Design Guide

iC7 Series Liquid-cooled System Modules

Active Front-End, Grid Converter, Inverter, and DC/DC Converter Modules

drives.danfoss.com | iC7

Contents

1 Introduction

1.1 Purpose of this Design Guide

This design guide is intended for qualified personnel, such as:

- Project and systems engineers.
- Design consultants.
- Application and product specialists.

The design guide provides technical information to understand the capabilities of the iC7 drives for integration into motor control and monitoring systems. Its purpose is to provide design considerations and planning data for integration of the drive into a system. It caters for selection of drives and options for a diversity of applications and installations. Reviewing the detailed product information in the design stage enables developing a well-conceived system with optimal functionality and efficiency.

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

1.2 Additional Resources

Additional resources are available to help understand the features, and safely install and operate the iC7 products:

- Safety guides, which provide important safety information related to installing iC7 drives.
- Installation guides, which cover the mechanical and electrical installation of drives, or functional extension options.
- Operating guides, which include instructions for control options, and other components for the drive.
- Application guides, which provide instructions on setting up the drive for a specific end use. Application guides for application software packages also provide an overview of the parameters and value ranges for operating the drives, configuration examples with recommended parameter settings, and troubleshooting steps.
- *Facts Worth Knowing about AC Drives*, available for download on www.danfoss.com.
- Other supplemental publications, drawings, and guides are available at 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 Planning and Design Support Materials

1.3.1 Overview of Available Planning and Design Support Materials

Danfoss provides access to a consolidated product environment that supports throughout the product lifecycle.

All iC7 series design guides, installation guides, safety guides, operating guides, and application guides are available for download at https://www.danfoss.com. It is also possible to order printed guides.

For each iC7 drive, 2D and 3D drawings, and wiring schematics are available in standard file formats. EPLAN files with macros, technical data, and 3D models are also provided to support in the system design.

Configuration files for drives are also available. MyDrive® Suite provides tools that support the entire lifecycle of the drive, from system design to service. MyDrive® Suite is available at https://suite.mydrive.danfoss.com/.

The product configurator helps in the product selection, and when the process has been completed, the tool provides a list of relevant documentation and accessories.

Detailed product information can also be accessed by reading the 2D code on the product label.

1.3.2 Locating Support Information

Additional information is available on the company website.

1. Go to https://www.danfoss.com.
2. Select *Products*.
3. Select *Drives*.
4. Select the product series, for example *Low-voltage drives* or *System modules*.
5. Select the product series (for example, iC7).

The browser opens the product page, which provides links to documents, drawings, and software of the product.

1.4 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
172K2848A	Design Guide created based on the previous Operating Guide 139Z5997C.

1.5 Abbreviations

Table 2: Abbreviations, Acronyms, and Symbols

Term	Definition
AC	Alternating current
AFE	Active front-end
AI	Analog input
AO	Analog output
DC	Direct current
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
EN	European standards
ESD	Electrostatic discharge
GC	Grid converter
GND	Ground
I	Current
IEC	International Electrotechnical Commission

Table 2: Abbreviations, Acronyms, and Symbols ***(continued)***

Term	Definition
INU	Inverter
I/O	Input/output
IP	Ingress protection
IT	Impedance grounded
LC	Inductor-capacitor
LED	Light-emitting diode
L/R	Time constant for a DC circuit
NC	Normally closed
NEMA	National Electrical Manufacturers Association
NFE	Non-regenerative front end
NO	Normally open
PCB	Printed circuit board
PE	Protective earth
RMS	Root mean square
RTC	Real-time clock
STO	Safe torque off
U	Voltage

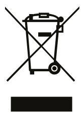
1.6 Recommended Disposal

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 under 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 your 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 https://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.

2 Safety

2.1 Safety

When designing AC drives, some residual dangers cannot be avoided. One example is the discharge time, which must be observed to avoid potential death or serious injury. The discharge time is shown on the danger label on the drive.

For further information on safety precautions related to the installation, operation, or maintenance of products, refer to the product-specific installation, safety, and operating guides.

2.2 Safety Symbols

The following symbols are used in Danfoss documentation.

⚠ 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).

The guide also includes ISO warning symbols related to hot surfaces and burn hazard, high voltage and electrical shock, and referring to the instructions.

	ISO warning symbol for hot surfaces and burn hazard
	ISO warning symbol for high voltage and electrical shock
	ISO action symbol for referring to the instructions

2.3 General Safety Considerations

⚠ WARNING	
	**LACK OF SAFETY AWARENESS** This guide provides important information on preventing injury and damage to the equipment or the system. Ignoring this information can lead to death, serious injury, or severe damage to the equipment. • Make sure to fully understand the dangers and safety measures present in the application.

WARNING

ELECTRIC SHOCK

Drives contain hazardous voltage when a power source is connected to AC or DC terminals. Failure to disconnect all power sources can result in death or serious injury.

- Before performing any electrical work on the drive, disconnect, lock out, and tag out all power sources to the drive.
- There is more than one live circuit. See the relevant wiring diagram in the product guide.

WARNING

DISCHARGE TIME

The drive contains capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the drive.
- Disconnect all input and output power sources of the drive (for example permanent magnet type motors, batteries, or DC-link connections to other drives).
- Wait for the capacitors to discharge fully before performing any service on the equipment. The discharge time is 5 minutes. If the device is broken or fuses have tripped, the discharge time is longer.
- Use a measuring device to make sure that there is no voltage, before opening the drive or performing any work on the cables.

WARNING

UNINTENDED START

When the drive is connected to a power source, the system may start at any time, causing risk of death, serious injury, and equipment or property damage.

- Stop the drive and motor before configuring parameters.
- Make sure that the drive cannot be started by an external switch, a fieldbus command, an input reference signal from the control panel, or after a cleared fault condition.
- Disconnect the drive from the power source whenever safety considerations make it necessary to avoid unintended start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

2.4 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.

3 Danfoss iC7 Series

3.1 Overview of iC7 Series

The Danfoss iC7 series comprises 3 products that combine hardware and software:

- iC7-Automation
- iC7-Hybrid
- iC7-Marine

The series consists of 3 hardware variants:

- System modules
- Enclosed drives
- Frequency converters

Additional application software can be purchased and some application software are only available for a specific hardware variant and product.

The following application software packages are available for the system modules.

- iC7-Automation: Industry, AFE, Motion
- iC7-Marine: Propulsion & Machinery, AFE
- iC7-Hybrid: Grid Converter, DC/DC Converter

There are application guides available for all the application software packages.

4 Overview of the iC7 Series Liquid-cooled System Modules

4.1 System Modules

The liquid-cooled system modules have 2 product categories:

- The **system modules** are ideal for installation with low height clearance. Needed filters are installed externally.
- The **system modules with integration units** have integrated filters in a compact design, easy cabinet installation, and easy serviceability.

The protection rating of the power units is IP00, and that is why the drive must be installed in a cabinet or another enclosure after delivery.

The liquid-cooled system modules are available with different functions: inverter, active front-end, grid converter, and DC/DC converter modules. The modules can be installed in parallel for higher power ratings.

The control unit of the system modules is installed separately. The control unit and the system modules are connected via fiber optics.

Inverter

The inverter (INU) module is intended for the regulation of motor speed in response to system feedback or to remote commands from external controllers. The inverter module requires a DC power source such as AFE or NFE to form a motor drive system. A drive system consists of the system modules, the motor, and equipment driven by the motor. The inverter module module can be used for power generation applications, but it is also intended for system and motor status surveillance.

Active front-end

The active front-end (AFE) module is used to transfer power between the AC input and the intermediate DC bus. The main functionality of the AFE module is to maintain a stable DC-bus voltage reference and supply power for motor drives (INU). When there is load in the DC bus, the AFE module rectifies the alternating current and voltage and transfers power from the AC input to the DC bus. When there is excess energy in the DC bus, such as braking power of motors, the AFE module inverts the direct current and voltage, and transfers power from the DC bus to the AC input.

The AFE can boost the DC-bus voltage within the voltage window of the converter hardware. The advantage is that the DC voltage available for the inverters is not limited even under unideal grid conditions or if the grid voltage is lower in some regions.

Power quality of the AFE is superior to diode or thyristor rectifiers, since it does not draw reactive current from the grid and the harmonic distortion is low (<5%). The advantage is that the incoming transformer does not need to be oversized, transformer losses are lower, and the unit can meet the most stringent harmonic requirements. The DC-bus voltage is also much smoother and AFE can also produce reactive current to compensate for other low power factor equipment.

Grid converter

The grid converter (GC) module is a dedicated inverter for advanced grid forming and bi-directional AC/DC power conversion. The GC can invert the DC voltage and rectify the AC voltage just like an AFE, but the power conversion control features are more advanced. The grid converter supports both open-loop and closed-loop AC voltage and frequency control.

The grid converter can create a microgrid and operate as the only power supply (island mode). The GC module can also be connected in parallel to other generating units with the frequency drooping function (μGrid mode), and maintain the grid on its own if the other power generation is stopped. The grid converter can also inject high short-circuit current to ensure selectivity in the microgrid. Alternatively, the GC can be used to control active and reactive AC power or current, and DC power, current, or voltage.

Typical use cases for grid converters are AC coupled energy storage, DC power supply for hydrogen electrolysis, micro grid forming, shore power, shaft generator, and other marine energy management applications.

DC/DC converter

The DC/DC converter is a bi-directional power converter, which enables the interconnection of two DC systems with different voltage levels. The DC/DC converter can boost the voltage from a lower voltage source to a higher DC-bus voltage, and step down the voltage of a DC bus to feed the source/load. The DC/DC converter can either control the DC-source voltage, DC-source current, or DC-bus voltage.

The DC/DC converter is often needed due to a mismatch between the voltage of the energy source and the DC voltage of the system. DC/DC converters can also be used as an adjustable DC voltage or current source and sink. A typical use case for the DC/DC converter is to connect an energy source to a DC grid or DC bus of a drive system for backup power, peak shaving, or fully electric applications.

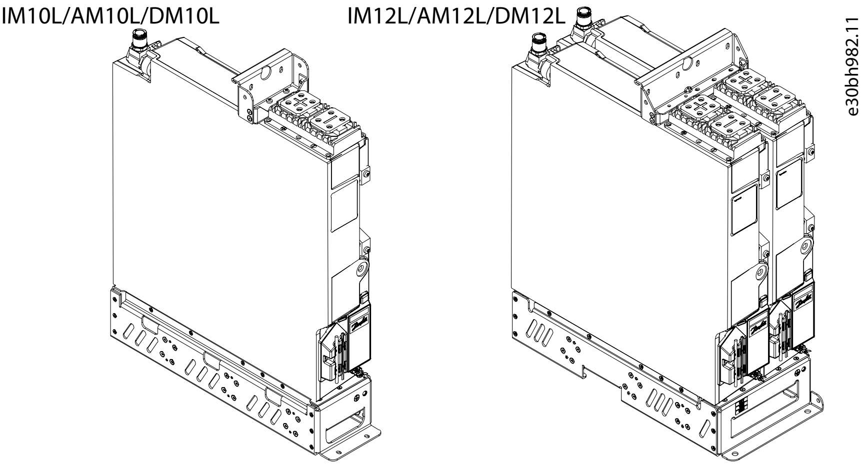


Figure 1: System Modules: IM10L/AM10L/DM10L and IM12L/AM12L/DM12L

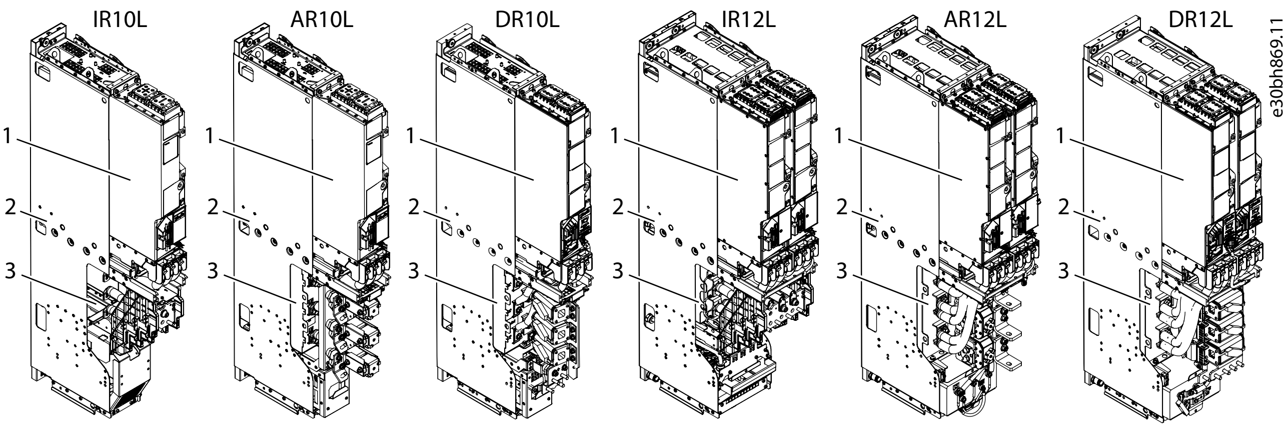


Figure 2: System Modules with Integration Units: IR10L, AR10L, DR10L, IR12L, AR12L, and DR12L

1	System module	**2**	Integration unit
3	Integrated filters (optional)		

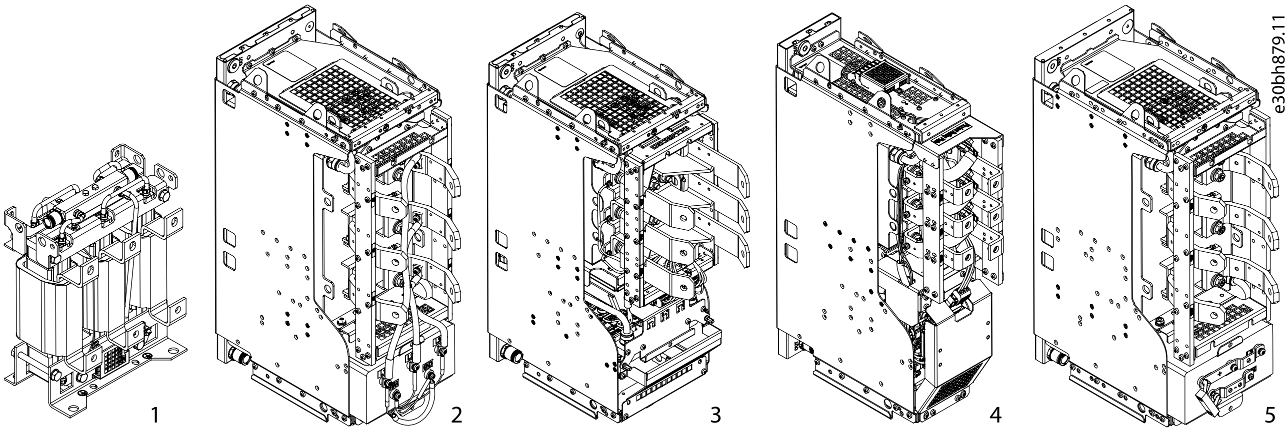


Figure 3: Liquid-cooled Filter Modules

1	Input L filter (part of LCL Filter)	**2**	LC Filter
3	dU/dt Filter	**4**	dU/dt and Common-mode Filter
5	DC Filter		

4.2 Control System of the System Modules

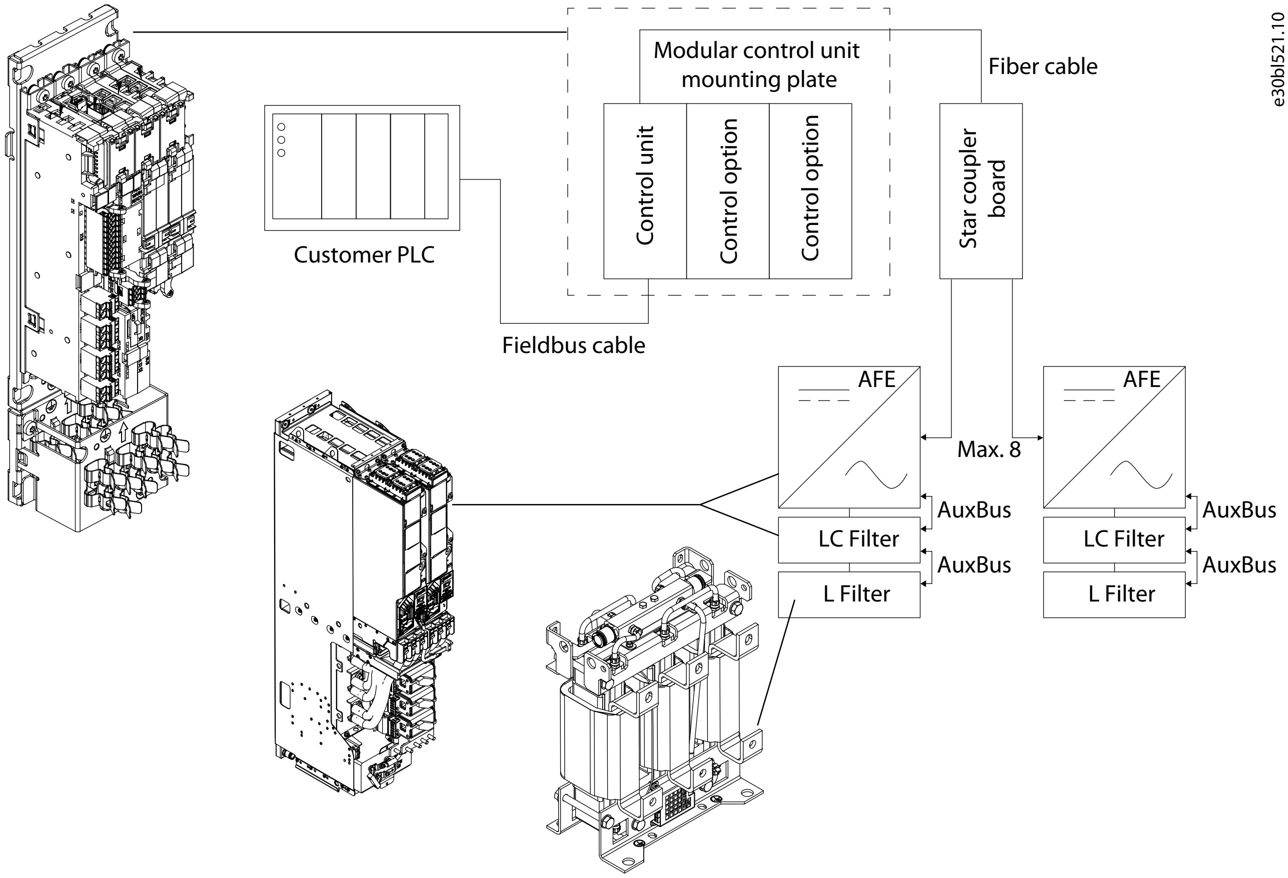


Figure 4: Example of a Control System of an AFE Module

4.3 Contents of the Delivery

The contents of the shipment of system modules

- Control unit with ordered control options
- Star coupler board for frames IM12L, AM12L, DM12L, IR12L, AR12L, and DR12L when the product consists of 2–16 power units
- Power unit
- Optical fiber cable
- One or two accessories bags for each power unit
- Other parts based on selected options
- Safety instructions

4.4 Description of the Frame Designation

A frame designation is used to refer to different types of iC7 Series system modules. The frame designation describes the function, mechanical variant, size, and cooling method of the system module.

The frame designation can have this format, for example:

IM10L

Table 3: Description of the Frame Designation

Code	Description
I	**Function** I = Inverter A = Active front-end/Grid converter D = DC/DC converter
M	**Mechanical variant** M = System module R = System module with integration unit
10	**Size** 10 or 12
L	**Cooling method** L = Liquid-cooled

4.5 Weights

The weights in Table 4 include the system module, the integration unit and the filters.

Table 4: Weights of the Liquid-cooled System Modules

Product	Weight [kg]	Weight [lb]
Inverter module, AFE/GC module, or DC/DC converter module, IM10L, AM10L, DM10L	41	90
Inverter module + integration unit (no filter +AE10), IR10L	73	161
Inverter module + integration unit (dU/dt Filter +AEU1), IR10L	106	234
Inverter module + integration unit (dU/dt+CM Filter +AEU2), IR10L	115	254
Inverter module + integration unit (Sine-wave Filter +AES1), IR10L	138	304

Table 4: Weights of the Liquid-cooled System Modules ***(continued)***

Product	Weight [kg]	Weight [lb]
AFE/GC module + integration unit (+AEZ1), AR10L	138	304
AFE/GC module + integration unit + L Filter (+AEZ3), AR10L	170	375
DC/DC converter module + integration unit (DC Filter +AED1), DR10L	130	287
Two inverter modules, two AFE modules, or two DC/DC converter modules, IM12L, AM12L, DM12L	80	176
Two inverter modules + integration units (no filter +AE10), IR12L	125	276
Two inverter modules + integration units (dU/dt Filter +AEU1), IR12L	178	392
Two inverter modules + integration units (Sine-wave Filter +AES1), IR12L	222	489
Two AFE/GC modules + integration units (+AEZ1), AR12L	230	507
Two AFE/GC modules + integration units + L Filter (+AEZ3), AR12L	230 + OF7Z5(1)	507 + OF7Z5(1)
Two DC/DC converter modules + integration units (DC Filter +AED1), DR12L	230	507

1) The size of the external L Filter OF7Z5 and number of filters depend on the number of parallel AR12L modules. See the weights for OF7Z5 in Table 5.

When a system module is ordered without an integration unit, the weights of the filters alone can be seen in Table 5.

Table 5: Weights of the Liquid-cooled Filters

Product	Weight [kg]	Weight [lb]
dU/dt Filter for IM10L, OF7U1	52	115
dU/dt + Common-mode Filter for IM10L, OF7U2	62	137
dU/dt Filter for IM12L, OF7U1	130	287
LC Filter for AM10L, OF7Z1	70	154
LC Filter for AM12L, OF7Z1	130	287
L filter (input side) for AM10L/AR10L, OF7Z5	32	71
L filter (input side) for AM12L/AR12L, 1000 A, OF7Z5	74	163
L filter (input side) for AM12L/AR12L, 1640 A, OF7Z5	125	276
DC filter for DM10L, OF7D1	70	154
DC filter for DM12L, OF7D1	130	287

4.6 Common DC Bus Drive System

A common DC bus drive system consists of one or more front-end modules (AFE, GC, or NFE) that convert the mains AC voltage into DC voltage and current, providing power to the common DC bus. A grid converter can also be used to form a local AC grid.

The common DC bus transfers the power to the inverter modules. The regenerative braking energy of an inverter can be used by the other inverters.

A common DC bus drive system can also include a brake chopper module or a DC/DC converter and an energy storage.

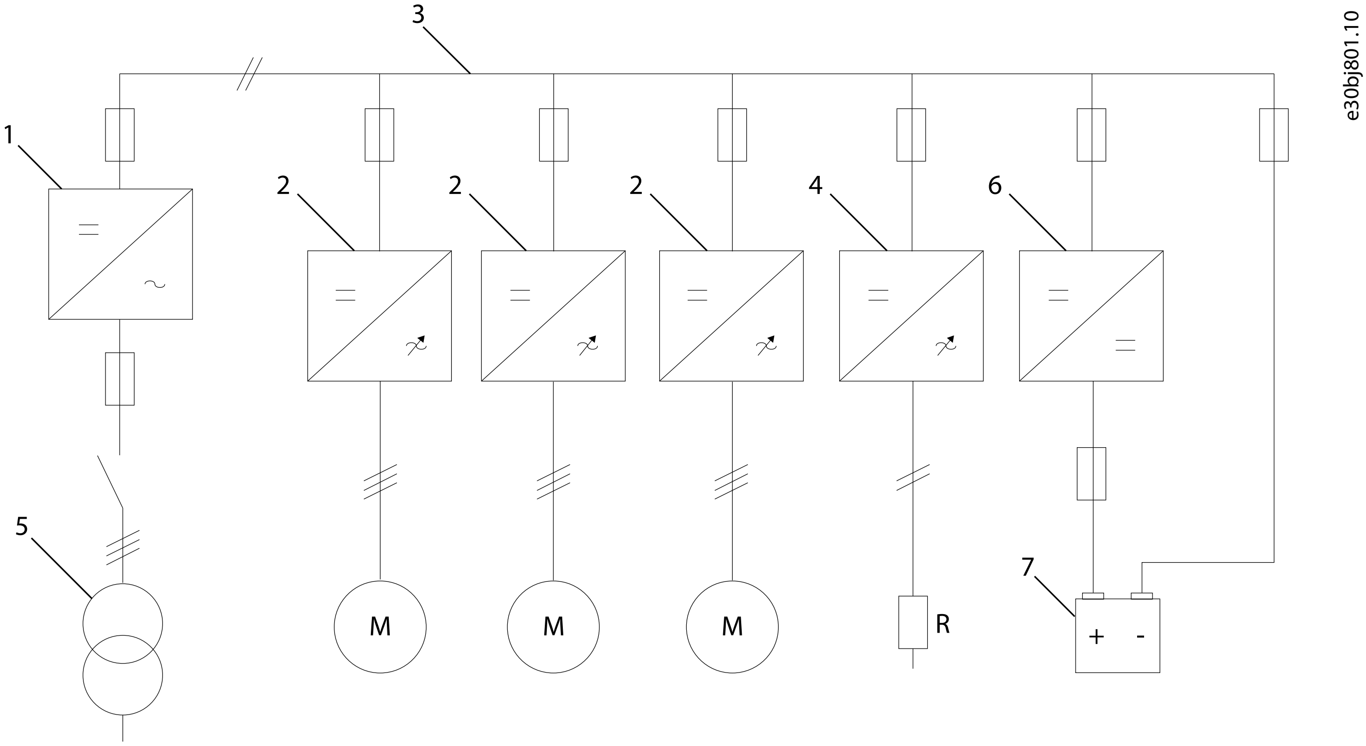


Figure 5: An Example of a Common DC Bus Drive System

1	AFE, GC, or NFE	**2**	Inverter module
3	DC bus	**4**	Brake chopper
5	Mains	**6**	DC/DC converter
7	Energy storage		

4.7 Description of the Model Code

The model code defines the specifications of the product included in the delivery. It is shown on 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:

iC7-60SLIN07-300AE00F4+XXXX(+XXXX)

Table 6: Description of the Model Code

Code	Description
iC7-60	**Product group**
SL	**Product category** SL = System module, liquid-cooled
IN	**Product type** 3A = 3-phase active front-end, AFE GC = Grid converter module, GC IN = Inverter module, INU DC = DC/DC converter, DC

Table 6: Description of the Model Code ***(continued)***

Code	Description
07	**Voltage rating** 07 = 525–690 V AC (640–1100 V DC) B5 = 380–500 V AC
-300A	**Current rating ($I_{L(1/5)}$)** -03A0 = 3 A -300A = 300 A -3000 = 3000 A
E00	**Protection rating** E00 = IP00/Open type
F4	**EMC level** F3 = C3 industry environment F4 = C4 system component
+XXXX	**Options** See separate list.

4.8 Labels on the Products

4.8.1 Labels on the System Module

To provide information about the product and the system modules, several labels are placed in the front of the modules.

- Product label
  - Includes the model code and other information about the product. See 4.7 Description of the Model Code.
  - See 4.8.3 Product Label.
  - When the product includes several system modules, the product label is only placed on the first module on the left-hand side of the lineup.
  - The product label is on a detachable plate. If the module is replaced, remove the label plate and mount it on the new module.
- Power module label
  - Includes information about the system module.
  - The information on the label is specific to each system module.
  - Includes the serial number of the product to which the system module belongs.
- Approvals label
  - List of approvals for the product.
- Service label
  - Label for service-related information.
- Product modified label
  - List of changes done to the module.
  - See 9.3 Using the Product Modified Label.

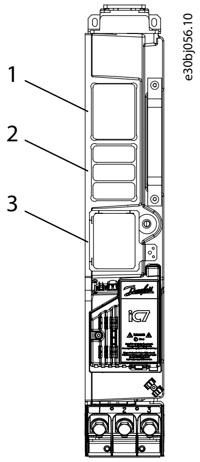


Figure 6: Locations of the Labels on the System Module

1	Power unit label	**2**	Approvals label, service label, and product modified label
3	Product label		

4.8.2 Labels on other Components

There is an identification label on the components to provide information about the part, and information to which product and system modules the component belongs. It is important to match the components with the correct product and system modules.

The identification label on control units and star coupler boards includes:

- Name of the component and information to which system modules the component belongs, for example, "Control for 4xAR12L" or "Star for 3xIR10L".
- The serial number (S/N) of the product to which the component belongs, for example DC1234XZ. This code is also shown in a small QR code.
- Code for the component, for example 137G2222.
- QR code, which shows the model code of the product to which this component belongs.

There are similar identification labels on the integration units, filters, subassemblies, and other components. For example, the label on L Filters includes:

- Information about the filter.
- The serial number (S/N) of the product to which the filter belongs.

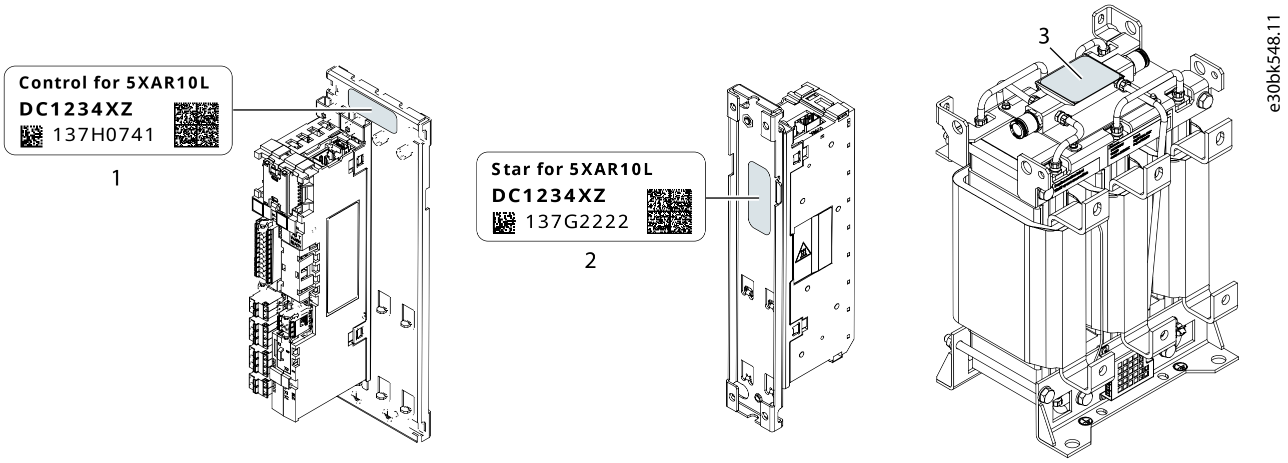


Figure 7: Locations of Labels on the Components

1	Label on the control unit	**2**	Label on the star coupler board
3	Label on the L Filter		

4.8.3 Product Label

The product label gives information about the product.

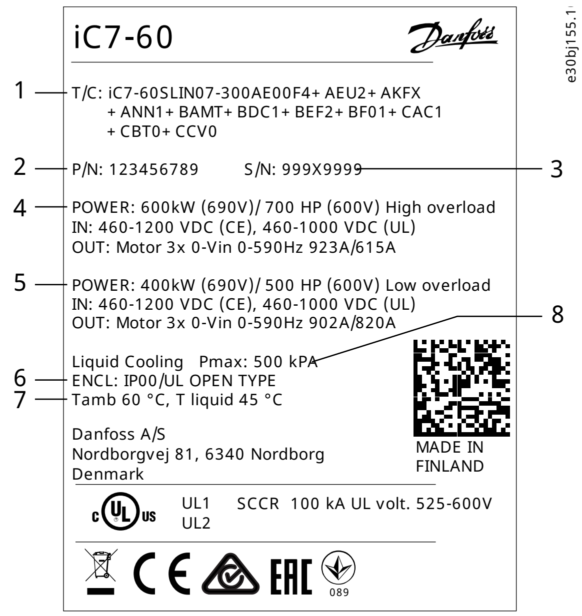


Figure 8: Product Label for iC7 Series Liquid-cooled System Modules

1	Model code of the product	**2**	Product number
3	Serial number	**4**	Power, input, and output ratings for high overload
5	Power, input, and output ratings for low overload	**6**	Protection rating
7	Temperature ratings for ambient air and coolant	**8**	Maximum continuous coolant pressure

4.9 Lifting the Product

4.9.1 Lifting the System Modules

1. Attach the lifting device in the hole on the top of the system module.
2. If necessary, lift the system module into a vertical position.

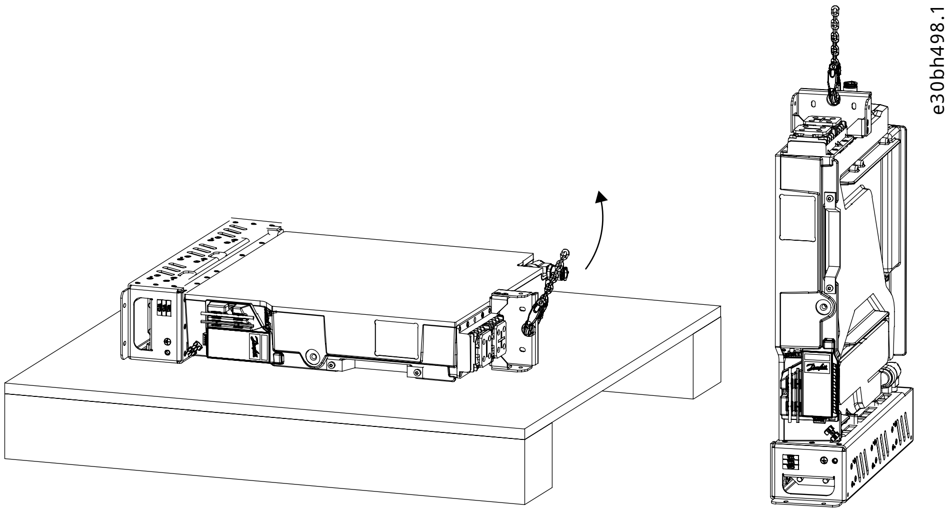


Figure 9: Lifting the System Module

3. Lift the system module to the required location.

4.9.2 Lifting the System Modules with Integration Unit

1. Put the lifting hooks in 4 holes at the top of the system module.

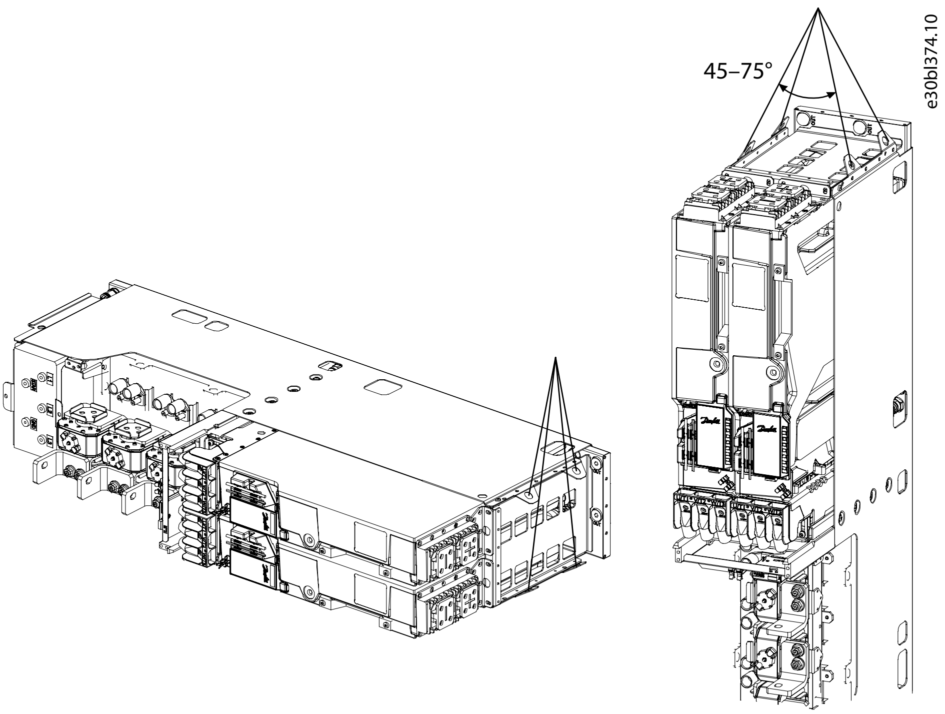


Figure 10: Lifting the System Module with Integration Unit

2. If necessary, lift the system module into a vertical position.

The recommended lifting angle is 60° ± 15°.

3. Lift the system module to the required location.

4.9.3 Lifting the Filters

Use these instructions to lift the L Filter, the LC Filter, the dU/dt Filter, the dU/dt and Common-mode Filter, and the DC/DC Filter.

1. Put the lifting hooks in 4 holes at the top of the filter.
2. If necessary, lift the filter into a vertical position.

The recommended lifting angle is 60° ± 15°.

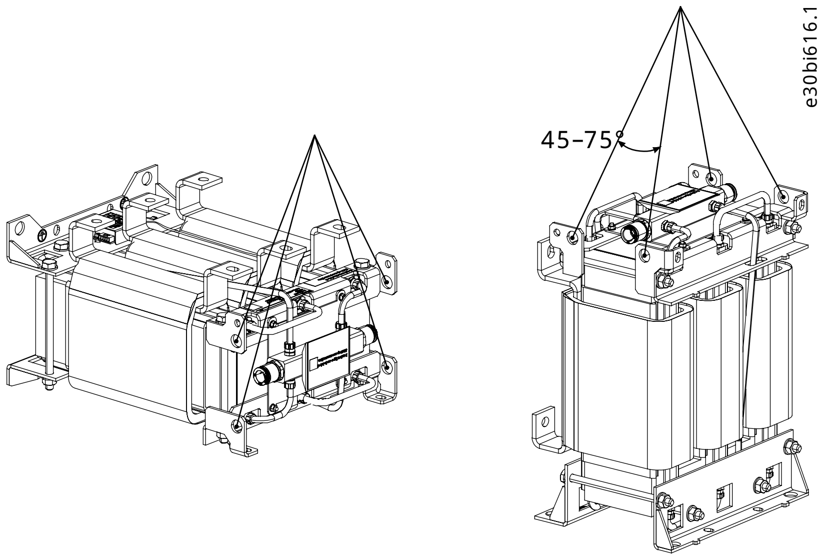


Figure 11: Example: Lifting the L Filter

3. Lift the filter to the required location.

5 Mechanical Installation Considerations

5.1 Storing the System Module

If it is necessary to store the product before installing it, follow these instructions. Keep the equipment sealed in its packaging until installation.

1. Make sure that the ambient conditions correspond to these:

   Temperature: -40...+70 °C (-40...+158°F)

   Humidity: 0...96%, condensation must be avoided

2. If the package is kept in storage for more than 2 months, keep it in controlled conditions.
   a. Make sure that the temperature variation is small.
   b. Make sure that the humidity is less than 50%.

5.2 Requirements for the Cabinet

The system modules that are described in this guide have the protection rating IP00/Open Type and do not have an enclosure. They must be installed in a cabinet or other enclosure that has a correct level of protection against the ambient conditions in the installation area. Make sure that the cabinet gives protection against water, humidity, dust, and other contaminations. The protection rating of the cabinet must be at least IP21/UL Type 1. The mounting surface of the cabinet must be non-combustible.

The cabinet must also be sufficiently strong to carry the weight of the system module and other devices. It is recommended to use a free-standing, floor-mounted cabinet made of sheet metal.

The maximum temperature of the air inside the cabinet is +60 °C (+140 °F).

When preparing the installation, obey the local regulations.

5.3 Mechanical Installation

5.3.1 Installation Requirements

The system modules that are described in this guide have the protection rating IP00/Open Type. Install them in a cabinet or other enclosure that has a correct level of protection against the ambient conditions in the installation area.

The installation procedure varies between product categories and mechanical variants depending on selected options.

Reserve enough space around the system module to ensure sufficient cooling. The mounting plane must be relatively even.

5.3.2 Installation Directions

NOTICE

Do not install the system module upside down or the front side facing down.

The system module can be installed vertically, horizontally, and on its backside.

5.3.3 Installing System Modules

5.3.3.1 Installing System Modules into a Cabinet Vertically

1. Install the system module into the cabinet in a vertical position.
2. Use mounting holes to attach the system module into the cabinet.
   a. Use M6 grade 8.8 screws.

b. For an AM12L or IM12L, use M8 grade 8.8 screws for the lower parts.

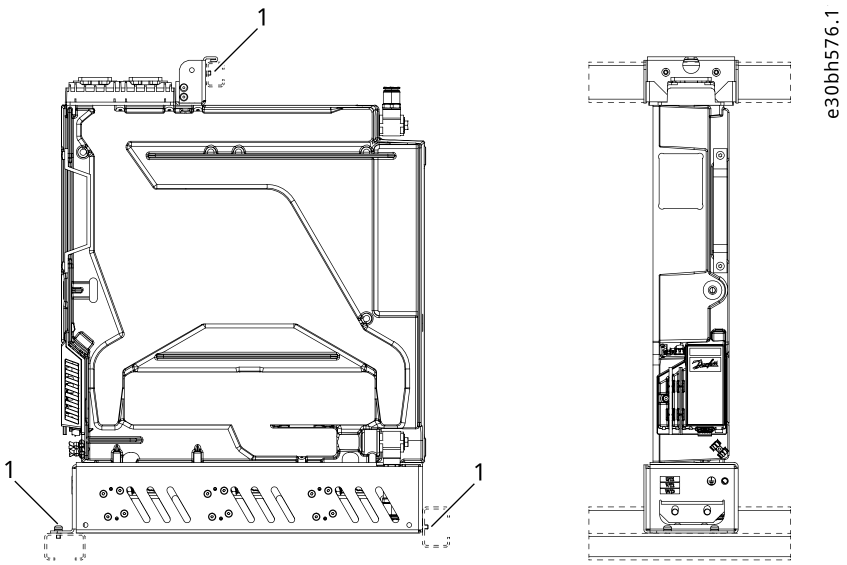


Figure 12: Mounting Holes of the System Module in Vertical Position

1	Mounting holes

3. Attach the system module to the mounting brackets of the cabinet.

The mounting brackets are not included in the delivery.

a. To ease the removal of the system module from the cabinet for service, use support bars under the system module.

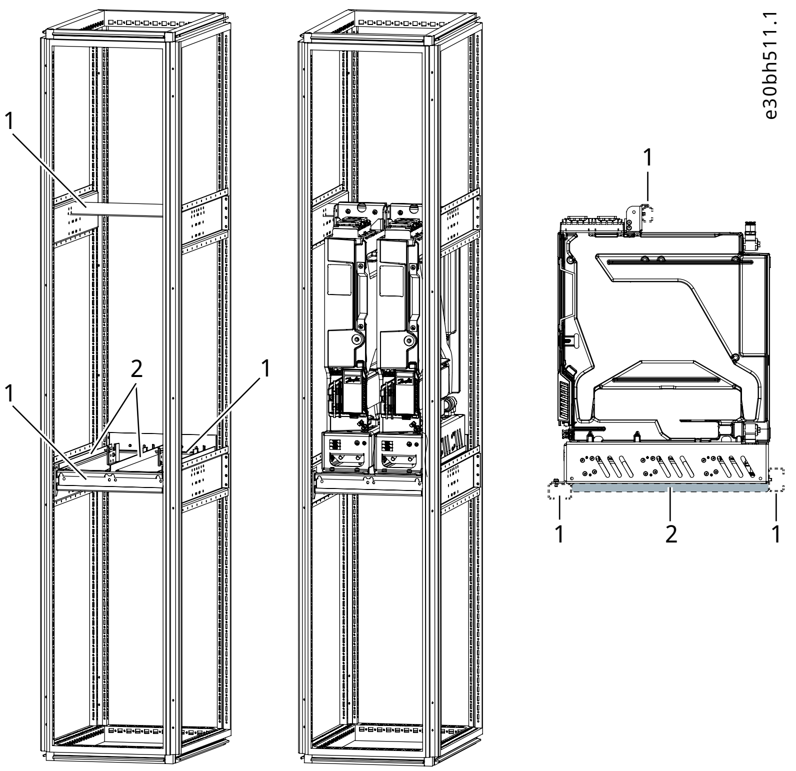


Figure 13: The Mounting Brackets and the Installation of System Modules into the Cabinet

1	Mounting brackets	2	Support bars

5.3.3.2 Installing System Modules into a Cabinet Horizontally

1. Install the system module into the cabinet in a horizontal position on its left side.
2. Use mounting holes to attach the system module into the cabinet.
   a. Use M6 grade 8.8 screws.
   b. For an AM12L or IM12L, use M8 grade 8.8 screws for the lower parts.

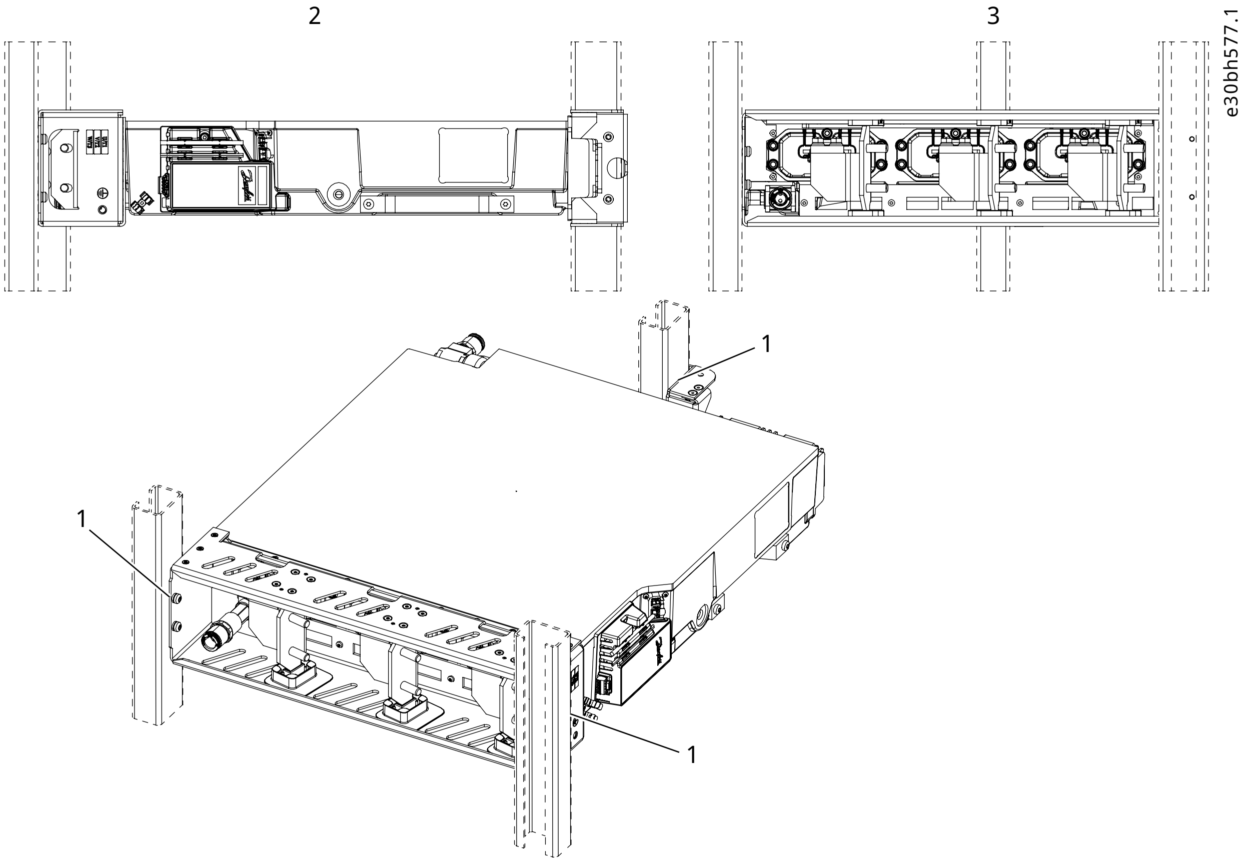


Figure 14: Mounting Holes of the System Module in Horizontal Position

1	Mounting holes	2	View from the front
3	View from the bottom		

3. Attach the system module to the mounting brackets of the cabinet.

> The mounting brackets are not included in the delivery.

5.3.3.3 Installing System Modules into a Cabinet on their Backsides

1. Install the system module into the cabinet on its backside.
2. Use mounting holes to attach the system module into the cabinet.
   a. Use M6 grade 8.8 screws.
   b. For an AM12L or IM12L, use M8 grade 8.8 screws for the lower parts.

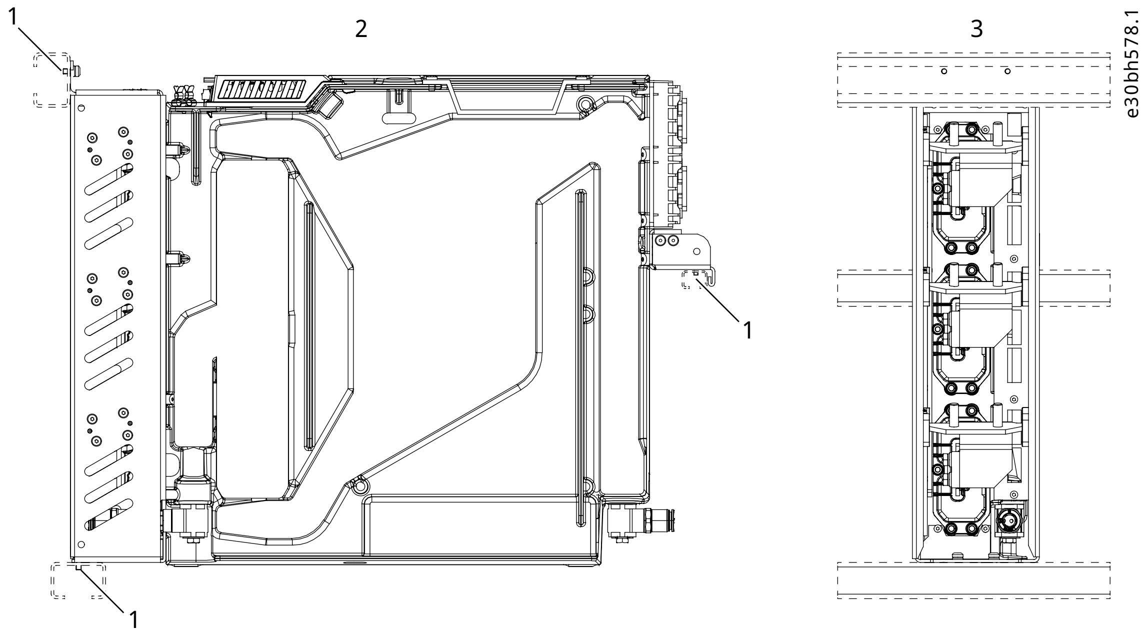


Figure 15: Mounting Holes of the System Module on its Backside

1	Mounting holes	**2**	View from the side
3	View from the bottom		

3. Attach the system module to the mounting brackets of the cabinet.

   The mounting brackets are not included in the delivery.

5.3.4 Installing System Modules with Integration Units

5.3.4.1 Installing System Modules with Integration Units into a Cabinet Vertically

1. Install the system module into the cabinet in a vertical position.
2. Use mounting holes to attach the system module into the cabinet.
   a. For aluminum parts, use M6 grade 8.8 screws with a thread depth of 6–14 mm (0.24–0.55in), and a tightening torque of 6–8 Nm (53–71 in-lb).
   b. For sheet metal parts, use M5 (DIN 7500) screws with a maximum thread depth of 20 mm (0.78 in), and a tightening torque of 3–4 Nm (27–35 in-lb).

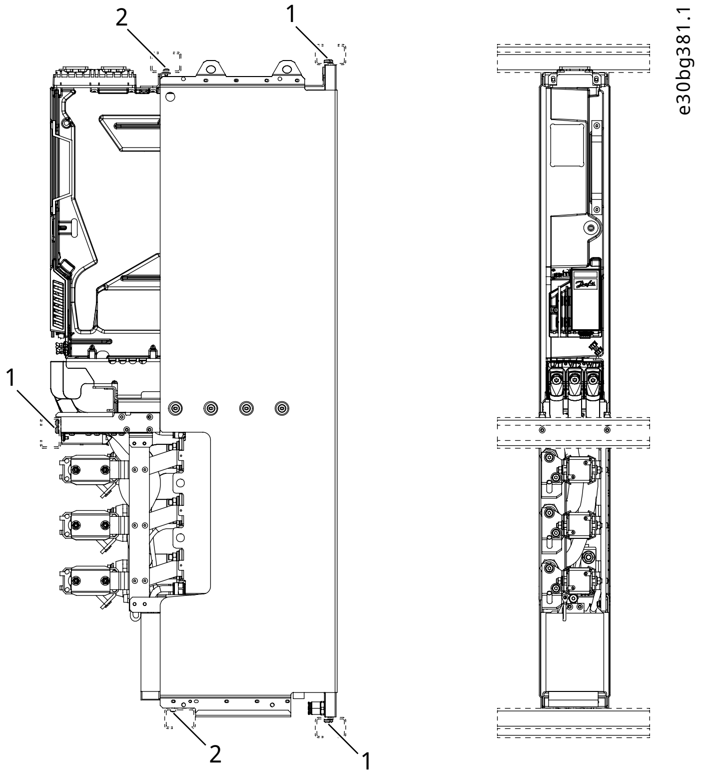


Figure 16: Mounting Holes of the System Module, AFE with the Integration Unit

1	Mounting holes in aluminum parts	**2**	Mounting holes in sheet metal parts

3. Attach the system module to the mounting brackets of the cabinet.

The mounting brackets are not included in the delivery.

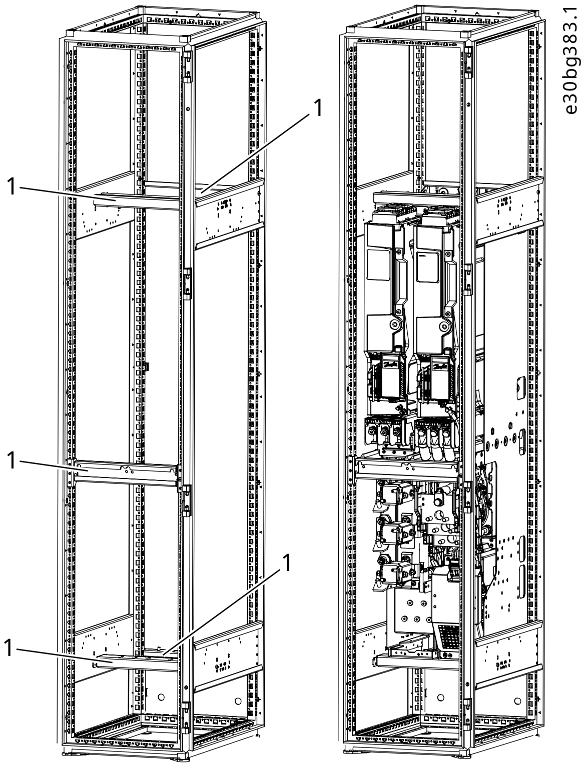


Figure 17: The Mounting Brackets and the Installation of System Modules with the Integration Unit into the Cabinet

1	Mounting brackets

5.3.4.2 Installing System Modules with Integration Units into a Cabinet Horizontally

1. Install the system module into the cabinet in a horizontal position on its left side.
2. Use mounting holes to attach the system module into the cabinet.
   a. For aluminum parts, use M8 grade 8.8 screws with a thread depth of 6–14 mm (0.24–0.55in), and a tightening torque of 6–8 Nm (53–71 in-lb).
   b. For sheet metal parts, use M5 (DIN 7500) screws with a maximum thread depth of 20 mm (0.78 in), and a tightening torque of 3–4 Nm (27–35 in-lb).

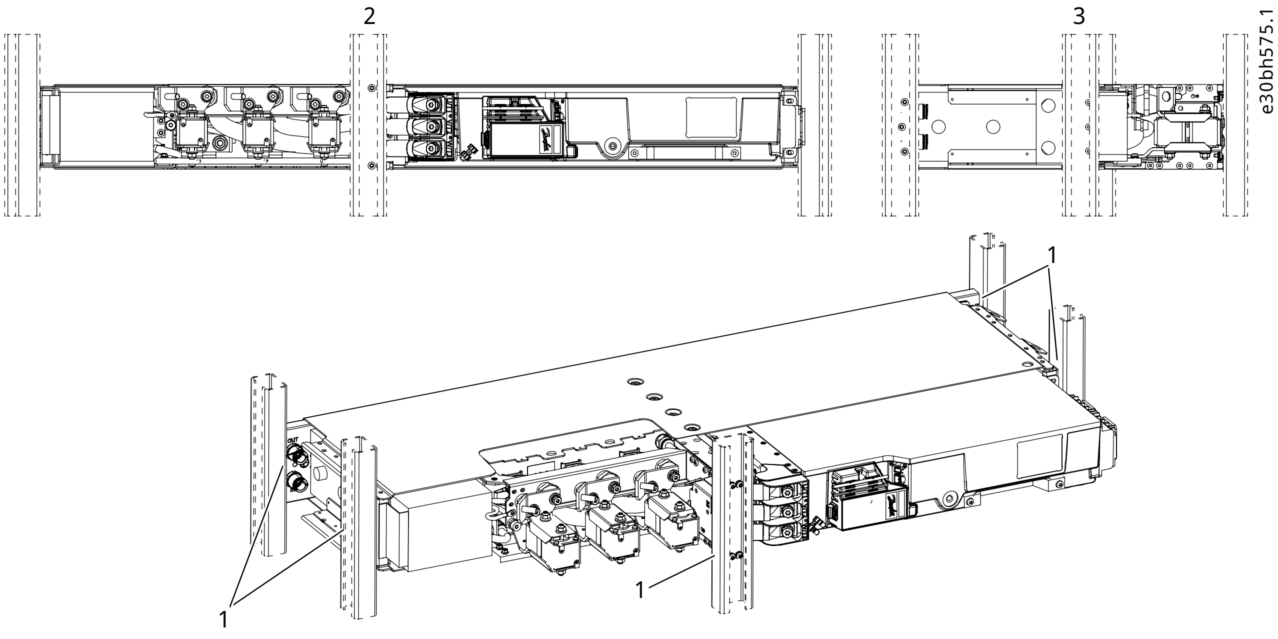


Figure 18: Mounting Holes of the System Module with the Integration Unit in Horizontal Position

1	Mounting holes	**2**	View from the front
3	View from the bottom		

3. Attach the system module to the mounting brackets of the cabinet.

> The mounting brackets are not included in the delivery.

5.3.4.3 Installing System Modules with Integration Units into a Cabinet on their Backsides

1. Install the system module into the cabinet on its backside.

2. Use mounting holes to attach the system module into the cabinet.

  a. For aluminum parts, use M6 grade 8.8 screws with a thread depth of 6–14 mm (0.24–0.55in), and a tightening torque of 6–8 Nm (53–71 in-lb).

  b. For sheet metal parts, use M5 (DIN 7500) screws with a maximum thread depth of 20 mm (0.78 in), and a tightening torque of 3–4 Nm (27–35 in-lb).

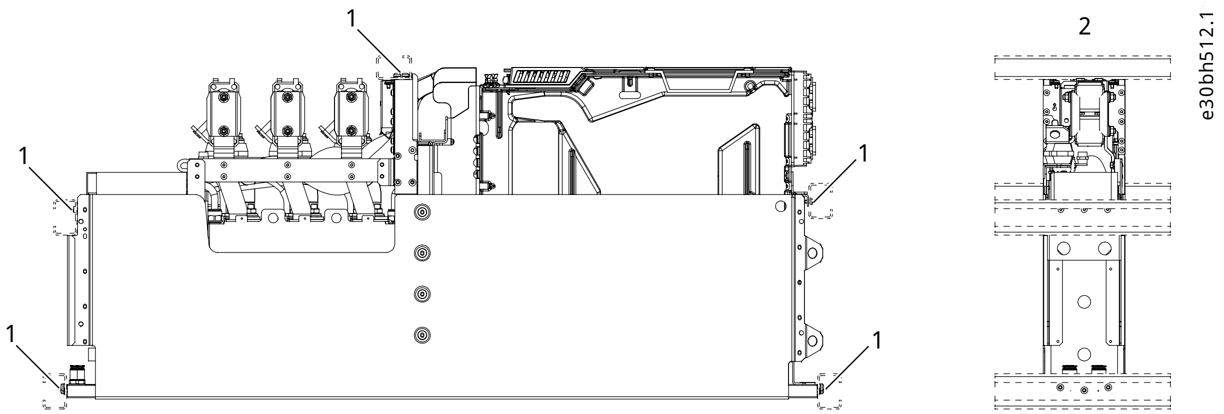


Figure 19: Mounting Holes of the System Module with the Integration Unit on its Backside

1	Mounting holes	2	View from the bottom

3. Attach the system module to the mounting brackets of the cabinet.

   The mounting brackets are not included in the delivery.

5.3.5 Installing Filters

5.3.5.1 Installing L Filter into a Cabinet, 400 A, 1000 A

1. Install the filter into the cabinet in a vertical position.
2. Align the filter so that the pins of the filter fit into the square holes at the back wall of the cabinet.

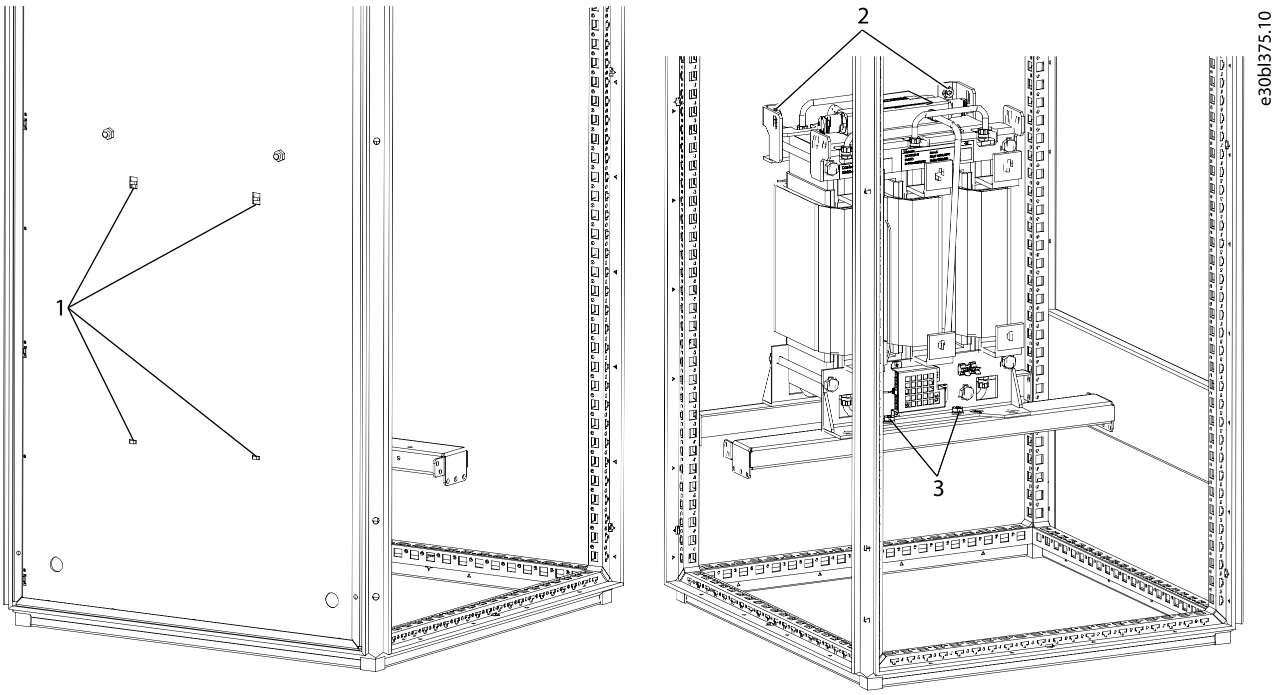


Figure 20: Installing the L Filter into a Cabinet (400 A, 1000 A)

1	Square mounting holes	2	The mounting holes at the top
3	The mounting holes at the bottom		

3. Use the mounting holes to attach the filter.
   a. Attach the filter from all the corners: top front, top back, bottom front, and bottom back.

   The mounting brackets are not included in the delivery.

5.3.5.2 Installing L Filter into a Cabinet, 1640 A

1. Install the filter into the cabinet in a vertical position.
2. Use the mounting holes to attach the filter.
   a. Attach the filter from all the corners: top front, top back, bottom front, and bottom back.

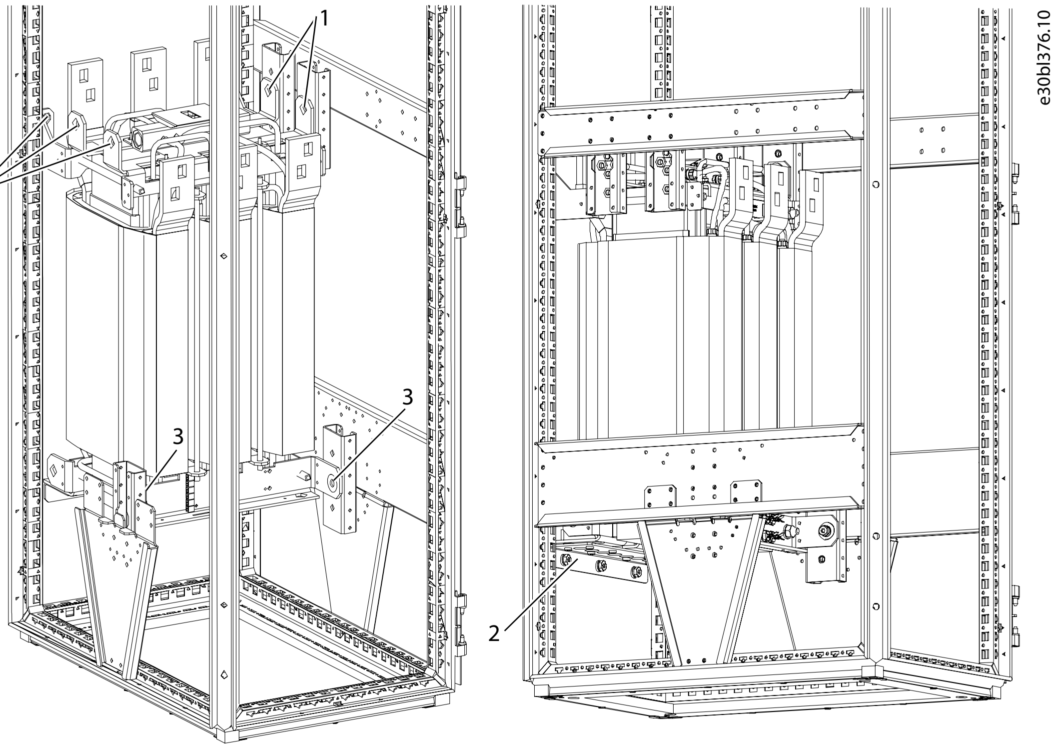


Figure 21: Installing the L Filter into a Cabinet (1640 A)

1	The mounting holes at the top	**2**	The bracket
3	The mounting holes at the bottom		

3. Use the bracket to attach the filter from below.

The mounting brackets are not included in the delivery.

6 Cooling Requirements

6.1 Safety in Liquid-cooling

⚠ WARNING

POISONOUS COOLANTS

Glycols and inhibitors are poisonous. If touched or consumed, they can cause injury.

- Prevent the coolant from getting into the eyes. Do not drink the coolant.

⚠ CAUTION

HOT COOLANT

Hot coolant can cause burns.

- Avoid contact with the hot coolant.

⚠ CAUTION

PRESSURIZED COOLING SYSTEM

Sudden release of pressure from the cooling system can cause injury.

- Be careful when operating the cooling system.

NOTICE

INSUFFICIENT COOLING CAPACITY

Insufficient cooling can cause the product to become too hot and thus become damaged.

- To make sure that the cooling capacity of the cooling system stays sufficient, make sure that the cooling system is vented and that the coolant circulates properly.

NOTICE

DAMAGE TO COOLING SYSTEM

If the coolant circulation is stopped too soon, high-temperature components can cause rapid local increase in the coolant temperature, which can damage the cooling system.

- Do not stop the cooling system when stopping the drive. Keep the coolant circulation flowing for 2 minutes after the drive has been stopped.

6.2 General Information on Cooling

NOTICE

The maximum pressure in the cooling system cannot exceed 5 bar.

- Equip the cooling system with a relief valve.

The product is cooled with liquid. The liquid circulation of the drive is usually connected to a heat exchanger (liquid-to-liquid or liquid-to-air) that cools down the liquid circulating in the cooling elements of the drive. The cooling elements are made of aluminum. That is why the coolants allowed to be used are demineralized (or deionized, or distilled) water with corrosion inhibitors, or a mixture of this type of water and glycol with corrosion inhibitors.

There are two types of circulation system: open systems and closed systems.

Always use a closed system with liquid-cooled drives.

An open system has no pressure but the hydrostatic and pumping pressure. It allows free contact between the coolant and air. Air is continuously dissolved into the coolant, which corrodes and damages the components.

In a closed system, the piping is air-tight and there is a preset pressure inside the pipes. The pipes must be made of metal, or a specific plastic or rubber that includes an oxygen barrier that limits the diffusion of oxygen. Minimizing of oxygen content in the coolant decreases the risk of corrosion of the metal parts. Closed systems usually have an expansion tank that allows for a safe change of volume of the coolant due to temperature changes.

The electrical resistance of the plastic and rubber pipes must be >10^9 Ω.

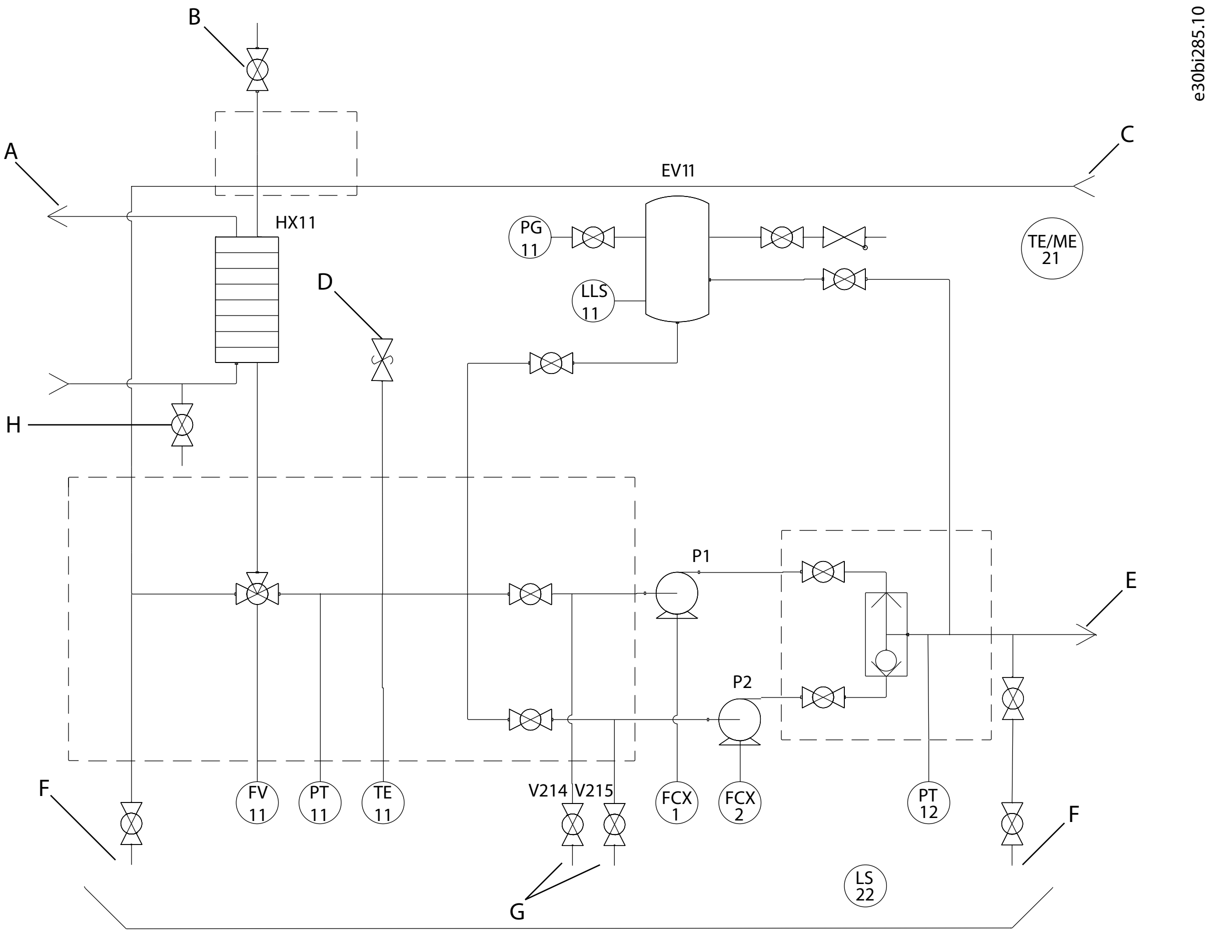


Figure 22: Example PID Diagram of the Cooling Circuit

A	Customer cooling circuit	**B**	De-airing valve
C	Coolant from the drives	**D**	Relief valve
E	Coolant to the drives	**F**	Filling and draining
G	Draining		

6.3 Coolant

6.3.1 Quality Requirements for the Purified Water

NOTICE

DAMAGE TO SYSTEM FROM THE USE OF HYDROCARBONS

Hydrocarbons damage the rubber seals of the cooling system.

- Do not use hydrocarbons (for example mineral oil) as coolant. Do not mix hydrocarbons to coolant.

Table 7: Requirements for the Purified Water

Property	Required value
pH	6...8
Chlorides	≤ 25 ppm
Sulphate ions	≤ 25 ppm
Maximum particle size	≤ 50 µm
Total dissolved solids	≤ 200 ppm
Total hardness ($CaCO_3$)	3…4.6 dH° (53…80 ppm)
Hydrogen carbonate	≤ 50 ppm
Electrical conductivity	≤ 500 µS/cm

6.3.2 Purified Water as Coolant

Purified water can be used as coolant if there is no risk of freezing. Freezing water permanently damages the cooling system. Purified water is demineralized, deionized, or distilled water.

Always use an inhibitor Cortec VpCI-649 with 1.0% of volume with purified water.

