Catalog D 86.2 • 2007

ac-motors
LARGE DRIVES

Three-phase synchronous motors
based on permanent
magnet technology
HT-direct 1FW4

SIEMENS

Related catalogs

Low-Voltage Motors D 81.1
IEC Squirrel-Cage Motors

Order No.:
German: E86060-K5581-A111-A1
English: E86060-K5581-A111-A1-7600

Asynchronous Motors D 86.1
Standardline
N-compact 1LA8
H-compact 1LA4

Order No.:
German: E86060-K5586-A111-A1
English: E86060-K5586-A111-A1-7600

SINAMICS G130 D 11
Drive Converter Chassis Units
SINAMICS G150
Drive Converter Cabinet Units
75 kW to 800 kW

Order No:
German: E86060-K5511-A101-A3
English: E86060-K5511-A101-A3-7600

SINAMICS S120 D 21.1
Drive System
0.12 kW to 1200 kW

Order No.:
German: E86060-K5521-A111-A2
English: E86060-K5521-A111-A2-7600

SINAMICS S150 D 21.3
Drive converter cabinet units
75 kW to 1200 kW

Order No.:
German: E86060-K5521-A131-A1
English: E86060-K5521-A131-A1-7600

Catalog CA 01 CA 01
The Offline Mall of
Automation and Drives

Order No.:
CD E86060-D4001-A110-C5-7600
DVD: E86060-D4001-A510-C5-7600

A&D Mall

Internet:
http://www.siemens.com/automation/mall

Three-phase synchronous motors based on permanent magnet technology

HT-direct 1FW4

Catalog D 86.2 · 2007

The products and systems described in this catalog are manufactured under application of a quality management system certified by DQS in accordance with EN ISO 9001 (Certificate Registration No. 002241 QM UM). The certificate is recognized in all IQ Net countries.

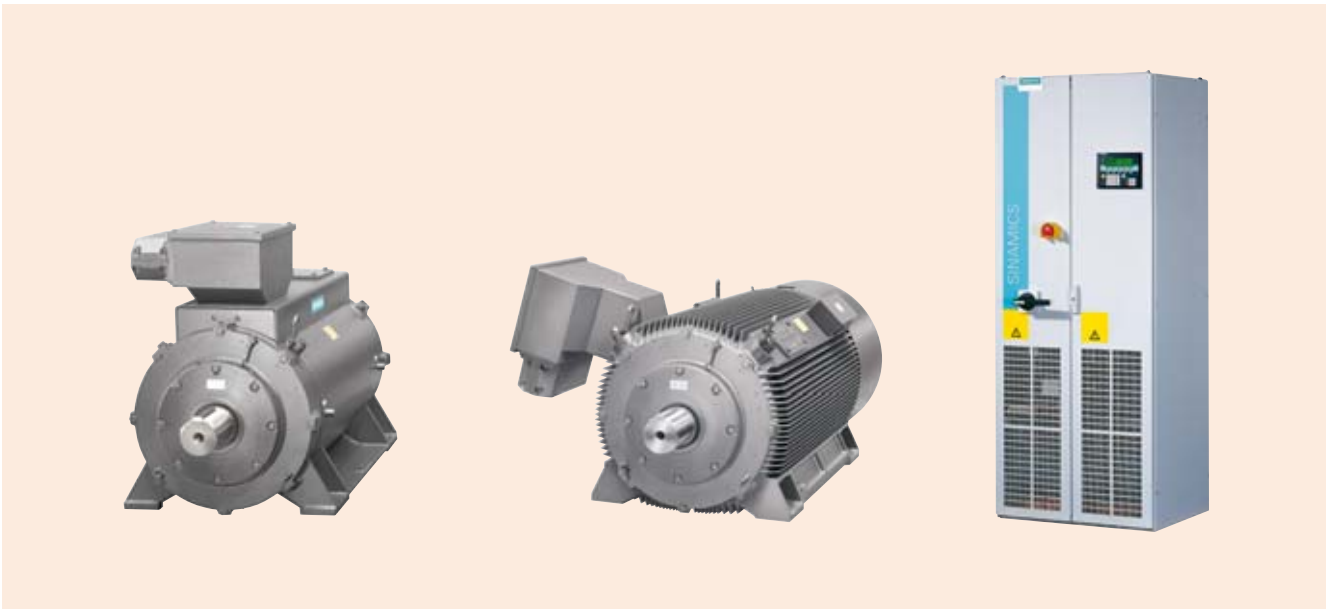
SIEMENS

Introduction

1

Overview

High-torque motors with SINAMICS frequency converters



HT-direct motors in combination with SINAMICS frequency converters form a variable-speed drive system for

- High torques
- Low speeds
- Low-maintenance operation

With

- Small space requirements
- High availability

With

- High efficiency
- Rugged design
- Low noise level

The HT-direct motors are a product range of extremely compact, low-voltage high-torque motors. In combination with a SINAMICS frequency converter, the HT-direct motor forms a perfectly matched drive system.

- Motor shaft heights of 400, 450 and 500 mm
- Motor torque range 5 – 40 kNm
- Motor rated voltage 400, 460 or 690 V
- Motor rated speed 200 to 800 rpm
- Type of construction of the motor IMB3
- Degree of protection of the motor IP55
- Motor cooling: Water-jacket cooled or forced ventilation
- Low-voltage converter with input voltages: 400 and 690 V/50 Hz, 460 V/60 Hz

SINAMICS frequency converters are designed for use in variable-speed drives in mechanical and plant engineering applications. They offer a low-cost drive solution which can be flexibly tailored from a wide spectrum of components and options to meet the requirements of individual customers.

HT-direct motors can be operated with converters of the SINAMICS S120/S150 and G130/G150 types. Closed-loop control software for permanent-magnet synchronous motors has also been developed.

SINAMICS S converters are used in the implementation of demanding drive-system tasks and satisfy stringent requirements on

- Dynamics and accuracy
- Integration of extensive technological functions in the drive control system.

SINAMICS G converters are designed for standard applications. These applications have less stringent requirements regarding the dynamics and accuracy of the motor speed.

For a detailed description of the SINAMICS product series, see the following catalogs:

Siemens converter series	Catalog short code	Catalog Order No.
SINAMICS G130 (chassis units)	D 11	E86060-K5511-A101-A3
SINAMICS G150 (cabinet units)		
SINAMICS S120 (chassis and booksize units)	D 21.1	E86060-K5521-A111-A2
SINAMICS S150 (cabinet units)	D 21.3	E86060-K5521-A131-A1
SINAMICS S120 (cabinet modules)	D 21.3 CM	–

Benefits

The benefits of the HT-direct motors:

- With slow-running drives, the efficiency of the HT-direct motors is approximately 2 to 3% higher than for similar drive concepts. For a 1000 kW motor, this results in a saving of 33 kW, which is an annual saving of approximately 15000 € for an operating time of 8 hours per day.
- The multi-pole drive design ensures that the space requirement and mass of the motors are lower than for similar induction machines. The slow-running motors of the HT-direct series obviate the need for a gearbox in many cases (reduction in engineering, assembly and maintenance outlay, lower investment and lower operating costs).
- Efficient, optimally matched drive system, SINAMICS converter and HT-direct motor for operation without encoders.
- Thanks to their long service life (nominal bearing lifetime > 60000 hours), HT-direct motors are maintenance-low and have a high availability especially for applications in which a gearbox can be omitted.
- Environmentally friendly system (where applicable, no disposal of gearbox oil is necessary; energy-saving drive system).

Application

Permanent-magnet synchronous motors are used in combination with converters as slow-running direct drives, e.g. for paper machines, in the steel and plastics industries and in shipbuilding.

1FW4 405-1HZ70-1AA0-Z

Order No. code

High-torque motors with permanent-magnet technology

Position	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16	
	1	F	W	4	■	■	■	–	■	H	■	■	0	–	1	A	A	■	– Z
					4	0	5												
									1										
											Z	7							
																		0	

Positions 1 to 3 (digit, character, character)	Type
Position 4 (digit)	Type series
Positions 5 to 7 (digits)	Frame size
Position 8 (digit)	Cooling method
Position 9 (character)	Number of poles
Position 10 (character)	Rated speed
Position 11 (digit)	Voltage
Position 12 (digit)	Type of construction
Position 13 (digit)	Rotor design
Position 14 (character)	(Not used at this time)
Position 15 (character)	Shaft version
Position 16 (digit)	Bearing design
Special versions	Please specify additional order code and any plain text

Ordering example

HT-direct motor, water-cooled

400 rpm; 40 kNm; 1676 kW; 690 V$\curlyvee$ →
Frame size 508

Temperature class 155 (F)
Used acc. to 155 (F)
IP55 degree of protection
IM B3 type of construction
Standard bearing design

Order No.	**1 F W 4 5 0 8 – 1 ■ ■ ■ ■ – ■ A ■ ■**
Number of poles	**– H**
Rated speed	**– C**
Voltage	**– 7**
Type of construction	**– 0**
Rotor design	**– 1**
(Spare position)	**– A**
Shaft version	**– A**
Bearing design	**– 0**
Specify when ordering:	**1 F W 4 5 0 8 – 1 H C 7 0 – 1 A A 0**

Protection strategy

Reverse power

Due to the permanent magnets in the rotor, magnetic flux is continuously present in the motor and for each revolution of the rotor, a voltage is generated at the motor terminals, even when the feeding converter is switched off and disconnected from the supply system.

