Hardware Installation Manual

SIMOTICS
Synchronous Built-In Motors M-1FE1
For SINAMICS S120

Edition 12/2016

www.siemens.com
Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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

Disclaimer of Liability

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

Keeping the documentation safe

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

Target group

This Hardware Installation Manual addresses installation technicians, commissioning engineers, service and maintenance personnel.

About this Hardware Installation Manual

This Hardware Installation Manual applies to SIMOTICS M-1FE1 synchronous built-in motors, called "1FE1" in the following text.

The Hardware Installation Manual explains how to handle the 1FE1 from delivery to disposal.

The Hardware Installation Manual provides information about the components that enable the target group to install, set up, test, commission, operate, and troubleshoot the products and systems correctly and safely.

- Before you start using the motor, you must read this Hardware Installation Manual. This will ensure safe, problem-free operation and maximize the service life of the motor.
- Always follow the safety instructions and notices in this Hardware Installation Manual.

This Hardware Installation Manual complements the relevant Siemens Configuration Manual.

Siemens strives continually to improve the quality of information provided in this Hardware Installation Manual.

- If you find any mistakes or would like to offer suggestions about how this document could be improved, contact the Siemens Service Center.

The warning notice system is explained on the rear of the inside front.
Text features

In addition to the notes that you must observe for your own personal safety as well as to avoid material damage, in this document you will find the following text features:

**Operating instructions**
Operating instructions with the specified sequence are designated using the following symbols:

The arrow indicates the start of the operating instructions.

The individual handling steps are numbered.

1. Execute the operating instructions in the specified sequence.

The square indicates the end of the operating instruction.

Operating instructions without a specified sequence are identified using a bullet point:

- Execute the operating instructions.

**Enumerations**

- Enumerations are identified by a bullet point without any additional symbols.
  - Enumerations at the second level are hyphenated.

**Notes**

Notes are shown as follows:

---

**Note**

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

---

**More information**

Information on the following topics is available under the link:

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


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

docu.motioncontrol@siemens.com
Internet address for products

Products (http://www.siemens.com/motioncontrol)

My support

The following link provides information on how to create your own individual documentation based on Siemens content, and adapt it for your own machine documentation:

My support (https://support.industry.siemens.com/My/de/en/documentation)

Note

If you want to use this function, you must first register.
Later, you can log on with your login data.

Training

The following link provides information on SITRAIN - training from Siemens for products, systems and automation engineering solutions:

SITRAIN (http://siemens.com/sitrain)

Technical Support

Country-specific telephone numbers for technical support are provided on the Internet under Contact:


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1.1 General safety instructions

**DANGER**

**Danger to life due to live parts and other energy sources**

Death or serious injury can result when live parts are touched.

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

Generally, six steps apply when establishing safety:

1. Prepare for shutdown and notify all those who will be affected by the procedure.
2. Disconnect the machine from the supply.
   - Switch off the machine.
   - Wait until the discharge time specified on the warning labels has elapsed.
   - Check that it really is in a no-voltage condition, from phase conductor to phase conductor and phase conductor to protective conductor.
   - Check whether the existing auxiliary supply circuits are de-energized.
   - Ensure that the motors cannot move.
3. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water.
4. Isolate or neutralize all hazardous energy sources by closing switches, grounding or short-circuiting or closing valves, for example.
5. Secure the energy sources against switching on again.
6. Ensure that the correct machine is completely interlocked.

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

**WARNING**

**Danger to life through a hazardous voltage when connecting an unsuitable power supply**

Touching live components can result in death or severe injury.

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

**Danger to life when live parts are touched on damaged motors/devices**

Improper handling of motors/devices can damage them.

For damaged motors/devices, hazardous voltages can be present at the enclosure or at exposed components.

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

### WARNING

**Danger to life through electric shock due to unconnected cable shields**

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

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

### WARNING

**Danger to life due to electric shock when not grounded**

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

- Ground the device in compliance with the applicable regulations.

### WARNING

**Danger to life due to electric shock when opening plug connections in operation**

When opening plug connections in operation, arcs can result in severe injury or death.

- Only open plug connections when the equipment is in a no-voltage state, unless it has been explicitly stated that they can be opened in operation.
NOTICE

Material damage due to loose power connections

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

- Tighten all power connections with the specified tightening torques, e.g. line supply connection, motor connection, DC link connections.
- Check all power connections at regular intervals. This applies in particular after transport.

WARNING

Danger to life through unexpected movement of machines when using mobile wireless devices or mobile phones

Using mobile wireless devices or mobile phones with a transmit power > 1 W closer than approx. 2 m to the components may cause the devices to malfunction, influence the functional safety of machines therefore putting people at risk or causing material damage.

- Switch the wireless devices or mobile phones off in the immediate vicinity of the components.

WARNING

Danger of an accident occurring due to missing or illegible warning labels

Missing or illegible warning labels can result in accidents involving death or serious injury.

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

1.1 General safety instructions

![WARNING]

**Danger to life when safety functions are inactive**

Safety functions that are inactive or that have not been adjusted accordingly can cause operational faults on machines that could lead to serious injury or death.

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

**Note**

**Important safety notices for Safety Integrated functions**

If you want to use Safety Integrated functions, you must observe the safety notices in the Safety Integrated manuals.

![WARNING]

**Danger to life from electromagnetic fields**

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment, such as transformers, converters, or motors.

People with pacemakers or implants are at particular risk in the immediate vicinity of this equipment.

- If you have a heart pacemaker or implant, maintain the minimum distance specified in chapter "Correct usage" from such motors.

![WARNING]

**Danger to life from permanent-magnet fields**

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

- If you have a heart pacemaker or implant, maintain the minimum distance specified in chapter "Correct usage".
- When transporting or storing permanent-magnet motors always use the original packing materials with the warning labels attached.
- Clearly mark the storage locations with the appropriate warning labels.
- IATA regulations must be observed when transported by air.
### WARNING

**Risk of injury caused by moving parts or parts that are flung out**

Touching moving motor parts or drive output elements and loose motor parts that are flung out (e.g. feather keys) in operation can result in severe injury or death.

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

### WARNING

**Danger to life due to fire if overheating occurs because of insufficient cooling**

Inadequate cooling can cause overheating resulting in death or severe injury as a result of smoke and fire. This can also result in increased failures and reduced service lives of motors.

- Comply with the specified coolant requirements for the motor.

### WARNING

**Danger to life due to fire as a result of overheating caused by incorrect operation**

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

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

### CAUTION

**Risk of injury due to touching hot surfaces**

In operation, the motor can reach high temperatures, which can cause burns if touched.

- Mount the motor so that it is not accessible in operation.

Measures when maintenance is required:

- Allow the motor to cool down before starting any work.
- Use the appropriate personnel protection equipment, e.g. gloves.
1.2 Handling electrostatic sensitive devices (ESD)

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

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<th>NOTICE</th>
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<tbody>
<tr>
<td><strong>Damage through electric fields or electrostatic discharge</strong></td>
</tr>
<tr>
<td>Electric fields or electrostatic discharge can cause malfunctions through damaged individual components, integrated circuits, modules or devices.</td>
</tr>
<tr>
<td>• Only pack, store, transport and send electronic components, modules or devices in their original packaging or in other suitable materials, e.g. conductive foam rubber of aluminum foil.</td>
</tr>
<tr>
<td>• Only touch components, modules and devices when you are grounded by one of the following methods:</td>
</tr>
<tr>
<td>– Wearing an ESD wrist strap</td>
</tr>
<tr>
<td>– Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring</td>
</tr>
<tr>
<td>• Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container).</td>
</tr>
</tbody>
</table>
1.3 Industrial security

Note

Industrial security

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

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

The customer is responsible for preventing unauthorized access to its plants, systems, machines and networks. Systems, machines and components should only be connected to the enterprise network or the internet if and to the extent necessary and with appropriate security measures (e.g. use of firewalls and network segmentation) in place.

Additionally, Siemens’ guidance on appropriate security measures should be taken into account. For more information about industrial security, please visit: Industrial security (http://www.siemens.com/industrialsecurity).

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

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed at: Industrial security (http://www.siemens.com/industrialsecurity).

<table>
<thead>
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<th>WARNING</th>
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<tbody>
<tr>
<td>Danger to life as a result of unsafe operating states resulting from software manipulation</td>
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</tbody>
</table>

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

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

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

1. Unintentional movements of driven machine or system components during commissioning, operation, maintenance, and repairs caused by, for example,
   - Hardware and/or software errors in the sensors, control system, actuators, and cables and connections
   - Response times of the control system and of the drive
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of wireless devices/mobile phones in the immediate vicinity of electronic components
   - External influences/damage
   - X-ray, ionizing radiation and cosmic radiation

2. Unusually high temperatures, including open flames, as well as emissions of light, noise, particles, gases, etc., can occur inside and outside the components under fault conditions caused by, for example:
   - Component failure
   - Software errors
   - Operation and/or environmental conditions outside the specification
   - External influences/damage

3. Hazardous shock voltages caused by, for example:
   - Component failure
   - Influence during electrostatic charging
   - Induction of voltages in moving motors
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - External influences/damage

4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close

5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly

6. Influence of network-connected communication systems, e.g. ripple-control transmitters or data communication via the network

For more information about the residual risks of the drive system components, see the relevant sections in the technical user documentation.
2.1 Special safety notices for handling built-in motors

Components with permanent magnets

For the 1FE1 built-in motor described in this manual, the permanent magnets are located in the rotor.

Risk to persons as a result of strong magnetic fields

WARNING

Danger to life as a result of permanent magnet fields

Even when not installed, the permanent-magnetic fields of electric motors represent a potential risk for persons with heart pacemakers or implants if they are close to motors.
- If you are an affected person, maintain a minimum separation of 500 m.
- When transporting or storing permanent magnet motors always use the original packing materials with the warning labels attached.
- Clearly mark the storage locations with the appropriate warning labels.

WARNING

Electrical shock hazard

Each movement of the rotor in relation to the stator or vice versa induces a voltage. If you use defective cable ports, you could suffer an electric shock.
- Do not touch the cable ports.
- Connect the motor cable ports correctly, or insulate them properly.

Material damage caused by strong magnetic fields

NOTICE

Data loss caused by strong magnetic fields

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

**WARNING**

Danger to life and material damage when incorrectly used

If you do not use the motors correctly, there is a risk of death, severe injury and/or material damage.

- Only use the motors for their intended purpose.
- Make sure that the conditions at the location of use comply with all the rating plate data.
- Make sure that the conditions at the location of use comply with the conditions specified in this documentation. When necessary, take into account deviations regarding approvals or country-specific regulations.

**WARNING**

Danger to life caused by magnetic and electrical fields to persons with active implants

Electric motors represent a danger for people with active implants who come close to the motors.

- If you are an affected person, maintain a minimum separation of 500 m to motors.

If you wish to use special versions and design variants whose specifications vary from the motors described in this document, then contact your local Siemens office.

If you have any questions regarding the intended usage, please contact your local Siemens office.

**WARNING**

Danger to life through the use of an incomplete machine

If you use a machine that does not conform to the 2006/42/EU decree, there is the danger of death, severe injury and/or material damage.

- Commission the machine only when it conforms to the regulations of the EU 2006/42/EU machine decree and the conformity has been declared.

Synchronous built-in motors are components for installation in machines and for deployment in industrial or business plants.

Any other application of the motor is considered to be incorrect usage.

The observance of the specifications contained in the Hardware Installation Manual and the Configuration Manual is part of the correct usage.

- Observe the data on the rating plate.

Conditions at the location of use must comply with the specifications on the rating plate.
The 1FE1 is designed for operation in sheltered areas under normal climatic conditions, such as those found on shop floors.

The 1FE1 is not permitted to be operated in hazardous areas.

The 1FE1 motor is only certified for operation through a converter.

The 1FE1 is a three-phase motor for low voltage.

The motor is deployed for machine tool main spindle drives.

A motor spindle unit results after installing the rotor and the stator in the machine tool spindle.

### 2.3 Overview of the motors

<table>
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<th>IPM rotor (rotor with internal permanent magnets)</th>
<th>APM rotor (rotor with external permanent magnets)</th>
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<td>1FE105☐-4W</td>
<td>1FE105☐-4H</td>
</tr>
<tr>
<td>1FE107☐-4W</td>
<td>1FE110☐-4</td>
</tr>
<tr>
<td>1FE108☐-4W</td>
<td>1FE112☐-4</td>
</tr>
<tr>
<td>1FE109☐-4W</td>
<td>1FE104☐-6</td>
</tr>
<tr>
<td>1FE105☐-6W</td>
<td>1FE114☐-8</td>
</tr>
<tr>
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<td>1FE109☐-6W</td>
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<tr>
<td>1FE111☐-6W</td>
<td></td>
</tr>
</tbody>
</table>
2.4 Technical features and environmental conditions

2.4.1 Directives and standards

Standards that are complied with

SIMOTICS S, SIMOTICS M, SIMOTICS L, SIMOTICS T, SIMOTICS A motors - subsequently called the "SIMOTICS motor series " - comply with the following standards:

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

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

<table>
<thead>
<tr>
<th>Feature</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of protection</td>
<td>IEC / EN 60034-5</td>
</tr>
<tr>
<td>Cooling ¹)</td>
<td>IEC / EN 60034-6</td>
</tr>
<tr>
<td>Type of construction</td>
<td>IEC / EN 60034-7</td>
</tr>
<tr>
<td>Connection designations</td>
<td>IEC / EN 60034-8</td>
</tr>
<tr>
<td>Noise levels ¹)</td>
<td>IEC / EN 60034-9</td>
</tr>
<tr>
<td>Temperature monitoring</td>
<td>IEC / EN 60034-11</td>
</tr>
<tr>
<td>Vibration severity levels ¹)</td>
<td>IEC / EN 60034-14</td>
</tr>
</tbody>
</table>

¹) Standard component, e.g. cannot be applied to built-in motors

Relevant directives

The following directives are relevant for SIMOTICS motors.

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

European Machinery Directive
SIMOTICS motors do not fall within the area of validity covered by the Machinery Directive. However, the use of the products in a typical machine application has been fully assessed for compliance with the main regulations in this directive concerning health and safety.

European EMC Directive
SIMOTICS motors do not fall within the area of validity covered by the EMC Directive. The products are not considered as devices in the sense of the directive.
2.4 Technical features and environmental conditions

**Eurasian conformity**

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

**China Compulsory Certification**

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

CCC product certification


**Underwriters Laboratories**

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

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

**Quality systems**

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

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

Certificates for SIMOTICS motors

### 2.4 Technical features and environmental conditions

#### 2.4.2 Technical characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of motor</strong></td>
<td>Synchronous motor with permanent-magnet excited rotor (4, 6 or 8-pole)</td>
</tr>
<tr>
<td><strong>Type of construction</strong></td>
<td>Individual components (IM 5110 acc. to IEC 60034-7) Stator, rotor</td>
</tr>
<tr>
<td><strong>Degree of protection</strong></td>
<td>IP00 (acc. to DIN IEC 6034, Part 5): Stator, rotor</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>Water cooling with $T_{\text{H2O}} = 25^\circ \text{C}$ acc. to EN 60034-1</td>
</tr>
<tr>
<td><strong>Standard protection - temperature</strong></td>
<td>Two KTY 84 or Pt1000 PTC thermistors in the stator winding (1x reserve)</td>
</tr>
<tr>
<td><strong>Full protection (optional)</strong></td>
<td>In addition to the standard protection 1 x PTC thermistor triplet (3 sensors in series) Can be evaluated, e.g. using a thermal motor protection unit:</td>
</tr>
<tr>
<td><strong>Universal protection (optional)</strong></td>
<td>Full protection + NTC PT3-51-F + NTC K227</td>
</tr>
<tr>
<td><strong>Winding insulation</strong></td>
<td>Temperature class 155 (F) acc. to EN 6034 permits an average winding temperature rise of 105 K. The power data is valid for a cooling water temperature of +5° - 25° C.</td>
</tr>
<tr>
<td><strong>Balance quality of the rotor (acc. to ISO 1940-1)</strong></td>
<td>- Rotor with sleeve: Depending on the particular version, pre-balanced, balance quality G 2.5 reference speed 3600 rpm or non-balanced for complete balancing after mounting and installation</td>
</tr>
<tr>
<td></td>
<td>- Rotor without sleeve:</td>
</tr>
<tr>
<td><strong>Motor voltage (terminal voltage)</strong></td>
<td>regulated: Maximum 3 AC 430 $V_{\text{rms}}$ Non-regulated: Maximum 3 AC 460 $V_{\text{rms}}$</td>
</tr>
</tbody>
</table>
| **Supply voltage of the SINAMICS S120 drive system** | ALM 400 V $\rightarrow$ $V_{\text{DC link}} \leq 600$ V  
SLM 400 V $\rightarrow$ $V_{\text{DC link}} \leq 600$ V  
SLM 480 V $\rightarrow$ $V_{\text{DC link}} \leq 650$ V  
**Note:** For ALM 480 V infeed, a change must be made to "Smart Mode operation".  |
| **Type of connection**                    | Free single cables U1, V1, W1 (cables freely brought out); Length 0.5 m (preferred version) or 1.5 m  |
| **Torque ripple**                         | $\leq 1\%$ at 20 rpm and $M_N/2$ referred to the rated torque  
$\leq 1\%$ at 20 rpm and $M_N/2$ referred to the rated torque  
$\leq 2\%$ at 20 rpm and $M_N/2$ referred to the rated torque  |
| **UL marking**                            | With a few exceptions, motors are UL-1004 approved, see Chapter "Directives and standards (Page 24)"                                    |

**Note**

Technical data is system data and is applicable only in conjunction with the specified system components (1FE1 built-in motor, SINAMICS S120, VPM, IVP, etc.).
2.4 Technical features and environmental conditions

**Motor parts**

**Note**
Special versions and construction variants may differ in the scope of delivery with respect to certain technical aspects.

