

SIEMENS

Operating Instructions
Installation Instructions

Low-voltage motor

SIMOTICS HT Series HT-direct

Type 1FW4...1.....A

Edition

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SIEMENS

Low-voltage motor

SIMOTICS HT Series HT-direct Type 1FW4...1.....A

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Installation Instructions

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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

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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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Introduction

In the following text, the motor is referred to as "electrical machine" – or abbreviated, just "machine".

These operating instructions are valid for water-cooled synchronous motors in the 1FW4 series. The serial number of the motor can be found on the rating plate.

These instructions describe the machine and explain how to handle it, from initial delivery to final disposal of the equipment. Keep these instructions for later use.

Read these operating instructions before you handle the machine and follow the instructions to become familiar with its design and operating principles and thus ensure safe, problem-free machine operation and long service life.

Safety instructions and handling-related warning notes are provided in these instructions. When carrying out any activity at or with the machine, carefully comply with all of these notes for your own safety, to protect other people and to avoid material damage.

Please contact the Service Center (Page 113) if you have any suggestions on how to improve this document.

Text format features

You can find the following text format features in these instructions:

1. Handling instructions are always formatted as a numbered list. Always perform the steps in the order given.
- Lists are formatted as bulleted lists.
 - Lists on the second level are hyphenated.

Note

The note provides you with additional information about the product itself, handling the product - and the relevant documentation.

1.1 Compiling personal documents

On the Internet pages in Industry Online Support you have the possibility of compiling personal documents using the function Documentation (<https://support.industry.siemens.com/My/www/en/documentation>)

Using the "Documentation" function, from Product Support manuals, you can compile your own "Documentation". However, you can also include other Product Support content such as FAQs or characteristics in the documentation that you compile.

1.1 Compiling personal documents

In the "Documentation" function, you have the option of creating your own compiled documents in your own structure and managing them. You can delete or shift individual chapters or topics. Further, using the note function you can import your own content. The compiled "documentation" can be exported as PDF, for example.

Using the "Documentation" function, you can efficiently compile your own plant or system documentation. The "Documentation" compiled in a specific language can also be automatically exported in one of the other available languages.

The full functionality is only available for registered users.

Safety instructions

2.1 Information for those responsible for the plant or system

This electric machine has been designed and built in accordance with the specifications contained in Directive 2014/35/EU ("Low-Voltage Directive") and is intended for use in industrial plants. Please observe the country-specific regulations when using the electric machine outside the European Community. Follow the local and industry-specific safety and setup regulations.

The persons responsible for the plant must ensure the following:

- Planning and configuration work and all work carried out on and with the machine is only to be done by qualified personnel.
- The operating instructions must always be available for all work.
- The technical data as well as the specifications relating to the permissible installation, connection, ambient and operating conditions are taken into account at all times.
- The specific setup and safety regulations as well as regulations on the use of personal protective equipment are observed.

Note

Use the services and support provided by the local service center (Page 113) for planning, installation, commissioning and service work.

2.2 The 5 safety rules

To ensure your own personal safety as well as to avoid material damage, always comply with the safety-relevant instructions when carrying out any work. Also carefully comply with the 5 safety rules according to EN 50110-1 "Working in a no-voltage state" in the specified sequence.

5 safety rules

1. Disconnect the system.
Also disconnect the auxiliary circuits, for example, anti-condensation heating.
2. Secure against reconnection.
3. Verify absence of operating voltage.
4. Ground and short-circuit.
5. Provide protection against adjacent live parts.

To energize the system, apply the measures in reverse order.

2.3 Qualified personnel

All work at the machine must be carried out by qualified personnel only. For the purpose of this documentation, qualified personnel is taken to mean people who fulfill the following requirements:

- Through appropriate training and experience, they are able to recognize and avoid risks and potential dangers in their particular field of activity.
- They have been instructed to carry out work on the machine by the appropriate person responsible.

2.4 Safe handling

Workplace safety depends on the attentiveness, care, and common sense of the personnel who install, operate, and maintain the machine. In addition to the safety measures cited, as a matter of principle, the use of caution is necessary when you are near the machine. Always pay attention to your safety.

Also observe the following to prevent accidents:

- General safety regulations applicable in the country where the machine is deployed.
- Manufacturer-specific and application-specific regulations
- Special agreements made with the operator
- Separate safety instructions supplied with the machine
- Safety symbols and instructions on the machine and its packaging

Danger as a result of stationary parts under voltage (live parts)

Live parts represent a hazard. Touch protection against active (live) parts is no longer guaranteed if covers are removed. The minimum clearance and creepage distances may be violated when coming close to live parts. Touching or coming close to them can result in death, serious injury or material damage.

- Ensure that all live parts are suitably covered.
- Switch off and disconnect the machine first if you want to remove covers. Observe the "5 safety rules" (Page 13).

Risk of injury due to rotating parts

Rotating parts are dangerous. Touch protection against rotating parts is no longer guaranteed if covers are removed. Touching rotating parts can result in death, serious injury or material damage.

- Ensure that all rotating parts are reliably covered.
- Switch off and disconnect the machine first if you want to remove covers. Observe the "5 safety rules" (Page 13).
- Only remove covers when the rotating parts have come to a complete standstill.

Risk of burns due to hot surfaces

Individual machine parts can become hot in operation. Burns can result when coming into contact with these parts.

- Never touch machine parts during operation.
- Allow the machine to cool before starting work on the machine.
- Check the temperature of parts before touching them. If required, wear suitable protective equipment.

Health hazard due to chemical substances

Chemical substances required for the setup, operation and maintenance of machines can present a health risk.

- Observe the product information provided by the manufacturer.

Flammable substances hazard

Chemical substances required for the setup, operation and maintenance of machines may be flammable. These substances can ignite if handled incorrectly. They can cause burns and property damage.

- Observe the product information provided by the manufacturer.

See also

Inspection and maintenance (Page 93)


Noise emissions

During operation, the machine's noise emission levels can exceed those permitted at the workplace, which can cause hearing damage.

- Ensure that nobody is in the area of increased noise emissions during machine operation.
- Take steps to reduce noise so that the machine can be operated safely within your system. The following measures may help to reduce noise.
 - Covers
 - Noise insulation
 - Hearing protection measures

2.5 Working on machines with permanent magnets

On machines with permanent magnets, the magnetic field is guided in an assembled state in the magnetic circuit of the machine. This means that no magnetic fields, which may be to your health, are detectable outside the machine.

 WARNING
Strong magnetic field when the machine is open
<p>A strong magnetic field is always present inside the machine. If the housing is open, e.g. when maintenance openings are open or when working inside the machine, magnetic objects can be suddenly attracted by this magnetic field. This can result in death, serious injury or material damage.</p>
<ul style="list-style-type: none">• Working in the vicinity of the rotor is only permitted in exceptional circumstances. Unambiguous access rules must be established in accordance with the magnetic fields prevailing in the workplace. Clearly mark the boundaries of the areas where standing is permitted.• People who need to use electronic or magnetic medical aids such as pacemakers, hearing aids, implants or similar devices, are at particularly high risk. Such persons must undergo an industrial medicine assessment.• Observe the following measures.

Personal protective measures

- Ensure that you never wear or carry any of the following objects and that they are kept a safe distance from the machine:
 - All kinds of magnetic metal parts such as, keys, glasses, tools, knives, scissors, tape measures, etc.
 - Magnetic jewelry such as rings, chains, needles, watches, etc.
 - Electronic devices and data carriers such as service cards, check cards, credit cards, calculators, cell phones, etc.
 - Wallets or other iron-containing objects
 - Electrically conductive foreign bodies
- Do not use any magnetic tools or lifting devices.
- Wear only occupational safety items without magnetic metal parts, e.g. occupational safety shoes with non-magnetic protective caps and soles.
- Keep your shoes and clothing free from chips and waste containing iron.
- Exercise caution when installing accessories. Ensure that no parts fall into the inside of the machine.
- Do not perform any cutting at the machine, e.g. manufacturing threaded holes. Any exceptions require written approval from the manufacturer.

Danger due to induced voltages

Electrical voltages are induced in the stator when rotating the rotor. Touching the stator connections can result in death or severe injury.

- Before starting any work at the machine, carefully ensure that the system is secured to prevent the rotor accidentally turning in compliance with the regulations.
- If you must rotate the rotor, then ensure that each phase is grounded.

2.6 Electrostatic sensitive devices

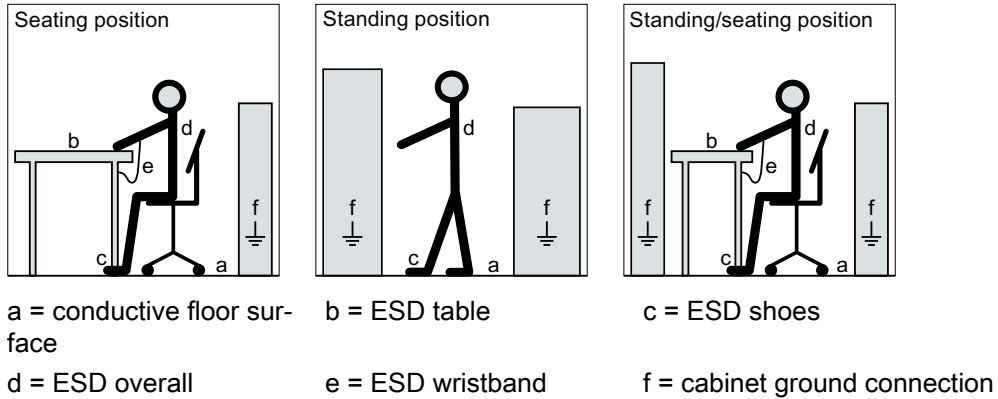
Material damage due to electrostatic discharge

Electronic modules contain components that can be destroyed by electrostatic discharge. These components can be damaged or destroyed if they are not handled correctly. To protect equipment against damage, follow the instructions given below.

- Only touch electronic modules if you absolutely have to work on them.
- The body of the person concerned must have been electrostatically discharged and grounded immediately before any electronic modules are touched.
- Electronic modules should not be brought into contact with electrically insulating materials, such as:
 - Plastic film
 - Plastic parts
 - Insulating table supports
 - Clothing made of synthetic fibers
- Always place electrostatic sensitive devices on conductive bases.
- Always pack, store and transport electronic modules or components in conductive packaging, such as:
 - Metallized plastic or metal containers
 - Conductive foam material
 - Domestic aluminum foil

2.9 Electromagnetic fields when operating electrical power engineering installations

The ESD protective measures required for components that can be destroyed due to electrostatic discharge are shown in the following drawings:



2.7 Interference immunity

By selecting suitable signal cables and evaluation units, ensure that the interference immunity of the machine is not diminished.

2.8 Interference voltages when operating the converter

Interference voltages when operating the converter

When a converter is in operation, the emitted interference varies in strength depending on the converter (manufacturer, type, interference suppression measures undertaken). On machines with integrated sensors (e.g. PTC thermistors), interference voltages caused by the converter may occur on the sensor lead. This can cause faults which can result in eventual or immediate death, serious injury or material damage.

- Comply with the EMC information provided by the manufacturer of the converter. This is how you prevent the limit values stipulated by IEC/EN 61000-6-3 for the drive system (consisting of the machine and converter) from being exceeded.
- You must put appropriate EMC measures in place.

2.9 Electromagnetic fields when operating electrical power engineering installations

Electrical power equipment generate electromagnetic fields during operation. Potentially lethal malfunctions can occur in medical implants, e.g. pacemakers, in the vicinity of electrical power equipment. Data may be lost on magnetic or electronic data carriers.

- Protect the personnel working in the plant by taking appropriate measures, such as erecting identifying markings, safety barriers and warning signs and giving safety talks.
- Observe the nationally applicable health and safety regulations.

2.9 Electromagnetic fields when operating electrical power engineering installations

- It is forbidden for people with pacemakers to be close to the machine.
- Do not carry any magnetic or electronic data media.

Description

Area of application

The series 1FW4 motors are multi-pin, permanent-magnet synchronous motors with full-shaft rotors. The motors are liquid or air cooled. The operating behavior is comparable to that of electrically excited synchronous motors.

Motors of the 1FW4 series are used together with converters as slow running direct drives, e.g. in the following sectors:

- Pulp and paper industry
- Steel industry
- Plastics industry
- Marine
- Crushers

WARNING

Risk of explosion

This machine is not designed for use in hazardous areas. An explosion can occur if the machine is operated in these areas. This can result in death, serious injury or material damage.

- **Never** operate this machine in hazardous areas.



Figure 3-1 1FW4 water-cooled motor

Machine design

The regulations and standards used as basis for designing and testing this machine are stamped on the rating plate. The machine design basically complies with the following standards. Please refer to the EU Declaration of Conformity for the versions of the harmonized standards referenced.

Table 3-1 Machine design

Feature	Standard
Dimensions and operation characteristics	IEC / EN 60034-1
Degree of protection	IEC / EN 60034-5
Cooling	IEC / EN 60034-6
Type of construction	IEC / EN 60034-7
Terminal markings and direction of rotation	IEC/EN 60034-8
Noise emission	IEC / EN 60034-9
Mechanical vibrations	IEC / EN 60034-14
IEC-standard voltages	IEC/DIN IEC 60038
Vibration limit values	DIN ISO 10816-3

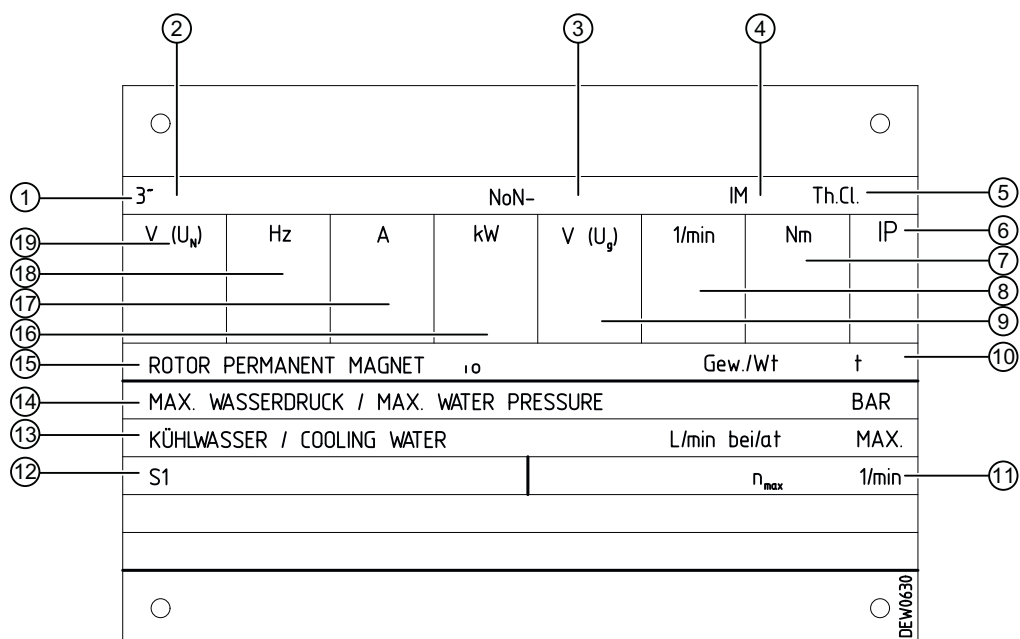
See also

Quality documents (Page 117)

Rating plate

The rating plate shows the identification data and the most important technical data. The data on the rating plate and the contractual agreements define the limits of proper usage.

Rating plate



- | | |
|---|--|
| ① Motor type: Three-phase motor | ⑪ Maximum operating speed [rpm] |
| ② Motor type: Synchronous motor, order number | ⑫ Operating mode |
| ③ Serial number | ⑬ Required amount of cooling water [l/min] at the maximum cooling water inlet temperature [°C] |
| ④ Type | ⑭ Maximum water pressure [bar] |
| ⑤ Temperature class | ⑮ Rotors, standards and regulations |
| ⑥ Degree of protection | ⑯ Rated power [kW] |
| ⑦ Rated torque [Nm] | ⑰ Rated current [A] |
| ⑧ Rated speed [rpm] | ⑱ Rated frequency [Hz] |
| ⑨ Induced voltage | ⑲ Rated voltage [V] |
| ⑩ Motor weight [t] | |

Figure 3-2 Rating plate diagram

Degree of protection

The machine is available with degree of protection IP55.

Ambient conditions

The standard machines are not suitable for use in corrosive atmospheres, atmospheres with a high salt content, or outdoor applications.

Water cooling

The cooling system is designed as a closed, internal cooling circuit. A shaft-mounted fan ensures circulation of the cooling air. The machine has cooling type IC71W according to IEC / EN 60034-6.

Cooling power

To ensure adequate cooling of the machine, it is essential to adhere to the specified cooling water rate, temperature and cooling water quality.

Drive

The machine is designed for operation with SINAMICS converters and has been type-tested for use with these converters. No liability is assumed in respect of damage to the motor or converter and no warranty is issued in respect of the drive function if you operate the motor with a different converter.

As far as the SINAMICS Motor Modules are concerned, special control software has been developed for these motors. The converter module is selected depending on many influencing parameters, e.g.:

- Torque
- Speed
- Overload
- Duty cycles
- Control precision
- Capable of energy recovery

More detailed information is provided in Catalog D86.2 "SIMOTICS HT-direct". Contact the Service Center if you have additional questions.

Anti-condensation heating (option)

The machine is fitted with anti-condensation heating. The connection data is listed on an additional plate on the machine.

Rotor shipping brace

Depending on the order, the machine is fitted with a rotor shipping brace.

Supplementary devices

Temperature sensors are integrated in the stator winding to monitor the winding temperature. Various supplementary devices can be integrated or mounted, depending on the order. These include, for example, anti-condensation heating to prevent condensation or temperature sensors for monitoring bearings.