Power from feeding converter

Also, when the rotor is at a standstill, voltage can still be present at the motor terminals if the feeding converter has not yet been switched off or the DC link circuit of the converter is not yet discharged.

Notes on safety, application and design

If work is to be performed on the drive system (converter and/or motor), the following safety measures must be implemented:

- The converter must be isolated from the supply system by a switch (isolating switch or circuit-breaker).
- Prevent any rotary motion of the motor.
- A separate protective device must be used for plants, in which the rotor can be accelerated by an active load, for example a circuit breaker must be used.
- The field weakening range is limited to 120%. In case of an active load (rotor can be accelerated by the plant) the DC link must be protected against overspeed/overvoltage.

Safety precautions when working on		**Maintenance or repair on the motor and/or the converter after commissioning of the drive system may only be carried out under the following preconditions.**
Motor terminal box	Important! Only permissible when the rotor is at a standstill!	Before opening the motor terminal box it must be ensured that • the rotor is at a standstill, • the converter is disconnected from the supply and • the DC link of the converter is discharged.
Converter	On rotor standstill.	Before opening the converter it must be ensured that • the converter is disconnected from the supply, • the DC link of the converter is discharged and • the rotor is at a standstill.
	With a rotating rotor that is coupled depending on the plant.	Before opening the converter it must be ensured that • the converter is disconnected from the supply, • the DC link of the converter is discharged and • that the (coupled) motor is electrically isolated from the converter by means of a suitable switch (for SINAMICS S120 Cabinet Modules a corresponding circuit-breaker on the output side can be ordered with the converter opion **L34**).

Converter-fed operation

Converters

SINAMICS S converters

The **SINAMICS S120 and S150 converters** allow regenerative feedback into the supply system. The motor can be operated, if required, with a rotor position encoder.

SINAMICS G converters

The **SINAMICS G130 and G150 converters** do not allow regenerative feedback into the supply system. These converters also do not support the use of a rotor position encoder. The motor can only be operated without encoder.

All converters must be operated at a pulse frequency of ≥ 2.5 kHz due to the eddy-current losses that arise in the magnets.

Encoderless speed control

Encoderless speed and torque control has been developed for the HT-direct motors.

The motors can be started up from a standstill without encoders. After a few revolutions, the converter can calculate the speed and position of the rotor from the voltage induced by the magnets in the motor winding. Motor operation down to standstill is possible. For highly dynamic torque control, an encoder is required at low speeds. For connection to a rotating machine (capture) in encoderless operation, a voltage measuring module is required. This module is offered as an option (K 51) for the converter and can be used instead of an encoder module.

Synchronized operation of multiple drives

The accuracy for speed or frequency for synchronized operation of several drives is 0.01% related to the maximum speed or frequency over a period of one second. A SINAMICS converter is required for each motor.

Approach

Start-up from standstill with full rated torque is possible for encoderless motors as well as for motors with speed encoders.

Creep operation

Water-jacket-cooled and forced-ventilated motors can be operated for 3 hours with 1/100 of the rated speed. At this operating point, the converter is only permitted to be operated at 50% of the rated current. A speed encoder is required for torque-controlled operation in this range.

In creep mode, if the torque is more than the applicable torque at 50% of rated current, a converter with a higher rating must be selected.

Operation in the field weakening range

The field weakening range for the HT-direct motors is limited to 20% of the rated speed. The magnets in the rotor do not allow conventional field weakening, so field weakening can only be achieved by the injection of a phase-displaced current by the converter. In the case of high field-weakening speeds, this would require an increase in converter frame size. The limited field-weakening range also ensures that the DC-link voltage of the converter does not exceed the maximum permissible value in case of pulse blocking due to the induced voltage of the motor.

Overload capability

The overload capability of the motor converter system is determined by the design of the converter and motor (see SINAMICS catalogs). The motor and converter can be temporarily overloaded by up to 50%. The basic load current of the converter that is available is reduced by overload requirements which may require selection of a larger converter. For higher overloads and more complex duty cycles, please submit an enquiry.

Cable lengths between the motor and converter

The maximum cable length for shielded motor connection cables is 300 m without any additional measures (see the section “Bearings and bearing currents”).

Duty type

The standard duty type is S1. For other duty types, please specify the duty cycle.

Use according to temperature class 130 (previously temperature class B) available on request.

General technical data

Bearings and bearing currents

When operating multiphase AC machines by a converter, an electrical bearing stress results from a capacitive induced voltage via the bearing lubricating film, depending on the principle being used. The physical cause of this is the common-mode voltage at the converter output: The sum of the three phase-to-neutral voltages is not zero at all times, unlike with direct on-line operation. The high-frequency, pulse-shaped common-mode voltage brings about a residual current, which closes back to the converter's DC link via the machine's internal capacitances, the machine housing and the earthing circuit. The machine's internal capacitances include the main insulation winding capacitance, the geometric capacitance between the rotor and stator, the lubricating film capacitance and the capacitance of any bearing insulation that may be present. The current level via the internal capacitances is proportional to the common-mode voltage regulation ($i(t) = C \cdot du/dt$).

In order to apply currents to the motor which are sinusoidal as far as possible (smooth running, oscillation torques, stray losses), a high pulse frequency is required for the converter's output voltage. The related (very steep) switching edges of the converter output voltage (and also, therefore, of the common-mode voltage) cause correspondingly high capacitive currents and voltages on the machine's internal capacitances.

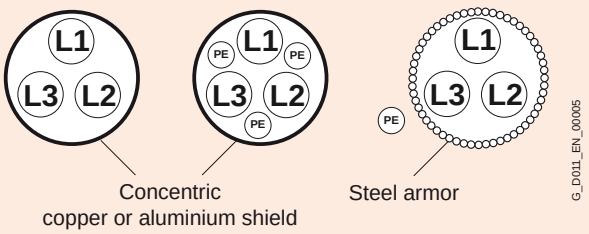
In the worst-case scenario, the capacitive voltage induced via the bearing can lead to random punctures of the bearing lubricating film, thus damaging the bearing/causing premature wear. The current pulses caused by the puncture in the lubricating film are referred to as EDM (Electrostatic Discharge Machining) currents, although this is not primarily a question of an electrostatic effect, but more of (partial) punctures of insulating material, i.e., of partial discharges.

This physical effect, which occurs in isolated cases, has mostly been observed in connection with larger motors.

EMC-compliant installation of the drive system is a basic prerequisite for preventing premature bearing damage via bearing currents.

The most important measures for reducing bearing currents:

- Use of cables with a symmetrical cable cross-section (see Figure below)

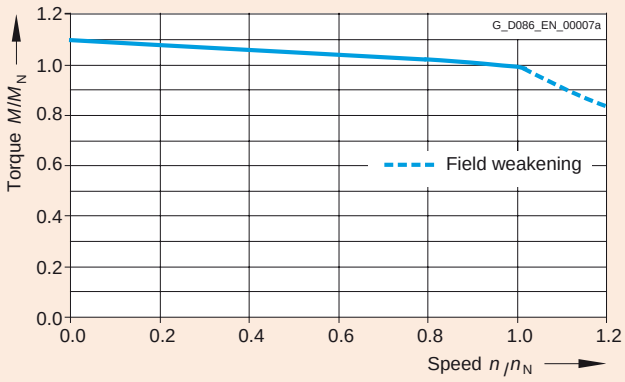


- Use of motor reactors (converter option L08)
- Preference given to a supply with insulated neutral point (IT system)
- Use of grounding cables with low impedance in a large frequency range (DC up to approximately 70 MHz): for example, plaited copper ribbon cables, HF litz wires
- Separate HF equipotential-bonding cable between motor housing and driven machine
- Separate HF equipotential-bonding cable between motor housing and converter PE busbar
- 360° HF contacting of the cable shield on the motor housing and the converter PE busbar. This can be achieved using EMC screwed glands on the motor end and EMC shield clips on the converter end, for example.
- Common-mode filters at the converter output
- The HT-direct motors are equipped with an electrically insulated bearing housing at NDE.

Thermal limit characteristic and field-weakening range

Due to the speed-independent cooling of the HT-direct motors, no torque reduction or only a relatively minor torque reduction (depending on their speed range) is required for operation at constant load torque and with wide speed ranges.

Guide values for the maximum load torques at various speeds can be obtained from the diagrams below:



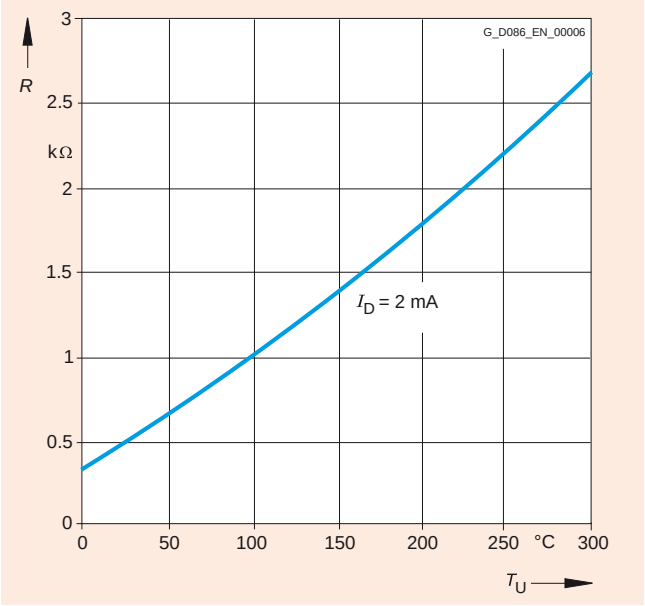
Motor protection

In addition to the current-dependent overload protection device located in the connecting leads, we recommend that you also monitor the temperature rise in the motor - and consequently the winding temperature - with the aid of the KTY 84-130 temperature sensors built into the stator winding as standard.

