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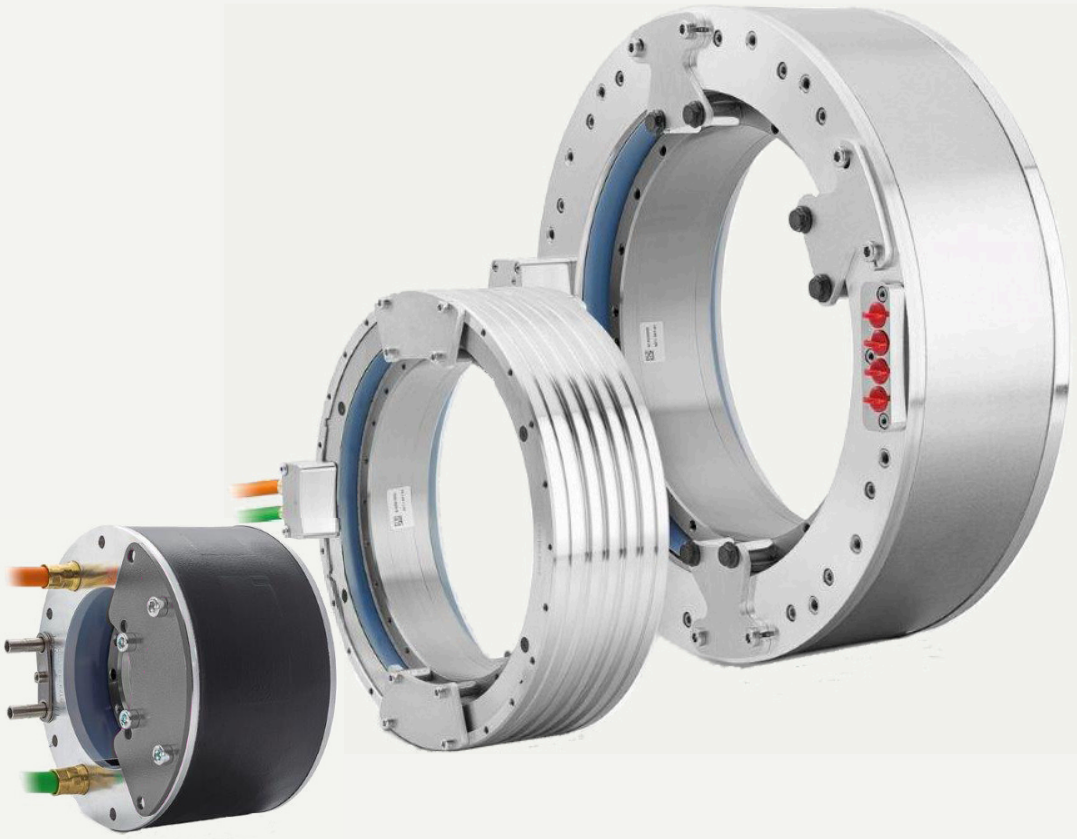

Edition 09/2022

OPERATING INSTRUCTIONS

SIMOTICS

SIMOTICS T-1FW6 built-in torque motors

Drive technology

www.siemens.com/drives

SIEMENS

SIMOTICS

Drive Technology
1FW6 built-in torque motors

Operating Instructions

09/2022
A5E52220812B AA

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 Aktiengesellschaft. 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.

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GERMANY

A5E52220812B AA
Ⓟ 12/2023 Subject to change

Table of contents

Introduction 1

1.1 About SIMOTICS

Description

SIMOTICS is the Siemens family of electric motors addressing the complete motor spectrum in Digital Industry.

1.2 About this manual

1.2.1 Contents

Description

These Operating Instructions inform you about the motor and its components. You will learn how to handle the motor properly and safely from delivery to disposal:

- Transporting and storing
- Assembly and mounting
- Connecting
- Commissioning
- Checking
- Operation
- Troubleshooting
- Disassembling
- Disposal

This documentation should be kept in a location where it can be easily accessed and made available to the personnel responsible.

You can find additional information in the relevant Configuration Manual.

To illustrate possible application areas for our products, typical use cases are listed in this product documentation and in the online help. These are purely exemplary and do not constitute a statement on the suitability of the respective product for applications in specific individual cases. Unless explicitly contractually agreed, Siemens assumes no liability for such suitability. Suitability for a particular application in specific individual cases must be assessed by the user, taking into account all technical, legal, and other requirements on a case-by-case basis. Always observe the descriptions of the technical properties and the relevant constraints of the respective product contained in the product documentation.

Information regarding third-party products

Note

Recommendation relating to third-party products

This document contains recommendations relating to third-party products. Siemens accepts the fundamental suitability of these third-party products.

You can use equivalent products from other manufacturers.

Siemens does not accept any warranty for the properties of third-party products.

1.2.2 Target group

Description

These operating instructions are intended for:

- Fitters
- Commissioning engineers
- Machine operators
- Service and maintenance personnel
- Warehouse personnel
- Personnel decommissioning the motor
- Personnel disposing of the motor

1.2.3 Avoiding dangers

Description

Avoid dangers. Ensure safe, problem-free operation and a maximum service life:

- Before you start using the motor, you must read these Operating Instructions.
- Always follow the safety instructions and notices in these operating instructions.

The warning notice system is explained at the beginning of this document.

1.2.4 Standard scope

Description

This documentation describes the functionality of the standard scope. This scope may differ from the scope of the functionality of the system that is actually supplied. Please refer to the ordering documentation only for the functionality of the supplied drive system.

Further functions may be executable in the system, which are not explained in this documentation. However, there is no entitlement to these functions in the case of a new delivery or service.

This documentation does not contain all detailed information on all types of the product. Furthermore, this documentation cannot take into consideration every conceivable type of installation, operation and service/maintenance.

The machine manufacturer must document any additions or modifications they make to the product themselves.

1.2.5 Websites of third-party companies

Description

This document may contain hyperlinks to third-party websites. Siemens is not responsible for and shall not be liable for these websites and their content. Siemens has no control over the information which appears on these websites and is not responsible for the content and information provided there. The user bears the risk for their use.

1.3 SIMOTICS documentation

Description

Comprehensive documentation on SIMOTICS, SIMOGEAR and on the SINAMICS converter family are provided in Internet (https://support.industry.siemens.com/cs/ww/en/ps/13204/man).

You can display documents or download them in PDF and HTML5 format.

The documentation is divided into the following categories:

Table 1-1 SIMOTICS / SIMOGEAR / SINAMICS documentation

Information	Documentation class[1)]	Content	Target group
General information	Configuration Manual	Rules, guidelines, and tools for configuring products, systems, and plants. Also contains information on the operating and ambient conditions for hardware and software, the use of functions, as well as on circuit diagrams and terminal diagrams and the installation of software insofar as this is necessary for commissioning.	Planners, configuration engineers
Device information	Installation Instructions	All relevant information on setting up, installing and cabling, as well as the required dimensional drawings and circuit diagrams	Installation personnel, commissioning engineers, service and maintenance personnel
Basic information	Operating instructions	Comprehensive collection of all information necessary for the safe operation of products, plant/system parts and complete plants (IEC 82079)	Machine operators, plant operators
	Compact instructions	Essential contents of the operating instructions in a reduced and condensed form	Machine operators, plant operators
	Product Information	Information that only becomes known shortly before or even after start of delivery and is therefore not included in the associated user documentation	Planners, configuration engineers, technologists, installation personnel, constructors; commissioning engineers, machine operators, programmers, service and maintenance personnel
	Online help	Instructions for configuring, programming, and commissioning	Configuration engineers, programmers, commissioning engineers

[1)] Not all documentation classes are available for every SIMOTICS / SIMOGEAR / SINAMICS product.

1.4 Service and Support

1.4.1 Siemens Industry Online Support on the Web

Description

The following is available via Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/), among others:

- Product support
- Global forum for information and best practice sharing between users and specialists

- Local contact persons via the contact person database (→ Contact)
- Information about field services, repairs, spare parts, and much more (→ Services)
- Search for product info
- Important topics at a glance
- FAQs (frequently asked questions)
- Application examples
- Manuals
- Downloads
- Compatibility tool
- Newsletters with information about your products
- Catalogs/brochures

1.4.2 Siemens Industry Online Support on the road

Description

Figure 1-1 "Siemens Industry Online Support" app

The "Industry Online Support" app supports you in the following areas, for example:

- Resolving problems when executing a project
- Troubleshooting when faults develop
- Expanding a system or planning a new system

Furthermore, you have access to the Technical Forum and other articles that our experts have drawn up:

- FAQs
- Application examples
- Manuals
- Certificates
- Product announcements and much more

There is a Data Matrix code on the nameplate of your product. You can obtain technical information about the device if you scan the code using the "Industry Online Support" app (https://support.industry.siemens.com/cs/ww/en/sc/2067).

The app is available for Apple iOS and Android.

1.4.3 Feedback on the technical documentation

Description

We welcome your questions, suggestions, and corrections for this technical documentation. Please use the "Provide feedback" link at the end of the entries in Siemens Industry Online Support.

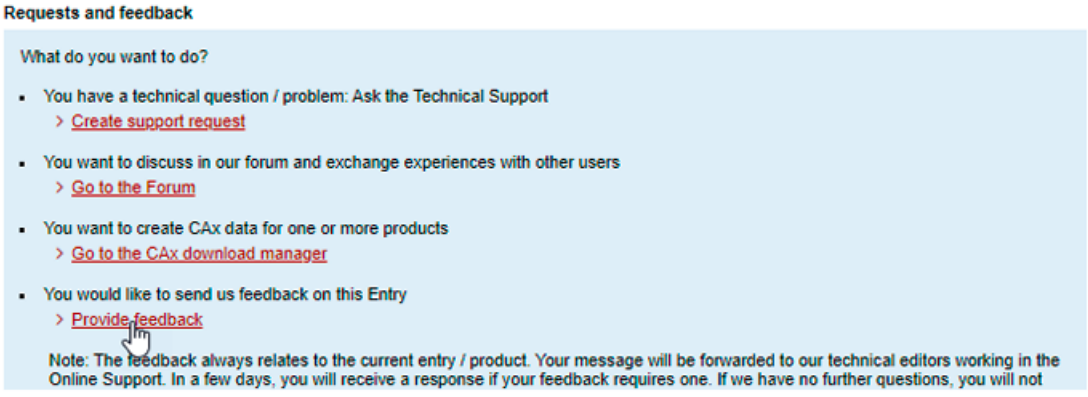


Figure 1-2 Requests and feedback

1.4.4 mySupport documentation

Description

With the "mySupport documentation" web-based system, you can compile your own individual documentation based on Siemens content and adapt this for your own machine documentation.

To start the application, click the "My Documentation" tile on the mySupport homepage (https://support.industry.siemens.com/cs/ww/en/my):

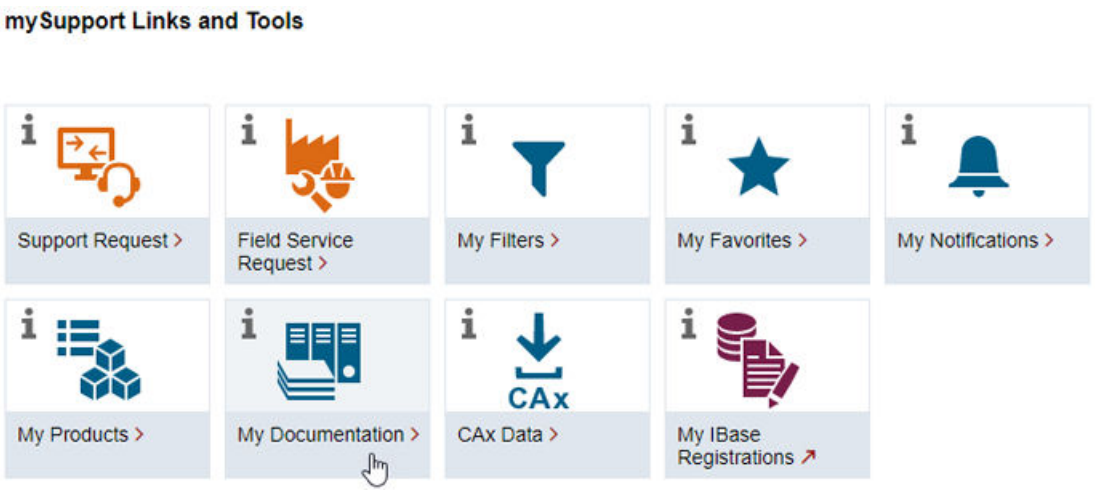


Figure 1-3 mySupport

The configured manual can be exported in the PDF or XML format.

Siemens content that supports the mySupport documentation can be identified by the "Configure" link.

1.4.5 Technical support

Description

Your routes to technical support (https://support.industry.siemens.com/cs/ww/en/sc/4868):

- Support Request (https://www.siemens.com/SupportRequest)
- Contact person database (https://www.automation.siemens.com/aspa_app)
- "Industry Online Support" mobile app

The Support Request is the most important input channel for questions relating to products from Siemens Industry. This will assign your request a unique ticket number for tracking purposes. The Support Request offers you:

- Direct access to technical experts
- Recommended solutions for various questions (e.g. FAQs)
- Status tracking of your requests

Technical support also assists you in some cases via remote support (https://support.industry.siemens.com/cs/de/en/view/106665159) to resolve your requests. A Support representative will assist you in diagnosing or resolving the problem through screen transfer.

More information on the Support service packages is available on the Internet via the following address (https://support.industry.siemens.com/cs/ww/en/sc/4869).

If you need support with the topics "Application" and "Mechatronics", contact Application & Mechatronic Support Direct Motors (mailto:motor.support.motioncontrol@siemens.com).

1.4.6 Training

Description

SITRAIN – Digital Industry Academy offers a comprehensive range of training courses on Siemens industrial products – directly from the manufacturer, for all industries and use cases, for all knowledge levels from beginner to expert.

More information can be found on the Internet via the following address (https://www.siemens.com/sitrain).

1.5 Important product information

1.5.1 Intended use

⚠ WARNING

Risk of death and material damage as a result of incorrect use

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

- Only use the motors for industrial or commercial plants and systems.
- Do not install the motors in hazardous zones if the motors have not been expressly and explicitly designed and authorized for this purpose. Carefully observe any special additional notes provided.
- Only use direct drives and their components for applications that Siemens has explicitly specified.
- Protect the motors against dirt and contact with corrosive substances.
- Ensure that the installation conditions comply with the rating plate specifications and the condition specifications contained in this documentation. Where relevant, take into account deviations regarding approvals or country-specific regulations.
- Contact your local sales partner if you have any questions relating to proper and intended use.
- If you wish to use special versions and design versions whose technical details vary from the motors described in this document, then you must contact your local sales partner.

⚠ WARNING

Danger to life for wearers of active implants due to magnetic and electrical fields

Electric motors pose a danger to people with active medical implants, e.g. cardiac stimulators, who come close to the motors.

- If you are affected, stay a minimum distance of 300 mm from the motors (tripping threshold for static magnetic fields of 0.5 mT according to the Directive 2013/35/EU).

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

- Rotary axes
- Rotary tables, rotary indexing machines, subassemblies
- Turret indexing and drum indexing for single-spindle and multi-spindle machines
- Dynamic tool magazines
- Rotating spindles
- Roller and cylinder drives
- Infeed and handling axes

⚠ WARNING

Injury and material damage by not observing machinery directive 2006/42/EC

There is a risk of death, serious injury and/or material damage if machinery directive 2006/42/EC is not carefully observed.

- The products included in the scope of delivery are exclusively designed for installation in a machine. Commissioning is prohibited until it has been fully established that the end product conforms with machinery directive 2006/42/EC.
- Please observe all safety instructions and provide these safety instructions to the end user.

Avoiding violation of protective rights

Carefully observe all national and international license terms when operating direct motors so that no patent rights are violated.

1.5.2 Reasonably foreseeable misuse

Description

Avoid the following incorrect uses:

- Disregarding safety information and instructions in this manual
- Directly connecting the motor power connection to the line supply
- Directly connecting temperature sensors to the converter
- Untrained or non-authorized personnel working at the motor
- Working on a motor that is not adequately secured
- Handling the motor carelessly or in a deliberately negligent way
- Underestimating the magnetic force of attraction of permanent magnets
- Disregarding safety clearances for persons with pacemakers, implanted defibrillators and/or metal implants
- Underestimating voltages at cable connections caused by induction
- Incorrect commutation setting when installing and replacing the encoder
- Contact with hot surfaces
- Handling the motor without personal protection equipment
- Disregarding any damage
- Using the motor
  - For non-industrial or commercial applications
  - In impermissible environmental conditions
  - In hazardous zones
  - In a dirty state
  - When in contact with aggressive substances
  - With inadequate cooling
- Disregarding data on the rating plate
- Incorrect packaging, storage and/or incorrect transport
- Opening the motor
- Incorrect disposal of the motor

Fundamental safety instructions

2

2.1 General safety instructions

⚠ WARNING

Electric shock and danger to life due to other energy sources

Touching live components can result in death or severe injury.

- Only work on electrical devices when you are qualified for this job.
- Always observe the country-specific safety rules.

Generally, the following steps apply when establishing safety:

1. Prepare for disconnection. Notify all those who will be affected by the procedure.
2. Isolate the drive system from the power supply and take measures to prevent it being switched back on again.
3. Wait until the discharge time specified on the warning labels has elapsed.
4. Check that there is no voltage between any of the power connections, and between any of the power connections and the protective conductor connection.
5. Check whether the existing auxiliary supply circuits are de-energized.
6. Ensure that the motors cannot move.
7. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water. Switch the energy sources to a safe state.
8. Check that the correct drive system is completely locked.

After you have completed the work, restore the operational readiness in the inverse sequence.

⚠ WARNING

Electric shock due to connection to an unsuitable power supply

When equipment is connected to an unsuitable power supply, exposed components may carry a hazardous voltage. Contact with hazardous voltage can result in severe injury or death.

- Only use power supplies that provide SELV (Safety Extra Low Voltage) or PELV- (Protective Extra Low Voltage) output voltages for all connections and terminals of the electronics modules.

⚠ WARNING

Electric shock due to damaged motors or devices

Improper handling of motors or devices can damage them.

Hazardous voltages can be present at the enclosure or at exposed components on damaged motors or devices.

- Ensure compliance with the limit values specified in the technical data during transport, storage and operation.
- Do not use any damaged motors or devices.

⚠ WARNING

Electric shock due to unconnected cable shield

Hazardous touch voltages can occur through capacitive cross-coupling due to unconnected cable shields.

- As a minimum, connect cable shields and the conductors of power cables that are not used (e.g. brake cores) at one end at the grounded housing potential.

⚠ WARNING

Electric shock if there is no ground connection

For missing or incorrectly implemented protective conductor connection for devices with protection class I, high voltages can be present at open, exposed parts, which when touched, can result in death or severe injury.

- Ground the device in compliance with the applicable regulations.

⚠ WARNING

Arcing when a plug connection is opened during operation

Opening a plug connection when a system is operation can result in arcing that may cause serious injury or death.

- Only open plug connections when the equipment is in a voltage-free state, unless it has been explicitly stated that they can be opened in operation.

NOTICE

Property damage due to loose power connections

Insufficient tightening torques or vibration can result in loose power connections. This can result in damage due to fire, device defects or malfunctions.

- Tighten all power connections to the prescribed torque.
- Check all power connections at regular intervals, particularly after equipment has been transported.

NOTICE

Damage to equipment due to unsuitable tightening tools.

Unsuitable tightening tools or fastening methods can damage the screws of the equipment.

- Only use screw inserts that exactly match the screw head.
- Tighten the screws with the torque specified in the technical documentation.
- Use a torque wrench or a mechanical precision nut runner with a dynamic torque sensor and speed limitation system.
- Adjust the tools used regularly.

⚠ WARNING

Unexpected machine movement caused by radio devices or mobile phones

Using radio devices, cellphones, or mobile WLAN devices in the immediate vicinity of the components can result in equipment malfunction. Malfunctions may impair the functional safety of machines and can therefore put people in danger or lead to property damage.

- Therefore, if you move closer than 20 cm to the components, be sure to switch off radio devices, cellphones or WLAN devices.
- Use the "SIEMENS Industry Online Support app" only on equipment that has already been switched off.

⚠ WARNING

Unrecognized dangers due to missing or illegible warning labels

Dangers might not be recognized if warning labels are missing or illegible. Unrecognized dangers may cause accidents resulting in serious injury or death.

- Check that the warning labels are complete based on the documentation.
- Attach any missing warning labels to the components, where necessary in the national language.
- Replace illegible warning labels.

⚠ WARNING

Unexpected movement of machines caused by inactive safety functions

Inactive or non-adapted safety functions can trigger unexpected machine movements that may result in serious injury or death.

- Observe the information in the appropriate product documentation before commissioning.
- Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components.
- Ensure that the safety functions used in your drives and automation tasks are adjusted and activated through appropriate parameterizing.
- Perform a function test.
- Only put your plant into live operation once you have guaranteed that the functions relevant to safety are running correctly.

Note

Important Safety instructions for Safety Integrated

If you want to use Safety Integrated functions, you must observe the Safety instructions in the Safety Integrated documentation.

⚠ WARNING

Active implant malfunctions due to electromagnetic fields

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment, such as transformers, converters, or motors. People with pacemakers or implants are at particular risk in the immediate vicinity of this equipment.

- If this affects you, maintain the minimum distance to such equipment that is specified in the "Important product information" chapter.

⚠ WARNING

Active implant malfunctions due to permanent-magnet fields

Even when switched off, electric motors with permanent magnets represent a potential risk for persons with heart pacemakers or implants if they are close to converters/motors.

- If this affects you, maintain the minimum distance to such equipment that is specified in the "Important product information" chapter.
- When transporting or storing permanent-magnet motors always use the original packing materials with the warning labels attached.
- Clearly mark the storage locations with the appropriate warning labels.
- IATA regulations must be observed when transported by air.

⚠ WARNING

Injury caused by moving or ejected parts

Contact with moving motor parts or drive output elements and the ejection of loose motor parts (e.g. feather keys) out of the motor enclosure can result in severe injury or death.

- Remove any loose parts or secure them so that they cannot be flung out.
- Do not touch any moving parts.
- Safeguard all moving parts using the appropriate safety guards.

⚠ WARNING

Fire due to incorrect operation of the motor

When incorrectly operated and in the case of a fault, the motor can overheat resulting in fire and smoke. This can result in severe injury or death. Further, excessively high temperatures destroy motor components and result in increased failures as well as shorter service lives of motors.

- Operate the motor according to the relevant specifications.
- Only operate the motors in conjunction with effective temperature monitoring.
- Immediately switch off the motor if excessively high temperatures occur.

⚠ CAUTION

Burns and thermal damage caused by hot surfaces

Temperatures above 100 °C may occur on the surfaces of motors, converters, and other drive components.

Touching hot surfaces may result in burns. Hot surfaces may damage or destroy temperature sensitive parts.

- Ensure that temperature-sensitive parts do not come into contact with hot surfaces.
- Mount drive components so that they are not accessible during operation.

Measures when maintenance is required:

- Allow drive components to cool off before starting any work.
- Use appropriate personnel protection equipment, e.g. gloves.

2.2 Equipment damage due to electric fields or electrostatic discharge

Electrostatic sensitive devices (ESD) are individual components, integrated circuits, modules or devices that may be damaged by either electric fields or electrostatic discharge.

NOTICE

Equipment damage due to electric fields or electrostatic discharge

Electric fields or electrostatic discharge can cause malfunctions through damaged individual components, integrated circuits, modules or devices.

