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1. General information

This manual is the installation, operation and maintenance manual for the EM-PME375-T150 and EM-PME375-T200 electric machines.

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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-PME 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-PME375-T150-XXXX+XX
- EM-PME375-T200-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 electrical machine requires a three phase power system.

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.
1. General information

Conformity according to standards

The electric machine as partly completed machinery is in conformity with the following other directive(s), harmonized standard(s) or other normative document(s), provided it/they are used in accordance with our instructions. As partly completed machinery the product itself does not have declaration of conformity but instead declaration of incorporation. This partly completed machinery must not be used before the final machinery into which it is to be incorporated has been declared in conformity with the Machinery Directive and other relevant directives.

Table 2. 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>
<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.
1. General information

Terms and abbreviations

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

Table 3. 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_{\text{rms}} )</td>
</tr>
<tr>
<td>I</td>
<td>Rated current (AC)</td>
<td>( A_{\text{rms}} )</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_{\text{max}} )</td>
<td>Maximum torque</td>
<td>Nm</td>
</tr>
<tr>
<td>n</td>
<td>Rated speed</td>
<td>rpm</td>
</tr>
<tr>
<td>( \text{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 \phi ))</td>
<td></td>
</tr>
<tr>
<td>( Q_{\text{c}} )</td>
<td>Rated coolant liquid flow</td>
<td>l/min</td>
</tr>
<tr>
<td>( T_{\text{c}} )</td>
<td>Rated coolant liquid input temperature</td>
<td>°C</td>
</tr>
<tr>
<td>( T_{\text{amb}} )</td>
<td>Rated ambient temperature</td>
<td>°C</td>
</tr>
<tr>
<td>RES_COS</td>
<td>Cosine signal received from the resolver</td>
<td>deg</td>
</tr>
<tr>
<td>RES_SIN</td>
<td>Sinusoidal signal received from the machine resolver</td>
<td>deg</td>
</tr>
<tr>
<td>GND</td>
<td>Ground in electrical connections</td>
<td></td>
</tr>
<tr>
<td>( \Omega ) (Ohm)</td>
<td>Resistance</td>
<td>( \Omega )</td>
</tr>
</tbody>
</table>

Table 4. Term / abbreviation

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolver</td>
<td>Rotation meter in electric machines, used for measuring degrees of rotation</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>PMSM</td>
<td>Permanent Magnet Synchronous Machine</td>
</tr>
<tr>
<td>SRPM</td>
<td>Synchronous Reluctance assisted Permanent Magnet</td>
</tr>
<tr>
<td>S1</td>
<td>Duty type according to the IEC60034; Continuous running duty</td>
</tr>
<tr>
<td>S9</td>
<td>Duty type according to the IEC60034; Duty with non-periodic load and speed variations</td>
</tr>
</tbody>
</table>

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.
1. General information

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>
</table>
| ![STOP](image) | Danger
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. |
| ![General warning](image) | General warning
This symbol is identified by a yellow background, black triangular band, and a black exclamation point symbol. It indicates a general potentially hazardous situation. |
| ![Electric shock warning](image) | Electric shock warning
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. |
| ![Burn warning](image) | Burn warning
The symbol is identified by a yellow background, black triangular band, and a black wavy lines-symbols. It indicates a hot device that could cause burns to a person. |
| ![Magnet warning](image) | Magnet warning
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. |
2. Safety information

Rotating rotor warning
The symbol is identified by a yellow background, black triangular band, and a black rotating rotor symbol. It indicates strong rotating rotor 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 machines have 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 electric 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.

Electromagnetic compatibility (EMC)

When interfacing other equipment, connect only equipment that are specified as part of the system and that are compatible.

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:

- Areas in which electric equipment and parts are operated
- Areas in which electric equipment with permanent magnets are stored, mounted, operated or repaired

If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.
2. Safety information

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 machine is not a complete machine as such, but it must be integrated to the other system. This requires more work and planning than normal electric machine does.

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.
- Possibility for 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.

The integrated electric machines have several frame models (sizes) to be the optimal solutions for several applications. These are iXS and iXSe frames. The electric machines also have options for temperature sensors.