⚠ CAUTION

CORROSION HAZARD WITH DRINKING WATER

Some components are made of aluminum, which has limited corrosion resistance against high chloride concentrations. Drinking water can have a chloride concentration of 250 ppm, which increases the aluminum corrosion rate. High chloride concentration exposes aluminum especially to pitting corrosion which can damage the system relatively quickly.

- Use purified (demineralized, deionized, or distilled) water with corrosion inhibitors.

6.3.3 Antifreeze Mix as Coolant

The following antifreeze products are a good general solution for liquid cooling since they provide freeze protection and corrosion protection.

The allowed antifreeze coolants are the following ethylene glycols and propylene glycols.

Ethylene glycols

- DOWCAL 100
- Clariant Antifrogen N

Propylene glycols

- DOWCAL 200
- Clariant Antifrogen L

These glycols already include corrosion inhibitors. Do not add any other inhibitor. Do not mix different glycol qualities because there can be harmful chemical interactions.

The glycol concentration of the coolant must be 25–55% by volume, according to the specified ambient temperature. Higher concentration reduces cooling capacity. Lower concentration results in biological growth and inadequate amount of corrosion inhibitors. Antifreeze must be mixed with purified water according to 6.3.1 Quality Requirements for the Purified Water.

6.3.4 Temperature of the Coolant

To gain full performance of the product, the temperature of the coolant entering the system module must be a maximum of 45 °C (113 °F). While circulating inside the cooling element, the liquid transfers the heat produced by the power semiconductors and other components. The temperature rise of the coolant during the circulation is typically less than 7 °C (13 °F) for INU modules and less than 10 °C (18 °F) for AFE modules. Typically, 95% of the power losses are dissipated in the coolant. It is recommended to equip the cooling circulation with temperature supervision.

6.4 Cooling System

6.4.1 Materials

⚠ CAUTION

DAMAGE TO THE SYSTEM FROM INCORRECT MATERIALS

Using steel, copper, or copper alloy pipes or parts in contact with the coolant damages the system.

- Do not use pipes or parts made of steel, copper, or alloys that include copper. If metallic pipes are used in the cooling system, use aluminum or stainless steel pipes. Use AISI316 for steel, and, for example, EN-AW6060, EN-AW6063, or EN-AW6082 for aluminum.

Allowed materials in the cooling system

If they are compatible with the coolant, these materials are allowed in the cooling system:

- Aluminum
- Stainless steel AISI 304/316
- Plastic*
- Elastomers (EPDM, NBR, FDM)*

* If plastic or elastomers are used, check material compatibility within the temperature range of the coolant. See 10.8 Technical Data.

Do not use PVC, copper, brass, steel or other materials not compatible with the heat sink material or coolant.

Recommended material for plastic pipes

- PA11
- PA12
- PEX with oxygen barrier
- PEX-AL-PEX

6.4.2 Heat Exchanger

The heat exchanging equipment can be located outside the electrical room in which the AC drives are. The connections between these two are made on site. To minimize the pressure drops, the piping must be made as short and straight as possible. It is also recommended to install a regulating valve that is equipped with a flow rate measurement point. This makes it possible to measure and regulate the coolant circulation in the commissioning phase.

The highest point of the piping must be equipped with either an automatic or a manual venting device. The material of the piping must comply with at least AISI 304 (and AISI 316 is recommended). Before connecting the pipes, clean the bores thoroughly. If cleaning with water is not possible, use pressured air to remove all loose particles and dust.

6.4.3 Flow Rate of the Coolant

Table 8: Liquid-cooled System Modules and Integrated Filters

Product type	Frame	Nominal flow rate with water [l/min]	Nominal flow rate with 30% glycol [l/min]	Nominal flow rate with 50% glycol [l/min]	Maximum flow rate [l/min]	Liquid volume per element [l]
GC/AFE/INU module	AM10L/IM10L	11.0	14.5	16.5	18.0	0.55
GC/AFE/INU module	AM12L/IM12L	22.0	29.0	33.0	36.0	1.10
AFE/GC with LC Filter for AFE (+AEZ1)	AR10L	19	25	29	30	1.70
AFE/GC with LC Filter for AFE (+AEZ1)	AR12L	34	44	51	54	3.25
INU with dU/dt Filter (+AEU1)	IR10L	26	33	38	41	1.68
INU with dU/dt and CM Filter (+AEU1, +AEU2)	IR10L	26	33	38	41	1.68
INU without filters (+AE10)	IR10L	12	16	18	19	1.50
INU with dU/dt Filter (+AEU1)	IR12L	37	48	56	59	3.34
INU without filters (+AE10)	IR12L	25	33	38	40	3.00
INU with Sine-wave Filter (+AES1)	IR10L	19	25	29	30	1.70
INU with Sine-wave Filter (+AES1)	IR12L	34	44	51	54	3.25
DC/DC converter with DC Filter (+AED1)	DR10L	18	23	27	28	1.70
DC/DC converter with DC Filter (+AED1)	DR12L	34	44	51	54	3.25

Table 9: Liquid-cooled Input and Output Filters

Product	Current at 690 V AC [A]	Nominal flow rate with water [l/min]	Nominal flow rate with 30% glycol [l/min]	Nominal flow rate with 50% glycol [l/min]	Maximum flow rate [l/min]	Liquid volume per element [l]
LC Filter for AFE/GC OF7Z1	380	8.0	10.4	12.0	12.8	0.70
LC Filter for AFE/GC OF7Z1	760	11.0	14.3	16.5	17.6	1.25
LCL Filter for AFE/GC OF7Z3	400	15.5	20.2	23.3	24.8	0.90
LCL Filter for AFE/GC OF7Z3	800	18.5	24.1	27.8	29.6	1.25
L Filter OF7Z5	400	7.5	9.8	11.3	12.0	0.20
L Filter OF7Z5	1000	7.5	9.8	11.3	12.0	0.20
L Filter OF7Z5	1640	8.5	11.1	12.8	13.6	0.60
dU/dt Filter OF7U1	416	18.5	24.1	27.8	29.6	0.68
dU/dt Filter OF7U1	820	20.5	26.7	30.8	32.8	1.34
dU/dt and CM Filter OF7U2	416	18.5	24.1	27.8	29.6	0.68
Sine-wave Filter OF7S1	416	8.0	10.4	12.0	12.8	0.70
Sine-wave Filter OF7S1	820	11.0	14.3	16.5	17.6	1.25
DC Filter OF7D1	570	6.7	8.7	10.1	10.7	0.70
DC Filter OF7D1	1200	11.0	14.3	16.5	17.6	1.25

6.4.3.1 Flow Rates in Parallel Power Units

In system modules with 2 parallel power units and a filter (IR12L/AR12L/DR12L), the flow rate of the coolant is not divided equally between cooling channels 1 and 2. The difference in flow rate between the cooling channels is significant, but normal behavior. There is a difference in flow rate, because the filter is connected to the inlet of channel 2 and outlet of channel 1.

The following tables show coolant flow rates measured from the inlet channels of IR12L and AR12L modules.

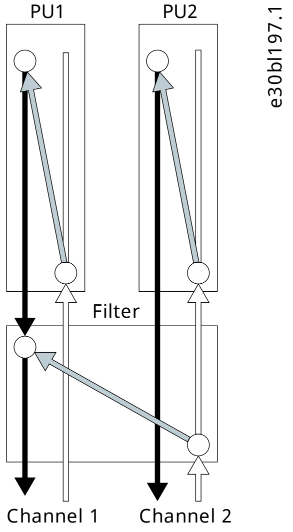


Figure 23: Coolant Flow in Parallel Power Units

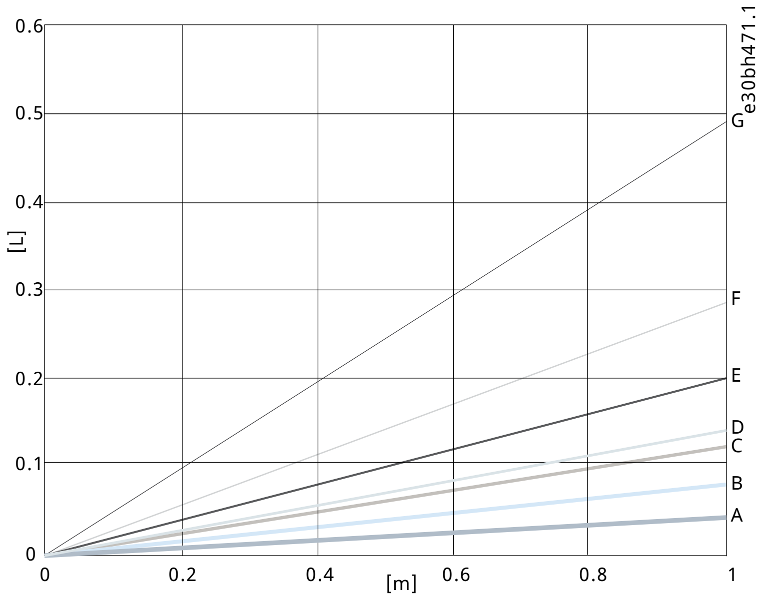
Table 10: Examples of Measured Coolant Flow Rates of IR12L

Channel 1 flow rate (l/min)	Channel 2 flow rate (l/min)	Total flow rate (l/min)
11.6	25.2	36.8
14.7	32.4	47.1
17.4	38.3	55.7
18.2	40.2	58.4

Table 11: Examples of Measured Coolant Flow Rates of AR12L

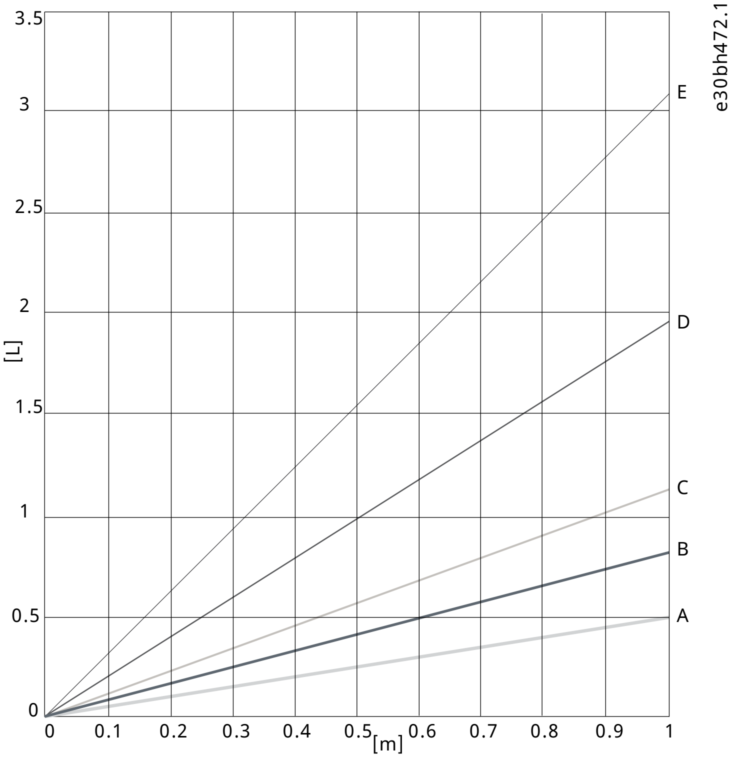
Channel 1 flow rate (l/min)	Channel 2 flow rate (l/min)	Total flow rate (l/min)
12.8	21	33.8
16.4	26.8	43.2
19.3	31.7	51
20.2	33.1	53.3

6.4.4 Volume of the Pipe



A	8 mm	**B**	10 mm
C	12 mm	**D**	13 mm
E	16 mm	**F**	19 mm
G	25 mm		

Figure 24: Volume of the Pipe with Different Inside Diameters, 8–25 mm



A	25 mm	**B**	32 mm
C	38 mm	**D**	50 mm
E	63 mm		

Figure 25: Volume of the Pipe with Different Inside Diameters, 25–63 mm

6.4.5 Pressure Drop

6.4.5.1 Pressure Drop and Correction Factors

The pressure drop with 20 °C (68 °F) water was calculated with a 13 mm (0.5 in) pipe of 1 m (3.3 ft) length at inlet and outlet.

The pressure drop with 48 °C (118 °F) antifreeze can be calculated with the help of the graphs by multiplying them by correction factors.

Table 12: Corrections Factors for Pressure Drop with Antifreeze

Antifreeze	Correction factor
Ethylene glycol 10%	1.0
Ethylene glycol 20%	1.0
Ethylene glycol 30%	1.0
Ethylene glycol 40%	1.05
Ethylene glycol 50%	1.1
Propylene glycol 10%	1.0
Propylene glycol 20%	1.0
Propylene glycol 30%	1.05

Table 12: Corrections Factors for Pressure Drop with Antifreeze ***(continued)***

Antifreeze	Correction factor
Propylene glycol 40%	1.1
Propylene glycol 50%	1.2

6.4.5.2 Pressure Drop of IM10L, IM12L, AM10L, AM12L, DM10L and DM12L

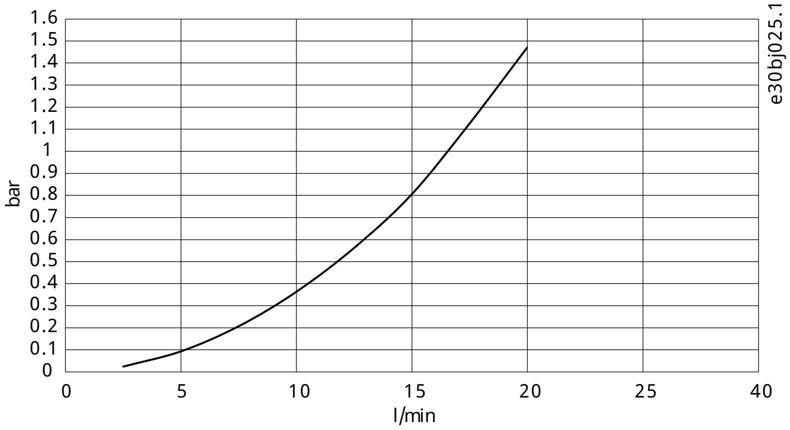


Figure 26: Unit Pressure Drop with Water, IM10L/AM10L/DM10L

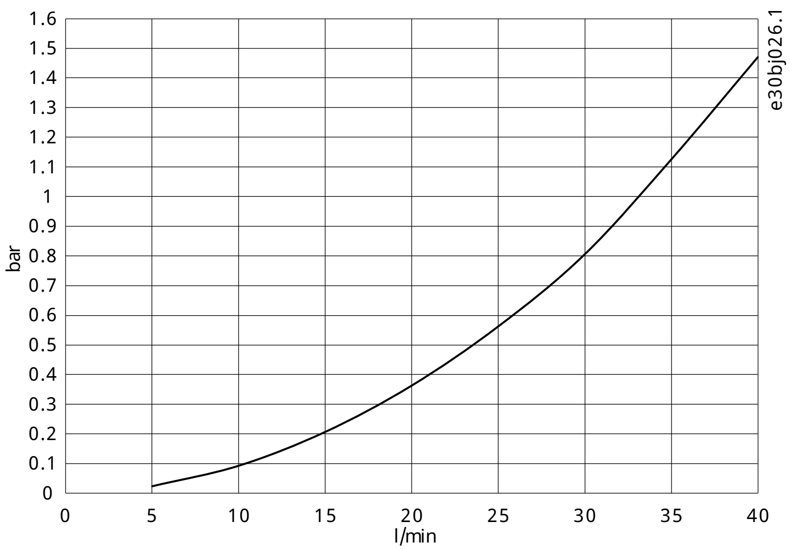


Figure 27: Unit Pressure Drop with Water, IM12L/AM12L/DM12L

6.4.5.3 Pressure Drop of AR10L, IR10L, and Filters

Figure 28: Unit Pressure Drop with Water, AFE AR10L

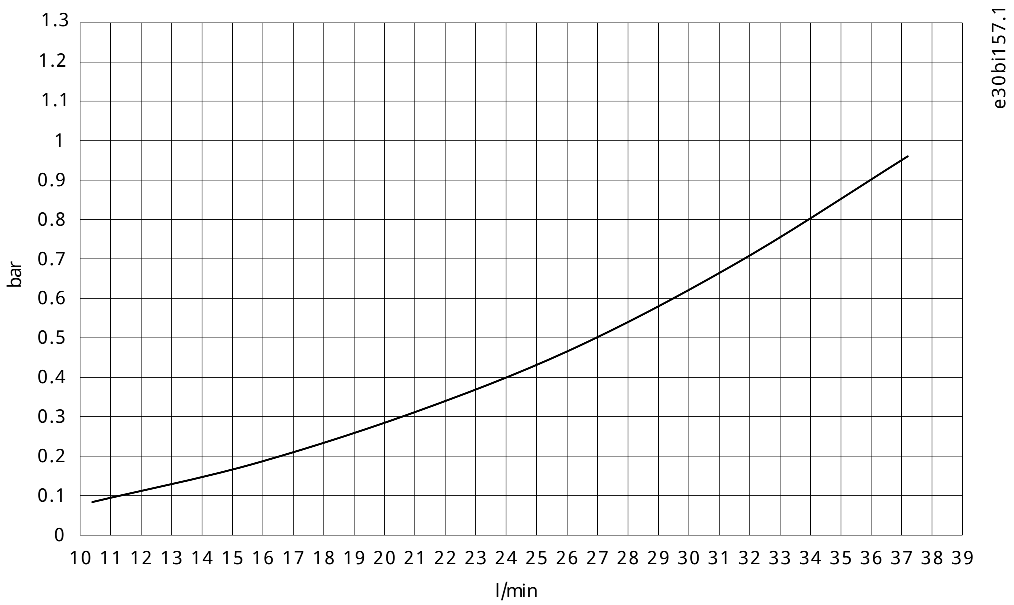


Figure 29: Unit Pressure Drop with Water, IR10L with dU/dt and Common-mode Filter (+AEU1, +AEU2)

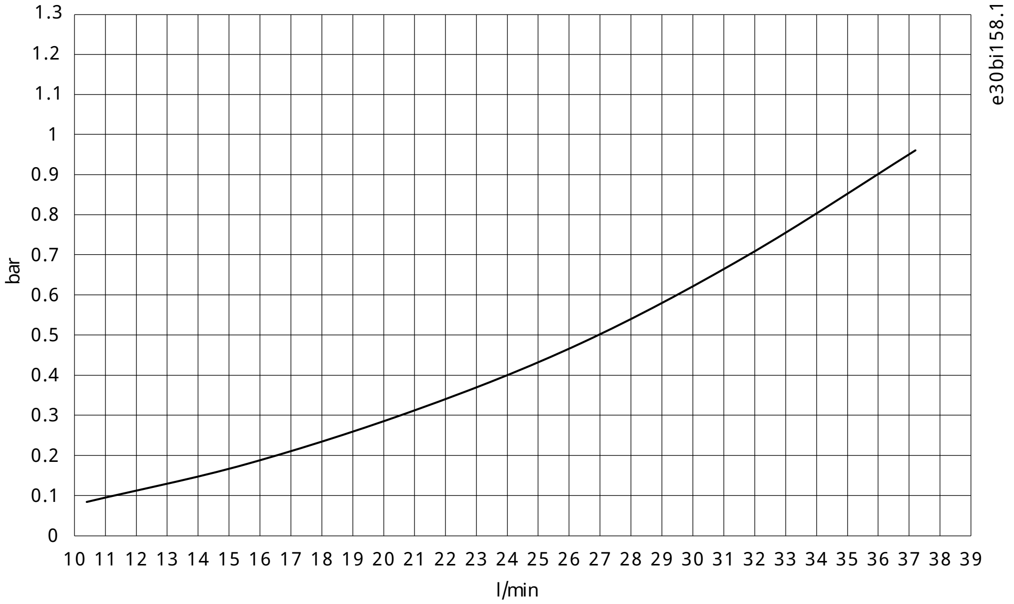


Figure 30: Unit Pressure Drop with Water, IR10L with dU/dt Filter (+AEU1)

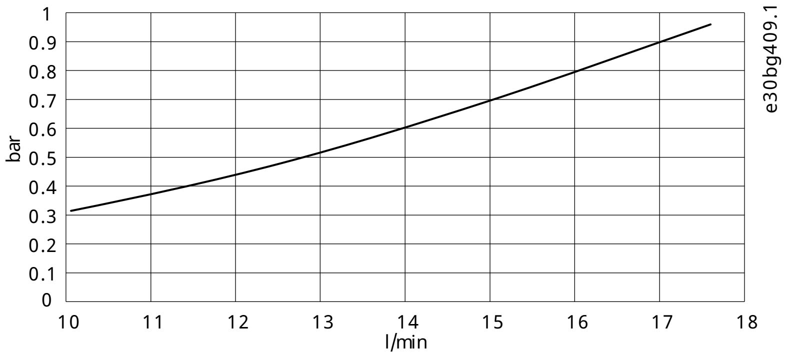


Figure 31: Unit Pressure Drop with Water, INU IR10L without Filters (+AE10)

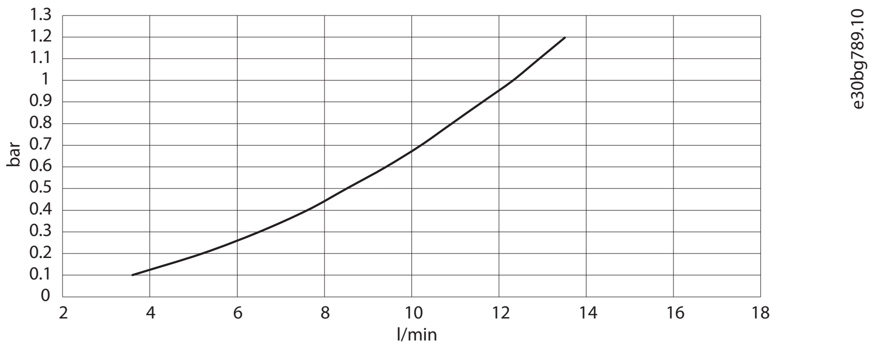


Figure 32: Pressure Drop with Water, LC Filter for AFE OF7Z1 (+AEZ1), 380 A

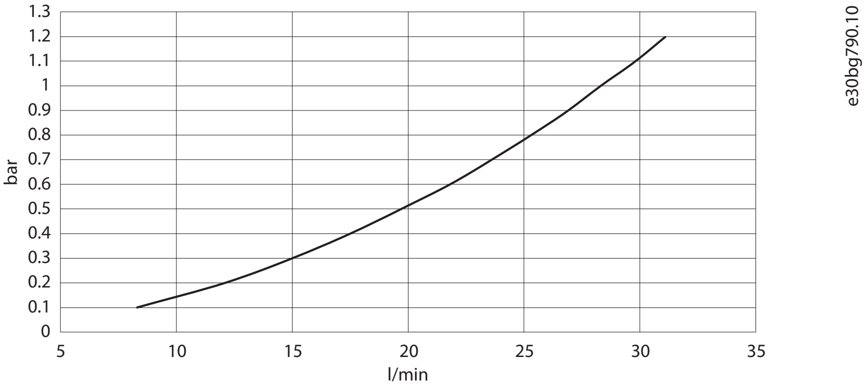


Figure 33: Pressure Drop with Water, dU/dt Filter OF7U1 (+AEU1), 416 A, and dU/dt and CM Filter OF7U2 (+AEU2), 416 A

6.4.5.4 Pressure Drop of AR12L, IR12L, and Filters

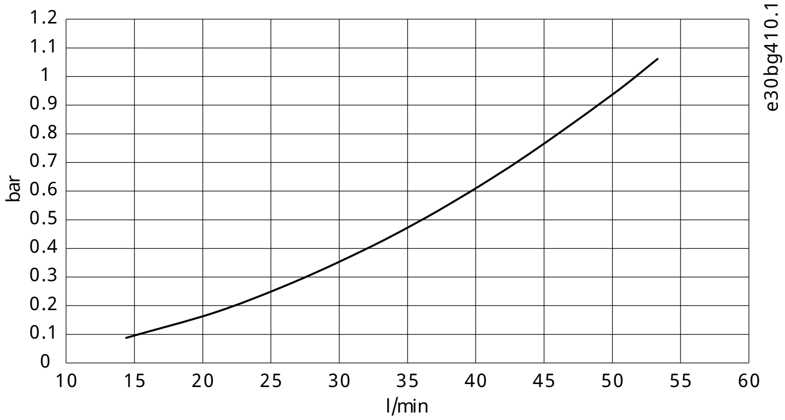


Figure 34: Unit Pressure Drop with Water, AFE AR12L

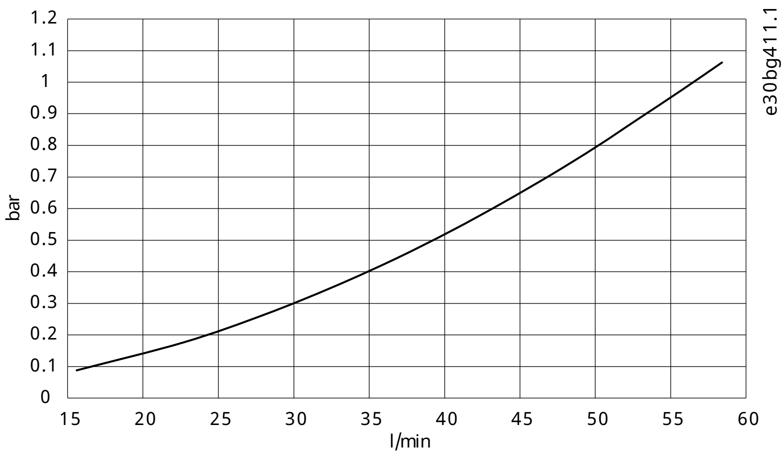


Figure 35: Unit Pressure Drop with Water, INU IR12L with dU/dt Filter (+AEU1)

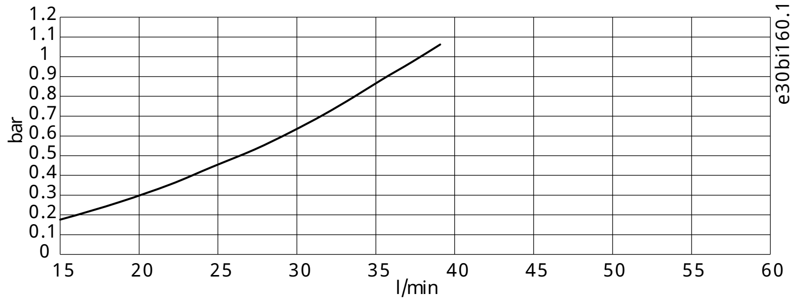


Figure 36: Unit Pressure Drop with Water, INU IR12L without Filters (+AE10)

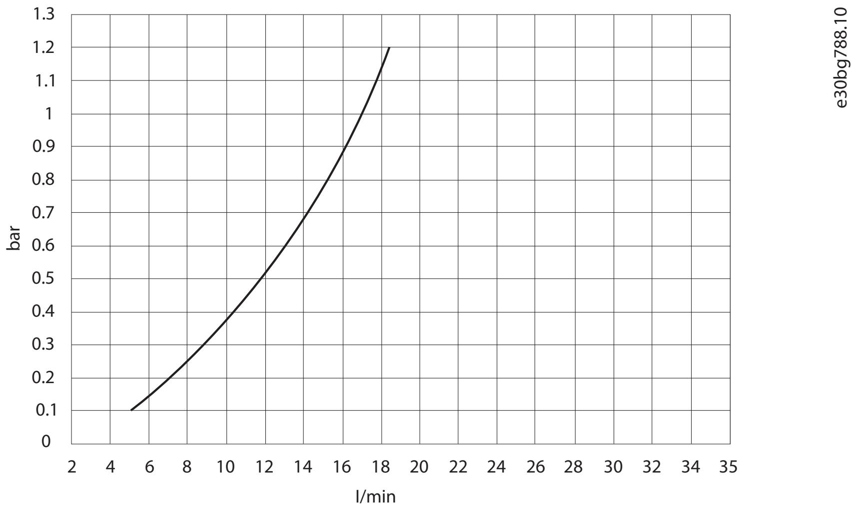


Figure 37: Pressure Drop with Water, LC Filter for AFE OF7Z1 (+AEZ1), 760 A

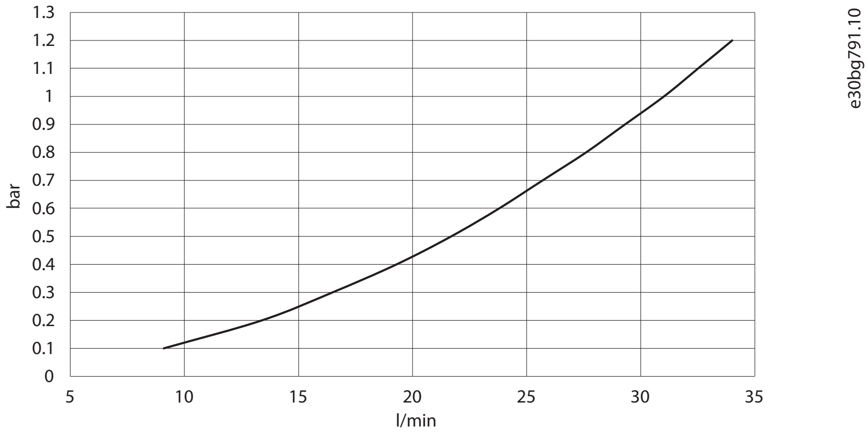


Figure 38: Pressure Drop with Water, dU/dt Filter OF7U1 (+AEU1), 820 A

6.4.5.5 Pressure Drop of the Grid-side L Filter

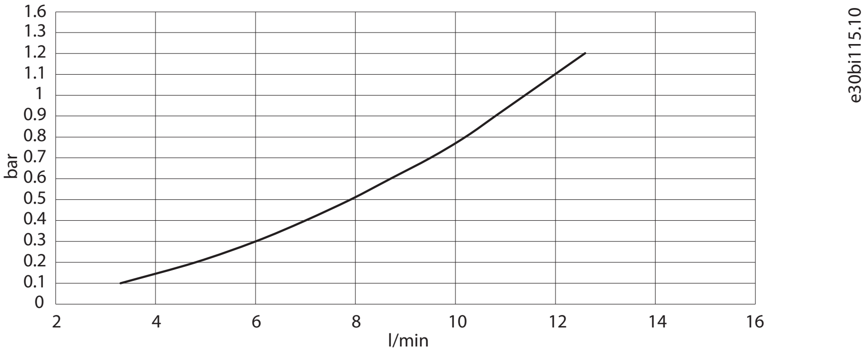


Figure 39: Pressure Drop, Grid-side L Filter OF7Z5, 690 V/400 A

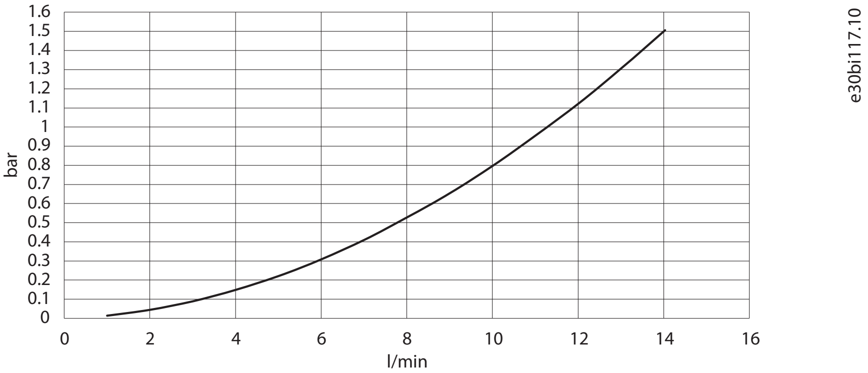


Figure 40: Pressure Drop, Grid-side L Filter OF7Z5, 690 V/1000 A

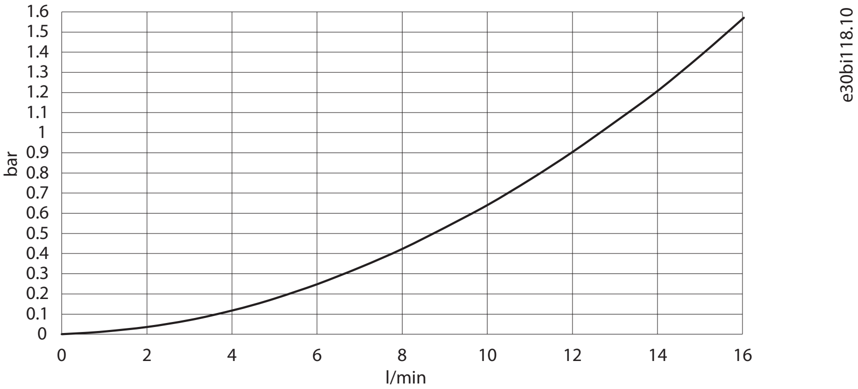


Figure 41: Pressure Drop, Grid-side L Filter OF7Z5, 690 V/1640 A

6.4.5.6 Pressure Drop of DR10L, DR12L, and Filters

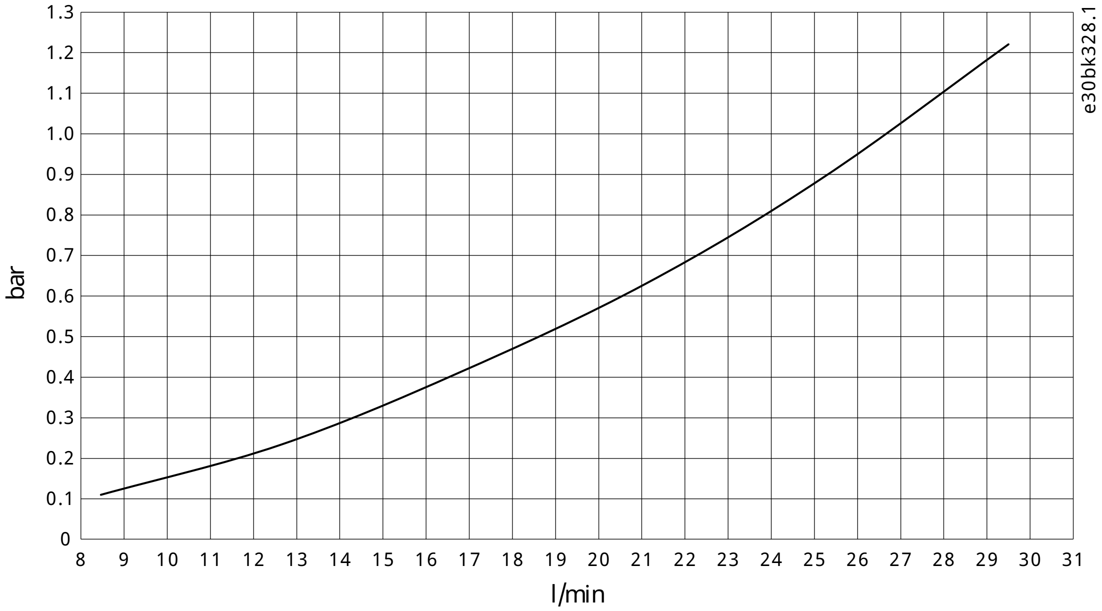


Figure 42: Unit Pressure Drop with Water, DC/DC Converter DR10L with DC Filter (+AED1)

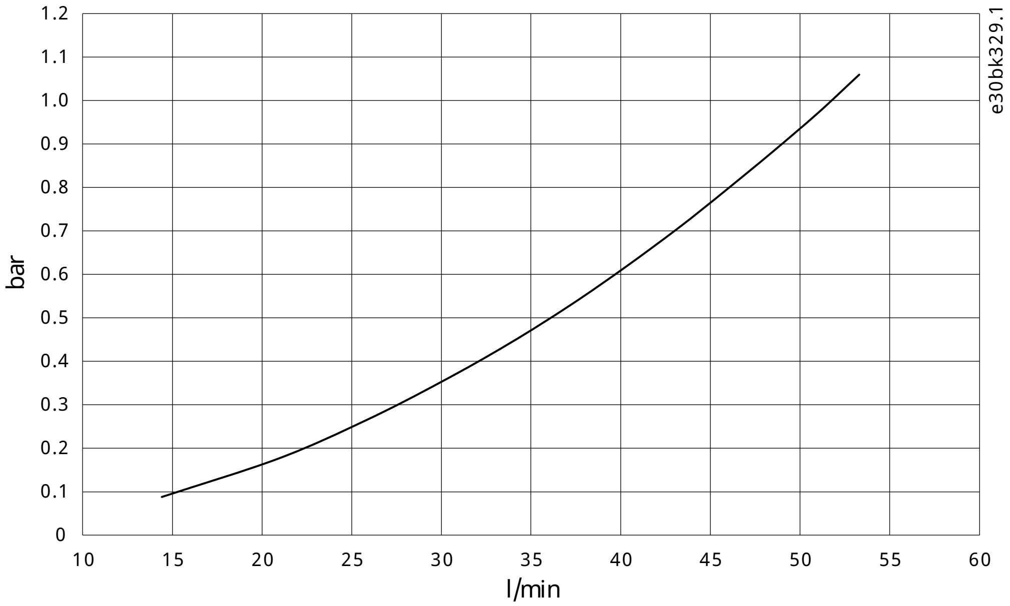


Figure 43: Unit Pressure Drop with Water, DC/DC Converter DR12L with DC Filter (+AED1)

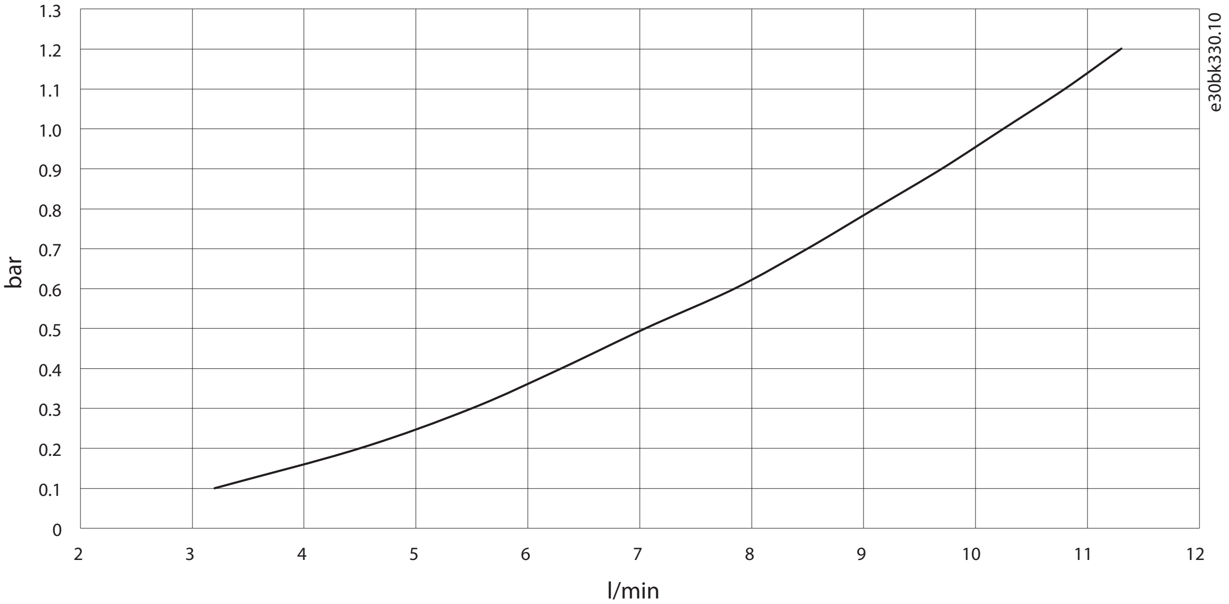


Figure 44: Pressure Drop with Water, DC Filter for DC/DC Converter OF7D1, 570 A

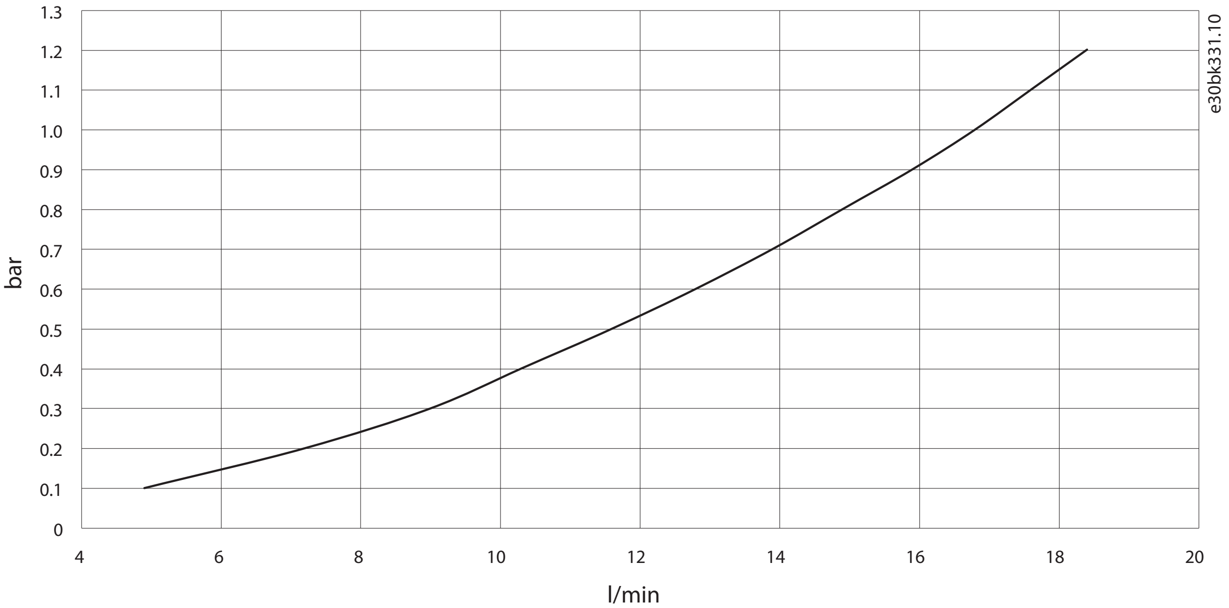


Figure 45: Pressure Drop with Water, DC Filter for DC/DC Converter OF7D1, 1200 A

6.4.6 Cooling Circuit Connectors

The cooling system has cooling circuit connectors located in the manifold plate. The internal thread size of the cooling circuit connectors is G1/2. The depth of the threads is 13 mm (0.5 in). The maximum tightening torque is 30 Nm (266 in-lb). The push-in connectors are available as an option.

The inlet connectors are at the bottom of the system module. The outlet connectors can be at the top or at the bottom.

If the optional outlet connectors at the top are used, the outlet connectors at the bottom must be closed with a plug.

Table 13: Recommended Connectors

Connector	Tightening torque [Nm (in-lb)]	Pipe	Pipe ferrule
Parker 69111621 MALE STUD 1/2"BSPP SS STEEL 31 6L D16 EPDM SEAL	20–30 (177–266)	PA 16/13 pipe	Parker 1827-16-13

Do not connect the system modules in series. Connecting in series requires high flow rates and high pressure because of the temperature rise of the coolant in the system modules.

6.4.6.1 Pipe Ferrules

CAUTION

LEAKAGE HAZARD

When the product is used in an ambient temperature of below 0 °C (32 °F), the plastic pipe shrinks more than the metallic connector, and can cause the coolant to leak.

- In freezing ambient temperatures, use stainless steel pipe ferrules.

To make sure that the ends of the pipes stay straight, it is possible to use pipe ferrules. The pipe ferrules must be round. The pipe ferrules cannot be made of red brass or steel because of corrosion. Allowed material for the pipe ferrules is stainless steel. See 6.4.1 Materials.

Insert the pipe ferrule fully into the pipe.

6.4.6.2 Insertion of Pipes into Cooling Circuit Connectors

The insertion length of a Ø16 mm (0.63 in) pipe is 29 mm (1.14 in). Make a mark on the pipe where it can be checked that the pipe is correctly inserted into the cooling circuit connector.

To remove the pipe from the connector, push the release sleeve towards the connector and pull out the pipe.

For cold PA11 plastic pipes, the minimum bending radius is 138 mm (5.43 in). A smaller bending radius requires heating of the pipe. See 6.4.7 Cooling Circuit Pipes.

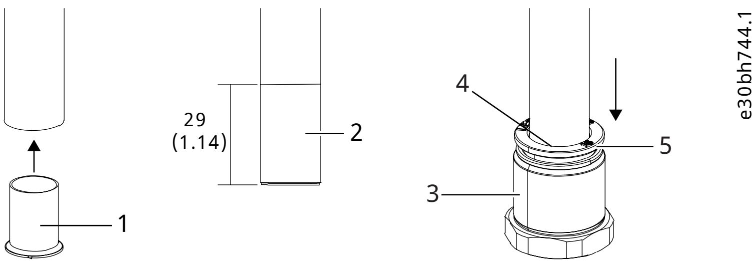


Figure 46: Inserting a Pipe into the Cooling Circuit Connector, mm (in)

1	The pipe ferrule	2	The pipe ferrule inside the pipe
3	A cooling circuit connector (available as option)	4	The mark in the pipe
5	The release sleeve		

6.4.6.3 Inlet and Outlet Connectors of System Modules

NOTICE

INCORRECT INLET AND OUTLET CONNECTIONS IN THE COOLING SYSTEM

If inlet and outlet connectors are connected incorrectly, the cooling does not work as expected. Incorrect cooling can damage the product.

- Make the connections carefully.

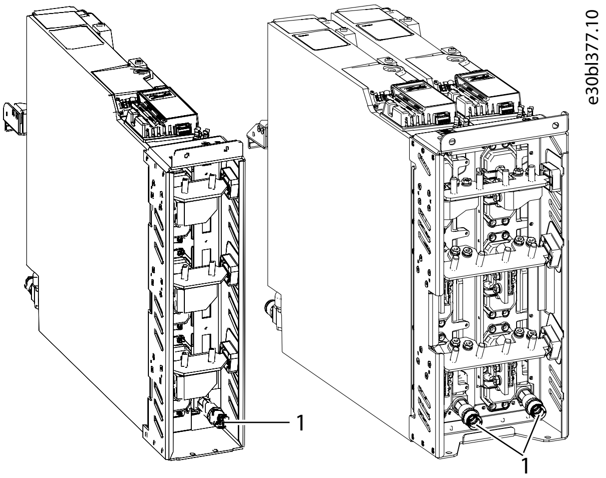


Figure 47: Inlet Connectors of IM10L (left) and IM12L (right)

1	Inlet connectors

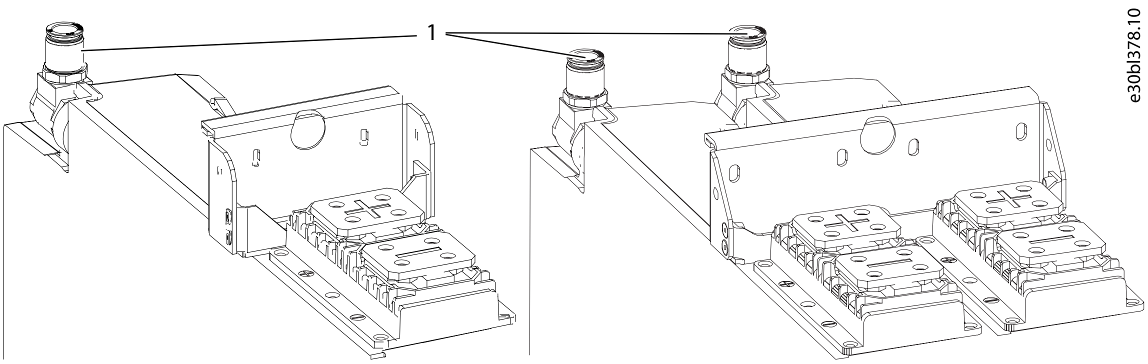


Figure 48: Outlet Connectors of IM10L (left) and IM12L (right)

1	Outlet connectors

6.4.6.4 Inlet and Outlet Connectors of System Modules with Integration Units

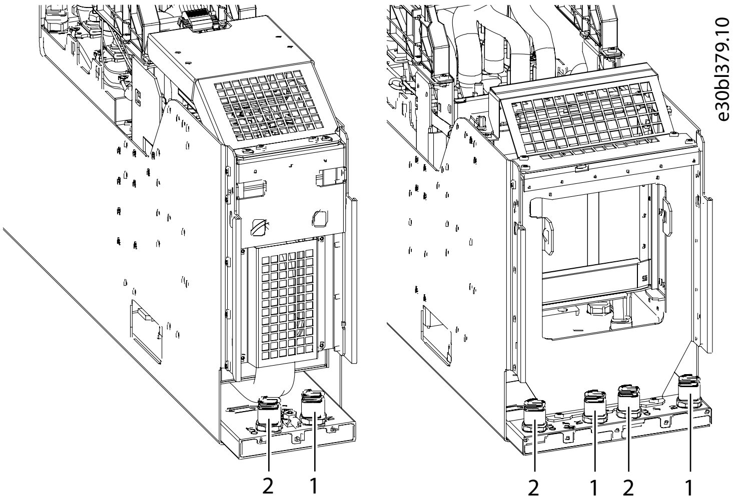


Figure 49: Inlet and Outlet Connectors of IR10L (left) and IR12L (right)

1	Inlet connector	**2**	Outlet connector

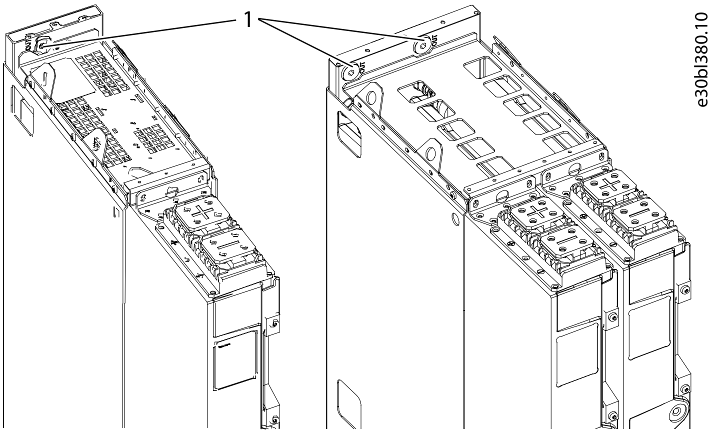


Figure 50: Optional Outlet Connectors of IR10L (left) and IR12L (right)

1	Optional outlet connector

6.4.6.5 Inlet and Outlet Connectors of the L Filter

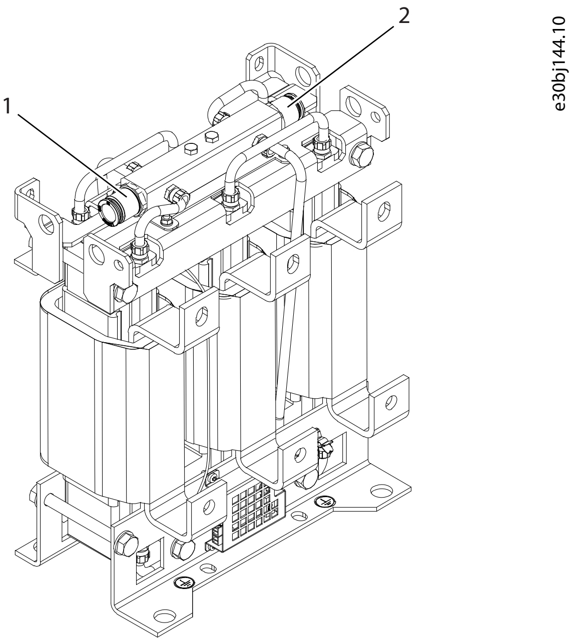


Figure 51: Inlet and Outlet Connectors of the L Filter

1	Inlet/outlet connector	**2**	Inlet/outlet connector

6.4.7 Cooling Circuit Pipes

The pipes used in the cooling circuit are PA11 plastic pipes with a diameter of Ø16/13 mm (0.63/0.51 in) (Rilsan model code BESNOP40TL).

There are 2 ways to make permanent bends to the pipes.

- The quickest and easiest way is to make the bend in the air by bending it by hand. Do this if only 1 bend is needed and the dimensions do not matter, or the dimension can be adjusted by cutting the pipe after bending.
- If multiple precise pipes with several bends are needed, it is recommended to use a bending jig. There are commercial jigs on the market (for example, Eiskoffer Bending Kit from Alphacool), but the jig can be also self-made from plywood or some other easy-to-work material. But the material must be able to withstand at least 200 °C (392 °F).

Required tools for bending the pipes:

- Gloves
- Adjustable heat gun
- Round silicone rubber cord
  - Ø12–12.5 mm (0.47–0.49 in)
  - Solid
  - Hardness: minimum 60 Shore A, recommended >70 Shore A

Recommended tools for bending the pipes:

- Water bucket or sink
- Distilled water
- Bending jig

NOTICE

OVERHEATING OF THE PIPES

If the pipe is overheated, the wall thickness and pressure resistance change, and the shape of the pipe collapses easily.

- Do not heat the pipes above 180 °C (356 °F).

NOTICE

UNEVEN HEATING OF THE PIPES

If the pipe is heated unevenly or over a too small area, it wrinkles easily when the pipe is bent. The wall strength and pressure resistance at the wrinkled point is uncertain.

- Before bending the pipes, heat the pipes evenly and over the whole bending area.

6.4.7.1 Bending Pipes in the Air

1. Insert the silicon cord into the pipe and to the bending location.

   It is recommended that the pipe end is at least 5 cm (2 in) from the bending area. If the bending area is too close to the pipe end, the pipe end can become oval, which can cause the pipe and fitting joint to leak.

   It is recommended to moisten the cord with distilled water to make it easier to insert into the pipe.

   The cord is inserted into the pipe before it is heated, to produce equal counter pressure and to prevent the tube from buckling. The hard pipe is easy to bend evenly with the cord inside.

2. Set the heat gun upright on the table and set the temperature to 350 °C (662 °F).

   Make sure that the heat gun does not fall down.

3. Slowly move the pipe back and forth while rotating it over the heat gun.

   The aim is to heat the pipe evenly over the entire bending area to around 150–170 °C (302–338 °F). Examples of heating times:

   - When making a simple L-bend, a suitable heating time is approximately 2 minutes for a distance of 5–10 cm (2–4 in).
   - When making a U-bend, the heating time is approximately 4 minutes for 15–20 cm (6–8 in).

   Beware of overheating. If the pipe temperature rises above 180 °C (356 °F), it starts to melt, and the wall thickness can change. As the temperature of the pipe approaches the melting point, the pipe changes color from cloudy to clear, and starts to smell burned.

4. Once the tube is heated all around the bending area, bend it to the desired shape.

   The recommended minimum bending radius >30 mm (1.18 in).

5. Hold the pipe in the desired position and cool it quickly, for example, in a sink or under a tap.

   ➡ If the pipe was heated enough, the bending is permanent.

6. Pull the cord out of the pipe. If the bend is steep, it can be necessary to open the bend slightly to get out the cord.
7. After bending the pipe, check the circularity of the pipe ends.

A Ø16/13 mm (0.63/0.51 in) tube ferrule (for example, 1827-16-13 from Parker) can be inserted into the pipe as an aid to assess the circularity of the pipe.

6.4.7.2 Bending Pipes with a Bending Jig

These instructions were prepared with the Eiskoffer bending kit from Alphacool, but other commercial or self-made jigs can also be used.

1. Prepare the bending jig.
2. Insert the silicon cord in to the pipe and to the bending location.

   It is recommended that the pipe end is at least 5 cm (2 in) from the bending area. If the bending area is too close to the pipe end, the pipe end can become oval, which can cause the pipe and fitting joint to leak.

   It is recommended to moisten the cord with distilled water to make it easier to insert into the pipe.

   The cord is inserted into the pipe before it is heated, to produce equal counter pressure and to prevent the tube from buckling. The hard pipe is easy to bend evenly with the cord inside.

3. With the cord inside, bend the pipe to the jig.

   The recommended minimum bending radius >30 mm (1.18 in).

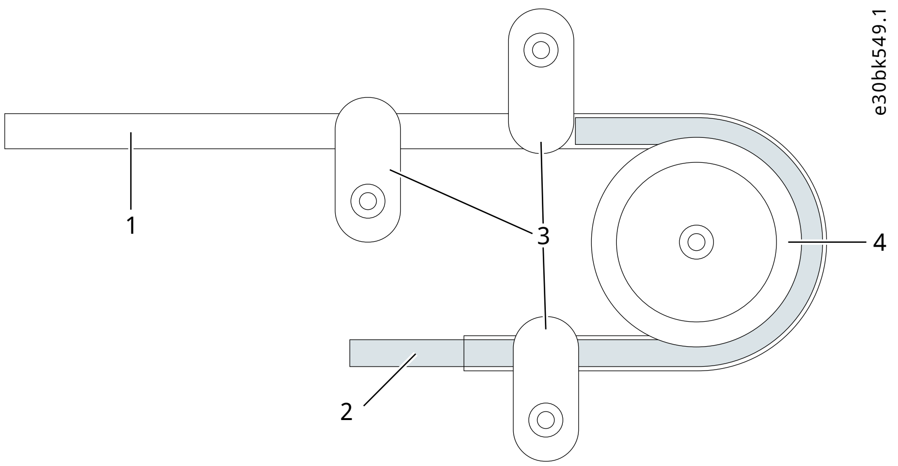


Figure 52: Pipe Bending Jig Example

1	Pipe	**2**	Silicon cord
3	Pipe holders	**4**	Bending wheel

4. Set the heat gun temperature to 200 °C (392 °F).
5. Slowly move the heat gun back and forth over the entire bending area.

   The aim is to heat the pipe evenly over the entire bending area to around 150–170 °C (302–338 °F). When the pipe is heated only at the outer edge, it takes time to heat the inner edge of the pipe as well. Therefore, the temperature used is fairly low and, for example, when making a 180° bend with radius Ø32 mm (Ø1.26 in), the suitable heating time is 10 minutes.

Beware of overheating. If the pipe temperature rises above 180 °C (356 °F), it starts to melt, and the wall thickness can change. As the temperature of the pipe approaches the melting point, the pipe changes color from cloudy to clear, and starts to smell burned.

6. Before removing the pipe from the jig, let it cool completely. The cooling takes more than 10 minutes.

   To accelerate the cooling process, submerge the jig and pipe in water.

7. Once the pipe has cooled, remove it from the jig.

   If the pipe was heated enough, the bending is permanent.

8. Pull the cord out of the pipe. If the bend is steep, it can be necessary to open the bend slightly to get out the cord.
9. After bending the pipe, check the circularity of the pipe ends.

   A Ø16/13 mm (0.63/0.51 in) tube ferrule (for example, 1827-16-13 from Parker) can be inserted into the pipe as an aid to assess the circularity of the pipe.

An alternative way to use the bending jig is to preheat the pipes as advised in 6.4.7.1 Bending Pipes in the Air, and then fold them into the jig and let them cool down.

6.4.8 Filling the Cooling System

Before you begin:

- Fill one system module at a time.
- Make sure that there is a point of exit for air in the cooling system during filling.
- Use a relief valve to limit the pressure to a maximum of 5 bar. The location of relief valve has an effect on the pressure. The maximum pressure of the cooling system is 5 bar.
- The minimum filling flow rate of the cooling system is 10 l/min. The stronger the flow, the faster the cooling system is filled.

NOTICE

The numbering of the valves can be different than the one mentioned in these instructions. These instructions use the valve numbering of the Danfoss cooling module.

Use these instructions to add liquid into the cooling system and to deair the cooling system.

Procedure

1. Mix the coolant in a sufficiently large container.

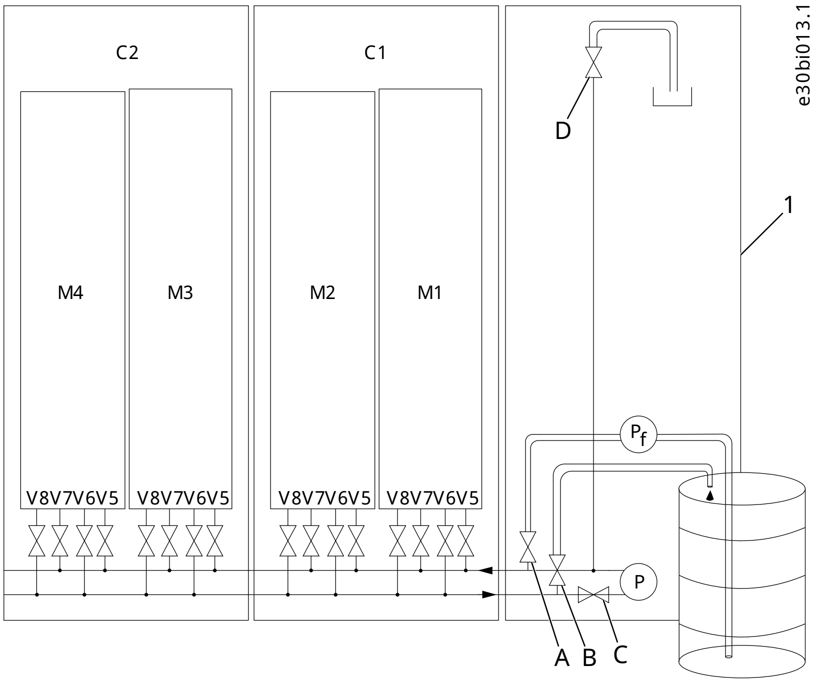
   The necessary amount of coolant depends on the size of the cooling system.

2. Connect hoses to the input and output valves A (V212) and B (V213) of the drive side of the cooling module.
3. Connect a filling pump to the valve A (V212).
4. Close the pump shut-off valve C (V112 if you have a Danfoss cooling module and the single-pump option +SAP1, V112 and V113 if you have the dual-pump option +SAP2).
5. Put the hose of the filling pump into the coolant. Make sure that air does not go into the hose.
6. Hang the other hose over the container.

   It is easy to see when all the air has come out of the cooling system.

7. Close all the valves in cabinets C1 and C2 except for the valves V5, V6, V7, and V8 of the first system module (M1).

Figure 53: Example of Filling the Cooling System with Liquid



1	Cooling module	**A**	Filling valve
B	Draining valve	**C**	Pump shut-off valve
C1	First cabinet	**C2**	Second cabinet
D	De-airing valve	P_f	Filling pump
P	Pump, cooling module		

8. Open the valves A (V212) and B (V213) of the cooling module.
9. If you have a Danfoss cooling module, make sure that the valve V211 is open.

The valve V211 is in series with V212.

10. Start the filling pump P_f.
11. Wait for the system module M1 to fill up.

See the table for examples of filling times.

Flow rate	Time [minutes]
10 l/min	10
15 l/min	1

➡ When there are no longer air bubbles coming out from the hose hanging over the container, the system module is filled.

12. To exhaust the last air out of the cooling system, stop the filling pump for 10 s and restart it.
13. Stop the filling pump.
14. Close the valves A (V212) and B (V213) of the cooling module.
15. Close the valves V5, V6, V7, and V8 of the first system module (M1).
16. Repeat the steps 7.-14. for each of the system modules in turn.
17. Open the valve A (V212) of the cooling module.
18. Open the pump shut-off valve C (V112 if you have the option +SAP1, V112 and V113 if you have the option +SAP2).
19. Open the de-airing valve D (V218) of the cooling module.
20. Put a container under the hose that is attached to the de-airing valve D (V218).
21. Start the filling pump P_f.
22. Wait until liquid comes out of the de-airing valve D (V218).
23. Close the de-airing valve D (V218).
24. Keep on filling until the specified liquid surface or system pressure is reached.

    If you have a Danfoss cooling module, keep on filling until the liquid surface reaches the default level marked in the indication pipe of the expansion vessel.

25. Stop the filling pump.
26. Adjust the correct pressure or liquid surface level according to the cooling module manual.

    If you have a Danfoss cooling module, adjust the correct system pressure via the pneumatic connection of the expansion vessel.

27. Close the valves A and B (V212 and V213) of the cooling module.

    If you have a Danfoss cooling module, also close the valve V211 which is in series with V212.

28. Open all the valves of all the system modules.

    To ensure equal coolant flow to each system module, open the valves equally.

29. Start the pump P of the cooling module and let it run for a few minutes.

    If the pressure of the cooling system drops, add more coolant or adjust the pressure in the cooling system according to the instructions in the steps 7.-14. and 26.

30. Detach the filling pump P_f and the hoses connected to the valves A and B (V212 and V213).
31. Start the cooling module.
32. Stop the cooling module for 10 s and restart it. Repeat if necessary.

    ➡ The cooling system is now ready for operation.

6.5 Condensation

Condensation must be avoided.

Therefore, the temperature of the coolant must be kept higher than the dewpoint in the electrical room. Use Figure 54 to determine if the drive operating conditions (combination of room temperature, humidity, and coolant temperature) are safe. The graph can also be used to select the temperature for the coolant. The coolant temperature must be higher than the dewpoint.

Increasing the temperature of the coolant above the data in the loadability charts decreases the nominal output current of the drive. The data of the graph is valid at sea level altitude (1013 mbar).

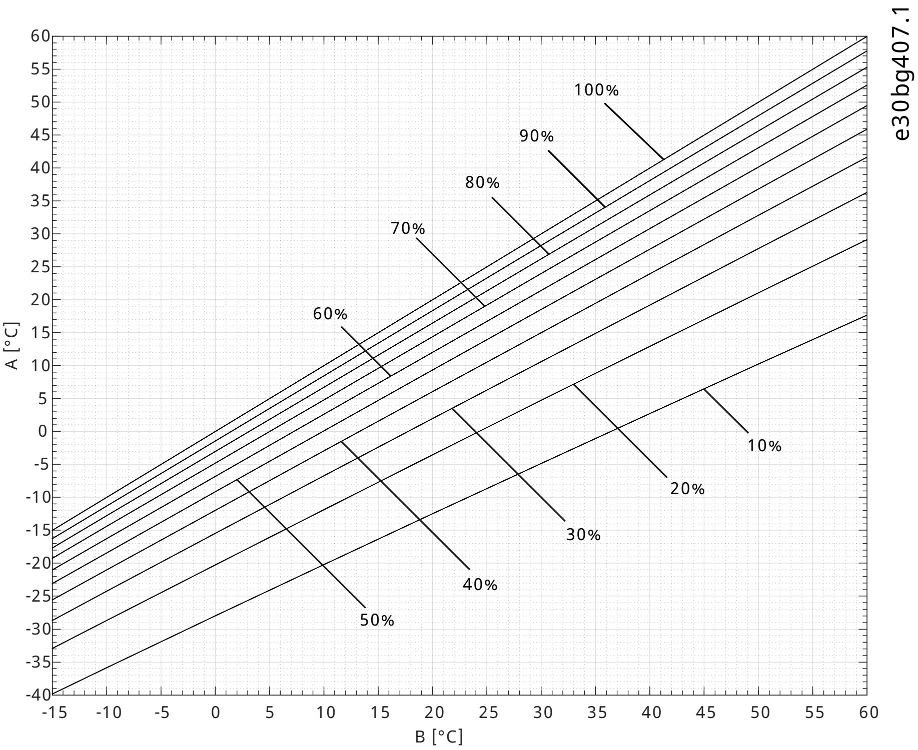


Figure 54: Relative humidity 100...10%

A	Dewpoint temperature	**B**	Ambient temperature

The Danfoss cooling module has an automatic condensation prevention system.

6.6 Air Cooling Requirements

iC7 Series Liquid-cooled System Modules are liquid-cooled, but in a liquid-cooled drive system, there are always some heat losses to the air. The heat losses come from the busbars, fuses, and other auxiliary components. When installing the system modules and other components to an enclosure, ensure that there is sufficient airflow in each section.

The ambient conditions in each enclosure section must be in line with the specifications for the drive. Make sure that the temperature of the cooling air does not become higher than the maximum ambient temperature or lower than the minimum ambient temperature of the drive.

The structure of the enclosure must be such, that the air can move freely through the enclosure, and the air flow is directed to the components which require cooling.

The door or bottom part of the enclosure must have air gaps for air intake, and outlet air gaps at the top. The inlet and outlet air gaps must obey the requirements set by the selected protection rating. The structure in the enclosure must move the hot air to the outlet at the top of the enclosure. The structure must also make sure that the hot air goes out of the enclosure and does not come back in.

Monitor the air cooling capability inside the enclosure. The system modules only monitor the temperature of the modules and filters. Ensure sufficient air flow through the critical areas. Critical areas for air-cooling are:

- DC and AC fuses
- Terminals
- Busbars
- Power cables
- Electrical components

Considerations for directing the air flow:

- Block the gaps and empty space between the side wall of the enclosure and the system modules to direct air flow to the areas that need cooling.
- If the adjacent enclosure section has lower air pressure, there must be a wall between the sections to prevent air from escaping into the adjacent section.
- An air deflector is recommended above the DC fuses to force the air to flush the fuses.
- The airflow rate must be more than 2 m/s when the temperature inside the enclosure is +40...+60 °C (+104...+140 °F).

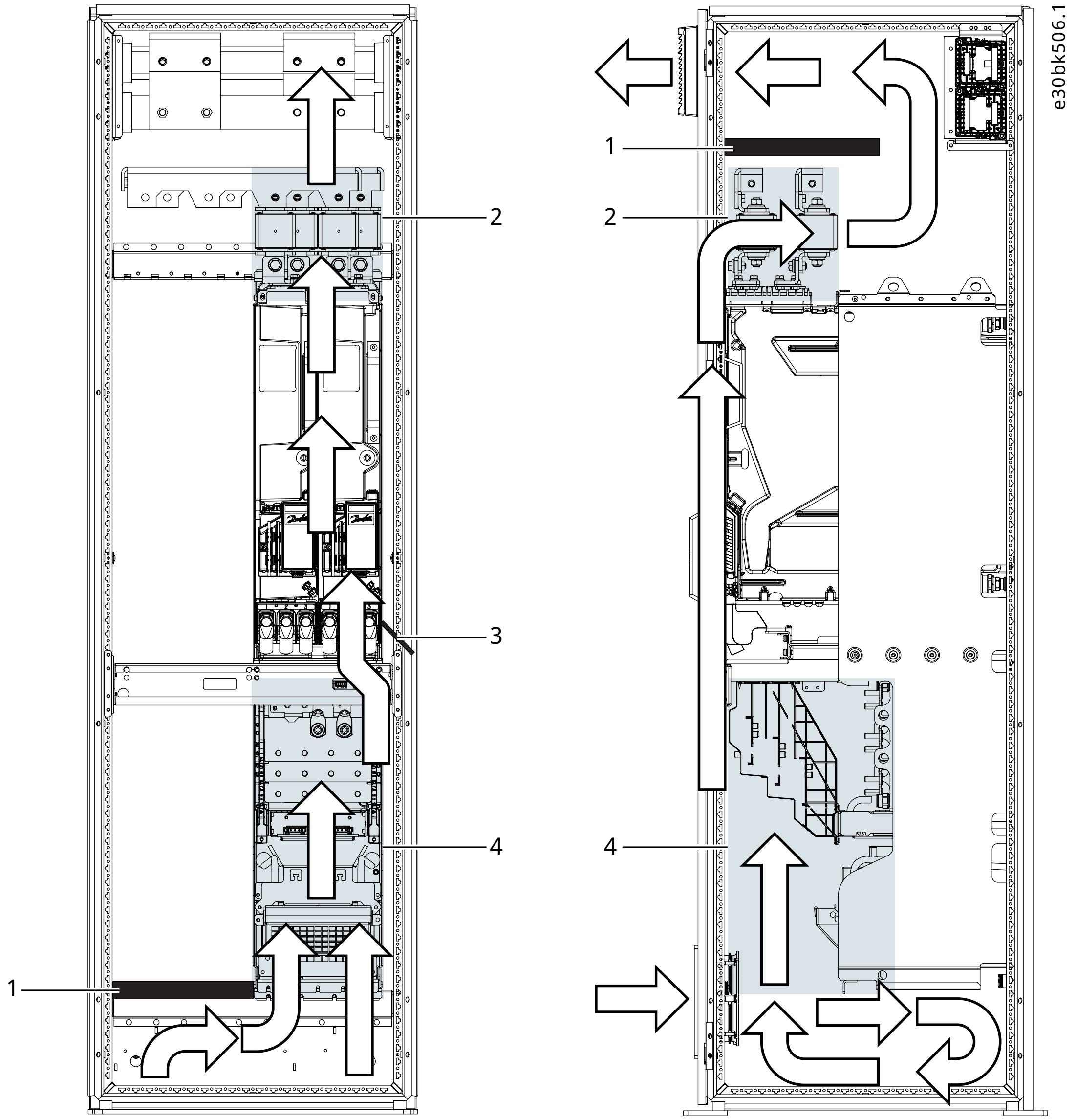


Figure 55: Example of Air Circulation Inside an Enclosure

1	Air deflector	**2**	Critical area (DC fuses and busbars)
3	Air block between wall and system module	**4**	Critical area (fuses, terminals, busbars, power cables, and electrical components)

7 Electrical Installation

7.1 Fuses of the Drive System

The drive system must be equipped with ultra-rapid AC fuses to limit the damage of the drive system. The fuse sizes are based on Mersen aR fuses. Use these fuses to achieve sufficient protection against short circuits. Select the supply cable protection according to local regulations.

DC fuses must be installed for parallel units where necessary to limit the damage of the drive system. Each DC supply line must be equipped with fuses. The DC fuses are provided with the delivery as option. Do not replace the DC fuses with any other types.

The protective devices must be integrated within the same overall assembly as the system module.

The fuse tables can be found in 10.5.1 List of Fuse Size Information.

Fuse ratings are based on a maximum ambient temperature of 60 °C and a minimum airflow of 2 m/s around the fuse.

To ensure fuse performance, make sure that available supply short circuit current is sufficient. See minimum required values ($I_{cp,mr}$) at the fuse location in 10.5.2 AC Fuses for AFE or GC 525–690 V AC, IP00/Open Type.

7.2 Guidelines for DC Connections of System Modules

The DC busbars and cabling must be dimensioned according to local installation regulations and codes, so that the cross-section is sufficiently large for the current flowing at the relevant point. See the DC current ratings in 10.6.1 List of Current Rating Information.

The DC busbar itself must be designed to attain the lowest possible inductance.

Adequate fuse protection for the drive configuration must be provided on the line side and on the DC side. The power cables and busbars must be dimensioned with sufficient thermal and mechanical strength to handle short circuits in the system. See the fuse ratings in 10.5.1 List of Fuse Size Information.

