SIMOTICS T-1FW6 built-in torque motors

Operating Instructions · 09/2012

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Drive Technology SIMOTICS T-1FW6 built-in torque motors

Compact Operating Instructions

09/2012

6SN1197-0AF00-0BP1

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Siemens AG
Industry Sector
Postfach 48 48
90026 NÜRNBERG
GERMANY

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Introduction 1

These operating instructions describe the motor and explain how to handle the motor from the delivery to the disposal stage.

Before you start using the motor, you must read these operating instructions to ensure safe, problem-free operation and to maximize the service life.

These operating instructions complement the relevant Siemens configuration manual. You can also request all descriptions and safety instructions from your local Siemens office.

Always follow the safety instructions and notices in these operating instructions. The warning notice system is explained on the rear of the inside front.

These operating instructions should be kept in a location where they can be easily accessed and made available to the personnel responsible.

Differences to the configuration manual

In contrast to the configuration manual, the operating instructions are independent of the drive system. They do not contain any data sheets or installation/dimension drawings. Information on the configuring and ordering of the motors is also not part of these instructions.

Text format features

In addition to the safety-related notices and instructions which you must read, the text in these operating instructions is formatted in the following way:

1. Handling instructions are always formatted as a numbered list. Always perform the steps in the order given.

- Lists are formatted as bulletted lists.
  - Lists on the second level are hyphenated.

Note

A Note is an important item of information about the product, handling of the product or the relevant section of the document. Notes provide you with help or further suggestions/ideas.

Target group

These operating instructions are intended for electricians, fitters, service technicians and warehouse personnel.

Technical Support

For technical support telephone numbers for different countries, go to:

http://www.siemens.com/automation/service&support

Recommended additional documents

System components	Manufacturer's manuals
Motor	• Configuration Manual • Safety instructions for direct drives
Encoder system	• User Manual • Operating Instructions
Brake	• Operating Instructions
Sensor module	• Manual
Drive system	• Commissioning Manual • List Manual • Function Manual

More information

Information on the following topics is available under the link:

- Ordering documentation/overview of documentation
- Additional links to download documents
- Using documentation online (find and search in manuals/information)

http://www.siemens.com/motioncontrol/docu

Please send any questions about the technical documentation (e.g. suggestions for improvement, corrections) to the following e-mail address:

docu.motioncontrol@siemens.com

Current manuals and operating instructions for motors / direct drives are available on the Internet under the following link:

http://www.siemens.com/motioncontrol/docu

Any manuals or operating instructions that you may have in printed or electronic file form could be of an older product version.

Websites of third parties

This publication contains hyperlinks to websites of third parties. Siemens does not take any responsibility for the contents of these websites or adopt any of these websites or their contents as their own, because Siemens does not control the information on these websites and is also not responsible for the contents and information provided there. Use of these websites is at the risk of the person doing so.

Internet address for products

http://www.siemens.com/motioncontrol

Safety notes

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We want to make you particularly aware of the safety instructions and notes regarding the powerful permanent magnets installed in the rotor of the built-in torque motor.

Residual risks of power drive systems

When carrying out a risk assessment of the machine in accordance with the EU Machinery Directive, the machine manufacturer must as a minimum consider the following residual risks associated with the control and drive components of a power drive system (PDS).

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions not within the scope of the specification
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / cellular phones in the immediate vicinity of the controller
   - External influences / damage
2. Exceptional temperatures as well as emissions of light, noise, particles, or gas caused by, for example:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions not within the scope of the specification
   - External influences / damage
3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions not within the scope of the specification
   - Condensation / conductive contamination
   - External influences / damage

4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc. if they are too close.
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly.

More extensive information concerning the residual risks associated with the PDS is provided in the relevant chapters of the technical user documentation.

⚠ DANGER

It may be dangerous for people to remain in the immediate proximity of the product – especially for those with pacemakers, implants or similar – due to electric, magnetic and electromagnetic fields (EMF) occurring as a consequence of operation.

The machine/system operator and the people present near the product must observe the relevant guidelines and standards! These are, for example, in the European Economic Area (EEA) the Electromagnetic Fields Directive 2004/40/EC and the standards EN 12198-1 to 12198-3 and in the Federal Republic of Germany the Employer's Liability Insurance Association Regulations for the Prevention of Industrial Accidents BGV 11, with the relevant rule BGR 11 "Electromagnetic Fields".

Then a risk assessment must be carried out for every workplace, activities for reducing dangers and exposure for people decided upon and implemented, as well as determining and observing exposure and danger areas.

2.1 Observing and complying with safety instructions

⚠ DANGER

There is a danger of death, severe physical injury, and/or damage to property if the safety instructions are not observed and complied with.

It is essential that you observe the safety instructions in this documentation. This includes the special safety instructions in the individual sections.

Observe all warning and information plates.

Make sure that your end product satisfies all relevant standards and legal specifications. The applicable national, local, and machine-specific safety regulations and requirements must also be taken into account.

Also observe the relevant operating instructions when working on the drive system.

2.2 Handling direct drives and components

⚠ DANGER

There is danger of death, serious bodily injury and/or property damage when untrained personnel is allowed to handle direct drives and/or their components.

Only personnel who are familiar with and who observe the safety guidelines are allowed to handle direct drives and their components.

Installation, commissioning, operation and maintenance may only be performed by qualified, trained and instructed personnel. The personnel must be thoroughly familiar with the content of this guide.

All work must be performed by at least two persons.

Note

Make sure that the information about the sources of danger and the safety measures is available at all times! Keep all the descriptions and safety guidelines concerning direct drives and their components if possible!

All descriptions and safety guidelines can also be requested from your local Siemens office.

2.3 Intended use

⚠ DANGER

There is a risk of death, serious personal injury and/or serious material damage when direct drives or their components are used for a purpose for which they were not intended.

The motors are designed for industrial or commercial machines. It is prohibited to use them in areas where there is a risk of explosion (Ex-zone) unless they are designed expressly for this purpose (observe the separately enclosed additional instructions where applicable). If increased demands (e.g. touch protection) are applicable in special cases – for use in non-commercial systems – these conditions must be ensured on the machine side during installation.

Direct drives and their components may only be used for the applications specified by the manufacturer. Please contact your Siemens branch responsible if you have any questions on this matter.

The motors must be protected from dirt and contact with aggressive substances.

Special versions and design variants whose specifications vary from the motors described herein are subject to consultation with your Siemens branch.

The on-site conditions must comply with the rating plate specifications and the condition specifications contained in this documentation. Any differences regarding approvals or country-specific guidelines must be taken into account separately.

⚠ DANGER

The products included in the scope of delivery are exclusively designed for installation in a machine. Commissioning is prohibited until it has been established that the end product conforms with Directive 2006/42/EC. All safety instructions must be observed and given to the end user for his/her information.

⚠ DANGER

Risk of electric shock if a hazardous voltage is present on the stator when operated as a single component.

To ensure that the components have sufficient shock-hazard protection, voltage must only be applied to the motors once they have been installed.

⚠ WARNING

The motors cannot be operated directly on the supply system, but may only be operated with a suitable drive system.

2.4 Danger from strong magnetic fields

Occurrence of magnetic fields

Strong magnetic fields occur in the components of the motor that contain permanent magnets. The magnetic field strength of the motors results exclusively from the magnetic fields of the components with permanent magnets in the de-energized state. Electromagnetic fields also occur during operation.

Components with permanent magnets

⚠ CAUTION
The permanent magnets of the 1FW6 torque motors are located in the rotor.

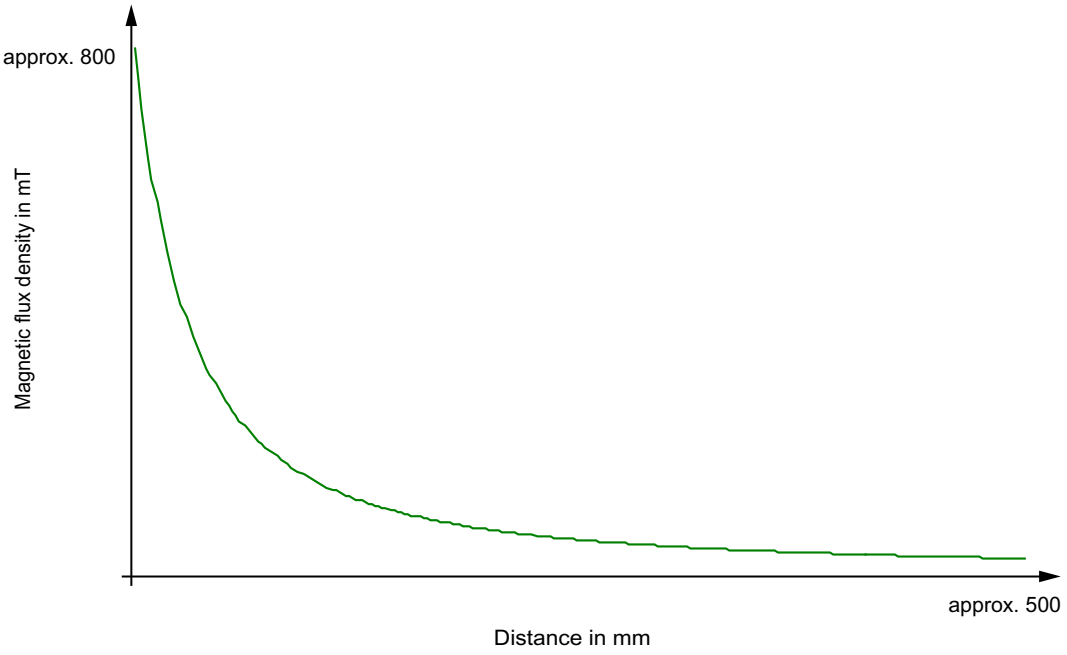


Figure 2-1 Schematic representation of the static magnetic field of a rotor, as a function of distance

Danger from strong magnetic fields

⚠ DANGER

Strong magnetic fields can pose a risk to personnel and cause damage.

With regard to the effect of strong magnetic fields on people, the work guideline BGV B 11 "Electromagnetic Fields" applies in Germany. This specifies all the requirements that must be observed in the workplace. In other countries, the relevant applicable national and local regulations and requirements must be taken into account.

People with active electrical component implants (e.g. pacemakers, insulin pumps), metal implants and magnetic or electrically conducting foreign bodies are urgently advised to avoid direct contact with components containing permanent magnets. This applies to, e.g., any work connected with assembly, maintenance or storage.

BGV B 11 specifies a limit value of 212 mT for static magnetic fields. This must be observed for distances greater than 20 mm from a rotor.

The requirements of BGV B 11 must also be taken into account with regard to strong magnetic fields (BGV B11 §14).

⚠ DANGER

Personnel who are exposed to magnetic fields in their daily work must maintain a distance of at least 50 mm from a rotor.

Personnel with pacemakers must maintain a distance of at least 500 mm from a rotor.

Humans have no sensory organs for picking up strong magnetic fields and have no experience with them as a rule. Therefore, the magnetic forces of attraction emanating from strong magnetic fields are often underestimated.

The magnetic forces of attraction may be several kN in the vicinity of the motor components containing permanent magnets (within a distance of less than 100 mm). – Example: Magnetic attractive forces are equivalent to a mass of several hundred kilos, which can trap a part of the body (hands, fingers, feet etc.)!

⚠ DANGER

Strong attractive forces on magnetizable materials lead to a great danger of crushing in the vicinity of components with permanent magnets (distance less than 100 mm).

Do not underestimate the strength of the attractive forces!

Do not carry any objects made of magnetizable materials (e. g. watches, steel or iron tools) and/or permanent magnets close to the motor or close to a component with permanent magnets.

For the event of accidents when working with permanent magnets, the following objects must be on hand to free clamped body parts (hands, fingers, feet etc.):

- a hammer (about 3 kg) made of solid, non-magnetizable material
- two pointed wedges (wedge angle approx. 10° to 15°) made of solid, non-magnetizable material (e.g. hard wood)

First aid in the case of accidents involving permanent magnets

- Stay calm.
- Press the emergency stop switch and, where necessary, switch off the main switch if the machine is live.
- Administer FIRST AID. Call for further help if required.
- To free jammed body parts (e.g., hands, fingers, feet), pull apart components that are clamped together.
  - To do this, use a hammer to drive a wedge into the separating rift
  - Release the jammed body parts.
- If necessary, call for an EMERGENCY DOCTOR.

NOTICE

Magnetic fields can lead to a loss of data on magnetic or electronic data media and damage watches.

Keep all magnetic or electronic data media (e.g. credit cards, disks, etc.) and watches away from the rotor (< 100 mm).

2.5 Risk of electric shock

⚠ DANGER

Risk of electric shock! When an installed torque motor rotates, potentially dangerous voltages are induced at the cable ends of the motor.

Insulate terminals and leads in open cable ends or take measures to prevent torque motors that have been installed from rotating.

⚠ DANGER

Danger due to high leakage currents

If high leakage currents are present, more stringent requirements may apply to the PE conductor. Warning signs may also be required on the PDS. You can find more detailed information in the standard DIN EN EN 61800-5-1.

Protective measures against residual voltages

⚠ DANGER

There is a shock hazard danger due to the residual voltages at the motor terminals!

When the power supply voltage is switched-out, active parts of the motor can have a charge of more than 60 µC. In addition, at open-circuit cable ends - e.g. when a connector is withdrawn - even after the power has been disconnected, a voltage or more than 60 V can be present for 1 s. This is the reason that you must apply the appropriate measures to provide protection against residual voltages!

2.6 Attaching warning signs

Any danger areas encountered during normal operation, maintenance, and servicing must be identified by well visible warning and prohibiting signs (pictograms) in the immediate vicinity of the danger (close to the motor). The associated texts must be available in the language of the country in which the product is used.

2.7 Pictograms supplied for 1FW6

To indicate dangers, the following durable adhesive stickers are supplied:

Table 2- 1 Warning signs to BGV A8 / DIN 4844-2 and what they indicate

Sign	Meaning	Sign	Meaning
	Warning: strong magnetic field (D-W013)		Warning: hand injuries (D-W027)
	Warning: hazardous electric voltage (D-W008)		Warning: hot surfaces (D-W026)

Table 2- 2 Prohibiting signs to BGV A8 / DIN 4844-2 and what they indicate

Sign	Meaning	Sign	Meaning
	No pacemakers (D-P011)		No metal implants (D-P016)
	No metal objects or watches (D-P020)		No magnetic or electronic data media (D-P021)

Note

The quality of the label can diminish as result of extreme environmental conditions.

Description

3

3.1 Area of application

1FW6 torque motors are designed as built-in motors for use in low-speed direct drives with a high torque output.

Built-in torque motors are liquid-cooled, permanent-magnet-excited, (high pole number) three-phase synchronous motors with hollow-shaft rotors. The motors are delivered as components that are subsequently built-in. When delivered, the stator and rotor are kept together using transport locks and the rotor is protected using a spacer film. For a complete drive unit, bearings and rotary encoder are required.

The product range includes 9 frame sizes (or external diameters), each with at least 4 different axis lengths. Most of the motors are available for at least two different speed ranges. Most of the stators and rotors are equipped with flanges at both ends with centering surfaces and tapped holes, which allow them to be integrated into a machine.

In conjunction with a suitable drive system, the built-in torque motors can be used as direct drive for the following machine applications:

- Rotary indexing machines, rotary tables, swivel axes
- Rotary axes (A, B, C axes in 5-axes machine tools)
- Rotary tables, rotary indexing machines, sub-machine assemblies
- Turret indexing and drum indexing for single-spindle and multi-spindle machines
- Dynamic tool magazines
- Rotating spindles in milling machines
- Roller and cylinder drives
- Infeed and handling axes

Please take note of national and international license terms when operating direct motors so that no patent rights are violated.

Note

Note that when 1FW6 direct motors (torque motors) are used in fork heads for machine tools or robots, a license for US patent US5584621 and the associated international patent protection may be required.

3.2 Rating plate data

Note

A rating plate is attached to each stator. Additionally, a second rating plate that the customer can attach to the machine in which the motor is installed is included in the delivery.

If stators and rotors are separated, you must ensure that they can be correctly assigned to each other at a later stage.

Data on the rating plate

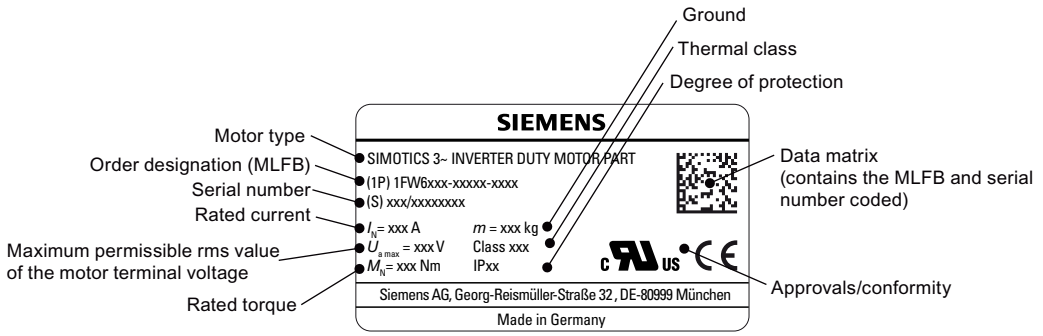


Figure 3-1 1FW6 rating plate (diagram)

Note

The data on the rating plate only applies in conjunction with the corresponding rotor.

3.3 Design

3.3.1 Motor components

Motor components

The built-in torque motor contains the following components:

- Stator:
  this comprises an iron core and a 3-phase winding.
  The winding is encapsulated to ensure that the heat loss can be dissipated more effectively. The motor is designed for water cooling (main cooler). The system design depends on the frame size (external diameter) of the motor, see the "Cooling type version" table at the end of this chapter.
- Rotor:
  this is the reaction part of the motor. It comprises a cylindrical hollow steel shaft with permanent magnets around its circumference.
- Cooling connection adapter (optional):
  this can be ordered for motors with integrated cooling whereby the main and precision cooler are operated in parallel on one heat-exchanger unit.

