ENGINEERING
TOMORROW

User Guide

Motor / Generator
EM-PMI540B

www.danfoss.com

Revision history

Table of revisions

Date	Changed	Rev
August 2024	First edition	0101

Contents

Contents

General information

Intended use of the user guide

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

This user guide uses illustrations as examples only. Illustrations in this user guide 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-PMI540B-T1500-XXXX+XX
- EM-PMI540B-T2000-XXXX+XX
- EM-PMI540B-T3000-XXXX+XX
- EM-PMI540B-T4000-XXXX+XX

The naming codes of the electric machine

Part of the name	Meaning
EM	Electric Machine
PMIXXX or PMEXXX	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
TXXXX	Average continuous torque of the motor range, relative to the length of the machine
XXXX	Rated rotation speed
+XX	Options. Standard options are indicated by a star (*).

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-PMI540B-T3000-2000-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. For detailed information on the models, options and characteristics, see product-specific data sheet.

General information

EM-PMI540B-T1500 options

Variant	Code	Description	Additional information
High voltage connections	-DUAL	Two galvanically isolated 3 phase systems	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
Connection extension	*	None	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
	+CE1	Double phase connections	Extended connection boxes with two M32 cable glands per phase
Low voltage connections (signal and auxiliaries)	*	Low voltage connections done with connector	See Connections section of the data sheet
	+LVB1	Low voltage connections done with connection box and terminal strip	D-end: LV connection box with 1xM16 cable gland + terminal strips N-end: LV connection box with 1xM25, 2xM16 and 1xM12 cable glands + terminal strips
Foot mounting	*	None	
	+FM1	Foot	Foot mounting, shaft height 315 mm
N-end attachment	*	None	
	+NE4	Male shaft, no flange	DIN 5480 W55x2x26x8f D-end shaft length changes from 80 mm to 100 mm with this option
Bearing insulation	*	Non-insulated bearings	Non-insulated bearings
	+BIN	Insulated bearing in N-end	Insulated bearing in N-end
	+BIA	Insulated bearing in both ends	Insulated bearing in both ends
Shaft grounding	*	None	No shaft grounding
	+SG1	D-end shaft grounding	Inbuilt grounding ring
Rotation sensor (resolver)	*	None	No resolver
	+RES1	Resolver	Inbuilt non-contacting resolver, 8-pole pair
	+RES2	Double resolver	Inbuilt non-contacting resolver, 8-pole pair
Winding temperature sensor (**	*	Redundant temperature surveillance	6 x PT100 (two wire) in windings
	+TEMP5	Redundant temperature surveillance	12 x PT100 (two wire) in windings
Bearing temperature sensor	*	None	
	+BTMP1	PT100 in bearings	Plugin connector
Anti-condensation heaters	*	None	
	+HEAT1	One anti-condensation heater	230 V_{AC} / 130 W
Machine coating	*	None	
	+C5	High corrosion category	Type of coating: Epoxy Minimum number of coats (MNOC): 2 Minimum nominal dry film thickness: 240 µm

General information

EM-PMI540B-T2000 options

Variant	Code	Description	Additional information
High voltage connections	-DUAL	Two galvanically isolated 3 phase systems	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
Connection extension	*	None	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
	+CE1	Double phase connections	Extended connection boxes with two M32 cable glands per phase
Low voltage connections (signal and auxiliaries)	*	Low voltage connections done with connector	See Connections section of the data sheet
	+LVB1	Low voltage connections done with connection box and terminal strip	D-end: LV connection box with 1xM16 cable gland + terminal strips N-end: LV connection box with 1xM25, 2xM16 and 1xM12 cable glands + terminal strips
Foot mounting	*	None	
	+FM1	Foot	Foot mounting, shaft height 315 mm
N-end attachment	*	None	
	+NE4	Male shaft, no flange	DIN 5480 W55x2x26x8f
Bearing insulation	*	Non-insulated bearings	Non-insulated bearings
	+BIN	Insulated bearing in N-end	Insulated bearing in N-end
	+BIA	Insulated bearing in both ends	Insulated bearing in both ends
Shaft grounding	*	None	No shaft grounding
	+SG1	D-end shaft grounding	Inbuilt grounding ring
Rotation sensor (resolver)	*	None	No resolver
	+RES1	Resolver	Inbuilt non-contacting resolver, 8-pole pair
	+RES2	Double resolver	Inbuilt non-contacting resolver, 8-pole pair
Winding temperature sensor (**	*	Redundant temperature surveillance	6 x PT100 (two wire) in windings
	+TEMP5	Redundant temperature surveillance	12 x PT100 (two wire) in windings
Bearing temperature sensor	*	None	
	+BTMP1	PT100 in bearings	Plugin connector
Anti-condensation heaters	*	None	
	+HEAT1	One anti-condensation heater	230 V_{AC} / 130 W
Machine coating	*	None	
	+C5	High corrosion category	Type of coating: Epoxy Minimum number of coats (MNOC): 2 Minimum nominal dry film thickness: 240 µm

General information

EM-PMI540B-T3000 options

Variant	Code	Description	Additional information
High voltage connections	-DUAL	Two galvanically isolated 3 phase systems	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
	-QUAD	Four galvanically isolated 3 phase systems	Four connection boxes each containing one 3 phase system with one M32 cable gland per phase
Low voltage connections (signal and auxiliaries)	*	Low voltage connections done with connector	See Connections section of the data sheet
	+LVB1	Low voltage connections done with connection box and terminal strip	D-end: LV connection box with 1xM16 cable gland + terminal strips N-end: LV connection box with 1xM25, 2xM16 and 1xM12 cable glands + terminal strips
D-end shaft	*	Male shaft, cylindrical	Cylindrical shaft, diameter 70 mm h7
	+S3	Male shaft, spline	DIN 5480 W70x2x30x34x8f
N-end shaft	*	None	
	+NE4	Male shaft, no flange	Cylindrical shaft, diameter 70 mm h7 (standard) DIN 5480 W70x2x30x34x8f (+S3)
Foot mounting	*	None	
	+FM1	Foot	Foot mounting, shaft height 315 mm
Bearing insulation	*	Non-insulated bearings	Non-insulated bearings
	+BIN	Insulated bearing in N-end	Insulated bearing in N-end
	+BIA	Insulated bearing in both ends	Insulated bearing in both ends
Shaft grounding	*	None	
	+SG1	D-end shaft grounding	Inbuilt grounding ring
Rotation sensor (resolver)	*	None	No resolver
	+RES1	Resolver	Inbuilt non-contacting resolver, 8-pole pair
	+RES2	Double resolver	Inbuilt non-contacting resolver, 8-pole pair
Winding temperature sensor (**	*	Redundant temperature surveillance	12 x PT100 in the windings
	+TEMP5	Redundant temperature surveillance	24 x PT100 in the windings
Bearing temperature sensor	*	None	No temperature sensors
	+BTMP1	PT100 in bearings	Plugin connector
Anti-condensation heaters	*	None	
	+HEAT2	Two anti-condensation heaters	2 x 230 V_{AC} / 130 W
Machine coating	*	None	
	+C5	High corrosion category	Type of coating: Epoxy Minimum number of coats (MNOC): 2 Minimum nominal dry film thickness: 240 µm

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EM-PMI540B-T4000 options

Variant	Code	Description	Additional information
High voltage connections	-DUAL	Two galvanically isolated 3 phase systems	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
	-QUAD	Four galvanically isolated 3 phase systems	Four connection boxes each containing one 3 phase system with one M32 cable gland per phase
Low voltage connections (signal and auxiliaries)	*	Low voltage connections done with connector	See Connections section of the data sheet
	+LVB1	Low voltage connections done with connection box and terminal strip	D-end: LV connection box with 1xM16 cable gland + terminal strips N-end: LV connection box with 1xM25, 2xM16 and 1xM12 cable glands + terminal strips
D-end shaft	*	Male shaft, cylindrical	Cylindrical shaft, diameter 70 mm h7
	+S3	Male shaft, spline	DIN 5480 W70x2x30x34x8f
N-end shaft	*	None	
	+NE4	Male shaft, no flange	Cylindrical shaft, diameter 70 mm h7 (standard) DIN 5480 W70x2x30x34x8f (+S3)
Foot mounting	*	None	
	+FM1	Foot	Foot mounting, shaft height 315 mm
Bearing insulation	*	Non-insulated bearings	Non-insulated bearings
	+BIN	Insulated bearing in N-end	Insulated bearing in N-end
	+BIA	Insulated bearing in both ends	Insulated bearing in both ends
Shaft grounding	*	None	
	+SG1	D-end shaft grounding	Inbuilt grounding ring
Rotation sensor (resolver)	*	None	No resolver
	+RES1	Resolver	Inbuilt non-contacting resolver, 8-pole pair
	+RES2	Double resolver	Inbuilt non-contacting resolver, 8-pole pair
Winding temperature sensor (**	*	Redundant temperature surveillance	12 x PT100 in the windings
	+TEMP5	Redundant temperature surveillance	24 x PT100 in the windings
Bearing temperature sensor	*	None	No temperature sensors
	+BTMP1	PT100 in bearings	Plugin connector
Anti-condensation heaters	*	None	
	+HEAT2	Two anti-condensation heaters	2 x 230 V_{AC} / 130 W
Machine coating	*	None	
	+C5	High corrosion category	Type of coating: Epoxy Minimum number of coats (MNOC): 2 Minimum nominal dry film thickness: 240 µm

*(** Winding temperature sensors are for stator winding. The selection of high voltage connections does not have an influence on the quantity of PT100 elements.*

General information

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:

Applicable directives and standards

Standard	Explanation
Low Voltage Directive 2006/95/EC (until 19.4.2016) and Low Voltage Directive 2014/35/EU (from 20.4.2016 onwards)	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.
IEC 60034-1:2010	Rotating electrical machines - Part 1: Rating and performance
IEC 60034-5:2001/A1:2007	Rotating electrical machines - Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification
IEC 60034-6:1991	Rotating electrical machines - Part 6: Methods of cooling
IEC 60034-7:1992/A1:2001	Rotating electrical machines - Part 7: Classification of types of construction, mounting arrangements and connection box position (IM Code)
IEC 60034-8:2007/A1:2014	Rotating electrical machines - Part 8: Terminal markings and direction of rotation
IEC 60034-14:2004/A1:2008	Amendment 1 - Rotating electrical machines - Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of vibration severity.

It should be noted, that the commissioning party is responsible for establishing the conformity of the end product with the Directive 2006/42/EC, when the EM-PMI electric machines are fitted into machinery.

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.

Symbols

Symbol	Variable	Unit
U	Rated voltage (phase-to-phase AC)	V_{rms}
I	Rated current (AC)	A_{rms}
P	Rated Power (S1)	kW
T	Rated torque (S1) at rated speed	Nm
T_{max}	Maximum torque	Nm

General information

Symbols (continued)

Symbol	Variable	Unit
n	Rated speed	rpm
Max n	Maximum speed	rpm
f	Rated supply frequency at nominal speed	Hz
PF	Power factor (cosφ)	
Q_c	Rated coolant liquid flow	l/min
T_c	Rated coolant liquid input temperature	°C
T_{amb}	Rated ambient temperature	°C
RES_COS	Cosine signal received from the resolver	deg
RES_SIN	Sinusoidal signal received from the machine resolver	deg
Ω (Ohm)	Resistance	Ω

Term / abbreviation

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

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 user guide.
- The electric machine is installed, maintained and serviced in accordance with the instructions in this user guide.

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 user guide, 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 user guide and on the electric machine.

	**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** **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** **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** **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.** **The symbol also indicates that the device should be placed and installed so that contact with its potentially hot surface is not possible.**

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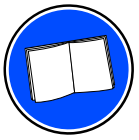
	**Magnet warning** **The symbol is identified by a yellow background, black triangular band, and a black magnet symbol. It indicates strong magnetic field that could cause harm to a person or property.**
	**Rotating shaft warning** **The symbol is identified by a yellow background, black triangular band, and a black rotating shaft symbol. It indicates strong rotating shaft that could cause harm to a person or property.**
	**General Information.**
	**Read the instructions in the user guide.**

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 machine. 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 number of the temperature sensors in the windings of the electric machine follows the requirements of the standards. The amount of the sensors depends on the options chosen. The temperature signal(s)

Safety information

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.

The electric machine can be ordered with bearing temperature measurement. This option includes one PT100 temperature sensor (four wire) 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 (2 pcs) 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)

	**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**.

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 user guide to achieve the required level of EMI protection.

It is the responsibility of the installer to make sure 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 2014/30/EU.

Product overview

	**This user guide is about four electric machines:** • **EM-PMI540B-T1500** • **EM-PMI540B-T2000** • **EM-PMI540B-T3000** • **EM-PMI540B-T4000**
	**For harsh conditions, like salty air in marine applications, it is recommended to check the surface treatment possibilities with the factory.**

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:

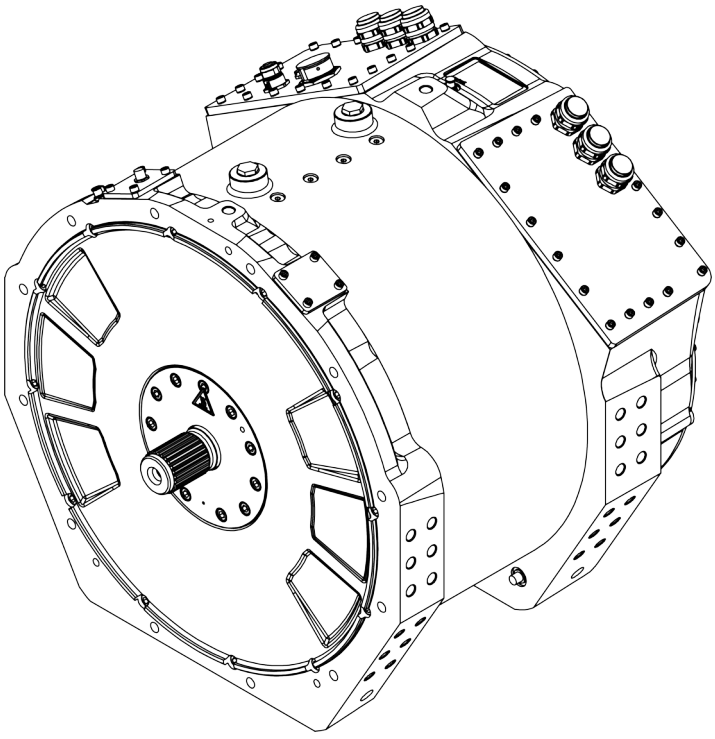
- Motor (electric propulsion) and generator for hybrid marine vessels or mobile work machines and bus parallel hybrid applications.
- Traction motor and generator for electrical or hybrid electrical mobile work machines or buses.

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

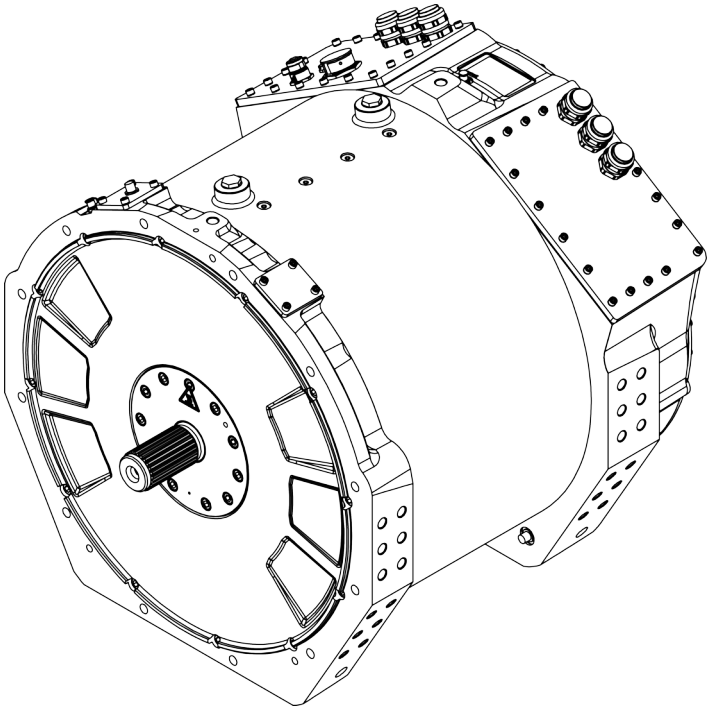
- Extremely compact and robust structure.
- High efficiency throughout the operation range.
- Liquid cooling with water-glycol mixture.
- Low coolant flow required.
- High allowed coolant temperature.
- IP67 enclosure class to maximize reliability.
- Multiple mounting possibilities.
- Extended speed 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.

Product overview

EM-PMI540B-T1500

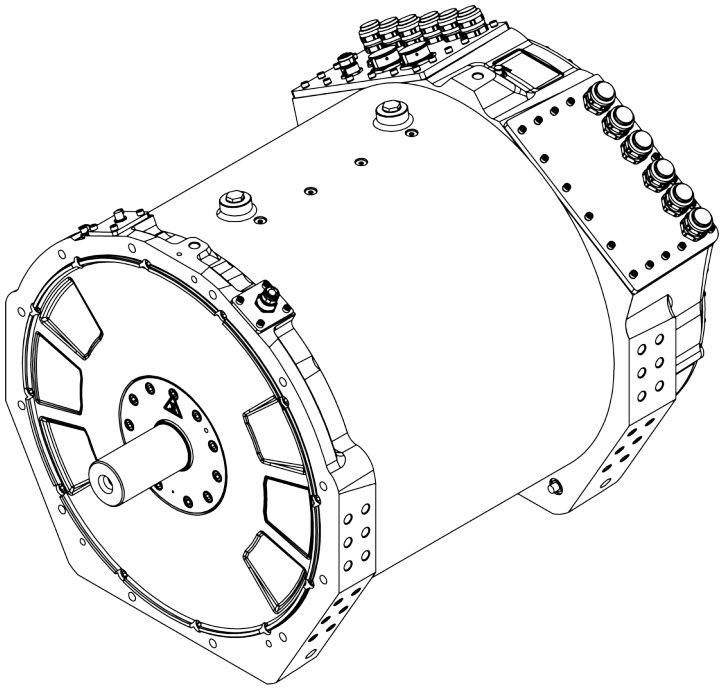


EM-PMI540B-T2000

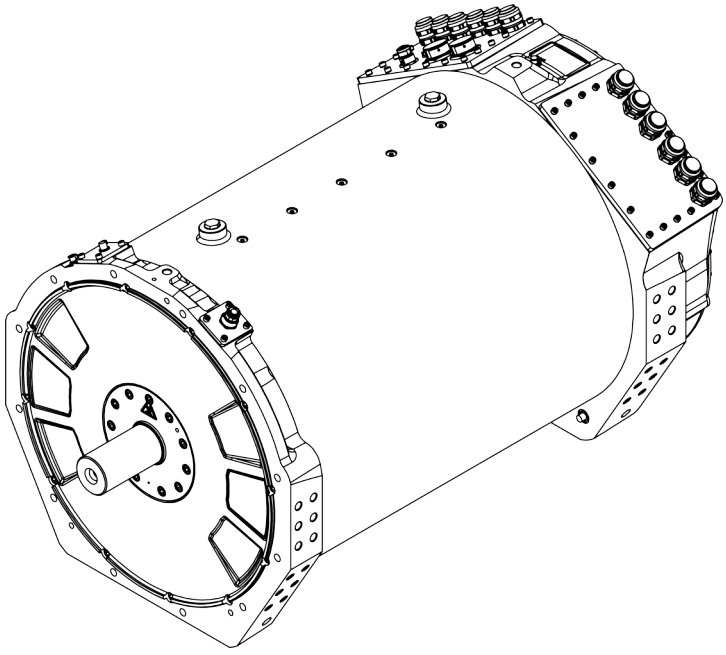


Product overview

EM-PMI540B-T3000



EM-PMI540B-T4000



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.

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:

Product overview

- 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.

Forbidden 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 user guide.
- Disregarding the obligation to comply with the user guide, safety signs and rating plate of the electric machine.
- Using the electric machine, making adjustments and maintenance without first reading this user guide.
- 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 user guide 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.
- Touching the connection terminal of the electric machine or doing maintenance or adjustment operations on the electric machine with the electricity connected.
- 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

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.

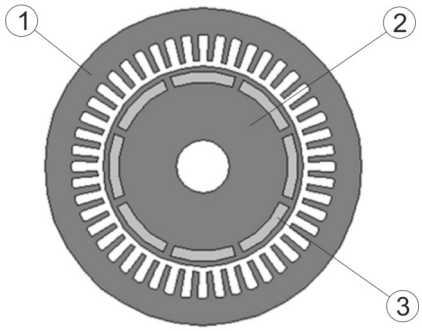
The supply current to the machine stator windings create rotating magnetic field, which in turn rotates the rotor containing permanent magnets. In the synchronous permanent magnet machine, the rotation

Product overview

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.