Rolling bearing design for "Increased degree of protection" (option)

By locating a grease chamber in front of the actual bearing cartridge, bearing cartridges can be better sealed against the ingress of dust and water. Although the same grease is used in both cases, a distinction is made here between "lubricating grease" and "sealing grease" because of their different functions.

Layout

Together with the bearing housing, the outer bearing cover forms the space where the lubricating grease collects, and together with the labyrinth sealing ring (optional), forms the sealing grease chamber for the sealing grease. The 2nd lubricating nipple with the grease duct for pressing in the sealing grease is also located in the outer bearing cap.

The sealing grease chamber is sealed off from the lubricating grease collection space using a V-ring or a combination of V-ring and felt ring to prevent the sealing grease that is pressed into the sealing grease chamber from entering the lubricating grease collection space.

During operation, the sealing grease in the sealing grease chamber slowly runs out via the labyrinth and seals it, additionally removing any dust from inside and around the outside of the labyrinth ring.

Preparing for use

Good planning and preparation of machine applications are essential in terms of keeping installation simple and avoiding errors, ensuring safe operation, and allowing access to the machine for servicing and corrective maintenance.

This chapter outlines what you need to consider when engineering/configuring your plant in relation to this machine and the preparations you need to make before the machine is delivered.

4.1 Safety-related aspects to consider when configuring the plant

A number of residual risks are associated with the machine. These are described in the chapter titled "Safety information" (Page 13) and in related sections.

Take appropriate safety precautions (covers, barriers, markings, etc.) to ensure the machine is operated safely within your plant.

4.2 Observing the operating mode

Observe the machine's operating mode. Use a suitable control system to prevent overspeeds, thus protecting the machine from damage.

4.3 Cooling water quality

- The cooling water must circulate in a closed cooling circuit.
- Avoid fluctuations in the oxygen content of the cooling water.
- The cooling system is maintenance-free provided cooling water of the specified quality is used.

Note

Order-specific agreements

Observe any order-specific agreements regarding the cooling water specification. These might deviate from the named cooling water specification.

Cooling water specification

Characteristic	Specified as	Measured value	German unitary procedure	Currently ISO / alternative
pH		7.5 - 10	DIN 38404-5 (Z)	ISO 10523

4.4 Cooling water inlet temperature (water-cooled motor)

Conductivity		<600 µS/cm	DIN 38404-8 (Z)	ISO 7888
Chloride	Cl	<150 mg/l	DIN 38405-1	ISO 9297
Manganese	Mn	<0.05 mg/l	DIN 38406-2	ISO 6333 / ISO 11885
Fluoride	F	<0.05 mg/l	DIN 38405-4	ISO 10359-1
Sulfate	SO ₄ ²⁻	<150 mg/l	DIN 38405-5	ISO 10304
Copper	Cu = Total copper	<0.1 mg/l	DIN 38406-7	ISO 8288 / ISO 11885
Silicic acid	SiO ₂	<25 mg/l	F1 (DIN 38407-1)	ISO 16264
Free carbon dioxide	CO ₂	0 mg/l	G1 (DIN 38408-1)	-
Total salts		<1000 mg/l	DIN 38409-1	-
Nitrate	NO ₃ ⁻	<20 mg/l	DIN 38405-9	ISO 7890-1 (Z) / ISO 10304
Suspended matter		<10 mg/l	DIN 38409-2	ISO 11923
Permanganate consumption	O	<12 mg/l	H4 (DIN 38409-5)	ISO 8467
Total hardness	Mg+Ca	<12 °DH	DIN 38409-6	ISO 6059
Carbonate hardness	HCO ₃ ⁻	<12 °DH	DIN 38404-10	ISO 9963-1
Ammonium content	N ISO 11732 / NH ₄ ⁺ ISO 14911	<10 mg/l	DIN 38406-5	ISO 11732 / ISO 14911
Iron content	Fe = Total iron	<0.2 mg/l	DIN 38406-1	ISO 6332 / ISO 11885

4.4 Cooling water inlet temperature (water-cooled motor)

The motor has two cooling circuits that can be used to achieve intensive, effective cooling.

- The fan inside the motor provides air circulation between DE and NDE. This cools, in particular, the stator winding overhang, the magnetic rotor and the bearings.
- The motor housing is designed with a water-cooling system. This allows a high power density. The coolant flows through a duct that runs in a spiral from the DE to the NDE in the cooling jacket. The coolant inlet is on the DE, the coolant outlet is on the NDE. Seen from the shaft end, connection is possible from the right and from the left.

Close the duct provided for cooling on the cooling circuit. The cooling duct geometry is designed so that the stator power losses are dissipated. Forced air ventilation prevents local temperature peaks inside the motor. This also draws off the low magnetic losses in the rotor via the stator.

Ambient and coolant inlet temperature

To prevent the formation of condensation, the coolant inlet temperature for a stationary motor and still operational cooling system must be higher than the ambient temperature.

$$T_{\text{cooling water}} \geq T_{\text{ambient}} + 2 \text{ °C}$$

The motor is designed in accordance with EN 60034-1 for operation up to a coolant temperature of 25 °C, maintaining all motor data. If you operate the motor with a higher coolant

4.4 Cooling water inlet temperature (water-cooled motor)

inlet temperature and/or an ambient temperature > +40°C, then you must reduce the torque. Note the derating factors shown in the table below.

Table 4-1 Derating factors

Coolant inlet temperature up to	25 °C	30 °C	35 °C	40 °C	45 °C
Ambient temperature up to	40 °C	45 °C	50 °C	55 °C	60 °C
Derating factor k_T	1.0	0.97	0.95	0.92	0.89

Cooling volumetric flow and water pressure

Table 4-2 Coolant flow rate and maximum permissible water pressure

Type	Cooling volumetric flow <i>l/min</i>	Max. permissible water pressure ¹ MPa	Thread sizes for water connections
1FW440.	30	0.5	G ³ / ₄
1FW445.	50	0.5	G1
1FW4503 / 1FW4505	65	0.5	G1½
1FW4507 / 1FW4508	80	0.5	G1½

¹ A maximum pressure drop of approximately 0.1 MPa occurs in the water jacket.

Cooling water quality

The cooling water must meet the following prerequisites:

- Chemically neutral reaction
- Water cleaned by solids
- Max. particle size of particles carried: ≤0.1 mm
- No salt water

NOTICE
Damage due to sea water
The cooling system is made of St37 steel. This material is not resistant to sea water.
<ul style="list-style-type: none"> • Do not use seawater to cool the motor.

Table 4-3 Chemical requirements of the cooling water quality

Contents and chemical composition	Value
pH value	6.0 to 8.0
Total hardness	< 170 ppm
Chloride	< 40 ppm
Sulphate	< 50 ppm
Nitrate	< 10 ppm

4.4 Cooling water inlet temperature (water-cooled motor)

Contents and chemical composition	Value
Iron	< 0.2 ppm
Ammonia	< 10 ppm
Dissolved solids	< 340 ppm
Conductivity	< 500 µS/cm

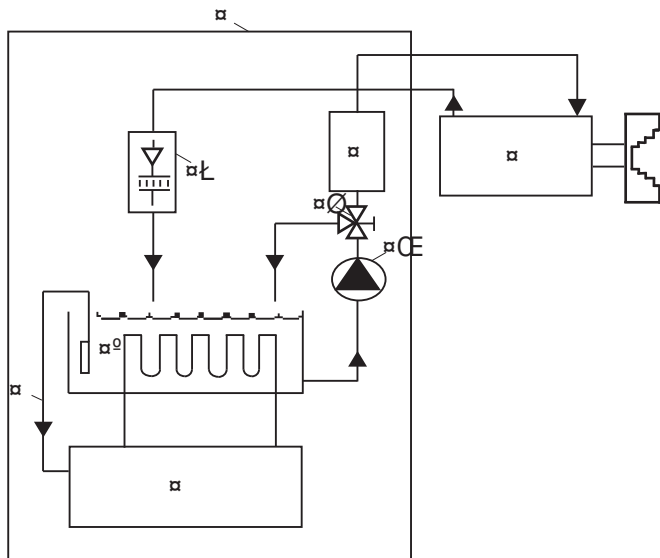
Mix additives in with the cooling water in appropriate quantities to protect against corrosion and inhibit the growth of algae. The type and quantity of additive should be taken from the respective manufacturer's specifications for these additives and the particular ambient conditions.

Cooling unit

The use of a correspondingly dimensioned cooling unit ensures the coolant inlet temperature of 25°C. You can operate several motors and/or the converter on one cooling unit.

Use a closed cooling circuit. This will prevent deposits in the cooling circuit, cooling is then permanently guaranteed.

The cooling unit is not part of the motor's scope of delivery.



- ① Filter¹
- ② Flow quantity display ①
- ③ Flow regulating valve ①
- ④ Pump
- ⑤ Cooling-medium reservoir
- ⑥ Coolant temperature sensing
- ⑦ Compressor/cooling unit
- ⑧ Motor
- ⑨ Cooling unit

¹ These components are not absolutely necessary.

Figure 4-1 Example of a cooling circuit

4.5 Interlock circuit for anti-condensation heating

If the anti-condensation heating is operated while the machine is running, this can increase the temperatures inside the machine.

- Install an interlock circuit that switches off the anti-condensation heating once the main machine is switched on.
- Only switch on the anti-condensation heating at the earliest two hours after the machine has been switched off.

See also

Avoidance of condensation or formation of condensation within the machine (Page 86)

4.6 Thermal motor protection

The machine is equipped as standard with two KTY 84 temperature sensors, optionally with six PT100 to directly monitor the motor temperature to protect the machine against overload in operation. Plan a corresponding circuit for monitoring.

4.7 Noise emissions

Noise emissions

During operation, the machine's noise emission levels can exceed those permitted at the workplace, which can cause hearing damage.

- Ensure that nobody is in the area of increased noise emissions during machine operation.
- Take steps to reduce noise so that the machine can be operated safely within your system. The following measures may help to reduce noise.
 - Covers
 - Noise insulation
 - Hearing protection measures

4.8 Rotational speed limit values

Excessive rotational speed can lead to serious damage to the machine and the converter. This can result in death, serious injury or material damage.

- The converter control must ensure that operation at impermissible speeds is prevented.
- Please note the speed data specified in the Electrical Data.

4.9 System-inherent frequencies

Excessively high vibration levels and system resonances can damage the machine set.

- Configure and match the system consisting of the foundation and machine set in such a way that no system resonances can arise and result in the permissible vibration levels being exceeded.
- The vibration values according to DIN ISO 10816-3 must not be exceeded.

4.10 Torsional loading of the drive train due to faults in the electrical supply

In the event of faults in the electrical connection during operation, excessive air gap torques can lead to additional mechanical torsional load on the line shaft.

Risk of torsional stress on the drive train

If the configuration does not correctly recognize the mechanical torsional loadings of the shaft assembly, this can lead to serious damage to the machine. This can result in death, serious injury or material damage.

- When planning the system, consider the configuration data. The system planner is responsible for the entire drive train.

Note

More information about this may be found in the catalog.

4.11 Transport

4.11.1 Safety instructions for transport

Observe the following when carrying out any work on the machine:

- Comply with the general safety instructions (Page 13).
- Comply with the applicable national and sector-specific regulations.
- When using the machine within the European Union, comply with the specifications laid down in EN 50110-1 regarding safe operation of electrical equipment.

Danger due to induced voltages

Electrical voltages are induced in the stator when rotating the rotor. Touching the stator connections can result in death or severe injury.

- Before starting any work at the machine, carefully ensure that the system is secured to prevent the rotor accidentally turning in compliance with the regulations.
- If you must rotate the rotor, then ensure that each phase is grounded.

4.11.1.1 Transporting the machine set

Danger if the machine falls

The attachment points on the machine are designed for the weight of the machine only. If a machine set is lifted and transported at a single machine, this can fracture the attachment point. The machine or machine set may fall. This can result in death, serious injury or material damage.

- Do not lift machine sets by attaching lifting tackle to the individual machines.
- Use only the equipment provided, e.g. the openings or lugs on the base plates, for transporting machine sets. Note the maximum capacity of the lifting lug.

4.11.2 Checking the delivery

The components are assembled on an individual basis. When you take receipt of the delivery, please check immediately whether the scope of the delivery matches up with the accompanying documents. Subsequent claims cannot be recognized.

- Report any apparent transport damage to the delivery agent immediately.
- Report any detectable defects or incomplete delivery immediately to the Service Center.

These Operating Instructions are part of the scope of delivery; keep them in a location where they can be easily accessed.

4.11.3 Securing the rotor

Depending on the version, the machine is fitted with a rotor shipping brace. This protects the bearings against damage due to shock and vibration during transport or storage.

NOTICE

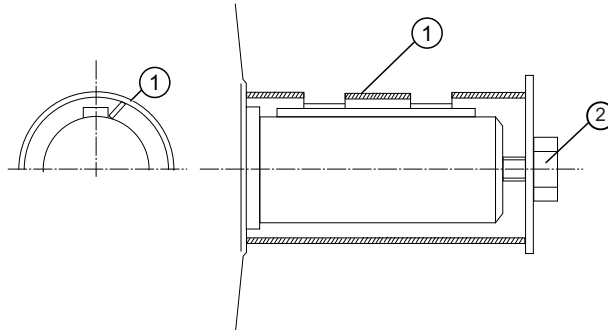
Motor damage due to vibrations

Not using the rotor shipping brace can cause damage to the machine if it is jolted during transport or storage. Material damage can result.

- If the machine is fitted with a rotor shipping brace, this should always be used when transporting the machine. The rotor shipping brace must be attached during the transport.
- Protect the motor against strong radial shocks and vibration when storing, as the rotor shipping brace cannot completely absorb these forces.
- Do not remove the rotor shipping brace until you are ready to push on the output element.
- If the customer already has mounted parts, such as a coupling or belt pulley, the bearings can be damaged during transport. In this case, make sure that the customer uses a rotor shipping brace.
- For machines with a vertical type of construction:
 - Do not remove the rotor shipping brace until the machine is in a vertical position.
 - If a machine has to be transported in a horizontal position, the rotor must be fixed in position before the machine is turned onto its side. Vertical machines can be supplied in the horizontal position from the manufacturing plant.

Alternative rotor bracing

- If you transport the machine after the output element has been pulled on, then you must axially fix the rotor in another way.



① Sleeve

② Shaft screw and washer

Figure 4-2 Axial fastening of the rotor

Thread in the shaft extension	Tightening torque
M20	80 Nm
M24	150 Nm
M30	230 Nm

Tightening torques for other rotor shipping brace types

- The thread in the shaft extension indicates the rotor weight. This indirectly specifies the required preload force when axially fastening the rotor.

Thread in the shaft extension	Preload
M20	20 kN
M24	30 kN
M30	40 kN

Axial preload force for other rotor shipping brace types

Storing the rotor locking device

Store the rotor locking device in a safe place. It must be remounted if the machine is removed and shipped on further.

4.11.4 Protecting cooling water ducts

The cooling water ducts are not filled with cooling water when the motor is supplied. To avoid corrosion, the cooling water ducts are treated with a rust protection agent.

- If the cooling water has been drained, you must flush the cooling circuit with a rust protection agent if the motor is going to sit idle for a long period of time. Otherwise material damage will occur.
- Foreign bodies in the cooling system can cause blockages in individual cooling water ducts. Water-cooled components can overheat and the motor fails.
 - Ensure that no foreign bodies can enter the cooling system.
 - Do not remove the protective cover until you are ready to make the final water connections.
- The cooling circuit can be damaged if the cooling water freezes. Drain the water from the cooling system before you transport and store the motor.
 - Drain the cooling water ducts.
 - Blow out the cooling water ducts with compressed air.

4.11.5 Transporting a motor that has already been in operation

If the machine had already been operated, then proceed as follows before transporting it:


1. Allow the machine to cool down.
2. Remove the connections provided by the customer.
3. Drain the cooling-water system and purge it carefully with air.
4. Lock the rotor.
5. Only use the eyebolts on the bearing shields - for example - to transport and lift the machine.


4.11.6 Lifting and transportation

To safely lift and transport the machine, the following requirements must be met:


- Personnel operating cranes and fork-lift trucks must be appropriately qualified.
- If the machine is packed:
 - Depending on the weight, size and on-site conditions, lift crates and transport frames using a crane with slings or a forklift truck.
 - Use a crane or fork-lift truck suitable for the load.

- When lifting the machine, use only approved and undamaged sling guides and spreaders of sufficient rated capacity. Carefully check the lifting equipment prior to using it. The weight of the machine is shown on the rating plate.
- When lifting the machine, refer to the information on the lifting plate.
 - Comply with the specified spreading angles.
 - Do not exceed the maximum lifting acceleration and lifting speed specified on the lifting plate. Lift the machine without jerking it.
Acceleration $a \leq 0.4 \text{ g}$ ($\approx 4 \text{ m/s}^2$)
Velocity $v \leq 20 \text{ m/min}$

 WARNING
<p>Transport for a different type of construction</p> <p>If you do not transport or lift the machine in a position appropriate for its construction, the machine can tip, slip into the lifting equipment or fall down. This can result in death, serious injury or material damage.</p> <ul style="list-style-type: none"> • Use only the load carrying device on the stator frame for lifting. • Use the load carrying device appropriate for the machine position. • Only use suitable rope guiding or spreading devices.

 WARNING
<p>Center of gravity not centered</p> <p>If the center of gravity is not located centrally between the attachment points, when the machine is being transported or lifted, it can tip over or slip out of the lifting equipment and fall. This can result in death, serious injury or material damage.</p> <ul style="list-style-type: none"> • Carefully comply with the handling instructions on the machine when transporting it. • Carefully take into account the different load levels of the sling ropes or lifting straps as well as the carrying capacity of the lifting equipment. • Always take account of the center of gravity when transporting or lifting the machine. If the center of gravity is not located centrally between the attachment points, then position the hoisting hook above the center of gravity.