<table>
<thead>
<tr>
<th>Rotor</th>
<th>with IPM (internal permanent magnets)</th>
<th>with APM (external permanent magnets)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>without sleeve</td>
<td>without sleeve</td>
</tr>
<tr>
<td></td>
<td>with sleeve</td>
<td>with sleeve</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stator</th>
<th>with cooling jacket</th>
<th>without cooling jacket (available only on special motor request)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>4 O-ring seals</th>
<th>Rating plate</th>
</tr>
</thead>
</table>
### 2.4.2.1 Weights and moments of inertia

<table>
<thead>
<tr>
<th>Motor article number</th>
<th>Order code</th>
<th>Stator weight [kg]</th>
<th>Rotor weight [kg]</th>
<th>Moment of inertia [kg * m²]</th>
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</table>

1FE1 synchronous built-in motors
### 2.4 Technical features and environmental conditions

<table>
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<tr>
<th>Motor article number</th>
<th>Order code</th>
<th>Stator weight [kg]</th>
<th>Rotor weight [kg]</th>
<th>Moment of inertia [kg * m²]</th>
</tr>
</thead>
<tbody>
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<td>-</td>
<td>73.00</td>
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<td>0.12445</td>
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<tr>
<td><strong>8-pole built-in motors</strong></td>
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<td></td>
<td></td>
<td></td>
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<td>3.10</td>
<td>0.00559</td>
</tr>
<tr>
<td>1FE1083–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>20.00</td>
<td>4.70</td>
<td>0.00847</td>
</tr>
<tr>
<td>1FE1084–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>25.00</td>
<td>6.20</td>
<td>0.01118</td>
</tr>
<tr>
<td>1FE1085–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>30.00</td>
<td>7.70</td>
<td>0.01388</td>
</tr>
<tr>
<td>1FE1092–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>26.00</td>
<td>3.80</td>
<td>0.00916</td>
</tr>
<tr>
<td>1FE1093–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>33.00</td>
<td>7.50</td>
<td>0.01694</td>
</tr>
<tr>
<td>1FE1093–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>33.00</td>
<td>5.60</td>
<td>0.01350</td>
</tr>
<tr>
<td>1FE1094–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>40.50</td>
<td>9.60</td>
<td>0.02168</td>
</tr>
<tr>
<td>1FE1094–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>40.50</td>
<td>7.50</td>
<td>0.01808</td>
</tr>
<tr>
<td>1FE1095–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>48.00</td>
<td>11.70</td>
<td>0.02642</td>
</tr>
<tr>
<td>1FE1095–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>48.00</td>
<td>9.30</td>
<td>0.02242</td>
</tr>
<tr>
<td>1FE1096–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>55.50</td>
<td>13.90</td>
<td>0.03139</td>
</tr>
<tr>
<td>1FE1096–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>55.50</td>
<td>11.20</td>
<td>0.02700</td>
</tr>
<tr>
<td>1FE1103–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>35.00</td>
<td>5.30</td>
<td>0.01589</td>
</tr>
<tr>
<td>1FE1104–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>43.00</td>
<td>7.00</td>
<td>0.02098</td>
</tr>
<tr>
<td>1FE1105–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>52.00</td>
<td>8.70</td>
<td>0.02608</td>
</tr>
<tr>
<td>1FE1106–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>60.00</td>
<td>10.50</td>
<td>0.03147</td>
</tr>
<tr>
<td>1FE1124–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>58.00</td>
<td>12.10</td>
<td>0.05112</td>
</tr>
<tr>
<td>1FE1125–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>69.50</td>
<td>15.00</td>
<td>0.06337</td>
</tr>
<tr>
<td>1FE1126–4W☐☐☐☐☐☐☐</td>
<td>-</td>
<td>81.00</td>
<td>18.00</td>
<td>0.07604</td>
</tr>
</tbody>
</table>

1) As an alternative, Z is also valid for N.

### Note

**Rotor weights**

The weights of special versions are specified on the rating plate.
2.4 Technical features and environmental conditions

2.4.2.2 Magnetic forces that occur

Table 5-5 Magnetic forces of attraction

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Axial attractive force $F_a$ [N]</th>
<th>Radial attractive force $F_r$ [N]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1FE1051-4W</td>
<td>189</td>
<td>290</td>
</tr>
<tr>
<td>1FE1052-4W</td>
<td></td>
<td>580</td>
</tr>
<tr>
<td>1FE1053-4W</td>
<td></td>
<td>870</td>
</tr>
<tr>
<td>1FE1072-4W</td>
<td></td>
<td>700</td>
</tr>
<tr>
<td>1FE1073-4W</td>
<td></td>
<td>1050</td>
</tr>
<tr>
<td>1FE1074-4W</td>
<td></td>
<td>1400</td>
</tr>
<tr>
<td>1FE1075-4W</td>
<td></td>
<td>1750</td>
</tr>
<tr>
<td>1FE1082-4W</td>
<td></td>
<td>850</td>
</tr>
<tr>
<td>1FE1083-4W</td>
<td></td>
<td>1275</td>
</tr>
<tr>
<td>1FE1084-4W</td>
<td></td>
<td>1700</td>
</tr>
<tr>
<td>1FE1085-4W</td>
<td></td>
<td>2125</td>
</tr>
<tr>
<td>1FE1092-4W</td>
<td>180</td>
<td>1000</td>
</tr>
<tr>
<td>1FE1093-4W</td>
<td></td>
<td>1500</td>
</tr>
<tr>
<td>1FE1094-4W</td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>1FE1095-4W</td>
<td></td>
<td>2500</td>
</tr>
<tr>
<td>1FE1096-4W</td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td>1FE1051-6W</td>
<td>180</td>
<td>200</td>
</tr>
</tbody>
</table>

Acting magnetic forces of attraction

1. Spindle shaft with rotor core
2. Stator core with spindle housing

$F_a$ Axial attractive force
$F_r$ Radial attractive force

Figure 2-1 Attractive_forces_motor_spindle
## 2.4 Technical features and environmental conditions

### Motor type
<table>
<thead>
<tr>
<th>Motor type</th>
<th>Axial attractive force $F_a$ [N]</th>
<th>Radial attractive force $F_r$ [N]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1FE1052-6W</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>1FE1054-6W</td>
<td></td>
<td>800</td>
</tr>
<tr>
<td>1FE1061-6W</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>1FE1062-6W</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>1FE1064-6W</td>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>1FE1082-6W</td>
<td>350</td>
<td>700</td>
</tr>
<tr>
<td>1FE1083-6W</td>
<td></td>
<td>1050</td>
</tr>
<tr>
<td>1FE1084-6W</td>
<td></td>
<td>1400</td>
</tr>
<tr>
<td>1FE1091-6W</td>
<td>360</td>
<td>350</td>
</tr>
<tr>
<td>1FE1092-6W</td>
<td></td>
<td>700</td>
</tr>
<tr>
<td>1FE1093-6W</td>
<td></td>
<td>1050</td>
</tr>
<tr>
<td>1FE1113-6W</td>
<td>450</td>
<td>1300</td>
</tr>
<tr>
<td>1FE1114-6W</td>
<td></td>
<td>1700</td>
</tr>
<tr>
<td>1FE1115-6W</td>
<td></td>
<td>2200</td>
</tr>
<tr>
<td>1FE1116-6W</td>
<td></td>
<td>2600</td>
</tr>
</tbody>
</table>

### Rotors with external permanent magnets (APM)
<table>
<thead>
<tr>
<th>Motor type</th>
<th>Axial attractive force $F_a$ [N]</th>
<th>Radial attractive force $F_r$ [N]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1FE1051-4H</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>1FE1052-4H</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>1FE1053-4H</td>
<td></td>
<td>450</td>
</tr>
<tr>
<td>1FE1103-4W</td>
<td>250</td>
<td>750</td>
</tr>
<tr>
<td>1FE1104-4W</td>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>1FE1105-4W</td>
<td></td>
<td>1250</td>
</tr>
<tr>
<td>1FE1106-4W</td>
<td></td>
<td>1500</td>
</tr>
<tr>
<td>1FE1124-4W</td>
<td>350</td>
<td>1800</td>
</tr>
<tr>
<td>1FE1125-4W</td>
<td></td>
<td>2300</td>
</tr>
<tr>
<td>1FE1126-4W</td>
<td></td>
<td>2800</td>
</tr>
<tr>
<td>1FE1041-6W</td>
<td>180</td>
<td>200</td>
</tr>
<tr>
<td>1FE1042-6W</td>
<td></td>
<td>400</td>
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<tr>
<td>1FE1143-8W</td>
<td>700</td>
<td>1800</td>
</tr>
<tr>
<td>1FE1144-8W</td>
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<td>2400</td>
</tr>
<tr>
<td>1FE1145-8W</td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td>1FE1147-8W</td>
<td></td>
<td>4200</td>
</tr>
</tbody>
</table>
2.4 Technical features and environmental conditions

2.4.3 Rating plate data

Figure 2-2  1FE1 rating plate (example)

Note

All data applies only in conjunction with the associated rotor.

<table>
<thead>
<tr>
<th>Position</th>
<th>Description / technical data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor type / designation (article number)</td>
</tr>
<tr>
<td>2</td>
<td>Motor serial number</td>
</tr>
<tr>
<td>3</td>
<td>Rated current $I_N$ [A]</td>
</tr>
<tr>
<td>4</td>
<td>Rated speed $n_N$ [rpm]</td>
</tr>
<tr>
<td>5</td>
<td>Maximum speed $n_{\text{max}}$ [rpm]</td>
</tr>
<tr>
<td>6</td>
<td>Induced voltage $U_N$ [V] at $n_N$</td>
</tr>
<tr>
<td>7</td>
<td>Type of construction</td>
</tr>
<tr>
<td>8</td>
<td>Temperature class</td>
</tr>
<tr>
<td>9</td>
<td>Degree of protection</td>
</tr>
<tr>
<td>10</td>
<td>Technical data for S1 and S6 40% 2 minutes</td>
</tr>
<tr>
<td>11</td>
<td>ID, temperature sensor</td>
</tr>
<tr>
<td>12</td>
<td>2D code contains the motor data</td>
</tr>
<tr>
<td>13</td>
<td>Standards and regulations</td>
</tr>
<tr>
<td>14</td>
<td>Data regarding water cooling</td>
</tr>
<tr>
<td>15</td>
<td>Maximum torque $M_{\text{max}}$ [Nm]</td>
</tr>
<tr>
<td>16</td>
<td>Maximum induced voltage $V_{\text{max}}$ [V]</td>
</tr>
<tr>
<td>17</td>
<td>Stator and rotor mass $m$ [kg]</td>
</tr>
<tr>
<td>18</td>
<td>Maximum current $I_{\text{max}}$ [A]</td>
</tr>
</tbody>
</table>
## 2.4 Technical features and environmental conditions

### 2.4.4 Structure of the article number

The article number comprises a combination of digits and letters. It is divided into three hyphenated blocks.

Possible combinations, see Catalog NC 62.

Please note that not every theoretical combination is available.

<table>
<thead>
<tr>
<th>Description</th>
<th>Position of the article number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMOTICS M-1FE1 synchronous built-in motors</td>
<td>1 F E 1</td>
</tr>
<tr>
<td>Standard type with water cooling, machine tools - main spindle drive</td>
<td></td>
</tr>
<tr>
<td>Frame size</td>
<td>0 4</td>
</tr>
<tr>
<td></td>
<td>0 5</td>
</tr>
<tr>
<td></td>
<td>0 6</td>
</tr>
<tr>
<td></td>
<td>0 7</td>
</tr>
<tr>
<td></td>
<td>0 8</td>
</tr>
<tr>
<td></td>
<td>0 9</td>
</tr>
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<td>1 1</td>
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<td></td>
<td>1 2</td>
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<td></td>
<td>1 4</td>
</tr>
<tr>
<td>Overall length</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Lamination</td>
<td>4-pole 4</td>
</tr>
<tr>
<td></td>
<td>6-pole 6</td>
</tr>
<tr>
<td></td>
<td>8-pole 8</td>
</tr>
<tr>
<td>Cooling</td>
<td>Water cooling W</td>
</tr>
<tr>
<td></td>
<td>Air cooling L</td>
</tr>
<tr>
<td>Winding design</td>
<td>Impregnated winding with standard protection (2 temperature sensors) 0</td>
</tr>
<tr>
<td></td>
<td>Cast winding with standard protection (2 temperature sensors) 1</td>
</tr>
<tr>
<td></td>
<td>Cast winding with full protection (standard protection + PTC thermistor triplet) 3</td>
</tr>
<tr>
<td></td>
<td>Cast winding with universal protection (full protection + NTC-PT3-51F + NTC K227) 5</td>
</tr>
</tbody>
</table>
### 2.4 Technical features and environmental conditions

**Description**

<table>
<thead>
<tr>
<th>Description</th>
<th>Position of the article number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Voltage limitation</strong></td>
<td>Operation without VPM module</td>
</tr>
<tr>
<td></td>
<td>Operation with VPM module</td>
</tr>
<tr>
<td><strong>Scope of delivery</strong></td>
<td>Stator and rotor; 2 KTY temperature sensors</td>
</tr>
<tr>
<td></td>
<td>Spare part: Stator only (W in rotor version); 2 KTY temperature sensors</td>
</tr>
<tr>
<td></td>
<td>Spare part: Rotor only (W in stator version)</td>
</tr>
<tr>
<td></td>
<td>Stator and rotor; 2 Pt1000 temperature sensors</td>
</tr>
<tr>
<td></td>
<td>Spare part: Stator only (W in rotor version); 2 Pt1000 temperature sensors</td>
</tr>
<tr>
<td><strong>Stator version</strong></td>
<td>Stator without cooling jacket</td>
</tr>
<tr>
<td></td>
<td>Stator with cooling jacket ¹</td>
</tr>
<tr>
<td></td>
<td>Stator with special cooling jacket ²</td>
</tr>
<tr>
<td></td>
<td>Replacement rotor; the stator has no significance</td>
</tr>
<tr>
<td><strong>Rotor version (with different bore versions)</strong></td>
<td>Without rotor sleeve; for di, see dimensions table</td>
</tr>
<tr>
<td></td>
<td>With rotor sleeve; for d*, see dimensions table (only for 1FE1061/1FE108/1FE109)</td>
</tr>
<tr>
<td></td>
<td>With rotor sleeve, for d**, see dimensions table (only for 1FE1051/1FE1052/1FE108/1FE109)</td>
</tr>
<tr>
<td></td>
<td>With rotor sleeve, for d**, see dimensions table (only for 1FE1082)</td>
</tr>
<tr>
<td></td>
<td>With special rotor sleeve ²</td>
</tr>
<tr>
<td></td>
<td>Replacement stator, rotor has no significance</td>
</tr>
<tr>
<td><strong>Connection type</strong></td>
<td>Free cable ends, length 1.5 m</td>
</tr>
<tr>
<td></td>
<td>Free cable ends, length 0.5 m</td>
</tr>
<tr>
<td></td>
<td>Free cable ends, length 1.5 m</td>
</tr>
<tr>
<td></td>
<td>Cable outlet at small outer diameter of cooling jacket (on request)</td>
</tr>
</tbody>
</table>

¹ Temperature sensors, see scope of delivery

² Available only on request; contact your local Siemens office
Motor components

3.1 Thermal motor protection

The thermal motor protection is available in three versions:

- **Standard protection:** Temperature sensors (2x KTY 84-130 or 2x Pt1000)
- **Full protection (option):** Temperature sensors + PTC thermistor triplet (3 sensors in series) (2x KTY 84-130 or Pt1000 + 1x PTC180 C)
  
  see Chapter "Temperature evaluation using the PTC thermistor triplet (full motor protection, option) (Page 114)"

- **Universal protection (option):** Temperature sensors + PTC thermistor triplet + NTC thermistor (2x KTY 84-130 or Pt1000 + 1x PTC180 C + NTC PT3-51F + NTC K227/33k/A1)
  
  see Chapter "Temperature evaluation using NTC thermistors (universal protection, option) (Page 113)"

The stator core has two temperature sensors to monitor the winding; one of these is a reserve.

**Note**

Temperature sensors of the same type are always installed in one particular motor.

The type of temperature sensor installed is stamped on the rating plate.
Two temperature sensor types are integrated:

Table 3- 1  Features and technical data

<table>
<thead>
<tr>
<th>Type</th>
<th>KTY 84-130</th>
<th>Pt1000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature sensors KTY 84 are ESD components.</td>
<td>Pt1000 temperature sensors are not ESD components.</td>
</tr>
<tr>
<td></td>
<td>When delivered, they are short-circuited with a terminal.</td>
<td></td>
</tr>
<tr>
<td>Resistance when cold</td>
<td>Approx. 580 Ω</td>
<td>Approx. 1090 Ω</td>
</tr>
<tr>
<td>(20° C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance when hot</td>
<td>Approx. 1000 Ω</td>
<td>Approx. 1390 Ω</td>
</tr>
<tr>
<td>(100° C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection</td>
<td>Via signal cable</td>
<td>Via signal cable</td>
</tr>
<tr>
<td>Response temperature</td>
<td>Prewarning &lt; 150° C</td>
<td>Prewarning &lt; 150° C</td>
</tr>
<tr>
<td></td>
<td>Alarm/trip at max. 170° C ±5° C</td>
<td>Alarm/trip at max. 170° C ±5° C</td>
</tr>
</tbody>
</table>

High short-term overload conditions require additional protective measures as a result of the thermal coupling time of the temperature sensor.

3.2  Cooling

Note
The manufacturer of the motor spindle is responsible for the design and construction of the cooling.

Information about the materials and components in the cooling circuit is contained in the Configuration Manual.

Please observe the spindle manufacturer's project requirements.

Equipotential bonding

WARNING
Danger to life by incorrectly routing cooling water pipes

If electrically conductive cooling water pipes come into contact with live parts, this can cause an electric shock leading to death or severe injury.

- Ensure adequate insulation.
- Securely fasten the pipes.

- Provide all components in the cooling system (motor, heat exchanger, piping system, pump, pressure equalization tank, etc.) with equipotential bonding.
- Implement the equipotential bonding using a copper rail or finely stranded copper cable with the appropriate conductor cross-sections.
Preventing cavitation

**NOTICE**

**Motor damage caused by cavitation and abrasion**

An excessive pressure drop at the motor can cause motor damage as the result of cavitation and/or abrasion.

- Operate the motor so that the pressure drop at a converter or motor in continuous operation does not exceed 0.2 MPa.

Coolant inlet temperature

**NOTICE**

**Motor damage caused by condensation formation**

Water condensation can cause motor damage.

- Select the coolant inlet temperature so that condensation does not form on the surface of the motor. \( T_{\text{cooling}} > T_{\text{ambient}} - 5 \text{ K} \).
- Interrupt the supply of coolant for a longer motor standstill.

The motors are designed for full-load operation at maximum +25° C coolant inlet temperature.

Operation up to +40° C coolant inlet temperature is possible with derating (reduced power).

**Note**

**Derating**

The spindle manufacturer is responsible for the derating.
Motor components

3.2 Cooling

Coolant specification

As coolant, use only water that complies with the "water specification for coolant".

Note

If possible, use deionized water with reduced conductivity (5 ... 10 μS/cm) as the coolant.

Table 3- 2 Coolant water specifications

<table>
<thead>
<tr>
<th>Quality of the water used as coolant for motors with aluminum, stainless steel tubes + cast iron or steel jacket</th>
<th>Quality of the water used as coolant for motors with aluminum, stainless steel tubes + cast iron or steel jacket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride ions</td>
<td>Chloride ions</td>
</tr>
<tr>
<td>&lt; 40 ppm, can be achieved by adding deionized water.</td>
<td>&lt; 40 ppm, can be achieved by adding deionized water.</td>
</tr>
<tr>
<td>Sulfate ions</td>
<td>Sulfate ions</td>
</tr>
<tr>
<td>&lt; 50 ppm</td>
<td>&lt; 50 ppm</td>
</tr>
<tr>
<td>Nitrate ions</td>
<td>Nitrate ions</td>
</tr>
<tr>
<td>&lt; 50 ppm</td>
<td>&lt; 50 ppm</td>
</tr>
<tr>
<td>pH value</td>
<td>pH value</td>
</tr>
<tr>
<td>6 ... 9 (for aluminum 6 ... 8)</td>
<td>6 ... 9 (for aluminum 6 ... 8)</td>
</tr>
<tr>
<td>Electrical conductivity</td>
<td>Electrical conductivity</td>
</tr>
<tr>
<td>&lt; 500 μS/cm</td>
<td>&lt; 500 μS/cm</td>
</tr>
<tr>
<td>Total hardness</td>
<td>Total hardness</td>
</tr>
<tr>
<td>&lt; 170 ppm</td>
<td>&lt; 170 ppm</td>
</tr>
<tr>
<td>Dissolved solids</td>
<td>Dissolved solids</td>
</tr>
<tr>
<td>&lt; 340 ppm</td>
<td>&lt; 340 ppm</td>
</tr>
<tr>
<td>Size of entrained particles</td>
<td>Size of entrained particles</td>
</tr>
<tr>
<td>&lt; 100 μm</td>
<td>&lt; 100 μm</td>
</tr>
<tr>
<td>Corrosion protection</td>
<td>Corrosion protection</td>
</tr>
<tr>
<td>0.2 to 0.25% inhibitor, Nalco TRAC100 (previously 0GE056)</td>
<td>0.2 to 0.25% inhibitor, Nalco TRAC100 (previously 0GE056)</td>
</tr>
<tr>
<td>Anti-freeze protection</td>
<td>Anti-freeze protection</td>
</tr>
<tr>
<td>When required, 20 - 30% Tyfocor</td>
<td>When required, 20 - 30% Tyfocor</td>
</tr>
</tbody>
</table>

The values specified for the water as a coolant are the requirements for a closed cooling circuit. Not all of the specified concentrations will occur in the water at the same time. When necessary, contact your water utility for the values.