- Only pack, store, transport and send electronic components, modules or devices in their original packaging or in other suitable materials, e.g conductive foam rubber of aluminum foil.
- Only touch components, modules and devices when you are grounded by one of the following methods:
  - Wearing an ESD wrist strap
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container).

2.3 Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit
https://www.siemens.com/industrialsecurity.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under
https://www.siemens.com/cert.

Further information is provided on the Internet:

Industrial Security Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/108862708)

⚠ WARNING

Unsafe operating states resulting from software manipulation

Software manipulations, e.g. viruses, Trojans, or worms, can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.
- Make sure that you include all installed products into the holistic industrial security concept.
- Protect files stored on exchangeable storage media from malicious software by with suitable protection measures, e.g. virus scanners.
- On completion of commissioning, check all security-related settings.

2.4 Residual risks of power drive systems

When assessing the machine or system-related risk in accordance with the respective local regulations (e.g. EC Machinery Directive), the machine manufacturer or system integrator must take into account the following residual risks emanating from the control and drive components of a drive system:

1. Unintentional movements of driven machine or system components during commissioning, operation, maintenance, and repairs caused by, for example,
   - Hardware faults and/or software errors in the sensors, control system, actuators, and connections
   - Response times of the control system and of the drive
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of wireless devices/mobile phones in the immediate vicinity of electronic components
   - External influences/damage
   - X-ray, ionizing radiation and cosmic radiation
2. Unusually high temperatures, including open flames, as well as emissions of light, noise, particles, gases, etc., can occur inside and outside the components under fault conditions caused by, for example:
   - Component failure
   - Software errors
   - Operation and/or environmental conditions outside the specification
   - External influences/damage

3. Hazardous shock voltages caused by, for example:
   - Component failure
   - Influence during electrostatic charging
   - Induction of voltages in moving motors
   - Operation and/or environmental conditions outside 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
6. Influence of network-connected communication systems, e.g. ripple-control transmitters or data communication via the network
7. Motors for use in potentially explosive areas:
   When moving components such as bearings become worn, this can cause enclosure components to exhibit unexpectedly high temperatures during operation, creating a hazard in areas with a potentially explosive atmosphere.

For more information about the residual risks of the drive system components, see the relevant sections in the technical user documentation.

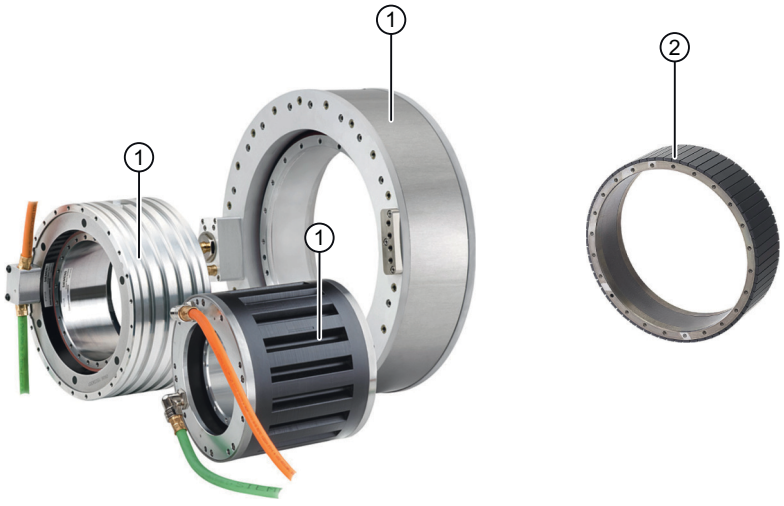
Description

3

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

These 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.



① Stator with rotor
② Rotor

3.1 Technical features and ambient conditions

3.1.1 Standards and guidelines

The chapter lists the standards and directives that are applicable for the motor and which the motor complies with.

Standards that are complied with

Note

The standards listed in this manual are not dated.

You can take the currently relevant and valid dates from the Declaration of Conformity.

The motors of the type series SIMOTICS S, SIMOTICS M, SIMOTICS L, SIMOTICS T, SIMOTICS A, called "SIMOTICS motor series" below, fulfill the requirements of the following directives and standards:

- EN 60034-1 - Rotating electrical machines – Dimensioning and operating behavior
- EN 60204-1 - Safety of machinery – Electrical equipment of machines; general requirements

Where applicable, the SIMOTICS motor series are in conformance with the following parts of EN 60034:

Feature	Standard
Degree of protection	EN 60034-5
Cooling [1)]	EN 60034-6
Type of construction	EN 60034-7
Connection designations	EN 60034-8
Noise levels [1)]	EN 60034-9
Temperature monitoring	EN 60034-11
Vibration severity grades [1)]	EN 60034-14

[1)] Standard part, e.g. cannot be used for built-in motors.

Relevant directives

The following directives are relevant for SIMOTICS motors.

CE

European Low-Voltage Directive

SIMOTICS motors comply with the Low-Voltage Directive 2014/35/EU.

European Machinery Directive

SIMOTICS motors do not fall within the scope covered by the Machinery Directive.

However, the use of the products in a typical machine application has been fully assessed for compliance with the main regulations in this directive concerning health and safety.

European EMC Directive

SIMOTICS motors do not fall within the scope covered by the EMC Directive. The products are not considered as devices in the sense of the directive. Installed and operated with a converter, the motor - together with the Power Drive System - must comply with the requirements laid down in the applicable EMC Directive.

European RoHS Directive

The SIMOTICS motor series complies with the Directive 2011/65/EU regarding limiting the use of certain hazardous substances.

European Directive on Waste Electrical and Electronic Equipment (WEEE)

SIMOTICS motors comply with the 2012/19/EU directive on taking back and recycling waste electrical and electronic equipment.

European Directive 2005/32/EC defining requirements for environmentally friendly design of electric motors

The SIMOTICS motor series is not subject to Regulation (EC) No. 640/2009 for implementation of this directive.

European Directive 2009/125/EC defining ecodesign requirements of electric motors and speed controls

The SIMOTICS motor series is not subject to (EU) Regulation 2019/1781 for implementation of this directive.

Eurasian conformity

SIMOTICS motors comply with the requirements of the Russia/Belarus/Kazakhstan (EAC) customs union.

China Compulsory Certification

SIMOTICS motors do not fall within the scope covered by the China Compulsory Certification (CCC).

CCC negative certification (https://support.industry.siemens.com/cs/de/de/view/109769143)

Underwriters Laboratories

SIMOTICS motors are generally in compliance with UL and cUL as components of motor applications, and are appropriately listed.

Specifically developed motors and functions are the exceptions in this case. Here, it is crucial that you carefully observe the content of the quotation and that there is a UL or cUL mark on the rating plate!

Quality systems

Siemens employs a quality management system that meets the requirements of ISO 9001 and ISO 14001.

Certificates for SIMOTICS motors can be downloaded from the Internet at the following link:

Certificates for SIMOTICS motors (https://support.industry.siemens.com/cs/ww/de/ps/13347/cert)

China RoHS

SIMOTICS motors comply with the China RoHS.

You can find more information at:

China-RoHS (https://support.industry.siemens.com/cs/de/de/view/109738670/en)

UKCA - United Kingdom Conformity Assessed

The SIMOTICS motor series satisfies the conformity requirements for England, Wales and Scotland.

3.1.2 Danger from strong magnetic fields

Occurrence of magnetic fields

Motor components with permanent magnets generate very strong magnetic fields. In the no-current condition, the magnetic field strength of the motors comes exclusively from the magnetic fields of components equipped with permanent magnets. Additional electromagnetic fields occur in operation.

Components with permanent magnets

The rotors of the 1FW6 built-in torque motors described in this manual contain permanent magnets.

Figure 3-1 Rotor

Figure 3-2 Schematic representation of the static magnetic field of a rotor, as a function of distance

Risk to persons as a result of strong magnetic fields

⚠ WARNING

Risk of death as a result of permanent magnet fields

The permanent magnets in the motors represents a danger for people with active medical implants, who come close to the motors. This is also the case when the motor is switched off.

Examples of active medical implants include: Heart pacemakers, insulin pumps.

- If you are affected, stay a minimum distance of 300 mm from the permanent magnets (tripping threshold for static magnetic fields of 0.5 mT according to the Directive 2013/35/EU).

With regard to the effect of strong magnetic fields on people, in Germany the DGUV regulation 103-013 "Electromagnetic fields" of the German Social Accident Insurance must be complied with! This regulation lists all of the requirements that must be observed at workplaces. In other countries, the relevant applicable national and local regulations and requirements must be taken into account.

For magnetic fields, you must carefully comply with the requirements laid down in the DGUV regulation 103-013 of the German Social Accident Insurance.

⚠ CAUTION

Safety distance to the rotor

The rotor magnetic fields are permanent. If you come into direct bodily contact with the rotors, a static magnetic flux density of 2 T is not exceeded.

- Carefully comply with the DGUV regulation 103-013, Paragraph 14 "Systems with high static magnetic fields".

⚠ WARNING

Electrical shock hazard

Every movement of the rotor compared with the stator and vice versa induces a voltage at the stator power connections.

If you use defective cable ports, you could suffer an electric shock.

- Do not touch the cable ports.
- Correctly connect the stator power connections, or insulate them properly.

⚠ WARNING

Risk of rotor permanent magnets causing crushing injuries

The forces of attraction of magnetic rotors act on materials that can be magnetized. The forces of attraction increase significantly close to the rotor. The response threshold of 3 mT for risk of injury through attraction and causing a projectile effect is reached at a distance of 100 mm (Directive 2013/35/EU). Rotors and materials that can be magnetized can suddenly slam together unintentionally. Two rotors can also unintentionally slam together.

There is a significant risk of crushing when you are close to a rotor.

Close to the motor, the magnetic forces of attraction can be up to several kN. – Example: Magnetic attractive forces are equivalent to a force of 100 kg, which is sufficient to trap a body part.

- Do not underestimate the strength of the attractive forces, and work very carefully.
- Wear safety gloves.
- The work should be done by at least two people.
- Do not unpack the rotor until immediately before assembly.
- Never unpack several rotors at once.
- Never place the rotors directly next to one another without providing adequate protection.
- Never carry any objects made of magnetizable materials (for example watches, steel or iron tools) and/or permanent magnets close to the rotor! If tools that can be magnetized are still required, then hold any tool firmly using both hands. Slowly bring the tool to the rotor.
- Immediately install the rotor after it has been unpacked.
- Use a special installation device when centering and assembling the stator and rotor as individual components. Maintain the special procedure.
- Keep the following tools at hand to release parts of the body (hand, fingers, foot etc.) trapped between two components:
  - A hammer (about 3 kg) made of solid, non-magnetizable material
  - Two pointed wedges (wedge angle approx. 10° - 15°, minimum height 50 mm) made of solid, non-magnetizable material (e.g. hard wood)

First aid in the case of accidents involving permanent magnets

- Stay calm.
- If the machine is energized, press the emergency stop switch and open the main switch if necessary.
- Administer FIRST AID. Call for further help if required.

- To free jammed parts of the body (e.g. hands, fingers, feet), pull apart components that are clamped together.
  - Do this using the non-magnetic hammer to drive the non-magnetic wedges into the separating rift.
  - Release the jammed body parts.
- If necessary, call the emergency medical service or an emergency physician.

Material damage caused by strong magnetic fields

NOTICE
Data loss caused by strong magnetic fields If you are close to the rotor (< 100 mm) any magnetic or electronic data medium as well as electronic devices that you are carrying can be destroyed. For example, credit cards, USB sticks, floppy disks and watches are at risk. • Do not carry any magnetic/electronic data media and no electronic devices when you are close to a rotor!

3.1.3 Technical features

Table 3-1 Standard version of the 1FW6 built-in torque motor

Technical feature	Version
Type of motor	**Synchronous motor with permanent magnet rotor** • High number of poles, rotor pole number from 22 up to 98
Type of construction	**Individual components** • Stator • Rotor
Degree of protection according to DIN EN 60034-5	**Motor: IP23** • The final degree of protection (minimum degree of protection: IP54) of the installed motor must be realized by the machine manufacturer
Cooling method	**Water cooling** • Jacket cooling: sizes 1FW6090, 1FW6130, 1FW6150 • Integrated cooling (1 cooling circuit): frame sizes 1FW6050 and 1FW6060 • Integrated cooling (2 cooling circuits): frame sizes 1FW6160, 1FW6190, 1FW6230, 1FW6290
Pressure in the cooling circuit	Max. 10 bar (static)

Technical feature	Version
Cooler connection	**Motors with cooling jacket** • The machine OEM must establish the connection via the surrounding mechanical assembly **Motors with integrated cooling** • Connection with/without cooling connection adapter according to Chapter "Cooler connection (Page 83)"
Thermal motor protection	**1FW6050 to 1FW6290** • 1 x triple PTC thermistor with response threshold +130 °C (according to DIN 44081/44082) **1FW6090 to 1FW6290 in conjunction with KTY 84** • Can only be ordered as spare part • 1x PTC thermistor triplet with response threshold +130 °C and 1 x PTC triplet with response threshold +150 °C (according to DIN 44081/44082) **Evaluation** • According to the SINAMICS S120 Equipment Manual via – Sensor Module SME120/SME125 or – TM120
Temperature monitoring	**1FW6xxx-xxxxx-xxx3** • 1 x Pt1000 (according to DIN EN 60751) **1FW6xxx-xxxxx-xxx1 and 1FW6xxx-xxxxx-xxx2** • Can only be ordered as spare part • 1 x KTY 84 (according to DIN EN 60034-11) **Evaluation** • According to the SINAMICS S120 Equipment Manual via – Sensor Module SME120/SME125 or – TM120
2nd rating plate	Enclosed separately
Insulating material class of the stator winding according to DIN EN 60034-1	Temperature class 155 (F)
Impulse withstand voltage insulation class according to EN 60034-18-41	IVIC: C
Magnet material	Rare earth material

Technical feature	Version
Connection, electrical	**Cable outlet** • Axial • Radial towards the outside – Not for 1FW6050 and 1FW6060 • Tangential – Not for motors with single cores **Connection types** • Permanently connected power and signal cables – Open wire ends – Length: 2 m • Permanently connected power cables with single cores and signal cables – Open wire ends – Length: 1 m • Permanently connected power and signal cables – Prefabricated with connectors – Length: 0.5 m – Not for motors with single cores
Motor feeder cables	**Power and signal cables** • MOTION-CONNECT 800PLUS, type 6FX8
Torque ripple	≤ 1.5 % M_0

3.1.4 Defining the direction of rotation

Direction of rotation

If the built-in torque motor is connected with a phase sequence U-V-W, and is fed from a three-phase system with a clockwise phase sequence, then the rotor rotates clockwise. You can identify the direction of rotation by viewing the DE of the built-in torque motor. The cable outlet of the built-in torque motor is on the opposite side - the NDE.

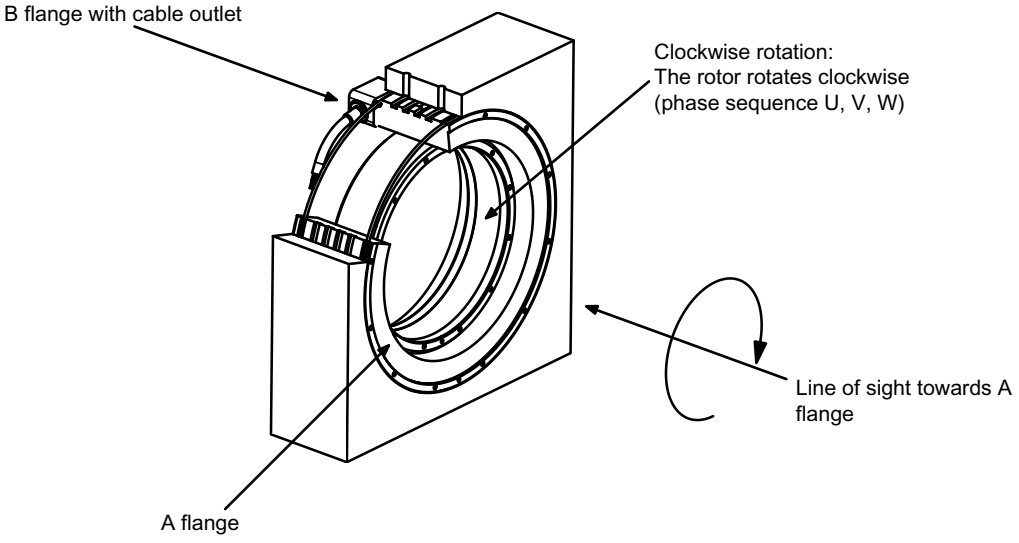


Figure 3-3 Line of sight for determining the direction of rotation

3.1.5 Ambient conditions for fixed operation

Classify the environmental conditions for stationary use at weather-protected locations according to the standard DIN IEC 60721-3-3. The environmental effects and their limit values are defined in various classes in this standard.

With the exception of environmental parameters "Low air temperature" and "Low air pressure", the motors satisfy climate class 3K3.

Table 3-2 **Ambient conditions are based on climate class 3K3**

Ambient parameter		Unit	Value
a)	Low air temperature	°C	- 5
b)	High air temperature	°C	+ 40
c)	Low relative humidity	%	5
d)	High relative humidity	%	85
e)	Low absolute humidity	g/m³	1
f)	High absolute humidity	g/m³	25
g)	Rate of temperature change[1)]	°C/min	0.5

Ambient parameter		Unit	Value
h)	Low air pressure[4)]	kPa	78.4
i)	High air pressure[2)]	kPa	106
j)	Solar radiation (insolation)	W/m^2	700
k)	Thermal radiation	-	-
l)	Air movement[3)]	m/s	1.0
m)	Condensation	-	Not permissible
n)	Wind-driven precipitation (rain, snow, hail, etc.)	-	-
o)	Water (other than rain)	-	See degree of protection
p)	Formation of ice	-	-

1) Averaged over a period of 5 min

2) Conditions in mines are not considered.

3) A cooling system based on natural convection can be disturbed by unforeseen air movements.

4) The limit value of 78.4 KPa covers altitudes up to 2000 m.

Additional ambient conditions applicable for the motors for stationary use at weather-protected locations according to standard DIN IEC 60721-3-3 include.

Mechanically active ambient conditions	Class 3S1
Mechanical ambient conditions	Class 3M3

Note

Installation instructions

The motors are not suitable for operation

- In salt-laden or corrosive atmospheres
- Outdoors

You can find additional data on the environmental conditions, such as ambient temperatures or conditions for transport and storage of the motors, in the relevant chapters of this documentation.

3.1.6 Degree of protection

NOTICE

Damage to the motor caused by pollution

If the area where the motor is installed is polluted and dirty, then the motor can malfunction and clog up.

- Keep the area where the motor is installed free of all dirt and pollution.

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.

1FW6 torque motors have degree of protection IP23.

3.1.7 Noise emission

⚠ WARNING

Hearing damage

Hearing damage may occur if the motor exceeds a sound pressure level of 70 dB (A) due to the type of mounting or pulse frequency.

- Reduce the sound pressure level by implementing sound damping and/or soundproofing measures.

The following components and settings influence the noise levels reached when built-in motors are operational:

- Machine design
- Encoder system
- Bearing
- Controller settings
- Pulse frequency

As a result of unfavorable machine designs, configuration or system settings, measuring surface sound pressure levels of over 70dB (A) can occur. Contact Application & Mechatronic Support Direct Motors if you require help in applying remedial measures. You can find contact data in the Introduction under "Technical Support".

3.1.8 Vibration response

The vibration response of build-in motors in operation essentially depends on the machine design and the application itself.

As a result of an unfavorable machine design, configuration or system settings, resonance points can be excited, so that vibration severity level A according to EN 6003414 is not reached.

Excessive vibration caused by resonance effects can frequently be avoided by making suitable settings. Contact Application & Mechatronic Support Direct Motors if you require help in applying remedial measures. You can find contact data in the Introduction under "Technical Support".

3.2 Derating factors

For installation altitudes more than 2000 m above sea level, reduce the voltage stress of the motors according to the "Factors to reduce the maximum DC link voltage" table (reciprocal values from EN 60664-1 Table A. 2).

Table 3-3 Factors to reduce the maximum DC link voltage

Installation altitude above sea level in m up to	Factor
2000	1
3000	0.877
4000	0.775
5000	0.656
6000	0.588
7000	0.513
8000	0.444

Reducing the DC link voltage reduces the converter output voltage. The operating range in the M-n diagram is also reduced.

You can find the M-n diagrams in the associated data sheet.

Operation in a vacuum is not permissible due to the low voltage strength and the poor cooling.

3.3 Rating plate data

Technical data of the stator is provided on the rating plate (name plate). A second rating plate is provided loose for the stator.

If, at a certain point in time, the stator and rotor are separated, then you must ensure that the stator and rotor can be assigned to one another at a later point in time.

Data on the rating plate

Note

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

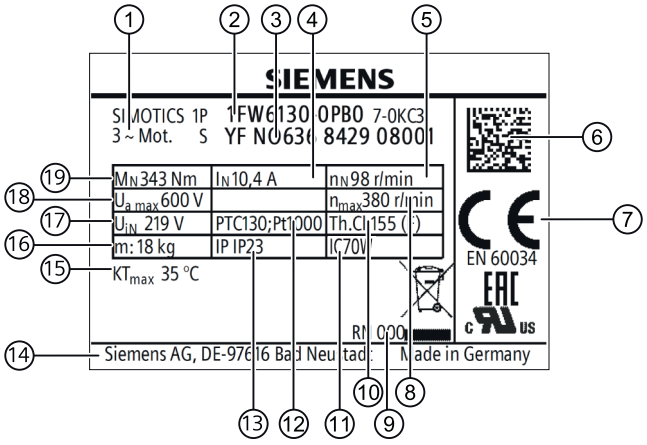


Figure 3-4 Example of a rating plate for 1FW6 built-in torque motors

Table 3-4 Data on the rating plate for 1FW6 built-in torque motors

Position	Description
1	Type of motor
2	Article No.
3	Serial number
4	Rated current I_N
5	Rated speed n_N
6	2D code, contains the motor data
7	Approvals/conformities
8	Maximum speed n_{max}
9	Motor version
10	Temperature class
11	Cooling method
12	Temperature sensors
13	Degree of protection
14	Manufacturer
15	Max. coolant temperature at which the ratings are reached
16	Weight
17	Induced voltage U_{iN} at rated speed n_N
18	Maximum permissible rms value of the motor terminal voltage $U_{a\,max}$
19	Rated torque M_N

3.4 Design

3.4.1 Motor components

3.4.1.1 Motor design

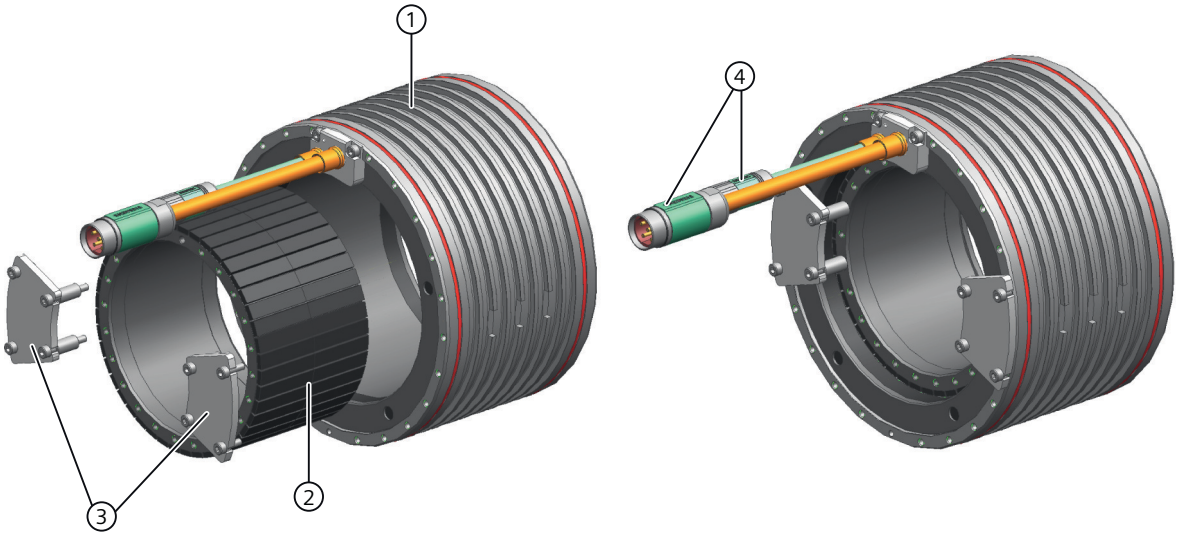
The built-in torque motor contains the following components:

- Stator
  The stator comprises an iron core and a 3-phase winding.
  The winding is potted to ensure that the power loss can be dissipated more effectively. For liquid cooling, the motor uses water as coolant (main cooler). The cooling system design depends on the frame size (outer diameter) of the motor, refer to the "Cooling method" table at the end of this chapter.
- Rotor
  The rotor is the reaction part of the motor and consists of a cylindrical hollow steel shaft with permanent magnets attached around its circumference.
- Cooling connection adapter (option)
  For motors with integrated cooling, you can purchase a cooling connection adapter for main and precision coolers connected in parallel to a cooling unit.