- Never remain under or in the immediate vicinity of the machine when it is lifted.

 WARNING
<p>Danger to life as a result of a machine falling</p> <p>If the lifting gear or load handling attachments were to fail, the machine could fall. This can result in death, serious injury or material damage.</p> <ul style="list-style-type: none"> • In order to gain easy and safe access to the underside of the machine, place it in a secure and raised position.

4.12 Storage

You must correctly store the machine if you do not install and use the machine after it has been delivered.

NOTICE

Bearing seizure damage if incorrectly stored

If storage conditions are inappropriate there is a risk of bearing seizure damage. Resulting damage can include scoring (brinelling) and corrosion.

- Follow the storage guidelines.

Preconditions and preparations

- Only store goods in undamaged packaging. Unpack the goods if the packaging is damaged. Correctly store the goods corresponding to the type.
- Repair any damage to the packaging before putting the equipment into storage insofar as this is necessary to ensure proper storage conditions.

General instructions for storage

Store the machine in a storage room. The place of storage must satisfy the following general conditions:

- Select a sufficiently sized dry and horizontal place of storage that is above flood level and free of vibration ($v_{\text{eff}} \leq 0.2 \text{ mm/s}$).
 - The place of storage must be well ventilated as well as free of dust and frost. Provide protection against extreme weather conditions. Ensure that the temperature remains stable in the range from 10 °C to 50 °C – or 50 °F to 120 °F. If there is a risk of condensation, the room temperature must be approx. 10 K above the outside temperature. It is not permissible that the temperature falls below -20 °C.
 - The relative humidity of the air must be lower than 60 %.
 - The floor of the place of storage must be sufficiently strong. The maximum permissible floor loading or storage compartment loading may not be exceeded.
 - The ambient air must not contain any harmful gases.
- Protect the machine from shocks and humidity.
- Protect the machines, devices and crates against rising damp and water. Place them on pallets, beams or suitable foundations.
- Ensure that the air circulation under the equipment is not impeded.
 - Place wooden spacer blocks between the covers and the machine.
 - Covers or tarpaulins must not trail on the floor around the machine.

Storing outdoors

When storing the machines outside, the storage location must comply with the following conditions:

- The ground must be sufficiently strong. Prevent the machine from sinking into the ground.
- Covers or tarpaulins used to protect the equipment against the weather must not make contact with the surfaces of the equipment. Otherwise air circulation under the stored items will be prevented.

Protection against humidity

If a dry storage space is not available, protect the machine as follows against humidity:

- Wrap the machine in humidity-absorbent material.
- Wrap the machine in plastic film:
 - Place a humidity meter inside the plastic film.
 - Place desiccant within the plastic film.
 - Pack the machine air-tight.
- Inspect the machine regularly.

Storage for longer than three months

Lubricate the machine after every two years of storage.

1. Unpack the machine.
2. Remove the rotor shipping brace, if one is fitted.
3. When stored for longer than two years, lubricate with twice the grease quantity in accordance with the lubricant plate. This ensures that the grease is evenly distributed and covers all surfaces. Corrosion damage is avoided.

NOTICE
Rolling bearing damage due to unchanged resting position
Rolling bearings can be damaged when kept in the same or almost the same position.
<ul style="list-style-type: none">• Every three months, manually rotate the rotor through five revolutions.• Make sure that the resting position of the rotor after the rotor has been turned over is different from its previous position. Use the feather key as a reference point, if present.

4. Replace the corrosion protection.
5. Reattach the rotor shipping brace, if present.
6. Pack the machine again.

Long-term storage

If you store the machine for more than 6 months, you must check its condition every 6 months to ensure that it is in a correct state. Store the machine in a packed state in accordance with the specifications in Chapter "Storage (Page 38)".

- Check the motor for damage.
- Carry out any necessary maintenance work.
- Make sure that the storage conditions are such that condensation cannot form in the motor.

If the machine is not sealed in foil:

- Continually and slightly heat the machine, e.g. using the anti-condensation heating system (if available).
- Ensure that air circulates in the storage room or area.

4.13 Converter operation

4.13.1 Converter input voltage

The insulation system of SIMOTICS machines always complies with the requirements of stress category C (IVIC C = high stress). If voltage peaks higher than those specified according to IVIC C can occur, contact the Service Center.

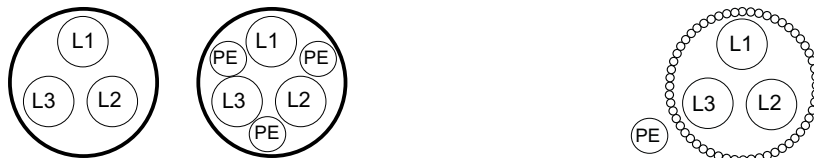
- For a line supply voltage (converter input voltage) up to max. 480 V, and when controlled from a SINAMICS G/SINAMICS S converter with uncontrolled/controlled infeed: Comply with the guidelines for configuring motor and converter.
- For line voltages (converter input voltages) higher than 480 V, motors, which are ordered for converter operation, have an appropriate insulation system.
- Operation with a converter from another manufacturer: Comply with the permissible voltage peaks according to IEC 60034-18-41 in accordance with stress category C, dependent on the particular line voltage (converter input voltage) and the motor insulation system.

NOTICE
Material damage caused by an excessively high supply voltage
The insulation system will be damaged if the supply voltage is too high for the insulation system. This can completely destroy the machine.
<ul style="list-style-type: none">• Comply with the peak voltages as laid down in the guidelines above.

4.13.2 Reducing bearing currents

To prevent damage due to bearing currents, you must carefully assess the complete system, i.e. the motor, converter and driven machine.

- In addition to grounding the motors via the grounding conductor, supplement the RF grounding with braided flat copper cables or RF stranded conductors. Ensure that contact is established across the largest possible surface area. Solid copper cables are not suitable for RF grounding because of the skin effect.
- Use symmetrically constructed, shielded connection cables to connect the motor to a converter. The cable shielding, made up of as many strands as possible, must have good electrical conductivity. Braided shields made of copper or aluminum are well suited. Connect the shielding at both ends on the motor and on the converter. Keep unshielded cable ends as short as possible.



Concentric copper or aluminum shield

Steel armor

- To ensure that high-frequency currents are appropriately discharged, establish a contact through the largest possible surface area at both ends. Establish a 360° contact of the cable shielding on the motor enclosure and on the protective grounding bar of the converter, for example, as follows:
 - Motor side: EMC glands at the cable entries
 - Converter side: EMC shield clips
- In the overall system, set up a properly meshed grounding system with low impedance for high-frequency currents.
- No potential difference between the motor, converter, and working machine.
 - Use equipotential bonding cables between the terminal box and the high-frequency grounding point on the motor enclosure.
 - Use a separate high-frequency equipotential bonding cable between the motor enclosure and the protective grounding bar of the converter.
 - Use a separate high-frequency equipotential bonding cable between the motor enclosure and the driven machine.
- Use the common-mode filter (damping cores) at the converter output. The Siemens sales representative is responsible for selection and dimensioning.
- Limit the rise in voltage by using output filters. Output filters dampen the harmonic content in the output voltage.
- Use the motor reactors.
- Preferably use an IT line supply with an insulated neutral point.

The operating instructions for the converter are not part of this documentation. Carefully comply with the instructions in the converter configuring information.

4.13.3 Insulated bearings for converter operation

If the machine is operated from a low-voltage converter, insulated bearings, and optionally an insulated encoder with insulated bearings, are fitted at the NDE.

Carefully comply with the information on the plates attached to the machine regarding bearing insulation and possible jumpers.

Do not jumper the bearing insulation. The bearing can be damaged when current flows through it.

- Also for subsequent installation work, for example, when installing an automatic lubrication system or a non-insulated vibration sensor, carefully ensure that the bearing insulation is not jumpered.
- Where necessary, contact the Service Center.

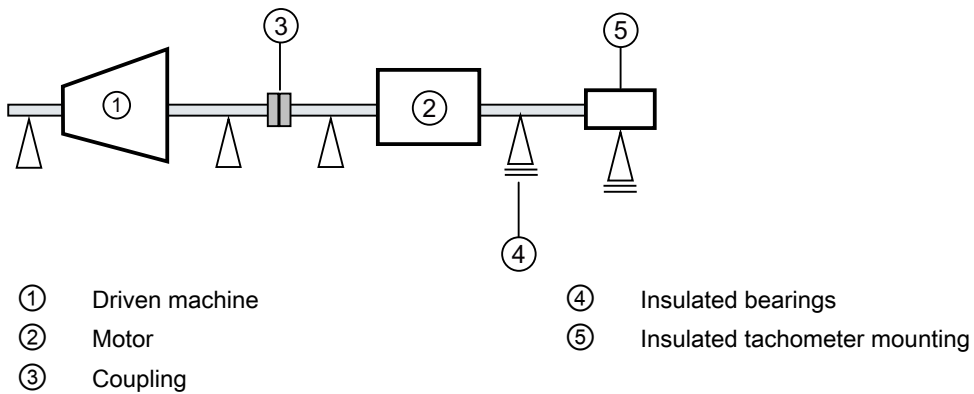


Figure 4-3 Schematic representation of a single drive

See also

Service and support (Page 113)

Mounting

5.1 Safety instructions when mounting

Observe the following when carrying out any work on the machine:

- Comply with the general safety instructions (Page 13).
- Comply with the applicable national and sector-specific regulations.
- When using the machine within the European Union, comply with the specifications laid down in EN 50110-1 regarding safe operation of electrical equipment.

Injury and material damage caused by inappropriate fastening material

If screws of an incorrect property class have been selected or if they have been fastened to an incorrect tightening torque, they may break or become loose. This will cause the machine to move, which could damage the bearings. The rotor could smash into the machine enclosure and machine parts could be flung out of place. This can result in death, serious injury or material damage.

- Comply with the required property classes for screwed connections.
- Tighten the screwed connections to the specified tightening torques.

Injury and material damage caused by incorrect machine alignment

If the machine has not been properly aligned, this will mean the fastening parts are subjected to stress/distortion. Screws may become loose or break, the machine will move, machine parts could be flung out of place. This can result in death, serious injury or material damage.

- Carefully align the machine to the driven machine.

Material damage caused by improper handling

Mounting parts such as temperature sensors or speed sensors are attached to the machine and could be ripped off or destroyed as a result of improper handling. This could lead to machine malfunctions, extending even to total loss of the machine.

- Where necessary, use suitable steps when performing installation work on the machine.
- Do not stand on cables or attachments during installation. Do not use attachments as steps.

Injury and material damage caused by incorrect mounting

Incorrect installation can result in death, serious injury or substantial material damage. Correct installation is essential to ensure that the machine works safely without any problems.

- All installation and mounting work should be carried out by qualified, authorized personnel who adhere strictly to the safety procedures described in these instructions.

Damage to mounted parts and components as a result of high temperatures

The motor components get very hot during operation. High temperatures can damage parts mounted by customers, such as cables manufactured out of materials that are not heat resistant.

- Temperature-sensitive parts must not come into contact with or be attached to components mounted on the machine.
- Only use heat-resistant mounting parts. The connecting cables and cable entries must be suitable for the particular application.

Loss of conformity with European directives

In the delivery state, the machine corresponds to the requirements of the European directives. Unauthorized changes or modifications to the machine lead to the loss of conformity with European Directives and the loss of the associated warranty.

5.2 Preparations for installation

5.2.1 Requirements for installation

The following requirements must be satisfied prior to starting installation work:

- Staff have access to the operating and installation instructions.
- The machine is unpacked and ready for mounting at the installation location.
- Measure the insulation resistance of the winding before starting any installation work. If the insulation resistance lies below the specified value, take appropriate remedial measures. These remedial measures may necessitate the machine being removed again and transported.

5.2.2 Insulation resistance and polarization index

Measuring the insulation resistance and polarization index (PI) provides information on the condition of the machine. It is therefore important to check the insulation resistance and the polarization index at the following times:

- Before starting up a machine for the first time
- After an extended period in storage or downtime
- Within the scope of maintenance work

The following information is provided regarding the state of the winding insulation:

- Is the winding head insulation conductively contaminated?
- Has the winding insulation absorbed moisture?

As such, you can determine whether the machine needs commissioning or any necessary measures such as cleaning and/or drying the winding:

- Can the machine be put into operation?
- Must the windings be cleaned or dried?

Detailed information on testing and the limit values can be found here:

"Testing the insulation resistance and polarization index" (Page 45)

5.2.3 Checking the insulation resistance and polarization index of the winding



⚠ WARNING

Hazardous voltage at the terminals

Hazardous voltages are sometimes present at the terminals during and immediately after measurement of the insulation resistance or polarization index of the winding. Contact with these can result in death, serious injury or material damage.

- If power cables are connected, ensure that a line voltage cannot be applied.
- Discharge the winding after measurement until the risk is eliminated, e.g. using the following measures:
 - Ground the terminals until the recharge voltage drops to a non-hazardous level.
 - Attach the connection cable.

Measure the insulation resistance

1. Follow the instructions in the Operating Manual of the insulation measuring instrument used.
2. Ground other windings, integrated winding temperature sensors and, if applicable, other mounted and installed components.
3. If power cables are connected, ensure that a line voltage cannot be applied.
If no power cables are connected, this reduces the effect of the I/O devices on the measurement.
4. Measure the winding temperature and the insulation resistance of the winding in relation to the machine enclosure. The winding temperature should not exceed 40 °C during the measurement.
5. Convert the measured insulation resistances in accordance with the formula to the reference temperature of 40 °C. This thereby ensures that the minimum values specified can be compared.
6. Read out the insulation resistance one minute after applying the measuring voltage.
7. Discharge the winding after measurement, e.g. by doing the following:
 - Connect the terminals to the ground potential until the recharge voltage drops to a non-hazardous level
 - Attach the connection cable.

Limit values for the winding insulation resistance

The following table specifies the measuring voltage and limit values for the insulation resistance. These values correspond to the recommendations of IEC 60034-27-4 and IEEE 43-2000.

Table 5-1 Insulation resistance of the winding at 40 °C

U_N V	U_{meas} V	R_C MΩ
$U \leq 1000$	500	≥ 5
$1000 \leq U \leq 2500$	500 (max. 1000)	100
$2500 < U \leq 5000$	1000 (max. 2500)	
$5000 < U \leq 12000$	2500 (max. 5000)	
$U > 12000$	5000 (max. 10000)	

U_{rated} = rated voltage, see the rating plate

U_{meas} = DC measuring voltage

R_C = minimum insulation resistance at a reference temperature of 40 °C

Conversion to the reference temperature

When measuring at winding temperatures other than 40 °C, convert the measured value to the reference temperature of 40 °C according to the following equations from IEC 60034-27-4 and IEEE 43-2000.

$R_C = K_T \cdot R_T$	R_C	Insulation resistance converted to 40° C reference temperature
	K_T	Temperature coefficient, see below
	R_T	Measured insulation resistance for measuring/winding temperature T in °C
$K_T = (0.5)^{(40-T)/10}$	40	Reference temperature in °C
	10	Halving/doubling of the insulation resistance with 10 K
	T	Measuring/winding temperature in °C

In this case, doubling or halving the insulation resistance at a temperature change of 10 K is used as the basis.

- The insulation resistance halves every time the temperature rises by 10 K.
- The resistance doubles every time the temperature falls by 10 K.

For a winding temperature of approx. 25° C, the minimum insulation resistances are 20 MΩ (U ≤ 1000 V) or 300 MΩ (U > 1000 V). The values apply for the complete winding to ground. Twice the minimum values apply to the measurement of individual assemblies.

- Dry, new windings have an insulation resistance of between 100 ... 2000 MΩ, or possibly even higher values. An insulation resistance value close to the minimum value could be due to moisture and/or dirt accumulation. The size of the winding, the rated voltage and other characteristics affect the insulation resistance and may need to be taken into account when determining measures.
- Over its operating lifetime, the motor winding insulation resistance can drop due to ambient and operational influences. Calculate the critical insulation resistance value depending on the rated voltage by multiplying the rated voltage (kV) by the specific critical resistance value. Convert the value for the current winding temperature at the time of measurement, see above table.

Measuring the polarization index

1. To determine the polarization index, measure the insulation resistances after one minute and ten minutes.
2. Express the measured values as a ratio:

$$\text{Polarization index} = R_{\text{insul } 10 \text{ min}} / R_{\text{insul } 1 \text{ min}}$$
 Many measuring devices display these values automatically following the measurement.

Measuring the polarization index is not helpful for insulation resistances > 5000 MΩ, and is therefore not included in the assessment.

$R_{(10 \text{ min})} / R_{(1 \text{ min})}$	Assessment
≥ 2	Insulation in good condition
< 2	Dependent on the complete diagnosis of the insulation

NOTICE

Damage to insulation

If the critical insulation resistance is reached or undershot, this can damage the insulation and cause voltage flashovers.

- Contact the service center (Page 113).
- If the measured value is close to the critical value, you must subsequently check the insulation resistance at shorter intervals.

Limit values of the anti-condensation heating insulation resistance

It is not permissible that the insulation resistance of the anti-condensation heating with respect to the machine enclosure falls below 1 MΩ when measured at 500 V DC.

5.3 Lift the machine to where it will be mounted and position it

5.2.4 Preparing installation surfaces

Prepare the foundation faces dependent on the machine type:

- Mounting on a foundation
 - Ensure that the foundation faces are flat and free of contaminations.
 - Check the dimensions of the mounting-foot holes.
- Flange connection
 - Clean the flange before installation. Ensure that the flange surfaces are flat and perfectly clean.
 - Check the geometry of the flange.
- Wall mounting
 - Ensure that the wall faces are flat and free of contaminations.
 - Check the dimensions of the mounting-foot holes.
 - Support the machine from below, e.g. using a wall bracket or by bolting it.

