

ENGINEERING
TOMORROW



Operating Guide

iC7-Hybrid String PCS

300 kVA, 1500 V DC



drives.danfoss.com |

iC7

Contents

1 Introduction

1.1 Purpose of this Operating Guide	7
1.2 Additional Resources	7
1.3 Version History	7
1.4 Abbreviations and Acronyms	7

2 Safety

2.1 Target Group and Necessary Qualifications	9
2.2 Safety Symbols	9
2.3 General Safety Considerations	10
2.4 Switch Disconnectors	13
2.5 Designated Use	14

3 Product Overview

3.1 Use in Battery Energy Storage Systems	15
3.2 Description of the Model Code	15
3.3 Labels on the Product	16
3.4 Product Label	16
3.5 External Structure	17
3.6 Internal Structure	20
3.7 Indicator Lights	21
3.8 ON/OFF Switch	21
3.9 Safety Hardware	22
3.9.1 Surge Protection Devices	22

4 Receiving the Product

4.1 Transportation	23
4.2 Storage	23
4.3 Lifting and Moving the Package	23
4.4 Contents of the Delivery	23
4.5 Checking the Delivery	24
4.6 Unpacking the Product	24
4.7 Lifting the Units	26

5 Mechanical Installation

5.1 Environmental Conditions	28
5.2 Installation Requirements	28
5.3 Space Requirements	28
5.4 Mounting the Units	30

6 Electrical Installation

6.1 Power Cabling Guidelines	34
6.2 Transformer Requirements	35
6.3 AC Power Cable Requirements	35
6.4 External Protection for Mains Connection	35
6.5 DC Power Cable Requirements	36
6.6 DC Input Fuses	36
6.7 Cable Lug Selection	36
6.8 Grounding	37
6.9 Installing the Power Cables	37
6.10 Installing the DC Fuses	41

7 Control Installation

7.1 Control Unit	43
7.2 Control Board	43
7.3 Definitions of the Indicator Lights on the Control Board	44
7.4 Control Board Connections	45
7.5 I/O and Relay Option (OC7C1) Connections	46
7.6 I/O and Relay Option Interface	49
7.6.1 Analog Inputs	49
7.6.2 Analog Outputs	50
7.6.3 Digital Inputs	51
7.6.4 Digital Outputs	51
7.6.5 Relay Outputs	51
7.6.6 Analog Reference Voltage Output	52
7.6.7 24 V DC Voltage Output	52
7.6.8 Thermistor Input	53
7.7 Installing Boards to the Modular Control Unit	53

7.8	Installing the Control Cables into the Control Terminals	54
7.9	Connecting the Control Panel	55
7.10	Fiber Cable Requirements	55
7.11	Installing the microSD Card	56
8 Commissioning		
8.1	Inspection Before Commissioning	57
8.2	Commissioning Procedure	57
9 Maintenance		
9.1	Preventive Maintenance Recommendations	58
9.2	Service Safety	60
9.3	De-energizing the Converter	60
9.4	Opening the Connection Unit for Maintenance	61
9.5	Replacing the RTC Battery	62
9.6	Replacing the Cooling Fans	64
9.7	Replacing the DC Fuses	65
9.8	Checking the Surge Protection Devices	65
9.9	Recommended Disposal	67
10 Specifications		
10.1	Technical Data	68
10.2	Ratings and Specifications	68
10.3	Weights	69
10.4	Dimensions	69
10.5	Options	70
10.6	High-altitude Characteristics	71
10.7	Capability of Generating Reactive Power	73

1 Introduction

1.1 Purpose of this Operating Guide

This operating guide provides information for the safe installation and commissioning of the iC7-Hybrid String PCS. The guide is intended for use by qualified personnel. To use the product safely and professionally, read and follow the instructions. Pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the product.

If not otherwise stated, all the instructions concern only the iC7-Hybrid String PCS and not the external system that the product is connected to.

This guide is targeted at a worldwide audience. Therefore, wherever occurring, both SI and imperial units are shown.

1.2 Additional Resources

Other resources are available to understand advanced drive functions, operation, programming, and options.

- The iC7 Series application guides provide greater detail on how to work with the applications and how to set the parameters of the converter.
- The operating and installation guides for iC7 Series options give detailed information about specific drive options.
- Other supplemental publications, drawings, and guides are available at <https://www.danfoss.com>.

Latest versions of Danfoss product guides are available for download at <https://www.danfoss.com/en/service-and-support/documentation/>.

1.3 Version History

This guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this guide is English.

Table 1: Version History

Version	Remarks
A	First release.
B	Updated 2.3 General Safety Considerations . Updated 3.6 Internal Structure . Updated 3.8 ON/OFF Switch . Updated 7.5 I/O and Relay Option (OC7C1) Connections . Updated 10.2 Ratings and Specifications . Updates to illustrations.

1.4 Abbreviations and Acronyms

Term	Definition
AC	Alternating current
BESS	Battery energy storage system
CU	Connection unit
DC	Direct current
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ES	Energy storage

Term	Definition
ESD	Electrostatic discharge
IEC	International Electrotechnical Commission
I/O	Input/output
IP	Ingress protection
ISO	International Organization for Standardization
IT	Isolé-terre, system isolated from ground
LV	Low voltage
MU	Main unit
NEC	National Electric Code
PCB	Printed circuit board
PE	Protective earth
RMS	Root mean square
SPD	Surge protection device

2 Safety

2.1 Target Group and Necessary Qualifications

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the products. Only qualified personnel are allowed to perform all related activities for these tasks. Qualified personnel are defined as properly trained staff, who are familiar with and authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this guide and other relevant guides. Non-qualified electricians are not allowed to perform any electrical installation or troubleshooting activities.

Only Danfoss authorized, qualified personnel are allowed to repair this equipment. Specialized training is required to perform the activities related to repair.

2.2 Safety Symbols

The following symbols are used in Danfoss documentation and products.

DANGER	
Indicates a hazardous situation which, if not avoided, will result in death or serious injury.	
WARNING	
Indicates a hazardous situation which, if not avoided, could result in death or serious injury.	
CAUTION	
Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.	
NOTICE	
Indicates information considered important, but not hazard-related (for example, messages relating to property damage).	
	ISO warning symbol for general warnings
	ISO warning symbol for hot surfaces and burn hazard
	ISO warning symbol for high voltage and electric shock
	Symbol for indicating the required discharge time of the capacitors in the product.
	ISO action symbol for referring to the instructions

2.3 General Safety Considerations

NOTICE

IMPORTANT SAFETY INSTRUCTIONS

This guide contains important instructions for the iC7-Hybrid String PCS that must be followed during installation, operation, and maintenance of the product.

- SAVE THESE INSTRUCTIONS

The following notifications are always valid when working with the equipment.

DANGER



RISK OF ELECTRIC SHOCK FROM CAPACITORS

Capacitors included in the equipment store energy which is discharged slowly after disconnecting the power supplies. This energy maintains the voltage in the DC link causing a high risk of electric shock. Contact with this voltage can cause death or serious injury.

- Do not open the covers before the 5 minutes discharging time has elapsed.
- Always ensure by measuring that there are no voltages present before working on the equipment.

DANGER



RISK OF ELECTRIC SHOCK FROM ENERGY STORAGE

When a battery is connected to the iC7-Hybrid String PCS, and if there is no external disconnecter outside the converter, the battery supplies DC voltage to the DC terminals of the converter. The voltage in the DC link causes a high risk of electric shock. Contact with this voltage can cause death or serious injury.

- If installed, always open the switch disconnectors from both sides of the converter and prevent closing while working.
- Always ensure by measuring that there are no voltages present before working on the equipment.

DANGER



ONLY QUALIFIED PERSONNEL ARE ALLOWED TO OPEN THE MAIN UNIT COVER

Voltages in the main unit are dangerous. Contact with these voltages can cause death or serious injury. Also the components included are sensitive and opening the cover exposes the components to ambient conditions, for example to dust.

- Do not open the main unit cover.
- Do not perform any service tasks other than the ones specified in the operating instructions. Only qualified personnel are allowed to do more advanced service tasks.
- Contact qualified service personnel if the cover must be opened.

⚠ WARNING**SHOCK HAZARD FROM PE CONDUCTOR**

The drive can cause a DC current in the PE conductor. Failure to use a residual current-operated protective device (RCD) Type B or a residual current-operated monitoring device (RCM) can lead to the RCD not providing the intended protection and therefore can result in death or serious injury.

- Use a type B RCD or RCM device on the mains side of the drive.

⚠ WARNING**HIGH LEAKAGE CURRENT ON PE CONDUCTOR**

Leakage current on the PE conductor exceeds 5% of the rated input current. Contact with this current can result in death or serious injury.

- The following protective means are required:

An oversized PE conductor

Protective equipotential bonding between the PCS and simultaneously accessible external conductive objects within 2.5 m (8.2 ft)

⚠ WARNING**ACCIDENT AT WORK**

As the product includes several sensitive components and the product is heavy, it also entails a high risk of an occupational accident, even when de-energized.

- Always study and plan all the actions beforehand.
- Follow the instructions and regulations.
- If in any doubt, abort the ongoing action.

⚠ WARNING**USE PROTECTIVE EQUIPMENT**

Ignoring the use of personal protective equipment causes a high risk of an occupational accident.

- Always use the required personal protective equipment while working.

⚠ WARNING**LABELS ON THE EQUIPMENT**

Labels on the equipment include detailed information about the product and important safety instructions for the user.

- Do not remove or cover any labels attached to the product.

⚠ CAUTION**MODIFICATIONS ARE FORBIDDEN**

Modifying the product can change the functionality and cause failures and accidents at work.

- Use only original spare parts.
- Do not make any modifications to the product.

⚠ CAUTION**WEIGHT OF THE PRODUCT CAUSES A RISK OF INJURY**

Unsafe or wrong lifting and moving can cause injury or damage to the product.

- Follow the lifting and moving instructions in this guide.
- Use only safe and accepted tools.

⚠ CAUTION**ACOUSTIC NOISE**

Exposure to acoustic noise can cause hearing damage.

- When the acoustic noise level is >70 dB(A), use hearing protection.

NOTICE**ELECTROSTATIC DISCHARGE**

Many electronic components within the converter are sensitive to static electricity.

Failure to conform to standard ESD procedures can reduce component life, diminish performance, or destroy sensitive electronic components.

- Use proper electrostatic discharge (ESD) procedures to prevent damage to sensitive components.
- Always use required personal protective equipment while working.
- Do not touch components on the circuit boards.

NOTICE**EFFECT OF EXTERNAL FACTORS**

If the covers of the product are opened, the ambient conditions at the installation site can cause a device failure.

- Always keep the covers closed and locked while there is no justified reason to open them.
- Always make a risk analysis before opening the covers.
- Protect the device from water, dust, and other external factors.

NOTICE

This equipment is not intended for use in residential locations and does not guarantee adequate protection to radio reception in such locations.

2.4 Switch Disconnectors

⚠ DANGER



RISK OF ELECTRIC SHOCK

Voltages inside the converter and at the supply terminals are dangerous. Contact with these voltages can cause death or serious injury. As the switch disconnectors are located inside the converter, opening the switch disconnectors does not disconnect the voltage from the supply terminals or all the voltages inside the unit.

- Study the circuitry to plan the correct actions for disconnecting the voltages.
- Prevent reconnecting power to the converter while working.
- Always keep the protective covers properly installed.
- Always ensure by measuring that the unit is de-energized before working on the equipment.
- All the electrical connections must be done by a certified electrician and in accordance with the local requirements and regulations.

⚠ DANGER



RISK OF ELECTRIC SHOCK

The AC switch disconnector is optional. If the AC switch disconnector is not installed on the converter, the AC supply causes a risk of electric shock over a wider area of the device. Contact with the AC supply voltage can cause death or serious injury.

- If the optional AC switch disconnector is not installed, an external switch or breaker is required to perform the disconnection from the AC supply.

iC7-Hybrid String PCS can be disconnected from the supply with switch disconnectors in both the AC and DC sides of the product. The disconnectors are in the connection unit (CU) and can be controlled from outside the unit.

Make sure that the ON/OFF switch (see [3.8 ON/OFF Switch](#)) is in the OFF position before operating the switch disconnectors.

See the following figure for a principle presentation. The switch handles are shown in the OFF position.

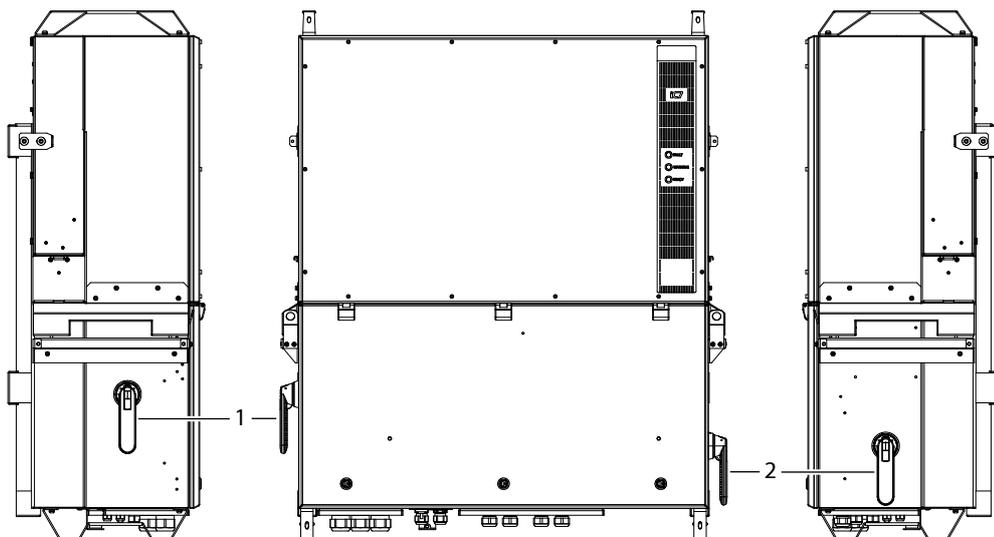


Figure 1: Switch Disconnectors on the iC7-Hybrid String PCS

1 AC switch disconnector (optional)

2 DC switch disconnector

The switch disconnectors themselves have position indications OFF and ON.

- OFF = OPEN
- ON = CLOSED

Although the switch disconnectors do not disconnect the voltage from the supply terminals, the CU meets the requirements for ingress protection IP20 when the cover is open.

To meet the requirements for the IP20, the protection covers must be kept in place.

NEC 2017 defines the disconnection capability for the switch disconnectors. Normally, the main unit inverter and the contactors interrupt the current. In a fault situation, the software or other protective devices, for example fuses, interrupt the overcurrent. The switch disconnectors are used for service and for possible fault situations where the converter is not disconnected in a normal way. There is no trip mechanism included.

In the DC side the switch must disconnect both potentials, as the battery energy storage (ES) system is always ungrounded in the iC7-Hybrid String PCS.

2.5 Designated Use

Installing and operating a Danfoss product not adhering to the following preconditions is regarded as non-designated use. Danfoss does not take any liability for non-designated use.

Danfoss products are units intended for installation in electrical systems. They comply with the requirements of various directives and certifications. To see all valid certifications for the product, check the product label.

When the product is installed in machinery or a system, these have to comply with relevant national regulations.

In any case, the product and its components have to be operated in accordance with all national Occupational Safety & Health regulations and directives.

Operation of Danfoss products is only allowed under observance of the respective EMC regulations.

Operation of Danfoss products is only allowed under observance of the specifications and requirements given on the product label and in the product-specific documentation.

Only use spare parts approved and provided by Danfoss. Using other spare parts can damage the product.

3 Product Overview

3.1 Use in Battery Energy Storage Systems

iC7-Hybrid String PCS is designed for use in battery energy storage (ES) applications in professional use. All other use is strictly forbidden.

A battery energy storage system (BESS) consists of a battery energy storage and an ES converter with integrated or additional protection components.

The BESS stores the energy in batteries via the ES converter and supplies it back to the AC grid via the same ES converter with reversed power direction. There is always a protection fuse stage in the DC connection between the battery storage and ES converter either integrated or as a separate component.

In addition, there can be disconnection switches on both sides of the converter to separate the unit from the DC supply and from the grid.

The battery storage must always be floating when connected to the iC7-Hybrid String PCS.

3.2 Description of the Model Code

The model code defines the specifications of the product included in the delivery. It is shown on the product label and the package label. The model code is made of standard codes and plus codes. Each part of the model code corresponds to the data in the order.

The model code can have this format, for example:

iC7-50EAGCG7-252AE65F3+XXXX

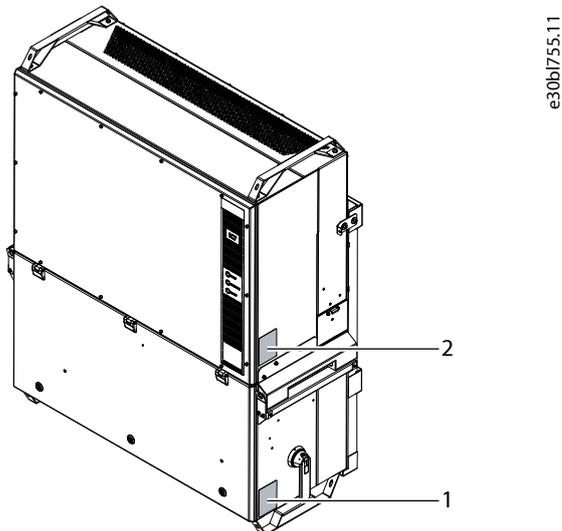
Table 2: Description of the Model Code

Code	Description
iC7-50	Product group
EA	Product category EA = enclosed, air-cooled
GC	Product type GC = Grid converter module, GC
G7	Voltage rating G7 = 400–690 V AC
-252A	Current rating -252A = 252 A
E65	Protection rating E65 = IP65/Nema Type 4
F3	EMC category F3 = Industrial network F4 = IT network
+XXXX	Options See 10.5 Options .

3.3 Labels on the Product

To provide information about the product, several labels are placed on the converter.

- Product label
 - Includes the model code and other information about the product. See [3.4 Product Label](#) and [3.2 Description of the Model Code](#).
- Main unit label
 - Includes the serial number of the main unit.
- Safety labels
 - Warnings and cautions
- Other labels
 - Phase terminal numbering labels
 - AC and DC switch labels
 - ON/OFF switch instruction label



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Figure 2: Locations of the Labels on the iC7-Hybrid String PCS

1	Product label	2	Main unit label
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3.4 Product Label

The product label gives information about the product.

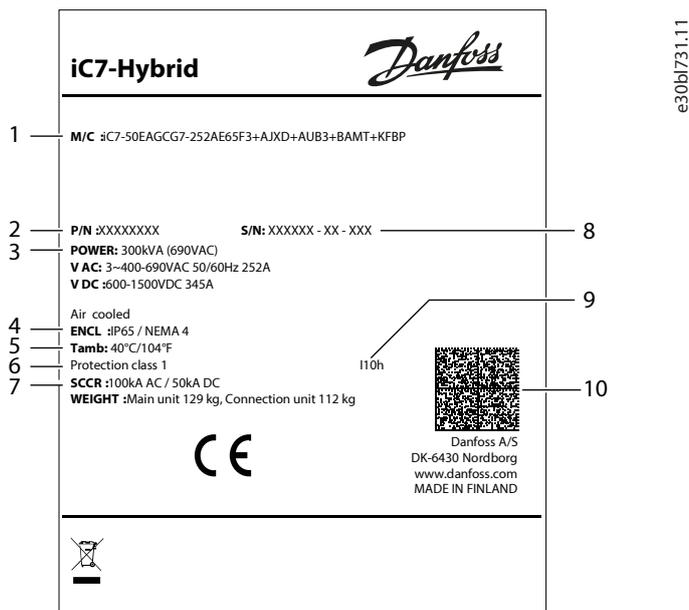


Figure 3: Product Label for iC7-Hybrid String PCS

1	Model code of the product	2	Product number
3	Power and voltage ratings	4	Protection rating
5	Temperature rating for ambient air	6	Protective class
7	Short-circuit current rating	8	Serial number
9	Frame designation	10	2D code accessible with a Datamatrix ECC 200 compatible barcode reader

3.5 External Structure

iC7-Hybrid String PCS is divided into 2 main parts, the connection unit (CU) and main unit (MU).

The CU is the lower part of the device. It includes the connection points for both the grid and DC connections. All the parts which need to be accessed, for example, fuses and terminals, are inside the CU.

The customer plate includes cable glands for I/O cables, a service port, and the ON/OFF switch.