3.4.1.2 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 machine OEM must provide the coolant intake and return at the surrounding machine assembly.



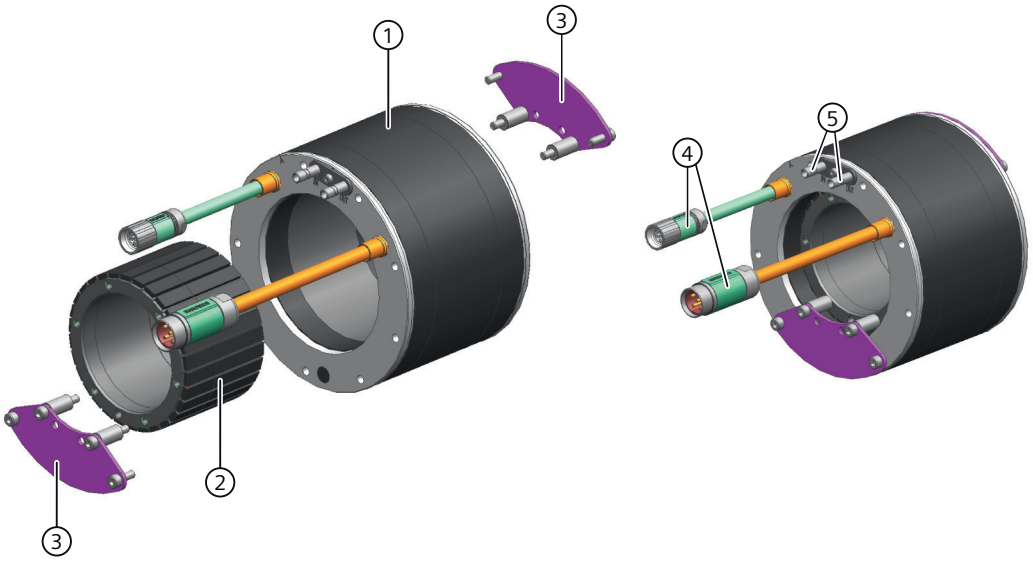
① Stator with cooling jacket
② Rotor with permanent magnets
③ Transport locks
④ Electrical connections

Figure 3-5 Motor components of the 1FW6090, 1FW6130 and 1FW6150 built-in torque motors with cooling jacket

3.4.1.3 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.



① Stator with integrated cooling
② Rotor with permanent magnets
③ Transport lock
④ Electrical connections
⑤ Cooler connection

Figure 3-6 Motor components of the 1FW6050 and 1FW6060 built-in torque motors with integrated cooling (1 cooling circuit)

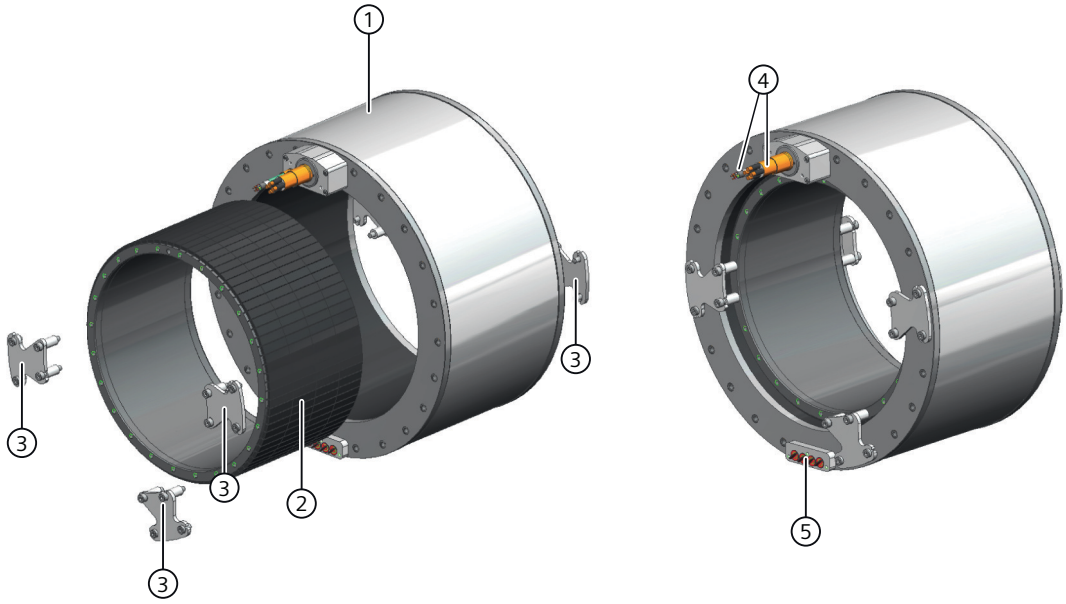
Motors with integrated dual-circuit cooling

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.



① Stator with integrated cooling
② Rotor with permanent magnets
③ Transport lock
④ Electrical connections
⑤ Cooler connection

Figure 3-7 Motor components of the 1FW6160 to 1FW6290 built-in torque motors with integrated cooling (2 cooling circuits)

3.4.1.4 Cooling method

Built-in torque motor stators are equipped with a liquid cooler to dissipate power loss.

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

Table 3-5 Cooling method

Frame size	Cooling jacket	Integrated cooling with one cooling circuit (only main cooler)	Integrated cooling with two cooling circuits (main cooler and precision cooler)
1FW6050		X	
1FW6060		X	
1FW6090	X		
1FW6130	X		
1FW6150	X		
1FW6160			X
1FW6190			X

Frame size	Cooling jacket	Integrated cooling with one cooling circuit (only main cooler)	Integrated cooling with two cooling circuits (main cooler and precision cooler)
1FW6230			X
1FW6290			X

3.4.2 Scope of delivery

3.4.2.1 Preassembled built-in torque motors with cooling jacket

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

Note

Supplied as individual components

Stator and rotor as individual components are supplied without transport locks with spacers and screws.

A spacer foil is supplied with stators as individual components.

3.4.2.2 Preassembled built-in torque motor with integrated cooling

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

Note

Supplied as individual components

Stator and rotor as individual components are supplied without transport locks with spacers and screws.

A spacer foil is supplied with stators as individual components.

3.4.2.3 Supplied pictograms

To warn of hazards, the following durable adhesive stickers are supplied:

Table 3-6 Warning signs provided according to BGV A8 and DIN EN ISO 7010 and their significance

Sign	Meaning	Sign	Meaning
	Warning against magnetic field (W006)		Warning against hand injuries (W024)
	Warning against electric voltage (W012)		Warning against hot surface (W017)

Table 3-7 Prohibit signs provided according to BGV A8 and DIN EN ISO 7010 and their significance

Sign	Meaning	Sign	Meaning
	No access for persons with pacemakers or implanted defibrillators (P007)		No access for persons with metal implants (P014)
	Prohibited to carry/wear metal parts or watches (P008)		

Note

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

Any danger areas encountered during normal operation and when maintaining and servicing the motor must be identified using clearly visible warning and prohibit 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.

3.4.3 Cooling

3.4.3.1 Cooling circuits

Cooling circuit requirements

Avoid algae growth by using suitable chemical agents and opaque water hoses or tubes.

We recommend that the cooling circuits be designed as closed systems. The maximum permissible pressure is 10 bar.

NOTICE
Blocked and clogged cooling circuits Cooling circuits can become blocked and clogged as a result of pollution and longer-term deposits. • We recommend that you use a separate cooling circuit to cool the motors.

- If you use the machine cooling circuits to also cool the motors, you must ensure that the coolant fully complies with the requirements listed in this chapter.
- Also note the maximum non-operational times of cooling circuits corresponding to the coolant manufacturer's data.

Interconnecting cooling circuits

NOTICE
Leaks associated with rigid connections Rigid connections between the cooling circuits can lead to problems with leaks. • Use flexible connections (hoses) when interconnecting cooling circuits.

Note

Connecting cooling circuits in parallel

If you connect the cooling circuits of the stator in series, coolant at different temperatures flows through the cooling circuits.

- Connect the stator cooling circuits in parallel. This ensures that coolant flows through each stator with the same intake temperature.

Ensure the same pressure drop and an even flow in every stator.

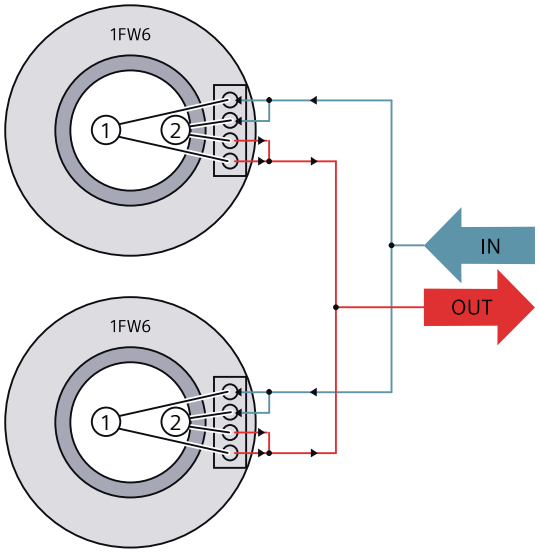
Influencing variables in this regard are:

- Pipe lengths
- Pipe material
- Pipe cross-section

- Pipe routing
- Regulation of the flow rate

Example for interconnecting cooling circuits

The following diagram shows an example of the cooling circuits of 2 stators with main and precision cooler connected in parallel. Due to the chosen positions for the water intake (IN) and the water outlet (OUT), all cooling circuits contain an even flow. As far as cooling is concerned, it does not make any difference in which direction the coolant flows through the cooling circuit.



① Main cooler connection
② Precision cooler connection

Figure 3-8 Parallel connection of cooling circuits (example, schematic diagram)

Materials used in the cooling circuits of torque motors

Table 3-8 Materials in the cooling circuits of torque motors (not including the material used for the connections)

Cooling jacket	Integrated cooling (main cooler)	Integrated cooling (precision cooler)	Cooling connection adapter
1FW6090, 1FW6130: • EN AW-5083 (EN 573-3) • Viton® (FPM) gasket **1FW615x*):** • S355J2G3 (EN 10025) • Viton® (FPM) gasket	**1FW6050, 1FW6060:** • X10CrNiS18-9 (DIN 17440) • SF-Cu (DIN 17671) • Viton® (FPM) gasket **1FW6160, 1FW619x*), 1FW623x*), 1FW6290:** • X6CrNiTi18-10 (EN 10088) • SF-Cu (DIN 17671) • CW617N (DIN EN 12449 / DIN EN 12167) • Viton® (FPM) gasket • Ag 102 (EN 1045) + welding flux EN 1045-FH10	**1FW6160, 1FW619x*), 1FW623x*), 1FW6290:** • X6CrNiTi18-10 (EN 10088) • SF-Cu (DIN 17671) • CW617N (DIN EN 12449) • Viton® (FPM) gasket	**1FW6160, 1FW619x*), 1FW623x*), 1FW6290:** • CW617N (DIN EN 12449 / DIN EN 12167) • Viton® (FPM) gasket

*) Applicable for the corresponding frame size, also for 1FW6 High Speed built-in torque motors

NOTICE

Corrosion as a result of unsuitable materials used to connect the cooler

Corrosion damage can occur if you use unsuitable materials to connect to the cooler.

- We recommend that you use brass or stainless steel fittings when connecting the cooler.

Coolant inlet temperature

NOTICE
Corrosion in the machine Condensation can lead to corrosion in the machine. • Choose inlet temperatures that prevent condensation from forming on the surface of the motor. Condensation does not occur if the intake temperature T_{VORL} is higher than the ambient temperature - or corresponds to the ambient temperature.

The rated motor data refer to operation at a coolant inlet temperature of 35 °C. If the intake temperature is different, then the continuous motor current changes as shown in the following diagram.

Note

For a cooler intake temperature of < 35 °C, the possible continuous motor current is greater I_0. I_0 is the current (rms value) of the stator at torque M_0 and speed n = 1 r/min.

Larger cable cross-sections may be required. This means that you must take into account the rated current of the cables.

The following diagram shows the principle dependency of the relevant continuous motor current on the intake temperature of the cooling water in the main cooler. The rotor losses are omitted as negligible.

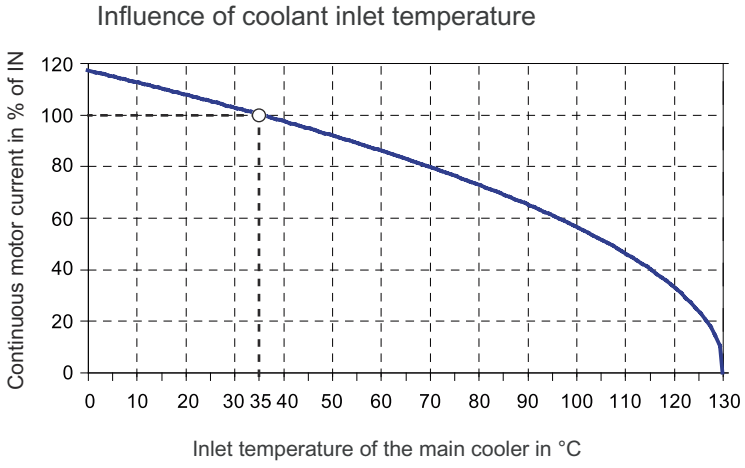


Figure 3-9 Influence of the coolant inlet temperature

3.4.3.2 Coolant

Providing the coolant

The customer must provide the coolant. The motors are designed for water cooling. The water must comply with the requirements corresponding to the corrosion protection agent.

Note

Power derating when using oil as coolant

If you are using oil as coolant, then this can reduce the power loss dissipated by the cooler. Appropriately reduce the motor power. Contact your local sales partner if you have any questions.

Use water with anti-corrosion protection agent

If you use water with corrosion protection agent as coolant, you can avoid scaling and the formation of algae and slime as well as corrosion.

This allows you to avoid the following damage and/or faults, for example:

- Worsening of the heat transfer
- Higher pressure losses due to restricted cross-sections
- Blockage of nozzles, valves, heat exchangers and cooling ducts

General requirements placed on the coolant

The coolant must be pre-cleaned or filtered in order to prevent the cooling circuit from becoming blocked. Formation of ice is not permissible.

Note

The maximum permissible size of particles in the coolant is 100 µm.

Requirements placed on the water

Water, which is used as basis for the coolant must comply as a minimum with the following requirements:

- Chloride concentration: $c < 100$ mg/l
- Sulfate concentration: $c < 100$ mg/l
- $6.5 \leq$ pH value ≤ 9.5

Coordinate additional requirements with the manufacturer of the anti-corrosion agent.

Requirements placed on the corrosion protection agent

The corrosion protection agent must comply with the following requirements:

- Basis is ethylene glycol (also "Ethandiol").
- Water and anticorrosion protection agent do not separate.
- The freezing point of the water used must be reduced down to at least -5 °C.
- The corrosion protection agent used must be compatible with the fittings and hoses of the cooling system as well as the materials used in the motor cooler.

Coordinate these requirements, especially the material compatibility, with the cooling equipment manufacturer and the manufacturer of the corrosion protection 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

Recommended manufacturers are listed in the Appendix.

3.4.4 Temperature monitoring and thermal motor protection

3.4.4.1 Temperature monitoring circuits Temp-S and Temp-F

The motors are equipped with the two temperature monitoring circuits - Temp-S and Temp-F - that are described below.

- Temp-S activates the thermal motor protection when the motor windings are thermally overloaded. In this case the precondition is that Temp-S is correctly connected and evaluated. For a thermal overload, the drive system must bring the motor into a no-current condition.
- Temp-F is used for temperature monitoring and diagnostics during commissioning and in operation.

Both temperature monitoring circuits are independent of one another.

For example, the SME12x Sensor Module or the TM120 Terminal Module evaluates the temperature sensor signals.

You can obtain commissioning information from Technical Support. Contact data is provided in the introduction.

Temp-S

All motors are equipped with the following temperature monitoring circuit to protect the motor winding against thermal overload:

- 1 x PTC 130 °C temperature sensor per phase winding U, V and W, i.e. response threshold at 130 °C

In addition, 1FW6090-xxxxx-xxx2 to 1FW6290-xxxxx-xxx2 motors are equipped with the following temperature monitoring circuit:

- 1 x PTC 150 °C temperature sensor for each phase winding U, V and W, response threshold at 150 °C

The three PTC temperature sensors (PTC thermistor temperature sensors) of this temperature monitoring circuit are connected in series with a PTC triplet.

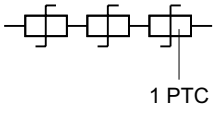


Figure 3-10 PTC triplet

To protect the power connection at the enclosure against thermal overload, an additional PTC 80 °C is connected in series with the PTC 130 °C triplet. For stators of 1FW6090-xxxxx-xxx2 to 1FW6290-xxxxx-xxx2, an additional PTC 80 °C is connected in series with the PTC 150 °C triplet.

Every phase winding is monitored so that also uneven currents - and therefore the associated different thermal loads of the individual phase windings - are detected. For the following motion and/or operating states, the individual phase windings have different thermal loads, while the motor simultaneously outputs a torque:

- At standstill (holding)
- When rotating very slowly
- Oscillation through a very small angle

Note

Shutdown time

If Temp-S responds, and its response threshold is not undershot again in the meantime, then the drive system must shut down (de-energize) the motor within 2 seconds. This prevents the motor windings from becoming inadmissibly hot.

NOTICE
Motor destroyed as a result of overtemperature The motor can be destroyed if the motor winding overheats. • Connect Temp-S. • Evaluate Temp-S. • Ensure that the shutdown time is not exceeded.

Note

No temperature monitoring with Temp-S

As a result of their non-linear characteristic, PTC temperature sensors are not suitable for determining the instantaneous temperature.

Temp-F

The Temp-F temperature monitoring circuit comprises an individual temperature sensor. Contrary to Temp-S, this temperature sensor only monitors one phase winding. As a consequence, Temp-F is only used for monitoring the temperature and diagnosing the motor winding temperature.

NOTICE

Motor destroyed as a result of overtemperature

If you use Temp-F for thermal motor protection, then the motor is not adequately protected against destruction as a result of overtemperature.

- Evaluate the Temp-S temperature monitoring circuit to implement thermal motor protection.

Types of temperature monitoring circuits

Article No.	Temp-S (PTC 130 °C), Temp-F (KTY 84)	Temp-S (PTC 130 °C), Temp-F (Pt1000)	Temp-S (PTC 130 °C and PTC 150 °C), Temp-F (KTY 84)
1FW6050-xxxxx-xxx1 *)	X		
1FW6050-xxxxx-xxx3		X	
1FW6060-xxxxx-xxx1 *)	X		
1FW6060-xxxxx-xxx3		X	
1FW6090-xxxxx-xxx2 *)			X
1FW6090-xxxxx-xxx3		X	
1FW6130-xxxxx-xxx2 *)			X
1FW6130-xxxxx-xxx3		X	
1FW6150-xxxxx-xxx2 *)			X
1FW6150-xxxxx-xxx3		X	
1FW6160-xxxxx-xxx2 *)			X
1FW6160-xxxxx-xxx3		X	
1FW6190-xxxxx-xxx2 *)			X
1FW6190-xxxxx-xxx3		X	

Article No.	Temp-S (PTC 130 °C), Temp-F (KTY 84)	Temp-S (PTC 130 °C), Temp-F (Pt1000)	Temp-S (PTC 130 °C and PTC 150 °C), Temp-F (KTY 84)
1FW6230-xxxxx-xxx2 *)			X
1FW6230-xxxxx-xxx3		X	
1FW6290-xxxxx-xxx2 *)			X
1FW6290-xxxxx-xxx3		X	

*) These motors and/or stators are now only available as spare part.

Temp-F as KTY 84 or Pt1000

The 16th Position of the order designation on the stator rating plate indicating as to whether a KTY 84 or a Pt1000 is installed, see Rating plate data (Page 37):

1FW6xxx-xxxxx-xxx1: with KTY 84

1FW6xxx-xxxxx-xxx2: with KTY 84

1FW6xxx-xxxxx-xxx3: with Pt1000

No direct connection of the temperature monitoring circuits

⚠ WARNING

Risk of electric shock if the temperature monitoring circuits are incorrectly connected

In the case of a fault, circuits Temp-S and Temp-F do not provide safe electrical separation with respect to the power circuits.

- Use the TM120 or SME12x to connect temperature monitoring circuits Temp-S and Temp-F. You therefore comply with the directives for safe electrical separation according to DIN EN 61800-5-1 (previously safe electrical separation according to DIN EN 50178).

Correctly connecting temperature sensors

NOTICE

Motor destroyed as a result of overtemperature

The motor can be destroyed as a result of overtemperature if you do not correctly connect the temperature sensors.

- When connecting temperature sensor cables with open conductor ends, adhere to the correct assignment of conductor colors as described in "Signal connection (Page 101)".

3.4.4.2 Technical features of temperature sensors

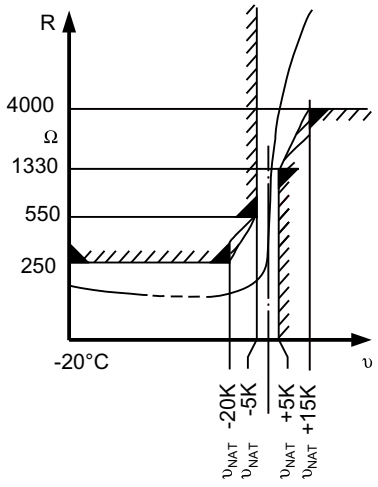
Technical features of PTC temperature sensors

Every PTC temperature has a "quasi-switching" characteristic. The resistance suddenly increases in the vicinity of the response threshold (nominal response temperature ϑ_{NAT}).

PTC temperature sensors have a low thermal capacity - and have good thermal contact with the motor winding. As a consequence, the temperature sensors and the system quickly respond to inadmissibly high motor winding temperatures.

