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ABB INDUSTRIAL DRIVES

# ACS880-17LC drives

## Hardware manual





# ACS880-17LC drives

## Hardware manual

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*Further information*



# 1

## Safety instructions

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### Contents of this chapter

This chapter contains the safety instructions which you must obey when you install, start-up, operate and do maintenance work on the drive. If you ignore the safety instructions, injury, death or damage can occur.

### Use of warnings and notes

Warnings tell you about conditions which can cause injury or death, or damage to the equipment. They also tell you how to prevent the danger. Notes draw attention to a particular condition or fact, or give information on a subject.

The manual uses these warning symbols:

**WARNING!**

Electricity warning tells about hazards from electricity which can cause injury or death, or damage to the equipment.

---

**WARNING!**

General warning tells about conditions other than those caused by electricity, which can cause injury or death, or damage to the equipment.

---

**WARNING!**

Electrostatic sensitive devices warning tells you about the risk of electrostatic discharge which can cause damage to the equipment.

---

## General safety in installation, start-up and maintenance

These instructions are for all personnel who do work on the drive.



### WARNING!

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

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- Keep the drive in its package until you install it. After unpacking, protect the drive from dust, debris and moisture.
- Use the required personal protective equipment: safety shoes with metal toe cap, safety glasses, protective gloves and long sleeves, etc. Some parts have sharp edges.
- Lift a heavy drive with a lifting device. Use the designated lifting points. See the dimension drawings.
- Incorrect lifting can cause danger or damage. Obey the local laws and regulations applicable to lifting, such as requirements for planning the lift, for capacity and condition of lifting equipment, and for training of personnel.
- The lifting bars attached to large drive cabinets are heavy. Be careful when removing or reinstalling the bars. Whenever possible, use a lifting device attached to the designated lifting points.
- Attach the drive cabinet to the floor to prevent it from toppling over. The cabinet has a high center of gravity. When you pull out heavy components or power modules, there is a risk of overturning. Attach the cabinet also to the wall when necessary.



- Do not stand or walk on the cabinet roof. Make sure that nothing presses against the roof, side or back plates or door. Do not store anything on the roof while the drive is in operation.
  - Be careful when handling a tall module. The module overturns easily because it is heavy and has a high center of gravity. Whenever possible, secure the module with chains. Do not leave an unsupported module unattended especially on a sloping floor.
-



- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, and brake resistors, remain hot for a while after disconnection of the electrical supply.
- Make sure that debris from drilling, cutting and grinding does not enter the drive during the installation. Electrically conductive debris inside the drive may cause damage or malfunction.
- Make sure that there is sufficient cooling. See the technical data.
- Keep the cabinet doors closed when the drive is powered. With the doors open, a risk of a potentially fatal electric shock, arc flash or high-energy arc blast exists. If you cannot avoid working on a powered drive, obey the local laws and regulations on live working (including – but not limited to – electric shock and arc protection).
- Before you adjust the drive operation limits, make sure that the motor and all driven equipment can operate throughout the set operation limits.
- Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or supply break. If these functions are activated, the installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors.
- If you have connected safety circuits to the drive (for example, Safe torque off or emergency stop), validate them at start-up. See separate instructions for the safety circuits.

**Note:**

- If you select an external source for the start command and it is on, the drive will start immediately after fault reset unless you configure the drive for pulse start. See the firmware manual.
- If the drive is in remote control mode, you cannot stop or start the drive with the control panel.
- Only authorized persons are allowed to repair a malfunctioning drive.



## ■ Work on the liquid cooling system

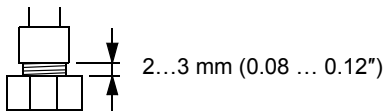
These instructions are intended for all personnel that do installation, commissioning and maintenance work on the liquid cooling system.



### WARNING!

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

- Use the required personal protective equipment. See the Safety data sheet for Antifrogen® L coolant by Clariant ([www.clariant.com](http://www.clariant.com)) for the instructions on the respiratory, hand and eye protection when handling the coolant.
- Beware of hot, high-pressure coolant (6 bar, max. 50 °C) that is present in the internal cooling circuit when it is in operation. Before you disconnect a pipe, release the pressure. Close the appropriate stop valve(s). If necessary, stop the cooling circuit pumps.
- Avoid skin contact with coolant. If coolant splashes onto the skin or in the eyes, rinse immediately with plenty of water. Do not syphon it by mouth. If you swallow or get it into the eyes, seek medical advice.
- Before the drive power up, make sure that the internal cooling circuit is filled up with coolant, and the cooling is in operation (coolant is circulating).
- Make sure that coolant meets the ABB specification. See the appropriate hardware manual of the drive/unit.
- To avoid breaking the coolant pipes, do not overtighten the nuts of the unions. Leave 2 to 3 millimeters (0.08 to 0.12 inches) of thread visible.



- Do not drain coolant into the sewer system.
- If you need to store the drive in temperature below -15 °C (5 °F), drain the cooling circuit, or make sure that it is filled with the coolant specified by ABB.
- Drives with the cooling unit: Do not open the cooling unit pump inlet or outlet valves before filling up the coolant circuit. The pumps are filled with a mixture at the factory to prevent corrosion and the valves are closed at the factory.
- Drives with the cooling unit: Do not run the cooling unit pump dry.

## Electrical safety in installation, start-up and maintenance

### ■ Electrical safety precautions

These electrical safety precautions are for all personnel who do work on the drive, motor cable or motor.



#### **WARNING!**

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

If you are not a qualified electrical professional, do not do installation or maintenance work.

Do these steps before you begin any installation or maintenance work.

1. Clearly identify the work location and equipment.
2. Disconnect all possible voltage sources. Make sure that re-connection is not possible. Lock out and tag out.
  - Open the main disconnecting device of the drive.
  - Open the charging switch if present.
  - Open the disconnecter of the supply transformer. (The main disconnecting device in the drive cabinet does not disconnect the voltage from the AC input power busbars of the drive cabinet.)
  - Close the grounding switch or switches ([Q9], option +F259) if present. Do not use excessive force as the switch has electromagnetic interlocking.
  - Open the auxiliary voltage switch-disconnector (if present), and all other possible disconnecting devices that isolate the drive from dangerous voltage sources.
  - In the liquid cooling unit (if present), open the switch-disconnector of the cooling pumps.
  - If you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
  - Disconnect all dangerous external voltages from the control circuits.
  - After you disconnect power from the drive, always wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized. Use a quality voltage tester. If the measurement requires removal or disassembly of shrouding or other cabinet structures, obey the local laws and regulations applicable to live working (including – but not limited to – electric shock and arc protection).
  - Before and after measuring the installation, verify the operation of the voltage tester on a known voltage source.
  - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is zero.
  - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is zero.



Important! Repeat the measurement also with the DC voltage setting of the tester. Measure between each phase and ground. There is a risk of dangerous DC voltage charging due to leakage capacitances of the motor circuit. This voltage can remain charged for a long time after the drive power-off. The measurement discharges the voltage.

- Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero. In cabinet-built drives, measure between the drive DC busbars (+ and -) and the grounding (PE) busbar.



**WARNING!**

The busbars inside the cabinet of liquid-cooled drives are partially coated. Measurements made through the coating are potentially unreliable, so only measure at uncoated portions. Note that the coating does not constitute a safe or touch-proof insulation.

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6. If the drive is not equipped with a grounding switch, install temporary grounding as required by the local regulations.
7. Ask for a permit to work from the person in control of the electrical installation work.

■ **Additional instructions and notes**

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**WARNING!**

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

If you are not a qualified electrical professional, do not do installation or maintenance work.

---

- Keep the cabinet doors closed when the drive is powered. With the doors open, a risk of a potentially fatal electric shock, arc flash or high-energy arc blast exists.
- Make sure that the electrical power network, motor/generator, and environmental conditions agree with the drive data.
- Do not do insulation or voltage withstand tests on the drive.
- If you have a cardiac pacemaker or other electronic medical device, keep away from the area near motor, drive, and the drive power cabling when the drive is in operation. There are electromagnetic fields present which can interfere with the function of such devices. This can cause a health hazard.
- ABB does not recommend attaching the cabinet by arc welding. If you have to, obey the welding instructions in the drive manuals.

**Note:**

- When the drive is connected to the input power, the motor cable terminals and the DC bus are at a dangerous voltage.  
After disconnecting the drive from the input power, these remain at a dangerous voltage until the intermediate circuit capacitors have discharged.
  - External wiring can supply dangerous voltages to the relay outputs of the control units of the drive.
  - The Safe torque off function does not remove the voltage from the main and auxiliary circuits. The function is not effective against deliberate sabotage or misuse.
- 



## Optical components

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**WARNING!**

Obey these instructions. If you ignore them, damage to the equipment can occur.

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- Handle the fiber optic cables with care.
- When you unplug the fiber optic cables, always hold the connector, not the cable itself.
- Do not touch the ends of the fibers with bare hands as the ends are extremely sensitive to dirt.
- Do not bend the fiber optic cables too tightly. The minimum allowed bend radius is 35 mm (1.4 in).

## Printed circuit boards

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**WARNING!**

Use a grounding wristband when you handle printed circuit boards. Do not touch the boards unnecessarily. The boards contain components sensitive to electrostatic discharge.

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### ■ Grounding

These instructions are for all personnel who are responsible for the grounding of the drive.

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**WARNING!**

Obey these instructions. If you ignore them, injury or death, or equipment malfunction can occur, and electromagnetic interference can increase.

If you are not a qualified electrical professional, do not do grounding work.

---

- Always ground the drive, the motor and adjoining equipment. This is necessary for the personnel safety.
  - Make sure that the conductivity of the protective earth (PE) conductors is sufficient and that other requirements are met. See the electrical planning instructions of the drive. Obey the applicable national and local regulations.
  - When using shielded cables, make a 360° grounding of the cable shields at the cable entries to reduce electromagnetic emission and interference.
  - In a multiple-drive installation, connect each drive separately to the protective earth (PE) busbar of the power supply.
- 



## General safety in operation

These instructions are for all personnel that operate the drive.



### **WARNING!**

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

---

- Keep the cabinet doors closed when the drive is powered. With the doors open, a risk of a potentially fatal electric shock, arc flash or high-energy arc blast exists.
- If you have a cardiac pacemaker or other electronic medical device, keep away from the area near motor, drive, and the drive power cabling when the drive is in operation. There are electromagnetic fields present which can interfere with the function of such devices. This can cause a health hazard.
- Give a stop command to the drive before you reset a fault. If you have an external source for the start command and the start is on, the drive will start immediately after the fault reset, unless you configure the drive for pulse start. See the firmware manual.
- Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or supply break. If these functions are activated, the installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".

### **Note:**

- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors. If you need to start or stop the drive, use the control panel keys or commands through the I/O terminals of the drive.
- If the drive is in remote control mode, you cannot stop or start the drive with the control panel.

## Additional instructions for permanent magnet motor drives

### ■ Safety in installation, start-up, maintenance

These are additional warnings concerning permanent magnet motor drives. The other safety instructions in this chapter are also valid.

---



### **WARNING!**

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

If you are not a qualified electrical professional, do not do installation or maintenance work.

---

- Do not do work on the drive when a rotating permanent magnet motor is connected to it. A rotating permanent magnet motor energizes the drive including its input and output power terminals.
-



Before installation, start-up and maintenance work on the drive:

- Stop the drive.
- Disconnect the motor from the drive with a safety switch or by other means.
- If you cannot disconnect the motor, make sure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, can rotate the motor directly or through any mechanical connection like felt, nip, rope, etc.
- Do the steps in section *Electrical safety precautions (page 17)*.
- Install temporary grounding to the drive output terminals (T1/U, T2/V, T3/W). Connect the output terminals together as well as to the PE.

During the start-up:

- Make sure that the motor cannot run overspeed, for example, driven by the load. Motor overspeed causes overvoltage that can damage or destroy the capacitors in the intermediate circuit of the drive.

### ■ Safety in operation

---



#### **WARNING!**

Make sure that the motor cannot run overspeed, for example, driven by the load. Motor overspeed causes overvoltage that can damage or destroy the capacitors in the intermediate circuit of the drive.

---





# 2

## Introduction to the manual

---

### Contents of this chapter

This chapter describes the manual. It contains a flowchart of steps in checking the delivery, installing and starting up the drive. The flowchart refers to chapters/sections in this manual and to other manuals.

### Target audience

This manual is intended for people who plan the installation, install, commission and do maintenance work on the drive, or create instructions for the end user of the drive concerning the installation and maintenance of the drive.