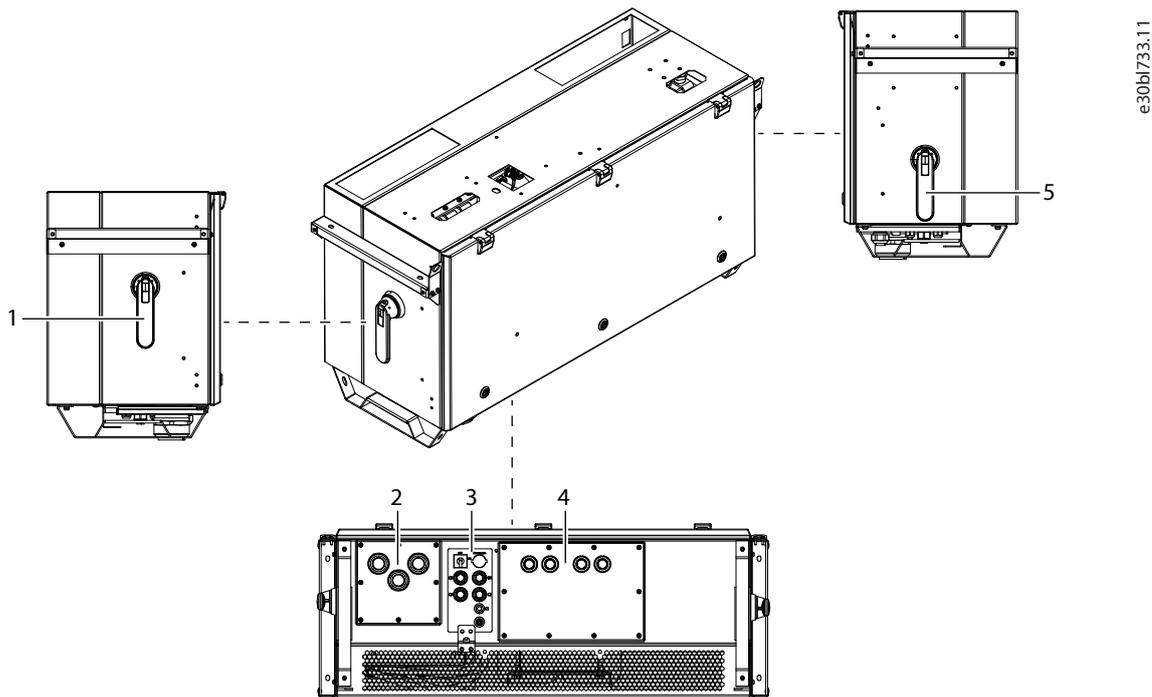


Figure 4: Layout of the Connection Unit

1	AC switch disconnector	2	AC gland section
3	Customer plate	4	DC gland section
5	DC switch disconnector		

The MU is the upper part of the device. It includes the parts for actual power conversion and control, for example, the printed circuit boards (PCB).

The MU is not configurable. All options are installed in the CU. See the list of available options in [10.5 Options](#).

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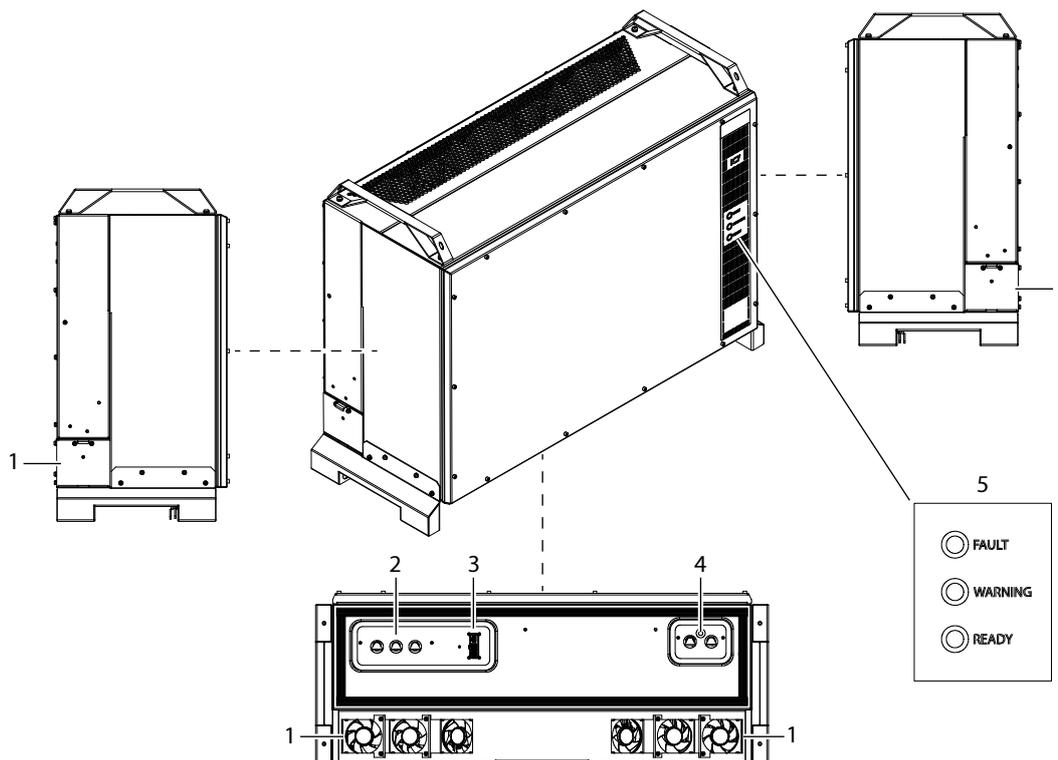


Figure 5: Layout of the Main Unit

1	Cooling fan assemblies	2	AC cables
3	Control I/O terminals	4	DC cables
5	Indicator lights (see 3.7 Indicator Lights)		

⚠ DANGER



RISK OF ELECTRIC SHOCK

Voltages in the main unit are dangerous and can cause death or serious injury. Also the components included are sensitive and opening the cover exposes the components to ambient conditions, for example to dust.

- Do not open the main unit cover
- If the cover must be opened, contact qualified service personnel.

3.6 Internal Structure

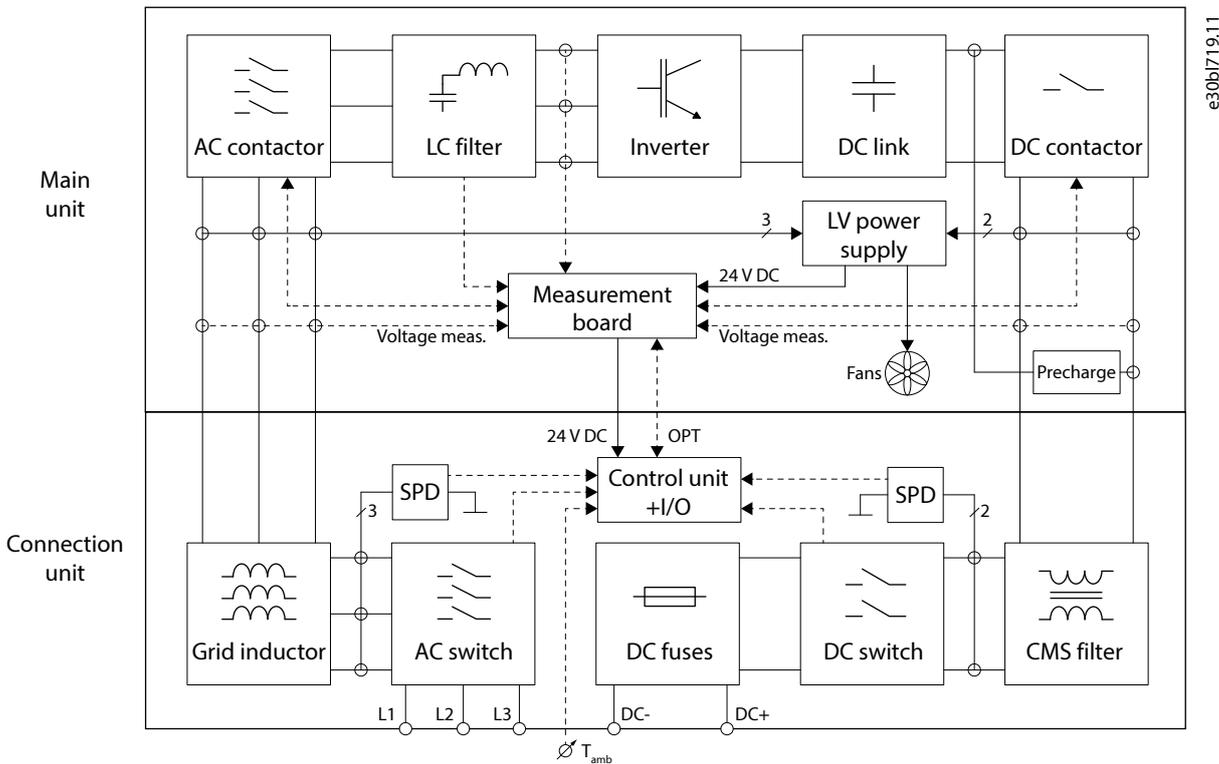


Figure 6: Single-line Diagram of iC7-Hybrid String PCS

DC side fuses, when included, are located immediately after the DC cable connection. DC-side connection/DC fuses have several optional configurations. See [10.5 Options](#) for additional information.

After the DC fuse placeholders, there is a DC switch. As the energy storage is always ungrounded in the iC7-Hybrid String PCS, the DC switch disconnects both potentials. The DC switch handle is located outside the connection unit (CU) for safety reasons but it still meets the ingress protection (IP) rating requirements.

For impulse voltages, there are surge protection devices (SPD) on both AC and DC sides.

Between the DC switch and the DC contactor, there is a filter for electromagnetic interference (EMI).

Before closing the DC contactor, the DC link between the DC contactor and the converter bridge is charged through the charging circuit. As iC7-Hybrid String PCS is an outdoor converter, the DC link must be discharged under 30 V DC limit within 5 minutes of shutting down. The discharging is accomplished through the integrated discharging system.

On the AC side between the converter bridge and AC contactor, there is filtering for harmonics. Filtering for EMI is on the other side of the AC contactor.

Between the EMI filtering and the AC cable connection, there is an optional AC switch if included. The handle of the switch is located outside the CU for safety reasons but it still meets the protection rating requirements.

The low-voltage power supply has input from the AC and DC circuits. The power supply feeds power to the cooling fans and the measurement board. The control unit receives the 24 V DC supply from the measurement board.

Internal measurements are done on the measurement board. The board receives input signals from:

- Grid voltage
- DC-input voltage
- Phase current

- Phase-input voltage
- LC inductor temperature monitoring
- AC-contactor feedback
- DC-contactor feedback

The control unit is connected optically to the measurement board. For more information about the control unit, see [7.1 Control Unit](#).

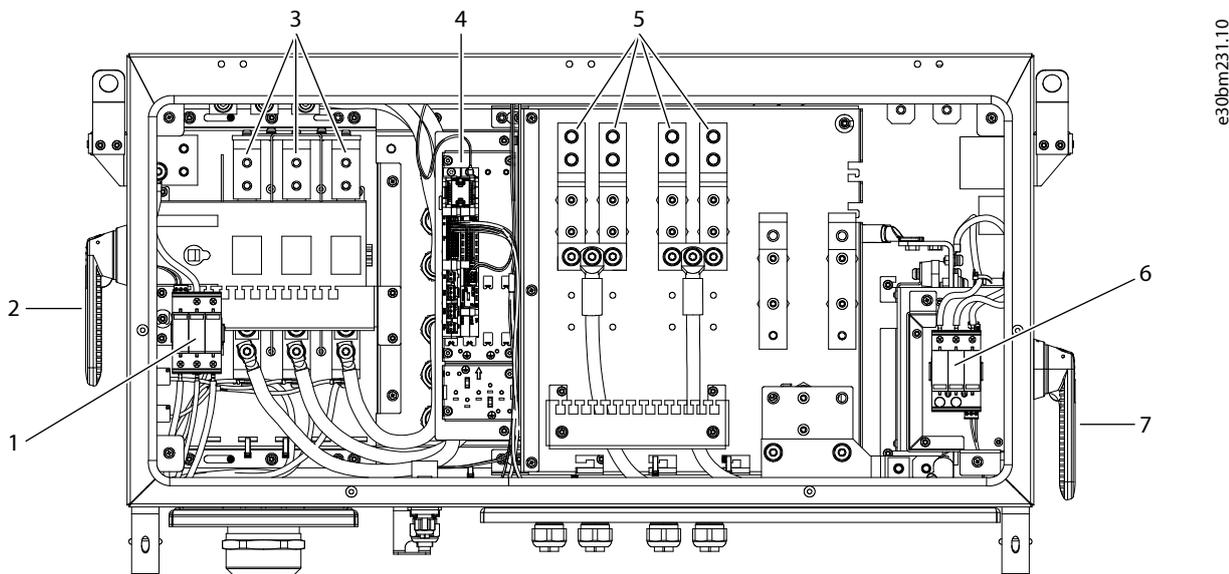


Figure 7: Internal Layout of the Connection Unit

1	AC SPD	2	AC switch disconnecter (optional)
3	AC terminals	4	Control unit
5	DC terminals	6	DC SPD
7	DC switch disconnecter		

3.7 Indicator Lights

There are 3 indicator lights visible on the front cover of the main unit. See [Figure 5](#).

Table 3: Definitions of the Indicator Lights

Indicator name	Function (color)	Description
Fault	On (red)	Fault active
Warning	On (yellow)	Warning active
Ready	On (green)	In operation

3.8 ON/OFF Switch

The ON/OFF switch is located on the bottom plate of the connection unit (CU). See [Figure 8](#).

- When the switch handle is in position ON (position 1), the iC7-Hybrid String PCS operates based on the commands from the remote control system.
- When the switch handle is in position OFF (position 0), the converter does not head to the start procedure, but the communication is functional.

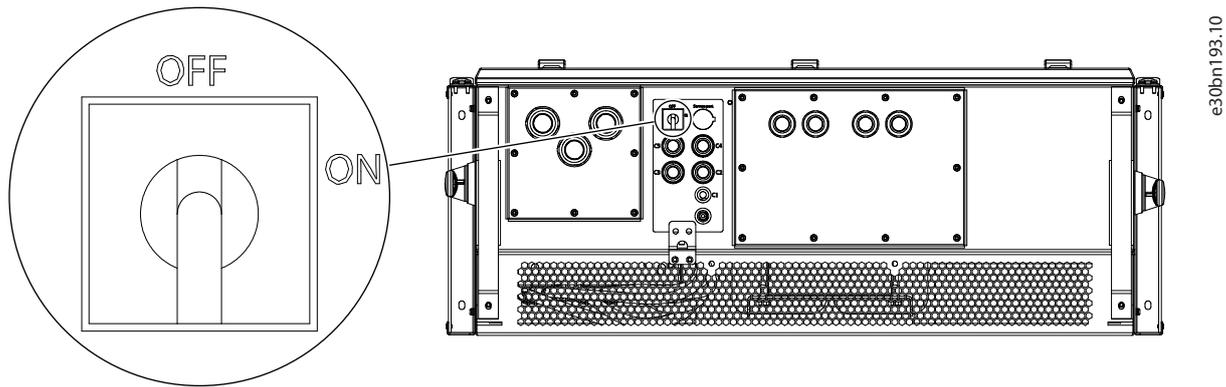


Figure 8: Location of the ON/OFF Switch

3.9 Safety Hardware

3.9.1 Surge Protection Devices

Surge protection devices (SPD) are included on the AC and DC connections to protect the converter internally. The surge protection devices limit the impulse voltages under assumed conditions to 4 kV with monitored, replaceable plug-in format SPD cartridges.

DC SPD type

- EN 50539-11: Type 2, Class PV II, 1500 V
- UL 1449: 1CA/2CA, DC PV 1500 V

AC SPD type

- EN 50539-11: Type 2, Class II, 400/690 V
- UL 1449: 1CA/2CA, 750 V

4 Receiving the Product

4.1 Transportation

During the transportation, the product must be protected from heavy vibration, shocks, humidity, and temperature changes. The transportation is taken in account in packing, but as the device includes sensitive components, it must be handled with care.

For detailed information, see [10.2 Ratings and Specifications](#).

4.2 Storage

The packaging of the product is designed so that 2 packages can be stacked on top of each other.

For the condition requirements for storage, see [10.2 Ratings and Specifications](#).

If the product is stored for a longer time, humidity can cause problems. In sea deliveries, the package includes dehumidifiers and the product is delivered packed in plastic. With longer storage times, the capacity of the dehumidifiers is not enough. If the product is planned to be in the package for longer than 6 months, contact Danfoss for storage instructions.

4.3 Lifting and Moving the Package

WARNING

LIFTING HEAVY LOAD

Not following the safe lifting instructions can result in death or serious injury and damage to the equipment.

- Follow the lifting and moving instructions and the local safety regulations on lifting.
- Use a lifting device that is in proper working condition and appropriate for the weight of the load.
- If the package must be lifted manually, follow local safety regulations and make sure that the number of lifting personnel is such that the weight limit per lifter is not exceeded.
- Check the weight of the drive. The weight is provided on the outside of the shipping box.
- Test lift the load to verify the proper center of gravity. Reposition the lifting point if not level.
- Do not walk under, or place any part of your body under a suspended load.

Lift and move the package according to the given instructions.

The package can be lifted with a forklift or equivalent lifting device.

Move the package with great care and precision. The product is protected by packaging elements, but it must be handled carefully to protect the sensitive components.

4.4 Contents of the Delivery

The delivery is packed in a plywood box. Open the package only when installing the product.

Contents of the delivery:

- Main unit (MU)
- Connection unit (CU)
- Mounting rack
- Operating guide
- Bolts and nuts

The delivery does not include the bolts for mounting the mounting rack.

4.5 Checking the Delivery

1. Examine the packaging and the product for transport damage.
 - a. If the product was damaged during transport, contact the cargo insurance company or the carrier.
2. Make sure that the items supplied and the information on the product label correspond to the order confirmation.
 - a. If the delivery does not match the order, contact the vendor immediately.

4.6 Unpacking the Product

CAUTION

CUT HAZARD

The packing material can have sharp edges. The sharp edges can cause personal injury.

- Use personal protective equipment when unpacking the product.

NOTICE

DAMAGE TO THE PRODUCT WHEN UNPACKING

Careless use of tools can harm the device during unpacking.

- If tools are used for unpacking, avoid contact with the device.

All parts of the delivery are packed in one box made of 8 mm (5/16") thick plywood. The parts are supported in the box with wooden supporting pieces and foam cushioning.

1. Remove the lid of the box.
 - a. Open the clamps holding the lid.
 - b. Lift off the lid.
-  Removing the lid reveals the foam cushioning in the box.
2. Remove the foam cushioning from the top of the connection unit (CU).
 3. Remove the side walls of the box.
 - a. Remove the 4 screws fastening the side walls to the middle supporting piece.
 - b. Open the clamps and remove the side walls.

There are 2 screws on each of the shorter side walls.

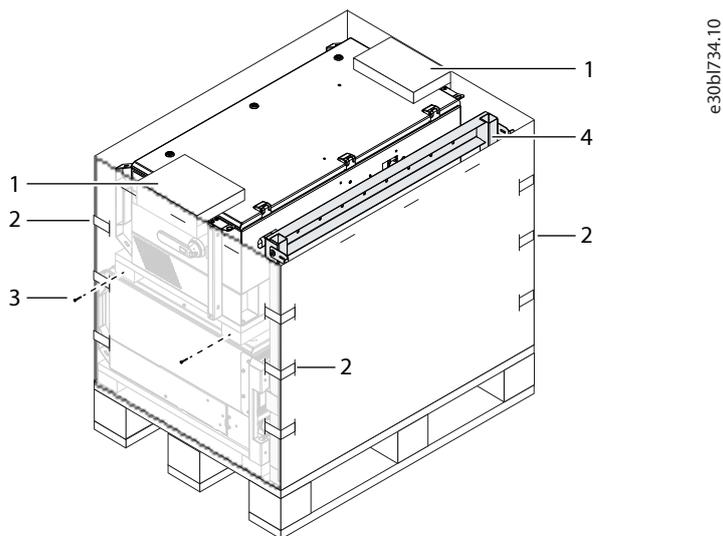


Figure 9: Removing the Side Walls of the Box

1	Foam cushioning	2	Clamps
3	Screws	4	Mounting rack

4. Remove the mounting rack from the packaging.
 - a. Remove the plastic rim holding the mounting rack to the CU and the middle supporting piece.
 - b. Lift the mounting rack from the packaging.

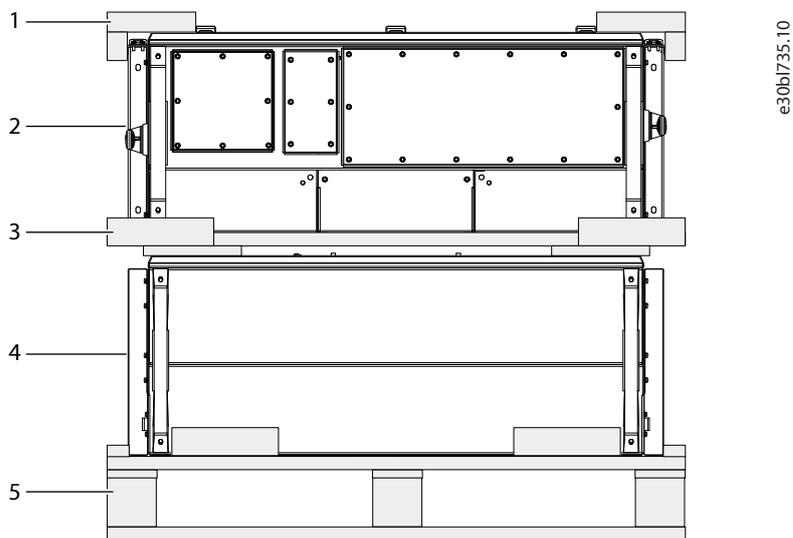


Figure 10: The Package with Side Walls and Mounting Rack Removed

1	Foam cushioning	2	Connection unit
3	Middle supporting piece	4	Main unit
5	Pallet		

5. Remove the CU from the packaging.
 - a. Unwrap the CU.
 - b. Lift the CU from the packaging.
6. Remove the middle supporting piece.

