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<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>
1. General information

This manual is the installation, operation and maintenance manual for the EM-PMI540-T2000 electric machine.

Copyright

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No parts of this manual may be reproduced or transmitted in any form or by any means, electrical or mechanical including photocopying, recording or by an information storage or retrieval system, without permission in writing from the publisher.

All specifications and contents of this manual are subject to change without notice.

Intended use of the manual

This manual contains instructions necessary to safely and properly handle, install, operate and maintain the electric machine. They should be brought to the attention of anyone who installs, operates or maintains the machine or associated equipment.

All of the safety warnings and instructions in this book must be followed to prevent injury to personnel or damage to property. Only qualified and authorized personnel, familiar with health and safety requirements and national legislation, shall be permitted to handle, install, operate and maintain the device.

This manual must be kept for future reference during installation, operation and maintenance.

This manual uses illustrations as examples only. Illustrations in this manual may not necessarily reflect all system features.

Product naming convention

In this user guide, EM-PMI family permanent magnet motors and generators are referred to as the electric machine.

Frame model indicates dimensions and electrical characteristics of the electric machine. The following naming convention is used to refer to the electric machine frame model:

- EM-PMI540-T2000-XXXX+XX

Table 1. The naming codes of the electric machine

<table>
<thead>
<tr>
<th>Part of the name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>EM</td>
<td>Electric Machine</td>
</tr>
<tr>
<td>PMIXXX or PMEXXX</td>
<td>Permanent Magnet Internal and a number relative to the diameter of the electric machine, or Permanent Magnet External and a number relative to diameter of the electric machine</td>
</tr>
<tr>
<td>TXXXX</td>
<td>Average continuous torque of the motor range, relative to the length of the machine</td>
</tr>
<tr>
<td>XXXX</td>
<td>Rated rotation speed</td>
</tr>
<tr>
<td>+XX</td>
<td>Options, see option table below</td>
</tr>
</tbody>
</table>

The power input of the machine may require one or several three phase power systems. This is indicated by a power connection option marking, for example: DUAL or QUAD in the machine model code. One three phases power system can include one or three connection boxes in the machine. The most usual case is when an electric machine has a single connection box, but this is not shown in the machine model code.

- Example: EM-PMI540-T2000-1300-DUAL
The electric machine can include some of the options available. The options of the electric machine are shown also in the rating plate, following the frame model code. Note! Only options that differ from the standard delivery are indicated. Following options are used, see Table below. For detailed information of the models, options and characteristics, see product data sheets.

Table 2. EM-PMI540-T2000 options

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
<th>Standard option</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High voltage connections</td>
<td>-DUAL</td>
<td>x</td>
<td>2 connection boxes each containing one 3 phase system with one M32 cable gland per phase</td>
</tr>
<tr>
<td>Connection extension</td>
<td>*</td>
<td>x</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>-CE1</td>
<td></td>
<td>2 connection boxes each containing one 3 phase system with two M32 cable glands per phase</td>
</tr>
<tr>
<td>N-end attachment</td>
<td>*</td>
<td>x</td>
<td>The machine can not be attached from its N-end</td>
</tr>
<tr>
<td></td>
<td>-NE4</td>
<td></td>
<td>Male shaft, no flange: DIN5480 W35x2x30x26x8a</td>
</tr>
<tr>
<td>Bearing insulation</td>
<td>*</td>
<td>x</td>
<td>Bearing types according to BHS</td>
</tr>
<tr>
<td></td>
<td>-BIN</td>
<td></td>
<td>SKF 6214 insulated bearing in N-end</td>
</tr>
<tr>
<td></td>
<td>-BIA</td>
<td></td>
<td>SKF 6214 insulated bearing in both ends</td>
</tr>
<tr>
<td>Shaft grounding</td>
<td>*</td>
<td>x</td>
<td>No shaft grounding</td>
</tr>
<tr>
<td></td>
<td>-SG1</td>
<td></td>
<td>In-built grounding ring</td>
</tr>
<tr>
<td>Rotation sensor (resolver)</td>
<td>*</td>
<td>x</td>
<td>No rotation sensor</td>
</tr>
<tr>
<td></td>
<td>-RES1</td>
<td></td>
<td>In-built non contacting resolver, 8-pole pair</td>
</tr>
<tr>
<td>Winding temperature sensor</td>
<td>*</td>
<td>x</td>
<td>3 x PT100 in the windings</td>
</tr>
<tr>
<td></td>
<td>-TEMP4</td>
<td></td>
<td>6 x PT100 in the windings</td>
</tr>
<tr>
<td>Bearing temperature sensor</td>
<td>*</td>
<td>x</td>
<td>No temperature sensors</td>
</tr>
<tr>
<td></td>
<td>-BTMP1</td>
<td></td>
<td>PT-100 in bearings with plug in connector</td>
</tr>
<tr>
<td>Anti-condensation heaters</td>
<td>*</td>
<td>x</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>-HEAT1</td>
<td></td>
<td>1 x 230VAC/50W</td>
</tr>
</tbody>
</table>

Conformity according to standards

The electric machine has been designed to be in conformity with the following directives and to meet the requirements specified in the following standards:

Table 3. Applicable Directives and standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Voltage Directive 2006/95/EC (until 19.4.2016) and Low Voltage Directive 2014/35/EC (from 20.4.2016 onwards)</td>
<td>Electrical equipment means any equipment designed for use with a voltage rating of between 50 and 1000 V for alternating current. This electric machine is subject to the Low Voltage Directive 2006/95/EC or 2014/35/EC.</td>
</tr>
<tr>
<td>Machinery Directive 2006/42/EC</td>
<td>This electric machine is partly subject to the Machinery Directive 2006/42/EC and it is considered as partly completed machinery, as a part of the final machinery.</td>
</tr>
<tr>
<td>IEC 60034-1:2010</td>
<td>Rotating electrical machines - Part 1: Rating and performance</td>
</tr>
</tbody>
</table>
1. General information

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60034-5:2001/A1:2007</td>
<td>Rotating electrical machines - Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification</td>
</tr>
<tr>
<td>IEC 60034-6:1993</td>
<td>Rotating electrical machines - Part 6: Methods of cooling</td>
</tr>
<tr>
<td>IEC 60034-7:1993</td>
<td>Rotating electrical machines - Part 7: Classification of types of construction, mounting arrangements and connection box position (IM Code)</td>
</tr>
</tbody>
</table>

Warranty

Danfoss offers warranty against defects in workmanship and materials for its products for a period of twelve (12) months from commissioning or eighteen months (18) from delivery (Incoterms-EXW), whichever occurs first.

In order for the warranty to be valid, the customer must follow the requirements of this and all related documents, especially those set out in the product installation and maintenance, as well as the applicable standards and regulations in force in each country.

Defects arising from the improper or negligent use, operation, and/or installation of the equipment, non-execution of regular preventive maintenance, as well as defects resulting from external factors or equipment and components not supplied/recommended by Danfoss, will not be covered by the warranty.

The warranty will not apply if the customer at its own discretion makes repairs and/or modifications to the equipment without prior written consent from Danfoss.

Terms and abbreviations

The symbols, terms and abbreviations in the Tables below are possibly used in this manual.

Table 4. Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Variable</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>Rated voltage (phase to phase AC)</td>
<td>V&lt;sub&gt;rms&lt;/sub&gt;</td>
</tr>
<tr>
<td>I</td>
<td>Rated current (AC)</td>
<td>A&lt;sub&gt;rms&lt;/sub&gt;</td>
</tr>
<tr>
<td>P</td>
<td>Rated Power (S9)</td>
<td>kW</td>
</tr>
<tr>
<td>T</td>
<td>Rated torque (S9) at rated speed</td>
<td>Nm</td>
</tr>
<tr>
<td>T&lt;sub&gt;max&lt;/sub&gt;</td>
<td>Maximum torque</td>
<td>Nm</td>
</tr>
<tr>
<td>n</td>
<td>Rated speed</td>
<td>rpm</td>
</tr>
<tr>
<td>Max n</td>
<td>Maximum speed</td>
<td>rpm</td>
</tr>
<tr>
<td>f</td>
<td>Rated supply frequency at nominal speed</td>
<td>Hz</td>
</tr>
<tr>
<td>PF</td>
<td>Power factor (cos φ)</td>
<td></td>
</tr>
<tr>
<td>Q&lt;sub&gt;c&lt;/sub&gt;</td>
<td>Rated coolant liquid flow</td>
<td>l/min</td>
</tr>
</tbody>
</table>
1. General information

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_c$</td>
<td>Rated coolant liquid input temperature °C</td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>Rated ambient temperature °C</td>
</tr>
<tr>
<td>RES_COS</td>
<td>Cosine signal received from the resolver deg</td>
</tr>
<tr>
<td>RES_SIN</td>
<td>Sinusoidal signal received from the machine resolver deg</td>
</tr>
<tr>
<td>GND</td>
<td>Ground in electrical connections</td>
</tr>
<tr>
<td>$\Omega$ (Ohm)</td>
<td>Resistance Ω</td>
</tr>
</tbody>
</table>

Table 5. Term / abbreviation

Trademarks

All trademarks in this material are property of the respective companies. Danfoss and the Danfoss logotype are trademarks of Danfoss A/S. All rights reserved.

Responsibility of the manufacturer

Danfoss is responsible for the safety, reliability and performance of the electric machine only if:

- Handling, mounting, installation, operation and maintenance are done by qualified and authorized personnel.
- The installation of the system complies with the requirements of the appropriate regulations.
- The electric machine is used in accordance with the instructions in this manual.
- The electric machine is installed, maintained and serviced in accordance with the instructions in this manual.
2. Safety information

General safety statement

- The electric machine is intended for use as a component for industrial and commercial installations. The end product containing the electric machine must conform with all related regulations.
- The use of the electric machine is prohibited in hazardous areas unless it is expressly designed for such use.
- The electric machine is intended for installation, use and maintenance by qualified personnel, familiar with health and safety requirements and national legislation. Ignoring these instructions may invalidate all applicable warranties.
- These instructions must be followed to make sure of safe and correct installation, operation and maintenance of the electric machine. They should be brought to the attention of anyone who installs, operates or maintains the electric machine or associated equipment.
- High voltage and rotating parts can cause serious or fatal injuries. For electric machine covered by this manual, it is important to observe safety precautions to protect personnel from possible injury.

Safety message signal words

Safety message signal words indicate the severity of a potential hazard.