3.3.1.1 Motors with a cooling jacket

The cooling jacket surface of the motor contains circular grooves which, in conjunction with a surrounding construction provided by the machine manufacturer, create a closed liquid cooling circuit.

The coolant inlet/return flow circuit must be provided by the machine manufacturer in the surrounding construction.

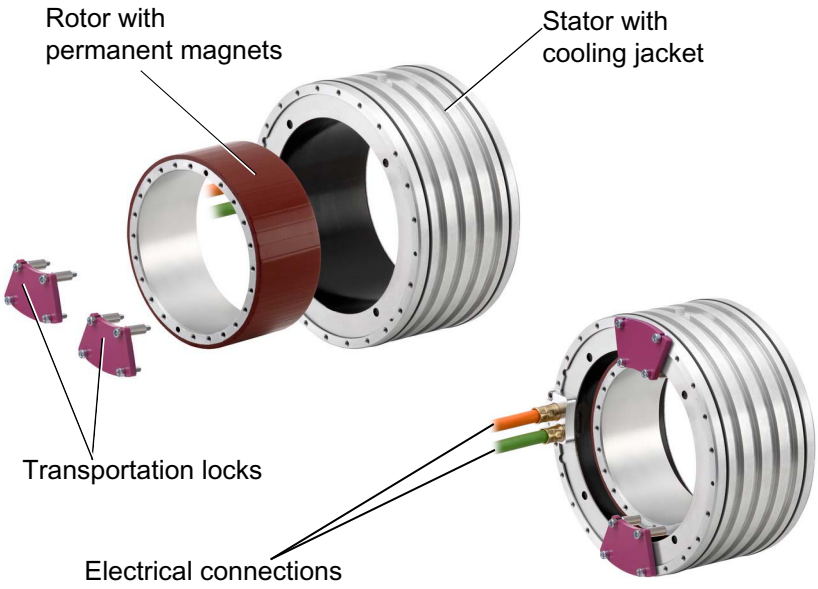


Figure 3-2 1FW6 motor components with a cooling jacket

Scope of delivery of the built-in torque motor with a cooling jacket

- The rotor is secured in the stator by means of transport locks and is protected using a spacer film
- Stator with a cooling jacket; one cable for the power connection and one cable for the signal connection with connector or open core ends
- Transportation locks with spacers and screws
- O-rings (quantity: 2)
- Rating plate (attached); additional loose rating plate
- Safety instructions

3.3.1.2 Motors with integrated cooling

Motors with integrated single-circuit cooling

These motors have an integrated single-circuit cooling system that is ready to be connected. Further, they are compact, and can therefore be simply integrated into a machine.

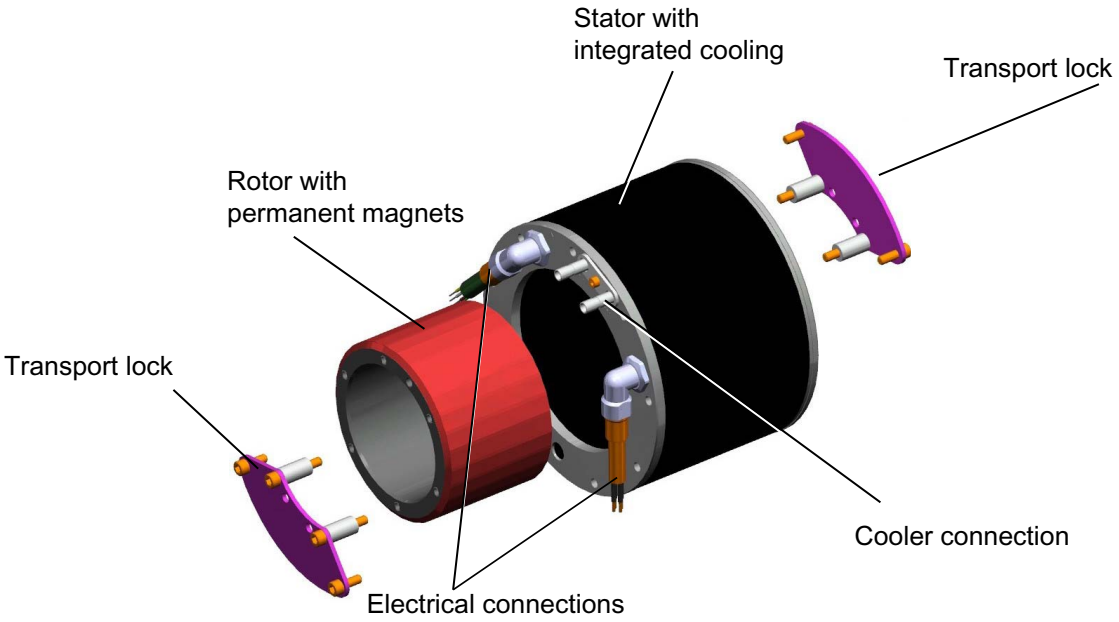


Figure 3-3 1FW605 and 1FW606 motor components with integrated cooling (1 cooling circuit)

Motors with integrated dual-circuit cooling

These motors are equipped with a ready-to-connect, integrated dual-circuit cooling system, which provides considerable thermal insulation with respect to the mechanical axis construction.

The dual-circuit cooling system comprises a main and precision cooler (thermo-sandwich® principle).

An internal cooling circuit (main cooler) dissipates most of the winding losses P_v of the stator. A thermal insulation layer between the stator and the mounting flanges of the stator prevents heat from flowing from the motor winding to the machine construction.

Any heat that does flow through the insulation layer is captured, for the most part, by a second heat sink (precision cooler) on the flange surfaces and dissipated. This ensures that the temperature on the mounting surfaces of the stator remains suitably low under all permissible operating conditions.

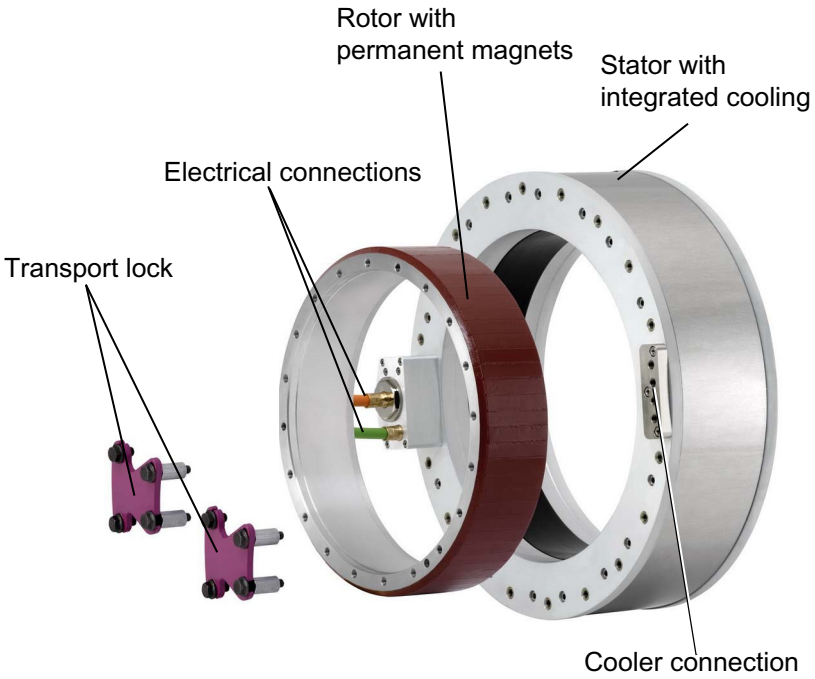


Figure 3-4 1FW616 up to 1FW629 motor components with integrated cooling (2 cooling circuits)

Scope of delivery of the built-in torque motor with integrated cooling

- The rotor is secured in the stator by means of transport locks and is protected using a spacer film
- Stator with ready-to-connect cooling system; one cable for the power connection and one cable for the signal connection with connector or open conductor ends
- Transportation locks with spacers and screws
- Rating plate (attached); additional loose rating plate
- Safety instructions

3.3.1.3 Cooling method

Cooling method

The stator in the built-in torque motors is equipped with a liquid cooler for dissipating heat loss.

The cooling method used depends on the size (external diameter) of the motor as follows.

Table 3- 1 Cooling method

Size	Cooling jacket	Integrated cooling with one cooling circuit (only main cooler)	Integrated cooling with two cooling circuits (main cooler and precision cooler)
1FW605		X	
1FW606		X	
1FW609	X		
1FW613	X		
1FW615	X		
1FW616			X
1FW619			X
1FW623			X
1FW629			X

3.3.2 Protecting the motor components

Degree of protection

The machine construction surrounding the motor must fulfill degree of protection IP54 to DIN EN 60529 as a minimum.

The degree of protection for built-in motors is governed by the surrounding machine construction. The better the motor installation space is protected against the ingress of foreign particles (ferromagnetic particles), the longer the service life.

In particular, foreign particles in the air gap between the stator and rotor can destroy the motor during operation.

This also applies to corrosive chemicals (e.g. coolants, oil) that could penetrate the motor compartment. Corrosive chemicals can damage the magnetic bonds of the rotor.

Liquids can compromise the insulation resistance of the stator.

The thermal properties of the motor are influenced by the ingress of liquids and foreign particles.

⚠ WARNING

Contamination in the motor compartment can cause the motor to stop functioning or cause wear and tear.

1FW6 torque motors have degree of protection IP23.

3.3.3 Ambient conditions

Ambient conditions for long-term storage, transport, and use in fixed locations

Based on DIN EN 60721-3-1 (for long-term storage), DIN EN 60721-3-2 (for transport), and DIN EN 60721-3-3 (for use in fixed, weather-protected locations)

Table 3- 2 Climatic ambient conditions

Lower air temperature limit:	- 5 °C (deviates from 3K3)
Upper air temperature limit:	+ 40 °C
Lower relative humidity limit:	5 %
Upper relative humidity limit:	85 %
Rate of temperature fluctuations:	Max. 0.5 K/min
Condensation:	Not permissible
Formation of ice:	Not permissible
Long-term storage:	Class 1K3 and class 1Z1 have a different upper relative humidity
Transport:	Class 2K2
Fixed location:	Class 3K3

Storage, transport and operation permissible only in locations that are fully protected against the weather (in halls or rooms).

Table 3- 3 Biological ambient conditions

Long-term storage:	Class 1B1
Transport:	Class 2B1
Fixed location:	Class 3B1

Table 3- 4 Chemical ambient conditions

Long-term storage:	Class 1C1
Transport:	Class 2C1
Fixed location:	Class 3C2 Different to class 3C2: Operating site in the immediate vicinity of industrial plants with chemical emissions

Table 3- 5 Mechanically active ambient conditions

Long-term storage:	Class 1S2
Transport:	Class 2S2
Fixed location:	Class 3S1

Table 3- 6 Mechanical ambient conditions

Long-term storage:	Class 1M2
Transport:	Class 2M2
Fixed location:	Class 3M3

3.3.4 Cooling

3.3.4.1 Cooling circuits

Cooling circuit requirements

We recommend that the cooling circuits be designed as closed systems, to prevent the growth of algae. The maximum permissible pressure is 10 bar.

Note

We do not recommend that the cooling circuits of machines are also used to cool the motors: Due to accumulated dirt and long-term deposits, blockage may result! This especially applies to cooling-lubricating medium circuits.

If the cooling circuits of the machines are also used to cool the motors, then they must fulfill all of the requirements listed here. Also note the demands on the cooling medium as well as the maximum standstill times of cooling circuits according to the specifications of the cooling medium manufacturer!

Materials used in the cooling circuits of torque motors

Table 3- 7 Materials in the cooling circuits of torque motors (not including the material used for the connections)

Cooling jacket for 1FW609, 1FW613 and 1FW615	Integrated cooling (main cooler) for 1FW605, 1FW606 and 1FW616 up to 1FW629	Integrated cooling (precision cooler) for 1FW616 to 1FW629	Cooling connection adapter for 1FW616 to 1FW629
1FW609, 1FW613: • EN AW-5083 (EN 573-3) • Viton® (FPM) gasket 1FW615: • S355J2G3 (EN 10025) • Viton® (FPM) gasket	1FW605, 1FW606: • X10CrNiS18-9 (DIN 17440) • SF-Cu (DIN 17671) • Viton® (FPM) gasket 1FW616 to 1FW629: • X6CrNiTi18-10 (EN 10088) • SF-Cu (DIN 17671) • CW617N (DIN EN 12449) • Viton® (FPM) gasket • Silicon hose • Ag 102 (EN 1045) + welding flux EN 1045-FH10	• X6CrNiTi18-10 (EN 10088) • SF-Cu (DIN 17671) • CW617N (DIN EN 12449) • Viton® (FPM) gasket • Silicon hose	• CW617N (DIN EN 12449) • Viton® (FPM) gasket

Coolant intake temperature

The intake temperatures must be selected in such a way that no condensation forms on the surface of the motor. Condensation can lead to corrosion in the machine.

$T_{kühl} \geq T_{Umgeb} - 2\ K$

The rated motor data refer to operation at a coolant inlet temperature of 35 °C. For a different inlet temperature, the continuous motor current changes according to the following diagram.

Note

For a main cooler inlet temperature of < 35 °C, the continuous motor current is greater than I_N. Larger cable cross-sections may be required. This means that you must take into account the rated current of the cables.

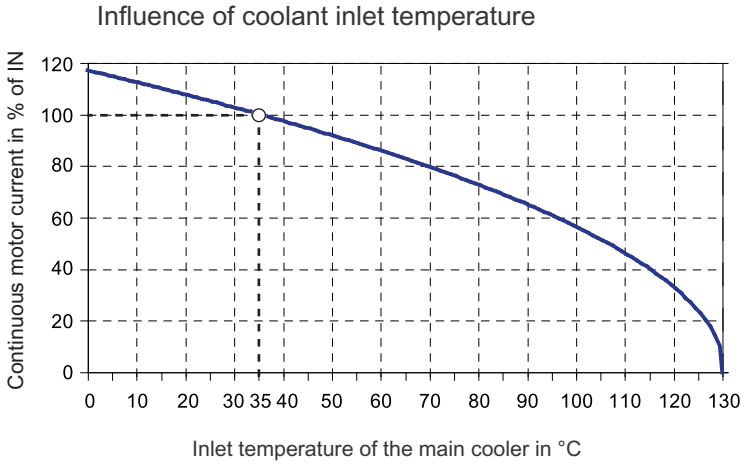


Figure 3-5 Principal dependency of the continuous motor current on the intake temperature of water cooling in the main cooler when the rotor losses are disregarded

3.3.4.2 Coolants

Provision of the cooling medium

The customer must provide the cooling medium. Only water with anti-corrosion agent should be used as the cooling medium.

⚠ WARNING

Oil must not be used as a coolant because it is incompatible with materials used in motors with a cooling jacket and may cause O-rings to corrode. In motors with integrated cooling, oil can corrode the hoses of the cooling system inside the motor.

Reason for the use of water with an anti-corrosion agent

The use of untreated water may lead to considerable damage and malfunctions due to water hardness deposits, the formation of algae and slime, as well as corrosion, for example:

- Worsening of the heat transfer
- Higher pressure losses due to reductions in cross-sectional area
- Blockage of nozzles, valves, heat exchangers and cooling ducts

General requirements placed on the cooling medium

The cooling medium must be pre-cleaned or filtered in order to prevent the cooling circuit from becoming blocked. The formation of ice is not permitted!

Note

The maximum permissible size for particles in the cooling medium is 100 µm.

Requirements placed on the water

The water used as the basis of the cooling medium must fulfill the following minimum requirements:

- Concentration of chloride: c < 100 mg/l
- Concentration of sulfate: c < 100 mg/l
- 6.5 ≤ pH value ≤ 9.5

Please check further requirements with the manufacturer of the anti-corrosion agent!

Requirements placed on the anti-corrosion agent

The anti-corrosion agent must fulfill the following requirements:

- The basis is ethylene glycol (also called ethanediol)
- The water and anti-corrosion agent do not segregate
- The freezing point of the water used is reduced to at least -5 °C
- The anti-corrosion agent used must be compatible with the fittings and cooling system hoses used as well as the materials of the motor cooler

Check these requirements, especially in regard to material compatibility, with the cooling unit manufacturer and the manufacturer of the anti-corrosion agent!

Suitable mixture

- 25 % - 30 % ethylene glycol (= ethanediol)
- The water used contains a maximum of 2 g/l dissolved mineral salt and is largely free from nitrates and phosphates

Manufacturer recommendations: see appendix

3.3.5 Temperature monitoring and thermal motor protection

Temperature monitoring circuits Temp-F and Temp-S

The motors are supplied with two temperature monitoring circuits: Temp-F and Temp-S. Temp-F is used to monitor and evaluate the temperature characteristic in the motor. Temp-S is used to activate the motor protection when the motor windings become too warm.

Both circuits are independent of each other. They are generally evaluated via the drive system.

Temp-F (KTY 84 Sensor)

The *temperature monitoring circuit* Temp-F consists of a KTY 84 temperature sensor located at the coils. Under certain circumstances – especially with varying current feed of the individual phases – this can result in the maximum temperature of the three phase windings not being measured. An evaluation of Temp-F for motor protection is thus not permissible. Temp-F is used rather to observe the temperature and if necessary to warn that the drive is being switched off due to a response from Temp-S.

Temp-S (PTC element)

The *overtemperature shutdown circuit* consists of thermistor temperature sensors (PTC elements). There is a thermistor temperature sensor for monitoring the motor winding in each of the three phase-windings (U, V and W). This ensures overload protection, even if the current feed is uneven in a primary section's individual phases or if several primary sections are being loaded differently. The PTC elements are connected in series.

Technical properties of the KTY 84

The KTY 84 produces a resistance/temperature characteristic curve that is progressive and approximately linear (see the image below). In addition, the KTY 84 has a low thermal capacity and provides good thermal contact with the motor winding.