Machine topology

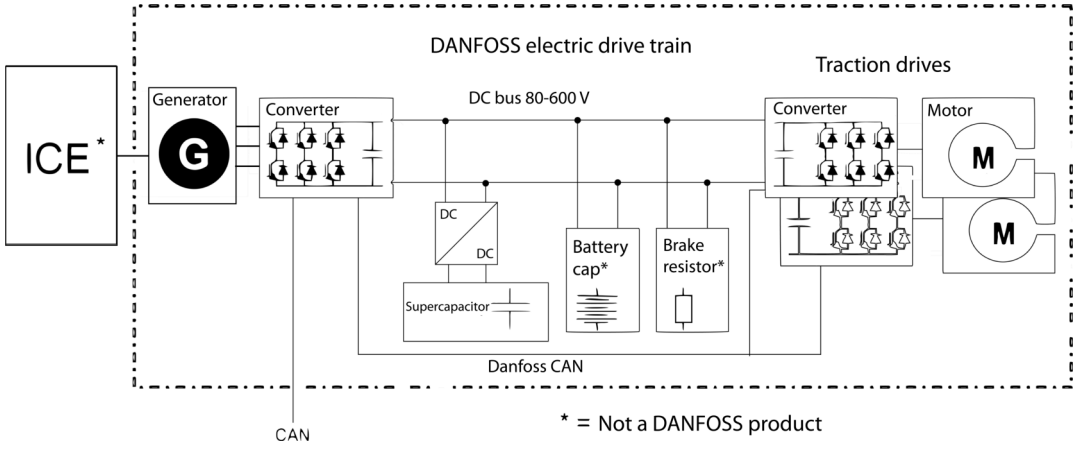


1	Electric machine stator and stator windings
2	Electric machine rotor
3	Permanent magnets in the rotor

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 for converting from traditional to hybrid electric (HEV) or electric vehicle (EV) solutions. Danfoss technology saves fuel and lowers emission and noise levels.

Overview of the Danfoss drive train system

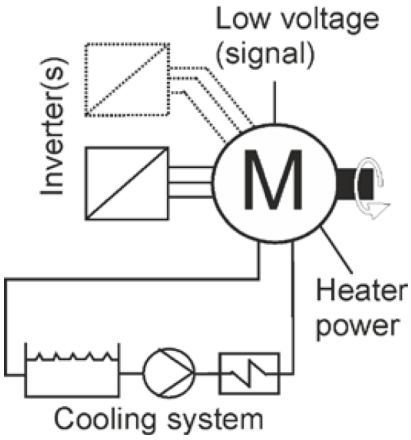


The electric machines are liquid cooled with water-glycol mixture. For more information, see Chapter *Cooling connections*.

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*.

Product overview

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:

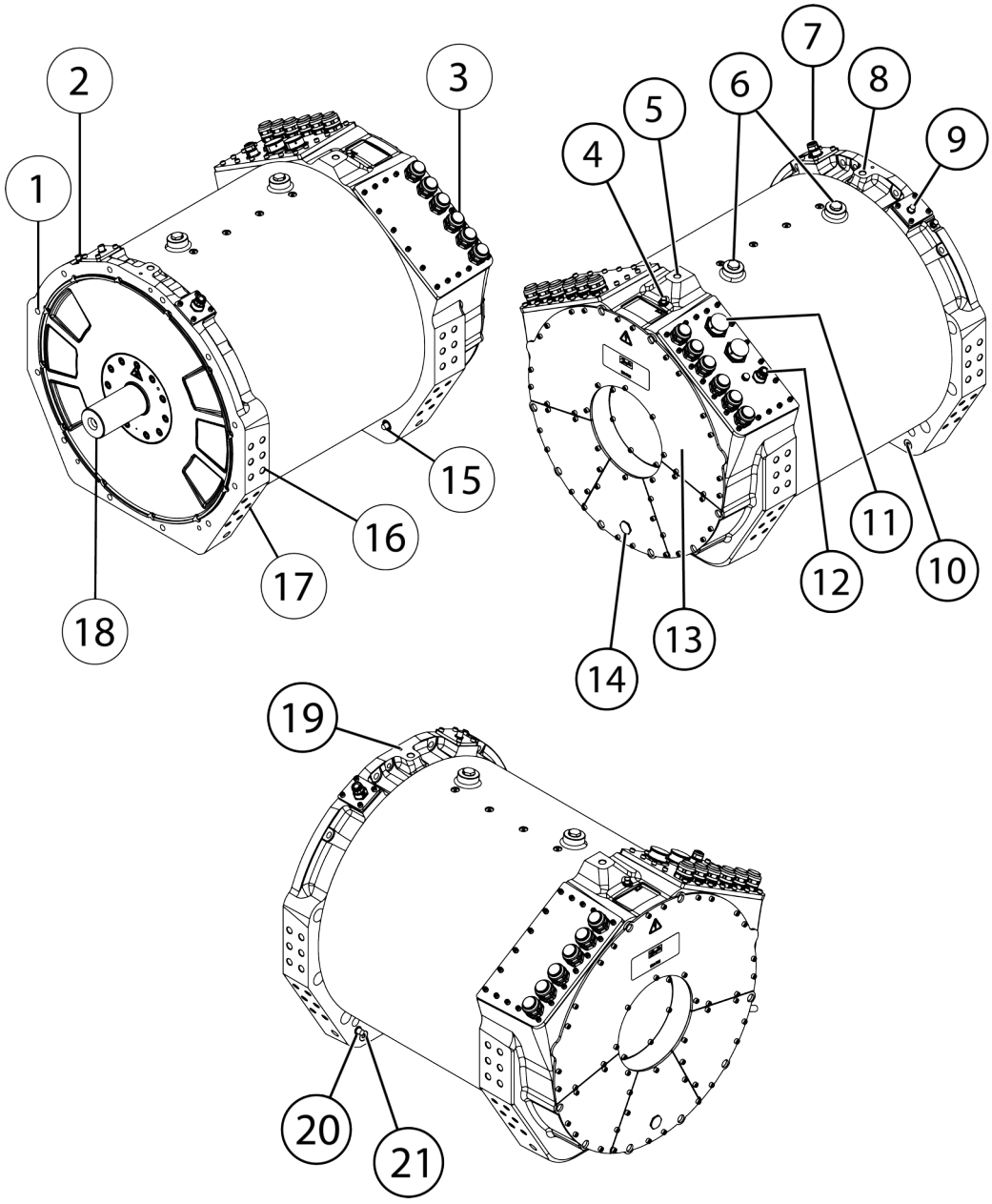
- Lifting eyes.
- Foot mounting and additional flange connection (D-end).
- Shaft connection.
- Cooling system connections (bores).
- Grease escape/fill connections; maintenance use only.
- Air ventilation plug.
- Vibration sensor connection point.

Electrical interfaces:

- Power connections through the connection box.
- Measurement connector (connection through the connection box) / Measurement signal connectors.
- Anti-condensation heater connection (+HEAT1) (through the connection box) / Anti-condensation heater connections (+HEAT2 option).
- Bearing temperature connectors (+BTMP1 option).
- Leakage sensor connectors.

Product overview

Connections and interfaces



1	Mounting bores (12 pcs)
2	Grease inlet D-end bearing (DIN 71412)
3	Power connection
4	Grease inlet N-end bearing (DIN 71412)
5	Lifting point
6	Cooling system connection
7	Optional: Anti-condensation heater connector
8	Lifting point
9	Bearing temperature measurement connector
10	Grease escape connection (alternative to item 21)

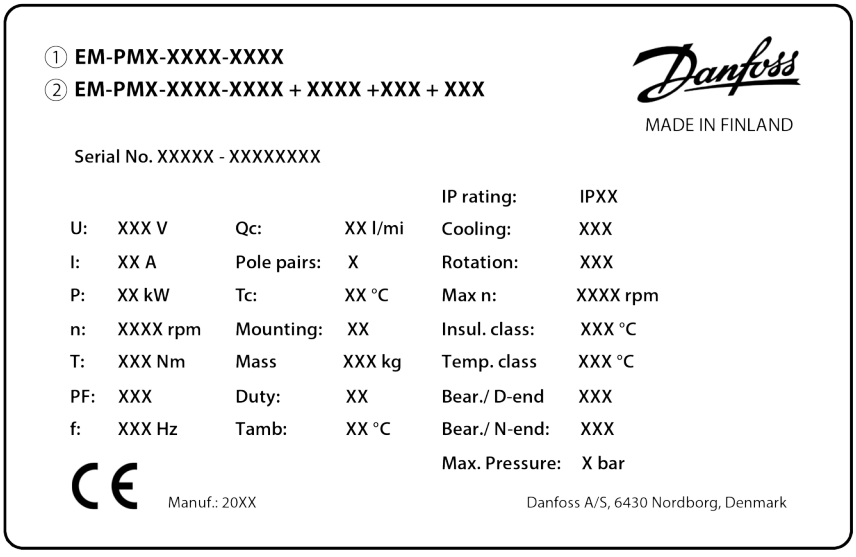
Product overview

11	Low voltage connector - winding temperature sensors and resolver connections - bearing temperature measurement sensor connector
12	Anti-condensation heater connector
13	Connection boxes
14	Grease escape connection
15	Leakage sensor connection
16	Side mounting bores
17	Foot / V- mounting bores
18	Shaft connection
19	Vibration sensor connection
20	Leakage sensor connection
21	Grease escape connection (alternative to item 10)

Rating plate

Each electric machine has a rating plate which can be found on the machine frame. 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



Rating plate fields

Field	Explanation	Unit
1	Electric machine product family: EM-PMI or EM-PME	
2	Electric machine type code and options	
Serial No.	Serial number	
U	Rated voltage (phase-to-phase AC)	V_{rms}
I	Rated current (AC)	I_{rms}
P	Rated power (S9) according to IEC60034-1	kW

Product overview

Rating plate fields (continued)

n	Rated speed	rpm
T	Rated torque (S9) at rated speed	Nm
PF	Power factor	
f	Rated supply frequency at nominal speed	Hz
Q_c	Rated coolant liquid flow	l/min
Pole pairs	Number of magnetic pole pairs of the machine	
T_c	Rated coolant liquid input temperature	°C
Mounting	Allowed mounting position according to IEC60034-7	
Mass	Mass of the electric machine	kg
Duty	Defined rotating electric machine duty cycles by IEC60034-1 standard	
T_{amb}	Rated ambient temperature	°C
IP rating	Enclosure class according to IEC60034-5	
Cooling	Cooling method according to IEC60034-6	
Rotation	Direction of rotor rotation with default phase order. Observed facing the D-end.	
Max n	Maximum rotation speed	rpm
Insul. class	Temperature rating (class) of insulation of the electric machine according to IEC60034-1	
Temp. class	Temperature rating (class) of individual insulation materials of the insulation according to IEC60034-1	
Bear. / D-end	Bearing type (types) in the D-end of the electric machine	
Bear. / N-end	Bearing type in the N-end of the electric machine	
Max. pressure	Cooling liquid max pressure	
CE	CE marking	

Tightening torques

	**Tightening torque tolerance is +/- 5 % of the specified tightening torque, unless otherwise stated.**
	**Use threadlocking adhesive for RST, that is, stainless steel bolts to avoid breakage.**
	**Do not install dry screws or other fastening equipment.** **Add suitable lubrication, for example Wuerth HSP 1400, to prevent excess friction.**

Connection	**Tightening torque**
Connection box (High voltage boxes at N-end) cover plate screws, M6	11 Nm
Low voltage box cover plate screws, M6 (only if +LVB1)	11 Nm
Cable lug	15 Nm

Product overview

Tightening torques for different mounting options

	V & S (M16)	**Feet (M16)**	**Flange (M12)**
Torque (Nm)	235	280	80
Bolt strength class	10.9	10.9	8.8

Values in the table are calculated with:

- All mountings: hardened washers under bolt head
- Feet & Flange mounting: 0.12 friction factor under bolt head and in the thread
- V & S mounting: 0.12 friction factor under bolt head and 0.14 friction factor in the thread
- V & S mounting: 24 mm thread engagement

Tightening torques to use unless otherwise noted

	8.8	10.9	12.9
Thread	Nm	Nm	Nm
M5	7	10	11
M6	11	17	19
M8	27	40	47
M10	54	79	93
M12	93	137	160
M14	148	218	255
M16	230	338	395

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 medium flows freely in and out from the electric machine with the cooling medium flow equal or higher than rated.**
	**The cooling medium 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 electric machine rating plate.

The number of the temperature sensors in the windings of the electric machine follows the requirements of the standards. The amount of the sensors depends on the options chosen. The temperature signal(s) can be read out from the measurement connector of the electric 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 Ω at 0°C temperature, and the resistance increases 0.385 Ω per each 1°C increase of temperature.

Insulation lifetime

	**Heat cycles, environment, moisture, vibrations and similar variables have an effect on the lifetime expectancy of the insulation of the electric machine. The value of the insulation lifetime expectancy is a calculated value and it is not tested in practice.**

The insulation of the electric machine has the following lifetime expectancy.

Design principles

Insulation class	Lifetime expectancy
F (150°C)	20 000 h
H (175°C)	20 000 h 100 000 h if driven with maximum winding temperature of 150°C

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 electric machine is driven with an inverter from a 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:

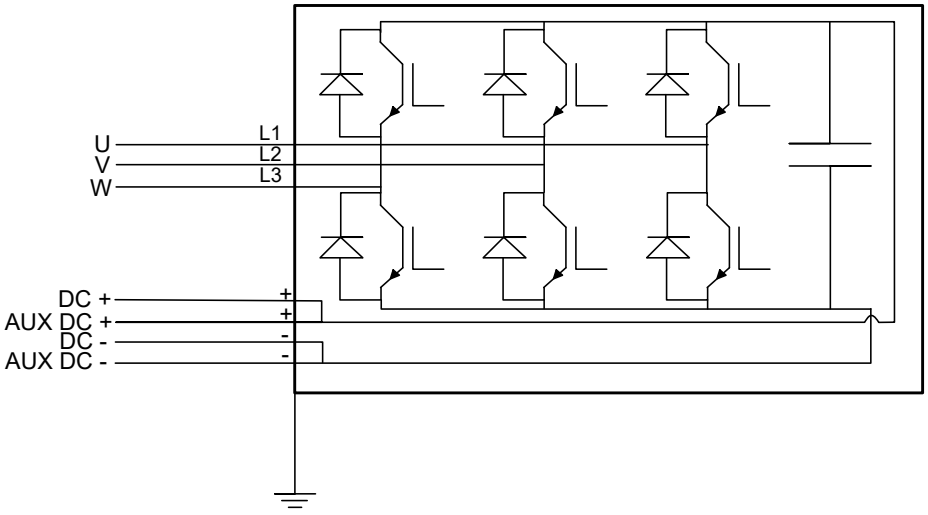
- Compact and light.
- Liquid cooled.
- Tolerant to high mechanical vibration (10 G) and shock (50 G).
- Efficient, efficiency > 98 %.
- Reliable, no moving components.

	**Do not exceed the maximum rotation speed of the electric machine.**

EC-C1200

Design principles

Schematic of the inverter powerstage



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

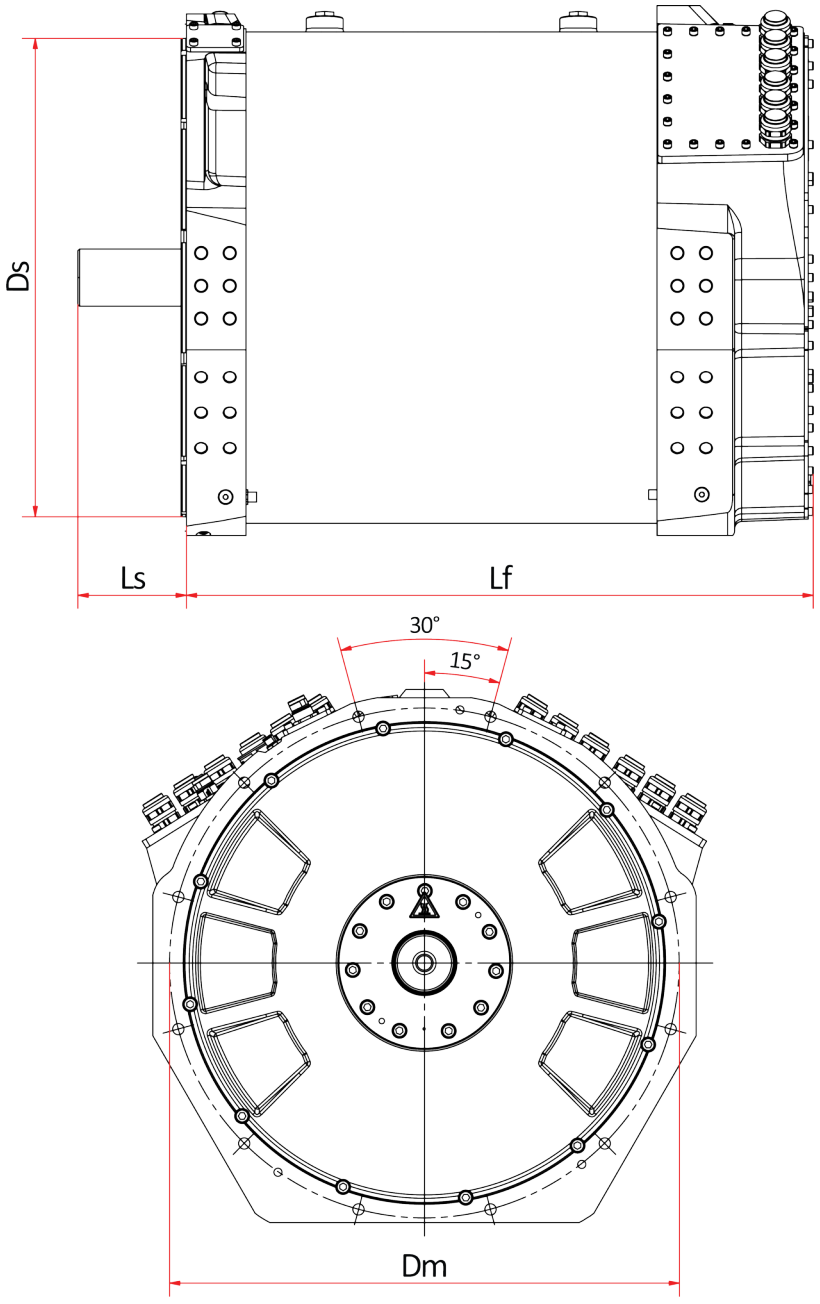
The supporting structure for the electric machine must be such that the electric machine can be mounted using its allowed mounting positions, see Chapter *Allowed mounting positions*.

The mounting space must be adequate for the electric 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 transmission housing D-end flange. A SAE 1/2 flywheel housing is required as mating flange. The connection boxes are connected to N-end.

Design principles

Main dimensions of the electric machine



Symbol	Explanation
L_F	Length of the electric machine frame.
L_S	Length of the shaft (from the end of the shaft to the electric machine D-end mounting shoulder).
D_M	Diameter of the flange mounting bore circle.
D_S	Diameter of the mounting shoulder.

Design principles

Electric machine measurements

Measurement (mm)	T1500	T2000	T3000	T4000
Lf	534	614	766	1014
Ls	80.5	100.5	132.5	132.5
Dm	ø 619.12	ø 619.12	ø 619.12	ø 619.12
Ds	ø 584.2	ø 584.2	ø 584.2	ø 584.2

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.
Use of flexible coupling is recommended. Flexible coupling does not compensate for excessive misalignment, so proper alignment must be ensured regardless of the coupling type used.

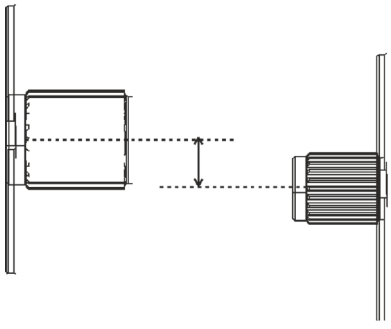
For electric machines EM-PMI540B-T1500 and EM-PMI540B-T2000, the type of the electric machine shaft is DIN 5480 W55x2x26x8f. The flange type is SAE 1/2 transmission housing.

For electric machines EM-PMI540B-T3000 and EM-PMI540B-T4000, 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. Flexible coupling does not compensate for excessive misalignment.

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.

Parallel alignment of the shaft and mating structure



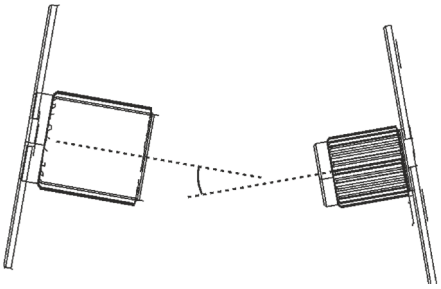
Maximum parallel misalignment values

	Non-flexible coupling *	Flexible coupling *
rpm	**mm**	**mm**
0-1000	0.07	0.13
1000-2000	0.05	0.10
2000-3000	0.03	0.07
3000-4000	0.02	0.05
4000-6000	< 0.02	0.03

* The values given might differ between coupling types.

