maximum permissible axial forces without additional radial forces *

Frame size	Horizontal shaft				Vertical shaft - force upwards				Vertical shaft - force downwards			
	3000 min $^{-1}$ kN	1500 min $^{-1}$ kN	1000 min $^{-1}$ kN	750 min $^{-1}$ kN	3000 min $^{-1}$ kN	1500 min $^{-1}$ kN	1000 min $^{-1}$ kN	750 min $^{-1}$ kN	3000 min $^{-1}$ kN	1500 min $^{-1}$ kN	1000 min $^{-1}$ kN	750 min $^{-1}$ kN
56	0.16	0.21	-	-	0.18	0.22	-	-	0.15	0.19	-	-
63	0.19	0.26	-	-	0.21	0.28	-	-	0.17	0.24	-	-
71	0.23	0.33	0.33	0.37	0.26	0.35	0.36	0.39	0.21	0.30	0.31	0.34
80	0.32	0.44	0.46	0.50	0.34	0.47	0.48	0.53	0.29	0.41	0.43	0.47
90	0.34	0.48	0.49	0.54	0.38	0.47	0.53	0.58	0.31	0.44	0.46	0.51
100	0.48	0.68	0.70	0.77	0.54	0.74	0.76	0.83	0.43	0.62	0.64	0.71
112	0.48	0.68	0.70	0.77	0.56	0.75	0.77	0.84	0.40	0.60	0.62	0.69
132	0.6	0.9	1.1	1.3	1.0	1.3	1.5	1.9	0.5	0.75	0.75	1.05
160	0.5	0.8	1.2	1.5	1	1.4	1.8	2	0.2	0.4	0.6	0.9
180	0.5	0.8	1.2	1.5	1.1	1.4	1.8	2.1	0.2	0.4	0.6	0.9
200	0.8	1.3	1.5	1.8	1.8	2.3	2.5	2.8	0.2	0.7	0.9	1.1
225	1.0	1.6	1.9	2.4	2.1	2.6	2.9	3.4	0.3	0.70	1.0	1.5
250	1.1	1.6	2.0	2.5	2.3	2.7	3.2	3.7	0.2	0.60	1.1	1.5
280	1.7	1.9	2.4	2.9	2.9	3.1	3.6	3.7	0.15	0.3	0.8	1.0
315	3.5	4.0	4.5	5.0	6.0	7.0	7.5	8.0	1.0	1.9	2.4	2.9

Values for 50 Hz. For service on 60 Hz, reduce values by 10%

* Consult according to direction of force

Permissible radial forces

without additional axial force

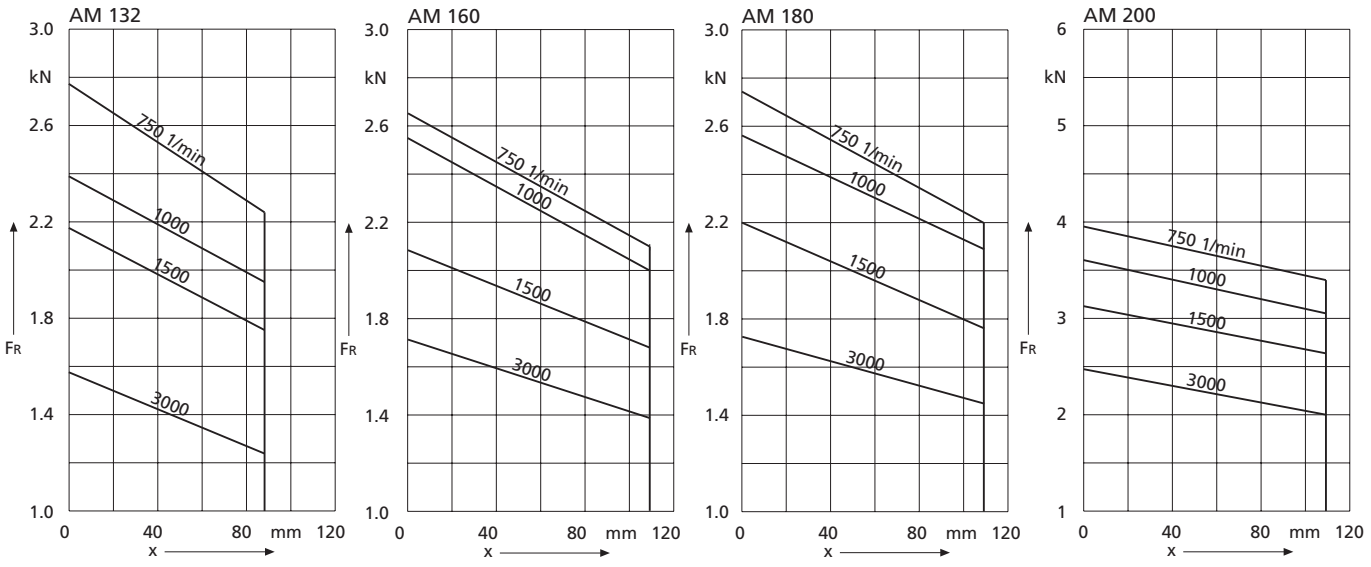
(Ball bearings)

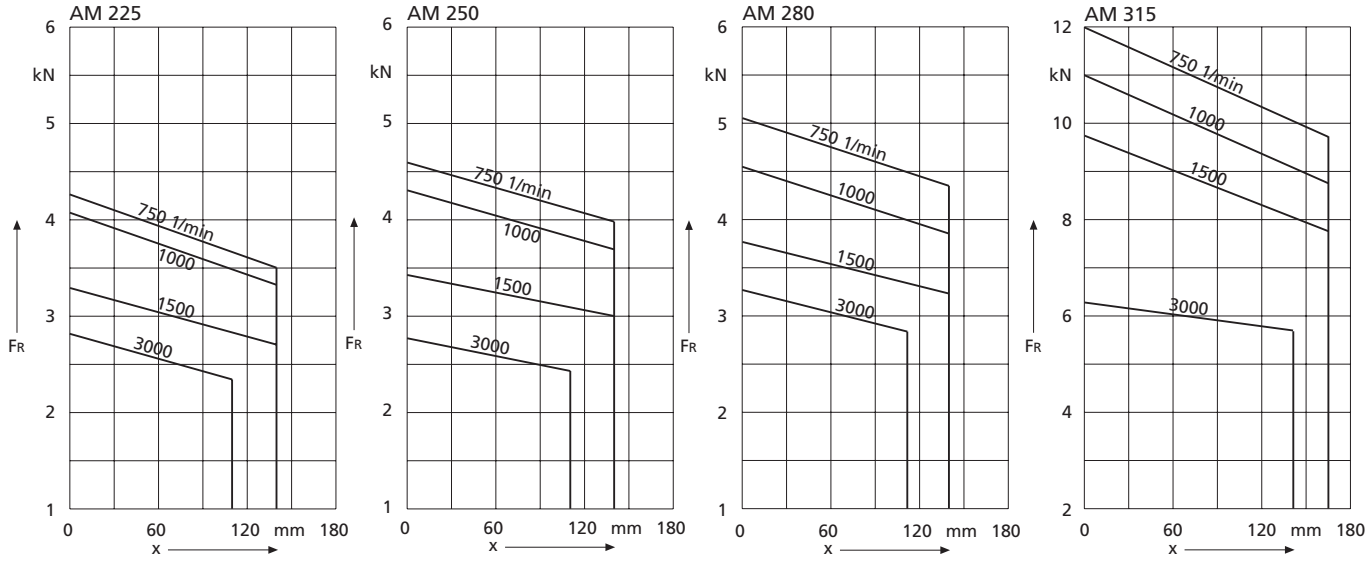
Nominal life = 20.000 h (Lh10)

F_R = permissible radial force in kN

X = Distance between point of application of force and shaft shoulder (e.g. half pulley width)

Size	F_R in N when 2p= 2	4	6	8
56	340	428	-	-
63	385	485	-	-
71	463	583	668	735
80	590	830	860	945
90SL	675	940	975	1070
100L	925	1295	1335	1470
112M	930	1300	1340	1476





Reinforced bearings (special design)

Roller bearings to DIN 5412

Frame size	No. of poles	Drive end	Non-drive end
160	2 - 8	NU 209 E	6209-2Z C3
180	2 - 8	NU 210 E	6210-2Z C3
200	2 - 8	NU 212 E	6212-2Z C3
225	2 - 8	NU 213 E	6213-2Z C3

Frame size	No. of poles	Drive end	Non-drive end
250	2 - 8	NU 214 E	6214 C3
280	2 - 8	NU 216 E	6216 C3
315	2	NU 316 E	6316 C3
	4 - 8	NU 319 E	6319 C3
315SY	4 - 8	NU 319 E	6316 C3

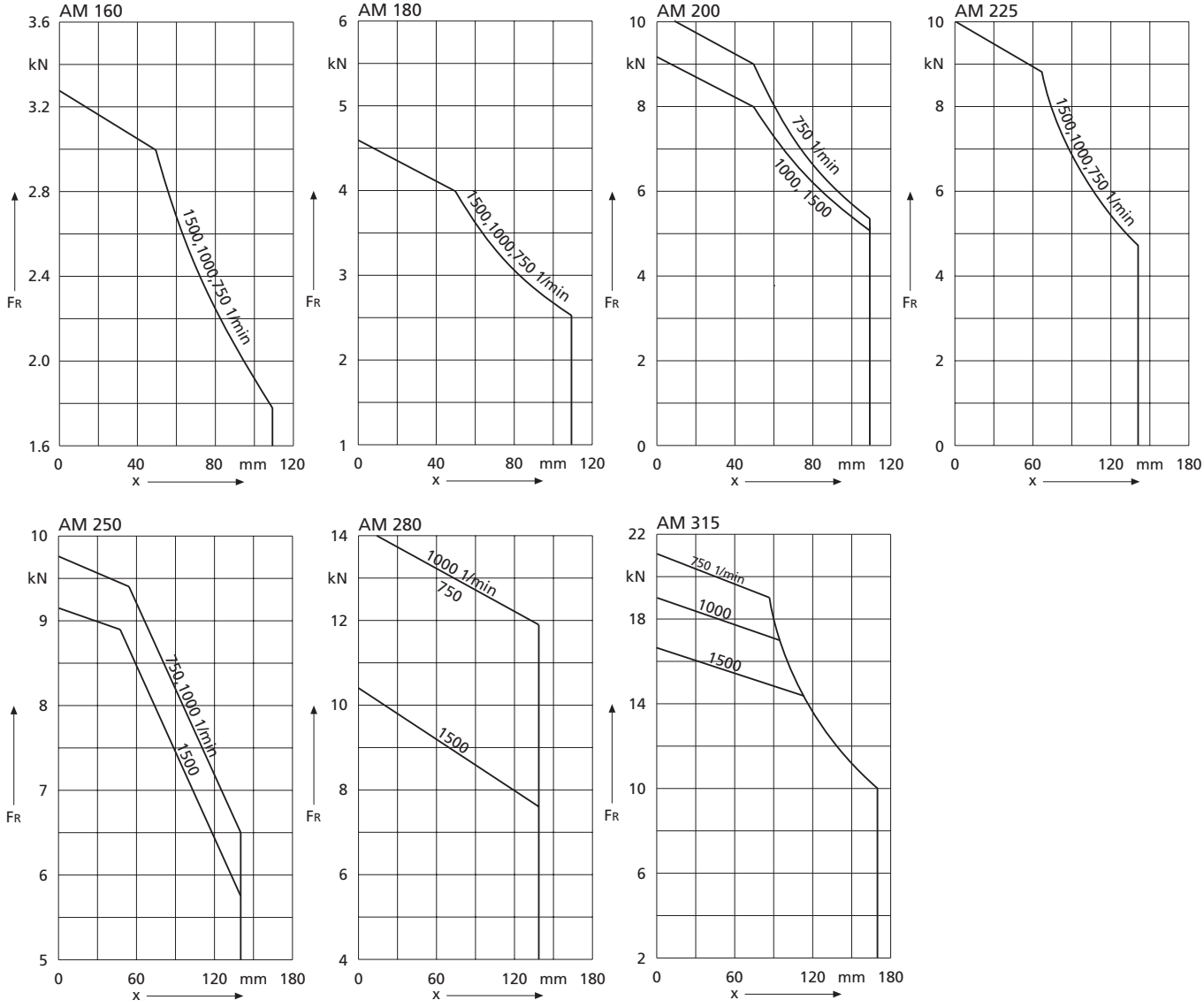
The modification from standard design to roller bearings is not possible, except for frame size 315.

Permissible radial forces

without additional axial forces (Roller bearings)

F_R = permissible radial force in kN

X = Distance between point of application of force and shaft shoulder (e.g. half pulley width)



Special bearings and flanges

Frame size	IM B3 / IM B5 Oversized bearing	IM B14 Oversized bearing	IM B5 Reduced flange
132	6308	-	A250*
160	6309	C250-6309	A300
180	6310	-	A300
200	6312	-	A350*
225	6313	-	A400
250	6314	-	A450
280	6316	-	A450*
315	-	-	-

*not interchangeable with standard motors

Belt drive

The data apply only to the normal drive end shaft extension of IM B3 motors with one speed.

Calculation of belt drive:

$$F_R = \frac{19120 \cdot P \cdot k}{D_1 \cdot n}$$

F_R = Radial shaft load in N
P = Output in kW
n = Speed in min^{-1}
D_1 = Pulley diameter in m
k = Belt tension factor, varying with the type of belt, assumed to be approximately:
3-4 for normal flat belt without idler pulley
2-2.5 for normal flat belt with idler pulley
2.2-2.5 for V-belt
For exact data apply to the belt manufacturer.

Lubrication and maintenance of bearings

Bearings of standard motors up to frame size 250 have permanent lubrication. Bearing grease K3N to DIN 51 825 (e.g. KLÜBER ASONIC GHY72, ESSO UNIREX N3 or similar) is used.

Maintenance-free life for motors with permanent lubrication at ambient temperature of 40° C and service at 50 Hz:

2 and 4/2 pole motors 10,000 h
4 and more pole motors 20,000 h, but not more than 4 years.

From frame size 280 upwards the motors are equipped with regreasing device and grease slinger (possible from frame size 160 at extra cost).

First lubrication is made with grease K3N to DIN 51 825 (lithium-based, water resistant to DIN 51 807 part 1: grade 0 or 1).

For motors with regreasing device, regreasing interval and required quantity of grease is indicated on the nameplate.

For regreasing please observe the Operating Instructions.

Where unfavourable conditions prevail (e.g. high ambient temperature, dusty conditions, corrosive atmosphere, operation by frequency converter), relubrication should be carried out more frequently.

Lubricating nipples

Flat lubricating nipples M 10x1 to DIN 3404.

Cooling

Surface cooling, independent of the direction of rotation.

Motors type AM available without internal fan as type AG, e.g. for installation in a directed air stream (outputs on request).

Vibration

The amplitude of vibration in electric motors is governed by EN 60034-14 *Mechanical vibration of rotating electrical machines with shaft heights 56 and larger - methods of measurement and limits.*

Standard motors are designed to vibration class N (normal). Vibration class R (reduced) and vibration class S (special) are available at extra cost.

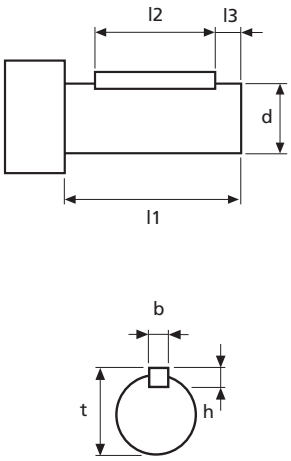
Pole-changing motors in Dahlander connection can only be supplied in vibration class N.

Rotors are at present dynamically balanced with **half** key fitted as per DIN ISO 8821. Other balancing only on request.

The motors are identified as follows:

"H" or "blank" means balanced with *half key*
"F" means balanced with *full key*
"N" means *no key*

Position and dimensions of key



Frame size	d x l1	b x h	l2	l3	t
56	9 x 20	3 x 3	15	2.5	10.2
63	11 x 23	4 x 4	15	4	12.5
71	14 x 30	5 x 5	20	5	16
80	19 x 40	6 x 6	30	6	21.5
90	24 x 50	8 x 7	40	6	27
100	28 x 60	8 x 7	50	6	31
112	28 x 60	8 x 7	50	6	31
132	38 x 80	10 x 8	70	5	41
160	42 x 110	12 x 8	100	5	45
180	48 x 110	14 x 9	100	5	51.5
200	55 x 110	16 x 10	100	5	59
225 2 poles	55 x 110	16 x 10	100	5	59
225 4 poles	60 x 140	18 x 11	110	10	64
250 2 poles	60 x 140	18 x 11	110	10	64
250 4 poles	65 x 140	18 x 11	110	10	69
280 2 poles	65 x 140	18 x 11	100	10	69
280 4 poles	75 x 140	20 x 12	100	10	79.5
315 2 poles	65 x 140	18 x 11	125	7.5	69
315 4 poles	80 x 170	22 x 14	140	10	85

Dimensions in mm
For larger shafts in special design the dimensions l2 and l3 are maintained.

Anti-condensation heater

On request, motors which due to strong temperature fluctuations are exposed to condensation during standstill, can be fitted against surcharge with an anti-condensation heater (space heater).

For supply voltage and heater rating please refer to the following table:

Frame size	Supply voltage (V)	Heater rating per motor (W)
112 - 160	110 or 230	40
180 - 225	"	50
250 - 280	"	65
315	"	99

During operation of the motor, the heating must be switched off.

Noise

The noise level of an electrical machine is determined by measuring the sound pressure level in accordance with curve A of the sound level meter to EN 60651 and is indicated in dB (A).

The permitted noise levels of electrical machines are fixed in EN 60034-9 (IEC 34-9). The noise level of our motors is well below these limit values.

Air-borne sound measurements are carried out in an anechoic testing chamber to EN 21680.

Speed corresponding to a mains frequency of 50 Hz and the number of poles.

Measures for noise reduction

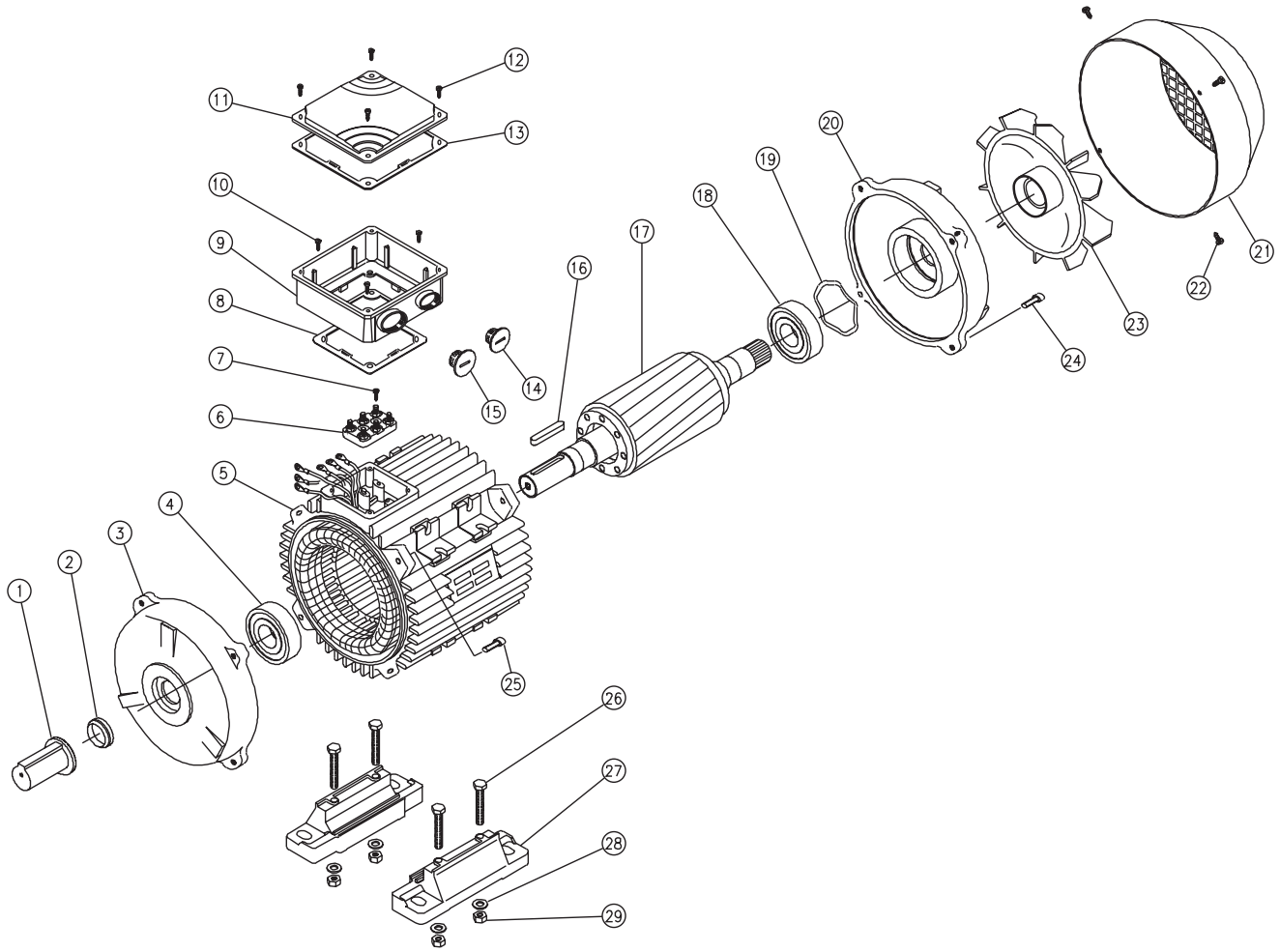
With special measures noise level can be reduced (special fan, noise reducing hood, etc.).

Noise levels

The noise values listed below refer to 50 Hz at rated voltage with a tolerance of up to + 3 dB(A). Values for pole-changing motors on request. For 60 Hz supply values are 3-5 dB(A) higher.

Sound pressure level L_{pA} and sound power level L_{WA} for three-phase squirrel-cage motors

Frame size	2 pole		4 pole		6 pole		8 pole	
	L_{WA}	L_{pA}	L_{WA}	L_{pA}	L_{WA}	L_{pA}	L_{WA}	L_{pA}
56	57	48	47	38				
63	58	49	47	38				
71	61	52	51	42	49	40		
80	72	60	60	48	52	40	47	35
90	74	62	61	49	58	46	54	42
100	78	66	62	50	62	51	58	46
112	80	68	65	53	65	53	58	46
132	81	69	71	59	69	57	64	52
160	85	72	73	60	71	58	69	56
180	88	75	74	61	72	59	71	58
200	88	75	76	63	73	60	72	59
225	89	76	78	65	75	62	73	60
250	90	76	80	66	78	64	74	60
280	92	79	83	69	80	66	75	61
315	92	79	84	70	82	68	79	65



Part description

1	Shaft protection
2	Dust seal drive end
3	Endshield drive end
4	Bearing drive end
5	Stator frame
6	Terminal board
7	Fixing screw terminal board
8	Gasket terminal box
9	Terminal box
10	Fixing screw terminal box
11	Terminal box lid
12	Fixing screw terminal box lid
13	Gasket terminal box lid
14	Blank gland plug
15	Blank gland plug
16	Key
17	Rotor complete
18	Bearing non-drive end
19	Pre-load washer
20	Endshield non-drive end
21	Fan cover
22	Fixing screw fan cover
23	Fan
24	Fixing bolt endshield non-drive end
25	Fixing bolt endshield drive end
26	Fixing bolt motor feet
27	Motor feet
28	Fixing washer motor feet
29	Fixing nut motor feet

In enquires and orders for spare parts please state always:
Designation of spare part, motor type, mounting arrangement, motor serial number (Product No. when available)
Enquires and orders cannot be handled without these data.

Rated voltage

For the rated voltage of the motors, EN 60 034-1 allows a tolerance of ± 5 %. According to IEC 60038, the mains voltages may have a tolerance of ± 10 %.

Therefore the motors are designed for the following rated voltage ranges (exceptions are shown in the data tables):

Mains voltage to DIN IEC 38	Rated voltage range of motor
230 V ± 10%	218-242 V ± 5%
400 V ± 10%	380-420 V ± 5%
690 V ± 10%	655-725 V ± 5%

Within the rated motor voltage range, the permissible maximum temperature is not exceeded. When the motors are operated at the limits of the voltage tolerance, the permissible overtemperature of the stator winding may be exceeded by 10 K.

For frame sizes 56 to 132 nameplates are marked with the maximum rated currents within the stated voltage ranges.

For motors in 500 V, 50 Hz design, as well as all abnormal voltages, no voltage range is marked. The voltage tolerances to EN 60034-1 apply.

Rated frequency

50 Hz motors can also be operated on 60 Hz mains, provided the mains voltage increases proportionally to the frequency. The relative values for starting and breakaway torque remain nearly unchanged and slightly increase for the starting current. The rated speed increases by the factor 1.2 and output by factor 1.15. Should a motor designed for 50 Hz be operated at 60 Hz without the voltage being increased, the rated output of the motor cannot be increased. Under these operating conditions, rated speed increases by factor 1.2. The relative values for starting and breakaway torque are reduced by factor 0.82 and for starting current by factor 0.9.

Additionally to the voltage range for 50 Hz operation, single-speed motors in frame sizes 56 to 315 are also marked with the voltage range for 60 Hz operation.
Example:

Frame sizes 56-132

Frame sizes 160-315

Rated current

The rated currents listed in the data tables apply to an operating voltage of 400 V. The conversion to other operating voltages, with output and frequency remaining unchanged, is to be made as follows:

Nominal voltage (V)	230	380	**400**	440	500	660	690
Conversion factor x I_N	1.74	1.05	**1.0**	0.91	0.80	0.61	0.58

Rated torque

$$\text{Rated torque in Nm} = 9550 \times \frac{\text{Rated voltage in kW}}{\text{Rated speed in min}^{-1}}$$

Output

The outputs stated in this catalogue are for constant load in continuous running duty S1 according to EN 60034-1, based on an ambient temperature of 40° C and installation at altitudes up to 1000 m above sea level.

For severe operating conditions, e.g. high switching rate, long run-up time or electric braking, a thermal reserve is necessary, which could call for higher thermal class or the use of a motor with a higher rating. In these cases we recommend to enquire with detailed information on the operating conditions.

Overload

At operating temperature three-phase motors are capable of withstanding an overload for 15 seconds at 1.5 times the rated torque at rated voltage. This overload is according to EN 60034-1 and will not result in excessive heating.

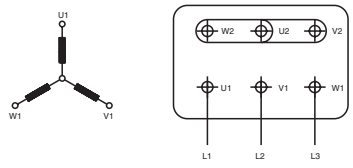
Utilizing thermal class F, motors can be operated continuously with an overload of 12 %. Nevertheless this is not valid for motors which to catalogue are utilized to thermal class F.

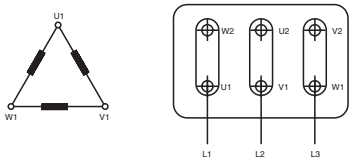
Connection

Motor output at 50 Hz	230 V Δ 400 V Y	400 V Δ 690 V Y	500 V Y	500 V Δ	690 V Δ
under 1.5 kW	standard	on request	on request	on request [1)]	-
1.5 to 4 kW	standard	standard	on request	on request	-
5.5 to 90 kW	standard	standard	on request	standard	standard
≥ 110 kW	on request	standard	on request	standard	standard

[1)] Available from 0.25 kW

Connection diagrams





Windings of standard three-phase motors can be connected either in star or delta connection.

Star connection

A star connection is obtained by connecting W2, U2, V2 terminals to eachother and the U1, V1, W1 terminals to the mains. The phase current and voltage are:

Iph = In ; Uph = Un / $\sqrt{3}$

where In is the line current and Vn the line voltage referred to the star connection.

Delta connection

A delta connection is obtained by connecting the end of a phase to the beginning of the next phase.

The phase current Iph and the phase voltage Uph are:

Iph = In / $\sqrt{3}$; Uph = Un

where In and Un are referred to the delta connection.

Star-delta starting

Star-delta starting allows a peak current reduction, ensuring however that the peak torque obtained is bigger than the resistant torque. Actually, it should be noted that the torque of an induction squirrel-cage motor is directly proportional to the square of the voltage. Motors whose rated voltage with delta connection corresponds to the mains voltage, can be started with the star-delta method.

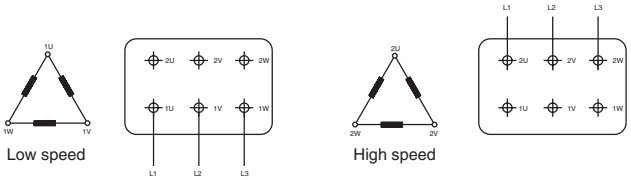
All motors can be supplied with windings designed for star-delta starting (for example: 400 V Δ / 690 V Y).

Pole-changing motors

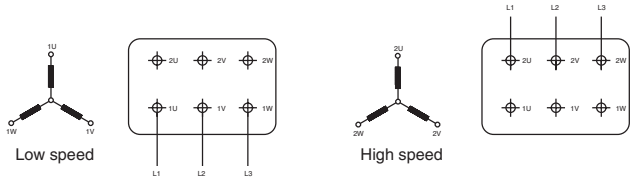
Standard pole-changing motors are designed for single voltage and direct-on-line starting (special design for Y-Δ-connection on request).

When the ratio between the two speeds is from 1 to 2, the standard motors have one single winding (Dahlander connection). For the other speeds, the motors have two separate windings.

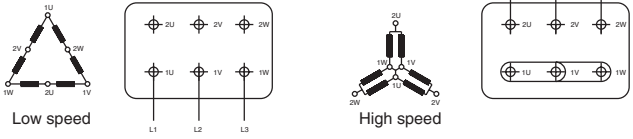
AM/AMV - two separate windings △/△



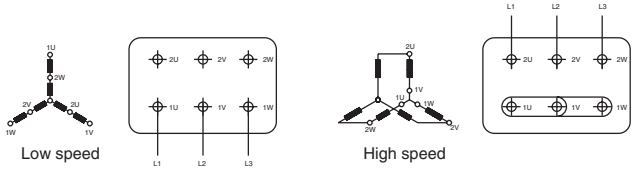
AM/AMV - two separate windings Y/Y



AM - Dahlander connection △/YY



AMV - Dahlander connection Y/YY



Insulation and temperature rise

Class F insulation to EN 60034-1 is used throughout.

In standard design motors are intended for operation at 40° C ambient temperature with class B temperature rise only, with an overtemperature limit of 80 K. This also applies for the rated voltage range to IEC 60038. Exceptions are shown on the data tables.

Temperature rise (ΔT^*) and maximum temperatures at the hottest points of the winding (T_{max}) according to the temperature classes of EN 60034-1.

	ΔT^*	T_{max}
Class B	80 K	125° C
Class F	105 K	155° C
Class H	125 K	180° C

*Measurement by resistance method

Output reduction at ambient temperatures over 40° C

Ambient temperature	45° C	50° C	55° C	60° C
Reduction of nominal output to approx.	95 %	90 %	85 %	80 %

When a winding is utilized to temperature class F (105K), no output reduction is required up to an ambient temperature of 60° C. *This does not apply to motors which in their standard design are already utilized to thermal class F.*

Installation at altitudes of more than 1000 m above sea level (see also EN 60034-1)

Altitude of installation	2000 m	3000 m	4000 m
At 40°C ambient temperature and thermal class B Rated output reduced to approx.	92 %	84 %	76 %
At 40°C ambient temperature and thermal class F Rated output reduced to approx.	89 %	79 %	68 %
Full nominal output to data tables with thermal class B and ambient temperature of	32° C	24° C	16° C
Full nominal output to data tables with thermal class F and ambient temperature of	30° C	19° C	9° C

Starting rate

The permissible number of starts per hour can be taken as given in the table below, provided the following conditions are met:

Additional moment of inertia ≤ moment of inertia of the rotor: load torque rising with the square of the speed up to nominal torque; starts at even intervals.

Shaft height	Permissible No. of starts per hour for 2p		
	= 2	= 4	≥ 6
56 - 71	100	250	350
80 - 100	60	140	160
112 - 132	30	60	80
160 - 180	15	30	50
200 - 225	8	15	30
250 - 315	4	8	12

For permissible number of starts for larger and pole-changing motors please consult us, indicating the complete operating conditions.

Thermal protection

The decision on a particular type of thermal protection should be taken according to the actual operating conditions. Motors may be protected by means of current-dependent thermal protection switches, overcurrent relays and temperature detectors.

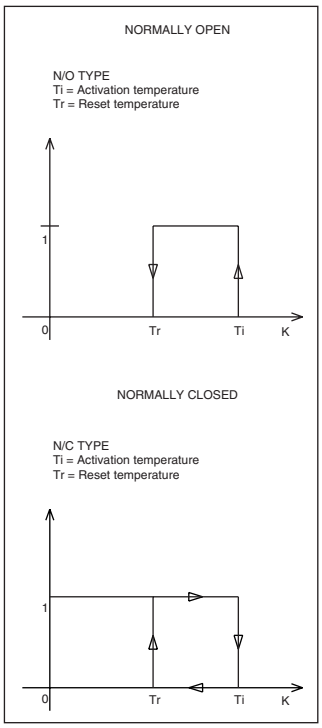
Thermal protection is possible as follows:

- Thermal protection switch with bimetal release
- Thermistor protection with semiconductor temperature detectors (PTC) in the stator winding in connection with release (if required, with additional motor protection switch).
- Bimetal temperature detector as N/C or N/O in the stator winding (if required, with additional motor protection switch).
- Resistance thermometer for monitoring winding and bearing temperature.

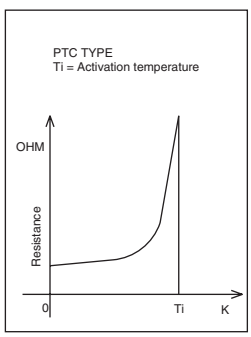
Should protection of the motor be required, we install protection switch with bimetal release up to frame size 112 and semiconductor temperature detectors in motors ≥ 132.

Although there are motors available from stock with built-in semiconductor temperature detector, a special remark has to be made in the enquiry or order when motor protection is required.

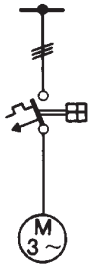
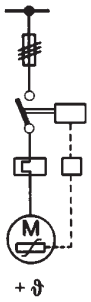
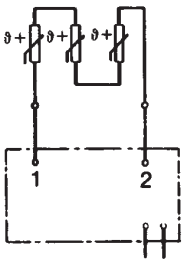
Operating specifications
Thermal cut-out



Operating specifications
of the thermistors



Examples of connection

	Protection method	Protection
	Motor protection switch with thermal and electromagnetic overcurrent release	against: • Overload in continuous service • Locked rotor
	Contactor with overcurrent relay Thermistor protection and fuse	in service against: • Overload in continous service • Long starting and braking periods • High switching rate in case of fault against: • Obstruction of cooling • Increased ambient temperature • Single-phase operation • Frequency fluctuations • Switching against locked rotor
	Semiconductor temperature detector with release	in service against: • Overload in continous service • Long starting and braking periods • High switching rate in case of fault against: • Obstruction of cooling • Increased ambient temperature • Single-phase operation • Frequency fluctuations • Switching against locked rotor

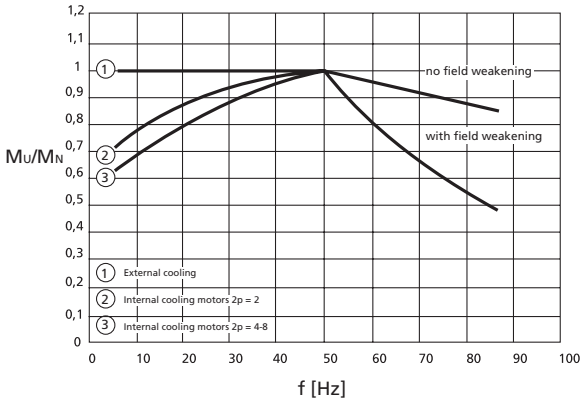
Three-phase cage motors driven by frequency converters

The motors frame sizes 90 upwards in standard design are suitable for operation on static frequency converters, taking into account the following remarks:

- Maximum converter output voltage 500V at peak voltages $\hat{U} \leq 1460V$ and $du/dt \leq 13$ kV/us. For higher converter output voltages or stresses, a special insulation is required.
- With square characteristic of the load torque, motors can be driven with their rated torque.
- For constant torque, the rated torque of motors with internal cooling must be reduced due to reduced cooling air inlet. Depending on the control range, the use of an external fan would be advisable.
- The motors frame sizes 90 – 112 are suitable for a maximum output frequency of the converter of 60 Hz (e.g. applications with square torque, control range 1 : 10, such as pumps and fans). For higher frequencies, a special range with type designation AMI is available on request. From frame size 132 upwards, motors designed Δ/Y 230/400 V, 50 Hz can be operated in delta with a maximum frequency of 87 Hz (observe mechanical limit speed).
- For motors frame size 315 we recommend an insulated bearing at the non-drive end.

The motors frame size 56 – 80 can be operated on single-phase converters up to maximum 60 Hz. (Special range with type designation AMI for operation on three-phase converters with output voltage ≥ 400 V and output frequency > 60 Hz).

The electrical values and dimensions of the range AMI in frame size 56 to 112 are identical to AM motors (see data tables pages 36-49).



Thermal maximum-torque curve for approximate determination of the required torque reduction with constant load torque curve

Noise

Depending on the operating point and converter type, converter-fed motors produce between approx. 4 - 10 dB(A) higher noise values than when supplied from the mains. For motors driven with a frequency over 50 Hz, more fan noise is produced. We recommend the use of an external fan.

Degree of protection

Depending on the accessories used.

Mechanical limit speeds

For motors of standard design, the following maximum operating speeds are permitted:

Frame size	2p = 2 min $^{-1}$	2 p = 4 - 8 min $^{-1}$
56-112 [1)]	3600	1800
132-180	6000	6000
200	5000	5000
225	4500	4500
250	4300	4300
280	4300	3800
315 S/M	4300	3600
315 L	3600	3600

[1)] Higher speeds with special range AMI

Vibration amplitude

When operating at high speeds (according to frequency > 60 Hz) a reduced vibration amplitude "R" to DIN ISO 2373/DIN VDE 0530, part 14 may be required, measured at a mains frequency of 50 Hz or 60 Hz and sinusoidal mains voltage.

Accessories

Motors are available with the following accessory:
· *Encoder* with internal or external cooling

Encoder (standard design)

Supply voltage U_B	5 V	
Pulses per revolution	500-2048	
Outputs	2 signals with rectangular pulses A, B 2 signals with inverted rectangular pulses A, B zero pulse and inverted zero pulse	
Pulse displacement between	outputs	90°
Output amplitude	U_{High}	2.5 V
	U_{Low}	0.5 V
Maximum frequency	100 kHz	
Maximum speed	3,000 (6,000) min $^{-1}$	
Temperature range	-20°C to + 85°C	
Degree of protection	IP 54	

Motors for normal continuous duty (S1) and normal operating conditions

Quotation (if submitted)	No./Date
Quantity	Units
Designation	Type
Output (for pole-changing motors, outputs referred to speeds)	kW
Speed (for pole-changing motors, outputs referred to outputs)	min^{-1}
Direction of rotation (viewed on shaft extension)	
Mounting arrangement (to IEC 60034-7)	
Degree of protection, motor/terminal box (to IEC 60034-5)	
Mains voltage	V
Mains frequency	Hz
Method of starting (direct-on-line or Y-Δ)	
Location of terminal box	
Machine to be driven	

Dimensions of cables, if these differ from those allocated by VDE 0100, referred to an ambient temperature of 40° C, or when aluminium conductors are used. It should be stated when parallel connected conductors are used.

Additional information for special designs

Second or non-standard shaft extension
Radial sealing ring
Paint coating
Corrosive protection
Vibration level
Anti-condensation heating
Temperature detectors
Noise requirements
Mechanical or electrical brake
Special stipulations

Additional information for special duties and difficult operating conditions

S 2: ... min (short-time duty)

S 3: ... % - ... min (intermittent duty)

S 4: ... % - J_M ... kgm² - J_{ext} ... kgm²
(intermittent duty with starting)

S 5: ... % - J_M ... kgm² - J_{ext} ... kgm²
(intermittent duty with electric braking)

S 6: ... % - min
(continuous-operation periodic duty with intermittent load)

S 7: J_M ... kgm² - J_{ext} ... kgm²
(continuous-operation periodic duty with electric braking)

S 8: J_M ... kgm² - J_{ext} ... kgm²
(continuous-operation periodic duty with speed changes)

S 9: ... kW equ (continuous duty with non-periodic load and speed variations). For this duty type suitable full load values should be taken as the overload concept.

S10: p/Δt .... r .... TL (Duty with discrete constant loads).
Starting conditions (no-load or loaded starting)

Shock loads

Load torque curve during run-up (characteristic)

Moment of inertia (J_{ext}) referred to the motor shaft	kgm²
Description of the type of drive (direct coupling, flat or V-belt, straight or helical gears, sprocket, crank, eccentric cam, etc.)	
Radial force (or diameter of drive element)	N
Direction of force and point of application (distance from shaft shoulder or width of drive element)	mm
Axial force and direction of application (pull/thrust)	N

Ambient conditions (e.g. increased humidity, dust accumulation, corrosive gases or vapours, increased or extremely low ambient temperature, outdoor installation, installation at altitudes over 1000 m above sea level, extraneous vibration, etc.)

Type designation

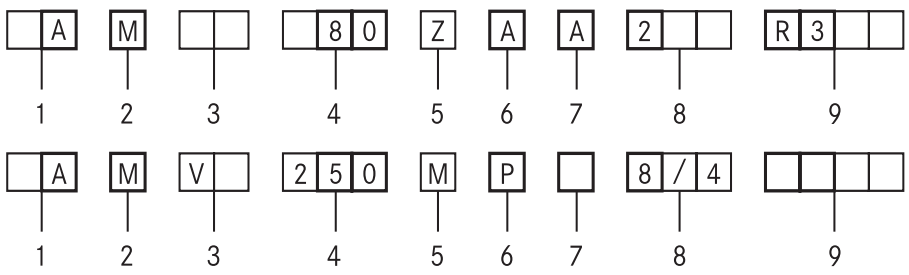
Apart from other information, it is necessary to specify the exact type designation in all enquiries, when ordering spare parts or replacement motors or when asking for documentary information.

The type designation of our motors comprises 9 points of reference, each of which may consist of several letters and/or numerals. The meaning of each symbol can be seen from the following table. For motors not included in our standard range, special symbols may be used which are not listed here.

Meaning of the symbols

Ref. point	Meaning	Description of symbols used for our motors				
1	Type of motor	A	Asynchronous motor			
2	Cooling	M G MFV	Surface cooled with external fan, cooling fins Surface cooled without external fan, cooling fins Surface cooled with forced ventilation, cooling fins			
3	Type of motor	blank V H HE I	Three-phase motor Three-phase pole-changing motor for driving fans Three-phase motor, efficiency to EPACT regulations Three-phase motor, efficiency eff 1 to CEMEP Voluntary Agreement Special design for three-phase motor driven with frequency converter			
4	Shaft centre height	56, 63, 71, 80, 90, 100, 112, 132,160, 180, 200, 225, 250, 280, 315				
5	Frame length	Z S M L	 Mechanical dimension (short) Mechanical dimension (medium) Mechanical dimension (long)			
6	Mechanical design and output value	A B C D	Frame size 56-112	Stage of development	X,P,J Y,R,L Z,V,T	Frame size 132-315
7	Frame material and/or stage of development	A G E	Aluminium frame Cast iron frame Stage of development			
8	Number of poles	2 4 6 8	4/2 8/4 4/6 6/8			
9	Special features	R3	High resistance rotor			

Examples



Three-phase squirrel cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

EFF 2

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency			Power factor	Rated current at		Direct-on-line starting			Pull-out torque ratio	Moment of inertia	Weight
						η			I_N		Starting current ratio	Breakaway torque ratio	Pull-up torque ratio			
		kW	HP	min^{-1}	50%	75%	100%	$\cos\varphi$	400V	380-420V	I_A/I_N	M_A/M_N	M_S/M_N	M_K/M_N	J 10^{-3} kgm²	kg
3000 min^{-1} (2 poles)																**Aluminium frame**
AM 56Z AA	**2**	0.09	0.12	2810	49	53	58.3	0.62	0.38	0.4	3.9	3.8	3.8	3.9	0.09	3.4
AM 56Z BA	**2**	0.12	0.16	2800	51	56	61.6	0.70	0.4	0.42	3.9	3.8	3.8	3.9	0.1	3.5
AM 63Z AA	**2**	0.18	0.25	2790	54	58	63	0.77	0.6	0.66	4.2	3	3.1	3.2	0.13	4.1
AM 63Z BA	**2**	0.25	0.33	2790	56.4	61.2	65.3	0.77	0.71	0.75	4.5	3.2	3.2	3.3	0.19	4.6
AM 63Z CA	**2***	0.37 [1]	0.50 [1]	2800	54	58	63	0.75	1.13	1.25	4.6	3.4	3.3	3.4	0.20	4.7
AM 71Z AA	**2**	0.37	0.50	2820	54	60.5	65.3	0.70	1.1	1.2	4.7	3.6	3.4	3.6	0.36	5.7
AM 71Z BA	**2**	0.55	0.75	2830	57	64	70.8	0.70	1.6	1.7	4.8	3.2	3.1	3.3	0.46	6.3
AM 71Z CA	**2***	0.75 [1]	1.0 [1]	2800	58	64.3	71	0.75	1.9	2.0	5.2	3.1	3.2	3.1	0.58	6.9
AM 80Z AA	**2**	0.75		2840	67.7	73.0	74.5	0.78	1.9	2.0	5.0	2.8	2.8	2.9	0.75	8.4
AM 80Z BA	**2**	1.1	1.5	2810	74.3	77.3	77.6	0.82	2.5	2.6	4.6	2.4	2.8	2.9	0.89	9.5
AM 80Z CA	**2***	1.5 [1]	2.0 [1]	2825	76.5	79.4	79.1	0.83	3.3	3.4	5.0	2.9	3.0	3.3	1.05	11.1
AM 90S AA	**2**	1.5	2.0	2830	75.4	78.4	78.6	0.82	3.4	3.5	5.0	3.1	2.9	3.0	1.37	12.7
AM 90S BA	**2***	1.8	2.5	2805	75.18	78.3	78.5	0.80	4.2	4.3	4.5	2.6	2.4	2.5	1.37	12.7
AM 90L CA	**2**	2.2	3.0	2860	78.6	81.4	81.8	0.81	4.9	4.9	7.1	4.1	3.6	4.0	1.8	16.0
AM 90L DA	**2***	3 [1]	4.0 [1]	2860	78.8	81.9	82.3	0.80	6.5	6.8	7.2	3.9	3.4	3.8	2.09	18.7
AM 100L AA	**2**	3	4.0	2860	81.7	82.2	82.6	0.85	6.4	6.7	6.0	3.1	3.1	3.3	2.80	19.3
AM 100L BA	**2***	4 [1]	5.5 [1]	2835	82.4	83.8	83.0	0.88	8.0	8.1	6.2	2.9	2.5	2.9	3.35	19.7
AM 100L CA	**2***	5.5 [1]	7.5 [1]	2865	83.5	85.3	85.0	0.85	10.8	11.0	7.2	3.5	3.4	4.1	4.5	25.9
AM 112M AA	**2**	4	5.5	2900	80.9	84.2	85.0	0.84	8.5	8.7	8.1	3.8	3.6	4.0	6.48	27.4
AM 112M BA	**2***	5.5 [1]	7.5 [1]	2930	81.0	84.7	86.2	0.81	11.5	12.3	9.0	4.2	2.6	3.6	8.58	33.6
AM 132S YA	**2**	5.5	7.5	2885	84.7	86.2	85.7	0.86	10.8	11.0	6.6	2.5	2.1	2.9	10.0	40
AM 132S ZA	**2**	7.5	10.0	2890	86.5	87.6	87.0	0.89	14.1	14.5	7.2	2.6	2.2	3.0	14.0	45
AM 132M ZA	**2***	9.2 [1]	12.5 [1]	2870	84.5	86.6	86.7	0.83	18.7	19.8	7.0	2.8	2.4	3.2	14.0	48
AM 132M RA	**2***	11	15.0	2900	88.2	89.2	88.7	0.87	20.6	21	7.8	2.9	2.5	3.3	20.5	53
AM 132M TA	**2***	15 [1]	20.0 [1]	2890	88.0	89.0	88.5	0.88	28.0	28.5	7.8	3.1	2.6	3.4	25.0	59
AM 160M VA	**2**	11	15	2925	86.6	88.5	88.7	0.84	21.5	22	6.7	2.3	2.2	3.0	28	81
AM 160M XA	**2**	15	20	2920	88.0	89.6	89.7	0.85	28.5	29.5	7.2	2.4	2.2	3.1	36	93
AM 160L XA	**2**	18.5	25	2925	88.8	90.3	90.4	0.86	34.5	35	7.6	2.7	2.5	3.3	42	101
AM 160L RA	**2***	22 [1]	30 [1]	2920	89.0	90.8	90.8	0.87	41	42	7.9	2.7	2.5	3.3	52	114
AM 180M XA	**2**	22	30	2925	89.1	90.7	90.8	0.86	41	42	7.4	2.5	2.3	3.2	65	130
AM 180M RA	**2***	30 [1]	40 [1]	2925	89.3	91.4	91.5	0.86	56	57.5	7.9	2.7	2.5	3.4	88	150
AM 200L LA	**2**	30	40	2945	89.2	91.1	91.6	0.85	56	57	7.8	2.2	2.0	3.0	120	172
AM 200L NA	**2**	37	50	2950	90.0	91.8	92.2	0.86	67.5	69	7.7	2.2	2.0	3.0	145	190

1) Temperature rise to class F

***** Higher output (progressive motor)

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency			Power factor	Rated current at		Direct-on-line starting				Moment of inertia	Weight
						η		$\cos\varphi$	I_N		Starting current ratio I_A/I_N	Breakaway torque ratio M_A/M_N	Pull-up torque ratio M_S/M_N	Pull-out torque ratio M_K/M_N	J	
		kW	HP	min^{-1}	50%	75%	100%		400V	380-420V					10^{-3} kgm²	kg
3000 min^{-1} (2 poles)																**Cast iron frame**
AM 132S YG	**2**	5.5	7.5	2885	84.7	86.2	85.7	0.86	10.8	11.0	6.6	2.5	2.1	2.9	10.0	55
AM 132S ZG	**2**	7.5	10.0	2890	86.5	87.6	87.0	0.89	14.1	14.5	7.2	2.6	2.2	3.0	14.0	60
AM 132M ZG	**2***	9.2 [1]	12.5 [1]	2870	84.5	86.6	86.7	0.83	18.7	19.8	7.0	2.8	2.4	3.2	14.0	63
AM 132M RG	**2***	11	15.0	2900	88.2	89.2	88.7	0.87	20.6	21	7.8	2.9	2.5	3.3	20.5	68
AM 132M TG	**2***	15 [1]	20.0 [1]	2890	88.0	89.0	88.5	0.88	28.0	28.5	7.8	3.1	2.6	3.4	25.0	74
AM 160M VG	**2**	11	15	2925	86.6	88.5	88.7	0.84	21.5	22	6.7	2.3	2.2	3.0	28	101
AM 160M XG	**2**	15	20	2920	88.0	89.6	89.7	0.85	28.5	29.5	7.2	2.4	2.2	3.1	36	113
AM 160L XG	**2**	18.5	25	2925	88.8	90.3	90.4	0.86	34.5	35	7.6	2.7	2.5	3.3	42	121
AM 160L RG	**2***	22 [1]	30 [1]	2920	89.0	90.8	90.8	0.87	41	42	7.9	2.7	2.5	3.3	52	134
AM 180M XG	**2**	22	30	2925	89.1	90.7	90.8	0.86	41	42	7.4	2.5	2.3	3.2	65	155
AM 180M RG	**2***	30 [1]	40 [1]	2925	89.3	91.4	91.5	0.86	56	57.5	7.9	2.7	2.5	3.4	88	175
AM 200L LG	**2**	30	40	2945	89.2	91.1	91.6	0.85	56	57	7.8	2.2	2.0	3.0	120	212
AM 200L NG	**2**	37	50	2950	90.0	91.8	92.2	0.86	67.5	69	7.7	2.2	2.0	3.0	145	230
AM 225M N	**2**	45	60	2945	90.9	92.4	92.6	0.89	80	83	7.8	2.4	1.9	2.8	270	310
AM 250M N	**2**	55	75	2950	90.9	92.7	93.1	0.89	96	101	7.5	2.3	1.8	3.0	424	410
AM 280S T	**2**	75	100	2975	90.9	92.9	93.7	0.87	134	136	7.2	1.9	1.5	3.2	770	540
AM 280M T	**2**	90	125	2975	93.6	94.8	94.1	0.89	156	161	7.3	1.9	1.5	3.2	957	615
AM 315S YE	**2**	110	150	2980	93.2	94.5	95.0	0.85	195	200	7.7	2.2	1.6	3.3	1000	650
AM 315M ZE	**2**	132	180	2980	94.1	95.2	95.5	0.88	227	235	6.8	2.4	1.3	2.6	1200	810
AM 315L YE	**2**	160	220	2980	94.7	95.7	95.9	0.90	267	280	7.2	2.5	1.3	2.6	1400	900
AM 315L ZE	**2**	200 [1]	270 [1]	2980	95.2	96.1	96.3	0.91	329	347	7.8	2.7	1.3	2.7	1600	1000

1) Temperature rise to class F

***** Higher output (progressive motor)

Three-phase squirrel cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

EFF 2

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency			Power factor	Rated current at		Direct-on-line starting				Moment of inertia	Weight
						η		$\cos\varphi$	I_N		Starting current ratio I_A/I_N	Breakaway torque ratio M_A/M_N	Pull-up torque ratio M_S/M_N	Pull-out torque ratio M_K/M_N	J	
		kW	HP	min^{-1}	50%	75%	100%		400V	380-420V					10^{-3} kgm^2	kg
1500 min^{-1} (4 poles)																**Aluminium frame**
AM 56Z AA	**4**	0.06	0.08	1300	42	44	48	0.55	0.35	0.4	2.6	2.1	2.0	2.1	0.14	3.2
AM 56Z BA	**4***	0.09	0.12	1330	43	47	51	0.60	0.4	0.45	2.5	2.2	2.1	2.2	0.14	3.3
AM 63Z AA	**4**	0.12	0.16	1350	46	50	54	0.69	0.45	0.5	2.4	2.0	1.9	2.0	0.25	4.1
AM 63Z BA	**4**	0.18	0.25	1330	47	50	56	0.70	0.6	0.65	2.3	1.9	1.8	1.9	0.27	4.6
AM 63Z CA	**4***	0.25	0.33	1360	49	52.5	58	0.60	1.0	1.2	2.7	2.2	2.0	2.1	0.30	4.9
AM 71Z AA	**4**	0.25	0.33	1340	55	59	64	0.71	0.7	0.8	3.2	1.9	1.8	2.0	0.63	5.2
AM 71Z BA	**4**	0.37	0.50	1370	60	63	67	0.67	1.18	1.25	3.3	2.2	2.1	2.2	0.76	5.4
AM 71Z CA	**4***	0.55 [1]	0.75 [1]	1380	61	64	68	0.67	1.73	1.8	3.6	2.4	2.3	2.4	0.98	6.3
AM 80Z AA	**4**	0.55	0.75	1400	67.0	69.0	70.0	0.72	1.6	1.7	3.6	2.6	2.5	2.6	1.58	8.2
AM 80Z BA	**4**	0.75	1.0	1410	62.5	69.0	70.6	0.71	2.2	2.3	4.4	2.8	2.3	2.8	2.00	9.3
AM 80Z CA	**4***	1.1 [1]	1.5 [1]	1385	74.1	76.4	75.9	0.77	2.8	2.9	4.4	2.5	2.5	2.6	2.41	10.6
AM 90S AA	**4**	1.1	1.5	1400	69.6	75.4	76.5	0.78	2.7	2.9	5.2	2.5	2.4	2.8	2.5	12.5
AM 90L BA	**4**	1.5	2.0	1400	75.6	78.7	78.6	0.77	3.6	3.7	5.7	2.8	2.6	3.0	3.13	14.5
AM 90L CA	**4***	1.8 [1]	2.5 [1]	1380	75.1	77.8	77.3	0.80	4.2	4.3	5.5	2.7	2.5	2.9	3.13	14.5
AM 90L DA	**4***	2.2 [1]	3.0 [1]	1400	76.3	79.3	79.3	0.75	5.3	5.5	4.8	2.9	2.8	3.2	4.05	17
AM 100L AA	**4**	2.2	3.0	1435	77.5	80.2	81.0	0.74	5.4	5.6	5.3	2.5	2.4	2.7	4.6	19.5
AM 100L BA	**4**	3	4.0	1425	81.7	83.4	82.8	0.76	6.8	6.9	4.6	2.4	2.3	2.5	5.58	22.5
AM 100L CA	**4***	4 [1]	5.5 [1]	1400	82.1	83.0	81.6	0.78	9.2	9.3	6.0	2.6	2.4	2.9	6.05	25
AM 112M AA	**4**	4	5.5	1430	84.5	85.3	84.2	0.81	8.5	8.8	6.3	2.2	2.0	2.8	12.2	29.5
AM 112M BA	**4***	5.5 [1]	7.5 [1]	1430	85.9	86.2	85.2	0.83	11.4	11.7	6.5	2.2	2.0	2.9	15.2	34
AM 132S ZA	**4**	5.5	7.5	1445	85.6	86.6	85.7	0.82	11.3	11.7	6.2	2.4	2.1	2.9	22	46
AM 132M ZA	**4**	7.5	10.0	1445	87.7	88.1	87.0	0.84	14.8	15.5	6.5	2.6	2.1	2.9	30	55
AM 132M ZA	**4***	9.2 [1]	12.5 [1]	1440	87.3	88.1	87.2	0.83	18.5	19.2	6.4	2.7	2.2	3.0	30	56
AM 132M TA	**4***	11 [1]	15.0 [1]	1430	87.5	87.9	86.8	0.84	22	22.5	6.7	2.8	2.2	3.1	36	65
AM 160M XA	**4**	11	15	1460	88.4	89.2	88.6	0.83	21.5	22.5	6.8	2.3	2.1	2.9	59	86
AM 160L XA	**4**	15	20	1460	89.6	90.3	89.6	0.85	29	29.5	7.2	2.4	2.1	3.0	82	102
AM 160L ZA	**4***	18.5 [1]	25 [1]	1450	89.2	90.2	90.2	0.81	37	38	7.4	2.7	2.4	3.3	82	102
AM 160L RA	**4***	22 [1]	30 [1]	1455	89.8	90.7	90.5	0.82	42	43	7.5	2.7	2.4	3.3	93	112
AM 180M XA	**4**	18.5	25	1460	90.0	90.8	90.3	0.84	35.5	36.5	7.2	2.7	2.2	3.0	105	125
AM 180L XA	**4**	22	30	1460	90.4	91.1	90.5	0.84	42	43.5	7.3	2.7	2.2	3.0	118	135
AM 180L RA	**4***	30 [1]	40 [1]	1455	90.4	91.4	91.4	0.82	58	60	7.8	3.0	2.4	3.2	150	150
AM 200L NA	**4**	30	40	1465	90.5	91.6	91.5	0.84	56.5	58.5	7.0	2.4	1.8	2.6	195	185
AM 200L FA	**4***	37	50	1465	91.7	92.4	92.4	0.83	69.5	71.5	7.4	2.6	2.0	2.8	248	215

1) Temperature rise to class F

***** Higher output (progressive motor)

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency			Power factor	Rated current at		Direct-on-line starting			Pull-out torque ratio	Moment of inertia	Weight
						η		$\cos\varphi$	I_N		Starting current ratio I_A/I_N	Breakaway torque ratio M_A/M_N	Pull-up torque ratio M_S/M_N	M_K/M_N	J	
		kW	HP	min^{-1}	50%	75%	100%		400V	380-420V					10^{-3} kgm²	kg
1500 min^{-1} (4 poles)																**Cast iron frame**
AM 132S ZG	**4**	5.5	7.5	1445	85.6	86.6	85.7	0.82	11.3	11.7	6.2	2.4	2.1	2.9	22	61
AM 132M ZG	**4**	7.5	10.0	1445	87.7	88.1	87.0	0.84	14.8	15.5	6.5	2.6	2.1	2.9	30	70
AM 132M ZG	**4***	9.2 [1]	12.5 [1]	1440	87.3	88.1	87.2	0.83	18.5	19.2	6.4	2.7	2.2	3.0	30	71
AM 132M TG	**4***	11 [1]	15.0 [1]	1430	87.5	87.9	86.8	0.84	22	22.5	6.7	2.8	2.2	3.1	36	80
AM 160M XG	**4**	11	15	1460	88.4	89.2	88.6	0.83	21.5	22.5	6.8	2.3	2.1	2.9	59	106
AM 160L XG	**4**	15	20	1460	89.6	90.3	89.6	0.85	29	29.5	7.2	2.4	2.1	3.0	82	122
AM 160L ZG	**4***	18.5 [1]	25 [1]	1450	89.2	90.2	90.2	0.81	37	38	7.4	2.7	2.4	3.3	82	122
AM 160L RG	**4***	22 [1]	30 [1]	1455	89.8	90.7	90.5	0.82	42	43	7.5	2.7	2.4	3.3	93	132
AM 180M XG	**4**	18.5	25	1460	90.0	90.8	90.3	0.84	35.5	36.5	7.2	2.7	2.2	3.0	105	150
AM 180L XG	**4**	22	30	1460	90.4	91.1	90.5	0.84	42	43.5	7.3	2.7	2.2	3.0	118	160
AM 180L RG	**4***	30 [1]	40 [1]	1455	90.4	91.4	91.4	0.82	58	60	7.8	3.0	2.4	3.2	150	175
AM 200L NG	**4**	30	40	1465	90.5	91.6	91.5	0.84	56.5	58.5	7.0	2.4	1.8	2.6	195	225
AM 200L FG	**4***	37 [1]	50 [1]	1465	91.7	92.4	92.4	0.83	69.5	71.5	7.4	2.6	2.0	2.8	248	255
AM 225S N	**4**	37	50	1475	90.8	92.1	92.2	0.84	69.5	71.5	7.5	2.3	2.0	2.9	356	290
AM 225M N	**4**	45	60	1475	91.7	92.7	92.6	0.86	81.5	85	7.6	2.3	2.0	2.9	461	330
AM 250M N	**4**	55	75	1475	92.6	93.3	93.1	0.84	103	107	6.5	3.5	2.1	2.4	640	385
AM 250M K	**4***	75	100	1470	92.3	93.4	93.6	0.82	142	146	7.3	3.9	2.3	2.7	812	440
AM 280S T	**4**	75	100	1480	92.4	93.6	93.7	0.84	139	143	6.5	2.1	1.8	2.7	990	510
AM 280M T	**4**	90	125	1480	92.9	94.0	94.1	0.84	165	171	6.6	2.2	1.8	2.7	1260	565
AM 315S YE	**4**	110	150	1480	94.5	95.0	95.1	0.85	199	208	7.1	2.3	1.8	2.8	1400	620
AM 315M YE	**4**	132	180	1485	94.1	95.2	95.5	0.86	228	239	7.3	2.1	1.6	2.8	2200	860
AM 315M ZE	**4**	160	220	1485	94.6	95.5	95.7	0.88	274	288	7.3	2.1	1.5	2.8	2500	940
AM 315L ZE	**4**	200 [1]	270 [1]	1485	95.0	95.8	96.0	0.89	342	359	7.6	2.3	1.6	2.8	3100	1120

1) Temperature rise to class F

***** Higher output (progressive motor)

Three-phase squirrel cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency			Power factor	Rated current at		Direct-on-line starting				Moment of inertia	Weight
						η		$\cos\varphi$	I_N		Starting current ratio I_A/I_N	Breakaway torque ratio M_A/M_N	Pull-up torque ratio M_S/M_N	Pull-out torque ratio M_K/M_N	J	
		kW	HP	min^{-1}	50%	75%	100%		400V	380-420V					10^{-3} kgm^2	kg
1000 min^{-1} (6 poles)																**Aluminium frame**
AM 71Z AA	**6**	0.18	0.25	850	44.0	47.0	51.0	0.73	0.7	0.75	2.2	1.6	1.5	1.6	0.6	5.7
AM 71Z BA	**6**	0.25 1)	0.33 1)	870	46.0	50.0	54.0	0.68	1.0	1.1	2.5	1.7	1.6	1.7	0.9	6.3
AM 80Z AA	**6**	0.37	0.5	910	47.0	58.0	60.0	0.72	1.2	1.25	2.7	1.6	1.6	2.1	1.97	8
AM 80Z BA	**6**	0.55	0.75	910	60.0	64.0	68.0	0.67	1.8	1.8	2.9	2.2	2.1	2.1	2.47	9.4
AM 90S AA	**6**	0.75	1	910	71.0	73.0	72.0	0.63	2.4	2.5	2.9	1.7	1.5	1.7	3.18	11.6
AM 90L BA	**6**	1.1	1.5	908	71.0	73.0	72.0	0.63	3.5	3.6	3.0	1.7	1.5	1.7	4.78	15
AM 100L AA	**6**	1.5	2	930	70.0	75.0	72.0	0.71	4.2	4.4	3.7	1.8	1.8	2.3	6.73	17.5
AM 100L BA	**6***	1.8	2.5	940	71.0	75.0	76.0	0.67	5.1	5.3	4.2	2.4	2.4	2.8	9.43	22
AM 112M AA	**6**	2.2	3	940	81.0	83.0	82.0	0.72	5.3	5.4	4.4	2.4	2.4	2.6	14.18	26
AM 112M BA	**6***	2.6	3.5	930	82.2	83.7	82.4	0.73	6.3	6.5	4.9	3.0	2.9	3.1	16.73	29.7
AM 112M CA	**6***	3	4	940	83.0	84.0	84.0	0.75	7.0	7.2	5.3	2.9	2.9	2.9	18.7	39
AM 132S ZA	**6**	3	4	955	81.6	83.7	83.4	0.75	7.0	7.1	5.8	2.1	1.8	2.7	27	43
AM 132M YA	**6**	4	5.5	955	83.2	84.9	84.5	0.76	9.1	9.2	6.2	2.3	1.9	2.8	34	49
AM 132M ZA	**6**	5.5	7.5	955	83.8	85.2	84.6	0.77	12.3	12.5	6.2	2.3	1.9	2.8	40	54
AM 132M TA	**6***	7.5 1)	10 1)	950	85.0	85.7	85.0	0.77	16.5	16.9	6.3	2.3	1.9	2.8	46	62
AM 160M ZA	**6**	7.5	10	965	86.8	87.7	87.0	0.82	15.2	15.9	5.9	1.9	1.7	2.5	78	83
AM 160L ZA	**6**	11	15	965	88.6	89.0	88.1	0.82	22	22.5	6.1	2.0	1.8	2.6	102	100
AM 180L ZA	**6**	15	20	970	90.5	90.8	90.0	0.83	29	30	6.7	2.2	1.8	2.8	169	130
AM 200L PA	**6**	18.5	25	970	89.3	90.4	90.2	0.82	36	37	5.3	2.2	1.8	2.3	260	170
AM 200L RA	**6**	22	30	975	89.9	91.0	90.8	0.82	42.5	44	5.7	2.2	1.8	2.3	285	180
1000 min^{-1} (6 poles)																**Cast iron frame**
AM 132S ZG	**6**	3	4	955	81.6	83.7	83.4	0.75	7.0	7.1	5.8	2.1	1.8	2.7	27	58
AM 132M YG	**6**	4	5.5	955	83.2	84.9	84.5	0.76	9.1	9.2	6.2	2.3	1.9	2.8	34	64
AM 132M ZG	**6**	5.5	7.5	955	83.8	85.2	84.6	0.77	12.3	12.5	6.2	2.3	1.9	2.8	40	69
AM 132M TG	**6***	7.5 1)	10 1)	950	85.0	85.7	85.0	0.77	16.5	16.9	6.3	2.3	1.9	2.8	46	77
AM 160M ZG	**6**	7.5	10	965	86.8	87.7	87.0	0.82	15.2	15.9	5.9	1.9	1.7	2.5	78	103
AM 160L ZG	**6**	11	15	965	88.6	89.0	88.1	0.82	22	22.5	6.1	2.0	1.8	2.6	102	120
AM 180L ZG	**6**	15	20	970	90.5	90.8	90.0	0.83	29	30	6.7	2.2	1.8	2.8	169	155
AM 200L PG	**6**	18.5	25	970	89.3	90.4	90.2	0.82	36	37	5.3	2.2	1.8	2.3	260	210
AM 200L RG	**6**	22	30	975	89.9	91.0	90.8	0.82	42.5	44	5.7	2.2	1.8	2.3	285	220
AM 225M P	**6**	30	40	975	90.7	91.7	91.5	0.83	56	58	5.7	2.3	1.6	2.3	536	290
AM 250M P	**6**	37	50	975	90.8	91.9	91.8	0.84	68	71	7.1	3.2	2.5	2.6	880	380
AM 280S V	**6**	45	60	985	91.4	92.5	92.4	0.86	84	87	5.6	1.8	1.5	2.4	1350	460
AM 280M V	**6**	55	75	985	91.5	92.7	92.6	0.86	102	106	5.6	1.8	1.5	2.4	1640	515
AM 315S YE	**6**	75	100	985	93.2	94.0	93.9	0.87	134	139	6.8	1.9	1.7	2.6	2200	620
AM 315M YE	**6**	90	125	988	94.2	94.8	94.5	0.87	159	167	7.6	2.5	2.0	2.6	3100	790
AM 315M ZE	**6**	110	150	987	94.5	95.0	94.7	0.87	192	202	7.4	2.5	2.0	2.6	3600	860
AM 315L ZE	**6**	132 1)	180 1)	987	95.0	95.3	94.9	0.88	229	241	7.7	2.7	2.0	2.5	4300	990

1) Temperature rise to class F

***** Higher output (progressive motor)

Three-phase squirrel cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency			Power factor	Rated current at		Direct-on-line starting				Moment of inertia	Weight
											Starting current ratio	Breakaway torque ratio	Pull-up torque ratio	Pull-out torque ratio		
		kW	HP	min^{-1}	50%	η 75%	100%	cos φ	400V	I_N 380-420V	I_A/I_N	M_A/M_N	M_S/M_N	M_K/M_N	J 10^{-3} kgm^2	kg
750 min^{-1} (8 poles)																**Aluminium frame**
AM 71Z AA	**8**	0.12	0.16	670	40	44	49	0.51	0.7	0.75	2.4	2.5	2.4	2.5	0.90	6.3
AM 80Z AA	**8**	0.25	0.33	680	40	47	51	0.62	1.1	1.2	2.2	1.8	1.9	2.0	1.97	8
AM 90S AA	**8**	0.37	0.50	680	52	58	59	0.53	1.7	1.8	2.1	1.4	1.3	1.6	3.18	11.4
AM 90L BA	**8**	0.55	0.75	680	52	58	59	0.54	2.5	2.7	2.1	1.4	1.3	1.6	4.78	15
AM 100L AA	**8**	0.75	1.0	690	59	64	65	0.65	2.6	2.8	3.0	1.6	1.5	1.7	6.72	17.6
AM 100L BA	**8**	1.1	1.5	690	59	67	68	0.62	3.9	4.0	3.0	1.9	1.3	1.4	15.93	22.6
AM 112M AA	**8**	1.5	2.0	696	66	69	70	0.66	4.6	4.8	4	1.8	2.0	2.4	16.70	35
AM 132S ZA	**8**	2.2	3.0	700	79.3	80.5	79.0	0.72	5.70	5.90	4.2	1.7	1.6	2.1	27	43
AM 132M ZA	**8**	3	4.0	700	81.4	82.3	80.5	0.72	7.50	7.90	4.3	1.7	1.6	2.1	34	50
AM 160M YA	**8**	4	5.5	725	83.5	84.9	84.5	0.72	9.40	10.1	4.8	1.7	1.6	2.3	78	83
AM 160M ZA	**8**	5.5	7.5	725	84.3	85.6	85.2	0.72	12.9	14.0	4.8	1.7	1.6	2.3	90	89
AM 160L ZA	**8**	7.5	10.0	725	85.0	86.3	85.8	0.73	17.4	18.2	4.8	1.7	1.6	2.3	110	100
AM 180L ZA	**8**	11	15	725	86.7	87.8	86.9	0.73	25.0	25.5	4.6	2.1	1.4	1.9	215	150
AM 200L RA	**8**	15	20	730	87.2	88.8	88.5	0.76	32.0	33.5	5.3	2.3	1.9	2.5	285	180
750 min^{-1} (8 poles)																**Cast iron frame**
AM 132S ZG	**8**	2.2	3.0	700	79.3	80.5	79.0	0.72	5.70	5.90	4.2	1.7	1.6	2.1	27	58
AM 132M ZG	**8**	3	4.0	700	81.4	82.3	80.5	0.72	7.50	7.90	4.3	1.7	1.6	2.1	34	65
AM 160M YG	**8**	4	5.5	725	83.5	84.9	84.5	0.72	9.40	10.1	4.8	1.7	1.6	2.3	78	103
AM 160M ZG	**8**	5.5	7.5	725	84.3	85.6	85.2	0.72	12.9	14.0	4.8	1.7	1.6	2.3	90	109
AM 160L ZG	**8**	7.5	10.0	725	85.0	86.3	85.8	0.73	17.4	18.2	4.8	1.7	1.6	2.3	110	120
AM 180L ZG	**8**	11	15	725	86.7	87.8	86.9	0.73	25.0	25.5	4.6	2.1	1.4	1.9	215	175
AM 200L RG	**8**	15	20	730	87.2	88.8	88.5	0.76	32.0	33.5	5.3	2.3	1.9	2.5	285	220
AM 225S P	**8**	18.5	25	730	88.6	89.9	89.5	0.77	39.0	41.0	5.2	2.3	1.9	2.2	438	255
AM 225M P	**8**	22	30	730	88.7	89.9	89.5	0.77	46.6	48.0	5.6	2.5	2.0	2.3	538	285
AM 250M P	**8**	30	40	730	88.7	90.2	90.2	0.78	61.0	65.0	6.5	3.2	2.5	2.6	1080	400
AM 280S V	**8**	37	50	740	91.1	92.3	92.2	0.81	74.0	74.0	6.0	2.1	1.7	2.3	1520	480
AM 280M V	**8**	45	60	740	91.1	92.4	92.3	0.81	90.0	90.0	6.0	2.1	1.7	2.3	1860	500
AM 315S YE	**8**	55	75	738	92.2	93.0	92.7	0.82	105	112	6.1	2.2	1.7	2.3	2200	620
AM 315M YE	**8**	75	100	738	93.2	94.0	93.8	0.82	142	150	6.1	2.4	1.8	2.1	3100	790
AM 315M ZE	**8**	90	125	738	93.4	94.2	94.0	0.82	169	179	6.2	2.5	1.8	2.1	3600	900
AM 315L ZE	**8**	110 [1]	150 [1]	738	93.5	94.3	94.1	0.82	206	218	6.4	2.7	1.8	2.1	4300	990

1) Temperature rise to class F

Pole-changing squirrel-cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency	Power factor	Rated current at		Direct-on-line starting		Moment of inertia	Weight
									Starting current ratio	Breakaway torque ratio		
		kW	HP	min^{-1}	η 100%	$cos\ \varphi$	400V I_N	380-420V I_N	I_A/I_N	M_A/M_N	J $10^{-3}\ kgm^2$	kg
1500/3000 min^{-1} (4/2 poles) - Dahlander connection Δ/YY												
AM 63Z AA	**4/2**	0.20/0.30	0.27/0.40	1345/2700	56/65	0.65/0.81	0.8/0.83	0.89/0.88	2.4/3.2	2.1/2.1	0.40	4.6
AM 71Z AA	**4/2**	0.30/0.45	0.40/0.65	1374/2830	61/66	0.78/0.73	1.0/1.35	1.2/1.5	3.3/3.0	2.3/2.1	0.76	6.3
AM 80Z AA	**4/2**	0.45/0.60	0.65/0.80	1390/2760	64/68.8	0.75/0.80	1.4/1.6	1.5/1.7	3.8/4.0	2.3/2.2	1.58	8.3
AM 80Z BA	**4/2**	0.55/0.75	0.75/1.0	1435/2850	70/71.2	0.67/0.77	1.7/2.0	1.8/2.1	4.5/5.0	2.6/2.8	2.00	11.5
AM 80Z CA	**4/2**	0.8/1.1	1.1/1.5	1425/2830	76.1/77.2	0.70/0.79	2.2/2.6	2.5/2.8	4.5/4.9	2.5/2.7	2.41	14.7
AM 90L AA	**4/2**	1.2/1.55	1.6/2.1	1435/2850	77.4/78.3	0.71/0.79	3.2/3.7	3.4/3.9	4.7/5.1	2.6/2.7	3.10	15.6
AM 90L BA	**4/2**	1.6/2.0 [1]	2.15/2.7 [1]	1390/2810	73.5/75.5	0.78/0.86	4.0/4.6	4.1/4.7	4.1/5.5	2.7/2.6	3.73	17.1
AM 100L AA	**4/2**	1.8/2.5	2.5/3.35	1420/2865	78.5/77.4	0.76/0.84	4.5/5.6	4.7/5.8	5.2/5.5	2.2/2.2	4.60	21.4
AM 100L BA	**4/2**	2.2/3.0	3.0/4.0	1410/2830	74.6/71.4	0.72/0.82	5.9/7.4	6.1/7.7	4.2/4.3	1.8/2.0	4.60	22.5
AM 100L CA	**4/2**	2.6/3.3	3.5/4.4	1430/2890	82.6/78.6	0.78/0.76	5.9/8.0	6.1/8.5	4.7/5.5	1.9/2.2	5.58	23.2
AM 112M AA	**4/2**	3.3/4.4	4.4/5.9	1410/2800	77.4/75.4	0.82/0.85	7.5/9.9	7.8/10.6	4.5/5.1	2.1/2.4	13.30	36.1
AM 132S ZA	**4/2**	4.7/6	6.4/8	1440/2880	85/83	0.83/0.88	9.7/12	10.2/12.8	5.3/6.0	2.1/2.1	22.00	46
AM 132M ZA	**4/2**	6.4/7.8	8.7/10.5	1440/2900	86/85	0.84/0.89	13/15	13.5/16	5.5/6.7	2.2/2.3	30.00	55
AM 160M ZA	**4/2**	8.7/10.7	11.7/14.5	1450/2925	88/89	0.83/0.85	17.5/21.5	18.5/22.5	6.4/7.3	2.0/2.2	59.00	87
AM 160L ZA	**4/2**	12.5/16.5	17/22.5	1465/2940	89/90	0.84/0.85	25.5/32	27/34	6.8/7.5	2.2/2.4	82.00	102
AM 180M ZA	**4/2**	15/19.5	20/26.5	1465/2955	89/87	0.80/0.88	30/36.5	31.5/38.5	5.8/7.2	2.0/1.8	112.0	130
AM 180L ZA	**4/2**	17.5/23	24/31	1465/2950	90/88	0.81/0.86	34.5/43	36.5/46	6.5/7.5	2.0/1.8	132.0	140
AM 200L PG	**4/2**	24/29	32.5/39	1470/2955	91/89.5	0.83/0.89	46/52	48/55	6.2/7.8	2.1/2.5	206.0	230
AM 200L RG	**4/2**	26/33	35/45	1470/2955	91.5/89.5	0.84/0.91	50/59	52/62	6.4/7.9	2.0/2.2	248.0	255
AM 225S P	**4/2**	30/38	40/52	1470/2965	92/91	0.85/0.91	55/66	58/70	5.8/7.8	1.7/1.8	356.0	325
AM 225M P	**4/2**	34/46 [1]	46/63 [1]	1475/2960	92/91	0.85/0.90	63/81	66/85	6.6/7.8	1.9/1.8	428.0	330
AM 250M P	**4/2**	50/58	68/79	1470/2965	93/92.5	0.85/0.90	92/100	96/104	5.8/8.6	3.0/3.5	750.0	465
AM 280S V	**4/2**	60/72 [1]	82/98 [1]	1480/2975	94/93	0.85/0.91	108/122	114/129	5.9/8.5	2.0/2.2	1200.0	580
AM 280M V	**4/2**	70/84 [1]	95/114 [1]	1480/2975	94/93	0.85/0.91	126/142	133/150	5.9/8.5	2.0/2.2	1400.0	620
AM 315S ZE	**4/2**	85/115	116/156	1485/2970	94.5/93	0.86/0.91	150/195	156/203	6.0/7.4	1.6/1.5	2200.0	860
AM 315M ZE	**4/2**	100/125	136/170	1485/2970	95/94	0.87/0.91	175/210	182/217	6.6/7.9	1.7/1.6	3100.0	940
AM 315L ZE	**4/2**	120/150	163/204	1485/2970	95/94	0.87/0.91	210/255	219/264	6.6/7.9	1.7/1.6	3100.0	1120

1) Temperature rise to class F

Pole-changing squirrel-cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency	Power factor	Rated current at		Direct-on-line starting		Moment of inertia	Weight
									Starting current ratio	Breakaway torque ratio		
		kW	HP	min^{-1}	η 100%	$\cos\varphi$	400V	I_N 380-420V	I_A/I_N	M_A/M_N	J 10^{-3} kgm²	kg
750/1500 min^{-1} (8/4 poles) - Dahlander connection Δ/YY												
AM 71Z AA	**8/4**	0.09/0.15	0.12/0.20	610/1310	40/56	0.61/0.75	0.53/0.52	0.59/0.57	2.5/3.2	1.6/1.6	0.71	6.3
AM 80Z AA	**8/4**	0.18/0.37	0.25/0.50	700/1370	43.2/58.7	0.63/0.83	1.0/1.1	1.1/1.2	2.6/3.4	1.8/1.6	1.97	7.9
AM 80Z BA	**8/4**	0.26/0.51	0.35/0.68	700/1360	44.1/61.2	0.60/0.88	1.2/1.4	1.3/1.5	2.5/3.6	2.0/1.6	2.47	9.2
AM 90S AA	**8/4**	0.37/0.75	0.50/1.0	690/1385	52.2/67.1	0.58/0.82	1.8/2.0	1.9/2.1	2.8/3.9	1.9/1.8	3.18	13.5
AM 90L BA	**8/4**	0.5/1.0	0.67/1.34	690/1410	52.2/72.5	0.58/0.80	2.4/2.4	2.5/2.5	3.3/4.0	2.3/1.9	4.78	15.7
AM 100L AA	**8/4**	0.7/1.4	0.94/1.9	700/1440	57.2/78.5	0.50/0.78	3.5/3.3	3.7/3.4	2.8/4.3	2.1/1.9	5.58	21.9
AM 100L BA	**8/4**	0.9/1.8 [1]	1.2/2.5 [1]	690/1415	62/76	0.56/0.87	3.8/4.0	4.0/4.3	2.5/4.5	1.9/1.8	6.00	23.7
AM 112M AA	**8/4**	1/1.8	1.34/2.5	710/1445	66.1/78.5	0.61/0.82	4.1/4.1	4.4/4.2	3.9/6.3	2.2/2.1	14.18	31.7
AM 112M BA	**8/4**	1.3/2.6 [1]	1.75/3.0 [1]	705/1420	70.0/76.3	0.65/0.88	4.6/5.7	4.8/5.9	3.2/4.8	2.1/2.0	16.70	34.2
AM 132S ZA	**8/4**	1.8/4	2.5/4.6	720/1410	76/82	0.60/0.90	5.7/6.7	6/7.1	4.7/5.5	2.3/1.7	27.00	43
AM 132M ZA	**8/4**	2.3/4.4	3.1/6.0	720/1420	78/83	0.62/0.91	7/8.5	7.5/9	5.0/5.7	2.4/1.8	40.00	54
AM 160M YA	**8/4**	4/7.5	5.5/10	730/1455	82/85.5	0.67/0.91	10.5/14	11.5/14.5	5.4/5.8	2.0/1.5	78.00	84
AM 160M ZA	**8/4**	5.5/9	7.5/12.2	725/1455	83/86.5	0.71/0.89	14/16.5	14.5/17.5	5.3/6.0	1.9/1.6	90.00	90
AM 160L ZA	**8/4**	7.5/12.5	10/17	725/1460	84/87.5	0.69/0.91	18.5/23	19.5/24	5.3/6.0	2.0/1.6	110.0	100
AM 180L ZA	**8/4**	11/18	15/24	730/1465	87/89	0.72/0.90	26/32	27/34	5.8/6.8	2.0/1.6	215.00	150
AM 200L PG	**8/4**	15/23	20/31	730/1465	88/88	0.77/0.92	33.5/41	34/43	5.3/7.0	2.0/2.3	285.00	220
AM 200L RG	**8/4**	18/29	24/39	735/1470	89/89	0.73/0.91	40/51	42/54	5.6/7.5	2.6/2.4	375.00	255
AM 225S P	**8/4**	21/32	28/43	735/1475	89/90	0.79/0.92	44/55	45/59	5.8/7.4	2.2/2.0	576.00	310
AM 225M P	**8/4**	26/37 [1]	35/50 [1]	735/1475	90/90	0.78/0.91	53/65	56/68	5.4/7.2	2.1/2.1	577.00	315
AM 250M P	**8/4**	32/46 [1]	43/63 [1]	730/1470	90/90.5	0.77/0.91	67/81	70/85	6.0/8.8	2.8/2.8	1320.0	490
AM 280S V	**8/4**	44/60 [1]	60/82 [1]	740/1485	91/91	0.80/0.91	88/105	93/110	5.8/8.2	2.1/2.3	2000.0	580
AM 280M V	**8/4**	52/70 [1]	71/95 [1]	740/1485	91/91	0.80/0.91	105/122	110/128	5.8/8.2	2.1/2.3	2320.0	620
AM 315S ZE	**8/4**	60/100	82/136	735/1480	93/93	0.75/0.88	117/170	123/180	6.6/7.5	2.2/2.2	3100.0	790
AM 315M ZE	**8/4**	75/120	100/163	735/1480	93/93	0.76/0.89	152/205	160/215	6.6/7.7	2.3/2.3	3600.0	860
AM 315L ZE	**8/4**	90/150	120/200	735/1480	94/94	0.76/0.89	180/253	190/266	6.9/7.9	2.3/2.5	4300.0	990

1) Temperature rise to class F

Pole-changing squirrel-cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency	Power factor	Rated current at I_N			Direct-on-line starting: Starting current ratio I_A/I_N	Direct-on-line starting: Breakaway torque ratio M_A/M_N	Moment of inertia J	Weight
		kW	HP	min^{-1}	η 100%	$cos\ \varphi$	400V	380-420V				$10^{-3}\ kgm^2$	kg
1500/1000 min^{-1} (4/6 poles) - separate windings													
AM 71Z AA	**4/6**	0.22/0.15	0.30/0.20	1430/900	61/44	0.7/0.64	0.78/0.68	0.83/0.73		1.9/3.4	1.5/1.8	0.73	6.2
AM 80Z AA	**4/6**	0.37/0.26	0.50/0.35	1385/905	61.4/48.1	0.82/0.80	1.1/1.0	1.1/1.1		3.7/2.6	1.7/1.3	1.97	8.3
AM 80Z BA	**4/6**	0.55/0.37	0.75/0.50	1380/900	60.5/51.1	0.64/0.82	1.5/1.3	1.6/1.4		3.7/2.7	1.6/1.2	2.47	10.0
AM 90S AA	**4/6**	0.75/0.5	1.0/0.67	1400/930	63/64	0.81/0.61	2.2/1.9	2.3/2.1		3.0/3.5	1.4/1.8	4.10	13.4
AM 90L BA	**4/6**	1/0.65	1.34/0.87	1380/920	68.8/67.1	0.81/0.62	2.6/2.3	2.8/2.5		2.9/3.4	1.1/1.6	4.78	16.4
AM 100L AA	**4/6**	1.2/0.8	1.6/1.07	1460/940	76.0/67.9	0.66/0.70	3.5/2.5	3.8/2.6		4.7/3.0	2.1/1.5	4.60	24.4
AM 100L BA	**4/6**	1.6/1.0	2.15/1.34	1445/935	77.6/69.5	0.73/0.63	4.1/3.3	4.3/3.5		5.8/3.0	2.8/1.7	5.58	33.2
AM 112M AA	**4/6**	1.8/1.3	2.5/1.75	1445/950	74.6/69.5	0.85/0.78	4.2/3.6	4.4/3.7		5.9/3.8	1.9/1.3	14.18	33.3
AM 112M BA	**4/6**	2.6/1.85	3.5/2.5	1445/950	73.8/71.6	0.86/0.73	6.0/5.2	6.2/5.4		6.1/4.4	2.0/1.7	17.53	37.0
AM 132S ZA	**4/6**	3.1/2.2	4/3	1440/965	80/78	0.81/0.74	7/5.5	7.5/6		5.8/5.6	2.1/2.0	27.00	43
AM 132M ZA	**4/6**	4.9/3.2	6.7/4.3	1440/965	83/80	0.84/0.77	10/7.5	10.5/8		6.3/5.9	2.2/2.1	40.00	54
AM 160M YA	**4/6**	7.5/5	10/6.8	1460/980	85.5/83	0.83/0.77	15.6/11.4	16.5/12		5.8/6.2	1,6/1,8	78.00	84
AM 160M ZA	**4/6**	9/6	12.2/8	1465/980	85.5/84	0.86/0.77	17.6/13.3	18.5/14		5.8/6.2	1.6/1.8	90.00	90
AM 160L ZA	**4/6**	12/8	16/11	1465/980	86.5/85	0.86/0.79	22.8/17	24/18		6.0/6.3	1.7/1.9	110.0	100
AM 180L ZA	**4/6**	16.5/11	22.5/15	1475/985	89/86	0.87/0.76	31/24	32.5/25.5		7.6/7.8	2.0/2.4	215.0	150
AM 200L PG	**4/6**	21/14	28/19	1470/980	88/87	0.88/0.81	39/28,5	41/30		6.0/6.4	1.8/2.2	285.0	220
AM 200L RG	**4/6**	26/18	35/24	1475/985	89.5/88.5	0.88/0.81	48/36	50/38		7.2/7.4	2.0/2.5	375.0	255
AM 225S P	**4/6**	30/21	40/28	1475/985	91/89	0.89/0.81	53/42	56/44		6.8/7.4	1.9/2.6	583.0	310
AM 225M P	**4/6**	37/25 [1]	50/34	1475/985	90.5/89	0.90/0.83	66/49	69/51		6.2/6.8	1.8/2.2	583.0	315
AM 250M P	**4/6**	45/30	60/40	1475/980	91/90.5	0.90/0.86	79/56	83/59		8.5/7.6	2.8/3.0	1320.0	490
AM 280S V	**4/6**	65/45 [1]	88/60	1485/988	91.5/92	0.88/0.83	117/86	123/90		7.0/6.8	1.7/2.3	1200.0	580
AM 280M V	**4/6**	80/54 [1]	109/73	1485/988	91.5/91	0.88/0.83	144/105	151/110		7.0/6.8	1.7/2.3	1400.0	620
AM 315S ZE	**4/6**	87/58	117/78	1480/985	93/93	0.90/0.85	150/105	157/110		7.8/7.8	1.9/2.2	3100.0	790
AM 315M ZE	**4/6**	95/65	129/88	1480/985	93/93	0.90/0.85	165/118	171/124		7.8/7.8	2.0/2.2	3600.0	860
AM 315L ZE	**4/6**	105/72	141/96	1480/985	94/94	0.93/0.87	175/127	183/135		7.8/8.0	2.0/2.3	4300.0	990

1) Temperature rise to class F

Pole-changing squirrel-cage motors designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Temperature rise to class B

Type		Rated output		Rated speed	Efficiency	Power factor	Rated current at I_N		Direct-on-line starting: Starting current ratio I_A/I_N	Direct-on-line starting: Breakaway torque ratio M_A/M_N	Moment of inertia J	Weight
		kW	HP	min^{-1}	η 100%	$cos\ \varphi$	400V	380-420V			$10^{-3}\ kgm^2$	kg
1000/750 min^{-1} (6/8 poles) - separate windings												
AM 80Z AA	**6/8**	0.37/0.18	0.50/0.25	915/700	51.1/44.2	0.81/0.65	1.3/1.0	1.4/1.0	2.8/2.5	1.4/1.7	2.47	9.5
AM 90L AA	**6/8**	0.55/0.30	0.75/0.40	950/710	65.2/45.1	0.62/0.52	2.0/1.8	2.1/1.9	3.9/2.6	2.5/1.9	4.78	16.2
AM 100L AA	**6/8**	0.75/0.45	1.0/0.60	960/720	72.6/61.8	0.67/0.54	2.2/2.0	2.3/2.1	4.1/2.9	1.9/1.9	6.73	23.4
AM 112M AA	**6/8**	0.95/0.65	1.3/0.90	965/715	65.2/62.1	0.78/0.70	3.0/2.2	3.2/2.3	4.5/3.8	1.4/1.7	14.18	32.0
AM 112M BA	**6/8**	1.5/0.75	2.0/1.0	970/720	75.3/64.6	0.66/0.60	4.4/2.8	4.6/3.0	4.6/3.8	2.2/2.1	18.70	36.2
AM 132S ZA	**6/8**	1.6/1.3	2.2/1.8	965/715	78/75	0.74/0.71	4/3.5	4.5/3.8	5.3/4.4	1.6/1.6	27.00	43
AM 132M ZA	**6/8**	2.9/2.2	3.9/3	965/715	81/77	0.74/0.71	7/5.8	7.5/6.3	5.8/4.7	1.7/1.7	40.00	54
AM 160M YA	**6/8**	4/3	5.5/4	980/730	82/77	0.75/0.72	9.3/7.6	9.8/8.5	5.4/3.8	1.9/1.8	78.00	84
AM 160M ZA	**6/8**	5.5/4	7.5/5.5	975/725	83/78	0.75/0.70	12.5/10.5	13/11	5.4/3.8	1.9/1.9	90.00	90
AM 160L ZA	**6/8**	7.5/5.5	10/7.5	980/725	84/79	0.75/0.73	17/14.5	18/15	5.5/3.8	2.0/2.1	110.0	100
AM 180L ZA	**6/8**	11/8.5	15/11.5	985/730	86/83	0.76/0.74	24/20	26/22	6.8/5.5	2.0/2.1	215.0	150
AM 200L PG	**6/8**	15/11.5	20/15.6	980/735	88/86.5	0.82/0.74	30.5/25.5	32/27	5.8/4.8	1.8/2.3	285.0	220
AM 200L RG	**6/8**	19/14.5	26/19.7	980/735	89/86.5	0.83/0.75	37/32	39/34	6.0/5.5	1.9/2.3	375.0	255
AM 225S P	**6/8**	23/18	31/24	985/735	89/88	0.83/0.78	45/38	47/40	6.2/5.2	1.9/2.0	583.0	310
AM 225M P	**6/8**	28/21 [1]	38/28	985/735	90/88.5	0.82/0.78	54/45	57/47	5.8/5.0	1.9/1.9	583.0	315
AM 250M P	**6/8**	31/24	42/32.5	985/735	91/91	0.84/0.79	59/49	62/51	8.4/7.5	2.6/3.4	1320.0	490
AM 280S V	**6/8**	44/33 [1]	59.5/45	988/738	91/90	0.81/0.75	87/70	91/74	5.2/5.0	1.4/1.7	1200.0	580
AM 280M V	**6/8**	55/42 [1]	75/57	988/738	91/90	0.81/0.75	108/90	113/95	5.2/5.0	1.5/2.1	1400.0	620
AM 315S ZE	**6/8**	65/48	87/64	988/740	92.0/92.0	0.87/0.81	117/90	121/94	7.5/7.4	2.0/2.2	3100.0	790
AM 315M ZE	**6/8**	75/55	100/74	988/740	92.5/92.0	0.87/0.81	135/105	140/109	7.5/7.4	2.1/2.3	3600.0	860
AM 315L ZE	**6/8**	90/70	120/94	988/740	93.0/92.5	0.87/0.81	160/135	166/140	7.5/7.5	2.2	4300.0	9900

1) Temperature rise to class F

Pole-changing squirrel-cage motors for fan drives designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Type		Temp. class	Rated output		Rated speed	Efficiency	Power factor	Rated current at I_N		Direct-on-line starting: Starting current ratio I_A/I_N	Direct-on-line starting: Breakaway torque ratio M_A/M_N	Moment of inertia J	Weight
			kW	HP	min^{-1}	η 100%	cos φ	400V	380-420V			10^{-3} kgm^2	kg
1500/3000 min^{-1} (4/2 poles) - Dahlander connection Y/YY													
AMV 63Z AA	**4/2**	B	0.07/0.33	0.095/0.45	1350/2700	55/60	0.70/0.80	0.25/0.95	0.27/1.1	2.5/2.6	1.8/1.6	0.37	5.0
AMV 71Z AA	**4/2**	B	0.08/0.37	0.11/0.5	1350/2870	60/64	0.65/0.68	0.30/1.3	0.35/1.4	3.2/4.3	2.0/2.8	0.82	7.9
AMV 71Z BA	**4/2**	B	0.12/0.55	0.16/0.75	1430/2835	70/68	0.65/0.72	0.40/1.6	0.42/1.7	4.1/4.0	3/2.8	1.08	10.0
AMV 80Z AA	**4/2**	F	0.15/0.75	0.2/1.0	1400/2710	70/68	0.68/0.80	0.45/1.9	0.45/2.0	2.6/4.6	2.8/2.9	1.58	8.3
AMV 80Z BA	**4/2**	B	0.22/1.1	0.3/1.5	1420/2820	70/73	0.75/0.84	0.6/2.5	0.65/2.6	4.6/4.7	2.7/2.9	2.0	11.5
AMV 90L AA	**4/2**	B	0.30/1.5	0.4/2.0	1400/2830	69/70	0.70/0.84	0.9/3.5	1.0/3.7	4.7/5.0	2.7/3.0	3.13	15.6
AMV 90L BA	**4/2**	B	0.44/2.2	0.6/3.0	1430/2830	74/72	0.76/0.89	1.1/4.8	1.2/5.0	4.5/5.2	2.6/2.8	3.73	17.1
AMV 100L AA	**4/2**	B	0.50/2.5	0.67/3.3	1430/2840	72/73	0.77/0.88	1.3/5.3	1.4/5.6	4.6/5.0	2.2/2.3	4.6	21.4
AMV 100L BA	**4/2**	B	0.60/3.0	0.8/4.0	1440/2850	78/77	0.79/0.87	1.3/6.2	1.4/6.5	4.5/4.5	2.2/2.1	5.58	23.2
AMV 112M AA	**4/2**	B	0.75/3.70	1.0/5.0	1440/2850	74/72	0.80/0.90	1.7/7.9	1.9/2.2	4.5/5.1	2.0/2.4	13.3	36.1
AMV 112M BA	**4/2**	B	0.9/4.5	1.2/6.1	1440/2850	75/73	0.82/0.90	2.0/9.5	2.1/9.8	4.5/5.5	2.0/2.3	14.75	40.0
AMV 132S ZA	**4/2**	B	1.2/6	1.6/8	1455/2880	84.5/83	0.81/0.88	2.6/12	2.8/12.5	5.5/6.0	2.4/2.1	22.00	46
		F	1.5/7	2/9.5	1445/2870	84/83	0.83/0.89	3.2/14	3.4/14.5	4.5/5.2	2.0/1.8		
AMV 132M ZA	**4/2**	B	1.6/8	2.1/10.6	1455/2890	86.5/85	0.82/0.89	3.3/15.3	3.5/15.8	5.6/6.4	2.5/2.2	30.00	55
		F	1.85/9	2.5/12	1445/2870	86/84.5	0.84/0.90	3.7/17.2	3.9/18	5.0/5.7	2.2/2.0		
AMV 160M ZA	**4/2**	B	2.8/11	3.8/14.7	1450/2925	86.5/86	0.84/0.85	5.5/22.5	5.8/23	4.7/6.2	1.6/2.0	59.00	87
		F	3.3/13.5	4.4/18	1440/2915	86/85	0.85/0.86	6.5/27	6.8/27.5	4.0/5.2	1.4/1.6		
AMV 160L ZA	**4/2**	B	4/16.5	5.5/22.1	1470/2940	88.5/88	0.82/0.85	8.5/32.5	8.8/33	5.2/7.1	2.1/2.2	82.00	102
		F	4.4/18.5	5.9/24.5	1465/2930	88/87.5	0.83/0.86	9.5/36	10/36.5	4.7/6.4	1.9/2.0		
AMV 180M ZA	**4/2**	B	5/20	6.7/27	1470/2950	89/88	0.83/0.89	10/37.5	10.5/38.5	5.5/7.5	2.0/2.1	112.0	130
		F	5.5/22.5	7.5/30	1465/2940	88.5/87	0.84/0.90	11/42	11.5/43	5.0/6.7	1.8/1.9		
AMV 180L ZA	**4/2**	B	6/24	8/32	1470/2940	90/89	0.83/0.88	11.5/45	13/47	5.5/7.5	2.0/2.1	132.0	140
		F	6.8/27	9/36	1465/2930	89/88	0.84/0.89	13.2/51	13.8/53	4.9/6.6	1.8/1.9		
AMV 200L PG	**4/2**	B	6.5/30	8/40	1480/2950	91.5/90	0.81/0.89	12.2/53	12.6/55	7.1/7.7	2.6/2.3	206.0	230
		F	7/34	9.5/45	1475/2940	91/89	0.82/0.90	13.2/60	13.7/62	6.6/6.8	2.4/2.1		
AMV 200L RG	**4/2**	B	7/35	9.5/47	1480/2950	91.5/90	0.82/0.89	14/62	14.8/64	7.1/7.7	2.6/2.3	248.0	255
		F	7.8/39	10.5/52	1475/2940	91/89	0.83/0.90	15.6/69	16.5/71	6.6/6.8	2.4/2.1		
AMV 225M P	**4/2** [1]	B	8.0/40	10.7/54	1485/2970	92/91	0.81/0.89	15.5/70	16.1/73	7.5/8.5	2.3/2.1	428.0	330
		F	9.2/46	12.3/62	1480/2960	92/91	0.82/0.91	17.5/80	18.2/83	6.5/7.4	2.0/1.8		
AMV 250M P	**4/2**	B	11.0/55	14.7/75	1485/2965	93/92.5	0.82/0.92	21/92	22/96	7.4/8.4	3.6/3.4	750.0	465
		F	12.5/60	17/80	1480/2955	92.5/92	0.83/0.92	24/100	25/103	6.5/7.7	3.2/3.1		
AMV 280S V	**4/2**	B	13/67	17/90	1485/2980	93.5/93	0.83/0.88	24.5/118	26/122	8.4/8.9	2.9/2.5	1200.0	580
		F	15/75	20/100	1480/2975	93.5/93	0.84/0.89	28/131	30/136	7.5/8.0	2.5/2.2		
AMV 280M V	**4/2**	B	16/80	21/107	1485/2980	93.5/93	0.83/0.88	29.5/140	32/144	8.4/8.9	2.9/2.5	1400.0	620
		F	18/90	24/120	1485/2975	93.5/93	0.84/0.89	33/157	36/162	7.5/8.0	2.5/2.2		
AMV 315S ZE	**4/2**	B	20/100	27/134	1492/2975	93.5/93	0.84/0.90	37/174	39/180	7.4/8.3	1.9/1.6	2200.0	860
		F	22/110	30/150	1490/2970	93.5/93	0.85/0.91	40/190	42/196	6.8/7.6	1.7/1.5		
AMV 315M ZE	**4/2**	B	23/120	31/160	1492/2975	94.5/94	0.84/0.90	42/207	45/213	7.8/8.6	2.0/1.8	2500.0	940
		F	26/132	35/175	1490/2970	94.5/94	0.85/0.91	47/225	50/232	7.0/7.9	1.8/1.6		
AMV 315L ZE	**4/2**	B	28/145	38/195	1492/2975	94.5/94	0.84/0.90	51/250	54/257	8.0/8.7	2.0/1.8	3100.0	1120
		F	32/160	43/215	1490/2970	94.5/94	0.85/0.91	58/275	61/282	7.0/7.9	1.8/1.6		

1) Same mounting dimensions 225S

Motors from frame size 132 upwards, with double marking

Pole-changing squirrel-cage motors for fan drives designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Type		Temp. class	Rated output		Rated speed	Efficiency	Power factor	Rated current at		Direct-on-line starting		Moment of inertia	Weight
										Starting current ratio	Breakaway torque ratio		
			kW	HP	min^{-1}	η 100%	cos φ	400V	380-420V	I_A/I_N	M_A/M_N	J 10^{-3} kgm^2	kg
750/1500 min^{-1} (8/4 poles) - Dahlander connection Y/YY													
AMV 71Z AA	**8/4**	B	0.08/0.37	0.11/0.5	660/1370	26/57	0.63/0.72	0.60/1.25	0.65/1.35	2.8/3.4	1.9/1.7	1.24	6.8
AMV 80Z AA	**8/4**	B	0.12/0.55	0.16/0.75	685/1420	50/69	0.60/0.74	0.58/1.53	0.65/1.6	1.9/3.3	1.4/1.5	2.47	9.2
AMV 80Z BA	**8/4**	B	0.18/0.75	0.25/1.0	660/1380	53/67	0.73/0.81	0.65/1.9	0.7/2.0	2.0/3.5	1.6/1.7	2.41	10.6
AMV 90L AA	**8/4**	B	0.18/1.1	0.25/1.5	680/1400	60/70	0.65/0.82	0.9/2.7	1.0/2.8	2.8/4.0	1.5/2.0	2.98	15.7
AMV 90L CA	**8/4**	B	0.4/1.6	0.54/2.15	675/1400	61.5/75	0.64/0.79	1.8/4.0	1.8/4.1	3.1/5.0	1.6/2.2	3.70	19.6
AMV 100L AA	**8/4**	F	0.45/2.2	0.60/3.0	680/1420	63.1/75.3	0.60/0.80	1.7/5.0	1.9/5.3	2.7/4.7	1.7/2.0	5.58	21.9
AMV 100L BA	**8/4**	F	0.6/2.6	0.80/3.5	680/1435	64.0/76.2	0.63/0.75	2.2/6.5	2.3/6.7	2.7/4.8	1.7/2.2	6.00	23.7
AMV 112M AA	**8/4**	F	0.7/3.3	0.94/4.5	690/1420	62/78	0.70/0.80	2.2/7.4	2.3/7.6	3.4/6.5	1.8/2.4	16.70	34.2
AMV 112M CA	**8/4**	B	1.0/4.0	1.34/5.5	720/1420	60/77	0.70/0.82	3.1/8.6	3.3/9.0	3.5/5.0	2.3/1.9	19.50	40.0
AMV 132SZA	**8/4**	B	1.4/4.6	1.9/6.2	715/1450	72/84	0.60/0.77	4.7/10.5	5/11	3.3/6.7	1.6/2.4	22.00	46
		F	1.5/5.5	2/7.5	705/1430	72/83	0.62/0.79	5.0/12.5	5.5/13	3.0/5.7	1.5/2.0		
AMV 132M ZA	**8/4**	B	1.7/6.4	2.3/8.7	715/1450	74/85	0.60/0.82	5.6/13.5	6/14.2	3.5/6.8	1.7/2.4	30.00	55
		F	2/7.5	2.7/10	705/1440	74/84	0.62/0.84	6.5/15.8	7/16.5	3.3/5.8	1.5/2.0		
AMV 160M ZA	**8/4**	B	2.2/9.2	3/12.5	725/1465	83/88	0.59/0.82	7/19.2	7.5/20.5	4.0/7.0	1.8/2.2	59.00	87
		F	2.5/10.2	3.3/13.7	720/1460	82/87	0.60/0.83	8/21.5	8.5/23	3.5/6.0	1.6/1.9		
AMV 160L ZA	**8/4**	B	3.5/14	4.7/19	725/1465	84/89	0.61/0.83	10/27.5	11/29	4.0/7.4	1.8/2.4	82.00	102
		F	4/15.5	5.5/21	720/1460	83/88	0.62/0.84	11.5/30.5	12.5/32	3.5/6.7	1.6/2.2		
AMV 180M ZA	**8/4**	B	4/17	5.5/23	730/1465	84/90	0.61/0.83	11.5/33	13/34.5	4.0/7.2	1.7/2.3	112.0	130
		F	4.5/19	6/25.5	715/1455	83/89	0.62/0.84	12.5/35.5	14/37	3.7/6.3	1.6/2.0		
AMV 180L ZA	**8/4**	B	5/20	6.8/27	730/1470	84/90	0.61/0.83	14.5/39	15/41	4.2/7.6	1.7/2.3	132.0	140
		F	5.5/22.5	7.5/30	725/1465	83/89	0.62/0.84	15.5/44	16/46	3.8/6.8	1.6/2.0		
AMV 200L PG	**8/4**	B	6/24	8/32.5	735/1480	87.5/90.5	0.62/0.82	15.5/50	16.5/52	3.6/7.6	1.6/2.4	206	230
		F	6.5/27	8.5/36	730/1470	87/90	0.63/0.83	16.8/56	17.5/58	3.3/6.8	1.4/2.1		
AMV 200L RG	**8/4**	B	7/28	9.5/38	735/1480	88/91	0.60/0.85	19/55	20/58	3.5/7.7	1.7/2.6	248	255
		F	8/32	10.5/43	730/1470	87/90.5	0.61/0.86	21.5/60	22.5/63	3.2/6.7	1.5/2.3		
AMV 225M P	**8/4** [1)]	B	8.5/36	11.5/49	735/1480	89.5/92	0.62/0.82	22/72	23/75	4.0/8.7	1.8/2.5	430	330
		F	11/44	15/60	725/1475	88.5/92	0.63/0.83	29/85	31/89	3.1/7.2	1.4/2.1		
AMV 250M P	**8/4**	B	11/46	15/62	740/1475	91.5/92	0.79/0.88	22/81	23/85	5.3/8.4	2.4/2.9	1110	490
		F	12/50	16/88	735/1465	91/91	0.81/0.90	24/88	25/93	5.8/7.8	2.2/2.7		
AMV 280S V	**8/4**	B	16/66	22/88	740/1485	90/93	0.62/0.85	42/121	44/127	3.3/7.0	1.5/2.4	1200	580
		F	18/74	24/100	735/1475	89.5/92	0.63/0.86	47/135	50/141	3.0/6.3	1.3/2.2		
AMV 280M V	**8/4**	B	19/78	26/106	740/1485	91/93	0.62/0.85	49/143	51/150	3.3/7.0	1.5/2.4	1400	620
		F	21/86	28/115	735/1475	90/92	0.63/0.86	54/157	56/165	3.0/6.3	1.3/2.2		
AMV 315S ZE	**8/4**	B	26/105	35/140	743/1480	92.5/94.0	0.60/0.87	68/185	75/193	4.1/5.5	1.1/1.6	1900	800
		F	29/115	39/155	740/1470	92/94	0.61/0.88	76/200	82/210	3.7/5.1	1.0/1.4		
AMV 315M ZE	**8/4**	B	33/132	45/177	743/1480	93.0/95.0	0.60/0.87	85/230	92/243	4.3/5.7	1.0/1.5	2500	940
		F	36/145	48/194	740/1470	92.5/95	0.61/0.88	93/250	98/260	3.9/5.3	0.9/1.3		
AMV 315L ZE	**8/4**	B	40/165	55/220	743/1480	93.0/95.5	0.61/0.88	103/285	109/300	4.2/6.0	1.2/1.6	3100	1120
		F	44/180	59/240	740/1470	92.5/95	0.62/0.89	113/310	120/325	3.8/5.5	1.1/1.4		

1) Same mounting dimensions 225S

Motors from frame size 132 upwards, with double marking

Pole-changing squirrel-cage motors for fan drives designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Type		Temp. class	Rated output		Rated speed	Efficiency	Power factor	Rated current at I_N		Direct-on-line starting: Starting current ratio I_A/I_N	Direct-on-line starting: Breakaway torque ratio M_A/M_N	Moment of inertia J	Weight
			kW	HP	min^{-1}	η 100%	cos φ	400V	380-420V			10^{-3} kgm^2	kg
1500/1000 min^{-1} (4/6 poles) - separate windings													
AMV 71Z AA	**4/6**	B	0.25/0.08	0.33/0.11	1370/900	60/40	0.80/0.70	0.75/0.4	0.8/0.45	3.0/2.5	1.6/1.6	1.15	6.7
AMV 71Z BA	**4/6**	F	0.37/0.13	0.50/0.18	1360/880	62/44	0.80/0.70	1.0/0.6	1.1/0.7	3.2/2.6	1.6/1.6	1.24	7.2
AMV 80Z AA	**4/6**	B	0.55/0.18	0.75/0.25	1380/920	60/42	0.83/0.82	1.60/0.75	1.7/0.8	3.5/2.4	1.6/1.0	1.97	8.3
AMV 80Z BA	**4/6**	B	0.75/0.25	1.0/0.33	1400/940	70/60	0.82/0.72	1.8/0.8	1.9/0.9	4.2/2.6	1.6/1.3	4.05	14
AMV 90S AA	**4/6**	B	0.75/0.24	1.0/0.32	1400/950	70/60	0.82/0.72	1.9/0.8	2.0/0.9	4.2/2.6	1.6/1.3	4.05	14
AMV 90L BA	**4/6**	B	1.1/0.37	1.5/0.50	1400/930	70/60	0.81/0.74	2.8/1.2	3.0/1.3	4.3/2.7	1.6/1.2	4.78	16.4
AMV 90L CA	**4/6**	B	1.5/0.5	2.0/0.67	1420/950	73/64	0.80/0.70	3.52/1.52	3.7/1.6	4.8/2.6	1.5/1.3	5.98	20.5
AMV 100L AA	**4/6**	B	1.85/0.60	2.5/0.75	1400/920	74/64	0.80/0.73	4.6/1.9	4.8/2.1	4.8/3.1	1.8/1.5	6.73	23.4
AMV 100L BA	**4/6**	B	2.2/0.75	3.0/1.0	1420/950	76/66	0.79/0.75	5.1/2.1	5.3/2.2	5.0/3.5	1.7/1.3	9.25	22.6
AMV 112M AA	**4/6**	B	3/1.0	4.0/1.34	1440/970	80/73	0.81/0.65	6.6/3.0	6.8/3.2	5.8/4.6	2.5/2.1	13.3	30.4
AMV 132S ZA	**4/6**	B	3.8/1.3	5/1.8	1450/970	84/74	0.84/0.71	8/3.7	8.5/4	6.2/4.2	2.2/1.8	22.0	46
		F	4.4/1.5	5.9/2	1440/960	83/73	0.86/0.72	9.2/4.2	9.6/4.5	5.4/3.7	1.9/1.6		
AMV 132M ZA	**4/6**	B	5.2/1.8	7/2.5	1450/970	86/76	0.84/0.71	10.5/5	11/5.5	6.5/4.6	2.4/1.9	30.0	55
		F	6/2	8/2.7	1445/965	85/75	0.85/0.72	13.6/5.8	14/6.3	5.6/4.0	2.1/1.7		
AMV 160M ZA	**4/6**	B	8/2.7	11/3.6	1465/985	87/80	0.84/0.70	15.5/6.6	16/6.8	6.2/5.2	1.7/1.4	59.0	87
		F	8.8/3	12/4	1460/980	86/80	0.85/0.71	17.2/7.3	17.7/7.6	5.6/4.7	1.5/1.4		
AMV 160L ZA	**4/6**	B	12/4	16/5.5	1465/985	88/82	0.85/0.70	23/10	24.5/10.5	6.2/5.5	1.8/1.5	82.0	102
		F	13.8/4.8	18.5/6.4	1460/980	87/81	0.86/0.71	26.5/12	28.2/12.6	5.4/4.6	1.6/1.3		
AMV 180L ZA	**4/6**	B	17/5.5	23/7.5	1470/975	89.5/86	0.86/0.84	31/11	33/11.5	7.6/5.5	1.9/1.5	215	150
		F	19/6	25.5/8	1465/970	89/85	0.87/0.85	34.5/12	36/12.5	6.8/5.1	1.7/1.4		
AMV 200L PG	**4/6**	B	21/7	28/9.5	1470/985	88/87	0.88/0.84	39/14	41/14.5	6.0/6.2	1.8/2.2	285	220
		F	23.5/7.8	31.5/11	1465/980	87.5/87	0.89/0.85	44/15.5	46/16	5.3/5.6	1.6/2.0		
AMV 200L RG	**4/6**	B	26/9	35/12	1475/985	89.5/88	0.88/0.85	48/17	50/18	7.0/6.2	2.0/2.1	375	255
		F	29/10	39/13.5	1470/980	89/88.5	0.89/0.86	54/19	56/20	6.2/5.5	1.8/1.9		
AMV 225M P	**4/6** [1)]	B	33/11	45/15	1475/985	90/89	0.89/0.85	60/21	63/22	7.0/6.8	2.0/2.4	583	315
		F	37/12	50/16	1475/985	90.5/89	0.90/0.87	66/22.5	69/23.5	6.2/6.0	1.8/2.0		
AMV 250M P	**4/6**	B	50/18	68/24	1470/985	91/90	0.90/0.85	89/34.5	93/36	8.5/8.5	2.8/3.2	1110	490
		F	55/20	74/27	1465/980	91/90	0.91/0.86	98/38	102/40	7.7/7.7	2.6/3.0		
AMV 280S V	**4/6**	B	63/22	84/29	1490/992	92.5/91	0.88/0.85	111/42	117/44	7.7/8.3	1.9/2.5	1200	580
		F	70/25	95/34	1485/990	92.5/91	0.89/0.86	123/47	129/49	7.0/7.5	1.7/2.3		
AMV 280M V	**4/6**	B	73/27	98/36	1490/992	92.5/91	0.87/0.85	131/50	137/53	7.7/8.3	1.9/2.5	1400	620
		F	80/30	109/40	1485/990	92/91	0.88/0.86	144/55	151/58	7.0/7.5	1.7/2.3		
AMV 315S ZE	**4/6**	B	90/31	121/42	1492/995	93/90.5	0.88/0.88	160/58	167/62	8.3/8.0	2.2/2.5	3100	790
		F	100/35	136/47	1490/993	93/90	0.88/0.88	176/65	184/69	7.5/7.2	2.0/2.3		
AMV 315M ZE	**4/6**	B	115/36	154/48	1492/995	93/90.5	0.88/0.87	200/67	209/71	8.3/8.0	2.2/2.5	3600	860
		F	130/40	174/54	1492/995	93/90	0.89/0.88	225/75	235/79	7.5/7.2	2.0/2.3		
AMV 315L ZE	**4/6**	B	135/43	180/58	1490/993	93.5/90	0.88/0.87	235/79	245/83	8.0/7.8	2.3/2.6	4300	990
		F	150/48	200/64	1488/993	93.5/90	0.89/0.88	260/88	270/92	7.2/7.0	2.1/2.4		

1) Same mounting dimensions 225S

Motors from frame size 132 upwards, with double marking

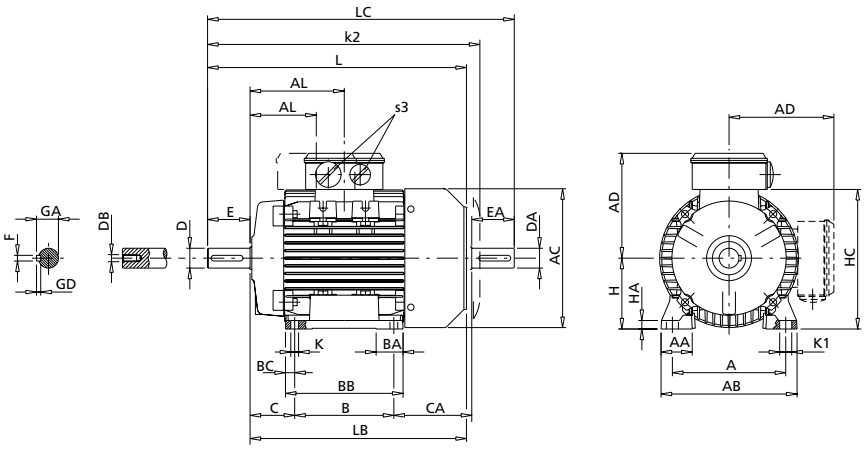
Pole-changing squirrel-cage motors for fan drives designed for range of rated voltage 380-420 V ± 5% - 50 Hz

For mains voltage to IEC 60038 400 V ± 10% - 50 Hz

Type		Temp. class	Rated output		Rated speed	Efficiency	Power factor	Rated current at		Direct-on-line starting		Moment of inertia	Weight
										Starting current ratio	Breakaway torque ratio		
			kW	HP	min^{-1}	η 100%	cos φ	400V	380-420V I_N	I_A/I_N	M_A/M_N	J 10^{-3} kgm^2	kg
1000/750 min^{-1} (6/8 poles) - separate windings													
AMV 80Z AA	**6/8**	B	0.25/0.11	0.33/0.15	930/720	53/49	0.79/0.62	0.9/0.55	1.0/0.7	2.9/3.0	1.6/1.8	1.97	7.9
AMV 80Z BA	**6/8**	B	0.37/0.15	0.50/0.25	920/715	52/47	0.81/0.63	1.3/0.8	1.4/0.9	2.8/2.8	1.4/1.9	2.47	9.5
AMV 90L AA	**6/8**	B	0.55/0.22	0.75/0.30	960/740	65/47	0.62/0.51	2.0/1.4	2.1/1.5	3.9/2.9	2.5/2.1	4.78	16.2
AMV 90L BA	**6/8**	F	0.75/0.30	1.0/0.40	940/720	64/45.5	0.67/0.52	2.5/1.85	2.7/1.9	3.4/2.6	2.2/1.9	4.78	16.2
AMV 100L AA	**6/8**	B	1.1/0.45	1.5/0.60	950/710	70.6/58	0.71/0.67	3.1/1.7	3.3/1.8	4.3/2.8	2.0/1.3	9.43	22.0
AMV 112M AA	**6/8**	B	1.5/0.6	2.0/0.80	970/720	75.8/65	0.65/0.60	4.4/2.3	3.7/2.5	5.5/3.4	2.8/2.1	18.70	39.0
AMV 132S ZA	**6/8**	B	2.2/1	3/1.4	955/715	79/72	0.78/0.71	5.3/2.9	5.8/3.1	4.8/4.0	1.5/1.4	27.0	43
		F	2.4/1.1	3.2/1.5	950/710	78/71	0.79/0.72	5.8/3.2	6.3/3.4	4.4/3.6	1.3/1.2		
AMV 132M YA	**6/8**	B	3/1.3	4/1.7	955/715	80/73	0.78/0.72	7.2/3.8	7.8/4.0	4.8/4.0	1.5/1.4	34.0	49
		F	3.4/1.5	4.6/2	950/710	79/72	0.79/0.73	8.2/4.3	8.8/4.6	4.2/3.5	1.3/1.3		
AMV 132M ZA	**6/8**	B	4/1.8	5.5/2.4	955/715	82/74	0.78/0.74	9.2/4.8	9.7/5.1	5.3/4.2	1.7/1.5	40.0	54
		F	4.5/2	6/2.7	950/710	80/73	0.80/0.76	10.3/5.3	10.8/5.6	4.7/3.8	1.5/1.3		
AMV 160M YA	**6/8**	B	5.5/2.5	7.5/3.4	975/730	83/76	0.77/0.67	12.5/7	13/7.5	5.7/5.5	1.6/1.9	78.0	84
		F	6.2/2.8	8.3/3.8	970/725	82/75	0.78/0.68	13.5/7.8	14/8.3	5.3/4.9	1.4/1.7		
AMV 160M ZA	**6/8**	B	7/3.5	9.4/4.7	975/730	84/78	0.80/0.75	15/9	16/9.5	6.0/5.6	1.7/2.0	90.0	90
		F	7.8/3.9	10.5/5.2	970/725	83/77	0.81/0.76	16.5/10	17.5/10.8	5.5/5.0	1.5/1.8		
AMV 160L ZA	**6/8**	B	9/4.5	12/6	975/730	85/79	0.78/0.73	20/11	20.5/11.5	6.2/5.7	1.8/2.0	110.0	100
		F	10/5	13.5/6.7	970/725	84/78	0.79/0.74	22/12.2	23/12.8	5.6/5.1	1.6/1.8		
AMV 180L ZA	**6/8**	B	12/6	16/8	985/735	87/84	0.76/0.72	26/14.5	27.5/15	7.2/6.0	2.1/2.1	215.0	150
		F	13.5/6.7	18/9	980/730	86/83	0.77/0.73	29/16	30.5/16.7	6.5/5.4	1.9/1.9		
AMV 200L PG	**6/8**	B	17/8.5	23/11.5	980/735	89/85	0.80/0.74	35/19.5	36.5/20.5	5.6/5.6	1.9/2.3	285	220
		F	19/9.5	26/13	975/730	88/84	0.81/0.75	39/21.5	41/22.5	5.0/5.1	1.7/2.1		
AMV 200L RG	**6/8**	B	22/11	30/15	980/735	89.5/86	0.81/0.75	43/24.5	46/26	6.3/5.7	2.3/2.5	375	255
		F	24.5/12.5	33/16.5	975/730	89/85	0.82/0.76	48/28	50/29.5	5.6/5.0	2.1/2.3		
AMV 225M P	**6/8** 1)	B	26/13	35/17.5	985/740	90.5/87	0.80/0.74	52/28.5	55/30	6.6/6.2	2.2/2.3	583	315
		F	32/15	43/20	980/735	90/87	0.84/0.77	62/33	64/34	5.5/5.4	1.7/2.0		
AMV 250M P	**6/8**	B	38/19	52/26	985/735	92/90	0.87/0.81	69/38	72/40	8.0/7.5	2.7/3.2	1110	490
		F	42/21	56/28	980/730	91/89	0.88/0.82	76/42	79/44	7.3/6.8	2.5/2.9		
AMV 280S V	**6/8**	B	43/22	58/29	990/745	92/90	0.80/0.77	84/46	88/48	5.8/6.0	1.5/2.2	1200	580
		F	48/24	65/32.5	988/740	92/90	0.81/0.78	93/50	98/52	5.2/5.5	1.4/2.0		
AMV 280M V	**6/8**	B	54/27	72/36	990/745	92/90	0.80/0.77	104/57	110/60	5.8/6.1	1.5/2.2	1400	620
		F	60/30	80/40	988/740	92/90	0.81/0.78	115/63	121/66	5.2/5.5	1.4/2.0		
AMV 315S ZE	**6/8**	B	73/35	98/47	988/745	92.5/91	0.87/0.81	130/68	137/71	7.3/7.3	2.0/2.2	3100	790
		F	80/38	107/51	985/740	92/90	0.88/0.82	142/74	149/77	6.7/6.7	1.8/2.0		
AMV 315M ZE	**6/8**	B	85/40	114/54	988/745	93/92	0.87/0.81	150/77	158/81	7.5/7.4	2.1/2.3	3600	860
		F	94/44	126/59	985/740	92/91	0.88/0.82	165/85	173/89	6.8/6.7	1.9/2.1		
AMV 315L ZE	**6/8**	B	105/50	140/167	988/745	93.5/92	0.87/0.82	185/95	193/100	7.5/7.5	2.4/2.2	4300	990
		F	115/55	154/74	985/740	93/91.5	0.88/0.83	202/105	210/110	6.9/6.8	2.2/2.0		

1) Same mounting dimensions 225S

Motors from frame size 132 upwards, with double marking

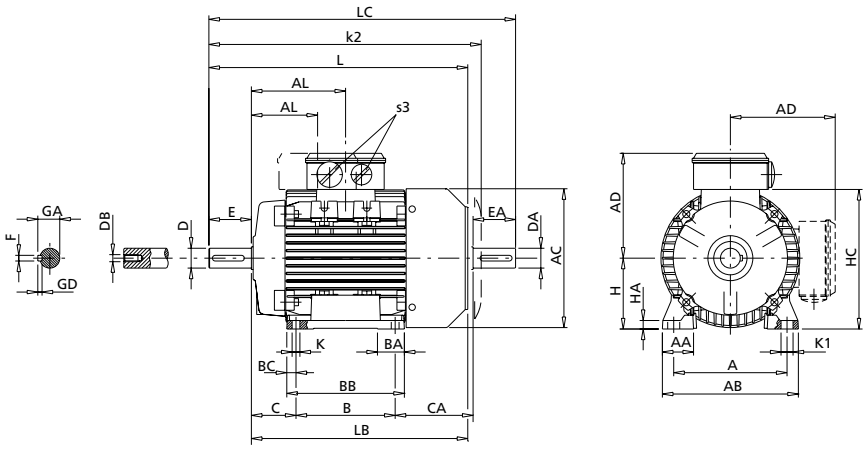


Aluminium frame

	IEC DIN	H h	A b	B a	C w_1	K[1)] s	AB f	BB e	BC	CA	AD[2)] g_4	HD[2)] m_1	AC g	HC	HA c	K_1
56Z AA, BA		56	90	71	36	6	109	90	9.5	65	98	154	112	110	8	12
63Z AA, BA, CA		63	100	80	40	7	126	105	12.5	72	103	166	125	125	8	12
71Z AA, BA, CA		71	112	90	45	7	144	109	9.5	86	112	183	142	142	9	17
80Z AA, BA, CA		80	125	100	50	9	153	125	12.5	89	129	209	160	162	9.5	14
90S AA, BA		90	140	100	56	10	170	150	12.5	113	138	228	180	181	11	15
90L CA, DA		90	140	125	56	10	170	150	12.5	88	138	228	180	181	11	15
100L AA, BA, CA		100	160	140	63	11	192	166	13	110	145	245	196	198	12	17
112M AA, BA, CA		112	190	140	70	10	220	175	17.5	126	161	273	225	226	15	19
132S AA, BA, YA, ZA		132	216	140	89	10	260	175	17.5	147.5	198	330	270	262	20	14
132M BA, CA, YA, ZA, RA		132	216	178	89	10	260	215	18.5	147.5	198	330	270	262	20	14
132M TA		132	216	178	89	10	260	215	18.5	197.5	198	330	270	262	20	14
160M XA, VA, ZA		160	254	210	108	12	292	250	20	192	246	406	335	324	20	14
160L RA, XA, ZA		160	254	254	108	12	292	294	20	192	246	406	335	324	20	14
180M RA, XA		180	279	241	121	12	330	324	22.5	256	266	446	366	360	22	18
180L RA, XA		180	279	279	121	12	330	324	22.5	218	266	446	366	360	22	18
200L LA, NA, PA, RA, FA		200	318	305	133	16	380	360	27.5	237	341	541	405	400	25	22

	IEC DIN	L k	LB	LC k_1	AL	AF	BA m	AA n	D/DA d/d_1	E/EA l/l_1	F/FA u/u_1	GD	GA/GC t/t_1	DB [3)] d_6/d_7
56Z AA, BA		190	170	211	63	89	22	22	9	20	3	3	10.2	M4
63Z AA, BA, CA		213	190	238	66	89	26	26	11	23	4	4	12.5	M4
71Z AA, BA, CA		245	215	278	75	89	22	30	14	30	5	5	16	M5
80Z AA, BA, CA		272	232	319	79	116	28.5	34.5	19	40	6	6	21.5	M6
90S AA, BA		317	267	372	85	116	37/53	37	24	50	8	7	27	M8
90L CA, DA		317	267	372	85	116	37/53	37	24	50	8	7	27	M8
100L AA, BA, CA		366	306	433	91	116	38	44	28	60	8	7	31	M10
112M AA, BA, CA		388	328	456	91.5	116	46	48	28	60	8	7	31	M10
132S AA, BA, YA, ZA		449.5	369.5	536.5	134	133	55	57.5	38	80	10	8	41	M12
132M BA, CA, YA, ZA, RA		487.5	407.5	574.5	134	133	57.5	57.5	38	80	10	8	41	M12
132M TA		547.5	457.5	624.5	134	133	57.5	57.5	38	80	10	8	41	M12
160M XA, VA, ZA		613	503	730	156	149	60	64	42	110	12	8	45	M16
160L RA, XA, ZA		657	547	774	156	149	60	64	42	110	12	8	45	M16
180M RA, XA		712	602	838	178.5	180	93	66	48	110	14	9	51.5	M16
180L RA, XA		712	602	838	178.5	180	93	66	48	110	14	9	51.5	M16
200L LA, NA, PA, RA, FA		779	669	895	195.5	265	90	78	55	110	16	10	59	M20

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2

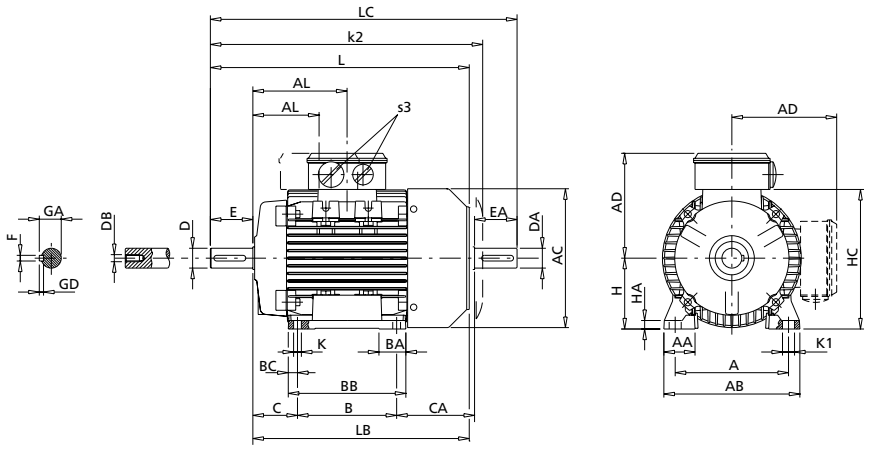


Cast iron frame

	IEC DIN	H h	A b	B a	C w_1	K[1)] s	AB f	BB e	BC	CA	AD[2)] g_4	HD[2)] m_1	AC g	HC	HA c	K_1
132S YG, ZG		132	216	140	89	10	260	175	17.5	185.5	201	333	270	262	20	14
132M YG, ZG, RG		132	216	178	89	10	260	215	18.5	147.5	201	333	270	262	20	14
132M TG		132	216	178	89	10	260	215	18.5	197.5	201	333	270	262	20	14
160M VG, XG, ZG		160	254	210	108	12	304	290	18	226	250	410	335	324	15	14
160L RG, XG, ZG		160	254	254	108	12	304	290	18	192	250	410	335	324	15	14
180M RG, XG		180	279	241	121	12	330	324	22.5	256	290	470	366	360	15	18
180L RG, XG, ZG		180	279	279	121	12	330	324	22.5	218	290	470	366	360	15	18
200L LG, NG, PG, RG, FG		200	318	305	133	16	380	360	22.5	237	341	541	405	400	18	_

	IEC DIN	L k	LB	LC k_1	AL	AF	BA m	AA n	D/DA d/d_1	E/EA l/l_1	F/FA u/u_1	GD	GA/GC t/t_1	DB [3)] d_6/d_7
132S YG, ZG		487.5	407.5	574.5	134	133	55	60	38	80	10	8	41	M12
132M YG, ZG, RG		487.5	407.5	574.5	134	133	57.5	60	38	80	10	8	41	M12
132M TG		547.5	457.5	624.5	134	133	57.5	60	38	80	10	8	41	M12
160M VG, XG, ZG		657	547	774	235	168	97	70	42	110	12	8	45	M16
160L RG, XG, ZG		657	547	774	235	168	97	70	42	110	12	8	45	M16
180M RG, XG		712	602	838	260.5	180	95	66	48	110	14	9	51.5	M16
180L RG, XG, ZG		712	602	838	260.5	180	95	66	48	110	14	9	51.5	M16
200L LG, NG, PG, RG, FG		779	669	895	285.5	265	90	79	55	110	16	10	59	M20

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2

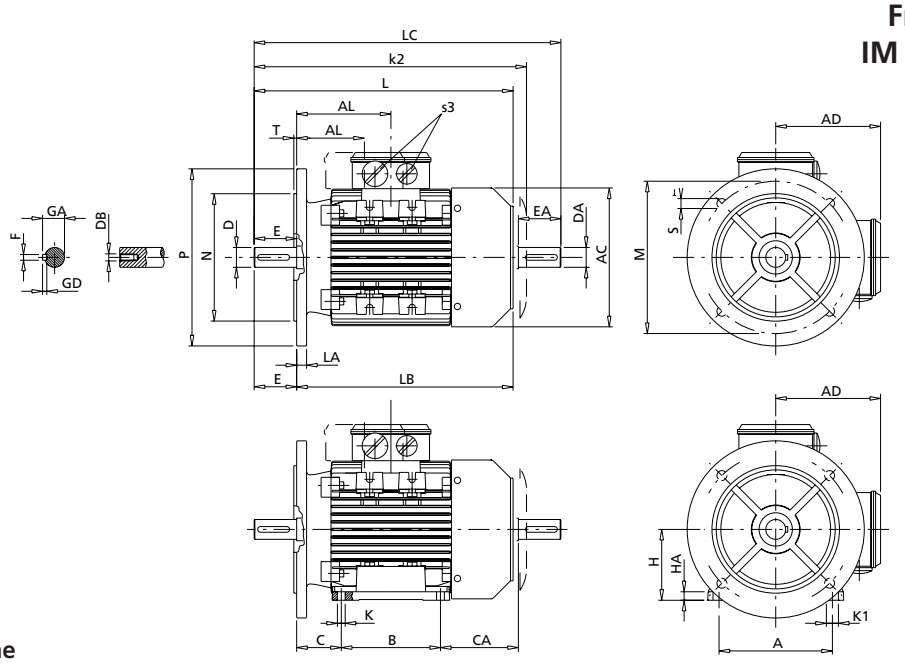


Cast iron frame

	No. of poles	H h	A b	B a	C w_1	K 1) s	AB f	BB e	BC	CA	AD 2) g_4	HD2) m_1	AC g	HC	HA c	K_1	L k
225S N P	2-4/2	225	356	286	149	16	420	375	32	318	360	585	463	450	22	16	857.5
	≥4	225	356	286	149	16	420	375	32	318	360	585	463	450	22	16	887.5
225M N, P	2-4/2	225	356	311	149	16	420	375	32	318	360	585	463	450	22	16	857.5
	≥4	225	356	311	149	16	420	375	32	318	360	585	463	450	22	16	887.5
250M K N, P	2-4/2	250	406	349	168	20	500	425	38	321	390	640	516	500	45	20	971.5
	≥4	250	406	349	168	20	500	425	38	321	390	640	516	500	45	20	971.5
280S T, V	2-4/2	280	457	368	190	20	560	450	41	325	423	703	506	564	50	20	1037
	≥4	280	457	368	190	20	560	450	41	325	423	703	506	564	50	20	1037
280M T, V	2-4/2	280	457	419	190	20	560	500	40.5	325	423	703	506	564	50	20	1088
	≥4	280	457	419	190	20	560	500	40.5	325	423	703	506	564	50	20	1088
315S YE	2-4/2	315	508	406	216	28	630	547	90	365	423	738	506	599	50	35	1117
	≥4	315	508	406	216	28	630	547	90	315	423	738	506	599	50	35	1097
315S ZE	2-4/2	315	508	406	216	28	630	547	45	342	515	830	620	660	55	35	1094
	≥4	315	508	406	216	28	630	547	45	342	515	830	620	660	55	35	1124
315M YE, ZE	2-4/2	315	508	457	216	28	630	547	45	291	515	830	620	660	55	35	1094
	≥4	315	508	457	216	28	630	547	45	291	515	830	620	660	55	35	1124
315L YE, ZE	2-4/2	315	508	508	216	28	630	598	45	360	515	830	620	660	55	35	1214
	≥4	315	508	508	216	28	630	598	45	360	515	830	620	660	55	35	1244

	No. of poles	LB	LC k1	AL	AF	BA m	AA n	D d	DA d1	E l	EA l1	F u	FA u1	GD	GA t	GC t1	DB 3) d6/d7
225S N P	2-4/2	747.5	973	304.5	265	95	90	55	55	110	110	16	16	11	59	59	M20
	≥4	747.5	1033	304.5	265	95	90	60	60	140	140	18	18	11	64	64	M20
225M N, P	2-4/2	747.5	973	304.5	265	95	90	55	55	110	110	16	16	10	59	59	M20
	≥4	747.5	1033	304.5	265	95	90	60	60	140	140	18	18	11	64	64	M20
250M K N, P	2-4/2	831.5	1118	342.5	265	120	135	60	60	140	140	18	18	11	64	64	M20
	≥4	831.5	1118	342.5	265	120	135	65	65	140	140	18	18	11	69	69	M20
280S T, V	2-4/2	897	1163	374	265	135	122	65	65	140	140	18	18	11	69	69	M20
	≥4	897	1163	374	265	135	122	75	75	140	140	20	20	12	79.5	79.5	M20
280M T, V	2-4/2	948	1214	399.5	265	135	122	65	65	140	140	18	18	11	69	69	M20
	≥4	948	1214	399.5	265	135	122	75	75	140	140	20	20	12	79.5	79.5	M20
315S YE	2-4/2	977	1267	399.5	265	135	122	65	60	140	140	18	18	11	69	64	M20
	≥4	927	1247	399.5	265	135	122	80	70	170	140	22	20	14	85	74.5	M20
315S ZE	2-4/2	954	1244	218	285	100	120	65	60	140	140	18	18	11	69	64	M20
	≥4	954	1274	218	285	100	120	80	70	170	140	22	20	14	85	74.5	M20
315M YE, ZE	2-4/2	954	1244	218	285	100	120	65	60	140	140	18	18	11	69	64	M20
	≥4	954	1274	218	285	100	120	80	70	170	140	22	20	14	85	74.5	M20
315L YE, ZE	2-4/2	1074	1364	218	285	100	120	65	60	140	140	18	18	11	69	64	M20
	≥4	1074	1394	218	285	100	120	80	70	170	140	22	20	14	85	74.5	M20

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2

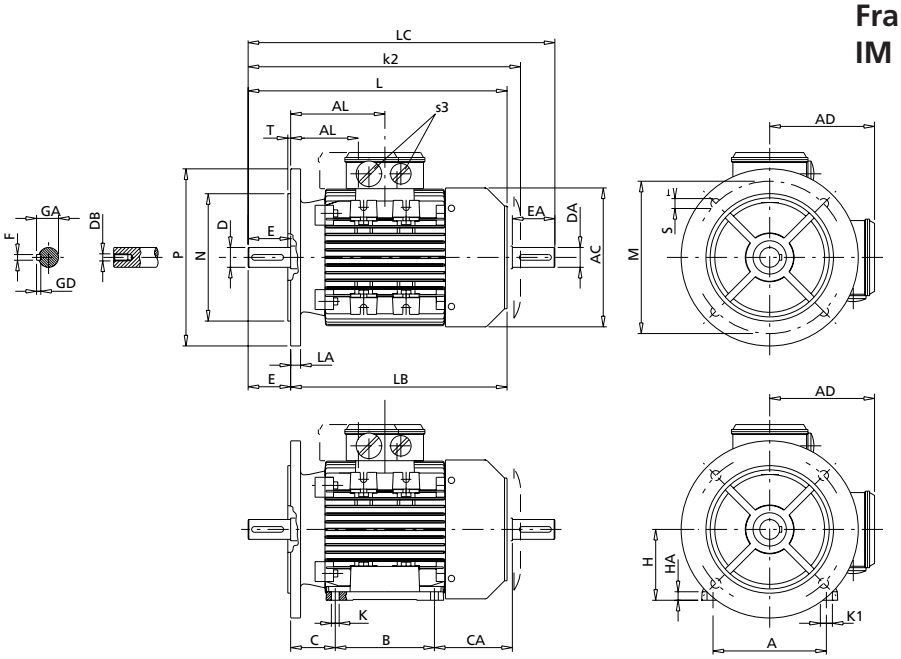


Aluminium frame

	IEC DIN	M e_1	N b_1	P a_1	T f_1	LA c_1	S[1] s_1	H h	A b	B a	C w_1	K s	CA	AD[2]	HD[2]	AC g
56Z AA, BA		100	80	120	2.5	5.5	M6	56	90	71	36	6	65	98	154	112
63Z AA, BA, CA		115	95	140	3	10	M8	63	100	80	40	7	72	103	166	125
71Z AA, BA, CA		130	110	160	3.5	10	M8	71	112	90	45	7	86	112	183	142
80Z AA, BA, CA		165	130	200	3.5	10	M10	80	125	100	50	9	89	129	209	160
90S AA, BA		165	130	200	3.5	12	M10	90	140	100	56	10	113	138	228	180
90L CA, DA		165	130	200	3.5	12	M10	90	140	125	56	10	88	138	228	180
100L AA, BA, CA		215	180	250	4	14	M12	100	160	140	63	11	110	145	245	196
112M AA, BA, CA		215	180	250	4	11	M12	112	190	140	70	10	126	161	273	225
132S AA, BA, YA, ZA		265	230	300	4	12	M12	132	216	140	89	10	147.5	198	330	270
132M BA, CA, YA, ZA, RA		265	230	300	4	12	M12	132	216	178	89	10	147.5	198	330	270
132M TA		265	230	300	4	12	M12	132	216	178	89	10	197.5	198	330	270
160M XA, VA, ZA		300	250	350	5	13	M16	160	254	210	108	12	192	246	406	335
160L RA, XA, ZA		300	250	350	5	13	M16	160	254	254	108	12	192	246	406	335
180M RA, XA		300	250	350	5	13	M16	180	279	241	121	12	256	266	446	366
180L RA, XA		300	250	350	5	13	M16	180	279	279	121	12	218	266	446	366
200L LA, NA, PA, RA, FA		350	300	400	5	15	M16	200	318	305	133	16	237	341	541	405

	BC	HA c	HC	K1	L k	LB	LC k1	AL	AF	D/DA d/d1	E/EA l/l1	F/FA u/u1	GD	GA/GC t,t1	DB3) d6/d7
56Z AA, BA	9.5	8	110	12	190	170	211	63	89	9	20	3	3	10.2	M4
63Z AA, BA, CA	12.5	8	125	12	213	190	238	66	89	11	23	4	4	12.5	M4
71Z AA, BA, CA	9.5	9	142	17	245	215	278	75	89	14	30	5	5	16	M5
80Z AA, BA, CA	12.5	9.5	162	14	272	232	319	79	116	19	40	6	6	21.5	M6
90S AA, BA	25	11	181	15	317	267	372	85	116	24	50	8	7	27	M8
90L CA, DA	12.5	11	181	15	317	267	372	85	116	24	50	8	7	27	M8
100L AA, BA, CA	13	12	198	17	366	306	433	91	116	28	60	8	7	31	M10
112M AA, BA, CA	17.5	15	226	19	388	328	456	91.5	116	28	60	8	7	31	M10
132S AA, BA, YA, ZA	17.5	20	262	14	449.5	369.5	536.5	134	133	38	80	10	8	41	M12
132M BA, CA, YA, ZA, RA	18.5	20	262	14	487.5	407.5	574.5	134	133	38	80	10	8	41	M12
132M TA	18.5	20	262	14	537.5	457.5	624.5	134	133	38	80	10	8	41	M12
160M XA, VA, ZA	20	20	324	14	613	503	730	156	149	42	110	12	8	45	M16
160L RA, XA, ZA	20	20	324	14	657	547	774	156	149	42	110	12	8	45	M16
180M RA, XA	22.5	22	360	18	712	602	838	178.5	180	48	110	14	9	51.5	M16
180L RA, XA	22.5	22	360	18	712	602	838	178.5	180	48	110	14	9	51.5	M16
200L LA, NA, PA, RA, FA	27.5	25	400	22	779	669	895	195.5	265	55	110	16	9	59	M20

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2

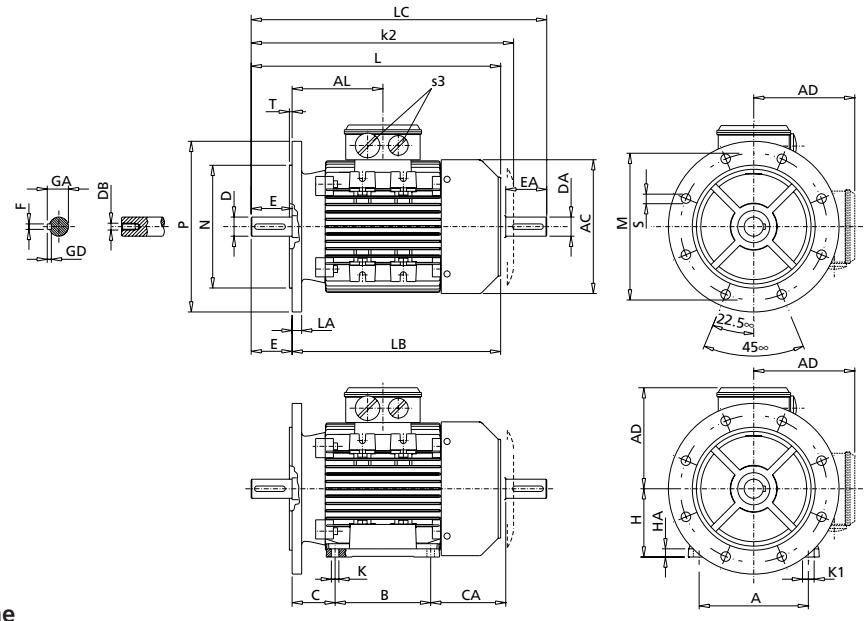


Cast iron frame

	IEC DIN	M e_1	N b_1	P a_1	T f_1	LA c_1	S[1)] s_1	H h	A b	B a	C w_1	K s	CA	AD[2)]	HD[2)]	AC g
132S YG, ZG		265	230	300	4	12	M12	132	216	140	89	10	185.5	201	333	270
132M YG, ZG, RG		265	230	300	4	12	M12	132	216	178	89	10	147.5	201	333	270
132M TG		265	230	300	4	12	M12	132	216	178	89	10	197.5	201	333	270
160M VG, XG, ZG		300	250	350	5	13	M16	160	254	210	108	12	226	250	410	335
160L RG, XG, ZG		300	250	350	5	13	M16	160	254	254	108	12	192	250	410	335
180M RG, XG		300	250	350	5	13	M16	180	279	241	121	12	256	290	470	366
180L RG, XG, ZG		300	250	350	5	13	M16	180	279	279	121	12	218	290	470	366
200L LG, NG, PG, RG, FG		350	300	400	5	15	M16	200	318	305	133	16	237	341	541	405

	BC	HA c	HC	K1	L k	LB	LC k1	AL	AF	D/DA d/d1	E/EA l/l1	F/FA u/u1	GD	GA/GC t,t1	DB3) d6/d7
132S YG, ZG	17.5	20	262	14	487.5	407.5	574.5	134	133	38	80	10	8	41	M12
132M YG, ZG, RG	18.5	20	262	14	487.5	407.5	574.5	134	133	38	80	10	8	41	M12
132M TG	18.5	20	262	14	537.5	457.5	624.5	134	133	38	80	10	8	41	M12
160M VG, XG, ZG	18	15	324	14	657	547	774	235	168	42	110	12	8	45	M16
160L RG, XG, ZG	18	15	324	14	657	547	774	235	168	42	110	12	8	45	M16
180M RG, XG	22.5	15	360	18	712	602	838	260.5	180	48	110	14	9	51.5	M16
180L RG, XG, ZG	22.5	15	360	18	712	602	838	260.5	180	48	110	14	9	51.5	M16
200L LG, NG, PG, RG, FG	27.5	18	400	_	779	669	895	285.5	265	55	110	16	9	59	M20

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2



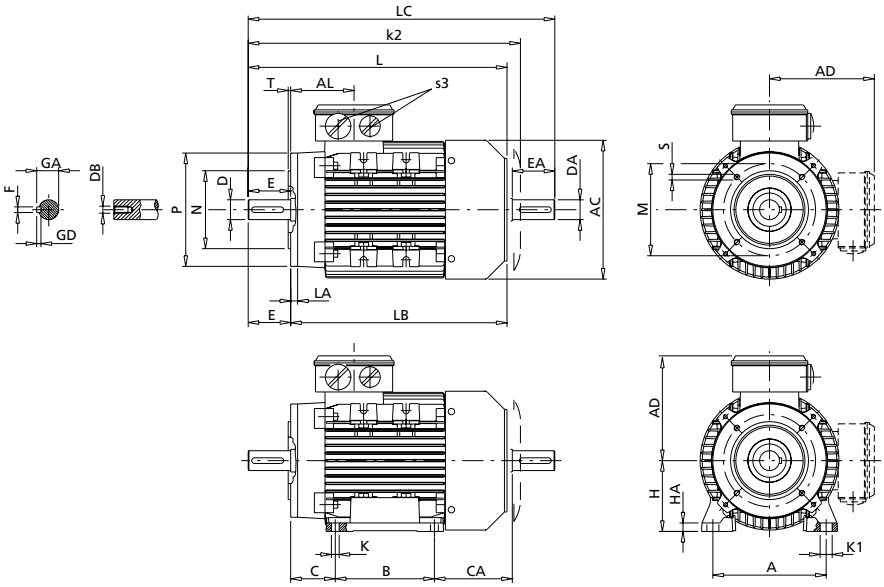
Cast iron frame

	No. of poles	M e_1	N b_1	P a_1	T f_1	LA c_1	S[1] s_1	H h	A b	B a	C w_1	K s	CA	HD[2] m_1	AC g	AD[2] g_4	HA c	K_1
225S N, P	2-4/2	400	350	450	5	16	M16	225	356	286	149	16	318	585	463	360	22	16
	≥4	400	350	450	5	16	M16	225	356	286	149	16	318	585	463	360	22	16
225M N, P	2-4/2	400	350	450	5	16	M16	225	356	311	149	16	318	585	463	360	22	16
	≥4	400	350	450	5	16	M16	225	356	311	149	16	318	585	463	360	22	16
250M K, N, P	2-4/2	500	450	550	5	18	M16	250	406	349	168	20	321	640	516	390	45	20
	≥4	500	450	550	5	18	M16	250	406	349	168	20	321	640	516	390	45	20
280S T, V	2-4/2	500	450	550	5	18	M16	280	457	368	190	20	325	703	514	423	50	20
	≥4	500	450	550	5	18	M16	280	457	368	190	20	325	703	514	423	50	20
280M T, V	2-4/2	500	450	550	5	18	M16	280	457	419	190	20	325	703	514	423	50	20
	≥4	500	450	550	5	18	M16	280	457	419	190	20	325	703	514	423	50	20
315S YE	2-4/2	600	550	660	6	22	M20	315	508	406	216	28	365	738	514	423	50	35
	≥4	600	550	660	6	22	M20	315	508	406	216	28	315	738	514	423	50	35
315S ZE	2-4/2	600	550	660	6	22	M20	315	508	406	216	28	342	830	620	515	55	35
	≥4	600	550	660	6	22	M20	315	508	406	216	28	342	830	620	515	55	35
315M YE, ZE	2-4/2	600	550	660	6	22	M20	315	508	457	216	28	291	830	620	515	55	35
	≥4	600	550	660	6	22	M20	315	508	457	216	28	291	830	620	515	55	35
315L YE, ZE *	2-4/2	600	550	660	6	22	M20	315	508	508	216	28	360	830	620	515	55	35
	≥4	600	550	660	6	22	M20	315	508	508	216	28	360	830	620	515	55	35

	No. of poles	L k	LB	LC k_1	AL	AF	BC	D d	DA d_1	E l	EA l_1	F u	FA u_1	GD	GA t	GC t_1	DB[3] d_6/d_7
225S N, P	2-4/2	857.5	747.5	973	304.5	265	32	55	55	110	110	16	16	11	59	59	M 20
	≥4	887.5	747.5	1033	304.5	265	32	60	60	140	140	18	18	11	64	64	M 20
225M N, P	2-4/2	857.5	747.5	973	304.5	265	32	55	55	110	110	16	16	10	59	59	M 20
	≥4	887.5	747.5	1033	304.5	265	32	60	60	140	140	18	18	11	64	64	M 20
250MK, P	2-4/2	971.5	831.5	1118	342.5	265	38	60	60	140	140	18	18	11	64	64	M 20
	≥4	971.5	831.5	1118	342.5	265	38	65	65	140	140	18	18	11	69	69	M 20
280S T, V	2-4/2	1037	897	1163	374	265	41	65	65	140	140	18	18	11	69	69	M 20
	≥4	1037	897	1163	374	265	41	75	75	140	140	20	20	12	79.5	79.5	M 20
280M T, V	2-4/2	1088	948	1214	399.5	265	40.5	65	65	140	140	18	18	11	69	69	M 20
	≥4	1088	948	1214	399.5	265	40.5	75	75	140	140	20	20	12	79.5	79.5	M 20
315S YE	2-4/2	1117	977	1267	399.5	265	90	65	60	140	140	18	18	11	69	64	M 20
	≥4	1097	927	1247	399.5	265	90	80	70	170	140	22	20	14	85	74.5	M 20
315S ZE	2-4/2	1094	954	1244	218	285	45	65	60	140	140	18	18	11	69	64	M 20
	≥4	1124	954	1274	218	285	45	80	70	170	140	22	20	14	85	74.5	M 20
315M YE, ZE	2-4/2	1094	954	1244	218	285	45	65	60	140	140	18	18	11	69	64	M 20
	≥4	1124	954	1274	218	285	45	80	70	170	140	22	20	14	85	74.5	M 20
315L YE, ZE *	2-4/2	1214	1074	1364	218	285	45	65	60	140	140	18	18	11	69	64	M 20
	≥4	1244	1074	1394	218	285	45	80	70	170	140	22	20	14	85	74.5	M 20

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2

* IM B5 on request

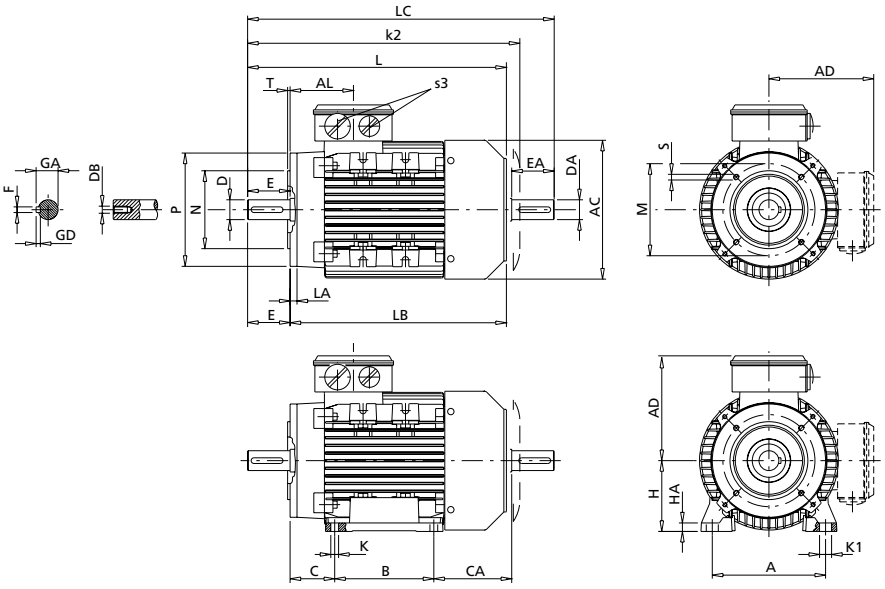


Aluminium frame

	Small flange						Large flange													
	P	N	LA	M	T	S	P	N	LA	M	T	S	L	LB	LC	AL	AF	D	DA	BC
	a_1	b_1	c_1	e_1	f_1	s_1	a_1	b_1	c_1	e_1	f_1	s_1	k		k_1			d	d_1	
56Z AA, BA	80	50		65	3	M5	105	70	8	85	2.5	M6	190	170	211	63	89	9	9	9.5
63Z AA, BA, CA	90	60		75	2.5	M5	120	80	8	100	2.5	M6	213	190	238	66	89	11	11	12.5
71Z AA, BA, CA	105	70		85	2.5	M6	140	95	8	115	2.5	M8	245	215	278	75	89	14	14	9.5
80Z AA, BA, CA	120	80	8	100	3	M6	160	110	8.5	130	3.5	M8	272	232	319	79	116	19	19	12.5
90S AA, BA	140	95	10	115	3	M8	160	110	9	130	3.5	M8	317	267	372	85	116	24	24	25
90L BA, CA, DA	140	95	10	115	3	M8	160	110	9	130	3.5	M8	317	267	372	85	116	24	24	12.5
100L AA, BA, CA	160	110	10	130	3.5	M8	200	130	12	165	3.5	M10	366	306	433	91	116	28	28	13
112M AA, BA, CA	160	110	10	130	3.5	M8	200	130	12	165	3.5	M10	388	328	456	91.5	116	28	28	17.5
132S AA, BA, YA, ZA	200	130	12	165	3.5	M10	250	180	12	215	4	M12	449.5	369.5	536.5	134	133	38	38	17.5
132M BA,CA,YA,ZA,RA	200	130	12	165	3.5	M10	250	180	12	215	4	M12	487.5	407.5	574.5	134	133	38	38	18.5
132M TA	200	130	12	165	3.5	M10	250	180	12	215	4	M12	537.5	457.5	624.5	134	133	38	38	18.5
160M XA, VA, ZA	250	180	12	215	4	M12	300	230	12	265	5	M16	613	503	730	156	149	42	42	20
160L RA, XA, ZA	250	180	12	215	4	M12	300	230	12	265	5	M16	657	547	774	156	149	42	42	20

	E	EA	F	FA	GD	GA	GC	DB[3]	H	A	B	C	K[1]	AB	BB	CA	AD[2]	HD[2]	AC	HC	HA	K_1
	l	l_1	u	u_1			t/t_1	d_6/d_7	h	b	a	w_1	s	f	e		g_4	m_1	g		c	
56Z AA, BA	20	20	3	3	3	10.2	10.2	M4	56	90	71	36	6	109	90	65	98	154	112	110	8	12
63Z AA, BA, CA	23	23	4	4	4	12.5	12.5	M4	63	100	80	40	7	126	105	72	103	166	125	125	8	12
71Z AA, BA, CA	30	30	5	5	5	16	16	M5	71	112	90	45	7	144	109	86	112	183	142	142	9	17
80Z AA, BA, CA	40	40	6	6	6	21.5	21.5	M6	80	125	100	50	9	153	125	89	129	209	160	9.5	14	14
90S AA, BA	50	50	8	8	7	27	27	M8	90	140	100	56	10	170	150	113	138	228	180	181	11	15
90L BA, CA, DA	50	50	8	8	7	27	27	M8	90	140	125	56	10	170	150	88	138	228	180	181	11	15
100L AA, BA, CA	60	60	8	8	7	31	31	M10	100	160	140	63	11	192	166	110	145	245	196	198	12	17
112M AA, BA, CA	60	60	8	8	7	31	31	M10	112	190	140	70	10	220	175	126	161	278	225	226	15	19
132S AA, BA, YA, ZA	80	80	10	10	8	41	41	M12	132	216	140	89	10	260	175	147.5	198	330	270	262	20	14
132M BA CA, YA, ZA, RA	80	80	10	10	8	41	41	M12	132	216	178	89	10	260	215	147.5	198	330	270	262	20	14
132M TA	80	80	10	10	8	41	41	M12	132	216	178	89	10	260	215	197.5	198	330	270	262	20	14
160M XA, VA, ZA	110	110	12	12	8	45	45	M16	160	254	210	108	12	292	250	192	246	406	335	324	20	14
160L RA, XA, ZA	110	110	12	12	8	45	45	M16	160	254	254	108	12	292	294	192	246	406	335	324	20	14

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2



Cast iron frame

	Small flange						Large flange													
	P	N	LA	M	T	S	P	N	LA	M	T	S	L	LB	LC	AL	AF	D	DA	BC
	a_1	b_1	c_1	e_1	f_1	s_1	a_1	b_1	c_1	e_1	f_1	s_1	k		k_1			d	d_1	
132S YG, ZG	200	130	12	165	3.5	M10	250	180	12	215	4	M12	449.5	369.5	536.5	134	133	38	38	17.5
132M YG, ZG, RG	200	130	12	165	3.5	M10	250	180	12	215	4	M12	487.5	407.5	574.5	134	133	38	38	18.5
132M TG	200	130	12	165	3.5	M10	250	180	12	215	4	M12	537.5	457.5	624.5	134	133	38	38	18.5
160M VG, XG, ZG	250	180	12	215	4	M12	300	230	12	265	5	M16	613	503	730	235	168	42	42	18
160L RG, XG, ZG	250	180	12	215	4	M12	300	230	12	265	5	M16	657	547	774	235	168	42	42	18

	E	EA	F	FA	GD	GA	GC	DB[3]	H	A	B	C	K[1]	AB	BB	CA	AD[2]	HD[2]	AC	HC	HA	K[1]
	l	l_1	u	u_1			t/t_1	d_6/d_7	h	b	a	w_1	s	f	e		g_4	m_1	g		c	
132S YG, ZG	80	80	10	10	8	41	41	M12	132	216	140	89	10	260	175	185.5	201	333	270	262	20	14
132M YG, ZG, RG	80	80	10	10	8	41	41	M12	132	216	178	89	10	260	215	147.5	201	333	270	262	20	14
132M TG	80	80	10	10	8	41	41	M12	132	216	178	89	10	260	215	197.5	201	333	270	262	20	14
160M VG, XG, ZG	110	110	12	12	8	45	45	M16	160	254	210	108	12	304	290	226	250	410	335	324	15	14
160L RG, XG, ZG	110	110	12	12	8	45	45	M16	160	254	254	108	12	304	290	192	250	410	335	324	15	14

1) Clearance hole for screw
2) Maximum dimension
3) Centering holes in shaft extensions to DIN 332 part 2

Notes

Factories

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05/2003

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The LS16 standard optic power is a multimode fibre optic interface which is converting RS232 signal into optic fibre and vice versa. The LS16 is for communication between wind turbines, weather stations and park PC's.