Table 3-9 Technical data of the PTC temperature sensors

Name	Description
Type	PTC triplet acc. to DIN 44082 Individual PTC temperature sensor according to DIN 44081
Response threshold (nominal response temperature ϑ_{NAT})	150 °C ± 5 K 130 °C ± 5 K 80 °C ± 5 K
Resistance when cold R (20 °C) in the PTC triplet and in the individual PTC temperature sensor	See characteristic **at -20 °C < T < ϑ_{NAT} -20 K** R ≤ 3 x 250 Ω + 1 x 250 Ω R ≤ 1000 Ω

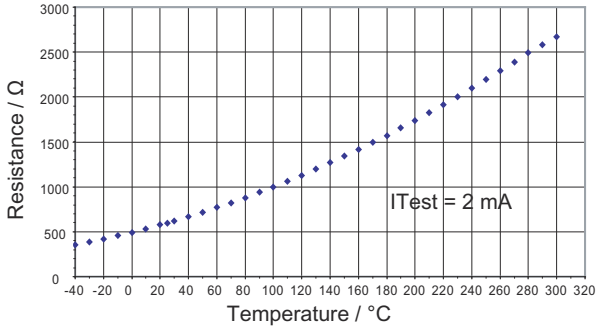
Name	Description
Minimum resistance when hot R in the PTC triplet and in the individual PTC temperature sensor	See characteristic **at T ≤ ϑ_{NAT} – 5 K** R ≤ 3 x 550 Ω + 1 x 550 Ω R ≤ 2200 Ω **at T > ϑ_{NAT} + 5 K** R ≥ 3 x 1330 Ω + 1 x 1330 Ω R ≥ 5320 Ω **at T > ϑ_{NAT} + 15 K** R ≥ 3 x 4000 Ω + 1 x 4000 Ω R ≥ 16000 Ω
Typical characteristic R(ϑ) of a PTC temperature sensor according to DIN 44081	

Technical features of the KTY 84 temperature sensor

The KTY 84 has a progressive temperature resistance characteristic that is approximately linear. In addition, the KTY 84 has a low thermal capacity and provides good thermal contact with the motor winding. The KTY 84 has a continuous characteristic.

Table 3-10 Technical data of the KTY 84 PTC thermistor

Name	Description
Type	KTY 84 according to EN 60034-11
Transfer range	-40 °C ... +300 °C
Resistance when cold (20 °C)	ca. 580 Ω

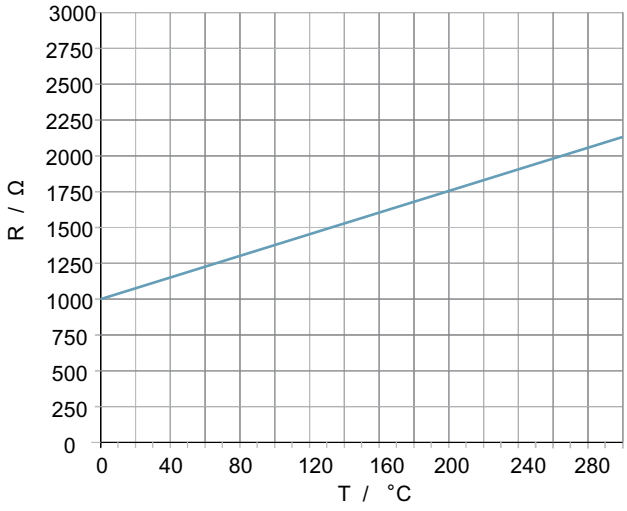
Name	Description
Resistance when warm (100 °C)	ca. 1000 Ω
Characteristic of a KTY 84	

Technical features of the Pt1000 temperature sensor

The Pt1000 has a linear temperature resistance characteristic. In addition, the Pt1000 has a low thermal capacity and provides good thermal contact with the motor winding.

Table 3-11 Technical data of the Pt1000 PTC thermistor

Name	Description
Type	Pt1000 according to EN 60751
Transfer range	0 °C ... +300 °C
Resistance when cold (20 °C)	ca. 1080 Ω

Name	Description
Resistance when warm (100 °C)	ca. 1380 Ω
Characteristic of a Pt1000	

System requirements for the Pt1000 temperature sensor

To use the Pt1000 together with the following systems, you will need at least the specified versions:

SINAMICS S120 Firmware V4.8 and V4.7 HF17

SINUMERIK V4.8 as well as V4.7 SP2 HF1 and V4.5 SP6

SIMOTION V4.5 (SINAMICS Integrated Firmware V4.8)

Preparation for use

4

⚠ WARNING

Risk of death and crushing as a result of permanent magnet fields

Severe injury and material damage can result if you do not take into consideration the safety instructions relating to permanent magnet fields.

- Refer to Chapter "Danger from strong magnetic fields (Page 28)".

Keep these operating instructions so that they are accessible at all times. Please provide these operating instructions to the appropriate personnel.

⚠ WARNING

Incorrect packaging, storage and/or incorrect transport

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

- Always follow the safety instructions for storage and transport.
- Before transporting or lifting machines or parts machines, lock the rotary axes so the they cannot accidentally rotate. This is necessary, as the axes are not self locking.
- Always correctly and carefully carry out storage, transport and lifting operations.
- Only use suitable devices and equipment that are in perfect condition.
- Only use lifting devices, transport equipment and suspension equipment that comply with the appropriate regulations.
- IATA regulations must be observed when components are transported by air.
- Mark locations where rotors are stored with warning and prohibition signs according to the tables in the Chapter "Supplied pictograms"
- Observe the warning instructions on the packaging.
- Always wear safety shoes and safety gloves.
- Take into account the maximum loads that personnel can lift and carry. The motors and their components can weigh more than 13 kg.
- Torque motors and rotors must always be transported and stored in the packaged condition.
  - Replace any defective packaging. Correct packaging offers protection against sudden forces of attraction that can occur in their immediate vicinity. Further, when correctly packaged you are protected against hazardous motion when storing and moving rotors.
  - Only use undamaged original packaging.

4.1 Shipping and packaging

When shipping products that contain permanent magnets by sea or road, no additional packaging measures are required for protection against magnetic fields.

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

Table 4-1 Warning signs according to BGV A8 and DIN EN ISO 7010 and their significance

Sign	Meaning	Sign	Meaning
	Warning: strong magnetic field (W006)		Warning: hand injuries (W024)

Table 4-2 Prohibit signs according to BGV A8 and DIN EN ISO 7010 and their significance

Sign	Meaning	Sign	Meaning
	No access for persons with pacemakers or implanted defibrillators (P007)		No access for persons with metal implants (P014)
	No metal objects or watches (P008)		

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)

Note

Original packaging

Keep the packaging of components with permanent magnets where possible!

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

4.2 Transporting and storage

Note

UN number for permanent magnets

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

NOTICE

Damage to the motor when incorrectly lifted

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.
- Screw the lifting eyebolts symmetrically into the tapped holes on the flat motor (or stator/rotor).
- Only lift motors (or stators/rotors) when they are in a horizontal position.
- 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).

⚠ WARNING

Risk of toppling over

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

- Never stack packed or unpacked motors, stators or rotors on top of one another.
- Only transport and store motors, stators and rotors in the horizontal position.
- Observe the safety instructions and handling on the packaging.

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.

4.2.1 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 IATA packaging instruction 953. If the values change, 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 (country of origin) 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.

Shipping originally packed motor components neither has to be disclosed nor marked.

4.2.2 Ambient conditions for long-term storage and transport

Based on DIN EN 60721-3-1 (for long-term storage) and DIN EN 60721-3-2 (for transport)

Table 4-4 Climatic ambient conditions

Lower air temperature limit for long-term storage:	- 5 °C (deviates from 3K3)
Lower air temperature limit for transport:	- 15 °C
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

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

Table 4-5 Biological ambient conditions

Long-term storage:	Class 1B1
Transport:	Class 2B1

Table 4-6 Chemical ambient conditions

Long-term storage:	Class 1C1
Transport:	Class 2C1

Table 4-7 Mechanically active ambient conditions

Long-term storage:	Class 1S2
Transport:	Class 2S2

Table 4-8 Mechanical ambient conditions

Long-term storage:	Class 1M2
Transport:	Class 2M2

4.2.3 Storage

Storing indoors

- Apply a preservation agent (e.g. Tectyl) to bare external motor components if this has not already been carried out in the factory.
- Store the motors as described in Section "Ambient conditions for long-term storage and transport". The storage room/area must meet the following conditions:
  - Dry
  - Dust-free
  - Free of vibration
  - Well ventilated
  - Protected against extreme weather conditions
  - The air inside the room or space must be free of any 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. Then wrap it in foil so that it is air tight.
- Include several bags of desiccant in the sealed packaging. Check the desiccant and replace it as required.
- Place a humidity meter in the sealed packaging to indicate the level of air humidity inside it.
- Inspect the motor on a regular basis.

Protecting the cooling system for motors with integrated cooling

Before you store the motor after use, perform the following actions:

- Empty the cooling channels.
- Blow out the cooling ducts with dry, compressed air so that the cooling ducts are completely empty.
- Seal the connections of the cooling system.

Installation

5

5.1 Safety instructions relating to installation

⚠ WARNING

Risk of death and crushing as a result of permanent magnet fields

Severe injury and material damage can result if you do not take into consideration the safety instructions relating to permanent magnet fields.

- Refer to Chapter "Danger from strong magnetic fields (Page 28)".

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

Only remove the transport locks when installing the torque motor in the mechanical axis assembly. On this topic, see Chapter "Procedure for installing the motor".

⚠ WARNING

Risk of rotor permanent magnets causing crushing injuries

The forces of attraction of magnetic rotors act on materials that can be magnetized. The forces of attraction increase significantly close to the rotor. The response threshold of 3 mT for risk of injury through attraction and causing a projectile effect is reached at a distance of 100 mm (Directive 2013/35/EU). Rotors and materials that can be magnetized can suddenly slam together unintentionally. Two rotors can also unintentionally slam together.

There is a significant risk of crushing when you are close to a rotor.

Close to the motor, the magnetic forces of attraction can be up to several kN. – Example: Magnetic attractive forces are equivalent to a force of 100 kg, which is sufficient to trap a body part.

- Do not underestimate the strength of the attractive forces, and work very carefully.
- Wear safety gloves.
- The work should be done by at least two people.
- Do not unpack the rotor until immediately before assembly.
- Never unpack several rotors at once.
- Never place the rotors directly next to one another without providing adequate protection.
- Never carry any objects made of magnetizable materials (for example watches, steel or iron tools) and/or permanent magnets close to the rotor! If tools that can be magnetized are still required, then hold any tool firmly using both hands. Slowly bring the tool to the rotor.
- Immediately install the rotor after it has been unpacked.
- Use a special installation device when centering and assembling the stator and rotor as individual components. Maintain the special procedure.
- Keep the following tools at hand to release parts of the body (hand, fingers, foot etc.) trapped between two components:
  - A hammer (about 3 kg) made of solid, non-magnetizable material
  - Two pointed wedges (wedge angle approx. 10° - 15°, minimum height 50 mm) made of solid, non-magnetizable material (e.g. hard wood)

NOTICE

Destruction of the motor

If you fix the rotor and/or stator at both ends, this can result in significant material deformation in the machine assembly due to thermal expansion. Further, if the stator is mounted at both ends, high mechanical loads can be transmitted through the stator, which could destroy the motor.

- Only fix the stator and rotor at one end.

⚠ WARNING

Electric shock caused by defective cables

Defective connection 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 (see "Important data for 1FW6 cables (Page 94)").
- Do not hold a motor by its cables.
- Do not pull the motor cables.

⚠ WARNING

Electrical shock hazard

Every movement of the rotor compared with the stator and vice versa induces a voltage at the stator power connections.

When the motor is switched on, the stator power connections are also at a specific voltage.

If you use defective cable ports, you could suffer an electric shock.

- Only mount and remove the electrical components if you are qualified to do so.
- Any work carried out at the motor must always be done with the system in a no-voltage condition.
- Do not touch the cable ports. Correctly connect the stator power connections, or insulate them properly.
- Do not disconnect the power connections when the stator is under voltage (live).
- Only use the specific power cables intended for the purpose.
- First connect the protective conductor (PE).
- Connect the cable shield through a wide area.
- First connect the power cable to the stator before you connect the power cable to the inverter.
- First disconnect the connection to the inverter before you disconnect the power connection to the stator.
- Disconnect the protective conductor PE last.

⚠ CAUTION

Risk of crushing when the rotor is installed

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

- Wear safety gloves.
- Take extreme care when performing any work.

⚠ CAUTION

Sharp edges and falling objects

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

- Always wear safety shoes and safety gloves!

5.2 Forces that occur between the stator and rotor

Radial and axial forces

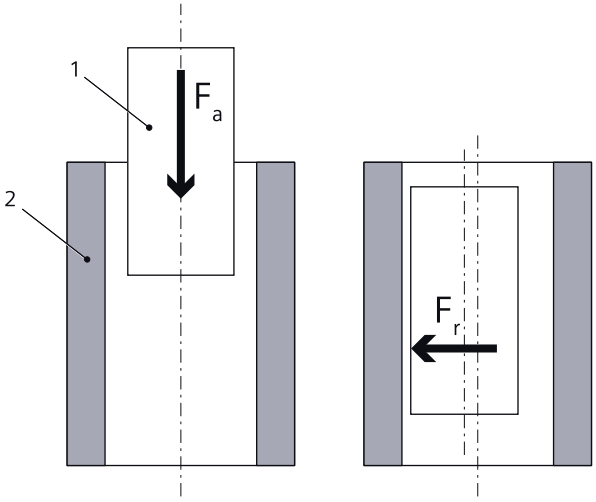


Figure 5-1 Active forces when stators and rotors are installed

1 Rotor with permanent magnets

2 Stator

F_a Axial attractive force

F_r Radial attractive force

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**
1FW6050	80	140	190	270	-	400	-
1FW6060	110	180	250	350	-	520	-

	Active length in mm						
	30	**50**	**70**	**100**	**110**	**150**	**200**
1FW6090	-	240	330	470	-	710	-
1FW6130	-	360	500	710	-	1070	-
1FW6150	-	330	460	660	-	990	-
1FW6160	-	290	410	590	-	880	1180
1FW6190	-	350	490	710	-	1060	1410
1FW6230	-	420	590	840	-	1260	1680
1FW6290	-	-	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. The maximum permissible concentricity error is specified in the dimension drawings in the "SIMOTICS T-1FW6 built-in torque motors" Configuration Manual.

Example

The eccentricity of a 1FW6090-0Px010-xxxx torque motor (active part length 100 mm) is 0.15 mm, for example.

The active radial force due to this centering error is therefore:

$$0.15\ \text{mm} \bullet \frac{470\ \text{N}}{0.1\ \text{mm}} = \underline{\underline{705\ \text{N}}}$$

Axial forces between the stator and rotor

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

	1FW6050	**1FW6060**	**1FW6090**	**1FW6130**	**1FW6150**	**1FW6160**	**1FW6190**	**1FW6230**	**1FW6290**
Axial forces in N	40	60	80	120	150	210	250	300	450

Note

When starting to insert the rotor into the stator, the axial forces of attraction between the stator and rotor are 4x to 5x higher.

At the end of the removal of the rotor from the stator, the axial forces of attraction between the stator and rotor are 4x to 5x higher.

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. When installing, observe the effective axial forces.

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 fixture must not have any play.

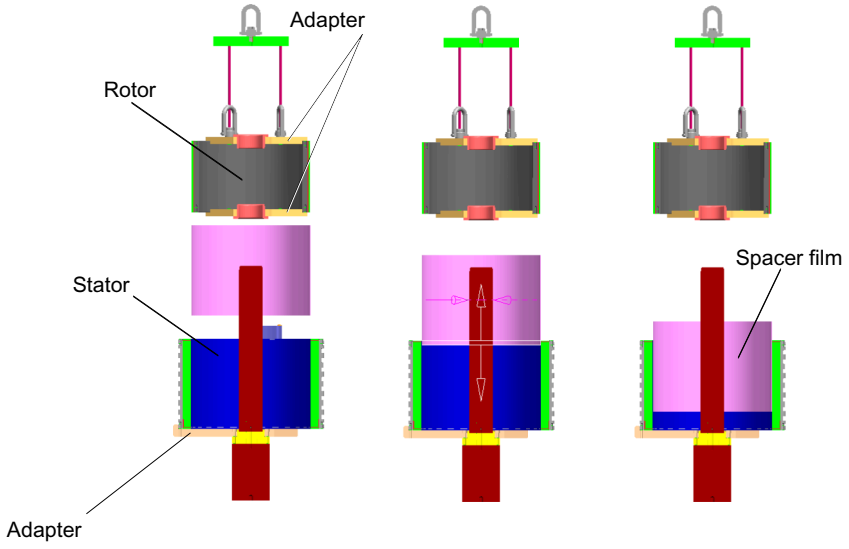
NOTICE
Destruction of the motor The stator and rotor must not come into contact with each other during centering and installation because damage cannot be ruled out. • Use the installation device during installation.

Example for centering and joining motors with cooling jacket

Procedure

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.

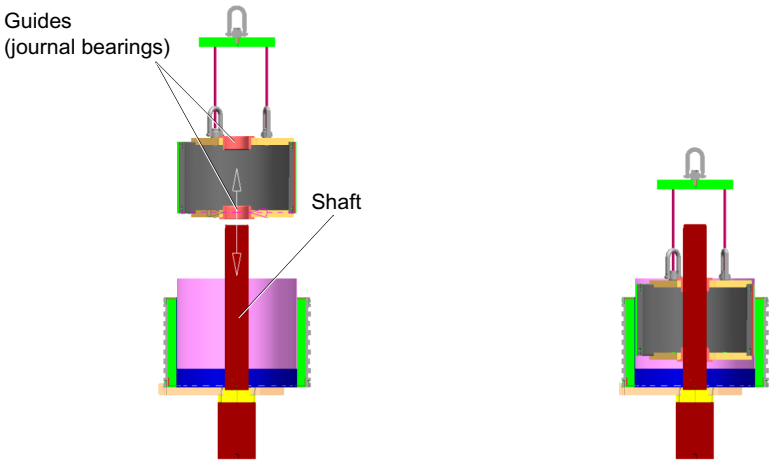
3. Insert the spacer film in the stator in such a way that approx. 1/4 of the spacer film protrudes.



The stator is positioned centered in the adapter of the lower joining fixture section

The rotor is positioned centered in the adapter of the upper joining fixture section

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.

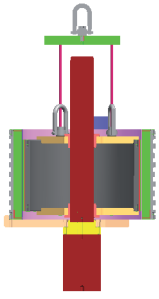


⚠ WARNING

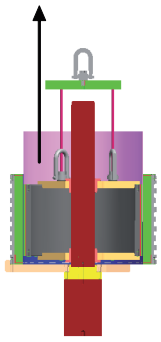
Risk of crushing when the rotor is lowered.

- 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 property 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 Specification of the installation side

Permissible installation side

Note

Only mount the stator and rotor on one side of the flange. It is not permissible to mount the stator and rotor at both flange sides.

As a result of the inherent design, for the following motors, mounting is only permissible 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		

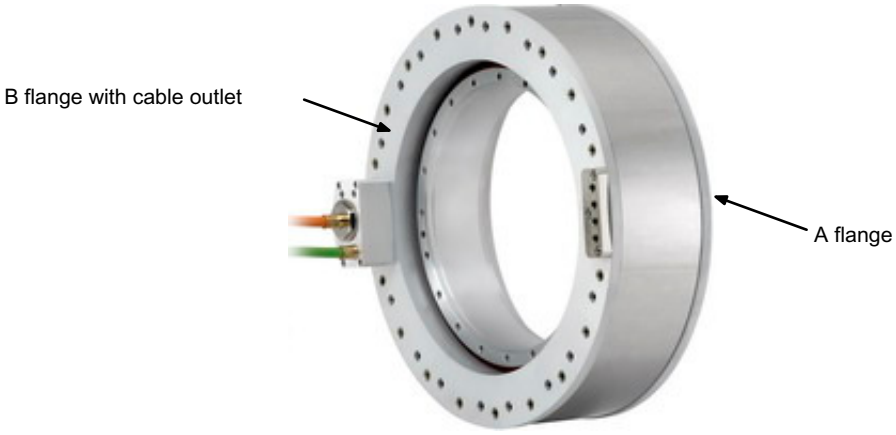


Figure 5-2 A flange and B flange

5.5 Specifications for integration in the machine

Fits for motors with integratedcooling

Built-in torque motor stators with integrated cooling have a centering collar at both flanges. In the factory, the centering collars are machined with tolerance class f8 with respect to the nominal dimensions. The outer diameter is always slightly below the nominal dimension.

Tolerance class H8 is recommended for the centering collar on the customer side in which you wish to insert the stator. The centering collar diameter always has its nominal dimension or is slightly larger.

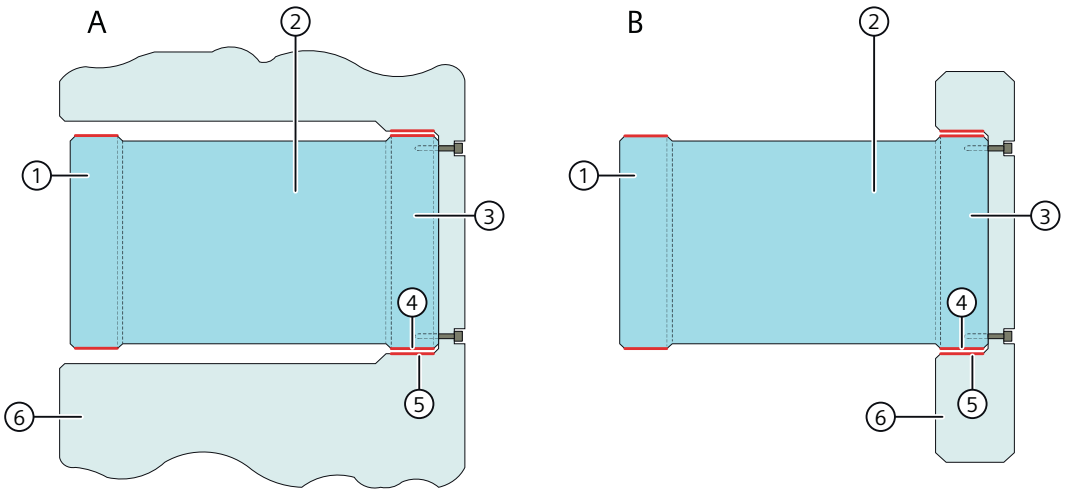
For motors with integrated cooling, a centering collar on the machine side as mating surface to the centering collar on the motor side is sufficient.

You may only insert motors with integrated cooling with the mounting flange in a centering collar.

It is not necessary to install the stator in a machine bore (enclosure).

However, if you do install the stator in a machine bore, then you must maintain a gap of at least 1.5 mm around the complete circumference to allow for thermal expansion of the stator, and more specifically:

- over the complete peripheral surface of the stator
- At the free flange



A	Installation with enclosure
B	Installation without enclosure
①	Free flange
②	1FW6 with integrated cooling
③	Mounting flange
④	Fit on the stator side: f8
⑤	Fit on the machine side: H8
⑥	Machine

Figure 5-3 Installation types, 1FW6 stator with integrated cooling (schematic)

5.6 Specifications for mounting torque motors

Mounting system

Consider the following when mounting the torque motor on the axis structure:

- Only use new (unused) fixing screws.
- The mounting surfaces must be free of oil and grease.
- Carefully observe the maximum permissible screw-in depth of the fixing screws in the stator and rotor according 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 1FW6050 and 1FW6060)
  1.3 x d (valid for 1FW6090 to 1FW6130)
  1.0 x d (valid for 1FW6150 and higher)
- Minimum insertion depth of the fixing screws in the rotor flange (in steel):
  1.1 x d (valid for 1FW6050 and 1FW6060)
  1.0 x d (valid for 1FW6090 to 1FW6290)

- 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.
- As a minimum, tighten the screws angle-controlled using a calibrated torque wrench with the shortest possible bit insert; always tighten in diagonally opposite (180°) pairs.
  You can increase the load capability of screw connections by employing an angle of rotation or yield strength controlled tightening technique.
- Tighten all the screws to minimize the risk of them penetrating other materials.