5.3 Lift the machine to where it will be mounted and position it

5.3.1 Preconditions for correct alignment and secure attachment

To align the machine correctly and fasten it securely, you require detailed specialist knowledge of the following necessary measures:

- Preparing the foundation
- Select and mount the coupling
- Measure the radial and axial eccentricity
- Position the machine

If you are not familiar with the necessary measures and procedures, then contact the Service Center (Page 113).

5.3.2 Checking the attachment points

- Carefully check the attachment points at the machine, e.g. attachment eyes, lifting eyes or ring bolts for possible damage. Replace any damaged attachment points.
- Before use, carefully check that the attachment points are correctly attached and mounted.

**WARNING****Danger caused by a falling machine**

The machine may fall when lifting if the attachment points and lifting gear are damaged or not correctly secured. This can result in death, serious injury or material damage.

- Do not remove the factory-fitted attachment points. In operation, the attachment points must remain screwed in. If you do remove the attachment points, then seal the holes so that they are airtight. Empty holes can corrode; the degree of protection may then be no longer guaranteed.

5.3.3 Removing the rotor shipping brace

If a rotor shipping brace is attached to the machine, remove it at the last possible moment, for example, when you are ready to push on the output or drive element.

Storing the rotor locking device

Store the rotor locking device in a safe place. It must be remounted if the machine is removed and shipped on further.

5.3.4 Removing the rotor shipping brace from machines with vertical type of construction

- Only remove the rotor shipping brace when the machine is in a vertical position. Dismantling the rotor shipping brace when the machine is in a horizontal position could damage the bearings.
- Fix the rotor in place before you turn the machine into a horizontal position. Failure to fit the rotor shipping brace can result in damage to the bearings while the machine is being turned onto its side.

5.3.5 Removing anti-corrosion protection

Machined, bright surfaces of machine parts and small components such as screws, bolts, wedges, feather keys and dowel pins, are treated with an anti-corrosion agent.

Carefully remove the anti-corrosion agent just before starting the installation work.

5.3 Lift the machine to where it will be mounted and position it

Bright surfaces on machine parts

- Remove the anti-corrosion coating from the machined surfaces of machine parts and from small components. To do this, use petroleum, petroleum ether - or a similar solvent or cleaning agent.

NOTICE
Paintwork damage Painted surfaces can be damaged if they come into contact with detergents or solvents.


- Use a suitable solvent to soften thick layers of anti-corrosion agent. Then push off the softened layers using a piece of hardwood (approximately 10 x 10 x 1 cm). Do not sand the protective coating down or scrape it off.

NOTICE
Damage to the machine surface Metal objects, such as scrapers, spatulas or pieces of metal, are not suitable to remove the anti-corrosion protection. These could damage the surfaces of the machine parts.

- Lightly oil the depreserved surfaces.

5.3.6 Only operate with a flexible coupling

It is only permissible to operate the machine using a flexible coupling.

 WARNING
Insufficient screw locking Vibration and shock loads can loosen the screws. The machine or components may fall down. This can result in death, serious injury or material damage. <ul style="list-style-type: none">• Lock the screwed connections with a screw-locking compound, e.g. Loctite 243.

5.3.7 Mounting the output elements

Type of balancing

The rotor is dynamically balanced. For shaft extensions with featherkeys, the balancing type is specified using the following coding on the face of the drive end of the shaft:

- "H" means balancing with a half feather key
- "F" means balancing with a whole feather key.

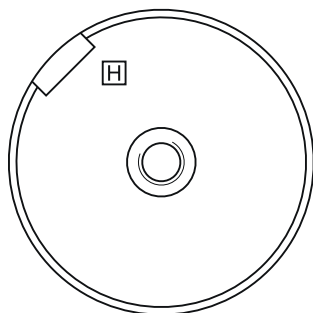


Figure 5-1 Balancing type on the drive-end side

Pushing on the power output elements

Prerequisites

- The coupling and/or the output element must be appropriately dimensioned for the operating case at hand.
- Comply with the coupling manufacturer's instructions.
- Make sure that the balancing type of the transmission element correctly matches the type of balance of the rotor.
- Use only ready drilled and balanced transmission elements. Check the hole diameters and the balancing status before pulling them on. Thoroughly clean the shaft extension.

Fitting

- Warm up the transmission elements to expand them before pulling them on. Select the temperature difference for the heating process to suit the coupling diameter, fit and material. See the coupling manufacturer's instructions.
- Power output elements may only be pushed on or pulled off with the correct equipment. The transmission element must be pulled on in one continuous operation via the front thread holes in the shaft or pushed on by hand.
- Do not strike it with a hammer, as this would damage the bearings.

Shaft extensions with feather key

To maintain the balancing quality, you have the following options:

- If the transmission element is shorter than the feather key with balancing type "H", then you must machine off the section of feather key protruding from the shaft contour and transmission element in order to maintain the balance quality.
- If the transmission element is drawn up on to the shoulder of the shaft, you must ensure that the part of the coupling groove where the feather key is not inserted is taken into consideration when balancing the coupling.

Danger when feather keys are flung out

The feather key is only secured to prevent it falling out during transport. The feather key may be flung out if the motor is operated without fitted transmission elements, such as coupling, etc.

This can result in death, serious injury or material damage.

- Only operate the motor with the transmission element pulled on.
- For test operation or when commissioning **without transmission element**, carefully secure the feather key using a suitable locking element. When doing this, take into account the type of balancing of the motor.

5.3.8 Lifting and transporting the machine

To safely lift and transport the machine, the following requirements must be met:

- Personnel operating cranes and fork-lift trucks must be appropriately qualified.
- If the machine is packed:
 - Depending on the weight, size and on-site conditions, lift crates and transport frames using a crane with slings or a forklift truck.
 - Use a crane or fork-lift truck suitable for the load.
- When lifting the machine, use only approved and undamaged sling guides and spreaders of sufficient rated capacity. Carefully check the lifting equipment prior to using it. The weight of the machine is shown on the rating plate.
- When lifting the machine, refer to the information on the lifting plate.
 - Comply with the specified spreading angles.
 - Do not exceed the maximum lifting acceleration and lifting speed specified on the lifting plate. Lift the machine without jerking it.
Acceleration $a \leq 0.4 \text{ g}$ ($\approx 4 \text{ m/s}^2$)
Velocity $v \leq 20 \text{ m/min}$

 WARNING**Transport for a different type of construction**

If you do not transport or lift the machine in a position appropriate for its construction, the machine can tip, slip into the lifting equipment or fall down. This can result in death, serious injury or material damage.

- Use only the load carrying device on the stator frame for lifting.
- Use the load carrying device appropriate for the machine position.
- Only use suitable rope guiding or spreading devices.

 WARNING**Center of gravity not centered**

If the center of gravity is not located centrally between the attachment points, when the machine is being transported or lifted, it can tip over or slip out of the lifting equipment and fall. This can result in death, serious injury or material damage.

- Carefully comply with the handling instructions on the machine when transporting it.
- Carefully take into account the different load levels of the sling ropes or lifting straps as well as the carrying capacity of the lifting equipment.
- Always take account of the center of gravity when transporting or lifting the machine. If the center of gravity is not located centrally between the attachment points, then position the hoisting hook above the center of gravity.

- Never remain under or in the immediate vicinity of the machine when it is lifted.

 WARNING**Danger to life as a result of a machine falling**

If the lifting gear or load handling attachments were to fail, the machine could fall. This can result in death, serious injury or material damage.

- In order to gain easy and safe access to the underside of the machine, place it in a secure and raised position.

5.3.9 Putting the machine down

Requirements

The following preconditions must be satisfied before setting down the machine at the installation location:

- The mating faces must be clean.
- The anti-corrosion protection paint has been removed from the mating faces, such as the machine mounting feet, flange, ...
- There is no condensation present within the machine.

Setting down the machine

- Set down the machine slowly and carefully at the installation location to avoid any impact.

5.3.10 Roughly aligning the machine

Requirement

The transmission element such as a coupling half has already been pulled on.

Roughly aligning the machine

- For horizontal positioning, push the motor sideways across the foundation. When doing so, ensure that the axial position is maintained.

5.4 Installing the machine

Note

Service Center

When performing the required installation work, contact the Service Center (Page 113) or engage personnel authorized by Siemens.

5.4.1 Selecting fixing screws

- Unless specified otherwise, use mounting bolts with at least strength class 8.8 to ISO 898-1. In this way you guarantee that the machine is securely mounted and the forces can be transferred through the torque.
- Take into account the maximum forces occurring in the case of a fault such as short circuit or system transfers in phase opposition.
 - When selecting the bolts
 - When designing the foundation

5.4.2 Preconditions for smooth, vibration-free operation

Preconditions for smooth, vibration-free operation:

- Stable foundation design
- Precise alignment of the machine

- Correct balancing of parts to be fitted to the shaft end.
- Vibration values in compliance with ISO 10816-3

5.4.3 Connection cables

Observe the following when installing connection cables:

- Connection cables must not be damaged.
- Connection cables must not be under tension.
- Connection cables must not be touched by rotating parts.

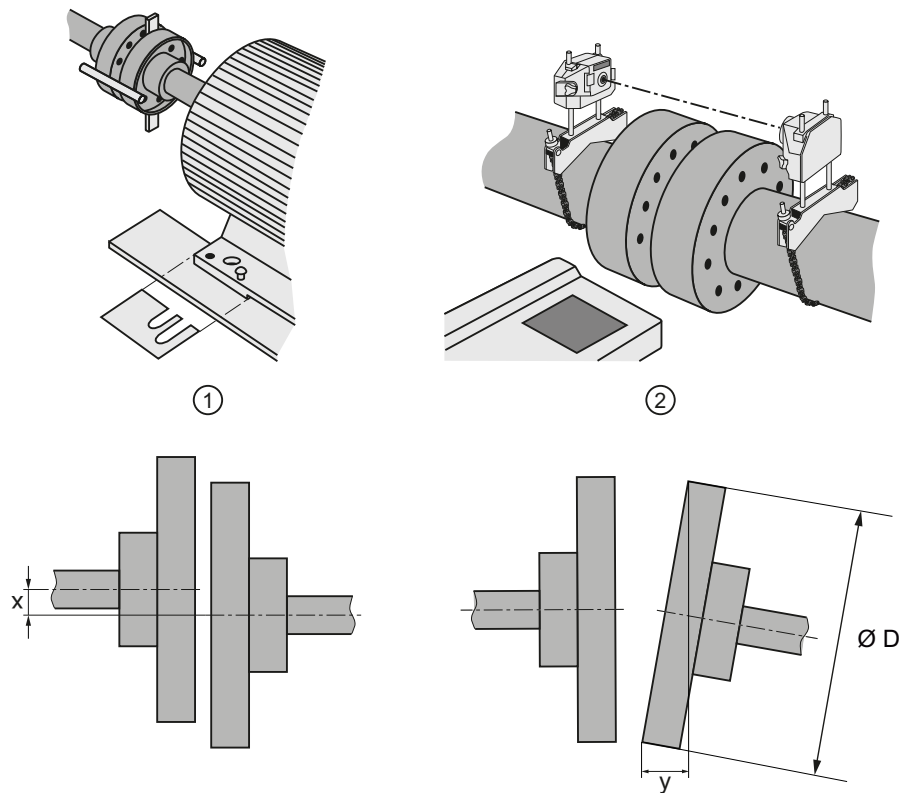
Observe the technical data in these operating instructions and on the rating plate.

5.4.4 Aligning the machine to the driven machine and mounting (IM B3)

1. Refer to any instructions for aligning the driven machine and those of the coupling manufacturer.
2. Align the machines with coupling output to the driven machine in such a manner that the center lines of the shafts at the operating temperature do not have any parallel or angular offset. This ensures that no additional forces affect their bearings during operation. If the thermal change of the motor and the driven machine is different, couple in the cold state with an appropriate alignment offset. The alignment offset to be set in the cold state must be determined and specified by the system specialist.
3. For the vertical positioning ($x \rightarrow 0$), place thin shims over a large surface area under the machine feet. The number of shims should be kept as low as possible, i.e. stack as few as possible. This also prevents the machine being subjected to any stress/distortion. Use the existing tapped holes for the forcing-off bolts to raise the machine. The balance state of the shaft (full-key or half-key balancing) and alignment errors primarily influence the service life of the bearing, especially for high motor speeds or when using rigid couplings.

5.4 Installing the machine

4. When positioning the machine, ensure that a uniform axial gap ($y \rightarrow 0$) is maintained around the coupling.
5. Fix the machine to the foundation. The choice of fixing elements depends on the foundation and is the plant operator's responsibility.



- ① Plates placed under the motor for alignment
- ② Laser alignment

Figure 5-2 Schematic diagram: Aligning the machine to the driven machine

Table 5-2 Permissible deviations for aligning the machine with flexible coupling

Max. speed n_{max}	Max. parallel offset x	Max. angular offset y
$n_{max} \leq 1500$ rpm	$x_{max} = 0.08$ mm	$y_{max} = 0.08$ mm / 100 mm $\varnothing D$
1500 rpm $< n_{max} \leq 3600$ rpm	$x_{max} = 0.05$ mm	$y_{max} = 0.05$ mm / 100 mm $\varnothing D$

Machine expansion

When performing alignment, make allowance for the thermal expansion of the machine due to rising temperature.

See also

Tightening torques for screw and bolt connections (Page 115)

5.4.5 Aligning the machine to the driven machine and mounting (IM V1)

The standard flange is provided with a centering. The choice of fit for the mating flange on the driven machine is the system manufacturer's or the plant operator's responsibility.

If the machine is not fitted with a standard flange, align the machine to suit the driven machine.

Procedure

The machine axis must be vertical when it is lifted and the flange must be parallel to the mating flange, so as to avoid seizing and stressing. Otherwise damage to the centering will result.

1. Grease the centering flange with assembly paste to make the process easier.
2. Screw in two studs into tapped holes on opposite sides of the driven machine flange. The studs act as positioning aids.
3. Lower the machine slowly toward the driven machine and into the centering, so that the flanges do not quite touch. Lowering too quickly risks damaging the centering.
4. If necessary, rotate the machine into the right position so that the clearance holes in the flange are central to the tapped holes.
5. Lower the machine completely onto the mating flange so that it is fully in contact; then remove the studs.
6. Fix the machine using the flange fixing bolts.

See also

Tightening torques for screw and bolt connections (Page 115)

Alignment accuracy

The coaxial characteristic of the shafts of electrical machines and driven machine may not exceed 0.05 mm in diameter.

5.4.6 Axial and radial forces

You can obtain the permissible values for axial and radial forces by contacting the Service Center (Page 113) or referring to the machine catalog.

NOTICE
Damage to bearings or the shaft
Large output masses and their centers of gravity outside the shaft extensions can lead to resonance in operation. This can result in damage to the bearings and shaft.
Ensure that the permissible loads for the forces on the shaft extension are adhered to in accordance with the catalog data or configuration data.

5.5 Connecting the cooling water supply

The size of the connecting threads is described in the "Technical data" section.

1. For the pipes, select materials with the required chemical composition in accordance with the water conditions. Also consider the pressure load and compatibility with the materials from which the cooler is made.
2. Use flexible water lines and hoses. This avoids mechanical stress at the connections as a result of the heat-dependent height increase of the machine (thermal expansion).
3. Route and support the water pipes so that the connecting flanges are not exposed to excessive stress, strain or vibration loads.
4. Remove the flange cover plate.
5. Insert the gaskets correctly.
6. Rinse out the water circuit before you connect the cooling water supply to the motor. This removes deposits and foreign bodies.
7. Should there be a possibility of the cooling water containing dirt and foreign bodies, install suitable filters in the cooling-water feed pipe.
8. Connect the cooling circuit to the machine.

Filling the cooling circuit

1. Fill the cooling circuit with water until the air has been completely forced out of the cooling circuit.
2. Perform a pressure check to see whether the cooling water supply is airtight. Do not exceed the maximum pressure. The maximum permissible pressure is specified in the technical data.
3. If you don't immediately commission the machine, then appropriately prepare for the non-operational period.

See also

Stoppages (Page 86)

5.6 Insulated bearings

The motor is fitted with electrically insulated bearings on the non-drive end.

NOTICE
Bearing damages
The bearing insulation must not be bridged. Damage may be caused to the bearings if there is a flow of current.

Electrical connection

6.1 Safety instructions relating to the electrical connection

Observe the following when carrying out any work on the machine:

- Comply with the general safety instructions (Page 13).
- Comply with the applicable national and sector-specific regulations.
- When using the machine within the European Union, comply with the specifications laid down in EN 50110-1 regarding safe operation of electrical equipment.

Material damage as a result of connection parts coming loose

If you use fixing elements made from the wrong material or apply the wrong tightening torque, this could impair current transfer or cause connecting parts to become loose. This could result in material damage to the machine or even in total failure, which could in turn lead indirectly to material damage to the system.

- Tighten the screwed connections to the specified tightening torques.
- Observe any specifications regarding the materials from which fixing elements must be made.
- When performing servicing, check the fastenings.

Note

Service Center

If you require support when electrically connecting up the machine, please contact the Service Center (Page 113).

6.2 Basic rules

The following generally applies to electrical connections:

- Ensure that there is a safe and reliable PE ground connection before starting any work.
- The connecting cables can be sealed and secured at every cable entry point into the terminal box.
- Lay the connecting cables and in particular the PE conductor in the terminal box in an open arrangement so that chafing of the cable insulation is prevented.

