

ENGINEERING
TOMORROW



User Guide

Electrical converter

ED3

EC-BDC1200



Revision history

Table of revisions

Date	Changed	Rev
October 2025	Updated sections: Electrical connections	0106
March 2025	Updated sections: Intended use of the electric device, Low voltage connections, Regular maintenance	0105
December 2024	Updated section: Measuring the insulation resistance	0104
October 2024	Updated document (general market)	0103
February 2024	Updated document for P03 hardware revision	0102
September 2022	First edition	0101

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General information

Intended use of the user guide

This user guide contains the installation, operation and maintenance instructions for the EC-BDC1200 electrical converter.

This user guide contains instructions necessary to safely and properly handle, install and maintain the electric device. They should be brought to the attention of anyone who installs or maintains the electric device 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 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, the EC-BDC1200 electric converter is referred to as the electric device.

The following naming convention is used to refer to electric device type code and options:

- EC-BDC1200

Part of the name	Explanation
EC	Electric Converter
BDC1200	Product name part 1

Conformity according to standards

The electric device has been designed in accordance with the essential parts of the following directives and to meet the requirements of the standards:

Applicable directives and standards

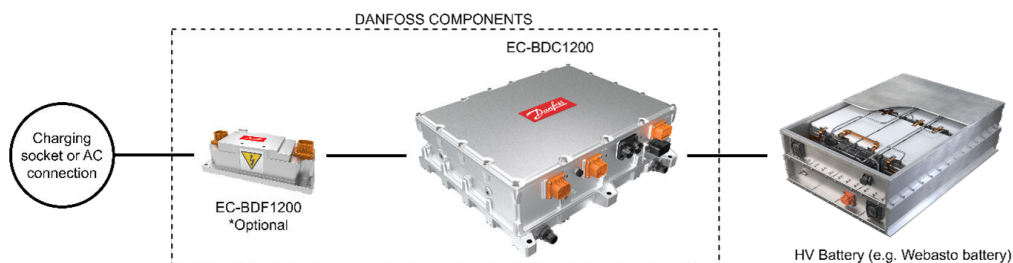
Directives / Standards	Explanation
Low Voltage Directive 2014/35/EU	The low voltage directive (LVD) (2014/35/EU) ensures that electrical equipment within certain voltage limits provides a high level of protection for European citizens, and benefits fully from the single market. It has been applicable since 20 April 2016.
The electromagnetic compatibility (EMC) Directive 2014/30/EU	EMC directive ensures that electrical and electronic equipment does not generate, or is affected by, electromagnetic disturbance.
EN 61851-21-1:2017	Electric vehicle conductive charging system - Part 21-1 Electric vehicle onboard charger EMC requirements for conductive connection to AC/DC supply.
UN Regulation No. 10 Revision 6	Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility.

EC-BDC1200 in vehicle usage

In vehicle usage, the electric device requires an external filter when operated as a charger to comply with UN Regulation No. 10. For more information, see the product data sheet.

General information

EC-BDC1200 system overview with external filter



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 documents, 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

Following symbols, terms and abbreviations may exist in this user guide.

Term/ Abbreviation	Explanation
AC	Alternating current
DC	Direct current
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ePTO	Electric power take-off
GND	Ground in electrical connections
HV	High voltage
IMD	Insulation measurement device
I/O	Input / Output
LV	Low voltage
MCB	Miniature circuit breaker
RCD	Residual current device

Symbol	Variable	Unit
U_{DC}	DC link voltage	V
U_{ac}	AC output voltage	V
I_n	Rated current	A_{rms}
P_n	Rated power	kW

General information

Symbol	Variable	Unit
$f_{in/out}$	Input / Output frequency	Hz
f_{switch}	Switching frequency	kHz
I_{peak}	Overcurrent limit	A
Q_c	Rated coolant liquid flow	l/min
T_c	Rated coolant liquid input temperature	°C
T_{amb}	Rated ambient temperature	°C
R	Resistance	Ω

Responsibility of the manufacturer

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

- Handling, mounting, installation, operation and maintenance are carried out by qualified and authorized service personnel.
- The installation of the system complies with the requirements of the appropriate regulations.
- The electric device is used in accordance with the instructions in this user guide.
- The electric device is installed, maintained and serviced in accordance with the instructions in this user guide.

Safety information

General safety statement

The electric device is intended for use as a component for work machines, vehicle and commercial installations.

The use of the electric device is prohibited in hazardous areas unless it is expressly designed for such use.

The electric device 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 ensure safe and proper installation, operation and maintenance of the electric device. They should be brought to the attention of anyone who installs, operates or maintains the electric device or associated equipment.

High voltage and rotating parts can cause serious or fatal injuries. For the electric device covered by this user guide, it is important to observe safety precautions to protect personnel from possible injury.



The user is responsible for complying with Functional and Cyber Security requirements.

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 may exist in this user guide and on the electric device.

	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.

Safety information

	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.
	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.
	Poison warning The symbol is identified by a yellow background, black triangular band, and a skull and crossbones symbol. It indicates a poisonous substance that could kill or cause an injury to a person.
	Electric shock warning - Read the instructions in the user guide.
	General Information.
	Read the instructions in the manual.

Personal protective equipment

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

	Use eye protective equipment like safety goggles or mask when you work with the electric device. Permanent damage to the eye could be caused by splashing fluids or other substances.
	Use hearing protective equipment when you work on the electric device. 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 device! Head injuries can be caused by object impact.
	Use cut resistant gloves when you handle and maintain the electric device. There is a risk of cut injuries.

Safety information



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

Safety features

Advanced protection features have been implemented. However, the device is not compliant with functional safety and cyber security standards.

Protection type	Built-in	Information
SW overcurrent trip	Yes	—
SW overvoltage trip	Yes	—
Short circuit protection	Yes	-
High-voltage interlock loop	Yes with monitoring	See user guide for more information
Converter thermal protection	Yes	Sophisticated thermal model that can automatically lower the current if needed
Converter temperature trip	Yes	-
eFuse	Yes	For AC-In, AC-Out and DC-Out

Electromagnetic compatibility (EMC)



When connecting to other equipment, ensure that only specified and compatible components of the system are used.



Individuals with heart pacemakers, metal implants, or hearing aids should be aware that electric machines generate magnetic and electromagnetic fields that can be a health hazard. These individuals should consult a doctor due to the risks posed by current-carrying conductors and permanent magnets before entering the following areas:

- **Areas where electrical equipment and parts are operating**
- **Areas where electrical equipment with permanent magnets is stored, assembled, operated, or repaired**

If necessary, perform a dedicated EMC test on the installation.

Electromagnetic compatibility (EMC) is the ability of electrical equipment to function correctly in its electromagnetic environment without causing interference to other devices. Meeting EMC requirements is a legal obligation for all equipment used within the European Economic Area (EEA)

Our products are designed with high standards of EMC in mind. Connect the power cables and groundings along the instructions in this user guide to achieve the required level of electromagnetic interference (EMI) shielding.

The installer is responsible for ensuring that the equipment or system into which this product is integrated complies with the EMC legislation of the country where it will be used. Within the European Union, equipment incorporating this product must comply with the EMC Directive 2014/30/EU.

Installation safety

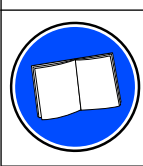


Only trained and qualified personnel familiar with the relevant safety requirements can install the electric device. If the electric device is installed incorrectly it may lead to safety hazard.

Safety information

	Make sure of correct grounding connections. Do not run the electric device without correctly attached protective earth conductor. The grounding cable must be sufficient to carry the maximum supply fault current which is normally limited by the fuses or Miniature Circuit Breaker (MCB). Suitably rated fuses or MCB should be fitted in the mains supply of the electric device, by the local legislation and recommendations.
	Use only correct (type and rating) protective fuses with the high voltage DC-system.
	Do not do any work on the electric device control cables when the power is applied to the electric device or to the external control circuits.
	The control input functions of the electric device – for example stop/start must be secured using independent channel protection in safety critical applications. All applications where malfunction could cause injury or loss of life must be subject to a risk assessment and improve control signal protection if needed.
	Do not activate the automatic fault reset function on any system, where this may cause a potentially dangerous situation. Reason for every fault situation should be determined before resetting the fault.
	Make sure that the supply voltage corresponds to the specification of the electric device.
	Do not attempt to repair the electric device. In the case of suspected fault or malfunction, contact Danfoss or Danfoss authorized service center for further assistance.
	When you install the electric device, make sure that the cooling system and the used coolant meet the specifications of the manufacturer. Make sure that the cooling system is in use when the device is powered.
	If the control cabling is installed close with the power cabling, make sure that minimum separation distance is 100 mm and crossings are at 90 degrees. Make sure that all terminal connections are tightened correctly by the instructions.
	Electric device must not be opened. Any attempt causes loss of warranty.
	Within the European Union, all machinery in which this product is used must comply with Directive 98/37/EC, Safety of Machinery. In particular, the machine manufacturer is responsible for providing a main switch and ensuring the electrical equipment complies with EN60204-1.

Safety information

	Use correct personal protective equipment when you are near the electric device.
	Read the instructions in this user guide before you start to install the electric device.

Operation safety

	Do not use the electric device without correctly dimensioned and operating cooling system.
	Maximum operation temperature must not be exceeded to avoid permanent damage to the electrical device.
	The requirements of this user guide and other related instructions and standards must be followed.
	Do not touch the electric device during operation. The surface of the electric device can be hot.

Safety information

	This electric device is intended for professional use as a part of complete equipment or system. The electric device uses high voltages and currents, and it has large amounts of stored electrical energy. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction.
	The electric device can only be used in the applications it is intended for. The rated nominal values and operational conditions are shown in the rating plate.