**DANGER** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

**CAUTION** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. CAUTION may also alert against unsafe practices.

**NOTICE** Indicates a potentially hazardous situation which, if not avoided, could result in property damage.

Safety symbols

The following safety- and information related symbols appear in this manual and on the electric machine.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="STOP.png" alt="Danger" /></td>
<td>This symbol is identified by a yellow background, red octagonal band and a black STOP text. It indicates a hazardous situation that causes severe injury or death. Action indicated by this symbol may not be executed.</td>
</tr>
<tr>
<td><img src="Exclamation.png" alt="General warning" /></td>
<td>This symbol is identified by a yellow background, black triangular band, and a black exclamation point symbol. It indicates a general potentially hazardous situation.</td>
</tr>
<tr>
<td><img src="Arrowhead.png" alt="Electric shock warning" /></td>
<td>The symbol is identified by a yellow background, black triangular band, and a black arrowhead symbol. It indicates dangerous electrical voltage that could cause an electric shock to a person.</td>
</tr>
<tr>
<td>![Burn warning](Wavy lines.png)</td>
<td>The symbol is identified by a yellow background, black triangular band, and a black wavy lines-symbol. It indicates a hot device that could cause burns to a person.</td>
</tr>
<tr>
<td><img src="Magnet.png" alt="Magnet warning" /></td>
<td>The symbol is identified by a yellow background, black triangular band, and a black magnet symbol. It indicates strong magnetic field that could cause harm to a person or property.</td>
</tr>
</tbody>
</table>
2. Safety information

Rotating shaft warning
The symbol is identified by a yellow background, a black triangular band, and a black rotating shaft symbol. It indicates strong rotating shafts that could cause harm to a person or property.

General Information

Read the instructions in the manual

Personal protective equipment

Personal protective equipment shall be used when necessary during handling, installation and maintenance of the electric machine to avoid injury.

Use eye protective equipment like safety goggles or mask when you work with the electric device. Permanent damage to the eye could be caused if bearing grease, melted nitrile rubber (radial lip seal), glycol or other fluids splash.

Use hearing protective equipment when you work on the electric machine. Hearing injuries can be caused by too loud noise (noise in excess of 85 dBA).

Use head protective equipment like helmet when you lift the electric machine! Head injuries can be caused by object impact.

Use cut resistant gloves when you handle and maintain the electric machine. There is a risk of cut injuries.

Use protective footwear when you lift or move the electric machine! Foot injuries could be caused if lifting system or lifting brackets fail.

Security features

The electric machine has at least one PT100 temperature sensor in the windings. The amount of sensors depends on the options chosen. The temperature signal(s) can be read out from the measurement connector of the machine. You can connect the temperature signal to the temperature surveillance pin in the inverter (EC-C) and make sure that the inverter has the machine temperature protection feature activated.

The electric machine can be ordered with bearing temperature measurement. This option includes one PT100 temperature sensor at both D-end and N-end bearings. The signal can be read out using a separate connector at both ends.

The electric machine has leakage sensors (2pcs) at the lower part of the electric machine. This feature is useful in moist conditions to detect possible excessive water in contact with the electric machine. Separate connectors for both leakage signals exist.
### Electromagnetic compatibility (EMC)

<table>
<thead>
<tr>
<th>![Warning]</th>
<th>When interfacing other equipment, connect only equipment that are specified as part of the system and that are compatible.</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Warning]</td>
<td>Magnetic and electromagnetic fields generated near the current-carrying conductors and permanent magnets in electric machines represent a health danger to persons with heart pacemakers, metal implants and hearing aids. Persons with a heart pacemaker, metal implants or hearing aids must consult a doctor before they enter the following areas:</td>
</tr>
<tr>
<td>![Warning]</td>
<td>• Areas in which electric equipment and parts are operated</td>
</tr>
<tr>
<td>![Warning]</td>
<td>• Areas in which electric equipment with permanent magnets are stored, mounted, operated or repaired</td>
</tr>
<tr>
<td>![Warning]</td>
<td>If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.</td>
</tr>
</tbody>
</table>

EMC stands for Electromagnetic compatibility. It is the ability of electric equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality. This is a legal requirement for all equipment taken into service within the European Economic Area (EEA).

Our products are designed with high standards of EMC in mind. Connect the power lines and groundings along the instructions in this manual to achieve the required level of EMI protection.

It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the EMC legislation of the country of use. Within the European Union, equipment into which this product is incorporated must comply with the EMC Directive 2004/108/EC.
The electric machines have been developed especially for heavy duty, marine and transportation applications. They are more reliable, smaller, lighter and more efficient than conventional products on the market.

Typical applications of the electric machines are:

- Motor (electric propulsion) and generator for hybrid marine vessels or mobile work machine and bus parallel hybrid applications.
- Traction motor and generator for electrical or hybrid electrical mobile work machines or buses.

The electric machines feature Synchronous Reluctance assisted Permanent Magnet (SRPM) motor technology, having several advanced features:

- Extremely compact and robust structure.
- High efficiency throughout the operation range.
- Liquid cooling with water/glycol mixture.
- Low coolant flow required.
- High allowed coolant temperature.
- IP65 enclosure class to maximize reliability.
- Multiple mounting possibilities.
- Extended speed and torque capabilities compared to standard PM machines.
- Machine structure designed to be able to produce high starting torques (instant torque to non-moving wheel).
- Optimized speed range to meet most common gear ratios used in heavy mobile machinery.

Figure 1. The electric machine

The electric machines have several frame models (sizes) to be the optimal solutions for several applications. They also have options for shaft type, attachment interface, bearings, connection box attachment, rotation sensors and temperature sensors.
3. Product overview

**Intended use of the electric machine**

This electric machine is intended to be used as a motor or generator and as a part of a machinery, for example in:

- Power train of a marine vessel, transportation vehicle or a heavy duty work machine.
- Power generation equipment.

The electric machine is intended to be powered and controlled with an inverter or inverters capable of supplying three-phase alternating current and that is capable of controlling the electric machine. The electric machine is not suitable for direct online use.

In a power generation equipment the electric machines are intended to be powered by a prime mover, for example, an internal combustion engine and controlled by the above mentioned electric power inverter.

The electric machine is solely intended for professional use, and may be operated only by trained professionals. The maintenance of the electric machine may be done only by trained professionals.

**Not-allowed use of the electric machine**

It is forbidden to use, handle and maintain the machine in following ways (including but not limited to):

- Using the electric machine for other purposes than defined in this manual.
- Disregarding the obligation to comply with the manual, safety signs and rating plate of the electric machine.
- Using the electric machine, making adjustments and maintenance without first reading this manual.
- Exceeding the designed limits during the electric machine operation.
- Using non-original service parts of wrong material causing corrosion problems and mechanical failures in time.
- Operating and performing maintenance for the electric machine without appropriate personal protective equipment.
- Using electric machine parts like frame, shaft end or terminal box for climbing or for support for other structures.
- Causing any kind of impact forces to the electric machine (for example hitting or hammering or dropping objects).
- Operating the electric machine with electric connections other than defined in the manual and/or other documents.
- Operating the electric machine with insufficiently tightened connections or cable glands.
- Operating the electric machine with power cables routed against the instructions.
- Operating the electric machine without properly dimensioned and operating cooling system.
- Operating the electric machine without following the bearing lubrication instructions.
- Accessing the connection box(es) of the electric machine, doing maintenance or adjustment operations on the electric machine with the electricity connected.
- Accessing the connection box(es) if the shaft can be turned by an external prime mover.
- Lifting the electric machine from wrong lifting points and without correct lifting equipment.
3. Product overview

- Lifting additional load with the machine.
- Storing the electric machine outdoors in wet or dusty conditions.
- Storing the electric machine without correct support to prevent rolling or falling of the machines.
- Using the electric machine in potentially explosive environment.
- Allowing dirt or liquid to enter into the electric machine or connection box.
- Using cables that cannot withstand the maximum currents of the electric machine.

Used technology

The electric machine is a Synchronous Reluctance assisted Permanent Magnet (SRPM) machine. This technology has several benefits compared to standard permanent magnet (PM) technology and traditional induction machine (IM) technology. The SRPM technology combines the benefits of PM and Synchronous Reluctance technology, having increased torque capability over wide speed range and ability to produce torque to higher speeds. The electric machine efficiency at lower speeds is also good.

The supply current to the machine stator windings create rotating magnetic field, which in turn rotates the rotor containing permanent magnets. In the synchronous permanent magnet machine, the rotation of the rotor (shaft) is synchronized with the frequency of the power supply current. The reluctance technology maximizes the pull-out torque of the machine.

The permanent magnets of the rotor are of salient-pole design, having embedded permanent magnets in the rotor structure. This structure makes the electric machine mechanically more stable and capable of higher speed operations. See Figure below illustrating the magnet topology of the electric machine. The figure shows the principle only, and is not an exact illustration of the structure.

![Figure 2. Machine topology](image.png)

<table>
<thead>
<tr>
<th></th>
<th>1. Electric machine stator and stator windings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Electric machine rotor</td>
</tr>
<tr>
<td>3</td>
<td>Permanent magnets in the rotor</td>
</tr>
</tbody>
</table>
3. Product overview

System introduction

Danfoss provides electric drive trains for applications in heavy mobile work machines, marine vessels and buses. The drive trains include all essential components from converting from traditional to hybrid electric (HEV) or electric vehicle (EV) solutions. Danfoss technology saves fuel and lowers emission and noise levels.

Figure 3. Overview of the Danfoss drive train system

The electric machines are liquid cooled with water/glycol mixture. For more information, see chapter Cooling connections.

A low voltage measurement signal connector is attached to the electric machines. Different temperature and resolver signals can be read, depending on the machine options chosen. For more information about the connection, see chapter Low voltage connections.

The electric machines (some models) can be equipped with one or two anti-condensations heater(s), depending on the machine type and the option chosen. The heater is used to prevent any water condensing inside the machine enclosure.

Figure 4. Overview of electric machine system
Connections and interfaces

The electric machines are connected mechanically and electrically as a part of a machinery or as a part of a power generation equipment.

Mechanical interfaces:
- Lifting points.
- Flange mounting (D-end).
- Mounting foot rails.
- Shaft connection.
- Cooling system connections (bores).
- Grease escape/fill connections; depending on option (+BHS); maintenance use only.
- Air ventilation plug.
- Vibration sensor connection points.

Electrical interfaces:
- Power connections through the connection box.
- Measurement connector (connection through the connection box).
- Anti-condensation heater connection (+HEAT1 option) (through the connection box).
- Bearing temperature connectors (+BTMP1 option).
- Leakage sensor connectors.