Read the manual before you work on the drive. You are expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

### Categorization by frame size and option code

Some instructions, technical data and dimension drawings which concern only certain frame sizes are marked with the symbol of the frame size. The frame size indicates the number of power modules that form the supply and inverter units respectively.

For example, the marking "2×R8i + 2×R8i" refers to a drive that has a supply unit consisting of two frame R8i supply modules and an inverter unit consisting of two frame R8i inverter modules. The frame size is marked on the type designation label, and can also be determined from the type code.

The instructions, technical data and dimension drawings which only concern certain optional selections are marked with option codes (such as "+E205"). The options included in the drive can be identified from the option codes visible on the type designation label. The option selections are listed in section [Type designation key \(page 43\)](#).

---

## Use of component designations

Some device names in the manual include the item designation in brackets, for example [Q20], to make it possible to identify the components in the circuit diagrams of the drive.

## Quick installation, commissioning and operation flowchart

Task	See
<p>Plan the electrical installation and acquire the accessories needed (cables, fuses, etc.).</p> <p>Check the ratings, required cooling air flow, input power connection, compatibility of the motor, motor connection, and other technical data.</p>	<p><i>Guidelines for planning the electrical installation (page 71)</i></p> <p><i>Technical data (page 173)</i></p>
↓	
<p>Check the installation site.</p>	<p><i>Ambient conditions (page 186)</i></p>
↓	
<p>Unpack and check the drive (only intact units may be started up). Make sure that all necessary optional modules and equipment are present and correct.</p> <p>Install the drive mechanically.</p>	<p><i>Mechanical installation (page 49)</i></p>
↓	
<p>Route the cables.</p>	<p><i>Routing the cables (page 81)</i></p>
↓	
<p>Connect the power cables.</p> <p>Connect the control cables.</p>	<p><i>Electrical installation (page 91)</i></p>
↓	
<p>Check the installation.</p>	<p><i>Installation checklist (page 133)</i></p> <p>If the drive has been non-operational for more than one year, reform the DC link capacitors. See <a href="#">Converter module capacitor reforming instructions (3BFE64059629 [English])</a>.</p>
↓	
<p>Start the drive up.</p>	<p><i>Start-up (page 135)</i></p>
↓	
<p>Operate the drive: start, stop, speed control etc.</p>	<p>ACS880 quick start-up guide, firmware manual</p>

## Terms and abbreviations

Term/ Abbreviation	Description
BCU	Type of control unit
Cabinet	An enclosure that consists of one or more cubicles
CIO	I/O module for controlling cooling fans
Cubicle	One section of a cabinet-installed drive. A cubicle is typically behind a door of its own.
Drive	Frequency converter for controlling AC motors
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
FEN-01	Optional TTL incremental encoder interface module
FEN-11	Optional TTL absolute encoder interface module
FEN-21	Optional resolver interface module
FEN-31	Optional HTL incremental encoder interface module
FIO-11	Optional analog I/O extension module
FPTC-01	Optional thermistor protection module
FPTC-02	Optional ATEX-certified thermistor protection module for potentially explosive atmospheres
Frame, frame size	Physical size of the drive or power module
FSO-12, FSO-21	Optional functional safety modules
IGBT	Insulated gate bipolar transistor
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.
Power module	Common term for drive module, inverter module, supply module, brake chopper module etc.
RFI	Radio-frequency interference
STO	Safe torque off (IEC/EN 61800-5-2)
Supply unit	Supply module(s) under control of one control unit, and related components.

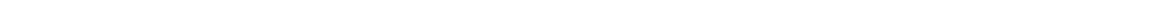
## Related manuals

You can find manuals and other product documents in PDF format on the Internet at [www.abb.com/drives/documents](http://www.abb.com/drives/documents).

The code below opens an online listing of the manuals applicable to this product.



[ACS880-17LC manuals](#)



# 3

## Operation principle and hardware description

---

### Contents of this chapter

This chapter briefly describes the operation principle and construction of the drive.

The ACS880-17LC is a four-quadrant, liquid-cooled, cabinet-installed drive for controlling asynchronous AC induction motors, permanent magnet synchronous motors, AC induction servomotors and ABB synchronous reluctance (SynRM) motors.

The drive consists of several cubicles that contain

- the supply and motor terminals
- 1 to 8 IGBT supply module(s) forming the supply unit (line-side converter)
- 1 to 8 inverter modules forming the inverter unit (motor-side converter)
- optional equipment.

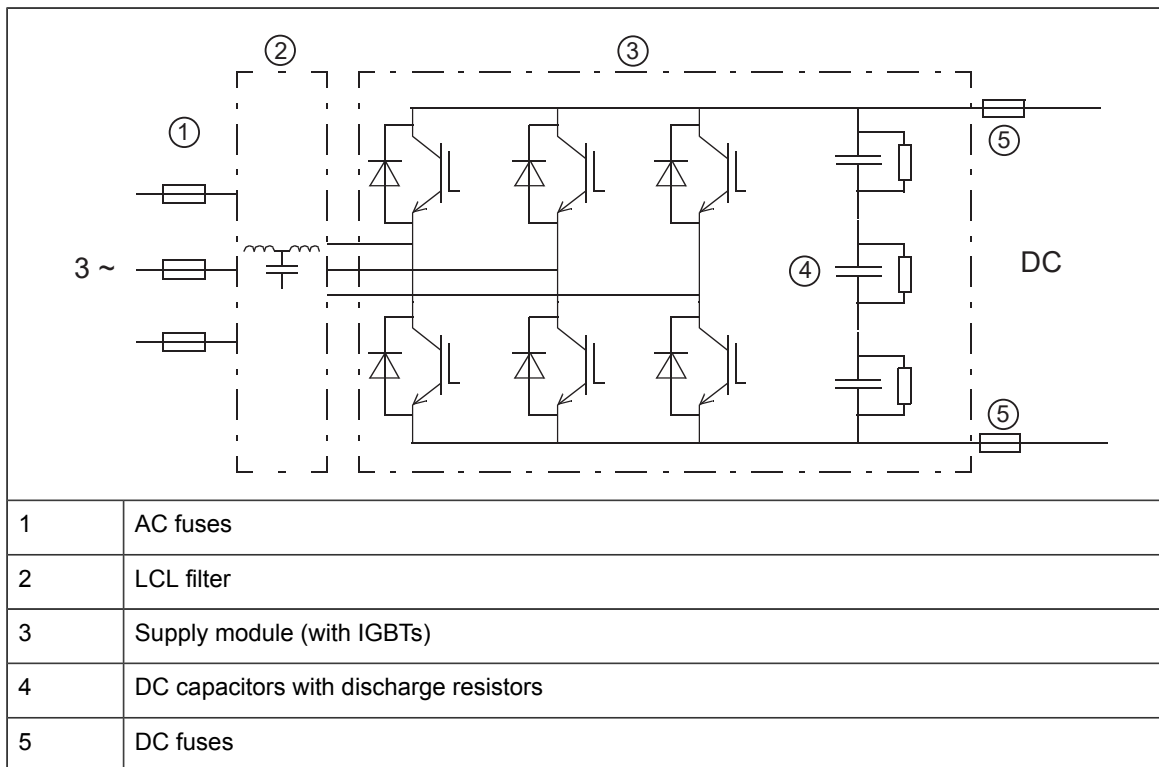
The actual arrangement of the cubicles varies from type to type and the selected options. Some optional equipment require additional cubicles. See chapter *Dimensions* for examples of cabinet line-ups.

### Supply unit

The supply unit rectifies three-phase AC current to direct current for the intermediate DC link of the drive. The supply unit is also capable of regenerating, ie. feeding braking energy back into the supply network.

The following figure shows the simplified main circuit diagram of the supply unit. Larger drives have supply units that consist of multiple supply modules connected in parallel. The supply unit is controlled by a type BCU control unit [A51].

---



### ■ AC voltage and current waveforms

The AC current is sinusoidal at a unity power factor. The LCL filter suppresses the AC voltage distortion and current harmonics. The high AC inductance smooths the line voltage waveform distorted by the high-frequency switching of the converter. The capacitive component of the filter effectively filters the high-frequency (over 1 kHz) harmonics.

### ■ Charging

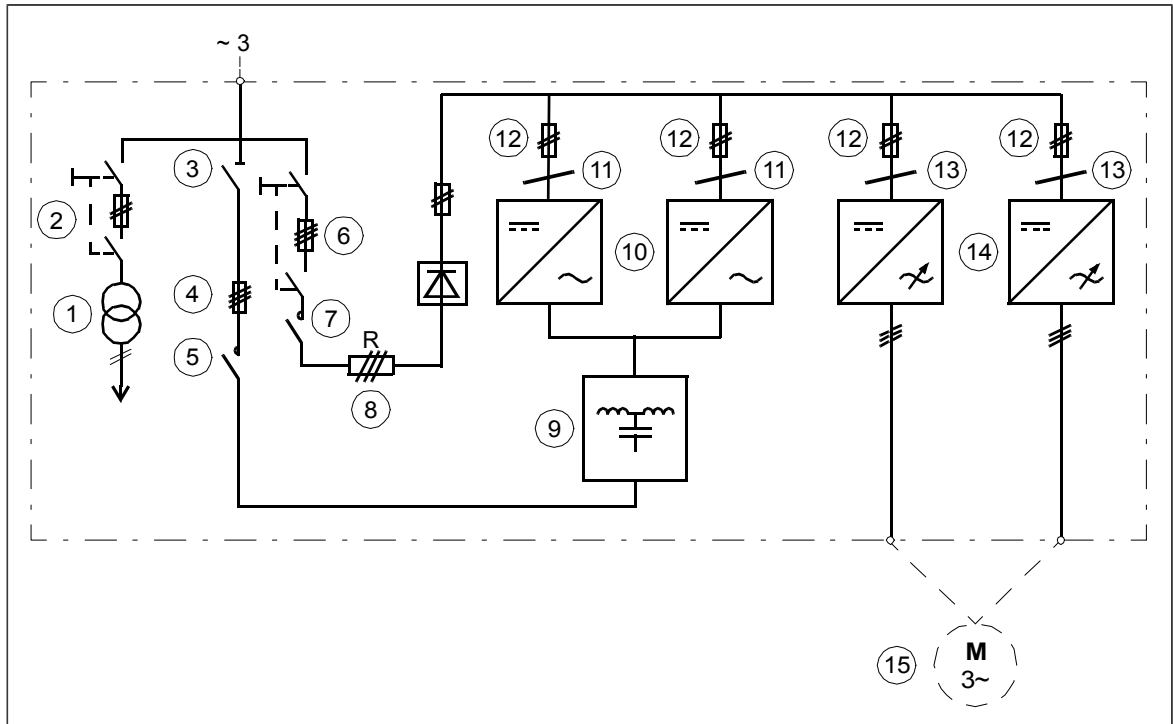
Charging is needed to power up the DC link capacitors smoothly. Discharged capacitors cannot be connected to the full supply voltage. The voltage must be increased gradually until the capacitors are charged and ready for normal use. The drive contains a resistive charging circuit consisting of fuses, contactor and charging resistors. The charging circuit is in use after start-up until the DC voltage has risen to a predefined level.

## Inverter unit

The inverter unit converts the DC back to AC that rotates the motor. It is also able to feed the braking energy from a rotating motor back into the DC link. The inverter unit is controlled by a type BCU control unit [A41].