6.3 Preparation

- Connect the machine in such a way that a permanent, safe electrical connection is maintained. Avoid protruding wire ends.
- Lay and secure external auxiliary cables separately from the main cable. Elements with cable ties may be present for this purpose.
- In case of high humidity or when installed outside, water drops can move along the cable jacket and enter the motor through the cable entry and cable gland.
If you route the cable with an appropriate loop then water doesn't enter the terminal box, but simply drips off.

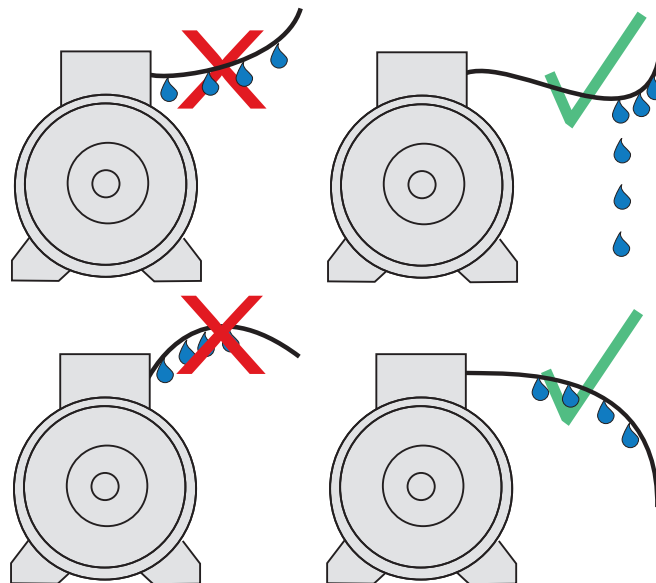


Figure 6-1 Water drip loop

6.3 Preparation

6.3.1 Terminal designation

According to IEC / EN 60034-8, the following basic definitions apply to the terminal designations for 3-phase machines:

Table 6-1 Terminal designations using the 1U1-1 as an example

1	U	1	-	1	Designation
x					Index for pole assignment for pole-changing machines where applicable. A lower index signifies a lower speed. Special case for split winding.
	x				Phase designation U, V, W
		x			Index for winding start (1) or end (2) or if there is more than one connection per winding
				x	Additional indices for cases in which it is obligatory to connect parallel power feed cables to several terminals with otherwise identical designations

6.3.2 Selecting cables

Take the following criteria into account when selecting the connecting cables:

- Rated current
- Rated voltage
- If required, service factor
- System-dependent conditions, such as ambient temperature, routing type, cable cross-section as defined by required length of cable, etc.
- Configuration notes
- Requirements according to IEC/EN 60204-1
- Dimensioning for bundled cable routing, e.g. according to DIN VDE 0298 Part 4 or IEC 60364-5-52

6.3.3 Connecting the machine for a specific direction of rotation

If the machine has one shaft extension or two shaft extensions with different diameters, the direction of rotation when looking at the front of the single or the thicker shaft extension is defined as follows:

- If you connect the power cables in the phase sequence L1, L2, L3 to U, V, W, the resulting rotation will be clockwise.
- If you interchange two connections, e.g. L1, L2, L3 to W, V, U, the resulting rotation will be counter-clockwise.
- On machines which are only allowed to run in one direction, the rating plate shows an arrow which indicates the permitted direction of rotation, and it also specifies the terminal connections in the required phase sequence.

NOTICE
Incorrect direction of rotation
The machine will not be adequately cooled if it is operated other than how it was originally ordered or with the incorrect direction of rotation. This can result in machine damage.
Observe the direction of rotation data on the nameplate.

6.3.4 Connecting the grounding conductor

The grounding conductor cross-section of the machine must be in full conformance with the installation specifications and to IEC / EN 60204-1.

Table 6-2 Determining the cross-section of the grounding conductor

External cable cross-section S	Cross-section of the grounding conductor [mm ²]
$S \leq 16 \text{ mm}^2$	S
$16 \text{ mm}^2 < S \leq 35 \text{ mm}^2$	16 mm ²
$S > 35 \text{ mm}^2$	S/2

There is a hexagon bolt with a flat washer and a spring washer on the stator frame at the designated connection point for the grounding conductor. This can be used for connecting stranded conductors with cable lugs or ribbon cables with an appropriately shaped conductor end.

When making connections, ensure the following:

- The connecting surface is bare and protected against corrosion using a suitable substance, e.g. acid-free Vaseline.
- The flat and spring washers are located under the bolt head.
- The maximum permissible clamping thickness of 10 mm for the cable lug or strap is not exceeded.
- The minimum required screw-in depth and the tightening torque for the clamping bolt as given in the table below are observed. Screw-in depth and tightening torque are different depending on whether cable lugs or ground terminals are used.

Table 6-3 Tightening torques of bolts (cable lug)

Bolt	Screw-in depth	Tightening torque
M12 x 25	> 16 mm	38 Nm
M16 x 35	> 20 mm	92 Nm

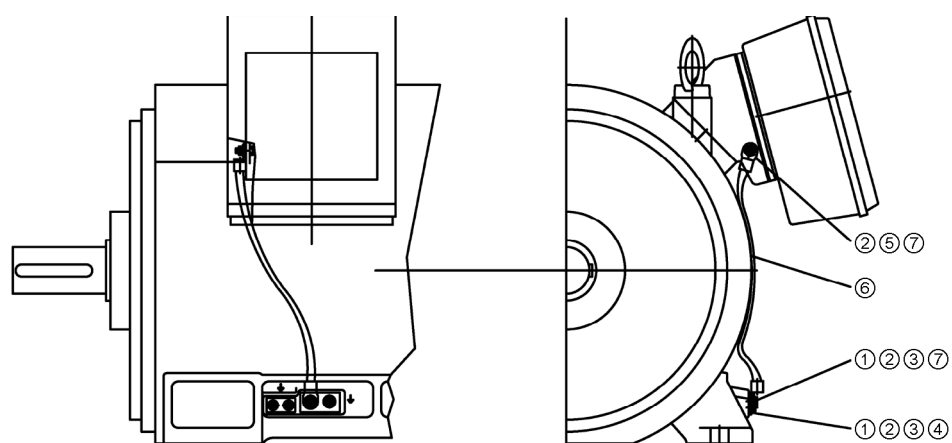
Table 6-4 Bolt tightening torques (ground terminals)

Bolt	Screw-in depth	Tightening torque
M6	> 9 mm	8 Nm
M8	> 12 mm	20 Nm
M10	> 15 mm	40 Nm
M12	> 18 mm	70 Nm
M16	> 20 mm	170 Nm

Connecting the grounding conductor in the terminal box

In the terminal box, use the connection terminals designated for the ground conductor.

Connecting the radio-frequency ground for forced-ventilated motors



- | | | | |
|------|----------------|---|--------------------------------|
| 1, 5 | Hexagon bolt | 4 | Grounding conductor |
| 2 | Spring washer | 6 | High-frequency grounding cable |
| 3 | Terminal Board | 7 | Cable lug |

Figure 6-2 High-frequency grounding

- Connecting using flat ribbon cables is recommended.
- Connection with cable lugs is possible.

High-frequency grounding for water-cooled motors

For water-cooled motors, a radio-frequency ground is required between the terminal box and the housing due to the steel housing.

6.4 Inserting and routing the cables

6.4.1 Circuit diagram

For the machine, the neutral point is formed internally. A separate neutral point circuit must not therefore be wired in the main terminal box by the servicing or commissioning personnel.

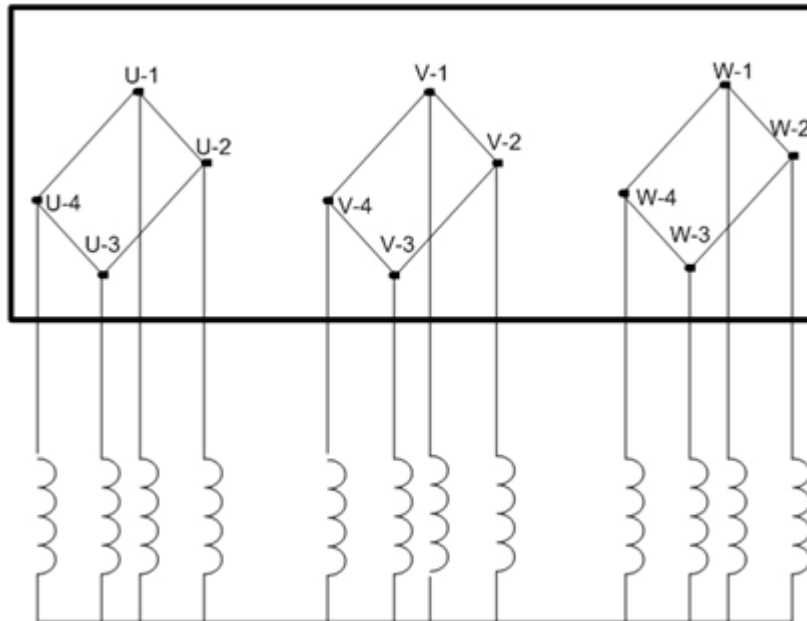


Figure 6-3 Neutral point connection

Data on the connection and connecting the motor winding can be found in the circuit diagram in the cover of the terminal box.

6.4.2 Terminal box

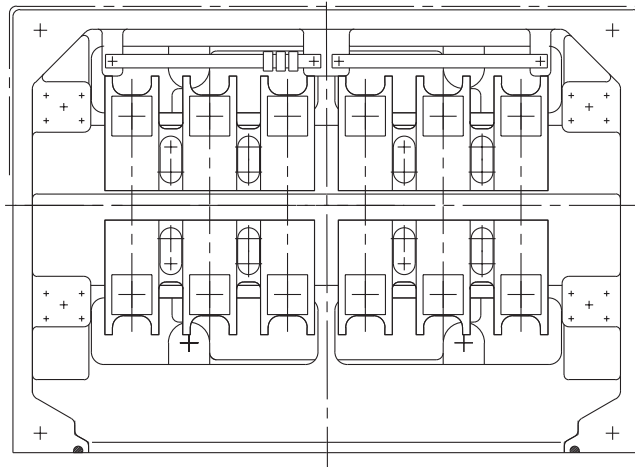


Figure 6-4 Terminal box 1XB1631

The connecting cables are inserted via cable glands with 4 x M80 x 2 threaded holes into the terminal box. The cable glands are not included in the standard scope of supply.

For more information, see:

- Introducing the cables into the terminal box and routing them (Page 65)
- Connecting cables with cable lugs (Page 66)

6.4.3 Introducing the cables into the terminal box and routing them

The connection cables are inserted into the terminal box via an exchangeable cable entry plate or cable entry support. The cable entry plate is drilled by default. The cable glands are not included in the standard scope of supply.

The cable entry can be turned by 180°.

Insert the cable into the terminal box

1. Unscrew the cable entry plate.
2. Drill the required number of holes or tapped holes in the required size into the cable entry plate, if necessary. Ensure that the cable entry plate can be assembled after drilling and that it features sufficient stiffness.
3. Fit the required cable glands.
4. Route the cables through the cable glands.
5. Fit the cable entry plate to the terminal box with the assembled cables.
6. Connect the ends of the cables to the terminals in accordance with the circuit diagram. The circuit diagram is located in the cover of the terminal box.

Refer to the "Connecting cables..." section for more information.

6.4.4 Connecting cables with cable lugs

1. Select the cable lugs according to the required cable cross-section and fixing screw or stud size. Information about the maximum cross-section for the respective standard terminal box design can be found in the catalog.
A sloped/angular arrangement of the supply cables is only permitted provided the required minimum air clearances are met.
2. Remove the insulation from the conductor ends so that the remaining insulation reaches almost up to the cable lug ①. Connect only one conductor per cable lug.
3. Fasten the cable lug to the end of the conductor correctly, e.g. by squeezing.

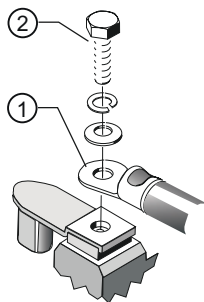


Figure 6-5 Connection with cable lug and fixing screw (schematic diagram)

4. Insulate the cable lug sleeves where necessary to ensure minimum air clearances and the creepage distance are maintained.
5. Place the cable lug on the terminal support. If you are using a disconnecting link, check its positioning.
6. Tighten the fixing element ② with the corresponding tightening torque:

Fixing element	Tightening torque
Fastening screw M12	20 Nm
Fixing screws M16	40 Nm
Fixing nuts M12	20 Nm

See also

Tightening torques for screw and bolt connections (Page 115)

6.4.5 Use of aluminum conductors

If you are using aluminum conductors, then comply with the following:

- Use only cable lugs that are suitable for connecting aluminum conductors.
- Immediately before inserting the aluminum conductor, remove the oxide layer from the contact areas on the conductor and/or the mating piece. Do this using a brush or file.
- Then grease the contact areas immediately using neutral Vaseline. This prevents a new oxide layer from forming.

NOTICE

Aluminum flow due to contact pressure

Aluminum flows following installation due to the contact pressure. The connection using clamping nuts can loosen as a result. The contact resistance increases, obstructing the current from being conducted. This can result in fire and material damage to the machine – or even in total failure, as well as material damage to the plant or system due to machine failure.

- Retighten the clamping nuts after approximately 24 hours and then again after approximately four weeks. Make sure that the terminals are de-energized before you tighten the nuts.

6.4.6 Using single-stranded cables

NOTICE

High temperatures from induced eddy currents

With high currents and where several single-stranded cables are used instead of multiple-stranded cables, high temperatures can result in the cable entry area due to induced eddy currents. This can result in material damage or even a machine failure.

- After commissioning, ensure that the temperature limits of the connected power cables are not exceeded during operation. This temperature effect can be reduced by altering the conditions at the entry points or by using modified cable entry plates after consultation with the manufacturing plant.
- Use a cable entry plate made of non-ferrous metal.

6.4.7 Minimum air clearances

After proper installation, verify that the minimum air clearances between non-insulated parts are maintained. Be aware of any protruding wire ends.

Table 6-5 Minimum air clearance dependent on rms value of the alternating voltage U_{rms}

Rms value of the alternating voltage V_{rms}	Minimum air clearance
$\leq 500\text{ V}$	8 mm
$\leq 630\text{ V}$	10 mm
$\leq 800\text{ V}$	12 mm
$\leq 1000\text{ V}$	14 mm
$\leq 1250\text{ V}$	18 mm

Values apply at an installation altitude of up to 2000 m.

When determining the required minimum air clearance, the voltage value in the table may be increased by a factor of 1.1, so that the rated input voltage range is taken into account during general use.

6.4.8 Internal equipotential bonding

The internal equipotential bonding between the grounding terminal in the box enclosure and the motor frame is established through the terminal box retaining bolts. The contact locations underneath the bolt heads are bare metal and protected against corrosion.

The standard cover fixing screws are sufficient for equipotential bonding between the terminal box cover and terminal box housing.

Note

Connecting points are available at the frame or bearing end shield to connect an external protective conductor or potential bonding connector.

6.4.9 Finishing connection work

1. Before closing the terminal box, please check that:
 - The electrical connections in the terminal box have been made in accordance with the specifications above and tightened with the correct tightening torque.
Remove the used bolts and fastening elements.
 - The machine is connected in such a way that it rotates in the direction specified.
 - The inside of the terminal box is clean and free of any cable debris, dirt and foreign bodies.
 - All of the seals and sealing surfaces of the terminal box are intact and in a good condition.
 - Unused cable entries are closed and their plugs are tightly screwed in place, i.e. they can only be released using a tool.
 - The connecting cables are freely routed. The cable insulation cannot be damaged in operation.
2. Close the terminal box using the cover fixing screws, see Chapter Tightening torques for screw connections. (Page 115)

6.5 Connecting the auxiliary circuits

The type designations of the mounted auxiliary terminal boxes, their arrangement, and the relevant connection terminals are documented in the "Technical data" section. The information required to connect anti-condensation heating and the auxiliary circuits is provided in the connection diagram, located on the inside of the terminal box cover, and in the "Technical data" section. The terminals are suitable for conductor cross-sections up to 4 mm².

6.5.1 Selecting cables

Take the following criteria into account when selecting the connecting cables for the auxiliary circuits:

- Rated current
- Rated voltage
- System-dependent conditions, such as ambient temperature, routing type, cable cross-section as defined by required length of cable, etc.
- Requirements according to IEC/EN 60204-1

6.5.2 Introducing cables into the auxiliary terminal box and routing them

The required data for connecting the auxiliary circuits is located on the terminal diagram on the inside of the respective auxiliary terminal or terminal box cover.

- In some cases a terminal strip is installed in the main terminal box for the auxiliary circuit connections.
- The required stripped length on conductors for auxiliary terminals differs according to terminal type (6 to 9 mm). When the length is correct, the conductor should reach the stop in the terminal and at the same time the conductor insulation should reach the contact part of the terminal.

Adapting the cable glands

A plate is bolted to the terminal box enclosure via a rectangular cutout through which the connecting cables enter. The plate is generally delivered with threaded holes and cable glands.

1. Open the auxiliary terminal box and undo the cable entry plate screws. Depending on the terminal box version, the cable entry plate is below a steel screening plate.
2. For the undrilled version, drill the required number of holes or threads in the required size of the cable gland into the cable entry plate.
3. Mark the cables if necessary for subsequent assignment.
4. Pull the cables through the cable glands and the cable entry plate, and connect the cables.
5. Fit the cable entry plate.
6. Make sure that the seal on the screwed sockets for the cable glands satisfies the degree of protection.

6.5.3 Connecting temperature monitoring for the stator winding

The stator winding is monitored for thermal loading by temperature sensors embedded in the stator winding.

