

ENGINEERING  
TOMORROW

*Danfoss*

User Guide

# Electrical converter

## EC-C1200-450



## Revision history

### *Table of revisions*

Date	Changed	Rev
June 2024	Section updated: Service parts	0205
May 2024	Sections updated: Electrical connections, Storage, Condition monitoring during operation, Disposal of the electric device	0204
October 2023	New section added: Measuring the insulation resistance. Section updated: Electrical installation	0203

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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-C1200-450 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-C1200-450 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-C1200-450-L+MC/+AFE/+UG/+DC

The rating plate of the electric device has the correct name of that particular electric device.

Part of the name	Explanation
EC	Electric Converter
C1200	Product name part 1
450	Product name part 2
L/S	System size
+MC*	Motor Control software -option
+AFE*	Active Front End software -option
+UG*	Microgrid ( $\mu$ grid) software -option
+DC**	DCDC-converter software -option

\*Followed with number that represents the nominal current ( $A_{RMS}$ ): 120, 180, 240, 300, 350. These options are available on the same electric device or alone.

\*\*Followed with number that represents the nominal current ( $A_{DC}$ ): 150, 250, 300, 400. This option is not available with other options.

Options are presented in the Table below. Standard options are indicated by a star (\*).

#### EC-C1200-450 options

Variant	Code	Description	Additional information
System size	-S	Small system	Default EC-C unit for individual or small system installations
	-L	Large system	EC-C unit for large system installations

## General information

*EC-C1200-450 options (continued)*

Variant	Code	Description	Additional information
Control	+MC70	Motor control, current limit 70 A	Converter for motor/ generator applications
	+MC120	Motor control, current limit 120 A	Converter for motor/ generator applications
	+MC180	Motor control, current limit 180 A	Converter for motor/ generator applications
	+MC240	Motor control, current limit 240 A	Converter for motor/ generator applications
	+MC300	Motor control, current limit 300 A	Converter for motor/ generator applications
	+MC350	Motor control, current limit 350 A	Converter for motor/ generator applications
	+AFE70	Active front end, current limit 70 A	Converter for active front end applications
	+AFE120	Active front end, current limit 120 A	Converter for active front end applications
	+AFE180	Active front end, current limit 180 A	Converter for active front end applications
	+AFE240	Active front end, current limit 240 A	Converter for active front end applications
	+AFE300	Active front end, current limit 300 A	Converter for active front end applications
	+AFE350	Active front end, current limit 350 A	Converter for active front end applications
	+UG70	Microgrid, current limit 70 A	Converter for microgrid applications
	+UG120	Microgrid, current limit 120 A	Converter for microgrid applications
	+UG180	Microgrid, current limit 180 A	Converter for microgrid applications
	+UG240	Microgrid, current limit 240 A	Converter for microgrid applications
	+UG300	Microgrid, current limit 300 A	Converter for microgrid applications
	+UG350	Microgrid, current limit 350 A	Converter for microgrid applications
	+DC150	DCDC control, current limit 150 ADC	Converter for DC/DC applications
	+DC250	DCDC control, current limit 250 ADC	Converter for DC/DC applications
	+DC300	DCDC control, current limit 300 ADC	Converter for DC/DC applications
	+DC400	DCDC control, current limit 400 ADC	Converter for DC/DC applications
Speed option	*	Normal speed version (<580 Hz output frequency)	EC-C with motor/generator control firmware, capable of speeds below 580 Hz
	+HS	High speed version (>580 Hz output frequency)	EC-C with motor/generator control firmware, capable of speeds up to 1000 Hz

## General information

### EC-C1200-450 options (continued)

Variant	Code	Description	Additional information
Communication	*	CAN1939	EC-C with Standard SAE1939-communication
	+CO	CANopen	EC-C with CANopen-communication
Connections	*	Normal connections	EC-C with default HV connections
	+CE1	Connection extension 1	EC-C with double DC and AC connectivity with connection extension box 1 (double M25 cable gland threads) (Not compatible with +DCE option)
	+CE2	Connection extension 2	EC-C with M32 cable gland threads on AC connection with connection extension box 2 (choose also +DCE if double DC connection is required)
	+DCE	DC-extension	EC-C with double DC-connections: copper bushings for double connection (compatible with +CE2/+CG4/+CG5)
Cable glands	*	No cable glands	EC-C with no cable glands or plugs
	+CG1	Default M25 cable glands	EC-C with 5x M25 cable glands and 2x M25 plugs
	+CG2	Default M25/M32 cable glands	EC-C with 2x M25 cable glands, 3xM32 cable glands and 3xM25 plugs (for +CE2 option)
	+CG3	Default M25 cable glands	EC-C with 10x M25 cable glands (for +CE1 option with double DC-link connections)
	+CG4	Default M25 cable glands	EC-C with 7x M25 cable glands (for +DCE option)
	+CG5	Default M25/M32 cable glands	EC-C with 4x M25 cable glands, 3xM32 cable glands and 3xM25 plugs (for combined +CE2 and +DCE options)
	+CG6	Default M25 cable glands	EC-C with 8x M25 cable glands and 2x M25 plugs (for +CE1 option with single DC-link connections)

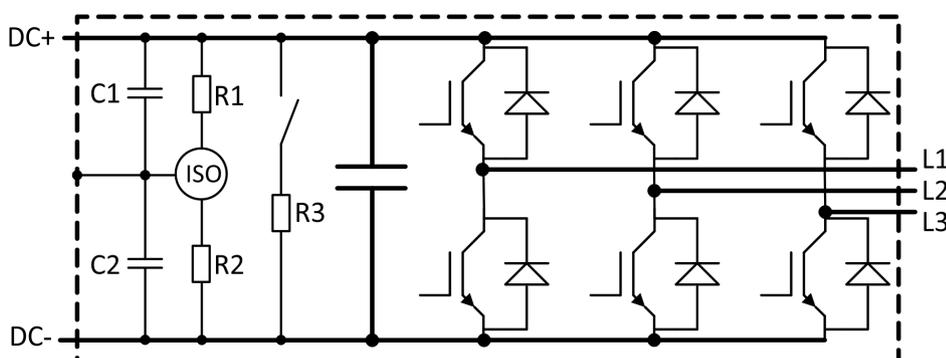
## General information

### EC-C1200-450 options (continued)

Variant	Code	Description	Additional information
Marine classification	*	No marine classification	
	+CL1		ABS American Bureau of Shipping
	+CL2		BV Bureau Veritas
	+CL3		DNV
	+CL4		LR Lloyd's Register
	+CL5		RINA
	+CL6		CCS China Classification Society
Customer specific	*	Default unit firmware-wise	EC-C with no pre-set parameters or application
	+CS	Customer specific parameters or application in FW	EC-C with separately specified application and/or parameters

Electric device has option for small systems (S) and large systems (L). Small system option is typical for vehicle applications and large system option is standard in marine applications because of the marine regulations. Complete system should be looked when choosing the option as for example vehicle system with many devices could also need the L-option to keep the isolation resistance or Y-capacitors at reasonable level. In large and small system options, there are differences in the isolation measurement resistance, DC-link discharge resistor and Y-capacitor values as shown in the Figure and Table below.

### S- and L-systems schematics



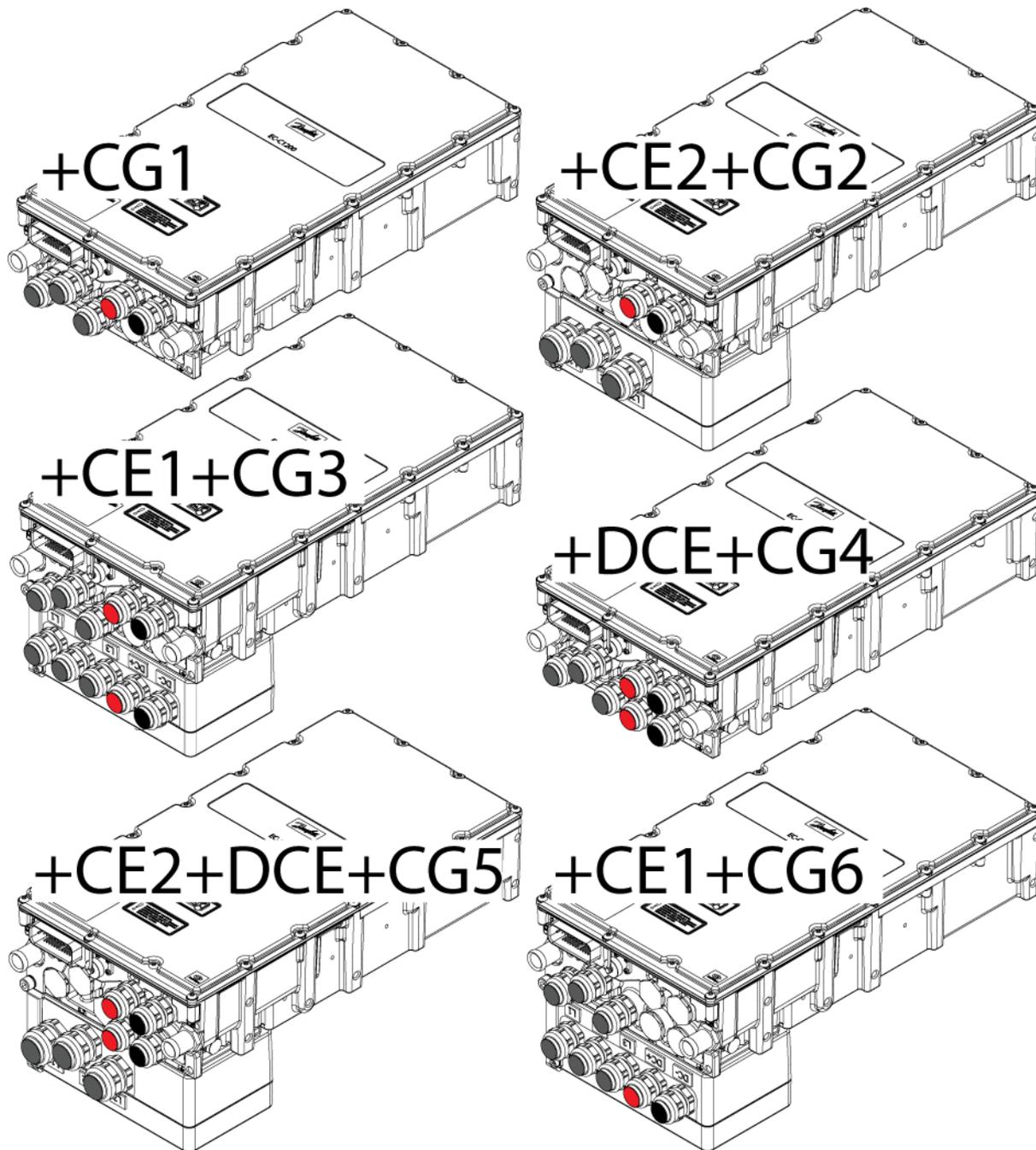
### S- and L-system component values

System option	Component	Value
<b>Small (S)</b>	Resistors R1 and R2 (isolation measurement)	12 M $\Omega$
	Resistor R3 (discharge)	3.9 k $\Omega$
	Capacitors C1 and C2 (Y-capacitors)	330 nF
	Capacitor C3	1 mF
	Isolation resistance from DC-link to enclosure	6 M $\Omega$
<b>Large (L)</b>	Resistors R1 and R2 (isolation measurement)	240 M $\Omega$
	Resistor R3 (discharge)	39 k $\Omega$
	Capacitors C1 and C2 (Y-capacitors)	3.3 nF
	Capacitor C3	1 mF
	Isolation resistance from DC-link to enclosure	120 M $\Omega$



General information

Connection options



Color coding

Color	Meaning
Gray	Cable glands for phases
Red	Cable glands for DC+
Black	Cable glands for DC-

## General information

### 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	Electrical equipment means any equipment designed for use with a voltage rating of between 50 and 1000 V for alternating current.
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 61800-5-1: 2007	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy.
EN ISO 13766-1:2018	Construction machinery. Electromagnetic compatibility of machines with internal electrical power supply.
UN Regulation No. 10 Revision 4 and Revision 5	Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility.

## 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
GND	Ground in electrical connections
HV	High voltage
I/O	Input / Output
LV	Low voltage
MCB	Miniature circuit breaker
RCD	Residual current device

## General information

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
$f_{in/out}$	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	$\Omega$

## 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 industrial and commercial installations. The end product containing the electric device must conform with all related regulations.

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.

### 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.

	<p><b>Danger</b>                  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.</p>
	<p><b>General warning</b>                  This symbol is identified by a yellow background, black triangular band, and a black exclamation point symbol. It indicates a general potentially hazardous situation.</p>
	<p><b>Electric shock warning</b>                  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.</p>
	<p><b>Burn warning</b>                  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.</p>

### Safety information

	<p><b>Magnet warning</b> 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.</p>
	<p><b>Poison warning</b> 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.</p>
	<p><b>Electric shock warning - Read the instructions in the user guide.</b></p>
	<p><b>General Information.</b></p>
	<p><b>Read the instructions in the manual.</b></p>

### Personal protective equipment

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

	<p><b>Use eye protective equipment like safety goggles or mask when you work with the electric device. Permanent damage to the eye could be caused if bearing grease, melted nitrile rubber (radial lip seal), glycol or other fluids splash.</b></p>
	<p><b>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).</b></p>
	<p><b>Use head protective equipment like helmet when you lift the electric device! Head injuries can be caused by object impact.</b></p>
	<p><b>Use cut resistant gloves when you handle and maintain the electric device. There is a risk of cut injuries.</b></p>
	<p><b>Use protective footwear when you lift or move the electric device! Foot injuries could be caused if lifting system or lifting brackets fail.</b></p>

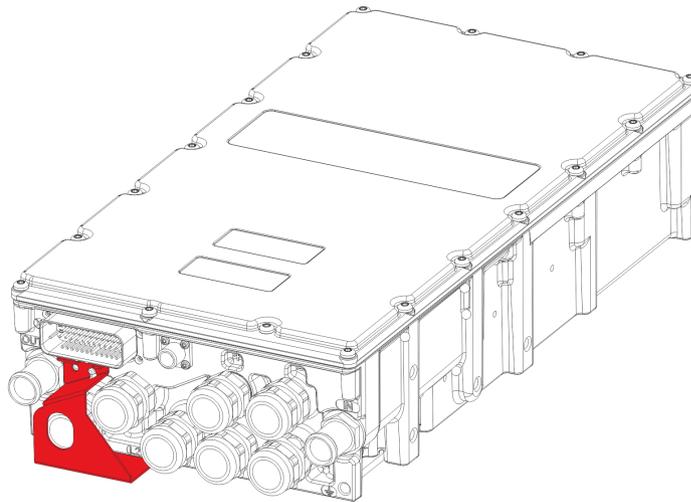
## Safety information

### Safety features

Protection type	Built-in	Information
Overcurrent	Yes	750 A <sub>peak</sub>
Overvoltage	Yes	1050 V <sub>DC</sub>
Short circuit	Yes	-
Overspeed (+MC -option only)	Yes	Adjustable according to controlled motor
Overheat (electric device internal temperature)	Yes	Sophisticated thermal model that can lower the current if needed
Emergency stop	Yes	Hardware secured device switch OFF feature

In addition to the electrical protection features, the electric device has mechanical safety feature, a connector shield, which prevents direct entry to the power terminals, when the electric device is powered ON. The connector shield is a sheet metal component, which secures the power terminal cover and it cannot be released without disconnecting the control signal connector (X1-connector) first. When X1-connector is disconnected, it shuts down the electric device and starts electrical energy discharging process.