Note

Inhibitor is not required if a Tyfocor concentration > 20% is ensured.

Derating is not required for antifreeze protection components < 30%.

Using a different coolant

Other coolants (e.g. cooling-lubricating medium, water-oil mixtures with 10% oil and higher) can reduce the power of the motor.

Note

Power reduction when using a different coolant

Derating is required for water-oil mixtures with more than 10% oil.

Measures for frost danger

If there is danger of frost, adopt frost protective measures for complete or preassembled motor spindle units.

- Replenish antifreeze for operation (see Table "Coolant water specifications").
Note
- Avoid mixing different antifreeze products.
- Use and dose the antifreeze according to the manufacturer’s specifications.

Maintenance and service for assembled motor spindles
Check at least once annually
- the filling level,
- for any discoloring and
- the cooling-water specification

Note
Use cooling water only with the permitted specification.

In case of cooling water loss, refill with a previously deployed mixture of deionized water and inhibitor or Antifrogen N.

3.3 Encoder
The encoder is not included in the scope of delivery.
The spindle manufacturer is responsible for the selection and assembly.

Note
Additional information about the encoder is contained in the associated Configuration Manual
4 Preparing for use

4.1 Safety instructions for electromagnetic and permanent-magnetic fields

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk of death and crushing as a result of permanent magnet fields</strong></td>
</tr>
<tr>
<td>Severe injury and material damage can result if you do not take into consideration the safety instructions relating to permanent magnet fields.</td>
</tr>
<tr>
<td>• Observe the information in Chapter Special safety notices for handling built-in motors (Page 21).</td>
</tr>
</tbody>
</table>

**Safety measures for electromagnetic and permanent-magnetic fields**

• Observe the relevant nationally applicable health and safety regulations.
• Take measures, e.g. using shields, to reduce electromagnetic fields at their source.
• Keep the motor components in their individual packaging until installation.
• Mark the storage location with the warning and prohibition signs from the following tables.
• Avoid being crushed when handling the rotor core.
• Place the unpacked rotor core on a safe non-magnetic surface. Secure the rotor core with non-magnetic devices.
• Avoid contact of the rotor core with ferromagnetic objects.
• Use tools made of non-magnetic materials. Ferromagnetic assembly tools must have low mass.

**Attaching warning signs**

Any danger areas must be identified by well visible warning and prohibition signs (pictograms) in the immediate vicinity of the danger.

**Note**

The text for the warning signs should be written in the language of the country of use.
Identification of dangers using warning and prohibition signs:

Table 4-1  Warning signs according to ISO 7010 and their meaning

<table>
<thead>
<tr>
<th>Sign</th>
<th>Meaning</th>
<th>Sign</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="W006" alt="Warning - magnetic field" /></td>
<td>Warning - magnetic field (W006)</td>
<td><img src="W024" alt="Warning - hand injuries" /></td>
<td>Warning - hand injuries (W024)</td>
</tr>
<tr>
<td><img src="W012" alt="Warning for electrical voltage" /></td>
<td>Warning for electrical voltage (W012)</td>
<td><img src="W017" alt="Warning - hot surface" /></td>
<td>Warning - hot surface (W017)</td>
</tr>
</tbody>
</table>

Table 4-2  Prohibition signs according to ISO 7010 and their meaning

<table>
<thead>
<tr>
<th>Sign</th>
<th>Significance</th>
<th>Sign</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="P007" alt="No access for persons with pacemakers or defibrillator implants" /></td>
<td>No access for persons with pacemakers or defibrillator implants (P007)</td>
<td><img src="P014" alt="No access for persons with metal implants" /></td>
<td>No access for persons with metal implants (P014)</td>
</tr>
<tr>
<td><img src="P008" alt="No metal objects or watches" /></td>
<td>No metal objects or watches (P008)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UN number 2807 is allocated to permit magnets as hazardous item.
4.1 Safety instructions for electromagnetic and permanent-magnetic fields

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
</table>

**Danger to life if devices are packed, stored or transported incorrectly.**

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

- Always follow the safety instructions for storage and transport.
- Before transporting or lifting machines or machine parts, lock the rotary axes so they cannot accidentally rotate. This is necessary, as the axes are not self locking.
- Always correctly and carefully carry out storage, transport and lifting operations.
- Only use suitable devices and equipment that are in perfect condition.
- Only use lifting devices, transport equipment and suspension equipment that comply with the appropriate regulations.
- IATA regulations must be observed when components are transported by air.
- Mark locations where rotors are stored with warning and prohibit signs according to the tables in Chapter "Supplied pictograms".
- Observe the warning instructions on the packaging.
- Always wear safety shoes and safety gloves.
- When working with permanent magnets, keep the following tools and aids available to free any trapped body parts:
  - A hammer made of non-magnetizable material
  - Two pointed wedges (wedge angle approx. 10° to 15°) made of non-magnetizable material (e.g. hard wood)
- Take into account the maximum loads that personnel can lift and carry.
- Transport and store built-in motors only in their packed state.
  - Replace any defective packaging. Correct packaging offers protection against sudden forces of attraction that can occur in their immediate vicinity. Further, when correctly packaged you are protected against hazardous motion when storing and moving rotors.
  - Use only undamaged original packaging.
4.2 Shipping and packaging

Transport

Note
Observe the country-specific regulations.

The 1FE1 synchronous built-in motors are supplied as motor components in individual or bulk packaging according to the delivery contract.

Note
The standard packaging of 1FE1 motors is suitable for transport by road, rail and sea.

- Please pay attention to the symbols on the packaging in which the motor is delivered.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Fragile" /></td>
<td>Fragile (0621)</td>
<td><img src="image2" alt="Keep dry" /></td>
<td>Keep dry (0626)</td>
</tr>
<tr>
<td><img src="image3" alt="Top" /></td>
<td>Top (0623)</td>
<td><img src="image4" alt="Stack limitation based on the count" /></td>
<td>Stack limitation based on the count (2403)</td>
</tr>
</tbody>
</table>

- Transport the motor carefully and, when possible, in its original packaging.
- Fasten the load suspension device to the provided locations of the packaging or the motor.
- Avoid any jerky and oscillating movements during transport.
### Notes regarding air transportation (IATA)

Observe the maximum permissible field strengths in accordance with IATA packaging instructions for the air transport of products that contain permanent magnets.

**Note**

The magnetic field strengths listed in the table always apply to the values for the constant magnetic field from the IATA packaging instructions 953.

Shipping must be approved, notified or marked for magnetic field strengths above those specified below.

<table>
<thead>
<tr>
<th>Subject to approval</th>
<th>Shipping a product whose largest determined field strength at 4.6 m distance is larger than 0.418 A/m.</th>
<th>This product may be transported only with approval by the responsible national authorities of the dispatching country and the air transportation company's base country.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notification and marking approval required</td>
<td>Shipping a product whose largest determined field strength at 2.1 m distance is greater than or equal to 0.418 A/m.</td>
<td></td>
</tr>
<tr>
<td>Notification and marking approval not required</td>
<td>Shipping a product whose largest determined field strength at 2.1 m distance is less than 0.418 A/m.</td>
<td></td>
</tr>
</tbody>
</table>

The shipping of original-packed 4-pole built-in motors requires notification and marking approval.

The shipping of original-packed 6-pole and 8-pole built-in motors does not require notification and marking approval.
Checking the delivery for completeness

Scope of delivery of a synchronous built-in motor

1A  Rotor core without sleeve or
1B  Rotor core with sleeve
2  Stator core with cooling jacket (optional, without cooling jacket)
3  4 O-ring seals (for version with standard cooling jacket)
4  Rating plate
   Safety notes / product information (without figure)
   Circuit diagram (without figure)

- Upon receipt of the delivery, check immediately whether the items delivered are in accordance with the accompanying documents.

Note

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

- Register a complaint about
  - any apparent transport damage with the delivery agent immediately.
  - any apparent defects or missing components with the appropriate SIEMENS office immediately.

The safety instructions are included in the scope of delivery.

Note

Store the safety instructions so they are always available.

Note

Special versions and construction variants may differ in the technical details and scope of delivery.
4.3 Transportation and storage

Transport and store the built-in motors in the original packaging.

Transporting

Note
Observe the country-specific regulations.

- Fasten the load suspension device to the provided locations of the packaging or the motor.
- Transport the motor carefully.
- Avoid any jerky and oscillating movements during transport.

If a motor is not installed immediately after the delivery, it must be stored appropriately. Observe the following storage conditions.

Storage

Storage conditions
Store the motor in a dry, dust-free and vibration-free indoor storage facility. Adhere to the following values:

- $v_{\text{rms}} < 0.2 \text{ mm/s}$
- Max. temperatures: $-15^\circ \text{ C} ... 70^\circ \text{ C}$
- Relative humidity: $5\% ... 85\%$

Identification of the storage location
Mark the storage location clearly with warning notices as per the packaging of the built-in motors.

Note
This identification must also be visible after removal of the external packaging.
Preparing for use

4.3 Transportation and storage

Label on the rotor packaging

WARNING! very strong magnets

WARNUNG! starke Dauermagnete

Beware risk of crushing!
Keep it away from heart pacemakers, electronic devices and magnetic storage media. Risk of injury. Keep the motor components in their original packaging until assembly.

Vorsicht! Quetschgefahr!

1 Warning about a hazardous location
2 Warning - hand injuries
3 Warning - magnetic field
4 Prohibition for people with a pacemaker

Figure 4-1 Warnings on the packaging

Please observe the warning instructions on the packaging and labels.

Long-term storage

Check the correct state of the machine every six months.

- Check the motor for any damage.
- Perform any necessary maintenance work.
- Check the state of the dehydrating agent and replace when necessary.
- Record the preservation work so that all preservation coating can be removed prior to the commissioning.
4.3 Transportation and storage

Condensation

The following ambient conditions encourage the formation of condensation:

- Significant fluctuations of the ambient temperature
- Direct sunshine
- High air humidity during storage

Avoid these ambient conditions.

Use a desiccant and a hygroscope in the packaging.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk of motor damage by voltage discharges resulting from condensation</strong></td>
</tr>
<tr>
<td>If the stator winding is damp, its insulation resistance decreases. This can cause voltage discharges that damage the windings.</td>
</tr>
<tr>
<td>• Keep the drain holes free so that condensation can escape freely.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk of motor damage by corrosion resulting from condensation</strong></td>
</tr>
<tr>
<td>Condensation that does not escape can cause corrosion and motor damage.</td>
</tr>
<tr>
<td>• Keep the drain holes free so that condensation can escape freely.</td>
</tr>
</tbody>
</table>
5 Mechanical mounting

5.1 Safety instructions

Safety measures for electromagnetic and permanent-magnetic fields

Note
Only qualified, suitably trained personnel who clearly understand the special hazards involved may work with and on permanent-magnet rotor cores.

Note
Apply safety marking in accordance with the country-specific regulations at the assembly stations for rotor cores.

- Observe the relevant nationally applicable health and safety regulations.
- Take measures, e.g. using shields, to reduce electromagnetic fields at their source.
- Keep the motor components in their original packaging until installation.
- Mark the storage location with the symbol for magnetic danger.
- Place the unpacked rotor core in a safe place. Secure the rotor core with non-magnetic devices.
- Avoid contact of the rotor core with ferromagnetic bodies.
- Preferably use tools made of non-magnetic materials. Ferromagnetic assembly tools must have low mass. Work carefully!

Attaching warning signs

Any danger areas encountered during normal operation, maintenance, and servicing must be identified by well visible warning and prohibition signs (pictograms) in the immediate vicinity of the danger.

The associated texts must be provided in the language of the country in which the product is used.
Mechanical mounting

5.1 Safety instructions

Identification of dangers using warning and prohibition signs:

Table 5-1 Warning signs according to ISO 7010 and their meaning

<table>
<thead>
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<th>Sign</th>
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<th>Significance</th>
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<tr>
<td><img src="image" alt="Warning - magnetic field" /></td>
<td>Warning - magnetic field (W006)</td>
<td><img src="image" alt="Warning - hand injuries" /></td>
<td>Warning - hand injuries (W024)</td>
</tr>
<tr>
<td><img src="image" alt="Warning for electrical voltage" /></td>
<td>Warning for electrical voltage (W012)</td>
<td><img src="image" alt="Warning - hot surface" /></td>
<td>Warning - hot surface (W017)</td>
</tr>
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</table>

Table 5-2 Prohibition signs according to ISO 7010 and their meaning

<table>
<thead>
<tr>
<th>Sign</th>
<th>Significance</th>
<th>Sign</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="No access for persons with pacemakers or defibrillator implants" /></td>
<td>No access for persons with pacemakers or defibrillator implants (P007)</td>
<td><img src="image" alt="No access for persons with metal implants" /></td>
<td>No access for persons with metal implants (P014)</td>
</tr>
<tr>
<td><img src="image" alt="No metal objects or watches" /></td>
<td>No metal objects or watches (P008)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

⚠️ WARNING

Danger to life when lifting and transporting

Incorrect lifting and transport operations, as well as devices and equipment that are unsuitable or damaged can result in death, severe injury and/or material damage.

- Lifting devices, industrial trucks, and load suspension devices must comply with the regulations.
- The maximum capacity of the lifting equipment and the load suspension device must correspond to the weight of the motor parts (see the rating plate) or of the (partially) mounted motor spindle.
- Do not attach any additional loads to the lifting equipment.
- To hoist the motor, use suitable cable-guidance or spreading equipment (particularly if the motor is equipped with built-on assemblies).
- Fasten the lifting equipment only in the provided threaded holes and never at the balancing disk.
- Do not lift and transport the motor with the motor cables.
- Do not stand in the slewing range of hoisting gear or under suspended loads.
- Observe the country-specific regulations.
**WARNING**

### Danger to life from permanent magnet fields

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

- If you have a heart pacemaker or implant, maintain a minimum distance of 50 cm.
- When transporting or storing permanent magnet motors always use the original packing materials with the warning labels attached.
- Clearly mark the storage locations with the appropriate warning labels.
- IATA regulations must be observed when transported by air.

### NOTICE

### Data loss or damage caused by magnetic fields

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

- Keep magnetic or electronic data media (e.g. credit cards, memory cards) and watches outside magnetic fields (> 100 mm).

**WARNING**

### Danger of crushing caused by the strong attractive forces of permanent magnets

The strong attractive forces on magnetizable materials and tools when working near motors with permanent magnets (distance less than 100 mm) can cause severe injuries that result from crushing.

- Do not underestimate the strength of the attractive forces.
- Wear protective gloves.
- Always work at least as a pair.
- Remove the packaging of the motor components only immediately before assembly.
- Do not carry any objects made of magnetizable materials (e.g. watches, steel or iron tools) and/or permanent magnets close to the motor with permanent magnets.
- Never place components with permanent magnets directly next to each other.
- To free any trapped body parts (hand, finger, foot, etc.), keep available:
  - A hammer (about 3 kg) made of solid, non-magnetizable material
  - Two pointed wedges (wedge angle approx. 10° to 15°) made of solid, non-magnetizable material (e.g. hard wood)
First aid in the case of accidents involving permanent magnets

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

---

**WARNING**

Danger to life caused by damage to the insulation of the connection cables during mounting

Damaged insulation of the motor cables can cause an electric shock that can lead to death or severe injuries.

- Perform the mounting without exerting force on the connecting cables.
- Ensure that the minimum bending radii are not exceeded.
- Connect the connection cables with an effective strain relief.

---

**CAUTION**

Risk of injury due to touching hot surfaces

The hot surfaces associated with warm shrinking can cause injuries.

- Do not touch any hot surfaces.
- Wear heat-resistant gloves, safety goggles and closed work clothes.
5.2 Mounting instructions

The mounting instructions in the following chapters are recommendations.

The spindle manufacturer can specify different actions, and tools and resources needed for mounting.

Tools and resources needed for mounting are not included in the scope of delivery. The spindle manufacturer is responsible for their provision.

To mount/dismantle the motor parts, ensure the following ambient conditions:

- A draught-free room
- Technically dust-free and dry environment. The permissible relative air humidity lies within the range 5% to 85%.
- The occupational safety equipment required is specified in the appropriate work stages.

**NOTICE**

**Danger of damage to the rotor banding**

APM rotors have a banding (composite fiber) around the external diameter of the rotor that must not be damaged.

- Keep the protective film until mounting the rotor.
- Remove the protective film only for balancing or immediately before mounting.
- Check the banding for damage before mounting.
- Mount the APM rotor centered in the spindle box using a mounting device.
- Use an assembly film.
5.3 Mounting/dismantling the rotor

5.3.1 Tools and resources

You require the following assembly tools and other resources:

- Occupational safety equipment
  - Face protection shield
  - Protective gloves
  - Closed protective clothing for protection against any oil leaks and high or low surface temperatures
- Fixture for checking the radial runout of the spindle shaft
- For the joining, you require the following assembly tools and resources depending on the deployed version:

<table>
<thead>
<tr>
<th>Joining with the hot process (shrink fit)</th>
<th>Joining with the cold process (stretch fit)</th>
<th>Cold-hot process</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hot-air oven with temperature monitoring - suitable for temperatures specified in the &quot;Mounting temperatures&quot; table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Oven volume appropriate for the rotor type, placement of the oven in the immediate vicinity of the workplace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Air-conditioned room or cold chamber for tempering the spindle shaft and rotor core</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dewar vessel with liquid nitrogen N2 (-195.8 °C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• For a small workspace: good ventilation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Hot-air oven with temperature monitoring - suitable for temperatures specified in the &quot;Mounting temperatures&quot; table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Oven volume appropriate for the rotor type, placement of the oven in the immediate vicinity of the workplace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cold chamber for tempering the spindle shaft and rotor core</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WARNING

Danger to life through the use of a different coolant for the cold process

Liquid oxygen or liquid air can cause explosions and death or severe injuries.

- Use only liquid nitrogen for the cold process.
5.3 Mounting/dismantling the rotor

- Hoisting gear, gripper, load suspension device (see "Examples for transporting components" figure)
  - Carrying capacity dependent upon the weight or the rotor core and/or spindle shaft, refer to the rating plate
  - Preferably with a device for quick lowering

![Figure 5-1 Transporting the rotor components (examples)](image)

1. Rotor with a smaller diameter with gloves
2. Rotor with a larger diameter with a gripper tool
3. Spindle shaft with lifting eyes and lifting lug

Figure 5-1 Transporting the rotor components (examples)
5.3 Mounting/dismantling the rotor

- Mounting device depending on the rotor mounting arrangement

  The rotor can be mounted in two ways:
  - Version A: The rotor is mounted on the spindle shaft.
  - Version B: The spindle shaft is inserted in the rotor.

![Figure 5-2 Arrangement for mounting the rotor](image)

  ① Rotor core  
  ② Spindle shaft  
  ③ Stable support with opening  
  ④ Mounting fixture (non-magnetic, resistant to heat and cold, thermally insulating)

- Suitable oil-pressure hand pump with manometer for relieving stress or dismantling the rotor with sleeve for "oil press fit" device version.