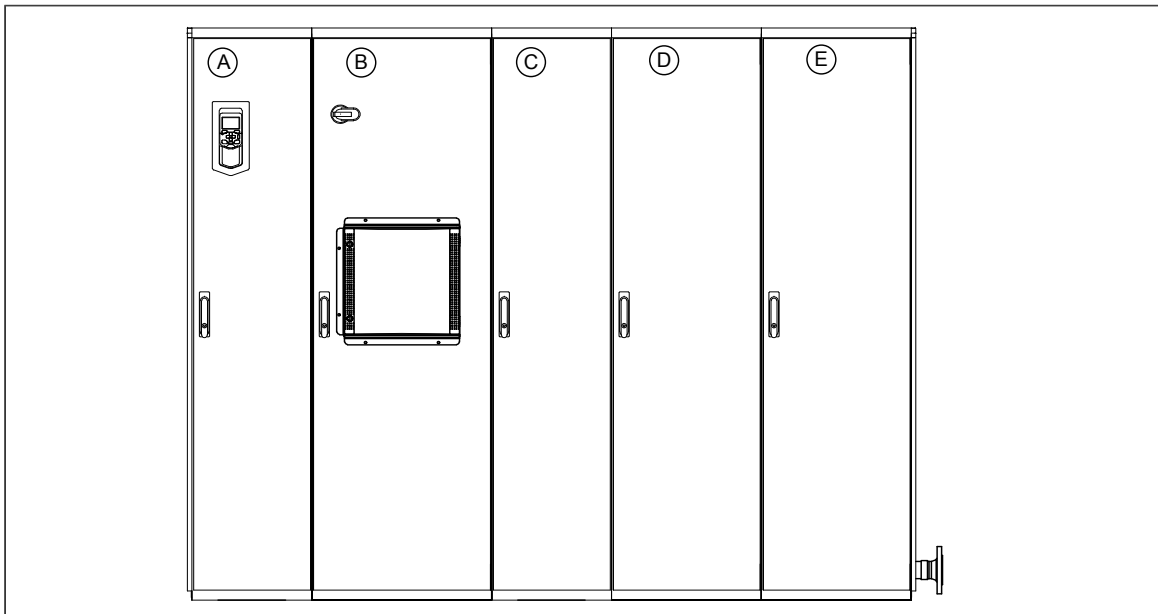
## Overview circuit diagram of the drive



1	Auxiliary voltage transformer(s)
2	Auxiliary voltage switch [Q21]
3	*Main switch/disconnector [Q1.1]
4	*AC fuses [F1.x]. If the drive has multiple LCL filters, there are additional AC fuses at the input of each filter.
5	*Main contactor [Q2]
*Some drive types can be ordered with a main circuit breaker (or are equipped with a main circuit breaker as standard) [Q1]. In that case, the AC fuses are located at the input of each LCL filter.	
6	Charging switch [Q3] and fuses
7	Charging contactor [Q4]
8	Charging resistors [R4.x]
9	LCL filter
10	Supply module(s) [T1.x]. The diagram shows two modules connected in parallel.
11	Common mode filters [R1.x] at the output of each supply module
12	DC fuses at the output of each supply module [F2.x], and at the input of each inverter module [F11.x].
13	Common mode filters [R11.x] at the input of each inverter module
14	Inverter unit consisting of one or several inverter modules [T11.x]
15	Motor

## Cabinet line-up and layout examples

### ■ Frame 2×R8i+2×R8i line-up

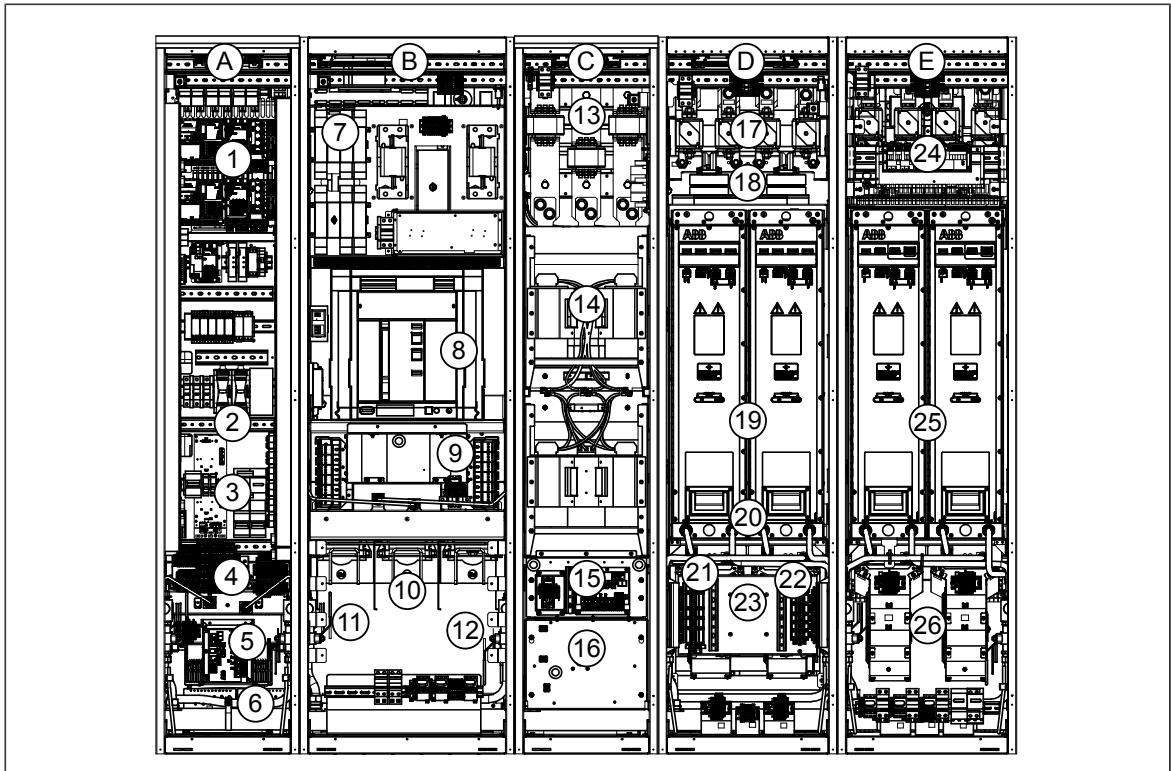


#### Cabinet line-up example

A	Auxiliary control unit (ACU). Contains control electronics.
B	Input cubicle (IPU). Contains the input power cable terminals.
C	LCL filter cubicle (LCL).
D	Supply module cubicle (ISU).
E	Inverter module cubicle (INU). Contains the motor cable terminals.

See also sections [Door switches and lights \(page 34\)](#) and [Control panel \(page 35\)](#).

■ Frame 2×R8i+2×R8i layout



**Cabinet layout example**

A	Auxiliary control unit (ACU). Contains control electronics.
B	Input cubicle (IPU). Contains the input power cable terminals.
C	LCL filter cubicle (LCL).
D	Supply module cubicle (ISU).
E	Inverter module cubicle (INU). Contains the motor cable terminals.
1	Supply control unit (A51) and inverter control unit (A41)
2	Control electronics
3	Auxiliary voltage transformers (obscured)
4	Heat exchanger
5	CIO module, cooling fan (obscured)
6	Control cable entry
7	Auxiliary voltage disconnecter
8	Main circuit breaker
9	Cooling fan and heat exchanger
10	Input power cable terminals
11	Inlet manifold with stop and drain valves
12	Outlet manifold with stop and drain valves
13	AC fuses
14	Capacitors. Inductors are located behind the capacitors.
15	CIO-01 I/O module
16	Cooling fan and heat exchanger
17	Supply module DC fuses

### 32 Operation principle and hardware description

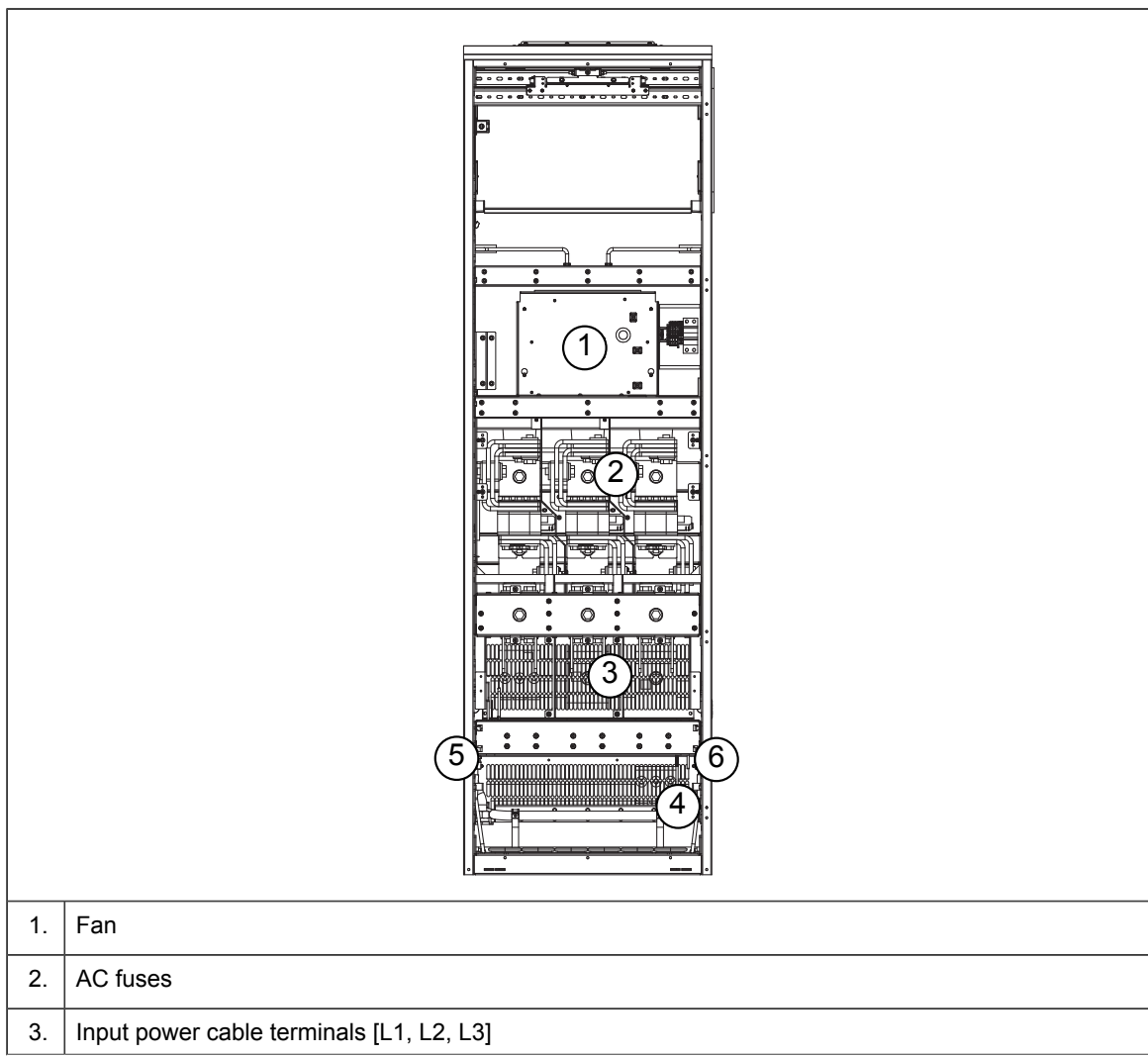
18	Common mode filters
19	IGBT supply modules of frame size R8i
20	Coolant connections
21	Air-to-liquid heat exchanger installed below each module
22	(Behind the mounting plate) Fan. Forces air inside the cubicle through the heat exchanger.
23	Mounting plate with terminal blocks for customer connections
24	Inverter module DC fuses
25	Inverter modules
26	Inverter module cooling fan. A heat exchanger is located between the fan and the module.

See also sections [Door switches and lights \(page 34\)](#) and [Control panel \(page 35\)](#).

#### ■ 100 kA input cubicle (option +F274)

100 kA input cubicle (option +F274) increases the short-circuit withstand rating of the drive. The cubicle contains extra fuses. The 100 kA cubicle is installed beside the standard 65 kA incoming cubicle or input cubicle at the factory. The input power cables enter the 100 kA input cubicle. All other customer cables enter the auxiliary control cubicle or other supply unit cubicles. The factory installs no optional door devices (such as meters, etc.) on the door of the 100 kA cubicle. No UL version (option +C129) is available.