*Connector shield (mechanical safety feature)*



### Electromagnetic compatibility (EMC)

	<p><b>When interfacing other equipment, connect only equipment that are specified as part of the system and that are compatible.</b></p>
	<p><b>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:</b></p>

## Safety information

	<ul style="list-style-type: none"> <li>• <b>areas in which electric equipment and parts are operated</b></li> <li>• <b>areas in which electric equipment with permanent magnets are stored, mounted, operated or repaired</b></li> </ul> <p><b>If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.</b></p>
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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.

## Installation safety

	<b>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.</b>
	<b>Do not do any flash tests or voltage withstand tests on the electric device. If electrical tests or measurements are required, do the tests with the electric device disconnected and stored energy discharged.</b>
	<b>Disconnect and isolate the electric device before you start any work on it. High voltages are present at the terminals and within the inverter. Passive discharging of the DC-link capacitor is done by the discharge resistor. Discharging below 50 Volts is completed within 8 minutes after the power is disconnected. Make sure that voltage is not present on any inverter power terminals prior you start any work on it.</b>
	<b>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.</b>
	<b>Use only correct (type and value) protective fuses with the high voltage DC-system.</b>
	<b>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.</b>
	<b>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.</b>

Safety information

	<p>The electric device can start at power up if the start- input signal is present.</p>
	<p>The STOP function does not remove potentially lethal high voltages. Isolate the electric device and wait for 8 minutes before you start any work with it. Never do any work on the electric device, external devices or electric cables if the input power is connected to the electric device.</p>
	<p>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.</p>
	<p>Make sure that the supply voltage corresponds to the specification of the electric device.</p>
	<p>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.</p>
	<p>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 DC-link is powered.</p>
	<p>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.</p>
	<p>Electric device must not be opened (excluding the connection box lid). Any attempt causes loss of warranty.</p>
	<p>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.</p>
	<p>Use correct personal protective equipment when you are near the electric device.</p>



### Safety information

  	
	<p><b>Read the instructions in this user guide before you start to install the electric device.</b></p>

### Operation safety

	<p><b>Do not use the electric device without correctly dimensioned and operating cooling system.</b></p>
	<p><b>Maximum operation temperature must not be exceeded to avoid permanent damage to the electrical device.</b></p>
	<p><b>The requirements of this user guide and other related instructions and standards must be followed.</b></p>
	<p><b>Make sure that the cooling system is in use when the DC-link is powered.</b></p>
	<p><b>Do not touch the electric device during operation. The surface of the electric device can be hot.</b></p>
	<p><b>This electric device is intended for professional use as complete equipment or system and as part of a fixed installation. 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.</b></p>

## Safety information



**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 electric device is a heavy-duty converter designed especially for electric or hybrid drive trains for mobile work machines, buses or marine vessels. Depending on the options selected, it can act as a motor inverter (+MC option), active front end (+AFE option) or a DCDC-converter (+DC option), or it can create a microgrid (+UG option).

#### The advantages and features of the electric device:

- Extremely compact structure, weight only 15 kg.
- Robust design withstanding high levels of mechanical vibrations and shocks.
- High protection class IP67 ensuring operation in extreme conditions.
- Wide ambient operating temperature range from -40°C...+105°C.
- Liquid cooling.
- Wide allowed coolant temperature range.
- Multiple mounting possibilities.
- Designed especially for highly cyclical loads typical in heavy mobile work machines.
- Controls both induction and permanent magnet motors with or without sensor.
- Speed and torque reference motor control.
- Generator control mode for DC-link voltage control.
- Flexible control interface –CAN, resolver, analog, digital inputs/outputs.
- PowerUSER PC-program for commissioning available.
- Various communication protocols, for example CANopen, SAE J-1939.
- High performance vector control.
- Wide selection of protective safety functions.

#### These electric devices are designed for variety of applications:

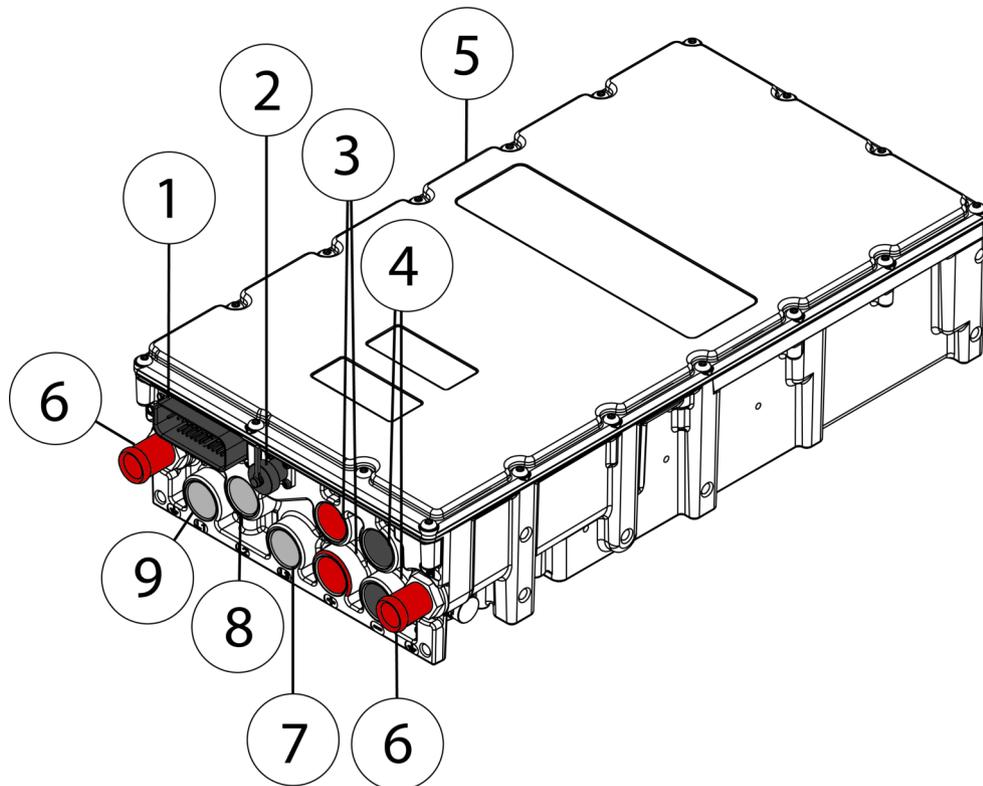
- Boosting battery voltage to higher DC-link voltage. (+DC option)
- Charging high voltage batteries from higher DC-link voltage. (+DC option)
- Converting alternating current (AC) from electrical generator to direct current (+MC option) for energy storage
- Active Front End for connecting to AC grid with regenerative power and low harmonic. (+AFE option)
- Creating standalone microgrid (+UG option)

Note that +DC option functions together with an EC-LTS unit which is sold separately.

Note also that +AFE and +UG options require an external LCL-filter unit or a transformer and LC-filter combination.

**Product overview**

*Main components*

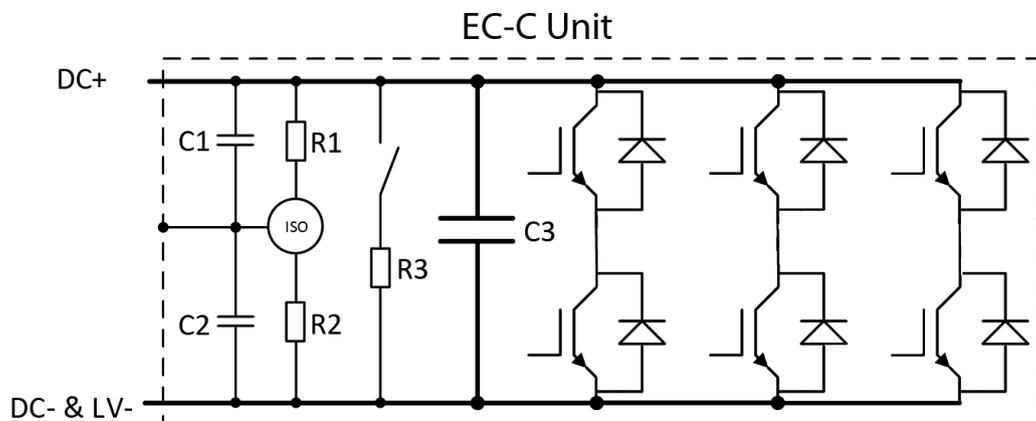


Note that this Figure shows the connections related to the +DC option and is not a general presentation of the main components.

1	X1-connector (Low voltage connector for measurement data and control signals)
2	X2-connector (maintenance connector)
3	DC+
4	DC- / LV-
5	EC-C unit
6	Electric device cooling connections 2 x 20 mm
7	LV3
8	LV2
9	LV1

## Product overview

Electric device power connection diagram



### Protections and limits for options:

The options for EC-C1200-450 have certain protections and limits that affect their function. The difference between protections and limits is that protections stop all high voltage functions of the electric device immediately, whereas limits only limit the functions instead of stopping them.

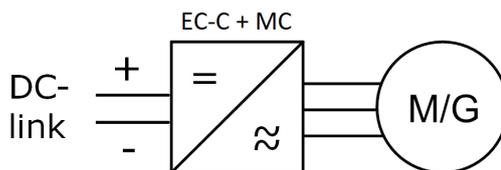
Overcurrent and short circuit trips protect the device from overcurrent and short circuits on the AC side of the device. First protection is a configurable software based overcurrent trip, where the trip level can be set by the user. Second protection is a hardware based overcurrent trip with fixed trip current level of  $750 A_{peak}$  (reaction time  $<15\mu s$ ). In most cases, the hardware overcurrent trip protects the device also from short circuits. In case even the hardware overcurrent trip fails, the final protection is a short circuit trip that has maximum current value of  $2700 A_{peak}$  (self-limiting, reaction time  $<2\mu s$ ).

In the following Sections, the protections and limits are listed for each option.

### Motor Control (+MC option, motor and generator control)

Motor control option is used to control the speed and torque of electrical machines and also converting alternating current (AC) from electrical generator to direct current (DC) for energy storage.

Motor Control application example



### Motor Control characteristics

<b>Controllable motor types</b>	<ul style="list-style-type: none"> <li>Synchronous permanent magnet motors</li> <li>Asynchronous induction motors</li> <li>Special features to control Danfoss synchronous reluctance assisted permanent magnet motors.</li> </ul>
<b>Control principle</b>	<ul style="list-style-type: none"> <li>Rotor flux oriented current vector control</li> </ul>
<b>Reference types</b>	<ul style="list-style-type: none"> <li>Torque reference motor control</li> <li>Speed reference motor control</li> <li>Generator control mode for regulating the DC-link voltage</li> </ul>

## Product overview

### Motor Control characteristics (continued)

<b>Field weakening control</b>	<ul style="list-style-type: none"> <li>Maximizes the field weakening performance by optimizing the use of inverter current and torque production capability of the motor.</li> </ul>
<b>Working point optimization</b>	<ul style="list-style-type: none"> <li>Maximum torque per ampere working point optimization is used to improve efficiency of the motor.</li> </ul>

### Motor Control protections and limits

Protections
Software overcurrent trip (configurable)
Hardware overcurrent trip (fixed 750 A <sub>peak</sub> , AC-side)
Short circuit trip
Software overvoltage trip (configurable)
Hardware overvoltage trip (fixed 1050 V <sub>DC</sub> , DC-link voltage)
Inverter overtemperature trip (measured)
Inverter overtemperature trip (estimated)
Electric machine temperature surveillance and trip (configurable)
Over speed trip (configurable)
Undervoltage trip (configurable, DC-link voltage)
Earth fault trip
Phase loss trip

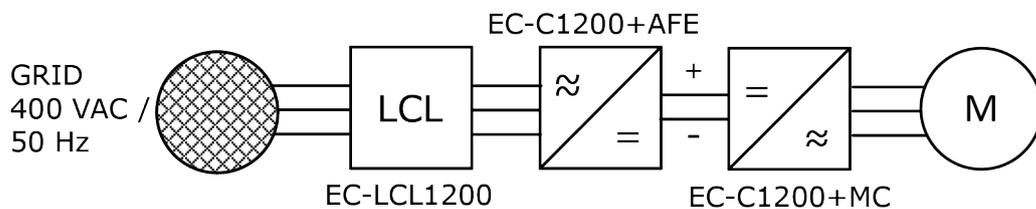
Limits
Speed limit positive
Speed limit negative
Torque limit positive
Torque limit negative
Mechanical power limit positive (motoring)
Mechanical power limit negative (generating)
DC current limit positive (motoring)
DC current limit negative (generating)
Overvoltage controller (DC-link voltage)
Undervoltage controller (DC-link voltage)
Electric machine configurable derating according to winding temperature
Back-emf max. value limit

### Active Front End (+AFE option)

Active Front End is used for connecting to AC grid with regenerative power and low harmonic. In addition, it is used for bidirectional connection to AC grids.

## Product overview

### Active Front End application example



### Active Front End protections and limits

Protections
Software overcurrent trip (configurable)
Hardware overcurrent trip (fixed 750 A <sub>peak</sub> )
Short circuit trip
Software overvoltage trip (configurable)
Hardware overvoltage trip (fixed 1050 V <sub>DC</sub> )
Inverter overtemperature trip (measured)
Inverter overtemperature trip (estimated)
Over frequency trip
Under frequency trip
Grid loss trip

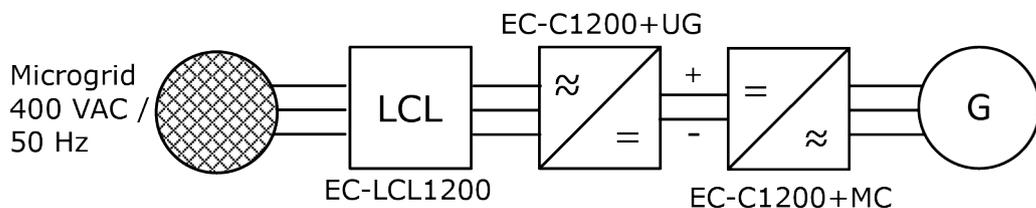
  

Limits
Electrical power limit positive (DC to AC)
Electrical power limit negative (AC to DC)
DC current limit positive (DC to AC)
DC current limit negative (AC to DC)
AC current limit (any direction)
Overvoltage controller (DC-link voltage)
Undervoltage controller (DC-link voltage)

### Microgrid (+UG option)

Microgrid (+UG) option is used for creating a stand-alone island grid.

### Microgrid application example



### Microgrid protections and limits

Protections
Hardware overcurrent trip (fixed 750A <sub>peak</sub> )
Short circuit trip
Software overvoltage trip (configurable)
Hardware overvoltage trip (fixed 1050 V <sub>DC</sub> )

## Product overview

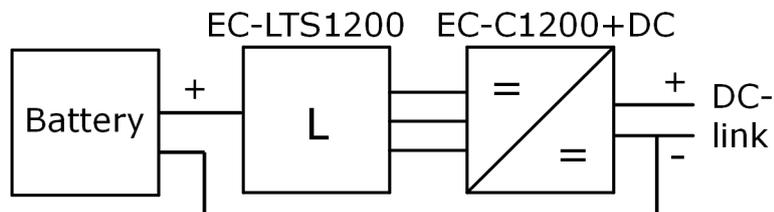
### Microgrid protections and limits (continued)

Protections
Inverter overtemperature trip (measured)
Inverter overtemperature trip (estimated)
Limits
Output voltage reduction in overcurrent situation
Frequency reduction in overcurrent situation
Grid voltage reduction in low DC-link situation

### DCDC converter (+DC option)

DCDC converter is used for connecting to different voltage levels, for example, connecting a high voltage battery to higher DC-link voltage.