Product overview

General specifications

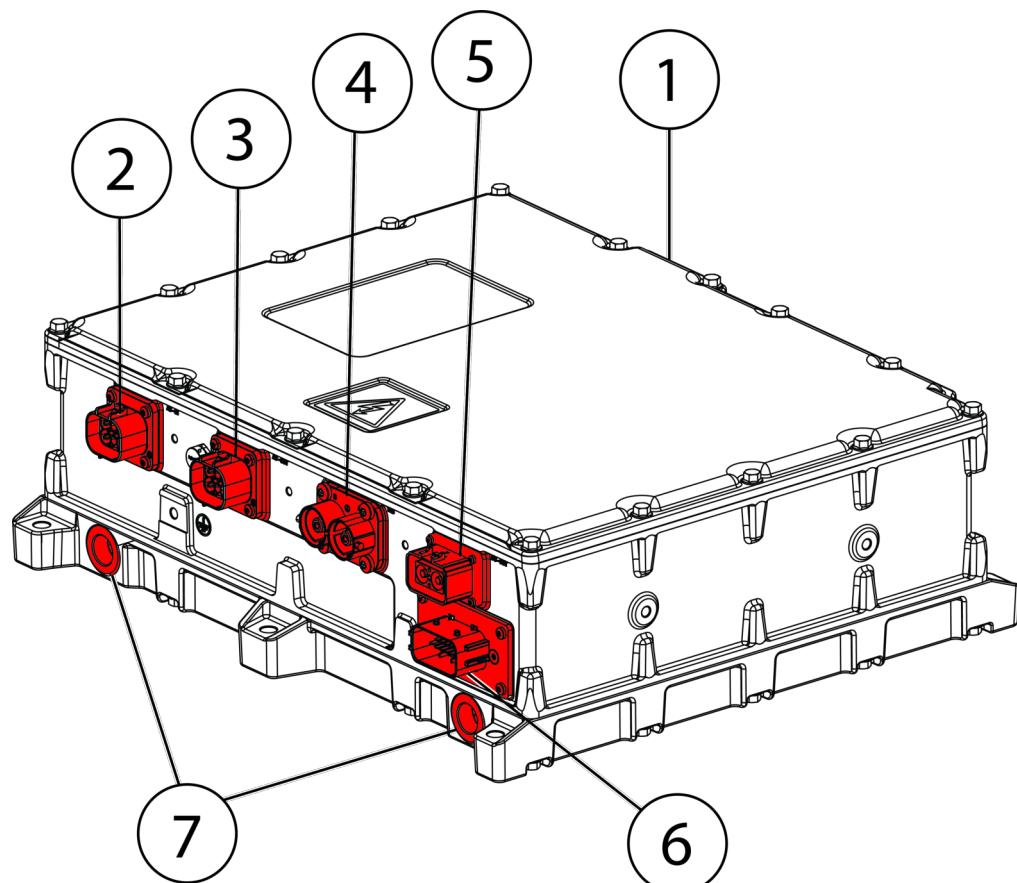
Electric device

The device is a multifunctional converter that can be used as an onboard charger for electric and hybrid commercial vehicles and off-highway work machines. Alternatively, it can be used as an electric power take-off for supplying AC or DC voltage to auxiliary equipment.

The advantages and features of the electric device:

- Enclosure with high degree of protection from ingress (IP6K9K) – sealed from moisture and dust
- Efficiency up to 96 %
- Liquid cooled with water-glycol mixture
- Ambient temperature range of -40°C and +85°C
- Allowed coolant temperature up to +70°C. For more information, see the product data sheet.
- Robust design withstanding high levels of mechanical vibration and shocks
- Support for single and three phase charging at 63 A_{rms} up to 43.6 kVA
- DC power take-off up to 44 kW
- AC power take-off up to 43.6 kVA
- J1939 compliant Danfoss proprietary CAN interface
- Bidirectional energy flow control
- High performance current and voltage control
- Wide selection of protective functions

Main components



Product overview

1	Bidirectional onboard charger
2	AC-In connector
3	AC-Out connector
4	High voltage battery connector (TVB)
5	DC-Out connector
6	Signal connector
7	Coolant interface

The advantages and features of the EC-BDF1200-63 filter unit* (required for AC-In for R10 compliance)

- EC-BDF1200-63 filter unit is a separate product, but it is often sold together with the electric device.
- Enclosure with high degree of protection from ingress (IP6K9K) – sealed from moisture and dust
- Passive cooling
- Ambient temperature between -40°C and +70°C
- Robust design withstanding high levels of mechanical vibration and shocks

*Unit sold separately

Protections and limits

The device includes the following protections and limits:

- SW overcurrent trip
- SW overvoltage trip
- Short circuit protection
- High-voltage interlock loop
- Converter thermal protection
- Converter temperature trip
- eFuse

	The minimum supported cable length for DC ePTO overcurrent detection is 6 meters per cable (12 meters in total).
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HVIL circuit

HVIL (Hazardous Voltage Interlock Loop) is a safety feature that uses a current circuit to monitor whether high voltage connectors are plugged in or not. It ensures that the high voltage connectors are connected safely before the device can be operated. The electric device has a HVIL for each high voltage connector:

- HVIL1 loop is for the High voltage battery connector
- HVIL2 loop is for the AC in connector
- HVIL3 loop is for the AC out connector
- HVIL 4 loop is for DC out connector

HVIL1 loop for the High voltage battery connector requires an external current to be sourced. The current is fed to the device via HVIL_IN pin from which it is routed through the High voltage battery connector and comes out from HVIL_OUT. The current must be between 8-30 mA to operate the device.

HVIL2, HVIL3 and HVIL4 have an internal circuit that feeds the current for the HVIL and monitors the state of the connectors.

All of the High voltage connectors have to be mated to allow the device to be operated.

Product overview

eFuse

eFuse protection is used to prevent the critical components from overheating but still allowing inrush current to support inductive loads at the AC-Out DC-Out outputs. For further information refer to the product SW user guide.

Intended use of the electric device

	The electric device is intended only for professional use. Installation, operation and maintenance of the electric device is permitted only for trained personnel and professionals.
	The electric device is intended for installation as a part of complete power generation equipment or system.
	Product shall be used only in permitted use cases.

Typical applications for the electric device:

- Onboard charger for high voltage battery of electric vehicle and off-highway machinery
- AC power take-off for single and three phase auxiliary loads, usable during vehicle or machine operation
- DC power take-off for HVAC or heaters, usable during vehicle or machine operation

Permitted use cases

The EC-BDC1200 is designed for specific use cases that must be followed to ensure safe operation of the electric device. Operation of the EC-BDC1200 without a protective device, such as an Insulation Monitoring Device (IMD) or Residual Current Device (RCD), is prohibited. Permitted use cases for different operation modes are described below.

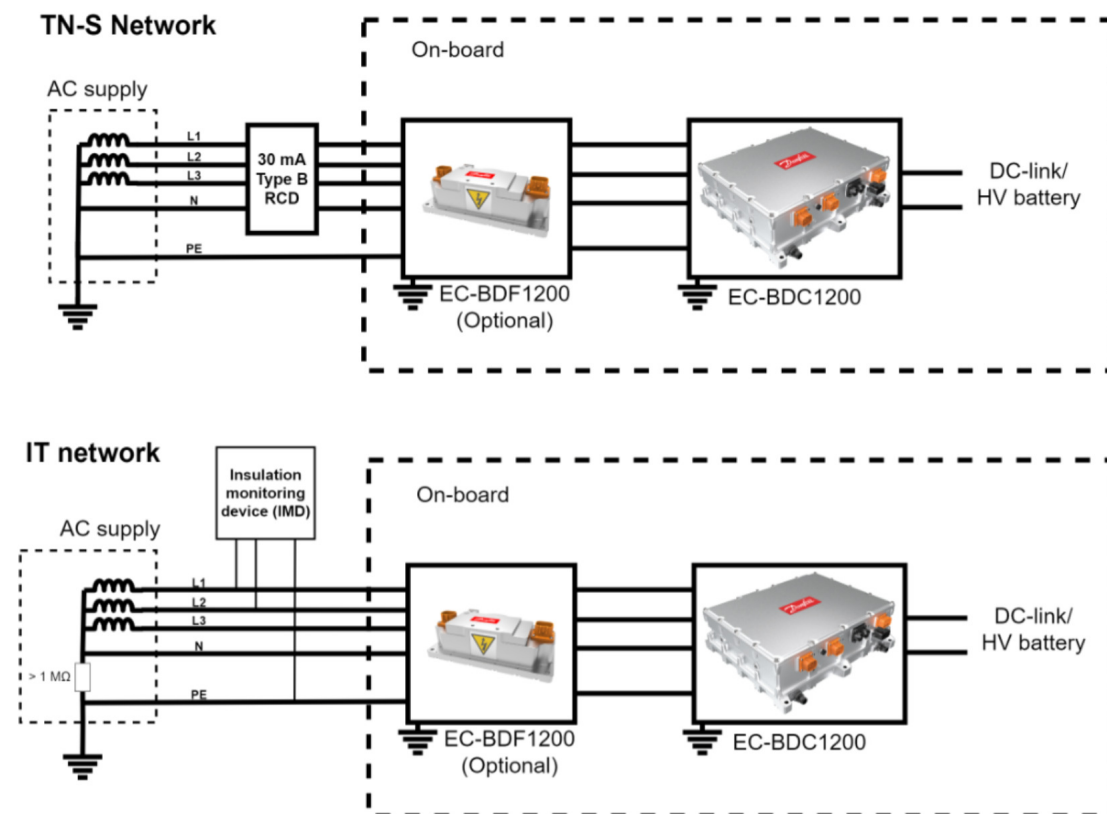
Charging

Charging is permitted from TN-S or IT networks, provided that appropriate protective devices are in place. When charging from a TN network (with or without neutral), the EC-BDC1200 must be used with a functional 30 mA Type B RCD. When charging from an IT network (with or without neutral), the EC-BDC1200 must be used with a functional IMD.

Charging is prohibited from corner grounded networks.