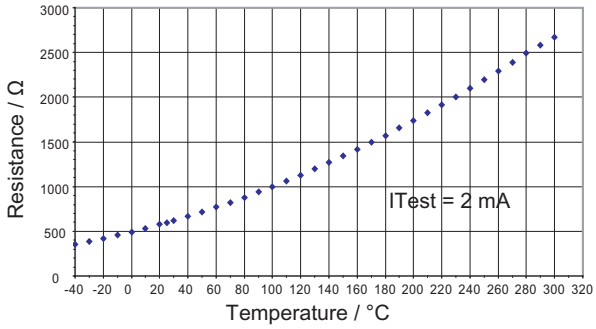


Figure 3-6 Characteristic curve of a KTY 84

Technical data:

- Resistance when cold (20 °C): approx. 580 Ω
- Resistance when hot (100 °C): approx. 1000 Ω

Technical properties of PTC elements

Each PTC element displays a sudden increase in resistance in the region of the rated response temperature ϑ_{NAT}, see following figure. This gives it a quasi-switching characteristic. Due to low thermal capacity and good thermal contact between the PTC element and the motor winding, the sensors - and therefore the system - are able to react quickly to inadmissibly high temperatures in the winding.

The PTC elements of the triplet are connected in series. The characteristics correspond with DIN EN 60947-8, DIN 44081, and DIN 44082.

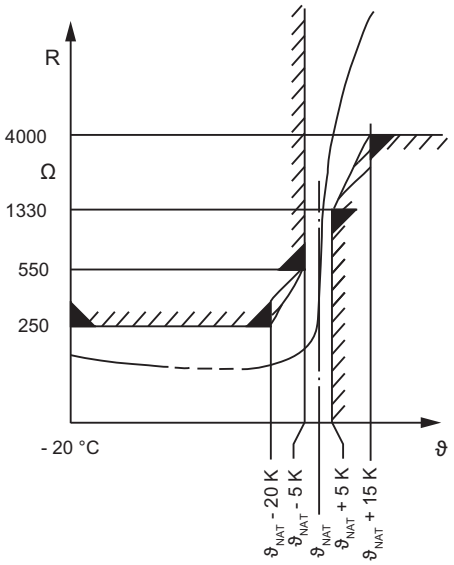


Figure 3-7 Typical characteristic curve of a PTC element; source: DIN 44081 / DIN 44082

Technical data:

According to DIN 44081 / DIN 44082, the resistance at the triplet is

- maximum 3x250 Ω = 750 Ω at T > -20 °C and T < ϑ_{NAT} - 20 K
- maximum 3x550 Ω = 1650 Ω at T < ϑ_{NAT} - 5 K
- minimum 3x1330 Ω = 3990 Ω at T < ϑ_{NAT} + 5 K
- minimum 3x4000 Ω = 12000 Ω at T < ϑ_{NAT} + 15 K

Note

The PTC elements are pure sensors and can only disconnect the motor via an external evaluation.

Preparation for use

4

The rotor is secured in the stator by means of transport locks, and is protected by spacer film. The original packaging for the built-in torque motor and the transport locks (incl. the screws) are required for storage/transport purposes and should, therefore, be kept in a safe place.

Note

When reusing the original packaging do not cover safety instructions that are possibly attached. When required, use transparent adhesive tape for the packaging.

Original packaging can also be requested from your local Siemens office.

Note

Always follow the safety instructions and notices in these operating instructions.

Checking the delivery for completeness

When you take receipt of the delivery, please check immediately whether the items delivered are in accordance with the accompanying documents.

- Report any apparent transport damage to the delivery agent immediately.
- Report any apparent defects / missing components to the appropriate Siemens office immediately.

Siemens will not accept any claims relating to items missing from the delivery and which are submitted at a later date.

Keep these operating instructions so that they are accessible at all times.

4.1 Shipment and packaging

Dangers are marked as follows on the original packaging of 1FW6 rotors:

Table 4- 1 Warning signs according to BGV A8 / DIN 4844-2 and their significance

Sign	Meaning	Sign	Meaning
	Warning: strong magnetic field (D-W013)		Warning: hand injuries (D-W027)

Table 4- 2 Prohibiting signs according to BGV A8 / DIN 4844-2 and their significance

Sign	Meaning	Sign	Meaning
	No pacemakers (D-P011)		No metal implants (D-P016)
	No metal objects or watches (D-P020)		No magnetic or electronic data media (D-P021)

Further, the following symbols are marked on the original packaging of 1FW6 built-in torque motors, stators and rotors:

Table 4- 3 Handling notes and their significance

Symbols	Meaning	Symbols	Meaning
	fragile (ISO 7000, No. 0621)		protect against moisture (ISO 7000, No. 0626)
	top (ISO 7000, No. 0623)		do not stack (ISO 7000, No. 2402)

When shipping products that contain permanent magnets by sea or road, no additional packaging measures are required.

4.2 Transport and storage

UN number 2807 is allocated to permit magnets as hazardous item.

4.2.1 Safety instructions for transport and storage

When packing/unpacking and transporting torque motors or rotors, take measures to minimize risks posed by strong magnetic fields from the rotors (see also "Danger from strong magnetic fields").

⚠ DANGER

Risk of death, injury and/or material damage if the devices are packed, stored, or transported incorrectly.

Personnel must be familiar with and observe the safety precautions regarding storage and transport.

When transporting machines or machine parts, take measures to ensure that the rotary axes (axes) cannot move unintentionally (no self-locking).

Hazards during lifting and transport!

Devices and tools that are badly designed, unsuitable, or damaged can result in personal injury and/or material damage.

Lifting devices, industrial trucks, and load bearing equipment must comply with requirements.

IATA regulations must be observed when components are transported by air.

Storage areas for rotors must be specially identified with pictograms (see "Attaching warning and prohibiting signs").

Note the warnings on the packaging.

Wear safety shoes and work gloves.

Take into account the maximum loads that personnel can lift and carry. The motors and their components can weigh more than 13 kg.

Never store or transport built-in torque motors or rotors when they are unpacked.

Never store or transport unpacked motor components; this also applies to the company's own premises.

Only use undamaged original packaging.

Damaged packaging must be replaced immediately. If rotors are not packaged properly, they are not sufficiently protected against the sudden attractive forces that can occur in their immediate vicinity. Dangerous movements of the rotor can also occur when it is stored or shifted.

⚠ DANGER

Danger of tilting Motors, stators, and rotors must not be stacked too high – risk of death, personal injury and/or material damage.

Motors, stators, and rotors must not be stacked excessively (packed or unpacked).

Motors and rotors must only be stored and transported horizontally.

Read the warnings and handling instructions on the packaging.

⚠ WARNING

Improper use of lifting devices can cause plastic deformation of the motor.

To lift the motor (or stator/rotor), at least three lifting eyebolts are required. These must be screwed into the tapped holes on the flat motor (or stator/rotor) so that they are symmetrical with each other.

Motors (or stators/rotors) must only be lifted horizontally. The lifting ropes must be the same length. The tightened lifting ropes must form an angle of at least 50° between the lifting rope and motor (or stator/rotor).

4.2.2 Storage

The motors can be stored for up to two years under the following conditions:

Storing indoors

- Apply a preservation agent (e.g. Tectyl) to bare external components if this has not already been carried out in the factory.
- Store the motors as described in Section "Ambient conditions". The storeroom must be:
  - Dry, free of dust and not subject to vibration
  - Well ventilated
  - Provide protection against extreme weather conditions
  - Free of aggressive gases
- Protect the motor against shocks and humidity.
- Make sure that the motor is covered properly.

Protection against humidity

If a dry storage area is not available, then take the following precautions:

- Wrap the motor in humidity-absorbent material and then wrap it in film so that it is air tight.
- Include several bags of desiccant in the seal-tight packaging. Check the desiccant and replace as required.
- Place a humidity meter in the seal-tight packaging to indicate the level of air humidity inside it in four steps.
- Inspect the motor on a regular basis.

Protecting the cooling system for motors with integrated cooling

Before you store the motor after use:

- Empty the cooling channels
- Blow air through to completely empty them and
- Seal them

4.2.3 Packaging specifications for air transportation

When transporting products containing permanent magnets by air, the maximum permissible magnetic field strengths specified by the appropriate IATA Packing Instruction must not be exceeded. Special measures may be required so that these products can be shipped. Above a certain magnetic field strength, shipping requires that you notify the relevant authorities and appropriately label the products.

Note

The magnetic field strengths listed in the following always refer to values for the DC magnetic field specified in the IATA packaging instruction 953, which has been in force since January 1, 2011. If the values change, then we will take this into account in the next edition.

Products whose highest field strength exceeds 0.418 A/m, as determined at a distance of 4.6 m from the product, require shipping authorization. This product will only be shipped with previous authorization from the responsible national body of the country from where the product is being shipped and the country where the airfreight company is based. Special measures need to be taken to enable the product to be shipped.

When shipping products whose highest field strength is equal to or greater than 0.418 A/m, as determined at a distance of 2.1 m from the product, you have a duty to notify the relevant authorities and appropriately label the product.

When shipping products whose highest field strength is less than 0.418 A/m, as determined at a distance of 2.1 m from the product, you do not have to notify the relevant authorities and you do not have to label the product.

Rotors

Shipping motor components in their original packaging with order designations (MLFB)
1FW6xxx-8RAxx-xxxx (rotor as individual component in a package),
1FW6xxx-2xxxx-xxxx (stator and rotor as individual components, separate in one package)
and
1FW6xxx-0xxxx-xxxx (rotor and stator are in an assembled state)
does not require that the relevant authorities are notified and labels attached.

Assembling

5

5.1 Safety instructions for assembling the motor

Important information about motor assembly

Before assembling the motor, the assembly instructions provided in this documentation must be read carefully.

⚠ DANGER

Installing torque motors involves carrying out work in the vicinity of unpacked rotors. The resulting danger from strong magnetic fields is, therefore, particularly high.

You must read the "Safety information" section along with the safety information provided in this section.

Only remove the packaging for the built-in torque motor when you are ready to assemble it.

Under no circumstances should several rotors be unpacked at the same time.

Immediately assemble the unpacked rotor.

At least two people are required to install the motor.

Use the installation equipment provided.

Never place metal on magnetic surfaces (and vice versa).

Keep magnetizable objects and/or permanent magnets away from magnetic surfaces.

Never use magnetizable tools. If such tools are required, however, they must be held firmly with both hands and moved slowly toward the built-in torque motor.

Installation work on machinery may only be carried out when it is de-energized and isolated from the power supply! Risk of electric shock!

When installing individual components, you must use special equipment and follow specific procedures.

⚠ WARNING

The transportation locks must not be removed until the torque motor has been installed in the axes construction. You must carry out the steps in the specified sequence (see "Procedure for installing the motor").

⚠ WARNING

If the stator and rotor are fixed at both ends, this can result in significant material deformation in the machine construction due to thermal expansion, which could destroy the motor.

Only fix the stator and rotor at one end.

⚠ DANGER

Defective connecting cables can cause an electric shock and/or material damage (e.g. by fire).

When installing the motor, make sure that the connection cables...

- are not damaged
- are not under tension
- cannot come into contact with any rotating parts

Note the permissible bending radii according to Chapter "Notes on routing cables".

The motor must not be held or pulled by the cables.

⚠ DANGER

Risk of electric shock! When an installed torque motor rotates, potentially dangerous voltages are induced at the cable ends of the motor.

Insulate terminals and leads in open cable ends or take measures to prevent torque motors that have been installed from rotating.

⚠ DANGER

There is a risk of crushing when the rotor of an assembled torque motor rotates!

Take extreme care when performing any work.

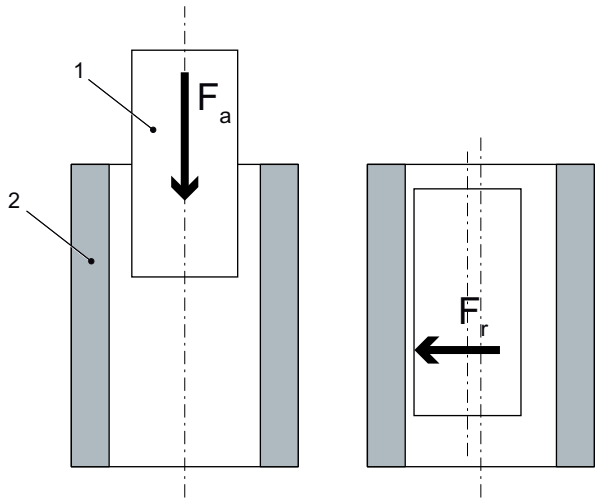
⚠ WARNING

Sharp edges can cause cuts and falling objects can injure feet.

Always wear work gloves and safety shoes.

5.2 Forces that occur between the stator and rotor

Radial and axial forces



1 Rotor with permanent magnets
2 Stator
F_a Axial attractive force
F_r Radial attractive force

Figure 5-1 Active forces when stators and rotors are installed

Radial forces between the stator and rotor

The following table shows the active radial forces (in N per 0.1 mm centering error) between the stator and rotor. The longer the active component, the greater the radial force.

Table 5- 1 Radial forces in N/0.1 mm with radial centering errors during installation

	Active length in mm						
	30	**50**	**70**	**100**	**110**	**150**	**200**
1FW605	80	140	190	270	-	400	-
1FW606	110	180	250	350	-	520	-
1FW609	-	240	330	470	-	710	-
1FW613	-	360	500	710	-	1070	-
1FW615	-	330	460	660	-	990	-
1FW616	-	290	410	590	-	880	1180
1FW619	-	350	490	710	-	1060	1410
1FW623	-	420	590	840	-	1260	1680
1FW629	-	-	600	-	940	1280	1630

Note

It is imperative that you observe the radial forces between the stator and rotor as well as the maximum permissible concentricity error. This is specified in the dimension drawings in the Configuration Manual "Built-in torque motors 1FW6".

Example

With torque motor 1FW6090-0Px010-xxxx (active component length: 100 mm), the eccentricity is 0.2 mm, for example.

The active radial force as a result of this centering error is, therefore:

$$0.2\ \text{mm} \bullet \frac{470\ \text{N}}{0.1\ \text{mm}} = \underline{\underline{940\ \text{N}}}$$

Axial forces between the stator and rotor

Table 5- 2 Axial forces (in N) between the stator and rotor during installation

	1FW605	1FW606	1FW609	1FW613	1FW615	1FW616	1FW619	1FW623	1FW629
Axial forces in N	40	60	80	120	150	210	250	300	450

Note

The axial attractive forces between the stator and rotor are approximately 4 to 5 times greater when the rotor is about to be inserted in the stator.

5.3 Installation device

Requirements of the installation device

The installation device is designed to ensure that the stator and rotor are aligned centrically during the entire installation procedure. Observe the axial forces that are effective when installing.

The installation device must be adapted by the customer in line with the machine construction. It must be sufficiently rigid so that it is not warped by the strong attractive forces between the stator and rotor. Radial forces must be taken into account when the installation device is dimensioned.

The installation device must not have any loose parts.

⚠ WARNING

The stator and rotor must not come into contact with each other during centering and installation.

The stator and rotor cannot be separated without causing any damage. The motor can no longer be used. This is why an installation device must be used.

If the motors are delivered as separate components, a special installation device must be used.

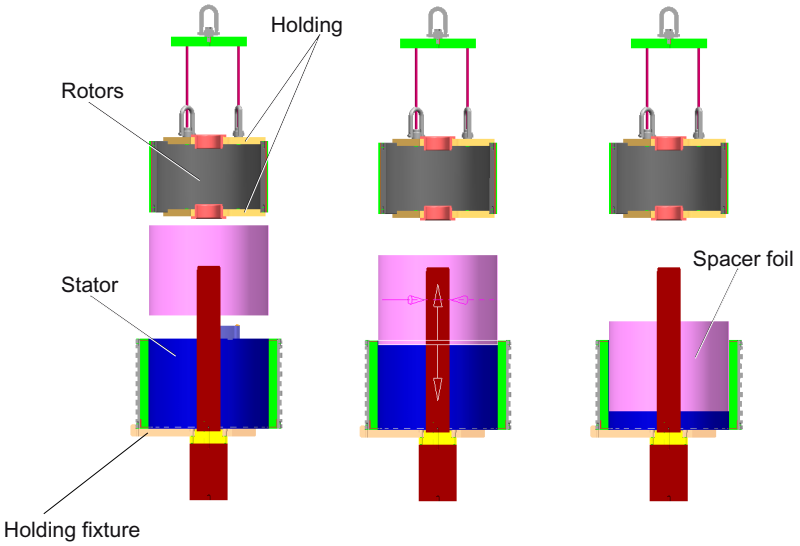
⚠ DANGER

Danger of compression when the stator and rotor are centered and installed.

Do not install or center the stator and rotor manually.

Example: Centering and installing motors with a cooling jacket

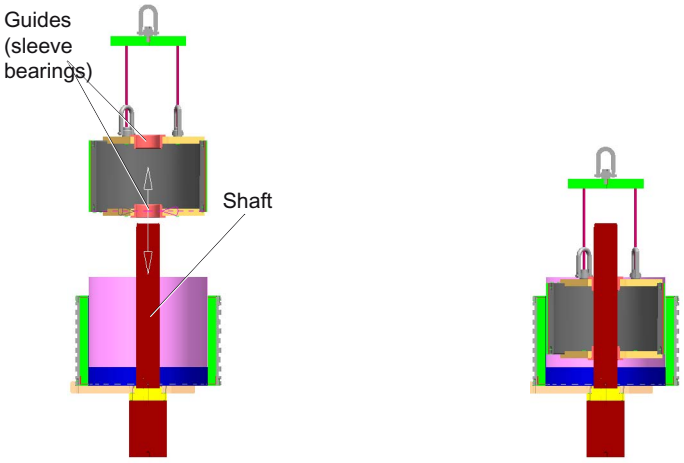
1. Place the stator so that it is centered in the holding fixture of the lower part of the installation device.
2. Place the rotor so that it is centered in the holding fixture of the upper part of the installation device.
3. Insert the spacer film in the stator in such a way that approx. 1/4 of the spacer film protrudes.