#### DCDC converter application example



### DCDC converter protections and limits

Protections
Software overcurrent trip (configurable)
Hardware overcurrent trip (fixed 750 A <sub>peak</sub> )
Short circuit protection
Software overvoltage trip (configurable)
Software undervoltage trip (configurable)
Hardware overvoltage trip (fixed 1050 V <sub>DC</sub> )
Inverter overtemperature trip (measured)
Inverter overtemperature trip (estimated)
Limits
Power limit, HV to LV direction (buck)
Power limit, LV to HV direction (boost)
Current limit, HV to LV direction (buck)
Current limit, LV to HV direction (boost)
Overvoltage controller (HV-side)
Undervoltage controller (HV-side)
Overvoltage controller (LV-side)
Undervoltage controller (LV-side)



## Product overview

### ***The advantages and features of the EC-LTS unit\* (required for +DC option)***

- EC-LTS unit is a separate product, but it is often sold together with the electric device.
- Extremely compact design: 410 A unit weighs only 23 kg.
- High enclosure class IP67 – sealed from moisture and dust.
- Liquid cooled with water/glycol mixture, allowed coolant temperature up to +65°C.
- Ambient temperature up to +105°C and down to -40°C.
- Robust design withstanding high levels of mechanical vibrations and shocks.
- Designed especially for highly cyclical loads typical in heavy mobile work machines.
- Three temperature sensors included for temperature surveillance.

\*Unit sold separately

## Intended use of the electric device

	<p><b>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.</b></p>
	<p><b>The electric device is intended for fixed installation, as a part of complete power generation equipment or system.</b></p>

Typical applications for the electric device:

- System component, functioning as a speed and torque controller for electric motors
- System component, functioning as a current converter, converting alternating current (AC) from electric generator to direct current (DC) for energy storage.
- System component, boosting battery voltage to higher DC-Link voltage.
- System component, charging HV-Batteries from higher DC-Link voltage.

### **Not allowed use of the electric device**

It is forbidden to use, handle, maintain and storage the electric device in 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 insufficiently tightened connections or cable glands.
- Operating the electric device with power cables routed against the instructions.

## Product overview

- Operating the electric device without properly dimensioned and operating cooling system.
- Accessing the connection box(es) of the electric device, 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 or connection box.
- Using cables that can not withstand the maximum current values of the electric device.
- Using dirty cable lugs or broken tools.
- Connecting power cables so that there is less than 10 mm air gap between the cable lug and other metallic structure (including the braid of the cable).
- 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/>.

## System introduction

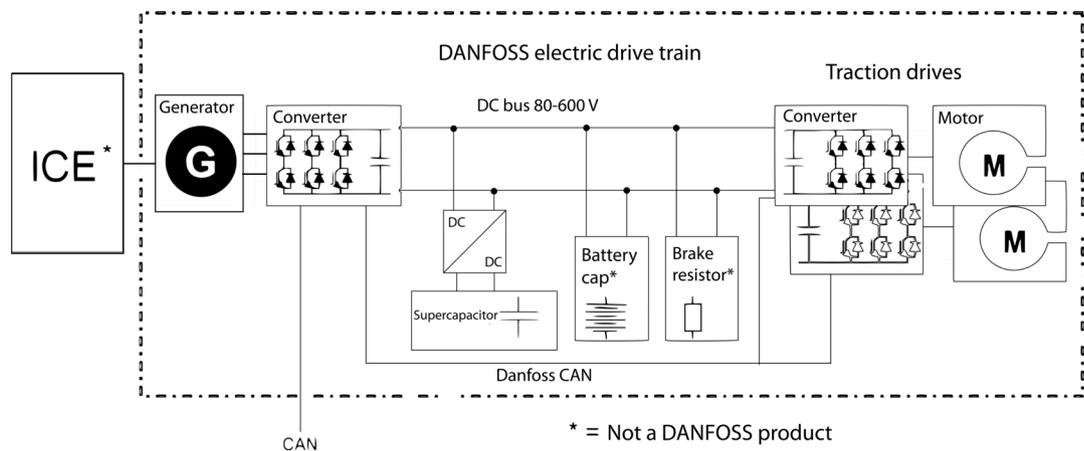
Danfoss provides electric drivetrains for applications in heavy mobile work machines, marine vessels and transportation vehicles. The drivetrains include all essential components for converting from traditional to hybrid electric (HEV) or electric vehicle (EV) solutions. This technology saves fuel and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

The electrical devices are an essential part of the electric drivetrain system. Typically they are used as a speed and torque controller for electric motors and as a current converter, converting alternating current (AC) from electric generator to direct current (DC) for energy storage.

The electric device is capable for supplying three-phase alternating current, powering and controlling electric machines, for example the EM-PMI product family electric machines.

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

*Overview of the drivetrain system (for reference only).*



## Product overview

### Cooling

#### Cooling system requirements

Cooling system properties	Specification
Cooling type	Liquid cooling
Coolant type	Water-glycol mixture (max. 50 % corrosive inhibitor)
Coolant temperature	-40°C...+65°C
Coolant temperature	-40°C...+40°C for 350 A version
Coolant flow minimum	10 l/min
Nominal operating pressure	2 bar
Pressure drop	100 mbar with 10 l/min (+25°C coolant)

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. The rating values in the Figure are illustrations only. For the exact information, see the rating plate on the electric device and product data sheets at <https://www.danfoss.com/>.

#### Rating plate example

① **XX-XXXX-XXXX**

② **XXXX-XXXX-XXXX + XXX + XXX + XXX**

Serial No. XXXXX - XXXXXXXX

	In / Out 2	In / Out 1		
n ph:	X	X	Duty:	X
U nom:	XXX VDC	XXX VAC	Cooling:	XXXXX
U range:	X-XX VDC	X-XXX VAC	Tc:	XX°C
I nom:	XXX A	XXX A	Qc:	XX l/min.
f1:	XXX Hz	XXX Hz	IP class:	IPXX
P nom	XXX kVA		Mass:	XX kg
			Tamb:	XX...XX °C
			Tstorage:	XX...XX°C
			Max. Pressure:	X bar

MADE IN FINLAND

Manuf.: 2018

Danfoss A/S, 6430 Nordborg, Denmark

#### Rating plate fields

Field	Explanation	Unit
1	Electric device product family	
2	Electric device device full type code including possible options	
Serial No.	Serial number	
n ph	Number of phases	
U nom	Nominal voltage	V

## Product overview

### Rating plate fields (continued)

U range	Voltage range	V
f1	Frequency	Hz
I nom	Nominal current	A
P nom	Nominal power	VA
Manuf.	Manufacturing year	
Duty	Duty class	
Cooling	Cooling type	
T <sub>C</sub>	Coolant temperature	°C
Q <sub>C</sub>	Coolant flow	l/min
IP rating	Enclosure class according to IEC60034-5	
Mass	Total weight of the electric device	kg
T <sub>amb</sub>	Ambient temperature limits	°C
T <sub>storage</sub>	Storage temperature limits	°C
Max. pressure	Coolant maximum pressure	bar

The rating plate and its values shown here may not all be relevant for every electric device.

## 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.

	<b>Tightening torque tolerance is +/- 5% of the specified tightening torque.</b>
--	--

### Tightening torques

Connection	Torque
Electric device mounting screws, M8	20 Nm
Electric device mounting screws, M6	10 Nm
Connection box lid (power terminal cover) mounting screws	4 Nm
Connector shield mounting screw, M4	2 Nm
Cable lug mounting screws	15 Nm
Grounding cable mounting screws, M8	15 Nm
Cable gland (tighten from the frame of the gland)	15 Nm

## Transportation and storage

### Transportation

	<p><b>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.</b></p>
	<p><b>Do not apply any excess weight on the electric device during transportation.</b></p>
	<p><b>See the weight of the electric device from the product Data sheet.</b></p>

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.

### 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.

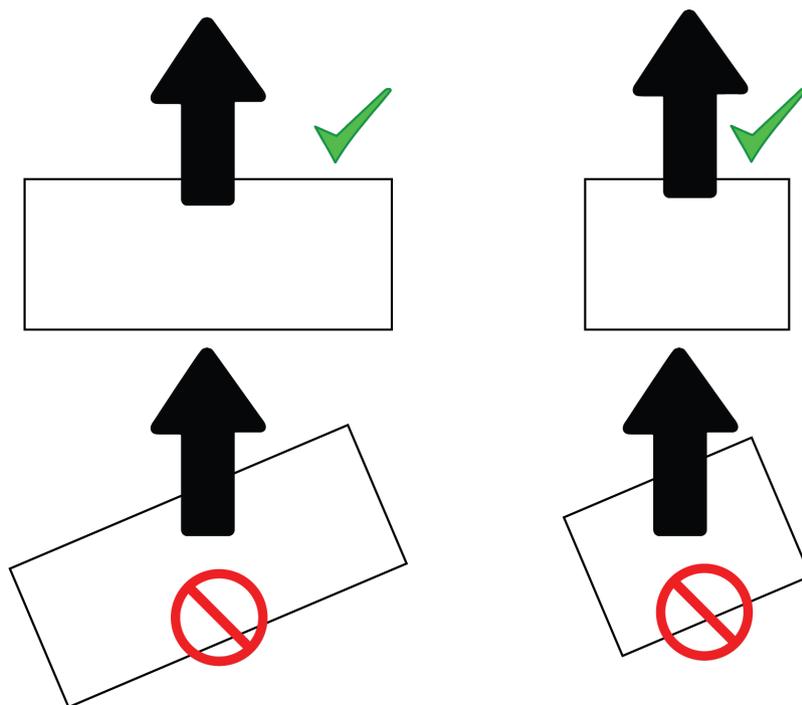
### Lifting

	<p><b>Use correct, adequately dimensioned lifting devices and inspect them before lifting.</b></p>
	<p><b>Do not apply any excess weight on the electric device when lifting it.</b></p>
	<p><b>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.</b></p>
	<p><b>See the rating plate and data sheets for weight information.</b></p>

### Transportation and storage

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

#### Correct lifting and incorrect lifting



### Handling

	<p>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.</p>
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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

	<p>When the device is dismantled and stored and packed for delivery, measure that there is no voltage and then install short circuit wire to the conductor rails to prevent charge from building up.</p>
--	--

### Transportation and storage

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

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

	<p><b>Risk of electric shock during electrical installations. Use insulated tools.</b></p>
---	--

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

- Ratchet torque wrench.
- Hex head wrench kit with different metric sizes.
- Socket wrench kit with different metric sizes.
- Heavy duty cable cutter for the power cables.
- Small wire cutters for trimming the cable shield wires.
- Cable gland tightening tool. Size according to cable glands.
- Cable skinning knife.
- Crimping tool for cable lugs.

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

### Insulation resistance test

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

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

The reference value 100 MΩ has to be exceeded at reference ambient temperature +25°C (measured with 500 V<sub>DC</sub> / 1 min insulation resistance test). Contact Danfoss Editron service if the reference value is not exceeded.

### Measuring the insulation resistance

	<p><b>Insulation resistance testers generate lethal voltages. Only qualified personnel should perform insulation resistance measurements.</b></p>
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## Installation

The insulation resistance is measured between terminals and the converter enclosure. When measuring the main circuit, the auxiliary circuits are grounded. When measuring the auxiliary circuits, the main circuit is grounded.

### Main circuit

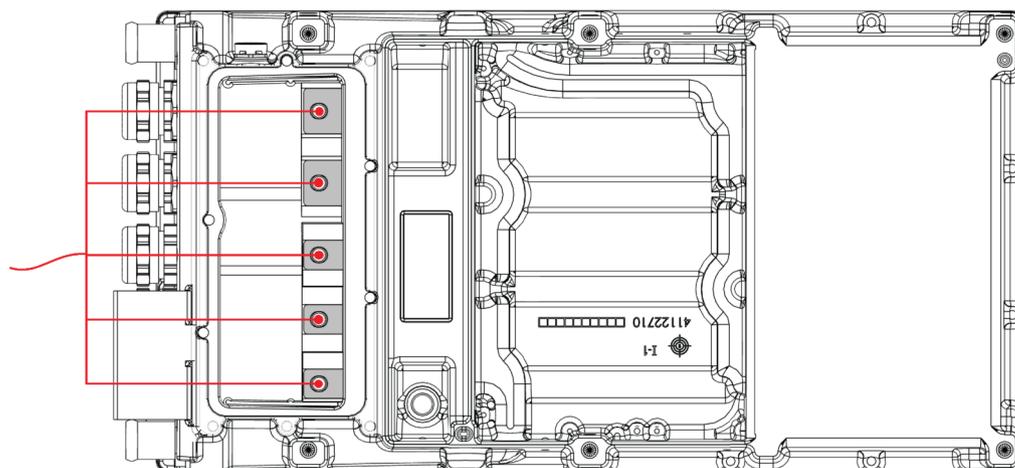
The following table lists test conditions and pass criteria for the EC-C1200-450-L and EC-C1200-450-S inverters.

Test voltage	Test duration	Pass criteria for "-L"	Pass criteria for "-S"
500 V <sub>DC</sub>	60 s	> 100 MΩ	> 5 MΩ

Measurement procedure:

1. Connect main circuits DC+, DC-, L1, L2 and L3 together.
2. Connect all pins of X1 connector to the converter enclosure.
3. Connect the measurement devices ground cable to the converter enclosure.
4. Connect the measurement probe to the main circuits.

*Main circuit measurement*



### Auxiliary circuits

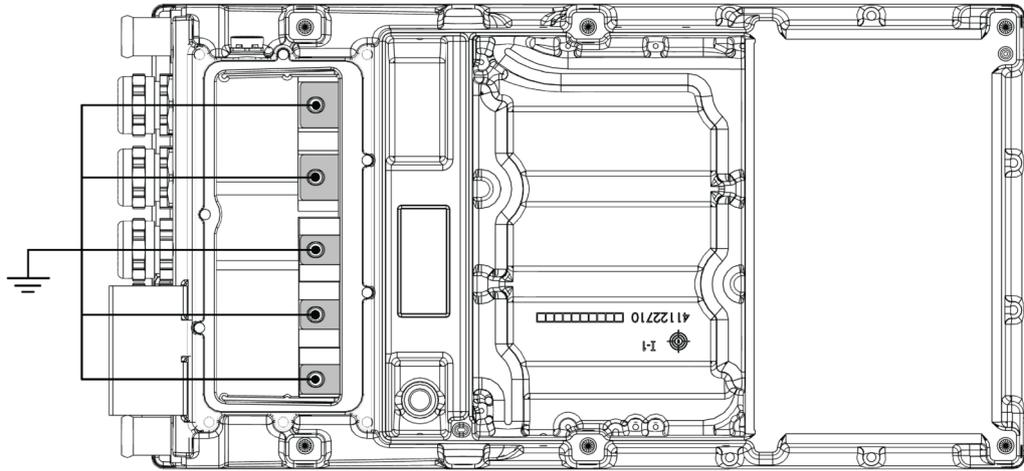
Test voltage	Test duration	Pass criteria
50 V <sub>DC</sub>	60 s	> 10 MΩ

Measurement procedure:

1. Connect main circuits DC+, DC-, L1, L2 and L3 to the converter enclosure.
2. Connect all pins of X1 connector together, except pin 35 (enclosure ground).
3. Connect the measurement devices ground cable to the converter enclosure.
4. Connect the measurement probe to the connector X1 pins 1 - 34.