Design principles

Angular alignment of the shaft and mating structure



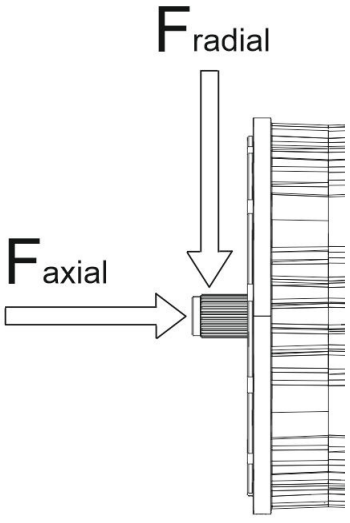
Maximum angular misalignment values

	Non-flexible coupling *	**Flexible coupling ***
rpm	**mm / 100 mm**	**mm / 100 mm**
0-1000	0.06	0.10
1000-2000	0.05	0.08
2000-3000	0.04	0.07
3000-4000	0.03	0.06
4000-6000	< 0.03	0.05

* The values given might differ between coupling types.

The maximum external force directed to the shaft axially and radially may not exceed machine specific values. For more information, see document DOC-000454. Calculate the relevant values with the help of the document.
Contact Danfoss service at *https://danfosseditron.zendesk.com/hc/en-gb* or send email to editron.service@danfoss.com to obtain the document.

External shaft forces of the electric machine



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, fails 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.**
	**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 not be rotated.**
	**Remove the transportation supports of the electric machine.**

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 electric machine upon arrival, or before installing the electric machine. Reference value of 500 MΩ shall be exceeded in room temperature, otherwise contact Danfoss representative. Refer to Chapter *Insulation resistance test* on page 36.
- Remove any shaft locks and rotate the shaft. It is normal for the rotation of the shaft to be difficult.

Lifting

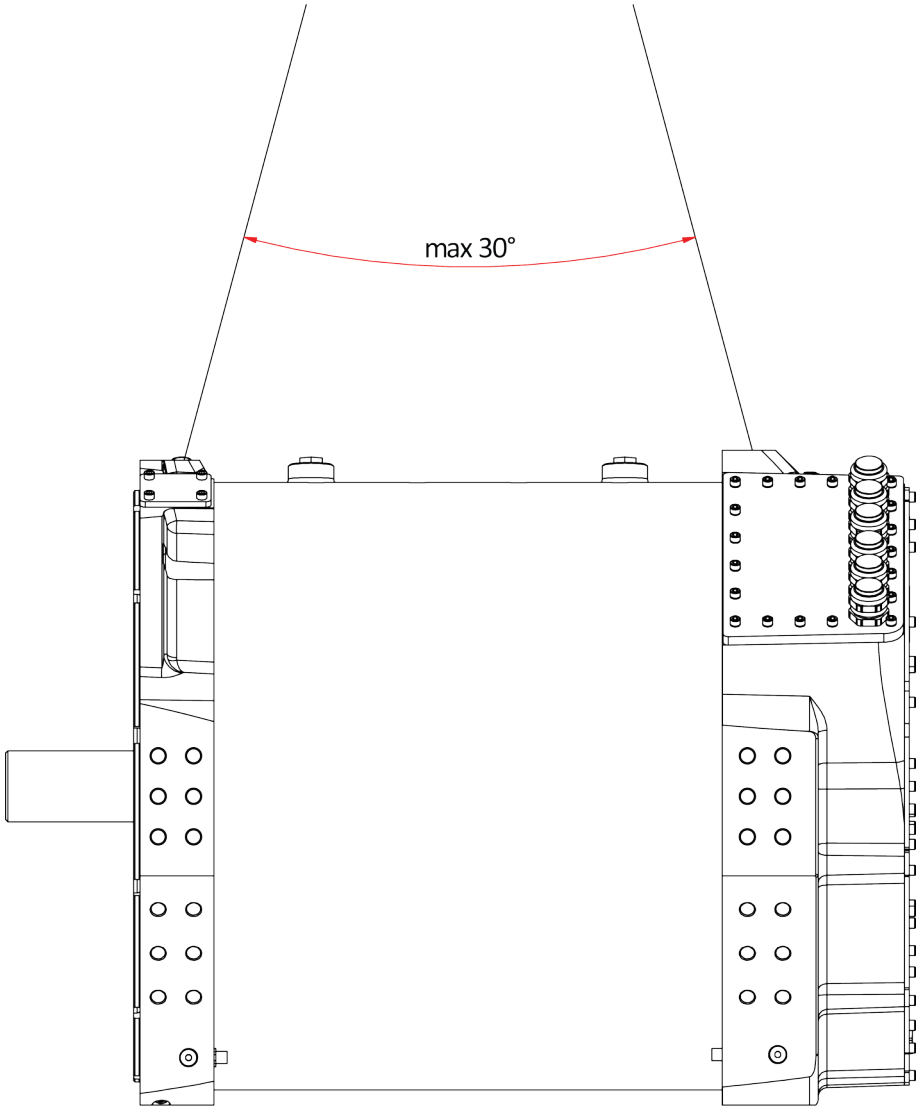
	**Use correct, adequately dimensioned lifting devices and inspect them before lifting.**
	**Do not lift from the shaft of the electric machine!**

Transportation and storage

	**Do not apply any excess weight on the electric machine when lifting.**
	**Use correct lifting slings. Use correct position and angle of lifting.**
	**See the electric machine rating plate for weight information.**
	**Lift the electric machine using the correct lifting lugs/eyes only.**
	**Do not go under a lifted load.**
	**Lifting slings cannot touch the electric machine during the lifting.**

Transportation and storage

Lifting lugs/eyes/points for lifting slings and lifting position of the electric machine



Lifting eye type: e.g. RUD VLBG-Plus-2t M16 (2 pcs)

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.

Storage

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

Transportation and storage

Keep the electric machine on a correct base. Support the electric machine to prevent accidental turning and falling.

- Always store the electric machine indoors. Storage temperature must be above -20°C and 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.
- To avoid water condensing in the electric machine, use anti-condensation heater(s), if fitted, or direct winding heating to keep the machine temperature above dew point.
- Rotate the shaft of the electric machine by hand monthly at least ten revolutions to prevent grease migration. If necessary use a tool such as a spanner. Do not damage the shaft in any case.

Extended storage

Electric machines equipped with relubricable bearings: apply grease before and after long term storage.

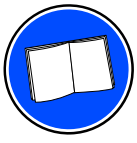
It is recommended to inspect the electric machine in storage at periodic intervals. Use attached storage checklist.

Rotate the shaft of the electric machine once a month.

Keep the electric machine in its installation position while in storage. For example, vertically installed electric machines should be stored in vertical position.

Installation

The following safety and information related symbols appear in this user guide and on the electric machine.

	**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.**
	**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 user guide before you install the electric machine.**

Installation

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 and crimping.
- Lifting slings with sufficient rated capacity.
- Lifting eyes. Size according to machine type. See Chapter *Lifting* on page 31.

Insulation resistance test

	**Before performing the insulation resistance measurement, disconnect all cables and connectors from the electric machine under test.**
	**Do not touch the electric machine during the insulation resistance check. Discharge the electric machine afterwards.**
	**Measure the insulation resistance of the electric machine before and after the installation of the electric machine.**

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

Reference value of 500 MΩ has to be exceeded at reference ambient temperature 25°C (measured with 500 V_{DC} / 1 min insulation resistance test). Contact Danfoss Editron service if the reference value is not exceeded.

Measuring the insulation resistance

	**Insulation resistance testers generate lethal voltages. Only qualified personnel should perform insulation resistance measurements.**

The insulation resistance is measured between motor terminals and the frame. When measuring the windings, the auxiliary circuits and other windings are grounded. When measuring the auxiliary circuits, all windings are grounded.

Dual winding motors - Winding 1

Test voltage	Test duration	Pass criteria
500 V_{DC}	60 s	> 500 MΩ

Measurement procedure:

Installation

1. Connect winding 2 phases to the motor frame.
2. Connect all pins of the LV connector, bearing temperature sensors and heaters to the motor frame.
3. Connect the measurement devices ground cable to the motor frame.
4. Connect the measurement probe to the winding 1 phases.

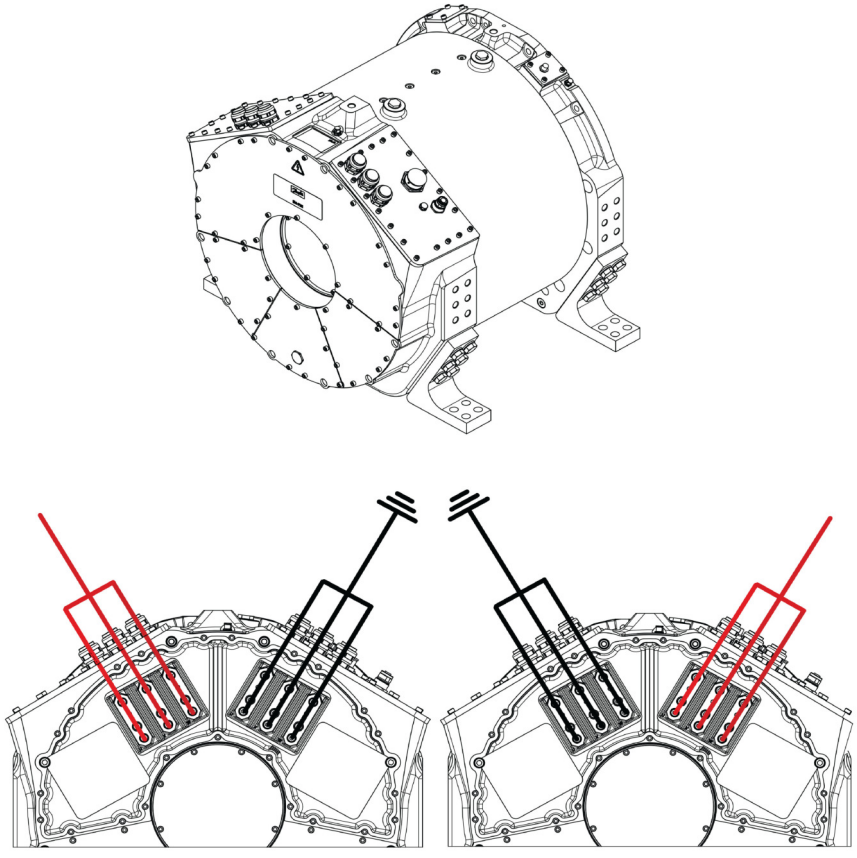
Dual winding motors - Winding 2

Test voltage	Test duration	Pass criteria
500 V_{DC}	60 s	> 500 MΩ

Measurement procedure:

1. Connect winding 1 phases to the motor frame.
2. Connect all pins of the LV connector, bearing temperature sensors and heaters to the motor frame.
3. Connect the measurement devices ground cable to the motor frame.
4. Connect the measurement probe to the winding 2 phases.

Dual winding motor



Quad winding motors

For quad winding motors, repeat the measurement procedure given above for windings 1 and 2, but in addition connect windings 3 and 4 to the motor frame before making the measurements. Then proceed to the following measurement steps for windings 3 and 4.

Quad winding motors - Winding 3

Test voltage	Test duration	Pass criteria
500 V_{DC}	60 s	> 500 MΩ

Installation

Measurement procedure:

1. Connect winding 1, 2 and 4 phases to the motor frame.
2. Connect all pins of the LV connector, bearing temperature sensors and heaters to the motor frame.
3. Connect the measurement devices ground cable to the motor frame.
4. Connect the measurement probe to the winding 3 phases.

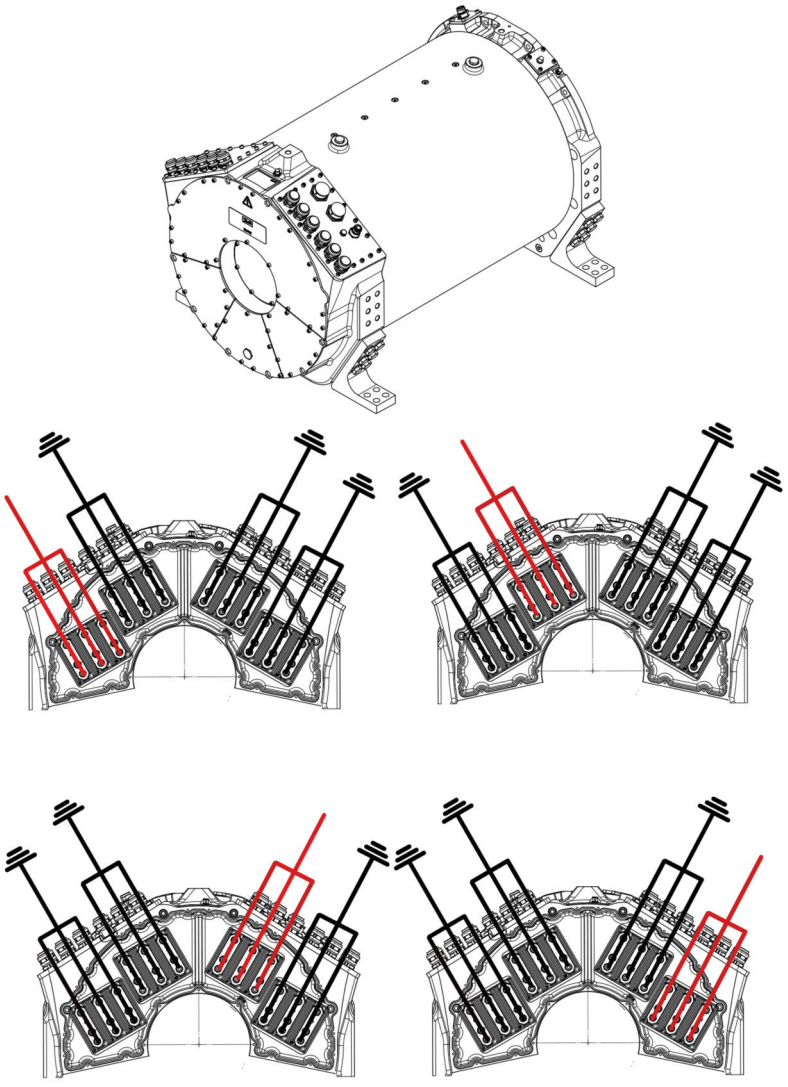
Quad winding motors - Winding 4

Test voltage	Test duration	Pass criteria
500 V_{DC}	60 s	> 500 MΩ

Measurement procedure:

1. Connect winding 1, 2 and 3 phases to the motor frame.
2. Connect all pins of the LV connector, bearing temperature sensors and heaters to the motor frame.
3. Connect the measurement devices ground cable to the motor frame.
4. Connect the measurement probe to the winding 4 phases.

Quad winding motors



Installation

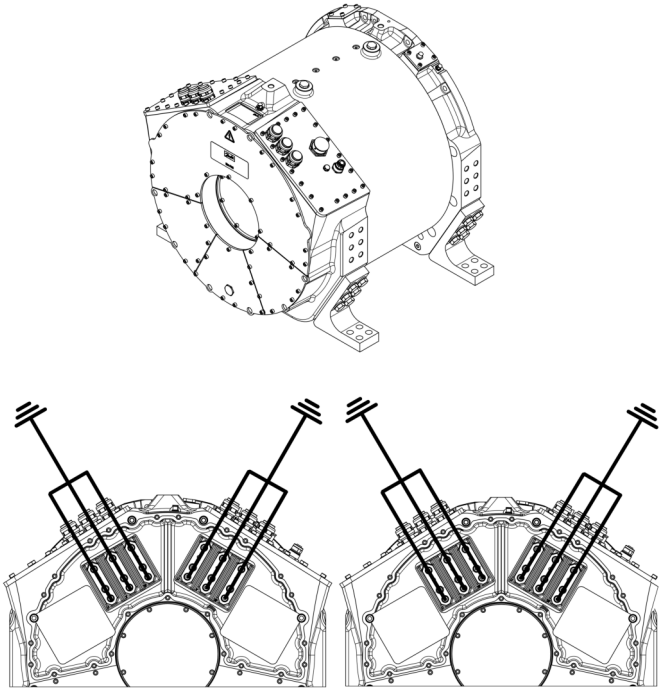
Auxiliary circuits

Test voltage	Test duration	Pass criteria
500 V_{DC}	60 s	> 500 MΩ

Measurement procedure:

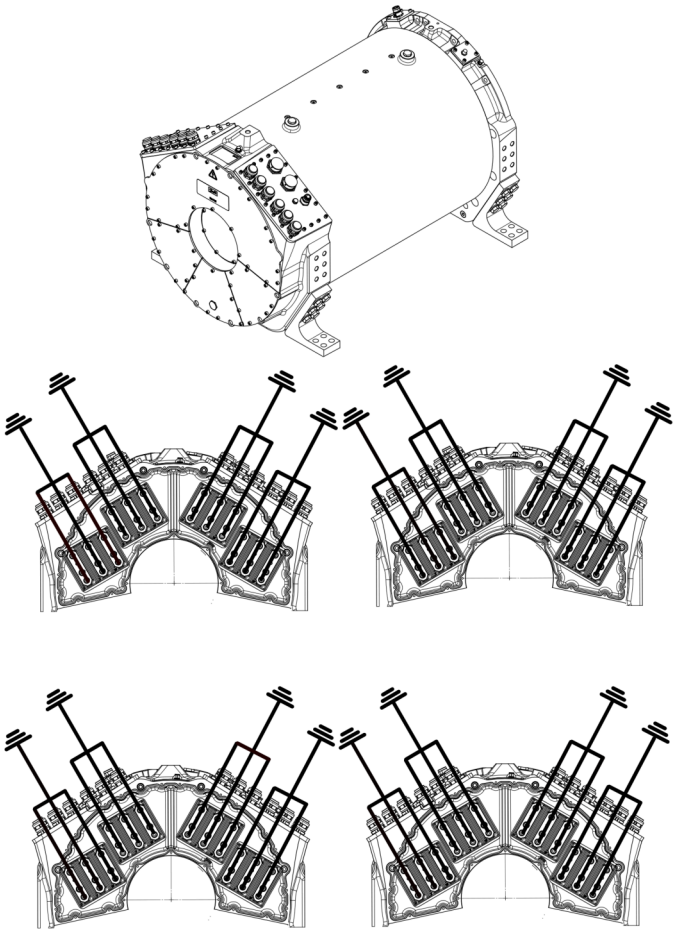
1. Connect all winding phases to the motor frame.
2. Connect all auxiliary circuits together by using counter connectors, but see exemptions below:
   a. For LV connector Deutsch HD34-24-47PE, do not connect grounding pins 1, 4, 5, 6 and 34.
   b. For heater connector Hummel Twinlock, do not connect grounding pin 3.
   c. PMI540B-T1500/T2000: For LV connection box, do not connect pin 35 and grounding pins.
   d. PMI540B-T3000/T4000: For LV connection box, do not connect grounding pins.
3. Connect the measurement device ground to the motor frame.
4. Connect the measurement probe to all auxiliary circuits.