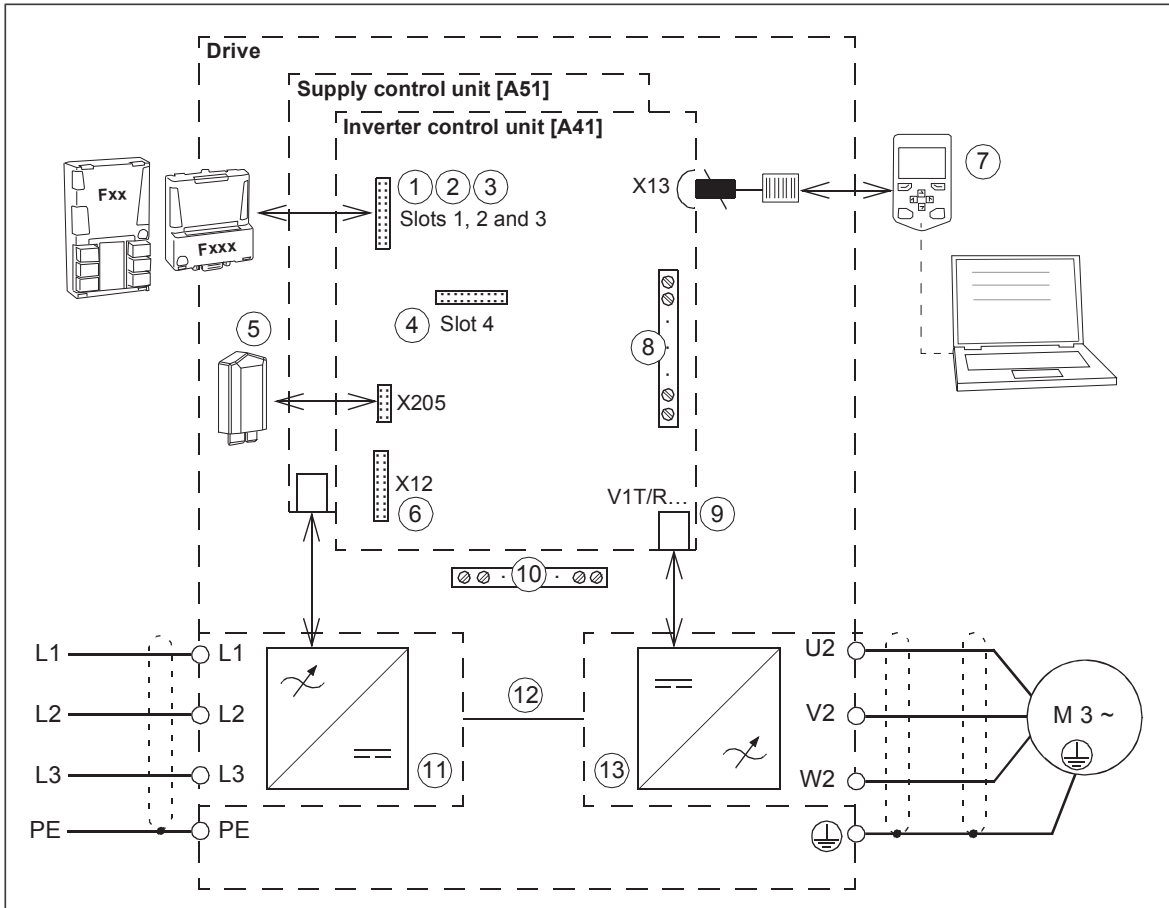
The layout drawing presents the bottom power cable entry version.



4.	Protective earth (ground)
5.	Inlet manifold with stop and drain valves
6.	Outlet manifold with stop and drain valves

## Overview of power and control connections

The diagram shows the power connections and control interfaces of the drive.



1	Option modules can be inserted into slots 1, 2, 3 and 4 as follows:
2	<b>Module type</b>
3	<b>Slots</b>
4	Analog and digital I/O extension modules
	Feedback interface modules
	Fieldbus communication modules
	RDCO-04 DDCS communication option module (standard equipment). As standard, 4 a fiber optic link connects the supply and inverter control units.
	Additional modules can be installed on an optional FEA-03 extension adapter connected to an RDCO module on slot 4.
5	Memory unit
6	Connection for FSO safety functions module
7	Control panel and PC connection
8	Terminal blocks on the inverter control unit.

9	Fiber optic link to each inverter module. Similarly, each supply module is connected to the supply control unit by fiber optic cables.
10	Terminal blocks for customer connections installed in the drive cabinet.
11	Supply unit (consisting of one or more supply modules)
12	DC intermediate link
13	Inverter unit (consisting of one or more inverter modules)

## Door switches and lights

### ■ Main disconnecting device [Q1]

The drive is equipped with a main circuit breaker [Q1]. Units with 12-pulse supply connection (option +A004), as well as some of the largest 6-pulse types, have two breakers, [Q1.1] and [Q1.2]. To close the main breaker, auxiliary voltage must be switched on, and the grounding switch (if present) must be open.

By racking out the breaker, you can isolate the main circuit of the drive from the power line.



#### **WARNING!**

The main disconnecting device does not isolate the input power terminals, AC voltage meters, or the auxiliary voltage circuit from the power line. To isolate the auxiliary voltage circuit, open the auxiliary voltage switch [Q21]. To isolate the input power terminals and AC voltage meters, open the main breaker of the supply transformer.

### ■ Auxiliary voltage switch [Q21]

The auxiliary voltage switch controls the supply to the internal auxiliary voltage transformers. The transformer feeds the control circuits inside the drive such as cooling fans, relays and measuring equipment.

**Note:** Frame 1×R8i+1×R8i units are not fitted with an auxiliary voltage switch. The auxiliary voltage is switched on and off by the main disconnecting device [Q1], and protected by fuse disconnectors F20.1...F20.3.

### ■ Grounding (earthing) switch [Q9], optional

The grounding switch [Q9] (option +F259) connects the main AC power bus to the PE busbar.

To close the grounding switch, auxiliary voltage must be switched on, and the main disconnecting device must be open.



#### **WARNING!**

The grounding switch does not ground the input power terminals of the drive or the auxiliary (control) voltage circuits.

### ■ Other devices on the door

- Voltmeter (option +G334); comes with a phase selector switch.

**Note:** The voltage is measured on the supply side of the main switch or breaker.

- AC current meter (option +G335) on one phase.
- AC current meter (option +3G335) on three phases.

## ■ Control panel

The ACS-AP-W is the user interface of the drive. It provides the essential controls such as Start/Stop/Direction/Reset/Reference, and the parameter settings for the inverter control program.

The control panel can be removed by pulling it forward by the top edge and reinstalled in reverse order. For the use of the control panel, see [ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual \(3AUA0000085685 \[English\]\)](#) and the firmware manual.



## Control by PC tools

There is a USB connector on the front of the panel that can be used to connect a PC to the drive. When a PC is connected to the control panel, the control panel keypad is disabled.

## Descriptions of options

**Note:** All options are not available for all drive types, do not coexist with certain other options, or may require additional engineering. Check actual availability with ABB.

### ■ Degree of protection

The standard degree of protection is IP42 (UL type 1). IP54 (UL type 12) is available as option +B055.

### Definitions

According to IEC/EN 60529, the degree of protection is indicated by an IP code where the first numeral means protection against ingress of solid foreign objects, and the second numeral protection against ingress of water. The IP codes of the standard cabinet and options covered in this manual are defined below.

IP code	The equipment is protected ...	
	First numeral	Second numeral
IP42	against ingress of solid foreign objects > 1 mm	against dripping (15° tilting) water
IP54	dust-protected	against splashing water

### ■ Marine construction (option +C121)

The option includes the following accessories and features:

- reinforced mechanics
- grab railings
- door flush bolt which allows the door to open 90 degrees and prevents it from slamming close
- self-extinctive materials
- flat bars at base of the cabinet for fastening
- fastening brackets at the top of the cabinet.

Additional wire markings may be required for classification. See section [Wire markings \(page 38\)](#).

### ■ UL Listed (option +C129)

The cabinet contains the following accessories and features:

- top entry and exit with US cable conduit entries (plain plate without ready-made holes)
- all components UL/CSA Listed/Recognized
- maximum supply voltage 600 V
- US-type main switch and fuses.

### ■ Plinth height (options +C164 and +C179)

These options specify a plinth height of 100 mm (+C164) or 200 mm (+C179).



### ■ **du/dt filter**

The du/dt filter protects the motor insulating system by reducing the voltage rise speed at the motor terminals. The filter also protects the motor bearings by reducing the bearing currents.

More information on when the option is required: See section [Examining the compatibility of the motor and drive \(page 72\)](#).

### ■ **Common mode filter (option +E208)**

The common mode filter contains ferrite rings mounted around the AC output busbars in the drive module. The filter protects the motor bearings by reducing the bearing currents.

More information on when the option is required: See section [Examining the compatibility of the motor and drive \(page 72\)](#).

### ■ **Cabinet heater with external supply (option +G300)**

The option contains:

- heating elements in the cubicles or supply/inverter modules
- load switch for providing electrical isolation during service
- miniature circuit breaker for overcurrent protection
- terminal block for external power supply.

The heater prevents condensation inside the cabinet when the drive is not in operation. The power output of the heating elements increases when the surrounding air temperature is low and decreases when the surrounding air temperature is high. The customer must stop the heating when it is not needed by disconnecting the heater supply voltage.

The customer must supply the heater from an external 110...240 V AC power source.

For the actual wiring, see the circuit diagrams delivered with drive.

### ■ **Cabinet lighting (option +G301)**

This option contains LED lighting fixtures in each cubicle (except joining and brake resistor cubicles) and a 24 V DC power supply. The lighting is powered from the same external 110...240 V AC power source as the cabinet heater (option +G300).

### ■ **Terminals for external control voltage (option +G307)**

The option provides terminals for connecting an external uninterruptible control voltage to the control unit and control devices when the drive is not powered.

See also:

- [Supplying power for the auxiliary circuits \(page 86\)](#)
- circuit diagrams delivered with drive for the actual wiring.

### ■ **Output for motor space heater (option +G313)**

The option contains:

- load switch for providing electrical isolation during service
  - miniature circuit breaker for overcurrent protection
  - terminal block for heater and external heater supply connection.
-

When the drive is powered (and not faulted), the heater is switched off. Otherwise, the heater is controlled by the external supply voltage.

The power and voltage of the heater depend on the motor.

See also:

- [Supplying power for the auxiliary circuits \(page 86\)](#)
- circuit diagrams delivered with drive for the actual wiring.

### ■ Halogen-free wiring and materials (option +G330)

The option provides halogen-free cable ducts, control wires and wire sleeves, thus reducing toxic fire gases.

### ■ V-meter with selector switch (option +G334)

The option contains a voltmeter and a selector switch on the cabinet door. The switch selects the two input phases across which the voltage is measured.

### ■ Wire markings

#### Standard wiring

##### Color

The standard color of the wiring is black, with the following exceptions:

- PE wiring: Yellow/Green, or yellow/green sleeving
- UPS input wiring (option +G307): Orange
- Pt100 sensor wiring with ATEX-certified thermal protection (option +nL514): Light blue.



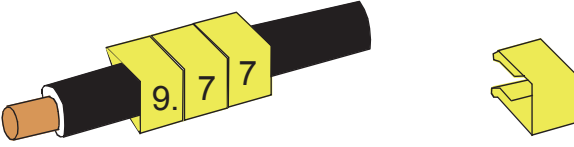


##### Markings

As standard, wires and terminals are marked as follows:

- Main circuit terminals: Connector identifier (eg. "U1") marked on terminal, or on insulating material close to the terminal. Input and output main circuit cables are not marked.
  - Plug-in connectors of wire sets (except those that require special tools to disconnect) are labeled with connector designation (eg. "X1"). The marking is either directly on the connector, or near the connector on printed sleeving or tape.
  - Grounding busbars are marked with stickers.
  - Fiber optic cable pairs and data cables have component designation and connector designations (eg. "A1:V1", "A1:X1") marked with rings or tape.
  - Data cables are marked with tape.
  - Ribbon cables are marked with either labels or tape.
  - Customer-specific (engineered) wiring (option +P902) is not marked.
-

### Additional wire markings

The following additional wire markings are available.

Option	Additional markings
+G338 (class A1)	<p>Equipment pin identifiers are marked with printing (or equivalent) on conductors that connect to equipment, or are part of the wiring between power modules. (Short, obvious connections, main circuit conductors, and conductors going to terminal blocks or plug-type connectors are not marked.)</p> 
+G339 (class A2)	<p>Equipment pin identifiers are marked with printing (or equivalent) on conductors that connect to equipment or terminal blocks, or are part of the wiring between power modules. Main circuit conductors are marked with white tape or printing. (Short, obvious connections, or conductors going to plug-type connectors are not marked.)</p> 
+G340 (class A3)	<p>Single wires not attached to plug-in connectors are marked with component pin numbers on snap-on or ring markers. Plug-in connectors are marked with an identification label placed on the wires near the connector (individual wires are not marked). Short, obvious connections are not marked. PE wires are not marked unless connected directly to components.</p> 
+G341 (class B1)	<p>Equipment designations and pin identifiers are marked with snap-on markers (or equivalent) on conductors that connect to equipment, terminal blocks or detachable plug-type connectors, or are part of the wiring between power modules. Fiber optic cables are marked in the same way. Plug-type connector identifications are marked on labels near the connectors. The label holders are attached around conductor bundles. Main circuit conductors are marked with white tape or printing. Short and obvious connections are marked with printing (or equivalent) only.</p>  <p><b>Note:</b> Even wires with equipment and pin identifiers printed on the wire insulation are marked with rings or tubing.</p>
+G342 (class C1)	<p>Single wires connected to components, between modules, or to terminal blocks are marked with component identification and pin numbers for both ends. The marking is printed on sleeving or, if necessary, snap-on markers. Plug-in connectors are marked with an identification label (or snap-on markers) placed on the wires near the connector (individual wires are not marked). Short, obvious connections are not marked. PE wires are not marked unless connected directly to components.</p> 

### ■ Voltage measurement with BAMU auxiliary measurement unit (option +G442)

In weaker supply networks with a short-circuit ratio less than 8, it is highly recommended to install a BAMU auxiliary measurement unit to the drive. In such networks, there is a risk

of nuisance DC overvoltage tripping due to disturbances caused by probable high-voltage THD in the supply voltage.