## Installation

### Auxiliary circuit measurement



## Mechanical installation

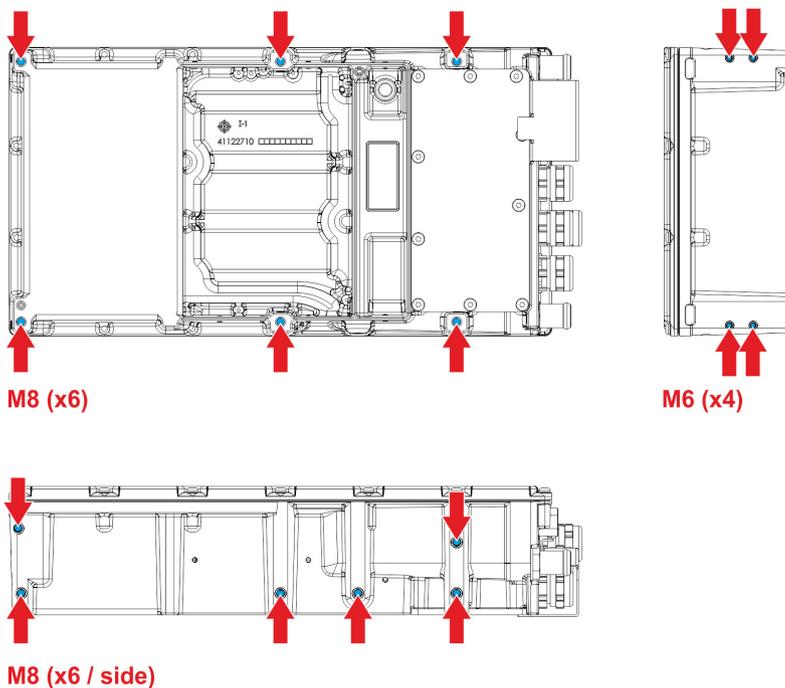
### Allowed mounting position

	<p><b>Do not place the electric device on the ground without proper mounting or protective structure.</b></p>
	<p><b>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.</b></p>

- The electric device must be mounted on a flat, heat- and flame-resistant mounting place (for example on a bracket).
- The electric device can be mounted in any direction. Mount the electric device permanently from the mounting points.
- To fulfill the mechanical and environmental standards, for example vibration and shock, it is recommended to mount the electric device from the bottom side, with at least 6 pcs of M8 screws.
- Mounting points are shown in the Figure *Location of the mounting points* below.

## Installation

### Location of the mounting points



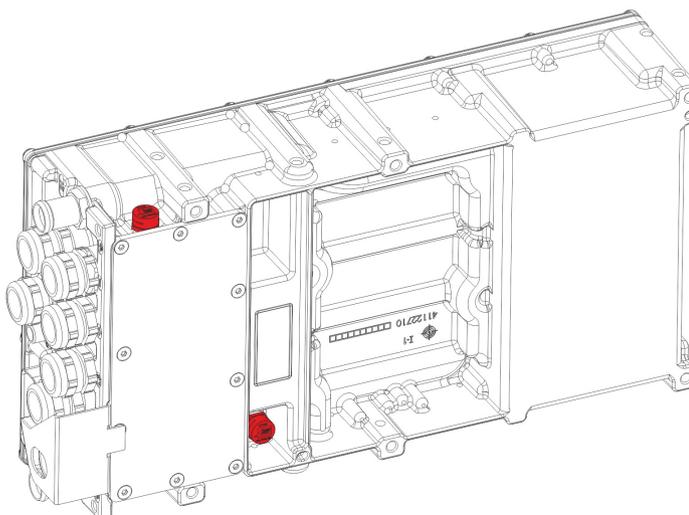
Selected mounting position must allow the cooling system to work properly. Bleed the air away from the cooling channels to prevent air pockets.

### Breather plug

Make sure that the breather plugs (2 pcs) are clean and the selected installation place and mounting direction do not allow water, dust or dirt to block them.

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

### Location of the breather plug



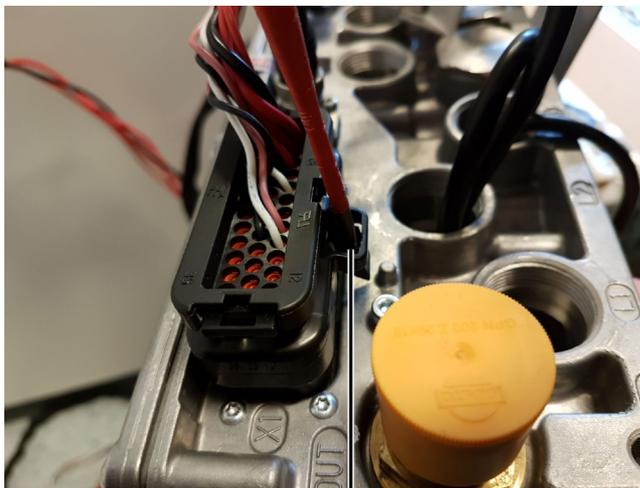
## Installation

### Installation procedure

	<p>Risk of electric shock when the connection box lid is open. Make sure that the electric device is discharged; measure the voltage to make sure of safety.</p>
	<p>Do not touch the exposed circuit board under the connection box lid when installing electrical connections or performing maintenance. An ESD could damage the circuitry.</p>
	<p>Heavy electric device. Handle with care. Handle the electric device correctly when you install it to the correct mounting position. See Chapter <a href="#">Handling</a> on page 30.</p>
	<p>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.</p>
	<p>Do not use excessive force when installing and removing the X1-connector because the plastic housing of the X1-connector can break. See the Figure below for more information.</p>
	<p>Always check the compatibility of the X1-connector and the counterpart. Never alter the connector in any way.</p>

## Installation

### Removing the X1-connector



### 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 32.
- 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.

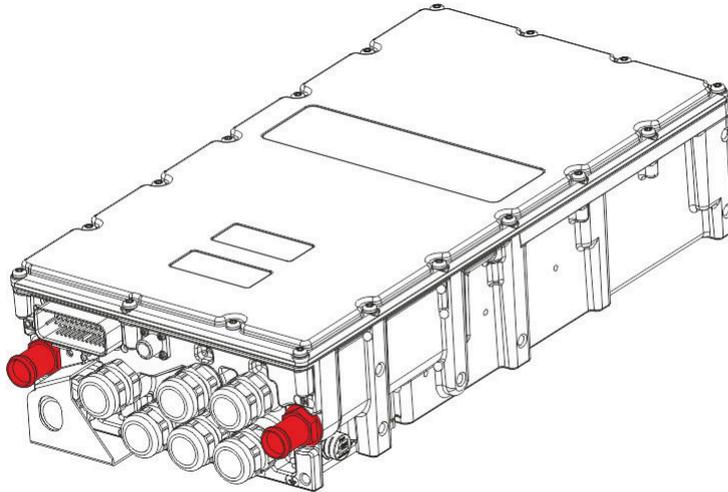
### Installation procedure

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 29.
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 28.
4. Connect the cooling system. See Chapter [Cooling connections](#) on page 39 or the *Main dimension drawing* for connection details. Make sure that there are no air pockets in the cooling channels and that

## Installation

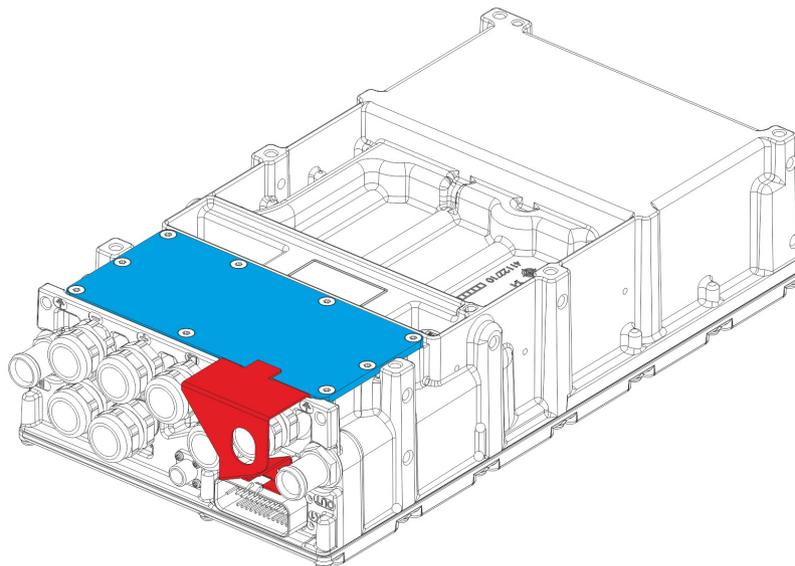
the coolant goes freely in and out. Coolant flow direction is shown next to the coolant inlet/outlet. Make sure that the cooling system operates correctly.

### *Cooling system connections*



5. Make sure that the devices and machines you will connect to the electric device have no voltage.
6. Make the grounding of the frame of the electric device by direct contact between it and the metal bracket and / or from the protective earth contacts. The grounding contacts must be paint-free. See Chapter [Grounding](#) on page 47.
7. Uninstall the connector shield (mechanical safety component, sheet metal part).
8. Dismount the connection box lid (power terminal cover).

### *Connection box lid*

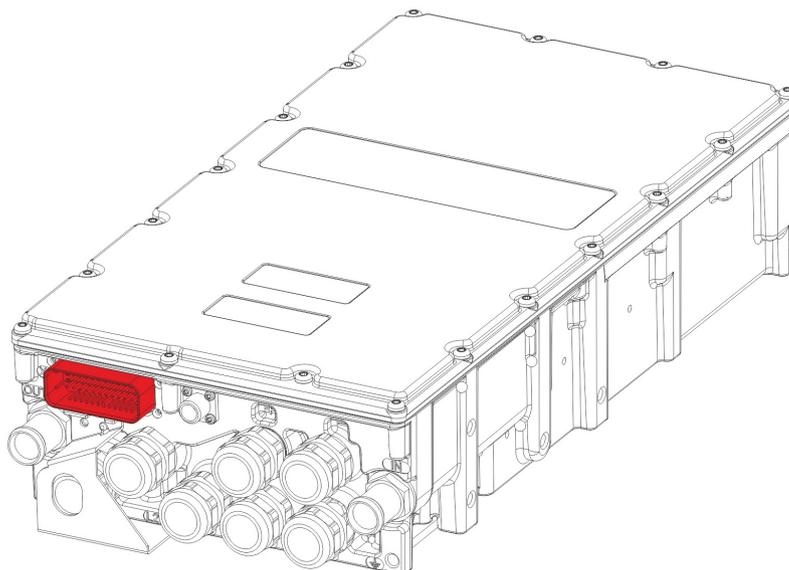


9. Connect the power cabling. Refer to Chapter [Electrical connections](#) on page 40.
10. Install the connection box lid.

## Installation

11. Install the connector shield.
12. Connect the X1-connector (control signal connector).

*X1-connector*



### Cooling connections

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

- 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 40 and product data sheets. Rated values can be found on the rating plate of the electric device.
- Coolant connections: 2 x 20 mm (for 19 mm hose).
- 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.

## Installation

### Recommended coolants

	<p><b>Ethylene glycol is a toxic compound. Avoid exposure to the coolant.</b></p>
	<p><b>Handle with care. Use appropriate personal protective equipment when you handle the coolant.</b></p>
	<p><b>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.</b></p>

The electric device works correctly with water based coolant. Plain water with appropriate corrosive inhibitor is acceptable, for example, water with maximum of 50% glycol coolant.

Ethylene glycol based Glysantin® G48® (includes also corrosion inhibitors) or similar can be used. Propylene glycol based coolants, like Splash® RV&Marine antifreeze, can also be used. Propylene glycol is a relatively safe compound for humans and the environment.

## Electrical installation

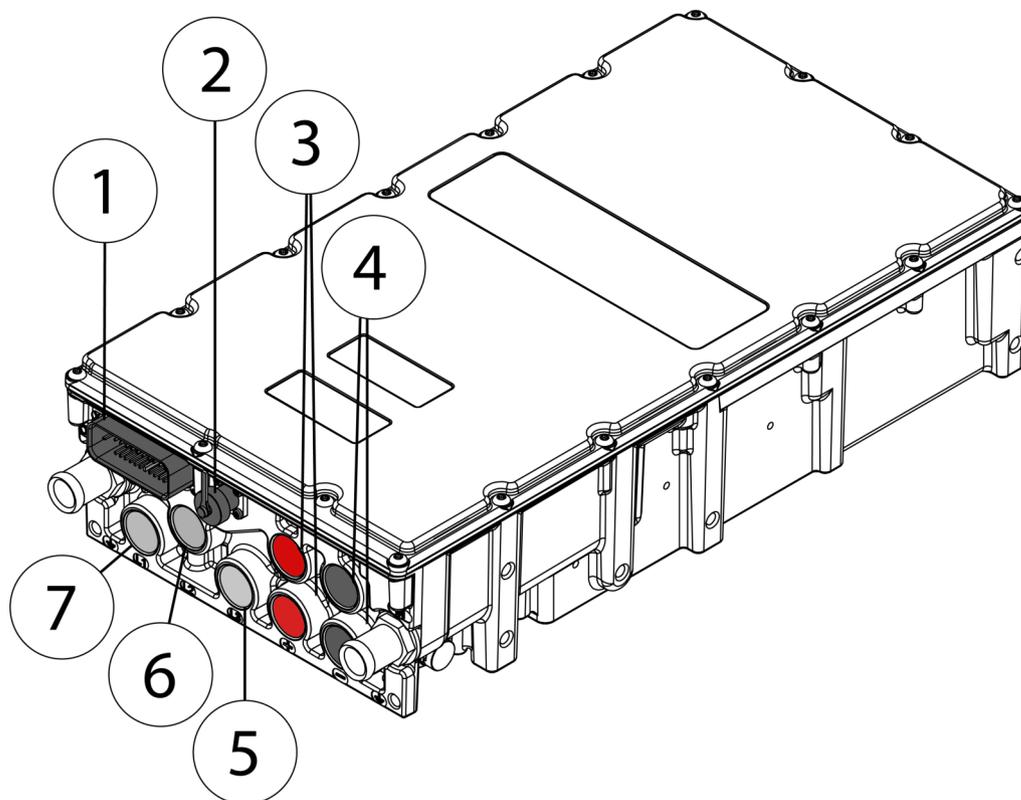
### Electrical connections

	<p><b>Before you start the electrical installation, make sure that the frame of the electric device is grounded correctly. Refer to Chapter <a href="#">Grounding</a> on page 47.</b></p>
	<p><b>Risk of electric shock when power terminal cover is open. Before working with the power connections make sure that electricity has been disconnected and the electric device has discharged.</b></p>
	<p><b>Before you start the electrical installation, make sure that the environment is dry and free from conductive dust particles.</b></p>
	<p><b>Cable lugs are not included in the delivery.</b></p>