The stator is located in the holding fixture of the lower part of the installation device centered

The rotor is located in the holding fixture of the upper part of the installation device centered

4. Carefully lower the rotor using the upper part of the installation device and carefully fit it into the lower part of the installation device in such a way that the rotor can be aligned centrically over the sleeve bearing and shaft in the stator.

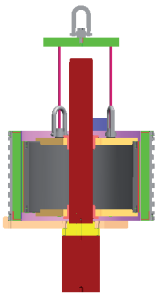


DANGER

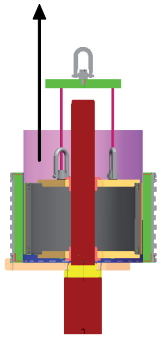
Risk of compression when the rotor is lowered.

Take extreme care when performing any work.

5. Using the top part of the installation device, lower the rotor as far as it will go into the lower part of the installation device.



6. Fix the stator and rotor using the transport locks. To do this, tighten the bolts with the specified tightening torques according to the table "Required strength classes and tightening torques for stator and rotor".
7. Remove the spacer foil. When the stator and rotor are correctly centered, the spacer film can be easily removed by hand.



5.4 Specifications relating to the mounting side

Permissible mounting side

Note

As a result of the design, the following motors may only be mounted at the A flange.

Table 5- 3 Mounting at the A flange

1FW616	1FW619	1FW623	1FW629
1FW6160-xxB10-2Pxx	1FW6190-xxB10-2Pxx	1FW6230-xxB15-0Wxx	1FW6290-xxB07-2Pxx
1FW6160-xxB15-2Pxx	1FW6190-xxB15-2Pxx	1FW6230-xxB20-0Wxx	1FW6290-xxB11-2Pxx
1FW6160-xxB15-0Wxx	1FW6190-xxB15-0Wxx		1FW6290-xxB15-2Pxx
1FW6160-xxB20-2Pxx	1FW6190-xxB20-2Pxx		1FW6290-xxB20-2Pxx
1FW6160-xxB20-0Wxx	1FW6190-xxB20-0Wxx		

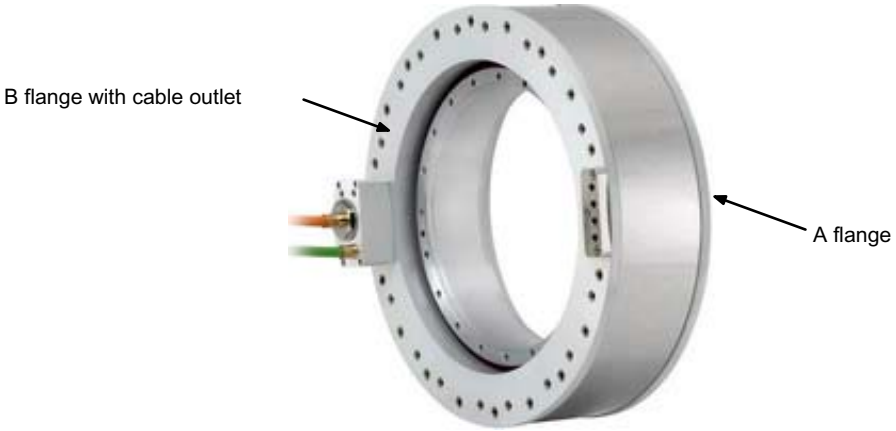


Figure 5-2 A flange and B flange

5.5 Specifications for mounting torque motors

Mounting system

The following must be taken into account when the torque motor is mounted:

- Only use new (unused) fixing screws.
- The mounting surfaces must be free of oil and grease.
- Note the maximum permissible insertion depth of the fixing screws in the stator and rotor (refer to the relevant installation drawing or the following table).
- The minimum insertion depth for the fixing screws in the stator:
  1.0 x d + section without threads (valid for 1FW605 and 1FW606)
  1.3 x d (valid for 1FW609 to 1FW613)
  1.0 x d (valid for 1FW615 and higher)
- Minimum insertion depth of the fixing screws in the rotor flange (in steel):
  1.1 x d (valid for 1FW605 and 1FW606)
  1.0 x d (valid for 1FW609 to 1FW629)
- To secure the screws, choose long clamping lengths l_k, l_k / d > 5 if possible; alternatively (if l_k / d > 5 is not possible), check pretensioning of the screws at regular intervals (tighten with calibrated torque wrench).
- Note the tightening torques specified in the table below.
- Tighten the screws in such a way that the angle of rotation is controlled. Using a calibrated torque wrench with the shortest possible bit insert, however, ensure that they are tightened in diagonally opposite (180°) pairs.
- Tighten all the screws to minimize the risk of them penetrating other materials.
- Do not use any liquids for securing the screws.

Explanations:

l_k = Clamping length of the screw in mm

d = Nominal diameter of the screw in mm (e.g. M8 screw: d = 8 mm)

Screw material and tightening torques

Screws of varying strength classes are required to secure the motor to the machine structure. The table below shows the required strength classes and tightening torques for the stator and rotor fixing screws.

Table 5- 4 Required strength classes and tightening torques for the stator and rotor

Type series	Screw (strength class)	Tightening torque M_A in Nm
1FW605-xxB03-xxxx to 1FW605-xxB15-xxxx	M6 (8.8)	9
1FW606-xxB03-xxxx to 1FW606-xxB15-xxxx	M6 (8.8)	9
1FW6090-xxB05-xxxx to 1FW6090-xxB15-xxxx	M5 (8.8)	5.2
1FW6130-xxB05-xxxx to 1FW6130-xxB15-xxxx	M5 (8.8)	5.2
1FW6150-xxB05-xxxx to 1FW6150-xxB15-xxxx	M6 (8.8)	9
1FW6160-xxB05-xxxx to 1FW6160-xxB15-xxxx	M8 (8.8)	21.6
1FW6160-xxB20-xxxx	M8 (10.9)	31.8
1FW6190-xxB05-xxxx to 1FW6190-xxB15-xxxx	M8 (8.8)	21.6
1FW6190-xxB20-xxxx	M8 (10.9)	31.8
1FW6230-xxB05-xxxx to 1FW6230-xxB15-xxxx	M8 (8.8)	21.6
1FW6230-xxB20-xxxx	M8 (10.9)	31.8
1FW6290-xxB07-xxxx to 1FW6290-xxB15-xxxx	M10 (8.8)	43
1FW6290-xxB20-xxxx	M10 (10.9)	61.8

Note

Underlying friction factor μ_{ges} = 0.1

With lower friction values, the tightening torques may have to be reduced.

Also note the maximum tightening torques of the screws used. These may be lower than the values specified in the table above.

Table 5- 5 Maximum permissible screw insertion depths for the stator and rotor

Type series	Max. permissible screw-in depth in mm	Thread	Components
1FW605, 1FW606	8.5 + section without thread *)	M6	Stator
1FW605, 1FW606	11	M6	Rotors
1FW609, 1FW613	10	M5	Stator and rotor
1FW615	12	M6	Stator and rotor
1FW616, 1FW619, 1FW623	13	M8	Stator
1FW616, 1FW619, 1FW623	12	M8	Rotors
1FW629	15	M10	Stator
1FW629	15	M10	Rotors

*) See the installation drawing "detail Z"

5.6 Procedure for installing the motor

Sequence for installing the motor

⚠ DANGER

If the components are installed in a different sequence, this can endanger personnel and/or destroy motor components.

1. Preparing and cleaning the mounting surfaces for motor parts and the machine.
   - Deburr and round off the holes (e.g. cooling inlet/outlet holes) inside the machine housing.
   - Carefully remove any machining residue (e.g. chippings, dirt, foreign bodies, etc.).
   - Grease or oil the components.
   - For motors with cooling jacket:
     grease the O-rings and components. Take into account compatibility with the O-ring material (fluoric rubber, Viton®). Do not use any lubricants containing solid particles (e.g. molybdenum disulfide or zinc sulfide).
2. This point only applies to motors with cooling jacket:
   Guide both O-rings over the cooling jacket surface of the motor into the grooves provided.
   - Do not overstretch the O-rings (O-rings maximum of up to 10 % during installation, otherwise installation and leak tightness problems may occur).
   - Do not twist the O-rings.
   - Do not use any sharp objects!
   - Use special tools to help you position the components correctly.
   - Use installation devices whenever possible.
3. If necessary, insulate the power connections properly (otherwise there is a risk of electric shock when rotating as a result of the induced voltage and short-circuit braking torques for a phase short-circuit).
4. In the delivery condition, the transport locks on the stator and rotor are attached at both flange surfaces.
   Remove the transport looks at the mounting side. Loosen the transport locks on the opposite side.
   If transport locks are removed or loosened, the motor must always be carefully moved.
   Keep the transport locks as they may be required in the case of service and when removing the motor.
   Do not manually center and install the stator and rotor as individual components due to the risk of crushing!
   To do this, always use the special installation device. Please refer to the description of the installation device in this chapter.
5. This point only applies to motors with cooling jacket:
   Insert the motor with the free flange face forwards into the prepared locating hole of the machine housing.
   In this case, the O-rings must not be forced out of the slot and damaged.
   Ensure that the motor does not become canted in the installation space during the installation procedure. If the motor does however become slightly canted, this can be corrected by gently hitting the flange with a rubber mallet.
6. Screw the flange face of the stator to the machine housing and the flange face of the rotor to the adjustable axle. In this case, observe the specified torques and the mounting technology specifications listed in this chapter.
   If the stator and rotor on opposite flange faces are screwed to the machine construction, a special mounting device is required.

7. Completely remove any transport locks that are still in place.
   This point is not applicable for stator and rotor as individual components.
8. Remove the spacer film. When the stator and rotor are correctly centered, the spacer film can be easily removed by hand. Keep spacer film safe for subsequent transport, packaging and storage of the motor.
9. Make sure that the rotor can move without hindrance. Make sure that the spacer film and all other foreign bodies are removed from the air gap.
10. Connect the coolant ducts.
11. Connect the power and signal cables.

5.7 Important data for 1FW6 cables

Table 5- 6 Specifications for the power cable on the stator

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1])	Connector size [2])
1FW6050-xxB03-0Fxx	4x2.5	44	1
1FW6050-xxB05-0Fxx	4x2.5	44	1
1FW6050-xxB07-0Fxx	4x2.5	44	1
1FW6050-xxB07-0Kxx	4x2.5	44	1
1FW6050-xxB10-0Kxx	4x2.5	44	1
1FW6050-xxB15-0Kxx	4x2.5	44	1
1FW6050-xxB15-1Jxx	4x2.5	44	1
1FW6060-xxB03-0Fxx	4x2.5	44	1
1FW6060-xxB05-0Fxx	4x2.5	44	1
1FW6060-xxB05-0Kxx	4x2.5	44	1
1FW6060-xxB07-0Fxx	4x2.5	44	1
1FW6060-xxB07-0Kxx	4x2.5	44	1
1FW6060-xxB10-0Kxx	4x2.5	44	1
1FW6060-xxB10-1Jxx	4x2.5	44	1
1FW6060-xxB15-0Kxx	4x2.5	44	1
1FW6060-xxB15-1Jxx	4x2.5	44	1
1FW6090-xxB05-0Fxx	4x2.5	44	1
1FW6090-xxB05-0Kxx	4x2.5	44	1
1FW6090-xxB07-0Kxx	4x2.5	44	1
1FW6090-xxB07-1Jxx	4x2.5	44	1
1FW6090-xxB10-0Kxx	4x2.5	44	1
1FW6090-xxB10-1Jxx	4x2.5	44	1
1FW6090-xxB15-1Jxx	4x2.5	44	1
1FW6090-xxB15-2Jxx	4x4.0	49.2	1.5
1FW6130-xxB05-0Kxx	4x2.5	44	1

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1)]	Connector size [2)]
1FW6130-xxB05-1Jxx	4x2.5	44	1
1FW6130-xxB07-0Kxx	4x2.5	44	1
1FW6130-xxB07-1Jxx	4x2.5	44	1
1FW6130-xxB10-1Jxx	4x2.5	44	1
1FW6130-xxB10-2Jxx	4x4.0	49.2	1.5
1FW6130-xxB15-1Jxx	4x2.5	44	1
1FW6130-xxB15-2Jxx	4x4.0	49.2	1.5
1FW6150-xxB05-1Jxx	4x2.5	44	1
1FW6150-xxB05-4Fxx	4x10.0	72.8	1.5
1FW6150-xxB07-2Jxx	4x4.0	49.2	1.5
1FW6150-xxB07-4Fxx	4x10.0	72.8	1.5
1FW6150-xxB10-2Jxx	4x4.0	49.2	1.5
1FW6150-xxB10-4Fxx	4x10.0	72.8	1.5
1FW6150-xxB15-2Jxx	4x10.0	72.8	1.5
1FW6150-xxB15-4Fxx	4x10.0	72.8	1.5
1FW6160-xxB05-1Jxx	4x2.5	44	1
1FW6160-xxB05-2Jxx	4x4.0	49.2	1.5
1FW6160-xxB05-5Gxx	4x16.0	89.2	1.5
1FW6160-xxB07-1Jxx	4x2.5	44	1
1FW6160-xxB07-2Jxx	4x4.0	49.2	1.5
1FW6160-xxB07-5Gxx	4x16.0	89.2	1.5
1FW6160-xxB07-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6160-xxB10-1Jxx	4x2.5	44	1
1FW6160-xxB10-2Jxx	4x4.0	49.2	1.5
1FW6160-xxB10-5Gxx	4x16.0	89.2	1.5
1FW6160-xxB10-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6160-xxB10-2Pxx	3x(1x50) + M10 f. PE (1x25)*)	54.6	-
1FW6160-xxB15-2Jxx	4x4.0	49.2	1.5
1FW6160-xxB15-5Gxx	4x16.0	89.2	1.5
1FW6160-xxB15-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6160-xxB15-2Pxx	3x(1x50) + M10 f. PE (1x25)*)	54.6	-
1FW6160-xxB15-0Wxx	3x(1x70) + M10 f. PE (1x35)*)	61.5	-
1FW6160-xxB20-5Gxx	4x16.0	89.2	1.5
1FW6160-xxB20-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1])	Connector size [2])
1FW6160-xxB20-2Pxx	3x(1x50) + M10 f. PE (1x25)*)	54.6	-
1FW6160-xxB20-0Wxx	3x(1x70) + M10 f. PE (1x35)*)	61.5	-
1FW6190-xxB05-1Jxx	4x2.5	44	1
1FW6190-xxB05-2Jxx	4x4.0	49.2	1.5
1FW6190-xxB05-5Gxx	4x16.0	89.2	1.5
1FW6190-xxB07-1Jxx	4x2.5	44	1
1FW6190-xxB07-2Jxx	4x4.0	49.2	1.5
1FW6190-xxB07-5Gxx	4x16.0	89.2	1.5
1FW6190-xxB07-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6190-xxB10-1Jxx	4x2.5	44	1
1FW6190-xxB10-2Jxx	4x4.0	49.2	1.5
1FW6190-xxB10-5Gxx	4x16.0	89.2	1.5
1FW6190-xxB10-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6190-xxB10-2Pxx	3x(1x50) + M10 f. PE (1x25)*)	54.6	-
1FW6190-xxB15-2Jxx	4x4.0	49.2	1.5
1FW6190-xxB15-5Gxx	4x16.0	89.2	1.5
1FW6190-xxB15-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6190-xxB15-2Pxx	3x(1x50) + M10 f. PE (1x25)*)	54.6	-
1FW6190-xxB15-0Wxx	3x(1x70) + M10 f. PE (1x35)*)	61.5	-
1FW6190-xxB20-5Gxx	4x16.0	89.2	1.5
1FW6190-xxB20-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6190-xxB20-2Pxx	3x(1x50) + M10 f. PE (1x25)*)	54.6	-
1FW6190-xxB20-0Wxx	3x(1x70) + M10 f. PE (1x35)*)	61.5	-
1FW6230-xxB05-1Jxx	4x2.5	44	1
1FW6230-xxB05-2Jxx	4x4.0	49.2	1.5
1FW6230-xxB05-5Gxx	4x16.0	89.2	1.5
1FW6230-xxB07-1Jxx	4x2.5	44	1
1FW6230-xxB07-2Jxx	4x4.0	49.2	1.5
1FW6230-xxB07-5Gxx	4x16.0	89.2	1.5
1FW6230-xxB07-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6230-xxB10-2Jxx	4x4.0	49.2	1.5

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1)]	Connector size [2)]
1FW6230-xxB10-5Gxx	4x16.0	89.2	1.5
1FW6230-xxB10-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6230-xxB10-2Pxx	3x(1x35) + M10 f. PE (1x25)*)	48.3	-
1FW6230-xxB15-4Cxx	4x6.0	59.6	1.5
1FW6230-xxB15-5Gxx	4x16.0	89.2	1.5
1FW6230-xxB15-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6230-xxB15-2Pxx	3x(1x35) + M10 f. PE (1x25)*)	48.3	-
1FW6230-xxB15-0Wxx	3x(1x70) + M10 f. PE (1x35)*)	61.5	-
1FW6230-xxB20-5Gxx	4x16.0	89.2	1.5
1FW6230-xxB20-8Fxx	3x(1x25) + M10 f. PE (1x25)*)	40.5	-
1FW6230-xxB20-2Pxx	3x(1x35) + M10 f. PE (1x25)*)	48.3	-
1FW6230-xxB20-0Wxx	3x(1x70) + M10 f. PE (1x35)*)	61.5	-
1FW6290-xxB07-5Gxx	4x16.0	89.2	1.5
1FW6290-xxB07-0Lxx	3x(1x35)+1x25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB07-2Pxx	3x(1x70)+1x35	R(70) = 61.5 R(35) = 48.3	-
1FW6290-xxB11-7Axx	4x16.0	89.2	1.5
1FW6290-xxB11-0Lxx	3x(1x35)+1x25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB11-2Pxx	3x(1x70)+1x35	R(70) = 61.5 R(35) = 48.3	-
1FW6290-xxB15-7Axx	4x16.0	89.2	1.5
1FW6290-xxB15-0Lxx	3x(1x35)+1x25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB15-2Pxx	3x(1x70)+1x35	R(70) = 61.5 R(35) = 48.3	-

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1])	Connector size [2])
1FW6290-xxB20-0Lxx	3x(1x35)+1x25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB20-2Pxx	3x(1x70)+1x35	R(70) = 61.5 R(35) = 48.3	-

[1]) Power cable fixed; [2]) Applies to motors with connector

*) PE cable to be connected separately; not included in scope of delivery

Table 5- 7 Specifications for the signal cable on the stator

Motor type	No. of cores (signal cores) x cross-section + no. of cores (PE) x cross-section in mm²	Min. bending radius in mm [1])	Connector size [2])
1FW6xxx-xxxxx-xxxx	6 x 0.5 + 1 x 1.0	48.4	M17

[1]) Signal cable fixed; [2]) Applies to motors with connector

5.8 Checking the work carried out

Checking the installation work

Once installation has been carried out, make sure that the rotor can move without hindrance. Before doing so, remove all tools and objects from the area of the rotor and air gap.