![Figure 5-3 Oil pressure hand pump](image)
Mechanical mounting

5.3 Mounting/dismantling the rotor

- Fixture for relieving stress and dismantling

1. Connection hydraulic hand pump
2. Connector nipple
3. Extension tube
4. Slotted nut (only for relieving stress)
5. Spacer sleeve (only for relieving stress)
6. Non-magnetic fixture (prism)
7. Non-magnetic tray

A Dimension for the axial relative movement for dismantling, 90 mm

Figure 5-4   Fixture for relieving stress and dismantling

- Accessories:
  - Connector with nipple (1, 2), e.g. type SKF 1077454
  - Extension tube (3), e.g. type SKF1077453
  - Non-magnetic fixture (prism, 6)
  - Slotted nut (4), spacing sleeve (5)
  - Non-magnetic tray (7) for catching oil, e.g. made from aluminum
  - Pressure oil for relieving stress, e.g. SKF LHMF 300 (viscosity 300 mm²/s at 20° C)
  - Pressure oil for dismantling, e.g. SKF LHDF 900 (viscosity 900 mm²/s at 20° C)

- Balancing machine for balancing the rotor (fine or complete balancing)
- Detergent, e.g. Loctite 7061 or Loctite 7063; bolt locking compound, e.g. Loctite 243
5.3.2 Preparation

Perform the following work before starting mounting:

1. Check that the components to be joined are correct and complete.

2. Clean the surfaces to be joined as a prerequisite for the separation and reuse of the components later. The surfaces to be joined must be free from contamination, rust, sharp edges, damage and machining marks.

3. Clean the oil connection holes in accordance with the following description.
   - Remove the grub screws from the connection holes.
   - Remove oil, grease or other contaminants from the grub screws and holes (e.g. with Loctite 7061 or 7063).

**Note**

Observe the manufacturer's instructions for the cleaning products used.
Ensure adequate ventilation for solvent-based products.

4. Measure and record the radial runout of the spindle to the reference plane, see measurement plane "R"

![Figure 5-5 Checking the radial runout](image)

- **Spindle shaft**
- **Position of the rotor core**
- **Oiled surface (mounting without stress relief)**
- **Reference plane for radial runout check**
- **Measured value (before and after mounting)**
- **Spindle shaft axis (reference axis)**

Figure 5-5 Checking the radial runout
5. If the stress of the rotor core is not relieved after mounting, rub dismantling oil in the joined surfaces e.g. SKF LHMF 300.

6. The rotor core and spindle shaft are mounted using thermal joining.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Damage to the permanent magnets of the rotor</strong></td>
</tr>
<tr>
<td>If the rotor temperature exceeds 150° C (140° C for APM rotors), the permanent magnets in the rotor will be demagnetized irreversibly.</td>
</tr>
<tr>
<td>• Ensure the rotor is not heated above 150° C (140° C for APM rotors) by checking the rotor temperature with a temperature-reactive dye or a temperature measuring device.</td>
</tr>
<tr>
<td>• Inductive heating of the rotor is not permissible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Danger of damage to the rotor banding caused by impermissible temperatures</strong></td>
</tr>
<tr>
<td>APM rotors have a banding (composite fiber) around the external diameter of the rotor that can be damaged by impermissible temperatures during mounting.</td>
</tr>
<tr>
<td>• Comply with the permissible temperatures during mounting.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Danger of bearing damage on the spindle shaft</strong></td>
</tr>
<tr>
<td>Low temperatures can damage the bearing of the spindle shaft.</td>
</tr>
<tr>
<td>• Use the cold process only when the bearing lubricant is certified for low temperatures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>A hot box or Dewar vessel must be kept in the immediate vicinity of the mounting location.</td>
</tr>
</tbody>
</table>

Three processes are deployed.

<table>
<thead>
<tr>
<th>Hot process (shrinkage)</th>
<th>Cold process (stretching)</th>
<th>Combined cold-hot process</th>
</tr>
</thead>
<tbody>
<tr>
<td>The tempered spindle shaft is inserted into the rotor core that has been heated up.</td>
<td>The rotor core is inserted over the spindle shaft that has been cooled down.</td>
<td>The heat rotor core is inserted over the spindle shaft that has been cooled down.</td>
</tr>
</tbody>
</table>
Temper the components in accordance with the mounting version at the following temperatures:

<table>
<thead>
<tr>
<th>Joining process</th>
<th>Rotor temperature</th>
<th>Spindle shaft temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot process (shrinkage) 1)</td>
<td>IPM rotors: 145° ... max. 150° C</td>
<td>10° ... 20° C</td>
</tr>
<tr>
<td></td>
<td>APM rotors: 135° ... max. 140° C</td>
<td></td>
</tr>
<tr>
<td>Cold process (stretching) 2)</td>
<td>20° ... 40° C</td>
<td>-160° ... -196° C</td>
</tr>
<tr>
<td>Cold-hot process</td>
<td>IPM rotors: 145° ... max. 150° C</td>
<td>-40° ... -30° C</td>
</tr>
<tr>
<td></td>
<td>APM rotors: 135° ... max. 140° C</td>
<td></td>
</tr>
</tbody>
</table>

1) For frame size < 1FE108□ do not use, use the cold-hot process or cold process.
2) After joining the rotor with the shaft, dry for 2 to 3 hours at approx. 60° C

5.3.3 Mounting the rotor

Mounting the rotor

⚠️ WARNING

Risk of injury caused by hot/cold surfaces

During mounting, the components are very hot or very cold and can cause burns or frost bite.
- Do not touch any components with unprotected hands.
- Wear heat-resistant gloves, safety goggles and closed work clothes.
5.3 Mounting/dismantling the rotor

Procedure
Select joining process A or B
Perform the following operations for mounting:

A Joining the rotor

B Joining the spindle shaft

1. Check that the resources function properly.

Note
Avoid positioning errors
- Perform the joining procedure without delay.
- Observe the position of the pressure oil connections for the rotor with sleeve.

2. Position the components, see the "Joining the rotor" figures.
3. Join without delay the rotor core or the spindle shaft at its final position.
4. Allow the joined parts to assume room temperature.
5. Measure the radial runout at the reference level and mark the position of largest deviation, see the "Checking the radial runout" figure.

You have mounted the rotor.
5.3.4 Compensating mechanical stresses and deformations of the spindle shaft

The thermal joint causes stresses (pressing) by the fit interference of the spindle shaft. These stresses can deform the spindle shaft.

Note
The following stress compensation is possible only for mounted rotors with sleeve.

After joining, a destressing of the spindle shaft with oil pressure for stress compensation or for reducing the spindle deformation is recommended.

⚠️ WARNING
Danger to life caused by oil under high pressure
The spurting of oil and/or mechanical damage at the hydraulic system can cause death or severe injuries.
- Use only intact devices and resources for destressing.
- Observe the prescribed pressures.

Forcing oil between the spindle shaft and the rotor core releases the step press fit. If the pressure is sufficient, the spindle shaft will slide off the rotor core.
- Prevent axial relative movements during the destressing (see "Mechanical stress compensation" figure).

Safety measures for the stress equalization
- Check the pump and accessories for functional safety.
- Operate the pump only with manometer.
- Do not make any changes to the device and its safety equipment.
- Observe the notes contained in the oil press pump operating instructions.
- Wear a face protective mask and closed work clothes.
- Vent the hydraulic system.
  - The oil pressure is built up manually.
- Do not exceed the maximum permissible oil pressure. See the following table.

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Maximum oil pressure $P_{\text{max}}$ [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1FE105□-6W</td>
<td>100</td>
</tr>
<tr>
<td>1FE106□-6W, 1FE108□-6W, 1FE109□-4W, 1FE109□-6W, 1FE111□-6W, 1FE114□-8W</td>
<td>80</td>
</tr>
<tr>
<td>1FE1 Rotor cores without rotor sleeves</td>
<td>No oil press fit</td>
</tr>
</tbody>
</table>
Note
Please consult your local Siemens office for special versions with rotor sleeve.

Oil that can be used for the stress equalization

| Viscosity | 300 mm²/s at 20° C | e.g. type SKF LHMF 300 |

Stress equalization

NOTICE
Danger to the environment caused by escaping oil
The forcing of oil can cause oil to escape and result in environmental damage.
- Catch any escaping oil.
- Bind the escaping oil with a suitable oil binding agent.
- Dispose of the oil and oil binding agent in accordance with the legal regulations.

Procedure
Perform the following operations for stress equalization and realignment:

1. Connection hydraulic hand pump
2. Connector nipple
3. Extension tube
4. Slotted nut
5. Spacing sleeve
6. Supporting fixture (prism)
7. Catchment tray
8. Manual oil pump

Figure 5-6  Compensating mechanical stresses
Mechanical mounting

5.3 Mounting/dismantling the rotor

1. Unscrew both grub screws from the rotor core sleeve.
2. Wrap the threaded shoulder on the extension tube and the second grub screw with Teflon sealing tape.
3. Screw the extension tube firmly into the sleeve of the rotor core.
4. Place the rotor core with spindle shaft, slotted nut and the spacing sleeve on the prism.
5. Attach the oil hand pump.
6. Vent the hydraulic system.
7. Screw the second grub screw with Teflon sealing tape tightly into the sleeve thread.
8. Force the oil with the hand pump slowly until the pressure of approx. 50 MPa (500 bar) is reached.
9. Allow the oil to act for approximately 15 minutes.
   → The oil penetrates the fitting gaps and distributes itself.
10. Increase the pressure to approx. 60 to 70 MPa (600 to 700 bar).
    → The unit floats.
    The rotor is prevented from sliding off by the slotted nut and the spacing sleeve.
11. Reduce the oil pressure at the pump.
12. Check the radial runout at the reference mark (see the "Checking the radial runout" figure).
13. If the required accuracy is not attained, repeat the pressure operation.
    → The rotor core and the shaft are rotated against each other.
14. Remove the extension pipe.
15. Place the "rotor - spindle shaft" system vertical.
    → Allow the oil to drip from the sleeve.
16. Store the unit for 24 hours.
    → Collect the escaping residual oil in the sump.

   The "rotor - spindle shaft" system is fully loadable again after 24 hours.
17. Degrease the threaded holes and grub screws with e.g. Loctite 7061.
18. To secure the grub screw, apply Loctite 243 or similar to the threaded hole.
19. Screw the grub screws into the threaded hole.
20. Mark on the face the position of the rotor to the spindle.

You have removed tensions in the rotor.
5.3.5 Balancing

In accordance with the requirements for smooth running, the rotor core with the spindle shaft must be implemented with the appropriate vibration severity level.

- Remove the protective film before balancing the rotor core.
- Balance the mounted rotor core as described below.

**Note**
The spindle manufacturer is responsible for performing and providing proof of the balancing procedure.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk of motor damage caused by remaining drilling chips</strong></td>
</tr>
<tr>
<td>Ferrite chips stick to the rotor core. During balancing by drilling the balancing disks, chips can damage the rotor core and pre-mounted bearing.</td>
</tr>
<tr>
<td>- Ensure an effective chip removal.</td>
</tr>
<tr>
<td>- Protect the bearing from contaminations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk of damage to the rotor core banding</strong></td>
</tr>
<tr>
<td>The protective film must be removed before balancing the rotor core. Careless handling of the rotor core can damage banding made of composite fiber.</td>
</tr>
<tr>
<td>- Handle the rotor core carefully.</td>
</tr>
<tr>
<td>- Prevent damage to the rotor core banding (composite fiber).</td>
</tr>
</tbody>
</table>

- After balancing the rotor, reattach a protective film to the rotor banding.

**Rotor core with sleeve**

Depending on the variant, the manufacturer delivers the rotor cores with sleeve either pre-balanced or not pre-balanced.

**Note**
The rotor core must not be modified.

- The pre-balanced rotor cores with sleeve in the delivered state conform with ISO 1940: G2.5 (reference speed 3600 rpm).
- After mounting, fine balancing of the “spindle shaft - rotor core” system may be necessary.
- The “spindle shaft - not pre-balanced rotor core” system must be balanced. To do this, use the balancing planes provided by the spindle manufacturer on the spindle axis provided for this purpose.
- Drilling holes on the balancing disks of the rotor core ① are permissible only for fine balancing.
- Observe the specifications from the following figure and table when balancing.

![Figure 5-7 Fine balancing a spindle shaft and rotor with sleeve](image)

<table>
<thead>
<tr>
<th>Motor type</th>
<th>a [mm]</th>
<th>t1 [mm]</th>
<th>w [mm]</th>
<th>t2 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1FE105□-6</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>1FE109□-6</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>1FE111□-6</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>
5.3 Mounting/dismantling the rotor

Rotor core without sleeve

- The rotor core is not pre-balanced by the manufacturer.
- The "spindle shaft - rotor core without sleeve" system must be balanced, e.g. with balancing disk. To do this, use the balancing planes provided by the spindle manufacturer on the spindle axis provided for this purpose.

![Diagram of rotor core without sleeve](image)

- Balancing disk (not included in scope of delivery)
- Rotor core
- Spindle shaft

Figure 5-8 Balancing a spindle shaft and rotor core without sleeve

5.3.6 Dismantling the rotor

Note

The rotor can be dismantled only for variants with sleeve.

The rotor core is dismantled from the spindle shaft using the oil pressing procedure, e.g. for a bearing change.

The oil pressing procedure causes a high level of mechanical stress in the components.

![WARNING]

Danger to life caused by oil under high pressure

The spurting of oil and/or mechanical damage at the hydraulic system can cause death or severe injuries.

- Use only intact devices and resources for destressing.
- Observe the prescribed pressures.

Forcing oil between the spindle shaft and the rotor core releases the step press fit. If the pressure is sufficient, the spindle shaft will slide off the rotor core.

The necessary section is specified by the construction of the stepped press fit. The section is specified by dimension A in the "Rotor core dismantling" table.

The non-magnetic fixture must permit movement of the rotor core.
Safety measures for dismantling

- Check the pump and accessories for functional safety.
- Operate the pump only with manometer.
- Do not make any changes to the device and its safety equipment.
- Observe the notes contained in the oil press pump operating instructions.
- Wear a face protective mask and closed work clothes.
- Vent the hydraulic system. The oil pressure is built up manually.
- Do not exceed the maximum permissable oil pressure See the following table.

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Maximum oil pressure $P_{\text{max}}$ [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1FE105□-6W</td>
<td>100</td>
</tr>
<tr>
<td>1FE106□-6W, 1FE108□-6W, 1FE109□-4W, 1FE109□-6W, 1FE111□-6W, 1FE114□-8W</td>
<td>80</td>
</tr>
</tbody>
</table>

Oil that can be used for dismantling

- Viscosity: $900 \text{ mm}^2/\text{s at } 20^\circ \text{ C}$
- e.g. type LHDF 900

Dismantling

**NOTICE**

Danger to the environment caused by escaping oil

The forcing of oil can cause oil to escape and result in environmental damage.
- Catch any escaping oil.
- Bind the escaping oil with a suitable oil binding agent.
- Dispose of the oil and oil binding agent in accordance with the legal regulations.
### Procedure

#### Table 5- 5  Dismantling the rotor core

<table>
<thead>
<tr>
<th>Position before loosening</th>
<th>Position after loosening</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Hydraulic hand pump connection</td>
<td>① A Movement dimension = 55 mm, for the 1FE114□-8 = 80 mm</td>
</tr>
<tr>
<td>② Connector nipple</td>
<td>⑤ Catchment tray</td>
</tr>
<tr>
<td>③ Extension tube</td>
<td>④ Supporting fixture (prism)</td>
</tr>
<tr>
<td>④ Supporting fixture (prism)</td>
<td>⑤ Catchment tray</td>
</tr>
<tr>
<td>⑤ Catchment tray</td>
<td>④ Supporting fixture (prism)</td>
</tr>
</tbody>
</table>

A’ Distance after loosening

1. Unscrew both grub screws from the rotor core sleeve.
2. Wrap the threaded shoulder on the extension tube and the second grub screw with Teflon sealing tape.
3. Screw the extension tube firmly into the sleeve of the rotor core.
4. Place the rotor core with spindle shaft, slotted nut and the spacing sleeve on the prism.
5. Attach the oil hand pump.
6. Vent the hydraulic system.
7. Screw the second grub screw with Teflon sealing tape tightly into the sleeve thread.
8. Force the oil with the hand pump slowly until the pressure of approx. 50 MPa (500 bar) is reached.
9. Allow the oil to act for approximately 15 minutes.
   → The oil penetrates the fitting gaps and distributes itself.
10. Increase the pressure to approx. 60 to 70 MPa (600 to 700 bar) until the oil escapes at both sides of the press fit. If the oil escapes only at one side, retain pressure by repumping.
→ The rotor core slides off the spindle of its own accord.

**Note**
A few oil drops can spurt out in the axial direction.
The rotor movement is limited by the prism.
If necessary, support the loosening of the rotor core by tapping lightly, for example, with a soft-faced hammer.
Consult your Siemens representative if dismantling is not successful.

11. Check the joint surfaces for scratches or marks in the longitudinal direction.

**Note**
Scratches or marks in the longitudinal direction inhibit the pressure build-up in subsequent dismantling operations and consequently the release of the joined components.

You have dismantled the rotor core.
5.4 Mounting the stator with the spindle housing

5.4.1 Production equipment, assembly tools and other resources

Ensure the ambient conditions from Chapter Mounting instructions (Page 55).

Provide the following production equipment, assembly tools and other resources:

1. Appropriate axial stops (examples)
2. Lifting accessories (examples)
3. Eyebolts
4. Spacing sleeves
5. Plastic-covered support arm for horizontal mounting (example)
6. Internal tensioning spindle (example)

- Occupational safety equipment:
  - Face protection shield
  - Protective gloves
  - Closed protective clothing for protection against high surface temperatures

- Hoisting gear with suitable load suspension device for the stator core
- Eyebolts or ring nuts and spacing sleeves
- Axial stop for cooling jacket/stator core without cooling jacket
- Internal tensioning spindle for the laminated stator core
- Plastic-covered support arm (for horizontal mounting)
- Anti-corrosion agent for steel surfaces
- Grease or talcum as lubricants for Viton O-ring seals

For the leak test with liquid:
- Water connection, maximum test pressure 0.7 MPa (7 bar).
Mechanical mounting

5.4 Mounting the stator with the spindle housing

For joining by heating the spindle housing (shrink fit):

- Hot-air oven with temperature monitoring
  - Oven volume appropriate for the stator type
  - Placement of the oven in the immediate vicinity of the workplace
- Device for cooling the heated-up cooling jacket.

5.4.2 Mounting preparation

Procedure

1. Check that the components are correct and complete.

2. Check the insulation resistance before mounting stators that have been stored for a longer period. See Chapter "Test the insulation resistance (Page 125)".

3. Clean the surfaces to be joined.

All surfaces must be free from contamination, rust, sharp edges, shrink holes, damage and machining marks, in particular:

- The ring slots for the O-ring seals
- The cooling thread on the cooling jacket (for the stator with cooling jacket variant)
- The spindle housing
- The cable duct in the spindle housing
- The drain holes
4. Apply a suitable anti-corrosion agent for steel to the stator and spindle housing surfaces that do not come into contact with the cooling fluid.

![Diagram showing stator core with cooling jacket, spindle housing, O-ring seal, surface coated with anti-corrosion agent, and drain hole.]

Figure 5-10 Applying anti-corrosion agent (the figure shows the fully mounted stator).