The connecting cables of the temperature sensors are routed to the main or auxiliary terminal box, depending on the version. The connection and assignment of the terminals is specified in the circuit diagram.



⚠ WARNING

Hazard due to electric shock

The installation of the temperature sensors for the winding monitoring with respect to the winding is implemented according to the requirements for basic insulation. The temperature sensor connections are located in terminal boxes, safe to touch, and have no protective separation. This is the reason that in the case of a fault, a hazardous voltage can be present at the measuring sensor cable. When touched, this can result in death, severe bodily injury and material damage.

- When connecting the temperature sensor to external temperature monitoring devices, when required, apply additional measures to fully comply with the requirements set out in IEC 60664-1 or IEC 61800-5-1 "Hazard due to electric shock".

6.5.4 Internal equipotential bonding in the auxiliary terminal box

The equipotential bonding between the PE terminals in the relevant auxiliary terminal box enclosure and the machine enclosure is established via a fixing bolt in each auxiliary terminal box enclosure. The contact point underneath the bolt head is bare metal and protected against corrosion.



⚠ WARNING

Ineffective equipotential bonding

If the equipotential bonding connection fails, parts of the machine may become live. If you touch them, you will receive an electric shock. This can result in death, serious injury or material damage.

- When performing any installation work you must always take care to ensure that all equipotential bonding connections remain effective.

6.5.5 Terminating the connection work (auxiliary circuit)

1. Before closing the auxiliary terminal box, please check that:
 - The cables are connected in accordance with the terminal diagram.
 - The cables are freely arranged so that they cannot come into contact with the machine, and the cable insulation cannot be damaged.
 - The inside of the terminal box is clean and free of any cable debris, dirt and foreign bodies.
 - The cable glands are firmly tightened, are suitable with respect to the degree of protection, type of cable routing, permissible cable diameter, etc., and have been mounted in full compliance with specifications and regulations
 - The threads in the connection plate are sealed using cable and conductor entries, thread adapters or sealing plugs that achieve the respective degree of protection.
 - Unused cable entries are sealed. The sealing elements are firmly screwed in, and can only be released using a tool.
 - All of the seals/gaskets and sealing surfaces of the terminal box are in good condition
 - The screws of all of the screw clamps are fully tightened, even if they are not being used.
2. Close the auxiliary terminal box using the cover supplied for this purpose. See section "Tightening torques for screw and bolt connections (Page 115)" for the tightening torque of the fixing bolts for the cover.

6.6 Converter operation

 **WARNING**

Dangerous voltage via the converter

As long as the feeding converter is switched on, or the DC link of the converter is not discharged, there can be a voltage at the motor terminals even when the rotor is not moving. The voltage is up to 1000 V, depending on the converter type.

Ensure that the five safety rules (Page 13) are followed before working on the motor.

6.6.1 Operation on a converter with a low pulse frequency

NOTICE
Increased motor temperature If the pulse frequency is less than the rated pulse frequency, then increased motor losses occur. This results in a higher motor temperature. <ul style="list-style-type: none">• Reduce the power to prevent exceeding the temperature class and to avoid consequential premature thermal aging of the insulation.• Contact the Service Center if necessary.

6.6.2 Converter operation on a grounded network

NOTICE
Damage resulting from protective conductor currents When the machine is operated on a converter with current limiter, but without ground-fault monitoring, protective conductor currents of up to 1.7 times the external conductor current can arise if there is a ground fault on the output side. Neither the PE conductors of normally rated multi-core connecting cables nor the PE connecting points of normal terminal boxes are suitable for this purpose. Material damage can result. <ul style="list-style-type: none">• Use an appropriately sized PE conductor.• Connect the PE conductor to the grounding terminal on the motor enclosure.

Commissioning

7.1 Safety instructions for commissioning

Observe the following when carrying out any work on the machine:

- Comply with the general safety instructions (Page 13).
- Comply with the applicable national and sector-specific regulations.
- When using the machine within the European Union, comply with the specifications laid down in EN 50110-1 regarding safe operation of electrical equipment.

Note

Service Center

Please contact the Service Center (Page 113) if you require commissioning support.

Danger to life as a result of the converter voltage

As long as the feeding converter is switched on, or the DC link of the converter is not discharged, there can be a voltage at the motor terminals even when the rotor is not moving. Depending on the converter type, the voltage is up to 1000 V. When coming into contact, this can result in death, serious injury, and material damage.

- Maintain the five safety rules (Page 13) at all times when operating the machine.

Danger to life as a result of voltage at the motor terminals when the rotor is rotating

There is always a magnetic flux in the motor due to the permanent magnets in the rotor. With each rotation of the rotor, a voltage occurs at the motor terminals. As a result of this, there is also a voltage at the converter output terminals via the connecting cable. Contact with them can cause death, serious injury or material damage.

- When working on the drive system, you must prevent any rotational movement of the motor shaft.

Damage caused by the short-circuit current

When the permanent magnet rotor is driven, a voltage ("rotor voltage") is induced in the stator winding, that can be measured at the motor terminals. If a cable or converter short-circuit simultaneously occurs, then a short-circuit current is driven by the induced rotor voltage. This can result in material damage.

- Use cables that are short-circuit proof.
- Alternatively, use a circuit breaker close to the motor to protect the cable against a short circuit.

7.2 Checks to be carried out prior to commissioning

The following list of checks to be performed prior to commissioning does not claim to be complete. It may be necessary to perform further checks and tests in accordance with the specific situation on-site.

Once the system has been correctly installed, you should check the following prior to commissioning:

- The machine is undamaged.
- The machine has been properly installed and aligned.
- The output elements are either correctly set, aligned and/or balanced depending on the type.
- All fixing screws, connection elements, and electrical connections have been tightened to the specified tightening torques.
- The operating conditions match the data provided in accordance with the technical documentation, such as degree of protection, ambient temperature, etc..
- Moving parts move freely, for example the coupling.
- Moving and energized parts are protected against contact.
- Screwed-in lifting eyes are removed after installation or secured to prevent them from becoming loose.
- For test operation or when commissioning **without output element**, carefully secure the feather key using a suitable security element. When doing this, take into account the balancing type of the motor.

Second shaft extension

If the second shaft extension is not used:

- Carefully secure the feather key to prevent it from being thrown out, and for balancing type "H" (standard type), ensure its weight is reduced to approximately 60 % of the original value.
- Using covers, carefully secure the unused shaft extension so that it cannot be touched.

Electrical connection

- Carefully check the grounding and potential bonding connections.
- Connect the machine corresponding to the specified direction of rotation.
- Using the appropriate open-loop control and speed monitoring functions, carefully ensure that no higher speeds can be achieved than are permitted and specified in the technical data. For this purpose, compare the data on the rating plate or, if necessary, the system-specific documentation.
- Comply with the minimum insulation resistances.
- Comply with the minimum air clearances.
- Correctly connect possibly available machine monitoring devices and equipment - and carefully ensure that they are functioning correctly.
- Check the correct functioning of the brakes or backstops.

- Set the values for "Alarm" and "Shutdown" at the monitoring devices.
- Carefully ensure that temperature-sensitive parts and components, e.g. cables are not in contact with the machine enclosure.

See also

Setting values for temperature monitoring of the bearing thermometer (Page 81)

Setting values for temperature monitoring (slot thermometer) (Page 81)

Converter operation

- If the motor design requires connection to a specific converter type, carefully check the supplementary data on the rating plate/supplementary plate.
- Ensure that the converter is correctly parameterized. Depending on the design, you will find some parameterization data on the rating plate of the machine. Further information is provided in the converter documentation. If necessary, contact the Service Center.
- Check that the supplementary equipment and devices to monitor the machine are correctly connected and are functioning correctly.
- In continuous operation, carefully ensure that the motor cannot exceed the specified upper speed limit n_{max} or fall below the lower speed limit n_{min} . The permissible acceleration time to the limit speed n_{min} depends on the parameter assignment.
- The bearing insulation should be implemented as shown on the plates.
- If the machine can be driven by the mechanical system, then protect the converter DC link voltage against overvoltage conditions: Limit the field-weakening operation to 120%.

The machine will be destroyed if it is directly connected to the line supply. Only operate the machine using a converter.

Cooling

- Check that the machine cooling is available for commissioning.

Cooling water supply

- The cooling water supply is connected and ready for operation.
- The cooling water supply is switched on. The data can be found on the rating plate.
- Cooling water is available in the configured quality and quantity.

7.3 Lubricating the rolling bearings prior to commissioning

The following information assumes that the specified storage conditions have been complied with.

General specifications

- Pay attention to the instructions on the lubricant plate.
- Regrease in portions. The shaft must rotate so that the new grease can be distributed in the bearings.

Regreasing the rolling bearings prior to commissioning

- If the period between delivery and commissioning is more than a year and less than four years:
 - Re-grease the rolling bearings with twice the amount of grease specified on the lubricant plate.
 - Check the bearing temperature, as far as possible.

Regreasing rolling bearings before commissioning

You must regrease the rolling bearings under the following conditions:

- If the machine has been in storage for more than four years.
- If the machine has not been stored in accordance with the specifications in the "Storage" section.

Contact the Service Center.

See also

Transport (Page 32)

Service and support (Page 113)

7.4 Setting the converter pulse frequency

- At the converter, set a minimum pulse frequency of 2.5 kHz in operation. This means that the guaranteed machine parameters can be maintained.

7.5 Test run

After installation or inspection, carry out a test run:

1. Start up the machine without a load. To do this, close the circuit breaker and do not switch off prematurely. Check whether it is running smoothly.
Switching the machine off again while it is starting up and still running at slow speed should be kept to a bare minimum, for example for checking the direction of rotation or for checking in general.
Allow the machine to run down before switching it on again.
2. If the machine is running smoothly and evenly, switch on the cooling equipment. Continue to observe the machine for a while in no-load operation.

3. If it runs perfectly, connect a load.

NOTICE

Thermal overload of motors connected directly to the line supply

In addition to the load torque, the ramp-up (accelerating) time is essentially influenced by the moment of inertia to be accelerated. While ramping up when connected to the line supply, the inrush (starting) current is a multiple of the rated current. This can result in thermal overload. This can damage the motor.

As a consequence, when ramping up, observe the following:

- | |
|---|
| <ul style="list-style-type: none"> • Monitor the ramp-up time and number of consecutive starts. • Comply with the limit values and/or ramp-up conditions specified in the catalog or the order documentation. |
|---|

4. During the test run, check and document the following:
- Check whether it is running smoothly.
 - Document the voltage, current and power values. As far as possible, document the corresponding values of the driven machine.
 - If this is possible using the available measuring equipment, check the bearing and stator winding temperatures until they have reached steady-state values.
 - Check the machine for noise or vibrations on the bearings or bearing shields as it runs.
5. In case of uneven running or abnormal noise, switch off the machine. As the machine runs down, identify the cause.
- If the mechanical operation improves immediately after the machine is switched off, then the cause is magnetic or electrical.
 - If the mechanical running does not improve immediately after switching the machine off, then the cause is mechanical.
 - Imbalance of the electrical machine or the driven machine
 - The machine set has not been adequately aligned
 - The machine is being operated at the system resonance point. System = motor, base frame, foundation, ...

NOTICE

Serious damage to the machine

If the vibration values in operation are not maintained in accordance with DIN ISO 10816-3, then the machine can be mechanically destroyed.

- | |
|--|
| <ul style="list-style-type: none"> • During operation, observe the vibration values in accordance with DIN ISO 10816-3. |
|--|

7.6 Measure the insulation resistance and polarization index for the commissioning

Measuring the insulation resistance and polarization index (PI) provides information on the condition of the machine. It is therefore important to check the insulation resistance and the polarization index at the following times:

- Before starting up a machine for the first time
- After an extended period in storage or downtime
- Within the scope of maintenance work

The following information is provided regarding the state of the winding insulation:

- Is the winding head insulation conductively contaminated?
- Has the winding insulation absorbed moisture?

As such, you can determine whether the machine needs commissioning or any necessary measures such as cleaning and/or drying the winding:

- Can the machine be put into operation?
- Must the windings be cleaned or dried?

Detailed information on testing and the limit values can be found here:

"Testing the insulation resistance and polarization index" (Page 45)

7.7 Switching on the machine

- After starting the motor, observe it for a while to see if it is running smoothly and check the monitoring devices.
- Monitor operation and the monitoring devices regularly and record the values you read off.

NOTICE

Motor damage caused by impermissible speeds

The motor is designed for a certain speed range. If a motor is operated at impermissible speeds damage to the winding, bearings, or complete destruction of the motor can be the result.

- Ensure that the speeds specified on the rating plate are not exceeded by appropriately configuring controller and speed monitoring components.

See also

Description (Page 21)

7.8 Setting values for temperature monitoring of the bearing thermometer

Before the first machine run, set the tripping temperatures of the monitoring system.

Table 7-1 Guidelines for setting the tripping temperature of bearing thermometers

Set value		Temperature
Prior to commissioning	For shutdown	$T_0 = 110\text{ °C}$
	For warning	$T_1 = T + 5\text{ K (max. } 115\text{ °C)}$
During operation	For shutdown	$T_2 = T + 10\text{ K (max. } 120\text{ °C)}$

T = temperature in steady state (°C)

7.9 Setting values for temperature monitoring (slot thermometer)

Before the first machine run, set the tripping temperatures of the monitoring system.

The tripping temperatures of winding thermometers differ depending on the temperature class of the machine. The temperature class can be found on the rating plate.

Table 7-2 Guidelines for setting the tripping temperature of winding thermometers

Set value		Temperature class F/B	Temperature class F/F
Prior to commissioning	for shutdown	$T_0 = 120\text{ °C}$	$T_0 = 140\text{ °C}$
	for warning	$T_1 = T + 10\text{ K (max. } 135\text{ °C)}$	$T_1 = T + 10\text{ K (max. } 150\text{ °C)}$
During operation	for shutdown	$T_2 = T + 15\text{ K (max. } 140\text{ °C)}$	$T_2 = T + 15\text{ K (max. } 155\text{ °C)}$

T = temperature in steady state (°C)

7.10 Switching off the machine

- Do not switch off the water-cooling system immediately after switching off the machine. Wait for the machine to cool. This will prevent the accumulation of residual heat.

Operation

8.1 Safety instructions for operation

Observe the following when carrying out any work on the machine:

- Comply with the general safety instructions (Page 13).
- Comply with the applicable national and sector-specific regulations.
- When using the machine within the European Union, comply with the specifications laid down in EN 50110-1 regarding safe operation of electrical equipment.

Risk of injury due to rotating parts

Rotating parts are dangerous. Touch protection against rotating parts is no longer guaranteed if covers are removed. Touching rotating parts can result in death, serious injury or material damage.

- Carefully ensure that all of the covers are closed while operational.
- First switch off and disconnect the machine if you must remove covers. Comply with the "Five safety rules":
- Only remove the covers when the rotating parts have come to a complete standstill.

Danger as a result of stationary parts under voltage (live parts)

Live parts represent a hazard. Touch protection against active (live) parts is no longer guaranteed if covers are removed. The minimum air and creepage distances may be fallen below (violated) when coming close to active parts. Touching or coming close can result in death, serious injury or material damage.

- Carefully ensure that all of the covers are closed while operational.
- First switch off and disconnect the machine if you must remove covers. Comply with the "Five safety rules":
- When the machine is in operation, the terminal boxes must remain closed at all times. Terminal boxes may be opened only when the machine is stopped and in a no-voltage condition.

Faults in operation

Any changes with respect to the normal condition can indicate that the machine is not functioning correctly.

- Higher power consumption, temperatures or vibration levels.
- Unusual noise or smells.
- Monitoring devices respond.

This can cause faults which can result in eventual or immediate death, serious injury or material damage.

- Immediately inform the service personnel.
- If you are in doubt, immediately switch off the machine, carefully observing the system-specific safety conditions.

Damage caused by condensation

Humidity in the air can condense for intermittent duty or load fluctuations. Condensate can collect. Moisture can have a negative impact on the winding insulation or result in damage, such as corrosion.

- Ensure that any condensation can freely flow away.

Risk of burn injuries as a result of hot surfaces

Individual machine parts can become hot in operation. Burns can result when coming into contact with these parts.

- Never touch machine parts during operation.
- Allow the machine to cool down before starting work.
- Check the temperature of parts before touching them. If required, wear suitable protective equipment.

Danger to life as a result of voltage at the motor terminals when the rotor is rotating

There is always a magnetic flux in the motor due to the permanent magnets in the rotor. With each rotation of the rotor, a voltage occurs at the motor terminals. As a result of this, there is also a voltage at the converter output terminals via the connecting cable. Contact with them can cause death, serious injury or material damage.

- When working on the drive system, you must prevent any rotational movement of the motor shaft.

Damage caused by the short-circuit current

When the permanent magnet rotor is driven, a voltage ("rotor voltage") is induced in the stator winding, that can be measured at the motor terminals. If a cable or converter short-circuit simultaneously occurs, then a short-circuit current is driven by the induced rotor voltage. This can result in material damage.

- Use cables that are short-circuit proof.
- Alternatively, use a circuit breaker close to the motor to protect the cable against a short circuit.

Damage due to overheating

If the cooling water supply fails or if the motor is operated for a short time without water cooling, the motor will overheat. This can result in material damage, or even destroy the machine completely.

- Never operate the motor without the cooling water supply switched on.
- Monitor the permissible water intake temperatures.

Risk of burns from hot steam

If the cooling water supply fails, the motor will overheat. If cooling water enters the hot machine, hot steam will suddenly be generated, which escapes under high pressure. The cooling water system can burst. This can result in death, serious injury or material damage.

- Do not connect the cooling water supply until the machine has cooled down.

Excessively high machine temperature when heating is switched on

If the anti-condensation heating is operated while the machine is running, this can increase the temperatures inside the machine. Material damage can result.