⚠ DANGER

Risk of electric shock!

A voltage is induced when the rotor is rotated by hand. Before the motor is rotated, the power connections must be properly connected or insulated.

- The mounted rotary axes must always be able to move without hindrance.
  Examples of axes that cannot necessarily be checked by hand:
  - Large axes with a high friction torque
  - Blocking in a current-free state
  - Uneven weight forces

  ⚠ DANGER

  Risk if axes moves in an uncontrolled manner.

  Take care when removing a block or releasing a brake when the motor when is disconnected from the power supply and in an uncontrolled state.

- All cables must be routed and secured in such a way that they cannot be bent, pressed against rotating parts or damaged in any other way.
- Coolant supply ducts must be easily accessible and the coolant must be allowed to flow freely.

Connection

6

6.1 Mechanically connecting the water cooling system

The connectors can generally be installed using standard tools.

The pressure losses of the individual cooling components and the piping must be checked beforehand and compared with the capacity of the heat-exchanger unit.

6.1.1 Motors with a cooling jacket

Cooler connection for motors with a cooling jacket

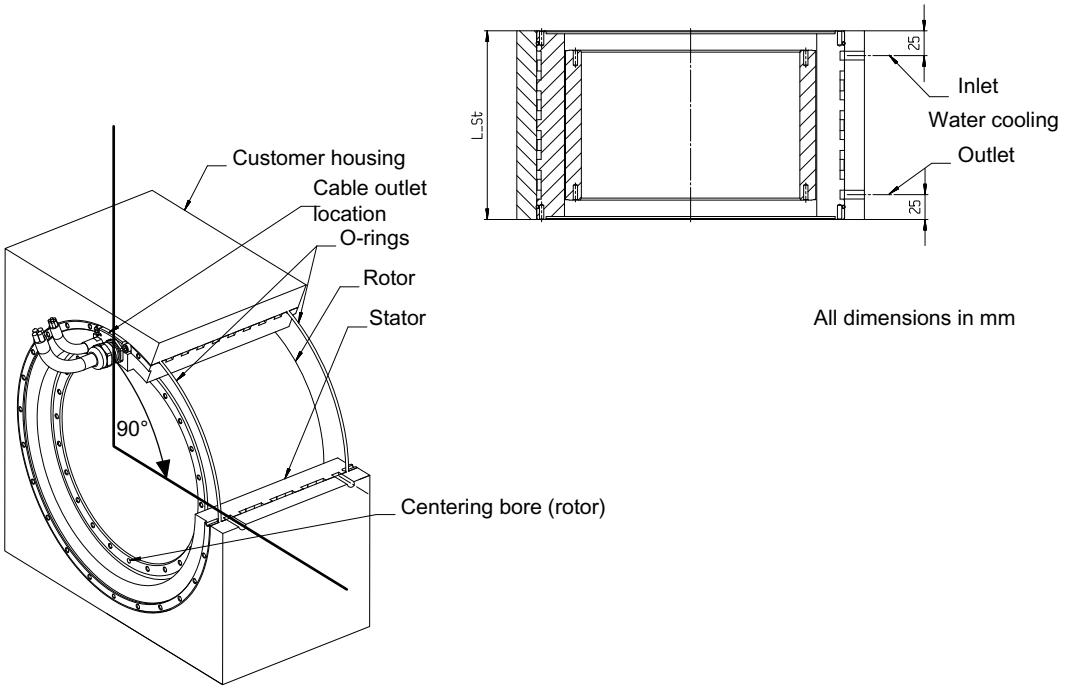


Figure 6-1 Cooler connection for 1FW609 and 1FW613 (example)

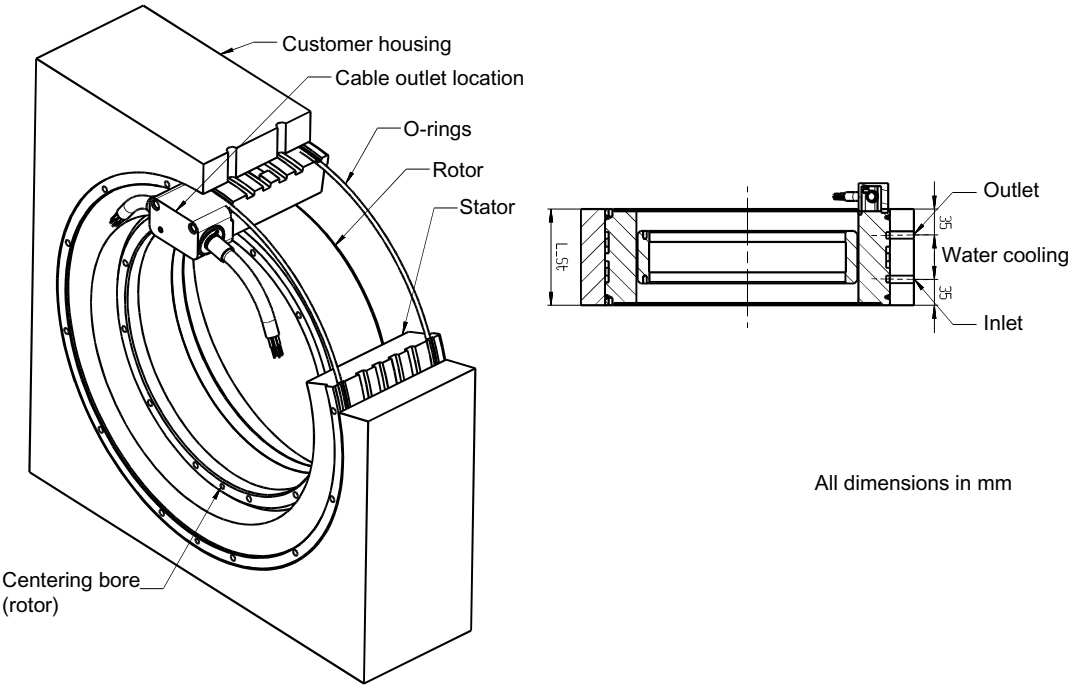


Figure 6-2 Cooler connection for 1FW615 (example)

6.1.2 Motors with integrated cooling

Cooler connection for motors with integrated cooling

The cooler can be directly connected using the appropriate fittings (1/8" pipe thread DIN 2999). 1FW605 and 1FW606 motors are connected to the cooling system using plug connections that can be simply released. For motors that are equipped with a precision and main cooler, each cooling circuit can be separately fed and controlled.

Suitable connectors are required for connecting the hoses.

Note

Keep the pressure loss for motors with precision and main cooler low

In order to keep the pressure loss low, connect the precision and main coolers in parallel immediately before the cooler connections using a cooling connection adapter. Further, do not use excessively thin hoses directly after the cooling connection adapter.

The optional cooling connection adapter that can be ordered, can be connected via a 1/4" pipe thread (DIN 2999) either axially or radially (on the outside).

Note

Cooling principle

In a series connection, the coolant must flow through the precision cooler first and then the main cooler. Otherwise, the coolant already warmed up in the main cooler would enter the precision cooler and have a negative impact on the cooling effect there.

Every cooler has an inlet and discharge. As far as cooling is concerned, it doesn't make any difference in which direction the coolant flows through the cooling circuit. Which connection is used as inlet and which as discharge can be freely selected.

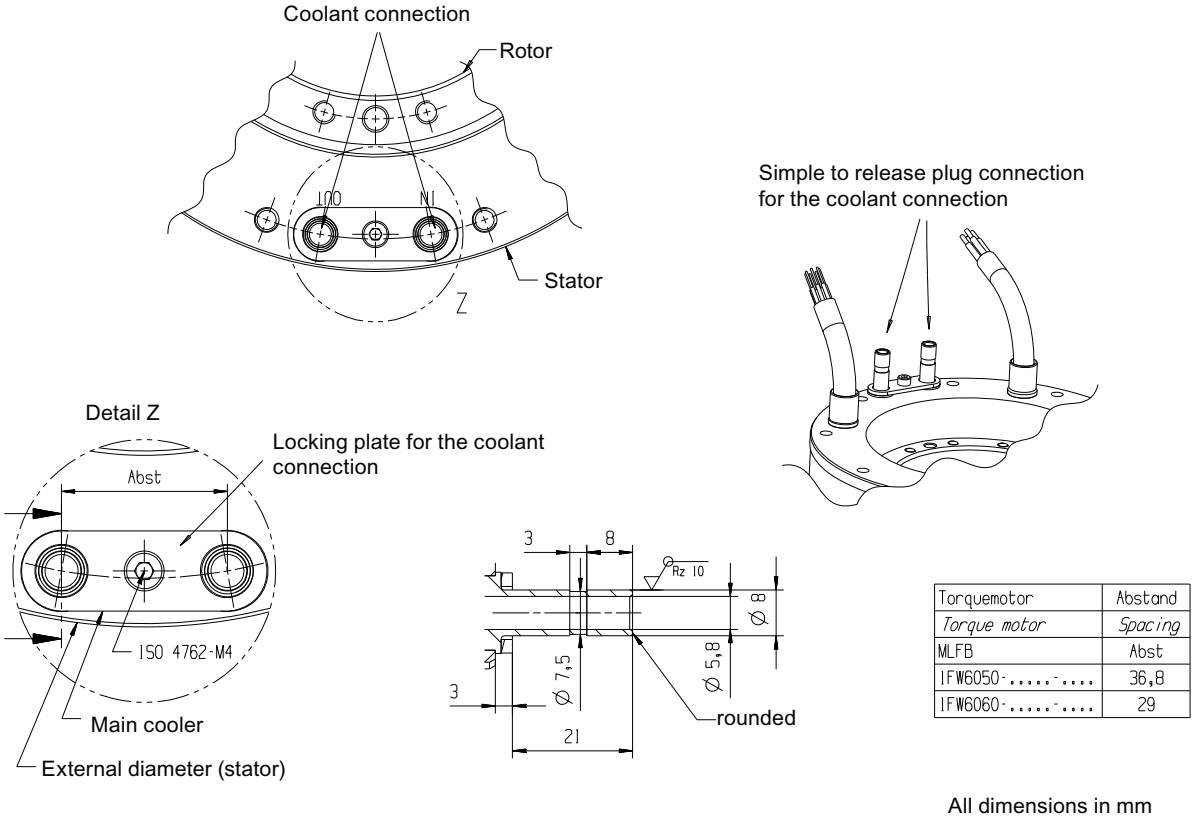
⚠ WARNING

Most of the motors have a permanently mounted cooling connection plate, which may not be removed. The motor may be destroyed if the cooling connection plate is removed.

⚠ CAUTION

It is only permissible to remove the locking plate for the cooling connection for 1FW605 and 1FW606 motors for service purposes, and this must be done by a Siemens service center employee.

Cooler connection for 1FW605 and 1FW606



Torquemotor	Abstand
Torque motor	*Spacing*
MLFB	Abst
1FW6050-.....-....	36,8
1FW6060-.....-....	29

Figure 6-3 Axial cooler connection 1FW605 and 1FW606

Cooler connection for 1FW616, 1FW619 and 1FW623

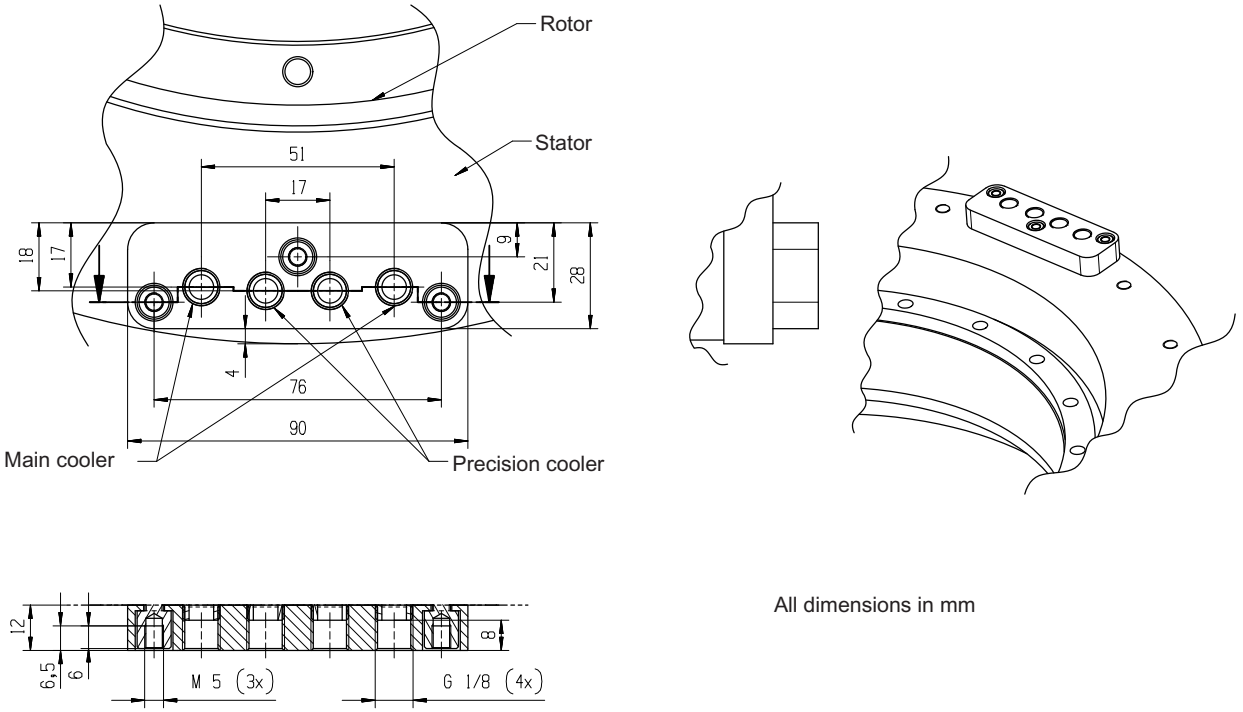


Figure 6-4 Cooling connection plate for 1FW616, 1FW619, 1FW623

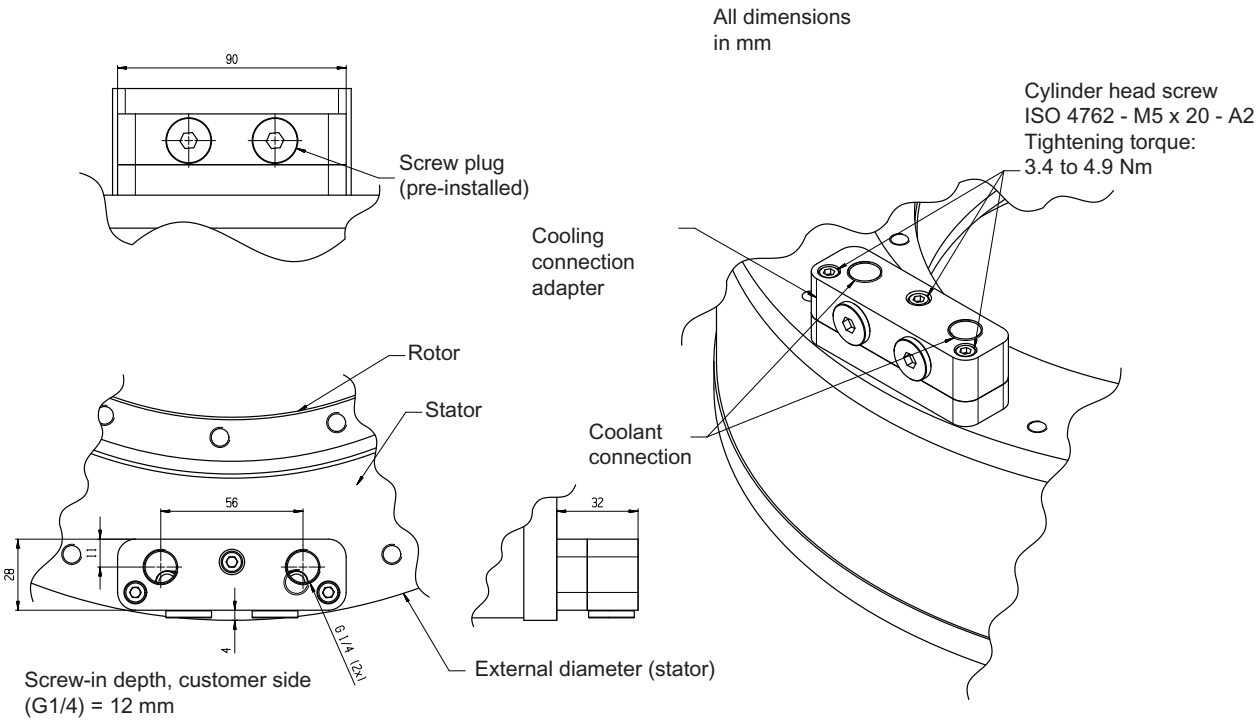


Figure 6-5 Axial cooler connection with cooling connection adapter (option) for 1FW616, 1FW619, 1FW623