### 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.

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):

---

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3. Product overview

- 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 or rotor 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.
- Touching the connection terminal of the electric machine or doing maintenance or adjustment operations on the electric machine with the electricity connected.
- Touching the connection terminal if the rotor can be turned by an external prime mover.
- Lifting the electric machine from wrong lifting points and without correct lifting equipment.
- 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**

This 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 machine efficiency at lower speeds is also good.

The supply current to the 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 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.
3. Product overview

![Machine topology diagram](image)

**Figure 1. Machine topology**

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

**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.

![Drive train system diagram](image)

**Figure 2. Overview of the Danfoss drive train system**

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.
3. Product overview

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 and N-end).
- Cooling system connections (bores).

Electrical interfaces:
- Power connections.
- Measurement connections.
- Low voltage (measurement signal) grounding connection.
- Power grounding connection.

Figure 3. Overview of electric machine system
3. Product overview

![Figure 4. Connections and interfaces](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power connections</td>
</tr>
<tr>
<td>2</td>
<td>N-end flange mounting</td>
</tr>
<tr>
<td>3</td>
<td>Low voltage connector (measurement connector), including low voltage grounding connector</td>
</tr>
<tr>
<td>4</td>
<td>Lifting points</td>
</tr>
<tr>
<td>5</td>
<td>Cooling system connections (bores)</td>
</tr>
<tr>
<td>6</td>
<td>D-end flange mounting</td>
</tr>
</tbody>
</table>
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.

**Figure 5. Rating plate**

**Table 5. Rating plate fields**

<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>V_{rms}</td>
</tr>
<tr>
<td>I</td>
<td>Rated current (AC)</td>
<td>I_{rms}</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>
3. Product overview

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

**Tightening torques**

 Tightening torque tolerances are: -10%...0% of the specified tightening torque. Exceeding the specified tightening torque is not allowed.

**Tightening torques to use unless otherwise noted**

<table>
<thead>
<tr>
<th>Thread</th>
<th>8.8</th>
<th>10.9</th>
<th>12.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>Nm</td>
<td>Nm</td>
<td></td>
</tr>
<tr>
<td>M5</td>
<td>7</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>M6</td>
<td>11</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>M8</td>
<td>27</td>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>M10</td>
<td>54</td>
<td>79</td>
<td>93</td>
</tr>
<tr>
<td>M12</td>
<td>93</td>
<td>137</td>
<td>160</td>
</tr>
<tr>
<td>M14</td>
<td>148</td>
<td>218</td>
<td>255</td>
</tr>
<tr>
<td>M16</td>
<td>230</td>
<td>338</td>
<td>395</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 shown in the rating plate and in the data sheet.

The PT100 temperature sensor characteristics are: resistance 100 $\Omega$ in 0 ºC temperature, and the resistance increases 0.385 $\Omega$ per each 1 ºC 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

Figure 6. EC-C1200

Figure 7. Schematic of the inverter powerstage

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.
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 3 flywheel housing in N-end. The D-end has a circle of bolt holes for fastening. See specific installation instructions.
4. Design principles

Figure 8. Main dimensions of the machine
4. Design principles

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_F</td>
<td>Length of the machine frame</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>
<tr>
<td>D_R</td>
<td>Diameter of the rotor connection interface</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.**

Alignment between the shaft and mating structure must be accurate.

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 9. Parallel alignment of the shaft and mating structure*

*Figure 10. Angular alignment of the shaft and mating structure*
4. Design principles

Customer connection interface design instruction

Introduction
This document describes the necessary design loads and tolerances for designing connection interface for Danfoss integrated electric machines (EM-PME375-T150 and EM-PME375-T200).

Design loads for EM-PME375-T150 rotor

\( F_{\text{mgn}} = \) Magnetic force between rotor and frame

\( G = \) Gravitational force of rotor

\( F_{\text{mgn}} = 700 \text{ N} \)

\( G = mg = 216 \text{ N} \)

*Figure 11. Design loads for EM-PME375-T150 rotor*
4. Design principles

Figure 12. Design loads for EM-PME375-T200 rotor

**Allowed axial tolerances of connection interfaces**

Electric machine type EM-PME375-T150: Dimension X = 129.6 mm ± 0.5 mm

Electric machine type EM-PME375-T200: Dimension X = 150.0 mm ± 0.5 mm
4. Design principles