Winding temperature detection with KTY 84-130 temperature sensors (standard)

The KTY 84-130 sensor is a semiconductor sensor that changes its resistance depending on temperature in accordance with a defined, approximately linear characteristic. Two temperature sensors are built into the winding overhang as standard, whereby one sensor is used as a spare. The temperature is evaluated in the Siemens converter using the resistance of the temperature sensor. The required temperature for alarm and tripping can be set on the converter.

Two auxiliary terminals are provided for connection in the terminal box.



Optional winding temperature detection with PTC thermistors (thermistor motor protection)

Protection against thermal overloading of the motor is also provided by PTC thermistors installed in the winding overhang. When a limit temperature is reached (rated tripping temperature), the PTC thermistor undergoes a step change in resistance. This is evaluated by a tripping unit and can be used to open auxiliary circuits.

Two auxiliary terminals are provided in the terminal box for connecting three built-in temperature sensors for shutdown.

Optional winding temperature detection with PT100 resistance thermometers

PT100 resistance thermometers can also be installed in the winding overhang. An additional auxiliary terminal box is required for connection.

Changes in temperature are transferred to a display device in the form of changes in resistance. The indicator is not included in the scope of supply.

Bearing monitoring

Standard bearing vibration monitoring using SPM shock-pulse measurement

Measuring nipples for SPM shock-pulse measurement are screwed into the bearing housing at the drive end and non-drive end as standard.

Optional bearing temperature detection with PT100 resistance thermometers

As an option, bearing thermometers can be screwed into the bearing housings at the drive end and non-drive end. The wires are routed through an additional terminal box.

Changes in temperature are transferred to a display device in the form of changes in resistance. The indicator is not included in the scope of supply.

General technical data

Electrical design

Speeds

The rated motor speeds (rpm)
- 200
- 300
- 400
- 500
- 600
- 800

describe the transition speeds of the motor design.
Above the transition speed, a field weakening range of up to 20% is possible (e.g. a motor with a rated speed 500 rpm can be operated up to 600 rpm).

Voltages and frequencies

EN 60034-1 differentiates between Category A (combination of voltage deviation ±5% and frequency deviation ±2%) and Category B (combination of voltage deviation ±10% and frequency deviation +3/–5%) for voltage and frequency fluctuations.

The motors can supply their rated torque in both Category A and Category B. In Category A, the temperature rise is approx. 10 K higher than during normal operation. According to the standard, longer operation is not recommended for Category B.

The tolerance for HT-direct motors is in accordance with DIN EN 60034-1 in all cases. A rated voltage range is, therefore, not specified on the rating plate.

Line voltages	**690 V, 50 Hz**	**400 V, 50 Hz**	**460 V, 60 Hz**
Voltage code (11th position of the Order No.)	**7**	**8**	**4**

Windings and insulation

For the versions with windings of round wire, the well-proven DURIGNIT 2000 insulation system in temperature class 155 is used. Frame sizes ≥ 450 have shaped-coil windings whose insulation system is based on the same materials and whose winding design is adapted accordingly.

The components of the insulation system are
- Varnish or mica-insulated round or flat wires for the winding insulation
- Multi-layer flat insulation material for the slot and phase insulation
- Solvent-free impregnated resin

The high-quality materials offer resistance to continuous high temperatures approaching temperature class 180.
An impregnation technique optimized for the winding design is used that ensures a minimum resin fill level in the slot.

This ensures:
- The required mechanical stiffness of the winding in the vicinity of the slot and windings
- The quality of heat dissipation to the laminated core and the internal air circulation
- Protection of the winding from environmental effects such as humidity or corrosive chemicals.

Utilization

With the insulation system used under normal converter-fed operation, the motors are utilized according to temperature class 155 (previously: temperature class F).

Motor connection and connection boxes

Connecting cables

For motor currents that exceed the maximum current carrying capability of 1230 A of a terminal box, two galvanically isolated winding systems are equipped with two 1XB1 631 terminal boxes (for assignment, see the section “Selection and ordering data”).

The connecting cables must be dimensioned acc. to DIN VDE 0298.

Characteristics of the 1XB1 631 terminal box

Number of terminals	Quantity	12
Contact screw thread	Size	M16
Max. rec. conductor cross-section	mm^2	240
Outer cable diameter (sealing range)	mm	56 ... 68.5
Cable entry holes	Size	4 x M80 x 2
Cable glands (option **K57**)	Size	4 x M80 x 2 Z58 – Z67

Terminal box 1XB1 631

The possible mounting positions for the terminal boxes on the water-cooled or air-cooled motors are described in Sections 2 and 3.

Characteristics of the optional auxiliary terminal box

Number of terminals	Quantity	24
Outer cable diameter	mm	11 ... 16
Cable entry holes	Size	2 x M20 x 1.5
Cable glands (option **K57**)	Size	2 x M20 x 1.5

Mechanical design

Rotor construction

The rotor is fitted with permanent magnets. The magnets are integrated in the rotor and potted in resin.

For rotors **installed** in motors, a magnetic field cannot be detected externally.

Danger:
The magnetic field from a **disassembled** rotor can cause injury or damage to health if inappropriate tools are used. Installation and disassembly of the rotor is therefore only permitted to be performed at the manufacturer site.

Bearings and lubrication

The HT-direct motors are equipped as standard with one deep-groove ball bearing at DE and NDE installed in the bearing housing.

The DE bearing is responsible for axial guiding of the rotor (so-called fixed bearing).

The NDE bearing is installed as a floating bearing with axial clearance in the electrically insulated bearing housing. Axial pressure springs that act on the outer ring of the deep-groove ball bearing ensure backlash-free and smooth running of the motor.

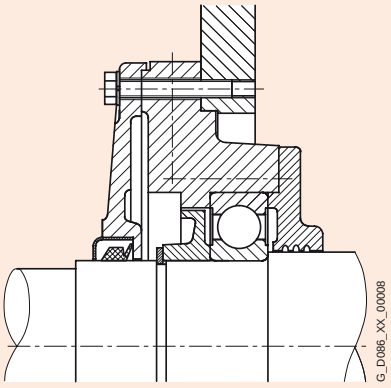
The roller bearings are greased and are equipped with a re-greasing device. The grease type, quantity and relubrication intervals are stated on the lubrication plate of the motor.

The calculated bearing lifetime is 60000 operating hours in S1 duty provided that the instructions for lubrication on the lubrication plate of the motor are complied with. In practice, however, the bearing lifetime is frequently longer than this.

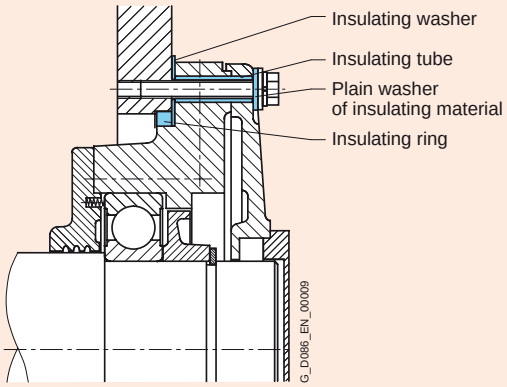
The compartment for storing the old grease must be sufficiently large to allow an operating time of > 60000 hours.

The requirements of the marine classification societies (Germanischer Lloyd, DNV, BV, LRS,ABS, CCS) are fulfilled, i.e. angular displacement is permitted in every direction up to 15° static and 22° dynamic. The requirement must be ordered with the appropriate E.. order code.

Measuring nipples are screwed into the bearing housing as standard for bearing monitoring based on the shock-pulse method.



Bearing at DE (fixed bearing)



Bearing at NDE (floating bearing):
Electrically insulated bearing cartridge, backlash-free adjusted deep-groove ball bearing

Standard bearing arrangement

Frame size	Drive end DE bearing	Non-drive end NDE bearing
40.	6232 C3	6228 C3
45.	6236 C3	6232 C3
50.	6240 C3	6236 C3

Changing the bearing

It is possible to change the bearings on site. Please contact your local Siemens sales representative regarding this.

Max. motor speed

The motors can be operated up to 20% above the rated speed.

General technical data

Balance and vibration severity

The rotors are dynamically balanced with half key. This corresponds to vibration severity grade A.

DIN EN 60034-14 is concerned with the mechanical vibrations of rotating electrical machines and specifies limits. “Half key balancing” is specified here based on DIN ISO 8821.

The balancing type is stamped on the face of the drive-end (DE) shaft extension.

F = Balancing with full featherkey
H = Balancing with half featherkey
N = Balancing without featherkey

Full key balancing is possible, on request, by specifying code **L68** (additional charge).

Low-vibration versions can be supplied to fulfill stricter requirements on smooth running (additional charge).

For vibration severity level **B** (special vibration requirements), order code **K02** must be specified in the order.