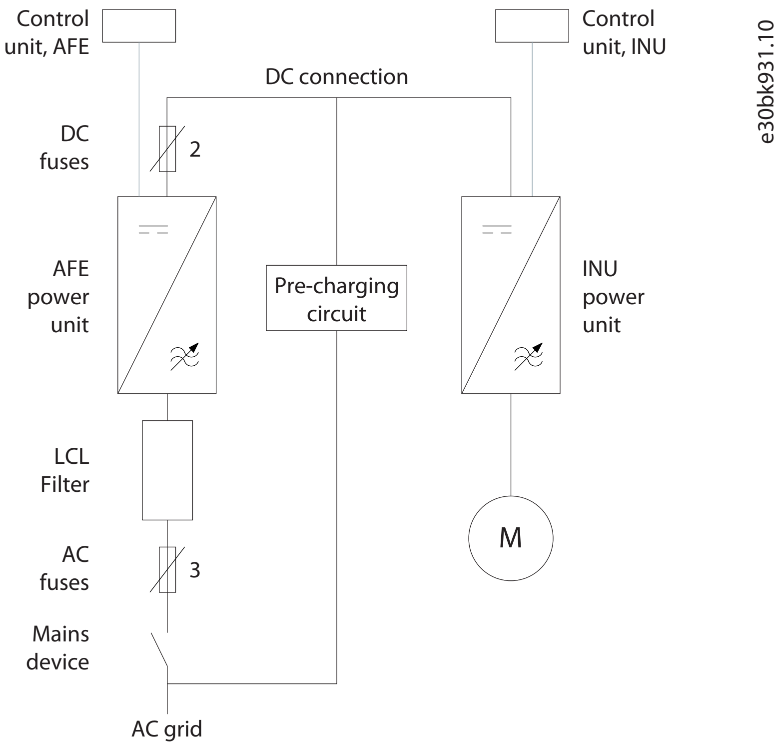


Figure 56: DC Connections of Single Power Units

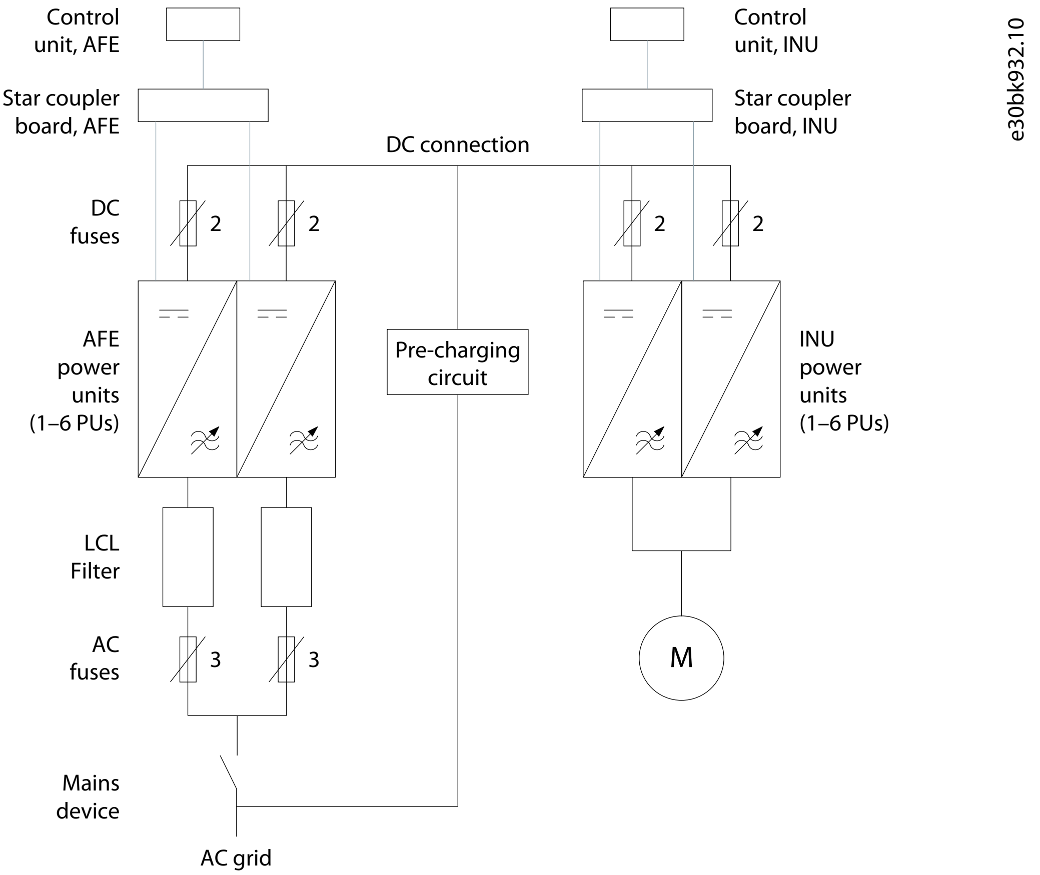


Figure 57: DC Connections of Parallel Power Units

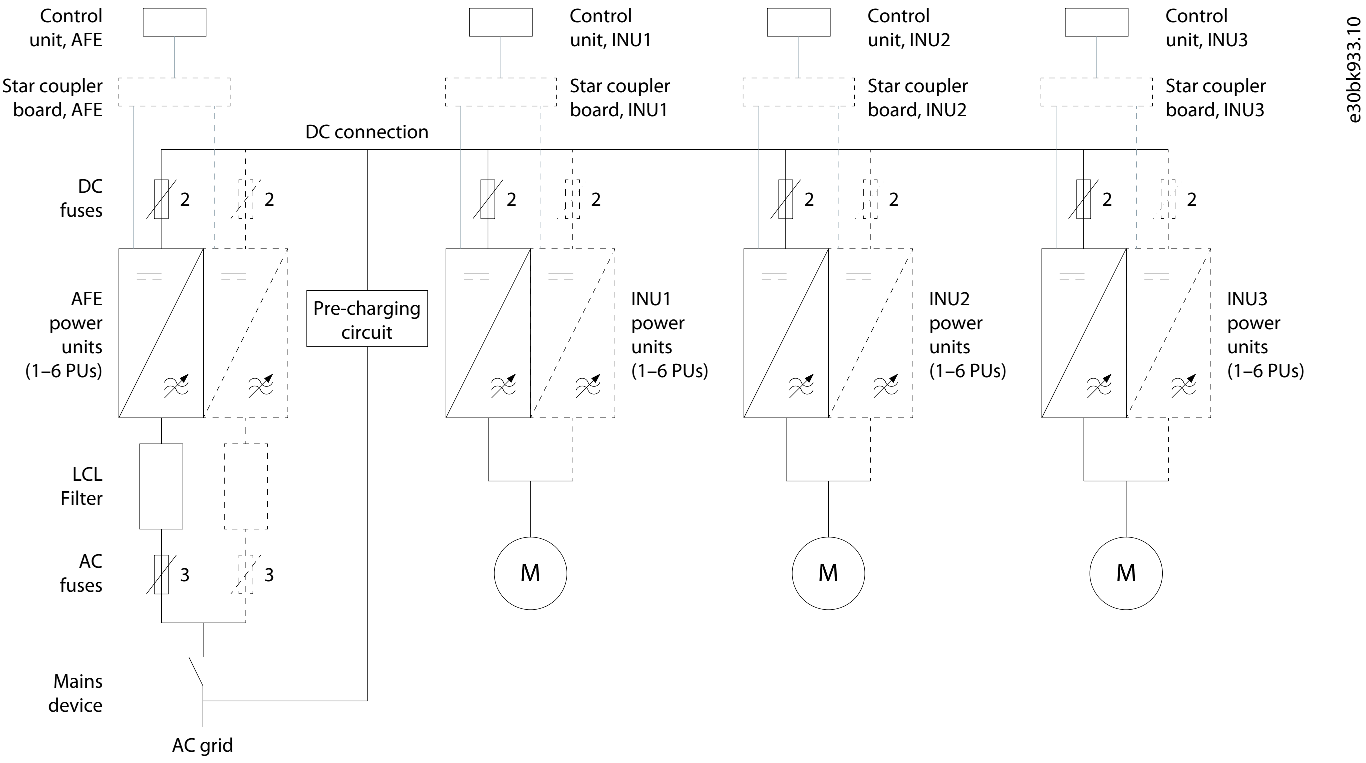


Figure 58: DC Connections of a Drive Lineup

7.3 Grounding Principles

Ground the AC drive in accordance with applicable standards and directives.

According to IEC 60364-5-54; 543.1, unless local wiring regulations state otherwise, the cross-sectional area of the protective grounding conductor must be at least ½ times of the phase conductor and made of the same material when the phase conductor cross-section is above 35 mm^2 (AWG 2).

The connection must be fixed.

7.4 Cable Requirements

7.4.1 Cable Requirements

Follow these requirements for the mains and motor cables used in the drive system.

- Select and install mains cables and motor cables according to the local safety regulations, the input voltage, and the load current of the drive. Protective conductor size must meet the requirements of IEC 61800-5-1.
- Use motor cables rated for +90 °C (194 °F) surface temperature. Consider the operating temperature of the mains terminals and make sure that the mains cables do not overheat near the input terminals. Sufficient forced air cooling is required for the cables when operating in high ambient temperatures.
- Use symmetrical power cabling with power units connected in parallel. Each power unit must have the same number of cables with an equal cross-section and equal length.

The maximum number of power unit cables and bolts sizes can be found in 10.4.1 List of Cable Size Information.

Only use symmetrical and shielded 3-phase motor cables. See Figure 59. Do not use symmetrical and shielded 3-phase cable with individual shield for each phase conductor or single-core phase conductors and PE with or without shield, see Figure 60.

To reach C3 EMC performance, use shielded motor and mains cables.

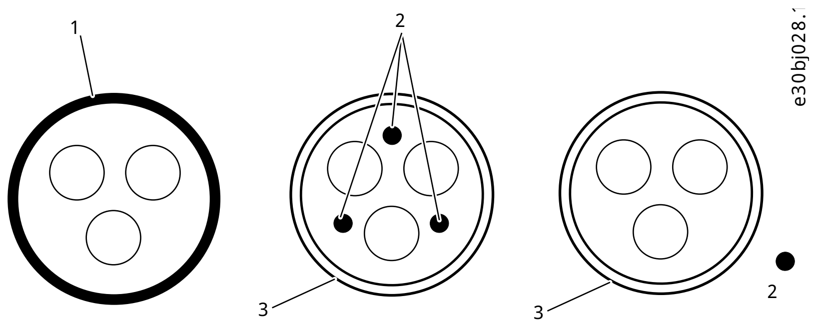


Figure 59: Recommended Cable Types for Mains and Motor Cabling

1	PE conductor and shield	**2**	PE conductor
3	Shield		

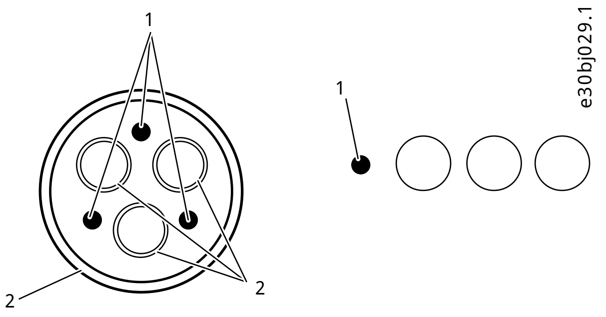


Figure 60: Not Recommended Motor Cable Types

1	PE conductor	**2**	Shield

7.4.2 Requirements for DC-source Cables of DC/DC Converters

It is recommended to use symmetrical cables with an even number of conductors for DC+ and DC-.

- 3-core cable: Use 2 conductors for DC+ and DC-, and the 3rd conductor for PE.
- 4-core cable: Use 2 conductors for DC+ and 2 conductors for DC-.

It is recommended to use cables with common shielding. Connect the cable shield to ground at both ends.

If single-core shielded cables are used, ground the cable shield only from one end.

Use single-core unshielded cables only if EMI protection is not necessary, or it is ensured by other means.

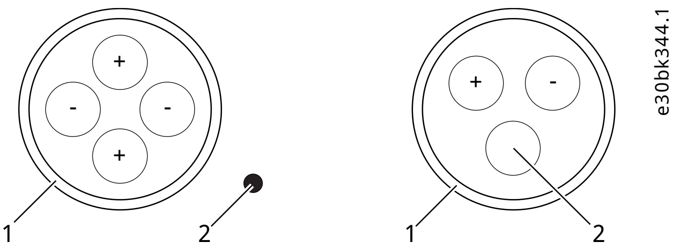


Figure 61: Recommended Cable Types for DC-source Cables

1	Shield	**2**	PE conductor

7.5 Prerequisites for Cable Installation

Table 14: Minimum Distances from Motor Cables to Other Cables

Distance to other cables [m (ft)]	Length of the shielded motor cable [m (ft)]
0.3 (1.0)	≤ 50 (164)
1.0 (3.3)	≤ 150 (492)

1. Before starting, make sure that none of the components of the AC drive is live. Read all safety precautions in this guide and other documents available for this product.
2. Make sure that the motor cables are sufficiently far from other cables.

3. The motor cables must go across other cables at an angle of 90°.
4. If it is possible, do not put the motor cables in long parallel lines with other cables.
5. If the motor cables are in parallel with other cables, obey the minimum distances (see Table 14).
6. The distances are also valid between the motor cables and the signal cables of other systems.
7. The maximum length of shielded motor cables is 150 m (492 ft). If the used motor cables are longer, contact the vendor to get more information. The motor cable length is based on the maximum number of cables for each frame. For example, 416 A INU module is based on 2 parallel cables, and 820 A INU module on 4 parallel cables. The default motor cable operating capacitance is 0.75 nF/m. If some other cable type is used or the number of cables connected in parallel does not match with recommendations, the maximum motor cable length must be derated so that the maximum total motor cable capacitance is not exceeded.
   a. Default maximum motor cable setup for Ix10L: 2x(3x120+70) mm^2, 150 m, 0.75 nF/m → C_{TOT} = 2 x 150 m x 0.75 nF/m = 225 nF = C_{MAX}
   b. Example where number of motor cables connected in parallel is higher than the default: 3x(3x120+70) mm^2, 100 m, 0.75 nF/m → C_{TOT} = 3 x 100 m x 0.75 nF/m = 225 nF = C_{MAX}
   c. Example where motor cable capacitance is higher than the default: 2x(3x120+70) mm^2, 130 m, 0.85 nF/m → C_{TOT} = 2 x 130 m x 0.85 nF/m = 221 nF < C_{MAX}
8. The minimum length of the motor cables without output filters is 5 m (16.4 ft).
9. See the maximum cable length of the filters in 7.13.1 dU/dt Filter and 7.13.2 Common-mode Filter.
10. Only use symmetrical and shielded motor cables.
11. Use symmetrical power cabling with power units connected in parallel. Each power unit must have the same number of cables with an equal cross-section and equal length.
12. Perform the cable insulation checks if necessary.

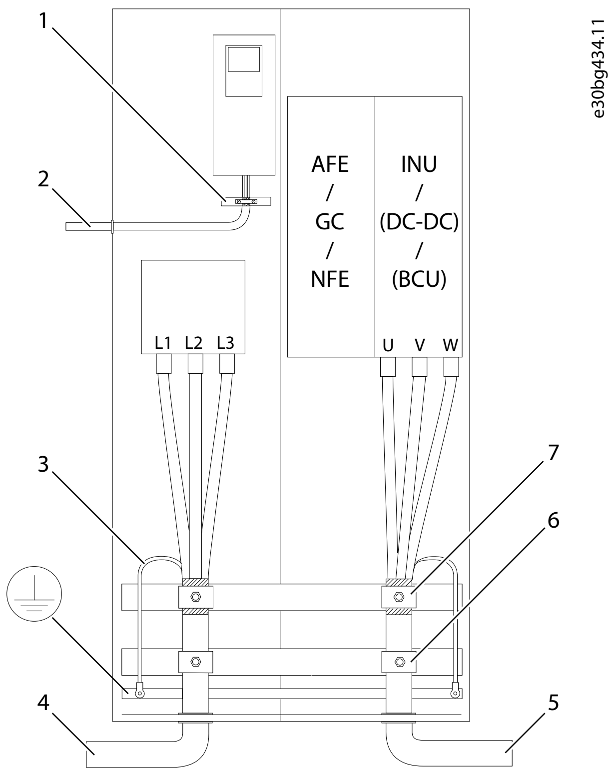


Figure 62: Cabling Principle

1	Grounding bar of the control cable	2	Control cable
3	Grounding conductor	4	Mains cables
5	Motor cables	6	Strain relief
7	The grounding clamp, 360° grounding		

7.6 Recommended Installation of Motor Cables

If the power units are connected in parallel without output filters or only with a common-mode filter, the recommended common coupling point of motor cables is at the motor terminals. It is also possible to use an alternative installation method where the common coupling point of the motor cables is near the drives. In this case, to avoid current imbalance, the installation must be symmetrical and the tolerance of cable length (impedance) to common coupling point is maximum 5%. If the cable connections are not symmetrical, use a dU/dt filter or a sine-wave filter.

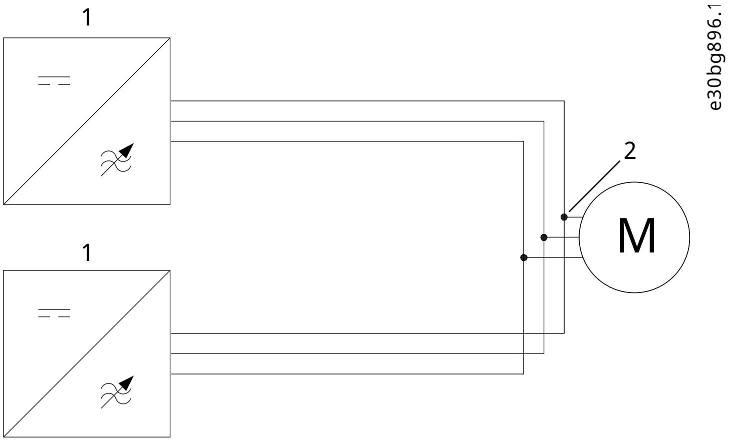


Figure 63: Recommended Installation

1	Inverter module	2	Common coupling point at the motor terminals

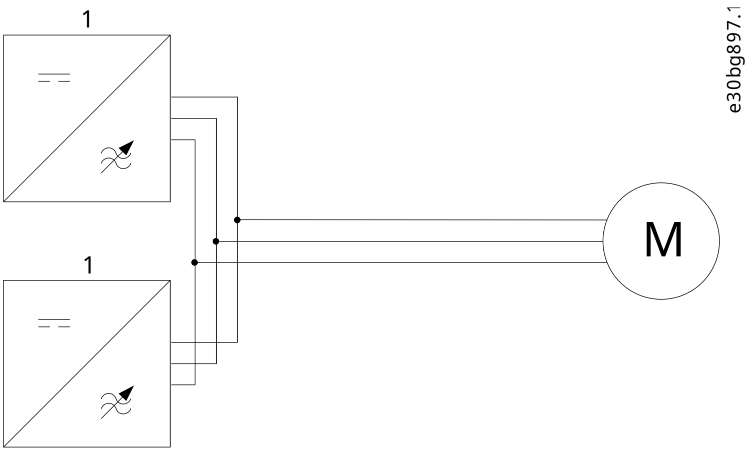


Figure 64: Alternative Installation Method

1	Inverter module

7.7 Field Cabling Installation

The field cabling terminals are not included in the delivery of the system module. Install field cabling to the appropriate terminals. Connect the terminals of the AFE/GC to the LCL Filter terminals with internal cables or busbars. Define the size of the internal cables or busbars according to the nominal current of the drive, and according to local regulations.

7.8 Installation of Cables with the Power Terminal Adapter

Typically, the motor cables in marine installations have a smaller cross-section compared to the cables in industrial installations, a maximum of 95 mm^2. That is why more cables must be connected in parallel. If local regulations require the use of several thin parallel motor cables, a power terminal adapter (+AFMC) is available for the installation.

See cable selection requirements in 10.4.7 Marine Cable Sizes for INU Modules 525–690 V AC.

7.9 Installing the DC Fuses to the DC Terminals

Use these instructions to install the DC fuses. The DC fuses are available as option +AKFX or +AKFF.

1. Attach busbars to the DC fuses. Make sure that the visual indicator (the red dot) of the DC fuse is facing forward.
    a. Screw the stud on the fuse. Make sure that the stud is inserted as far as it goes. The maximum tightening torque is 15 Nm (133 in-lb).
    b. Place the busbar on the stud.
    c. Mount the busbar with an M12 nut and washers, and tighten to torque 45 Nm (398 in-lb).

NOTICE

If the busbars on the DC fuses are not aligned, they can strain the fuse structure and break it over time. When tightening the screws, make sure that the busbars stay aligned.

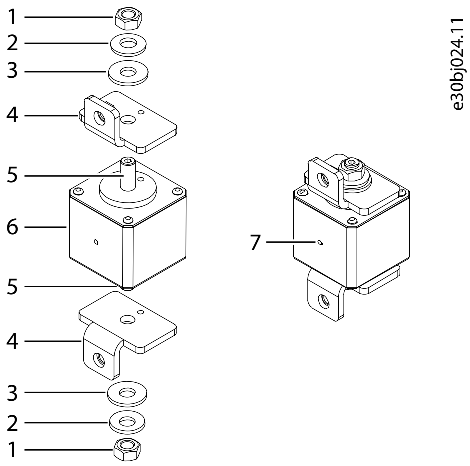


Figure 65: Installing Busbars to the DC Fuses

1	M12 nut	**2**	M12 spring washer
3	M12 washer	**4**	Busbar
5	Stud	**6**	Fuse
7	Visual indicator		

2. Attach DC-terminal busbars to the DC terminals of the system modules.

Use Combi M8 screws.

Use the tightening torque 20 Nm (177 in-lb).

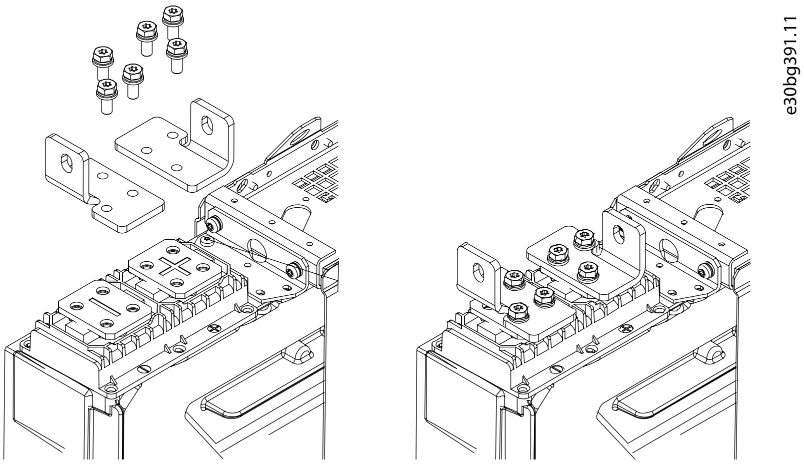


Figure 66: Installing DC-terminal Busbars to the DC Terminals

3. Attach the DC fuse assemblies to the DC-terminal busbars and to the common DC busbars.

Use M10 screws and washers.
Use the tightening torque 35–40 Nm (310–354 in-lb).

The common DC busbars are not included in the delivery.

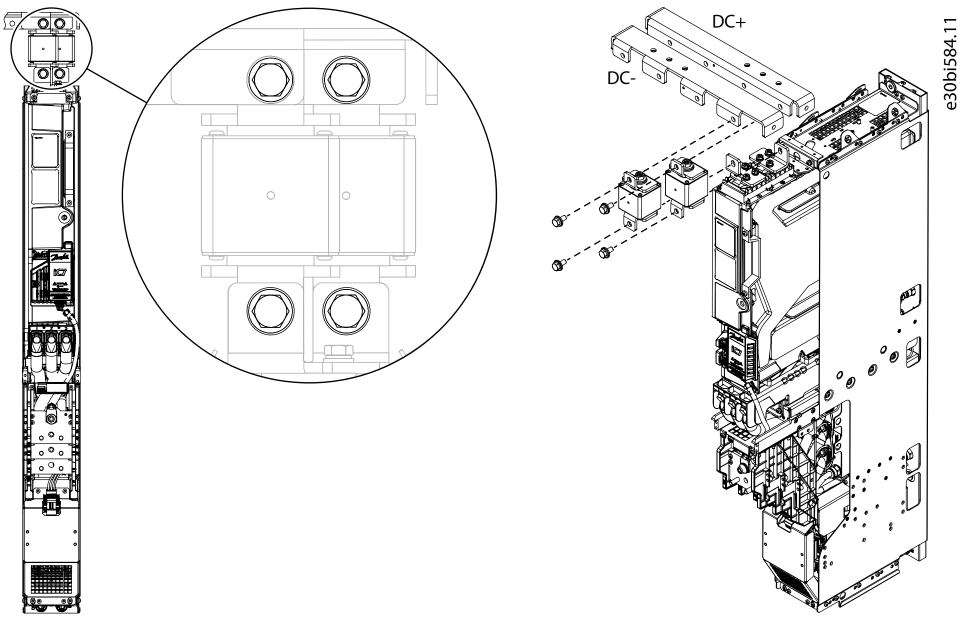


Figure 67: Installing DC Fuse Assemblies

7.10 DC-bus Connection Inductance

Certain DC-bus connection inductance configurations can induce resonance between the DC capacitors of the drive and DC-bus inductances. The resonance can be seen as increased DC-bus RMS current (DC + AC) and component temperatures in the drives. The drive can typically compensate the resonances, but at a certain inductance range, the resonance frequency between the drives can fall into a range where the compensation may not be effective enough. In that case, it is possible that the drive trips.

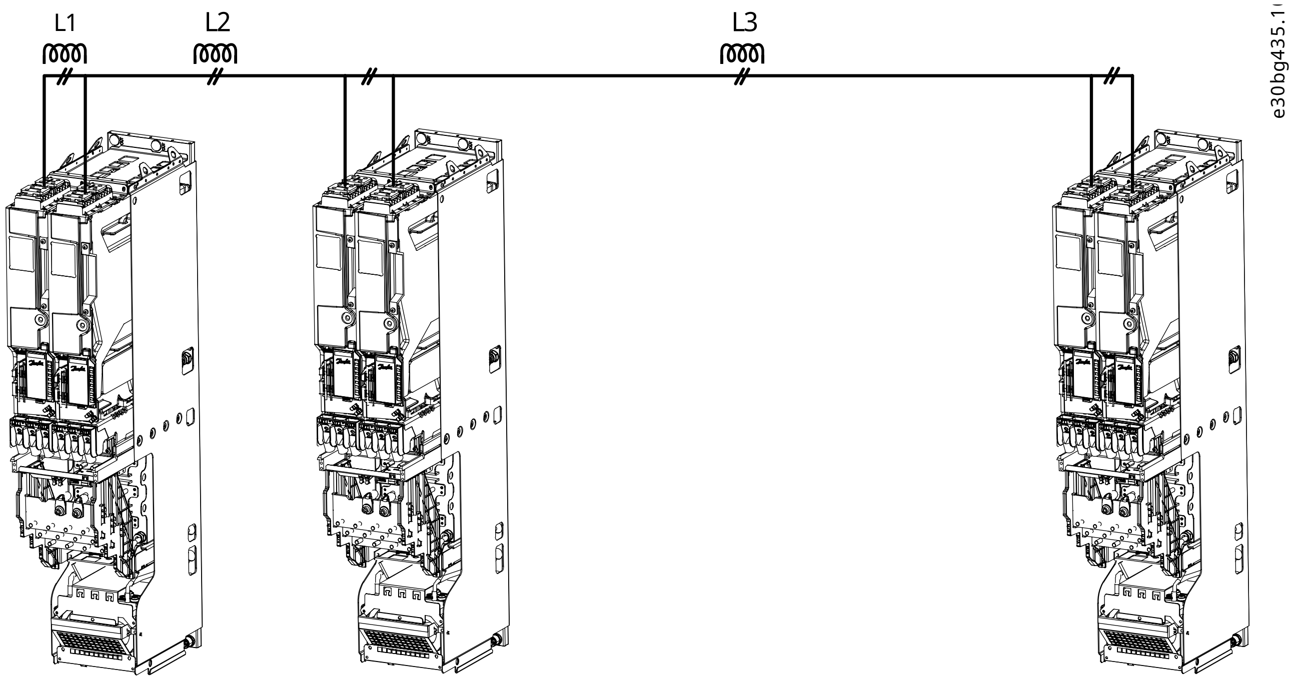


Figure 68: DC-bus Connection Inductance

L1	Connection inductance between system modules	**L2**	Connection inductance between drives
L3	Connection inductance of long DC-bus conductors between drives		

The possibility for excessive DC-bus resonance currents in the drives is largest when the individual connection inductance (L1, L2, or L3) or the sum of connection inductances (L1 + L2 + L3) is in the range of 2–10 µH.

It is recommended that especially inductance L1 is kept outside the 2–10 µH range by using short busbars or cables.

7.11 Auxiliary Power Connection, INU

The auxiliary 24 V DC power connection for the power unit is used for service purposes. When there is a 24 V DC power, it is possible to update the firmware, read or write parameters, and read monitored values.

Connector type: Molex Mini-Fit Jr. Receptacle Housing, dual row, 2 circuits, part number: 39012025

Terminal type: Molex Mini-Fit Female Crimp Terminal, part number: 39000039 (bag)

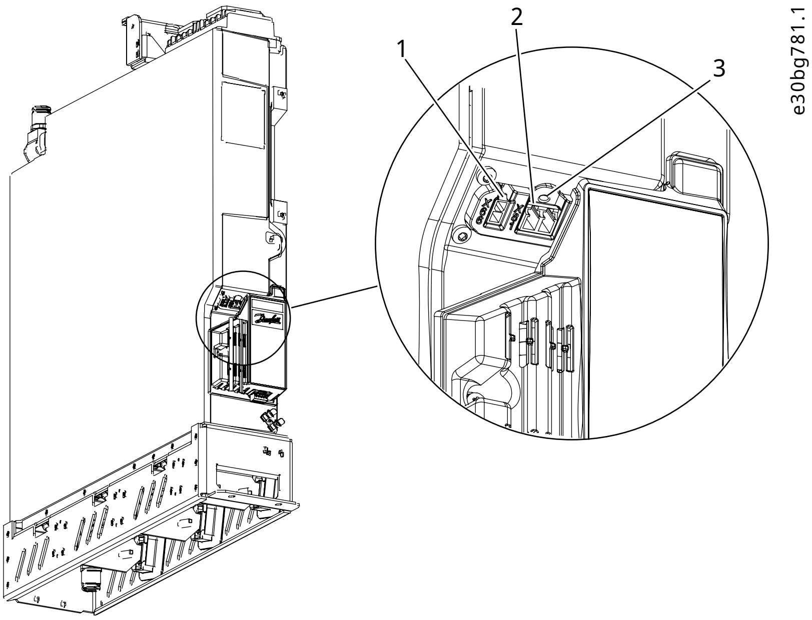


Figure 69: Auxiliary Power Connection for INU

1	Auxiliary +24 V DC connection (X66)	**2**	Optical fiber connection to control unit or star coupler board (X81)
3	Status indicator (See 7.11.1 Indicator Light Definitions.) (1)		

1) The status indicator is not implemented yet.

Pin number in X66	Voltage
1	23–26 V DC, 10 W continuous, 25 W peak power(1)
2	0 V DC

1) Cabling must be sufficient for supplying the 25 W peak power.

7.11.1 Indicator Light Definitions

Table 15: 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)	Signaling from an external application. Can be used for identifying where the external application is wirelessly connected to.

Table 15: Definitions of the Indicator Lights on the Control Board *(continued)*

Indicator name	Function (color)	Description
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.

7.12 Installation in an IT System

If the mains is impedance-grounded (IT), the AC drive must have the EMC protection level C4. If the drive has the EMC protection level C3, it is necessary to change it to C4. To change the EMC protection level of the AC drive from C3 to C4, disconnect the LC Filter ground capacitor. See instructions:

- 7.12.1 Changing the EMC Protection Level, AR10L
- 7.12.2 Changing the EMC Protection Level, AR12L
- 7.12.3 Changing the EMC Protection Level, LC Filter, OF7Z1, 380 A
- 7.12.4 Changing the EMC Protection Level, LC Filter, OF7Z1, 760 A

NOTICE

DAMAGE TO THE AC DRIVE FROM INCORRECT EMC LEVEL

The EMC level requirements for the AC drive depend on the installation environment. An incorrect EMC level can damage the drive.

- Before connecting the AC drive to the mains, make sure that the EMC level of the AC drive is correct for the mains.

In a non-dedicated IT system, it is recommended to leave the ground capacitors connected in each AFE and GC to limit conducted high-frequency disturbances between devices across the system. A non-dedicated IT system is defined here as a network where several separate DC links are fed from the same AC supply.

If the ground capacitors are connected, continuous operation during an IT ground fault is not allowed, because a large fault current is going through the capacitors.

In common DC bus installations supplied through a dedicated transformer or an NFE, and with common-mode voltage-sensitive energy storages or equipment connected to the DC bus, it is recommended to have ground capacitors on the DC bus side (DC+ to PE and DC- to PE) to balance the DC bus voltage against ground. In this case, the AC side ground capacitors should be disconnected. This can affect the installation altitude, see more details in 10.8 Technical Data. The ground capacitors should be sufficiently larger than the system parasitic capacitance to ground to be effective in limiting the common-mode voltage peaks.

As a rule-of-thumb:

- 10 x system parasitic capacitance ~ 100 V common-mode voltage to ground
- 100 x system parasitic capacitance ~ 10 V common-mode voltage to ground

Continuous operation during ground fault when DC side ground capacitors are connected is not allowed due to potentially large fault currents.

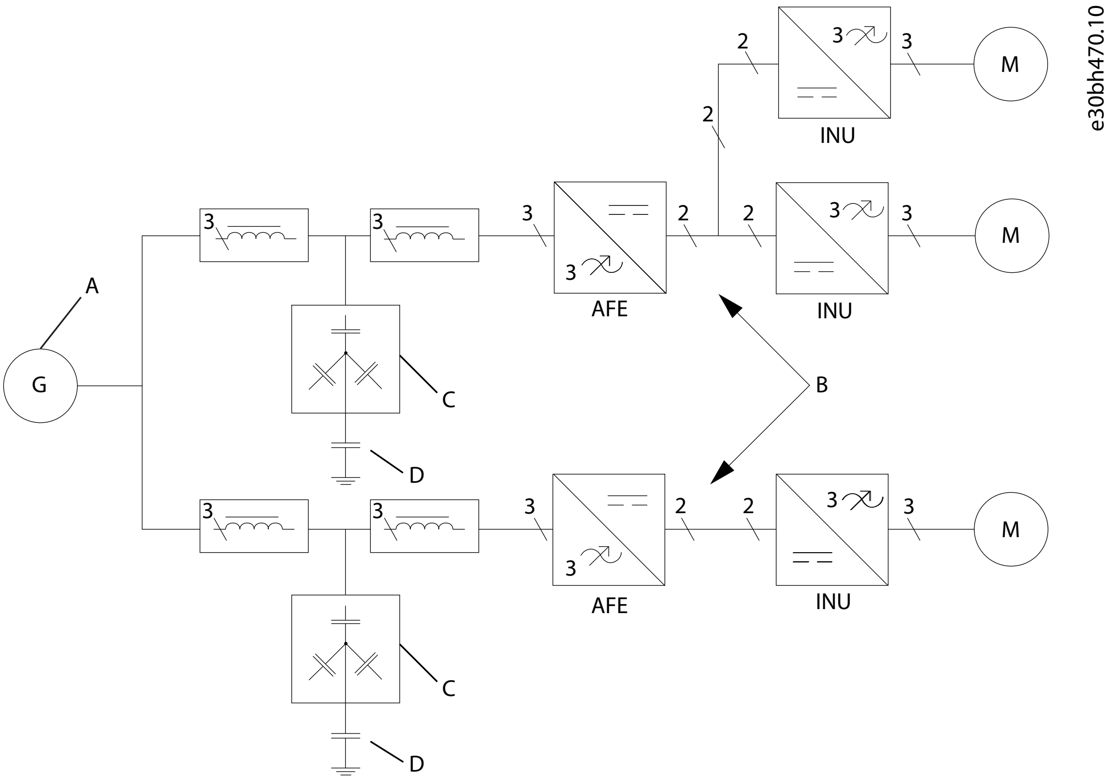


Figure 70: AFE Modules in IT System

A	Generator, floating	**B**	Separate DC links
C	Filter capacitors	**D**	Ground capacitor/capacitors on the LC Filter side

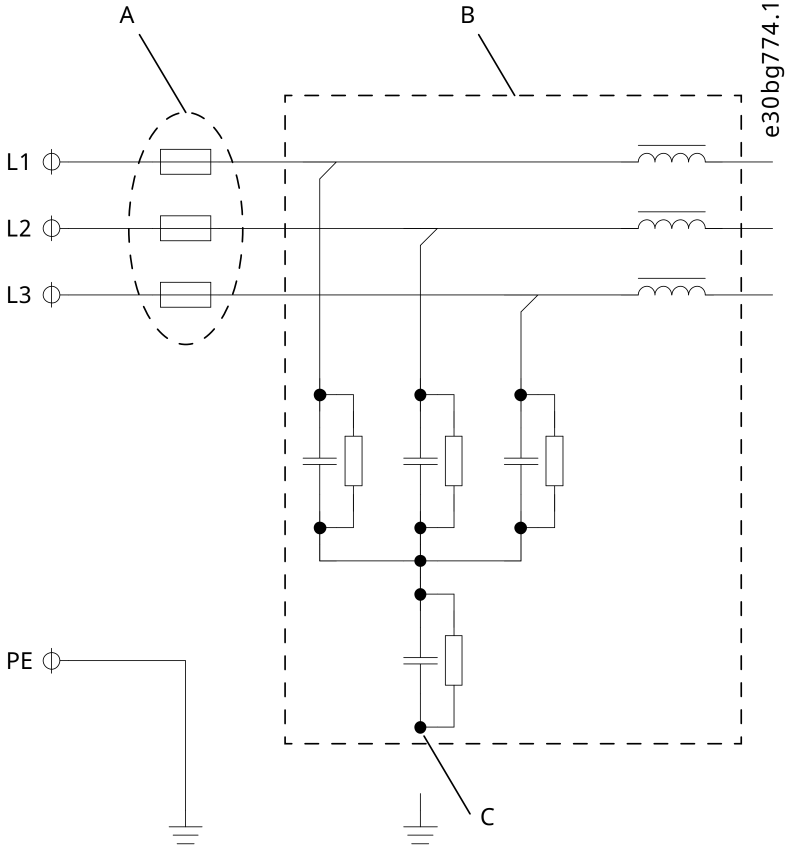


Figure 71: Diagram of the LC Filter

A	AC fuses	**B**	LC Filter
C	The grounding wire (disconnected)		

7.12.1 Changing the EMC Protection Level, AR10L

In an IT system, to change the EMC protection level of the AC drive from C3 to C4, disconnect the LC Filter ground capacitor.

Procedure

1. Loosen the screw of the grounding wire of the LC Filter.
2. Remove the grounding wire from the grounding terminal.
3. Move the cable lug of the grounding wire with the screw onto the insulator and tighten the screw (maximum 0.5 Nm (4.4 in-lb)).

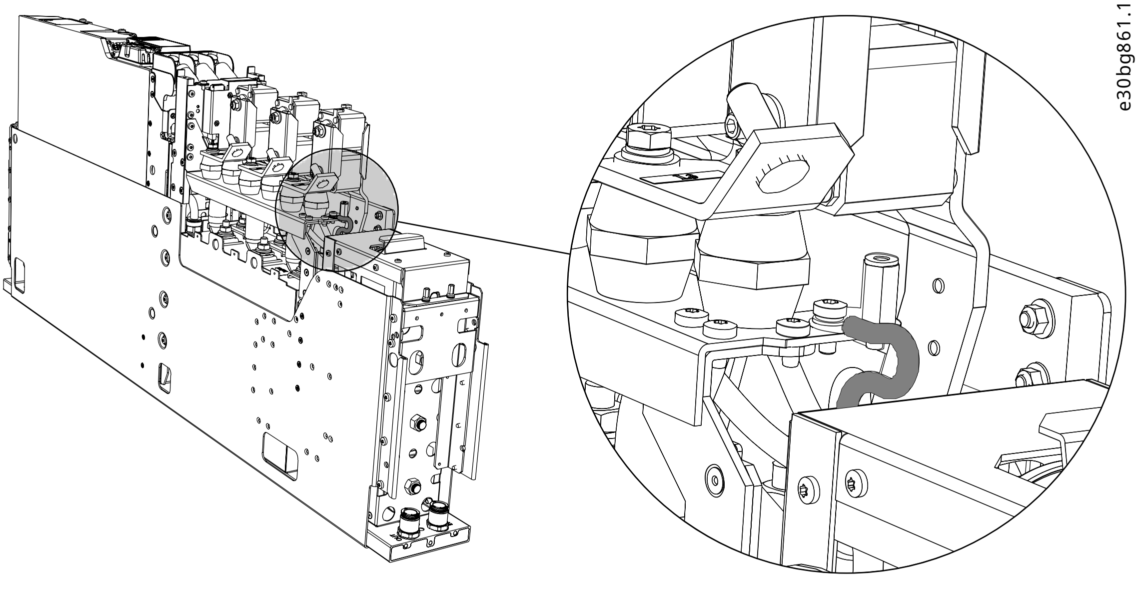


Figure 72: Level C3

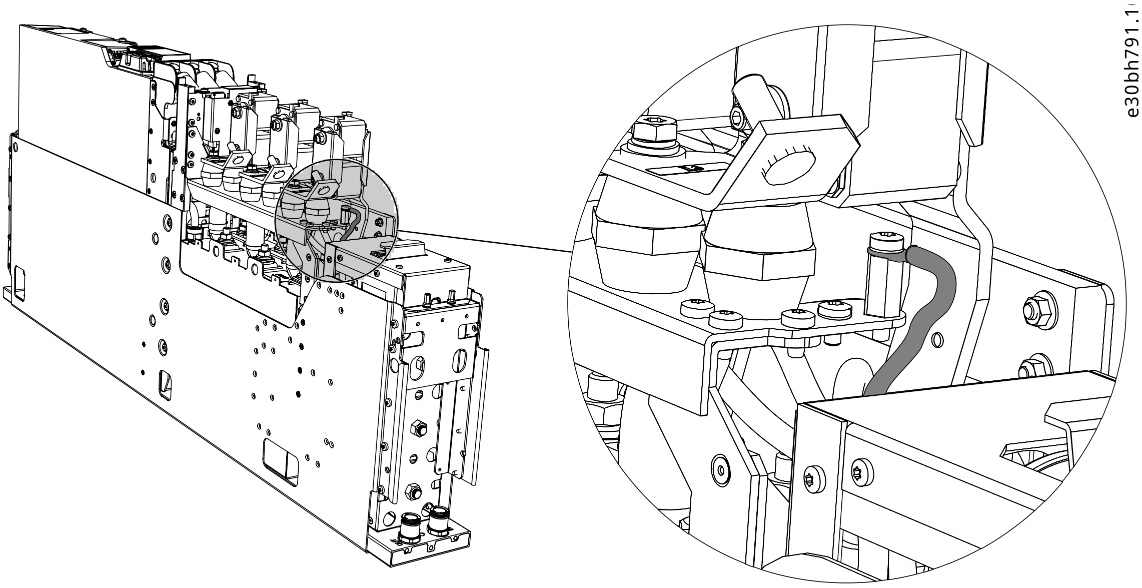


Figure 73: Level C4

4. After the change, write "The EMC level was changed from C3 to C4", and the date on the "product modified" label. If the label is not yet attached, attach it on the drive near the product label.

7.12.2 Changing the EMC Protection Level, AR12L

In an IT system, to change the EMC protection level of the AC drive from C3 to C4, disconnect the LC Filter ground capacitor.

Procedure

1. Loosen the screw of the grounding wire of the LC Filter.
2. Remove the grounding wire from the grounding terminal.
3. Move the cable lug of the grounding wire with the screw onto the insulator and tighten the screw (maximum 0.5 Nm (4.4 in-lb)).

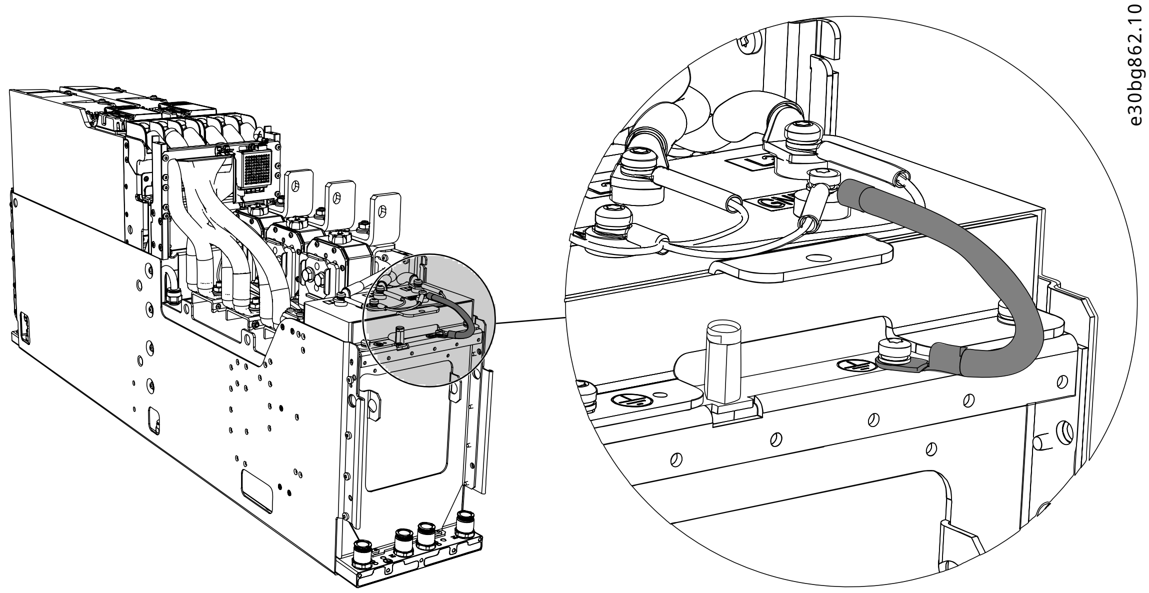


Figure 74: Level C3

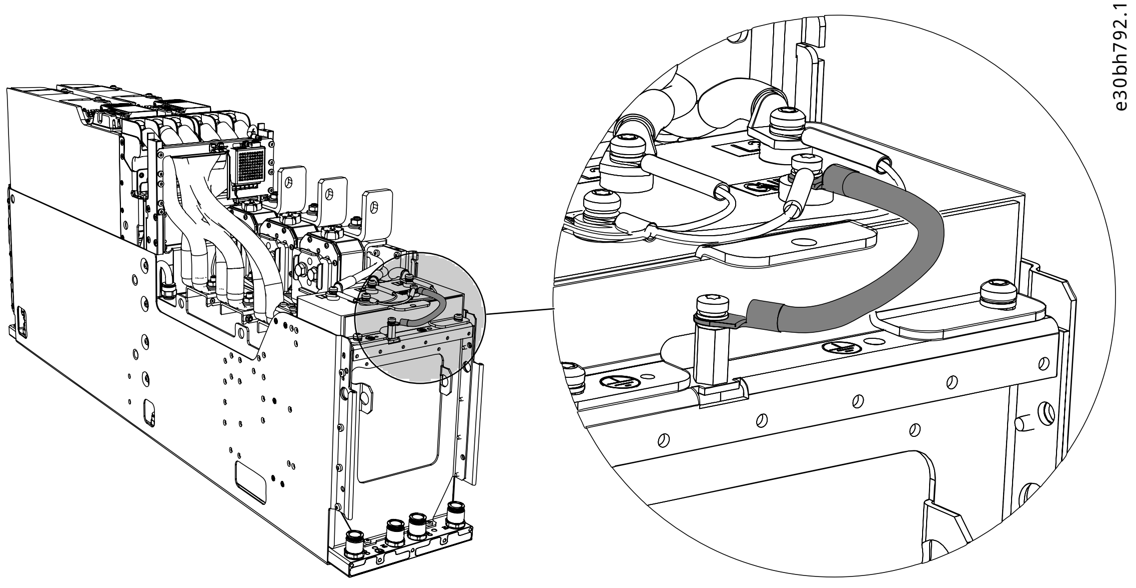


Figure 75: Level C4

4. After the change, write "The EMC level was changed from C3 to C4", and the date on the "product modified" label. If the label is not yet attached, attach it on the drive near the product label.

7.12.3 Changing the EMC Protection Level, LC Filter, OF7Z1, 380 A

In an IT system, to change the EMC protection level of the AC drive from C3 to C4, disconnect the LC Filter ground capacitor.

Procedure

1. Loosen the screw of the grounding wire of the LC Filter.
2. Remove the grounding wire from the grounding terminal.
3. Move the cable lug of the grounding wire with the screw onto the insulator and tighten the screw (maximum 0.5 Nm (4.4 in-lb)).

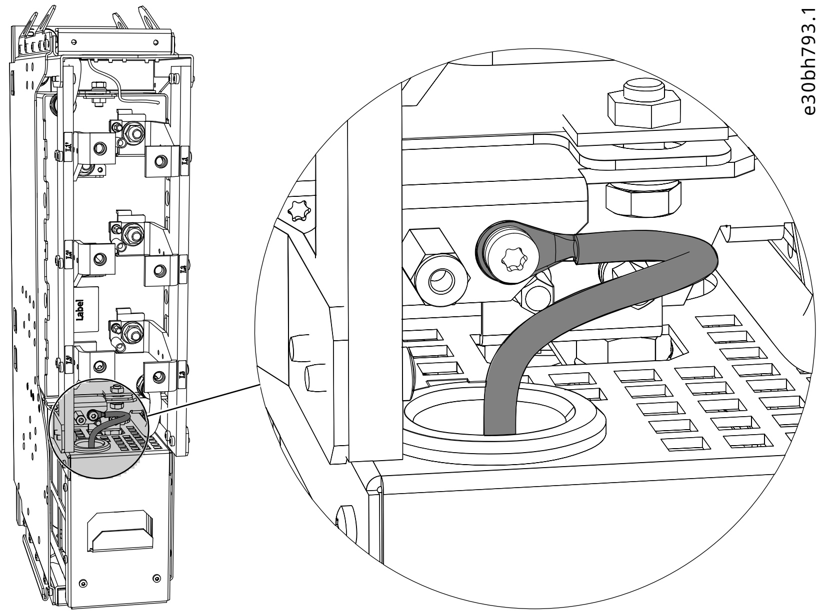


Figure 76: Level C3

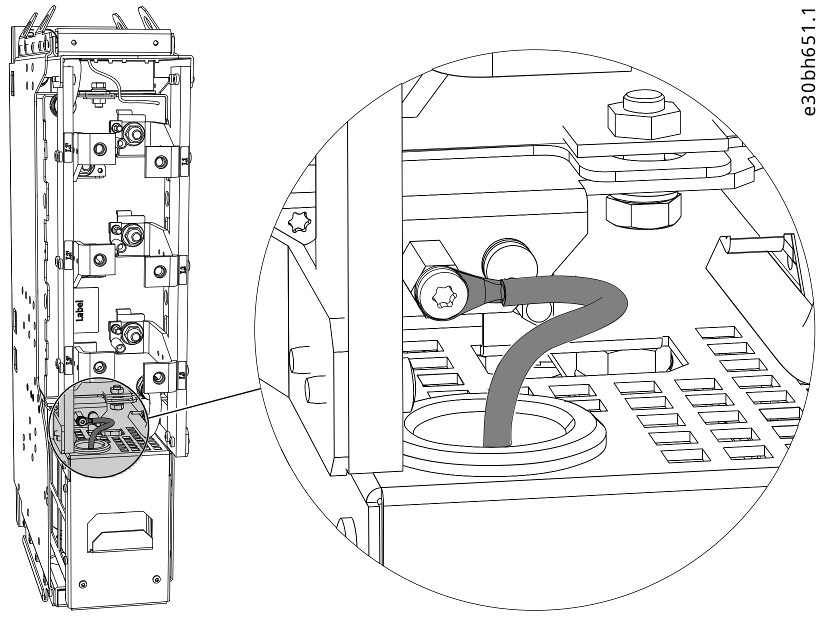


Figure 77: Level C4

4. After the change, write "The EMC level was changed from C3 to C4", and the date on the "product modified" label. If the label is not yet attached, attach it on the drive near the product label.

7.12.4 Changing the EMC Protection Level, LC Filter, OF7Z1, 760 A

In an IT system, to change the EMC protection level of the AC drive from C3 to C4, disconnect the LC Filter ground capacitor.

Procedure

1. Loosen the screw of the grounding wire of the LC Filter.
2. Remove the grounding wire from the grounding terminal.
3. Move the cable lug of the grounding wire with the screw onto the insulator and tighten the screw (maximum 0.5 Nm (4.4 in-lb)).

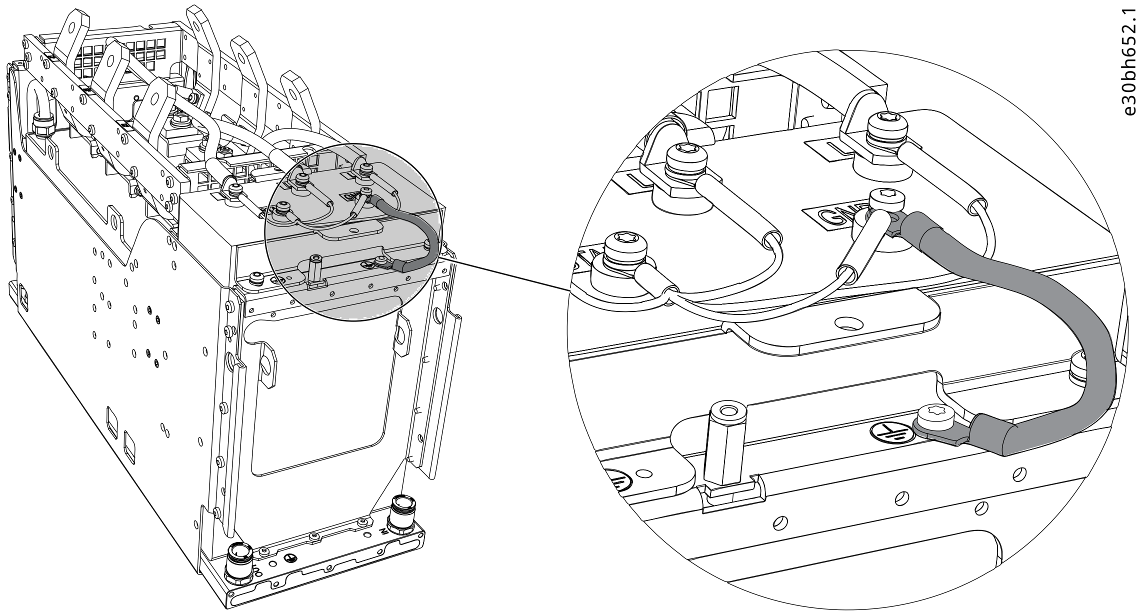


Figure 78: Level C3

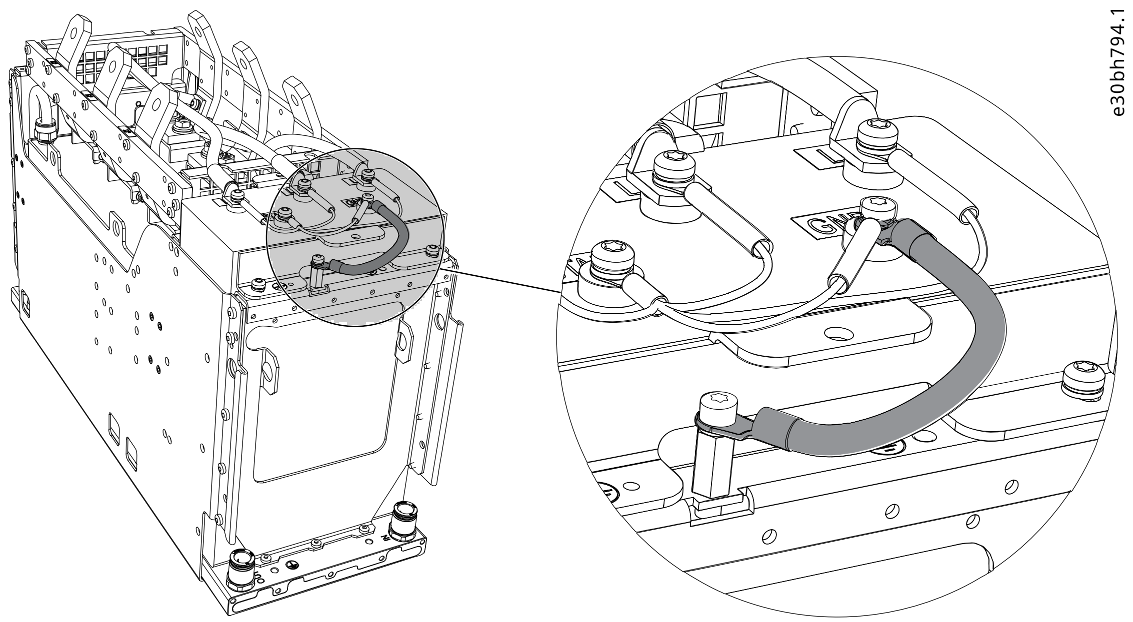


Figure 79: Level C4

4. After the change, write "The EMC level was changed from C3 to C4", and the date on the "product modified" label. If the label is not yet attached, attach it on the drive near the product label.

7.13 Filters

7.13.1 dU/dt Filter

With the dU/dt Filter, the nominal switching frequency is 2 kHz. The maximum switching frequency is 4 kHz.

The dU/dt Filter can be used without derating up to 70 Hz. For output frequencies higher than 70 Hz, current must be derated according to the curve presented below. Above 200 Hz, a special high-speed filter is recommended.

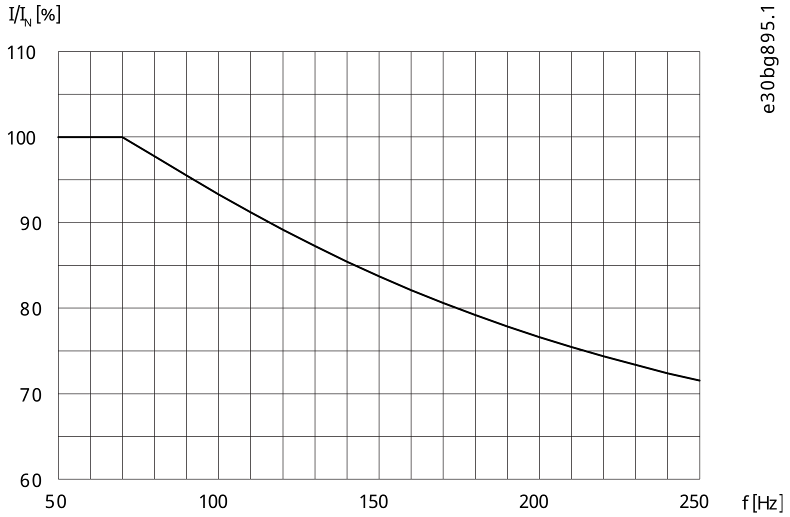


Figure 80: Output Frequency Derating

Maximum motor cable length depends mainly on switching frequency, DC-link voltage, and motor cable setup. Safe operation area graphs are presented below for all available filter types. The motor cable length is based on the maximum number of cables for each frame (see 10.4.4 Field Cable Sizes for INU Module, 525–690 V AC). For example, the graphs for a 416 A filter are based on two parallel cables, and for an 820 A filter on four parallel cables. The default motor cable operating capacitance is 0.75 nF/m. If some other cable type is used or the number of cables connected in parallel does not match with recommendations, the maximum motor cable length must be derated so that the maximum total motor cable capacitance is not exceeded.

Losses are higher in low output frequency range (0–5 Hz). If drives are operating in this range, the maximum motor cable length (capacitance) must be derated.

In an IT system, filter losses in a single-phase earth fault depend on the setup. All capacitances to ground should be minimized to minimize the fault current. The fault current increases the losses, and continuous operation during the earth fault cannot be guaranteed, especially if the filter is already in the limits without the fault. The filter has temperature protection in every phase to protect the filter against too high earth fault currents. If continuous operation during a single-phase earth fault is a strict requirement, a sine-wave filter is recommended.

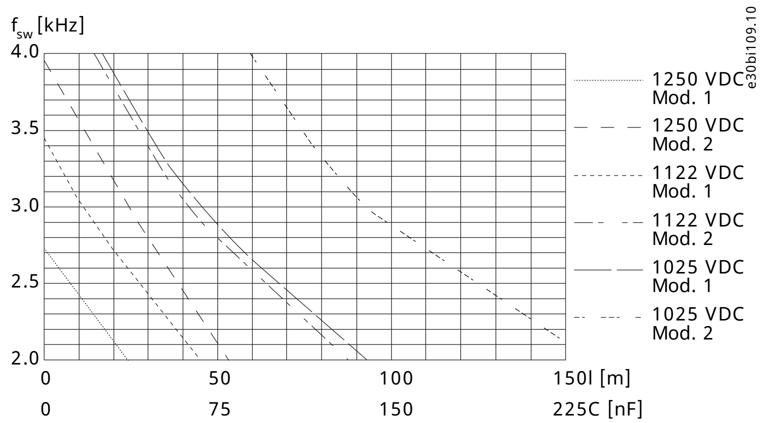


Figure 81: Safe Operation Area: 416 A dU/dt Filter

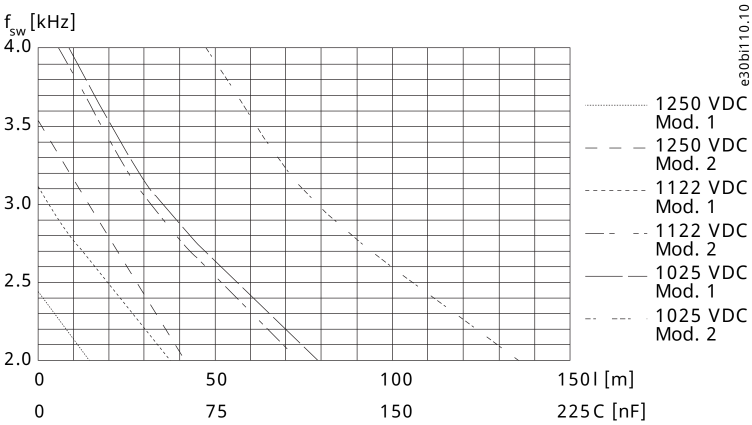


Figure 82: Safe Operation Area: 416 A dU/dt Filter, Low Output Frequency Range

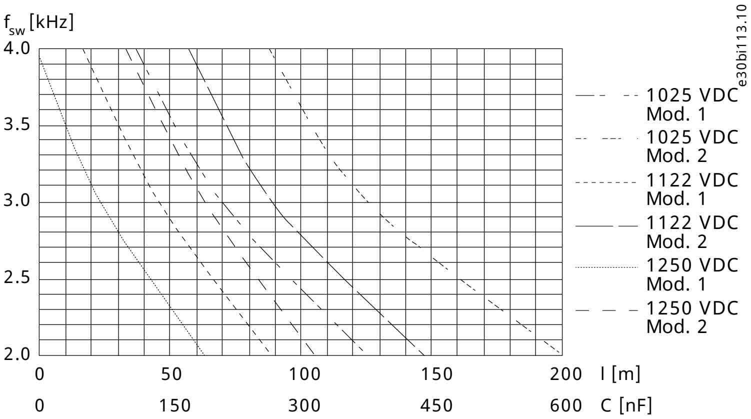


Figure 83: Safe Operation Area: 820 A dU/dt Filter

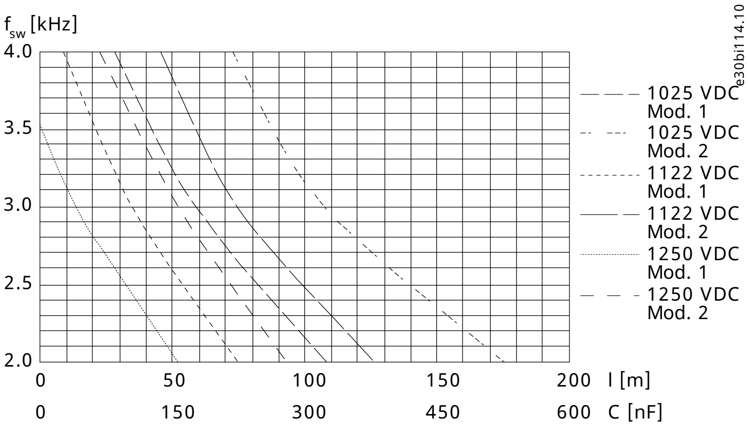


Figure 84: Safe Operation Area: 820 A dU/dt Filter, Low Output Frequency Range

7.13.2 Common-mode Filter

With the Common-mode Filter, the nominal switching frequency is 2 kHz. The maximum switching frequency is 4 kHz.

The Common-mode Filter can operate in the whole output frequency range of the drive.

The maximum motor cable length depends mainly on switching frequency, DC-link voltage, and motor cable setup. Safe operation area graphs are presented below for all available filter types. The motor cable length is based on the maximum number of cables for each frame (see 10.4.4 Field Cable Sizes for INU Module, 525–690 V AC). For example, the graphs for a 416 A filter are based on two parallel cables, and for an 820 A filter on four parallel cables. The default motor cable operating capacitance is 0.75 nF/m. If some other cable type is used or the number of cables connected in parallel does not match with recommendations, the maximum motor cable length must be derated so that the maximum total motor cable capacitance is not exceeded.

Losses are higher in low output frequency range (0–5 Hz). If drives are operating in this range, the maximum motor cable length (capacitance) must be derated.

In an IT system, filter losses in a single-phase earth fault depend on the setup. All capacitances to ground should be minimized to minimize the fault current. The fault current increases the losses, and continuous operation during the earth fault cannot be guaranteed, especially if the filter is already in the limits without the fault. The filter has temperature protection against too high earth fault currents.

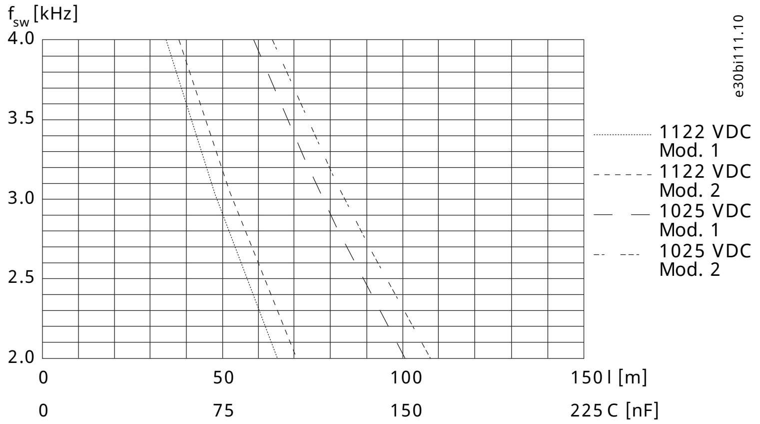


Figure 85: Safe Operation Area: 416 A Common-mode Filter

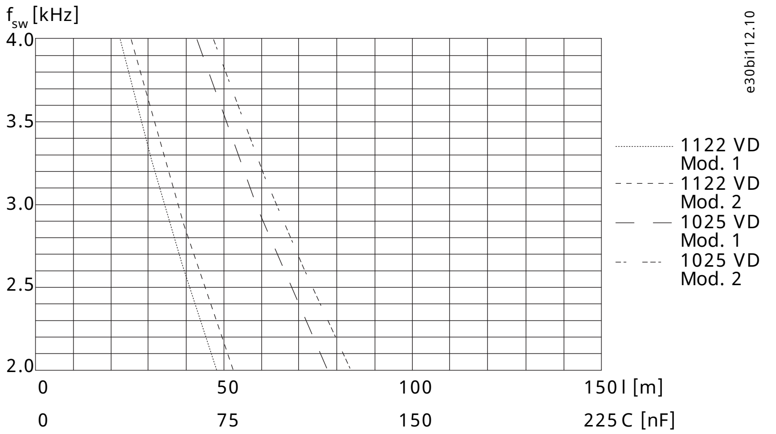


Figure 86: Safe Operation Area: 416 A Common-mode Filter, Low Output Frequency Range

If drives are connected in parallel, the recommended common connection point for motor cables is at the motor terminals. See 7.5 Prerequisites for Cable Installation.

7.13.3 LC Filter

When regenerative or low-harmonic functionality is required in an application, install an LC or LCL Filter between the power supply and the system module. The LC Filter can be used with the AFE module or the grid converter module, and it ensures correct power quality and minimal interruption to the grid. Use the LC Filter when one dedicated transformer serves each system module. The LC Filter is designed for the nominal AFE/GC switching frequency. It is safe to increase the switching frequency, but decreasing the switching frequency below nominal value increases the risk of overheating and unwanted resonances.

NOTICE

Use aR-type AC fuses with the LC Filter. The recommended fuse types can be found in 10.5.2 AC Fuses for AFE or GC 525–690 V AC, IP00/Open Type. Select the fuses according to the frame and the current rating of the system module. When designing the fuse installation, refer to 10.3.1 Wiring Diagram, AFE/GC, AR10L and 10.3.2 Wiring Diagram, AFE/GC, AR12L.

7.13.4 DC Filter

The DC/DC converter requires a DC Filter inductance between the source and the system module for current control and ability to boost voltage. The filter also smoothens the current and voltage waveform, making them suitable for most DC sources or loads.

It is safe to increase the switching frequency which further reduces the current and voltage ripple at the DC source. Decreasing the switching frequency below the nominal value increases the risk of overheating.

The total capacitance of the capacitors in the DC Filter (capacitance between + and - terminals of DC Filter):

- DC Filter, 570 A = 180 µF
- DC Filter, 1200 A = 480 µF

NOTICE

Use aR-type DC fuses with the DC Filter. The recommended fuse types can be found in 10.5.6 Source DC+ Fuses for DC/DC Converter, IP00/Open Type. Select the fuses according to the frame and the current rating of the system module. When designing the fuse installation, refer to 10.3.5 Wiring Diagram, DC/DC Converter, DR10L and 10.3.6 Wiring Diagram, DC/DC Converter, DR12L.

7.14 AuxBus Communication

7.14.1 Usage of AuxBus

AuxBus enables communication for filters. When AuxBus is connected, the drive provides temperature monitoring and other diagnostics of the used options thus giving vital information about the system. AuxBus is also used to create warning and fault signals for the system if the drive operates outside the set limits or if there is a failure.

NOTICE

For the drive/converter to be able to protect the filters, AuxBus must be connected.

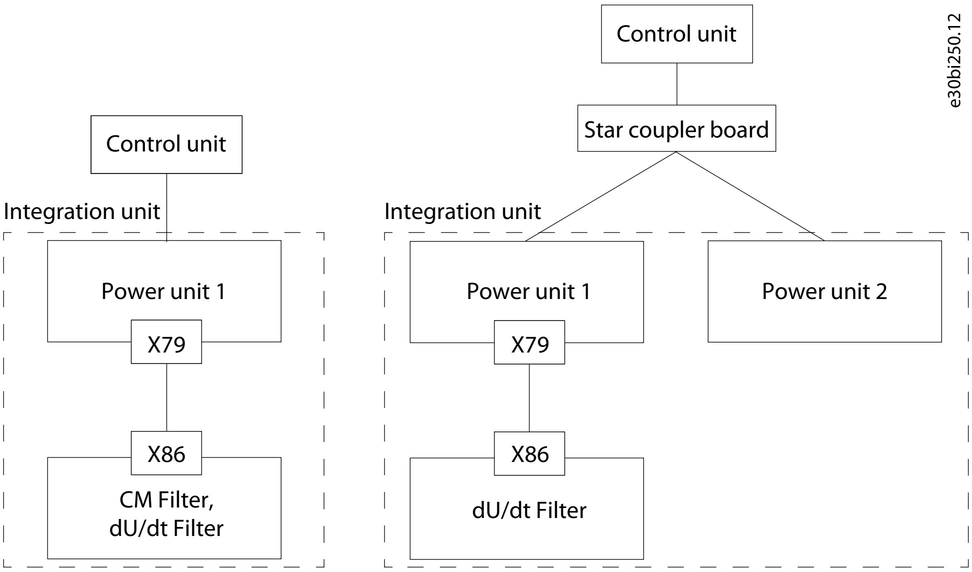


Figure 87: AuxBus Topology for Inverter Modules IR10L and IR12L

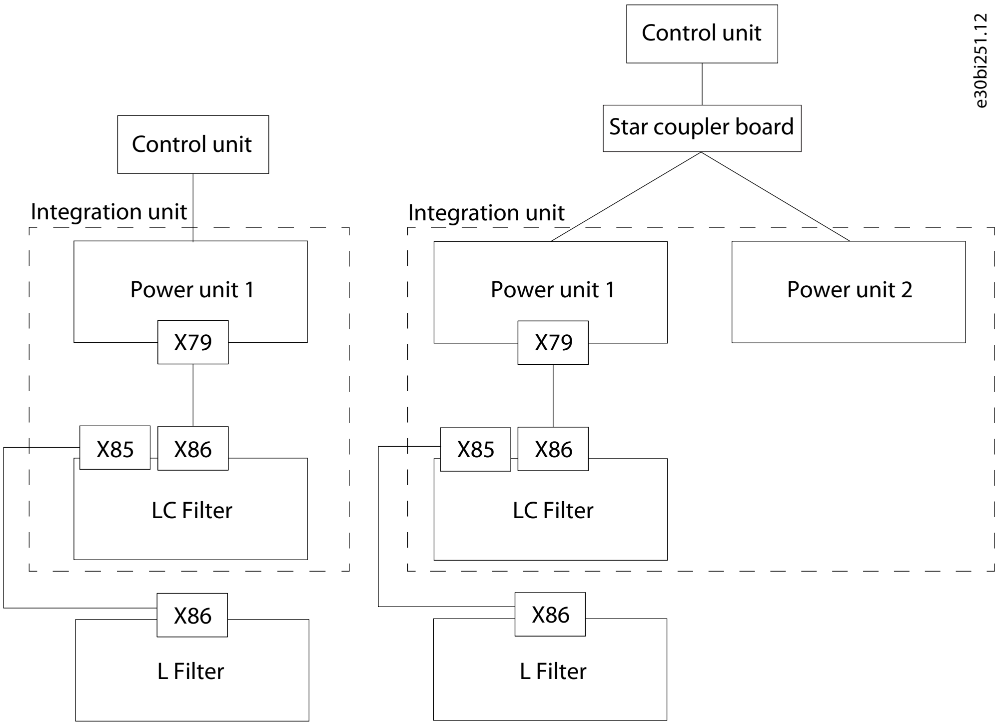


Figure 88: AuxBus Topology for AFE and Grid Converter Modules AR10L and AR12L

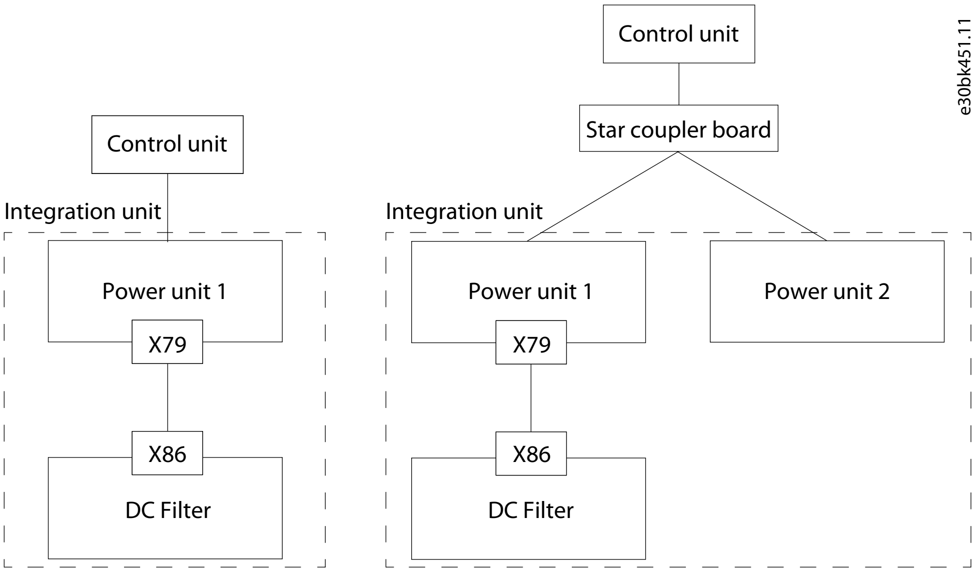


Figure 89: AuxBus Topology for DC/DC Converter Modules DR10L and DR12L

7.14.2 AuxBus Cable Requirements

It is recommended to use the AuxBus cables that are provided by Danfoss. AuxBus is delivered with 3 m (10 ft) of cable. If other cables are used, see the table Table 16.