Figure 13. Allowed axial tolerances

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Connection face to electric machine rotor</td>
</tr>
<tr>
<td>2</td>
<td>Connection face to electric machine frame</td>
</tr>
</tbody>
</table>
4. Design principles

Allowed concentricity tolerances of connection interfaces

1. Centerline of electric machine frame connection interface
2. Centerline of electric machine rotor connection interface

Figure 14. Allowed concentricity tolerances
4. Design principles

**Allowed angular displacement tolerances of connection interfaces**

![Diagram showing connection interfaces](image)

**Figure 15. Allowed angular displacement tolerances**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Connection face to electric machine frame</td>
</tr>
<tr>
<td>2</td>
<td>Centerline of electric machine frame connection interface</td>
</tr>
<tr>
<td>3</td>
<td>Centerline of electric machine rotor connection interface</td>
</tr>
</tbody>
</table>

**Required radial stiffness of connection interface**

When resultant force $F_{\text{tot}}$ ($F_{mgn} + G$, see Figure 1 or Figure 2) is applied to system, maximum allowed radial deformation of the rotor connection interface is 0.09mm in point P, see Figure below.

It should be noted that some components, for example bearings and gears, can cause additional flexibility to the rotor interface and it should be taken into account.
4. Design principles

Figure 16. Required radial stiffness
4. Design principles

Figure below describes how to connect the electric machine frame to the interface.

Figure 17. Frame connection
4. Design principles

Figure below describes how to connect the electric machine rotor to the interface.

Figure 18. Rotor connection
## 5. Transportation and storage

### Transportation

**Heavy equipment. Handle with care during transportation.**

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

**Do not touch the electric machine during the insulation resistance check. Discharge the electric machine afterwards.**

**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 rotor, 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.

### Lifting

- **Use correct, adequately dimensioned lifting devices and inspect them before lifting.**
- **Do not apply any excess weight on the electric machine when lifting.**
- **Use correct lifting slings. Use correct position and angle of lifting. Permissible range of lifting angles is from 0° to 30°.**
- **See the electric machine rating plate and data sheets for weight information.**
- **Lift the electric machine using the correct lifting lugs/eyes only.**
- **Do not go under a lifted load.**
5. Transportation and storage

*Figure 19. Lifting lugs/eyes for lifting slings and lifting position of the electric machine*

*Figure 20. Not allowed lifting procedures*
5. Transportation and storage

Storage

- Store the electric machine always indoors with the storage temperature above -20 ºC and the relative humidity less than 60 %.
- The storage should be dry, dust free and vibration free.
- Use anti-condensation heaters, if fitted, or direct winding heating to avoid water condensing in the electric machine.
- Do not keep the stator on its winding side down.

![Figure 21. Storing stator](image)

Extended storage

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

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:

- Areas in which electric equipment and parts are operated.
- Areas in which electric equipment with permanent magnets are stored, mounted, operated or repaired.

Risk of electric shock when working with the electric machine. Use isolated electric tools.

Only trained and qualified personnel familiar with the relevant safety requirements can work with the electric machine.

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

Read the instructions in this manual before you install the electric machine.

Required tools

Following tools are required to install the electric machine:

- Ratchet torque wrench.
- Hex head wrench kit with different metric sizes.
- Socket wrench kit with different metric sizes.
- Lifting slings with lifting eyes (with sufficient rated capacity). Size according to machine type.

Insulation resistance test

Do not touch the electric machine during the insulation resistance check. Discharge the machine afterwards.

Measure the insulation resistance of the electric machine before and after 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.
6. Installation

Mechanical installation

Allowed mounting positions

\[ X = 30^\circ \]

Figure 22. Allowed mounting position
Mounting the electric machine

Machine assembly

- The rotor has a powerful magnetic field that can cause injuries or even death. Obey these instructions when you are near the rotor.
  - Don’t put any electric devices near the rotor.
  - Don’t put any steel parts near the outer or inner surfaces of the rotor.
  - Handle the rotor carefully.
  - Use non-magnetic tools.
  - Persons with metallic, electronic or magnetic implants or devices in their body cannot go near the rotor.

- Do not put the frame near the rotor before it is connected to the hydraulic cylinder. Magnetic force can pull the frame against the flywheel housing adapter.