Product overview

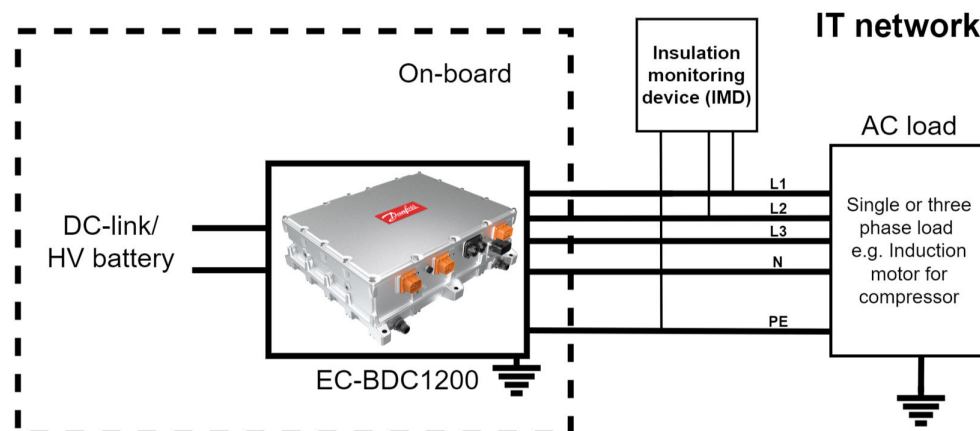
Allowed use case for charging in IT and TN-S networks



AC ePTO (AC-Out)

AC ePTO operation on an IT network is permitted only when used with an IMD. Supply to a TN network is prohibited.

Allowed use case for AC ePTO in IT network

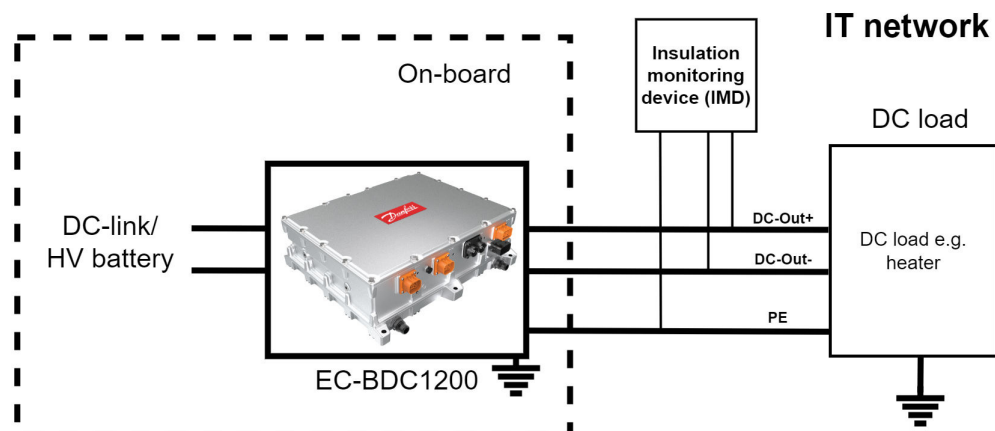


DC ePTO (DC-Out)

DC ePTO operation on an IT network is permitted only when used with an IMD.

Product overview

Allowed use case for DC ePTO in IT network



In case of questions about the allowed use cases, contact Danfoss for more information before using the product.

Prohibited use of the electric device

It is prohibited to use, handle, maintain and store the electric device in the following ways (including but not limited to):

- Using the electric device for other purposes than defined in the user guide.
- Disregarding the obligation to comply with the user guide, safety signs and rating plate of the electrical device.
- Using the electric device, making adjustments and maintenance without first reading the user guide.
- Exceeding the designed limits during the operation.
- Using non-original service parts of wrong material causing corrosion problems and mechanical failures in time.
- Operating and performing maintenance on the electric device without appropriate personal protective equipment.
- Using the electric device for supporting other structures or indirect movements.
- Causing any kind of impact forces to the electric device (for example hitting or hammering or dropping objects).
- Operating the electric device with electric connections other than defined in the user guide.
- Operating the electric device with power cables routed against the instructions.
- Operating the electric device without properly dimensioned and operating cooling system.
- Performing maintenance or adjustment operations without securing that the electricity is disconnected and electric device is discharged as defined in the user guide.
- Lifting the electric device with additional load attached.
- Using the electric device in potentially explosive environment.
- Allowing dirt or liquid to enter into the electric device.
- Using cables that can not withstand the maximum current values of the electric device.
- Using damaged electric device or damaged connectors.
- Storing the electric device contrary to the guidelines presented in this user guide, for example, outdoors in wet or dusty conditions.
- Storing the electric device without proper support that prevents overturning and falling.

For product specific and up to date information see product data sheets at <https://www.danfoss.com/>.

Product overview

System introduction

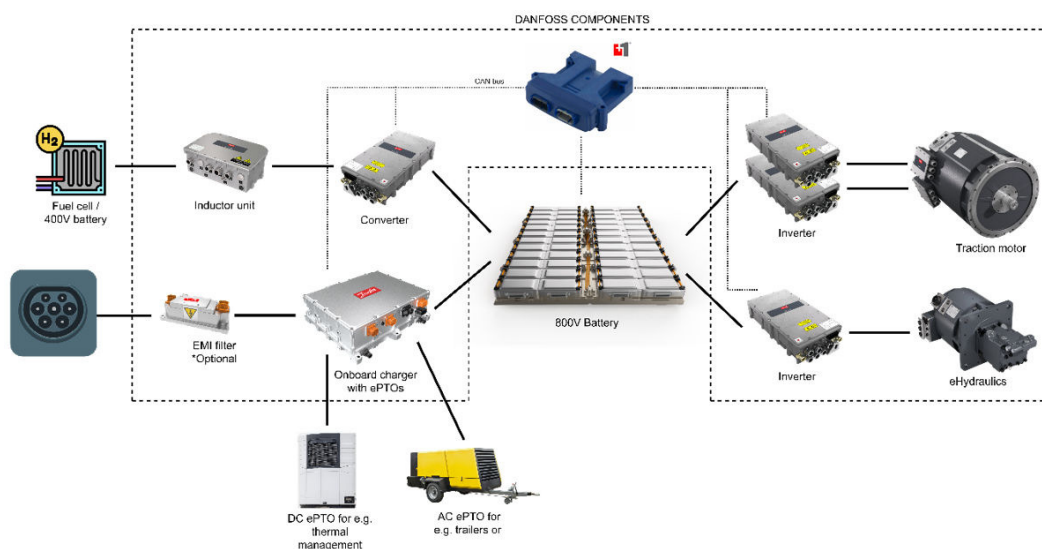
EC-BDC1200 System overview

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

The electrical devices are an essential part of the electric drivetrain system.

Typically, HEV or EV applications include traction or propulsion system, energy storage and a charging system by using an onboard charger or generator system with combustion engine.

Danfoss electric converter products are designed for controlling the flow of power in heavy-duty, marine and transportation applications.



Cooling

Cooling system requirements

Cooling system properties	Specification
Cooling type	Liquid cooling
Coolant type	Water-glycol mixture (nominal 50 %, max. 60 % corrosive inhibitor)
Coolant temperature	-40°C...+70°C (For details, see the product data sheet)
Nominal coolant flow	10 l/min
Maximum continuous pressure	3 bar

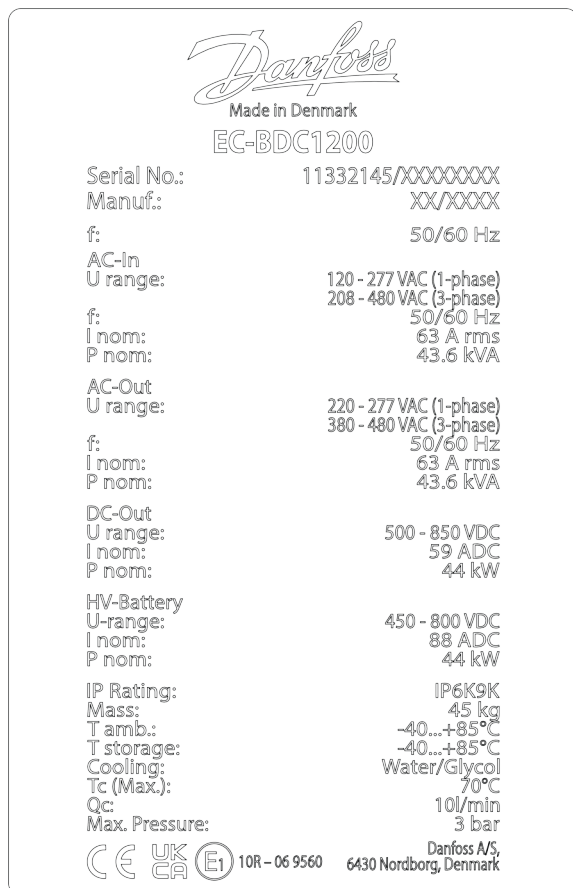
See detailed information and specifications from the product data sheet. Rated values can be found from the rating plate.

Rating plate

Each electric device has a rating plate (also called product label) which can be found on top of the electric device. The rating plate contains device rating and identification details. The figure below shows an example of a rating plate. For exact information, see the product-specific data sheet at <https://www.danfoss.com/> or the rating plate on the electric device.

Product overview

Rating plate example



Rating plate fields

Field	Explanation	Unit
1	Electric device product family	
Serial No.	Serial number	
Manuf.	Manufacturing year	
f	Frequency	Hz
U range	Voltage range	V _{DC} or V _{AC}
I nom	Nominal current	A
P nom	Nominal power	kVA
IP rating	Enclosure class according to IEC60034-5	
Mass	Total weight of the electric device	kg
T _{amb}	Ambient temperature limits	°C
T _{storage}	Storage temperature limits	°C
Cooling	Cooling type	
Tc (Max)	Coolant temperature	°C
Qc	Coolant flow	l/min
Max. pressure	Coolant maximum pressure	bar

Product overview

Tightening torques

For correct and safe operation, it is essential to use specified tightening torques for the electric device screws. Tightening torques (screw preloads) used in the electric device are shown in the Table below.

Tightening torques

Connection	Torque
Lifting points	24 Nm +/-4 Nm, M8
Coolant connections	48 Nm +/-5 Nm
Grounding point	24 Nm +/-4 Nm, M8
Cable bracket	10 Nm +/-1.5 Nm, M6
Mounting points	48 Nm +/- 8 Nm, M10

Transportation and storage

Transportation

	Heavy electric device, handle with care. Use applicable lifting equipment for lifting and supporting the electric device during transportation and handling. Inspect the condition of the lifting equipment before attempting to start any work. Weight information can be found on the rating plate of the electric device and product data sheets.
	Do not apply any excess weight on the electric device during transportation.
	See the weight of the electric device from the product Data sheet.