Vibration severity grade	Limit values (rms values) for the maximum vibration level for the vibration speed in mm/s in a rigid configuration according to IEC/EN 60034-14
A	2.3
B	1.5

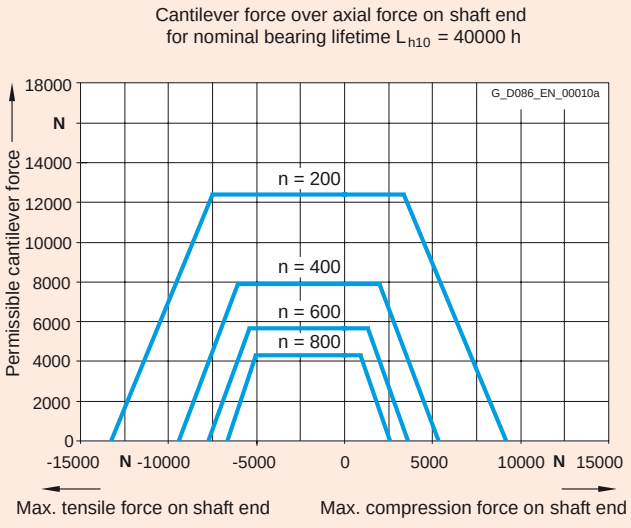
Note: The tolerance of the measuring instrument can be ± 10%.

Noise

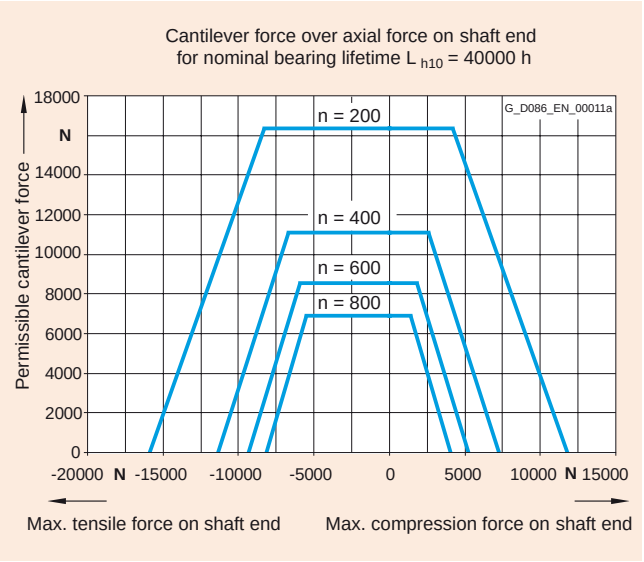
Noise is measured in a room with low reflection characteristics according to DIN EN ISO 1680, however at rated power. The noise level is specified as A-weighted measuring surface sound pressure level L_{pfA} in dB (A). This value is the spatial average value of the sound pressure levels measured at the measuring surface. The measuring surface is a cube 1 m away from the surface of the motor.

The sound pressure level in converter-fed operation depend on the speed and torque of the drive application. In most cases, the values for water-cooled motors are below 82 dB(A) and for air-cooled motors they are below 85 dB(A).

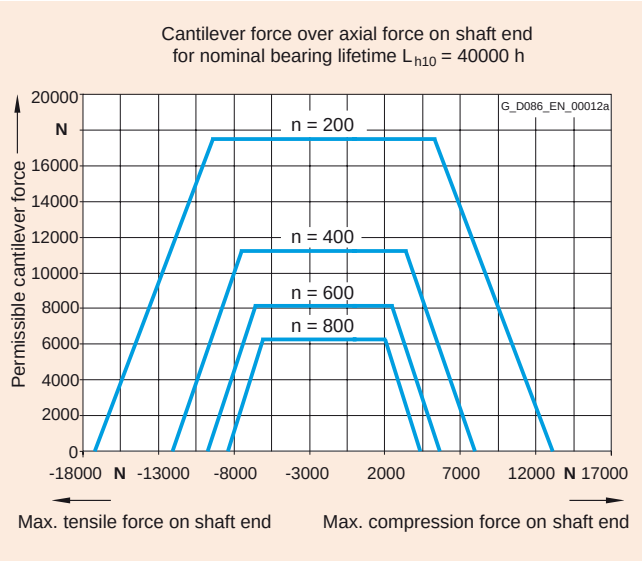
Permissible cantilever forces depending on the axial forces that occur



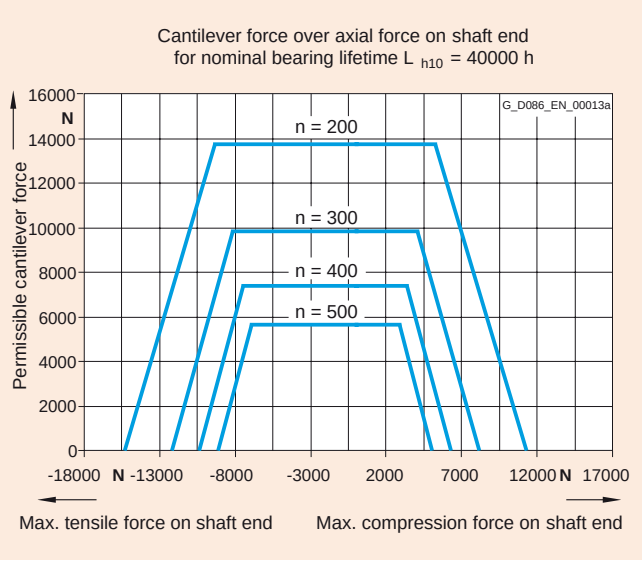
Frame size 400, 1FW4 40. IM B3



Frame size 450, 1FW4 45. IM B3



Frame size 503/505, 1FW4 503/505 IM B3



Frame size 507/508, 1FW4 507/508 IM B3

Paint finish

Design	Suitability of paint finish for climate group in accordance with DIN IEC 60 721, Part 2– 1	
Normal paint finish (layer thickness 60 to 90 μm)	**Extended:** Covers moderate outdoor climates, in particular, the "cold moderate climate", the "moderate climate", the "moderately dry climate" and the "warm dry climate". For indoors and outdoors under a roof not directly subjected to weather conditions The concentration of pollutants can be up to the applicable TRGS value (previously MAK value).	Short-term: Up to 120 °C Continu-ous: Up to 100 °C
Special paint finish (layer thickness 90 to 120 μm)	**Global:** Covers all statistical outdoor climates. For outdoor installations subjected to direct solar irra-diation and/or weathering over a wide temperature and moisture range. Any aggressive pollutants must not exceed a concentration of three times the TRGS value.	Short-term: Up to 140 °C Continu-ous: Up to 120 °C

All motors can be repainted with commercially available paints.

All motors are painted with RAL 7030 if the color is not specified.

Special coatings with thicker layers are available on request.

Degrees of protection

HT-direct motors are designed to IP 55 degree of protection. They can be installed in dusty or humid environments. The motors can be suitable for operation in tropical climates as an option. Guide value 60% relative humidity at 40 °C ambient temperature. Other requirements on request.

The motors can be supplied in IP56 degree of protection on request (order code **K52**).

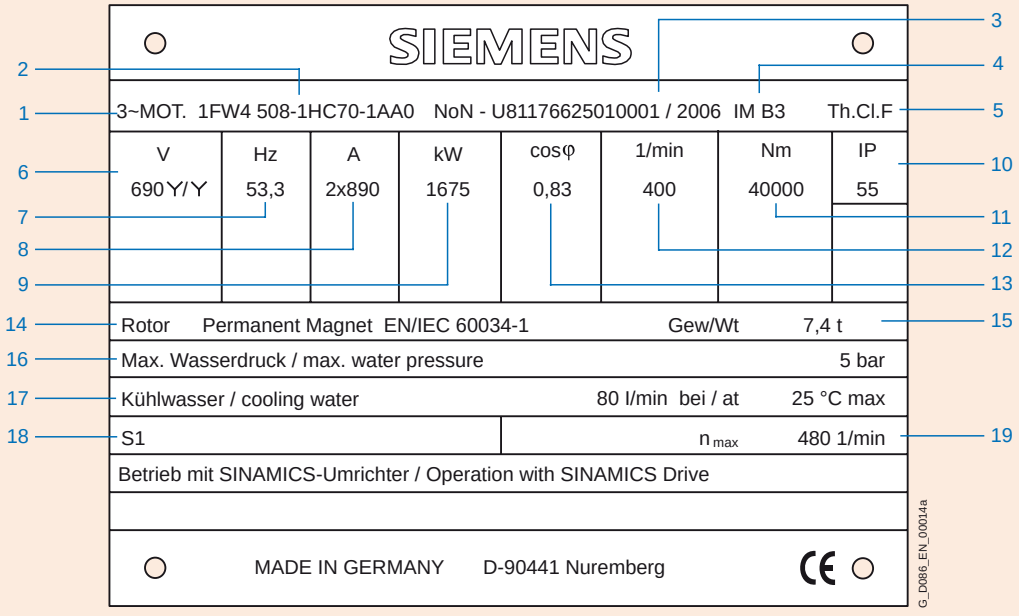
Explanation of the degrees of protection

- IP55: Protection against harmful dust deposits, protection against water jets.
- IP56: Protection against harmful dust deposits, protection against heavy water jets (non-heavy sea).

Condensation water drain hole:

If condensation water builds up in the motor it can drain through holes positioned at the lowest point in the motor housing. When the motors are delivered, these holes are sealed.

Rating plate (example for water-cooled motor)



1 Motor type
2 Order No.
3 ID No. (factory No.)
4 Type of construction
5 Temperature class
6 Rated voltage [V]
7 Rated frequency [Hz]
8 Rated current [A]
9 Rated power [kW]
10 Degree of protection
11 Rated torque [Nm]
12 Rated speed [rpm]
13 Power factor
14 Rotor
15 Motor weight [t]
16 Max. water pressure [bar]
17 Required cooling water flowrate [l/min] at max. cooling water temperature [°C]
18 Duty type
19 Max. operating speed [rpm]

1

General technical data

Anti-condensation heating (optional)

Motors whose windings are at risk of condensation due to the climatic conditions, e.g. inactive motors in humid atmospheres or motors that are subjected to widely fluctuating temperatures can be equipped with anti-condensation heaters as an option.