Short-circuit ratio is defined as the supply network's apparent short-circuit power  $S_{k,net}$  V divided by the drive's nominal apparent power  $S_n$ .

#### ■ **Bottom cable entry/exit (options +H350 and +H352)**

For UL Listed (+C129) units, the default input and output cabling direction is through the roof of the cabinet. The bottom entry (+H350) and bottom exit (+H352) options provide power and control cable entries at the floor of the cabinet. The entries are equipped with grommets and 360° grounding hardware.

For non-UL Listed units, bottom entry/exit is the default cabling arrangement.

#### ■ **Top cable entry/exit (options +H351 and +H353)**

The top entry (+H351) and top exit (+H353) options provide power and control cable entries at the roof of the cabinet. The entries are equipped with grommets and 360° grounding hardware.

#### ■ **Common motor terminal cubicle (option +H359)**

As standard, each inverter module must be individually cabled to the motor. This option provides an additional cubicle containing a single set of terminals for the motor cables.

The width of the cubicle and the size of the terminals within depend on the power rating of the drive.

#### ■ **Thermal protection with PTC relays (options +L505, +2L505, +L513, +2L513, +L536, +L537)**

PTC thermistor relay options are used for overtemperature supervision of motors equipped with PTC sensors. When the motor temperature rises to the thermistor wake-up level, the resistance of the sensor increases sharply. The relay detects the change and indicates motor overtemperature through its contacts.

#### **+L505, +2L505, +L513, +2L513**

Option +L505 provides a thermistor relay and a terminal block. The terminal block has connections for the measuring circuit (one to three PTC sensors in series), an output indication of the relay, and an optional external reset button. The relay can be reset either locally or externally, or the reset circuit can be jumpered for automatic reset.

By default, the thermistor relay is wired internally to digital input DI6 of the drive control unit. The loss of the input is set to trigger an external fault.

The output indication on the terminal block can be wired by the customer, for example, to an external monitoring circuit. See the circuit diagrams delivered with the drive.

Option +L513 is an ATEX-certified thermal protection function that has the same external connectivity as +L505. In addition, +L513 comes with +Q971 (ATEX-certified safe disconnection function) as standard and is wired at the factory to activate the Safe torque off function of the drive in an overtemperature situation. A manual reset for the protection function is required by Ex/ATEX regulations. For more information, see [ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives \(options +L513+Q971 and +L514+Q971\) user's manual \(3AXD50000014979 \[English\]\)](#).

Options +2L505 and +2L513 duplicate options +L505 and +L513 respectively, containing the relays and connections for two separate measurement circuits.

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### **+L536, +L537**

An alternative to a thermistor relay option is the FPTC-01 (option +L536) or FPTC-02 (option +L537, also requires option +Q971) thermistor protection module. The module mounts onto the inverter control unit, and has reinforced insulation to keep the control unit PELV-compatible. The connectivity of the FPTC-01 and the FPTC-02 is the same, but the FPTC-02 is Type Examined as a protective device within the scope of the European ATEX (and UKEX) Product Directive.

For protection purposes, the FPTC has a "fault" input for the PTC sensor. An overtemperature situation executes the SIL/PL-capable SMT (Safe motor temperature) safety function by activating the Safe torque off function of the drive.

The FPTC also has a "warning" input for the sensor. When the module detects overtemperature through this input, it sends a warning indication to the drive.

For more information and wiring examples, see the module manuals and the circuit diagrams delivered with the drive.

See also

- firmware manual for parameter settings
- [FPTC-01 thermistor protection module \(option +L536\) for ACS880 drives user's manual \(3AXD50000027750 \[English\]\)](#)
- [FPTC-02 ATEX-certified thermistor protection module, Ex II \(2\) GD \(option +L537+Q971\) for ACS880 drives user's manual \(3AXD50000027782 \[English\]\)](#)
- circuit diagrams delivered with the drive for the actual wiring.

### **■ Thermal protection with Pt100 relays (options +nL506, +nL514)**

Pt100 temperature monitoring relays are used for overtemperature supervision of motors equipped with Pt100 sensors. For example, there can be three sensors to measure the temperature of the motor windings and two sensors for the bearings. As the temperature rises, the sensor resistance increases linearly. At an adjustable wake-up level, the monitoring relay de-energizes its output.

The standard Pt100 relay options include three (+3L506), five (+5L506) or eight (+8L506) relays.

By default, the relays are wired internally to digital input DI6 of the drive control unit. The loss of the input is set to trigger an external fault. The options include a terminal block for sensor connection. The output indication on the terminal block can be wired by the customer, for example, to an external monitoring circuit. See the circuit diagrams delivered with the drive.

Options +3L514 (3 relays), +5L514 (5 relays) and +8L514 (8 relays) are ATEX-certified thermal protection functions that have the same external connectivity as +nL506. In addition, each monitoring relay has a 0/4...20 mA output that is available on the terminal block. Option +nL514 comes with +Q971 (ATEX-certified safe disconnection function) as standard and is wired at the factory to activate the Safe torque off function of the drive in an overtemperature situation. As the monitoring relay does not have a reset functionality, the manual reset required by Ex/ATEX regulations must be implemented using drive parameters. For more information, see [ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives \(options +L513+Q971 and +L514+Q971\) user's manual \(3AXD50000014979 \[English\]\)](#).

See also

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- firmware manual for parameter settings
- [ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives \(options +L513+Q971 and +L514+Q971\) user's manual \(3AXD50000014979 \[English\]\)](#)
- Pt100 relay alarm and trip limit setting instructions in the start-up instructions
- circuit diagrams delivered with the drive for the actual wiring.

### ■ **Starter for auxiliary motor fan (options +M600...M610)**

#### **What the option contains**

The option provides switched and protected connections for 3-phase auxiliary motor fans. Each fan connection is equipped with:

- fuses
- a manual motor starter switch with an adjustable current limit
- a contactor controlled by the drive, and
- terminal block X601 for customer connections.

#### **Description**

The output for the auxiliary fan is wired from the 3-phase supply voltage to terminal block X601 through a motor starter switch and a contactor. The contactor is operated by the drive. The 230 V AC control circuit is wired through a jumper on the terminal block; the jumper can be replaced by an external control circuit.

The starter switch has an adjustable trip current limit, and can be opened to permanently switch the fan off.

The statuses of both the starter switch and the fan contactor are wired to the terminal block.

See the circuit diagrams delivered with the drive for the actual wiring.

---

## Type designation label

The type designation label includes ratings, appropriate markings, a type designation and a serial number, which allow the identification of each unit. A sample label is shown below.

Quote the complete type designation and serial number when contacting technical support.

<p><b>ABB</b> MADE IN FINLAND ABB Oy Hiomotie 13 00380 Helsinki Finland</p> <p>FRAME 8xR8I +8xR8I</p> <p>Liquid cooling Icw 65 kA IP54</p> <p>UL/CSA: max. 600 VAC</p> <p>① ACS880-17LC-6260A-7+A012+B055+C138+C141+E205+E210+F255+F276+G307+G315+G316+G320+G330+G336+G341+G344+G437+G450+H350+H353+H368+J400+K450+K454+K473+L502+3L506+L509</p> <p>Input U1 3~ 525/600/690 VAC I1 5810 A f1 50/60 Hz</p> <p>Output U2 3~ 0...U1 I2 6260 A f2 0...500 Hz Sn 7481 kVA</p> <p>CE, EAC, UKCA, TUV MARK Safety Approved, 20, S/N: 1183605236</p>	
1	Type designation (see section <a href="#">Type designation key</a> )
2	Frame size
3	Short-time withstand current rating (see chapter <a href="#">Technical data (page 173)</a> ); degree of protection; UL/CSA specifications
4	Ratings. See also chapter <a href="#">Technical data (page 173)</a> .
5	Valid markings
6	Serial number. The first digit of the serial number refers to the manufacturing plant. The next four digits refer to the unit's manufacturing year and week, respectively. The remaining digits complete the serial number so that there are no two units with the same number.

## Type designation key

The type designation contains information on the specifications and configuration of the drive. The first digits from left express the basic drive type. The optional selections are given thereafter, separated by plus signs, eg, +E202. Codes preceded by a zero (eg, +0J400) indicate the absence of the specified feature. The main selections are described below. Not all selections are available for all types. For more information, refer to the ordering instructions available separately on request.

Code	Description
<b>Basic code</b>	
ACS880	Product series
ACS880-17LC	Default configuration: liquid-cooled cabinet-installed drive, IP42 (UL Type 1), main switch-disconnector (and contactor) or breaker, aR fuses, ACS-AP-W assistant control panel (with Bluetooth), EMC filter (category 3, 2nd Environment), du/dt filters, common mode filtering, standard wire markings, ACS880 primary control program, Safe torque off function, coated circuit boards, bottom entry and exit of cables with lead-through-type entries, USB memory stick containing circuit diagrams, dimension drawings and manuals.
<b>Size</b>	
xxxxx	Refer to the rating tables
<b>Voltage range</b>	
7	525...690 V AC. This is indicated in the type designation label as typical input voltage levels (3~ 525/600/690 V AC)



## ■ Option codes

Code	Description
A012	50 Hz supply frequency
A013	60 Hz supply frequency
B054	IP42 (UL Type 1 Filtered)
B055	IP54 (UL Type 12)
C121	Marine construction. See section <a href="#">Marine construction (option +C121) (page 36)</a> .
C129	UL Listed (evaluated to both U.S. and Canadian safety requirements). See section <a href="#">UL Listed (option +C129) (page 36)</a> .
C132	Marine type approval. Refer to <a href="#">ACS880 +C132 marine type-approved cabinet-built drives supplement (3AXD50000039629 [English])</a> .
C138	ACS880-1007LC cooling unit as part of line-up
C139	ACS880-1007LC cooling unit separate from line-up (stand-alone)
C140	Single-pump cooling unit
C141	Redundant (twin-pump) cooling unit
C142	Pipe connection through bottom
C143	Pipe connection on right
C144	Pipe connection on left
C145	ANSI flange pipe connection
C146	External cooling circuit suitable for sea water
C164	Plinth height 100 mm. See section <a href="#">Plinth height (options +C164 and +C179) (page 36)</a> .
C176	Door hinges on left
C179	Plinth height 200 mm. See section <a href="#">Plinth height (options +C164 and +C179) (page 36)</a> .
C205	Marine product certification issued by DNV GL
C206	Marine product certification issued by the American Bureau of Shipping (ABS)
C207	Marine product certification issued by Lloyd's Register (LR)
C209	Marine product certification issued by Bureau Veritas
C213	Cooling unit pumps can run simultaneously
C228	Marine product certification issued by China Classification Society (CCS)
C229	Marine product certification issued by Russian Maritime Register of Shipping (RS)
C242	2-way valve in a dedicated cubicle
E205	du/dt filtering
E208	Common mode filtering
E210	EMC/RFI filter for 2nd environment TN (grounded) or IT (ungrounded) system, category C3
F253	Disconnect switch
F259	Grounding (earthing) switch
F271	Output grounding terminals
F274	100 kA short-circuit rating (100 kA input cubicle)
G300	Cabinet and module heating elements (external supply). See section <a href="#">Cabinet heater with external supply (option +G300) (page 37)</a> .
G301	Cabinet lighting. See section <a href="#">Cabinet lighting (option +G301) (page 37)</a> .
G304	Control (auxiliary) voltage 115 V AC