NOTICE

RISK OF ELECTRICAL INTERFERENCE

AuxBus consists of point-to-point connection, but the signals are connected in series. Cables that are longer than 10 m (33 ft) can create interference and communication problems.

- Do not exceed 10 m (33 ft) of total AuxBus cabling.
- Keep AuxBus cables as short as possible and separate them from high-power cables.

Table 16: Cable Requirements for Other than Danfoss-provided Cables

Item	Value
Cable type	6-wire, shielded and twisted pair (STP)
Impedance	120 Ω
Maximum length	10 m (33 ft)

Cable (example): LAPP KABEL, UNITRONIC® BUS LD FB P, 2170215.

Cable (example, UL): LAPP KABEL, UNITRONIC® BUS LD FB P A, 2170815.

Connector: Phoenix Contact, MC 1,5/ 5-ST-3,5 BK, 1769919 (LCL Filter: 2721-105/026-000).

Cabling recommendation for drives with a loose option AuxBus

Cabling recommendation for drives with integration unit filters

7.14.3 AuxBus Grounding Principles

To ensure robust communication, good grounding strategy is needed. Below is a recommended grounding strategy illustrated using integration units. Same strategy can be applied for loose option filters.

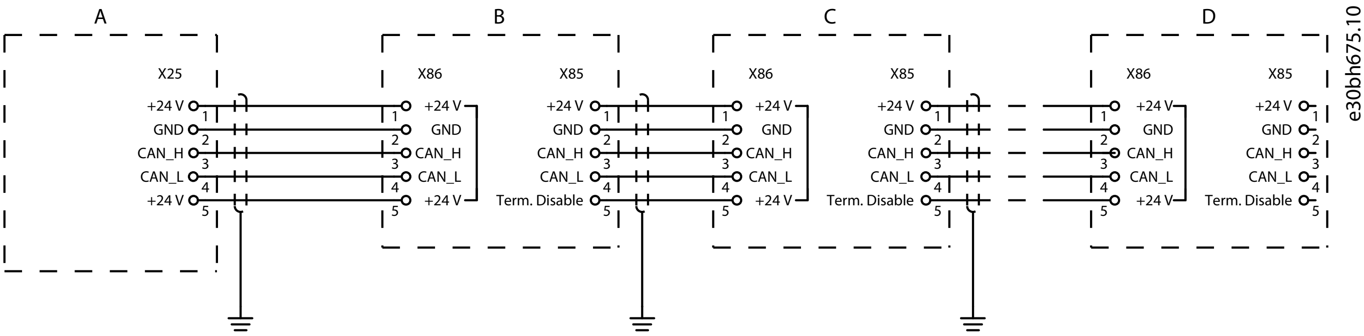


Figure 90: AuxBus Circuit Diagram

A	The AuxBus interface in the power unit	**B**	AuxBus board 1
C	AuxBus board 2	**D**	AuxBus board 3

7.15 The Pre-charging Unit

The pre-charging unit is used for pre-charging the system modules that are connected to the same DC bus. There are 3 electrical sizes, and an IEC and an UL variant of these. The pre-charging unit is available as an accessory.

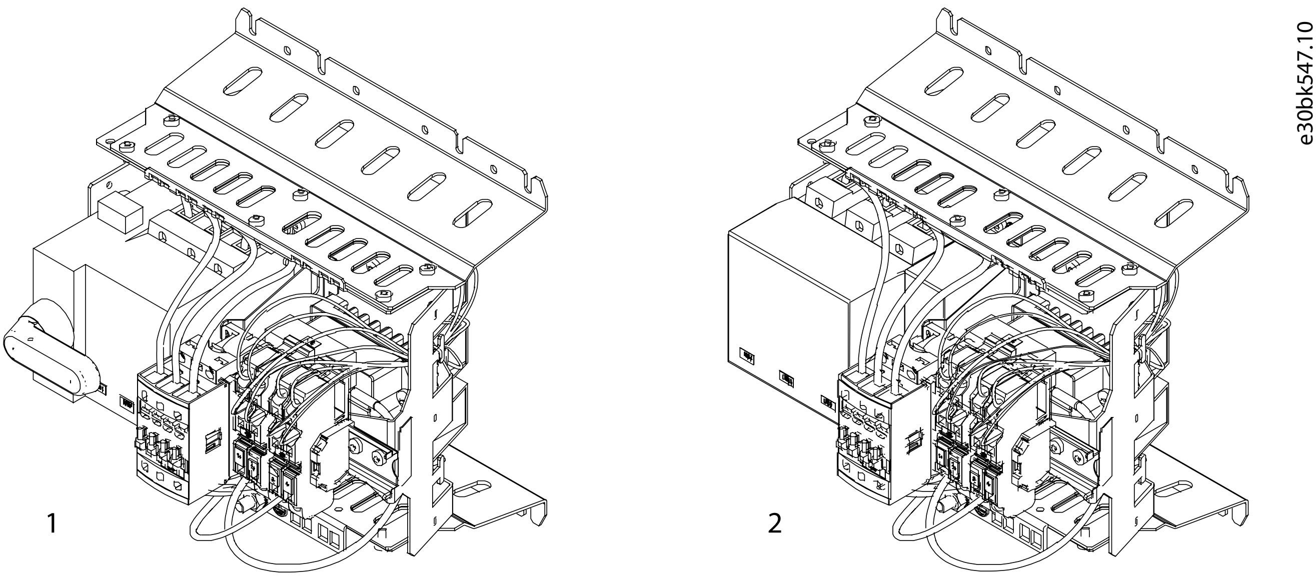


Figure 91: Pre-charging Units

1	Pre-charging unit, IEC	**2**	Pre-charging unit, UL

Table 17: Selection of the Correct Pre-charging Unit

System modules	Pre-charging unit
IM10L + IM10L / IR10L + IR10L	Pre-charging unit 10 (IEC or UL)
IM12L + IM12L / IR12L + IR12L	
2 x IM12L + 2 x IM12L / 2 x IR12L + 2 x IR12L	
3 x IM12L + 3 x IM12L / 3 x IR12L + 3 x IR12L	
4 x IM12L + 4 x IM12L / 4 x IR12L + 4 x IR12L	
5 x IM12L + 5 x IM12L / 5 x IR12L + 5 x IR12L	Pre-charging unit 20 (IEC or UL)
6 x IM12L + 6 x IM12L / 6 x IR12L + 6 x IR12L	
7 x IM12L + 7 x IM12L / 7 x IR12L + 7 x IR12L	
8 x IM12L + 8 x IM12L / 8 x IR12L + 8 x IR12L	

Table 18: Maximum Capacitance of the Pre-charging Unit

Pre-charging unit	Network [V AC]	Capacitance [μF]
Pre-charging unit 10 (IEC or UL)	400/500	66500
	690	29500
Pre-charging unit 20 (IEC or UL)	400/500	184000
	690	76500
Pre-charging unit 30 (IEC or UL)	400/500	275000
	690	114500

There are thermal restrictions in a repeated use of the pre-charging unit. See the allowed pre-charging cycle in a 60 °C (140 °F) ambient temperature in Table 19.

Table 19: The Thermally Allowed Pre-charging Cycle

Step	Task	Duration
1.	Charging	10 s
2.	Discharging	50 s
3.	Charging	10 s
4.	Discharging	50 s
5.	Wait for the pre-charging unit to cool down.	10 min
6.	Repeat	–

7.16 Derating

7.16.1 Derating of Switching Frequency, INU

The inverter unit can be used without derating up to 3 kHz. For switching frequencies higher than 3 kHz, current must be derated according to the diagram.

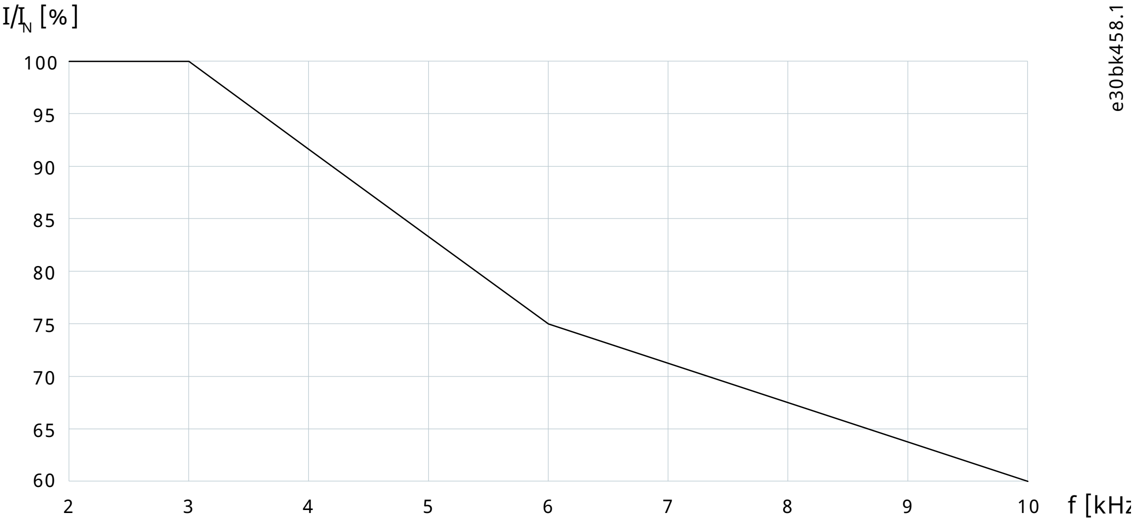


Figure 92: Switching Frequency Derating

7.16.2 Derating of Coolant Temperature

The liquid-cooled system modules can be used without derating up to 38 °C (100 °F) or 45 °C (113 °F), depending on the current rating. For higher coolant temperatures, current must be derated 1%/1 °C (1%/1.8 °F) as shown in the following diagram.

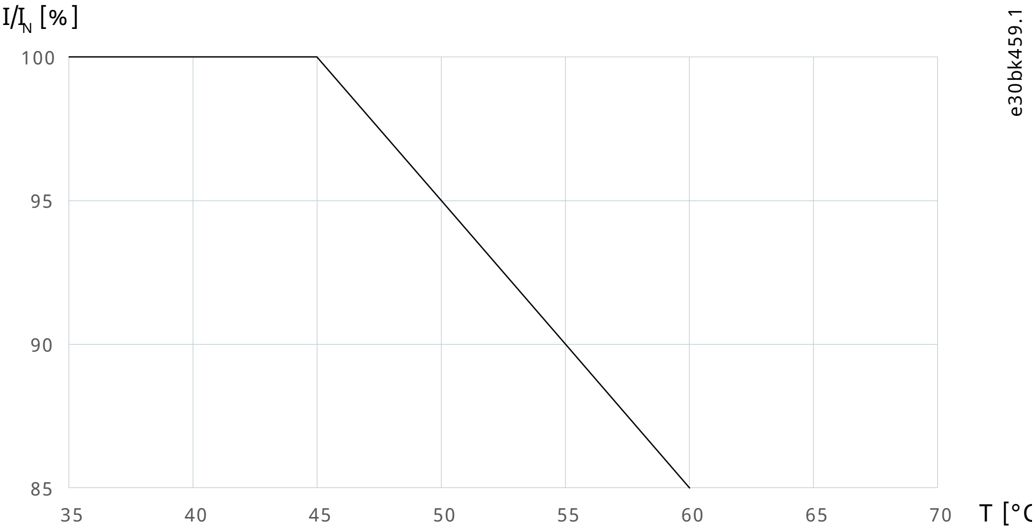


Figure 93: Coolant Temperature Derating

7.16.3 Derating of Voltage Imbalance, AFE/GC

AFE and grid converter units can be used without derating up to 3%. For voltage imbalances higher than 3%, current must be derated according to the diagram.

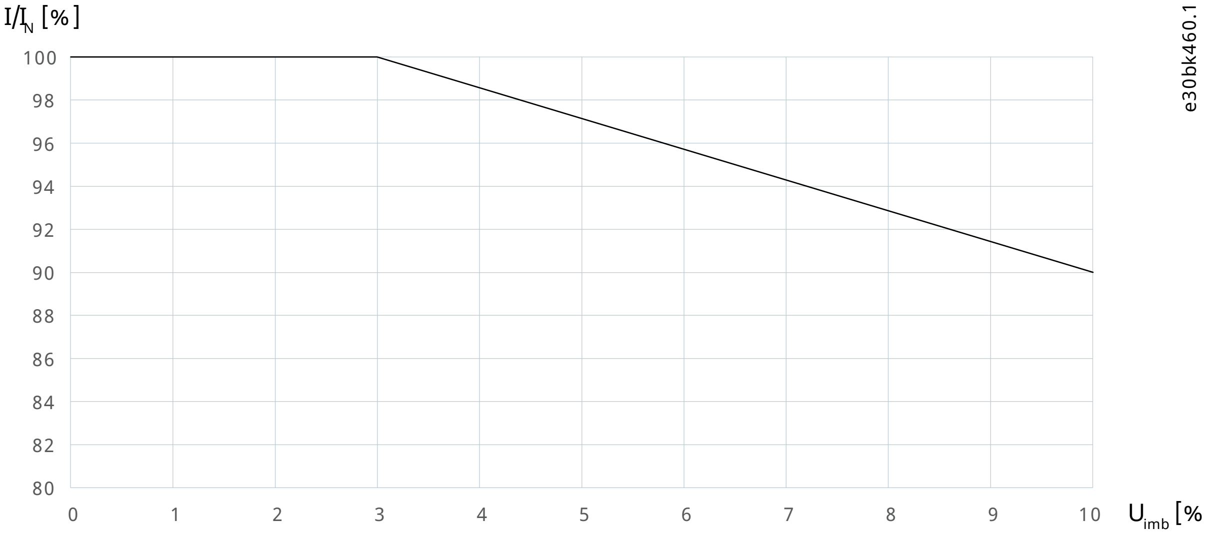


Figure 94: Voltage Imbalance Derating

7.16.4 Derating of DC-bus Voltage

The drive can be used without derating up to 1025 V DC. For DC-bus voltages higher than 1025 V DC, current must be derated according to the diagram.

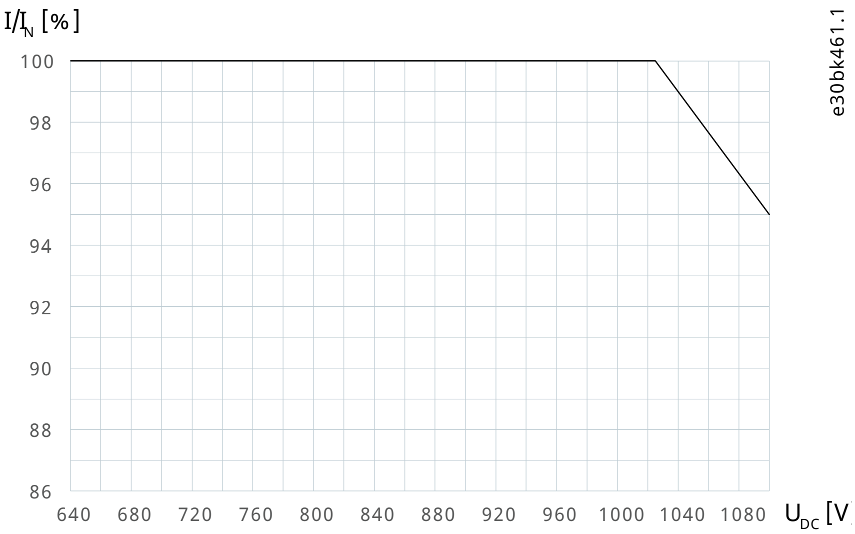


Figure 95: DC-bus Voltage Derating

7.17 Modulator Types

The following are the available modulator types for AFE, GC, and INU modules. For more detailed descriptions and instructions on modulator type selection, see the iC7 series application guides.

Modulator types for AFE and GC

Modulator type 4 – CMRPWM

- The default modulator type for AFE. This modulator can be used in the AFE to minimize motor voltage spikes. The modulator cannot be used when independent paralleling is used (when *Paralleling sync. Mode* is enabled).

Modulator type 5 – Grid Converter

- The default modulator type for Grid Converters. The modulator optimizes the trade-off between losses and harmonics during normal operation, while enabling short term current injection STCI. Independent paralleling is feasible with this modulator type (*Paralleling sync. Mode* is enabled).

Modulator types for INU

Modulator type 1 – SVPWM

- Standard Space Vector Pulse Width Modulation. Can be useful with certain filters and transformers on drive output. Drive derating is required.

Modulator type 2 – Optimized

- Optimizes the trade-off between losses and harmonics during normal operation. Default and best selection in most applications.

8 Control Unit

8.1 Modular Control Unit

The maximum input power of the internal 24 V DC power supply is 60 W.

NOTICE

EXTERNAL 24 V DC POWER SUPPLY NEEDED

The power units do not provide a 24 V DC power supply for the control unit. Lack of a 24 V DC power supply can prevent the operation of the product.

- Provide an external 24 V DC +15%/-10% power supply for the control unit.

NOTICE

CABLE INSULATION

- Insulation between 2 circuits must be designed according to the circuit that has the highest voltage.

NOTICE

SEPARATE 24 V WIRES FROM 115/240 V CABLES

The 24 V wires must be separated from the 115 V/240 V cables. If they are not separated, all wirings must be made with shielded 115 V/240 V cables.

NOTICE

SIGNAL CABLES

- It is recommended to use shielded/twisted pair signal cables.

Table 20: Maximum Power Consumption of the Control Unit Components

Component	Power consumption [W]
Control unit, including control panel	6
Star coupler board	4
I/O and Relay Option, 250 mA at 24 V_{out}	8
Any other option board, 1 pcs	4

The system modules are controlled with the modular control unit. The control unit and the system modules are connected via fiber optics. When 2 or more parallel system modules are used, a star coupler board is needed. The modular control unit provides an interface towards the upper control system. The control unit includes two Ethernet ports for a fieldbus connection. Daisy chaining the fieldbus is supported for typical protocols, such as Modbus TCP and PROFINET RT. Additional 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 modular control unit can be mounted nearby to or remotely from the power unit. The control unit consists of various boards installed on a mounting plate. The boards are connected to each other with option connectors. Several boards and mounting plates can be installed in parallel.

There are 3 different mechanical board types in the modular control unit:

- Control board
- Star coupler board
- Functional extensions, for example:
    - I/O and Relay Option
    - Encoder/Resolver Option
    - Temperature measurement option
    - Voltage measurement option

See more information on the option boards in the iC7 Series Functional Extension Options Installation Guide, the iC7 Series Functional Extension Options Operating Guide, and the iC7 Series Voltage Measurement Option OC7V0 Operating Guide.

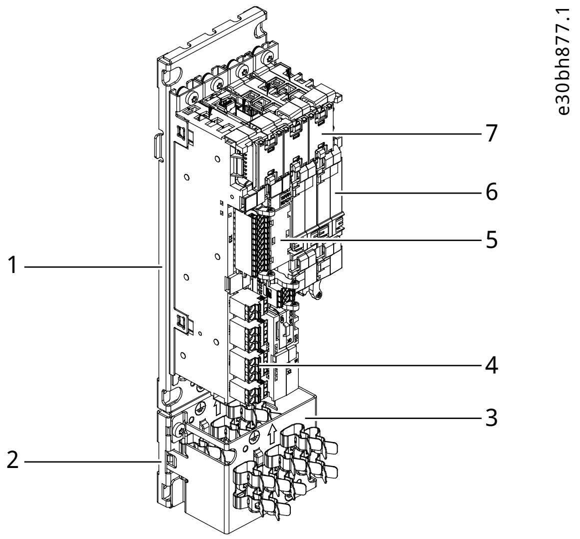


Figure 96: Example of the Modular Control Unit

1	Mounting plate	**2**	Base grounding plate
3	Grounding plate extension	**4**	I/O and Relay Option
5	Control board	**6**	Option board
7	Option connector		

8.2 Control Board

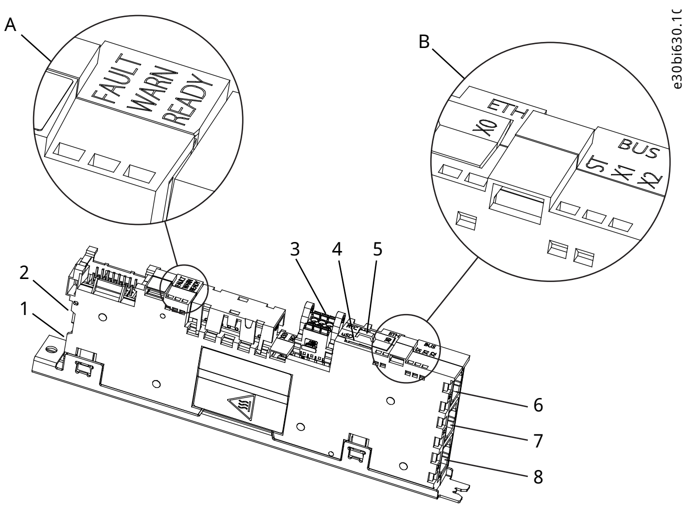


Figure 97: The Control Board

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)

8.3 Definitions of the Indicator Lights on the Control Board

Table 21: 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.

8.4 Control Board Connections

Table 22: 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)

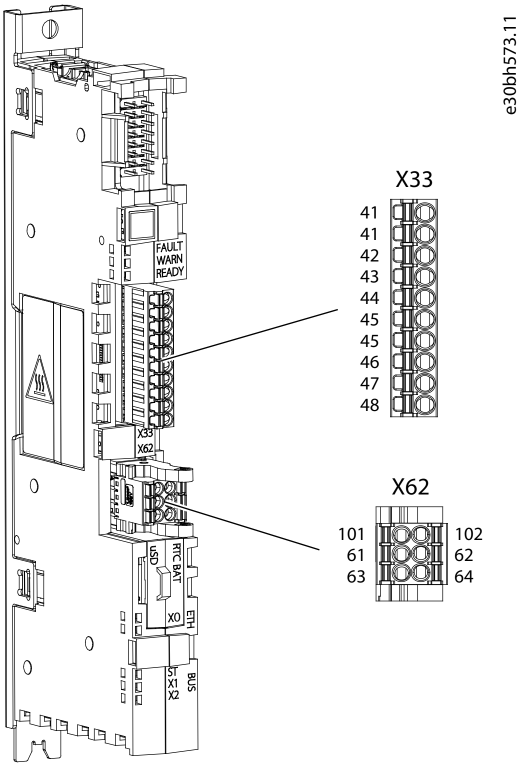


Figure 98: Control Board Terminal Block and Terminal Numbering

Table 23: 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

Table 23: STO Terminal Signals (X33) for the Inverter Module *(continued)*

Terminal	Function	Description
42	S.INA+	+ Safe Input Channel A
43	S.INB+	+ Safe Input Channel B
44	S.FB+	+ STO Feedback
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 24: 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

For the circuit diagrams of the control unit, see 10.3.11 Wiring Diagrams of the +24 V Supply for the Control Unit.

8.5 Star Coupler Board

System modules for high current ratings consist of multiple power units that are connected via a star coupler board to 1 control unit.

With the star coupler board, it is possible to connect up to 16 power units in parallel. The fiber connection is always needed between the control board and star coupler board.

An external 24 V power supply is required for the star coupler board. Connect the supply to the top of the star coupler board.

The star coupler board can be installed next to the control unit. The star coupler board can also be installed near the power units to make the cabling from the star coupler board to the power units easier. See Figure 101 and Figure 102.

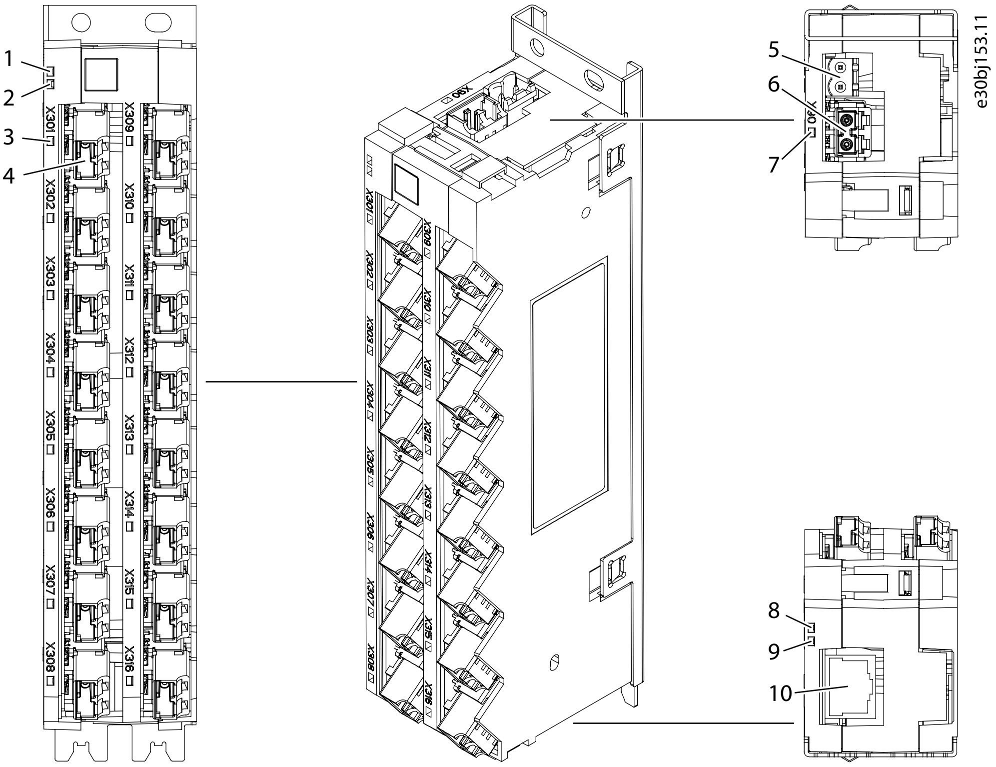


Figure 99: The Star Coupler Board with 16 Ports

1	Board configuration status indicator	**2**	+24 V power status indicator
3	Power unit connection status indicators	**4**	Fiber connection to the power unit (X301–X316)
5	+24 V power supply (X65)	**6**	Fiber connection to the control board (X90)
7	Control link status indicator	**8**	Ethernet speed indicator
9	Ethernet link activity indicator	**10**	Ethernet port (X7)

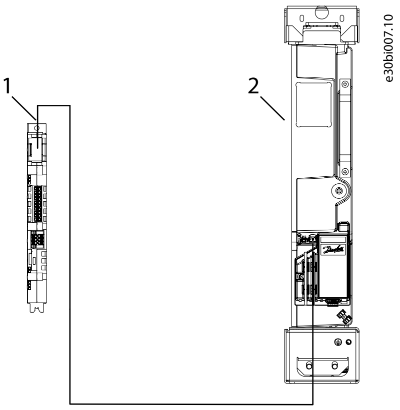


Figure 100: Control Connection

1	Control board	**2**	Power unit

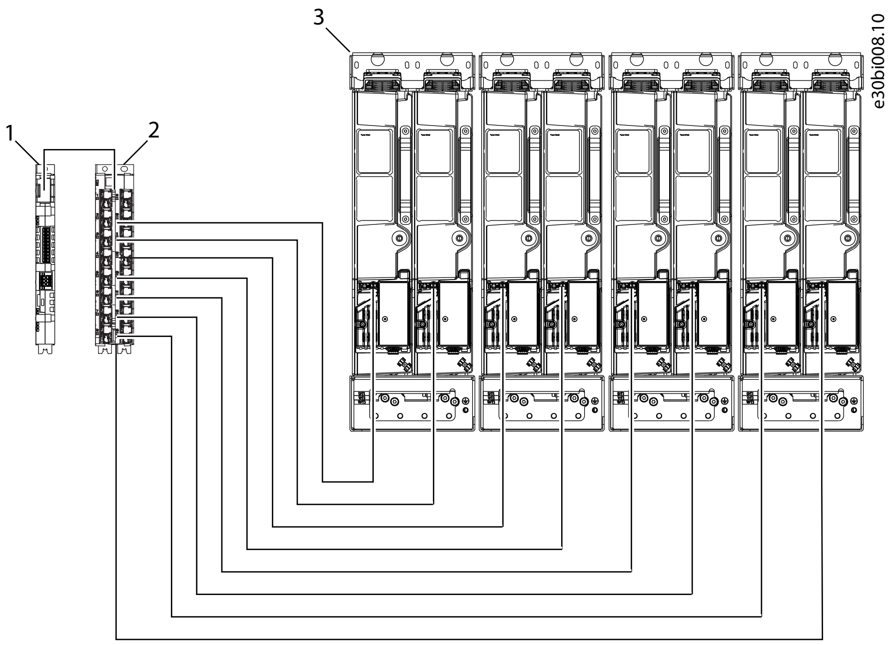


Figure 101: Example Control Connection with a Star Coupler Board: 8 Power Units in Parallel

1	Control board	2	Star coupler board
3	Maximum 16 power units		

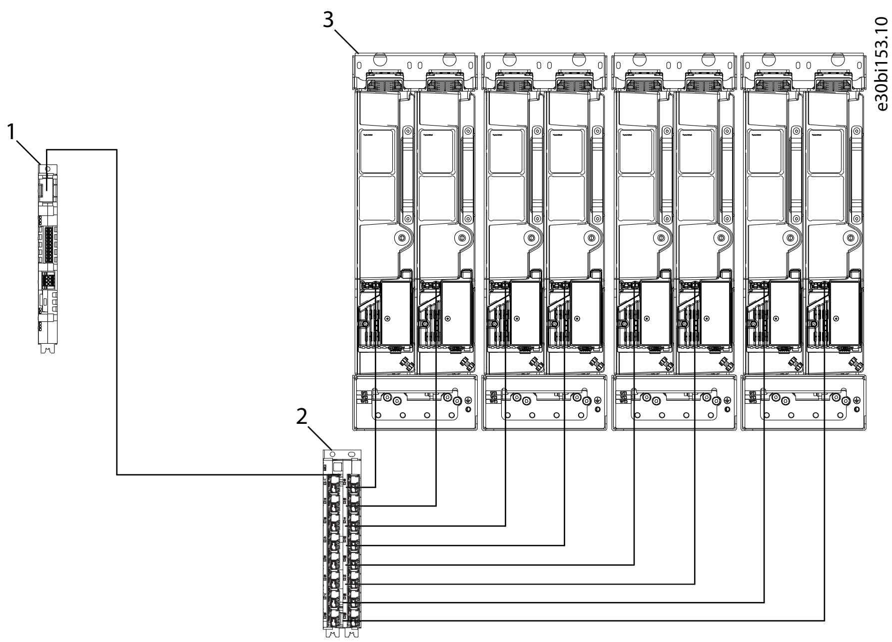


Figure 102: Example Control Connection with a Star Coupler Board: 8 Power Units in Parallel, Star Coupler Board near the Power Units

1	Control board	2	Star coupler board
3	Maximum 16 power units		

8.6 Definitions of the Indicator Lights on the Star Coupler Board

Table 25: Definitions of the Indicator Lights on the Star Coupler Board

Indicator name	Function (color)	Description
Configuration status	Off	During booting, until the software configuration is executed.
	Blinking 10 Hz (green)	Software updating.
	On (green)	Board configuration succeeded and all port communication works as intended.
	On (red)	Board configuration failed or any port communication failed on startup or during run.
24 V power status	On (white)	Star coupler board is powered.
Power unit link status (X301–X316)	Off	No link established.
	On (green)	Link established.
Control link status	Off	No link established.
	On (green)	Link established.
Ethernet speed	Off	No link or 10 Mbps link
	On (orange)	100 Mbps link
Ethernet link activity	Off	No link
	On (green)	Link OK, no data
	Blinking (green)	Link OK, data communication

8.7 Star Coupler Board Connections

Table 26: Star Coupler Board Connections

Terminal	Function	Connector type
X7	Ethernet port	RJ45
X65	24 V DC supply	2 x spring force connector 2.5 mm^2
X90	Fiber optic link to control board	LC-duplex
X301–X316	Fiber optic link to power unit	LC-duplex

Table 27: 24 V DC Supply Signals (X65)

Terminal	Function	Description
61	+24 V external input	External +24 V DC star coupler supply, maximum 10 A. Must be fuse-protected.
62	GND	Power supply ground

8.8 I/O and Relay Option Connections

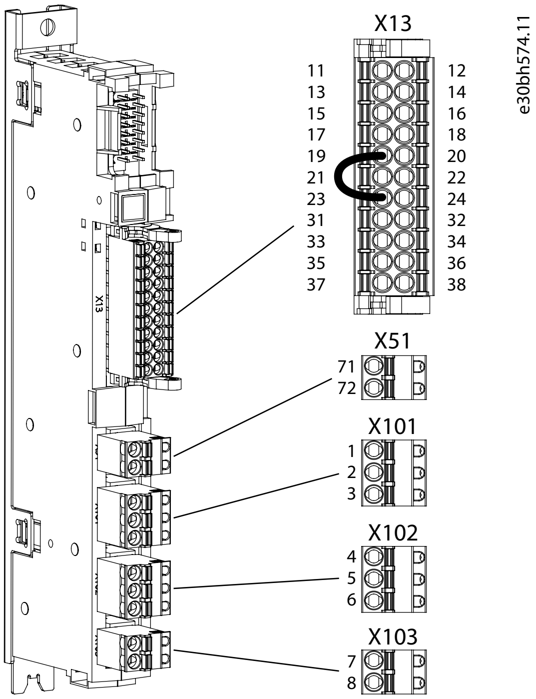


Figure 103: I/O and Relay Option Terminal Block and Terminal Numbering

Table 28: I/O and Relay Option 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 29: I/O Terminal Signals (X13)

Terminal	Function	Description
11	+24 V_{out}	Control voltage output. 24 V DC (-15...+20%) Maximum current 200 mA Short-circuit protected
12	+24 V_{out}	

Table 29: I/O Terminal Signals (X13) *(continued)*

Terminal	Function	Description
13	DI 1	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	
15	DI 3	
16	DI 4	
17	DI 5	
18	DI 6	
19	DGND	Digital input ground, not isolated by default. 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.
20	DGND	
21	DO 1	Configurable digital output.[(1)] Push-pull 24 V/50 mA Open collector (NPN/PNP) 48 V/50 mA Short-circuit protected
22	DO 2	
23	GND	I/O ground. Ground for digital outputs, +10 V Ref, +24 V_{out}, analog inputs, and analog outputs.
24	GND	
31	AO 1	Configurable analog output. Voltage mode: • 0...10 V • R_L ≥ 1 kΩ • accuracy ≤ ± 0.5% of full scale • short-circuit protected Current mode: • 0...20 mA • R_L ≤ 600 Ω • accuracy ≤ ± 0.5% of full scale • short-circuit protected
32	+10 V ref.	10 V (0...+3%), maximum current 10 mA
33	AI 1	Configurable analog input. Voltage mode: • 0 ± 10 V • single-ended • R_i ~ 10 kΩ • accuracy ± 0.5% of full scale Current mode: • 0 ± 20 mA • differential • R_i ~ 200 Ω • accuracy ± 0.5% of full scale
34	AI 2	

Table 29: I/O Terminal Signals (X13) ***(continued)***

Terminal	Function	Description
35	GND	I/O ground. Ground for digital outputs, +10 V Ref, +24 V_{out}, analog inputs, and analog outputs.
36	GND	
37	GND	
38	GND	

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

Table 30: Thermistor Input Signals (X51)

Terminal	Function	Description
71	TI+	Thermistor input, galvanically isolated. R_{trip} = 4 kΩ
72	TI-	

Table 31: Relay 1 Signals (X101)

Terminal	Function	Description
1	COM	Configurable relay output. Switching capacity: • 24 V DC/8 A • 250 V AC/8 A • 125 V DC/0.4 A Minimum switching load: 5 V/10 mA
2	NO	
3	NC	

Table 32: Relay 2 Signals (X102)

Terminal	Function	Description
4	COM	Configurable relay output. Switching capacity: • 24 V DC/8 A • 250 V AC/8 A • 125 V DC/0.4 A Minimum switching load: 5 V/10 mA
5	NO	
6	NC	

Table 33: Relay 3 Signals (X103)

Terminal	Function	Description
7	COM	Configurable relay output. Switching capacity: • 24 V DC/8 A • 250 V AC/8 A • 125 V DC/0.4 A Minimum switching load: 5 V/10 mA
8	NO	

8.9 I/O and Relay Option Interface

8.9.1 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 shows the specification for the analog inputs.

The analog inputs are protected in overvoltage conditions.

Table 34: Analog Input Types, Values, and Tolerances

Parameter	Value
Measuring range: voltage mode	-10...+10 V
Measuring range: current mode	-20...+20 mA
Input impedance	Voltage mode ≈ 10 kΩ
	Current mode ≈ 200 Ω
Accuracy	0.5% of full scale
Reaction time	0...90% step: < 1 ms
Number of inputs	2
Overvoltage limit	+15/-15 V
Overcurrent limit	+32/-32 mA
Electrical fast transient (EFT)	2 kV

8.9.2 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 shows the specification for the analog output.

The analog output is protected in overvoltage conditions.

Table 35: 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 ms
Electrical fast transient (EFT)	2 kV

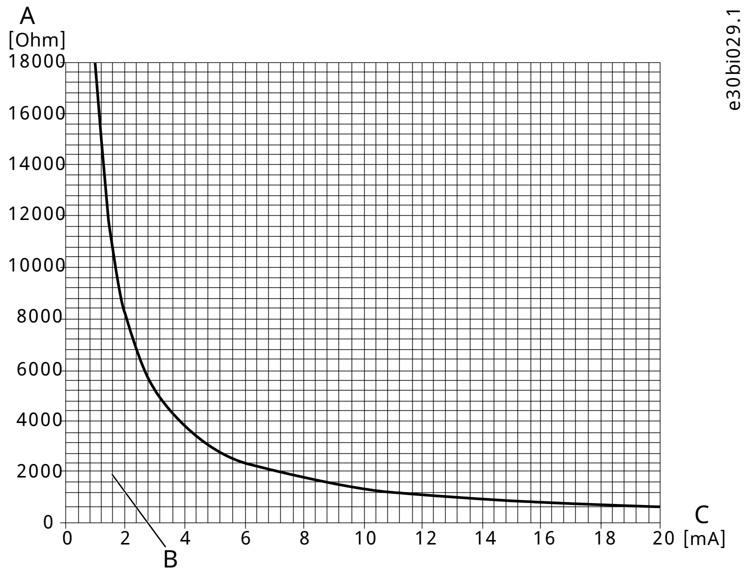


Figure 104: Allowed Load Resistance of Analog Output in Current Mode

A	Load resistance	**B**	Allowed load resistance
C	Output current		

8.9.3 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 36: 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} ≤ 5 V 1 = V_{TH} ≥ 15 V
Input Load	7.5 mA constant current and 10 kΩ resistive load
Reaction Time	< 5 µs
Maximum Frequency	100 kHz
Electrical fast transient (EFT)	2 kV

8.9.4 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 37: Digital Output Voltage and Current

Parameter	Value
Output Voltage	0 = max 2 V 1 = min 20 V(1)
Rated Current	±50 mA
Overcurrent Limit	±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

8.9.5 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 ≤ 300 V. The lifetime for relays is 100.000 cycles.

Table 38: Relay Output Values

Parameter	Value
Rated Voltage	250 V AC
Max. Switching Voltage	400 V AC
Rated Current	8 A
Breaking Capacity Max	2000 VA
Operate Time Max.	9 ms
Release Time Max.	5 ms
DC Breaking Capacity	See Figure 105.

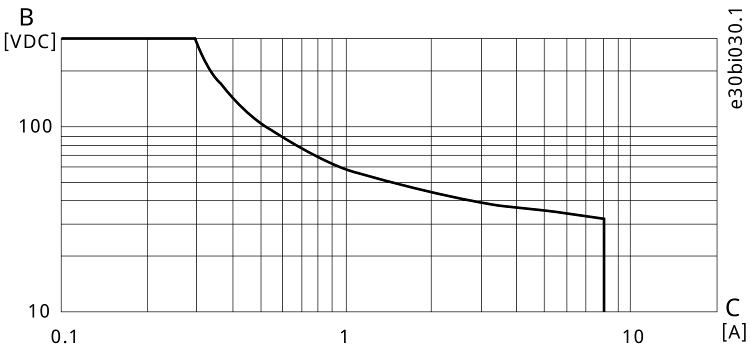


Figure 105: Maximum DC Load Breaking Capacity

B	DC voltage	**C**	DC current

8.9.6 Analog Reference Voltage Output

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

Table 39: 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

8.9.7 24 V DC Voltage Output

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

Table 40: 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

8.9.8 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 41: Thermistor Input

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

8.10 Assembling the Control Unit Mounting Plates

Use these instructions to assemble the mounting plate of the modular control unit. All the parts can be found in the accessories bag.

1. Assemble the mounting plate as shown in the illustration.
   a. Attach the base grounding plate into the mounting plate.
   b. Align the cable clamps in the holes in a wave-like form and attach with screws.
   c. Attach the grounding plate extension onto the base grounding plate with 2 screws.

d. Attach the cable clamps with screws.

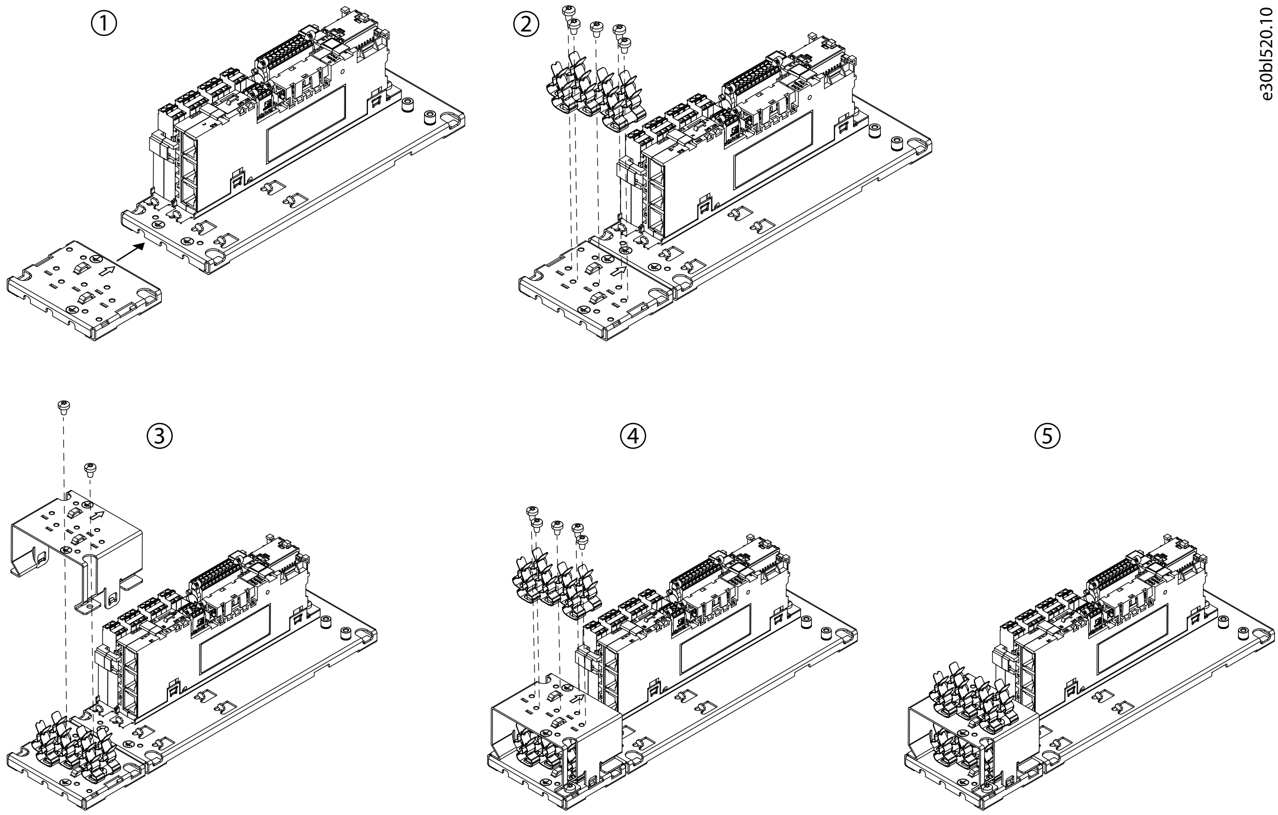


Figure 106: Assembling the Mounting Plate

8.11 Attaching the Control Unit Mounting Plates

Use these instructions to attach 2 or several mounting plates to each other, and to install mounting plates to the cabinet. All the parts can be found in the accessories bag.

1. Install the mounting plates to each other by fitting the sides together.

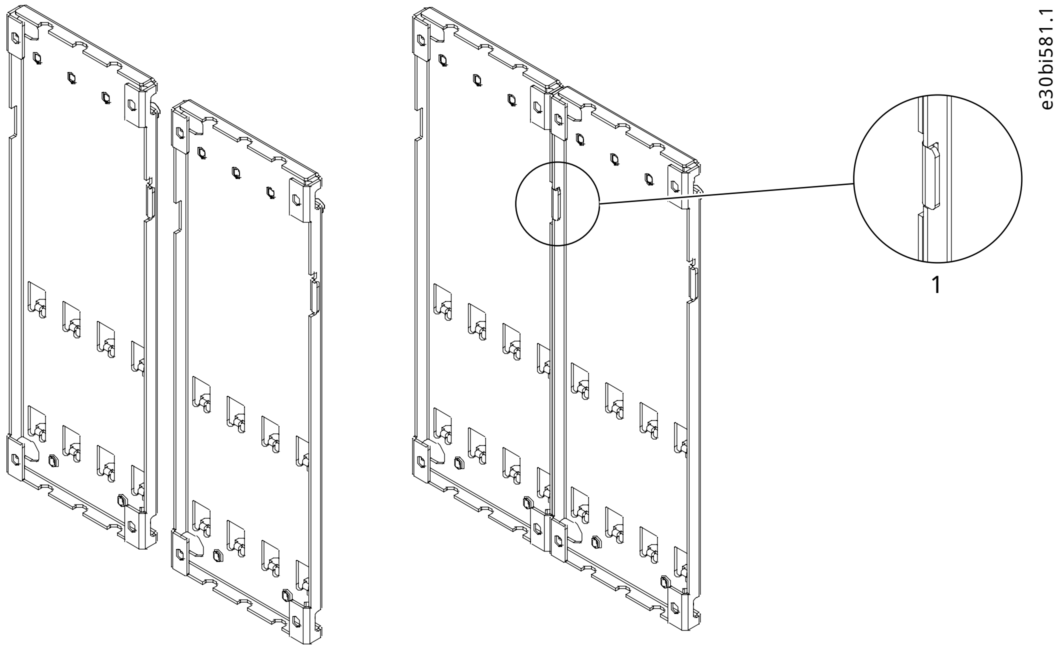


Figure 107: Attaching Mounting Plates to Each Other

1	Lip

2. Attach the mounting plates onto the cabinet with screws by the 4 mounting holes in the corners of the mounting plates.

   The screws are not included in the delivery. Use an M4/M5 screw.

8.12 Installing the Control Unit

Install the control unit to the selected location. Use the 4 mounting holes in the corners of the mounting plate.

8.13 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.

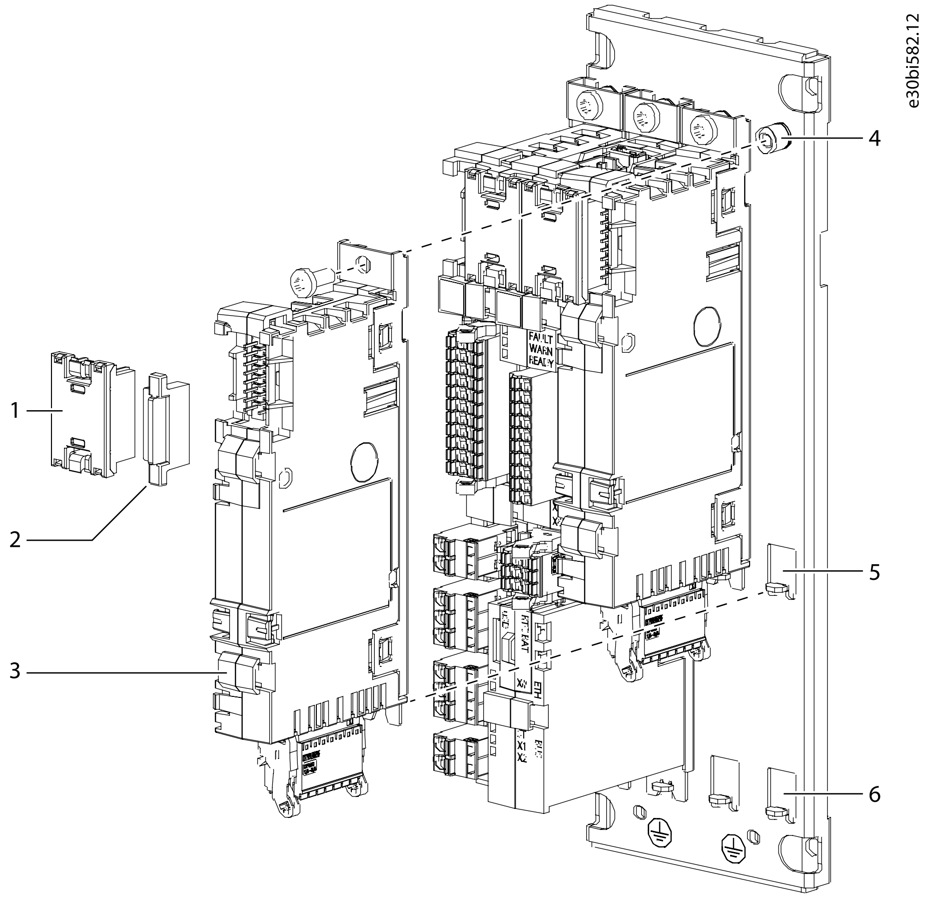


Figure 108: Installing a Board to the Modular Control Unit Mounting Plate

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 newly installed board and the board next to it.
5. Attach option terminal covers to the empty terminals.

8.14 Connecting the Fieldbus Cable and the Fiber Cables

1. Connect the PLC to the Ethernet port X1 or X2 in the control board with a fieldbus cable.
2. Connect the terminal X80 in the control board to the terminal X90 in the star coupler board with a fiber cable.
3. Connect the terminals X301–X316 in the star coupler board to the power units with fiber cables.

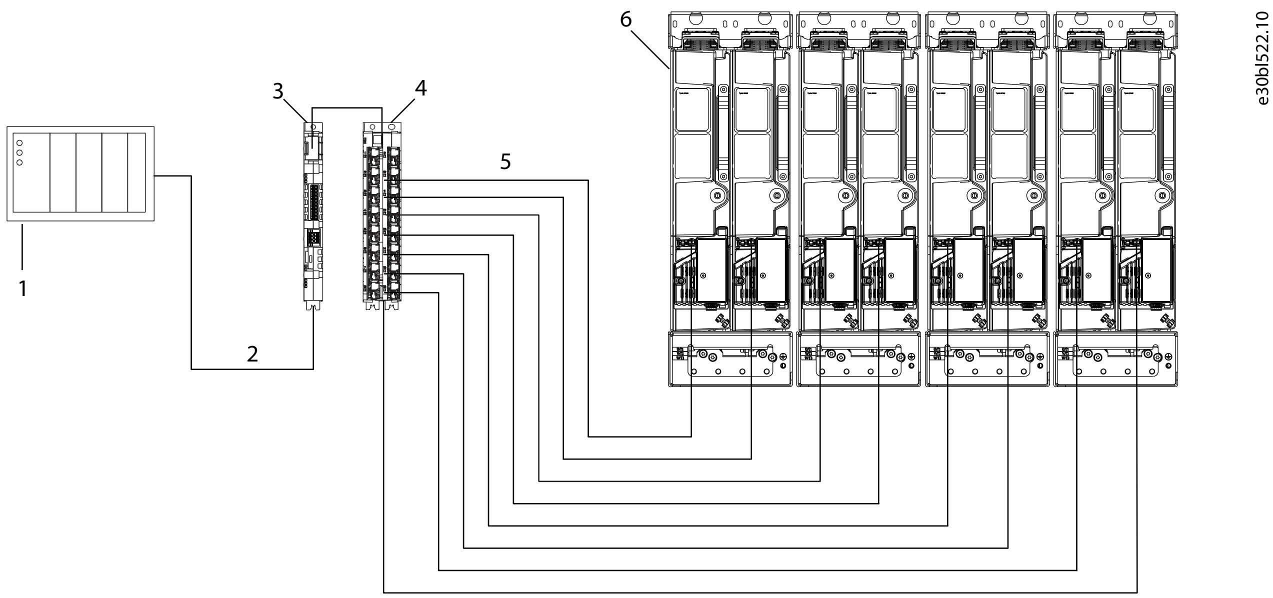


Figure 109: Connecting the Fieldbus Cable and the Fiber Cables

1	PLC (not included in the delivery)	**2**	Fieldbus cable
3	Control board	**4**	Star coupler board
5	Fiber cables	**6**	Power units

8.15 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 8.8 I/O and Relay Option Connections.

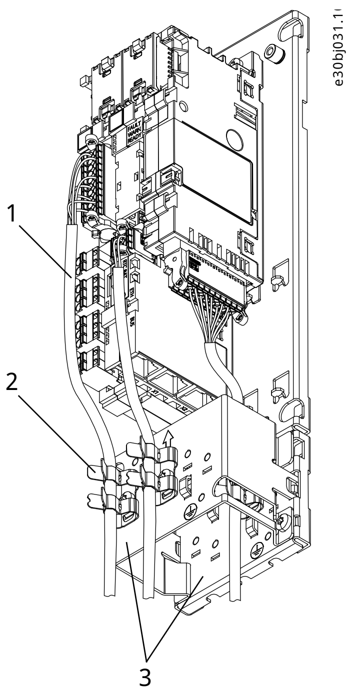


Figure 110: Example of Installing the Control Cables

1	Control cable	**2**	Cable clamp
3	Grounding plates		

2. 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.

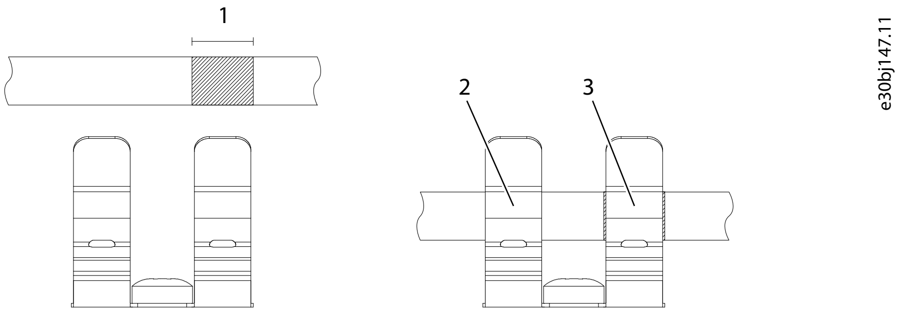


Figure 111: Stripping the Cable and Using the Grounding Plates

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

8.16 Connecting the Control Panel

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

8.17 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).

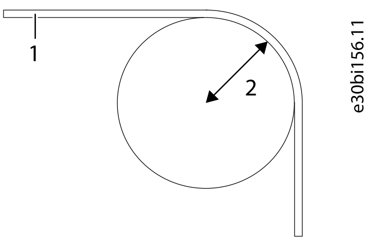


Figure 112: Bending Radius of the Fiber Cables

1	Cable	**2**	Bending radius (25 mm, 1.0 in)

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 liquid-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 42: Maintenance Schedule for Liquid-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.

Table 42: Maintenance Schedule for Liquid-cooled Drives ***(continued)***

Component	Inspection interval(1)	Service schedule(2)	Preventive maintenance actions
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			
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	5–10 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.

Table 42: Maintenance Schedule for Liquid-cooled Drives *(continued)*

Component	Inspection interval(1)	Service schedule(2)	Preventive maintenance actions
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			
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	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.
Coolant			
Log	Commissioning/startup, or when replacing coolant	–	To create a baseline for future reference before and after adding inhibitor and glycol, record the water quality specification values. Also, record the system pressure, coolant flow rate, and temperature range.
Glycols	1 year	Based on findings	Measure and record the level of glycol in the cooling system. The minimum concentration level is always 75/25% demineralized water/glycol.
Corrosive inhibitors	1 year	Based on findings	Measure and record the level of Danfoss recommended corrosive inhibitor (Cortec-VpCI-649) in the liquid coolant (see specification). Measure the level of the inhibitor every year. If the inhibitor level is below the recommended level of 1%, add more inhibitor. Before adding more inhibitor, practice caution not to exceed the level of electrical conductivity.
Pre-mixed coolant with glycol and inhibitor	1 year	Based on findings	The pre-mixed coolants contain specific percentages of glycol and inhibitor for antifreeze and corrosion protection. The advantage of using a pre-mixed coolant is that the chemical composition is within Danfoss specifications, and there is no need for analyzing the coolant.
Demineralized water	1 year	Based on findings	Only use demineralized or deionized water in the coolant solution. Record and compare the chemical composition values when replacing or adding coolant.
Liquid-cooling system			
Pipes, hoses, and connections	1 year	1 year	Check for external signs of moisture, corrosion, and coolant leaks. Check the tightness of the cooling pipe connections. Check the heat sinks and host pipes in the cooling system.
Leak detector	1 year	10 years	Test the functioning of the leak detector.

Table 42: Maintenance Schedule for Liquid-cooled Drives *(continued)*

Component	Inspection interval(1)	Service schedule(2)	Preventive maintenance actions
Power unit heat sinks	1 year	6 years	Check that the heat sink temperature across all cooling circuits or power phases is balanced. Imbalanced temperature of the cooling circuits is a possible sign of a restriction. Under normal conditions, clean or acid-wash the heat sinks every 6 years with Danfoss recommended cleaning products. Refill the coolant system and log the new coolant specification values.
Auxiliary equipment	1 year	According to manufacturer recommendations	Check that the sensors, gauges, and indicators are functioning correctly. Act based on the findings.
System cooling capacity	1 year	Based on findings	Test the cooling capacity and the thermal transfer of the system. Record the coolant system flow, pressure, and input and output temperature, and compare to the previous measurements. Act based on the findings.

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 Maintenance Log for Cooling System

During the commissioning phase of the product and during each inspection refer to the maintenance schedule. Record values such as the ambient air temperature, system pressure, flow, and input/output cooling liquid temperature during run condition. Record the water chemical analysis values and the type and percentages of glycol and inhibitor or pre-mixed solutions of the liquid coolant.

The initial values create a base-line value to compare versus future values measured during preventive maintenance intervals. Record the chemical analysis values each time the liquid coolant is replaced. Record all the maintenance tasks and service tasks with counter values, date, and time.

9.3 Using the Product Modified Label

In the accessories bag, there is also a "product modified" label. The function of the label is to tell the service personnel about the changes that are made in the AC drive.

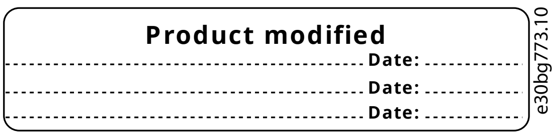


Figure 113: The Product Modified Label

1. Attach the label on the side of the AC drive, in a place where it is easy to find.
    a. Attach the label, for example, next to the other labels on the power unit.
2. If changes are made to the AC drive, write the change and date on the label.

9.4 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 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.
- For detailed safety information, refer to the documentation provided with the battery.

⚠ CAUTION

RISK OF FIRE OR EXPLOSION

- Do not recharge, disassemble, or dispose of 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.

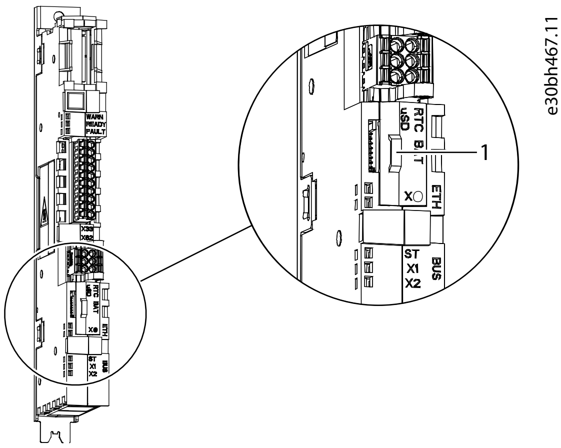


Figure 114: Location of the RTC Battery

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.

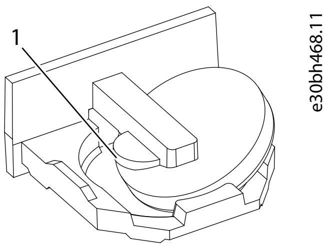


Figure 115: Replacing the Battery

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 BR1632.

5. Push the holder back into the control board.

9.5 Removing the System Module from the Integration Unit

These instructions apply to xR10L and xR12L system modules with integration units. The system module shown in the illustrations is an IR10L.

1. If removing power unit 1 from a system module lineup, remove the detachable product label plate from the front of power unit 1.
   a. To release the product label plate, remove the M4x8 screw (141N2502) with a TX20 bit.
   b. Keep the product label plate with the product. Install the plate on the new power unit.

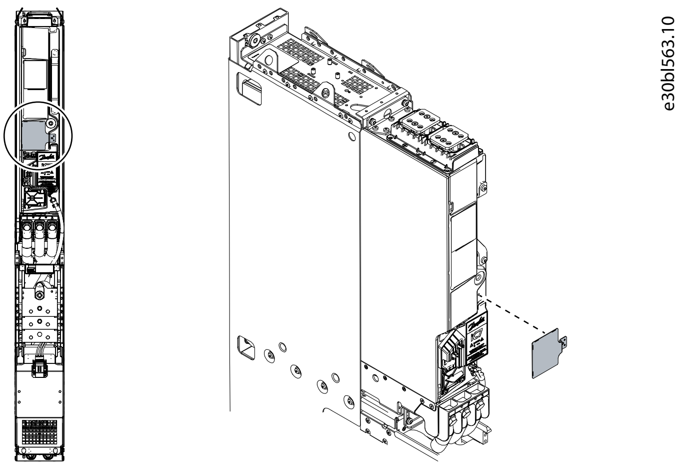


Figure 116: Mounting Location of the Product Label Plate

2. Disconnect the cables from the system module.
   a. Disconnect the optical fiber cable from control terminal X81.
   b. Disconnect the AuxBus cable from terminal X79.
   c. Disconnect the power cables.

      The power cables are mounted with M10x30 mounting bolts (141N9277). Use a 17 mm (0.67 in) bit to remove them. The tightening torque of the bolts is 35 Nm (310 in-lb).

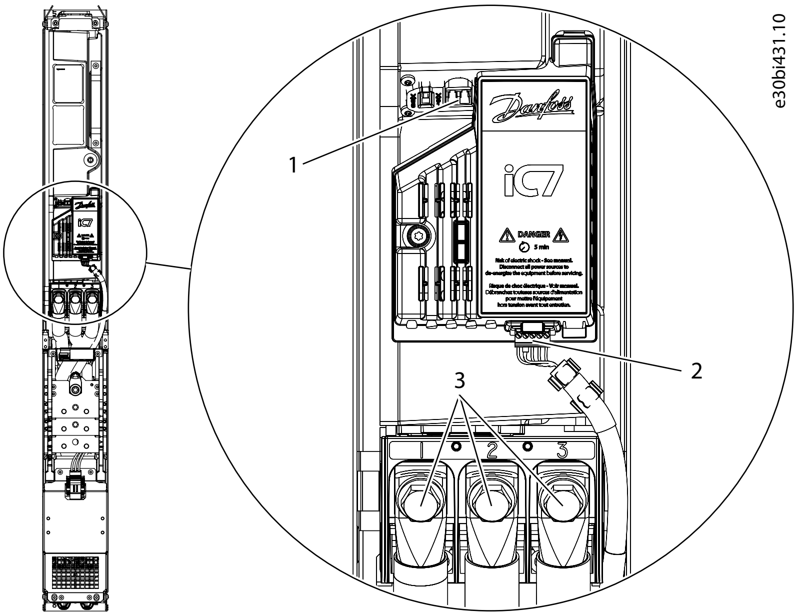


Figure 117: Disconnecting the Cables from the System Module

1	Control terminal X81	2	AuxBus terminal X79
3	Power cable mounting bolts		

3. Release the fuses from the DC busbars. Remove the two M10x25 screws (141L3598) from each fuse.

   See Figure 67.

4. Release the handle on the front of the system module and install it so that it can be used to move the module.

   The handle is mounted with two 6x12 screws (141N2374). Use a TX30 bit to release and mount the screws. Tighten the screws to torque 5 Nm (44 in-lb).

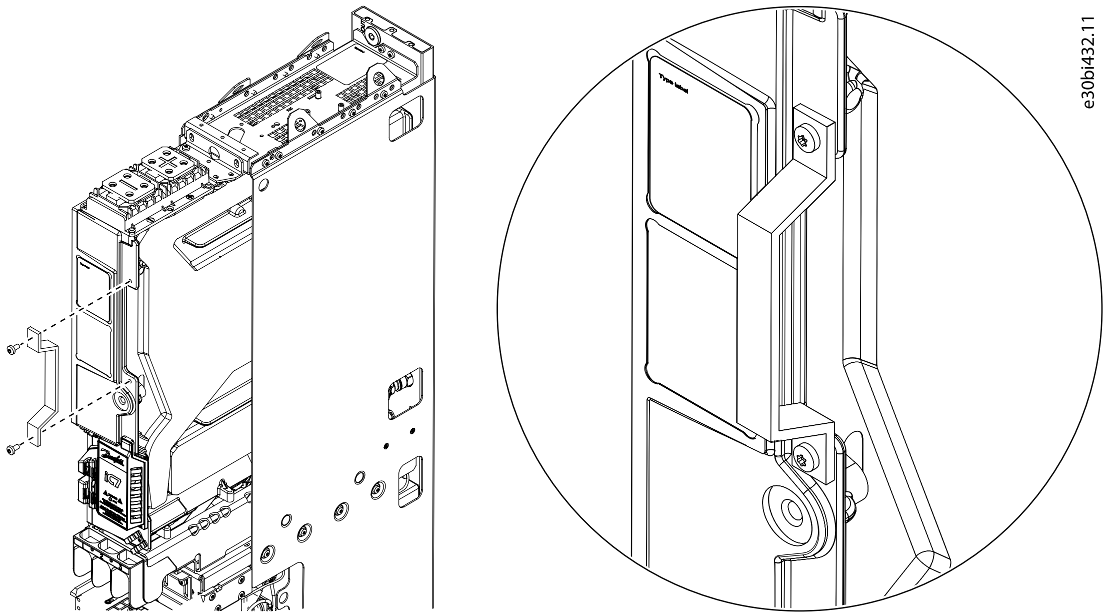


Figure 118: The Handle on the System Module

5. Remove the 2 size M6x16 screws (141L3015) at the top of the system module.

   Use a TX30 bit to remove the screws. The tightening torque of the screws is 5 Nm (44 in-lb).

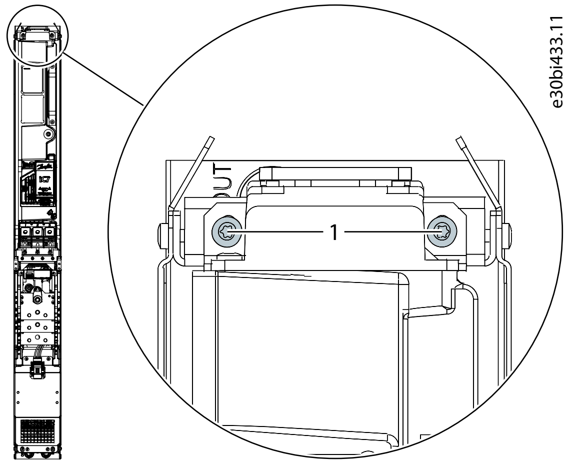


Figure 119: System Module Mounting Screws

1	Mounting screws

6. Release the module locking plate and slide it down to release the system module.

   Loosen the 5 size M6x16 screws (141L3015) on the module locking plate. Use a TX30 bit. The tightening torque of the screws is 5 Nm (44 in-lb).

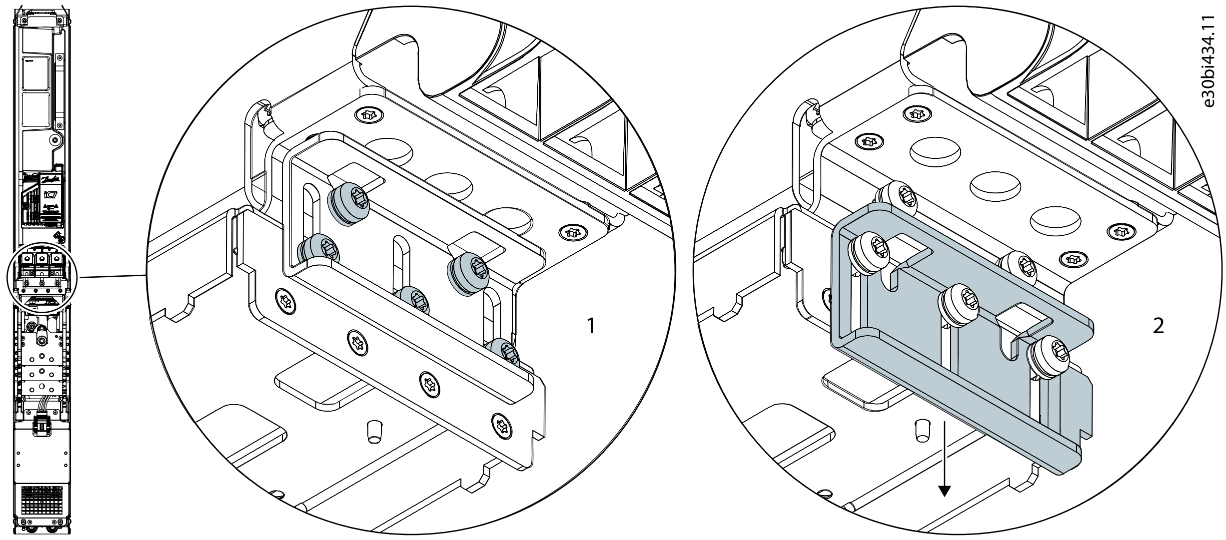


Figure 120: Releasing the Locking Plate

1	Loosen the screws.	**2**	Slide down the locking plate.

7. If necessary, use a lifting device to lift the system module. Attach the lifting device on the top of the system module and use the handle to pull the module out from the integration unit.

   The weight of the system module is approximately 40 kg (88 lb).

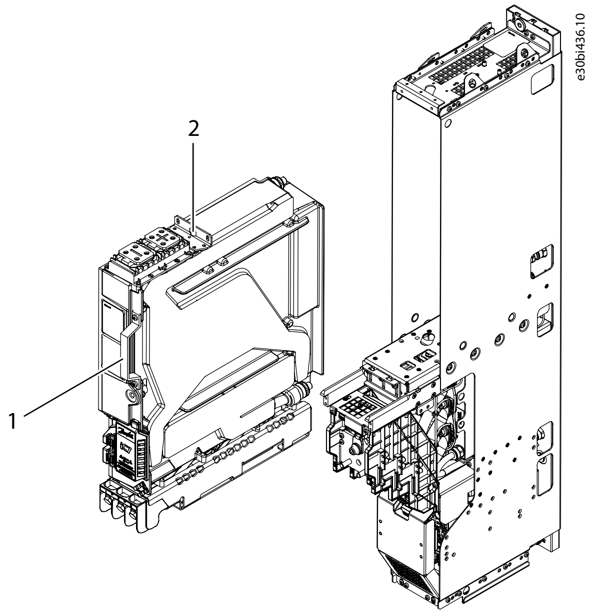


Figure 121: Lifting the System Module from the Integration Unit

1	Handle	**2**	Lifting point

8. Drain the system module before storage or transportation.

NOTICE

When the system module is removed, the cooling circuit is filled with coolant. If the module is not drained, the coolant in the cooling channels expands as a function of temperature, and can break the components in the module.