7. Remove the main unit (MU) from the packaging.
 - a. Unwrap the MU.
 - b. Lift the MU from the packaging.

What to do next: Dispose of all the packing materials according to the laws and regulations valid at the installation location. If the packing materials are in good condition, they can be reused.

4.7 Lifting the Units

WARNING

LIFTING HEAVY LOAD

Not following the safe lifting instructions can result in death or serious injury and damage to the equipment.

- Follow local safety regulations on lifting.
- Use a lifting device that is in proper working condition and appropriate for the weight of the load.
- Test lift the load to verify the proper center of gravity. Reposition the lifting point if not level.
- Do not walk under, or place any part of your body under a suspended load.

After the product has been unpacked, the units can be lifted with a hoist.

Lift the units with great care and precision. To protect the sensitive components, handle the units carefully.

1. To lift the connection unit (CU), put the lifting hooks in the lifting holes.

To achieve a sufficient lifting angle when lifting the unit with chains, leave at least 1200 mm (48 in) between the hoist and the unit.

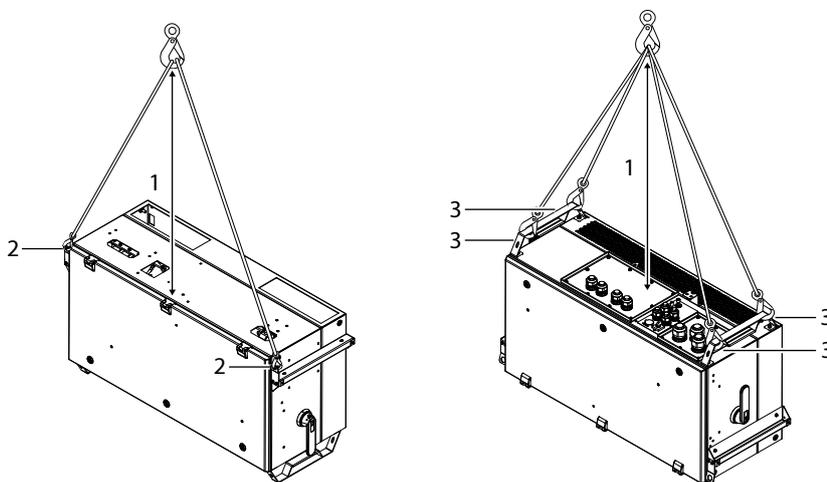


Figure 11: Lifting the Connection Unit

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Required distance between hoist and unit 3 Lifting point at bottom of unit | <ol style="list-style-type: none"> 2 Lifting point at top of unit |
|---|--|

2. To lift the main unit (MU), put the lifting hooks in the lifting holes.

To achieve a sufficient lifting angle when lifting the unit with chains, leave at least 1200 mm (48 in) between the hoist and the unit.
 If a lifting beam is used for the lifting, there is no requirement for the minimum distance between the lifting beam and the unit.

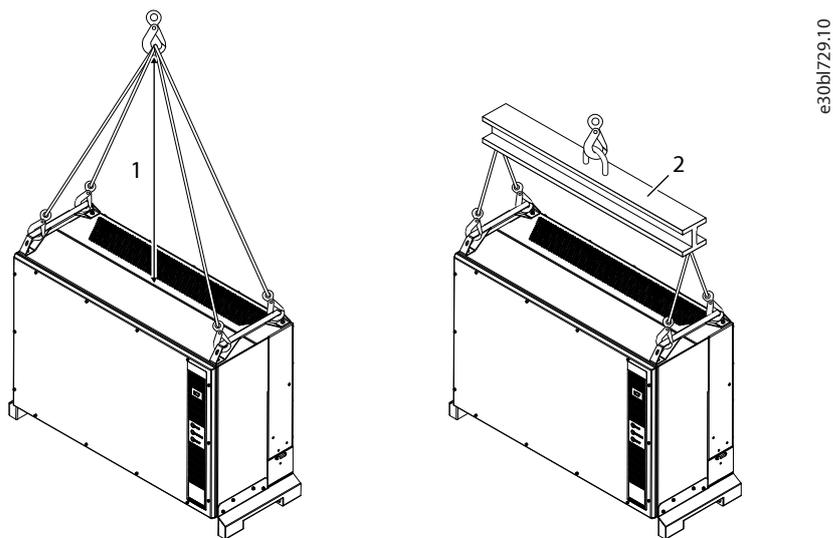


Figure 12: Lifting the Main Unit

1	Required distance between hoist and unit	2	Lifting beam
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5 Mechanical Installation

5.1 Environmental Conditions

iC7-Hybrid String PCS can be installed both indoors and outdoors. The ingress protection (IP) class of the product is high and the equipment is designed and certified for a wide temperature and humidity range. For details, see [10.2 Ratings and Specifications](#).

The device is designed for demanding outdoor conditions, but if there are extreme conditions, for example, heavy snow load or sand storms, agree the acceptable conditions in advance with Danfoss.

NOTICE

EFFECT OF EXTERNAL FACTORS

If the covers of the product are opened, the ambient conditions at the installation site can cause a device failure.

- Always keep the covers closed and locked while there is no justified reason to open them.
- Always make a risk analysis before opening the covers.
- Protect the device from water, dust, and other external factors.

To minimize environmental stress and to provide the maximum lifetime and power generation capability, it is recommended to install iC7-Hybrid String PCS in the shade from the sun. To maintain high performance, it is recommended to install a roof to protect the device from external factors.

Corrosion class C5-M (ISO 12944-2) installations require the use of a roof.

5.2 Installation Requirements

The installation location, safety areas, and required space for ventilation are presented in [5.3 Space Requirements](#).

Install the iC7-Hybrid String PCS on a wall or strong structure suitable to bear the weight of the converter and the mounting rack. The structural integrity of the wall or a strong structure is the responsibility of the installer.

Select the installation position so that the switch disconnectors can always be accessed.

When planning the installation, consider that the iC7-Hybrid String PCS is heavy. The wall or the rack used for installation must be able to support the weight of the converter. Select the used fastening components according to the used materials and the weight of the iC7-Hybrid String PCS. For more information, see [10.2 Ratings and Specifications](#).

Conditions of NEC 2017 part II 110.26 (A) apply.

5.3 Space Requirements

iC7-Hybrid String PCS requires free space around it for ventilation and for installation and service purposes.

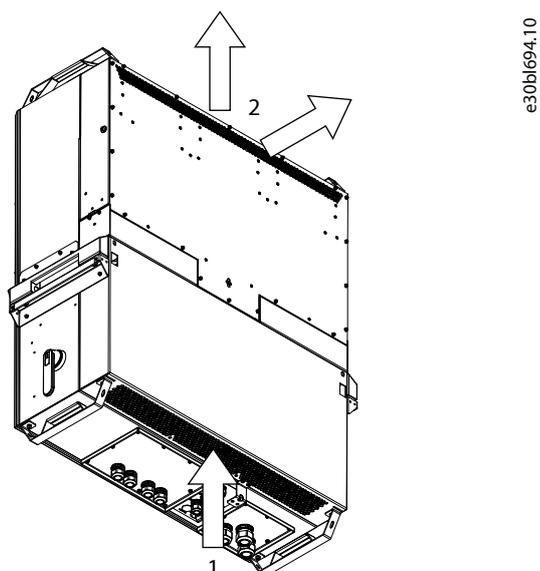


Figure 13: Ventilation of the iC7-Hybrid String PCS

1	Inlet for cooling air at the bottom	2	Outlets for cooling air at the top
---	-------------------------------------	---	------------------------------------

- Above the unit: 300 mm (12 in) is needed for the air coming out from the unit.
- Below the unit: 500 mm (20 in) is needed to achieve proper ventilation. The required 500 mm (20 in) below the converter must be free space without any vegetation or any other obstacles.
- On both sides of the unit: A clearance of 400 mm (16 in) is required for operating the switch disconnectors and for fan maintenance.
- In front of the unit: There must be at least 1000 mm (40 in) free space for maintenance and safety reasons.

If shorter distances are required, contact Danfoss. If regulations require larger distances, follow the local regulations on the installation site.

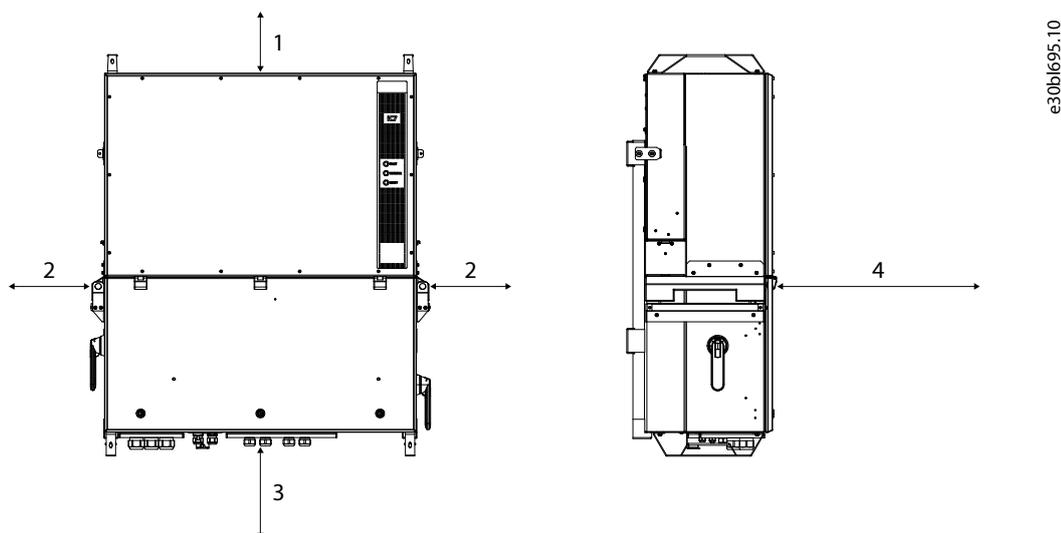


Figure 14: Minimum Free Space Requirements around the Converter

1	Free space above	2	Free space on both sides
3	Free space below	4	Free space in front

When installing converters side-by-side, the distance between the devices must be at least 150 mm (5.9 in). If a shorter distance is required, contact Danfoss.

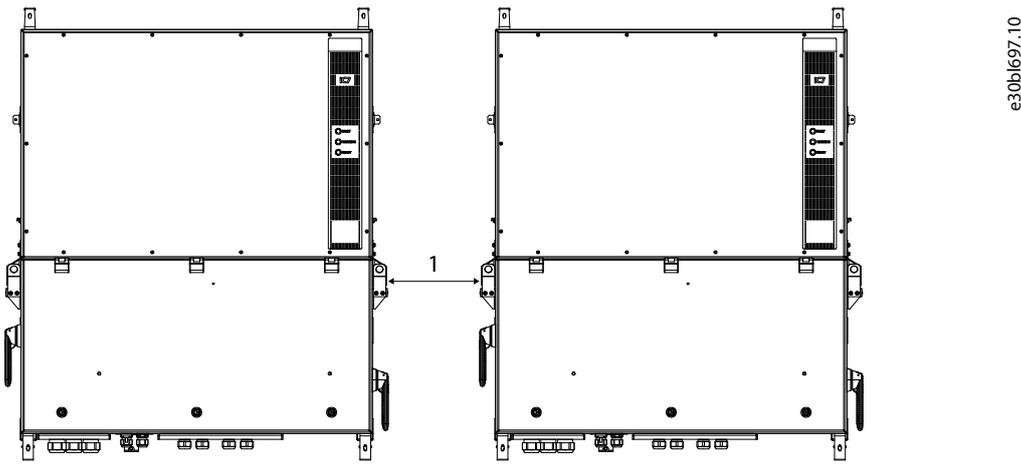


Figure 15: Installation Side-by-side

- 1 Free space between converters installed side-by-side

When installing converters back-to-back, the required minimum distance between the mounting racks is 50 mm (2 in).

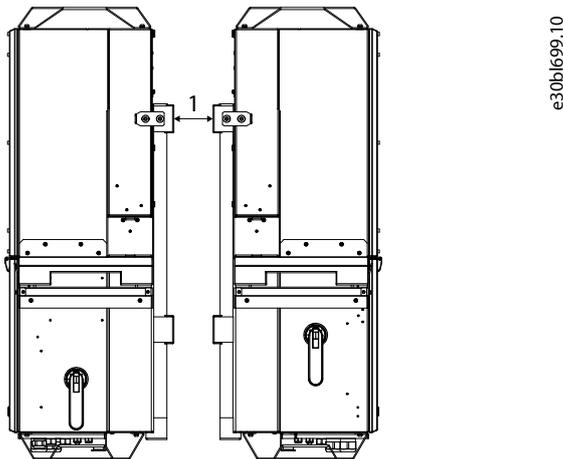


Figure 16: Installation Back-to-back

- 1 Free space between converters installed back-to-back

5.4 Mounting the Units

CAUTION

RISK OF FIRE

Combustible material causes a risk of fire.

- The structure of the mounting rack or mounting wall must be of non-combustible material.
- There must be no flammable material around the device.

1. Secure the mounting rack with at least 4 screws.

Select the screws according to the wall material. Mount the rack with M8 hexagon socket head cap screws and 20 mm plain washers.

Use a 6 mm hex bit and tighten the screws to 10 Nm (88.5 in-lb).

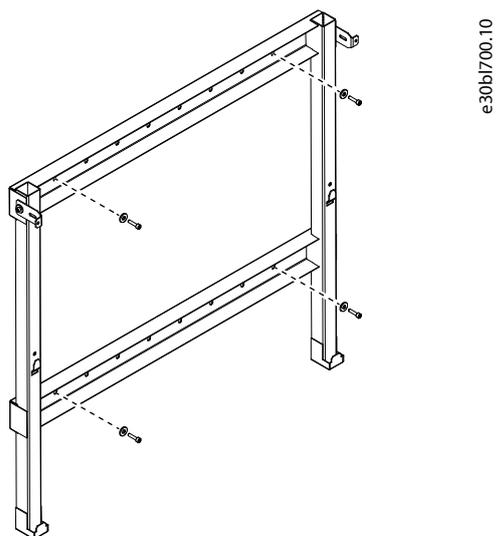


Figure 17: Attaching the Mounting Rack

2. Lift the connection unit (CU) near the mounting rack.

Use the lifting handles for lifting. Follow the instructions in [4.7 Lifting the Units](#).

3. Lift the CU into place and push the unit against the mounting rack. Slide the unit down so that the unit attaches to the hooks in the mounting rack.

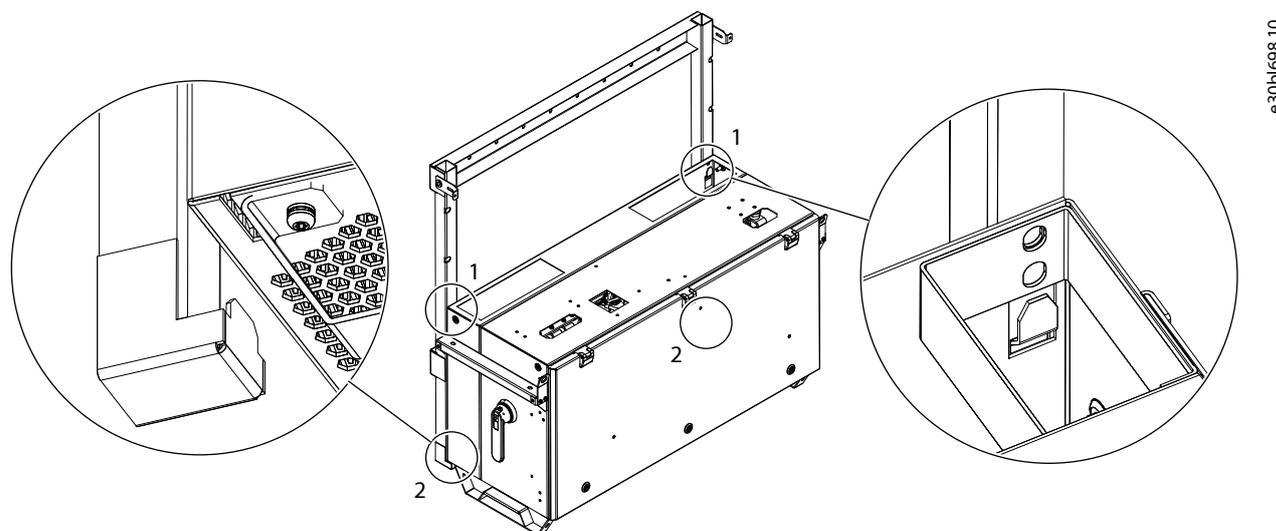
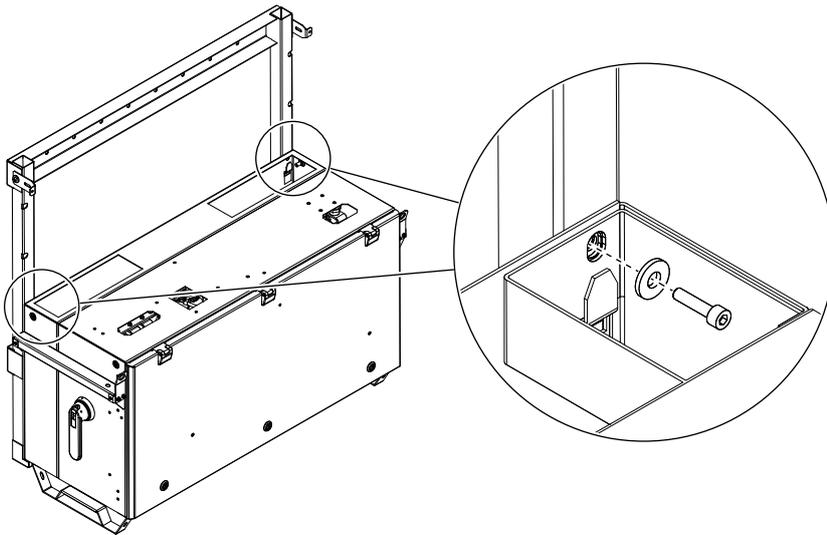


Figure 18: Attaching the Connection Unit to the Mounting Rack

- | | |
|---|--|
| 1 Connection point at the top of the unit | 2 Connection point at the bottom of the unit |
|---|--|

4. Lock the CU in place with 2 bolts from the top of the air vents.

Mount the unit with M6x25 hexagon socket head cap screws and 18 mm plain washers. Use a 5 mm hex bit and tighten the screws to 6 Nm (53 in-lb).

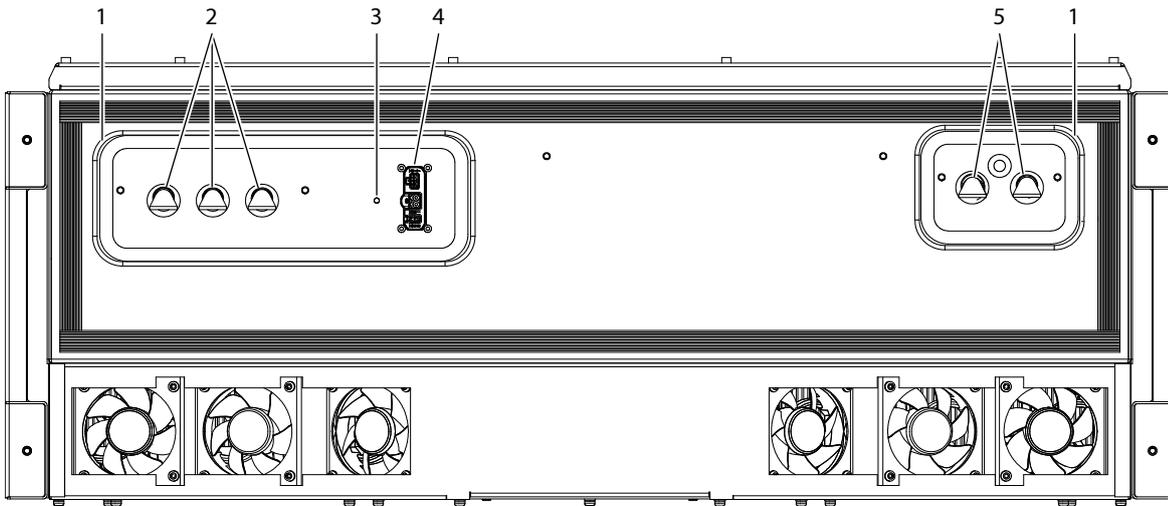


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Figure 19: Locking the Connection Unit in Place

➔ When the connection unit is mounted, it is possible to install the AC and DC cables. For detailed information, see [6.9 Installing the Power Cables](#).

- Before lifting the main unit (MU) on top of the CU, check that the sealants at the bottom of the MU are in place and whole.



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Figure 20: Bottom of the Main Unit

1	Sealants	2	AC cables
3	Bolt for grounding	4	Control I/O terminals
5	DC cables		

- Lift the MU near the mounting rack.

Use the lifting handles for lifting. Follow the instructions in [4.7 Lifting the Units](#).

- Just before lifting the MU into place, remove the protective plastic film from the top of the CU.
- Lift the MU on top of the CU.
 - Push the MU against the mounting rack.
 - Make sure that the cables in the bottom of the MU fit in the openings on the top of the CU.