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

Motor	Screw (strength class)	Tightening torque M_A in Nm
1FW6050-xxB03-xxxx to 1FW6050-xxB15-xxxx	M6 (8.8)	9
1FW6060-xxB03-xxxx to 1FW6060-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

Motor	Screw (strength class)	Tightening torque M_A in Nm
1FW6290-xxB07-xxxx to 1FW6290-xxB15-xxxx	M10 (8.8)	43
1FW6290-xxB20-xxxx	M10 (10.9)	61.8

Note

Friction value

For the contact surface of the screw head and the screw thread, the friction value $\mu_{tot} = 0.1$ is taken as a basis.

- For smaller friction values, you must reduce the tightening torque and for larger friction values you must increase the tightening torque.
- 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

Component	max. permissible screw-in depth in mm	Thread
1FW6050, 1FW6060 / stator	8.5 + section without thread *)	M6
1FW6050, 1FW6060 / rotor	11	M6
1FW6090, 1FW6130 / stator and rotor	10	M5
1FW6150 / stator and rotor	12	M6
1FW6160, 1FW6190, 1FW6230 / stator	13	M8
1FW6160, 1FW6190, 1FW6230 / rotor	12	M8
1FW6290 / stator	15	M10
1FW6290 / rotor	15	M10

*) On this topic, see installation drawing "Detail Z"

5.7 Procedure for installing the motor

Sequence for installing the motor

⚠ WARNING

Risk of injury and material damage

Injury and/or destruction of motor components can occur if you do not observe the specified sequence when installing the motor.

- Perform work steps in the specified sequence during installation.

⚠ WARNING

Risk of electric shock

Every movement of the rotor relative to the stator and vice versa induces a voltage at the stator power connections. There is a risk of electric shock if you touch the power connections. Furthermore, in case of a phase short-circuit, short-circuit braking torques which prevent free rotation of the rotor can be generated.

- Insulate the open power connections properly.

⚠ WARNING

Danger of crushing

If you join the stator and rotor as individual components manually, there is a risk of crushing.

- Use a special joining device for centering and installing. Follow the description of the joining fixture.

Procedure

1. Prepare the mounting surfaces of the components to be mounted and the machine as follows:
   - Carefully remove machining debris, e.g. metal chips, dirt and foreign particles.
   - This point only applies to motors with cooling jacket, frame sizes 1FW6090, 1FW6130 and 1FW6150:
     Deburr and round off any interior drill holes (e.g. drill holes for coolant inlet and outlet) of the machine housing.

2. This point only applies to motors with cooling jacket, frame sizes 1FW6090, 1FW6130 and 1FW6150:
   Guide both O-rings over the cooling jacket surface of the motor into the grooves provided.
   - Do not overstretch the O-rings. Do not stretch the O-rings more than 10 %.
   - Lightly lubricate the O-rings. Pull the O-rings through an oil-soaked rag, for example. Take into account compatibility with the O-ring material (Viton fluoroelastomer).
   - Do not twist the O-rings.
   - Do not use any sharp objects!

3. Insulate uncovered power connections.

4. The following description applies to installed motors that are pre-assembled with transport locks:

   In the delivery state, the stators and rotors of frame size 1FW6090 and 1FW6130 are only equipped with transport locks on the flange surface with the cable outlet.

   For all other motors, the transport locks are mounted on both flange surfaces.

   If you want to secure motors of the size 1FW6090 or 1FW6130 on the cable outlet side, then you must first mount the transport locks on the opposing side.
   To do this, first loosen a transport lock. Mount the first transport lock on the other side. Then loosen the second transport lock and also mount the second transport lock on the other side.
   If there are still transport locks on the securing side, remove these transport locks.

   If you want to secure motors of different frame sizes, then you must remove the transport locks from the securing side.

   For problem-free mounting, you must loosen the opposing transport locks.

   Once you have removed or loosened transport locks, you may only move the motor with care.

   Keep the transport locks in a safe place. Keep the transport locks as they may be needed again in the case of maintenance and when removing the motor.

5. This point only applies to motors with cooling jackets, frame sizes 1FW6090, 1FW6130, and 1FW6150:
   Position the motor with the free flange surface pointing forward in the machined precisely dimensioned bore of the machine housing.
   O-rings must not be pressed out of the groove or damaged during this step.

   Ensure that the motor does not become tilted in the installation space during installation. Slight tilting of the motor can be remedied by careful blows with a rubber hammer on the flange.

6. Screw the flange face of the stator to the machine housing and the flange face of the rotor to the moving axis. In this case, observe the specified torques and the mounting technology specifications.

   A special mounting device is required when installing the stator and rotor on opposite flange faces on the machine construction.

7. Completely remove any existing transport locks.

8. Remove the spacer foil. When the stator and rotor are correctly centered, the spacer film can be easily removed by hand.
   Keep the spacer film. You may need the spacer film for subsequent transport, packaging and storage of the motor.

9. Check that the rotor can rotate freely. Ensure that the spacer film and any other foreign bodies are completely removed from the air gap.

10. Connect the coolant lines.

11. Connect the power and signal lines.

❒

5.8 Mechanical adjustment angle and EMF phase position

The EMF phase positions of motors connected in parallel must match one another. The maximum deviation within a particular EMF phase position may be 10° (or +/-5°) electrical. Otherwise, when mounting the motor you must correct the mechanical adjustment angle so that you maintain the specified tolerance for the EMF phase position.

The relationship between the EMF phase position (electrical angle) and the mechanical adjustment angle is shown in the following.

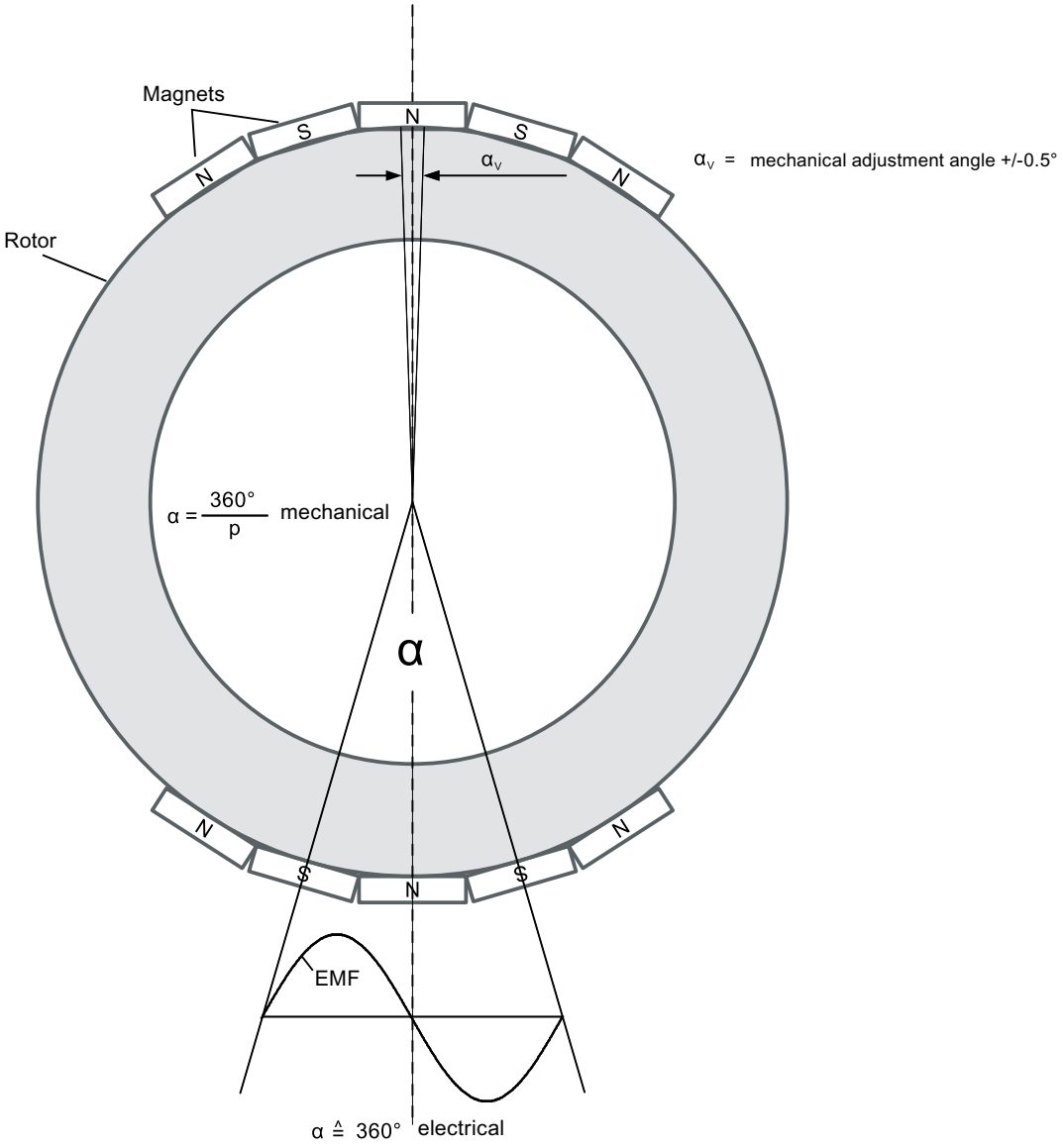


Figure 5-4 Mechanical adjustment angle for coupled motors

Table 5-6 Interrelationship between the electrical and mechanical angle

Frame size	5° electrical corresponds to mechanical	360° electrical corresponds to mechanical
1FW6050	0.4545°	32.72°
1FW6060	0.3333°	24.00°
1FW6090	0.2273°	16.36°
1FW6130	0.1515°	10.91°
1FW6150	0.1515°	10.91°
1FW6160	0.1429°	10.29°
1FW6190	0.1190°	8.57°

Frame size	5° electrical corresponds to mechanical	360° electrical corresponds to mechanical
1FW6230	0.1020°	7.35°
1FW6290	0.1190°	8.57°

More information about coupled motors is provided in the Configuration Manual "SIMOTICS T-1FW6 built-in torque motors for SINAMICS S120".

5.9 Checking the work performed

Checking the mounting work

After installation has been completed, check that the rotor can freely rotate. Note that with short-circuited motor phases, the rotor is difficult to turn - even if no mechanical resistance is otherwise present.

Before moving the rotor, remove all tools and objects from the area of the rotor and air gap.

⚠ WARNING

Risk of electric shock

A voltage is induced in the stator when the rotor rotates. You can get an electric shock when touching the terminals, the open cable ends or the plug connector contacts.

- Correctly connect the motor power cables.
  Alternatively:
  Insulate the plug connector contacts or terminals and conductors of open cable ends before you rotate the rotor.

- 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

  ⚠ WARNING

  Danger if an axis moves in an uncontrolled manner.

  There is a risk that the axis moves in an uncontrolled fashion if you release the locking or brake when the axis is de-energized and not subject to closed-loop control.

  - Carefully ensure that nobody is in the hazard zone.

- 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 Cooler connection

The connectors can generally be installed using standard tools.

First determine the sum of the pressure losses of the individual cooling components and the associated piping. Compare the result with the cooling capacity of the cooling unit.

6.1.1 Cooler connection for motors with a cooling jacket

Note

Flow direction of the coolant

Every cooler has an inlet and a return. As far as cooling is concerned, it does not make any difference in which direction the coolant flows through the cooling circuit. Which connection point is used as the inlet and which as the return can be freely selected.

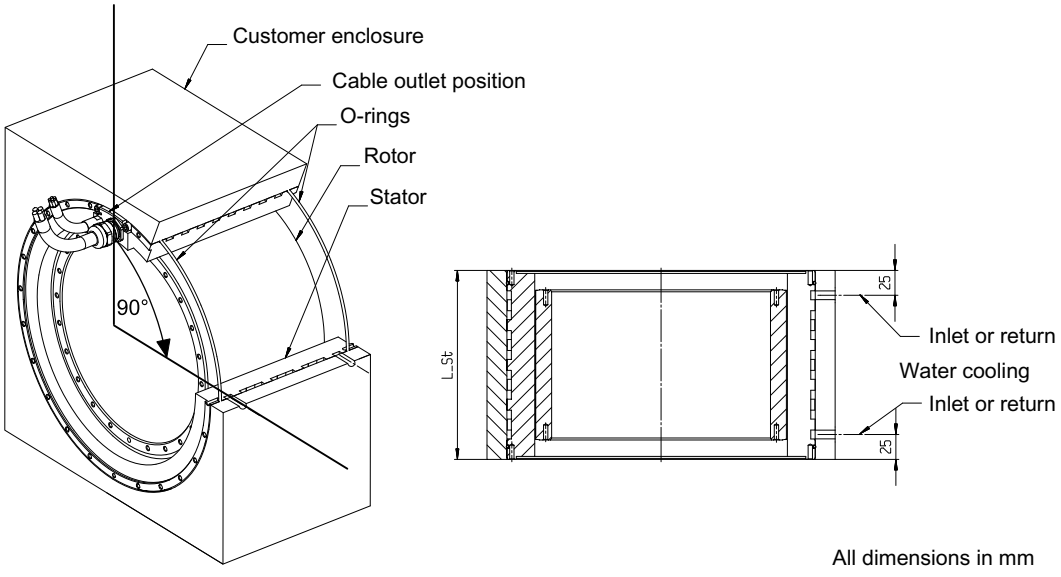


Figure 6-1 Cooler connection for 1FW6090 and 1FW6130 (example)

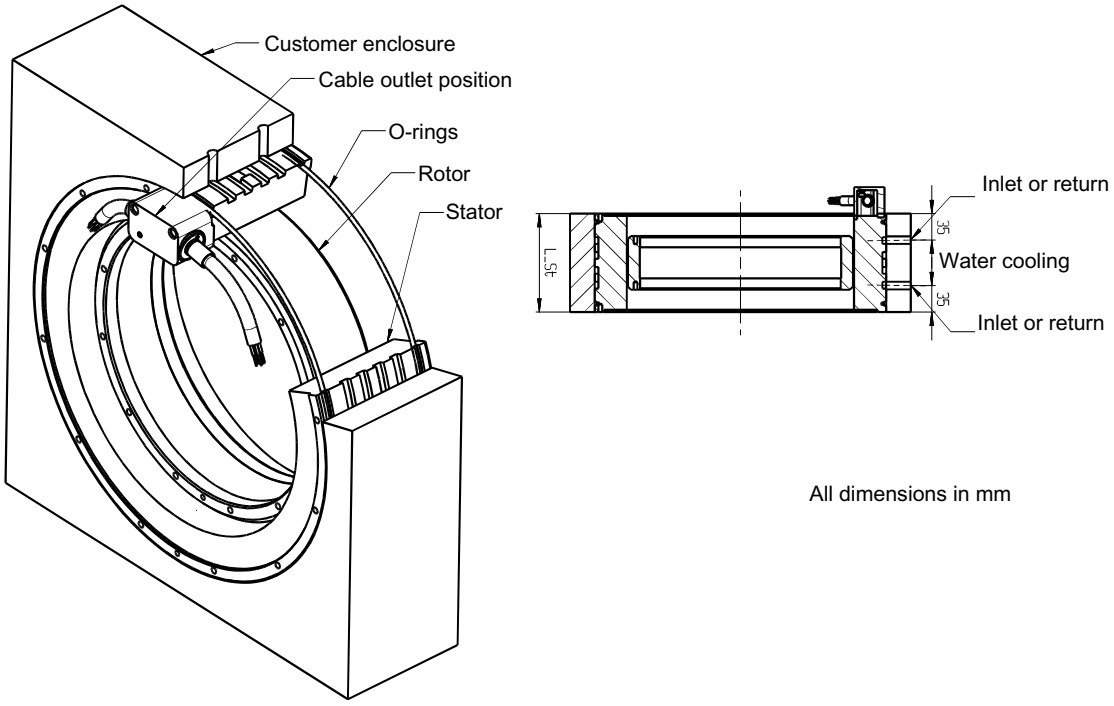


Figure 6-2 Cooler connection for 1FW6150 (example)

6.1.2 Cooler connection for motors with integrated cooling

Note

Significance of the 7th position in the Article No.

In this chapter, for certain 1FW6 Article Nos., an "x" should be inserted at the 7th position. This means that the information provided for the specific cooler connections and the cooling connection adapter for the particular frame size also applies to 1FW6 High Speed built-in torque motors.

You can directly connect the cooler through the appropriate fittings (1/8" pipe thread, DIN 2999). Motors, sizes 1FW6050 and 1FW6060 are connected to the cooling system using plug connections that can be simply released. For motors equipped with a precision and main cooler, each cooling circuit can be separately fed and connected/disconnected.

Suitable connectors are required for connecting the hoses.

Note

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

Apply measures to keep the pressure loss low:

- Connect the precision and main coolers in parallel using the cooling connection adapter immediately before the cooler connections.
- Use cooling lines with the largest possible cross-section for coolant intake and return.
- Avoid reducing cross-sections as a result of unnecessary coupling locations.

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

Every cooler has an inlet and a return. As far as cooling is concerned, it does not make any difference in which direction the coolant flows through the cooling circuit. Which connection point is used as the inlet and which as the return can be freely selected.

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.

NOTICE

Destruction of the motor

Most of the motors have a permanently mounted cooling connection plate. If you remove the cooling connection plate, the motor could be destroyed.

- Do not remove the cooling connection plate.

Note

Locking plate for the coolant connection

It is only permissible to remove the locking plate for the coolant connection for 1FW6050 and 1FW6060 motors for service purposes, and this must be done by a Siemens Service Center employee.

Cooling connection adapter (option)

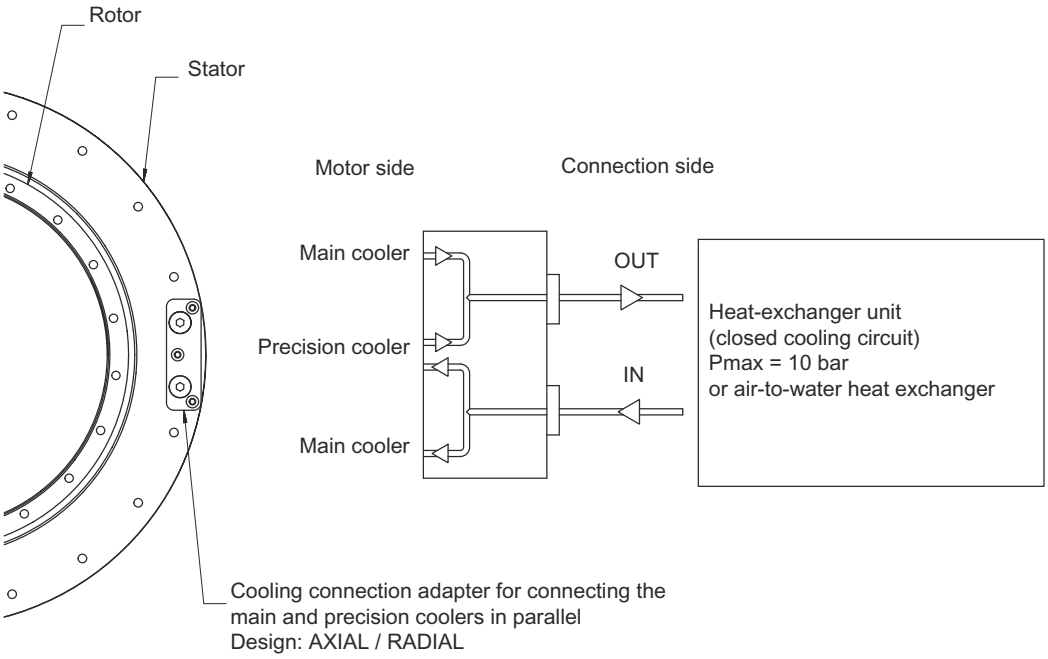
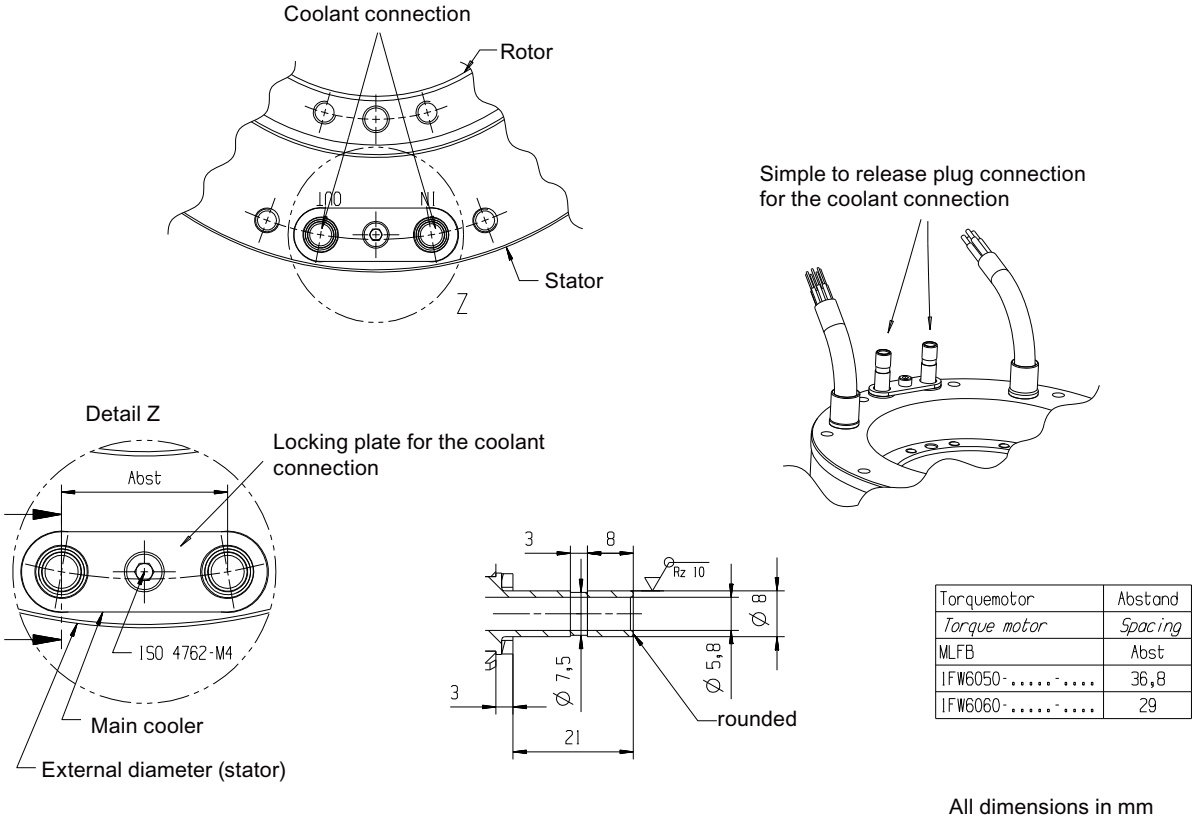


Figure 6-3 Cooling connection adapter (option) for parallel connection of the main cooler and precision cooler for 1FW6160, 1FW619x, 1FW623x, 1FW6290