- Always drain the system module before storage or transportation.

See 9.7.2 Draining the Power Units for xR10L and xR12L.

9.6 Installing the System Module in the Integration Unit

Before you begin:

NOTICE

MODULE COMPATIBILITY

Do not install modules with different configurations in the same drive system.

1. If necessary, use a lifting device to lift the system module in the integration unit. Attach the lifting device on the top of the system module and use the handle to move the module and push it in the integration unit.

   The weight of the system module is approximately 40 kg (88 lb).

   See the lifting points in Figure 121.

2. To make sure that the push-in cooling connectors at the back of the system module are connected properly, push the system module all the way to the back of the integration unit.

The cooling connectors are visible from the sides of the integration unit.

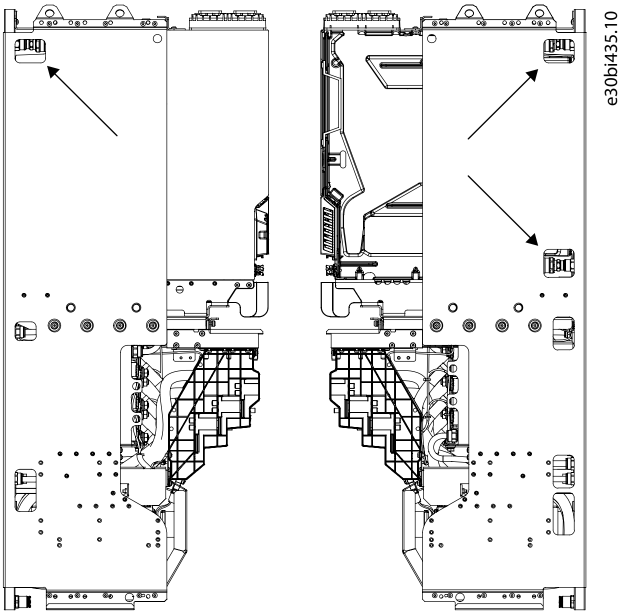


Figure 122: Cooling Connectors on the System Module

3. Slide up the module locking plate and fix it on the system module.

   Tighten the 5 size M6x16 screws (141L3015) on the module locking plate. Use a TX30 bit and tighten the screws to torque 5 Nm (44 in-lb). See Figure 120.

4. Mount the system module on the integration unit with 2 size M6x16 screws (141L3015) at the top part of the system module.

   Use a TX30 bit to mount the screws. Tighten the screws to torque 5 Nm (44 in-lb). See Figure 119.

5. Release the handle on the front of the system module and install it so that it is facing the module.

   The handle is mounted with two 6x12 screws (141N2374). Use a TX30 bit to release and mount the screws. Tighten the screws to torque 5 Nm (44 in-lb). See Figure 118.

6. Install DC fuses on the DC busbars. Use two M10x25 screws (141L3598) on each fuse.

   See Figure 67.

7. Connect the cables on the system module.
   a. Connect the optical fiber cable to control terminal X81.
   b. Connect the AuxBus cable to terminal X79.
   c. Connect the power cables.

      Mount the power cables with M10x30 mounting bolts (141N9277). Use a 17 mm (0.67 in) bit to tighten the bolts to torque 35 Nm (310 in-lb).

   See Figure 117.

8. Check that the cables are not pinned between the system module and the frame of the integration unit.

9. If the product label plate was removed from power unit 1, mount it on the new power unit.
   a. Mount the product label plate with a M4x8 screw (141N2502). Use a TX20 bit to tighten the screw to torque 2 Nm (18 in-lb).

   See Figure 116.

9.7 Draining the System Modules

9.7.1 Draining the System Modules, System Modules with Integration Units, and Filters

Always drain the system modules and filters before storage or transportation.

Required for the draining procedure:

- Container large enough for the drained coolant. One system module can hold 0.55 l of coolant.
- Pressurized air can be used for the draining. Maximum pressure is 5 bar.
- Dust caps or tape.

1. Close the valves of the system module to be drained.
2. Place the container below the coolant inlet and outlet.
3. Disconnect the coolant outlet and inlet hoses from the main manifold and drain the coolant to the container.
4. To drain all the coolant from the module, supply pressurized air to the outlet connector.
5. After all the coolant is drained, remove the system module from the cabinet.
6. Before storage or transportation, plug the coolant inlet and outlet connectors.

   Use the dust caps delivered with new system modules, or if not available, use tape.

7. Dispose of the coolant according to local laws and regulations.

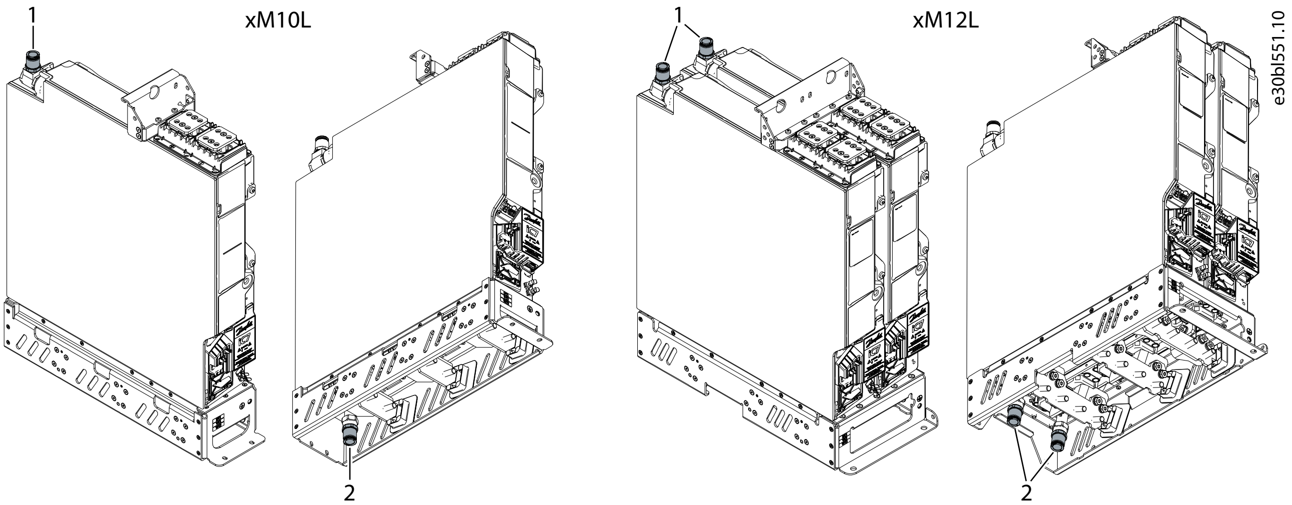


Figure 123: Inlet and Outlet Connectors of System Modules xM10L and xM12L

1	Outlet connectors	**2**	Inlet connectors

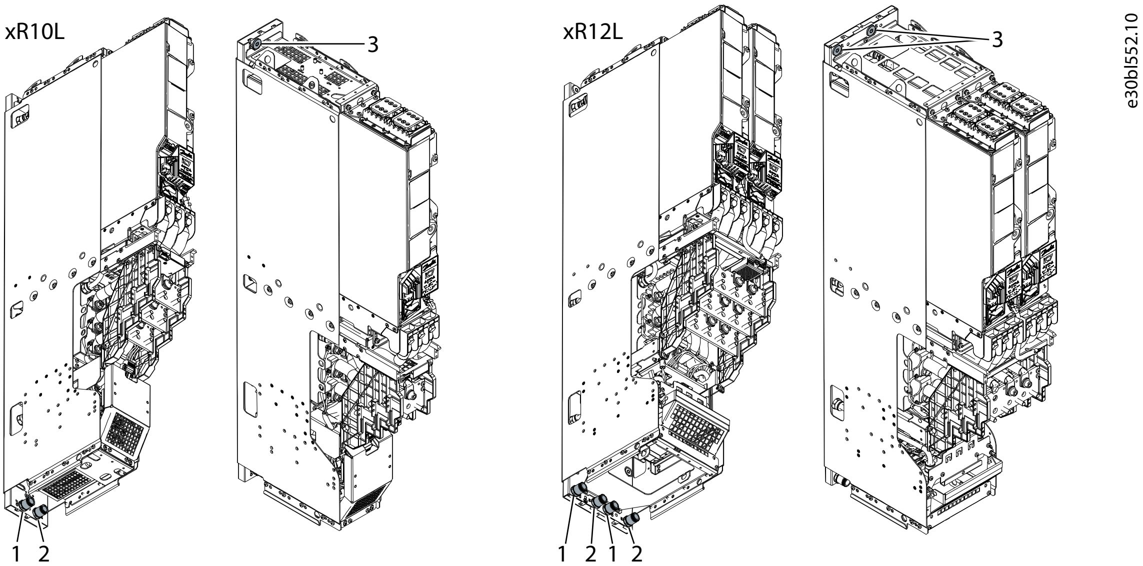


Figure 124: Inlet and Outlet Connectors of System Modules with Integration Units xR10L and xR12L

1	Outlet connectors	**2**	Inlet connectors
3	Optional outlet connectors		

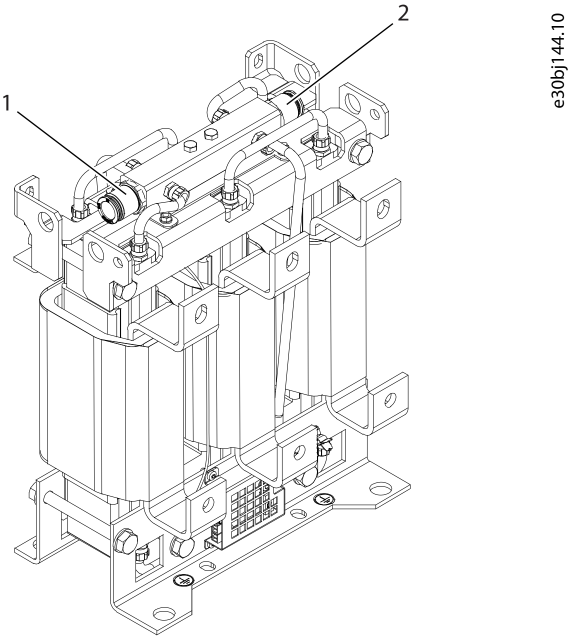


Figure 125: Inlet and Outlet Connectors of the L Filter

1	Inlet/outlet connector	**2**	Inlet/outlet connector

9.7.2 Draining the Power Units for xR10L and xR12L

Always drain the power units before storage or transportation.

Required for the draining procedure:

- Tools for opening the quick-release connectors of the coolant inlet and outlet.

- Container large enough for the drained coolant. One system module can hold 0.55 l of coolant.
- To perform the procedure easily, 2 people are required.
- Pressurized air can be used for the draining. Maximum pressure is 5 bar.

1. Remove the power unit from the integration unit.
2. Place the power unit in a vertical position and place the container below the coolant inlet at the bottom of the module.
3. To open the quick-release connectors of the coolant outlet and inlet, push in the valves with a blunt tool.

   Do not insert sharp or hard metallic objects in the connectors. Sharp objects can damage the connectors or the sealing inside the connectors.

4. Drain the coolant to the container. To drain all the coolant:
   - Tilt the module, or
   - Supply pressurized air to the outlet connector.
5. Dispose of the coolant according to local laws and regulations.

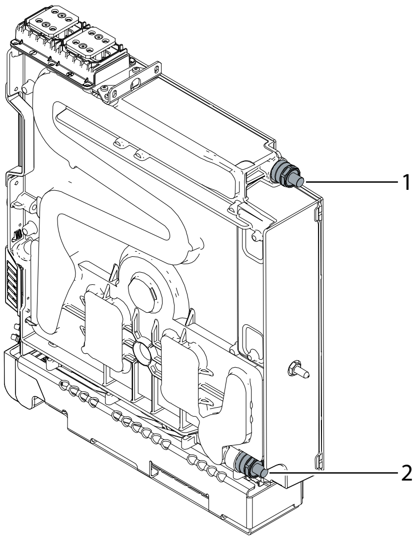


Figure 126: Inlet and Outlet Connectors of Power Units for xR10L and xR12L

1	Outlet connector	**2**	Inlet connector

10 Specifications

10.1 Tightening Torques

Table 43: Tightening Torques and Bolt Lengths of the Terminals

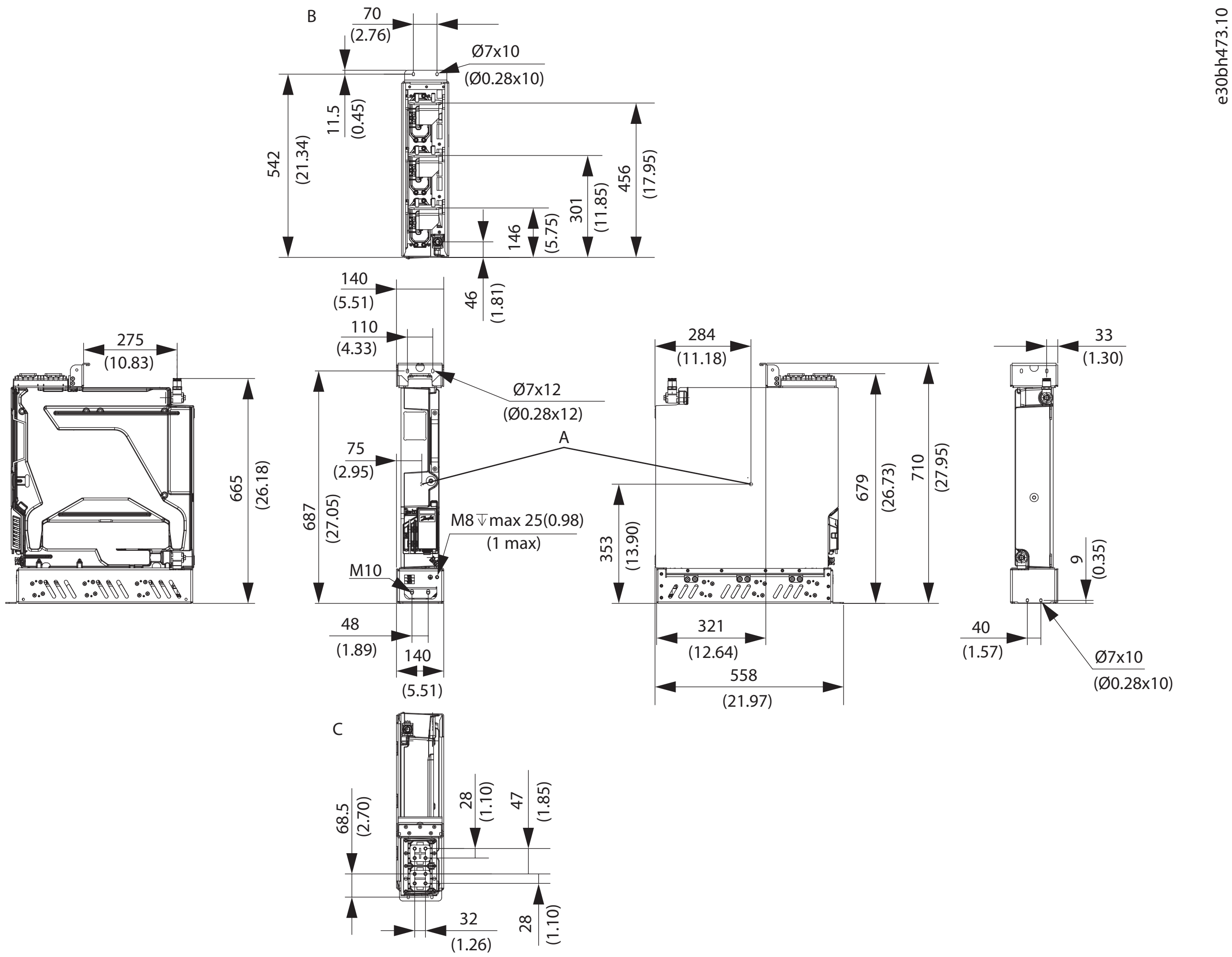
Bolt	Tightening torque [Nm]	Maximum length of bolt under the busbar [mm]	Tightening torque [in-lb]	Maximum length of bolt under the busbar [in]
M4	2–2.5	–	18–22	–
M5	3–4	–	27–35	–
M6	6–9	–	53–80	–
M8	17–20	10	150–177	0.39
M10	35–40	22	310–354	0.87
M12	65–70	22	575–620	0.87
Grounding bolt (M8)	17–20	20	150–177	0.79

Table 44: Tightening Torques of Fuses

Fuse size	Tightening torque [Nm]	Tightening torque [in-lb]	Stud maximum torque [Nm]	Stud maximum torque [in-lb]	Stud	Bolt
31	13.5 +0/-2	119 +0/-17	10	88	M8x30 Zn DIN913	–
44	26 +0/-2	230 +0/-17	–	–	–	M10x20 DIN933-8.8-Zn
73	46 +0/-4	407 +0/-35	15	132	M12x35 Zn DIN913	–

10.2 Dimensions

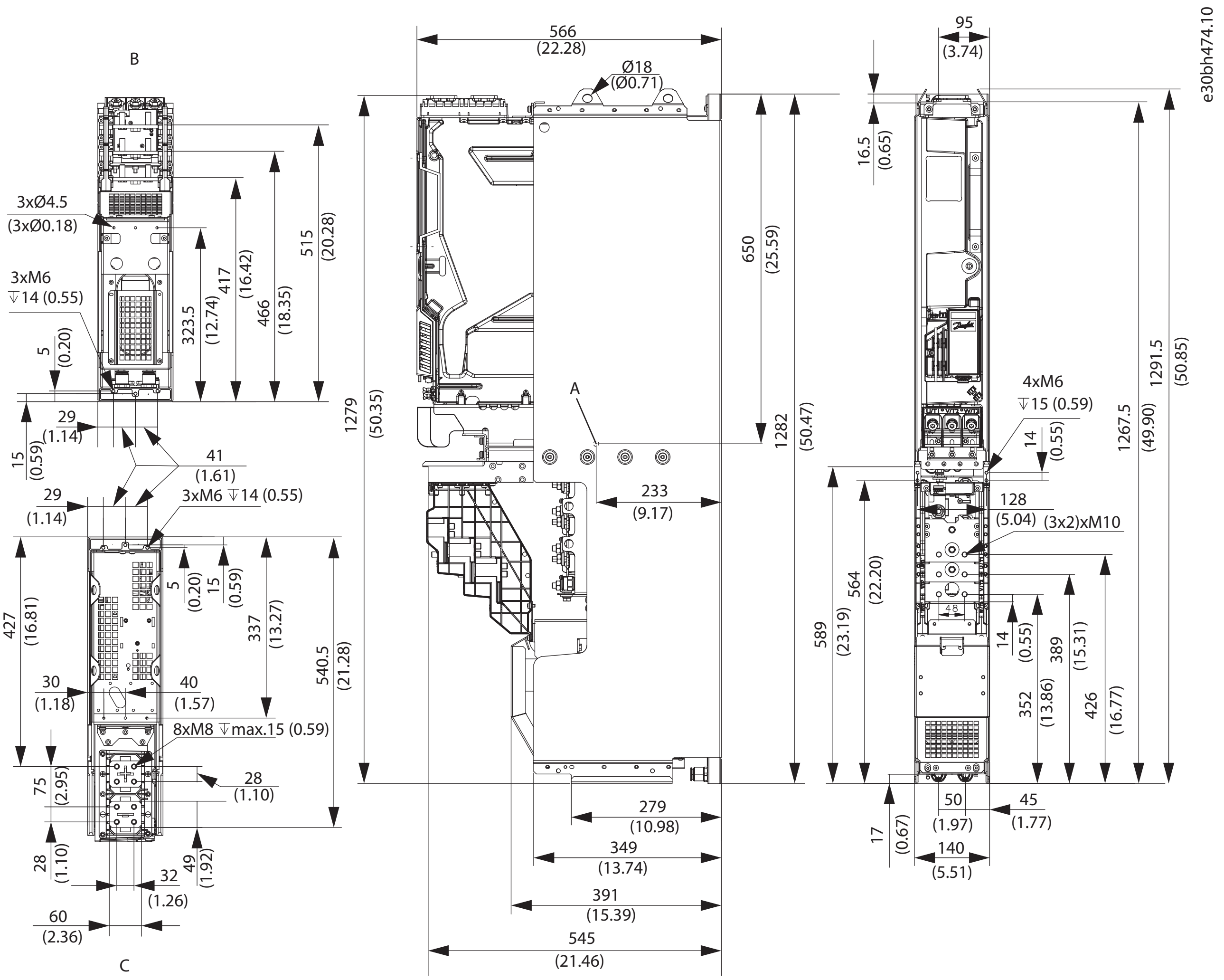
10.2.1 Dimensions of the Inverter Module, IM10L, AFE/GC Module, AM10L, and DC/DC Converter Module, DM10L



A	The center of gravity	**B**	View from the bottom
C	View from the top		

Figure 127: Dimensions of INU, IM10L, AFE/GC, AM10L, and DC/DC Converter, DM10L in mm (in)

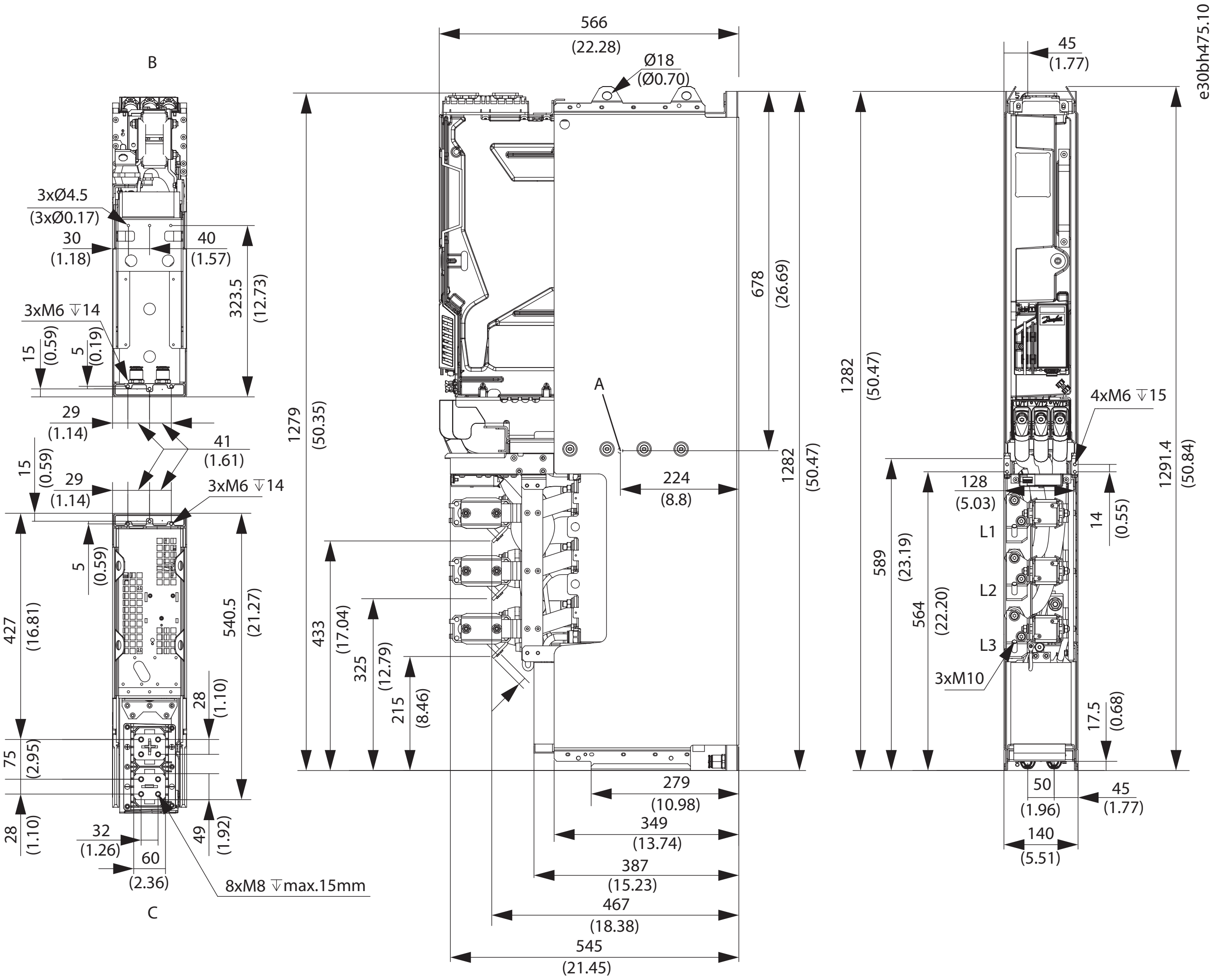
10.2.2 Dimensions of the Inverter Module, IR10L



A	Center of gravity	**B**	View from the bottom
C	View from the top		

Figure 128: Dimensions of INU, IR10L, in mm (in)

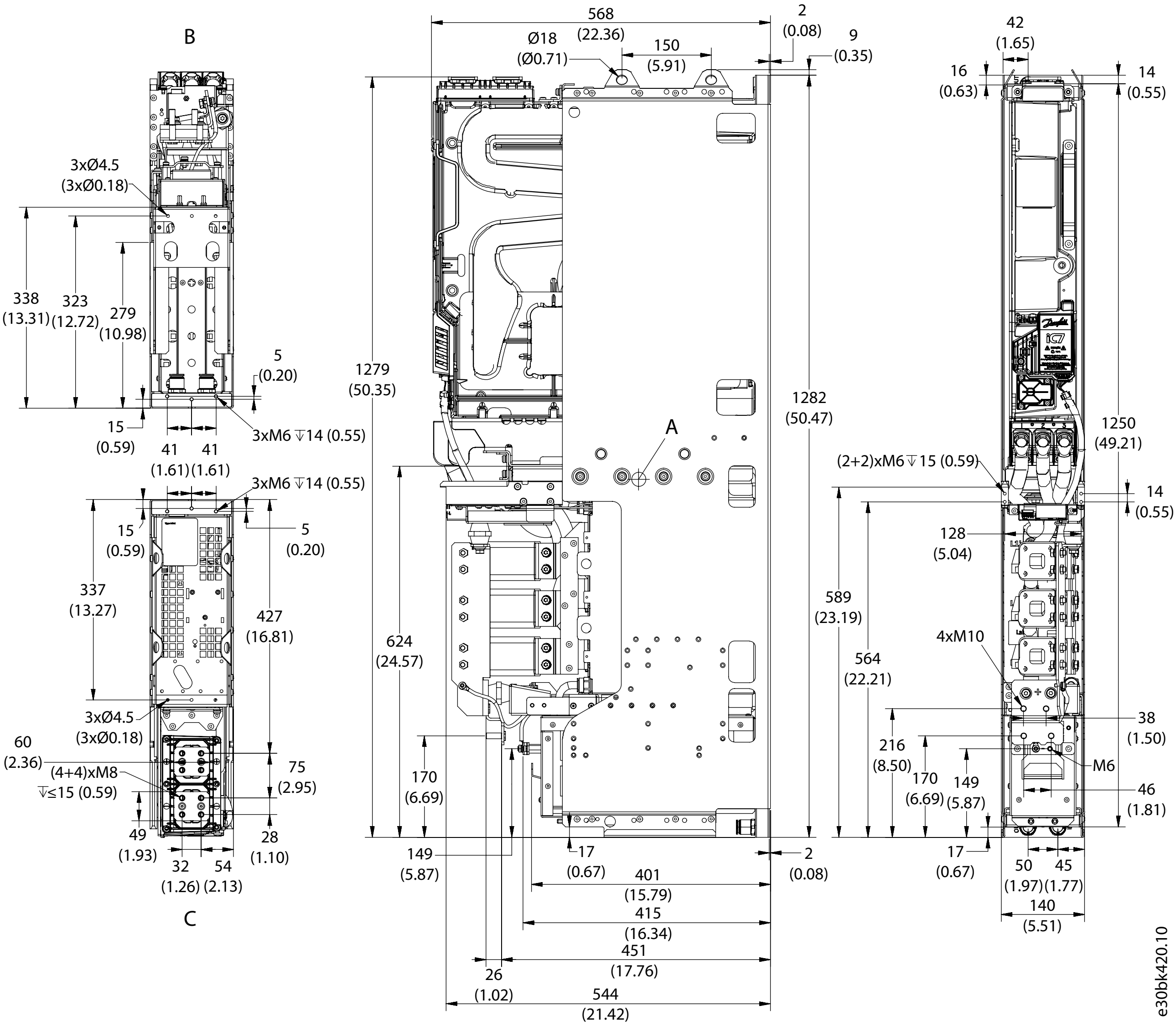
10.2.3 Dimensions of the Active Front-end Module/Grid Converter, AR10L



A	The center of gravity	**B**	View from the bottom
C	View from the top		

Figure 129: Dimensions of AFE/GC, AR10L, in mm (in)

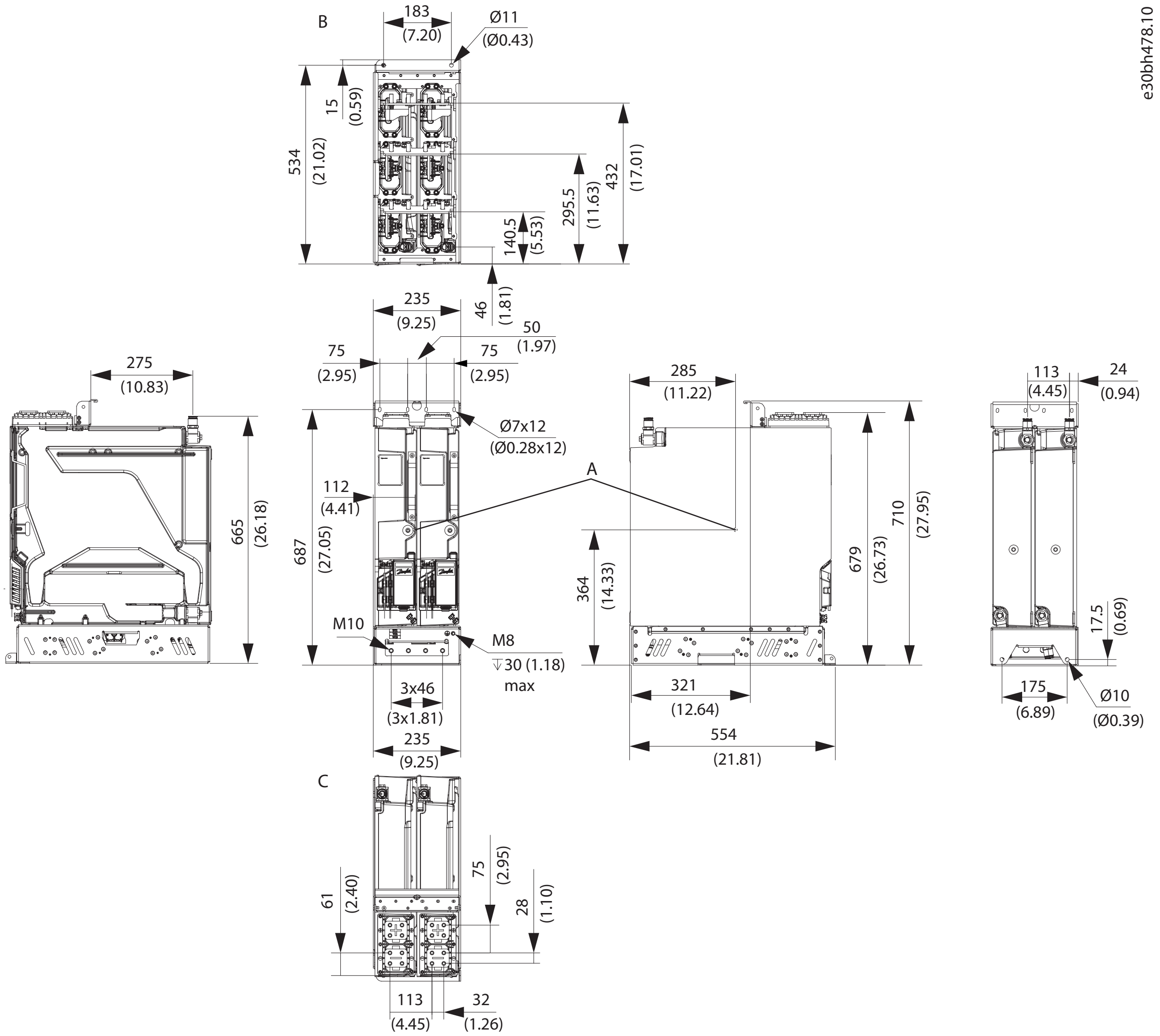
10.2.4 Dimensions of the DC/DC Converter, DR10L



A	Center of gravity	**B**	View from the bottom
C	View from the top		

Figure 130: Dimensions of DC/DC Converter, DR10L, in mm (in)

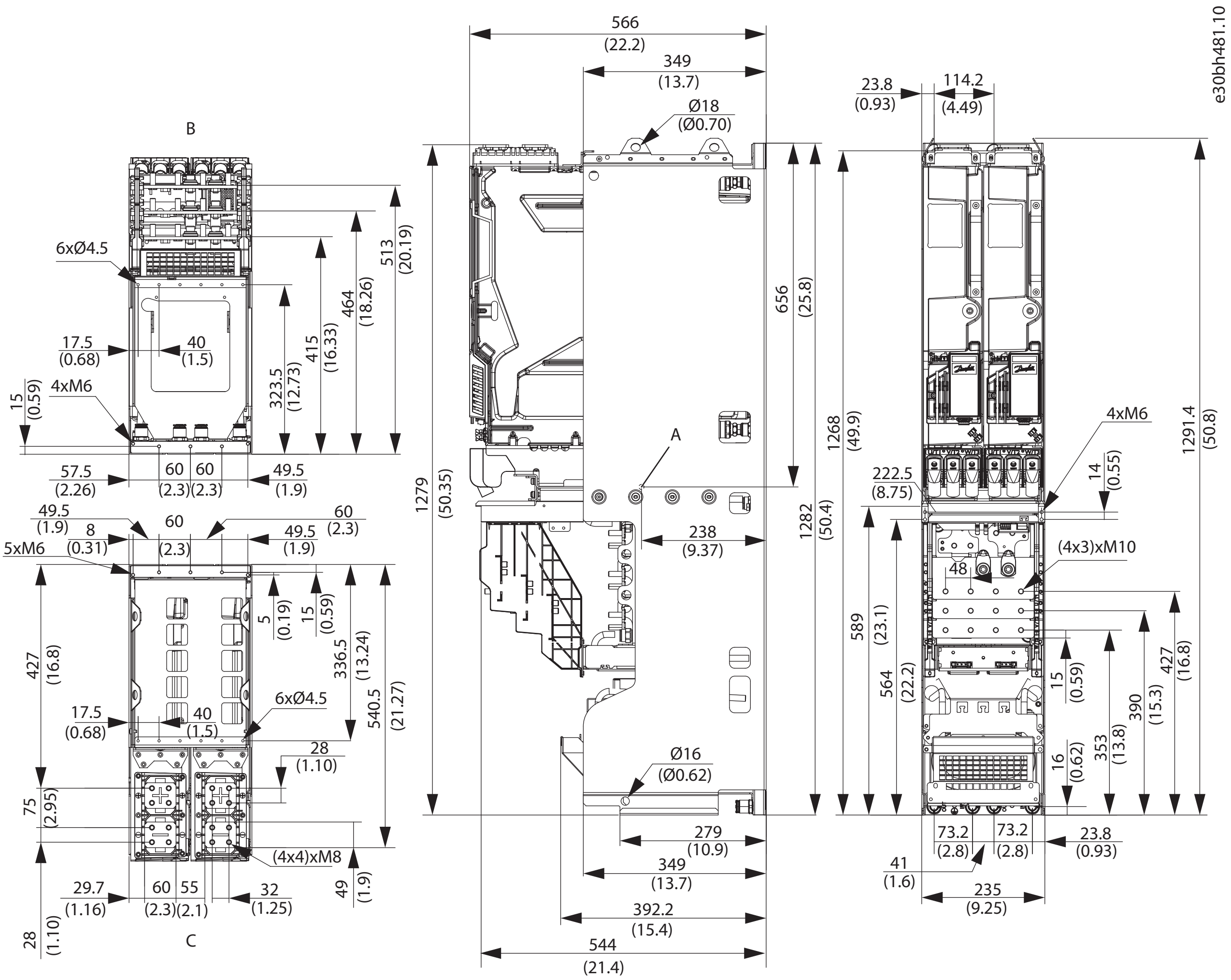
10.2.5 Dimensions of the Inverter Module, IM12L, AFE/GC Module, AM12L, and DC/DC Converter Module, DM12L



A	Center of gravity	**B**	View from the bottom
C	View from the top		

Figure 131: Dimensions of INU, IM12L, AFE/GC, AM12L, and DC/DC Converter, DM12L in mm (in)

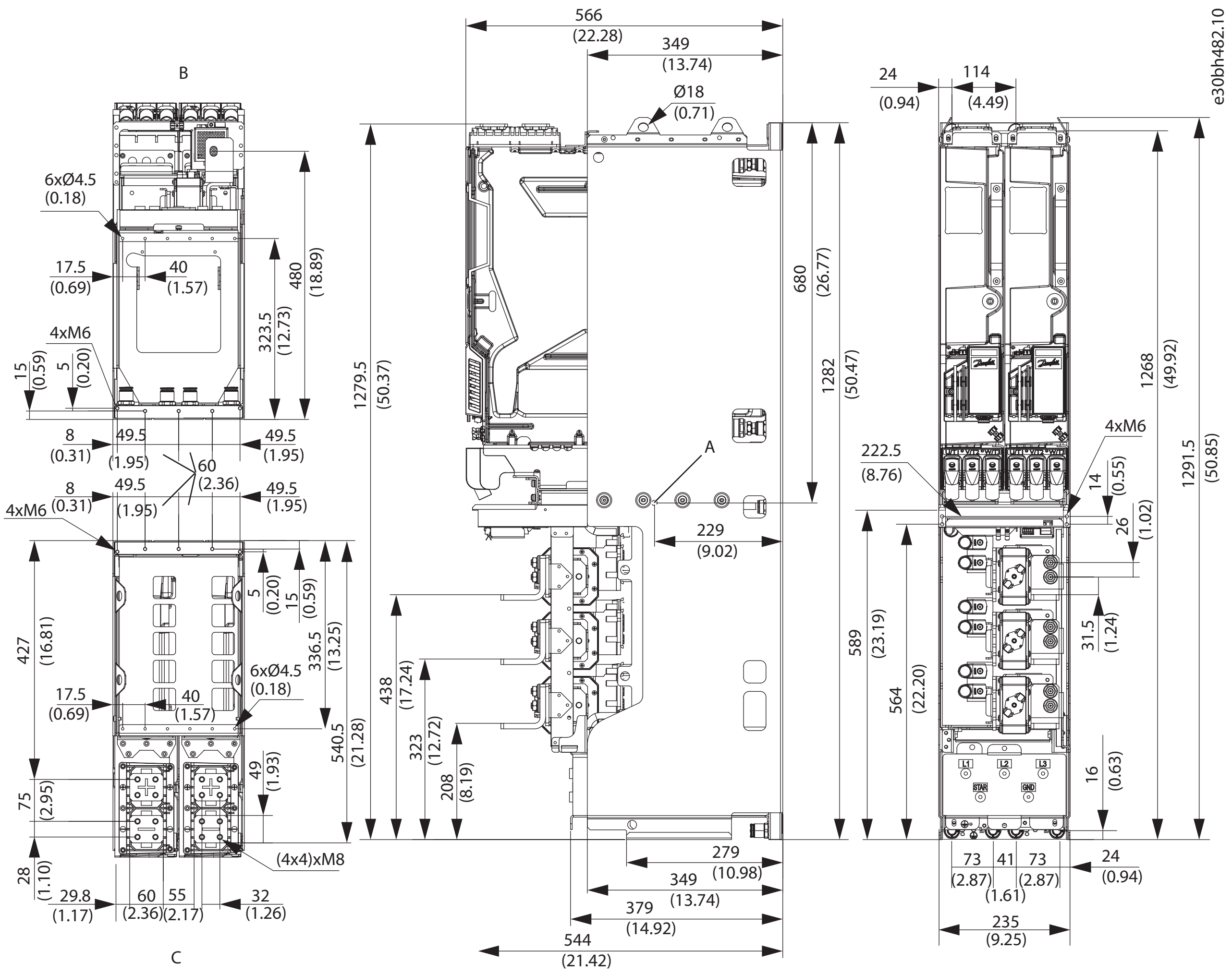
10.2.6 Dimensions of the Inverter Module, IR12L



A	Center of gravity	**B**	View from the top
C	View from the bottom		

Figure 132: Dimensions of INU, IR12L, in mm (in)

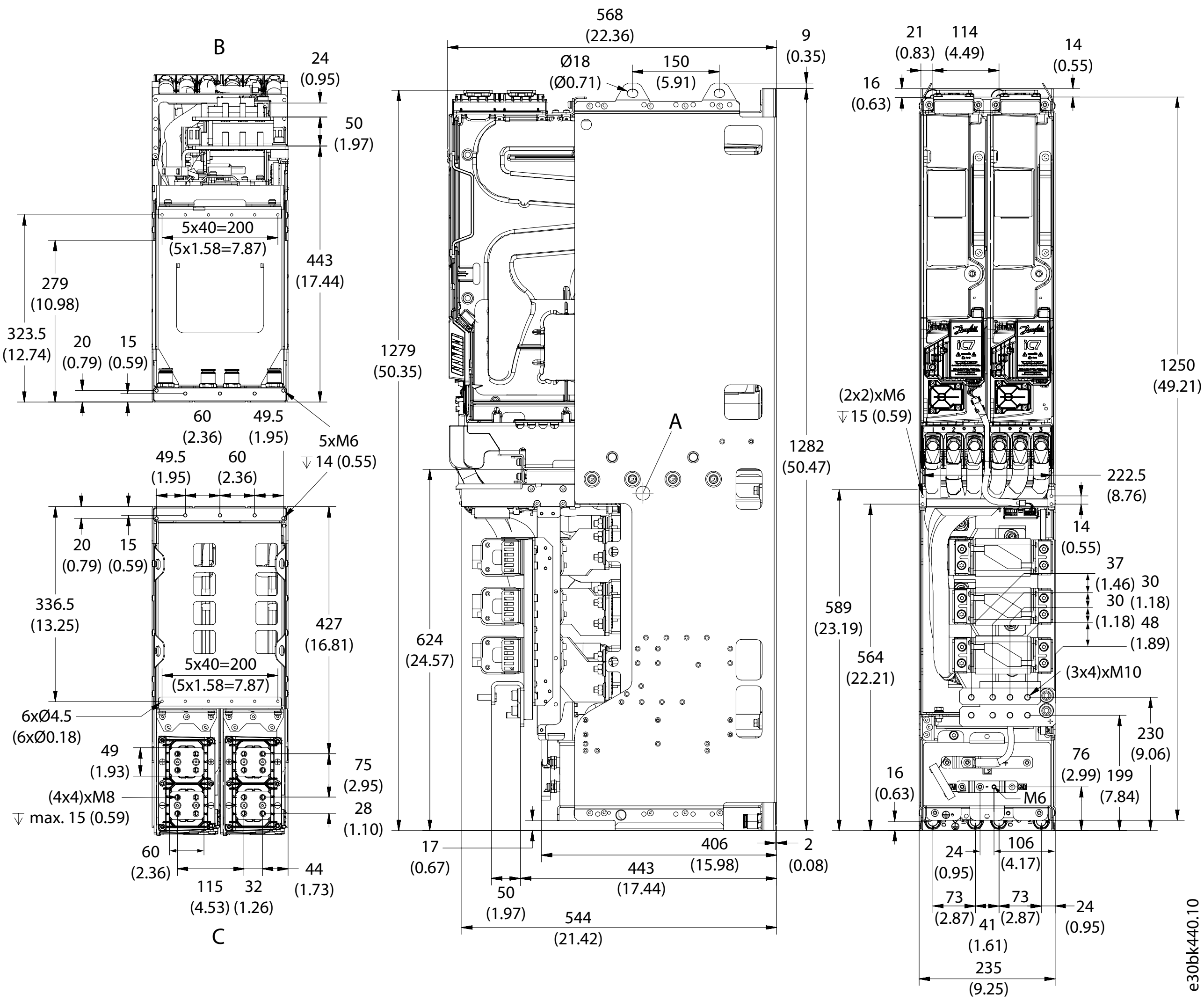
10.2.7 Dimensions of Active Front-end Module/Grid Converter, AR12L



A	Center of gravity	**B**	View from the bottom
C	View from the top		

Figure 133: Dimensions of AFE/GC, AR12L, in mm (in)

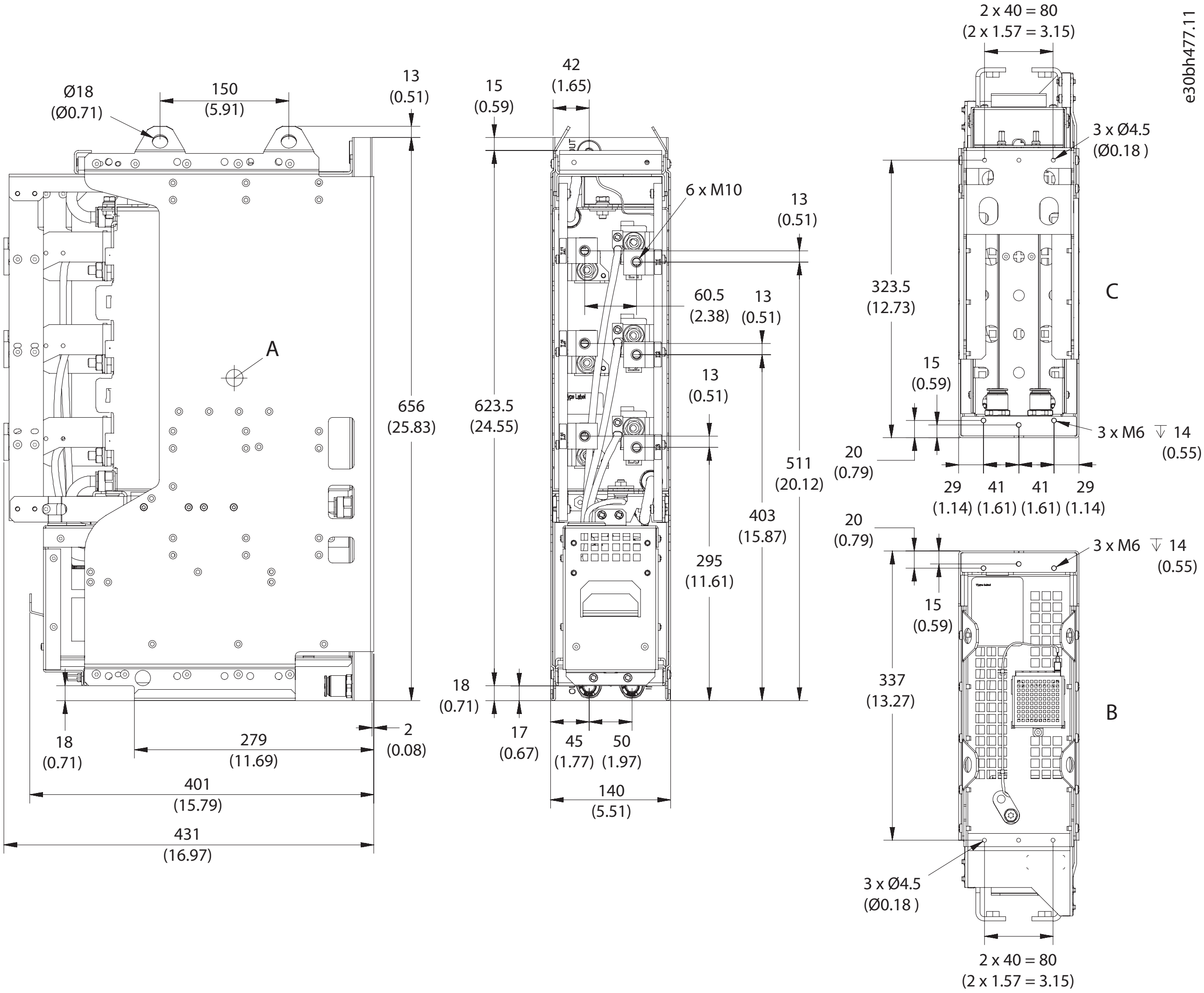
10.2.8 Dimensions of the DC/DC Converter, DR12L



A	Center of gravity	**B**	View from the bottom
C	View from the top		

Figure 134: Dimensions of DC/DC Converter, DR12L, in mm (in)

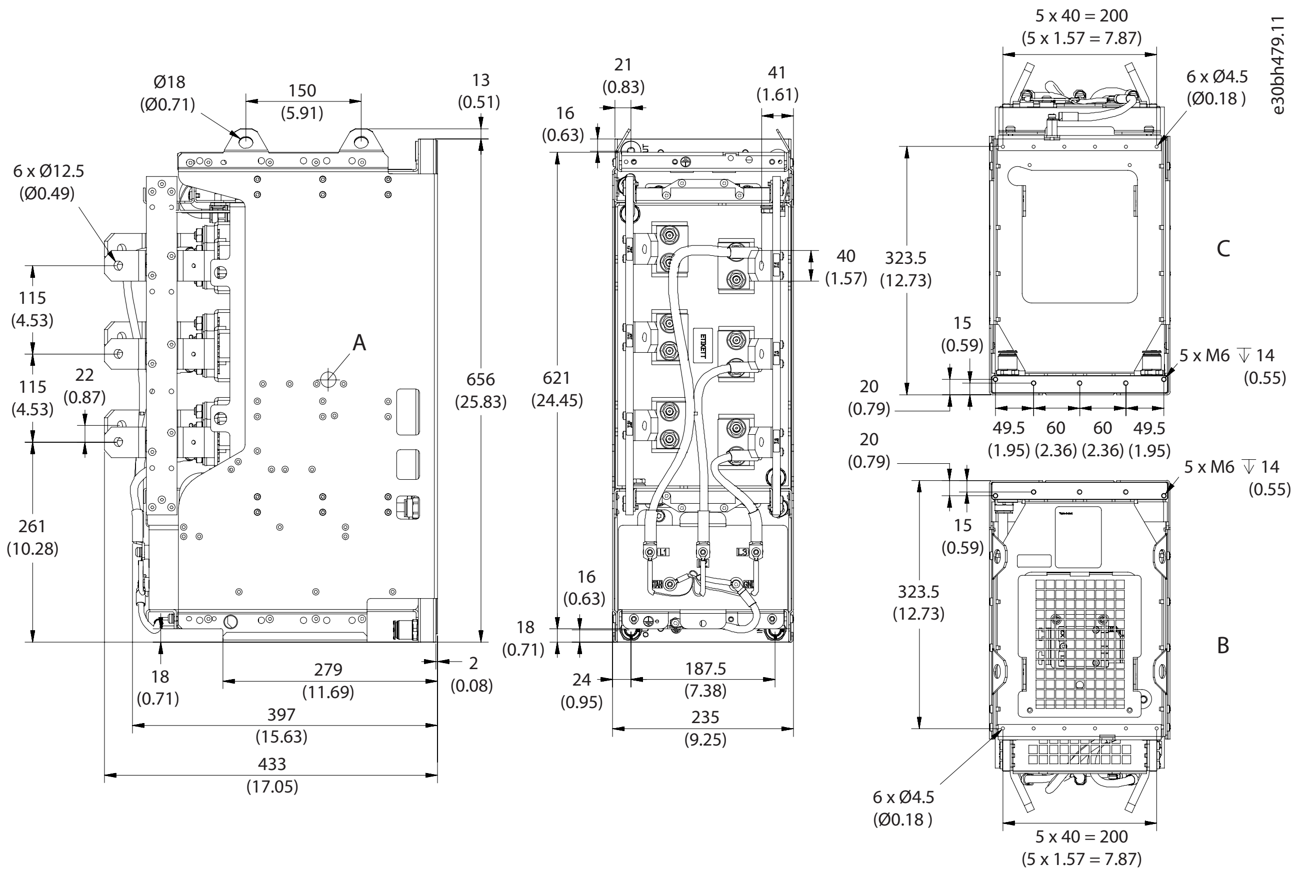
10.2.9 Dimensions of the LC filter for AM10L



A	Center of gravity	**B**	View from the top
C	View from the bottom		

Figure 135: Dimensions of the LC Filter for AM10L, in mm (in)

10.2.10 Dimensions of the LC Filter for AM12L



A	Center of gravity	**B**	View from the top
C	View from the bottom		

Figure 136: Dimensions of the LC Filter for AM12L, in mm (in)

10.2.11 Dimensions of the L Filter, 400 A

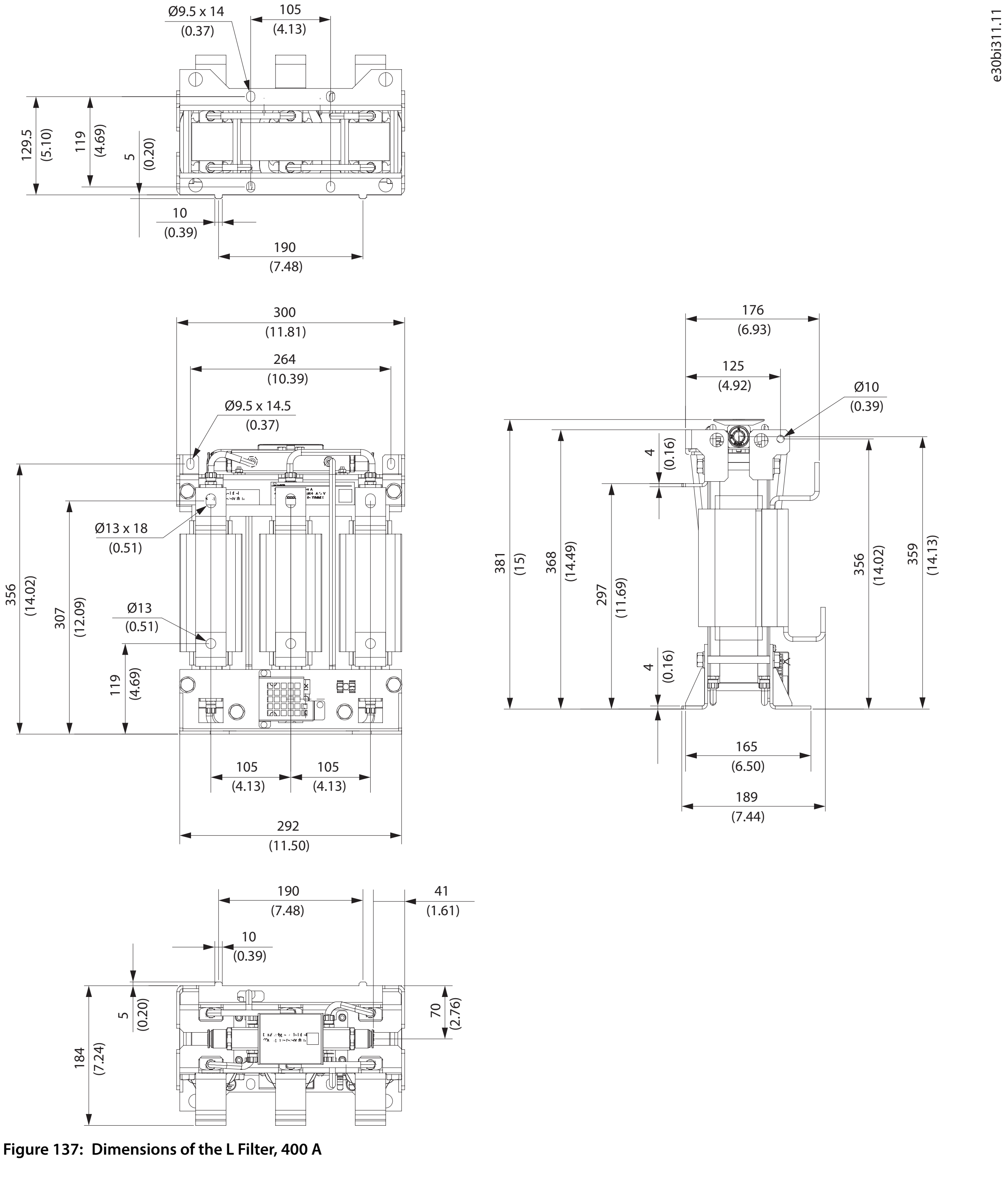


Figure 137: Dimensions of the L Filter, 400 A

10.2.12 Dimensions of the L Filter, 1000 A

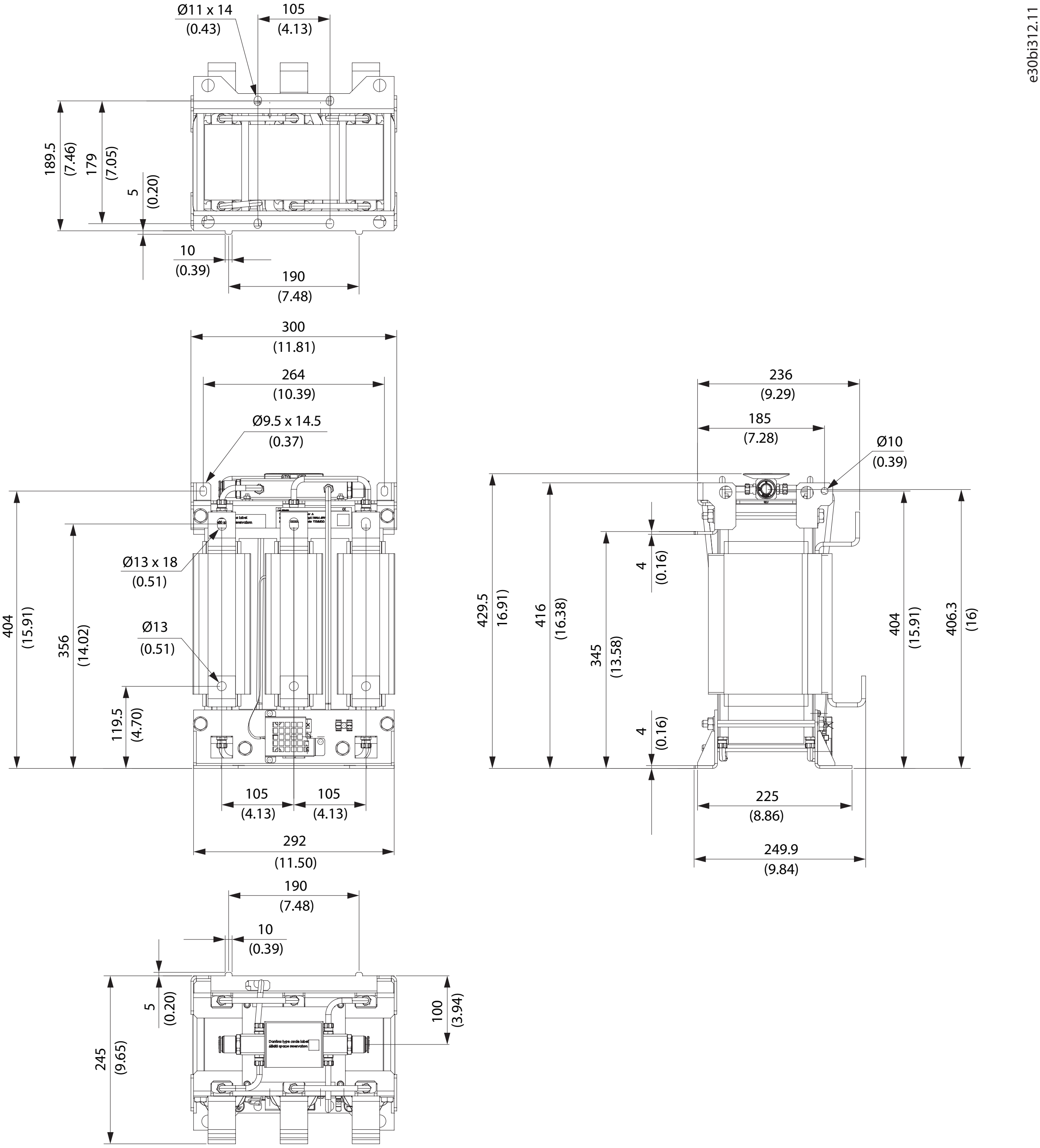
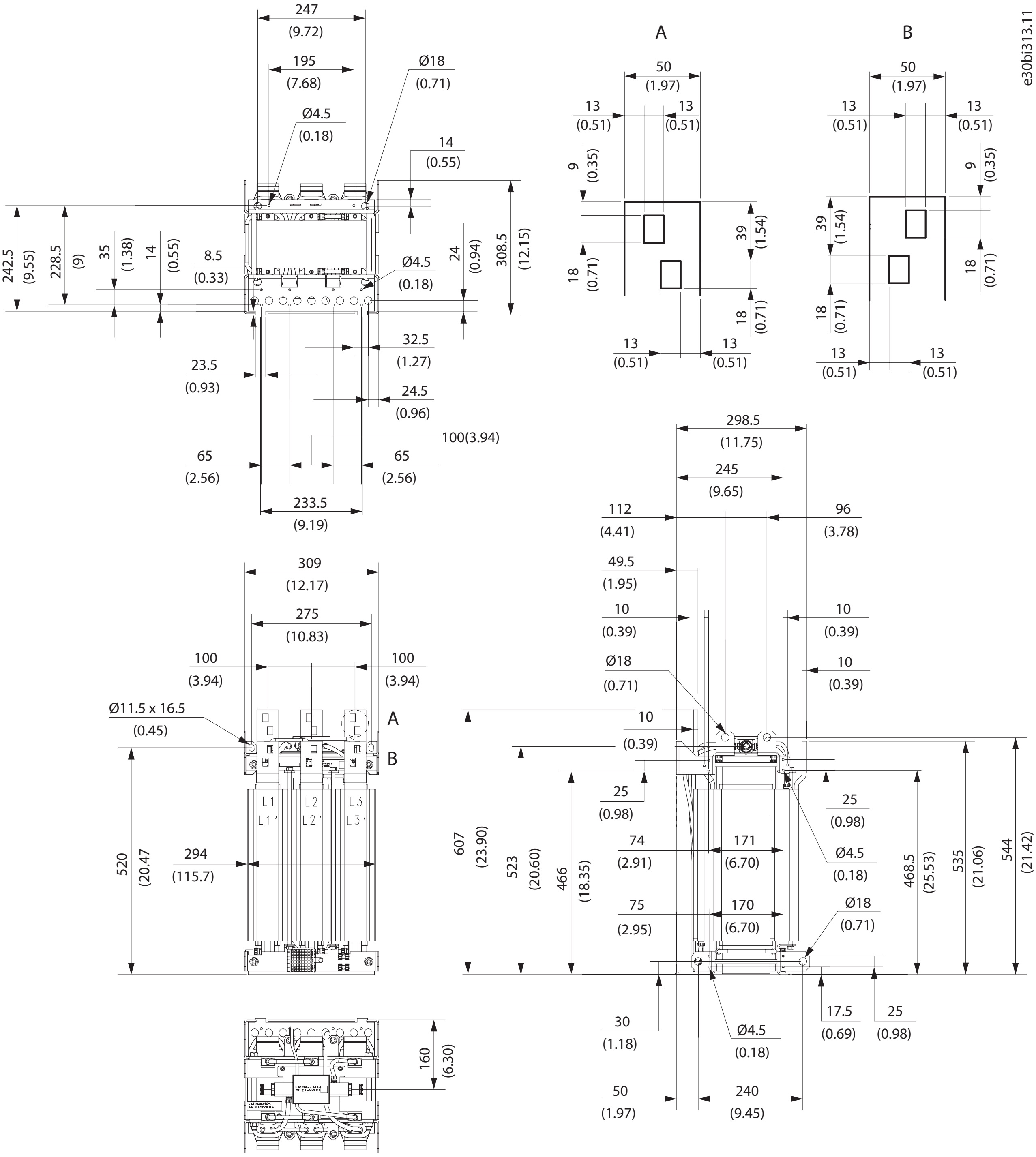


Figure 138: Dimensions of the L Filter, 1000 A

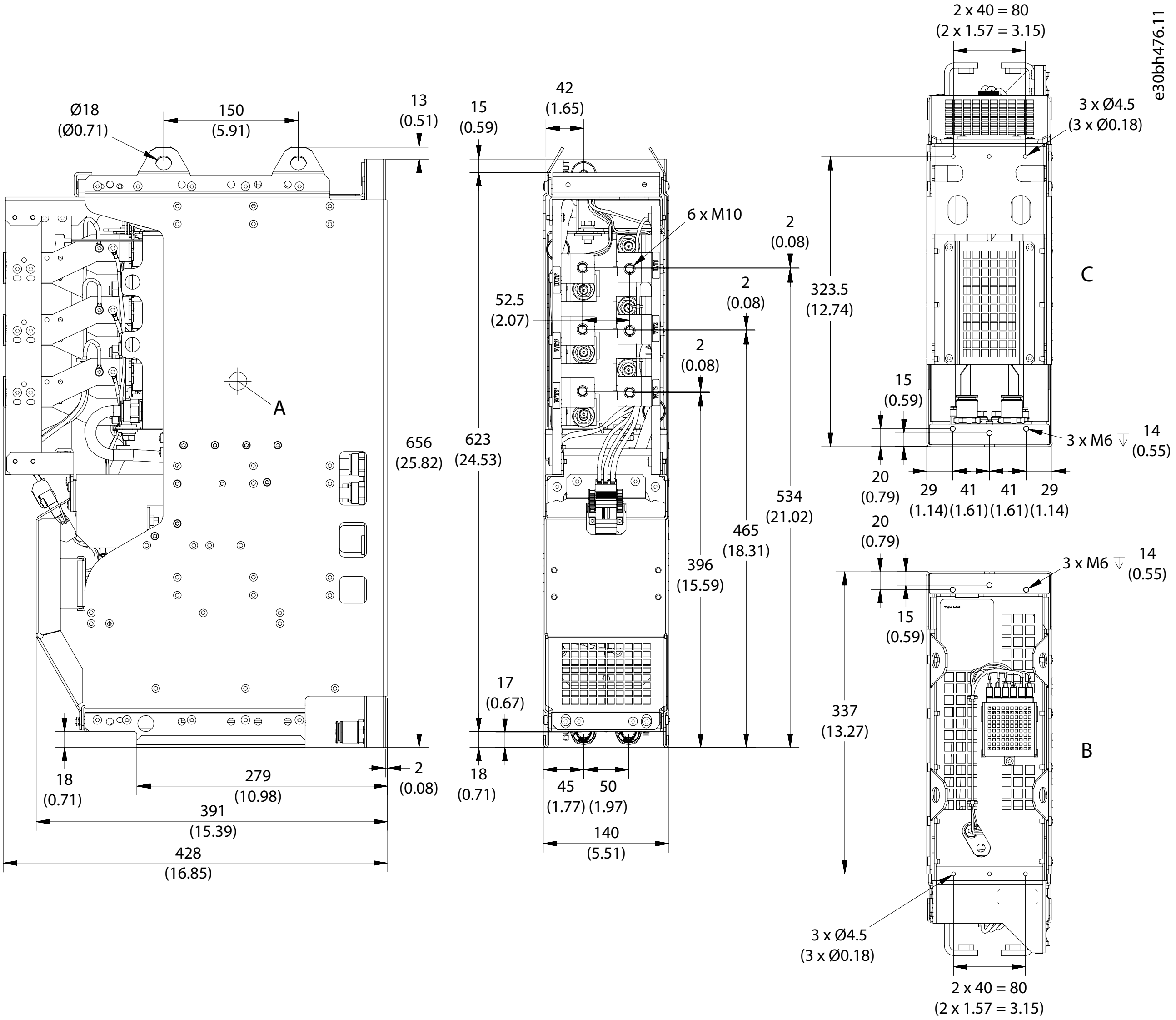
10.2.13 Dimensions of the L Filter, 1640 A



A	The connector on top of the filter	**B**	The connector on top of the filter

Figure 139: Dimensions of the L Filter, 1640 A

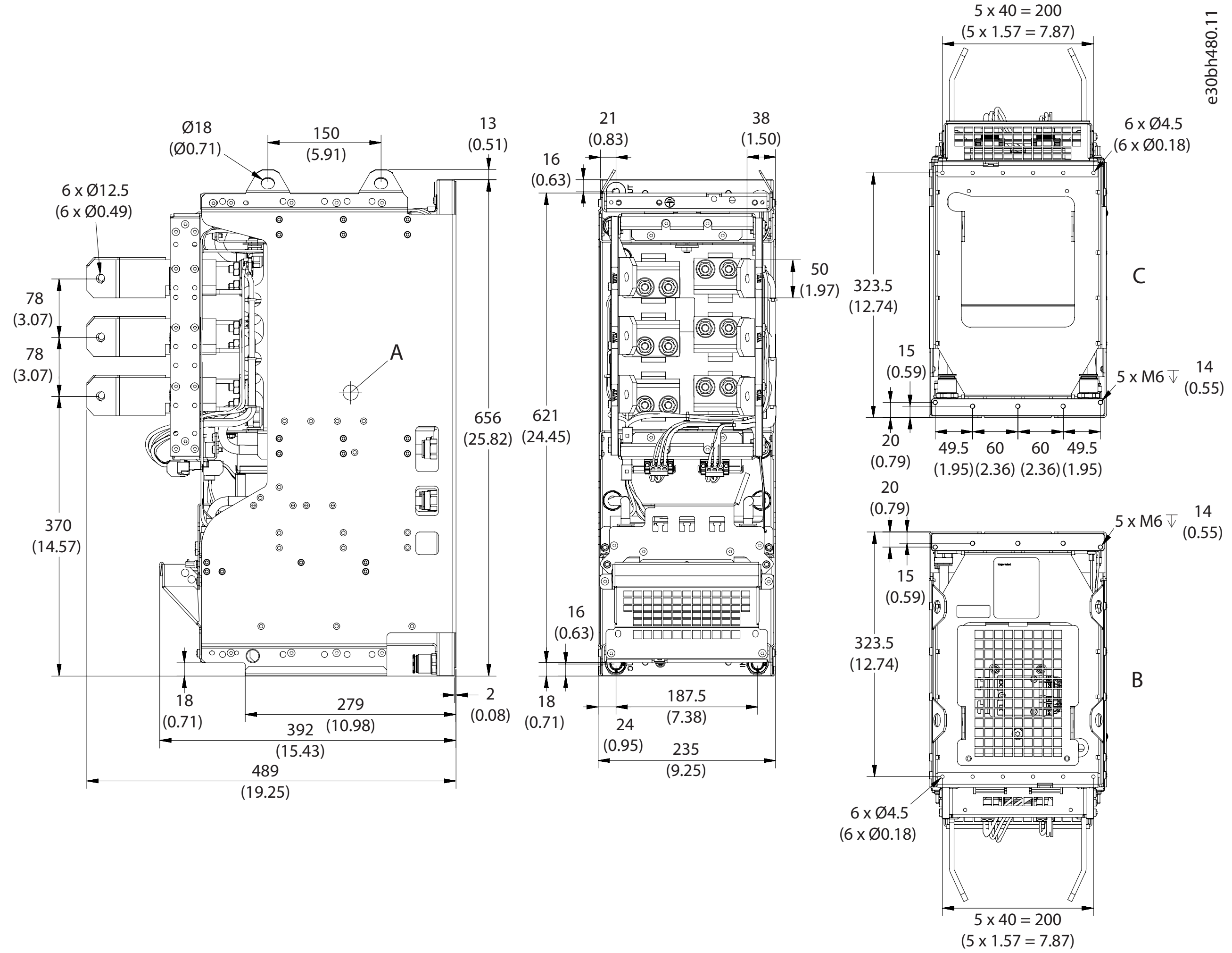
10.2.14 Dimensions of the dU/dt Filter and the Common-mode Filter for IM10L



A	Center of gravity	**B**	View from the top
C	View from the bottom		

Figure 140: Dimensions of the dU/dt Filter and Common-mode Filter for IM10L, in mm (in)

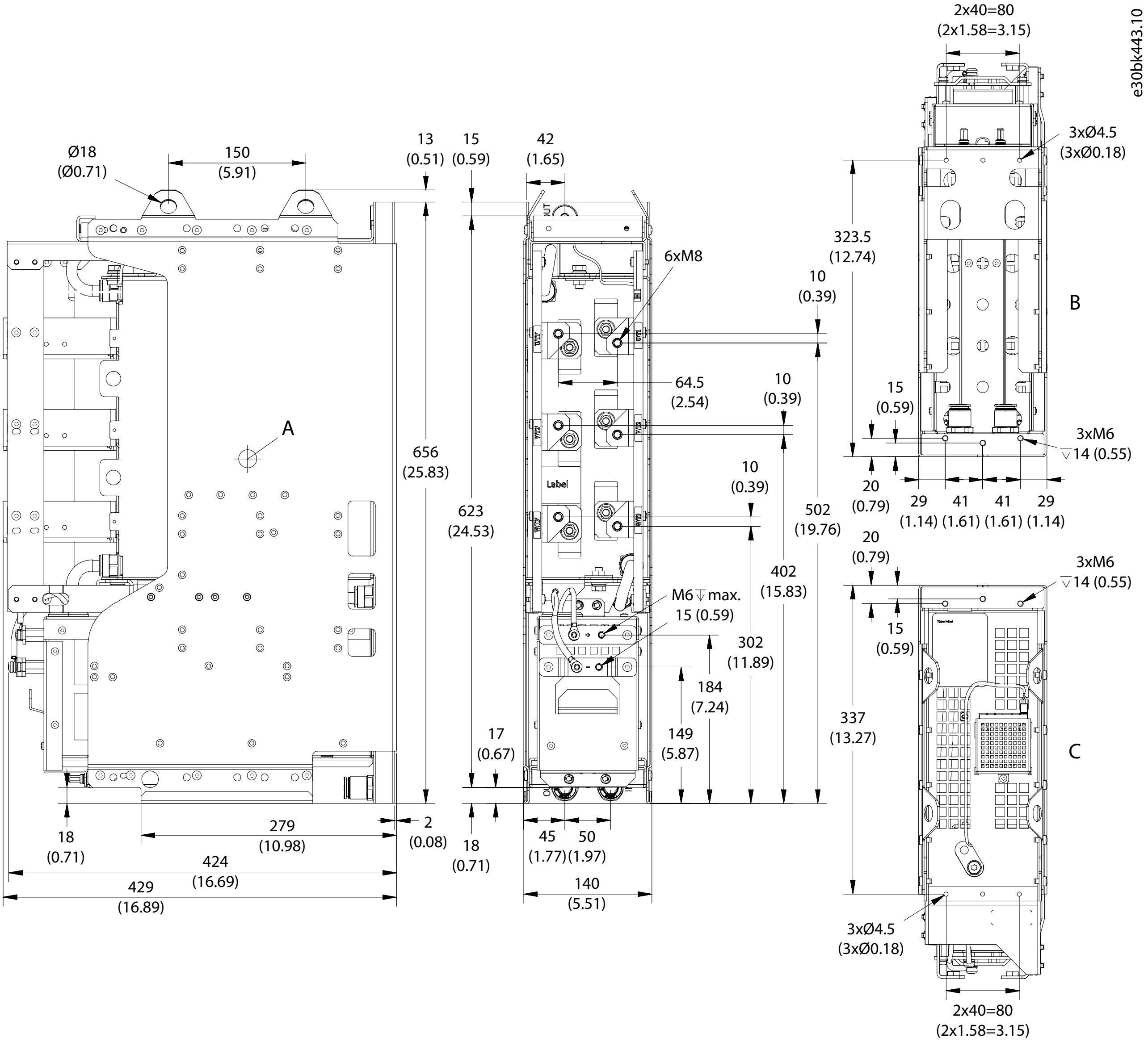
10.2.15 Dimensions of the dU/dt Filter for IM12L