5. To improve sliding, rub the O-ring seals with an appropriate grease or talcum.

![Diagram showing the slots for the O-ring seals.]

2 The slots for the O-ring seals
6. Insert the O-ring seals in the slots.

7. Screw the eyebolts, if necessary with spacer sleeves, into the front face of the cooling jacket for the attachment of the hoisting gear.

You have made preparations for mounting.

5.4.3 Mounting the stator with cooling jacket

There are several variants for joining the stator with the spindle housing.

**Note**

The spindle manufacturer is responsible for selecting and executing the joining process.

**NOTICE**

**Damage to power and sensor cables**

The power and sensor cables can be damaged during mounting.

- Position the cables so they are not damaged during mounting.
- Avoid tensions on the cables.
- Do not crush the cables.

**Note**

The spindle housing seals the cooling thread of the cooling jacket from the exterior.
Examples for the vertical mounting of the spindle housing

Example A: Vertical mounting of the stator in the spindle housing

Use this joining procedure when the connection cables exit from the larger cooling jacket diameter.

Procedure

1. Place the spindle housing at the axial stop.
2. Remove the lifting lug and the eyebolts.
3. Check that the four O-ring seals are fitted correctly.
4. Fasten the eyebolts, possibly with spacer sleeves, to the cooling jacket.
5. Take the stator at the lifting lug.
6. Position the stator so that you can route the connection cables through the cable gland of the spindle housing or the bearing shield later.
7. Insert the stator from above into the spindle housing.

**Note**
- In necessary, push the stator by hand to the final position.
- When joining, ensure that the O-ring seals remain in the stator slots.

8. Remove the lifting lug and the spacer sleeves from the stator.

9. Push the connection cables through the cable gland of the spindle housing or the bearing shield in accordance with the project specifications.

10. Attach the bearing shield.

11. Bolt the bearing shield or mounting shield onto the cooling jacket. See Chapter "Mounting the motor spindle (Page 86)".

- First tighten all bolts with half the maximum tightening torque.
- Then tighten the bolts with a torque wrench diagonally to the maximum tightening torque. See "Tightening torques" table.

12. Use a liquid medium to check whether the spindle housing is sealed properly. Test pressure 0.7 MPa (7 bar).

- Turn the spindle housing so that the drain holes are facing downwards.

13. If the spindle housing leaks, dismantle the spindle housing.

- Replace the O-ring seals.
- Debur any sharp edges.

14. Remount the spindle housing.

You have mounted the spindle housing.
Example B: Vertical mounting of the spindle housing over the stator

Use this joining procedure when the connection cables exit from the smaller cooling jacket diameter.

Procedure

1. Check that the four O-ring seals are fitted correctly.
2. Position the stator on the axial stop.
3. Remove the internal tensioning spindle from the stator.
4. Position the spindle housing so that you can route the electrical cables through the cable gland of the spindle housing or the bearing shield later.
5. Place the spindle housing over stator from above.

Note
- If necessary, push the the spindle housing by hand to the final position.
- When joining, ensure that the O-ring seals remain in the stator slots.
6. Remove the lifting lug and the eyebolts from the spindle housing.
7. Push the connection cables through the cable gland of the spindle housing or the bearing shield in accordance with the project specifications.
8. Attach the bearing shield.
9. Bolt the bearing shield or mounting shield onto the cooling jacket. See Chapter "Mounting the motor spindle (Page 86)".
   - First tighten all bolts with half the maximum tightening torque.
   - Then tighten the bolts with a torque wrench diagonally to the maximum tightening torque. See "Tightening torques" table.
10. Use a liquid medium to check whether the spindle housing is sealed properly. Test pressure 0.7 MPa (7 bar).
   - Turn the spindle housing so that the drain holes are facing downwards.
11. If the spindle housing leaks, dismantle the spindle housing.
   - Replace the O-ring seals.
   - Debur any sharp edges.
12. Remount the spindle housing.

You have mounted the spindle housing.

Example for the horizontal mounting of the stator in the spindle housing

Procedure

Figure 5-13  Horizontal mounting of the stator in the spindle housing, steps 3, 4 and 7
1. Check that the four O-ring seals are fitted correctly.
2. Take the stator at the support arm.
3. Position the spindle housing so that you can route the electrical cables through the cable gland of the spindle housing or the bearing shield.
4. Insert the stator horizontally in the spindle housing. When inserting, ensure that the O-ring seals remain in the stator slots.
5. Thread the connection cables through the cable gland.
6. Attach the bearing shield.
7. Bolt the bearing shield or mounting shield onto the cooling jacket. See Chapter "Mounting the motor spindle (Page 86)".
   - First tighten all bolts with half the maximum tightening torque.
   - Then tighten the bolts with a torque wrench diagonally to the maximum tightening torque. See "Tightening torques" table.

Use a liquid medium to check whether the spindle housing is sealed properly. Test pressure 0.7 MPa (7 bar).
   - Turn the spindle housing so that the drain holes are facing downwards.
8. If the spindle housing leaks, dismantle the spindle housing.
   - Replace the O-ring seals.
   - Debur any sharp edges.
9. Remount the spindle housing.

You have mounted the spindle housing.

**Tightening torques**

Use bolts with at least property class 8.8 μ_\text{tol} = 0.14

<table>
<thead>
<tr>
<th>Diameter [mm]</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>6</td>
</tr>
<tr>
<td>M6</td>
<td>10</td>
</tr>
<tr>
<td>M8</td>
<td>25</td>
</tr>
</tbody>
</table>
5.4 Mounting the stator with the spindle housing

5.4.4 Mounting the stator without cooling jacket

The stator is connected with the spindle housing of the spindle manufacturer by warm shrinking.

There are several variants for joining the stator with the spindle housing.

---

**Note**

The spindle manufacturer is responsible for selecting and executing the joining process.

---

**Note**

Perform the joining procedure without delay.

---

**Example A: Mounting the stator in the spindle housing**

**Procedure**

1. Axial stop for stator
2. Spindle housing
3. Cable entry
4. Stator without cooling jacket
5. Connection cables
6. Internal tensioning spindle

Figure 5-14  Mounting the stator without cooling jacket in the spindle housing, steps 3, 6 and 7
1. Clean contaminants and chips from the subassemblies ② and ④.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of damage to the winding and insulation</td>
</tr>
<tr>
<td>Excessive temperatures can damage the winding and insulation.</td>
</tr>
<tr>
<td>• Ensure that the temperatures when joining spindle housings do not exceed 160° C.</td>
</tr>
</tbody>
</table>

2. Warm up the spindle housing.
3. Place the heated spindle housing on the mounting support.
4. Remove without delay the lifting lug and the eyebolts.
5. Take the stator without cooling jacket with the inner tensioning spindle.
6. Insert without delay the stator in the spindle housing using the internal tensioning spindle. Ensure the correct position of the connection cables at the cable gland in the spindle housing.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage to the power and signal cables caused by a hot spindle housing</td>
</tr>
<tr>
<td>The insulation can be damaged if the power and signal cables come into contact with the hot spindle housing.</td>
</tr>
<tr>
<td>• Avoid the cables making contact with the hot spindle housing.</td>
</tr>
</tbody>
</table>

**Note**
- If necessary, push the stator with the internal tensioning spindle by hand to the final position.
7. Remove the internal tensioning spindle plug.
8. Let the hot spindle housing cool down.
9. Push the connection cables through the cable gland of the spindle housing or the bearing shield in accordance with the project specifications.
10. Attach the bearing shield.
11. Bolt the bearing shield onto the spindle housing.
    - First tighten all bolts with half the maximum tightening torque.
    - Then tighten the bolts with a torque wrench diagonally to the maximum tightening torque. See "Tightening torques" table.

You have mounted the stator in the spindle housing.
Example B: Mounting the spindle housing over the stator

1. Clean contaminants and chips from the subassemblies ② and ④.

NOTICE

Risk of damage to the winding and insulation
Excessive temperatures can damage the winding and insulation.
• Ensure that the temperatures when joining spindle housings do not exceed 160° C.

2. Place the stator on the mounting support.
3. Remove the internal tensioning spindle from the stator.
4. Warm up the spindle housing.
5. Mount without delay the lifting lug and the eyebolts.
6. Take the heated spindle housing at the lifting lug.
7. Push without delay the spindle housing over the stator.
   Ensure the correct position of the connection cables at the cable gland in the spindle
   housing or bearing shield.

   **NOTICE**

   **Damage to the power and signal cables caused by a hot spindle housing**
   The insulation can be damaged if the power and signal cables come into contact with
   the hot spindle housing.
   - Avoid the cables making contact with the hot spindle housing.

   **Note**
   - If necessary, push the the spindle housing by hand to the final position.

8. Let the hot spindle housing cool down.

9. Push the connection cables through the cable gland of the spindle housing or the bearing
   shield in accordance with the project specifications.

10. Attach the bearing shield.

11. Bolt the bearing shield onto the spindle housing.
    - First tighten all bolts with half the maximum tightening torque.
    - Then tighten the bolts with a torque wrench diagonally to the maximum tightening
      torque. See "Tightening torques" table.

   You have mounted the spindle housing over the stator.

**Tightening torques**

Use bolts with at least property class 8.8 \( \mu_{\text{tot}} = 0.14 \)

<table>
<thead>
<tr>
<th>Diameter [mm]</th>
<th>Tightening torque [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>6</td>
</tr>
<tr>
<td>M6</td>
<td>10</td>
</tr>
<tr>
<td>M8</td>
<td>25</td>
</tr>
</tbody>
</table>
5.5 Mounting the motor spindle

5.5.1 Preparation

Stator core with spindle enclosure and spindle shaft with rotor core are mounted to form a complete motor spindle.

Production equipment and other resources required

- Hoisting gear with suitable load suspension device
- Eyebolts
- Centering assembly fixture
- Assembly film (only for APM rotors)
- Personnel protective equipment

5.5.2 Acting magnetic forces

The higher magnetic forces present as a result of the permanent magnets in the rotor can draw the spindle into the stator bore.

![Diagram showing attractive forces](image)

- **Spindle shaft with rotor core**
- **Stator core with spindle housing**
- **$F_a$** Axial attractive force
- **$F_r$** Radial attractive force

The magnitude of the present magnetic forces is motor-specific.
The present magnetic forces are contained in the table in Chapter "Magnetic forces that occur (Page 30)".

**Note**

The specified radial forces are the maximum values that occur if the rotor comes into contact with the stator at one side. For an ideally centric rotor (no eccentricity), the resulting radial force is zero.

The radial force between a centric rotor and the rotor in contact with the stator can be linearly converted (calculated air gap, 0.5 mm) depending on the eccentricity.

Depending upon the relative position and the weight of the rotor core, an additional axial mounting force of about 300 N is required.

### 5.5.3 Mounting the motor spindle with IPM rotor

**Procedure**

1. Clean contaminants and chips from the subassemblies ①②.

2. Lower the spindle shaft with the rotor core onto the stator core.
3. Bolt on the bearing shield as specified in Chapter Mounting the stator with cooling jacket (Page 76). This may necessitate overcoming the radial force $F_r$.

![Diagram of complete motor spindle](image)

1. Encoder (separate mounting instructions)
2. Housing bolts
3. Stator core with cooling jacket
4. Rotor core
5. Free cable ends
6. Flexible tube
7. Bearing shield NDE
8. Drain hole
9. Coolant connection
10. Spindle housing
11. Spindle shaft with bearings
12. Bearing shield DE

Figure 5-18 Complete_motor_spindle

4. Complete the motor spindle in accordance with the project.

5. Fasten the rating plate, supplied as a loose item, securely to the spindle box in a clearly visible position.

You have mounted the motor spindle.

### 5.5.4 Mounting the motor spindle with APM rotor

**NOTICE**

**Danger of damage to the rotor banding**

The banding (composite composite fiber) must not be damaged and must not come into contact with the stator bore.

- Remove the protective film only immediately before mounting.
- Use an assembly film.
- Always use a centering assembly fixture for mounting.
Procedure

Carry out the mounting according to the following sequence:

1. Clean contaminants and chips from the subassemblies ①②.
2. Remove carefully the protective film from the rotor (in the scope of delivery for some variants).

3. Place the required assembly film in the stator bore.

Figure 5-19  Mounting the motor spindle

1 Spindle shaft with rotor core
2 Stator core with spindle housing
3 Centering assembly fixture for stator core
4 Centering assembly fixture for rotor core
5 Stable support
6 Assembly film
7 Bolts for attaching the bearing shield
4. Using the hoisting gear, ease the spindle shaft with rotor core ① slowly and carefully into the stator core ②.

**Note**
Depending upon the relative position and the weight of the rotor core, an additional axial mounting force of about 300 N is required.

5. Bolt on the bearing shield.

6. Rotate the premounted motor spindle through 180°.
7. Remove the assembly film.

8. Complete the motor spindle in accordance with the project.

9. Fasten the rating plate, supplied as a loose item, securely to the spindle box in a clearly visible position.

You have mounted the motor spindle.
5.6 Installation

5.6.1 Placement of the motor spindle

**NOTICE**

**Danger of component destruction caused by contact with hot surfaces**

If temperature-sensitive components and cables come into contact with hot motor surfaces, they can be damaged or destroyed.

- Install temperature-sensitive components and cables so they cannot come into contact with the hot motor surface.

- Observe the project specifications of the spindle manufacturer.
- Observe the technical data on the motor housing rating plate or the details contained in the machine documentation of the spindle manufacturer.
- Check whether the rating plate details match the conditions pertaining at the installation location.
- Observe the permitted maximum radial and axial vibration values.
- Ensure that the motor spindle mounting (e.g. foot-flange or mounting foot) has even contact with the mounting surface. Stresses of the motor spindle are not permitted.
- Turn the output elements by hand. If a grinding noise occurs, rectify the cause or contact the manufacturer.

**Emissions**

The motors are certified for a wide range of mounting and operating conditions.

The installation and operating conditions can affect the motor noise.

5.6.2 Permissible motor vibrations

The following effects can increase motor vibration values:

- The on-site system vibration characteristics depend on factors such as the output elements, mounting conditions, alignment and installation.
- Effects of external vibration

Ensure that the vibration values conform to project specifications and the following tables are not exceeded at the specified measuring points on the motor.

Observe the notes for measuring points, measurement and evaluation according to ISO 10816.
If necessary, balance the rotor with the drive system completely.

Table 5-6  Maximum permitted radial vibration values

<table>
<thead>
<tr>
<th>Vibration frequency</th>
<th>Vibration values</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 6.3 Hz</td>
<td>Vibration displacement s ≤ 0.16 mm</td>
</tr>
<tr>
<td>6.3 - 250 Hz</td>
<td>Vibration velocity v_{rms} ≤ 4.5 mm/s</td>
</tr>
<tr>
<td>&gt; 250 Hz</td>
<td>Vibration acceleration a ≤ 10 m/s²</td>
</tr>
</tbody>
</table>

Table 5-7  Maximum permitted axial vibration values

<table>
<thead>
<tr>
<th>Vibration velocity</th>
<th>Vibration acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>v_{rms} = 4.5 mm/s</td>
<td>a_{peak} = 2.25 m/s²</td>
</tr>
</tbody>
</table>

Figure 5-21  Maximum permissible vibration velocity taking into account the vibration displacement and vibration acceleration

Measure the vibration velocity using appropriate measuring equipment.
The vibration acceleration is evaluated as a peak value in the frequency band 10 to 2000 Hz.

**Note**

If vibration excitations in excess of 2000 Hz (e.g. gear teeth meshing frequencies) can be expected, the measurement range must be adapted accordingly.
The permitted maximum values remain unchanged.
6 Connecting

6.1 Connecting the cooling

6.1.1 Warning of the consequences of unqualified work

**WARNING**
Defective work on the cooling circuit
Defective work on the cooling circuit can cause injury and/or damage to property.
- Only qualified personnel may assemble, install, and commission the cooling circuit.
- Perform installation or service work on the cooling circuit only when the system is de-energized.

6.1.2 Safety instructions

**WARNING**
Danger to life caused by an electric shock
Electrical conducting parts of the machine that touch parts of the cooling system can cause death or injuries.
- Prepare for shutdown and notify all those who will be affected by the procedure.
- Before performing any work on the cooling system, de-energize the motor and the auxiliary circuits.
- Check that the cabinet is de-energized.
- Take measures to prevent reconnection of the energy sources.
### 6.1 Connecting the cooling

#### WARNING

**Danger to life caused by short-circuit to a frame in a fault situation**

The spindle housing must be electrically connected to the cooling jacket.

In a fault situation, lethal voltage can be present at the spindle housing that causes death or severe injuries because of an electric shock.

- Ground the complete motor spindle in accordance with the regulations.

#### WARNING

**Danger to life caused by rotation of the assembled spindle shaft**

The rotating of an assembled built-in motor produces induction that causes lethal voltages at the cable ends of the motor.

The voltages can cause death or severe injuries because of an electric shock.

- Do not touch any bare cable ends.
- Prevent assembled built-in motors from turning.
- Insulate the terminals and cores of bare cable ends.

#### WARNING

**Danger to life caused by high leakage currents**

High leakage currents can cause death or injuries as result of an electric shock.

- Satisfy the requirements placed on protective conductors in accordance with EN 61800-5-1.

#### WARNING

**Danger to life caused by high residual voltages**

When the power supply voltage is switched-off, active components of the motor can have an electrical charge of more than 60 μC.

The residual voltages that occur at the connections of the built-in motor several seconds after power-down can cause death or severe injuries as result of an electric shock.

- Do not touch any bare connections.
- Protect bare connections and active components against inadvertent contact.
- Ground the motor properly.
6.1 Connecting the cooling

**WARNING**

**Danger to life when the cooling system bursts**

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

- Never operate the motor without cooling.
- Only commission the cooling water circuit when the motor is in a cool condition.

**CAUTION**

**Danger of burns a result of touching hot surfaces**

In operation, the motor housing can reach high temperatures, which can cause burns if touched.

- Do not touch any hot surfaces.
- Allow the motor to cool down before starting any work.
- Use the appropriate personnel protection equipment, e.g. gloves.

**NOTICE**

**Material damage due to the effect of electrochemical series**

When using different conductive materials, material damage can occur as a result of the electrochemical series.

- Do not use any zinc in the cooling circuit.
- Use brass, stainless steel or plastic for pipes and fittings.

**NOTICE**

**Motor damage due to lack of cooling**

If you operate the motor without water cooling, the motor will be damaged or destroyed.

- Only operate the motor with a closed cooling water loop with heat exchange equipment.
6.1.3 Connecting the water cooling

**Note**
Lay the cooling water supply intake and drain outlet connections according to project requirements.

**Preconditions**
- Ensure that the cooling water complies with the required cooling water specification. See Chapter “Cooling (Page 36)”.
- Ensure that cooling water with the required flow volume is available. See rating plate (type plate).

**Procedure**

1. Connect the cooling water pipes for intake and drainage according to project requirements.
   - Drain holes
   - Connections for the cooling water pipes

2. Set for the inlet a maximum permitted operating pressure of 0.7 MPa.

**NOTICE**
**Risk of motor damage by voltage discharges resulting from condensation**
If the stator winding is damp, its insulation resistance decreases. This can cause voltage discharges that damage the windings.
- Keep the drain holes free so that condensation can escape freely.

**NOTICE**
**Risk of motor damage by corrosion resulting from condensation**
Condensation that does not escape can cause corrosion and motor damage.
- Keep the drain holes free so that condensation can escape freely.
3. Check that the drain holes are free so that condensation can escape freely.

4. Check the water cooling for leaks.

You have connected the water cooling.