Anti-condensation heating must not be switched on during operation. For this purpose, an appropriate interlocking circuit with the main switch of the machine must be installed when erecting the electrical system.

For additional protection against the build-up of condensation, it is recommended that the cooling circuit of a water-cooled machine is shut down during long periods of inactivity.

The anti-condensation heating available as an option must principally be switched on 1 hour after shutdown of the machine to prevent damage to the winding insulation.

For the connection of auxiliary leads, separate auxiliary terminal boxes can be mounted as an option (option M52).

Additional order codes for anti-condensation heating

Supply voltage	Order code	
230 V (~)	**K45**	
400 V (~)	**L08**	
500 V (~)	**L09**	
115 V (~)	**K46**	
460 V (~)	**Y83**	With additional plain text: “For 460 V supply voltage”

Marine version (optional)

Motors for operation in a marine climate (saline sea air containing up to 1 mg salt/m^3 of air and 96% air humidity) can be supplied in a “Marine version” as an option. To prevent corrosion at the bearing seal, the shaft section under the bearing seal is coated.

For installation on deck, forced-ventilated motors must be protected against flooding. The motors must also be protected against ice formation at temperatures below 0 °C (precautions must be taken against the external fan freezing solid or against freezing of the cooling water).

Standards and regulations

The motors comply with the appropriate standards and regulations, especially those listed in the table below.

Title	IEC	DIN/EN/ISO
General specifications for rotating electrical machines	IEC 60034-1 IEC 60085	DIN EN 60034-1
Starting characteristics for rotating electrical machines	IEC 60034-12	DIN EN 60034-12
Terminal designations and direction of rotation for rotating electrical machines	IEC 60034-8	DIN EN 60034-8
Designation for type of construction, installation and terminal box position	IEC 60034-7	DIN EN 60034-7
Entry to terminal box	–	DIN 42925
Built-in thermal protection	IEC 60034-11	DIN EN 60034-11
Noise limit values for rotating electrical machines	IEC 60034-9	DIN EN 60034-9
IEC standard voltages	IEC 60038	DIN IEC 60038
Cooling methods for rotating electrical machines	IEC 60034-6	DIN EN 60034-6
Vibration severity of rotating electrical machines	IEC 60034-14	DIN EN 60034-14
Vibration limits	–	DIN ISO 10816
Degrees of protection for rotating electrical machines	IEC 60034-5	DIN EN 60034-5
Technique for measuring the emitted sound from rotating electrical machines	–	DIN EN ISO 1680

Selection and ordering HT-direct motors 1FW4 water-cooled

2

Overview

The motors are designed for the following rated voltages:

- 690 V⅄/50 Hz
- 400 V⅄/50 Hz
- 460 V⅄/60 Hz

Ambient temperature: –20 °C to +40 °C; when operated below 0 °C, use anti-freeze in cooling water. Motors can optionally be ordered for higher ambient temperatures (see Page 2/6).

Cooling water inlet temperature: max. 25 °C; at higher coolant inlet temperatures up to 45 °C, a motor Order No. must be selected in accordance with the derating factors (see Page 2/10). The order code for the higher cooling water inlet temperature (see Page 2/6) must also be specified in the order.

Degree of protection: IP55

Cooling method: IC71W

Type of construction: IM B3

Overview of torques and outputs
in accordance with the rated speed

Rated speed rpm	Max. rated torque Nm	Max. rated output kW
200	42000	879
300	41000	1288
400	40000	1675
500	34235	1792
600	33000	2073
800	19000	1591

Benefits

When high torques and low speeds are required for electrical drives in combination with compact dimensions and a low-noise design, the HT-direct motor with water-jacket cooling provides the ideal customer solution. Depending on the ambient conditions, water-jacket cooling generally provides maximum cooling performance – with minimal heating of the immediate environment.

Selection and ordering data

Rated torque	Rated output [1]	Frame size	Efficiency at 690 V	Power factor at 690 V	Rated current at			Norm. max. torque at 690 V [2]	Moment of inertia	Version with two galvanically isolated winding systems [3]			Order No.	Weight, approx.
			4/4-load	4/4-load	690 V Y	400 V Y	460 V Y	T_{max}/T_{rated}	J	690 V Y	400 V Y	460 V Y		
Nm	kW		%	cos φ	A	A	A		kgm²					kg
200 rpm, IP55 degree of protection, IMB3 type of construction														
9375	196	401	94.4	0.89	205	335	305	1.5	19.4	–	–	–	1FW4401-1HA■0-1AA0	3040
11250	235	403	94.4	0.88	245	410	370	1.5	22.4	–	–	–	1FW4403-1HA■0-1AA0	3310
13125	274	405	94.7	0.89	280	485	425	1.5	26.1	–	–	–	1FW4405-1HA■0-1AA0	3650
15000	314	407	95.0	0.90	315	530	465	1.5	30.9	–	–	–	1FW4407-1HA■0-1AA0	4100
16215	339	451	93.1	0.79	400	740	650	1.5	37.9	–	–	–	1FW4451-1HA■0-1AA0	4010
18975	397	453	93.9	0.80	460	840	720	1.5	44.9	–	–	–	1FW4453-1HA■0-1AA0	4350
21850	457	455	94.3	0.81	550	900	830	1.5	51.5	–	–	–	1FW4455-1HA■0-1AA0	4680
27600	578	503	95.0	0.80	660	1190	990	1.5	89.3	–	–	–	1FW4503-1HA■0-1AA0	5610
32775	686	505	94.8	0.79	870	1350	1210	1.5	102.6	–	✓	–	1FW4505-1HA■0-1AA0	6110
37950	794	507	95.2	0.80	930	1720	1340	1.5	118.4	–	✓	✓	1FW4507-1HA■0-1AA0	6680
42000	879	508	95.6	0.82	930	1600	1400	1.5	139.3	–	✓	✓	1FW4508-1HA■0-1AA0	7440
300 rpm, IP55 degree of protection, IMB3 type of construction														
9060	284	401	95.7	0.90	275	475	420	1.5	19.4	–	–	–	1FW4401-1HB■0-1AA0	3040
10875	341	403	95.8	0.89	340	550	510	1.5	22.4	–	–	–	1FW4403-1HB■0-1AA0	3310
12690	398	405	96.1	0.89	390	640	580	1.5	26.1	–	–	–	1FW4405-1HB■0-1AA0	3650
14500	455	407	96.3	0.90	450	750	670	1.5	30.9	–	–	–	1FW4407-1HB■0-1AA0	4100
15860	498	451	95.3	0.79	560	1010	840	1.5	37.9	–	–	–	1FW4451-1HB■0-1AA0	4010
18560	583	453	95.6	0.81	700	1100	990	1.5	44.9	–	–	–	1FW4453-1HB■0-1AA0	4350
21375	671	455	95.8	0.81	890	1390	1220	1.5	51.5	–	✓	–	1FW4455-1HB■0-1AA0	4680
26700	838	503	96.2	0.81	960	1640	1440	1.5	89.3	–	✓	✓	1FW4503-1HB■0-1AA0	5610
31705	996	505	96.3	0.80	1170	1960	1680	1.5	102.6	–	✓	✓	1FW4505-1HB■0-1AA0	6110
36710	1153	507	96.5	0.80	1290	2330	1940	1.5	118.4	✓	✓	✓	1FW4507-1HB■0-1AA0	6680
41000	1288	508	96.7	0.82	1360	2220	2190	1.5	139.3	✓	✓	✓	1FW4508-1HB■0-1AA0	7440
400 rpm, IP55 degree of protection, IMB3 type of construction														
8750	366	401	96.4	0.90	360	580	530	1.5	19.4	–	–	–	1FW4401-1HC■0-1AA0	3040
10500	439	403	96.5	0.90	435	700	630	1.5	22.4	–	–	–	1FW4403-1HC■0-1AA0	3310
12250	513	405	96.7	0.91	485	850	750	1.5	26.1	–	–	–	1FW4405-1HC■0-1AA0	3650
14000	586	407	96.9	0.93	540	930	810	1.5	30.9	–	–	–	1FW4407-1HC■0-1AA0	4100
15510	649	451	96.0	0.80	710	1240	1100	1.5	37.9	–	✓	–	1FW4451-1HC■0-1AA0	4010
18150	760	453	96.4	0.82	800	1380	1210	1.5	44.9	–	✓	–	1FW4453-1HC■0-1AA0	4350
20900	875	455	96.5	0.81	950	1590	1370	1.5	51.5	–	✓	✓	1FW4455-1HC■0-1AA0	4680
25800	1080	503	96.8	0.83	1110	1880	1620	1.5	89.3	–	✓	✓	1FW4503-1HC■0-1AA0	5610
30635	1283	505	96.8	0.81	1420	2290	2270	1.5	102.6	✓	✓	✓	1FW4505-1HC■0-1AA0	6110
35475	1485	507	97.0	0.81	1610	[4]	2270	1.5	118.4	✓	[4]	✓	1FW4507-1HC■0-1AA0	6680
40000	1675	508	97.2	0.83	1780	[4]	[4]	1.5	139.3	✓	[4]	[4]	1FW4508-1HC■0-1AA0	7440