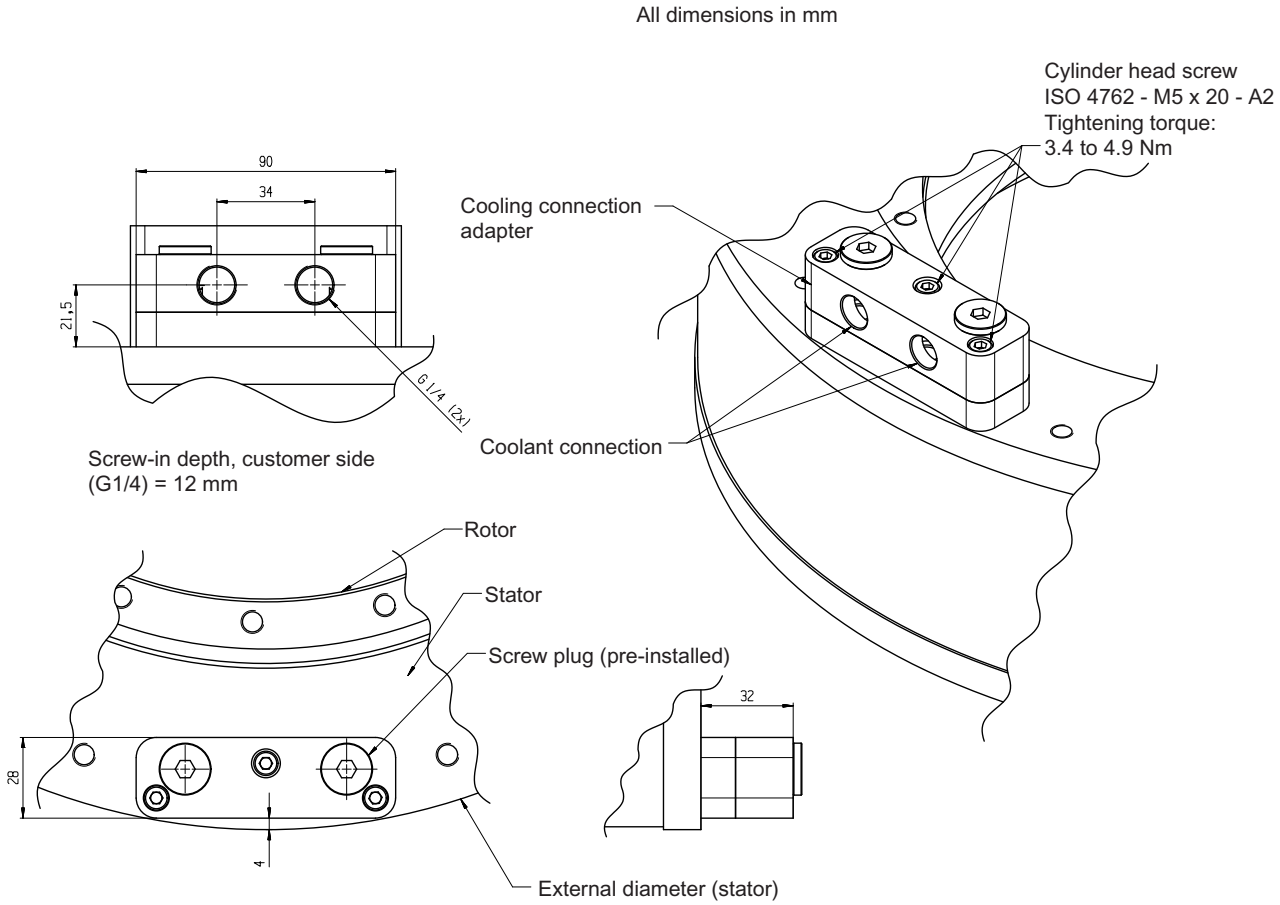


Figure 6-6 Outer radial cooler connection with cooling connection adapter (option) for 1FW616, 1FW619, 1FW623

Cooler connection for 1FW629

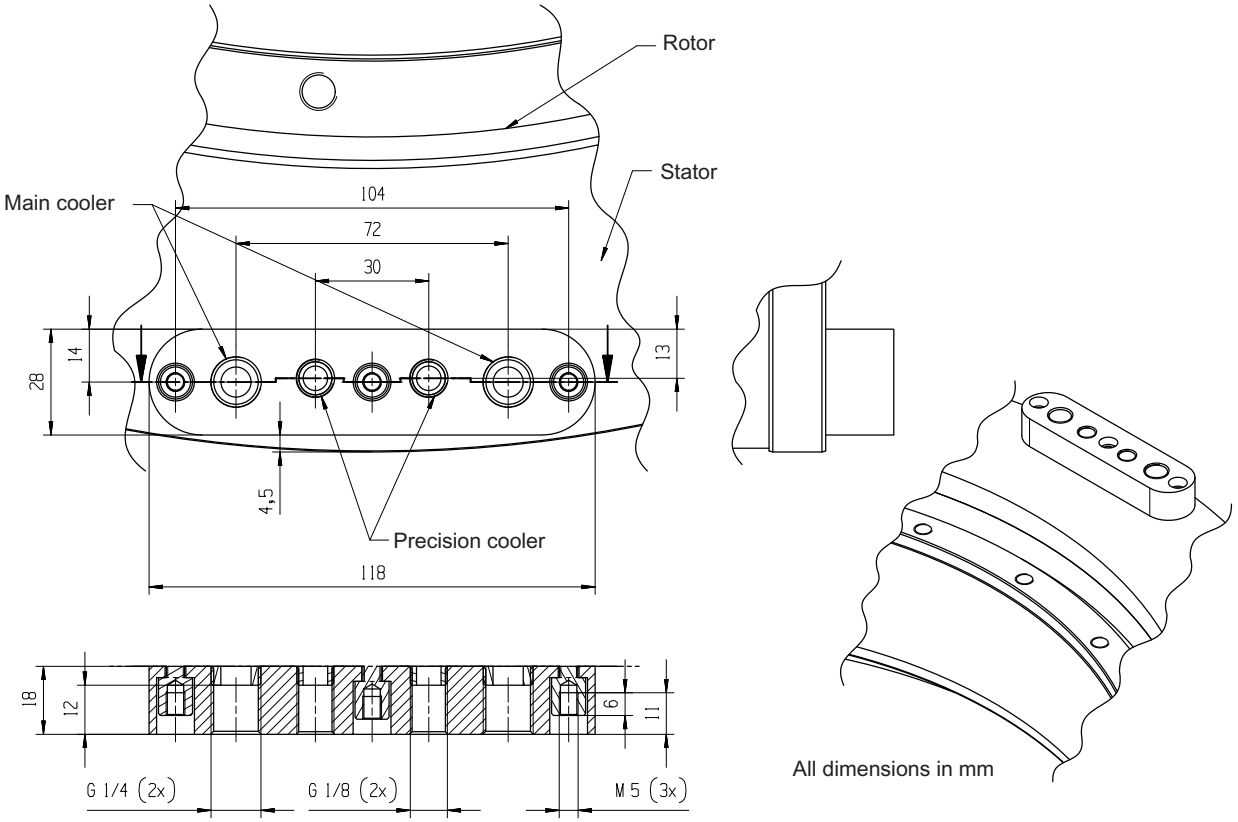


Figure 6-7 Cooling connection plate for 1FW629

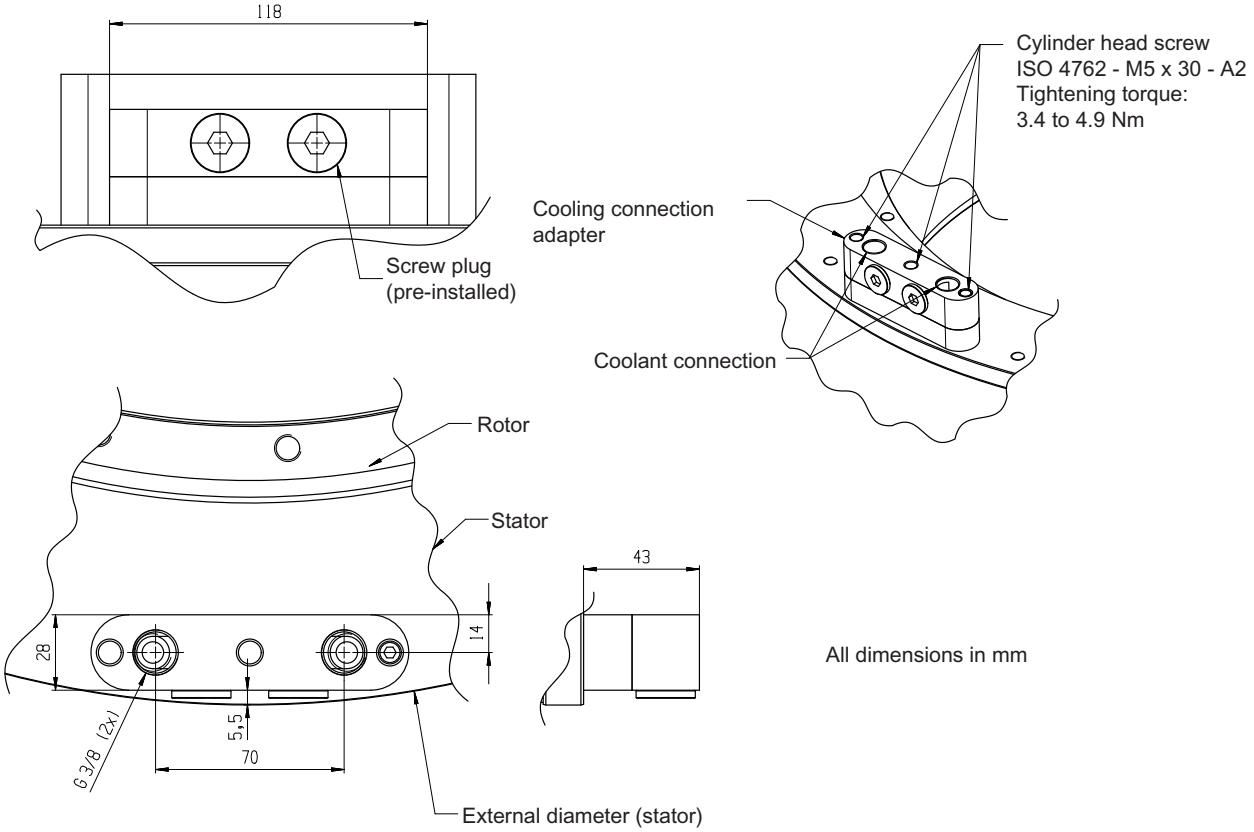


Figure 6-8 Axial cooler connection with cooling connection adapter (option) for 1FW629

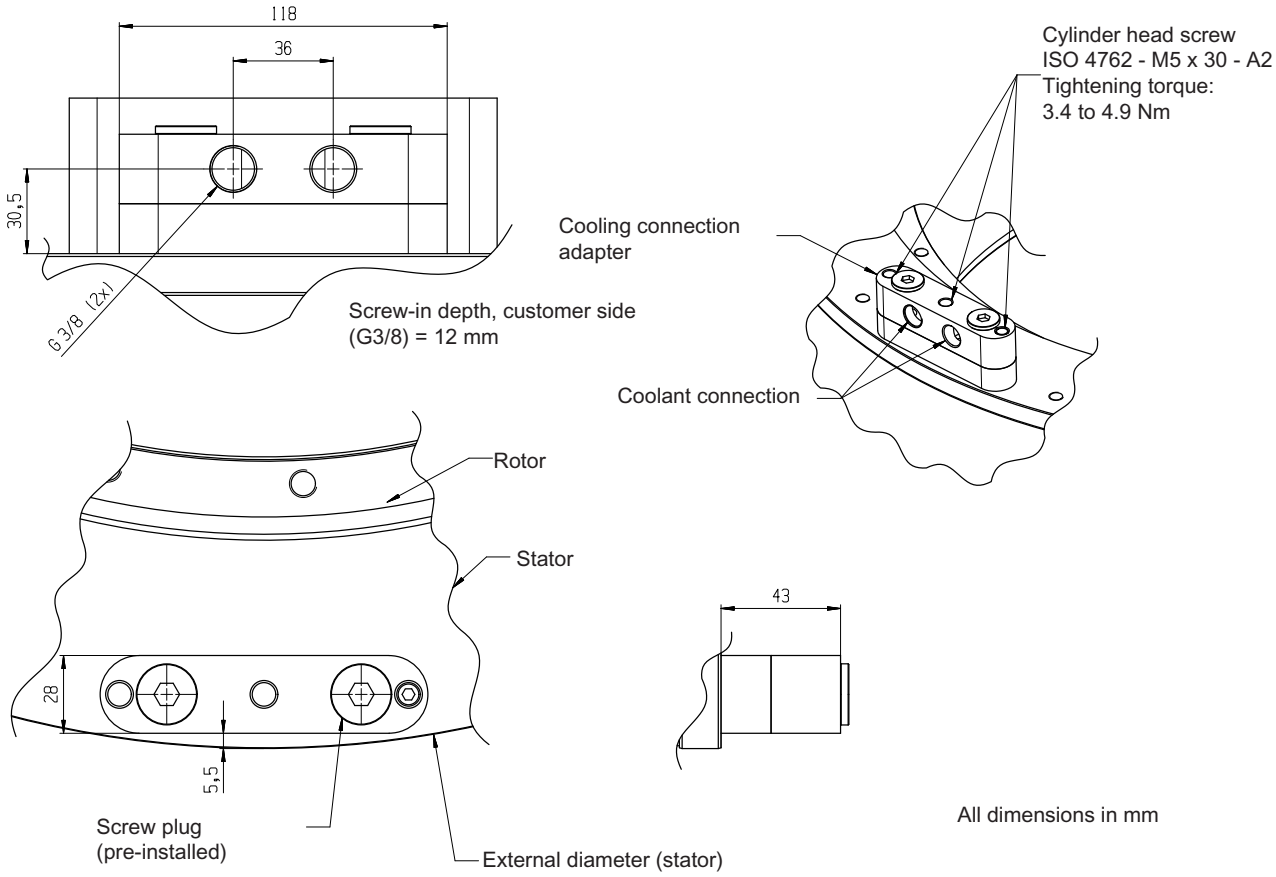


Figure 6-9 Outer radial cooler connection with cooling connection adapter (option) for 1FW629

6.2 Electrical connection

6.2.1 Safety instructions

⚠ DANGER

Risk of death, serious personal injury (electrical shock), and/or material damage if direct drives are connected incorrectly.

The motors must be connected in accordance with the circuit diagram provided in this documentation, and must be fed with a sinusoidal current. They must not be connected directly to the three-phase supply because this will damage them.

See also the documentation for the drive system.

⚠ DANGER

Components in electrical devices may be under hazardous voltage. There is a risk of electric shock!

A hazardous voltage is present at the motor terminals when the rotor moves.

All work involving the electrics must only be carried out by skilled personnel when the device is disconnected from the power supply and the motor is at a standstill.

The regulations for working on electrical installations must be strictly observed!

In particular, the following safety rules for working on electrical installations in accordance with DIN EN 50110-1/BGV A3 must be observed:

- Disconnect the system.
- Protect against reconnection.
- Make sure that the equipment is de-energized.
- Ground and short-circuit.
- Cover or enclose adjacent components that are still live.

Only work on electrical devices when they are de-energized. The protective conductor should be the first thing to be connected and the last to be disconnected.

All cables in safety extra-low voltage circuits (PELV), for example temperature sensor cables, must meet the requirements of protective separation in accordance with DIN EN 61800-5-1.

⚠ WARNING

The connection block on the motor for the motor supply cables (power and signal cables) must never be removed.

This could destroy the motor.

The cables for the power connection are brought out at the front of the stator (B flange). The open cable ends must be connected in a terminal box, which must be provided by the machine manufacturer. Sufficient installation space must be provided in the axes construction. Standard MOTION–CONNECT cables, which are available with the standard range of accessories for the drive system, can be used from this EMC-compliant terminal box (minimum degree of protection: IP54).

⚠ DANGER

Risk of electric shock!

For a fault in the motor, a voltage up to the magnitude of the converter DC link voltage can be present at the connector for the temperature sensors or at the cable ends of the temperature sensors.

For temperature sensor cables (PTC and KTY), the directives for protective separation to power circuits according to DIN EN 61800-5-1 (previously protective separation according to DIN EN 50178) must be implemented outside the motor.

NOTICE

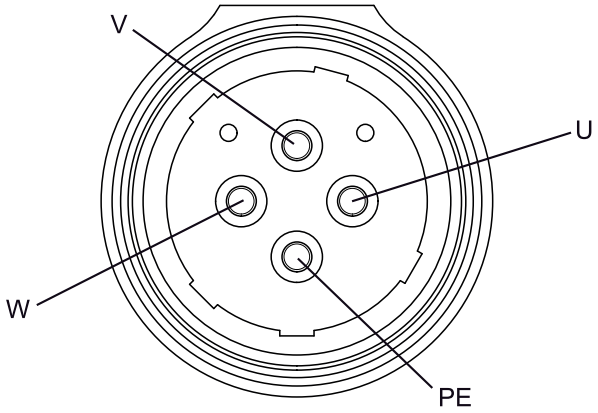
Avoid damaging cables

Observe the permissible acceleration rates for the cables. In particular, this applies when the cables are routed via a tow chain.

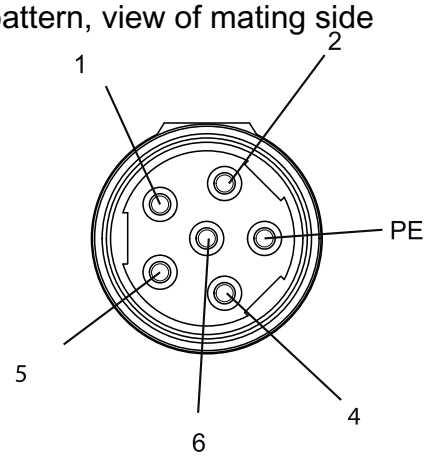
To prevent wear and tear, the cables fixed permanently to the motor should not be routed via a tow chain because they cannot be replaced if they are damaged.