The electric device is shipped in first class condition. Products are inspected and packed correctly to prevent damage from ordinary handling during the transportation. Transportation conditions must be in accordance with the product specification and shocks of any kind must be avoided.

Plug and seal the cabling and cooling connections for transportation.

The required ambient temperature during transportation:

- $-40^{\circ}\text{C} \leq T \leq +85^{\circ}\text{C}$

Receiving and unpacking

Inspect the electric device and the package immediately upon arrival. Ensure that the rating plate data in the cover letter complies with the purchase order. All external damage in the package or in the electric device must be photographed and reported to Danfoss immediately.

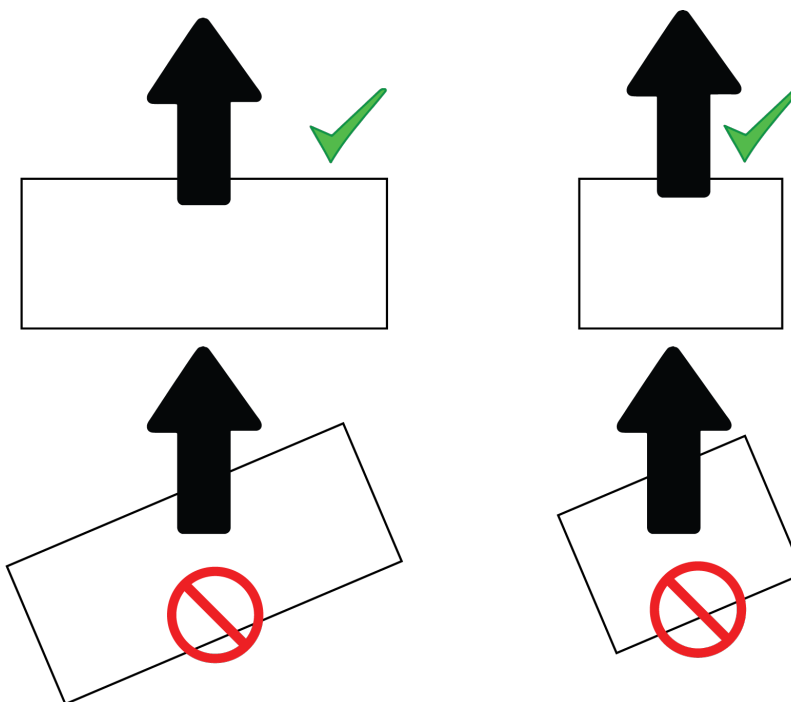
Lifting

	Use correct, adequately dimensioned lifting devices and inspect them before lifting.
	Do not apply any excess weight on the electric device when lifting it.
	Use correct lifting slings. Use correct position and angle of lifting. The maximum permissible range of lifting angles is shown in lifting figures. Make sure that lifting slings are correctly routed so that they do not cause momentum on any of the signal connectors.
	See the rating plate and data sheets for weight information.

Transportation and storage

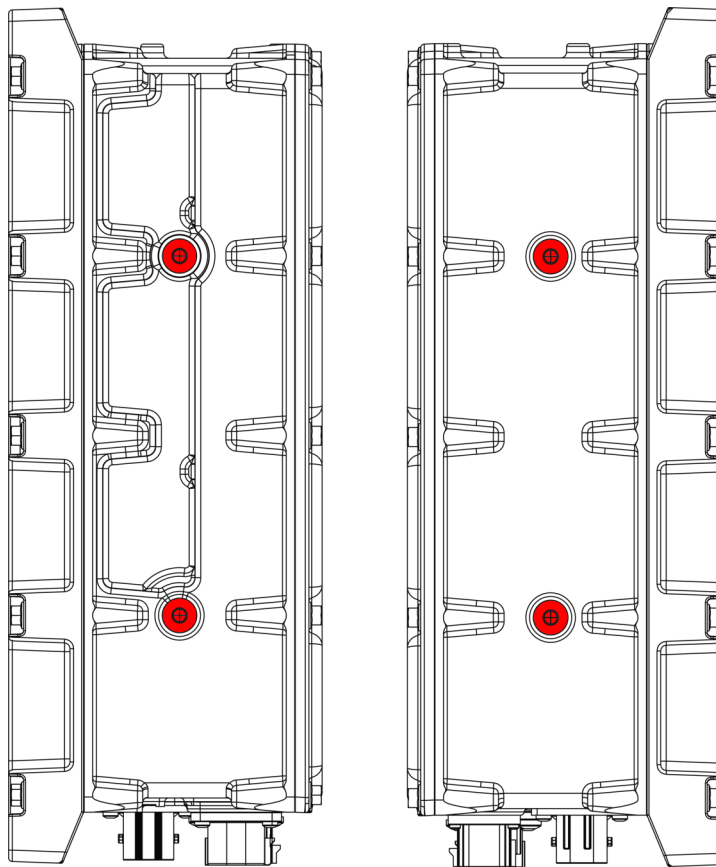
	Lift the electric device using the correct lifting lugs/eyes only. See the lifting Figures in this Chapter.
	Do not go under a lifted load.

Correct lifting and incorrect lifting



Transportation and storage

Lifting points



The electric device can be lifted both in horizontal and vertical position.

M8 lifting hardware should be used for safe handling.

Handling



When turning or lifting the electric device, lift it in the air in order to prevent damage to the frame or other parts of the electric device.

Although the electric device is designed to operate in harsh and demanding environment, any misuse or improper handling of the electric device is prohibited to avoid malfunctions later.

Storage



When the device is dismantled and stored and packed for delivery, measure that there is no voltage.

Transportation and storage

	Heavy equipment. Store on appropriate base. Support the electric device to prevent accidental turning and falling.
	Do not apply any excess weight on the electric device during storage.

Always store the electric device indoors. The storage temperature should preferably be above -20°C and the relative humidity less than 60 %. Storage conditions must be dry and dust free.

Make sure that the cabling and cooling connections are plugged and sealed before storage.

Always dry the cooling circuit units before long storage.

The electric device must not be subjected to any external vibrations during storage to avoid possible hidden structural damages.

Installation

Required tools

	Risk of electric shock during electrical installations. Use insulated tools.
	Measure voltage before working on the device.

To install the electric device, the following tools are required:

- Torque wrench for correct range.
- Vacuum filling equipment for coolant.
- M8 lifting hardware where necessary for safe handling.

For more detailed information, see appropriate sections in this user guide and product data sheets at <https://www.danfoss.com>.

Insulation resistance test

	Before performing the insulation resistance measurement, disconnect all cables and connectors from the device under test.
	Do not touch the electric device during the test and make sure you discharge the electric device afterwards.
	Measure the insulation resistance of the electric device before and after the installation of the electric device.

Measure the insulation resistance of the electric device before and after the installation of the electric device.

The reference value 50 M Ω 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.
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The insulation resistance should be measured between break out boxes and the converter enclosure (in order to avoid damage to the connector pins).

Installation

Primary circuit and secondary circuit to enclosure

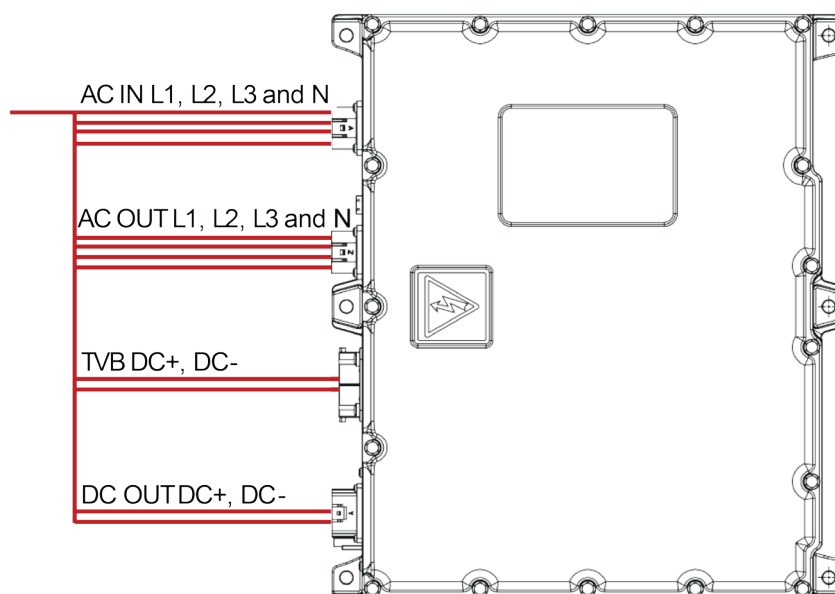
The following table lists test conditions and pass criteria for the ED3 onboard charger.

Test voltage	Test duration	Pass criteria
500 V _{DC}	60 s	> 50 MΩ

Measurement procedure:

1. Connect secondary circuits high voltage battery DC+, DC- and primary circuits AC IN and AC OUT L1, L2, L3 and N and DC OUT DC+, DC- together.
2. Connect all pins of control signal connector to device enclosure.
3. Connect the measurement devices ground cable to the converter enclosure.
4. Connect the measurement probe to the primary and secondary circuits.

Primary and secondary circuits to enclosure measurement



Primary circuit to secondary circuit

The following table lists test conditions and pass criteria for the ED3 onboard charger.