- Make sure that the anti-condensation heating is switched off before the machine is switched on.
- Only operate anti-condensation heating when the machine is switched off.

8.2 Switching on the machine

1. If at all possible, run the machine without load and check that it is running smoothly.
2. If it runs perfectly, connect a load.

NOTICE

Thermal overload of motors connected directly to the line supply

In addition to the load torque, the ramp-up (accelerating) time is essentially influenced by the moment of inertia to be accelerated. While ramping up when connected to the line supply, the inrush (starting) current is a multiple of the rated current. This can result in thermal overload. This can damage the motor.

As a consequence, when ramping up, observe the following:

- Monitor the ramp-up time and number of consecutive starts.
- Comply with the limit values and/or ramp-up conditions specified in the catalog or the order documentation.

3. If this is possible using the available measuring equipment, check the bearing and stator winding temperatures.

8.3 Stoppages

The stoppage is a shutdown for a period of time, during which the machine is stopped but remains at the location of use.

Under normal ambient conditions, e.g. the stationary machine is not exposed to any vibration, no increased level of corrosion, ... then the following measures are required.

8.3.1 Prolonged outage periods

If the machine is out of operation for longer than one month, start up the machine regularly, that is, approximately once a month. Alternatively, as a minimum, turn the rotor.

If the machine is to be taken out of operation for more than 12 months, suitable anti-corrosion, preservation, packaging, and drying measures must be taken.

See also

Protecting cooling water ducts (Page 36)

8.3.2 Avoidance of frost and corrosion damage in the cooling system

- For avoidance of frost and corrosion damage, completely drain the water from the cooling system. Then blow air through the cooling system to dry it.
If the cooling system cannot be drained because standby capability is required at short notice, protect the cooling circuit against frost and corrosion damage. To do this, add suitable additives to the cooling water.

NOTICE
Impairment of the heat transport
Additives such as anti-freeze and corrosive inhibitor can impair the heat transport.
Operate the motor only with the contractually agreed water quality.

For avoidance of deposits, the cooling water circuit must then be kept running. So as to be certain of excluding the possibility of formation of condensation within the machine, the anti-condensation heating should also remain switched on (if fitted).

8.3.3 Avoidance of condensation or formation of condensation within the machine

- If the controller does not do this automatically, switch on any anti-condensation heating during stoppages. This will avoid the formation of condensation.
- Do not switch on the anti-condensation heating for at least two hours after the motor has been switched off. This prevents damage to the winding insulation.

8.3.4 Avoidance of damage to rolling bearings during stoppages

Extended stoppages at the identical or almost identical resting position of the rotor in the rolling bearings can result in damage, such as brinelling or corrosion.

- During stoppages, regularly start up the machine for a brief period once a month. As a minimum, turn the rotor several times.
If you have uncoupled the machine from the driven machine and secured the rotor with a rotor shipping brace, then remove this before turning the rotor over or starting up the machine.
Make sure that the resting position of the rotor after the rotor has been turned over is different from its previous position. Use the fitted key or the coupling halves as reference markers.
- During recommissioning, refer to the information in Chapter "Commissioning".

See also

Commissioning (Page 75)

8.3.5 Measuring the insulation resistance after an extended non-operational period

Measuring the insulation resistance and polarization index (PI) provides information on the condition of the machine. It is therefore important to check the insulation resistance and the polarization index at the following times:

- Before starting up a machine for the first time
- After an extended period in storage or downtime
- Within the scope of maintenance work

The following information is provided regarding the state of the winding insulation:

- Is the winding head insulation conductively contaminated?
- Has the winding insulation absorbed moisture?

As such, you can determine whether the machine needs commissioning or any necessary measures such as cleaning and/or drying the winding:

- Can the machine be put into operation?
- Must the windings be cleaned or dried?

Detailed information on testing and the limit values can be found here:

"Testing the insulation resistance and polarization index" (Page 45)

8.4 Switching off the machine

- Do not switch off the water-cooling system immediately after switching off the machine. Wait for the machine to cool. This will prevent the accumulation of residual heat.

See also

Avoidance of condensation or formation of condensation within the machine (Page 86)

8.5 Switching on again after an emergency switching-off

- Check the machine before recommissioning the driven machine after an Emergency Off.
- Eliminate all the causes that have led to the emergency off

8.6 Decommissioning the machine

NOTICE
Damage as a result of an extended period out of service
If the machine is going to be out of service for longer than six months, then take the necessary measures for preservation and storing. Otherwise damage to the machine will result.

Record the decommissioning steps. This log will be useful upon recommissioning.

8.7 Re-commissioning the machine

When you re-commission the machine, proceed as follows:

- Study the record made when the machine was decommissioned, and reverse the measures that were taken for conservation and storage.
- Perform the measures listed in the "Commissioning" section.

See also

Commissioning (Page 75)

8.8 Faults

8.8.1 Inspections in the event of faults

Natural disasters or unusual operating conditions, such as overloading or short circuit, are faults that overload the machine electrically or mechanically.

Immediately perform an inspection after such faults.

Correct the cause of the fault as described in the respective remedial measures section. Repair any damage to the machine.

8.8.2 Electrical faults water-cooled machines

Note

When operating the machine with a converter, also refer to the operating instructions of the frequency converter if electrical faults occur.

Table 8-1 Electrical faults

↓ Motor fails to start						
↓ Motor accelerates sluggishly						
↓ Humming noise when starting						
↓ Humming noise in operation						
↓ High temperature rise during no-load operation						
↓ High temperature rise under load						
↓ High temperature rise of individual winding sections						
					Possible causes of faults	Remedial measures
X				X		Rotor (partially) demagnetized Contact the Service Center.
X	X		X	X		Overload Reduce the load.
X						Interruption of a phase in the feeder cable Check the frequency converters and feeder cables.
	X	X	X		X	Interrupted phase in the feeder cable after switching on Check the frequency converters and feeder cables.
	X	X	X		X	Winding short circuit or inter-phase short circuit in stator winding Determine the winding resistances and insulation resistances. Contact the Service Center.
				X		Converter output voltage too high, frequency too low Check the settings at the frequency converter and perform the automatic motor identification.
				X	X	Cooling water not connected Cooling water supply switched off Water connection / pipes defective Check the cooling water connection. Switch on the cooling water supply. Find the leak and seal it. Contact the Service Center.
				X	X	Cooling water flow rate too low Inlet temperature too high Increase the cooling water flow. Set the correct upstream temperature.

8.8.3 Mechanical faults

Table 8-2 Mechanical faults

↓ Grinding noise						
↓ Radial vibrations						
↓ Axial vibrations						
					Possible causes of faults	Remedial measures
X					Rotating parts are grinding	Establish the cause and realign the parts.
	X				Rotor not balanced	Contact the Service Center.

↓ Grinding noise			
↓ Radial vibrations			
↓ Axial vibrations			
Possible causes of faults			Remedial measures
X		Rotor out of true, shaft bent	Contact the Service Center.
X	X	Poor alignment	Align the machine set and check the coupling. ¹⁾
X		Coupled machine not balanced	Rebalance the coupled machine.
	X	Shocks from coupled machine	Examine the coupled machine.
X	X	Resonance with the foundation	Stabilize the foundation after prior discussion.
X	X	Changes in foundation	Determine the cause of the changes and, if necessary, rectify. Realign the machine.

¹⁾ Take into account possible changes which may occur during overheating.

8.8.4 Rolling bearing faults

Damage to rolling bearings can be difficult to detect in some cases. If in doubt, replace the rolling bearing. Contact the Service Center.

Table 8-3 Rolling bearing faults

↓ Bearing overheats			
↓ Bearing "whistles"			
↓ Bearing "knocks"			
Possible causes of fault			Remedial measures
X		High coupling pressure	Align the machine more accurately.
X		Ambient temperature higher than 40 °C	Use high-temperature grease.
X	X	Insufficient lubrication	Grease the bearings as instructed.
X		Too much grease in bearing	Remove surplus grease. Where necessary, contact the Service Center.
X		Wrong grease in the bearing	Use the correct grease.
X		Belt tension too high *	Reduce the drive belt tension.
X		Bearing contaminated	Contact the Service Center.
X	X	Bearing canted	
X	X	Insufficient bearing play	
X	X	Bearing corroded	
	X	Friction marks on raceway	
	X	Brinelling or scoring	
	X	Excessive bearing play	
	X	Mechanical wear of bearing elements	

* Only in special version

See also

Service and support (Page 113)

8.8.5 Water cooling faults

The following table shows the possible causes of and remedial measures for faults on water-cooled machines.

Table 8-4 Cooling system faults

↓ Overheating		
↓ Water leaking		
	Possible causes of faults	Remedial measures
X	Reduced cooling	<ul style="list-style-type: none"> • Check the cooling water flow, increase the amount of cooling water if necessary. • Clean the cooling system, e.g. by briefly increasing the cooling water flow rate or by adding suitable cleaning agents.
X	Cooling water flow rate too low	Consult the manufacturer. If the specified cooling water quality is observed, the cooling system is maintenance-free.
X	Inlet temperature too high	Set the correct upstream temperature.
X	Cooling water supply switched off	Switch on the cooling water supply.
X	Cooling water contains too many or unsuitable antifreeze and corrosion-protection agents	Use cooling water of the agreed quality.
X	Leaks in the cooling system	Consult the manufacturer.
X	Defective cooling water connection	Find the leak and seal it.

Maintenance

Observe the following when carrying out any work on the machine:

- Comply with the general safety instructions (Page 13).
- Comply with the applicable national and sector-specific regulations.
- When using the machine within the European Union, comply with the specifications laid down in EN 50110-1 regarding safe operation of electrical equipment.

Note

Please contact the service center (Page 113), if you require support with service, maintenance or repair.

9.1 Inspection and maintenance

9.1.1 Safety instructions for inspection and maintenance

Danger as a result of stationary parts under voltage (live parts)

Live parts represent a hazard. Touch protection against active (live) parts is no longer guaranteed if covers are removed. The minimum air and creepage distances may be fallen below (violated) when coming close to active parts. Touching or coming close can result in death, serious injury or material damage.

- Take the machine out of operation.
- Switch off the machine and ensure that it is in a no-voltage condition. Carefully comply with the "5 safety rules" (Page 13).
- Only open the terminal box when the motor is stationary and in a no voltage condition.

Risk of injury due to rotating parts

Rotating parts are dangerous. Touch protection against rotating parts is no longer guaranteed if covers are removed. Touching rotating parts can result in death, serious injury or material damage.

- Before carrying out any repair work on the machine, take it out of operation, and carefully lock it out so that it cannot be switched on again.
- Only remove the covers when the rotating parts have come to a complete standstill.

Risk of burn injuries due to hot surfaces

In operation, the temperature of individual machine parts can increase - and only decrease slowly after switching off. You can burn yourself if you touch hot surfaces.

- Allow the machine to cool before starting any maintenance and service work on the machine.
- Check the temperature of parts before touching them. If required, wear suitable protective equipment.

Damage if the machine is not maintained

The machine can be damaged if it is not appropriately maintained. This can cause faults which can result in eventual or immediate death, serious injury or material damage.

- Maintain the machine at the specified maintenance intervals.

Damage from foreign bodies in the machine

Foreign bodies such as dirt, tools or loose components can be left by accident inside the machine after maintenance is performed. These can cause short circuits, reduce the performance of the cooling system or increase noise in operation. They can also damage the motor.

- Ensure that no foreign bodies are left in or on the motor.
- Securely attach all loose parts once you have completed the work.
- Carefully remove any dirt.

9.1.2 Inspections in the event of faults

Natural disasters or unusual operating conditions, such as overloading or short circuit, are faults that overload the machine electrically or mechanically.

Immediately perform an inspection after such faults.

9.1.3 First service after installation or repair

- Check after approx. 500 operating hours, but after not more than one year:

Check	When the motor is running	At standstill
The electrical parameters are maintained.	X	
The permissible bearing and winding temperatures are not exceeded (Page 81).	X	
The smooth running characteristics and machine running noise have not deteriorated.	X	
The foundation has no cracks or indentations. (*)	X	X

(*) You can perform these checks while the motor is at standstill or, if required, while running.

- Further checks may be required if so specified in operating instructions of components or in accordance with the plant-specific conditions.
- If you find any deviations during the inspection, you must rectify them immediately. They may otherwise damage the motor.

Checking the cooling system

- With the machine stopped, check the condition of the cooling system:
 - The cooling system is in good condition.
 - The pressure drop between entry and exit has not increased appreciably.

9.1.4 Main inspection

- Check that the installation conditions are observed. Perform the following checks after approx. 16 000 operating hours or at the latest after two years:

Checking	When the motor is running	At standstill
The electrical parameters are maintained	X	
The permissible bearing and winding temperatures are not exceeded (Page 81).	X	
The smooth running characteristics and machine running noise have not deteriorated.	X	
The foundation has no cracks or indentations. (*)	X	X
The machine is aligned within the permissible tolerance ranges.		X
All the fixing bolts/screws for the mechanical and electrical connections have been securely tightened		X
All the potential connections, grounding connections and shield supports are correctly seated and properly bonded		X
The winding insulation resistances are sufficiently high (Page 45)		X
Any bearing insulation is fitted as shown on the plates and labels		X
The CABLES and insulating parts and components are in good condition and there is no evidence of discoloring		X
Condensation can freely flow away.		X

(*) This check can be made at standstill or when running.

- If you detect any deviations during the inspection, you must rectify them immediately. They may otherwise cause damage to the machine.

9.1.5 Measuring the insulation resistance during the course of maintenance work

Measuring the insulation resistance and polarization index (PI) provides information on the condition of the machine. It is therefore important to check the insulation resistance and the polarization index at the following times:

- Before starting up a machine for the first time
- After an extended period in storage or downtime
- Within the scope of maintenance work

The following information is provided regarding the state of the winding insulation:

- Is the winding head insulation conductively contaminated?
- Has the winding insulation absorbed moisture?

As such, you can determine whether the machine needs commissioning or any necessary measures such as cleaning and/or drying the winding:

- Can the machine be put into operation?
- Must the windings be cleaned or dried?

Detailed information on testing and the limit values can be found here:

"Testing the insulation resistance and polarization index" (Page 45)

9.1.6 Servicing and maintaining the anti-condensation heating

The anti-condensation heating is maintenance-free. If it is defective, then contact the Service Center (Page 113).

9.1.7 Rolling bearings

Inspecting rolling bearings



! WARNING

Hazard due to magnetic fields

Do not disassemble the bearing. Do not remove the rotor. If it becomes necessary to remove the rotor with permanent magnets or change a bearing at the machine site, please contact a Siemens Service Center (Page 113).

NOTICE

Different intervals for regreasing and inspection

The required relubrication intervals for rolling bearings are not the same as the servicing intervals. It is essential to adhere to them. The bearings may be damaged if the relubrication intervals are not adhered to.

Note

Lubrication data

Information on regreasing (e.g. grease type, grease quantity and relubrication intervals) is given on the lubrication plate on the machine.

9.1.8 Regreasing intervals and types of grease for operating rolling bearings

Grease types

"Lubcon Thermogrease DSV 2 EP" grease is used for initial lubrication of the bearings. The amount of grease for the initial lubrication is 25% to 35% of the free bearing volume.

"Shell Gadus S3 V220C" grease is suitable and has been tested.

9.1 Inspection and maintenance

These greases have lithium soap as the thickening agent and mineral oil as the base oil. They exceed the standard requirements of DIN 51825 in several important respects and are, therefore, compatible with the specified relubrication intervals.

Note

Damage due to mixing grease types

Mixing greases and oils which are based on different types of soap or oil can degrade their lubrication properties. Mixing low-temperature grease with normal temperature grease can cause lumps to form in the lubricant. The consequence can be damage to the rolling bearings due to overheating.

Never mix greases that have different thickening agents and different base oils.

Regreasing

The regreasing intervals are specified on the lubricant plate of the machine. If the specified number of operating hours is not reached within three years, regrease the bearings at the main inspection.

If you use other KP2N greases, some of which only meet the minimum requirements per DIN 51825, halve the regreasing intervals.

1. Clean the lubricating nipple and press in suitable grease. The shaft should rotate so that the new grease can be distributed throughout the bearing. The bearing temperature rises sharply at first, then drops to the normal value again after the excess grease has been displaced out of the bearing.

The used grease collects outside the bearing.

After several regreasing operations, remove the spent grease depending on the specified relubrication intervals. To do this, loosen the outer bearing cover.

9.1.9 Touch up any damaged paintwork

If the paint is damaged, it must be repaired in order to protect the unit against corrosion.

Note

Paint system

Contact the Service Center (Page 113) before you repair any damage to paint. They will provide you with more information about the correct paint system and methods of repairing paint damage.

9.1.10 Maintaining terminal boxes

Requirement

The machine is de-energized.

Checking the terminal box

- Terminal boxes must be regularly checked for tightness, undamaged insulation, and tight terminal connections.
- If dust or humidity have infiltrated the terminal box, this should be cleaned and dried (particularly the insulators).
Check all the seals and sealing surfaces and address the cause of the leakiness.
- Check the insulators, connectors and cable connections in the terminal box.
- Replace any damaged components.

 WARNING
Short-circuit hazard
Short-circuits can occur as a result of damaged components. This can result in death, serious injury or material damage.
Replace damaged components.


9.2 Corrective maintenance

Observe the following when carrying out any work on the machine:

- Comply with the general safety instructions.
- Comply with the applicable national and sector-specific regulations.
- When using the machine within the European Union, comply with the specifications laid down in EN 50110-1 regarding safe operation of electrical equipment.