Cooler connection for 1FW6050 and 1FW6060



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

Figure 6-4 Axial cooler connection with sleeve for 1FW6050 and 1FW6060

Cooler connection for 1FW6160, 1FW619x and 1FW623x

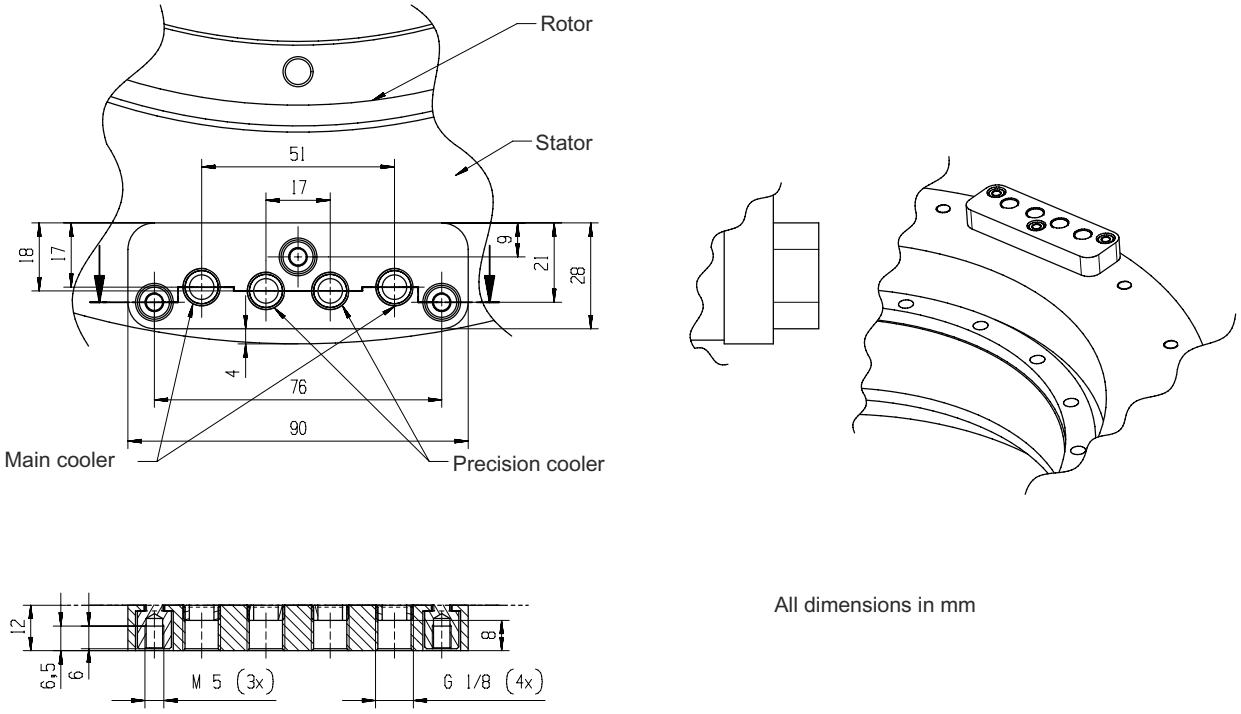


Figure 6-5 Cooling connection plate for 1FW6160, 1FW619x, 1FW623x

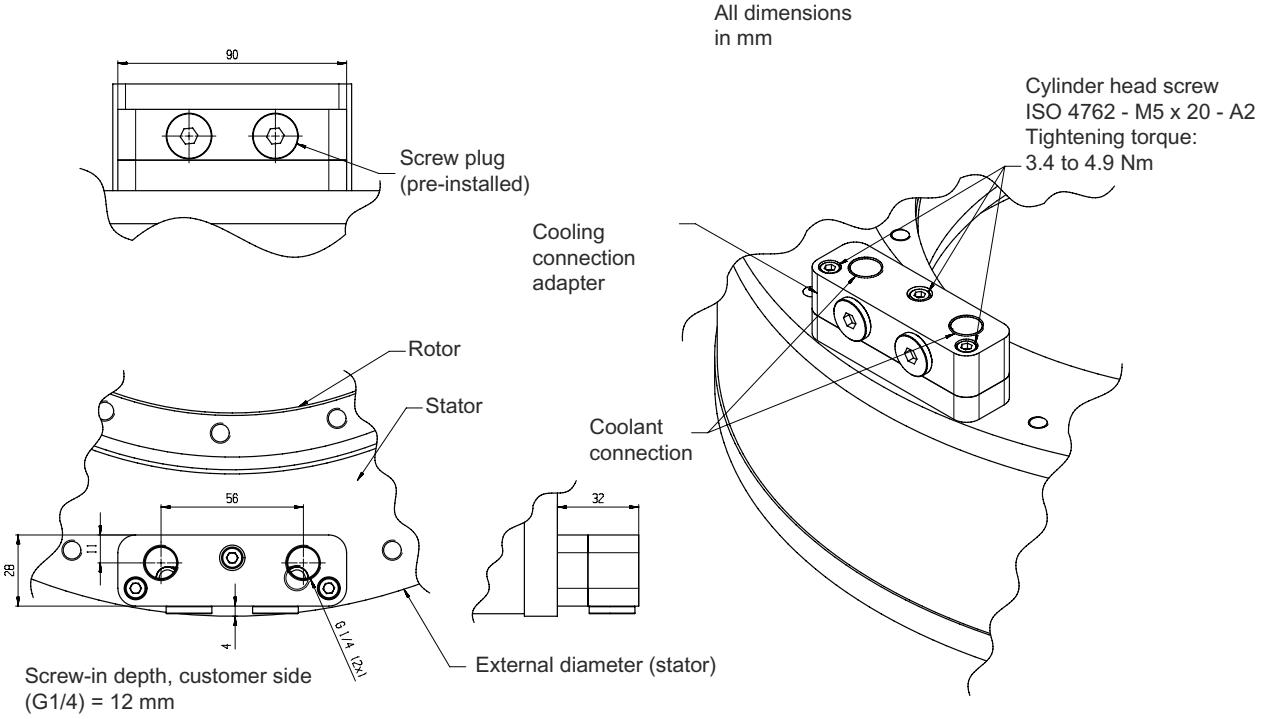


Figure 6-6 Axial cooler connection with cooling connection adapter (option) for 1FW6160, 1FW619x, 1FW623x

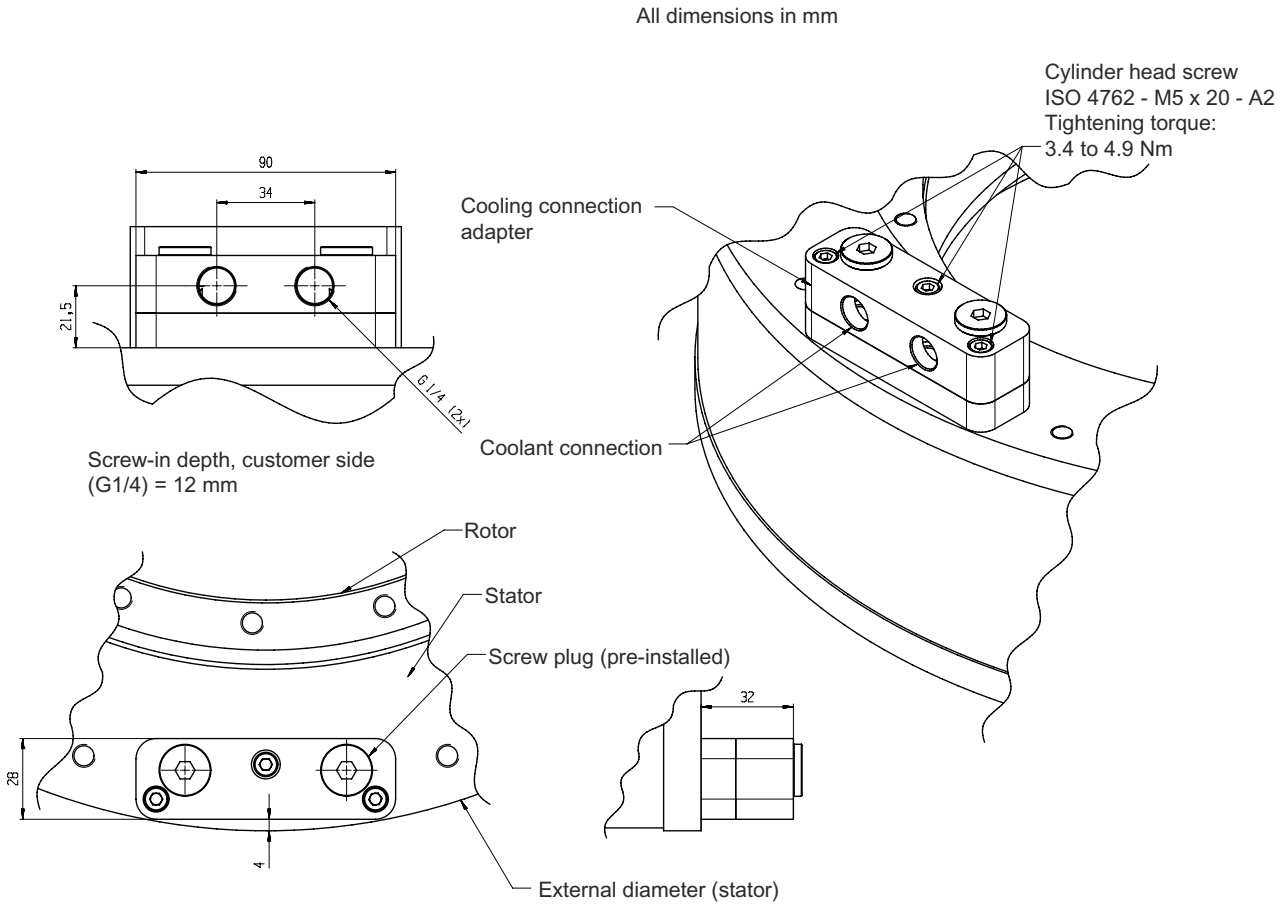


Figure 6-7 Outer radial cooler connection with cooling connection adapter (option) for 1FW6160, 1FW619x, 1FW623x

Cooler connection for 1FW6290

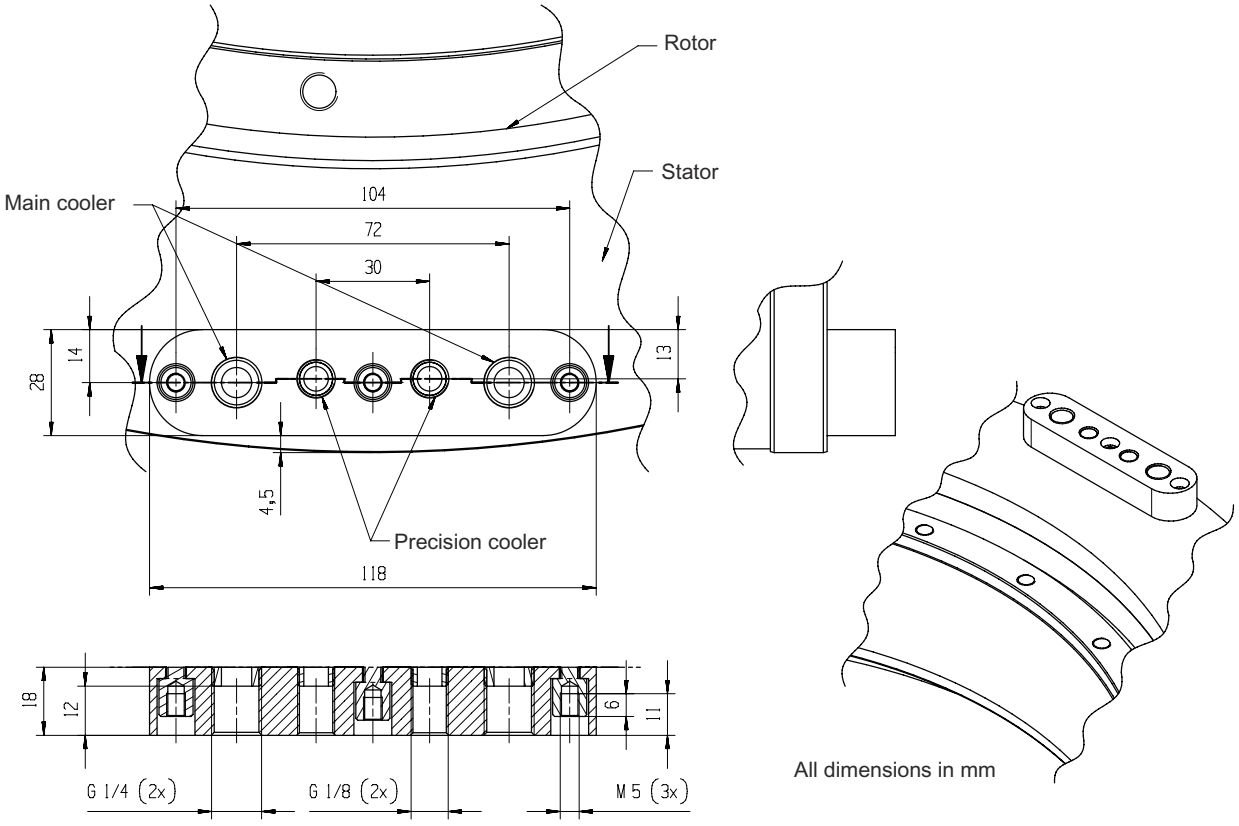


Figure 6-8 Cooling connection plate for 1FW6290

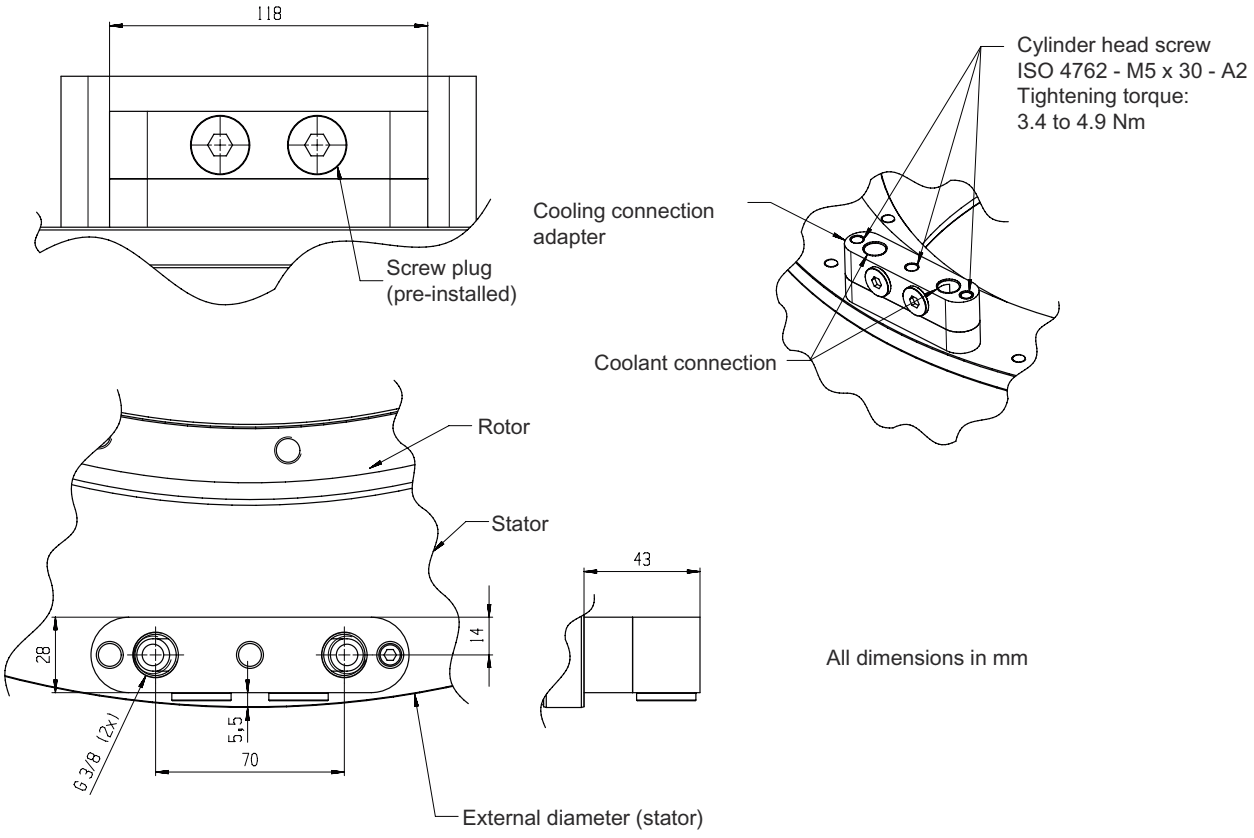


Figure 6-9 Axial cooler connection with cooling connection adapter (option) for 1FW6290

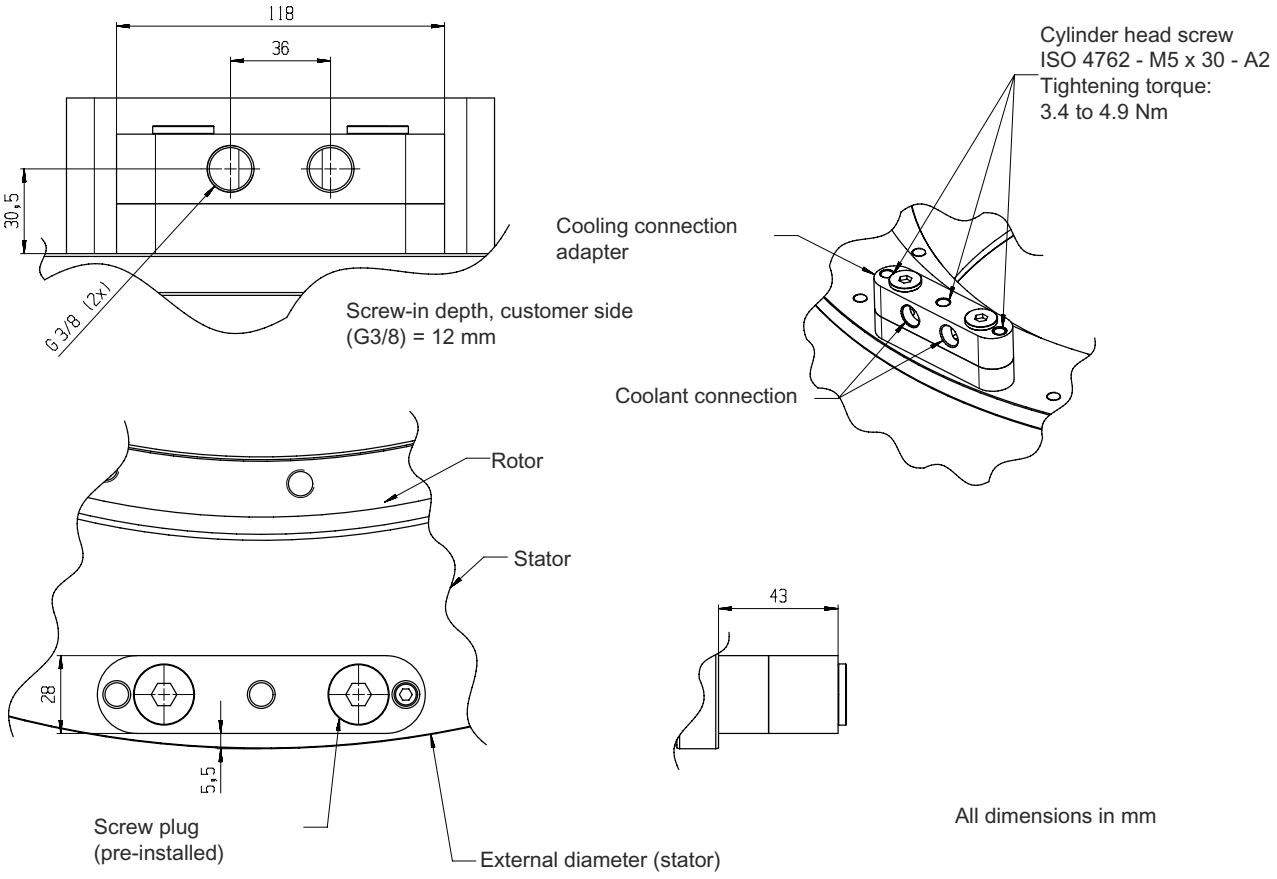


Figure 6-10 Outer radial cooler connection with cooling connection adapter (option) for 1FW6290

6.2 Electrical connection

6.2.1 Safety instructions for electrical connections

NOTICE
Destruction of the motor if it is directly connected to the three-phase line supply
The motor will be destroyed if it is directly connected to the three-phase line supply. • Only operate the motors with the appropriately configured converters.

⚠ WARNING

Risk of electric shock due to incorrect connection

If you incorrectly connect the motor this can result in death, serious injury, or extensive material damage. The motors require an impressed sinusoidal current.

- Connect the motor in accordance with the circuit diagram provided in this documentation.
- Refer also to the documentation for the drive system used.

⚠ WARNING

Electrical shock hazard

Every movement of the rotor compared with the stator and vice versa induces a voltage at the stator power connections.

When the motor is switched on, the stator power connections are also at a specific voltage.

If you use defective cable ports, you could suffer an electric shock.

- Only mount and remove the electrical components if you are qualified to do so.
- Any work carried out at the motor must always be done with the system in a no-voltage condition.
- Do not touch the cable ports. Correctly connect the stator power connections, or insulate them properly.
- Do not disconnect the power connections when the stator is under voltage (live).
- Only use the specific power cables intended for the purpose.
- First connect the protective conductor (PE).
- Connect the cable shield through a wide area.
- First connect the power cable to the stator before you connect the power cable to the inverter.
- First disconnect the connection to the inverter before you disconnect the power connection to the stator.
- Disconnect the protective conductor PE last.

NOTICE

Destruction of the motor

Removing the connection block for the motor feeder cables at the motor can destroy the motor.

- Never remove the connection block on the motor for the motor feeder cables (power and signal cables).

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. Refer to the Chapter "Shielding, grounding and equipotential bonding". 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).

⚠ WARNING

Electric shock caused by high leakage currents

When touching conductive parts of the machine, high leakage currents can result in an electric shock.

- For high leakage currents, observe the increased requirements placed on the protective conductor. The requirements are laid down in standards DIN EN 61800-5-1 and DIN EN 60204-1.
- For high leakage currents, attach warning symbols to Power Drive System .

⚠ WARNING

Risk of electric shock as a result of residual voltages

There is a risk of electric shock if hazardous residual voltages are present at the motor connections. Even after switching off the power supply, active motor parts can have a charge exceeding 60 µC. In addition, even after withdrawing the connector 1 s after switching off the voltage, more than 60 V can be present at the free cable ends.

- Wait for the discharge time to elapse.

NOTICE

Damage to cables

Cables subject to high acceleration rates can wear more quickly. The cables permanently connected to the motor cannot be replaced if they are damaged.

- Observe the permissible acceleration rates for the cables.
- Do not use a drag chain for the cables permanently attached to the motor.