- Finger crushing hazard. When you work with the rotor, be careful with its strong magnetic field: do not put your fingers in between rotor and other components during the installation.

- Use correct screw preload. See the preload values below.

- Threadlocker is not included in the delivery.

Mount the electric machine on a correct supporting structure that is discussed in the chapter Customer connection interface design instruction.

Assembly procedure

1. Install flywheel adapter (2) to flywheel (1) with suitable screws (3) (not included in delivery). Use strong threadlocker (for example Loctite 278, not included in delivery). Use sufficient screw preload. Check preload from flywheel manufacturer.

2. Install flywheel housing adapter (4) to flywheel housing (1) with suitable screws (5) (not included in the delivery). Use strong threadlocker (for example Loctite 278, not included in delivery).

3. Assemble Enerpac BAD142 flange mount (6) with retainer nut (7) to Enerpac BRD-46 hydraulic cylinder (8).

4. Assemble hydraulic cylinder with flange mount to assembly tool cylinder holder (9) with M10X25 DIN 912 screws (10), 4 pcs.

5. Connect hydraulic cylinder to hydraulic hand pump with hydraulic hoses, see Enerpac instructions.

6. Assemble rotor bracket (12) to electric machine rotor (11) with M10X25 DIN 912 A4 stainless screws (13), 2 pcs.

7. Install 2 pcs. of alignment pins (14) in the electric machine rotor (11).

8. Assemble the assembly tool with Enerpac cylinder to (15) flywheel housing adapter with M10X25 DIN 912 screws (16), 4 pcs.

9. Lift the rotor carefully with lifting sling (not included in delivery) between the assembly tool (15) and the flywheel housing adapter.
6. Installation

10. Push the rotor carefully inside to flywheel housing adapter to correct position using the hydraulic cylinder.

11. Attach the rotor to the flywheel adapter with rotor connection screws (18), 10 pcs. and Nord-Lock locking washer (17), 10 pcs. Make sure that rotor aligns correctly to flywheel adapter and rotor can be rotated freely.

12. Remove the rotor bracket from the rotor and assembly tool with the Enerpac cylinder.

13. Install frame assembly pins (19), 3 pcs. to flywheel housing adapter.

14. Assemble frame bracket (20) to frame (21) in correct position with M8x25 DIN 912 screws (22), 4 pcs.

15. Install O-ring (23) in frame (21).

16. Lift the frame using frame lifting points with suitable lifting eyes (not included in delivery) and slide frame on to frame assembly pins.

17. Assemble the assembly tool with Enerpac cylinder to flywheel housing adapter with M10x25 DIN 912 screws (24), 4 pcs.

18. Connect hydraulic cylinder piston to frame bracket. Make sure that the hydraulic cylinder is retracted fully inside. Make sure that hydraulic cylinder is not pressurized.

19. Push the frame carefully inside the rotor to correct position using the hydraulic cylinder, until the frame is tightly against flywheel housing adapter. Make sure that O-ring stays in place during assembly.

20. Connect the frame to flywheel housing adapter with M8x80 DIN 7991 screws (25), 10 pcs. Use strong threadlocker (for example, Loctite 278, not included in delivery).

21. Remove:
   - Assembly tool with the Enerpac cylinder.
   - Frame bracket with connection screws.
   - Frame assembly pins.

### Installation procedure

- **Rotor has powerful magnets. Persons with pacemakers cannot go near the rotor. Keep electronic devices and credit cards clear of the rotor.**

- **Do not put your fingers between components, as they might get crushed by sudden movement of the components caused by magnetic or other forces.**

- **Refer to flywheel manufacturer instructions for the screw preload. Flywheel attachment screws are not included in the delivery.**
6. Installation

- Use strong threadlocker, for example Loctite 278. (Not included in the delivery)
- Connection interface screws are not included in the delivery.
- Brackets and installation tools not included in a standard delivery.