- c. Slide down the MU on top of the CU.

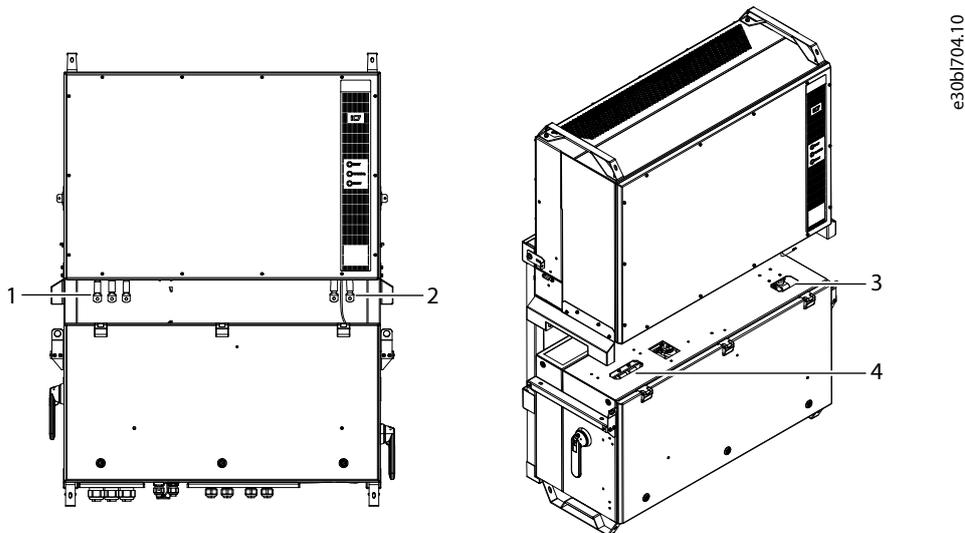


Figure 21: Placing the Main Unit on top of the Connection Unit

1	AC cables	2	DC cables
3	Opening for DC cables	4	Opening for AC cables

- 9. Lock the MU in place.

- a. Lock the MU to the mounting rack with 2 bolts.

Mount the unit to the mounting rack with M6x25 hexagon socket head cap screws and 18 mm plain washers. Use a 5 mm hex bit and tighten the screws to 6 Nm (53 in-lb).

- b. Lock the MU from lifting handles to the lifting handles of the CU with four bolts.

Mount the MU to the lifting handles of the CU with M6x25 hexagon socket head cap screws and 18 mm plain washers. Use a 5 mm hex bit and tighten the screws to 4 Nm (35 in-lb).

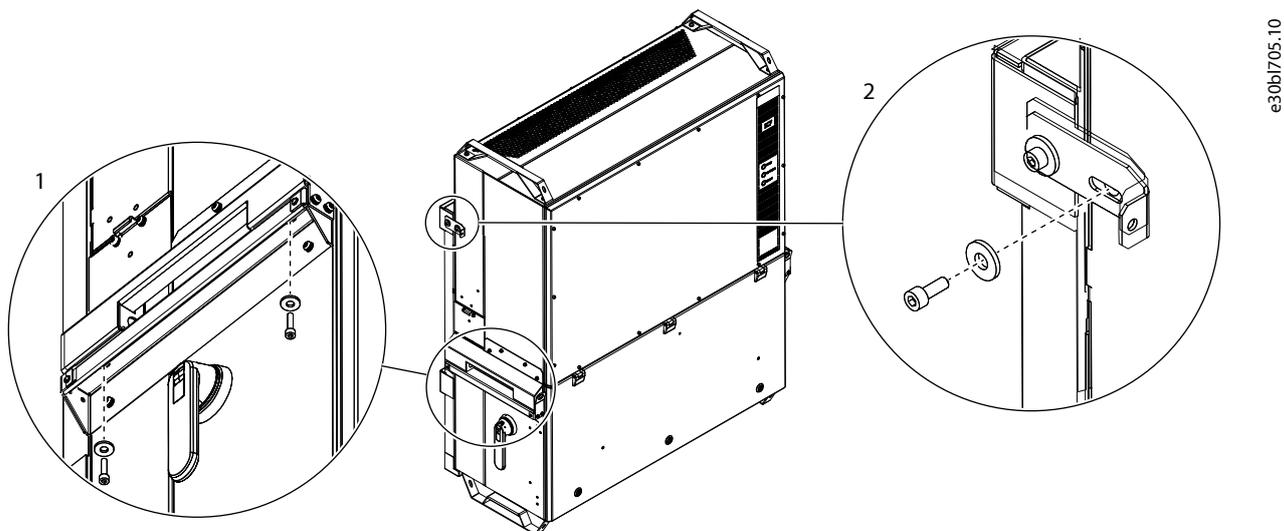


Figure 22: Locking the Main Unit in Place

1	Mounting from lifting handles	2	Mounting location to mounting rack
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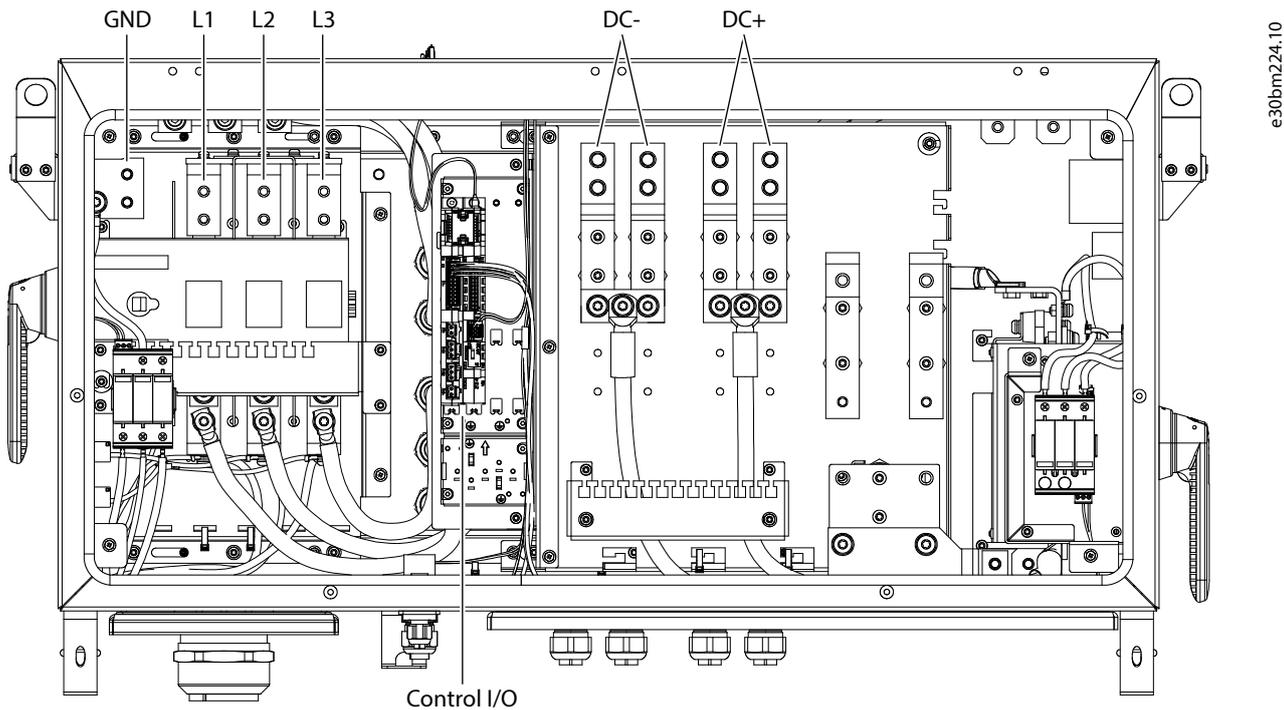
6 Electrical Installation

6.1 Power Cabling Guidelines

Select the DC, AC, and equipment grounding cables used with iC7-Hybrid String PCS according to local regulations. Design the power cabling so that it complies with the environmental stress and the required maximum current in the installation. The maximum allowed temperature of the cables must be at least 90 °C (194 °F).

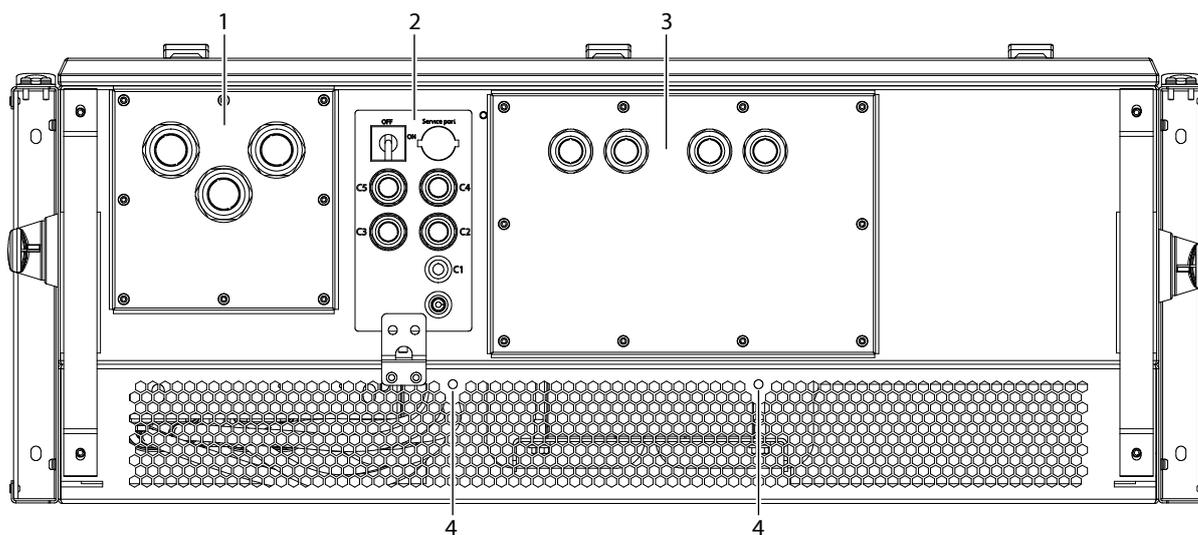
See the following principle figures about the layout of connection points and where the cables are led into the device.

The bottom of the device varies according to the selected AC connection and DC connection options. See [10.5 Options](#) for details.



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Figure 23: Terminals in the Connection Unit



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Figure 24: Cable Lead-through Points in the Bottom Plate of the Connection Unit

1	Lead-through for AC power cables	2	Lead-through for control cables
3	Lead-through for DC power cables	4	Grounding points

6.2 Transformer Requirements

Design the transformer so that it matches the environmental conditions at the intended application and complies with all applicable standards, rules, and regulations at the intended installation location. The converter side of the transformer must comply with IT grounding requirements of the converter.

In principle, the iC7-Hybrid String PCS can operate with any delta-wye configuration arrangement. The transformer must be suitable for converter applications, for example, contain an electrostatic shield. The rated capacity of the transformer has to be at least the total rated capacity of converters connected to the transformer. The voltage levels on all windings must match the requirements of the converter and the external requirements by the local grid. The rated frequency of the transformer must match the requirements of the converter and the external requirements by the local grid.

Danfoss recommends reviewing the intended converter connection scheme with the customer at an early stage. The capacity of the transformer must include an adequate margin to maintain good design practices. The recommended impedance of the transformer is 5–6%, but the iC7-Hybrid String PCS can operate at other impedance levels with a prior approval from Danfoss.

In North American variants (UC), the used transformer must comply with 1 of the following standards, whichever applies:

- Standard for Dry-Type General Purpose and Power Transformers, UL 1561
- Standard for Transformers, Distribution, Dry-Type - Over 600 Volts, UL 1562

Always check the local regulations for the transformer.

6.3 AC Power Cable Requirements

Use cables with rated voltage of $690 V_{RMS}$ or higher.

The standard configuration of the global variant has a cable gland for a single 3-phase cable with a protective earth (PE) conductor. The gland for the cable includes screw thread tightening. The cross-sectional area of the conductor varies depending on the material of the conductor and the cable assembly. See the phase current ratings in [10.1 Technical Data](#).

The AC power cable must be a shielded multi-conductor cable. The ingress protection (IP) requirement is achieved with an IP68 cable gland. The cable gland allows a single cable of 34–48 mm (1.34–1.89 in) diameter. For detailed information about mounting the cables, see [6.9 Installing the Power Cables](#).

Danfoss recommends using AC power cable including a PE conductor or a shield with an adequate cross-section connected to PE. For more detailed information, see [6.8 Grounding](#).

Table 4: Minimum Sizes for the Standard Configuration

Conductor type	Minimum size
Copper conductor	95 mm ²
Aluminum conductor	150 mm ²

Table 5: Maximum Cable Size in Field Wiring with 1 Cable per Pole

Options	Maximum cable size with 1 cable per pole
+KFBP, +KF75, +KF63, +KF3S	350 mm ²

6.4 External Protection for Mains Connection

External protection with fuses or breaker is required for the mains connection of the iC7-Hybrid String PCS.

Design the protection (selection of fuse value or setting of a breaker) to comply with the local requirements and conditions.

- The protection must allow the maximum AC current of the converter when the specified thermal conditions are met.

- The minimum AC voltage rating must meet the AC voltage of the converter model.
- The minimum short-circuit rating of the breaker or fuse must be adequate for the short-circuit capacity of the AC station transformer and the utility.

Recommended AC fuses:

- IEC: Type gG, 690 V AC, 315 A (minimum prospective current I_{SC} : 2100 A)
- UL: Class J, 350 A

See [10.1 Technical Data](#) for more information about the converter ratings.

6.5 DC Power Cable Requirements

The use of single-core cables is recommended. The available DC connection type options are listed in [10.5 Options](#).

Always use cables with rated voltage of 1500 V DC or higher.

The selected cable and the used external cable support must withstand the short-circuit current from the connected batteries.

In the +KJ2D option configuration, 1 single cable fits in each DC cable gland. As shown in [6.1 Power Cabling Guidelines](#), the ingress protection (IP) tightness is achieved with IP68 cable glands.

- Recommended minimum Cu conductor size: 50 mm²
- Maximum cable size in field wiring with 1 cable per pole: 350 mm²

6.6 DC Input Fuses

Only 1500 V DC aR fuses are allowed for the iC7-Hybrid String PCS.

The DC fuses of the iC7-Hybrid String PCS only provide short-circuit protection for the converter. Separate overcurrent protection for the DC circuit must be provided according to local regulations.

When selecting the fuses, consider:

- The range of the allowed values for each input variant in [10.1 Technical Data](#)
- The number of DC power cables
- The mounting method of the fuses

See the list of available DC connection type, DC fuse placeholder type, and DC fuse type options in [10.5 Options](#).

The current rating of each fuse is as defined on the fuse surface. Replace the fuses only with 1500 V DC aR fuses of the same current rating and matching with the fuse holder or mounting method.

6.7 Cable Lug Selection

Select the cable lugs according to the dimensions of the AC and DC terminals shown in the following figure.

The screw sizes:

- AC terminals: M8
- DC terminals: M10

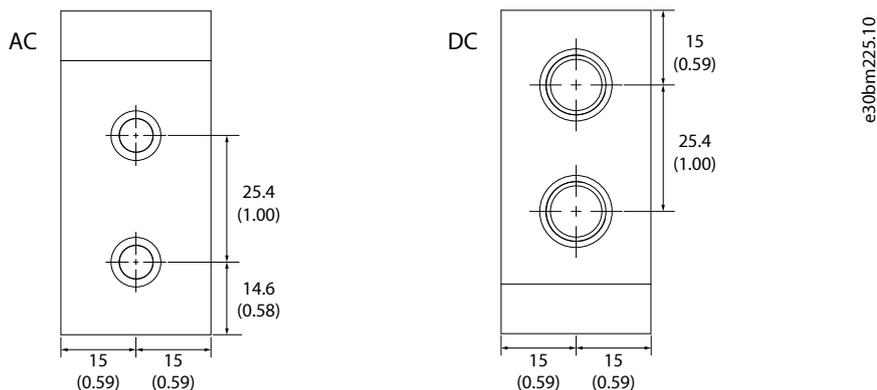


Figure 25: Dimensions of the AC and DC Terminals

6.8 Grounding

As the iC7-Hybrid String PCS is a protective class 1 device, an earth ground conductor is required. iC7-Hybrid String PCS has 2 grounding points: 1 inside the connection unit (see [Figure 23](#)) and 1 outside the converter frame (see [Figure 24](#)). One of these points must be used for the grounding.

Do the protective earthing (PE) according to the local requirements and guidelines. Unless otherwise specified, do the design according to IEC 60364-5-54 or IEC 62477-1.

Danfoss recommends using AC power cable including a PE conductor or a shield with an adequate cross-section connected to PE. If this grounding method is not possible or preferred, it is also possible to connect the PE conductor outside the iC7-Hybrid String PCS. Either of these 2 PE connection methods must be used.

When using the ground connection point inside, the size of the earth ground conductor is approximately 72–120 mm².

There is also a grounding point for the DC side. The DC-side grounding point is not for customer use. It is reserved only for Danfoss.

If the mounting rack and the iC7-Hybrid String PCS must have a separate bonding and connection to the ground, implement it in accordance with the local requirements.

6.9 Installing the Power Cables

All the electrical connections must be done by a certified electrician and in accordance with local requirements and regulations.

All the wiring methods used must be in accordance with the National Electrical Code, ANSI/NFPA 70.

1. Open the cover of the connection unit (CU).

For detailed information, see [9.4 Opening the Connection Unit for Maintenance](#).

2. Remove the contact protection covers.
 - a. AC protection cover: Loosen the 4 size M5x10 screws.
 - b. DC protection cover: Loosen the 6 size M5x10 screws.

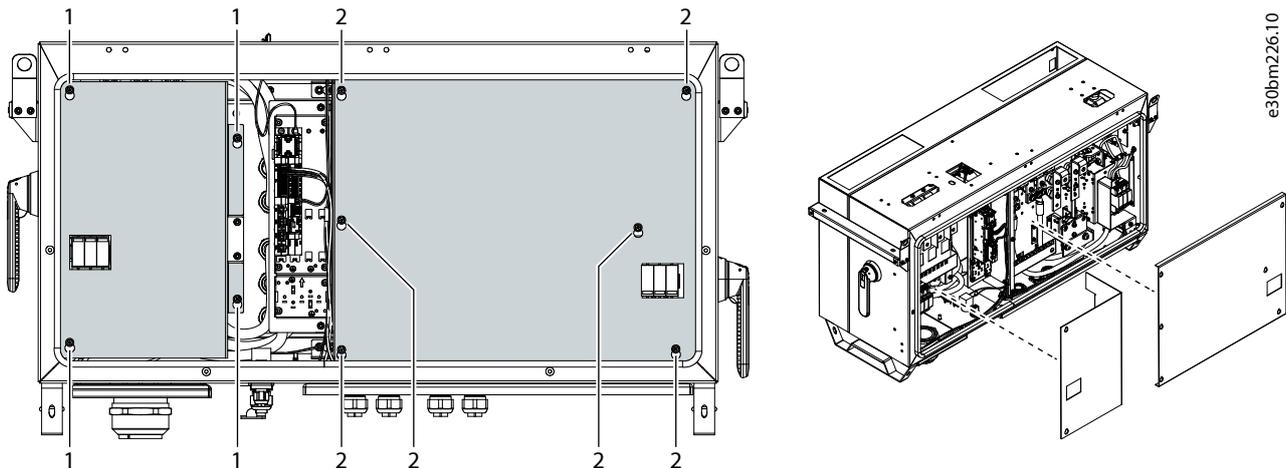


Figure 26: Removing the Contact Protection Covers

1	2
Mounting screws for the AC protection cover	Mounting screws for the DC protection cover

3. Connect the cables from the main unit (MU) to the CU.

a. Connect the AC cables.

Mount the cables with M8x25 hexagon socket head cap screws, 18 mm pressure washers, and 20 mm plain washers. Use a 5 mm hex bit and tighten the screws to 20 Nm (177 in-lb).

b. Connect the DC cables.

Mount the cables with M8x25 hexagon socket head cap screws, 18 mm pressure washers, and 20 mm plain washers. Use a 5 mm hex bit and tighten the screws to 20 Nm (177 in-lb).

c. Connect a grounding cable between the grounding points.

The grounding cable is installed on the CU at the factory.
Mount the cable with an M5 flange nut.
Use an 8 mm socket wrench and tighten the nut to 4 Nm (35 in-lb).

d. Connect the following cables from the MU to the control unit.