## Installation

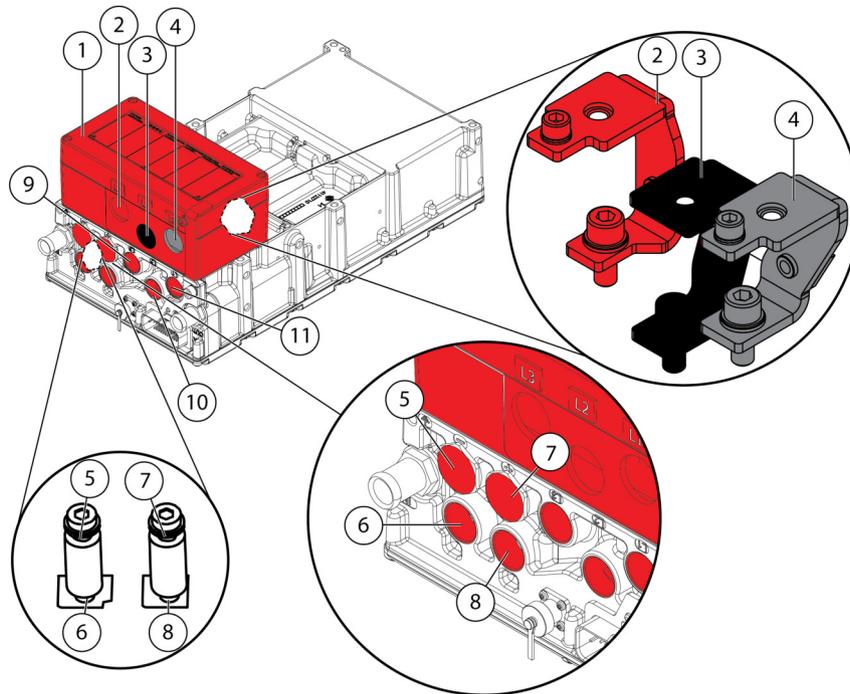
*Electrical connections*



1	X1-connector (Low voltage connector for measurement data and control signals)
2	X2-connector (maintenance connector)
3	DC+
4	DC- / LV-
5	L3
6	L2
7	L1

## Installation

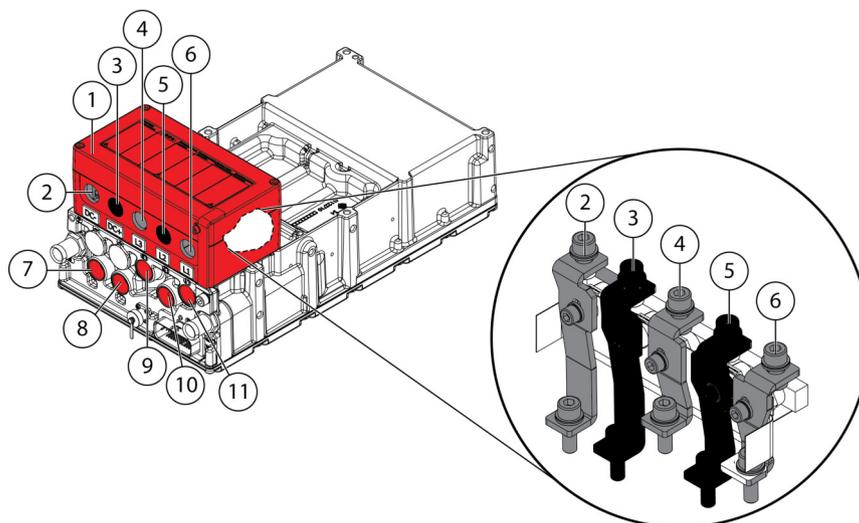
*Electrical connections with +CE2 option and +DCE option*



1	External connection box
2	L3 connection, external
3	L2 connection, external
4	L1 connection, external
5	DC- connection (+DCE)
6	DC- connection (+DCE)
7	DC+ connection (+DCE)
8	DC+ connection (+DCE)
9	Not in use
10	Not in use
11	Not in use

## Installation

### Electrical connections with +CE1 option



1	External connection box
2	DC- connection, external
3	DC+ connection, external
4	L3 connection, external
5	L2 connection, external
6	L1 connection, external
7	DC- connection
8	DC+ connection
9	L3 connection
10	L2 connection
11	L1 connection

Before attaching the cable lugs (1), loosen the busbar fixing bolts (2). Use all cable lug locations. After attaching the cable lugs, tighten the busbar fixings to torque.

Not using all cable lugs could lead to overheating.

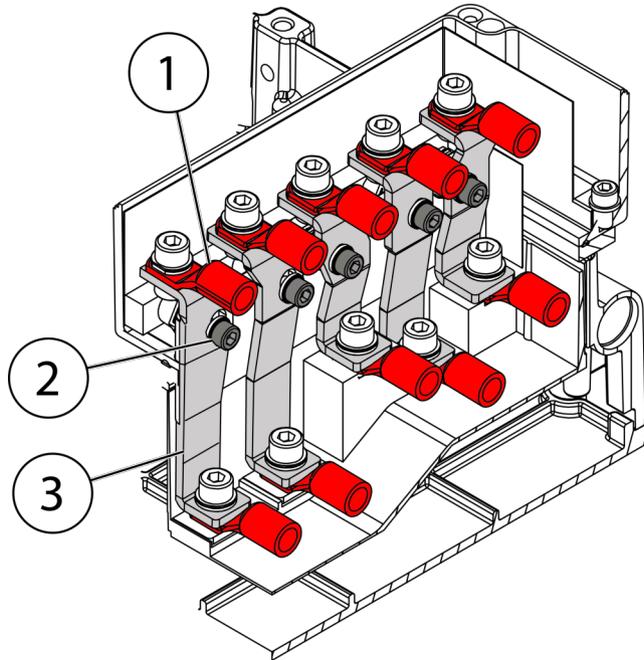
With the lower device connections 7-11, attach the cable lugs *between* the device terminals and +CE1 connection box busbars. The cable lugs do not fit on top of the +CE1 busbars in these positions!

However, with the upper connections 2-6 on the external connection box, attach the cable lugs *on top of* the busbars. For more information, see the figures below.

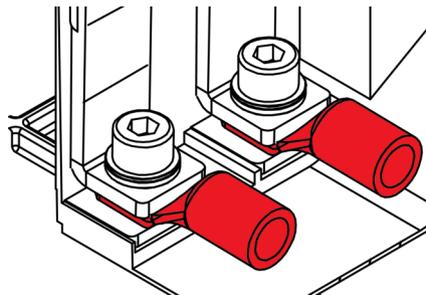
1	Cable lug
2	Busbar fixing bolt
3	Busbar

## Installation

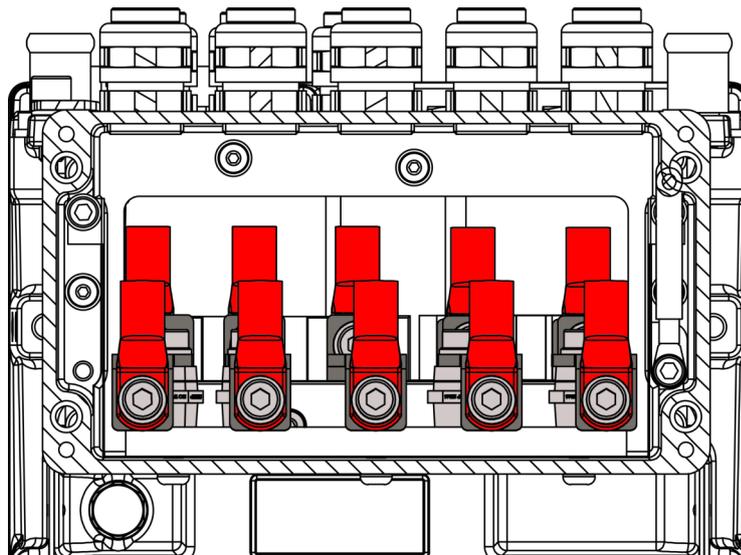
*Cable lug position with +CE1 option*



*Cable lug position in lower device connections*



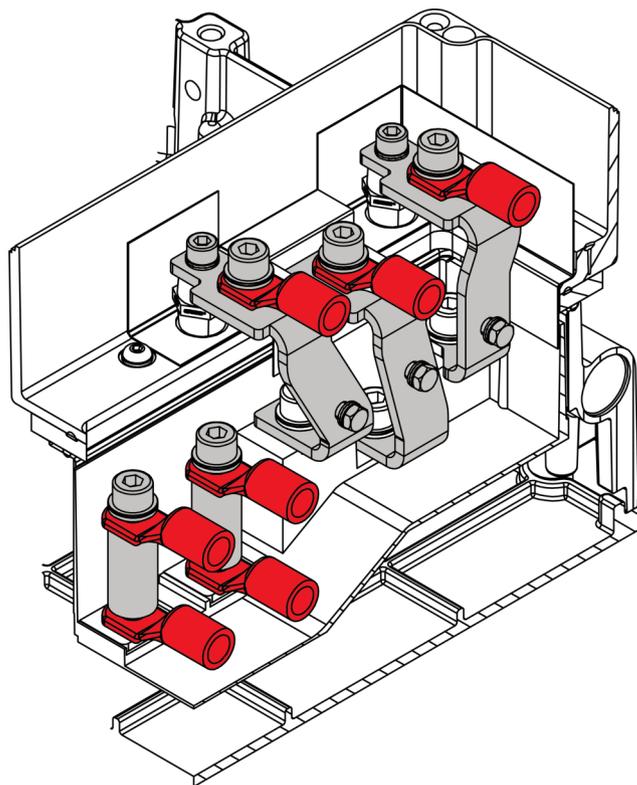
*Cable lug position with +CE1 option, top view*



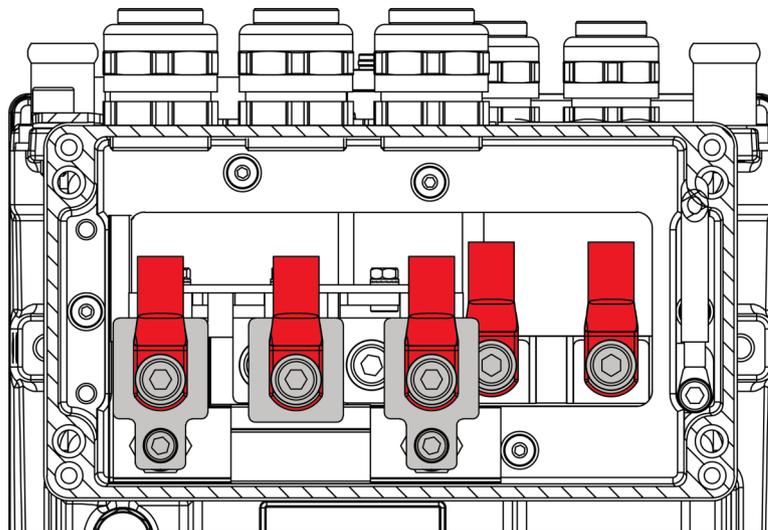
## Installation

	<p><b>When using option +CE2, do not loosen the busbar attachment screws of connection points 9-11 as they are tightened to the correct torque at the factory. Loose connections raise the risk of overheating.</b></p>
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*Cable lug position with +CE2+DCE options*



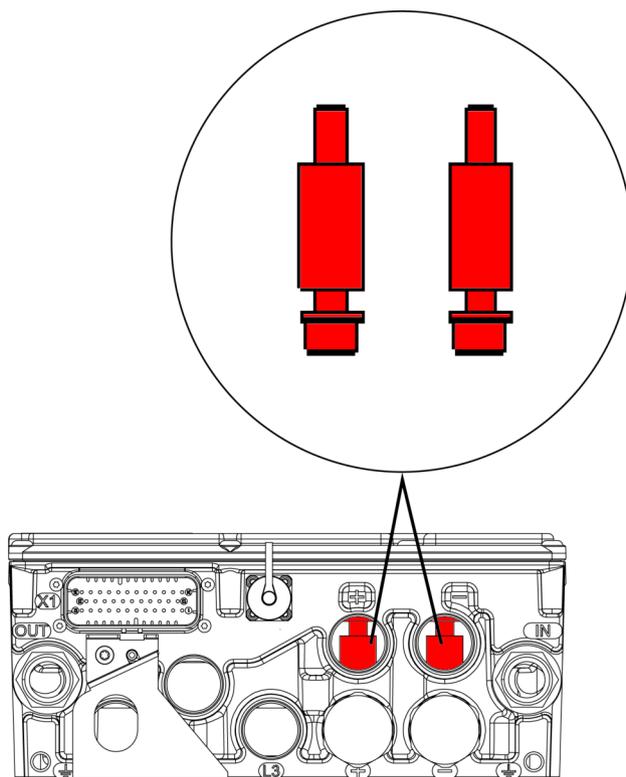
*Cable lug position with +CE2+DCE options, top view*



## Installation

	<p>Use all connections when you install an electric device with +CE1 option. Using only connections in the connection extension box can cause overheating of the electric device. Note that +CE1 and +CG6 option combination is an exception where only connections 2 and 3 are in use and connections 7 and 8 are not.</p>
	<p>+DCE should only be used when connecting double cables per DC connection. Otherwise, overheating is possible.</p>

Electrical connections with +DCE option



### Maximum cable lug width and length

Measurements L1, L2 and L3 are illustrated in Figure *Cable lug length and width* below the tables.

#### EC-C

Description	Converter connection box
Cable lug width max., L1	17.5 mm
Cable lug length L2	11.5 mm
Cable lug length max., L3	55 mm

#### EC-C+CE1

Description	Converter connection box	CE1 connection box
Cable lug width max., L1	17.5 mm	21 mm
Cable lug length L2	11.5 mm	17 mm
Cable lug length max., L3	55 mm	60 mm

## Installation

### EC-C+CE2

Description	Converter connection box (for DC-link connection only)	CE2 connection box
Cable lug width max., L1	17.5 mm	30.5 mm
Cable lug length L2	11.5 mm	15 mm
Cable lug length max., L3	55 mm	60 mm

### Cable lug length and width



## Grounding

	<b>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.</b>
	<b>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.</b>
	<b>Obey the installation instructions and the guidelines for component selection given in this user guide.</b>
	<b>Make sure that the safety grounding is correct. Refer to Chapter Mechanical installation.</b>

### 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.

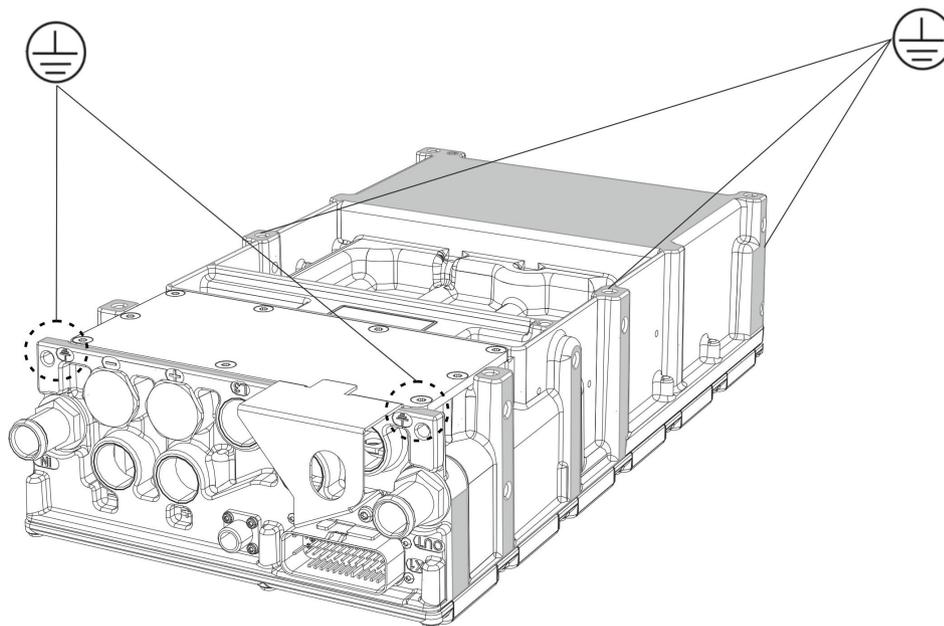
### Main frame

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

## Installation

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 points



### Safety grounding points and protective earth conductor

	<b>Touch current in the protective earth conductor exceeds 3,5 mA AC and 10 mA DC.</b>
	<b>The cross sectional area of the protective earth conductor must be at least equal to that of the incoming supply conductor.</b>

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.