**Figure 23. Installation overview**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frame / Stator connection interface (for example diesel engine flywheel housing)</td>
</tr>
<tr>
<td>2</td>
<td>Rotor connection interface (for example diesel engine flywheel adapter)</td>
</tr>
<tr>
<td>3</td>
<td>Rotor of the electric machine</td>
</tr>
<tr>
<td>4</td>
<td>Frame of the electric machine</td>
</tr>
<tr>
<td>5</td>
<td>Stator attachment screws</td>
</tr>
<tr>
<td>6</td>
<td>Rotor attachment screws (Nord-Lock locking washers recommended)</td>
</tr>
<tr>
<td>7</td>
<td>Rotor bracket</td>
</tr>
<tr>
<td>8</td>
<td>Assembly tool</td>
</tr>
<tr>
<td>17</td>
<td>Frame bracket</td>
</tr>
</tbody>
</table>

Install the rotor of the electric machine (3) and the flywheel adapter (2) on the flywheel with screws (6). See chapters below.
6. Installation

**Figure 24. Rotor and flywheel installation procedure principle**

**Rotor assembly tool installation**

Install the rotor bracket (7) on the rotor. Install the rotor alignment pins (10) on the rotor if necessary. See figure below.

**Figure 25. Rotor bracket and rotor alignment pin installation**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Rotor bracket</td>
</tr>
<tr>
<td>9</td>
<td>M10X25 DIN 912 A4 screws, 2 pcs. Use stainless steel screws.</td>
</tr>
<tr>
<td>10</td>
<td>Rotor alignment pin, 2 pcs. Optional.</td>
</tr>
</tbody>
</table>

Assemble the rotor assembly tool. See figure below.
6. Installation

1. Install the rotor assembly tool (8) on the rotor (3).
2. Lift the rotor next to the frame / stator connection interface (1) with the rotor connection interface (2).
3. Attach the assembly tool on the frame / stator connection interface with screws (15).
4. Connect a hydraulic hand pump to the Enerpac BRD-46 hydraulic cylinder (11) of the rotor assembly tool.
5. Pump pressure in Enerpac BRD-46 hydraulic cylinder with the hydraulic hand pump until the rotor, frame / stator connection interface and the rotor connection interface are firmly together.
6. Fasten the rotor on the rotor connection interface with screws (6).
7. Remove the rotor assembly tool (8) and the rotor bracket when most screws are in place.
8. Install the rest of the screws as the rotor bracket prevents some of them being installed.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Enerpac BRD-46 hydraulic cylinder</td>
</tr>
<tr>
<td>12</td>
<td>M10x25 DIN 912 screws, 4 pcs</td>
</tr>
<tr>
<td>13</td>
<td>Enerpac retainer nut</td>
</tr>
<tr>
<td>14</td>
<td>Enerpac BS5904D flange mount</td>
</tr>
<tr>
<td>15</td>
<td>Assembly tool cylinder holder</td>
</tr>
</tbody>
</table>
6. Installation

![Figure 27. Rotor installation with rotor assembly tool](image)

| 21 | M10X25 DIN 912 screws, 4 pcs |

![Figure 28. Rotor and rotor connection interface installed on the flywheel](image)

**Preparations for the frame installation**

Install the frame assembly pins (16) in the frame / stator connection interface. See figure below.
6. Installation

**Figure 29. Installing frame assembly pins**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Frame assembly pin, 3 pcs</td>
</tr>
</tbody>
</table>

- Install the frame bracket (17) on the frame of the electric machine. Fasten it with screws (18).
- Install the o-ring (19).

See figure below.

**Figure 30. Frame bracket installation**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Frame bracket</td>
</tr>
<tr>
<td>18</td>
<td>M8x25 DIN 912 screw</td>
</tr>
<tr>
<td>19</td>
<td>O-ring, D400x3</td>
</tr>
</tbody>
</table>
6. Installation

Frame installation

Do not push the frame too close to the rotor before the assembly tool is installed and the hydraulic cylinder is pressurized. Magnetic force can pull the frame in forcefully and damage it.

Lift the frame next to the rotor and put in in the position shown in the figure below. Make sure that the frame assembly pins go into the correct holes of the frame.

Figure 31. Frame lifting

Figure 32. Frame position before installation

This step of the installation is very dangerous for the fingers as they can be cut off by the components moved by the magnetic forces. Do not put your fingers between the stator and rotor.

Install the assembly tool on the frame / stator connection interface and fasten it with screws. See figure below.
6. Installation

Figure 33. Assembly tool installation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>M10X25 DIN 912 screws, 4 pcs</td>
</tr>
</tbody>
</table>

See figure below.