6.1.4 Connecting the air cooling

Air-cooled motors are special versions. Connection is in accordance with the spindle manufacturer's project requirements.
6.2 Electrical connection

6.2.1 Safety information

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor destruction caused by incorrect connection</strong></td>
</tr>
<tr>
<td>The direct connection to the three-phase line supply damages the motor.</td>
</tr>
<tr>
<td>• Connect the motor only at the configured converters.</td>
</tr>
<tr>
<td>• Observe the correct phase sequence.</td>
</tr>
</tbody>
</table>

6.2.2 High-voltage test

<table>
<thead>
<tr>
<th>DANGER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lethal voltage hazards</strong></td>
</tr>
<tr>
<td>A dangerous voltage is present at the motor during a high-voltage test. Death or serious injury can result when live parts are touched.</td>
</tr>
<tr>
<td>• Do not touch any live parts.</td>
</tr>
<tr>
<td>• Adhere to the fundamental safety instructions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Destruction of electronic components and damage to the insulation</strong></td>
</tr>
<tr>
<td>A high-voltage test on the motor can damage the insulation of the motor and destroy electronic components, e.g. temperature sensors.</td>
</tr>
<tr>
<td>• Use maximum 80% of the test voltage in accordance with EN 60034-1.</td>
</tr>
<tr>
<td>• Prior to the test, short-circuit the cable ends of the temperature sensors.</td>
</tr>
</tbody>
</table>

Before being shipped, the stators of the built-in motors are subject to a high-voltage test in compliance with EN 60034-1. However, the Standards Commission recommends that when electrical components (such as built-in motors) are installed, a new high-voltage test according to EN 60034-1 should be performed after the final assembly has been completed.
6.2.3 Electrical equipment

The following equipment is provided by the spindle manufacturer:

- Terminal box or connectors, variant with at least IP54 according to EN 60034
- Flexible tube
- Ground cable with cable lug

6.2.4 Connection cables

In the standard version, the stator core has the following connection cables:

- Power connection marked U1, V1, W1
- Two cables for the temperature sensor (one reserve), two-wire with color coding, each cable cross-section 0.22 mm².

Note

Electrical connection via terminal box or power connector

The power cables of the motor are not suitable as direct electrical interface of the spindle. The electrical connection of the spindle must be made via the terminal box or power connector.

- Feed out the free cable ends from the spindle box in a suitable protective tubing with cable gland to a terminal box provided by the customer.
- Ensure effective strain relief. Maintain the required minimum bending radii (3 to 4 x the outer cable diameter).
- To connect the motor to a converter, use MOTION-CONNECT cables or shielded connecting cables from the spindle box interface.

Note

The maximum length of the connecting cable is 50 m with and without VPM.

- Due to the high voltages, use cables for higher mechanical requirements in combination with a connection socket and VPM.
The spindle manufacturer installs the following cable connections:

1. Power connection
2. Internal protective ground cable (protection from dangerous shock currents)
3. Connection for the temperature sensors
   Two types of temperature sensors can be installed.

<table>
<thead>
<tr>
<th>KTY 84</th>
<th>Pt1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD component</td>
<td>No ESD component</td>
</tr>
<tr>
<td>Ensure proper polarity</td>
<td>No polarity: 2 yellow connection cables</td>
</tr>
<tr>
<td>+  = brown connection cable</td>
<td></td>
</tr>
<tr>
<td>-  = white connection cable</td>
<td></td>
</tr>
</tbody>
</table>

Example circuits for additional temperature evaluations are contained in the following chapters:

Temperature evaluation using the PTC thermistor triplet (full motor protection, option)  
(Page 114)

Connect the temperature sensor to the flanged connection socket of the encoder.

4. Encoder connection

**Example for connecting with terminal box**

![Terminal box diagram](image)

1. Power connection U, V, W
2. Internal protective conductor
3. Connection for internal and external protective conductors
4. Connection for temperature sensors. The color coding depends on the installed temperature sensor, see table above.

Figure 6-1  Terminal box (example)
## 6.2 Electrical connection

### 6.2.5 Cable cross-sections and outer diameter of the connecting cables

<table>
<thead>
<tr>
<th>Motor type</th>
<th>$L = 0.5 \text{ m} \phantom{1}^1$</th>
<th>$L = 1.5 \text{ m} \phantom{1}^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cable cross-section per phase [mm$^2$]</td>
<td>Cable outer diameter [mm]</td>
</tr>
<tr>
<td></td>
<td><img src="" alt="Image" /></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td>6-pole built-in motors</td>
<td><img src="" alt="Image" /></td>
<td><img src="" alt="Image" /></td>
</tr>
<tr>
<td>1FE1041-6WM□□</td>
<td>2.5$^3$</td>
<td>4.4$^3$</td>
</tr>
<tr>
<td>1FE1041-6WU□□</td>
<td>2.5$^3$</td>
<td>4.4$^3$</td>
</tr>
<tr>
<td>1FE1042-6WN□□</td>
<td>2.5$^3$</td>
<td>4.4$^3$</td>
</tr>
<tr>
<td>1FE1042-6WR□□</td>
<td>2.5$^3$</td>
<td>4.4$^3$</td>
</tr>
<tr>
<td>1FE1042-6WT□□</td>
<td>2.5$^3$</td>
<td>4.4$^3$</td>
</tr>
<tr>
<td>1FE1051-6WK□□</td>
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<tr>
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<td>4.4</td>
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<td>1FE1052-6WK□□</td>
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<td>5.5</td>
</tr>
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<td>6.3</td>
</tr>
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<td>4.4</td>
</tr>
</tbody>
</table>
### Connecting

#### 6.2 Electrical connection

<table>
<thead>
<tr>
<th>Motor type</th>
<th>L = 0.5 m</th>
<th>L = 1.5 m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cable cross-section per phase [mm²]</td>
<td>Cable outer diameter [mm]</td>
</tr>
<tr>
<td>1FE1113-6WU□□</td>
<td>6.0</td>
<td>6.3</td>
</tr>
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<tr>
<td>1FE1114-6WR□□</td>
<td>16.0</td>
<td>9.0</td>
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<tr>
<td>1FE1114-6WT□□</td>
<td>10.0</td>
<td>7.9</td>
</tr>
<tr>
<td>1FE1114-6WW□□</td>
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<tr>
<td>1FE1116-6WY□□</td>
<td>4.0</td>
<td>5.5</td>
</tr>
</tbody>
</table>

1) According to EN 46200 can only be used in the motor spindle
2) Notes on using cables is provided in VDE 0298, Part 3 and Part 4
3) Teflon cable

<table>
<thead>
<tr>
<th>Motor type</th>
<th>L = 0.5 m</th>
<th>L = 1.5 m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cable cross-section per phase [mm²]</td>
<td>Cable outer diameter [mm]</td>
</tr>
<tr>
<td>8-pole built-in motors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1FE1143-8WM□1</td>
<td>25.0</td>
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</tr>
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<td>10.0</td>
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<td>25.0</td>
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<td>7.9</td>
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<tr>
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<td>10.0</td>
<td>7.9</td>
</tr>
<tr>
<td>1FE1145-8WQ□1</td>
<td>2 * 16</td>
<td>2 * 9</td>
</tr>
<tr>
<td>1FE1145-8WQ□1</td>
<td>2 * 10</td>
<td>2 * 7.9</td>
</tr>
<tr>
<td>1FE1145-8WS□1</td>
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<td>11.0</td>
</tr>
<tr>
<td>1FE1147-8WM□1</td>
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<td>2 * 9</td>
</tr>
<tr>
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<td>2 * 9</td>
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<tr>
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<td>2 * 10</td>
<td>2 * 7.9</td>
</tr>
<tr>
<td>1FE1147-8WS□1</td>
<td>25.0</td>
<td>11.0</td>
</tr>
</tbody>
</table>

1) According to EN 46200 can only be used in the motor spindle
2) Notes on using cables is provided in VDE 0298, Part 3 and Part 4
### 6.2 Electrical connection

#### 4-pole built-in motors

<table>
<thead>
<tr>
<th>Motor type</th>
<th>L = 0.5 m</th>
<th>L = 1.5 m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[mm²]</td>
<td>[mm]</td>
</tr>
<tr>
<td></td>
<td>2-pole</td>
<td>4-pole</td>
</tr>
<tr>
<td></td>
<td>built-in</td>
<td>built-in</td>
</tr>
</tbody>
</table>

1FE1 synchronous built-in motors

Hardware Installation Manual, 12/2016, 610.43000.40b
### 6.2 Electrical connection

<table>
<thead>
<tr>
<th>Motor type</th>
<th>L = 0.5 m ¹</th>
<th>L = 1.5 m ²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cable cross-section per phase [mm²]</td>
<td>Cable outer diameter [mm]</td>
</tr>
<tr>
<td>1FE1092-4W□1</td>
<td>2.5</td>
<td>4.4</td>
</tr>
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<td>1FE1093-4W□1</td>
<td>10.0</td>
<td>7.9</td>
</tr>
<tr>
<td>1FE1093-4W□1</td>
<td>6.0</td>
<td>6.3</td>
</tr>
<tr>
<td>1FE1094-4W□1</td>
<td>6.0</td>
<td>6.3</td>
</tr>
<tr>
<td>1FE1094-4W□1</td>
<td>16.0</td>
<td>9.0</td>
</tr>
<tr>
<td>1FE1094-4W□1</td>
<td>10.0</td>
<td>7.9</td>
</tr>
<tr>
<td>1FE1094-4W□1</td>
<td>6.0</td>
<td>6.3</td>
</tr>
<tr>
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<td>4.0</td>
<td>5.5</td>
</tr>
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<td>1FE1095-4W□1</td>
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<td>9.0</td>
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<td>1FE1096-4W□1</td>
<td>16.0</td>
<td>9.0</td>
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<td>7.9</td>
</tr>
<tr>
<td>1FE1103-4W□1</td>
<td>10.0</td>
<td>7.9</td>
</tr>
<tr>
<td>1FE1103-4W□1</td>
<td>6.0</td>
<td>6.3</td>
</tr>
<tr>
<td>1FE1104-4W□1</td>
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<td>9.0</td>
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<td>9.0</td>
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<tr>
<td>1FE1105-4W□1</td>
<td>10.0</td>
<td>7.9</td>
</tr>
<tr>
<td>1FE1106-4W□1</td>
<td>16.0</td>
<td>9.0</td>
</tr>
<tr>
<td>1FE1106-4W□1</td>
<td>16.0</td>
<td>9.0</td>
</tr>
<tr>
<td>1FE1106-4W□1</td>
<td>16.0</td>
<td>9.0</td>
</tr>
<tr>
<td>1FE1106-4W□1</td>
<td>10.0</td>
<td>7.9</td>
</tr>
<tr>
<td>1FE1106-4W□1</td>
<td>6.0</td>
<td>6.3</td>
</tr>
<tr>
<td>1FE1124-4W□1</td>
<td>25.0</td>
<td>11.0</td>
</tr>
<tr>
<td>1FE1125-4W□1</td>
<td>25.0</td>
<td>11.0</td>
</tr>
<tr>
<td>1FE1125-4W□1</td>
<td>25.0</td>
<td>11.0</td>
</tr>
<tr>
<td>1FE1125-4W□1</td>
<td>16.0</td>
<td>9.0</td>
</tr>
<tr>
<td>1FE1126-4W□1</td>
<td>2 * 16</td>
<td>2 * 9</td>
</tr>
<tr>
<td>1FE1126-4W□1</td>
<td>2 * 16</td>
<td>2 * 9</td>
</tr>
<tr>
<td>1FE1126-4W□1</td>
<td>25.0</td>
<td>11.0</td>
</tr>
</tbody>
</table>

1) According to EN 46200, can be used only within the motor spindle. 

2) Notes on using cables is provided in VDE 0298, Part 3 and Part 4

3) Teflon cable
6.2.6 Information on cable routing

Cable selection

- Select the connecting cables appropriate for the rated dynamic currents and the plant-specific conditions, e.g. ambient temperature, routing type.

Note

As a result of the converter operation, high-frequency current and voltage oscillations in the motor feeder cables can cause electromagnetic interference.

Only use shielded power and signal cables.

- Use shielded cables whose shields have a large-area conductive connection with the terminal box of the motor via EMC cable glands.

- Use prefabricated cables from Siemens. These cables reduce the installation time and costs and increase operational reliability.

- Use EMC cable glands for permanently installed entry fittings.

Information on cable routing

- Lay loose connection cables so that the insulation is not damaged.

- Make sure that the minimum bending radii are not exceeded. Minimum radius for fixed installation: \( R = 4 \times D \) 
  \((D = \text{outer cable diameter})\).

- Only remove insulation from the cable ends so that the insulation reaches up to the cable lug, terminal, or wire end ferrule.

- Use cable lugs or wire end ferrules appropriate for the dimensions of the terminal board connections and the cable cross-section. If necessary, install parallel connection cables.

- Ensure that the inside of the terminal box or connector is clean and free of cable cuttings and moisture.

- Tighten all of the screws for the electrical connections (terminal board connections, with the exception of the terminal strips) to the torque specified by the spindle manufacturer.

- Observe the minimum air clearances for the connection and for the laying of internal connection cables.

<table>
<thead>
<tr>
<th>Supply voltage [V]</th>
<th>Minimum air clearance [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 500</td>
<td>4.5</td>
</tr>
<tr>
<td>500 - 600</td>
<td>6</td>
</tr>
</tbody>
</table>

- Avoid protruding cable ends.

- Close the terminal boxes and cable entries in accordance with the configured degree of protection.

- Ensure that connecting cables cannot rotate, are not subject to strain and pushing force, and also provide anti-kink protection.

- Plug in or remove the connector only when the system is de-energized.
6.2.7 Connecting to a converter

To connect the motor to a converter, use MOTION-CONNECT cables or shielded connecting cables.

The braided shielding must have good electrical conductivity. Prefer braided shielding made of copper or aluminum.

The shield must be connected at both ends to the motor and the converter; unshielded cable ends must be kept as short as possible.

Attach the shielding with a large area as 360° contact to the converter and to the motor. Use for instance, EMC glands at the cable entries.

6.2.8 Connection overview

The circuit diagram contains information about wiring and connecting the motor winding.

Figure 6-2 Circuit diagram with SIMODRIVE (example)

1  Ground connection
2  Temperature sensor (1 x reserve)
3  Encoders
4  VP module (if required)
6.2 Electrical connection

1. Power cable
2. Signal line, trailable or only conditionally trailable
3. Signal connector, 17 pole, external thread, MLFB 6FX2003-1CF17
   Optional assembly flange for retrofitting MLFB 6FX2003-7DX00
4. DRIVE-CLiQ cable 6FX2002-2DC10_xxx, trailable or only conditionally trailable
5. SME120, encoder, motor side, connector kits 6FX2003-0SA12, 12-pin
6. Encoder
7. Temperature sensor (+1 reserve)
8. Ground connection
9. Voltage limiting (VPM, IVP), only if EMF > 820 V

Figure 6-3 Circuit diagram with SINAMICS (example)

---

**Note**

Connect a rotary encoder according to the project requirements.

---

6.2.9 Grounding

Ground the 1FE1 according to the project requirements.
6.2.10 Connecting the temperature sensors

---

**NOTICE**

**Risk of damage to temperature-sensitive components**

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

- Ensure that no temperature-sensitive components are in contact with hot surfaces.

---

**Connecting the KTY**

---

**NOTICE**

**Risk of destroying temperature sensors when the ESD notes are ignored**

Temperature sensors KTY 84 are ESD components. When delivered, they are short-circuited with a terminal.

- Observe the ESD notes.
- Remove the terminal only when the temperature sensor is connected.

**NOTICE**

**Risk of destroying the KTY 84 temperature sensor because of incorrect polarity**

Incorrect polarity destroys the KTY 84 temperature sensor.

- Connect the KTY 84 with the correct polarity.

---

Connect the KTY 84 as follows:

- Brown cable: positive polarity (temperature)
- White cable: negative polarity (temperature)
Figure 6-4  KTY temperature monitoring with PTC thermistor triplet (example)
Connecting the Pt1000
Pt1000 temperature sensors are not ESD components.
Connect the Pt1000 temperature sensor independent of the polarity with two-wire yellow cables.

Thermistor protective relay for motor

Synchronous built-in motor

1FE1

W1

1TP1

PTC

1TP2

U1

1R1

yellow

Pt1000

1R2

yellow

V1

- Temp

X411

+ Temp

SIMODRIVE 611 digital
SIMODRIVE 611 universal
SINAMICS S120

Figure 6-5  Pt1000 temperature monitoring with PTC thermistor triplet (example)

Circuit diagrams

Note
SMC20
For additional information on connecting and operating the SMC20, refer to the documentation in the SINAMICS Function Manual 1 and List Manual 1.

Note
Before the motor is commissioned, carefully check that the shutdown circuit via the PLC (programmable logic controller) functions correctly.
6.2.11 Temperature evaluation using NTC thermistors (universal protection, option)

**Note**

Temperature evaluation using the NTC K227 and NTC PT3-51F thermistors does not guarantee full motor protection.

The K227 and PT3-51F NTC thermistors are used if the drive system cannot evaluate the KTY 84 or Pt1000 PTC thermistor.

The NTC thermistors are provided for operating the motor on third-party systems.

The NTC thermistor should be connected in accordance with the configuration and operating instructions of the third-party system.

The drive system senses and evaluates the motor temperature using the sensor signal (refer to the drive system documentation).

Table 6-1 Technical data, NTC K227 and NTC PT3-51

<table>
<thead>
<tr>
<th>Designation</th>
<th>Technical data</th>
<th>NTC K227</th>
<th>NTC PT3-51F</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTC thermistor resistance (25°C)</td>
<td></td>
<td>Approx. 32.8 kΩ</td>
<td>Approx. 49.1 kΩ</td>
</tr>
<tr>
<td>Resistance when hot (100°C)</td>
<td></td>
<td>Approx. 1800 Ω</td>
<td>Approx. 3300 Ω</td>
</tr>
<tr>
<td>Cable cross-section</td>
<td></td>
<td>0.14 mm²</td>
<td>0.14 mm²</td>
</tr>
<tr>
<td>Outer diameter</td>
<td></td>
<td>0.8 mm</td>
<td>0.8 mm</td>
</tr>
</tbody>
</table>

Temperature characteristic

[Graphs showing temperature characteristics for NTC K227/33k/A1 and NTC PT3-51F]
6.2.12 Temperature evaluation using the PTC thermistor triplet (full motor protection, option)

For special applications (e.g. when a load is applied with the motor stationary or for extremely low speeds), the temperature of all of the three motor phases must be additionally monitored using a PTC thermistor triplet.

**Note**

If water-cooled synchronous built-in motors are operated for longer than one minute in standstill with the standstill torque, a phase can be thermally loaded overproportionately.

- Reduce the permanent standstill torque to 20%.
- Protect the winding thermally with a thermistor triplet (PTC) with an external trip unit or with an I²t monitoring of the drive system.

The PTC thermistor triplet must be evaluated using an external tripping/evaluation unit (this is not included in the scope of delivery). This means that the sensor cable is monitored for wire breakage and short-circuit by this unit.

The motor must be de-energized within 1 second when the response temperature is exceeded.