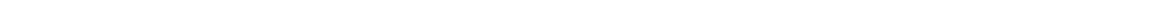
Code	Description
G307	Terminals for connecting external control voltage (230 V AC or 115 V AC, eg. UPS). See section <a href="#">Terminals for external control voltage (option +G307) (page 37)</a> .
G313	Output for motor space heater (external supply)
G314	Aluminum busbars
G315	Tin-plated copper DC busbars
G316	Cable supply conductors
G320	Control (auxiliary) voltage 230 V AC
G330	Halogen-free wiring and materials
G332	Electrical disconnect push button on the door (black, opens main contactor / ACB)
G333	kW-meter on door
G334	V-meter with selector switch
G335	A-meter in one phase
3G335	A-meter in three phases
G338	Wire marking class A1. See section <a href="#">Wire markings (page 38)</a> .
G339	Wire marking class A2. See section <a href="#">Wire markings (page 38)</a> .
G340	Wire marking class A3. See section <a href="#">Wire markings (page 38)</a> .
G341	Wire marking class B1. See section <a href="#">Wire markings (page 38)</a> .
G342	Wire marking class C1. See section <a href="#">Wire markings (page 38)</a> .
G344	Auxiliary voltage transformer
G432	Frequency monitoring device. Only for installation altitudes up to 2000 meters (6561 ft).
G442	BAMU auxiliary measurement unit. See section <a href="#">Voltage measurement with BAMU auxiliary measurement unit (option +G442) (page 39)</a> .
H350	Power cabling entry from bottom. See section <a href="#">Bottom cable entry/exit (options +H350 and +H352) (page 40)</a> .
H351	Power cabling entry from top. See section <a href="#">Top cable entry/exit (options +H351 and +H353) (page 40)</a> .
H352	Power cabling exit from bottom. See section <a href="#">Bottom cable entry/exit (options +H350 and +H352) (page 40)</a> .
H353	Power cabling exit from top. See section <a href="#">Top cable entry/exit (options +H351 and +H353) (page 40)</a> .
H359	Common motor terminal cubicle. See section <a href="#">Common motor terminal cubicle (option +H359) (page 40)</a> .
H364	Cable gland plates (3 mm aluminum, undrilled)
H367	Control cabling through floor of cabinet
J400	ACS-AP-W control panel (with Bluetooth)
K451	FDNA-01 DeviceNet™ adapter module
K452	FLON-01 LonWorks® adapter module
K454	FPBA-01 PROFIBUS DP adapter module
K457	FCAN-01 CANopen adapter module
K458	FSCA-01 RS-485 (Modbus/RTU) adapter module
K462	FCNA-01 ControlNet™ adapter module
K469	FECA-01 EtherCAT adapter module
K470	FEPL-02 Ethernet POWERLINK adapter module
K473	FENA-11 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols

#### 46 Operation principle and hardware description

Code	Description
K475	FENA-21 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
L500	FIO-11 analog I/O extension module
L501	FIO-01 digital I/O extension module
L502	FEN-31 HTL incremental encoder interface module
L505	Thermal protection with PTC relays (1 or 2 pcs). See section <i>Thermal protection with PTC relays (options +L505, +2L505, +L513, +2L513, +L536, +L537) (page 40)</i> .
L506	Thermal protection with Pt100 relays (3, 5 or 8 pcs). See section <i>Thermal protection with Pt100 relays (options +nL506, +nL514) (page 41)</i> .
L513	ATEX-certified thermal protection with PTC relays (1 or 2 pcs)
L514	ATEX-certified thermal protection with Pt100 relays (3, 5 or 8 pcs)
L521	FSE-31 pulse encoder interface module
L536	FPTC-01 thermistor protection module
L537	FPTC-02 ATEX-certified thermistor protection module
M601	Starter for auxiliary motor fan, trip limit 1.6 ... 2.5 A
M602	Starter for auxiliary motor fan, trip limit 2.5 ... 4 A
M603	Starter for auxiliary motor fan, trip limit 4 ... 6.3 A
M604	Starter for auxiliary motor fan, trip limit 6.3 ... 10 A
M605	Starter for auxiliary motor fan, trip limit 10...16 A
M606	Starter for auxiliary motor fan, trip limit 16...20 A
M633	Pump motor in delta connection
M634	Pump motor in star connection
N5000	Winder control program
N5050	Crane control program
N5100	Winch control program
N5200	PCP (Progressive Cavity Pump) control program
N5300	Test bench control program
N5450	Override control program
N5600	ESP (Electrical Submersible Pump) control program
N5700	Position control program
N7502	Control program for synchronous reluctance motors (SynRM)
N8010	IEC 61131-3 application programmability
P902	Customized
P913	Special color (RAL Classic)
Q950	Prevention of unexpected start-up with FSO safety functions module, by activating the Safe torque off function
Q951	Emergency stop (category 0) with safety relays, by opening the main breaker/contactor
Q952	Emergency stop (category 1) with safety relays, by opening the main breaker/contactor
Q954	Earth fault monitoring for IT (ungrounded) systems
Q957	Prevention of unexpected start-up with safety relays, by activating the Safe torque off function
Q963	Emergency stop (category 0) with safety relays, by activating the Safe torque off function
Q964	Emergency stop (category 1) with safety relays, by activating the Safe torque off function
Q965	Safely-limited speed with FSO-21 and encoder

<b>Code</b>	<b>Description</b>
Q966	Safely-limited speed without encoder
Q971	ATEX-certified safe disconnection function
Q972	FSO-21 safety functions module
Q973	FSO-12 safety functions module
Q978	Emergency stop (configurable for category 0 or 1) with FSO safety functions module, by opening the main breaker/contactator
Q979	Emergency stop (configurable for category 0 or 1) with FSO safety functions module, by activating the Safe torque off function
Q982	PROFIsafe with FSO safety functions module and FPNO-21 Ethernet adapter module
Q984	Emergency stop button monitoring
Q986	FSPS-21 PROFIsafe safety functions module

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# 4

## Mechanical installation

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### Contents of this chapter

This chapter describes the mechanical installation procedure of the drive.



### Examining the installation site

Examine the installation site. Make sure that:

- The installation site is sufficiently ventilated or cooled to remove heat from the drive. See the technical data.
- The ambient conditions of the drive meet the specifications. See the technical data.
- There is sufficient free space above the drive for cooling, maintenance, and operation of the pressure relief (if present).
- The floor that the drive cabinet is installed on is of non-flammable material, as smooth as possible, and strong enough to support the weight of the unit. Check the floor flatness with a spirit level. The maximum allowed deviation from the surface level is 5 mm (0.2 in) in every 3 meters (10 ft). Level the installation site, if necessary, as the cabinet is not equipped with adjustable feet.

### Necessary tools

The tools required for moving the unit to its final position, fastening it to the floor and wall and tightening the connections are listed below:

- crane, fork-lift or pallet truck (check load capacity!), slate/spud bar, jack and rollers
  - Pozidriv and Torx screwdrivers
  - torque wrench
  - set of wrenches or sockets.
-

## Examining the delivery

The drive delivery contains:

- drive cabinet line-up
- optional modules (if ordered) installed onto the control unit(s) at the factory
- appropriate drive and optional module manuals
- delivery documents.

Make sure that there are no signs of damage. Before attempting installation and operation, see the information on the type designation labels of the drive to verify that the delivery is of the correct type.



## Moving and unpacking the drive

Move the drive in its original packaging to the installation site as shown below to avoid damaging the cabinet surfaces and door devices. When you are using a pallet truck, check its load capacity before you move the drive.

The drive cabinet is to be moved in the upright position.

The center of gravity of the cabinet is high. Be therefore careful when moving the unit. Avoid tilting.

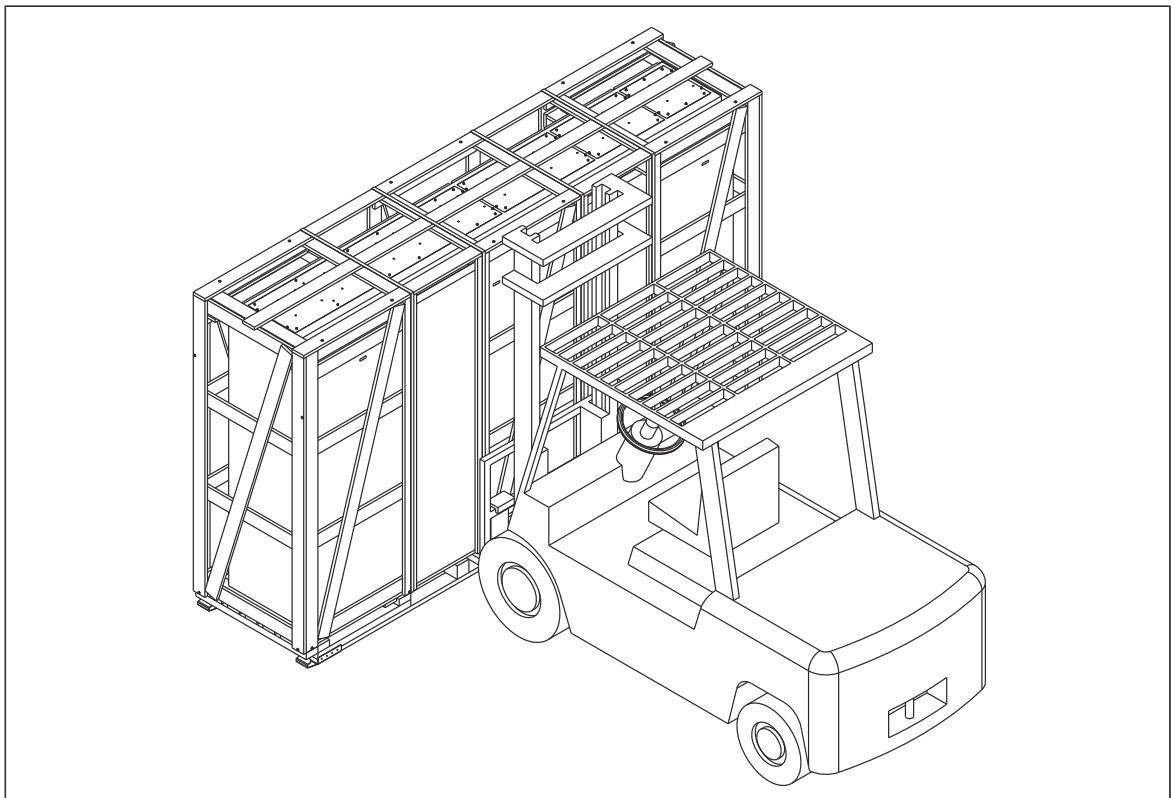
### ■ Moving the drive in its packaging

#### Lifting the crate with a forklift



#### **WARNING!**

Incorrect lifting can cause danger or damage. Obey the local laws and regulations applicable to lifting, such as requirements for planning the lift, for capacity and condition of lifting equipment, and for training of personnel.

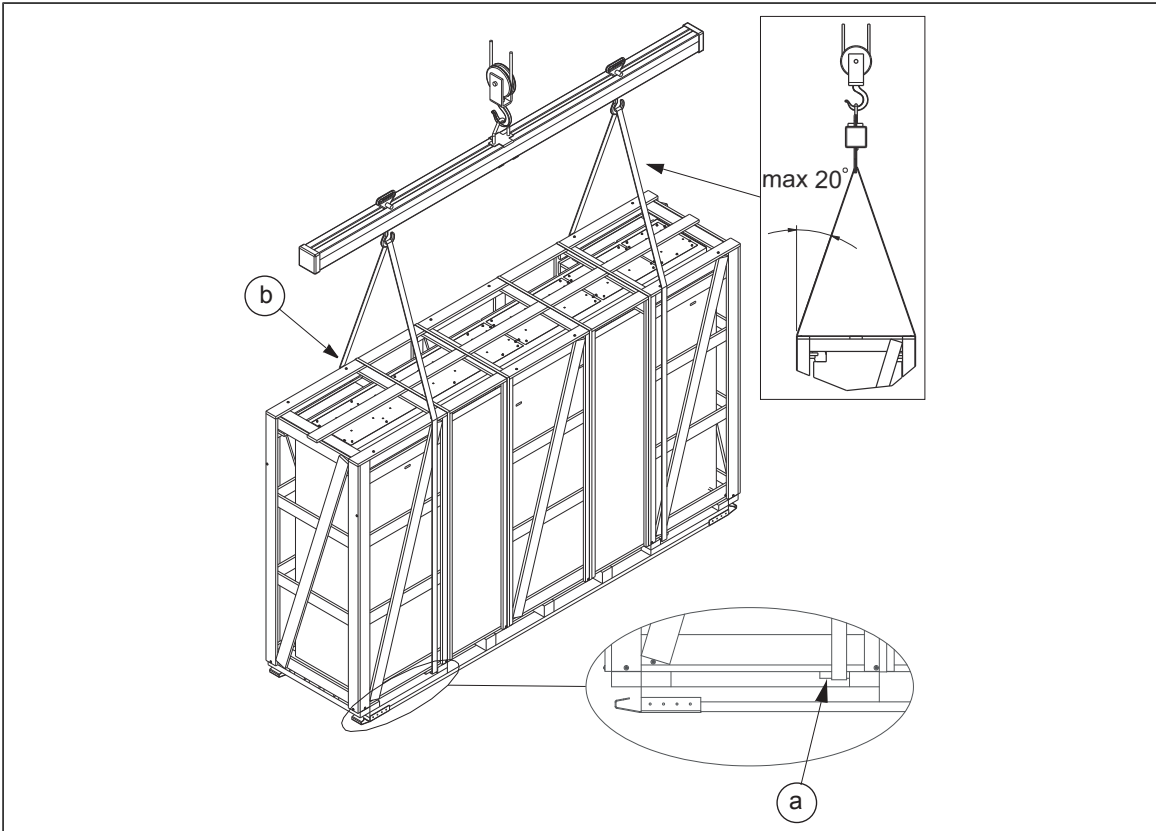


### Lifting the crate with a crane



**WARNING!**

Incorrect lifting can cause danger or damage. Obey the local laws and regulations applicable to lifting, such as requirements for planning the lift, for capacity and condition of lifting equipment, and for training of personnel.