Figure 5. Connections and interfaces
3. Product overview

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Grease fill connection (nipple); D-end (+BHS option).</td>
</tr>
<tr>
<td>2</td>
<td>Bearing temperature measurement connector, D-end (+BTMP1 option). Type 4-pin M12 A coded male.</td>
</tr>
<tr>
<td>3</td>
<td>Vibration sensor connection points. Both in the D- and N-end, one on the top and two on the sides.</td>
</tr>
<tr>
<td>4</td>
<td>Lifting points. The two outermost needed for normal lifting.</td>
</tr>
<tr>
<td>5</td>
<td>Inner lifting point. Can be used for additional lifting lug/eye connection and as machine enclosure</td>
</tr>
<tr>
<td></td>
<td>(power) grounding connection point when mounted.</td>
</tr>
<tr>
<td>6</td>
<td>Grease fill connection (nipple); N-end (+BHS option).</td>
</tr>
<tr>
<td>7</td>
<td>Cooling system connections (bores).</td>
</tr>
<tr>
<td>8</td>
<td>Mounting foot rails. Four rails in 90° circular pattern around the frame.</td>
</tr>
<tr>
<td>9</td>
<td>Air ventilation plug.</td>
</tr>
<tr>
<td>10</td>
<td>Connection boxes (two boxes with -DUAL option).</td>
</tr>
<tr>
<td>11</td>
<td>Power connection; cable gland (six glands with -DUAL option).</td>
</tr>
<tr>
<td>12</td>
<td>Bearing temperature measurement connector, N-end (+BTMP1 option). Connected through the connection</td>
</tr>
<tr>
<td></td>
<td>box. Type 4-pin M12 A coded male.</td>
</tr>
<tr>
<td>13</td>
<td>Cable gland for anti condensation heater connection cables. Anti connection heater connector inside</td>
</tr>
<tr>
<td></td>
<td>the connection box.</td>
</tr>
<tr>
<td>14</td>
<td>Low voltage connector (measurement connector), low voltage grounding through the connector metal</td>
</tr>
<tr>
<td></td>
<td>body.</td>
</tr>
<tr>
<td>15</td>
<td>Grease escape connections, N-end (+BHS option dependent). One axial and one radial plug (downwards)</td>
</tr>
<tr>
<td></td>
<td>in the N-end.</td>
</tr>
<tr>
<td>16</td>
<td>Leakage measurement connectors. One leakage measurement connector in both ends.</td>
</tr>
<tr>
<td>17</td>
<td>Grease escape connections, D-end (+BHS option dependent). One axial plug and four radial plugs in 90°</td>
</tr>
<tr>
<td></td>
<td>angles around the flange in the D-end.</td>
</tr>
<tr>
<td>18</td>
<td>D-end flange mounting (12 connection bores around the flange).</td>
</tr>
<tr>
<td>19</td>
<td>Shaft connection.</td>
</tr>
</tbody>
</table>
3. Product overview

Rating plate

Each electric machine has a rating plate which can be found on top of the machine. The rating plate contains machine rating and identification. The rating values in the figure below are not correct for this machine. See the rating plate on the machine and data sheets for the correct values.

![Rating plate](image)

*Figure 6. Rating plate*

<table>
<thead>
<tr>
<th>Field</th>
<th>Explanation</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electric machine product family: EM-PMI or EM-PME</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Electric machine type code and options</td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>Serial number</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>Rated voltage (phase-to-phase AC)</td>
<td>Vrms</td>
</tr>
<tr>
<td>I</td>
<td>Rated current (AC)</td>
<td>Imax</td>
</tr>
<tr>
<td>P</td>
<td>Rated power (S9) according to IEC60034-1</td>
<td>kW</td>
</tr>
<tr>
<td>n</td>
<td>Rated speed</td>
<td>rpm</td>
</tr>
<tr>
<td>T</td>
<td>Rated torque (S9) at rated speed</td>
<td>Nm</td>
</tr>
<tr>
<td>PF</td>
<td>Power factor</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>Rated supply frequency at nominal speed</td>
<td>Hz</td>
</tr>
<tr>
<td>Qc</td>
<td>Rated coolant liquid flow</td>
<td>l/min</td>
</tr>
<tr>
<td>Pole pairs</td>
<td>Number of magnetic pole pairs of the machine</td>
<td></td>
</tr>
</tbody>
</table>

Made in Finland

Danfoss A/S, 6430 Nordborg, Denmark

Manuf. 2018
3. Product overview

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_c$</td>
<td>Rated coolant liquid input temperature</td>
</tr>
<tr>
<td>Mounting</td>
<td>Allowed mounting position according to IEC60034-7</td>
</tr>
<tr>
<td>Mass</td>
<td>Mass of the electric machine</td>
</tr>
<tr>
<td>Duty</td>
<td>Defined rotating electric machine duty cycles by IEC60034-1 standard</td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>Rated ambient temperature</td>
</tr>
<tr>
<td>IP rating</td>
<td>Enclosure class according to IEC60034-5</td>
</tr>
<tr>
<td>Cooling</td>
<td>Cooling method according to IEC60034-6</td>
</tr>
<tr>
<td>Rotation</td>
<td>Direction of rotor rotation with default phase order. Observed facing the D-end.</td>
</tr>
<tr>
<td>Max n</td>
<td>Maximum rotation speed</td>
</tr>
<tr>
<td>Insul. class</td>
<td>Temperature rating (class) of insulation of the machine according to IEC60034-1</td>
</tr>
<tr>
<td>Temp. class</td>
<td>Temperature rating (class) of individual insulation materials of the insulation according to IEC60034-1</td>
</tr>
<tr>
<td>Bear. / D-end</td>
<td>Bearing type in the D-end of the machine</td>
</tr>
<tr>
<td>Bear. / N-end</td>
<td>Bearing type in the N-end of the machine</td>
</tr>
<tr>
<td>Max. pressure</td>
<td>Cooling liquid max pressure</td>
</tr>
</tbody>
</table>

**Tightening torques**

<table>
<thead>
<tr>
<th>Connection</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting bolts for D-end attachment</td>
<td>69 Nm</td>
</tr>
<tr>
<td>Connection box mounting screws</td>
<td>7 Nm</td>
</tr>
<tr>
<td>Connection box cover plate screws</td>
<td>4 Nm</td>
</tr>
<tr>
<td>Cable gland (tighten from the cap of the gland)</td>
<td>15 Nm</td>
</tr>
<tr>
<td>Cable lug</td>
<td>15 Nm</td>
</tr>
</tbody>
</table>
4. Design principles

This chapter describes design principles that must be taken into account when designing the system using the electric machine.

System design

Cooling and temperature measurement

- Do not operate the electric machine without correctly dimensioned and operating cooling system.
- Mount the electric machine in correct position, see Chapter Allowed mounting position.
- When you connect the cooling system make sure that the cooling liquid runs freely in and out from the electric machine with the coolant flow equal or higher than rated.
- The coolant temperature at the inlet of the electric machine must be lower or equal to the rated temperature.

See more detailed information about coolant connection bore specifications, required coolant liquid flow and other specifications in the product data sheet. Rated values can be found from the machine rating plate.

The electric machine has at least one PT100 temperature sensor in the windings. The amount of the sensors depend on the options chosen. The temperature signal(s) can be read out from the measurement connector of the machine.

You can connect one temperature signal to the temperature surveillance pin in the inverter (EC-C1200) and make sure that the inverter has the machine temperature protection feature activated.

The maximum allowed winding temperature of the electric machine is 150 °C.

The PT100 temperature sensor characteristics are: resistance 100 Ω in 0 °C temperature, and the resistance increases 0.385 Ω per each 1 °C increase of temperature.

Inverter

The electric machine is intended to be powered and controlled with an inverter capable of supplying three-phase alternating current and that is capable of controlling the electric machine. The electric machine is not suitable for direct online use.

If the machine is driven with a inverter from supplier other than Danfoss Editron, the electric machine performance may differ from rated values. The optimum performance of the electric machine is obtained with Danfoss Editron inverters. These inverters are:
- Compact and light.
- Liquid cooled.
- Tolerant to high mechanical vibration (10 G) and shock (50 G).
- Efficient, efficiency > 98 %.
- Reliable, no moving components.

Do not exceed the maximum rotation speed of the machine.
4. Design principles

The main machine power driving parameters are shown in the machine rating plate. For more information, please contact Danfoss representative.

You can connect one of the temperature signals (from the low voltage connector) to the temperature surveillance pin in the inverter and make sure that the inverter has the machine temperature protection feature activated.

**Mounting structure**

**Supporting structure requirements**

- **Do not install the electric machine near or in direct contact with easily flammable materials. The surface of the electric machine can be hot.**

- The mating housing arrangement of the electric machine must be secure and sufficiently rigid to prevent vibrations and mechanical failures. Necessary actions should be taken to avoid corrosion on the mating housing arrangement.

![EC-C1200](image1)

*Figure 7. EC-C1200*

![Schematic of the inverter powerstage](image2)

*Figure 8. Schematic of the inverter powerstage*
4. Design principles

The supporting structure for the electric machine must be such that the machine can be mounted using its allowed mounting positions, see chapter Allowed mounting positions.

The mounting space must be adequate for the machine mounting and possible auxiliary components. See the length and the diameter data of the electric machine from the product drawing. Main dimensions of the electric machine are shown in the Figure below (the illustration may differ from the actual electric machine).

The electric machine has a SAE 1/2 D-end flange (IM 3001). A SAE 1/2 flywheel housing is required as mating flange. The connection boxes are connected to N-end.

![Figure 9. Main dimensions of the machine](image)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_F$</td>
<td>Length of the machine frame (including the connection box(es)).</td>
</tr>
<tr>
<td>$L_S$</td>
<td>Length of the shaft (from the end of the shaft to the machine D-end mounting shoulder).</td>
</tr>
<tr>
<td>$D_M$</td>
<td>Diameter of the flange mounting bore circle.</td>
</tr>
<tr>
<td>$D_S$</td>
<td>Diameter of the mounting shoulder.</td>
</tr>
</tbody>
</table>

For all dimensions of the electric machine, see the product drawings.

**Shaft alignment and load**

> Improper alignment (misalignment) may result in bearing overloads, premature bearing failures, vibrations and shaft failures. Flexible coupling does not compensate for excessive misalignment.

The type of the electric machine shaft is cylindrical shaft with diameter of 70 mm h7 and contact length of 130 mm. The flange type is SAE 1/2 Transmission housing.

Alignment between the shaft and mating structure must be accurate.
4. Design principles

The misalignment can be parallel or angular misalignment, or combination of those. With parallel misalignment, the center lines of both shafts are parallel but they are offset. With angular misalignment, the shafts are at an angle to each other. Figures below illustrate the parallel and angular misalignment.