- DIN plug (11-poled) connector for mounting in the power panel and connection of supply.
- Specified for 50/125µm, 62.5/125µm, 100/140µm and 200µm PCS fibre optic cable.
- Power supply, which can be either AC or DC, offers total switchmode galvanic separation.
- Fibreoptic communication offers total galvanic separation.
- Optic power level selectable with STANDARD/HIGH switch.
- Configuration in park selectable with NO LOOP/LOOP switch (Master/Slave).
- The LS16 is produced in accordance with demands in the DS/EN ISO 9001-standard. It complies with EMC demands such as the EN61000-6-2 (Industry), the EN61000-6-4 (Industry) and the EN61000-4-5 (Surge).

LS16 ISOLATED OPTIC/RS23C CONVERTER, STANDARD POWER

Mita-Teknik a/s

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Tel:+45 86 65 86 00
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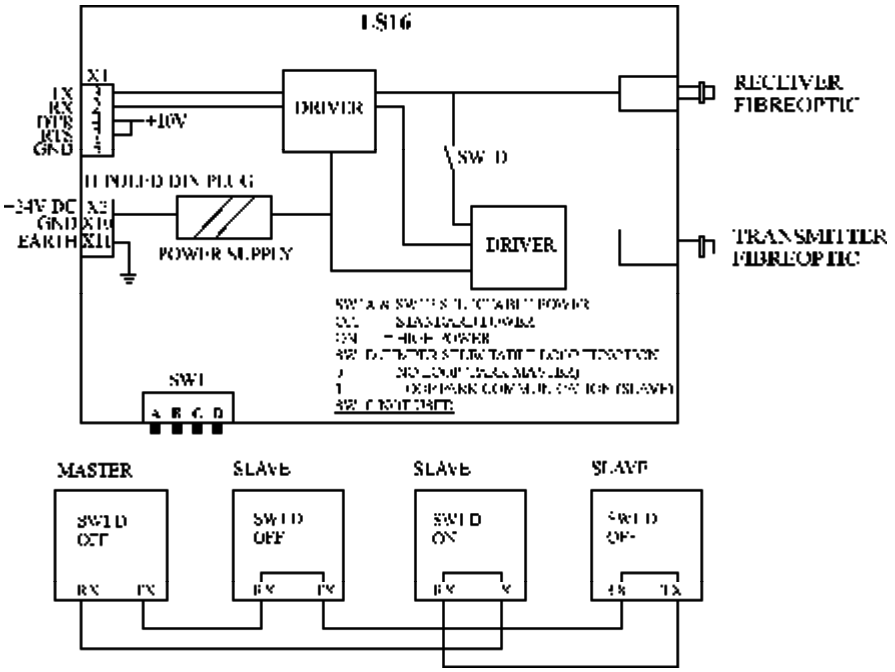
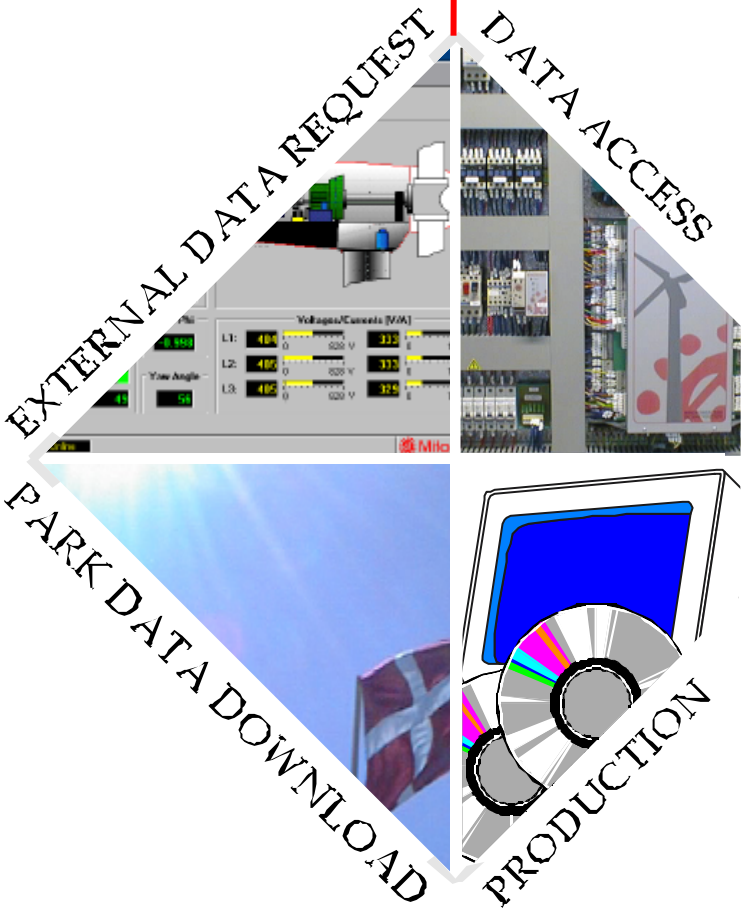


TECHNICAL DATA	MIN.	TYP.	MAX.	
Fibreoptic cable: 50/125µm, 62.5/125µm, 100/140µm and 200µm PCS				
Supply voltage	10/10		30/28	V DC/AC
Supply current @ 24V DC	50	60	85	mA
Communication speed			400	kBaud
Peak output power, measured on 1 m cable: 971016002 50/125µm fibreoptic cable, NA = 0.20 62.5/125µm fibreoptic cable, NA = 0.275	 -19.8 -16.0	 -15.8 -10.4	 -12.8 -9.0	 dBm dBm
Minimum input sensitivity (HFBR2412)		-25.4	-24.0	dBm
Optic power budget (OPB): 971016002 (HFE4080/HFBR2412) with 62.5µm 971016002 (HFE4080/HFBR2412) with 50µm Distance: 971016002 (HFE4080/HFBR2412) with 62.5µm (3.2dB/km) 971016002 (HFE4080/HFBR2412) with 50µm (2.7dB/km)	 8.0 4.2 1000 0	 15.0 9.6 3188 1777		 dB dB m m
Minimum distance required for secure transmission	0			m
High power. (SW1A and SW1B). Extra optic power (+20mA)		1.0		dBm
Temperature, continuous operation stock	-20 -20		+70 +85	°C °C
Height Width Depth			75 38 90	mm mm mm
Weight			110	g

LS16 ISOLATED OPTIC/RS23C CONVERTER, STANDARD POWER

Mita-Teknik a/s

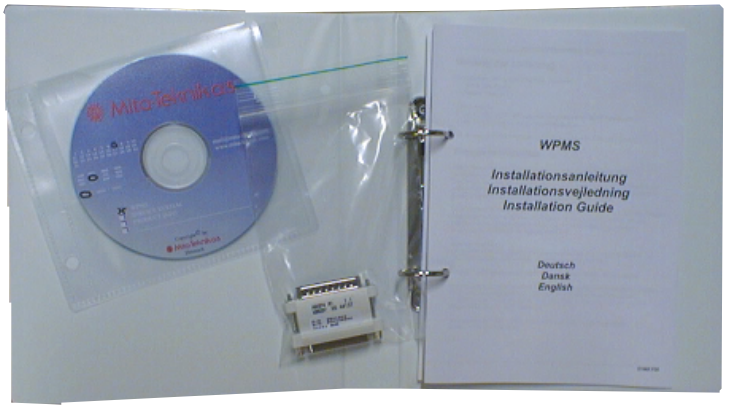
WPMS -
WindPower Management System



System Structure

The modular structure of the WPMS enables you to customise the system according to yourneeds. Thebasic module is easily extended by a variety of advanced functions-merely by adding release access codes. The contents of a basic program package is the following:installation guide, CD, dongle (hardwarelock) and on-line manual.

Toinstall the program package, you only have to follow the automatic installation guide,which will lead you through all stages of the installation. Extensions are activated by entering the release access code, which i s delivered by Mita-Teknik or bythewindturbinemanufacturer.



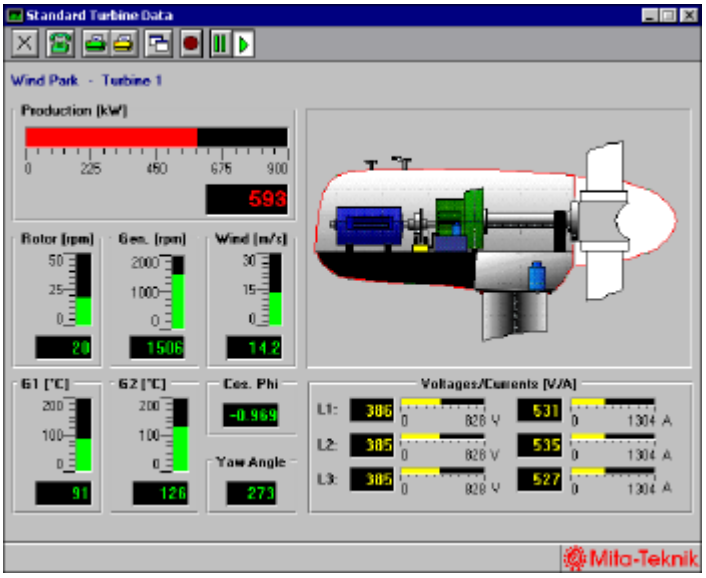
TheWPMS Basic System can be extended with

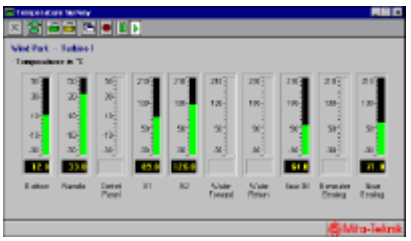
- External Data Request
- Data Access
- Control Panel
- Park Control Panel
- Wind Power Data
- Autocall
- Alarm Call Forwarding-SMS
- Alarm Call Forwarding-OPS
- Alarm Call Forwarding-WPMS
- Park Redirection
- Park Data Download
- Park Monitor
- Advanced Reporting Tool (ART)
- Remote Display WP2000 R/O
- Remote Display WP2000 R/W
- Remote Display WP3000 R/O
- Remote Display WP3000 R/W
- Weather Station

Welcome to our worldwide concept of quality

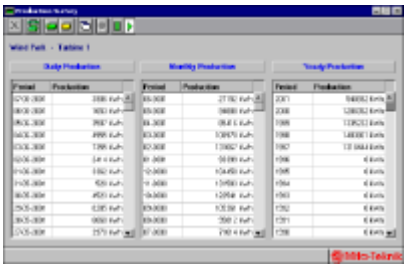
WPMS Basic System

The WindPower Management System is developed especially for the efficient and professional monitoring of all types of wind turbines. Theprogram gives the user the possibility of on-line surveillance, alarm reception, remote control and graphic presentation of operational data. The user-friendliness of the program has been given very high priority andisreflected in theflexibility of the graphical user interface. In the following text the WindPower ManagementSystem will be referred to as the WPMS.





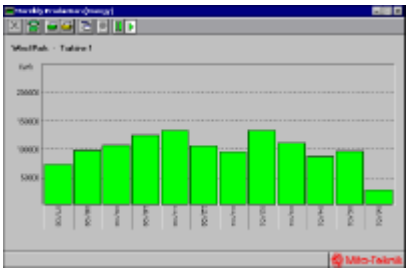
Temperature survey-on line



Production survey

The basic program package contains all the on-line and statistical data needed by the owner of a wind turbine or a small scale wind park.The basic program package gives you on-line access to the following data:

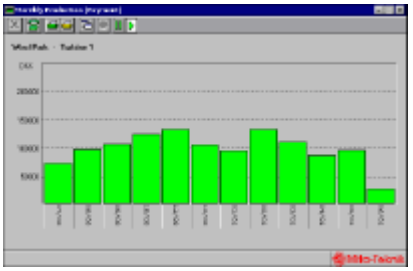
- Production and wind data
- Temperatures
- Currents, voltages and power factor.
- Number of revolutions etc.



Monthly production (kWh)

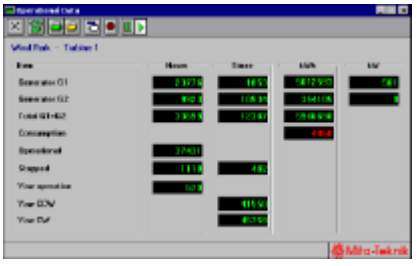
Graphs and tables showing a variety of data are also available with the basic program package, e.g.:

- Production statistics going years, months and days back
- Detailed operation statistics of the last24 hours
- Status and event lists
- Summary of status and error messages
- Operation hours of a numbe of units in the wind turbine.



Monthly production ($)

Functions such as reliable alarm reception, advanced printing facilities and communication surveillance are also part of the package.

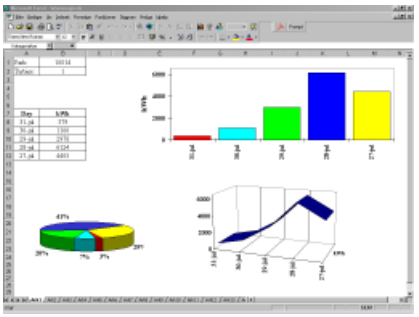


Operational d ata-on-line

Extend the WPMS Basic System

The WPMS Basic System can be extended dependent on your requirements. With our large choice of extension modules WPMS can supply you with a variety of intelligent functionsmaking it easier to monitor wind turbine operation.Access is given to statistical functions,remote control, parameter settings, automatic data collection and alarm management throughthe dongle release codes. In the following the extension modules will be described one by one:

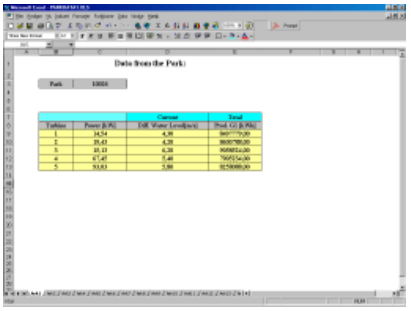
External Data Request



Module for the generation of user-defined reports and high-quality analyses. The module gives you the possibility of placingon-line wind turbine data in a spreadsheet,like for example the MSEXCEL. When the module is used in combination with the WP3000DATAACCESS-1 module, almost infinite possibilities of designing reports, analyses and diagrams are at your disposal. Data aredevided into groups of operational data, summaries, events, stall curves, digital input signals and a number of interval data. Data are shown as actual values or data collected from a log in the WINDPOWER computer.

P/N.:9842101

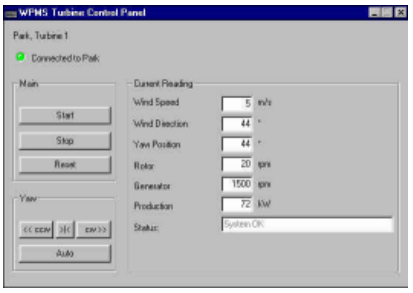
DataAccess-1



This module gives you access to data saved in the WP3000 computer. The module is to be used together with WPMS External Data Request or Autocall every time access to stored data is needed.

P/N.:9842401

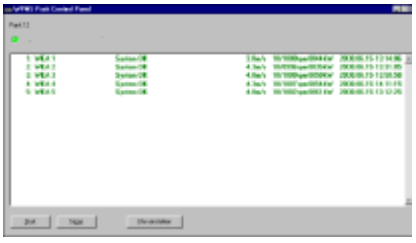
Control Panel



Module for the manual remote control of a wind turbine. You can start, stop, andyaw by means of this control panel. Besides the remote control functions, operational data such as wind speed, wind direction, yaw angle, number of generator androtor revolutions, the production and status of thewindturbine are shown.

P/N.:9842103

Park Control Panel



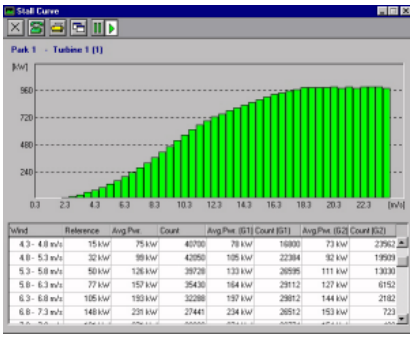
Module for the on-line presentation of wind turbines in a park. You can start, stop and set the clock by means of this control panel. Besides the remote control functions; the status of the wind turbine, the generator- and rotor revolutions, and wind speeds are shown.

P/N.:9842152

Wind Power Data

Module for the on-line presentati on of wind turbine power curves. You can select 3 power curvesintheWP3000computer and also chose the design by double-clicking on the mouse. The included STALL REFERENCE CURVE EDITOR shows the theoretical POWER CURVE, and enables a comparison with the current POWER CURVE.

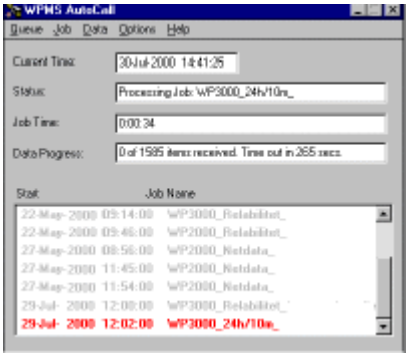
P/N.:Customer specified number



Autocall

This module has been developed for users,like park owners and company service personnel, who collect a large amount of statistical data from a number of wind turbines. With this module you can specify the wind turbine, the data to be collected, the time of collection and the intervals. The program automatically collects the data which can be processed in MS ACCESS™ and MS EXCEL.

P/N.:9842104



Remote Display WP2000/WP3000

Module for monitoring a wind turbine with a WP2000 computer or a WP3000 computer. The module isavailable in two versions, R/O or R/W:

Read Only R/O

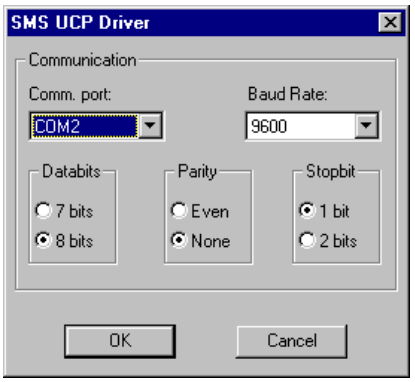
Wind turbine data are shown but commands cannot be issued and parameters cannot be changed. This module is mainly used by sales persons, wishing to present the possibilities of rendering professional assistance via modem.

Read and Write R/W

Wind turbine data are presented. Furthermore commands can be issued and parameters can be changed. This module is mainly used by service personnel and gives exactly the same functions as the display in a wind turbine.

P/N.:Customer specified numbers

Extend the WPMS Basic System



Alarm Call Forwarding

These modules are especially used in parks with for example a park-PC.

Alarm Call Forwarding via SMS

Module for reception of alarm calls. Alarm calls are saved and re-transmitted as SMS (Short Message Service) to mobile telephone.
P/N.:9842114

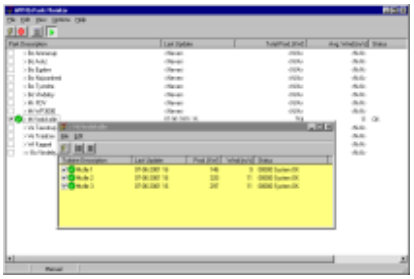
Alarm Call Forwarding via OPS

Module for reception of alarm calls. Alarm calls are saved and re-transmitted via the OPS system.
P/N.:9842112

Alarm Call Forwarding via WPMS

Module for reception of alarm calls. Alarm calls are saved and re-transmitted to another computer with a WPMS system.
P/N.:9842115

Park Monitor

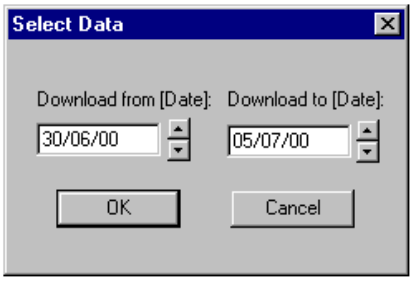


This module isused for the surveillance of one or more parks. With the Park Monitor module the operational data and thestatus of parks and wind turbines are automatically collected (from the WPMSdatabase). Reports of the actual operational status may also be generated and printed out.
P/N.:9842106

WeatherStation

Module for presentation of data from a IC1000 weather station. With this module you are given access to weather data such as wind speed, wind direction, temperature, atmospheric pressure, rainfall, and lightning frequency. Via the WPMS EXTERNAL DATA REQUEST and the WPMS AUTOCALL modules, summarised data, going as far back as 20 years, can be collected and presented.
P/N.:9842130

Park Redirection

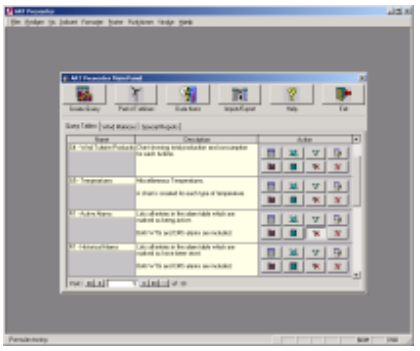


Module for collecting data via modem from one or more wind turbines in a park. The module is used in a Park-PC.
P/N.:9842105

Park Data Download

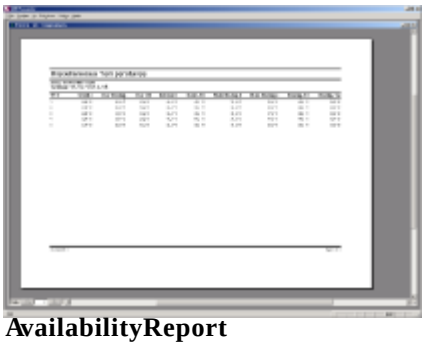
This module is used for transmission of collected data on a Park-PC to another PC. The data may be processed using MSACCESS™ or MSEXCEL
P/N.:9842106.

ART (Advanced Reporting Tool)
This module is an extension to the WPMS AUTOCALL module. The module exports data collected by AUTOCALL to a MSACCESS data base. When data have been exported, a userfriendly environment in the ACCESS database enables the user to design his or her own reports and graphs. When designing statistics the user is guided through every step of the way. As the calculation of statistics may be very consuming, it is possible to let the program work at night and have the resultready and printed in the morning. Statistics can be displayed in tables, reports, graphs or in MSEXCEL.
P/N.:9842122

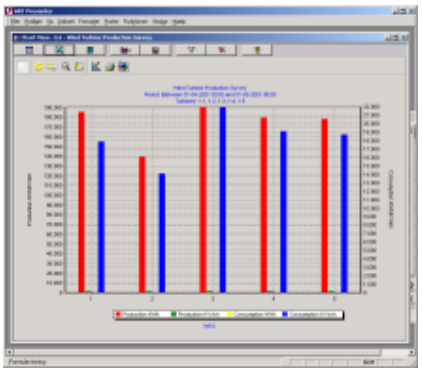

MainxScreen

Examples of ART Reports

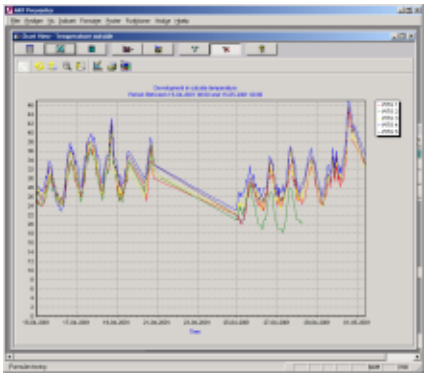
Availability Reports
Availability is the percentage of the time that the wind turbine operates or is ready to operate. Availability can be calculated from a number of data collected from the single turbine. The data will be collected using WPMS Autocall and can be presented in ART reports.


AvailabilityReport

Graphical Presentation of e.g. Production
Using the WPMS ART Module you can have a quick survey of a number of wind turbine data. For example energy production and consumption for a certain period. Each column section represents a wind turbine.


Production

Graphical Presentation of the Development in e.g. Temperatures
During optimisation and analyses it is often important to follow the development of the collected data. This data screen is also collected within a certain period, which is shown in the report.


TemperatureDevelopment

You can download the commercial version of WPMS at:
www.mita-teknik.com/support/support.html

Mita-Teknik a/s

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Mita-Teknik a/s

WPMS -
WEB Browser System

WPMS WEB Browser System

System Description

Mita-Teknik has just released a new web server solution for online presentation of wind turbine data. The solution covers surveillance of both single wind turbines and wind farms.

Traditionally the user-access to wind turbine data is made through modem, which enables the user to access all available data and operate the wind turbine. This requires a SCADA system per user.

The web server solution is especially developed for manufacturers, plan offices and operators wanting to give their customers an extra appreciation and added value.
With the new web server solution you can offer your customers and joint owners internet-access to production data daily, monthly and yearly.

Furthermore, the web server provides online-access to an animated graphical park view and single turbine data. Additional data can be added if the task requires so.

In order to protect data from unauthorized access the user has to perform a login procedure. The operation is browser based and very user-friendly.

Flexibility has a high priority in the system design. It is possible to customize the system with your own logo, park logos and backgrounds on the graphical park view. The overall lay-out is generic and made in neutral colours.

Hardware Configuration

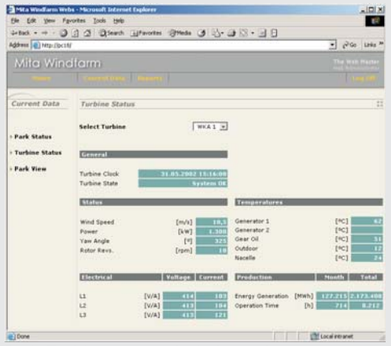
The hardware configuration depends on the location of the server. It is possible to place the server directly in the park, at the manufacturer/the operator or on an external WEB hotel. Mita-Teknik will assist with this task.

Complete Solutions

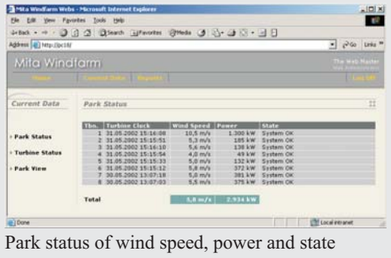
Everybody knows that an easy and fast installation saves both time and money and consequently we have chosen only to offer package solutions pre-configured by Mita-Teknik.

On-Site Installation

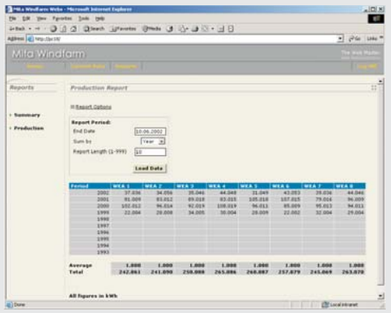
Mita-Teknik can provide a turn-key solution.



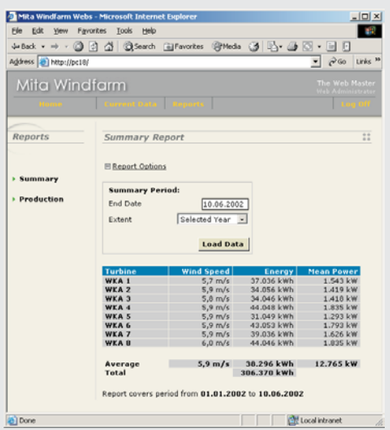
Park/Turbine status of wind speed, temperatures electrical values, and production



Park status of wind speed, power and state



Production report total and avarage for the turbines

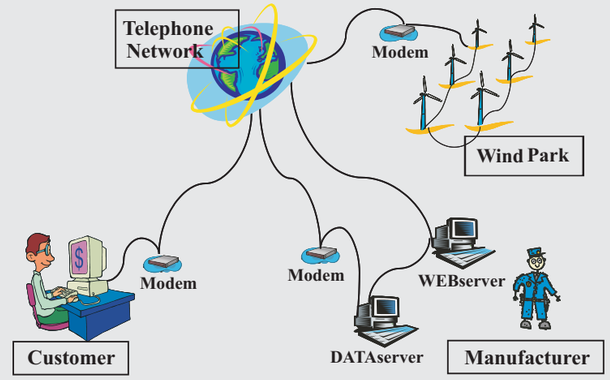


Summary report of wind speed, production and mean power

WPMS WEB Browser System

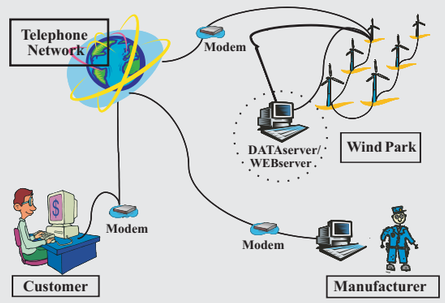
Three Solutions for WEB Browser System

1. Server at Manufacturer

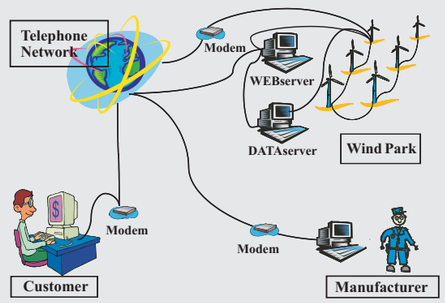


2. Server in Wind Park

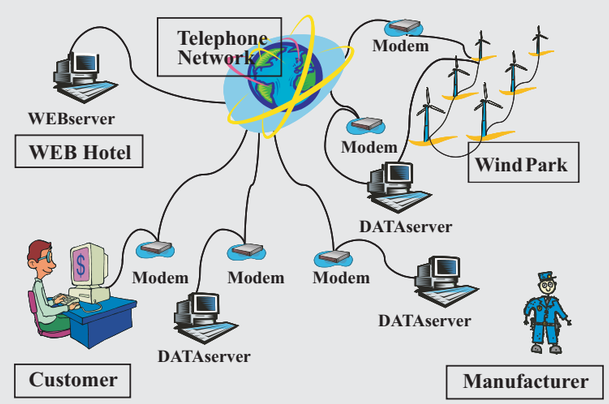
WEB Server with integrated DATA server



WEB Server with separate DATA server

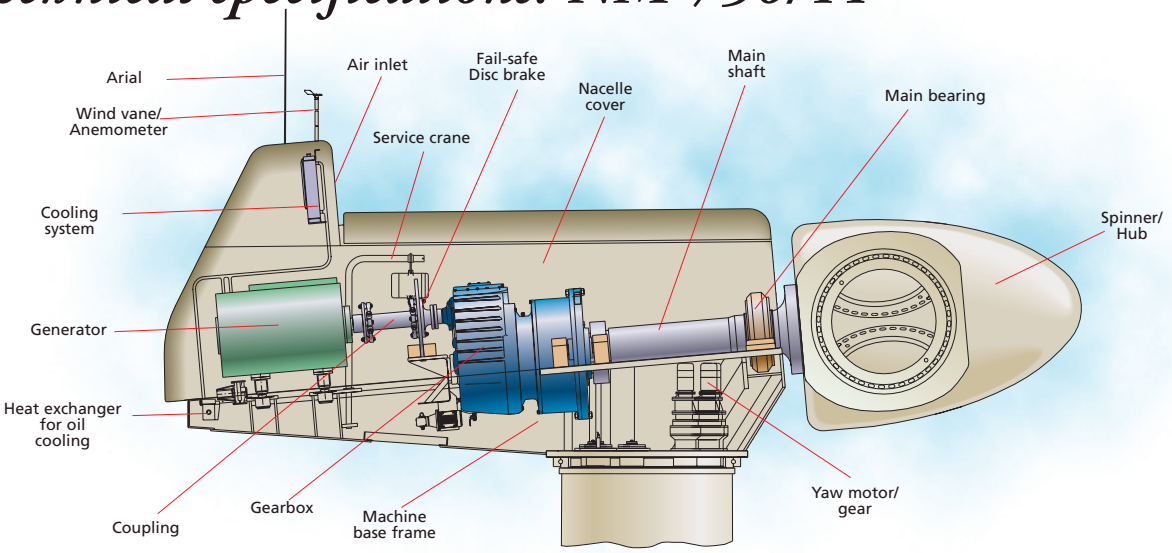


3. Server at WEB Hotel



FLEXIBLE STRUCTURE • CUSTOMISED DESIGN • COMPETITIVE • PACKAGE SOLUTIONS • USERFRIENDLY

Technical specifications: NM 750/44



Operational parameters

Nominal output	750 kW
Power regulation	Stall
Nominal wind speed	16 m/s
Cut-in	4 m/s
Cut-out	25 m/s

Rotor

Rotor diameter	44 m
Rotor swept area	1520 m^2
Number of blades	3
Rotor revolutions	27/18 rpm
Rotor placing	Upwind rotor

Brake system

Blade tip air brake	Hydraulic, fail-safe
Disc brake	Hydraulic, fail-safe

Drive train

Gear type	Planetary - parallel axle
Ratio	1:55,6
Main shaft	Forged shaft and flange
Main bearing	Spherical roller bearing
Cooling	Heat exchanger with pump

Generator

Type	Asynchronous, 4/6 pole
Nominal voltage	690 V
Nominal frequence	50 Hz
Name plate rating	750/200 kW
Cooling	Liqued-cooled with pump

Yaw system

Type	Ball bearing
Yaw brake	Friction brake/motor brake
Yaw motor/gear	3 electrical planetary gears

Tower

Type	Conical, steel, painted
Hub height	40/46/50/55 m

Controller

Type	Computer controlling
Cut in system	Soft by thyristors
Capacitor bank	No-load compensated
Remote control	By modem

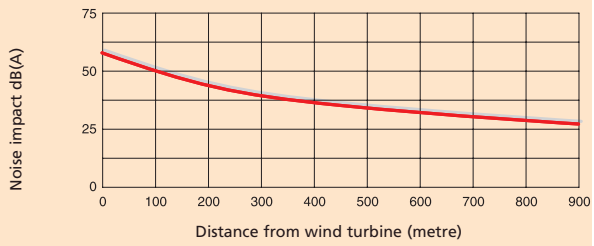
Sensors

RPM sensors	Rotor, generator, yaw system
Temperature sensors	Gear, generator, controller
Thermal sensors/warning	Main switch, engine protection
Vibration sensor	Nacelle, rotor
Meteorology	Anemometer, wind vanes, thermometer
Hydraulic systems	Pressure sensitive switches, pressure transducer

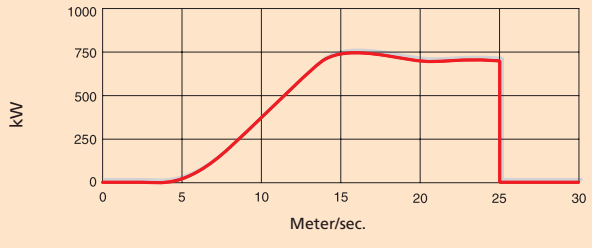
Lightning protection

According to standard	IEC 1024
Blades	Receptor in the blade tips
Nacelle	Arial

Noise level



Power curve



DANAK Reg.nr. 5001
Certified firm according to DS/EN ISO 9001 by Det Norske Veritas, Danmark A/S

Please note that the power curve has been noted at standard atmospheric density according to DIN ISO 2533.

Please note that the rotor and the hub heights have been approved for specific markets and wind classes – please call for further information. Note that the turbine is also available in a 60Hz version.

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Fax: +45 8710 5001 · E-mail: mail@neg-micon.dk · www.neg-micon.com

N·E·G MICON®
Powerful Simplicity

00.05.6.000.01 GB

HAWKER OLDHAM BATTERIES

STANDBY BATTERIES

SERIES EG 207

Installation, operating and maintenance instructions

SAFETY PRECAUTIONS

Handing

The EG 207 batteries are supplied charged ; they must be unpacked carefully. Avoid all short-circuit between opposite polarity poles as the cell will produce very high short-circuit currents.

Keep Flames Away

In case of accidental overcharge a flammable gas can leak off the safety vent.
Discharge any possible static electricity from clothes by touching an earth connected part.

Tools

Use tools with insulated handles. Do not place or drop metal objects on top of the battery. Remove rings, wristwatch and articles of clothing with metal parts that might come in contact with the battery terminals.

RECEIVING THE SHIPMENT

Unpack the batteries immediately upon arrival. Do not overturn the package. Inspect for possible damage in shipment. Make sure that no small package is thrown out together with the packing material.

Warning

The batteries contain sulphuric acid retained in microfibre separators. Batteries with broken lids or containers may loose small amounts of acid when deformed. Wear rubber gloves when handing broken batteries.

STORAGE

Store the battery at a dry, clean and preferably cool location.
As the batteries are supplied charged, storage time is limited. In order to easily charge the batteries after prolonged storage, it is advised not to store it more than
6 months at 20°C,
4 months at 30°C,
2 months at 40°C.
A refreshing charge shall be performed after this time at 2.23V/cell at 20°C. for 96 hours or until the charged current does not vary for a 3 hour period.
Failure to observe these conditions may result in greatly reduced capacity and service life.

INSTALLATION

The battery should be installed in a clean, dry area. It does not give off corrosive gas in normal operation and therefore can be installed together with other electrical equipment. It is important that the battery is mounted firmly.

Temperature

Avoid placing the battery in a hot place or behind a sunny window. The battery will give the best performance and service life when working at a temperature between 20° C and 25° C.

Ventilation

Under normal conditions the gas release is negligible and natural ventilation is sufficient for cooling purposes and inadvertant overcharge, enabling batteries to be used safety in offices and equipment.

Mounting

OLDHAM battery racks are recommended for proper installation. Assemble the rack according to instructions. Place the battery blocks or cells on the rack and arrange the positive and the negative terminals for connection according the wiring diagram. Check that all contact surfaces are clean and apply the block or cell connectors and the poles screws. Tighten the screws securely. Follow the polarity to avoid short circuiting of cell groups. Finally connect the battery terminals.

Pole screw Tightening

The maximum torque load of intercell connector bolts is 23 Nm (2.3 Mkg) to 25 Nm (2.5 Mkg). A loose connector can cause trouble during discharge or charge and occurate voltage drop and important heating, which can cause damage to the battery and/or persons. Finally put on the connector covers.

CELLS IN PARALLEL STRINGS

EG 207 cells of the same ampere hour rating may be connected in parallel to give higher current capability. One must not exceed 4 parallel strings. However, precautions must be taken : equipotential wiring is required ; that means connectors are designed such that the current is distributed equally between each string.

CHARGE

Float Voltage

The recommended float/charge voltage is 2.23 V per cell at 20° C.
When the average ambient temperature deviates more than ± 5° C from the reference, it is recommended to adjust the float voltage as follows :
2.35 V.p.c. at 0° C
2.28 V.p.c. at 10° C
2.23 V.p.c. at 20° C(reference T°C)
2.20 V.p.c. at 30° C
2.17 V.p.c. at 35° C
Due the phenomena of gas recombination a difference of ± 2.5% for an individual cell voltage can be observed. However the total voltage of the battery shall be within the limits stated above.

Charging Current

For maximum service life, EG 207 batteries should only be used with current limited constant potential float chargers, current limited to 0.3 C_{10}. However if the utilization assures a depth of discharge (DOD) below 40% of the rated capacity, the charging current limits itself and a current limitation may be omitted.

Fast Recharge

The battery may be recharged at 2.35V per cell with a current limited to 0.3 C_{10}. Fast charging should be stopped after approx. 10 or 15 hrs.

Quality of the charging current under floating voltage

The nature of the charging current has an influence on the life expectancy of the batteries. The rms value of the alterning component (fundamental and harmonics) must not exceed 0.1C_{10} on continuous charge.

State of Charge

The battery state of charge can be determined approximately by measuring the open circuit voltage after the battery has been a rest for a minimum of 24 hours.

State of charge	Voltage
100%	2.13 V.p.c.
70%	2.09 V.p.c.
50%	2.06 V.p.c.
20%	2.02 V.p.c.

DISCHARGING

End of Discharge Voltage according to the discharge time

The end of discharge voltage must be limited to the values listed below :

Discharge time (t)	End voltage (Volts)
1h < t < 5h	1.70 V
5h < t < 8h	1.75V
8h < t < 24h	1.80V

A low voltage disconnect or timer is recommended to prevent deep discharge.
Special attention shall be given to pilot lights that are not automatically disconnected at end of discharge.

Discharged Cells

EG 207 batteries must not be left in a discharged condition after supplying the load, but must be immediately returned to float recharge mode.
Failure to observe these conditios may result in greatly reduced service life and unreliability.

Accidental deep discharged

The battery must then be recharged with 2.23 V/cell, with a current imperatively limited to 0.1C_{10} capacity in order to prevent excessive heating. As the internal resistance is high in the beginning, a minimum charge of 96 hours is necessary.

important notice : this type of deep discharge will provoke a premature deterioration of the battery and a not negligible effect on the life expectancy.

The effect of temperature on capacity

Correction factor of the capacity, according to the temperature, the reference temperature being 20°C.

Discharge time (hour)	End voltage (Volt)	Temperature °C				
		-10°C	0°C	10°C	20°C	30°C
1	1.67	0.39	0.59	0.80	1	1.05
3	1.75	0.55	0.70	0.85	1	1.05
5	1.77	0.60	0.74	0.87	1	1.04
10	1.80	0.60	0.74	0.87	1	1.04

MAINTENANCE/CHECKS

EG 207 are maintenance free, sealed, lead acid batteries and do not have to be topped up.
The containers and lids shall be kept dry and free from dust. Cleaning must be done exclusively with a wet cotton cloth.
Every month, check that total voltage at battery terminals is (N x 2.23 V) for a temperature of 20° C. (N being the number of cells in the battery).
Once a year, it is necessary to effect a reading of the voltages of cells constituting the battery.
It is necessary to keep a logbook in which the measured values can be noted as well as power cuts, discharge tests, etc. An autonomy control can be effected once a year.

SPECIAL APPLICATIONS

Whenever the EG 207 is used for special applications such as cycling or under extreme ambients conditions please contact our SALES OFFICE for recommendations.

TECHNICAL DATA OF CHARGING WITH A CONSTANT VOLTAGE

Type	Ah/10hrs	Recommended charging current (A)
2 EG 200	200	20
2 EG 250	250	25
2 EG 300	300	30
2 EG 350	350	35
2 EG 420	420	42
2 EG 490	490	49
2 EG 600	600	60
2 EG 800	800	80
2 EG 1000	1000	100
2 EG 1200	1200	120
2 EG 1500	1500	150
2 EG 2000	2000	200
2 EG 2500	2500	250
2 EG 3000	3000	300

For further informations on the EG 207 cells, please read our brochures :
- Tubular gel technology EG 207 range Ref. DCE 203 G
- Technical handbook series EG 207 Ref. DCE 204 G

HAWKER OLDHAM BATTERIES

INDUSTRIAL BATTERIES

Plant and Head Office
Z.I. Est - Rue Alexander Fleming
62000 ARRAS - FRANCE

Postal Address
OLDHAM FRANCE S.A.
B.P. 962
F-62033 ARRAS CEDEX

Plant Tel. (33) 03 21 60 25 25 - Telefax (33) 03 21 73 16 51 - Telex 120 752 F

Ref. DCE 205G 07-97 Gaillard Arras SIR 631 920 113 000/16

LEAD ACID BATTERY

RECORD BOOK

HAWKER

OLDHAM

BATTERIES

BATTERY TYPE:

Number of cells . . . . . _____

Type of cells . . . . . _____

Nominal capacity . . . . . _____ Ah in _____ hours

Date of commissioning . . . . . _____

Specific gravity at medium level . . . . . _____

Voltage per cell in floating service . . . . . _____

STANDBY POWER SYSTEMS

Stationary batteries - Safety precautions and maintenance

• Safety

1) Remember : NO SMOKING is the rule in battery rooms.
2) Always wear protecting glasses, gloves and preferably protective clothing.
   ELECTROLYTE IS A CORROSIVE SULPHURIC ACID SOLUTION.
3) TO AVOID ELECTROSTATIC CHARGES AND EXPLOSION RISKS, whether cells are dry or full, charged or discharged, they can always contain explosive gases (hydrogen and oxygen) which can, in presence of a spark or flame, cause an explosion. It is therefore forbidden :
   - to smoke in battery rooms
   - to create electric sparks
   - to use soldering equipment
   - to use portable machines plugged into an electric plug
   - to wear clothes likely to acquire an electrostatic charge (nylon)
   - to use unprotected tools
   - to keep metallic objects near the battery (to avoid spark formation).

   If the preceding safety conditions are fulfilled, "discharge " yourself regurarly into the earth by touching a metallic part (door, water pipe, etc.) in order to eliminate electrostatic charges acquired while working on the battery, such as : taking off protection caps or covers, checking voltage, etc.
4) Take care not to create accidental short-circuits by dropping a metallic object on intercell connectors.

• Equipment

- Densimeter
- Thermometer
- Filler
- Voltmeter

• Maintenance

- Keep containers, lids and battery room perfectly clean.
- Wipe out salt and acid stains on terminals, connections and lids with a wet sponge.
- Never clean containers and lids with solvents, detergents, oil or similar products.
- Wash vent plugs periodically (about once every 2 years) in clean water and dry them before putting them back on the battery.

• Every month :

1) Check total voltage at battery terminals. It must equal : N x U where N = number of battery cells
   U = floating voltage per cell
   to be applied according to cell type and annual average room temperature.
2) Measure voltage, specific gravity and temperature of a few reference cells.
3) Check electrolyte levels.
4) Measure room temperature.

• Every quarter :

1) Measure total voltage of battery and ambient temperature.
2) Measure all cells voltages.
3) Measure specific gravity of a few cells with varying voltages as well as electrolyte level and temperature.
4) Apply equalizing charge.
   AN AUTONOMY TEST CAN BE APPLIED ONCE OR TWICE A YEAR.

• Water topping up

- Filling up with distilled or de-ionized water must be carried out on a charged battery, before electrolyte reaches minimum level.
- When adding water, never exceed maximum level.
- Time intervals between two water topping up vary from 1 to 3 years, in terms of :
  - type of alloy
  - cell type
  - room temperature
  - battery age.
- After having checked electrolyte levels, it is necessary to apply an equalizing charge to homogenize electrolyte until nominal specific gravity is obtained.

MAINTENANCE

Date of operation	Work carried out

TEST OF CAPACITY

Date of operation	Current (A)	Obtained capacity	Remarks

YEAR 19

DATE / N° cells																				
	Voltage **U**	Specific gravity **D**	Temp. in °C **T**	Voltage **U**	Sperific gravity **D**	Temp. in °C **T**	Voltage **U**	Specific gravity **D**	Temp. in °C **T**	Voltage **U**	Specific gravity **D**	Temp. in °C **T**	Voltage **U**	Specific gravity **D**	Temp. in °C **T**	Voltage **U**	Specific gravity **D**	Temp. in °C **T**
Battery Voltage*																		
Ambient Temperature																		

* At the terminals of the battery

Temp. in °C	Voltage	Specific gravity	Temp. in °C	Voltage	Specific gravity	Temp. in °C	Voltage	Specific gravity	Temp. in °C	Voltage	Specific gravity	Temp. in °C	Voltage	Specific gravity	Temp. in °C	Voltage	Specific gravity	Temp. in °C
T	U	D	T	U	D	T	U	D	T	U	D	T	U	D	T	U	D	T

INSTRUCTIONS DE MONTAGE
ASSEMBLY INSTRUCTIONS

-1- *Fixer le chantier rep 1 au sol en utilisant des chevilles adaptées à la nature du sol.*
Anchor the stand rep 1 to the floor by using dowels suitable to the nature of the floor.

-2- *Positionner les calages rep 10 dans le fond du chantier.*
Place the wedging plates rep 10 in the bottom of the stand.

-3- *Glisser les éléments rep 7 en commençant par le niveau inférieur.*
Slide the cells rep 7 beginning by the level below.

-4- *Intercaler les calages de 10mm rep 11 entre chaque élément.*
Insert the 10mm wedging rep 11 between each cell.

-5- *Si nécessaire, intercaler les calages de 2,5mm rep 12.*
If required, insert the 2,5mm wedging rep 12.

-6- *Fixer les plats de serrage rep 2,3,4 à l'aide des vis rep 6 et des rondelles rep 5 en respectant le couple de serrage de 20 Nm.*
Fix the plate rep 2,3,4 with the screws rep 6 and the washers rep 5 following the torque 20Nm.

V = 50.3 VDC

-7- *Poser les cablôts rep 8,9.*
Place the cable connectors 8,9.

REP	NBR	DESIGNATION	REF	MATIERE	MASSE	OBS/PLAN

BATTERIE DE 24 ELEMENTS 2 EGA 215
BATTERY OF 24 CELLS 2 EGA 215
MONTAGE HORIZONTAL - *HORIZONTAL ARRANGEMENT*
chantier antisismique 0,6g - *earthquake proof stand up to 0,6g*

HAWKER OLDHAM

IND	N.MODIF	DATE		DATE	INIT.	VISA.	FORMAT	N.D'IDENTIFICATION	N.FOLIO
B	BECS 98/099	12/06/98		12/06/98					
A	ORIGINAL	25/05/98	ETABLI	12/06/98	RF		A4	S81273	3/3
			VERIFIE	12/06/98					

A B

REP	NBR	DESIGNATION	REF	MATIERE	MASSE	OBS/PLAN
12	12	**CALAGE 350x200x2,5**		PVC		
		WEDGING PLATE 350x200x2,5				
11	18	**CALAGE 350x200x10**		PVC		
		WEDGING PLATE 350x200x10				
10	18	**CALAGE 435x210 EP10+2+2**		PVC		
		WEDGING PLATE 435x210 EP10+2+2				
9	3	**CABLOT 35 mm² ENTRAXE 130 mm**	1445130			
		CABLE 35 mm² AXIS 130 mm				
8	20	**CABLOT 35 mm² ENTRAXE 170 mm**	1445170			
		CABLE 35 mm² AXIS 170 mm				
7	24	**ELEMENT 2 EGA 215**				
		CELL 2 EGA 215				
6	21	**VIS C HC, M 8-22**				
		SCREW C HC, M 8-22				
5	21	**RONDELLE M8**				
		WASHER M8				
4	1	**PLAT 527x50x5**				
		PLATE 527x50x5				
3	5	**PLAT 527x85x5**				
		PLATE 527x85x5				
2	1	**PLAT 527x70x5**				
		PLATE 527x70x5				
1	1	**CHANTIER ANTISISMIQUE**				
		EARTHQUAKE PROOF STAND				

BATTERIE DE 24 ELEMENTS 2 EGA 215

BATTERY OF 24 CELLS 2 EGA 215

MONTAGE HORIZONTAL - *HORIZONTAL ARRANGEMENT*

chantier antisismique 0,6g - *earthquake proof stand up to 0,6g*

REFERENCE :S81273C

HAWKER OLDHAM

IND	N.MODIF	DATE				
B	BECS 98/099	12/06/98		DATE	INIT.	VISA.
A	ORIGINAL	25/05/98	ETABLI	12/06/98	RF	
			VERIFIE	12/06/98		

FORMAT	N.D'IDENTIFICATION	N.FOLIO
A4	**S81273**	*2/3*

A B

SAFT

NIFE

MANUAL DE OPERACION Y MANTENIMIENTO

CARGADOR DE BATERIAS MONOFASICO

TIPO SLR

SAFT NIFE MEXICO, S.A. DE C.V.

SAN LUIS TLATILCO 25 C.P. 53470 NAUCALPAN TEL. 576-26-11 FAX. 358-50-27 TELEX 1777352

S A F T

NIFE

SAFT NIFE MEXICO S.A. DE C.V.

SAN LUIS TLATILCO No.25
PARQUE INDUSTRIAL NAUCALPAN
NAUCALPAN DE JUAREZ EDO. DE MEX.
TEL. 5-76-26-11 FAX 3-58-50-27

RECEPCION DE MATERIAL

DISTINGUIDO USUARIO:

SAFT NIFE MEXICO AGRADECE LA OPORTUNIDAD DE PODER SERVIRLE COMO USTED SE MERECE, PARA TAL EFECTO, LE SUPLICAMOS DE LA MANERA MAS ATENTA, SE SIRVA CONTESTAR LA SIGUIENTE INFORMACION Y REMITIRLA A LA DIRECION ANTERIORMENTE DESCRITA A LA MAYOR BREVEDAD POSIBLE.

ES MUY IMPORTANTE, YA QUE SU CONTESTACION NOS PROPORSIONARA LA INFORMACION NECESARIA PARA PODER RESPETARLE SU GARANTIA

FECHA DE ELABORACION: _____ FACTURA No. _____

CLIENTE: _____

DOMICILIO; _____

TELEFONO: _____

PERSONA QUE PROPORSIONA LOS DATOS: _____ PUESTO: _____

DESCRIPCION DEL EQUIPO RECIBIDO: _____

MODELO: _____ TIPO: _____

CANTIDAD: _____

No. DE SERIE _____

EN QUE CONDICIONES RECIBIO SU MATERIAL ? _____

OBSERVACIONES: _____

SUGERENCIAS: _____

FIRMA

SAFT

NIFE

GARANTIA NIFE

LOS PRODUCTOS NIFE ESTÁN GARANTIZADOS CONTRA DEFECTOS DE MANO DE OBRA Y MATERIALES, POR UN PERÍODO DE UN AÑO A PARTIR DE LA PUESTA EN MARCHA Ó - 18 MESES A PARTIR DEL EMBARQUE, LO QUE SUCEDA PRIMERO.

ESTA GARANTÍA ES VÁLIDA ÚNICAMENTE EN NUESTRA PLANTA EN NAUCALPAN, EDO. DE MÉXICO.

SI EL CLIENTE DETERMINA HACERLA EN EL LUGAR DONDE SE ENCUENTREN INSTALADOS LOS EQUIPOS, DEBERÁ PAGAR LOS GASTOS DE TRASLADO, ALIMENTACIÓN Y HOSPEDAJE DE NUESTRO TÉCNICO, ASÍ COMO EL CARGO POR SERVICIOS EXTERNOS DE ACUERDO A LA LISTA DE PRECIOS EN VIGOR.

MATERIAL QUE SE CONSIDERE DEFECTUOSO PUEDE SER REGRESADO A LA FÁBRICA -- "FLETE PAGADO" PARA SU REVISIÓN.

LAS PARTIDAS QUE SE ENCUENTREN DEFECTUOSAS EN MANO DE OBRA Y MATERIALES, - SERÁN REPARADAS Ó REEMPLAZADAS POR **SAFT NIFE México, S.A. de C.V.**, SIN -- NINGÚN CARGO.

SAFT NIFE México, S.A. de C.V., NO AUTORIZA CARGO POR INVESTIGACIÓN Ó REPARACIONES HECHAS EN EL LUGAR DE INSTALACIÓN.

LA PRESENTE GARANTÍA QUEDARÁ SIN EFECTO SI PERSONAL NO AUTORIZADO POR -- **SAFT NIFE México, S.A. de C.V.** EFECTÚA REPARACIONES A DICHOS MATERIALES.

ATENTAMENTE
SAFT NIFE México, S.A. de C.V.

LIC. ROBERTO TROOP PLIEGO.
DIRECTOR GENERAL.

MAR.*

SAFT NIFE MEXICO, S.A. DE C.V.

SAN LUIS TLATILCO 25 C.P.53470 NAUCALPAN TEL. 576-26-11 FAX 358 50 27 TELEX 1777352

SAFT NIFE (MEXICO)

CARGADOR DE BATERIAS MONOFASICO

TIPO SLR

MANUAL DE OPERACION Y MANTENIMIENTO

No. de Instructivo: 4725-65-92590-00
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INTRODUCCION

Los cargadores Saft Nife de la serie SLR, estan diseñados para una vida útil larga y una gran confiabilidad en operacion continua para aplicaciones comerciales e industriales Esto se logra mediante un amplio programa que incluye una ingenieria de diseño muy prudente, el empleo de tecnicas de inducción modernas y programas de prueba del tipo de unidades en serie.

Hemos preparado este manual de instrucciones y paquete de documentación para familiarizar al usuario con esta unidad y que sirva como una guía para su propio uso y mantenimiento Para asegurar una operación libre de problemas, el usuario debera familiarizarse con el contenido de este manual.

Este documento se puede aplicar a todos los cargadores Saft Nife de la serie SLR. Incluye declaraciones breves acerca de las opciones disponibles. Si existen algunas de ellas, osu información se incluye actualizada en la última sección de este manual.

Aprovechamos la ocasión para agradecerle la preferencia por los productos SAFT NIFE.

1.0 PROPOSITO FUNCIONAL

1.1 Descripcion

El cargador de baterias Saft Nife es controlado mediante SCR's para proporcionar una fuente de alimentacion de CD idónea y altamente estable para cargar baterias de Níquel-Cadmio, Plomo - Calcio y Plomo - Antimonio.

Las características que incluye son:

- carga a voltaje constante
- control de limitación de corriente
- interruptor manual de flotación/régimen alto con regreso automático.
- control automatico de carga
- arranque lento
- mantenimiento mínimo

1.2 Especificaciones

Características nominales de entrada

VOLTAJE	:	120,208 o 240 Vca (dependiendo del rango de cd)
TOLERANCIA	:	de +10% a -10%
FRECUENCIA	:	57-63 Hz
FASE	:	Monofásico

Características nominales de salida

VOLTAJE NOMINAL	MAXIMO	
12	16.0	Vcd
24	32.0	Vcd
48	63.0	Vcd
120	154.0	Vcd

Rango de voltaje en cd:
Flotación del 80% al 135% del cd nominal
Régimen Alto del 80% al 135% del cd nominal

Estabilidad de Voltaje (estático) : +/- 0.5%
Bajo las siguientes condiciones:
del 1 al 100% de la carga con
+/- 10% de variación de voltaje de entrada
+/- 5% de variación en la frecuencia

Rizo de salida : Un máximo del 2% del voltaje nominal de cd cuando se conecta a una bateria de capacidad en Amperes-hora de por lo ménos cuatro veces el régimen de corriente de salida del cargador.

Corriente : 5, 10, 20, 30, 50, 75 o 100 Acd (modelos 12, 24 y 48 Vcd)
5, 10, 15, 30 o 50 Acd (modelos 120 Vcd)

Límite de Corriente :
Ajustable de 20% al 100% de la corriente nominal de cd

Estabilidad de Corriente :
+/- 2% de la corriente de límite

1.3 CONTROLES

- Boton de régimen alto manual
- Potenciómetro de voltaje en flotación
- Potenciómetro de voltaje en régimen alto
- Potenciómetro de límite de corriente

1.4 INDICADORES

- Voltmetro de cd, 3" tolerancia 2%
- Ampermetro de cd, 3" tolerancia 2%
- Indicador de encendido verde LED
- Indicador de régimen alto ambar LED

1.5 CONDICIONES AMBIENTALES

Temperatura Ambiente	:	de -10 C a +40 C
de Operación	:	de +40 C a +55 C se reduce la corriente nominal a razon de 1.25% /1 C
de Almacenamiento	:	de -25 C a + 70 C
Altitud	:	1000 msnm de 1000 a 4000 m con una reducción a razon de 6.7% /1000 m
Humedad Relativa	:	95% sin condensación
Enfriamiento	:	por convección

1.6 PROTECCIONES

Para la entrada de CA cuenta con un dispositivo termo-magnético contra sobrecargas
Para la salida de CD un fusible
Supresores de tensión en CA y CD
Circuito de Arranque lento
Protección contra inversión de polaridad en bateria

1.7 GENERALIDADES

1.7.1 Magnéticas

Clase : 155 C
Temperatura de aislamiento mínima : 185 C
Voltaje de ruptura en aislamientos : 2500 Vrms mínimos

1.7.2 Alambrado

Aislamiento : 600 V
Todos los cables estan identificados bajo especificaciones NEC, NFPA - 70

1.7.3 Gabinete

Tipo : NEMA - 1 con ventilacion
Terminacion : Pintura Epoxica
Color : Gris ASA 61
Panel : Azul Cadmio
Terminación bastidor : Dicromato de Zinc amarillo

1.7.4 Pruebas

Evaluado de acuerdo a NEMA RI - 2

1.7.5 Respuesta en la salida

Cambio en la carga	Un elemento unico (L/LC) filtro en la carga de la bat.	
10 - 100%	-5%	250 ms
100 - 10%	+5%	70 ms

2.0 OPCIONES

1) Una tarjeta de alarmas con las opciones siguientes:
- LED indicador de falla de CA
- LED indicador de alto voltaje de CD
- LED indicador de bajo voltaje de CD
- LED indicador de + a tierra
- LED indicador de - a tierra
- LED indicador de falla del rectificador
- Interruptor para prueba de LED's/restablecimiento
- Relevador de alarma común

Especificaciones para los contactos del relevador
CA : 240 Vca, 5 A, 480 VA, FP= 1.0
CD : 100 Vcd, 5 A, 120 W, Resistivos

2) Compensación de temperatura en la bateria
3) Límite de corriente en la bateria
4) Compartimiento de carga (cargadores en paralelo)
5) Contactos de alarmas. Arriba mencionadas 6 alarmas

3.0 INSTALACION Y ALAMBRADO

3.1 Instalación

Coloque el cargador en el lugar deseado, de acuerdo al dibujo dimensional mostrado en la última sección del manual. Evite los lugares en donde se encuentren equipos que generen calor, mucha suciedad o humedad. Todos los gabinetes deberán ser montados verticalmente. Mantenga distancias de ventilación segun se muestra en el dibujo (por ejmplo: 51mm en la parte posterior y 254 mm en la superior e inferior). NO BLOQEE LAS RANURAS DE VENTILACION.

3.1.1 Gabinetes de pared

Instale las unidades que se colocan en la pared utilizando tornillos de 1/4" de diametro o más grandes de acuerdo al peso de la unidad y del material de la pared. Con los tornillos en su lugar (hoyos de montaje), instale el gabinete. Abra la puerta para poder tener acceso a los tornillos y poder ajustarlos.

3.1.2 Gabinetes de piso

Los gabinetes para montaje en piso Saft Nife se pueden mover facilmentemediante el uso de un patín hidraulico. Observe que las placas de ventilación son removibles, dando acceso al elemento de izaje para tirar de él suavemente.

3.2 Inspección

Antes de efectuar cualquier conexión al cargador, se debera verificar lo siguiente:
1) La placa de especificaciones de operación para asegurar que la alimentacion de CA de entrada y la bateria corresondan a los parámetros del cargador.

2) Que todas las fuentes de alimentación de llegada al cargador esten apagadas

3) Que las protecciones de CA y CD del cargador esten desactivadas

4) Que todos los desechos dentro y alrededor del equipo hayan sido eliminados.

3.3 Conexiones

La entrada de cableado al gabinete se efectúa normalmente por el fondo. Los conductos pueden ser conectados en la tapa, parte posterior o a los lados según se requiera. Para una adecuada conexión de las entradas refierase al esquema del cargador, al final del manual Instale y alambre la bateria de acuerdo al diagrama de distribución proporcionado por el fabricante de la bateria.
Cuando se hagan conexiones al cargador utilice cables del calibre adecuado para la corriente de salida del cargador, listada en la placa de datos característicos del cargador. Refiérase al diagrama esquemático del cargador.
Si la bateria esta colocada a una destancia considerable del cargador, los cables deberan elegirse para una caida de voltaje mínima y para la corriente de salida máxima de CD.

3.3.1 Conexiones de la carga y de la bateria

Con las fuentes de alimentación al cargador y las protecciones de CA y CD apagadas, haga las siguientes conexiones:
- Para evitar accidentes, observe la polaridad adecuada.
- Alambre la terminal de +Vcd y la terminal positiva de la carga a la terminal positiva de la bateria
- Alambre la terminal de -Vcd y la terminal negativa de la carga a la terminal negativa de la bateria

Refiérase al diagrama del cargador, conforme se requieran conexiones no estandares.

NOTA. La carga de CD se deberá conectar a las terminales de la bateria y nó a las terminales del cargador. Esto es vital para aplicaciones que requieren de altas corrientes.

3.3.2 Conexión de la alimentación de CA

Verifique la linea de CA, sus valores de voltaje, frecuencia y fase deberan adecuarse a las especificaciones segun se lista en la placa de caracteristicas del cargador, localizada al frente. La línea

de CA debera ser la adecuada para permitir el manejo de máxima capacidad de corriente, segun se indica en las características del interruptor de entrada. Conecte la entrada de CA a las terminales indicadas en la secuencia de fase correcta. Asegúrece de conectar la terminal de tierra (GND).

PRECAUCION : Las celdas cargadas, contienen mucha energia almacenada y se deberá tener cuidado cuando use herramientas metálicas alrededor de la bateria para evitar cortos.

3.4 Controles opcionales

3.4.1 Compensación de temperatura en la bateria (de inserción en tarjeta principal)

Este circuito compensa el voltaje de salida de la unidad a una temperatura relativa de la bateria en un rango de -0.18% / C de -20 C a +50 C, reduciendo a 0% / C en un rango de -40 C a + 80 C respectivamente. Esta opción puede ser usada para compensar el voltaje del cargador.
Esta opción auxilia al cargador de baterias reduciendo el consumo de agua e incrementando la vida de las baterias. El sensor externo se monta en la bateria y se alambra hacia la unidad.

3.4.2 Límite de corriente de bateria y compartimiento de la carga. (de inserción en tarjeta principal)

3.4.2.1 Límite de corriente de bateria

El amplificador de límite de corriente de bateria, en conjunto con un SHUNT (conectado en serie a la bateria) permite un control de la corriente de carga de bateria, independiente del circuito de límite de corriente principal. Esta función se aplica normalmente cuando la corriente total de salida es demasiado grande para la bateria (por ejemplo una bateria pequeña)

3.4.2.2 Compartimiento de carga

El compartimiento de carga permite a dos o más cargadores operar en paralelo dentro del 10% uno del otro sin alambrado adicional.

3.4.3 Tarjetas de alarmas opcionales

La tarjeta de alarmas, cuando de suministra, provee un medio de anunciarse mediante un relevador de alarma remota para las siguientes funciones:

3) Que las protecciones de CA y CD del cargador esten desactivadas

4) Que todos los desechos dentro y alrededor del equipo hayan sido eliminados.

3.3 Conexiones

La entrada de cableado al gabinete se efectúa normalmente por el fondo. Los conductos pueden ser conectados en la tapa, parte posterior o a los lados según se requiera. Para una adecuada conexión de las entradas refierase al esquema del cargador, al final del manual Instale y alambre la bateria de acuerdo al diagrama de distribución proporcionado por el fabricante de la bateria.
Cuando se hagan conexiones al cargador utilice cables del calibre adecuado para la corriente de salida del cargador, listada en la placa de datos característicos del cargador. Refiérase al diagrama esquemático del cargador.
Si la bateria esta colocada a una destancia considerable del cargador, los cables deberan elegirse para una caida de voltaje mínima y para la corriente de salida máxima de CD.

3.3.1 Conexiones de la carga y de la bateria

Con las fuentes de alimentación al cargador y las protecciones de CA y CD apagadas, haga las siguientes conexiones:
- Para evitar accidentes, observe la polaridad adecuada..
- Alambre la terminal de +Vcd y la terminal positiva de la carga a la terminal positiva de la bateria
- Alambre la terminal de -Vcd y la terminal negativa de la carga a la terminal negativa de la bateria

Refiérase al diagrama del cargador, conforme se requieran conexiones no estandares.

NOTA. La carga de CD se deberá conectar a las terminales de la bateria y nó a las terminales del cargador. Esto es vital para aplicaciones que requieren de altas corrientes.

3.3.2 Conexión de la alimentación de CA

Verifique la linea de CA, sus valores de voltaje, frecuencia y fase deberan adecuarse a las especificaciones segun se lista en la placa de características del cargador, localizada al frente. La línea

de CA debera ser la adecuada para permitir el manejo de máxima capacidad de corriente, segun se indica en las características del interruptor de entrada. Conecte la entrada de CA a las terminales indicadas en la secuencia de fase correcta. Asegúrece de conectar la terminal de tierra (GND).

PRECAUCION : Las celdas cargadas, contienen mucha energia almacenada y se deberá tener cuidado cuando use herramientas metálicas alrededor de la bateria para evitar cortos.

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3.4.2 Límite de corriente de bateria y compartimiento de la carga. (de inserción en tarjeta principal)

3.4.2.1 Límite de corriente de bateria

El amplificador de límite de corriente de bateria, en conjunto con un SHUNT (conectado en serie a la bateria) permite un control de la corriente de carga de bateria, independiente del circuito de límite de corriente principal. Esta función se aplica normalmente cuando la corriente total de salida es demasiado grande para la bateria (por ejemplo una bateria pequeña)

3.4.2.2 Compartimiento de carga

El compartimiento de carga permite a dos o más cargadores operar en paralelo dentro del 10% uno del otro sin alambrado adicional.

3.4.3 Tarjetas de alarmas opcionales

La tarjeta de alarmas, cuando de suministra, provee un medio de anunciarse mediante un relevador de alarma remota para las siguientes funciones:

El nivel de la alarma de conexion a tierra esta fijado a 10 mA o 100 ohm/V. La indicacion de la alarma puede ser medida utilizando un voltmetro, conectado entre TP1 (0V) y TP70 para conexiones a tierra POS., y TP80 para conexiones a tierra NEG. Para iniciar las alarmas, utilice una resistencia de un valor adecuado, conectada de la salida positiva de CD a tierra para la conexion a tierra POS. y de la salida negativa a tierra para la conexion a tierra NEG.

El valor de la resistencia se puede calcular utilizando la formula

R = VCD NOM x 100 ohm

Cuando ocurre una alarma, el voltaje en los puntos de prueba sera aproximadamente de 8V. El tiempo de retardo en la alarma esta fijo a 4 segundos.

3.3.5 Falla del Rectificador

Simule una falla del rectificador abriendo el circuito de entrada de CA, o eliminando el fusible de salida de CD. Después de aproximadamente 15 segundos, se encendera el LED H80 que se encuentra en el control principal, y después de 2 segundos mas, se encendera el LED H90 localizado en la tarjeta de alarma.

3.3.6 Prueba de Lamparas/Restablecimiento

Reconecte la carga y utilice el boton pulsador del indicador de prueba/restablecimiento localizado en la tarjeta de alarma para restablecer todas las alarmas.

- Falla de CA
- Alto voltaje de CD
- Bajo voltaje de CD
- Fuga a tierra de +
- Fuga a tierra de -
- Falla del rectificador

El indicador local de cada alarma es suministrado por LED's individuales, montados en la tarjeta de alarmas.

3.4.4 Contactos de alarmas remotas selectivas

Se suministran contactos individuales tipo 'C' para las 6 alarmas arriba mencionadas.
Rango de los contactos 0.6A, 125 Vca, 2 A, 30 Vcd
0.6A, 125 Vcd

4.0 Instrucciones de operación

4.1 Generalidades

El voltaje de salida y la corriente del cargador son ajustados desde fábrica para satisfacer las especificaciones de carga de bateria, por lo que generalmente no se requiere de ajustes posteriores. En caso de ser necesario efectuar algun ajuste, consulte la sección 6.0 para detalles de ajuste.

4.2 Puesta en marcha

La operación adecuada del cargador de baterias requiere que todo el alambrado de entrada/salida, bateria o carga (si la hay) sea conectado adecuadamente segun la sección 2.0. Una vez completado el alambrado, inserte el fusible de salida (si lo quitó previamente). El voltaje de la bateria se indicara en el voltmetro de salida. Encienda el interruptor de entrada de CA y el cargador debera incrementar lentamente su voltaje de salida hasta alcanzar el nivel establecido o el límite de corriente.
El cargador arrancara en el modo de flotación. Conmute el cargador hacia el modo de régimen alto para permitir la carga de la bateria, por el período de tiempo especificado por el fabricante de la bateria. Después que éste tiempo se ha completado, el cargador regresa automáticamente al modo de flotación. Con esto se evita sobrecargar la bateria y por ende algun daño a la misma. Esta función es controlada automáticamente por el Control Automático de Carga (CAC) o manualmente mediante el boton de 'régimen alto programado'

4.3 Apagado

Apague el cargador utilizando el interruptor de CA y observe que no existe corriente en la salida. El

voltaje de salida estará indicandose una vez que el fusible de salida de CD ha sido instalado.

4.4 Operación

Durante la operación normal, el cargador compensara la carga adquirida de la bateria por el regulador.
Los cargadores recargarán automáticamente la bateria en 'régimen alto' después de una descarga. Una carga periódica en el modo de régimen alto se podría requerir en algunos casos (por ejemplo en un sistema de alerta).
La función de régimen alto puede ser activada oprimiendo el boton iluminado como 'régimen alto programado'
El cargador regresará automáticamente a flotación después de 6 horas.

PRECAUCION : NUNCA DEJE EL CARGADOR EN EL MODO DE 'REGIMEN ALTO' POR MAS TIEMPO DEL RECOMENDADO POR EL FABRICANTE DE LA BATERIA. UNA SOBRECARGA OCASIONARA QUE LA BATERIA GASIFIQUE (POR ELECTROLISIS). ESTO CONSUMIRA EL AGUA REDUCIENDO EL NIVEL DE ELECTROLITO Y PUEDE SER CONTRAPRODUCENTE PARA LA VIDA DE LA BATERIA.

4.5 Controles

En el panel frontal se encuentran botones de contacto e indicadores. Uno de ellos es el control manual del modo de operación: 'Régimen Alto Programado'

'Regimen Alto Manual'
Presione momentáneamente el boton para inicializar el temporizador de CAC. Para cancelarlo presione por 3 segundos y luego suelte el botón pulsador

NOTA : El tiempo programado de régimen alto (6 hrs) se incrementará por el tiempo que el cargador permanezca en límite de corriente.
Después de haberse completado el tiempo inicializado por el boton pulsador, el cargador regresará a flotación

4.6 Verificación de operación funcional

4.6.1 Prueba del estado de la carga de la bateria

El estado aproximado del estado de la carga de la bateria puede ser determinado mediante una verificación sencilla.

1) Conmute el cargador a 'régimen alto'
2) Observe que la unidad entre en límite de corriente (en el ampermetro de salida)
3) Si el cargador permanece en el límite de corriente

por mas de 36 segundos, la bateria demanda la carga de régimen alto. Si la bateria ya está cargada adecuadamente, el cargador abandonará el modo de límite de corriente (esto se manifiesta como la disminución en la corriente de bateria o a la salida del cargador) . Presione y mantenga por 3 segundos el boton de régimen alto para restablecer el cargador a su modo de flotación. Si el cargador se encuentra en límite de corriente, aún cuando se oprima el boton, el cargador no regresará al modo de flotación.

4.7 Verificaciones periódicas

4.7.1 Voltajes de Flotación/ Régimen Alto

Los voltajes de flotación y régimen alto deberán ser verificados periódicamente (semestralmente) para el cumplimiento de los requerimientos establecidos en la seccion 6.0

4.7.2 La bateria

La bateria es una parte importante de su sistema que se le deberá proporcionar mantenimiento regularmante segun recomendación del fabricante. Se deberá poner especial cuidado en el nivel de electrólito en las celdas ventiladas.

5.0 Operación y descripción de circuitos

5.1.1 Bosquejo del rectificador

El cargador SLR convierte la potencia de CA a CD, controlando el voltaje y corriente de salida. Esto permite que la unidad funcione como un cargador de baterias Se pueden utilizar varias funciones de control para lograr satisfacer los requerimientos de las baterias y las cargas, mejorando el funcionamiento y ayudar a la carga automática.

5.1.2 Operación del cargador SLR

(Observe la figura 5.1.a) El voltaje de CA se aplica al embobinado primario del transformador de potencia a traves del interruptor de CA. El transformador aisla galvánicamente el voltaje principal de CA de los voltajes del secundario elevándolo o disminuyéndolo a los niveles requeridos.
El embobinado secundario esta conectado a un puente rectificador controlado de onda completa, compuesto por

dos tiristores, dos diodos y un diodo freewheeling. El puente controlado por fase convierte la señal de CA no regulada a un voltaje de CD regulado. El puente se conecta a través de una inductancia L1 y un ampermetro (o derivador) al negativo de salida. Y a través de un fusible F1 a la terminal positiva de salida.
Para el control del voltaje y la corriente, se utilizan dos lazos de realimentación independientes. Sólo una de ellas esta activa a la vez.

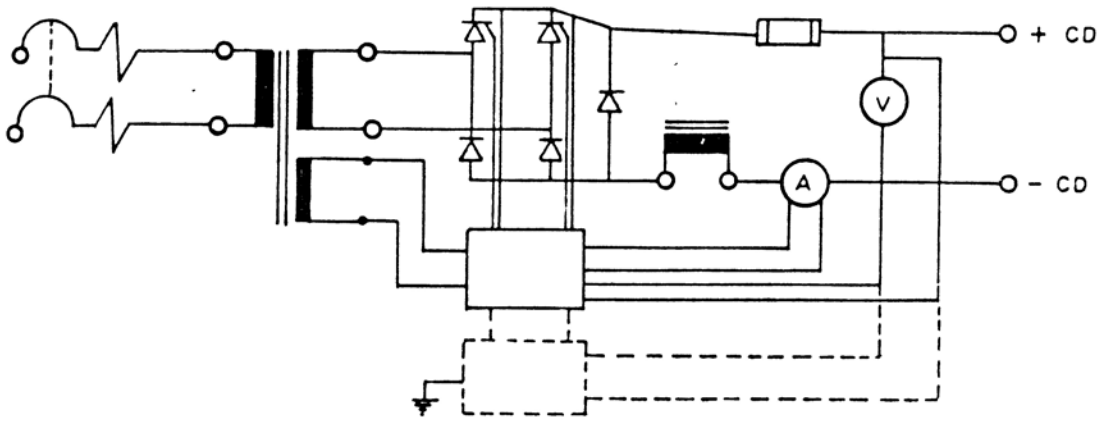


Fig. 5.1.a Cargador de baterias típico SLR

El voltaje de CD es realimentado a la tarjeta de control, encargándose de su regulación en ambos modos flotación y régimen alto. Ambos niveles pueden ser ajustados en la tarjeta de control. El rectificador opera normalmente en el modo de flotación. El modo de régimen alto puede ser operado de manera automático (mediante un temporizador interno) o manualmente mediante la presión del pulsador de régimen alto.

En este modo el rectificador es controlado mediante un control automático de carga existente en la tarjeta de control. Si la demanda de corriente en la salida excede la característica nominal, el rectificador conmutará del modo de voltaje constante al modo de corriente constante. El voltaje alcanzado en el derivador SH (proporcional a la corriente de salida) es sensado y procesado por un amplificador de límite de corriente en la tarjeta de control. El cargador regula su salida de voltaje y corriente mediante el control del puente de tiristores. El puente está diseñado como un rectificador de onda completa y los tiristores determinan la cantidad de corriente proporcionada a la salida. El tiristor está apagado y enciende hasta que le aplican un pulso de disparo en la compuerta. Una vez disparado, el tiristor permanece conduciendo en su polaridad directa hasta que la corriente que fluye por él, es cero.

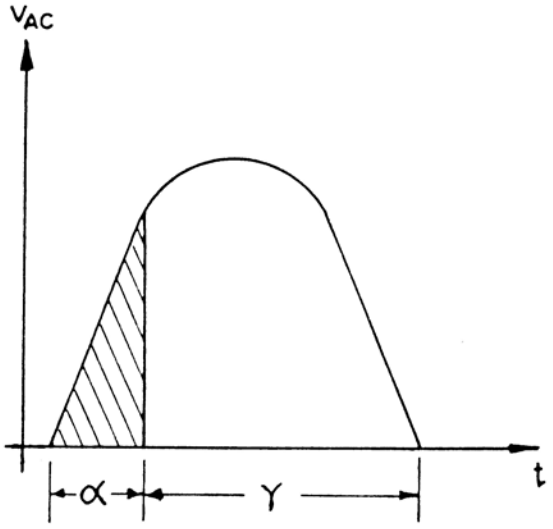


Fig.5.1.b Control del Angulo de fase

El control de ángulo de fase se reliza mediante la variación del retardo en los pulsos de disparo con ello tambien se varía la cantidad de energia disponible en las terminales de salida. Si se requiere de mucha corriente el pulso de disparo comenzará incrementando durante el

medio ciclo de la onda senoidal y viceversa. El voltaje de salida se compensa por éste método tambien.

5.2 Descripción del circuito de control

5.2.0 Generalidades

La tarjeta de control regula automáticamente la salida de voltaje y de corriente dentro de los límites establecidos por los potenciómetros de la tarjeta. Opera retardando el pulso de disparo respecto del cruce por cero de la alimentación de CA, con el fin de controlar el ángulo de conducción de los SCR's.
Los potenciómetros de la tarjeta permiten ajustes independientes de 'Flotación', 'Régimen Alto' y Límite de Corriente.

5.2.1 Fuente de alimentación

De los embobinados aislados del transformador principal, se proporcionan 20 Vca al puente D1-D4 y C1 filtra la CA rectificada. La resistencia R1 y el zener regulador DZ1 proporcionan un voltaje de 15 Vcd para la circuitería de control. TP5 es usado como punto de prueba común para todas las mediciones de voltaje.

5.2.2 Sincronización

Los diodos D5 y D6 rectifican la señal de CA, produciendo un nivel de CD no filtrado, el divisor resistivo R2-R3 El transistor Q1 sensa el rizo de CA y enciende cuando el voltaje de CD es mayor que el Vbe del transistor e inversamente cuando este cae abajo de Vbe. Por tanto un pulso de 0.5 ms es generado en cada cruce por cero. El pulso positivo es aplicado a Q2, el cual enciende y reseta al integrador en el cruce por cero.

5.2.3 Amplificador de voltaje de error y referencia de voltaje.

U1 forma el corazón de una referencia de voltaje interna, de presición y un amplificador de voltaje de error. La referencia de voltaje (+7 Vcd) esta disponible del pin 6 y es usado en otras secciones de la circuiteria.
Para la regulación del voltaje de salida, una muestra del voltaje (ajustable) se toma del divisor de resistencias y es aplicado al -Ve del amplificdor de error, comparándolo con una referencia de voltaje fija. La diferencia (error) es amplificado 100 veces y aplicado al modulador.
El ajuste de voltaje de flotación es llevado a cabo por el potenciómetro P1 y el ajuste de régimen alto por P2 cuando el pin 39 es cortocircuitado al pin 25.

5.2.4 Amplificador de corriente de error

U2a, esta configurado como un amplificador diferencial para reforzar la señal de corriente de salida del SHUNT en cualquier modo único, finalizado o diferenciado.
La señal de corriente amplificada es aplicada a la entrada -Ve del amplifacador de corriente U2b, con una referencia ajustable en la entrada +Ve. La señal de error amplificada se aplica al modulador.

5.2.5 Modulador

La función del modulador es controlar el ángulo de conducción de los SCR's. Opera produciendo un retrazo en los pulsos de encendido respecto al cruce por cero de CA. Este retrazo es aproximádamante igual a la proporción inversa del voltaje de control en su entrada (S'MOD).
U2c junto con sus componentes asociados forma un generador de rampa no lineal. El generador de rampa no lineal ayuda a agrupar las características de transferencia del circuito de control a la respuesta del filtro de entrada puente/inductor. El generador de rampa es reseteado en cada cruce por cero por el circuito de sincronización.
La modulación del corrimiento de fase de la señal de control es producida por un muestreo natural en U2d, el cual compara la rampa negativa con la señal de control. Una señal de habilitación al circuito de encendido es generado, cuando la rampa de voltaje es ligeramente inferior al voltaje de control.
El voltaje de control de la entrada del modulador (S' MOD) es determinada por la condición 'OR' del amplificador del voltaje de error, amplificador de corriente de error, arranque lento o capacitor limitador de voltaje. Cualquiera de éstos circuitos pueden operar para reducir el tiempo de conducción de los SCR's.

5.2.6 Arranque lento

El capacitor C11 forma el corazón del circuito de arranque lento. La velocidad de crecimiento del voltaje a través del capacitor, producida por la corriente de carga que fluye a traves de R49, es aplicada al transistor Q3 y a la terminal de modulación. El tamaño del capacitor determina la velocidad de crecimiento de la corriente de salida del cargador, la cual es aproximadamente lineal.

5.2.7 Limitador de voltaje

Las resistencias R48 y R50 forman una red divisora de voltaje la cual es efectivamente alambrada a través del capacitor del filtro de entrada. El rango de voltaje es llevado a cabo por el uso de una resistencia en serie

R48. Cuando el voltaje a través de R50 desarrolla aproximadamente 13.5 V. El diodo zener DZ4 inicia la - - conducción, por tanto polariza al LED dentro del optoacoplador U3. Esto provoca que conduzca el transistor dentro de U3, ocasionando una reducción del ángulo de conducción de los SCR's, a través de Q3 de la terminal del modulador.

5.2.8 Circuito de encendido

El circuito de encendido entrega un tren de pulsos al SCR cuando está habilitado. El transistor Q5 (conmutador de potencia), Q4 sensor de corriente y el transformador de pulsos T1 están configurados como un oscilador de relajación auto-oscilante a una frecuencia aproximada de 10 KHz. El transistor Q4, cuando enciende (por el comparador U2d), deshabilita el circuito de disparo. D17 en el devanado secundario rectifica el pulso de salida y lo aplica a los SCR's a través de unas resistencias de compartimiento de corriente R46 y R47.

5.2.9 Control automático de carga. (CAC) Tarjeta de Inserción.

El amplificador operacional U1a sensa el límite de corriente monitoreando el amplificador de voltaje de error en la forma tradicional. El LED DS1, indica la condición de límite de corriente. El capacitor C4, junto con U1d forma un simple circuito de retrazo de tiempo. El retrazo de tiempo es seleccionado por la reisitencia R13a-c (haciendo una selección apropiada como se indica en el esquemático). U3 suministra el voltaje de referencia para la tarjeta.
U2c y U2d estan configurados como un candado R-S. El cual es activado por una transición positiva de U1b. El candado puede ser activado tambien por una señal externa de pulsadores momentáneos (o cortocircuitando TP a TP sobre la tarjeta de circuito impreso PCB).
El reset es afectado manteniendo la señal activa (manteniendo el reset de la PB) por mas de dos segundos.
Cuando el candado esta activo, el temporizador U4 es activado y una instrucción de régimen alto es dado a través de Q2 y Q3. El temporizador se habilita para contabilizar el tiempo, cuando la señal de límite de corriente es eliminada. El período de tiempo es ajustado para 6,10 o 15 horas por la selección de R17/R18 (6 hrs es lo estándar).

NOTA. El cargador no regresará a flotación cuando la botonera manual de régimen alto es presionada, si la unidad esta en límite de corriente.
Las funciones de control opcionales, estan disponibles como tarjetas de inserción, las cuales son insertadas sobre la tarjeta de control de fase. Los sensores requeridos por cada opción estan alambrados al conector de la

tarjeta de control.

5.3.1 Compensación de temperatura en la bateria (CTB). Tarjeta de inserción opcional.

El sensor usado es un termistor de 10K NTC montado en una cápsula terminal de cobre plateado. Normalmente es montada en un conector intercelda. Esto suministra un verdadero sensor de temperatura de bateria. El voltaje de salida es cambiado en un rango de 0.18%/ (sobre el rango de -20 A + 50 C con una compensación reducida en los extremos.
La señal del termistor es linealizada y amplificada por el puente resistivo R1-4 y U1a e invertido por U1b. La señal de temperatura compenzada es aplicada a través de Vrt a la tarjeta principal (La cual viene a ser dominante) U1c esta configurado como un comparador para verificar la integridad del termistor. Con un termistor en circuito abierto, U1c enciende Q1, inhibiendo la compensación de temperatura forzando Vrt a una temperatura simulada de + 30 C. Al mismo tiempo el LED local , DS1 esta encendido.
Lo siguiente es suministrado solamente con 4111-70-12335 01 (opciones no estándares) U1d suministra una alarma para temperatura alta de bateria a través de Q3. al mismo tiempo inhibe cualquier cambio a régimen alto, (forza el regreso del cargador a flotación) hasta que la bateria se enfría. El suministro de P1 permite ajustes a la alarma la temperatua.

5.3.2 Amplificador de corriente de bateria y compartimiento de carga. Tarjeta de inserción

Amplificador de corriente de bateria.

U1a esta configurado como un amplificador de corriente diferencial, el cual amplifica la señal de corriente de bateria del shunt. La señal de corriente amplificada es aplicada al amplificador de corriente de error con una referencia ajustable de P1. La salida a través de D1 es aplicada a el modulador en la tarjeta principal.
Usando esta opción permite un control independiente de la corriente de bateria, aparte de la corriente del sistema, y puede ser requerida cuando la salida del cargador es grande en relación a la bateria. En tales casos esta opción tambien proporciona una acción correcta del control CAC (un ejemplo de tales aplicaciones puede ser en cargas "grandes" con bateria "pequeñas").

Compartimiento de carga.

El circuito lo comprende U1c,d dónde U1c actúa como un amplificador de error amplificando el error (diferencia en una corriente local y una corriente de un cargador

remoto). El cual es usado para ajustar el amplificador de voltaje de error y consecuentemente el voltaje de salida del cargador. Un potenciómetro P2, es usado para inicializar el balance del cargador para sistemas en paralelo.

6.0 Ajustes.

El cargador de bateria es embarcado y armado de fábrica para el sistema de baterias especificando, de tal forma que no se requieran ajustes adicionales cuando se ponga en operación. Sin embargo, si fueran necesarios los ajustes, la sección siguiente debera utilizarse como una guía.

6.1 Herramientas.

- Herramientas de alineación para potenciómetros o un desarmador plano pequeño.
- Un voltímetro de precisión o multímetro digital (precisión + 1% o mejor)
- Un diagrama de la tarjeta de control (fig. 6.0.a)

El voltmetro deberá ser conectado a través de las terminales de salida de CD del cargador.

6.2 Voltaje en Flotación.

6.2.1 Verificacion del voltaje de flotación.

Verifique que el cargador este en modo de flotación, observando que la lampara de 'Régimen Alto' esté apagada. Si el cargador está en el modo de 'Régimen Alto' regréselo a Flotación presionando y liberando el boton de 'Régimen Alto'. No será posible regresarlo a Flotación si el cargador está en el modo de Límite de Corriente.

NOTA: Con el cargador a menos de plena carga, el voltaje de 'Flotación' deberá ser de 1.40 a 1.42 volts, por celda, para baterias de Níquel-Cadmio, o 2.17 a 2.25 volts por celda para baterias de plomo, dependiendo de las especificadiones del fabricante.

Si el voltaje es el adecuado, continue con el párrafo 6.3.

6.2.2 Ajuste del Voltaje en Flotación.

- Verifique que el cargador no esté produciendo la corriente de salida total (No en límite de corriente).
- Reduzca la carga si es necesario.
- Observe el voltmetro mientras efectúa los ajustes.
- Para incrementar el voltaje de salida, ajuste el potenciómetro de Flotación en sentido horario (CW) en

pequeños incrementos hasta que se logre el voltaj
deseado.
- Para disminuir el voltaje de salida, ajuste e
potenciómetro de flotación en sentido antihorario (CCW
en pequeños incrementos hasta que se logre el voltaj
deseado.
- Permita que el voltaje se estabilice despues de cad
incremento antes de continuar.

6.3 Voltaje en Régimen Alto.

6.3.1 Verificación del voltaje en Régimen Alto.

Conmute el cargador a 'Régimen Alto' presionando y
liberando el boton/lámpara de 'Régimen Alto'. La lámpar
de 'Régimen Alto' se iluminará. Permita que el voltaje d
salida y la corriente se estabilice.

NOTA: Con el cargador a una carga menor a la carg
plena, el voltaje en Regimen Alto debera se 1.52 volt
por celda o mayor (1.55V/C estándar) para baterias d
niquel-cadmio o 2.33 volts por celda para baterias d
plomo-ácido, dependiendo de las recomendaciones del
fabricante de la bateria.

6.3.2 Ajuste del Voltaje en Régimen Alto.

Verifique que la carga no esté produciendo una corrient
a plena carga (no en límite de corriente).

- Reduzca la carga si es necesario.
- Observe el voltmetro mientras efectúa ajustes.
- Para aumentar el voltaje de salida, ajuste el
potenciómentro de 'Régimen Alto' en sentido horario (CW)
en pequeños incrementos, hasta lograr el voltaje deseado.
- Para disminuir el voltaje de salida, ajuste el
potenciómetro de 'Régimen Alto' en sentido antihorario
(CCW) en pequeños incrementos hasta lograr el voltaje
deseado.
- Permita que el voltaje se estabilice despues de cada
incremento antes de continuar.
- Cuando quede ajustado adecuadamente, regrese el
cargador al modo de 'Flotación' presionando y liberando
el boton de 'Régimen Alto'.
- Observe que se apague la lámpara de 'Régimen Alto'.

6.4 Ajuste de control automático de carga.

P1 sobre la tarjeta 4111-70-12334-XX ajusta el punto en
el cual el control automático de carga es activado por el
límite de corriente del cargador. Este viene ajustado de
fábrica, pero si un nuevo ajuste de la tarjeta es
requerido, incremente la carga hasta que el límite de
corriente sea alcanzado y ajuste P1 hasta que el LED DS1

encienda.

6.5 Sistema de Límite de Corriente.

6.5.1 Verificacion del Límite de Corriente de bateria (opción) 4111-70-12333-XX.

- Remueva todas las cargas del cargador excepto la bateria.
- Conmute el cargador a 'Régimen Alto' y monitoree la corriente de salida. Esta corriente deberá seguir las recomendaciones del fabricante.

NOTA: Si la bateria esta descargada, una carga adicional a las terminales de la bateria puede ser requerida. Si se desea ajustar el límite de corriente a un valor diferente, o para ajustar una nueva tarjeta, use el siguiente procedimiento.

6.5.2 Ajuste del límite de corriente de bateria.

- Gire el potenciómentro de límite de corriente P1 completamente en sentido horario en la tarjeta 4111-70-12333-XX.
- Aplique la carga que ligeramente exceda el límite de corriente (en las terminales de bateria).
- Observando el amperímetro ajuste P1 en sentido antihorario hasta el límite de corriente deseado.
- Incremente la carga debiendose mantener la misma corriente (aproximadamente).

Si desea ajustar el límite de corriente a un valor menor o ajustar una tarjeta de control nueva, utilice el procedimiento siguiente.

6.5.3 Verificacion del límite de corriente del sistema

PRECAUCION : EL LIMITE DE CORRIENTE VIENE AJUSTADO DE FABRICA AL 100% DE LA CORRIENTE NOMINAL DE SALIDA. NO INTENTE EXCEDER LA CORRIENTE NOMINAL MAXIMA, DEFINIDA EN LA PLACA DE CARACTERISTICAS DEL CARGADOR, YA QUE CONDICIONES INADECUADAS DAÑARIAN AL CARGADOR.

- Incremente la corriente de carga mientras observa el voltmetro de CD. (La carga deberá ser tomada de las terminales de la carga si la opción de límite de corriente de bateria esta aplicada).
- Observe la corriente a la cual el voltaje de salida comienza a disminuir.

6.5.4 Ajuste de Límite de Corriente del Sistema.

PRECAUCION: NO EXCEDA LAS CARACTIRISTICAS NOMINALES DE LA CORRIENTE DE PLACA.

- Gire el potenciómetro de Límite de Corriente completamente en sentido horario (CW).
- Aplique una carga ligeramente mayor que la establecida como nominal (En las terminales de la carga si la opción de límite de corriente de bateria es aplicable).
- Observando el amperímetro, ajuste el potenciómetro del límite de corriente.

6.6 Opción.Compartimiento de carga. Tarjeta P2. 4111-70-12333-XX

Ajusta la corriente entre dos cargadores en paralelo. Este viene ajustado de fábrica, pero si un nuevo ajuste o reajuste es requerido, el siguiente procedimiento deberá ser usado:
- Remueva la bateria y ajuste la carga a un 50% del total
- Ajuste los cargadores a sus voltajes de 'flotación' y despues a 'régimen alto' para que sean los mismos, usando un voltmetro digital.
- Ajuste P2 ligeramente en un cargador y después en el otro, en un ajuste fino hasta que sean iguales (25% por cargador).

6.7 Opción. Compensación de Temperatura en bateria. 4111-70-12333-XX.

Esta tarjeta no requiere ajuste. (P1 no es usado). DS1 indica un termistor abierto.

7.0 Procedimiento de búsqueda de fallas

Las Cartas de Diagnóstico para búsqueda de fallas han sido preparadas para ayudar a aislar la falla en el caso de una falla del cargador. En casos de mal funcionamiento, primero verifique lo siguiente:

a) Todas las conexiones entre celdas y entre contenedores, deben ser de positivo a negativo (en serie), y deben estar sujetos de forma segura.
b) Las conexiones entre la bateria y el cargador son positivo a positivo, negativo a negativo (en paralelo) y deben estar sujetos de forma segura.
c) Voltajes en las celdas individuales. En el modo de flotación estas lecturas de voltaje deberán ser 1.40 a 1.42 volts por celda para baterias de níquel cadmio o 2.17 a 2.25 por celda para plomo ácido. Si hay una variación mayor de 0.05 volts entre celdas con las lecturas más alta y más baja, cargue la bateria en régimen alto durante 24 hrs para igualar voltajes y vuelva a verificar.
d) El voltaje y la frecuencia de CA de entrada, deben cumplir con la entrada de diseño del cargador segun

se muestra en la placa de características nominales.

Despues de verificar si todas las conexiones externas estan correctas, los voltajes en las celdas estan dentro de las tolerancias y el voltaje y la frecuencia de CA en la entrada son iguales a los del cagador. Efectúe detenidamente un análisis en cada bloque y proceda segun lo indicado por el resultado.

S I N T O M A	ACCION CORRECTIVA
El fusible de CD se quema inmediatamante.	Refierase al diagrama de diagnostico # 1
El breaker de la red, abre inmediatamente.	Refierase al diagrama de diagnostico # 2
No hay potencia de salida	Refierase al diagrama de diagnostico # 3
El rectificador opera continuamente en el modo de límite de corriente o el voltaje de salida esta incorrecto.	Refierase al diagrama de diagnostico # 4

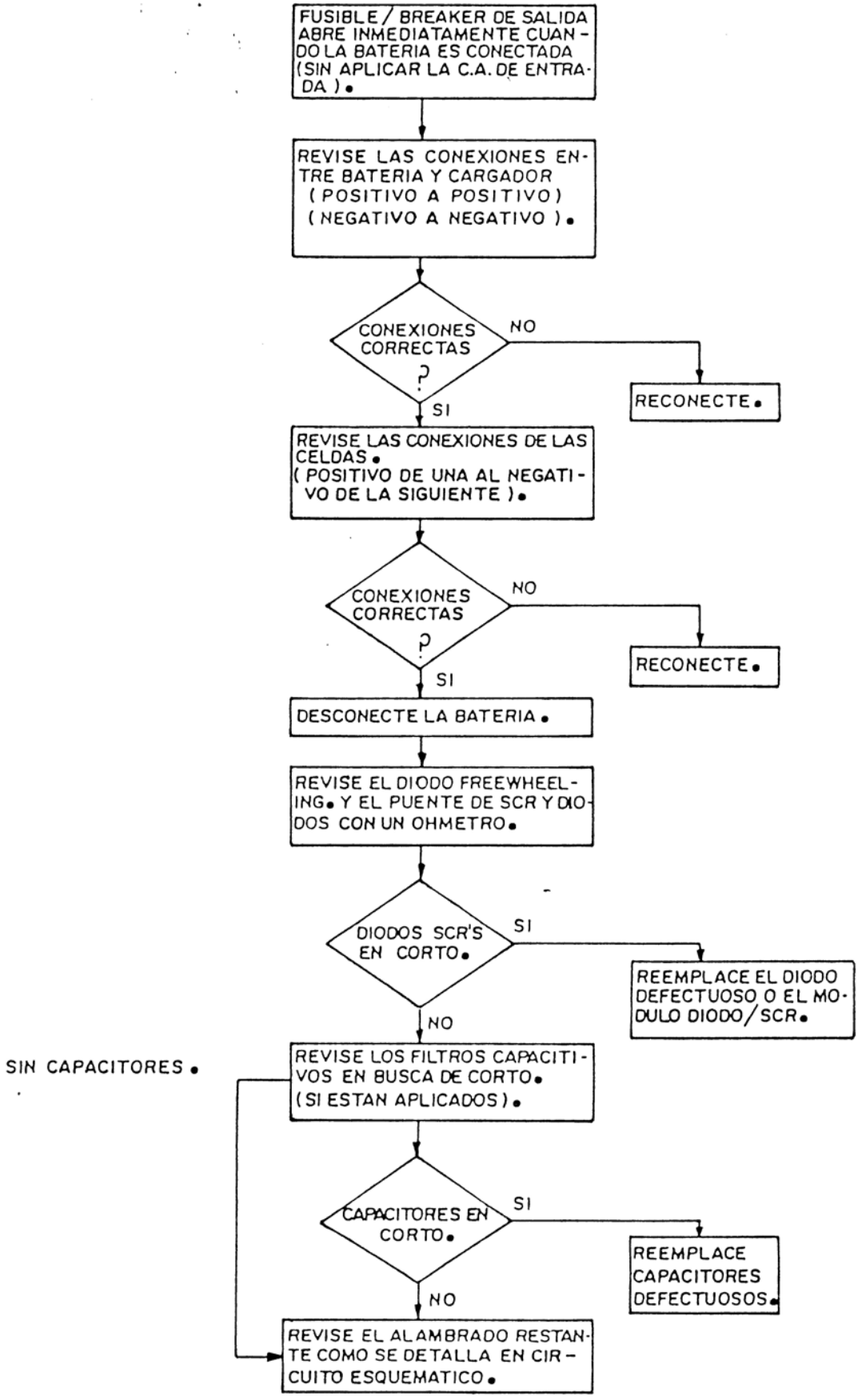
NOTA : SE DEBERA TENER CUIDADO EN TODO TIEMPO, PARA EVITAR EL CONTACTO CON CIRCUITOS VIVOS.

7.1 Verificación del ensamble del puente

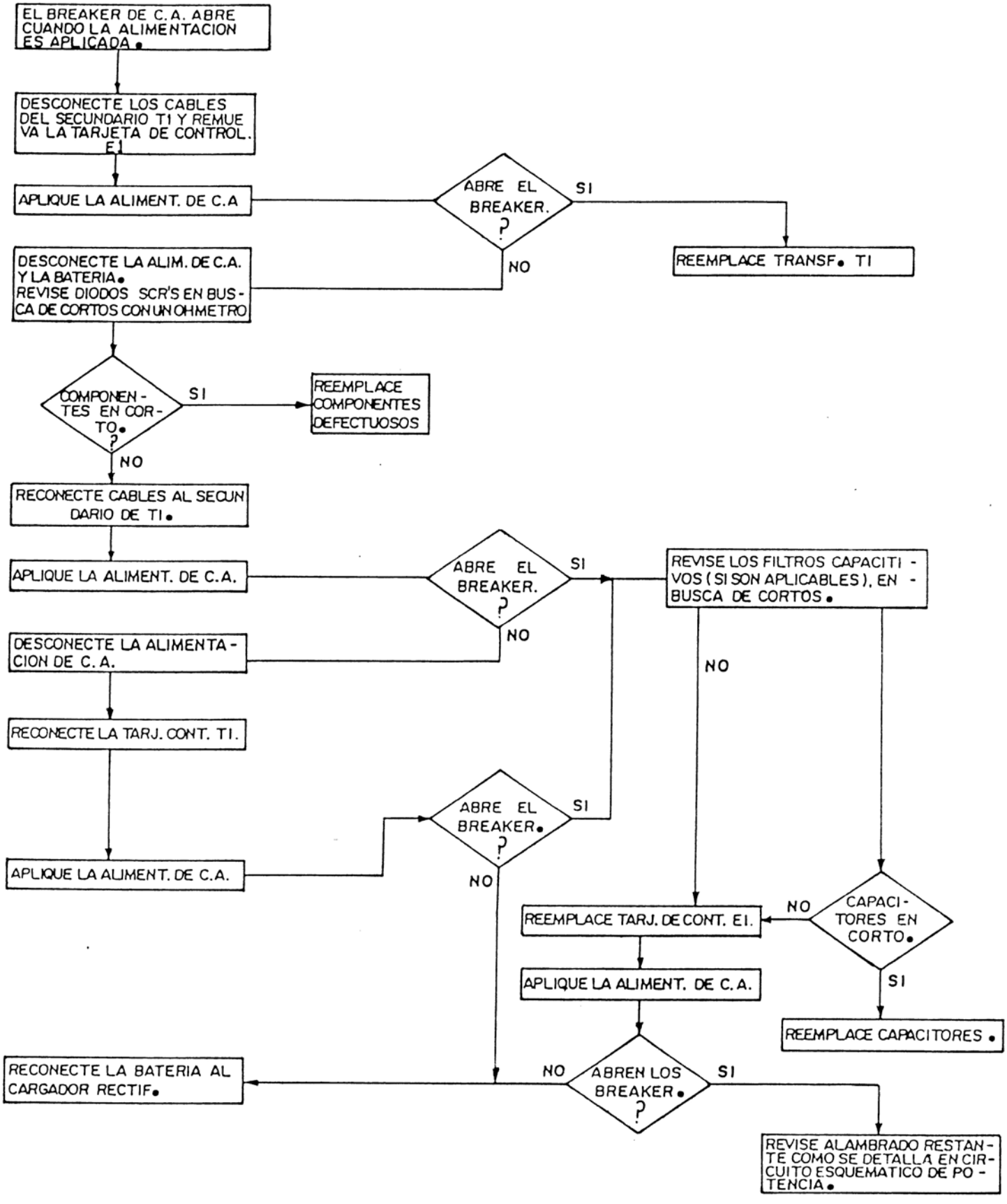
Para cargadores de 100 A de salida o menores se utiliza modulos de SCR/DIODO. Todas las conexiones se hacen a través de las terminales de los módulos. Para verificar la existencia de un corto circuito, primero desconecte la alimentación de la red de CA que viene de la entrada abriendo el circuito interruptor de CA. Utilice un ohmetro o un multímetro en la escala de baja resistencia y verifique ambas direcciones a través de las componentes. Si se indica un corto circuito, desconecte los alambres para aislar la componente dañada. Un SCR en forma individual indicará un circuito abierto en ambas direcciones Para verificar la compuerta, desconecte la terminal de color blanco (compuerta) y verifique la resistencia de compuerta a cátodo (blanco a rojo) con el ohmetro/multimetro. Las resistencias varían pero típicamente estan dentro del rango de 30 a 100 OHMS en ambas direcciones Tambien verifique la resistencia de compuerta a ánodo, deberá ser esencialmente circuito abierto.
Para los diodos, verifique la resistencia de ánodo a cátodo. La resistencia deberá ser baja de ánodo a cátodo y alta de cátodo a ánodo.

Refiriendose al diagrama esquemático, las componentes deberán cumplir con lo siguiente:

CA1	-	(+) TY1	ALTA	(-)	-	(+)	D3	ALTA
(+)	-	CA1 TY1	ALTA	(+)	-	(-)	D3	BAJA
CA2	-	(+) TY2	ALTA	(-)	-	CA1	D1	ALTA
(+)	-	CA2 TY2	ALTA	CA1	-	(-)	D1	BAJA
(+)	-	G1 COMPUERTA1 30-100 OHMS		(-)	-	CA2	D2	ALTA
(+)	-	G1 COMPUERTA1 30-100 OHMS		CA2	-	(-)	D2	BAJA
G2	-	(+) COMPUERTA2 30-100 OHMS						
(+)	-	G2 COMPUERTA2 30-100 OHMS						
G1	-	(-) COMPUERTA1 ALTA						
(-)	-	G1 COMPUERTA1 ALTA						
G2	-	(-) COMPUERTA2 ALTA						
(-)	-	G2 COMPUERTA2 ALTA						



CARTA DE DIAGNOSTICO # 1.



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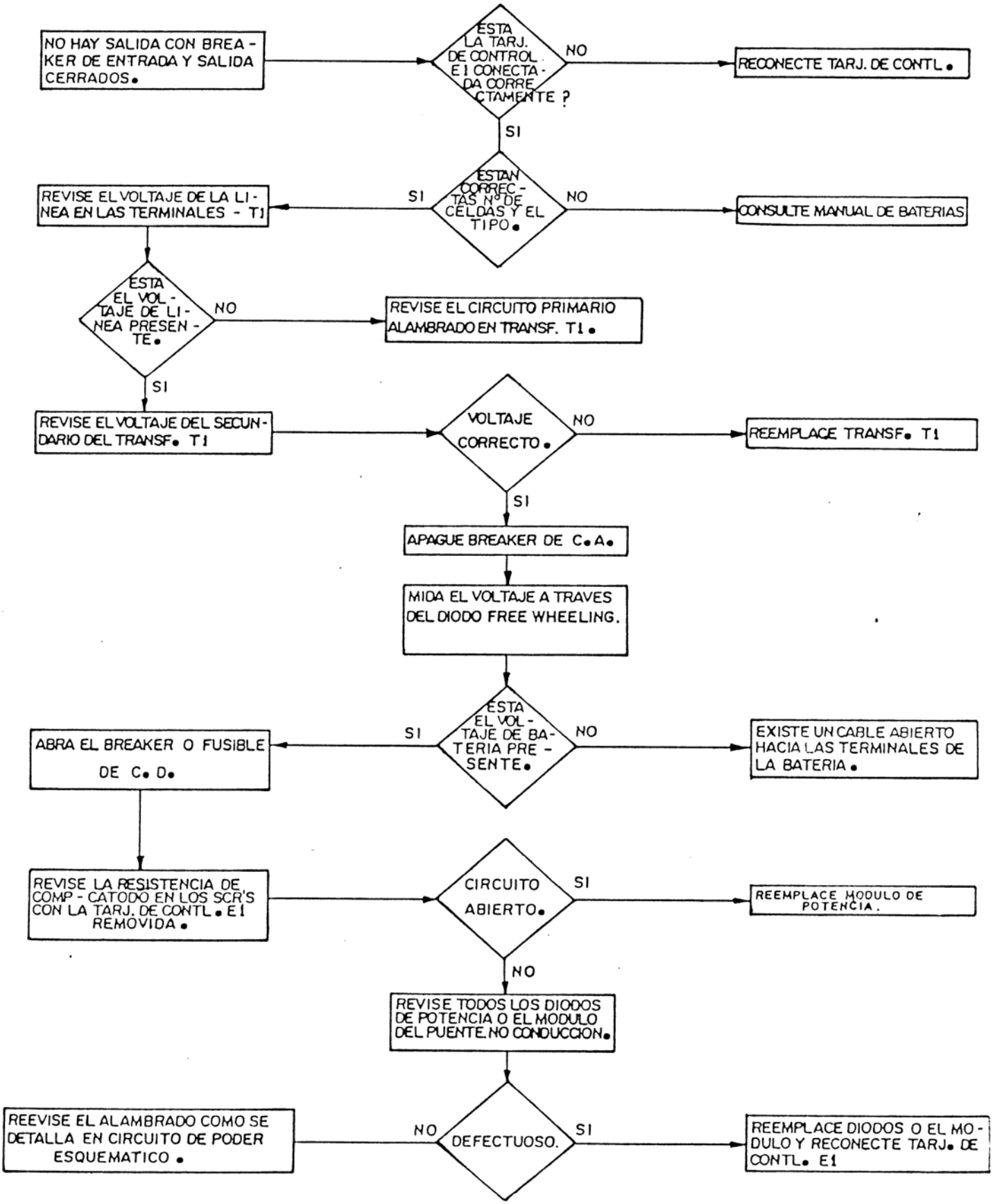
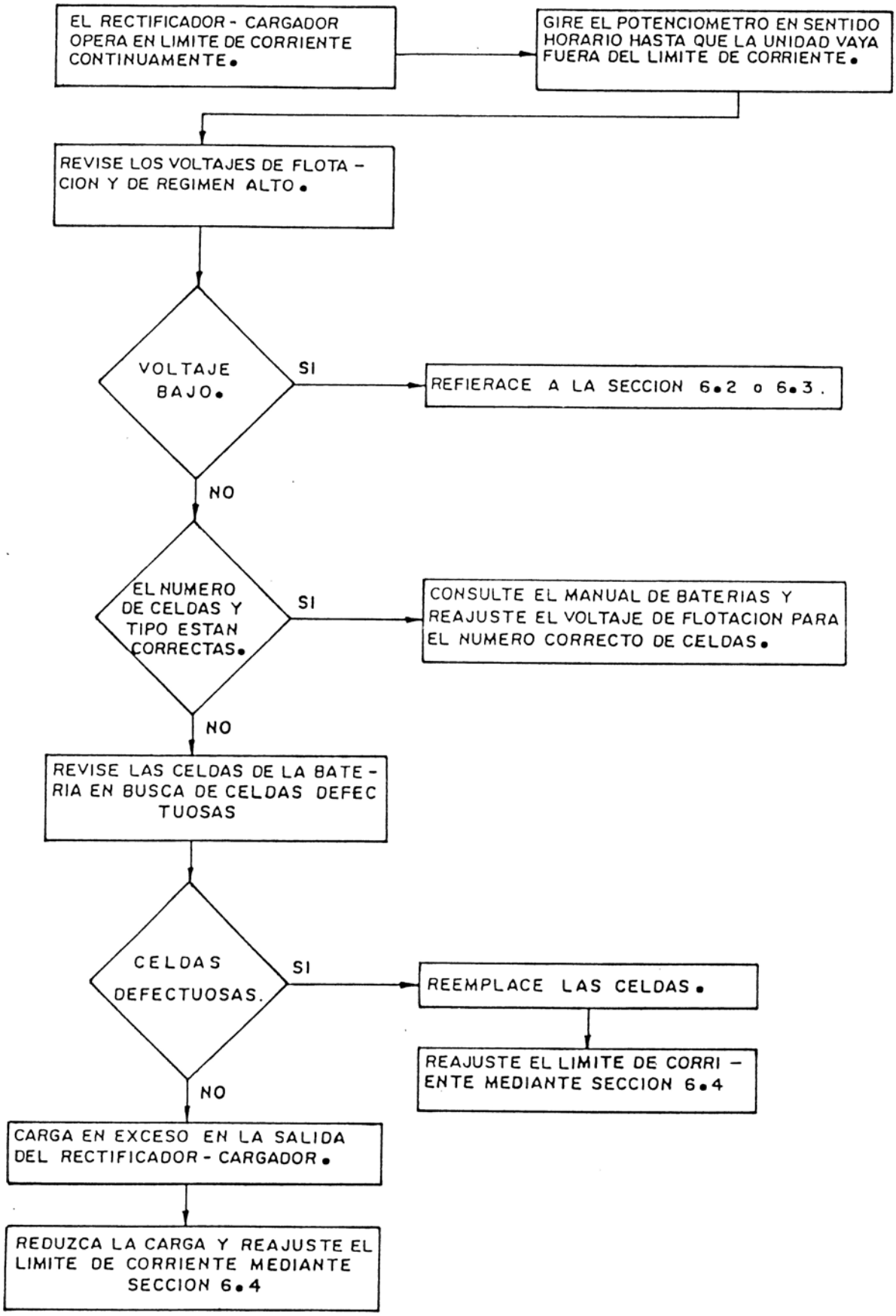


CARTA DE DIAGNOSTICO # 3.



CARTA DE DIAGNOSTICO ## 4.

8.0 Conexiones de la tarjeta de control SCR

MH1	-	1	COMUN
MH1	-	2	NO USADO
MH1	-	3	V SENSOR +
MH1	-	4	NO USADO
MH1	-	5	CATODO DEL SCR
MH1	-	6	CATODO DEL SCR
MH1	-	7	COMPUERTA DEL SCR
MH1	-	8	COMPUERTA DEL SCR
MH1	-	9	NO USADO
MH1	-	10	LIMITADOR DE VOLTAJE (NEGATIVO)
MH2	-	1	CONTROL DE REGIMEN ALTO
MH2	-	2	SHUNT DE BATERIA +
MH2	-	3	SHUNT DE BATERIA -
MH2	-	4	TERMISTOR P/COMP. DE TEMP. EN BATERIA
MH2	-	5	TERMISTOR P/COMP. DE TEMP. EN BATERIA
MH2	-	6	SHUNT DEL SISTEMA -
MH2	-	7	SHUNT DEL SISTEMA +
MH2	-	8	LED DE REGIMEN ALTO
MH2	-	9	BOTON PULSADOR DE CONTRL. AUTOM. DE CARGA
MH2	-	10	20 Vca
MH2	-	11	20 Vca
MH2	-	12	FALLA DE CA
MH2	-	13	FALLA DEL CARGADOR
MH2	-	14	LED DE CA ENCENDIDO +
MH2	-	15	LED DE REGIMEN ALTO +

8.1 Voltajes del secundario del transformador T1 (Vrms)

VOLTAJE NOMINAL DE CD	SECUNDARIO X1-X2	SECUNDARIO X3-X4
12	23 V	20
24	43 V	20
48	83 V	20
120	202 V	20

8.2 Características del fusible de CD/Termonagnético

CORRIENTE NOMINAL DE SALIDA EN CD (AMPS)	FUSIBLE (AMPS)
5	8
10	15
15	25
20	30
30	45

CORRIENTE NOMINAL DE SALIDA EN CD (AMPS)	TERMOMAGNETICO
50	75
75	125
100	150

9.0 Manteniminento

Los cargadores de bateris Saft Nife no emplean ninguna parte móvil mas que los potenciómetros de ajuste y los medidores indicadores utilizados para las alarmas. No se requiere de ningún mantenimiento adicional, al necesario para eliminar el polvo del cargador, las verificaciones periódicas y los ajustes durante la vida de la unidad.

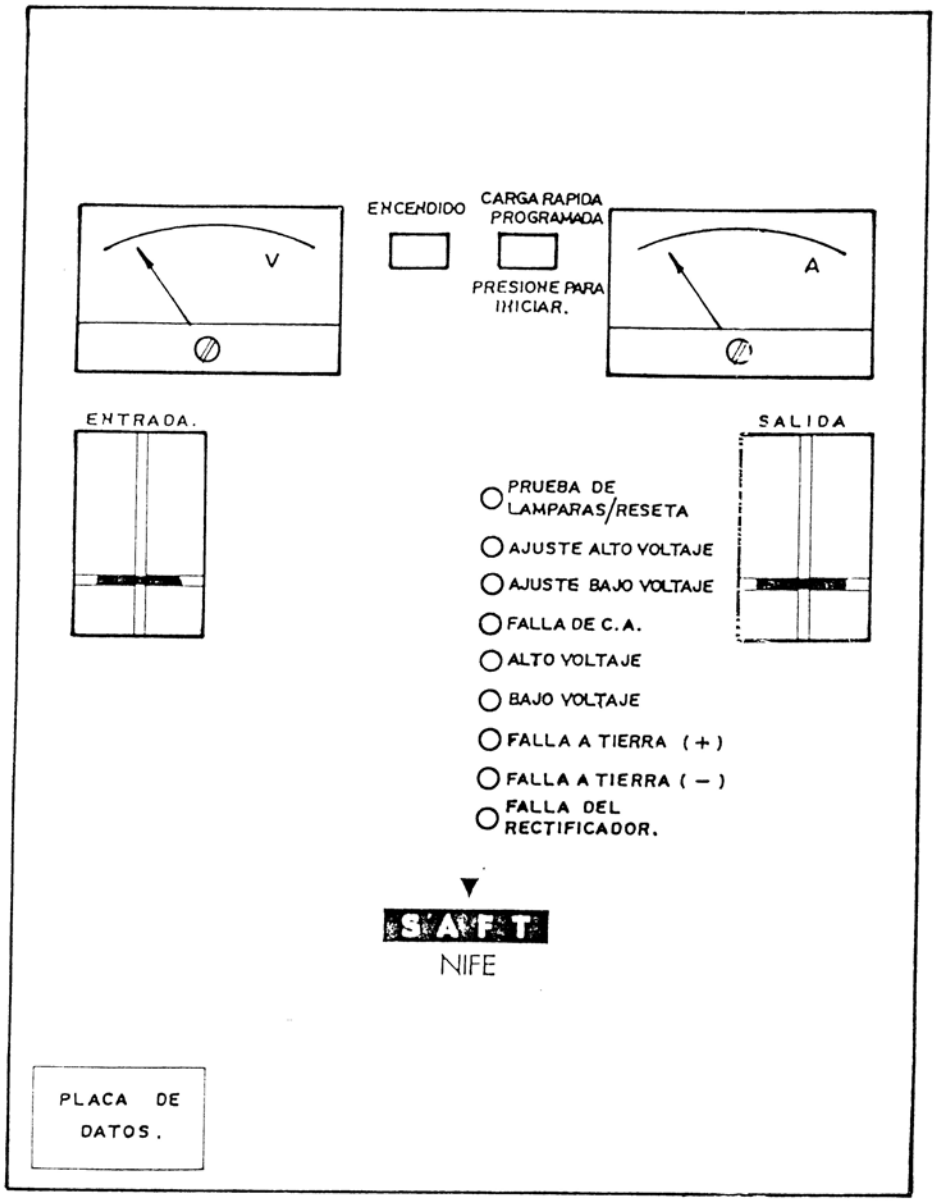
Todas las componentes magnéticas, reisitencias, capacitancias y semiconductores se han seleccionado prudentemente para un período de vida largo.

Se deberá verificar regularmente el estado aproximado de la carga de la bateria. Esto se podrá lograr mediante el procedimiento siguiente:

1) Inicie una carga rápida presionando el boton de régimen alto.
2) Observe que el cargador entre en límite de corriente (en el amperímetro de salida)
3) Si el cargador permanece en límite de corriente por más de 36 segundos, la bateria requiere entonces de una carga en régimen alto. Si la bateria ya ha sido cargada en forma adecuada, el cargador dejará el modo de límite de corriente (obsevada por la disminución de la corriente en la bateria ó a la salida del cargador.
4) Cancele la carga manual en régimen alto si la bateria no requiere de la carga.

Además, regularmente se deberá proporcionar mantenimiento a la bateria como lo indica el fabricante. Se deberá poner atención especial en el nivel de electrólito de las celdas con ventilación. Tambien se deberán verificar los voltajes de 'Flotación' y 'Régimen Alto' semestralmente para que estén de acuerdo a las características mencionadas en la sección 6.0

No.	Revisión	Fecha	Firma	No.	Revisión	Fecha	Firma



No. Pzas.	Pos	No. de Parte	Descripción	Material

No. de Parte

Dibujo: R. RGUEZ. R.

Revisó: M. Sandoval P. | Aprobó:

Fecha: 1992 - 05 - 18.

S.A.B.T. NIFE

Material: | Acabado:

Descripción:

VISTA FRONTAL

CARGADOR —

SLRF 48/50

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Esc: SIN. | Acot:

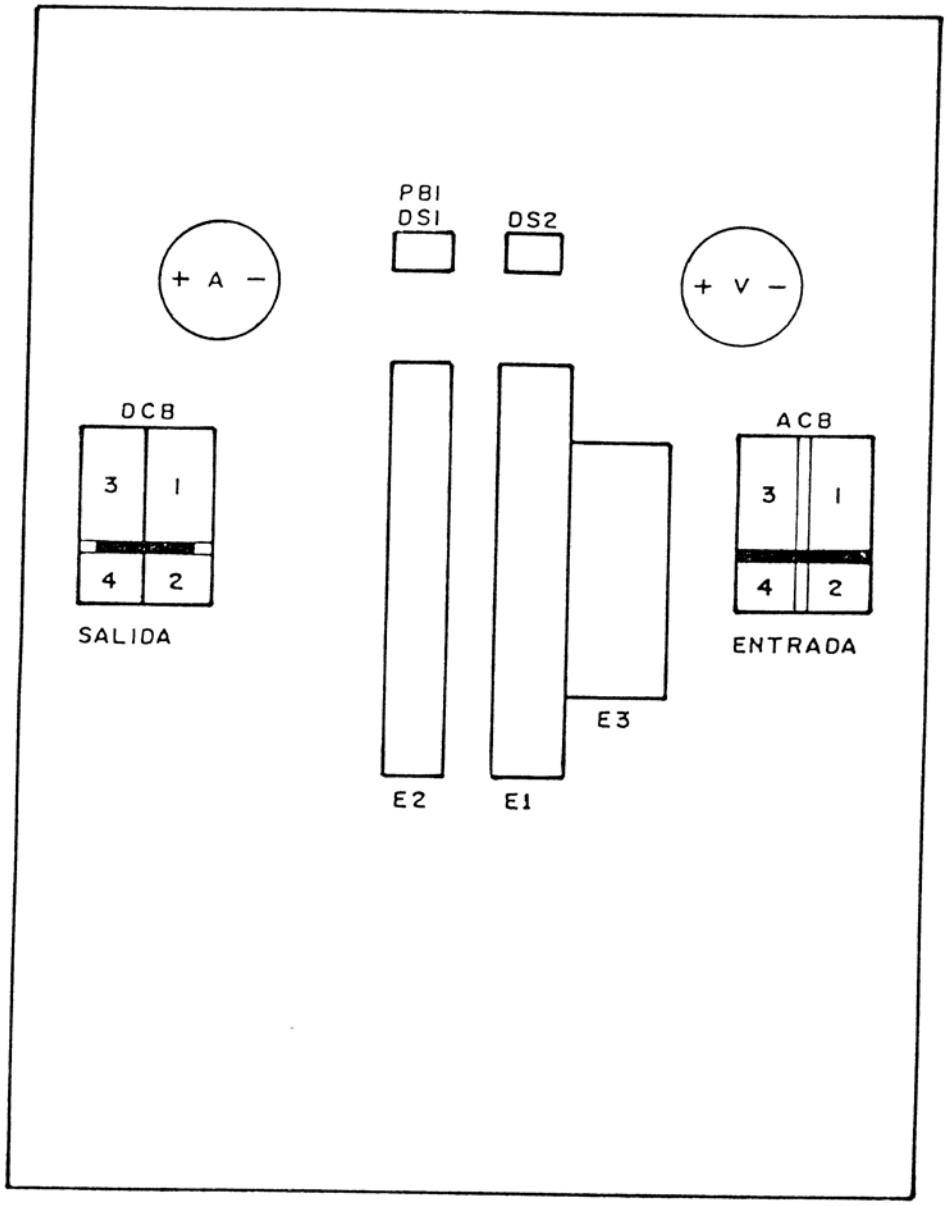
Substituye a:

Pertenece a:

Art. gr. | Reg. | Rev.

Dibujo No.

No.	Revisión	Fecha	Firma	No.	Revisión	Fecha	Firma



VISTA INTERIOR.

No. Pzas.	Pos	No. de Parte	Descripcion	Material

No. de Parte

Dibujo: R. RGUEZ. R.

Reviso: M. Sandoval P. | Aprobo:

Fecha: 1992 - 05 - 18.

SAB NIFE

Material: | Acabado:

Descripción: MV - 21

DISTRIBUCION DE COMPONENTES DE PUERTA EN GABINETE "A" Y "B" CARGADOR TIPO SLR.

SLRF 48/50

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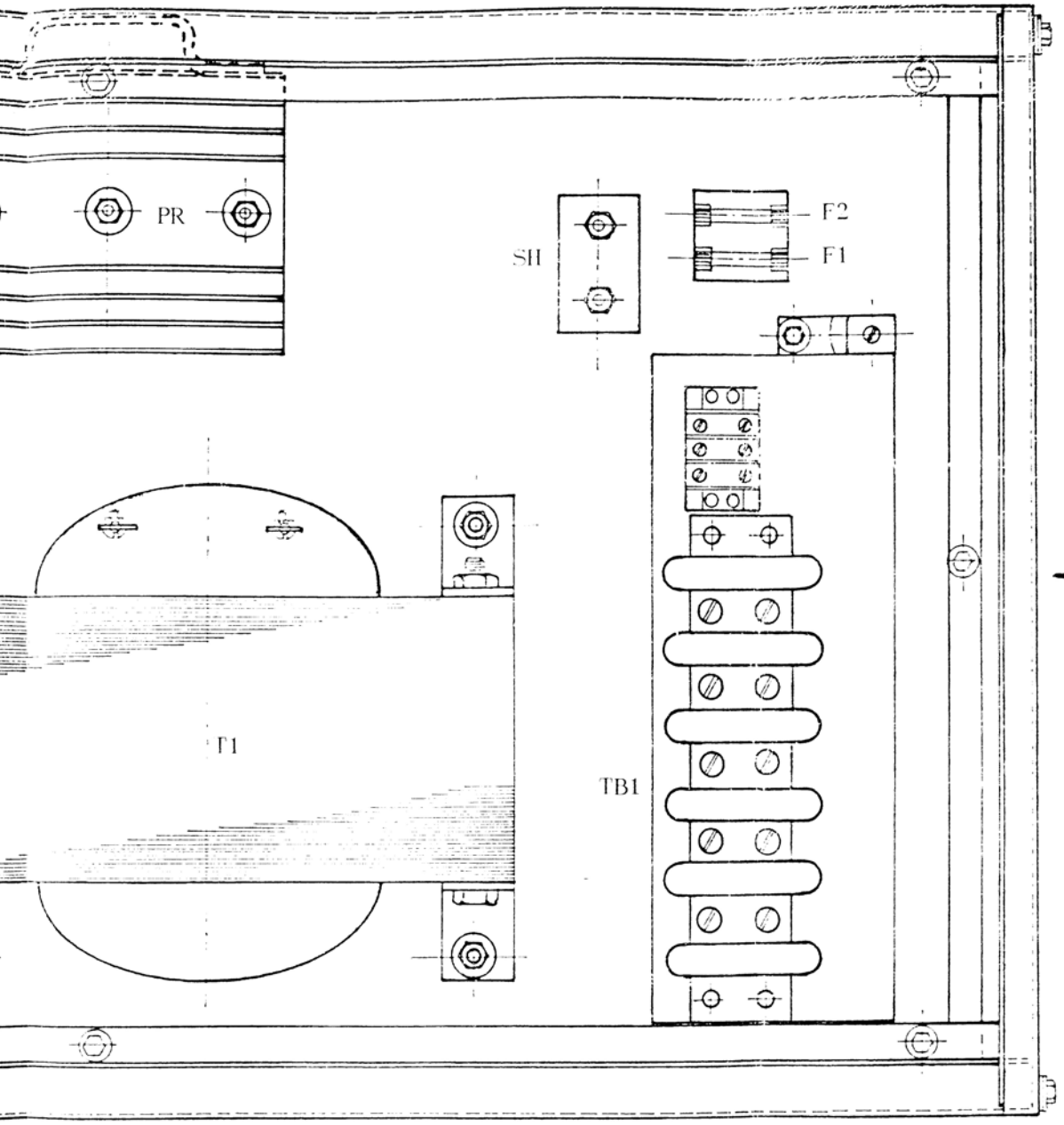
Dibujo No.

No.	Revisión	Fecha	Firma	No.	Revisión	Fecha	Firma



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DISTRIBUCION DE COMPONENTES

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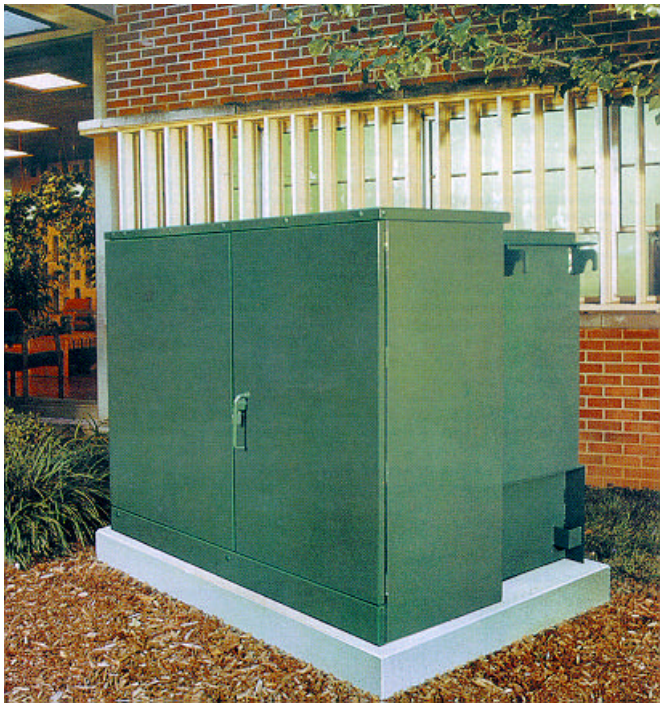
GE Commercial Transformer



Three-Phase Padmounted Transformers

Three-phase COMPAD® Transformers (75-5000 kVA)

COMPAD CONSTRUCTION

COMPAD® oil-immersed transformers are padmounted compartmental-type transformers. Designed for outdoor installation on a concrete pad, the transformers provide underground power distribution to commercial, industrial and institutional loads.

GE COMPAD Transformers are available with oil, R'Temp and silicone insulation fluids. Oil is generally the standard choice for outdoor applications where flash and fire points are not an issue. For applications requiring less-flammable liquids, R'Temp and silicone insulation fluids are generally required. Internal switching in not available in GE silicone fluid-insulated transformers. R'Temp is generally the standard choice when switching is required.

APPROXIMATE FLASH AND FIRE POINTS ARE AS FOLLOWS:

	OIL	R'TEMP	SILICONE
Flash Point	145C	238C	268C
Fire Point	165C	311C	371C

Featuring tamper- and weather-resistant construction for safety, these transformers meet ANSI security requirements. All live parts are completely enclosed in lockable high- and low-voltage compartments, which are interlocked for safety once a user-installed padlock is added.

These power-distribution packages are designed in a neat, clean, modern style and painted olive-green color (Munsell 7GY 3.29/1.5) for pleasing appearance and to harmonize with most surroundings.

Three-phase COMPAD transformers are furnished with an enclosure consisting of high- and low-voltage sections, separated by a steel barrier bolted in place. The low-voltage compartment door is equipped with a steel rod handle with provisions for padlocking. User-installed padlocks are required to complete the cabinet security system. In addition, the doors are so arranged that accessibility to the high-voltage compartment can only be gained after opening the low-voltage compartment door and releasing a captive screw. Cables enter and exit the compartment sections from below, through openings in the mounting pad.

The high- and low-voltage cabinet sections are completely removable with all screws and bolts accessible from inside the compartments. The transformer tank is constructed so that it can be lifted, rolled, slid, or skidded into place on a pad without disturbing the cables.