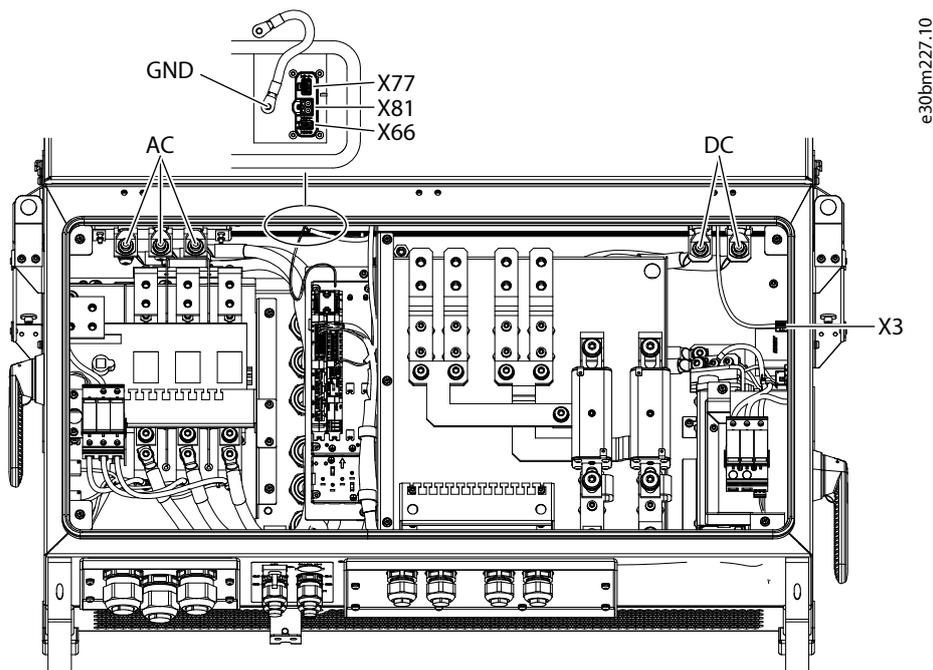
Table 6: Cable Connections between the Control Unit and Main Unit

Cable	Control unit terminal	Main unit terminal
+24 V DC supply cable	X62	X66
Fiber optic cable	X80	X81

See the locations of the control unit terminals in [7.2 Control Board](#).

e. Connect the CMS-filtering feedback wire to terminal X3 on the EMC filter board (SEFI-3).

See the locations of the cables in the bottom of the MU in [Figure 20](#).



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Figure 27: Terminals for the Connections between MU and CU

4. Install the AC power cables.

a. Bring the AC power cables inside the CU.

- If an AC connection option with cable glands is installed, remove the plugs from the gland.
- If an AC connection option with a cable plate is installed, remove it. Drill the necessary holes and add the Nema type 4 compliant connections and reinstall the plate.

See [10.5 Options](#) for a list of the available AC connection options.

b. Connect the AC power cables to the correct terminals. See the markings on the terminals.

Mount the cables with M8x25 hexagon socket head cap screws, 18 mm pressure washers, and 20 mm plain washers. Mount the cables in the following order: screw + pressure washer + plain washer. Use a 5 mm hex bit and tighten the screws to 20 Nm (177 in-lb).

c. Connect the grounding cable.

See [6.8 Grounding](#) for details.

Mount the cable with an M8x25 hexagon socket head cap screw, 18 mm pressure washer, and 20 mm plain washer. Mount the cable in the following order: screw + pressure washer + plain washer. Use a 5 mm hex bit and tighten the screw to 20 Nm (177 in-lb).

If option +KF3S is selected (AC connection with 3 single-phase cables), use the grounding point at the bottom of the connection unit. See [Figure 24](#).

d. Use cable ties to secure the cables to the cable mounting bracket.

The cable ties must be suitable for industrial use in the temperature range -40...80 °C (-40...176 °F).

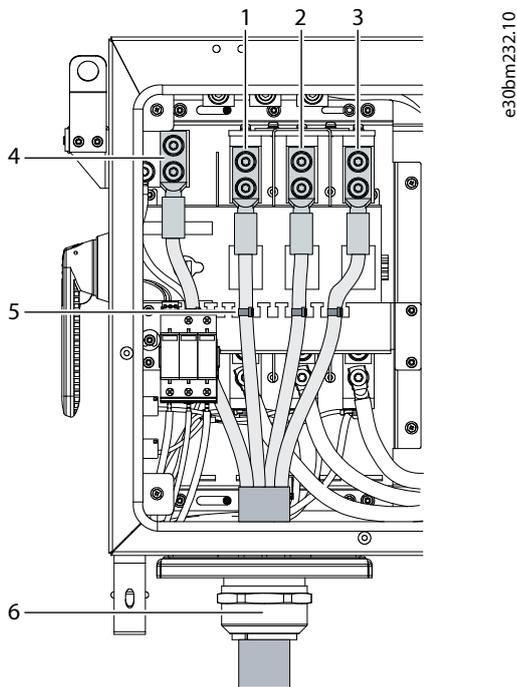


Figure 28: Installing the AC Power Cables

1	L1 terminal	2	L2 terminal
3	L3 terminal	4	Ground terminal
5	Cable mounting bracket	6	Cable gland

5. Install the DC power cables.

a. Bring the DC power cables inside the CU.

- If a DC connection option with cable glands is installed, remove the plugs from the gland.
- If a DC connection option with a cable plate is installed, remove it. Drill the necessary holes and add the Nema type 4 compliant connections and reinstall the plate.

See [10.5 Options](#) for a list of the available DC connection options.

b. Connect the DC power cables to the correct terminals. See the markings on the terminals.

Mount the cables with M8x25 hexagon socket head cap screws, 18 mm pressure washers, and 20 mm plain washers. Mount the cables in the following order: screw + pressure washer + plain washer. Use a 5 mm hex bit and tighten the screws to 20 Nm (177 in-lb).

c. Use cable ties to secure the cables to the cable mounting bracket.

The cable ties must be suitable for industrial use in the temperature range -40...80 °C (-40...176 °F).

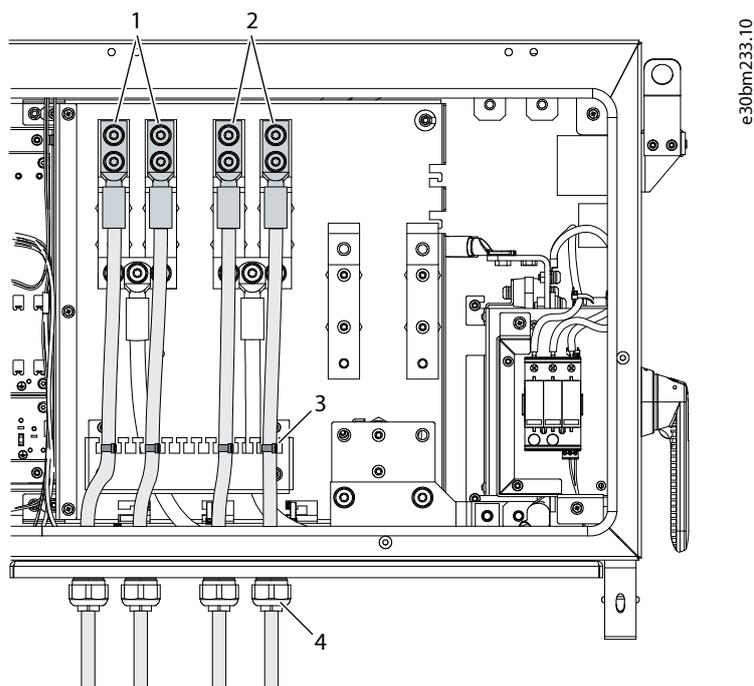


Figure 29: Installing the DC Power Cables

1	DC- terminals	2	DC+ terminals
3	Cable mounting bracket	4	Cable glands

6. Install the control I/O cabling.

See [7.4 Control Board Connections](#) and [7.5 I/O and Relay Option \(OC7C1\) Connections](#).

7. Check that the cable glands are properly fastened to meet the ingress protection (IP) requirements.
8. Install the contact protection covers.

See [Figure 26](#).

9. Before closing the cover of the CU, check that the sealant is in place and in good condition.
10. Close the cover of the CU.
11. Make sure that the locks of the CU are locked.

6.10 Installing the DC Fuses

By default, the iC7-Hybrid String PCS has a 500 A, 1500 V DC fuse mounted on the DC+ busbar. Other DC fuse mounting options are available. See the list in [10.5 Options](#).

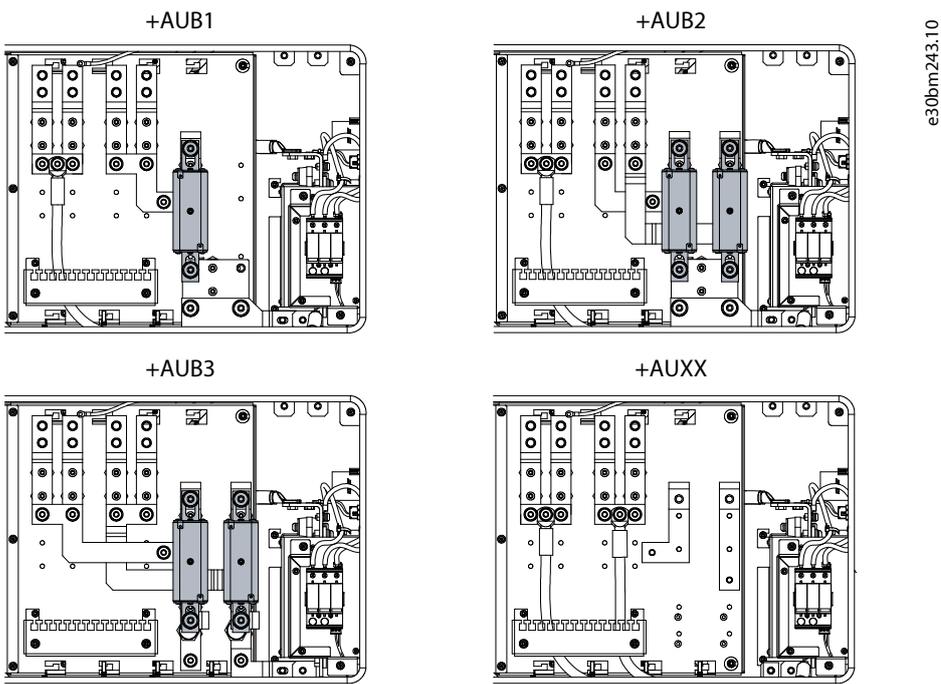


Figure 30: DC Fuse Mounting Type Options with Fuses Installed

1. Mount the fuses on the busbars with M10x25 TX screws. Use pressure balancing washers and spring washers.

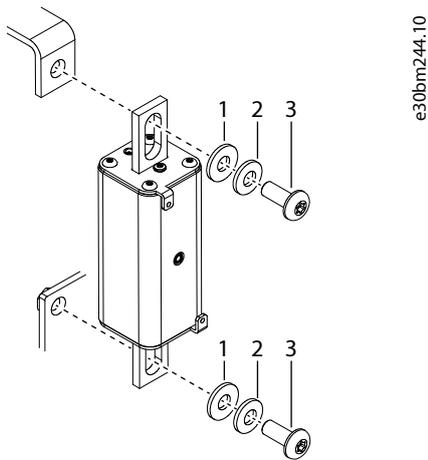


Figure 31: Mounting the DC Fuses

- | | | | |
|---|-------------------------------|---|-------------------|
| 1 | Pressure balancing washer M10 | 2 | Spring washer M10 |
| 3 | M10x25 TX screw | | |

7 Control Installation

7.1 Control Unit

The iC7-Hybrid String PCS is controlled with the modular control unit. The control and I/O board circuits are DVC As circuits. The control unit is installed inside the connection unit (CU). The control unit and the main unit (MU) are connected via fiber optics. The modular control unit provides an interface towards the upper control system of the customer. The control unit includes 2 Ethernet ports for a fieldbus connection. Daisy chaining the fieldbus is supported for typical protocols, such as Modbus TCP and PROFINET RT. Functional extensions can be added to incorporate analog and digital inputs and outputs as well as other functionality such as temperature measurement or voltage measurement. A control panel is available for local control.

The control unit consists of various boards installed on a mounting plate. The boards are connected to each other with option connectors. The following 2 boards are installed by default:

- Control board
- I/O and Relay Option OC7C1

There are 2 installation slots for functional extensions, for example:

- Temperature Measurement OC7T0
- Voltage Measurement OC7V0

See the full list of available options in [10.5 Options](#). For detailed information about the options, see the option-specific operating guides.

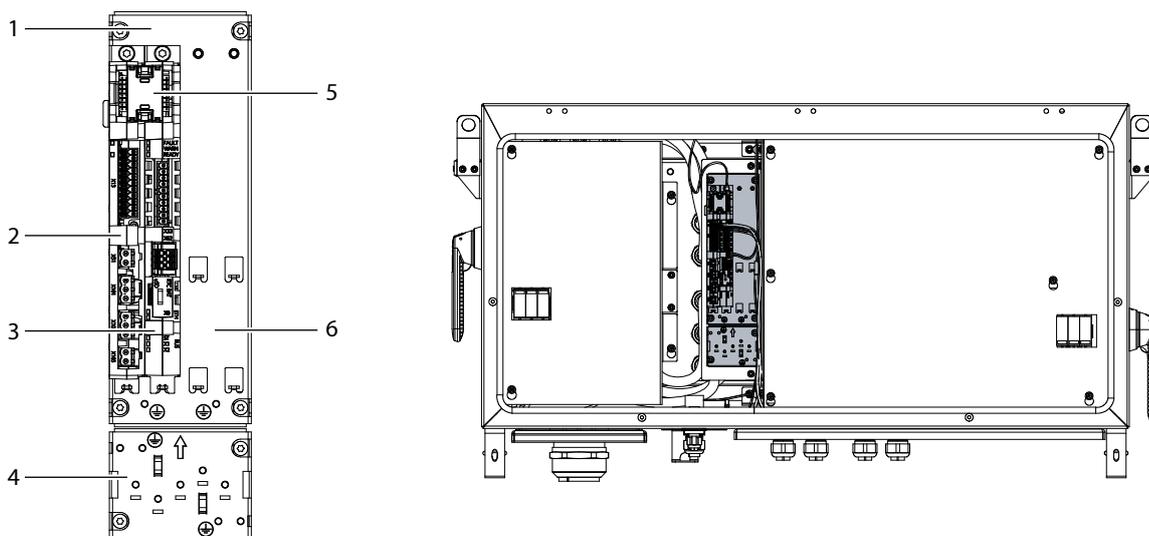
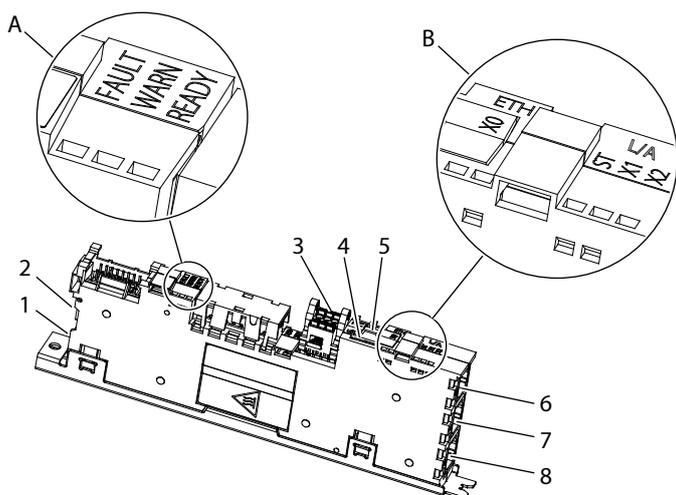


Figure 32: Control Unit of the iC7-Hybrid String PCS

1	Mounting plate	2	I/O and Relay Option OC7C1
3	Control board	4	Grounding plate
5	Option connector	6	Installation slots A/B for functional extensions

7.2 Control Board



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Figure 33: The Control Board

A	Status indicators (FAULT, WARN, READY)	B	Fieldbus indicators (ST, X1, X2) and Ethernet port indicators (X0)
1	Control panel connector (X9)	2	Fiber optic link to power unit (X80)
3	24 V DC supply (X62)	4	microSD card
5	RTC battery holder	6	Ethernet port (X0)
7	Ethernet port (X1)	8	Ethernet port (X2)

7.3 Definitions of the Indicator Lights on the Control Board

Table 7: Definitions of the Indicator Lights on the Control Board

Indicator name	Function (color)	Description
Fault	On (red)	Fault active
Warn	On (yellow)	Warning active
Ready	On (white)	Ready for operation
	Blinking 1 Hz (white)	Power on, not ready
Fault+Warn+Ready	Blinking (red + yellow + white)	Winking from an external application. Can be used for identifying where the external application is wirelessly connected to.
X0 link activity	Off	No link
	On (green)	Link OK, no data
	Blinking (green)	Link OK, data communication
X0 link speed	Off	No link or 10 Mbps link
	On (orange)	100 Mbps link

For the description of the fieldbus indicators (ST, X1, X2), see the relevant application guide.

7.4 Control Board Connections

Table 8: Control Board Connections

Terminal	Function	Connector type
X1	Ethernet port (used for fieldbus)	RJ45
X2	Ethernet port (used for fieldbus)	RJ45
X0	Ethernet port (used for the PC tool)	RJ45
Micro SD	microSD card	Micro SD
X62	24 V DC supply	2 x 3 spring force connector 0.2–1.5 mm ²
X33 for inverter module	STO terminal	1 x 10 spring force connector 0.2–1.5 mm ²
Option bus	Option bus (internal connection)	Custom
X80	Fiber optic link to power unit or star coupler board	LC-duplex
X9	Control panel terminal	iX Industrial
RTC battery	RTC battery	BR1632 (battery type)

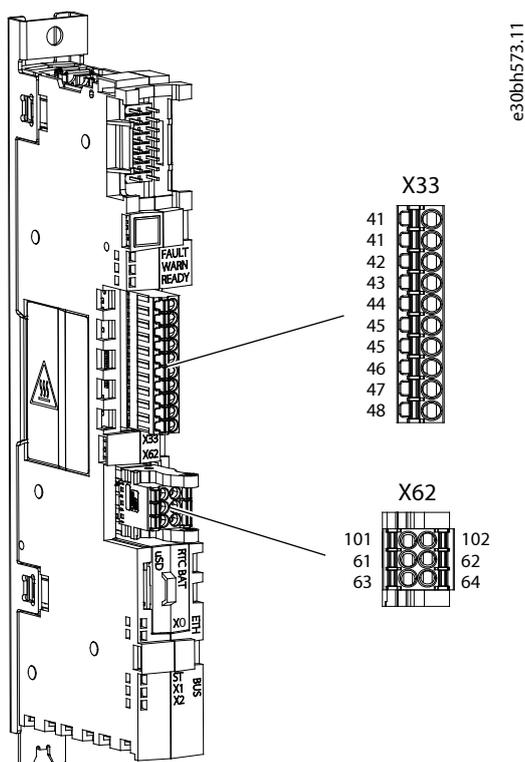


Figure 34: Control Board Terminal Block and Terminal Numbering

Table 9: STO Terminal Signals (X33) for the Inverter Module

Terminal	Function	Description
41A ⁽¹⁾	24 V	+ 24 V DC Output
41B ⁽¹⁾	24 V	+ 24 V DC Output
42	S.INA+	+ Safe Input Channel A
43	S.INB+	+ Safe Input Channel B
44	S.FB+	+ STO Feedback

Table 9: STO Terminal Signals (X33) for the Inverter Module - (continued)

Terminal	Function	Description
45A ⁽¹⁾	GND	0 V/GND
45B ⁽¹⁾	GND	0 V/GND
46	S.INA-	- Safe Input Channel A
47	S.INB-	- Safe Input Channel B
48	S.FB-	- STO Feedback

1) Terminals 41A, 41B, 45A, and 45B have double pins to make connections easier.

Table 10: 24 V DC Supply Signals (X62)

Terminal	Function	Description
101	+24 V input	Internal +24 V DC, 60 W control supply
102	GND	Power supply ground
61	+24 V external input	External +24 V DC control supply, maximum 10 A. Must be fuse-protected. Possible to daisy chain for multiple controllers.
62	GND	Power supply ground
63	+24 V output	+24 V DC output for daisy chain, only available when the +24 V DC external input control supply is used.
64	GND	Power supply ground

7.5 I/O and Relay Option (OC7C1) Connections

NOTICE

- Do not change the internal I/O connections. Changing the connections can change the functionality of the device and cause failures.

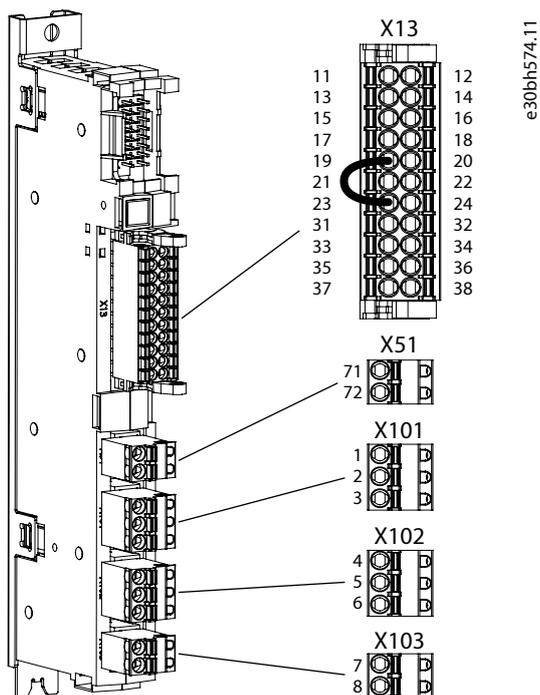


Figure 35: I/O and Relay Option Terminal Block and Terminal Numbering

Table 11: I/O and Relay Option (OC7C1) Signals

Terminal	Function	Connector type
X13	I/O terminal	2 x 11 spring-force connector 0.2–1.5 mm ²
X51	Thermistor input	1 x 2 spring-force connector 0.25–2.5 mm ²
X101	Relay 1	1 x 3 spring-force connector 0.25–2.5 mm ²
X102	Relay 2	1 x 3 spring-force connector 0.25–2.5 mm ²
X103	Relay 3	1 x 2 spring-force connector 0.25–2.5 mm ²

Table 12: I/O Terminal Signals (X13)

Terminal	Function	Internal use	Description
11	+24 V _{out}	Reserved	Control voltage output. 24 V DC (-15...+20%) Maximum current 200 mA Short-circuit protected
12	+24 V _{out}	-	
13	DI 1	Reserved. Input for run enable switch.	Configurable digital input, galvanically isolated. 24 V DC, 0 < 5 V, 1 > 15 V. Input load 7.5 mA constant current + 10 kΩ resistive load, maximum pulse frequency 100 kHz.
14	DI 2	Reserved. Input for DC-switch monitoring.	
15	DI 3	Reserved. Input for DC-SPD monitoring.	
16	DI 4	-	
17	DI 5	Reserved. Input for AC-switch monitoring.	
18	DI 6	Reserved. Input for AC-SPD monitoring.	