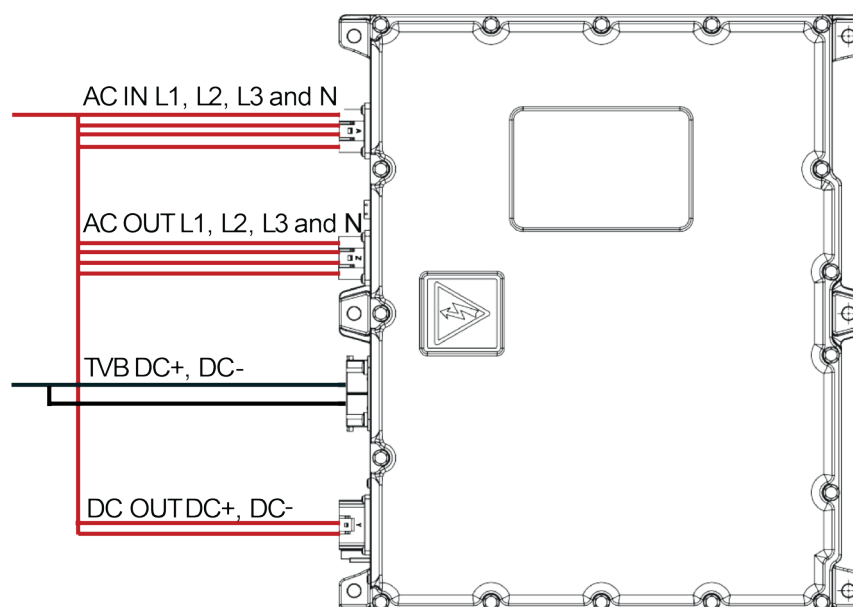
Test voltage	Test duration	Pass criteria
500 V _{DC}	60 s	> 50 MΩ

Measurement procedure:

1. Connect secondary circuits high voltage battery DC+, DC- together.
2. Connect primary circuits AC IN and AC OUT L1, L2, L3 and N and DC OUT DC+, DC- together.
3. Connect all pins of control signal connector to device enclosure.
4. Connect the measurement devices ground cable to the converter enclosure.
5. Connect the measurement probe to DC OUT plus and DC OUT minus.

Installation

Primary to secondary circuit measurement



Measure the insulation between the TVB connection (marked in black) and the rest of the connections AC IN, AC OUT and DC OUT (marked in red).

Auxiliary circuit to enclosure

The following table lists test conditions and pass criteria for the ED3 onboard charger.

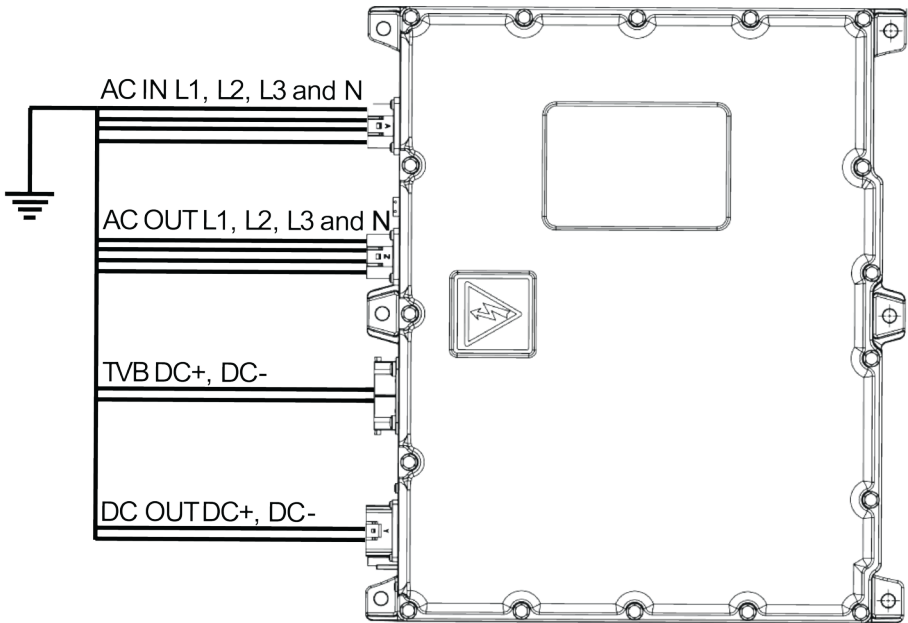
Test voltage	Test duration	Pass criteria
500 V _{DC}	60 s	> 1 MΩ

Measurement procedure:

1. Connect secondary circuits high voltage battery DC+, DC- and primary circuits AC IN and AC OUT L1, L2, L3 and N and DC OUT DC+, DC- to device enclosure.
2. Connect all pins of control signal connector together.
3. Connect the measurement devices ground cable to the converter enclosure.
4. Connect the measurement probe to the pins of the control signal connector.

Installation

Auxiliary circuit to enclosure



Mechanical installation

Allowed mounting position

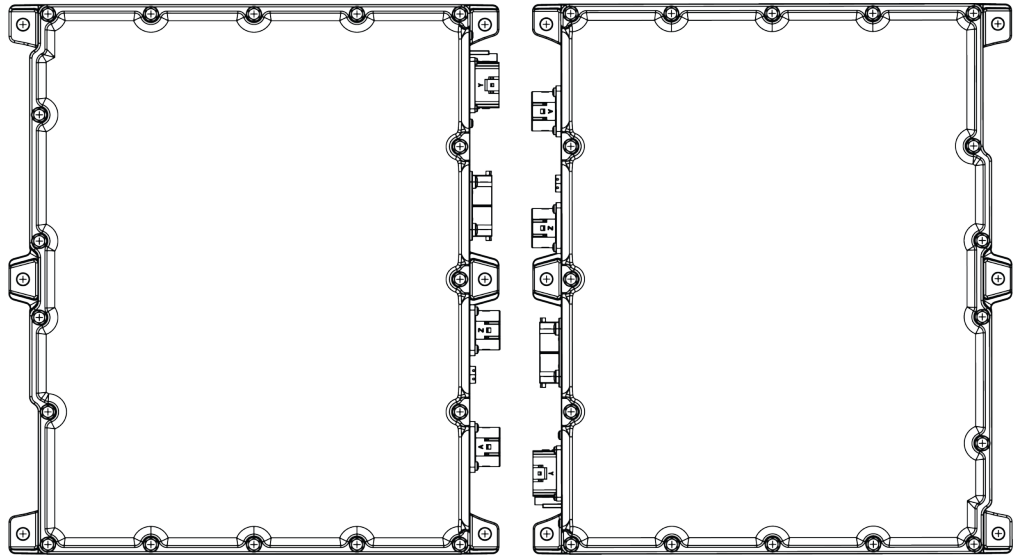
	Do not place the electric device on the ground without proper mounting or protective structure.
	The electric device must be mounted in a way that no other object or structure, which can cause compression, pull, torsion, rotation etc., touches the enclosure of the electric device. In addition, the electric device should not be used to support any other structure of the system.

Installation

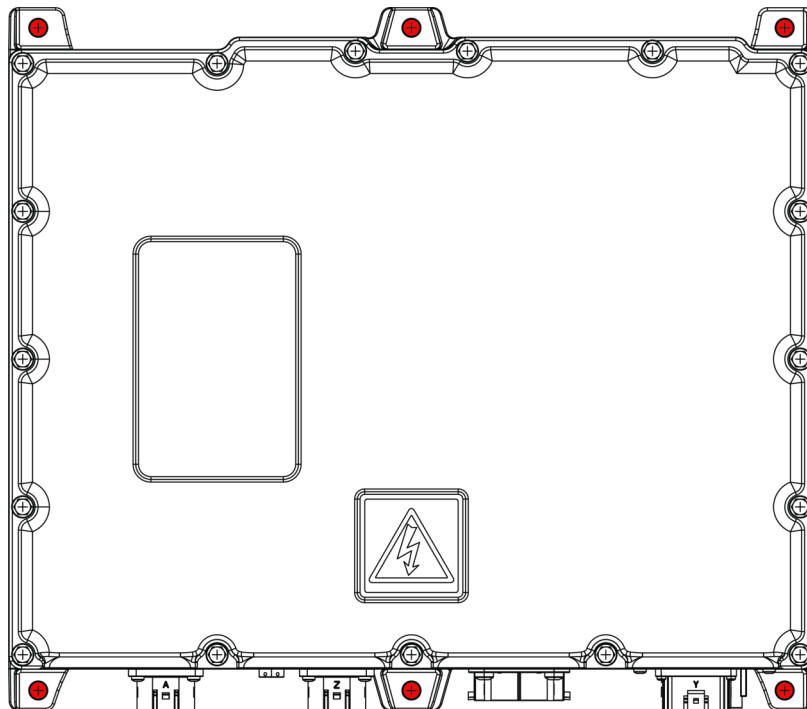
- The electric device must be mounted on a flat, heat- and flame-resistant mounting place (for example on a bracket).
- It is recommended to install the electric device vertically with connectors pointing left or right. All other installation directions should be evaluated on a case-by-case basis. See Figure *Recommended mounting position* below.

Note that it is not allowed to install the electric device upside down (the top of the device downward) horizontally.

Recommended mounting position



Location of the mounting points



M10 holes, 3 pcs per side.

Installation

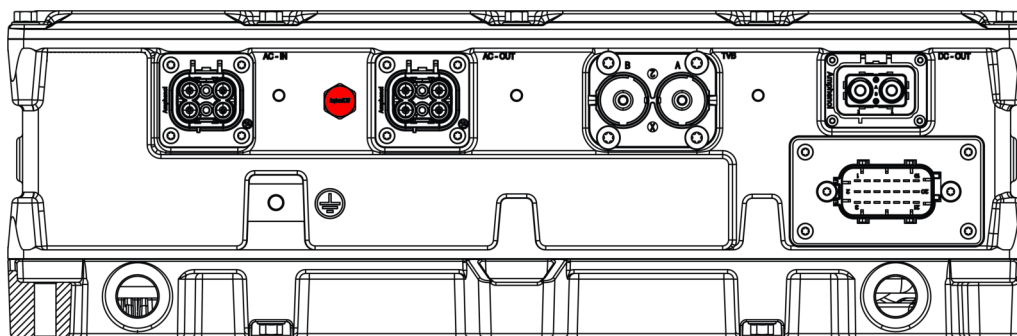
Selected mounting position must allow the cooling system to work properly. Vacuum filling is mandatory for nominal performance.

Breather plug

The purpose of breather plugs is to equalize the pressure between the inside of the device enclosure and the surrounding environment. Do not remove the breather plug(s) under any circumstances.

Make sure that the breather plug is clean and the selected installation place and mounting direction do not allow water, dust or dirt to block it.