See also

Safety instructions (Page 13)

 WARNING
Strong magnetic field when the machine is open
A strong magnetic field is always present inside the machine. If the housing is open, e.g. when maintenance openings are open or when working inside the machine, magnetic objects can be suddenly attracted by this magnetic field. This can result in death, severe injury or material damage.
<ul style="list-style-type: none">• Repairs are only permissible within the scope of the work described in these operating instructions.• For repairs that go beyond this scope, please contact the Service Center.

See also

Service and support (Page 113)

If the motor has to be transported, please observe the information and instructions in the "Transport (Page 32)" chapter.

9.2.1 Prepare servicing work

- The drawings and parts lists do not contain any detailed information about the type and dimensions of fixing elements and components. For this reason, you should establish this information when dismantling them and make a note of it for the purpose of reassembly.
- Document the type, dimensions and arrangement of the parts so that you will be able to reassemble the machine to its original state.
- Use suitable tools to disassemble the machine.
- Take measures to prevent parts from dropping down before you dismantle them, e.g. by replacing fastening elements with extra-long screws, threaded bolts or similar. This ensures that the part is supported after it is pulled off.
- The centerings in the shaft extensions have reset threads. Use lifting gear which is suitable for the rotor weight and direction of loading.

See also

Service and support (Page 113)

9.2.2 Anti-condensation heating

The anti-condensation heater is mounted directly on the winding. The anti-condensation heater cannot be removed without causing damage to the winding. A new anti-condensation heater may only be installed by Siemens Service Center (Page 113) specialists.

9.2.3 Replacing bearings

We recommend that the rolling bearings are replaced after approx. 60,000 operating hours, however, at the latest after 10 years.



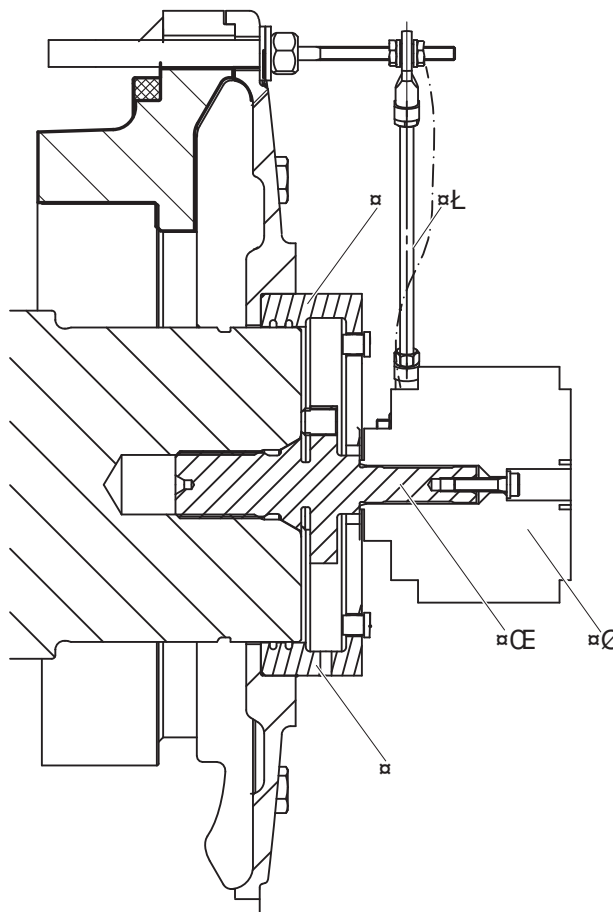
NOTICE

Rotor removal or bearing change

Improper handling can lead to irreparable damage to the motor.

If it is necessary to remove the rotor or change the bearings, then under all circumstances please contact the Service Center (Page 113).

9.2.4 Replacing the speed encoder



- | | | | |
|---|------------------|---|---------------|
| ① | Touch protection | ③ | Speed encoder |
| ② | Torque arm | ④ | Shaft journal |

Figure 9-1 Detailed view of the speed encoder

9.2 Corrective maintenance

To remove the speed encoder, proceed as follows:

1. Unscrew the speed encoder cover.
2. Detach the electrical connection.
 - Carefully withdraw the cable out of its holder.
 - Withdraw the connector.

3. Remove the torque arm of the speed encoder.
4. Withdraw the speed encoder from the shaft using a pressure screw. The procedure depends on the mounted speed encoder.
Speed encoder "Heidenhain EQN 425"
 - Remove screw M5x50.
 - Screw in a grub screw (M5x50) and a screw (M6x70) one after the other. This releases the speed encoder from the shaft journal taper.
 - Remove the speed encoder.Speed encoder "Hübner-Berlin HOG10, HOG11 andHMG111"
 - Remove screw M6x25.
 - Screw in the screw M8x60. This releases the speed encoder hollow shaft from the shaft journal.
 - Remove the speed encoder.

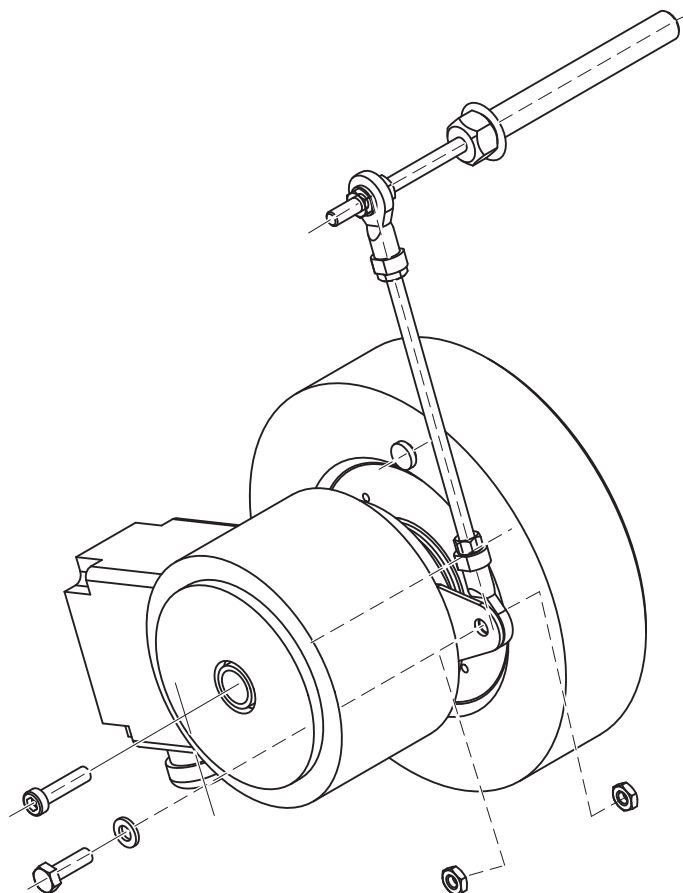


Figure 9-2 Replacing a speed encoder

Mounting the speed encoder

1. Removing the coupling at the DE.
2. Screw a suitable lever into the tapped hole on the face of the shaft extension. You can use the centering hole at the end of the shaft for this purpose.
3. Rotate the rotor using the lever. The required torque is approximately 200 Nm. Measure the radial runout of the shaft journal. The radial runout must be less than 0.1 mm when the rotor turns.
4. If the height of the shaft journal is more than 0.1 mm, dismantle the contact guard with the outer bearing cover. Adjust the shaft journal using the three grub screws in such a way that the height of the shaft journal is less than 0.1 mm when rotating the rotor. Install the outer bearing cover with contact guard.
5. Mount the new speed encoder.
6. Mount the torque arm of the speed encoder.
7. Insert the connector into the socket.
8. Press the cable into the holder provided for it.
9. Screw on the speed encoder cover. Take care that you do not catch the cable as you screw it in.

Note

Identifying the position of the rotor

After replacing the speed encoder, perform a rotor position identification routine (automatic encoder adjustment) using the converter Motor Module.

Spare parts

10.1 Ordering data

In addition to the exact part designation, please specify the machine type and serial number in all orders for spare parts. Ensure that the spare part designation matches that on the spare parts list and make sure you use the appropriate part number as well.

Example

- Bearing shield, drive end (Part 5.00)
- Machine type
- Serial number

The machine type and serial number can be found on the rating plate. The serial number is also stamped on the end face of the shaft extension at the drive end.

Note

The graphical representations in this chapter show schematic diagrams of the basic versions. They are used for spare parts definitions. The supplied version may differ in details from these representations.

10.2 Determining the spare parts via the Internet



You can use "Spares on Web" to determine the order numbers for motor spare parts quickly and easily.

Spares on Web (<https://www.sow.siemens.com/>).

See also

Guide for Spares on Web (<http://support.automation.siemens.com/WW/news/en/25248626>)

You can use commercially available, standard components, but ensure that they have the same construction type, dimensions, strength class etc.



NOTICE

Rotor removal or bearing change

Improper handling can lead to irreparable damage to the motor.

If it is necessary to remove the rotor or change the bearings, then under all circumstances please contact the Service Center (Page 113).

Rolling bearings

When ordering rolling bearings, in addition to the bearing identification code, the supplementary specifying code is also necessary for the bearing version. Both of these codes are stamped on the lubricant plate and specified in the motor documentation, or can also be taken from the installed bearings.

Always replace the rolling bearings with the identical bearings.

If insulated rolling bearings are fitted, use insulated rolling bearings of the same type as spare parts. This will prevent any bearing damage being caused by bearing currents.

10.3 Anti-condensation heating

The anti-condensation heater is mounted directly on the winding. The anti-condensation heater cannot be removed without causing damage to the winding. A new anti-condensation heater may only be installed by Siemens Service Center (Page 113) specialists.

Disposal

11.1 Introduction

Protecting the environment and preserving its resources are corporate goals of the highest priority for us. Our worldwide environmental management system to ISO 14001 ensures compliance with legislation and sets high standards in this regard. Environmentally friendly design, technical safety and health protection are always firm goals even at the product development stage.

Recommendations for the environmentally friendly disposal of the machine and its components are given in the following section. Be sure to comply with local disposal regulations.

Country-specific legislation



The machine uses materials that can be recovered or recycled. Correctly separating materials helps to simply recycle important materials.

- When disposing of the machine or of waste that is created during the individual phases of its life cycle, please observe the statutory requirements applicable in the country of use.
- Please contact your local authorities for more information about disposal.

11.2 RoHS - restricting the use of certain hazardous substances

In compliance with RoHS ("Restriction of certain Hazardous Substances") we replace substances that are damaging to the environment by those that are not based on state-of-the-art technology. In doing so, safety in operation and handling will take priority at all times.

11.3 Information according to Article 33 of the REACH regulation

This product contains one or several subproducts in which the following substance – belonging to the "list of candidates" – exists in a concentration exceeding 0.1 percent by weight.

- CAS No. 7439-92-1, lead

Based on the currently available information, we assume that this substance does not represent any risk when correctly used, including its disposal.

11.4 Preparing for disassembly

Disassembly of the machine must be carried out and/or supervised by qualified personnel with appropriate expert knowledge.

1. Contact a certified waste disposal organization in your vicinity. Clarify what is expected in terms of the quality of dismantling the machine and provision of the components.
2. Carefully follow the 5 safety rules (Page 13).
3. Disconnect all electrical connections and remove all cables.
4. Remove all liquids such as oil and cooling liquids. Collect the liquids separately and dispose of them in a professional manner.
5. Detach the machine fixings.
6. Transport the machine to a suitable location for disassembly.

11.5 Working on machines with permanent magnets

On machines with permanent magnets, the magnetic field is guided in an assembled state in the magnetic circuit of the machine. This means that no magnetic fields, which may be to your health, are detectable outside the machine.

WARNING

Strong magnetic field when the machine is open

A strong magnetic field is always present inside the machine. If the housing is open, e.g. when maintenance openings are open or when working inside the machine, magnetic objects can be suddenly attracted by this magnetic field. This can result in death, serious injury or material damage.

- Working in the vicinity of the rotor is only permitted in exceptional circumstances. Unambiguous access rules must be established in accordance with the magnetic fields prevailing in the workplace. Clearly mark the boundaries of the areas where standing is permitted.
- People who need to use electronic or magnetic medical aids such as pacemakers, hearing aids, implants or similar devices, are at particularly high risk. Such persons must undergo an industrial medicine assessment.
- Observe the following measures.

Personal protective measures

- Ensure that you never wear or carry any of the following objects and that they are kept a safe distance from the machine:
 - All kinds of magnetic metal parts such as, keys, glasses, tools, knives, scissors, tape measures, etc.
 - Magnetic jewelry such as rings, chains, needles, watches, etc.
 - Electronic devices and data carriers such as service cards, check cards, credit cards, calculators, cell phones, etc.
 - Wallets or other iron-containing objects
 - Electrically conductive foreign bodies
- Do not use any magnetic tools or lifting devices.
- Wear only occupational safety items without magnetic metal parts, e.g. occupational safety shoes with non-magnetic protective caps and soles.
- Keep your shoes and clothing free from chips and waste containing iron.
- Exercise caution when installing accessories. Ensure that no parts fall into the inside of the machine.
- Do not perform any cutting at the machine, e.g. manufacturing threaded holes. Any exceptions require written approval from the manufacturer.

11.6 Disposing of permanent magnets

If the entire motor is melted down, no special action is required for the permanent magnets. Remove all cables before the melting process.

Demagnetizing the motor

If the motor is disassembled and dismantled, the permanent magnets must be demagnetized. To do this, the motor is heated up to 350 °C so that during and after disposal, the rotors do not represent any danger. The disposal must be carried out by an authorized waste disposal company.

Note

Removing the permanent magnet rotor

Injury and material damage can occur if the permanent magnet rotor is incorrectly removed. Only authorized workshops and waste disposal companies are permitted to remove the rotor.

Demagnetizing the rotors

Waste disposal companies that are authorized to demagnetize rotors use a specially designed disposal furnace. The insides of the disposal furnace consist of non-magnetic material. The rotors are put in the furnace in a solid, heat-resistant container made of non-magnetic material and left in the furnace during the entire demagnetization procedure. Demagnetization is achieved by heating the rotor in the furnace until the permanent magnets have reached a temperature of 350 °C.

NOTICE
Emissions
Exhaust gas that is released must be collected and rendered harmless without damaging the environment.

Note

Authorized waste disposal companies

Information regarding authorized disposal companies and workshops can be obtained from the Service Center (Page 113).

11.7 Disposal of components

Components

The machines consist mainly of steel and various proportions of copper and aluminum. Metals are generally considered to be unlimitedly recyclable.

Sort the components for recycling according to whether they are:

- Iron and steel
- Aluminum
- Non-ferrous metal, e.g. windings
The winding insulation is incinerated during copper recycling.
- Insulating materials
- Cables and wires
- Electronic waste

Process materials and chemicals

Sort the process materials and chemicals for recycling according to whether they are for example:

- Oil
- Grease
- Cleaning substances and solvents

- Paint residues
- Anti-corrosion agent
- Coolant additives such as inhibitors, antifreeze or biocides

Dispose of the separated components according to local regulations or via a specialist disposal company. The same applies for cloths and cleaning substances which have been used while working on the machine.

Packaging material

- If necessary, contact a suitable specialist disposal company.
- Wooden packaging for sea transport consists of impregnated wood. Observe the local regulations.
- The foil used for water-proof packaging is an aluminum composite foil. It can be recycled thermally. Dirty foil must be disposed of via waste incineration.

Service and support



Technical questions or additional information



If you have any technical queries or you require additional information, please contact www.siemens.com/yourcontact (www.siemens.com/yourcontact).

Please have the following data ready:

- Type
- Serial number

You can find this data on the rating plate.

Contact person



If you wish to request on-site service or order spare parts, please contact your local office. This office will contact the responsible service center on your behalf. You can find your contact person in the relevant contact database:

Technical Support (<https://support.industry.siemens.com/cs/ww/en/sc/4868>)

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Technical data

B.1 Tightening torques for screw and bolt connections

Bolt locking devices

- Refit nuts or bolts that are mounted together with locking, resilient, and/or force-distributing elements with identical, fully-functional elements when re-assembling. Always renew keyed elements.
- When screwing together threads secured with a liquid adhesive, use a suitable medium such as Loctite 243.
- Always use suitable securing devices or removable adhesives (e.g., Loctite 243) when installing fixing bolts with a clamping length of less than 25 mm. The clamping length is taken as the distance between the head of the bolt and the point at which the bolt is screwed in.

Tightening torques

The bolted connections with metal contact surfaces, such as end shields, bearing cartridge parts, terminal box parts bolted onto the stator frame, should be tightened to the following torques, depending on the thread size:

Table B-1 Tightening torques for bolted connections with a tolerance of $\pm 10\%$.

Case	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30	M36	M42	M48	M56	
A	1.2	2.5	4	8	13	20	40	52	80	150	-	-	-	-	Nm
B	1.3	2.6	4.5	11	22	38	92	180	310	620	1080	1700	2600	4200	Nm
C	3	5	8	20	40	70	170	340	600	1200	2000	3100	4700	7500	Nm

B.1 Tightening torques for screw and bolt connections

Applications

The above-mentioned tightening torques apply for the following applications:

- Case A
Applies to electrical connections in which the permissible torque is normally limited by the bolt materials and/or the current carrying capacity of the insulators, with the exception of the busbar connections in case B.
- Case B
Applies to bolts screwed into components made from materials with lower property class (e. g. aluminum) and to bolts with property class 8.8 according to ISO 898-1.
- Case C
Applies to bolts with property class 8.8, A4-70 or A4-80 according to ISO 898-1, however only to bolts screwed into components made from materials with higher property class, e.g. cast iron, steel or cast steel.

Note

Non-standard tightening torques

Different tightening torques for electrical connections and bolted connections for parts with flat seals or insulating parts are specified in the relevant sections and drawings.

Quality documents



Quality documents can be found here:

<https://support.industry.siemens.com/cs/ww/en/ps/13323/cert> (<https://support.industry.siemens.com/cs/ww/en/ps/13323/cert>)

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