Table 12: I/O Terminal Signals (X13) - (continued)

Terminal	Function	Internal use	Description
19	DGND	-	Digital input ground, not isolated by default.
20	DGND	-	When using the internal +24 V _{out} supply, connect the external jump wire between DGND and GND. When using the external +24 V DC supply, remove the external jump wire between DGND and GND.
21	DO 1	-	Configurable digital output. ⁽¹⁾
22	DO 2	-	Push-pull 24 V/50 mA Open collector (NPN/PNP) 48 V/50 mA Short-circuit protected
23	GND	-	I/O ground.
24	GND	-	Ground for digital outputs, +10 V Ref, +24 V _{out} , analog inputs, and analog outputs.
31	AO 1	Reserved. Output to ambient temperature monitoring.	Configurable analog output. Voltage mode: <ul style="list-style-type: none"> • 0...10 V • $R_L \geq 1 \text{ k}\Omega$ • Accuracy $\leq \pm 0.5\%$ of full scale • Short-circuit protected Current mode: <ul style="list-style-type: none"> • 0...20 mA • $R_L \leq 600 \Omega$ • Accuracy $\leq \pm 0.5\%$ of full scale • Short-circuit protected
32	+10 V ref.	-	10 V (0...+3%), maximum current 10 mA
33	AI 1	Reserved. Input from ambient temperature monitoring.	Configurable analog input. Voltage mode: <ul style="list-style-type: none"> • $0 \pm 10 \text{ V}$ • Single-ended • $R_i \sim 10 \text{ k}\Omega$ • Accuracy $\pm 0.5\%$ of full scale Current mode: <ul style="list-style-type: none"> • $0 \pm 20 \text{ mA}$ • Differential • $R_i \sim 200 \Omega$ • Accuracy $\pm 0.5\%$ of full scale
34	AI 2	-	
35	GND	Reserved	I/O ground.
36	GND	-	Ground for digital outputs, +10 V Ref, +24 V _{out} , analog inputs, and analog outputs.
37	GND	-	
38	GND	-	

1) Digital outputs are not recommended for main circuit breaker control, use relay outputs instead.

Table 13: Thermistor Input Signals (X51)

Terminal	Function	Description
71	TI+	Thermistor input, galvanically isolated. $R_{trip} = 4\text{ k}\Omega$
72	TI-	

Table 14: Relay 1 Signals (X101)

Terminal	Function	Description
1	COM	Configurable relay output.
2	NO	Switching capacity: <ul style="list-style-type: none"> • 24 V DC/8 A • 250 V AC/8 A • 125 V DC/0.4 A Minimum switching load: 5 V/10 mA
3	NC	

Table 15: Relay 2 Signals (X102)

Terminal	Function	Description
4	COM	Configurable relay output.
5	NO	Switching capacity: <ul style="list-style-type: none"> • 24 V DC/8 A • 250 V AC/8 A • 125 V DC/0.4 A Minimum switching load: 5 V/10 mA
6	NC	

Table 16: Relay 3 Signals (X103)

Terminal	Function	Description
7	COM	Configurable relay output.
8	NO	Switching capacity: <ul style="list-style-type: none"> • 24 V DC/8 A • 250 V AC/8 A • 125 V DC/0.4 A Minimum switching load: 5 V/10 mA

7.6 I/O and Relay Option Interface

7.6.1 Analog Inputs

The I/O and Relay Option has 2 analog inputs that can be configured with the software to voltage input or current input. The [Table 17](#) shows the specification for the analog inputs.

The analog inputs are protected in overvoltage conditions.

Table 17: Analog Input Types, Values, and Tolerances

Parameter	Value
Measuring range: voltage mode	-10...+10 V
Measuring range: current mode	-20...+20 mA

Table 17: Analog Input Types, Values, and Tolerances - (continued)

Parameter	Value
Input impedance	Voltage mode $\approx 10\text{ k}\Omega$
	Current mode $\approx 200\ \Omega$
Accuracy	0.5% of full scale
Reaction time	0...90% step: $< 1\text{ ms}$
Number of inputs	2
Overvoltage limit	+15/-15 V
Overcurrent limit	+32/-32 mA
Electrical fast transient (EFT)	2 kV

7.6.2 Analog Outputs

The I/O and Relay Option has 1 analog output that can be configured with the software to voltage output or current output. The [Table 18](#) shows the specification for the analog output.

The analog output is protected in overvoltage conditions.

Table 18: Analog Output Types and Values

Parameter	Value
Output voltage range	0...10 V
Output current range	0...20 mA
Accuracy	0.5% of full scale
Reaction time	0...90% step: $< 1\text{ ms}$
Electrical fast transient (EFT)	2 kV

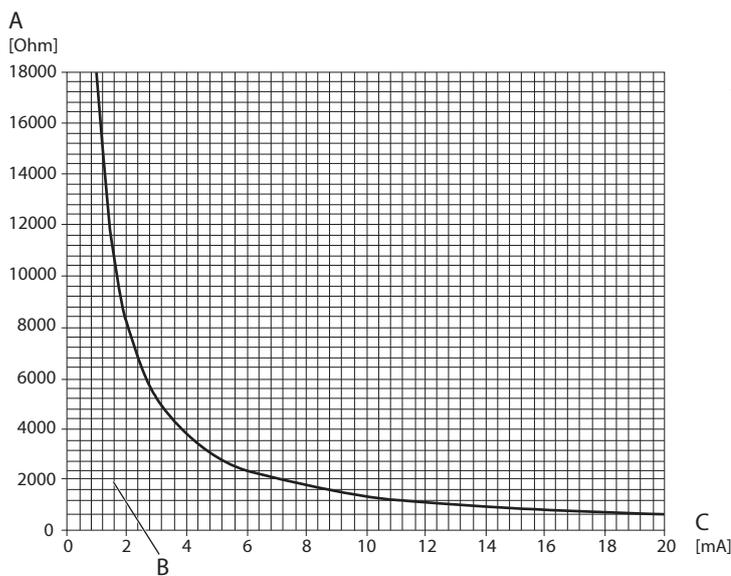


Figure 36: Allowed Load Resistance of Analog Output in Current Mode

A	Load resistance	B	Allowed load resistance
C	Output current		

7.6.3 Digital Inputs

The I/O and Relay Option has 6 digital inputs. By default, the digital inputs are not isolated, because there is an external wire between the connector pins 19 (D_{GND}) and 23 (GND). The digital inputs can be functionally isolated from the PCB ground of the I/O and Relay Option by removing the wire. The digital inputs are polarity free.

Digital inputs are overvoltage protected.

Table 19: Digital Inputs Logic Levels and Other Requirements

Parameter	Value
Recommended operation voltage	0...24 V +20%/-10%
Overvoltage limit	33 V
Logic level	0 = $V_{TL} \leq 5$ V 1 = $V_{TH} \geq 15$ V
Input load	7.5 mA constant current and 10 k Ω resistive load
Reaction time	< 5 μ s
Maximum frequency	100 kHz
Electrical fast transient (EFT)	2 kV

7.6.4 Digital Outputs

The I/O and Relay Option has 2 digital outputs. The digital outputs are the push-pull type. The digital outputs can also be used as the open collector type.

The digital outputs are short-circuit protected.

Table 20: Digital Output Voltage and Current

Parameter	Value
Output voltage	0 = max 2 V 1 = min 20 V
Rated current	\pm 50 mA
Overcurrent limit	\pm 80 mA
Maximum voltage when used as open collector output	48 V
Maximum frequency	100 kHz
Electrical fast transient (EFT)	2 kV

1) Control unit power supply 24 V +20%/-10% and I_{load} max 50 mA

7.6.5 Relay Outputs

The I/O and Relay Option has 3 relay outputs. Relay 1 and Relay 2 have NO and NC contacts [1 form C (CO)]. Relay 3 has only an NO contact [1 form A (NO)]. The relay output interface is reinforced for system voltages \leq 300 V. The lifetime for relays is 100.000 cycles.

Table 21: Relay Output Values

Parameter	Value
Rated voltage	250 V AC
Maximum switching voltage	400 V AC
Rated current	8 A

Table 21: Relay Output Values - (continued)

Parameter	Value
Breaking capacity maximum	2000 VA
Operate time maximum	9 ms
Release time maximum	5 ms
DC breaking capacity	See Figure 37 .

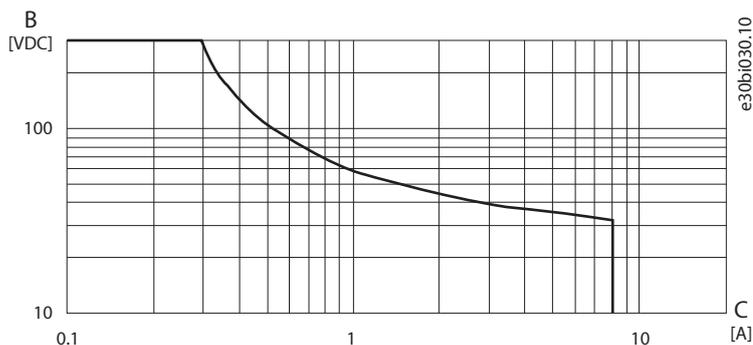


Figure 37: Maximum DC Load Breaking Capacity

B	DC voltage	C	DC current
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7.6.6 Analog Reference Voltage Output

The I/O and Relay Option contains 1 analog reference voltage output.

Table 22: Analog Reference Voltage Output Values

Parameter	Value
Nominal voltage	10 V
Accuracy	-3...+3% of nominal voltage
Maximum output current	10 mA
Short-circuit current	13 mA
Electrical fast transient (EFT)	2 kV

7.6.7 24 V DC Voltage Output

The I/O and Relay Option contains 1 voltage output of 24 V DC.

Table 23: 24 V DC Voltage Output

Parameter	Value
Nominal voltage	24 V
Accuracy	-15...+20%
Maximum output current	200 mA
Short-circuit current	250 mA
Electrical fast transient (EFT)	2 kV

7.6.8 Thermistor Input

The I/O and Relay Option contains 1 thermistor input. Thermistor input has basic isolation for system voltages ≤ 600 V and reinforced isolation for system voltages ≤ 300 V (OVC III 3000 m). For system voltage of 600 V, supplementary insulation is necessary at the motor end.

Table 24: Thermistor Input

Parameter	Value
Electrical fast transient (EFT)	2 kV
Sensor	R_{trip} 4.0 k Ω (PTC)

7.7 Installing Boards to the Modular Control Unit

NOTICE

DAMAGE TO OPTION BOARDS

Do not install, remove, or replace option boards on the drive when the power is on. Doing this can cause damage to the boards.

- Switch off the AC drive before installing, removing, or replacing option boards on the drive.

NOTICE

For best performance, install the Option Extender OC7F2 next to the control unit in 1 of the first 2 slots.

1. Remove the screw that is pre-attached to the fixing point at the top of the mounting plate and keep it.
2. Slide the lower edge of the board to the mounting plate fixing point.

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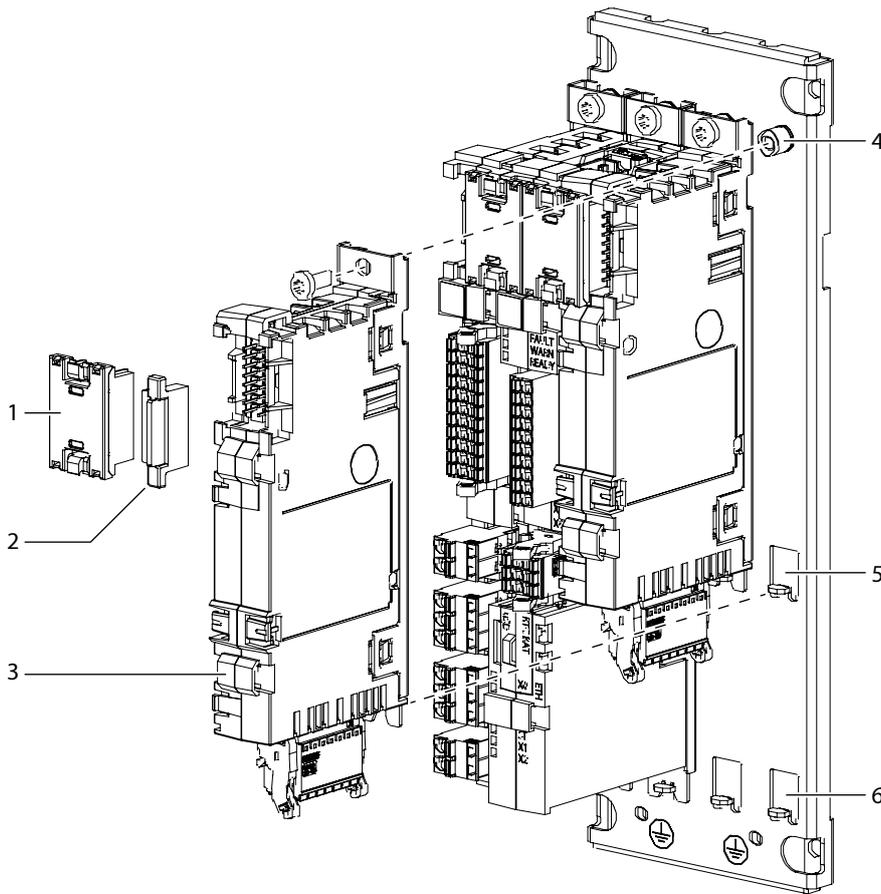


Figure 38: Installing a Board to the Modular Control Unit Mounting Plate

1	Option connector	2	Option terminal cover
3	Option board	4	Fixing point at the top
5	Fixing point at the middle	6	Fixing point at the bottom

3. Use the screw to attach the board to the fixing point at the top.
4. Attach an option connector to the installed board and the board next to it.
5. Attach option terminal covers to the empty terminals.

7.8 Installing the Control Cables into the Control Terminals

1. Install the control cables into the control terminals.

See the pin numbering of the I/O and Relay Option in [7.5 I/O and Relay Option \(OC7C1\) Connections](#).

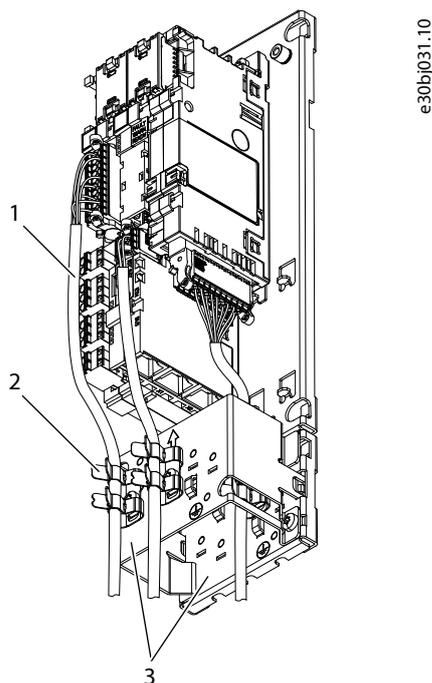


Figure 39: Example of Installing the Control Cables

1	Control cable	2	Cable clamp
3	Grounding plates		

- Strip the control cables. Attach the control cables to the cable clamps on the suitable grounding plate.

The lower part of the cable clamp fixes the cable to the plate and provides strain relief. The upper part provides ~360° grounding for the cable shield.

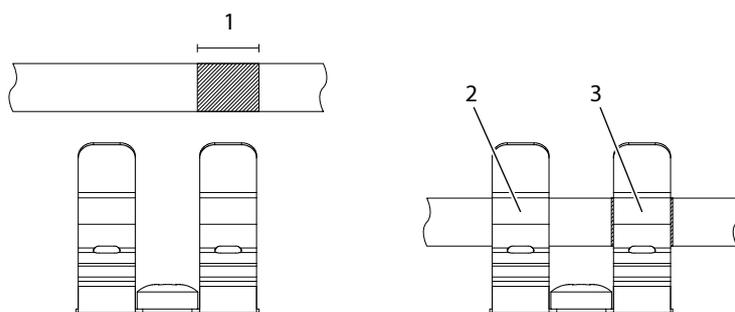


Figure 40: Stripping the Cable and Using the Grounding Plates

1	Stripping length, 10 mm (0.4 in)	2	Strain relief
3	Grounding		

7.9 Connecting the Control Panel

- Connect the control panel to the terminal X9 in the modular control unit with a panel cable adapter.

7.10 Fiber Cable Requirements

The required fiber cable type is LC duplex cable assembly 0.5NA SI-POF.

The installation temperature of the fiber cable is -40...+85 °C (-40...+185 °F). The minimum bending radius is 25 mm (1.0 in).

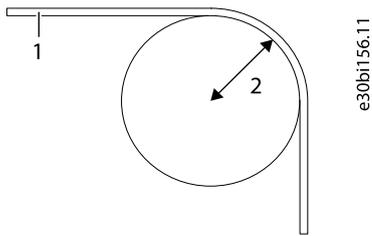


Figure 41: Bending Radius of the Fiber Cables

1	Cable	2	Bending radius (25 mm, 1.0 in)
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7.11 Installing the microSD Card

Supported microSD card types:

- SD
- SDHC
- SDXC

The microSD card must be formatted for the file system FAT32. It is recommended to use SDHC type cards as they are preformatted to FAT32.

1. Locate the microSD card hole on the control board of the control unit.

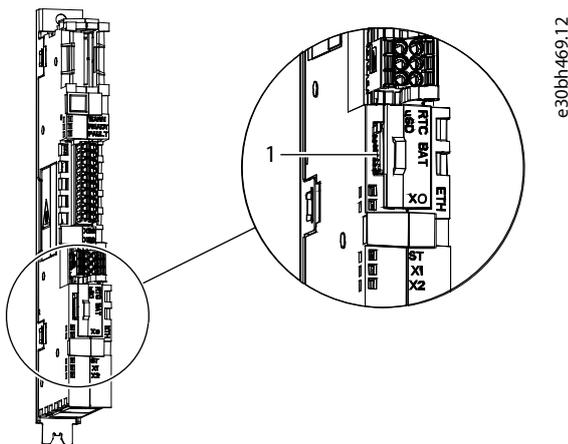


Figure 42: Location of the microSD Card

- 1 The microSD card

2. Push the new microSD card into the hole.

The contact area must face the text μ SD on the right.

To remove the microSD card, push it. The microSD card pops out.

8 Commissioning

8.1 Inspection Before Commissioning

Prerequisites:

Make sure that the iC7-Hybrid String PCS has been installed according to the instructions and requirements.

Complete the following checklist before starting to operate the unit.

1. Check that the DC switch handle is in the position OFF.
2. Check that the AC switch handle is in the position OFF.

See [2.4 Switch Disconnectors](#).

3. Check that the ON/OFF switch handle is in the position OFF.

See [3.8 ON/OFF Switch](#).

4. Check that no foreign objects are on top of the unit, or blocking the airways.
5. Check that no foreign objects are leaning on the unit.
6. Verify with measurements that the external cables and signal wires going to the unit are terminated correctly and according to local laws and regulations for electrical installations and safe practices.
7. Check that the unit is properly sealed according to the instructions.
8. Check that warning signs and labels are securely fixed to the unit.

8.2 Commissioning Procedure

Prerequisites:

Make sure that the checklist in [8.1 Inspection Before Commissioning](#) has been completed.

To start the unit, complete the following list.

1. Verify that the AC and DC voltage levels are at the correct level before connecting to supply.
2. Turn the DC switch handle to the ON position.
3. Turn the AC switch handle to the ON position.

See [2.4 Switch Disconnectors](#).

4. Turn the ON/OFF switch handle to the ON position.

See [3.8 ON/OFF Switch](#).

5. Confirm that the remote control system has access to the system.
6. Check that the communication to the remote control system is functional.
7. Ensure that the indicator lights on the cover of the unit show that the condition is OK.

See [3.7 Indicator Lights](#).

8. Observe that the unit starts operating normally according to the commands from the remote control system.

9 Maintenance

9.1 Preventive Maintenance Recommendations

Generally, all technical equipment, including Danfoss AC drives, need a minimum level of preventive maintenance. To ensure trouble-free operation and long life of the drive, regular maintenance is recommended. It is also recommended as a good service practice to record a maintenance log with counter values, date, and time describing the maintenance and service actions.