Figure 10. Parallel alignment of the shaft and mating structure

Figure 11. Angular alignment of the shaft and mating structure

The maximum external force directed to the shaft axially and radially may not exceed machine specific values. Calculate these values with the document DOC-000454.
4. Design principles

Figure 12. External shaft forces of the machine
5. Transportation and storage

Transportation

<table>
<thead>
<tr>
<th>![Warning]</th>
<th>Heavy equipment. Handle with care during transportation.</th>
</tr>
</thead>
</table>

Electric machine is shipped in first class condition. It has been inspected and packed correctly to prevent damage from ordinary handling during shipment. During transportation, shocks, falls and humidity should be avoided. Protect the cooling holes for transportation.

The weight of the electric machine can be found on the machine rating plate, and in the product data sheet.

Receiving and unpacking

<table>
<thead>
<tr>
<th>![Warning]</th>
<th>Do not touch the electric machine during the insulation resistance check. Discharge the electric machine afterwards.</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Warning]</td>
<td>Do not touch the electrical terminals when the rotor is rotated. The electrical terminals have dangerous voltage during rotation. Contact Danfoss representative if the rotor can’t be rotated.</td>
</tr>
</tbody>
</table>

Check upon arrival and unpacking

- The electric machine and the package must be inspected immediately upon arrival. Make sure that the rating plate data in the cover letter complies with the purchase order. Any external damage (in shaft-ends, flanges, electrical interfaces and paint) must be photographed and reported immediately.

- It is recommended to measure the insulation resistance of the machine upon arrival, or before installing the electric machine. Reference value of 150 MΩ shall be exceeded in room temperature, otherwise contact Danfoss representative.

- Remove any shaft locks and rotate the shaft by hand. It is normal for the rotation of the shaft to be difficult.
5. Transportation and storage

### Lifting

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="warning.png" alt="Warning" /></td>
<td>Use correct, adequately dimensioned lifting devices and inspect them before lifting.</td>
<td></td>
</tr>
<tr>
<td><img src="warning.png" alt="Warning" /></td>
<td>Do not lift from the shaft of the electric machine!</td>
<td></td>
</tr>
<tr>
<td><img src="warning.png" alt="Warning" /></td>
<td>Do not apply any excess weight on the electric machine when lifting.</td>
<td></td>
</tr>
<tr>
<td><img src="warning.png" alt="Warning" /></td>
<td>Use correct lifting slings. Use correct position and angle of lifting. Permissible range of lifting angles is from 0° to 30°.</td>
<td></td>
</tr>
<tr>
<td><img src="warning.png" alt="Warning" /></td>
<td>See the electric machine rating plate and data sheets for weight information.</td>
<td></td>
</tr>
<tr>
<td><img src="warning.png" alt="Warning" /></td>
<td>Lift the electric machine using the correct lifting lugs/eyes only.</td>
<td></td>
</tr>
<tr>
<td><img src="warning.png" alt="Warning" /></td>
<td>Do not go under a lifted load.</td>
<td></td>
</tr>
</tbody>
</table>
5. Transportation and storage

![Diagram](image_url)

**Figure 13. Lifting lugs/eyes for lifting slings and lifting position of the electric machine**

<table>
<thead>
<tr>
<th>Diagram Caption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifting eye type of ANSI B18.13.1M M12x19 is recommended in M12 bores for horizontal and vertical lifting. Not included in the delivery. Use the outmost lifting positions in horizontal lifting.</td>
</tr>
</tbody>
</table>

**Horizontal lifting**

Install 2 pieces of lifting eyes to the lifting bores in the electric machine frame. The lifting eyes should be mounted with their full threaded length.

**Vertical lifting**

Install 4 pieces of lifting eyes to the lifting bores (M12x1,75) in the N-end bearing shield (non-shaft end). Lifting eye should be mounted with its full threaded length.
5. Transportation and storage

Storage

Do not touch the electrical terminals when the shaft is rotated. The electrical terminals have dangerous voltage during rotation.

- Store the electric machine always indoors with the storage temperature above -20 °C and the relative humidity less than 60%.
- The storage should be dry, dust free and vibration free.
- Treat the unprotected electric machine surfaces such as the shaft-end and flanges against corrosion. Seal the cable exit holes and cooling bores for storage.
- The electric machine must not be subject to any external vibrations during storage to avoid damage to the bearings.
- Use anti-condensation heaters, if fitted, or direct winding heating to avoid water condensing in the electric machine.
- Rotate the shaft of the electric machine by hand monthly at least ten revolutions to prevent grease migration.

Extended storage

Electric machines equipped with relubricable bearings (+BHS option): Apply grease before and after long term storage.

It is recommended to inspect the electric machine in storage at periodic intervals. Use attached storage checklist.
6. Installation

<table>
<thead>
<tr>
<th>![Warning Icon]</th>
<th>Risk of electric shock when the connection box is open. When you work with power connections make sure that electricity is disconnected and rotor rotation is prevented.</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Attention Icon]</td>
<td>Magnetic and electromagnetic fields generated near the current-carrying conductors and permanent magnets in electric machines represent a health danger to persons with heart pacemakers, metal implants and hearing aids. Persons with a heart pacemaker, metal implants or hearing aids must consult a doctor before they enter the following areas:</td>
</tr>
<tr>
<td>![Warning Icon]</td>
<td>- Areas in which electric equipment and parts are operated.</td>
</tr>
<tr>
<td></td>
<td>- Areas in which electric equipment with permanent magnets are stored, mounted, operated or repaired.</td>
</tr>
<tr>
<td>![Warning Icon]</td>
<td>Risk of electric shock when working with the electric machine. Use isolated electric tools.</td>
</tr>
<tr>
<td>![Warning Icon]</td>
<td>Only trained and qualified personnel familiar with the relevant safety requirements can work with the electric machine.</td>
</tr>
<tr>
<td>![Information Icon]</td>
<td>Use correct personal protective equipment when you are near the electric machine.</td>
</tr>
<tr>
<td>![Information Icon]</td>
<td>Read the instructions in this manual before you install the electric machine.</td>
</tr>
</tbody>
</table>

**Required tools**

Following tools are required to install the electric machine:

- Grease pump.
- Ratchet torque wrench.
- Hex head wrench kit with different metric sizes.
- Socket wrench kit with different metric sizes.
- Cable gland tightening tool. Size according to cable glands.
- Cable skinning knife.
- Crimping tool for cable lugs. Consult cable lug manufacturer for correct size.
- Lifting slings with sufficient rated capacity.
- Lifting eyes. Size according to machine type. See Chapter Lifting.
6. Installation

**Insulation resistance test**

| ![Warning Icon] | Do not touch the electric machine during the insulation resistance check. Discharge the machine afterwards. |

Measure the insulation resistance of the electric machine before the installation of the electric machine. Because of the structure of the electric machine it is possible that the stator is damaged during the installation. The reference value of 150 MΩ must be exceeded in room temperature. Contact Danfoss representative if the reference value is not exceeded.

**Mechanical installation**

**Allowed mounting positions**

The electric machine with standard horizontal mounting option must be installed horizontally. It can be turned around its axis (shaft) for maximum of 45° both directions from its default assembly direction. Along the axis, the tilt angle may be maximum of 10° both directions. See Figure below.

![Allowed horizontal mounting position of the electric machine, mounting option 2](image)

**Figure 14. Allowed horizontal mounting position of the electric machine, mounting option 2**

The electrical machine with option MDV is for vertical assembly, and may not be assembled horizontally. The allowed vertical mounting angle is +/- 30°, see Figure Vertical mounting of the machine.
6. Installation

Mounting the electric machine

- **Warning**: Do not exceed the maximum axial and radial forces calculated for the shaft with the document DOC-000454.

- **Warning**: Do not use the N-end of the electric machine for mounting the electric machine.

- **Note**: Refer to chapter "Allowed mounting positions" for the correct mounting positions of the electric machine.

Mount the electric machine on a correct supporting structure that is discussed in chapter "Supporting structure requirements".

1. Lift the electric machine to the correct mounting position. See Chapter "Lifting" for details.

2. The electric machine is mounted from its D-end flange (SAE1/2 transmission housing flange). SAE1/2 flywheel housing is required as a mating flange. The mounting foot rails in the side of the electric machine (4 pieces) can also be used for mounting.

3. Align the electric machine with the mating housing alignment. See Chapter "Shaft alignment and load".

4. Connect the shaft of the electric machine, make sure to use full spline engagement. Lubricate the spline.

5. Attach the mounting bolts. For steel housing the minimum length of the bolt is 40 mm and for aluminium housing 45 mm.

A recommended spline lubricant is a 50/50 compound of a high temperature grease and a molybdenum disulphide powder. When applied initially and re-applied at proper intervals, it will help prevent fretting corrosion and premature wear. This lubricant is not soluble in oil and should be used accordingly. Further products which may be recommended are Molykote, Metaflux, Never Seeze, Optimol and similar.
Use tightening torque of 69 Nm for D-end bolts. The N-end of the electric machine is not intended to be used for mounting.

Figure 16. Mechanical mounting connections of the electric machine (horizontal mounting)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shaft of the electric machine; spline structure of the shaft (DIN5480 W55x2x30x26x8a).</td>
</tr>
<tr>
<td>2</td>
<td>D-end flange (SAE1/2) and bolt bores for mounting the machine (12 pieces).</td>
</tr>
<tr>
<td>3</td>
<td>Bores for the lifting eyes.</td>
</tr>
<tr>
<td>4</td>
<td>Mounting foot rails (see Main dimension drawing).</td>
</tr>
<tr>
<td>5</td>
<td>Mounting bolts (12 pcs of DIN912 M12 socket head). Not included in the delivery.</td>
</tr>
</tbody>
</table>

Vertical assembly

In vertical assembly, follow the steps given in the previous chapter "Horizontal assembly."
6. Installation

**Figure 17. Mechanical mounting connections of the electric machine (vertical mounting)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mounting foot rails (4 rails in 90° circular pattern around the frame).</td>
</tr>
<tr>
<td>2</td>
<td>Bores for the lifting eyes, N-end.</td>
</tr>
<tr>
<td>3</td>
<td>D-end flange (SAE1/2) and bolt bores for mounting the machine (12 pieces).</td>
</tr>
<tr>
<td>4</td>
<td>Shaft of the machine; spline structure of the shaft (DIN5480 W55x2x30x26x8a).</td>
</tr>
<tr>
<td>5</td>
<td>Mounting bolts (12 pcs of DIN912 M12 socket head). Not included in the delivery.</td>
</tr>
</tbody>
</table>

**Cooling connections**

[Warning icon]

Make sure that cooling liquid runs freely into and out from the machine.

Connect the electric machine properly to the cooling circuit. Ensure that the coolant flow is equal or higher than rated and the coolant temperature at the inlet of the machine cooling is lower or equal to the rated temperature. For more information, see Chapter **Recommended coolants** and product data sheet. Rated values can be found in the electric machine rating plate.
6. Installation

It is recommended to use coolant connector equipped with o-ring seal or to use sealing washer (for example Usit or Bonded seals) in the connection. In addition, it is recommended to use thread sealant (Loctite 577 or similar) at the coolant connections to prevent loosening. Loosening can be caused by vibration or temperature variations.