Auxiliary circuit measurement - Dual winding motor



Installation

Auxiliary circuit measurement - Quad winding motor



Mechanical installation

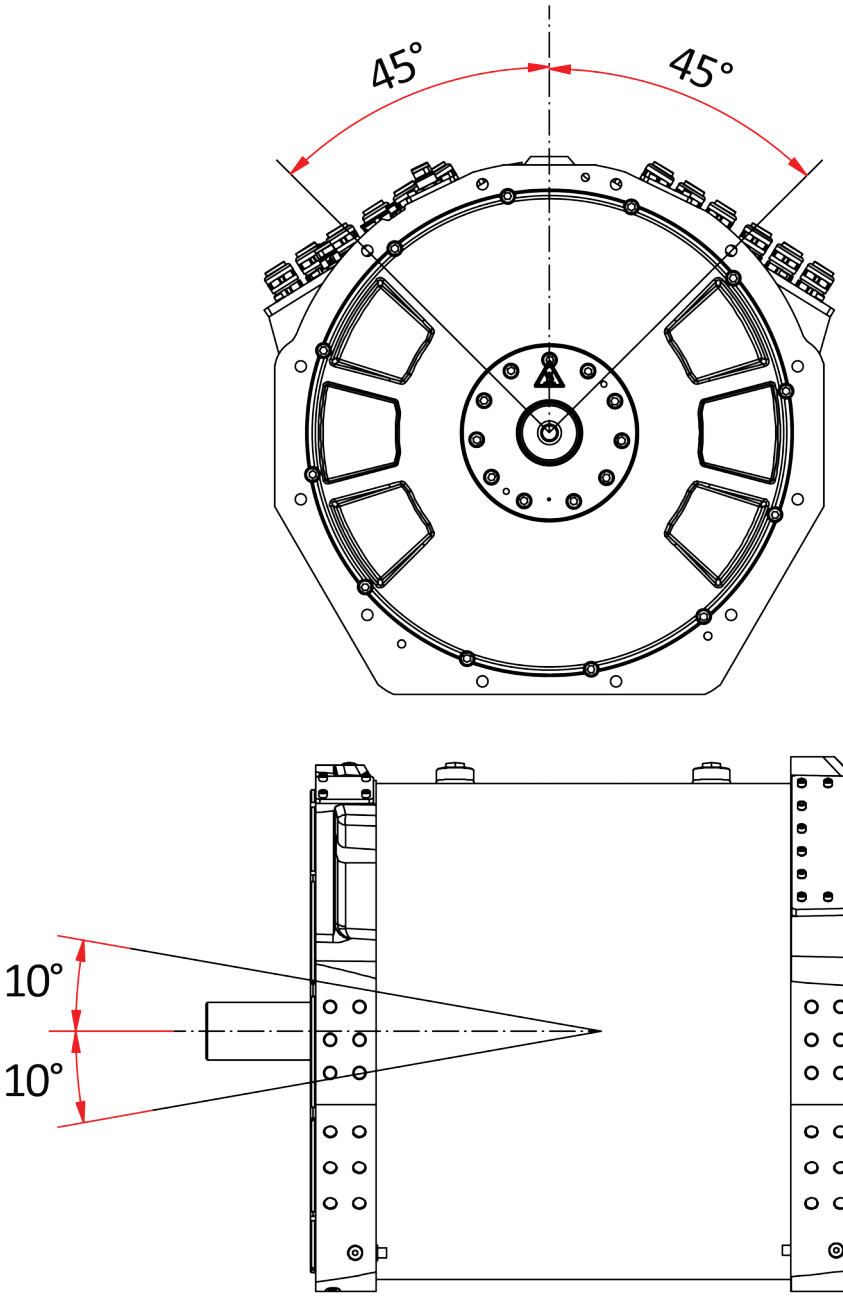
Allowed mounting positions

	**If the application is a moving work machine or similar, it is allowed to deviate from the allowed mounting position for the duration of 30 % of the work cycle. This applies to electric machines with grease lubricated bearings.**
	**It is in some cases possible to make an exception from the limitations of the mounting positions. Document *Allowed bearing loads for EM-PMI machines DOC-000454* gives more information about this. Contact Danfoss to obtain the document.**

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

Installation

Allowed mounting position

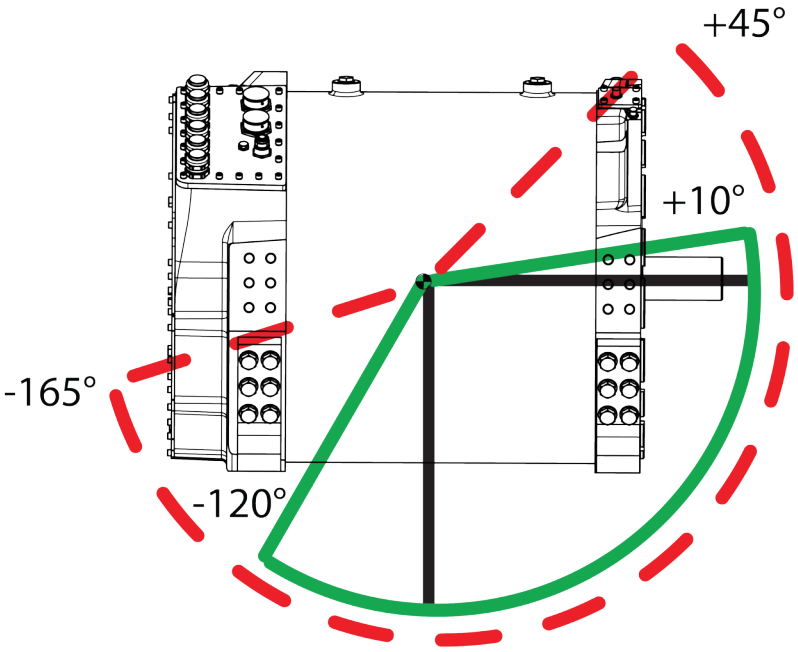


Line type	Meaning
	Allowed machine tilt angle for continuous operation. (viewed from the shaft end)
	Allowed momentary machine tilt angle, for the maximum duration of 30 % of the work cycle. (viewed from the shaft end)

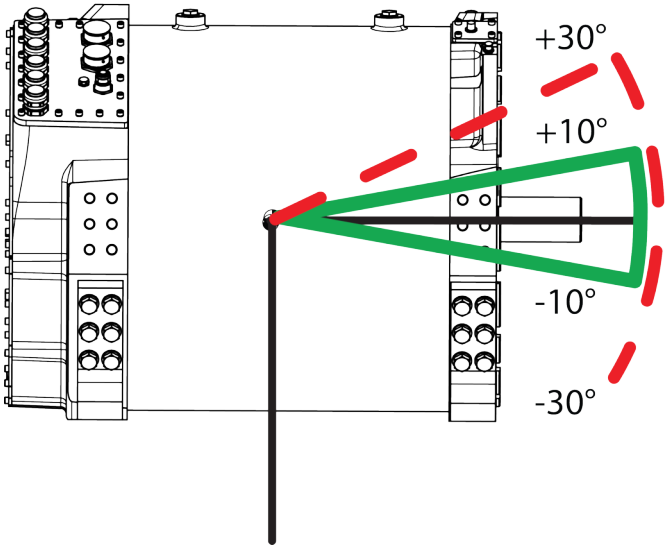
Installation

Allowed machine tilt angle during operation

EM-PMI540B-T1500, -T2000



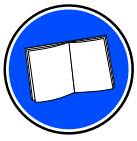
EM-PMI540B-T3000, -T4000



Mounting the electric machine

	Do not exceed the maximum axial and radial forces calculated for the shaft. Document Allowed bearing loads for EM-PMI machines DOC-000454 gives more information about this. Contact Danfoss to obtain the document.

Installation

	**Do not use the N-end of the electric machine for mounting the electric machine.**
	**Refer to Chapter** *Allowed mounting positions* **for the correct mounting positions of the electric machine.**

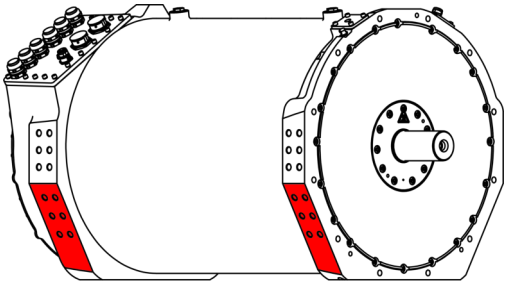
Mount the electric machine on a correct supporting structure as discussed in Chapter *Supporting structure requirements*.

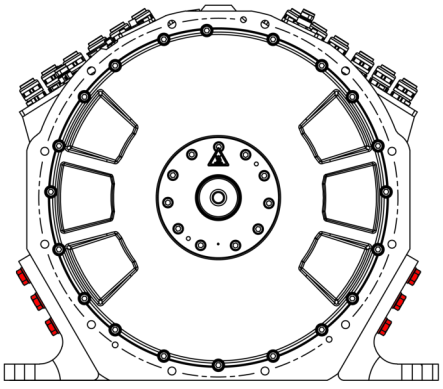
Horizontal assembly

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. If additional support is needed, use the Side/Foot/V-mounting bores.

Note that V-mounting is not applicable to the EM-PMI540B-T4000 variant, and the highlighted mounting is used only for Foot 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.

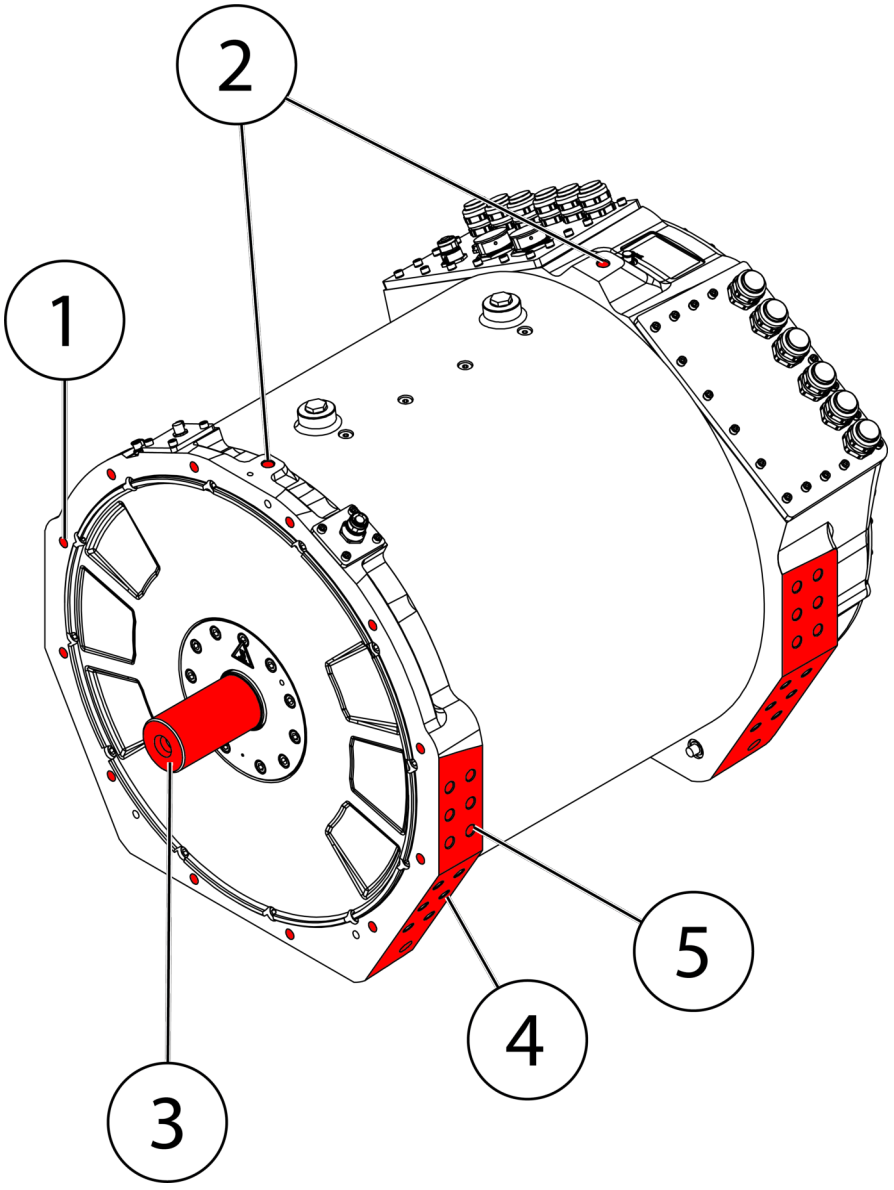
	**Before connecting to the shaft of the electric machine, clean the protection wax on the shaft splines carefully to avoid potential reaction with the spline lubricant.**

Installation

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 Molycote, Metaflux, Never Seeze, Optimol and similar.

5. Attach the mounting bolts. For steel housing the minimum length of the bolt is 40 mm and for aluminum housing 45 mm. Refer to Chapter *Tightening torques* on page 23 for the correct tightening torques.

Mechanical mounting connections of the electric machine (horizontal mounting)



1	D-end flange (SAE1/2) and bolt bores for mounting the electric machine (12 pieces).
2	Bores for the lifting eyes.
3	Shaft of the electric machine: EM-PMI540B-T1500/T2000: W55x2x26x8f EM-PMI540B-T3000/T4000: Cylindrical shaft, dia:70 mm h7, contact length130 mm

Installation

4	Foot / V- mounting bores.
5	Side mounting bores.

Vertical assembly

In vertical assembly, follow the Steps given in the previous Section *Horizontal assembly*.

Cooling connections

	**Make sure that cooling liquid runs freely into and out from the electric machine.**
	**To prevent damage to the cooling connectors, refer to the documentation of the manufacturer for the correct tightening torque of the cooling liquid nipples.**
	**When selecting cooling liquid nipples, choose nipples that can resist galvanic corrosion.**

Connect the electric machine properly to the cooling circuit. Make sure 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.

Aluminum frame water-cooled construction is only to be used with a closed fresh water circulation with corrosive inhibitor described in the data sheet. The water cooling circuit connection is described in the data sheet. Use only suitable and high-class connection parts and seals to connect the electric machine to the water circuit. Check for possible leaks after the piping and joints have been connected.

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.

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.**

Installation

	**When installing the connection box lid, make sure there are no foreign particles between the connection box lid and the insulation and that all connection box fasteners are in place. Missing or loose screws can compromise the insulation.**
	**Make sure the power cables exit straight from the terminals and do not rub against the sharp cable through-holes or other sharp edges which could wear out the cable insulation over time.**
	**Do not place any excess weight on the connection box lid(s).**

The high voltage cables of the electric machine are connected to the connection box(es) of the electric machine. The figure below shows the components of the high voltage connection box assembly.

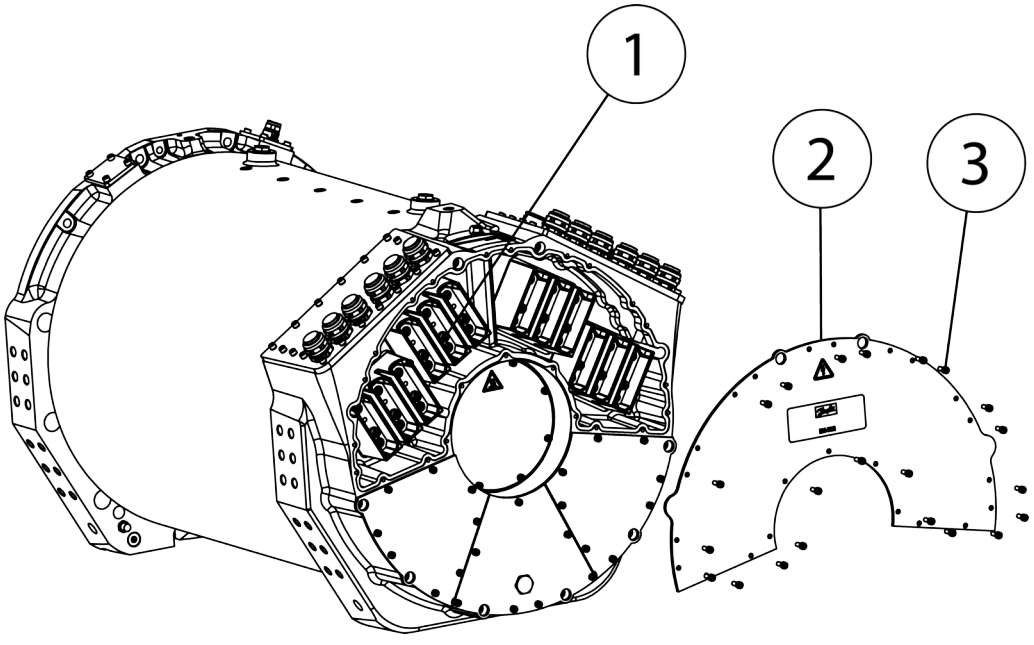
You are allowed to open only the nuts and bolts that are specified here. Only Danfoss professionals are allowed to open other nuts and bolts in the terminal box.

Installing the power cables:

1. Remove the cover of the terminal box.
2. Install the power cables.
   a. Remove the cable lug attachment nut/bolt and washers.
   b. Place the cable lug against the busbar.
   c. Place flat washer on top of the cable lug and spring washer on top of the flat washer.
   d. Screw on the nut/bolt and tighten. Refer to Section *Tightening torques* on page 23 for the correct torque.
3. Install the cover of the terminal box back.

For more information on how to install the power cables, see especially Steps 8-13 in *Cable gland assembly and power line connection* on page 49.

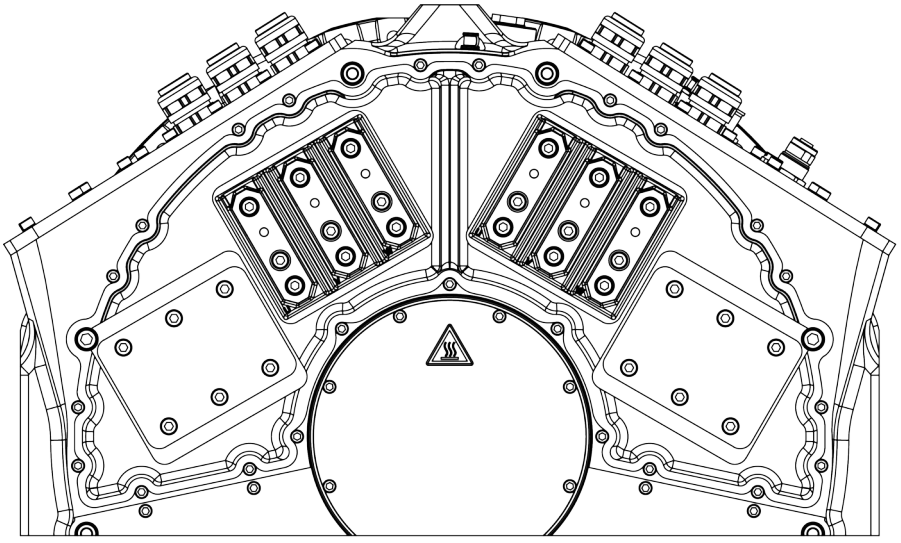
High voltage connection assembly structure



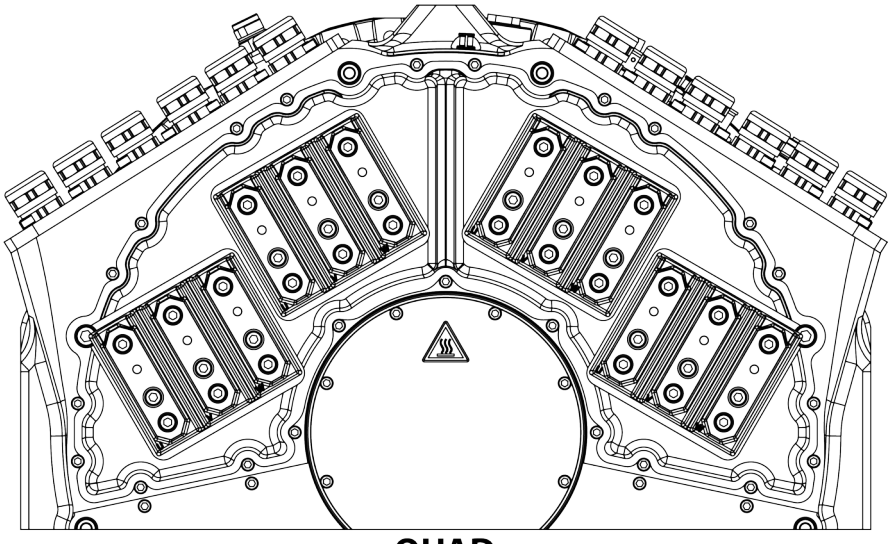
Installation

1	Connection box module
2	Connection box cover plate, gasket extruding
3	Connection box mounting bolts, M6 x 16

DUAL and QUAD winding motors



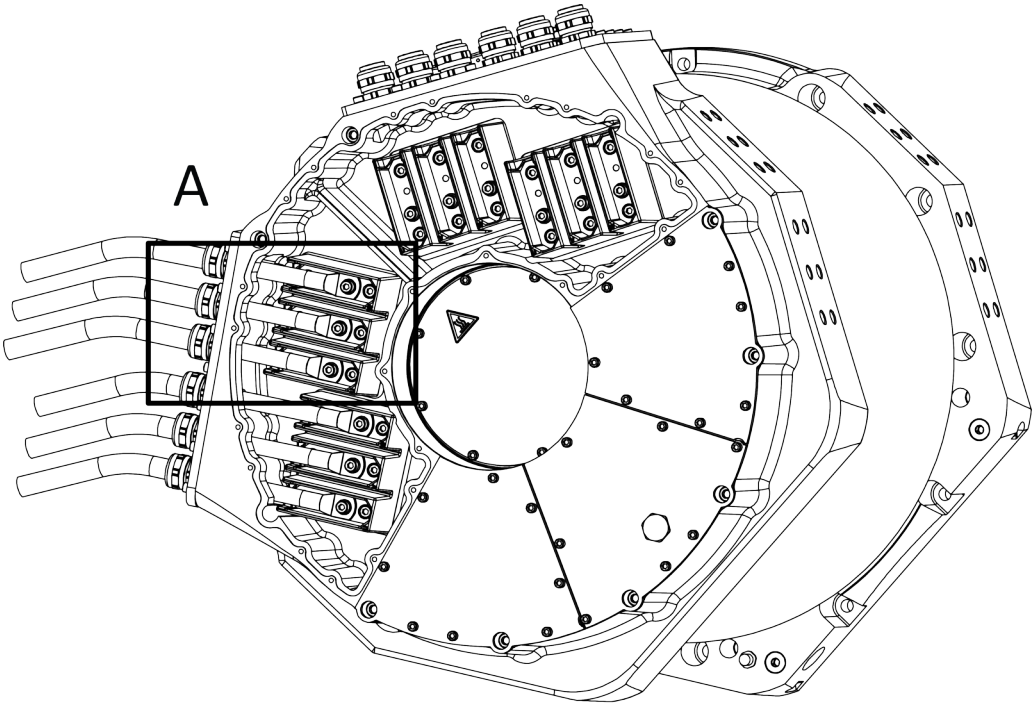
DUAL

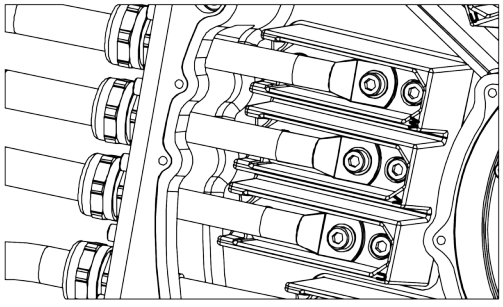


QUAD

Installation

Inside view of the machine connection box





A (1 : 5)

Leave the connection box cover plate open for further electrical assembly as instructed in Chapter *Cable gland assembly and power line connection* on page 49.