### Table 6- 2 Technical data for the PTC thermistor triplet

<table>
<thead>
<tr>
<th>Designation</th>
<th>Technical data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (acc. to DIN 44082–M180)</td>
<td>PTC thermistor triplet</td>
</tr>
<tr>
<td>Thermistor resistance (20°C)</td>
<td>≤ 750 Ω</td>
</tr>
<tr>
<td>Resistance when hot (180°C)</td>
<td>≥ 1710 Ω</td>
</tr>
<tr>
<td>Connection</td>
<td>Via an external trip unit</td>
</tr>
<tr>
<td>Cable cross-section/outer diameter</td>
<td>0.14 mm²/0.9 mm</td>
</tr>
<tr>
<td>Response temperature</td>
<td>180° C</td>
</tr>
</tbody>
</table>

**Note:** PTC thermistors do not have a linear characteristic curve and are, therefore, not suitable for determining the instantaneous temperature.
6.2 Electrical connection

6.2.13 Voltage limitation

Note

EMF (Electro Motive Force) > 820 V

In a fault situation, a voltage limitation of the DC-link voltage on the converter is required. The voltage limitation depends on the maximum EMF (induced chained voltage peak > 820 V).

A voltage limitation is required when the motor is operated with speed \( n > n_{\text{max inv}} \).

If the line voltage fails at maximum motor speed or if the drive converter pulses are canceled as a result of the power failure, the synchronous motor regenerates a high voltage back into the DC link. The voltage protection detects a DC-link voltage that is too high (> 820 VDC) and short-circuits the three motor supply cables. The energy remaining in the motor is converted into heat as a result of the short-circuit and causes the motor to quickly brake.

The VPM (Voltage Protection Module) is deployed as voltage limiter for SINAMICS S120.

Operation without voltage limiting

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danger of motor damage caused by exceeding the maximum speed</td>
</tr>
</tbody>
</table>

If a motor with EMF > 820 V is operated without voltage limitation, the maximum permitted speed must be reduced.

- Never operate the motor without voltage limitation.
- Do not exceed the maximum permissible speed.

Calculate the maximum permissible speed for operation without voltage limitation with the following equation:

\[
\begin{align*}
n_{\text{max, new}} \text{ [rpm]} &= \frac{820 \text{ [V]} \cdot 1000}{k_{E} \text{ [V/1000 rpm]} \cdot \sqrt{2}}
\end{align*}
\]

\( k_{E} \) = voltage constant, see Chapter "Technical data and characteristic curves" in the Configuration Manual.

Voltage limitation with the Voltage Protection Module (VPM)

The Voltage Protection Module (VPM) is not included with the 1FE1 built-in motors.

- The VPM ordering information is contained in Catalog NC 62.
### WARNING

**Danger to life caused by the incorrect use of the VPM**

The VPM can be used up to a maximum motor EMF of 2 kV. The use of motors with higher EMC can cause death or severe injury.

- Deploy the VPM only for motors with an EMF greater than 800 V to maximum 2 kV.
- The connection of motors with an EMF > 2 kV on the VPM is prohibited.

## Integration and system prerequisites of the VPM

**Integration**

The VPM is located between the motor and the drive system. The maximum distance to the drive system is 1.5 m.

**Note**

No switching elements may be added to the U, V, W connection cables between the drive system, VPM and motor.

Connect the VPM with shielded motor supply cables.

**System requirements:**

- SINAMICS S120 booksize (6SL31xx-xxxxx-xxxx3)
- SINUMERIK 840D sl as of software release 1.3
## Technical data

### Table 6-3 Technical data VPM

<table>
<thead>
<tr>
<th>Designation</th>
<th>VPM 120</th>
<th>VPM 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article number for metric gland</td>
<td>6SN1113-1AA00-1JA1</td>
<td>6SN1113-1AA00-1KA1</td>
</tr>
<tr>
<td>Dimensions (H x W x D) [mm]</td>
<td>300 x 150 x 180</td>
<td>300 x 250 x 190</td>
</tr>
<tr>
<td>Drive system connection (cable cross-section)</td>
<td>U3, V3, W3; M50 (max. 50 mm²)</td>
<td>U3, V3, W3; 2 x M50 (max. 2 x 50 mm²)</td>
</tr>
<tr>
<td>Motor side connection (cable cross-section)</td>
<td>U4, V4, W4; M50 (max. 50 mm²)</td>
<td>U4, V4, W4; 2 x M5 (max. 2 x 50 mm²)</td>
</tr>
<tr>
<td>Cable lug</td>
<td>Crimp-type cable lug M6</td>
<td>Crimp-type cable lug M8</td>
</tr>
<tr>
<td>Signaling contact 1 x M16 Max. cable cross-section</td>
<td>1 x NC contact (floating) 24 VDC ≤ 1.5 mm²</td>
<td>1 x NC contact (floating) 24 VDC ≤ 1.5 mm²</td>
</tr>
<tr>
<td>Rated current</td>
<td>≤ 3 AC 120 A_eff</td>
<td>≤ 3 AC 200 A_eff</td>
</tr>
<tr>
<td>Max. permissible short-circuit current</td>
<td>90 A</td>
<td>200 A</td>
</tr>
<tr>
<td>Short-time loading</td>
<td>2 x I_N for approx. 500 ms</td>
<td>3 x I_N for approx. 500 ms</td>
</tr>
<tr>
<td>Connection length, drive system</td>
<td>≤ 1.5 m</td>
<td>≤ 1.5 m</td>
</tr>
<tr>
<td>Connection length, motor side</td>
<td>≤ 50 m</td>
<td>≤ 50 m</td>
</tr>
<tr>
<td>Power loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal operation</td>
<td>approx. 0 W</td>
<td>approx. 0 W</td>
</tr>
<tr>
<td>Short-circuit operation with I_N</td>
<td>approx. 360 W (max. 2 min)</td>
<td>approx. 1.1 kW (max. 2 min)</td>
</tr>
<tr>
<td>Tripping voltage</td>
<td>830 VDC +/- 1%</td>
<td>830 VDC +/- 1%</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP20</td>
<td>IP20</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0° ... 50° C</td>
<td>0° ... 50° C</td>
</tr>
<tr>
<td>Installation altitude</td>
<td>1000 m above sea level (otherwise power reduction)</td>
<td>1000 m above sea level (otherwise power reduction)</td>
</tr>
<tr>
<td>Vibratory load (according to DIN EN 60721)</td>
<td>Up to 1 g</td>
<td>Up to 1 g</td>
</tr>
<tr>
<td>Shock load (according to DIN EN 60721)</td>
<td>Up to 10 g</td>
<td>Up to 10 g</td>
</tr>
<tr>
<td>Max. permissible braking duration</td>
<td>≤ 2 min</td>
<td>≤ 2 min</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 6 kg</td>
<td>approx. 11 kg</td>
</tr>
</tbody>
</table>

### Capacity of the drive system with VPM

To ensure in a fault situation that a defined DC-link voltage is not exceeded and the voltage gain speed is limited, the DC link must have a minimum capacitance.

The DC-link minimum capacitance is calculated using the following equation:

\[ C_{\text{DC-link min}} [\mu\text{F}] = I_{\text{motor}} [\text{A}] \times 33.33 \]

Consider the calculated DC-link capacitance when configuring the system.
6.2 Electrical connection
7 Commissioning

7.1 Safety instructions

**WARNING**

Danger to life as a result of hazardous voltages when connected to inadequately grounded line supplies

In the case of a fault, connecting a motor to an inadequately grounded line supply can result in death, severe injury and motor damage.

- Connect motors, as part of the drive system, to TN and TT line supplies with a grounded neutral point or to IT line supplies.
- Ensure that the SINAMICS devices and motors are compatible with the residual current device according to EN 61800-5-1 before you connect the devices and motors to the line supply using residual current devices (RCDs).
- For line supplies with grounded line conductor, e.g. TT line supplies, use an isolating transformer with grounded neutral point (on the secondary side) between the line supply and the drive system, so that the motor insulation is not overstressed.
- When connected to IT line supplies, a monitoring device must signal the first fault between an active part and ground. Remove this fault immediately.

**WARNING**

Danger to life through the use of an incomplete machine

If you use a machine that does not conform to the 2006/42/EU decree, there is the danger of death, severe injury and/or material damage.

- Commission the machine only when it conforms to the regulations of the EU 2006/42/EU machine decree and the conformity has been declared.
### 7.1 Safety instructions

#### WARNING

**Danger to life caused by dangerous voltage while testing the insulation resistance**

During the measurement and immediately afterwards, high voltages can be present at the terminals that can cause death or severe injury as result of an electric shock.

Contact to live parts causes electric shocks.
- Work on power installations must only be carried out by specialists.
- Before you begin measuring the insulation resistance, read the operating manual for the insulation resistance meter you are going to use.
- Never touch the terminals when making measurements or immediately after the measurement.
- Check the connected supply feeder cables to ensure that the line supply voltage cannot be connected.

#### WARNING

**Danger to life caused by rotating rotors or ejected parts**

Rotating rotors and the resulting ejected parts can cause death or injury.
- Secure rotating output elements using the appropriate safety guards.
- Secure loose parts, e.g. featherkeys to prevent the ejection.

#### WARNING

**Danger to life caused by machine movement and loose objects**

Machine movement and loose objects that can fall out or be ejected can cause death or severe injury.
- Ensure that the machine has been completely installed and all of the setting work completed.
- Ensure that nobody is at risk at switch on.
- Before switching on, check that there are no loose objects in or on the motor that can fall or be flung off.

#### WARNING

**Danger to life when the cooling system bursts**

The motor will overheat if it is operated without cooling. When cooling water enters the hot motor, this immediately and suddenly generates hot steam that escapes under high pressure. This can cause the cooling water system to burst, resulting in death, severe injury and material damage.
- Never operate the motor without cooling.
- Only commission the cooling water circuit when the motor is in a cool condition.
CAUTION

Burns as a result of touching hot surfaces
In operation, the motor housing can reach high temperatures, which can cause burns if touched.

• Do not touch any hot surfaces.
• Allow the motor to cool down before starting any work.
• Use the appropriate personnel protection equipment, e.g. gloves.

NOTICE

Motor damage caused by overheating as result of missing cooling
If the cooling fails or the motor is operated briefly without cooling, the motor overheats. This can cause motor damage.

Never operate the motor without activated cooling.
Monitor the permitted water inlet temperatures and the cooling air supply.
Operate the motor only in conjunction with an effective temperature control.

NOTICE

Thermal damage to temperature-sensitive parts
Some parts of the electrical motor enclosure can reach temperatures that exceed 100° C. If temperature-sensitive parts, e.g. electric cables or electronic components, come into contact with hot surfaces, these parts could be damaged.

• Ensure that no temperature-sensitive parts are in contact with hot surfaces.

NOTICE

Motor damage when the maximum speed is exceeded
The maximum speed \( n_{\text{max}} \) is the highest permissible operating speed. The maximum speed is specified on the rating plate.

The motor can be damaged if operated at inadmissible speeds.

• Ensure that the maximum permissible speed is not exceeded. Realize this using a suitable control system or activate the speed monitoring function in the drive.

NOTICE

Motor damage caused by uneven running or abnormal noise
The motor can be damaged by improper handling during transport, storage or installation. If a damaged motor is operated, this can damage the winding or bearings and could even destroy the system.

• In case of uneven running or abnormal noise, switch off the motor.
• Identify the cause.
7.2 Checklists for commissioning

Note

Required checks

The lists below do not claim to be complete. It may be necessary to perform additional checks and tests appropriate for the situation specific to the particular system.

Before commissioning the system, check that it is properly mounted and connected.
Commission the drive system according to the operating instructions of the converter or inverter being used.

Checklists for commissioning 1FE1 motors

Thoroughly familiarize yourself with the safety instructions and observe the checklists below before starting any work.

Table 7-1 Checklist (1) - general checks

<table>
<thead>
<tr>
<th>Check</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are all of the necessary components of the configured drive line-up available, correctly dimensioned, installed and connected?</td>
<td></td>
</tr>
<tr>
<td>Is the manufacturer documentation for the system components (e.g. drive system, encoder, cooling system, brake) and the &quot;SIMOTICS M-1FE1 built-in motors&quot; Configuration Manual available?</td>
<td></td>
</tr>
<tr>
<td>If the 1FE1 motor is to be operated on the SINAMICS S120 drive system:</td>
<td></td>
</tr>
<tr>
<td>Is the following, current SINAMICS documentation available?</td>
<td></td>
</tr>
<tr>
<td>• SINAMICS S120 Commissioning Manual</td>
<td></td>
</tr>
<tr>
<td>• Getting Started S120</td>
<td></td>
</tr>
<tr>
<td>• S120 Function Manual</td>
<td></td>
</tr>
<tr>
<td>• S120/150 List Manual</td>
<td></td>
</tr>
<tr>
<td>If the 1FE1 motor should be operated on the SINAMICS S120 drive system:</td>
<td></td>
</tr>
<tr>
<td>Was the Chapter &quot;Checklists for commissioning SINAMICS S&quot; in the SINAMICS S120 Commissioning Manual carefully observed?</td>
<td></td>
</tr>
<tr>
<td>Is the motor type to be commissioned known?</td>
<td></td>
</tr>
<tr>
<td>(e.g. 1FE1 _ _ _ _ _ _ _ _ _ _ _ _)</td>
<td></td>
</tr>
<tr>
<td>Are the environmental conditions in the permissible range?</td>
<td></td>
</tr>
</tbody>
</table>
### 7.2 Checklists for commissioning

#### Table 7-2 Checklist (2) - checks regarding the mechanical system

<table>
<thead>
<tr>
<th>Check</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have all touch protection measures for moving and live parts been implemented?</td>
<td></td>
</tr>
<tr>
<td>Has the motor been correctly mounted and aligned?</td>
<td></td>
</tr>
<tr>
<td>Can you rotate the rotor without it touching the stator?</td>
<td></td>
</tr>
<tr>
<td>Do the operating conditions correspond to the data specified on the rating plate?</td>
<td></td>
</tr>
<tr>
<td>Have all fastening screws, fastening elements, and electrical connections been tightened with the prescribed torques and properly attached?</td>
<td></td>
</tr>
<tr>
<td>Do the output elements have the correct setting conditions according to type? Examples:</td>
<td></td>
</tr>
<tr>
<td>• Have the couplings been aligned and balanced?</td>
<td></td>
</tr>
<tr>
<td>• Has the belt drive tension been correctly adjusted?</td>
<td></td>
</tr>
<tr>
<td>• Have the gear tooth flank and gear tooth tip play as well as radial play been correctly adjusted for geared outputs?</td>
<td></td>
</tr>
<tr>
<td>Is the rating plate visible and fastened permanently on the spindle box?</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 7-3 Checklist (3) - checks regarding the electrical system

<table>
<thead>
<tr>
<th>Check</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has the motor been connected so that it rotates in the specified direction?</td>
<td></td>
</tr>
<tr>
<td>Have the minimum insulation resistance values been maintained?</td>
<td></td>
</tr>
<tr>
<td>Have the grounding and equipotential bonding connections been correctly established?</td>
<td></td>
</tr>
<tr>
<td>Is the specified limit speed $n_{\text{max}}$ maintained during the operation on the converter?</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 7-4 Checklist (4) - Monitoring equipment checks

<table>
<thead>
<tr>
<th>Check</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has it been ensured that speeds higher than the maximum speed $n_{\text{max}}$ cannot be reached?</td>
<td></td>
</tr>
<tr>
<td>Have all supplementary motor monitoring devices been correctly connected and are they working properly?</td>
<td></td>
</tr>
</tbody>
</table>
### 7.2 Checklists for commissioning

#### Table 7-5 Checklist (5) - Cooling system checks

<table>
<thead>
<tr>
<th>Check</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water cooling</strong></td>
<td></td>
</tr>
<tr>
<td>Has the cooling water supply been connected and is it ready for operation?</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Coolant circuit diagram" /></td>
<td></td>
</tr>
<tr>
<td>1 Cooling unit</td>
<td></td>
</tr>
<tr>
<td>2 Flow rate indicator (optional)</td>
<td></td>
</tr>
<tr>
<td>3 Filter (optional)</td>
<td></td>
</tr>
<tr>
<td>4 Set the flow rate (optional)</td>
<td></td>
</tr>
<tr>
<td>5 Pump</td>
<td></td>
</tr>
<tr>
<td>6 Coolant container</td>
<td></td>
</tr>
<tr>
<td>7 Compressor / recooling unit</td>
<td></td>
</tr>
<tr>
<td>8 Coolant temperature measurement</td>
<td></td>
</tr>
<tr>
<td>Is the cooling water circulation (flow direction, flow rate, temperature) in compliance with the specifications?</td>
<td></td>
</tr>
<tr>
<td>Is the seal between the spindle housing and the cooling jacket tight? No coolant may escape from the drain holes.</td>
<td></td>
</tr>
</tbody>
</table>

#### Air cooling (special version)

| Is the air cooling operational?                                      |    |
| Is the air circulation (flow rate, temperature) in compliance with the specifications? |    |

#### Table 7-6 Checklist (7) - checks regarding roller bearings

<table>
<thead>
<tr>
<th>Check</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the roller bearings OK?</td>
<td></td>
</tr>
</tbody>
</table>
7.3 Test the insulation resistance

After long storage or shutdown periods, you must check the insulation resistance of the windings with respect to ground using a DC voltage.

- Always measure the insulation resistance of the winding to the motor housing when the winding temperature is between 20° and 30° C.
- When measuring, wait until the final resistance value is reached. This will take approximately one minute.

Limit values

The table below specifies the measuring circuit voltage as well as the limit values for the minimum insulation resistance and the critical insulation resistance with a rated motor voltage of $V_N < 2\, \text{kV}$:

Table 7-7 Stator winding insulation resistance at 25° C

<table>
<thead>
<tr>
<th></th>
<th>Rated voltage $V_N &lt; 2, \text{kV}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement voltage</td>
<td>500 V (minimum, 100 V)</td>
</tr>
<tr>
<td>Minimum insulation resistance with new, cleaned, or repaired windings</td>
<td>10 MΩ</td>
</tr>
<tr>
<td>Critical specific insulation resistance after a long operating time</td>
<td>0.5 MΩ/kV</td>
</tr>
</tbody>
</table>

Note the following:

- Dry, new windings have an insulation resistance of between 100 and 2000 MΩ.

**Note**

**Measured value of the insulation resistance near the critical value**

If the measured value lies near the critical value, the insulation resistance must be checked in shorter intervals.

Values apply to the measurement at a winding temperature of 25° C.

- The insulation resistance of the motor winding can reduce during the course of its service life due to ambient and operational influences (moisture, contamination).
- Calculate the critical insulation resistance at a winding temperature of 25° C by multiplying the rated voltage (kV) by the specific critical resistance value (0.5 MΩ/kV).

Example: critical resistance for the rated voltage ($V_N$) = 0.6 kV:

$$0.6\, \text{kV} \times 0.5\, \text{MΩ/kV} = 0.3\, \text{MΩ}$$
7.4 Commutation angle and pole position identification

Measures on overshooting or undershooting the critical insulation resistance

If the critical insulation resistance is less than or equal to this value, then the windings must be dried or, if the fan is removed, cleaned thoroughly and dried.

**Note**

**Lower resistance**

Note that the insulation resistance of dried, clean windings is lower than that of warm windings. The correct insulation resistance must be achieved for a winding that has been cooled down to room temperature (approx. 20° to 30° C).

Commission the motor only when the insulation resistance has achieved the specified values.

7.4 Commutation angle and pole position identification

7.4.1 Commutation angle

**Note**

With synchronous spindles, the commutation angle must be determined or entered when the spindle is first commissioned or when the spindle is replaced!

The stator magnetic field must be aligned to the rotor magnetic field for the optimum torque development (synchronized).