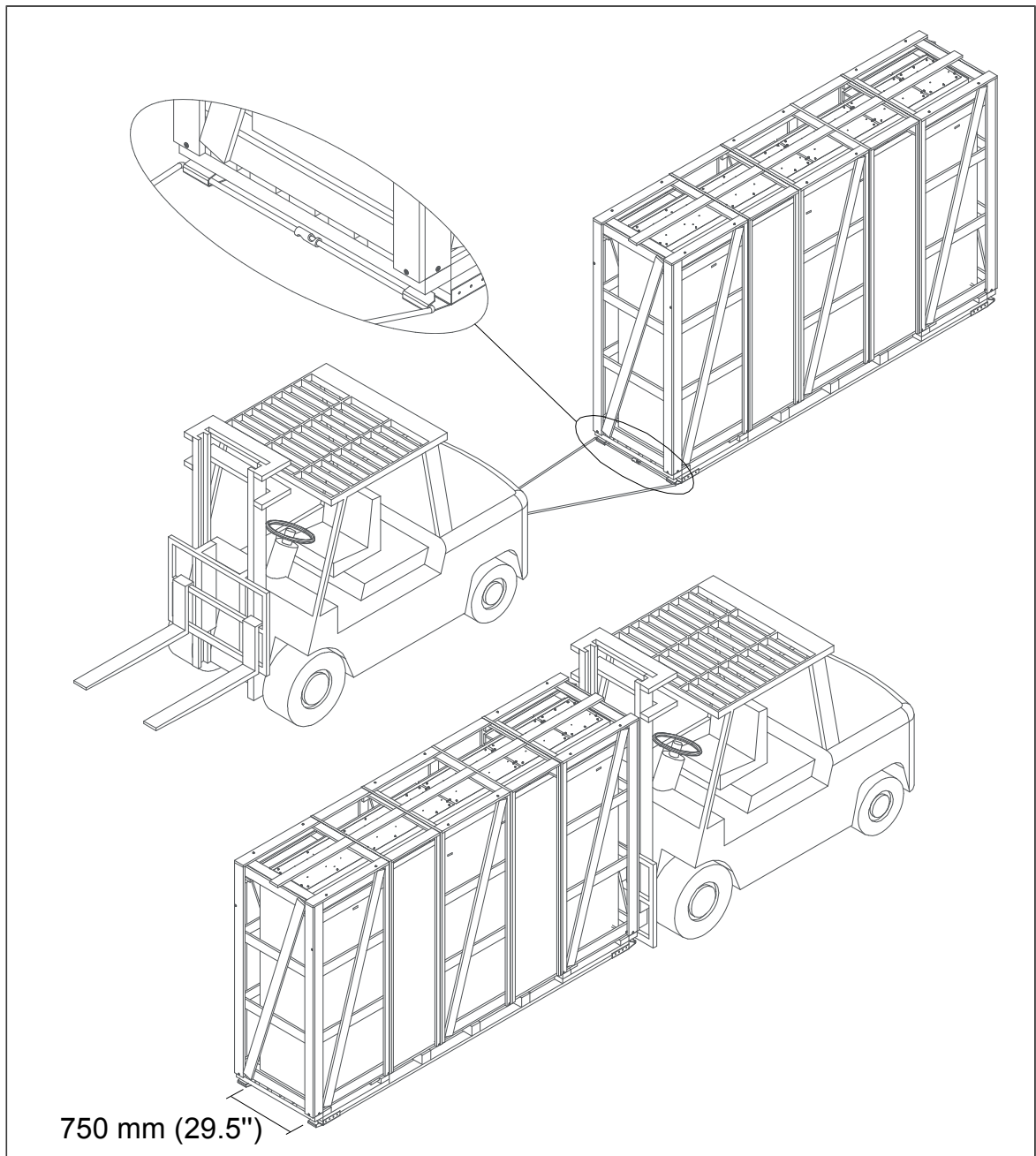


a	Lifting point
b	Optimal position for the lifting sling: as close to the traverse board as possible





### Moving the crate with a forklift



### ■ Removing the transport package

Remove the transport package as follows:

1. Undo the screws that attach the wooden parts of the transport crate to each other.
2. Remove the wooden parts.
3. Remove the clamps with which the drive cabinet is mounted onto the transport pallet by undoing the fastening screws.
4. Remove the plastic wrapping.



## ■ Moving the unpacked drive cabinet

### Lifting the cabinet with a crane

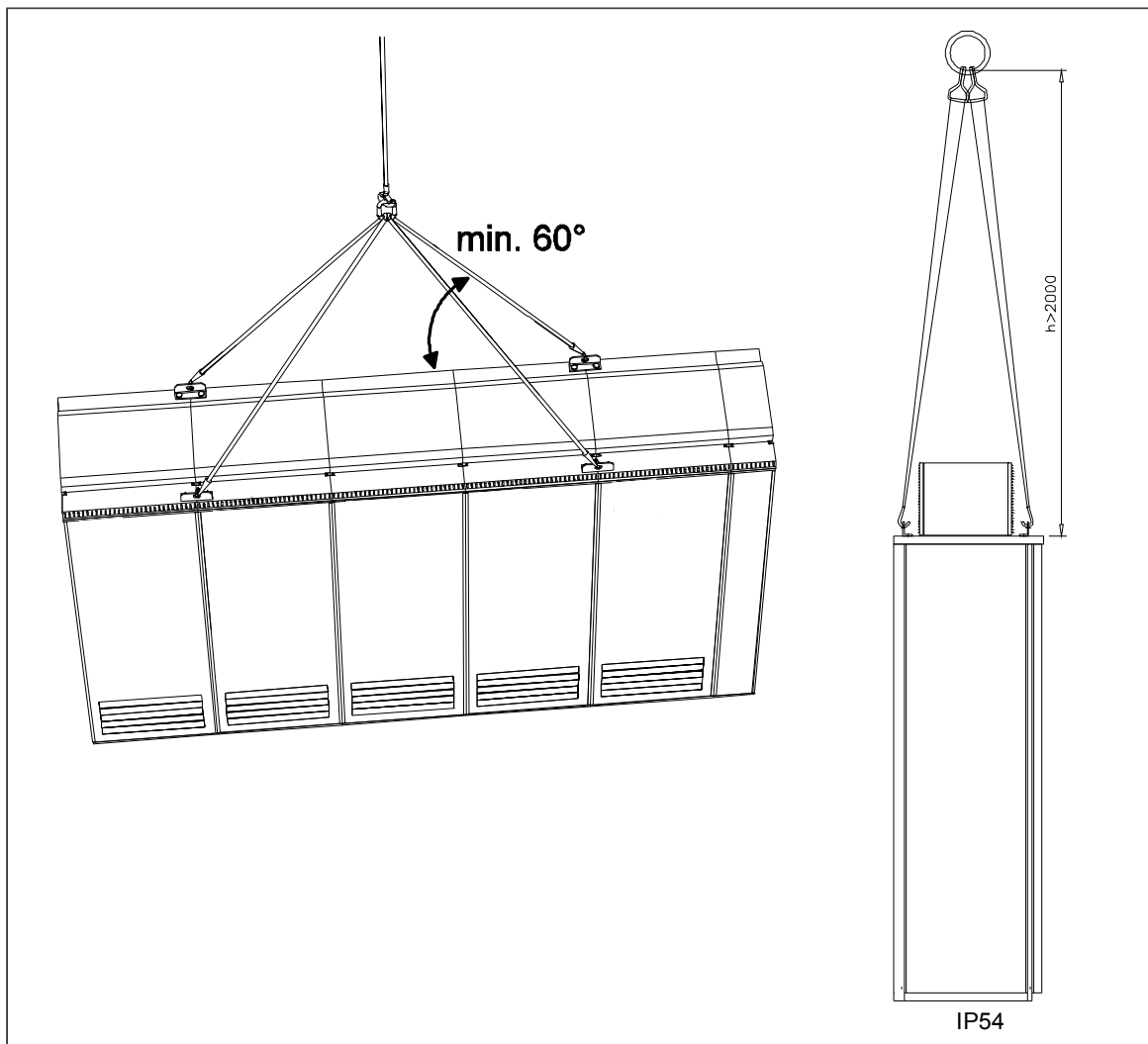


#### **WARNING!**

Incorrect lifting can cause danger or damage. Obey the local laws and regulations applicable to lifting, such as requirements for planning the lift, for capacity and condition of lifting equipment, and for training of personnel.

Lift the drive cabinet by its designated lifting points. Depending on the size of the cabinet, it has either bolt-on lifting lugs, or lifting bars with lifting holes.

**Note:** The minimum allowed height of the lifting slings with IP54 units is 2 meters (6'7").



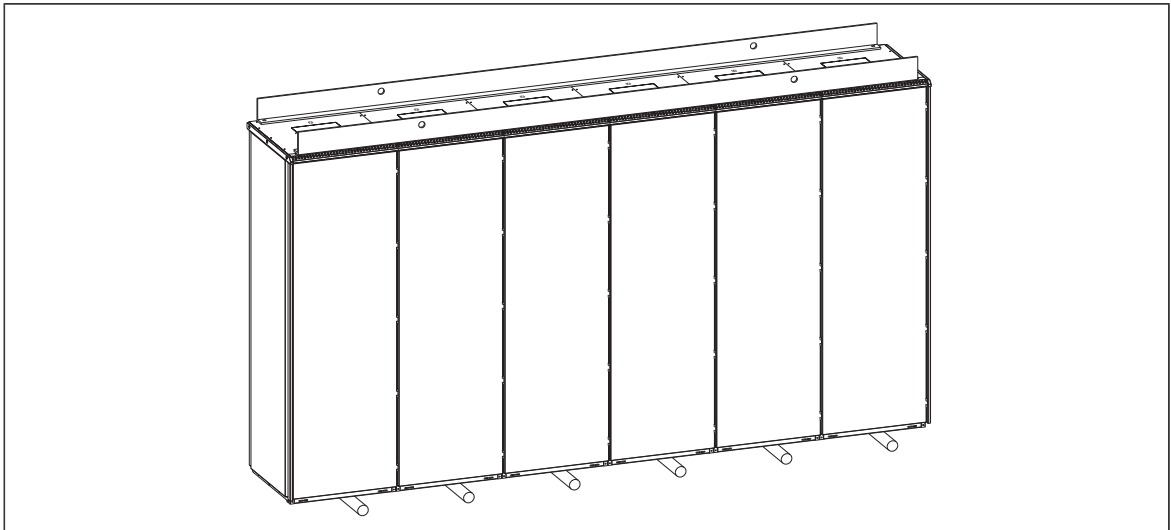
### Moving the cabinet on rollers



**WARNING!**

Do not move marine versions (option +C121) on rollers.

Lay the cabinet on the rollers and move it carefully until close to its final location. Remove the rollers by lifting the unit with a crane, forklift, pallet truck or jack.