Connection diagram

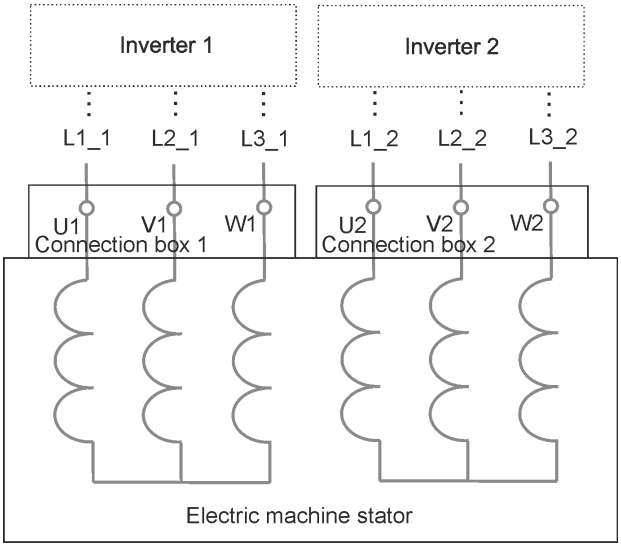
The electric machines are intended to be powered and controlled by three-phase alternating current, supplied by an inverter or inverters. The electric machine is not suitable for direct online use.

The amount of inverters depends on the electric machine and converter current ratings. See also the relevant wiring diagrams.

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

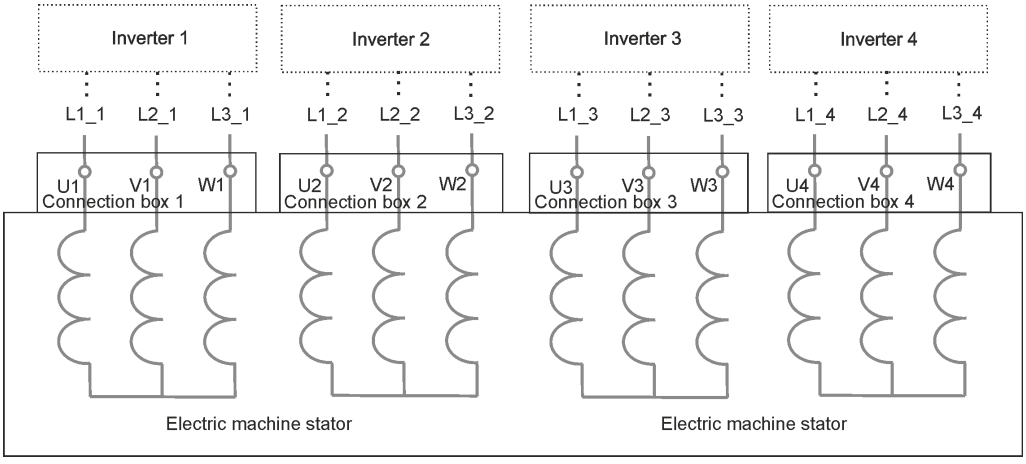
Installation

Connection diagram for DUAL option



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

Connection diagram for QUAD option



Cable gland assembly and power line connection

	**If you are not using the recommended cable lugs, select cable lugs that leave 10 mm gap between each and every cable lug on the same connection plate.**
	**The pictures are schematic, and the actual components can look different.**

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 catalog available from *http://www.pflitsch.de*.

Installation

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

Cable gland alternatives

Cable gland	Cable cross sectional area (*	Thread	Max. cable Ø	Max. shield Ø
Pflitsch bg 225ms tri	35 mm^2 50 mm^2 70 mm^2	M25 x 1.5, 7.5 mm	20 mm	16 mm
Pflitsch bg 232ms tri	70 mm^2 95 mm^2 120 mm^2	M32 x 1.5, 8.0 mm	25 mm	20 mm

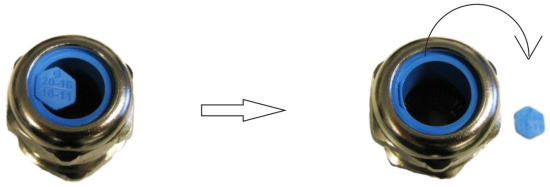
(* Applicable with the recommended cable type (HUBER+SUHNER Radox Elastomer S)

Blueglobe cable gland tightening torques

Metric thread	Nominal torque
M10 x 1.0	3.0 Nm
M12 x 1.5	5.0 Nm
M16 x 1.5	8.0 Nm
M20 x 1.5	10.0 Nm
M25 x 1.5	15.0 Nm
M32 x 1.5	15.0 Nm
M40 x 1.5	20.0 Nm
M50 x 1.5	30.0 Nm
M63 x 1.5	35.0 Nm
M75 x 1.5	80.0 Nm
M85 x 2.0	100.0 Nm

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

   BlueGlobe-sealing

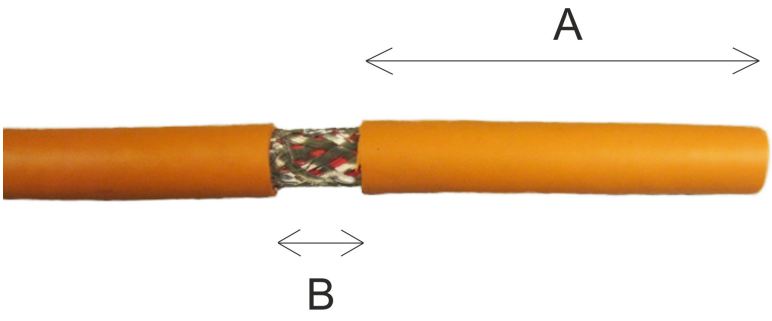


2. Cut the cable sheath at the distance A from the end of the cable, see Figure below. Pull the cut part of the sheath partly (length B is from 10 to 15 mm) off the cable as shown in the Figure. The distance A depends of the length of the cable lug used. Measure with the cable lug that is used and cut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

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

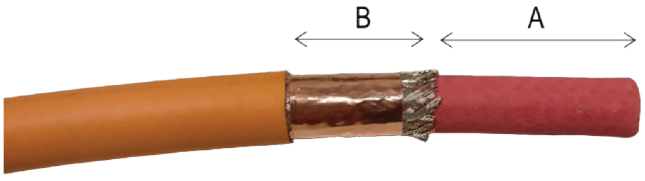
Installation

Cut length of the cable sheath



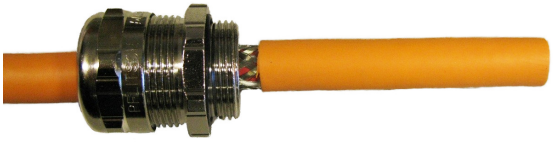
3. Wrap two layers of copper tape on the cable so that the distance B is covered. Use 3M™ Copper Foil Tape 1181 or similar. Contrary to the image below and depending on the cable and the cable gland size, you can leave the length A sheath in place for the next step to help the placement of the cable gland and remove the sheath only after the next step.

Cover the cable with copper tape



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

Cable to the gland assembly

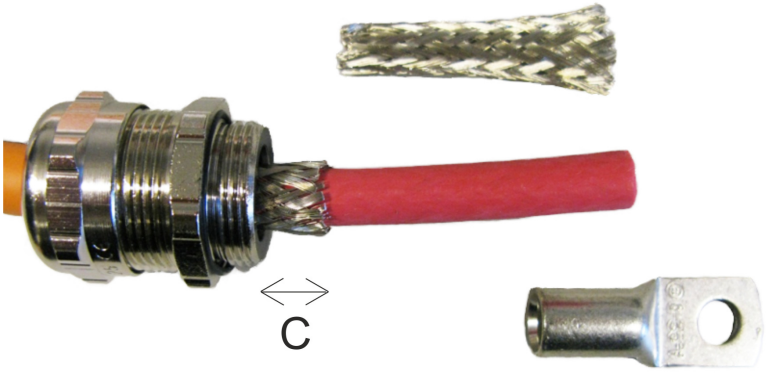


Installation

5. 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.

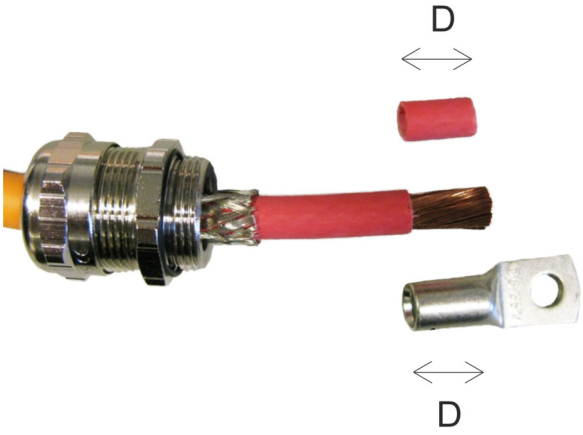
	**Make sure that the cable gland spring is against the cable sheath (that is protected with copper tape) before cutting the braid screen.**

Cut the braid screen



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

Cutting the inner sheath



7. a) Make sure that the conducting strands of the cable are completely free of silicone and other impurities. Insert cable conductors fully into cable lug. Make sure that the cable lug is not too loose and that all conductors fit inside the lug. If not, check from the part list that you are using the correct cable lugs.

b) Always use the crimping tool of the cable lug manufacturer. Before crimping, check the cable lug size from the lug (e.g. 35-8 is 35 mm^2) and select the same size dies for the crimping tool. Use hexagonal dies.

c) Crimp the cable lug at least twice in different places starting as near to the flat part of the lug as possible and towards the barrel part of the lug. Make sure that the cable does not slip out from the lug while crimping.

Installation

d) Remove any excess compound emerging from the sides of the cable lugs after the crimping. Verify that the cable lug is evenly compressed with clear hexagonal crimps and that no conductors are broken. See Figure below.

Connecting cable lug

8. 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.

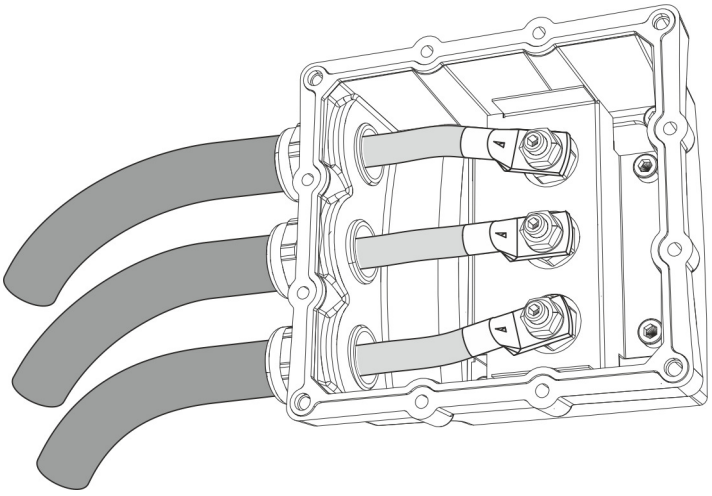
Shrink tube

9. 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.

Installation

	**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 to the connection box (example only, the connection box may look different)



10. Screw the cable gland to the connection box as shown in the Figure above.

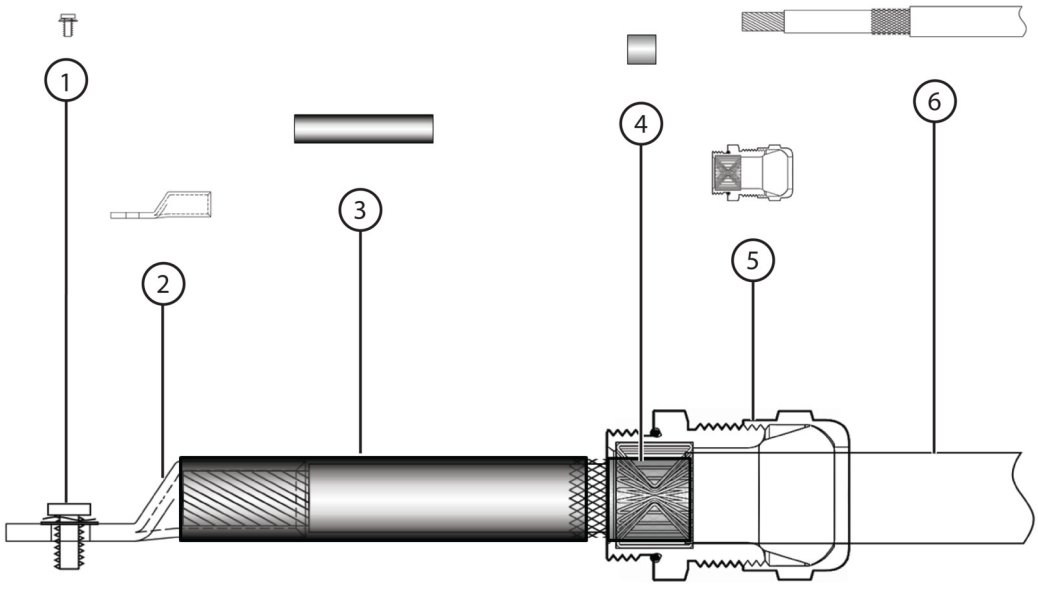
	**Tighten the cable gland from the cable gland body to enclosure. Refer to *Tightening torques* on page 23 for the correct torque. Then tighten the cap of the cable gland according to the instructions provided by cable gland manufacturer (recommendation Pflitsch).**

11. Tighten the cable lug. Refer to *Tightening torques* on page 23 for the correct torque.
12. Repeat the procedure to the other cables and connection boxes.
13. Check that the phase connections order in the connection box is correct, that is, the corresponding phases between the inverter and the machine are connected (U, V, W correspond to the L1, L2, L3 phases).
14. 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 connections* on page 68.
15. Check the power cable shield grounding, see Chapter *Grounding connections*.

Installation

Cable lug and cable gland assembly cross section



1	Cable lug bolt
2	Cable lug
3	Shrink wrap
4	Copper tape
5	Cable gland
6	Cable

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)**
	**Electric machine can have a low voltage connector or optionally a low voltage connection box (option +LVB1).**

The electric machine has a connector or a connection box which is used to read out in-built temperature and rotation sensor (resolver) data from the electric 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 electric machine: different options add sensors, and some electric machines do not have all the sensors. For more information about the options, refer to Chapter *Product naming convention* on page 5.

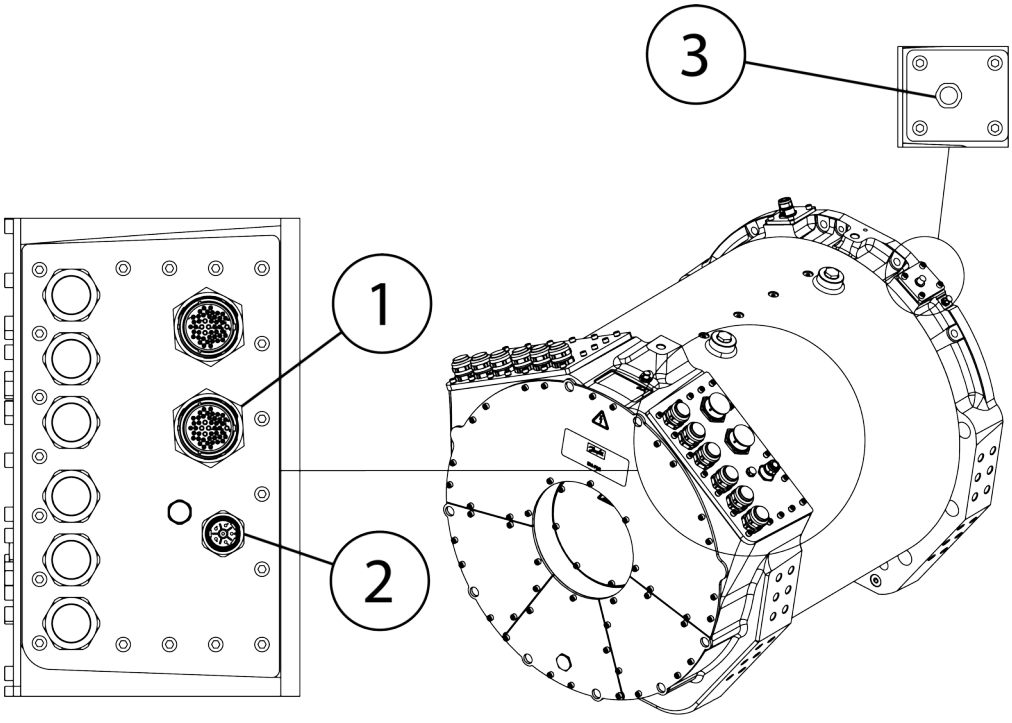
See more information and instructions about DEUTSCH connectors at *https://www.deutschconnector.com/*.

Installation

Recommended cable types for low voltage connections

Application	Cable type
Resolver cabling	Shielded cable (twisted pair)
Temperature measurement (PT100)	Shielded cable (twisted pair)

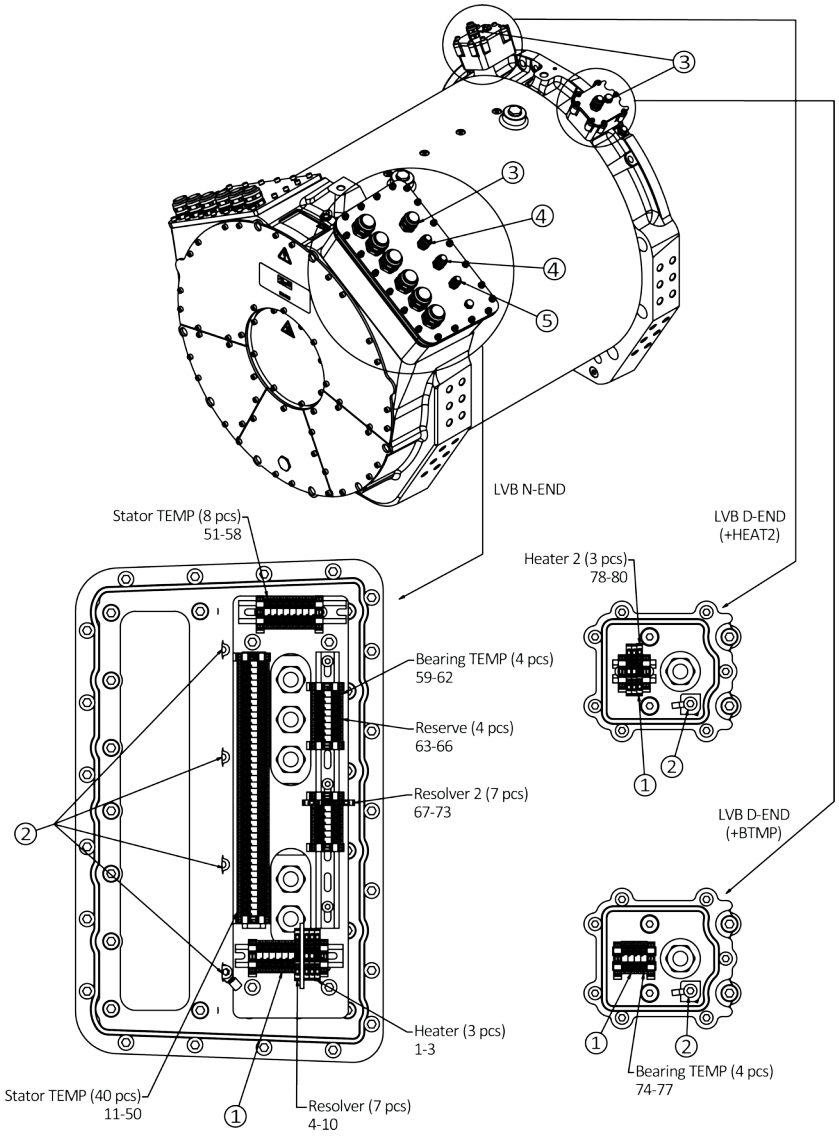
Location of the low voltage connectors in the connection box



1	Low voltage connector: - Winding temperature sensors and resolver connections - Bearing temperature measurement sensor connector
2	Anti-condensation heater connector
3	Bearing temperature measurement connector

Installation

Low voltage connection box (+LVB1 -option)



LVB D-END (cover removed)

1	Terminal block
2	Grounding connection (M5)
3	M16 cable gland

LVB N-END (cover removed)

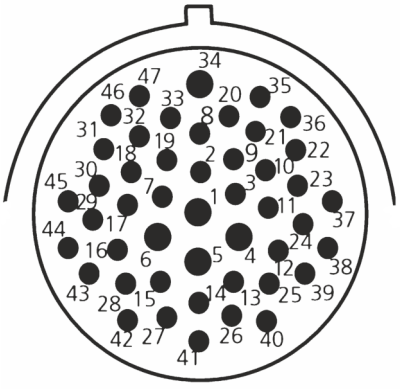
1	Terminal block
2	Grounding connections (M5)
3	M25 cable gland
4	M16 cable glands
5	M12 cable gland

Installation

Low voltage connector details

	Deutsch HD34-24-47PE connector has two kinds of mating pins: 1 mm and 1.5 mm in diameter.