A	Center of gravity	**B**	View from the top
C	View from the bottom		

Figure 141: Dimensions of the dU/dt Filter for IM12L, in mm (in)

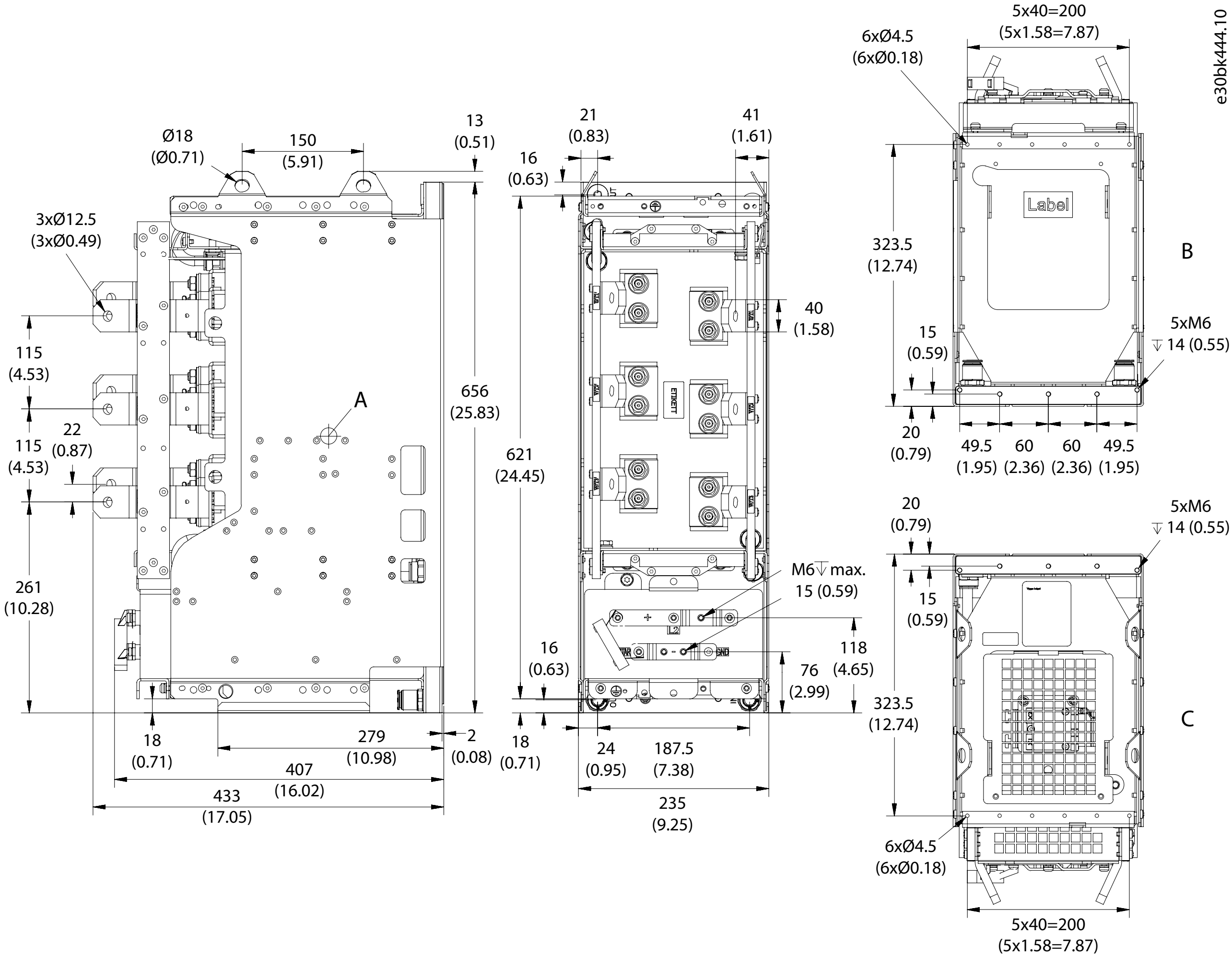
10.2.16 Dimensions of the DC Filter for DM10L



A	Center of gravity	**B**	View from the bottom
C	View from the top		

Figure 142: Dimensions of the DC Filter for DM10L in mm (in)

10.2.17 Dimensions of the DC Filter for DM12L



A	Center of gravity	**B**	View from the bottom
C	View from the top		

Figure 143: Dimensions of the DC Filter for DM12L in mm (in)

10.2.18 Dimensions of the Control Unit

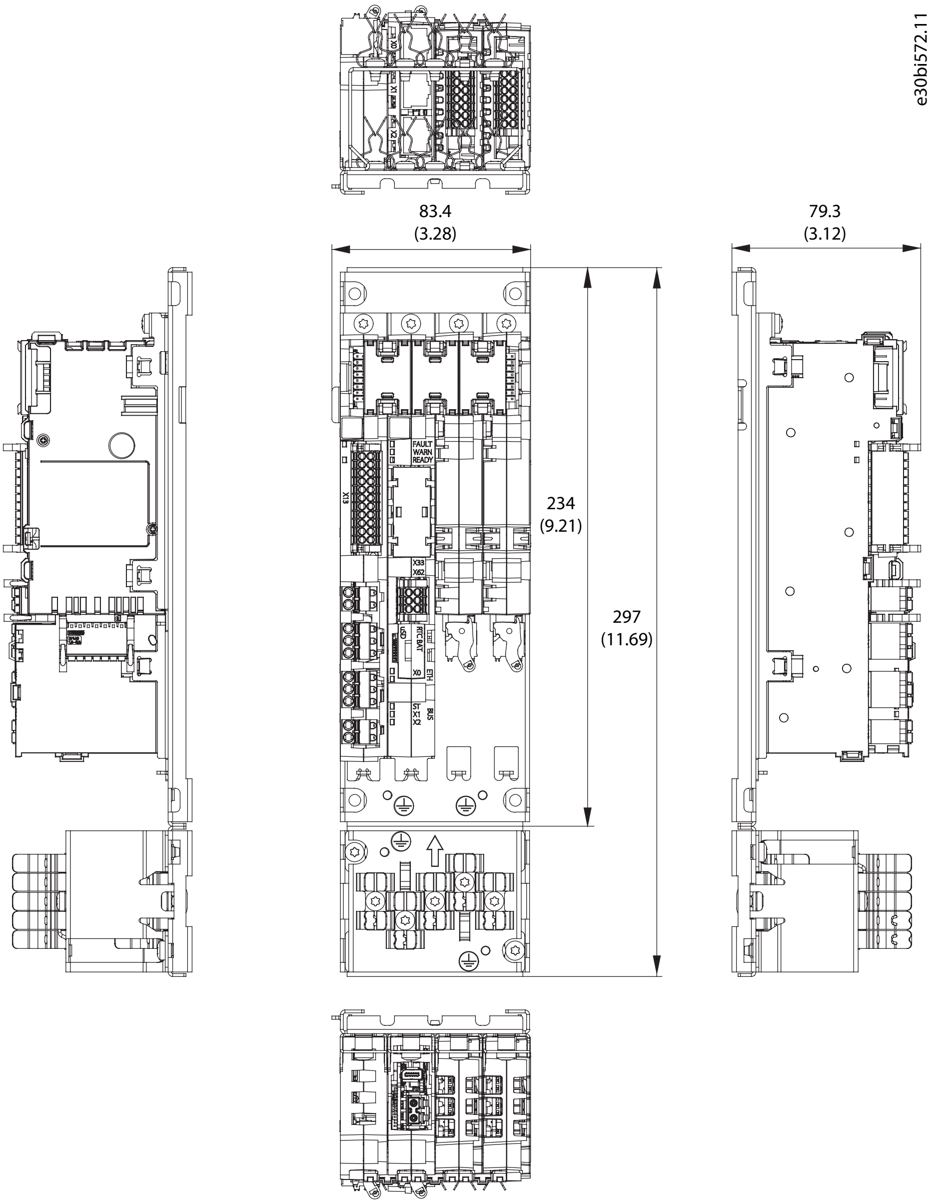


Figure 144: Dimensions of the Control Unit in mm (in), Example Configuration

10.2.19 Dimensions of the Control Unit Mounting Plate

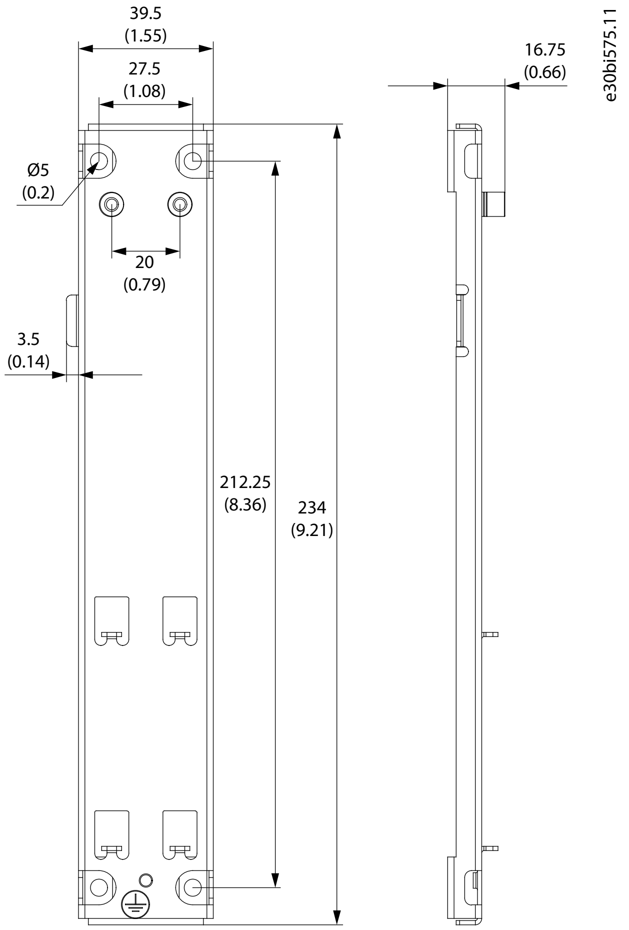


Figure 145: Dimensions of the Modular Control Unit Mounting Plate in mm (in), 2 Places

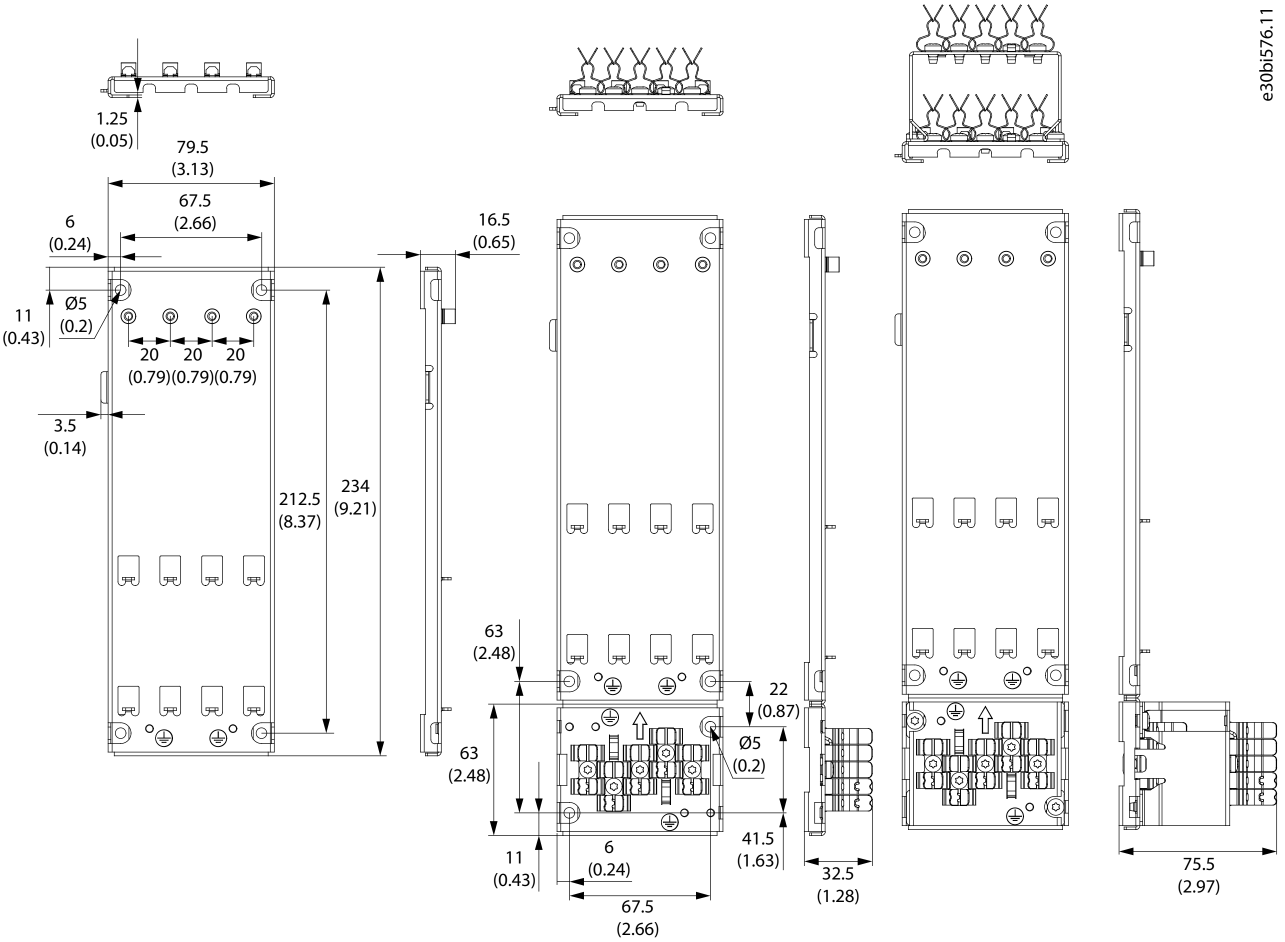


Figure 146: Dimensions of the Modular Control Unit Mounting Plate in mm (in), 4 Places

10.2.20 Dimensions of the Option Connector

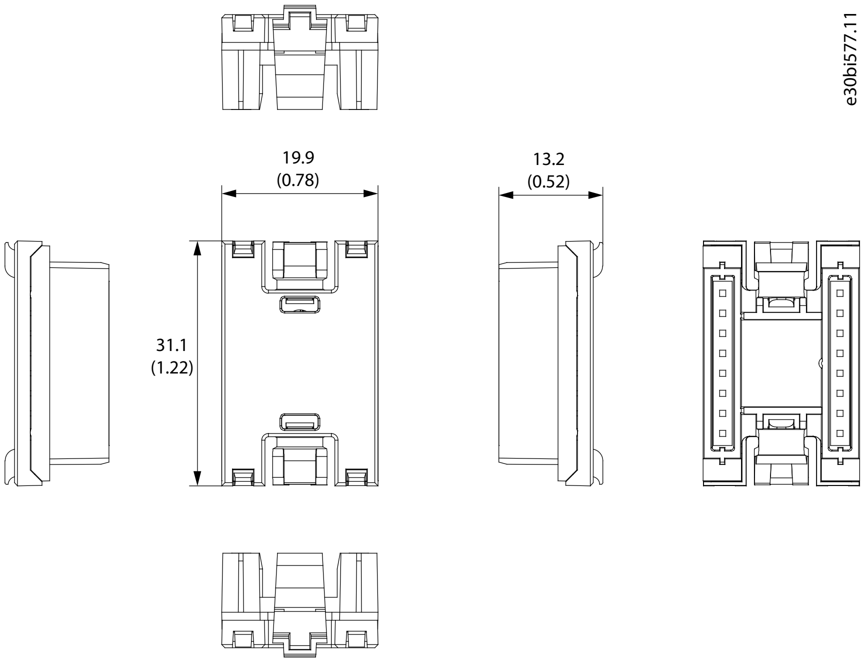


Figure 147: Dimensions of the Option Connecto in mm (in)

10.2.21 Dimensions of the Control Board

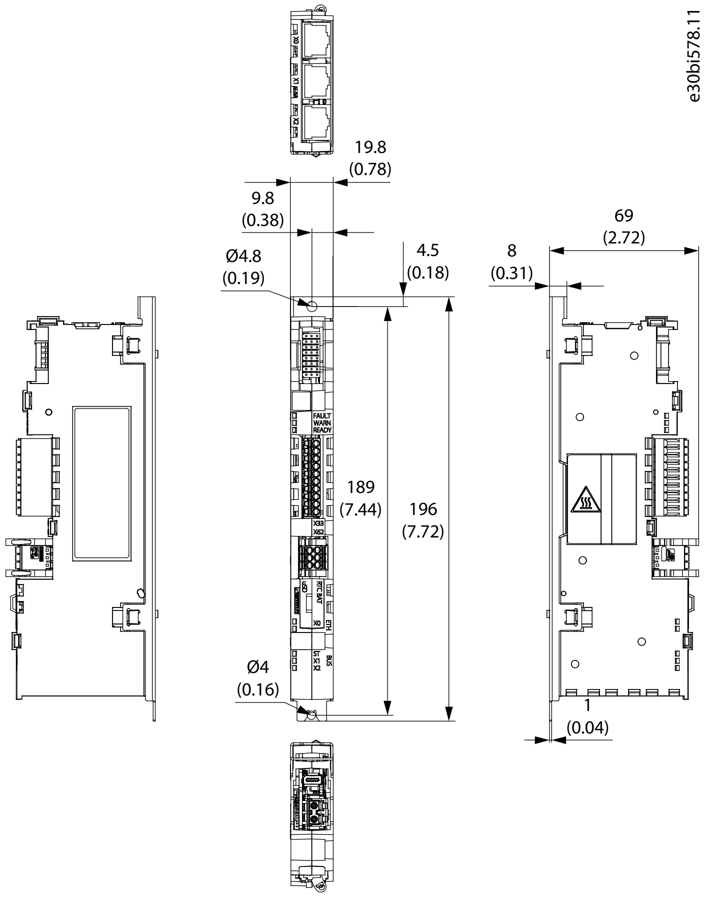


Figure 148: Dimensions of the Control Board in mm (in)

10.2.22 Dimensions of the I/O and Relay Option

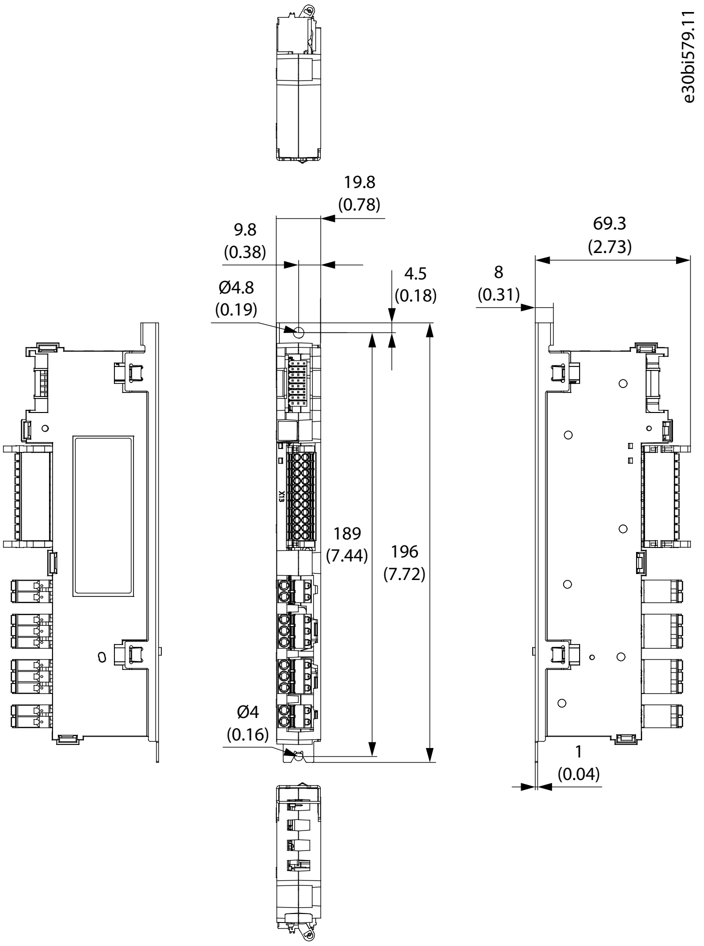


Figure 149: Dimensions of the I/O and Relay Option in mm (in)

10.2.23 Dimensions of an Option Board

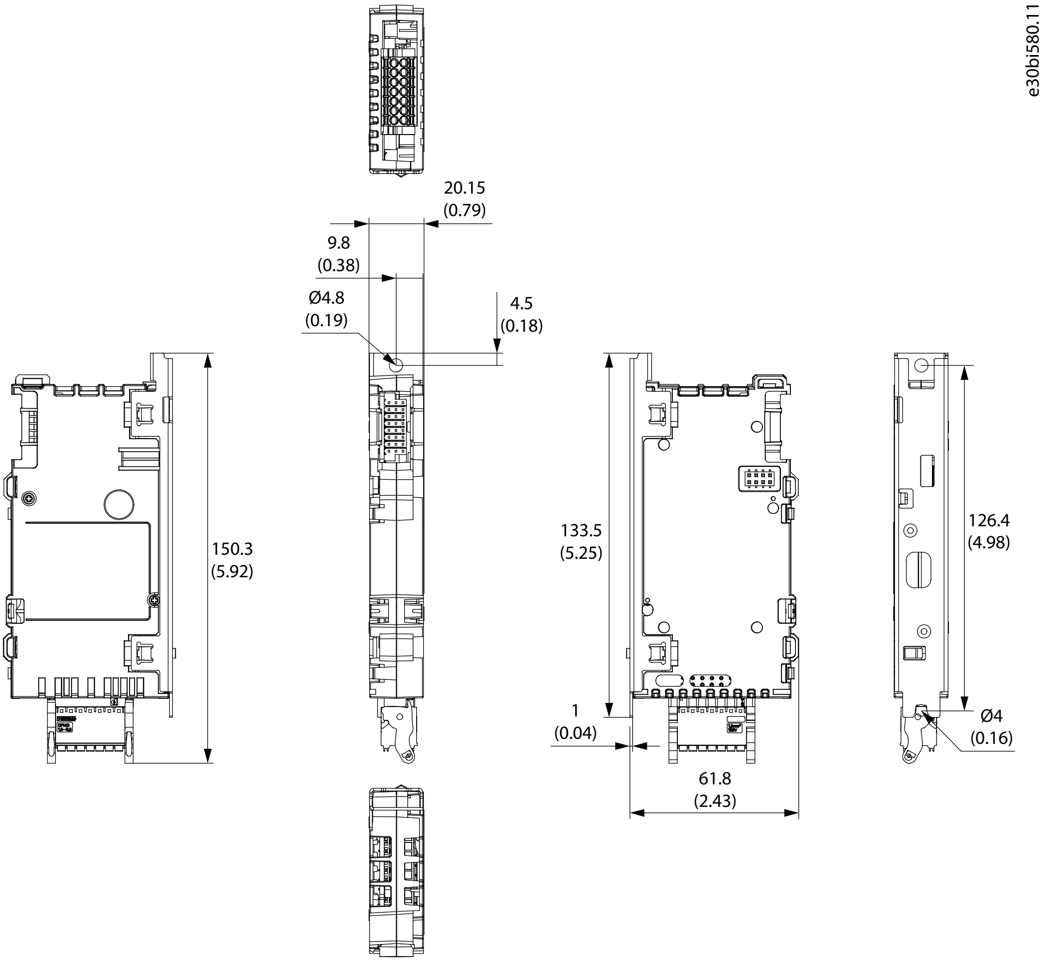


Figure 150: Dimensions of an Option Board in mm (in)

10.2.24 Dimensions of the Star Coupler Board

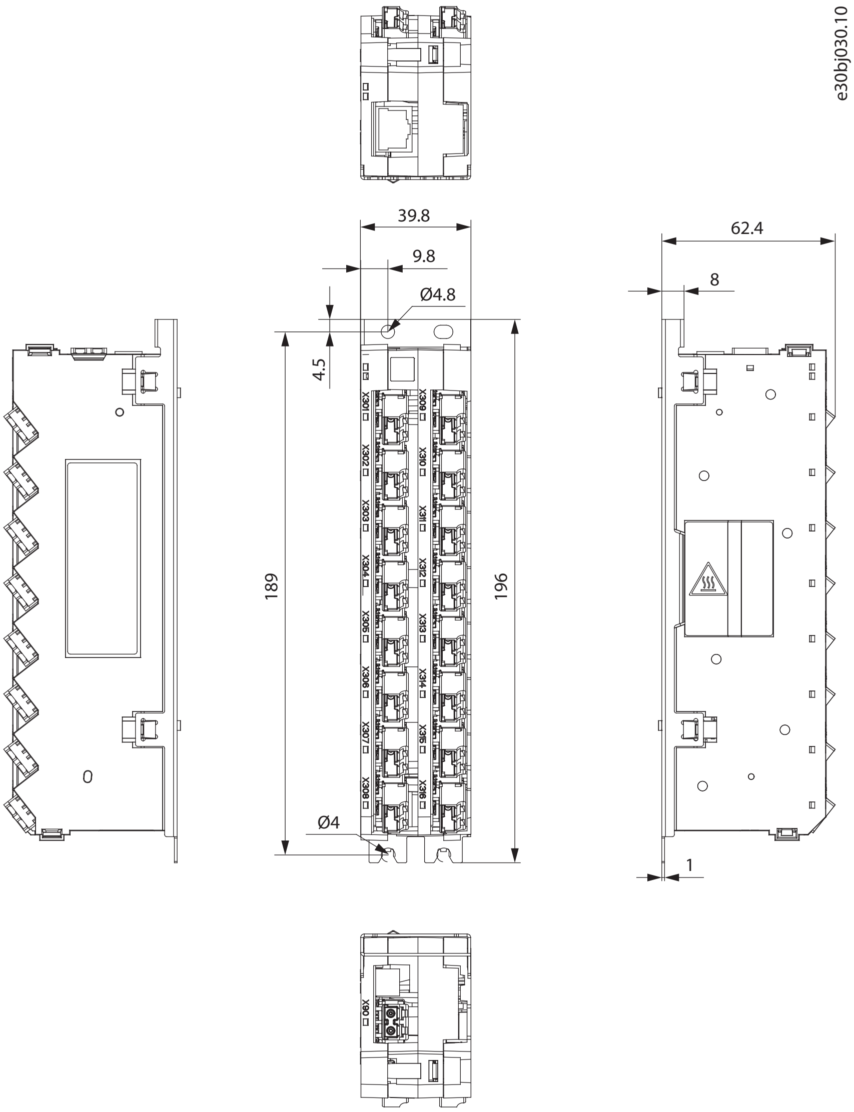


Figure 151: Dimensions of the Star Coupler Board

10.2.25 Dimensions of the Pre-charging Unit, IEC

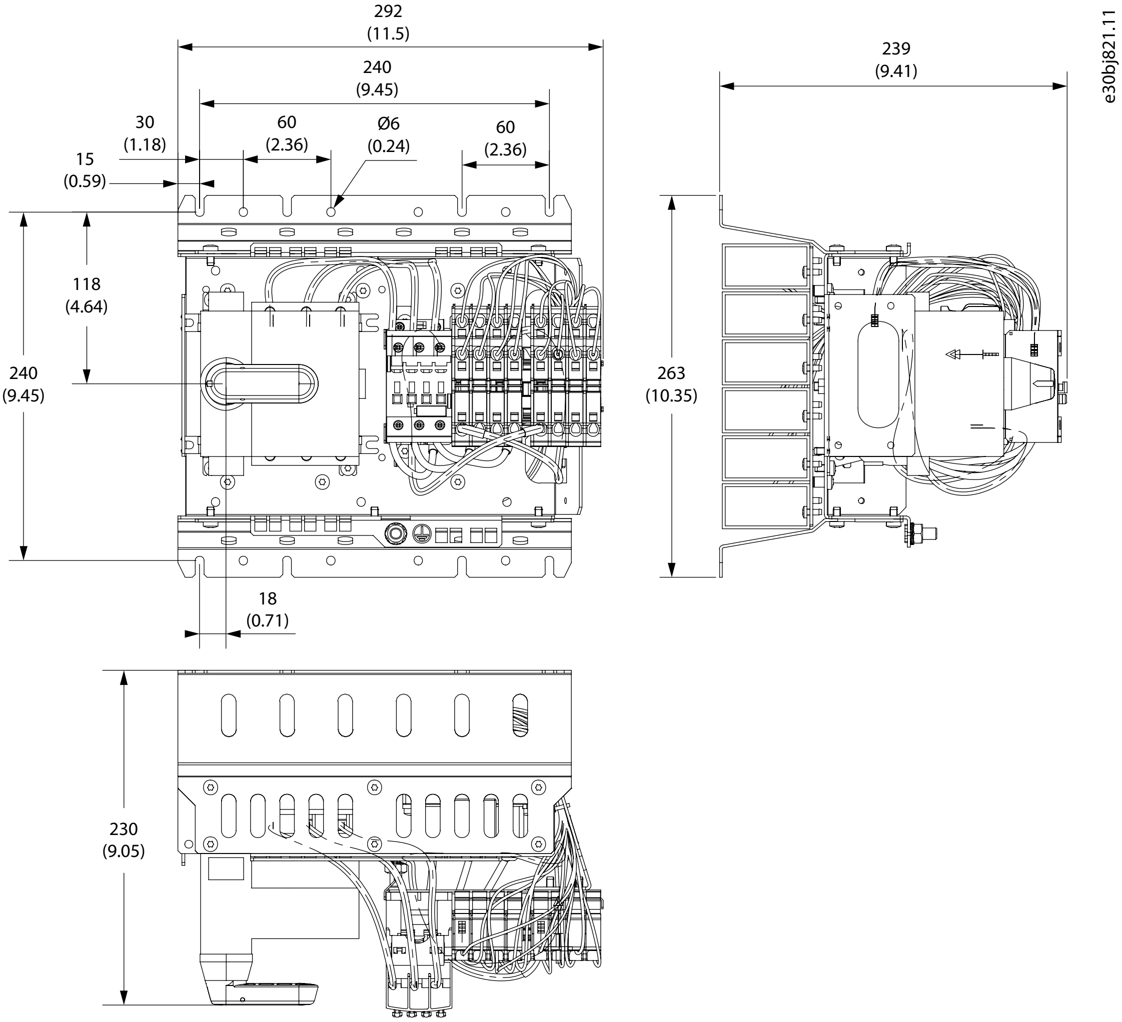


Figure 152: Dimensions of the Pre-charging Unit in mm (in), IEC

10.2.26 Dimensions of the Pre-charging Unit, UL

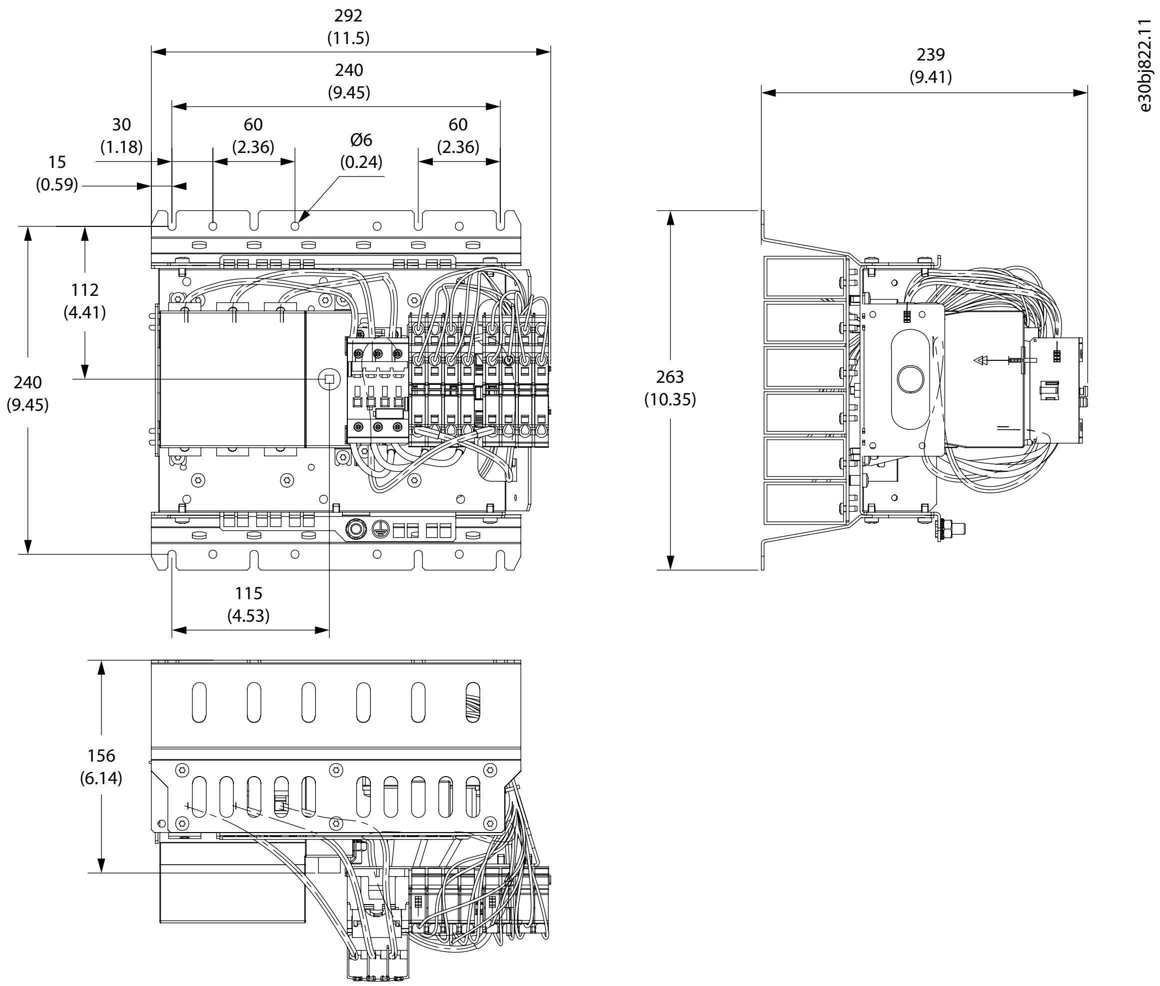


Figure 153: Dimensions of the Pre-charging Unit in mm (in), UL

10.2.27 Dimensions of the DC Fuses, xx10L

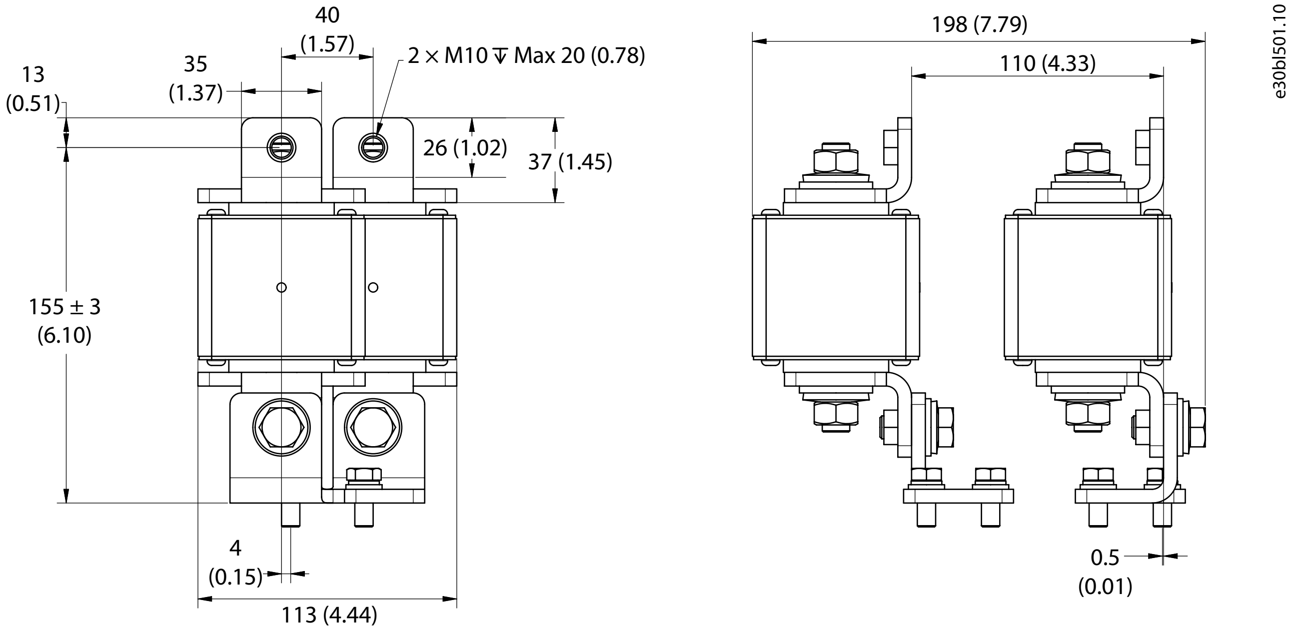


Figure 154: Dimensions of the DC Fuses, AR10L, IR10L, DR10L, AM10L, IM10L, DM10L, in mm (in)

10.2.28 Dimensions of the DC Fuses, xx12L

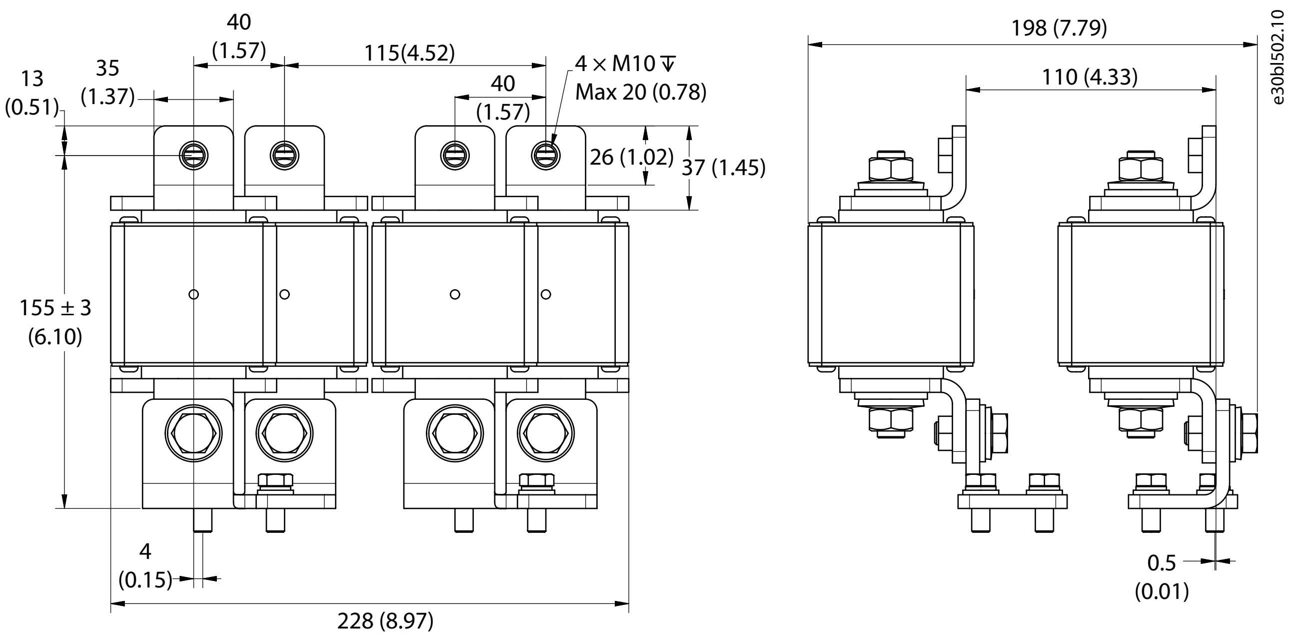


Figure 155: Dimensions of the DC Fuses, AR12L, IR12L, DR12L, AM12L, IM12L, DM12L, in mm (in)

10.2.29 Dimensions for the Control Panel Flush Mounting Kit

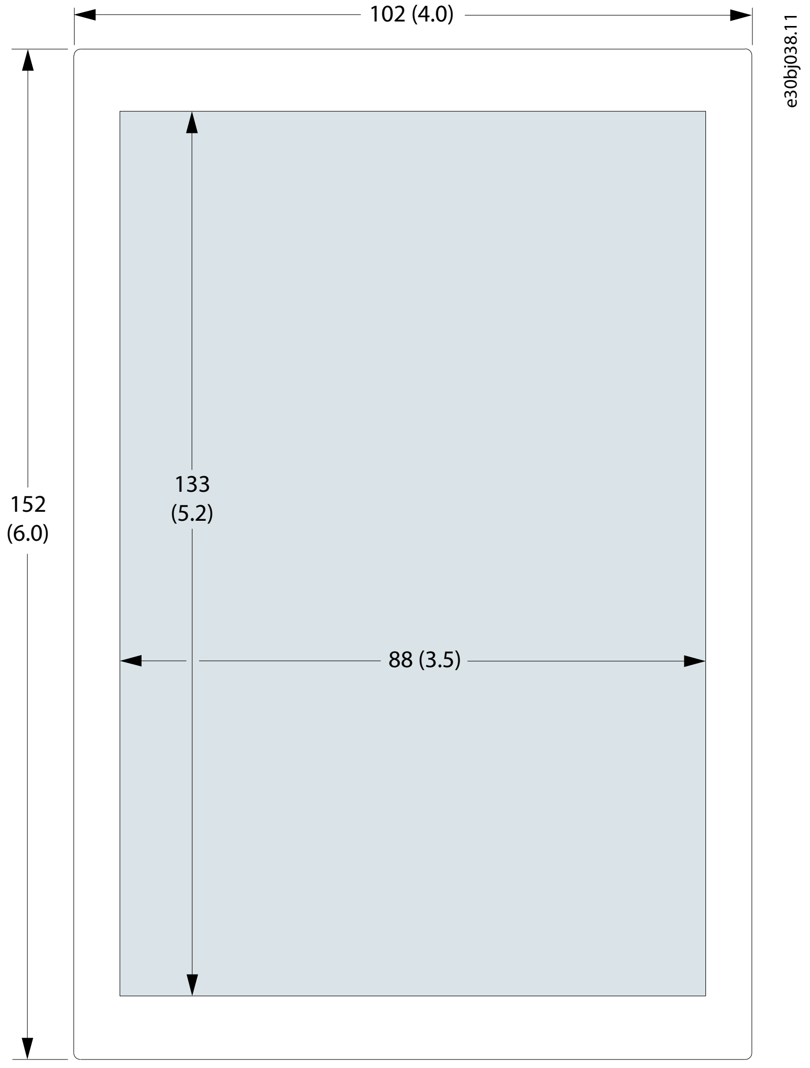


Figure 156: Flush Mounting Kit Drilling Template, mm (in)

10.2.30 Dimensions for the Control Panel Surface Mounting Kit

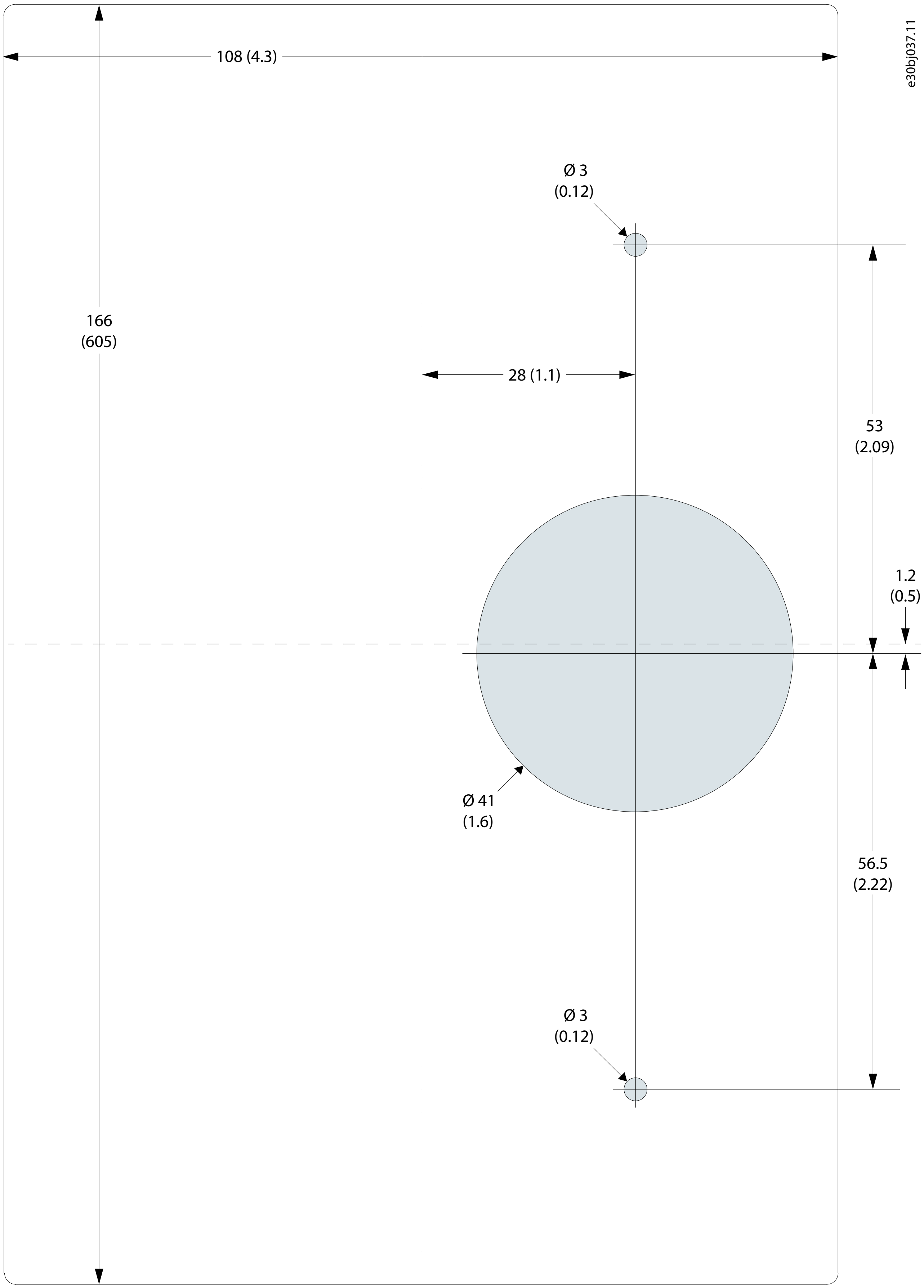
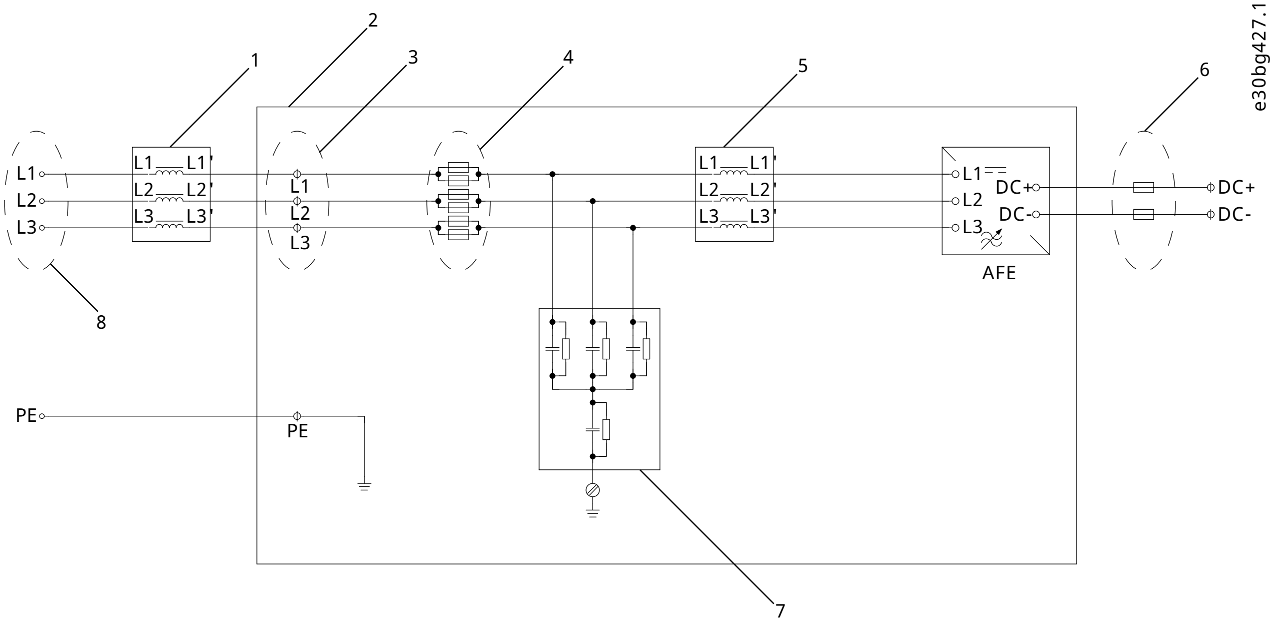


Figure 157: Surface Mounting Kit Drilling Template, mm (in)

10.3 Wiring Diagrams

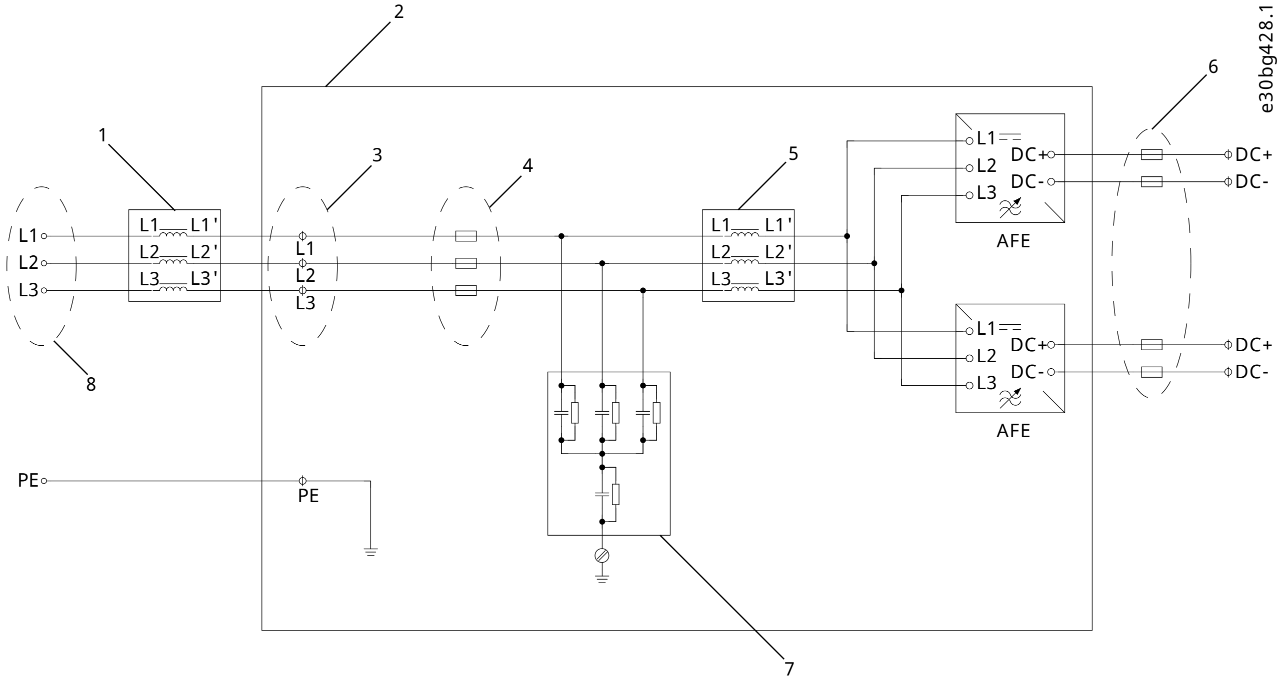
10.3.1 Wiring Diagram, AFE/GC, AR10L



1	L Filter, grid side, loose option	2	AFE/GC module AR10L
3	Input terminals	4	AC fuses
5	LCL Filter choke, drive side	6	DC fuses, loose option
7	LCL Filter capacitors	8	Supply

Figure 158: Wiring Diagram, AR10L

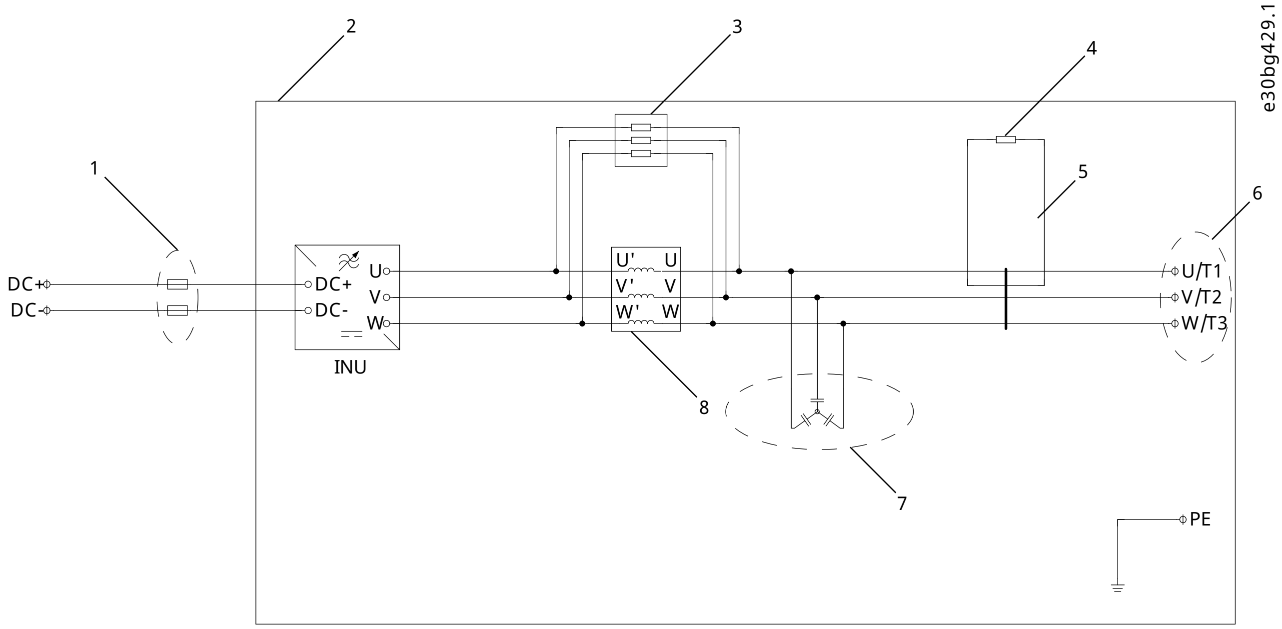
10.3.2 Wiring Diagram, AFE/GC, AR12L



1	L Filter, grid side, loose option	**2**	AFE/GC module AR12L
3	Input terminals	**4**	AC fuses
5	LCL Filter choke, drive side	**6**	DC fuses, loose option
7	LCL Filter capacitors	**8**	Supply

Figure 159: Wiring Diagram, AR12L

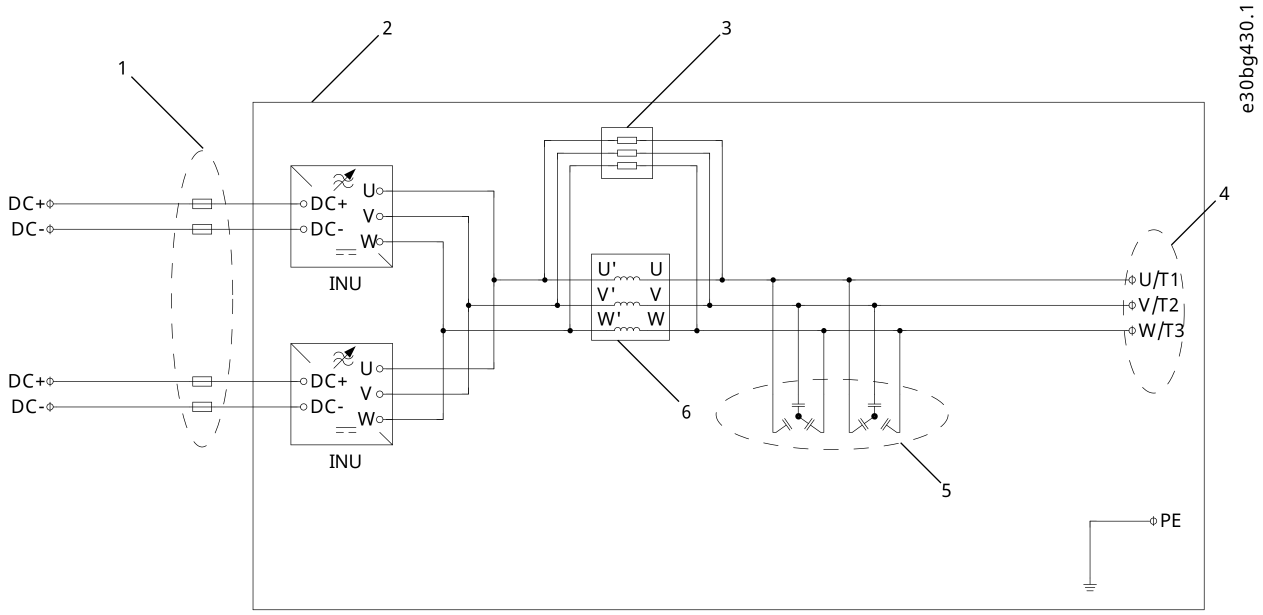
10.3.3 Wiring Diagram, INU, IR10L



1	DC fuses, loose option	**2**	Inverter module IR10L
3	Damping resistors	**4**	Damping resistor
5	Common-mode Filter	**6**	Output terminals
7	dU/dt Filter capacitors	**8**	dU/dt Filter choke

Figure 160: Wiring Diagram, IR10L

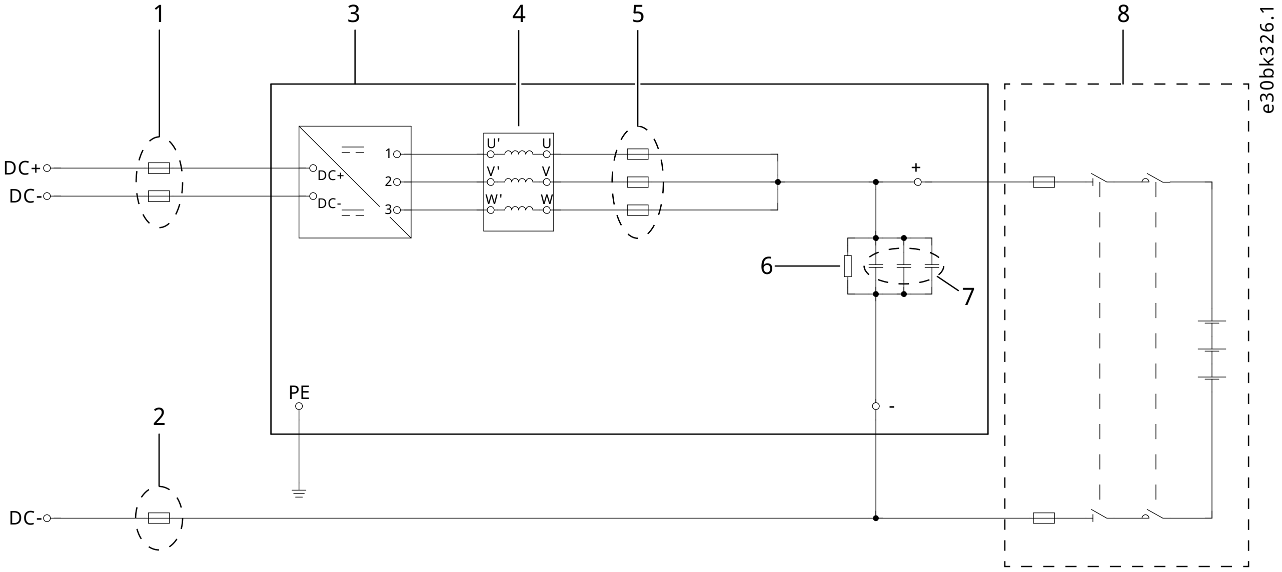
10.3.4 Wiring Diagram, INU, IR12L



1	DC fuses, loose option	**2**	Inverter module IR12L
3	Damping resistors	**4**	Output terminals
5	dU/dt Filter capacitors	**6**	dU/dt Filter choke

Figure 161: Wiring Diagram, IR12L

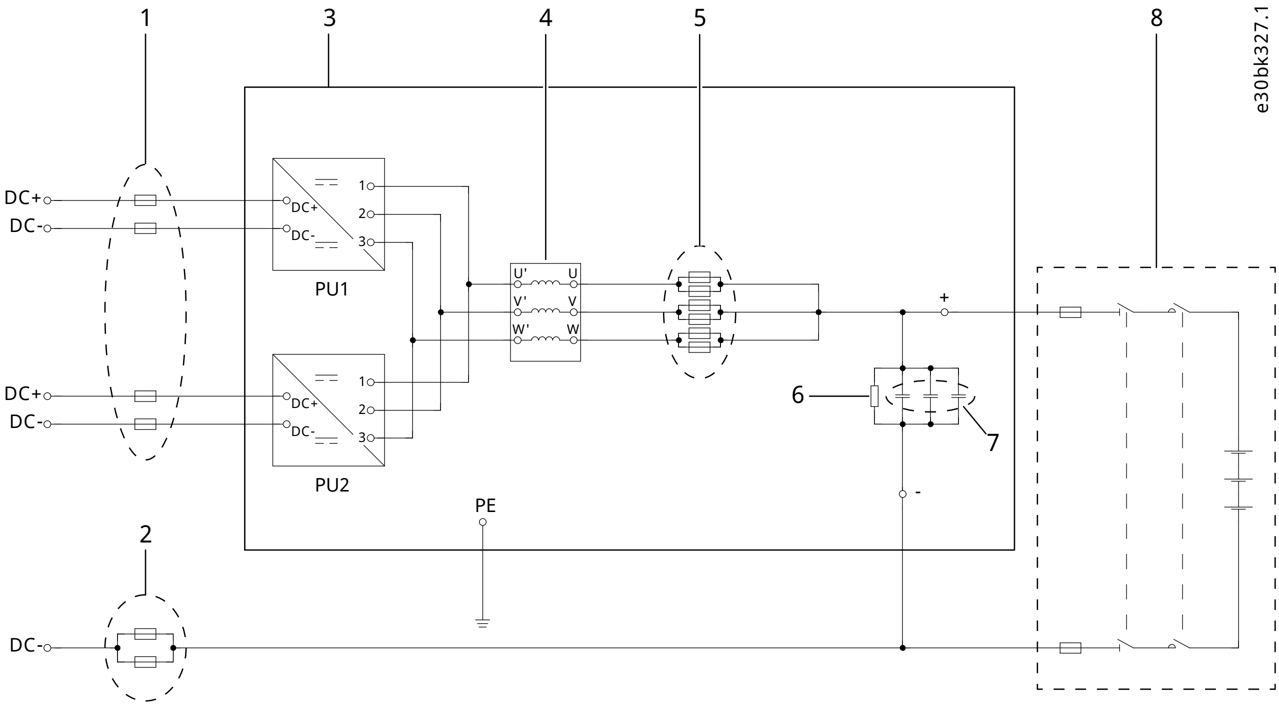
10.3.5 Wiring Diagram, DC/DC Converter, DR10L



1	DC-bus fuses, option	**2**	Source DC- fuses, option
3	DC/DC converter module DR10L	**4**	DC-filter inductor
5	Source DC+ fuses, option	**6**	Discharging resistor
7	Capacitors	**8**	DC source/load

Figure 162: Wiring Diagram, DR10L

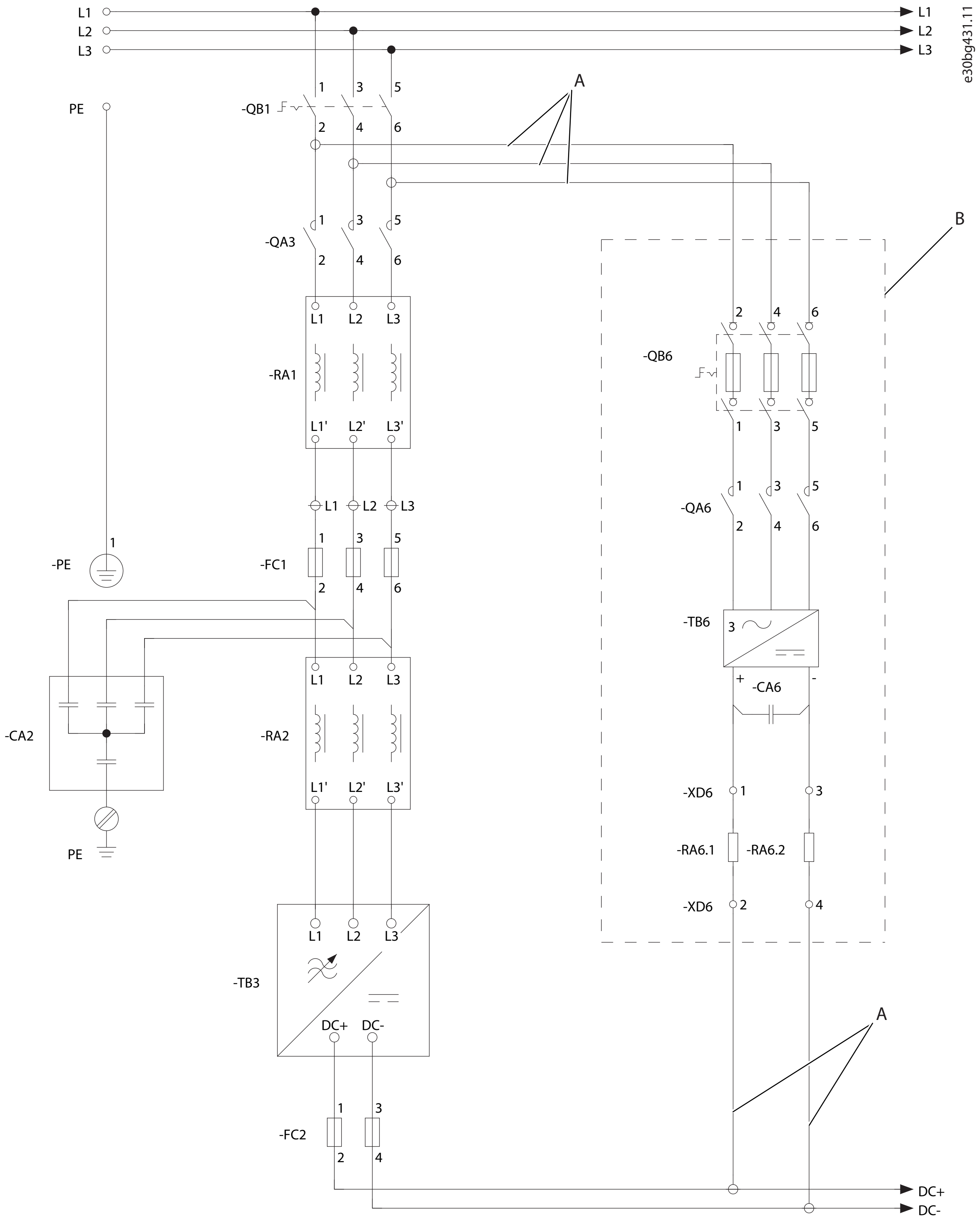
10.3.6 Wiring Diagram, DC/DC Converter, DR12L



1	DC-bus fuses, option	**2**	Source DC- fuses, option
3	DC/DC converter module DR12L	**4**	DC-filter inductor
5	Source DC+ fuses, option	**6**	Discharging resistor
7	Capacitors	**8**	DC source/load

Figure 163: Wiring Diagram, DR12L

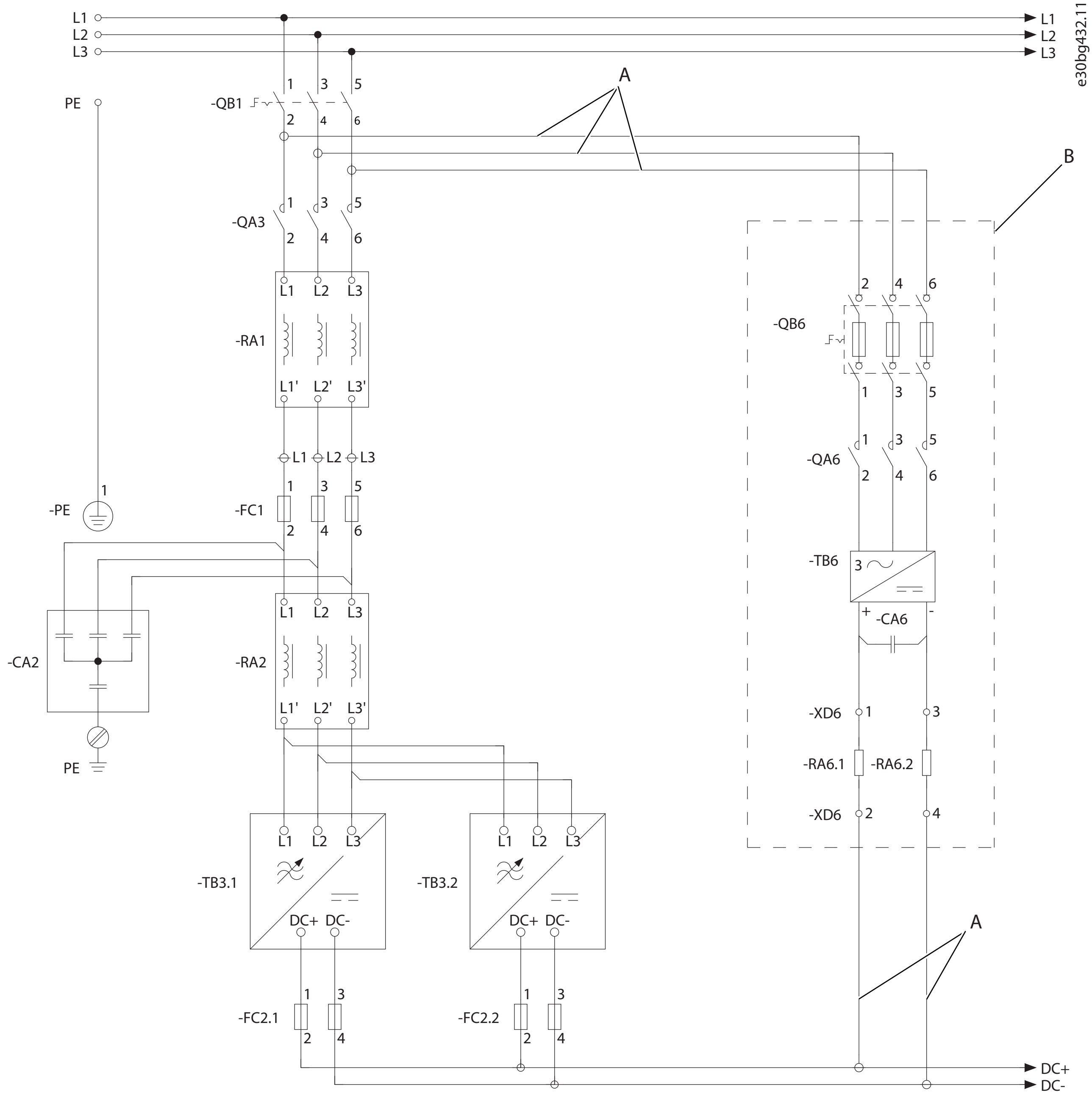
10.3.7 Pre-charging Circuit, AR10L



A	Double-insulated cable	**B**	Pre-charging circuit

Figure 164: Pre-charging Circuit Diagram, AR10L

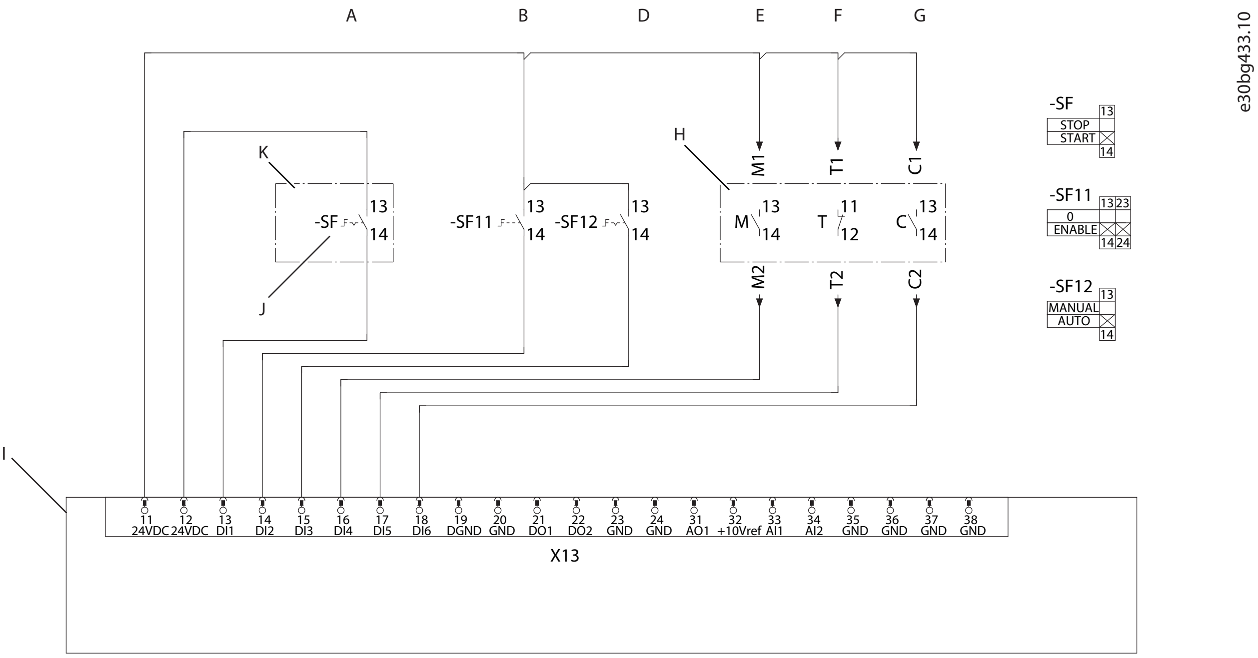
10.3.8 Pre-charging Circuit, AR12L



A	Double-insulated cable	**B**	Pre-charging circuit

Figure 165: Pre-charging Circuit Diagram, AR12L

10.3.9 Pre-charging Control Circuit



A	AFE or GC remote control start/stop	**B**	Mains 0-enable
D	Pre-charging man-auto	**E**	Main input device status
F	Main input device tripped (circuit breaker)	**G**	Cooling supervision
H	Status/supervision	**I**	I/O and Relay Option
J	AFE start/stop	**K**	Field connection

Figure 166: Pre-charging Control Circuit Diagram

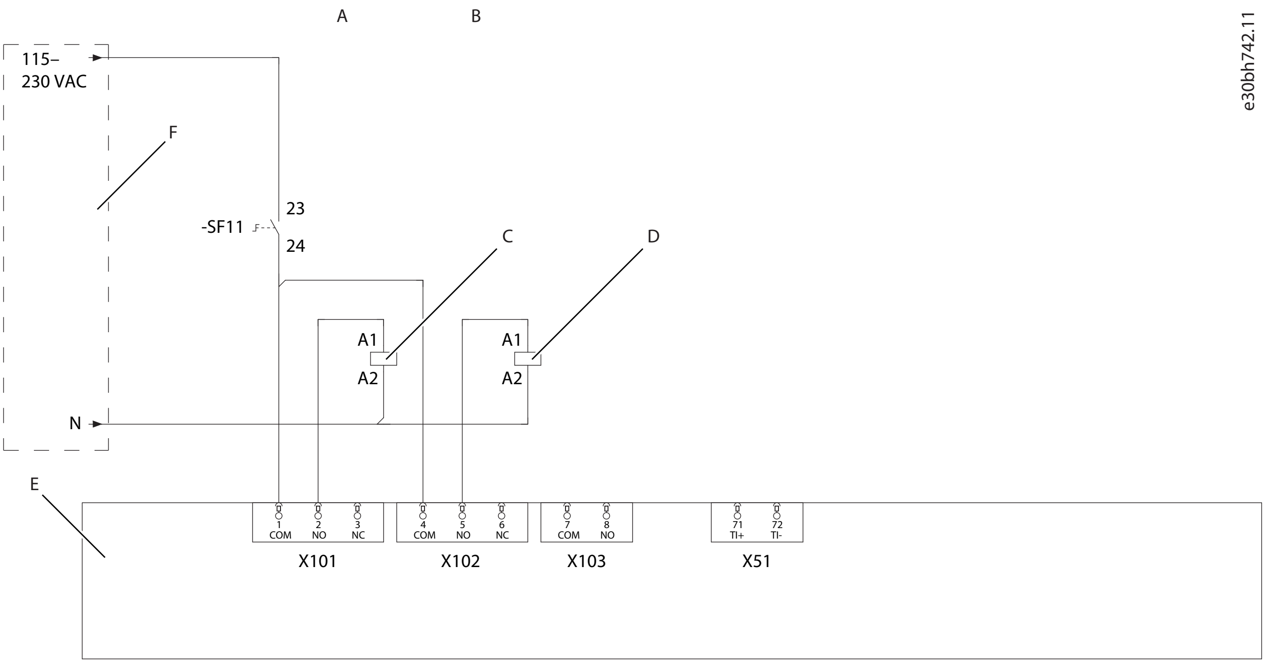


Figure 167: Pre-charging Control Circuit Diagram

A	Pre-charging contactor control	**B**	Main input device control
C	-QA6, Pre-charging contactor coil	**D**	-QA3, Mains contactor coil
E	I/O and Relay Option	**F**	Short-circuit protected supply

10.3.10 The Pre-charging Function

To avoid high inrush current to drive capacitors, pre-charge the drive before switching on main power.