Location of the breather plug(s)



Installation procedure

	Heavy electric device. Handle with care. Handle the electric device correctly when you install it to the correct mounting position. See Chapter Handling on page 24.
	Always check the compatibility of the Signal connector and the counterpart. Never alter the connector in any way.
	Make sure that the electric device is not installed near or in direct contact with easily flammable materials, as the surface of the device can get hot while the device is in use. Wearing personal protective equipment when working with the electric device is required.

Preparations

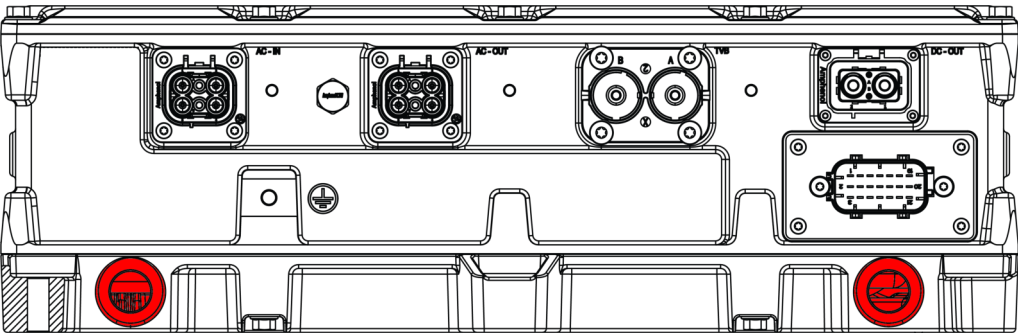
- Make sure that the chosen installation place fulfills the environmental requirements specified for the electric device.
- Protect the electric device against corrosive gases, liquids, conductive contaminants (such as condensation, carbon dust, and metallic particles) and sprays or splashing water from all directions.
- Protect the electric device from excess humidity, salt and chemicals with suitable additional enclosure.
- The mounting place and mounting interfaces should be sufficient to carry the weight of the electric device.
- Make sure that the electric device has sufficient mounting and operating clearances for maintenance work.
- Measure the insulation resistance of the electric device before and after the installation of the electric device. For more information, see [Insulation resistance test](#) on page 26.
- Installation procedure may vary from that shown in this user guide. All steps must be included in the procedure, although the order of the steps can be different.

Installation

Installation procedure

- 1. Prepare the installation place and make sure that it meets the requirements for the product.
- 2. Lift and support the electrical device for the mounting. Refer to Chapter [Lifting](#) on page 22.
- 3. Install all appropriate mounting screws, do not tighten the screws until they are aligned and pre-installed. See the tightening torques from Chapter [Tightening torques](#) on page 21.
- 4. Remove the protective plugs just before installing the connectors and hoses to protect the cooling package from contaminants. Connect the cooling system. See Chapter [Cooling connections](#) on page 32 or the *Main dimension drawing* for connection details. Vacuum filling is mandatory to avoid air pockets in the cooling channels. Also, make sure that the coolant goes freely in and out and the cooling system operates correctly.

Cooling system connections



- 5. Ground the frame of the electric device by ensuring direct contact between it and the metal bracket and/or the protective earth contacts. Both grounding and mounting contacts must be free of paint. See section [Grounding](#) on page 35.
- 6. Ensure that the cables and devices are de-energized before making any connections. Install the cables and connectors as required. Secure the cables with cable ties to mitigate vibration. For further details, see section [High voltage connections](#) on page 36.

Cooling connections

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

Installation

- Connect the electric device directly 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 electric device is lower or equal to the rated temperature.
- For more information, see Chapter [Recommended coolants](#) on page 33 and product data sheets. Rated values can be found on the rating plate of the electric device.
- It is recommended to fix the hose on the coolant connection with a hose clamp or a hose clip after the protection cap has been removed.
- Use water-glycol mixture with appropriate corrosion inhibitor as coolant.

Recommended coolants

	Ethylene glycol is a toxic compound. Avoid exposure to the coolant.
	Handle with care. Use appropriate personal protective equipment when you handle the coolant.
	Make sure that the coolant used is compatible with the materials in the coolant circuit. See the product data sheet for more information on the main materials. Follow the instructions of the coolant manufacturer.

The electric device has full performance with a coolant mixture of water and antifreeze fluid content of 40 % or 50 % . The percentage of antifreeze fluid depends on the application. The antifreeze, concentrated or diluted in water, should correspond to one of the following:

- Volvo Coolant VCS, part number 8714581
- Volvo coolant, part number 8707741
- Texaco Extended Life Coolant, part number 20358716
- Texaco Heavy Duty Coolant, part number 8714515
- Maxigel Plus, Renault Trucks specifications 41-01-001/--S Type D
- Delo extended life prediluted 50/50 Coolant/Antifreeze Nitrite Free – Bittered
- Chevron Heavy Duty Prediluted 50/50 Coolant/Antifreeze Phosphate Free – B, product number 227045

Electrical installation

Electrical connections

	Before you start the electrical installation, make sure that the frame of the electric device is grounded correctly. Refer to Chapter Grounding on page 35.
	Risk of electric shock is always present when operating high voltage equipment. Before working with the power connections make sure that electricity has been disconnected and the electric device has discharged.

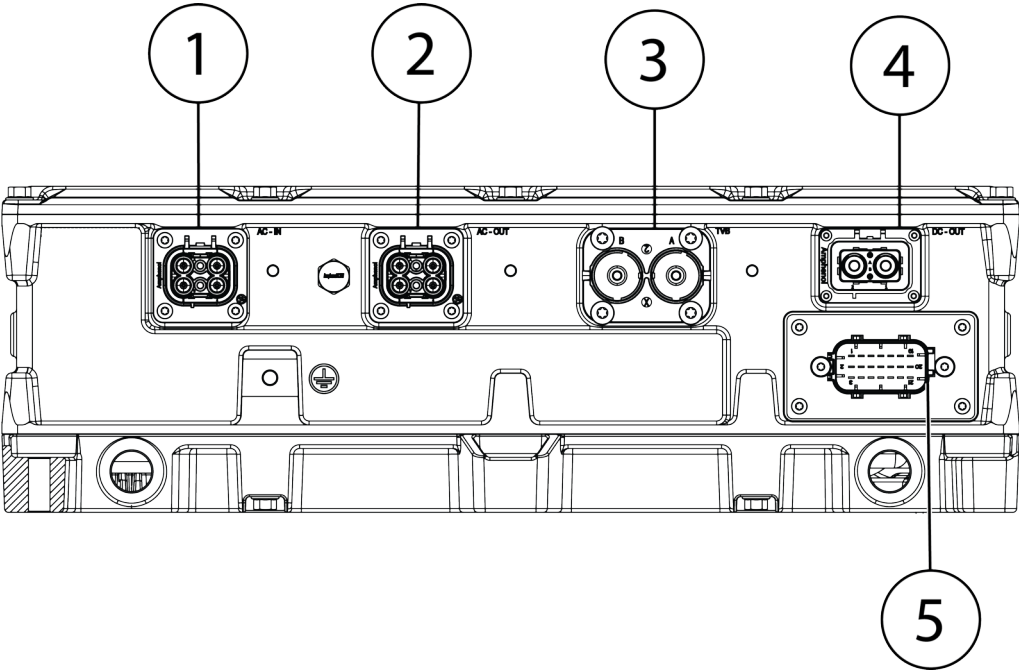
Installation

	Before you start the electrical installation, make sure that the environment is dry and free from conductive dust particles.
	Minimum cable temperature withstand is +95°C.

The charger has four power electronic connections: 3-phase grid connection with neutral wire as input (AC-In), 3-phase AC-Out connection with neutral wire as output, bi-directional isolated DC-connection (High voltage battery connection), and DC output (DC-Out). All four power electric connections have High Voltage Interlock Loops (HVIL).

	Improper connections may result in damage to the unit. See the product data sheet for correct high voltage pinout.
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Electrical connections



1	AC-In connector
2	AC-Out connector
3	High voltage battery connector (TVB)
4	DC-Out connector
5	Signal connector

For further information on the Signal connector, see Section *Signal connections* in [Low voltage connections](#) on page 37.

Installation

To make sure that the electric device functions correctly and to minimize the radiated emissions, all connected cables and wires must be EMC-shielded. Shieldings must be connected to the ground at both ends of the cable or wire. Make sure that the low voltage cable (control signal cable) shield is also grounded from both ends.

	Route the power cables as far from the control signal wires as possible. The minimum separating distance is 100 mm. The crossings must be in an angle of 90°. Power cables and control wires should be routed near the frame of the application. Make sure that all terminal connections are tightened correctly.
	When you work with the power connections make sure that electricity has been disconnected and the electric device has discharged. Measure the level of the remaining voltage before you touch the power terminals.

Install the electric device following the instructions. Make sure that all the applications of the system, for example, the batteries are connected to the electric device according to the instructions in this user guide and the product specific guidelines.

Grounding

	Make sure that the electric device is correctly grounded. Do not operate the electric device without correctly attached protective earth conductor. Obey the installation instructions and the guidelines for component selection given in this user guide.
	The grounding cable must be able to carry the maximum supply fault current which normally will be limited by the fuses or the Miniature Circuit Breaker (MCB). Put correctly rated fuses or MCB in the mains supply of the electrical device: obey the local legislation and recommendations.
	Obey the installation instructions and the guidelines for component selection given in this user guide.
	Make sure that the safety grounding is correct. Refer to Chapter Mechanical installation.