1. Connect a hydraulic hand pump to the Enerpac BRD-46 hydraulic cylinder (11) of the rotor assembly tool.

2. Pump pressure in Enerpac BRD-46 hydraulic cylinder with the hydraulic hand pump until the frame and the frame/stator connection interface are firmly together.

3. Fasten the frame on the frame/stator connection interface with screws (20).

4. Remove the assembly tool and the frame bracket.

Figure 34. Frame fastening

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>M8 DIN 912 screw, 10 pcs (client determines the length)</td>
</tr>
</tbody>
</table>
Make sure that cooling liquid runs freely into and out from the machine.

Cooling connectors have G1/2 bores, depth 18.

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.

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.
6. Installation

Electrical installation

Power connections

High voltage connection

- **Risk of electric shock.** When you work with power connections make sure that electricity is disconnected and that the rotation of the rotor is prevented.

- **Mating connectors of the high voltage cables are not part of a standard delivery.**

- **The order of the phases is marked on the power terminal with stickers.**

**Figure 36. High voltage connection**

| 1. | **Power terminal**  
   | **Connector type:** AMPHENOL HVBI005R10AMHARD  
   | **Mating connector:** AMPHENOL HVBI-7-05R10-XFC-XXXX-FG/PC (straight plug)  
   | AMPHENOL HVBI-9-05R10-XFC-XXXX-FG/PC (right angle plug) |

**Installing the high voltage cables**

1. Remove the power terminal shield. See figure below.
2. Install the high voltage cables. Refer to the instructions of the manufacturer of the mating connectors.
3. Install the power terminal shield back.
6. Installation

![Connection Diagram](image.png)

**Figure 37. Power terminal shield**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fasteners</td>
</tr>
<tr>
<td>2</td>
<td>Power terminal shield</td>
</tr>
</tbody>
</table>

**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.

![Connection Diagram](image.png)

**Figure 38. Connection diagram**
6. Installation

Low voltage connections

The electric machine has a low voltage (measurement signal) connector which is used to read out inbuilt temperature and rotation sensor (resolver) data from the machine. The temperature data comes from PT100 sensors located in the stator windings. Check from the rating plate which pin configuration is valid. Find the configuration for temperature and resolver measurements option in rating plate type field. The electric machine has three PT100 sensors in windings as a standard option. The electrical machine has these options:

- RES1 (In-built non contacting resolver, 6-pole pair).
- TEMP4 (six PT-100 sensors).

The measurement connector includes following connector housing and pins:

- 12pin TE HDSCS for temperature surveillance
- Machine connector: TE 115645201
- Pin type at machine connector: TE 9642703 (gold plated)
- Mating female connector type: TE 117036391
- Pin type for the mating connector: TE 12413813 (use gold plated pins)

![Figure 39. Pin configuration of the machine connector TE 115645201](image)

Default pin configuration
6. Installation

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>5</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>6</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 4 PT100)</td>
</tr>
<tr>
<td>11</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 5 PT100)</td>
</tr>
<tr>
<td>12</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 6 PT100)</td>
</tr>
</tbody>
</table>

Pin configuration with resolver (RES1)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Resolver, RES_COSN</td>
</tr>
<tr>
<td>2</td>
<td>Resolver, RES_SINN</td>
</tr>
<tr>
<td>3</td>
<td>Resolver, EXCN</td>
</tr>
<tr>
<td>4</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>5</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>6</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>7</td>
<td>Resolver, RES_COSP</td>
</tr>
<tr>
<td>8</td>
<td>Resolver, RES_SINP</td>
</tr>
<tr>
<td>9</td>
<td>Resolver, EXCP</td>
</tr>
<tr>
<td>10</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 4 PT100)</td>
</tr>
<tr>
<td>11</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 5 PT100)</td>
</tr>
<tr>
<td>12</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 6 PT100)</td>
</tr>
</tbody>
</table>

Pin configuration with 6pcs of PT100 sensors (option TEMP4)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>2</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>3</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>4</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>5</td>
<td>Temperature, PT100, windings</td>
</tr>
</tbody>
</table>
6. Installation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Temperature, PT100, windings</td>
</tr>
<tr>
<td>7</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 1 PT100)</td>
</tr>
<tr>
<td>8</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 2 PT100)</td>
</tr>
<tr>
<td>9</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 3 PT100)</td>
</tr>
<tr>
<td>10</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 4 PT100)</td>
</tr>
<tr>
<td>11</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 5 PT100)</td>
</tr>
<tr>
<td>12</td>
<td>GND, Temperature, PT100, windings (corresponds to pin 6 PT100)</td>
</tr>
</tbody>
</table>

The shielded measurement cable shield can be connected to a low voltage grounding connection point. See Figure below, and Chapter Grounding connections for more information.