Rated voltage	
• 460 V Y	**4**
• 690 V Y	**7**
• 400 V Y	**8**
Special voltage	**9**
Other rated speed with additional plain text	**-Z**

[1] Temperature class 155 (temperature class F), used according to temperature class 155 (temperature class F)

[2] Maximum torque T_{max} = Overload torque for 120 s (higher overload torques on request)

[3] In the version with two galvanically isolated winding systems, two main terminal boxes 1XB1 631 are required.
– Not applicable
✓ Applicable

[4] Cannot be implemented

HT-direct motors 1FW4 water-cooled

Rated torque	Rated output [1]	Frame size	Efficiency at 690 V	Power factor at 690 V	Rated current at			Norm. max. torque at 690 V [2]	Moment of inertia	Version with two galvanically isolated winding systems [3]			Order No.	Weight, approx.
			4/4-load	4/4-load	690 V Y	400 V Y	460 V Y	T_{max}/T_{rated}	J	690 V Y	400 V Y	460 V Y		
Nm	kW		%	cos φ	A	A	A		kgm²					kg
500 rpm, IP55 degree of protection, IMB3 type of construction														
8440	441	401	96.8	0.91	415	680	610	1.5	19.4	–	–	–	1FW4401-1HD■0-1AA0	3040
10125	530	403	96.9	0.90	510	840	740	1.5	22.4	–	–	–	1FW4403-1HD■0-1AA0	3310
11810	618	405	97.0	0.90	590	960	830	1.5	26.1	–	–	–	1FW4405-1HD■0-1AA0	3650
13500	706	407	97.2	0.95	630	1080	930	1.5	30.9	–	–	–	1FW4407-1HD■0-1AA0	4100
15160	793	451	96.6	0.80	880	1400	1390	1.5	37.9	–	✓	✓	1FW4451-1HD■0-1AA0	4010
17740	928	453	96.8	0.81	1050	1600	1580	1.5	44.9	–	✓	✓	1FW4453-1HD■0-1AA0	4350
20425	1069	455	96.9	0.82	1170	1880	1580	1.5	51.5	–	✓	✓	1FW4455-1HD■0-1AA0	4680
24900	1303	503	97.0	0.83	1340	2200	2150	1.5	89.3	✓	✓	✓	1FW4503-1HD■0-1AA0	5610
29565	1548	505	97.2	0.84	1570	[4]	[4]	1.5	102.6	✓	[4]	[4]	1FW4505-1HD■0-1AA0	6110
34235	1792	507	97.3	0.84	1820	[4]	[4]	1.5	118.4	✓	[4]	[4]	1FW4507-1HD■0-1AA0	6680
600 rpm, IP55 degree of protection, IMB3 type of construction														
8125	510	401	97.0	0.90	490	800	710	1.5	19.4	–	–	–	1FW4401-1HE■0-1AA0	3040
9750	612	403	97.1	0.90	580	940	820	1.5	22.4	–	–	–	1FW4403-1HE■0-1AA0	3310
11375	714	405	97.2	0.90	700	1090	940	1.5	26.1	–	–	–	1FW4405-1HE■0-1AA0	3650
13000	816	407	97.3	0.93	750	1250	1070	1.5	30.9	–	✓	–	1FW4407-1HE■0-1AA0	4100
14805	930	451	96.9	0.81	1050	1610	1580	1.5	37.9	–	✓	✓	1FW4451-1HE■0-1AA0	4010
17325	1088	453	97.0	0.82	1160	1870	1850	1.5	44.9	–	✓	✓	1FW4453-1HE■0-1AA0	4350
19950	1253	455	97.0	0.83	1300	2280	1850	1.5	51.5	✓	✓	✓	1FW4455-1HE■0-1AA0	4680
24000	1507	503	97.4	0.87	1490	[4]	2160	1.5	89.3	✓	[4]	✓	1FW4503-1HE■0-1AA0	5610
28500	1790	505	97.4	0.86	1780	[4]	[4]	1.5	102.6	✓	[4]	[4]	1FW4505-1HE■0-1AA0	6110
33000	2073	507	97.5	0.84	2100	[4]	[4]	1.5	118.4	✓	[4]	[4]	1FW4507-1HE■0-1AA0	6680
800 rpm, IP55 degree of protection, IMB3 type of construction														
7500	628	401	97.2	0.91	590	990	850	1.5	19.4	–	–	–	1FW4401-1HF■0-1AA0	3040
9000	753	403	97.2	0.91	740	1190	1010	1.5	22.4	–	–	–	1FW4403-1HF■0-1AA0	3310
10500	879	405	97.3	0.92	830	1460	1180	1.5	26.1	–	✓	–	1FW4405-1HF■0-1AA0	3650
12000	1005	407	97.3	0.92	930	1500	1400	1.5	30.9	–	✓	✓	1FW4407-1HF■0-1AA0	4100
14100	1181	451	96.9	0.82	1290	2260	1810	1.5	37.9	✓	✓	✓	1FW4451-1HF■0-1AA0	4010
16500	1382	453	97.3	0.83	1470	2290	2210	1.5	44.9	✓	✓	✓	1FW4453-1HF■0-1AA0	4350
19000	1591	455	97.4	0.90	1510	[4]	2270	1.5	51.5	✓	[4]	✓	1FW4455-1HF■0-1AA0	4680

Rated voltage		
• 460 V Y	**4**	
• 690 V Y	**7**	
• 400 V Y	**8**	
Special voltage	**9**	
Other rated speed with additional plain text		**-Z**

Notes for current-calculation:

The stator current from permanent-excited motors can not be calculated as usual with the rated output, converter output voltage, power factor and efficiency. The reason is that the induced voltage at the rated point does not comply with the converter output voltage automatically. The real terminal voltage is depending on the speed, the torque and the integer number of turns.

The stator current of the 1FW4-motor series is proportional to the speed. With it the required stator current for a torque differing from the rated torque can be calculated. The stator current should be calculated exactly with the project tool „SINAMICS MICROMASTER SIZER“.

1) Temperature class 155 (temperature class F), used according to temperature class 155 (temperature class F)

2) Maximum torque T_{max} = Overload torque for 120 s (higher overload torques on request)

3) In the version with two galvanically isolated winding systems, two main terminal boxes 1XB1 631 are required.
– Not applicable
✓ Applicable

4) Cannot be implemented

Special versions

Special versions	Order code	Comments
Motor protection		
Motor temperature monitoring using built-in temperature sensor 1 x KTY 84-130	**A23**	
Motor temperature monitoring using built-in temperature sensor 2 x KTY 84-130	**A25**	
2 PT100 resistance thermometers or 3-wire for 4-wire circuit from terminals, without evaluation unit for rolling-contact bearings	**A40**	
2 PT100 dual resistance thermometers for 3-wire or 4-wire circuit from terminals, without evaluation unit for rolling-contact bearings	**A42**	
6 PT100 resistance thermometers for winding temperature monitoring for 3-wire or 4-wire circuit from terminals	**A65**	
Rolling-contact bearing monitor based on SPM shock pulse method, complete alarm box	**H07**	
Motor connection and connection boxes		
Two-part plate on connection box	**K06**	
Cable entry DIN 89280, maximum configuration	**K57**	
Rotation of the terminal box through 90°, entry from DE (This option is only possible when the motor can only be implemented with one terminal box).	**K83**	
Rotation of the terminal box through 90°, entry from NDE. (This option is only possible when the motor can only be implemented with one terminal box).	**K84**	
Rotation of connection box through 180°	**K85**	
Undrilled cable entry plate	**L01**	
Auxiliary terminal box with cast-iron housing	**M50**	
Auxiliary terminal box with stainless-steel housing	**M51**	
Separate auxiliary terminal box with cable entry for heater	**M52**	
Auxiliary terminal box with aluminium housing	**M88**	
Shaft and rotor		
Standard cylindrical shaft end, but without keyway	**K42**	
Non-standard cylindrical shaft end (only when technically possible); additional plain text stating the dimensions of the non-standard shaft end is required (in mm)	**Y55**	
Coupling		
Thrust ring for coupling guard	**L15**	
Mounting of supplied coupling	**L17**	
Heating		
Anti-condensation heating for 230 V supply voltage	**K45**	
Anti-condensation heating for 115 V supply voltage	**K46**	
Anti-condensation heating for 400 V supply voltage	**L08**	
Anti-condensation heating for 500 V supply voltage	**L09**	
Anti-condensation heating for other supply voltages (with plain text for voltage)	**Y83**	
Colors and paint finish		
Unpainted (primed)	**K23**	
Special paint finish in standard color	**K26**	
Normal paint finish not in standard color	**Y53**	
Special paint finish not in standard color	**Y54**	
Special mounting technology		
Mounting of absolute encoder EQN 425 EnDat 2.1 2048	**H81**	
Mounting of absolute encoder HMG111 HTL + SSI	**H82**	
Mounting of incremental encoder HOG10 DN 2048	**H83**	
Mounting of incremental encoder HOG11 DN 2048	**H84**	
Mounting of incremental encoder LL861 (2048 pulses)	**H85**	
Mounting of a rotary pulse encoder in special design (with plain text for encoder designation)	**Y70**	
Balance and vibration severity		
Vibration severity grade B	**K02**	
Full-key balancing	**L68**	