6.2.2 PIN assignments for the connectors

Power connector size 1.5
Pole pattern, view of mating side



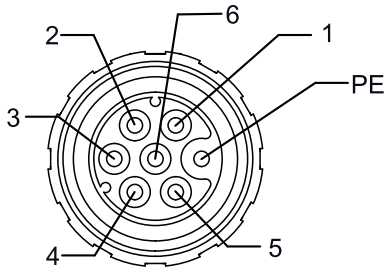
Power connector size 1.0
Pole pattern, view of mating side



Electrical connector pin assignments

PIN	1FW6
1	U
2	V
PE	PE
4	-
5	-
6	W

Signal connector M17
Pole pattern, view of mating side



Electrical connector pin assignments

PIN	1FW6
1	-1R2: KTY -
2	+1R1: KTY +
3	1TP1: PTC 130 °C
4	1TP2: PTC 130 °C
5	2TP1: PTC 150 °C *
6	2TP2: PTC 150 °C *
⏚	PE

* is not evaluated by the SME9x

Figure 6-10 PIN assignments for the connectors

6.2.3 Power connection

Table 6- 1 Conductor assignment power connection

Color	Connection
green/yellow	PE
bk1 or 1	U
bk2 or 2	V
bk3 or 3	W

6.2.4 Temperature sensor connection

PTC elements must be evaluated for thermal motor protection. On this topic, refer to the Configuration Manual "1FW6 built-in torque motors".

Note

Carefully note the polarity when connecting the KTY!

Table 6- 2 Core assignment of the temperature sensors (PTC, KTY)

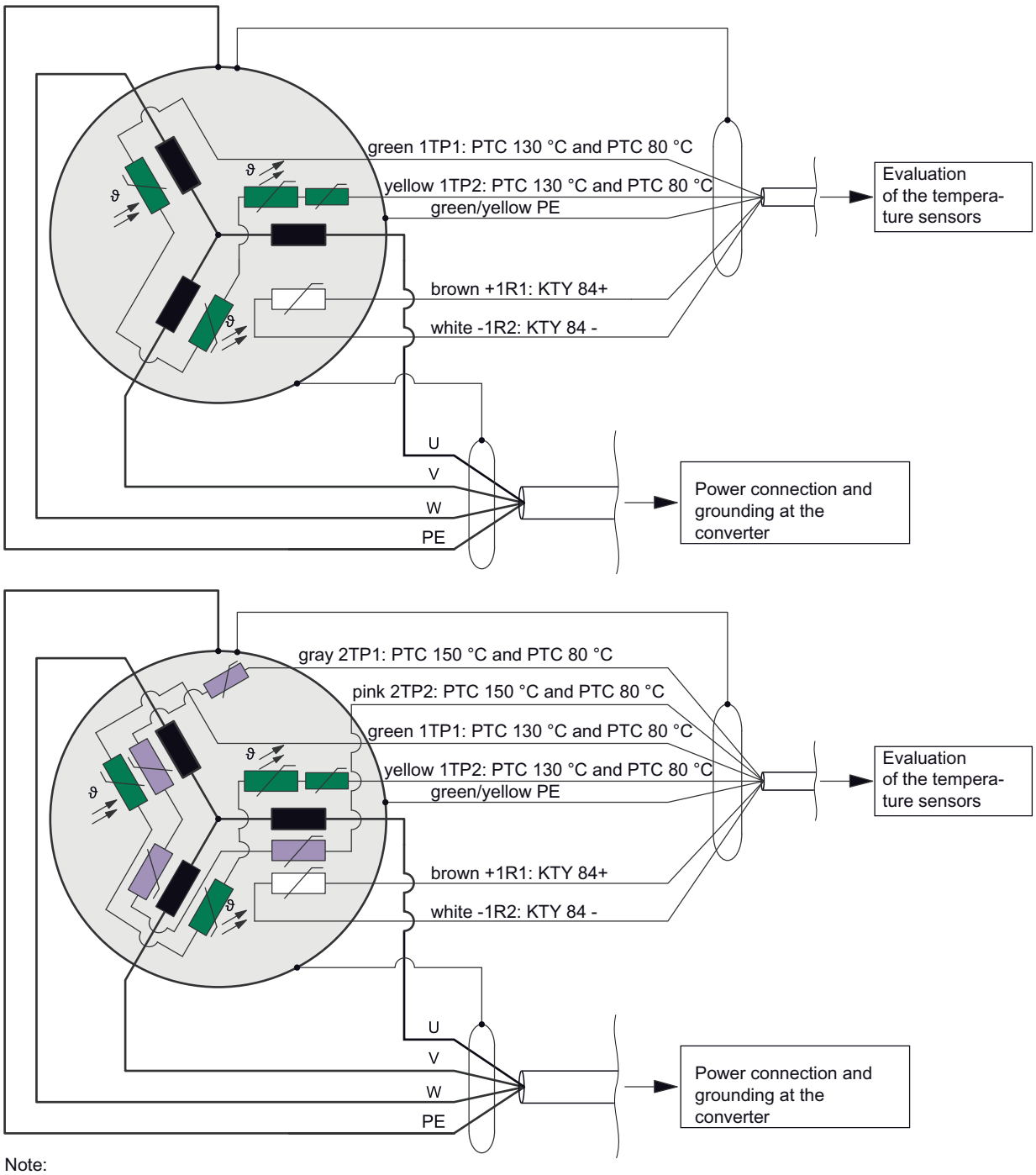
Core assignment for motors with signal cable without connector	Sensor contact for 1FW6
white	-1R2: KTY-
brown	+1R1: KTY+
green	1TP1: PTC 130 °C
yellow	1TP2: PTC 130 °C
gray	2TP1: PTC 150 °C
pink	2TP2: PTC 150 °C
green/yellow	PE

Table 6- 3 Types of temperature monitoring circuits

Size	Temp-S (PTC 130 °C), Temp-F (KTY 84)	Temp-S (PTC 130 °C and PTC 150 °C), Temp-F (KTY 84)
1FW605	X	
1FW606	X	
1FW609		X
1FW613		X
1FW615		X
1FW616		X
1FW619		X
1FW623		X
1FW629		X

6.2.5 1FW6 circuit diagram

1FW6 built-in torque motors



Note:
- PTC: Characteristic to DIN VDE 0660 Part 303, DIN 44081, DIN 44082
- The shutdown circuit must be carefully checked before the motor is actually commissioned to ensure that it correctly shuts down!

Figure 6-11 Circuit diagram: at the top for 1FW605 and 1FW606, at the bottom for 1FW609 to 1FW629

6.2.6 Shielding, grounding, and equipotential bonding

Important notes regarding shielding, grounding and equipotential bonding

Correct installation, correctly connecting cable shields and protective conductors is very important, not only for the safety of personnel but also for the effect on interference emission and interference immunity.

⚠ DANGER

Risk of electric shock!

Hazardous touch voltages can be present at unused cores and shields if they have not been grounded or insulated.

Cable shields must be connected to the respective housing using clamps or suitable terminal or screwed connectors through the largest possible surface area.

Unused cores of unshielded or shielded cables and their shields must either be connected at one end to the grounded housing potential or they must be insulated. The insulation must be able to withstand the rated voltage.

Further, unshielded or incorrectly shielded cables can lead to faults in the drive – particularly the encoder – or in external devices, for example.

Electrical charges that are the result of capacitive cross coupling are discharged by connecting the cores and shields.

NOTICE

High leakage currents may damage other devices if the motor PE is not directly connected to the power unit.

Connect the motor protective conductor (PE) directly at the power unit.

NOTICE

High leakage currents may damage other devices if the motor power cable shield is not directly connected to the power unit.

Connect the power cable shield at the shield connection of the power module.

Note

Apply the EMC installation guideline of the converter manufacturer. For Siemens converters, this is available under Order No. 6FC5297-□AD30-0AP□.

Note

With 1FW6 built-in torque motors featuring single-core power cables without a PE cable, a connection point is provided for the PE. A separate PE cable with the specified cross-section must be connected to this to ensure a direct connection to the power unit. For the cross-section specifications, refer to the table "Data of the power cable at the stator" in the Chapter "Notes on routing cables".

6.2.7 Defining the direction of rotation

Direction of rotation

The rotor for the built-in torque motor rotates clockwise if the built-in torque motor is connected to phase sequence U, V, W. You can see this when you look at the A flange of the motor.

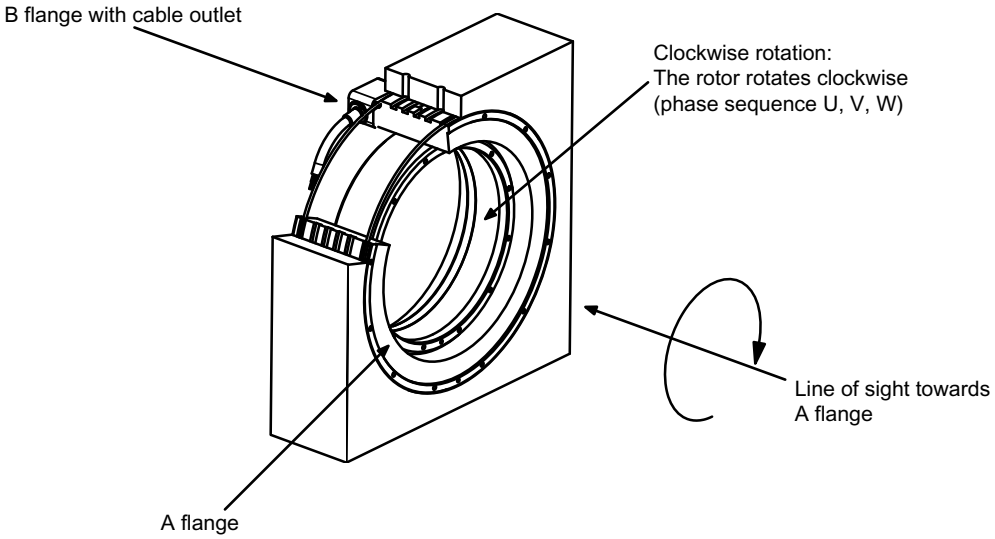


Figure 6-12 Line of sight for determining the direction of rotation

Commissioning 7

The motor can only be commissioned when it has been installed in a machine and integrated in a functioning system. The commissioning documentation of all the system components, e.g. the documentation of the drive, encoder and cooling system, must be taken into account for the commissioning. The appropriate configuration manual and these operating instructions contain important information for the commissioning of the motor.

7.1 Safety instructions for commissioning

⚠ DANGER

Risk of death, serious personal injury, and/or material damage if a machine that does not fulfill the recognized safety requirements is commissioned.

Plants and machines with converter-fed low-voltage three-phase motors must fulfill the protection requirements of the EMC Directive 2004/108/EC. The plant engineer is responsible for ensuring that installation is carried out in an EMC-compliant manner. The signal and power cables must be shielded. Refer to the EMC installation guideline (order designation 6FC5297-□AD30-0AP□) issued by the converter manufacturer.

⚠ DANGER

Unexpected movements of the motor may result in a risk of death, serious personal, and/or material damage.

Danger from rotating rotor. Never carry out work in the vicinity of rotating parts when the machine is switched on.

Keep persons away from rotating parts and areas where there is a danger of crushing.

Ensure that the rotors can rotate without hindrance.

Check the commutation setting before switching on the machine. Note also the commissioning instructions issued for the drive system.

Limit the motor currents.

Set low values for speed limiting.

Monitor limit positions.

⚠ WARNING

Incorrect commutation can result in uncontrolled motor movements.

When installing and replacing an encoder, make sure that the commutation setting is correct. The procedures involved here must only be carried out by trained personnel.

⚠ WARNING

The surface temperature of the motors may be more than 100 °C (212 °F). Risk of burns

Make sure that the cooling system (if available) is working properly.

Do not touch the motor during/directly after use.

Display the "Hot Surface Do Not Touch" (D-W026) warning sign clearly in the vicinity of the motor.

Temperature-sensitive parts (electric cables, electronic components) may not be placed on hot surfaces.

NOTICE

The motor may overheat without temperature protection and be destroyed.

Check whether the temperature protection is effective before (!) switching on the DC link voltage for the first time!

⚠ WARNING

During torque motor operation, the rotor must not exceed a temperature of 120 °C otherwise the permanent magnet may become demagnetized.

This must be ensured during initial commissioning by carrying out the appropriate checks.

Special attention should be paid here to non-uniform current loads during standstill or operation with short, cyclic rotation because this can generate extremely high, localized temperatures.

⚠ WARNING

For inclined and horizontal axes, the load may be reduced in an uncontrolled manner if the center of gravity is outside the rotary axes when the system is disconnected from the power supply. At certain times the axes angle cannot be monitored.

Note

In systems where direct drives are used on controlled infeeds, electrical oscillations can occur with respect to ground potential. These oscillations are, among other things, influenced by:

- The lengths of the cables
- The rating of the infeed/regenerative feedback module
- The type of infeed/regenerative feedback module (particularly when an HFD commutating reactor is already present)
- The number of axes
- The size of the motor
- The winding design of the motor
- The type of line supply
- The place of installation

The oscillations lead to increased voltage loads and may damage the main insulation! We thus recommend using an HFD commutating reactor with damping resistance for damping the oscillations. For specific details, refer to the documentation of the drive system being used or contact your local Siemens office.

Note

Please note the following if the motor is to be fed from a SINAMICS S120:

The corresponding Active Interface Module or the appropriate HFD line reactor must be used to operate the Active Line Module controlled infeed unit.

7.2 Checklists

Checklists for commissioning 1FW6 built-in torque motors

Before starting any work, get to know and understand the safety notes and observe the following checklists.

Table 7- 1 Checklist (1) - General checks

Check	OK
Are all of the necessary components of the configured drive line-up available, correctly dimensioned, installed and connected?	
Are the manufacturer documentation for the system components (e.g. drive system, encoder, cooling system, brake) and the Configuration Manual "SIMOTICS T-1FW6 built-in torque motors" available?	
If the 1FW6 built-in torque motor is to be fed from a SINAMICS S120 drive system: Is the following, current SINAMICS documentation available? • SINAMICS S120 Commissioning Manual • Getting Started S120 • S120 Function Manual • S120/150 List Manual	
If the 1FW6 built-in torque motor is to be fed from a SINAMICS S120 drive system: Was the Chapter "Checklists for commissioning SINAMICS S" in the SINAMICS S120 Commissioning Manual carefully observed?	
Is the motor type to be commissioned known? (e.g. 1FW6 _ _ _ – _ _ _ _ _ – _ _ _ _)	
If the motor is to be fed from a SINAMICS S120 drive system: If it involves a "third-party motor", are the following motor data known as a minimum? (A "third-party motor" is a motor that is not saved as standard in the Siemens commissioning software.) • Rated motor current • Rated motor speed • Motor pole pair number • Motor torque constant • Maximum motor speed • Maximum motor current • Motor limit current • Motor moment of inertia • Motor stator resistance, cold • Motor stator leakage inductance	
Are the environmental conditions in the permissible range?	

Table 7- 2 Checklist (2) - Checks regarding the mechanical system

Check	OK
Is the motor already correctly mounted according to the motor manufacturer's data and ready to be powered up?	
Were the transport locks removed according to the assembly chapter of the Configuration Manual "SIMOTICS T-1FW6 built-in torque motors"?	
Is the axis free to move over the complete speed range?	
Have all the screws been tightened to the specified torque?	
Have the stator and rotor been centered according to the motor manufacturer's data?	
If a motor holding brake is being used, is this functioning correctly?	
Has the encoder been correctly mounted and adjusted according to the manufacturer's data? Important information on the encoder is provided in the Configuration Manual "1FW6 built-in torque motors".	
Has the cooling system required for a liquid-cooled motor been connected according to the manufacturer's data, and is it functioning correctly?	
Is the coolant in compliance with the requirements according to the Chapter "Coolant" in the Configuration Manual " SIMOTICS T-1FW6 built-in torque motors"?	
Were the cooling circuits purged before being filled with coolant?	
Is it ensured that the permissible cooling circuit pressure will not be exceeded (on this topic, refer to "Technical features" in the Configuration Manual "SIMOTICS T-1FW6 built-in torque motors")?	
Are moving cables correctly routed in a tow chain?	
Have the power cables been properly connected to the component terminals with the specified torque?	
Have measures been taken to relieve strain on the cables?	

Table 7- 3 Checklist (3) - Checks regarding the electrical system

Check	OK
Has all wiring work been successfully completed?	
Is the protective conductor correctly connected?	
Is the ground for the motors directly connected to the ground for the power modules (short distance to avoid high discharge currents)?	
Are all connectors correctly plugged in and screwed in place?	
Are the motors connected with shielded power cables?	
Are the power cable shields connected as closely as possible to the terminal box across a wide area?	
Are all cable shields connected to the respective housings through the largest possible surface area?	
Have the control cables been connected in accordance with the required interface configuration and the shield applied?	
Are the motor power cables correctly connected to the power module with the UVW phase sequence (clockwise rotating field)?	

Check	OK
Do the temperature monitoring circuits fulfill the specifications of protective separation? Important additional information on the temperature monitoring circuits Temp-S and Temp-F are provided in the Configuration Manual "SIMOTICS T-1FW6 built-in torque motors".	
Before commissioning and switching on the DC link voltage for the first time, have you checked the temperature monitoring circuits to ensure that they correctly trip?	
Has the encoder been correctly connected?	
Have the digital and analog signals been routed using separate cables?	
Has the distance from power cables been observed?	
Have the line-side and motor-side power cables been dimensioned and routed in accordance with the environmental and routing conditions?	
Have the maximum permissible cable lengths between the frequency converter and the motor (depending on the type of cables used) been observed?	

7.3 Checking the insulation resistance

Notes for checking the insulation resistance

⚠ WARNING

An insulation resistance inspection under high-voltage conditions can damage the motor insulation!