### Cabling and wiring

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. All power connections must be secured with cable lugs and cable glands. EMC-shielded cable glands are used in all Danfoss products for the power connections. Make sure that the low voltage cable (control signal cable) shield is also grounded from the both ends.



## Installation

### Cable gland assembly and power line connection

	<b>Risk of electric shock when the connection box lid is not installed.</b>
	<b>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.</b>

### 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

All electrical connections must be done according to instructions. It is essential to make sure that all terminal connections are installed properly and the and the intended application is suitable for the product in terms of electrical requirements/characteristics.

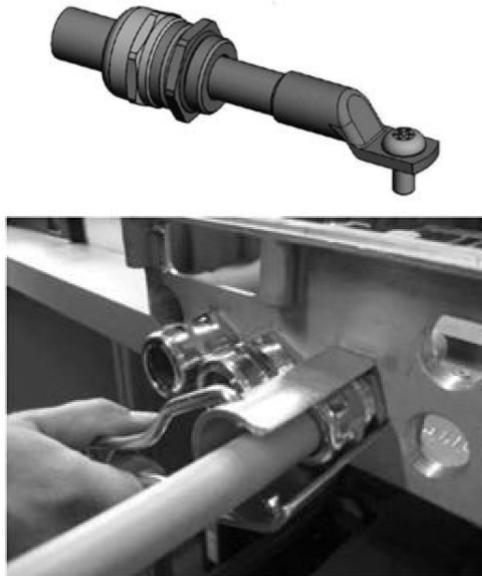
The cable harness for electric connections needs to be terminated with cable lugs and cable glands. It is recommended to use IP67/68 rated, 360° shielded cable glands and single core automotive rated screened cable.

The cable gland has three functions, it works as a stress relief, it seals the connection against water and dirt and provides appropriate EMI shielding. Advanced cable glands could achieve high EMI attenuation over a wide frequency range.

The cable lug and cable gland must be assembled according to instructions. For correct assembly of the cable gland, it is recommended to use a torque key with a turnkey head and a key to adapt the cable gland. The cable lug is connected to terminal with a M8 screw. Shielding of the power cable must be connected to the electric device body by the cable gland. Recommendations for the tightening torques must be followed. See the manufacturer's instructions on how to install the cable glands and the cable lugs. The following instructions may not apply to every type of connection this electric device has.

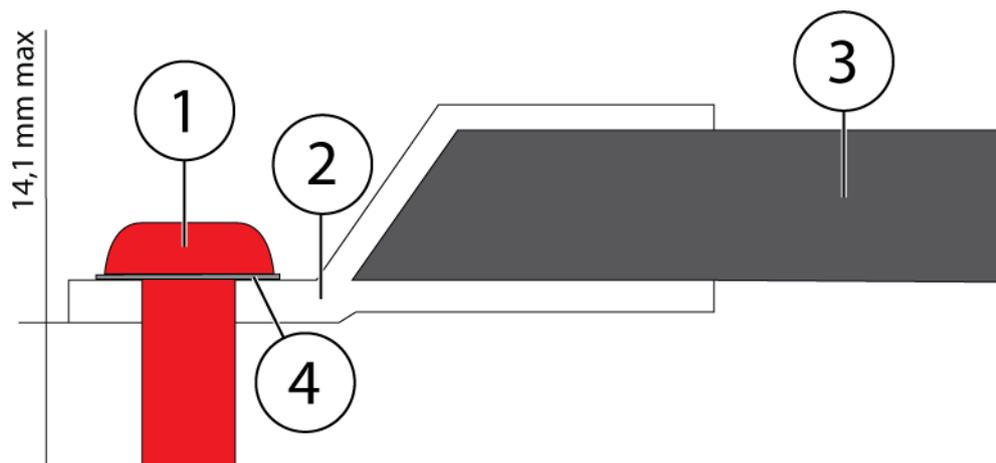
## Installation

*Cable harness connection with the cable lug and the cable gland (for illustration only)*



	<p><b>It is recommended to use screw size M8 x 16 and a washer combination of wave and regular washers.</b></p>
--	---

*Maximum protrusion of the screw through washer and cable lug*



	Description
1	Screw
2	Cable lug
3	Cable
4	Washer

Pflitsch BlueGlobe-series cable glands and HUBER+SUHNER Radox Elastomer S, screened, single core, automotive cables are recommended.

The information below describes how to assemble screened power cables to the electric device.

## Installation

Cable gland assembly instruction can also be found from Pflitsch cable gland catalogue available at <https://www.pflitsch.de>.

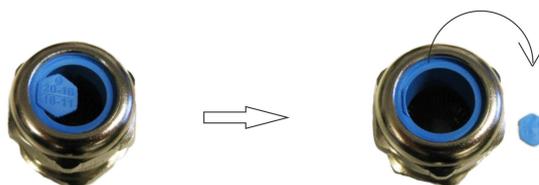
Correct cable gland type for the high voltage cables is Pflitsch blueglobe TRI bg XXXms tri (depending on option 225ms tri max. cable Ø 20 mm, max. screen Ø 16 mm or 232ms tri max. cable Ø 25 mm, max. screen Ø 20 mm).

### Cable lug and cable gland assembly steps

Note that these instructions apply only for components that are recommended for this product.

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

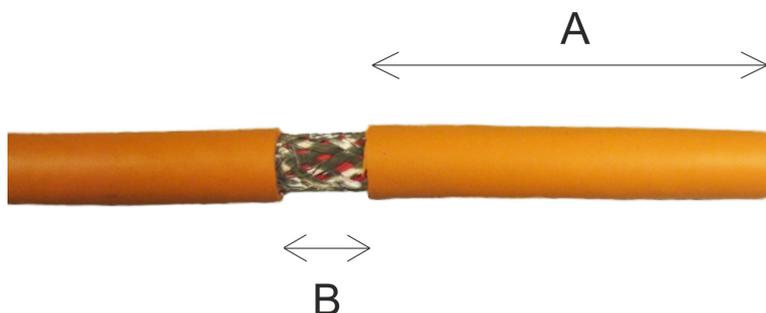
*BlueGlobe-sealing*



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. Distance A depends of the length of the used cable lug. Measure with the cable lug that is used and cut to suitable length.

	<p><b>Do not remove the cable sheath completely at this point and do not cut the braid screen of the cable.</b></p>
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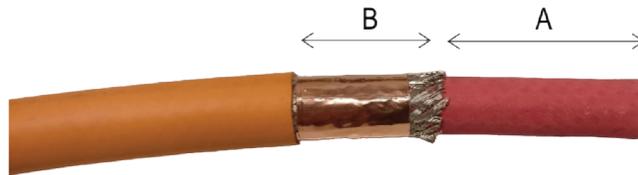
*Cut length of the cable sheath*



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.

## Installation

*Cover the cable with copper tape*



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

*Cable to the gland assembly*



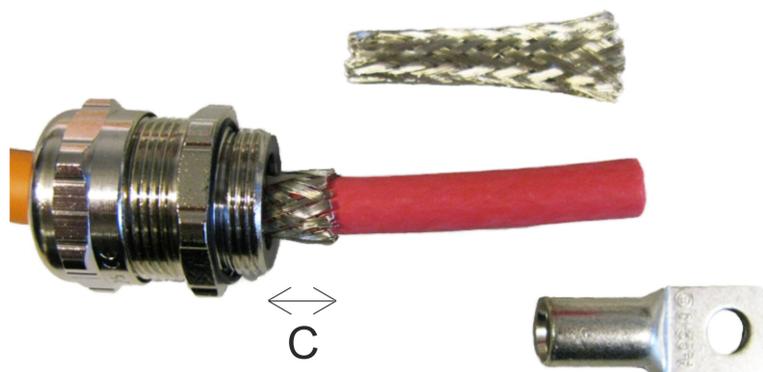
5. After the cable gland is in place remove the length A piece of the sheath and cut the braid screen (cover) from 10 mm (distance C) from the gland bottom as shown in Figure below.



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

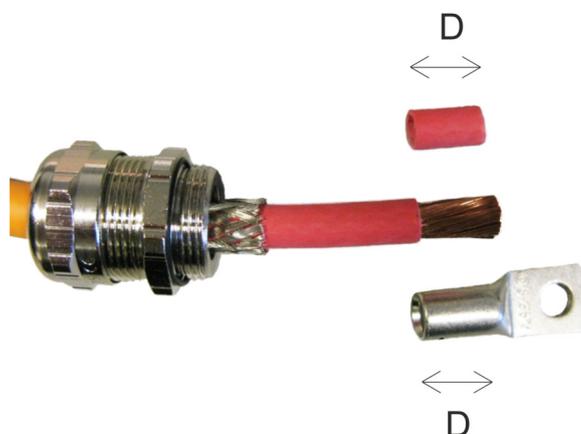
## Installation

*Cut the braid screen*



6. Cut a piece of length D of the inner sheath shown in Figure below. The length D must be 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<sup>2</sup>) 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.
- 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.

## Installation

### 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.

	<p><b>The shrink tube must be specified for operating temperature range from -40°C to +150°C. Self adhesive shrink tube is recommended.</b></p>
--	---

### Shrink tube



9. Insert the cable through the corresponding hole in the electric device frame and connect the cable lug to the power terminal with the correct screw. Use spring washer between the cable lug and the connection screw or nut. Do not tighten the cable lug screw at this point to ensure fitting of the cable gland.

	<p><b>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.</b></p>
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10. Screw the cable gland to the power terminals of the electric device according to instructions. Tighten the cable gland with the specified torque.

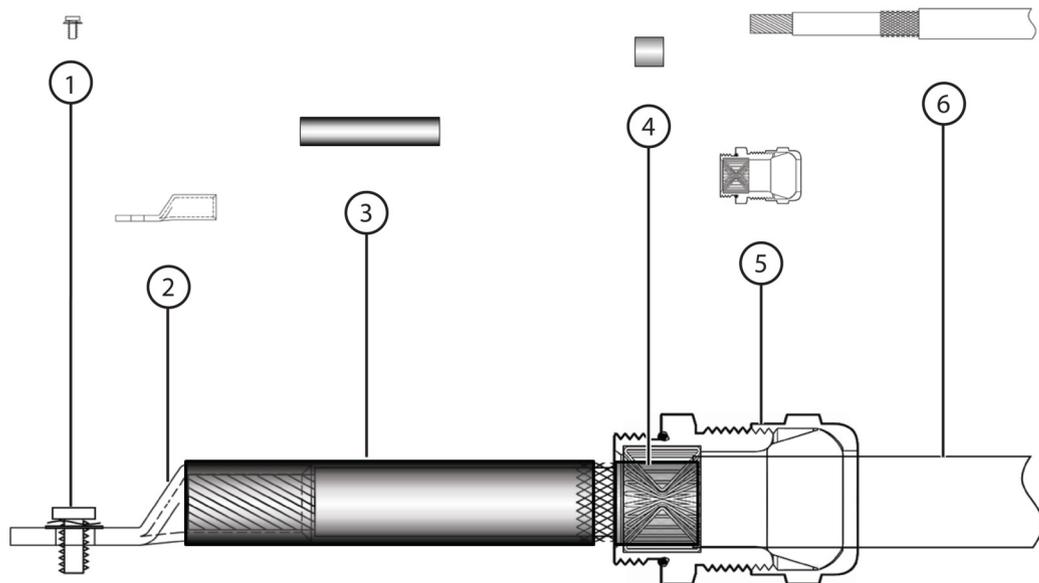
## Installation



**Tighten the cable gland from the cable gland body to enclosure with torque 15 Nm. Then tighten the cap of the cable gland according to the instructions provided by cable gland manufacturer (recommendation Pflitsch).**

11. Tighten the cable lug using the specified torque.
12. Repeat the procedure to the other cables and connections.
13. Close the power terminal cover and install the connector shield.
14. Make sure that the power cable shields are grounded properly.

*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

*Example of the equipment needed for the assembly*

	Description	Manufacturer's homepage	Art.No./Part No.
Assembly equipment (example)	Torque key and turnkey head	<a href="http://www.pflitsch.de">http://www.pflitsch.de</a>	730N/10-50
	Key	<a href="http://www.pflitsch.de">http://www.pflitsch.de</a>	SE30

## Installation

Example of the equipment needed for the assembly (continued)

	Description	Manufacturer's homepage	Art.No./Part No.
Assembly example for a 70 mm <sup>2</sup> cable	Cable with nominal cross-section of 70 mm <sup>2</sup>	<a href="http://www.hubersuhner.com">http://www.hubersuhner.com</a>	HUBER+SUHNER Radox Elastomer S, screened, single core, automotive cable (FHRL4GC13X)
	Cable lug	<a href="http://www.druseidt.de">http://www.druseidt.de</a>	Druseidt with narrow flange 03906
	Cable gland	<a href="http://www.pflitsch.de">http://www.pflitsch.de</a>	Pflitsch blueglobe TRI bg 225ms tri Or depending on option (see option list) Pflitsch blueglobe TRI bg 232ms tri
	Screw	-	DIN 912 M8x16
	Washer	-	DIN 2093, 8,2 x 16 x 0,9
	Washer	-	DIN 125 D8
	Assembly example for a 50 mm <sup>2</sup> cable	Cable with nominal cross-section of 50 mm <sup>2</sup>	<a href="http://www.hubersuhner.com">http://www.hubersuhner.com</a>
Cable lug		<a href="http://www.druseidt.de">http://www.druseidt.de</a>	Druseidt with narrow flange 03903
Cable gland		<a href="http://www.pflitsch.de">http://www.pflitsch.de</a>	Pflitsch blueglobe TRI bg 225ms tri Or depending on option (see option list) Pflitsch blueglobe TRI bg 232ms tri
Screw		-	DIN 912 M8x16
Washer		-	DIN 2093, 8,2 x 16 x 0,9
Washer		-	DIN 125 D8

### Cabling and wiring

	<b>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.</b>
	<b>If the electric device drives a motor or generator, contact Danfoss if the power cable is longer than 15 m. For EMC related reasons, a filter might be needed.</b>

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.



## Installation

### Cabling

- For the power cables, it is recommended to use Radox Elastomer S, screened automotive cable or equivalent cable with similar specifications.
- Cable cross section can be 35 mm<sup>2</sup>, 50 mm<sup>2</sup> or max. 70 mm<sup>2</sup>, depending on the maximum current of the electric device.
- 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.

All Danfoss products use EMI shielded cable glands for power connections.

### Wiring

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
Resolver cabling	Shielded cable (twisted pair)
CAN cabling	Shielded cable (twisted pair)
Other signals	Shielded multistrand wire
External temperature measurement (PT100/PT1000)	Shielded cable (twisted pair)
User I/O cabling	Shielded cable (twisted pair)

### High voltage connections

	<b>The high voltage connections have a common ground connector.</b>
	<b><math>U_{HV} \geq U_{LV}</math></b> The voltage on the LV side ( $U_{LV}$ ) of the device cannot be higher than the HV side voltage ( $U_{HV}$ ). If a higher voltage is applied to the LV side, current will immediately flow through the diodes of device and the HV side voltage will increase to the same level as the LV side voltage.
	<b>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.</b>
	<b>Do not place any excess weight on the connection box lid(s).</b>

- 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.
- The electric device is delivered with the power terminal cover mounted. To access the power connections, remove the mechanical safety feature and the connection box lid.