Generic grounding guidelines

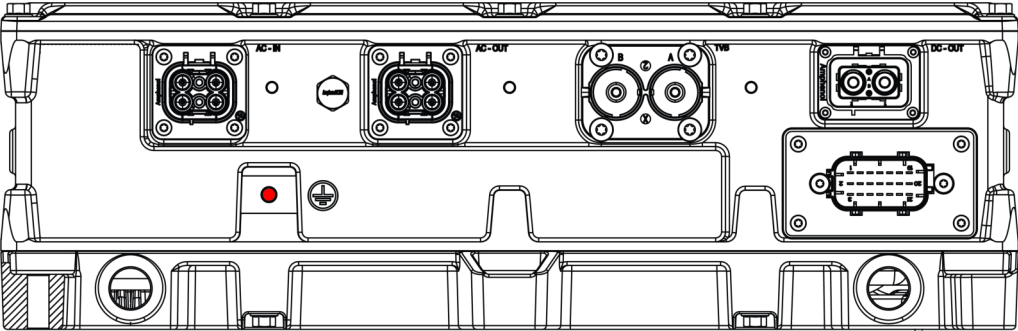
- Connect the ground terminal of each electric device individually to the site grounding bus bar.
- The grounding connections cannot loop from one electric device to another electric device, or to any other piece of equipment, or from any other piece of equipment.
- Ground impedance must be compliant with local industrial safety regulations.
- The protective ground of the unit must be connected to the system ground. Ground impedance must meet with the requirements of national and local industrial safety regulations and electrical requirements. The condition of the grounding connections must be checked periodically.
- Make sure that all grounding surfaces are clean and remove paint from the contact areas.
- For detailed information, see appropriate Chapters in this user guide.

Installation

Main frame

The best grounding is achieved when the main frame of each electric device is directly connected to the ground. If this is not possible, the electric device must be grounded at least from one of the safety grounding points with an appropriate grounding cable. For good functional grounding use wide flat grounding braid. Round grounding wires are adequate for safety grounding but it does not provide very good functional grounding because of its higher impedance at high frequencies. The grounding points are marked to the electric device.

Grounding point(s)



Grounding connection: M8 hole. Note that the grounding cable connects to the grounding point from the side. Refer to *Main dimension drawing* for more details.

Safety grounding points and protective earth conductor

	Touch current in the protective earth conductor exceeds 3,5 mA AC and 10 mA DC.
	The cross sectional area of the protective earth conductor must be at least equal to that of the incoming supply conductor.
	The impedance between the device enclosure and the grounding point of the application must be less than 50 milliohms (mΩ).

One of the safety groundings must be connected to an appropriate grounding point. Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

High voltage connections

	The high voltage connections have a common ground connector. Check connector manufacturer's instructions for plugging in, unplugging and locking the connectors. Incorrect procedure can damage the connectors or reduce their lifetime.
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Installation

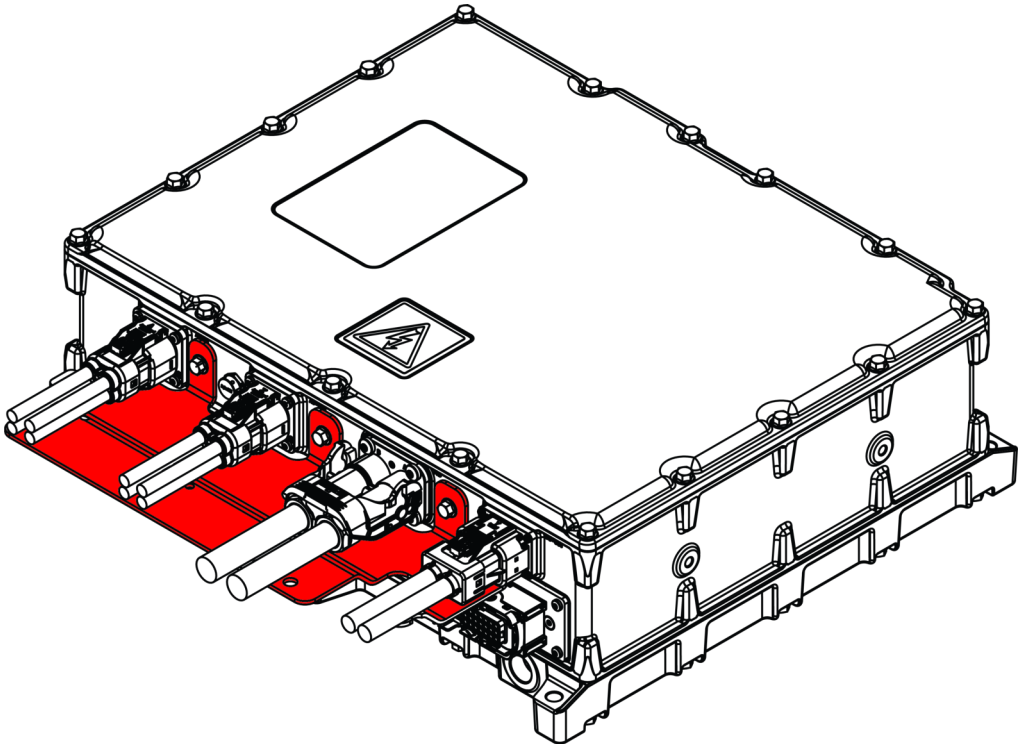


Do not reverse the TVB and DC Out polarities. Reversing the polarity will result in permanent damage to the device.

- The electric device must be installed and connected according to the instructions.
- Make sure that all the connected applications are connected to the electric device according to the product specific operating voltage.
- Use only EMI shielded power cables to make sure the correct operation of the electric device and to minimize the radiated emissions. Cable shields must be connected to the electric device ground at both ends of the cable.

For more information, see appropriate chapters in this user guide and the product data sheets.

The figure below shows an example of how to connect the high voltage connections for vibration. The cable bracket (highlighted in red) is attached with M6 bolts to the device enclosure, and the cables are tied to the cable bracket with zipties or similar. See section [Tightening torques](#) on page 21 for correct tightening.



Low voltage connections

To ensure correct and steady operation, use EMI shielded cables for the control signals of the electric device. Cable shields must be connected to the electric device ground at both ends of the cable.

Recommendations for control signal cables

Cable	Cable type and properties
Control signals	Shielded multistrand wire For more information, see Signal connector manufacturer specification.

Installation

Signal connections



For details on assembling the control signal connector, please visit the manufacturer's website.

In addition to high-voltage connections, the device features a signal connector for low-voltage supply, communication, and system wake-up. The device is equipped with a CAN bus for starting and controlling the device, as well as reading status information. The CAN bus provides a J1939-compliant proprietary CAN interface and can also be used to access UDS services. For more information about the implemented UDS services, please refer to the product software user guide.

The CAN addresses can be configured using dedicated CAN ID and CAN ID REF pins via the wire harness. The device can have two CAN addresses depending on the state of the CAN ID X pins:

0x80 – ID states 0 0 0

0x81 – ID states 1 0 0

0x82 – ID states 0 1 0

0x83 – ID states 1 1 0

0x84 – ID states 0 0 1

0x85 – ID states 1 0 1

0x86 – ID states 0 1 1

0x87 – ID states 1 1 1

For example, the address 0x86 is set by connecting the CAN ID 1 pin to CAN ID REF 2, CAN ID 2 to CAN ID 2, and CAN ID 3 to CAN ID REF 1. For more information, see the product SW user guide.

CAN termination can be achieved using external termination resistors or the internal termination resistor on the device end of the CAN bus, eliminating the need for an external resistor near the device. Please refer to the product data sheet for more information about the pinout.

To ensure stable operation, always use the proper mating connector and pins, appropriate shielded wiring, and the correct tools for installation, as indicated in the tables below.

Control signal connector information

Description	Part number	Supplier example
Signal connector (in the enclosure)	TE 1534238-1	https://www.te.com/en/product-1534238-1.html
Signal mating connector	TE 1-1534127-1	https://www.te.com/en/product-1-1534127-1.html
Signal mating connector pin and seals	Pins: 0.5 – 1.0 mm ² TE 1-968855-2 Wire seal: TE 828904-1 Sealing plug for empty cavities: TE 828922-1 Backshell: TE 9-1394050-1	https://www.te.com/en/product-1-968855-2.html https://www.te.com/en/product-828904-1.html https://www.te.com/en/product-828922-1.html https://www.te.com/en/product-9-1394050-1.html

Tool

Description	Part number	Supplier example
Crimping Tool Assembly 1976143-1 with Die Assembly 1976143-2	TE 1976143-1	https://www.te.com/en/product-1534238-1.html

Detailed and up-to-date information can be found on the manufacturer's website. Always perform connector assembly according to the manufacturer's installation instructions.

Installation

The minimum wiring and connections required to power the electric device are shown below. If any of these signals are not connected, the electric device will not turn on.

Pin	Signal name	Description
1	CANH_A	CAN bus A high
2	CANL_A	CAN bus A low
3	VIN_P	Positive Power Supply (8-32 V)
4	CAN ID REF 1	CAN ID reference 1. Reference pin that can be used to set CAN ID input HIGH.
5	CAN ID REF 2	CAN ID reference 2. Reference pin that can be used to set CAN ID input LOW.
6	VIN_N/GND	Negative Power Supply (0 V)
7	WAKE_UP	Rising edge enables the device communication but only allows operation mode Charging. Ignored after enable has been received. See ED3 Software manual for shutdown. Active rising edge, Turn ON @> 5.46 V, Turn OFF < 4.52 V. Current draw is 8-11 mA.
8	HVIL_IN	High voltage internal lock input for DC-link connector. Current between 8-30 mA must be supplied externally to allow charging. 4.7 Ω resistor between HVIL_IN and HVIL_OUT pins.
9	HVIL_OUT	High voltage internal lock output for DC-link connector.
10	CAN_A TERM 1	Termination of CAN bus A, Connect to CANH_A to connect the termination resistor. Can be left unconnected if external termination is used.
11	CAN_A TERM 2	Termination of CAN bus A, Connect to CANL_A to connect the termination resistor. Can be left unconnected if external termination is used.
12	CAN ID 1	CAN A source address and PGN configuration input 1 Short to supply > 16.07 V 1 = 7.86 - 16.07 V 0 = 4.28 - 7.86 V Open circuit = 4.28 - 2.14 V Short to ground < 2.14 V Input resistance 220 Ω
13	Reserved	-
14	Reserved	-
15	CAN ID 2	CAN A source address and PGN configuration input 2 Short to supply > 16.07 V 1 = 7.86 - 16.07 V 0 = 4.28 - 7.86 V Open circuit = 4.28 - 2.14 V Short to ground < 2.14 V Input resistance 220 Ω
16	Reserved	-
17	Reserved	-
18	CAN ID 3	CAN A source address and PGN configuration input 3 Short to supply > 16.07 V 1 = 7.86 - 16.07 V 0 = 4.28 - 7.86 V Open circuit = 4.28 - 2.14 V Short to ground < 2.14 V Input resistance 220 Ω
19	Reserved	-
20	Reserved	-
21	EPTO_ENABLE	Enables the use of AC-out or DC-out. Active High, Turn ON @> 6.26 V, Turn OFF < 4.48 V. Current draw is 8-11 mA.