The electric machines are equipped with at least three PT100 temperature sensors in the windings. The amount of the sensors depend on the options chosen. The temperature signal(s) can be read out from the measurement connector of the machine.

You can connect the temperature signal to the temperature monitoring pin in the inverter (EC-C) and make sure that the inverter has the machine temperature protection feature activated.

Electrical installation

Power connections

High voltage connection

| Risk of electric shock when connection box is open. When you work with power connections make sure that electricity is disconnected and shaft rotation is prevented. |

The high voltage cables of the electric machine are connected to the connection box, or connection boxes of the machine. Figure below shows the components of the high voltage connection box assembly.

1. Remove the cover of the terminal box.
2. Install the power cables according to the wiring diagram.
3. Replace the cover of the terminal box.
6. Installation

Figure 18. High voltage connection assembly structure

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mounting bolts (7 pcs) for coverplate</td>
</tr>
<tr>
<td>2</td>
<td>Connection box cover plate</td>
</tr>
<tr>
<td>3</td>
<td>Connection box cover plate gasket</td>
</tr>
<tr>
<td>4</td>
<td>Mounting bolts (4 pcs) for connection box</td>
</tr>
<tr>
<td>5</td>
<td>Connection box frame</td>
</tr>
<tr>
<td>6</td>
<td>Cable glands (3 pcs/ connection box)</td>
</tr>
<tr>
<td>7</td>
<td>Insulation sheet</td>
</tr>
<tr>
<td>8</td>
<td>Phase connection points (L1, L2, L3) for one phase</td>
</tr>
<tr>
<td>9</td>
<td>Low voltage (measurement) and anti condensation heater connection part (see Chapters Low voltage (measurement signal) connections and Anti condensation heater connections)</td>
</tr>
<tr>
<td>10</td>
<td>Connection box gasket</td>
</tr>
</tbody>
</table>
6. Installation

The figure below illustrates the connection box from the inside. The power connections are located in the upper part of the connection box. The lower part incorporates the low voltage signal cabling (winding temperature, bearing temperature and resolver) from the low voltage connectors as well as the anti condensation heater connector. For further information see Chapters Low voltage (measurement signal) connections and Anti condensation heater connections.

![Connection Box Diagram](image)

*Figure 19. Inside view of the machine connection box*

The connection box(es) of the electric machine are in fixed position, they can’t be rotated or changed with each other.

Leave the connection box cover plate open for further electrical assembly, instructed in Chapter Cable gland assembly and power line connection.

**Connection diagram**

The electric machines are intended to be powered and controlled by three-phase alternating current, supplied by an inverter or inverters. The electric machine is not suitable for direct online use.

For an electric machine with option DUAL (two three-phase systems), the electrical connection principles from the inverters are shown in Figure below.

For an electric machine with connection option other than SINGLE, the electrical connection principles from the inverters are shown in the Figure below. See also Wiring Diagram. The amount of inverters depends upon the motor and converter current ratings.
6. Installation

Cable gland assembly and power line connection

This chapter describes how to assemble screened power cables to the electric machine. See the cable glands recommendations from the table below. Cable gland assembly instruction can also be found from PFLITSCH gland catalogue available from http://www.pflitsch.de.

Use correct type of gland for different cable diameters. These are shown in Table below.

Table 7. Cable gland alternatives

<table>
<thead>
<tr>
<th>Cable gland</th>
<th>35 mm²</th>
<th>50 mm²</th>
<th>70 mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pfittsch blueglobe mstr225</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Pfittsch blueglobe mstr232</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

1. Remove the small hexagonal piece from the BlueGlobe-sealing insert as shown in Figure below.
6. Installation

Figure 21. BlueGlobe-sealing

2. Cut the cable sheath at the distance A from the end of the cable, see Figure below. Pull the cut part of the sheath partly (length B is from 10 to 15 mm) off the cable as shown in the figure. The distance A depends on the length of the cable lug used. Measure with the cable lug that is used and cut to suitable length.

Do not remove the cable sheath completely at this point and do not cut the braid screen of the cable!

Figure 22. Cut length of the cable sheath

3. Insert the cable to the cable gland with slight turning motion. This helps the cable go through the spring inside the cable gland. Push the cable gland against the sheath of the cable as shown in Figure below.
6. Installation

Figure 23. Cable to the gland assembly

4. After the cable gland is in place remove the length A piece of the sheath and cut the braid screen (cover) from 10 mm (distance C) from the gland bottom as shown in Figure below. Make sure that the cable gland spring is against the cable sheath before cutting the braid screen.

Figure 24. Cut the braid screen

5. Cut a piece of length D of the inner sheath shown in Figure Cutting the inner sheath. The length D must equal to the length of the cable lug body.
6. Installation

**Figure 25. Cutting the inner sheath**

6. Place the cable inside the cable lug body, and crimp the cable lug twice in different places. See Figure below.

**Figure 26. Connecting cable lug**

7. Cut piece of shrink tube and shrink it over the cable lug and braid screen as shown in Figure below. This is done to keep the braid screen in place and for extra insulation.

The shrink tube must be specified for operating temperature range from -40 °C to 150 °C. Self gluing shrink tube is recommended.
6. Installation

8. Insert the cable through the corresponding hole in the connection box and connect the cable lug to the connection point. Use spring washer between the cable lug and the connection screw or nut. Example of the connection is shown in Figure below. Do not tighten the connection at this point to ensure fitting of the cable gland.

![Shrink tube](image)

Figure 27. Shrink tube

- Make sure that there is at least 10 mm air gap between the cable lug and other metallic structures including the braid of the cable. If the air gap is smaller, use extra insulation shrink tube to cover the lug.

![Cable lug connection](image)

Figure 28. Cable lug connection to the connection box (example only, the connection box may look different)

9. Screw the cable gland to the connection box as shown in Figure below. Tighten the cable gland from the cap of the gland. See Chapter [Tightening torques](#).
6. Installation

**Do not turn the body of the gland!** By tightening from the cap of the gland the cable is sealed to the cable gland and at the same time the cable gland is tightened to the connection box with correct torque.

10. Tighten the cable lug. Use tightening torque of 15 Nm.

11. Repeat the procedure to the other cables and connection box.

12. Check that the phase connections order in the connection box is correct, i.e. corresponding phases between the inverter and the machine are connected (U, V, W correspond to the L1, L2, L3 phases).

13. Close the connection box. Tighten the connection box cover screws. See chapter **Tightening torques**. Use thread locking compound that makes it possible to remove the screws. (For example Loctite 221).

If you must connect the anti condensation heater, you can leave the connection box open. See Chapter **Anti condensation heater**.

Check that the phase connections order in the connection box is correct, i.e. corresponding phases between the inverter and the machine are connected (U, V, W correspond to the L1, L2, L3 phases).

Check the power cable shield grounding, see Chapter **Grounding connections**.

**Low voltage connections**

Plug the unused socket holes of the low voltage connector with suitable plugs:

- DEUTSCH 0413-003-1605 (size 16)
- DEUTSCH 0413-204-2005 (size 20)

The electric machine has a connector which is used to read out in-built temperature and rotation sensor (resolver) data from the machine. The temperature data comes from PT100 sensors in the stator windings and in some cases in the bearings. The rating plate has the information about the options of the machine: different options add sensors, and some machines do not have all the sensors that are listed in the table below. For more information about the options, refer to the data sheet of the electric machine.

![Location of the low voltage connectors in the connection box (N-end of the machine)](image)

**Figure 29. Location of the low voltage connectors in the connection box (N-end of the machine)**

| 1 | Low voltage (measurement signal) connector including winding temperature sensors (PT100) and resolver connections |
| 2 | Bearing temperature measurement sensor (PT100) connector in the N-end of the machine |
| 3 | Inlet (cable gland) for anti condensation heater cable (see Chapter Anti condensation heater connections) |
6. Installation

![Figure 30. Pin configuration of the Deutch HD34-24-47PE connector](image)

Table 8. Pin configuration of the Deutch HD34-24-47PE connector

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Description</th>
<th>PIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature 1</td>
<td>Temperature 1, PT100 (P), windings</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Temperature 1, PT100 (N), windings</td>
<td>46</td>
</tr>
<tr>
<td>Temperature 2</td>
<td>Temperature 2, PT100 (P), windings</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Temperature 2, PT100 (N), windings</td>
<td>32</td>
</tr>
<tr>
<td>Temperature 3</td>
<td>Temperature 3, PT100 (P), windings</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Temperature 3, PT100 (N), windings</td>
<td>31</td>
</tr>
<tr>
<td>Temperature 4</td>
<td>Temperature 4, PT100 (P), windings, option TEMP4</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Temperature 4, PT100 (N), windings, option TEMP4</td>
<td>29</td>
</tr>
<tr>
<td>Temperature 5</td>
<td>Temperature 5, PT100 (P), windings, option TEMP4</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Temperature 5, PT100 (N), windings, option TEMP4</td>
<td>43</td>
</tr>
<tr>
<td>Temperature 6</td>
<td>Temperature 6, PT100 (P), windings, option TEMP4</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Temperature 6, PT100 (N), windings, option TEMP4</td>
<td>16</td>
</tr>
<tr>
<td>Resolver COS_N</td>
<td>Resolver, RES_COS_N, in-built non contacting</td>
<td>35</td>
</tr>
<tr>
<td>Resolver COS_P</td>
<td>Resolver, RES_COS_P, in-built non contacting</td>
<td>20</td>
</tr>
<tr>
<td>Resolver SIN_N</td>
<td>Resolver, RES_SIN_N, in-built non contacting</td>
<td>36</td>
</tr>
<tr>
<td>Resolver SIN_P</td>
<td>Resolver, RES_SIN_P, in-built non contacting</td>
<td>21</td>
</tr>
<tr>
<td>Resolver EXCN</td>
<td>Resolver, EXCN, in-built non contacting</td>
<td>22</td>
</tr>
<tr>
<td>Resolver EXCP</td>
<td>Resolver, EXCP, in-built non contacting</td>
<td>10</td>
</tr>
<tr>
<td>Resolver shield</td>
<td>Resolver, SHIELD/GROUND, in-built non contacting</td>
<td>34</td>
</tr>
</tbody>
</table>
6. Installation

**Figure 31. Bearing temperature measurement connector (optional)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PT-100 pin.</td>
</tr>
<tr>
<td>2</td>
<td>PT-100 pin.</td>
</tr>
<tr>
<td>3</td>
<td>PT-100 ground pin.</td>
</tr>
<tr>
<td>4</td>
<td>PT-100 ground pin.</td>
</tr>
</tbody>
</table>

**Grounding connections**

The grounding points on the frame of the electric machine are for safety grounding, and signal cables and power cable shields have their own grounding points.