6.2.2 Important data for 1FW6 cables

Table 6-1 Data of the power cable at 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	4 x 2.5	44	1
1FW6050-xxB05-0Fxx	4 x 2.5	44	1
1FW6050-xxB07-0Fxx	4 x 2.5	44	1
1FW6050-xxB07-0Kxx	4 x 2.5	44	1
1FW6050-xxB10-0Kxx	4 x 2.5	44	1

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1])	Connector size [2])
1FW6050-xxB15-0Kxx	4 x 2.5	44	1
1FW6050-xxB15-1Jxx	4 x 2.5	44	1
1FW6060-xxB03-0Fxx	4 x 2.5	44	1
1FW6060-xxB05-0Fxx	4 x 2.5	44	1
1FW6060-xxB05-0Kxx	4 x 2.5	44	1
1FW6060-xxB07-0Fxx	4 x 2.5	44	1
1FW6060-xxB07-0Kxx	4 x 2.5	44	1
1FW6060-xxB07-1Jxx	4 x 2.5	44	1
1FW6060-xxB10-0Kxx	4 x 2.5	44	1
1FW6060-xxB10-1Jxx	4 x 2.5	44	1
1FW6060-xxB15-0Kxx	4 x 2.5	44	1
1FW6060-xxB15-1Jxx	4 x 2.5	44	1
1FW6090-xxB05-0Fxx	4 x 2.5	44	1
1FW6090-xxB05-0Kxx	4 x 2.5	44	1
1FW6090-xxB07-0Kxx	4 x 2.5	44	1
1FW6090-xxB07-1Jxx	4 x 2.5	44	1
1FW6090-xxB10-0Kxx	4 x 2.5	44	1
1FW6090-xxB10-1Jxx	4 x 2.5	44	1
1FW6090-xxB15-1Jxx	4 x 2.5	44	1
1FW6090-xxB15-2Jxx	4 x 4.0	49.2	1.5
1FW6130-xxB05-0Kxx	4 x 2.5	44	1
1FW6130-xxB05-1Jxx	4 x 2.5	44	1
1FW6130-xxB07-0Kxx	4 x 2.5	44	1
1FW6130-xxB07-1Jxx	4 x 2.5	44	1
1FW6130-xxB10-1Jxx	4 x 2.5	44	1
1FW6130-xxB10-2Jxx	4 x 4.0	49.2	1.5
1FW6130-xxB15-1Jxx	4 x 2.5	44	1
1FW6130-xxB15-2Jxx	4 x 4.0	49.2	1.5
1FW6150-xxB05-1Jxx	4 x 2.5	44	1
1FW6150-xxB05-4Fxx	4 x 10.0	72.8	1.5
1FW6150-xxB07-1Jxx	4 x 2.5	44	1
1FW6150-xxB07-2Jxx	4 x 4.0	49.2	1.5
1FW6150-xxB07-4Fxx	4 x 10.0	72.8	1.5
1FW6150-xxB10-1Jxx	4 x 2.5	44	1
1FW6150-xxB10-2Jxx	4 x 4.0	49.2	1.5
1FW6150-xxB10-4Fxx	4 x 10.0	72.8	1.5
1FW6150-xxB15-2Jxx	4 x 10.0	72.8	1.5
1FW6150-xxB15-4Fxx	4 x 10.0	72.8	1.5
1FW6160-xxB05-0Kxx	4 x 2.5	44	1
1FW6160-xxB05-1Jxx	4 x 2.5	44	1

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1])	Connector size [2])
1FW6160-xxB05-2Jxx	4 x 4.0	49.2	1.5
1FW6160-xxB05-5Gxx	4 x 16.0	89.2	1.5
1FW6160-xxB07-1Jxx	4 x 2.5	44	1
1FW6160-xxB07-2Jxx	4 x 4.0	49.2	1.5
1FW6160-xxB07-5Gxx	4 x 16.0	89.2	1.5
1FW6160-xxB07-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6160-xxB10-1Jxx	4 x 2.5	44	1
1FW6160-xxB10-2Exx	4 x 4.0	49.2	1.5
1FW6160-xxB10-2Jxx	4 x 4.0	49.2	1.5
1FW6160-xxB10-5Gxx	4 x 16.0	89.2	1.5
1FW6160-xxB10-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6160-xxB10-2Pxx	3 x (1 x 50) + M10 f. PE (1 x 25)*)	54.6	-
1FW6160-xxB15-2Jxx	4 x 4.0	49.2	1.5
1FW6160-xxB15-5Gxx	4 x 16.0	89.2	1.5
1FW6160-xxB15-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6160-xxB15-2Pxx	3 x (1 x 50) + M10 f. PE (1 x 25)*)	54.6	-
1FW6160-xxB15-0Wxx	3 x (1 x 70) + M10 f. PE (1 x 35)*)	61.5	-
1FW6160-xxB20-5Gxx	4 x 16.0	89.2	1.5
1FW6160-xxB20-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6160-xxB20-2Pxx	3 x (1 x 50) + M10 f. PE (1 x 25)*)	54.6	-
1FW6160-xxB20-0Wxx	3 x (1 x 70) + M10 f. PE (1 x 35)*)	61.5	-
1FW6190-xxB05-1Jxx	4 x 2.5	44	1
1FW6190-xxB05-2Jxx	4 x 4.0	49.2	1.5
1FW6190-xxB05-5Gxx	4 x 16.0	89.2	1.5
1FW6190-xxB07-1Jxx	4 x 2.5	44	1
1FW6190-xxB07-2Jxx	4 x 4.0	49.2	1.5
1FW6190-xxB07-5Gxx	4 x 16.0	89.2	1.5
1FW6190-xxB07-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6190-xxB10-1Jxx	4 x 2.5	44	1
1FW6190-xxB10-2Jxx	4 x 4.0	49.2	1.5
1FW6190-xxB10-5Gxx	4 x 16.0	89.2	1.5
1FW6190-xxB10-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1])	Connector size [2])
1FW6190-xxB10-2Pxx	3 x (1 x 50) + M10 f. PE (1 x 25)*)	54.6	-
1FW6190-xxB15-2Jxx	4 x 4.0	49.2	1.5
1FW6190-xxB15-5Gxx	4 x 16.0	89.2	1.5
1FW6190-xxB15-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6190-xxB15-2Pxx	3 x (1 x 50) + M10 f. PE (1 x 25)*)	54.6	-
1FW6190-xxB15-0Wxx	3 x (1 x 70) + M10 f. PE (1 x 35)*)	61.5	-
1FW6190-xxB20-4Fxx	4 x 10.0	72.8	1.5
1FW6190-xxB20-5Gxx	4 x 16.0	89.2	1.5
1FW6190-xxB20-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6190-xxB20-2Pxx	3 x (1 x 50) + M10 f. PE (1 x 25)*)	54.6	-
1FW6190-xxB20-0Wxx	3 x (1 x 70) + M10 f. PE (1 x 35)*)	61.5	-
1FW6230-xxB05-1Jxx	4 x 2.5	44	1
1FW6230-xxB05-2Jxx	4 x 4.0	49.2	1.5
1FW6230-xxB05-5Gxx	4 x 16.0	89.2	1.5
1FW6230-xxB07-1Jxx	4 x 2.5	44	1
1FW6230-xxB07-2Jxx	4 x 4.0	49.2	1.5
1FW6230-xxB07-5Gxx	4 x 16.0	89.2	1.5
1FW6230-xxB07-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6230-xxB10-2Jxx	4 x 4.0	49.2	1.5
1FW6230-xxB10-5Gxx	4 x 16.0	89.2	1.5
1FW6230-xxB10-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6230-xxB10-2Pxx	3 x (1 x 35) + M10 f. PE (1 x 25)*)	48.3	-
1FW6230-xxB15-4Cxx	4 x 6.0	59.6	1.5
1FW6230-xxB15-5Gxx	4 x 16.0	89.2	1.5
1FW6230-xxB15-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-
1FW6230-xxB15-2Pxx	3 x (1 x 35) + M10 f. PE (1 x 25)*)	48.3	-
1FW6230-xxB15-0Wxx	3 x (1 x 70) + M10 f. PE (1 x 35)*)	61.5	-
1FW6230-xxB20-4Fxx	4 x 10.0	72.8	1.5
1FW6230-xxB20-5Gxx	4 x 16.0	89.2	1.5
1FW6230-xxB20-8Fxx	3 x (1 x 25) + M10 f. PE (1 x 25)*)	40.5	-

Motor type	No. of cores x cross-section in mm²	Min. bending radius "R1" in mm [1])	Connector size [2])
1FW6230-xxB20-2Pxx	3 x (1 x 35) + M10 f. PE (1 x 25)*)	48.3	-
1FW6230-xxB20-0Wxx	3 x (1 x 70) + M10 f. PE (1 x 35)*)	61.5	-
1FW6290-xxB07-5Gxx	4 x 16.0	89.2	1.5
1FW6290-xxB07-0Lxx	3 x (1 x 35) + 1 x 25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB07-2Pxx	3 x (1 x 70) + 1 x 35	R(70) = 61.5 R(35) = 48.3	-
1FW6290-xxB11-5Gxx	4 x 16.0	89.2	1.5
1FW6290-xxB11-7Axx	4 x 16.0	89.2	1.5
1FW6290-xxB11-0Lxx	3 x (1 x 35) + 1 x 25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB11-2Pxx	3 x (1 x 70) + 1 x 35	R(70) = 61.5 R(35) = 48.3	-
1FW6290-xxB15-7Axx	4 x 16.0	89.2	1.5
1FW6290-xxB15-0Lxx	3 x (1 x 35) + 1 x 25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB15-2Pxx	3 x (1 x 70) + 1 x 35	R(70) = 61.5 R(35) = 48.3	-
1FW6290-xxB20-0Lxx	3 x (1 x 35) + 1 x 25	R(35) = 48.3 R(25) = 40.5	-
1FW6290-xxB20-2Pxx	3 x (1 x 70) + 1 x 35	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 6-2 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	50	M17

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

6.2.3 PIN assignments for the connectors

The pin configurations of the plug connectors are subsequently shown. The view is from the plug-in side.

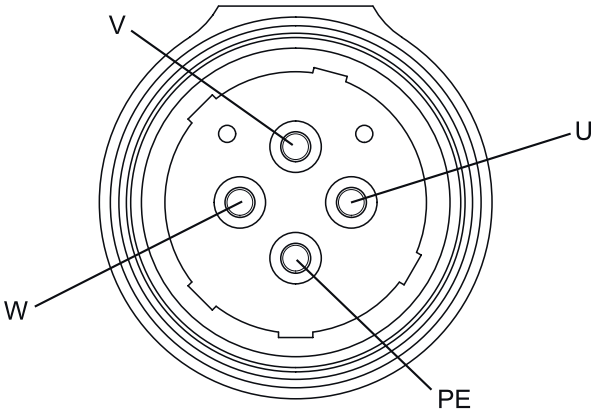


Figure 6-11 Pin configuration, Size 1.5 power connector

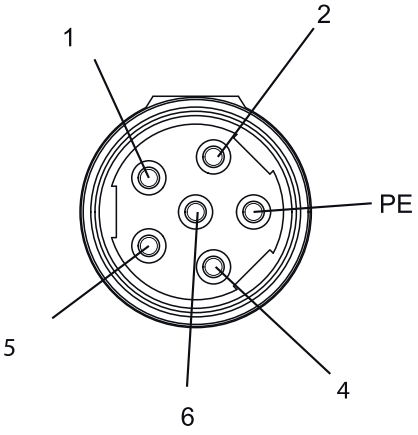


Figure 6-12 Pin configuration, Size 1.0 power connector

Table 6-3 **Pin assignment, Size 1.0 power connector**

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

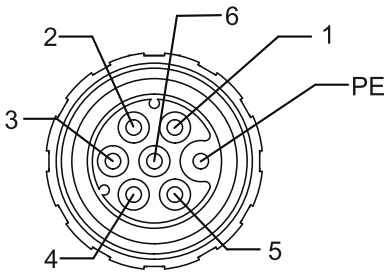


Figure 6-13 Pin configuration, M17 signal connector

Table 6-4 **PIN assignment, M17 signal connector**

PIN	Interface
1	-1R2: -KTY or Pt1000
2	+1R1: +KTY or Pt1000
3	1TP1: PTC 130 °C
4	1TP2: PTC 130 °C
5	2TP1: PTC 150 °C *)
6	2TP2: PTC 150 °C *)
⏚	PE

*) PTC 150 °C, optional in conjunction with KTY 84

6.2.4 Power connection

Table 6-5 Conductor assignment for power cables with open conductor ends

Color/identification	Connection
green/yellow	PE
black / U / L1 / C / L+	U
black / V / L2	V
black / W / L3 / D / L-	W

Cable protection for motors connected in parallel electrically

For the following configurations, you require a circuit breaker for each motor as conductor protection:

- Several motors are connected in parallel to one Motor Module.
- The current-carrying capacity of the feeder cable cross-section is less than the rated current of the Motor Module.

Connect all of the motors to be connected in parallel to a Motor Module via a circuit breaker.

- Connect phases U, V, W of the motor in question to the corresponding terminals of the associated circuit breaker:
  U - L1
  V - L2
  W - L3
- Connect phases U, V, W of the Motor Module to the circuit breaker terminals:
  U - T1
  V - T2
  W - T3
- Connect the auxiliary NO contacts of the circuit breaker in series.
- Connect the auxiliary NO contacts to an input on the CU/NCU.
- Connect the auxiliary NO contact to an external drive fault of the drive using BICO technology. This means that when a circuit breaker trips, the complete drive is shut down (OFF2).
- You can also evaluate the auxiliary NO contact of the circuit breaker using the PLC.
- Adjust the circuit breaker to the rated current of the motor feeder cables +10 %.

Avoiding false circuit breaker tripping

At the subsequent link you can find information in the Internet on the topic of "Influence of high-frequency currents on thermal overload releases of circuit breakers (3RV, 3VU) and overload relays (3RU, 3UA)" and "Additional effects that can result in nuisance tripping".

FAQ entry ID 24153083 (http://support.automation.siemens.com/WW/llisapi.dll?func=cslib.csinfo&objid=24153083&nodeid0=20358027&caller=view&lang=de&extranet=standard&viewreg=WW&u=NDAwMDAxNwAA&siteID=cseus)

6.2.5 Signal connection

⚠ WARNING

Risk of electric shock if the temperature monitoring circuits are incorrectly connected

In the case of a fault, circuits Temp-S and Temp-F do not provide safe electrical separation with respect to the power circuits.

- Use the TM120 or SME12x to connect temperature monitoring circuits Temp-S and Temp-F. You therefore comply with the directives for electrical separation according to DIN EN 61800-5-1 (previously electrical separation according to DIN EN 50178).

Correctly connecting temperature sensors

NOTICE
Motor destroyed as a result of overtemperature The motor can be destroyed as a result of overtemperature if you do not correctly connect the temperature sensors. • When connecting temperature sensor cables with open conductor ends, pay attention to the correct assignment of conductor colors.

Note

Observe the polarity

Carefully note the polarity when connecting the KTY.

PTC elements must be evaluated for thermal motor protection.

Table 6-6 Conductor assignment for Temp-S and Temp-F temperature sensor cables

Core assignment for motors with signal cable without connector	Sensor contact for 1FW6
White	-1R2: -KTY or Pt1000
Brown	+1R1: +KTY or Pt1000
Green	1TP1: PTC 130 °C
Yellow	1TP2: PTC 130 °C
Gray	2TP1: PTC 150 °C *)
Pink	2TP2: PTC 150 °C *)
green/yellow	PE

*) PTC 150 °C, optional in conjunction with KTY 84

Types of temperature monitoring circuits

Article No.	Temp-S (PTC 130 °C), Temp-F (KTY 84)	Temp-S (PTC 130 °C), Temp-F (Pt1000)	Temp-S (PTC 130 °C and PTC 150 °C), Temp-F (KTY 84)
1FW6050-xxxxx-xxx1 *)	X		
1FW6050-xxxxx-xxx3		X	
1FW6060-xxxxx-xxx1 *)	X		
1FW6060-xxxxx-xxx3		X	
1FW6090-xxxxx-xxx2 *)			X
1FW6090-xxxxx-xxx3		X	
1FW6130-xxxxx-xxx2 *)			X
1FW6130-xxxxx-xxx3		X	
1FW6150-xxxxx-xxx2 *)			X
1FW6150-xxxxx-xxx3		X	
1FW6160-xxxxx-xxx2 *)			X
1FW6160-xxxxx-xxx3		X	
1FW6190-xxxxx-xxx2 *)			X
1FW6190-xxxxx-xxx3		X	
1FW6230-xxxxx-xxx2 *)			X
1FW6230-xxxxx-xxx3		X	
1FW6290-xxxxx-xxx2 *)			X
1FW6290-xxxxx-xxx3		X	

*) These motors and/or stators are now only available as spare part.

6.2.6 Circuit diagram of the motor

The circuit diagram of a stator looks like this:

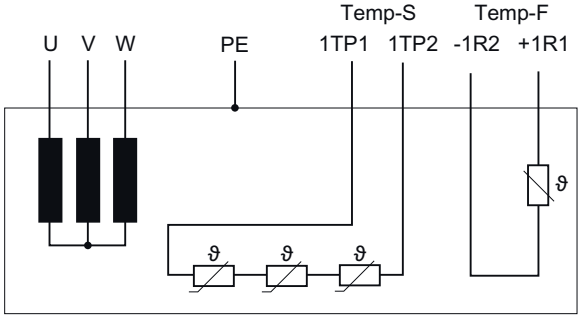


Figure 6-14 Circuit diagram of a stator

Note

Additional temperature monitoring circuit Temp-S

1FW6090-xxxxx-xxx2 to 1FW6290-xxxxx-xxx2 motors are equipped with an additional temperature monitoring circuit Temp-S. The associated interface designations are 2TP1 and 2TP2.

Note

Checking the shutdown circuit

Before commissioning and before switching on the DC link voltage for the first time, carefully check the Temp-S temperature monitoring circuit to ensure that it correctly shuts down (trips).

The typical characteristic R(ϑ) of a PTC temperature sensor according to DIN 44081 is provided in the Chapter "Technical features of temperature sensors (Page 54)".

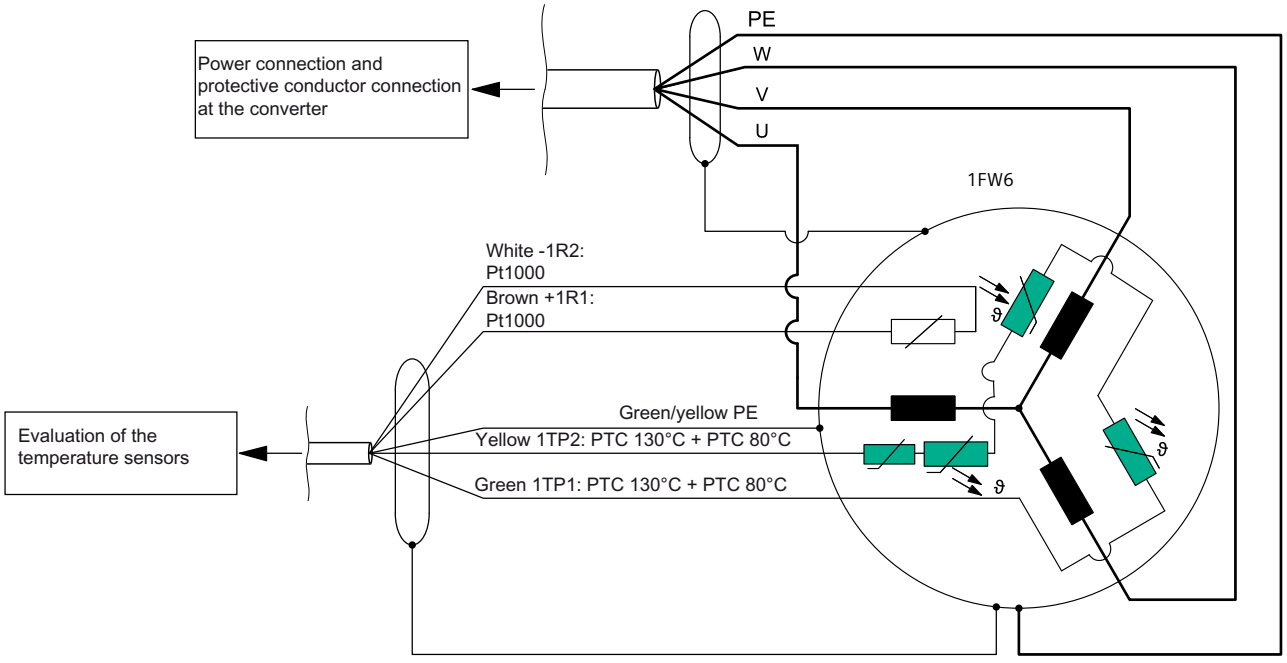


Figure 6-15 Schematic connection overview for 1FW6050xxxxx-xxx3 to 1FW6290xxxxx-xxx3 with Pt1000

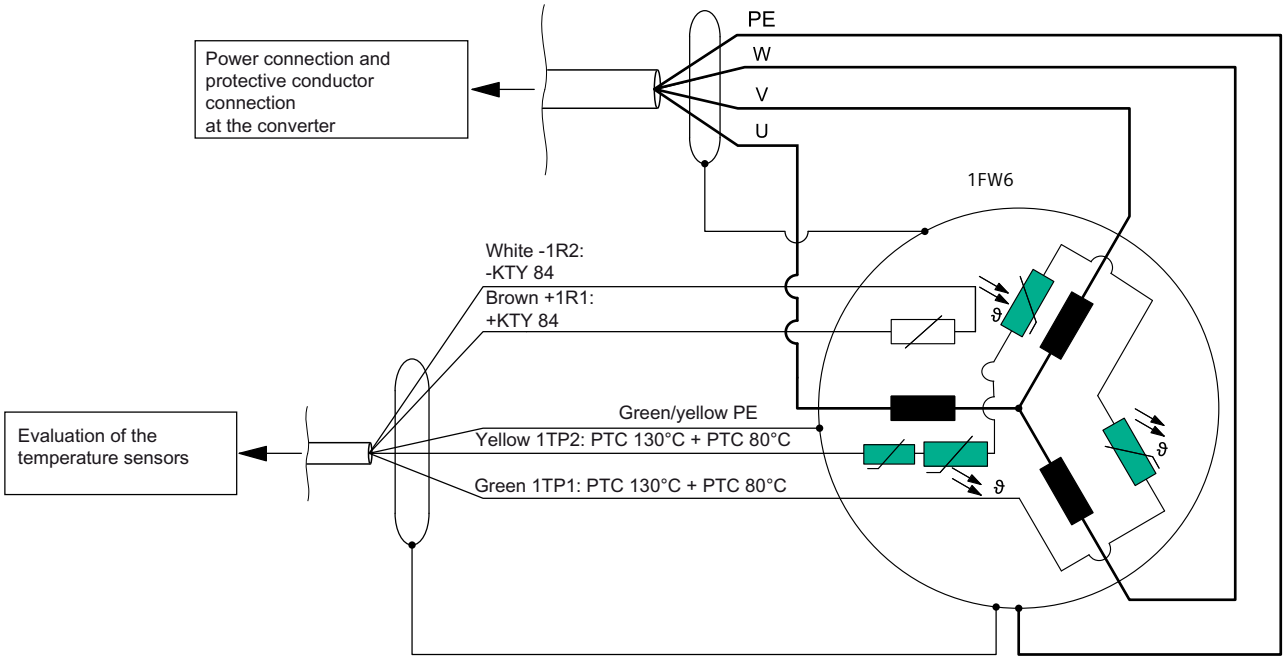


Figure 6-16 Schematic connection overview for 1FW6050xxxxx-xxx1 and 1FW6060xxxxx-xxx1 with KTY 84

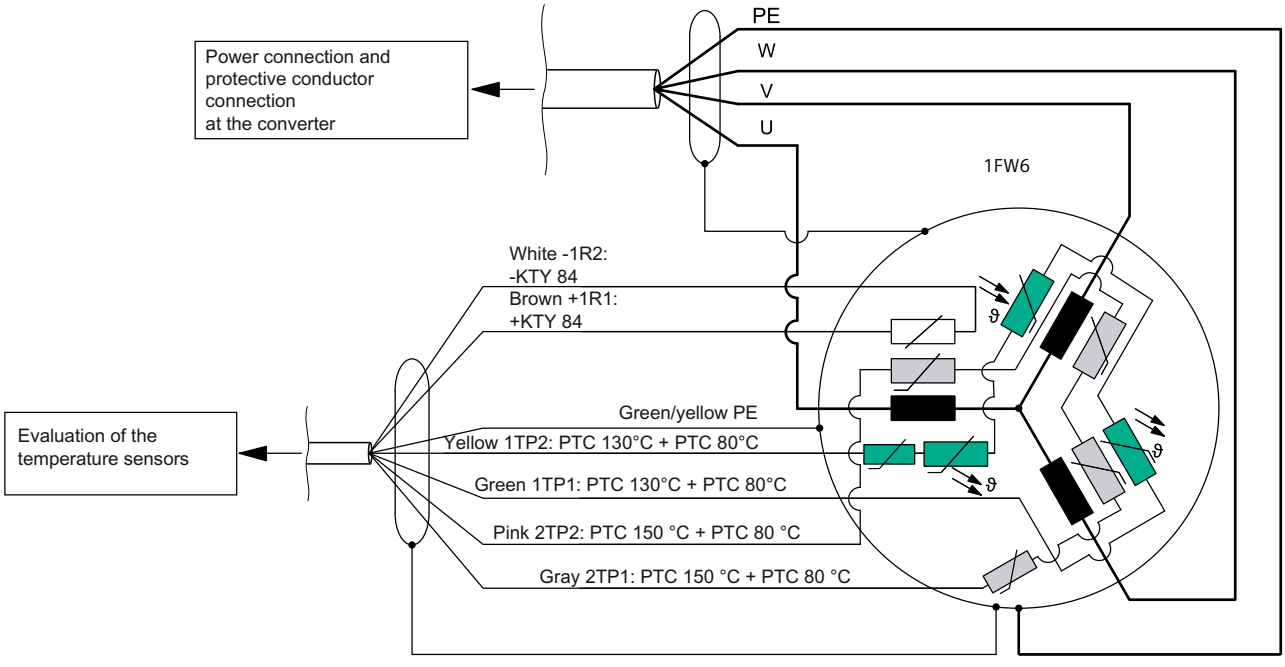


Figure 6-17 Schematic connection overview for 1FW6090-xxxxx-xxx2 to 1FW6290-xxxxx-xxx2 with KTY 84

6.2.7 Shielding, grounding, and equipotential bonding

Important notes regarding shielding, grounding and equipotential bonding

The correct installation and connection of the cable shields and protective conductors is of crucial importance, not only for personal safety but also for interference and immunity to a disturbance.