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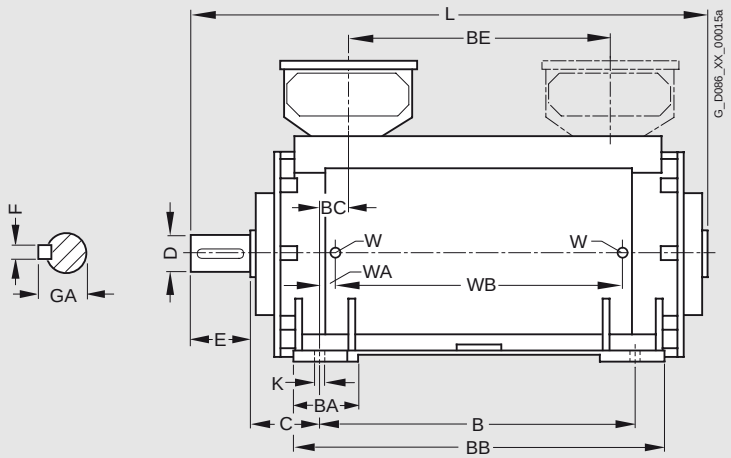
Special versions	Order code	Comments
Mechanical design and degrees of protection		
Bearing design for increased cantilever forces	**K20**	
IP56 degree of protection (non-heavy-sea)	**K52**	
Bolts for fixing machine to steel foundation	**L31**	
T-head bolts, anchor sleeves and soleplates for mounting on a concrete foundation	**L33**	
External screws made of stainless steel	**P45**	
Anormal stator winding		
Anormal stator winding for speeds below 170 rpm	**L1Y**	
Cooling water inlet temperature and ambient temperature		
Cooling water inlet temperature up to 30 °C (ambient temperature up to 45 °C), torque reduction 3%	**D15**	
Cooling water inlet temperature up to 35 °C (ambient temperature up to 50 °C), torque reduction 5%	**D16**	
Cooling water inlet temperature up to 40 °C (ambient temperature up to 55 °C), torque reduction 8%	**D17**	
Cooling water inlet temperature up to 45 °C (ambient temperature up to 60 °C), torque reduction 11%	**D18**	
Marine version - Acceptance/certification		
Individual acceptance by classification authority with witness-testing and acceptance inspection certificate 3.1.C	**E09**	
Individual acceptance by classification authority	**E10**	
Marine design to GL, CT 45 °C, temperature class 155 used according to 155 (F according to F)	**E11**	
Marine design to LR, CT 45 °C, temperature class 155 used according to 155 (F according to F)	**E21**	
Marine design to BV, CT 45 °C, temperature class 155 used according to 155 (F according to F)	**E31**	
Marine design to DNV, CT 45 °C, temperature class 155 used according to 155 (F according to F)	**E51**	
Marine design to ABS, CT 45 °C, temperature class 155 used according to 155 (F according to F)	**E61**	
Marine design to CCS, CT 45 °C, temperature class 155 used according to 155 (F according to F)	**E71**	
Marine design, higher ambient temperature and/or temperature class 155 used according to 130 (F according to B), with plain text for ambient temperature, utilization and classification society	**E80**	
Rating plate and additional plates		
Second rating plate, separately packed	**K31**	
Rating plate with different data	**Y80**	
Additional plate with ordering data (customer information in plain text)	**Y82**	
Packaging, safety notes, documentation and test certificates		
Acceptance test certificate 3.1 according to EN 10204	**B02**	
Documentation on CD	**B21**	
Document - EU manufacturer's declaration	**B30**	
Document - Electrical data sheet	**B31**	
Document - Order dimension drawing	**B32**	
Document - Routine test certificate	**B33**	
Documentation in German	**D00**	(Documentation in English standard)
Documentation in Russian	**D56**	
Documentation in Italian	**D72**	
Documentation in French	**D77**	
Documentation in Spanish	**D78**	
Documentation in Portuguese	**D79**	
Documentation in Swedish	**D83**	
Standard test (routine test), witnessed	**F01**	
Visual acceptance and report handover, witnessed	**F03**	
Heating test at rated operating point at converter, unwitnessed	**F04**	
Heating test at rated operating point at converter, witnessed	**F05**	

Special versions	Order code	Comments
Packaging, safety notes, documentation and test certificates (continued)		
Recording of continuous short-circuit characteristic and calculation of losses, unwitnessed	**F16**	
Recording of continuous short-circuit characteristic and calculation of losses, witnessed	**F17**	
Recording of load characteristic (T-n-characteristic curve) on converter, unwitnessed	**F18**	
Recording of load characteristic (T-n-characteristic curve) on converter, witnessed	**F19**	
Noise measurement in no-load operation, no noise analysis, unwitnessed	**F28**	
Noise measurement in no-load operation, no noise analysis, witnessed	**F29**	
Noise measurement in no-load operation, with noise analysis, unwitnessed	**F62**	
Noise measurement in no-load operation, with noise analysis, witnessed	**F63**	
Type test with heat run for horizontal motors, unwitnessed	**F82**	
Type test with heat run for horizontal motors, witnessed	**F83**	
Customized acceptance on customer converter, additional information required	**F99**	

2

Dimension drawings



Type	Dimensions														
	A	AA	AB	AD [1]	B	BA	BB	BC	BE	C	H	HA	HD	K	L
1FW4401	750	150	900	400	1120	260	1365	155	880	254	400	30	1180	35	1880
1FW4403															
1FW4405															
1FW4407															
1FW4451	850	180	1030	400	1250	265	1515	165	975	280	450	30	1280	42	2090
1FW4453															
1FW4455															
1FW4503	950	180	1130	400	1400	300	1624	250	935	280	500	40	1385	42	2265
1FW4505															
1FW4507	950	180	1130	400	1500	300	1782	135	628	315	500	40	1385	42	2415
1FW4508															

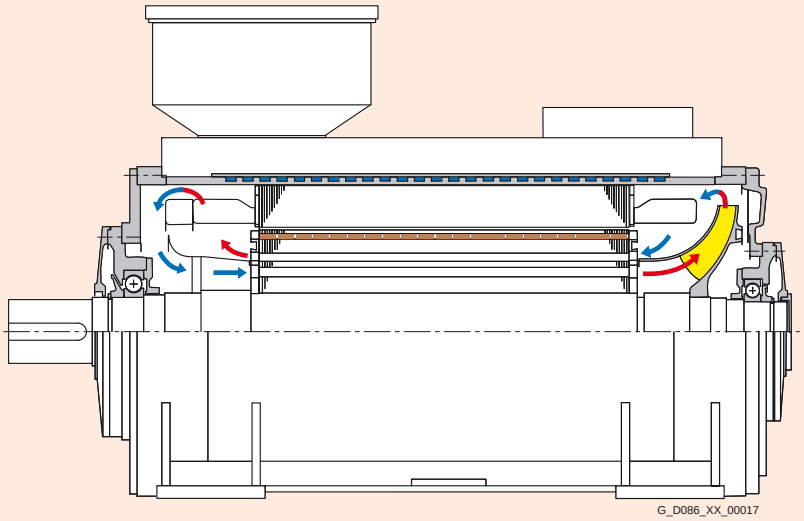
Type	Dimensions for shaft extension according to DIN 748 "short"				Dimensions of cooling water connection [2]		
	D	E	F	GA	W	WA	WB
1FW4401	150	200	36	158	G3/4"	50	780
1FW4403							
1FW4405							
1FW4407							
1FW4451	170	240	40	179	G1"	63	1175
1FW4453							
1FW4455							
1FW4503	190	280	45	200	G11/2"	85	1260
1FW4505							
1FW4507	190	280	45	200	G11/2"	40	1440
1FW4508							

1) For 1XB1 631 terminal box.

2) The cooling water connection is available on both sides (RHS and LHS of motor).

Further information

Structure



Basic structure of the water-cooled HT-direct motor 1FW4

HT-direct motors have two cooling circuits that can be used to achieve intensive and effective cooling:

- The aluminium fan within the motor provides air circulation between DE and NDE. This cools, in particular, the stator winding overhang, the magnetic rotor and the bearings.
- The heat from the internal air is transferred to the cooling water through the motor housing.

Frame design

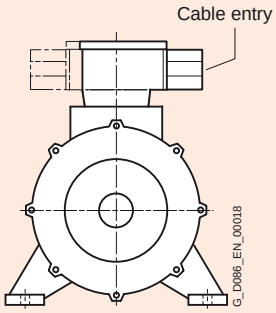
A welded steel stator housing. The condensation water drainage holes are present and they are sealed during transport. For certain applications (e.g. in shipbuilding and the chemicals industry), external components made from aluminium are not permitted in the case of some customers. In these cases, aluminium components (e.g. terminal boxes) are replaced with other materials.
If external components are not permitted to be made from aluminium, this must be specified in plain text in the order.

Position of the terminal box and cable entry

The terminal box is mounted **on the top**, in the **basic version at DE with cable entry from the right** (with view onto DE shaft extension). If a second terminal box is required, this is mounted behind it at NDE.

As an option, cable entry from the LHS is possible (order code **K85**).

When **only one** terminal box is mounted, cable entry is also possible from **DE** (order code **K83**) or **NDE** (order code **K84**).



Position of the terminal box and cable entry

2

Additional information

Packing weights and packing dimensions

Packing weights, tare

Type 1FW4 . . .	Land transport on battens Type of construction IM B3 kg	Sea transport in wooden cases Type of construction IM B3 kg
. . . 401/403/405/407	70	280
. . . 451/453/455	75	340
. . . 503/505	80	390
. . . 507/508	85	410

Packing dimension = Largest motor dimension + Supplement

Dimensions	Supplements for Land transport on battens Type of construction IM B3 mm	 Sea transport in wooden cases Type of construction IM B3 mm
Length	+250	+250
Width	+200	+200
Height	+200	+500

Water-jacket cooling

To achieve a high power density, the motor housing is designed with water-jacket cooling.