For proper and safe operation, it is important to ensure proper grounding (earthing) of the machine and cable shields connected to the machine. In the electric machine the middle lifting bore can be used as a connection point for machine enclosure grounding. The low voltage (measurement) signal cable is grounded through the ground/shield pins of the low voltage connector (pins 1, 4, 5, 6 and 34), and the power cables through the cable glands in the connection box.
6. Installation

Figure 32. The machine enclosure grounding point, safety grounding

Figure 33. Low voltage cable grounding points
6. Installation

Figure 34. Power cable grounding through the cable gland

Testing the power cable shield grounding (earthing)
The power cable shields are grounded (earthed) through the cable glands to the connection box and further to the electric machine enclosure. After the cable gland assembly and power cable installations, and any time when needed, make sure that the grounding (earthing) connections are correct.

1. Connect one terminal of the measurement device to the cable shield of one power cable (in the inverter end of the cable).
2. Connect the other terminal of the measurement device to the cable shield of another power cable. You can also use the machine enclosure grounding point for the measurement.
3. Measure the resistance between the two cable shields or between the cable shield and the enclosure grounding point.
4. Change the measurement device terminal(s) to the shield of different power cable and repeat the measurement until all cables have been measured.

Testing the low voltage (measurement signal) cable shield grounding (earthing)
The low voltage (measurement signal) cable shield connects to the ground through the connector grounding/earthing pins, see Figure Low voltage cable shield grounding. After cable installation, and any time when needed, make sure that the grounding (earthing) connection is valid.

1. Connect one terminal of the measurement device to the low voltage cable shield (in the non-machine end of the cable).
2. Connect the other terminal of the measurement device to the machine enclosure grounding point.
3. Measure the resistance between the cable shield and the enclosure grounding point.
6. Installation

Anti-condensation heater connections

Do not run the electric machine when the anti-condensation heater is in use.

Water condensing inside the electric machine enclosure can result in failure or corrosion of the machine. This often happens in cooler temperatures or higher humidity areas typically in marine environment, when the machine is not running.

The electric machine can be equipped with anti-condensation heater to avoid condensation issues. The heater (+HEAT1) or heaters (+HEAT2) are factory assembled see Figure. The installed heater may not be used when the machine mains are switched on, and the machine is running.

The installed anti-condensation heater must be supplied with 230 Vac power. The heater connector is inside the connection box, in the lower part if it. The anti-condensation heater cable has an inlet (cable gland) next to the low voltage signal connector. See Figure below.

![Figure 35. Anti-condensation heater connector](image_URL)

1. Anti-condensation heater connector (inside the connection box).
2. Inlet and cable gland for the anti-condensation heater cable.

After installation of the machine, and any time when needed, the resistance of the warming element can be measured. Connect the measurement device between the heater terminals. The resistance shall be around 1 kΩ. Measuring no value, or zero value indicates a possible failure in the heater element.

If the electric machine has an anti-condensation heater and failure is suspected, contact Danfoss representative.
7. Operation

| ![Warning] | Only trained and qualified personnel familiar with the relevant safety requirements are allowed to operate the electric machine. |
| ![Warning] | Do not use the electric machine without properly dimensioned and operating cooling system. Maximum operation temperature, current and rotational speed of the electric machine must not be exceeded to avoid permanent damage. |
| ![Warning] | The surface of the electric machine might be hot. Do not touch the electric machine during operation. |
| ![Warning] | Entanglement hazard! Do not touch the electric machine during operation. |
| ![Warning] | Do not run the electric machine when the heater is in use. |
| ![Warning] | Use the anti-condensation heater, if fitted, when the electric machine is not in use. This prevents condensation and possible damage to the electric machine. |
| ![Icon PNG] | Use sufficient personal protective equipment when you are near the electric machine. |
| ![Icon PNG] | Read the instructions in this user guide before you install the electric machine. |

**Operation conditions**

The electric machine should be used for its intended purpose only and within limits specified by the manufacturer, concerning:

- Loading.
- Cooling.
- Speed range.
- Service interval.
- Ambient condition such as temperature and moisture.
7. Operation

The electric machine is designed for the following conditions:

- Ambient temperature limits: -40°C ... +65 °C.
- Maximum altitude 2000 m above sea level.
- Maximum coolant liquid temperature at the inlet of the coolant circuit, see product data sheet.
- Coolant liquid must be water-glycol mixture with maximum of 50 % glycol content. See Chapter Recommended coolants.

If electric machine operation limits are exceeded, please contact Danfoss representative.

Condition monitoring during operation

| Supervising the electric machine correctly during the operation ensures reliable operation and designed lifetime. |
| If you notice any deviations from the normal operation, for example elevated temperatures, noise or vibration, stop the electric machine. Find the reason for the deviation and repair the electric machine. Refer to Chapter 9 Troubleshooting. |
| Maximum temperature of the bearings of the electric machine is: |
| 120°C. |
| Maximum temperature of the windings of the electric machine is 150°C. |

Recommended lubricants

| Do not mix different types of grease! Consult SKF for using other greases. |

Greased for life bearings do not need relubrication during their lifetime. Grease relubricable bearings (BHS option) need regular greasing. See Chapter Maintenance - Bearings and lubrication for further information.

The recommended grease type for the machine bearings is SKF LGHP-2 or equivalent. LGHP-2 is high performance, high temperature bearing grease. For further information, see http://www.skf.com/

Each electric machine has its own greasing recommendations, see the sticker on the electric machine or contact Danfoss.
7. Operation

Recommended coolants

| Use correct personal protective equipment when you handle the coolant. |
| Ethylene glycol is a toxic compound. Avoid exposure to the coolant. |

The electric machines are designed to work properly with water based coolant. Plain water with appropriate corrosive inhibitor is acceptable, for example 50 % water-50 % glycol coolant.

Other options:
- Propylene glycol based coolants, like Splash® RV&Marine antifreeze.
- Ethylene glycol based Glysantin® G48® (includes also corrosion inhibitors).

Emergency operation

The electric machine should be operated within the operation limits and in the conditions specified by the manufacturer. However, it can be limitedly used in the following fault/emergency situations.

Cooling of the electric machine fails

The cooling system failure can be caused by dregs (sediment) accumulating to the cooling system tubes. Try opening the possible blockage by changing the coolant flow direction. See also Chapter Cooling system maintenance.

If the cooling of the electric machine fails, limited operation is still possible with no coolant flow. The operation speed must be limited to half (1/2) of the rated speed and maximum 20 % of the nominal torque may be used. In such case, the electric machine may be operated for maximum one hour. Repair the cooling system as soon as possible. For further information, contact Danfoss representative.

The temperature measurement of the electric machine fails

The operation temperature of the machine is measured by PT100 temperature sensors in the electric machine windings. The temperature signals can be read out from the measurement connector of the electric machine, and connect to the temperature surveillance pin in the inverter for example. In case of a temperature measurement sensor failure in the electric machine, an additional PT100 sensor can be mounted close to the end of the windings at the low voltage (measurement signal) cable opening inside the connection box.

1. Remove the connection box cover.
2. Mount (glue) an additional PT100 temperature sensor close to the end of the windings at the opening where the signal cables are routed inside the electric machine enclosure (inside the connection box lower part). Use resin/glue specified for correct temperatures (Temp. class in the rating plate, class F / 155 ºC).
3. Connect the PT100 sensor to the low voltage connector (replace the failed sensor connection by the new connection).
4. Remount the connector box cover.

When reading the temperature (resistance) values from the additional sensor, add +15 ºC to the measured value. This gives more correct estimation of the inner temperature of the machine. In case of the temperature measurement failure and using additional temperature sensor, replace the electric machine as soon as possible, but no later than in two months.

Contact the Danfoss service.
8. Maintenance

This chapter contains necessary information for the qualified and trained personnel to carry out regular maintenance work.

- **Do not disassemble the electric machine.** Only procedures described in this user guide may be done.

- **Only trained and qualified personnel familiar with the relevant safety requirements are allowed to do maintenance to the electric machine.**

- **Risk of electric shock when the connection box is open.**
  Voltage may be connected to the anti-condensation heater.

- **Use correct personal protective equipment when you are near the electric machine.**

- **Read the instructions in the manual before you start to work with the electric machine.** To ensure safe and reliable operation of the machine, obey the maintenance instructions carefully.

**Regular maintenance**

- **Inspect the machine at regular intervals.** Use the regular maintenance checklists for help.

- **Do not attempt to tighten bolts or screws that are not discussed in this manual and that are not needed for normal installation and maintenance procedures.** The sealing of the bolts and screws can break.

Correct supervision and maintenance of the electric machine makes sure of reliable operation and designed lifetime.
8. Maintenance

Table 9. Maintenance schedule

<table>
<thead>
<tr>
<th>Object</th>
<th>Check/Task</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>General construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>Noise, vibration. If clearly increased, contact Danfoss.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mounting</td>
<td>Bolt tightness. Tighten to proper value if necessary. Applies to bolts and screws that are discussed in this manual. See chapter Tightening torques.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bearings</td>
<td>Listen to any unusual noise or vibration. If exists, contact Danfoss.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Enclosure and connected parts</td>
<td>Check cleanliness. Clean if necessary. See Chapter Cleaning.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Shaft seals</td>
<td>Check the wear. Replace if necessary.</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Electrical system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cables</td>
<td>Wearing of the cables. Replace if necessary.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Electrical connections</td>
<td>Check connections. Ensure that sufficient tightening torque is applied to cable glands. See chapter Tightening torques.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Groundings (earthing)</td>
<td>Check groundings (earthing). Make sure that the connection resistance is valid. Re-connect if necessary.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Anti-condensation heater</td>
<td>Check anti-condensation heater connections and resistance, if option installed. If needed, contact Danfoss.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Cooling system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>Functioning. Cooling system functions as specified.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Tubing and connection tightness</td>
<td>No visible leakage. If leaking, tighten connections appropriately, or replace parts.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ventilation plug</td>
<td>Cleanliness. Clean if necessary. See chapter Cleaning.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Coolant flow</td>
<td>Coolant flow direction. Change direction by changing the connections or flow direction from the pump. See Chapter Cooling system maintenance.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Coolant quality</td>
<td>Coolant as specified. Proper glycol used, and water/glycol mixture appropriate. Refill if necessary. See Chapter Cooling system maintenance.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Lubrication (BHS option)</td>
<td>Relubrication depending on the use (see Chapter Bearings and lubrication), if the option has been installed. Maximum relubrication interval is six months.</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Cleaning

Keep the electric machine clean. For cleaning, use non-abrasive and non-corrosive cleaning products. Make sure that the detergent may be used for aluminium.