Standard Ratings

Three-phase COMPAD transformers are rated 75 through 5000 kVA, 60 hertz, 65C rise, up through 34500 GrdY/19920 150 kV BIL with low-voltage ratings of 208Y/120 and 240 delta through 1500 kVA, 480 delta through 3000 kVA, 480 wye/277 through 3750 kVA, 2400 to 7200 delta or wye from 750 kVA through 5000 kVA.

Units comply with ANSI Standards C57.12.22 for live-front application and C57.12.26 for separable insulated high-voltage connector application.

Kilovolt ampere ratings are based upon not exceeding 65C average temperature rise above 30C average ambient with a maximum ambient not to exceed 40C.

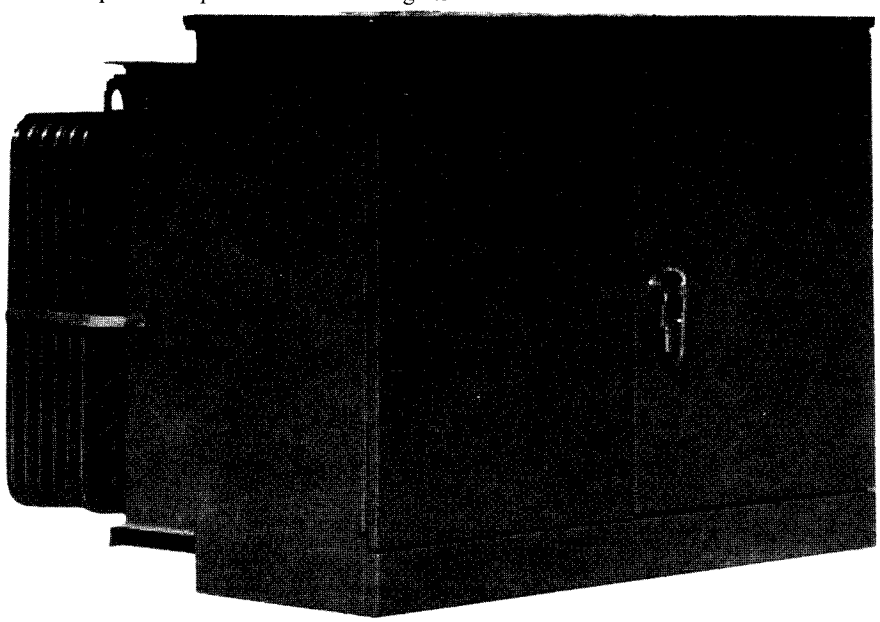
Standard kilovolt ampere ratings are as follow:

75 kVA	500 kVA	2500 kVA
112.5 kVA	750 kVA	3000 kVA
150 kVA	1000 kVA	3750 kVA
225 kVA	1500 kVA	5000 kVA
300 kVA	2000 kVA	

Standard high-voltage basic insulation levels (BIL) for common high-voltage ratings are as follow:

2400 delta or wye 60 kV BIL
4160 delta or wye 60 kV BIL
4800 delta or wye 60 kV BIL
7200 delta or wye 75 kV BIL
8320 delta or wye 75 kV BIL
12000 delta or wye 95 kV BIL
12470 delta or wye 95 kV BIL
13200 delta or wye 95 kV BIL
13800 delta or wye 95 kV BIL
14400 delta or wye 95 kV BIL
16340 delta or wye 95 kV BIL
22860 GrdY/13200 125 kV BIL
23900 GrdY/13800 125 kV BIL
24940 GrdY/14400 125 kV BIL
*34500 GrdY/19920 150 kV BIL

*Also available at 125 kV BIL.



Standard Features and Accessories

STANDARD TESTS PERFORMED

Each GE distribution transformer receives the following tests as required by ANSI Standards. Tests are made in accordance with the ANSI Test Code C57.12.00/C57.12.90, latest revision, and are available by transformer serial number at no charge.

1. No-load loss
2. Exciting current at rated voltage
3. Polarity check
4. Ratio check
5. Dielectric tests at low frequency (high- and low-voltage in accordance with TABLE 1)
   a. For delta high-voltage transformers:
      Applied potential test and induced-potential test
   b. For grounded wye transformers:
      Induced-potential test only
6. Mechanical leak test

In addition to the above required tests, GE performs the following:

1. Load loss
2. Impedance
3. Production line impulse test (in accordance with TABLE 1)

ANSI DESIGN TESTS (NON-STANDARD)

The following tests are performed on new GE transformers with electrical or thermal design configuration:

1. Temperature rise
2. Impulse
3. Short-circuit test*
4. Resistance measurement
5. Audible sound level
6. Dielectric breakdown
7. Mechanical
   -Lifting
   -Pressure

*Not a design test. Listed in ANSI Test Code C57.12.00/C57.12.90 as "other."

Losses and Impedance

The total losses of a transformer shall be the sum of the excitation losses (no-load losses) and the load losses.

The losses represented by test of a transformer or transformers on a given order shall not exceed the specified losses by more than the percentage listed in TABLE 18 (in accordance with ANSI Test Code C57.12.00, latest revision).

TABLE 1

Transformer Rating	BIL Test (Full wave) (kV)	Low-frequency Test (Hi-pot) (kV)
2400/4160Y	60	19
4800/8320Y	75	26
12470GrdY/7200	95	-
7620/13200Y	95	34
13200GrdY/7620	95	-
12000	95	34
13200/22860Y	125	40
14400/24940Y	125	40
24940GrdY/14400	125	-
19920/34500Y	125	40
34500GrdY/19920	125	-
19920/34500Y	150	50
34500GrdY/19920	150	-

NOTE: Transformers may be provided with taps for voltages above the rated voltage values shown in TABLE 1 without increasing the insulation class.

TABLE 1A
Tolerances for Three-phase Transformer Losses

No. of Units on One Order	Basis of Determination	Percentage	
		No-load Losses	Total Losses
1	1 Unit	10	6
2 or More	Each Unit	10	6
2 or More	Average of All Units	0	0

COMPAD® Standard Core-and-coil Construction

Where craftsmanship and manufacturing expertise meet.

Each COMPAD® transformer starts with the careful selection of compatible materials. The five-legged core-and-coil assembly — the heart of the transformer — represents years of research and development efforts directed at improving and developing materials and techniques that result in long, reliable transformer life. For example, a patented metallurgical bonding and specially developed insulation materials contribute to the transformer designed to give you the most efficient operation possible.

A The coils are clamped axially, top and bottom, to prevent shifting under short-circuit conditions.

B The layer insulation paper is coated with a thermal setting adhesive that during the oven-curing process bonds the winding and interlayer insulation into a solid structure.

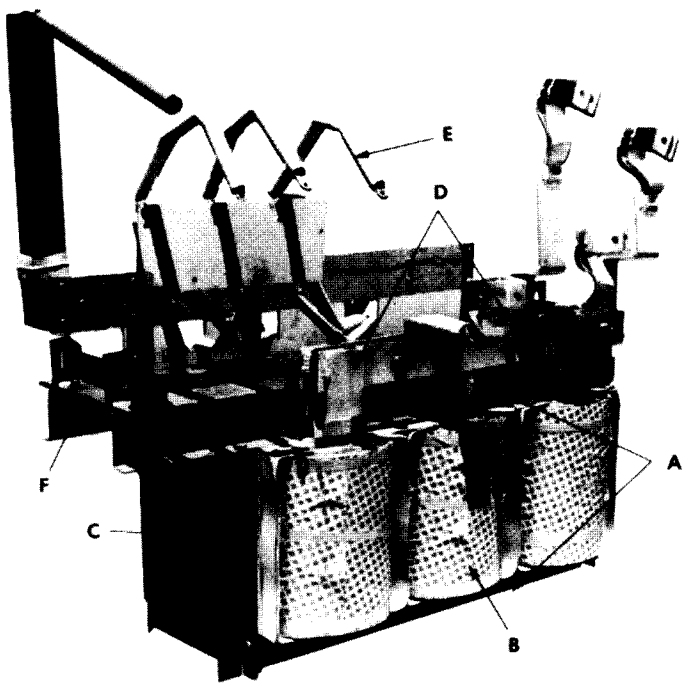
C The transformer core is cradled and retained, minimizing mechanical stresses.

D Transition joints in low-voltage bus structure and leads are welded.

E High- and low-voltage leads are flexible to minimize damage that could result from forces due to short-circuits and shipping.

F Firm positioning of interior assembly within tank is assured by bolting at top corners of the assembly.

G Five-legged core is standard on all COMPAD transformers.



This construction allows use of wye-wye connections to avoid ferroresonance problems and minimize tank heating. Every completed COMPAD transformer is placed in a vacuum chamber where air and moisture are removed before filling tank to proper level with clean, dry de-aerated oil.

GE is the leader in the design and manufacturing of high-efficiency, low-loss transformers. We offer a full range of efficiencies designed to match individual customer costs-of-energy criteria. GE has the product to meet industry needs – from standard efficiency, for customers who purchase on a first-cost basis, to high efficiency and ultra-efficient transformers, for customers who use EEI loss-evaluation methodology or purchase high-efficiency transformers.

The ULTRA Efficient Amorphous Core Transformer technology consists of a new class of metal that has no crystaline structure. The amorphous atomic structure is more easily magnetized and demagnetized 50 to 60 cycles per second in a transformer core resulting in 70 to 85% lower core losses than transformers with silicone steel cores. The combination of GE's advanced core technology, proven coil construction and patented manufacturing processes has resulted in a high-quality, extremely reliable, ultra-efficient transformer offering.

Fully processed grain-oriented silicon core steel is machine-cut and wound, then formed in a rectangular shape. Core quality and characteristics are improved by this method, which also results in less handling damage and more positive core-and-coil alignment. The annealing process eliminates any stress in the core during the fabrication process and results in reduced core losses and improved COMPAD transformer performance.

Enameled primary wire and full-width secondary strip are layered with paper insulation to form COMPAD coils. The strip is edge-conditioned to eliminate sharp edges and burrs that could penetrate paper layer insulation and cause turn-to-turn failures. Proper tension is maintained during the winding process to produce tight, compact coils that assure uniform electrical characteristics and superior resistance to short-circuit forces.

High-voltage coils are wound with conductor that is shaved, drawn and formed into rectangular wire. An enamel coating is applied to thoroughly cleaned wire and cured in successive coatings to assure uniform thickness. The techniques used assure positive bonding of enamel to conductor.

Each unit also goes through final electrical tests – load and no-load losses, exciting current, polarity and ratio checks, dielectric tests at low frequency, impedance test, impulse testing – and results are recorded.

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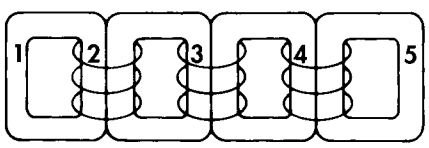
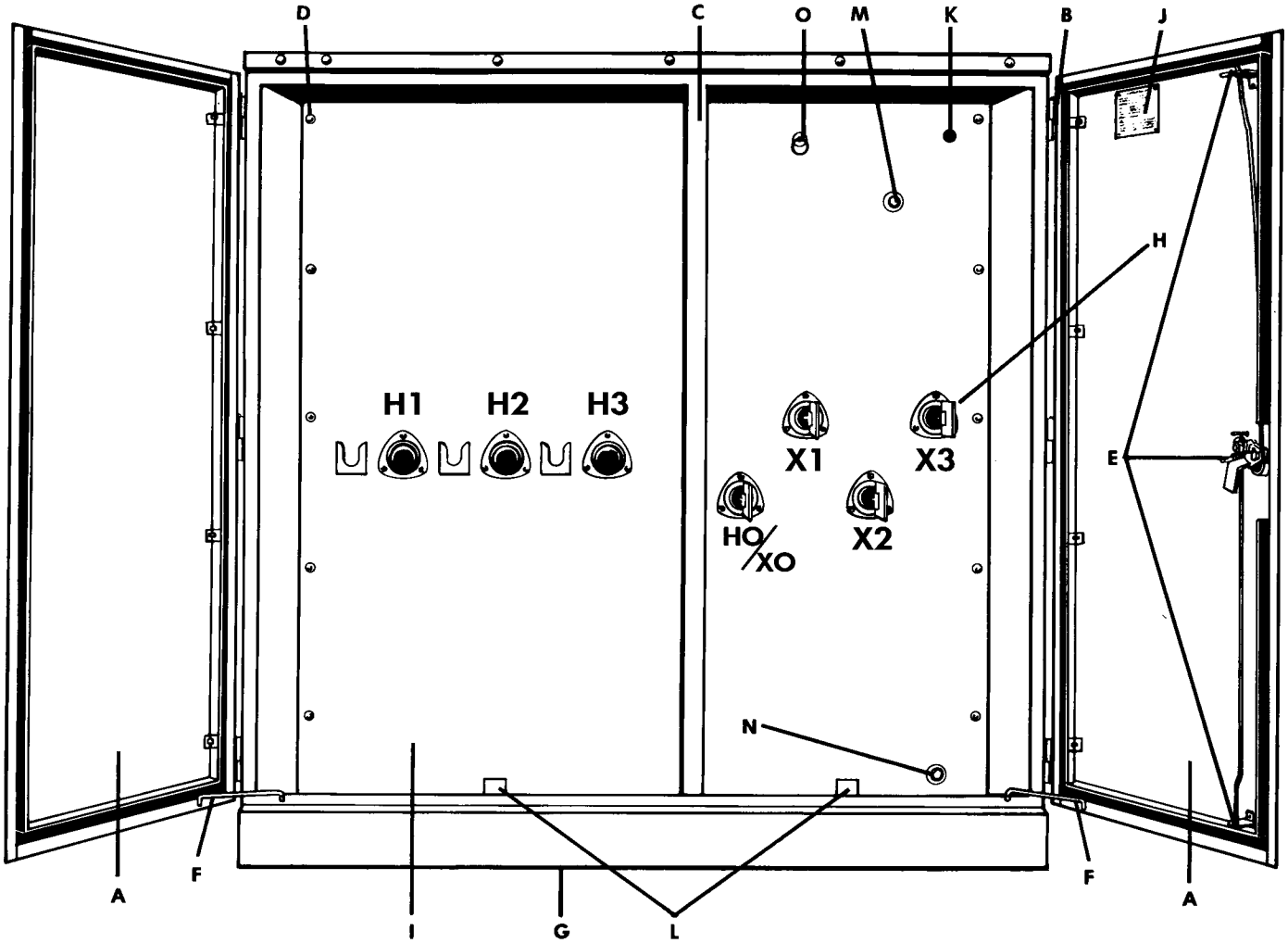


Standard Features



A Easily removable compartment doors give authorized personnel added access to compartment interior. A special padlocking provision gives shearing action to the padlock hasp. Double right-angle bends are formed at all points where the doors come together with compartment structure, providing a unit that meets ANSI security requirements.

B Stainless-steel hinges and $^{3}/_{8}$-inch pins inhibit corrosion.

C A rigid, steel partition separates high- and low-voltage compartments to give added strength and safety. This partition acts as a groundplane and reduces the possibility of a voltage potential building up on the partition.

D All-bolted compartment construction permits one-person removal of side panel sections; allows easy, on-site replacement; and affords maximum working space during cabling.

E Three-point latching (shown in open position) of low-voltage door with recurved rod securely wedges top, middle and bottom for a tight, rigid fit free from vibration. Door handle of cold rolled steel permits easy and convenient operation. A bearing on the handle prevents binding.

F Sturdy, captive hold-open devices hold COMPAD® doors in the open position, then store conveniently in transformer door.

G Low sill height affords greater access to cabling area. Transformer sill is easily removed to facilitate installation. Sill construction combined with the front panels, side panels and middle partition provides a rigid cabinet.

H High-quality, low-voltage bushings with bolt-on blades are standard through 300 kVA and on 500 kVA, 480Y/277. Threaded-stud secondary bushings are furnished on RUS units through 300 kVA and 500 kVA, 480Y/277.

I Transformer tank is welded from cover to base for maximum structural strength and leak-free seals. All welds are 100% leak tested.

J The permanent nameplate is conveniently located on the inside surface of the low-voltage door. Nameplate is large and easy to read with cables in place. Permanent serial number identification is also stamped over low-voltage bushings, supplementing serial number on nameplate.

K The filling plug consists of a one-inch NPT opening to the transformer front plate and furnished with a one-inch pipe plug.

L The ANSI tank ground pads consist of one (1) $^{1}/_{2}$ to 13-inch tapped hole in 75 to 500 kVA and two (2) $^{1}/_{2}$ to 13-inch tapped holes in 750 to 2500 kVA units.

M Liquid-level indication consists of a flange with a $^{1}/_{2}$-inch NPT opening welded to the tank wall and a $^{1}/_{2}$-inch pipe plug. It is located at the 25C insulating-oil level with this level indicated by stencil marking on the tank wall.

N One-inch drain valve and sampler on all units 75 to 5000 kVA.

O Qualitrol 202 Series (or equal) automatic pressure-relief device.

Standard Features

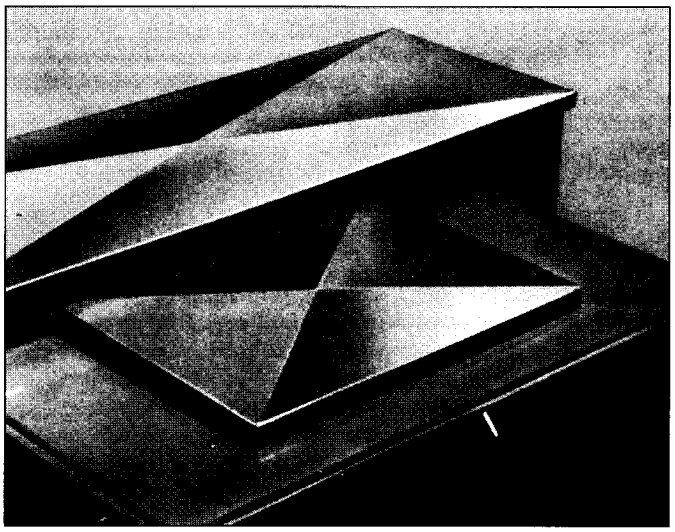
One 7.6-inch by 19-inch handhole in the transformer tank cover is provided on all units. The handhole is sealed with a reusable, one–piece molded nitrile rubber gasket with metal stops to prevent damage to the gasket from overcompression.

Access to the tank handhole is provided only after removing the false cover that is mechanically interlocked with the compartment cover. No nuts or bolts can be removed or loosened without first gaining access to the transformer compartment.

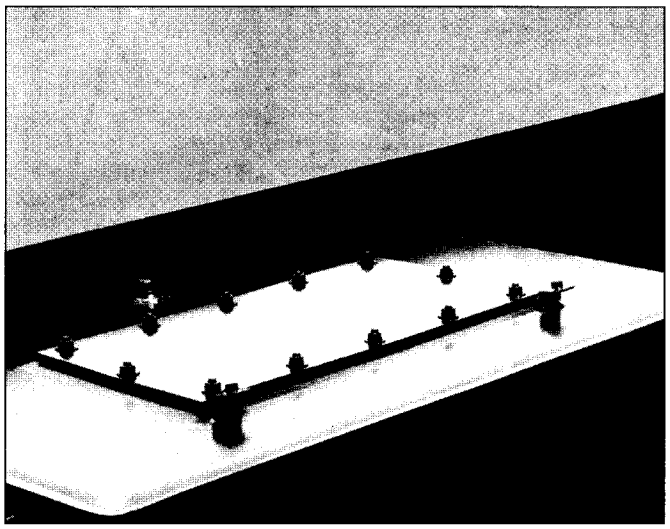
The high-voltage door is held closed by captive stainless-steel bolts, accessible only after the low-voltage door is opened. A planned operation is therefore required prior to gaining entrance to the high-voltage compartment.

The low-voltage door has three-point latching and provisions for padlocking. A captive and recessed pentahead bolt is provided for additional security of the low-voltage door.

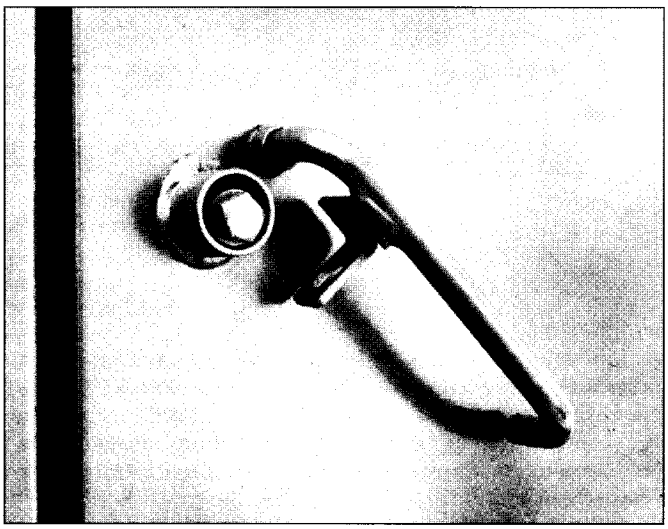
(An optional hexhead bolt is available in place of the standard pentahead bolt when specified.)



False cover over handhole can be easily removed after removing nuts inside cabinet.



Handhole featuring one-piece nitrile gasket with built-in gasket stops.

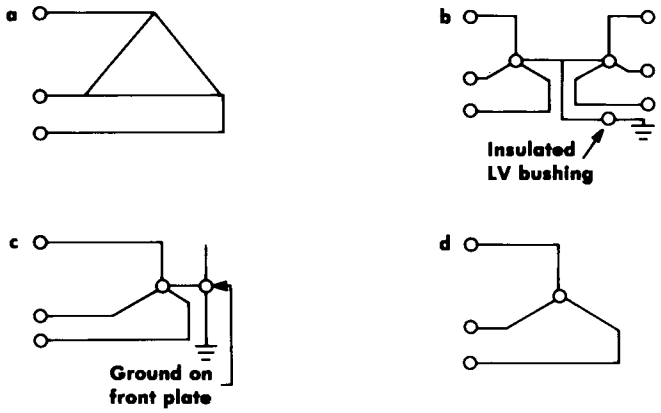


Low-voltage door handle. Padlock cannot be engaged until bolt is seated.

Standard Connections

Units may be: (a) delta-connected; (b) grounded wye-connected having primary neutral connected (bolted) internally to the secondary neutral which is an insulated low-voltage bushing externally grounded to the tank front plate; (c) grounded wye-connected having neutral grounded (bolted) internally to the tank front plate; (d) wye-connected with internally isolated neutral.

It is recommended that the grounded wye (GrdY) rating be specified with the primary neutral connected to the secondary neutral. For wye-wye applications where the secondary neutral cannot be grounded, the recommendation is to provide the transformer with the primary neutral grounded (bolted) internally to the tank front plate.



For livefront radial feed, three high-voltage porcelain bushings are furnished as standard. Line connections H1, H2, and H3 are identified by stencil markings on the tank front plate.

Porcelain high-voltage bushings equipped with tin-plate terminals are furnished on 75-5000 kVA COMPAD® transformers with livefront construction. The bushings are made of wet-process porcelain and are clamped externally to the wall of the transformer tank. Reusable nitrile rubber gaskets seal the bushings to the tank wall and the terminals to the porcelain.

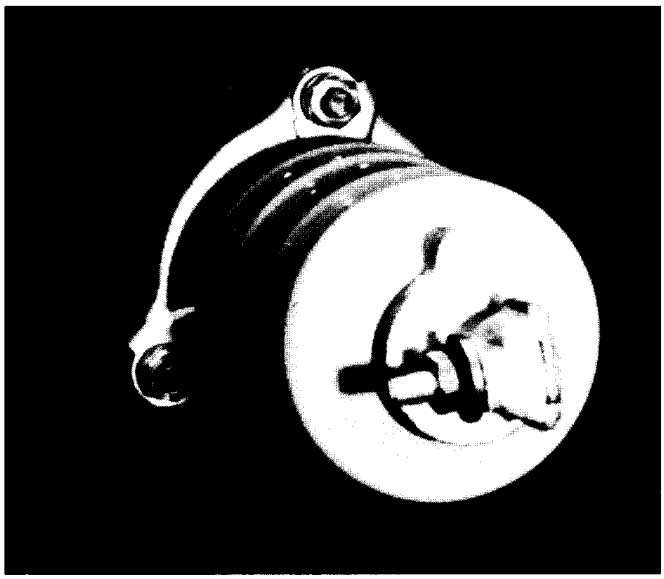
Radial-feed units, 75-500 kVA, have clamp-type terminals for No. 8 through 2/0 cable sizes as shown in photo A. Radial-feed units, 750-5000 kVA, and all loop-feed units, 75-5000 kVA, are equipped with three-hole blade terminals (9/16-inch diameter holes) as shown in photo B. Livefront construction meets the latest revision of ANSI C57.12.22 requirements for padmounted compartmental type, self-cooled, three-phase distribution transformers, 5000 kVA and below.

In both types of bushings, the high-voltage cable terminals are oriented for vertical take-off of primary cables entering the compartment from below.

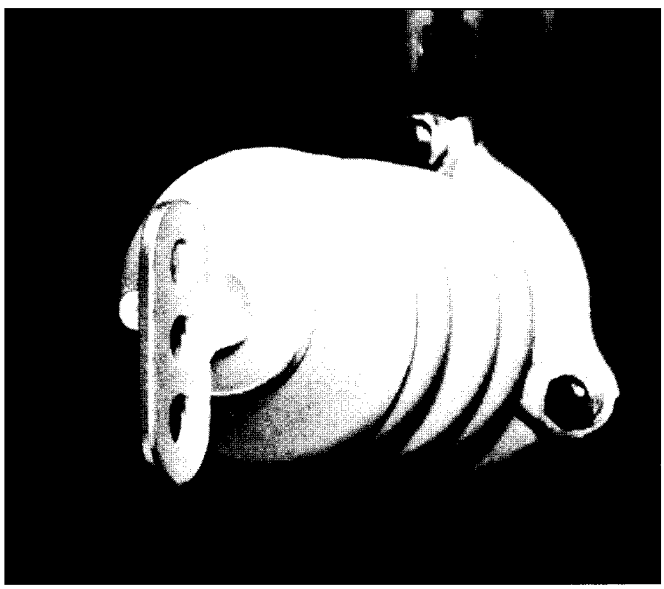
Where separable insulated high-voltage connectors for radial feed are desired on COMPAD transformers, as shown in photo C, GE offers three (3) universal bushing wells for radial feed, six (6) universal bushing wells for loop feed as standard.

The separable insulated high-voltage connector system construction (deadfront) meets the latest revision of ANSI C57.12.26 requirements for padmounted compartmental type, self-cooled, three-phase distribution transformers, 5000 kVA and below.

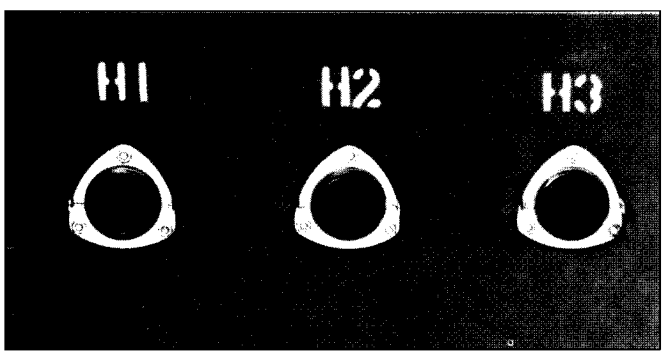
High-voltage Bushings, Live Front



A. Externally clamped high-voltage bushing, 75-500 kVA radial feed only.



B. High-voltage bushing with three-hole blade, 750-5000 kVA radial feed, and 75-5000 kVA loop feed.



C. High-voltage bushing wells, 75-5000 kVA radial feed.

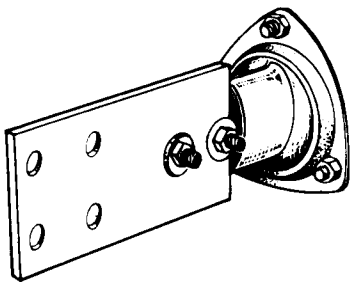
Standard Secondary Bushings Arrangements

The secondary bushing location on the extreme left of the low-voltage compartment can be either; (a) the neutral connection on wye ratings; (b) the common neutral connection (primary and secondary HO-XO) for grounded wye-grounded wye ratings; (c) the 120-Volt midtap connection in one phase of the low-voltage 240-Delta connection; or (d) the low-voltage neutral connection for delta rated high-voltage and grounded wye low-voltage ratings. The neutral bushing is an insulated porcelain bushing with an external ground strap connecting the blade to the tank wall.

The low-voltage bushing terminal is a tin-plated spade-type and is arranged for vertical-takeoff of outgoing cables. The low-voltage "H" blades, having 9/16-inch holes on $1^{3}/_{4}$-inch centers, are provided with the "H" blades as listed in the following table as standard.

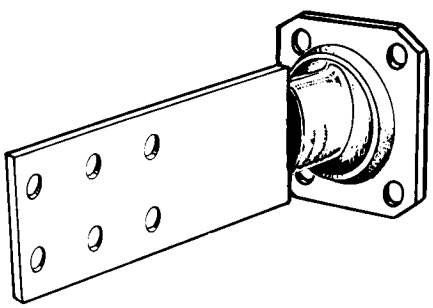
(4) Hole Blades

kVA Rating	Low-Voltage Rating (Volts)
75-300	208Y/120
75-500	240
75-500	480,480Y/277

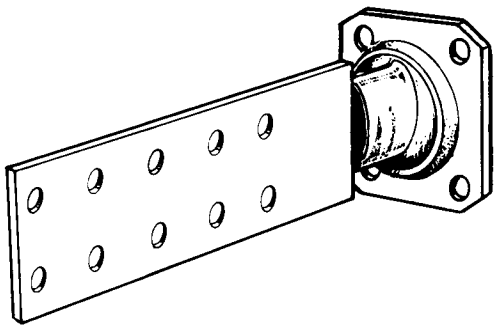


(6) Hole Blades

kVA Rating	Low-Voltage Rating (Volts)
500	208Y/120
750	240
750-1500	480, 480Y/277

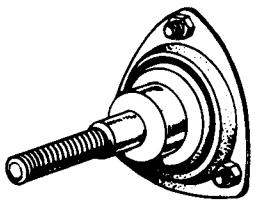


kVA Rating	Low-Voltage Rating (Volts)
750-1000	208Y/120
1000	240
2000-2500	480, 480Y/277



NOTE : 3000-5000 kVA are normally supplied with 10- to 18-hole low-voltage spades.

RUS stud type secondary bushings are available as a standard offering when so specified. Sizes and availability per the following table.



Availability Table

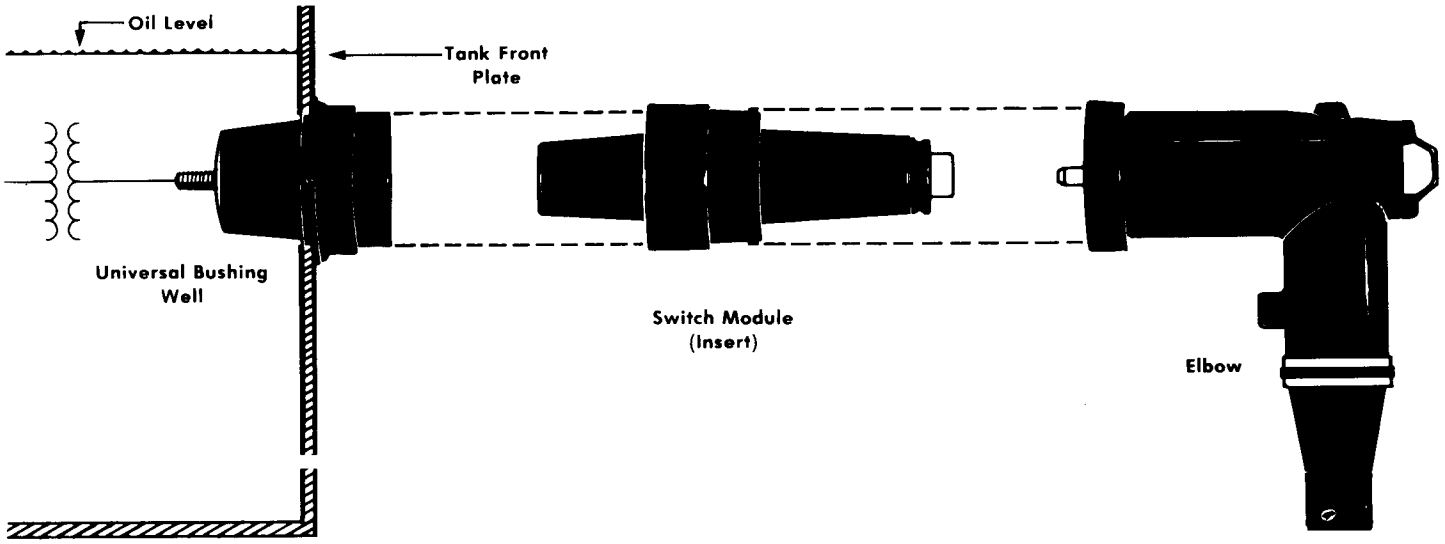
kVA	Voltage Rating	Standard Stud Size (In Inches)
75-150	480 and below	$^{5}/_{8}$-11 x 1¼
225-300	480 and 480Y/277	$^{5}/_{8}$-11 x 1¼
225-300	208Y/120	1-14 x 1¼
500	480Y/277	1-14 x 1¾
500	208Y/120	Not Available
750 and above	All Voltages	Not Available

Optional Features and Accessories

SEPARABLE INSULATED HIGH-VOLTAGE CONNECTOR CONSTRUCTION (ANSI C57.12.26)

There are two different deadfront interfaces available in the industry.

200 amp rated devices



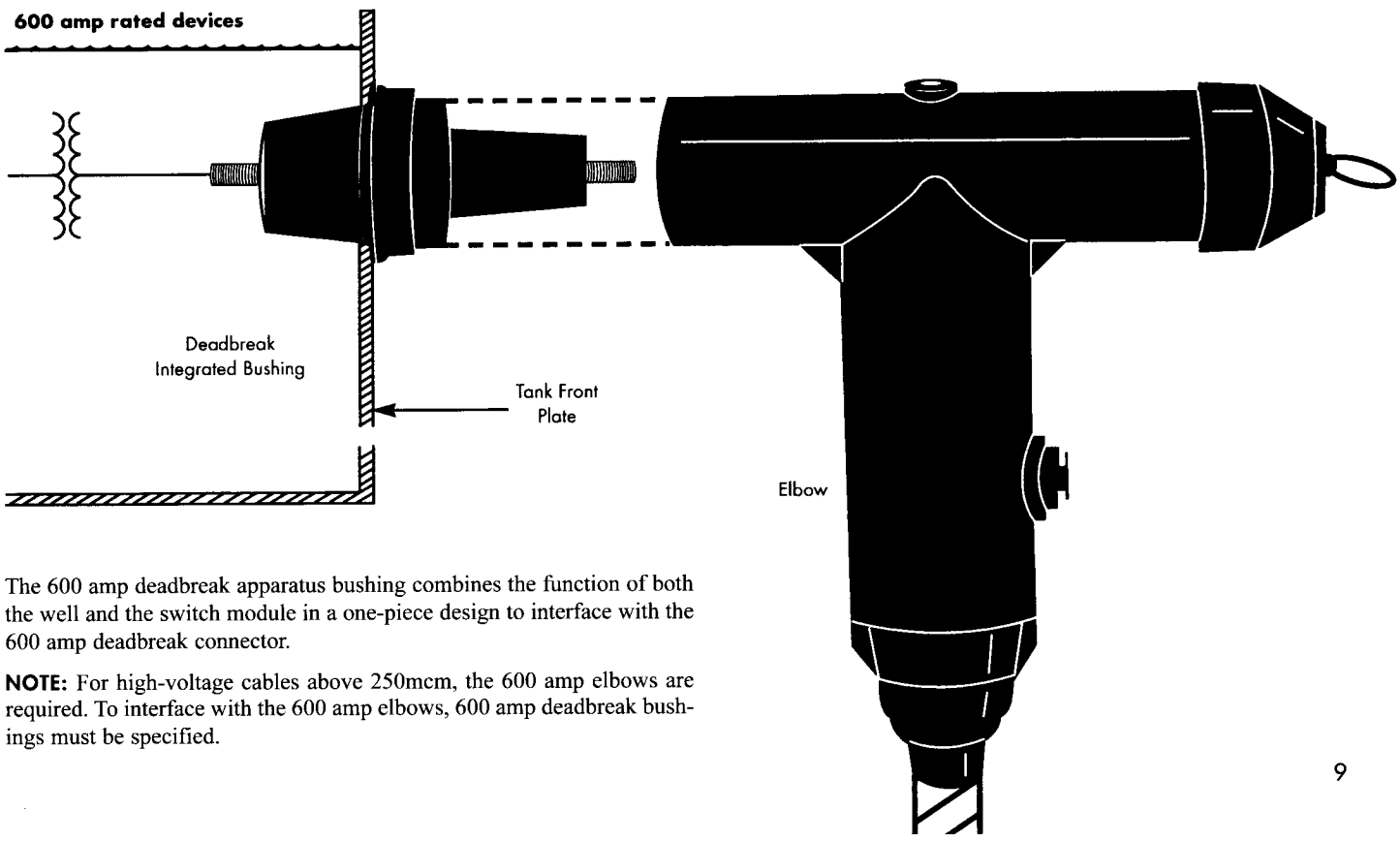
The bushing well is designed for the termination of primary winding leads in liquid-filled padmounted transformers. The bushing mating interface conforms to the ANSI/IEEE Standard 386, latest revision, for separable insulated connectors and will accept inserts complying to the standard.

The switch module is rated 200 amperes and is designed to fit into bushing wells meeting the requirements of figure 1 of ANSI/IEEE Standard 386, latest revision. The switch module is sized according to the high-voltage rating at either 15 kV class or 25 kV class.

The molded shield elbow interfaces with either the switch module or the integrated bushing to provide the basic connector system. The elbow is sized according to the high-voltage class (15 kV or 25 kV) plus the cable insulation diameter and cable conductor size.

NOTE: 200 amp elbows can accept a maximum high-voltage cable size of 250mcm. For high-voltage cables 250mcm and below, specify the 200 amp high-voltage wells to interface with the 200 amp inserts and elbows.

600 amp rated devices



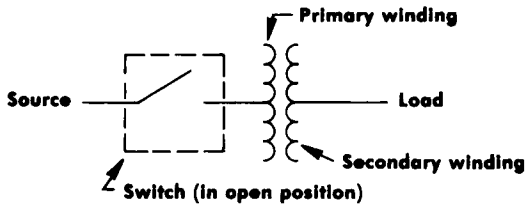
The 600 amp deadbreak apparatus bushing combines the function of both the well and the switch module in a one-piece design to interface with the 600 amp deadbreak connector.

NOTE: For high-voltage cables above 250mcm, the 600 amp elbows are required. To interface with the 600 amp elbows, 600 amp deadbreak bushings must be specified.

Optional Oil Switching

Radial Feed Switch – 300 amp

The 300 amp radial-feed, two-position internal oil switch is a two-position, gang-operated loadbreak switch, hook stick-operable, that uses a manually charged over-toggle storing spring assembly that is independent of operator speed. The spring-loaded activating mechanism ensures quick loadbreak and loadmake operation. It can be used to de-energize the transformer. The operating handle and nameplate are located in the high-voltage compartment.



Loop-feed Switch–300 amp

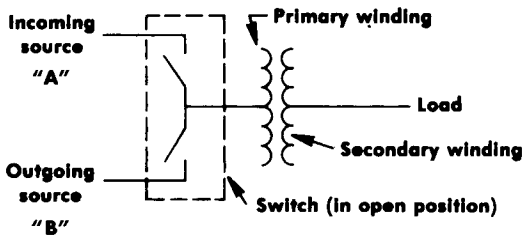
The loop-feed switch arrangement consists of two (2) two-position under-oil gang-operated switches. It may be used for sectionalizing and loop connections such as selection of power sources in a loop-feed primary distribution system; isolating faulted cables or transformers; or isolating transformers for changeout or maintenance. Six high-voltage bushings are furnished with a typical arrangement. Three bushings are identified as "A" source and three as "B" source. Switch positions are as follow:

1. Both pointers in CLOSED position. This position permits loop-feed for adjacent transformers.

2. Left-hand pointer in CLOSED position; right-hand pointer in OPEN position. In this position, only one side of the loop ("A" bushings) is connected to the transformer windings.

3. Left-hand pointer in OPEN position; right-hand pointer in CLOSED position. In this position, only one side of the loop ("B" bushings) is connected to the transformer windings.

4. Both pointers in OPEN position. In this connection, both sides of the loop ("A" and "B"bushings) are disconnected, thereby isolating and de-energizing the transformer windings from the loop-feed system.



Loop/Radial Switch – 300 amp

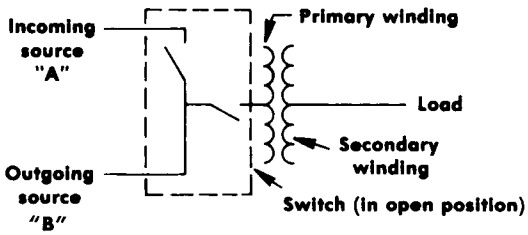
The two (2) two-position loadbreak switches may be provided for use as a combination of the loop and radial switch functions. The combination consists of a transformer switch (Line B) and a LOOP switch (Line A). The positions are as follow:

1. Both pointers in CLOSED position. This position closes the loop by connecting line "A" to line "B" and connects the transformer to the loop.

2. Left-hand pointer in CLOSED position; right-hand pointer in OPEN position. In this position, the transformer is disconnected from the loop and the loop is closed.

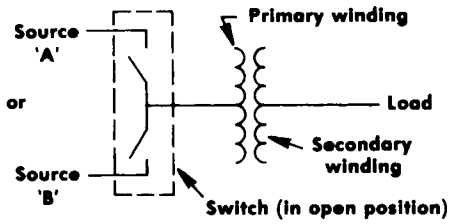
3. Left-hand pointer in OPEN position; right-hand pointer in CLOSED position. In this position, the loop is open and the transformer is connected to source "B".

4. Both pointers in OPEN position. In this connection, the transformer is de-energized and the loop is open.



Alternate-source Switch – 300 amp

The alternate feed switch is used for the selection of either of the two voltage sources to energize the transformer. An interlock on the switch handle allows the transformer to be energized only from one source at a time. (Source "A" or source "B".)



Optional Oil Switching

Loop Switch with ON/OFF Radial Switch

This combination combines the functions of the loop-switch operations, allowing the transformer to be de-energized and allowing either loop to be de-energized.

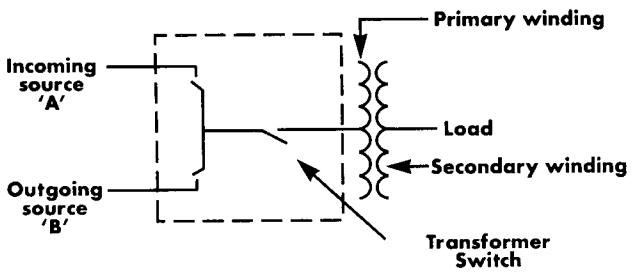


TABLE 2
Oil Switch Ratings

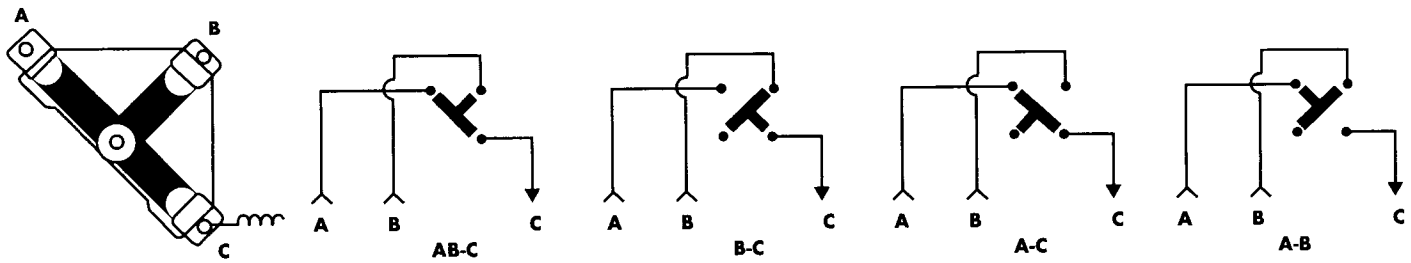
	Two-position		"T" Blade/"V" Blade	
Maximum kV	38	15	25	35
kV BIL	150	95	125	150
One-minute withstand	70	34	40	50
Maximum continuous and loadbreak amps	300	600	300	200
Momentary and fault close				
RMS-SYM-amps	12000	10000	10000	10000
RMS-ASYM-amps	19000	10000	10000	10000

'T' Blade Sectionalizing Switch

The "T" blade hot stick-operable sectionalizing switch rotates 360 degrees in either direction for alternate-source selection. A spring-loaded activating mechanism ensures quick loadbreak action and positive contact engagement through all positions. Switching can be accomplished in $^1/_2$ to $^1/_3$ cycles, which minimizes power outages.

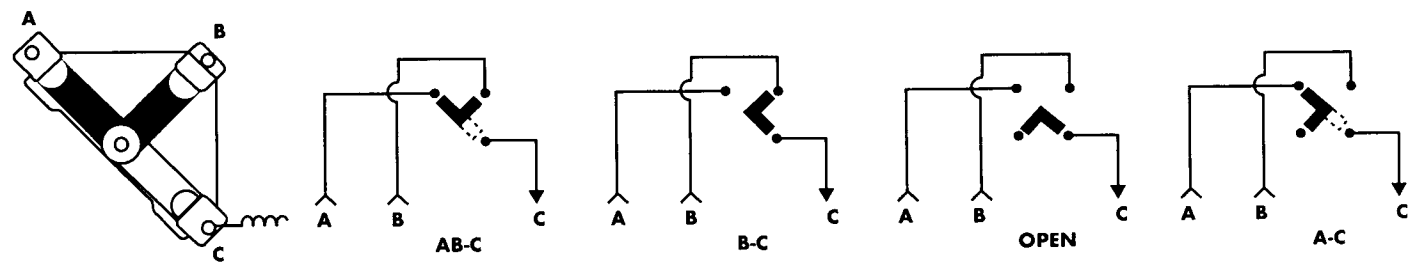
'T' Blade Functions

"T" Blade Switch allows the loop to be energized while the transformer is de-energized.



'V' Blade Function

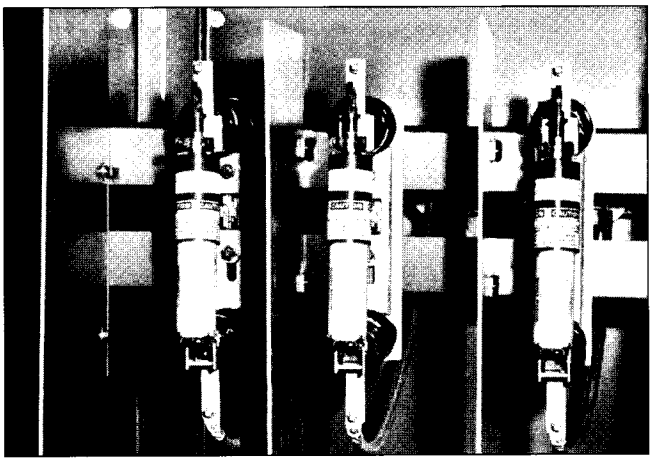
"V" Blade Switch allows the loop plus the transformer to be de-energized at the same time.



NOTE: Internal switching is not available with silicone fluid.

Optional Radial Air Switch

Fused air switches or blade disconnects can be located in the primary cabinet. The fuses are current-limiting type with an interrupting capacity of 50,000 amps, and are individually operable with a hook stick. The fuse supports are mounted on rigid support rails that extend across the compartment in front of the primary bushings. Non-hygroscopic barriers are placed phase-to-phase and phase-to-ground to increase the effective air dielectric.



Radial feed fused air switches.

NOTES: 1. Fuse selection is based on 30C outside ambient and a minimum loading of 145% for eight (8) hours following 100% load for eight (8) hours. In addition, each fuse tabulated meets minimum inrush requirements of 12xN for 0.1 second and 25xN for 0.01 second.

2. The heavy line in the tabulation is drawn to the right of the largest available fuse that meets the above requirements. If the customer is willing to accept reduced overloads, fuses to the right of the line may be used to extend the range. The reduced overload is indicated. Inrush requirements are met.

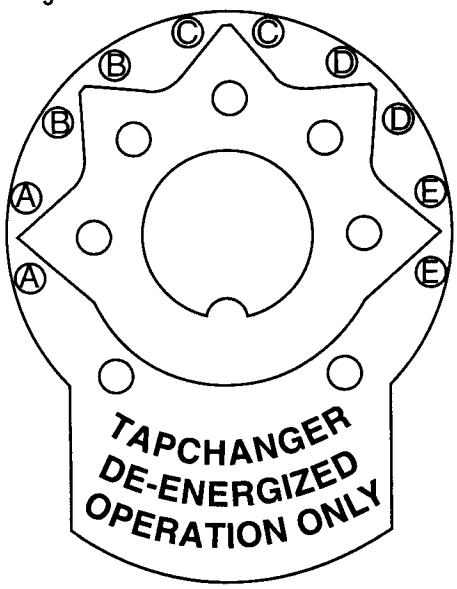
3. Parallel fuses are designated by "2x" in TABLE 3.

TABLE 3
FUSE APPLICATION AIR SWITCH

Voltage		FUSE kV	75 kVA	112.5 kVA	150 kVA	225 kVA	300 kVA	500 kVA	750 kVA	1000 kVA	1500 kVA	2000 kVA	2500 kVA
2300	2300Y	4.3	25	45	65	100	2x65	2x100 1.4	-	-	-	-	-
2400	2400Y	4.3	25	45	65	100	2x65	2x100 1.4	-	-	-	-	-
4160	4160Y	4.3	18	25	35	45	65	2x50	2x100	2x100 1.3	-	-	-
4800	4800Y	5.5	12	18	25	40	65	2x50	2x75	2x75 1.3	-	-	-
7200	7200Y	8.3	10	18	18	30	40	2x30	2x40 1.4	-	-	-	-
8320	8320Y	8.3	8	12	18	25	30	2x25	2x40	2x40 1.3	-	-	-
12000	12000Y	15.5	8	10	12	18	25	40	2x30	2x40	-	-	-
12470	12470Y	15.5	6	10	12	18	20	40	2x25	2x40	2x40 1.3	-	-
13200	13200Y	15.5	6	10	10	18	20	40	2x25	2x40	2x40 1.3	-	-
13800	13800Y	15.5	6	10	10	12	18	30	2x25	2x30	2x40 1.4	-	-
14400	14400Y	15.5	6	10	10	12	18	30	2x25	2x30	2x40 1.4	-	-
16340	16340Y	-	-	-	-	-	-	-	-	-	-	-	-
22900		-	-	-	-	-	-	-	-	-	-	-	-
4160GrdY/2400		4.3	18	25	35	45	65	2x50	2x100	2x100 1.3	-	-	-
7200GrdY/4160		4.3	10	12	18	25	35	65	2x65	2x65	2x100 1.4	-	-
8320GrdY/4800		5.5	8	12	18	25	30	50	2x40	2x50	2x75 1.4	-	-
12000GrdY/6930		8.3	8	8	12	18	25	40	2x30	2x40	-	-	-
12470GrdY/7200		8.3	6	8	12	18	20	40	2x25	2x40	2x40 1.3	-	-
13200GrdY/7620		8.3	6	8	10	18	20	40	2x25	2x40	2x40 1.3	-	-
13800GrdY/7970		8.3	6	8	10	18	18	30	2x25	2x30	2x40 1.3	-	-
14400GrdY/8320		8.3	6	8	10	18	18	30	2x25	2x30	2x40 1.4	-	-
20780GrdY/12000		15.5	3	6	8	10	12	20	30	2x25	2x30	2x40	2x40 1.3
24940GrdY/14400		15.5	3	6	6	10	12	18	25	40	2x25	2x40	2x40 1.4

Optional Accessories

Tap-changer Control



A tap-changer control for external operation is a standard feature on all COMPAD® transformers whenever taps are furnished. The control switch is located either in the high-voltage or low-voltage compartments. The five-position, 150 amp tap-changer positions are easily changed by pulling out the spring-loaded handle, turning it to the desired position, and allowing the pointer to drop into the slotted index plate. The padlockable operating handle provides greater leverage and can be operated by hook stick or by hand. The tapchanger is for de-energized operation ONLY.

NOTE: 150 amp tap-changer is standard. A 300 amp tap-changer is available for applications greater than 150 amps.

Dual-voltage or Delta-wye Switch

When dual voltage (series-multiple or delta-wye) is specified, the control handle is brought out through the front plate for external operation when the transformer is DE-ENERGIZED. This feature allows an economical means of uprating to higher system voltage, as well as eliminating the need for replacing transformers when changing system voltage.

The padlockable, hot stick-operable control handle is springloaded, providing a positive indication of voltage switching. It is normally located in the high-voltage compartment and provides external operation, eliminating the necessity of opening the transformer to change links on a terminal board.

Optional Accessories

EXPULSION FUSES (FAULT-SENSING)

Primary oil-immersed expulsion fuses are sized at approximately three times rated primary current. Their function is to remove a faulted transformer from the line in the remote case of an internal failure. Access to the fuses is through a 7.6 by 19-inch handhole located in the tank cover. See TABLE 3 for IC rating of the fuses. For application data, see TABLE 4 (below).

TABLE 3
Expulsion Fuse Interrupting Ratings

Voltage	Amperes Asymmetrical
2400	5000
4800	5000
7200	3500
14400	2000
23000	1500

TABLE 4
Minimum Continuous Rating - 3.0 X Normal
Internal High Voltage Fuse Application Chart.

Voltage		FUSE kV	75 kVA	112.5 kVA	150 kVA	225 kVA	300 kVA	500 kVA	750 kVA	1000 kVA	1500 kVA	2000 kVA	2500 kVA
2400	2400Y	8.3	$^{30}_{3.3}$	$^{31}_{3.8}$	$^{31}_{2.8}$	$^{32}_{3.4}$	$^{33}_{3.0}$	$^{34}_{3.0}$	$^{36}_{3.8}$	$^{36}_{2.8}$	-	-	-
4160	4160Y	8.3	$^{9}_{2.9}$	$^{11}_{2.9}$	$^{30}_{2.9}$	$^{31}_{3.3}$	$^{32}_{4.4}$	$^{33}_{3.7}$	$^{34}_{3.5}$	$^{35}_{3.6}$	$^{36}_{3.3}$	-	-
4800	4800Y	8.3	$^{9}_{3.3}$	$^{10}_{2.8}$	$^{30}_{3.3}$	$^{31}_{3.8}$	$^{31}_{2.8}$	$^{32}_{3.1}$	$^{33}_{2.9}$	$^{34}_{3.0}$	$^{36}_{3.8}$	$^{36}_{2.8}$	-
7200	7200Y	8.3	$^{7}_{3.1}$	$^{9}_{3.3}$	$^{10}_{3.1}$	$^{30}_{3.3}$	$^{31}_{4.2}$	$^{32}_{4.6}$	$^{32}_{3.1}$	$^{33}_{3.2}$	$^{34}_{3.0}$	$^{35}_{3.1}$	$^{36}_{3.4}$
8320	8320Y	8.3	$^{6}_{3.0}$	$^{8}_{3.1}$	$^{9}_{2.9}$	$^{11}_{2.9}$	$^{30}_{2.9}$	$^{31}_{2.9}$	$^{32}_{3.6}$	$^{33}_{3.7}$	$^{34}_{3.5}$	$^{35}_{3.6}$	$^{35}_{2.9}$
12000	12000Y	15.5	$^{5}_{3.5}$	$^{7}_{3.4}$	$^{8}_{3.2}$	$^{9}_{2.9}$	$^{11}_{3.0}$	$^{31}_{4.2}$	$^{31}_{2.8}$	$^{32}_{3.8}$	$^{33}_{3.6}$	$^{34}_{3.8}$	$^{34}_{3.0}$
12470	12470Y	15.5	$^{4}_{2.8}$	$^{6}_{2.8}$	$^{8}_{3.3}$	$^{9}_{3.0}$	$^{11}_{3.1}$	$^{31}_{4.4}$	$^{31}_{2.9}$	$^{32}_{4.0}$	$^{33}_{3.7}$	$^{33}_{2.8}$	$^{34}_{3.2}$
13200	13200Y	15.5	$^{4}_{2.9}$	$^{6}_{2.9}$	$^{7}_{2.8}$	$^{9}_{3.2}$	$^{10}_{2.9}$	$^{31}_{4.7}$	$^{31}_{3.1}$	$^{32}_{4.2}$	$^{32}_{2.8}$	$^{33}_{3.0}$	$^{34}_{3.3}$
13800	13800Y	15.5	$^{4}_{3.1}$	$^{6}_{3.1}$	$^{7}_{2.9}$	$^{9}_{3.3}$	$^{10}_{3.0}$	$^{30}_{2.9}$	$^{31}_{3.3}$	$^{32}_{4.4}$	$^{32}_{2.9}$	$^{33}_{3.1}$	$^{34}_{3.5}$
14400	14400Y	15.5	$^{4}_{3.2}$	$^{5}_{2.8}$	$^{7}_{3.0}$	$^{9}_{3.5}$	$^{10}_{3.1}$	$^{30}_{3.0}$	$^{31}_{3.4}$	$^{32}_{4.6}$	$^{32}_{3.1}$	$^{33}_{3.2}$	$^{34}_{3.6}$
16340	16340Y	15.5	$^{3}_{3.0}$	$^{5}_{3.2}$	$^{7}_{3.4}$	$^{8}_{2.9}$	$^{9}_{3.0}$	$^{30}_{3.4}$	$^{31}_{3.8}$	$^{31}_{2.9}$	$^{32}_{3.5}$	$^{33}_{3.7}$	$^{33}_{2.9}$
22900		23	$^{2}_{3.1}$	$^{4}_{3.4}$	$^{5}_{3.4}$	$^{7}_{3.2}$	$^{8}_{3.1}$	$^{10}_{3.0}$	-	-	-	-	-
4160GrdY/2400		8.3	$^{9}_{2.9}$	$^{11}_{2.9}$	$^{30}_{2.9}$	$^{31}_{3.3}$	$^{32}_{4.4}$	$^{33}_{3.7}$	$^{34}_{3.5}$	$^{35}_{3.6}$	$^{36}_{3.3}$	-	-
7200GrdY/4160		8.3	$^{7}_{3.1}$	$^{9}_{3.3}$	$^{10}_{3.1}$	$^{30}_{3.3}$	$^{31}_{4.2}$	$^{32}_{4.6}$	$^{32}_{3.1}$	$^{33}_{3.2}$	$^{34}_{3.0}$	$^{35}_{3.1}$	$^{36}_{3.4}$
8320GrdY/4800		8.3	$^{6}_{3.0}$	$^{8}_{3.1}$	$^{9}_{2.9}$	$^{11}_{2.9}$	$^{30}_{2.9}$	$^{31}_{2.9}$	$^{32}_{3.6}$	$^{33}_{3.7}$	$^{34}_{3.5}$	$^{35}_{3.6}$	$^{35}_{2.9}$
12000GrdY/6930		8.3	$^{4}_{2.8}$	$^{6}_{2.9}$	$^{8}_{3.3}$	$^{10}_{3.5}$	$^{11}_{3.1}$	$^{31}_{4.2}$	$^{31}_{2.8}$	$^{32}_{3.8}$	$^{33}_{3.6}$	$^{34}_{3.8}$	$^{34}_{3.0}$
12470GrdY/7200		8.3	$^{4}_{2.9}$	$^{6}_{3.0}$	$^{8}_{2.4}$	$^{9}_{2.9}$	$^{11}_{3.2}$	$^{31}_{4.4}$	$^{31}_{2.9}$	$^{32}_{4.0}$	$^{33}_{3.7}$	$^{33}_{2.8}$	$^{34}_{3.2}$
13200GrdY/7620		8.3	$^{4}_{3.1}$	$^{6}_{3.2}$	$^{7}_{2.9}$	$^{9}_{3.0}$	$^{10}_{2.9}$	$^{31}_{4.7}$	$^{31}_{3.1}$	$^{32}_{4.2}$	$^{32}_{2.8}$	$^{33}_{3.0}$	$^{34}_{3.3}$
13800GrdY/7970		8.3	$^{4}_{3.2}$	$^{5}_{2.8}$	$^{7}_{3.0}$	$^{9}_{3.2}$	$^{10}_{3.0}$	$^{30}_{2.9}$	$^{31}_{3.3}$	$^{32}_{4.4}$	$^{32}_{2.9}$	$^{33}_{3.1}$	$^{34}_{3.5}$
14400GrdY/8320		8.3	$^{4}_{3.3}$	$^{5}_{2.9}$	$^{7}_{3.1}$	$^{9}_{3.3}$	$^{10}_{3.1}$	$^{30}_{3.0}$	$^{31}_{3.4}$	$^{32}_{4.6}$	$^{32}_{3.1}$	$^{33}_{3.2}$	$^{34}_{3.6}$
20780GrdY/12000		15.5	$^{2}_{2.8}$	$^{4}_{3.1}$	$^{5}_{3.1}$	$^{7}_{2.9}$	$^{8}_{2.8}$	$^{11}_{3.1}$	$^{30}_{2.9}$	$^{31}_{3.7}$	$^{32}_{4.4}$	$^{32}_{3.3}$	$^{33}_{3.7}$
24940GrdY/14400		15.5	$^{2}_{3.3}$	$^{3}_{3.0}$	$^{4}_{2.8}$	$^{6}_{2.8}$	$^{8}_{3.4}$	$^{10}_{3.2}$	$^{30}_{3.2}$	$^{31}_{4.0}$	$^{31}_{2.9}$	$^{32}_{4.0}$	$^{32}_{3.2}$
34500GrdY/19920		23	$^{1}_{3.3}$	$^{2}_{3.1}$	$^{3}_{3.1}$	$^{5}_{3.4}$	$^{6}_{2.9}$	$^{8}_{2.8}$	$^{10}_{3.0}$	-	-	-	-

NOTES: 1. Upper number is fuse curve.
2. Lower number is times normal current fuse will carry for 300 seconds in 150° oil.

Optional Accessories

BAYONET FUSING

The GE BAYONET fusing devise is an externally removable fuse-holder available with either a fault-sensing or an overload-sensing expulsion fuse. The fuseholder is hot stick-operable and is capable of breaking transformer load current.

Fuses are removable without lifting hood.

Drip shields to contain oil are standard with bayonet fuses.

Bayonet Overload Sensing Fuse Chart, Phase-to-phase Voltage (kV)

kVA	2.40	4.16	4.80	8.32	12.0	12.47	13.2	13.8 14.4	20.8	22.9**	24.9**
758	A	A	A	A	A	A	A	A	A	A	A
112.5	A	A	A	A	A	A	A	A	A	A	A
150	A	A	A	A	A	A	A	A	A	A	A
225	A	A	A	A	A	A	A	A	A	A	A
300	A	A	A	A	A	A	A	A	A	A	A
500	N/A	A	A	A	A	A	A	A	A	A	A
750	N/A	A	A*	A	A	A	A	A	A	A	A
1000	N/A	N/A	N/A	A	A*	A*	A*	A*	A*	A	A
1500	N/A	N/A	N/A	N/A	N/A	A	A	A	A	A	A

NOTES: 1. Applications based on 200% of transformer loading for two hours and 160% loading for seven hours based on thermal characteristics of transformer.

2. Application meets inrush requirements of 12 times transformer rated current for 0.1 second.

A = Fusing Available
N/A = Fusing Not Available

*Use will result in some loss of overload capacity.

**Must be GrdY/GrdY system with less than 50% delta loading or delta voltages 17000.

Bayonet Fault-sensing Fuse Chart

kVA	2.4	4.16	4.8	8.32	12.0	12.47	13.2	13.8 14.4	20.8†	22.9†	24.9†
75	A	A	A	A	A	A	A	A	A	A	A
112.5	A	A	A	A	A	A	A	A	A	A	A
150	A	A	A	A	A	A	A	A	A	A	A
225	A	A	A	A	A	A	A	A	A	A	A
300	A	A	A	A	A	A	A	A	A	A	A
500	A	A	A	A	A	A	A	A	A	A	A
750	N/A	A	A	A	A	A	A	A	A	A	A
1000	N/A	N/A	A	A	A	A	A	A	A	A	A
1500	N/A	N/A	N/A	A	A	A	A	A	A	A	A
2000	N/A	N/A	N/A	N/A	A	A	A	A	A	A	A
2500	N/A	N/A	N/A	N/A	A	A	A	A	A	A	A

† Not to be used at voltages greater than 17000 for delta configuration or 24940GrdY/14400. (Must be GrdY/GrdY system with less than 50% delta loading.)

A = Fusing Available
N/A = Fusing Not Available

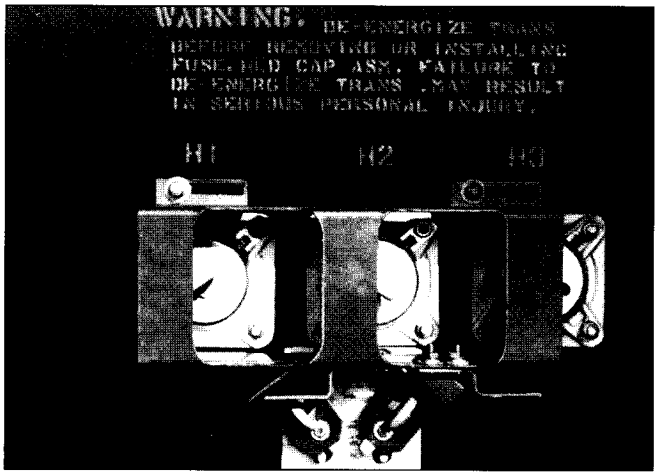
Optional Accessories

NON-LOADBREAK DRY-WELL CURRENT-LIMITING FUSEHOLDER

This feature combines the proven interrupting capability of general-purpose, current-limiting fuses in air-insulated, oil-sealed, dry-well fuseholders. These fuseholders are available on both live-front and on units equipped with separable insulated high-voltage connectors, and are easily operable with a hotstick. The non-loadbreak fuseholder assembly has an integral warning notice and safety baffle to warn against removal of the fuse while transformer is energized. The non-loadbreak fuseholders can also be mechanically interlocked with a loadbreak switch (as shown).

Once transformer is DE-ENERGIZED by operation of loadbreak switch, safety baffle can be moved permitting easy access to fuses.

Non-loadbreak fuseholders are available at maximum voltage ratings of 8.3, 15.2 and 21.1 kV, and with impulse withstands of 95-, 125-, and 150-kV BIL respectively.



Non-loadbreak dry-well fuseholders with baffle and switch interlock in closed position.

Non-loadbreak Dry-well Fuse Application Chart

System Voltage	Fuse kV	Amps per kVA											
		75	112	150	225	300	500	750	1000	1500	2000	2500	3000
2400, 2400Y	4.3	35	45	65	100	2x65	2x100	-	-	-	-	-	-
4160, 4160Y	4.3	18	25	35	45	65	2x65	2x75	-	-	-	-	-
4800, 4800Y	5.5	18	20	30	40	65	2x65	2x65	-	-	-	-	-
7200, 7200Y	8.3	6	12	18	25	30	50	2x40	-	-	-	-	-
8320, 8320Y	8.3	6	12	18	20	30	50	2x40	2x50	-	-	-	-
12000, 12000Y	15.5	6	6	8	18	20	30	50	2x30	2x50	-	-	-
12470, 12470Y	15.5	6	6	8	18	20	30	50	2x30	2x50	-	-	-
13200, 13200Y	15.5	6	6	8	12	20	30	50	2x30	2x50	-	-	-
13800, 13800Y	15.5	6	6	8	12	20	30	50	2x30	2x50	-	-	-
14400, 14400Y	15.5	6	6	8	12	20	30	50	2x30	2x50	-	-	-
16340, 16340Y	23	3	6	6	12	12	25	40	2x25	2x40	-	-	-
22900	23	3	6	6	6	12	18	25	40	2x25	2x40	-	-
4160GY/2400	4.3	18	25	35	45	65	2x65	2x75	-	-	-	-	-
7200GY/4160	4.3	10	18	18	35	35	65	100	2x65	2x100	-	-	-
8320GY/4800	5.5	8	12	18	25	30	50	75	2x65	2x75	-	-	-
12000GY/6930	8.3	6	6	8	18	20	30	50	2x30	2x50	-	-	-
12470GY/7200	8.3	6	6	8	18	20	30	50	2x30	2x50	-	-	-
13200GY/7620	8.3	6	6	8	12	20	30	50	2x30	2x50	-	-	-
13800GY/7970	8.3	6	6	8	12	20	30	50	2x30	2x50	-	-	-
14400GY/8320	8.3	6	6	8	12	20	30	50	2x30	2x50	-	-	-
20780GY/12000	15.5	3	6	6	6	12	20	25	40	2x25	2x40	2x50	-
24940GY/14400	15.5	3	6	6	6	12	18	25	40	2x25	2x40	2x50	2x50
34500GY/19920	23	3	3	3	6	6	12	18	20	40	2x25	2x30	2x40

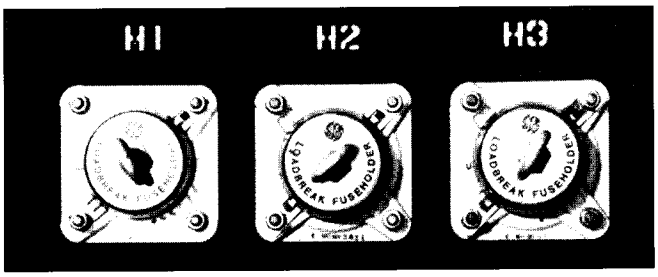
NOTES: 1. Fuse selection based on 30C outside embient and a loading of 150% for eight hours following 100% load.
2. Each fuse meets inrush requirements of 12xN for 0.1 second.
3. Oil switch with parallel fuseholders refer to the factory.
4. Parallel fuses are designated by "2x" in above table.

Optional Accessories

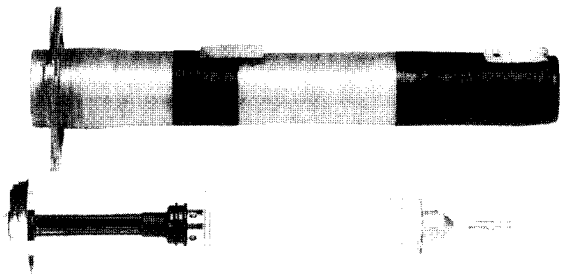
LOADBREAK DRY-WELL FUSEHOLDER

This fuseholder is similar to the non-loadbreak model with the addition of an integral loadbreak switching device. The switching device utilizes the rod-and-bore principle to accomplish loadbreak within the fuseholder.

Available ratings are 8.3 kV (maximum) at 95-kV BIL and 15.2 kV (maximum) at 125-kV BIL.



Loadbreak dry-well fuseholders.



Draw out assemblies for loadbreak dry-well fuseholders.

Loadbreak Dry-well Fuse Application Chart

System Voltage	Fuse kV	Amps per kVA 75	112	150	225	300	500	750	1000	1500	2000	2500	3000
2400, 2400Y	4.3	35	45	65	100	2x65	2x100	-	-	-	-	-	-
4160, 4160Y	4.3	18	25	35	45	65	2x65	2x75	-	-	-	-	-
4800, 4800Y	5.5	18	20	30	40	65	2x65	2x65	-	-	-	-	-
7200, 7200Y	8.3	6	12	18	25	30	50	2x40	-	-	-	-	-
8320, 8320Y	8.3	6	12	18	20	30	50	2x40	2x50	-	-	-	-
12000, 12000Y	15.5	6	6	8	18	20	30	50	2x30	2x50	-	-	-
12470, 12470Y	15.5	6	6	8	18	20	30	50	2x30	2x50	-	-	-
13200, 13200Y	15.5	6	6	8	12	20	30	50	2x30	2x50	-	-	-
13800, 13800Y	15.5	6	6	8	12	20	30	50	2x30	2x50	-	-	-
14400, 14400Y	15.5	6	6	8	12	20	30	50	2x30	2x50	-	-	-
16340, 16340Y	23	3	6	6	12	12	25	40	2x25	2x40	-	-	-
22900	23	3	6	6	6	12	18	25	40	2x25	2x40	-	-
4160GY/2400	4.3	18	25	35	45	65	2x65	2x75	-	-	-	-	-
7200GY/4160	4.3	10	18	18	35	35	65	100	2x65	2x100	-	-	-
8320GY/4800	5.5	8	12	18	25	30	50	75	2x65	2x75	-	-	-
12000GY/6930	8.3	6	6	8	18	20	30	50	2x30	2x50	-	-	-
12470GY/7200	8.3	6	6	8	18	20	30	50	2x30	2x50	-	-	-
13200GY/7620	8.3	6	6	8	12	20	30	50	2x30	2x50	-	-	-
13800GY/7970	8.3	6	6	8	12	20	30	50	2x30	2x50	-	-	-
14400GY/8320	8.3	6	6	8	12	20	30	50	2x30	2x50	-	-	-
20780GY/12000	15.5	3	6	6	6	12	20	25	40	2x25	2x40	2x50	-
24940GY/14400	15.5	3	6	6	6	12	18	25	40	2x25	2x40	2x50	2x50
34500GY/19920	23	3	3	3	6	6	12	18	20	40	2x25	2x30	2x40

NOTES: 1. Fuse selection based on 30C outside ambient and loading of 150% for eight hours following 100% load.
2. Each fuse meets inrush requirements of 12xN for 0.1 second.
3. Oil switch with parallel fuseholders refer to the factory.
4. Parallel fuses are designated by "2x" in above table.
5. When double barrel fuses are provided, the top set are loadbreak, the bottom set are non-loadbreak.

Optional Accessories

OIL SUBMERSIBLE PROTECTOR

The Oil Submersible Protector (OSP) is a partial range current-limiting fuse that is used in series with an expulsion fuse to provide full range protection. The OSP is designed to clear high-current faults (up to 50,000 amperes symmetrical) and the expulsion link to clear low-current faults. These fuses are located under oil beneath the transformer handhole. Either internal expulsion fuses or "bayonets" are available as the series expulsion fuse.

The bayonet or the internal expulsion fuse is available for replacement. The OSP fuse is not available for replacement without removing the main tank cover.

OSP/Baynot Fuse Application Chart
GE T-Series OSP Current-limiting Fuses in Series with Load-sensing Bayonet Expulsion Fuses

Voltage	Fuse kV	75 kVA	112.5 kVA	150 kVA	225 kVA	300 kVA	500 kVA	750 kVA	1000 kVA	1500 kVA	2000 kVA	2500 kVA
2400 2400Y	8.3	SB	DB	A/DB	A/DB	A/DB	A/DB	-	-	-	-	-
4160 4160Y	8.3	SB	SB	SB	DB	A/DB	A/DB	A/DB	-	-	-	-
4800 4800Y	8.3	SB	SB	SB	DB	A/DB	A/DB	A/DB	A/DB	-	-	-
7200 7200Y	8.3	SB	SB	SB	SB	SB	A/SB	A/SB	A/DB	A/DB	-	-
8320 8320Y	8.3	SB	SB	SB	SB	SB	A/DB	A/DB	A/DB	A/DB	-	-
12000 12000Y	15.5	SB	SB	SB	SB	SB	SB	A/DB	A/DB	A/DB	A/DB	A/DB
12470 12470Y	15.5	SB	SB	SB	SB	SB	SB	A/DB	A/DB	A/DB	A/DB	A/DB
13200 13200Y	15.5	SB	SB	SB	SB	SB	SB	DB	A/DB	A/DB	A/DB	A/DB
13800 13800Y	15.5	SB	SB	SB	SB	SB	SB	DB	A/DB	A/DB	A/DB	A/DB
14400 14400Y	15.5	SB	SB	SB	SB	SB	SB	DB	A/DB	A/DB	A/DB	A/DB
16340 16340Y	15.5	SB	SB	SB	SB	SB	SB	SB	SB	A/DB	A/DB	A/DB
22900	23	SB	SB	SB	SB	SB	SB	-	-	A/DB	A/DB	A/DB
4160GrdY/2400	8.3	SB	SB	SB	DB	-	-	-	-	-	-	-
7200GrdY/4160	8.3	SB	SB	SB	SB	SB	-	-	-	-	-	-
8320GrdY/4800	8.3	SB	SB	SB	SB	SB	DB	-	-	-	-	-
12000GrdY/6930	8.3	SB	SB	SB	SB	SB	SB	DB	DB	SB	-	-
12470GrdY/7200	8.3	SB	SB	SB	SB	SB	SB	DB	DB	SB	-	-
13200GrdY/7620	8.3	SB	SB	SB	SB	SB	SB	DB	DB	SB	SB	-
13800GrdY/7970	8.3	SB	SB	SB	SB	SB	SB	DB	DB	SB	SB	-
14400GrdY/8320	8.3	SB	SB	SB	SB	SB	SB	DB	DB	SB	SB	-
20780GrdY/12000	15.5	SB	SB	SB	SB	SB	SB	SB	SB	A/DB	A/DB	A/DB
22860GrdY/13200	15.5	SB	SB	SB	SB	SB	SB	SB	SB	A/DB	A/DB	A/DB
24940GrdY/14400	15.5	SB	SB	SB	SB	SB	SB	SB	SB	A/DB	A/DB	A/DB
34500GrdY/19920	23	SB	SB	SB	SB	SB	SB	SB	A/SB	A/DB	A/DB	-

SB = Single Barrel Fusing
DB = Double Barrel Fusing
A = Silver Link Fusing
Where customer does not specify, GE will provide standard Bayonet offering where available.

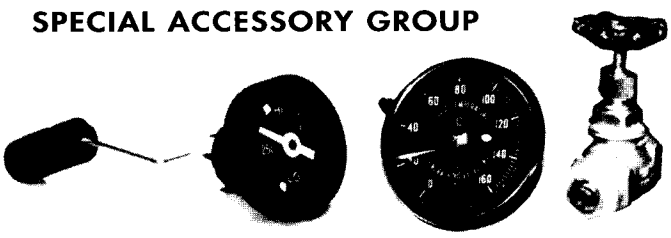
Optional Accessories

OSP/Expulsion Fuse Application Chart
GE T-Series OSP Current Limiting Fuses In Series With Internal Current-sensing Expulsion Fuses

Voltage		FUSE kV	75 kVA	112.5 kVA	150 kVA	225 kVA	300 kVA	500 kVA	750 kVA	1000 kVA	1500 kVA	2000 kVA	2500 kVA
2400	2400Y	8.3	$^{10}_{100}$	$^{30}_{100}$	$^{31}_{150}$	$^{32}_{200}$	$^{32}_{200}$	$^{34}_{2x150}$	$^{34}_{2x150}$	-	-	-	-
4160	4160Y	8.3	$^{7}_{65}$	$^{9}_{80}$	$^{10}_{80}$	$^{31}_{100}$	$^{31}_{150}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$	$^{34}_{2x150}$	-	-
4800	4800Y	8.3	$^{7}_{65}$	$^{8}_{65}$	$^{10}_{80}$	$^{31}_{100}$	$^{31}_{125}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$	$^{34}_{2x150}$	-	-
7200	7200Y	8.3	$^{5}_{40}$	$^{7}_{65}$	$^{8}_{65}$	$^{10}_{80}$	$^{11}_{80}$	$^{31}_{100}$	$^{32}_{200}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{34}_{2x150}$	$^{34}_{2x150}$
8320	8320Y	8.3	$^{4}_{40}$	$^{6}_{50}$	$^{7}_{65}$	$^{9}_{65}$	$^{10}_{80}$	$^{31}_{100}$	$^{32}_{200}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$	$^{34}_{2x150}$
12000	12000Y	15.5	$^{3}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{7}_{50}$	$^{9}_{65}$	$^{11}_{80}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{150}$	$^{33}_{2x125}$	$^{33}_{2x125}$
12470	12470Y	15.5	$^{3}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{11}_{80}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{150}$	$^{33}_{2x125}$	$^{33}_{2x125}$
13200	13200Y	15.5	$^{3}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{10}_{65}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{150}$	$^{33}_{2x125}$	$^{33}_{2x125}$
13800	13800Y	15.5	$^{3}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{10}_{65}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{150}$	$^{33}_{2x125}$	$^{33}_{2x125}$
14400	14400Y	15.5	$^{3}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{10}_{65}$	$^{31}_{100}$	$^{31}_{100}$	$^{31}_{125}$	$^{32}_{150}$	$^{33}_{2x125}$
16340	16340Y	15.5	$^{2}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{7}_{50}$	$^{9}_{65}$	$^{31}_{100}$	$^{31}_{100}$	$^{31}_{125}$	$^{32}_{150}$	$^{33}_{2x125}$
22900		23	$^{2}_{40}$	$^{3}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{8}_{50}$	$^{9}_{65}$	$^{10}_{65}$	-	-	-
4160GrdY/2400		8.3	$^{7}_{65}$	$^{9}_{80}$	$^{10}_{80}$	$^{31}_{100}$	$^{31}_{150}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$	$^{34}_{2x150}$	-	-
7200GrdY/4160		8.3	$^{5}_{40}$	$^{7}_{65}$	$^{8}_{65}$	$^{10}_{80}$	$^{11}_{80}$	$^{31}_{100}$	$^{32}_{200}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{34}_{2x150}$	-
8320GrdY/4800		8.3	$^{4}_{40}$	$^{6}_{50}$	$^{7}_{65}$	$^{9}_{65}$	$^{10}_{80}$	$^{31}_{100}$	$^{32}_{200}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$	$^{34}_{2x150}$
12000GrdY/6930		8.3	$^{3}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{7}_{50}$	$^{9}_{65}$	$^{11}_{80}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$
12470GrdY/7200		8.3	$^{3}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{11}_{80}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$
13200GrdY/7620		8.3	$^{3}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{10}_{80}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{200}$	$^{33}_{2x125}$	$^{33}_{2x125}$
13800GrdY/7970		8.3	$^{3}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{10}_{80}$	$^{31}_{100}$	$^{31}_{100}$	$^{32}_{200}$	$^{32}_{200}$	$^{33}_{2x125}$
14400GrdY/8320		8.3	$^{3}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{7}_{50}$	$^{8}_{65}$	$^{10}_{80}$	$^{31}_{100}$	$^{31}_{100}$	$^{31}_{125}$	$^{32}_{200}$	$^{33}_{2x125}$
20780GrdY/12000		15.5	$^{2}_{40}$	$^{3}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{8}_{65}$	$^{10}_{65}$	$^{30}_{80}$	$^{31}_{100}$	$^{31}_{125}$	$^{32}_{150}$
22860GrdY/13200		15.5	$^{2}_{40}$	$^{3}_{40}$	$^{4}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{8}_{65}$	$^{9}_{65}$	$^{11}_{80}$	$^{31}_{100}$	$^{31}_{125}$	$^{31}_{125}$
24940GrdY/14400		15.5	$^{2}_{40}$	$^{2}_{40}$	$^{3}_{40}$	$^{5}_{40}$	$^{5}_{40}$	$^{8}_{65}$	$^{9}_{65}$	$^{11}_{80}$	$^{31}_{100}$	$^{31}_{125}$	$^{31}_{125}$
34500GrdY/19920		23	$^{1}_{40}$	$^{2}_{40}$	$^{2}_{40}$	$^{3}_{40}$	$^{5}_{40}$	$^{6}_{40}$	$^{8}_{40}$	$^{9}_{65}$	$^{10}_{65}$	-	-

NOTES: •The upper number in the box is either the load-sensing bayonet fuse or the expulsion fuse model number.
•The lower number in the box is the back-up oil-immersed, current-limiting fuse (OSP) number.
•The OSP fusing is not available on dual-voltage units.

SPECIAL ACCESSORY GROUP



This accessory group includes the dial-type thermometer, liquid-level gage, one-inch drain valve, one-half inch sampling device and provision for vacuum-pressure gage. These are available as a complete group or as individual items. A description of each is covered under items 1-5.

1. Dial-type Thermometer

This thermometer is direct stem-mounted in a close well, located on the frontplate of the transformer to indicate the top-liquid temperature. The well is threaded into a 1/2-inch NPT fitting that is welded to the transformer tank wall so that the thermometer can be removed without breaking the tank seal. The thermometer has a slave-hand which is moved by the indicating hand to indicate maximum temperature. The thermometer dial reads 0° through 160° C.

Optional Accessories

2. Liquid-level Gage

This gage has a vertical face and is gasket mounted to the front plate of the transformer, inside the low-voltage compartment. The liquid-level gage dial reads LO-25C-HI.

3. Drain Valve

This is a one-inch globe-type valve furnished with a half-inch NPT standard pipe plug in the outer end. It is furnished as a standard on all units.

4. Sampling Device

This device is threaded into the one-half inch NPT opening normally occupied by the drain plug. In addition to serving as a plug, it provides for quick and easy sampling of the transformer oil. This sampler, when furnished, is located in the end of the drain valve. It is furnished as a standard on all kVA sizes.

5. Provision for Vacuum-pressure Gage

This consists of a flange with one-quarter inch NPT opening welded to the tank wall in the air space above the oil and is supplied with a one-quarter inch pipe plug.

6. ANSI Tank Ground Pads

Two-hole tank ground pads supplied on units rated 750-2500 kVA are optional on units 500 kVA and below. They are stainless steel with an unpainted surface. One pad is located in the high- and low-voltage compartments, and each pad has two $^1/_2$- 13-inch tapped holes on $1^3/_4$-inch centers.

7. Pressure Vacuum Gage

This gage is located in the low-voltage compartment above the bushings in the air space. This gage measures the internal pressure with dial readings from -10 PSIG to +10 PSIG.

8. Automatic Pressure Relief Device

The pressure relief device is located on the low-voltage tank wall above the bushings in the air space. This device relieves excessive internal tank pressure. The device opens at 10 PSIG ± 2 PSIG and reseals at a positive pressure.

9. Internal Lightning Arrestors

GE metal oxide distribution-type arrestors are housed and directly connected inside the transformer tank. These arrestors meet the requirements of ANSI C62.11, latest revision, and NEMA LA1, latest revision.

This arrestor concept enhances reliability through the elimination of external environment-related failure factors. Padmounted transformers and underground cable are adequately protected economically, while maintaining the integrity of ANSI C57.12.26 for separable insulated high-voltage connector construction.

The kV ratings normally supplied are listed in the following table.

Lightning Arrestors

Lightning arrestors with HV ratings are normally supplied when transformer is ordered "with arrestors." Other ratings of lightning arrestors will be supplied upon request.

High Voltage (Line-to-Line)	Transformer Primary Connection			
	Delta (Arrestor kV)		Grd-Wye (Arrestor kV)	
	External	Internal	External	Internal
2400	3	3	3	3
4160	6	6	3	3
4800	6	6	6	6
12000	12	12	9	10
12470	15	15	9	10
13200§	15	15	10	10
13800	15	15	10	12
14400	15	15	12	15
22900GrdY	-	-	18	18
24940GrdY	-	-	21	18
34500GrdY	-	-	27	27

§ Most systems with this voltage are connected wye with a solid grounded neutral, and arrestor indicated will provide maximum protection in such cases.

10. External Lightning Arrestors

Distribution-type direct connected lightning arrestors are supplied through 35 kV grounded wye on live-front designs only and when three-phase COMPAD® is ordered with arrestors. Unless otherwise specified, the kV rating of the arrestor normally supplied is listed in the above table.

11. Elbow Valve Arrestor

An elbow valve arrestor (available from others) provides surge protection for underground distribution circuits where transformers with separable insulated high-voltage connectors are utilized. Three would be used on radially fed six-bushing pad-mounted transformers utilizing the other three separable insulated high-voltage connectors for the incoming line.

12. Current Transformer Provisions

GE type JAB-0 and JKY-0 current transformers are designed to fit the low-voltage bushings, therefore provisions for these are standard.

Provisions for other types of current transformers or potential transformers consist of a plate mounted below the low-voltage bushings.

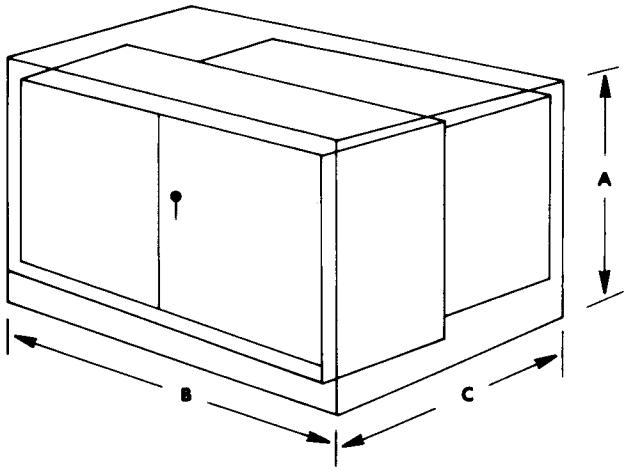
When provisions for both current and potential transformers are required, we offer a plate below the secondary bushings for the current transformers and a plate above the secondary bushings for the potential transformers.

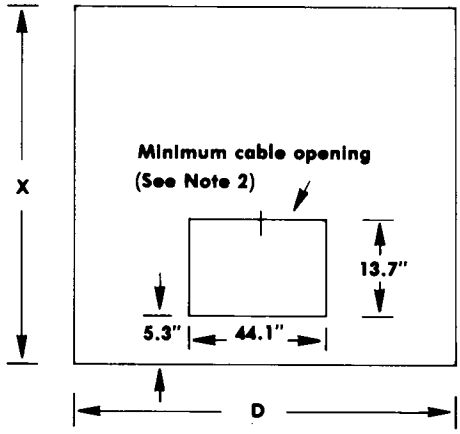
13. Molded-Case Circuit Breakers

A single-mounted, secondary molded-case circuit breaker with a maximum rating of 3000 amperes is available on all COMPAD transformers. The breaker is channel-mounted in the low-voltage compartment.

Panelboards containing molded-case circuit breakers are also available where application requirements do not exceed 1200 amperes and a "27X" maximum height. For space restrictions or further information consult GE's Electrical Distribution and Control Sales Division.

Mechanical and Electrical Data





NOTES: 1. In some cases (particularly larger kVAs), the radiation will extend beyond the pad. If this is not acceptable, substitute the "B" and "C" dimensions for the "D" and "X" dimensions, respectively, to determine an optimum pad size.

2. High- and low-voltage compartments are **not** symmetrical. Since cable opening shown is minimum, adequate space may not be available on some configurations.

Maximum Dimensions +						
Dimensions in Inches						
kVA	A	B	C	D	X	Max. Weight
75	87	83	54	86	52	4400
112.5	87	83	56	86	52	4500
150	87	83	58	86	52	4600
225	87	83	62	86	52	4800
300	87	87	67	86	55	5300
500	87	87	73	86	58	7000
750	87	89	77	86	59	8000
1000	87	91	77	86	60	9400
1500	87	91	84	86	61	10600
2000	89	93	85	86	65	13000
2500	89	93	85	86	67	15200

+ Not approved for installation

Typical Impedance	
kVA	% Impedance Range
75	1.50–2.50
112.5	1.70–2.20
150	1.70–3.10
225	2.20–3.40
300	2.60–4.00
500	3.00–5.52
750–2500*	

***ANSI Standards allow for 7½% tolerance.**

Audible Sound Levels	
kVA	Average Sound Levels (db)
51–100	51
101–300	55
301–500	56
750	57
1000	58
1500	60
2000	61
2500	62

Guide Form Specification — Three-phase Pad-mounted Transformer Equipped with Separable Insulated High-voltage Connectors

Rating

Three-phase – Self-cooled
☐ Oil-immersed; ☐R'Temp; ☐ Silicone
☐ 60 Hertz, ☐ 50 Hertz
☐ 65C Rise, ☐ 55/65C Rise

Select one

75 kVA ☐	500 kVA ☐	2500 kVA ☐
112.5 kVA ☐	750 kVA ☐	3000 kVA ☐
150 kVA ☐	1000 kVA ☐	3750 kVA ☐
225 kVA ☐	1500 kVA ☐	5000 kVA ☐
300 kVA ☐	2000 kVA ☐	

Select one

Primary voltage: _____ volts
Connected: Ground wye (preferred) ..... ☐
Delta ..... ☐

Select one

Primary taps: None ..... ☐
Four 2½ % below ..... ☐
Two 2½ % above and two 2½ % below ..... ☐

The tap changer control is for de-energized operation only and must be externally operable with a hotstick and requires at least two operator actions to change taps. The preferable location for the control is in the primary compartment.

Select one

Secondary voltage: _____ volts
Connected: Wye (preferred) ..... ☐
Delta ..... ☐

General Construction Features

Units shall be constructed in accordance with ANSI Standard C57.12.26 (latest revision).

All characteristics, definitions, terminology, and voltage designations and tests, except as otherwise specified herein, shall be in accordance with the following American National Standard Requirements, Terminology, and Test Code for Distribution, Power, and Regulating Transformers:

- •General Requirements, C57.12.00 (IEEE Std 462) (latest revision).
- •Terminal Markings and Connections, C57.12.70 (latest revision).
- •Terminology, C57.12.80, including Supplement C57.12.80a (latest revision).
- •Test Code, C57.12.90 (IEEE Std. 262) (latest revision).

The pad-mounted, compartmental-type transformer shall consist of the transformer tank with high- and low-voltage cable terminating compartment. The transformer tank and compartment shall be assembled as an integral unit for mounting on a pad. There shall be no exposed screws, bolts, or other fastening devices which are externally removable. There shall be no openings through which foreign objects such as sticks, rods, or wires might contact live parts. There shall be means for padlocking the compartment door(s). The construction shall limit the entry of water (other than flood water) into the compartment so as not to impair the operation of the transformer.

Full-height, air-filled incoming and outgoing terminal compartments with hinged doors shall be located side-by-side separated by a steel barrier, with the incoming compartment on the left. The high-voltage (incoming) compartment will be accessible only after the door to the low-voltage (outgoing) compartment has been opened. To facilitate making connections and permit cable pulling, the doors and compartment hood shall be removable. Removable door sill on compartments shall be provided to permit rolling or skidding of unit into place over conduit studs in foundation.

The compartments will have hinged doors equipped for latching in the open position. The high-voltage compartment door will have a fastening device which is accessible only through the low-voltage compartment.

The hinge assemblies shall be made of corrosion-resistant material. Stainless-steel hinge pins of 3/8-inch minimum diameter will be provided.

Both compartment doors must be capable of being secured with a single padlock having a maximum 1/2-inch diameter shackle.

Lifting provisions in accordance with ANSI Standards shall be provided.

Jacking and rolling provisions shall be provided.

The instruction nameplate is to be located in the low-voltage portion of the compartment and shall be readable with cables in place. Where the nameplate is mounted on a removable part, the manufacturer's name and transformer serial number shall be permanently affixed to a non-removable part.

Transformer tank shall be sealed-tank construction with a welded main cover.

A bolted tamper-resistant handhole shall be provided in the tank cover for access to internal connections.

Provisions for tank grounding shall be supplied in both the high-voltage and low-voltage compartments. These provisions shall consist of:

(1) 500 kVA and below: 1/2-13 UNC tapped hole 7/16-inch deep.
(2) 750 kVA and above: (2) 1/2-13 UNC tapped holes 1/2-inch deep.

Low-voltage bushings shall be tinned, spade-type with 9/16-inch holes spaced on 1 3/4-inch centers in accordance with the Latest Revisions of ANSI.

For wye-wye connected units the high-voltage and low-voltage neutrals shall be connected internally and brought out through a bushing located in the secondary compartment.

Unless otherwise specified, the incoming primary section shall be equipped with three 200-ampere bushing wells in accordance with ANSI Standard C119.2.

Optional Primary (separable insulated high-voltage connector) bushings:

A. Three (3) 200-ampere bushing wells equipped with 200 ampere loadbreak switch modules.
B. Three (3) 200-ampere loadbreak integrated bushings (com bines the functions of bushing well and switch module).
C. Three (3) 600-ampere deadbreak bushings.

Optional primary (separable insulated high-voltage connector) bushings for looped primary cable systems or primary selective systems:

A. Six (6) 200-ampere bushing wells in accordance with ANSI Standard C119.2.
B. Six (6) 200-ampere bushing wells equipped with 200-ampere loadbreak switch modules.
C. Six (6) 200-ampere loadbreak integrated bushing (combines the functions of bushing well and switch module).
D. Six (6) 600-ampere deadbreak bushings.

The following accessories are to be provided on all units.

(1) One-inch filling provision.
(2) One-inch drain provision.
(3) Liquid level indication.

Guide Form Specification — Three-phase Pad-mounted Transformer Equipped with Separable Insulated High-voltage Connectors

Optional Equipment
(To be Indicated on Inquiry)
Overcurrent Protection

(Only ONE of the following can be specified) Check preceding fuse charts for availability.

Select only one (If desired) **Overcurrent Protection**

☐Three internally mounted, oil-immersed, expulsion fuses accessible through the tank handhole.
☐Three Bayonet-type, oil-immersed, expulsion fuses accessible through the primary compartment. The fuses shall be removable using a hot stick, (without disassembly of the primary cabinet) for external replacement of fuse cartridges.
☐Three current-limiting fuses in NON-LOADBREAK, dry-well fuseholders. The fuseholder must accept either GE or McGraw Edison general-purpose, distribution current-limiting fuses with an interrupting capacity of 50,000 amperes. The fuseholders shall be located in the primary compartment and be hot-stick operable for external replacement of the fuses.
☐Three current-limiting fuses in LOADBREAK, dry-well fuseholders. The fuseholder must accept either GE or McGraw Edison general-purpose, distribution current-limiting fuses with an interrupting capacity of 50,000 amperes. The fuseholders shall be located in the primary compartment and be hot-stick operable for external replacement of the fuses. The loadbreak fuseholder must be capable of interrupting a minimum of 100 amperes.
☐A combination of oil-immersed, current-limiting fuses and internally mounted, oil-immersed, expulsion fuses coordinated to provide full-range protection with the expulsion fuse clearing low-current faults and the current-limiting fuse clearing high-current faults up to 50,000 amperes.
☐A combination of oil-immersed, current-limiting fuses and Bayonet oil-immersed, expulsion fuses coordinated to provide full range protection with the expulsion fuse clearing low-current faults and the current-limiting fuse clearing high-current faults up to 50,000 amperes.

Radial Feed Switch – 300 amp

☐Provide an internal, oil-immersed, gang-operated, two-position (ON/OFF), loadbreak, manually operated switch. The switch must be capable of switching transformer full-load current. The switch handle shall be located in the primary compartment and must be hot stick-operable.

Loop-feed Switch – 300 amp

☐Provide one loop-feed, internal, oil-immersed, gang-operated, loadbreak, manually operated switch for a looped primary cable system. The switch shall be either two (2) two-position switches or a four-position switch. The switch must be capable of switching 200, 400 or 600 amperes to permit sectionalizing of the looped system. The switch handles shall be located in the primary compartment and must be hot stick-operable. Six primary bushings will be provided.

Loop/Radial Switch – 300 amp

☐Provide switch consisting of two (2) two-position, oil-immersed, loadbreak, manually operated switches combining the loop- and radial-switch functions consisting of a transformer switch and a loop switch.

Alternate-source Switch – 300 amp

☐Provide a primary selective switch to permit energizing transformer from either of two primary sources (but not both). The alternate source switch shall consist of two internal, oil-immersed, gang-operated, two-position (ON/OFF), manually operated, loadbreak switches with a mechanical interlock to prevent closing both sources. The switch must be capable of switching transformer full-load current. The switch handles shall be located in the primary compartment and must be hot stick-operable. Six primary bushings will be provided.

Loop Switch with ON/OFF Radial Switch

☐This combination unites the functions of the loop-switch operations, allowing the transformer to be de-energized and allowing either loop to be de-energized.

'T' Blade, 'V' Blade Sectionalizing Switches

☐"T" Blade Switch allows the loop to be energized while the transformer is de-energized.

☐"V" Blade Switch allows the loop plus the transformer to be de-energized at the same time.

Additional Accessories
ANY of the following accessories can be specified:

Select items required

☐One-inch drain valve and sampler (standard on 750 kVA and above).
☐Special accessory group consisting of:
a. One-inch drain valve and sampler,
b. Dial-type thermometer,
c. Liquid-level gauge and
d. Provisions (1/4" NPT) for vacuum/pressure gauge.
☐Pressure-vacuum gauge.
☐Internal lightning arrestors.
☐Single, secondary, molded-case circuit breaker with a maximum rating of 3000 amperes; channel mounted in the low-voltage compartment. (Accessories mounted in low-voltage compartment may be covered by this device.)
☐Molded-case circuit-breaker panel board for 1200 amperes maximum and "27X" maximum height; channel mounted in the low-voltage compartment. (Accessories mounted in low-voltage compartment may be covered by this device.)
☐Low-voltage busway entrance through secondary compartment cover. See page 26 for details.

Guide Form Specification — Live-front Three-phase Pad-mounted Transformer Equipped for Application

Rating
Three-phase – Self-cooled
☐ Oil-immersed; ☐R'Temp; ☐Silicone
☐ 60 Hertz, ☐ 50 Hertz
☐ 65C Rise, ☐ 55/65C Rise

Select one

75 kVA ☐	500 kVA ☐	2500 kVA ☐
112.5 kVA ☐	750 kVA ☐	3000 kVA ☐
150 kVA ☐	1000 kVA ☐	3750 kVA ☐
225 kVA ☐	1500 kVA ☐	5000 kVA ☐
300 kVA ☐	2000 kVA ☐	

Select one
Primary voltage:_____ volts
Connected: Ground wye (preferred) ..... ☐
Delta ..... ☐

Select one
Primary taps: None ..... ☐
Four 2½ % below ..... ☐
Two 2½ % above and
two 2½ % below ..... ☐

The tap changer control is for de-energized operation only and must be externally operable with a hot stick and requires at least two operator actions to change taps. The preferable location for the control is in the primary compartment.

Select one
Secondary voltage:_____ volts
Connected: Wye (preferred) ..... ☐
Delta ..... ☐

General Construction Features

Units shall be constructed in accordance with ANSI Standard C57.12.22 (latest revision).

All characteristics, definitions, terminology, and voltage designations and tests, except as otherwise specified herein, shall be in accordance with the following American National Standard Requirements, Terminology, and Test Code for Distribution, Power, and Regulating Transformers:

- •General Requirements C57.12.00 (IEEE Std. 462) (latest revision).
- •Terminal Markings and Connections, C57.12.70 (latest revision).
- •Terminology, C57.12.80, including Supplement C57.12.80a (latest revision).
- •Test Code, C57.12.90 (IEEE Std. 262) (latest revision).

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The compartments will have hinged doors equipped for latching in the open position. The high-voltage compartment door will have a fastening device which is accessible only through the low-voltage compartment.

The hinge assemblies shall be made of corrosion-resistant material. Stainless-steel hinge pins of 3/8-inch minimum diameter will be provided.

Both compartment doors must be capable of being secured with a single padlock having a maximum 1/2-inch diameter shackle.

Lifting provisions in accordance with ANSI Standards shall be provided.

Jacking and rolling provisions shall be provided.

The instruction nameplate is to be located in the low-voltage portion of the compartment and shall be readable with cables in place. Where the nameplate is mounted on a removable part, the manufacturer's name and transformer serial number shall be permanently affixed to a non-removable part.

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A bolted tamper-resistant handhole shall be provided in the tank cover for access to internal connections.

Provisions for tank grounding shall be supplied in both the high-voltage and low-voltage compartments. These provisions shall consist of:

(1) 500 kVA and below: 1/2-13 UNC tapped hole 7/16-inch deep.
(2) 750 kVA and above: (2) 1/2-13 UNC tapped holes 1/2-inch deep.

Low-voltage bushings shall be tinned, spade-type with 9/16-inch holes spaced on 1 3/4-inch centers in accordance with the Latest Revisions of ANSI.

For wye-wye connected units the high-voltage and low-voltage neutrals shall be connected internally and brought out through a bushing located in the secondary compartment.

Unless otherwise specified, the incoming primary section shall be equipped with three primary (live-front) porcelain bushings. The bushing terminals shall be:

(1). 500 kVA and below: clamp-type terminals for #8 solid through 2/0 stranded cable.
(2). 750 kVA and above: three-hole blade terminals.

The terminals shall be oriented for vertical cabling from below.

The following Accessories are to be provided on all units.

(1). One-inch filling provision.
(2). One-inch drain provision.
(3). Liquid-level indication.

Guide Form Specification — Live-front Three-phase Pad-mounted Transformer Equipped for Application

Optional Equipment
(To be Indicated on Inquiry)
Overcurrent Protection

(Only ONE of the following can be specified) Check preceding fuse charts for availability.

Select only one (If desired) **Overcurrent Protection**

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☐Three Bayonet-type, oil-immersed, expulsion fuses accessible through the primary compartment. The fuses shall be removable using a hot-stick, (without disassembly of the primary cabinet) for external replacement of fuse cartridges.

☐Three current-limiting fuses in NON-LOADBREAK, dry-well fuseholders. The fuseholder must accept either GE or McGraw Edison general-purpose, distribution current-limiting fuses with an interrupting capacity of 50,000 amperes. The fuseholders shall be located in the primary compartment and be hot-stick operable for external replacement of the fuses.

☐Three current-limiting fuses in LOADBREAK, dry-well fuseholders. The fuseholder must accept either GE or McGraw Edison general-purpose, distribution current-limiting fuses with an interrupting capacity of 50,000 amperes. The fuseholders shall be located in the primary compartment and be hot-stick operable for external replacement of the fuses. The loadbreak fuseholder must be capable of interrupting a minimum of 100 amperes.

☐A combination of oil-immersed, current-limiting fuses and internally mounted, oil-immersed, expulsion fuses coordinated to provide full-range protection with the expulsion fuse clearing low-current faults and the current-limiting fuse clearing high-current faults up to 50,000 amperes.

☐A combination of oil-immersed, current-limiting fuses and Bayonet oil-immersed, expulsion fuses coordinated to provide full range protection with the expulsion fuse clearing low-current faults and the current-limiting fuse clearing high-current faults up to 50,000 amperes.

An Arc Strangler® fused switch assembly consisting of single-pole units equipped with McGraw-Edison type NX® current-limiting fuse/switch capable of breaking 200 amperes of load current and interrupting up to 50,000 amperes of fault current. (Do not specify when specifying oil switches).

Radial Feed Switch – 300 amp

☐Provide an internal, oil-immersed, gang-operated, two-position (ON/OFF), loadbreak, manually operated switch. The switch must be capable of switching transformer full-load current. The switch handle shall be located in the primary compartment and must be hot stick-operable.

Loop-feed Switch – 300 amp

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Loop/Radial Switch – 300 amp

☐Provide switch consisting of two (2) two-position, oil-immersed, loadbreak, manually operated switches combining the loop- and radial-switch functions consisting of a transformer switch and loop switch.

Alternate-source Switch – 300 amp

☐Provide a primary selective switch to permit energizing transformer from either of two primary sources (but not both). The alternate source switch shall consist of two internal, oil-immersed, gang-operated, two-position (ON/OFF), manually operated, load break switches with a mechanical interlock to prevent closing both sources. The switch must be capable of switching transformer full-load current. The switch handles shall be located in the primary compartment and must be hot stick-operable. Six primary bushings will be provided.

Loop Switch with ON/OFF Radial Switch

☐This combination unites the functions of the loop-switch operations, allowing the transformer to be de-energized and allowing either loop to be de-energized.

'T' Blade, 'V' Blade Sectionalizing Switches

☐"T" Blade Switch allows the loop to be energized while the transformer is de-energized.

☐"V" Blade Switch allows the loop plus the transformer to be de-energized at the same time.

Additional Accessories
ANY of the following accessories can be specified:

Select items required

☐One-inch drain valve and sampler (standard on 750 kVA and above).

☐Special accessory group consisting of:
a. One-inch drain valve and sampler,
b. Dial-type thermometer,
c. Liquid-level gauge and
d. Provisions (1/4" NPT) for vacuum/pressure gauge.

☐Pressure-vacuum gauge.

☐Internal lightning arrestors.

☐Single, secondary, molded-case circuit breaker with a maximum rating of 3000 amperes; channel mounted in the low-voltage compartment. (Accessories mounted in low-voltage compartment may be covered by this device.)

☐Molded-case circuit-breaker panel board for 1200 amperes maximum and "27X" maximum height; channel mounted in the low-voltage compartment. (Accessories mounted in low-voltage compartment may be covered by this device.)

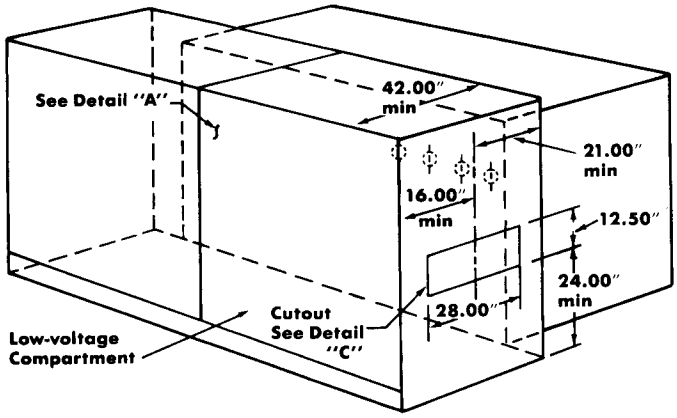
☐Low-voltage busway entrance through secondary compartment cover. See page 26 for details.

Outline and Typical Mechanical Data

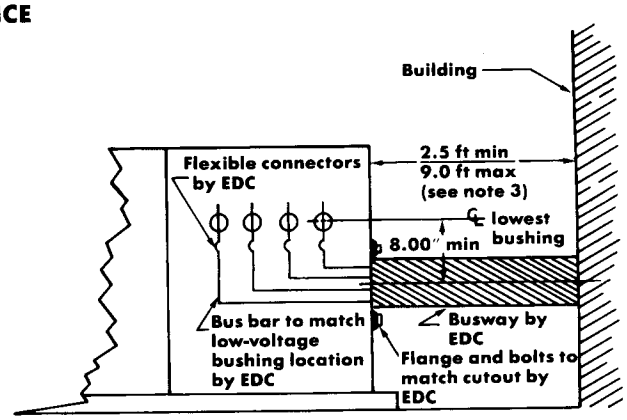
Low-voltage Bus-Duct Entrance Provisions for Three-phase Pad-mounted Transformers 75-5000 kVA

NOTES: 1. Not available in combination with panelboard secondary.
2. Details shown are for coordination with GE Electrical Distribution and Control Sales busway only.
3. Transformer cabinet will support reasonable weight. However, the user is cautioned to use discretion in the assembly and employ separate support means when the need is evident.

SIDE ENTRANCE

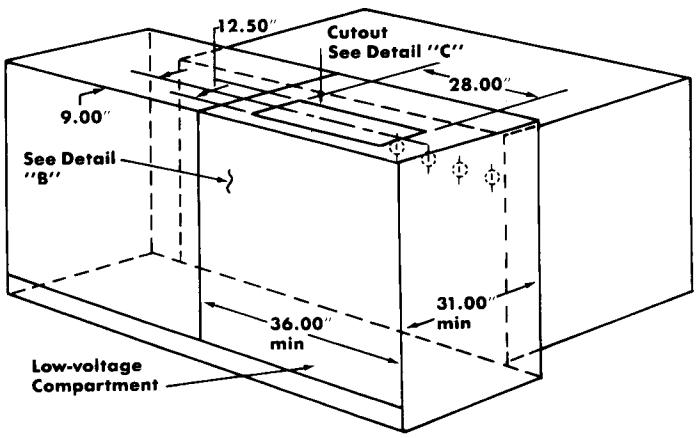


Low-voltage bus-duct top entrance

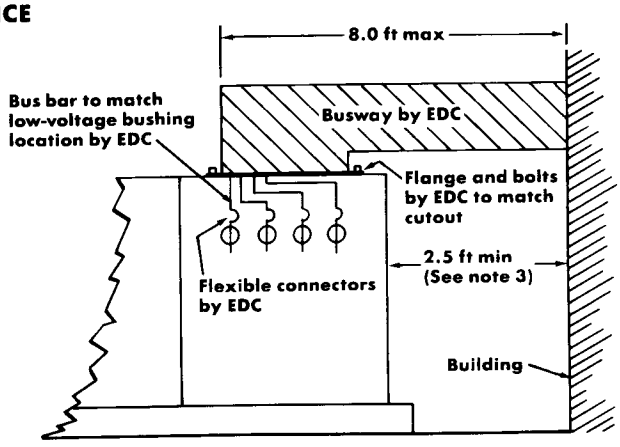


Detail "A"

TOP ENTRANCE



Low-voltage bus-duct side entrance

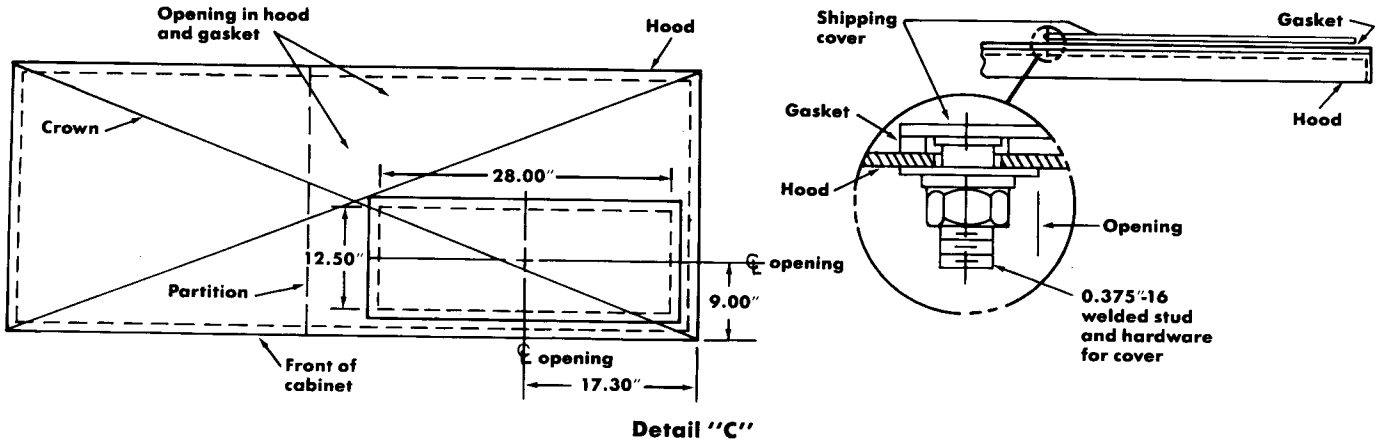


Detail "B"

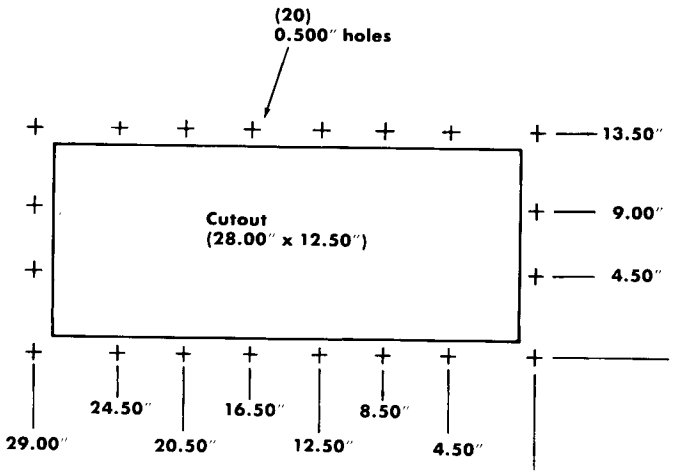
Outline and Typical Mechanical Data

Bus Duct Entrance Provisions

TYPICAL ENTRANCE DETAILS (Top Shown)



BOLT HOLE PATTERN FOR TOP AND SIDE ENTRANCE



Important Features

- Less flammable R'Temp or silicone insulation available as options.
- Test reports by transformer serial number.
- Steel barrier between high- and low-voltage compartments.
- Bolted-on handhole cover with tamper-resistant hood standard on transformer tank cover.
- Zinc-oxide under-oil distribution lightning arrestors mounted inside transformer tank.
- Five-legged core construction.
- Optional low-loss, high-efficiencies design flexibility to decrease total owning costs.

Standards and References

Padmounted transformers / three-phase / 75-5000 kVA

American National Standards Institute (ANSI)

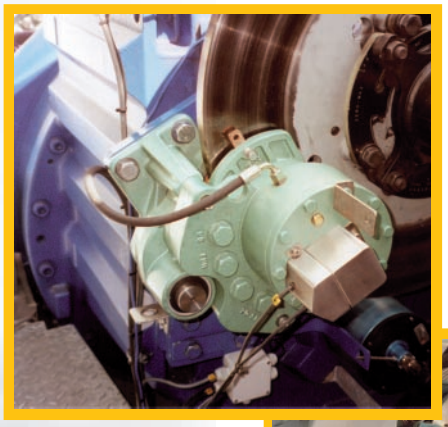
ANSI C57.12.22 (latest revision)	Requirements for livefront, padmounted, compartmental-type, self-cooled, three-phase distribution transformers, 2500 kVA and below.
ANSI C57.12.26 (latest revision)	Requirements for deadfront, padmounted, compartmental-type, self-cooled, three-phase distribution transformers, 2500 kVA and below.
ANSI C57.12.00	General requirements for liquid-immersed, distribution, power-regulating transformers.
ANSI C57.12.90	IEEE standard test code for liquid-immersed distribution, power and regulating transformers and IEEE guide for short-circuit testing of distribution and power transformers.

GE Commercial Transformer

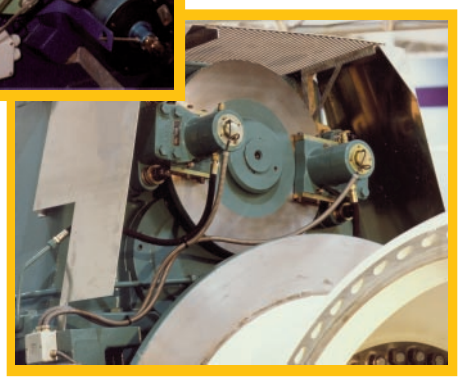
General Electric Company
Commercial Transformer Operation
7000 Bert Kouns Industrial Loop
Shreveport, LA 71129-3008

GET 6859B 9/98 (10M)

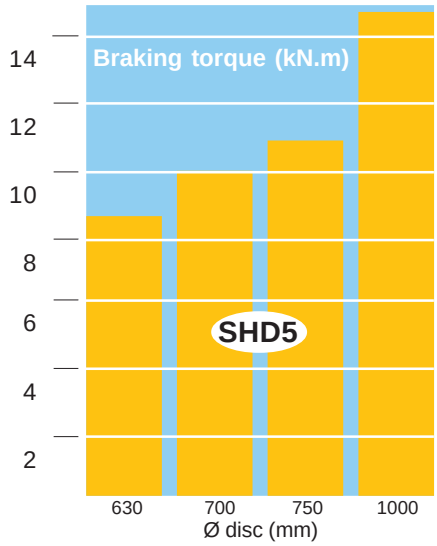
SHD5 caliper for Windmills



left:
SHD5 caliper - gearbox of a 900 kW windmill



2xSHD /high speed drive (600 kW wind turbine)



SIME-Stromag introduces the **WACS** - self **W**ear **A**djustment and **C**entering **S**ystem. The SHD5 caliper features both **automatic air gap centering** and **self wear compensation**, for easy maintenance and reduced costs.

The SHD5 caliper is a fail-safe single-spring hydraulical caliper, designed for high speed shaft drives of windturbines.
The SHD5 delivers high energy braking and is designed to be installed directly onto the drive line gear box.

Main characteristics:	***Advantages:***
Torque stability	Protection of windmill's mechanical components
Single-spring design	Installation onto the gear box is possible
Special braking spring design	Low torque loss /mm. of lining wear
Few moving parts	Reliable assembly
Large area linings	Lower operating temperature, longer lining life
Linings installation in **shoes axis**	No caliper displacement to replace linings
Positive lining fastening	Easy replacement
Wear proving switch	Preventive maintenance - safer operation
Option: **WACS**(*) -**W**ear **A**djustment **C**entering **S**ystem	Constant torque over lining life, reduced costs
Option: **DM** -Manual release	Easier installation and maintenance

(*) *Patent pending*

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Disc brake

Technical data and dimensions

Caliper SHD5W

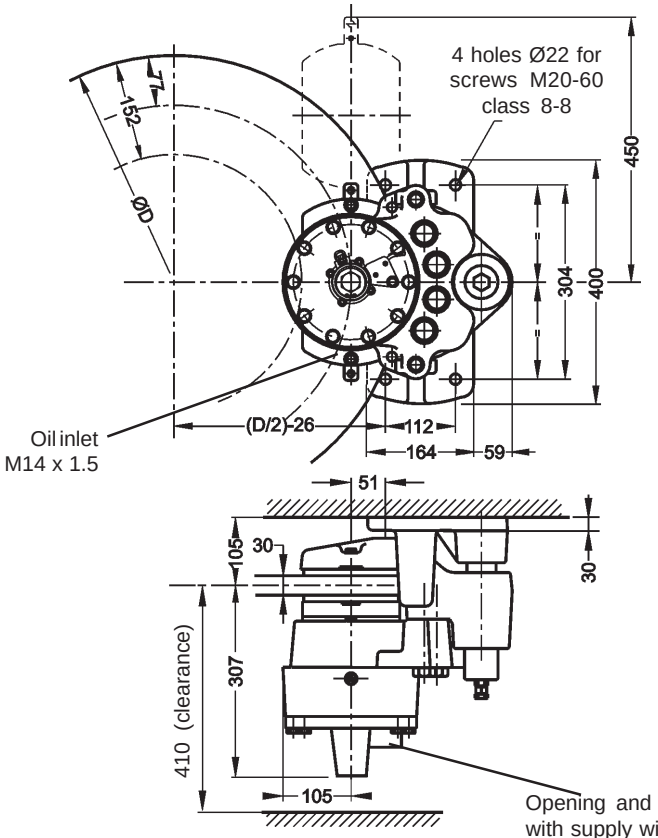
Fail safe braking
Braking by spring application
Hydraulic release
Opening proving switch
Lining wear proving switch
Temperature detection of the linings
Automatic lining wear compensation (WACS)

Working conditions:
- Ambient temperature: -20°C to +60°C
- Relative humidity ≤ 70%
- Dust in atmosphere ≥ 65µ

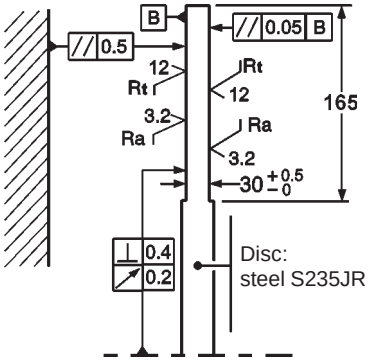
Other conditions, consult SIME.

Use:
- Emergency stopping brake in case of overspeed or loss of electrical supply

Options:
- Manual release tool (DM)
- Positive braking
- Detection of full lining wear
- Switch for PLC
- Marine protection
- Factory scaling of the braking force to [BF-10%]



Installation instructions:



Opening and wear proving switches with supply wires: 3 x 0.75 mm² and length 2 m

Weight: 105 kg
Torque and effort values are subject to a variation of ±10%
Response time at nominal torque ≤ 0.3s
Maximum working pressure: 200 bars

Designation	Caliper		SHD5W-6	SHD5W-5	SHD5W-4	SHD5W-3	SHD5W-2	SHD5W-1
	Lining *		EF 3-1/ES 3-5					
Braking force BF for 1.25 mm of air gap disc/lining*		Dynamic N	33 000	27 000	23 000	18 000	15 000	13 500
Linear speed of the disc for TF		m/s	< 60	< 60	< 60	<60	< 60	< 60
Dynamic braking torque BT (N.m) for a caliper mounted on a disc ØD (mm)		710 mm	9180	7500	6400	5000	4170	3760
		1000 mm	13960	11420	9730	7610	6350	5720
		1500 mm	22210	18170	15480	12110	10100	9090
		N.m	BT = TF (D/2000 - 0.077)					
Opening pressure	Min.	bars	120	100	85	70	65	55
	Max.	bars	140	120	105	90	85	75
Total volume of oil displaced		cm³	15.9 per stroke (for nominal disc/lining stroke of 1.25 mm per side)					
Max. oil volume of the jack		cm³	76					

Electrical data:
- Proving switches: 240V, 5A, 50VA AC 220V, 5A, 50W CC

*** Lining quality EF 3-1 or ES 3-5 depending on the application: consult us.**

Due to continuous development and improvement, all dimensions and characteristics are subject to change without notice

SIME-Stromag SAS
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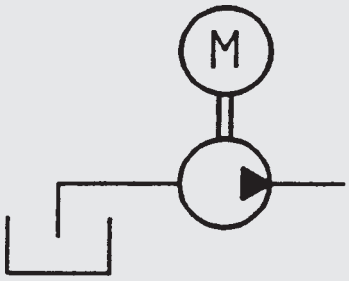
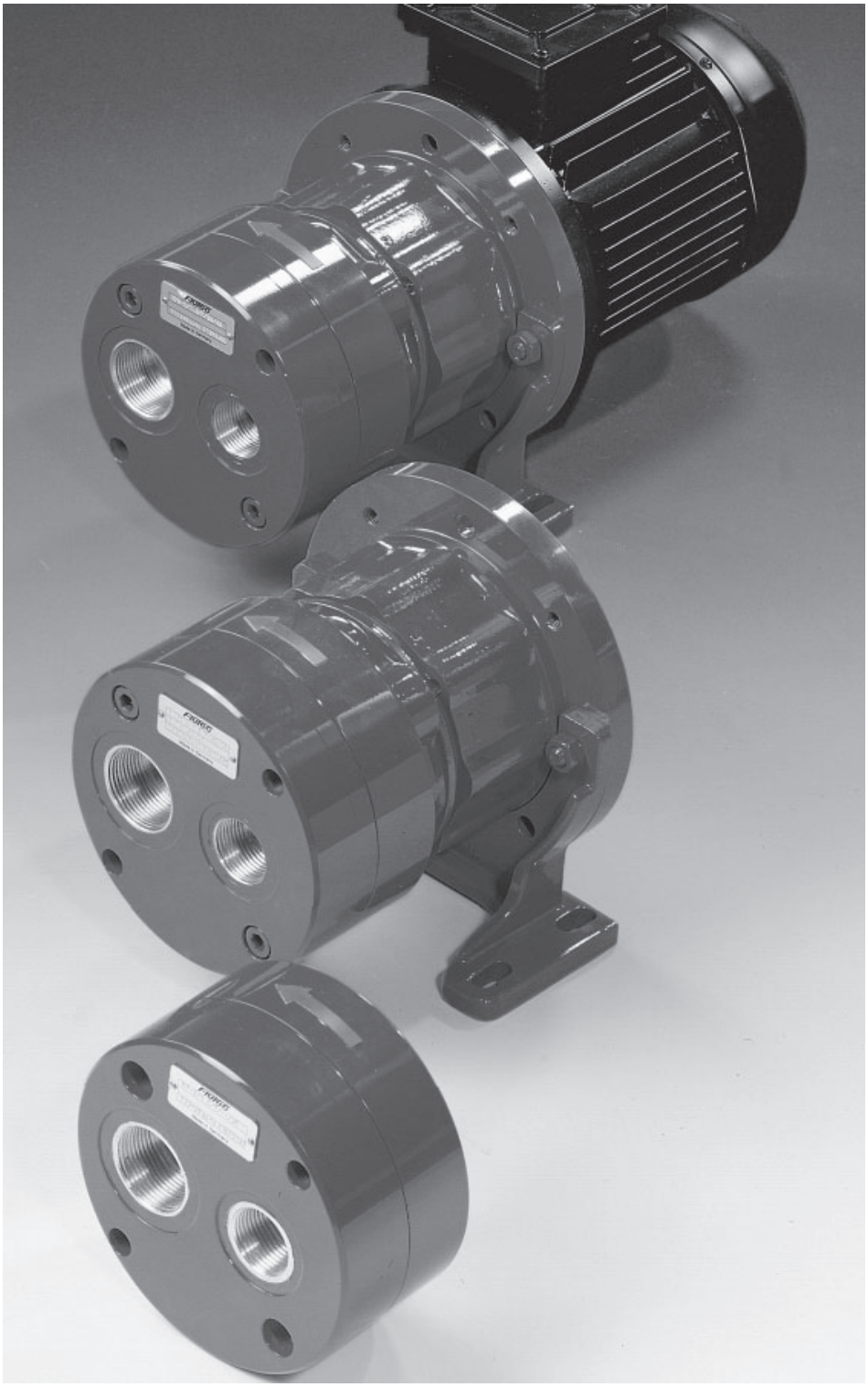
Tel.: +33 (0)1.49.90.32.20 - Fax: +33 (0)1.49.89.06.38 - Email: sales@sime-stromag.com

HYDAC INTERNATIONAL

Feed Pumps
Low-Noise Series





FEED PUMP SERIES VP

1. GENERAL

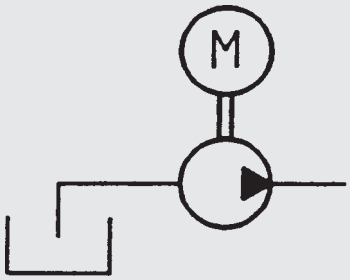
The VP series of feed pumps are low-noise, single-stroke vane pumps with constant flow rate.

By using a dampened bell housing (PT) a reduction in noise level is achieved.

1.1. AREAS OF APPLICATION

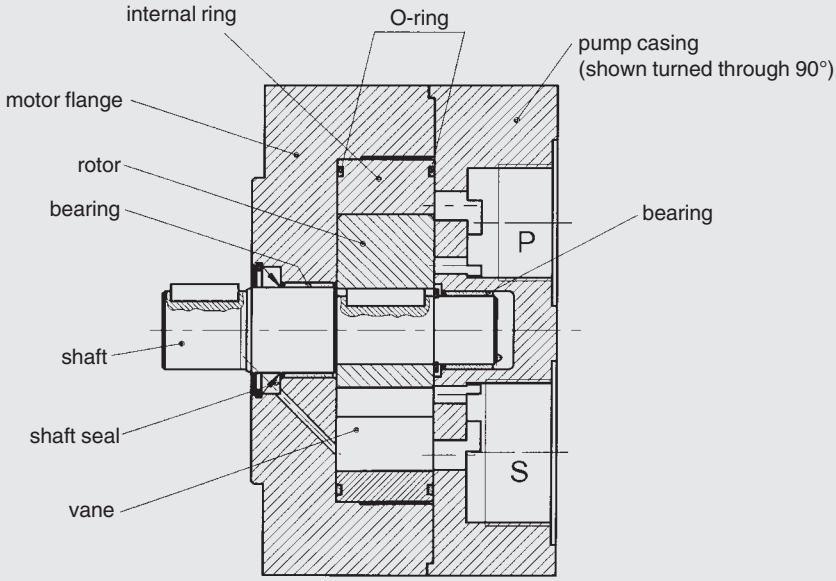
– filter circuits
– cooling circuits
– lubrication applications
– pump transfer units

1.2. SYMBOL



2. DESCRIPTION

2.1. DIAGRAMMATIC ILLUSTRATION



2.2. NOTES ON INSTALLATION

Pressure differentials (flow rate losses)

$$\Delta p\ [bar] = 5.84 \times \frac{l\ [m]}{d^4\ [mm]} \times Q\ [l/min] \times \gamma\ [mm^2/s]$$

– effect of the internal diameter on the flow rate losses using the following example values:
l = 1m; Q = 150 l/min; γ = 200mm²/s

	Internal diameter (mm)		
	di_1(38)	di_1(32)	di_1(25)
Δp (bar/m)	0.084	0.167	0.45

– Only applicable for straight pipes
– Additional threaded connections and pipe bends increase the flow rate losses

Notes:
– as few threaded connections as possible
– few pipe bends; if required use large radius
– difference in height between pump and oil level as small as possible
– hoses must be suitable for a vacuum of min. 5000 mmW (e.g. hoses to be steel reinforced)
– do not reduce piping cross-section predetermined by the threaded connection.

3. MODEL CODE

VPBM - 2 / 1.0 / P / 90/40 / 1.5/400-50

Pump + PT + coupling + motor — **VPBM**
Pump + PT + coupling — **VPB**
Pump — **VP**
(PT = bell housing)

Size 2
3

Modification number

Seals = P (Perbunan)
(other materials on request)

Motor size and flow rate

Size	Motor size	Motor output	Flow rates in ccm/revolutions (others on request)					
			20	**30**	**40**	**70**	**100**	**130**
2	80	0.75 kW	●	●	●			
	90	1.5 kW	●	●	●			
3	100	2.2 kW				●	●	●
	112	4 kW				●	●	●
	132	5.5 kW					●	●
	132	7.5 kW						●

(Please note: max. pressure 16 bar)

Motor output and voltage (n = 1500 rpm)
(only for VPBM)

Motor version: B5

Size 2:	**Motor output**	**Nominal current (for 400V - 50 Hz)**
	0.75 kW	2.1 A
	1.5 kW	3.8 A

Size 3:	**Motor output**	**Nominal current (for 400 V - 50 Hz)**
	2.2 kW	5.0 A
	4 kW	9.0 A
	5.5 kW	12.3 A
	7.5 kW	16.3 A

Standard voltages and frequencies for 3-phase motors

Motor output 0.75 KW - 4 KW

380 - 420 V star/220 - 240 V delta - 50 Hz
440 - 480 V star/254 - 277 V delta - 60 Hz (motor output x 1.15)

Motor output 5.5 KW - 7.5 KW

660 - 720 V star/380 - 420 V delta - 50 Hz
760 - 830 V star/440 - 480 V delta - 60 Hz (motor output x 1.15)

4. TECHNICAL SPECIFICATIONS

4.1. OPERATING PRESSURE
16 bar max.

4.2. SUCTION PRESSURE
-0.4 bar max. for mineral oil

4.3. FLUID
Mineral oil
to DIN 51524, parts 1 and 2
Permissible contamination
≤ NAS 12

4.4. FLUID TEMPERATURE
-20° C to +80° C
for mineral oil

4.5. VISCOSITY
See graphs

4.6. AMBIENT TEMPERATURE
-20°C to +40°C

4.7. MOUNTING POSITION
Preferably horizontal

4.8. REVOLUTIONS
min. 1000 rpm
max. 2000 rpm
Direction of rotation: clockwise
(when looking at motor fan wheel)

4.9. WEIGHTS

VP - 2:			5.0 kg
VP - 3:			13.0 kg
VPB - 2:			8.5 kg
VPB - 3	2.2 - 4	kW:	18.0 kg
VPB - 3	5.5 - 7.5	kW:	19.5 kg
VPBM - 2	0.75	kW:	18.0 kg
VPBM - 2	1.5	kW:	24.0 kg
VPBM - 3	2.2	kW:	39 kg
VPBM - 3	4	kW:	49 kg
VPBM - 3	5.5	kW:	60 kg
VPBM - 3	7.5	kW:	79 kg

4.10. DRIVE (ONLY VPBM)

Type of drive:	electric motor
Type of current:	three-phase
Output and voltage:	see model code
Safety type:	IP54
Insulation class:	F

4.11. VOLUMETRIC EFFICIENCY:
>90% (at ν=40 mm²/s)

4.12. NOISE LEVELS IN dB(A)

	ccm/rev	1bar	6bar	10bar
Size 2	20	57	60	63
	30	60	61	64
	40	61	62	64
Size 3	70	62	64	67
	100	66	67	69
	130	68	69	70

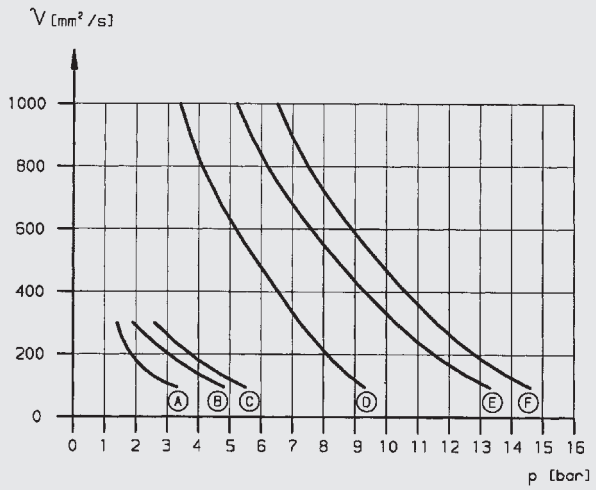
Test fluid: ISOVG46 at 40° C

Measured with dampened bell housing.

The noise levels are only a guide as acoustic properties of a room, connections, viscosity and reflections have an effect on the noise level.

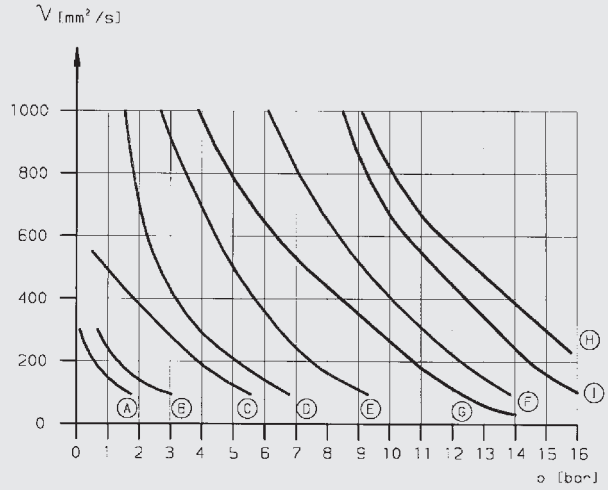
4.13. GRAPHS (n = 1500 rpm)

VP-2



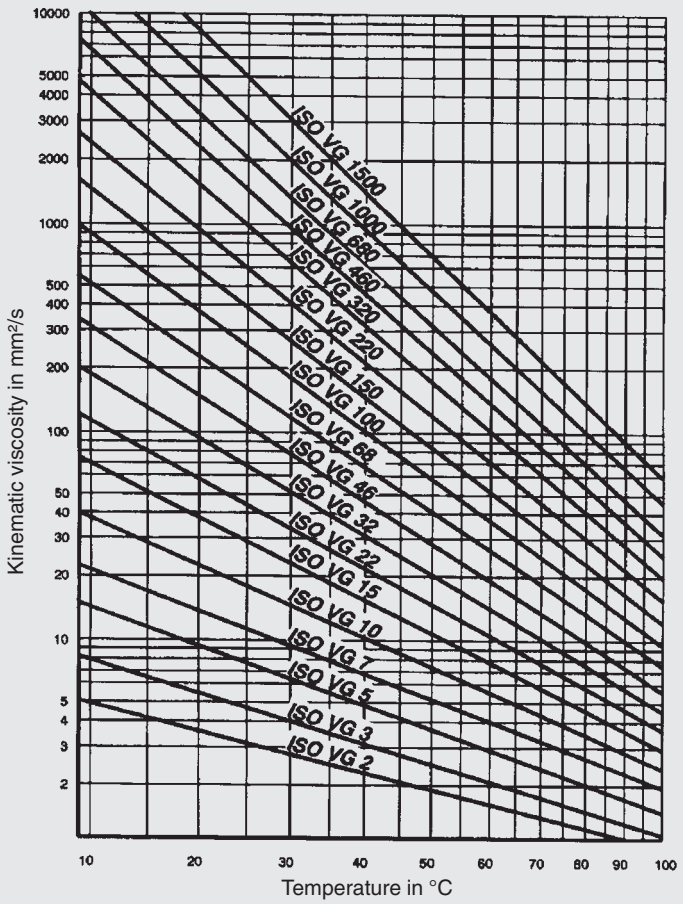
Ⓐ 40 cm³/rev-0.75 kW Ⓓ 40 cm³/rev-1.5 kW
Ⓑ 30 cm³/rev-0.75 kW Ⓔ 30 cm³/rev-1.5 kW
Ⓒ 20 cm³/rev-0.75 kW Ⓕ 20 cm³/rev-1.5 kW

VP-3

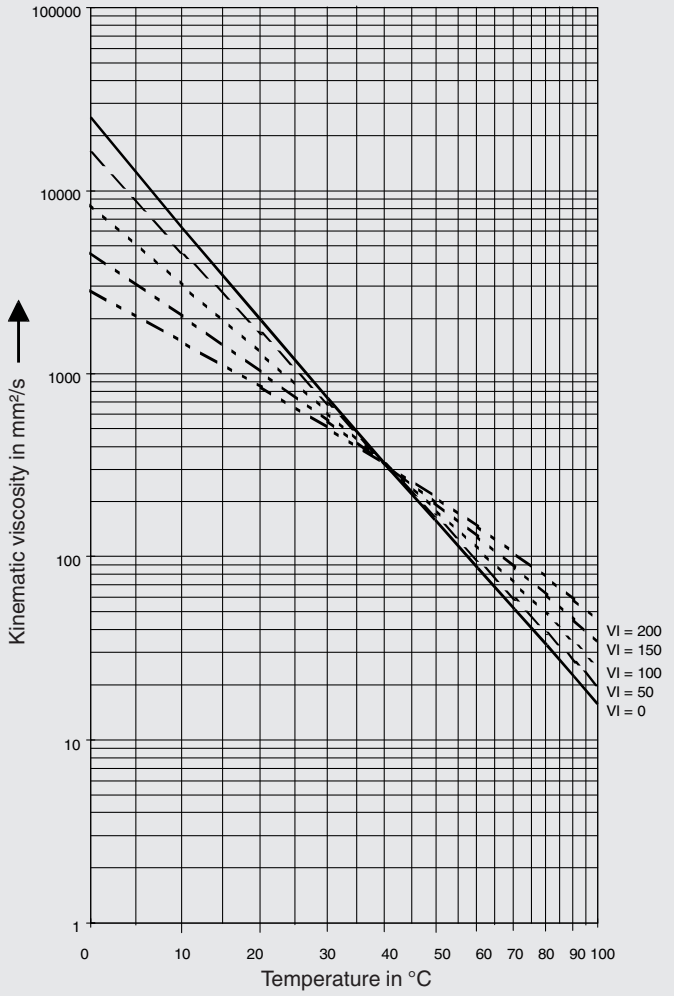


Ⓐ 130 cm³/rev-2.2 kW Ⓓ 130 cm³/rev-4.0 kW Ⓖ 130 cm³/rev-5.5 kW
Ⓑ 100 cm³/rev-2.2 kW Ⓔ 100 cm³/rev-4.0 kW Ⓗ 130 cm³/rev-7.5 kW
Ⓒ 70 cm³/rev-2.2 kW Ⓕ 70 cm³/rev-4.0 kW Ⓘ 100 cm³/rev-5.5 kW

4.14. VISCOSITY-TEMPERATURE GRAPH to DIN 51519 viscosity index 50



4.15. VISCOSITY-TEMPERATURE GRAPH Viscosity Index 0 to 200 Oil ISO VG 320

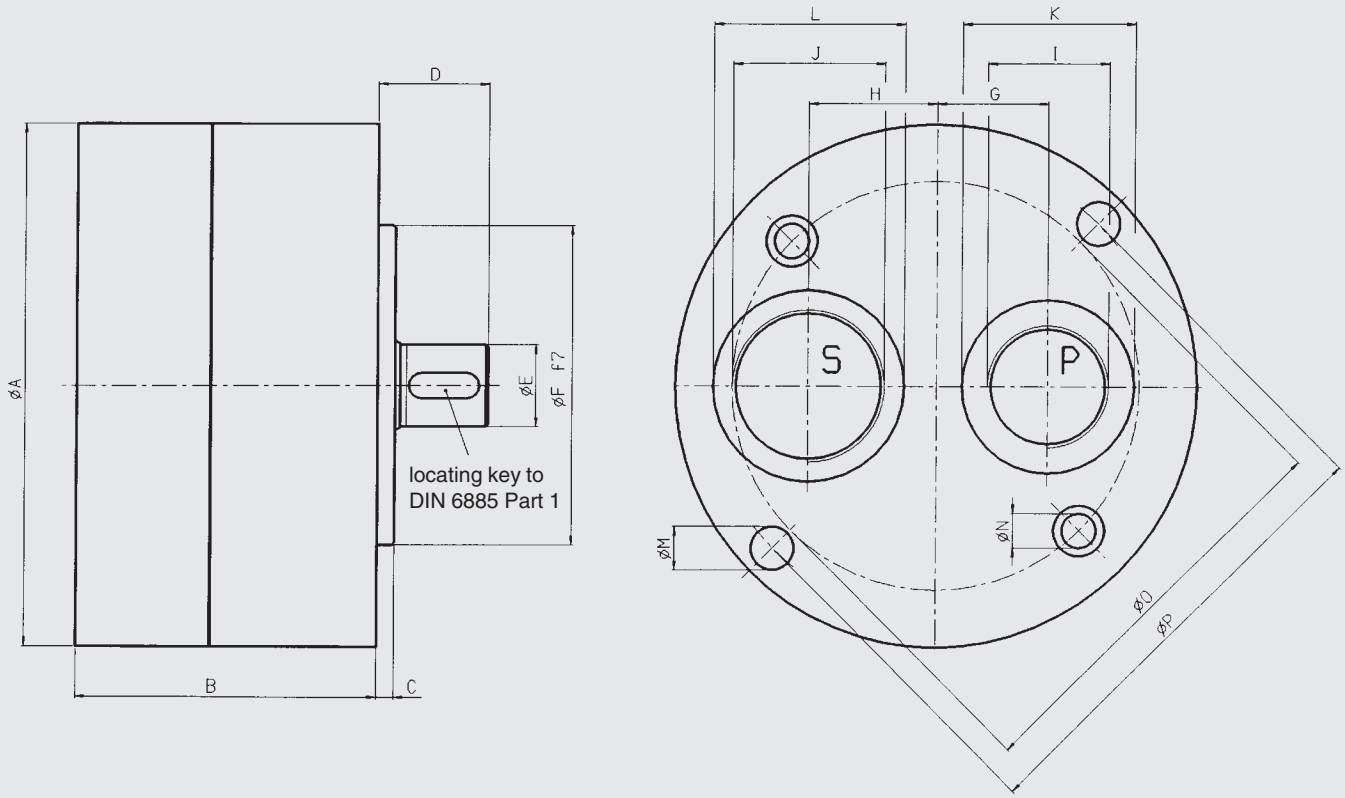


The viscosity index (VI) indicates how much the viscosity of the oil changes with temperature.
The higher the viscosity index, the smaller the change in viscosity in relation to the temperature.

⇒ Oils with a high viscosity index have a lower viscosity at low temperatures than oils with a low viscosity index.

5. DIMENSIONS

VP



Size	Flow rates l/min at 1500 rpm	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
VP-2	30 - 60	160	79.5	7	44	22	100	30	35	G1	G1¼	50	60	13.5	11	125	140
VP-3	100 - 200	205	119	7	44	32	125	44	50	G1½	G2	68	76	17	13.5	160	180

The VP pump can be combined with various hydraulic pumps.
The following combinations are possible:

Brueninghaus axial piston pump

Main pump	Through drive	HYDAC low noise pump	Shaft
A10VSO	K25	VP-2/1.0	Cyl. diam. = 22 mm
A10VSO	K27	VP-3/1.0	Cyl. diam. = 32 mm
A10VSO	KB3	VP-2/1.3	Splined shaft 7/8" 13T 16/32 DP
A10VSO	KB5	VP-3/1.3	Splined shaft 1 1/4" 14T 12/24 DP
A10VO	K07	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP

Rexroth vane pump

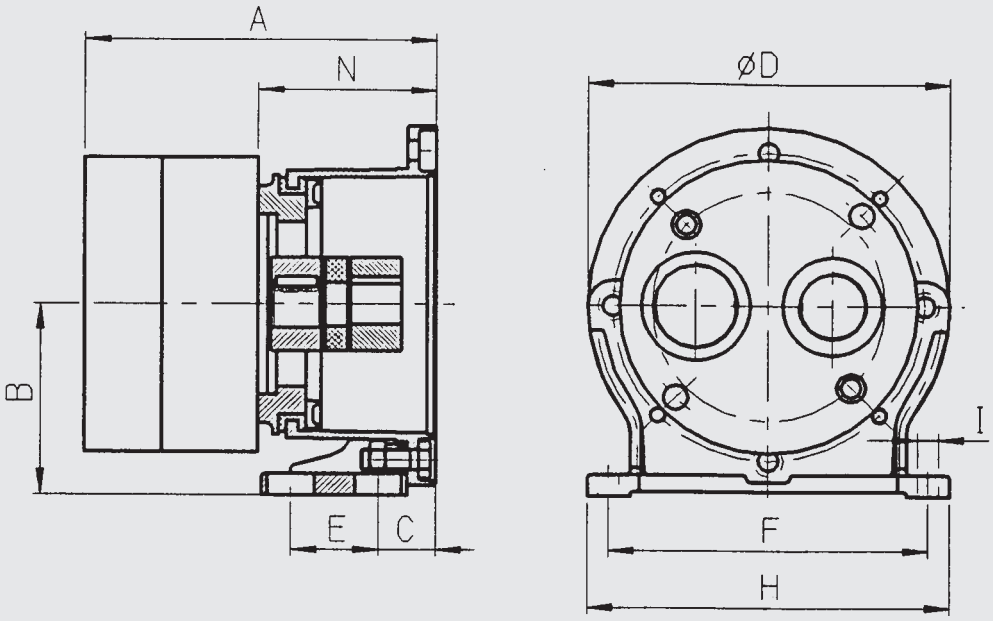
Main pump	With intermediate flange and coupling adaptor for:	HYDAC low noise pump	Shaft
V7 / 40	V7 / 40	VP-3/1.0	Cyl. diam. = 32 mm
V7 / 63	V7 / 40	VP-3/1.0	Cyl. diam. = 32 mm
V7 / 63	V7 / 63	VP-3/1.0	Cyl. diam. = 32 mm
V7 / 100	V7 / 40	VP-3/1.0	Cyl. diam. = 32 mm
V7 / 100	V7 / 63	VP-3/1.0	Cyl. diam. = 32 mm

Voith internal gear pump

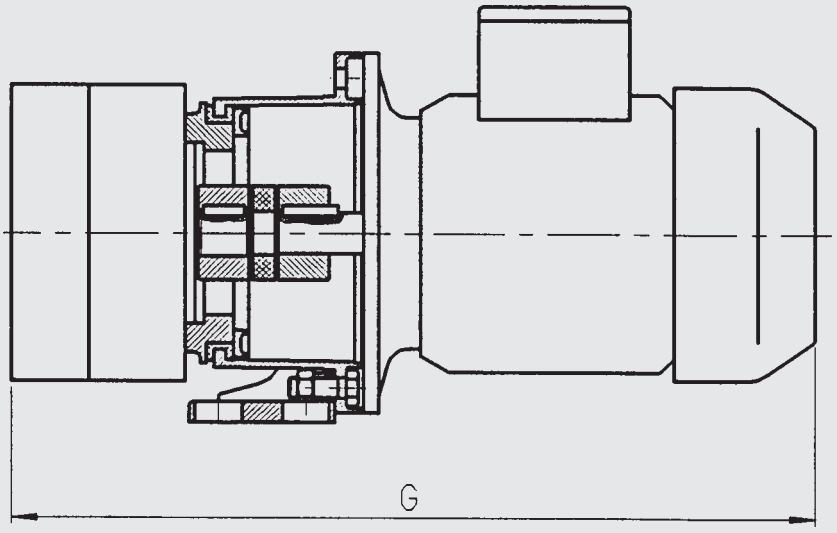
Main pump	Voith intermediate housing	HYDAC low noise pump	Shaft
IPC6 / A10VO71	110	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPH6 / A10VO71	111	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPC7 / A10VO71	111	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPH5	110	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPV6	110	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPC6	110	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPH6	111	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPV7	111	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP
IPC7	111	VP-3/2.3 (S=G2, P=G 1 1/4) VP-3/1.4 (S=SAE 2", P=SAE 1 1/2")	Splined shaft 1 1/4" 14T 12/24 DP

Other combinations on request!
Technical specifications and drawings for the low noise pumps are available on request.