This reference is established by a pole position identification (PLI) and the subsequent traversing of the encoder zero mark. The associated determined commutation angle offset is stored in the drive system.

**Determining the pole position identification / commutation angle with STARTER for SINAMICS**

1. Select the Motor Module and select the (closed-loop) control type "Speed control with encoder".

2. Select the synchronous built-in motor in the motor selection list. Press the "Next" key.

3. Select the speed encoder (hollow shaft incremental encoder, 1 Vpp). Press the "Enter data" key.

4. The pole position identification routine provides coarse synchronization. A zero mark exists in the encoder. When the zero mark traversed, the pole position can be matched automatically with the zero mark position (fine synchronization). The zero mark position must be electrically adjusted (p0431).

   We recommend a fine synchronization (p0404.15 = 1). It prevents measurement scattering and allows an additional test of the determined pole position.

5. Select the "Pole position identification" under coarse synchronization in the encoder data mask.
Select "Zero marks" for the fine synchronization. The other fields are already preassigned. The "Saturation-based 1st harmonic" is selected and acknowledged using "Pole position ID parameter".

6. The configuration is completed when the wizard is closed and the data has been loaded into the drive. The correct pole position identification technique (p1980) is preassigned with the motor-specific identification currents (p0325, p0329) and their selection (p1982).

7. Check the control direction of the drive, i.e. the encoder in r0061 must return a positive actual speed value for a clockwise motor, before you determine the commutation angle offset.

8. Select p1990 = 1 to determine the correct commutation angle offset (p0431). In the expert list, switch-on the drive using the commissioning tool (control panel) (PLI will be performed). p1990 = 1.

9. Enter a small speed setpoint. After the zero mark has been crossed for the first time, the determined commutation angle offset is automatically entered into p0431. Alarm A07971 is output during the determination routine. p1990 is automatically set to the value of 0 at the end of the measurement.

10. Check whether the automatically determined value in p0431 is plausible. Several techniques are recommended in the parameter description for p1990 (see SINAMICS S120/S150 List Manual LH1).

If the angle is already known (e.g. final acceptance report), use this value to check the determined value.

**Note**

**Deviations > 5°**

For deviations > 5°, the authorized technical personnel of the manufacturer must be contacted.

### 7.4.2 Pole position identification variants

The pole position identification is available in two variants.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>Motion-based pole position identification</th>
<th>Induction-based pole position identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>The rotor must be able to freely rotate.</td>
<td>• The rotor can rotate freely or be blocked</td>
<td></td>
</tr>
<tr>
<td>• The rotor can rotate freely or be blocked</td>
<td>• The pole position identification requires a minimum current. The rated current (S1 current) of the motor module must be ≥ 50% of the rated motor current.</td>
<td></td>
</tr>
<tr>
<td>Accuracy of determining the rotor position.</td>
<td>High, independent of the magnetic properties</td>
<td>Dependent on the magnetic motor characteristics</td>
</tr>
<tr>
<td>Effect of series reactors</td>
<td>The deployment of series reactors has no effect on the result.</td>
<td>When using series reactors or for motors with a low degree of saturation, the accuracy when determining the rotor position is low or the pole position identification does not provide any result at all.</td>
</tr>
</tbody>
</table>
7.5 Commissioning the cooling circuit

- To prevent contamination to the cooling water pipes, flush them before you connect the motor and the converter to the cooling circuit.
- Commission the cooling circuit before performing the electrical commissioning.

7.6 Switching on and switching off

**Note**
**EMERGENCY OFF**
To avoid accidents, inform yourself about the EMERGENCY OFF function before you switch on the system.

The motor is switched on and off using the converter.
- Read about this topic in the converter operating instructions.

**Before switching on**
- Ensure that the converter is correctly parameterized.
- Use the appropriate commissioning tools, e.g. "Drive ES" or "STARTER".
- Switch on the cooling system.

**Switching on**
1. Switch-on the motor at the converter.
2. Ensure smooth motor operation.
3. Check the function of the motor cooling system.
4. Check the function of the safety equipment.
5. Check whether the motor reaches the required parameters

**Switching off**
- Switch-off the motor at the converter.

The motor has been commissioned.
8.1 Safety instructions

**WARNING**

Danger to life caused by machine movement and loose objects

Machine movement and loose objects that can fall out or be ejected can cause death or severe injury.
- Ensure that the machine has been completely installed and all of the setting work completed.
- Ensure that nobody is at risk at switch on.
- Before switching on, check that there are no loose objects in or on the motor that can fall or be flung off.
- Before switching on, check that all safety guard covers are installed and all safety equipment functions correctly.

**WARNING**

Danger to life caused by a rotating rotor or ejected parts

Rotating rotors and the resulting ejected parts can cause death or injury.
- Secure rotating output elements using the appropriate safety guards.
- Secure loose parts, e.g. featherkeys to prevent the ejection.

**WARNING**

Danger to life when the forced ventilation of the motor draws in hair and articles of clothing

Hair, ties or loose objects sucked into the air inlet can cause death or severe injury.
- Secure hair, ties and loose objects from being sucked in.

**WARNING**

Danger to life when the cooling system bursts

The motor will overheat if it is operated without cooling. When cooling water enters the hot motor, this immediately and suddenly generates hot steam that escapes under high pressure. This can cause the cooling water system to burst, resulting in death, severe injury and material damage.
- Never operate the motor without cooling.
- Only commission the cooling water circuit when the motor is in a cool condition.
## Safety instructions

### CAUTION

**Burns as a result of touching hot surfaces**

In operation, the motor housing can reach high temperatures, which can cause burns if touched.

- Do not touch any hot surfaces.
- Allow the motor to cool down before starting any work.
- Use the appropriate personnel protection equipment, e.g. gloves.

### NOTICE

**Motor damage caused by overheating as result of missing cooling**

If the cooling fails or the motor is operated briefly without cooling, this can cause it to overheat. This can cause motor damage.

- Never operate the motor without activated cooling.
- Monitor the permitted water inlet temperatures, the cooling water circulation and the cooling air supply.
- Operate the motor only in conjunction with an effective temperature control.
- Keep the air ducting free.
- Do not remove any air ducting.

### NOTICE

**Thermal damage to temperature-sensitive parts**

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

- Ensure that no temperature-sensitive parts are in contact with hot surfaces.

### NOTICE

**Motor damage when the maximum speed is exceeded**

The maximum speed $n_{\text{max}}$ is the highest permissible operating speed. The maximum speed is specified on the rating plate.

The motor can be damaged if operated at inadmissible speeds.

- Ensure that the maximum permissible speed is not exceeded. Realize this using a suitable control system or activate the speed monitoring function in the drive.
### NOTICE

**Motor damage caused by uneven running or abnormal noise**

The motor can be damaged by improper handling during transport, storage or installation. If a damaged motor is operated, this can damage the winding or bearings and could even destroy the system.

- In case of uneven running or abnormal noise, switch off the motor.
- Identify the cause.

### CAUTION

**Gearbox faults can cause injuries or gearbox damage**

Changes to the gearbox during operation can cause injuries or gearbox damage.

- If deviations from normal operation (e.g. unusual noise, unusual temperature rise) occur, switch off the drive unit immediately.
- If possible, determine the cause of the fault using the fault table (Page 133).
- Rectify any faults or contact the Siemens Service Center.
8.2 Operation

Note

EMERGENCY OFF
To avoid accidents, inform yourself about the EMERGENCY OFF function before you switch on the system.

The motor is switched on and off using the converter.
- Read about this topic in the converter operating instructions.

Before switching on
- Ensure that the converter is correctly parameterized.
- Switch on the cooling system.

Switching on
1. Switch-on the motor at the converter.
2. Ensure smooth motor operation.
3. Check the function of the motor cooling system.
4. Check the function of the safety equipment.
5. Check whether the motor reaches the required parameters

The motor is switched on.

Operation
While the motor is operating, ensure that the specified parameters are maintained.
Observe the following during operation:
- The power consumption lies in the specified range.
- The motor is cooled.
  - With water cooling: Check the liquid level and coolant circulation.
  - With air cooling: Check that the heat can dissipate freely.
- The motor runs without any unusual noise.
- The motor temperature lies in the specified range.

Note
Observe the maintenance intervals
Maintain the motor as specified in the project specifications of the spindle manufacturer.

Switching off
- Switch-off the motor at the converter.
8.3 Faults

Note
Correct the cause of the fault as specified in the remedial measures section.
Repair any damage to the machine / motor spindle.

Note
When operating the motor spindle with a converter, refer also to the Operating Instructions of the frequency converter if electrical faults occur.

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

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

Table 8-1 Possible faults

<table>
<thead>
<tr>
<th>Fault</th>
<th>Cause of fault (see key table)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor spindle does not start</td>
<td>A</td>
</tr>
<tr>
<td>Motor spindle starts slowly</td>
<td>A</td>
</tr>
<tr>
<td>Rumbling noise during startup</td>
<td>C</td>
</tr>
<tr>
<td>Rumbling noise during operation</td>
<td>A</td>
</tr>
<tr>
<td>Overheating during no-load operation</td>
<td>D</td>
</tr>
<tr>
<td>Overheating with load</td>
<td>A</td>
</tr>
<tr>
<td>High temperature rise of individual winding sections</td>
<td>E</td>
</tr>
<tr>
<td>Uneven running</td>
<td>J</td>
</tr>
<tr>
<td>Grinding sound, bearing noise</td>
<td>L</td>
</tr>
<tr>
<td>Radial vibrations</td>
<td>M</td>
</tr>
<tr>
<td>Axial vibrations</td>
<td>O</td>
</tr>
<tr>
<td>Water is escaping</td>
<td>P</td>
</tr>
</tbody>
</table>
# Operation

## 8.3 Faults

<table>
<thead>
<tr>
<th>No.</th>
<th>Cause of fault</th>
<th>Remedial measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Overload</td>
<td>Reduce load</td>
</tr>
<tr>
<td>B</td>
<td>Interruption of a phase in the supply cable</td>
<td>Check frequency converter and supply cables</td>
</tr>
<tr>
<td>C</td>
<td>Interruption of a phase in the supply after switching on</td>
<td>Check frequency converter and supply cables</td>
</tr>
<tr>
<td>D</td>
<td>Converter output voltage too high, frequency too low</td>
<td>Check the settings on the frequency converter, perform automatic motor identification</td>
</tr>
<tr>
<td>E</td>
<td>Stator winding incorrectly connected</td>
<td>Check winding connections</td>
</tr>
<tr>
<td>F</td>
<td>Winding short-circuit or phase short-circuit in stator winding</td>
<td>Measure the winding resistances and insulation resistances, repair after consultation with manufacturer</td>
</tr>
<tr>
<td>G</td>
<td>Cooling water not connected / switched off</td>
<td>Check cooling water connection / switch on cooling water</td>
</tr>
<tr>
<td></td>
<td>Water connection / pipes defective</td>
<td>Locate leaks and seal as necessary, or consult the manufacturer</td>
</tr>
<tr>
<td>H</td>
<td>Cooling water flow rate too low</td>
<td>Increase cooling water flow rate</td>
</tr>
<tr>
<td></td>
<td>Inlet temperature too high</td>
<td>Set correct inlet temperature</td>
</tr>
<tr>
<td>I</td>
<td>Heat dissipation impeded by deposits</td>
<td>Clean the surface of the drives and ensure that the cooling air can flow in and out unimpeded</td>
</tr>
<tr>
<td></td>
<td>Cooling air inlet/outlet is blocked by foreign bodies</td>
<td>Remove the block and ensure that the cooling air can flow in and out unimpeded</td>
</tr>
<tr>
<td></td>
<td>Fan motor does not start up</td>
<td>Make sure that the fan motor works properly</td>
</tr>
<tr>
<td>J</td>
<td>Insufficient shielding for motor and/or encoder cable</td>
<td>Check the shielding and grounding</td>
</tr>
<tr>
<td>K</td>
<td>Excessive drive controller gain</td>
<td>Adjust the controller</td>
</tr>
<tr>
<td>L</td>
<td>Rotating parts are grinding</td>
<td>Determine cause and adjust parts</td>
</tr>
<tr>
<td></td>
<td>Foreign bodies within the motor</td>
<td>Send to manufacturer for repair</td>
</tr>
<tr>
<td></td>
<td>Bearing damage</td>
<td>Send to manufacturer for repair</td>
</tr>
<tr>
<td>M</td>
<td>Rotor not balanced</td>
<td>Decouple rotor and rebalance</td>
</tr>
<tr>
<td>N</td>
<td>Rotor out of true, shaft bent</td>
<td>Consult the manufacturer</td>
</tr>
<tr>
<td>O</td>
<td>Poor alignment</td>
<td>Align motor unit, check coupling</td>
</tr>
<tr>
<td>P</td>
<td>Cooling water pipe / water connection defective</td>
<td>Locate leaks and seal as necessary, or consult the manufacturer</td>
</tr>
</tbody>
</table>
8.4 Stoppages

Measures for longer non-operational periods

---

**Note**

**Damage due to improper storage**

The motor can be damaged if it is not stored properly.

- If the motor is out of service for extended periods of time, implement suitable anti-corrosion, preservation, and drying measures.
- When recommissioning the motor after longer stoppages, perform the measures recommended in Chapter "Commissioning".

---

- Disconnect the motor from the cooling water system.
- Remove any cooling water from the motor.
- Blow out the cooling ducts with compressed air to dry them.
- Observe the instructions for storage contained in Chapter "Transportation and storage (Page 47)".
- If the motor is not operational for extended periods of time, run it at regular intervals (roughly once a month) or spin the rotor by hand.
- Refer to the Chapter "Commissioning (Page 119)" before switching on for recommissioning.
8.4 Stoppages
Service and maintenance

Note
Carry out maintenance and servicing in accordance with the spindle manufacturer's project requirements.
Decommissioning and disposal

10.1 Safety instructions

Removing the motor from the machine

**WARNING**

Danger to life caused by falling machine parts

The machine partially comprises heavy individual components. When removing the machine, these components can fall. This can result in death, serious injury or material damage.

- Secure the machine components that are being released so that they cannot fall.

**WARNING**

Injury as a result of suspended loads

When being dismantled and transported, the motor can cause injury as a result of its movement.

- Only use perfectly functioning hoisting and load suspension equipment dimensioned to carry the motor load.
- Pay careful attention to possible movement when the motor is released.
- Do not stand under suspended loads or in their slewing range.
- When placing down the motor, ensure that it cannot roll.

**CAUTION**

Injuries caused by liquids when draining and environmental pollution

When draining, liquids can cause injuries, such as burns, chemical burns, irritation. Spilt oil can make floor surfaces slippery and pollute the environment.

- Allow the liquid to cool down.
- Use a sufficiently large collection container.
- Avoid liquids coming into contact with the skin. Use suitable personnel protection equipment, e.g. protective eyewear, gloves.
- Have materials on hand to soak up leaked liquids and prevent areas from being slippery.
10.2 Decommissioning

Removing the motor

The motor must only be removed by qualified personnel with the appropriate technical know-how.

Contact a certified waste disposal organization in your vicinity.

Procedure

1. Disconnect all of the electrical connections
2. Remove all liquids such as oil, water.
3. Release all of the supply lines
4. Remove all cables.
5. Remove the fixing elements from the motor.
6. Transport the motor to a suitable location for storage.

Refer also to the information in the section headed "Maintenance (Page 137)".

You have removed the motor.

Note

Dismantling the motor

The motor must be dismantled by an authorized company or the manufacturer.
10.3 Disposal

10.3.1 Disposal - Introduction

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

10.3.2 Guidelines for disposal

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury or material damage if not correctly disposed of</td>
</tr>
<tr>
<td>If you do not correctly dispose of direct drives or their components (especially components with permanent magnets), then this can result in death, severe injury and/or material damage.</td>
</tr>
<tr>
<td>• Ensure that direct drives and their associated components are correctly disposed of.</td>
</tr>
</tbody>
</table>

Main constituents of a proper disposal procedure

• Complete demagnetization of the components that contain permanent magnets

• Components that are to be recycled should be separated into:
  – Electronics scrap (e.g. encoder electronics, Sensor Modules)
  – Electrical scrap (e.g. motor windings, cables)
  – Scrap iron (e.g. laminated cores)
  – Aluminum
  – Insulating materials

• No mixing with solvents, cold cleaning agents, or residue of paint, for example
10.3 Disposal

10.3.3 Disposal of 1FE1 rotors

**WARNING**

**Risk of death and crushing as a result of permanent magnet fields**
Severe injury and material damage can result if you do not take into consideration the safety instructions relating to permanent magnet fields.
- Observe the information in Chapter Special safety notices for handling built-in motors (Page 21).

Disposing of and demagnetizing 1FE1 rotors

The magnetized rotors must be subject to a special thermal treatment so they do not pose any risk during or after disposal.
- Dispose of magnetized rotors by an appropriately specialized disposal company.
- For transport, pack the rotors individually in the original rotor packaging.

Demagnetizing rotors

Rotors are demagnetized in a special furnace at minimum 300° C for at least 30 minutes.

10.3.4 Disposal of packaging

Packaging materials and disposal

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

**Note**

**Original rotor packaging**

Retain the original rotor packaging for transport to the disposal company.

Only recyclable plastics are used as packing aids:
- Code 02 PE-HD (polyethylene)
- Code 04 PE-LD (polyethylene)
- Code 05 PP (polypropylene)
- Code 04 PS (polystyrene)
Spare Parts/Accessories

Note
Spare parts can be ordered in our Service Center based on the motor designation. Please also refer to the scope of delivery described in section Technical Support (https://support.industry.siemens.com/sc/ww/en/sc/2090).
## List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APM</td>
<td>Rotor with external permanent magnets and banding</td>
</tr>
<tr>
<td>BGR</td>
<td>Health and safety at work regulations</td>
</tr>
<tr>
<td>BGV</td>
<td>Health and safety at work regulations</td>
</tr>
<tr>
<td>CE</td>
<td>Conformité Européenne - compliance with EU directives</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsche Industrie Norm (German Industry Standard)</td>
</tr>
<tr>
<td>DRIVE-CLiQ</td>
<td>Drive Component Link with IQ - for installation with SINAMICS components</td>
</tr>
<tr>
<td>EGB</td>
<td>Electrostatic Sensitive Devices</td>
</tr>
<tr>
<td>EMF</td>
<td>Electromotive force</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>EN</td>
<td>European standard</td>
</tr>
<tr>
<td>IATA</td>
<td>International Air Transport Association</td>
</tr>
<tr>
<td>IPM</td>
<td>Rotor with internal permanent magnets</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IP</td>
<td>International Protection</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>IVP</td>
<td>Internal Voltage Protection</td>
</tr>
<tr>
<td>KTY</td>
<td>Silicon temperature sensor - temperature sensor with progressive, almost linear characteristic curve</td>
</tr>
<tr>
<td>MLFB</td>
<td>Machine-Readable Product Code</td>
</tr>
<tr>
<td>NTC</td>
<td>Negative Temperature Coefficient - temperature sensor with negative temperature coefficient</td>
</tr>
<tr>
<td>Pt1000</td>
<td>Platinum temperature sensor with rated value of 1000 Ω at 0° C</td>
</tr>
<tr>
<td>PTC</td>
<td>Positive Temperature Coefficient - temperature sensor with positive temperature coefficient</td>
</tr>
<tr>
<td>SME</td>
<td>Sensor Module External</td>
</tr>
<tr>
<td>VDE</td>
<td>Association of Electrical Engineering, Electronics and Information Technology (Germany)</td>
</tr>
<tr>
<td>VPM</td>
<td>Voltage Protection Module</td>
</tr>
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