The pre-charging function uses AFE or GC control unit I/Os and relays. The pre-charging function requires auxiliary voltage for the control unit and the pre-charging circuit. Pre-charging can be operated either locally (manually or automatically) or remotely (manually). Pre-charging is enabled by activating Digital Input 2. Select the MANUAL or AUTO mode by activating/deactivating Digital Input 3 (activated = AUTO). Select remote operation by activating Digital Input 1. Connect the input device, the contactor, or the circuit breaker, the auxiliary contacts to the control unit as described in Figure 166. Connect also the cooling supervision signal from the cooling module if possible. The charging circuit is protected by fuses installed in the fuse-switch disconnector. Turn the switch ON.

Manual operation

Enable pre-charging and switch it to MANUAL mode. Pre-charging starts by pressing the Run button on the control panel of the AFE or grid converter module. The pre-charging contactor closes. When charging is done, the main input device closes and the pre-charging contactor opens. Charging must be performed again after a power outage.

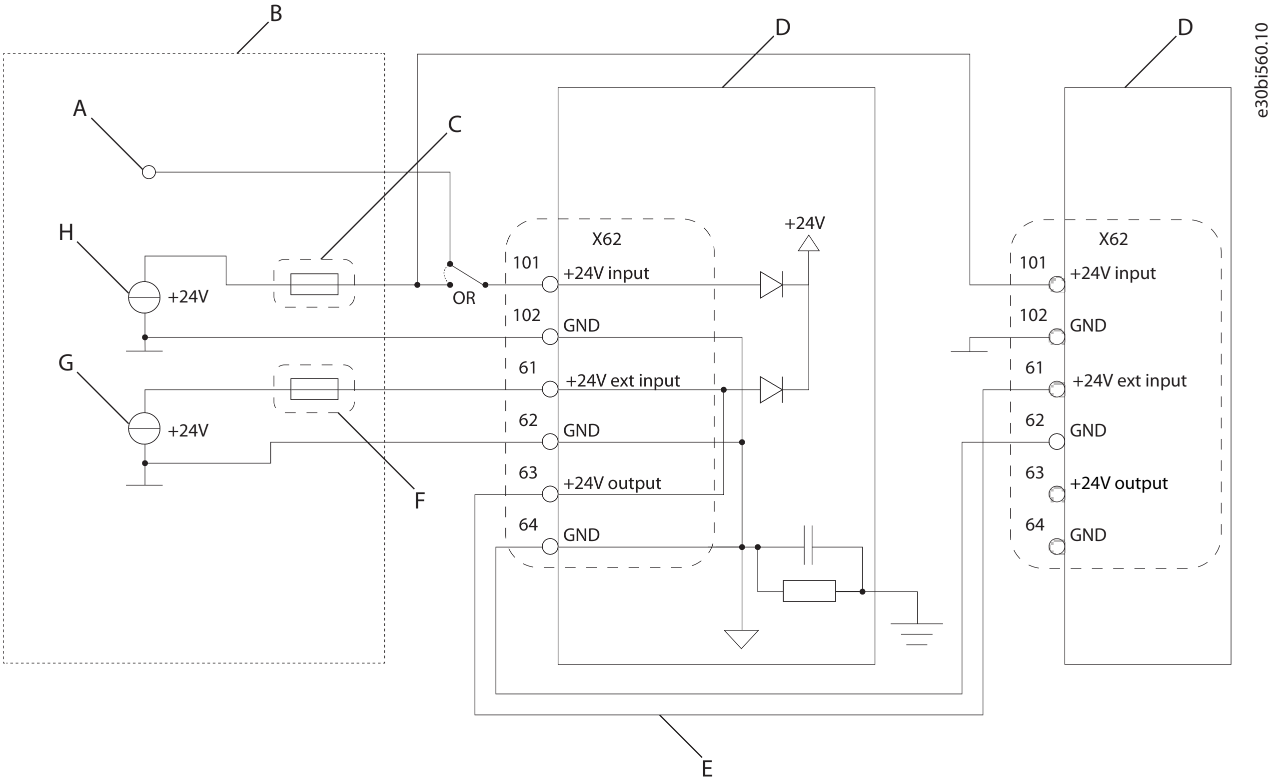
Auto operation

Enable pre-charging and switch it to AUTO mode. Pre-charging starts immediately. The pre-charging contactor closes. When charging is done, the main input device closes and the pre-charging contactor opens. Charging is performed automatically after a power outage.

Remote operation

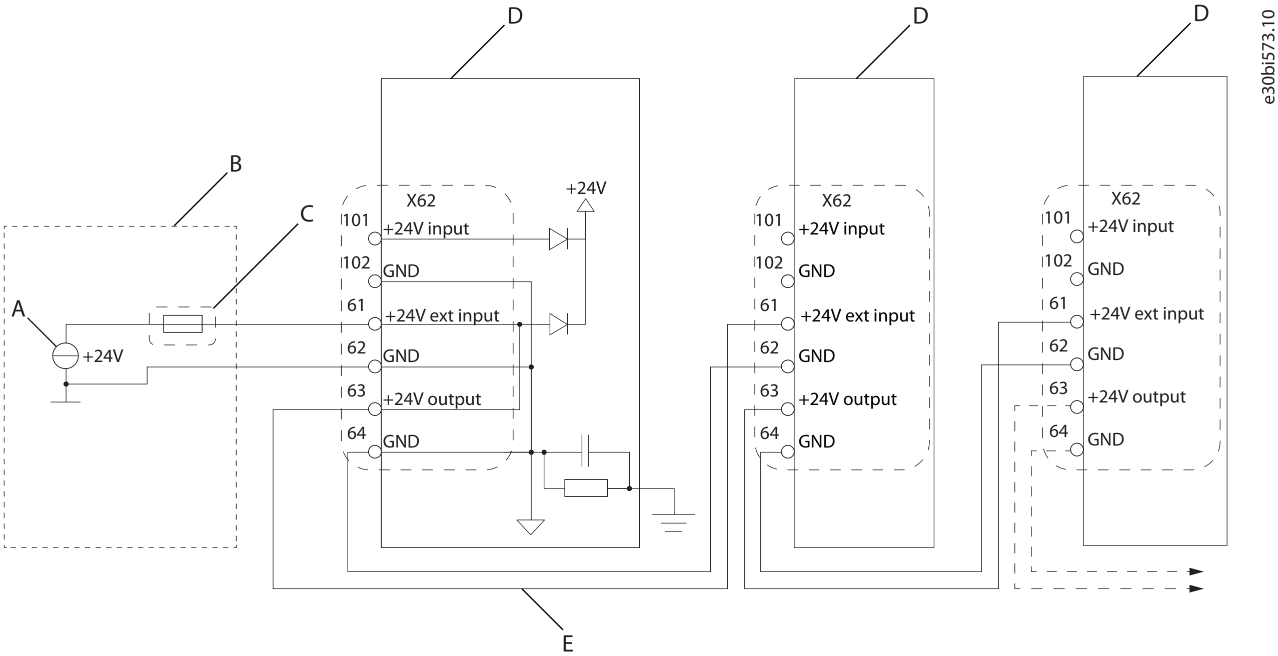
Enable pre-charging and set it to MANUAL mode. Pre-charging starts by activating Digital Input 1. The AFE or grid converter module starts and the pre-charging contactor closes. When charging is done, the main input device closes and the pre-charging contactor opens. Charging must be performed again after a power outage.

10.3.11 Wiring Diagrams of the +24 V Supply for the Control Unit



A	Internal +24 V supply (if provided)	**B**	Reference design, redundant +24 V power
C	3 A fuse	**D**	Control board
E	Power daisy-chaining	**F**	Fuse (Fuse rating depends on the complete daisychained system configuration. Maximum 10 A.)
G	Primary external supply	**H**	External redundant supply

Figure 168: Wiring Diagram of Redundant Supplies



A	Normal external supply	**B**	Reference design, daisy-chained +24 V power
C	Fuse (Fuse rating depends on the complete daisychained system configuration. Maximum 10 A.)	**D**	Control board
E	Power daisy-chaining		

Figure 169: Wiring Diagram of a Daisy-chained +24 V Supply for the Control Units

10.4 Cable Sizes

10.4.1 List of Cable Size Information

The cable sizing is based on the ambient temperature of 40 °C (104 °F), cables laid side by side on cable ladders, maximum 9 cables per ladder, and 3 ladders on top of each other. Use cable insulation that can withstand a temperature of at least 90 °C (194 °F). In other conditions, refer to the local safety regulations, the input voltage, and the load current of the drive.

The cable size tables for the liquid-cooled system modules can be found with these links.

- 10.4.2 Field Cable Sizes for AFE and GC Modules, 525–690 V AC
- 10.4.3 Internal Cable Sizes for AFE and GC Modules, 525–690 V AC
- 10.4.4 Field Cable Sizes for INU Module, 525–690 V AC
- 10.4.5 Marine Cable Sizes for AFE or GC Modules 525–690 V AC
- 10.4.7 Marine Cable Sizes for INU Modules 525–690 V AC
- 10.4.6 Source Cable Sizes for DC/DC Converter Modules, 640–1100 V DC and 640–1200 V DC

10.4.2 Field Cable Sizes for AFE and GC Modules, 525–690 V AC

The AFE and GC modules with integration units do not have field cabling terminals for mains. Connect the AFE and GC modules to adequate size field cabling terminals or switching device.

Table 45: Field Cable Sizes for AFE and GC Modules, 525–690 V AC

Model code	Frame (1)	I_N [A]	Cu [mm^2]	Al [mm^2]
iC7-60SLxx07-236AE00Fx	Ax10L	245	3x150+70	3x240+72
iC7-60SLxx07-300AE00Fx		310	3x240+120	2x(3x120+41)
iC7-60SLxx07-334AE00Fx		345	2x(3x95+50)	2x(3x150+41)
iC7-60SLxx07-380AE00Fx		390	2x(3x120+70)	2x(3x185+57)
iC7-60SLxx07-425AE00Fx	Ax12L	435	2x(3x120+70)	2x(3x185+57)
iC7-60SLxx07-475AE00Fx		490	2x(3x150+70)	2x(3x240+72)
iC7-60SLxx07-530AE00Fx		545	2x(3x185+70)	3x(3x150+41)
iC7-60SLxx07-595AE00Fx		610	2x(3x240+120)	3x(3x185+57)
iC7-60SLxx07-670AE00Fx		690	4x(3x120+70)	4x(3x150+41)
iC7-60SLxx07-760AE00Fx		770	4x(3x120+70)	4x(3x150+41)
iC7-60SLxx07-850AE00Fx	2 x Ax12L	870	4x(3x120+70)	4x(3x185+57)
iC7-60SLxx07-945AE00Fx		970	4x(3x150+70)	4x(3x240+72)
iC7-60SLxx07-1040E00Fx		1070	4x(3x185+95)	6x(3x150+41)
iC7-60SLxx07-1230E00Fx		1260	4x(3x240+120)	6x(3x185+57)
iC7-60SLxx07-1325E00Fx		1360	8x(3x120+70)	8x(3x150+41)
iC7-60SLxx07-1500E00Fx		1540	8x(3x120+70)	8x(3x150+41)
iC7-60SLxx07-1700E00Fx	3 x Ax12L	1740	6x(3x185+95)	9x(3x150+41)
iC7-60SLxx07-1800E00Fx		1840	6x(3x240+120)	9x(3x185+57)
iC7-60SLxx07-2000E00Fx		2050	6x(3x240+120)	9x(3x240+72)
iC7-60SLxx07-2250E00Fx		2300	12x(3x120+70)	9x(3x240+72)
iC7-60SLxx07-2500E00Fx	4 x Ax12L	2560	8x(3x240+120)	12x(3x185+57)
iC7-60SLxx07-2650E00Fx		2710	12x(3x150+70)	12x(3x240+72)
iC7-60SLxx07-2940E00Fx		3002	12x(3x150+70)	12x(3x240+72)
iC7-60SLxx07-3120E00Fx	5 x Ax12L	3190	10x(3x240+120)	15x(3x185+57)
iC7-60SLxx07-3600E00Fx		3680	15x(3x150+70)	15x(3x240+72)
iC7-60SLxx07-3900E00Fx	6 x Ax12L	3990	18x(3x150+70)	18x(3x240+72)
iC7-60SLxx07-4320E00Fx		4410	18x(3x150+70)	18x(3x240+72)
iC7-60SLxx07-4750E00Fx	7 x Ax12L	4850	21x(3x150+70)	21x(3x240+72)
iC7-60SLxx07-5040E00Fx		5150	21x(3x150+70)	21x(3x240+72)
iC7-60SLxx07-5400E00Fx	8 x Ax12L	5520	24x(3x150+70)	24x(3x240+72)
iC7-60SLxx07-5750E00Fx		5870	24x(3x150+70)	24x(3x240+72)

1) AM10L, AR10L, AM12L, or AR12L

10.4.3 Internal Cable Sizes for AFE and GC Modules, 525–690 V AC

Table 46: Bolt Sizes for the AFE and GC Modules

Frame(1)	Bolt size for internal cable or busbar	Number of grounding terminals/bolt size
Ax10L	M10	1/M8
Ax12L	M10	1/M8
2 x Ax12L	M10	2/M8
3 x Ax12L	M10	3/M8
4 x Ax12L	M10	4/M8
5 x Ax12L	M10	5/M8
6 x Ax12L	M10	6/M8
7 x Ax12L	M10	7/M8
8 x Ax12L	M10	8/M8

1) AM10L, AR10L, AM12L, or AR12L

10.4.4 Field Cable Sizes for INU Module, 525–690 V AC

Table 47: Field Cable Sizes for INU Module, 525–690 V AC

Model code	Frame(1)	I_N [A]	Motor cable Cu [mm^2]	Motor cable Al [mm^2]	Terminal max. cable size	Number of grounding terminals/ bolt size	Max. number of cables/ bolt size
iC7-60SLIN07-170E00Fx	Ix10L	215	3x120+70	3x185+57	300 Cu/Al	1/M8	2/M10
iC7-60SLIN07-261E00Fx		270	3x185+95	2x(3x95+29)	300 Cu/Al	1/M8	2/M10
iC7-60SLIN07-325E00Fx		335	3x240+120	2x(3x120+41)	300 Cu/Al	1/M8	2/M10
iC7-60SLIN07-365E00Fx		375	2x(3x95+50)	2x(3x150+41)	300 Cu/Al	1/M8	2/M10
iC7-60SLIN07-416E00Fx		425	2x(3x120+70)	2x(3x185+57)	300 Cu/Al	1/M8	2/M10
iC7-60SLIN07-465E00Fx	Ix12L	475	2x(3x150+70)	2x(3x240+72)	300 Cu/Al	1/M8	4/M10
iC7-60SLIN07-525E00Fx		535	2x(3x185+95)	3x(3x150+41)	300 Cu/Al	1/M8	4/M10
iC7-60SLIN07-590E00Fx		605	2x(3x240+120)	3x(3x185+57)	300 Cu/Al	1/M8	4/M10
iC7-60SLIN07-650E00Fx		665	2x(3x240+120)	3x(3x185+57)	300 Cu/Al	1/M8	4/M10
iC7-60SLIN07-730E00Fx		745	3x(3x150+70)	4x(3x150+41)	300 Cu/Al	1/M8	4/M10
iC7-60SLIN07-820E00Fx		840	4x(3x120+70)	4x(3x185+57)	300 Cu/Al	1/M8	4/M10

Table 47: Field Cable Sizes for INU Module, 525–690 V AC *(continued)*

Model code	Frame(1)	I_N [A]	Motor cable Cu [mm^2]	Motor cable Al [mm^2]	Terminal max. cable size	Number of grounding terminals/ bolt size	Max. number of cables/ bolt size
iC7-60SLIN07-945E00Fx	2 x Ix12L	965	4x(3x150+70)	4x(3x240+72)	300 Cu/Al	2/M8	8/M10
iC7-60SLIN07-1060E00Fx		1 090	4x(3x185+95)	6x(3x150+41)	300 Cu/Al	2/M8	8/M10
iC7-60SLIN07-1230E00Fx		1 260	4x(3x240+120)	6x(3x185+57)	300 Cu/Al	2/M8	8/M10
iC7-60SLIN07-1400E00Fx		1 430	4x(3x240+120)	8x(3x150+41)	300 Cu/Al	2/M8	8/M10
iC7-60SLIN07-1500E00Fx		1 540	8x(3x120+70)	8x(3x150+41)	300 Cu/Al	2/M8	8/M10
iC7-60SLIN07-1640E00Fx		1 680	8x(3x120+70)	8x(3x185+57)	300 Cu/Al	2/M8	8/M10
iC7-60SLIN07-1795E00Fx	3 x Ix12L	1 840	9x(3x120+70)	9x(3x185+57)	300 Cu/Al	3/M8	12/M10
iC7-60SLIN07-2080E00Fx		2 130	9x(3x150+70)	12x(3x150+41)	300 Cu/Al	3/M8	12/M10
iC7-60SLIN07-2300E00Fx		2 350	12x(3x120+70)	12x(3x150+41)	300 Cu/Al	3/M8	12/M10
iC7-60SLIN07-2460E00Fx		2 560	12x(3x120+70)	12x(3x185+57)	300 Cu/Al	3/M8	12/M10
iC7-60SLIN07-2830E00Fx	4 x Ix12L	2 890	12x(3x150+70)	16x(3x150+41)	300 Cu/Al	4/M8	16/M10
iC7-60SLIN07-3050E00Fx		3 120	16x(3x120+70)	16x(3x185+57)	300 Cu/Al	4/M8	16/M10
iC7-60SLIN07-3260E00Fx		3 330	16x(3x120+70)	16x(3x185+57)	300 Cu/Al	4/M8	16/M10
iC7-60SLIN07-3500E00Fx	5 x Ix12L	3 580	15x(3x150+70)	20x(3x150+41)	300 Cu/Al	5/M8	20/M10
iC7-60SLIN07-4035E00Fx		4 120	20x(3x120+70)	20x(3x185+57)	300 Cu/Al	5/M8	20/M10
iC7-60SLIN07-4400E00Fx	6 x Ix12L	4 500	18x(3x150+70)	24x(3x150+41)	300 Cu/Al	6/M8	24/M10
iC7-60SLIN07-4850E00Fx		4 960	24x(3x120+70)	24x(3x185+57)	300 Cu/Al	6/M8	24/M10

Table 47: Field Cable Sizes for INU Module, 525–690 V AC *(continued)*

Model code	Frame(1)	I_N [A]	Motor cable Cu [mm^2]	Motor cable Al [mm^2]	Terminal max. cable size	Number of grounding terminals/ bolt size	Max. number of cables/ bolt size
iC7-60SLIN07-5300E00Fx	7 x Ix12L	5 410	28x(3x120+70)	28x(3x150+41)	300 Cu/Al	7/M8	28/M10
iC7-60SLIN07-5600E00Fx		5 720	28x(3x120+70)	28x(3x185+57)	300 Cu/Al	7/M8	28/M10
iC7-60SLIN07-6100E00Fx	8 x Ix12L	6 230	32x(3x120+70)	32x(3x185+57)	300 Cu/Al	8/M8	32/M10
iC7-60SLIN07-6400E00Fx		6 540	32x(3x120+70)	32x(3x185+57)	300 Cu/Al	8/M8	32/M10

1) IM10L, IR10L, IM12L, or IR12L

10.4.5 Marine Cable Sizes for AFE or GC Modules 525–690 V AC

Table 48: Cable Sizes for AFE or GC Module 525–690 V AC for Marine Applications (Marine cables according to IEC 60092-352)

Model code	Frame(1)	I_N [A]	Mains cable Cu [mm^2]	Terminal max. cable size	Number of grounding terminals/ bolt size	Max. number of cables/ bolt size
iC7-60SLxx07-236AE00Fx	Ax10L	245	2x(3x70)	150 Cu/Al	1/M8	3/M8
iC7-60SLxx07-300AE00Fx		310	2x(3x95)	150 Cu/Al	1/M8	3/M8
iC7-60SLxx07-334AE00Fx		345	3x(3x70)	150 Cu/Al	1/M8	3/M8
iC7-60SLxx07-380AE00Fx		390	3x(3x95)	150 Cu/Al	1/M8	3/M8
iC7-60SLxx07-425AE00Fx	Ax12L	435	3x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLxx07-475AE00Fx		490	3x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLxx07-530AE00Fx		545	4x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLxx07-595AE00Fx		610	4x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLxx07-670AE00Fx		690	5x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLxx07-760AE00Fx		770	5x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLxx07-850AE00Fx	2 x Ax12L	870	6x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLxx07-945AE00Fx		970	6x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLxx07-1040E00Fx		1070	8x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLxx07-1230E00Fx		1260	8x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLxx07-1325E00Fx		1360	10x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLxx07-1500E00Fx		1540	10x(3x95)	150 Cu/Al	2/M8	12/M10

Table 48: Cable Sizes for AFE or GC Module 525–690 V AC for Marine Applications (Marine cables according to IEC 60092-352) ***(continued)***

Model code	Frame(1)	I_N [A]	Mains cable Cu [mm^2]	Terminal max. cable size	Number of grounding terminals/ bolt size	Max. number of cables/ bolt size
iC7-60SLxx07-1700E00Fx	3 x Ax12L	1740	12x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLxx07-1800E00Fx		1840	12x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLxx07-2000E00Fx		2050	12x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLxx07-2250E00Fx		2300	12x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLxx07-2500E00Fx	4 x Ax12L	2560	16x(3x95)	150 Cu/Al	4/M8	24/M10
iC7-60SLxx07-2650E00Fx		2710	20x(3x95)	150 Cu/Al	4/M8	24/M10
iC7-60SLxx07-2940E00Fx		3002	20x(3x95)	150 Cu/Al	4/M8	24/M10
iC7-60SLxx07-3120E00Fx	5 x Ax12L	3190	25x(3x95)	150 Cu/Al	5/M8	30/M10
iC7-60SLxx07-3600E00Fx		3680	25x(3x95)	150 Cu/Al	5/M8	30/M10
iC7-60SLxx07-3900E00Fx	6 x Ax12L	3990	30x(3x95)	150 Cu/Al	6/M8	36/M10
iC7-60SLxx07-4320E00Fx		4410	30x(3x95)	150 Cu/Al	6/M8	36/M10
iC7-60SLxx07-4750E00Fx	7 x Ax12L	4850	35x(3x95)	150 Cu/Al	7/M8	42/M10
iC7-60SLxx07-5040E00Fx		5150	35x(3x95)	150 Cu/Al	7/M8	42/M10
iC7-60SLxx07-5400E00Fx	8 x Ax12L	5520	40x(3x95)	150 Cu/Al	8/M8	48/M10
iC7-60SLxx07-5750E00Fx		5870	40x(3x95)	150 Cu/Al	8/M8	48/M10

1) AM10L, AR10L, AM12L, or AR12L

10.4.6 Source Cable Sizes for DC/DC Converter Modules, 640–1100 V DC and 640–1200 V DC

Ambient air temperature maximum 60 °C (140 °F). Cable insulation is rated for minimum 90 °C (194 °F).

Use symmetrical cabling with modules connected in parallel. Each module must have the same number of cables with equal cross-section.

Table 49: DC/DC Converter Module 640–1100 V DC and 640–1200 V DC Source Cable Sizes, IP00/Open Type.

Model code	Frame	Current (I_L) [A]	1-core cable Cu [mm^2]	3-core cable Cu [mm^2](1)	4-core cable Cu [mm^2](2)	Max. Number of terminals/ Bolt size
iC7-60SLDC07-300A	DR10L	300	3x(1x95)	2x(3x70)	1x(4x70)	4 / M10
iC7-60SLDC07-360A		360	3x(1x95)	2x(3x70)	1x(4x70)	
iC7-60SLDC07-420A		420	4x(1x95)	2x(3x95)	1x(4x95)	
iC7-60SLDC07-480A		480	4x(1x95)	2x(3x95)	1x(4x95)	
iC7-60SLDC07-570A		570	4x(1x120)	2x(3x120)	1x(4x120)	

Table 49: DC/DC Converter Module 640–1100 V DC and 640–1200 V DC Source Cable Sizes, IP00/Open Type. ***(continued)***

Model code	Frame	Current (I_L) [A]	1-core cable Cu [mm^2]	3-core cable Cu [mm^2](1)	4-core cable Cu [mm^2](2)	Max. Number of terminals/ Bolt size
iC7-60SLDC07-720A	DR12L	720	5x(1x95)	3x(3x95)	2x(4x70)	8 / M10
iC7-60SLDC07-840A		840	6x(1x95)	3x(3x95)	2x(4x70)	
iC7-60SLDC07-960A		960	7x(1x95)	3x(3x120)	2x(4x95)	
iC7-60SLDC07-1080		1080	7x(1x95)	3x(3x120)	2x(4x95)	
iC7-60SLDC07-1200		1200	8x(1x95)	4x(3x120)	2x(4x120)	
iC7-60SLDC07-1440	2 x DR12L	1440	10x(1x95)	6x(3x95)	4x(4x70)	16 / M10
iC7-60SLDC07-1680		1680	12x(1x95)	6x(3x95)	4x(4x70)	
iC7-60SLDC07-1920		1920	14x(1x95)	6x(3x120)	4x(4x95)	
iC7-60SLDC07-2160		2160	14x(1x95)	6x(3x120)	4x(4x95)	
iC7-60SLDC07-2400		2400	16x(1x95)	8x(3x120)	4x(4x120)	
iC7-60SLDC07-2880	3 x DR12L	2880	21x(1x95)	9x(3x120)	6x(4x95)	24 / M10
iC7-60SLDC07-3240		3240	21x(1x95)	9x(3x120)	6x(4x95)	
iC7-60SLDC07-3600		3600	24x(1x95)	12x(3x120)	6x(4x120)	
iC7-60SLDC07-3840	4 x DR12L	3840	28x(1x95)	12x(3x120)	8x(4x95)	32 / M10
iC7-60SLDC07-4320		4320	28x(1x95)	12x(3x120)	8x(4x95)	
iC7-60SLDC07-4800		4800	32x(1x95)	16x(3x120)	8x(4x120)	

1) 3-core cables: Use 2 conductors for 'plus' and 'minus', and a third conductor for PE.

2) 4-core cables: Use 2 conductors for 'plus' and 2 conductors for 'minus'.

10.4.7 Marine Cable Sizes for INU Modules 525–690 V AC

Table 50: Cable Sizes for INU Module 525–690 V AC for Marine Applications (Marine cables according to IEC 60092-352)

Model code	Frame(1)	$I_{N\ [A]}$	Motor cable Cu [mm^2]	Terminal max. cable size	Earth terminal	Max. number of cables/ bolt size
iC7-60SLIN07-170E00Fx	Ix10L	215	2x(3x70)	150 Cu/Al	1/M8	3/M8
iC7-60SLIN07-261E00Fx		270	2x(3x95)	150 Cu/Al	1/M8	3/M8
iC7-60SLIN07-325E00Fx		335	2x(3x95)	150 Cu/Al	1/M8	3/M8
iC7-60SLIN07-365E00Fx		375	3x(3x95)	150 Cu/Al	1/M8	3/M8
iC7-60SLIN07-416E00Fx		425	3x(3x95)	150 Cu/Al	1/M8	3/M8

Table 50: Cable Sizes for INU Module 525–690 V AC for Marine Applications (Marine cables according to IEC 60092-352) ***(continued)***

Model code	Frame[(1)]	$I_{N\,[A]}$	Motor cable Cu [mm^2]	Terminal max. cable size	Earth terminal	Max. number of cables/ bolt size
iC7-60SLIN07-465E00Fx	Ix12L	475	3x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLIN07-525E00Fx		535	4x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLIN07-590E00Fx		605	4x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLIN07-650E00Fx		665	4x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLIN07-730E00Fx		745	5x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLIN07-820E00Fx		840	5x(3x95)	150 Cu/Al	1/M8	6/M10
iC7-60SLIN07-945E00Fx	2 x Ix12L	965	6x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLIN07-1060E00Fx		1090	8x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLIN07-1230E00Fx		1260	8x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLIN07-1400E00Fx		1430	10x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLIN07-1500E00Fx		1540	10x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLIN07-1640E00Fx		1680	10x(3x95)	150 Cu/Al	2/M8	12/M10
iC7-60SLIN07-1795E00Fx	3 x Ix12L	1840	12x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLIN07-2080E00Fx		2130	15x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLIN07-2300E00Fx		2350	15x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLIN07-2460E00Fx		2560	18x(3x95)	150 Cu/Al	3/M8	18/M10
iC7-60SLIN07-2830E00Fx	4 x Ix12L	2890	20x(3x95)	150 Cu/Al	4/M8	24/M10
iC7-60SLIN07-3050E00Fx		3120	20x(3x95)	150 Cu/Al	4/M8	24/M10
iC7-60SLIN07-3260E00Fx		3330	20x(3x95)	150 Cu/Al	4/M8	24/M10
iC7-60SLIN07-3500E00Fx	5 x Ix12L	3580	25x(3x95)	150 Cu/Al	5/M8	30/M10
iC7-60SLIN07-4035E00Fx		4120	25x(3x95)	150 Cu/Al	5/M8	30/M10
iC7-60SLIN07-4400E00Fx	6 x Ix12L	4500	30x(3x95)	150 Cu/Al	6/M8	36/M10
iC7-60SLIN07-4850E00Fx		4960	30x(3x95)	150 Cu/Al	6/M8	36/M10
iC7-60SLIN07-5300E00Fx	7 x Ix12L	5410	35x(3x95)	150 Cu/Al	7/M8	42/M10
iC7-60SLIN07-5600E00Fx		5720	35x(3x95)	150 Cu/Al	7/M8	42/M10
iC7-60SLIN07-6100E00Fx	8 x Ix12L	6230	40x(3x95)	150 Cu/Al	8/M8	48/M10
iC7-60SLIN07-6400E00Fx		6540	40x(3x95)	150 Cu/Al	8/M8	48/M10

1) IM10L, IR10L, IM12L, or IR12L

10.4.7.1 Cable Sizes for DC-filter Capacitors

For connecting the minus terminal of the DC-filter capacitor to the DC bus, use copper cable or single wire with at least 1100 V DC voltage, and 90 °C (194 °F) temperature rating. See also the iC7 Series Liquid-cooled System Modules Installation Guide.

Minimum cable sizes

- DR10L: 16 mm^2 (AWG 6)
- DR12L: 35 mm^2 (AWG 2)

The terminal size is M6.

10.5 Fuses

10.5.1 List of Fuse Size Information

This topic lists the links to find the fuse size tables for the system modules.

- 10.5.2 AC Fuses for AFE or GC 525–690 V AC, IP00/Open Type
- 10.5.3 DC Fuses for AFE or GC 640–1200 V DC, IP00/Open Type
- 10.5.4 DC Fuses for INU 640–1200 V DC, IP00/Open Type
- 10.5.5 DC-bus Fuses for DC/DC Converter, IP00/Open Type
- 10.5.6 Source DC+ Fuses for DC/DC Converter, IP00/Open Type
- 10.5.7 Source DC- Fuses for DC/DC Converter, IP00/Open Type

Table 51: Abbreviations Used in the Fuse Tables

Abbreviation	Description
$I_{cp, mr}$	Minimum required prospective short-circuit current at 5 ms pre-arcing time. If there is a short-circuit fault in the common DC bus, a multiplied $I_{cp, mr}$ value is required.
I_L	Nominal current of the drive with low overload (110%). Allows a +10% load variation for 1 minute every 5 minutes.
I_N	Nominal current of the fuse.
U_N	Nominal voltage of the fuse.

10.5.2 AC Fuses for AFE or GC 525–690 V AC, IP00/Open Type

Table 52: AC Fuses for AFE or GC 525–690 V AC, IP00/Open Type

Model code(1)	Frame	Rated current I_L[A]	Number of fuses	Fuse size	Part number	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLxx0x-236AE00Fx	Ax10L	236	6	31	PC31UD69V250TF	690	250	2900
iC7-60SLxx0x-261AE00Fx(2)		261						
iC7-60SLxx0x-300AE00Fx		300						
iC7-60SLxx0x-325AE00Fx(2)		325			PC31UD69V315TF	690	315	3600
iC7-60SLxx0x-334AE00Fx		334						
iC7-60SLxx0x-380AE00Fx		380						

Table 52: AC Fuses for AFE or GC 525–690 V AC, IP00/Open Type *(continued)*

Model code[1]	Frame	Rated current I_L[A]	Number of fuses	Fuse size	Part number	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLxx0x-425AE00Fx	Ax12L	425	3	44	PC44UD75V12CTQ	750	1200	7200
iC7-60SLxx0x-475AE00Fx		475						
iC7-60SLxx0x-530AE00Fx		530						
iC7-60SLxx0x-595AE00Fx		595						
iC7-60SLxx0x-670AE00Fx		670						
iC7-60SLxx0x-760AE00Fx		760						
iC7-60SLxx0x-850AE00Fx	2 x Ax12L	850	6	44	PC44UD75V12CTQ	750	1200	2x7200
iC7-60SLxx0x-945AE00Fx		945						
iC7-60SLxx0x-1040E00Fx		1040						
iC7-60SLxx0x-1230E00Fx		1230						
iC7-60SLxx0x-1325E00Fx		1325						
iC7-60SLxx0x-1500E00Fx		1500						
iC7-60SLxx0x-1700E00Fx	3 x Ax12L	1700	9	44	PC44UD75V12CTQ	750	1200	3x7200
iC7-60SLxx0x-1800E00Fx		1800						
iC7-60SLxx0x-2000E00Fx		2000						
iC7-60SLxx0x-2250E00Fx		2250						
iC7-60SLxx0x-2500E00Fx	4 x Ax12L	2500	12	44	PC44UD75V12CTQ	750	1200	4x7200
iC7-60SLxx0x-2650E00Fx		2650						
iC7-60SLxx0x-2940E00Fx		2940						
iC7-60SLxx0x-3120E00Fx	5 x Ax12L	3120	15	44	PC44UD75V12CTQ	750	1200	5x7200
iC7-60SLxx0x-3600E00Fx		3600						
iC7-60SLxx0x-3900E00Fx	6 x Ax12L	3900	18	44	PC44UD75V12CTQ	750	1200	6x7200
iC7-60SLxx0x-4320E00Fx		4320						
iC7-60SLxx0x-4750E00Fx	7 x Ax12L	4750	21	44	PC44UD75V12CTQ	750	1200	7x7200
iC7-60SLxx0x-5040E00Fx		5040						
iC7-60SLxx0x-5400E00Fx	8 x Ax12L	5400	24	44	PC44UD75V12CTQ	750	1200	8x7200
iC7-60SLxx0x-5750E00Fx		5750						

1) For example, iC7-60SL3A07-236AE00F4

2) Only for B5 voltage class

10.5.3 DC Fuses for AFE or GC 640–1200 V DC, IP00/Open Type

Table 53: DC Fuses for AFE or GC 640–1200 V DC, IP00/Open Type

Model code(1)	Frame	Rated current I_L [A]	Number of fuses	Fuse size	Part number	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SL3A0x-236AE00Fx	Ax10L	236	2	73	PC73UD13C800TF	1250	800	8900
iC7-60SL3A0x-300AE00Fx		300						
iC7-60SL3A0x-334AE00Fx		334			PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-380AE00Fx		380						
iC7-60SL3A0x-425AE00Fx	Ax12L	425	4	73	PC73UD13C800TF	1250	800	8900
iC7-60SL3A0x-475AE00Fx		475						
iC7-60SL3A0x-530AE00Fx		530						
iC7-60SL3A0x-595AE00Fx		595						
iC7-60SL3A0x-670AE00Fx		670			PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-760AE00Fx		760						
iC7-60SL3A0x-850AE00Fx	2 x Ax12L	850	8	73	PC73UD13C800TF	1250	800	8900
iC7-60SL3A0x-945AE00Fx		945						
iC7-60SL3A0x-1040E00Fx		1040						
iC7-60SL3A0x-1230E00Fx		1230			PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-1325E00Fx		1325						
iC7-60SL3A0x-1500E00Fx		1500						
iC7-60SL3A0x-1700E00Fx	3 x Ax12L	1700	12	73	PC73UD13C800TF	1250	800	8900
iC7-60SL3A0x-1800E00Fx		1800			PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-2000E00Fx		2000						
iC7-60SL3A0x-2250E00Fx		2250						
iC7-60SL3A0x-2500E00Fx	4 x Ax12L	2500	16	73	PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-2650E00Fx		2650						
iC7-60SL3A0x-2940E00Fx		2940						
iC7-60SL3A0x-3120E00Fx	5 x Ax12L	3120	20	73	PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-3600E00Fx		3600						
iC7-60SL3A0x-3900E00Fx	6 x Ax12L	3900	24	73	PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-4320E00Fx		4320						
iC7-60SL3A0x-4750E00Fx	7 x Ax12L	4750	28	73	PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-5040E00Fx		5040						

Table 53: DC Fuses for AFE or GC 640–1200 V DC, IP00/Open Type ***(continued)***

Model code(1)	Frame	Rated current I_L [A]	Number of fuses	Fuse size	Part number	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SL3A0x-5400E00Fx	8 x Ax12L	5400	32	73	PC73UD12C900TF	1200	900	10200
iC7-60SL3A0x-5750E00Fx		5750						

1) For example, iC7-60SL3A07-236AE00F4

10.5.4 DC Fuses for INU 640–1200 V DC, IP00/Open Type

Table 54: DC Fuses for INU 640–1200 V DC, IP00/Open Type

Model code(1)	Frame	Rated current I_L [A]	Number of fuses	Fuse size	Part number	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLIN0x-170AE00Fx	Ix10L	170	2	73	PC73UD13C630TF	1250	630	5900
iC7-60SLIN0x-206AE00Fx(2)		206						
iC7-60SLIN0x-208AE00Fx		208						
iC7-60SLIN0x-245AE00Fx(2)		245			PC73UD13C800TF		800	8900
iC7-60SLIN0x-261AE00Fx		261						
iC7-60SLIN0x-302AE00Fx(2)		302						
iC7-60SLIN0x-325AE00Fx		325						
iC7-60SLIN0x-365AE00Fx		365			PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-385AE00Fx(2)		385						
iC7-60SLIN0x-416AE00Fx		416						
iC7-60SLIN0x-465AE00Fx	Ix12L	465	4	73	PC73UD13C800TF	1250	800	8900
iC7-60SLIN0x-525AE00Fx		525						
iC7-60SLIN0x-590AE00Fx		590						
iC7-60SLIN0x-650AE00Fx		650						
iC7-60SLIN0x-730AE00Fx		730			PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-820AE00Fx		820						
iC7-60SLIN0x-945AE00Fx	2 x Ix12L	945	8	73	PC73UD13C800TF	1250	800	8900
iC7-60SLIN0x-1060E00Fx		1060						
iC7-60SLIN0x-1230E00Fx		1230						
iC7-60SLIN0x-1400E00Fx		1400			PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-1500E00Fx		1500						
iC7-60SLIN0x-1640E00Fx		1640						

Table 54: DC Fuses for INU 640–1200 V DC, IP00/Open Type *(continued)*

Model code[1]	Frame	Rated current I_L [A]	Number of fuses	Fuse size	Part number	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLIN0x-1795E00Fx	3 x Ix12L	1795	12	73	PC73UD13C800TF	1250	800	8900
iC7-60SLIN0x-2080E00Fx		2080			PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-2300E00Fx		2300						
iC7-60SLIN0x-2500E00Fx		2500						
iC7-60SLIN0x-2830E00Fx	4 x Ix12L	2830	16	73	PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-3050E00Fx		3050						
iC7-60SLIN0x-3260E00Fx		3260						
iC7-60SLIN0x-3500E00Fx	5 x Ix12L	3500	20	73	PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-4035E00Fx		4035						
iC7-60SLIN0x-4400E00Fx	6 x Ix12L	4400	24	73	PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-4850E00Fx		4850						
iC7-60SLIN0x-5300E00Fx	7 x Ix12L	5300	28	73	PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-5600E00Fx		5600						
iC7-60SLIN0x-6100E00Fx	8 x Ix12L	6100	32	73	PC73UD12C900TF	1200	900	10200
iC7-60SLIN0x-6400E00Fx		6400						

1) For example, iC7-60SLIN07-140AE00F4

2) Only for B5 voltage class

10.5.5 DC-bus Fuses for DC/DC Converter, IP00/Open Type

Table 55: DC-bus Fuses for DC/DC Converter, Voltage Classes B5 and 07, IP00/Open Type

Model code[1]	Frame	Rated current (I_L) [A]	Number of fuses	Fuse size	Part number (Mersen)	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLDCxx-300AE00F4	DR10L	300	2	73	PC73UD13C630TF	1250	630	5900
iC7-60SLDCxx-360AE00F4		360	2					
iC7-60SLDCxx-420AE00F4		420	2	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-480AE00F4		480	2	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-570AE00F4		570	2	73	PC73UD12C900TF	1200	900	10200

Table 55: DC-bus Fuses for DC/DC Converter, Voltage Classes B5 and 07, IP00/Open Type ***(continued)***

Model code[1]	Frame	Rated current (I_L) [A]	Number of fuses	Fuse size	Part number (Mersen)	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLDCxx-720AE00F4	DR12L	720	4	73	PC73UD13C630TF	1250	630	5900
iC7-60SLDCxx-840AE00F4		840	4	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-960AE00F4		960	4					
iC7-60SLDCxx-1080E00F4		1080	4	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-1200E00F4		1200	4					
iC7-60SLDCxx-1440E00F4	2 x DR12L	1440	8	73	PC73UD13C630TF	1250	630	5900
iC7-60SLDCxx-1680E00F4		1680	8	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-1920E00F4		1920	8					
iC7-60SLDCxx-2160E00F4		2160	8	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-2400E00F4		2400	8					
iC7-60SLDCxx-2880E00F4	3 x DR12L	2880	12	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-3240E00F4		3240	12	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-3600E00F4		3600	12					

1) xx = B5 or 07

10.5.6 Source DC+ Fuses for DC/DC Converter, IP00/Open Type

Table 56: Source DC+ Fuses for DC/DC Converter, Voltage Classes B5 and 07, IP00/Open Type

Model code[1]	Frame	Rated current (I_L) [A]	Number of fuses	Fuse size	Part number (Mersen)	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLDCxx-300AE00F4	DR10L	300	3	72	D72SG120V250QF	1200	250	1600
iC7-60SLDCxx-360AE00F4		360	3					
iC7-60SLDCxx-420AE00F4		420	3					
iC7-60SLDCxx-480AE00F4		480	3	72	D72SG120V315QF	1200	315	2200
iC7-60SLDCxx-570AE00F4		570	3					
iC7-60SLDCxx-720AE00F4	DR12L	720	3	272	D272SG120V500QF	1200	500	3100
iC7-60SLDCxx-840AE00F4		840	3					
iC7-60SLDCxx-960AE00F4		960	3					
iC7-60SLDCxx-1080E00F4		1080	3	272	D272SG120V630QF	1200	630	4400
iC7-60SLDCxx-1200E00F4		1200	3					

Table 56: Source DC+ Fuses for DC/DC Converter, Voltage Classes B5 and 07, IP00/Open Type *(continued)*

Model code[(1)]	Frame	Rated current (I_L) [A]	Number of fuses	Fuse size	Part number (Mersen)	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLDCxx-1440E00F4	2 x DR12L	1440	6	272	D272SG120V500QF	1200	500	2x3100
iC7-60SLDCxx-1680E00F4		1680	6					
iC7-60SLDCxx-1920E00F4		1920	6					
iC7-60SLDCxx-2160E00F4		2160	6	272	D272SG120V630QF	1200	630	2x4400
iC7-60SLDCxx-2400E00F4		2400	6					
iC7-60SLDCxx-2880E00F4	3 x DR12L	2880	9	272	D272SG120V500QF	1200	500	3x3100
iC7-60SLDCxx-3240E00F4		3240	9	272	D272SG120V630QF	1200	630	3x4400
iC7-60SLDCxx-3600E00F4		3600	9					

1) xx = B5 or 07

10.5.7 Source DC- Fuses for DC/DC Converter, IP00/Open Type

Table 57: Source DC- Fuses for DC/DC Converter, Voltage Classes B5 and 07, IP00/Open Type

Model code[(1)]	Frame	Rated current (I_L) [A]	Number of fuses	Fuse size	Part number (Mersen)	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLDCxx-300AE00F4	DR10L	300	1	73	PC73UD13C630TF	1250	630	5900
iC7-60SLDCxx-360AE00F4		360	1					
iC7-60SLDCxx-420AE00F4		420	1	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-480AE00F4		480	1	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-570AE00F4		570	1	73				
iC7-60SLDCxx-720AE00F4	DR12L	720	2	73	PC73UD13C630TF	1250	630	5900
iC7-60SLDCxx-840AE00F4		840	2	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-960AE00F4		960	2					
iC7-60SLDCxx-1080E00F4		1080	2	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-1200E00F4		1200	2					
iC7-60SLDCxx-1440E00F4	2 x DR12L	1440	4	73	PC73UD13C630TF	1250	630	5900
iC7-60SLDCxx-1680E00F4		1680	4	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-1920E00F4		1920	4					
iC7-60SLDCxx-2160E00F4		2160	4	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-2400E00F4		2400	4					

Table 57: Source DC- Fuses for DC/DC Converter, Voltage Classes B5 and 07, IP00/Open Type *(continued)*

Model code[(1)]	Frame	Rated current (I_L) [A]	Number of fuses	Fuse size	Part number (Mersen)	Fuse U_n [V]	Fuse I_n [A]	$I_{cp, mr}$ [A]
iC7-60SLDCxx-2880E00F4	3 x DR12L	2880	6	73	PC73UD13C800TF	1250	800	8900
iC7-60SLDCxx-3240E00F4		3240	6	73	PC73UD12C900TF	1200	900	10200
iC7-60SLDCxx-3600E00F4		3600	6					

1) xx = B5 or 07

10.6 Current Ratings

10.6.1 List of Current Rating Information

The current rating tables show the ratings of the system modules at relevant voltage ratings. The current rating tables for the different products can be found with these links.

- 10.6.2 Current Ratings for AFE 525–690 V AC (640–1100 V DC), IP00/Open Type
- 10.6.3 Current Ratings for AFE 380–500 V AC (465–800 V DC), IP00/Open Type
- 10.6.4 Current Ratings for GC 525–690 V AC (640–1100 V DC), IP00/Open Type
- 10.6.5 Current Ratings for GC 380–500 V AC (465–800 V DC), IP00/Open Type
- 10.6.6 Current Ratings for INU 525–690 V AC (640–1100 V DC), IP00/Open Type
- 10.6.7 Current Ratings for INU 380–500 V AC (465–800 V DC), IP00/Open Type
- 10.6.8 Current Ratings for DC/DC Converter 640–1100 V DC-bus Voltage, IP00/Open Type
- 10.6.9 Current Ratings for DC/DC Converter 465–800 V DC-bus Voltage, IP00/Open Type

Table 58: Abbreviations Used in the Rating Tables

Abbreviation	Description
I_N	Nominal current. If the process does not require any overloadability or the process does not include any load variation or margin for overloadability, the dimensioning can be done according to this current.
I_L	Nominal current with low overload (110%). Allows a +10% load variation for 1 minute every 5 minutes.
I_H	Nominal current with high overload (150%). Allows a +50% load variation for 1 minute every 5 minutes.
I_{peak}	Start current. Available for 3 s at start, then as long as the system module temperature allows. Relevant for inverter modules.
I_{S1}	Short-term current injection available for 1 s. Applicable for the grid converter control mode in grid forming in the event of short-circuit current feed.
I_{S2}	Short-term current injection available for 0.5 s. Applicable for the grid converter in the grid forming control mode in the event of short-circuit current feed.

Table 58: Abbreviations Used in the Rating Tables *(continued)*

Abbreviation	Description
P_L	Output power, low overload (INU: motor power, AFE/GC: DC power)
P_H	Output power, high overload (INU: motor power, AFE/GC: DC power)
S_L	Apparent power, low overload

10.6.2 Current Ratings for AFE 525–690 V AC (640–1100 V DC), IP00/Open Type

Table 59: Current Ratings for Active Front-end Module, 525–690 V AC (640–1100 V DC)

Model code	AC current			DC power, 690 V AC mains(1)		Frame	Frame with option +AEZ1 or +AEZ3(2)	Input L Filter size [A](3)
	I_N[A]	I_L[A]	I_H[A]	P_L[kW]	P_H[kW]			
iC7-60SL3A07-236AE00F4	241	236	177	277	208	AM10L	AR10L	400
iC7-60SL3A07-300AE00F4	307	300	225	352	264	AM10L	AR10L	400
iC7-60SL3A07-334AE00F4	341	334	250	392	293	AM10L	AR10L	400
iC7-60SL3A07-380AE00F4	388	380	285	446	334	AM10L	AR10L	400
iC7-60SL3A07-425AE00F4	434	425	318	498	373	AM12L	AR12L	1000
iC7-60SL3A07-475AE00F4	485	475	356	557	417	AM12L	AR12L	1000
iC7-60SL3A07-530AE00F4	542	530	397	621	465	AM12L	AR12L	1000
iC7-60SL3A07-595AE00F4	608	595	446	697	523	AM12L	AR12L	1000
iC7-60SL3A07-670AE00F4	684	670	502	785	588	AM12L	AR12L	1000
iC7-60SL3A07-760AE00F4	776	760	562	891	668	AM12L	AR12L	1000
iC7-60SL3A07-850AE00F4	868	850	637	996	747	2 x AM12L	2 x AR12L	1640
iC7-60SL3A07-945AE00F4	965	945	708	1107	830	2 x AM12L	2 x AR12L	1640
iC7-60SL3A07-1040E00F4	1062	1040	780	1219	914	2 x AM12L	2 x AR12L	1640
iC7-60SL3A07-1230E00F4	1256	1230	922	1441	1080	2 x AM12L	2 x AR12L	1640
iC7-60SL3A07-1325E00F4	1353	1325	993	1552	1164	2 x AM12L	2 x AR12L	1640
iC7-60SL3A07-1500E00F4	1532	1500	1125	1757	1318	2 x AM12L	2 x AR12L	1640
iC7-60SL3A07-1700E00F4	1736	1700	1275	1992	1494	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3A07-1800E00F4	1838	1800	1350	2109	1582	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3A07-2000E00F4	2042	2000	1500	2343	1757	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3A07-2250E00F4	2297	2250	1687	2636	1976	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3A07-2500E00F4	2552	2500	1875	2929	2197	4 x AM12L	4 x AR12L	2 x 1640

Table 59: Current Ratings for Active Front-end Module, 525–690 V AC (640–1100 V DC) ***(continued)***

Model code	AC current			DC power, 690 V AC mains[1]		Frame	Frame with option +AEZ1 or +AEZ3[2]	Input L Filter size [A][3]
	I_N[A]	I_L[A]	I_H[A]	P_L[kW]	P_H[kW]			
iC7-60SL3A07-2650E00F4	2706	2650	1987	3104	2328	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SL3A07-2940E00F4	3002	2940	2205	3444	2583	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SL3A07-3120E00F4	3185	3120	2340	3655	2741	5 x AM12L	5 x AR12L	3 x 1640
iC7-60SL3A07-3600E00F4	3675	3600	2700	4217	3163	5 x AM12L	5 x AR12L	3 x 1640
iC7-60SL3A07-3900E00F4	3982	3900	2925	4568	3426	6 x AM12L	6 x AR12L	3 x 1640
iC7-60SL3A07-4320E00F4	4410	4320	3240	5060	3795	6 x AM12L	6 x AR12L	3 x 1640
iC7-60SL3A07-4750E00F4	4849	4750	3562	5564	4172	7 x AM12L	7 x AR12L	4 x 1640
iC7-60SL3A07-5040E00F4	5145	5040	3780	5903	4428	7 x AM12L	7 x AR12L	4 x 1640
iC7-60SL3A07-5400E00F4	5513	5400	4050	6325	4744	8 x AM12L	8 x AR12L	4 x 1640
iC7-60SL3A07-5750E00F4	5870	5750	4312	6735	5051	8 x AM12L	8 x AR12L	4 x 1640

1) cos φ = 1.00, efficiency = 98.0%, values calculated at 1025 V DC

2) LC Filter +AEZ1, LCL Filter +AEZ3 (grid side L Filter separate module)

3) Part of LCL Filter, +AEZ3

10.6.3 Current Ratings for AFE 380–500 V AC (465–800 V DC), IP00/Open Type

Table 60: Current Ratings for Active Front-end Module, 380–500 V AC (465–800 V DC)

Model code[1]	AC current			DC power, 500 V AC mains[2]		Frame	Frame with option +AEZ1 or +AEZ3[3]	Input L Filter size [A][4]
	I_N[A]	I_L[A]	I_H[A]	P_L[kW]	P_H[kW]			
iC7-60SL3AB5-261AE00F4	267	261	196	222	167	AM10L	AR10L	400
iC7-60SL3AB5-325AE00F4	332	325	244	276	208	AM10L	AR10L	400
iC7-60SL3AB5-380AE00F4	388	380	285	323	242	AM10L	AR10L	400
iC7-60SL3AB5-425AE00F4	434	425	318	361	270	AM12L	AR12L	1000
iC7-60SL3AB5-475AE00F4	485	475	356	404	303	AM12L	AR12L	1000
iC7-60SL3AB5-530AE00F4	542	530	397	450	337	AM12L	AR12L	1000
iC7-60SL3AB5-595AE00F4	608	595	446	505	379	AM12L	AR12L	1000
iC7-60SL3AB5-670AE00F4	684	670	502	569	427	AM12L	AR12L	1000
iC7-60SL3AB5-760AE00F4	776	760	570	646	484	AM12L	AR12L	1000
iC7-60SL3AB5-850AE00F4	868	850	637	722	541	2 x AM12L	2 x AR12L	1640
iC7-60SL3AB5-945AE00F4	965	945	708	803	601	2 x AM12L	2 x AR12L	1640
iC7-60SL3AB5-1040E00F4	1062	1040	780	883	662	2 x AM12L	2 x AR12L	1640

Table 60: Current Ratings for Active Front-end Module, 380–500 V AC (465–800 V DC) *(continued)*

Model code(1)	AC current			DC power, 500 V AC mains(2)		Frame	Frame with option +AEZ1 or +AEZ3(3)	Input L Filter size [A](4)
	I_N[A]	I_L[A]	I_H[A]	P_L[kW]	P_H[kW]			
iC7-60SL3AB5-1230E00F4	1256	1230	922	1044	783	2 x AM12L	2 x AR12L	1640
iC7-60SL3AB5-1325E00F4	1353	1325	993	1125	843	2 x AM12L	2 x AR12L	1640
iC7-60SL3AB5-1500E00F4	1532	1500	1125	1274	955	2 x AM12L	2 x AR12L	1640
iC7-60SL3AB5-1700E00F4	1736	1700	1275	1443	1083	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3AB5-1800E00F4	1838	1800	1350	1528	1146	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3AB5-2000E00F4	2042	2000	1500	1698	1274	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3AB5-2250E00F4	2297	2250	1687	1910	1432	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SL3AB5-2500E00F4	2552	2500	1875	2122	1592	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SL3AB5-2650E00F4	2706	2650	1987	2250	1687	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SL3AB5-2940E00F4	3002	2940	2205	2496	1872	4 x AM12L	4 x AR12L	2 x 1640

1) The hardware has improved transient withstand.

2) cos φ = 1.00, efficiency = 98.0%, values calculated at 742 V DC

3) LC Filter +AEZ1, LCL Filter +AEZ3 (grid side L Filter separate module)

4) Part of LCL Filter, +AEZ3

10.6.4 Current Ratings for GC 525–690 V AC (640–1100 V DC), IP00/Open Type

Table 61: Current Ratings for Grid Converter Module, 525–690 V AC (640–1100 V DC)

Model code	AC current(1)					Power, 690 V AC mains		Frame	Frame with option +AEZ1 or +AEZ3(2)	Input L Filter size [A](3)
	I_N [A]	I_L [A]	I_H [A]	I_{S1} [A]	I_{S2} [A]	P_L [kW]	S_L [kVA]			
iC7-60SLGC07-236AE00F4	241	236	177	354	330	277	283	AM10L	AR10L	400
iC7-60SLGC07-300AE00F4	307	300	225	450	420	352	359	AM10L	AR10L	400
iC7-60SLGC07-334AE00F4	341	334	250	501	468	392	400	AM10L	AR10L	400
iC7-60SLGC07-380AE00F4	388	380	285	570	532	446	455	AM10L	AR10L	400
iC7-60SLGC07-425AE00F4	434	425	318	638	595	498	508	AM12L	AR12L	1000
iC7-60SLGC07-475AE00F4	485	475	356	712.5	665	557	568	AM12L	AR12L	1000
iC7-60SLGC07-530AE00F4	542	530	397	795	742	621	634	AM12L	AR12L	1000
iC7-60SLGC07-595AE00F4	608	595	446	892.5	833	697	712	AM12L	AR12L	1000
iC7-60SLGC07-670AE00F4	684	670	502	1005	938	785	801	AM12L	AR12L	1000
iC7-60SLGC07-760AE00F4	776	760	570	1140	1064	891	909	AM12L	AR12L	1000

Table 61: Current Ratings for Grid Converter Module, 525–690 V AC (640–1100 V DC) ***(continued)***

Model code	AC current[1]					Power, 690 V AC mains		Frame	Frame with option +AEZ1 or +AEZ3[2]	Input L Filter size [A][3]
	I_N [A]	I_L [A]	I_H [A]	I_{S1} [A]	I_{S2} [A]	P_L [kW]	S_L [kVA]			
iC7-60SLGC07-850AE00F4	868	850	637	1275	1190	996	1016	2 x AM12L	2 x AR12L	1640
iC7-60SLGC07-945AE00F4	965	945	708	1417.5	1323	1107	1130	2 x AM12L	2 x AR12L	1640
iC7-60SLGC07-1040E00F4	1062	1040	780	1560	1456	1219	1243	2 x AM12L	2 x AR12L	1640
iC7-60SLGC07-1230E00F4	1256	1230	922	1845	1722	1441	1470	2 x AM12L	2 x AR12L	1640
iC7-60SLGC07-1325E00F4	1353	1325	993	1988	1855	1552	1584	2 x AM12L	2 x AR12L	1640
iC7-60SLGC07-1500E00F4	1532	1500	1125	2250	2100	1757	1793	2 x AM12L	2 x AR12L	1640
iC7-60SLGC07-1700E00F4	1736	1700	1275	2550	2380	1992	2032	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGC07-1800E00F4	1838	1800	1350	2700	2520	2109	2152	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGC07-2000E00F4	2042	2000	1500	3000	2800	2343	2391	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGC07-2250E00F4	2297	2250	1687	3375	3150	2636	2690	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGC07-2500E00F4	2552	2500	1875	3750	3500	2929	2988	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SLGC07-2650E00F4	2706	2650	1987	3975	3710	3104	3168	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SLGC07-2940E00F4	3002	2940	2205	4410	4116	3444	3514	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SLGC07-3120E00F4	3185	3120	2340	4680	4368	3655	3729	5 x AM12L	5 x AR12L	3 x 1640
iC7-60SLGC07-3600E00F4	3675	3600	2700	5400	5040	4217	4303	5 x AM12L	5 x AR12L	3 x 1640
iC7-60SLGC07-3900E00F4	3982	3900	2925	5850	5460	4568	4661	6 x AM12L	6 x AR12L	3 x 1640
iC7-60SLGC07-4320E00F4	4410	4320	3240	6480	6048	5060	5163	6 x AM12L	6 x AR12L	3 x 1640

Table 61: Current Ratings for Grid Converter Module, 525–690 V AC (640–1100 V DC) ***(continued)***

Model code	AC current[1]					Power, 690 V AC mains		Frame	Frame with option +AEZ1 or +AEZ3[2]	Input L Filter size [A][3]
	I_N [A]	I_L [A]	I_H [A]	I_{S1} [A]	I_{S2} [A]	P_L [kW]	S_L [kVA]			
iC7-60SLGC07-4750E00F4	4849	4750	3562	7125	6650	5564	5677	7 x AM12L	7 x AR12L	4 x 1640
iC7-60SLGC07-5040E00F4	5145	5040	3780	7560	7056	5903	6024	7 x AM12L	7 x AR12L	4 x 1640
iC7-60SLGC07-5400E00F4	5513	5400	4050	8100	7560	6325	6454	8 x AM12L	8 x AR12L	4 x 1640
iC7-60SLGC07-5750E00F4	5870	5750	4312	8625	8050	6735	6872	8 x AM12L	8 x AR12L	4 x 1640

1) I_{S1} and I_{S2} are intended for short-circuit current injection in grid forming operation. The rating is valid when the parameter Paralleling sync. Mode is disabled and the maximum residual voltage of the fault is 30% of nominal at the grid converter terminals. Voltage measurement option OC7V0 is also required.

2) LC Filter +AEZ1, LCL Filter +AEZ3 (grid side L Filter separate module)

3) Part of LCL Filter, +AEZ3

10.6.5 Current Ratings for GC 380–500 V AC (465–800 V DC), IP00/Open Type

Table 62: Current Ratings for Grid Converter Module, 380–500 V AC (465–800 V DC)

Model code[1]	AC current[2]					Power, 500 V AC mains		Frame	Frame with option +AEZ1 or +AEZ3[3]	Input L Filter size [A][4]
	I_N[A]	I_L[A]	I_H[A]	I_{S1} [A]	I_{S2} [A]	P_L[kW]	S_L[kVA]			
iC7-60SLGCB5-261AE00F4	267	261	196	392	365	222	227	AM10L	AR10L	400
iC7-60SLGCB5-325AE00F4	332	325	244	488	455	276	282	AM10L	AR10L	400
iC7-60SLGCB5-380AE00F4	388	380	285	570	532	323	330	AM10L	AR10L	400
iC7-60SLGCB5-425AE00F4	434	425	318	638	595	361	369	AM12L	AR12L	1000
iC7-60SLGCB5-475AE00F4	485	475	356	713	665	404	412	AM12L	AR12L	1000
iC7-60SLGCB5-530AE00F4	542	530	397	795	742	450	459	AM12L	AR12L	1000
iC7-60SLGCB5-595AE00F4	608	595	446	893	833	505	516	AM12L	AR12L	1000
iC7-60SLGCB5-670AE00F4	684	670	502	1005	938	569	581	AM12L	AR12L	1000
iC7-60SLGCB5-760AE00F4	776	760	570	1140	1064	646	659	AM12L	AR12L	1000
iC7-60SLGCB5-850AE00F4	868	850	637	1275	1190	722	737	2 x AM12L	2 x AR12L	1640

Table 62: Current Ratings for Grid Converter Module, 380–500 V AC (465–800 V DC) ***(continued)***

Model code[1]	AC current[2]					Power, 500 V AC mains		Frame	Frame with option +AEZ1 or +AEZ3[3]	Input L Filter size [A][4]
	I_N[A]	I_L[A]	I_H[A]	I_{S1} [A]	I_{S2} [A]	P_L[kW]	S_L[kVA]			
iC7-60SLGCB5-945AE00F4	965	945	708	1418	1323	803	819	2 x AM12L	2 x AR12L	1640
iC7-60SLGCB5-1040E00F4	1062	1040	780	1560	1456	883	901	2 x AM12L	2 x AR12L	1640
iC7-60SLGCB5-1230E00F4	1256	1230	922	1845	1722	1044	1066	2 x AM12L	2 x AR12L	1640
iC7-60SLGCB5-1325E00F4	1353	1325	993	1988	1855	1125	1148	2 x AM12L	2 x AR12L	1640
iC7-60SLGCB5-1500E00F4	1532	1500	1125	2250	2100	1274	1300	2 x AM12L	2 x AR12L	1640
iC7-60SLGCB5-1700E00F4	1736	1700	1275	2550	2380	1443	1473	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGCB5-1800E00F4	1838	1800	1350	2700	2520	1528	1559	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGCB5-2000E00F4	2042	2000	1500	3000	2800	1698	1733	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGCB5-2250E00F4	2297	2250	1687	3375	3150	1910	1949	3 x AM12L	3 x AR12L	2 x 1640
iC7-60SLGCB5-2500E00F4	2552	2500	1875	3750	3500	2122	2166	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SLGCB5-2650E00F4	2706	2650	1987	3975	3710	2250	2295	4 x AM12L	4 x AR12L	2 x 1640
iC7-60SLGCB5-2940E00F4	3002	2940	2205	4410	4116	2496	2547	4 x AM12L	4 x AR12L	2 x 1640

1) The hardware has improved transient withstand.

2) I_{S1} and I_{S2} are intended for short-circuit current injection in grid forming operation. The rating is valid when the parameter Paralleling sync. Mode is disabled and the maximum residual voltage of the fault is 30% of nominal at the grid converter terminals. Voltage measurement option OC7V0 is also required.

3) LC Filter +AEZ1, LCL Filter +AEZ3 (grid side L Filter separate module)

4) Part of LCL Filter, +AEZ3

10.6.6 Current Ratings for INU 525–690 V AC (640–1100 V DC), IP00/Open Type

Table 63: Current Ratings for Inverter Module 525–690 V AC (640–1100 V DC)

Model code	AC current				Motor output power, 690 V AC(1)		Frame	Frame with option +AExx
	I_N[A]	I_L[A]	I_H[A]	I_{peak} [A]	P_L[kW]	P_H[kW]		
iC7-60SLIN07-170AE00F4	174	170	127	254	160	90	IM10L	IR10L
iC7-60SLIN07-208AE00F4	213	208	156	312	200	132	IM10L	IR10L
iC7-60SLIN07-261AE00F4	267	261	195	390	250	160	IM10L	IR10L
iC7-60SLIN07-325AE00F4	332	325	243	486	315	200	IM10L	IR10L
iC7-60SLIN07-365AE00F4	373	365	273	546	355	250	IM10L	IR10L
iC7-60SLIN07-416AE00F4	425	416	312	624	400	250	IM10L	IR10L
iC7-60SLIN07-465AE00F4	475	465	348	696	450	315	IM12L	IR12L
iC7-60SLIN07-525AE00F4	536	525	393	786	500	355	IM12L	IR12L
iC7-60SLIN07-590AE00F4	603	590	442	884	560	400	IM12L	IR12L
iC7-60SLIN07-650AE00F4	664	650	487	974	630	450	IM12L	IR12L
iC7-60SLIN07-730AE00F4	746	730	547	1094	710	500	IM12L	IR12L
iC7-60SLIN07-820AE00F4	838	820	615	1230	800	560	IM12L	IR12L
iC7-60SLIN07-945AE00F4	965	945	708	1416	900	630	2 x IM12L	2 x IR12L
iC7-60SLIN07-1060E00F4	1083	1060	795	1590	1000	710	2 x IM12L	2 x IR12L
iC7-60SLIN07-1230E00F4	1256	1230	922	1844	1100	800	2 x IM12L	2 x IR12L
iC7-60SLIN07-1400E00F4	1430	1400	1050	2100	1300	900	2 x IM12L	2 x IR12L
iC7-60SLIN07-1500E00F4	1532	1500	1125	2250	1400	1000	2 x IM12L	2 x IR12L
iC7-60SLIN07-1640E00F4	1675	1640	1230	2460	1500	1100	2 x IM12L	2 x IR12L
iC7-60SLIN07-1795E00F4	1833	1795	1346	2692	1700	1250	3 x IM12L	3 x IR12L
iC7-60SLIN07-2080E00F4	2124	2080	1560	3120	1900	1400	3 x IM12L	3 x IR12L
iC7-60SLIN07-2300E00F4	2348	2300	1725	3450	2100	1600	3 x IM12L	3 x IR12L
iC7-60SLIN07-2500E00F4	2552	2500	1875	3750	2300	1750	3 x IM12L	3 x IR12L
iC7-60SLIN07-2830E00F4	2889	2830	2122	4244	2600	1950	4 x IM12L	4 x IR12L
iC7-60SLIN07-3050E00F4	3114	3050	2287	4574	2800	2000	4 x IM12L	4 x IR12L
iC7-60SLIN07-3260E00F4	3328	3260	2445	4890	3000	2200	4 x IM12L	4 x IR12L
iC7-60SLIN07-3500E00F4	3573	3500	2625	5250	3300	2400	5 x IM12L	5 x IR12L
iC7-60SLIN07-4035E00F4	4119	4035	3026	6052	3800	2800	5 x IM12L	5 x IR12L
iC7-60SLIN07-4400E00F4	4492	4400	3300	6600	4100	3100	6 x IM12L	6 x IR12L
iC7-60SLIN07-4850E00F4	4951	4850	3637	7274	4500	3500	6 x IM12L	6 x IR12L

Table 63: Current Ratings for Inverter Module 525–690 V AC (640–1100 V DC) ***(continued)***

Model code	AC current				Motor output power, 690 V AC[(1)]		Frame	Frame with option +AExx
	I_N[A]	I_L[A]	I_H[A]	I_{peak} [A]	P_L[kW]	P_H[kW]		
iC7-60SLIN07-5300E00F4	5411	5300	3975	7950	5000	3700	7 x IM12L	7 x IR12L
iC7-60SLIN07-5600E00F4	5717	5600	4200	8400	5300	4000	7 x IM12L	7 x IR12L
iC7-60SLIN07-6100E00F4	6227	6100	4575	9150	5700	4300	8 x IM12L	8 x IR12L
iC7-60SLIN07-6400E00F4	6534	6400	4800	9600	6000	4600	8 x IM12L	8 x IR12L

1) efficiency = 98.5%

10.6.7 Current Ratings for INU 380–500 V AC (465–800 V DC), IP00/Open Type

Table 64: Current Ratings for Inverter Module, 380–500 V AC (465–800 V DC)

Model code[(1)]	AC current				Motor output power, 500 V AC[(2)]		Frame	Frame with option +AExx
	I_N[A]	I_L[A]	I_H[A]	I_{peak} [A]	P_L[kW]	P_H[kW]		
iC7-60SLINB5-206AE00F4	211	206	155	310	132	90	IM10L	IR10L
iC7-60SLINB5-245AE00F4	251	245	184	368	160	110	IM10L	IR10L
iC7-60SLINB5-302AE00F4	309	302	227	454	200	132	IM10L	IR10L
iC7-60SLINB5-385AE00F4	394	385	289	578	250	160	IM10L	IR10L
iC7-60SLINB5-416AE00F4	425	416	312	624	270	200	IM10L	IR10L
iC7-60SLINB5-525AE00F4	536	525	393	786	355	250	IM12L	IR12L
iC7-60SLINB5-590AE00F4	603	590	442	884	400	250	IM12L	IR12L
iC7-60SLINB5-650AE00F4	672	650	487	974	400	315	IM12L	IR12L
iC7-60SLINB5-730AE00F4	746	730	547	1094	500	355	IM12L	IR12L
iC7-60SLINB5-820AE00F4	838	820	615	1230	560	400	IM12L	IR12L
iC7-60SLINB5-1060E00F4	1083	1060	795	1590	630	500	2 x IM12L	2 x IR12L
iC7-60SLINB5-1230E00F4	1256	1230	922	1844	800	630	2 x IM12L	2 x IR12L
iC7-60SLINB5-1400E00F4	1430	1400	1050	2100	900	710	2 x IM12L	2 x IR12L
iC7-60SLINB5-1500E00F4	1532	1500	1125	2250	1000	710	2 x IM12L	2 x IR12L
iC7-60SLINB5-1640E00F4	1675	1640	1230	2460	1100	800	2 x IM12L	2 x IR12L
iC7-60SLINB5-1795E00F4	1833	1795	1346	2692	1200	900	3 x IM12L	3 x IR12L
iC7-60SLINB5-2080E00F4	2124	2080	1560	3120	1400	1000	3 x IM12L	3 x IR12L
iC7-60SLINB5-2300E00F4	2348	2300	1725	3450	1500	1100	3 x IM12L	3 x IR12L
iC7-60SLINB5-2500E00F4	2552	2500	1875	3750	1700	1200	3 x IM12L	3 x IR12L

Table 64: Current Ratings for Inverter Module, 380–500 V AC (465–800 V DC) ***(continued)***

Model code[1]	AC current				Motor output power, 500 V AC[2]		Frame	Frame with option +AExx
	I_N[A]	I_L[A]	I_H[A]	I_{peak} [A]	P_L[kW]	P_H[kW]		
iC7-60SLINB5-2830E00F4	2889	2830	2122	4244	2600	1950	4 x IM12L	4 x IR12L
iC7-60SLINB5-3050E00F4	3114	3050	2287	4574	2800	2000	4 x IM12L	4 x IR12L
iC7-60SLINB5-3260E00F4	3328	3260	2445	4890	3000	2200	4 x IM12L	4 x IR12L

1) The hardware has improved transient withstand.