VPB (Pump + bell housing + coupling)



VPBM (Pump + bell housing + coupling + motor)



Size	Motor size	A	B	C	D	E	F	G	H	I	N
2	80 0.75 kW	192.5	112	19	200	60	180	430	210	11	113
	90 1.5 kW	192.5	112	19	200	60	180	485	210	11	113
3	100 2.2 kW	243	132	40	250	60	220	560	250	14	124
	112 4 kW	243	132	40	250	60	220	580	250	14	124
	132 5.5 kW	263	160	39	300	80	260	680	290	14	144
	132 7.5 kW	263	160	39	300	80	260	680	290	14	144

6. NOTE

The information in this brochure relates to the operating conditions and applications described.

For applications or operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.

SAFT

NIFE

MANUAL DE OPERACION Y MANTENIMIENTO

CARGADOR DE BATERIAS MONOFASICO

TIPO SLR

SAFT NIFE MEXICO, S.A. DE C.V.

SAN LUIS TLATILCO 25 C.P. 53470 NAUCALPAN TEL. 576-26-11 FAX. 358-50-27 TELEX 1777352

S A F T

NIFE

SAFT NIFE MEXICO S.A. DE C.V.

SAN LUIS TLATILCO No.25
PARQUE INDUSTRIAL NAUCALPAN
NAUCALPAN DE JUAREZ EDO. DE MEX.
TEL. 5-76-26-11 FAX 3-58-50-27

RECEPCION DE MATERIAL

DISTINGUIDO USUARIO:
SAFT NIFE MEXICO AGRADECE LA OPORTUNIDAD DE PODER SERVIRLE COMO USTED SE MERECE, PARA TAL EFECTO, LE SUPLICAMOS DE LA MANERA MAS ATENTA, SE SIRVA CONTESTAR LA SIGUIENTE INFORMACION Y REMITIRLA A LA DIRECION ANTERIORMENTE DESCRITA A LA MAYOR BREVEDAD POSIBLE.
ES MUY IMPORTANTE, YA QUE SU CONTESTACION NOS PROPORSIONARA LA INFORMACION NECESARIA PARA PODER RESPETARLE SU GARANTIA

FECHA DE ELABORACION: _____ FACTURA No. _____

CLIENTE: _____

DOMICILIO; _____

TELEFONO: _____

PERSONA QUE PROPORSIONA LOS DATOS: _____ PUESTO: _____

DESCRIPCION DEL EQUIPO RECIBIDO: _____

MODELO: _____ TIPO: _____

CANTIDAD: _____

No. DE SERIE _____

EN QUE CONDICIONES RECIBIO SU MATERIAL ? _____

OBSERVACIONES: _____

SUGERENCIAS: _____

FIRMA

SAFT

NIFE

GARANTIA NIFE

LOS PRODUCTOS NIFE ESTÁN GARANTIZADOS CONTRA DEFECTOS DE MANO DE OBRA Y MATERIALES, POR UN PERÍODO DE UN AÑO A PARTIR DE LA PUESTA EN MARCHA Ó - 18 MESES A PARTIR DEL EMBARQUE, LO QUE SUCEDA PRIMERO.

ESTA GARANTÍA ES VÁLIDA ÚNICAMENTE EN NUESTRA PLANTA EN NAUCALPAN, EDO. DE MÉXICO.

SI EL CLIENTE DETERMINA HACERLA EN EL LUGAR DONDE SE ENCUENTREN INSTALADOS LOS EQUIPOS, DEBERÁ PAGAR LOS GASTOS DE TRASLADO, ALIMENTACIÓN Y HOSPEDAJE DE NUESTRO TÉCNICO, ASÍ COMO EL CARGO POR SERVICIOS EXTERNOS DE ACUERDO A LA LISTA DE PRECIOS EN VIGOR.

MATERIAL QUE SE CONSIDERE DEFECTUOSO PUEDE SER REGRESADO A LA FÁBRICA -- "FLETE PAGADO" PARA SU REVISIÓN.

LAS PARTIDAS QUE SE ENCUENTREN DEFECTUOSAS EN MANO DE OBRA Y MATERIALES, - SERÁN REPARADAS Ó REEMPLAZADAS POR **SAFT NIFE México, S.A. de C.V.**, SIN -- NINGÚN CARGO.

SAFT NIFE México, S.A. de C.V., NO AUTORIZA CARGO POR INVESTIGACIÓN Ó REPARACIONES HECHAS EN EL LUGAR DE INSTALACIÓN.

LA PRESENTE GARANTÍA QUEDARÁ SIN EFECTO SI PERSONAL NO AUTORIZADO POR -- **SAFT NIFE México, S.A. de C.V.** EFECTÚA REPARACIONES A DICHOS MATERIALES.

ATENTAMENTE
SAFT NIFE México, S.A. de C.V.

LIC. ROBERTO TROOP PLIEGO.
DIRECTOR GENERAL.

MAR.*

SAFT NIFE (MEXICO)

CARGADOR DE BATERIAS MONOFASICO

TIPO SLR

MANUAL DE OPERACION Y MANTENIMIENTO

No. de Instructivo: 4725-65-92590-00
Fecha : 92-02-10
Revision : 0

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INTRODUCCION

Los cargadores Saft Nife de la serie SLR, estan diseñados para una vida útil larga y una gran confiabilidad en operacion continua para aplicaciones comerciales e industriales Esto se logra mediante un amplio programa que incluye una ingenieria de diseño muy prudente, el empleo de tecnicas de inducción modernas y programas de prueba del tipo de unidades en serie.

Hemos preparado este manual de instrucciones y paquete de documentación para familiarizar al usuario con esta unidad y que sirva como una guía para su propio uso y mantenimiento Para asegurar una operación libre de problemas, el usuario debera familiarizarse con el contenido de este manual.

Este documento se puede aplicar a todos los cargadores Saft Nife de la serie SLR. Incluye declaraciones breves acerca de las opciones disponibles. Si existen algunas de ellas. osu información se incluye actualizada en la última sección de este manual.

Aprovechamos la ocasión para agradecerle la preferencia por los productos SAFT NIFE.

1.0 PROPOSITO FUNCIONAL

1.1 Descripcion

El cargador de baterias Saft Nife es controlado mediante SCR's para proporcionar una fuente de alimentacion de CD idónea y altamente estable para cargar baterias de Níquel-Cadmio, Plomo - Calcio y Plomo - Antimonio.

Las características que incluye son:

- carga a voltaje constante
- control de limitación de corriente
- interruptor manual de flotación/régimen alto con regreso automático.
- control automatico de carga
- arranque lento
- mantenimiento mínimo

1.2 Especificaciones

Características nominales de entrada

VOLTAJE	:	120,208 o 240 Vca (dependiendo del rango de cd)
TOLERANCIA	:	de +10% a -10%
FRECUENCIA	:	57-63 Hz
FASE	:	Monofásico

Características nominales de salida

VOLTAJE	NOMINAL	MAXIMO	
	12	16.0	Vcd
	24	32.0	Vcd
	48	63.0	Vcd
	120	154.0	Vcd

Rango de voltaje en cd:
Flotación del 80% al 135% del cd nominal
Régimen Alto del 80% al 135% del cd nominal

Estabilidad de Voltaje (estático) : +/- 0.5%
Bajo las siguientes condiciones:
del 1 al 100% de la carga con
+/- 10% de variación de voltaje de entrada
+/- 5% de variación en la frecuencia

Rizo de salida : Un máximo del 2% del voltaje nominal de cd cuando se conecta a una bateria de capacidad en Amperes-hora de por lo ménos cuatro veces el régimen de corriente de salida del cargador.

Corriente : 5, 10, 20, 30, 50, 75 o 100 Acd (modelos 12, 24 y 48 Vcd)
5, 10, 15, 30 o 50 Acd (modelos 120 Vcd)

Límite de Corriente :
Ajustable de 20% al 100% de la corriente nominal de cd

Estabilidad de Corriente :
+/- 2% de la corriente de límite

1.3 CONTROLES

- Boton de régimen alto manual
- Potenciómetro de voltaje en flotación
- Potenciómetro de voltaje en régimen alto
- Potenciómetro de límite de corriente

1.4 INDICADORES

- Voltmetro de cd, 3" tolerancia 2%
- Ampermetro de cd, 3" tolerancia 2%
- Indicador de encendido verde LED
- Indicador de régimen alto ambar LED

1.5 CONDICIONES AMBIENTALES

Temperatura Ambiente	:	de -10 C a +40 C
de Operación	:	de +40 C a +55 C se reduce la corriente nominal a razon de 1.25% /1 C
de Almacenamiento	:	de -25 C a + 70 C
Altitud	:	1000 msnm de 1000 a 4000 m con una reducción a razon de 6.7% /1000 m
Humedad Relativa	:	95% sin condensación
Enfriamiento	:	por convección

1.6 PROTECCIONES

Para la entrada de CA cuenta con un dispositivo termo-magnético contra sobrecargas
Para la salida de CD un fusible
Supresores de tensión en CA y CD
Circuito de Arranque lento
Protección contra inversión de polaridad en bateria

1.7 GENERALIDADES

1.7.1 Magnéticas

Clase : 155 C
Temperatura de aislamiento mínima : 185 C
Voltaje de ruptura en aislamientos : 2500 Vrms mínimos

1.7.2 Alambrado

Aislamiento : 600 V
Todos los cables estan identificados bajo especificaciones NEC, NFPA - 70

1.7.3 Gabinete

Tipo	: NEMA - 1 con ventilacion
Terminacion	: Pintura Epoxica
Color	: Gris ASA 61
Panel	: Azul Cadmio
Terminación bastidor	: Dicromato de Zinc amarillo

1.7.4 Pruebas

Evaluado de acuerdo a NEMA RI - 2

1.7.5 Respuesta en la salida

Cambio en la carga	Un elemento unico (L/LC) filtro en la carga de la bat.	
10 - 100%	-5%	250 ms
100 - 10%	+5%	70 ms

2.0 OPCIONES

1) Una tarjeta de alarmas con las opciones siguientes:
- LED indicador de falla de CA
- LED indicador de alto voltaje de CD
- LED indicador de bajo voltaje de CD
- LED indicador de + a tierra
- LED indicador de - a tierra
- LED indicador de falla del rectificador
- Interruptor para prueba de LED's/restablecimiento
- Relevador de alarma común

Especificaciones para los contactos del relevador
CA : 240 Vca, 5 A, 480 VA, FP= 1.0
CD : 100 Vcd, 5 A, 120 W, Resistivos

2) Compensación de temperatura en la bateria
3) Límite de corriente en la bateria
4) Compartimiento de carga (cargadores en paralelo)
5) Contactos de alarmas. Arriba mencionadas 6 alarmas

3.0 INSTALACION Y ALAMBRADO

3.1 Instalación

Coloque el cargador en el lugar deseado, de acuerdo al dibujo dimensional mostrado en la última sección del manual. Evite los lugares en donde se encuentren equipos que generen calor, mucha suciedad o humedad. Todos los gabinetes deberán ser montados verticalmente. Mantenga distancias de ventilación segun se muestra en el dibujo (por ejmplo: 51mm en la parte posterior y 254 mm en la superior e inferior). NO BLOQEE LAS RANURAS DE VENTILACION.

3.1.1 Gabinetes de pared

Instale las unidades que se colocan en la pared utilizando tornillos de 1/4" de diametro o más grandes de acuerdo al peso de la unidad y del material de la pared. Con los tornillos en su lugar (hoyos de montaje), instale el gabinete. Abra la puerta para poder tener acceso a los tornillos y poder ajustarlos.

3.1.2 Gabinetes de piso

Los gabinetes para montaje en piso Saft Nife se pueden mover facilmentemediante el uso de un patín hidraulico. Observe que las placas de ventilación son removibles, dando acceso al elemento de izaje para tirar de él suavemente.

3.2 Inspección

Antes de efectuar cualquier conexión al cargador, se debera verificar lo siguiente:
1) La placa de especificaciones de operación para asegurar que la alimentacion de CA de entrada y la bateria corresondan a los parámetros del cargador.

2) Que todas las fuentes de alimentación de llegada al cargador esten apagadas

3) Que las protecciones de CA y CD del cargador esten desactivadas

4) Que todos los desechos dentro y alrededor del equipo hayan sido eliminados.

3.3 Conexiones

La entrada de cableado al gabinete se efectúa normalmente por el fondo. Los conductos pueden ser conectados en la tapa, parte posterior o a los lados según se requiera. Para una adecuada conexión de las entradas refierase al esquema del cargador, al final del manual Instale y alambre la bateria de acuerdo al diagrama de distribución proporcionado por el fabricante de la bateria.
Cuando se hagan conexiones al cargador utilice cables del calibre adecuado para la corriente de salida del cargador, listada en la placa de datos característicos del cargador. Refiérase al diagrama esquemático del cargador.
Si la bateria esta colocada a una destancia considerable del cargador, los cables deberan elegirse para una caida de voltaje mínima y para la corriente de salida máxima de CD.

3.3.1 Conexiones de la carga y de la bateria

Con las fuentes de alimentación al cargador y las protecciones de CA y CD apagadas, haga las siguientes conexiones:
- Para evitar accidentes, observe la polaridad adecuada.
- Alambre la terminal de +Vcd y la terminal positiva de la carga a la terminal positiva de la bateria
- Alambre la terminal de -Vcd y la terminal negativa de la carga a la terminal negativa de la bateria

Refiérase al diagrama del cargador, conforme se requieran conexiones no estandares.

NOTA. La carga de CD se deberá conectar a las terminales de la bateria y nó a las terminales del cargador. Esto es vital para aplicaciones que requieren de altas corrientes.

3.3.2 Conexión de la alimentación de CA

Verifique la linea de CA, sus valores de voltaje, frecuencia y fase deberan adecuarse a las especificaciones segun se lista en la placa de características del cargador, localizada al frente. La línea

de CA debera ser la adecuada para permitir el manejo de máxima capacidad de corriente, segun se indica en las características del interruptor de entrada. Conecte la entrada de CA a las terminales indicadas en la secuencia de fase correcta. Asegúrece de conectar la terminal de tierra (GND).

PRECAUCION : Las celdas cargadas, contienen mucha energia almacenada y se deberá tener cuidado cuando use herramientas metálicas alrededor de la bateria para evitar cortos.

3.4 Controles opcionales

3.4.1 Compensación de temperatura en la bateria (de inserción en tarjeta principal)

Este circuito compensa el voltaje de salida de la unidad a una temperatura relativa de la bateria en un rango de -0.18% / C de -20 C a +50 C, reduciendo a 0% / C en un rango de -40 C a + 80 C respectivamente. Esta opción puede ser usada para compensar el voltaje del cargador.
Esta opción auxilia al cargador de baterias reduciendo el consumo de agua e incrementando la vida de las baterias. El sensor externo se monta en la bateria y se alambra hacia la unidad.

3.4.2 Límite de corriente de bateria y compartimiento de la carga. (de inserción en tarjeta principal)

3.4.2.1 Límite de corriente de bateria

El amplificador de límite de corriente de bateria, en conjunto con un SHUNT (conectado en serie a la bateria) permite un control de la corriente de carga de bateria, independiente del circuito de límite de corriente principal. Esta función se aplica normalmente cuando la corriente total de salida es demasiado grande para la bateria (por ejemplo una bateria pequeña)

3.4.2.2 Compartimiento de carga

El compartimiento de carga permite a dos o más cargadores operar en paralelo dentro del 10% uno del otro sin alambrado adicional.

3.4.3 Tarjetas de alarmas opcionales

La tarjeta de alarmas, cuando de suministra, provee un medio de anunciarse mediante un relevador de alarma remota para las siguientes funciones:

3) Que las protecciones de CA y CD del cargador esten desactivadas

4) Que todos los desechos dentro y alrededor del equipo hayan sido eliminados.

3.3 Conexiones

La entrada de cableado al gabinete se efectúa normalmente por el fondo. Los conductos pueden ser conectados en la tapa, parte posterior o a los lados según se requiera. Para una adecuada conexión de las entradas refierase al esquema del cargador, al final del manual Instale y alambre la bateria de acuerdo al diagrama de distribución proporcionado por el fabricante de la bateria.
Cuando se hagan conexiones al cargador utilice cables del calibre adecuado para la corriente de salida del cargador, listada en la placa de datos característicos del cargador. Refiérase al diagrama esquemático del cargador.
Si la bateria esta colocada a una destancia considerable del cargador, los cables deberan elegirse para una caida de voltaje mínima y para la corriente de salida máxima de CD.

3.3.1 Conexiones de la carga y de la bateria

Con las fuentes de alimentación al cargador y las protecciones de CA y CD apagadas, haga las siguientes conexiones:
- Para evitar accidentes, observe la polaridad adecuada..
- Alambre la terminal de +Vcd y la terminal positiva de la carga a la terminal positiva de la bateria
- Alambre la terminal de -Vcd y la terminal negativa de la carga a la terminal negativa de la bateria

Refiérase al diagrama del cargador, conforme se requieran conexiones no estandares.

NOTA. La carga de CD se deberá conectar a las terminales de la bateria y nó a las terminales del cargador. Esto es vital para aplicaciones que requieren de altas corrientes.

3.3.2 Conexión de la alimentación de CA

Verifique la linea de CA, sus valores de voltaje, frecuencia y fase deberan adecuarse a las especificaciones segun se lista en la placa de características del cargador, localizada al frente. La línea

de CA debera ser la adecuada para permitir el manejo de máxima capacidad de corriente, segun se indica en las características del interruptor de entrada. Conecte la entrada de CA a las terminales indicadas en la secuencia de fase correcta. Asegúrece de conectar la terminal de tierra (GND).

PRECAUCION : Las celdas cargadas, contienen mucha energia almacenada y se deberá tener cuidado cuando use herramientas metálicas alrededor de la bateria para evitar cortos.

3.4 Controles opcionales

3.4.1 Compensación de temperatura en la bateria (de inserción en tarjeta principal)

Este circuito compensa el voltaje de salida de la unidad a una temperatura relativa de la bateria en un rango de -0.18% / C de -20 C a +50 C, reduciendo a 0% / C en un rango de -40 C a + 80 C respectivamente. Esta opción puede ser usada para compensar el voltaje del cargador.
Esta opción auxilia al cargador de baterias reduciendo el consumo de agua e incrementando la vida de las baterias. El sensor externo se monta en la bateria y se alambra hacia la unidad.

3.4.2 Límite de corriente de bateria y compartimiento de la carga. (de inserción en tarjeta principal)

3.4.2.1 Límite de corriente de bateria

El amplificador de límite de corriente de bateria, en conjunto con un SHUNT (conectado en serie a la bateria) permite un control de la corriente de carga de bateria, independiente del circuito de límite de corriente principal. Esta función se aplica normalmente cuando la corriente total de salida es demasiado grande para la bateria (por ejemplo una bateria pequeña)

3.4.2.2 Compartimiento de carga

El compartimiento de carga permite a dos o más cargadores operar en paralelo dentro del 10% uno del otro sin alambrado adicional.

3.4.3 Tarjetas de alarmas opcionales

La tarjeta de alarmas, cuando de suministra, provee un medio de anunciarse mediante un relevador de alarma remota para las siguientes funciones:

El nivel de la alarma de conexion a tierra esta fijado a 10 mA o 100 ohm/V. La indicacion de la alarma puede ser medida utilizando un voltmetro, conectado entre TP1 (0V) y TP70 para conexiones a tierra POS., y TP80 para conexiones a tierra NEG. Para iniciar las alarmas, utilice una resistencia de un valor adecuado, conectada de la salida positiva de CD a tierra para la conexion a tierra POS. y de la salida negativa a tierra para la conexion a tierra NEG.

El valor de la resistencia se puede calcular utilizando la formula

R = VCD NOM x 100 ohm

Cuando ocurre una alarma, el voltaje en los puntos de prueba sera aproximadamente de 8V. El tiempo de retardo en la alarma esta fijo a 4 segundos.

3.3.5 Falla del Rectificador

Simule una falla del rectificador abriendo el circuito de entrada de CA, o eliminando el fusible de salida de CD. Después de aproximadamente 15 segundos, se encendera el LED H80 que se encuentra en el control principal, y después de 2 segundos mas, se encendera el LED H90 localizado en la tarjeta de alarma.

3.3.6 Prueba de Lamparas/Restablecimiento

Reconecte la carga y utilice el boton pulsador del indicador de prueba/restablecimiento localizado en la tarjeta de alarma para restablecer todas las alarmas.

- Falla de CA
- Alto voltaje de CD
- Bajo voltaje de CD
- Fuga a tierra de +
- Fuga a tierra de -
- Falla del rectificador

El indicador local de cada alarma es suministrado por LED's individuales, montados en la tarjeta de alarmas.

3.4.4 Contactos de alarmas remotas selectivas

Se suministran contactos individuales tipo 'C' para las 6 alarmas arriba mencionadas.
Rango de los contactos 0.6A, 125 Vca, 2 A, 30 Vcd
0.6A, 125 Vcd

4.0 Instrucciones de operación

4.1 Generalidades

El voltaje de salida y la corriente del cargador son ajustados desde fábrica para satisfacer las especificaciones de carga de bateria, por lo que generalmente no se requiere de ajustes posteriores. En caso de ser necesario efectuar algun ajuste, consulte la sección 6.0 para detalles de ajuste.

4.2 Puesta en marcha

La operación adecuada del cargador de baterias requiere que todo el alambrado de entrada/salida, bateria o carga (si la hay) sea conectado adecuadamente segun la sección 2.0. Una vez completado el alambrado, inserte el fusible de salida (si lo quitó previamente). El voltaje de la bateria se indicara en el voltmetro de salida. Encienda el interruptor de entrada de CA y el cargador debera incrementar lentamente su voltaje de salida hasta alcanzar el nivel establecido o el límite de corriente.
El cargador arrancara en el modo de flotación. Conmute el cargador hacia el modo de régimen alto para permitir la carga de la bateria, por el período de tiempo especificado por el fabricante de la bateria. Después que éste tiempo se ha completado, el cargador regresa automáticamente al modo de flotación. Con esto se evita sobrecargar la bateria y por ende algun daño a la misma. Esta función es controlada automáticamente por el Control Automático de Carga (CAC) o manualmente mediante el boton de 'régimen alto programado'

4.3 Apagado

Apague el cargador utilizando el interruptor de CA y observe que no existe corriente en la salida. El

voltaje de salida estará indicandose una vez que el fusible de salida de CD ha sido instalado.

4.4 Operación

Durante la operación normal, el cargador compensara la carga adquirida de la bateria por el regulador. Los cargadores recargarán automáticamente la bateria en 'régimen alto' después de una descarga. Una carga periódica en el modo de régimen alto se podría requerir en algunos casos (por ejemplo en un sistema de alerta). La función de régimen alto puede ser activada oprimiendo el boton iluminado como 'régimen alto programado' El cargador regresará automáticamente a flotación después de 6 horas.

PRECAUCION : NUNCA DEJE EL CARGADOR EN EL MODO DE 'REGIMEN ALTO' POR MAS TIEMPO DEL RECOMENDADO POR EL FABRICANTE DE LA BATERIA. UNA SOBRECARGA OCASIONARA QUE LA BATERIA GASIFIQUE (POR ELECTROLISIS). ESTO CONSUMIRA EL AGUA REDUCIENDO EL NIVEL DE ELECTROLITO Y PUEDE SER CONTRAPRODUCENTE PARA LA VIDA DE LA BATERIA.

4.5 Controles

En el panel frontal se encuentran botones de contacto e indicadores. Uno de ellos es el control manual del modo de operación: 'Régimen Alto Programado'

'Regimen Alto Manual'
Presione momentáneamente el boton para inicializar el temporizador de CAC. Para cancelarlo presione por 3 segundos y luego suelte el botón pulsador

NOTA : El tiempo programado de régimen alto (6 hrs) se incrementará por el tiempo que el cargador permanezca en límite de corriente.
Después de haberse completado el tiempo inicializado por el boton pulsador, el cargador regresará a flotación

4.6 Verificación de operación funcional

4.6.1 Prueba del estado de la carga de la bateria

El estado aproximado del estado de la carga de la bateria puede ser determinado mediante una verificación sencilla.

1) Conmute el cargador a 'régimen alto'
2) Observe que la unidad entre en límite de corriente (en el ampermetro de salida)
3) Si el cargador permanece en el límite de corriente

por mas de 36 segundos, la bateria demanda la carga de régimen alto. Si la bateria ya está cargada adecuadamente, el cargador abandonará el modo de límite de corriente (esto se manifiesta como la disminución en la corriente de bateria o a la salida del cargador) . Presione y mantenga por 3 segundos el boton de régimen alto para restablecer el cargador a su modo de flotación. Si el cargador se encuentra en límite de corriente, aún cuando se oprima el boton, el cargador no regresará al modo de flotación.

4.7 Verificaciones periódicas

4.7.1 Voltajes de Flotación/ Régimen Alto

Los voltajes de flotación y régimen alto deberán ser verificados periódicamente (semestralmente) para el cumplimiento de los requerimientos establecidos en la seccion 6.0

4.7.2 La bateria

La bateria es una parte importante de su sistema que se le deberá proporcionar mantenimiento regularmante segun recomendación del fabricante. Se deberá poner especial cuidado en el nivel de electrólito en las celdas ventiladas.

5.0 Operación y descripción de circuitos

5.1.1 Bosquejo del rectificador

El cargador SLR convierte la potencia de CA a CD, controlando el voltaje y corriente de salida. Esto permite que la unidad funcione como un cargador de baterias Se pueden utilizar varias funciones de control para lograr satisfacer los requerimientos de las baterias y las cargas, mejorando el funcionamiento y ayudar a la carga automática.

5.1.2 Operación del cargador SLR

(Observe la figura 5.1.a) El voltaje de CA se aplica al embobinado primario del transformador de potencia a traves del interruptor de CA. El transformador aisla galvánicamente el voltaje principal de CA de los voltajes del secundario elevándolo o disminuyéndolo a los niveles requeridos.
El embobinado secundario esta conectado a un puente rectificador controlado de onda completa, compuesto por

dos tiristores, dos diodos y un diodo freewheeling. El puente controlado por fase convierte la señal de CA no regulada a un voltaje de CD regulado. El puente se conecta a través de una inductancia L1 y un ampermetro (o derivador) al negativo de salida. Y a través de un fusible F1 a la terminal positiva de salida.
Para el control del voltaje y la corriente, se utilizan dos lazos de realimentación independientes. Sólo una de ellas esta activa a la vez.

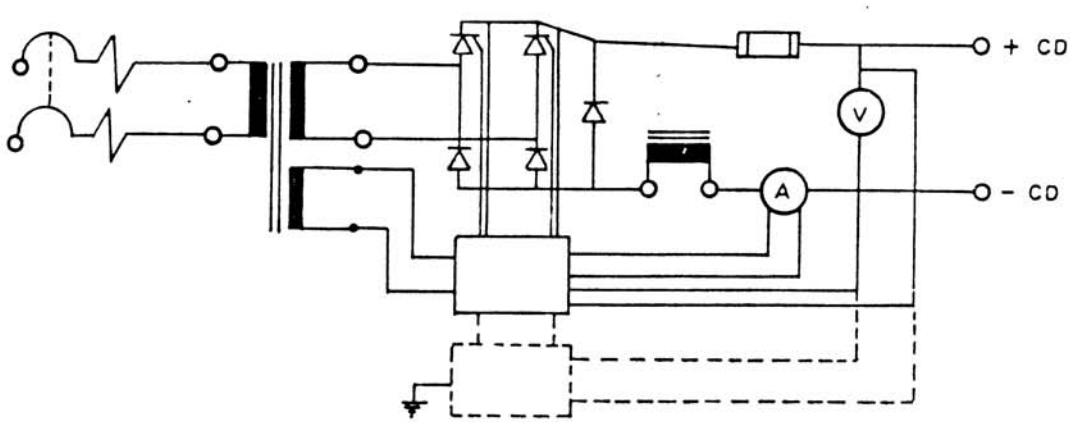


Fig. 5.1.a Cargador de baterias típico SLR

El voltaje de CD es realimentado a la tarjeta de control, encargándose de su regulación en ambos modos flotación y régimen alto. Ambos niveles pueden ser ajustados en la tarjeta de control. El rectificador opera normalmente en el modo de flotación. El modo de régimen alto puede ser operado de manera automático (mediante un temporizador interno) o manualmente mediante la presión del pulsador de régimen alto.

En este modo el rectificador es controlado mediante un control automático de carga existente en la tarjeta de control. Si la demanda de corriente en la salida excede la característica nominal, el rectificador conmutará del modo de voltaje constante al modo de corriente constante. El voltaje alcanzado en el derivador SH (proporcional a la corriente de salida) es sensado y procesado por un amplificador de límite de corriente en la tarjeta de control. El cargador regula su salida de voltaje y corriente mediante el control del puente de tiristores. El puente está diseñado como un rectificador de onda completa y los tiristores determinan la cantidad de corriente proporcionada a la salida. El tiristor está apagado y enciende hasta que le aplican un pulso de disparo en la compuerta. Una vez disparado, el tiristor permanece conduciendo en su polaridad directa hasta que la corriente que fluye por él, es cero.

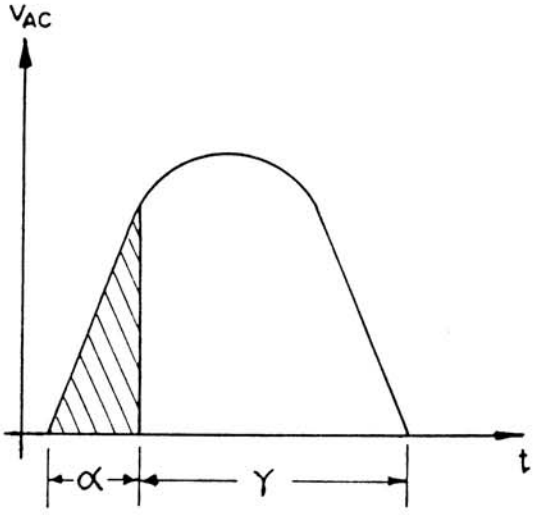


Fig.5.1.b Control del Angulo de fase

El control de ángulo de fase se reliza mediante la variación del retardo en los pulsos de disparo con ello tambien se varía la cantidad de energia disponible en las terminales de salida. Si se requiere de mucha corriente el pulso de disparo comenzará incrementando durante el

medio ciclo de la onda senoidal y viceversa. El voltaje de salida se compensa por éste método tambien.

5.2 Descripción del circuito de control

5.2.0 Generalidades

La tarjeta de control regula automáticamente la salida de voltaje y de corriente dentro de los límites establecidos por los potenciómetros de la tarjeta. Opera retardando el pulso de disparo respecto del cruce por cero de la alimentación de CA, con el fin de controlar el ángulo de conducción de los SCR's.
Los potenciómetros de la tarjeta permiten ajustes independientes de 'Flotación', 'Régimen Alto' y Límite de Corriente.

5.2.1 Fuente de alimentación

De los embobinados aislados del transformador principal, se proporcionan 20 Vca al puente D1-D4 y C1 filtra la CA rectificada. La resistencia R1 y el zener regulador DZ1 proporcionan un voltaje de 15 Vcd para la circuitería de control. TP5 es usado como punto de prueba común para todas las mediciones de voltaje.

5.2.2 Sincronización

Los diodos D5 y D6 rectifican la señal de CA, produciendo un nivel de CD no filtrado, el divisor resistivo R2-R3 El transistor Q1 sensa el rizo de CA y enciende cuando el voltaje de CD es mayor que el Vbe del transistor e inversamente cuando este cae abajo de Vbe. Por tanto un pulso de 0.5 ms es generado en cada cruce por cero. El pulso positivo es aplicado a Q2, el cual enciende y reseta al integrador en el cruce por cero.

5.2.3 Amplificador de voltaje de error y referencia de voltaje.

U1 forma el corazón de una referencia de voltaje interna, de presición y un amplificador de voltaje de error. La referencia de voltaje (+7 Vcd) esta disponible del pin 6 y es usado en otras secciones de la circuiteria.
Para la regulación del voltaje de salida, una muestra del voltaje (ajustable) se toma del divisor de resistencias y es aplicado al -Ve del amplificdor de error, comparándolo con una referencia de voltaje fija. La diferencia (error) es amplificado 100 veces y aplicado al modulador.
El ajuste de voltaje de flotación es llevado a cabo por el potenciómetro P1 y el ajuste de régimen alto por P2 cuando el pin 39 es cortocircuitado al pin 25.

5.2.4 Amplificador de corriente de error

U2a, esta configurado como un amplificador diferencial para reforzar la señal de corriente de salida del SHUNT en cualquier modo único, finalizado o diferenciado. La señal de corriente amplificada es aplicada a la entrada -Ve del amplifacador de corriente U2b, con una referencia ajustable en la entrada +Ve. La señal de error amplificada se aplica al modulador.

5.2.5 Modulador

La función del modulador es controlar el ángulo de conducción de los SCR's. Opera produciendo un retrazo en los pulsos de encendido respecto al cruce por cero de CA. Este retrazo es aproximádamante igual a la proporción inversa del voltaje de control en su entrada (S'MOD).
U2c junto con sus componentes asociados forma un generador de rampa no lineal. El generador de rampa no lineal ayuda a agrupar las características de transferencia del circuito de control a la respuesta del filtro de entrada puente/inductor. El generador de rampa es reseteado en cada cruce por cero por el circuito de sincronización.
La modulación del corrimiento de fase de la señal de control es producida por un muestreo natural en U2d, el cual compara la rampa negativa con la señal de control. Una señal de habilitación al circuito de encendido es generado, cuando la rampa de voltaje es ligeramente inferior al voltaje de control.
El voltaje de control de la entrada del modulador (S' MOD) es determinada por la condición 'OR' del amplificador del voltaje de error, amplificador de corriente de error, arranque lento o capacitor limitador de voltaje. Cualquiera de éstos circuitos pueden operar para reducir el tiempo de conducción de los SCR's.

5.2.6 Arranque lento

El capacitor C11 forma el corazón del circuito de arranque lento. La velocidad de crecimiento del voltaje a través del capacitor, producida por la corriente de carga que fluye a traves de R49, es aplicada al transistor Q3 y a la terminal de modulación. El tamaño del capacitor determina la velocidad de crecimiento de la corriente de salida del cargador, la cual es aproximadamente lineal.

5.2.7 Limitador de voltaje

Las resistencias R48 y R50 forman una red divisora de voltaje la cual es efectivamente alambrada a través del capacitor del filtro de entrada. El rango de voltaje es llevado a cabo por el uso de una resistencia en serie

R48. Cuando el voltaje a través de R50 desarrolla aproximadamente 13.5 V. El diodo zener DZ4 inicia la - - conducción, por tanto polariza al LED dentro del optoacoplador U3. Esto provoca que conduzca el transistor dentro de U3, ocasionando una reducción del ángulo de conducción de los SCR's, a través de Q3 de la terminal del modulador.

5.2.8 Circuito de encendido

El circuito de encendido entrega un tren de pulsos al SCR cuando está habilitado. El transistor Q5 (conmutador de potencia), Q4 sensor de corriente y el transformador de pulsos T1 están configurados como un oscilador de relajación auto-oscilante a una frecuencia aproximada de 10 KHz. El transistor Q4, cuando enciende (por el comparador U2d), deshabilita el circuito de disparo. D17 en el devanado secundario rectifica el pulso de salida y lo aplica a los SCR's a través de unas resistencias de compartimiento de corriente R46 y R47.

5.2.9 Control automático de carga. (CAC) Tarjeta de Inserción.

El amplificador operacional U1a sensa el límite de corriente monitoreando el amplificador de voltaje de error en la forma tradicional. El LED DS1, indica la condición de límite de corriente. El capacitor C4, junto con U1d forma un simple circuito de retrazo de tiempo. El retrazo de tiempo es seleccionado por la reisitencia R13a-c (haciendo una selección apropiada como se indica en el esquemático). U3 suministra el voltaje de referencia para la tarjeta.
U2c y U2d estan configurados como un candado R-S. El cual es activado por una transición positiva de U1b. El candado puede ser activado tambien por una señal externa de pulsadores momentáneos (o cortocircuitando TP a TP sobre la tarjeta de circuito impreso PCB).
El reset es afectado manteniendo la señal activa (manteniendo el reset de la PB) por mas de dos segundos.
Cuando el candado esta activo, el temporizador U4 es activado y una instrucción de régimen alto es dado a través de Q2 y Q3. El temporizador se habilita para contabilizar el tiempo, cuando la señal de límite de corriente es eliminada. El período de tiempo es ajustado para 6,10 o 15 horas por la selección de R17/R18 (6 hrs es lo estándar).

NOTA. El cargador no regresará a flotación cuando la botonera manual de régimen alto es presionada, si la unidad esta en límite de corriente.
Las funciones de control opcionales, estan disponibles como tarjetas de inserción, las cuales son insertadas sobre la tarjeta de control de fase. Los sensores requeridos por cada opción estan alambrados al conector de la

tarjeta de control.

5.3.1 Compensación de temperatura en la bateria (CTB). Tarjeta de inserción opcional.

El sensor usado es un termistor de 10K NTC montado en una cápsula terminal de cobre plateado. Normalmente es montada en un conector intercelda. Esto suministra un verdadero sensor de temperatura de bateria. El voltaje de salida es cambiado en un rango de 0.18%/ (sobre el rango de -20 A + 50 C con una compensación reducida en los extremos.
La señal del termistor es linealizada y amplificada por el puente resistivo R1-4 y U1a e invertido por U1b. La señal de temperatura compenzada es aplicada a través de Vrt a la tarjeta principal (La cual viene a ser dominante) U1c esta configurado como un comparador para verificar la integridad del termistor. Con un termistor en circuito abierto, U1c enciende Q1, inhibiendo la compensación de temperatura forzando Vrt a una temperatura simulada de + 30 C. Al mismo tiempo el LED local , DS1 esta encendido.
Lo siguiente es suministrado solamente con 4111-70-12335 01 (opciones no estándares) U1d suministra una alarma para temperatura alta de bateria a través de Q3. al mismo tiempo inhibe cualquier cambio a régimen alto, (forza el regreso del cargador a flotación) hasta que la bateria se enfría. El suministro de P1 permite ajustes a la alarma la temperatua.

5.3.2 Amplificador de corriente de bateria y compartimiento de carga. Tarjeta de inserción

Amplificador de corriente de bateria.

U1a esta configurado como un amplificador de corriente diferencial, el cual amplifica la señal de corriente de bateria del shunt. La señal de corriente amplificada es aplicada al amplificador de corriente de error con una referencia ajustable de P1. La salida a través de D1 es aplicada a el modulador en la tarjeta principal.
Usando esta opción permite un control independiente de la corriente de bateria, aparte de la corriente del sistema. y puede ser requerida cuando la salida del cargador es grande en relación a la bateria. En tales casos esta opción tambien proporciona una acción correcta del control CAC (un ejemplo de tales aplicaciones puede ser en cargas "grandes" con bateria "pequeñas").

Compartimiento de carga.

El circuito lo comprende U1c.d dónde U1c actúa como un amplificador de error amplificando el error (diferencia en una corriente local y una corriente de un cargador

remoto). El cual es usado para ajustar el amplificador de voltaje de error y consecuentemente el voltaje de salida del cargador. Un potenciómetro P2, es usado para inicializar el balance del cargador para sistemas en paralelo.

6.0 Ajustes.

El cargador de bateria es embarcado y armado de fábrica para el sistema de baterias especificando, de tal forma que no se requieran ajustes adicionales cuando se ponga en operación. Sin embargo, si fueran necesarios los ajustes, la sección siguiente debera utilizarse como una guía.

6.1 Herramientas.

- Herramientas de alineación para potenciómetros o un desarmador plano pequeño.
- Un voltímetro de precisión o multímetro digital (precisión + 1% o mejor)
- Un diagrama de la tarjeta de control (fig. 6.0.a)

El voltmetro deberá ser conectado a través de las terminales de salida de CD del cargador.

6.2 Voltaje en Flotación.

6.2.1 Verificacion del voltaje de flotación.

Verifique que el cargador este en modo de flotación, observando que la lampara de 'Régimen Alto' esté apagada. Si el cargador está en el modo de 'Régimen Alto' regréselo a Flotación presionando y liberando el boton de 'Régimen Alto'. No será posible regresarlo a Flotación si el cargador está en el modo de Límite de Corriente.

NOTA: Con el cargador a menos de plena carga, el voltaje de 'Flotación' deberá ser de 1.40 a 1.42 volts, por celda, para baterias de Níquel-Cadmio, o 2.17 a 2.25 volts por celda para baterias de plomo, dependiendo de las especificadiones del fabricante.

Si el voltaje es el adecuado, continue con el párrafo 6.3.

6.2.2 Ajuste del Voltaje en Flotación.

- Verifique que el cargador no esté produciendo la corriente de salida total (No en límite de corriente).
- Reduzca la carga si es necesario.
- Observe el voltmetro mientras efectúa los ajustes.
- Para incrementar el voltaje de salida, ajuste el potenciómetro de Flotación en sentido horario (CW) en

pequeños incrementos hasta que se logre el voltaje deseado.
- Para disminuir el voltaje de salida, ajuste el potenciómetro de flotación en sentido antihorario (CCW) en pequeños incrementos hasta que se logre el voltaje deseado.
- Permita que el voltaje se estabilice despues de cada incremento antes de continuar.

6.3 Voltaje en Régimen Alto.

6.3.1 Verificación del voltaje en Régimen Alto.

Conmute el cargador a 'Régimen Alto' presionando y liberando el boton/lámpara de 'Régimen Alto'. La lámpara de 'Régimen Alto' se iluminará. Permita que el voltaje de salida y la corriente se estabilice.

NOTA: Con el cargador a una carga menor a la carga plena, el voltaje en Regimen Alto debera se 1.52 volts por celda o mayor (1.55V/C estándar) para baterias de niquel-cadmio o 2.33 volts por celda para baterias de plomo-ácido, dependiendo de las recomendaciones del fabricante de la bateria.

6.3.2 Ajuste del Voltaje en Régimen Alto.

Verifique que la carga no esté produciendo una corriente a plena carga (no en límite de corriente).

- Reduzca la carga si es necesario.
- Observe el voltmetro mientras efectúa ajustes.
- Para aumentar el voltaje de salida, ajuste el potenciómentro de 'Régimen Alto' en sentido horario (CW) en pequeños incrementos, hasta lograr el voltaje deseado.
- Para disminuir el voltaje de salida, ajuste el potenciómetro de 'Régimen Alto' en sentido antihorario (CCW) en pequeños incrementos hasta lograr el voltaje deseado.
- Permita que el voltaje se estabilice despues de cada incremento antes de continuar.
- Cuando quede ajustado adecuadamente, regrese el cargador al modo de 'Flotación' presionando y liberando el boton de 'Régimen Alto'.
- Observe que se apague la lámpara de 'Régimen Alto'.

6.4 Ajuste de control automático de carga.

P1 sobre la tarjeta 4111-70-12334-XX ajusta el punto en el cual el control automático de carga es activado por el límite de corriente del cargador. Este viene ajustado de fábrica, pero si un nuevo ajuste de la tarjeta es requerido, incremente la carga hasta que el límite de corriente sea alcanzado y ajuste P1 hasta que el LED DS1

encienda.

6.5 Sistema de Límite de Corriente.

6.5.1 Verificacion del Límite de Corriente de bateria (opción) 4111-70-12333-XX.

- Remueva todas las cargas del cargador excepto la bateria.
- Conmute el cargador a 'Régimen Alto' y monitoree la corriente de salida. Esta corriente deberá seguir las recomendaciones del fabricante.

NOTA: Si la bateria esta descargada, una carga adicional a las terminales de la bateria puede ser requerida. Si se desea ajustar el límite de corriente a un valor diferente, o para ajustar una nueva tarjeta, use el siguiente procedimiento.

6.5.2 Ajuste del límite de corriente de bateria.

- Gire el potenciómentro de límite de corriente P1 completamente en sentido horario en la tarjeta 4111-70-12333-XX.
- Aplique la carga que ligeramente exceda el límite de corriente (en las terminales de bateria).
- Observando el amperímetro ajuste P1 en sentido antihorario hasta el límite de corriente deseado.
- Incremente la carga debiendose mantener la misma corriente (aproximadamente).

Si desea ajustar el límite de corriente a un valor menor o ajustar una tarjeta de control nueva, utilice el procedimiento siguiente.

6.5.3 Verificacion del límite de corriente del sistema

PRECAUCION : EL LIMITE DE CORRIENTE VIENE AJUSTADO DE FABRICA AL 100% DE LA CORRIENTE NOMINAL DE SALIDA. NO INTENTE EXCEDER LA CORRIENTE NOMINAL MAXIMA, DEFINIDA EN LA PLACA DE CARACTERISTICAS DEL CARGADOR, YA QUE CONDICIONES INADECUADAS DAÑARIAN AL CARGADOR.

- Incremente la corriente de carga mientras observa el voltmetro de CD. (La carga deberá ser tomada de las terminales de la carga si la opción de límite de corriente de bateria esta aplicada).
- Observe la corriente a la cual el voltaje de salida comienza a disminuir.

6.5.4 Ajuste de Límite de Corriente del Sistema.

PRECAUCION: NO EXCEDA LAS CARACTIRISTICAS NOMINALES DE LA CORRIENTE DE PLACA.

- Gire el potenciómetro de Límite de Corriente completamente en sentido horario (CW).
- Aplique una carga ligeramente mayor que la establecida como nominal (En las terminales de la carga si la opción de límite de corriente de bateria es aplicable).
- Observando el amperímetro, ajuste el potenciómetro del límite de corriente.

6.6 Opción.Compartimiento de carga. Tarjeta P2. 4111-70-12333-XX

Ajusta la corriente entre dos cargadores en paralelo. Este viene ajustado de fábrica, pero si un nuevo ajuste o reajuste es requerido, el siguiente procedimiento deberá ser usado:
- Remueva la bateria y ajuste la carga a un 50% del total
- Ajuste los cargadores a sus voltajes de 'flotación' y despues a 'régimen alto' para que sean los mismos, usando un voltmetro digital.
- Ajuste P2 ligeramente en un cargador y después en el otro, en un ajuste fino hasta que sean iguales (25% por cargador).

6.7 Opción. Compensación de Temperatura en bateria. 4111-70-12333-XX.

Esta tarjeta no requiere ajuste. (P1 no es usado). DS1 indica un termistor abierto.

7.0 Procedimiento de búsqueda de fallas

Las Cartas de Diagnóstico para búsqueda de fallas han sido preparadas para ayudar a aislar la falla en el caso de una falla del cargador. En casos de mal funcionamiento, primero verifique lo siguiente:

a) Todas las conexiones entre celdas y entre contenedores, deben ser de positivo a negativo (en serie), y deben estar sujetos de forma segura.
b) Las conexiones entre la bateria y el cargador son positivo a positivo, negativo a negativo (en paralelo) y deben estar sujetos de forma segura.
c) Voltajes en las celdas individuales. En el modo de flotación estas lecturas de voltaje deberán ser 1.40 a 1.42 volts por celda para baterias de níquel cadmio o 2.17 a 2.25 por celda para plomo ácido. Si hay una variación mayor de 0.05 volts entre celdas con las lecturas más alta y más baja, cargue la bateria en régimen alto durante 24 hrs para igualar voltajes y vuelva a verificar.
d) El voltaje y la frecuencia de CA de entrada, deben cumplir con la entrada de diseño del cargador segun

se muestra en la placa de características nominales.

Despues de verificar si todas las conexiones externas estan correctas, los voltajes en las celdas estan dentro de las tolerancias y el voltaje y la frecuencia de CA en la entrada son iguales a los del cagador. Efectúe detenidamente un análisis en cada bloque y proceda segun lo indicado por el resultado.

S I N T O M A	ACCION CORRECTIVA
El fusible de CD se quema inmediatamante.	Refierase al diagrama de diagnostico # 1
El breaker de la red, abre inmediatamente.	Refierase al diagrama de diagnostico # 2
No hay potencia de salida	Refierase al diagrama de diagnostico # 3
El rectificador opera continuamente en el modo de límite de corriente o el voltaje de salida esta incorrecto.	Refierase al diagrama de diagnostico # 4

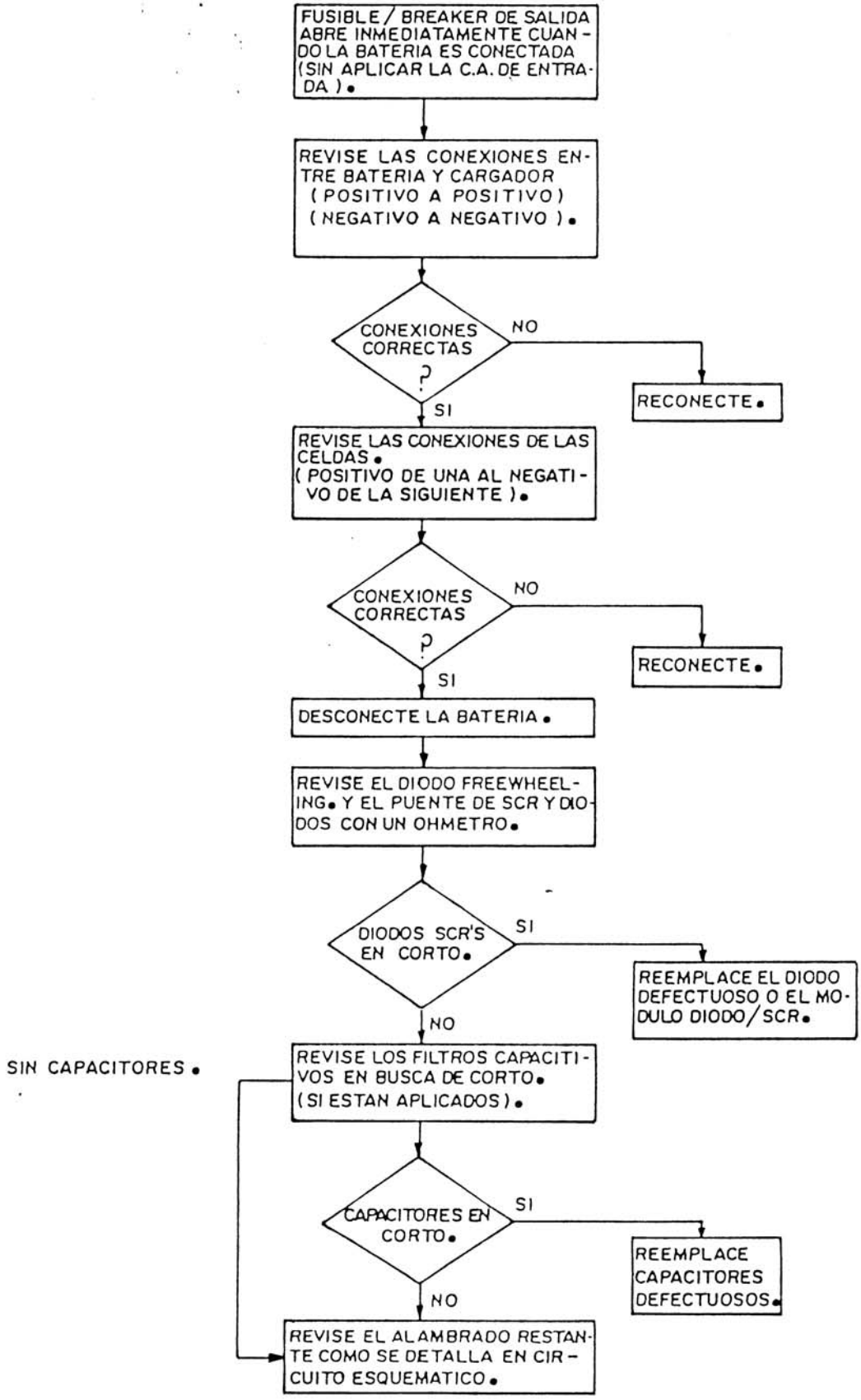
NOTA : SE DEBERA TENER CUIDADO EN TODO TIEMPO, PARA EVITAR EL CONTACTO CON CIRCUITOS VIVOS.

7.1 Verificación del ensamble del puente

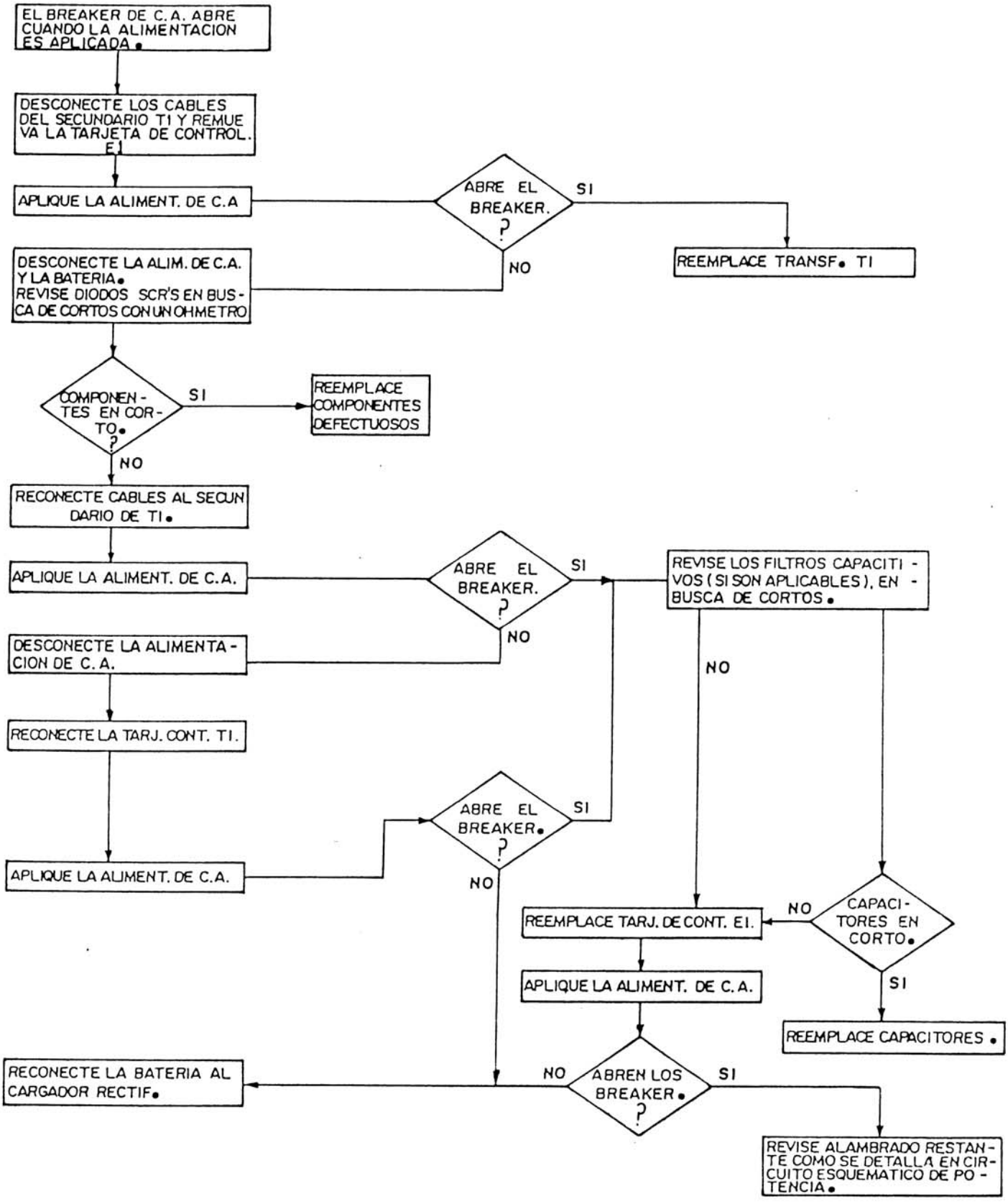
Para cargadores de 100 A de salida o menores se utiliza modulos de SCR/DIODO. Todas las conexiones se hacen a través de las terminales de los módulos. Para verificar la existencia de un corto circuito, primero desconecte la alimentación de la red de CA que viene de la entrada abriendo el circuito interruptor de CA. Utilice un ohmetro o un multímetro en la escala de baja resistencia y verifique ambas direcciones a través de las componentes. Si se indica un corto circuito, desconecte los alambres para aislar la componente dañada. Un SCR en forma individual indicará un circuito abierto en ambas direcciones Para verificar la compuerta, desconecte la terminal de color blanco (compuerta) y verifique la resistencia de compuerta a cátodo (blanco a rojo) con el ohmetro/multimetro. Las resistencias varían pero típicamente estan dentro del rango de 30 a 100 OHMS en ambas direcciones Tambien verifique la resistencia de compuerta a ánodo, deberá ser esencialmente circuito abierto.
Para los diodos, verifique la resistencia de ánodo a cátodo. La resistencia deberá ser baja de ánodo a cátodo y alta de cátodo a ánodo.

Refiriendose al diagrama esquemático, las componentes deberán cumplir con lo siguiente:

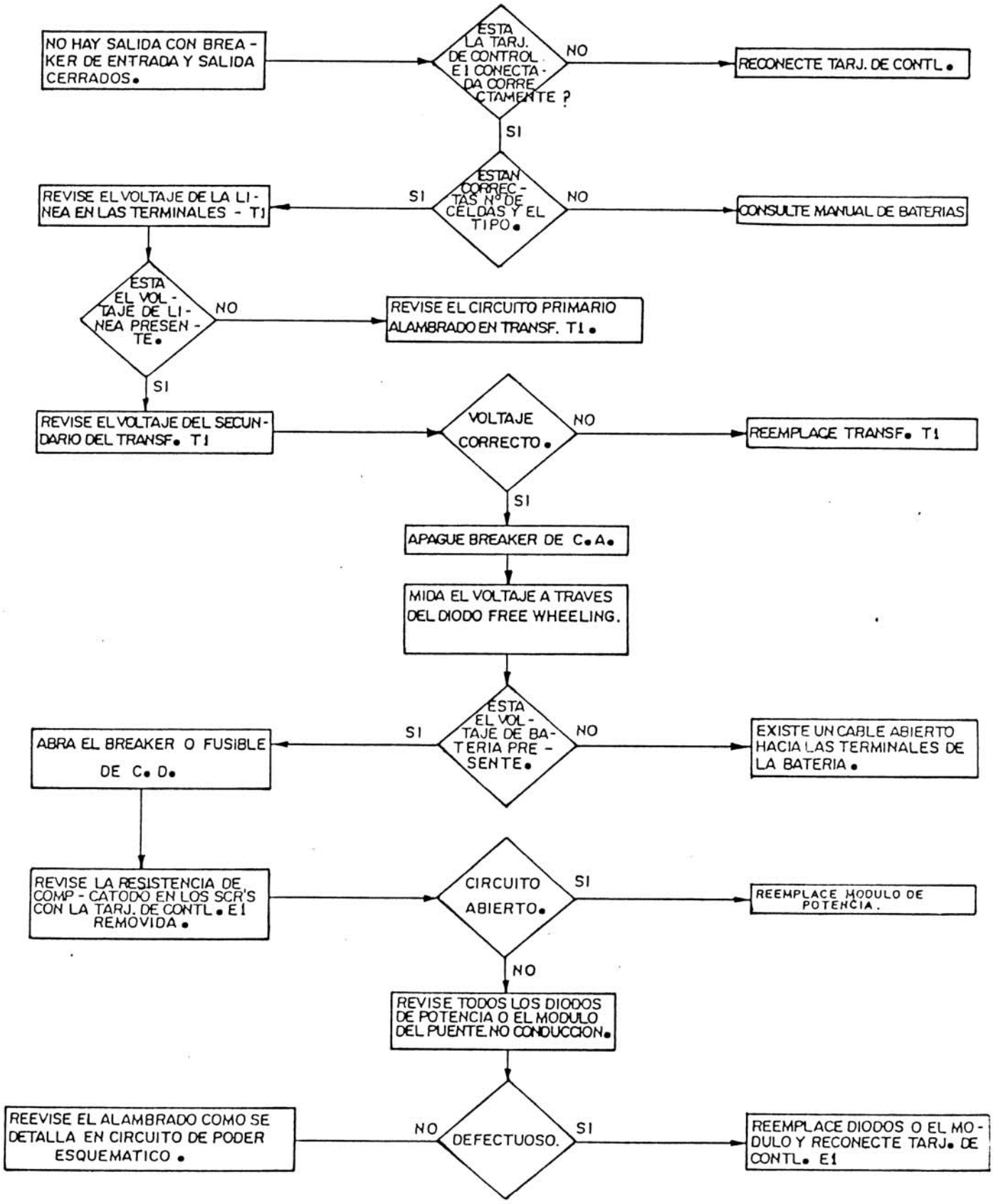
CA1	-	(+) TY1	ALTA	(-)	-	(+)	D3	ALTA
(+)	-	CA1 TY1	ALTA	(+)	-	(-)	D3	BAJA
CA2	-	(+) TY2	ALTA	(-)	-	CA1	D1	ALTA
(+)	-	CA2 TY2	ALTA	CA1	-	(-)	D1	BAJA
(+)	-	G1 COMPUERTA1 30-100 OHMS		(-)	-	CA2	D2	ALTA
(+)	-	G1 COMPUERTA1 30-100 OHMS		CA2	-	(-)	D2	BAJA
G2	-	(+) COMPUERTA2 30-100 OHMS						
(+)	-	G2 COMPUERTA2 30-100 OHMS						
G1	-	(-) COMPUERTA1 ALTA						
(-)	-	G1 COMPUERTA1 ALTA						
G2	-	(-) COMPUERTA2 ALTA						
(-)	-	G2 COMPUERTA2 ALTA						



CARTA DE DIAGNOSTICO # 1.



CARTA DE DIAGNOSTICO # 2.



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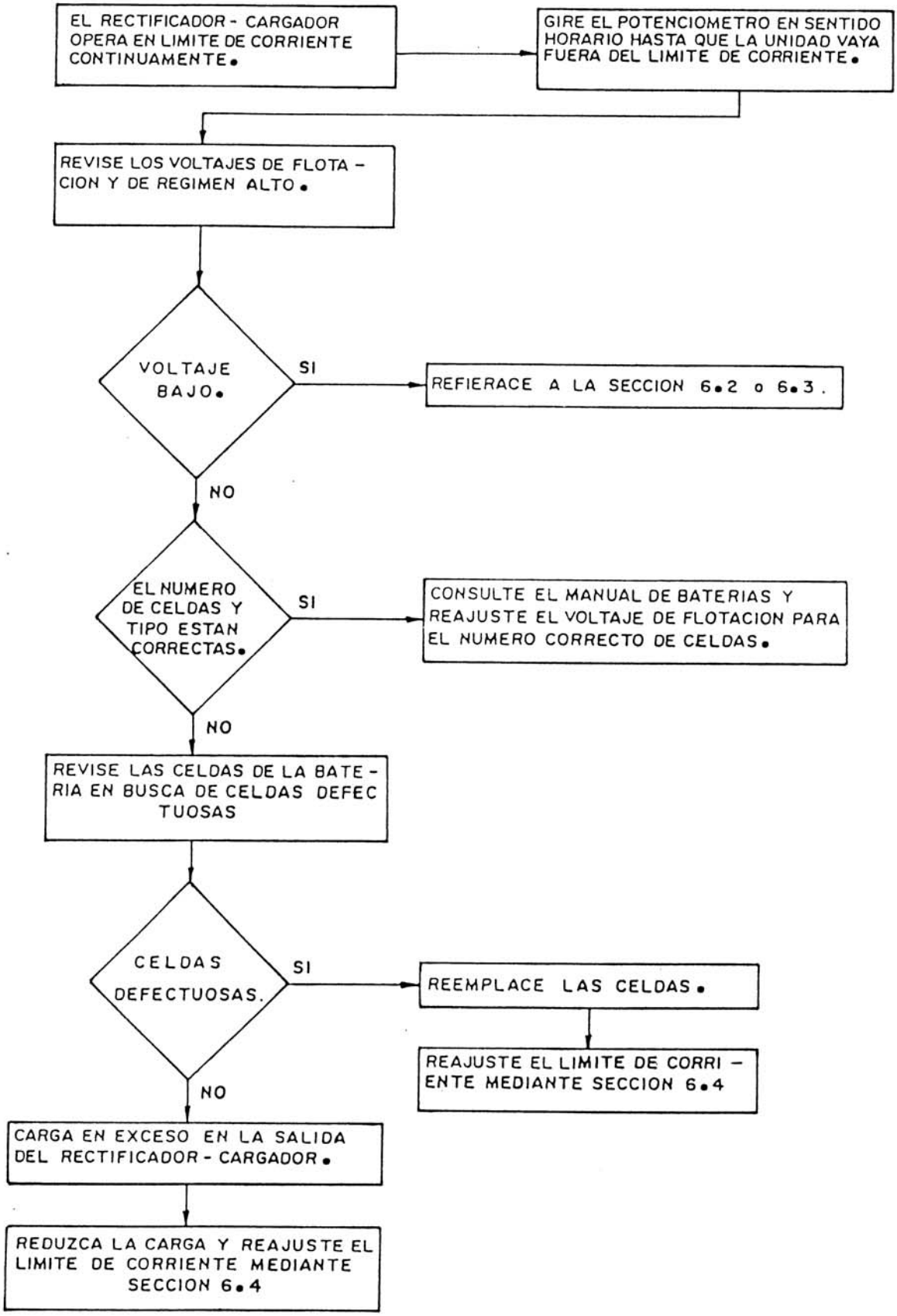


CARTA DE DIAGNOSTICO # 4.

8.0 Conexiones de la tarjeta de control SCR

MH1	-	1	COMUN
MH1	-	2	NO USADO
MH1	-	3	V SENSOR +
MH1	-	4	NO USADO
MH1	-	5	CATODO DEL SCR
MH1	-	6	CATODO DEL SCR
MH1	-	7	COMPUERTA DEL SCR
MH1	-	8	COMPUERTA DEL SCR
MH1	-	9	NO USADO
MH1	-	10	LIMITADOR DE VOLTAJE (NEGATIVO)
MH2	-	1	CONTROL DE REGIMEN ALTO
MH2	-	2	SHUNT DE BATERIA +
MH2	-	3	SHUNT DE BATERIA -
MH2	-	4	TERMISTOR P/COMP. DE TEMP. EN BATERIA
MH2	-	5	TERMISTOR P/COMP. DE TEMP. EN BATERIA
MH2	-	6	SHUNT DEL SISTEMA -
MH2	-	7	SHUNT DEL SISTEMA +
MH2	-	8	LED DE REGIMEN ALTO
MH2	-	9	BOTON PULSADOR DE CONTRL. AUTOM. DE CARGA
MH2	-	10	20 Vca
MH2	-	11	20 Vca
MH2	-	12	FALLA DE CA
MH2	-	13	FALLA DEL CARGADOR
MH2	-	14	LED DE CA ENCENDIDO +
MH2	-	15	LED DE REGIMEN ALTO +

8.1 Voltajes del secundario del transformador T1 (Vrms)

VOLTAJE NOMINAL DE CD	SECUNDARIO X1-X2	SECUNDARIO X3-X4
12	23 V	20
24	43 V	20
48	83 V	20
120	202 V	20

8.2 Características del fusible de CD/Termonagnético

CORRIENTE NOMINAL DE SALIDA EN CD (AMPS)	FUSIBLE (AMPS)
5	8
10	15
15	25
20	30
30	45

CORRIENTE NOMINAL DE SALIDA EN CD (AMPS)	TERMOMAGNETICO
50	75
75	125
100	150

9.0 Manteniminento

Los cargadores de bateris Saft Nife no emplean ninguna parte móvil mas que los potenciómetros de ajuste y los medidores indicadores utilizados para las alarmas. No se requiere de ningún mantenimiento adicional, al necesario para eliminar el polvo del cargador, las verificaciones periódicas y los ajustes durante la vida de la unidad.

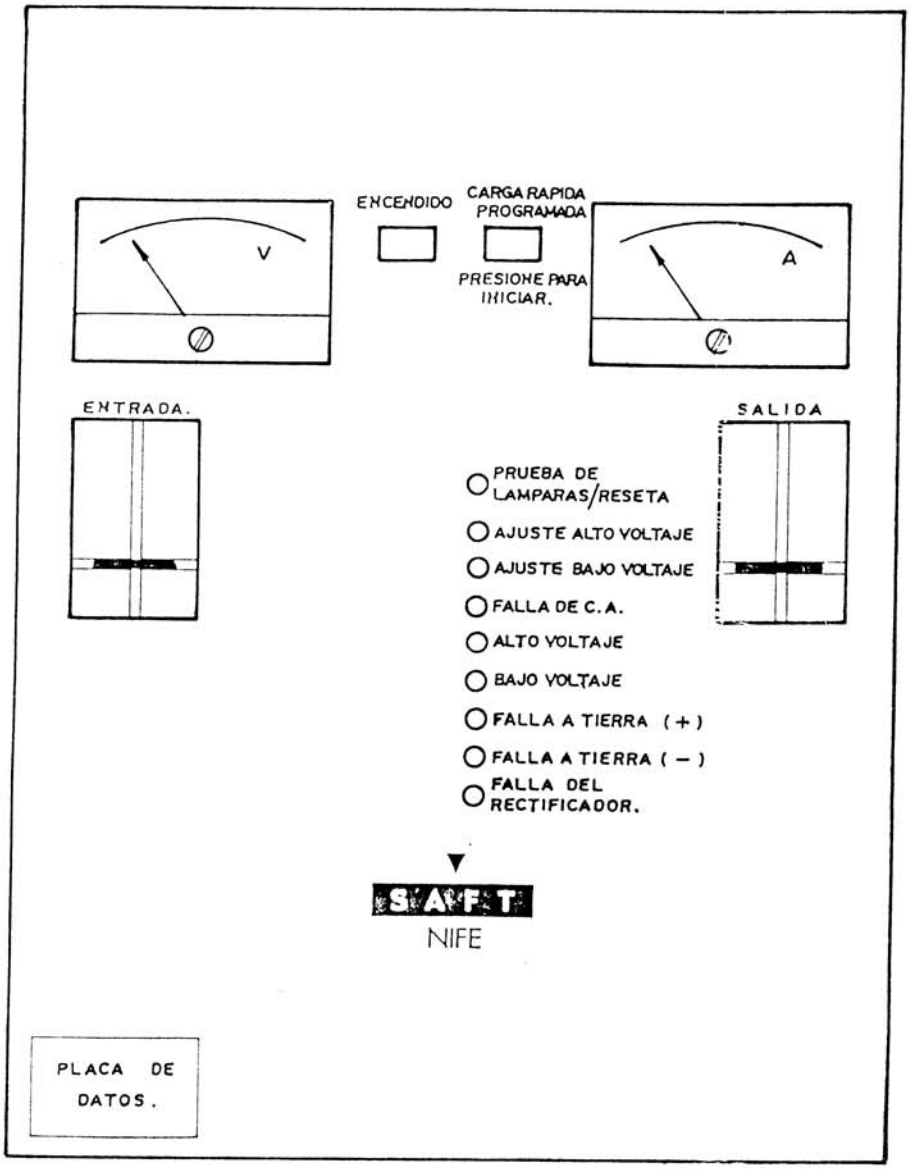
Todas las componentes magnéticas, reisitencias, capacitancias y semiconductores se han seleccionado prudentemente para un período de vida largo.

Se deberá verificar regularmente el estado aproximado de la carga de la bateria. Esto se podrá lograr mediante el procedimiento siguiente:

1) Inicie una carga rápida presionando el boton de régimen alto.
2) Observe que el cargador entre en límite de corriente (en el amperímetro de salida)
3) Si el cargador permanece en límite de corriente por más de 36 segundos, la bateria requiere entonces de una carga en régimen alto. Si la bateria ya ha sido cargada en forma adecuada, el cargador dejará el modo de límite de corriente (obsevada por la disminución de la corriente en la bateria ó a la salida del cargador.
4) Cancele la carga manual en régimen alto si la bateria no requiere de la carga.

Además, regularmente se deberá proporcionar mantenimiento a la bateria como lo indica el fabricante. Se deberá poner atención especial en el nivel de electrólito de las celdas con ventilación. Tambien se deberán verificar los voltajes de 'Flotación' y 'Régimen Alto' semestralmente para que estén de acuerdo a las características mencionadas en la sección 6.0

No.	Revisión	Fecha	Firma	No.	Revisión	Fecha	Firma



No. Pzas.	Pos	No. de Parte	Descripción	Material

No. de Parte

Dibujo: R. RGUEZ. R.

Reviso: M. Sandoval P. | Aprobo:

Fecha: 1992 - 05 - 18.

SAFT
NIFE

Material: | Acabado:

Descripción:

VISTA FRONTAL
CARGADOR —
SLRF 48/50

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Esc: SIN. | Acot:

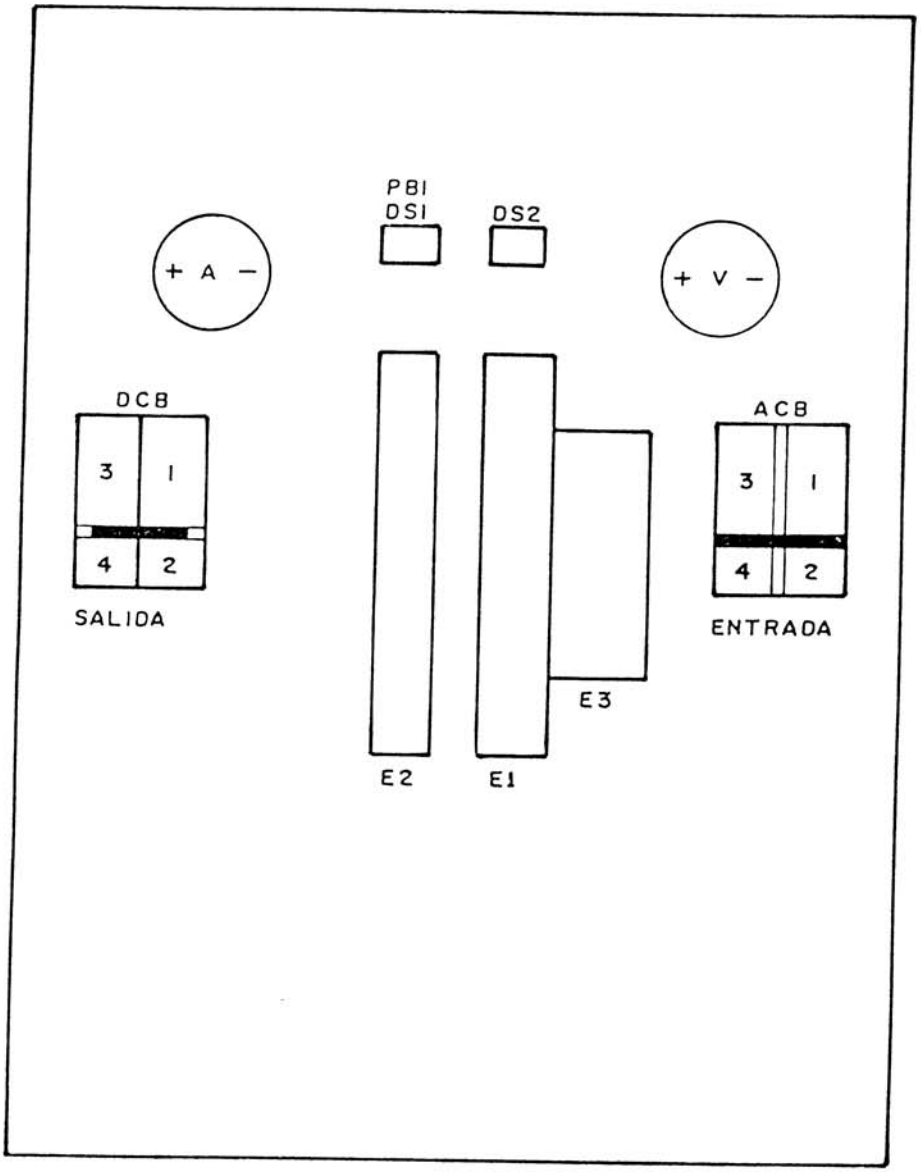
Substituye a:

Pertenece a:

Art. gr. | Reg. | Hoja

Dibujo No.

No.	Revisión	Fecha	Firma	No.	Revisión	Fecha	Firma



VISTA INTERIOR.

No. Pzas.	Pos	No. de Parte	Descripcion	Material

No. de Parte

Dibujo: R. RGUEZ. R.

Reviso: M. Sandoval P.

Aprobo:

Fecha: 1992 - 05 - 18.

SAB NIFE

Material: | Acabado:

Descripción: MV - 21

DISTRIBUCION DE COMPONENTES DE PUERTA EN GABINETE "A" Y "B" CARGADOR TIPO SLR.

SLRF 48/50

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Esc: SIN. | Acot:

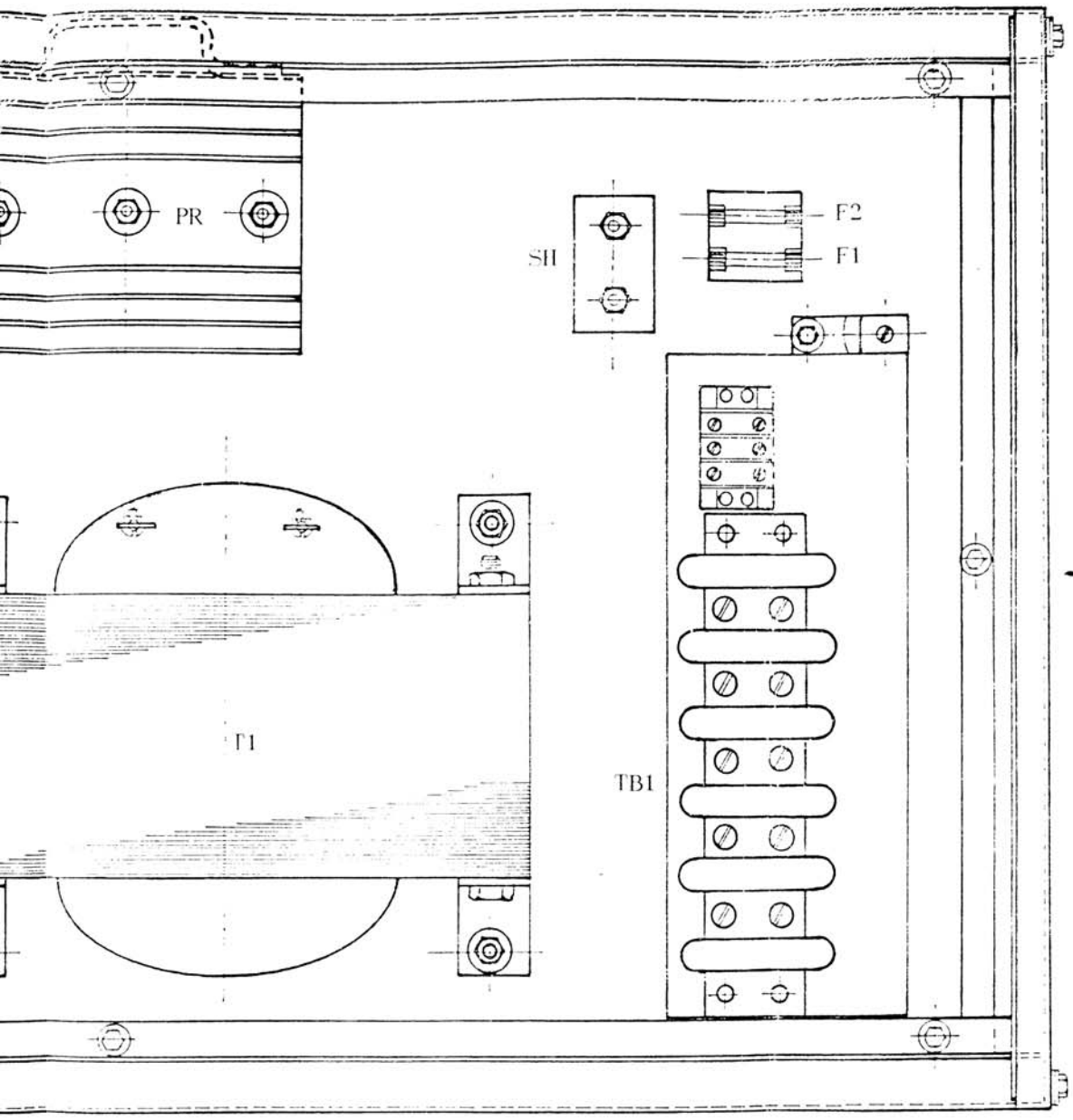
Substituye a:

Pertenece a:

Art. gr. | Reg. | Rev.

Dibujo No.

No.	Revisión	Fecha	Firma	No.	Revisión	Fecha	Firma



No. Pzas.	Pos	No. de Parte	Descripción	Material
	No. de Parte	Dibujó: R.RGUEZ.R.	Material:	Acabado:
		Revisó: M.A.V. Aprobó:	Descripción: DISTRIBUCION DE COMPONENTES SLRF 48/50	Substituye a:
		Fecha: 1993 - 07 - 04		Pertenece a:
		NIFE		Dibujo No.

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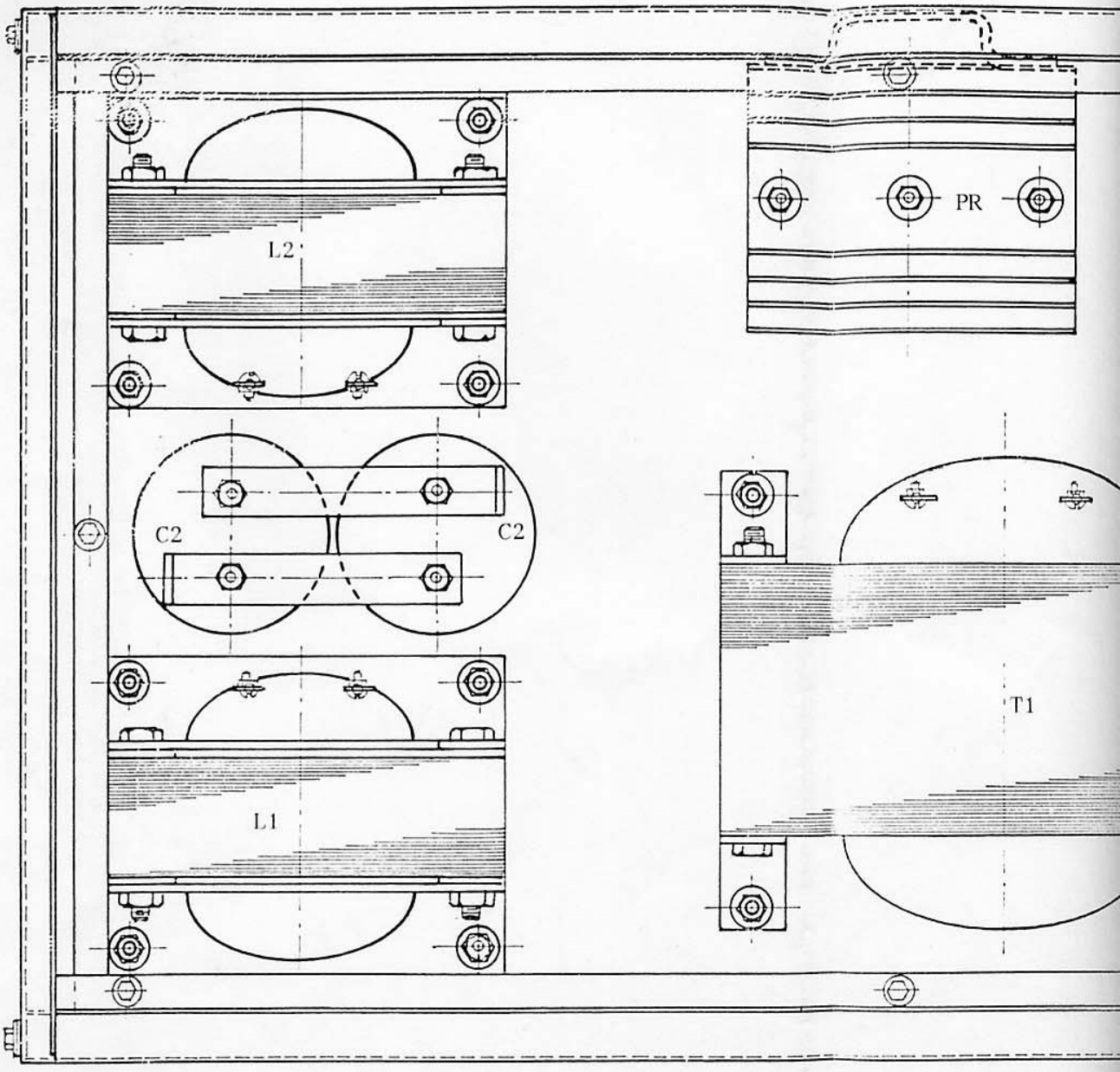
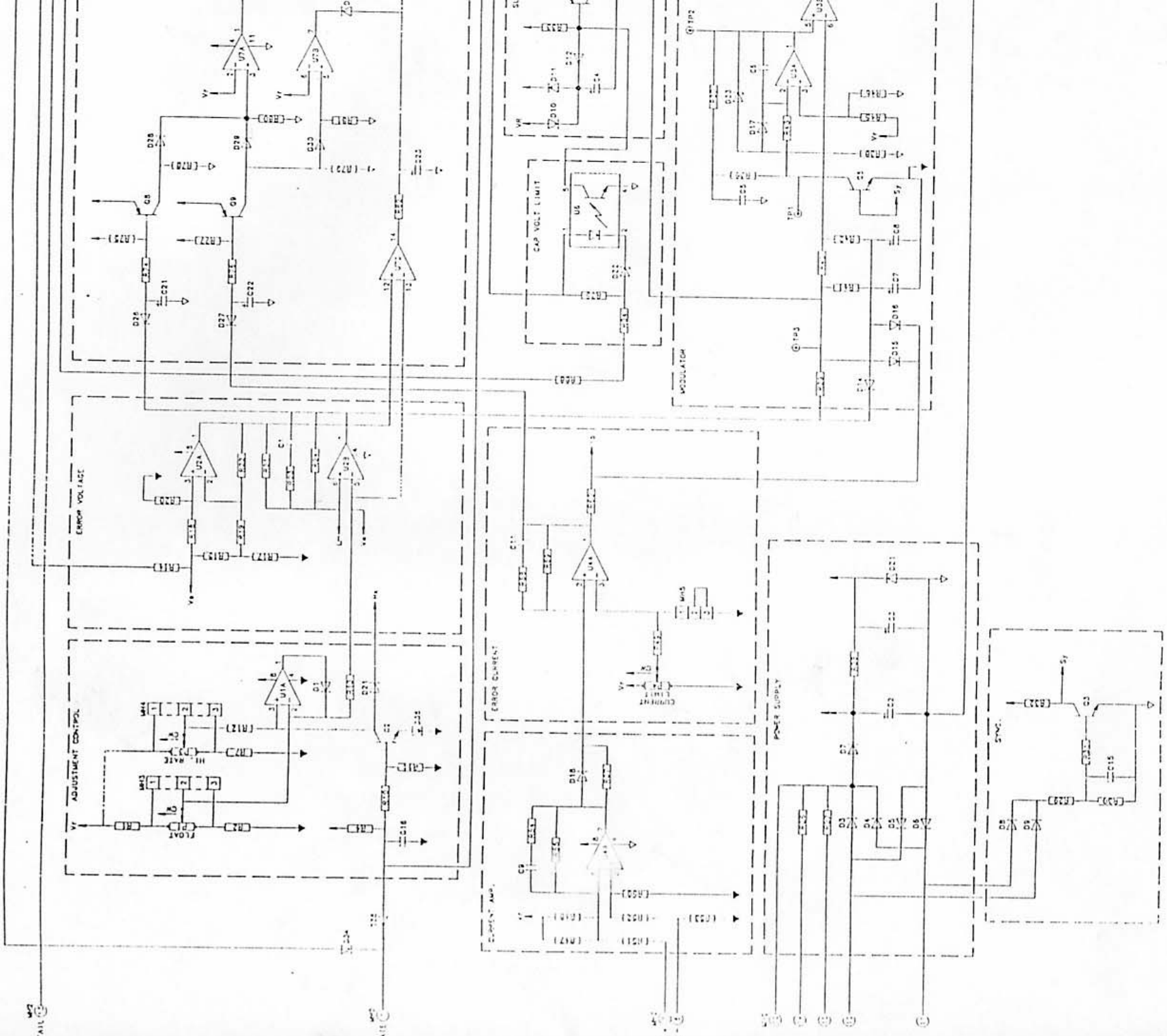
No.	

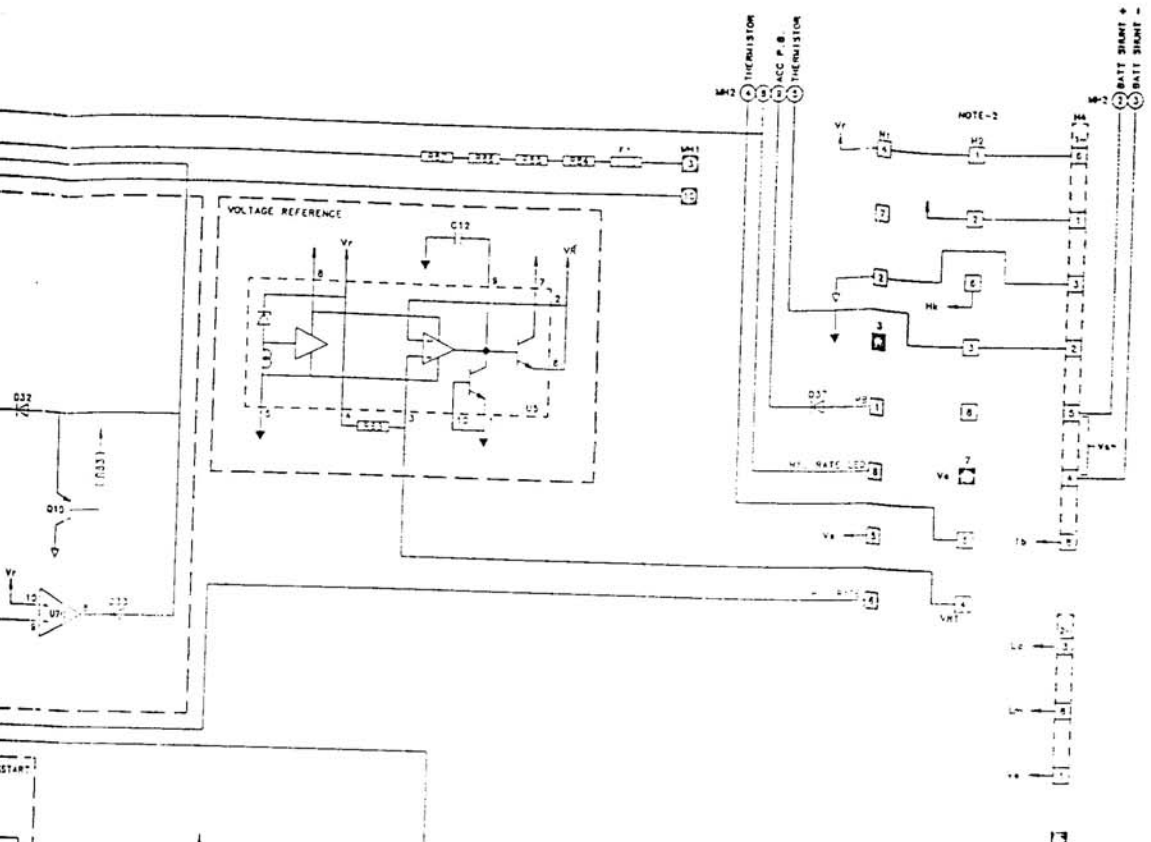


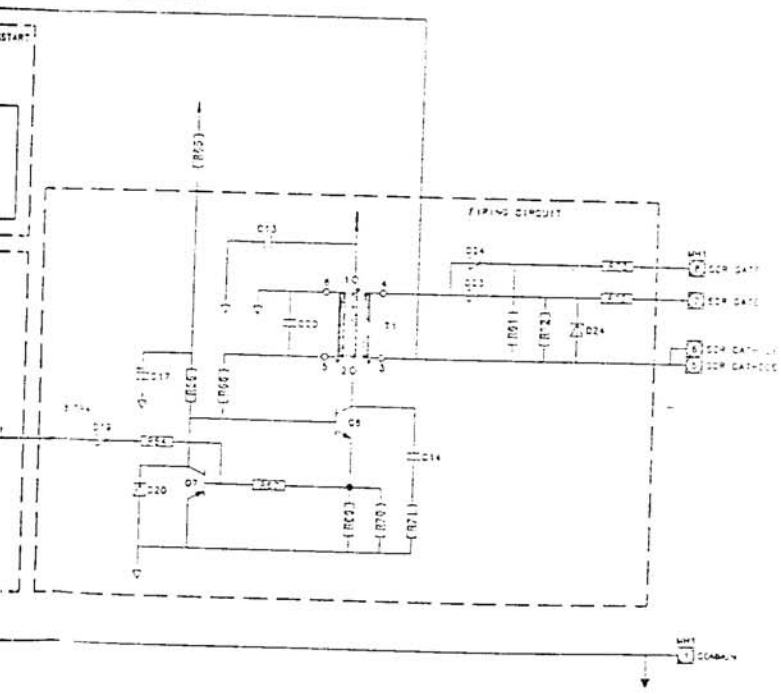
No. Pzas.	Pos
	No. de Parte

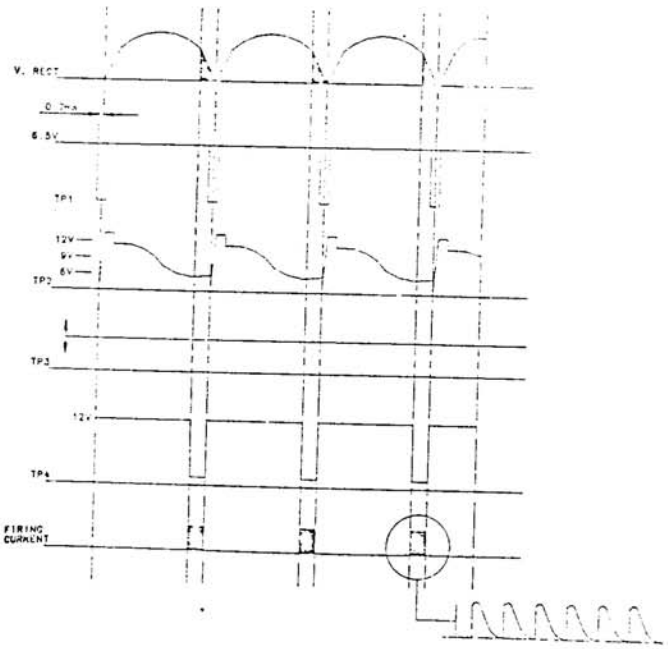

ERROR VOLTAGE
ADJUSTMENT CONTROL
CAP VOLT LIMIT
MODULATION
ERROR CURRENT
CURRENT AMP.
POWER SUPPLY
SYNC.
HI RATE
FLOAT
RECT FAIL
HIGH RATE

NOTES

1. ALL TEST POINTS MEASURED TO GROUND REFERENCE.
2. H1 – (ACC) AUTO CHARGE CONTROL.
   SEE DWG. No. 4111-65-68795-00
   H2 – (BTC) BATTERY TEMP. COMPENSATION.
   SEE DWG. No. 4111-65-68796-00
   H4 – (BAS) BATTERY CURRENT AMP. & LOAD SHARE.
   SEE DWG. No. 4111-65-68798-00
3. VARIATIONS – PT. No. 4111-68-12332-XX
   PT. No. 4111-66-12332-00
   PT. No. 4111-65-12332-01
   PT. No. 4111-65-12332-02
   PT. No. 4111-66-12332-03
   PT. No. 4111-68-12332-04





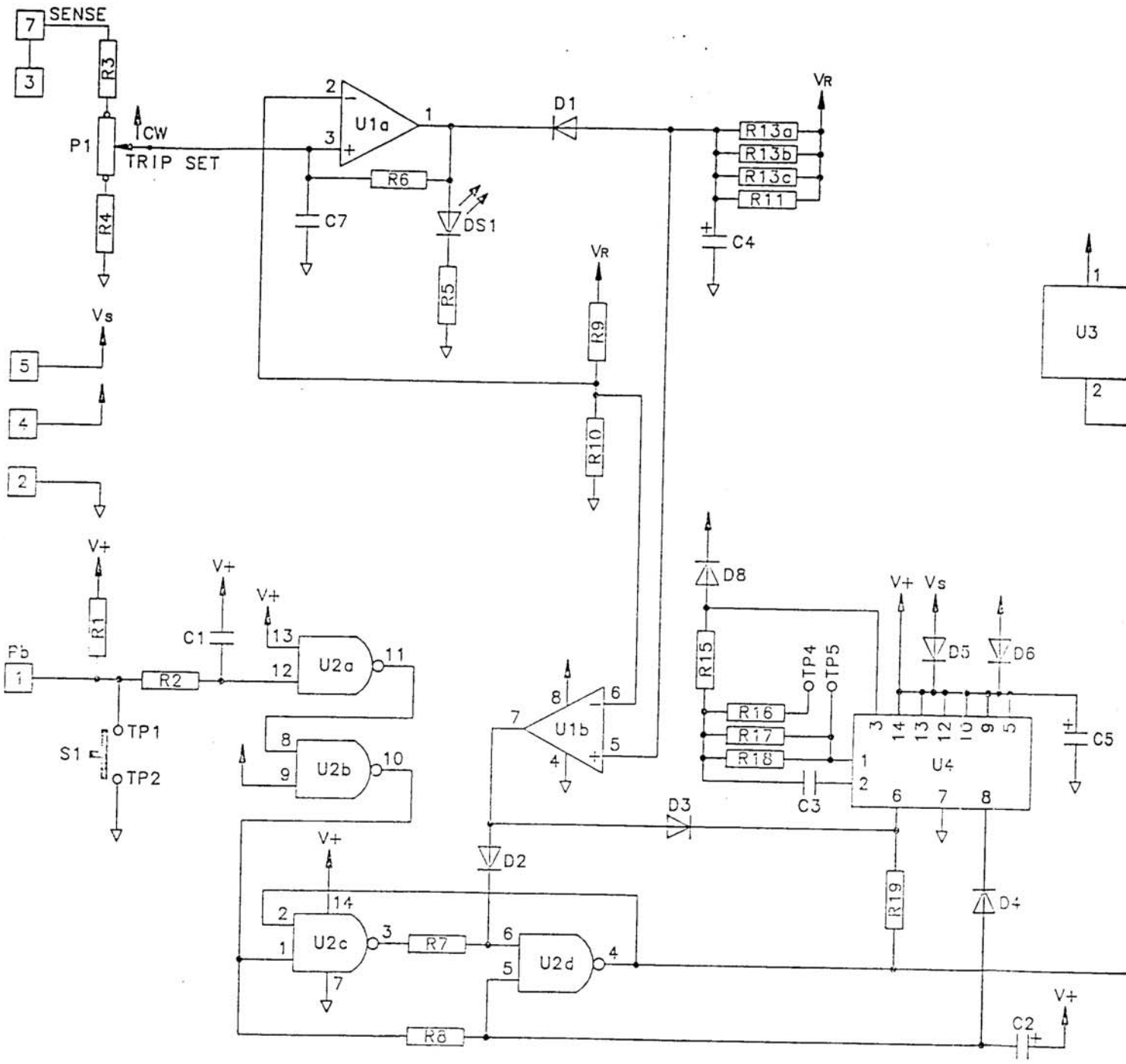


	DRAWN
	DATE 1991-10-31
CUSTOMER	ED PROJ. 00
CUSTOMER ORDER NO.	DWG. No.
BATT-MATE CORP. ORDER NO.	SCALE
CSA NO.	SHEET No.

BATT-MATE Corporation

SCHEMATIC
SINGLE PHASE SLR CONTROL
PT. No. 4111-70-12332-XX

DWG NO. 4111-65-68315-00



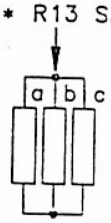
CUSTOMER CLIENT	
CUSTOMER ORDER No. No. DE COMMANDE DU CLIENT	
NIFE CORP. ORDER No. No. DE COMMANDE DE NIFE CORP.	
JOB No. No. DE MANUFACTURATION	

NOTES

1. HIGH RATE ACTIVATE DELAY.

TIME OUT	R13 ** a b c	PART No. SUFFIX		
19 SEC	I I I	00	20	40
24 SEC	I I X	01	21	41
27 SEC	I X I	02	22	42
36 SEC	I X X	03*	23	43
42 SEC	X I I	04	24	44
72 SEC	X I X	05	25	45
100 SEC	X X I	06	26	46
10 MIN	X X X	07	27	47

** R13 SELECTION



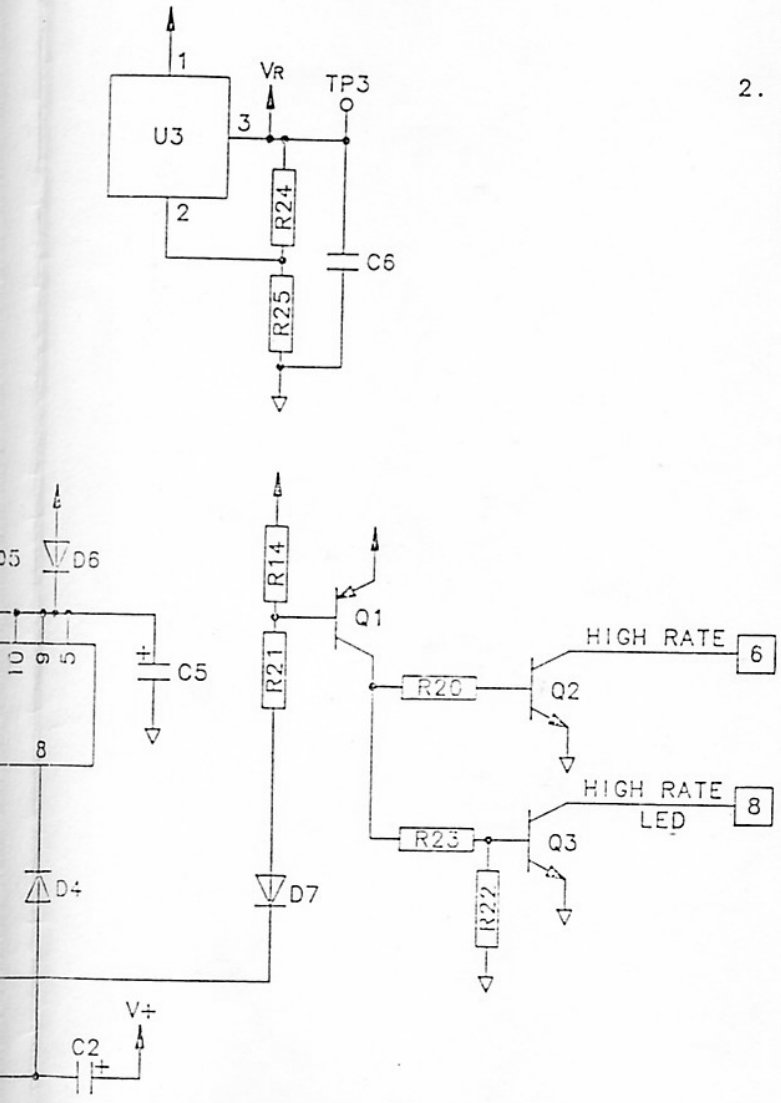
BCD CODE I I I
e.g. I X X
(STANDARD)
36 SECS.

I – INDICATES "IN"
X – INDICATES "OUT"

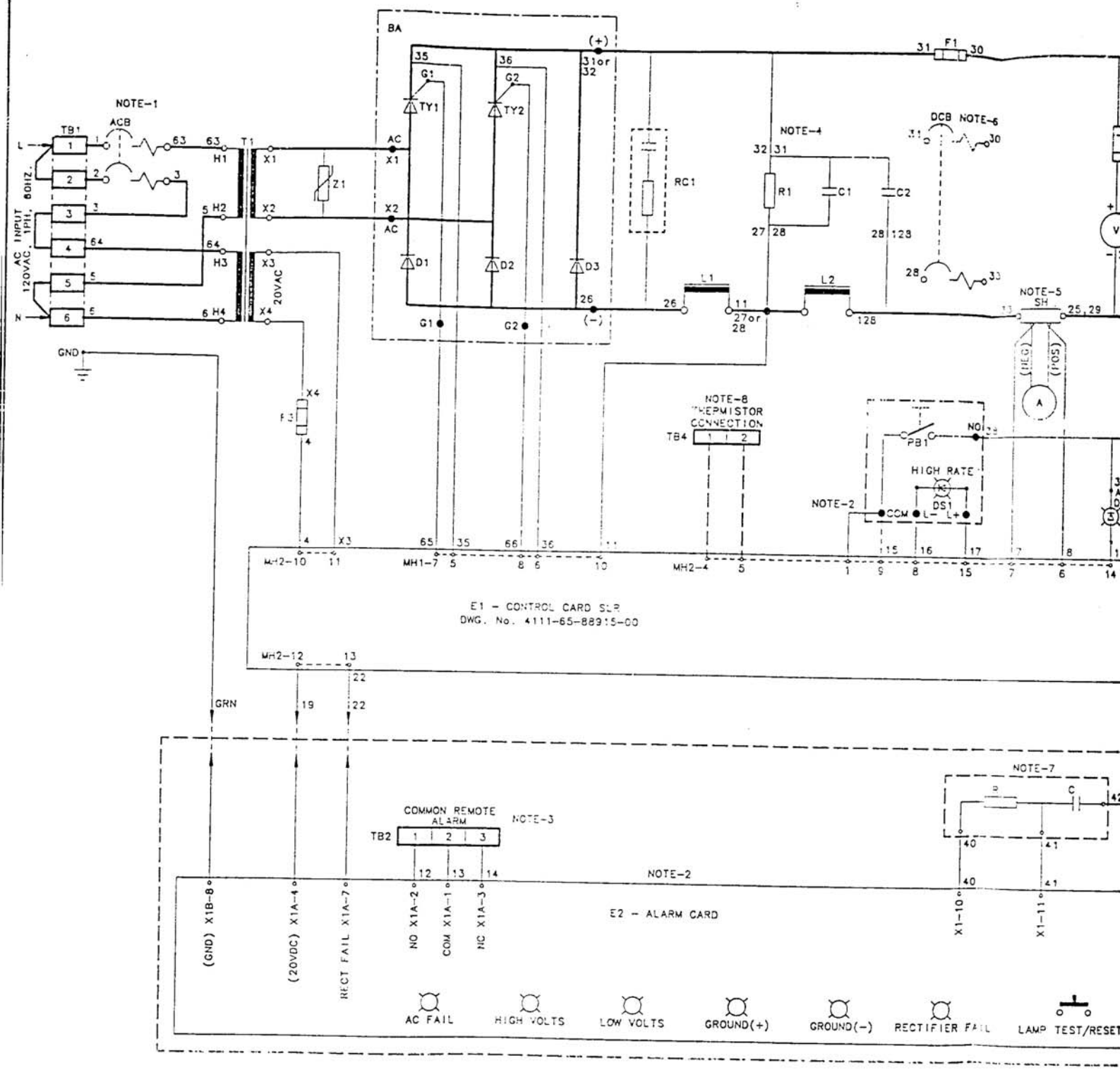
2. TIME OUT.

TIME OUT	R17	R18
* 6 HR.	I	I
10 HR.	I	X
15 HR.	X	I

* STANDARD



	DWN BY DESS PAR d.c.griffin	SAFT NIFE Corporation
	DATE 1992-01-31	
	CHKD BY VER PAR	SLR AUTOMATIC CHARGE CONTROL
	APPR BY APPR PAR	PT. No: 4111-70-12334-XX
	SCALE ECHELLE	
	TOLERANCE	DWG No 4111-65-09265-00 REV

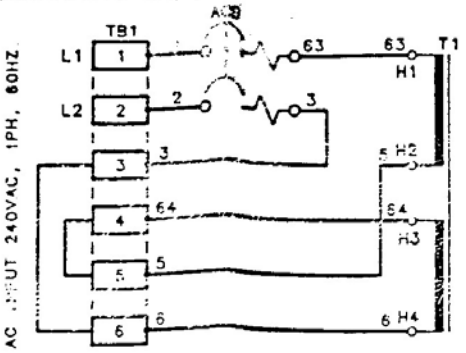


1	1993-02-11	REVISED AS PER ECN 1993-20 R.E.L.

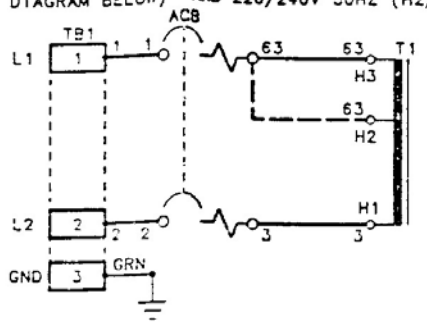
INPUT / ENTREE	
OUTPUT / SORTIE	
CUSTOMER / CLIENT	SAFT N
CUSTOMER ORDER No. / No. DE COMMANDE DU CLIENT	
SAFT NIFE CORP. ORDER No. / No. DE COMMANDE DE SAFT NIFE CORP.	
JOB No. / No. DE MANUFACTURATION	

NOTES

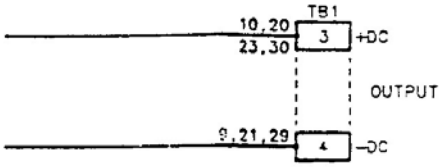
1. AC INPUT CONNECTIONS FOR 240VAC (120/240) UNITS. (SEE DIAGRAM BELOW)



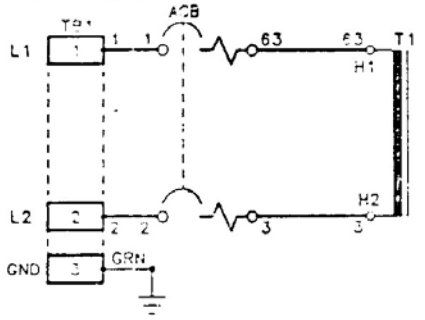
1a. AC INPUT CONNECTIONS FOR 208/240V 60HZ (H2/H3) AND 220/240V 50HZ (H2/H3) (SEE DIAGRAM BELOW)



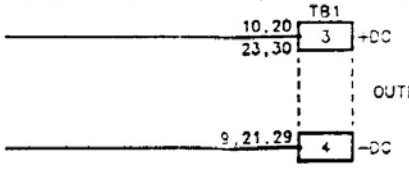
DC OUTPUT CONNECTIONS (SEE DIAGRAM BELOW)



1b. AC INPUT CONNECTIONS FOR 120, 480 & 600VAC (SEE DIAGRAM BELOW)



DC OUTPUT CONNECTIONS (SEE DIAGRAM BELOW)



2. ALARM CARD E2 ASSEMBLY AND AUTO CHARGE ARE ARE OPTIONAL. WHEN ACC IS SUPPLIED PB1-COM IS CONNECTED TO MH2-S.

3. COMMON REMOTE ALARM CONTACTS ARE SHOWN IN THE ALARM CONDITION (RELAY DE-ENERGIZED).
ALARM CONTACT RATINGS:
AC: 120V, 2A, 125VA, 1.0PF.
DC: 120V, 2A, 60W, RES. MAX.

4. OPTIONAL 30MV FILTER: C1/L1/L2.
OPTIONAL BATTERY ELIMINATOR FILTER: C1/C2/L1/L2.

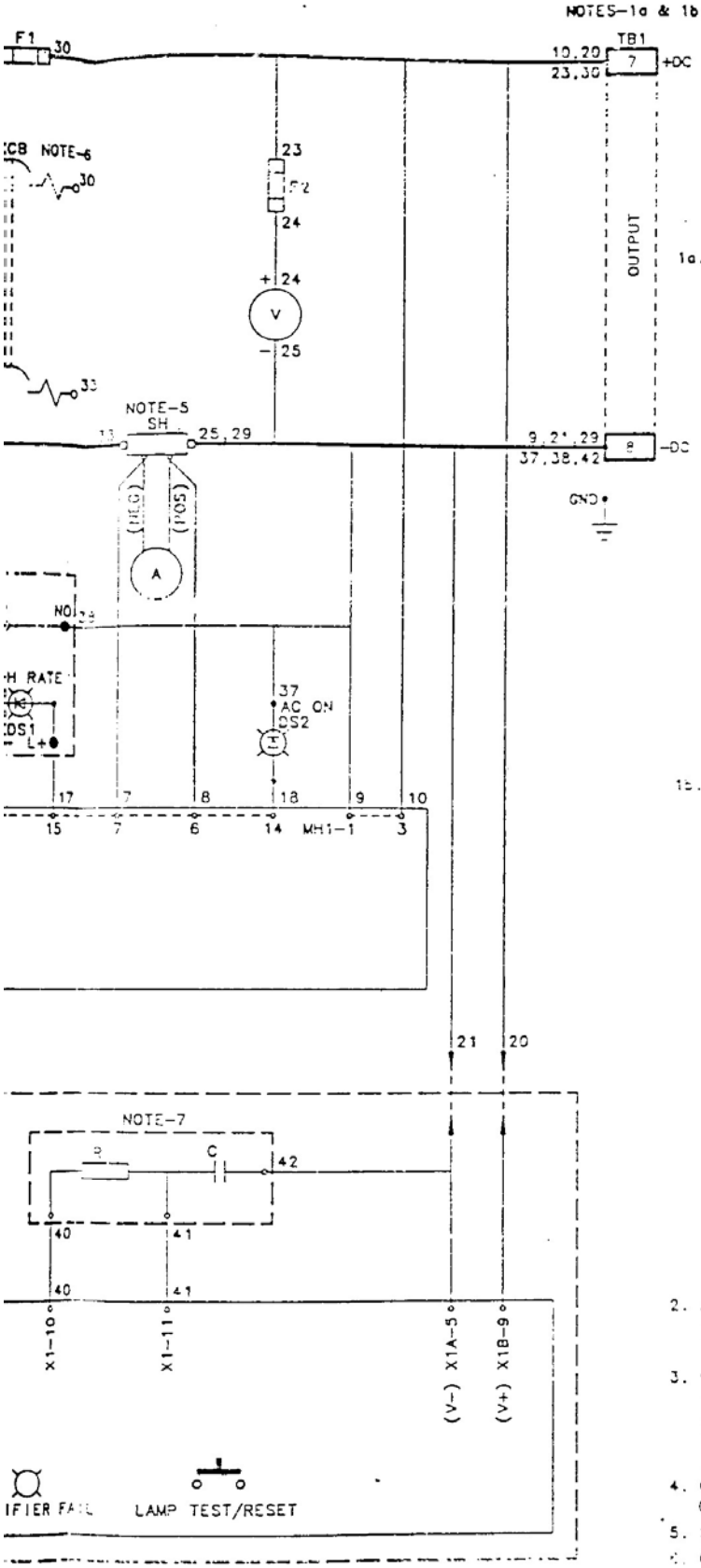
5. SHUNT (SH) USED ON UNITS RATED 50ADC & HIGHER.

6. OPTIONAL CIRCUIT BREAKER CB8 REPLACES F1.

7. REQUIRED FOR 240VDC UNITS ONLY.
(JUMPER J1 IS REMOVED FROM E2 SLR ALARM CARD).

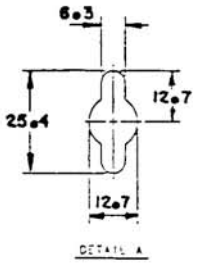
8. OPTIONAL BATTERY TEMPERATURE COMPENSATION.

NOTES-1a & 1b

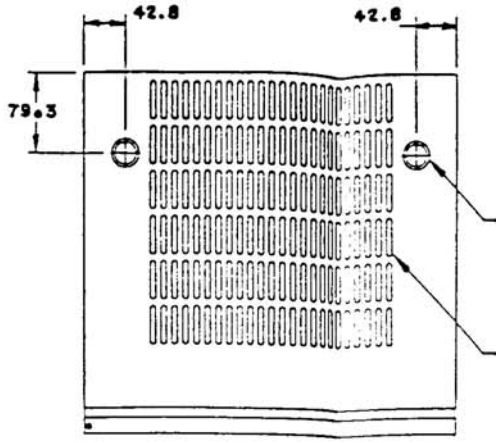


	DWN BY DESS PAR d.c.griffin	SAFT NIFE Corporation	
	DATE 1992-11-09		
SAFT NIFE MEXICO	CHKD BY VER PAR R.S.M.		
R No. DE DU CLIENT	APPR BY APPR PAR D.S.	SCHEMATIC BATTERY CHARGER TYPE SLR	
P. ORDER DE DE SAFT NIFE CORP.	SCALE ECHELLE		
DCTURATION	TOLERANCE	DWG No DESS No 4725-65-79249-50	REV

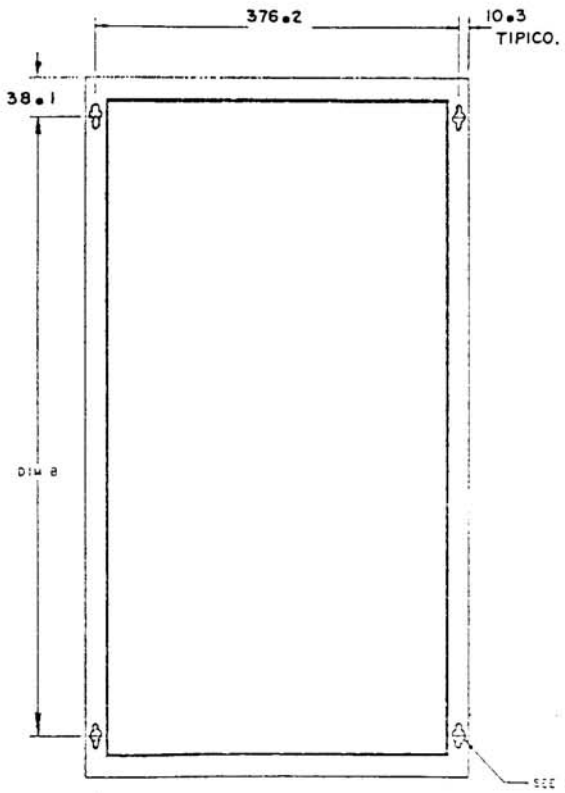
GABINETE TIPO	PART No.	DIM A	DIM B
H500	2153-46-21508-01	476.2	396.8
H700	2153-46-21508-01	685.8	606.4



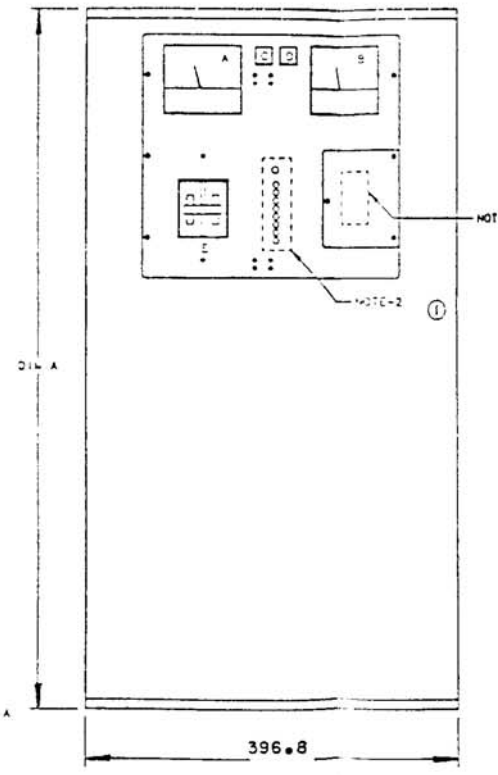
DETAIL A



TOP VIEW

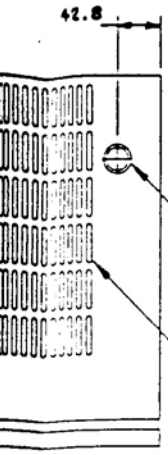


VISTA POSTERIOR.



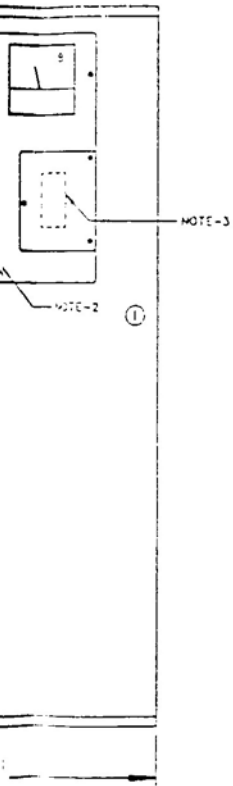
VISTA FRONTAL.

No.	Revisión	Fecha	Firma	No.	Revisión	Fecha	Firma

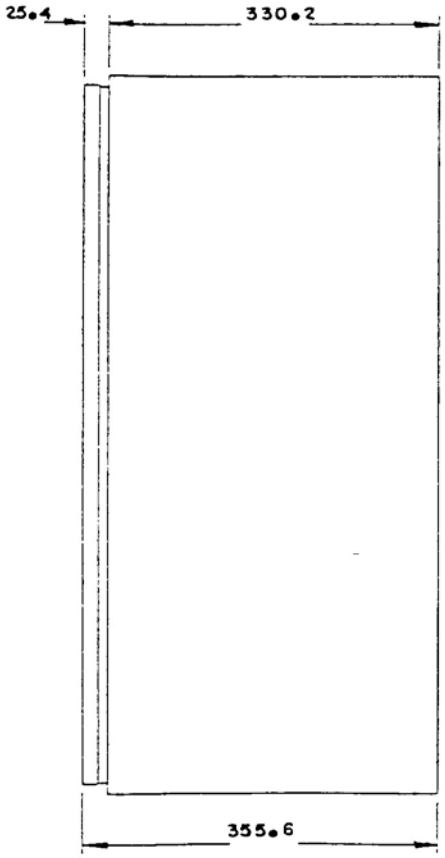


NOTAS

1. — LAS DIMENSIONES ESTAN EN mm.
2. — LOCALIZACION DE ALARMAS OPCIONALES CUANDO SON SUMINISTRADAS.
3. — LOCALIZACION DEL BREAKER OPCIONAL DE SALIDA, CUANDO ESTA SUMINISTRADA.
4. — COMPONENTES:
   - A — VOLTMETRO DE C.D.
   - B — AMPERMETRO DE C.D.
   - C — LAMPARA DE ENCENDIDO
   - D — LAMP. FLOT./CARGA RAPIDA PULSADOR.
   - E — BREAKER ENTRADA DE C.A.
5. — ACABADO: GRIS A.S.A. 61.



NTAL.



VISTA LATERAL.

No. Pzas.	Pos	No. de Parte	Descripción	Material
	No. de Parte	Dibujó: R. RGUEZ.R.	Material:	Acabado:
		Revisó: Ing. A. Delgado. Aprobó:	Descripcion: DIMENSIONES GENERALES SLRF 48-50 GABINETE TIPO 6	Esc: SIN. Acot: Milimetros.
		Fecha: 1992 - 08 - 11.		Substituye a:
		SAFT NIFE		Pertenece a:
				Art. gr. / Reg. / Rev.
				Dibujo No:
			Información confidencial propiedad de NIFE S.A. de C.V. No podrá ser reproducida sin permiso escrito de la Compañía. Devuélvase al ser requerida.	Pág. 1 de 1.

SAFT NIFE (MEXICO)

TARJETA DE ALARMAS

TIPO SLR

MANUAL DE OPERACION Y MANTENIMIENTO

INSTRUCTIVO 4111-65-92591-00
REVISION: 0
FECHA: 92/02/10

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1.0 ESPECIFICACIONES

1.1 Introduccion

La tarjeta de alarma se realizo para poder efectuar una supervisi basica de los cargadores de bater a de una fase tipo SLR Saft NIFE. Pa indicar la condicion de alarma se cuenta con lamparas indicador individuales (LED), conectadas a un grupo integral de alarma de conexi remota mediante relevadores. El restablecimiento y la prueba del LED se logra mediante un boton localizado en la tarjeta.

1.2 La entrada a partir de la señal de salida de CD

De la salida de CD:	Voltaje Nominal de CD	-25%	+40%
Rango Estandar:	12V	4111-70-12332-01	
	24V	4111-70-12332-02	
	48V	4111-70-12332-03	
	120V	4111-70-12332-04	
Corriente:	Max. 85 mA		

1.3 Entrada a partir de la señal de alimentacion de CA

A partir de la tarjeta de control:	20VCD
Corriente:	Max. 40 mA

1.4 Alarmas y Ajustes

1.4.1 Alarma de Falla de CA

-Sin ajuste, fijo a -30%, +/-10% de la entrada nom. de CA
-10% de histéresis
-Alarma con retardo de 4 segundos

1.4.2 Alto Voltaje

-Ajuste 0-150% del Voltaje nom. de CD
-Ajuste del potenciometro R20
-Sin histéresis
-Alarma con retardo de 4 segundos

1.4.3 Bajo Voltaje

-Ajuste 0-150% del Voltaje nom. de CD
-Ajuste del potenciometro R40
-Sin histéresis
-Alarma con retardo de 4 segundos

1.4.4 Alarma de conexion a tierra de las polaridades positi
negativa

-Sin ajuste, fija a 10 mA (100 Ohm/V)
-Sin histéresis
-Alarma con retardo de 4 segundos

1.4.5 Falla del Rectificador

-Sin ajuste, entrada digital
-Sin histéresis
-Alarma con retardo de 4 segundos

1.5 Salidas del Relevador de Alarma Comun

CA: 240V 5A 480VA carga resistiva
CD: 100V 5A 120W carga resistiva

1.6 Interfaz

Entradas externas: Las posiciones 7 y 4 del bloque de termi
Un cable planar de 10 posiciones. DIN (usado con la tar
relevadores opcionales)

1.7 Medio Ambiente

Temperatura:	Operacion:	-10 a +55 grados C
	Almacenamiento:	-40 a +70 grados C
Humedad:	al 95% sin condensacion	

1.8 Mecanicas

Montaje: En el panel frontal sobre gu as de tarjetas
Acceso: En el frente para todos los ajustes
Dimensiones: PCB : 110X 160 mm

2.0 OPERACION Y DESCRIPCION DE LOS CIRCUITOS

Parte No. : 4111-70-12332-XX
Dibujo No.: 4111-65-87239-00

2.1 Generalidades

La tarjeta de alarma tiene 6 alarmas de sujecion independiente con indicacion de LED, conectada a un relevador comun de alarma.

Falla de CA
Alto Voltaje
Bajo Voltaje
Falla de conexion a tierra de la polaridad positiva
Falla de conexiòn a tierra de la polaridad negativa
Falla del Rectificador

La fuente de alimentacion esta dividida en dos partes, del lado de CD y del lado de CA. La fuente de alimentacion de CA es utilizada por el relevador comun y como un sensor para las fallas principales. La de CD es utilizada para la alimentacion de los circuitos en las tarjetas.

.2 Fuente de Alimentacion y Referencia

Alimentacion de potencia de CD (X1:09) para la tarjeta de alarma, es alimentada desde la salida del rectificador. El nivel de voltaje de alimentacion de 9V (TP2), es proporcionado por un regulador lineal consistente de transistores, V34 y circuitos asociados.

Un voltaje de referencia de 5V proporcionado por N1 puede ser medido en TP3.

.3 Falla de CA

El voltaje de entrada de CA es sensado en el secundario, de bajo voltaje del transformador principal, a través de MH2-10 y MH2-11 en la tarjeta principal de control. El voltaje de CA es rectificado por V1 y V3 en la tarjeta de control, y filtrado por C1 y sensado por un disparador inversor Schmitt D2f en la tarjeta tarjeta de alarma. El nivel de la alarma es fijado al 70% de la entrada nominal de CA. La histéresis es fijada al 10% mediante R17.

El estado de la alarma puede ser medido en TP10 (alarma = señal alta). Para el tiempo de retardo e indicacion, vea la seccion 2.8.

4 Alarma de Alto Voltaje

La entrada de sensado de voltaje esta en X1:09, la misma que la entrada de CD a la tarjeta de alarma. El voltaje de CD es dividido en la tarjeta mediante la resistencia R60-63. R22 es utilizada como una entrada comun para ambas alarmas de alto y bajo voltaje. El nivel de la alarma de alto voltaje es establecido mediante el ajuste del potenciometro R20 (Vref) comparado con el voltaje sensado en N2a.

No se añade la histéresis en la tarjeta. La señal de alarma puede ser medida en TP20 (alarma= señal alta). Para el tiempo de retardo y la indicacion, vea la seccion 2.8.

2.5 Alarma de Bajo Voltaje

La entrada de sensado de voltaje esta en X1:09, la misma que la entrada de CD a la tarjeta de alarma. El voltaje de CD es dividido en la tarjeta mediante la resistencia R60-63. R22 es utilizada como una entrada comun para ambas alarmas de alto y bajo voltaje. El nivel de la alarma de bajo voltaje es establecido mediante el ajuste del potenciometro R40 (Vref) y comparado con el voltaje sensado en N2b.

No se añade la histéresis en la tarjeta. La señal de alarma puede ser medida en TP40 (alarma= señal alta). Para el tiempo de retardo y la indicacion, vea la seccion 2.8.

2.6 Alarma de conexion a tierra de las polaridades positiva y negativa

La falla de conexion a tierra es fijada a 10 mA o 100 Ohm/V y no es ajustable. El voltaje de salida rectificado es dividido a la mitad del voltaje mediante las resistencias R50-53 y amplificada en corriente por una etapa de emisor seguidor V50. La terminal del sensado de voltaje esta en X1:09, la misma que la entrada de CD a la tarjeta de alarma. El voltaje de CD es dividido en la tarjeta por las resistencias R60-63. Puesto que X1:08 (tierra) esta conectada al punto central de R50-53, el detector de ventana, formado por N2c y N2d, sensa una diferencia de voltaje y se va a alto cuando la falla de conexion a tierra excede 10 mA. Una falla de conexion a tierra de la polaridad positiva puede ser medida en TP70, y la negativa en TP80.

No se añade la histéresis en la tarjeta. Para el tiempo de retardo y la indicacion, vea la seccion 2.8.

2.7 Falla del Rectificador

La alarma de falla del rectificador es sensada en la tarjeta de control principal. Después de un retardo de tiempo de 15s, la entrada de la tarjeta de alarma X1:7 baja para indicar una alarma de falla del rectificador.

No se añade histeresis en la tarjeta. Para el tiempo de retardo y la indicacion vea la seccion 2.8.

2.8 Circuitos de alarma

Los circuitos de alarma para cada una de las alarmas mencionadas son idénticos, por lo que se utilizara una alarma de falla de CA como ejemplo, las alarmas operan como sigue:

Normal Todas las lamparas de las alarmas estan apagadas y el relevador de alarma K1 esta energizado.

-Coloque la tarjeta en el rectificador y encienda la alimentacion de energ a.
-Verifique el voltaje TP1 - TP2 = 9V
-Verifique VREF TP1 - TP3 = 5V
-Verifique la prueba y restablecimiento del LED.

3.3 Funcional

3.3.1 Alarma de Falla de CA

El nivel de la alarma esta fijado al 70% del CA nominal. Conecte un voltmetro entre TP1 (0V) y TP10 la cual es la terminal de prueba de falla de CA.
Cortocircuite TP11 a 0V como simulacion de la alarma. Cuando ocurra una alarma, el voltaje en TP10 es aproximadamente de 8V. El tiempo de retardo en la alarma esta fijado a 4 segundos.

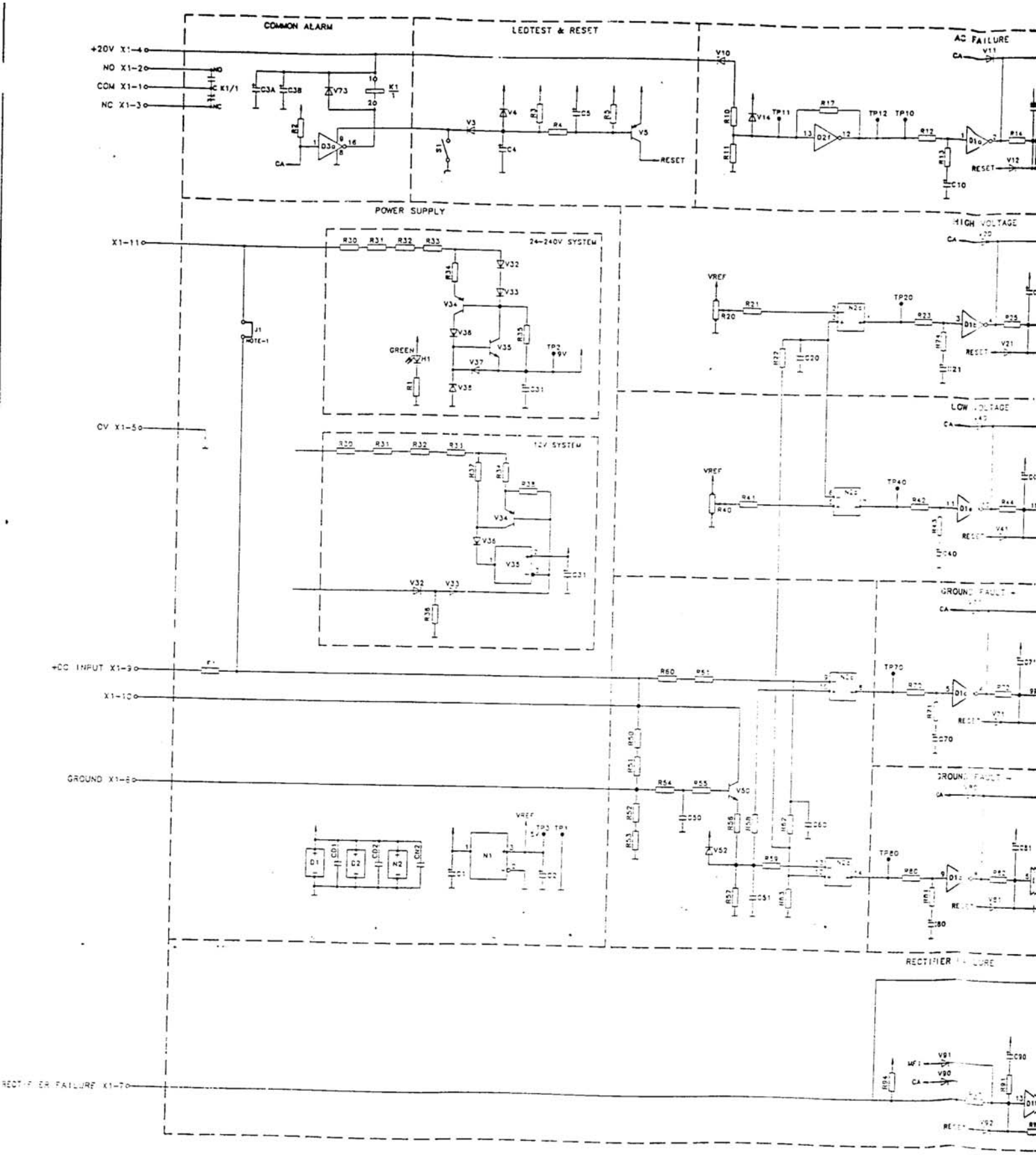
3.3.2 Alarma de Alto Voltaje

EL nivel de la alarma esta ajustado mediante el potenciometro R20. Conecte un voltmetro entre TP1 (0V) y TP20 la cual es la terminal de prueba de alto voltaje. Cuando ocurre una alarma, el voltaje en TP20 es aproximadamente de 8V. El rango de ajuste es 0-150% del voltaje nominal de salida de CD. Gire el potenciometro R20 completamente en sentido horario. Ajuste la salida del cargador al nivel deseado de alarma ya sea con el potenciometro de flotacion o el de carga rapida que se encuentra en la tarjeta de control. Gire lentamente R20 en sentido antihorario hasta que aparezca la alarma. El tiempo de retardo en la alarma esta fijo a 4 segundos. Reajuste el voltaje de salida rectificado.

3.3.3 Alarma de Bajo Voltaje

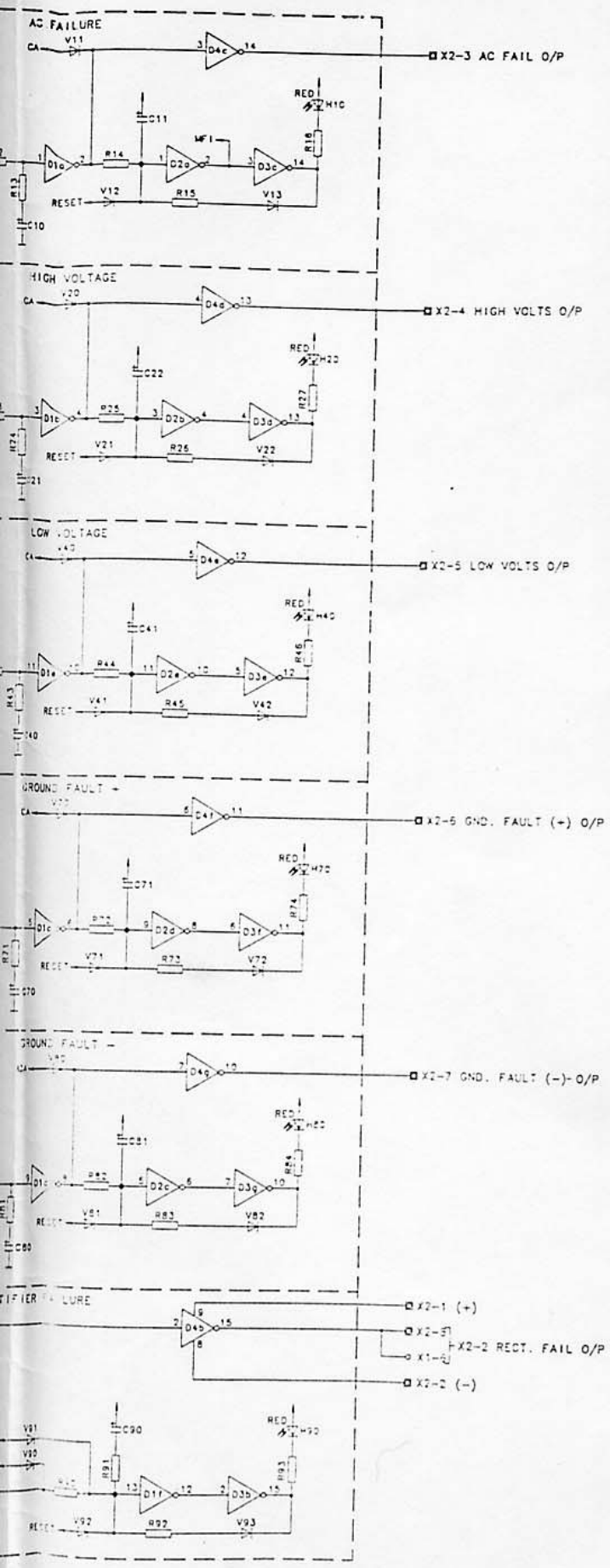
Para establecer esta alarma sera necesario un banco de capacitores adecuado o una bater a descargada, siendo una bater a cargada no permitira que el voltaje disminuya a un nivel deseado. La alarma se ajusta con el potenciometro R40. Conecte un voltmetro entre TP1 (0V) y TP40 la cual es la terminal de prueba de la alarma de bajo voltaje. Cuando ocurre una alarma, el voltaje en TP40 es aproximadamente de 8V. El rango de ajuste es de 0-150% del voltaje nominal de salida de CD. Gire completamente el R40 en sentido antihorario. Ajuste la salida del rectificador al nivel deseado de alarma ya sea con el potenciometro de flotacion o de carga rapida localizado en la tarjeta de control principal. Gire lentamente el potenciometro en sentido horario hasta que se active la alarma. El tiempo de retardo en la alarma esta fijado en 4 segundos. Reajuste el voltaje de salida del rectificador.

.3.4 Alarma de conexion a tierra de las polaridades positiva y negativa


COMMON ALARM
LEDTEST & RESET
AC FAILURE
POWER SUPPLY
HIGH VOLTAGE
LOW VOLTAGE
GROUND FAULT
RECTIFIER FAILURE
+20V X1-4
NO X1-2
COM X1-1
NC X1-3
X1-11
0V X1-5
+DC INPUT X1-9
X1-10
GROUND X1-8
RECTIFIER FAILURE X1-7
24←240V SYSTEM
12V SYSTEM
RESET
VREF
GREEN

NOTES

1. FOR 12VDC TO 120VDC – JUMPER
   FOR 240VDC – JUMPER



	DRN BY / DESS PAR	
	DATE	1991-02-02
CUSTOMER / CLIENT	CHKD BY / VER PAR	DC
CUSTOMER ORDER No. / No. DE COMMANDE DU CLIENT	APPR BY / APPR PAR	REL
SAFT NIFE CORP. ORDER No. / No. DE COMMANDE DE SAFT NIFE CORP.	SCALE / ECHELLE	
JOB No. / No. DE MANUFACTURATION	TOLERANCE	

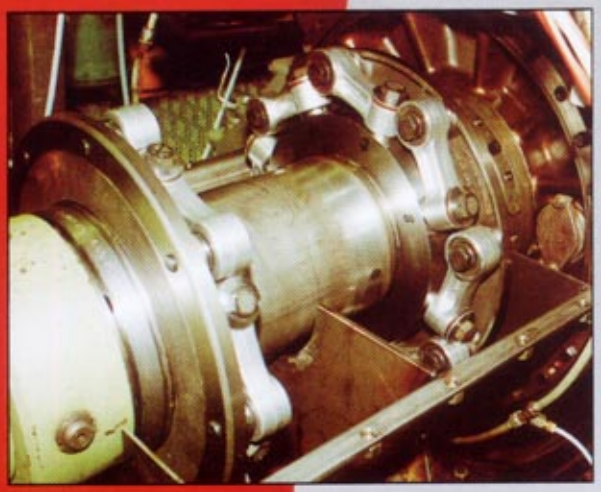
SAFT NIFE Corporat

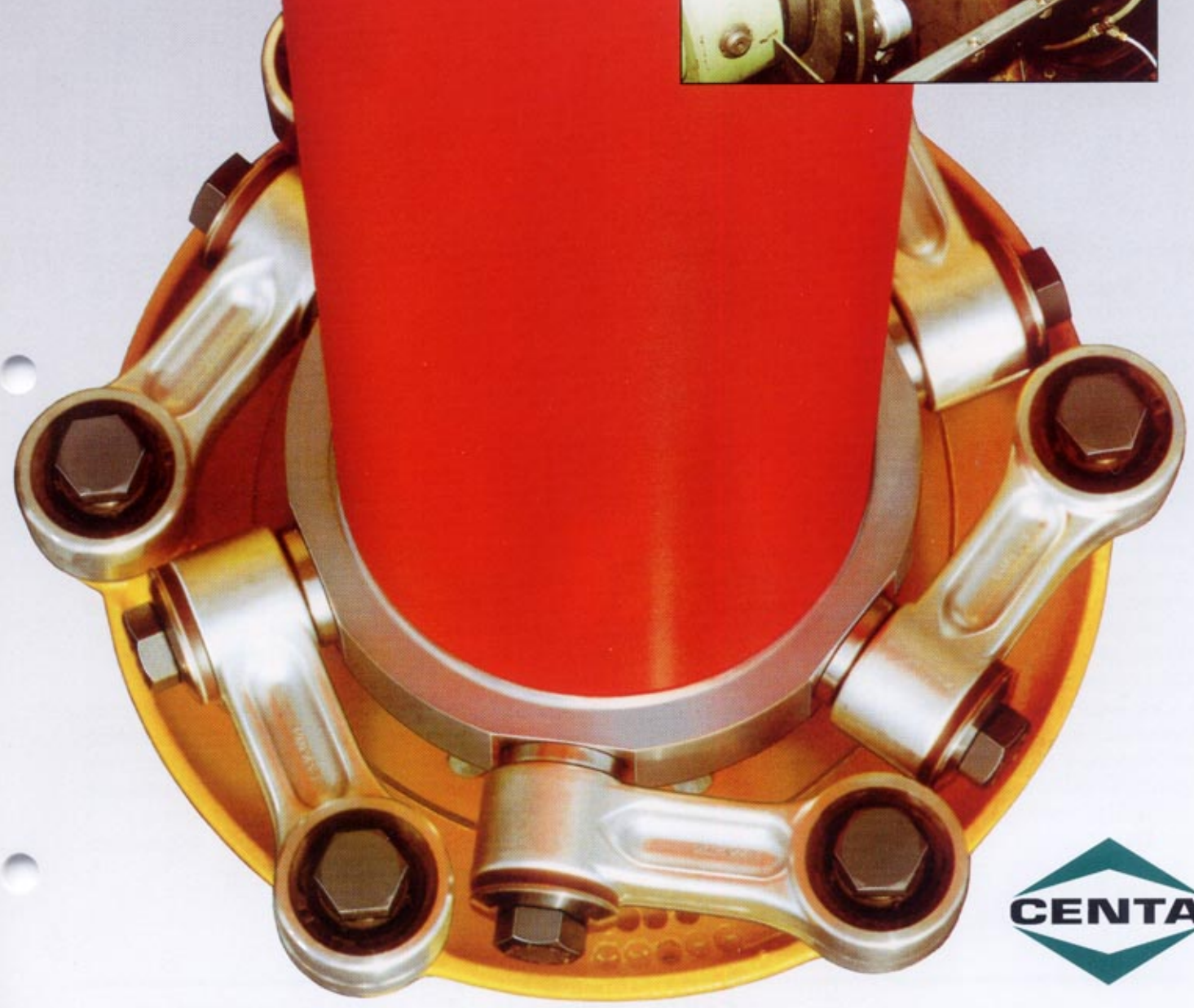
SCHEMATIC
SLR ALARM CARD A3
PT. No 4111-70-12321-XX

DWG No. / DESS No. 4111-65-87239-00

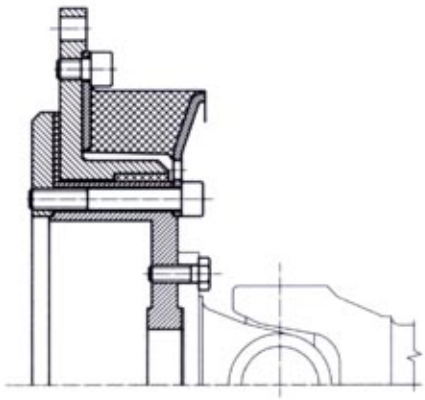
CENTALINK®

The silent driveshaft





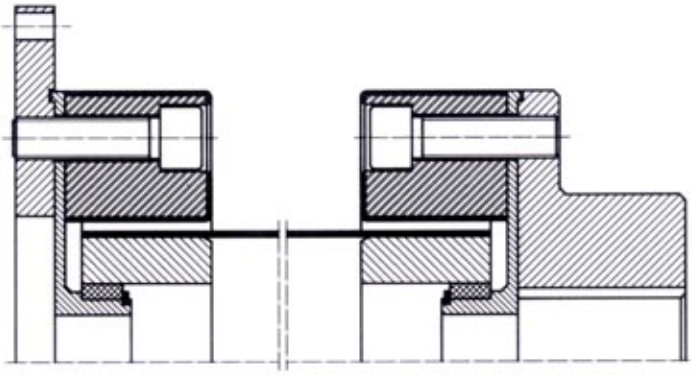
CENTA



CENTA couplings for similar application areas
CENTA-Kupplungen für ähnliche Einsatzgebiete

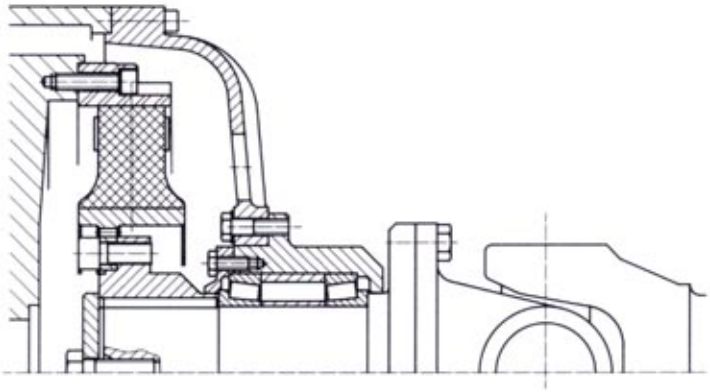
CENTAX-V torsionally damping intermediate coupling for U-joint shafts, well proven over 5 years with thousands of applications.
T_{KN} = 0,23 — 50 kNm
Catalog CX-V

CENTAX-V drehelastische dämpfende Vorschaltkupplungen für Kardanwellen, seit 5 Jahren tausendfach bewährt.
T_{KN} = 0,23 ... 50 KNm
Katalog CX-V



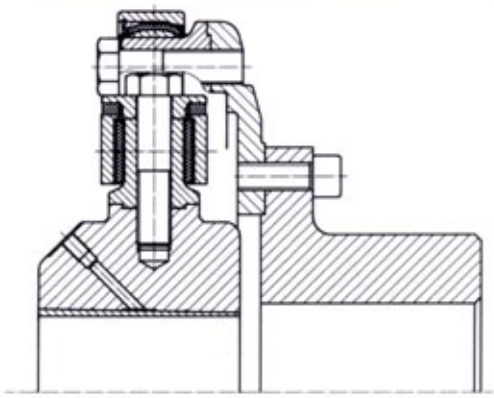
CENTAFLEX, series A — Types G and GZ
Torsionally soft, very flexible in all directions, free of backlash and wear, ideal for Diesel engines, for flywheel and front P.T.O's.
Million times proven over 23 years.
T_{KN} = 0,1 — 2,5 KNm
Catalog CF-A

CENTAFLEX, Baureihe A, Bauform G und GZ
drehelastisch, spielfrei, große Verlagerungsfähigkeit in jeder Richtung, ideal für Dieselmotore, seit 23 Jahren millionenfach bewährt.
T_{KN} = 0,1 ... 2,5 KNm
Katalog CF-A



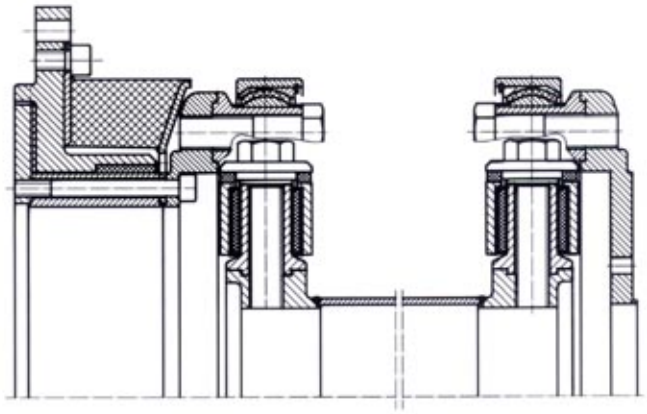
CENTA FH bearing housing
with torsionally flexible coupling (CENTAX or CENTAMAX) for use with diesel engines and U-joint shafts. The bearings in the flange housing protect the crankshaft of the diesel engine from all harmful forces due to the use of cardan shafts.
T_{KN} = 0,8 — 20 kNm
For SAE-housings sizes 2, 1, 0, 00 Catalog CX-V

CENTA-FH Flanschlagergehäuse
mit drehelastischer Kupplung (CENTAX oder CENTAMAX) zur Verbindung von Dieselmotoren mit Kardanwellen. Die Lagerung im Flanschgehäuse schützt die Kurbelwelle des Dieselmotors vor allen schädlichen Kräften aus der Kardanwelle.
T_{KN} = 0,8 ... 20 KNm
Für SAE Gehäuse Größen 2, 1, 0, 00 Katalog CX-V



Single **CENTALINK-joint**
flexible in axial and angular directions, yet radially stiff, forms the second bearing for shafts with only one bearing, e.g. water jet drives.
T_{KN} = 2,5 — 125 kNm

Einzelnes **CENTALINK-Gelenk**
Axial- und winkelbeweglich, jedoch radial steif, bildet gleichzeitig die 2. Lagerstelle für Wellen mit nur einer Lagerung, z. B. Wasser-Jet-Antriebe.
T_{KN} = 2,5 ... 125 KNm



CENTALINK combined with torsionally flexible CENTAX-elements

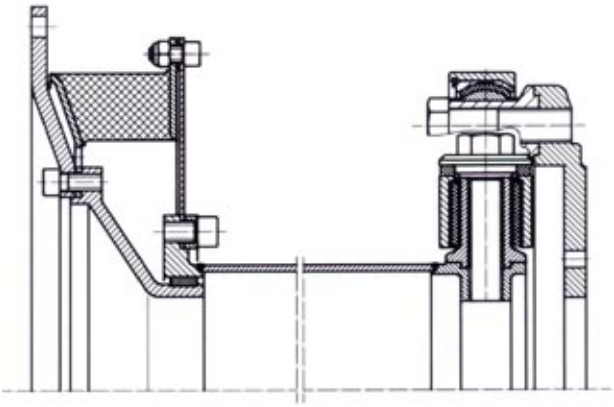
Kombinationen von CENTALINK mit drehelastischen CENTAX-Kupplungen

CENTALINK shaft with torsionally damping CENTAX-V intermediate coupling

T_{KN} = 2,5 — 50 kNm

CENTALINK-Gelenkwelle mit drehelastischer dämpfender CENTAX-V Vorschaltkupplung

T_{KN} = 2,5 ... 50 KNm



Single CENTALINK joint with highly flexible CENTAX element and membrane.