⚠ WARNING

Risk of electric shock!

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

- Connect the cable shields to the respective housings through the largest possible surface area. Use suitable clips, clamps or screw couplings to do this.
- Connect unused cores of shielded or unshielded cables and their associated shields to the grounded enclosure potential at one end as minimum.
  Alternatively:
  Insulate conductors and their associated shields that are not used. 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

Device damage as a result of leakage currents for incorrectly connected protective conductor

High leakage currents may damage other devices if the motor protective conductor is not directly connected to the power module.

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

NOTICE

Device damage as a result of leakage currents for incorrect shielding

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

- 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 document order No. 6FC5297-□AD30-0□P□.

Note

Single-core power cables without protective earth

With 1FW6 built-in torque motors featuring single-core power cables without a PE cable, a connection point is provided for the PE.

Connect a separate protective conductor cable to this connection point. Pay attention to the specified cross section for direct connection to the power unit. For the cross-section specifications, see the table "Data of the power cable at the stator" in Chapter "Important data for 1FW6 cables."

Commissioning

7

The following information refers to commissioning the hardware components. Siemens provides commissioning support through its Technical Support organization.

The motor can only be commissioned when it has been installed and integrated in a functioning system. The commissioning documentation of all the system components must be taken into account for the commissioning.

7.1 Safety instructions for commissioning

⚠ WARNING

Risk of death and crushing as a result of permanent magnet fields

Severe injury and material damage can result if you do not take into consideration the safety instructions relating to permanent magnet fields.

- Refer to Chapter "Danger from strong magnetic fields (Page 28)".

⚠ WARNING

injury and material damage if EMC safety requirements are not observed

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

- Plants and machines with converter-fed low-voltage three-phase motors must fulfill the protection requirements of EMC Guideline 2014/30/EU.
- The plant engineer is responsible for ensuring that installation is carried out in an EMC-compliant manner. Use shielded signal and power cables. Apply the EMC installation guideline of the converter manufacturer. For Siemens converters, this is available under document order No. 6FC5297-□AD30-0□P□.

⚠ WARNING

Danger of severe injuries caused by unexpected movements of the motor

Unexpected movements of the motor may cause death, serious injury (crushing) and/or property damage.

- Never work in the vicinity of rotating parts for a switched-on machine.
- Keep persons away from rotating parts and areas where there is a danger of crushing.
- Ensure that the axis transversing angle is free of any obstruction.
- Check before switching on the commutation! Also observe the instructions of the drive system being used.
- Set the motor current limiting too low values.
- Set the speed limitation to small values.
- Monitor the end positions of the motor.

⚠ WARNING

Electrical shock hazard

Every movement of the rotor compared with the stator and vice versa induces a voltage at the stator power connections.

When the motor is switched on, the stator power connections are also at a specific voltage.

If you use defective cable ports, you could suffer an electric shock.

- Only mount and remove the electrical components if you are qualified to do so.
- Any work carried out at the motor must always be done with the system in a no-voltage condition.
- Do not touch the cable ports. Correctly connect the stator power connections, or insulate them properly.
- Do not disconnect the power connections when the stator is under voltage (live).
- Only use the specific power cables intended for the purpose.
- First connect the protective conductor (PE).
- Connect the cable shield through a wide area.
- First connect the power cable to the stator before you connect the power cable to the inverter.
- First disconnect the connection to the inverter before you disconnect the power connection to the stator.
- Disconnect the protective conductor PE last.

⚠ WARNING

Risk of electric shock as a result of residual voltages

There is a risk of electric shock if hazardous residual voltages are present at the motor connections. Even after switching off the power supply, active motor parts can have a charge exceeding 60 µC. In addition, even after withdrawing the connector 1 s after switching off the voltage, more than 60 V can be present at the free cable ends.

- Wait for the discharge time to elapse.

⚠ WARNING

Incorrect commutation

Incorrect commutation can result in uncontrolled motor movements.

- When installing and replacing an encoder, ensure the correct commutation setting.
- Only carry out the associated work if you have been appropriately trained.

⚠ WARNING

Fire hazard resulting from hot surfaces

Touching the surfaces of the motors may result in burns. The surface temperature of the motors can be more than 100 °C (212 °F).

- Ensure that the cooling system is functioning perfectly.
- Never touch the motor during or immediately after use.
- Attach the "Hot Surface Do Not Touch" (W017) warning sign close to the source of danger where it can be easily seen.

NOTICE

Thermal damage to temperature-sensitive parts

Some parts of the electrical motor enclosure can reach temperatures that exceed 100 °C. If temperature-sensitive parts, for instance electric cables or electronic components, come into contact with hot surfaces then these parts can be damaged.

- Ensure that no temperature-sensitive parts come into contact with hot surfaces.

NOTICE

Motor destroyed as a result of overheating

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!

NOTICE

Demagnetizing the permanent magnets

If, while the torque motor is operational, the rotor exceeds the maximum temperature of 120 °C, then there is a risk that the permanent magnets will be demagnetized.

Especially high temperatures are to some extent locally possible as a result of an even current loading. Operating states with uneven current loading include standstill or operation with short, cyclic rotary motion.

- When commissioning the system for the first time, make the appropriate checks so that it is ensured that the rotor does not exceed the maximum temperature of 120 °C.

⚠ WARNING

Uncontrolled rotation for inclined and horizontal axes

Torque motors are not self clamping. For inclined and horizontal axes in the no current state, if the center of gravity lies outside the axis of rotation and there is no weight equalization, then load can move downwards in an uncontrolled fashion. This can result in injury and material damage.

- Use a holding brake for inclined and horizontal axes that are not equipped with weight equalization.

NOTICE

Damaged main insulation

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!

- To dampen the oscillations we recommend the use of the associated Active Interface Module or an HFD reactor with damping resistor. Review the documentation of the drive system being used for details. If you have any questions, please contact your local sales partner.

Note

Use an Active Interface Module or the matching HFD line reactor

Please note the following when connecting the motor to a SINAMICS S120 drive system:

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

Note

Voltage Protection Module VPM

Above a speed defined for a particular motor type, each motor requires a Voltage Protection Module VPM; also see Configuration Manual "SIMOTICS T-1FW6 Built-in Torque Motors".

7.2 Checklists

Checklists for commissioning 1FW6 built-in torque motors

Before starting any work, familiarize yourself with and understand the safety instructions 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 Chapter "Installation" in these operating instructions?	
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 also provided in the Configuration Manual "SIMOTICS T-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.	
Does the coolant meet the requirements specified in 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 stated in chapter "Technical features" in the operating instructions will not be exceeded?	
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?	
Have all installation devices and tools been removed? Have you removed the spacer film from the air gap?	

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 through the widest possible surface 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?	

Check	OK
Are the motor power cables correctly connected to the power module with the UVW phase sequence (clockwise rotating field)?	
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?	
When designing and installing, have you carefully complied with the EMC installation directives of the inverter manufacturer?	
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

Installation inspection, preventive maintenance and troubleshooting are examples of required checking of the insulation resistance on a machine/system with direct drives or directly on the motors.

⚠ WARNING

Risk of electric shock

If you check the insulation resistance using high voltage, this can damage the motor insulation. There is a risk of death or serious injury if energized parts are touched.

- Only use test equipment that is in compliance with DIN EN 61557-1, DIN EN 61557-2 and DIN EN 61010-1 or the corresponding IEC standards.
- Check the insulation resistance on the individual motors only according to the following procedure.
- If a DC voltage > 1000 V or an AC voltage is necessary to test the machine/system, then coordinate this test with your local sales partner.
- Carefully observe the operating instructions of the test device.

Procedure

1. Interconnect all winding and temperature sensor connections. Check against the PE connection or the motor enclosure with a maximum voltage of 1000 VDC for maximally 60 s.
2. Connect all temperature sensor connections to the PE connection and interconnect all winding connections. Check the winding against the PE connection or the motor enclosure with a maximum voltage of 1000 VDC for maximally 60 s.

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Each insulation resistance must be at least 10 MΩ. A lower insulation resistance indicates that the motor insulation is damaged.

⚠ WARNING

Risk of death due to 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

⚠ WARNING

Risk of burning when touching hot surfaces

There is a risk of burning when touching hot surfaces immediately after the motor has been operational.

- Wait until the motor has cooled down.

⚠ WARNING

Danger to life if the cooling system bursts

The motor will overheat if it is operated without cooling. When cooling water enters the hot motor, this immediately and suddenly generates hot steam that escapes under high pressure. This can cause the cooling water system to burst, resulting in death, severe injury and material damage.

- Only commission the cooling water circuit when the motor is in a cool condition.

⚠ CAUTION

Risk of burns when hot cooling water escapes

There is a risk of burns caused by escaping hot cooling water and steam if you open the cooling circuit of a motor that was previously in operation.

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

Operation

8

8.1 Safety guidelines for operation

⚠ WARNING

Danger to persons in areas with rotary and crushing motion

Machine parts driven by the torque motors can cause substantial injury, e.g. by crushing. This is due to the very high speeds and acceleration rates, as well as low friction and self clamping.

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

NOTICE

Material damage caused by incorrect operation

Improper operation can lead to serious material damage.

- Only operate the motor at installations equipped with full weather protection: The environment must be dry and protected against heat and cold.
- Keep the area where the motor is installed free of all foreign bodies. Foreign bodies include metal chips, particles, liquids, oils, screws, tools, etc.
- Ensure that the torque motor cooling system functions perfectly.
- Only operate the motor in conjunction with effective thermal protection.

⚠ WARNING

Faults while the motor is operational

Examples of faults that indicate functional impairments are:

- Higher power consumption
- Changed temperatures
- Vibration
- Unusual noise
- Unusual smells
- Response of the monitoring devices

Faults while the motor is operational can result in death, severe injury or material damage.

- Immediately inform the maintenance personnel.
- If in doubt, shut down the motor immediately, taking into account the plant-specific safety regulations.

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.

⚠ WARNING

Risk to life as a result of non-functioning protective devices

Protective devices that are not functioning can result in death, serious injury or material damage.

- Do not deactivate protective devices. This also applies to test operation.
- Only work with protective devices that are fully functional.

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.
- Replace damaged motors.

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
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, then contact Technical Support or your responsible sales partner.

Maintenance 9

9.1 Safety instructions for maintenance

⚠ WARNING

Risk of injury as a result of undesirable rotary motion

If, with the motor switched on, you work in the rotational range of the motor, and the motor undesirably rotates, this can result in death, injury and/or material damage.

- Always switch off the motor before working in the rotational range of the motor. Ensure that the motor is in a completely no-voltage condition.

⚠ WARNING

Risk of death and crushing as a result of permanent magnet fields

Severe injury and material damage can result if you do not take into consideration the safety instructions relating to permanent magnet fields.

- Refer to Chapter "Danger from strong magnetic fields (Page 28)".

⚠ WARNING

Risk of rotor permanent magnets causing crushing injuries

The forces of attraction of magnetic rotors act on materials that can be magnetized. The forces of attraction increase significantly close to the rotor. The response threshold of 3 mT for risk of injury through attraction and causing a projectile effect is reached at a distance of 100 mm (Directive 2013/35/EU). Rotors and materials that can be magnetized can suddenly slam together unintentionally. Two rotors can also unintentionally slam together.

There is a significant risk of crushing when you are close to a rotor.

Close to the motor, the magnetic forces of attraction can be up to several kN. – Example: Magnetic attractive forces are equivalent to a force of 100 kg, which is sufficient to trap a body part.

- Do not underestimate the strength of the attractive forces, and work very carefully.
- Wear safety gloves.
- The work should be done by at least two people.
- Do not unpack the rotor until immediately before assembly.
- Never unpack several rotors at once.
- Never place the rotors directly next to one another without providing adequate protection.
- Never carry any objects made of magnetizable materials (for example watches, steel or iron tools) and/or permanent magnets close to the rotor! If tools that can be magnetized are still required, then hold any tool firmly using both hands. Slowly bring the tool to the rotor.
- Immediately install the rotor after it has been unpacked.
- Use a special installation device when centering and assembling the stator and rotor as individual components. Maintain the special procedure.
- Keep the following tools at hand to release parts of the body (hand, fingers, foot etc.) trapped between two components:
  - A hammer (about 3 kg) made of solid, non-magnetizable material
  - Two pointed wedges (wedge angle approx. 10° - 15°, minimum height 50 mm) made of solid, non-magnetizable material (e.g. hard wood)

⚠ WARNING

Risk of burning when touching hot surfaces

There is a risk of burning when touching hot surfaces immediately after the motor has been operational.

- Wait until the motor has cooled down.

⚠ WARNING

Danger to life if the cooling system bursts

The motor will overheat if it is operated without cooling. When cooling water enters the hot motor, this immediately and suddenly generates hot steam that escapes under high pressure. This can cause the cooling water system to burst, resulting in death, severe injury and material damage.

- Only commission the cooling water circuit when the motor is in a cool condition.

⚠ CAUTION

Risk of burns when hot cooling water escapes

There is a risk of burns caused by escaping hot cooling water and steam if you open the cooling circuit of a motor that was previously in operation.

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

⚠ WARNING

Risk of electric shock due to incorrect connection

There is a risk of electric shock if direct drives are incorrectly connected. This can result in death, serious injury, or material damage.

- Motors must always be precisely connected up as described in these instructions.
- Direct connection of the motors to the three-phase supply is not permissible.
- Consult the documentation of the drive system being used.

⚠ WARNING

Electrical shock hazard

Every movement of the rotor compared with the stator and vice versa induces a voltage at the stator power connections.

When the motor is switched on, the stator power connections are also at a specific voltage.

If you use defective cable ports, you could suffer an electric shock.

- Only mount and remove the electrical components if you are qualified to do so.
- Any work carried out at the motor must always be done with the system in a no-voltage condition.
- Do not touch the cable ports. Correctly connect the stator power connections, or insulate them properly.
- Do not disconnect the power connections when the stator is under voltage (live).
- Only use the specific power cables intended for the purpose.
- First connect the protective conductor (PE).
- Connect the cable shield through a wide area.
- First connect the power cable to the stator before you connect the power cable to the inverter.
- First disconnect the connection to the inverter before you disconnect the power connection to the stator.
- Disconnect the protective conductor PE last.

⚠ WARNING

Risk of electric shock as a result of residual voltages

There is a risk of electric shock if hazardous residual voltages are present at the motor connections. Even after switching off the power supply, active motor parts can have a charge exceeding 60 µC. In addition, even after withdrawing the connector 1 s after switching off the voltage, more than 60 V can be present at the free cable ends.

- Wait for the discharge time to elapse.

⚠ WARNING

Risk of injury when carrying out disassembly work

Risk of death, serious personal injury and/or material damage when carrying out disassembly 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:

⚠ WARNING

Risk of injury when changing safety-relevant motor properties

Changing safety-relevant motor properties may result in death, serious injury and/or material damage.

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.

Technical Support is available for any questions you might have. Contact data is provided in the introduction.

⚠ CAUTION

Sharp edges and falling objects

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

- Always wear safety shoes and safety gloves!

9.2 Inspection and maintenance

Performing maintenance work on the motor

Note

It is essential that you observe the safety information provided in this documentation.

As a result of their inherent principle of operation, the motors are always wear-free. 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 axis is free to rotate.
- Ensure perfect operation and that the power losses are adequately dissipated:
  - Keep the air gap free of metal chips and particles.
  - Keep pollution and dirt away from the motor space, e.g. metal chips and oil.
  - Clean the motor, depending on local degree of pollution.
- Regularly check the general condition of the motor components.
- Check the current drawn in the previously defined test cycle.
- Check the cables to ensure that they are not damaged and are not worn. Never use electrical devices and equipment 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

Inspection and change intervals for the coolant

You must coordinate inspection and change intervals for the coolant with the manufacturer of the cooling equipment and with the manufacturer of the anti-corrosion agent.

Decommissioning and disposal 10

⚠ WARNING

Risk of death and crushing as a result of permanent magnet fields

Severe injury and material damage can result if you do not take into consideration the safety instructions relating to permanent magnet fields.

- Refer to Chapter "Danger from strong magnetic fields (Page 28)".

10.1 Decommissioning

Sequence when decommissioning and disassembling the motor

⚠ WARNING

Risk of injury and material damage

Injury and/or destruction of motor components can occur if you do not observe the specified sequence when decommissioning and disassembling the motor.

- Perform decommissioning and disassembly work in the specified sequence only.

Procedure

1. Bring the motor into a no-voltage condition. Wait until the DC link of the power unit has been discharged.
2. Allow the motor to cool down for at least 30 min.
3. Switch off the cooling. Reduce the pressure to 0 bar.
4. Disconnect the power and signal cables and the coolant pipes.
5. Insulate uncovered power connections.
6. Drain the coolant from the motor and dispose of it correctly.
7. Remove chips, dirt, foreign particles, etc. from the motor.
8. Insert the spacer film between the stator and rotor.
9. Screw on the transport locks at the opposite end of the motor to the mounting end. If the stator and rotor come into contact with each other, these two components can be separated again only with considerable effort. The reason for this is the extremely high magnetic attractive forces which they exert.

10. Separate the flange face of the stator from the machine housing and the flange face of the rotor from the moving axis.
    Do not damage the O rings if you remove a motor with cooling jacket from the precisely dimensioned bore. It is not permissible that you re-use damaged O rings.
    Carefully move the removed rotor, as the transport locks are only at one end.
11. Attach the transport locks to the still unprotected flange face of the motor.
12. This point only applies to motors with cooling jacket:
    If you wish to reuse the O rings from the motor cooling jacket surface, then you must not damage the O rings when removing them:
    - Do not overstretch the O-rings. Do not stretch the O-rings more than 10 %.
    - Do not twist the O-rings.
    - Do not use any sharp objects!
    - Use the appropriate equipment and installation devices.
13. Pack the motor in its original packaging and store the motor properly.

❒

Note

We recommend using new O-rings when the motor with cooling jacket is reassembled. You can reorder O-rings as spare parts. You will find the order designation in the Configuration Manual.

10.2 Disposal

Recycling and disposal

For environmentally-friendly recycling and disposal of your old device, please contact a company certified for the disposal of waste electrical and electronic equipment, and dispose of the old device as prescribed in the respective country of use.

⚠ WARNING

Injury or material damage if not correctly disposed of

If you do not correctly dispose of direct drives or their components (especially components with permanent magnets), then this can result in death, severe injury and/or material damage.

- Ensure that direct drives and their associated components are correctly disposed of.

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. motor windings, cables)
  - Scrap iron (e.g. laminated cores)
  - Aluminum
  - Insulating materials
- No mixing with solvents, cold cleaning agents, or residue 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.

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 Recommended manufacturers

Information regarding third-party products

Note

Recommendation relating to third-party products

This document contains recommendations relating to third-party products. Siemens accepts the fundamental suitability of these third-party products.

You can use equivalent products from other manufacturers.

Siemens does not accept any warranty for the properties of third-party products.

A.1.1 Supply sources for anti-corrosion agents

TYFOROP CHEMIE GmbH	
Anti-corrosion protection: Tyfocor	Internet address: (https://www.tyfo.de)

Clariant Produkte (Deutschland) GmbH	
Anti-corrosion protection: Antifrogen N	Internet address: (https//:www.clariant.com)

A.1.2 Supply source for spacer foils

SAHLBERG GmbH & Co. KG	
	Internet address: (https://www.sahlberg.de)

Properties of spacer foils

Use polyamide PA 6 spacer foils with a thickness of

- 0.5 mm for frame sizes 1FW6050 to 1FW6150
- 1.0 mm for frame sizes 1FW6160 to 1FW6290

A.2 List of abbreviations

BGV	Binding national health and safety at work regulations (in Germany)
CE	Conformité Européenne (European Conformity)
DIN	Deutsches Institut für Normung (German standards organization)
EU	European Union
EMF	Electromagnetic fields
EMC	Electromagnetic compatibility
EN	Europäische Norm (European standard)
HFD	High-frequency damping
IATA	International Air Transport Association
IEC	International Electrotechnical Commission
IP	International Protection
KTY	Temperature sensor with progressive, almost linear characteristic
PE	Protective earth
PELV	Protective extra low voltage
PDS	Power drive system
ph value	Concentration of hydrogen ions in a liquid
Pt	Platinum
PTC	Temperature sensor with positive temperature coefficients and "quasi-switching" characteristic
RoHS	Restriction of (the use of certain) Hazardous Substances
TN	Terre Neutral
UL	Underwriters Laboratories
VDE	Association of Electrical Engineering, Electronics and Information Technology (in Germany)

More information

Siemens:
www.siemens.com/simotics

Industry Online Support (service and support):
www.siemens.com/online-support

Industry Mall:
www.siemens.com/industrymall

Siemens AG
Digital Industries
Motion Control
Postfach 31 80
91050 ERLANGEN
Germany

Scan the QR code for more information about SIMOTICS.