2) efficiency = 98.5%

10.6.8 Current Ratings for DC/DC Converter 640–1100 V DC-bus Voltage, IP00/Open Type

Table 65: Current Ratings for DC/DC Converter 640–1100 V DC-bus Voltage, IP00/Open Type

Model code	DC bus current	DC source current[1]			DC power, 1000...250 V DC source	Frame	Frame with option +AE__
	I_{N-DC} [A]	I_N [A]	I_L [A]	I_H [A]	P_{L-typ} [kW]		
iC7-60SLDC07-300AE00F4	307	307	300	225	300...75	DM10L	DR10L
iC7-60SLDC07-360AE00F4	368	368	360	270	360...90	DM10L	DR10L
iC7-60SLDC07-420AE00F4	429	429	420	315	420...105	DM10L	DR10L
iC7-60SLDC07-480AE00F4	490	490	480	360	480...120	DM10L	DR10L
iC7-60SLDC07-570AE00F4	582	582	570	428	570...142	DM10L	DR10L
iC7-60SLDC07-720AE00F4	735	735	720	540	720...180	DM12L	DR12L
iC7-60SLDC07-840AE00F4	858	858	840	630	840...210	DM12L	DR12L
iC7-60SLDC07-960AE00F4	980	980	960	720	960...240	DM12L	DR12L
iC7-60SLDC07-1080E00F4	1103	1103	1080	810	1080...270	DM12L	DR12L
iC7-60SLDC07-1200E00F4	1225	1225	1200	900	1200...300	DM12L	DR12L
iC7-60SLDC07-1440E00F4	1470	1470	1440	1080	1440...360	2xDM12L	2xDR12L
iC7-60SLDC07-1680E00F4	1715	1715	1680	1260	1680...420	2xDM12L	2xDR12L
iC7-60SLDC07-1920E00F4	1960	1960	1920	1440	1920...480	2xDM12L	2xDR12L
iC7-60SLDC07-2160E00F4	2205	2205	2160	1620	2160...540	2xDM12L	2xDR12L
iC7-60SLDC07-2400E00F4	2450	2450	2400	1800	2400...600	2xDM12L	2xDR12L
iC7-60SLDC07-2880E00F4	2940	2940	2880	2160	2880...720	3xDM12L	3xDR12L
iC7-60SLDC07-3240E00F4	3308	3308	3240	2430	3240...810	3xDM12L	3xDR12L
iC7-60SLDC07-3600E00F4	3675	3675	3600	2700	3600...900	3xDM12L	3xDR12L

1) Sum of 3 phases.

The ratings are valid at 1025 V DC-voltage.

10.6.9 Current Ratings for DC/DC Converter 465–800 V DC-bus Voltage, IP00/Open Type

Table 66: Current Ratings for DC/DC Converter 465–800 V DC-bus Voltage, IP00/Open Type

Model code	DC bus current	DC source current[1]			DC power, 700...250 V DC source	Frame	Frame with option +AE__
	$I_{N\text{-}DC}$[A]	I_N[A]	I_L[A]	I_H[A]	$P_{L\text{-}typ}$[kW]		
iC7-60SLDCB5-300AE00F4	307	307	300	225	210...75	DM10L	DR10L
iC7-60SLDCB5-360AE00F4	368	368	360	270	252...90	DM10L	DR10L
iC7-60SLDCB5-420AE00F4	429	429	420	315	294...105	DM10L	DR10L
iC7-60SLDCB5-480AE00F4	490	490	480	360	336...120	DM10L	DR10L
iC7-60SLDCB5-570AE00F4	582	582	570	428	399...143	DM10L	DR10L
iC7-60SLDCB5-720AE00F4	735	735	720	540	504...180	DM12L	DR12L
iC7-60SLDCB5-840AE00F4	858	858	840	630	588...210	DM12L	DR12L
iC7-60SLDCB5-960AE00F4	980	980	960	720	672...240	DM12L	DR12L
iC7-60SLDCB5-1080E00F4	1103	1103	1080	810	756...270	DM12L	DR12L
iC7-60SLDCB5-1200E00F4	1225	1225	1200	900	840...300	DM12L	DR12L
iC7-60SLDCB5-1440E00F4	1470	1470	1440	1080	1008...360	2xDM12L	2xDR12L
iC7-60SLDCB5-1680E00F4	1715	1715	1680	1260	1176...420	2xDM12L	2xDR12L
iC7-60SLDCB5-1920E00F4	1960	1960	1920	1440	1344...480	2xDM12L	2xDR12L
iC7-60SLDCB5-2160E00F4	2205	2205	2160	1620	1512...540	2xDM12L	2xDR12L
iC7-60SLDCB5-2400E00F4	2450	2450	2400	1800	1680...600	2xDM12L	2xDR12L
iC7-60SLDCB5-2880E00F4	2940	2940	2880	2160	2016...720	3xDM12L	3xDR12L
iC7-60SLDCB5-3240E00F4	3308	3308	3240	2430	2268...810	3xDM12L	3xDR12L
iC7-60SLDCB5-3600E00F4	3675	3675	3600	2700	2520...900	3xDM12L	3xDR12L

1) Sum of 3 phases.

The ratings are valid at 800 V DC-voltage.

10.7 Power Losses

10.7.1 List of Power Loss Information

The power loss tables for the liquid-cooled system modules can be found with these links.

- 10.7.2 Power Losses of AFE and GC Modules, Voltage Class 07
- 10.7.3 Power Losses of AFE and GC Modules, Voltage Class 07, with +AEZ1 and +AEZ3
- 10.7.4 Power Losses of AFE and GC Modules, Voltage Class B5
- 10.7.5 Power Losses of AFE and GC Modules, Voltage Class B5, with +AEZ1 and +AEZ3
- 10.7.6 Power Losses of INU Modules with +AEU1, Voltage Class 07, Motor Cable Maximum Length 150 m (492 ft)

10.7.2 Power Losses of AFE and GC Modules, Voltage Class 07

- The specifications for the values in the table
  - AFE or GC module
  - 525–690 V AC (640–1100 V DC)
  - DC voltage 1025 V DC
  - Modulator type 4
    - The default modulator type for grid converters is type 5, which results in slightly lower losses than given in the table.

Table 67: Power Loss for AFE and GC Modules

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module		+AKFX[1]	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3A07-236AE00F_	AM10L	236	3.29	0.03	0.01	0.07
iC7-60SL3A07-300AE00F_	AM10L	300	4.44	0.04	0.02	0.07
iC7-60SL3A07-334AE00F_	AM10L	334	5.13	0.05	0.02	0.07
iC7-60SL3A07-380AE00F_	AM10L	380	6.16	0.06	0.03	0.07
iC7-60SL3A07-425AE00F_	AM12L	425	5.82	0.06	0.01	0.13
iC7-60SL3A07-475AE00F_	AM12L	475	6.63	0.07	0.02	0.13
iC7-60SL3A07-530AE00F_	AM12L	530	7.58	0.08	0.03	0.13
iC7-60SL3A07-595AE00F_	AM12L	595	8.79	0.09	0.04	0.13
iC7-60SL3A07-670AE00F_	AM12L	670	10.31	0.10	0.05	0.13
iC7-60SL3A07-760AE00F_	AM12L	760	12.32	0.12	0.07	0.13
iC7-60SL3A07-850AE00F_	2xAM12L	850	11.64	0.12	0.02	0.26
iC7-60SL3A07-945AE00F_	2xAM12L	945	13.19	0.13	0.04	0.26
iC7-60SL3A07-1040E00F_	2xAM12L	1040	14.81	0.15	0.04	0.26
iC7-60SL3A07-1230E00F_	2xAM12L	1230	18.36	0.19	0.07	0.26
iC7-60SL3A07-1325E00F_	2xAM12L	1325	20.30	0.21	0.10	0.26
iC7-60SL3A07-1500E00F_	2xAM12L	1500	24.17	0.24	0.13	0.26
iC7-60SL3A07-1700E00F_	3xAM12L	1700	24.76	0.25	0.11	0.39

Table 67: Power Loss for AFE and GC Modules *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module		+AKFX[1]	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3A07-1800E00F_	3xAM12L	1800	26.67	0.27	0.09	0.39
iC7-60SL3A07-2000E00F_	3xAM12L	2000	30.71	0.31	0.14	0.39
iC7-60SL3A07-2250E00F_	3xAM12L	2250	36.25	0.37	0.20	0.39
iC7-60SL3A07-2500E00F_	4xAM12L	2500	37.52	0.38	0.17	0.52
iC7-60SL3A07-2650E00F_	4xAM12L	2650	40.60	0.41	0.19	0.52
iC7-60SL3A07-2940E00F_	4xAM12L	2940	46.95	0.47	0.28	0.52
iC7-60SL3A07-3120E00F_	5xAM12L	3120	46.80	0.47	0.18	0.66
iC7-60SL3A07-3600E00F_	5xAM12L	3600	56.99	0.58	0.33	0.66
iC7-60SL3A07-3900E00F_	6xAM12L	3900	59.34	0.60	0.25	0.79
iC7-60SL3A07-4320E00F_	6xAM12L	4320	68.38	0.69	0.40	0.79
iC7-60SL3A07-4750E00F_	7xAM12L	4750	73.43	0.74	0.34	0.92
iC7-60SL3A07-5040E00F_	7xAM12L	5040	79.78	0.81	0.46	0.92
iC7-60SL3A07-5400E00F_	8xAM12L	5400	83.30	0.84	0.38	1.05
iC7-60SL3A07-5750E00F_	8xAM12L	5750	90.97	0.92	0.53	1.05

1) DC fuses

10.7.3 Power Losses of AFE and GC Modules, Voltage Class 07, with +AEZ1 and +AEZ3

- The specifications for the values in the table
  - AFE or GC module
  - 525–690 V AC (640–1100 V DC)
  - DC voltage 1025 V DC
  - Modulator type 4
    - The default modulator type for grid converters is type 5, which results in slightly lower losses than given in the table.
  - Option +AEZ1 or +AEZ3

Table 68: Power Loss for AFE and GC Modules with Options +AEZ1 and +AEZ3

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEZ1[(1)]		System module and +AEZ3[(2)]		+AKFX[(3)]	Standby loss, system module and +AEZ1 [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3A07-236AE00F_	AR10L	236	4.1	0.19	4.2	0.27	0.01	0.07
iC7-60SL3A07-300AE00F_	AR10L	300	5.6	0.27	5.8	0.40	0.02	0.07
iC7-60SL3A07-334AE00F_	AR10L	334	6.5	0.31	6.7	0.47	0.02	0.07
iC7-60SL3A07-380AE00F_	AR10L	380	7.8	0.38	8.1	0.59	0.03	0.07
iC7-60SL3A07-425AE00F_	AR12L	425	6.6	0.25	6.7	0.32	0.01	0.14
iC7-60SL3A07-475AE00F_	AR12L	475	7.5	0.29	7.7	0.38	0.02	0.14
iC7-60SL3A07-530AE00F_	AR12L	530	8.6	0.35	8.8	0.46	0.03	0.14
iC7-60SL3A07-595AE00F_	AR12L	595	10.0	0.40	10.2	0.54	0.04	0.14
iC7-60SL3A07-670AE00F_	AR12L	670	11.7	0.52	12.0	0.69	0.05	0.14
iC7-60SL3A07-760AE00F_	AR12L	760	14.0	0.61	14.3	0.84	0.07	0.14
iC7-60SL3A07-850AE00F_	2xAR12L	850	13.3	0.48	13.6	0.71	0.02	0.27
iC7-60SL3A07-945AE00F_	2xAR12L	945	15.1	0.57	15.5	0.85	0.04	0.27
iC7-60SL3A07-1040E00F_	2xAR12L	1040	16.9	0.69	17.4	1.03	0.04	0.27
iC7-60SL3A07-1230E00F_	2xAR12L	1230	20.9	0.89	21.6	1.35	0.07	0.27
iC7-60SL3A07-1325E00F_	2xAR12L	1325	23.2	1.00	24.0	1.55	0.10	0.27
iC7-60SL3A07-1500E00F_	2xAR12L	1500	27.6	1.23	28.7	1.95	0.13	0.27
iC7-60SL3A07-1700E00F_	3xAR12L	1700	28.2	1.14	-	-	0.11	0.41
iC7-60SL3A07-1800E00F_	3xAR12L	1800	30.4	1.25	-	-	0.09	0.41
iC7-60SL3A07-2000E00F_	3xAR12L	2000	35.0	1.51	-	-	0.14	0.41
iC7-60SL3A07-2250E00F_	3xAR12L	2250	41.4	1.83	-	-	0.20	0.41
iC7-60SL3A07-2500E00F_	4xAR12L	2500	42.8	1.79	44.2	2.76	0.17	0.55
iC7-60SL3A07-2650E00F_	4xAR12L	2650	46.3	1.96	48.0	3.07	0.19	0.55
iC7-60SL3A07-2940E00F_	4xAR12L	2940	53.6	2.33	55.7	3.71	0.28	0.55
iC7-60SL3A07-3120E00F_	5xAR12L	3120	53.4	2.25	-	-	0.18	0.69
iC7-60SL3A07-3600E00F_	5xAR12L	3600	65.0	2.82	-	-	0.33	0.69
iC7-60SL3A07-3900E00F_	6xAR12L	3900	67.7	2.85	70.0	4.44	0.25	0.82
iC7-60SL3A07-4320E00F_	6xAR12L	4320	78.0	3.24	81.0	5.24	0.40	0.82
iC7-60SL3A07-4750E00F_	7xAR12L	4750	83.7	3.63	-	-	0.34	0.96

Table 68: Power Loss for AFE and GC Modules with Options +AEZ1 and +AEZ3 *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEZ1[1]		System module and +AEZ3[2]		+AKFX[3]	Standby loss, system module and +AEZ1 [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3A07-5040E00F_	7xAR12L	5040	91.0	3.96	-	-	0.46	0.96
iC7-60SL3A07-5400E00F_	8xAR12L	5400	95.0	4.13	98.5	6.44	0.38	1.10
iC7-60SL3A07-5750E00F_	8xAR12L	5750	103.8	4.51	107.8	7.16	0.53	1.10

1) System module and the LC Filter in the integration unit

2) System module and the LC Filter in the integration unit and the L Filter

3) DC fuses

10.7.4 Power Losses of AFE and GC Modules, Voltage Class B5

- The specifications for the values in the table
  - AFE or GC module
  - 380–500 V AC (465–800 V DC)
  - DC voltage 594 V DC
  - Modulator type 4
    - The default modulator type for grid converters is type 5, which results in slightly lower losses than given in the table.

Table 69: Power Loss for AFE and GC Modules

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module		+AKFX[1]	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3AB5-261A	AM10L	261	2.50	0.03	0.02	0.04
iC7-60SL3AB5-325A	AM10L	325	3.28	0.03	0.02	0.04
iC7-60SL3AB5-380A	AM10L	380	4.02	0.04	0.03	0.04
iC7-60SL3AB5-425A	AM12L	425	3.96	0.04	0.01	0.07
iC7-60SL3AB5-475A	AM12L	475	4.49	0.05	0.02	0.07
iC7-60SL3AB5-530A	AM12L	530	5.10	0.05	0.03	0.07
iC7-60SL3AB5-595A	AM12L	595	5.87	0.06	0.04	0.07
iC7-60SL3AB5-670A	AM12L	670	6.81	0.07	0.05	0.07
iC7-60SL3AB5-760A	AM12L	760	8.04	0.08	0.07	0.07
iC7-60SL3AB5-850A	2xAM12L	850	7.92	0.08	0.02	0.14
iC7-60SL3AB5-945A	2xAM12L	945	8.93	0.09	0.04	0.14

Table 69: Power Loss for AFE and GC Modules *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module		+AKFX(1)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3AB5-1040	2xAM12L	1040	9.97	0.10	0.04	0.14
iC7-60SL3AB5-1230	2xAM12L	1230	12.23	0.12	0.07	0.14
iC7-60SL3AB5-1325	2xAM12L	1325	13.44	0.14	0.1	0.14
iC7-60SL3AB5-1500	2xAM12L	1500	15.80	0.16	0.13	0.14
iC7-60SL3AB5-1700	3xAM12L	1700	16.58	0.17	0.11	0.22
iC7-60SL3AB5-1800	3xAM12L	1800	17.79	0.18	0.09	0.22
iC7-60SL3AB5-2000	3xAM12L	2000	20.31	0.21	0.14	0.22
iC7-60SL3AB5-2250	3xAM12L	2250	23.70	0.24	0.2	0.22
iC7-60SL3AB5-2500	4xAM12L	2500	24.95	0.25	0.17	0.29
iC7-60SL3AB5-2650	4xAM12L	2650	26.87	0.27	0.19	0.29
iC7-60SL3AB5-2940	4xAM12L	2940	30.76	0.31	0.28	0.29

1) DC fuses

10.7.5 Power Losses of AFE and GC Modules, Voltage Class B5, with +AEZ1 and +AEZ3

- The specifications for the values in the table
  - AFE or GC module
  - 380–500 V AC (465–800 V DC)
  - DC voltage 594 V DC
  - Modulator type 4
    - The default modulator type for grid converters is type 5, which results in slightly lower losses than given in the table.
  - Option +AEZ1 or +AEZ3

Table 70: Power Loss for AFE and GC Modules with Options +AEZ1 and +AEZ3

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEZ1(1)		System module and +AEZ3(2)		+AKFX (3)	Standby loss, system module and +AEZ1 [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3AB5-261A	AR10L	261	3.12	0.20	3.26	0.29	0.02	0.04
iC7-60SL3AB5-325A	AR10L	325	4.22	0.25	4.43	0.38	0.02	0.04
iC7-60SL3AB5-380A	AR10L	380	5.33	0.32	5.62	0.51	0.03	0.04
iC7-60SL3AB5-425A	AR12L	425	4.47	0.19	4.58	0.26	0.01	0.07

Table 70: Power Loss for AFE and GC Modules with Options +AEZ1 and +AEZ3 *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEZ1(1)		System module and +AEZ3(2)		+AKFX (3)	Standby loss, system module and +AEZ1 [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SL3AB5-475A	AR12L	475	5.11	0.23	5.24	0.32	0.02	0.07
iC7-60SL3AB5-530A	AR12L	530	5.84	0.29	6.01	0.40	0.03	0.07
iC7-60SL3AB5-595A	AR12L	595	6.75	0.34	6.95	0.47	0.04	0.07
iC7-60SL3AB5-670A	AR12L	670	7.95	0.45	8.21	0.63	0.05	0.07
iC7-60SL3AB5-760A	AR12L	760	9.48	0.54	9.81	0.76	0.07	0.07
iC7-60SL3AB5-850A	2xAR12L	850	8.94	0.37	9.26	0.59	0.02	0.15
iC7-60SL3AB5-945A	2xAR12L	945	10.16	0.46	10.57	0.73	0.04	0.15
iC7-60SL3AB5-1040	2xAR12L	1040	11.41	0.57	11.91	0.91	0.04	0.15
iC7-60SL3AB5-1230	2xAR12L	1230	14.12	0.75	14.81	1.21	0.07	0.15
iC7-60SL3AB5-1325	2xAR12L	1325	15.65	0.86	16.47	1.41	0.1	0.15
iC7-60SL3AB5-1500	2xAR12L	1500	18.60	1.08	19.67	1.79	0.13	0.15
iC7-60SL3AB5-1700	3xAR12L	1700	19.05	0.94	19.69	1.37	0.11	0.22
iC7-60SL3AB5-1800	3xAR12L	1800	20.47	1.04	21.18	1.51	0.09	0.22
iC7-60SL3AB5-2000	3xAR12L	2000	23.67	1.30	24.57	1.90	0.14	0.22
iC7-60SL3AB5-2250	3xAR12L	2250	27.90	1.60	29.05	2.37	0.2	0.22
iC7-60SL3AB5-2500	4xAR12L	2500	28.88	1.52	30.31	2.47	0.17	0.30
iC7-60SL3AB5-2650	4xAR12L	2650	31.30	1.68	32.94	2.78	0.19	0.30
iC7-60SL3AB5-2940	4xAR12L	2940	36.16	2.03	38.22	3.40	0.28	0.30

1) System module and the LC Filter in the integration unit

2) System module and the LC Filter in the integration unit and the L Filter

3) DC fuses

10.7.6 Power Losses of INU Modules with +AEU1, Voltage Class 07, Motor Cable Maximum Length 150 m (492 ft)

- The specifications for the values in the table
  - Inverter module
  - 525–690 V AC (640–1100 V DC)
  - Option +AEU1
  - Switching frequency 2 kHz or 3 kHz
  - Modulator type 2
  - Motor cable length a maximum of 150 m (492 ft)

Table 71: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 150 m (492 ft)

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency(1)		System module and +AEU1, 3 kHz switching frequency(1)		+AKFX(2)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLIN07-170AE00F_	IR10L	170	2.07	0.08	2.58	0.10	0.01	0.07
iC7-60SLIN07-208AE00F_	IR10L	208	2.42	0.09	2.99	0.11	0.02	0.07
iC7-60SLIN07-261AE00F_	IR10L	261	2.98	0.11	3.58	0.13	0.02	0.07
iC7-60SLIN07-325AE00F_	IR10L	325	3.71	0.14	4.39	0.16	0.04	0.07
iC7-60SLIN07-365AE00F_	IR10L	365	4.66	0.18	5.40	0.20	0.04	0.07
iC7-60SLIN07-416AE00F_	IR10L	416	5.35	0.21	6.26	0.23	0.05	0.07
iC7-60SLIN07-465AE00F_	IR12L	465	5.25	0.18	6.48	0.23	0.03	0.13
iC7-60SLIN07-525AE00F_	IR12L	525	5.80	0.20	7.11	0.24	0.04	0.13
iC7-60SLIN07-590AE00F_	IR12L	590	6.53	0.22	7.84	0.26	0.06	0.13
iC7-60SLIN07-650AE00F_	IR12L	650	7.11	0.24	8.56	0.28	0.07	0.13
iC7-60SLIN07-730AE00F_	IR12L	730	8.73	0.29	10.29	0.35	0.08	0.13
iC7-60SLIN07-820AE00F_	IR12L	820	10.24	0.35	12.28	0.42	0.11	0.13
iC7-60SLIN07-945AE00F_	2xIR12L	945	11.05	0.37	13.11	0.46	0.05	0.26
iC7-60SLIN07-1060E00F_	2xIR12L	1060	11.64	0.40	14.34	0.49	0.08	0.26
iC7-60SLIN07-1230E00F_	2xIR12L	1230	13.45	0.45	16.27	0.54	0.11	0.26
iC7-60SLIN07-1400E00F_	2xIR12L	1400	15.37	0.51	18.39	0.60	0.13	0.26
iC7-60SLIN07-1500E00F_	2xIR12L	1500	18.43	0.64	22.56	0.79	0.16	0.26
iC7-60SLIN07-1640E00F_	2xIR12L	1640	20.21	0.69	24.56	0.84	0.19	0.26
iC7-60SLIN07-1795E00F_	3xIR12L	1795	20.77	0.74	25.89	0.91	0.18	0.39
iC7-60SLIN07-2080E00F_	3xIR12L	2080	24.32	0.83	29.42	1.00	0.20	0.39
iC7-60SLIN07-2300E00F_	3xIR12L	2300	28.18	0.97	34.51	1.20	0.23	0.39
iC7-60SLIN07-2500E00F_	3xIR12L	2500	30.86	1.05	37.45	1.28	0.31	0.39
iC7-60SLIN07-2830E00F_	4xIR12L	2830	33.06	1.13	39.96	1.36	0.26	0.52
iC7-60SLIN07-3050E00F_	4xIR12L	3050	37.52	1.29	45.79	1.59	0.31	0.52
iC7-60SLIN07-3260E00F_	4xIR12L	3260	40.33	1.38	48.80	1.67	0.48	0.52
iC7-60SLIN07-3500E00F_	5xIR12L	3500	40.96	1.40	49.46	1.68	0.33	0.66
iC7-60SLIN07-4035E00F_	5xIR12L	4035	49.61	1.70	60.40	2.08	0.51	0.66

Table 71: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 150 m (492 ft) ***(continued)***

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency(1)		System module and +AEU1, 3 kHz switching frequency(1)		+AKFX(2)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLIN07-4400E00F_	6xIR12L	4400	52.44	1.76	62.02	2.09	0.54	0.79
iC7-60SLIN07-4850E00F_	6xIR12L	4850	59.59	2.04	72.64	2.50	0.58	0.79
iC7-60SLIN07-5300E00F_	7xIR12L	5300	64.60	2.24	79.58	2.76	0.59	0.92
iC7-60SLIN07-5600E00F_	7xIR12L	5600	69.29	2.37	83.86	2.89	0.67	0.92
iC7-60SLIN07-6100E00F_	8xIR12L	6100	75.02	2.58	91.56	3.18	0.67	1.05
iC7-60SLIN07-6400E00F_	8xIR12L	6400	78.67	2.70	95.85	3.30	0.77	1.05

1) System module and the dU/dt Filter in the integration unit

2) DC fuses

10.7.7 Power Losses of INU Modules with +AEU1, Voltage Class 07, Motor Cable Maximum Length 50 m (164 ft)

- The specifications for the values in the table
  - Inverter module
  - 525–690 V AC (640–1100 V DC)
  - Option +AEU1
  - Switching frequency 2 kHz or 3 kHz
  - Modulator type 2
  - Motor cable length a maximum of 50 m (164 ft)

Table 72: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 50 m (164 ft)

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency(1)		System module and +AEU1, 3 kHz switching frequency(1)		+AKFX(2)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLIN07-170AE00F_	IR10L	170	1.83	0.07	2.27	0.08	0.01	0.07
iC7-60SLIN07-208AE00F_	IR10L	208	2.17	0.08	2.65	0.10	0.02	0.07
iC7-60SLIN07-261AE00F_	IR10L	261	2.73	0.10	3.24	0.11	0.02	0.07
iC7-60SLIN07-325AE00F_	IR10L	325	3.46	0.13	4.05	0.14	0.04	0.07

Table 72: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 50 m (164 ft) ***(continued)***

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency(1)		System module and +AEU1, 3 kHz switching frequency(1)		+AKFX(2)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLIN07-365AE00F_	IR10L	365	4.17	0.15	4.75	0.17	0.04	0.07
iC7-60SLIN07-416AE00F_	IR10L	416	4.82	0.18	5.56	0.20	0.05	0.07
iC7-60SLIN07-465AE00F_	IR12L	465	4.64	0.15	5.69	0.19	0.03	0.13
iC7-60SLIN07-525AE00F_	IR12L	525	5.19	0.17	6.31	0.20	0.04	0.13
iC7-60SLIN07-590AE00F_	IR12L	590	5.92	0.19	7.05	0.22	0.06	0.13
iC7-60SLIN07-650AE00F_	IR12L	650	6.50	0.20	7.77	0.24	0.07	0.13
iC7-60SLIN07-730AE00F_	IR12L	730	7.75	0.24	9.00	0.28	0.08	0.13
iC7-60SLIN07-820AE00F_	IR12L	820	8.99	0.28	10.46	0.33	0.11	0.13
iC7-60SLIN07-945AE00F_	2xIR12L	945	9.84	0.31	11.53	0.38	0.05	0.26
iC7-60SLIN07-1060E00F_	2xIR12L	1060	10.42	0.34	12.75	0.41	0.08	0.26
iC7-60SLIN07-1230E00F_	2xIR12L	1230	12.23	0.39	14.69	0.46	0.11	0.26
iC7-60SLIN07-1400E00F_	2xIR12L	1400	14.15	0.44	16.81	0.52	0.13	0.26
iC7-60SLIN07-1500E00F_	2xIR12L	1500	15.93	0.51	18.92	0.60	0.16	0.26
iC7-60SLIN07-1640E00F_	2xIR12L	1640	17.72	0.56	20.92	0.65	0.19	0.26
iC7-60SLIN07-1795E00F_	3xIR12L	1795	17.83	0.58	22.01	0.70	0.18	0.39
iC7-60SLIN07-2080E00F_	3xIR12L	2080	21.39	0.68	25.55	0.80	0.20	0.39
iC7-60SLIN07-2300E00F_	3xIR12L	2300	24.43	0.78	29.05	0.91	0.23	0.39
iC7-60SLIN07-2500E00F_	3xIR12L	2500	27.12	0.86	31.99	0.99	0.31	0.39
iC7-60SLIN07-2830E00F_	4xIR12L	2830	29.14	0.92	34.79	1.08	0.26	0.52
iC7-60SLIN07-3050E00F_	4xIR12L	3050	32.53	1.03	38.52	1.21	0.31	0.52
iC7-60SLIN07-3260E00F_	4xIR12L	3260	35.34	1.11	41.53	1.29	0.48	0.52
iC7-60SLIN07-3500E00F_	5xIR12L	3500	36.06	1.14	43.00	1.34	0.33	0.66
iC7-60SLIN07-4035E00F_	5xIR12L	4035	43.38	1.37	51.31	1.60	0.51	0.66
iC7-60SLIN07-4400E00F_	6xIR12L	4400	46.57	1.45	54.27	1.69	0.54	0.79
iC7-60SLIN07-4850E00F_	6xIR12L	4850	52.10	1.65	61.73	1.92	0.58	0.79
iC7-60SLIN07-5300E00F_	7xIR12L	5300	55.86	1.78	66.85	2.09	0.59	0.92
iC7-60SLIN07-5600E00F_	7xIR12L	5600	60.56	1.91	71.13	2.22	0.67	0.92

Table 72: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 50 m (164 ft) ***(continued)***

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency(1)		System module and +AEU1, 3 kHz switching frequency(1)		+AKFX(2)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLIN07-6100E00F_	8xIR12L	6100	65.04	2.06	77.02	2.41	0.67	1.05
iC7-60SLIN07-6400E00F_	8xIR12L	6400	68.70	2.17	81.30	2.53	0.77	1.05

1) System module and the dU/dt Filter in the integration unit

2) DC fuses

10.7.8 Power Losses of INU Modules without Options, Voltage Class 07, Modulator Type 1 – SVPWM

- The specifications for the values in the table
  - Inverter module
  - 525–690 V AC (640–1100 V DC)
  - DC voltage 1025 V DC
  - Switching frequency 2, 3, 4, or 6 kHz
  - Modulator type 1

Table 73: Power Loss for INU Modules without Options, Modulator Type 1

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKFX(1)
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLIN07-170AE00F_	IM10L	170	1.20	0.01	1.51	0.02	1.83	0.02	2.46	0.02	0.01
iC7-60SLIN07-208AE00F_	IM10L	208	1.49	0.02	1.87	0.02	2.27	0.02	3.17	0.03	0.02
iC7-60SLIN07-261AE00F_	IM10L	261	1.95	0.02	2.46	0.02	2.99	0.03	-	-	0.02
iC7-60SLIN07-325AE00F_	IM10L	325	2.57	0.03	3.23	0.03	-	-	-	-	0.04
iC7-60SLIN07-365AE00F_	IM10L	365	3.00	0.03	-	-	-	-	-	-	0.04

Table 73: Power Loss for INU Modules without Options, Modulator Type 1 ***(continued)***

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKFX[1]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLIN07-416AE00F_	IM10L	416	3.60	0.04	-	-	-	-	-	-	0.05
iC7-60SLIN07-465AE00F_	IM12L	465	3.40	0.03	4.25	0.04	5.15	0.05	-	-	0.03
iC7-60SLIN07-525AE00F_	IM12L	525	3.93	0.04	4.91	0.05	5.97	0.06	-	-	0.04
iC7-60SLIN07-590AE00F_	IM12L	590	4.54	0.05	5.80	0.06	6.94	0.07	-	-	0.06
iC7-60SLIN07-650AE00F_	IM12L	650	5.14	0.05	6.47	0.06	-	-	-	-	0.07
iC7-60SLIN07-730AE00F_	IM12L	730	6.00	0.06	-	-	-	-	-	-	0.08
iC7-60SLIN07-820AE00F_	IM12L	820	7.05	0.07	-	-	-	-	-	-	0.11
iC7-60SLIN07-945AE00F_	2xIM12L	945	6.93	0.07	9.30	0.09	11.40	0.11	-	-	0.05
iC7-60SLIN07-1060E00F_	2xIM12L	1060	7.95	0.08	9.83	0.10	11.95	0.12	-	-	0.08
iC7-60SLIN07-1230E00F_	2xIM12L	1230	9.57	0.10	12.02	0.12	-	-	-	-	0.11
iC7-60SLIN07-1400E00F_	2xIM12L	1400	11.33	0.11	14.30	0.14	-	-	-	-	0.13
iC7-60SLIN07-1500E00F_	2xIM12L	1500	12.44	0.13	-	-	-	-	-	-	0.16
iC7-60SLIN07-1640E00F_	2xIM12L	1640	14.10	0.14	-	-	-	-	-	-	0.19
iC7-60SLIN07-1795E00F_	3xIM12L	1795	13.86	0.14	16.80	0.17	21.00	0.21	-	-	0.18
iC7-60SLIN07-2080E00F_	3xIM12L	2080	16.79	0.17	21.14	0.21	-	-	-	-	0.20
iC7-60SLIN07-2300E00F_	3xIM12L	2300	19.24	0.19	-	-	-	-	-	-	0.23

Table 73: Power Loss for INU Modules without Options, Modulator Type 1 ***(continued)***

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKF X[(1)]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLIN07-2500E00F_	3xIM12L	2500	21.64	0.22	-	-	-	-	-	-	0.31
iC7-60SLIN07-2830E00F_	4xIM12L	2830	23.00	0.23	28.94	0.29	-	-	-	-	0.26
iC7-60SLIN07-3050E00F_	4xIM12L	3050	25.47	0.26	-	-	-	-	-	-	0.31
iC7-60SLIN07-3260E00F_	4xIM12L	3260	27.95	0.28	-	-	-	-	-	-	0.48
iC7-60SLIN07-3500E00F_	5xIM12L	3500	28.33	0.29	35.75	0.36	-	-	-	-	0.33
iC7-60SLIN07-4035E00F_	5xIM12L	4035	34.45	0.35	-	-	-	-	-	-	0.51
iC7-60SLIN07-4400E00F_	6xIM12L	4400	36.21	0.37	-	-	-	-	-	-	0.54
iC7-60SLIN07-4850E00F_	6xIM12L	4850	41.45	0.42	-	-	-	-	-	-	0.58
iC7-60SLIN07-5300E00F_	7xIM12L	5300	44.14	0.45	-	-	-	-	-	-	0.59
iC7-60SLIN07-5600E00F_	7xIM12L	5600	47.64	0.48	-	-	-	-	-	-	0.67
iC7-60SLIN07-6100E00F_	8xIM12L	6100	50.94	0.51	-	-	-	-	-	-	0.67
iC7-60SLIN07-6400E00F_	8xIM12L	6400	54.45	0.55	-	-	-	-	-	-	0.77

1) DC fuses

10.7.9 Power Losses of INU Modules without Options, Voltage Class 07, Modulator Type 2 – Optimized

- The specifications for the values in the table
  - Inverter module
  - 525–690 V AC (640–1100 V DC)
  - DC voltage 1025 V DC
  - Switching frequency 2, 3, 4, or 6 kHz

- Modulator type 2

Table 74: Power Loss for INU Modules without Options, Modulator Type 2

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKF X(1)
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLIN07-170AE00F_	IM10L	170	1.00	0.01	1.20	0.01	1.47	0.01	1.83	0.02	0.01
iC7-60SLIN07-208AE00F_	IM10L	208	1.25	0.01	1.49	0.02	1.83	0.02	2.27	0.02	0.02
iC7-60SLIN07-261AE00F_	IM10L	261	1.68	0.02	1.95	0.02	2.37	0.02	2.99	0.03	0.02
iC7-60SLIN07-325AE00F_	IM10L	325	2.21	0.02	2.57	0.03	3.15	0.03	-	-	0.04
iC7-60SLIN07-365AE00F_	IM10L	365	2.68	0.03	3.00	0.03	3.93	0.04	-	-	0.04
iC7-60SLIN07-416AE00F_	IM10L	416	3.13	0.03	3.60	0.04	-	-	-	-	0.05
iC7-60SLIN07-465AE00F_	IM12L	465	2.91	0.03	3.40	0.03	4.27	0.04	5.15	0.05	0.03
iC7-60SLIN07-525AE00F_	IM12L	525	3.36	0.03	3.93	0.04	4.93	0.05	5.97	0.06	0.04
iC7-60SLIN07-590AE00F_	IM12L	590	3.97	0.04	4.54	0.05	5.82	0.06	6.94	0.07	0.06
iC7-60SLIN07-650AE00F_	IM12L	650	4.43	0.04	5.14	0.05	6.50	0.06	-	-	0.07
iC7-60SLIN07-730AE00F_	IM12L	730	5.37	0.05	6.00	0.06	7.87	0.08	-	-	0.08
iC7-60SLIN07-820AE00F_	IM12L	820	6.24	0.06	7.05	0.07	-	-	-	-	0.11
iC7-60SLIN07-945AE00F_	2xIM12L	945	6.35	0.06	6.93	0.07	9.31	0.09	11.40	0.11	0.05
iC7-60SLIN07-1060E00F_	2xIM12L	1060	6.73	0.07	7.95	0.08	9.88	0.10	11.95	0.12	0.08
iC7-60SLIN07-1230E00F_	2xIM12L	1230	8.23	0.08	9.57	0.10	12.07	0.12	-	-	0.11

Table 74: Power Loss for INU Modules without Options, Modulator Type 2 *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKF X[(1)]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLIN07-1400E00F_	2xIM12L	1400	9.80	0.10	11.33	0.11	14.37	0.14	-	-	0.13
iC7-60SLIN07-1500E00F_	2xIM12L	1500	10.79	0.11	12.44	0.13	15.84	0.16	-	-	0.16
iC7-60SLIN07-1640E00F_	2xIM12L	1640	12.23	0.12	14.10	0.14	-	-	-	-	0.19
iC7-60SLIN07-1795E00F_	3xIM12L	1795	11.53	0.12	13.86	0.14	16.92	0.17	21.00	0.21	0.18
iC7-60SLIN07-2080E00F_	3xIM12L	2080	14.48	0.14	16.79	0.17	21.25	0.21	-	-	0.20
iC7-60SLIN07-2300E00F_	3xIM12L	2300	16.63	0.17	19.24	0.19	-	-	-	-	0.23
iC7-60SLIN07-2500E00F_	3xIM12L	2500	18.77	0.19	21.64	0.22	-	-	-	-	0.31
iC7-60SLIN07-2830E00F_	4xIM12L	2830	19.82	0.20	23.00	0.23	29.09	0.29	-	-	0.26
iC7-60SLIN07-3050E00F_	4xIM12L	3050	22.15	0.22	25.47	0.26	-	-	-	-	0.31
iC7-60SLIN07-3260E00F_	4xIM12L	3260	24.43	0.24	27.95	0.28	-	-	-	-	0.48
iC7-60SLIN07-3500E00F_	5xIM12L	3500	24.49	0.24	28.33	0.29	35.93	0.36	-	-	0.33
iC7-60SLIN07-4035E00F_	5xIM12L	4035	29.85	0.30	34.45	0.35	-	-	-	-	0.51
iC7-60SLIN07-4400E00F_	6xIM12L	4400	32.21	0.32	36.21	0.37	47.24	0.47	-	-	0.54
iC7-60SLIN07-4850E00F_	6xIM12L	4850	35.83	0.36	41.45	0.42	-	-	-	-	0.58
iC7-60SLIN07-5300E00F_	7xIM12L	5300	37.82	0.38	44.14	0.45	55.51	0.56	-	-	0.59
iC7-60SLIN07-5600E00F_	7xIM12L	5600	41.75	0.42	47.64	0.48	-	-	-	-	0.67

Table 74: Power Loss for INU Modules without Options, Modulator Type 2 *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKFX[1]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLIN07-6100E00F_	8xIM12L	6100	44.30	0.44	50.94	0.51	-	-	-	-	0.67
iC7-60SLIN07-6400E00F_	8xIM12L	6400	47.19	0.47	54.45	0.55	-	-	-	-	0.77

1) DC fuses

10.7.10 Power Losses of INU Modules with +AEU1, Voltage Class B5, Motor Cable Maximum Length 150 m (492 ft)

- The specifications for the values in the table
  - Inverter module
  - 380–500 V AC (465–800 V DC)
  - DC voltage 594 V DC
  - Option +AEU1
  - Switching frequency 2 kHz or 3 kHz
  - Modulator type 2
  - Motor cable length a maximum of 150 m (492 ft)

Table 75: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 150 m (492 ft)

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency[1]		System module and +AEU1, 3 kHz switching frequency[1]		+AKFX[2]	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLINB5-206AE00F_	IR10L	206	1.64	0.06	1.94	0.07	0.02	0.036
iC7-60SLINB5-245AE00F_	IR10L	245	1.97	0.07	2.31	0.08	0.02	0.036
iC7-60SLINB5-302AE00F_	IR10L	302	2.51	0.09	2.92	0.10	0.04	0.036
iC7-60SLINB5-385AE00F_	IR10L	385	3.55	0.14	4.12	0.15	0.04	0.036
iC7-60SLINB5-416AE00F_	IR10L	416	3.94	0.16	4.55	0.17	0.05	0.036
iC7-60SLINB5-525AE00F_	IR10L	525	4.05	0.13	4.82	0.15	0.04	0.072

Table 75: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 150 m (492 ft) ***(continued)***

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency(1)		System module and +AEU1, 3 kHz switching frequency(1)		+AKFX (2)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLINB5-590AE00F_	IR12L	590	4.59	0.15	5.45	0.17	0.06	0.072
iC7-60SLINB5-650AE00F_	IR12L	650	5.16	0.17	6.17	0.19	0.07	0.072
iC7-60SLINB5-730AE00F_	IR12L	730	6.08	0.20	7.17	0.22	0.08	0.072
iC7-60SLINB5-820AE00F_	IR12L	820	7.18	0.24	8.49	0.27	0.11	0.072
iC7-60SLINB5-1060AE00F_	2xIR12L	1060	8.16	0.26	9.73	0.30	0.08	0.144
iC7-60SLINB5-1230AE00F_	2xIR12L	1230	9.66	0.31	11.42	0.35	0.11	0.144
iC7-60SLINB5-1400AE00F_	2xIR12L	1400	11.27	0.36	13.27	0.40	0.13	0.144
iC7-60SLINB5-1500AE00F_	2xIR12L	1500	12.84	0.42	15.23	0.48	0.16	0.144
iC7-60SLINB5-1640AE00F_	2xIR12L	1640	14.36	0.47	16.98	0.53	0.19	0.144
iC7-60SLINB5-1795AE00F_	3xIR12L	1795	14.43	0.47	17.18	0.54	0.18	0.216
iC7-60SLINB5-2080AE00F_	3xIR12L	2080	17.14	0.56	20.25	0.63	0.20	0.216
iC7-60SLINB5-2300AE00F_	3xIR12L	2300	19.77	0.65	23.45	0.74	0.23	0.216
iC7-60SLINB5-2500AE00F_	3xIR12L	2500	21.97	0.73	25.98	0.82	0.31	0.216
iC7-60SLINB5-2830AE00F_	4xIR12L	2830	23.42	0.76	27.64	0.86	0.26	0.288
iC7-60SLINB5-3050AE00F_	4xIR12L	3050	26.15	0.86	31.07	0.98	0.31	0.288
iC7-60SLINB5-3260AE00F_	4xIR12L	3260	28.57	0.94	33.69	1.06	0.48	0.288

1) System module and the dU/dt Filter in the integration unit

2) DC fuses

10.7.11 Power Losses of INU Modules with +AEU1, Voltage Class B5, Motor Cable Maximum Length 50 m (164 ft)

- The specifications for the values in the table
  - Inverter module
  - 380–500 V AC (465–800 V DC)
  - DC voltage 594 V DC
  - Option +AEU1
  - Switching frequency 2 kHz or 3 kHz
  - Modulator type 2
  - Motor cable length a maximum of 50 m (164 ft)

Table 76: Power Loss for INU Modules with Option +AEU1, Motor Cable Maximum Length 50 m (164 ft)

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module and +AEU1, 2 kHz switching frequency(1)		System module and +AEU1, 3 kHz switching frequency(1)		+AKFX(2)	Standby loss [kW]
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]	
iC7-60SLINB5-206AE00F_	IR10L	206	1.56	0.06	1.84	0.06	0.02	0.036
iC7-60SLINB5-245AE00F_	IR10L	245	1.89	0.07	2.21	0.08	0.02	0.036
iC7-60SLINB5-302AE00F_	IR10L	302	2.43	0.09	2.81	0.10	0.04	0.036
iC7-60SLINB5-385AE00F_	IR10L	385	3.39	0.13	3.90	0.14	0.04	0.036
iC7-60SLINB5-416AE00F_	IR10L	416	3.78	0.15	4.33	0.16	0.05	0.036
iC7-60SLINB5-525AE00F_	IR10L	525	3.86	0.12	4.56	0.13	0.04	0.072
iC7-60SLINB5-590AE00F_	IR12L	590	4.41	0.14	5.19	0.15	0.06	0.072
iC7-60SLINB5-650AE00F_	IR12L	650	4.98	0.16	5.91	0.17	0.07	0.072
iC7-60SLINB5-730AE00F_	IR12L	730	5.80	0.18	6.79	0.20	0.08	0.072
iC7-60SLINB5-820AE00F_	IR12L	820	6.83	0.22	7.96	0.24	0.11	0.072
iC7-60SLINB5-1060AE00F_	2xIR12L	1060	7.79	0.24	9.21	0.27	0.08	0.144
iC7-60SLINB5-1230AE00F_	2xIR12L	1230	9.30	0.29	10.90	0.32	0.11	0.144
iC7-60SLINB5-1400AE00F_	2xIR12L	1400	10.91	0.34	12.75	0.38	0.13	0.144
iC7-60SLINB5-1500AE00F_	2xIR12L	1500	12.13	0.39	14.17	0.43	0.16	0.144
iC7-60SLINB5-1640AE00F_	2xIR12L	1640	13.65	0.44	15.92	0.48	0.19	0.144
iC7-60SLINB5-1795AE00F_	3xIR12L	1795	13.60	0.43	16.02	0.48	0.18	0.216
iC7-60SLINB5-2080AE00F_	3xIR12L	2080	16.32	0.51	19.09	0.57	0.20	0.216
iC7-60SLINB5-2300AE00F_	3xIR12L	2300	18.71	0.60	21.86	0.66	0.23	0.216
iC7-60SLINB5-2500AE00F_	3xIR12L	2500	20.90	0.67	24.39	0.73	0.31	0.216
iC7-60SLINB5-2830AE00F_	4xIR12L	2830	22.31	0.70	26.10	0.78	0.26	0.288
iC7-60SLINB5-3050AE00F_	4xIR12L	3050	24.73	0.79	28.95	0.87	0.31	0.288
iC7-60SLINB5-3260AE00F_	4xIR12L	3260	27.15	0.87	31.57	0.95	0.48	0.288

1) System module and the dU/dt Filter in the integration unit

2) DC fuses

10.7.12 Power Losses of INU Modules without Options, Voltage Class B5, Modulator Type 1 – SVPWM

- The specifications for the values in the table
  - Inverter module
  - 380–500 V AC (465–800 V DC)

- DC voltage 594 V DC
- Switching frequency 2, 3, 4, or 6 kHz
- Modulator type 1

Table 77: Power Loss for INU Modules without Options, Modulator Type 1

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKFX (1)
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLINB5-206AE00F_	IM10L	206	1.18	0.01	1.39	0.01	1.60	0.02	2.03	0.02	0.02
iC7-60SLINB5-245AE00F_	IM10L	245	1.45	0.01	1.69	0.02	1.94	0.02	2.46	0.02	0.02
iC7-60SLINB5-302AE00F_	IM10L	302	1.87	0.02	2.17	0.02	2.49	0.02	3.17	0.03	0.04
iC7-60SLINB5-385AE00F_	IM10L	385	2.58	0.03	2.99	0.03	3.42	0.03	4.37	0.04	0.04
iC7-60SLINB5-416AE00F_	IM10L	416	2.88	0.03	3.33	0.03	3.81	0.04	4.88	0.05	0.05
iC7-60SLINB5-525AE00F_	IM10L	525	3.15	0.03	3.65	0.04	4.19	0.04	5.33	0.05	0.04
iC7-60SLINB5-590AE00F_	IM12L	590	3.64	0.04	4.22	0.04	4.84	0.05	6.16	0.06	0.06
iC7-60SLINB5-650AE00F_	IM12L	650	4.18	0.04	5.79	0.06	5.47	0.05	6.97	0.07	0.07
iC7-60SLINB5-730AE00F_	IM12L	730	4.80	0.05	5.57	0.06	6.37	0.06	8.13	0.08	0.08
iC7-60SLINB5-820AE00F_	IM12L	820	5.63	0.06	6.52	0.07	7.44	0.07	9.58	0.10	0.11
iC7-60SLINB5-1060AE00F_	2xIM12L	1060	6.37	0.06	7.43	0.07	8.51	0.09	10.79	0.11	0.08
iC7-60SLINB5-1230AE00F_	2xIM12L	1230	7.67	0.08	8.94	0.09	10.22	0.10	12.98	0.13	0.11
iC7-60SLINB5-1400AE00F_	2xIM12L	1400	9.08	0.09	10.54	0.11	12.06	0.12	15.34	0.15	0.13
iC7-60SLINB5-1500AE00F_	2xIM12L	1500	9.96	0.10	11.55	0.12	13.23	0.13	16.87	0.17	0.16

Table 77: Power Loss for INU Modules without Options, Modulator Type 1 *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKFX (1)
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLINB5-1640AE00F_	2xIM12L	1640	11.27	0.11	13.03	0.13	14.87	0.15	19.15	0.19	0.19
iC7-60SLINB5-1795AE00F_	3xIM12L	1795	11.11	0.11	12.90	0.13	14.76	0.15	18.77	0.19	0.18
iC7-60SLINB5-2080AE00F_	3xIM12L	2080	13.45	0.13	15.62	0.16	17.84	0.18	22.76	0.23	0.20
iC7-60SLINB5-2300AE00F_	3xIM12L	2300	15.40	0.15	17.84	0.18	20.42	0.20	26.06	0.26	0.23
iC7-60SLINB5-2500AE00F_	3xIM12L	2500	17.29	0.17	20.00	0.20	22.88	0.23	29.30	0.29	0.31
iC7-60SLINB5-2830AE00F_	4xIM12L	2830	18.42	0.18	21.34	0.21	24.46	0.24	31.18	0.31	0.26
iC7-60SLINB5-3050AE00F_	4xIM12L	3050	20.38	0.20	23.61	0.24	26.97	0.27	34.49	0.34	0.31
iC7-60SLINB5-3260AE00F_	4xIM12L	3260	22.34	0.22	25.90	0.26	29.66	0.30	37.98	0.38	0.48

1) DC fuses

10.7.13 Power Losses of INU Modules without Options, Voltage Class B5, Modulator Type 2 – Optimized

- The specifications for the values in the table
  - Inverter module
  - 380–500 V AC (465–800 V DC)
  - DC voltage 594 V DC
  - Switching frequency 2, 3, 4, or 6 kHz
  - Modulator type 2

Table 78: Power Loss for INU Modules without Options, Modulator Type 2

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKFX (1)
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLINB5-206AE00F_	IM10L	206	1.05	0.01	1.25	0.01	1.33	0.01	1.60	0.02	0.02
iC7-60SLINB5-245AE00F_	IM10L	245	1.29	0.01	1.53	0.02	1.62	0.02	1.94	0.02	0.02
iC7-60SLINB5-302AE00F_	IM10L	302	1.67	0.02	1.98	0.02	2.08	0.02	2.49	0.02	0.04
iC7-60SLINB5-385AE00F_	IM10L	385	2.30	0.02	2.72	0.03	2.86	0.03	3.42	0.03	0.04
iC7-60SLINB5-416AE00F_	IM10L	416	2.57	0.03	3.04	0.03	3.19	0.03	3.81	0.04	0.05
iC7-60SLINB5-525AE00F_	IM10L	525	2.81	0.03	3.32	0.03	3.51	0.04	4.19	0.04	0.04
iC7-60SLINB5-590AE00F_	IM12L	590	3.24	0.03	3.84	0.04	4.04	0.04	4.84	0.05	0.06
iC7-60SLINB5-650AE00F_	IM12L	650	3.67	0.04	4.41	0.04	4.59	0.05	5.47	0.05	0.07
iC7-60SLINB5-730AE00F_	IM12L	730	4.29	0.04	5.07	0.05	5.33	0.05	6.37	0.06	0.08
iC7-60SLINB5-820AE00F_	IM12L	820	5.04	0.05	5.95	0.06	6.26	0.06	7.44	0.07	0.11
iC7-60SLINB5-1060AE00F_	2xIM12L	1060	5.67	0.06	6.72	0.07	7.11	0.07	8.51	0.09	0.08
iC7-60SLINB5-1230AE00F_	2xIM12L	1230	6.86	0.07	8.09	0.08	8.54	0.09	10.22	0.10	0.11
iC7-60SLINB5-1400AE00F_	2xIM12L	1400	8.10	0.08	9.58	0.10	10.10	0.10	12.06	0.12	0.13
iC7-60SLINB5-1500AE00F_	2xIM12L	1500	8.91	0.09	10.51	0.11	11.07	0.11	13.23	0.13	0.16
iC7-60SLINB5-1640AE00F_	2xIM12L	1640	10.07	0.10	11.90	0.12	12.51	0.13	14.87	0.15	0.19
iC7-60SLINB5-1795AE00F_	3xIM12L	1795	9.90	0.10	11.72	0.12	12.36	0.12	14.76	0.15	0.18

Table 78: Power Loss for INU Modules without Options, Modulator Type 2 *(continued)*

Model code	Frame	Rated current $I_{L(1/5)}$ [A]	System module, 2 kHz switching frequency		System module, 3 kHz switching frequency		System module, 4 kHz switching frequency		System module, 6 kHz switching frequency		+AKFX (1)
			Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]	Power loss to air [kW]
iC7-60SLINB5-2080AE00F_	3xIM12L	2080	12.02	0.12	14.19	0.14	14.96	0.15	17.84	0.18	0.20
iC7-60SLINB5-2300AE00F_	3xIM12L	2300	13.76	0.14	16.25	0.16	17.06	0.17	20.42	0.20	0.23
iC7-60SLINB5-2500AE00F_	3xIM12L	2500	15.44	0.15	18.27	0.18	19.16	0.19	22.88	0.23	0.31
iC7-60SLINB5-2830AE00F_	4xIM12L	2830	16.46	0.16	19.43	0.19	20.46	0.20	24.46	0.24	0.26
iC7-60SLINB5-3050AE00F_	4xIM12L	3050	18.17	0.18	21.52	0.22	22.57	0.23	26.97	0.27	0.31
iC7-60SLINB5-3260AE00F_	4xIM12L	3260	20.06	0.20	23.60	0.24	24.86	0.25	29.66	0.30	0.48

1) DC fuses

10.7.14 Power Losses of DC/DC Converter Modules, Voltage Class 07

- The specifications for the values in the table
  - DC/DC converter module
  - DC voltage 1025 V DC
  - Default switching frequency
  - Power losses at rated low overload current I_L, 50% duty cycle

Table 79: Power Loss for DC/DC Converter Modules

Product code	Frame		Nominal current I_L [A]	System module		System module with +AED1 (1)		DC fuses +AKFF (2) [kW]	Standby loss [kW]
	System module	System module with +AED1		Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]		
07-300A	DM10L	DR10L	300	2.61	0.03	2.94	0.06	0.08	0.07
07-360A	DM10L	DR10L	360	3.16	0.03	3.54	0.07	0.11	0.07
07-420A	DM10L	DR10L	420	3.76	0.04	4.20	0.09	0.13	0.07
07-480A	DM10L	DR10L	480	3.84	0.04	4.40	0.10	0.14	0.07
07-570A	DM10L	DR10L	570	4.08	0.04	4.87	0.13	0.19	0.07

Table 79: Power Loss for DC/DC Converter Modules *(continued)*

Product code	Frame		Nominal current I_L [A]	System module		System module with +AED1[1]		DC fuses +AKFF[2] [kW]	Standby loss [kW]
	System module	System module with +AED1		Power loss to liquid [kW]	Power loss to air [kW]	Power loss to liquid [kW]	Power loss to air [kW]		
07-720A	DM12L	DR12L	720	4.79	0.05	5.80	0.16	0.24	0.13
07-840A	DM12L	DR12L	840	5.67	0.06	6.98	0.20	0.31	0.13
07-960A	DM12L	DR12L	960	6.61	0.07	8.30	0.26	0.33	0.13
07-1080	DM12L	DR12L	1080	7.63	0.08	9.76	0.31	0.34	0.13
07-1200	DM12L	DR12L	1200	8.73	0.09	11.36	0.38	0.45	0.13
07-1440	2xDM12L	2xDR12L	1440	9.58	0.10	11.59	0.32	0.46	0.26
07-1680	2xDM12L	2xDR12L	1680	11.33	0.11	13.97	0.41	0.60	0.26
07-1920	2xDM12L	2xDR12L	1920	13.22	0.13	16.61	0.51	0.68	0.26
07-2160	2xDM12L	2xDR12L	2160	15.25	0.15	19.53	0.63	0.69	0.26
07-2400	2xDM12L	2xDR12L	2400	17.46	0.18	22.73	0.76	0.81	0.26
07-2880	3xDM12L	3xDR12L	2880	19.82	0.20	24.91	0.77	1.02	0.39
07-3240	3xDM12L	3xDR12L	3240	22.88	0.23	29.29	0.94	1.03	0.39
07-3600	3xDM12L	3xDR12L	3600	26.19	0.27	34.09	1.14	1.21	0.39

1) +AED1 = LC Filter

2) +AKFF = DC bus fuses and source fuses

10.7.15 Power Losses of DC/DC Converter Modules, Voltage Class B5

- The specifications for the values in the table
  - DC/DC converter module
  - DC voltage 594 V DC
  - Default switching frequency
  - Power losses at rated low overload current I_L, 50% duty cycle

Table 80: Power Loss for DC/DC Converter Modules

Product code	Frame		Nominal current I_L [A]	Power loss [kW]			Standby loss [kW]
	System module	System module with +AED1		System module	System module with +AED1[1]	DC fuses +AKFF[2]	
B5-300A	DM10L	DR10L	300	1.64	1.83	0.08	0.04
B5-360A	DM10L	DR10L	360	1.95	2.19	0.11	0.04
B5-420A	DM10L	DR10L	420	2.28	2.58	0.13	0.04

Table 80: Power Loss for DC/DC Converter Modules *(continued)*

Product code	Frame		Nominal current I_L [A]	Power loss [kW]			Standby loss [kW]
	System module	System module with +AED1		System module	System module with +AED1 (1)	DC fuses +AKFF (2)	
B5-480A	DM10L	DR10L	480	2.63	3.00	0.14	0.04
B5-570A	DM10L	DR10L	570	3.20	3.70	0.19	0.04
B5-720A	DM12L	DR12L	720	3.51	4.19	0.24	0.07
B5-840A	DM12L	DR12L	840	4.11	5.03	0.31	0.07
B5-960A	DM12L	DR12L	960	4.74	5.94	0.33	0.07
B5-1080	DM12L	DR12L	1080	5.42	6.95	0.34	0.07
B5-1200	DM12L	DR12L	1200	6.13	8.04	0.45	0.07
B5-1440	2xDM12L	2xDR12L	1440	7.02	8.38	0.46	0.14
B5-1680	2xDM12L	2xDR12L	1680	8.22	10.06	0.60	0.14
B5-1920	2xDM12L	2xDR12L	1920	9.49	11.89	0.68	0.14
B5-2160	2xDM12L	2xDR12L	2160	10.83	13.89	0.69	0.14
B5-2400	2xDM12L	2xDR12L	2400	12.26	16.08	0.81	0.14
B5-2880	3xDM12L	3xDR12L	2880	14.23	17.83	1.02	0.22
B5-3240	3xDM12L	3xDR12L	3240	16.24	20.84	1.03	0.22
B5-3600	3xDM12L	3xDR12L	3600	18.38	24.12	1.21	0.22

1) +AED1 = LC Filter

2) +AKFF = DC bus fuses and source fuses

10.8 Technical Data

Table 81: Technical Data

Technical item or function		Technical data
Mains connection, Protective Class I	Input voltage U_{in}	Voltage class 07: 3 x 525–690 V AC (-15…+10%) Voltage class B5: 3 x 380–500 V AC (-15…+10%)
	Input frequency	45–66 Hz for AFE/GC 25–70 Hz for GC. Low frequency operation below 45 Hz with derating of 0.2%/Hz
	Default switching frequency, AFE/GC	8 kHz
	Mains network	TN-S, TN-C, IT and TT. Supply voltage limited to 500 V AC for corner grounded networks, Wye/Delta.
	Power factor	cos φ = 1: (fundamental) (AFE) cos φ = 0 ind. to 0 cap: (fundamental) (GC)
	Total harmonics distortion THDi (nominal current and undistorted network)	AFE/GC modules: < 5% AFE/GC modules with a dedicated transformer: < 3%
	Short-circuit current rating, with the specified fuses	The maximum short circuit current I_{cc} ≤ 100 kA The time constant L/R of the fault loop impedance <10 ms for DC fuses.
	Overvoltage category	Category III
	Imbalance	Nominal performance with voltage imbalance ≤ 3%. Derated performance with >3% voltage imbalance.
	Connections to mains	Once every 60 s for 5 minutes, then pause of 10 minutes

Table 81: Technical Data *(continued)*

Technical item or function		Technical data
Motor connection	Output voltage	0–U_{in}, 3-phase
	Output frequency	0–599 Hz
	Switching frequency, INU	1.5–10 kHz Default: 3 kHz Default: 8 kHz with +AES1
	Field weakening point	1–600 Hz
	Motor control principles	U/f control VVC+ (Vector Voltage Control) Flux Vector Control
	Motor and generator types supported	Induction/asynchronous motor Non-Salient Permanent Magnet Motor Salient Permanent Magnet Motor Synchronous Reluctance Assisted Permanent Magnet Motor
	Torque control, torque step rise time	Open loop: <5 ms with nominal torque and <1 ms with nominal torque with AFE supply Closed loop: <5 ms with nominal torque and <1 ms with nominal torque with AFE supply
	Torque control, static accuracy	Open loop: <2% of motor nominal torque up to nominal speed and <4% of motor nominal torque in the field weakening area Closed loop: <2% of motor nominal torque up to nominal speed and <4% of motor nominal torque in the field weakening area
	Speed control, static accuracy	Open loop: 5% of motor nominal slip up to motor nominal motor frequency and 10% of motor nominal slip in the field weakening area Closed loop: 0.01% static error of nominal speed with encoder PPR of 1024 or better
	Speed control, dynamic accuracy (response)	Open loop: 0.2–0.4% s with nominal torque step Closed loop: 0.1–0.2% s with nominal torque step
	Motor control resolution	Reference setpoint resolution 31 bit + sign
	Cable length	Up to 150 m symmetrical and shielded motor cable. See the cable restrictions for filters in 7.13.1 dU/dt Filter and 7.13.2 Common-mode Filter.

Table 81: Technical Data *(continued)*

Technical item or function		Technical data
DC-bus connection	Nominal DC-bus voltage	Voltage class 07: 1025 V DC Voltage class B5: 742 V DC
	DC-bus voltage range	Voltage class 07: 640–1100 V DC (-0...+0%) DC/DC: Start-up and short-term operation 350–640 V DC Voltage class B5: 465–800 V DC (-0...+0%) GC, DC/DC: Start-up and short-term operation 350–465 V DC
	Capacitance	AM10L, IM10L, DM10L, AR10L, IR10L, DR10L: 1600 µF AM12L, IM12L, DM12L, AR12L, IR12L, DR12L: 3200 µF
DC/DC converter DC-source connection	Source voltage range	3–100% of DC-bus voltage with limited control performance 3–97% of DC-bus voltage with full control performance
	Maximum short-circuit current from DC source	Up to 100 kA if the time constant L/R of the fault loop impedance <15 ms. Valid for recommended fuse selection. Consult Danfoss for fuse selection if L/R >15 ms.
	Source current ripple with DC filter (+AED1/OF7D1)	DR10L/DC10L: <1% of I_N RMS typical DR12L/DC12L: <0.5% of I_N RMS typical
	Default switching frequency	07: • 570–3600 A: 6 kHz • 480 A: 7 kHz • 300–420 A: 8 kHz B5: • DM10L/DR10L 300 A, 360 A, 420 A, 480 A: 8 kHz • DM10L/DR10L 570 A: 6 kHz • DM12L/DR12L: 6 kHz
	DC/DC Converter control principles	DC-bus voltage reference Source voltage reference Source power and current references Current and voltage limit controllers
Control electronic connection	Input voltage U_{in}	24 V DC (20.4–28.8 V), DVC As, implemented in accordance with IEC/EN 61800-5-1, minimum power 20 W Ground = negative polarity grounded via the electronics For details, see 8.1 Modular Control Unit.

Table 81: Technical Data *(continued)*

Technical item or function		Technical data
Ambient conditions	Protection rating	IP00/NEMA/UL Open Type
	Surrounding operating temperature	Power units: -15 (no frost)…+60 °C (5...140 °F) at I_N Control units: -15 (no frost)…+55 °C (5...131 °F) at I_N
	Installation temperature	-10...+70 °C (14...158°F)
	Storage/transportation temperature	-40…+70 °C (–40...158°F) Glycol to be used in the coolant when temperature is under 0 °C (32 °F). Freezing not allowed. No coolant allowed in modules during storage/transportation.
	Relative humidity	5–96% RH, no condensation, no dripping water
	Environmental conditions storage (IEC 60721-3-1)	Climatic conditions: Class 1K21 Chemically active substances: Class 1C2 Biological conditions: Class 1B1 Mechanically active substances: Class 1S12
	Environmental conditions transportation (IEC 60721-3-2)	Climatic conditions: Class 2K11 Chemically active substances: Class 2C2 Biological conditions: Class 2B1 Mechanical conditions: Class 2M5 Mechanically active substances: Class 2S5
	Environmental conditions operation (IEC 60721-3-3)	Climatic conditions: Class 3K22 Chemically active substances: IEC 60721-3-3 Edition 3.0/ ISO 3223 Second Edition, class C4 Biological conditions: Class 3B1 Mechanically active substances: Class 3S6 Special climatic conditions (heat radiation): Class 3Z1
	Pollution degree	PD3
	Altitude	0–4000 m (0–13000 ft) above sea level, when the network is not corner grounded: Voltage class B5 0–3000 m (0–10000 ft) above sea level: Voltage class 07 without AFE supply 0–2000 m (0–6500 ft): Voltage class 07 with AFE supply Above 1000 m (0–3000 ft): Derating of maximum surrounding operating temperature by 0.5 °C per each 100 m (0.9 °F per each 330 ft) is required.

Table 81: Technical Data *(continued)*

Technical item or function		Technical data
	Vibration (IEC 60068-2-6) • IEC/EN 61800-5-1 + A1 • IEC/EN 62477-1 + A1 • IACS UR E10	Testing was performed according to IEC/EN 61800-5-1 + A1 and IEC/EN 62477-1 + A1, with these specifications: • Frequency range 5–150 Hz • Amplitude ±0.5 mm, 5–22.29 Hz • Constant peak acceleration 10 m/s^2 (1 g_n), 22.29–150 Hz Testing was performed according to IACS UR E10, with these specifications: • Frequency range 2–100 Hz • Amplitude ±1.0 mm, 2–13.2 Hz • Constant peak acceleration 7 m/s^2 (0.7 g_n), 13.2–100 Hz with maximum amplification of 5
	Shock (IEC 60068-2-27)	Maximum 15 g, 11 ms (in package)
	Noise level (1)	• IM10L, AM10L, IR10L, AR10L, IR12L, AR12L: 70 dB(A) • DM10L, DM12L, DR10L, DR12L: max. 87 dB(A) at worst case operation point • 2 modules in parallel: +3 dB(A) • 3 modules in parallel: +4.8 dB(A) • 4 modules in parallel: +6 dB(A) • 5 modules in parallel: +7 dB(A) • 6 modules in parallel: +7.8 dB(A) • 7 modules in parallel: +8.5 dB(A) • 8 modules in parallel: +9 dB(A)
EMC	Immunity	Fulfills IEC/EN 61800-3 + A1, 1st and 2nd environment Fulfills IEC/EN 61000-6-2
	Emissions	525–690 V AC: IEC/EN 61800-3 + A1, category C3, when C3 > 100 A, if the drive is installed according to the instructions of the manufacturer. All: The EMC category can be changed to C4 for IT type mains. DC/DC converter: C4 Grid Converter: CISPR 11 (EN 55011) Class A

Table 81: Technical Data ***(continued)***

Technical item or function		Technical data
Protections	Overvoltage trip limit	Voltage class 07: 1250 V DC Voltage class B5: 911 V DC
	Undervoltage trip limit	Set by parameter Unit Voltage Class Voltage class B5: Class 13, mains voltage 380–500 V AC: 334 V DC Class 1, mains voltage 380–440 V AC: 334 V DC Class 2, mains voltage 440–480 V AC: 390 V DC Class 3, mains voltage 480–500 V AC: 503 V DC Voltage class 07: Class 13, mains voltage 525–690 V AC: 334 V DC Class 1, mains voltage 525 V AC: 334 V DC Class 2, mains voltage 600 V AC: 390 V DC Class 3, mains voltage 690 V AC: 503 V DC
	Earth fault protection	In TN and TT networks. Fulfills the requirements of IEC 60364-4-41 + AMD1, 411. Not available for DC/DC converter modules.
	Missing phase supervision	Yes
	Overcurrent protection	Yes
	Unit overtemperature protection	Yes
	Motor overload protection	Yes
	Motor stall protection	Yes
	Motor underload protection	Yes
Product compliance	Conformity	CE, RCM, UA, UKCA. See the product label of the drive for more approvals.
	Safety Standards	IEC/EN 61800-5-1 + A1 IEC/EN 62477-1 + A1
	Functional safety	–
	Marine type approvals	DNV, ABS, BV, CCS, RINA
Efficiency	Efficiency	See 10.7.1 List of Power Loss Information.

Table 81: Technical Data *(continued)*

Technical item or function		Technical data
Liquid cooling	Temperature of coolant	-10…+45 °C (14...113°F) at I_N (nominal) Except -10…+38 °C (14...100°F) at I_N(nominal) for: • AFE and GC, voltage class 07, current ratings 760 A, 1500 A, 2250 A, 2940 A, 3600 A, 4320 A, 5040 A, 5750 A • DC/DC converter, voltage class 07, current ratings 1200 A, 2400 A, 3600 A Temperature rise during circulation: • 7 °C (13 °F) for INU • 10 °C (18 °F) for AFE/GC • 5 °C (9 °F) for DC/DC converter Glycol to be used in coolant below 0 °C (32 °F). Freezing not allowed.
	Pressure limits	Recommended default pressure: 100–150 kPa (2) Maximum operating pressure (= Design pressure): 500 kPa Maximum test pressure: 750 kPa
	Pressure drop	50–100 kPa at rated volumetric flow
	Allowed coolants	Demineralized water or pure water with the quality specified in 6.3.2 Purified Water as Coolant. Ethylene glycol • DOWCAL 100 • Clariant Antifrogen N Propylene glycol • DOWCAL 200 • Clariant Antifrogen L
	Heat sink material	Aluminum

1) Measured at a distance of 1 m (3.3 ft), the product in a reference cabinet with the doors closed.

2) The default pressure is the static state pressure without operating the cooling pump. Cooling pump operation increases the pressure typically 100–200 kPa. Do not exceed the maximum operating pressure in any situation.

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