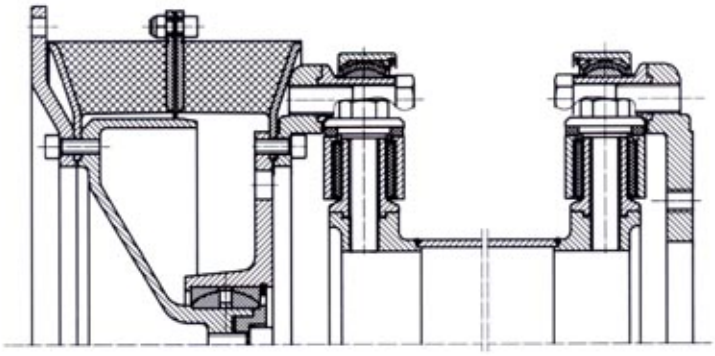
Simple, low cost solution for drives with moderate angular or radial misalignment

T_{KN} = 2,5 — 25 kNm

Einzelnes CENTALINK-Gelenk mit drehelastischem CENTAX-Element und Membran.

Einfache, preiswerte Lösung für Antriebe mit mäßigen winkeligen bzw. radialen Verlagerungen

T_{KN} = 2,5 ... 25 KNm

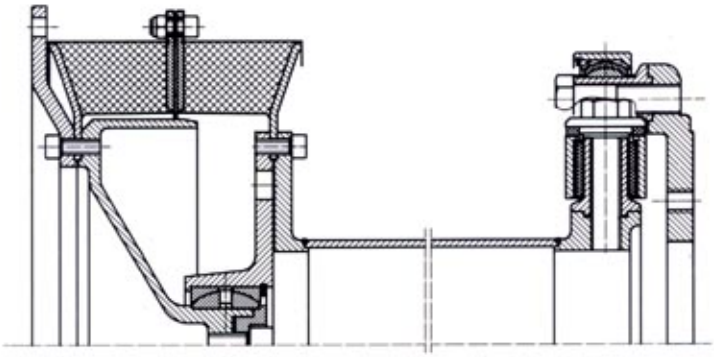


CENTALINK-shaft with twin element CENTAX coupling for high torsional flexibility and for large misalignments

T_{KN} = 2,5 — 25 kNm

CENTALINK-Gelenkwelle mit 2-reihiger CENTAX-Kupplung für hohe Drehelastizität und für große Verlagerungen

T_{KN} = 2,5 ... 25 KNm



Single CENTALINK-joint with twin element CENTAX coupling for high torsional flexibility and for moderate misalignments

T_{KN} = 2,5 — 25 kNm

Einzelnes CENTALINK-Gelenk mit 2-reihiger CENTAX-Kupplung für hohe Drehelastizität und für mäßige Verlagerungen

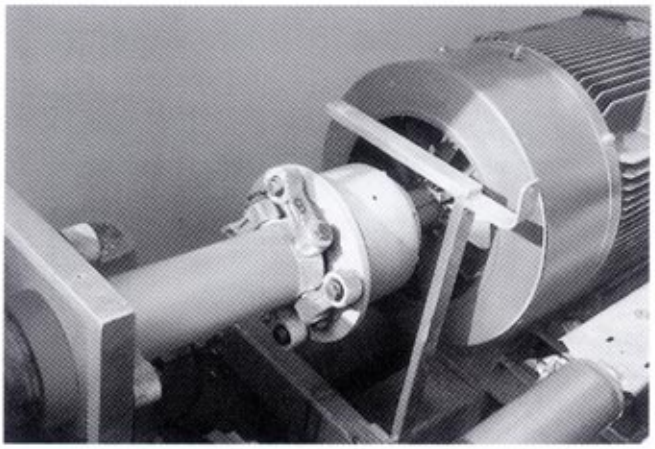
T_{KN} ... 2,5 — 25 KNm

Application - Samples

Einsatzbeispiele

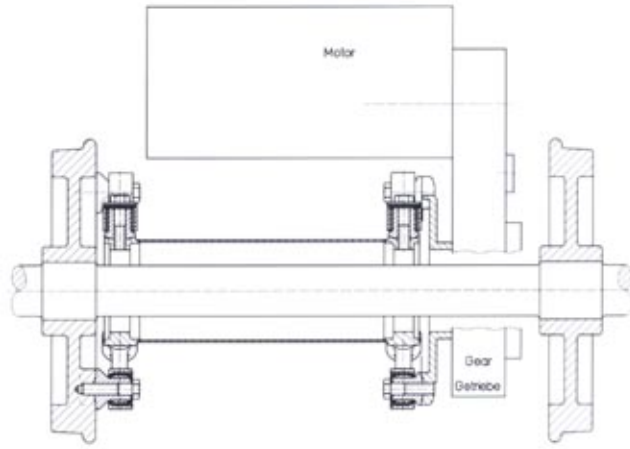
CENTALINK-joint with highly flexible CENTAX-coupling size 65 for ship main propulsion.
MAN 2842 - 700kW/2300 rpm.

CENTALINK-Gelenk mit hochelastischer CENTAX-Kupplung Größe 65 für Schiffshauptantrieb.
MAN 2842 - 700 kW/2300 min^{-1}.



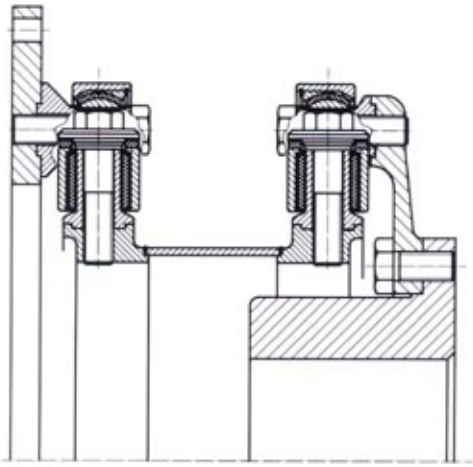
CENTALINK shaft size 55 in 500 kW windturbine.

CENTALINK-Gelenkwelle in 500 kW Windkraftwerk.

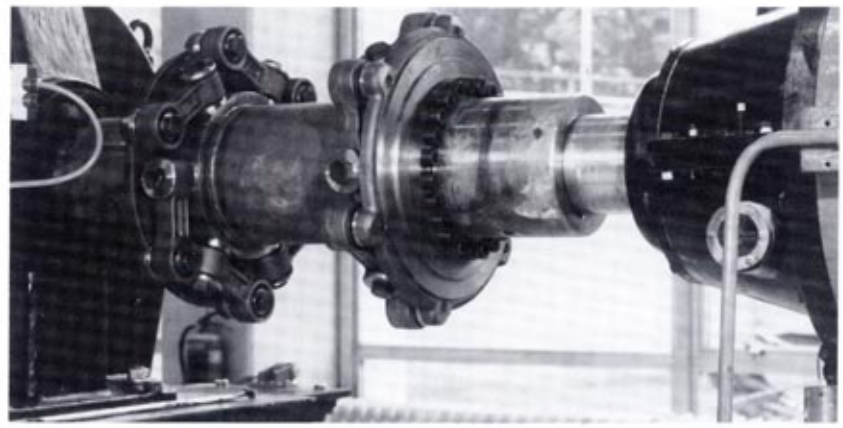


CENTALINK in axle drive of a rail car.

CENTALINK in Achsantrieb eines Schienenfahrzeuges.



CENTALINK
short version
Kurzbauform

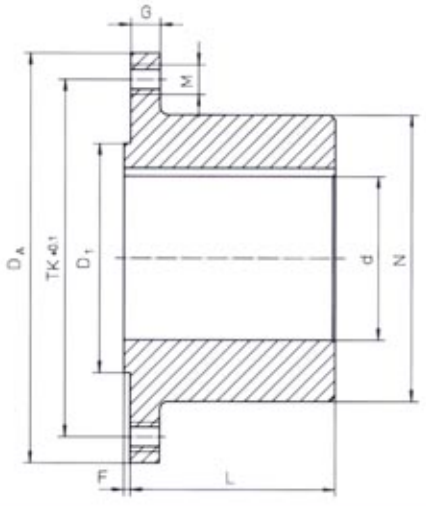


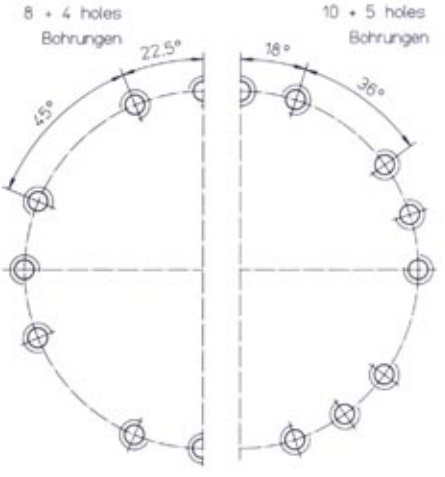
CENTALINK between gear and pump.
These drives in an office building of the Dutch government were originally rigidly mounted and they caused big problems with noise and vibration.
Therefore the drives were subsequently placed on very soft flexible mounts and CENTALINK flexible shafts were installed. These modifications completely solved the problems. The CENTALINK shafts compensate for all types of misalignment and they interrupt the transmission of structure-born noise.

CENTALINK zwischen Getriebe und Pumpe.
Diese Antriebe in einem Bürogebäude der holländischen Regierung waren früher starr gelagert und verursachten große Probleme infolge von Schwingungen und Geräuschen.
Daher wurde der Antrieb nachträglich hochelastisch gelagert und CENTALINK Gelenkwellen eingebaut. Damit waren alle Probleme gelöst. Die CENTALINK Gelenkwellen gleichen alle Verlagerungen aus und sie unterbrechen die Übertragung von Körperschall.

Standard flanged hubs for CENTALINK-shafts

Standard Flanschnaben für CENTALINK Gelenkwellen





Flange hub size	CENTALINK size											Tightening torque	Transmittable torque	Inertia	mass
Nenn-größe	CENTALINK Größe	D_A	D_1 h7	T_k	z x M	d min	d max	F	G	L	N	Schrauben-anzugs-moment	übertrag-bares Moment	Massen-trägheits-moment	Masse
Flansch-nabe												T_A * [Nm]	T_U [kNm]	J [kgm²]	m [kg]
180	48, 50, 55	180	110	155,5	(8+4) x M14	45	100	2,5	16	100	140	200	9,3	0,030	7,2
225	60,65	225	140	196	(8+4) x M16	50	110	4	16	110	155	310	16,2	0,061	10,7
250	68	250	140	218	(8+4) x M18	55	125	4	18	125	175	430	22,0	0,108	15,1
285	70	285	175	245	(8+4) x M20	65	150	5	20	150	210	610	31,0	0,238	24,6
315	71, 72	315	175	280	(8+4) x M22	70	160	5	22	160	225	820	45,0	0,359	31,3
350	75	350	220	310	(10+5) x M22	70	180	6	22	180	250	820	62,0	0,585	41,5
390	78	390	250	345	20 x M24	75	200	6	24	200	280	1050	106	1,015	58,3
435	80	435	280	385	20 x M27	90	240	8	27	240	340	1550	150	2,325	98,1

Values are based on max. bore
Dimensions in mm

* Bolt quality 10.9
Schraubenqualität

Werte basieren auf max. Fertigbohrung
Maße in mm

The connecting dimensions of these flanged hubs suit the CENTALINK shafts and mostly conform with the standards. To increase the transmittable torque we have increased the quantity of fasteners. The normal pattern for the holes remains, but we have added further holes, for the link-flanges as well as for the flanged hubs.

If required, the hubs can be provided with finish bore and keyway according to DIN 6885 or with involute spline, with taper bore and keyway or taper bore for oil-injection-fit. Then the hubs will be balanced with quality Q 6.3

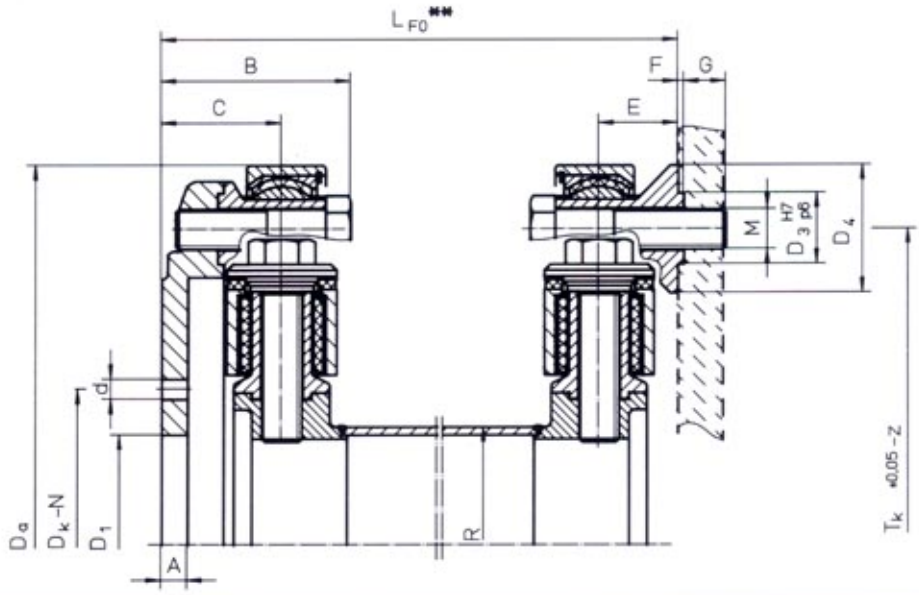
Unless otherwise specified, the hubs will be delivered prebored and unbalanced.

Die Anschlußmaße dieser Flanschnaben passen zu den CENTALINK Gelenkwellen und sie entsprechen weitgehend der Norm. Zur Erhöhung des übertragbaren Drehmomentes haben wir jedoch die Schraubenanzahl erhöht. Das genormte Bohrbild wurde übernommen, zusätzlich wurden jedoch weitere Löcher gebohrt, sowohl bei den Flanschnaben als auch bei den Gelenkwellenflanschen.

Falls gewünscht, können die Naben mit Fertigbohrung und Nut nach DIN 6885 oder mit Evolventenprofil oder mit Konusbohrung und Nut, oder auch für Ölpreßverband, geliefert werden. Dann werden die Naben mit Wuchtgüte Q 6.3 gewuchtet.

Ohne Angaben zur Bohrung werden die Naben vorgebohrt und ungewuchtet geliefert.

Series
Baureihe
CL-FO



CENTALINK Size / CENTALINK Größe	Nominal Torque / Nenndrehmoment T_{KN} [kNm]	Flanged hub Nominal Size / Kardanflansch Nenngröße	A	B	C	D_a	D_1 H7	D_k ±0,1	d	N	L_{FO} min.	R	D_3	D_4	T_k	Z	G	M	E	F
48	2,50	180 *	12	100	57	360	110	155,5	14,1	8+4	221	110x4	36	64	294,4	3	25	20	40	3
50	3,00	180 *	12	100	65	380	110	155,5	14,1	8+4	221	150x5	36	64	316	3	25	20	40	3
55	4,00	180 *	12	100	65	380	110	155,5	14,1	8+4	221	150x5	36	64	316	4	25	20	40	3
60	5,00	225 *	15	100	65	380	140	196	16,1	8+4	221	150x5	36	64	316	5	25	20	40	3
65	6,00	225 *	15	100	65	402	140	196	16,1	8+4	221	160x5	36	64	336,6	5	25	20	40	3
68	9,00	250 *	18	101	67	438	140	218	18,1	8+4	263	200x5	36	64	374	6	25	20	40	3
70	12,50	285 *	20	130	81,5	539	175	245	20,1	8+4	326	200x5	50	88	451,2	4	31	27	58	3
71	15,00	315 *	20	103	65	544	175	280	22,1	8+4	267	240x5	36	64	477	8	25	20	40	3
72	17,50	315 *	20	134	85	595	175	280	22,1	8+4	322	280x5	50	88	510	5	31	27	58	3
75	25,00	350 *	22	137	88,5	608	220	310	22,1	10+5	320	280x8	50	88	519,2	6	31	27	58	3
78	35,00	390 *	25	177	119	740	250	345	24,1	20	411	280x8	72	125	608,3	4	40	36	77	4
80	50,00	435 *	30	183	119	787	280	385	27,1	20	419	280x10	72	125	653	5	40	36	77	4
84	75,00	**	30	178	114	898	**	**	**	**	409	450x10	72	125	765,5	6	40	36	77	4
86	100,00	**	30	178	114	962	**	**	**	**	413	450x10	72	125	830	7	40	36	77	4
88	120,00	**	36	184	120	1009	**	**	**	**	425	450x10	72	125	877	8	40	36	77	4

For series FO a standard flange on one side is intended, while on the other side an existing plain flange can be used.

In order to ensure the necessary space for movement is available the axial bushes are elongated. Thus specially tailored series can be easily designed.

* The connecting dimension are to metric standards.
It is important that the value of clamping force is checked to ensure that the torque can be transmitted. If necessary larger standard flanges can be used. When using CENTA flanged hubs the torque capacity is increased using a higher quantity of fastener (please see page 12).

** To be agreed

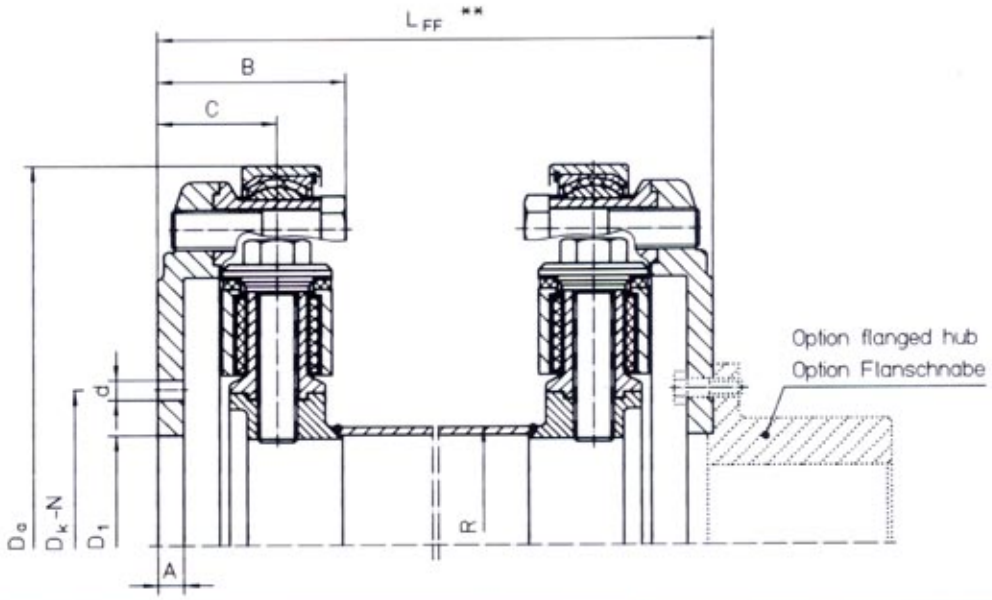
Bei der Bauform FO ist auf einer Seite der Standardflansch vorgesehen, während auf der anderen Seite ein vorhandener, planer Flansch mitbenutzt werden kann.

Um den nötigen Freiraum für Verlagerungen zu gewährleisten, sind die axialen Buchsen entsprechend verlängert. Damit können auf einfache weise maßgeschneiderte Sonderbauformen realisiert werden.

* Die Anschlußmaße entsprechen der DIN-Norm.
Die Dimensionierung der Verschraubung ist daraufhin zu überprüfen, ob das zu übertragende Drehmoment reibschlüssig übertragen wird. Nötigenfalls sind größere genormte Anschlüsse vorzusehen.
Bei Verwendung der CENTA Flanschnaben ist das übertragbare Drehmoment durch eine höhere Schraubenanzahl erhöht.
Sehen Sie bitte Seite 12.

** Nach Bedarf

Series
Baureihe
CL-FF



CENTALINK Size	Nominal Torque	Flanged hub Nominal Size											Weight m (kg) complete shaft without tube	Weight m (kg) per 100 mm tube	moment of inertia J (kgm²) complete shaft without tube	moment of inertia J (kgm²) per 100 mm tube
CENTALINK Größe	Nenndrehmoment T_{KN} [kNm]	Kardanflansch Nenngröße	A	B	C	D_a	D_1 H7	D_k ±0,1	d	N	L_{FF} min.	R	Gewicht (kg) komplette Gelenkw. ohne Rohr	Gewicht (kg) je 100 mm Rohrlänge	Massenträgheitsmoment J (kgm²) komplette Gelenkw. ohne Rohr	Massenträgheitsmoment J (kgm²) je 100 mm Rohrlänge
48	2,50	180 *	12	100	57	360	110	155,5	14,1	8+4	210	110	37,9	1,05	0,34	0,003
50	3,00	180 *	12	100	65	380	110	155,5	14,1	8+4	210	150	40,8	1,79	0,44	0,009
55	4,00	180 *	12	100	65	380	110	155,5	14.1	8+4	210	150	44,3	1,79	0,62	0,009
60	5,00	225 *	15	100	65	380	140	196	16,1	8+4	210	150	46,7	1,79	0,65	0,009
65	6,00	225 *	15	100	65	402	140	196	16,1	8+4	210	160	59,3	1,91	0,91	0,011
68	9,00	250 *	18	101	67	438	140	218	18,1	8+4	252	200	64,8	2,40	1,20	0,023
70	12,50	285 *	20	130	81,5	539	175	245	20,1	8+4	310	200	78,5	2,40	2,57	0,023
71	15,00	315 *	20	103	65	544	175	280	22,1	8+4	256	240	93,2	2,90	3,74	0,040
72	17,50	315 *	20	134	85	595	175	280	22,1	8+4	306	280	151,7	3,39	5,28	0,064
75	25,00	350 *	22	137	88,5	608	220	310	22,1	10+5	304	280	200,0	5,37	8,98	0,100
78	35,00	390 *	25	177	119	740	250	345	24,1	20	390	280	270,3	5,37	14,78	0,100
80	50,00	435 *	30	183	119	787	280	385	27,1	20	402	280	336,9	6,66	22,20	0,121
84	75,00	**	30	178	114	898	**	**	**	**	392	450	462,1	10,85	45,45	0,530
86	100,00	**	30	178	114	962	**	**	**	**	392	450	572,8	10,85	68,74	0,530
88	120,00	**	36	184	120	1009	**	**	**	**	404	450	656,0	10,85	97,45	0,530

The series FF is the normal series and includes 2 flanges, which can be similar or different in design. Furthermore, if required, standard flanged hubs (page 12) or other special hubs, flanges or adapters can be provided.

* The connecting dimensions are to metric standards.
It is important that the value of clamping force is checked to ensure that the torque can be transmitted. If necessary larger standard flanges can be used. When using CENTA flanged hubs the torque capacity is increased using a higher quantity of fastener (please see page 12).

** To be agreed

Die Bauform FF ist die Normalbauform und sie beinhaltet 2 Flansche, die gleich oder unterschiedlich ausgebildet sein können. Dazu kommen dann, je nach Bedarf, Standardflanschnaben (siehe Seite 12) oder sonstige fallspezifische Naben, Flansche oder Adapter.

* Die Anschlußmaße entsprechen der DIN-Norm.
Die Dimensionierung der Verschraubung ist daraufhin zu überprüfen, ob das zu übertragende Drehmoment reibschlüssig übertragen wird. Nötigenfalls sind größere genormte Anschlüsse vorzusehen.
Bei Verwendung der CENTA Flanschnaben ist das übertragbare Drehmoment durch eine höhere Schraubenanzahl erhöht.

** Nach Bedarf

CENTALINK

Technical Data
Technische Daten

CENTALINK Size	Nominal Torque	Max. Torque	Continuous Vibr. Torque at 10 Hz	Dyn. Torsional Stiffness * of links	Dyn. Torsional Stiffness * of tube	Allowable axial Shaft Displacement	Axial Stiffness	Allowable angular Displacement	Angular Stiffness	Max. Speed
CENTALINK Größe	Nenndrehmoment	Max. Drehmoment	Zul. Wechseldrehmoment bei 10 Hz	Dyn. Drehsteifigkeit * der Lenker	Dyn. Drehsteifigkeit * des Rohres	Zul. axialer Wellenversatz	Axiale Federsteife	Zul. winkelige Auslenkung	Winkelige Federsteife	Max. Drehzahl
	T_{KN} [kNm]	T_{Kmax} [kNm]	T_{KW} [kNm]	C_{links} [kNm/rad]	C_{tube} [kNm²/rad]	$\triangle K_a$ [mm]	C_a [kN/mm]	$\triangle K_w$ [∢ °]	C_w [kNm/grad]	n_{max} [min⁻¹]
48	2,50	7,50	1,25	400	305	± 20	0,11		0,05	2400
50	3,00	9,00	1,50	580	976	± 20	0,11		0,07	2400
55	4,00	12,00	2,00	770	976	± 20	0,14		0,08	2400
60	5,00	15,00	2,50	970	976	± 20	0,18		0,12	2400
65	6,00	18,00	3,00	1300	1190	± 20	0,18		0,15	2300
68	9,00	27,00	4,50	2200	2370	± 20	0,22		0,26	2100
70	12,50	37,50	6,25	2800	2370	± 26	0,26		0,36	2100
71	15,00	45,00	7,50	6000	4150	± 20	0,29		0,74	2100
72	17,50	52,50	8,75	4500	6650	± 26	0,31		0,58	1800
75	25,00	75,00	12,50	7000	10300	± 26	0,37		0,92	1800
78	35,00	105,00	17,50	12500	10300	± 36	0,44		1,14	1500
80	50,00	150,00	25,00	20000	12600	± 36	0,55		2,00	1500
84	75,00	225,00	37,50	40000	54500	± 36	0,65		4,00	1300
86	100,00	300,00	50,00	58000	54500	± 36	0,76		6,10	1200
88	120,00	360,00	60,00	76000	54500	± 36	0,87		8,10	1100

Please see page 7
Sehen Sie bitte Seite 7

* Dyn. Torsional Stiffness
Dyn. Drehsteifigkeit

$$\frac{1}{C_{Tdyn}} = \frac{1}{C_{links}} + \frac{L}{C_{tube}}$$

$$C_{Tdyn} = \frac{C_{links} \cdot C_{tube}}{L \cdot C_{links} + C_{tube}}$$

length of tube
Rohrlänge L in [m]

C_{links} is stiffness of 2 sets of links
Steifigkeit für 2 Gelenke

C_{tube} is stiffness of 1 m (1000 mm) tube
Steifigkeit für 1 m Rohr

Balancing

The common balancing quality for U-joint-shafts is Q16 according VDI 2060. If not agreed differently, the CENTALINK-shafts are balanced as follows:

a) flanges, flangehubs and innerpart to quality Q6,3

b) the links to quality Q16.

The links for the CENTALINK consist of forged aluminium alloy.

They are weighed and brought to the same weight within a close tolerance. Thus they will be as a set within the unbalance tolerance. They can therefore be mounted and exchanged as required.

Wuchtung

Die übliche Wuchtgüte für Gelenkwellen ist Q16 nach VDI 2060. Falls nicht anders vereinbart, werden CENTALINK-Gelenkwellen wie folgt gewuchtet:

a) Flansch, Flanschnaben und Mittelteil mit Wuchtgüte Q6,3.

b) Die Lenker mit Wuchtgüte Q16.

Die Lenker der CENTALINK bestehen aus geschmiedeter hochfester Aluminiumlegierung.

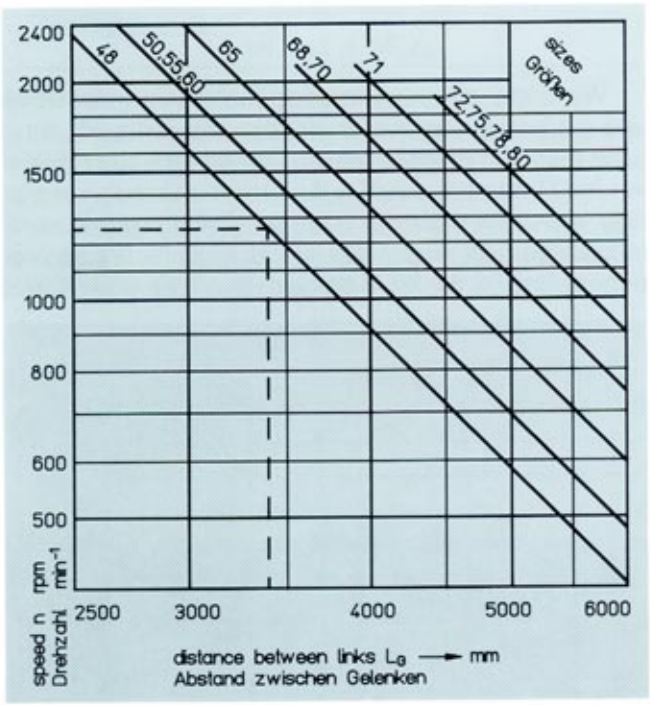
Sie werden ausgewogen und innerhalb einer engen Toleranz auf gleiches Gewicht gebracht. Danach liegen sie auch als Satz innerhalb der Unwuchttoleranz. Sie können daher beliebig eingebaut und ausgetauscht werden.

Allowable Speed

The value in the technical data tables shows the absolute maximum allowable speed. For longer lengths the allowable speed is also limited by the critical speed of the tube, and if necessary it has to be reduced. The diagram below shows the limiting values for speed and length of shaft sizes. Each combination of speed and length below the relevant diagonal lines is permissible.

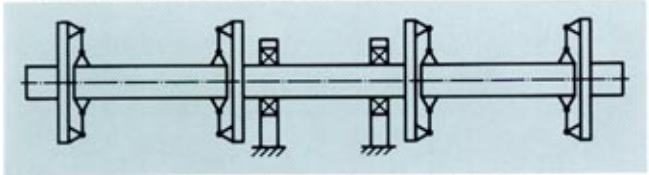
e.g. for size 48: n = 1250 rpm, thus:
L_{Gmax} = 3400 mm.

The radial stiffness of the links has hereby already been considered. A further conditions is, that the bearings and shafts, that are supporting the CENTALINK shaft, have sufficient rigidity.

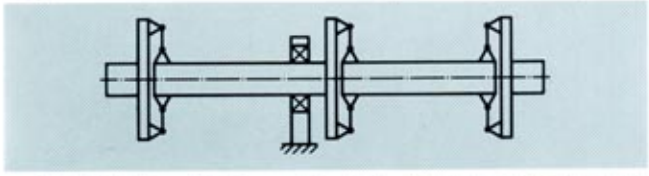


Should longer distances have to be spanned, 2 or more shafts have to be used.

The following sketches show 2 principles for such shafts:



2 U joint shafts with intermediate shaft supported by 2 bearings.



1 U joint shaft and 1 intermediate shaft with only 1 bearing and only 1 joint. The bearing has to be able to spherically adjust.

Zulässige Drehzahl

Der Wert in der Tabelle der technischen Daten gibt die absolut höchste zulässige Drehzahl an. Bei größeren Längen wird die zulässige Drehzahl jedoch auch durch die biegekritische Drehzahl des Rohres begrenzt, und gegebenenfalls reduziert. Nebenstehendes Diagramm zeigt für die einzelnen Gelenkwellengrößen die Grenzwerte für Drehzahl und Länge. Die schrägen Linien stellen die zulässigen Maxima für die einzelnen Größen dar, jede Kombination aus Drehzahl und Länge unterhalb der jeweiligen Linie ist zulässig.

z. B. für Größe 48: n = 1250 min^{-1}, daraus folgt:
L_{Gmax} = 3400 mm.

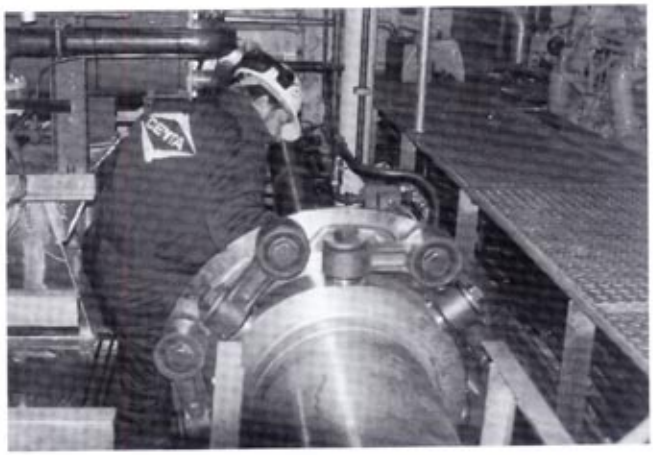
Hierbei ist die radiale Elastizität der Lenker berücksichtigt. Außerdem ist vorausgesetzt, daß die die Gelenkwelle tragenden Wellen und Lagerungen hinreichend steif sind.

Falls größere Abstände zu überbrücken sind, dann müssen 2 oder mehr Gelenkwellen verwendet werden.

Die Skizzen unten links zeigen 2 Prinzipien für solche Gelenkwellenstränge:

Obere Skizze:
2 Gelenkwellen mit 2-fach gelagerter Zwischenwelle.

Untere Skizze:
1 Gelenkwelle und einmal gelagerte Zwischenwelle mit nur 1 Gelenk. Das Lager muß sich spährisch einstellen können.



One of four CENTALINK-shaft lines size 86 in ferry „KATTEGAT"
P = 5800 kW / 560 rpm. T = 99 KNm each shaft

Eine von vier CENTALINK-Wellensträngen Größe 86 in der Fähre „KATTEGAT"
P = 5800 kW / 560 min^{-1} T = 99 KNm je Wellenstrang

The angle has to be checked at each joint separately, and the largest angle α_1 or α_2 has to stay within the allowable range.

The resulting total angle ß is not relevant for the selection of the shafts, as long as the two angles α_1 and α_2 are within their limits.

These rules also apply analogously for single joints.

The **continuously allowable angular misalignment** is about 1 degree. However, in the interest of long life this value should be kept as low as possible.

For **transient conditions** (eg. engine starting and stopping, very rough sea etc) up to 3 degrees are allowable.

For **shock situations** 6 degrees are allowable. These figures apply to each single joint.

The relation between angular misalignment, distance of the joints and the resulting radial misalignment lies in the following formula:

$$\triangle W_r = L_G \cdot \tan\alpha$$

Once the allowable misalignment is determined and a certain radial displacement is required, the resulting minimum distance L_G of the shafts can be calculated according to the a.m. formula as well. For an easy, fast layout these relationship are shown in the following diagramm for various allowable angles α.

Die Abwinkelung muß an jedem Gelenk für sich allein überprüft werden, und der jeweils größte Winkel α_1 oder α_2 darf den zulässigen Wert für $\triangle K_w$ nicht überschreiten.

Der resultierende Gesamtwinkel ß ist für die Auslegung nicht relevant, solange die beiden Winkel α_1 und α_2 im zulässigen Bereich bleiben.

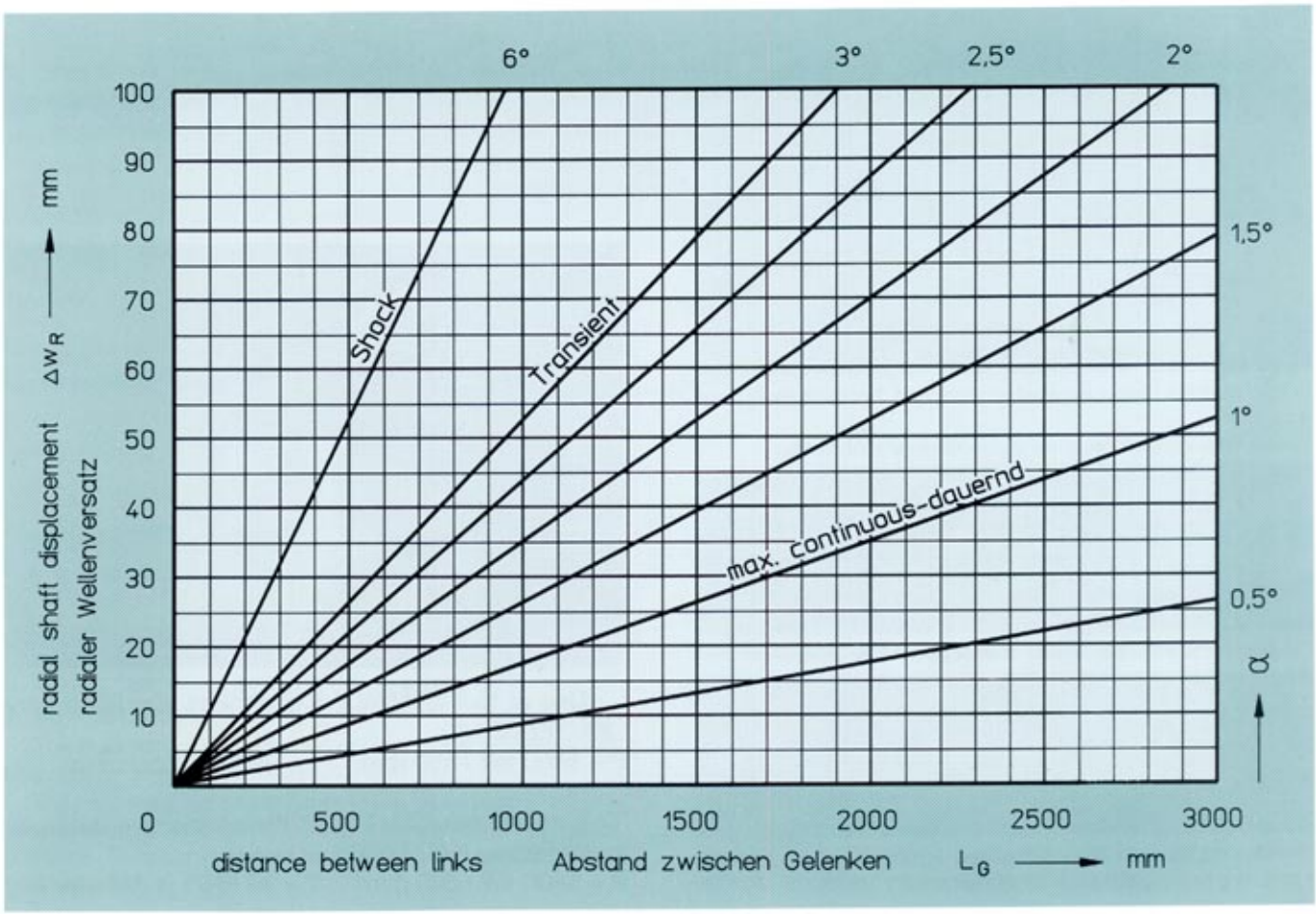
Der dauernd zulässige Winkelversatz beträgt ca. 1°. Er sollte jedoch im Interesse einer langen Lebensdauer so klein wie möglich gehalten werden.

Für **transiente Betriebszustände** (z. B. An- und Abstellen der Motoren, schwerer Seegang usw.) sind bis zu 3 Grad zulässig, und für **Schocksituationen** sind 6 Grad zulässig. Diese Werte gelten jeweils für ein Gelenk.

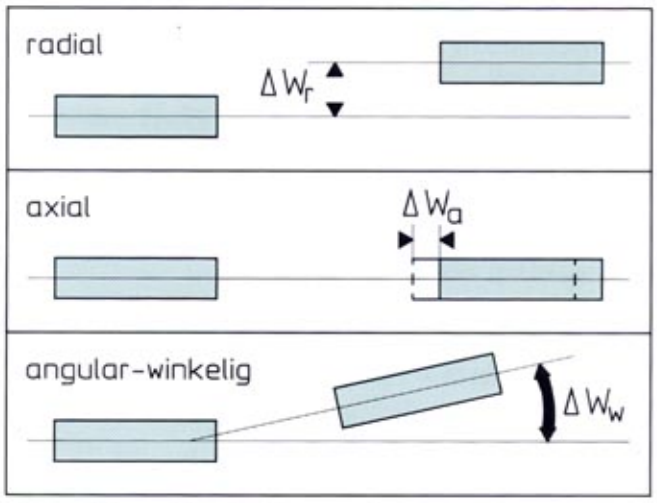
Der Zusammenhang zwischen zulässigem Winkelversatz, Abstand der Gelenke und dem daraus resultierenden radialen Versatz ergibt sich aus folgender Formel:

$$\triangle W_r = L_G \cdot \tan\alpha$$

Wenn die zulässige Winkelabweichung ermittelt ist und ein bestimmter Wellenversatz gefordert wird, dann kann man aus obiger Formel auch den daraus resultierenden Mindestabstand L_G der Gelenke berechnen. Für eine bequeme, schnelle Auslegung sind diese Zusammenhänge in folgendem Strahlendiagramm für verschiedene zulässige Winkel α dargestellt.



Misalignment Definition
Wellenversatz



Allowable axial misalignment

The value for $\triangle K_a$ in the technical data table is the maximum value for transient operation situation (eg. shock, heavy sea etc.).

The continuous (static) axial misalignment on installation of the shaft should be as low as possible, not greater than 20% of $\triangle K_a$.

$\triangle W_a \leqq 0{,}2 \cdot \triangle K_a$ for continuous operation

$\triangle W_a \leqq \triangle K_a$ for transient operation

axial reaction force:

$F_a = \triangle W_a \cdot C_a$ (KN)

Allowable radial and angular misalignment

For cardanic shafts a radial misalignment is always converted to angular misalignment. Additionally there may be an angular misalignment of the connected shafts.

Therefore both kinds of misalignment have to be checked at the same time.

There are 2 typical kinds of arrangements for such shafting.

Z-Arrangement

Driven and driving shafts are in parallel,yet displaced radially to each other. The radial misalignment of the connected shafts will be converted to an angular misalignment of the middle part.

W-Arrangement

Driven and driving shafts are not in parallel, but relate to each other in the resulting angle ß.

The angle α_1 produces a radial misalignment $\triangle W_r$ at the same time.

The angles α_1 and α_2 of both joints can be equal or different.

Zulässiger axialer Wellenversatz

Der Wert für $\triangle K_a$ in der Tabelle der technischen Daten gilt als maximaler Wert für transiente Betriebszustände (z. B. Shock, schwerer Seegang usw.).

Bei der Installation der Gelenkwelle sollte der fest vorgegebene, dauernde (statische) axiale Wellenversatz möglichst gering sein, höchstens jedoch 20% vom $\triangle K_a$.

$\triangle W_a \leqq 0{,}2 \cdot \triangle K_a$ für Dauerbetrieb

$\triangle W_a \leqq \triangle K_a$ für Transientbetrieb

Reaktionskraft bei axialem Versatz:

$F_a = \triangle W_a \cdot C_a$ (KN)

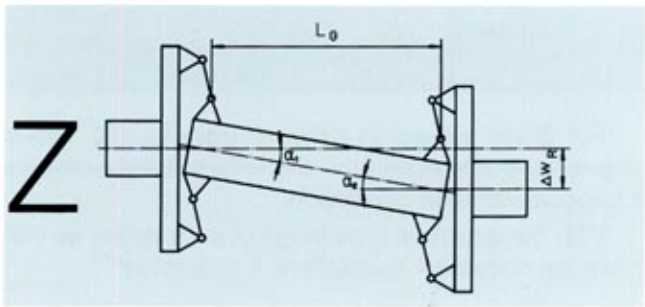
Zulässiger radialer und winkeliger Versatz

Bei Gelenkwellen wird ein radialer Versatz immer in einen Winkelversatz umgewandelt. Zusätzlich kann ein winkeliger Versatz der verbundenen Wellen vorliegen.

Diese beiden Versatzarten müssen daher gemeinsam betrachtet werden. Man unterscheidet bei Gelenkwellen 2 typische Anordnungen:

Z-Anordnung

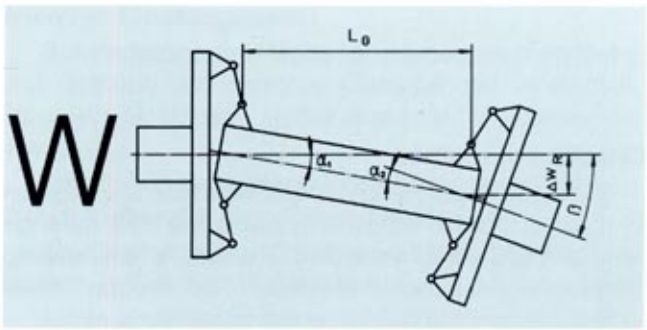
An- und Abtriebswellen sind parallel, jedoch zueinander radial versetzt. Der radiale Versatz der verbundenen Wellen wird in eine winkelige Verlagerung des Mittelteiles umgewandelt. $\alpha_1 \approx \alpha_2$



W-Anordnung

An- und Abtriebswellen sind nicht parallel, sondern stehen zueinander unter dem resultierenden Winkel ß. Aus dem Winkel α_1 resultiert gleichzeitig auch ein radialer Wellenversatz $\triangle W_r$.

Die Winkel α_1 und α_2 der beiden Gelenke können gleich oder verschieden sein.



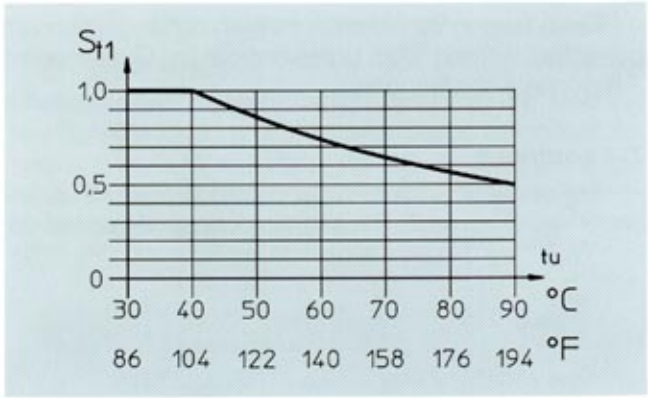
Explanation of technical data and selection of CENTALINK

Nominal torque

First the CENTALINK shaft selection has to be based on the nominal torque T_{KN}. This is allowable continuously within the permitted speed range. Under difficult operation conditions additional service factors may be required. For high ambient temperature the temperature factor of S_{t1} has to be considered.

$$T_{KN} \geqq \frac{P \cdot 9{,}55}{n \cdot S_{t1}}$$

T_{KN} = nominal torque of CENTALINK (kNm)
P = power to be transmitted (kW)
n = speed (rpm)
S_{t1} = temperature factor according to diagram



For drives subject to torsional vibration (eg. diesel engines) the selection of the shaft has to be checked by a torsional vibration calculation.

With our extensive knowledge of such drives we can make the necessary calculations if requested.

Maximum torque

The maximum torque is that which may occur in transient operation (start-up, shock, passing through resonance) and for a limited length of time.

Direction of rotation

Centalink shafts can be assembled to suit any direction of rotation, but for technical reasons the links must be fitted so that the links are pulled. Therefore when ordering please give the direction of rotation "cw" or "ccw" when looking at the driving end, as the example.

Erläuterung der technischen Daten und Auslegung von CENTALINK

Nenndrehmoment

Die Auslegung der CENTALINK Gelenkwellen muß zunächst nach dem Nenndrehmoment T_{KN} erfolgen. Dieses ist im zulässigen Drehzahlbereich dauernd zulässig, wenn nicht erschwerende Einsatzbedingungen noch sonstige Betriebsfaktoren erfordern. Bei höheren Umgebungstemperaturen muß der Temperaturfaktor S_{t1} berücksichtigt werden.

$$T_{KN} \geqq \frac{P \cdot 9{,}55}{n \cdot S_{t1}}$$

T_{KN} = Nenndrehmoment von CENTALINK (KNm)
P = zu übertragende Leistung (KW)
n = Drehzahl (min^{-1})
S_{t1} = Temperaturfaktor nach Diagramm

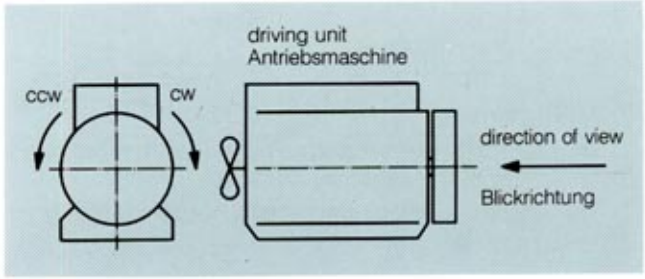
Bei Antrieben mit Drehschwingungen (z. B. Dieselmotoren) muß die Auslegung der Gelenkwelle immer durch eine Drehschwingungsrechnung überprüft werden. Unser Know how im Berechnen von Drehschwingungen und im Auslegen von entsprechenden Kupplungen steht Ihnen dazu gerne zur Verfügung.

Maximaldrehmoment

Das Maximaldrehmoment ist das Drehmoment, welches im transienten Betrieb (Anfahren, Stöße, Resonanzdurchfahrt usw.) höchstens und mit begrenzter Anzahl auftreten darf.

Drehrichtung

Die CENTALINK-Gelenkwellen sind jeweils nur für eine Drehrichtung ausgelegt, nämlich die Drehrichtung, wobei die Lenker unter Zug stehen. Daher bitten wir bei Bestellung immer um Angabe der Drehrichtung bei Blick auf die treibende Maschine, gemäß folgendem Beispiel:



Drehrichtung: cw oder ccw

CENTALINK joints offer the following outstanding advantages:

* compensation for considerable axial, radial and angular misalignment
* with very low reacting forces, and linear characteristics
* constant velocity transmission, angular deflection of the two joints may be different
* silent operation, transmitted noise reduced. The transmission of noise is interrupted in four places by rubber bushes.
* free of backlash, torsionally stiff. The single joints are also radially stiff
* free of maintenance, free of wear, with fail-safe-feature
* radially exchangeable without disturbing connected machinery
* easy visual check of the condition of the rubber bushes, easy and fast exchange of the links is possible without special tools
* long shaft distances can be spanned
* combinations with torsionally flexible CENTAX-elements allow optimal tuning of the torsional situation (page 14)
* the design is protected by international patents.

Die CENTALINK Gelenkwellen bieten folgende hervorragende Eigenschaften:

* Ausgleich von großen axialen, radialen und winkeligen Verlagerungen
* Dabei geringe Rückstellkräfte, mit linearer Kennlinie, d. h. proportional zur Auslenkung, und fast nicht beeinflußt vom übertragenen Drehmoment.
* Homokinetische Übertragung, der Beugewinkel der beiden Gelenke kann unterschiedlich sein.
* Geräuschfreie Arbeitsweise und Geräuschdämpfung, die Weiterleitung von Geräuschen und Vibrationen wird gedämpft, da der Körperschall durch die Gummibuchsen 4 mal nacheinander unterbrochen wird.
* Spielfrei, drehsteif. Das einzelne Gelenk ist auch radial steif.
* Wartungsfrei, verschleißfrei, durchdrehsicher.
* Mittelteil radial montierbar, ohne Verschiebung der Wellen.
* Leichte visuelle Überprüfung der Gummibuchsen, einfacher, schneller Austausch der Lenker ohne Spezialwerkzeug möglich.
* Große Wellenabstände können überbrückt werden.
* Kombinationen mit drehelastischen CENTAX-Elementen erlauben optimale Abstimmung der Drehschwingungslage. (Seite 14)
* Die Konstruktion ist durch internationale Patente geschützt.

Important areas of application

Ship main and auxiliary drives, between engine and gear and between gear and jet-drive, propeller, generator, hydraulic pump, waterpump etc.

Drive of **rail cars** between engine and gear or between gear and axle.

Windturbines, cooling towers, fan drives, mills, glazing rollers, steel mills. General construction and machine industry and heavy engineering.

Wichtige Einsatzgebiete

Schiffshaupt- und Nebenantriebe, zwischen Motor und Getriebe und zwischen Getriebe und Jet-Antrieb, Propeller, Generator, Hydraulikpumpe, Wasserpumpe usw.

Antrieb von **Schienenfahrzeugen,** zwischen Motor und Getriebe oder Getriebe und Achse.

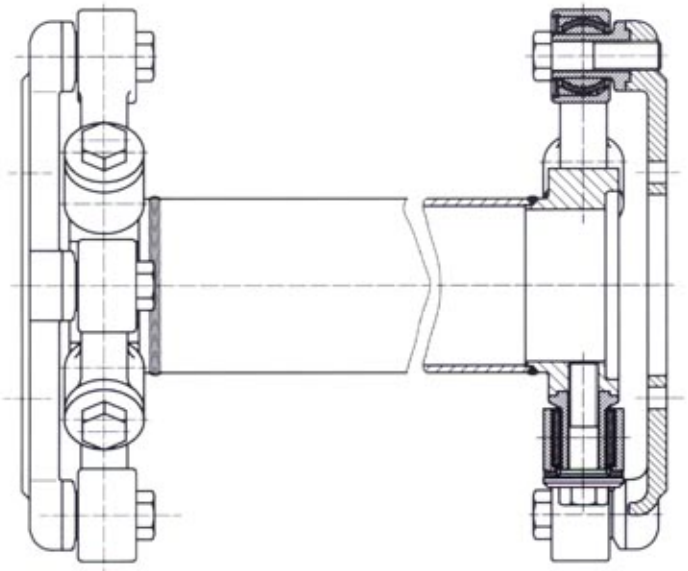
Windkraftwerke — Kühltürme — Ventilatorantriebe — Mühlen — Kalander Walzwerke.

Allgemeiner Maschinen- und Anlagenbau.

CENTALINK®

The silent driveshaft

The internationally patented CENTALINK shafts are on the market since 1991, more than 1000 units perform well in severe applications. Many of them have reached more than 20.000 hrs in service without any problems.



The CENTALINK shaft consists of links which are designed for efficiency using flexible bushes for push and pull. In each link there is a cylindrical flexible bush, which is connected radially to the hub and a spheroidal flexible bush which is connected axially to the flange.

This ingenious new design results in a very simple, highly flexible low cost and easy to assemble link coupling. There are between 3 and 8 links per joint depending on the shaft size.

The rubber joints of the CENTALINK shaft are based on well proven, well dimensioned rubber bushes or spherical joints, where the rubber is vulcanised to the inner and outer metal part and is under high precompression. Such couplings have been well proven in similar application, e.g. couplings for highspeed trains.

All movements of the joints are absorbed flexibly by the rubber bushes — without relative movement of the metal — and therefore free of wear.

Die international patentierten CENTALINK-Gelenkwellen sind seit 1991 auf dem Markt, mehr als 1000 Einheiten haben sich in harten Einsätzen bestens bewährt. Viele davon haben Laufzeiten von mehr als 20.000 h ohne Probleme erreicht.

Die CENTALINK Gelenkwelle besteht aus sinnvoll angeordneten, für Zug und Druck ausgelegten Lenkern mit gummielastischen Buchsen.

In jedem Lenker befinden sich eine zylindrische Gummibuchse, die radial mit der Nabe verschraubt ist und eine sphärische Gummibuchse, die axial mit einem Flansch verschraubt ist.

Diese neuartige Konstruktion ergibt eine sehr einfache, hochelastische, preiswerte und gut montierbare Lenkerkupplung. Je nach Baugröße sind 3-8 Lenker je Gelenk angeordnet.

Die Gummigelenke der CENTALINK Gelenkwelle basieren auf bewährten, reichlich dimensionierten Gummibuchsen bzw. Kugelgelenken, wobei das Gummi am inneren und äußeren Metall anvulkanisiert ist und unter hoher Druckvorspannung steht. Derartige Gummigelenke haben sich seit langer Zeit in vergleichbaren Anwendungsfällen, z. B. in Kupplungen für Hochgeschwindigkeitszüge, bestens bewährt.

Alle Bewegungen der Gelenke werden in den Gummibuchsen elastisch — ohne Relativbewegung zum Metall — und damit verschleißfrei aufgenommen.

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INHALTSVERZEICHNIS

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This catalogue shows the extent of our CENTALINK-shaft range at the time of printing. This program is still being extended with further sizes and series.

If you are unable to find a suitable shaft for your application please do not hesitate to contact us. The experience of Centa gained during 25 years of coupling manufacture with more than 5 million couplings sold combined with our extensive range of 20 coupling series allows us to provide a good technical and economic solution for almost all problems.

We reserve the right to amend any dimension or detail specified or illustrated in this publication without notice and without incurring any obligation to provide such modification to such couplings previously delivered. Please ask for an application drawing and current data before making detailed coupling selection.

We would like to draw your attention to the need to prevent accidents or injury. No safety guards are included in our supply. Copyright to this technical document is held by CENTA Antriebe Kirschey GmbH 1992.

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Catalogue No. CL-4-99

Dieser Katalog zeigt nur das bei Drucklegung vorhandene Programm der CENTALINK-Gelenkwellen. Dieses Programm wird jedoch ständig in Hinsicht auf weitere Baugrößen und Bauformen erweitert.

Falls Sie für Ihren Einsatzfall nicht die geeignete Gelenkwelle finden, fragen Sie bitte bei uns an. Die reiche Erfahrung der Firma Centa — gewonnen in 25 Jahren mit mehr als 5 Millionen verkauften CENTA-Kupplungen — und das umfangreiche Programm von 20 Kupplungsbaureihen bieten für fast alle Probleme eine technisch gute und wirtschaftlich günstige Lösung.

Wir behalten uns vor, die Maße, die technischen Daten und die Konstruktion zu ändern; alle Angaben dieses Kataloges sind unverbindlich. Fragen Sie bitte nach verbindlichen Einbauzeichnungen und Daten, wenn Sie eine Gelenkwelle einplanen.

Wir verweisen auf die rechtlichen Vorschriften für die Unfallverhütung. Eventuell vorzunehmende Abdeckungen oder dergleichen gehören nicht zu unserem Lieferumfang. Diese technische Unterlage hat gesetzlichen Schutz nach DIN 34.

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NEG MICON
FOR INFORMATION ONLY

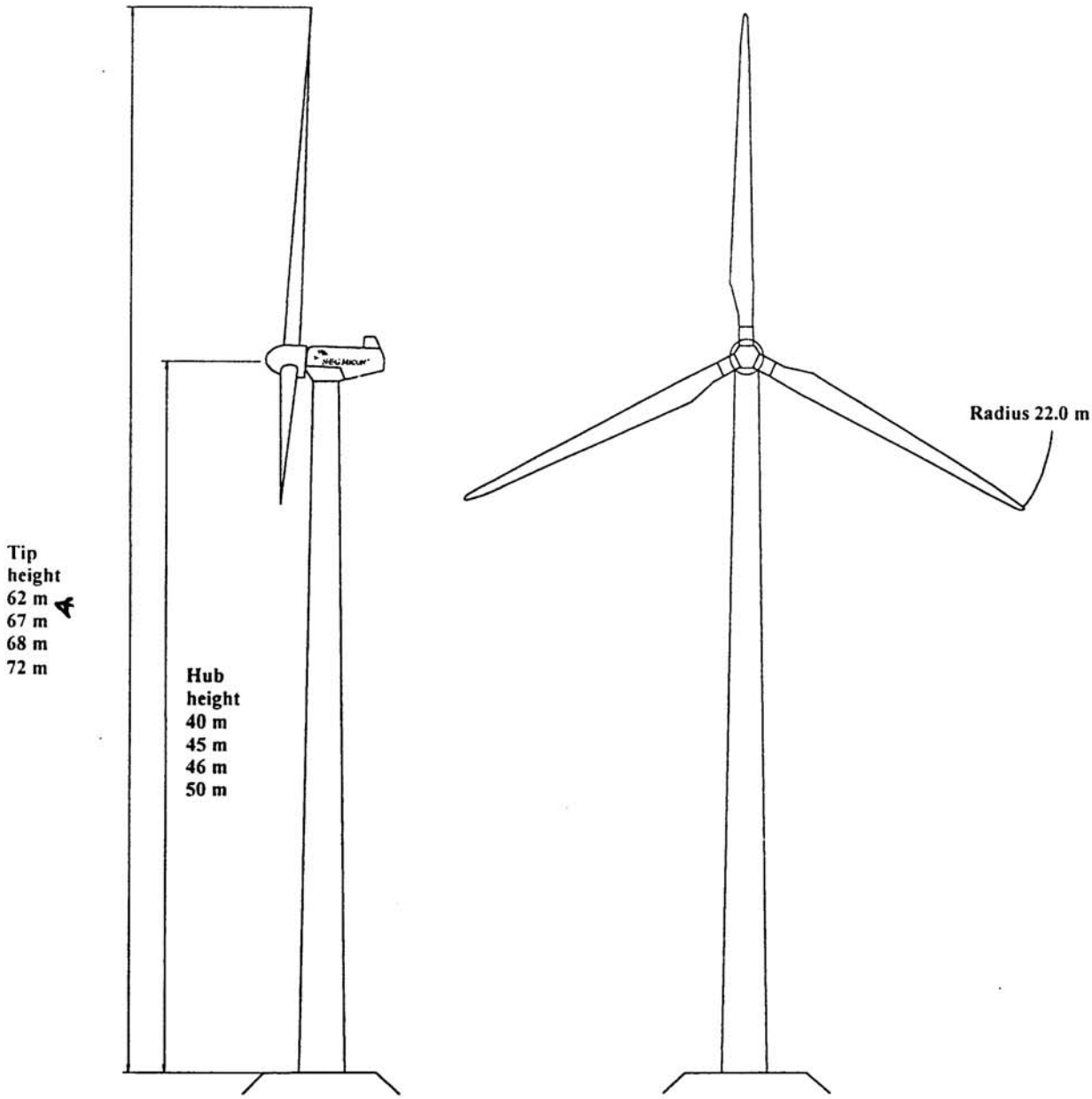
Main Specification

NM 750/44 - 60Hz

volver

R&D-TIC 98

0 Illustration



1 Main Data

Nominal Power	750-175	kW
Rotor diameter	44.0	m
Swept area	1520	m^2
Hub height	40	m
Rotational speed approx.	27/18	rpm
Total weight (at 40 m hub height)	--	tons

2	Nacelle Bed (IEC I+)		
	Manufacture		NEG Micon
	Type		20 t platform
	Material		Welded steel plate
	Surface treatment		Galvanised and painted
	Standard colour		RAL 7035
	Corrosion class	4	Acc. to DS/R-454, marine specification
	Weight (without components mounted)	7	tons
	Total weight (without rotor and tower)	22	tons

3	Rotor		
	Number of blades	3	pc
	Diameter	44.0	m
	Swept area	1520	m^2
	Hub height over terrain	40	m
	Rotor speed (synchronous)	27/18	rpm
	Tip speed (synchronous)	62.1	m/s
	Rotor shaft tilt	5	°
	Tip angle (standard)	-1.0	°
	Solidity (Total blade area/rotor area)	4.3	%
	Power regulation		Stall
	Rotor orientation		Upwind
	Total weight with hub (LM blades – type I)	10.5	tons

4a	Blades – type I		
	Manufacture		LM Glasfiber A/S
	Type		LM 19.1
	Blade length	19.04	m
	Material		Glasfiber-polyester/Carbon fibre-epoxy
	Type of rotor air brake		Pivotable blade tip
	Blade profiles		FFA-W3 NACA 63-serie
	Twist	20	°
	Largest cord	1.65	m
	Tip cord (at blade tip bottom)	0.5	m
	Blade area	21.9	m^2
	Weight each	1900	kg

5	Hub		
	Manufacture		NEG Micon
	Design/Type		NM750/48/Spherical
	Material		Meehanite SFF 400
	Surface treatment		Sand blast-metallized-painted
	Weight	4	tons

10	Oil pump for Cooling by Oil Cooler Unit		
	Manufacture		GalTech
	Type		2SPA-11D-7A
	Motor		MEZ-4AP80-2-B3/B5-2/3
	Voltage	480	Volt
	Power	1.1	kW
	Pump capacity	30	l/min.
	Maximum working pressure	15	bar
	Weight	9.6	kg

11	Oil Cooler Unit		
	Manufacture		Nissens A/S
	Type		HP 6-2
	Voltage	480	Volt
	Power	0.9	kW
	Weight without oil	65	kg

12	Cooling Pump for Generator		
	Manufacture		Grundfoss
	Type		CH4-20
	Motor type		Grundfoss
	Voltage	480	Volt
	Power	0.75	kW
	Pump capacity	30	l/min.
	Weight (without cooling water)	9.6	kg

13	Radiator for Cooling the generator.		
	Manufacture		Nissens A/S
	Type		942101A4
	Capacity	44	kW
	Weight (without cooling water)	60	kg

14	Mechanical Brake		
	Manufacture		Sime
	Type		2TWA36– Fail safe – hydraulic release
	Brake disc		Steel, mounted on high speed shaft
	Number of callipers	1	Pc
	Weight (Brake caliper/brake disc)	120/90	Kg

15	Coupling		
	Manufacture		Centa
	Type		CL-60
	Weight	45	kg

16	Generator			
	General standard data – 2 speed generator			
	Rated power output	750	175	kW
	Type			Water cooled
	Form of mounting			B3- foot mount
	Enclosure			IP54
	Isolation class			Class F
	Number of poles	4	6	
	Synchronous rotation speed	1800	1200	rpm
	Voltage		690	Volt
	Frequency		60	Hz

16a	Generator – type I						
	Manufacture			ELIN			
	Type			MCT-445L21F9Z-9			
	Maximum power at class F utilisation	774	210	kW			
	Full load current (at rated output)	710	200	Ampere			
	Maximum current (at class F utilisation)	728	209	Ampere			
	No load current	130	60	Ampere			
	Reactive power consumption at full load	390	130	kVAr			
	Reactive power consumption at no load	160	72	kVAr			
	Rotational speed at rated power output	1812	1208	rpm			
	Slip at rated power output	0.67	0.67	%			
	Electrical data			Efficiency %		Power factor (cos. φ)	
		Load		G1	G2	G1	G2
		110 %		96.8	95.0	0.89	0.84
		100 %		96.9	95.2	0.89	0.84
		75 %		96.9	95.3	0.89	0.82
		50 %		96.5	94.9	0.87	0.75
		25 %		94.5	92.0	0.75	0.55
	Weight (without cooling water)		3450	kg			

17	Slip Rings		
	Manufacture		Jørgen Hansen IDK
	Type		BGB-Engineering

18	Hydraulic Power Unit for Mechanical Brake		
	Manufacture		Sime
	Type		TE2L
	Motor type		Standard 4-pole/B3
	Voltage	400	Volt
	Power	0.37	kW
	Working pressure range	140-180	bar
	Relief valve	190-210	bar
	Oil type	SHC 524	Mobil
	Oil capacity	2.5	l
	Weight (without hydraulic oil)	40	kg

19	Hydraulic Power Unit for Blade Tip Air Brakes		
	Manufacture		AVN Hydraulic
	Type		AVN-V24
	Motor type		PM 50/42
	Voltage	24	Volt DC
	Working pressure range	95-100	bar
	Relief blow disc		bar
	Oil type	SHC 524	Mobil
	Oil capacity	3	l
	Weight (without hydraulic oil)	30	kg

20 a	Yaw System – Ball Bearing Slewing Ring		
	Manufacture		Rothe Erde
	Type		Ball bearing, internal gearing
	Weight	520	kg

20 b	Yaw System – Yaw Gear and Motors		
	Manufacture – gear/motor		Bonfiglioli Trasmittal
	Type - gear		73ST3F
	Motor type (brake motor)		ATA 80 B-5
	Voltage	400	Volt
	Power	0.37	kW
	Number of yaw gears	4	pc
	Weight		kg

20 c	Yaw System – Yaw Friction		
	Manufacture		NEG Micon
	Type		NM 20T
	Number of yaw friction units	3	pc
	Weight	76	kg

21	Tower				
	Manufacture		NEG Micon		
	Type		Conical, tubular		
	Material		Welded steel plate		
	Surface treatment		3-layer painting system		
	Corrosion class outside/inside	4/3	Acc. to DS/R-454, marine specification		
	Colour		RAL 7035		
	Access conditions		Internal, safety harness and ladder cage		
	Hub height over foundation	**40.0**			m
	Tower height	38.6			m
	Top diameter	1.64			m
	Bottom diameter	3.00			m
	Number of sections	2			pc
	Total weight	---			ton

22	Wind Turbine Controller/Power Cabinet		
	Manufacture		NEG Micon
	Type		WP3000
	Voltage	690	Volt
	Operation area, voltage	620-757	Volt (60 sec. average)
	Maximum voltage	771	Volt (0.5 sec. average)
	Maximum cut-in current	840	Ampere
	Cut-in system		Soft with thyristors
	Frequency area	60 ± 1	Hz (0.1 sec. average)
	Maximum power output	840	KW
	Capacitor banks	300	kVAr (5steps: 60+60+60+60+60)
	Weight	425	Kg

23	Climate and Site Conditions		
	Calculated minimum life	20	years
	Operational temperature limits	-20 to + 35	°C
	A-factor	7.9	m/s
	Form factor, k	2.0	
	Yearly average wind in 50 m hub height	7.0	m/s
	Terrain wind speed	0.01	
	Extreme wind speed	40	m/s (10 min. average)
	Survival wind speed	60	m/s (2 sec. average)
	Automatic stop limit	25	m/s (10 min. average)
	Turbulence intensity acc. to IEC II low (15m/s)	15	%
	Air density	1.28	kg/m³
	Distance between wind turbines in single rows	3	rotor diameters
	Distance between wind turbines in wind farms	5	rotor diameters
	Maximum hill slope	5	°

24 Power Curve

(m/s)	Pe
3	0
4	5,0
5	33,0
6	71,0
7	128,0
8	201,0
9	287,0
10	377,0
11	460,0
12	555,0
13	645,0
14	712,0
15	743,0
16	752,0
17	748,0
18	732,0
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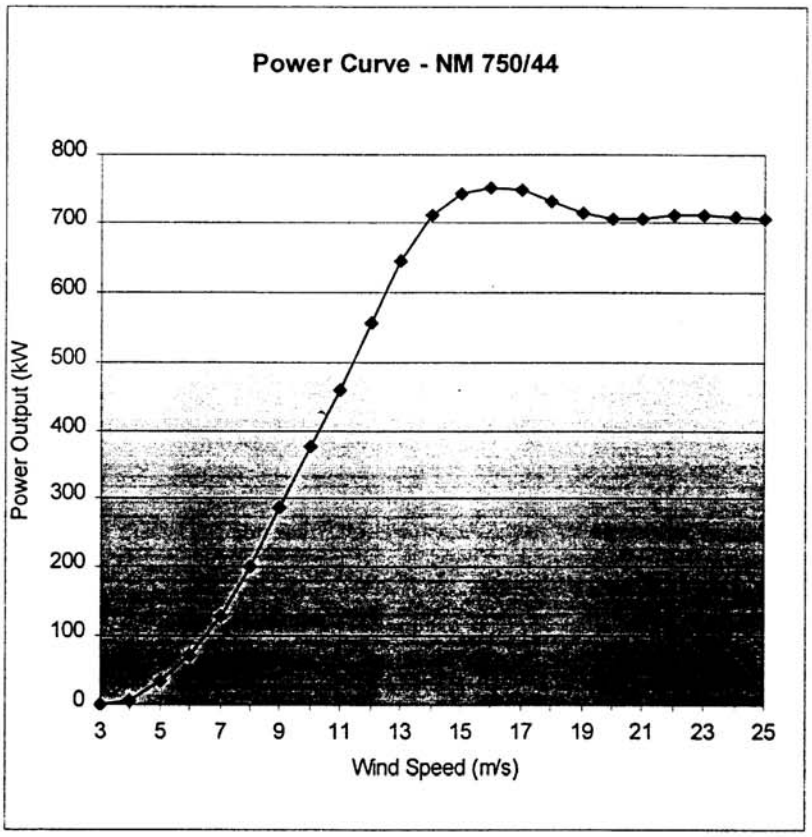


The power curve is shown at standard conditions according to DIN ISO 2533:
Air temperature 15 °C, air pressure 1013 hPa and maximum turbulence intensity of 15%

NEG Micon A/S reserves the right to change specifications and to use components of alternative manufacture without prior notice. Alternative components will be of the same high quality and standard as in this survey.

6	**Rotor shaft**		
	Manufacture		NEG Micon
	Design/Type		NEGM/forged shaft and flange
	Material		34CrNiMo6V
	Surface treatment		Painted
	Weight	2.3	tons

7	**Main Bearing**		
	Manufacture		SKF or FAG
	Design/Type		Spherical roller bearing
	Number of	1	pc
	Weight	112	kg

8	**Main Bearing Housing**		
	Manufacture		NEG Micon
	Design/Type		NEGM/Flange bearing
	Number of	1	pc
	Weight	440	kg

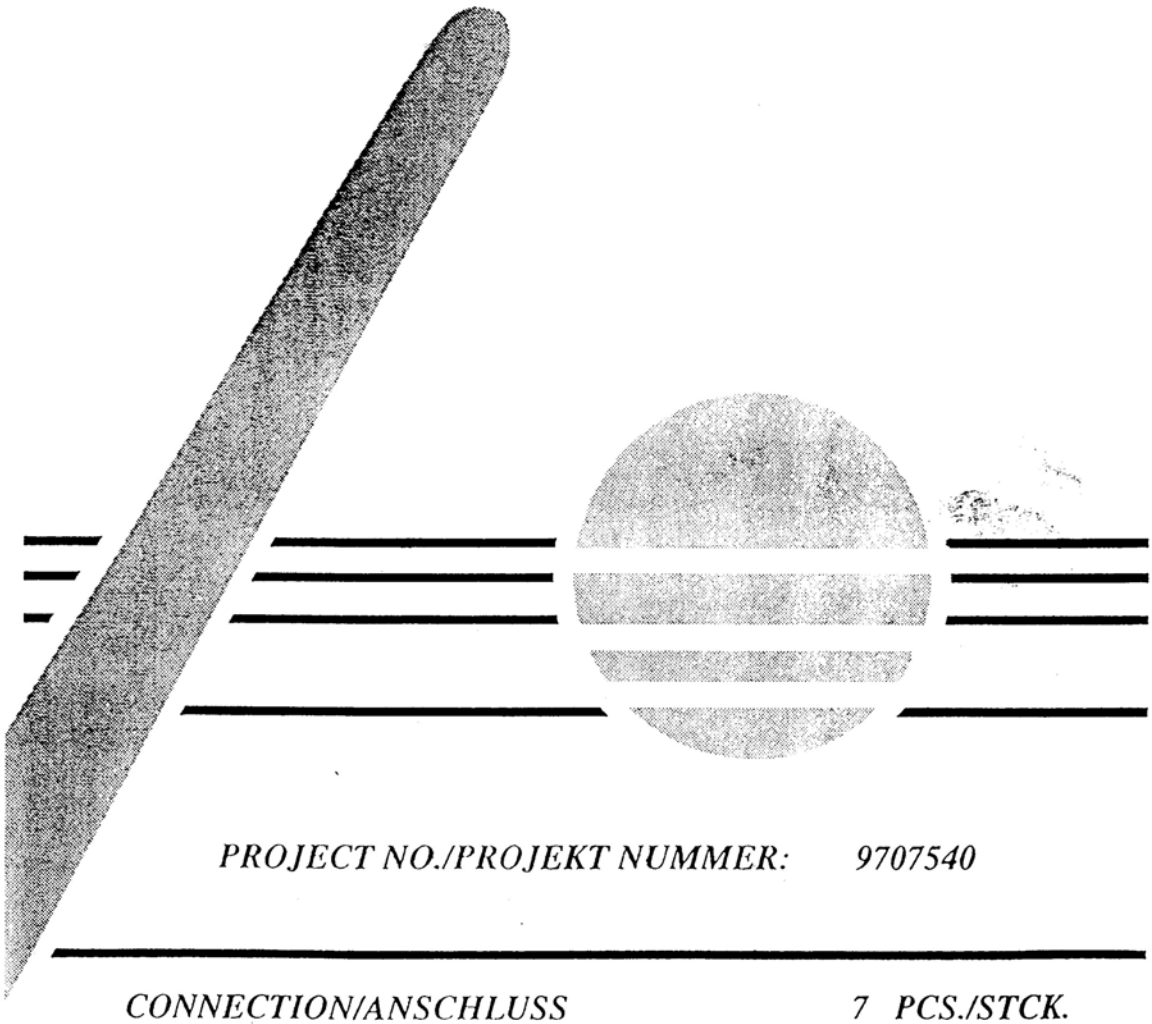
9b	**Gearbox – type II**		
	Manufacture		Flender
	Type		PEAS 4300
	Design		Planetary (1 step) parallel shafts (2 steps)
	Gear house material		Cast
	Ratio approx.		
	Mechanical power	807	KW
	Safety against fatigue in cog root		$S_F > 1.6$
	Safety against pitting		$S_H > 1.25$
	Safety against scuffing		$S_S > 1.5$
	Shaft seals		Maintenance free labyrinth-type
	Lubrication		Splash- with lubrication channels
	Oil sump approx.	65	l
	Oil type		Tribol 1510/320
	Weight without oil	5.5	tons

TURBINE:
M1500 - 750/175kW

CONTROL SYSTEM:
WP3000

MAIN SUPPLY/HAUPTVERSORGUNG: *3 x 690V + PE 60Hz*

CIRCUIT DIAGRAM: *COSTA RICA - WITH SPECIAL AIR COOLING*



PROJECT NO./PROJEKT NUMMER: *9707540*

CONNECTION/ANSCHLUSS	*7 PCS./STCK.*
CIRCUIT DIAGRAM/STEUERTEIL	*21 PCS./STCK.*

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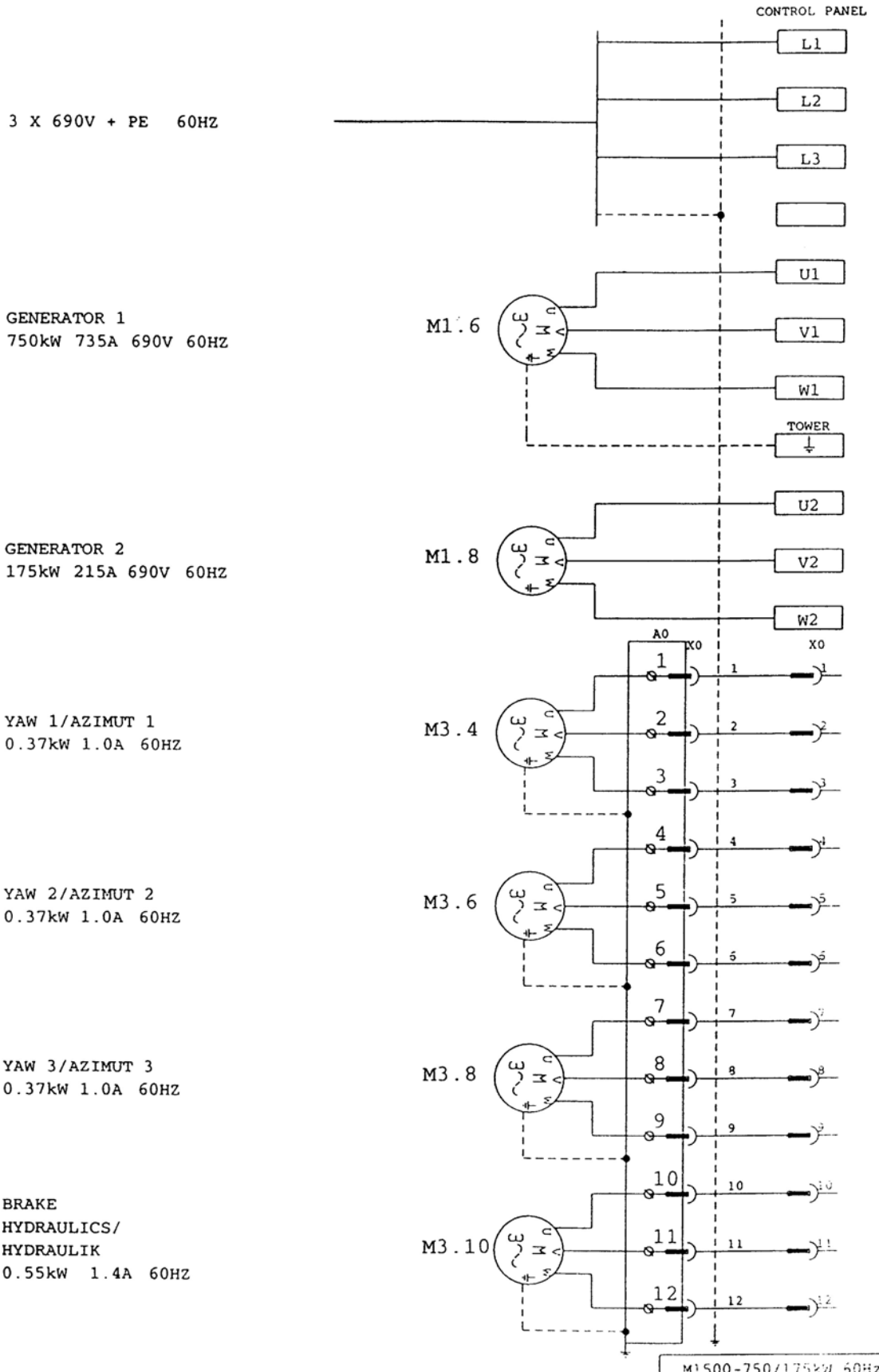
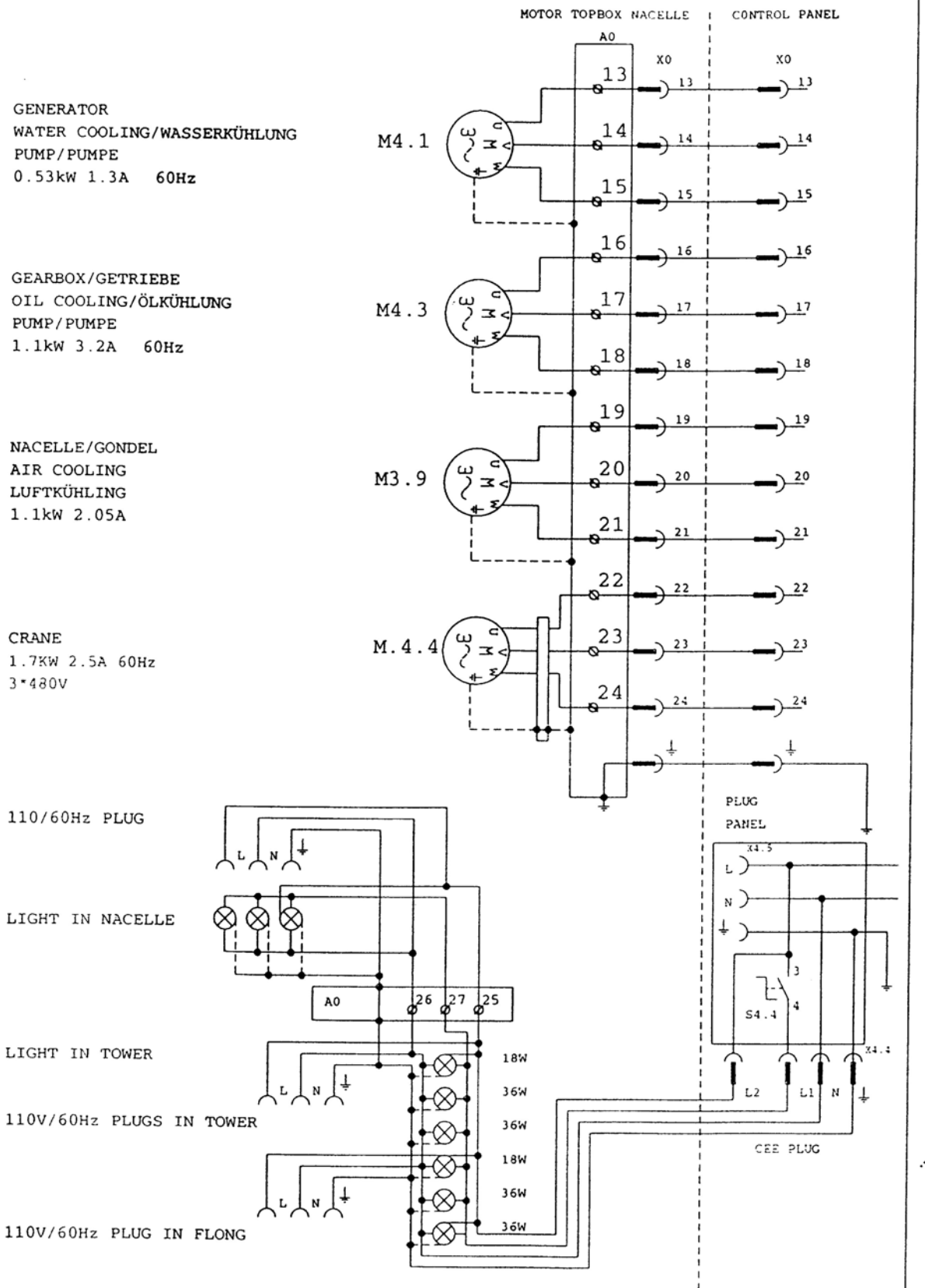
Fax: +45 8710 5001

N·E·G MICON®

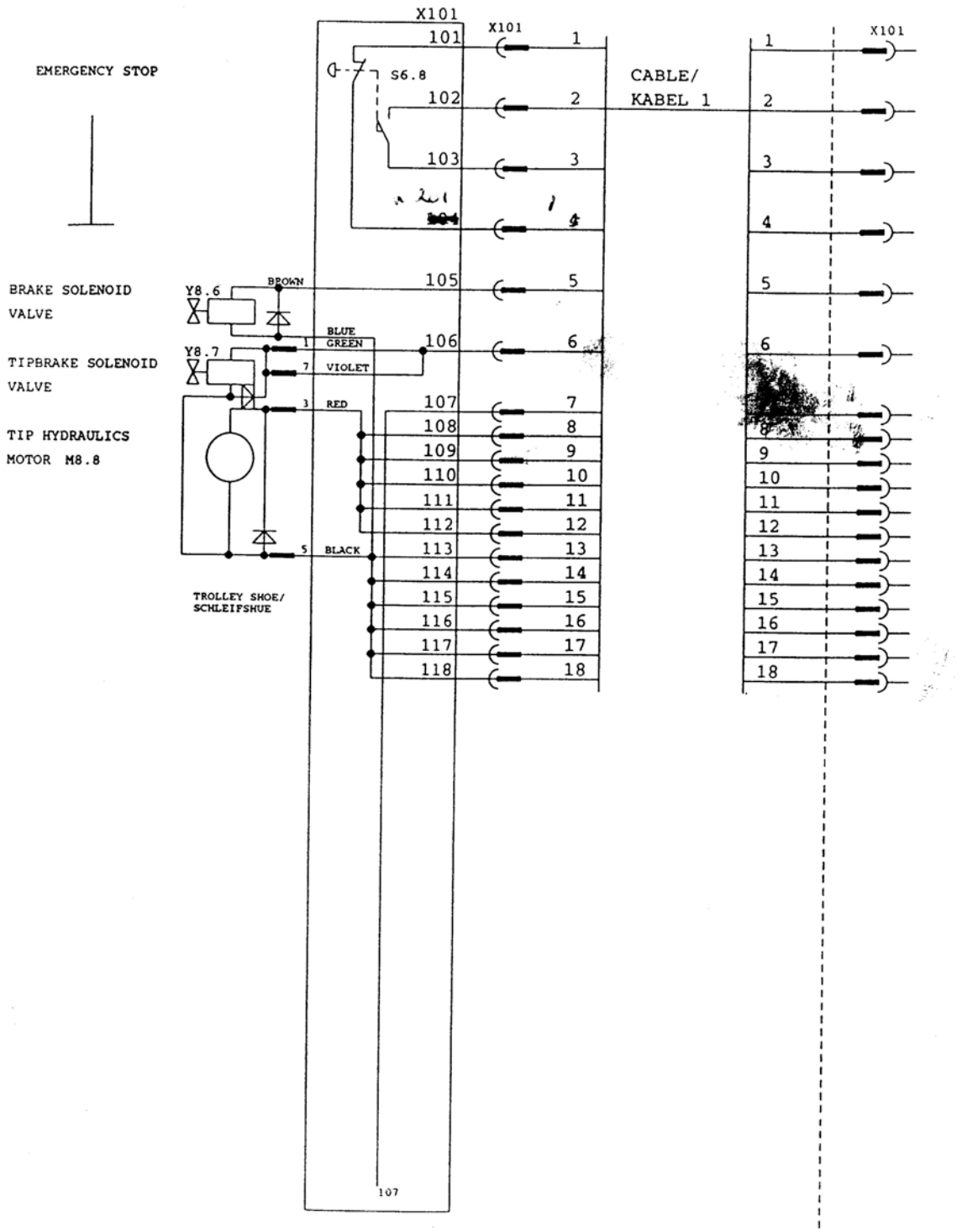


NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

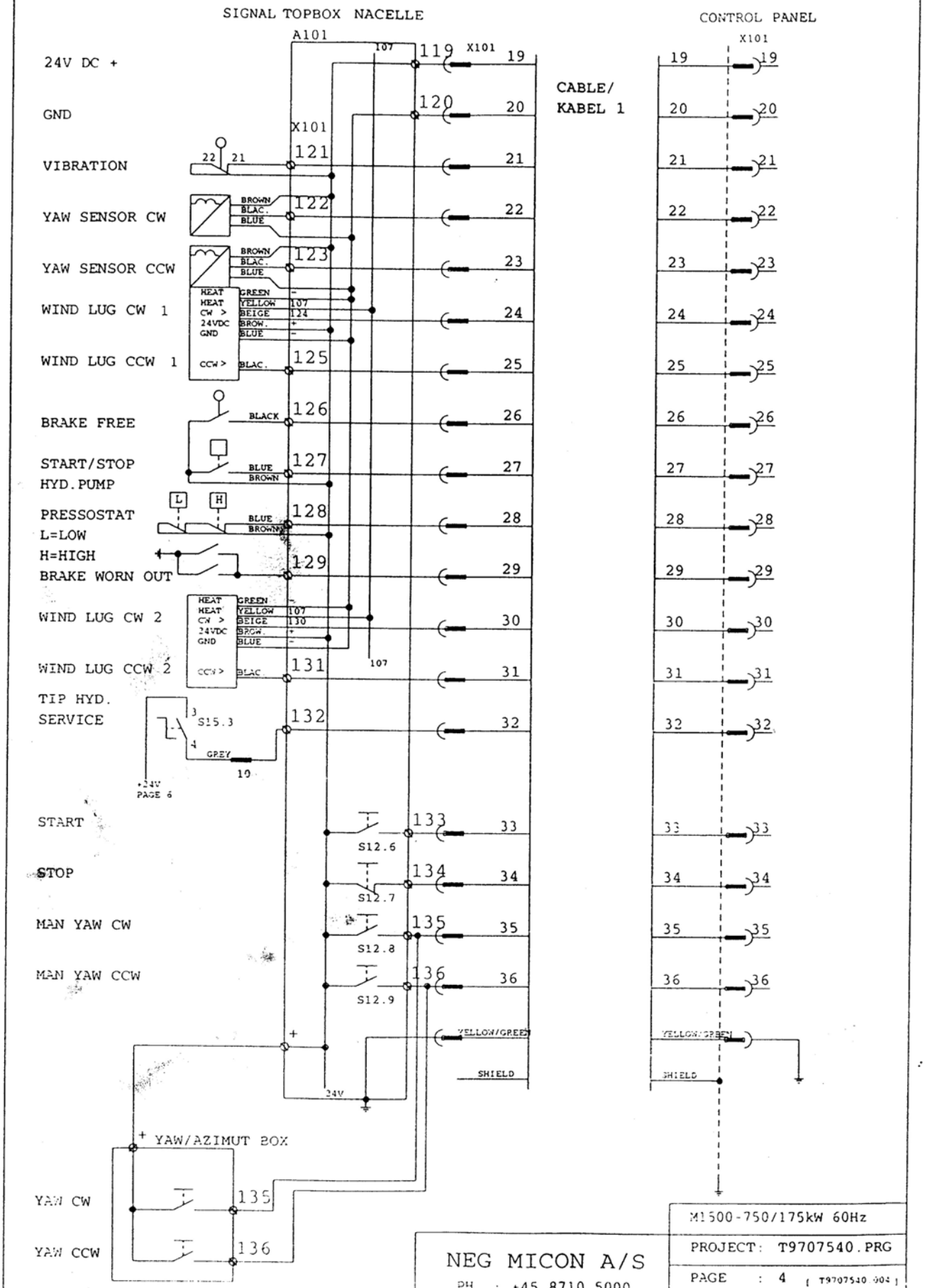
M1500-750/175kW 60Hz
PROJECT: T9707540.PRG
PAGE : 1
DATE : 14/11-97



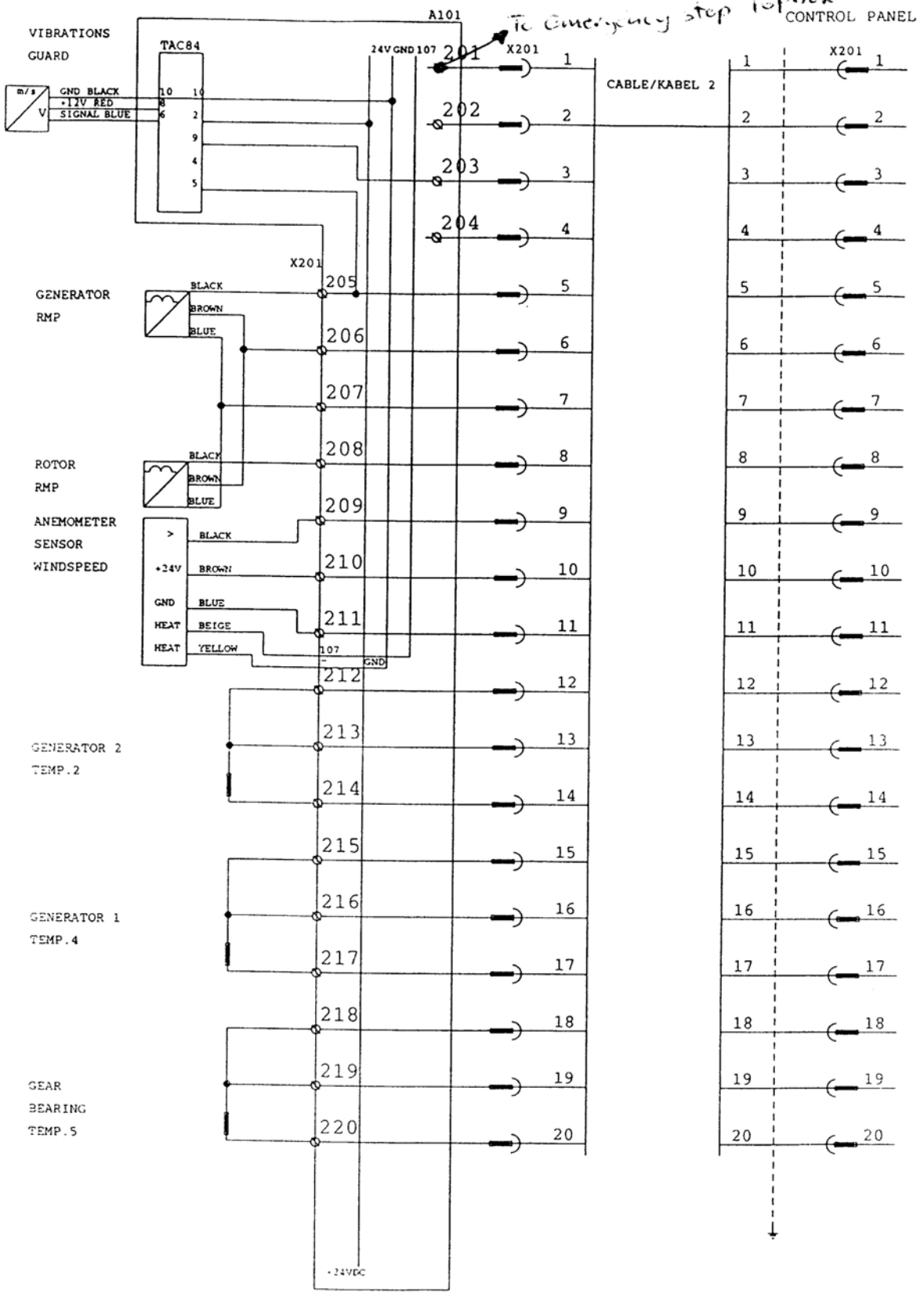
NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: T9707540.PRG
FAX : +45 8710 5001	PAGE : 2 (T9707540.002)
	DATE : 14/11/97



NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: T9707540.PRG
FAX : +45 8710 5001	PAGE : 3 (T9707540.003)
	DATE : 14/11/97

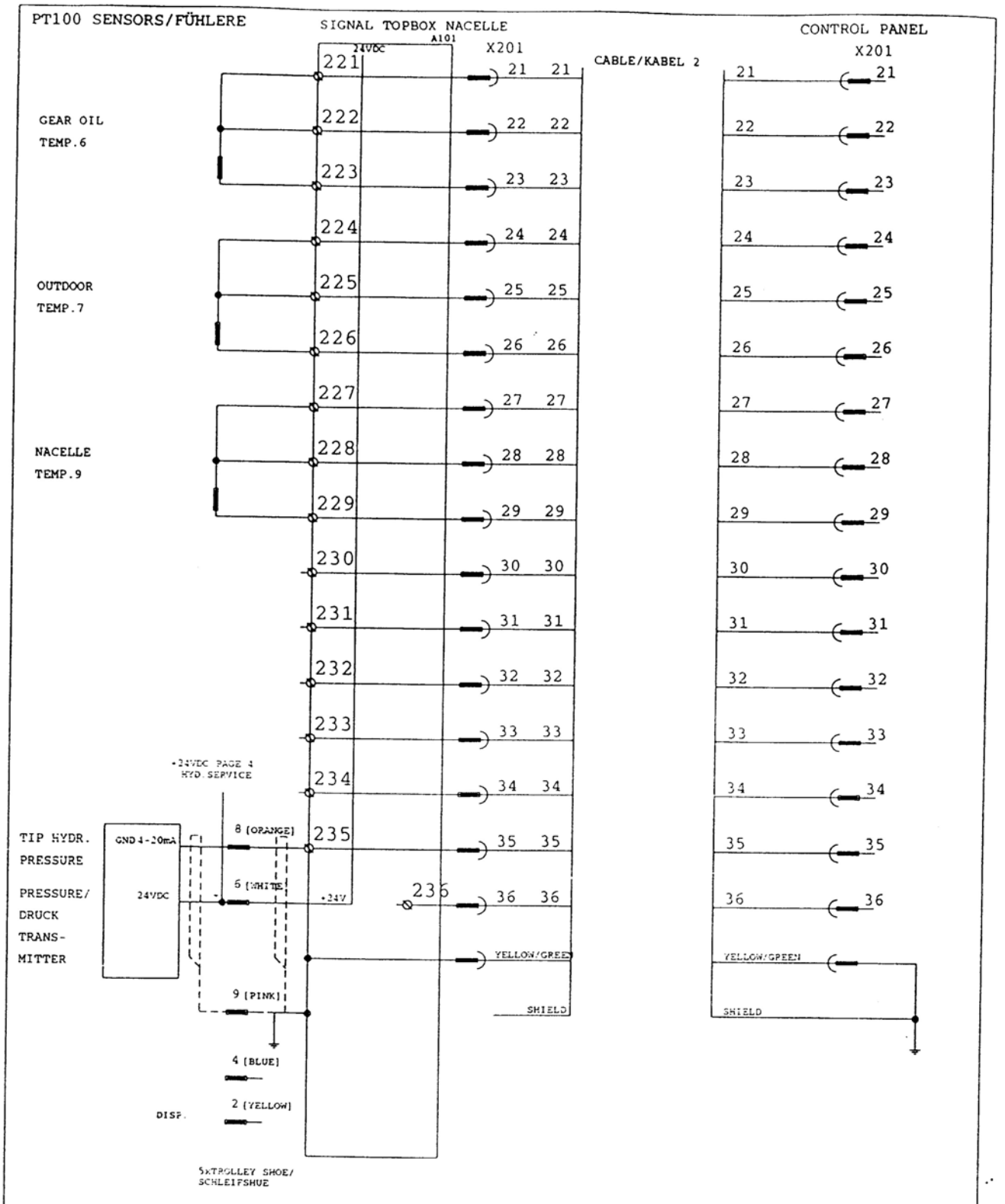

SIGNAL TOPBOX NACELLE
CONTROL PANEL
A101
X101
CABLE/
KABEL 1
24V DC +
GND
VIBRATION
YAW SENSOR CW
YAW SENSOR CCW
WIND LUG CW 1
WIND LUG CCW 1
BRAKE FREE
START/STOP
HYD.PUMP
PRESSOSTAT
L=LOW
H=HIGH
BRAKE WORN OUT
WIND LUG CW 2
WIND LUG CCW 2
TIP HYD.
SERVICE
START
STOP
MAN YAW CW
MAN YAW CCW
S15.3
S12.6
S12.7
S12.8
S12.9
+24V
PAGE 6
GREY
BROWN
BLAC.
BLUE
BLACK
BEIGE
YELLOW
GREEN
YELLOW/GREEN
SHIELD
24V
107
124
130
YAW/AZIMUT BOX
YAW CW
YAW CCW
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001
M1500-750/175kW 60Hz
PROJECT: T9707540.PRG
PAGE : 4 (T9707540-004)
DATE : 14/11/97

SIGNAL TOPBOX NACELLE



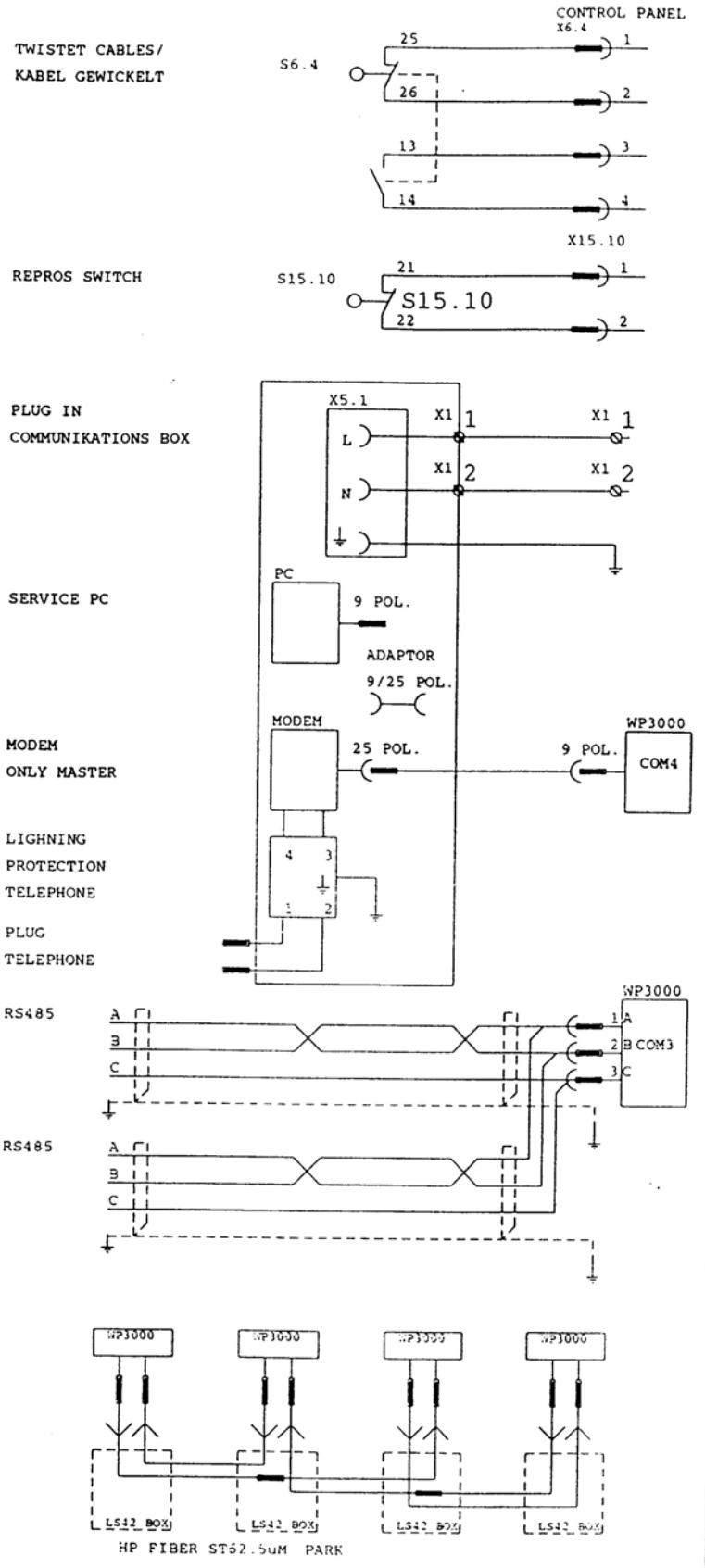
M1500-750/175kW 60Hz	
PROJECT: T9707540.PRG	
PAGE : 5	(T9707540.005)
DATE : 14/11/97	

NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

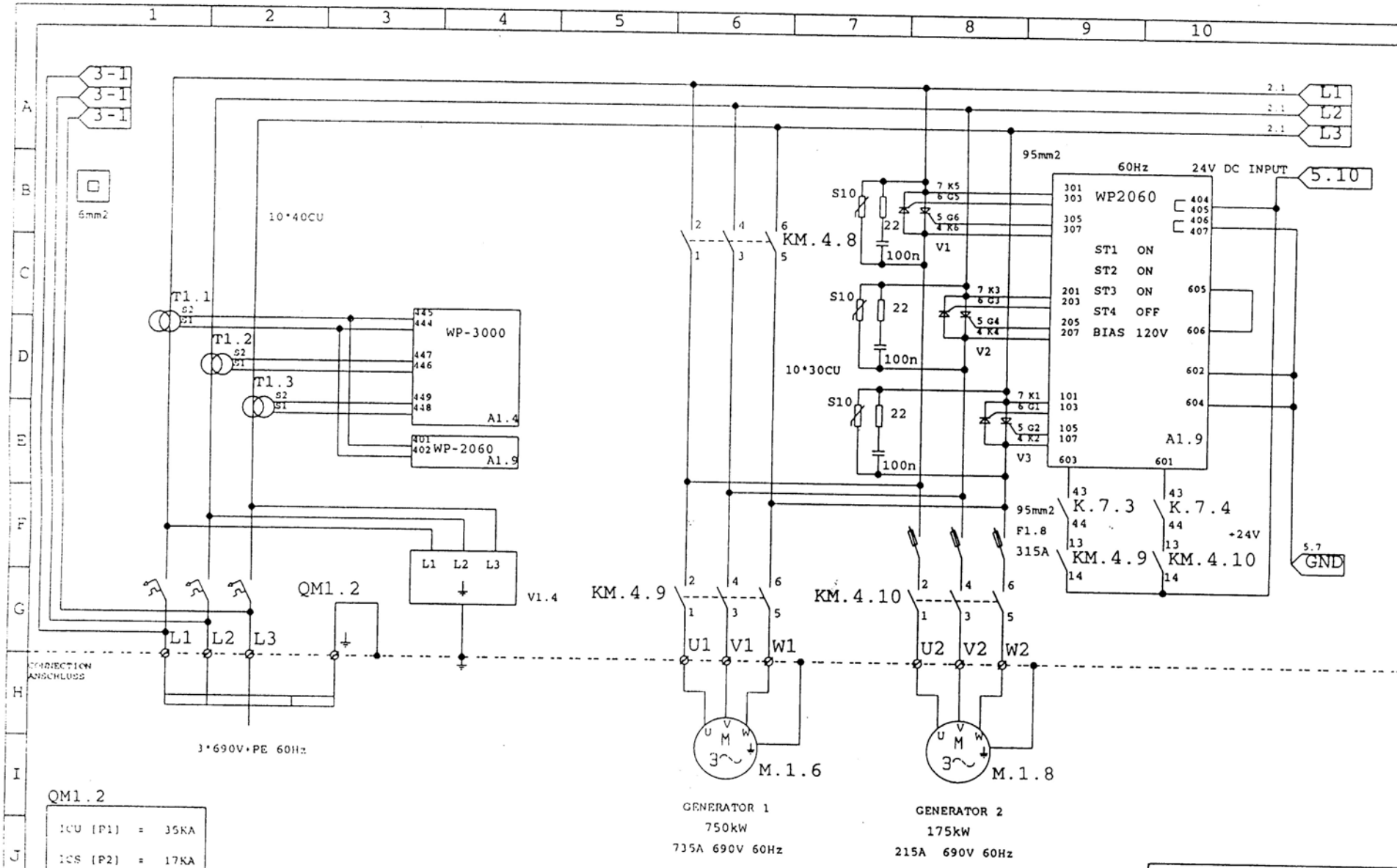


NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

M1500-750/175kW 60Hz
PROJECT: T9707540.PRG
PAGE : 6 (T9707540.006)
DATE : 14/11/97



NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: T9707540.PRG
FAX : +45 8710 5001	PAGE : 7 (T9707540.007)
	DATE : 14/11/97



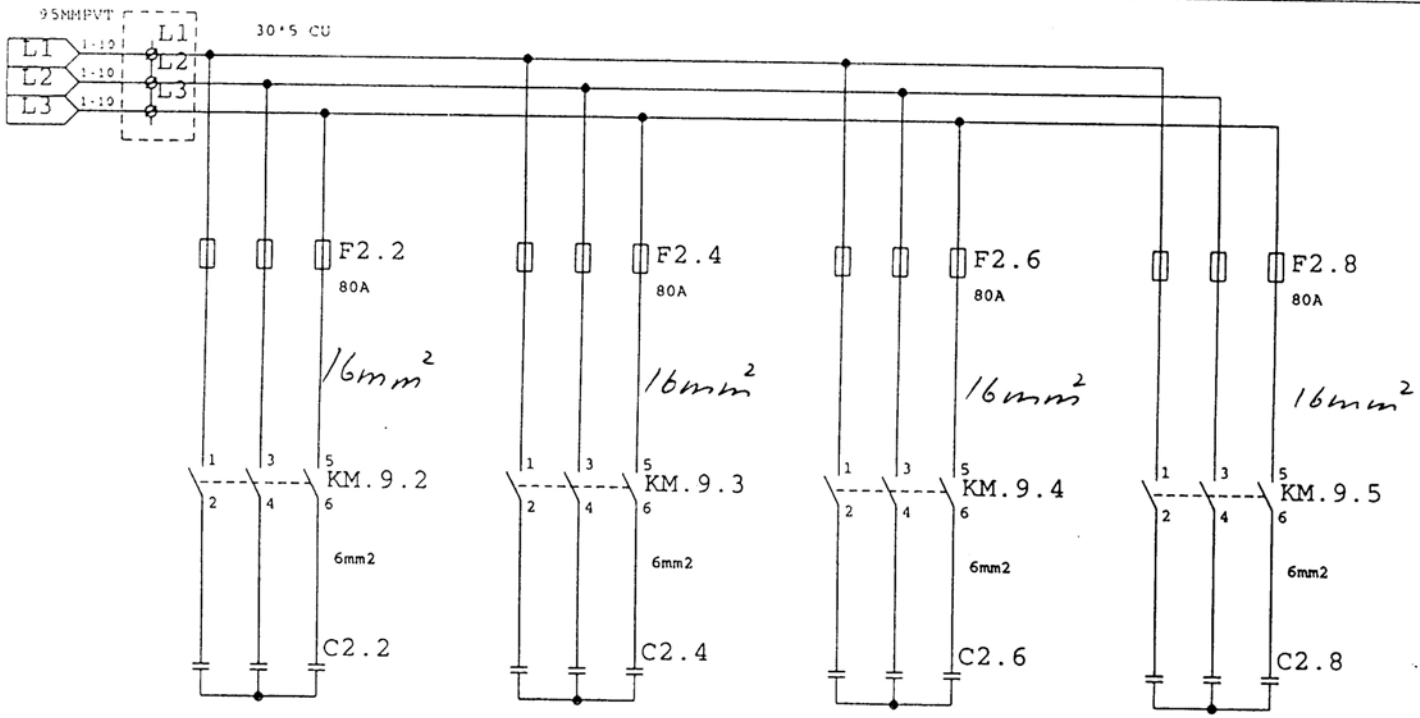
QM1.2

ICU [P1]	=	35KA
ICS [P2]	=	17KA
IN*IR	=	730A
IR*IM	=	1.5KA

NEG MICON A/S

M1500-750/175kW 60Hz

PROJECT: E9707540.PRG



CONNECTION
ANSCHLUSS

COMPENSATION 1
40kVAr 34A 60Hz
2*16.7KVAr50Hz

COMPENSATION 2
40kVAr 34A 60Hz
2*16.7KVAr50Hz

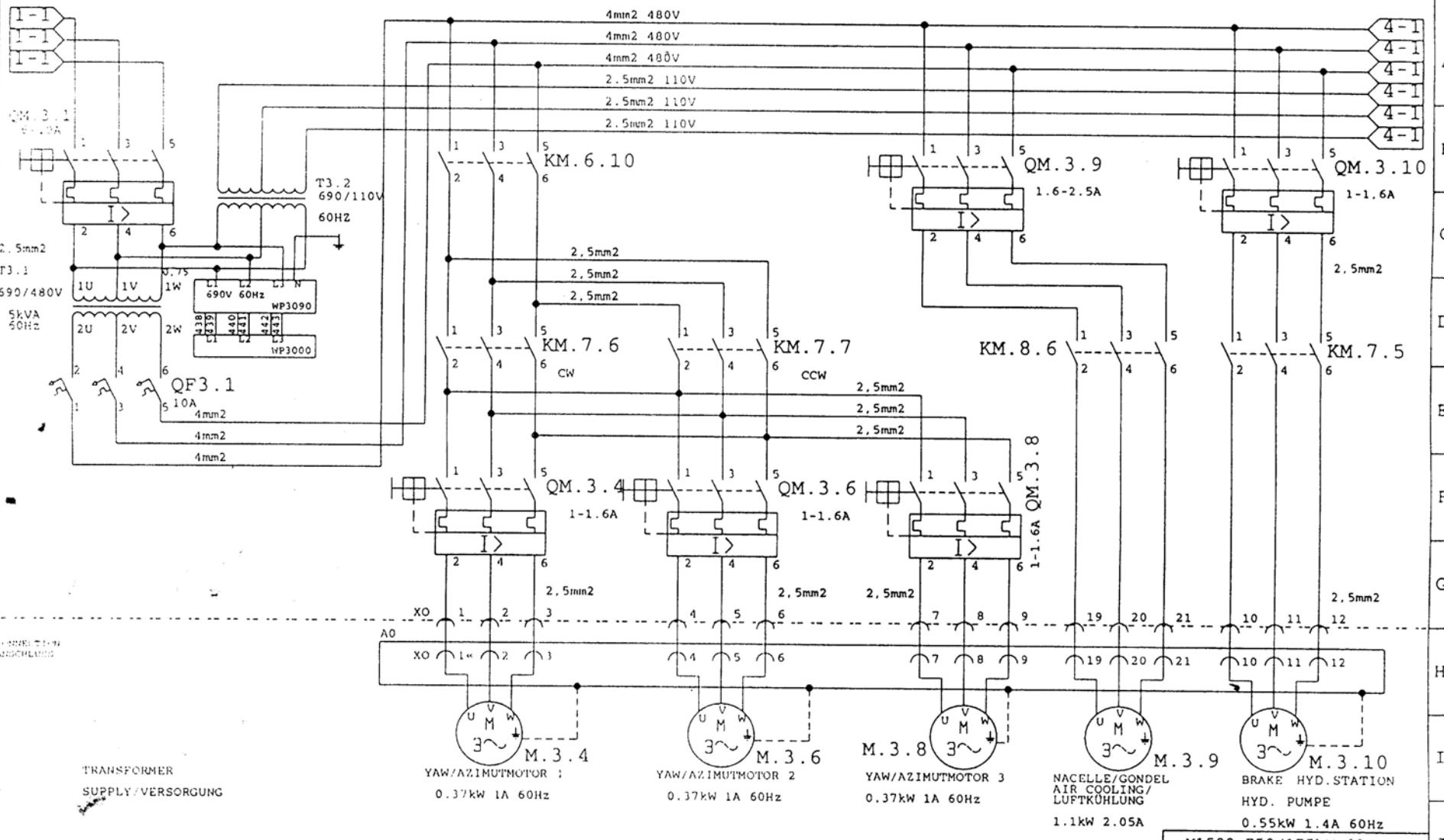
COMPENSATION 3
60kVAr 50A 60Hz
3*16.7KVAr50Hz

COMPENSATION 4
60kVAr 50A 60Hz
3*16.7KVAr50Hz

NEG MICON A/S

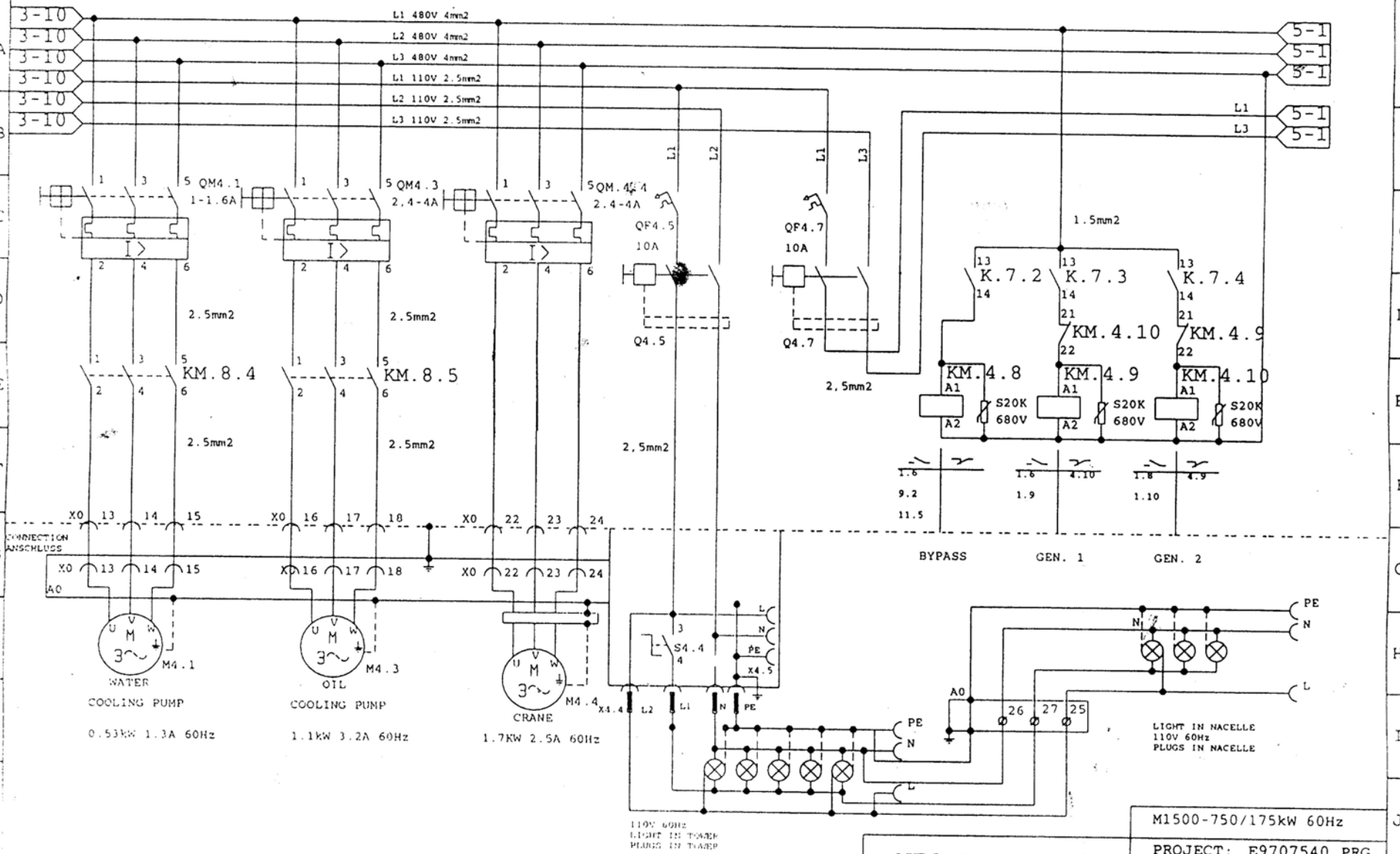
M1500-750/175kW 60Hz

PROJECT: E9707540.PRG



NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 3 (E9707540.003)
DATE : 14/11/97



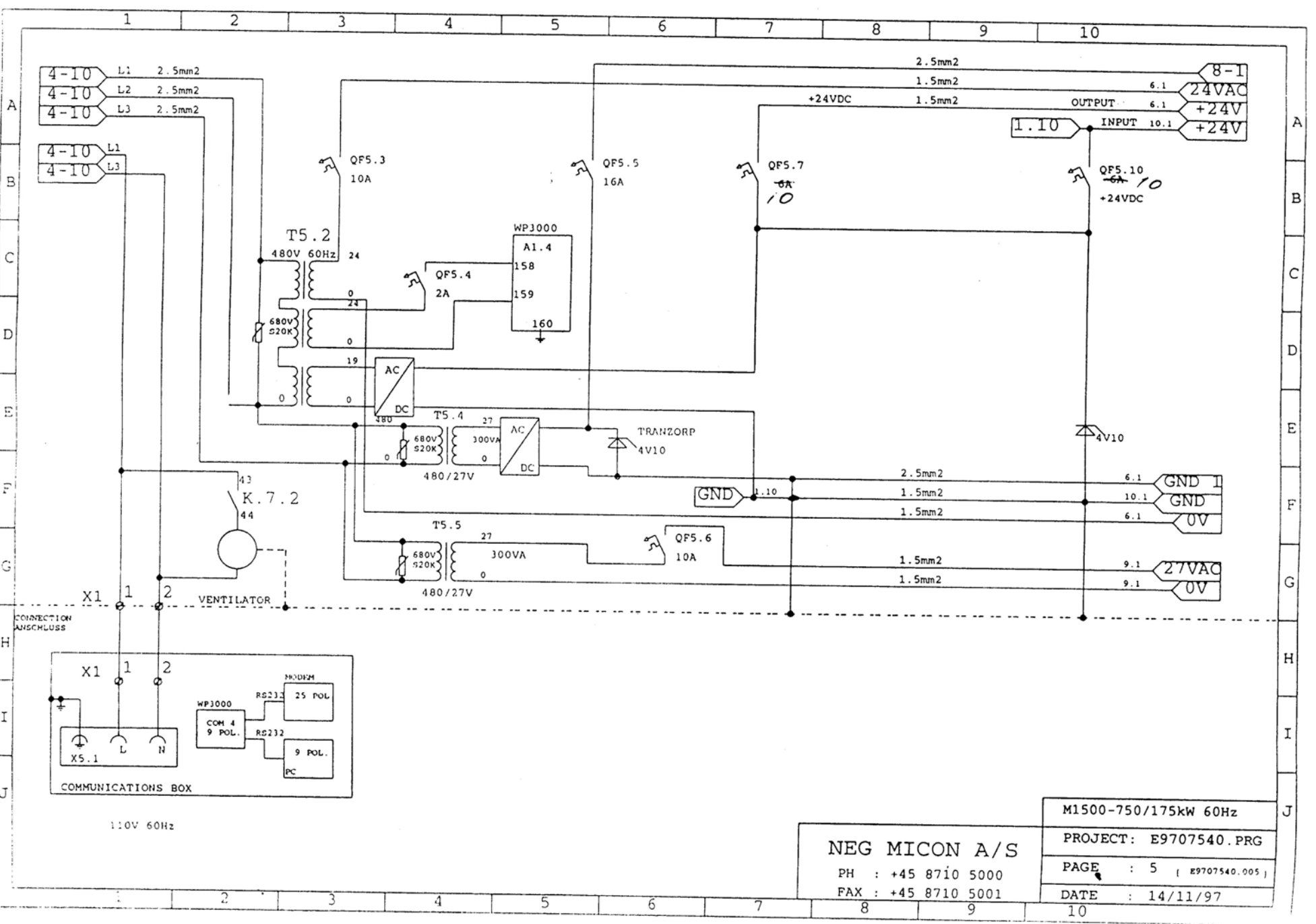
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

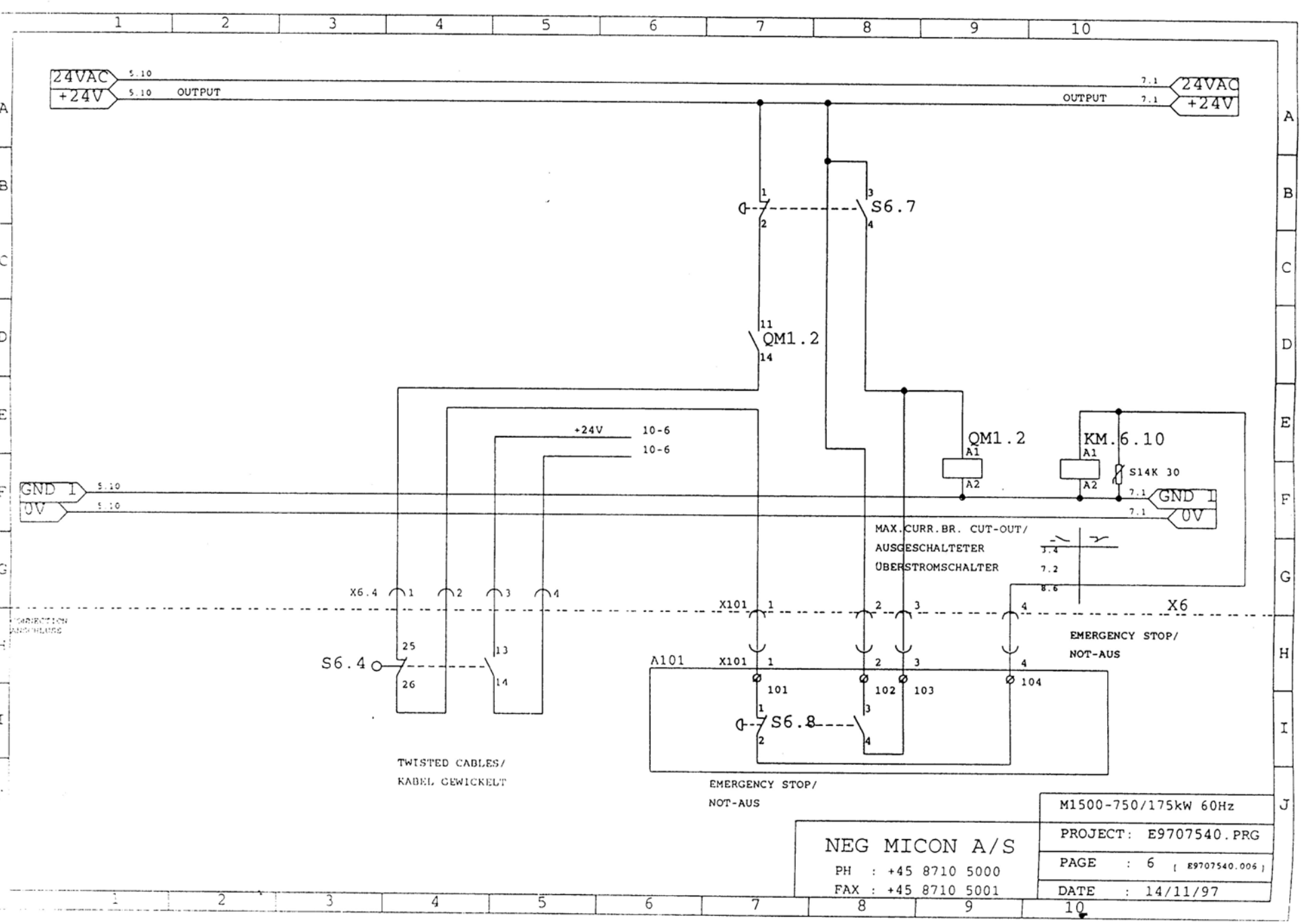
M1500-750/175kW 60Hz

PROJECT: E9707540.PRG

PAGE : 4 (E9707540.004)

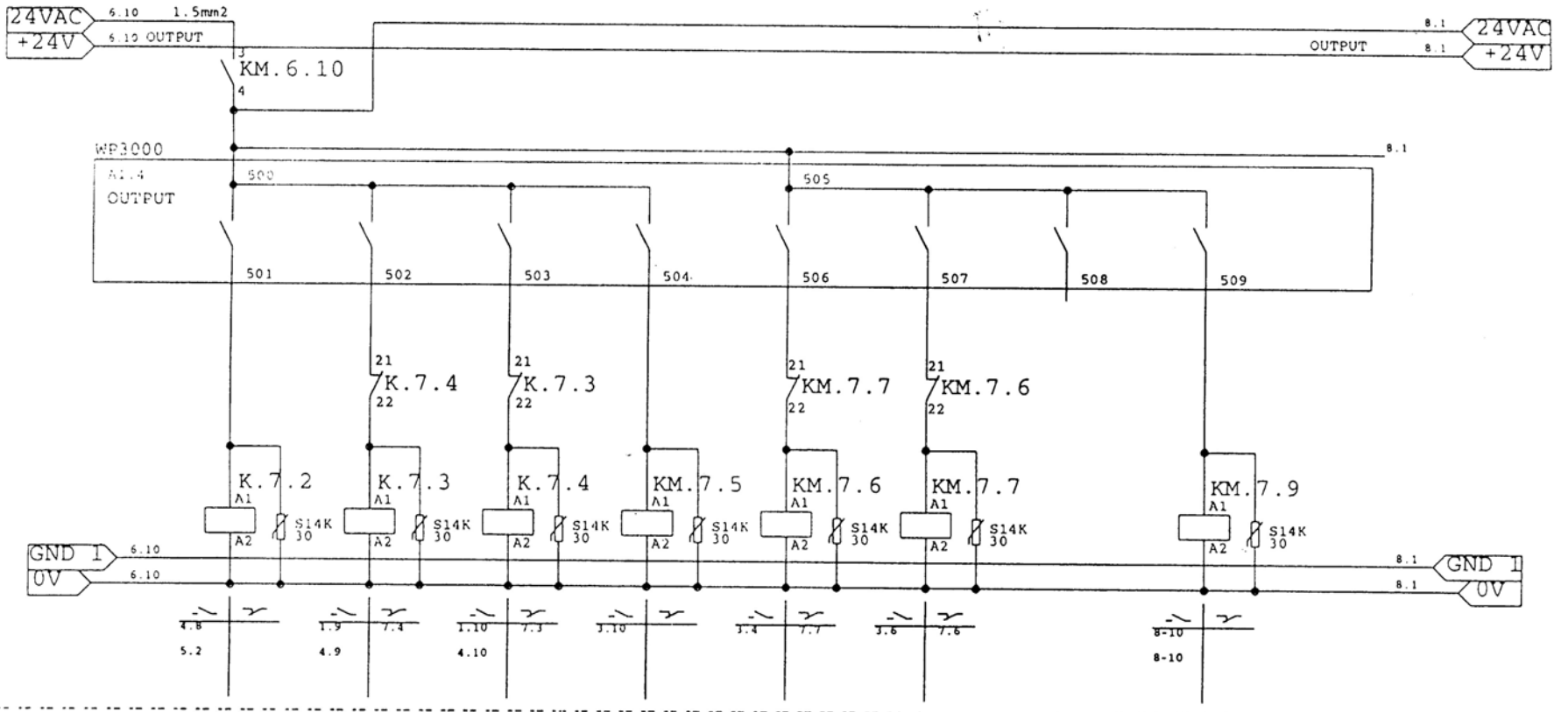
DATE : 14/11/97


4-10 L1 2.5mm2
4-10 L2 2.5mm2
4-10 L3 2.5mm2
4-10 L1
4-10 L3
QF5.3
10A
T5.2
480V 60Hz
24
0
24
0
19
0
0
680V S20K
AC
DC
480
T5.4
27
300VA
0
480/27V
680V S20K
0
WP3000
A1.4
158
159
160
QF5.4
2A
QF5.5
16A
TRANZORP
4V10
+24VDC
1.5mm2
2.5mm2
OUTPUT
INPUT
1.10
QF5.7
6A
10
QF5.10
6A
10
+24VDC
4V10
8-1
24VAC
+24V
+24V
GND
1.10
GND 1
GND
0V
43
K.7.2
44
T5.5
27
300VA
0
480/27V
680V S20K
QF5.6
10A
27VAC
0V
X1
1
2
VENTILATOR
CONNECTION
ANSCHLUSS
X1
1
2
MODEM
25 POL
RS232
WP3000
COM 4
9 POL.
RS232
9 POL.
PC
X5.1
L
N
COMMUNICATIONS BOX
110V 60Hz
M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 5 (E9707540.005)
DATE : 14/11/97
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001



M1500-750/175kW 60Hz	
PROJECT: E9707540.PRG	
PAGE : 6 (E9707540.006)	
DATE : 14/11/97	

NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

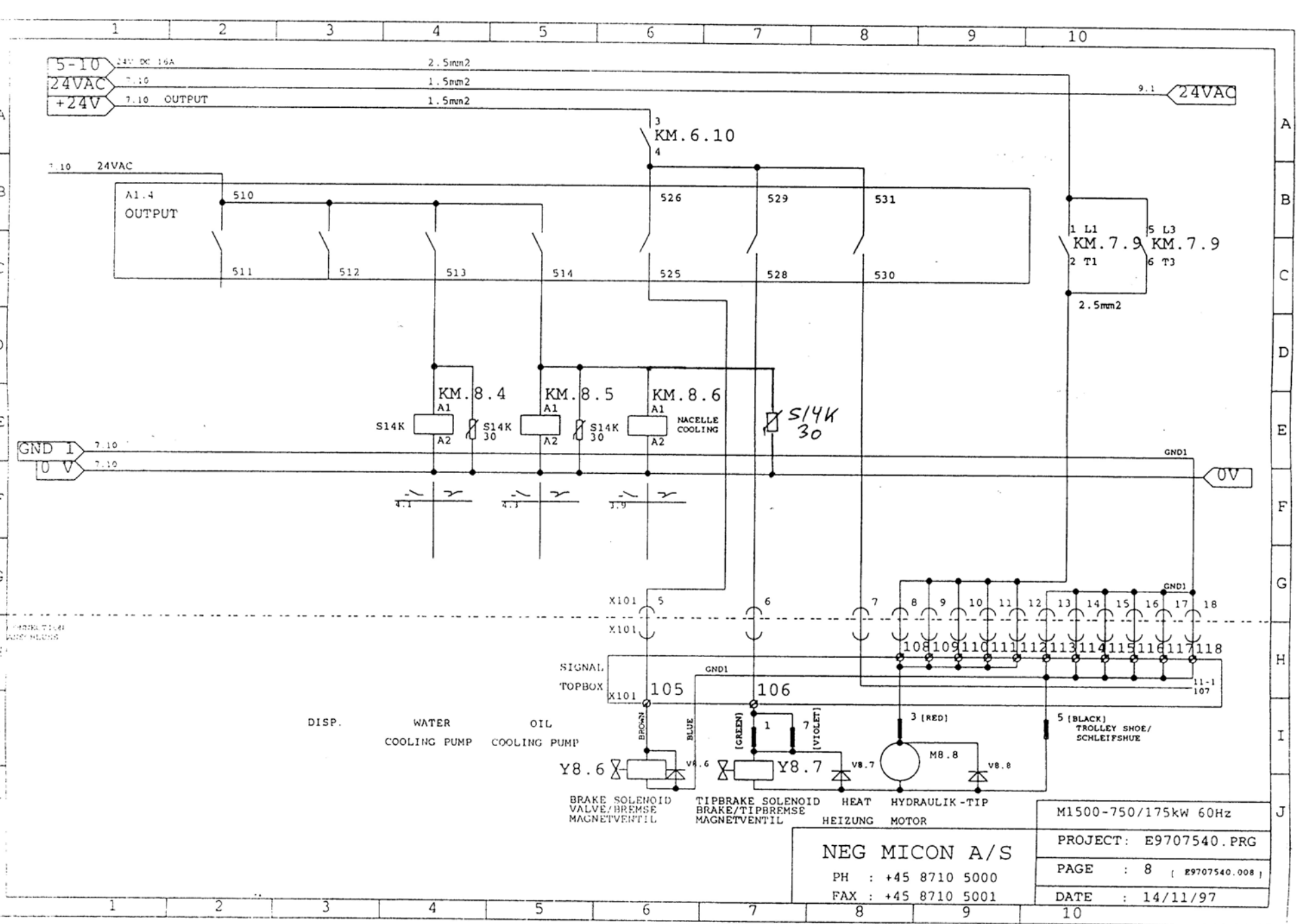


CONNECTION
ANSCHLUSS

BY-PASS/ ÜBERBRÜCKUNG | GENERATOR 1 | GENERATOR 2 | HYD.PUMPE | YAW/AZIMUT 1 RIGHT/RECHTS CW | YAW/AZIMUT 1 LEFT/LINKS CCW | DISP. | HYDRAULIK-TIP MOTOR

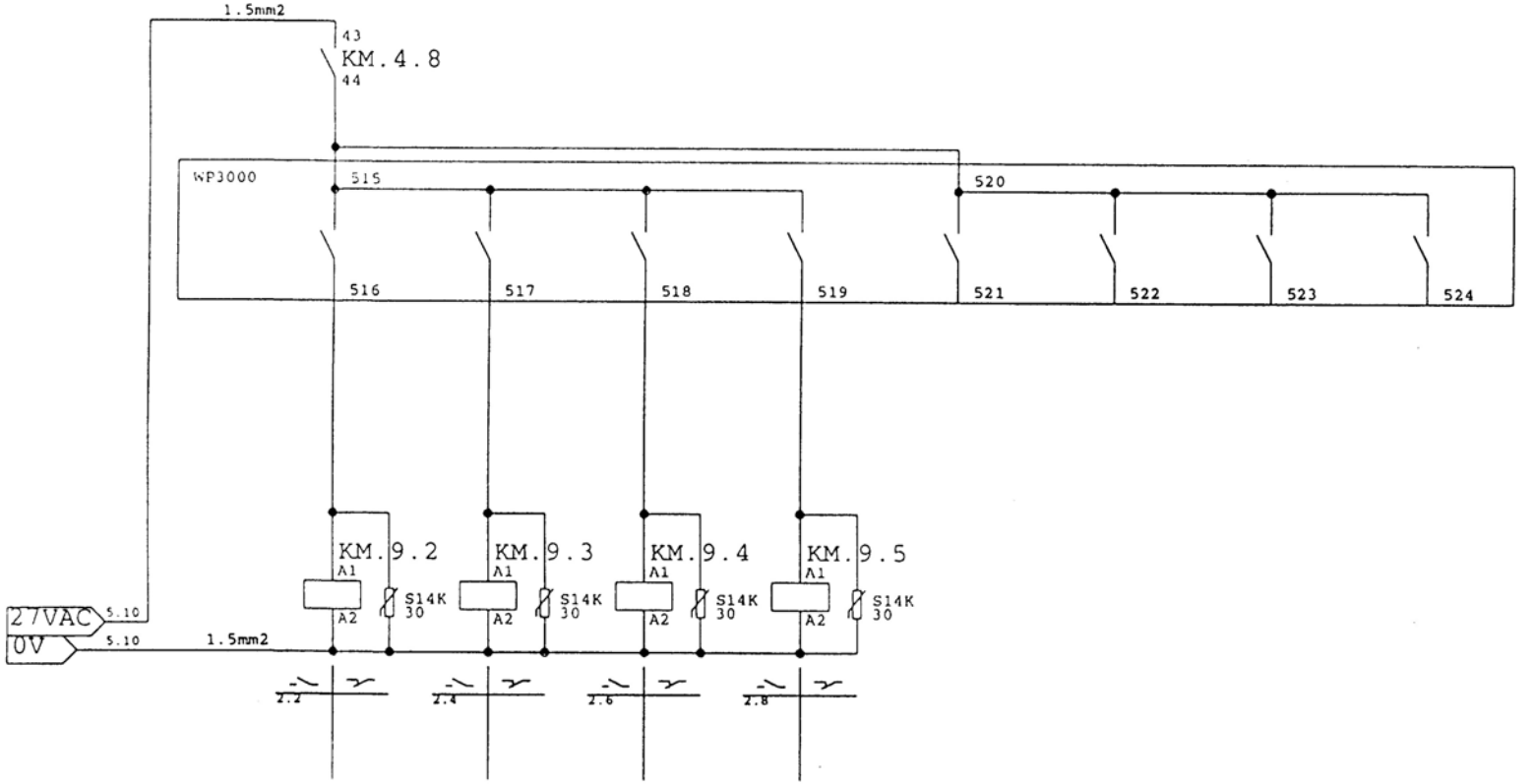
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 7 (E9707540.007)
DATE : 14/11/97



NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 8 (E9707540.008)
DATE : 14/11/97

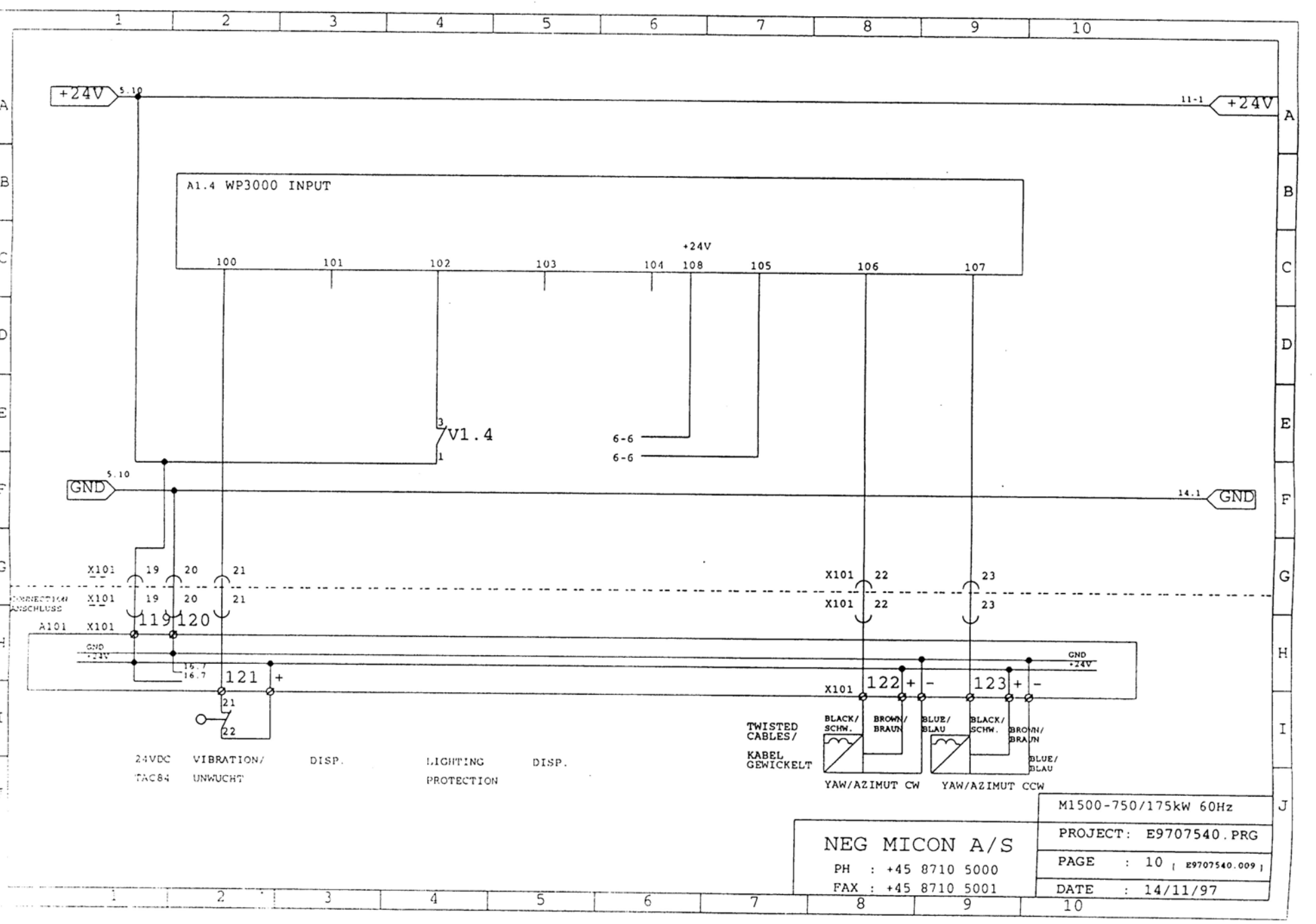


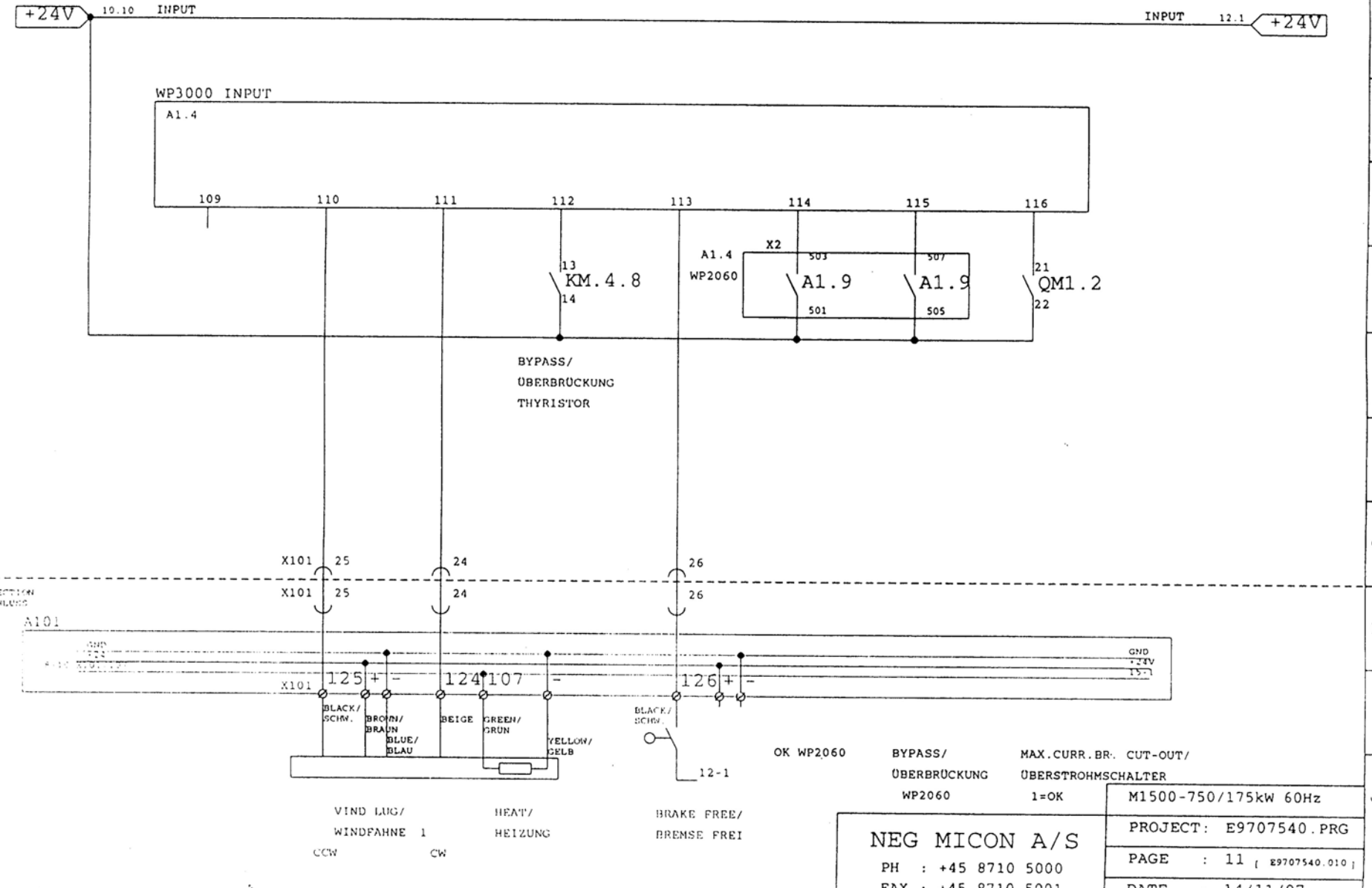
CONNECTION
ANSCHLUSS

COMPENSATION

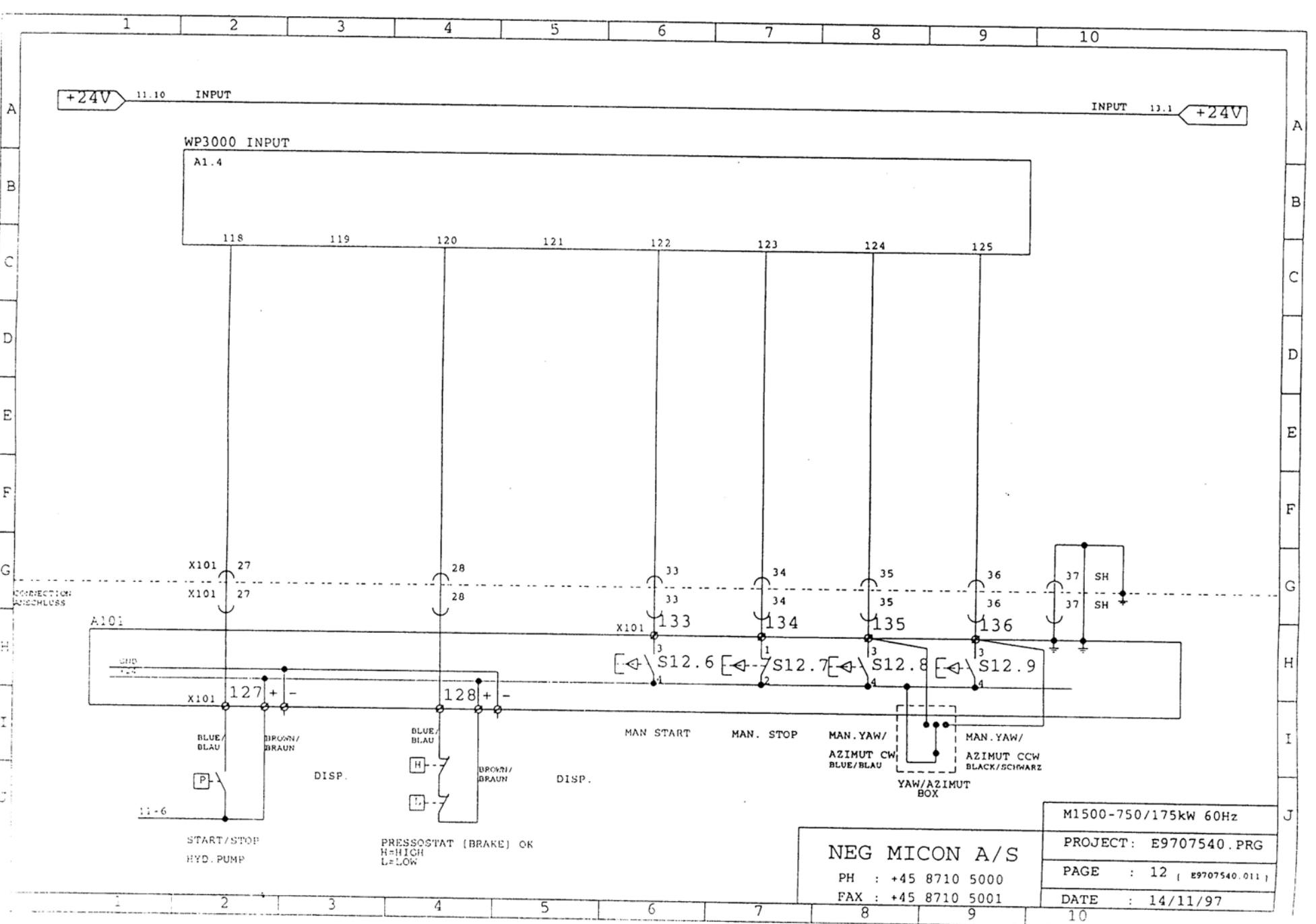
1 2 3 4

NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: E9707540.PRG
FAX : +45 8710 5001	PAGE : 9 [E9707540.08A]
	DATE : 14/11/97


+24V
5.10
11-1
+24V
A1.4 WP3000 INPUT
100
101
102
103
104
+24V
108
105
106
107
3
V1.4
1
6-6
6-6
GND
5.10
14.1
GND
X101
19
20
21
X101
22
23
CONNECTION/
ANSCHLUSS
X101
19
20
21
X101
22
23
A101
X101
119
120
GND
+24V
16.7
16.7
121
+
21
22
GND
+24V
X101
122
+
-
123
+
-
TWISTED
CABLES/
KABEL
GEWICKELT
BLACK/
SCHW.
BROWN/
BRAUN
BLUE/
BLAU
BLACK/
SCHW.
BROWN/
BRAUN
BLUE/
BLAU
YAW/AZIMUT CW
YAW/AZIMUT CCW
24VDC
TAC84
VIBRATION/
UNWUCHT
DISP.
LIGHTING
PROTECTION
DISP.
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001
M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 10 (E9707540.009)
DATE : 14/11/97

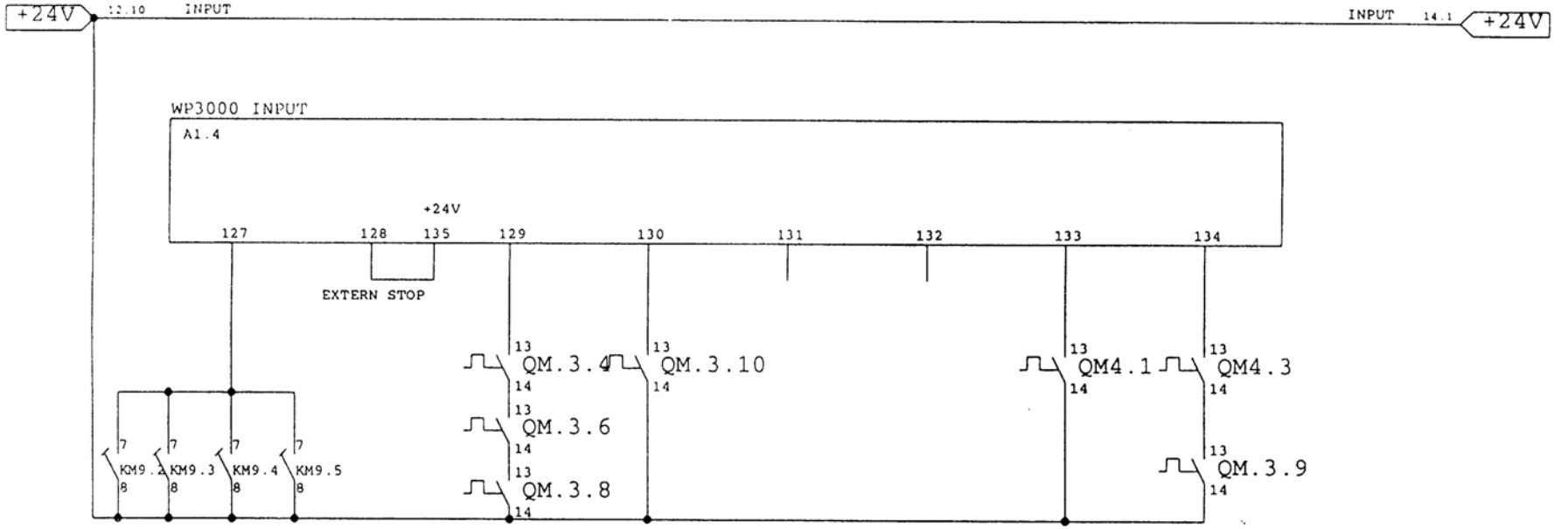


NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: E9707540.PRG
FAX : +45 8710 5001	PAGE : 11 (E9707540.010)
	DATE : 14/11/97



NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 12 (E9707540.011)
DATE : 14/11/97



CONNECTION
ANSCHLUSS

FEED BACK/
RÜCKMELDUNG
PHASEBATT.