Pin configuration of the Deutsch HD34-24-47PE connector



Pin configuration of LV-connector (+DUAL)

Measurement	Description	PIN	Option
Temperature 1	phase U1, main sensor, slot 1/72, PT100 (P)	47	
	phase U1, main sensor, slot 1/72, PT100 (N)	46	
Temperature 2	phase V1, main sensor, slot 17/72, PT100 (P)	33	
	phase V1, main sensor, slot 17/72, PT100 (N)	32	
Temperature 3	phase W1, main sensor, slot 57/72, PT100 (P)	45	
	phase W1, main sensor, slot 57/72, PT100 (N)	31	
Temperature 4	phase U2, main sensor, slot 13/72, PT100 (P)	30	
	phase U2, main sensor, slot 13/72, PT100 (N)	29	
Temperature 5	phase V2, main sensor, slot 29/72, PT100 (P)	44	
	phase V2, main sensor, slot 29/72, PT100 (N)	43	
Temperature 6	phase W2, main sensor, slot 69/72, PT100 (P)	28	
	phase W2, main sensor, slot 69/72, PT100 (N)	16	
Temperature 7	phase U1, spare sensor, slot 8/72, PT100 (P)	42	+TEMP5
	phase U1, spare sensor, slot 8/72, PT100 (N)	27	+TEMP5
Temperature 8	phase V1, spare sensor, slot 24/72, PT100 (P)	15	+TEMP5
	phase V1, spare sensor, slot 24/72, PT100 (N)	14	+TEMP5
Temperature 9	phase W1, spare sensor, slot 64/72, PT100 (P)	40	+TEMP5
	phase W1, spare sensor, slot 64/72, PT100 (N)	26	+TEMP5
Temperature 10	phase U2, spare sensor, slot 20/72, PT100 (P)	41	+TEMP5
	phase U2, spare sensor, slot 20/72, PT100 (N)	13	+TEMP5
Temperature 11	phase V2, spare sensor, slot 36/72, PT100 (P)	39	+TEMP5
	phase V2, spare sensor, slot 36/72, PT100 (N)	38	+TEMP5
Temperature 12	phase W2, spare sensor, slot 76/72, PT100 (P)	25	+TEMP5
	phase W2, spare sensor, slot 76/72, PT100 (N)	12	+TEMP5
Resolver COS	Resolver, RES_COS_N, Inbuilt non-contacting	35	

Installation

Pin configuration of LV-connector (+DUAL) (continued)

Measurement	Description	PIN	Option
Resolver COS	Resolver, RES_COS_P, Inbuilt non-contacting	20	
Resolver SIN	Resolver, RES_SIN_N, Inbuilt non-contacting	36	
Resolver SIN	Resolver, RES_SIN_P, Inbuilt non-contacting	21	
Resolver EXCN	Resolver, EXCN, Inbuilt non-contacting	22	
Resolver EXCP	Resolver, EXCP, Inbuilt non-contacting	10	
Resolver shield	Resolver, SHIELD/GROUND, Inbuilt non-contacting	34	
Resolver2 COS	Resolver 2, RES_COS_N, Inbuilt non-contacting	37	+RES2
Resolver2 COS	Resolver 2, RES_COS_P, Inbuilt non-contacting	24	+RES2
Resolver2 SIN	Resolver 2, RES_SIN_N, Inbuilt non-contacting	23	+RES2
Resolver2 SIN	Resolver 2, RES_SIN_P, Inbuilt non-contacting	11	+RES2
Resolver2 EXCN	Resolver 2, EXCN, Inbuilt non-contacting	9	+RES2
Resolver2 EXCP	Resolver 2, EXCP, Inbuilt non-contacting	8	+RES2
Resolver2 shield	Resolver 2, SHIELD/GROUND, Inbuilt non-contacting	4	+RES2
Bearing temperature, sensor 1	PT100	2	
Bearing temperature, sensor 1	PT100_GND	18	
Bearing temperature, sensor 2	PT100	3	
Bearing temperature, sensor 2	PT100_GND	19	

Pin configuration of LV-connectors (+QUAD)

LV-connector 1			
Measurement	**Description**	**PIN**	**Option**
Temperature 1	phase U1, main sensor, slot 1/72, PT100 (P)	47	
	phase U1, main sensor, slot 1/72, PT100 (N)	46	
Temperature 2	phase V1, main sensor, slot 17/72, PT100 (P)	33	
	phase V1, main sensor, slot 17/72, PT100 (N)	32	
Temperature 3	phase W1, main sensor, slot 57/72, PT100 (P)	45	
	phase W1, main sensor, slot 57/72, PT100 (N)	31	
Temperature 4	phase U2, main sensor, slot 13/72, PT100 (P)	30	
	phase U2, main sensor, slot 13/72, PT100 (N)	29	
Temperature 5	phase V2, main sensor, slot 29/72, PT100 (P)	44	
	phase V2, main sensor, slot 29/72, PT100 (N)	43	
Temperature 6	phase W2, main sensor, slot 69/72, PT100 (P)	28	
	phase W2, main sensor, slot 69/72, PT100 (N)	16	
Temperature 7	phase U3, main sensor, slot 25/72, PT100 (P)	42	
	phase U3, main sensor, slot 25/72, PT100 (N)	27	
Temperature 8	phase V3, main sensor, slot 41/72, PT100 (P)	15	
	phase V3, main sensor, slot 41/72, PT100 (N)	14	
Temperature 9	phase W3, main sensor, slot 81/72, PT100 (P)	40	
	phase W3, main sensor, slot 81/72, PT100 (N)	26	
Temperature 10	phase U4, main sensor, slot 37/72, PT100 (P)	41	
	phase U4, main sensor, slot 37/72, PT100 (N)	13	
Temperature 11	phase V4, main sensor, slot 53/72, PT100 (P)	39	
	phase V4, main sensor, slot 53/72, PT100 (N)	38	

Installation

Pin configuration of LV-connectors (+QUAD) (continued)

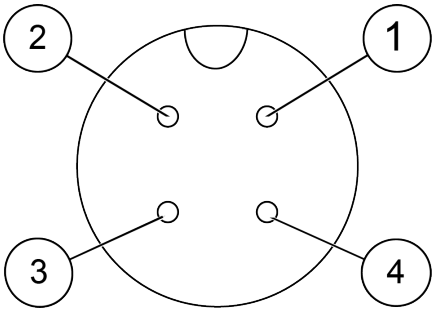
LV-connector 1			
Measurement	**Description**	**PIN**	**Option**
Temperature 12	phase W4, main sensor, slot 93/72, PT100 (P)	25	
	phase W4, main sensor, slot 93/72, PT100 (N)	12	
Resolver COS	Resolver, RES_COS_N, inbuilt non-contacting	35	
Resolver COS	Resolver, RES_COS_P, inbuilt non-contacting	20	
Resolver SIN	Resolver, RES_SIN_N, inbuilt non-contacting	36	
Resolver SIN	Resolver, RES_SIN_P, inbuilt non-contacting	21	
Resolver EXCN	Resolver, EXCN, inbuilt non-contacting	22	
Resolver EXCP	Resolver, EXCP, inbuilt non-contacting	10	
Resolver shield	Resolver, SHIELD/GROUND, inbuilt non-contacting	34	
Resolver2 COS	Resolver 2, RES_COS_N, inbuilt non-contacting	37	+RES2
Resolver2 COS	Resolver 2, RES_COS_P, inbuilt non-contacting	24	+RES2
Resolver2 SIN	Resolver 2, RES_SIN_N, inbuilt non-contacting	23	+RES2
Resolver2 SIN	Resolver 2, RES_SIN_P, inbuilt non-contacting	11	+RES2
Resolver2 EXCN	Resolver 2, EXCN, inbuilt non-contacting	9	+RES2
Resolver2 EXCP	Resolver 2, EXCP, inbuilt non-contacting	8	+RES2
Resolver2 shield	Resolver 2, SHIELD/GROUND, inbuilt non-contacting	4	+RES2
Bearing temperature, sensor 1	PT100	2	
Bearing temperature, sensor 1	PT100_GND	18	
Bearing temperature, sensor 2	PT100	3	
Bearing temperature, sensor 2	PT100_GND	19	

LV-connector 2			
Measurement	**Description**	**PIN**	**Option**
Temperature 13	phase U1, spare sensor, slot 8/72, PT100 (P)	47	+TEMP5
	phase U1, spare sensor, slot 8/72, PT100 (N)	46	+TEMP5
Temperature 14	phase V1, spare sensor, slot 24/72, PT100 (P)	33	+TEMP5
	phase V1, spare sensor, slot 24/72, PT100 (N)	32	+TEMP5
Temperature 15	phase W1, spare sensor, slot 64/72, PT100 (P)	45	+TEMP5
	phase W1, spare sensor, slot 64/72, PT100 (N)	31	+TEMP5
Temperature 16	phase U2, spare sensor, slot 20/72, PT100 (P)	30	+TEMP5
	phase U2, spare sensor, slot 20/72, PT100 (N)	29	+TEMP5
Temperature 17	phase V2, spare sensor, slot 36/72, PT100 (P)	44	+TEMP5
	phase V2, spare sensor, slot 36/72, PT100 (N)	43	+TEMP5
Temperature 18	phase W2, spare sensor, slot 76/72, PT100 (P)	28	+TEMP5
	phase W2, spare sensor, slot 76/72, PT100 (N)	16	+TEMP5
Temperature 19	phase U3, spare sensor, slot 32/72, PT100 (P)	42	+TEMP5
	phase U3, spare sensor, slot 32/72, PT100 (N)	27	+TEMP5
Temperature 20	phase V3, spare sensor, slot 48/72, PT100 (P)	15	+TEMP5
	phase V3, spare sensor, slot 48/72, PT100 (N)	14	+TEMP5
Temperature 21	phase W3, spare sensor, slot 88/72, PT100 (P)	40	+TEMP5
	phase W3, spare sensor, slot 88/72, PT100 (N)	26	+TEMP5
Temperature 22	phase U4, spare sensor, slot 44/72, PT100 (P)	41	+TEMP5
	phase U4, spare sensor, slot 44/72, PT100 (N)	13	+TEMP5

Installation

LV-connector 2			
Measurement	**Description**	**PIN**	**Option**
Temperature 23	phase V4, spare sensor, slot 60/72, PT100 (P)	39	+TEMP5
	phase V4, spare sensor, slot 60/72, PT100 (N)	38	+TEMP5
Temperature 24	phase W4, spare sensor, slot 4/72, PT100 (P)	25	+TEMP5
	phase W4, spare sensor, slot 4/72, PT100 (N)	12	+TEMP5

Bearing temperature measurement connector



Measurement	Description	PIN
Bearing temperature, sensor 1	PT100	1
Bearing temperature, sensor 1	PT100_GND	2
Bearing temperature, sensor 2	PT100	3
Bearing temperature, sensor 2	PT100_GND	4

Pin configuration of +LVB connection (+DUAL)

PIN	Measurement	Description	Option
		N-END	
1 ⏚	HEAT	Heater, ground / protective earth	+HEAT
2	HEAT	Heater, neutral	+HEAT
3	HEAT	Heater, phase, 230 V_AC	+HEAT
4 ⏚	Resolver shield	Resolver, SHIELD/GROUND, In-built non-contacting	+RES1
5	Resolver COS	Resolver, RES_COS_N, Inbuilt non-contacting	+RES1
6	Resolver COS	Resolver, RES_COS_P, Inbuilt non-contacting	+RES1
7	Resolver SIN	Resolver, RES_SIN_N, Inbuilt non-contacting	+RES1
8	Resolver SIN	Resolver, RES_SIN_P, Inbuilt non-contacting	+RES1
9	Resolver EXCN	Resolver, EXCN, Inbuilt non-contacting	+RES1
10	Resolver EXCP	Resolver, EXCP, Inbuilt non-contacting	+RES1
11	Temperature 1	phase U1, main sensor, slot 1/72, PT100 (P)	
12		phase U1, main sensor, slot 1/72, PT100 (N)	
13	Temperature 2	phase V1, main sensor, slot 17/72, PT100 (P)	
14		phase V1, main sensor, slot 17/72, PT100 (N)	
15	Temperature 3	phase W1, main sensor, slot 57/72, PT100 (P)	
16		phase W1, main sensor, slot 57/72, PT100 (N)	
17	Temperature 4	phase U2, main sensor, slot 13/72, PT100 (P)	
18		phase U2, main sensor, slot 13/72, PT100 (N)	
19	Temperature 5	phase V2, main sensor, slot 29/72, PT100 (P)	
20		phase V2, main sensor, slot 29/72, PT100 (N)	

Installation

Pin configuration of +LVB connection (+DUAL) (continued)

PIN	Measurement	Description	Option
21	Temperature 6	phase W2, main sensor, slot 69/72, PT100 (P)	
22		phase W2, main sensor, slot 69/72, PT100 (N)	
23	Temperature 7	phase U1, spare sensor, slot 8/72, PT100 (P)	+TEMP5
24		phase U1, spare sensor, slot 8/72, PT100 (N)	+TEMP5
25	Temperature 8	phase V1, spare sensor, slot 24/72, PT100 (P)	+TEMP5
26		phase V1, spare sensor, slot 24/72, PT100 (N)	+TEMP5
27	Temperature 9	phase W1, spare sensor, slot 64/72, PT100 (P)	+TEMP5
28		phase W1, spare sensor, slot 64/72, PT100 (N)	+TEMP5
29	Temperature 10	phase U2, spare sensor, slot 20/72, PT100 (P)	+TEMP5
30		phase U2, spare sensor, slot 20/72, PT100 (N)	+TEMP5
31	Temperature 11	phase V2, spare sensor, slot 36/72, PT100 (P)	+TEMP5
32		phase V2, spare sensor, slot 36/72, PT100 (N)	+TEMP5
33	Temperature 12	phase W2, spare sensor, slot 76/72, PT100 (P)	+TEMP5
34		phase W2, spare sensor, slot 76/72, PT100 (N)	+TEMP5
35	TEMP		
36	TEMP		
37	TEMP		
38	TEMP		
39	TEMP		
40	TEMP		
41	TEMP		
42	TEMP		
43	TEMP		
44	TEMP		
45	TEMP		
46	TEMP		
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50	TEMP		
51	TEMP		
52	TEMP		
53	TEMP		
54	TEMP		
55	TEMP		
56	TEMP		
57	TEMP		
58	TEMP		
59	Bearing temperature, sensor 1	PT100	+BTMP
60	Bearing temperature, sensor 1	PT100_GND	+BTMP
61	Bearing temperature, sensor 2	PT100	+BTMP
62	Bearing temperature, sensor 2	PT100_GND	+BTMP
63	Reserve		
64	Reserve		
65	Reserve		

Installation

Pin configuration of +LVB connection (+DUAL) (continued)

PIN	Measurement	Description	Option
66	Reserve		
67 ⏚	Resolver2 shield	Resolver 2, SHIELD/GROUND, Inbuilt non-contacting	+RES2
68	Resolver2 COS	Resolver 2, RES_COS_N, Inbuilt non-contacting	+RES2
69	Resolver2 COS	Resolver 2, RES_COS_P, Inbuilt non-contacting	+RES2
70	Resolver2 SIN	Resolver 2, RES_SIN_N, Inbuilt non-contacting	+RES2
71	Resolver2 SIN	Resolver 2, RES_SIN_P, Inbuilt non-contacting	+RES2
72	Resolver2 EXCN	Resolver 2, EXCN, Inbuilt non-contacting	+RES2
73	Resolver2 EXCP	Resolver 2, EXCP, Inbuilt non-contacting	+RES2
D-END 1/2			
74	Bearing temperature, sensor 1	PT100	+BTMP
75	Bearing temperature, sensor 1	PT100_GND	+BTMP
76	Bearing temperature, sensor 2	PT100	+BTMP
77	Bearing temperature, sensor 2	PT100_GND	+BTMP
D-END 2/2			
78 ⏚	HEAT2	Heater 2, ground / protective earth	+HEAT2
79	HEAT2	Heater 2, neutral	+HEAT2
80	HEAT2	Heater 2, phase, 230 V_AC	+HEAT2

Pin configuration of +LVB connection (+QUAD)

PIN	Measurement	Description	Option
N-END			
1 ⏚	HEAT	Heater, ground / protective earth	+HEAT
2	HEAT	Heater, neutral	+HEAT
3	HEAT	Heater, phase, 230 V_AC	+HEAT
4 ⏚	Resolver shield	Resolver, SHIELD/GROUND, In-built non-contacting	+RES1
5	Resolver COS	Resolver, RES_COS_N, Inbuilt non-contacting	+RES1
6	Resolver COS	Resolver, RES_COS_P, Inbuilt non-contacting	+RES1
7	Resolver SIN	Resolver, RES_SIN_N, Inbuilt non-contacting	+RES1
8	Resolver SIN	Resolver, RES_SIN_P, Inbuilt non-contacting	+RES1
9	Resolver EXCN	Resolver, EXCN, Inbuilt non-contacting	+RES1
10	Resolver EXCP	Resolver, EXCP, Inbuilt non-contacting	+RES1
11	Temperature 1	phase U1, main sensor, slot 1/72, PT100 (P)	
12		phase U1, main sensor, slot 1/72, PT100 (N)	
13	Temperature 2	phase V1, main sensor, slot 17/72, PT100 (P)	
14		phase V1, main sensor, slot 17/72, PT100 (N)	
15	Temperature 3	phase W1, main sensor, slot 57/72, PT100 (P)	
16		phase W1, main sensor, slot 57/72, PT100 (N)	
17	Temperature 4	phase U2, main sensor, slot 13/72, PT100 (P)	
18		phase U2, main sensor, slot 13/72, PT100 (N)	
19	Temperature 5	phase V2, main sensor, slot 29/72, PT100 (P)	
20		phase V2, main sensor, slot 29/72, PT100 (N)	
21	Temperature 6	phase W2, main sensor, slot 69/72, PT100 (P)	
22		phase W2, main sensor, slot 69/72, PT100 (N)	

Installation

Pin configuration of +LVB connection (+QUAD) (continued)

PIN	Measurement	Description	Option
23	Temperature 7	phase U3, main sensor, slot 25/72, PT100 (P)	
24		phase U3, main sensor, slot 25/72, PT100 (N)	
25	Temperature 8	phase V3, main sensor, slot 41/72, PT100 (P)	
26		phase V3, main sensor, slot 41/72, PT100 (N)	
27	Temperature 9	phase W3, main sensor, slot 81/72, PT100 (P)	
28		phase W3, main sensor, slot 81/72, PT100 (N)	
29	Temperature 10	phase U4, main sensor, slot 37/72, PT100 (P)	
30		phase U4, main sensor, slot 37/72, PT100 (N)	
31	Temperature 11	phase V4, main sensor, slot 53/72, PT100 (P)	
32		phase V4, main sensor, slot 53/72, PT100 (N)	
33	Temperature 12	phase W4, main sensor, slot 93/72, PT100 (P)	
34		phase W4, main sensor, slot 93/72, PT100 (N)	
35	Temperature 13	phase U1, spare sensor, slot 8/72, PT100 (P)	+TEMP5
36		phase U1, spare sensor, slot 8/72, PT100 (N)	+TEMP5
37	Temperature 14	phase V1, spare sensor, slot 24/72, PT100 (P)	+TEMP5
38		phase V1, spare sensor, slot 24/72, PT100 (N)	+TEMP5
39	Temperature 15	phase W1, spare sensor, slot 64/72, PT100 (P)	+TEMP5
40		phase W1, spare sensor, slot 64/72, PT100 (N)	+TEMP5
41	Temperature 16	phase U2, spare sensor, slot 20/72, PT100 (P)	+TEMP5
42		phase U2, spare sensor, slot 20/72, PT100 (N)	+TEMP5
43	Temperature 17	phase V2, spare sensor, slot 36/72, PT100 (P)	+TEMP5
44		phase V2, spare sensor, slot 36/72, PT100 (N)	+TEMP5
45	Temperature 18	phase W2, spare sensor, slot 76/72, PT100 (P)	+TEMP5
46		phase W2, spare sensor, slot 76/72, PT100 (N)	+TEMP5
47	Temperature 19	phase U3, spare sensor, slot 32/72, PT100 (P)	+TEMP5
48		phase U3, spare sensor, slot 32/72, PT100 (N)	+TEMP5
49	Temperature 20	phase V3, spare sensor, slot 48/72, PT100 (P)	+TEMP5
50		phase V3, spare sensor, slot 48/72, PT100 (N)	+TEMP5
51	Temperature 21	phase W3, spare sensor, slot 88/72, PT100 (P)	+TEMP5
52		phase W3, spare sensor, slot 88/72, PT100 (N)	+TEMP5
53	Temperature 22	phase U4, spare sensor, slot 44/72, PT100 (P)	+TEMP5
54		phase U4, spare sensor, slot 44/72, PT100 (N)	+TEMP5
55	Temperature 23	phase V4, spare sensor, slot 60/72, PT100 (P)	+TEMP5
56		phase V4, spare sensor, slot 60/72, PT100 (N)	+TEMP5
57	Temperature 24	phase W4, spare sensor, slot 4/72, PT100 (P)	+TEMP5
58		phase W4, spare sensor, slot 4/72, PT100 (N)	+TEMP5
59	Bearing temperature, sensor 1	PT100	+BTMP
60	Bearing temperature, sensor 1	PT100_GND	+BTMP
61	Bearing temperature, sensor 2	PT100	+BTMP
62	Bearing temperature, sensor 2	PT100_GND	+BTMP
63	Reserve		
64	Reserve		
65	Reserve		
66	Reserve		