If insulation resistance inspections need to be carried out on a machine/plant with direct drives or directly on the motors (e.g. installation inspection, preventive maintenance, troubleshooting), only inspection devices that comply with DIN EN 61557-1, DIN EN 61557-2, and DIN EN 61010-1 (or the relevant IEC standards) can be used.

The inspection may only be carried out with a maximum direct voltage of 1000 V for a maximum time of 60 s! The test voltage should be measured with respect to ground or the motor enclosure. If a higher DC or AC voltage is necessary for the purposes of inspecting the machine/plant, you must arrange the inspection with your local Siemens office.

Please follow the operating instructions for the inspection device!

Inspections of the insulation resistance on individual motors must always be carried out as follows:

1. Connect all winding and temperature sensor connectors with each other; inspection voltage not to exceed 1000 VDC, 60 s against PE connection.
2. Connect all temperature sensor connectors to the PE connector and all winding connectors with each other; the inspection voltage must not exceed 1000 VDC, 60 s, winding against PE connector.

Each insulation resistance must be at least 10 MΩ, otherwise the motor insulation is defective.

⚠ DANGER

Risk of electric shock!

During and immediately after the measurement, in some instances, the terminals are at hazardous voltage levels, which can result in death if touched.

Never touch the terminals during or immediately after measurement.

7.4 Cooling

⚠ DANGER

If work is carried out on the motor immediately after it has been in operation, there is a risk of burns if you come into contact with hot surfaces. The cooling water temperature can also increase after the motor has already been switched off.

To cool the motor down to the level of the inlet temperature T_{INLET}, the cooler must remain in operation for at least 30 minutes after the motor has been switched off. If the cooler is switched off, however, it takes significantly longer for the motor to cool down. This depends to a large extent on the installation situation.

⚠ DANGER

Risk of burns!

Risk of pressure surges: Do not switch on the cooling if the motor was operated without a cooler beforehand. A significant build-up of steam can cause burns or destroy the motor.

When you open the cooling circuit, you risk burning yourself when the hot cooling water and steam escapes. If the motor is operated without cooling, the cooling water in the cooling system heats up.

Do not open the motor cooling circuit until the motor has cooled down.

Operation 8

8.1 Safety guidelines for operation

⚠ DANGER

Due to the high speeds and acceleration as well as the friction and self-locking, machine parts that are driven with torque motors also represent a considerable risk of injury (e.g. crushing).

Keep persons away from moving parts and areas where there is a danger of crushing.

⚠ WARNING

Improper operation can lead to serious material damage.

Operation is allowed only in locations with full weather protection: The environment must be dry and protected against heat and cold.

Keep the motor compartment free from foreign bodies (chips, particles, liquids, oils, screws, tools, etc.).

Make sure that the cooling system for the torque motor functions properly.

8.2 Switching off and operating phases

During downtimes, deposits must not be produced that can block the cooling system. Check with the manufacturer of the coolant as to how long it can remain in the cooling system.

8.3 Dealing with faults

If there are deviations from normal operation or if faults occur, initially proceed according to the following list. In this regard, observe the relevant chapters in the documentation associated with the components of the complete drive system.

Even in test operation, never disable protective functions or devices.

NOTICE
Damage to the machine caused by faults Resolve the cause of the fault as specified in the remedial measures section. Repair any damage to the machine/motor.

Table 8- 1 Possible faults

Fault	Cause of the fault (see following table)												
Motor does not start	A	B		D									
Motor starts up slowly	A		C	D	E								
Humming noise when starting			C	D	E								
Humming noise during operation	A		C	D	E								
High temperature rise during no-load operation				D		F	G						
High temperature rise when under load	A		C			F	G						
Overheating of individual winding sections					E								
Uneven running								H	J				
Grinding sound, running noise										K			
Radial vibrations											L		
Axial vibrations											L	M	
Water is leaking													N

Table 8- 2 Key to causes of faults and remedial measures

No.	Cause of fault	How to remedy the problem
A	Overloading	Reduce load
B	Interrupted phase in the supply cable	Check frequency converter and supply cables
C	Interrupted phase in the supply cable after switching on	Check frequency converter and supply cables
D	Motor commutation is faulty	Check the commutation, if required re-adjust the commutation angle offset
E	Winding short circuit or phase short circuit in stator winding	Measure the winding resistances and insulation resistances, motor replacement after consultation with the manufacturer
F	Cooling water not connected / switched off	Check cooling water connection / switch on cooling water / check cooler
	Water connection / pipes defective	Locate leaks and seal as necessary, or consult the manufacturer
G	Cooling water flow rate too low	Check cooling water flow rate according to data sheet specification
	Intake temperature too high	Set correct intake temperature

No.	Cause of fault	How to remedy the problem
H	Insufficient shielding for motor and/or encoder cable	Check the shielding and grounding
J	Drive controller gain too high	Adjust the controller
K	Rotating parts grind	Determine cause and adjust parts
	Foreign bodies in the motor	Consult the manufacturer
	Bearing damage	Contact the manufacturer; where required, repair by the manufacturer
L	Poor alignment	Align motor unit, check coupling
M	Shocks from coupled machine	Check coupled machine
N	Cooling water pipes/water connection defective	Locate leaks and seal as necessary, or consult the manufacturer

If the fault still cannot be resolved after applying the measures specified above, please contact the manufacturer or your local Siemens office.

Maintenance 9

9.1 Safety information for maintenance and repairs

⚠ DANGER

Risk of death, serious personal injury and/or material damage if work is carried out when the machine is switched on. Before carrying out work in the vicinity of rotating parts, switch off the machine (disconnect it from the power supply).

Before carrying out work in the vicinity of rotating parts, disconnect the machine from the power supply to prevent accidental rotation.

⚠ DANGER

If work is carried out on the motor immediately after it has been in operation, there is a risk of burns if you come into contact with hot surfaces. The cooling water temperature can also increase after the motor has already been switched off.

To cool the motor down to the level of the inlet temperature T_{INLET}, the cooler must remain in operation for at least 30 minutes after the motor has been switched off. If the cooler is switched off, however, it takes significantly longer for the motor to cool down. This depends to a large extent on the installation situation.

⚠ DANGER

Risk of burns!

Risk of pressure surges: Do not switch on the cooling if the motor was operated without a cooler beforehand. A significant build-up of steam can cause burns or destroy the motor.

When you open the cooling circuit, you risk burning yourself when the hot cooling water and steam escapes. If the motor is operated without cooling, the cooling water in the cooling system heats up.

Do not open the motor cooling circuit until the motor has cooled down.

⚠ DANGER

Risk of death, serious personal injury and/or material damage during dismantling work.

When disassembling, observe the information in Chapter "Decommissioning".

The motors have been designed for a long service life. Carefully ensure that maintenance work is correctly performed, e.g. removing chips and particles from the air gap.

For safety reasons it is not permissible to repair the motors:

⚠ DANGER

Risk of death, serious bodily injury and/or material damage if the safety-relevant motor properties are changed.

Examples of changed safety-relevant motor properties:

- Damaged insulation does not protect against arcing. There is a risk of electric shock!
- Damaged sealing no longer guarantees protection against shock, ingress of foreign bodies and water, which is specified as IP degree of protection on the rating plate.
- Diminished heat dissipation can result in the motor being prematurely shut down and in machine downtime.

Do not open the motor.

Note

If incorrect changes or corrective maintenance are carried out by you or a third party on the contractual objects, then for these and the consequential damages, no claims can be made against Siemens regarding personal injury or material damage.

Siemens service centers are available to answer any questions you may have. Siemens Service Center addresses can be found at
http://www.siemens.com/automation/service&support

⚠ WARNING

Sharp edges can cause cuts and falling objects can injure feet.

Always wear work gloves and safety shoes.

9.2 Maintenance

Performing maintenance work on the motor

⚠ WARNING
Note the safety information provided in this documentation.

Due to their principle of operation, torque motors are free of wear. To ensure that the motor functions properly and remains free of wear, the following maintenance work needs to be carried out:

- Regularly check that the rotary axes can move without hindrance.
- Keep the air gap free of chippings and particles.
- Regularly check the condition of the motor components.
- Check the current consumption in the test cycle defined beforehand.

Ensure that the motor compartment remains free of contamination (e.g. chippings, oil, etc.). Depending on the local level of contamination, clean the machine to ensure that it functions properly and that heat loss is properly dissipated.

Check the cables to ensure that they are not damaged and are free of wear and tear. Do not use electrical devices with damaged cables.

Make sure that the cable glands are secure.

Intervals between maintenance

Since operating conditions differ greatly, it is not possible to specify intervals between maintenance work.

Indications that maintenance work is required

- Dirt in the motor cabinet
- Distinctive changes in the behavior of the machine
- Unusual sounds emitted by the machine
- Problems with positioning accuracy
- Higher current consumption

Test and replacement intervals of the cooling medium

The test and replacement intervals for the cooling medium should be agreed with the manufacturers of the anti-corrosion agent and the cooling system.

Decommissioning and disposal 10

10.1 Decommissioning

Sequence when decommissioning and disassembling the motor

⚠ DANGER

A different sequence when decommissioning and disassembling the motor can endanger personnel and/or destroy motor components.

1. Disconnect the motor and wait until the DC link of the power unit has discharged.
2. Let the motor cool down (at least 30 minutes), then shut down the cooling and reduce the pressure to 0 bar.
3. Disconnect the power and signal cables and the coolant lines.
4. If necessary, insulate the power connections properly (to prevent risk of induced voltage and ripple in the event of a phase short-circuit when the motor rotates).
5. Empty the coolant from the motor and dispose of it correctly.
6. Remove chips, dirt, foreign particles, etc. from the motor.
7. Insert the spacer foil between the stator and rotor.
8. Screw on the transport locks at the opposite end of the motor away from the mounting end. If the stator and rotor come into contact with one another, they can no longer be separated as a result of the extremely high magnetic forces of attraction.
9. Unscrew the flange face of the stator from the machine housing and the flange face of the rotor from the moving axis. If a motor with cooling jacket is removed from the bore, it is not permissible that the O-rings are damaged if these are to be reused. The removed rotor must always be carefully moved, as the transport locks are only at one end.
10. Only screw the transport locks to the still unprotected flange face of the motor.

11. This point only applies to motors with cooling jacket:
    Carefully remove both O-rings from the cooling jacket surface of the motor if these are to be reused.
    - Do not overstretch the O-rings (only expand O-rings maximum of up to 10 % during installation, otherwise problems will be encountered when installing the next time and leaks can occur).
    - Do not twist the O-rings.
    - Do not use any sharp objects!
    - Use the appropriate equipment and installation devices.
12. Pack the motor in the original packaging and store it correctly.

Note

When reinstalling a motor with a cooling jacket, it is recommended that new O-rings are used. O-rings can be ordered as spare part, for the order designation refer to the Configuration Manual.

10.2 Disposal

The product must be disposed of in the normal recycling process in compliance with national and local regulations.

⚠ DANGER

Death, serious bodily injury and/or property damage may result from improper disposal of direct drives or their components (especially components with permanent magnets).

Direct drives or their components must be disposed of properly.

Main constituents of a proper disposal procedure

- Complete demagnetization of the components that contain permanent magnets
- Components that are to be recycled should be separated into:
  - Electronics scrap (e.g. encoder electronics, sensor modules)
  - Electrical scrap (e.g. laminated cores, motor windings, cables)
  - Iron to be recycled
  - Aluminum
  - Insulating materials
- No mixing with solvents, cold cleaning agents, or remains of paint, for example

10.2.1 Disposing of 1FW6 rotors

Disposing of and demagnetizing 1FW6 rotors

The magnetized rotors must be subject to a special thermal disposal procedure so that they do not pose any risk during or after disposal. For this reason, they must be disposed of by a specialist disposal company.

Once the motor has been dismantled, the rotors must be packaged individually in the undamaged original packaging in accordance with the relevant guidelines.

⚠ DANGER

Due to the strong magnetic fields, unpacked rotors can cause personal and/or material damage.

Read the safety information provided in this documentation.

Demagnetizing the rotors

Disposal companies who specialize in demagnetization use special disposal furnaces. The interior of the disposal furnace is made of non-magnetic material.

The secondary sections are placed inside a solid, heat-resistant container (such as a skeleton container), which is made of non-magnetic material and left in the furnace during the entire demagnetization procedure. The temperature in the furnace must be at least 300 °C over a holding time of at least 30 minutes.

Escaping gases must be collected and decontaminated without damaging the environment.

10.2.2 Disposal of packaging

Packaging materials and disposal

The packaging and packing aids we use contain no problematic materials. With the exception of wooden materials, they can all be recycled and should always be disposed of for reuse. Wooden materials should be burned.

Only recyclable plastics are used as packing aids:

- Code 02 PE-HD (polyethylene)
- Code 04 PE-LD (polyethylene)
- Code 05 PP (polypropylene)
- Code 04 PS (polystyrene)

Appendix

A

A.1 Standards

Standards and regulations

The product complies with the standards relating to the Low-Voltage Directive stated in the EC Declaration of Conformity.

The motor components and also the packaging comply with EC directive 2002/95/EC (RoHS).

A.2 Declaration of conformity

EC declaration of conformity for 1FW6 built-in torque motors

SIEMENS

EG-Konformitätserklärung
EC Declaration of Conformity

No. 400006447-03

Hersteller: Manufacturer:	SIEMENS AG I DT MC MF-M EWM
Anschrift: *Address:*	Georg-Reismüller-Str. 32 80999 München
Produkt: *Product*	**Drehstrom-Synchroneinbaumotoren, Typ 1FW6...** *Built-in three-phase synchronous motors, type 1FW6...*

Die bezeichneten Produkte stimmen in der von uns in Verkehr gebrachten Ausführung mit den Vorschriften folgender Europäischer Richtlinien überein:

The products described above in the form as delivered are in conformity with the provisions of the following European Directives:

2006/95/EG Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedstaaten betreffend elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen.

Council Directive on the approximation of the laws of the Member States related to electrical equipment designed for use within certain voltage limits.

CE-Kennzeichnung */ CE marking :* siehe Anhang A / *see Annex A*

Die Konformität mit den Richtlinien wird nachgewiesen durch die Einhaltung der zutreffenden Kapitel folgender Normen:

Conformity to the Directives is assured through the application of the applicable sections of the following standards:

Referenznummer *Reference number*	Referenznummer *Reference number*
DIN EN 60034-1	EN 60204-1

München, 07.02.2012
Siemens AG I DT MC MF-M EWM

Dipl.-Ing. (FH) Georg Ketzer Werksleitung Name, Funktion *Name, function*	i.V. Unterschrift *signature*	Dipl.-Ing. Christian Volmert Leitung Entwicklung Name, Funktion *Name, function*	Ch. Volmert Unterschrift *signature*

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, ist jedoch keine Zusicherung von Eigenschaften.
Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.
This declaration certifies the conformity to the specified directives but contains no assurance of properties. The safety documentation accompanying the product shall be considered in detail.

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SIEMENS

Anhang A zur EG-Konformitätserklärung Nr. 400006447-03
Attachment A to EC Declaration of Conformity No. 4000006447-03

Lfd. Nr.	Komponente	Bestellbezeichnung	Erstmalige CE-Anbringung
1	Torquemotor	1FW609x-xxxxx-xxxx	2002
2	Torquemotor	1FW613x-xxxxx-xxxx	2002
3	Torquemotor	1FW616x-xxxxx-xxxx	2002
4	Torquemotor	1FW619x-xxxxx-xxxx	2002
5	Torquemotor	1FW623x-xxxxx-xxxx	2002
6	Torquemotor	1FW629x-xxxxx-xxxx	2002
7	Stator	1FW609x-xxxxx-xxxx	2002
8	Stator	1FW613x-xxxxx-xxxx	2002
9	Stator	1FW616x-xxxxx-xxxx	2002
10	Stator	1FW619x-xxxxx-xxxx	2002
11	Stator	1FW623x-xxxxx-xxxx	2002
12	Stator	1FW629x-xxxxx-xxxx	2002
13	Torquemotor	1FW615x-xxxxx-xxxx	06/2006
14	Stator	1FW615x-xxxxx-xxxx	06/2006
15	Torquemotor	1FW606x-xxxxx-xxxx	2011
16	Stator	1FW606x-xxxxx-xxxx	2011
17	Torquemotor	1FW605x-xxxxx-xxxx	2012
18	Stator	1FW605x-xxxxx-xxxx	2012
19			
20			
21			
22			
23			
24			
25			

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A.3 Recommended manufacturers

Information regarding third-party products

Note

This document contains recommendations relating to third-party products. This involves third-party products whose fundamental suitability is familiar to us. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations are to be seen as helpful information, not as requirements or regulations. We cannot accept any liability for the quality and properties/features of third-party products.

TYFOROP CHEMIE GmbH	
Anti-corrosion protection: Tyfocor	www.tyfo.de

Clariant Produkte (Deutschland) GmbH	
Anti-corrosion protection: Antifrogen N	www.clariant.de

A.4 List of abbreviations

BGV	Binding national health and safety at work regulations (in Germany)
CE	Communauté Européenne (European Community)
DAC	Digital-to-analog converter
DIN	Deutsches Institut für Normung (German standards organization)
EMC	Electromagnetic compatibility
EMF	Electromotive force
EN	Europäische Norm (European standard)
EU	European Union
FAQ	Frequently asked questions
HFD	High-frequency damping
IATA	International Air Transport Association
IEC	International Electrotechnical Commission
IP	International Protection
KTY	Temperature sensor with progressive, almost linear characteristic
PDS	Power drive system
PE	Protective earth
PELV	Protective extra low voltage
ph value	Concentration of hydrogen ions in a liquid
PTC	Temperature sensor with positive temperature coefficients and "quasi-switching" characteristic
RLI	Rotor position identification ("pole position identification"); procedure for determining the commutation angle offset
RoHS	Restriction of (the use of certain) Hazardous Substances
TN	Terre Neutral
VDE	Association of Electrical Engineering, Electronics and Information Technology (in Germany)

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Siemens AG
Industry Sector
Drive Technologies
Motion Control Systems
P.O. Box 3180
91050 ERLANGEN
GERMANY

www.siemens.com/motioncontrol