TERMO ERROR

YAW/AZIMUT

HYD.PUMP
BRAKE

DISP.

DISP.

WATER
COOLING PUMP

OIL
COOLING PUMP
AIR COOLING

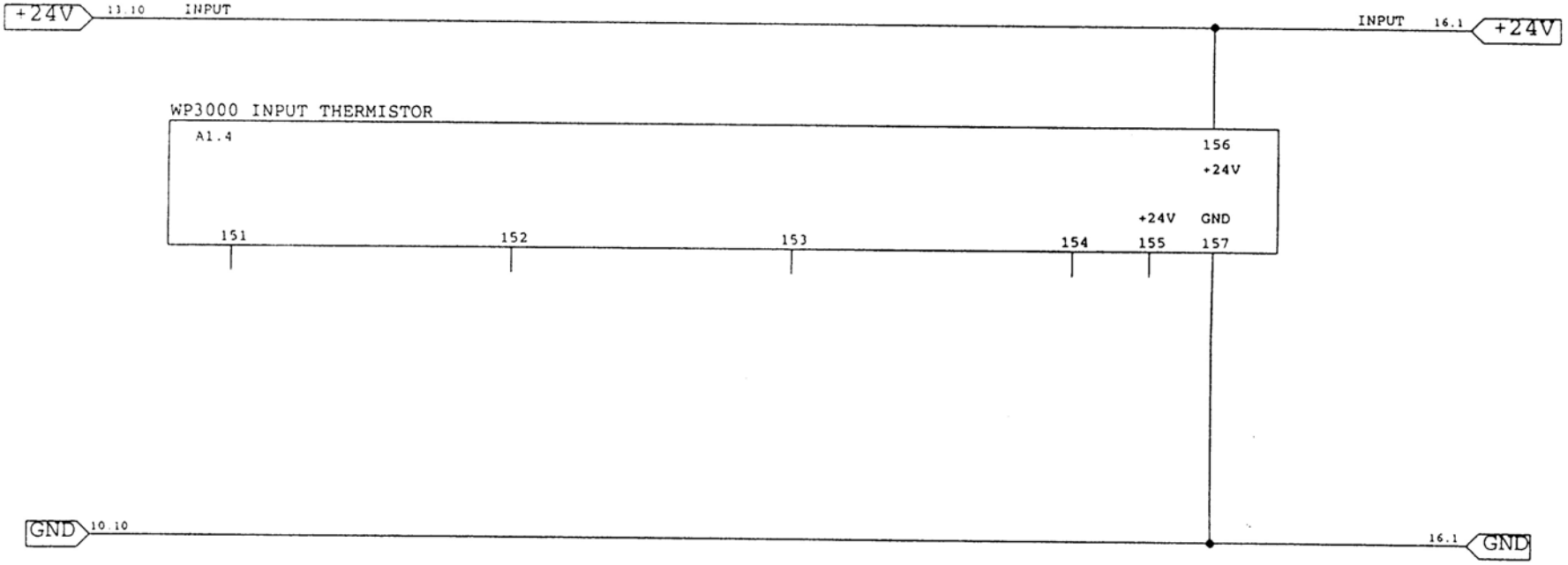
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

M1500-750/175kW 60Hz

PROJECT: E9707540.PRG

PAGE : 13 (E9707540.012)

DATE : 14/11/97

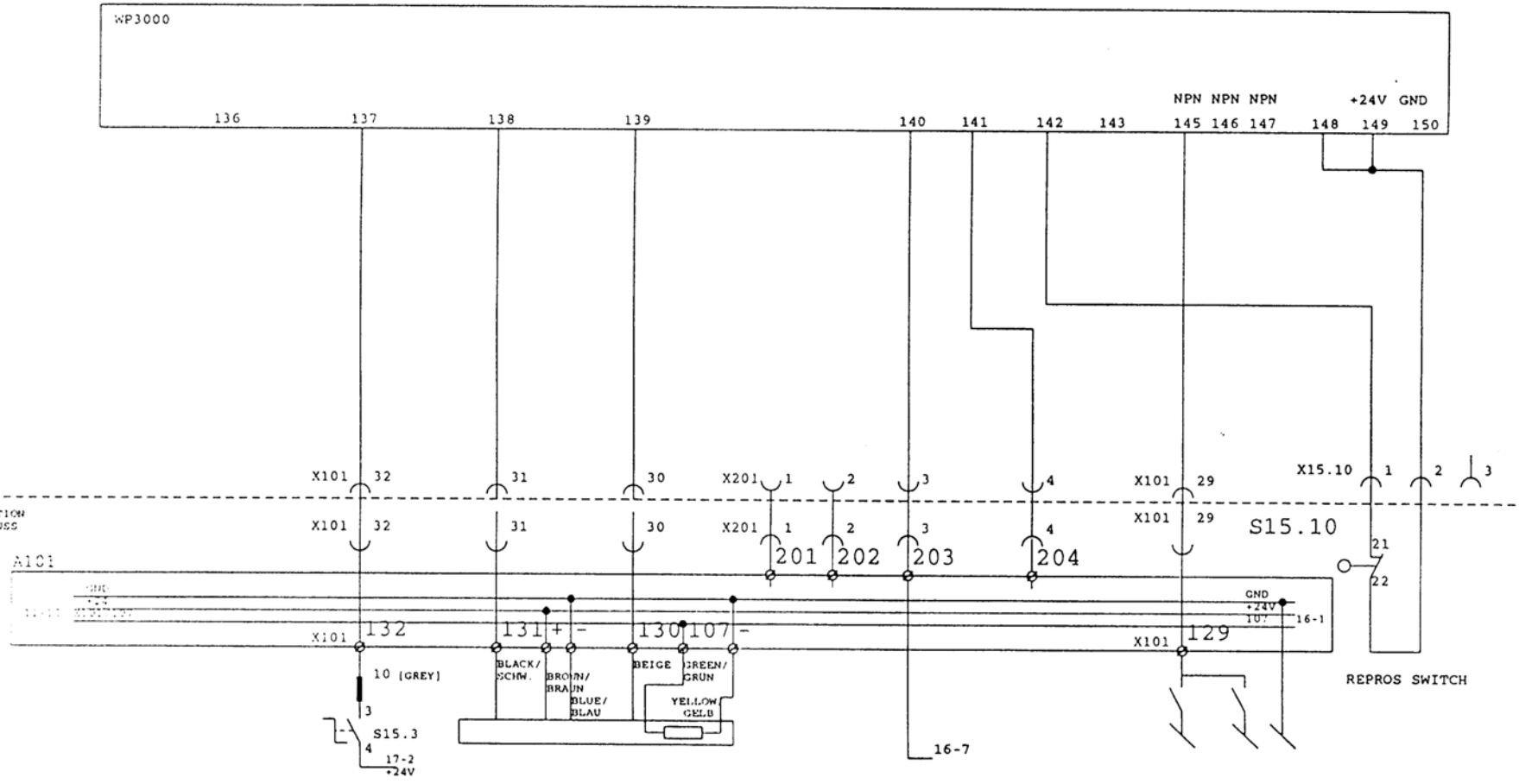


CONNECTION
ANSCHLUSS

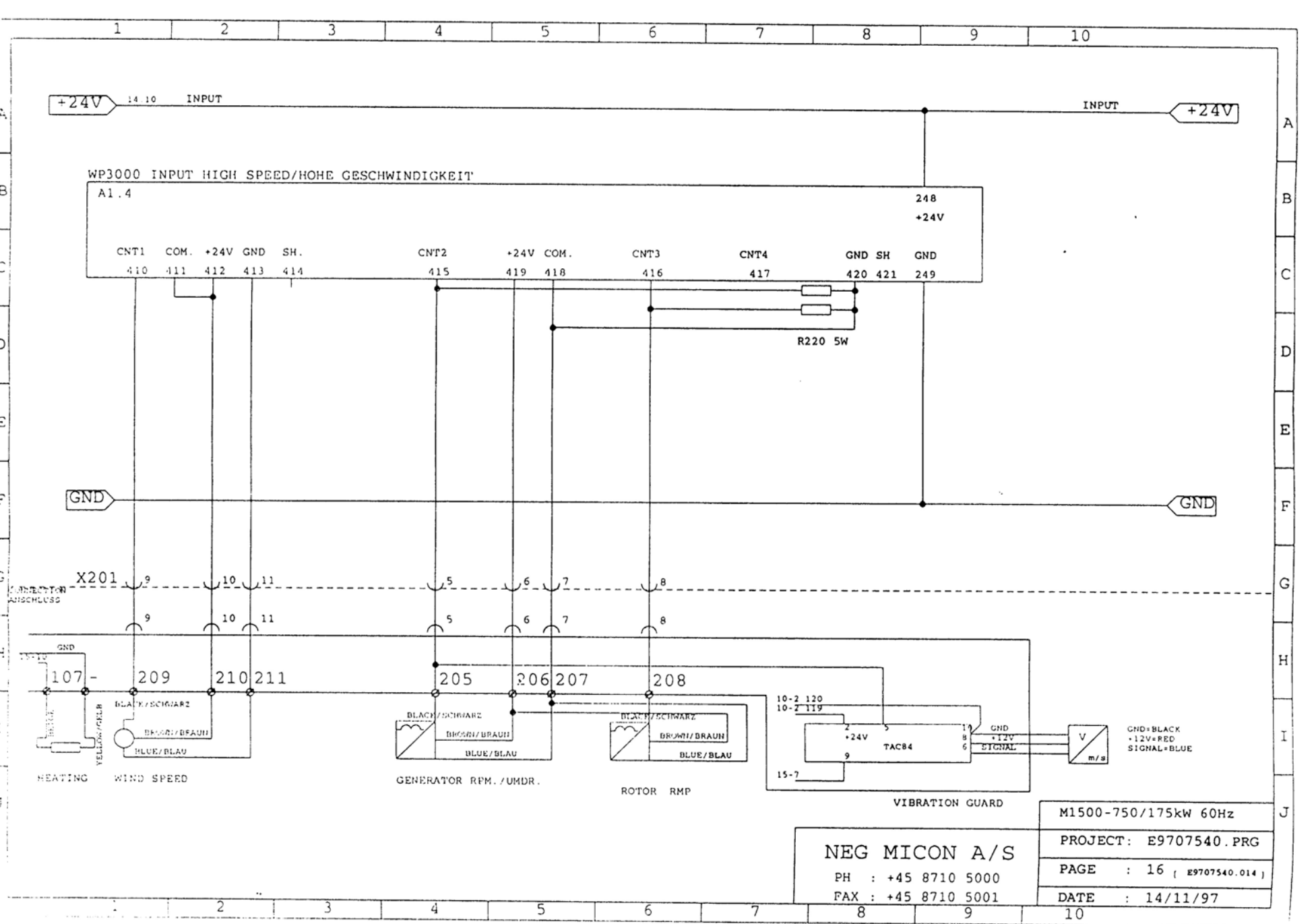
DISP. DISP. DISP. DISP.

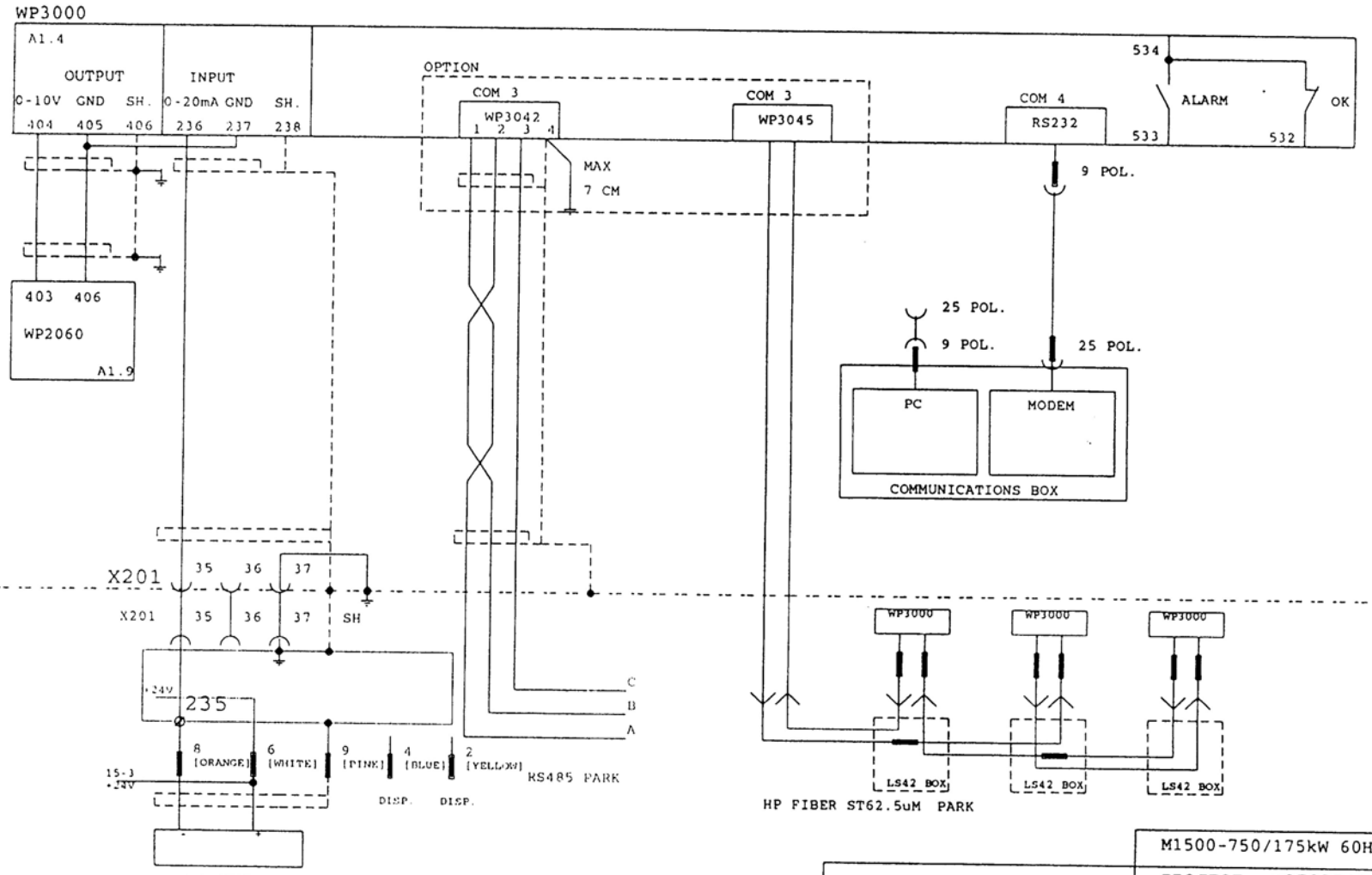
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 14 (E9707540.013)
DATE : 14/11/97



NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: E9707540.PRG
FAX : +45 8710 5001	PAGE : 15 (E9707540.00B)
	DATE : 14/11/97


+24V
14 10
INPUT
INPUT
+24V
WP3000 INPUT HIGH SPEED/HOHE GESCHWINDIGKEIT
A1.4
248
+24V
CNT1 COM. +24V GND SH.
410 411 412 413 414
CNT2 +24V COM. CNT3 CNT4 GND SH GND
415 419 418 416 417 420 421 249
R220 5W
GND
GND
X201
9 10 11 5 6 7 8
9 10 11 5 6 7 8
GND
107 209 210 211 205 206 207 208
BLACK/SCHWARZ
BROWN/BRAUN
BLUE/BLAU
YELLOW/GELB
HEATING
WIND SPEED
GENERATOR RPM./UMDR.
ROTOR RMP
10-2 120
10-2 119
15-7
+24V
TAC84
GND
+12V
SIGNAL
V
m/s
GND=BLACK
+12V=RED
SIGNAL=BLUE
VIBRATION GUARD
NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001
M1500-750/175kW 60Hz
PROJECT: E9707540.PRG
PAGE : 16 (E9707540.014)
DATE : 14/11/97



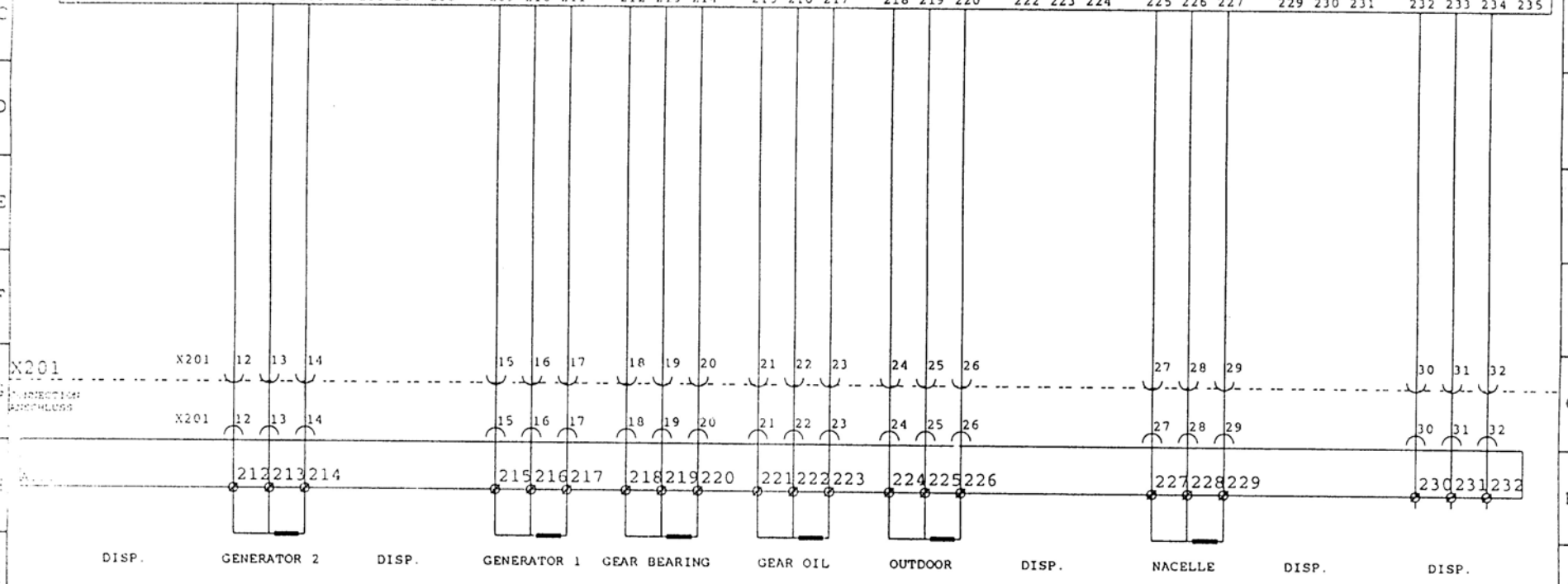
NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: E9707540.PRG
FAX : +45 8710 5001	PAGE : 17 (E9707540.015)
	DATE : 14/11/97

WP3000 INPUT

A1.4

PT 100 SENSOR/FÜHLER

TEMP.1	TEMP.2	TEMP.3	TEMP.4	TEMP.5	TEMP.6	TEMP.7	TEMP.8	TEMP.9	TEMP.10	TEMP.11
200 201 202	203 204 205	206 207 208	209 210 211	212 213 214	215 216 217	218 219 220	222 223 224	225 226 227	229 230 231	232 233 234 235



NEG MICON A/S

PH : +45 8710 5000

FAX : +45 8710 5001

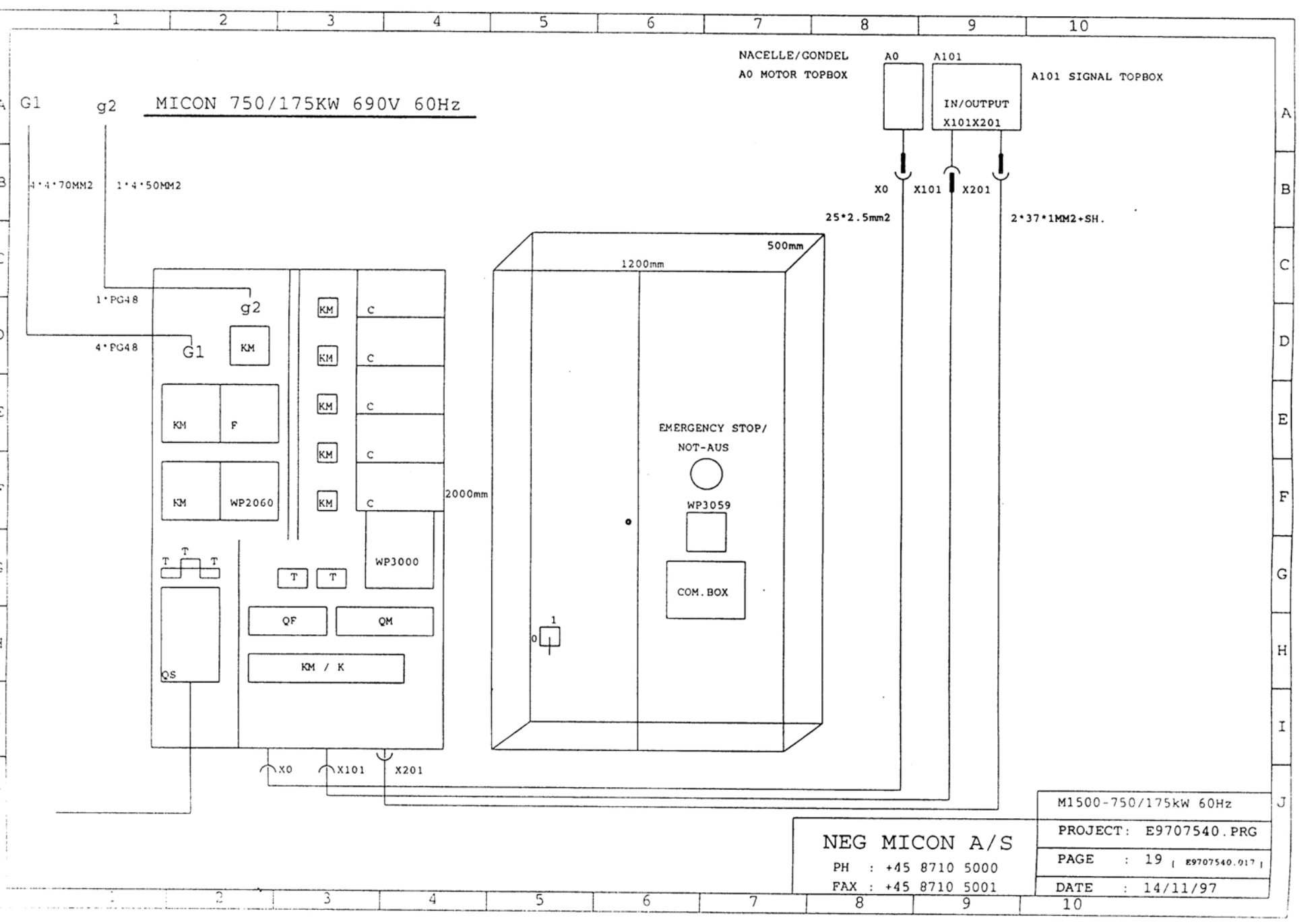
M1500-750/175kW 60Hz

PROJECT: E9707540.PRG

PAGE : 18 (E9707540.016)

DATE : 14/11/97

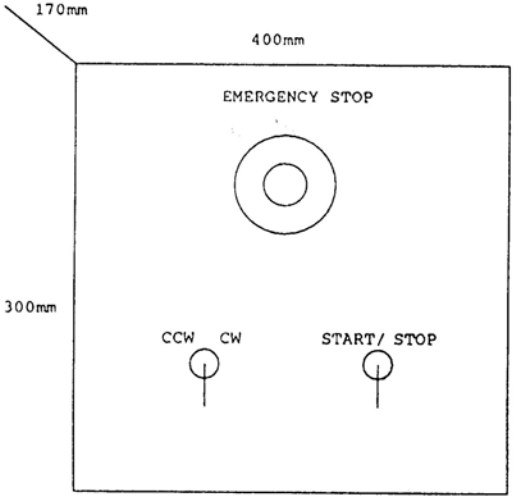
MICON 750/175KW 690V 60Hz

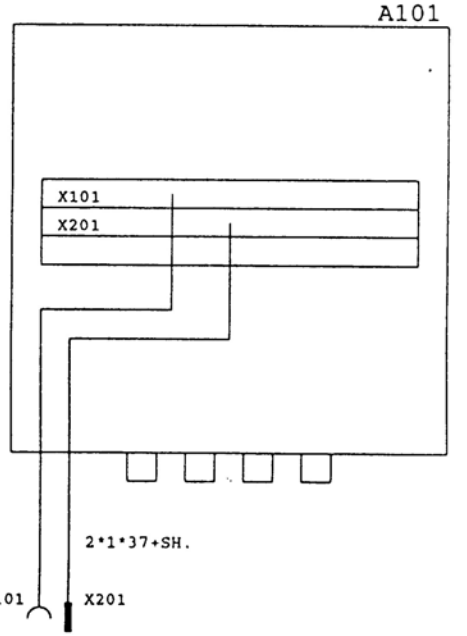


NEG MICON A/S
PH : +45 8710 5000
FAX : +45 8710 5001

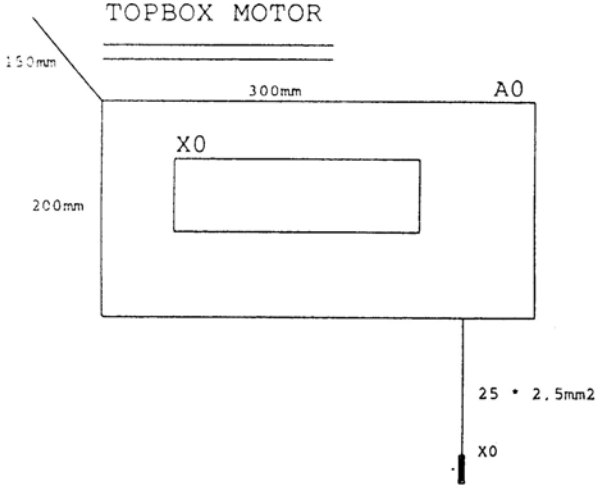
M1500-750/175kW 60Hz	
PROJECT:	E9707540.PRG
PAGE :	19 [E9707540.017]
DATE :	14/11/97

TOPBOX SIGNAL

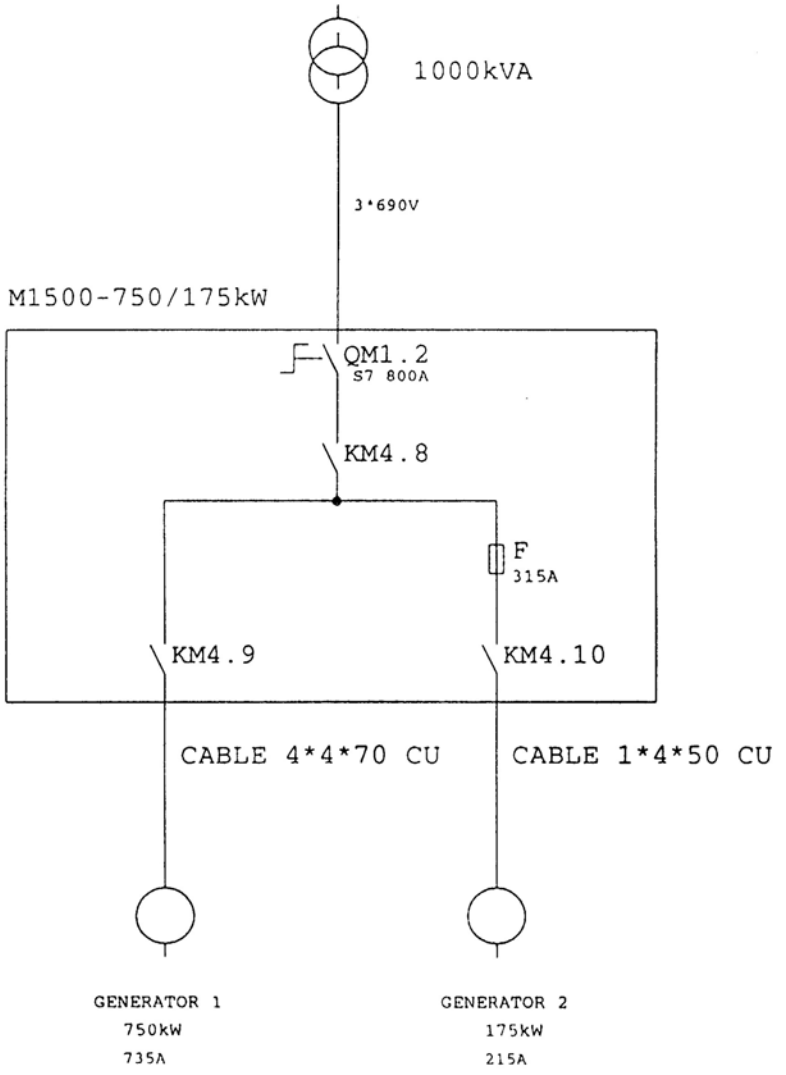




TOPBOX MOTOR



NEG MICON A/S	M1500-750/175kW 60Hz
PH : +45 8710 5000	PROJECT: E9707540.PRG
FAX : +45 8710 5001	PAGE : 20 (E9707540.018)
	DATE : 14/11/97



MAIN CABLE 25 C

CURRENT VALUE = 276A

REDUCTION FACTOR FOR PARALLEL CABLES = 0,8

BIG GENERATOR:

4*0,81*276 = 894A [45 C 0.87*671]=777A

SMALL GENERATOR:

1*223 = 223A [45 C 0.87*223]=194A

NEG MICON A/S
PH : +45 8710 5000
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M1500-750/175kW 60Hz

PROJECT: E9707540.PRG

PAGE : 21 (E9707540.019)

DATE : 14/11/97

Mobilith SHC Series

Grease

Product Description

Mobilith SHC Series greases are supreme performance products designed for a wide variety of applications at extremes of temperature. They combine the unique features of a polyalphaolefin (PAO) synthetic base fluid with those of a high quality lithium complex thickener. The wax-free nature of the PAO base oil and the low coefficient of traction (compared with mineral oils), provide excellent low temperature pumpability and very low starting and running torque. These products offer the potential for energy savings and can reduce operating temperatures in the load zone of rolling element bearings. The lithium complex thickener contributes excellent adhesion, structural stability and resistance to water. The greases have a high level of chemical stability and are formulated with special additive combinations to provide excellent protection against wear, rust and corrosion at high and low temperatures. Mobilith SHC Series greases are available in five grades, varying in base oil viscosity from ISO VG 100 to 1500 and in NLGI grade from 2 to 00.

The Mobilith SHC Series of greases is used in the widest range of applications, and a broad range of operating temperatures, depending on grade. They are used not only in numerous industrial applications, but also find significant usage in automotive, marine and aerospace sectors.

Mobilith SHC Series greases have become the products of choice for many users, in many industries worldwide. Their reputation is based on their exceptional quality, reliability, versatility and the performance benefits they deliver.

Features & Benefits

The Mobil SHC brand of oils & greases are recognised and appreciated around the world for their innovation and outstanding performance. These molecular design PAO synthetic products, pioneered by ExxonMobil research scientists, symbolise the continuing commitment to using advanced technology to provide outstanding products. A key factor in the development of Mobilith SHC Series were the close contacts between our scientists and application specialists with key Original Equipment Manufacturers (OEMs) to ensure that our product offerings would provide exceptional performance in the continually evolving industrial equipment designs.

Our work with equipment builders has helped confirm the results from our own laboratory tests showing the exceptional performance of the Mobilith SHC Series lubricants. These benefits include longer grease life, enhanced bearing protection and bearing life, wide temperature range of application, and the potential for improved mechanical efficiency and energy savings.

To combat high thermal exposure of the oil our product formulation scientists chose proprietary synthetic base oils for Mobilith SHC Series oils because of their exceptional thermal/oxidative resistance potential. Our scientists developed a state-of-the-art lithium complex thickener technology and used specific additives to enhance the performance of each grade of the Mobilith SHC Series product family. The Mobilith SHC Series greases offer the following features and benefits:

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Features	Advantages and Potential Benefits
Outstanding high temperature and low temperature performance	Wide application temperature ranges, with excellent protection at high temperatures and low torque, easy start-up at low temperatures
Excellent protection against wear, rust and corrosion	Reduced downtime and maintenance costs because of reduced wear, rust and corrosion
Excellent thermal stability and oxidation resistance	Extended service life with longer intervals between relubrication and improved bearing life
Low traction coefficient	Potential improved mechanical life and reduced energy consumption
Includes high viscosity grades with high VI, no wax base stocks	Outstanding protection of slow speed, heavily loaded bearings with good low temperature performance
Outstanding structural stability in the presence of water	Retains excellent grease performance in hostile aqueous environments
Low volatility	Helps resists viscosity increase at high temperatures to maximise relubrication intervals and bearing life

Applications

Application Considerations: While Mobilith SHC Series greases are compatible with most mineral oil based products, admixture may detract from their performance. Consequently it is recommended that before changing a system to one of the Mobilith SHC Series, it should be thoroughly cleaned out to achieve the maximum performance benefits.

While the Mobilith SHC Series greases share many performance benefits, their applications are best described in terms of each product grade:

- Mobilith SHC 100 is an antiwear grease primarily recommended for higher speed applications such as electric motors, where reduced friction, low wear and long service life are required. It is an NLGI 2 Grade / ISO VG 100 grease with PAO synthetic base fluid. Its operating temperature range is -50º C to 180º C.
- Mobilith SHC 220 is a multipurpose, extreme pressure grease recommended for heavy-duty automotive and industrial applications. It uses an ISO VG 220 PAO synthetic fluid and although it is a NLGI 2 Grade product, it has the low temperature pumpability of most NLGI 0 Grade mineral oil based greases. Mobilith SHC 220 has a recommended operating temperature range of -40º C to 180º C.
- Mobilith SHC 460 is an NLGI 1.5 Grade grease with ISO VG 460 synthetic base and is an extreme pressure grease recommended for tough industrial applications. It provides outstanding bearing protection under heavy loads at low-to-moderate speeds and in applications where water resistance is a critical factor. Mobilith SHC 460 has demonstrated outstanding performance in steel mills, paper mills and marine applications. The recommended operating temperature range is -40º C to 180º C.
- Mobilith SHC PM is a NLGI 1.5 Grade grease with ISO VG 460 synthetic base oil and is an extreme pressure grease recommended for critical rolling element bearing applications in paper machines. It provides outstanding protection against rust and acid water corrosion, making it ideal for the wet end of the paper machine. The heavy viscosity base fluid and anti-wear additive make it an excellent grease for the highly loaded press section roll bearings. The low volatility and excellent high temperature oxidation stability of the synthetic base fluid maximise relubrication intervals and bearing life in the high temperature felt roll and calendar stack bearings. The recommended operating temperature range is -40°C to 180°C with appropriate relubrication intervals.
- Mobilith SHC 1000 Special is a NLGI 2 Grade grease with ISO VG 1000 synthetic base oil and strongly fortified with solid lubricants including micronised graphite and molybdenum disulphide for maximum protection of plain or rolling element bearings operating under boundary lubrication regimes. This product is designed to extend bearing life under conditions of extremely slow speeds, heavy loads and high temperatures. Mobilith SHC 1000 Special has a recommended operating temperature of -30°C to 180°C with appropriate relubrication intervals. The wax-free synthetic base fluid provides excellent low temperature mobility / pumpability.

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- Mobilith SHC 1500 is an NLGI 1 Grade / ISO VG 1500 grease with PAO synthetic base fluid. It is intended for use in plain and rolling element bearings operating at extremely slow speeds, under heavy loads and high temperatures. Mobilith SHC 1500 has a recommended operating temperature range of -20 to 180º C with appropriate relubrication intervals. Continuous lubrication with Mobilith SHC 1500 has been very effective in prolonging bearing life in a severe roll press application. Mobilith SHC 1500 has also provided excellent performance in rotary kiln roller bearings and in slag transfer rail car bearings.
- Mobilith SHC 007 is an NLGI 00 Grade / ISO VG 460 grease with PAO synthetic base fluid; it has a recommended operating temperature range of -50º C to 180º C with appropriate relubrication intervals. Its primary use is in non-driven heavy-duty truck trailer wheel hubs. It is also well suited for use in grease filled gear cases subject to high temperatures, where conventional semi fluid greases will not provide acceptable lubricant life.

Typical Properties

Mobilith SHC Series	**100**	**220**	**460**	**1500**	**007**
NLGI Grade	2	2	1.5	1	00
Thickener Type	Lithium complex	Lithium complex	Lithium complex	Lithium complex	Lithium complex
Colour, Visual	Red	Red	Red	Red	Red
Penetration, Worked, 25º C, ASTM D 217	280	280	305	325	415
Dropping Point, ºC, ASTM D 2265	255	255	255	255	NA
Viscosity of Oil, ASTM D 445					
cSt @ 40º C	100	220	460	1370	460
Timken OK Load, ASTM D 2509, lb.	--	50	70		70
4-Ball Weld, ASTM D 2596, Load, Kg	250	250	250	250	
Water Washout, ASTM D 1264, Loss at 79º C. % wt	6	4	3	2	
Rust Protection, ASTM D 6138	0	0	0	0	
USSteel Mobility @ -18º C		6	5	4	27

Health & Safety

Based on available information, this product is not expected to produce adverse effects on health when used for the intended application and the recommendations provided in the Material Safety Data Sheet (MSDS) are followed. MSDS's are available upon request through your sales contract office, or via the Internet. This product should not be used for purposes other than its intended use. If disposing of used product, take care to protect the environment.

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Mobiltemp SHC® Series

Grease

Product Description

Mobiltemp SHC Series products are supreme performance antiwear greases primarily intended for high temperature applications. They combine the unique features of polyalphaolefin (PAO) synthetic base fluids with those of an organo-clay, non-soap thickener. The excellent resistance to thermal/oxidative degradation provided by the PAO base, coupled with the excellent high temperature structural stability and high dropping point of the clay thickener result in an outstanding high temperature greases. The wax-free nature of the synthetic base fluid and its high viscosity index also provide superior low temperature lubrication as well as excellent film protection at high temperatures.

Because the PAO base oil has low traction properties (compared to mineral oil), Mobiltemp SHC Series also offer the potential for energy savings through reduced friction and lower torque, and reduced temperatures in the load zone of rolling element bearings. The Mobiltemp SHC Series is available as three products: Mobiltemp SHC 32 is an NLGI 1 1/2 grade with ISO VG 32 base oil; Mobiltemp SHC 100 is an NLGI 2 grade with ISO VG 100 base oil; Mobiltemp SHC 460 Special is an NLGI 1 grade with ISO VG 460 base oil, plus molybdenum disulphide for extra wear protection.

The Mobiltemp SHC Series of greases is used in numerous high temperature applications, as well as applications where low temperature start-up or running torque are important. They provide excellent grease life at high temperatures and offer extended relubrication periods and energy savings potential.

Mobiltemp SHC Series greases have become the products of choice for many users, in many industries worldwide. Their reputation is based on very wide application temperature range, and their excellent overall performance.

Features & Benefits

The Mobil SHC brand of oils & greases are recognised and appreciated around the world for their innovation and outstanding performance. These molecular design PAO synthetic products, pioneered by ExxonMobil research scientists, symbolise the continuing commitment to using advanced technology to provide outstanding products. A key factor in the development of Mobiltemp SHC Series were the close contacts between our scientists and application specialists with key Original Equipment Manufacturers (OEMs) to ensure that our product offerings would provide exceptional performance in the continually evolving industrial equipment designs.

Our work with equipment builders has helped confirm the results from our own laboratory tests showing the exceptional performance of the Mobiltemp SHC Series lubricants. These benefits include superb high temperature performance including thickener integrity and oxidation life with enhanced bearing protection and bearing life.

To combat high thermal exposure of the oil our product formulation scientists chose PAO synthetic base oils for Mobiltemp SHC Series oils because of their exeptional thermal/oxidative resistance potential. Our formulators used a special clay thickener to provide excellent structural stability and high dropping point. Mobiltemp SHC Series greases offer the following benefits:

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Features	Advantages and Potential Benefits
Outstanding high and low temperature performance	Reduced downtime and lower maintenance costs
Excellent resistance to oxidation and maintenance of grease structure at high temperatures	Extended service life with longer intervals between relubrication
Low coefficient of traction	Reduced energy consumption potential
Outstanding low temperature pumpability	Easier low temperature start-up and lower running torque
Very good antiwear protection	Extended bearing life, reduced unanticipated downtime

Applications

Mobiltemp SHC greases offer excellent high temperature grease life, bearing protection and grease integrity along with excellent low temperature capability and good wear protection. Specific applications include:

- For Mobiltemp SHC 32
- Sealed or re-packable ball and roller bearings
- Splines, screws and some enclosed gearing
- Extreme temperature applications with a recommended operating temperature range of -50º C to 180º C (with appropriate relubrication intervals).
- For Mobiltemp SHC 100
- High speed bearings and thrust bearings where a wide temperature range is desired
- It is particularly suitable for use in electric motor bearings where operating conditions demand reduced friction, low wear and long service life
- Extreme temperature applications with a recommended operating temperature range of -50º C to 200º C (with appropriate relubrication intervals).
- For Mobiltemp SHC 460 Special
- The presence of molybdenum disulphide makes it particularly suitable for the lubrication of sliding machine elements such as cams and ways, which are subject to long relubrication intervals, limited motion or shock loading.
- Oven conveyor or kiln bearings which are subject to high temperatures or cycling between high and normal temperatures
- Extreme temperature applications with a recommended operating temperature range of -40º C to 180º C (with appropriate relubrication intervals).

Specifications & Approvals

Mobiltemp SHC Series meets or exceeds the following industry specifications:	32	100	460 Special
Quality Level USDA H2	X		

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Typical Properties

Mobiltemp SHC Series	32	100	460 Special
NLGI Grade	1.5	2	1
Thickener Type	Clay	Clay	Clay
Color, Visual	Red	Light Brown	Gray
Penetration, Worked, 25º C, ASTM D 217	315	280	325
Dropping Point, ºC, ASTM D 2265	316	260+	260+
Viscosity of Oil, ASTM D 445			
cSt @ 40º C	32	100	460
4-Ball Wear, ASTM D 2266, Scar, mm	0.7	0.4	0.4
4-Ball Weld, ASTM D 2596, Load, Kg	315	315	400

Health & Safety

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Mobilgear® SHC XMP Series

Gear Oil

Product Description

Mobilgear SHC XMP Series supreme performance, fully synthetic industrial gear oils designed to provide optimum equipment protection and oil life even under extreme conditions. Mobil's polyalphaolefin (PAO) technology has been selected for its exceptional oxidation resistance and thermal properties, naturally high viscosity index, excellent low temperature fluidity and absence of undesirable compounds that are often found in mineral oils. The high viscosity index and low traction coefficient of this oil combine to provide a significant reduction in power consumption in many gear drives. Mobilgear SHC XMP Series lubricants contain an advanced and carefully blended proprietary additive system designed to provide excellent protection against conventional wear modes such as scuffing but also provides a high level of resistance against micropitting fatigue. In addition, compared to conventional gear oil chemistries, it offers the potential for improved lubrication of gearbox rolling element bearings. Mobilgear SHC XMP Series products offer outstanding rust and corrosion protection versus conventional gear oils, including seawater and acidic water protection. They show no tendency to plug fine filters even when wet and have excellent compatibility with ferrous and non-ferrous metals even at elevated temperatures.

Mobilgear SHC XMP lubricants are recommended for enclosed industrial gear drives including steel-on-steel spur, helical, and bevel gears. It is especially recommended for applications that may be subject to micropitting: especially heavily loaded gearboxes with surface-hardened tooth metallurgies. It may also be used in gear applications where extreme low and/or high temperatures are encountered and applications where corrosion may be severe.

Because of their unique mix of properties, including resistance to micropitting wear, and their performance in tough applications and wide temperature range, Mobilgear SHC XMP Series products enjoy a growing reputation among customers and OEMs around the world.

Features & Benefits

The Mobil brand lubricants designated as SHC is recognised and appreciated around the world for innovation and outstanding performance. These molecular design PAO synthetic products, pioneered by our research scientists, symbolise the continuing commitment to using advanced technology to provide outstanding products. A key factor in the development of Mobilgear SHC XMP Series was the close contacts between our scientists and application specialists with key OEMs to ensure that our product offerings will provide exceptional performance with the rapidly evolving industrial gear designs and operation.

Our work with equipment builders has helped confirm the results from our own laboratory tests showing the exceptional performance of the Mobilgear SHC XMP Series lubricants. Not least among the benefits shown in work with OEMs is the ability to resist micropitting wear which can occur with some highly loaded, case-hardened gearing applications. This cooperative work also demonstrated the all-round balanced performance benefits for the new Mobilgear SHC XMP technology, including a wide temperature range of application.

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To address the issue of micropitting gear wear, our product formulation scientists designed a proprietary combination of additives which would resist traditional gear wear mechanisms as well as protecting against micropitting. Our formulators chose proprietary PAO synthetic base oils to provide exceptional oil life and deposit control and resistance to thermal/oxidative and chemical degradation, as well as the balance of the performance features. The wax-free nature of the synthetic base oil also provides low temperature fluidity characteristcs unmatched by mineral products and is a key benefit for remote, low ambient, applications. The Mobilgear SHC XMP Series lubricants offer the following benefits:

Features	Advantages and Potential Benefits
Superb protection from micropitting fatigue wear as well as high resistance to traditional scuffing wear	Extended gear and bearing life in enclosed gear drives operating under extreme conditions of load, speed and temperature
	Reduced unexpected downtime and less maintenance – especially critical for difficult to access gearboxes.
Excellent resistance to degradation at high temperatures	Extended oil life and drain intervals reduced oil consumption and manpower costs
Low traction PAO base stocks for improved gear efficiency	Reduced energy consumption and lower operating temperatures
High viscosity index base stocks reduce viscosity change with temperature	Ability to operate at both high and low temperatures: especially critical in remote applications with no oil heating or cooling
Excellent resistance to rust and corrosion and very good demulsibility	Smooth, trouble-free operation at high temperatures or in water-contaminated applications
	Excellent compatibility with soft metals
No filter plugging, even in presence of water	Less filter changes and reduced maintenance costs
Excellent compatibility with common gearbox materials of construction and with mineral-based gear oils	Easy changeover from mineral products

Applications

Application Considerations: While the Mobilgear SHC XMP Series are compatible with mineral oil based products, admixture may detract from their performance. Consequently it is recommended that before changing a system to one of the Mobilgear SHC XMP Series, it should be thoroughly cleaned out and flushed to achieve the maximum performance benefits.

Mobilgear SHC XMP Series supreme performance, fully synthetic industrial gear oils designed to provide optimum equipment protection and oil life even under extreme conditions. They are especially formulated to resist micropitting of modern, case hardened gearing and can operate in both high and low temperature environments. Typical applications include:

- Wind turbines, especially highly loaded and shock loaded units, remotely located units and extreme temperature environments
- Plastic extruder gearboxes
- Modern, highly loaded gearboxes used in the paper, steel, oil, textile, lumber and cement industries where gear protection and optimum oil life are required.

Specifications & Approvals

Mobilgear SHC XMP meets or exceeds the following industry specifications	150	220	320	460	680
Meets AGMA 9005-D94 –S (at appropriate viscosity grade)	X	X	X	X	X
Meets DIN 51517 Part 3 (CLP)	X	X	X	X	X
Meets ISO 12925-1 Type CKD	X	X	X	X	X

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Mobilgear SHC XMP Series has the following builder approvals	150	220	320	460	680
HANSEN	X	X	X	X	X
DAVID BROWN	X	X	X	X	X
FLENDER	X	X	X	X	-
JAHNEL-KESTERMANN	X	X	X	X	X

Typical Properties

Mobilgear SHC XMP Series	150	220	320	460	680
ISO Viscosity Grade	150	220	320	460	680
Viscosity, ASTM D 445					
cSt @ 40º C	150	220	335	460	680
cSt @ 100º C	20.7	27.8	38.3	48.7	65.3
Viscosity Index, ASTM D 2270	161	163	164	166	168
Pour Point, ºC, ASTM D 97	-48	-45	-38	-36	-30
Flash Point, ºC, ASTM D 92	240	244	242	232	238
Specific Gravity @15.6º C kg/l, ASTM D 4052	0.855	0.859	0.860	0.863	0.866
FZG Micropitting, FVA Proc No. 54,					
Fail Stage	-	10	10	10	10
GFT-Class	-	High	High	High	High
FZG Scuffing, DIN 51534 (mod) A/16.6/90, Fail Stage	13+	14+	14+	14+	14+
4-Ball Wear test, ASTM D 4172, mm (Mod 1,800 RPM, 20kg, 54º C, 60 Minutes)	0.25	0.25	0.25	0.25	0.25
Rust protection, ASTM D665, Sea Water	Pass	Pass	Pass	Pass	Pass
Water Seperability, ASTM D 1401, Time to 40/37/3 at 82º C, minutes	10	10	10	10	10
Foaming Characteristics, ASTM D 892, Seq. II, Tendency/Stability, ml/ml	0/0	0/0	0/0	0/0	0/0

Health & Safety

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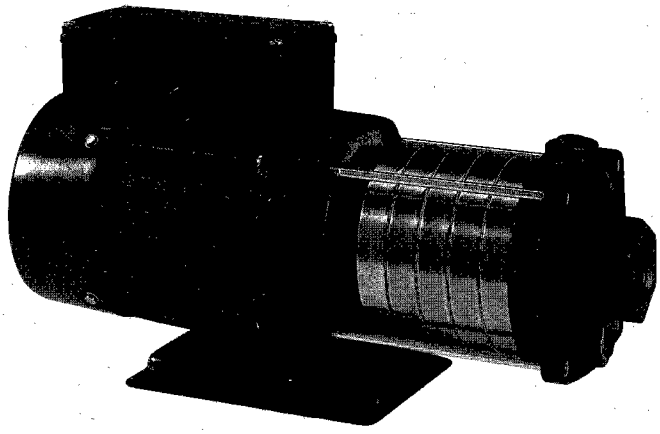
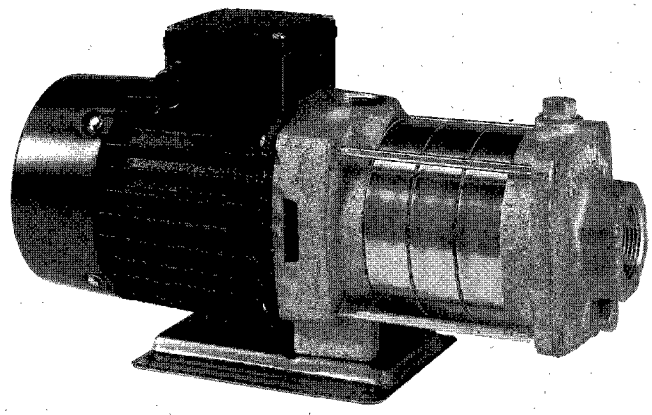
CH/CHN 4

Centrifugalpumpe
Centrifugal pump **50/60 Hz** **1/3 ~**
Kreiselpumpe

Delliste – Demontering og montering
Parts list – Dismantling and assembly
Teilliste – Demontage und Montage





96 48 53 26 04 02
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GRUNDFOS®

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DK GB D	Typenøgle Pump key Typenschlüssel	Model/Variant Model/Variant Modell/Variante	CH(N) 4

TYPENØGLE
PUMP KEY
TYPENSCHLÜSSEL

Variantkode
Variant code
Variantencode

									(1)		(2)		(3)
CH(N)	**4**	**-**	**30**		**X**		**A**	**-**	**A**	**-**	**CVBE**		

Typerække
Pump range
Baureihe

Nominelt flow i m^3/h
Nominal flow rate in m^3/h
Nennförderstrom in m^3/h

Afspærret tryk ved 50 Hz
Closed valve pressure, 50 Hz
Druck gegen geschlossenes Ventil, 50 Hz

Kode for specialprodukt
Code for special product
Code für Spezialprodukt

Kode for fysiske dimensioner
Code for physical dimensions
Code für physische Abmessungen

Kode for materialer
Code for materials
Code für Werkstoffe

Kode for akseltætning
Code for mechanical shaft seal
Code für Wellenabdichtung

Model/Variant
Model/Variant
Modell/Variante

CH 4

A-A-A
A-V-A
N-A-A
N-V-A
A-A-CVBE
N-A-CVBE
B-A-CVBE
A-A-CVBV
N-A-CVBV
B-A-CVBV
A-A-AUUE
B-A-AUUE
B-A-AUUV

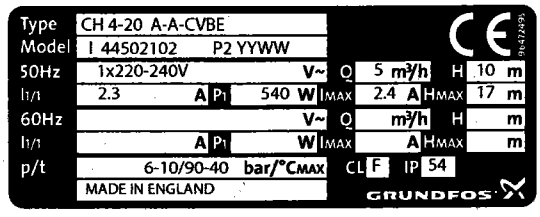
Dellisten er gældende for pumper mærket model F, H, I eller K med variantkoder:
Pumper mærket model A, B, C, D, E og G kan ikke serviceres og må erstattes af nye pumper.
This parts list applies to pumps marked model F, H, I or K with the variant codes:
Pumps marked model A, B, C, D, E and G cannot be serviced and must be replaced with new pumps.
Diese Teilliste gilt für Pumpen Modell F, H, I oder K mit den Variantencodes:
Pumpen Modell A, B, C, D, E und G können nicht gewartet werden und müssen durch neue Pumpen ersetzt werden.

CHN 4

A-W-I-CVBE
B-W-I-CVBE
A-W-I-CVBV
B-W-I-CVBV
B-W-I-AUUE
B-W-I-AUUV

Hvis der i dellisten ikke er angivet noget bogstav i kolonnerne "Model" og "Variantkode", indgår delen i ovennævnte modeller og varianter.
If no letter is stated in the columns "Model" and "Variant code" of the parts list, the part is used in the above models and variants.
Falls kein Buchstabe in den Kolonnen "Modell" und "Variantencode" der Teilliste angegeben ist, wird das Teil in den obigen Modellen und Varianten verwendet.

Skilt – Nameplate – Leistungsschild



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DK GB D	**Oversigtstabel** **Synoptic table** **Übersichtstabelle**

1 ~ CH

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	1) W	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode				
					A - A - CVBE	**A - A - CVBV**	**A - A - AUUE**	**N - A - CVBE**	**N - A - CVBV**
CH 4 - 20	50	1 x 220-240 V	540	I	44 50 21 02	44 55 21 02	44 56 21 02	44 70 21 02	44 75 21 02
	60	1 x 110 V	980	F	44 50 41 02	44 55 41 02		44 70 41 02	44 75 41 02
		1 x 110/220 V			44 50 42 02	44 55 42 02		44 70 42 02	44 75 42 02
		1 x 220 V			44 50 40 02	44 55 40 02		44 70 40 02	44 75 40 02
		1 x 127 V	920					44 70 47 02	
CH 4 - 30	50	1 x 220-240 V	840	H	44 50 21 03	44 55 21 03	44 56 21 03	44 70 21 03	44 75 21 03
	60	1 x 110	1520	F	44 50 41 03	44 55 41 03		44 70 41 03	44 75 41 03
		1 x 110/220 V			44 50 42 03	44 55 42 03		44 70 42 03	44 75 42 03
		1 x 220 V			44 50 40 03	44 55 40 03		44 70 40 03	44 75 40 03
		1 x 127 V	1300					44 70 47 03	
CH 4 - 40	50	1 x 220-240 V	1160	H	44 50 21 04	44 55 21 04	44 56 21 04	44 70 21 04	44 75 21 04
	60	1 x 110 V	1720	F	44 50 41 04	44 55 41 04		44 70 41 04	44 75 41 04
		1 x 110/220 V			44 50 42 04	44 55 42 04		44 70 42 04	44 75 42 04
		1 x 220 V			44 50 40 04	44 55 40 04		44 70 40 04	44 75 40 04
		1 x 127 V						44 70 47 04	
CH 4 - 50	50	1 x 220-240 V	1300	F	44 50 21 05	44 55 21 05	44 56 21 05		
CH 4 - 60	50	1 x 220-240 V	1460	F	44 50 21 06	44 55 21 06	44 56 21 06		

USA / CANADA

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	2) HP	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode			
					B - A - CVBE	**B - A - CVBV**	**B - A - AUUE**	**B - A - AUUV**
CH 4 - 20	60	1 x 115/230 V	0,5	K	44 80 41 02	44 81 41 02	44 86 41 02	44 87 41 02
CH 4 - 30	60	1 x 115/230 V	0,75	K	44 80 41 03	44 81 41 03	44 86 41 03	44 87 41 03
CH 4 - 40	60	1 x 115/230 V	1,0	K	44 80 41 04	44 81 41 04	44 86 41 04	44 87 41 04
CH 4 - 50	60	1 x 115/230 V	1,5	K	44 80 41 05	44 81 41 05	44 86 41 05	44 87 41 05

1 ~ CHN

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	1) W	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode	
					A-W-I-CVBE	**A-W-I-CVBV**
CHN 4 - 20	50	1 x 220-240 V	540	I	44 60 21 02	44 65 21 02
	60	1 x 110/220 V	980	F	44 60 42 02	44 65 42 02
CHN 4 - 30	50	1 x 220-240 V	840	H	44 60 21 03	44 65 21 03
	60	1 x 110/220 V	1520	F	44 60 42 03	44 65 42 03
CHN 4 - 40	50	1 x 220-240 V	1160	H	44 60 21 04	44 65 21 04
	60	1 x 110/220 V	1720	F	44 60 42 04	44 65 42 04
CHN 4 - 50	50	1 x 220-240 V	1300	F	44 60 21 05	44 65 21 05
CHN 4 - 60	50	1 x 220-240 V	1460	F	44 60 21 06	44 65 21 06

USA / CANADA

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	2) HP	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode			
					B-W-I-CVBE	**B-W-I-CVBV**	**B-W-I-AUUE**	**B-W-I-AUUV**
CHN 4 - 20	60	1 x 115/230 V	0,5	K	44 71 41 02	44 72 41 02	44 76 41 02	44 77 41 02
CHN 4 - 30	60	1 x 115/230 V	0,75	K	44 71 41 03	44 72 41 03	44 76 41 03	44 77 41 03
CHN 4 - 40	60	1 x 115/230 V	1,0	K	44 71 41 04	44 72 41 04	44 76 41 04	44 77 41 04
CHN 4 - 50	60	1 x 115/230 V	1,5	K	44 71 41 05	44 72 41 05	44 76 41 05	44 77 41 05

Optagen effekt.
1) Power input.
Leistungsaufnahme.

Mærkeeffekt.
2) Rated power.
Bemessungsleistung.

DK GB D	**Oversigtstabel** **Synoptic table** **Übersichtstabelle**	**CH(N) 4**

3 ~ CH

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	1) W	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode				
					A - A - CVBE	**A - A - CVBV**	**A - A - AUUE**	**N - A - CVBE**	**N - A - CVBV**
CH 4 - 20	50	3 x 220-240/ 380-415 V	560	H	44 50 11 02	44 55 11 02	44 56 11 02	44 70 11 02	44 75 11 02
	50	3 x 200-220/ 346-380 V	545	F	44 50 32 02	44 55 32 02		44 70 32 02	44 75 32 02
	60	3 x 200-230/ 346-400 V	810						
CH 4 - 30	50	3 x 220-240/ 380-415 V	820	H	44 50 11 03	44 55 11 03	44 56 11 03	44 70 11 03	44 75 11 03
	50	3 x 200-220/ 346-380 V	810	F	44 50 32 02	44 55 32 03		44 70 32 03	44 75 32 03
	60	3 x 200-230/ 346-400 V	1260						
CH 4 - 40	50	3 x 220-240/ 380-415 V	965	H	44 50 11 04	44 55 11 04	44 56 11 04	44 70 11 04	44 75 11 04
	50	3 x 200-220/ 346-380 V	900	F	44 50 32 04	44 55 32 04		44 70 32 04	44 75 32 04
	60	3 x 200-230/ 346-400 V	1525						
CH 4 - 50	50	3 x 220-240/ 380-415 V	1320	F	44 50 10 05	44 55 10 05	44 56 10 05		
CH 4 - 60	50	3 x 220-240/ 380-415 V	1510	F	44 50 10 06	44 55 10 06	44 56 10 06		

USA / CANADA

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	2) HP	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode			
					B - A - CVBE	**B - A - CVBV**	**B - A - AUUE**	**B - A - AUUV**
CH 4 - 20	60	3 x 208-230/440-480 V	0,5	K	44 80 30 02	44 81 30 02	44 86 30 02	44 87 30 02
	60	3 x 575 V		K	44 80 33 02	44 81 33 02	44 86 33 02	44 87 33 02
CH 4 - 30	60	3 x 208-230/440-480 V	0,75	K	44 80 30 03	44 81 30 03	44 86 30 03	44 87 30 03
	60	3 x 575 V		K	44 80 33 03	44 81 33 03	44 86 33 03	44 87 33 03
CH 4 - 40	60	3 x 208-230/440-480 V	1,0	K	44 80 30 04	44 81 30 04	44 86 30 04	44 87 30 04
	60	3 x 575 V		K	44 80 33 04	44 81 33 04	44 86 33 04	44 87 33 04
CH 4 - 50	60	3 x 208-230/440-480 V	1,5	K	44 80 30 05	44 81 30 05	44 86 30 05	44 87 30 05
	60	3 x 575 V		K	44 80 33 05	44 81 33 05	44 86 33 05	44 87 33 05

3 ~ CHN

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	1) W	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode	
					A-W-I-CVBE	**A-W-I-CVBV**
CHN 4 - 20	50	3 x 220-240/380-415 V	560	H	44 60 11 02	44 65 11 02
	50	3 x 200-220/346-380 V	545	F	44 60 32 02	44 65 32 02
	60	3 x 200-230/346-400 V	810			
CHN 4 - 30	50	3 x 220-240/380-415 V	820	H	44 60 11 03	44 65 11 03
	50	3 x 200-220/346-380 V	810	F	44 60 32 03	44 65 32 03
	60	3 x 200-230/346-400 V	1260			
CHN 4 - 40	50	3 x 220-240/380-415 V	965	H	44 60 11 04	44 65 11 04
	50	3 x 200-220/346-380 V	900	F	44 60 32 04	44 65 32 04
	60	3 x 200-230/346-400 V	1525			
CHN 4 - 50	50	3 x 220-240/380-415 V	1320	F	44 60 10 05	44 65 10 05
CHN 4 - 60	50	3 x 220-240/380-415 V	1510	F	44 60 10 06	44 65 10 06

USA / CANADA

Pumpetype Pump type Pumpentyp	Hz	Spænding Voltage Spannung	2) HP	Model Model Modell	Pumpenummer / Variantkode Pump number/ Variant code Pumpennummer / Variantencode			
					B-W-I-CVBE	**B-W-I-CVBV**	**B-W-I-AUUE**	**B-W-I-AUUV**
CHN 4 - 20	60	3 x 208-230/440-480 V	0,5	K	44 71 30 02	44 72 30 02	44 76 30 02	44 77 30 02
	60	3 x 575 V		K	44 71 33 02	44 72 33 02	44 76 33 02	44 77 33 02
CHN 4 - 30	60	3 x 208-230/440-480 V	0,75	K	44 71 30 03	44 72 30 03	44 76 30 03	44 77 30 03
	60	3 x 575 V		K	44 71 33 03	44 72 33 03	44 76 33 03	44 77 33 03
CHN 4 - 40	60	3 x 208-230/440-480 V	1,0	K	44 71 30 04	44 72 30 04	44 76 30 04	44 77 30 04
	60	3 x 575 V		K	44 71 33 04	44 72 33 04	44 76 33 04	44 77 33 04
CHN 4 - 50	60	3 x 208-230/440-480 V	1,5	K	44 71 30 05	44 72 30 05	44 76 30 05	44 77 30 05
	60	3 x 575 V		K	44 71 33 05	44 72 33 05	44 76 33 05	44 77 33 05

1) Optagen effekt.
Power input.
Leistungsaufnahme.

2) Mærkeeffekt.
Rated power.
Bemessungsleistung.

DK GB D	**Delliste** **Parts list** **Teilliste**

Model Model Modell **1**	Variantkode Variant code Variantencode **2**	Løberantal Number of impellers Anzahl der Laufräder **3**
Antal pr. pumpe (A = Løberantal) Number per pump (A = Number of impellers) Anzahl pro Pumpe (A = Anzahl der Laufräder) **4**	Suppl. oplysninger Suppl. information Zusätzl. Informationen **5**	Delnummer Part number Teilnummer **6**

Pos.	Benævnelse Description Benennung	1	2 (1)	2 (2)	2 (3)	3 60 Hz	3 50 Hz	4	5	6
2	Topstykke Discharge chamber Kopfstück								1″	44 00 46
									CHN 1″	44 01 29
									1″ NPT	44 01 17
									CHN 1″ NPT	43 00 72
4	Kammer Chamber Kammer					2-4	2-4	A-1		44 50 13
							5-6	A-2		
1) 4a	Kammer med leje Chamber with bearing Kammer mit Lager						5-6	1		44 50 15
6	Endestykke Suction chamber Sauggehäuse								5/4″	44 50 25
									5/4″ NPT	44 50 60
									CHN 5/4″	44 50 65
									CHN 5/4″ NPT	44 01 71
									1″	44 50 24
21	Rørprop Pipe plug							1	R 3/8	41 04 07
									CHN R 3/8	96 41 26 36
25	Stopfen							1	R 3/8	41 04 07
									CHN R 3/8	96 41 26 36
26	Støttebolt (unbrakoskrue) Staybolt (hexagon socket head screw) Stehbolzen (Innensechskantschraube)					2	2	4	M6 x 80 - NV 5	ID 57 41
						3	3	4	M6 x 110 - NV 5	ID 26 34
						4	4	4	M6 x 140 - NV 5	ID 57 43
						5	5	4	M6 x 170 - NV 5	ID 57 44
						6	6	4	M6 x 190 - NV 5	ID 57 45
28	Cylinderskrue Cheese-head screw Zylinderkopfschraube							4	M6 x 16	ID 99 19
28g	Sætskrue Hexagon head screw Sechskantschraube							2	M6 x 10	91 20 02 46
28h	Stjernefjederskive for pos. 28g Toothed lock washer for pos. 28g Fächerscheibe für Pos. 28g							2	ø6,4	ID 65 94
37	Pakning Gasket Dichtung							A	ø110/ø103 x 0,25	43 00 40
47a	Lejering Bearing ring Lagerring						5-6	1		41 01 21
49	Løber uden nav Impeller without hub Laufrad ohne Nabe							A		41 50 53
56	Fodplade Base plate Grundplatte							1		44 00 53
	CHN							1		44 00 16
62	Stopring Stop ring Stopring							1	ø12,8/ø10,8 x ø1,0	41 00 35
64	Afstandsbøsning Spacing pipe Distanzhülse					2-4	2-4	A-1	ø15/ø13 x 26	41 01 43
						5-6	5-6	A-2		
64a	Afstandsbøsning Spacing pipe Distanzhülse						5-6	1	ø15/ø13 x 15	41 01 42
66	Spændestykke Clamp Spannstück							1		40 00 61
67	Låsemøtrik Lock nut Sicherungsmutter							1	M8 - NV 13	ID 20 61
79	Slyngskive Diverting disc Schleuderscheibe							1	ø19/ø11,5 x 2	44 00 06
102	O-ring O-ring O-Ring									4)

1), og **4)**, se side 9.
1), and **4)**, see page 9.
1), und **4)**, siehe Seite 9.

DK GB D	**Delliste** **Parts list** **Teilliste**	**CH(N) 4**

Model Model Modell **1**	Variantkode Variant code Variantencode **2**	Løberantal Number of impellers Anzahl der Laufräder **3**
Antal pr. pumpe (A = Løberantal) Number per pump (A = Number of impellers) Anzahl pro Pumpe (A = Anzahl der Laufräder) **4**	Suppl. oplysninger Suppl. information Zusätzl. Informationen **5**	Delnummer Part number Teilnummer **6**

Pos.	Benævnelse Description Benennung		**1**	**2** (1)	(2)	(3)	**3** 60 Hz	50 Hz	**4**	**5**	**6**
105	Akseltætning Shaft seal Wellenabdichtung	EPDM				CVBE			1		98 51 84
						AUUE			1		98 57 38
		FKM				CVBV			1		98 51 85
						AUUV			1		98 57 39
107	O-ring O-ring O-Ring										4)
150	Stator med hus og klemkasse komplet består af pos. Stator with housing and terminal box complete consists of pos. Stator mit Gehäuse und Klemmenkasten komplett besteht aus Pos.		I					2		1 x 220-240 V	87 38 61
			H					3			88 74 14
			H					4			88 74 15
			F					5			88 58 90
			F					6			88 58 90
			F				2			1 x 110 V	88 58 93
							3				88 58 96
							4				88 58 99
			F				2			1 x 110/220 V	88 58 94
							3				88 58 97
							4				88 59 00
		151	F				2			1 x 127 V	88 59 01
							3				88 59 02
		152					4				88 59 03
		156	F				2			1 x 220 V	88 58 92
		158					3				88 58 95
		159					4				88 58 98
		161	K				2			1 x 115/230 V	88 21 49
		164					3				88 21 50
		164a					4				88 21 51
		166					5				88 24 89
		168	H					2		3 x 220-240/380-415 V	88 74 16
		173	H					3			88 74 16
		173a	H					4			88 74 16
		175	F					5			88 59 05
		176	F					6			88 59 05
			F				2	2		50 Hz 3 x 200-220/346-380 V	87 44 40
							3	3			87 44 41
							4	4		60 Hz 3 x 200-230/346-400 V	87 44 42
			K				2			3 x 208-230/440-480 V	88 24 73
							3				88 24 75
							4				88 24 77
							5				88 23 95
			K				2			3 x 575 V	88 24 91
							3				88 24 93
							4				88 24 95
							5				88 24 97
151	Ventilatorskærm Fan cover Lüfterabdeckung		F-K								88 03 39
			H-I								88 03 90
152	Skrue Screw Schraube		F						2	M5 x 16	ID 13 42
			F-K						2	M4 x 8	ID 15 65
			H-I						4	B 4,2 x 13	ID 60 77
153	Kugleleje Ball bearing Kugellager								1	6203 2ZRC3	ID 12 27
154									1	6201 2ZRC3	ID 29 31
155	Lejeafdækning Bearing cover plate Lagerabdeckung								1		44 00 05
156	Ventilator Fan Lüfter								1		88 01 66
158	Bølgefjeder Corrugated spring Gewellte Feder								1	ø31,7/ø24,5 x 0,5	88 01 73
159	O-ring O-ring O-Ring								1	ø32 x 2	ID 99 28

Se side 9.
4) See page 9.
Siehe Seite 9.

DK GB D	**Delliste** **Parts list** **Teilliste**

Model Model Modell **1**	Variantkode Variant code Variantencode **2**	Løberantal Number of impellers Anzahl der Laufräder **3**
Antal pr. pumpe (A = Løberantal) Number per pump (A = Number of impellers) Anzahl pro Pumpe (A = Anzahl der Laufräder) **4**	Suppl. oplysninger Suppl. information Zusätzl. Informationen **5**	Delnummer Part number Teilnummer **6**

Pos.	Benævnelse Description Benennung		1	2 (1)	2 (2)	2 (3)	3 60 Hz	3 50 Hz	4	5	6
160	Kondensatorholder kompl. inkl. pos. 161 Capacitor holder complete with pos. 161 Kondensatorhalter kompl. mit Pos. 161	**60 Hz** 1 x 115/230 V	K				4		1	50 µF/400 V	88 22 97
							5			60 µF/400 V	96 03 67 05
161	Kondensator Capacitor Kondensator	**50 Hz** 1 x 220-240 V	H-I					2-3	1	10 µF/400 V	ID 39 42
								4		16 µF/400 V	ID 39 37
			F					5-6		25 µF/400 V	ID 39 39
		60 Hz 1 x 110 V 1 x 220 V 1 x 110-220 V 1 x 127 V	F				2		1	20 µF/400 V	ID 39 38
							3		1	25 µF/400 V	ID 39 39
							4		1	30 µF/400 V	ID 39 40
		60 Hz 1 x 115/230 V	K				2		1	40 µF/400 V	ID 78 57
							3			40 µF/400 V	
							4			50 µF/400 V	88 22 96
							5		2	30 µF/400 V	ID 39 40
164	Klemkassedæksel Terminal box cover Klemmenkastendeckel		F						1	1 ~	88 57 84
			F-H							3 ~	88 57 86
			H-I							1 ~	88 74 07
			K				2-3		1	1 ~	88 96 84
							4				88 57 84
							5				96 01 05 35
			K				2-3		1	3 ~ 208-230/440-480 V	88 96 84
							4				88 96 86
							5				88 57 86
							2-5		1	3 ~ 3 x 575 V	88 96 84
164a	Klemkasse Terminal box Klemmenkasten		F						1	1 ~	88 57 83
							5-6		1	3 ~ 220-240/380-415 V	88 57 85
							2-4	2-4	1	3 ~	96 46 21 50
			H						1	3 ~	88 57 85
			H-I						1	1 ~	88 73 76
			K				2-3		1	1 ~	88 96 83
							4		1	1 ~	88 57 83
			K				2-3		1	3 ~ 208-230/440-480 V	88 96 83
							4				88 96 85
							5				88 57 85
							2-5		1	3 ~ 3 x 575 V	88 96 83
166	Skrue Screw Schraube		F-H-I						4	KBL 50 x 20	ID 42 12
168	Kabelforskruning Screwed cable entry Kabelverschraubung		F-K						1	16 Pg	ID 57 47
			H-I							1 ~ 13,5 Pg	ID 63 99
			H							3 ~ 16 Pg	ID 57 47
168b	Reduktionsmuffe Reducing socket Reduktionsmuffe		K						1	16 Pg 1/2" NPT	88 07 33
										M20 1/2" NPT	96 44 01 00
170	Skilt uden data Nameplate without data Typenschild ohne Daten								1		96 03 02 31
									1	USA 1 ~	88 25 36
										3 ~	88 24 67

DK GB D	Delliste Parts list Teilliste	CH(N) 4

Model Model Modell **1**	Variantkode Variant code Variantencode **2**	Løberantal Number of impellers Anzahl der Laufräder **3**
Antal pr. pumpe (A = Løberantal) Number per pump (A = Number of impellers) Anzahl pro Pumpe (A = Anzahl der Laufräder) **4**	Suppl. oplysninger Suppl. information Zusätzl. Informationen **5**	Delnummer Part number Teilnummer **6**

Pos.	Benævnelse Description Benennung	1	2 (1)	2 (2)	2 (3)	3 60 Hz	3 50 Hz	4	5	6
172	Rotor komplet med kuglelejer Rotor complete with ball bearings Rotor komplett mit Kugellagern	I					2		1 ~	44 60 92
		F				2			1 ~	44 60 72
		K				2			1 ~	43 61 98
		H					2		3 ~	44 60 87
		F				2	2		3 ~	44 60 75
		K				2			3 ~	43 61 82
		H					3		1 ~	44 60 85
		F				3			1 ~	44 60 73
		K				3			1 ~	43 61 99
		H					3		3 ~	44 60 88
		F				3	3		3 ~	44 60 78
		K				3			3 ~	43 60 88
		H					4		1 ~	44 60 86
		F				4			1 ~	44 60 74
		K				4			1 ~	43 62 00
		H					4		3 ~	44 60 89
		F				4	4		3 ~	44 60 79
		K				4			3 ~	91 20 01 61
		F					5		1 ~	44 60 82
		K				5			1 ~	43 62 01
		F					5		3 ~	44 60 80
		F					6		1 ~	44 60 83
		F					6		3 ~	44 60 81
173	Skrue Screw Schraube							1	M6 x 10	ID 42 09
173a	Underlag for pos. 173 Support for pos. 173 Unterlage für Pos. 173							1		87 06 60
174	Termokontakt Thermal switch Thermoschalter	**50 Hz** 1 x 220-240 V F					5-6	1	MEJ 00 LR	ID 39 82
		60 Hz 1 x 110 V F				2		1	MEJ 20 RR	ID 27 38
						3		1	MEJ 16 RR	ID 60 82
						4		1	MEJ 20 ABM	ID 27 42
		60 Hz 1 x 127 V F				2		1	MEJ 00 LR	ID 39 82
						3		1	MEJ 20 ABM	ID 27 42
						4		1	MEJ 16 BR	ID 39 83
		60 Hz 1 x 220 V F				2		1	MEJ 36 GR	ID 27 39
						3		1	MEJ 28 JX	ID 15 53
						4		1	MEJ 20 RR	ID 27 38
		60 Hz 1 x 115/230 V K				2		1	MEJ 59 AR	96 47 83 87
						3		1	MEJ 36 RR	ID 42 03
						4		1	MEJ 28 ABR	96 41 30 69
						5		1	MEJ 33 SR 1-2-3	88 26 25
175	Cylinderskrue Cheese-head screw Zylinderkopfschraube							4	M6 x 10	ID 55 25
176	Terminal komplet Terminal complete Anschlußeinheit komplett	F-H-I-K				2-4	2-6	1	8-polet 8-pole 8polig	88 57 82
	Klembræt Terminal board Klemmbrett	K				2-6		1	3 x 575 V	85 50 70
176a	Holder for klembræt Holder for terminal board Halter für Klemmbrett	K				2-6		1	3 x 575 V	88 03 26

Placering af kammer med leje, pos. 4a, se "Snittegning", side 15.
1) Position of chamber with bearing, pos. 4a, see "Sectional drawing" on page 15.
Stellung der Kammer mit Lager, Pos. 4a, siehe "Schnittzeichnung" auf Seite 15.

Se "Servicesæt" side 10.
4) See "Service kits" on page 10.
Siehe "Servicesätze" auf Seite 10.

DK GB D	**Servicesæt** **Service kits** **Servicesätze**	**Tilspændingsmomenter** **Torques** **Anzugsmomente**

Servicesæt **Service kits** **Servicesätze**				
Benævnelse Description Benennung	Type Type Typ	Model Model Modell	Løberantal Number of impellers Anzahl der Laufräder	Delnummer Part number Teilnummer
Akseltætning + pakninger Shaft seal + gaskets Wellenabdichtung + Dichtungen	CVBE/CVBV			**98 51 64**
	AUUE/AUUV			**98 58 48**
Lejesæt Bearing kit Lagersatz		F-H-I-K	2-6	**43 50 06**
Reparationssæt Repair kit Reparatursatz			2-4	**44 50 04**
			5-6	**44 50 17**

Servicesæt består af: **Service kits consist of:** **Servicesätze bestehen aus:**					
1) Pos.	Delnummer Part number Teilnummer				
	98 51 64	**98 58 48**	**43 50 06**	**44 50 04**	**44 50 17**
4a					1
28			4		
37	11	11	6	4	6
47a					1
49				1	1
62	1	1	1	1	1
66				1	1
67	1	1	1	1	1
79				1	1
102	1	1	1	1	1
105	1	1	1	1	1
107	1	1	1	1	1
153			1		
154			1		
155			1		
158			1		
159			1		
3)	1	1	1	1	1

Tekster til positionsnumre, se "Delliste".
1) Texts for position numbers, see "Parts list".
Texte für Positionsnummern, siehe "Teilliste".

Unbrakonøgle for pos. 26.
3) Key for hexagon socket head screws, pos. 26.
Innensechskantschlüssel fü Pos. 26.

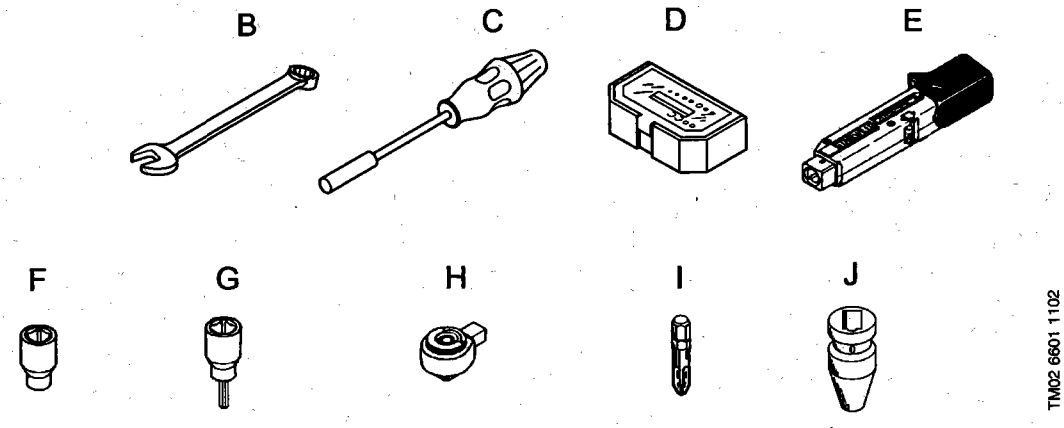
Tilspændingsmomenter **Torques** **Anzugsmomente**			
Pos.	Benævnelse Description Benennung	Suppl. oplysninger Suppl. information Zusätzl. Informationen	Moment Torque Anzugsmoment
1) 26	Støttebolt (unbrakoskrue) Staybolt (hexagon socket head screw) Stehbolzen (Innensechskantschraube)	M6	12 Nm (1,2 kpm)
1) 28	Cylinderskrue Cheese-head screw Zylinderkopfschraube	M6 x 16	8-10 Nm (0,8-1,0 kpm)
2) 67	Låsemøtrik Lock nut Sicherungsmutter	M8	10-12 Nm (1,0-1,2 kpm)

Smøres med gevindpasta THREAD-EZE, delnummer SV 99 97 (0,5 l).
1) Lubricate with thread paste THREAD-EZE, part number SV 99 97 (0.5 l).
Bestreichen mit Gewindepaste THREAD-EZE, Teilnummer SV 99 97 (0,5 l).

Smøres med olie, type GARDOLUBE L 6034, delnummer SV 99 95 (1 l).
2) Lubricate with oil, type GARDOLUBE L 6034, part number SV 99 95 (1 l).
Bestreichen mit Öl, Typ GARDOLUBE L 6034, Teilnummer SV 99 95 (1 l).

DK GB D F E	**Serviceværktøj** **Service tools** **Servicewerkzeuge**	**CH(N) 4**

Pos.	Benævnelse Description Benennung		Antal Number Anzahl	Suppl. oplysninger Suppl. information Zusätzl. Informationen	Delnummer Part number Teilnummer
	Standardværktøj **Standard tools** **Standardwerkzeuge**				
B	Ringgaffelnøgle for pos. Ring/open-end spanner for pos. Ringgabelschlüssel für Pos.	67	1	M8 - NV 13	SV 00 55
C	Bitholder for pos. Universal bit-holder for pos. Universalhalter für Pos.	**D**	1	1/4″	SV 20 11
D	Bits kit for pos. Bits kit for pos. Einsätze für Pos.	26 28	1		SV 20 10
	Værktøj for tilspændingsmomenter **Tools for torques** **Werkzeuge für Anzugsmomente**				
E	Momentnøgle Torque wrench Drehmomentschlüssel		1	4-20 Nm 9 x 12	SV 02 92
F	Topnøgle for pos. Socket spanner for pos. Steckschlüssel für Pos.	67	1	M8 - NV 13 1/2″ x 1/2″	SV 04 13
G	Unbrakotopnøgle for pos. Socket driver for hexagon socket head screw, pos. Schraubendrehereinsatz für Innensechskantschraube, Pos.	26	1	M6 - NV 5 1/2″ x 1/2″	SV 02 96
H	Knarre for pos. Ratchet insert tool for pos. Einsteck-Knarre für Pos.	**F-G-J**	1	9 x 12 x 1/2″ x 1/2″	SV 02 95
I	Stjerneskruetrækker for pos. Screwdriver for cross-head screw, pos. Kreuzschlitzschraubendreher für Pos.	28	1	PCD 3 1/4″ x 1/4″	SV 04 50
J	Holder for pos. Holder for pos. Halter für Pos.	**I**	1	1/2″ x 1/2″ x 1/4″ x 1/4″	SV 03 43



DK GB D	Viklingsmodstande / Forbindelsesdiagrammer Winding resistances / Wiring diagrams Wicklungswiderstände / Schaltbilder

1 ~

Viklingsmodstande
Winding resistances
Wicklungswiderstände

Pumpetype Pump type Pumpentyp CH/CHN 4	Hz	Spænding Voltage Spannung	1) W	Model Model Modell	Pos. 150	Stator Stator Stator	R (20°) ± 8%					Forbindelsesdiagram Wiring diagram Schaltbild
							R_A	R_M	R_{M1}	R_{M2}	R_{M3}	
- 20	50	1 x 220-240 V	540	I	87 38 61	88 79 97	23,8	11,8				98 37 17
	60	1 x 110 V	980	F	88 58 93	88 59 43	11,2		2,5	2,5		98 33 61
	60	1 x 110/220 V	980	F	88 58 94	88 59 43	11,2		2,5	2,5		98 33 63
	60	1 x 220 V	980	F	88 58 92	88 59 43	11,2		2,5	2,5		98 33 59
	60	1 x 127 V	920	F	88 59 01	88 59 46	8,55	1,58				98 33 62
- 30	50	1 x 220-240 V	840	H	88 74 14	88 74 08	20,0	8,0				98 37 17
	60	1 x 110 V	1520	F	88 58 96	88 59 44	6,45		1,68	1,68		98 33 61
	60	1 x 110/220 V	1520	F	88 58 97	88 59 44	6,45		1,68	1,68		98 33 63
	60	1 x 220 V	1520	F	88 58 95	88 59 44	6,45		1,68	1,68		98 33 59
	60	1 x 127 V	1300	F	88 59 02	88 59 47	6,40	1,1				98 33 58
- 40	50	1 x 220-240 V	1160	H	88 74 15	88 74 09	12,2	7,05				98 37 17
	60	1 x 110 V	1720	F	88 58 99	88 59 45	5,0		1,0	1,0		98 33 60
	60	1 x 110/220 V	1720	F	88 59 00	88 59 45	5,0		1,0	1,0		98 33 63
	60	1 x 220 V	1720	F	88 58 98	88 59 45	5,0		1,0	1,0		98 33 59
	60	1 x 127 V	1720	F	88 59 03	88 59 48	4,65		1,4	1,4		98 33 60
- 50	50	1 x 220-240 V	1300	F	88 58 90	88 56 17	5,7	2,6				98 32 25
- 60	50	1 x 220/240 V	1460	F	88 58 90	88 56 17	5,7	2,6				98 32 25

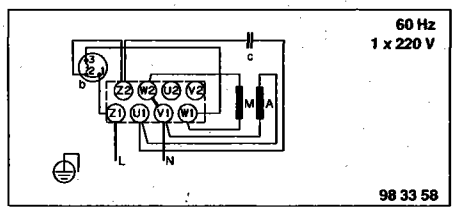
USA / CANADA

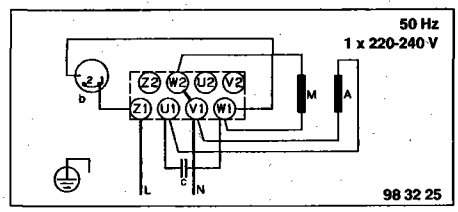
Pumpetype Pump type Pumpentyp CH/CHN 4	Hz	Spænding Voltage Spannung	2) HP	Model Model Modell	Pos. 150	Stator Stator Stator	R (20°) ± 8%					Forbindelsesdiagram Wiring diagram • Schaltbild
							R_A	R_M	R_{M1}	R_{M2}	R_{M3}	
- 20	60	1 x 115/230 V	0,5	K	88 21 49	88 21 24	4,05		2,6	2,65		98 32 03
- 30	60	1 x 115/230 V	0,75	K	88 21 50	88 21 25	3,4		1,8	1,8		98 32 04
- 40	60	1 x 115/230 V	1,0	K	88 21 51	88 21 26	2,55		1,26	1,26		98 32 03
- 50	60	1 x 115/230 V	1,5	K	88 24 89	88 17 87	1,42		0,53	0,53		98 32 02

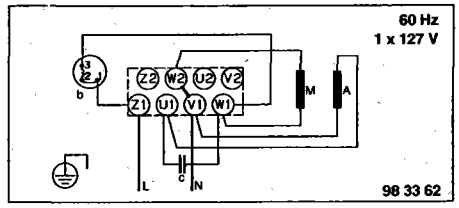
1) Optagen effekt. – Power input. – Leistungsaufnahme.

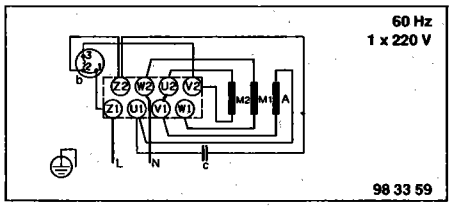
2) Mærkeeffekt. – Rated power. – Bemessungsleistung.

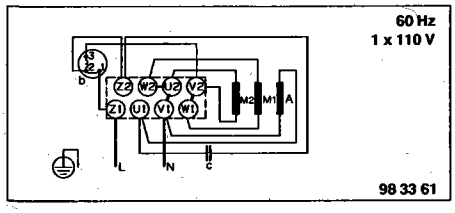
Forbindelsesdiagrammer
Wiring diagrams
Schaltbilder

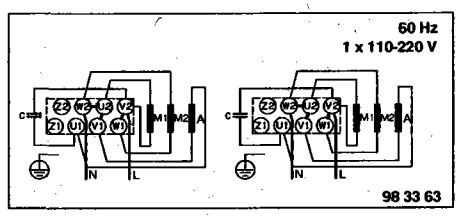


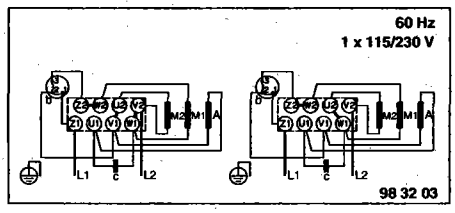


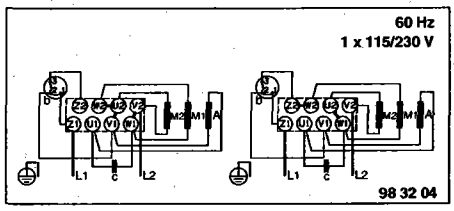


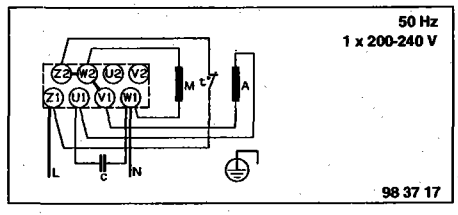


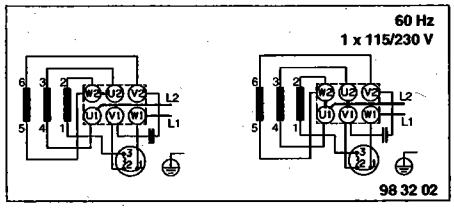


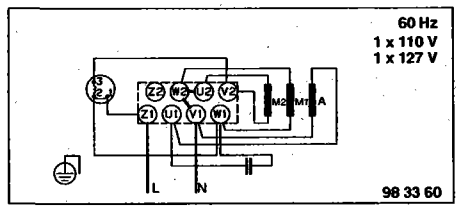












3 ~

Viklingsmodstande Winding resistances Wicklungswiderstände												
Pumpetype Pump type Pumpentyp CH/CHN 4	Hz	Spænding Voltage Spannung	1) W	Model Model Modell	Pos. 150	Stator Stator Stator	R (20°) ± 8%					Forbindelsesdiagram Wiring diagram Schaltbild
							R_A	R_M	R_{M1}	R_{M2}	R_{M3}	
- 20	50	3 x 220-240/380-415 V	560	H	88 74 16	88 74 10			18,0	18,0	18,0	98 31 69
	50	3 x 200-220/346-380 V	545	F	87 44 40	87 44 32			8,9	8,9	8,9	
	60	3 x 200-230/346-400 V	810									
- 30	50	3 x 220-240/380-415 V	820	H	88 74 16	88 74 10			18,0	18,0	18,0	98 31 69
	50	3 x 200-220/346-380 V	800	F	87 44 41	87 44 33			6,2	6,2	6,2	
	60	3 x 200-230/346-400 V	1260									
- 40	50	3 x 220-240/380-415 V	965	H	88 74 16	88 74 10			18,0	18,0	18,0	98 31 69
	50	3 x 200-220/346-380 V	900	F	87 44 42	87 44 34			4,7	4,7	4,7	
	60	3 x 200-230/346-400 V	1525									
- 50	50	3 x 220-240/380-415 V	1320	F	88 59 05	88 56 18			6,12	6,12	6,12	98 31 69
- 60	50	3 x 220-240/380-415 V	1510	F	88 59 05	88 56 18			6,12	6,12	6,12	98 31 69

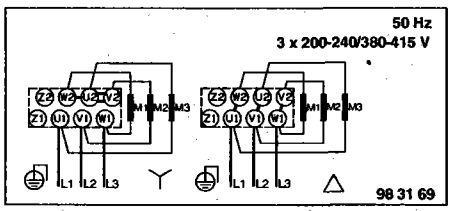
USA / CANADA

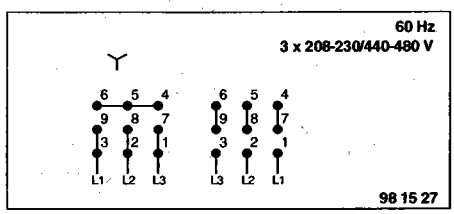
Viklingsmodstande Winding resistances Wicklungswiderstände												
Pumpetype Pump type Pumpentyp CH/CHN 4	Hz	Spænding Voltage Spannung	2) HP	Model Model Modell	Pos. 150	Stator Stator Stator	R (20°) ± 10%					Forbindelsesdiagram Wiring diagram Schaltbild
							R_A	R_M	R_{M1}	R_{M2}	R_{M3}	
- 20	60	3 x 208-230/440-480 V	0,5	K	88 24 73	88 79 85			4,2	4,2	4,2	98 15 27
		3 x 575 V			88 24 91	88 22 75			26,1	26,1	26,1	98 32 86
- 30	60	3 x 208-230/440-480 V	0,75	K	88 24 75	88 79 86			2,75	2,75	2,75	98 15 27
		3 x 575 V			88 24 93	88 22 76			17,0	17,0	17,0	98 32 86
- 40	60	3 x 208-230/440-480 V	1,0	K	88 24 77	88 75 20			1,82	1,82	1,82	98 15 27
		3 x 575 V			88 24 95	88 22 77			13,0	13,0	13,0	98 32 86
- 50	60	3 x 208-230/440-480 V	1,5	K	88 23 95	88 26 03			5,30	5,30	5,30	98 12 77
		3 x 575 V			88 24 97	88 22 78			8,95	8,95	8,95	98 32 86

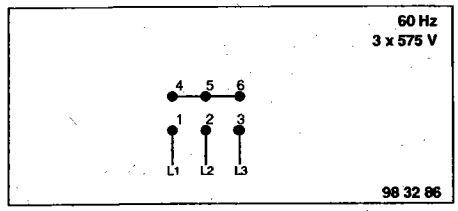
1) Optagen effekt.
Power input.
Leistungsaufnahme.

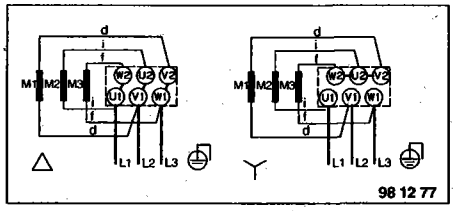
2) Mærkeeffekt.
Rated power.
Messungsleistung.

Forbindelsesdiagrammer
Wiring diagrams
Schaltbilder





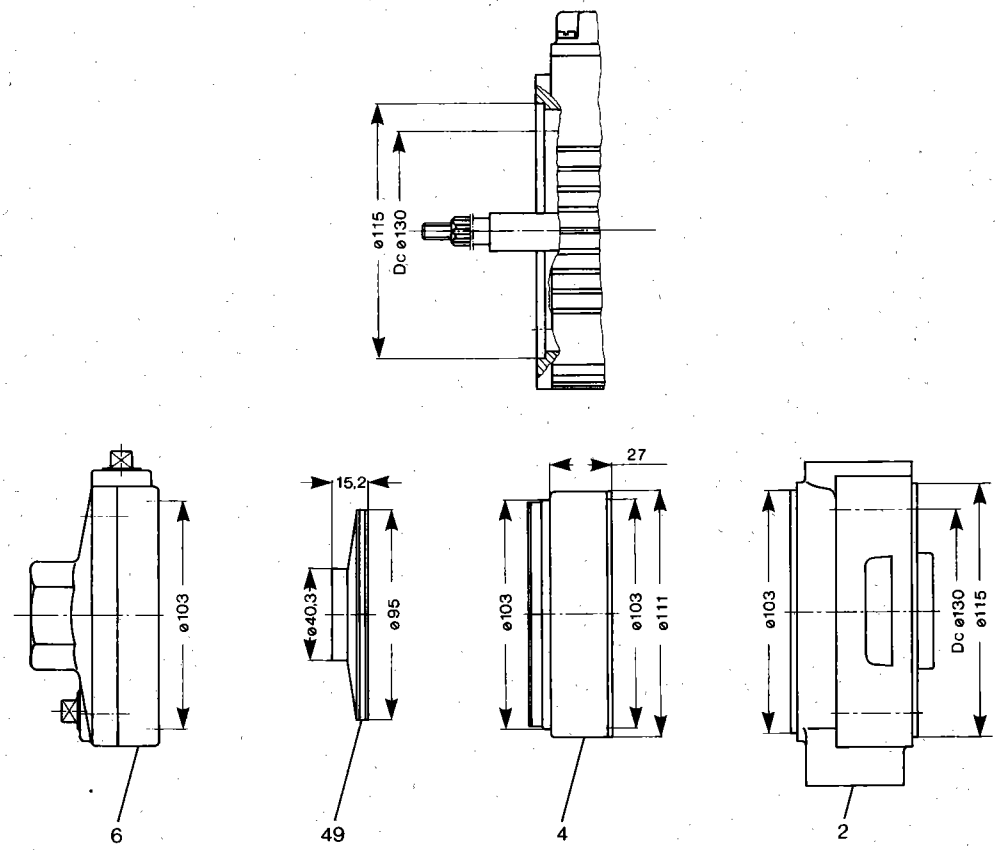




TM02 4271 0402

DK GB D	**Målskitser** **Dimensional sketches** **Maßskizzen**

Målskitser
Dimensional sketches
Maßskizzen

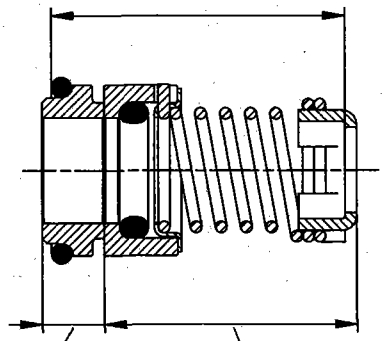


DK GB D	Akseltætninger Shaft seals Wellenabdichtungen	Snittegning Sectional drawing Schnittzeichnung	CH(N) 4

Akseltætninger, pos. 105
Shaft seals, pos. 105
Wellenabdichtungen, Pos. 105

CVBE
CVBV

CH(N) 4 = 37 mm

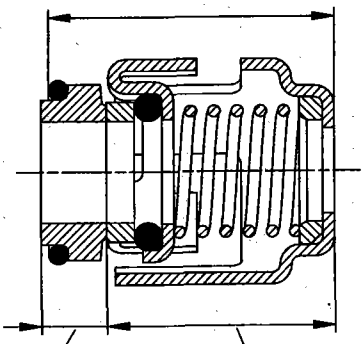


Stationær
Stationary
Stationäres

Roterende
Rotating
Rotierendes

AUUE
AUUV

CH(N) 4 = 37 mm

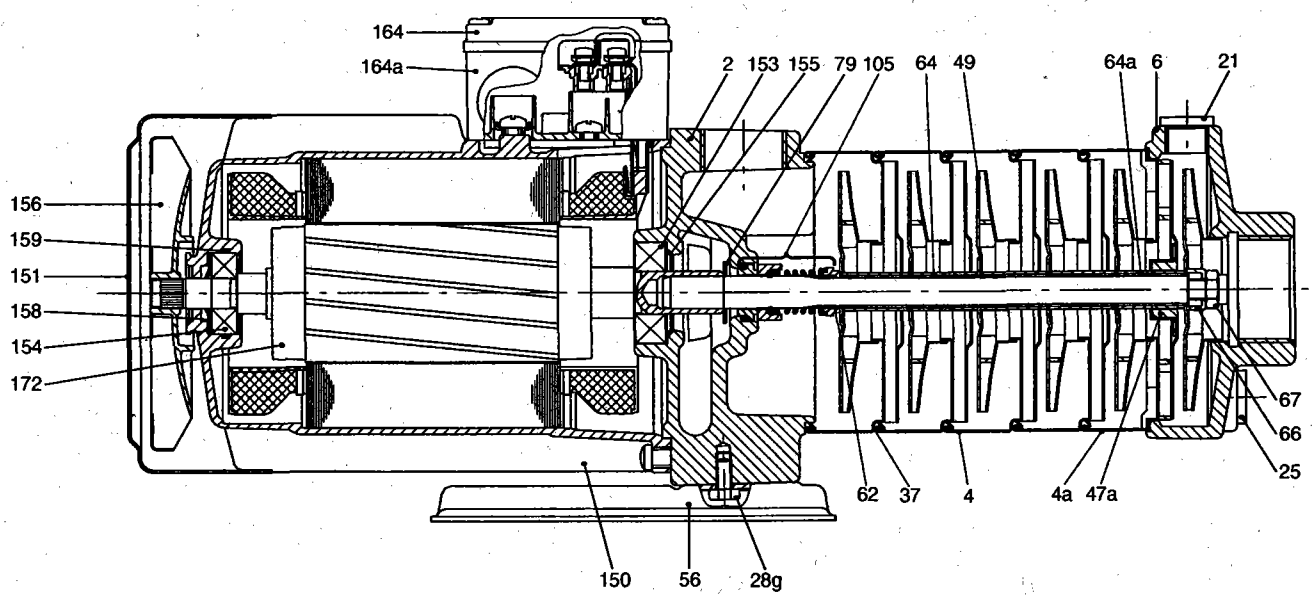


Stationær
Stationary
Stationäres

Roterende
Rotating
Rotierendes

TM02 4392 0902

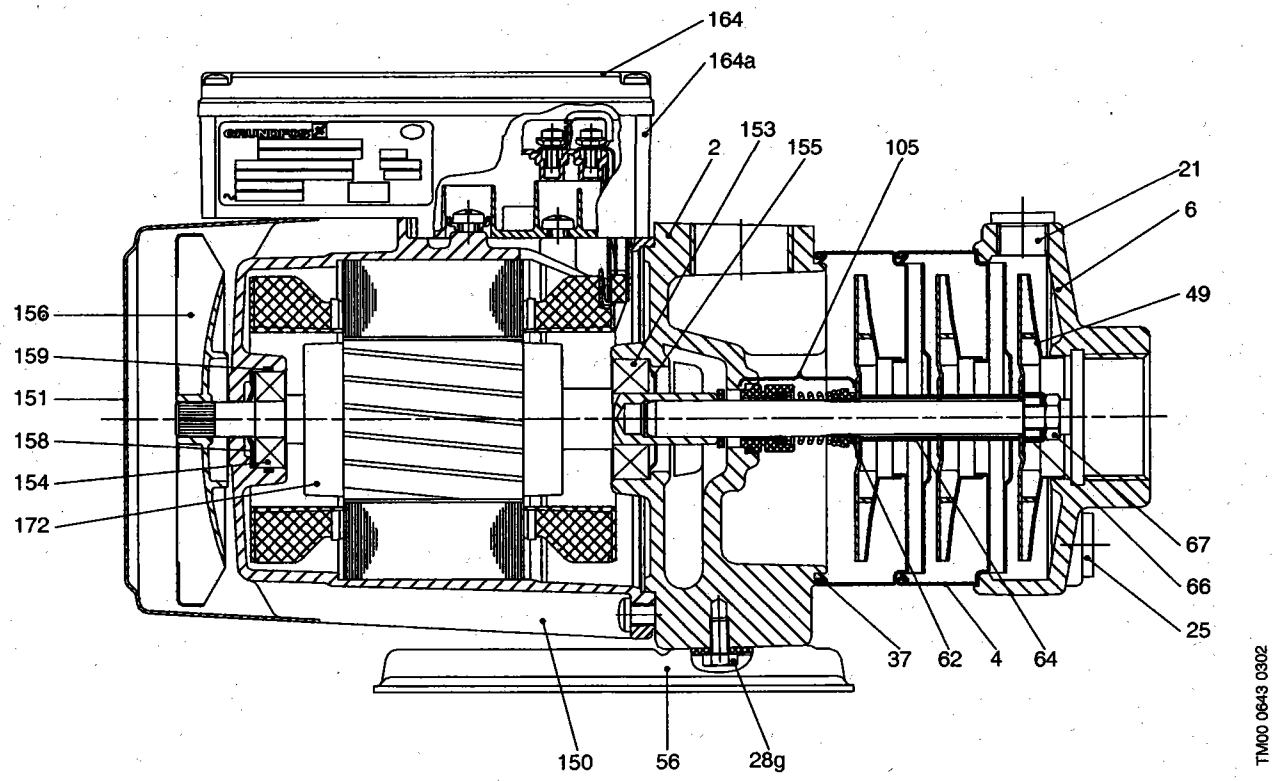
Snittegning
Sectional drawing
Schnittzeichnung



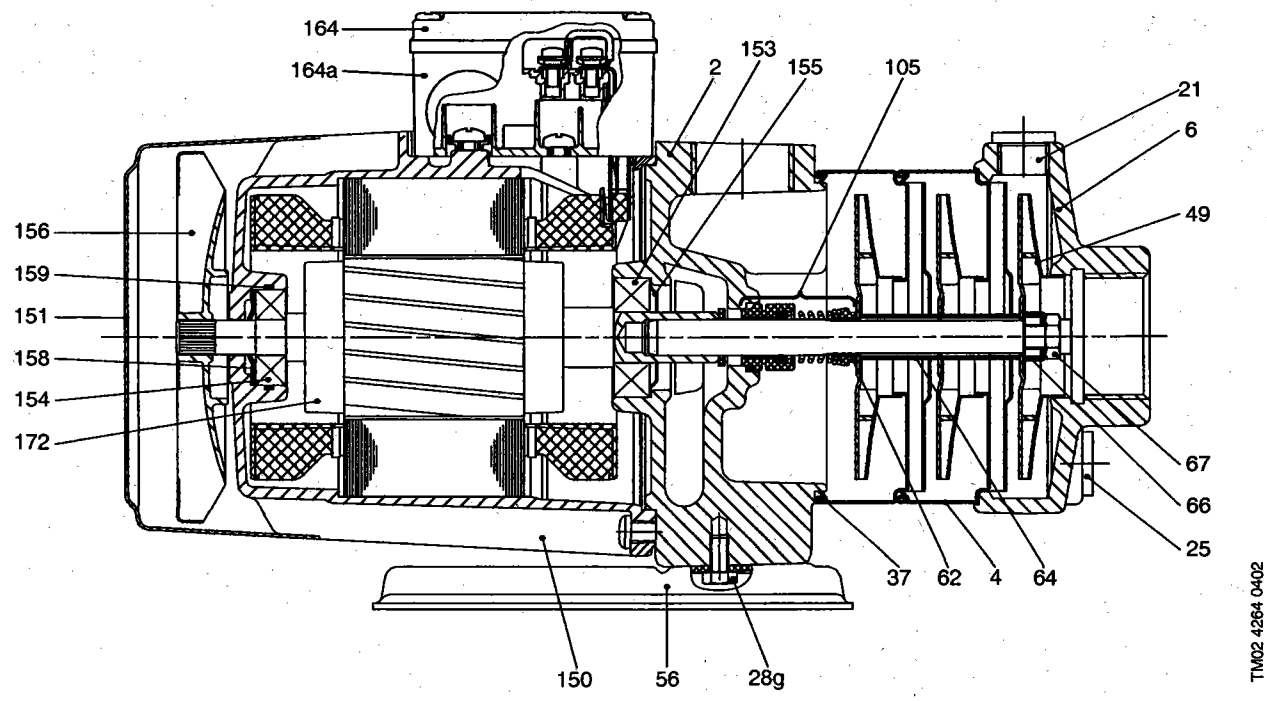
TM00 6609 4900

CH 4-60, model F.
CH 4-60, model F.
CH 4-60, Modell F.

DK GB D	**Snittegninger** **Sectional drawings** **Schnittzeichnungen**



CH(N) 4-30, model H og I
CH(N) 4-30, models H and I
CH(N) 4-30, Modell H und I

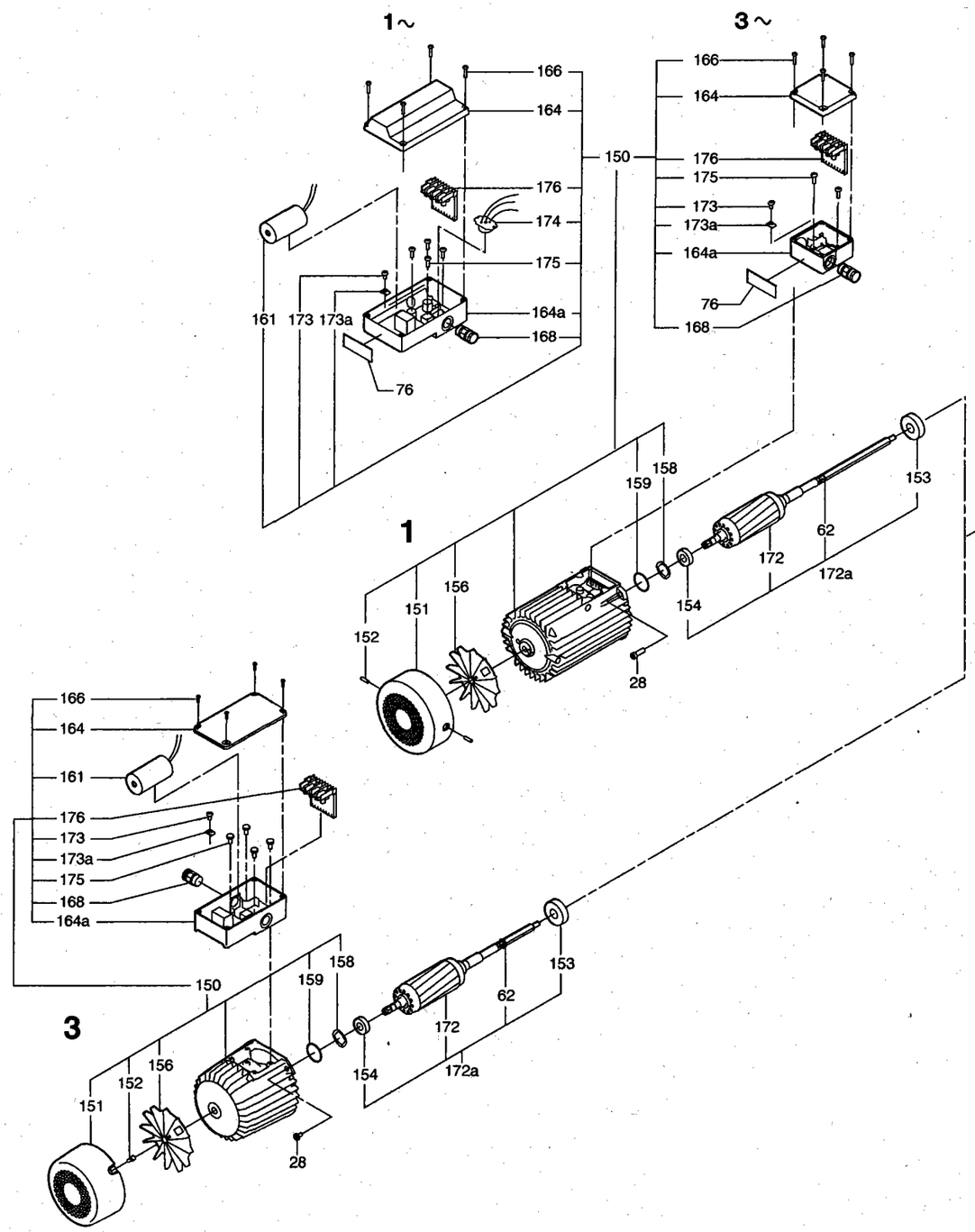


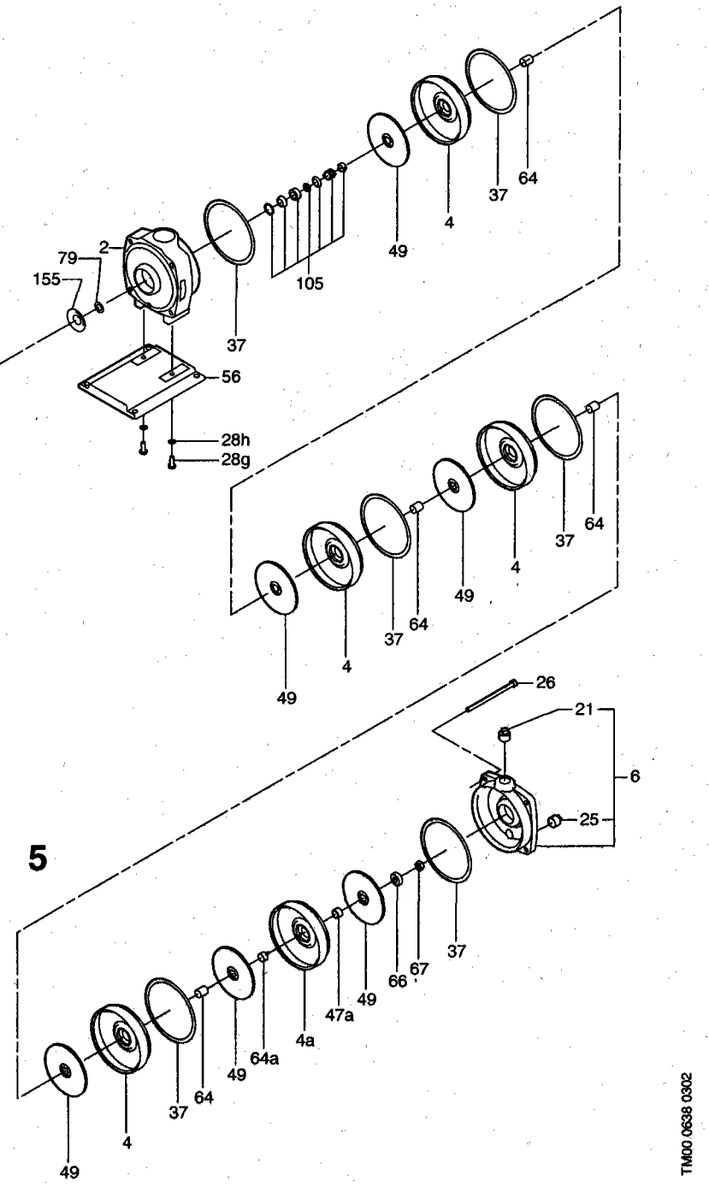
CH(N) 4-30, model K
CH(N) 4-30, model K
CH(N) 4-30, Modell K

DK GB D	Tegning til delliste / servicesæt Drawing for parts list / service kits Zeichnung für Teilliste / Servicesätze	CH(N) 4

DK GB D	Tegning til delliste / servicesæt Drawing for parts list / service kits Zeichnung für Teilliste / Servicesätze

Model Model Modell	Se fig. See fig. Siehe Abb.
F	1-5
H-I	3-5



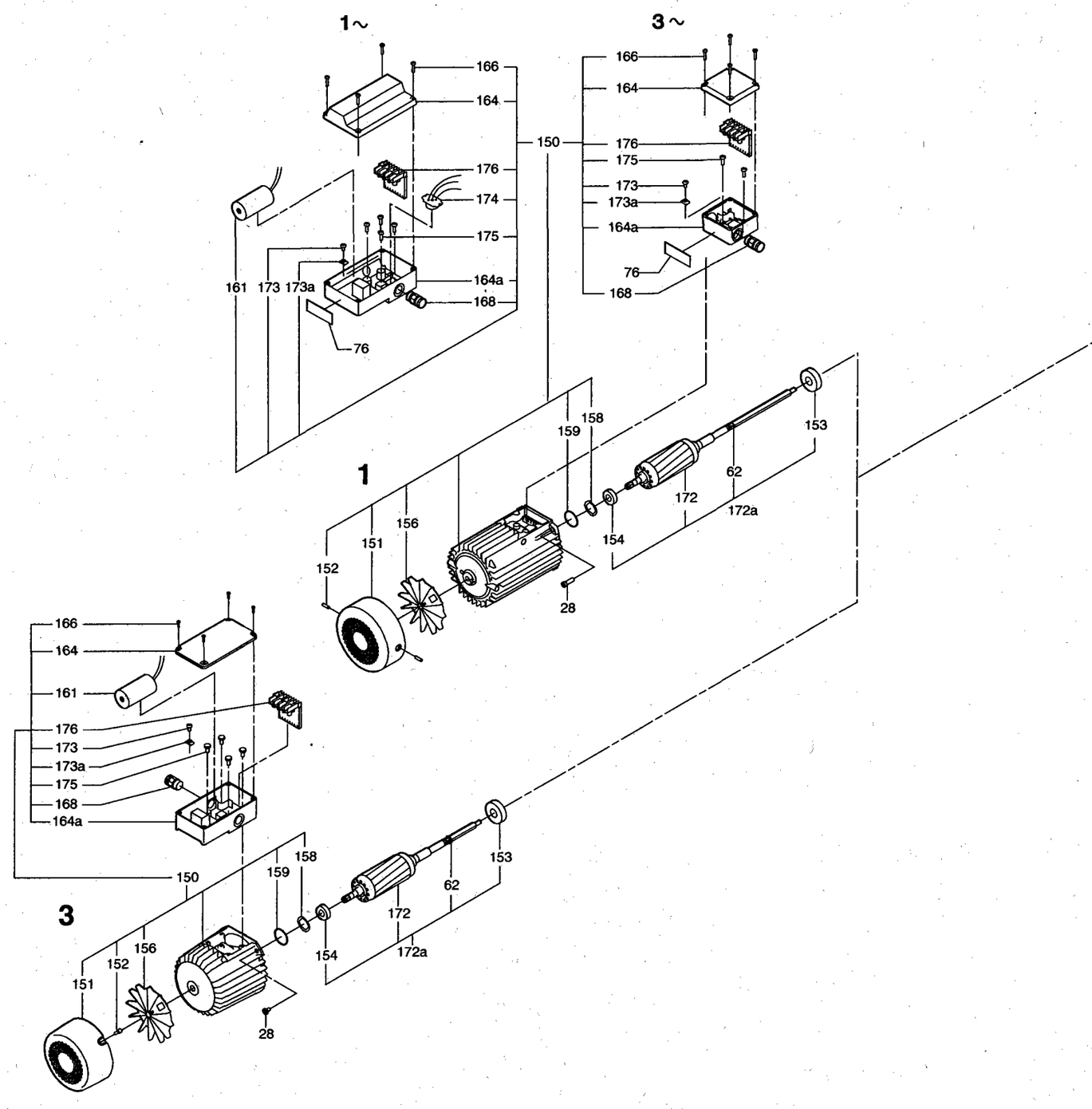


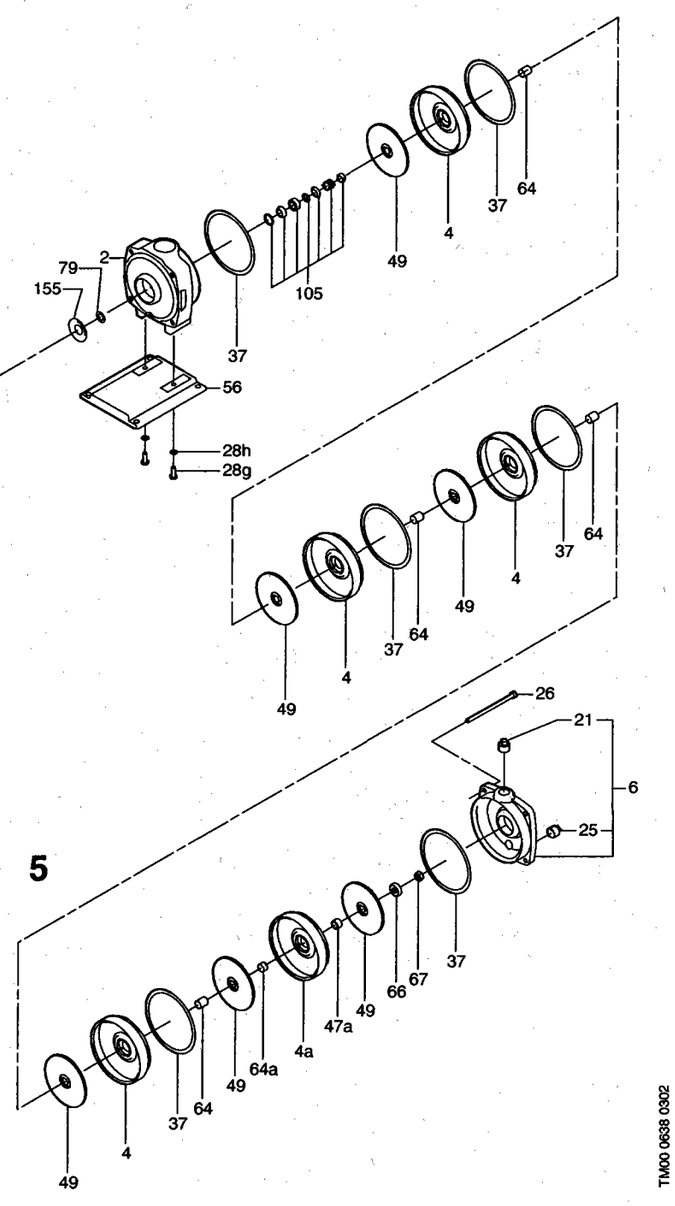
TM00 0638 0302

DK GB D	Tegning til demontering og montering Drawing for dismantling and assembly Zeichnung für Demontage und Montage	CH(N) 4

DK GB D	Tegning til demontering og montering Drawing for dismantling and assembly Zeichnung für Demontage und Montage

Model Model Modell	Se fig. See fig. Siehe Abb.
F	1-5
H-I	3-5





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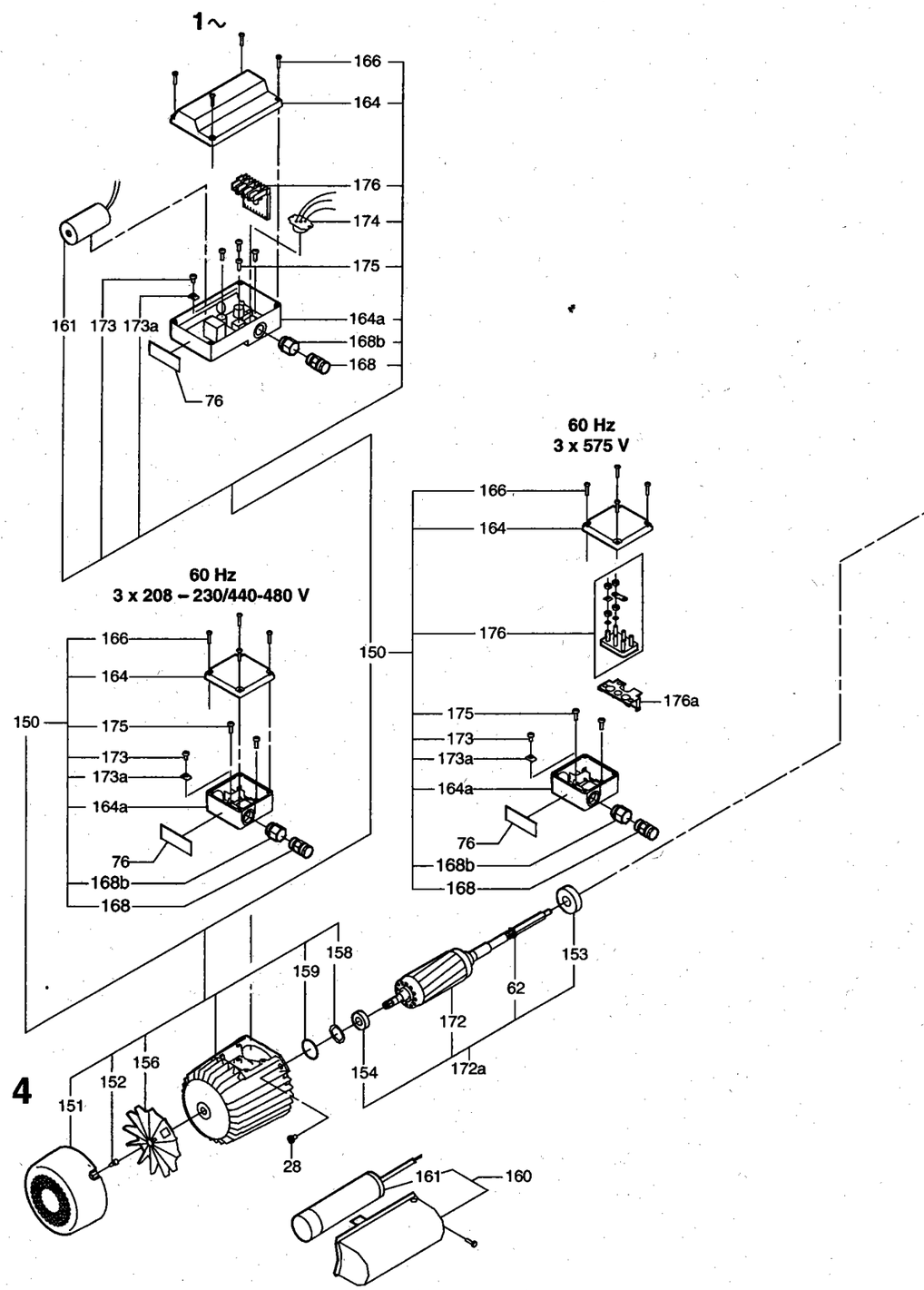
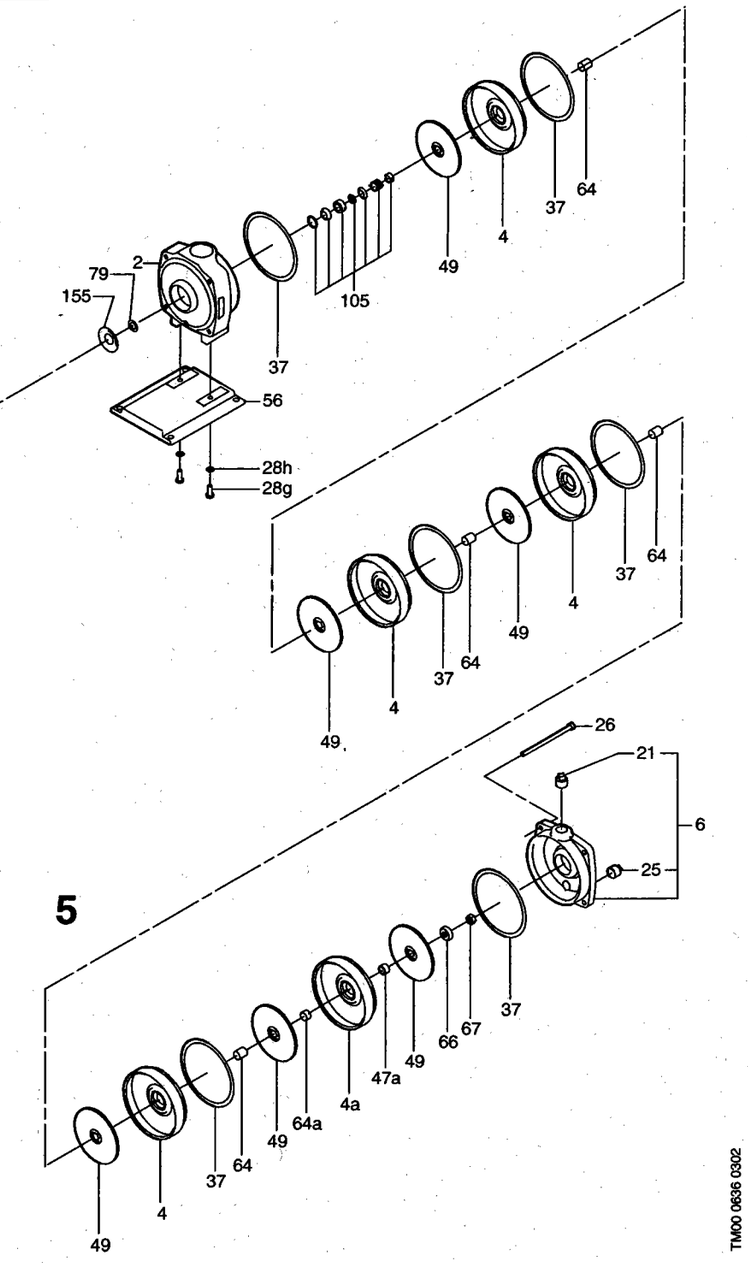
DK GB D	Tegning til delliste / servicesæt Drawing for parts list / service kits Zeichnung für Teilliste / Servicesätze	CH(N) 4



DK GB D	Tegning til delliste / servicesæt Drawing for parts list / service kits Zeichnung für Teilliste / Servicesätze

Model Model Modell	Se fig. See fig. Siehe Abb.
K	4-5



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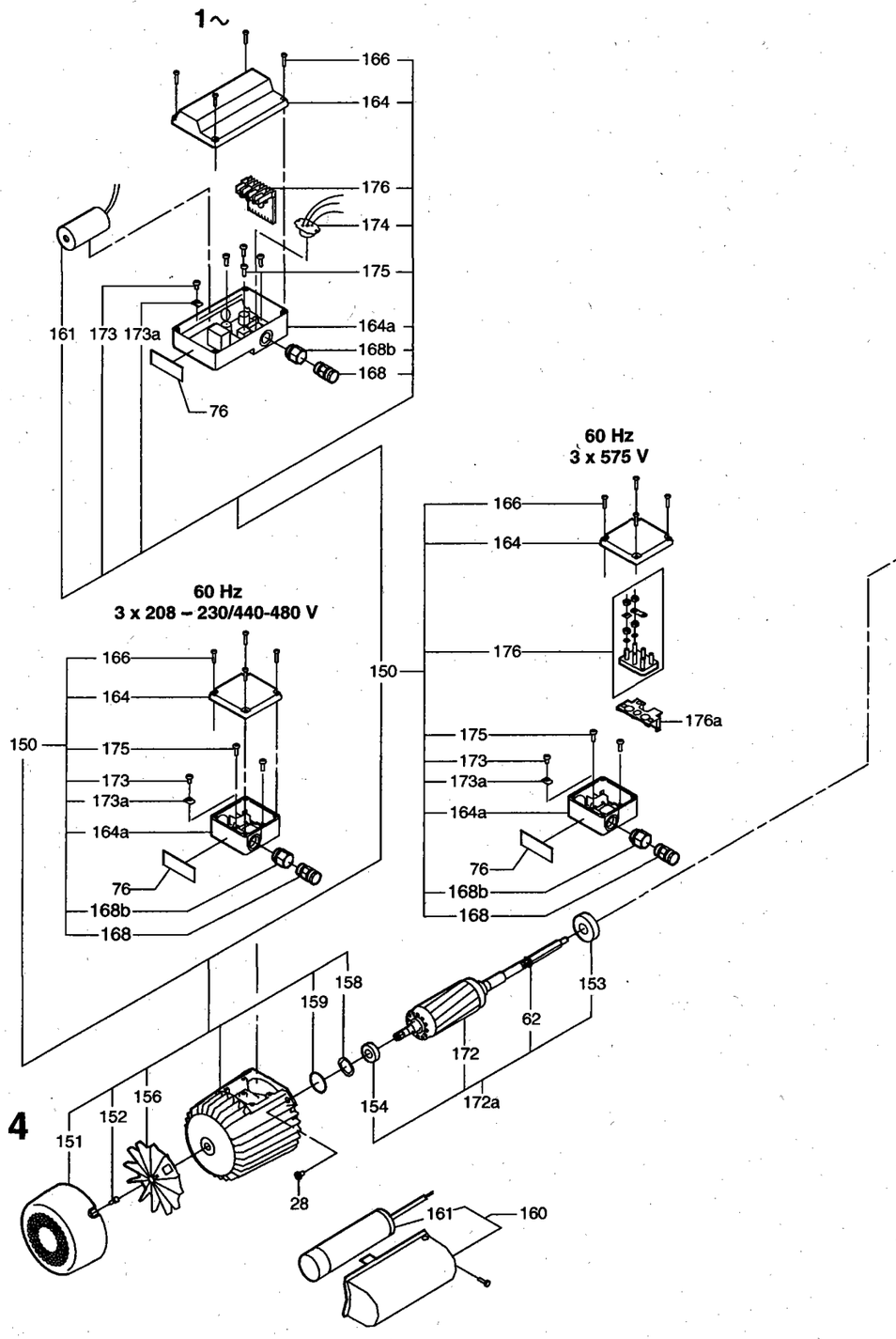
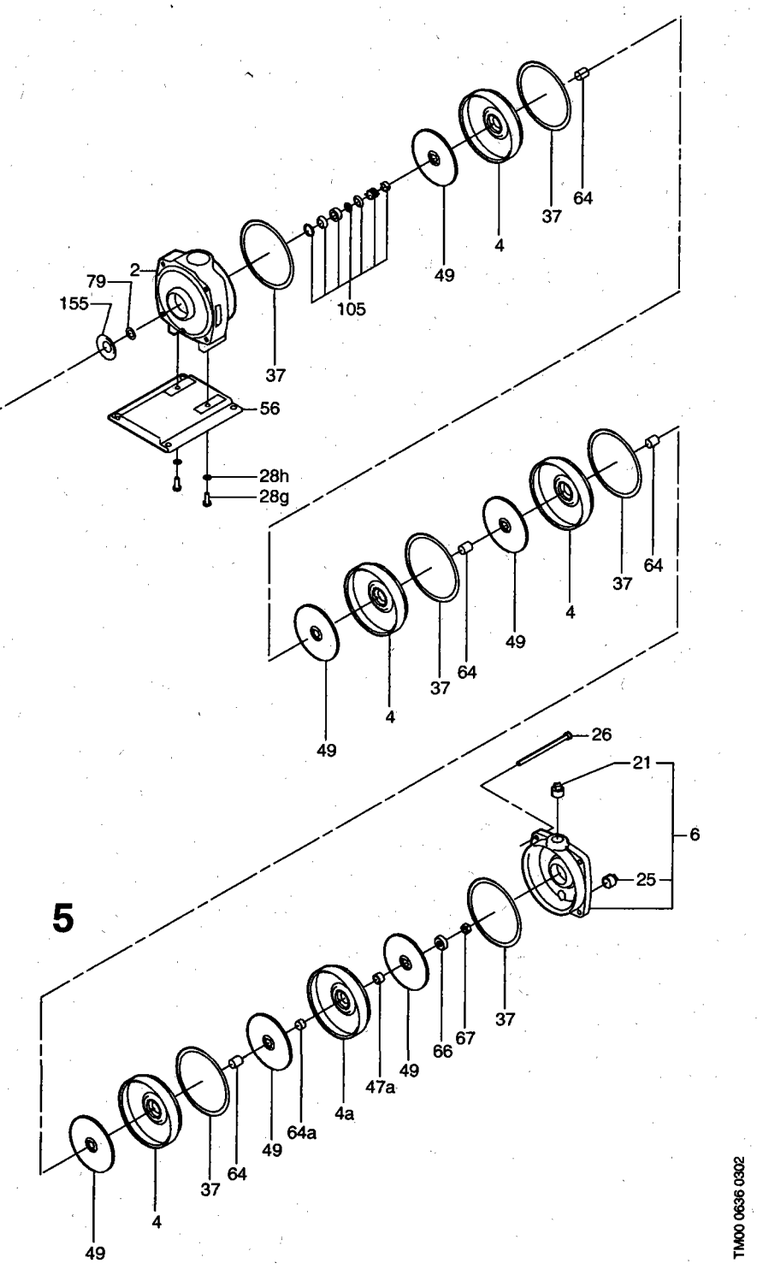
DK GB D	Tegning til demontering og montering Drawing for dismantling and assembly Zeichnung für Demontage und Montage	CH(N) 4



DK GB D	Tegning til demontering og montering Drawing for dismantling and assembly Zeichnung für Demontage und Montage

Model Model Modell	Se fig. See fig. Siehe Abb.
K	4-5



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Dansk

GRUNDFOS centrifugalpumpe, type CH 4, er en horisontal flertrinspumpe.

Bliver pumpen beskadiget eller tilstopper, så en demontering af pumpen er påkrævet, følges nedenstående anvisning.

Før demontering af pumpen påbegyndes, afbrydes strømtilførselen. Suge- og trykrør afmonteres.

Demontering og montering af el-førende dele foretages efter lokalt gældende regler.

Nedenstående positionsnumre, se "Tegning til demontering og montering" og "Serviceværktøj".

Henvisninger i " ", se indholdsfortegnelsen.

Demontering af pumpe

Støttebolte (unbrakoskruer), pos. 26, afmonteres, hvorefter endestykke, pos. 6, aftages. Sidder endestykket fast, løsnes det med et let slag på kanten. Ved at afmontere ventilatoren (se "Demontering af stator med hus") har man mulighed for at fastholde akselen, når møtrikken, pos. 67, løsnes (venstregevind). Møtrik, spændestykke (spændeskive), pos. 66, løber, pos. 49, kammer, pos. 4, og afstandsbøsning, pos. 64, aftages.

For CH 4-60 er rækkefølgen for demonteringen: Møtrik, pos. 67, spændestykke, pos. 66, løber, pos. 49, kammer med leje, pos. 4a, lejering, pos. 47a, og afstandsstykke, pos. 64a.

Sidder kammeret fast, løsnes det ved at presse en skruetrækker ned mellem kamrene og vippe det fri. *Vær opmærksom på, at kammeret ikke deformeres.*

Demontering fortsættes nu i nævnte rækkefølge indtil akseltætning, pos. 105: Løber, kammer og afstandsbøsning.

Tætningsringene i akseltætningen tåler ikke slag eller stød.

Den roterende del af akseltætningen trækkes fri af akselen.

Den stationære del af akseltætningen skal kun afmonteres, såfremt akseltætningen er utæt.

Er akseltætningen utæt, vippes stopringen, pos. 62, fri af recessen og trækkes af akselen. Stopringen kan ikke genanvendes.

Skruer, pos. 28, løsnes og aftages. Vær opmærksom på, at aksel med rotor ikke følger med topstykket, når dette trækkes fri af motoren.