Installation

Pin configuration of +LVB connection (+QUAD) (continued)

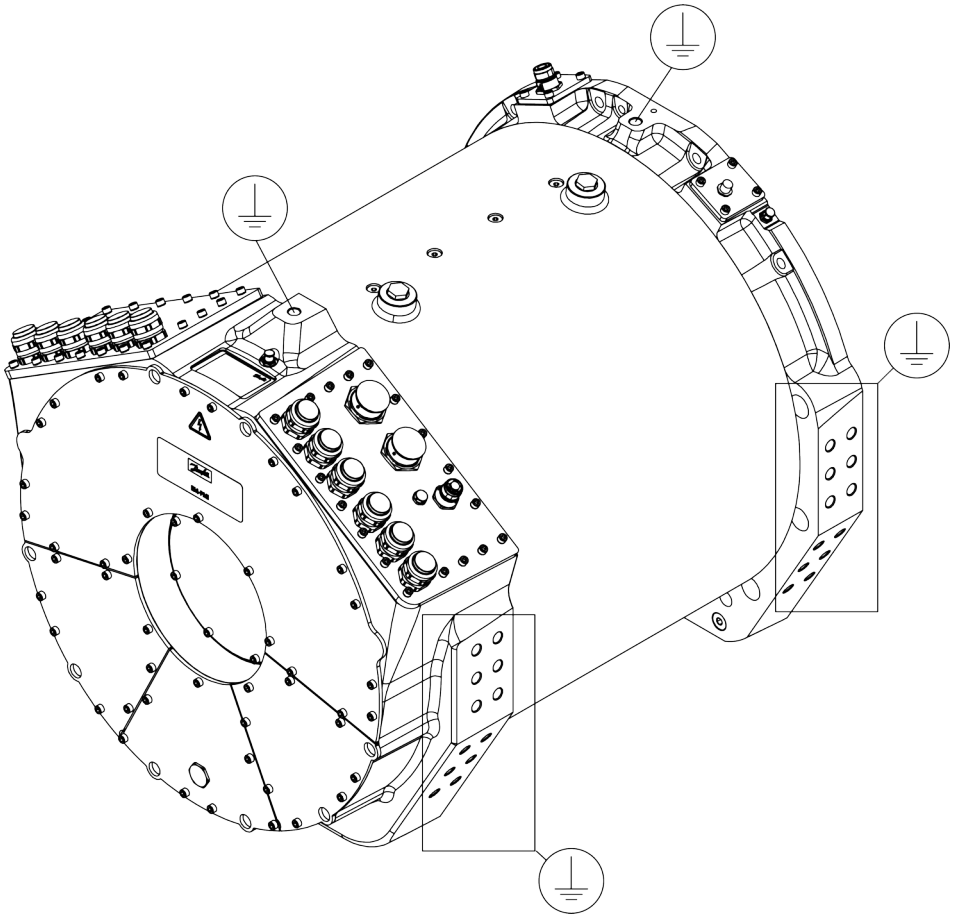
PIN	Measurement	Description	Option
67 ⏚	Resolver2 shield	Resolver 2, SHIELD/GROUND, inbuilt non-contacting	+RES2
68	Resolver2 COS	Resolver 2, RES_COS_N, inbuilt non-contacting	+RES2
69	Resolver2 COS	Resolver 2, RES_COS_P, inbuilt non-contacting	+RES2
70	Resolver2 SIN	Resolver 2, RES_SIN_N, inbuilt non-contacting	+RES2
71	Resolver2 SIN	Resolver 2, RES_SIN_P, inbuilt non-contacting	+RES2
72	Resolver2 EXCN	Resolver 2, EXCN, inbuilt non-contacting	+RES2
73	Resolver2 EXCP	Resolver 2, EXCP, inbuilt non-contacting	+RES2
D-END 1/2			
74	Bearing temperature, sensor 1	PT100	+BTMP
75	Bearing temperature, sensor 1	PT100_GND	+BTMP
76	Bearing temperature, sensor 2	PT100	+BTMP
77	Bearing temperature, sensor 2	PT100_GND	+BTMP
D-END 2/2			
78 ⏚	HEAT2	Heater 2, ground / protective earth	+HEAT2
79	HEAT2	Heater 2, neutral	+HEAT2
80	HEAT2	Heater 2, phase, 230 V_AC	+HEAT2

Grounding connections

	**Ground the electric machine from its frame to make sure it functions correctly and safely.**
	**Ground the cable shields of the power cables to make sure the electric machine functions correctly and safely.**
	**Ground the cable shields of the instrumentation cables to make sure the electric machine functions correctly and safely.**
	**It is recommended to perform a ground bond test after installing the electric machine to make sure the electric machine is correctly grounded.**
	**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.**

Installation

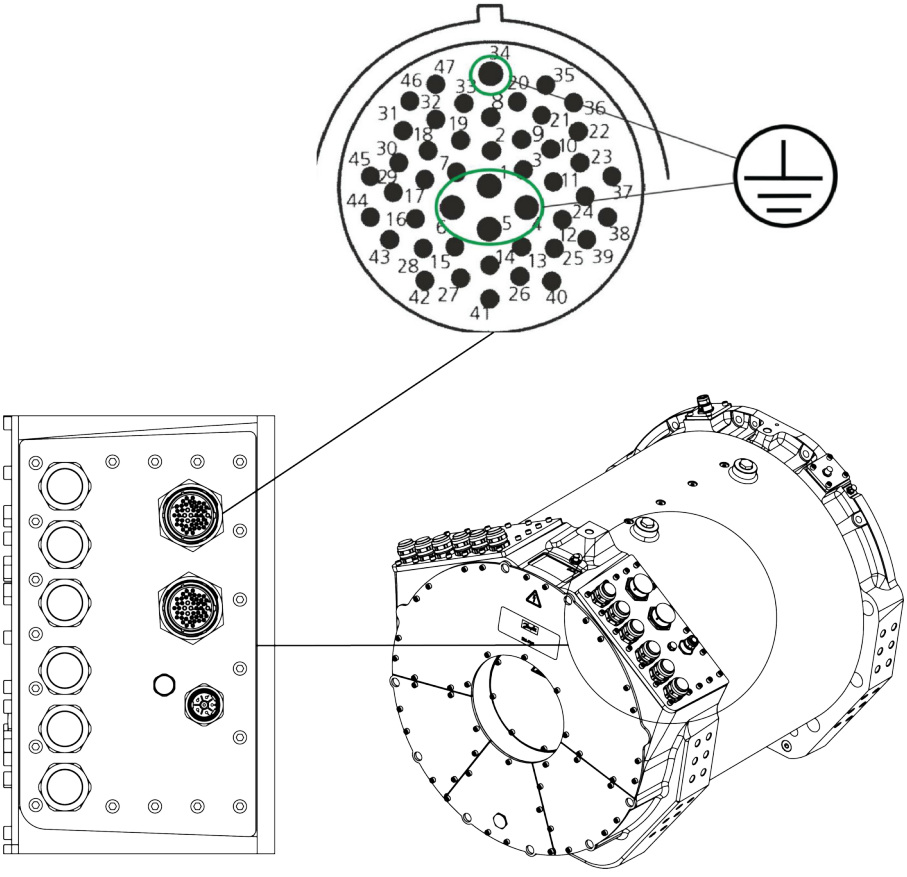
The machine enclosure grounding point, safety grounding



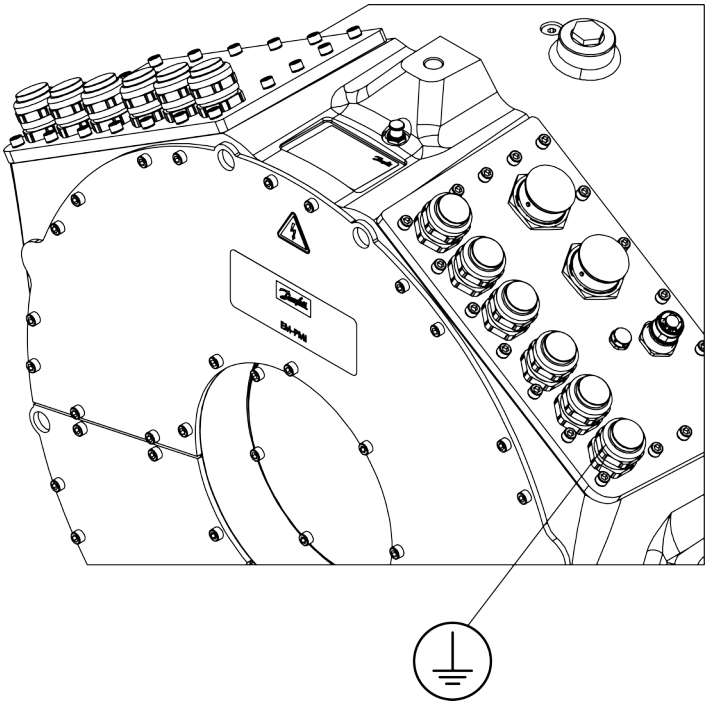
Side/Foot/V-mounting bores can be used for grounding if they are not in use.

Installation

Low voltage cable grounding points



Power cable grounding through the cable gland



Installation

Testing the power cable shield grounding (earthing)

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 an other 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. 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.

Anti-condensation heater connections

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

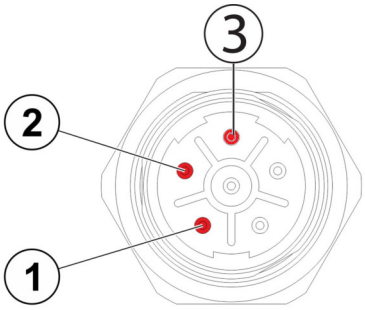
Water condensing inside the electric machine enclosure can result in failure or corrosion of the electric machine. This often happens in cooler temperatures or higher humidity areas typically in marine environment, when the machine is not running.

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

The installed anti-condensation heater must be supplied with 230 Vac power. The heater connector used is HUMMEL Twilock connector, illustrated in Figure below.

For the location of the heater connectors, see *Connections and interfaces* on page 20.

Connection of the heater element



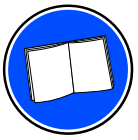
1	L
2	N
3	PE

Installation

After the installation of the electric 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 should 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.

Operation

	**Only trained and qualified personnel familiar with the relevant safety requirements are allowed to operate the electric machine.**
	**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.**
	**The surface of the electric machine might be hot. Do not touch the electric machine during operation.**
	**Entanglement hazard! Do not touch the electric machine during operation.**
	**Use sufficient personal protective equipment when you are near the electric machine.**
	**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:

Operation

- 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 altitude up to 4000 m above sea level. See the product data sheet for details.
- Coolant liquid must be water-glycol mixture with maximum of 50 % glycol content. See Chapter *Recommended coolants*.
- For the maximum coolant liquid temperature at the inlet of the coolant circuit, see the product data sheet.

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

Condition monitoring during operation

	**Supervise the electric machine during operation to make sure that the electric machine operates correctly and has a 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 *Troubleshooting* on page 81.**
	**Electrical safety of the system and the end application has to be guaranteed using appropriate methods, like external insulation resistance or residual current monitoring, depending on the application.**
	**Maximum temperature of the bearings of the electric machine is: 120°C.**
	**The maximum allowed winding temperature of the electric machine is shown on the rating plate and in the data sheet.**

Recommended lubricants

	**Do not mix different types of lubricants!**

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/*.

Operation

Recommended coolants

	**Ethylene glycol is a toxic compound. Avoid exposure to the coolant.**
	**Copper ions concentration of more than approx. 0.06 ppm causes *copper induced pitting corrosion*. Do not use copper components in the cooling system.**
	**Hard piping made of metal is recommended for the coolant instead of soft piping as rubber hoses.**
	**Use correct personal protective equipment when you handle 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.

Glycol coolant options:

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

Emergency operation

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

Cooling of the electric machine fails

Cooling system failure can be caused by dregs (sediment) accumulating in 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

When reading the temperature (resistance) values from the additional sensor, add +15°C to the measured value. This gives more correct estimation of the inner temperature of the electric 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.

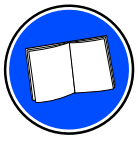
Danfoss service contact information

Operation

Contact Danfoss service at *https://danfosseditron.zendesk.com/hc/en-gb* or send email to editron.service@danfoss.com.

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 user guide before you start to work with the electric machine. To make sure that the operation of the electric machine is safe and reliable, obey the maintenance instructions.**

Regular maintenance

	**Inspect the electric machine at regular intervals.**

Maintenance

Do not attempt to tighten bolts or screws that are not discussed in this user guide 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 that the electric machine has reliable operation and designed lifetime.

Maintenance schedule

Object		Check/Task	Weekly	Monthly	Yearly
General construction	Operation	Noise, vibration. If clearly increased, contact Danfoss.	X		
	Mounting	Bolt tightness. Tighten to proper value if necessary. Applies to bolts and screws that are discussed in this user guide. See Chapter *Tightening torques*.			X
	Bearings	Detect any unusual noise or vibration. If exists, contact Danfoss.			X
	Enclosure and connected parts	Check cleanliness. Clean if necessary. See Chapter *Cleaning*.		X	
	Shaft seals	Check the wear. Replace if necessary.			X
Electrical system	Cables	Wearing of the cables. Replace if necessary.		X	
	Electrical connections	Check connections. Make sure that tightening torque is correct for the cable glands. See Chapter *Tightening torques*.			X
	Groundings (earthings)	Check groundings (earthings). Make sure that the connection resistance is correct. Re-connect if necessary.			X
	Anti-condensation heater	Check anti-condensation heater connections and resistance, if the option is installed. If needed, contact Danfoss.			X
Cooling system	Operation	Functioning. Cooling system functions as specified.	X		
	Tubing and connection tightness	No visible leakage. If leaking, tighten the connections, or replace parts.		X	
	Ventilation plug	Cleanliness. Clean if necessary. See Chapter *Cleaning*.		X	
	Coolant flow	Coolant flow direction. It is recommended to change the coolant flow direction by changing the connections or flow direction from the pump. See Chapter *Cooling system maintenance*.			X
	Coolant quality	Coolant as specified. Correct glycol used, and water/glycol mixture correct. Refill if necessary. See Chapter *Cooling system maintenance*.			X
Lubrication	Relubrication (grease lubricated bearings)	Relubricate depending on the use (see Chapter *Bearings and lubrication*). Maximum relubrication interval is six months.		X	

Cleaning

Never open or remove the watertight ventilation plugs. Clean them only from the outside.

Risk of electric shock if the electric machine is cleaned against instructions allowing water to go in to the electric machine.

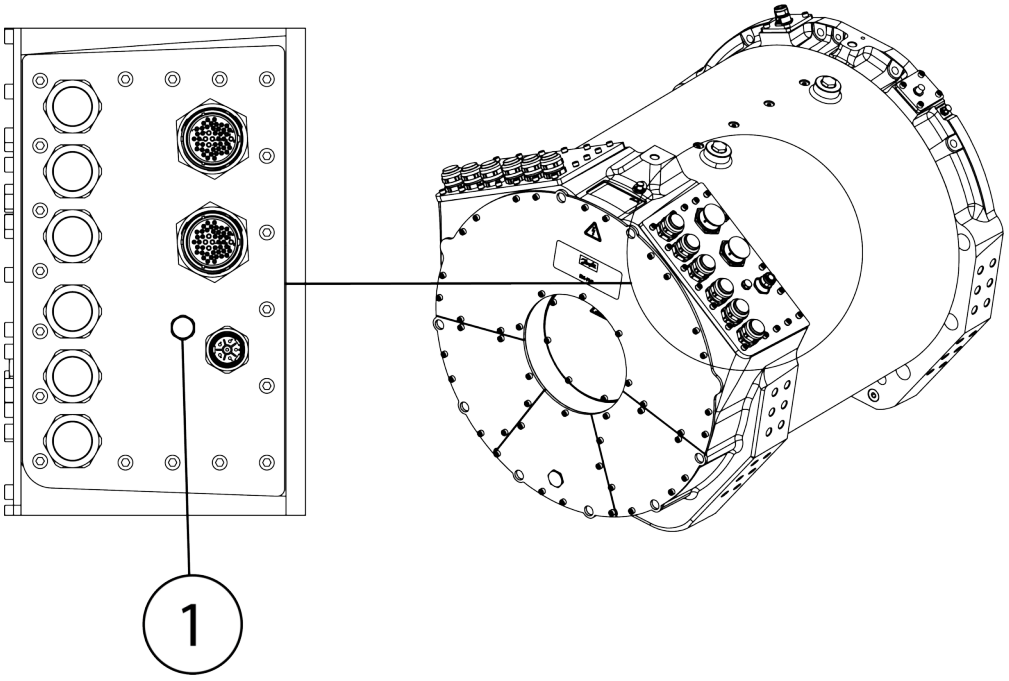
Keep the electric machine clean. For cleaning, use non-abrasive and non-corrosive cleaning products.

Maintenance

Make sure that the detergent may be used for aluminum.

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

Ventilation plugs



1	Ventilation plug (do not remove)

Bearings and lubrication

Grease relubricable bearings

	**The grease relubricable bearings need regular greasing. Follow the relubrication interval and instructions described in this Chapter.**
	**Lubricants can cause skin irritation and eye inflammation. Follow all safety precautions specified by the manufacturer of the lubricant.**
	**Make sure that the automatic greasing and the oil lubrication function correctly after you start the electric machine.**

Maintenance

	**The bearing type of the electric machine can be found on the rating plate of the electric machine.**
	**It is recommended to have a piping for the grease exiting the electric machine. The grease exit hole is often in an inconvenient location when the electric machine is installed.**

The bearing type for the electric machines EM-PMI540B-T1500 and EM-PMI540B-T2000 is 6214/C3 (non-insulated bearings) or 6214/C3 HC5 (insulated bearing). See the recommended lubricant in Chapter *Recommended lubricants* on page 71.

The bearing type for the electric machines EM-PMI540B-T3000 and EM-PMI540B-T4000 is 6216/C3 (non-insulated bearings) or 6216/C3VL0241 (insulated bearing). See the recommended lubricant in Chapter *Recommended lubricants* on page 71.

Bearing relubrication

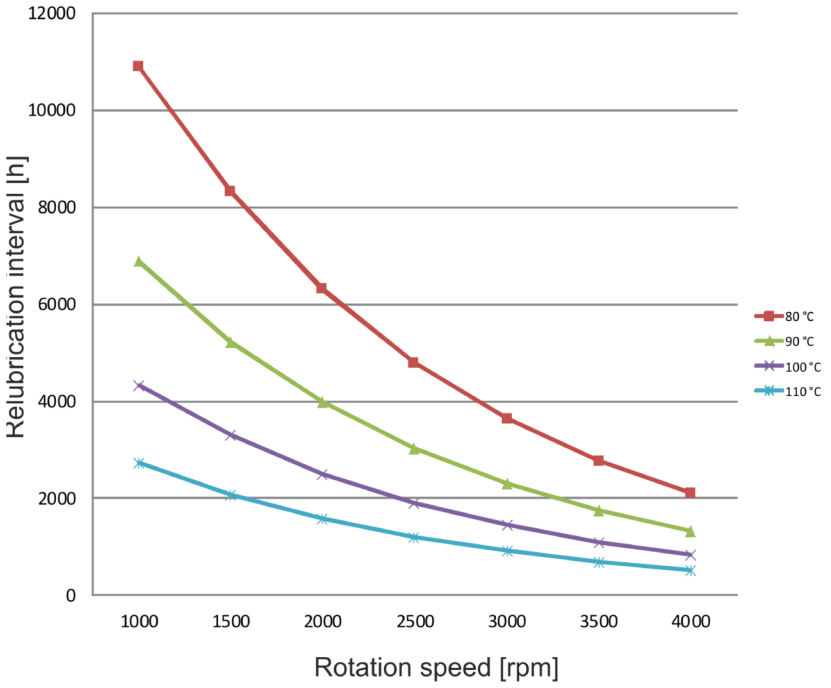
	**Beware of rotating parts. Do not touch the electric machine during operation.**
	**The surface of the electric machine can be hot. Use correct protective equipment (heat resistant gloves) when you handle the electric machine.**
	**The information of bearing lifetime and bearing grease lifetime are 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 six 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 the 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.