## Installation

### DC connection specifications (+MC, +AFE, +UG options)

DC-connection	
DC link voltage range	0-850 V <sub>DC</sub>
DC link nominal voltage	750 V <sub>DC</sub>

### AC connection specifications (+MC, +AFE, +UG -options)

AC connection	
AC output voltage	0-560 V <sub>EFF</sub> (U <sub>DC</sub> = 800V <sub>DC</sub> )
Output frequency	0...580 Hz. Up to 1000 Hz as option.
Switching frequency	8 kHz
Maximum power	300 kVA

### AC connection specifications by product type (+MC, +AFE, +UG -options)

AC connection					
Option	+MC120, +AFE120, +UG120	+MC180, +AFE180, +UG180	+MC240, +AFE240, +UG240	+MC300, +AFE300, +UG300	+MC350, +AFE350, +UG350
Nominal current	120 A <sub>RMS</sub>	180 A <sub>RMS</sub>	240 A <sub>RMS</sub>	300 A <sub>RMS</sub>	350 A <sub>RMS</sub>
Nominal power	100 kVA	150 kVA	200 kVA	250 kVA	300 kVA

### High voltage side connection (+DC -option only)

High-voltage side	
Voltage range, U <sub>HV</sub>	0-850 V <sub>DC</sub>
Nominal voltage	750 V <sub>DC</sub>
Maximum current	350 A <sub>DC</sub>

### Low-voltage side connection by product type, (+DC -option only)

Low-voltage side				
Option	+DC150	+DC250	+DC300	+DC400
Typical voltage, U <sub>LV</sub> <sup>*</sup>	75-750 V <sub>DC</sub>	75-750 V <sub>DC</sub>	75-750 V <sub>DC</sub>	75-750 V <sub>DC</sub>
Nominal current	150 A <sub>DC</sub>	250 A <sub>DC</sub>	300 A <sub>DC</sub>	400 A <sub>DC</sub>
Nominal power <sup>**</sup>	90 kW	150 kW	200 kW	240 kW

<sup>\*</sup> = Maximum transformation ration between LV and HV voltages is 1:10.

<sup>\*\*</sup> = Output power is limited by the LV-side voltage and current. LV-side voltage 600 V<sub>DC</sub>, HV-side voltage 750 V<sub>DC</sub>.

### Product types

Basic product type	Nominal power [kVA]	Nominal current [A <sub>RMS</sub> ]
EC-C1200-450+MC120+AFE120+UG120	100	120
EC-C1200-450+MC180+AFE180+UG180	150	180
EC-C1200-450+MC240+AFE240+UG240	200	240
EC-C1200-450+MC300+AFE300+UG300	250	300
EC-C1200-450+MC350+AFE350+UG350	300	350

## Installation

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

### Low voltage connections

	The durability of the X1-connector is limited to 10 installations / removals by the connector manufacturer.
	Always check the compatibility of the X1-connector and the counterpart. Never try to alter the connector in any way. Contact Danfoss Service if unsure.
	When powering OFF the electric device, use the POWER_ON input. The power supply (VIN_N and/or VIN_P) can be disconnected, if desired, after time $t_{min}$ has elapsed from the deactivation of POWER_ON (see Figure <i>Disconnecting the power supply</i> in this Chapter). A safe value for $t_{min}$ is 5 seconds.
	See the correct signal connections and product specific pin-layout from product data sheets at <a href="http://www.danfoss.com">http://www.danfoss.com</a> .
	For information about the assembly of the control signal connectors, see the manufacturer's web page.

### Control signals (option dependent)

Basic device supports following CAN-protocol:

- CANopen
- SAE J-1939

CAN-protocols are alternatives and the choice should be made when placing an order.

The control signals of the electric device are operated with the X1-connector.

To make sure of correct operation of the control signal, use compatible connector interface (male/female) and appropriate shielded wiring.

#### Control signal connector information

Description	Part number	Supplier example
X1-Control signal connector (in the chassis) Tyco Electronics/AMPSEAL, 35-pin (male)	1-776163-1	<a href="http://www.te.com/usa-en/product-1-776163-1.html">http://www.te.com/usa-en/product-1-776163-1.html</a>
X1-Cable connector (mating connector) Tyco Electronics/AMPSEAL, 35-pin (female)	Case:776164-1	<a href="http://www.te.com/usa-en/product-776164-1.html">http://www.te.com/usa-en/product-776164-1.html</a>
	Pins: 770854-3 (wire 0.5-1.25mm <sup>2</sup> )	<a href="http://www.te.com/usa-en/product-770854-3.html">http://www.te.com/usa-en/product-770854-3.html</a>

Make sure that the part number ends with -1 and not with any other number.

## Installation

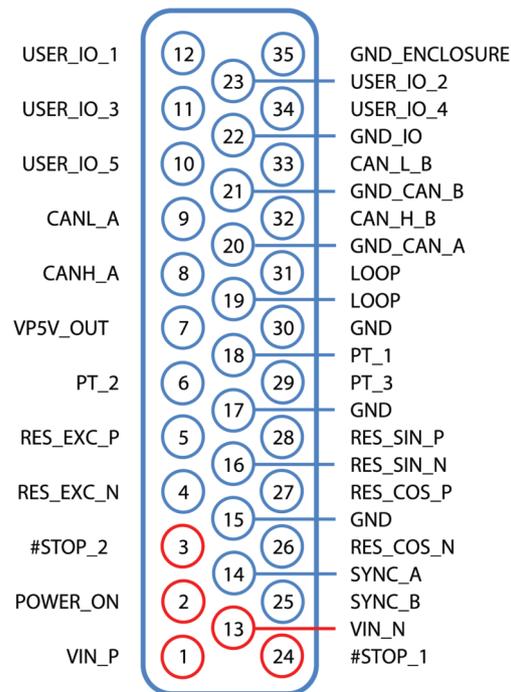
### Tools and accessories

Description	Part number	Supplier example
Crimping Tool Assembly 58529-1 with Die Assembly 58529-2	58529-1	<a href="http://fi.mouser.com/ProductDetail/TE-Connectivity/58529-1/?qs=Xf%252b3Aw93yEM%2FQReWlgzu%252bw%3D%3D">http://fi.mouser.com/ProductDetail/TE-Connectivity/58529-1/?qs=Xf%252b3Aw93yEM%2FQReWlgzu%252bw%3D%3D</a>
Connector seal plug (for storage and transportation)	770678-1	<a href="http://www.te.com/usa-en/product-770678-1.html">http://www.te.com/usa-en/product-770678-1.html</a>
35-position wire relief	776463-1	<a href="http://www.te.com/usa-en/product-776463-1.html">http://www.te.com/usa-en/product-776463-1.html</a>

Detailed and up to date information can be found at manufacturer's web-pages. Connector assembly according to connector manufacturer instructions (for example contact crimping).

Minimum wiring and connections needed for powering the electric device are shown below (marked with red). If any of these signals is not connected, the electric device will not be switched on or it will be in the tripped state and will not work.

*Low voltage signals: minimum connections needed for powering the electric device*



### Minimum wiring and connections

Pin	Signal name	Description
13	VIN_N	Power supply negative
1	VIN_P	Power supply positive (continuous). Typically 12-24 V, see data sheets.
2	POWER_ON	Power supply positive (from on/off key). Typically the same voltage as VIN_P.

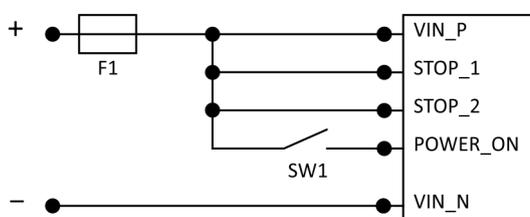
## Installation

### Minimum wiring and connections (continued)

24	STOP_1	Stop input 1. Needs to be pulled up (same range as VIN_P) for the converter to run. Disconnecting the STOP input or pulling it low externally causes the power semiconductor switch drivers to be disabled, which makes the converter a diode bridge. Stopping the converter with one of the STOP inputs causes also a fault, which needs to be cleared before continuing operation.
3	STOP_2	Stop input 2. Identical to stop input 1. Both need to be pulled up in order to be able to run.

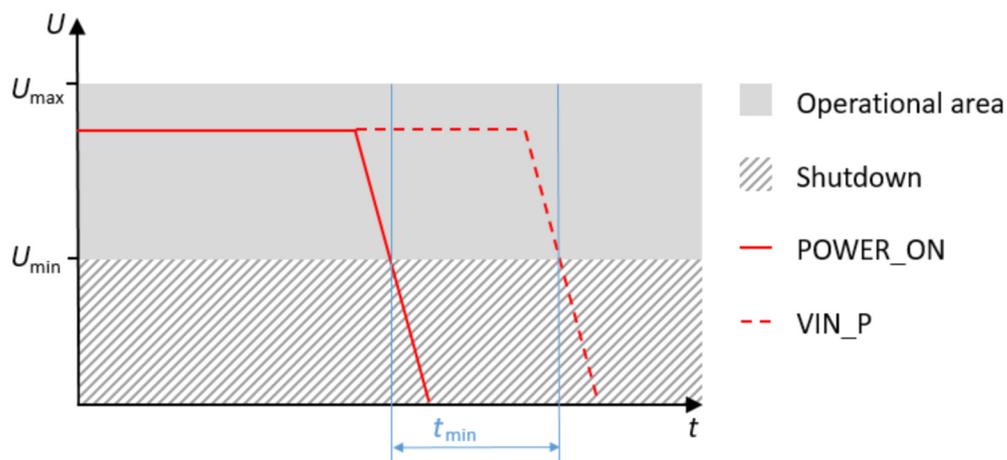
A minimal wiring scheme is shown in the figure below. The main point is that the POWER\_ON input is the one that should be used to turn the electric device ON or OFF. In particular, shut-down by disconnecting VIN\_N or VIN\_P may in some circumstances result in the corruption of the parameters of the electric device or other data.

### Example of the minimum connections



The switch (SW1) is used to turn the converter on and off. VIN\_P and VIN\_N are continuously connected to the power supply. There is an internal pull-down in the POWER\_ON input. Use appropriate fuse (F1) for protection. See values and information for fuse selection from the product data sheets.

### Disconnecting the power supply



Sufficient time should elapse between bringing the POWER\_ON voltage down and bringing VIN\_P down.

### Use of the grounding pins

In addition to the aforementioned signals, there are various ground (GND) pins in the signal connector. CAN and I/O features use separate GND pins. The difference between unisolated GND pins and VIN\_N is that VIN\_N/VIN\_P go through a common mode choke for the filtering of conducted emissions. Connecting signal GND and VIN\_N together effectively disables the common mode choke.

POWER\_ON and STOP signals use device internal GND as their reference. If, externally, they are produced with respect to VIN\_N, a high level of common mode disturbance may throw POWER\_ON and STOPs out of their operating range and cause the converter to stop or reboot. This can be fixed by connecting VIN\_N and signal GND, but this comes at the cost of increased EMI. Finally, there is an enclosure ground

## Installation

pin, which is connected to the enclosure (frame) of the converter and can be used to connect cable shields.

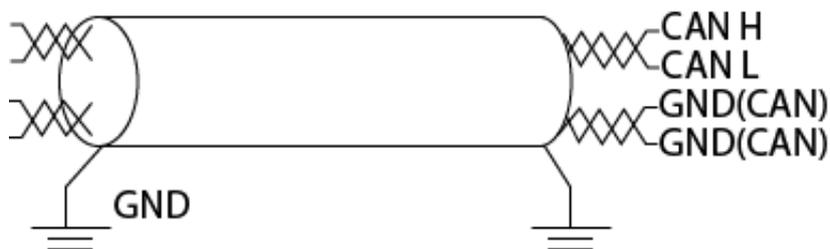
### General information

Connect VIN\_P to the positive power supply and VIN\_N to the negative power supply. POWER\_ON and STOP\_1/STOP\_2 are usually connected to positive power supply. If STOP signals are used connect the emergency stop switch between the STOP and positive power supply.

STOP signal should go high at the same time or before the power supply is connected to VIN\_P and VIN\_N. If STOP signals are connected after VIN\_P and VIN\_N the inverter will most likely register the STOP as active and be in emergency stop trip state. If this happens the wiring can be changed connecting the power supply to VIN\_P and VIN\_N at same time or before the STOP signals. The emergency state trip can also be cleared after every startup of the electric device.

CAN-network should be done using twisted pair shielded cable to minimize EMI for the CAN signals. It is recommended to not use the shield of the CAN cable as the CAN ground, but to use a separate ground wire.

### CAN grounding



If PT100/1000 temperature inputs are used, use signal ground as the ground connection for the sensor.

### Motor overload protection

The electric device has three PT100/1000 external temperature sensor inputs that can be used to protect the motor from overheating. These inputs can be configured to derate the motor current linearly between two temperatures. For example derate could start when motor temperature is 130°C and linearly derate the motor current as motor heats and the maximum derate could be at 150°C. Additionally there are three configurable temperature levels that can cause different actions. First level is note, second is warning and third is fault. Note can only be seen in fault log of the device. Warning can be seen as CAN-message as well as in fault log. Fault will trip the device stopping all operation and will also show as CAN message and in fault log.

In addition to the temperature surveillance that can be used the device has over current and short circuit protection that stops the device if short circuit or over current is detected.

### Signals for monitoring, diagnostics and set-up

The electric device can be connected to the USB-port of the PC with the maintenance connector (USB to RS485). Maintenance connector enables monitoring, diagnostics and setting up of the electric device. By using the PowerUSER application, it enables these functions via remote access, for example in the case of problem solving.

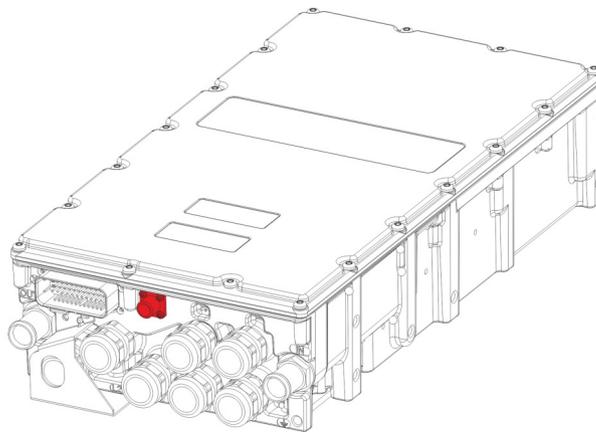
Reliable connection between the PC and the electric device can be ensured by using the Power Series Service Cable (PSSC). The PSSC is isolated RS485 and shielded cable, designed for demanding environments. The cable is available in 3 meter (PSSC-3M) and 10 meter version (PSSC-10M). Same cable can be used with all Danfoss products that have a service connector.

The service cable is ordered separately, see Chapter [Service parts](#) on page 74 for ordering details.

PowerUSER application can be downloaded for free from <http://www.danfoss.com/>.

## Installation

*Maintenance connector*



## Operation

### 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 operating temperature limits: -40°C...+105°C.
- Maximum altitude 2000 m above sea level.
- Maximum coolant liquid temperature at the inlet of the coolant circuit, see product data sheets.
- Coolant liquid must be a mixture of water and glycol with maximum of 50% glycol content. See chapter [Recommended coolants](#) on page 40.

The electric device must be pre-charged, see chapter [Pre-charging](#) on page 64.