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.

Figure 40. The machine enclosure grounding point, safety grounding
6. Installation

![Figure 41. Low voltage cable grounding points](image)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The grounding pin of the low voltage connector.</td>
</tr>
<tr>
<td>2</td>
<td>Cable shield grounding point.</td>
</tr>
</tbody>
</table>

**Testing the power cable shield grounding (earthing)**

The power cable shields are grounded (earthed) through the connection terminal 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 is connected to the grounding (earthing) point. 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.
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]
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]
Use sufficient personal protective equipment when you are near the electric machine.

![Icon]
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.

The electric machine is designed for the following conditions:

- Ambient temperature limits: -40°C...+65°C.
- 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.
7. Operation

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.
- The maximum allowed winding temperature of the electric machine is shown in the rating plate and in the data sheet.

Recommended coolants

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

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.**
- **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.

**Table 6. 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>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></td>
<td>X</td>
</tr>
</tbody>
</table>
# 8. Maintenance

<table>
<thead>
<tr>
<th>Electrical system</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cables</td>
<td>Wearing of the cables. Replace if necessary.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Electrical connections</td>
<td>Check connections. Make sure that sufficient tightening torque is applied to cable glands. See Chapter Tightening torques.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Groundings (earthing)</td>
<td>Check groundings (earthings). Make sure that the connection resistance is valid. Re-connect if necessary.</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooling system</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td>Functioning. Cooling system functions as specified.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Tubing and connection tightness</td>
<td>No visible leakage. If leaking, tighten connections appropriately, or replace parts.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ventilation plug</td>
<td>Cleanliness. Clean if necessary See Chapter Cooling system maintenance.</td>
<td>X</td>
<td></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 Cleaning.</td>
<td>X</td>
<td></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>X</td>
<td></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.

### Cooling system maintenance

The electric machine cooling system requires certain regular maintenance activities.

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.

See chapter *Mounting the electric machine*. Dismount the electric machine in reversed order.
10. Troubleshooting

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 7. 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 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>Attachment bolts are loose.</td>
<td>Replace and tighten the bolts.</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>Contact Danfoss.</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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change the cooling flow direction to flush the cooling system from sediment possibly accumulated. See also 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 particles inside the electric machine cooling channel.</td>
<td>Try pulsating coolant to open the channels. Contact Danfoss.</td>
</tr>
<tr>
<td></td>
<td>Wrong electric 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>
<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 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>Insulation fault.</td>
<td>Measure the insulation resistance, refer to manufacturer limits. See Chapter Insulation resistance test. Replace the electric machine if necessary.</td>
</tr>
<tr>
<td>Temperature measurement failure</td>
<td>The PT100 sensor is 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 an other sensor. Contact Danfoss. See also 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 42. Service parts](image)

Table 8. Service parts

<table>
<thead>
<tr>
<th>Position</th>
<th>Part</th>
<th>Order number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HV connector (standard option). AMPHONEL ART. NO. HVBI005R10AMHARD</td>
<td>14977</td>
</tr>
<tr>
<td></td>
<td>HV connector (+HVC1 - option). AMPHENOL ART. NO. HVBI003R8AMHARD19127101</td>
<td>15687</td>
</tr>
<tr>
<td>2</td>
<td>Seal for HV connector plate. T=3</td>
<td>14965</td>
</tr>
<tr>
<td>3</td>
<td>LV connector. TE 1-1564520-1 12 PIN ASSEMBLY FOR 3mm PLATE</td>
<td>11033</td>
</tr>
<tr>
<td>4</td>
<td>Seal for LV connector plate. SEAL. GASKET. T=3</td>
<td>14956</td>
</tr>
</tbody>
</table>
12. Disposal

Dispose of the electric machine and any of its parts by appropriate means in accordance with local laws and regulations.
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.

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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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