Danfoss recommends the following inspections and service intervals for air-cooled drives/systems.

NOTICE

The service schedule for part replacements can vary depending on operating conditions. Under specific conditions, the combination of stressful operation and environmental conditions work together to reduce the lifetime of the components significantly. These conditions can include, for example, extreme temperature, dust, high humidity, hours of use, corrosive environment, and loading.

For operation in stressful conditions, Danfoss offers the DrivePro® Preventive Maintenance service. DrivePro® services extend the lifetime and increase the performance of the product with scheduled maintenance including customized part replacements. DrivePro® services are tailored to the specific application and operating conditions.

Table 25: Maintenance Schedule for Air-cooled Drives

Component	Inspection interval ⁽¹⁾	Service schedule ⁽²⁾	Preventive maintenance actions
Installation			
Visual inspection	1 year	–	Check for the unusual, for example, for signs of overheating, aging, corrosion, and for dusty and damaged components.
Auxiliary equipment	1 year	According to manufacturer recommendations	Inspect equipment, switchgear, relays, disconnects, or fuses/circuit breakers. Examine the operation and condition for possible causes of operational faults or defects. The continuity check on fuses must be performed by trained service personnel.
EMC consideration	1 year	–	Inspect the wiring regarding the electromagnetic capability and the separation distance between control wiring and power cables.
Cable routing	1 year	–	Check for parallel routing of motor cables, mains wiring, and signal wiring. Avoid parallel routing. Avoid routing cables through free air without support. Check for aging and wearing of the cable insulation.
Control wiring	1 year	–	Check for tightness, damaged or crimped wires, or ribbon wires. Terminate the connections correctly with solid crimped ends. The use of shielded cables and grounded EMC plate, or a twisted pair is recommended.
Clearances	1 year	–	Check that the external clearances for proper airflow for cooling follow the requirements for the frame and product type. For clearances, refer to the local design regulations.
Sealing	1 year	–	Check that the sealing of the enclosure, the covers, and the cabinet doors are in good condition.
Corrosive environments	1 year	–	Conductive dust and aggressive gases, such as sulphide, chloride, and salt mist, can damage the electrical and mechanical components. Air filters do not remove airborne corrosive chemicals. Act based on the findings.
Drive			

Table 25: Maintenance Schedule for Air-cooled Drives - (continued)

Component	Inspection interval ⁽¹⁾	Service schedule ⁽²⁾	Preventive maintenance actions
Programming	1 year	–	Check that the AC drive parameter settings are correct according to the motor, drive application, and I/O configuration. Only trained service personnel are allowed to perform this action.
Control panel	1 year	–	Check that the display pixels are intact. Check the event log for warnings and faults. Repetitive events are a sign of potential issues. If necessary, contact a local service center.
Drive cooling capacity	1 year	–	Check for blockages or constrictions in the air passages of the cooling channel. The heat sinks must be free of dust and condensation.
Capacitors, DC link	1 year	8–15+ years	The expected lifetime of the capacitors depends on the loading profile of the application and the ambient temperature. For applications with heavy loads in demanding environments or high ripple currents, replace electrolytic capacitors every 8 years and plastic foil capacitors every 12 years. If within the specifications of the drive type, replace every 10–15+ years. Only trained service personnel are allowed to perform this action.
Cleaning and filters	1 year	–	Clean the interior of the enclosure annually, and more frequently if necessary. The amount of dust in the filter or inside the enclosure is an indicator for when the next cleaning or filter replacement is required.
Fans	1 year	3–10 years	Inspect the condition and operational status of all cooling fans. With the power off, the fan axis should feel tight, and spinning the fan with a finger, the rotation should be almost silent and not have abnormal rotation resistance. When in RUN mode, fan vibration, excessive or strange noise is a sign of the bearings wearing, and the fan must be replaced.
Grounding	1 year	–	The drive system requires a dedicated ground wire connecting the drive, the output filter, and the motor to the building ground. Check that the ground connections are tight and free of paint or oxidation. Daisy-chain connections are not allowed. If applicable, braided straps are recommended.
PCB	1 year	10–12 years	Visually inspect the printed circuit boards for signs of damage or degrading due to aging, corrosive environments, dust, or environments with high temperatures. Only trained service personnel are allowed to perform the inspection and service action.
Power cables and wiring	1 year	–	Check for loose connections, aging, insulation condition, and proper torque to the drive connections. Check for proper rating of fuses and continuity check. Observe if there are any signs of operation in a demanding environment. For example, discoloration of the fuse housing can be a sign of condensation or high temperatures.
Vibration	1 year	–	Check for abnormal vibration or noise coming from the drive to ensure that the environment is stable for electronic components.
Insulator gaskets	1 year	10–15 years	Inspect the insulators for signs of degradation due to high temperature and aging. Replacement is based on findings or done at the same time as DC capacitor replacement. Only trained service personnel are allowed to perform this action.
Batteries	1 year	7–10 years	Replace the batteries according to the manufacturer recommendation. Replace the real-time clock battery in the control unit every 7–10 years.
Spare parts			

Table 25: Maintenance Schedule for Air-cooled Drives - (continued)

Component	Inspection interval ⁽¹⁾	Service schedule ⁽²⁾	Preventive maintenance actions
Spare parts	1 year	2 years	Stock spares in their original boxes in a dry and clean environment. Avoid hot storage areas. Electrolytic capacitors require reforming as stated in the service schedule. The reforming must be performed by trained service personnel.
Exchange units and units stored for long periods before commissioning	1 year	2 years	Visually inspect for signs of damage, water, high humidity, corrosion, and dust within the visual field of view without disassembly. The exchange units with mounted electrolytic capacitors require reforming as stated in the service schedule. The reforming must be performed by trained service personnel.

1) Defined as the time after the commissioning/startup or the time from the previous inspection.

2) Defined as the time after the commissioning/startup or the time from the previous service schedule actions.

9.2 Service Safety

DANGER

ONLY QUALIFIED PERSONNEL ARE ALLOWED TO OPEN THE MAIN UNIT COVER

Voltages in the main unit are dangerous. Contact with these voltages can cause death or serious injury. Also the components included are sensitive and opening the cover exposes the components to ambient conditions, for example to dust.

- Do not open the main unit cover.
- Do not perform any service tasks other than the ones specified in the operating instructions. Only qualified personnel are allowed to do more advanced service tasks.
- Contact qualified service personnel if the cover must be opened.

All the parts that the operator is allowed to service can be accessed without opening the main unit (MU) cover. If the MU requires any service work, contact authorized service personnel.

Before opening the connection unit (CU) cover, always ensure that the converter is de-energized. See [9.3 De-energizing the Converter](#).

9.3 De-energizing the Converter

1. If the converter is running, stop the unit with a stop command from the remote control system.
2. Turn the ON/OFF switch handle to position OFF.
3. Open the switch disconnectors.
 - a. Open AC side switch disconnector if included. If not included, the voltage must be disconnected externally.
 - b. Open DC side switch disconnector.

See [2.4 Switch Disconnectors](#).

DANGER



RISK OF ELECTRIC SHOCK

The AC switch disconnecter is optional. If the AC switch disconnecter is not installed on the converter, the AC supply causes a risk of electric shock over a wider area of the device. Contact with the AC supply voltage can cause death or serious injury.

- If the optional AC switch disconnecter is not installed, an external switch or breaker is required to perform the disconnection from the AC supply.

DANGER



RISK OF ELECTRIC SHOCK

Voltages inside the converter and at the supply terminals are dangerous. Contact with these voltages can cause death or serious injury. As the switch disconnectors are located inside the converter, opening the switch disconnectors does not disconnect the voltage from the supply terminals or all the voltages inside the unit.

- Study the circuitry to plan the correct actions for disconnecting the voltages.
- Prevent reconnecting power to the converter while working.
- Always keep the protective covers properly installed.
- Always ensure by measuring that the unit is de-energized before working on the equipment.
- All the electrical connections must be done by a certified electrician and in accordance with the local requirements and regulations.

4. Lock or otherwise secure that the switch disconnectors cannot be closed during the maintenance.
5. Confirm that the converter is de-energized.

See the warning sign on the unit for detailed information about the discharging time. After the discharging time has elapsed, measure the voltages and confirm that no hazardous voltage levels are present.

DANGER



RISK OF ELECTRIC SHOCK FROM CAPACITORS

Capacitors included in the equipment store energy which is discharged slowly after disconnecting the power supplies. This energy maintains the voltage in the DC link causing a high risk of electric shock. Contact with this voltage can cause death or serious injury.

- Do not open the covers before the 5 minutes discharging time has elapsed.
- Always ensure by measuring that there are no voltages present before working on the equipment.

9.4 Opening the Connection Unit for Maintenance

DANGER



RISK OF ELECTRIC SHOCK

Voltages inside the equipment are dangerous. Contact with these voltages can cause death or serious injury.

- Always disconnect the converter from supplies before opening the connection unit cover.
- Always ensure by measuring that there are no voltages present before working on the equipment.

NOTICE

EFFECT OF EXTERNAL FACTORS

If the covers of the product are opened, the ambient conditions at the installation site can cause a device failure.

- Always keep the covers closed and locked while there is no justified reason to open them.
- Always make a risk analysis before opening the covers.
- Protect the device from water, dust, and other external factors.

1. De-energize the converter.

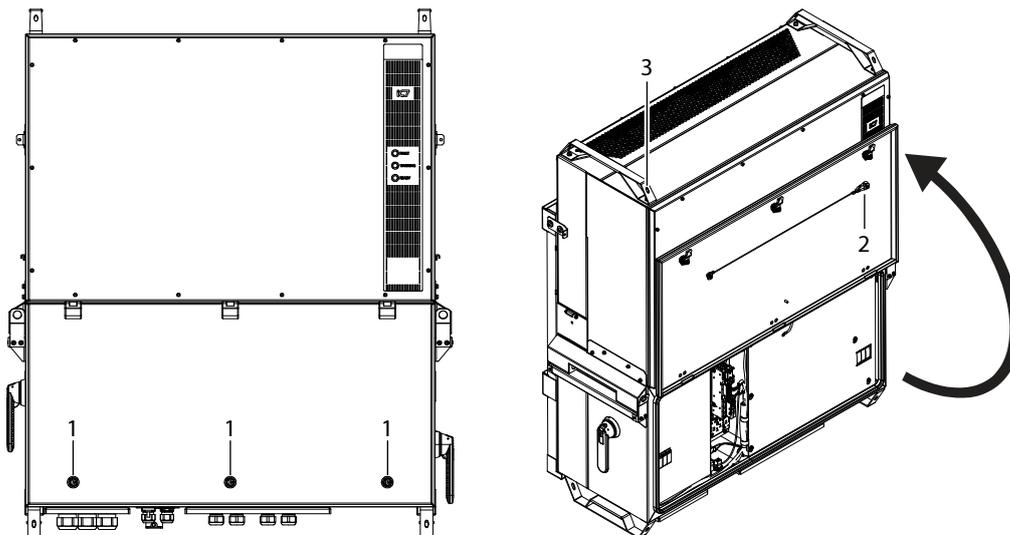
Follow the instructions in [9.3 De-energizing the Converter](#).

2. Open the locks on the connection unit (CU) cover.

The CU is locked with 3 locks.

3. Open the cover.

- a. Lift the cover.
- b. Secure the cover in the up position with the locking chain.



e30b1714.10

Figure 43: Opening the Connection Unit Cover

- | | |
|--|---|
| <ol style="list-style-type: none"> 1 Locks on the cover 3 Fixing point for the locking chain | <ol style="list-style-type: none"> 2 Locking chain for the cover |
|--|---|

9.5 Replacing the RTC Battery

The real-time clock (RTC) battery can be used to provide a reliable power source for the RTC. If power is lost in the control unit, the RTC battery keeps the internal real time. The time is used for scheduled activities and timestamping occurrences based on application needs. The RTC battery is optional and comes preinstalled if the option is selected.

CAUTION

RISK OF FIRE AND EXPLOSION

- Replace the battery with a Panasonic BR1632A (3 V, 125 °C) coin-cell battery only. Using another battery may present a risk of fire or explosion. Only qualified personnel can exchange the battery.
- Replace the battery with a Panasonic BR1632A or CR2032 coin-cell battery only, depending on the control board type. Using another battery may present a risk of fire or explosion. Only qualified personnel can exchange the battery.
- For detailed safety information, refer to the documentation provided with the battery.

CAUTION

RISK OF FIRE OR EXPLOSION

- Do not recharge or disassemble the battery, or dispose of it in fire.
1. Locate the RTC battery holder on the control board of the control unit.
 2. Pull from the handle next to the text RTC BAT.

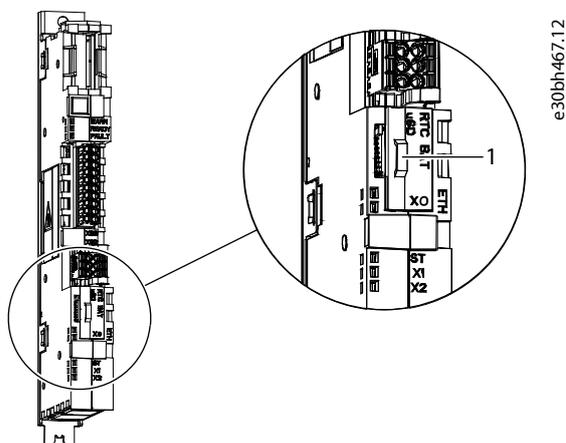


Figure 44: Location of the RTC Battery

1 The handle

➔ The battery holder slides out.

3. To remove the battery, push it on the tooth side and slide it out of the plastic holder.

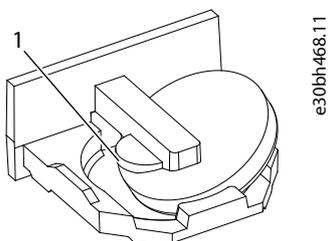


Figure 45: Replacing the Battery

1 The tooth

4. To put a new battery in place, start from the opposite side and slide it into the slot in the holder, the plus side towards the tooth.

The correct battery type is a coin type lithium battery BR1632A.

5. Push the holder back into the control board.

9.6 Replacing the Cooling Fans

There are 2 cooling fan assemblies, 1 on the left side and 1 on the right side of the iC7-Hybrid String PCS. Both assemblies contain 3 fans.

1. Shut down the iC7-Hybrid String PCS.
 - a. Turn the ON/OFF switch to the OFF position. See [3.8 ON/OFF Switch](#).
2. Remove the 2 screws holding the cooling fan assemblies.

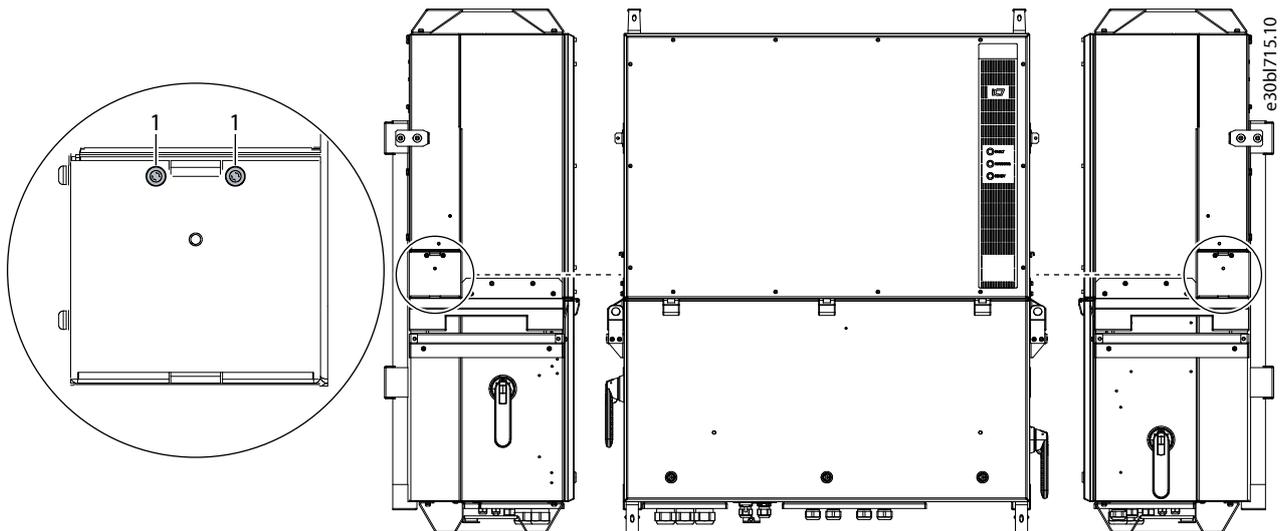


Figure 46: Releasing the Cooling Fan Assemblies

- 1 Mounting screws

3. Lift the housing slightly and pull it out approximately 10 cm (4 in).
4. Disconnect the fan wiring.

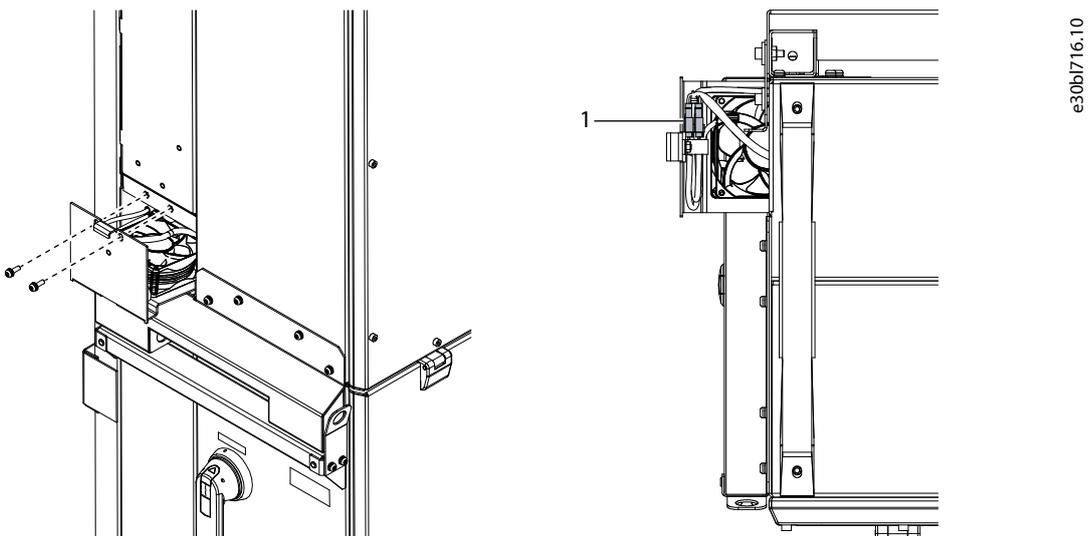


Figure 47: Fan Wiring

- 1 Fan wiring connectors

5. After the fan wiring is disconnected, pull out the fan assembly.

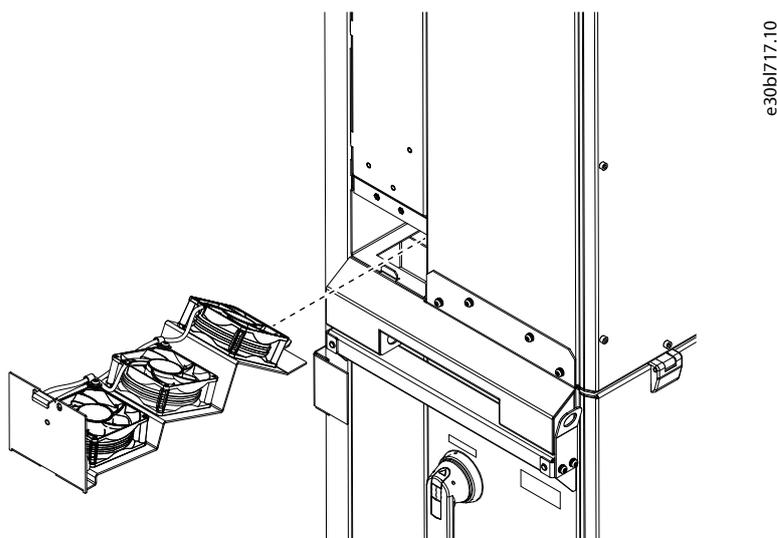


Figure 48: Cooling Fan Assembly Removed

6. Insert the new fan assembly, but do not push the assembly in completely
7. Connect the fan wiring

The fan wires are marked 1, 2, and 3.

8. Push in the fan assembly.
9. Mount the fan assembly with 2 screws.
10. Test that the fans function properly.

9.7 Replacing the DC Fuses

The DC fuse type (option +AVST) and number of fuses depend on the DC fuse mounting type (model codes for Littelfuse):

- +AUB1: 1 x PSX1XLUB0500
 - +AUB2: 2 x PSX1XLUB0250
 - +AUB3: 2 x PSX1XLUB0500
1. Open the cover of the connection unit.

See [9.4 Opening the Connection Unit for Maintenance](#).

2. Remove the DC protection cover by loosening the 6 size M5x10 screws.

See [Figure 26](#).

3. Release the DC fuses from the busbars by removing the M10x25 TX screws.

See the instructions in [6.10 Installing the DC Fuses](#).