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

### Pre-charging

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

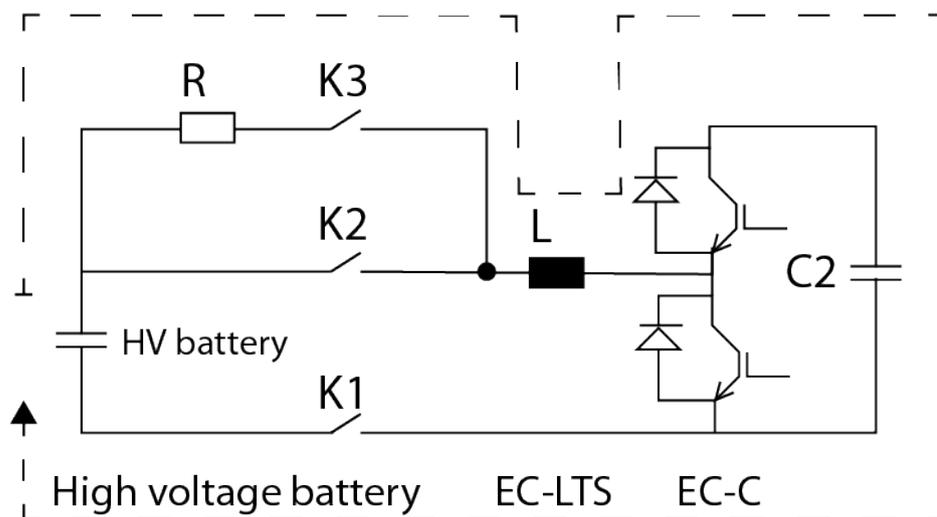
Devices with DC-link capacitance should be pre-charged before connecting them to battery, supercapacitor or charged DC-link. Pre-charging is needed to limit the inrush current that would happen, if the capacitors are not pre-charged. Pre-charging can be done by using pre-charge resistor and contactor before the DC-link is connected to battery, supercapacitor or to another DC-link that has different voltage. After pre-charging, the safe voltage difference between two potentials is 5-10 volts.

The Figure below shows the principle of pre-charging. C2 is pre-charged from a high voltage battery through K1, K3 and R.



## Operation

*Principle of pre-charging*



## Condition monitoring during operation

	<p><b>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.</b></p>
	<p><b>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 <a href="#">Troubleshooting</a> on page 72 for more information.</b></p>
	<p><b>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.</b></p>

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**

	<p>Do not disassemble the electric device. You can do only procedures described in this user guide. For further information contact Danfoss representative.</p>
	<p>Only trained and qualified personnel that are familiar with the relevant safety requirements can do any maintenance to the electric device.</p>
	<p>Risk of electric shock when the connection box lid is removed.</p>
	<p>Inspect the electric device at regular intervals. Use the regular maintenance checklists in the inspections.</p>
	<p>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 and maintenance procedures.</p>
	<p>Use correct personal protective equipment when you are near the electric device.</p>
	<p>Read the instructions in the user guide before you install the electric device. To ensure safe and reliable operation of the electric device, obey the maintenance instructions.</p>

## 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 <a href="#">Tightening torques</a> on page 28.			X
	Enclosure and connected parts	Check cleanliness. Clean if necessary. See Chapter <a href="#">Cleaning</a> on page 67.		X	
Electrical system	Cables	Visual check, for example wear. Replace if necessary.		X	
	Electrical connections	Check connections. Ensure that sufficient tightening torque is applied to cable glands. See Chapter <a href="#">Tightening torques</a> on page 28.			X
	Groundings (earthings)	Check groundings (earthings). Ensure that the connection resistance is valid. Re-connect 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 <a href="#">Cleaning</a> on page 67.		X	
	Coolant quality	Use the coolant as specified (water-glycol mixture appropriate). Refill if necessary. See Chapter <a href="#">Recommended coolants</a> on page 40 and <a href="#">Cooling system maintenance</a> on page 67.			X

### 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 40.

### Cleaning

	<b>Do not use pressure washer for cleaning. High water pressure may damage the gaskets allowing water to go in to the electric device.</b>
	<b>Never open or remove the watertight breather plugs. Clean them only from the outside.</b>

## Maintenance



**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

	<p><b>Risk of electric shock if dismounting steps are continued before the electric device is discharged and a safe voltage level has been measured.</b></p>
	<p><b>Do not touch the electric device or continue to work with the electric device until it cools down.</b></p>
	<p><b>Do not use excessive force when you disconnect the connector, because the plastic housing of the connector can break. Release the retaining clip of the connector before you disconnect the connector. Do not try to unplug the X1, X2 or X3 connectors by pulling from their wires.</b></p>
	<p><b>Support the electric device during dismounting, handle it with care.</b></p>
	<p><b>When the device is dismantled and stored and packed for delivery, measure that there is no voltage and then install short circuit wire to the conductor rails to prevent charge from building up.</b></p>
	<p><b>Refer to Chapter <a href="#">Installation procedure</a> on page 36 for additional information.</b></p>

### Dismounting procedure

1. Switch off the electric device.
2. Make sure that the cooling system remains operational.
3. Release the retaining clip of the X1-connector (control signal connector, low voltage, 35-pin) and disconnect the connector.
4. Wait until the electric device has fully discharged. Always measure that no voltage is present on the power terminals before you proceed.
5. Wait until the temperature of the electric device and cooling liquid has decreased below +40°C.
6. Remove the mounting screws and dismount the electric device from the mounting base.
7. Dismount the connector shield (mechanical safety component).
8. Dismount the connection box lid (power terminal cover).
9. Disconnect the power terminal cabling and the grounding cables (protective earth).
10. Disconnect the liquid cooling system.
11. Install the connection box lid and other parts and plug all electrical and cooling connections for longer storage.
12. Lift off the electric device according to Chapter [Lifting](#) on page 29.

## Dismounting and disposal of the electric device

### 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.

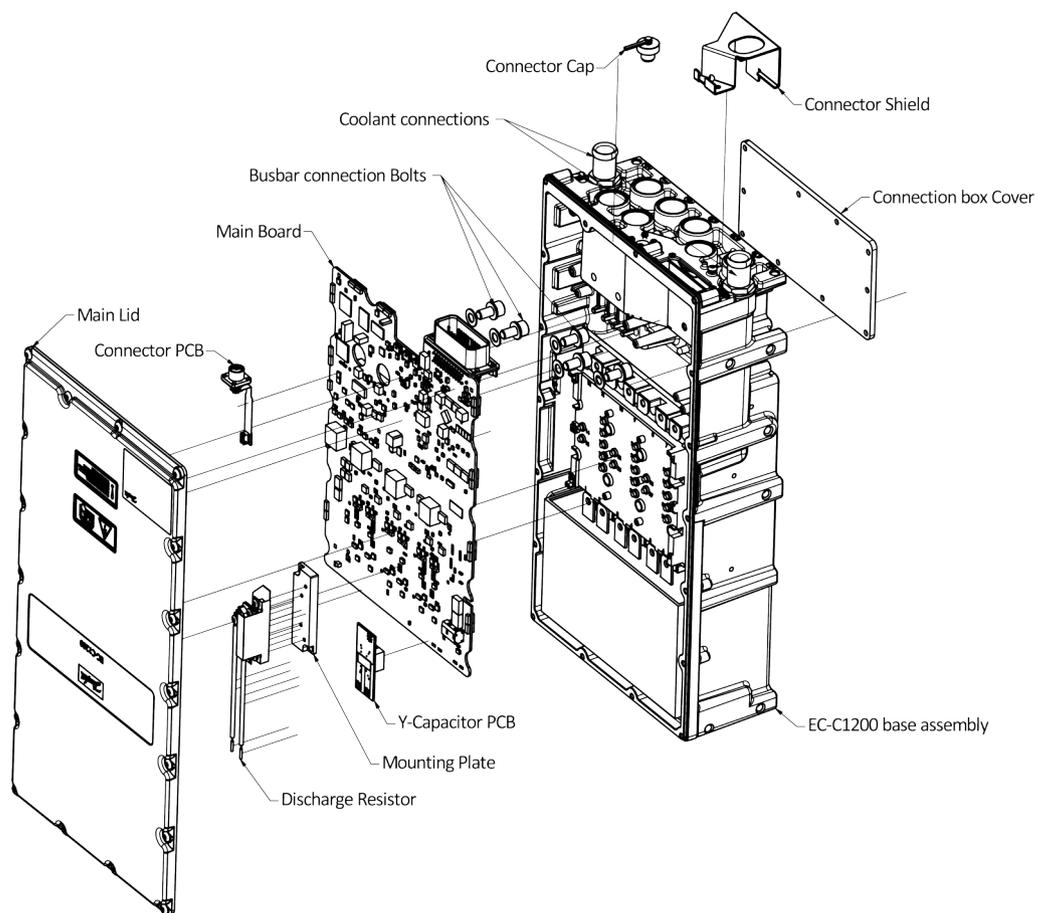
	<p><b>Electric device must not be opened (excluding the connection box lid). Any attempt causes loss of warranty.</b></p>
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### Main material content for EC-C1200-450

Components		Material class	Weight (kg)	(% wt)
EC-C1200 base assembly		Metal, electrical, plastic, miscellaneous	11.66	82.871
Lid and connection box cover		Aluminum	1.43	10.163
Coolant connections		Brass	0.204	1.45
Misc. plastic (M12 connector cap, insulation films etc.)		Plastic, miscellaneous	0.03	0.213
Misc. metal (screws, etc.)		Metal, miscellaneous	0.082	0.582
PCBAs	Main board (with plastic insulator)	Electrical	0.504	3.582
	Y-capacitor PCB	Electrical	0.01	0.071
	Connector PCB	Electrical	0.018	0.128
Discharge resistor assembly	Discharge resistor	Electrical	0.016	0.114
	Mounting plate	Aluminum	0.042	0.3
Connector shield		Stainless Steel AISI 304/1.4301	0.074	0.526

## Dismounting and disposal of the electric device

3D exploded view



## Troubleshooting

	<p><b>Do not activate the automatic fault reset function on any system where it can be the cause of a potentially dangerous situation.</b></p>
	<p><b>Do not try to repair the electric device. In the case of suspected fault or malfunction, contact Danfoss or authorized service centre for further assistance.</b></p>
	<p><b>For the reason of general safety and correct operative actions, read the instructions carefully before you start any analyses or work with the electric device.</b></p>
	<p><b>Use correct personal protective equipment when you are near the electric device.</b></p>

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.
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.



## Troubleshooting

### *Troubleshooting (continued)*

<b>Fault description</b>	<b>Possible cause</b>	<b>Action</b>
Electric device does not work correctly or the performance is poor	Poor powerline contacts (high voltage)	Inspect, clean and tighten the contacts.
	Poor control signal contacts (low voltage)	Inspect the X1-connector mounting.

### **Fault history and fault reset**

When an unusual operating condition is detected by the control diagnostics, the electric device gives a notification. The notifications vary depending on the consequences and required action:

- **Fault-** type of notification stops the electric device and requires reset.
- **Warning-** type of notification informs of unusual operating conditions, but the electric device stays operative (power on).

When a fault appears and stops the electric device, the root cause of the fault must be defined before any further actions. All faults are stored in to Fault history- menu.

After the root cause is defined and the electric device is inspected and recovered according to instructions, the fault can be reset. Fault resetting can be done with the reset signal through the fieldbus or by using maintenance connection and PowerUSER application.

For more information about the fault history and fault reset, see product data sheets.

## Aftersales

### Service policy

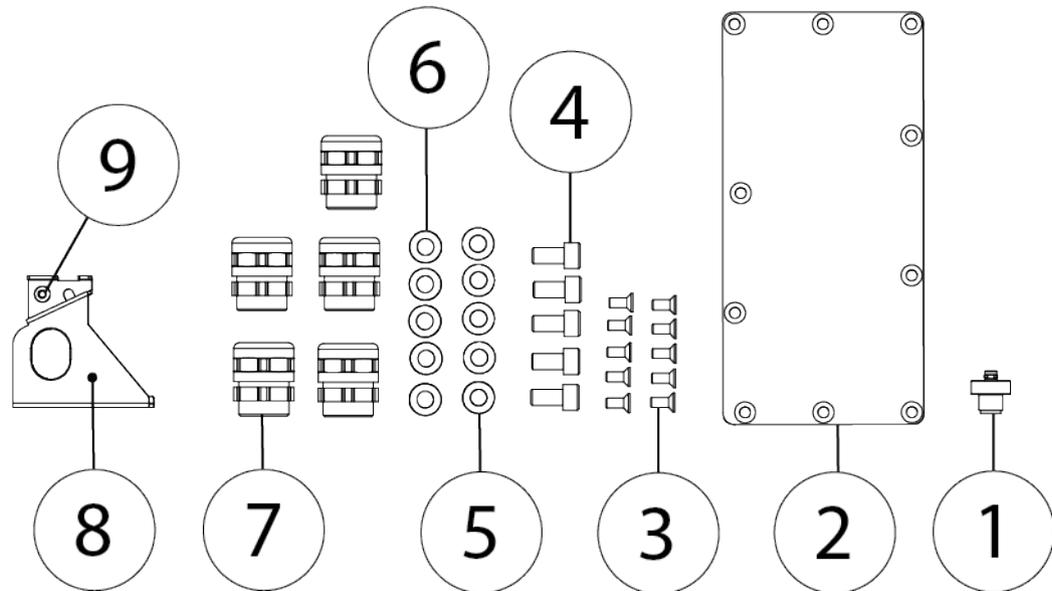
Maintenance and service of the electric device is limited to the procedures described in this user guide. See chapter [Service parts](#) on page 74 for available accessory and service parts.

For further information, go to <https://danfosseditron.zendesk.com/hc/en-gb> or send email to [editron.service@danfoss.com](mailto:editron.service@danfoss.com).

### Service parts

The recommended service kits are presented below. Contact Danfoss representative for more information and purchasing.

*Item kit*



*Item kit*

Inverter Item KIT Order number 11286812		
Number	Part	Quantity (pcs)
1	CONNECTOR, BINDER 08-2616-000-000	1
2	PLATE 41117400	1
3	BOLT. COUNTERSUNK- M5 x 12, DIN 965 A2 ]	10
4	BOLT. SOCKET HEAD-, M8 X 16 (ISO 4762) Z	5
5	SPRING.DISC-, D8, DIN 2093, 8,2 X 16 X 0,9	5
6	WASHER, D8 DIN 125	5
7	CABLE GLAND, M25 X 1.5, BG 225MS TRI PFLIT	5
8	HVIL SHEET T=1,5	1
9	BOLT, M4 x 8-4.8, ISO 14583, A2K OR A2F	1

## Aftersales

+DCE kit

<b>EC-C+DCE KIT Order number 11273429</b>	
<b>Part</b>	<b>Quantity (pcs)</b>
MODULE. DC CONNECTIONS, EC-C+DCE	1
WASHER, D8 DIN 125	2
BUSBAR, OD=16, ID=8,3, L=32	2
BOLT. SOCKET HEAD-, M8 X 55, DIN 912, ZI	2
SPRING.DISC-, D8, DIN 2093, 8,2 X 16 X 0,9	2
CABLE GLAND, M25 X 1.5, BG 225MS TRI PFLIT	2

**Products we offer:**

- Cartridge valves
- 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
- PLUS+1® displays
- PLUS+1® joysticks and pedals
- PLUS+1® operator interfaces
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- PLUS+1® software
- PLUS+1® software services, support and training
- Position controls and sensors
- PVG proportional valves
- Steering components and systems
- Telematics

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