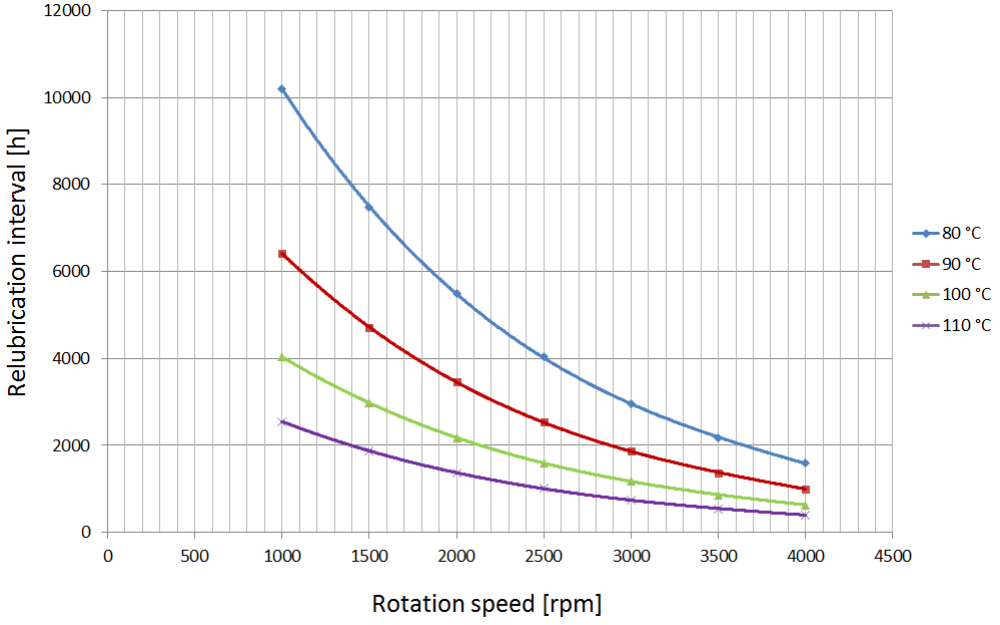
Relubrication interval of the machine compared to rotation speed and bearing temperature

For electric machines EM-PMI540B-T1500 and EM-PMI540B-T2000:

Maintenance



For electric machines EM-PMI540B-T3000 and EM-PMI540B-T4000:



For more information about the location of grease nipples and grease escape holes, see Chapter *Connections and interfaces* on page 20.

Bearing relubrication:

Maintenance

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.

1. Make sure that the electric machine has reached its operating temperature.
2. Remove the plugs from the grease escape hole(s).

   Select which grease escape hole you want to use at N-end (no need to use both).

   Make sure that grease from D-end does not push to N-end and vice versa.
3. Open the grease nipple plug(s).
4. Use grease piston to enter specific amount of grease into the grease nipple.
5. After re-greasing, the electric machine must be restarted with a short idle time of 10 minutes at 10...15% of the rated speed, so that the grease is transferred and settled to the rolling surfaces of the bearing.
6. Install the plug(s) on the grease nipple(s) and on the grease escape hole(s).

Cooling system maintenance

It is recommended to change the direction of the coolant liquid flow 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.

Dismounting

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

For dismounting the electric machine, follow the Steps below.

1. Prepare the electric machine for lifting, for more information refer to Chapter *Lifting* on page 31. Support the electric machine with lifting slings when dismounting.
2. Loosen the mounting bolts. For more information refer to Chapter *Mounting the electric machine* on page 42.
3. If force is required, use the bores in D-end flange to push the electric machine out from the mating structure, or use some other method that does not damage the electric machine.
4. Lift the electric machine off. Support the electric machine when lifting.

Troubleshooting

Some difficulties may occur while operating the electric machine. Possible causes and actions are given in the 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.

For more information, contact Danfoss service at *https://danfosseditron.zendesk.com/hc/en-gb* or send email to editron.service@danfoss.com.

Troubleshooting chart

Symptom	Possible cause	Action
Excessive vibration, noise	Imbalance at the connected electric machine or the powertrain components.	Check the balance and installation of the drivetrain components.
	Misalignment between the electric machine and the used device.	Check the shaft connections and couplings. Ensure that the alignment is within the specifications listed in Chapter *Shaft alignment and load* on page 29.
	Attachment bolts are loose.	Replace and tighten the bolts.
	Clearance at the spline connection.	Check the spline connection.
	Imbalance at the electric machine.	Contact local Danfoss representative.
	Particles inside the electric machine.	
	Bearing damage.	
	Inadequate lubrication (grease lubricated bearings).	Apply bearing lubricant/grease. See Chapter *Bearings and lubrication*. Contact local Danfoss representative for further information.
Bearing temperature rise	Inadequate lubrication (grease lubricated bearings).	Apply bearing lubricant/grease. See Chapter *Bearings and lubrication*.
	Too much grease in the bearing housing (grease lubricated bearings).	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.
	Incorrect bearing grease.	Check that the used grease is of correct type.
	Overloaded bearing.	Check that the system is not causing excess force or vibration to the machine bearings. Check the alignment of the machine shaft, see Chapter *Shaft alignment and load* on page 29.
	Bearing damage.	Contact local Danfoss representative for further information.
	Incorrect mounting option	Check motor mounting orientation and confirm that the motor has the correct option (vertical or horizontal mounting).
Electric machine overheating	Overload.	Reduce load. Check the machine rating plate and ensure that inverter limits are set accordingly.
	Cooling system failure.	Check the cooling system integrity, flow and fluid temperature. Change the cooling flow direction to flush the cooling system from sediment that has possibly accumulated. See also Chapter *Emergency operation*.
	Leakage in the cooling system.	Check the cooling system circuit and tighten the leaking connections.
	Rigid particle inside the machine cooling channel.	Try pulsating coolant to open the channels. Contact local Danfoss representative.
	Wrong machine parameters in the inverter.	Check and correct the machine parameters in the inverter.
	Damaged winding.	Measure the insulation resistance. Measure the winding resistance with a high-precision DC resistance meter and compare to manufacturer specifications. Replace the electric machine if necessary.
	Inverter switching frequency too low.	If other than a Danfoss Editron inverter is used, ensure that the switching frequency is at least equal to the required minimum switching frequency of the motor. See corresponding product data sheet.

Troubleshooting

Troubleshooting chart (continued)

Symptom	Possible cause	Action
Connection box and / or motor cables overheating	Cable lug bolts loose.	Check torque of cable lug bolts. See also Chapter *Power connections* on page 45.
	Cable diameter too small.	Replace power cables with appropriate cable type.
	Cable lug crimps insufficient or incorrect.	Replace cable lugs. Use recommended cable lugs and crimping tools.
	Contamination or insulating substance between cable lug and bus bar.	Check that the contact surfaces of the bus bars and cable lugs are clean and undamaged. Ensure there is no grease, thread locking compound, dirt or other foreign substances between the bus bar and cable lug.
Significant lubricant leak	Worn radial lip seal.	Contact local Danfoss representative.
	Block at the grease outlet channel.	Clean the grease escape channel from solidified grease using brush if necessary.
Electric machine does not work properly or the performance is poor	Wrong electric machine parameters in the inverter.	Check and correct the electric machine parameters from the inverter. See inverter user manual and other relevant documentation.
	Demagnetization of magnets due to overheating.	Check that the back-EMF of the motor is within specifications. Contact local Danfoss representative. Replace the electric machine if necessary.
	Bearing fault.	Check the bearing temperature, lubrication and conditions. Contact local Danfoss representative for further information.
	Insulation or winding fault.	Measure the insulation resistance, refer to the manufacturer limits. See Chapter *Insulation resistance test*. Measure the winding resistance with a high-precision DC resistance meter and compare to manufacturer specifications. Replace the electric machine if necessary.
Moisture and / or corrosion inside the connection box or motor	Cable glands installed incorrectly.	Check tightening torque and sealing of the cable glands.
	Power cables installed incorrectly.	Check cable installation and sealing with cable glands.
	Connection box cover bolts are too loose, too tight, or cover seal is damaged.	Check the integrity of the seal on the connection box cover. Tighten the cover bolts to the specified torque.
	Low voltage connector damaged or not connected.	Contact local Danfoss representative.
	Breather cap blocked.	Check that the breather cap of the electric machine is not submerged in liquid, painted, or covered by any object
Temperature measurement failure	The PT100 sensor is faulty.	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 local Danfoss representative. See also Chapter *Emergency operation*.
Resolver sensor failure	Resolver wiring is faulty.	Check the wiring of the resolver and make sure that a shielded and twisted pair cable is used with the correct pairing of the signals.
	Resolver sensor is damaged.	Contact local Danfoss representative.

Aftersales

Service policy

Maintenance and service of the electric machine is limited to the procedures described in this user guide.

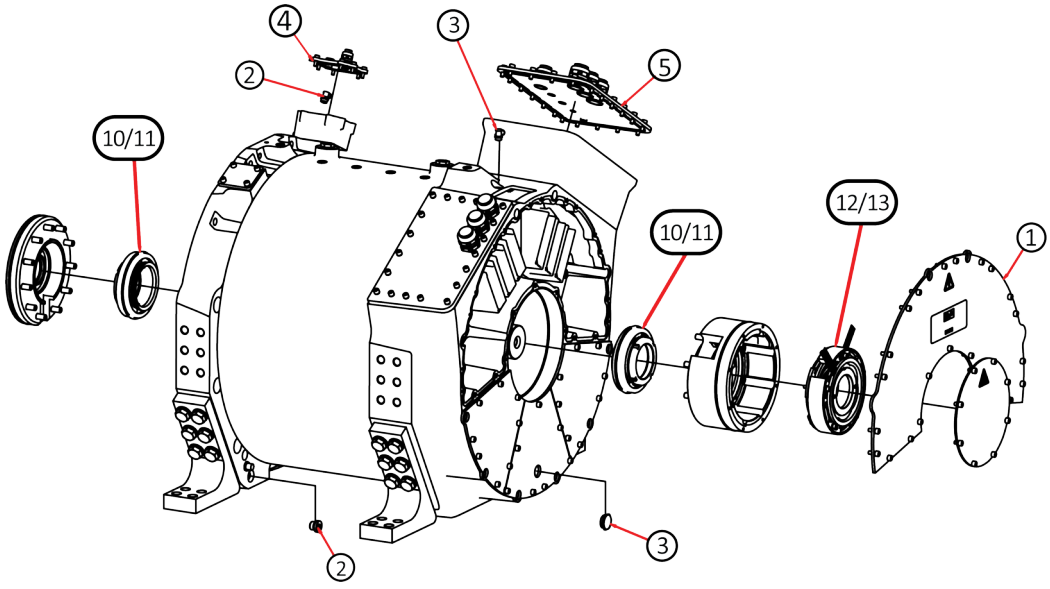
If the electric machine has service parts available, you can find them in Chapter *Service parts* on page 83.

For further information, go to *https://danfosseditron.zendesk.com/hc/en-gb* or send email to editron.service@danfoss.com.

Service parts

The recommended service parts are listed in this Section. Maintenance procedures not described in this user guide require special tools and instructions. Contact Danfoss for more information and purchasing.

Service part kits for EM-PMI540B-T1500 / T2000

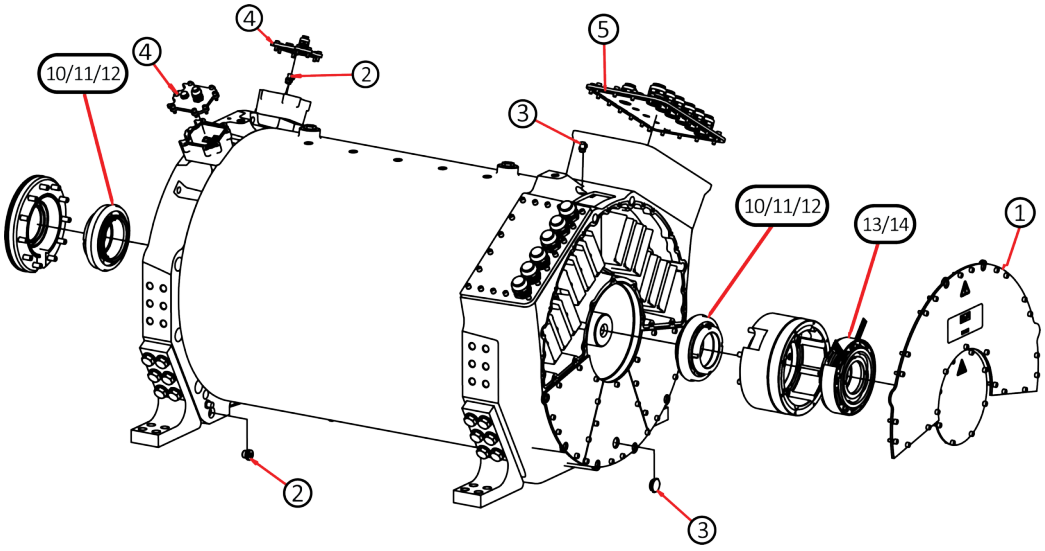


Position	Kit name	Description	Order number
1	HV terminal box cover	Replacement seals/bolts	11333593
2	Plugs D-end	Replacement plug/seal	11334553
3	Plugs, N-end	Replacement plug/seal	11334535
4	LV terminal box cover, D-end (with +LVB1)	Replacement seals/bolts	11333587
5	LV terminal box cover, N-end (with +LVB1)	Replacement seals/bolts	11333592 (*
10	Bearing kit, non-insulated	Bearing replacement kit	11334707
11	Bearing kit, BIN	Bearing replacement kit	11334711
12	Resolver 1	RES1 replacement kit	11334684
13	Resolver 2	RES2 replacement kit	11334683

(* Correct kit needs to be specified according to machine options.

Aftersales

Service part kits for EM-PMI540B-T3000 / T4000



Position	Kit name	Description	Order number
1	HV terminal box cover	Replacement seals/bolts	11333593
2	Plugs D-end	Replacement plug/seal	11334553
3	Plugs, N-end	Replacement plug/seal	11334535
4	LV terminal box cover, D-end (with +LVB1)	Replacement seals/bolts	11333587
5	LV terminal box cover, N-end (with +LVB1)	Replacement seals/bolts	11333592 (*
10	Bearing kit, non-insulated	Bearing replacement kit	11334512
11	Bearing kit, BIN	Bearing replacement kit	11334545
12	Resolver 1	RES1 replacement kit	11334534
13	Resolver 2	RES2 replacement kit	11334562

(* Correct kit needs to be specified according to machine options.

Disposal

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

Storage, installation and maintenance checklists

Electric machine installation checklist

Date:

Electric machine and customer information

Customer:	**Electric machine type (from the rating plate):**
Customer reference:	**Electric machine serial number:**
Service reference:	**Date installed:**

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

Installation checklist

	Approval	**N.A**	**PASS**	**FAIL**
General				
Electric machine type is correct		☐	☐	☐
Electric machine is undamaged		☐	☐	☐
Insulation resistance check For more information, see *Insulation resistance test* on page 36.	Reference value of 500 MΩ must be exceeded at reference ambient temperature 25°C (measured with 500 V_{DC} / 1 min insulation resistance test).	☐	☐	☐
Environmental conditions as specified (see data sheet)		☐	☐	☐
Mechanical installation				
Supporting structure as required		☐	☐	☐
Shaft alignment as specified (see chapter Shaft alignment and load).		☐	☐	☐
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 lug tightening torque (to the bus bar)		☐	☐	☐
Connection box cover bolts tightening torque		☐	☐	☐
Grounding				
Electric machine enclosure grounding connected		☐	☐	☐
Low voltage cable shield grounding connected		☐	☐	☐
Power cable shield connection resistances to ground (electric machine enclosure) measured and valid		☐	☐	☐

Storage, installation and maintenance checklists

Installation checklist (continued)

	Approval	N.A	PASS	FAIL
Low voltage cable shield grounding resistances measured and valid		☐	☐	☐
Notes: • • • • • • • • • • • • • **Date:** **Signature:**				

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.

Electric machine weekly maintenance checklist

Date:

Electric machine and customer information

Customer:	**Electric machine type (from the rating plate):**
Customer reference:	**Electric machine serial number:**
Service reference:	**Date installed:**

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

Electric machine weekly maintenance checklist

	N.A	PASS	FAIL
General construction			
Noise or vibration during operation in general	☐	☐	☐
Cooling system			

Storage, installation and maintenance checklists

Electric machine weekly maintenance checklist (continued)

	N.A	PASS	FAIL
Functioning of the cooling system in general	☐	☐	☐
Notes: • • • • • • • • • • • •			

Electric machine monthly maintenance checklist

Date:

Electric machine and customer information

Customer:	**Electric machine type (from the rating plate):**
Customer reference:	**Electric machine serial number:**
Service reference:	**Date installed:**

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

Electric machine monthly maintenance checklist

	N.A	PASS	FAIL
General construction			
Noise or vibration during operation in general	☐	☐	☐
Cleanliness of the enclosure and connected parts	☐	☐	☐
Electrical system			
Weariness of the cables	☐	☐	☐
Insulation monitoring	Continuous insulation monitoring. (It is recommended to use continuous insulation monitoring for the whole system where electric machine is used.)		
Encoder mounting	☐	☐	☐
Cooling system			
Functioning of the cooling system in general	☐	☐	☐
Tightness of the ventilation plug	☐	☐	☐

Storage, installation and maintenance checklists

Electric machine monthly maintenance checklist (continued)

	N.A	PASS	FAIL
Cleanliness of the ventilation plug	☐	☐	☐
Notes: • • • • • • • • • • • • •			

Electric machine yearly maintenance checklist

Date:

Electric machine and customer information

Customer:	**Electric machine type (from the rating plate):**
Customer reference:	**Electric machine serial number:**
Service reference:	**Date installed:**

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

Electric machine yearly maintenance checklist

	Acceptance	N.A	PASS	FAIL
General construction				
Noise or vibration during operation in general		☐	☐	☐
Mounting bolt tightness				
Cleanliness of the enclosure and connected parts		☐	☐	☐
Electrical system				
Weariness of the cables		☐	☐	☐
Electrical connections in general		☐	☐	☐
Cable lug tightening torque (to the bus bar)		☐	☐	☐
Connection box cover bolts tightening torque		☐	☐	☐
Cooling system				
Coolant flow direction changed and connection checked		☐	☐	☐
Coolant quality as specified		☐	☐	☐
Used coolant:				
Functioning of the cooling system in general		☐	☐	☐
Tightness of the tubing and connections (no leakages)		☐	☐	☐

Storage, installation and maintenance checklists

Electric machine yearly maintenance checklist (continued)

	Acceptance	N.A	PASS	FAIL
Cleanliness of the ventilation plug		☐	☐	☐
Grounding				
Power cable shield connection resistances to ground (electric machine enclosure) checked		☐	☐	☐
Low voltage cable shield grounding resistances checked		☐	☐	☐
Connection to grounding points checked		☐	☐	☐
Notes: • • • • • • • • • • • •				

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.

For cleaning instructions, refer to Chapter *Cleaning* on page 75.

Used service parts

Part description	Part type	Quantity	Item (order) number
_			
_			
_			
_			
_			
Notes: • • • • • • • • • • • • **Date:** **Signature:**			

Electric machine storage checklist

Date:

Storage, installation and maintenance checklists

Electric machine and customer information

Customer:	**Electric machine type (from the rating plate):**
Customer reference:	**Electric machine serial number:**
Service reference:	**Date installed:**

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

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

Storage checklist

Procedure	Date	Date	Date	Date	Date
Storage base as specified (vibration free)					
Storage temperature and humidity as specified					
Electric machine type and serial number is correct					
Electric machine supported correctly					
Corrosion protection of non-painted surfaces (for example shaft-end and grounding points)					
Insulation resistance (test insulation resistance every three months in storage)					
Shaft rotated as specified (10 rotations monthly)					

ENGINEERING
TOMORROW

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- DCV directional control valves
- Electric converters
- Electric machines
- Electric motors
- Gear motors
- Gear pumps
- Hydraulic integrated circuits (HICs)
- Hydrostatic motors
- Hydrostatic pumps
- Orbital motors
- PLUS+1® controllers
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- PLUS+1® joysticks and pedals
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