In addition to above signals, following connections are needed to operate the device in charging mode:

- Pins 1 and 2 for CAN communication
- Pins 8 and 9 for HVIL

For the ePTO operation with AC-Out or DC-Out also pin 21 is required to enable one of the ePTO outputs.

All connections on the signal connector are referenced to ground on pin 6.

Operation

Please refer to the product software user guide for information about starting and operating the electric device.

	Electrical safety of the system and the end application have to be guaranteed using appropriate methods, like insulation resistance measurement device (IT network) or residual current monitoring device (TN network), depending on the application.
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Operation conditions

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

- Loading.
- Cooling.
- Service interval.
- Ambient conditions such as temperature and moisture.

The electric device is designed for these conditions:

- Ambient temperature limits: -40°C...+85°C.
- Maximum altitude 3000 m above sea level.
- Maximum coolant liquid temperature: +70°C (for details, see the product data sheet).
- Coolant liquid must be water-glycol mixture with glycol content: nominal 50 %, max. 60 %. See chapter [Recommended coolants](#) on page 33.

If the operation limits are exceeded and the electric device is damaged, please contact local Danfoss representative.

Pre-charging

DC ePTO pre-charging

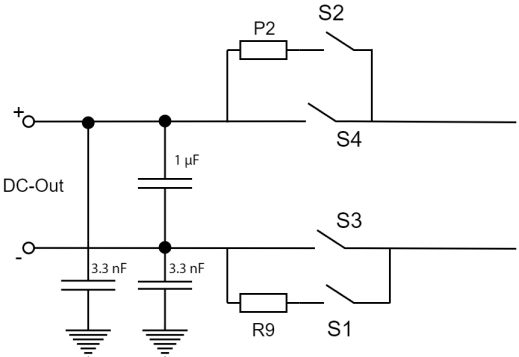
	Do the pre-charging correctly, or the high inrush current may break external electrical components of the electric device.
	The electric device DC-link capacitance can be found from the data sheet.

The purpose of pre-charging is to protect the device and load connected to it from high inrush currents. Maximum allowed capacitance for DC-Out is 2 mF.

For successful pre-charge, the following requirements have to be fulfilled:

Operation

- Voltage difference is less than 12 V_{DC} over the switches S3 and S4



The pre-charge time-out is 15 seconds, before the electric device trips.

Condition monitoring during operation

	Risk of permanent damage to the electric device. Use the electric device only if the technical guidelines and ambient conditions given in this user guide and in the data sheet are met.
	Risk of permanent damage to the electric device. If you notice deviations from the normal operation (for example: high temperatures or noise), stop the electric device. Find the reason for the deviation and refer to Chapter Troubleshooting on page 46 for more information.

Monitor the electric device regularly during operation to make sure of reliable operation, to foresee possible upcoming failures and to help to reach the designed lifetime of the product.

Maintenance

Regular maintenance

	Do not disassemble the electric device. You can do only procedures described in this user guide. For further information contact Danfoss representative.
	Only trained and qualified personnel that are familiar with the relevant safety requirements can do any maintenance to the electric device.
	Risk of electric shock if dismantling steps are continued before the electric device is discharged and a safe voltage level has been measured.
	Do not touch the electric device or continue to work with the electric device until it cools down.
	Do not attempt to tighten or release any screws, nuts or joints which are not shown in this user guide and that are not involved in the normal installation procedures.
    	Use correct personal protective equipment when you are near the electric device.

Maintenance

Maintenance intervals

Object		Check/Task	Weekly	Monthly	Yearly
General construction	Operation	Abnormal phenomenon, for example noise or heating. If clearly increased, contact Danfoss representative.	X		
	Mounting	Tightness of the screws. Tighten to proper value if necessary. Applies to screws that are presented in this user guide. See Chapter Tightening torques on page 21.			X
	Enclosure and connected parts	Check cleanliness. Clean if necessary. See Chapter Cleaning on page 43.		X	
Electrical system	Cables	Visual check, for example wear. Replace if necessary.		X	
	Electrical connections	Check connections for damage and that they are correctly secured.			X
	Groundings (earthings)	Check groundings (earthings). Ensure that the connection resistance is valid. Re-connect if necessary.			X
	Protective devices	Test the operation of protective devices (RCD and/or IMD). Replace if necessary.		X	
Cooling system	Operation	Functioning. Cooling system functions as specified.	X		
	Tubing and connection tightness	No visible leakage. If leaking, tighten connections appropriately, or replace parts.		X	
	Ventilation plug	Cleanliness. Clean if necessary. See Chapter Cleaning on page 43.		X	
	Coolant quality	Use the coolant as specified (water-glycol mixture appropriate). Refill if necessary. See Chapter Recommended coolants on page 33 and Cooling system maintenance on page 43.			X

The electric device does not require regular maintenance, nor does it have any parts that should be serviced or replaced by the customer.

Cooling system maintenance

The cooling system of the electric device requires regular observation and maintenance activities. Observe weekly that the cooling system operates correctly and check monthly that there are no leakages in the cooling system. The quality of the coolant must be checked yearly. The mixture of water and glycol as well as the type of the glycol used must be as specified. See Chapter [Recommended coolants](#) on page 33.

Vacuum filling is mandatory for nominal performance. Filling without vacuum may result in air in the cooling package and degradation in performance and/or lifetime.

Cleaning

	The electric device is pressure wash rated and can tolerate jets of water. However, prolonged exposure to steam or high pressure washing is not recommended.
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Maintenance

	Never open or remove the watertight breather plugs. Clean them only from the outside.
	Risk of electric shock if the electric device is cleaned against instructions allowing water to go in to the electric device.

Keep the electric device clean. For cleaning, use non-abrasive and non-corrosive cleaning products. Make sure that the detergent can be used for aluminum.

Dismounting and disposal of the electric device

	Risk of electric shock if dismounting steps are continued before the electric device is discharged and a safe voltage level has been measured.
	Do not touch the electric device or continue to work with the electric device until it cools down.
	Support the electric device during dismounting, handle it with care.
	Refer to Chapter Installation procedure on page 31 for additional information.

Dismounting procedure

1. Switch off the device via CAN and ECU_ENABLE pin.
2. Disconnect the high-voltage from the device.
3. Disconnect control signals from the device.
4. Make sure that the temperature of the electric device and cooling liquid has decreased below +40°C.
5. Disconnect the power terminal cabling.
6. Disconnect grounding cables (protective earth).
7. Disconnect the liquid cooling system. Note that coolant can remain in the cooling package. Beware of exposure of the coolant.
8. Remove the mounting screws and dismount the electric device from the mounting base.
9. Lift the electric device off.

Disposal of the electric device

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

	Electric device must not be opened. Any attempt causes loss of warranty.
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Troubleshooting

	For more information, see the product SW user guide for all faults and their healing conditions.
	Do not try to repair the electric device. In the case of suspected fault or malfunction, contact Danfoss or authorized service center for further assistance.
	For the reason of general safety and correct operative actions, read the instructions carefully before you start any analysis or work with the electric device.
	Use correct personal protective equipment when you are near the electric device.

Some unexpected situations may occur while operating the electric device. Some of the possible causes and actions are given in table below. If an unexpected 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.

Troubleshooting

Fault description	Possible cause	Action
Electric device overheating	Cooling system failure.	Inspect the cooling system operation and functionality, especially possible leaks, flow rate and fluid temperature. Change the cooling flow direction to flush the cooling system from sediment possibly accumulated.
	Leakage in the cooling system.	Inspect the cooling system circuit and connections.
	Rigid particle inside the cooling channel of the electric device.	Try to pulsate coolant to open the channels. Contact Danfoss representative.

Troubleshooting

Troubleshooting (continued)

Fault description	Possible cause	Action
Significant coolant leak	Loose connection in the cooling system.	Inspect, clean and tighten the connections. Replace them if necessary.
	Broken cooling hose.	Replace the cooling hose.
Electric device does not work correctly or the performance is poor	Poor powerline contacts (high voltage)	Inspect and clean the electrical connections. Replace mating connector if necessary.

Aftersales

Service policy

The electric device has no need for regular maintenance or service parts.

Service parts

The electric device does not have any customer serviceable parts. Contact Danfoss representative for more information.

Products we offer:

- Cylinders
- Electric converters, machines, and systems
- Electronic controls, HMI, and IoT
- Hoses and fittings
- Hydraulic power units and packaged systems
- Hydraulic valves
- Industrial clutches and brakes
- Motors
- PLUS+1® software
- Pumps
- Steering
- Transmissions

Danfoss Power Solutions designs and manufactures a complete range of engineered components and systems. From hydraulics and electrification to fluid conveyance, electronic controls, and software, our solutions are engineered with an uncompromising focus on quality, reliability, and safety.

Our innovative products makes increased productivity and reduced emissions a possibility, but it's our people who turn those possibilities into reality. Leveraging our unsurpassed application know-how, we partner with customers around the world to solve their greatest machine challenges. Our aspiration is to help our customers achieve their vision — and to earn our place as their preferred and trusted partner.

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www.daikin-sauer-danfoss.com

**Danfoss
Power Solutions (US) Company**
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6000

**Danfoss
Power Solutions GmbH & Co. OHG**
Krokamp 35
D-24539 Neumünster, Germany
Phone: +49 4321 871 0

**Danfoss
Power Solutions ApS**
Nordborgvej 81
DK-6430 Nordborg, Denmark
Phone: +45 7488 2222

**Danfoss
Power Solutions Trading
(Shanghai) Co., Ltd.**
Building #22, No. 1000 Jin Hai Rd
Jin Qiao, Pudong New District
Shanghai, China 201206
Phone: +86 21 2080 6201

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