NB: Lejeafdækning, pos. 155, og slyngskive, pos. 79, kan følge med topstykket. Er dette tilfældet, afmonteres de topstykket, før den stationære del af akseltætningen trykkes ud af topstykket fra motorsiden.

Pumpen er nu adskilt.

Spaltering, pos. 45

Er spalteringene slidt eller deformeret, udskiftes de ved at vippe holderen, pos. 65, op og fri af kammeret/endestykket med specialaftrækker, se "Serviceværktøj".

Demontering af stator med hus

El-kablet afmonteres klemkassen.

Skruer, pos. 152, løsnes og aftages sammen med ventilatorskærm, pos. 151.

Ventilator, pos. 156, vippes fri af akselen med to skruetrækkere ført ind under ventilatoren.

Skruer, pos. 28, løsnes og aftages.

Stator med hus løsnes med et let slag af en gummihammer og trækkes fri af pumpen.

Er kuglelejer eller aksel med rotor defekt, skal pumpen demonteres.

Montering

Før monteringen påbegyndes, skal alle dele være rengjorte og kontrollerede for eventuelle fejl/slitage. Dele, der ikke er fejlfrie, erstattes af nye.

Ved eftersyn bør følgende dele udskiftes: Møtrik for aksel, pakninger og diverse O-ringe.

Spaltering, pos. 45

Spalteringen placeres oven på holderen i kammeret/endestykket, hvorefter holderen, pos. 65, trykkes ned over spalteringen og i indgreb med kammeret/endestykket.

Spalteringen skal kunne bevæges frit (sideværts) mellem holderen og kammeret/endestykket.

Akseltætning, pos. 105

Ved monteringen skal tætningsringene i akseltætningen være fejlfrie og tætningsfladerne glatte og rene. *Tætningsringene må ikke udsættes for slag eller stød.*

Recessen i topstykket og O-ringen til den stationære del af akseltætningen fugtes med vand. Den stationære tætningsring inkl. O-ring trykkes i recessen på topstykket. O-ringen skal vende ind mod topstykket.

Kuglelejer, pos. 153 og 154, monteres på akselen. Type og placering, se "Delliste" og "Snittegning".

Montering af pumpe

Lejeafdækning, pos. 155, føres ned over akselen til anlæg mod kuglelejets yderste ring. Den buede side på lejeafdækningen skal vende væk fra kuglelejet, se "Tegning til demontering og montering". Slyngskive, pos. 79, trækkes ned over pumpeakselen til anlæg mod motorakselen.

Topstykke, pos. 2, med den stationære del af akseltætningen monteres og trykkes i bund på statorhusets reces. Kan topstykket ikke trykkes i bund, kontrolleres, om bølgefjeder, pos. 158, er placeret korrekt, se fig. 1.

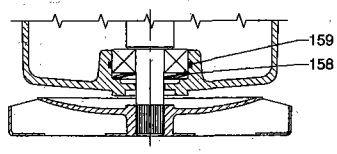

Fig. 1

Vær opmærksom på, at trykstudsen på topstykket og klemkassen på motoren vender i samme retning som før demonteringen.

Skruer, pos. 28, smøres med gevindpasta THREAD-EZE (delnummer, se "Tilspændingsmomenter"). Skruerne monteres og spændes diagonalt, se "Tilspændingsmomenter".

Ny stopring, pos. 62, føres ned over akselen og i indgreb med recessen på akselen.

Den roterende del af akseltætningen monteres, se "Akseltætninger" og "Tegning til demontering og montering". *Vær opmærksom på, at tætningsringene i akseltætningen, pos. 105, ikke tåler slag eller stød, og at gummidelene fugtes med vand.*

Kontrollér, at enderne af fjederen er i indgreb med slibesporet i tætningsringen og medbringertappen på afstandsstykket.

Monteringen fortsættes nu i nævnte rækkefølge til og med sidste løber: Pakning, pos. 37, løber, pos. 49, kammer, pos. 4, og afstandsbøsning, pos. 64.

For CH 4-60 fortsættes monteringen til og med næstsidste løber.

Derefter monteres: Afstandsstykke, pos. 64a, kammer med leje, pos. 4a, lejering, pos. 47a, og løber, pos. 49.

Vær opmærksom på, at den sidst monterede løber går i indgreb med splineakselen.

Gevindet på akselenden smøres med Gardolube (delnummer, se "Tilspændingsmomenter"), før spændestykke (spændeskive), pos. 66, og møtrik, pos. 67, monteres.

Ved at fastholde rotorakselen kan møtrikken fastspændes, se "Tilspændingsmomenter".

Husk pakning, pos. 37, mellem endestykke og kammer. Endestykke, pos. 6, monteres med spædeproppen, pos. 21, i samme retning som afgangsstudsen på topstykket.

Støttebolte (unbrakoskruer), pos. 26, smøres med gevindpasta THREAD-EZE (delnummer, se "Tilspændingsmomenter"), før de monteres og spændes diagonalt, se "Tilspændingsmomenter".

For ikke at beskadige kuglelejerne skal pumpeakselen understøttes gennem studsen på endestykket, når ventilatoren, pos. 156, drives i bund mod rotorakselen.

Kontrollér ved at dreje ventilatoren rundt, at pumpen går let og uhindret.

Ventilatorskærm, pos. 151, monteres på motoren og fastspændes med skruer, pos. 152.

El-kablet tilsluttes klemkassen.

Pumpen er nu færdigmonteret og klar til afprøvning efter følgende testspecifikationer:

CH 4: 96 46 87 25.
CH 4N: 96 46 87 29.

Montering af stator med hus

O-ring, pos. 159, trykkes ned i recessen på statoren, og bølgefjeder, pos. 158, monteres, se fig. 1.

Stator med hus, pos 150, placeres vertikalt med pumpetilslutningen opad.

Vær opmærksom på, at enden af rotorakselen kan passere frit gennem statorhuset, når pumpedelen med rotorakselen monteres i statorhuset.

Pumpen drejes således, at trykstuds og klemkasse er i samme position som før demonteringen.

Skruer, pos. 28, monteres og krydsspændes jævnt til angivne moment, se "Tilspændingsmomenter".

For ikke at beskadige kuglelejerne skal pumpeakselen understøttes gennem studsen på endestykket, når ventilatoren, pos. 156, drives i bund mod rotorakselen.

Kontrollér ved at dreje ventilatoren rundt, at pumpen går let og uhindret.

Ventilatorskærm, pos. 151, monteres på motoren og fastspændes med skruer, pos. 152.

El-kablet tilsluttes klemkassen.

Pumpen er nu færdigmonteret og klar til afprøvning efter følgende testspecifikationer:

CH 4: 96 46 87 25.
CH 4N: 96 46 87 29.

English

The GRUNDFOS centrifugal pump, type CH 4, is a horizontal multistage pump.

If it is necessary to dismantle the pump, either because it is choked or damaged, please follow the instructions below.

Before dismantling the pump, disconnect the electricity supply to the motor. Then remove the suction and discharge pipes.

The dismantling and assembly of electric parts should be carried out in accordance with local regulations.

Position numbers, see "Drawing for dismantling and assembly" and "Service tools".

References in " ", see table of contents.

Dismantling of pump

Remove the staybolts (hexagon socket head screws), pos. 26, and the suction chamber, pos. 6. If the suction chamber sticks, loosen it with a light blow on the edge. Remove the fan (see "Dismantling of stator with housing") and hold the shaft when the nut, pos. 67, is slackened (left-hand thread). Remove the nut, the clamp (washer), pos. 66, the impeller, pos. 49, the chamber, pos. 4, and the spacing pipe, pos. 64.

In the case of CH 4-60, continue the dismantling in the following order: Nut, pos. 67, clamp, pos. 66, impeller, pos. 49, chamber with bearing, pos. 4a, bearing ring, pos. 47a, and spacer, pos. 64a.

If the chamber sticks, loosen it by inserting a screwdriver between the chambers and turning it. *Take care not to deform the chamber.*

Then remove the parts in the following order up to the shaft seal, pos. 105: Impeller, chamber and spacing pipe.

Do not expose the shaft seal rings to blows or knocks.

Pull the rotating shaft seal part off the shaft.

The stationary shaft seal part should only be removed if the shaft seal leaks.

If the shaft seal leaks, push the stop ring, pos. 62, free of the recess and pull it off the shaft. The stop ring cannot be reused.

Slacken and remove the screws, pos. 28. Take care not to remove the shaft with rotor together with the pump head when this is removed from the motor.

Note: The bearing cover plate, pos. 155, and the diverting disc, pos. 79, may stick to the pump head. If this is the case, remove the stationary shaft seal part from the motor side.

The pump is now dismantled.

Neck ring, pos. 45

If the neck rings are worn, they must be replaced. Push the retainer, pos. 65, free of the chamber/suction chamber by means of a special puller, see "Service tools". Remove the neck ring.

Dismantling of stator with housing

Remove the electric cable from the terminal box.

Slacken and remove the screws, pos. 152, together with the fan cover, pos. 151.

Remove the fan, pos. 156, from the shaft by means of two screwdrivers.

Slacken and remove the screws, pos. 28.

Loosen the stator with housing with a light blow of a rubber mallet and pull it off the pump.

If the ball bearings or the shaft with rotor is defective, the pump must be dismantled.

Assembly

Before assembly, clean and check all parts and replace possible defective parts.

The following parts should always be replaced when the pump is overhauled: Nut for shaft, gaskets and all O-rings.

Neck ring, pos. 45

Position the neck ring on the retainer in the chamber/suction chamber. Then press the retainer, pos. 65, over the neck ring so that it engages with the chamber/suction chamber.

It must be possible to move the neck ring freely (sideways) between the retainer and the chamber/suction chamber.

Shaft seal, pos. 105

The seal rings must be intact, and the seal faces must be smooth and clean. *Do not expose the seal rings to blows or knocks.*

Moisten the recess of the pump head and the O-ring for the stationary shaft seal part with water. Press the stationary seal ring with O-ring home in the recess of the pump head. The O-ring must point towards the pump head.

Fit the ball bearings, pos. 153 and 154, to the shaft. For type and position, see "Parts list" and "Sectional drawing".

Assembly of pump

Fit the bearing cover plate, pos. 155, to the shaft so that it touches the outer ring of the ball bearing. The curved side of the bearing cover plate must point away from the ball bearing, see "Drawing for dismantling and assembly". Fit the diverting disc, pos. 79, to the pump shaft and push it until it touches the motor shaft.

Fit the pump head, pos. 2, with the stationary shaft seal part and press it home on the recess of the stator housing. If it is not possible to press home the pump head, check whether the corrugated spring, pos. 158, is positioned correctly, see fig. 1.

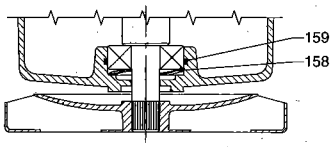

Fig. 1

Make sure that the discharge port of the pump head and the terminal box on the motor point in the same direction as before dismantling.

Lubricate the screws, pos. 28, with thread paste THREAD-EZE (part number, see "Torques"). Fit the screws and tighten diagonally, see "Torques".

Fit a new stop ring, pos. 62, to the shaft so that it engages with the recess of the shaft.

Fit the rotating shaft seal part, see "Shaft seals" and "Drawing for dismantling and assembly". *Do not expose the seal rings, pos. 105, to blows or knocks. Moisten the rubber parts with water.*

Check that the ends of the spring engage with the ground groove in the seal ring and the driving dog of the spacer.

Continue the assembly in the order mentioned until the last impeller has been fitted: Gasket, pos. 37, impeller, pos. 49, chamber, pos. 4, and spacing pipe, pos. 64.

In the case of CH 4-60, continue the assembly up to the last impeller but one.

Then fit the spacer, pos. 64a, the chamber with bearing, pos. 4a, the bearing ring, pos. 47a, and the impeller, pos. 49.

Make sure that the last impeller engages with the spline shaft.

Lubricate the threaded shaft end with Gardolube (part number, see "Torques") before the clamp (washer), pos. 66, and the nut, pos. 67, are fitted.

Hold the rotor shaft and tighten the nut, see "Torques".

Do not forget the gasket, pos. 37, between the suction chamber and the chamber. Fit the suction chamber, pos. 6, with the priming plug, pos. 21, in the same direction as the discharge port of the pump head.

Lubricate the staybolts (hexagon socket head screws), pos. 26, with thread paste THREAD-EZE (part number, see "Torques") before they are fitted and tightened diagonally, see "Torques".

In order not to damage the ball bearings, the pump shaft should be supported through the port of the suction chamber when the fan, pos. 156, is driven home against the rotor shaft.

Check the pump by turning the fan.

Fit the fan cover, pos. 151, to the motor and fit and tighten the screws, pos. 152.

Connect the electric cable to the terminal box.

The pump is now assembled, and it can be tested according to the following test specifications:

CH 4: 96 46 87 25.
CH 4N: 96 46 87 29.

Assembly of stator with housing

Press the O-ring, pos. 159, into the recess of the stator, and fit the corrugated spring, pos. 158, see fig. 1.

Stand the stator with housing, pos. 150, upright with the pump connection uppermost.

The end of the rotor shaft must be able to pass freely through the stator housing when the pump with rotor shaft is fitted in the stator housing.

Turn the pump so that the discharge port and the terminal box are in the same position as before dismantling.

Fit and tighten the screws, pos. 28, diagonally to the torque stated, see "Torques".

In order not to damage the ball bearings, the pump shaft should be supported through the port of the suction chamber when the fan, pos. 156, is driven home against the rotor shaft.

Check the pump by turning the fan.

Fit the fan cover, pos. 151, to the motor and fit and tighten the screws, pos. 152.

Connect the electric cable to the terminal box.

The pump is now assembled, and it can be tested according to the following test specifications:

CH 4: 96 46 87 25.
CH 4N: 96 46 87 29.

Deutsch

Die GRUNDFOS Kreiselpumpe, Typ CH 4, ist eine horizontale mehrstufige Pumpe.

Ist Demontage der Pumpe entweder infolge Verstopfung oder infolge Beschädigung notwendig, bitte die nachstehenden Anweisungen befolgen.

Vor der Demontage der Pumpe die Versorgungsspannung abschalten. Saug- und Druckrohr demontieren.

Die Demontage und Montage der elektrischen Teile müssen in Übereinstimmung mit den örtlichen Vorschriften des VDE bzw. EVU vorgenommen werden.

Positionsnummern, siehe "Zeichnung für Demontage und Montage" und "Servicewerkzeuge".

Hinweise in " ", siehe Inhaltsverzeichnis.

Demontage der Pumpe

Stehbolzen (Innensechskantschrauben), Pos. 26, demontieren und Sauggehäuse, Pos. 6, abziehen. Falls das Sauggehäuse festsitzt, wird dieses durch einen leichten Schlag auf die Kante gelöst. Lüfter demontieren (siehe "Demontage des Stators mit Gehäuse") und beim Lösen der Mutter, Pos. 67 (Linksgewinde), die Welle festhalten. Mutter, Spannstück (Unterlegscheibe), Pos. 66, Laufrad, Pos. 49, Kammer, Pos. 4, und Distanzhülse, Pos. 64, abnehmen.

Bei CH 4-60 ist die Reihenfolge der Demontage: Mutter, Pos. 67, Spannstück, Pos. 66, Laufrad, Pos. 49, Kammer mit Lager, Pos. 4a, Lagerring, Pos. 47a, und Distanzstück, Pos. 64a.

Falls die Kammer festsitzt, ist sie mit einem Schraubendreher zu lösen, der zwischen die Kammern eingeführt wird. *Es ist darauf zu achten, daß die Kammer nicht verformt wird.*

Weitere Demontage bis zur Wellenabdichtung, Pos. 105, in der erwähnten Reihenfolge vornehmen: Laufrad, Kammer und Distanzhülse.

Die Dichtungsringe der Wellenabdichtung vertragen keine Schläge oder Stöße.

Das rotierende Wellenabdichtungsteil von der Welle abziehen.

Das stationäre Wellenabdichtungsteil ist nur zu demontieren, falls die Wellenabdichtung undicht ist.

Falls die Wellenabdichtung undicht ist, den Stopring, Pos. 62, vom Rezeß abhebeln und von der Welle abziehen. Der Stopring kann nicht wiederverwendet werden.

Schrauben, Pos. 28, lösen und abnehmen. Es ist darauf zu achten, daß die Welle mit Rotor mit dem Kopfstück nicht abgezogen wird.

Achtung: Die Lagerabdeckung, Pos. 155, und die Schleuderscheibe, Pos. 79, können am Kopfstück hängen. In diesem Falle werden diese Teile vom Kopfstück entfernt, bevor das stationäre Wellenabdichtungsteil von der Motorseite her, aus dem Kopfstück gedrückt wird.

Die Pumpe ist jetzt demontiert.

Spaltring, Pos. 45

Bei eventuellem Verschleiß müssen die Spaltringe ausgewechselt werden. Halter, Pos. 65, von der Kammer/dem Sauggehäuse mit einem Spezialauszieher aushebeln, siehe "Servicewerkzeuge". Spaltring entfernen.

Demontage des Stators mit Gehäuse

Das elektrische Kabel vom Klemmenkasten entfernen.

Schrauben, Pos. 152, lösen und mit der Lüfterabdeckung, Pos. 151, abnehmen.

Lüfter, Pos. 156, mit zwei Schraubendrehern von der Welle abhebeln. Die beiden Schraubendreher unter den Lüfter einführen.

Schrauben, Pos. 28, lösen und abnehmen.

Stator mit Gehäuse durch einen leichten Schlag mit einem Gummihammer lösen und von der Pumpe freiziehen.

Falls die Kugellager oder die Welle mit Rotor defekt ist, muß die Pumpe demontiert werden.

Montage

Vor der Montage alle Teile reinigen, kontrollieren und evtl. defekte Teile gegen neue auswechseln.

Bei Überholung der Pumpe sollten die folgenden Teile immer ausgewechselt werden: Mutter für Welle, Dichtungen und alle O-Ringe.

Spaltring, Pos. 45

Spaltring auf dem Halter in der Kammer/dem Sauggehäuse anbringen und den Halter, Pos. 65, so über den Spaltring drücken, daß er in die Kammer/das Sauggehäuse einrastet.

Der Spaltring muß frei (seitwärts) zwischen dem Halter und der Kammer/dem Sauggehäuse bewegt werden können.

Wellenabdichtung, Pos. 105

Bei der Montage müssen die Dichtungsringe intakt und die Flächen glatt und sauber sein. *Die Dichtungsringe vertragen keine Schläge oder Stöße.*

Den Rezeß des Kopfstückes und den O-Ring für das stationäre Wellenabdichtungsteil mit Wasser anfeuchten. Den stationären Dichtungsring mit O-Ring in den Rezeß des Kopfstückes drücken. Der O-Ring muß zum Kopfstück zeigen.

Kugellager, Pos. 153 und 154, auf die Welle montieren. Typ und Stellung, siehe "Teilliste" und "Schnittzeichnung".

Montage der Pumpe

Lagerabdeckung, Pos. 155, auf die Welle stecken und bis zum Anschlag gegen den äußeren Ring des Kugellagers drücken. Die gebogene Seite der Lagerabdeckung muß vom Kugellager abgewandt sein, siehe "Zeichnung für Demontage und Montage". Schleuderscheibe, Pos. 79, auf die Pumpenwelle stecken und bis zum Anschlag gegen die Motorwelle drücken.

Kopfstück, Pos. 2, mit dem stationären Wellenabdichtungsteil aufsetzen und gegen den Rezeß des Statorgehäuses drücken. Falls das Kopfstück nicht korrekt nach unten gedrückt werden kann, prüfen, ob die gewellte Feder, Pos. 158, korrekt montiert ist, siehe Abb. 1.

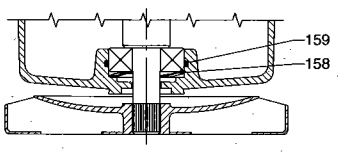

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Abb. 1

Es ist darauf zu achten, daß der Druckstutzen des Kopfstückes und der Klemmenkasten des Motors in derselben Richtung wie vor der Demontage angebracht werden.

Schrauben, Pos. 28, mit Gewindepaste THREAD-EZE (Teilnummer, siehe "Anzugsmomente") bestreichen. Schrauben einsetzen und kreuzweise anziehen, siehe "Anzugsmomente".

Einen neuen Stopring, Pos. 62, auf die Welle setzen und mit dem Rezeß der Welle in Eingriff bringen.

Das rotierende Wellenabdichtungsteil montieren, siehe "Wellenabdichtungen" und "Zeichnung für Demontage und Montage". *Die Dichtungsringe der Wellenabdichtung, Pos. 105, vertragen keine Schläge oder Stöße. Gummiteile mit Wasser anfeuchten.*

Prüfen, daß die Federenden in die geschliffene Vertiefung des Dichtungsringes und in den Mitnehmerzapfen des Zwischenstükkes einrasten.

Die Montage bis einschließlich des letzten Laufrades fortsetzen: Dichtung, Pos. 37, Laufrad, Pos. 49, Kammer, Pos. 4, und Distanzhülse, Pos. 64.

Bei CH 4-60 die Montage bis einschließlich des zweitletzten Laufrades fortsetzen.

Danach Distanzstück, Pos. 64a, Kammer mit Lager, Pos. 4a, Lagerring, pos. 47a, und Laufrad, Pos. 49, montieren.

Prüfen, daß das letzte Laufrad in die Vielnutwelle eingreift.

Das Gewinde des Wellenzapfens mit Gardolube (Teilnummer, siehe "Anzugsmomente") bestreichen, bevor das Spannstück (Unterlegscheibe), Pos. 66, und die Mutter, Pos. 67, montiert werden.

Rotorwelle beim Anziehen der Mutter festhalten, siehe "Anzugsmomente".

Vergessen Sie nicht, die Dichtung, Pos. 37, zwischen Sauggehäuse und Kammer zu montieren. Sauggehäuse, Pos. 6, mit dem Einfüllstopfen, Pos. 21, in die gleiche Richtung wie den Druckstutzen des Kopfstückes montieren.

Stehbolzen (Innensechskantschrauben), Pos. 26, mit Gewindepaste THREAD-EZE (Teilnummer, siehe "Anzugsmomente") bestreichen, bevor sie montiert und kreuzweise angezogen werden, siehe "Anzugsmomente".

Um die Kugellager nicht zu beschädigen, die Pumpenwelle durch den Stutzen des Sauggehäuses abstützen, wenn der Lüfter, Pos. 156, gegen die Rotorwelle getrieben wird.

Pumpe durch Drehen des Lüfters prüfen.

Lüfterabdeckung, Pos. 151, auf den Motor montieren und mit den Schrauben, Pos. 152, befestigen.

Das elektrische Kabel an den Klemmenkasten anschließen.

Die Pumpe ist jetzt wieder zusammengebaut und kann nach der folgenden Testspezifikation geprüft werden:

CH 4: 96 46 87 25.
CH 4N: 96 46 87 29.

Montage des Stators mit Gehäuse

O-Ring, Pos. 159, in den Rezeß des Stators drücken, und die gewellte Feder, Pos. 158, montieren, siehe Abb. 1.

Stator mit Gehäuse, Pos. 150, senkrecht mit dem Pumpenanschluß nach oben stellen.

Es ist darauf zu achten, daß die Rotorwelle frei durch das Statorgehäuse passieren kann, wenn die Pumpe mit Rotorwelle in das Statorgehäuse montiert wird.

Pumpe so drehen, daß der Druckstutzen und der Klemmenkasten in dieselbe Richtung wie vor der Demontage angebracht werden.

Schrauben, Pos. 28, einsetzen und kreuzweise bis zum angegebenen Moment anziehen, siehe "Anzugsmomente".

Um die Kugellager nicht zu beschädigen, die Pumpenwelle durch den Stutzen des Endstücks abstützen, wenn der Lüfter, Pos. 156, gegen die Rotorwelle getrieben wird.

Pumpe durch Drehen des Lüfters prüfen.

Lüfterabdeckung, Pos. 151, auf den Motor montieren und mit den Schrauben, Pos. 152, befestigen.

Das elektrische Kabel an den Klemmenkasten anschließen.

Die Pumpe ist jetzt wieder zusammengebaut und kann nach der folgenden Testspezifikation geprüft werden:

CH 4: 96 46 87 25.
CH 4N: 96 46 87 29.

Ret til ændringer forbeholdes.

Subject to alterations.

Technische Änderungen vorbehalten.

Ret til ændringer forbeholdes.
Subject to alterations.
Technische Änderungen vorbehalten.

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GRUNDFOS®

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CH, CHN

(GB) **Installation and operating instructions**
(D) **Montage- und Betriebsanleitung**
(F) **Notice d'installation et d'entretien**
(I) **Istruzioni di installazione e funzionamento**
(E) **Instrucciones de instalación y funcionamiento**
(P) **Instruções de instalação e funcionamento**
(GR) **Οδηγίες εγκατάστασης και λειτουργίας**
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(S) **Monterings- och driftsinstruktion**
(SF) **Asennus- ja käyttöohjeet**
(DK) **Monterings- og driftsinstruktion**

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GRUNDFOS®

Declaration of Conformity

We **GRUNDFOS** declare under our sole responsibility that the products **CH** and **CHN** to which this declaration relates, are in conformity with the Council Directives on the approximation of the laws of the EEC Member States relating to

- Machinery (89/392/EEC).
  Standard used: EN 292.
- Electromagnetic compatibility (89/336/EEC).
  Standards used: EN 50 081-1 and EN 50 082-2.
- Electrical equipment designed for use within certain voltage limits (73/23/EEC).
  Standards used: EN 60 335-1 and EN 60 335-2-51.

Konformitätserklärung

Wir **GRUNDFOS** erklären in alleiniger Verantwortung, daß die Produkte **CH** und **CHN**, auf die sich diese Erklärung bezieht, mit den folgenden Richtlinien des Rates zur Angleichung der Rechtsvorschriften der EG-Mitgliedstaaten übereinstimmen:

- Maschinen (89/392/EWG).
  Norm, die verwendet wurde: EN 292.
- Elektromagnetische Verträglichkeit (89/336/EWG).
  Normen, die verwendet wurden: EN 50 081-1 und EN 50 082-2.
- Elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen (73/23/EWG).
  Normen, die verwendet wurden: EN 60 335-1 und EN 60 335-2-51.

Déclaration de Conformité

Nous **GRUNDFOS** déclarons sous notre seule responsabilité que les produits **CH** et **CHN** auxquels se réfère cette déclaration sont conformes aux Directives du Conseil concernant le rapprochement des législations des Etats membres CEE relatives à

- Machines (89/392/CEE).
  Standard utilisé: EN 292.
- Compatibilité électromagnétique (89/336/CEE).
  Standards utilisés: EN 50 081-1 et EN 50 082-2.
- Matériel électrique destiné à employer dans certaines limites de tension (73/23/CEE).
  Standards utilisés: EN 60 335-1 et EN 60 335-2-51.

Dichiarazione di Conformità

Noi **GRUNDFOS** dichiariamo sotto la nostra esclusiva responsabilità che i prodotti **CH** e **CHN** ai quali questa dichiarazione si riferisce sono conformi alle Direttive del Consiglio concernente il ravvicinamento delle legislazioni degli Stati membri CEE relative a

- Macchine (89/392/CEE).
  Standard usato: EN 292.
- Compatibilità elettromagnetica (89/336/CEE).
  Standard usati: EN 50 081-1 e EN 50 082-2.
- Materiale elettrico destinato ad essere utilizzato entro certi limiti di tensione (73/23/CEE).
  Standard usati: EN 60 335-1 e EN 60 335-2-51.

Declaración de Conformidad

Nosotros **GRUNDFOS** declaramos bajo nuestra única responsabilidad que los productos **CH** y **CHN** a los cuales se refiere esta declaración son conformes con las Directivas del Consejo relativas a la aproximación de las legislaciones de los Estados Miembros de la CEE sobre

- Máquinas (89/392/CEE).
  Norma aplicada: EN 292.
- Compatibilidad electromagnética (89/336/CEE).
  Normas aplicadas: EN 50 081-1 y EN 50 082-2.
- Material eléctrico destinado a utilizarse con determinadas límites de tensión (73/23/CEE).
  Normas aplicadas: EN 60 335-1 y EN 60 335-2-51.

Declaração de Conformidade

Nós **GRUNDFOS** declaramos sob nossa única responsabilidade que os produtos **CH** e **CHN** aos quais se refere esta declaração estão em conformidade com as Directivas do Conselho das Comunidades Europeias relativas à aproximação das legislações dos Estados Membros respeitantes à

- Máquinas (89/392/CEE).
  Norma utilizada: EN 292.
- Compatibilidade electromagnética (89/336/CEE).
  Normas utilizadas: EN 50 081-1 e EN 50 082-2.
- Material eléctrico destinado a ser utilizado dentro de certos limites de tensão (73/23/CEE).
  Normas utilizadas: EN 60 335-1 e EN 60 335-2-51.

Δήλωση Συμμόρφωσης

Εμείς η **GRUNDFOS** δηλώνουμε με αποκλειστικά δική μας ευθύνη ότι τα προιόντα **CH** και **CHN** συμμορφώνονται με την Οδηγία του Συμβουλίου επί της σύγκλισης των νόμων των Κρατών Μελών της Ευρωπαικής Ενωσης σε σχέση με τα

- Μηχανήματα (89/392/EEC).
  Πρότυπο που χρησιμοποιήθηκε: EN 292.
- Ηλεκτρομαγνητική συμβατότητα (89/336/EEC).
  Πρότυπα που χρησιμοποιήθηκαν: EN 50 081-1 και EN 50 082-2.
- Ηλεκτρικές συσκευές σχεδιασμένες γιά χρήση εντός ορισμένων ορίων ηλεκτρικής τάσης (73/23/EEC).
  Πρότυπα που χρησιμοποιήθηκαν: EN 60 335-1 και EN 60 335-2-51.

Overeenkomstigheidsverklaring

Wij **GRUNDFOS** verklaren geheel onder eigen verantwoordelijkheid dat de produkten **CH** en **CHN** waarop deze verklaring betrekking heeft in overeenstemming zijn met de Richtlijnen van de Raad inzake de onderlinge aanpassing van de wetgevingen van de Lid-Staten betreffende

- Machines (89/392/EEG).
  Norm: EN 292.
- Elektromagnetische compatibiliteit (89/336/EEG).
  Normen: EN 50 081-1 en EN 50 082-2.
- Elektrisch materiaal bestemd voor gebruik binnen bepaalde spanningsgrenzen (73/23/EEG).
  Normen: EN 60 335-1 en EN 60 335-2-51.

Försäkran om överensstämmelse

Vi **GRUNDFOS** försäkrar under ansvar, att produkterna **CH** och **CHN**, som omfattas av denna försäkran, är i överensstämmelse med Rådets Direktiv om inbördes närmande till EU-medlemsstaternas lagstiftning, avseende

- Maskinell utrustning (89/392/EC).
  Använd standard: EN 292.
- Elektromagnetisk kompatibilitet (89/336/EC).
  Använda standarder: EN 50 081-1 och EN 50 082-2.
- Elektrisk material avsedd för användning inom vissa spänningsgränser (73/23/EC).
  Använda standarder: EN 60 335-1 och EN 60 335-2-51.

Vastaavuusvakuutus

Me **GRUNDFOS** vakuutamme yksin vastuullisesti, että tuotteet **CH** ja **CHN**, jota tämä vakuutus koskee, noudattavat direktiivejä jotka käsittelevät EY:n jäsenvaltioiden koneellisia laitteita koskevien lakien yhdenmukaisuutta seur.:

- Koneet (89/392/EY).
  Käytetty standardi: EN 292.
- Elektromagneettinen vastaavuus (89/336/EY).
  Käytetyt standardit: EN 50 081-1 ja EN 50 082-2.
- Määrättyjen jänniterajoitusten puitteissa käytettävät sähköiset laitteet (73/23/EY).
  Käytetyt standardit: EN 60 335-1 ja EN 60 335-2-51.

Overensstemmelseserklæring

Vi **GRUNDFOS** erklærer under ansvar, at produkterne **CH** og **CHN**, som denne erklæring omhandler, er i overensstemmelse med Rådets direktiver om indbyrdes tilnærmelse til EF medlemsstaternes lovgivning om

- Maskiner (89/392/EØF).
  Anvendt standard: EN 292.
- Elektromagnetisk kompatibilitet (89/336/EØF).
  Anvendte standarder: EN 50 081-1 og EN 50 082-2.
- Elektrisk materiel bestemt til anvendelse inden for visse spændingsgrænser (73/23/EØF).
  Anvendte standarder: EN 60 335-1 og EN 60 335-2-51.

Bjerringbro, 15th January 2000

Kenth Hvid Nielsen
Technical Manager

CH, CHN

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Before beginning installation procedures, these installation and operating instructions should be studied carefully. The installation and operation should also be in accordance with local regulations and accepted codes of good practice.

1. General data

1.1 Applications

The CH/CHN range of GRUNDFOS horizontal multistage centrifugal pumps are designed for the pumping of water and other thin, non-aggressive and non-explosive liquids, not containing solid particles or fibres.

1.2 Operating conditions

1.2.1 Liquid temperature

0°C to +90°C.

1.2.2 Ambient temperature

Up to +55°C.

1.2.3 Maximum operating pressure

0°C to +40°C: Up to 10 bar.
+41°C to +90°C: Up to 6 bar.

1.2.4 Maximum Inlet Pressure

The actual inlet pressure plus the pressure when the pump is operating against a closed valve should always be lower than the “maximum operating pressure”.

1.2.5 Minimum inlet pressure

The table below applies to the **maximum flow rates** of the pumps and a barometric pressure of 760 mmHg.

The values stated are the minimum inlet pressures/maximum suction lifts “H” [m head] at the pump suction port. The values are stated at different liquid temperatures. **The head loss in the suction pipe should therefore be taken into account.**

The maximum suction lift may be limited by the actual head.

Type	H [m head]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4.1	*3.6	*2.7	2.8
CHN 2	*4.1	*3.6	*2.7	2.8
CH 4	*7.5	*7.0	*6.1	*0.6
CHN 4	*7.5	*7.0	*6.1	*0.6
CH 8	*6.3	*5.8	*4.9	0.6
CH 12	*5.6	*5.1	*4.2	1.3
60 Hz				
CH 2	*3.1	*2.6	*1.7	3.8
CHN 2	*3.1	*2.6	*1.7	3.8
CH 4	*6.8	*6.3	*5.4	0.1
CHN 4	*6.8	*6.3	*5.4	0.1
CH 8	*6.9	*6.4	*5.5	0.0
CH 12	*3.5	*3.0	*2.1	3.4

“H” = minimum inlet pressure during operation.

“H” marked * = maximum suction lift during operation.

1 m head ≈ 0.1 bar.

1.3 Technical data

1.3.1 Electrical data

See the pump nameplate.

1.3.2 Dimensions

See page 50.

1.4 Sound pressure level

The sound pressure level of the pump is lower than the limiting values stated in the EC Council Directive 89/392/EEC relating to machinery.

2. Installation

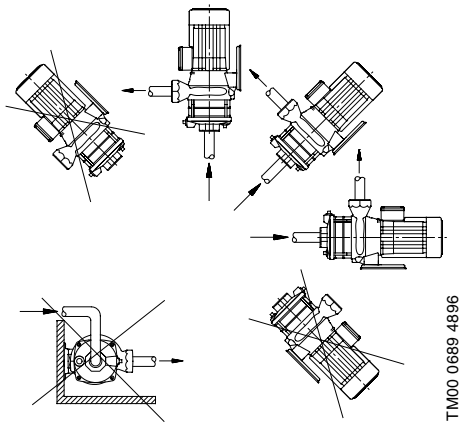
2.1 Pump location

The pump should be installed so that the suction pipe is as short and the suction lift as small as possible.

The pump should be sited in a well ventilated but frost-free position (see section *5.1 Frost protection*). It may be sited outside, but it should be protected from the elements by means of a suitable cover.

The pump may be installed in one of the positions shown in fig. 1.

Fig. 1



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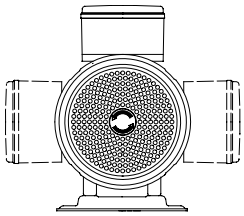
2.2 Position of terminal box

The terminal box can be turned to any one of the positions shown in fig. 2 before the pump is installed.

Fig. 2



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To change the position of the terminal box:

1. Remove the four screws which, from the motor side, are screwed into the discharge chamber.
2. Turn the stator housing to the required position.
3. Replace the screws and tighten securely.

2.3 Pipework

The pipes should be fitted so that any tension caused by variations in temperature does not affect the pump.

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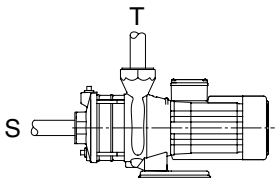
2.3.1 Suction pipe

If the pump is to draw liquid from a level lower than the pump suction port, a foot/non-return valve must be fitted to the end of the suction pipe, below the lowest liquid level, since the pump is not self-priming.

The suction pipe is connected to the pump suction port S, fig. 3.

Fig. 3



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When the suction pipe is longer than 10 metres or the suction lift is greater than 4 metres, the diameter of the suction pipe must be larger than that of the pump suction port.

Every joint of the suction pipe must be completely tight.

If a hose is used as suction pipe, it must be non-collapsible. A strainer is recommended in cases where solids could enter the suction pipe and block the pump.

2.3.2 Discharge pipe

The discharge pipe is connected to the discharge port T, fig. 3.

The discharge pipe should be at least the same diameter as the discharge port of the pump, to minimize pressure drop, high flow velocities and noise.

2.3.3 Bypass

If there is any danger of the pump running against a closed discharge valve, a minimum liquid flow through the pump should be ensured by connecting a bypass/a drain to the discharge pipe. The drain can for instance be connected to a tank.

A minimum flow rate equal to 10% of the flow rate at maximum efficiency is needed at all times. Flow rate and head at maximum efficiency are stated on the pump nameplate.

2.4 Installation examples

The pump is suitable for a wide range of applications.

Some examples are shown on page 49.

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3. Electrical connections

The electrical connections should be carried out in accordance with local regulations.

The operating voltage and frequency are marked on the nameplate. Please make sure that the motor is suitable for the electricity supply on which it will be used.

Never make any connections in the pump terminal box unless the electricity supply has been switched off.

The pump must be connected to an external mains switch.

Single-phase motors, 1 x 110/220 V, 60 Hz, do not incorporate motor protection and must be connected to an approved motor starter.

Other single-phase motors incorporate a thermal overload switch and require no additional motor protection.

Three-phase motors must be connected to a motor starter, the set nominal current of which must correspond to the electrical data on the pump nameplate.

Do not start the pump until it has been filled with liquid.

Connections should be made as shown on the inside of the terminal box cover.

Choose one of the two cable entries and knock out the pre-cut disk.

3.1 Checking of direction of rotation

(Three-phase motors)

Arrows on the motor fan cover indicate the correct direction of rotation.

The pump should rotate counter-clockwise when viewed from the motor end.

To reverse the direction of rotation, switch off the electricity supply and interchange any two of the incoming supply wires.

4. Starting

4.1 Priming

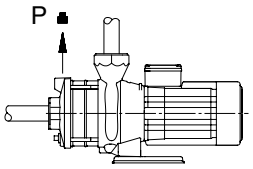
Do not start the pump until it has been filled with liquid and vented.

In systems with hot liquids, extreme caution should be exercised when venting the pump to eliminate the risk of personal injury caused by escaping water.

Booster systems and systems where the liquid level on the suction side is above the pump inlet:

1. Close the isolating valves either side of the pump.
2. Remove the priming plug P, fig. 4.
3. Slowly open the suction valve and keep it open until a steady stream of liquid runs out the priming port.
4. Close the valve, replace the priming plug and tighten securely.
5. Open the suction valve.
6. Start the pump and slowly open the discharge valve until it is fully open.

Fig. 4



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Pumping from tanks and wells where the liquid level on the suction side is below the pump inlet:

1. Close the discharge isolating valve.
2. Remove the priming plug P, fig. 4.
3. Pour water through the priming port. Make sure that the suction pipe and pump are completely filled with liquid and vented.
4. Replace the priming plug and tighten securely.
5. Start the pump and slowly open the discharge valve until it is fully open.

4.2 Frequency of starts and stops

Maximum 100 starts per hour.

5. Operation and maintenance

Under normal operating conditions, the pump does not require any maintenance.

If the pump has been used for pumping liquids that may leave impurities in the pump, it should be flushed through with clean water immediately after use.

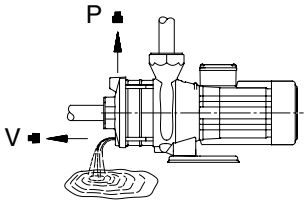
5.1 Frost protection

Pumps which are not being used during periods of frost should be drained to avoid damage.

Remove the priming and drain plugs P and V, fig. 5.

Do not replace the plugs until the pump is to be used again.

Fig. 5



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6. Fault finding chart

Before attempting to diagnose any fault, make sure that the electricity supply has been switched off.

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Fault	Cause
1. Pump does not start.	a) Supply failure. b) Control circuit has cut out or is defective. c) Motor is defective. d) Pump is blocked by impurities.
2. Pump runs but gives no water.	a) Pump is not filled with liquid. b) Suction or discharge pipe is blocked by impurities. c) Pump is blocked by impurities. d) Suction lift is too great. e) Leakage in suction pipe. f) Foot or non-return valve is blocked.
3. Pump runs at reduced capacity.	a) Wrong direction of rotation (three-phase). b) Suction lift is too great. c) Suction or discharge pipe is blocked. d) Pump is blocked by impurities. e) Foot or non-return valve is partly blocked.
4. Pump stops during operation.	a) Thermal overload switch in motor or external motor protection cuts out. b) Control circuit has cut out.

7. Disposal

Disposal of this product or parts of it must be carried out according to the following guidelines:

1. Use the local public or private waste collection service.
2. In case such waste collection service does not exist or cannot handle the materials used in the product, please deliver the product or any hazardous materials from it to your nearest GRUNDFOS company or service workshop.

D

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1. Sicherheitshinweise

1.1 Allgemeines

Diese Montage- und Betriebsanleitung enthält grundlegende Hinweise, die bei Installation, Betrieb und Wartung zu beachten sind. Sie ist daher unbedingt vor Montage und Inbetriebnahme vom Monteur sowie dem zuständigen Fachpersonal/Betreiber zu lesen. Sie muß ständig am Einsatzort der Anlage verfügbar sein.

Diese Montage- und Betriebsanleitung bezieht sich auf Pumpen der Baureihen CH und CHN.

Es sind nicht nur die unter diesem Abschnitt “Sicherheitshinweise” aufgeführten, allgemeinen Sicherheitshinweise zu beachten, sondern auch die unter den anderen Abschnitten eingefügten, speziellen Sicherheitshinweise.

1.2 Kennzeichnung von Hinweisen

Die in dieser Montage- und Betriebsanleitung enthaltenen Sicherheitshinweise, die bei Nichtbeachtung Gefährdungen für Personen hervorrufen können, sind mit allgemeinem Gefahrensymbol “Sicherheitszeichen nach DIN 4844-W9” besonders gekennzeichnet.

Achtung ***Dieses Symbol finden Sie bei Sicherheitshinweisen, deren Nichtbeachtung Gefahren für die Maschine und deren Funktionen hervorrufen kann.***

Hinweis ***Hier stehen Ratschläge oder Hinweise, die das Arbeiten erleichtern und für einen sicheren Betrieb sorgen.***

Direkt an der Anlage angebrachte Hinweise wie z.B.

- Fließrichtungspfeil
- Kennzeichnung für Fluidanschlüsse

müssen unbedingt beachtet und in vollständig lesbarem Zustand gehalten werden.

1.3 Personalqualifikation und -schulung

Das Personal für Bedienung, Wartung, Inspektion und Montage muß die entsprechende Qualifikation für diese Arbeiten aufweisen.

Verantwortungsbereich, Zuständigkeit und die Überwachung des Personals müssen durch den Betreiber genau geregelt sein.

1.4 Gefahren bei Nichtbeachtung der Sicherheitshinweise

Die Nichtbeachtung der Sicherheitshinweise kann sowohl eine Gefährdung für Personen als auch für die Umwelt und Anlage zur Folge haben. Die Nichtbeachtung der Sicherheitshinweise kann zum Verlust jeglicher Schadenersatzansprüche führen.

Im einzelnen kann Nichtbeachtung beispielsweise folgende Gefährdungen nach sich ziehen:

- Versagen wichtiger Funktionen der Anlage
- Versagen vorgeschriebener Methoden zur Wartung und Instandhaltung
- Gefährdung von Personen durch elektrische und mechanische Einwirkungen

1.5 Sicherheitsbewußtes Arbeiten

Die in dieser Montage- und Betriebsanleitung aufgeführten Sicherheitshinweise, die bestehenden nationalen Vorschriften zur Unfallverhütung sowie eventuelle interne Arbeits-, Betriebs- und Sicherheitsvorschriften des Betreibers, sind zu beachten.

1.6 Sicherheitshinweise für den Betreiber/Bediener

Gefährdungen durch elektrische Energie sind auszuschließen (Einzelheiten hierzu siehe z.B. in den Vorschriften des VDE und der örtlichen Energieversorgungsunternehmen).

1.7 Sicherheitshinweise für Wartungs-, Inspektions- und Montagearbeiten

Der Betreiber hat dafür zu sorgen, daß alle Wartungs-, Inspektions- und Montagearbeiten von autorisiertem und qualifiziertem Fachpersonal ausgeführt werden, das sich durch eingehendes Studium der Montage- und Betriebsanleitung ausreichend informiert hat.

Grundsätzlich sind Arbeiten an der Pumpe nur im Stillstand durchzuführen. Die in der Montage- und Betriebsanleitung beschriebene Vorgehensweise zum Stillsetzen der Anlage muß unbedingt eingehalten werden.

Unmittelbar nach Abschluß der Arbeiten müssen alle Sicherheits- und Schutzeinrichtungen wieder angebracht bzw. in Funktion gesetzt werden.

Vor der Wiederinbetriebnahme sind die im Abschnitt *5. Inbetriebnahme* aufgeführten Punkte zu beachten.

1.8 Eigenmächtiger Umbau und Ersatzteilherstellung

Umbau oder Veränderungen an Pumpen sind nur nach Absprache mit dem Hersteller zulässig. Originalersatzteile und vom Hersteller autorisiertes Zubehör dienen der Sicherheit. Die Verwendung anderer Teile kann die Haftung für die daraus entstehenden Folgen aufheben.

1.9 Unzulässige Betriebsweisen

Die Betriebssicherheit der gelieferten Pumpen ist nur bei bestimmungsgemäßer Verwendung entsprechend Abschnitt *2.1 Verwendungszweck* der Montage- und Betriebsanleitung gewährleistet. Die in den technischen Daten angegebenen Grenzwerte dürfen auf keinen Fall überschritten werden.

2. Allgemeines

2.1 Verwendungszweck

Die GRUNDFOS CH und CHN Pumpen sind horizontale, mehrstufige Kreiselpumpen zur Förderung von Wasser und anderen dünnflüssigen, nicht-aggressiven und nicht-explosiven Medien ohne abrasive oder langfaserige Bestandteile.

2.2 Betriebsbereich

2.2.1 Medientemperatur

0°C bis +90°C.

2.2.2 Umgebungstemperatur

Max. +55°C.

2.2.3 Max. Betriebsdruck

0°C bis +40°C: max. 10 bar.
+41°C bis +90°C: max. 6 bar.

2.2.4 Max. Zulaufdruck

Vorhandener Zulaufdruck + Pumpenenddruck (Pumpendruck bei Betrieb gegen geschlossenes Ventil) darf den “max. Betriebsdruck” nicht übersteigen.

2.2.5 Min. Zulaufhöhe

Die nachstehende Tabelle zeigt die Zulaufhöhen bei den **max. Förderströmen** der Pumpen und bei einem barometrischen Druck von 760 mmHg ~ 1013 hPa.

Die angeführten Werte sind min. Zulaufhöhen/max. Saughöhen “H” [mWS] am Pumpensaugstutzen bei verschiedenen Medientemperaturen. **Deshalb muß der Druckverlust in der Saugleitung beachtet werden.**

Wenn die Pumpe in Saugbetrieb eingesetzt wird, ist zu beachten, daß die max. Saughöhe kleiner sein muß als die max. Förderhöhe der Pumpe.

Typ	H [mWS]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

“H” = min. Zulaufhöhe während des Betriebes.

Wert “H” markiert mit * = max. Saughöhe während des Betriebes.

1 mWS ≈ 0,1 bar.

2.3 Technische Daten

2.3.1 Elektrische Daten

Siehe Leistungsschild.

2.3.2 Abmessungen

Siehe Seite 50.

2.4 Schalldruckpegel

Der Schalldruckpegel der Pumpe liegt unter den Grenzwerten, die in der EG-Richtlinie 89/392/EWG für Maschinen angeführt sind.

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3. Montage

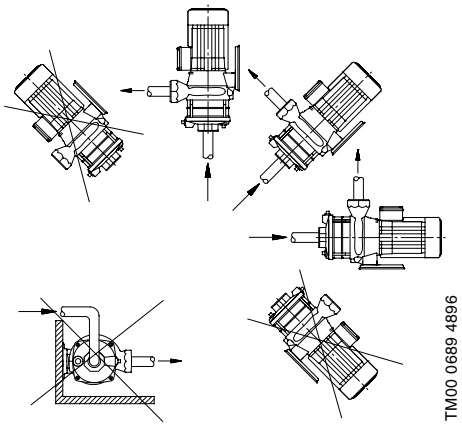
3.1 Aufstellung

Die Aufstellung der Pumpe sollte so erfolgen, daß die Saugleitung so kurz und die Saughöhe so gering wie möglich ist.

Der Aufstellungsort sollte gut belüftet und frostfrei sein (siehe Abschnitt *6.1 Frostsicherung*). Die Pumpe darf auch im Freien montiert werden, sollte aber gegen Regen geschützt sein, z.B. mit einem Schutzdach.

Die Pumpe darf in einer der in Abb. 1 gezeigten Lagen montiert werden.

Abb. 1



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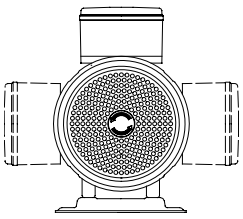
3.2 Klemmenkastenstellung

Die Klemmenkastenstellung kann wie in Abb. 2 gezeigt geändert werden, bevor die Pumpe montiert wird.

Abb. 2



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Änderung der Klemmenkastenstellung:

1. Die vier Schrauben, die von der Motorseite her in das Druckgehäuse geschraubt sind, entfernen.
2. Statorgehäuse in die gewünschte Stellung drehen.
3. Schrauben wieder einsetzen und fest anziehen.

3.3 Rohrleitungen

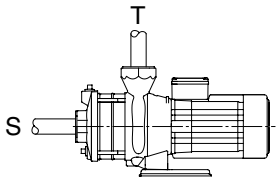
Die Pumpe muß spannungsfrei eingebaut werden, so daß Rohrleitungskräfte, z.B. durch Temperaturexpansion, ihre Funktion nicht beeinträchtigen können.

3.3.1 Saugleitung

In Anlagen, in denen der Mediumstand auf der Saugseite unterhalb der Pumpe liegt, muß die Saugleitung mit einem Fuß- oder Rückschlagventil versehen werden. Die Pumpe ist nicht selbstansaugend.

Die Saugleitung ist an den Saugstutzen S der Pumpe anzuschließen, Abb. 3.

Abb. 3



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Bei Saugleitungen länger als 10 m oder Saugtiefen größer als 4 m muß der Durchmesser der Saugleitung größer als der des Saugstutzens sein.

Alle Verbindungen der Saugleitung müssen dicht sein.

Als flexible Saugleitung sind verstärkte Schläuche zu verwenden. Um eine Verunreinigung der Pumpe zu vermeiden, kann die Saugleitung mit einem Saugkorb (Filter/Sieb) versehen werden.

Achtung ***Die max. Saughöhe darf auch bei Verunreinigungen des Filters/Siebes nicht überschritten werden.***

3.3.2 Druckleitung

Die Druckleitung ist an den Druckstutzen T der Pumpe anzuschließen, Abb. 3.

Wir empfehlen, den Durchmesser der Druckleitung gleich oder größer als den des Druckstutzens zu wählen, um Druckverluste, große Strömungsgeschwindigkeiten und Geräusche zu minimieren.

3.3.3 Bypass (Umlaufleitung)

In Anlagen, bei denen die Möglichkeit besteht, daß die Pumpe gegen ein geschlossenes Absperrventil in der Druckleitung arbeitet, muß ein Mindest-Förderstrom durch die Pumpe fließen. Das wird dadurch sichergestellt, daß ein Bypass oder ein Ablauf zu einem Behälter o.ä. auf der Druckseite der Pumpe installiert wird.

Ein Mindest-Förderstrom von 10% des Förderstroms im Wirkungsgradbestpunkt muß immer durch die Pumpe fließen. Der Förderstrom und die Förderhöhe im Wirkungsgradbestpunkt sind dem Leistungsschild der Pumpe zu entnehmen.

3.4 Montagebeispiele

Die Pumpe eignet sich für viele Anwendungsgebiete.

Auf Seite 49 sind einige Beispiele gezeigt.

4. Elektrischer Anschluß

Der elektrische Anschluß muß durch einen Fachmann in Übereinstimmung mit den örtlichen Vorschriften des EVU bzw. VDE vorgenommen werden.

Es ist darauf zu achten, daß die auf dem Leistungsschild angegebenen Daten mit der vorhandenen Stromversorgung übereinstimmen.

Vor jedem Eingriff im Klemmenkasten der Pumpe muß die Versorgungsspannung abgeschaltet sein.

Die Pumpe muß an einen externen Netzschalter angeschlossen werden.

Einphasenmotoren, 1 x 110/220 V, 60 Hz, besitzen **keinen** eingebauten Motorschutz und müssen deshalb an einen externen Motorschutzschalter angeschlossen werden.

Die übrigen Einphasenmotoren besitzen einen eingebauten Thermoschalter und benötigen keinen weiteren Motorschutz.

Drehstrommotoren müssen an einen VDE-geprüften Motorschutzschalter angeschlossen werden, dessen eingestellter Nennstrom mit den Stromdaten des Pumpen-Leistungsschildes übereinstimmt.

Auf eine allpolige Trennung mit Kontaktöffnungsweite von min. 3 mm (pro Pol) ist zu achten.

Die Pumpe darf nicht in Betrieb genommen werden, bevor sie mit dem Fördermedium gefüllt ist.

Der elektrische Anschluß ist in Übereinstimmung mit dem im Klemmenkasten vorhandenen Schaltbild vorzunehmen.

Eine der beiden Kabeleinführungen wählen und die vorgeprägte Scheibe ausbrechen.

4.1 Kontrolle der Drehrichtung

(Drehstrommotoren)

Die richtige Drehrichtung ist durch Pfeile auf der Lüfterhaube vorgegeben.

Vom Motor gesehen, muß die Pumpe entgegen dem Uhrzeigersinn laufen.

Ist die Drehrichtung falsch, sind zwei Phasen der Stromversorgung des Motors zu vertauschen.

5. Inbetriebnahme

5.1 Auffüllen

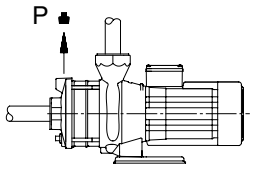
Vor der Inbetriebnahme muß die Pumpe unbedingt mit dem Fördermedium aufgefüllt und entlüftet sein.

Bei Anlagen mit heißen Medien ist bei der Entlüftung der Pumpe äußerste Vorsicht geboten, um Personenschäden durch austretendes Wasser zu vermeiden.

In Druckerhöhungsanlagen und Anlagen, in denen der Mediumstand auf der Saugseite oberhalb der Pumpe liegt:

1. Absperrventile auf der Saug- und Druckseite schließen.
2. Einfüllstopfen P demontieren, Abb. 4.
3. Das Absperrventil auf der Saugseite so weit öffnen, bis das Medium aus dem Einfüllstutzen herausläuft.
4. Absperrventil schließen und Einfüllstopfen wieder einsetzen und fest anziehen.
5. Das Absperrventil auf der Saugseite ganz öffnen.
6. Pumpe einschalten und Absperrventil auf der Druckseite sofort langsam öffnen.

Abb. 4



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Pumpen aus Behältern und Brunnen, in denen der Mediumstand auf der Saugseite unterhalb der Pumpe liegt:

1. Absperrventil auf der Druckseite schließen.
2. Einfüllstopfen P demontieren, Abb. 4.
3. Medium durch den Einfüllstutzen einfüllen. Es ist darauf zu achten, daß die Pumpe ganz aufgefüllt und entlüftet ist.
4. Einfüllstopfen wieder einsetzen und fest anziehen.
5. Pumpe einschalten und Absperrventil auf der Druckseite sofort langsam öffnen.

5.2 Schalthäufigkeit

Max. 100 Schaltungen pro Stunde.

6. Betrieb und Wartung

Unter normalen Betriebsbedingungen ist die Pumpe wartungsfrei.

Ist die Pumpe zur Förderung von unreinen Medien benutzt worden, die Verunreinigungen in der Pumpe hinterlassen haben, ist sofort nach Beendigung der Förderung die Pumpe mit sauberem Wasser durchzuspülen.

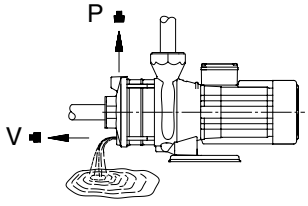
6.1 Frostsicherung

Pumpen, die in Frostperioden nicht verwendet werden und in nicht frostfreien Räumen installiert sind, sollten entleert werden, um Beschädigungen zu vermeiden.

Dazu die Einfüll- und Entleerungsstopfen P und V entfernen, Abb. 5.

Die Stopfen sind erst vor der erneuten Inbetriebnahme einzusetzen.

Abb. 5



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7. Störungsübersicht

Vor Beginn der Störungssuche muß die Versorgungsspannung unbedingt abgeschaltet sein.

Störung	Ursache
1. Pumpe läuft nicht an.	a) Keine oder fehlerhafte Stromversorgung zum Motor. b) Steuerstromkreislauf ausgefallen oder schadhaft. c) Motor defekt. d) Pumpe durch Verunreinigungen blockiert.
2. Pumpe läuft, fördert aber kein Wasser.	a) Pumpe ist nicht mit Medium gefüllt. b) Saug- oder Druckleitung verstopft. c) Pumpe verstopft. d) Saughöhe zu groß. e) Saugleitung undicht. f) Fuß- oder Rückschlagventil blockiert.
3. Pumpe läuft mit verringerter Leistung.	a) Falsche Drehrichtung (Drehstrommotoren). b) Saughöhe zu groß. c) Saug- oder Druckleitung verunreinigt. d) Pumpe verunreinigt. e) Fuß- oder Rückschlagventil blockiert.
4. Pumpe schaltet während des Betriebes ab.	a) Der Thermoschalter im Motor oder der externe Motorschutz löst aus. b) Steuerstromkreislauf ausgefallen.

8. Entsorgung

Dieses Produkt sowie Teile davon müssen umweltgerecht entsorgt werden:

1. Hierfür sollten die örtlichen öffentlichen oder privaten Entsorgungsgesellschaften in Anspruch genommen werden.
2. Falls eine solche Organisation nicht vorhanden ist, oder die Annahme der im Produkt verwendeten Werkstoffe verweigert wird, kann das Produkt oder eventuelle umweltgefährdende Werkstoffe an die nächste GRUNDFOS Gesellschaft oder Werkstatt geliefert werden.

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Avant d'engager les procédures d'installation, il faut étudier attentivement cette notice d'installation et d'entretien. L'installation et l'utilisation doivent également se conformer aux réglementations en vigueur et aux codes professionnels agréés.

1. Généralités

1.1 Applications

Les pompes GRUNDFOS CH et CHN sont des pompes centrifuges multicellulaires horizontales pour le pompage d'eau claire et d'autres liquides non agressifs et non explosifs, sans particules abrasives ou fibreuses.

1.2 Limites d'utilisation

1.2.1 Température du liquide

De 0°C à +90°C.

1.2.2 Température ambiante

Jusqu'à +55°C.

1.2.3 Pression de service maximale

0°C à +40°C: Jusqu'à 10 bars.
+41°C à +90°C: Jusqu'à 6 bars.

1.2.4 Pression d'entrée maximale

La pression d'entrée effective + la pression de la pompe à vanne fermée ne doivent pas dépasser la "pression de service maximale".

1.2.5 Pression d'entrée minimale

Le tableau ci-dessous s'applique au **débit maximal** de la pompe et à une pression barométrique de 760 mmHg.

La pression d'entrée minimale/hauteur d'aspiration maximale "H" [mCE] à l'aspiration de la pompe est indiquée à différentes températures de liquide. **Pour cette raison, la perte de charge dans la tuyauterie d'aspiration doit être prise en compte.**

La hauteur d'aspiration maximale peut être limitée par la hauteur manométrique réelle.

Type	H [mCE]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

"H" = pression d'entrée minimale lors du fonctionnement.

"H" marquée * = hauteur d'aspiration maximale lors du fonctionnement.

1 mCE ≈ 0,1 bar.

1.3 Caractéristiques techniques

1.3.1 Données électriques

Voir la plaque signalétique de la pompe.

1.3.2 Dimensions

Voir page 50.

1.4 Niveau de pression acoustique

Le niveau de pression acoustique de la pompe est inférieur aux seuils indiqués dans la Directive du Conseil 89/392/CEE (relative aux machines).

F

2. Installation

2.1 Positionnement de la pompe

La tuyauterie d'aspiration doit être aussi courte et la hauteur d'aspiration aussi petite que possible.

La pompe doit, autant que possible, être placée dans un endroit bien ventilé sans risque de gel (voir paragraphe *5.1 Protection contre le gel*). Elle peut être placée à l'extérieur, mais à l'abri de la pluie, par exemple sous un petit toit ou tout autre système de protection.

La pompe peut être montée dans les positions indiquées par la figure 1.

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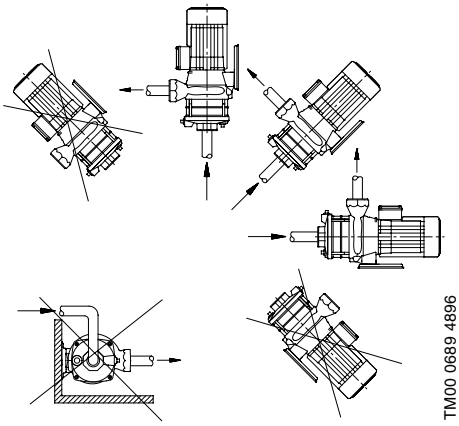
Fig. 1



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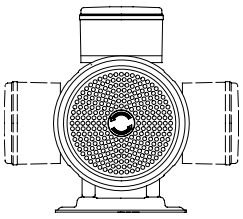
2.2 Position de la boîte à bornes

La boîte à bornes peut être placée suivant la figure 2 avant que la pompe soit installée.

Fig. 2



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Pour changer la position de la boîte à bornes:

1. Enlever les quatre vis qui, du côté moteur, sont vissées dans la chambre de refoulement.
2. Tourner le corps de stator vers la position voulue.
3. Remettre et serrer les vis.

2.3 Tuyauterie

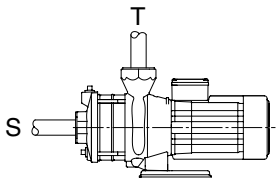
Vérifier que les contraintes de tuyauterie ne s'exercent pas sur la pompe, en particulier celles dues aux variations de température de l'eau.

2.3.1 Tuyauterie d'aspiration

Si le niveau d'eau côté aspiration est en dessous de l'orifice d'aspiration de la pompe, il faut monter un clapet de retenue/pied sur la tuyauterie d'aspiration. La pompe n'est pas auto-amorçante.

Raccorder la tuyauterie d'aspiration à l'orifice S de la pompe, fig. 3.

Fig. 3



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Si la longueur de la tuyauterie d'aspiration excède 10 m ou la hauteur d'aspiration est supérieure à 4 m, la tuyauterie d'aspiration doit être de dimension supérieure à celle de l'orifice d'aspiration.

Veiller à ce que les jonctions de la tuyauterie d'aspiration soient étanches.

N'employer un tube flexible à l'aspiration que si celui-ci est renforcé. Dans le cas d'un pompage d'eau chargée, il est recommandé de munir l'extrémité de la tuyauterie d'une crépine.

2.3.2 Tuyauterie de refoulement

Raccorder la tuyauterie de refoulement à l'orifice T de la pompe, fig. 3.

La tuyauterie et l'orifice de refoulement doivent au moins être de dimension égale pour limiter les pertes de charge, la vitesse d'écoulement et le bruit.

2.3.3 By-pass

S'il y a un risque pour que la pompe refoule contre une vanne fermée, un débit minimum doit être assuré en installant un by-pass/une purge du côté refoulement. La purge peut être, par exemple, connectée à un réservoir.

Un débit minimum égal à 10% du débit au rendement maximum doit être assuré. Le débit et la hauteur manométrique au rendement maximum sont indiqués sur la plaque signalétique de la pompe.

2.4 Exemples d'applications

La pompe est utilisable pour un vaste domaine d'applications.

Quelques exemples sont montrés à la page 49.

3. Branchement électrique

Le branchement électrique doit être exécuté conformément aux prescriptions locales.

Vérifier si la tension et la fréquence de l'alimentation électrique correspondent à la tension et à la fréquence indiquées sur la plaque signalétique.

Ne jamais effectuer aucune opération dans la boîte à bornes sans que l'alimentation électrique n'ait été coupée.

La pompe doit être reliée à un interrupteur principal externe.

Les moteurs monophasés, 1 x 110/220 V, 60 Hz, n'ont pas de protection moteur incorporée et, par conséquence, il faut les protéger par un disjoncteur extérieur.

Les autres moteurs monophasés sont équipés d'un rupteur thermique et n'exigent pas de protection moteur extérieure.

Les moteurs triphasés doivent être connectés à un disjoncteur, l'intensité nominale de consigne duquel doit correspondre aux données électriques inscrites sur la plaque signalétique des pompes.

Avant la mise en marche de la pompe, il faut la remplir de liquide.

Le branchement électrique s'effectue comme indiqué par le schéma de raccordement du couvercle de la boîte à bornes.

Choisir une des deux entrées de câble et percer le disque prédécoupé dans le presse-étoupe.

3.1 Contrôle du sens de rotation

(Moteurs triphasés)

Le sens de rotation correct est indiqué par des flèches sur le couvercle du ventilateur moteur.

Le sens de rotation correct est l'inverse de celui des aiguilles d'une montre, vu du côté moteur.

Si le moteur tourne dans le mauvais sens, couper l'alimentation électrique et inverser deux phases du moteur.

4. Mise en marche

4.1 Amorçage

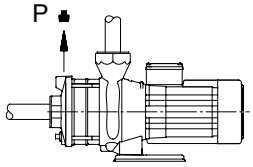
Ne pas mettre la pompe en marche avant de l'avoir remplie et purgée.

Dans les installations d'eau chaude, lorsque la pompe est purgée, faire très grande attention à l'eau chaude que s'échappe de la pompe.

Systèmes de surpression et systèmes dans lesquels le niveau d'eau côté aspiration est en charge:

1. Fermer les vannes d'isolement.
2. Enlever le bouchon de remplissage P, fig. 4.
3. Ouvrir progressivement la vanne côté aspiration et laisser ouvert jusqu'à obtention d'un filet d'eau constant.
4. Fermer la vanne, remettre en place le bouchon de remplissage et serrer avec précaution.
5. Ouvrir entièrement la vanne d'isolement côté aspiration.
6. Démarrer la pompe et ouvrir progressivement la vanne d'isolement côté refoulement jusqu'à ouverture complète.

Fig. 4



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Pompage de réservoirs, puits, etc. où le niveau d'eau côté aspiration est en dessous de l'orifice d'aspiration de la pompe:

1. Fermer la vanne d'isolement côté refoulement.
2. Enlever le bouchon de remplissage P, fig. 4.
3. Verser de l'eau à travers l'orifice de remplissage. S'assurer que la tuyauterie d'aspiration et la pompe sont purgées et entièrement remplies d'eau.
4. Remettre le bouchon de remplissage et serrer avec précaution.
5. Démarrer la pompe et ouvrir progressivement la vanne d'isolement côté refoulement jusqu'à ouverture complète.

4.2 Fréquence de démarrages et d'arrêts

Maximum: 100 démarrages par heure.

5. Fonctionnement et entretien

En fonctionnement normal, la pompe ne nécessite pas d'entretien.

Si la pompe a été utilisée pour le pompage de liquides chargés, il faut la nettoyer à l'eau claire immédiatement après utilisation.

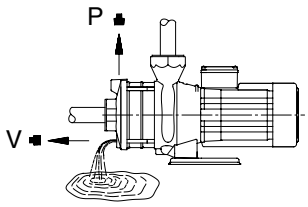
5.1 Protection contre le gel

Si la pompe n'est pas utilisée pendant les périodes de gel, il faut la vidanger pour éviter de l'endommager.

Pour vidanger la pompe, enlever les bouchons de remplissage et de vidange P et V, fig. 5.

Ne pas replacer les bouchons avant réutilisation de la pompe.

Fig. 5



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6. Recherche des pannes

Avant d'effectuer toute sorte d'opérations, être sûr que l'alimentation électrique ait bien été coupée.

Pannes	Causes
1. La pompe ne démarre pas.	a) Pas d'électricité. b) Le circuit de commande est coupé ou défectueux. c) Le moteur est défectueux. d) La pompe est bloquée par des impuretés.
2. La pompe tourne mais ne débite pas d'eau.	a) La pompe n'est pas remplie de liquide. b) La tuyauterie d'aspiration ou de refoulement est bouchée par des impuretés. c) La pompe est bouchée par des impuretés. d) La hauteur d'aspiration est trop élevée. e) La tuyauterie d'aspiration fuit. f) Le clapet de retenue/pied est bloqué.
3. Débit et pression trop faibles.	a) Le sens de rotation du moteur n'est pas correct (triphasé). b) La hauteur d'aspiration est trop élevée. c) La tuyauterie d'aspiration ou de refoulement est bouchée. d) La pompe est bouchée par des impuretés. e) Le clapet de retenue/pied est partiellement bloqué.
4. La pompe déclenche lors du fonctionnement.	a) Le rupteur thermique ou la protection moteur extérieure déclenche. b) Le circuit de commande est coupé.

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7. Dispositions

Dispositions relatives à l'utilisation du produit et de ses composants:

1. Utiliser un service local public ou privé d'assainissement.
2. Si aucun service d'assainissement n'est compétent pour le type de matériel, veuillez renvoyer le produit à GRUNDFOS ou un centre de réparation agréé.

Nous nous réservons tout droit de modifications.

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Prima di procedere all'installazione, leggere attentamente queste istruzioni. L'installazione ed il funzionamento dovranno inoltre essere conformi alla locale regolamentazione ed alla pratica della regola d'arte.

1. Dati generali

1.1 Applicazioni

Le pompe centrifughe multistadio orizzontale GRUNDFOS di tipo CH e CHN sono progettate per il pompaggio di acqua e altri liquidi non densi, non aggressivi e non esplosivi, che non contengano particelle solide o fibre.

1.2 Condizioni di funzionamento

1.2.1 Temperatura del liquido

0°C a +90°C.

1.2.2 Temperatura ambiente

Fino a +55°C.

1.2.3 Massima pressione di funzionamento

Da 0°C a +40°C: Max. 10 bar.
Da +41°C a +90°C: Max. 6 bar.

1.2.4 Pressione battente massima all'aspirazione

La pressione in aspirazione più la pressione differenziale erogata dalla pompa a bocca chiusa, deve sempre essere minore della "massima pressione di funzionamento".

1.2.5 Pressione battente minima all'aspirazione

I dati indicati nella tabella sottoriportata si riferiscono ad una pressione atmosferica di 760 mm Hg e **al valore massimo della portata**.

Sono riportati i valori di pressione battente minima/altezza massima di aspirazione "H" [m] alla bocca di aspirazione della pompa. Sono indicati i valori corrispondenti a diverse temperature del liquido. **La perdita di carico del tubo aspirante deve essere computata a parte.**

L'altezza massima di aspirazione può essere limitata dal valore della prevalenza.

Tipo	H [m]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

"H" = pressione battente minima all'aspirazione durante il funzionamento.

"H" marcato * = massima altezza di aspirazione durante il funzionamento.

1 m ≈ 0,1 bar.

1.3 Dati tecnici

1.3.1 Dati elettrici

Fare riferimento ai dati di targa sulla pompa.

1.3.2 Dimensioni

Vedere pag. 50.

1.4 Livello di rumorosità

Il livello sonoro è inferiore ai limiti stabiliti dalla Direttiva EC 89/392/EEC relativa alle macchine.

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2. Installazione

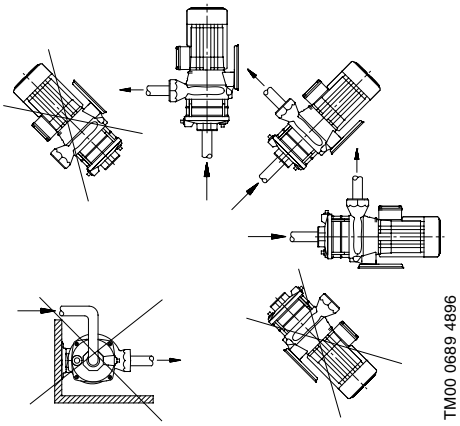
2.1 Collocazione della pompa

La lunghezza del tubo di aspirazione e l'altezza di sollevamento dovranno essere le più contenute possibili.

Dovrà essere posizionata in ambiente (pozzetto) ventilato e senza possibilità di gelo (vedere pragrafo *5.1 Protezione dal gelo*). Può essere posta all'esterno, ma protetta dalla pioggia tramite tettoia o similare.

La pompa potrà essere installata in una delle posizioni illustrate nella fig. 1.

Fig. 1



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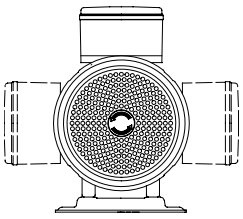
2.2 Posizionamente morsettiera

Per facilitare gli allacciamenti elettrici la morsettiera può essere ruotata come indicato in fig. 2.

Fig. 2



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Per cambiare la posizione della morsettiera:

1. A questo scopo allentare le quattro viti Phillips che fissano il motore sulla camera di mandata.
2. Ruotare nella posizione voluta.
3. Serrare in croce le quattro viti.

2.3 Tubazioni

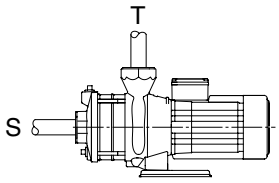
I tubi devono essere montati in modo da evitare che eventuali tensioni, causate da variazioni di temperatura, danneggino la pompa.

2.3.1 Tubo di aspirazione

Se la pompa deve sollevare il liquido da un livello più basso rispetto alla bocca di aspirazione, è necessario montare una valvola di fondo all'estremità del tubo di aspirazione al di sotto del livello dinamico, dal momento che si tratta di una pompa non autoadescante.

Il tubo di aspirazione è collegato alla bocca di aspirazione S, vedi fig. 3.

Fig. 3



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Quando il tubo di aspirazione è più lungo di 10 metri oppure il dislivello geodetico è più di 4 metri, il diametro del tubo di aspirazione deve essere incrementato.

Ogni giunto del tubo di aspirazione deve essere ben serrato.

Se viene usato un tubo flessibile come tubo di aspirazione, questo deve essere del tipo "armato", si raccomanda di montare un filtro nel caso in cui particelle solide possano entrare nel tubo di aspirazione e bloccare poi la pompa.

2.3.2 Tubo di mandata

Il tubo di mandata è collegato alla bocca di mandata T, vedi fig. 3.

Il tubo di mandata deve essere almeno dello stesso diametro della bocca di mandata della pompa. Questo per evitare cadute di pressione e rumorosità dovuta all'aumento di velocità del liquido.

2.3.3 Bypass

Se esiste rischio di funzionamento della pompa con la valvola di mandata chiusa, è opportuno consentire un flusso minimo di liquido attraverso la pompa prevedendo in mandata un tubo di by-pass o di scarico in serbatoio.

E' sempre necessaria una portata minima pari al 10% della portata al massimo rendimento. I valori di portata e prevalenza al massimo rendimento sono indicati sulla targhetta.

2.4 Esempi di installazione

La pompa è idonea per un'ampia gamma di applicazioni.

Alla pag. 49 sono illustrati alcuni esempi.

3. Collegamenti elettrici

I collegamenti elettrici devono essere eseguiti da un elettricista qualificato secondo le norme vigenti.

La tensione e la frequenza di esercizio sono indicate sulla targhetta. Accertare che il motore sia adatto al tipo di alimentazione cui sarà collegato.

Prima di accedere alla morsettiera, accertarsi che l'alimentazione elettrica sia stata tolta e non possa venire accidentalmente riattivata.

La pompa deve essere collegata ad un interruttore generale esterno.

I motori monofase 1 x 110/220 V, 60 Hz, non hanno termoprotettore interno e devono essere alimentati da adatto motoprotettore.

Gli altri motori monofase hanno un termoprotettore interno e per questo non richiedono un motoprotettore esterno.

I motori trifase devono essere collegati ad un motoprotettore la cui corrente nominale deve corrispondere al valore indicato sulla targhetta pompa.

Non avviate la pompa senza averla prima riempita con il liquido pompato.

I collegamenti devono essere eseguiti secondo lo schema sito all'interno del coperchio morsettiera.

Scegliete uno dei due pressacavi e spingete fuori il dischetto preimprontato.

3.1 Controllo del senso di rotazione

(Motori trifase)

Le frecce sul copriventola del motore indicano il corretto senso di rotazione.

La pompa deve ruotare in senso antiorario quando la si vede dal lato motore.

Per cambiare il senso di rotazione, interrompere l'alimentazione elettrica ed invertire due delle tre fasi.

4. Avviamento

4.1 Adescamento

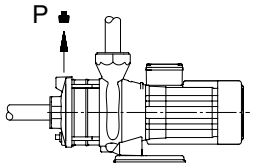
Non avviare la pompa prima di averla riempita con acqua e disaerata.

Negli impianti con liquidi caldi, molta attenzione deve essere posta nella fase di sfogo dell'aria al fine di evitare danni alla persona per fuoriuscita di acqua.

Gruppi autoclave ed impianti dove il livello del liquido all'aspirazione si trova al di sopra della bocca di aspirazione:

1. Chiudere le valvole a monte e a valle della pompa.
2. Togliere il tappo di adescamento P, fig. 4.
3. Aprire lentamente la valvola sull'aspirazione e mantenerla aperta fino alla fuoriuscita di un flusso di liquido costante dall'orifizio di adescamento.
4. Chiudere la valvola, riavvitare il tappo di adescamento e serrare bene.
5. Aprire la valvola sull'aspirazione.
6. Avviare la pompa ed aprire lentamente la valvola sulla mandata fino alla sua completa apertura.

Fig. 4



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Pompaggio da serbatoi e pozzi dove il livello del liquido all'aspirazione si trova al di sotto della bocca di aspirazione:

1. Chiudere la valvola sulla mandata.
2. Togliere il tappo di adescamento P, fig. 4.
3. Riempire completamente pompa e tubo di aspirazione attraverso l'orifizio di adescamento.
4. Riavvitare il tappo di adescamento e serrare bene.
5. Avviare la pompa ed aprire lentamente la valvola sulla mandata fino alla sua completa apertura.

4.2 Frequenza degli avvii ed arresti

100 avviamenti max. per ora.

5. Funzionamento e manutenzione

In condizioni normali non è necessaria una manutenzione preventiva.

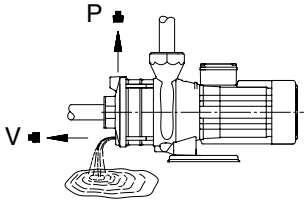
Se la pompa è stata usata per liquidi torbidi o aggressivi, risciacquatela immediatamente dopo l'uso.

5.1 Protezione dal gelo

Durante il periodo invernale le pompe non funzionanti dovranno essere svuotate totalmente svitando i tappi di riempimento e drenaggio, P e V, fig. 5.

Non inserite i tappi se non quando avvierete la pompa.

Fig. 5



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6. Tabella ricerca guasti

Prima di procedere al rilevamento dei guasti, togliere tensione alla pompa.

Difetta	Causa
1. La pompa non parte.	a) Mancanza di corrente. b) Circuito di controllo difettoso. c) Motore difettoso. d) Pompa bloccata da impurità.
2. La pompa è avviata ma non dà acqua.	a) Pompa disadescata. b) Tubo di aspirazione o mandata otturato da impurità. c) Pompa bloccata da impurità. d) Altezza di aspirazione eccessiva. e) Perdita nel tubo di aspirazione. f) Valvola di fondo o di ritegno bloccata.
3. La pompa funziona con valori di Q/H ridotti.	a) Senso di rotazione errato (trifase). b) Altezza di aspirazione eccessiva. c) Tubo di aspirazione o mandata otturato. d) Pompa bloccata da impurità. e) Valvola di fondo o di ritegno parzialmente bloccata.
4. La pompa si arresta durante il funzionamento.	a) Protezione termica interna o esterna scattata. b) Circuito di controllo scattato.

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7. Smaltimento

Lo smaltimento di questo prodotto, o di parte di esso, deve essere effettuato secondo le seguenti regole generali:

1. Usare i sistemi locali, pubblici o privati, di raccolta dei rifiuti.
2. In caso che tali sistemi non esistano o non possano smaltire tale materiale, allora inviare il rifiuto alla più vicina GRUNDFOS o officina di assistenza autorizzata.

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Antes de empezar con los procedimientos de instalación, deben leerse cuidadosamente estas instrucciones de instalación y funcionamiento, que deben también cumplir con la normativa local vigente.

1. Datos generales

1.1 Aplicaciones

Las bombas centrífugas multicelulares horizontales GRUNDFOS, tipos CH y CHN, están diseñadas para el bombeo de agua y otros líquidos limpios, no agresivos y no explosivos, que no contengan partículas sólidas o fibrosas.

1.2 Condiciones de funcionamiento

1.2.1 Temperatura del líquido

0ºC a +90ºC.

1.2.2 Temperatura ambiente

Hasta +55ºC.

1.2.3 Presión máxima de funcionamiento

0ºC a +40ºC: Hasta 10 bares.
+41ºC a 90ºC: Hasta 6 bares.

1.2.4 Presión máxima de entrada

La presión actual de entrada + la presión cuando la bomba está funcionando contra válvula cerrada debe ser siempre inferior a la “presión máxima de funcionamiento”.

1.2.5 Presión mínima de entrada

La siguiente tabla se refiere a los **caudales máximos** de las bombas y una presión barométrica de 760 mmHg.

Los valores indicados son las presiones mínimas de entrada/alturas máximas de aspiración “H” [m.c.a.] en la boca de aspiración de la bomba. Los valores están indicados a diferentes temperaturas del líquido. **Debe por lo tanto tenerse en cuenta la pérdida de carga en la tubería de aspiración.**

La altura máxima de aspiración puede estar limitada por la altura real.

Tipo	H [m.c.a.]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

“H” = presión mínima de entrada durante el funcionamiento.

“H” marcada * = altura máxima de aspiración durante el funcionamiento.

1 m.c.a. ≈ 0,1 bar.

1.3 Datos técnicos

1.3.1 Datos eléctricos

Ver la placa de identificación de la bomba.

1.3.2 Dimensiones

Ver página 50.

1.4 Nivel de ruido

El nivel de ruido de la bomba es inferior a los valores límite indicados en la Directiva del Consejo de la CEE 89/392/CEE sobre maquinaria.

E

2. Instalación

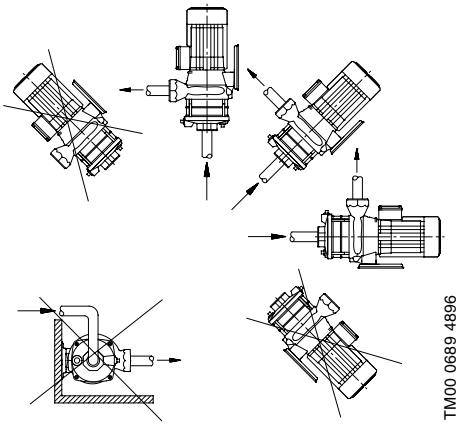
2.1 Ubicación de la bomba

La bomba debe instalarse de tal manera que la tubería de aspiración sea lo más corta posible y la altura de aspiración lo más pequeña posible.

La bomba debe instalarse en un lugar bien ventilado, pero sin riesgo de heladas (ver sección *5.1 Protección contra heladas*). Puede instalarse en el exterior, pero debe estar protegida mediante una cubierta adecuada.

La bomba puede instalarse en cualquiera de las posiciones indicadas en fig. 1.

Fig. 1



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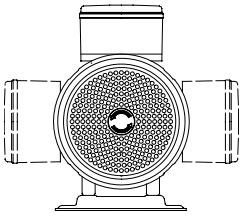
2.2 Posición de la caja de terminales

La caja de terminales puede girarse a cualquiera de las posiciones indicadas en la fig. 2 antes de instalar la bomba.

Fig. 2



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Para cambiar la posición de la caja de terminales:

1. Quitar los cuatro tornillos que, desde el lado del motor, están atornillados en la cámara de descarga.
2. Girar la carcasa del estator a la posición deseada.
3. Volver a poner los tornillos y apretarlos bien.

2.3 Tuberías

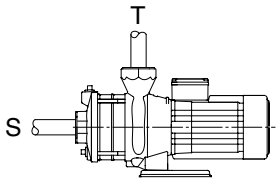
Las tuberías deben instalarse de forma que ninguna tensión causada por variaciones de la temperatura afecte a la bomba.

2.3.1 Tubería de aspiración

Si la bomba va a extraer líquido desde un nivel que está por debajo de la boca de aspiración, hay que instalar una válvula de pie/de retención en el extremo de la tubería de aspiración, por debajo del nivel mínimo del líquido, dado que la bomba no es autocebante.

Se conecta la tubería de aspiración a la boca de aspiración S de la bomba, fig. 3.

Fig. 3



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Cuando la tubería de aspiración mide más de 10 m o la altura de aspiración es mayor de 4 m, el diámetro de la tubería de aspiración debe ser mayor que el diámetro de la boca de aspiración de la bomba.

Todas las juntas de la tubería de aspiración deben ser herméticas.

Si se utiliza una manguera como tubería de aspiración, ésta debe ser rígida. Se recomienda instalar un filtro cuando es posible que sólidos entren en la tubería de aspiración y bloqueen la bomba.

2.3.2 Tubería de descarga

Se conecta la tubería de descarga a la boca de aspiración T, fig. 3.

La tubería de descarga debe tener por lo menos el mismo diámetro que la boca de descarga para minimizar las pérdidas de carga, altas velocidades del líquido y ruido.

2.3.3 Bypass

Si existe el riesgo de que la bomba funcione contra válvula cerrada, hay que asegurar un caudal mínimo de líquido a través de la bomba, conectando un bypass o una salida de agua a la tubería de descarga. Esta salida puede estar colocada en un depósito.

Siempre es necesario un caudal mínimo igual al 10% del caudal al rendimiento máximo. El caudal y la altura al rendimiento máximo están indicados en la placa de identificación de la bomba.

2.4 Ejemplos de instalación

La bomba es apta para una amplia gama de aplicaciones.

En la página 49 se muestran algunos ejemplos.

3. Conexión eléctrica

La conexión eléctrica debe realizarse de acuerdo con las normativas locales.

La tensión y frecuencia de funcionamiento están indicadas en la placa de identificación. Comprobar que el motor es adecuado para el suministro eléctrico donde va a ser utilizado.

Nunca hacer conexiones en la caja de terminales de la bomba sin antes desconectar el suministro eléctrico.

La bomba debe conectarse a un interruptor principal externo.

Los motores monofásicos, 1 x 110/220 V, 60 Hz, no llevan protección y deben conectarse a un arrancador homologado.

Los otros motores monofásicos incorporan un térmico y no requieren protección adicional.

Los motores trifásicos deben conectarse a un arrancador, cuya intensidad nominal debe coincidir con los datos eléctricos de la placa de identificación.

No arrancar la bomba hasta que esté llena de líquido.

Las conexiones deben realizarse como se indica dentro de la tapa de la caja de terminales.

Elegir una de las dos entradas de cable y quitar el disco precortado.

3.1 Comprobación del sentido de giro

(Motores trifásicos)

El sentido de giro correcto está indicado mediante flechas en la tapa del ventilador del motor.

Vista desde el extremo del motor, la bomba debe girar en sentido contrario de las agujas del reloj.

Para cambiar el sentido de giro, desconectar el suministro eléctrico e intercambiar dos de los cables de entrada.

4. Arranque

4.1 Cebado

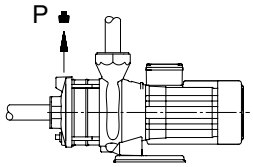
No arrancar la bomba hasta que esté llena de líquido y purgada.

En instalaciones con líquidos calientes, tener mucho cuidado al purgar la bomba para eliminar el riesgo de lesiones a personas causadas por escapes de agua.

Sistemas de presión y sistemas, donde el nivel del líquido en la aspiración está por encima de la entrada de la bomba:

1. Cerrar las válvulas de corte en ambos lados de la bomba.
2. Quitar el tapón de cebado P, fig. 4.
3. Abrir despacio la válvula de aspiración y mantenerla abierta hasta que un chorro contínuo de líquido salga por la boca de cebado.
4. Cerrar la válvula, volver a colocar el tapón de cebado y apretarlo bien.
5. Abrir la válvula de aspiración.
6. Arrancar la bomba y abrir despacio la válvula de descarga hasta que esté completamente abierta.

Fig. 4



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Bombeo desde depósitos y pozos, donde el nivel del líquido en la aspiración está por debajo de la entrada de la bomba:

1. Cerrar la válvula de corte de la descarga.
2. Quitar el tapón de cebado P, fig. 4.
3. Verter líquido por la boca de cebado. Comprobar que la tubería de aspiración y la bomba estén completamente llenas de líquido y purgadas.
4. Volver a poner el tapón de cebado y apretarlo bien.
5. Arrancar la bomba y abrir despacio la válvula de descarga hasta que éste completamente abierta.

E

4.2 Frecuencia de arranques y paradas

Máx. 100 arranques a la hora.

5. Funcionamiento y mantenimiento

Bajo condiciones de funcionamiento normales, la bomba no necesita mantenimiento.

Si se ha utilizado para bombear líquidos que pueden dejar impurezas en la bomba, hay que lavarla bien con agua limpia inmediatamente después de su utilización.

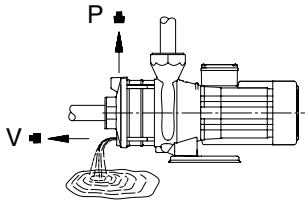
5.1 Protección contra heladas

Las bombas que no se utilizan durante periodos de heladas deben vaciarse para evitar daños.

Quitar los tapones de cebado P y de vaciado V, fig. 5.

No volver a poner los tapones hasta que la bomba vaya a utilizarse de nuevo.

Fig. 5



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6. Localización de fallos

Antes de intentar diagnosticar un fallo, comprobar que el suministro eléctrico está desconectado.

Fallo	Causa
1. La bomba no arranca.	a) Fallo del suministro eléctrico. b) El circuito de control se ha disparado o está defectuoso. c) La bomba está defectuosa. d) La bomba está bloqueada por impurezas.
2. La bomba funciona pero no da agua.	a) La bomba no está llena de líquido. b) La tubería de aspiración o de descarga está bloqueada por impurezas. c) La bomba está bloqueada por impurezas. d) La altura de aspiración es demasiado grande. e) Hay fugas en la tubería de aspiración. f) La válvula de pie o de retención está bloqueada.
3. La bomba funciona a capacidad reducida.	a) Sentido de giro contrario (trifásica). b) La altura de aspiración es demasiado grande. c) La tubería de aspiración o de descarga está bloqueada. d) La bomba está bloqueada por impurezas. e) La válvula de pie o de retención está parcialmente bloqueada.
4. La bomba para durante su funcionamiento.	a) Se dispara el térmico del motor o la protección externa. b) El circuito de control se ha disparado.

E

7. Eliminación

La eliminación de este producto o partes de él debe realizarse según las siguientes directrices:

1. Utilice el servicio local, público o privado, de recogida de resíduos.
2. En caso de que tal servicio no exista o no pueda tratar los materiales utilizados en el producto, por favor entréguelo al distribuidor o servicio técnico GRUNDFOS más cercano.

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Antes de iniciar os procedimentos de instalação, estas Instruções de Instalação e Funcionamento devem ser estudadas cuidadosamente. A instalação e o funcionamento devem estar de acordo com as normas locais e regras geralmente aceites.

1. Informações gerais

1.1 Aplicações

A gama CH/CHN de bombas centrífugas multicelulares horizontais GRUNDFOS destina-se a bombear água e outros líquidos finos, não agressivos e não explosivos, sem partículas ou fibras sólidas.

1.2 Condições de funcionamento

1.2.1 Temperatura do líquido

0°C a +90°C.

1.2.2 Temperatura ambiente

Até +55°C.

1.2.3 Pressão máxima de funcionamento

0°C a +40°C: máxima 10 bar.
+41°C a +90°C: máxima 6 bar.

1.2.4 Pressão máxima de admissão

A pressão de admissão actual mais a pressão durante o funcionamento da bomba com uma válvula fechada deverá ser sempre inferior à "pressão máxima de funcionamento".

1.2.5 Pressão mínima de admissão

O quadro seguinte refere-se aos **caudais máximos** das bombas e a uma pressão barométrica de 760 mm Hg.

Os valores indicados correspondem às pressões mínimas de admissão/alturas máximas de aspiração "H" [m] no lado de aspiração da bomba. Os valores são estabelecidos a diferentes temperaturas do líquido. **A perda de carga no tubo de aspiração deverá portanto ser considerada.**

A altura máxima de aspiração pode ser limitada pela altura manométrica efectiva.

Tipo	H [m]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

"H" = pressão mínima de admissão durante o funcionamento.

"H" com * = altura máxima de aspiração durante o funcionamento.

1 m ≈ 0,1 bar.

1.3 Características técnicas

1.3.1 Características eléctricas

Ver chapa sinalética da bomba.

1.3.2 Dimensões

Ver página 50.

1.4 Nível de pressão sonora

O nível de pressão sonora da bomba é inferior aos valores máximos definidos na Directiva do Conselho da UE 889/392/CEE relativamente a maquinaria.

P

2. Instalação

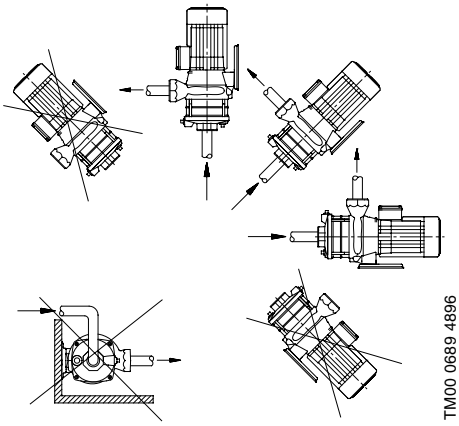
2.1 Localização da bomba

A bomba deve ser instalada de modo que o tubo de aspiração fique tão curto e a altura de aspiração tão pequena quanto possível.

A bomba deve ser colocada num local bem ventilado mas sem risco de congelamento (ver parágrafo *5.1 Protecção contra a formação de gelo*). Pode ser colocada no exterior mas protegida das intemperides através de uma protecção adequada.

A bomba pode ser colocada numa das posições da fig. 1.

Fig. 1



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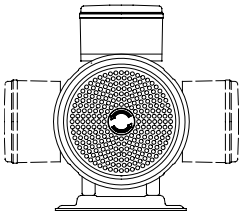
2.2 Posição da caixa de terminais

Antes da instalação da bomba pode-se colocar a caixa de terminais numa das posições indicadas na fig. 2.

Fig. 2



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Para mudar a posição da caixa de terminais:

1. Retirar os 4 parafusos do lado do motor, que estão aparafusados à câmara de descarga.
2. Rodar a caixa do estator para a posição exigida.
3. Colocar de novo os parafusos e apertá-los bem.

2.3 Tubagem

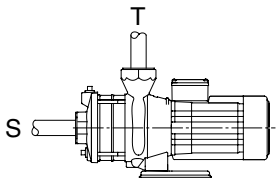
Os tubos devem ser montados de modo que a dilatação causada pelas variações de temperatura não afecte a bomba.

2.3.1 Tubo de aspiração

Se a bomba tem de bombear líquido de um nível inferior ao eixo de aspiração da bomba, deve-se montar uma válvula de pesca/retenção na extremidade do tubo de aspiração, abaixo do nível inferior do líquido, uma vez que a bomba não é auto-ferrante.

O tubo de aspiração está ligado do lado da admissão S da bomba, fig. 3.

Fig. 3



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Se o tubo de aspiração tem mais de 10 metros ou a altura de aspiração é superior a 4 metros, o diâmetro do tubo de aspiração tem de ser superior ao diâmetro de admissão da bomba.

Todas as juntas do tubo de aspiração devem estar bem apertadas.

Se utilizar uma mangueira no tubo de aspiração esta deve ser rígida. A utilização de um filtro é recomendada nos casos em que elementos sólidos podem penetrar no tubo de aspiração e bloquear a bomba.

2.3.2 Tubo de descarga

O tubo de descarga está ligado ao lado de saída T, fig. 3.

O tubo de descarga deverá ter pelo menos o mesmo diâmetro do lado de saída da bomba, para evitar quedas de pressão, velocidades de circulação altas e ruídos.

2.3.3 “Bypass”

Se existe o perigo de a bomba poder funcionar contra uma válvula fechada na compressão, deve assegurar-se a passagem de um caudal mínimo através da bomba, ligando um “bypass” ou dreno à tubagem de compressão. O dreno pode por exemplo ser ligado a um tanque.

Um caudal mínimo igual a 10% do caudal no ponto de rendimento máximo terá que ser sempre assegurado. O caudal e altura manométrica ao ponto de rendimento máximo estão inscritos na chapa de características da bomba.

2.4 Exemplos de instalações

A bomba é apropriada a uma vasta gama de aplicações.

Alguns exemplos são apresentados na página 49.

3. Ligações eléctricas

As ligações eléctricas devem ser feitas de acordo com as normas locais.

A tensão e frequência de funcionamento estão indicadas na placa de identificação. Verificar se o motor é apropriado para o abastecimento eléctrico onde vai ser utilizado.

Não devem ser feitas quaisquer ligações na caixa de terminais da bomba, sem que a alimentação eléctrica tenha sido desligada.

A bomba deve ser ligada a um interruptor de rede exterior.

Os motores monofásicos 1 x 110/220 V, 60 Hz, não incorporam uma protecção de motor e devem estar ligados a um arranque adequado.

Os outros motores monofásicos incorporam um interruptor térmico e não necessitam de protecção adicional.

Os motores trifásicos devem ser ligados a um arrancador, cuja regulação da corrente nominal deverá corresponder às características eléctricas, da chapa sinalética da bomba.

Não accionar a bomba antes de estar ferrada.

As ligações devem ser feitas conforme indicado no interior da tampa da caixa de terminais.

Escolher uma das duas entradas para o cabo eléctrico e quebrar a tampa de protecção, da entrada do bucim.

3.1 Verificação da direcção de rotação

(Motores trifásicos)

As setas na tampa do ventilador do motor indicam a direcção correcta da rotação.

A rotação da bomba deverá ser no sentido contrário ao dos ponteiros do relógio quando vista da extremidade do motor.

Para inverter a direcção da rotação desligar a corrente eléctrica e trocar dois dos fios eléctricos de entrada.

4. Arranque

4.1 Enchimento

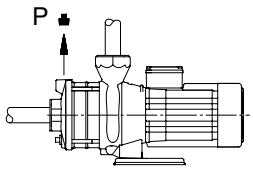
Ligar a bomba só depois de estar ferrada e ventilada.

Em sistemas com líquidos quentes a temperaturas elevadas, deverão ser tomadas grandes precauções quando se ferra a bomba, para evitar o risco de danos pessoais causados por esguinchos de água.

Sistemas de pressurização e sistemas em que o nível do líquido está acima da admissão da bomba:

1. Fechar as válvulas de isolamento de cada lado da bomba.
2. Retirar a tampa de enchimento P, fig. 4.
3. Abrir lentamente a válvula de ar e manté-la aberta até sair um caudal de líquido constante do lado de enchimento.
4. Fechar a válvula, colocar a tampa de enchimento e apertá-la bem.
5. Abrir a válvula de ar.
6. Accionar a bomba e abrir lentamente a válvula de descarga até estar completamente aberta.

Fig. 4



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Bombear água de reservatórios e poços onde o nível do líquido no lado de aspiração está abaixo da admissão da bomba:

1. Fechar a válvula de descarga.
2. Retirar a tampa de enchimento P, fig. 4.
3. Deitar água através do lado de enchimento. Verificar se o tubo de aspiração e a bomba estão completamente ferrados e ventilados.
4. Colocar de novo a tampa e apertá-la bem.
5. Accionar a bomba e abrir lentamente a válvula de descarga até estar completamente aberta.

4.2 Frequência dos arranques e paragens

Máximo 100 arranques por hora.

P

5. Funcionamento e manutenção

Em condições normais de funcionamento, a bomba não necessita de manutenção.

Se a bomba foi utilizada para bombear líquidos que possam ter deixado impurezas na bomba, deve ser lavada com água limpa logo após a utilização.

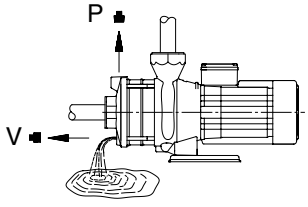
5.1 Protecção contra a formação de gelo

As bombas que não são utilizadas durante períodos de formação de gelo devem ser esvaziadas para evitar danos.

Retirar as tampas de enchimento e descarga P e V, fig. 5.

Não colocar as tampas antes da bomba ser usada de novo.

Fig. 5



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6. Tabela de localização de avarias

Antes de tentar diagnosticar qualquer avaria, verificar se a alimentação eléctrica foi desligada.

Avaria	Causa
1. A bomba não arranca.	a) Falha na corrente de energia. b) Circuito de controlo está desligado ou defeituoso. c) Motor defeituoso. d) Bomba bloqueada devido a impurezas.
2. A bomba trabalha mas não sai água.	a) A bomba não está ferrada. b) Tubos de aspiração ou descarga bloqueados devido a impurezas. c) Bomba bloqueada devido a impurezas. d) Excesso de altura de aspiração. e) Fuga no tubo de aspiração. f) Válvula de pesca/retenção bloqueada.
3. A bomba funciona a capacidade reduzida.	a) Direcção errada de rotação (trifásica). b) Excesso de altura de elevação. c) Tubos de aspiração ou descarga bloqueados ou defeituosos. d) Bomba bloqueada devido a impurezas. e) Válvula de pesca ou retenção parcialmente bloqueada.
4. A bomba para durante o funcionamento.	a) O interruptor térmico do motor ou da protecção exterior do motor desliga. b) Circuito de controlo está desligado.

7. Desperdício

P

O desperdício deste produto ou peças deve ser considerado em conformidade com as seguintes directrizes:

1. Utilizar o local público para o efeito ou o serviço de recolha de sucata.
2. Em caso deste serviço de recolha não existir ou a impossibilidade de manuseamento deste produto, agradecemos que este produto ou quaisquer materiais do mesmo sejam entregues na empresa GRUNDFOS ou serviço de reparações mais próximo.

ΠΕΡΙΕΧΟΜΕΝΑ

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Πριν από την έναρξη των διαδικασιών εγκατάστασης, παρακαλούμε να μελετήσετε προσεκτικά αυτές τις Οδηγίες Εγκατάστασης και Λειτουργίας. Η εγκατάσταση και λειτουργία θα πρέπει επίσης να πραγματοποιηθούν σύμφωνα με τους τοπικούς κανονισμούς και τους παραδεκτούς κανόνες σωστής χρήσης.

1. Γενικά Χαρακτηριστικά

1.1 Εφαρμογές

Η σειρά οριζόντιων πολυβάθμιων φυγόκεντρων αντλιών CH/CHN της GRUNDFOS σχεδιάστηκε για την άντληση νερού και άλλων λεπτόρευστων, μη-διαβρωτικών και μη-εκρηκτικών υγρών, που δεν περιέχουν στερεά σωματίδια ή ίνες.

1.2 Συνθήκες Λειτουργίας

1.2.1 Θερμοκρασία Υγρού

0˚C έως +90˚C.

1.2.2 Θερμοκρασία Περιβάλλοντος

Εως +55˚C.

1.2.3 Μέγιστη Πίεση Λειτουργίας

0˚C έως +40˚C: Εως 10 bars.
+41˚C έως +90˚C: Εως 6 bars.

1.2.4 Μέγιστη Πίεση Εισόδου

Η υπάρχουσα πίεση εισόδου συν την πίεση όταν η αντλία λειτουργεί με κλειστή βαλβίδα πρέπει να είναι πάντα μικρότερη από την "μέγιστη πίεση λειτουργίας".

1.2.5 Ελάχιστη Πίεση Εισόδου

Ο παρακάτω πίνακας αναφέρεται στις παροχές των αντλιών και σε μία βαρομετρική πίεση των 760 mmHg.

Οι τιμές που αναφέρονται είναι οι ελάχιστες πιέσεις εισόδου/μέγιστη ικανότητα αναρρόφησης "H" [m ύψους] στο στόμιο αναρρόφησης της αντλίας. Οι τιμές αναφέρονται σε διαφορετικές θερμοκρασίες υγρού. **Κατά συνέπεια, θα πρέπει να ληφθεί υπόψη η απώλεια στο σωλήνα αναρρόφησης.**

Η μέγιστη ικανότητα αναρρόφησης μπορεί να περιοριστεί από τις πραγματικές απώλειες.

Τάση	H [m ύψους]			
50 Hz	**20˚C**	**40˚C**	**55˚C**	**90˚C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

"H" = ελάχιστη πίεση εισόδου κατά τη λειτουργία.

"H" σημειωμένο με * = μέγιστη ικανότητα αναρρόφησης κατά τη λειτουργία.

1 m ύψους ≈ 0,1 bar.

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1.3 Τεχνικά Χαρακτηριστικά

1.3.1 Ηλεκτρικά Χαρακτηριστικά

Βλέπε την πινακίδα της αντλίας.

1.3.2 Διαστάσεις

Βλέπε σελίδα 50.

1.4 Στάθμη ηχητικής πίεσης

Η στάθμη ηχητικής πίεσης της αντλίας είναι μικρότερη από τις οριακές τιμές που ορίζονται στην Οδηγία του Συμβουλίου της ΕΚ 89/392/ΕΟΚ σχετικά με τα μηχανήματα.

2. Εγκατάσταση

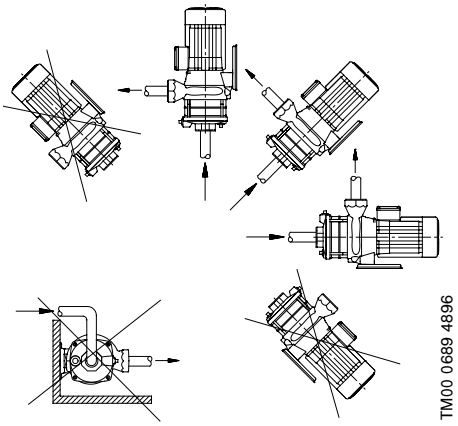
2.1 Τοποθέτηση της Αντλίας

Η αντλία πρέπει να τοποθετηθεί με τέτοιο τρόπο ώστε ο σωλήνας αναρρόφησης και το ύψος αναρρόφησης να είναι όσο το δυνατό μικρότερα.

Η αντλία πρέπει να τοποθετείται σε καλά αεριζόμενο χώρο, αλλά προστατευμένο έναντι του παγετού (βλέπε παράγραφο *5.1 Προστασία Εναντι Παγετού*). Μπορεί επίσης να τοποθετηθεί σε εξωτερικούς χώρους αρκεί να προστατεύεται από τα στοιχεία της φύσης κάτω από ένα σκέπαστρο ή οποιοδήποτε άλλο σύστημα προστασίας.

Η αντλία μπορεί να συναρμολογηθεί σε μία από τις παρακάτω θέσεις που απεικονίζονται στο σχήμα 1.

Σχήμα 1



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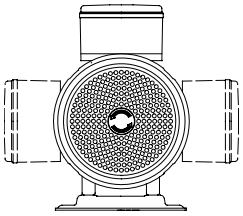
2.2 Τοποθέτηση του Ακροκιβωτίου

Το ακροκιβώτιο μπορεί να τοποθετηθεί σε μια οποιαδήποτε από τις παρακάτω θέσεις πριν από την εγκατάσταση της αντλίας.

Σχήμα 2



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Για να αλλάξετε τη θέση του ακροκιβωτίου:

1. Αφαιρέστε τις τέσσερις βίδες οι οποίες, από την πλευρά του κινητήρα, είναι βιδωμένες στο κέλυφος κατάθλιψης.
2. Γυρίστε το περίβλημα του στάτη στην επιθυμητή θέση.
3. Τοποθετείστε τις βίδες και σφίξτε.

2.3 Σωληνώσεις

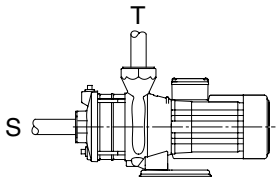
Οι σωλήνες πρέπει να τοποθετούνται με τέτοιο τρόπο ώστε οποιεσδήποτε συστολές/διαστολές που προκαλούνται από τις μεταβολές της θερμοκρασίας να μην καταπονούν την αντλία.

2.3.1 Σωλήνας Αναρρόφησης

Σε περίπτωση που η αντλία πρόκειται να αντλήσει υγρό από μία στάθμη που βρίσκεται χαμηλότερα από το στόμιο αναρρόφησης, μία ποδοβαλβίδα πρέπει να τοποθετηθεί στο άκρο του σωλήνα αναρρόφησης, κάτω από τη χαμηλότερη στάθμη του υγρού, εφόσον δεν πρόκειται για αντλία αυτόματης αναρρόφησης.

Ο σωλήνας αναρρόφησης συνδέεται στο στόμιο αναρρόφησης της αντλίας S, σχήμα 3.

Σχήμα 3



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Οταν ο σωλήνας αναρρόφησης είναι μακρύτερος από 10 μέτρα ή το ύψος αναρρόφησης είναι μεγαλύτερο από 4 μέτρα, η διάμετρος του σωλήνα αναρρόφησης πρέπει να είναι μεγαλύτερη από αυτή του στομίου αναρρόφησης της αντλίας.

Ολοι οι σύνδεσμοι του σωλήνα πρέπει να είναι απόλυτα στεγανοί.

Μην χρησιμοποιείτε εύκαμπτο σωλήνα αναρρόφησης παρά μόνο εάν είναι ενισχυμένος. Συνιστάται η χρησιμοποίηση ενός φίλτρου στις περιπτώσεις που υπάρχει πιθανότητα να εισέλθουν στερεά στο σωλήνα αναρρόφησης και να φράξουν την αντλία.

2.3.2 Σωλήνας Κατάθλιψης

Ο σωλήνας κατάθλιψης είναι συνδεδεμένος στο στόμιο κατάθλιψης T, σχήμα 3.

Ο σωλήνας κατάθλιψης θα πρέπει να έχει τουλάχιστον την ίδια διάμετρο με το στόμιο κατάθλιψης της αντλίας για να ελαχιστοποιείται η πτώση πίεσης, οι υψηλές ταχύτητες ροής και ο θόρυβος.

2.3.3 Bypass (Παράκαμψη)

Αν υπάρχει κίνδυνος η αντλία να λειτουργήσει με κλειστή βάννα κατάθλιψης, θα πρέπει να εξασφαλιστεί μια ελάχιστη ροή υγρού μέσα στην αντλία συνδέοντας ένα bypass/απομάστευση στο σωλήνα κατάθλιψης. Η απομάστευση μπορεί, για παράδειγμα, να συνδεθεί σε μια δεξαμενή.

Σε όλες τις περιπτώσεις απαιτείται μια ελάχιστη παροχή ίση με το 10% της παροχής κατά τη μέγιστη απόδοση. Η παροχή και το μανομετρικό ύψος κατά τη μέγιστη απόδοση υποδεικνύονται στην πινακίδα της αντλίας.

2.4 Παραδείγματα Εγκατάστασης

Η αντλία μπορεί να χρησιμοποιηθεί σε ένα ευρύ φάσμα εφαρμογών.

Ορισμένα παραδείγματα αναφέρονται στη σελίδα 49.

3. Ηλεκτρικές Συνδέσεις

Οι ηλεκτρικές συνδέσεις θα πρέπει να πραγματοποιούνται σύμφωνα με τις τοπικές προδιαγραφές.

Η τάση και η συχνότητα τροφοδοσίας αναφέρονται στην πινακίδα. Βεβαιωθείτε ότι ο κινητήρας είναι κατάλληλος για την ηλεκτρική παροχή στην οποία θα χρησιμοποιηθεί.

Ποτέ μην πραγματοποιήσετε οποιαδήποτε σύνδεση στο ακροκιβώτιο της αντλίας χωρίς να διακόψετε προηγουμένως την ηλεκτρική παροχή.

Η αντλία πρέπει να είναι συνδεδεμένη με έναν εξωτερικό γενικό διακόπτη.

Οι μονοφασικοί κινητήρες, 1 x 110/220 V, 60 Hz, δεν διαθέτουν ενσωματωμένη προστασία του κινητήρα και κατά συνέπεια πρέπει να συνδέονται με έναν εγκεκριμμένο εκκινητή.

Αλλοι μονοφασικοί κινητήρες περιλαμβάνουν θερμικό διακόπτη υπερφόρτωσης και δεν χρειάζονται συμπληρωματική προστασία κινητήρα.

Οι τριφασικοί κινητήρες πρέπει να συνδέονται σε εκκινητή, η ρύθμιση της ονομαστικής έντασης του οποίου πρέπει να ανταποκρίνεται στα ηλεκτρικά χαρακτηριστικά που αναγράφονται στην πινακίδα των αντλιών.

Μη θέσετε σε λειτουργία την αντλία πριν τη γεμίσετε με υγρό.

Οι συνδέσεις πρέπει να πραγματοποιηθούν με τον τρόπο που υποδεικνύεται στο εσωτερικό του καλύμματος του ακροκιβωτίου.

Επιλέξτε μία από τις δύο εισόδους καλωδίου και αφαιρέστε τον ήδη κομμένο δίσκο.

3.1 Ελεγχος της Φοράς Περιστροφής

(Τριφασικοί κινητήρες)

Η σωστή φορά περιστροφής επισημαίνεται με βέλη στο κάλυμμα του ανεμιστήρα του κινητήρα.

Η σωστή φορά περιστροφής είναι η αντίθετη της φοράς των δεικτών του ρολογιού, όταν κοιτάμε από την πλευρά του κινητήρα.

Σε περίπτωση που ο κινητήρας περιστρέφεται με τη λανθασμένη φορά, κλείστε την ηλεκτρική παροχή και εναλλάξτε δύο από τις τρεις φάσεις.

4. Εκκίνηση

4.1 Πλήρωση της Αντλίας

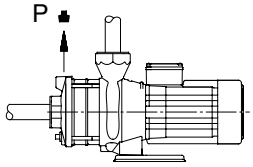
Μη θέσετε την αντλία σε λειτουργία εάν προηγουμένως δεν την έχετε γεμίσει με υγρό και εξαερώσει επαρκώς.

Σε εγκαταστάσεις ζεστού νερού, απαιτείται ιδιαίτερη προσοχή κατά την εξαέρωση της αντλίας προκειμένου να αποφευχθούν οι κίνδυνοι τραυματισμού που μπορεί να προκληθούν από τη διαφυγή καυτού νερού.

Πιεστικά συγκροτήματα και συστήματα όπου η στάθμη του υγρού στην πλευρά της αναρρόφησης βρίσκεται πάνω από την είσοδο της αντλίας:

1. Κλείστε τις αποφρακτικές βάννες και από τις δύο πλευρές της αντλίας.
2. Αφαιρέστε το πώμα πλήρωσης P, σχήμα 4.
3. Ανοίξτε σταδιακά τη βάννα αναρρόφησης και διατηρείστε την ανοικτή μέχρι να εξέλθει από το στόμιο ποσότητα υγρού με σταθερή ροή.
4. Κλείστε τη βάννα, επανατοποθετήστε το πώμα πλήρωσης και σφίξτε το προσεκτικά.
5. Ανοίξτε τη βάννα αναρρόφησης.
6. Θέστε σε λειτουργία την αντλία και ανοίξτε σταδιακά τη βάννα κατάθλιψης μέχρι να ανοίξει τελείως.

Σχήμα 4



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Αντληση από δεξαμενές και φρεάτια όπου η στάθμη του υγρού στην πλευρά της αναρρόφησης βρίσκεται κάτω από την είσοδο της αντλίας:

1. Κλείστε την αποφρακτική βάννα της κατάθλιψης.
2. Αφαιρέστε το πώμα πλήρωσης P, σχήμα 4.
3. Πληρώσατε με νερό από το στόμιο αναρρόφησης. Βεβαιωθείτε ότι ο σωλήνας αναρρόφησης και η αντλία έχουν γεμίσει και εξαερωθεί επαρκώς.
4. Επανατοποθετήστε το πώμα πλήρωσης και σφίξτε προσεκτικά.
5. Θέστε σε λειτουργία την αντλία και ανοίξτε σταδιακά τη βάννα κατάθλιψης μέχρι να ανοίξει τελείως.

4.2 Συχνότητα Εκκινήσεων και Στάσεων

100 εκκινήσεις/ώρα το πολύ.

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5. Λειτουργία και Συντήρηση

Υπό φυσιολογικές συνθήκες λειτουργίας, η αντλία δεν χρειάζεται συντήρηση.

Σε περίπτωση που η αντλία έχει χρησιμοποιηθεί για υγρά που μπορεί να αφήσουν ακαθαρσίες, η αντλία θα πρέπει να καθαριστεί με καθαρό νερό αμέσως μετά τη χρήση της.

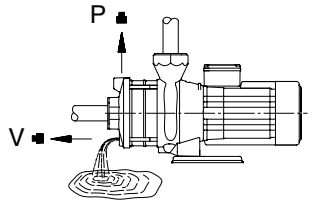
5.1 Προστασία Εναντι Παγετού

Αντλίες οι οποίες δεν χρησιμοποιούνται σε χρονικές περιόδους παγετού, θα πρέπει να αποστραγγίζονται για να αποφευχθούν πιθανές ζημιές.

Αφαιρέστε τα πώματα πλήρωσης και αποστράγγισης P και V, σχήμα 5.

Μην επανατοποθετείτε τα πώματα μέχρι την επαναχρησιμοποίηση της αντλίας.

Σχήμα 5



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6. Πίνακας Εντόπισης Προβλημάτων

Πριν αποπειραθείτε να εντοπίσετε οποιοδήποτε πρόβλημα, βεβαιωθείτε ότι έχετε κλείσει την παροχή ρεύματος.

Πρόβλημα	Αιτία
1. Η αντλία δεν ξεκινάει.	a) Διακοπή της παροχής ηλεκτρικού ρεύματος. b) Το κύκλωμα ελέγχου παρουσιάζει διακοπή ή είναι ελαττωματικό. c) Ο κινητήρας είναι ελαττωματικός. d) Η αντλία έχει φράξει από ακαθαρσίες.
2. Η αντλία λειτουργεί, αλλά δεν αντλεί νερό.	a) Η αντλία δεν είναι γεμάτη με υγρό. b) Ο σωλήνας αναρρόφησης ή κατάθλιψης έχει φράξει από ακαθαρσίες. c) Η αντλία έχει φράξει από ακαθαρσίες. d) Το ύψος αναρρόφησης είναι πολύ μεγάλο. e) Υπαρξη διαρροής στο σωλήνα αναρρόφησης. f) Η ποδοβαλβίδα ή η βαλβίδα αντεπιστροφής έχουν φράξει.
3. Η αντλία λειτουργεί με μειωμένη δυνατότητα.	a) Λανθασμένη φορά περιστροφής (τριφασικοί κινητήρες). b) Το ύψος αναρρόφησης είναι πολύ μεγάλο. c) Ο σωλήνας αναρρόφησης ή κατάθλιψης έχει φράξει από ακαθαρσίες. d) Η αντλία έχει φράξει από ακαθαρσίες. e) Η ποδοβαλβίδα ή η βαλβίδα αντεπιστροφής είναι μερικώς φραγμένες.
4. Η αντλία παρουσιάζει διακοπές κατά τη διάρκεια της λειτουργίας.	a) Ο θερμικός διακόπτης υπερφόρτωσης ή η εξωτερική προστασία κινητήρα έχει διακόψει. b) Το κύκλωμα ελέγχου έχει διακόψει.

GR

7. Απόρριψη

Η απόρριψη εξαρτημάτων ή ολόκληρου του προιόντος αυτού πρέπει να γίνεται σύμφωνα με τις ακόλουθες οδηγίες:

1. Χρησιμοποιείστε τα δημοτικά ή ιδιωτικά μέσα αποκομμιδής απορριμάτων.
2. Στην περίπτωση που δεν υπάρχουν τα ανωτέρω μέσα, παρακαλούμε παραδώστε το προιόν ή οποιοδήποτε επιβλαβές υλικό από αυτό στη GRUNDFOS ή στο πλησιέστερο εργαστήριο επισκευών.

Υπόκειται σε τροποποιήσεις.

INHOUD

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Alvorens de pomp te installeren dient u deze installatie- en bedieningsinstructies zorgvuldig te bestuderen. De installatie en bediening dienen volgens de in Nederland/België geldende regels en met kennis van zaken plaats te vinden.

1. Algemene gegevens

1.1 Toepassingen

De GRUNDFOS horizontale meertraps centrifugaalpompen serie CH en CHN zijn bestemd voor het verpompen van water en andere dunvloeibare, niet-agressieve en niet-explosieve vloeistoffen, die geen vaste delen of vezels bevatten.

1.2 Bedrijfsomstandigheden

1.2.1 Vloeistoftemperatuur

0°C tot +90°C.

1.2.2 Omgevingstemperatuur

Tot +55°C.

1.2.3 Maximum werkdruk

0°C tot +40°C: maximum 10 bar.
+41°C tot +90°C: maximum 6 bar.

1.2.4 Maximum inlaatdruk

De werkelijke inlaatdruk plus de druk als de pomp werkt met een gesloten persafsluiter, moet altijd lager zijn dan de maximum werkdruk.

1.2.5 Minimum inlaatdruk

Onderstaande tabel heeft betrekking op de **maximum doorstroomsnelheden** voor de diverse typen bij een barometerdruk van 760 mm Hg.

De opgegeven waarden zijn de minimum inlaatdrukken/maximum zuighoogten “H” (in m waterkolom) aan de zuigzijde van de pomp. Deze waarden zijn gegeven voor verschillende vloeistoftemperaturen. **Daarbij moet met het drukverlies in de zuigleiding rekening worden gehouden**.

De maximum aanzuighoogte kan beperkt worden door de opvoerhoogte van de pomp.

Type	H [mWk]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

“H” = de minimum inlaatdruk tijdens bedrijf.

“H” * = de maximum zuighoogte tijdens bedrijf.

1 m waterkolom ≈ 0,1 bar.

1.3 Technische gegevens

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1.3.1 Elektrische gegevens

Zie het typeplaatje van de pomp.

1.3.2 Afmetingen

Zie pagina 50.

1.4 Geluidsdrukniveau

Het geluidsdrukniveau van de pomp ligt binnen de grenzen als vermeld in de Richtlijn van de Europese Raad inzake de onderlinge aanpassing van de wetgevingen van de Lid-Staten betreffende machines (89/392/EEG).

2. Installatie

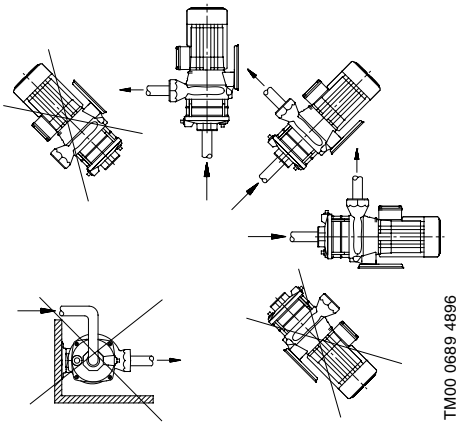
2.1 Plaatsing van de pomp

De pomp moet zo worden geïnstalleerd dat de zuigleiding zo kort mogelijk en de zuighoogte zo gering mogelijk is.

De pomp moet op een goed geventileerde, maar vorstvrije plaats worden opgesteld (zie punt *5.1 Vorstbeveiliging*). Hij kan buiten worden geplaatst, maar moet dan door een geschikte afdekking worden beschermd tegen de weersinvloeden.

De pomp kan in één van de in fig. 1 getoonde standen worden geplaatst.

Fig. 1



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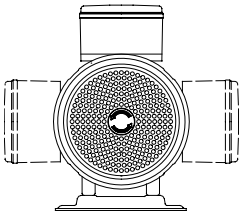
2.2 Stand van de klemmenkast

De elektrische klemmenkast kan vóór installatie van de pomp in één van de in fig. 2 getoonde standen worden gedraaid.

Fig. 2



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Om de stand van de klemmenkast te wijzigen moet men:

1. De vier bouten, die vanaf de motorzijde in de kamer aan de perszijde zijn geschroefd, wegnemen.
2. Het statorhuis in de gewenste stand draaien.
3. De vier bouten weer aanbrengen en goed vastzetten.

2.3 Leidingen

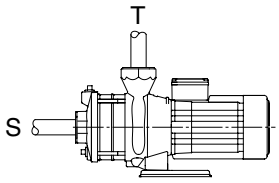
De leidingen moeten zo worden aangebracht dat eventuele spanningen als gevolg van wisselende temperaturen geen invloed hebben op de pomp.

2.3.1 Zuigleiding

Als de pomp vloeistof moet aanzuigen van een niveau dat lager is dan de zuigaansluiting van de pomp, moet een voetklep/terugslagklep worden aangebracht aan het einde van de zuigleiding beneden het laagst voorkomende vloeistofniveau, daar de pomp niet zelfaanzuigend is.

De zuigleiding moet aan de zuigaansluiting S van de pomp worden aangesloten, zie fig. 3.

Fig. 3



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Als de zuigleiding langer is dan 10 meter of de zuighoogte groter dan 4 meter, moet de diameter van de zuigleiding groter zijn dan die van de zuigaansluiting van de pomp.

Alle koppelingen van de zuigleiding moeten volkomen lucht- en vloeistofdicht zijn en goed zijn aangedraaid.

Indien een slang wordt gebruikt als zuigleiding, mag die niet kunnen dichtklappen. Het verdient aanbeveling, een zeef aan te brengen wanneer vaste deeltjes in de zuigleiding kunnen worden meegevoerd en de pomp kunnen verstoppen of doen vastlopen.

2.3.2 Persleiding

De persleiding moet aan de persaansluiting T van de pomp worden aangesloten, zie fig. 3.

De persleiding moet tenminste dezelfde diameter hebben als de persaansluiting van de pomp, teneinde drukverlies, hoge vloeistofsnelheden en hinderlijk geluid tot een minimum te beperken.

2.3.3 Bypass

Indien er enig gevaar bestaat dat de pomp tegen een gesloten persafsluiter draait, dient een bypass/aftap op de persleiding te worden gemonteerd, zodat er altijd een kleine hoeveelheid vloeistof blijft stromen. De aftap kan bijvoorbeeld worden aangesloten op een reservoir.

De minimale capaciteit mag nooit lager zijn dan 10% van de capaciteit bij maximaal rendement. De capaciteit en de opvoerhoogte bij maximaal rendement staan vermeld op het typeplaatje van de pomp.

2.4 Installatievoorbeelden

De pomp is geschikt voor een groot aantal toepassingen.

Op pag. 49 worden enige voorbeelden getoond.

3. Elektrische aansluiting

De elektrische aansluiting moet worden uitgevoerd volgens de ter plaatse geldende voorschriften.

De spanning en frequentie zijn op de naamplaat van de pomp vermeld. Controleer of de motor geschikt is voor de netstroom, waarop hij zal worden aangesloten.

Zorg dat de voedingsspanning is uitgeschakeld, alvorens in de klemmenkast aansluitingen uit te voeren.

De pomp dient te zijn aangesloten op een externe netschakelaar.

Wisselstroommotoren, 1 x 110/220 V, 60 Hz, zijn niet voorzien van een beveiliging en moeten worden aangesloten op een goedgekeurde beveiligingsschakelaar.

Andere wisselstroommotoren zijn voorzien van een thermische overbelastingsschakelaar en hebben geen verdere beveiliging nodig.

Draaistroommotoren moeten worden aangesloten aan een motorstarter met motorbeveiligingschakelaar. Deze dient afgesteld te worden in overeenstemming met de nominaalstroom welke staat gespecificeerd op het typeplaatje.

Start de pomp niet voordat hij met vloeistof is gevuld.

De aansluitingen moeten worden gemaakt volgens het schema dat zich aan de binnenkant van het deksel van de aansluitdoos bevindt.

Kies één van de twee kabelingangen en verwijder de voorgesneden ring.

3.1 Controle van de draairichting

(Draaistroommotoren)

De juiste draairichting is aangegeven door pijlen op het deksel van de ventilator van de motor.

De pomp moet linksom draaien, gezien vanaf de motorzijde.

Om de draairichting te veranderen schakelt u de stroomtoevoer uit en verwisselt twee van de drie stroomtoevoerdraden.

4. Starten

4.1 Vullen

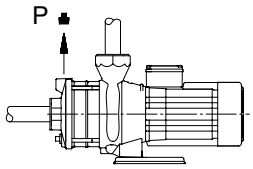
Start de pomp niet voordat hij met vloeistof gevuld en ontlucht is.

In systemen met hete vloeistoffen dient tijdens het ontluchten rekening gehouden te worden met gevaar voor verbranding door uitstromend water.

Situaties waarbij het vloeistofpeil aan de zuigzijde hoger is dan de inlaatopening van de pomp:

1. Sluit de afsluiters aan weerszijden van de pomp.
2. Neem de plug P, fig. 4, weg.
3. Open langzaam de zuigafsluiter en houd deze open tot een gelijkmatige stroom vloeistof uit de opening stroomt.
4. Zet de zuigafsluiter dicht, breng de plug weer op zijn plaats en draai hem goed vast aan.
5. Open de zuigafsluiter.
6. Start de pomp en open langzaam de persafsluiter tot deze geheel open staat.

Fig. 4



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Pompen van water of vloeistoffen uit tanks of putten waar het vloeistofpeil aan de zuigzijde lager is dan de inlaatopening van de pomp:

1. Sluit de afsluiter aan de perszijde van de pomp.
2. Neem de plug P, fig. 4, weg.
3. Giet water of vloeistof door de opening tot de zuigleiding en de pomp geheel gevuld en ontlucht zijn.
4. Breng de plug weer op zijn plaats en draai hem goed vast aan.
5. Start de pomp en open langzaam de persafsluiter tot deze geheel open staat.

4.2 Frequentie van starten en stoppen

Maximum 100 maal starten per uur.

5. Bedrijf en onderhoud

Onder normale bedrijfsomstandigheden heeft de pomp geen onderhoud nodig.

Als de pomp gebruikt is voor vloeistoffen die verontreinigingen in de pomp kunnen achterlaten, moet hij onmiddellijk na gebruik met schoon water worden doorgespoeld.

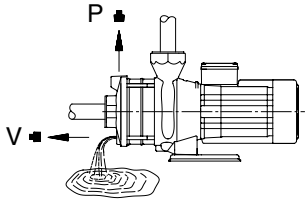
5.1 Vorstbeveiliging

Bij pompen, die tijdens vorstperioden niet in gebruik zijn, moet de vloeistof worden afgetapt om schade te voorkomen.

Verwijder daartoe de vul- en aftapplug P en V, fig. 5.

Breng de pluggen niet weer aan voordat de pomp opnieuw moet worden gebruikt.

Fig. 5



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6. Storingstabel

Schakel vóór het zoeken naar storingen eerst de voedingsspanning uit.

Storing	Dorzaak
1. Pomp start niet.	a) Geen stroomtoevoer. b) Stuurstroomcircuit is uitgeschakeld, afgeslagen of defect. c) Motor is defect. d) Pomp is verstopt door verontreiniging.
2. Pomp loopt, maar levert geen vloeistof.	a) Pomp is niet met vloeistof gevuld. b) Zuig- of persleiding is verstopt door verontreinigingen. c) Pomp is verstopt door verontreinigingen. d) Opvoerhoogte is te groot. e) Lekkage in de zuigleiding. f) Voet- of terugslagklep is geblokkeerd.
3. Pomp loopt met geringere capaciteit.	a) Verkeerde draairichting (draaistroommotor). b) Opvoerhoogte is te groot. c) Zuig- of persleiding is verstopt. d) Pomp is verstopt door verontreinigingen. e) Voet- of terugslagklep is gedeeltelijk geblokkeerd.
4. Pomp stopt tijdens bedrijf.	a) Thermische overbelastingsschakelaar of externe motorbeveiliging is afgeslagen. b) Stuurstroomcircuit is afgeslagen.

7. Afvalverwerking

Na gebruik van deze pomp of onderdelen dienen de volgende richtlijnen in acht genomen te worden.

1. Neem de overheids- en gemeentelijke richtlijnen voor afvalverwerking in acht.
2. Als de afvalverwerkende instanties ons product niet kunnen verwerken, dan kunt u ons product bij ons inleveren.

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Läs noggrant igenom denna monterings- och driftsinstruktion innan installation av pumpen påbörjas. I övrigt skall installation och drift ske enligt lokala föreskrifter och gängse praxis.

1. Allmänt

1.1 Användning

GRUNDFOS CH- och CHN-pumpar är horisontella flerstegs centrifugalpumpar för pumpning av rent vatten och andra tunnflytande, icke-aggressiva och icke-explosiva vätskor utan fasta beståndsdelar och fibrer.

1.2 Driftsområde

1.2.1 Vätsketemperatur

0°C till 90°C.

1.2.2 Omgivningstemperatur

Max. 55°C.

1.2.3 Max. driftstryck

0°C till 40°C: Max. 10 bar.
41°C till 90°C: Max. 6 bar.

1.2.4 Max. tilloppstryck

Aktuellt tilloppstryck + pumpens tryck mot stängd ventil skall vara mindre än “max. driftstryck”.

1.2.5 Min. tilloppstryck

Vid pumpens **max. flöde** och barometerstånd 760 mm Hg gäller nedanstående tabell.

Det är min. tilloppstryck / max. sughöjd “H” [m] vid pumpens sugstuds, som är angivet vid olika vätsketemperaturer, **varför hänsyn skall tas till tryckfall i sugledningen**.

Max. sughöjd begränsas eventuellt av den aktuella lyfthöjden.

Typ	H [m]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

“H” = min. tilloppstryck vid drift.

“H” med * = max. sughöjd vid drift.

1 m ≈ 0,1 bar.

1.3 Tekniska data

1.3.1 Elektriska data

Se pumpens typskylt.

1.3.2 Mått

Se sida 50.

1.4 Ljudtrycksnivå

Pumpens ljudtrycksnivå ligger under de gränsvärden, som finns angivna i Europarådets direktiv 89/392/EEC (maskindirektivet).

S

2. Installation

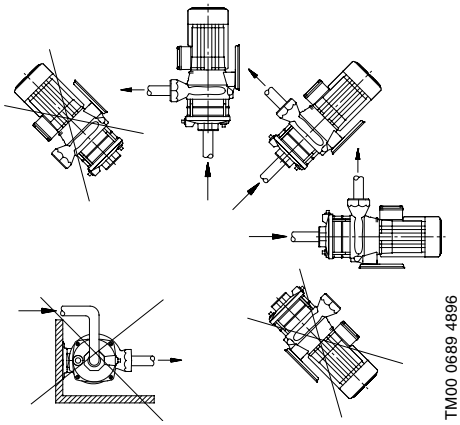
2.1 Placering av pumpen

Pumpen skall placeras så att sugrörslängden och sughöjden blir så kort som möjligt.

Pumpen bör placeras på frostfri plats (se avsnitt *5.1 Frostsäkring*) och med god ventilation. Den kan placeras utomhus, men bör skyddas mot direkt regn, t.ex. med en enkel takkonstruktion el. liknande.

Pumpen får sättas in i de lägen som visas i fig. 1.

Fig. 1



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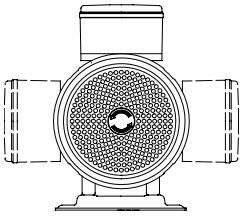
2.2 Kopplingsboxens placering

Kopplingsboxens position kan ändras till en av de i fig. 2 visade positionerna, innan pumpen monteras.

Fig. 2



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Ändring av kopplingsboxens position:

1. Demontera de fyra skruvarna som sitter i toppstycket från motorsidan.
2. Vrid statorhuset till önskad position.
3. Montera skruvarna och dra åt.

S

2.3 Rörledningar

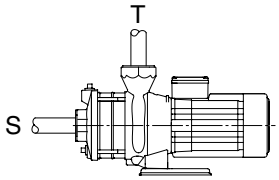
Rördragningen skall göras så att pumpen inte utsätts för mekanisk påverkan, ex. termisk expansion.

2.3.1 Sugledning

Är vätskenivån på sugsidan lägre än pumpen skall en back-/bottenventil monteras på sugledningen, eftersom pumpen inte är självsugande.

Sugledningen ansluts till pumpens sugstuds S, fig. 3.

Fig. 3



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Om sugledningen är längre än 10 m eller sughöjden större än 4 m skall sugledningens diameter vara större än sugstudsens.

Se till att alla anslutningar på sugledningen är täta.

Används slang på sugsidan skall denna vara förstärkt så att ihopsugning förhindras. För att förhindra uppsugning av föroreningar kan sugledningen förses med ett skydd (sil eller filter).

2.3.2 Tryckledning

Tryckledningen ansluts till pumpens tryckstuds T, fig. 3.

Tryckledningens diameter bör vara minst lika stor som tryckstudsens diameter för att undvika tryckfall, höga vattenhastigheter och oljud.

2.3.3 Returledning

Om det finns risk för drift mot stängd tryckledning måste ett minimiflöde genom pumpen säkras genom att trycksidan förses med en returledning/avlopp till en tank eller liknande.

Minimiflödet skall vara minst 10% av flödet vid max. verkningsgrad. Flöde och tryckhöjd vid max. verkningsgrad framgår av pumpens typskylt.

2.4 Installationsexempel

Pumpen har många användningsmöjligheter.

På sida 49 visas några exempel.

3. Elanslutning

Elanslutning skall utföras i enlighet med lokalt gällande bestämmelser och normer.

Kontrollera att nätspänning och frekvens stämmer med värdena på typskylten.

Före varje ingrepp i pumpens kopplingsbox skall nätspänningen slås ifrån.

Pumpen skall anslutas till en extern arbetsbrytare.

1-fas motorer stämplade 1 x 110/220 V, 60 Hz, har inte inbyggt motorskydd och skall därför anslutas till externt motorskydd.

Övriga 1-fas motorer har inbyggt motorskydd och behöver därför inget ytterligare motorskydd.

3-fas motorer skall anslutas till ett motorskydd, om inställd märkström skall stämma överens med elektriska data på pumpens typskylt.

Pumpen skall inte startas innan den är fylld med vätska.

Den elektriska anslutningen görs enligt anvisningarna i kopplingsboxens lock.

Välj en av de två kabelgenomföringarna och ta bort blindpluggen.

3.1 Rotationsriktning

(3-fas motorer)

Pilarna på motorns ventilationskåpa visar rätt rotationsriktning.

Rotationsriktningen skall vara moturs, sett mot ventilationskåpan.

Om rotationsriktningen är felaktig, skall två faser kastas om i motorns anslutning till motorskyddet.

4. Igångkörning

4.1 Vätskepåfyllning

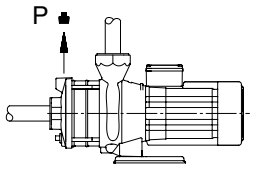
Innan pumpen kan startas, skall den fyllas med vatten och avluftas.

Vid anläggning med heta vätskor bör man, under avluftning, vara extra försiktig för att förhindra personskador förorsakat av utströmmande vätska.

I tryckstegringsanläggningar och anläggningar där vätskenivån på sugsidan ligger över pumpen:

1. Stäng avstängningsventilerna på sug- och trycksidan.
2. Skruva ur påfyllningsproppen P, fig. 4.
3. Öppna gradvis ventilen på sugsidan och håll den öppen, tills en jämn vattenstråle flödar ut från påfyllningsstudsen.
4. Stäng ventilen, sätt i påfyllningsproppen och dra åt den tills den blir tät.
5. Öppna ventilen på sugsidan helt.
6. Starta pumpen och öppna avstängningsventilen på trycksidan gradvis till helt öppet läge.

Fig. 4



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Pumpning från tank eller brunn, där vätskenivån på sugsidan ligger under pumpen:

1. Stäng avstängningsventilen på trycksidan.
2. Skruva ur påfyllningsproppen P, fig. 4.
3. Häll vatten i påfyllningshålet. Se till att sugledning och pump blir helt fyllda och avluftade.
4. Sätt i påfyllningsproppen igen och dra åt den så att den blir tät.
5. Starta pumpen och öppna avstängningsventilen på trycksidan gradvis till helt öppet läge.

4.2 Start/stopp

Max. 100 starter per timma.

5. Drift och underhåll

Pumpen kräver inte något underhåll vid normal drift.

Om pumpen använts för orena vätskor skall den rensköljas direkt efter användningen.

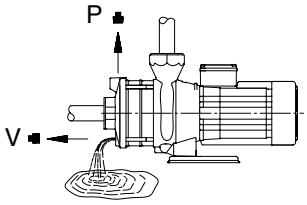
5.1 Frostsäkring

Pumpar som inte används i frostperioder, bör tömmas så att inte några skador kan uppstå.

Skruva ur påfyllnings- och tömningspropp P och V, fig. 5.

Sätt sedan inte i propparna förrän pumpen skall tas i drift igen.

Fig. 5



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6. Felsökning

Om felsökning skall påbörjas, skall strömmen vara frånslagen.

Fel	Orsak
1. Pumpen startar inte.	a) Spänningsförsörjning till motorn saknas eller är felaktig. b) Ev. styrkrets defekt. c) Motorn defekt. d) Pumpen blockerad av föroreningar.
2. Pumpen går men ger inget vatten.	a) Pumpen ej fylld med vätska. b) Sug- eller tryckledning blockerad av föroreningar. c) Pumpen blockerad av föroreningar. d) Sughöjden för stor. e) Sugledningen otät. f) Back-/bottenventil delvis blockerad.
3. Reducerat tryck och vätskemängd.	a) Motorns rotationsriktning fel (3-fas). b) Sughöjden för stor. c) Sug- eller tryckledning blockerad. d) Pumpen blockerad av föroreningar. e) Back-/bottenventil delvis blockerad.
4. Pumpen slår ifrån vid drift.	a) Termokontakt i motorn eller externt motorskydd löser ut. b) Ev. styrkrets defekt.

7. Destruktion

Destruktion av denna produkt eller delar härav skall ske enligt följande riktlinjer:

1. Använd lokalt gällande offentliga eller privata förordningar eller regler för destruktion.
2. Om sådana föreskrifter eller förordningar saknas eller att material som ingår i produkten inte emottages, kan produkten eller därifrån eventuella miljöfarliga material lämnas till närmaste GRUNDFOS-bolag.

S

Rätt till ändringar förbehålles.

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Ennenkuin pumpun asennus aloitetaan, on tämä asennus- ja käyttöohje luettava huolellisesti. Asennuksen ja käytön tulee muilta osin tapahtua paikallisten säännösten ja yleisen käytännön mukaisesti.

1. Yleistä

1.1 Käyttö

GRUNDFOS CH ja CHN pumput ovat makaavia monijaksoisia keskipakopumppuja veden ja muiden kevytjuoksuisten nesteiden pumppaukseen, jotka eivät sisällä kiintoaineita tai kuituja eivätkä ole aggressiivisia tai räjähdysalttiita.

1.2 Käyttöalue

1.2.1 Nesteen lämpötila

0°C ... +90°C.

1.2.2 Ympäristölämpötila

Enint. +55°C.

1.2.3 Suurin käyttöpaine

0°C ... +40°C: enint. 10 bar.
+41°C ... +90°C: enint. 6 bar.

1.2.4 Suurin tulopaine

Todellinen tulopaine lisättynä pumpun maks. paineella (nollatuotolla) tulee olla pienempi kuin “suurin käyttöpaine”.

1.2.5 Min. tulopaine

Pumpun **maksimituotolla** ja 760 mmHg ilmanpaineella pätevät alempana esitetyn taulukon arvot.

Taulukko ilmoittaa eri nestelämpötiloilla min. tulopaineen / maks. imukork. “H” [mvp] pumpun imuyhteessä, **joten painehäviöt pumpun imuputkessa on huomioitava**.

Suurinta imukorkeutta voi mahd. rajoittaa vaadittava nostokorkeus.

Malli	H [mvp]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

“H” = min. tulopaine käytön aikana.

“H” * = maks. imukorkeus käytön aikana.

1 mvp ≈ 0,1 bar.

1.3 Tekniset tiedot

1.3.1 Sähkötiedot

Katso pumpun laitekilvestä.

1.3.2 Mitat

Katso sivu 50.

1.4 Äänenpainetaso

Pumpun äänenpainetaso alittaa Euroopan Neuvoston direktiivin 89/392/EY (konedirektiivi) raja-arvot.

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2. Asennus

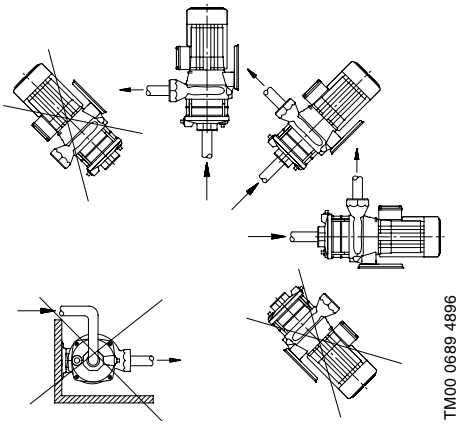
2.1 Pumpun sijoitus

Pumppu sijoitetaan niin, että imuputki on mahdollisimman lyhyt ja imukorkeus mahdollisimman pieni.

Pumppu on sijoitettava jäätymättömään tilaan (katso kohta *5.1 Jäätymisvaara*), jossa on hyvä ilmanvaihto. Se voidaan sijoittaa ulkotilaan, mutta tulee suojata suoralta sateelta katoksella tai muulla vastaavalla.

Pumppu voidaan asentaa kuvan 1 mukaisesti.

Kuva 1



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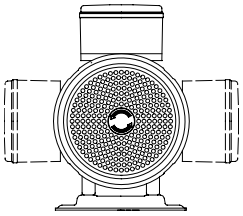
2.2 Kytkentärasian asento

Kytkentärasia voidaan kääntää kuvan 2 asentoihin ennen pumpun asennusta.

Kuva 2



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Kytkentärasian asennon muuttaminen:

1. Irroita moottoripuolen laipan 4 pulttia.
2. Käännä staattoripesä toivottuun asentoon.
3. Kiinnitä ja kiristä pultit entisiin reikiinsä.

2.3 Putkisto

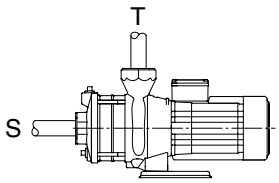
Putkisto tulee asentaa niin, että pumppuun ei kohdistu mekaanisia voimia, esim. lämpölaajenemisesta aiheutuvia.

2.3.1 Imuputki

Jos nestepinta imupuolella on pumpun alapuolella, on imuputkeen asennettava pohja/takaiskuventtiili, koska pumppu ei ole itseimevä.

Imuputki kiinnitetään pumpun imuyhteeseen S, kuva 3.

Kuva 3



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Imuputken pituuden ollessa suurempi kuin 10 m tai imukorkeuden ylittäessä 4 m tulee imuputken olla suurempi kuin imuyhde.

Imuputken kaikkien liitoksien on ehdottomasti oltava tiiviitä.

Jos imupuolella käytetään letkua, on tämän oltava rakenteeltaan tukikudosvahvisteinen, mikä estää letkun litistymisen. Jotta estettäisiin epäpuhtauksien pääsy imuputkeen, se voidaan varustaa siivilällä tai verkkosuotimella.

2.3.2 Paineputki

Paineputki kiinnitetään pumpun paineyhteeseen T, kuva 3.

Painehäviöiden, suurien virtausnopeuksien ja kohinan välttämiseksi on paineputken koon oltava vähintään sama kuin paineyhteen.

2.3.3 Paluukierto

Jos on olemassa vaara käytölle suljettua venttiiliä vastaan, on varmistettava vähimmäisvirtaama pumpun läpi varustamalla pumpun lähtöpuoli paluukierto/ohitusputkella takaisin säiliöön tai vastaavaan.

Minimivirtaaman on oltava vähintään 10% korkeimman hyötysuhteen virtaamasta. Korkeimman hyötysuhteen virtaama ja nostokorkeus ilmenee pumpun tyyppikilvestä.

2.4 Asennusesimerkkejä

Pumpulle löytyy monia käyttötarkoituksia ja asennusvaihtoehtoja.

Sivulla 49 on esitetty muutamia.

3. Sähköliitäntä

Sähköliitäntä suoritetaan kansallisten sääntöjen mukaisesti.

Tarkista, että syöttöjännite ja taajuus vastaavat pumppukilven arvoja.

Avattaessa pumpun kytkentärasia on pumpun syöttöjännite aina oltava katkaistuna.

Pumppuun on liitettävä ulkoinen verkkovirran katkaisija.