4. Replace the DC fuses with new ones.

9.8 Checking the Surge Protection Devices

Table 26: Surge Protection Devices and Replacement Cartridges

Connection side	SPD model code (Mersen)	Replacement cartridge model code (Mersen)
AC	STPT2-30K750V-3PM	SP2-30K750V
DC	STPT2-40K1500V-YPVM	SP2-40K1500V-PV

1. Open the cover of the connection unit.

See [9.4 Opening the Connection Unit for Maintenance](#).

2. Check the indicators on the surge protection devices.
 - If the color of the indicator is green, the status is OK. No action is required.
 - If the color of the indicator is not green, replace the cartridge.

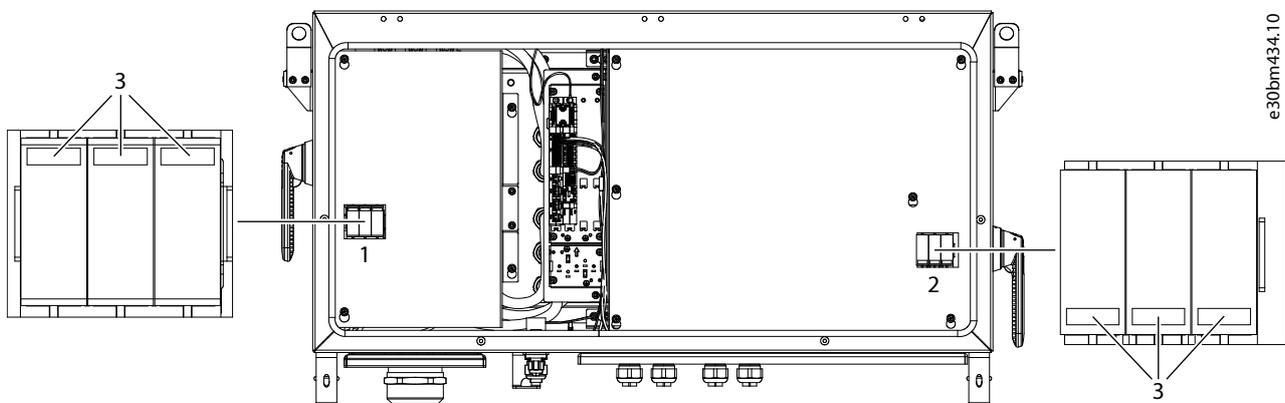


Figure 49: Locations of the Surge Protection Devices

1	AC SPD	2	DC SPD
3	Indicators		

3. To access the surge protection devices, remove the contact protection covers.
 - a. AC protection cover: Loosen the 4 size M5x10 screws.
 - b. DC protection cover: Loosen the 6 size M5x10 screws.

See [Figure 26](#).

4. Replace the cartridges of the surge protection devices with new ones.
 - a. Pull out the cartridge.
 - b. Push in the new cartridge.

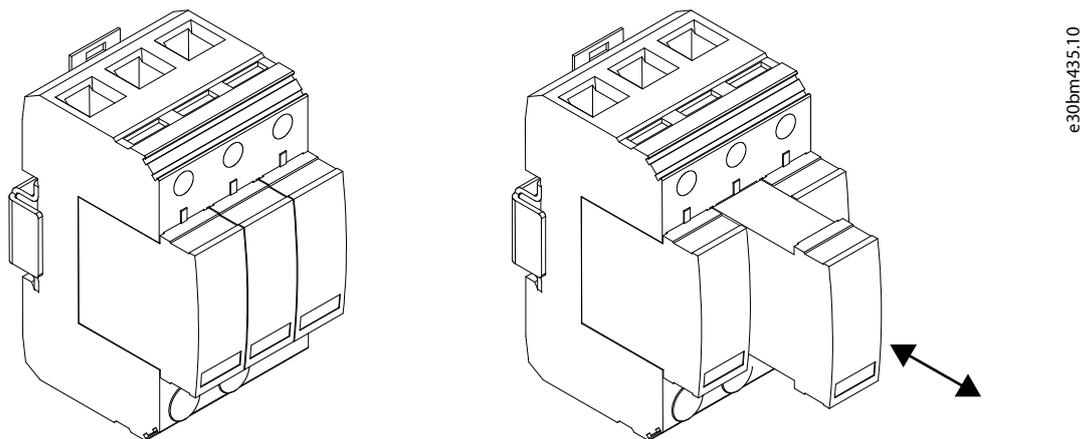


Figure 50: Replacing the Cartridges of the Surge Protection Devices

5. Reinstall the contact protection covers and close the cover of the connection unit.

9.9 Recommended Disposal

When the product reaches the end of its service life, its primary components can be recycled.

Before the materials can be removed, the product must be disassembled. Product parts and materials can be dismantled and separated. Generally, all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, and cardboard can be used in energy recovery. Printed circuit boards and large electrolytic capacitors with a diameter of over 2.5 cm (1 in) need further treatment according to IEC 62635 guidelines. To ease recycling, plastic parts are marked with an appropriate identification code.

Contact the local Danfoss office for further information on environmental aspects and recycling instructions for professional recyclers. End-of-life treatment must follow international and local regulations.

All products are designed and manufactured in accordance with Danfoss company guidelines on prohibited and restricted substances. A list of these substances is available at www.danfoss.com.



This symbol on the product indicates that it must not be disposed of as household waste. Do not dispose of equipment containing electrical components together with domestic waste.

It must be handed over to the applicable take-back scheme for the recycling of electrical and electronic equipment.

- Dispose of the product through channels provided for this purpose.
- Comply with all local and currently applicable laws and regulations.

10 Specifications

10.1 Technical Data

Table 27: Technical Data for iC7-Hybrid String PCS

Item	Value					
	400 V	480 V	600 V	630 V	660 V	690 V
AC voltage	400 V	480 V	600 V	630 V	660 V	690 V
Continuous operation voltage range	-15...+10%					
Nominal AC power at 40 °C (104 °F)	174 kVA	209 kVA	261 kVA	274 kVA	288 kVA	300 kVA
Maximum AC power at ≤30 °C (86 °F)	193 kVA	232 kVA	289 kVA	304 kVA	318 kVA	333 kVA
Absolute minimum grid voltage	320 V					
Nominal AC current at 40 °C (104 °F)	252 A					
Maximum AC current at ≤30 °C (86 °F)	279 A					
AC current distortion	< 3%					
Power factor - default	> 0.99 at nominal power					
Power factor range ⁽¹⁾	0.0 lag - 0.0 lead					
Nominal grid frequency	50/60 Hz (range ±10 Hz)					
Stand-by power consumption	≤10 W					
Maximum operating DC voltage [Nominal power up to 30 °C (86 °F)]	1300 V (1500 V with derating)					
Minimum DC voltage ⁽²⁾	615 V	725 V	900 V	940 V	980 V	1025 V
Maximum total continuous DC current at 40 °C (104 °F)	315 A					
Maximum total continuous DC current at ≤30 °C (86 °F)	345 A					
Maximum DC short-circuit rating	50/100 kA ⁽³⁾					
Maximum conversion efficiency	98.2%	98.4%	98.7%	98.8%	98.9%	99.0%
Inrush current	331 A, 220 μs					
Maximum backfeed current	0 A					
Maximum fault current and duration	671 A, 6 ms					

1) Limitations according to the grid code applied

2) See [10.7 Capability of Generating Reactive Power](#).

3) Planned product release

10.2 Ratings and Specifications

Table 28: Ratings and Specifications for iC7-Hybrid String PCS

Item	Value
Environmental category	Outdoor
Wet location classification	Yes
Pollution degree classification for the intended external environment	4
Ingress protection	IP65/Nema Type 4
Operating temperature range	-40...60 °C (-40...140 °F)

Table 28: Ratings and Specifications for iC7-Hybrid String PCS - (continued)

Item	Value
Ambient temperature during storage	-40...70 °C (-40...158 °F)
Relative humidity rating	Outdoor conditions
Maximum altitude	4000 m (13 000 ft) above sea level ⁽¹⁾
Overvoltage category	IV
Protective class	I
Grid connection type	TN-S, TN-C, IT If the converter is going to be connected to an IT grid, contact Danfoss for further instructions.
Vibration	Class 4M1
Chemically active substances	Class 4C2
Mechanically active substances	Class 4S2
Sound pressure	>70 dBA
Compliance marking	CE
EMC immunity	IEC/EN 61000-6-2
EMC emissions	CISPR 11 EN 55011 (Class A, Group 1)
Electrical safety	IEC/EN 62477-1
Grid codes	EN 50549-1/-2/-10, Regulation 2016/631 Contact Danfoss regarding available grid codes.

1) Contact Danfoss for characteristics above 1000 m (3300 ft)

10.3 Weights

The weights are approximate values depending on the selected options.

Table 29: Weights of the iC7-Hybrid String PCS

Unit	Weight	Additional information
Main unit	129 kg (285 lb)	-
Connection unit	112 kg (247 lb)	Depends on the selected product configuration
Mounting rack	10 kg (55 lb)	-

10.4 Dimensions

Table 30: Total Dimensions of the iC7-Hybrid String PCS

Dimension	Value
Height	1286 mm (50.63 in)
Width	1076 mm (42.36 in)
Depth	410 mm (16.14 in)
Depth with mounting rack	463 mm (18.23 in)

10.5 Options

The available pre-defined options are listed in the following table. Danfoss can also provide design customizations. Notice that design customization can affect the delivery time, pricing, and regulatory compliance.

Table 31: Options for the iC7-Hybrid String PCS

Option group	Plus code	Description
AC load switch	+AJXX	No integrated AC switch (default)
	+AJXD	Integrated AC switch on the connection unit
AC cable entry	+KF63	AC single M63 cable gland (default): A single cable gland for a 3-phase AC cable with ground, cable diameter 34–48 mm (1.34–1.89 in)
	+KF75	AC single M75 cable gland: A single, large cable gland for a 3-phase AC cable, cable diameter 48–62 mm (1.89–2.44 in)
	+KF3S	AC 3 single-phase M40 cable glands: Individual cable glands for each phase, cable diameter 16–28 mm (0.63–1.10 in)
	+KFBP	AC blind plate: A plate for the cables or conduits. Equipment grounding/protective earth connection is available both outside and inside the converter.
DC cable entry	+KJ2D	2 DC connection pairs (default): 2 DC cable pairs, 4 cable glands (2 cables per pole)
	+KJXX	DC blind plate: A plate for the cables or conduits.
DC fuse mounting	+AUB1	Single bolt-fuse placeholder on DC+ pole (default)
	+AUB2	2 bolt-fuse placeholders on DC+ pole
	+AUB3	Single bolt-fuse placeholder on DC+ pole and DC-pole
	+AUXX	No fuse holders The fuses must be installed outside the converter. Fuse type: 1500 V DC, aR bolt-type fuses in 1XL case size, fault current interruption capability 250 kA.
DC fuse selection	+AVST	1500 V DC, aR bolt-type fuses in 1XL case size, fault current interruption capability 250 kA (default) Nominal fuse ratings for the DC fuse mounting types: <ul style="list-style-type: none"> +AUB1: 500 A +AUB2: 250 A +AUB3: 2 x 500 A
	+AVXX	No fuses installed. The converter is shipped without fuses installed and the bolt-type fuse placeholders are empty. The recommended fuses must be installed before commissioning.
Common-mode filter	+MAC3	Common-mode filter included in the connection unit (default)
	+MAXX	Common-mode filter not included
Communication interface, X1/X2	+BAEL	Ethernet port, no protocol
	+BAMT	Modbus TCP OS7MT
	+BAPR	PROFINET RT OS7PR
	+BAPS	PROFINET RT/S2 OS7PS
	+BAEC	EtherCAT OS7EC
	+BAIP	EtherNet/IP OS7IP

Table 31: Options for the iC7-Hybrid String PCS - (continued)

Option group	Plus code	Description
Standard I/O	+BDXX	None
	+BDC1	I/O and Relay Option OC7C1
Control options ⁽¹⁾	+C_X0	None
	+C_C0	General Purpose I/O OC7C0
	+C_C1	I/O and Relay Option OC7C1
	+C_R0	Relay Option OC7R0
	+C_T0	Temperature Measurement OC7T0
	+C_V0	Voltage Measurement OC7V0
	+C_F2	Option Extender OC7F2

1) In the plus code, the second digit _ is either A or B, which stands for option slot A or option slot B.

10.6 High-altitude Characteristics

In outdoor applications, the most effective method to reach the maximum AC currents over a wide altitude range is to use the natural behavior of the temperature. At higher altitudes, the temperature is lower than near the sea level. Therefore, the impaired cooling capacity caused by thinner air at higher altitudes is mostly compensated for and the nominal and full power can be provided based on the outdoor conditions. This is not necessarily the case in indoor conditions so the preset operation limits are defined.

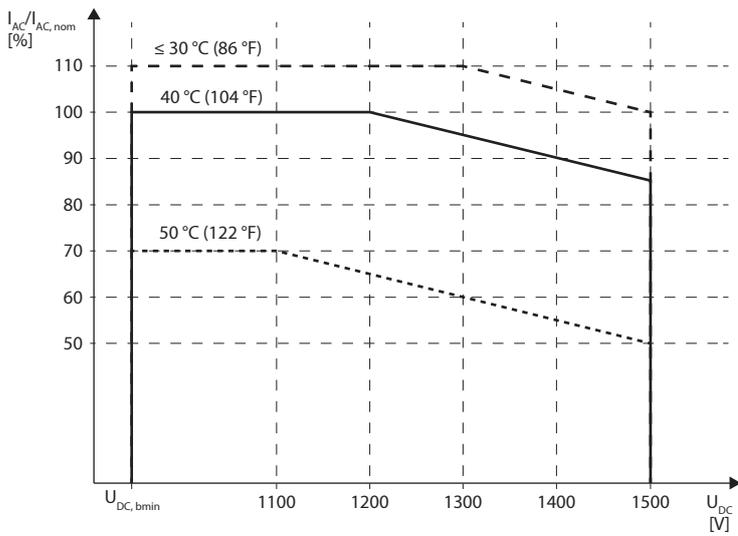
The linear decreasing rate of the ambient temperature allowing different current levels is 5 °C per 1000 m (3300 ft) over the whole altitude range 1000–4000 m (3300–13100 ft).

$$T = T_{1000m} - \frac{(h - 1000m) \times 5^{\circ}C}{1000m}$$

- h = altitude
- T_{1000 m} = temperature at 1000 m

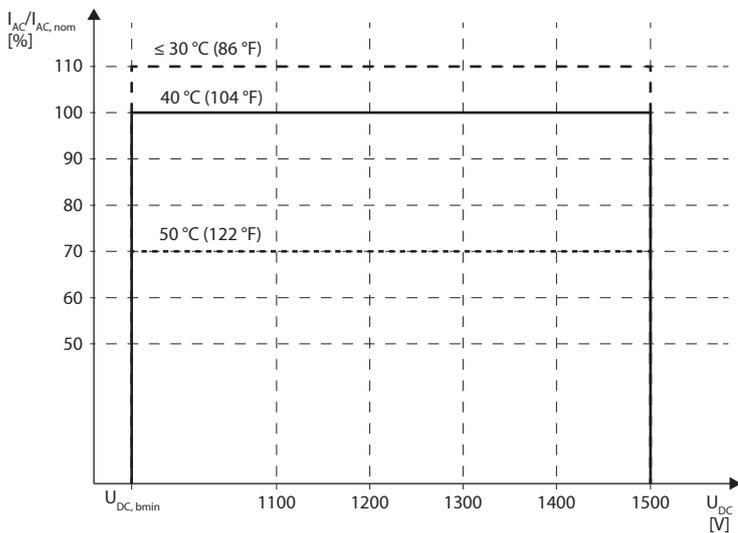
Table 32: Temperature limits for different current levels at 1000 m (3300 ft) altitude

Current level	Temperature limit
110%	30 °C (86 °F)
100%	40 °C (104 °F)
70%	50 °C (122 °F)



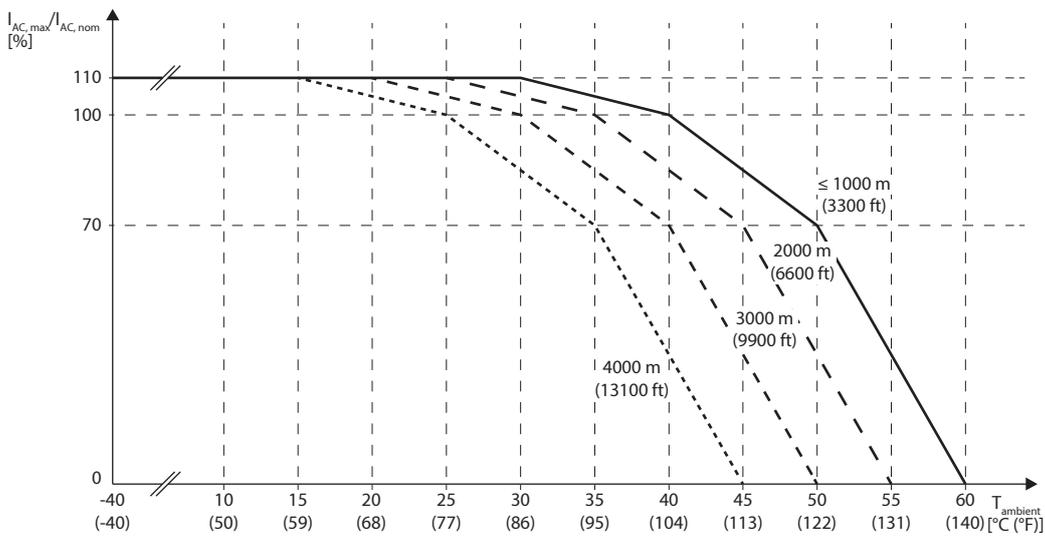
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Figure 51: Long-term (>4 h) Operation Curves at ≤ 1000 m (3300 ft) Altitude



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Figure 52: Short-term (≤2 h) Operation Curves at ≤ 1000 m (3300 ft) Altitude



e30bl722.10

Figure 53: Maximum Allowed AC Current (or Power)

10.7 Capability of Generating Reactive Power

iC7-Hybrid String PCS can produce reactive power in long-term operation without constraints regardless of the active power flow direction. The maximum power generation is presented in the following figures. Grid codes can include limitations which are not considered in the following figures. The limitations can be, for example:

- Differences in power factor limits
- In some grid codes, there are differences in defining the nominal power.

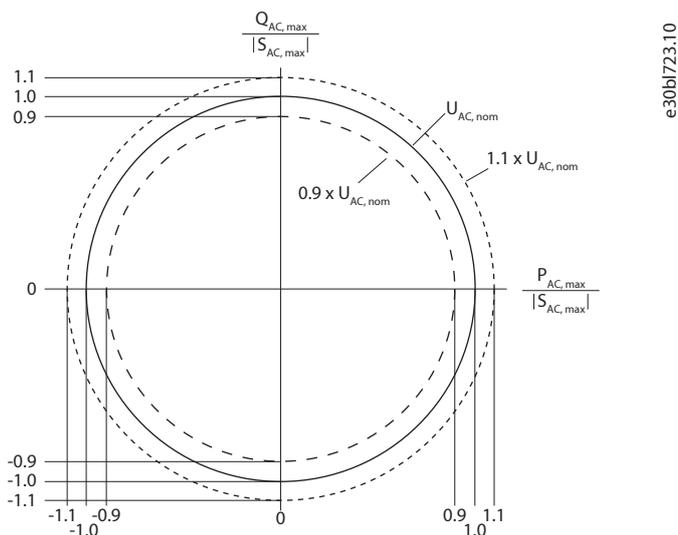


Figure 54: Maximum Power Generation Capability at 40 °C

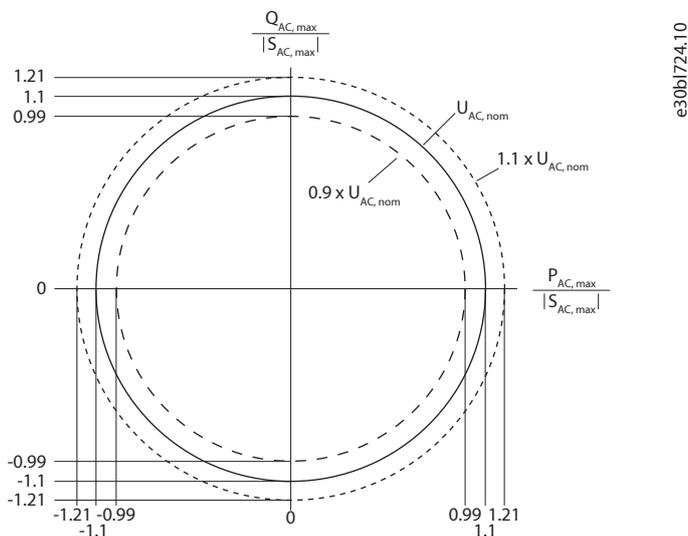


Figure 55: Maximum Power Generation Capability at $\leq 30\text{ }^{\circ}\text{C}$

In addition to the presentation shown in the previous figure, iC7-Hybrid String PCS includes preset grid code settings and parameterizable options. These settings and options can be controlled from the Danfoss Desktop Application. Part of the settings can be changed via Modbus.

See the Software guide for detailed information about the remote control system.

Due to grid filtering, the capacitive reactive power generation affects the minimum DC voltage operation limit. In grid control, the capacitive reactive power is used to support the grid when the voltage is dropping.

For further information, contact Danfoss.



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