When pressure washing the machine, make sure that the water spray does not directly hit the gaskets.

When cleaning the ventilation plugs, do not open / remove the plug. Clean the plug only from the outside.

Bearings and lubrication

Grease relubricable bearings (BHS option)

The mechanical bearing lifetime (grease relubricable bearings) of the machine is shown below. It depends on the bearing operation temperature and rotation speed.

The expression of $L_{10}$ in bearing lifetime information is a standard way of expressing the lifetime and means the time period at the end of which 90% of the bearings are still reliably working. Grease relubricable bearings (BHS option) need regular greasing. This is due to the limited lubricant (grease) lifetime in operation conditions, and is shorter time period than the actual bearing lifetime.
8. Maintenance

The bearing type for electric machine with option BHS is SKF 6214 C3 (non-insulated bearings) or SKF 6214 C3 HCS (insulated bearing). See the recommended lubricant in Chapter Recommended lubricants.

**Greased for life (BGL) bearing option**

Greased for life bearings (BGL option) do not need relubrication during their lifetime.

The lifetime of the bearing depends on the mounting position of the electric machine. The lifetime depends also on the rotation speed of the machine and the temperature of the bearing. The bearing lifetime is a combination of both mechanical bearing lifetime and bearing grease lifetime, and is illustrated in the following figures, both for horizontal and vertical mounting.

The information of bearing lifetime and bearing grease lifetime are approximations only. The bearing lifetime and bearing grease lifetime in customer application may vary. Danfoss is not responsible for the actual bearing lifetime in use. For further information please contact Danfoss.

### Bearing relubrication

- **Beware of rotating parts. Do not touch the electric machine during operation.**
- **The surface of the electric machine can be hot. Use correct protective equipment (heat resistant gloves) when you handle the electric machine.**
- **The information of bearing lifetime and bearing grease lifetime are estimations only to provide a magnitude of them. The bearing lifetime and bearing grease lifetime in customer application may vary. Danfoss is not responsible for the actual bearing lifetime in use. For further information contact Danfoss representative.**
- **The maximum relubrication interval in operation is 6 months. The amount of grease per relubrication is 20 g.**

The relubrication interval depends on the used rotation speed and bearing temperature, and is presented in Figure below. The different curves represent different bearing temperatures. The higher the temperature is and the higher the rotation speed is, the lower the relubrication interval is.
8. Maintenance

![Graph showing relubrication interval vs. rotation speed and bearing temperature]

*Figure 36. Relubrication interval of the machine (BHS option) compared to rotation speed and bearing temperature*
8. Maintenance

Figure 37. Relubrication interval of the machine (BHS option) compared to rotation speed and bearing temperature, vertical installation

Bearing relubrication:

1. Make sure that the machine has reached its operating temperature.
2. Remove the plugs from the grease escape holes.
3. Open the grease nipple plugs.
4. Use grease piston to enter specific amount of grease into the grease nipple.
5. If possible, let the machine run approximately one hour to let the old grease exit. NOTE! It is normal if no grease exits the electric machine. This is because the cavities inside the electric machine can hold a lot of grease.
6. Install the plugs on the grease nipples and on the grease escape holes.

Grease relubricable bearings (BHS option)
8. Maintenance

The mechanical bearing lifetime (grease relubricable bearings) of the machine is shown below. It depends on the bearing operation temperature and rotation speed.

The expression of $L_{10}$ in bearing lifetime information is a standard way of expressing the lifetime and means the time period at the end of which 90% of the bearings are still reliably working. Grease relubricable bearings (BHS option) need regular greasing. This is due to the limited lubricant (grease) lifetime in operation conditions, and is shorter time period than the actual bearing lifetime.

The bearing type for electric machine with option BHS is SKF 6214 C3 (non-insulated bearings) or SKF 6214 C3 HCS (insulated bearing). See the recommended lubricant in Chapter Recommended lubricants.

Cooling system maintenance

The electric machine cooling system requires certain regular maintenance activities.

The coolant liquid flow direction must be changed yearly. This is done by changing the order of the coolant connections, or changing the coolant pump direction. The reason for changing the coolant flow direction is to prevent possible dregs (sediment) accumulating to the cooling system.

The quality of the coolant must be checked yearly. The mixture of water and glycol as well as the type of the glycol used must be as specified. See Chapter Recommended coolants.
9. Dismounting

Make sure that the mating structure is not damaged. Do not pluck any bores or use flat headed bolts or rods for pushing the electric machine out of the mating structure.

For dismounting the electric machine, follow the steps below.

1. Install correct lifting eyes to the lifting bores in the machine frame, and the lifting slings to the lifting eyes. Support the machine with lifting slings when dismounting. Refer to Chapter Lifting.

2. Loosen the mounting bolts, for more information refer to Chapter Mounting the electric machine.

3. If axial force is required, use the bores in D-end flange to push the electric machine out from the mating structure.
Some difficulties may occur while operating the electric machine. Possible causes and actions are given in Table below. If the situation occurs, it should be corrected as soon as possible. These instructions do not cover all details or variations in the equipment nor provide information for every possible condition to be met in connection with installation, operation or maintenance. Contact Danfoss for more information.

Table 10. Troubleshooting chart

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive vibration, noise</td>
<td>Unbalance at the connected machine or the powertrain components.</td>
<td>Check the balance and installation of the actuator and drivetrain components.</td>
</tr>
<tr>
<td></td>
<td>Misalignment between the electric machine and the used device.</td>
<td>Check the connections and couplings.</td>
</tr>
<tr>
<td></td>
<td>Attachment bolts are loose.</td>
<td>Replace and tighten the bolts.</td>
</tr>
<tr>
<td></td>
<td>Clearance at the spline connection.</td>
<td>Check the spline connection.</td>
</tr>
<tr>
<td></td>
<td>Imbalance at the electric machine.</td>
<td>Contact Danfoss.</td>
</tr>
<tr>
<td></td>
<td>Particles inside the electric machine.</td>
<td>Apply bearing lubricant/grease. See Chapter Bearings and lubrication.</td>
</tr>
<tr>
<td></td>
<td>Bearing damage.</td>
<td>Contact Danfoss for further information.</td>
</tr>
<tr>
<td></td>
<td>Inadequate lubrication (electric machine with BHS option).</td>
<td>Apply bearing lubricant/grease. See Chapter Bearings and lubrication.</td>
</tr>
<tr>
<td></td>
<td>Too much grease at the bearing housing (electric machine with BHS option).</td>
<td>Open grease escape valve and let the electric machine run for 10 min. Clean the grease escape channel from solidified grease using brush if necessary.</td>
</tr>
<tr>
<td></td>
<td>Incorrect bearing grease.</td>
<td>Check that the used grease is of correct type.</td>
</tr>
<tr>
<td></td>
<td>Incorrect radial lip seal.</td>
<td>Check that the correct type of radial lip seal is used.</td>
</tr>
<tr>
<td></td>
<td>Overloaded bearing.</td>
<td>Check that the system is not causing excess force or vibration to the machine bearings.</td>
</tr>
<tr>
<td></td>
<td>Bearing damage.</td>
<td>Contact Danfoss for further information.</td>
</tr>
<tr>
<td>Electric machine overheating</td>
<td>Overload.</td>
<td>Reduce load. Check the electric machine model description and rating plate, check the inverter limits.</td>
</tr>
<tr>
<td></td>
<td>Cooling system failure.</td>
<td>Check the cooling system integrity, flow and fluid temperature. Change the cooling flow direction to flush the cooling system from sediment possibly accumulated. See Chapter Emergency operation.</td>
</tr>
<tr>
<td></td>
<td>Leakage in the cooling system.</td>
<td>Check the cooling system circuit and connections.</td>
</tr>
<tr>
<td></td>
<td>Rigid particle inside the machine cooling channel.</td>
<td>Try pulsating coolant to open the channels. Contact Danfoss.</td>
</tr>
<tr>
<td></td>
<td>Wrong machine parameters in the inverter.</td>
<td>Check and correct the machine parameters from the inverter.</td>
</tr>
<tr>
<td></td>
<td>Winding short circuit.</td>
<td>Replace the electric machine.</td>
</tr>
</tbody>
</table>
## 10. Troubleshooting

<table>
<thead>
<tr>
<th>Issue</th>
<th>Cause</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant lubricant leak</td>
<td>Worn radial lip seal.</td>
<td>Contact Danfoss.</td>
</tr>
<tr>
<td></td>
<td>Block at the grease outlet channel.</td>
<td>Clean the grease escape channel from solidified grease using brush if necessary.</td>
</tr>
<tr>
<td>Electric machine does not work properly or the performance is poor</td>
<td>Wrong electric machine parameters in the inverter.</td>
<td>Check and correct the electric machine parameters from the inverter.</td>
</tr>
<tr>
<td></td>
<td>Demagnetization of magnets due to overheating.</td>
<td>Measure the winding resistance, refer to manufacturer data. Replace the electric machine if necessary.</td>
</tr>
<tr>
<td></td>
<td>Bearing fault.</td>
<td>Check the bearings, lubrication and conditions.</td>
</tr>
<tr>
<td></td>
<td>Insulation fault.</td>
<td>Measure the insulation resistance, refer to the manufacturer limits. See Chapter Insulation resistance test.</td>
</tr>
<tr>
<td>Anti-condensation heater failure</td>
<td>The heater element is faulty.</td>
<td>Measure the resistance of the heater element, see Chapter Anti-condensation heater connections. If the heater is faulty, contact Danfoss.</td>
</tr>
<tr>
<td>Temperature measurement failure</td>
<td>The PT100 sensor faulty.</td>
<td>Measure the resistance of the PT100 sensor, see Chapter Low voltage connections. If the sensor is faulty, read out the signal from another sensor. Contact Danfoss. See Chapter Emergency operation.</td>
</tr>
</tbody>
</table>
11. Aftersales

Service policy

Maintenance and service of the electric machine is limited to the procedures described in this manual. See Chapter Service parts below for a list of available service parts. For further information, contact Danfoss.

Service parts

The recommended service parts are listed in the table below. Quantity describes the number of components in a single electric machine. Maintenance procedures not described in this manual require special tools and instructions. Contact Danfoss for more information and purchasing.