1-vaiheiset moottorit 1 x 110/220 V, 60 Hz, eivät ole varustettuja sisäänrakennetulla moottorisuojalla vaan vaativat ulkoisen moottorisuojan.

Muissa 1-vaiheisissa moottoreissa on sisäänrakennettu ylikuumenemissuoja eivätkä ne vaadi ulkoista moottorisuojaa.

3-vaiheisissa moottoreissa on liitettävämoottorisuoja, johon asetetun nimellisvirran on oltava yhdenmukainen pumpun tyyppikilven sähkötietojen kanssa.

Ennenkuin pumppu käynnistetään, se tulee täyttäänesteellä.

Sähköliitännät suoritetaan kytkentärasian kannen sisäpuolella olevan kaavion mukaisesti.

Valitse toinen kaapeliläpivienneistä ja poista suojalevy.

3.1 Pyörimissuunta

(3-vaiheiset)

Nuolet moottorin tuuletinkannessa osoittavat oikean pyörimissuunnan.

Pyörimissuunnan tulee olla vastapäivään moottorin takaa katsottuna.

Jos pyörimissuunta on väärä, tulee syöttövirta pumpulle katkaista ja vaihtaa moottorisuojan kaksi vaihetta keskenään.

4. Käyttöönotto

4.1 Nesteen täyttäminen

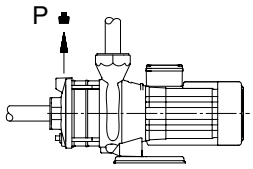
Ennenkuin pumppu käynnistetään, se tulee täyttää nesteellä ja ilmata.

Suoritettaessa ilmausta kuumien nesteiden kiertojärjestelmissä on aina oltava erittäin varovainen välttääkseen ulosvirtaavan nesteen aiheuttaman henkilövahingon vaaran.

Paineenkorotuslaitoksissa sekä laitoksissa, joissa nestepinta pumpun imupuolella on korkeammalla kuin pumppu:

1. Sulje sulkuventtiilit pumpun imu- ja painepuolella.
2. Avaa ja irroita pumpun pesäveden täyttötulppa P, kuva 4.
3. Avaa pumpun imupuolen sulkuventtiiliä hitaasti ja pidä se auki niin kauan kunnes neste valuu täyttötulpan aukosta tasaisena virtana.
4. Sulje venttiili ja asenna sekä kiristä täyttötulppa.
5. Aukaise imupuolen sulkuventtiili.
6. Käynnistä pumppu ja avaa painepuolen sulkuventtiili hitaasti, kunnes se on täysin auki.

Kuva 4



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Pumppaaminen säiliöstä tai kaivosta, jossa nestepinta pumpun imupuolella on alempana kuin pumppu:

1. Sulje painepuolen sulkuventtiili.
2. Avaa ja irroita pumpun täyttötulppa P, kuva 4.
3. Kaada pumpattavaa nestettä täyttötulpan aukosta. Varmista, että imuputki ja pumppu ovat täysin nesteen täyttämät ja ilmattuja.
4. Asenna täyttötulppa ja kiristä se.
5. Käynnistä pumppu ja avaa painepuolen sulkuventtiili hitaasti, kunnes se on täysin auki.

4.2 Käynnistys/pysäytys

Enintään 100 käynnistystä per tunti.

5. Käyttö ja huolto

Pumppu on huoltovapaa normaalikäytössä.

Jos pumppua käytetään epäpuhtaiden nesteiden pumppaamiseen, tulee pumppu huuhdella vedellä heti käytön jälkeen.

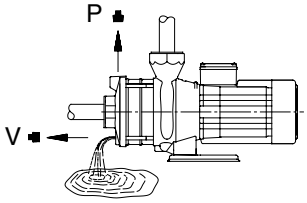
5.1 Jäätymisvaara

Pakkasolosuhteissa ja jäätymisen uhatessa pumppu on tyhjennettävä vaurioiden välttämiseksi.

Pumppu tyhjennetään avaamalla täyttö- ja tyhjennystulpat P ja V, kuva 5.

Asenna tulpat paikoilleen vasta sitten, kun pumppu otetaan uudelleen käyttöön.

Kuva 5



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6. Vianetsintä

Ennenkuin vianetsintä aloitetaan, on syöttöjännite katkaistava.

Vika	Syy
1. Pumppu ei käynnisty.	a) Virtakatkos tai väärä syöttöjännite. b) Katkos tai vika ohjausvirtapiirissä. c) Moottori viallinen. d) Pumppu tukkeutunut epäpuhtauksista.
2. Pumppu käy, mutta ei tuota nestettä.	a) Pumppu ei ole nesteen täyttämä. b) Imu- tai paineputki tukkeutunut. c) Pumppu tukkeutunut epäpuhtauksista. d) Liian suuri imukorkeus. e) Vuotoja imuputkessa. f) Pohja/takaiskuventtiili tukkeutunut.
3. Alentunut paine ja tuotto.	a) Moottorin pyörimissuunta väärä (3-vaihe moottorit). b) Imukorkeus on liian suuri. c) Imu- tai paineputki tukkeutunut. d) Pumppu tukkeutunut epäpuhtauksista. e) Pohja/takaiskuventtiili osittain tukkeutunut.
4. Pumppu pysähtyy käytön aikana.	a) Moottorin ylikuumenemissuoja tai ulkoinen moottorisuoja katkaisee virran. b) Ohjausvirtapiiri katkaisee käytön.

7. Hävittäminen

Tämän tuotteen tai sen osien hävittämisessä on noudatettava seuraavia ohjeita:

1. Käytä paikallisia yleisiä tai yksityisiä jätekeräilyn palveluja.
2. Jos jätekeräilyn palveluja ei ole, tai ne eivät vastaanota tai pysty käsittelemään tuotteen materiaaleja, voidaan tuote tai sen mahdolliset ympäristölle vaaralliset aineet toimittaa lähimpään GRUNDFOS-yhtiöön tai -huoltokorjaamoon.

SF

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Før installation af pumpen påbegyndes, skal denne monterings- og driftsinstruktion læses grundigt. Installation og drift skal i øvrigt ske i henhold til lokale forskrifter og gængs praksis.

1. Generelt

1.1 Anvendelse

GRUNDFOS CH og CHN pumper er horisontale, flertrins centrifugalpumper til pumpning af vand og andre tyndtflydende, ikke-aggressive og ikke-eksplosive væsker uden faste bestanddele og fibre.

1.2 Driftsområde

1.2.1 Medietemperatur

0°C til +90°C.

1.2.2 Omgivelsestemperatur

Maks. +55°C.

1.2.3 Maks. driftstryk

0°C til +40°C: Maks. 10 bar.
+41°C til +90°C: Maks. 6 bar.

1.2.4 Maks. tilløbstryk

Aktuelt tilløbstryk + pumpens tryk mod lukket ventil skal være mindre end "maks. driftstryk".

1.2.5 Min. tilløbstryk

Ved pumpens **maks. ydelse** og en barometerstand på 760 mmHg gælder nedenstående tabel.

Det er min. tilløbstryk/maks. sugehøjde "H" [mVS] ved pumpens sugestuds, der er opgivet ved forskellige medietemperaturer. **Derfor skal der tages hensyn til tryktab i sugeledningen.**

Maks. sugehøjde begrænses evt. af den aktuelle løftehøjde.

Type	H [mVS]			
50 Hz	**20°C**	**40°C**	**55°C**	**90°C**
CH 2	*4,1	*3,6	*2,7	2,8
CHN 2	*4,1	*3,6	*2,7	2,8
CH 4	*7,5	*7,0	*6,1	*0,6
CHN 4	*7,5	*7,0	*6,1	*0,6
CH 8	*6,3	*5,8	*4,9	0,6
CH 12	*5,6	*5,1	*4,2	1,3
60 Hz				
CH 2	*3,1	*2,6	*1,7	3,8
CHN 2	*3,1	*2,6	*1,7	3,8
CH 4	*6,8	*6,3	*5,4	0,1
CHN 4	*6,8	*6,3	*5,4	0,1
CH 8	*6,9	*6,4	*5,5	0,0
CH 12	*3,5	*3,0	*2,1	3,4

"H" = min. tilløbstryk under drift.

"H" med * = maks. sugehøjde under drift.

1 mVS ≈ 0,1 bar.

1.3 Tekniske data

1.3.1 Elektriske data

Se pumpens typeskilt.

1.3.2 Mål

Se side 50.

1.4 Lydtryksniveau

Pumpens lydtryksniveau ligger under de grænseværdier, der er angivet i Europarådets direktiv 89/392/EØF (maskindirektivet).

DK

2. Installation

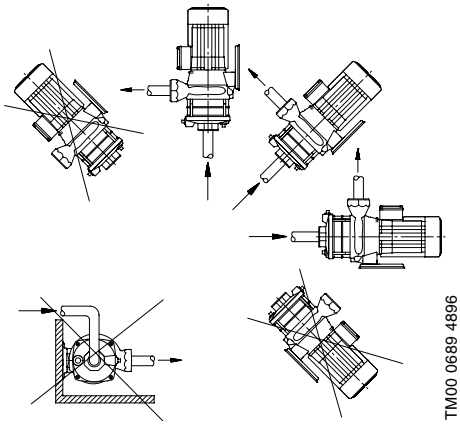
2.1 Placering af pumpen

Pumpen skal placeres således, at sugeledningen bliver så kort og sugehøjden så lille som muligt.

Pumpen bør placeres frostfrit (se afsnit *5.1 Frostsikring*) og med god ventilation. Den kan placeres udendørs, men bør beskyttes mod direkte regn med halvtag el.lign.

Pumpen må placeres som vist i fig. 1.

Fig. 1



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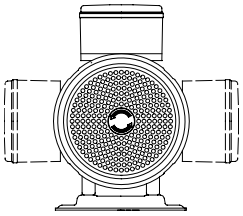
2.2 Klemkasseposition

Klemkassepositionen kan ændres til en af de i fig. 2 viste positioner, inden pumpen monteres.

Fig. 2



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Ændring af klemkasseposition:

1. Demontér de fire skruer, der er skruet i topstykket fra motorsiden.
2. Drej statorhuset til ønsket position.
3. Montér og fastspænd skruerne.

DK

2.3 Rørledninger

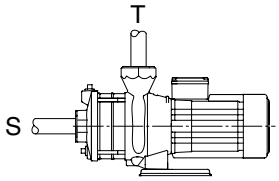
Rørføringen skal udføres, således at pumpen ikke udsættes for mekaniske påvirkninger, f.eks. på grund af termiske udvidelser.

2.3.1 Sugeledning

Er væskeniveauet på sugesiden under pumpen, skal sugeledningen monteres med en kontra-/bundventil, da pumpen ikke er selvansugende.

Sugeledningen tilsluttes pumpens sugestuds S, fig. 3.

Fig. 3



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Ved sugeledninger længere end 10 m eller sugehøjder større end 4 m skal sugeledningens diameter være større end sugestudsens.

Sørg for, at samlinger i sugeledningen bliver tætte.

Anvendes der slange på sugesiden, skal denne være med indlæg, som hindrer sammensugning. For at undgå indsugning af urenheder kan sugeledningen forsynes med en sugekurv (si eller filter).

2.3.2 Trykledning

Trykledningen tilsluttes pumpens trykstuds T, fig. 3.

Trykledningens diameter bør mindst være den samme som trykstudsens for at minimere trykfald, store vandhastigheder og støj.

2.3.3 Returløb

Hvis der er risiko for drift mod afspærret afgangsledning, skal der sikres et min. flow gennem pumpen ved at forsyne pumpens afgangsside med et returløb/afløb til tank eller lignende.

Min. flow skal være mindst 10% af flow ved maks. virkningsgrad. Flow og trykhøjde ved maks. virkningsgrad er angivet på pumpens typeskilt.

2.4 Installationseksempler

Pumpen har mange anvendelsesmuligheder.

På side 49 er vist nogle eksempler.

3. El-tilslutning

El-tilslutning skal foretages i henhold til de lokalt gældende el-regulativer og normer.

Kontrollér, at netspænding og frekvens svarer til de på pumpeskiltet angivne værdier.

Ved ethvert indgreb i pumpens klemkasse skal forsyningsspændingen være afbrudt.

Pumpen skal tilsluttes en ekstern netspændingsafbryder.

1-fasede motorer stemplet 1 x 110/220 V, 60 Hz, har ikke indbygget motorbeskyttelse og skal derfor tilsluttes et eksternt motorværn.

Øvrige 1-fasede motorer har indbygget termoafbryder og kræver derfor ingen yderligere motorbeskyttelse.

3-fasede motorer skal tilsluttes et motorværn, hvis indstillede mærkestrøm skal stemme overens med de elektriske data på pumpens typeskilt.

Pumpen må ikke startes, før den er fyldt med væske.

Den elektriske tilslutning udføres som vist i klemkasselåget.

Vælg én af de to kabelindføringer, og fjern udslagsblanketten.

3.1 Omdrejningsretning

(3-fasede motorer)

Pilene på motorens ventilatorskærm angiver korrekt omdrejningsretning.

Omdrejningsretningen skal være mod uret, set mod ventilatorskærmen.

Er omdrejningsretningen forkert, afbrydes strømforsyningen, og to faser ved motorens tilslutning til motorværnet ombyttes.

4. Idriftsætning

4.1 Væskepåfyldning

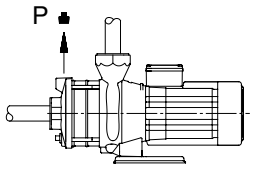
Før pumpen startes, skal den fyldes med væske og udluftes.

Ved anlæg med varme væsker skal der under udluftningen udvises største forsigtighed for at forhindre enhver risiko for personskade forårsaget af den udstrømmende væske.

Ved trykforøgeranlæg og anlæg, hvor væskeniveauet på sugesiden er over pumpen:

1. Luk afspærringsventilerne på suge- og trykside.
2. Demontér spædeproppen P, fig. 4.
3. Åbn ventilen på sugesiden gradvist, og hold den åben, indtil en jævn væskestrøm løber ud af spædestudsen.
4. Luk ventilen, montér spædeproppen og spænd tæt.
5. Åbn ventilen på sugesiden.
6. Start pumpen, mens afspærringsventilen på tryksiden gradvist åbnes til fuldt åben stilling.

Fig. 4



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Pumpning fra beholdere og brønde, hvor væskeniveauet på sugesiden er under pumpen:

1. Luk afspærringsventilen på tryksiden.
2. Demontér spædeproppen P, fig. 4.
3. Hæld vand gennem spædestudsen. Sørg for, at sugeledning og pumpe bliver helt fyldt med væske og udluftet.
4. Montér spædeproppen og spænd tæt.
5. Start pumpen, mens afspærringsventilen på tryksiden gradvist åbnes til fuldt åben stilling.

4.2 Start/stop

Maks. 100 starter pr. time.

5. Drift og vedligeholdelse

Pumpen kræver ikke vedligeholdelse under normal drift.

Anvendes pumpen til urene væsker, renskylles pumpen med rent vand straks efter brug.

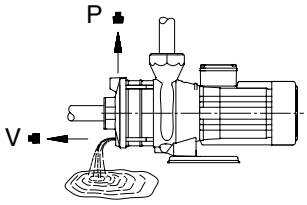
5.1 Frostsikring

Pumper, som ikke anvendes i frostperioder, skal tømmes for at undgå beskadigelse.

Demontér spæde- og tømmepropperne P og V, fig. 5.

Montér først propperne, når pumpen atter skal i drift.

Fig. 5



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6. Fejlfinding

Før fejlfindingen påbegyndes, skal forsyningsspændingen være afbrudt.

Fejl	Årsag
1. Pumpen starter ikke.	a) Manglende eller forkert el-forsyning til motor. b) Et eventuelt styrekredsløb er afbrudt eller defekt. c) Motor defekt. d) Pumpen blokeret af urenheder.
2. Pumpen kører, men giver ingen væske.	a) Pumpen ikke fyldt med væske. b) Suge- eller trykledning tilstoppet af urenheder. c) Pumpen tilstoppet af urenheder. d) Sugehøjde for stor. e) Sugeledning utæt. f) Kontra-/bundventil blokeret.
3. Reduceret tryk og væske-mængde.	a) Motorens omdrejningsretning forkert (3-faset). b) Sugehøjde for stor. c) Suge- eller trykledning tilstoppet. d) Pumpen tilstoppet af urenheder. e) Kontra-/bundventil delvis blokeret.
4. Pumpen kobler fra under drift.	a) Termoafbryder i motor ellerekstern motorbeskyttelse kobler ud. b) Et eventuelt styrekredsløb afbryder.

7. Bortskaffelse

Bortskaffelse af dette produkt eller dele deraf skal ske i henhold til følgende retningslinier:

1. Anvend de lokalt gældende offentlige eller private renovationsordninger.
2. Såfremt sådanne ordninger ikke findes eller ikke modtager de i produktet anvendte materialer, kan produktet eller eventuelle miljøfarlige materialer derfra afleveres til nærmeste GRUNDFOS-selskab eller -serviceværksted.

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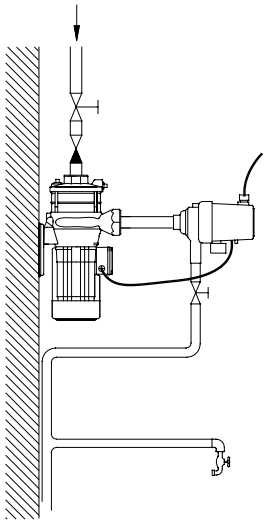
Ret til ændringer forbeholdes.



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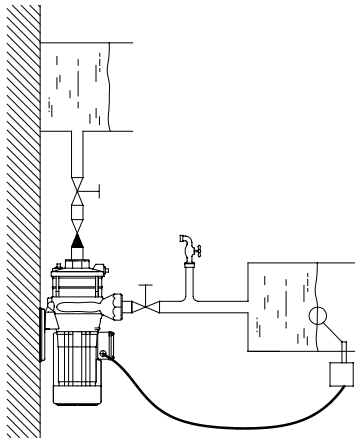

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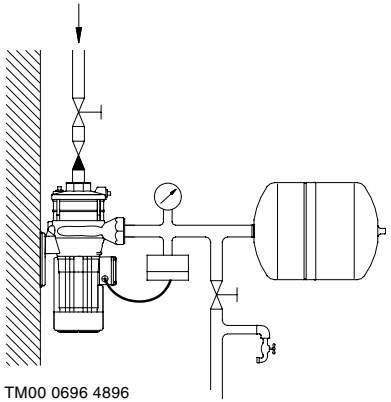

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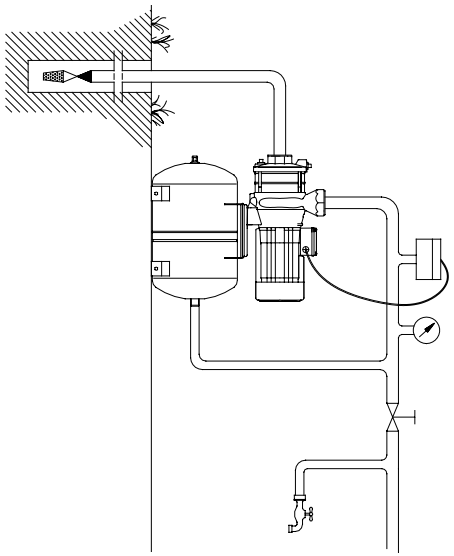

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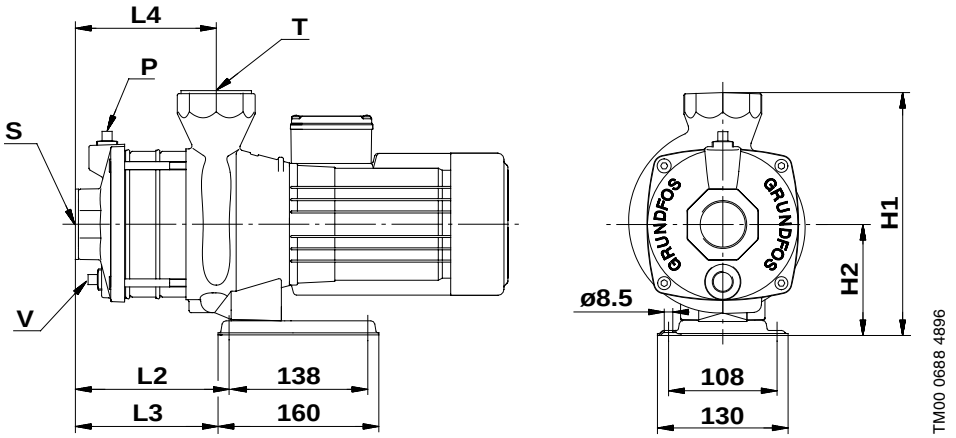

	L2 [mm]	L3 [mm]	L4 [mm]	H1 [mm]	H2 [mm]	S	T	P	V
CH 2-30	92	81	117	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CHN 2-30	92	81	117	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CH 2-40	110	99	135	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CHN 2-40	110	99	135	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CH 2-50	128	117	154	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CHN 2-50	128	117	154	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CH 2-60	146	135	172	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CHN 2-60	146	135	172	155	90	Rp 1	Rp 1	Rp 3/8	Rp 3/8
CH 4-20	83	72	108	155	90	Rp 1 / Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CHN 4-20	83	72	108	155	90	Rp 1 / Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CH 4-30	110	99	135	155	90	Rp 1 / Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CHN 4-30	110	99	135	155	90	Rp 1 / Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CH 4-40	137	126	163	155	90	Rp 1 / Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CHN 4-40	137	126	163	155	90	Rp 1 / Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CH 4-50	164	153	190	155	90	Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CHN 4-50	164	153	190	155	90	Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CH 4-60	191	180	217	155	90	Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CHN 4-60	191	180	217	155	90	Rp 1 1/4	Rp 1	Rp 3/8	Rp 3/8
CH 8-20	90	79	77	240	110	Rp 1 1/2	Rp 1 1/4	Rp 1/2	Rp 1/2
CH 8-25	120	109	107	240	110	Rp 1 1/2	Rp 1 1/4	Rp 1/2	Rp 1/2
CH 8-30	120	109	107	240	110	Rp 1 1/2	Rp 1 1/4	Rp 1/2	Rp 1/2
CH 8-40	120	109	107	240	110	Rp 1 1/2	Rp 1 1/4	Rp 1/2	Rp 1/2
CH 8-50	150	139	137	240	110	Rp 1 1/2	Rp 1 1/4	Rp 1/2	Rp 1/2
CH 8-60	150	139	137	240	110	Rp 1 1/2	Rp 1 1/4	Rp 1/2	Rp 1/2
CH 12-10	90	79	77	240	110	Rp 1 1/2	Rp 1 1/2	Rp 1/2	Rp 1/2
CH 12-20	90	79	77	240	110	Rp 1 1/2	Rp 1 1/2	Rp 1/2	Rp 1/2
CH 12-30	120	109	107	240	110	Rp 1 1/2	Rp 1 1/2	Rp 1/2	Rp 1/2
CH 12-40	120	109	107	240	110	Rp 1 1/2	Rp 1 1/2	Rp 1/2	Rp 1/2
CH 12-50	150	139	137	240	110	Rp 1 1/2	Rp 1 1/2	Rp 1/2	Rp 1/2
CH 12-60	150	139	137	240	110	Rp 1 1/2	Rp 1 1/2	Rp 1/2	Rp 1/2

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Addresses revised 06.12.1999

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6.1 OVERVIEW

Although setpoints can be entered manually using the front panel keys, it is much easier to use a computer to download values through the communications port. A free program called 239PC is available from Multilin to make this as convenient as possible. With 239PC running on your personal computer under Windows it is possible to:

- Program/modify setpoints
- Load/save setpoint files from/to disk
- Read actual values
- Monitor status
- Plot/print trends
- Read pre-trip data and trip record
- Get help on any topic
- Print the instruction manual from disk

The 239PC software allows immediate access to all the features of the 239 with easy to use pull down menus in the familiar Windows environment.

The 239PC software can run without a 239 connected to a computer and save settings to a file. If a 239 is connected to a serial port on a computer and communications is enabled, the 239 can be programmed from the *Setpoint* screens. In addition, measured values, status and trip messages can be displayed with the *Actual* screens.

6.2 HARDWARE CONFIGURATION

The 239 communications is setup as shown in the figure below.

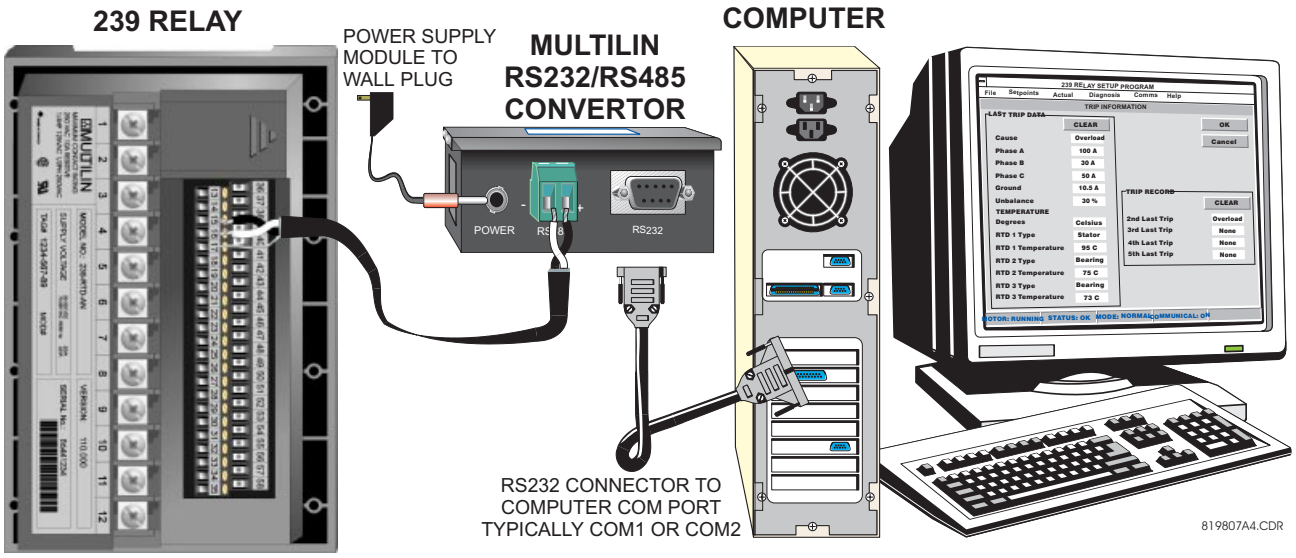
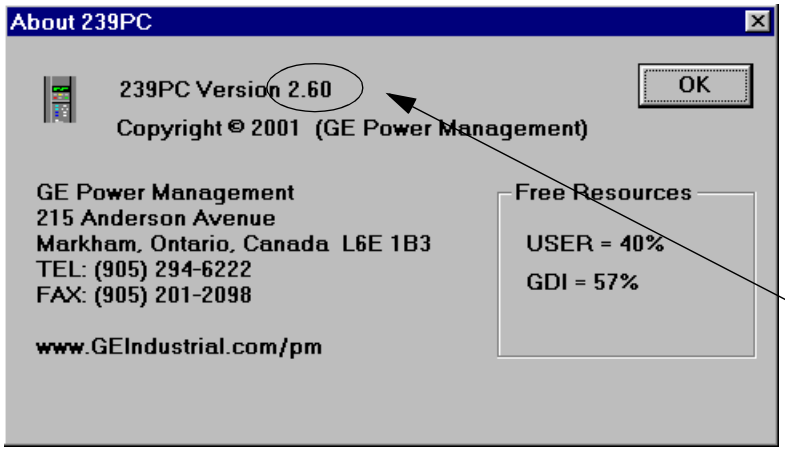


Figure 6–1: TYPICAL COMMUNICATIONS SETUP

6.3 239PC VERSION

If the 239PC software is already installed, check if it needs to be upgraded as shown below. If the 239PC software is installed and is up-to-date then skip to 6.4: INSTALLING/UPGRADING 239PC on page 6–3.

1. Select the **Help > About 239PC** menu item.



2. No upgrade is required if the two versions are identical.

Front page of manual.

The following minimum requirements must be met for the 239PC software to operate on the computer.

- Windows® 3.1 / Windows 95 or higher is installed and running
- 10MB free hard disk space

If the 239PC software already exists and is being upgraded, then please note down exact path and the directory name of the current installation because it will be required during the new installation process.

1. Start Windows.
2. Insert the GE Multilin Products CD into the appropriate drive (alternately, you can go to the GE Multilin website at www.GEindustrial.com/multilin to continue the installation—the steps are roughly the same).
3. The following window will be displayed by your default web browser once the CD drawer, with the Product CD, is closed:

4. Use the mouse to click on **Software**. If 3.5" floppy disks are required, they may be created from the installation program on this CD, created from the GE Multilin website at www.GEindustrial.com/multilin, or ordered directly from the factory.

5. The browser will display the GE Multilin product list in alphabetical order. Choose the **239 Motor Protection Relay** from this list.

6. Select the 239PC program from the list of software and firmware items.

239 Software

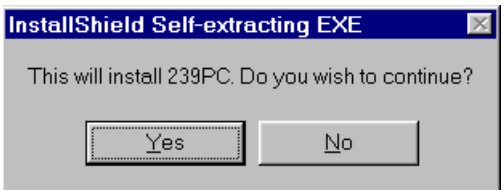
PC Program:

- 239PC Version 2.51 (.exe) [4M]

Relay Firmware:

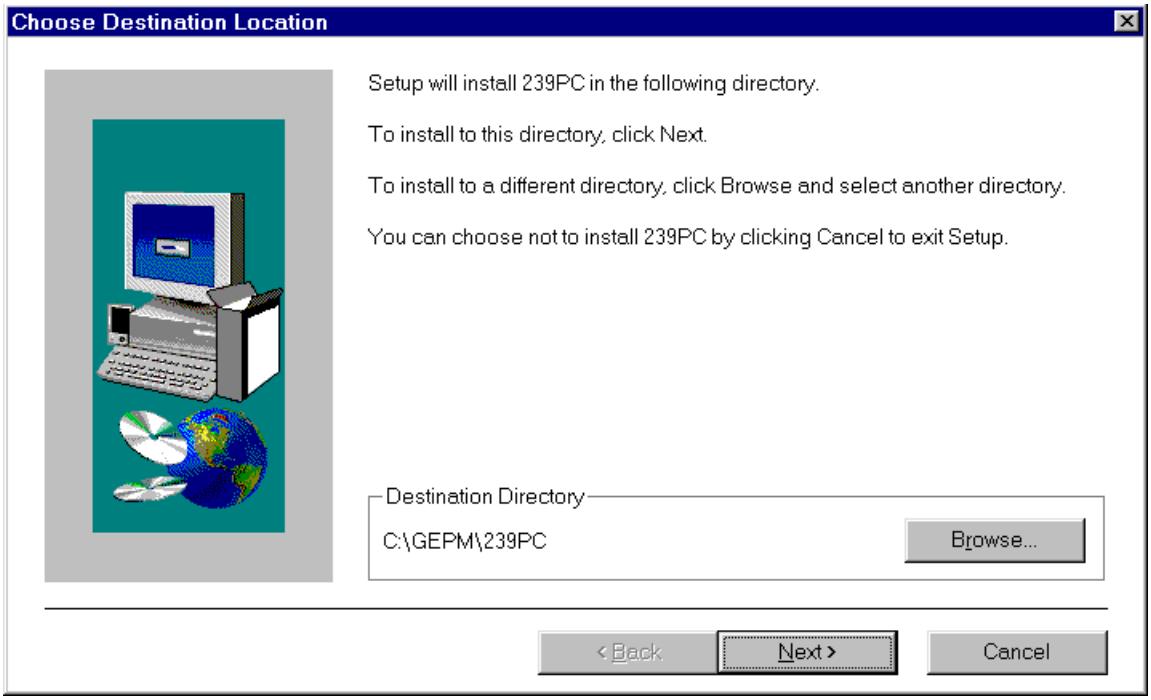
- 2.51 Firmware serial# beginning with B or C (.zip) [58k]
- 2.51 Firmware for serial# beginning with D (.zip) [59k]

7. The browser will launch the **File Download** window. Select the **Run this program from its current location** option and click **OK**. The following window will appear.



8. Verify that you wish to install 239PC by clicking **Yes**.
9. Click on **CONTINUE WITH 239 PC VERSION 2.50 INSTALLATION** to continue installing the PC software directly to your hard drive. If you wish to make a 1.44MB floppy disk containing the 239PC software, click on **Start Copying**.

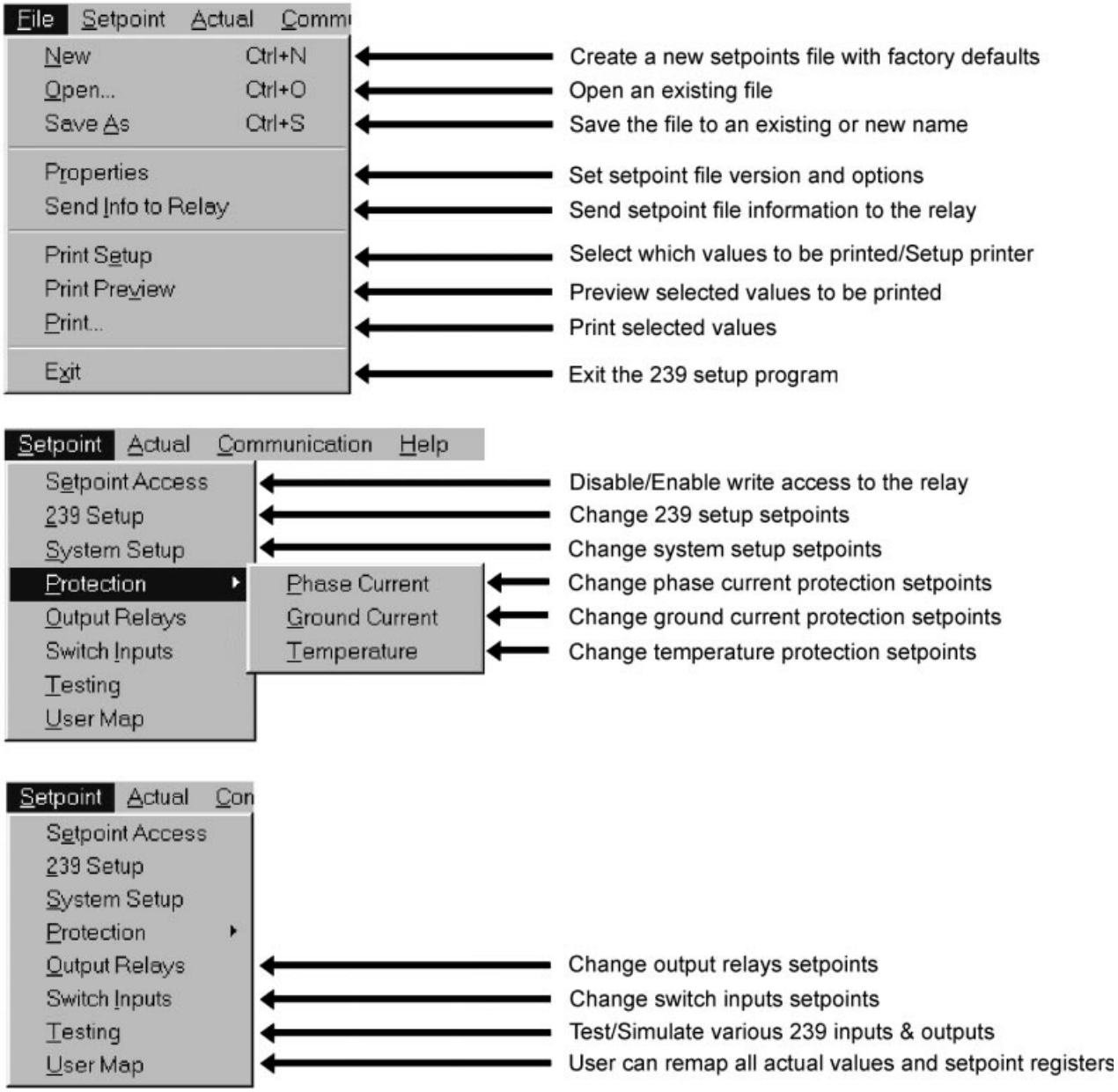
10. The install program will prompt for a destination folder.

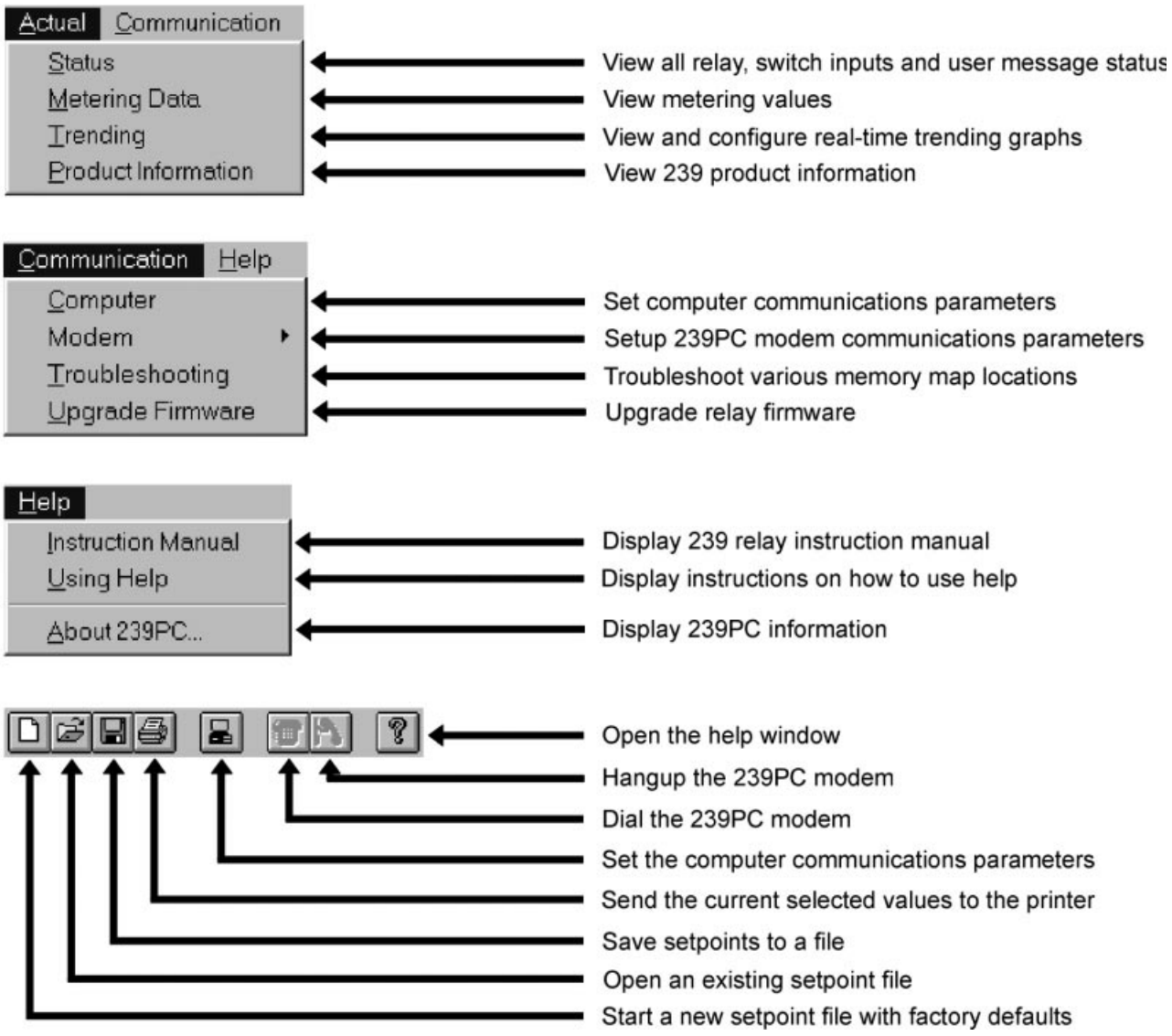


11. If the program is not to be installed in the default directory, or 239PC is already installed in a different location, click on **Browse** and enter the complete path for 239PC. If 239PC is already installed, the old files will be replaced with new ones. Click **Next** to continue with the installation process once the destination directory is correct.
12. The 239PC install program will ask you to choose between **Typical**, **Compact**, and **Custom** setup (**Typical** is fine for almost all cases). Choose the desired type of setup preferred and click **Next** to continue the installation process.
13. You will be prompted to choose a folder name to place the 239PC icon. Select a folder and click **Next** to continue.
14. Click on **Finish** to complete the installation of 239PC. It is recommended that you restart Windows before using the program.

NOTE

The 239PC program may also be installed from the GE Multilin website at www.GEindustrial.com/multilin. Follow the instructions above for installation.

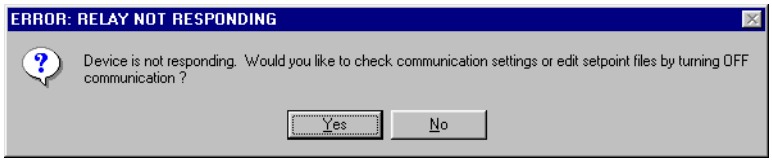

File Setpoint Actual Comm
New Ctrl+N
Open... Ctrl+O
Save As Ctrl+S
Properties
Send Info to Relay
Print Setup
Print Preview
Print...
Exit
Create a new setpoints file with factory defaults
Open an existing file
Save the file to an existing or new name
Set setpoint file version and options
Send setpoint file information to the relay
Select which values to be printed/Setup printer
Preview selected values to be printed
Print selected values
Exit the 239 setup program
Setpoint Actual Communication Help
Setpoint Access
239 Setup
System Setup
Protection
Output Relays
Switch Inputs
Testing
User Map
Phase Current
Ground Current
Temperature
Disable/Enable write access to the relay
Change 239 setup setpoints
Change system setup setpoints
Change phase current protection setpoints
Change ground current protection setpoints
Change temperature protection setpoints
Setpoint Actual Con
Setpoint Access
239 Setup
System Setup
Protection
Output Relays
Switch Inputs
Testing
User Map
Change output relays setpoints
Change switch inputs setpoints
Test/Simulate various 239 inputs & outputs
User can remap all actual values and setpoint registers



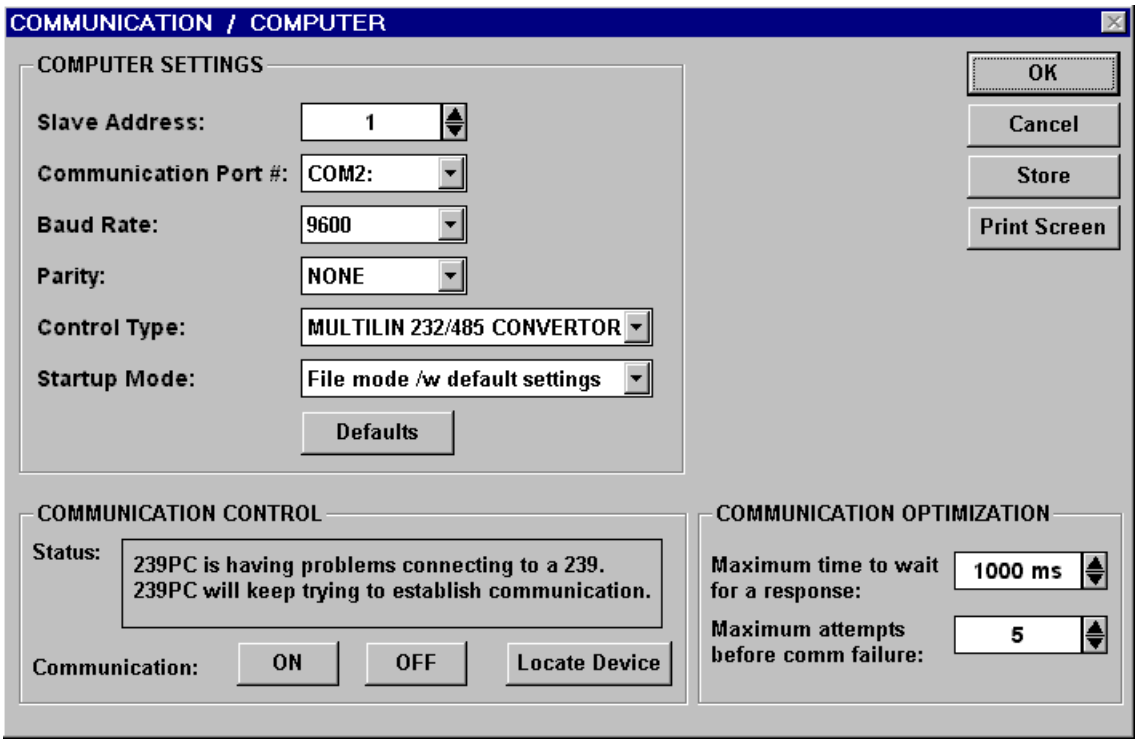
6.6 CONFIGURING 239PC

1. Start 239PC by double-clicking the **239PC** icon in the GE Multilin folder (or alternate folder containing the 239PC icon) or from the Start menu.
2. Once 239PC starts to execute, it will attempt to communicate with the relay. If communication is established successfully, the screen and LEDs on the relay graphic shown in the 239PC window will display the same information as the actual relay.

3. If 239PC cannot establish communication with the relay, the following message will be displayed.



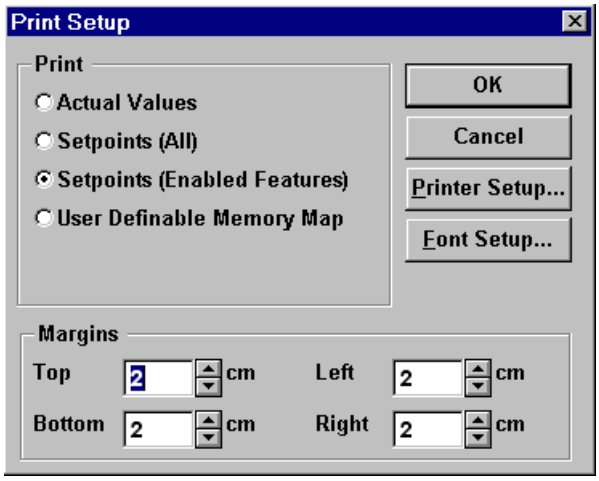
4. Click on **Yes** to edit the 239PC communication settings. This will display the **COMMUNICATION/ COMPUTER** window shown below.



5. Set **Slave Address** to match the relay address setpoint.
6. Set **Communication Port #** to the COM port where the relay is connected.
7. Set **Baud Rate** to match the relay baud rate setpoint.
8. Set **Parity** to match the relay parity setpoint.
9. If using the GE Multilin F485 converter, leave the **Control Type** setting as is.
10. Set **Startup Mode** to “Communicate with relay”.
11. Click the **ON** button to communicate with the relay and 239PC will notify when communications have been established with the relay. If it fails to communicate, check the following:
    - Ensure that the settings above match the relay settings.
    - Ensure the COM port setting matches the COM port being used.
    - Ensure the hardware is connected correctly as shown in Figure 6–1: TYPICAL COMMUNICATIONS SETUP on page 6–1.
    - Ensure the RS485 cable polarity is correct and connected to the correct relay terminals.

a) STEP 1—SAVING AND PRINTING SETPOINTS

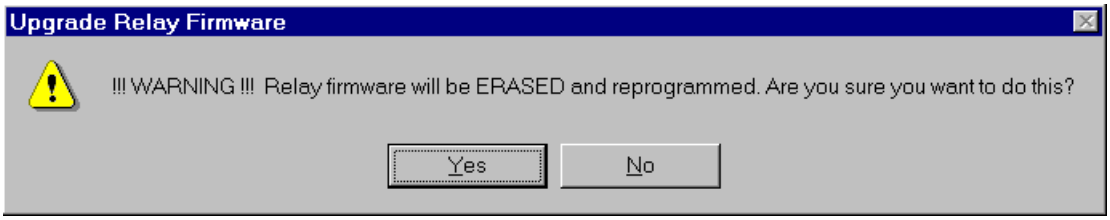
1. Save the 239 setpoints to a file by selecting **Save As** from the **File** menu.
2. 239PC will prompt for a file name and location. Choose an appropriate file name and directory then click **OK** to continue saving the setpoints.
3. Select **Print Setup** from the **File** menu.
4. The **Print Setup** dialog box (shown below) will appear. Select the desired information to be printed, in this case **Setpoints (All)**, and then click **OK**.



5. Select **Print** from the **File** menu.
6. Ensure the printer selected is setup and on-line and click **OK** to print setpoints.

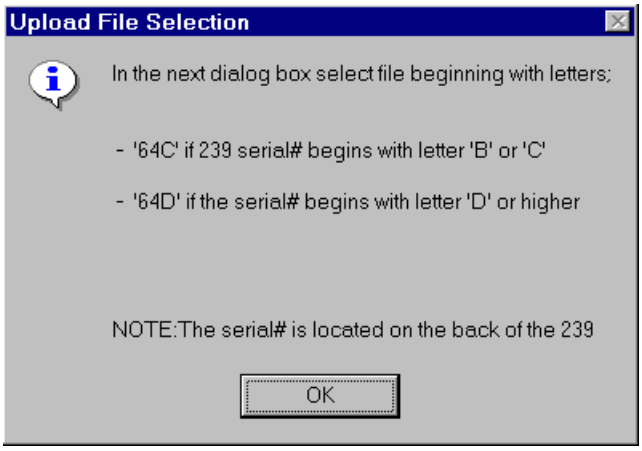
b) STEP 2—LOADING NEW FIRMWARE INTO THE 239

1. Select **Upgrade Firmware** from the **Communication** menu.
2. The following window will appear. Select **Yes** to proceed or **No** to abort the process.

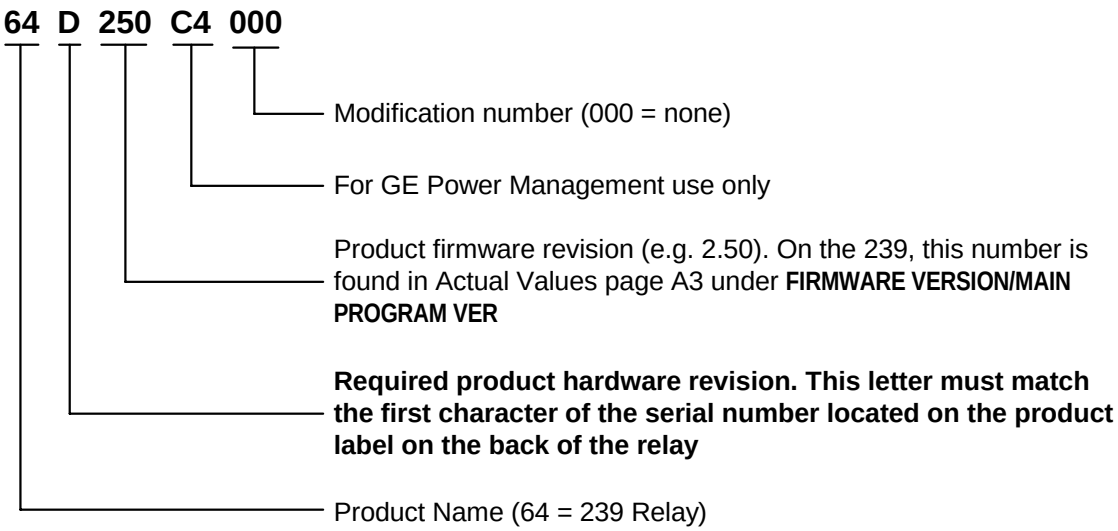


3. The file to be loaded into the 239 **must** match the hardware inside the 239.
   - If the 239 serial number begins with B or C, select the file beginning with the characters 64C.
   - If the 239 serial number begins with D, select the file beginning with the characters 64D.

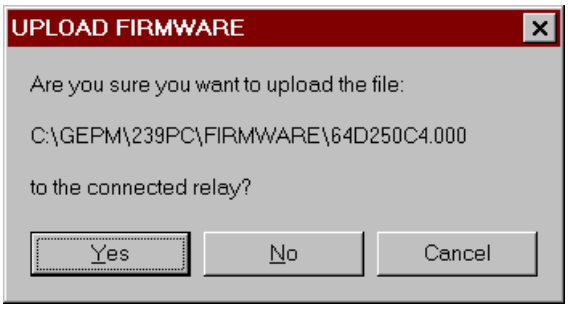
This is indicated in the following dialog box. Click **OK** to continue.



4. The Load Firmware dialog box appears. The firmware file name has the following format:



5. Locate the firmware file to be loaded into the relay and click OK to proceed.
6. The following dialog box will appear; select
   - **Yes** to proceed
   - **No** to load a different firmware file
   - **Cancel** to abort the process



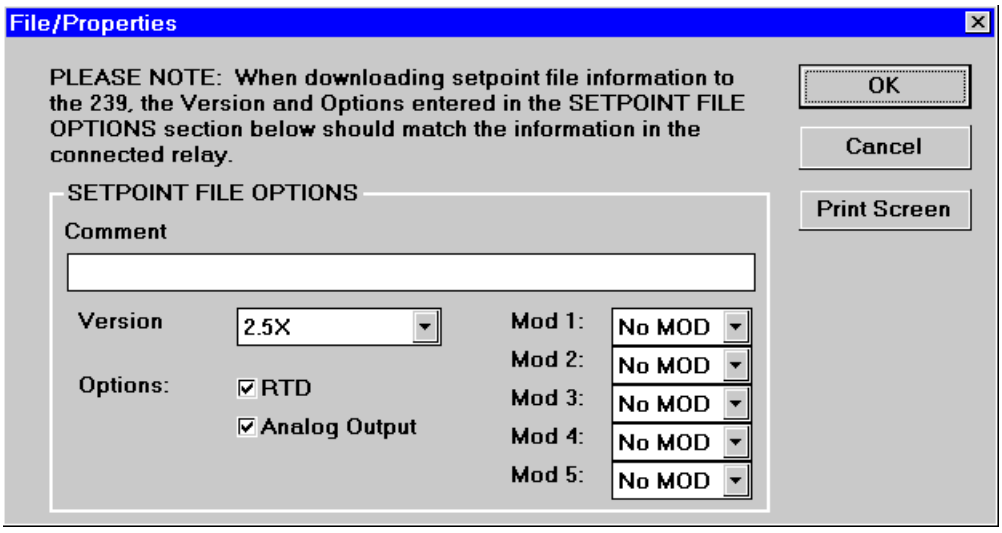
The program will now prepare the relay to receive the new firmware file. The 239 will display the UPLOAD MODE message. If the 239 has boot code revision 2.00 or earlier and a liquid crystal display, the UPLOAD MESSAGE may not appear. Also, if the 239 has boot code revision 3.00 or later and a vacuum fluorescent display, the UPLOAD MESSAGE may not appear. In both cases, the display returns to normal after the firmware upload has successfully completed.

7. A dialog box will appear indicating the file transfer progress and time elapsed. The entire download process takes approximately three minutes.
8. The following dialog box will appear when the firmware has been successfully loaded into the relay.

9. Carefully read any notes indicated in the box and click on **OK** to return to the main screen. If the relay does not communicate with the 239PC program, ensure the following setpoints agree with the 239PC settings shown in the **COMMUNICATION/COMPUTER** window.

c) STEP 3—LOADING SAVED SETPOINTS

1. Select **Open** from the **File** menu.
2. Select the file containing the setpoints to be loaded into the relay (saved in Step 1).
3. Select **Properties** from the **File** menu. The following dialog box will appear:



4. Change the **Version** and **Options** to match the firmware version and options of the 239 relay. The relay firmware and options can be in **A3: PRODUCT INFO/FIRMWARE VERSIONS** and **A3: PRODUCT INFO/**

MODEL INFORMATION, respectively. Also, select any MODs included with the relay. Click OK when finished.

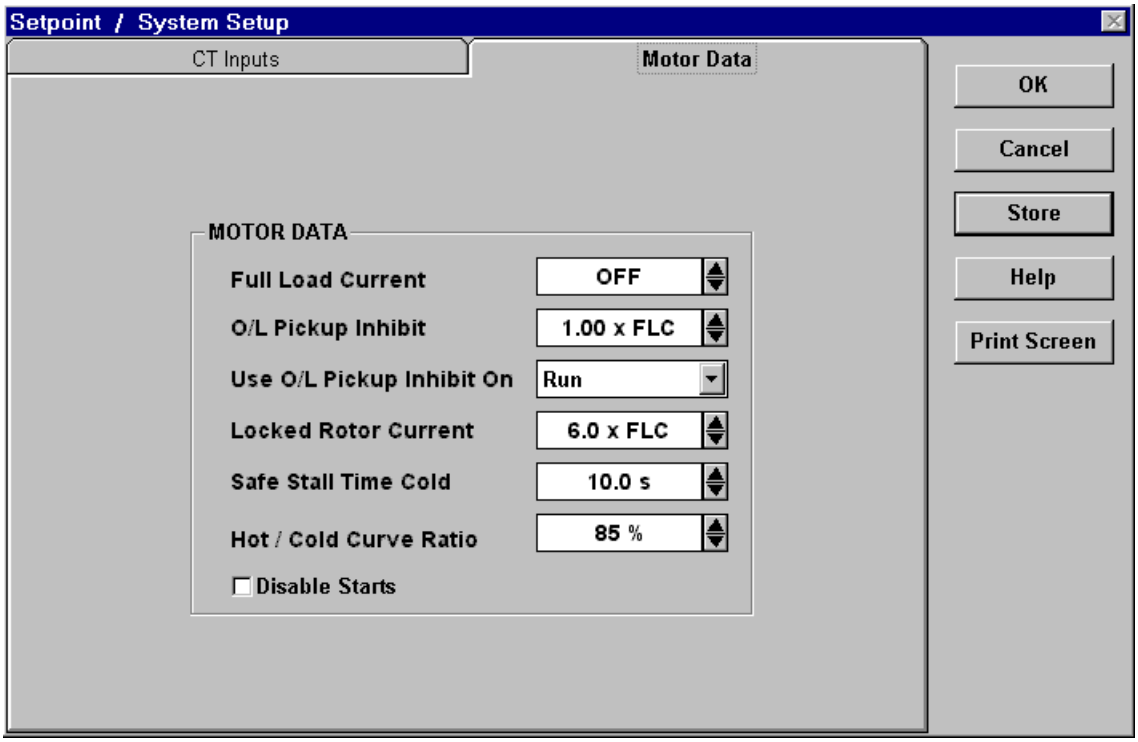
5. Select Send Info to Relay from the File menu to load the setpoints file into the 239 relay. If new setpoints were added to the upgrade software, they will be set to the factory defaults.
6. Upon successful completion of this procedure, the relay will have new firmware installed with the original setpoints.

6.8 USING 239PC

a) ENTERING SETPOINTS

All the 239 setpoints can be modified with 239PC. Setpoints pages S1 through S5 are available through the **Setpoints** menu.

For example, to change the value for setpoint **S2: SYSTEM SETUP/MOTOR DATA\OVERLOAD PICKUP INHIBIT**, choose the System Setup item from the Setpoints menu. This launches the **SETPOINT / SYSTEM SETUP** dialog box. Each subgroup (in this case, CT Inputs and Motor Data) are represented by folder tabs. Click the **Motor Data** tab to list the **S2: SYSTEM SETUP/MOTOR DATA** setpoints.



To change the **OVERLOAD PICKUP INHIBIT** setpoint, use the ▲ and ▼ buttons to choose an appropriate value and click **Store** to load into the relay.

All 239 setpoints can be changed in a similar manner.

b) ACTUAL VALUES

If a 239 is connected to a PC via the serial port, any measured value, status and last trip data can be displayed. Use the **Actual** pull-down menu to select various measured value screens. Monitored values will be displayed and continuously updated.

To plot a measured parameter, choose the **Trending** item from the **Actual** menu.

c) SAVING/PRINTING SETPOINT FILES

- To print and save all the setpoints to a file, follow the steps outlined in Section 6.7a) STEP 1—SAVING AND PRINTING SETPOINTS on page 6–9.

d) LOADING SETPOINT FILES

- To load an existing setpoints file to a 239 and/or send the setpoints to the 239, follow the steps outlined in Section 6.7c) STEP 3—LOADING SAVED SETPOINTS on page 6–11.

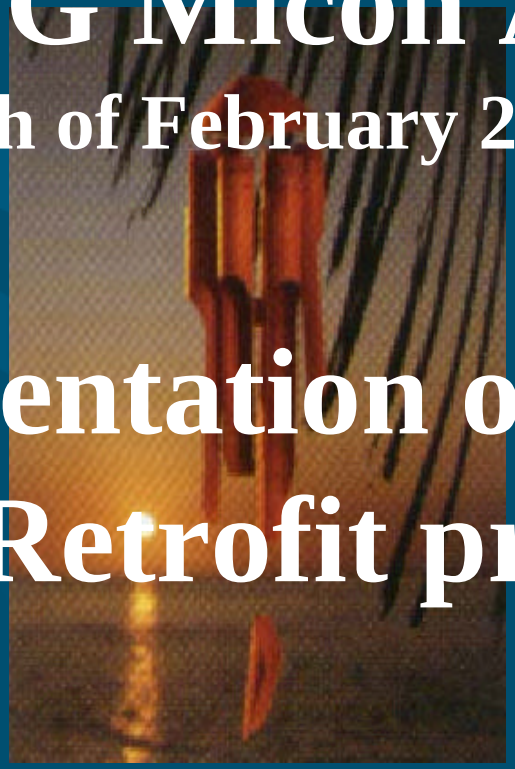
e) GETTING HELP

The complete instruction manual, including diagrams such as wiring, is available through on-line Help.

- Click on the **Help** menu and select the desired topic. Consult Help for an explanation of any feature, specifications, wiring, installation, etc.
- Context sensitive help can be activated by clicking on the desired function.
- For easy reference, any topic can be printed by selecting **File > Print Topic** while in Help. A laser printer is recommended for printing illustrations. Screen colors will appear in the printout if a color ink jet printer is used.

NEG Micon A/S

18th of February 2000



Presentation of the Gearbox Retrofit programme

N·E·G MICON®

Gearbox retrofit programme

This document reproduces the elements of a visual presentation and does not thoroughly describe the retrofit programme. Consequently, the document is not in any way binding for

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Agenda

- Top priority in the NEG Micon organisation
- Findings
- Conclusion - findings
- Decisions based on findings
- Lifetime of gearboxes until retrofit
- How to organise the programme
- Retrofit details
- Time schedule
- Exchange of gearbox
- Co-operation agreement and future with Flender

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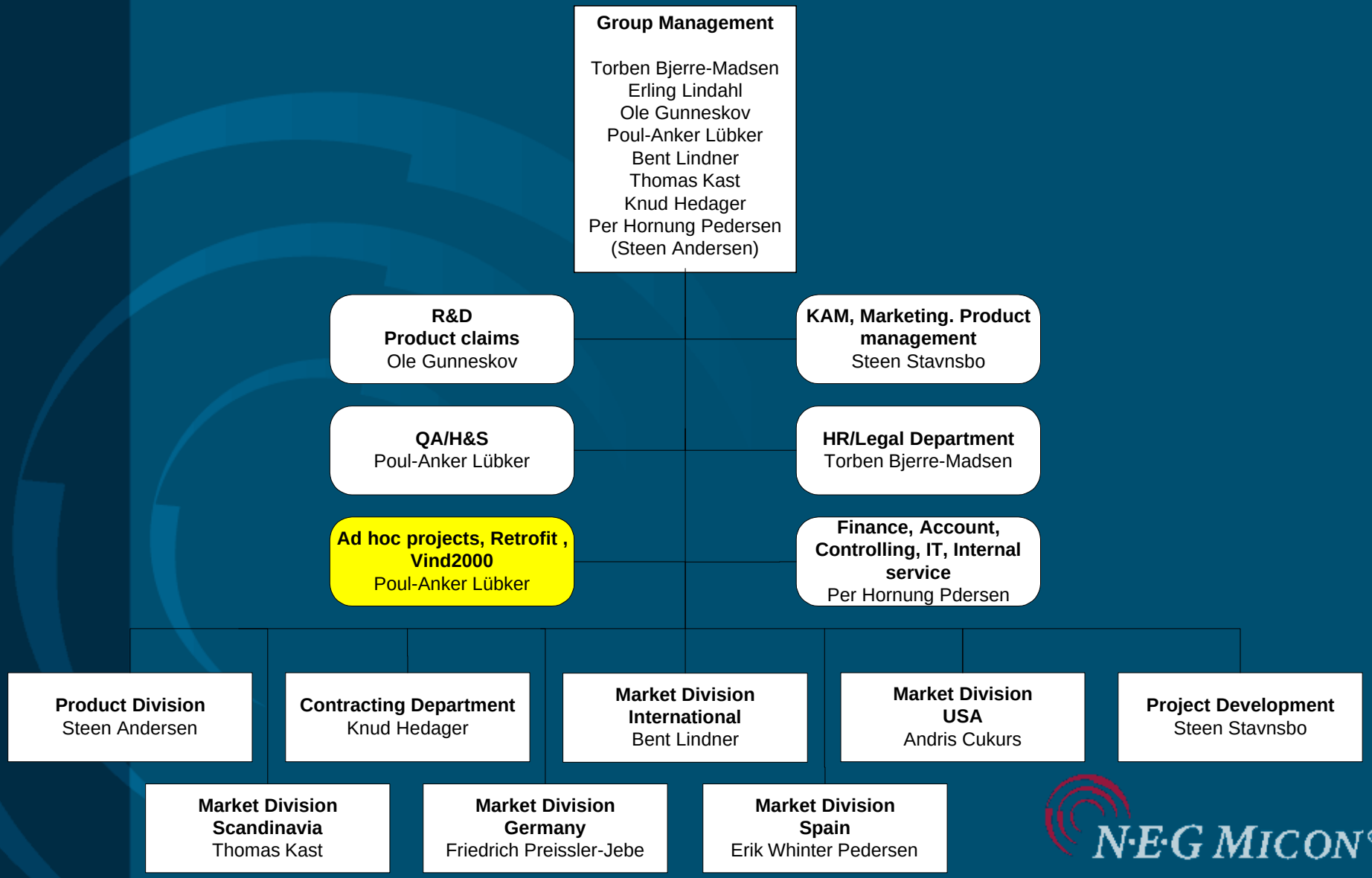
NEG Micon Organisation



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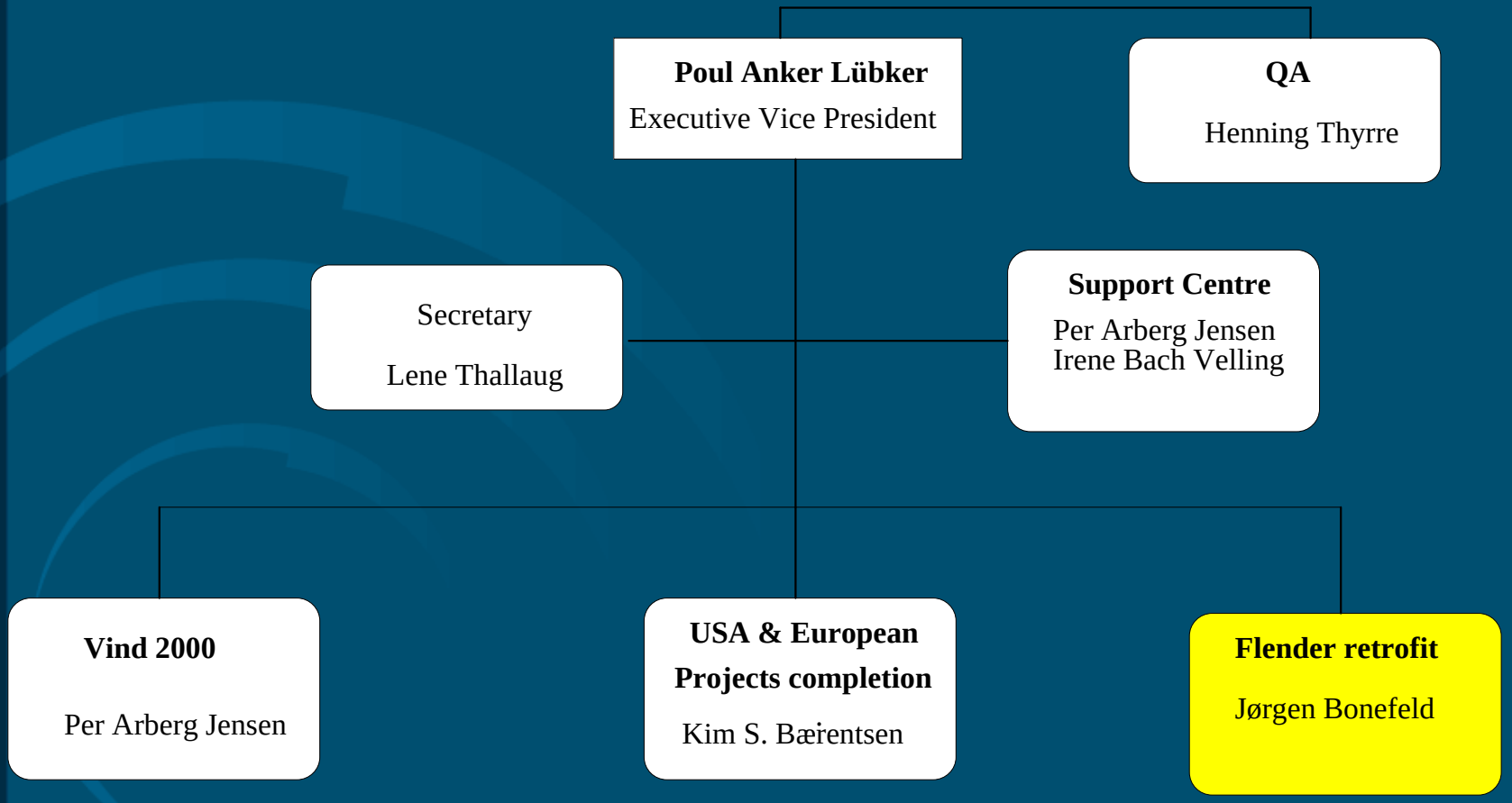
NEG Micon Organisation, Ad hoc projects



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Findings

- Experience of gearbox failures on:
  - PEAC 4280 used in NM 600/43 and NTK 600/43
  - PEAC 4300 used in NM 600/48, 750/44, 750/48
  - In total 9 different versions (different ratios)
- Other gearbox brands have been used in the same WTG models. These and other Flender gearbox types are ok
- The findings have shown different failure indications, so it is difficult to give an exact judgement
- Findings are based on statistical analyses of approx. 1000 WTG´s

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Number of PEAC gearboxes

Denmark	403	Argentina	10
USA	310	Japan	6
Germany	108	Sweden	6
China	125	Costa Rica	5
Spain	109	Sri Lanka	5
Canada	83	Finland	2
UK	25	Italy	2
Holland	35	Greece	1
Stock - worldwide, only 4300 with 3 different ratios, app.			**215**
Total			**1450**

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Findings of PEAC 4280 worldwide

• Total number of PEAC 4280:	309	
• Total number investigated:	292	93 %
• Percent changed:	26	9 %
• Percent with error:	51	17 %
• Percent OK:	215	74 %

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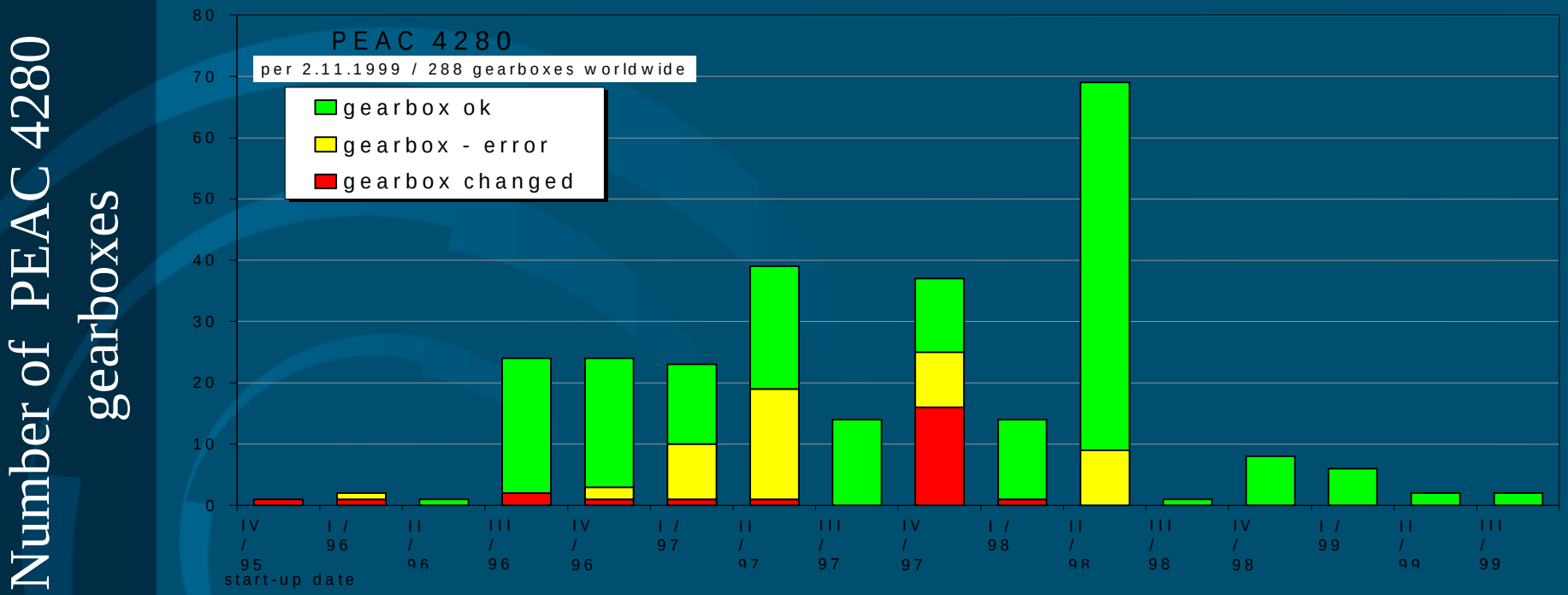
Findings of PEAC 4280 worldwide



Increase of PEAC 4280 worldwide per operation start

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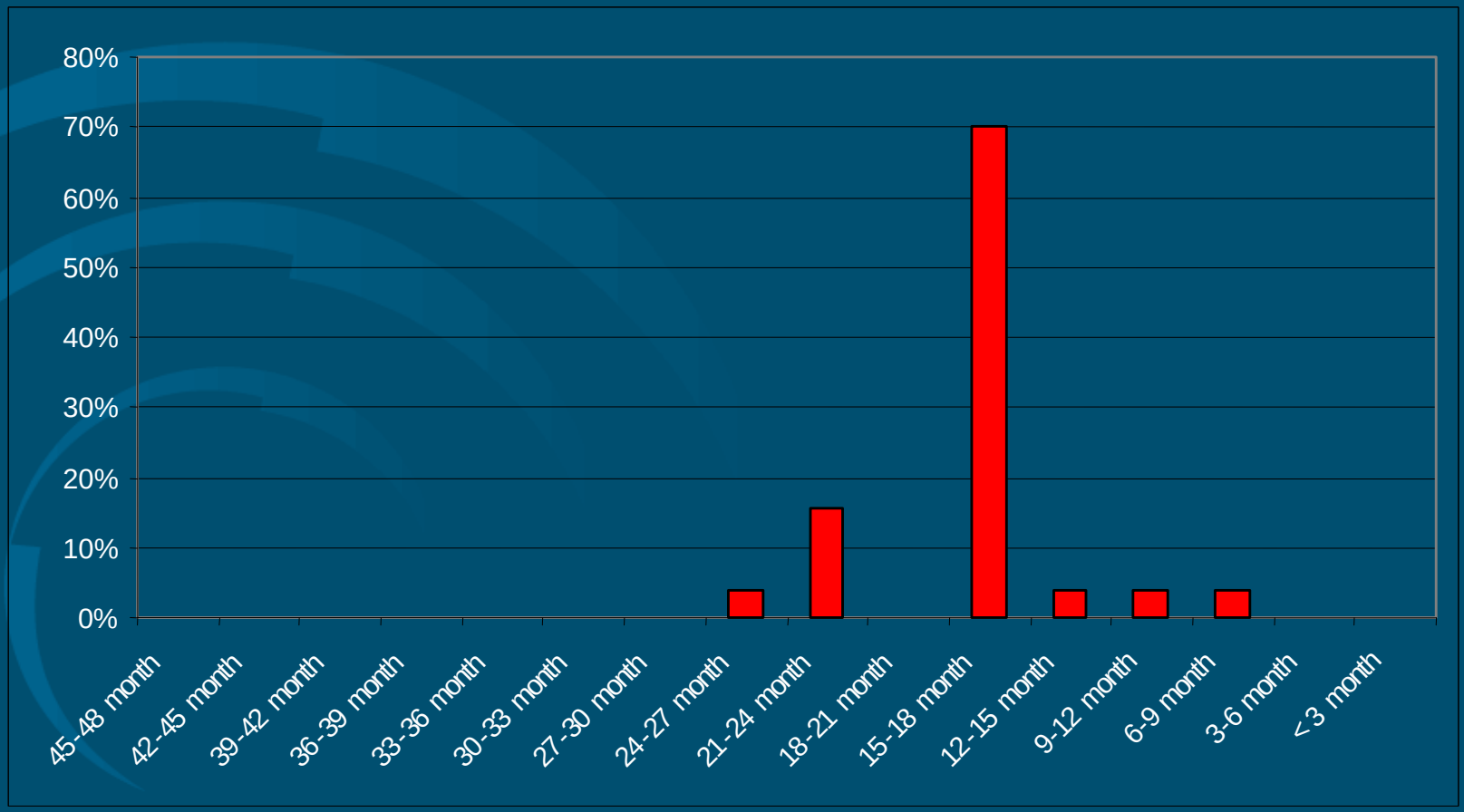
Findings of PEAC 4280 worldwide



Distribution of service life for exchanged PEAC 4280

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Findings of PEAC 4300 worldwide

- Total number of PEAC 4300: 1149
- Total number investigated: 891 78 %
- Percent changed: 50 6 %
- Percent with error: 47 5 %
- Percent OK: 791 89 %

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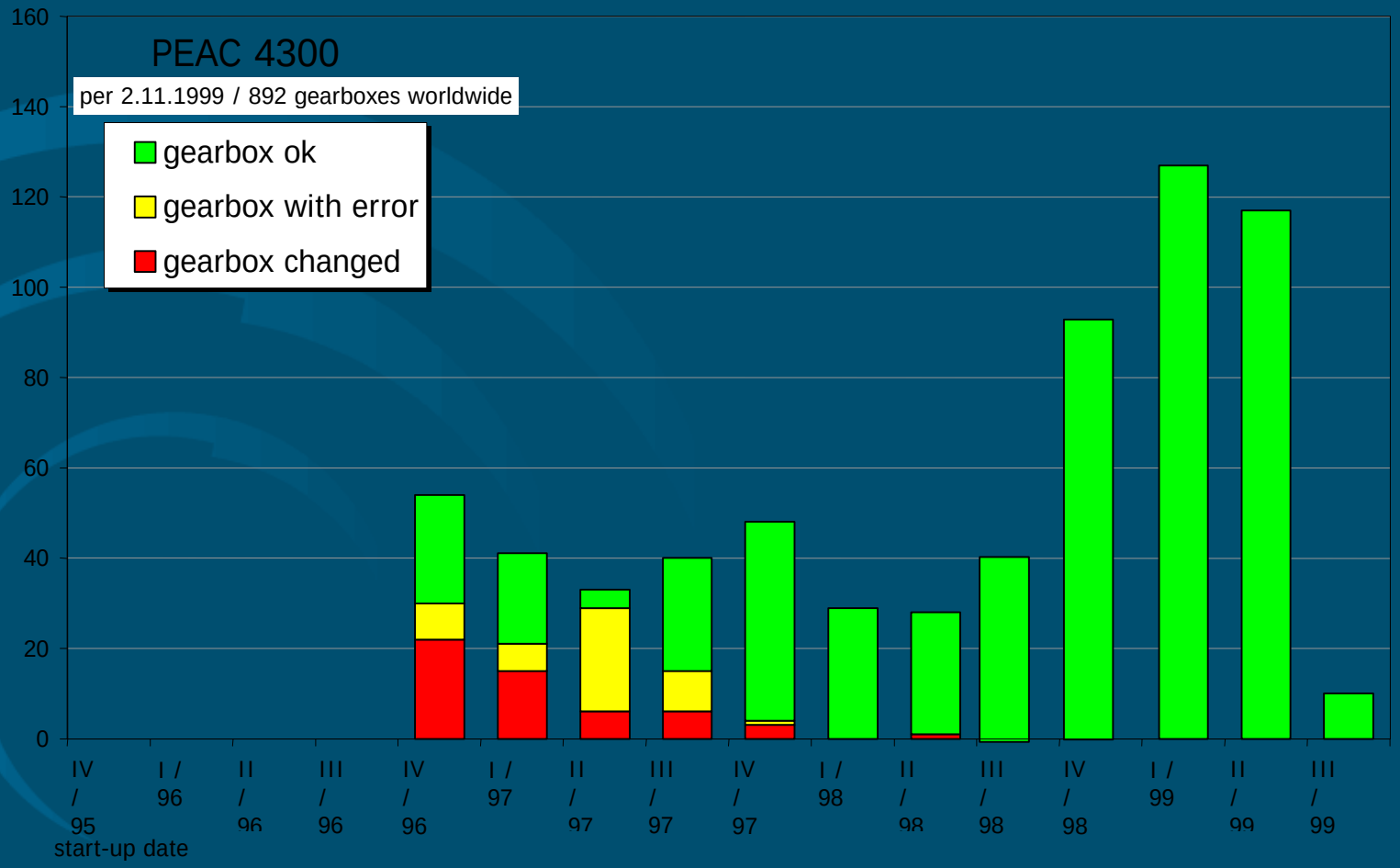
Findings of PEAC 4300 worldwide



Increase of PEAC 4280 worldwide per operation start

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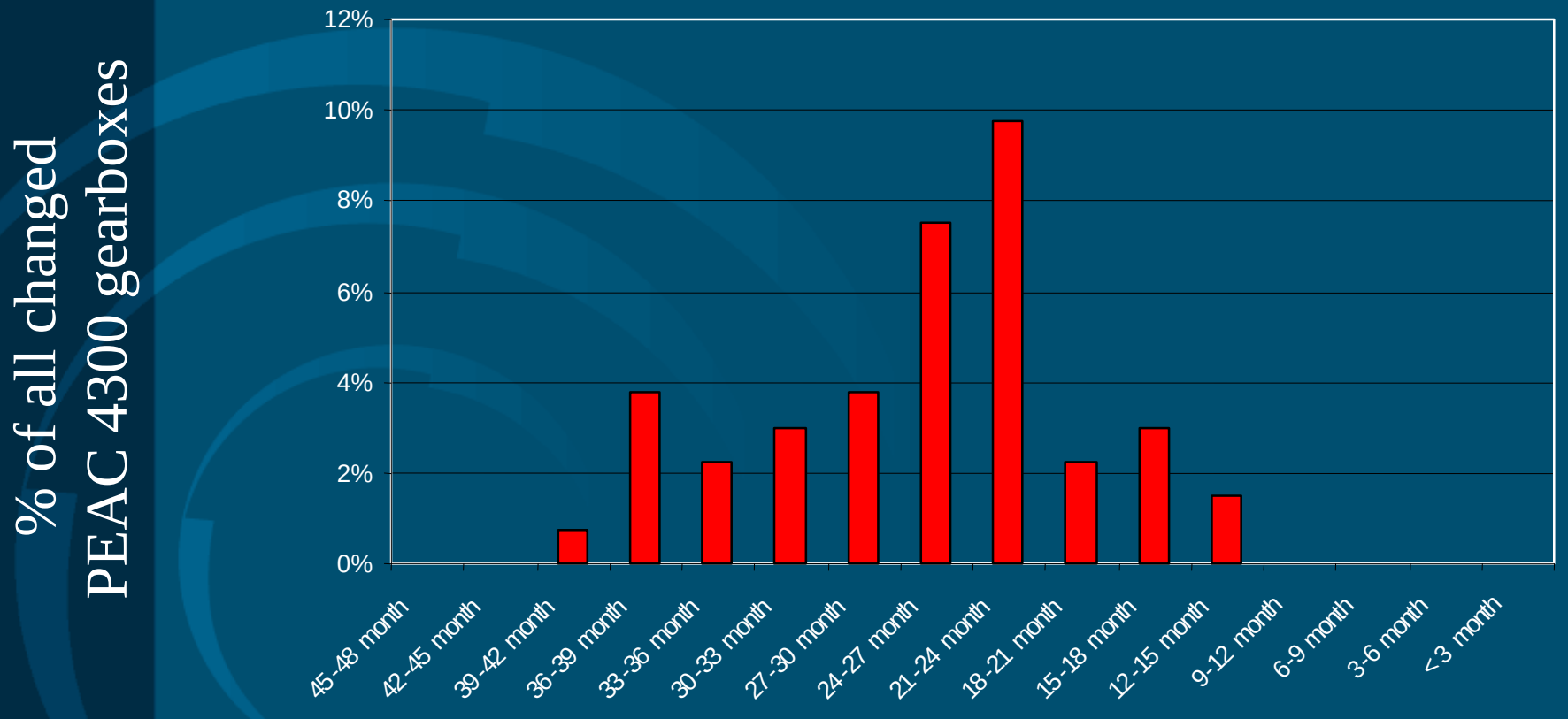
Findings of PEAC 4300 worldwide



Distribution of service life for exchanged PEAC 4300

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Conclusion - findings

- Apart from early fault due to grinding temper a low failure rate is expected in the first 2 years of operation
- After this time the failure rate increases
- Only 28 of a total of 76 exchanged had failed before preventive action could be taken

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Decisions based on findings

Due to the number of failures on Flender PEAC 4280 and 4300 gearboxes, it has been decided to retrofit these gearboxes in co-operation with Flender according to a co-operation agreement

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Lifetime of the gearboxes until retrofit?

- What has been done
  - Exchange of oil due to a sudden drop in the numbers of additives in the oil and to prevent micro-pitting
  - Mount filter, bypass and high pressure lubrication Improvement of lubrication, cooling system and cleanness of oil
  - Lower set point for oilsump temperature from max. 80ºC to max. 65ºC Increase lifetime of oil and improve operation conditions of the gearbox
  - Changed start temperature set point to 55ºC of oilpump to improve oil distribution in gearbox

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How to organise the programme

- The programme will last for a time period of approx. 2 years starting beginning of 2000 acc. to a Main Time Schedule
- Until we have the retrofitted gearboxes:
  - Increased and intensive surveillance of gearboxes in operation => Install filter clogg-alarm, oil analysis and check availability
    - Filter Clogg measures the pressure over the oil filter, and with a drop of 2 bars an alarm will go off. Actions will be taken acc. to NEG Micon instructions but WTG will not be stopped. Clogg alarm and visual inspection may result in preventive measures being taken by NEG Micon (stopping of WTG if no gearbox is available)
    - Oil analysis in conn.with service as usual

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How to organise the programme

- Until we have the retrofitted gearboxes, cont..:
  - Set up emergency procedures to ensure rapid exchange of unexpected exchanges of gearboxes
  - Gearboxes will be exchanged when we can see a failure under development
  - Approx. 215 gearboxes in service stock (only PEAC 4300) ready to be used or retrofitted at Flender

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How to organise the programme

Develop management of activities:

- Most efficient method of gearbox exchange will be used
- Set up Main Time Schedule for gearbox exchange programme
- Set up central WTG availability surveillance centre
- Set up central information centre
- Set up Health and Safety plans
- Set up gear test stand in Denmark
  - Accelerated test at overload
  - Development of monitoring systems

- Organisation set up, education of supervisors has been ready since beginning of 2000

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How to organise the programme

- Information from Information Centre will be relayed via normal communication lines
  - General information to NEG Micon key personnel
  - General information to the market
  - General customer info conc. the retrofit programme and specific info conc. the customer's own turbine
  - Customers will be informed approx. 2 months before exchange with a 2 weeks margin, starting 3rd quarter 2000
- Before starting the retrofit written agreements should be made with all customers

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Retrofit details

- The retrofit work:
  - All PEAC 4280 and PEAC 4300 gearboxes will be retrofitted with new bearings and re-grinded. The new bearing will have the strength of a PEAK gearbox, which has shown no damages
    - During retrofit all components in the gearbox will be inspected and appropriate measures taken depending on the condition of each component

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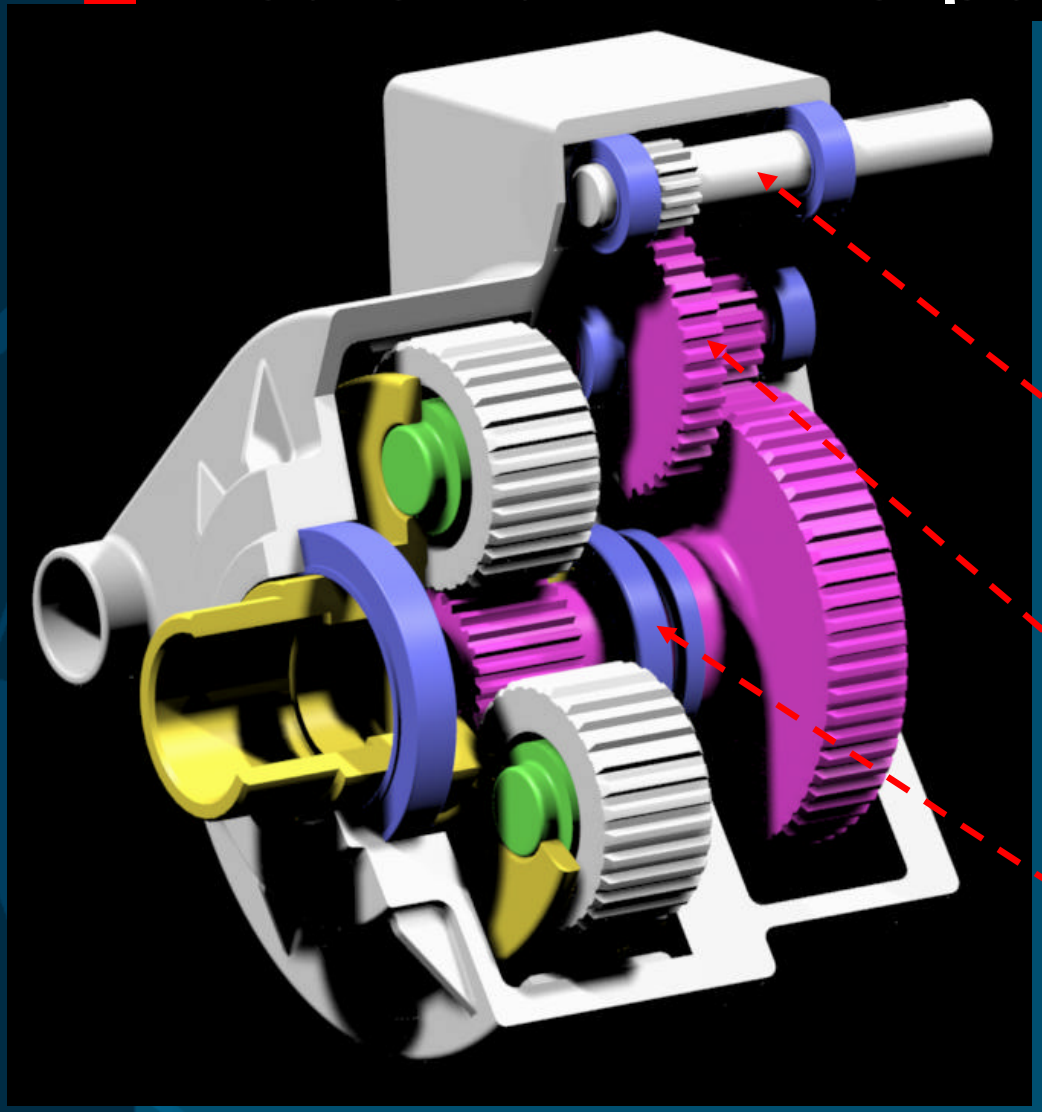
Retrofit - Principal sketch no. I



The gearbox has 3 gearing stages

High-speed stage

Intermediate stage

Planetary stage

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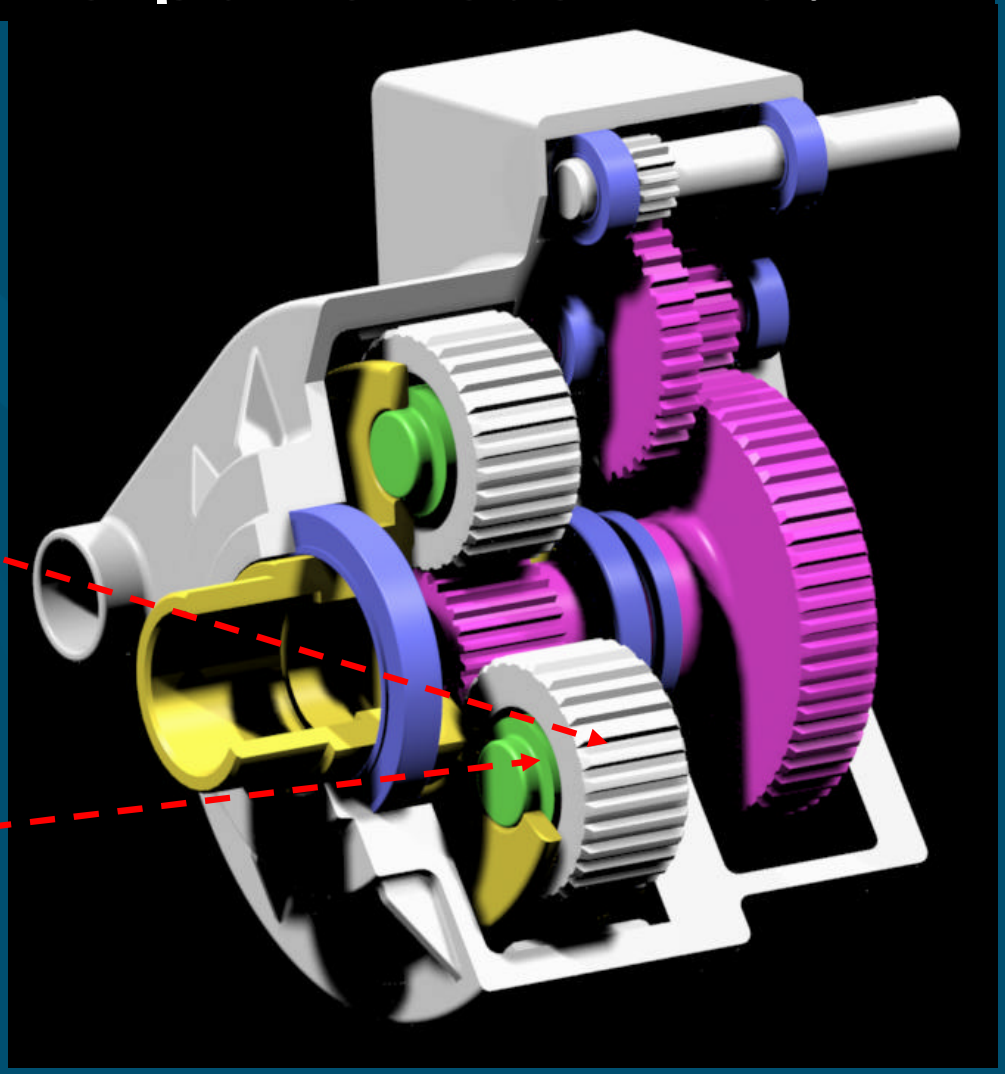
Retrofit - Principal sketch no. II

- Planetary stage:
  - Planet wheel (3)

    All bearings exchanged to new and stronger double bearings. To fit the new bearings, new planet wheels are produced (increased rim thickness on PEAC 4300) and oil distribution improved



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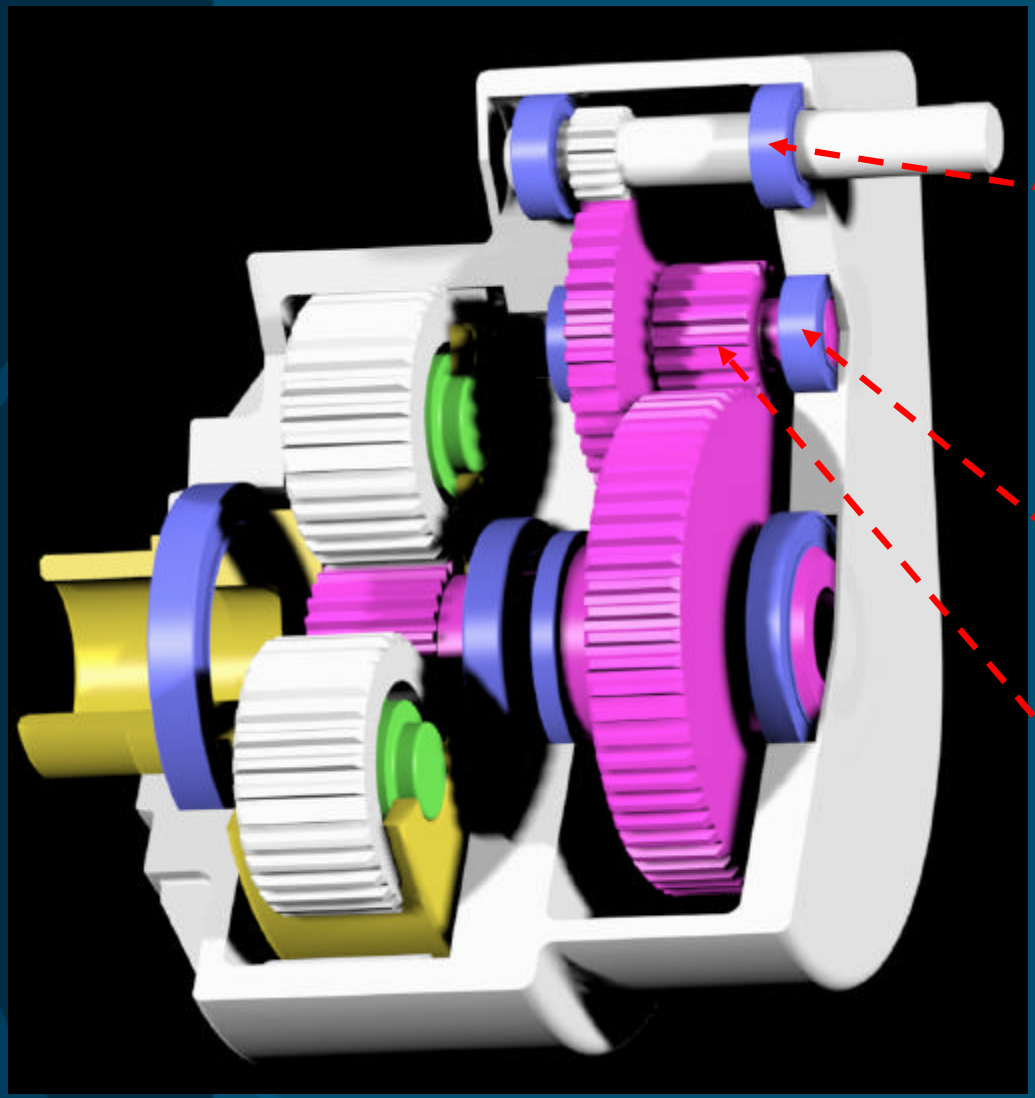
Retrofit - Principal sketch no.III



- High-speed stage:
  - Back bearing exchanged to new and stronger bearing arrangement with two instead of one bearing. Oil distribution improved
- Intermediate stage:
  - Back bearing exchanged to new and stronger bearing
  - Intermediate pinion
    - Re-grinding to optimised crowning to reduce the risk of development of micro-pitting => pitting

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Retrofit - Micro Pitting

- Micro pitting will occur in all gearboxes to a certain level. Subsequently, it will either increase or decrease
- Reasons for micro-pitting increase:
  - Overload
  - Wheel settings
  - Too few additives in the oil
  - Too high temperature
- An example
  - A dry teeth
  - Pressure mark
  - Dirty oil

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Retrofit - Grinding Temper

- Grinding temper is a result of:
  - Not 100% correct geometry of wheel after hardening process
    - Material stocking => Grinding at too high temperatures
  - Incorrect tool settings
  - Cooling oil too hot
- Result of grinding temper is case crushing

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Retrofit - Approvals

- The programme is approved by Det Norske Veritas (DNV) and will independently be challenged by some of the leading gear specialists in the world
  - Dr Hoffmann, University of Newcastle - submarine technology, independent gear specialist, UK
  - Don McVittie, Consultant, independent gear specialist, USA
  - Strange Skriver, independent wind turbine specialist, DK
- Final results of independent investigation are expected in beginning of March

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Retrofit - Quality Plan

- Actions on delivered old gearboxes at Flender
  - Receiving inspection of gearbox
  - Disassembly of gear and inspection of all parts
    - All exchanged parts will be scraped according to retrofit programme
    - Inspection for grinding temper on all re-worked parts according to retrofit programme. All other parts showing indication of grinding temper will be inspected
    - Reasons for possible failures in the gearbox will be determined

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Retrofit - Quality Plan

- Actions on the retrofitted gearbox
  - Inspection on all disassembled and reused parts
  - Receiving inspection of all new parts
  - Control of assembled gearbox
  - Control for grinding temper on all exchanged and new parts
  - Certificate will be issued for each gearbox
- NEG Micon will set up full-time QC inspection at Flender

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Retrofit - Test Programme

- The first PEAC 4280 and 4300 have been retrofitted and passed normal production tests at Flender with fine results
- Test of PEAC 4280 and 4300 gearboxes in wind turbines in Denmark and USA
- A special test programme has been set up testing noise, vibration and inside conditions of gearbox. Loads will be tested in co-operation with Wind Test
  - PEAC 4280 and PEAC 4300 50 Hz. Test programme is ongoing, and is looking good apart from some noise investigations. Final result is expected at the end of February 2000
  - US PEAC4300 60Hz wind turbine will be tested in first quarter of 2000

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Retrofit - Test Programme

- Overload test at Flender
  - Gears will be tested with 2 times nominal load for 200 hours
  - After the 200 hours test the gear will be tested additionally for 10 hours at overspeed (1800 rpm)
  - The test will take place during weeks 6 and 7. Final result is expected in week 10 after disassembly and inspection

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Time schedule

- Prototypes
  - Production release of 80 units
  - Additional 30 new PEAC 4280, with retrofit design, has been ordered to the retrofit programme. The first gears will be delivered in week 8.
  - Final retrofit design and production release is expected after final test in March 2000

- Flender will deliver 15 retrofitted PEAC 4280/4300 gearboxes per week beginning May/June year 2000 from new production facilities in Germany

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Time schedule

Gearboxes will be exchanged acc. to the following priorities:

- Gearboxes with indications of failures
- Gearboxes with potential risk of failure evaluated together with requirements of energy production and efficient use of logistics

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Exchange of gearbox

- Work on the wind turbine
  - Exchange gearbox with retrofitted gearbox
- The effect of the retrofit programme on the customers
  - The existing gearbox will be exchanged to a retrofitted gearbox
  - The retrofitted gearbox can be newer or max. 6 months older than the existing gearbox
  - A gearbox exchange will take 1 to 2 days, and will be carried out at a maximum wind speed of 10 m/s
  - Minor effect on avability

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Exchange of gearbox

- The effect of the retrofit programme conc. customers warranties
  - Existing or new warranties:
    - All existing warranties on gearboxes will stay in full force
    - New 2-year warranty on all renovated or new parts in the retrofitted gearbox from start of operation of retrofitted gearbox
    - 3-month total warranty after start of operation of retrofitted gearbox
    - 5-year warranty on grinding temper from start of operation of turbine

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Future co-operation with Flender

- Flender is a pioneer and market leader in power transmissions with 100 years of experience
- Flender has been involved in the wind turbine industry for almost 20 years
- Flender and NEG Micon have co-operated for almost 15 years, and Flender will continue to be a strategic partner to NEG Micon in the development and delivery of gear units for future wind turbines

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Questions ?

Or

contact NEG Micon´s

Gear Information Centre on

E-mail: gearinfo@neg-micon.dk

Or

look for special retrofit information on

www.neg-micon.dk

from end February 2000

N·E·G MICON®

BEA-002 (17.04.2002)

SOBO®
Soft Braking Option

If you cannot control your stopping speed, you might not get a second chance!

The solution for:

- **Wind Turbines**
- **Escalators**
- **Winches**
- **Ventilation Systems**
- **SAG and Ball Mills**
- **Cement Tumblers**
- **Conveyors**
- **Cranes**
- **Mine Winders**
- **Ski Lifts**
- **Reservoir Gates**
- **Swing Bridges**
- **Your custom application …**

SVENDBORG BRAKES

With the SOBO®, the SOft Braking Option, you will have the best-performing brake on the market!

The advantages of SOBO brakes:

- *"SOFT" braking.*
- *Controlled and precise braking regardless of load.*
- *A cost-effective solution compared to any other brake system.*

SOBO:

- Is a patented ''intelligent'' brake system that regulates the load deceleration during a braking sequence.
- Ensures a controlled ''soft'' braking process, resulting in less wear and stress on the mechanical components of the brake system.
- Is a soft braking option that can be used for any of the following applications: Wind turbines, escalators, conveyor systems, mine winders, large ventilation fans, etc.
- Is a system that can be used for all types of crane braking applications, ski lifts, ship propeller drives and anchor winches or for any applications involving large masses that must be slowed or stopped.

SOBO is a Cost-effective solution!

Why you should consider SOBO when designing any mechanical system:

- *A combination of compact and powerful components easily integrated into any brake system for existing or forthcoming machinery.*
- *A better braking solution that prevents unnecessary wear on braking components caused by erratic or harsh braking processes.*
- *Less wear, less maintenance.*
- *Simple programming and reporting features to assist operators and maintenance personnel in the field.*
- *Can be used for both passive and active brake systems.*
- *Several levels of security within the controller to maintain a consistent process.*
- *Built-in warning signals can be sent to main PLC when operation is*

”Soft” Braking with SOBO

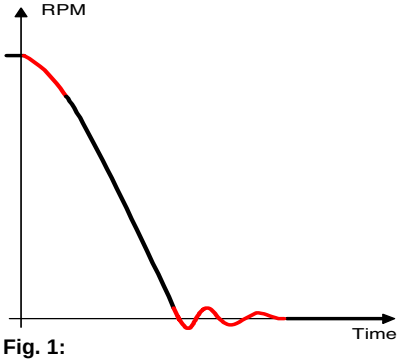


Fig. 1:

Illustrating the critical points of a “normal” braking

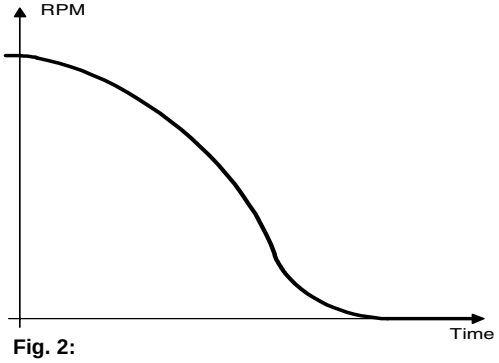


Fig. 2:

Non-controlled braking

A non-controlled or a "normal" braking sequence is relatively abrupt. The brake is activated with full braking force, creating "stress" at the beginning and end of the braking sequence, as shown in Fig. 1.

Fig. 3 shows the effects on the main shaft of a wind turbine. The shaft torque fluctuates, as the moment of inertia cannot be reduced as fast as the reduction in speed with this very rapid braking process.

The actual stop of the machinery will also create fluctuations of the moving parts, which will swing back and forth until the inertia has been reduced to zero - which may take several seconds or minutes. The fluctuations after stop are

SOBO-controlled braking

A SOBO-controlled braking sequence will be "soft", as the brake force will be applied in a controlled way. The brake pads will quickly make contact with the brake disc, but the brake force will be increased slowly and in a controlled manner. Fig. 2 shows the "soft" way in which the speed is reduced at the beginning of the braking sequence and, just as importantly, at the end.

Fig. 4 shows the dramatic reduction in the shaft torque of the wind turbine compared to non-controlled braking. The fluctuations and torque have been reduced to approx. 25%.

The unique parking sequence (see page 7) has firstly reduced the fluctuations and torque in the main shaft - but, just as importantly, the duration of these unwanted and destructive vibrations has also been reduced (to approx. 1/10).

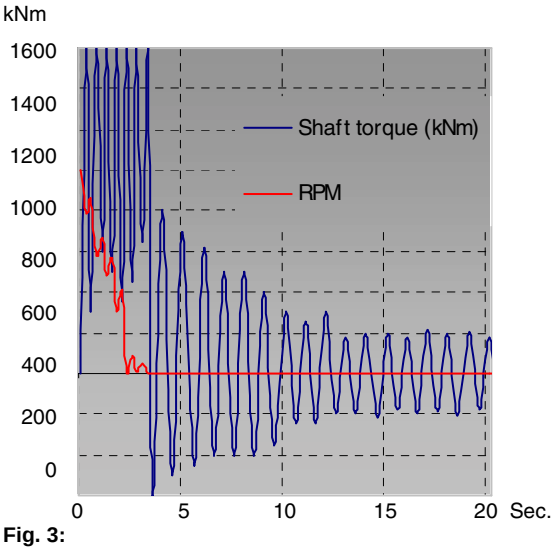


Fig. 3:

Stop of a MW wind turbine without brake control

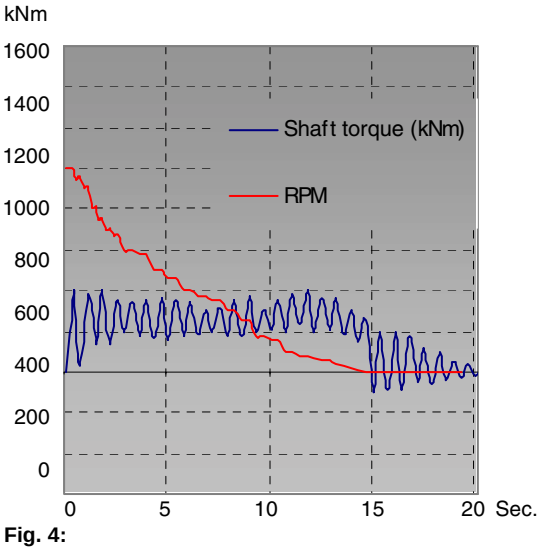


Fig. 4:

Stop of the same wind turbine using SOBO control

The concept is simple and complete

The SOBO concept can be designed as a turnkey system comprising the following components:

- SOBO Controller, electrical cabinet and speed sensor from SoboTech A/S.
- Hydraulic Power Unit from HydroTech International A/S.

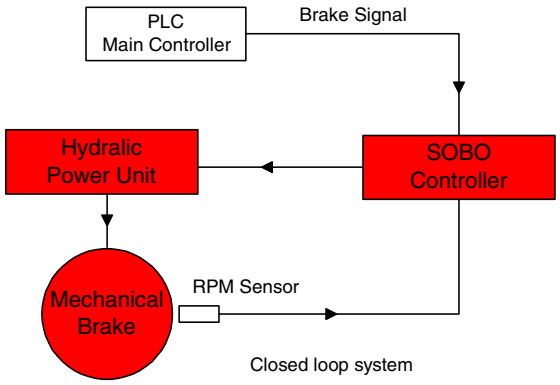


Fig. 5:

How does the SOBO system work ?

The sequence of operation:

- The SOBO controller "receives" a brake signal from the main PLC controller.
- The SOBO solenoid valves 20 and 21 are Pulse Width Modulated.
  (See page 5)
- The hydraulic pressure is reduced to zero in a controlled way as the hydraulic oil is returned to the tank.
- The spring pack in the brake calliper activates the brake.
- The SOBO solenoid valves are de-

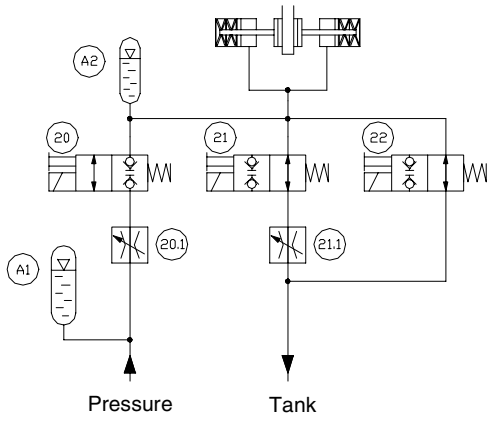


Fig. 6:

Hydraulic diagram, passive (fail safe) brake

Activating the brake

SOBO "soft" braking is a combination of hydraulic and electronic control. The adjustable throttle valves 20.1 and 21.1 and the SOBO accumulator A2 are the hydraulic components that make the braking "soft". The reduction in hydraulic pressure will not be instant, as the SOBO accumulator A2 and throttle valve 21.1 will try to keep the pressure up by "delaying" the flow of oil to the tank reservoir.

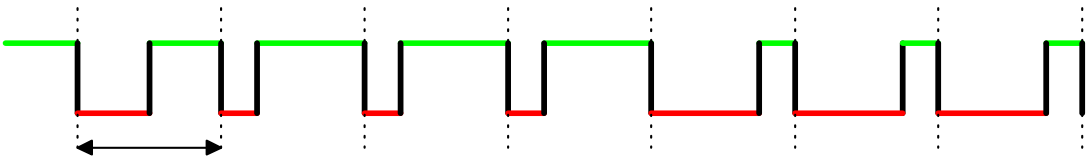
Releasing the brake

To release the brake after the braking cycle, the hydraulic system will operate in the opposite way. The brake is "lifted" in a "soft" way as the throttle valve 20.1 and the SOBO accumulator A2 delay the oil flow back to the brake cylinders. The pressure will increase, suppressing the brake springs and ultimately lifting the brakes.

The Pulse Width Modulation Principle

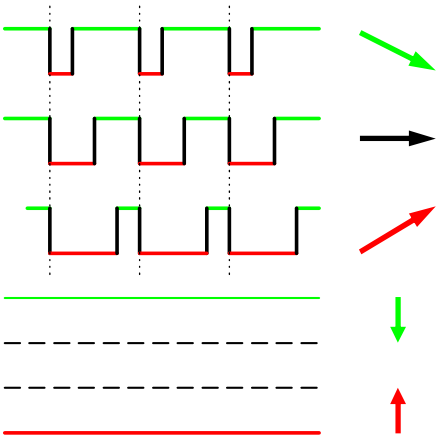
The SOBO modulation principle is a system based on ON/OFF Pulse Width Modulation of the two solenoid valves. This ON/OFF modulation based on the hydraulic and electronic components results in extremely safe and reliable braking.

The two solenoid valves "switch" ON / OFF at a rate of 10 times per sec., for example (Cycle time). By changing the time for brake OFF and ON, as shown below, it is possible to regulate the braking force. The SOBO controller will modulate the solenoid valves in such a way that the braking torque is regulated at all times to the actual need for "soft" and controlled braking of the mechanical machine concerned.



CycleTime (Pulse Width)

The Braking Force Control



= 75% / 25% ⇨ Less brake force

= 50% / 50% ⇨ Brake force does not change

= 25% / 75% ⇨ More brake force

= Brake OFF ⇨ The solenoid valves are energized

The SOBO Solenoid

Brake OFF

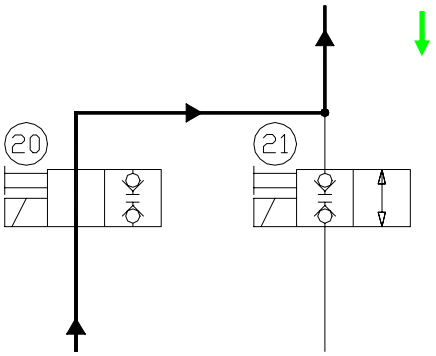


Fig. 7:

The solenoid valves are energized => Brake "lifted"

Brake ON

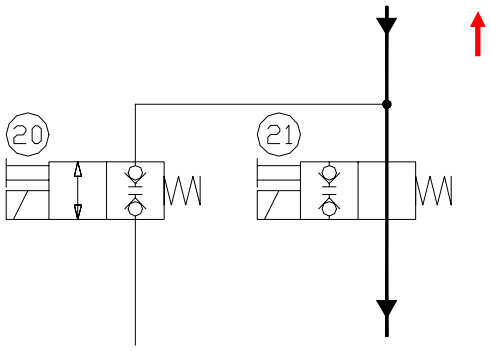


Fig. 8:

The solenoid valves are de-energized => Braking

The Deviation Band

The deviation band is one of the SOBO Controller's regulation functions. The deviation band effects regulation of brake torque by changing the Pulse Width Modulation of the solenoid valves (as explained on page 5). The deviation band determines the Pulse Width Modulation in such a way that an actual RPM value in the centre of the deviation band (the actual RPM value is equal to the programmed value) will result in "neutral" modulation of the solenoid valves, e.g. 50% / 50%, which means minimum change in brake torque. An actual RPM value above the midpoint of the deviation band will result in a Pulse Width Modulation that increases the braking torque, modulation e.g. 35% / 65% as shown in Fig. 9. An actual RPM value below the middle of the deviation band will result in a Pulse Width Modulation that decreases the braking torque, e.g. modulation 60% / 40% as shown in Fig. 9.

A "narrow" deviation band (B) will change the percentage of the Pulse Width Modulation as shown in Fig. 10. The difference between deviation band A and B is the effect the RPM deviation will have on the percentage of the solenoid valves' modulation - the percentage of the energized and de-energized time. The "wide" deviation band (A) will have less effect on the percentage change of the Pulse Width Modulation.

Configuration of the deviation band is carried out using the keyboard of the SOBO controller.

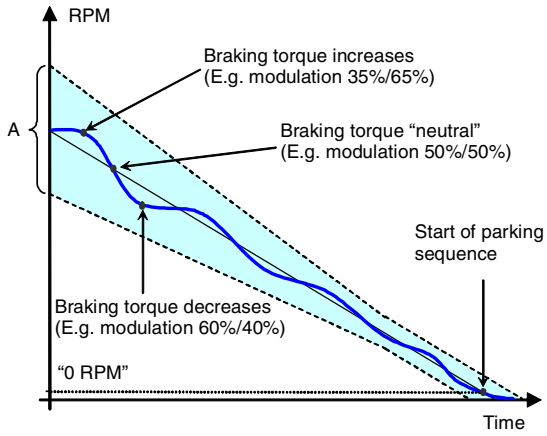


Fig. 9:

Illustrating a regulation sequence based on a "wide"

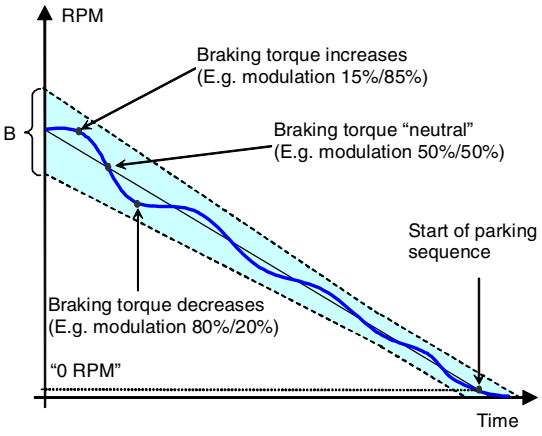


Fig. 10:

Illustrating a regulation sequence based on a "narrow"

Controlled Braking Torque

The basics of SOBO braking control and "soft" braking are firstly: To "apply" just enough braking torque to stop the brake disc rotation as required. The "0 RPM" value is an important part of the regulation as

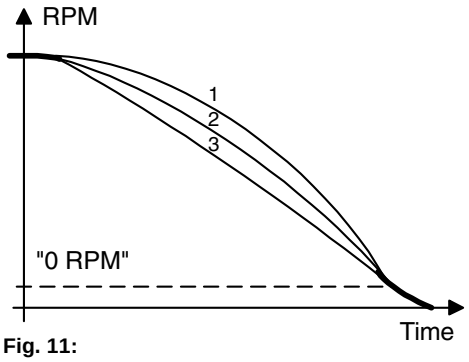


Fig. 11:

Illustrating 3 different curves for the RPM value as a function of time based on a conveyor system, for example, where curve 1 is a fully loaded conveyor, curve 2 is half loaded and curve 3 empty.

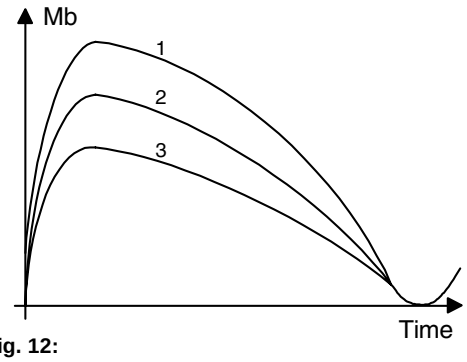


Fig. 12:

Illustrating the Braking Torque where curve 1 shows the extra braking torque "applied" to stop the fully loaded conveyor compared with the half loaded, curve

"0 RPM" and the SOBO Parking Sequence

One of the most unique functions of the SOBO Controller is the parking sequence. This function is particularly useful for stopping wind turbines and conveyors. The parking sequence is employed using 2 - 4 internal braking ramps that are built into the SOBO Controller. These braking ramps are based on the Pulse Width Modulation function and can be set to begin at a percentage of the nominal speed. This speed is pre-determined by the user to be the artificial zero RPM point (“0 RPM”).

When the artificial zero point (“0 RPM”) is reached, the braking ramps are activated to manage the braking sequence until the system reaches a true 0 RPM. These ramps can be set to any configuration, allowing for a parking sequence up to a maximum duration of 6 minutes. Using the parking sequence function reduces the amount of strain and fluctuation introduced into the drive system. This controlled braking torque will add to the lifetime of the mechanical machine involved.

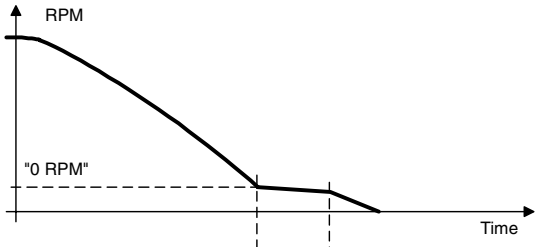


Fig. 13:

Illustrating the RPM value as a function of time in connection with a braking sequence where two internal braking ramps are activated at "0 RPM".

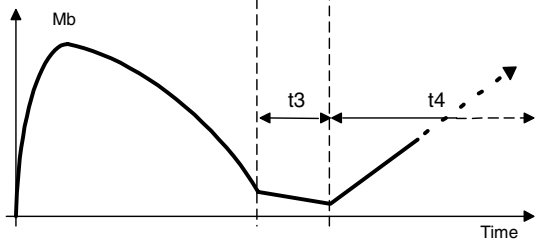


Fig. 14:

Illustrating the same braking sequence, showing the braking torque as a function of time. The braking torque is strong at the beginning and then gradually reduces as the inertia of the machine is reduced. The regulation after "0 RPM" is based on the two internal parking

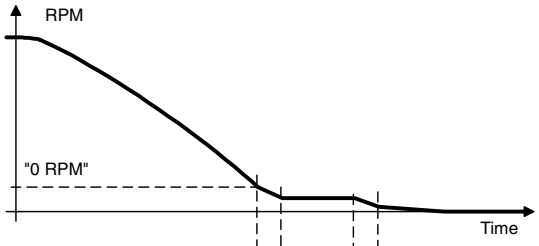


Fig. 15:

Illustrating a parking sequence where all four internal ramps are used. The difference in function compared to Fig. 13 is that the RPM value is kept at the same speed after "0 RPM". The machine is actually "free-wheeling" for

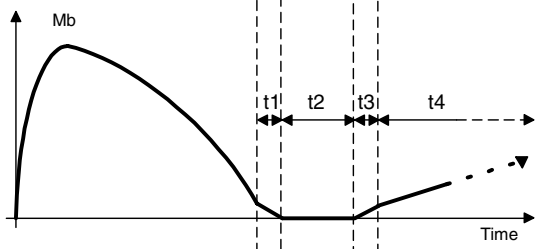


Fig. 16:

Illustrating the braking torque where the ramp t1 is the internal ramp that will bring the braking torque to 0. The ramp t2 is the time with no braking torque. The internal ramp t3 is the ramp for "neutral" and t4 the ramp for maxi-

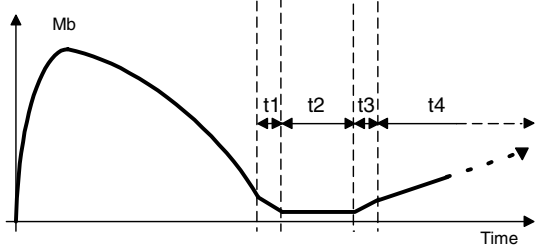


Fig. 17:

Illustrating the same parking sequence based on the 4 ramps as in Fig. 16, but the braking torque is not regulated to 0. The internal ramp t2 is regulated by the SOBO Controller for 0 braking torque, but the combination of SOBO regulation and a special hydraulic function will give a braking torque kept at a minimum value. The idea is to have the brake pads in

The SOBO Controller

The SOBO Controller is a programmable micro-processor-based controller. The SOBO concept comprises 3 different

models (see page 10). The controller is

extremely user-friendly with just one key

for each main function and minimum use

The Speed Sensor

The Speed Sensor (RPM Sensor) is an important part of the SOBO closed loop system. The proximity sensor (as below) is a commonly used RPM sensor, but the SOBO controller is also designed for encoders.

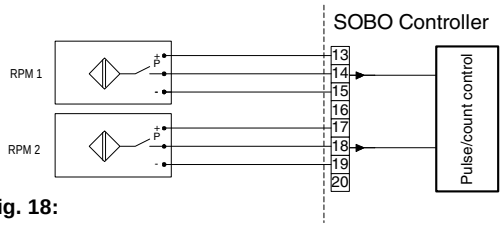


Fig. 18:

Note: The RUN BACK function requires 2 proximity switches or a two-channel encoder.

The Basic Connections

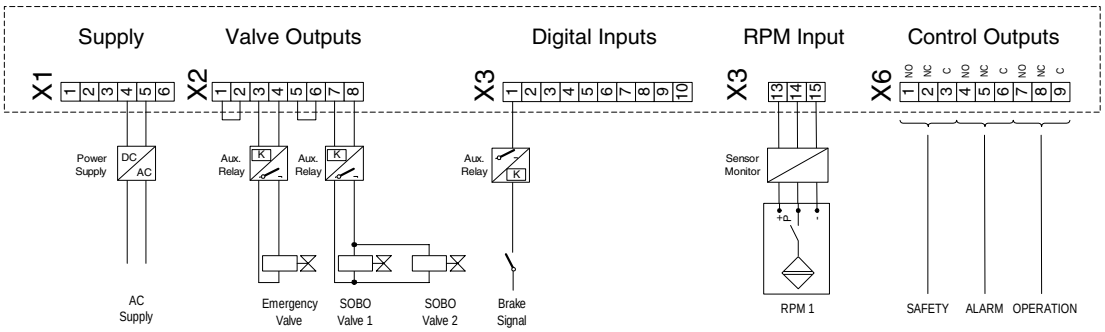


Fig. 19:

X1: 4,5, Power Supply: AC / 24 V DC.

X2: 3,4 and 7,8: 24 V DC output for the Solenoid Valves' auxiliary relays.

X3: 1-9: Digital inputs for Brake Signal and all other input commands to the controller.

X3: 13,14 and 15: Speed (RPM) Sensor signal.

X6: 1,2,3 - 4,5,6 - 7,8,9: Output signals from the SOBO Controller.

The **"SAFETY"** signal is a fail-safe relay output intended as the "Safety Chain" in applications where this function is used.

The **"ALARM"** signal is a fail-safe relay output. The relay will be deactivated in the event of any programmed alarm situation.

The Hydraulic Power Unit

The SOBO Hydraulic Power Unit is an integral part of the SOBO brake concept and as flexible as the SOBO Controller. The multipurpose specially engineered manifold block is designed for the max. pressure function, quick brake release and double-dump function. All the functions are activated and controlled by the SOBO control cabinet.

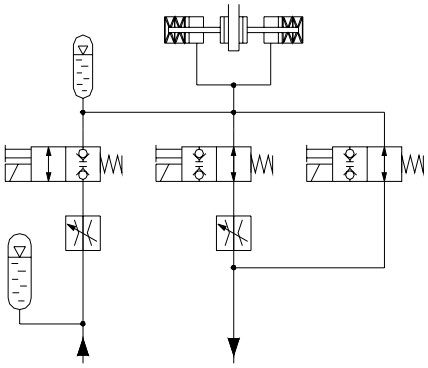


Fig. 20:

The passive (fail-safe) brake system is used for safety brake systems e.g. for escalators, mine winders, people conveyors and wind turbines.

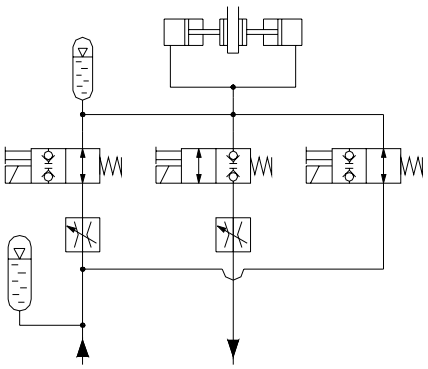


Fig. 21:

Active brakes are mainly used for applications where it may be fatal if the brake is applied when not wanted.

The Disc Brake

Svendborg Brakes is a world leader in the field of mechanical brakes, and springapplied disc brakes are the type most commonly used for SOBO brake applications.

One of the unique developments from Svendborg Brakes is the **AWA** (**A**utomatic **W**ear **A**djustment) brake, and this type can also be used as a "SOBO brake". The range of brakes includes brakes with a brake force from 2,000 N to 500,000 N.

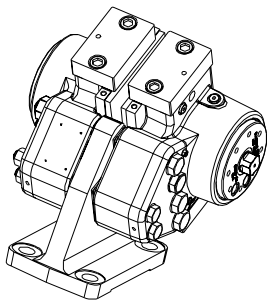
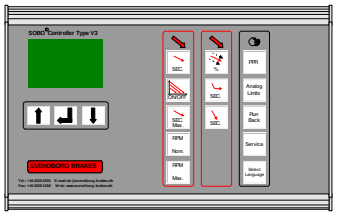


Fig. 22:

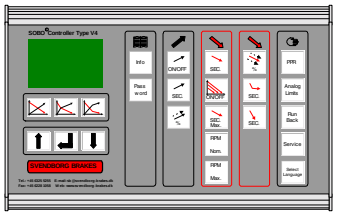
Svendborg Brakes has a large and rapidly growing R&D department that employs the most sophisticated design software. Our objective is to offer the solutions of tomorrow ahead of any other brake supplier.

Additional functions of the SOBO Controller

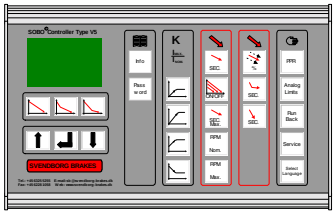
The SOBO Controller has some additional functions, which allow adjustment of the concept to suit present or future customer requirements. The following is an overview of these additional functions:



SOBO V3



SOBO V4



SOBO V5

	Sobo V3	Sobo V4	Sobo V5
1 Monitoring of maximum braking time	X	X	X
2 Monitoring of maximum speed	X	X	X
3 Quick contact with the brake disc	X	X	X
4 Special function for emergency/safety braking	X	X	X
5 Constant deceleration	X	X	X
6 Monitoring of nominal speed	X	X	X
7 Contrast adjustment (graphic display)	X	X	X
8 Monitoring and control of Run Back	X	X	X
9 Programmable regulation area	X	X	X
10 "Inching" function	X	X	X
11 External "Watchdog"	X	X	X
12 Controlled release of brake	X	X	X
13 User-friendly default function	X	X	X
14 Monitoring of pump time of the hydraulic unit	X	X	X
15 User-friendly Keyboard Lock function	X	X	X
16 Advanced Password function	X	X	X
17 Programmable "Artificial Zero-point" (“0 RPM”)	X	X	X
18 Advanced priority function	X	X	X
19 Option of coded inputs (binary code)	X	X	X
20 Alarm system with Event and Log configuration		X	X
21 Start and stop of electric motor for the hydraulic unit		X	X
22 Monitoring of the hydraulic pressure		X	X
23 Monitoring of the brake pad temperature		X	X
24 Controlled start-up (ramp-up)		X	
25 K-factor improvement			X
26 Battery back up (optional)	X	X	X

The Complete SOBO Control concept as a Turnkey delivery

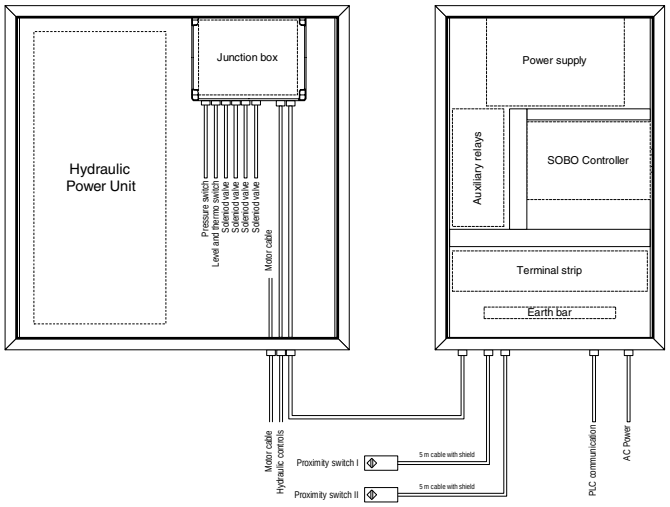


Fig. 23:

Illustrating the supply of 2 enclosures/cabinets for SOBO control of a disc brake. The cabinets are powder-painted steel (or stainless steel option (different dimensions)). The Hydraulic Power Unit cabinet: Width: 600 mm, Height: 600 mm and

Technical data

SOBO Controller

Dimensions:

215 x 135 x 60 mm

Dimensions with DIN bar:

215 x 135 x 70 mm

Mounting:

EN 50022:1977, DIN bar. Option: Bracket

Ambient temperature:

-20°C to +55°C (4°F to 131°F)

Storage temperature:

-20°C to +75°C (4°F to 167°F)

Ambient humidity:

90% RH, 40°C (104°F), not condensing

Power supply:

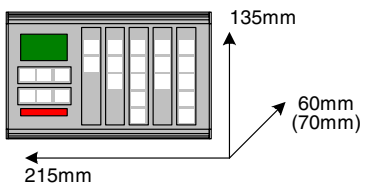
24V DC -10% +15% (21,6V - 27,6V)

Display:

100x64 dot graphic display, illuminated

Micro controller:

Mo-
torola
Cold
32 bit,
MHz



fire,
16

Multi-

Hydraulic Power Unit

Motor:

3x380-440V AC/50Hz, 0.75kW, 1.71A, 1415min-1

3x460-480V AC/60Hz, 0.75kW, 1.68A, 1690min-1

Ambient temperature:

-20°C to +40°C (4°F to 104°F)

Oil tank volume:

5 litres

Filtration by pressure filter:

10 µm

Recommended oil type:

Mineral oil HLP (HM) and HVLP, according to DIN 51524, parts 2 and 3 MOBIL-SHC 524, VG32

Weight:

40 kgs (88 lbs)

Valve coils:

24V DC, 1.05A, 25W - DIN 43650 ISO 4400

Max. flow for pump:

1.3 l/min

Pump displacement:

1.2 cm3/rev, max 200 bar

Pressure switch, motor on/off:

Max. 250V AC, 5A - 250V DC, 0.02A

SOBO Brake Control Equipment

The Hydraulic Power Unit, the SOBO Control Cabinet and the Speed Sensor.

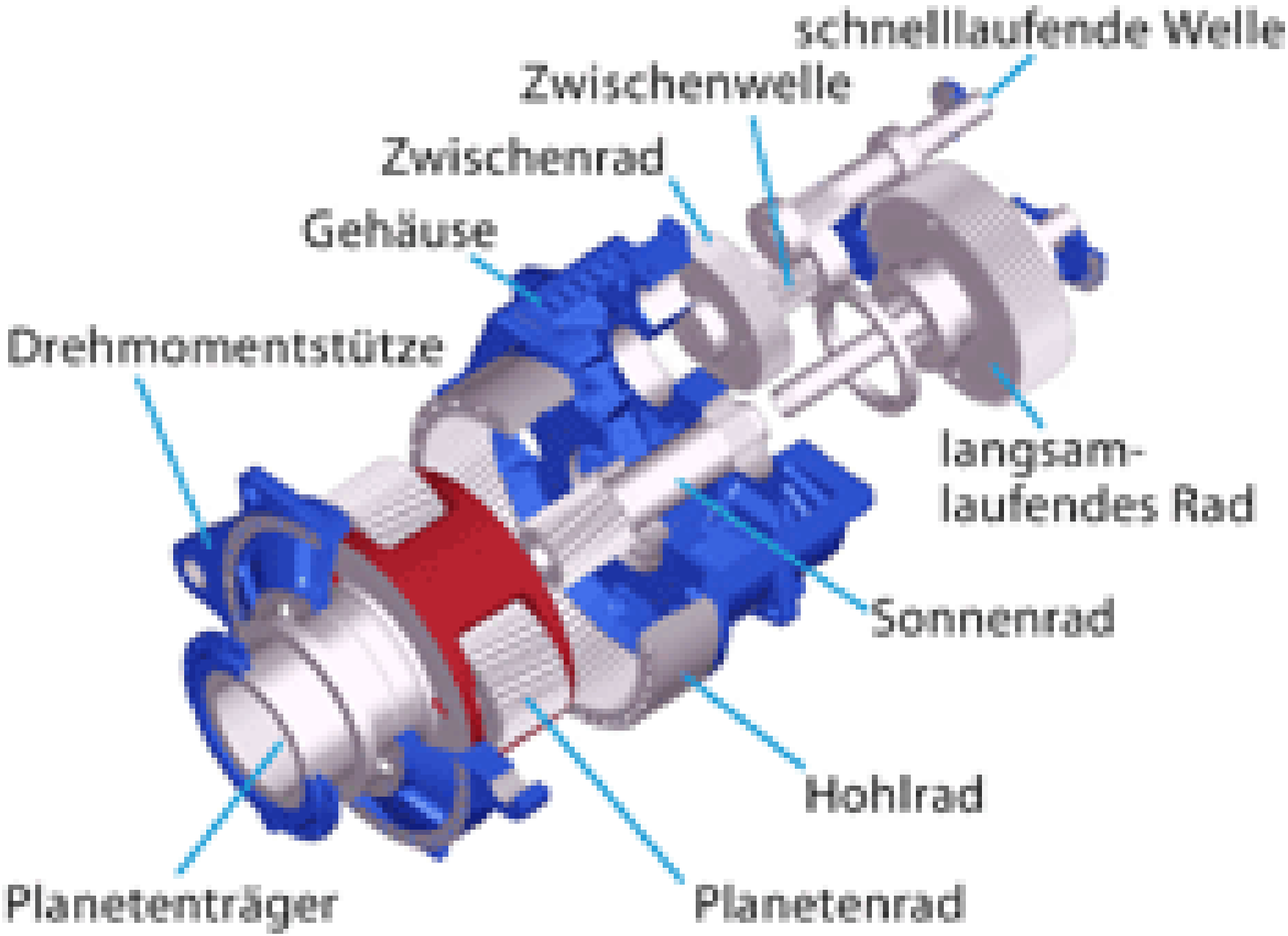
The photo above shows a typical SOBO delivery for an escalator, a conveyor system or a wind turbine. The equipment can be used with new machines or as a retrofit for existing applications.

With the Soft Braking Option,
you will have the best performing brake on the market!

SVENDBORG BRAKES

Jernbanevej 9, 5882 Vejstrup, Denmark Tel.: +45 63 255 255 Fax: +45 62 281 058

www.svendborg-brakes.dk E-mail:sb@svendborg-brakes.dk


schnelllaufende Welle
Zwischenwelle
Zwischenrad
Gehäuse
Drehmomentstütze
langsam-
laufendes Rad
Sonnenrad
Hohlrad
Planetenträger
Planetenrad

Wind Turbine Inspection Form -- Page 1 (General)

Windpower project: Movasa | Turbine ID no: #1, logbook #`13349 | Date: #########
Turbine make & model: Micon 750 | Turbine install year: 99 | Inspected by: NS, LH
Status prior to inspect: Online | Fault indication: none | Cumul kWh reading: 18542537
Weather: Good | Hub wind est.: _____ mph or mps | Logbook present? Yes
Logbook copied? No
Logbook quality/duration: Good

Inspection item	OK	Defects	Photo #'s (See Page 5)	Findings & Comments
Upon arrival (with turbine operating):				
Overview photo		X	1	Milldew on tower
Foundation	X			
Base of Tower	X			
Controller / Base Wiring		X	2,3	insulation melting off of power buses b/c of heat, conductor cable showing heat stress
Switchgear/contactor	X			
Noises (blades / mechanicals)	X			
Shutdown turbine (noises, etc.)	X			
Manual Yaw (operation, noises)	X			
Tower & nacelle inspections				
Ladder / Safety Equipment	X			
Tower (cracks, corrosion, bolts)	X		6	1/3 of tower wall has been painted from flange up to top b/c of corrosion
Tower Wiring / Hardware		X	7,8,9	light out, power cables show old damage but has been moved up and damage not reoccuring.
				clamp not over tightened as severly as at Movasa, power cables also showing damage at yaw deck b/c
				protection misplaced, some old damage significant but does not look like it is getting worse
Yaw Bearing	X			
Ring gear		X	10	dry, metal dust on floor
Yaw Drive / Pinion		X	11,12	dry, minor leak in yaw drive
General Condition of Nacelle		X	13,14	ano mast mounting hardware corroding, needs service, some brake dust
Cooling System	X			
Brakes (general condition, pads)	X			Pads: 1/2
Hydraulic Station	X			
Wind & Vibration Instruments	X			
Generator	X			
Oil Cooler	X			
Oil Pump		X	15	minor leak
Gearbox (general)	X			Detailed gearbox page? Yes
Main Shaft and Hub	X			
Blades (general)	X			Detailed blade pages? No

Gearbox mfr & S/N: Flender 421 906 138 | Rebuilt? no | Oil samples: yes
Generator mfr & S/N: 2003
Nacelle / Bed Plate S/N:

Wind Turbine Inspection Form -- Page 3 (Gearbox)

Windpower project: Movasa | Turbine ID no: #1 13349 | Date: ########
Gearbox manufacturer: Flender | Gearbox serial no. 421 906 138 | Inspected by: NS, LH

	Wear	OK	Defects	Photo No.	Comments
High Speed Shaft	L	X			
Right hand low speed intermidiate	L	X		16	showing very slight spots on carrier side
Right hand high speed intermidiate	L	X			
Primary low speed	L	X			
Oil Level		X			
Oil Sample Taken?	Yes				
Downwind Bearing/Gear Noise	No				
Oil Pump Noise	No				
Oil Flow Spray Nozzle		X			
Unusual Vibration	No				
Oil Flow (top bearing)		X			

Photo #1

Photo #2

Photo #3

Photo #4

Photo #5

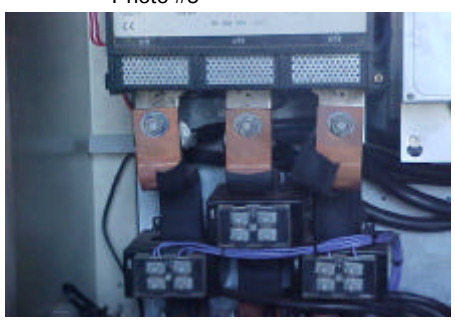


Photo #6

Photo #7

Photo #8

Photo #9

Photo #10

Photo #11

Photo #12

Photo #13

Photo #14

Photo #15

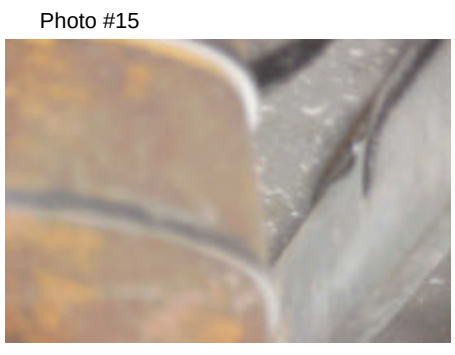


Photo #16

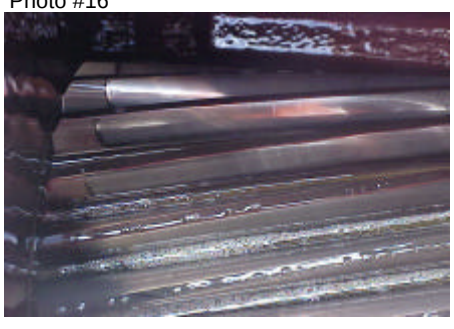


Photo #17

Photo #18

Photo #19

Photo #20

Photo #21

Wind Turbine Inspection Form -- Page 1 (General)

Windpower project: Movasa | Turbine ID no: #3 13342 | Date: #########

Turbine make & model: Micon 750 | Turbine install year: 98 | Inspected by: NS, LH

Status prior to inspect: Online | Fault indication: none | Cumul kWh reading: 19346077

Weather: Good | Hub wind est.: _____ mph or mps | Logbook present? Yes

Logbook copied? No

Logbook quality/duration: Good

Inspection item	OK	Defects	Photo #'s (See Page 5)	Findings & Comments
Upon arrival (with turbine operating):				
Overview photo		X	1	Milldew on tower
Foundation	X			
Base of Tower	X			
Controller / Base Wiring		X	2,3,4	insulation melting off and cable conductors showing heat stress
Switchgear/contactor	X			
Noises (blades / mechanicals)	X			
Shutdown turbine (noises, etc.)	X			
Manual Yaw (operation, noises)	X			
Tower & nacelle inspections				
Ladder / Safety Equipment	X			
Tower (cracks, corrosion, bolts)	X			1/3 of tower has been repainted from flange to top
Tower Wiring / Hardware		X	5,6	bunt out lights, some old insulation damage but not bad and not reoccuring
Yaw Bearing	X			
Ring gear		X	7	dry, metal dust
Yaw Drive / Pinion		X	8	dry, metal dust
General Condition of Nacelle		X	10	conduit cracking, needs service, some brake dust, cleaning to be done
Cooling System	X			
Brakes (general condition, pads)	X			Pads: 1/2
Hydraulic Station	X			
Wind & Vibration Instruments	X			
Generator	X			
Oil Cooler	X			
Oil Pump	X			
Gearbox (general)	X			Detailed gearbox page? Yes
Main Shaft and Hub		X	9	Missing hub bolt weather boots
Blades (general)	X			Detailed blade pages? No

Gearbox mfr & S/N: flender 02006 | Rebuilt? no | Oil samples: yes

Generator mfr & S/N: 421 109 808

Nacelle / Bed Plate S/N:

Wind Turbine Inspection Form -- Page 3 (Gearbox)

Windpower project: Movasa | Turbine ID no: aeroenergia #3 | Date: ########

Gearbox manufacturer: Flender | Gearbox serial no. 2006 | Inspected by: NS, LH

	Wear	OK	Defects	Photo No.	Comments
High Speed Shaft	L	X			
Right hand low speed intermidiate	L	X		11,12	very slightspotting on carrier side
Right hand high speed intermidiate	L	X			
Primary low speed	L	X			
Oil Level		X			
Oil Sample Taken?	Yes				
Downwind Bearing/Gear Noise	No				
Oil Pump Noise	No				
Oil Flow Spray Nozzle		X			
Unusual Vibration	No				
Oil Flow (top bearing)		X			

Photo #1

Photo #2

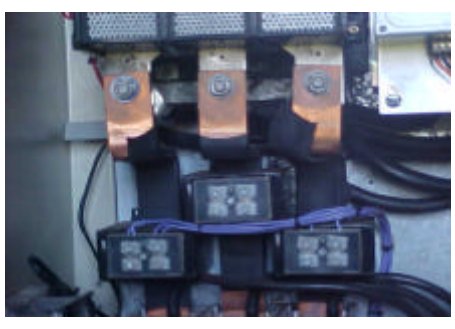


Photo #3

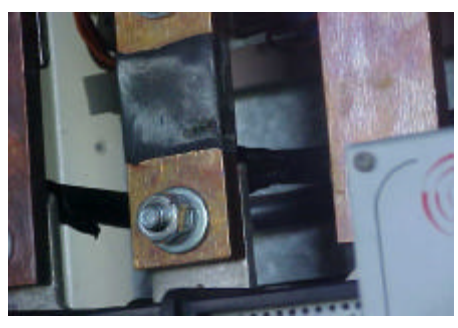


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Photo #5

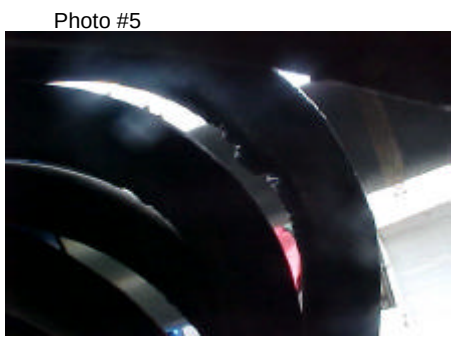

Photo #6

Photo #7

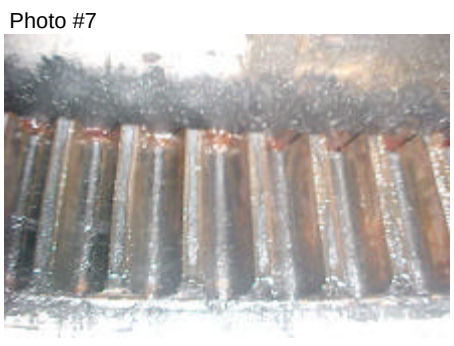

Photo #8

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Photo #16

Photo #17

Photo #18

Photo #19

Photo #20

Photo #21