The cooling water flows through a channel that runs in a spiral in the cooling jacket (from DE to NDE).

The cooling water inlet is at the drive end, on the LHS or RHS of the motor housing as required. The cooling water outlet is at the non-drive end, on the LHS or RHS of the motor housing as required (see dimension drawing). During transportation, the water inlet and outlet holes are sealed.

Cooling water flowrate and water pressure:

Type 1FW4 . . .	Cooling water flow rate l/min	Maximum permissible water pressure bar
. . . 401/403/405/407	30	5
. . . 451/453/455	50	5
. . . 503/505	65	5
. . . 507/508	80	5

The water quality must be taken into account:

- The cooling water should be chemically neutral, it should be clean, particles should have been filtered out and the following values must not be exceeded:
  ph value 6.0 to 8.0
  Overall hardness < 170 ppm
  Chloride < 40 ppm
  Sulfate < 50 ppm
  Nitrate < 10 ppm
  Iron < 0.2 ppm
  Ammonium < 10 ppm
  Loose material < 340 ppm
  Conductance < 500 µS/cm
- Max. size of any particles carried ≤ 0.1 mm
- No saltwater (sea water)
- If there is a danger of frost, then the appropriate anti-freeze measures are required for operation, storage and transport. For example, emptying and blowing-out with air, supplementary heating system for the cooling ducts.
- Additives must be mixed with the cooling water in appropriate quantities to protect against corrosion and the growth of algae. The type and quantity of additive should be taken from the manufacturer's specifications for these additives and the particular ambient conditions.

Materials used in the cooling circuit

Only steel is used in the cooling circuit. The heatsink material is not resistant to seawater. It is not permissible to directly cool the motors using seawater.

Different cooling water inlet temperature and site altitude

Cooling water inlet temperature (according to EN 60034-1 and IEC 60034-1)

The motors are designed for operation up to a cooling water inlet temperature of 25 °C, but still maintaining all of the specified motor data.

If the HT-direct motors are operated with higher cooling water inlet temperatures, the derating factors in the following table must be taken into account.

Derating factors for cooling water inlet temperatures >25 °C

Cooling water inlet temperature up to (ambient temperature up to)	25 °C (40 °C)	30 °C (45 °C)	35 °C (50 °C)	40 °C (55 °C)	45 °C (60 °C)
Derating factor k_T	1.0	0.97	0.95	0.92	0.89

This results in a maximum torque of the motor of:

$T_{max} = T_{rated} \cdot k_T$

T_{max} =Maximum torque in Nm

T_{rated}=Rated torque in Nm

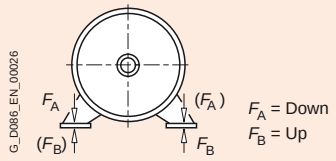
k_T =Factor for different cooling water inlet temperature

If the maximum torque is no longer adequate for the drive, it should be checked whether the motor with the next higher rated torque fulfills the requirements.

Site altitude (according to EN 60034-1 and IEC 60034-1)

For site altitudes >1000 m above sea level, derating factors do not have to be taken into account for water-cooled HT-direct motors. They may, however, affect the dimensioning of the converter.

Dynamic foundation loading



Type	F_A [1] kN	F_B [1] kN
1FW4401-1 . . .	53	22
1FW4403-1 . . .	62	29
1FW4405-1 . . .	72	35
1FW4407-1 . . .	85	44
1FW4451-1 . . .	91	51
1FW4453-1 . . .	111	68
1FW4455-1 . . .	136	90
1FW4503-1 . . .	125	69
1FW4505-1 . . .	148	88
1FW4507-1 . . .	176	110
1FW4508-1 . . .	205	132

[1] Load at one motor long side (that is for two feet).

Configuring

4

Configuration

HT-direct motors can only be operated in combination with SINAMICS converters. The drive system can be completely configured using the "SINAMICS MICROMASTER SIZER" configuration tool.

These motors cannot be used as line-fed machines (no self-starting capability).

Guideline for drive selection

These "guideline for drive selection" guide you step-by-step to the required HT-direct motor and SINAMICS converter:

Step 1	Technical requirements for the motor (example)		Further notes and alternatives
Determine the required product profile Required is, for example:	Torque in continuous operation ($T_{cont.}$)	16000 Nm	$T = P_{mech}$ [kW] x 9550 / n [rpm] = 1282 x 9550 / 765 T = 16000 Nm
	Short-term overload torque ($T_{overload}$)	18000 Nm	$T_{overload}/T_{cont.} < 1.5$: Rated torque = $T_{cont.}$ $T_{overload}/T_{cont.} > 1.5$: Rated torque = $T_{overload}/1.5$ Higher overloads on request.
	Duty type	S1	When, instead of S1 duty, duty cycles must be taken into account: Average torque is calculated from the root of the square of the required torques multiplied by the time divided by the total time: e.g. 140%, 10 seconds, then 80%, 30 seconds, results in an average 98.5% of the rated torque: $\sqrt{\left[(1,40^2 \times 10 + 0,80^2 \times 30)/40\right]} = 0,985$
	Utilization	Temperature class 155 (previously temperature class F)	In case of use according to temperature class 130 (previously temperature class B), the motor must be designed for a torque 20% higher: e.g. $T_{cont.}$ = 1.2 x 16000 = 19200 Nm
	Rated voltage	690 V	Alternatively 400 V or 460 V
	Max. speed in continuous operation	765 rpm	Rated speed acc. to catalog 800 rpm, max. perm. speed 20% higher (800 x 1.2 = 960 rpm) For speeds below 170 rpm the option L1Y must be selected (anormal stator winding).
	Cooling medium	Water with max. inlet temperature 25 °C	Higher cooling-water inlet temperatures must be accounted for with derating factors when the rated torque is determined: e.g. for 35 °C: 16000/0.95 = 16840 Nm For derating factors, see Page 2/10.
	Type of construction	IM B3	
Step 2	**Environmental requirements for the motor**		**Further notes and alternatives**
Determine the installation conditions	Ambient temperature	–20 to +40 °C	At ambient temperatures up to +40 °C, derating factors are not required for water-cooled motors. At higher ambient temperatures in combination with cooling-water inlet temperatures above 25 °C, the derating factors on Page 2/10 are applicable. For air-cooled motors, derating factors must be used in accordance to Page 3/12.
	Site altitude	< 1000 m	For water-cooled motors, the site altitude does not have to be taken into account for the derating factor. For site altitudes > 1000 m above sea level, the conditions of the converter must however be taken into account. For air-cooled motors, derating factors must be used in accordance to Page 3/12.
Step 3	**Selecting the motor**		**Further notes and alternatives**
Determining the motor Order No.	**1FW4453-1HF70-1AA0**		See "Selection and ordering data" (Section 2). Due to the current-carrying capability of the motor terminal box (max. 1230 A), the motor is designed with two terminal boxes and two galvanically isolated winding systems.

Step 4	Choosing the options		Further notes and alternatives
Completing the motor Order No.	Specifying options for special versions and tests.		See “Special versions” (Section 2).
Step 5	**Determining the motor currents**		**Further notes and alternatives**
Motor currents	Motor rated current for torque of 16000 Nm in continuous operation at 690 V	1425 A	See “Selection and ordering data” (Page 2/4). (16000/16500) x 1470 = 1425 A
	Required motor current for max. torque of 18000 Nm (temporary overload torque)	1603 A	(18000/16000) x 1425 = 1603 A
Step 6	**Selection of the converter or the motor module**		**Further notes and alternatives**
SINAMICS S120	Rated output current I_{rated}	1603 A	
	Due to the current level of 1593 A, distribution over two motor modules is necessary.	802 A per motor module	1603/2 = 802 A
	Derating factor due to two parallel motor modules	0.95	
	Current required per motor module	844 A	802/0.95 = 844 A
	Intermediate result for motor module selection	910 A, 900 kW	
	Derating factor for increasing the pulse frequency to 2.5 kHz for 900 kW motor module	0.87	Derating factors must be taken into account in general when pulse frequencies are increased. They are dependent on the converter type and converter rating. Derating factors are provided in the configuration manuals or should be requested.
	Max. output current of both motor modules	1504 A (too low, because 1603 A are necessary!)	2 x 910 A x 0.95 x 0.87 = 1504 A
	Selection of the next largest motor module	1025 A, 1000 kW	
	Derating factor for increasing the pulse frequency to 2.5 kHz for 1000 kW motor module	0.86	
	Max. output current of both motor modules	1675 A (sufficient)	2 x 1025 A x 0.95 x 0.86 = 1675 A
	SINAMICS S120 Vector Control: 2 Single Motor Modules Order No. **6SL3320-1TH41-0AA0**		The appropriate infeed must also be selected in accordance with the SINAMICS catalog.
	SINAMICS S120 Cabinet Modules: 2 Motor Modules Order No. **6SL3720-1TH41-0AA0**		The appropriate infeed must also be selected in accordance with the SINAMICS catalog.
Step 7	**Specification of the protection concept**		**Further notes and alternatives**
A protection concept must be specified when work has to be carried out on the converter and/or cables after switch-off when the rotor is still revolving.	The protection concept depends on the operating conditions and application. To specify any necessary protective measures, please contact your Siemens sales representative.		See page 1/4 "Protection strategy"

Notes

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