Figure 38. Recommended service parts
## 11. Aftersales

<table>
<thead>
<tr>
<th>Part number</th>
<th>Item (order) number</th>
<th>Qty</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10945</td>
<td>1</td>
<td>Seal, O-ring</td>
<td>208X4 NBR70</td>
</tr>
<tr>
<td>2</td>
<td>10974</td>
<td>1</td>
<td>Seal, Radial lip, D-end</td>
<td>65X90X10 FKM, TRELLEBORG, TREB00650-VC.BVR</td>
</tr>
<tr>
<td>3</td>
<td>10935</td>
<td>1</td>
<td>Bearing, D-end, Deep groove ball (non insulated in D-end, B10, and BIN options)</td>
<td>SKF 6214 C3</td>
</tr>
<tr>
<td>3</td>
<td>11093</td>
<td>1</td>
<td>Bearing, D-end, Deep groove ball (insulated in D-end, B10 and BIA options)</td>
<td>SKF 6214 C3 HCS (hybrid bearing)</td>
</tr>
<tr>
<td>4</td>
<td>10242</td>
<td>1</td>
<td>Seal, O-ring</td>
<td>124.5X3 NBR70</td>
</tr>
<tr>
<td>5</td>
<td>10546</td>
<td>2</td>
<td>Grease nipple (both in D-end and N-end)</td>
<td>DIN 71412, M10 x 1</td>
</tr>
<tr>
<td>6</td>
<td>10473</td>
<td>6</td>
<td>Cable gland (power connections), DUAL (two connection boxes)</td>
<td>M32 X 1.5, BG PFUTSCH</td>
</tr>
<tr>
<td>7</td>
<td>10935</td>
<td>1</td>
<td>Bearing, N-end, Deep groove ball (non insulated in N-end, B10 and BIA options)</td>
<td>SKF 6214 C3</td>
</tr>
<tr>
<td>7</td>
<td>11093</td>
<td>1</td>
<td>Bearing, N-end, Deep groove ball (insulated in N-end, BIN and BIA options)</td>
<td>SKF 6214 C3 HCS (hybrid bearing)</td>
</tr>
<tr>
<td>8</td>
<td>10451</td>
<td>1</td>
<td>Seal, O-ring</td>
<td>184.5X3 NBR70</td>
</tr>
<tr>
<td>9</td>
<td>10242</td>
<td>1</td>
<td>Seal, O-ring</td>
<td>124.5X3 NBR70</td>
</tr>
<tr>
<td>10</td>
<td>10349</td>
<td>7</td>
<td>Plug for Grease escape hole (both in D-end and in N-end) (horizontal and radial holes)</td>
<td>M16 x 1.5, VSTI16X1.5ED.71</td>
</tr>
<tr>
<td>11</td>
<td>10358</td>
<td>1</td>
<td>Ventilation plug</td>
<td>PMF 100444 Metal Vent</td>
</tr>
</tbody>
</table>

The bearing type depends on the Bearing insulation option selected.
12. Disposal

Dispose of the electric machine and any of its parts by appropriate means in accordance with local laws and regulations.
13. Storage, installation and maintenance checklists

Electric Machine Installation Checklist

Date:

Table 11. Machine and customer information

<table>
<thead>
<tr>
<th>Customer:</th>
<th>Machine type (from the rating plate):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer reference:</td>
<td>Machine serial number:</td>
</tr>
<tr>
<td>Service reference:</td>
<td>Date installed:</td>
</tr>
</tbody>
</table>

N.A = Procedure not applicable  PASS = Procedure passed  FAIL = Procedure failed

Table 12. Installation checklist

<table>
<thead>
<tr>
<th>Approval</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine type is correct</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Machine is undamaged</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Insulation resistance check</td>
<td>&gt;150MΩ</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Environmental conditions as specified (see data sheet)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

| Mechanical installation |     |      |      |
| Supporting structure as required | ☐ | ☐ | ☐ |
| Shaft alignment as specified (see chapter Shaft alignment and load) | ☐ | ☐ | ☐ |
| D-end attachment bolt tightening torque | 40 Nm | ☐ | ☐ | ☐ |
| N-end attachment bolt tightening torque | 30 Nm | ☐ | ☐ | ☐ |
| Cooling circuit connected and coolant flowing | ☐ | ☐ | ☐ |

| Used coolant: |     |      |      |

| Power connections |     |      |      |
| Cable gland assembly as specified (cable gland to cables) with correct cable diameter | ☐ | ☐ | ☐ |
| Cable lug air cap (to metallic structures) | ≥10 mm | ☐ | ☐ | ☐ |
| Cable gland tightening torque (to the box) | 15 Nm | ☐ | ☐ | ☐ |
| Cable lug tightening torque (to the busbar) | 13 Nm | ☐ | ☐ | ☐ |
| The phase connections order is correct (U, V, W -> L1, L2, L3) | ☐ | ☐ | ☐ |
| Connection box cover bolts tightening torque | 4 Nm | ☐ | ☐ | ☐ |
13. Storage, installation and maintenance checklists

<table>
<thead>
<tr>
<th>Grounding</th>
<th>☐</th>
<th>☐</th>
<th>☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine enclosure grounding connected</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Low voltage cable shield grounding connected</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Power cable shield connection resistances to ground (machine enclosure) measured and valid</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Low voltage cable shield grounding resistances measured and valid</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Do not try to tighten bolts or screws that are not discussed in the product manual and that are not needed for the normal installation procedures. Sealing of the screws may break.

Notes:
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Signature: ___________________________ Date: ___________________________
13. Storage, installation and maintenance checklists

Electric Machine Weekly Maintenance Checklist

Date:

Table 13. Machine and customer information

<table>
<thead>
<tr>
<th>Customer:</th>
<th>Machine type (from the rating plate):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer reference:</td>
<td>Machine serial number:</td>
</tr>
<tr>
<td>Service reference:</td>
<td>Date installed:</td>
</tr>
</tbody>
</table>

N.A = Procedure not applicable  PASS = Procedure passed  FAIL = Procedure failed

Table 14. Electric Machine Weekly Maintenance Checklist

<table>
<thead>
<tr>
<th></th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>General construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise or vibration during operation in general</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cooling system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functioning of the cooling system in general</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Notes:
- 
- 
- 
- 
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- 
- 
-
13. Storage, installation and maintenance checklists

Electric Machine Monthly Maintenance Checklist

Table 15. Machine and customer information

<table>
<thead>
<tr>
<th>Customer:</th>
<th>Machine type (from the rating plate):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer reference:</td>
<td>Machine serial number:</td>
</tr>
<tr>
<td>Service reference:</td>
<td>Date installed:</td>
</tr>
</tbody>
</table>

N.A = Procedure not applicable  PASS = Procedure passed  FAIL = Procedure failed

Table 16. Electric Machine Monthly Maintenance Checklist

<table>
<thead>
<tr>
<th>General construction</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise or vibration during operation in general</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cleanliness of the enclosure and connected parts</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical system</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weariness of the cables</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooling system</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functioning of the cooling system in general</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Tightness of the ventilation plug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cleanliness of the ventilation plug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Notes:
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## 13. Storage, installation and maintenance checklists

**Electric Machine Yearly Maintenance Checklist**

**Date:**

Table 17. Machine and customer information

<table>
<thead>
<tr>
<th>Customer:</th>
<th>Machine type (from the rating plate):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer reference:</td>
<td>Machine serial number:</td>
</tr>
<tr>
<td>Service reference:</td>
<td>Date installed:</td>
</tr>
</tbody>
</table>

N.A = Procedure not applicable  
PASS = Procedure passed  
FAIL = Procedure failed

Table 18. Yearly maintenance checklist

<table>
<thead>
<tr>
<th>General construction</th>
<th>Acceptance</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise or vibration during operation in general</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mounting bolt tightness</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D-end attachment bolt tightening torque</td>
<td>40 Nm</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>N-end attachment bolt tightening torque</td>
<td>30 Nm</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cleanliness of the enclosure and connected parts</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical system</th>
<th>Acceptance</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weariness of the cables</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Electrical connections in general</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cable gland tightening torque (to the box)</td>
<td>15 Nm</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cable lug tightening torque (to the busbar)</td>
<td>13 Nm</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Connection box cover bolts tightening torque</td>
<td>4 Nm</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooling system</th>
<th>Acceptance</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coolant flow direction changed and connection checked</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Coolant quality as specified</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Used coolant:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functioning of the cooling system in general</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Tightness of the tubing and connections (no leakages)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cleanliness of the ventilation plug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grounding</th>
<th>Acceptance</th>
<th>N.A</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power cable shield connection resistances to ground (machine enclosure) checked</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Low voltage cable shield grounding resistances checked</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Do not try to tighten bolts or screws that are not discussed in the product manual and that are not needed for the normal installation procedures. Sealing of the screws may break.
13. Storage, installation and maintenance checklists

For cleaning instructions, refer to chapter Cleaning.

Notes:
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### 13. Storage, installation and maintenance checklists

**Used service parts**

Table 19.

<table>
<thead>
<tr>
<th>Part description</th>
<th>Part type</th>
<th>Quantity</th>
<th>Item (order) number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Notes:**

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**Signature:**

**Date:**
13. Storage, installation and maintenance checklists

Electric Machine Storage Checklist

Date:

Table 20. Machine and customer information

<table>
<thead>
<tr>
<th>Customer:</th>
<th>Machine type (from the rating plate):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer reference:</td>
<td>Machine serial number:</td>
</tr>
<tr>
<td>Service reference:</td>
<td>Date installed:</td>
</tr>
</tbody>
</table>

This storage checklist is used when storing the electric machine. Regular inspection is required. See specifications for storage in this User Guide or from the Data Sheet.

Fill in the date of each inspection to the table below.

Table 21. Storage checklist

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Date</th>
<th>Date</th>
<th>Date</th>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage base as specified (vibration free)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature and humidity as specified</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine type and serial number is correct</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine supported correctly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft rotated as specified (10 rotations monthly)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
About
Danfoss Power Solutions

Danfoss Power Solutions is a global manufacturer and supplier of high-quality hydraulic and electric components. We specialize in providing state-of-the-art technology and solutions that excel in the harsh operating conditions of the mobile off-highway market as well as the marine sector. Building on our extensive applications expertise, we work closely with you to ensure exceptional performance for a broad range of applications. We help you and other customers around the world speed up system development, reduce costs and bring vehicles and vessels to market faster.

We offer you expert worldwide support for ensuring the best possible solutions for outstanding performance. And with an extensive network of Global Service Partners, we also provide you with comprehensive global service for all of our components.

Danfoss Power Solutions – your strongest partner in mobile hydraulics and mobile electrification.

Products we offer:
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- DCV directional control valves
- Electric converters
- Electric machines
- Hydrostatic motors
- Hydrostatic pumps
- Orbital motors
- PLUS+1® controllers
- PLUS+1® displays
- PLUS+1® joysticks and pedals
- PLUS+1® sensors
- PLUS+1® software services, support and training
- PLUS+1® software
- Position controls and sensors
- PVG proportional valves
- Steering components and systems
- Telematics

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