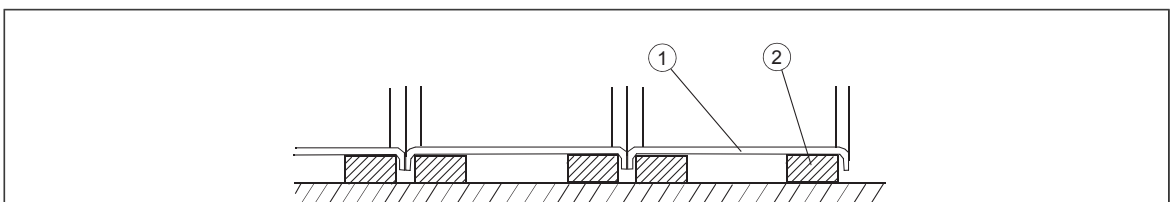
### Moving the cabinet on its back



**WARNING!**

Do not transport the drive with an LCL or L filter on its back. It will damage the filter.

If the cabinet needs to be laid on its back, support the cabinet from below alongside the cubicle seams.

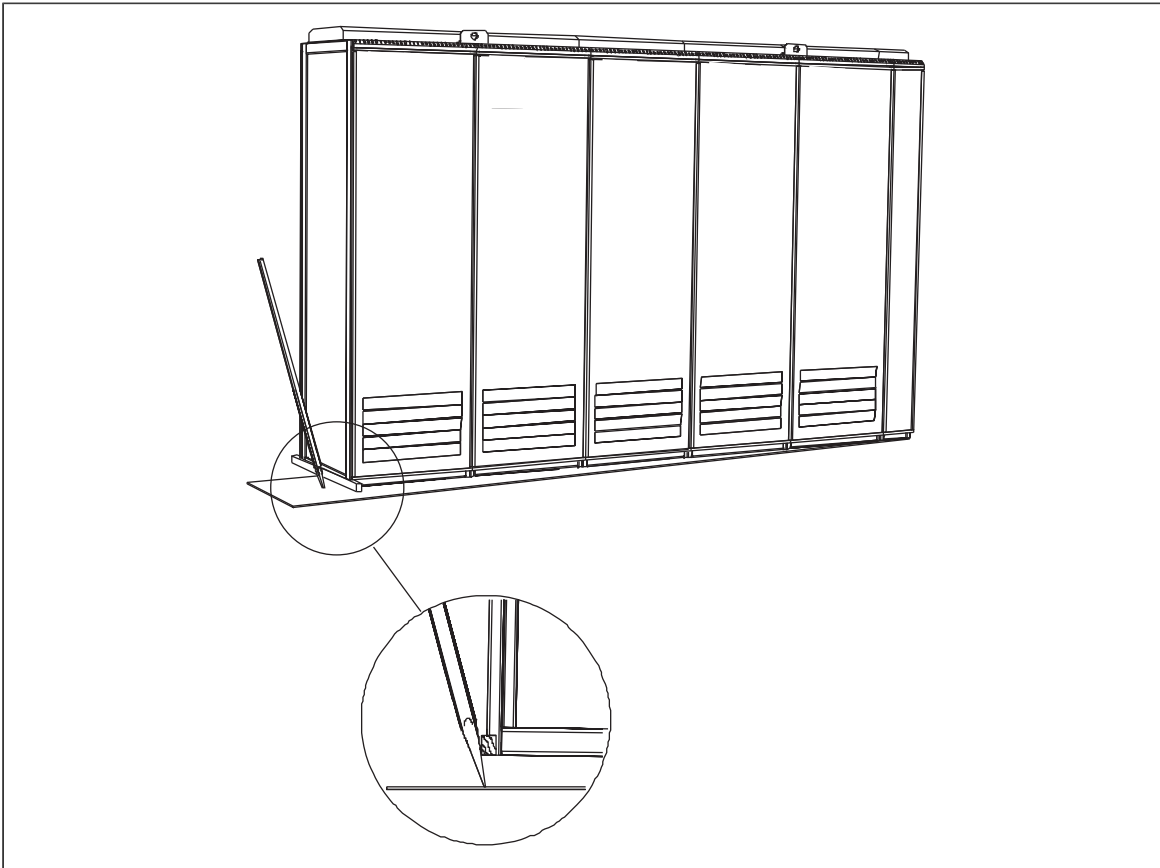


1	Cabinet back panel
2	Support



### Final placement of the cabinet

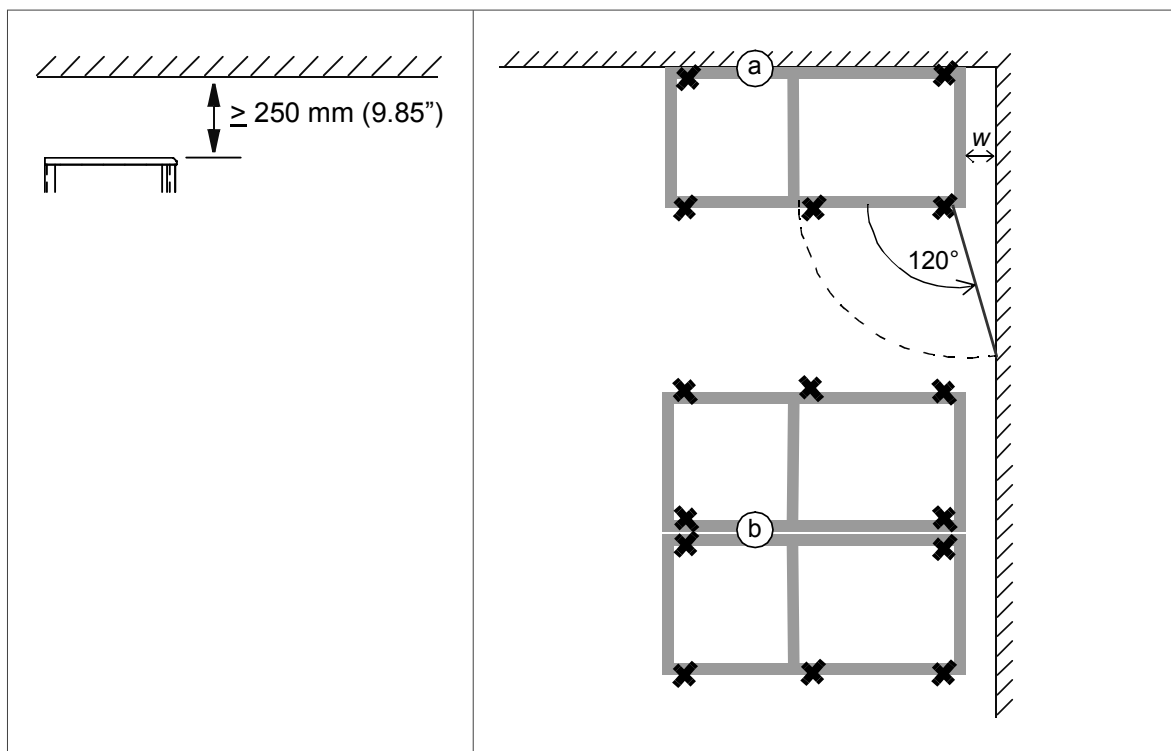
Move the cabinet into its final position with a slate bar (spud bar). Place a piece of wood between the edge of the cabinet and the bar to protect the cabinet frame.



## Attaching the cabinet to the floor and wall or roof

### ■ General rules

- The drive must be installed in an upright vertical position.
- Leave 250 mm (9.85") of free space above the cabinet for maintenance, and to allow pressure relief operation.
- The cabinet can be installed with its back against a wall (a), or back-to-back with another unit (b).
- Leave some space ( $w$ ) at the side where the cabinet outmost hinges are to allow the doors to open sufficiently. The doors must open  $120^\circ$  to allow module replacement.



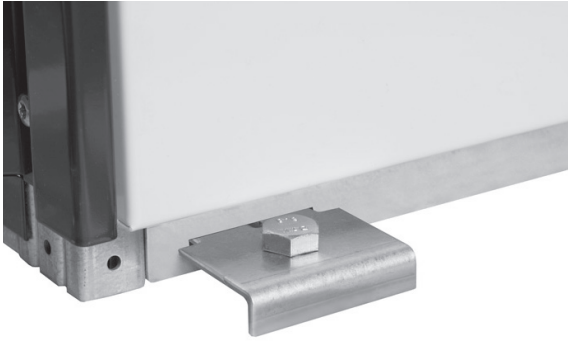
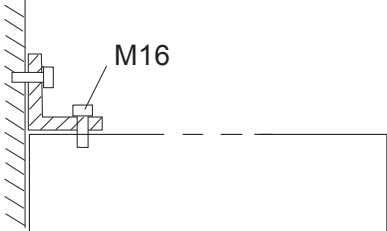
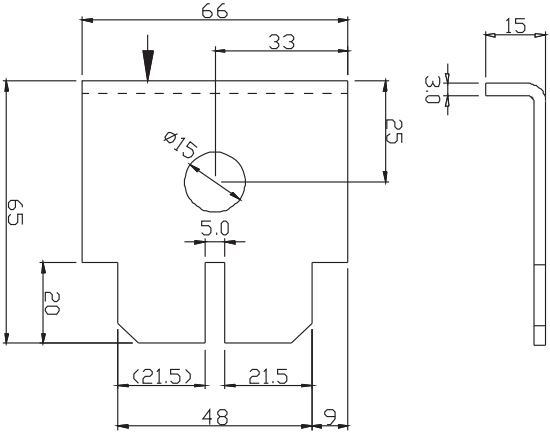
**Note 1:** Any height adjustment must be done before attaching the cabinet sections to the floor or to each other. Height adjustment can be done by using metal shims between the cabinet bottom and floor.

**Note 2:** Depending on the size of the cabinet, it has either bolt-on lifting eyes, or lifting bars with lifting holes. Bolt-on lifting eyes need not be removed unless the holes are used for attaching the cabinet. If the cabinet is delivered with lifting bars, either remove them or let them remain attached to the cabinet. If removed, store the bars for decommissioning. If the lifting bars have been removed, plug any unused holes using the existing bolts and sealing rings included. Tighten to  $70 \text{ N}\cdot\text{m (52 lbf}\cdot\text{ft)}$ .

■ **Attaching the cabinet (non-marine units)**

**Alternative 1 – Clamping**

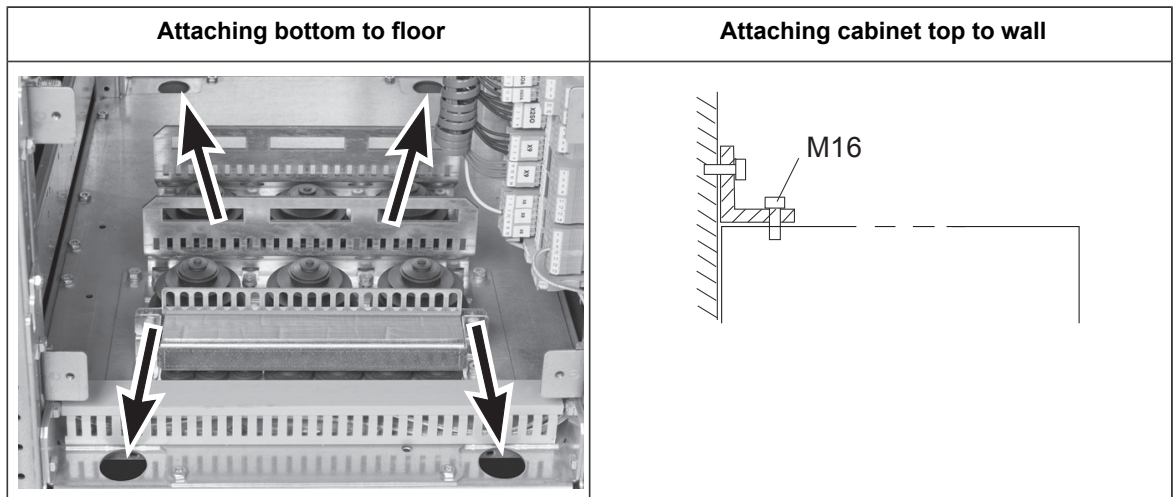
1. Insert the clamps (included) into the twin slots along the front and rear edges of the cabinet frame body and fasten them to the floor with a bolt. The recommended maximum distance between the clamps in the front edge is 800 mm (31.5”).
2. If floor mounting at the back is not possible, attach the top of the cabinet to the wall with L-brackets (not included in the delivery) bolted to the lifting eye/bar holes, and suitable hardware.

Clamping bottom to floor	Attaching top to wall
	
	



### Alternative 2 – Using the holes inside the cabinet

1. Attach the cabinet to the floor through the bottom fastening holes with size M10...M12 (3/8" ... 1/2") bolts. The recommended maximum distance between the front edge fastening points is 800 mm (31.5").
2. If the back fastening holes are not accessible, attach the top of the cabinet to the wall with L-brackets (not included in the delivery) bolted to the lifting eye/bar holes.

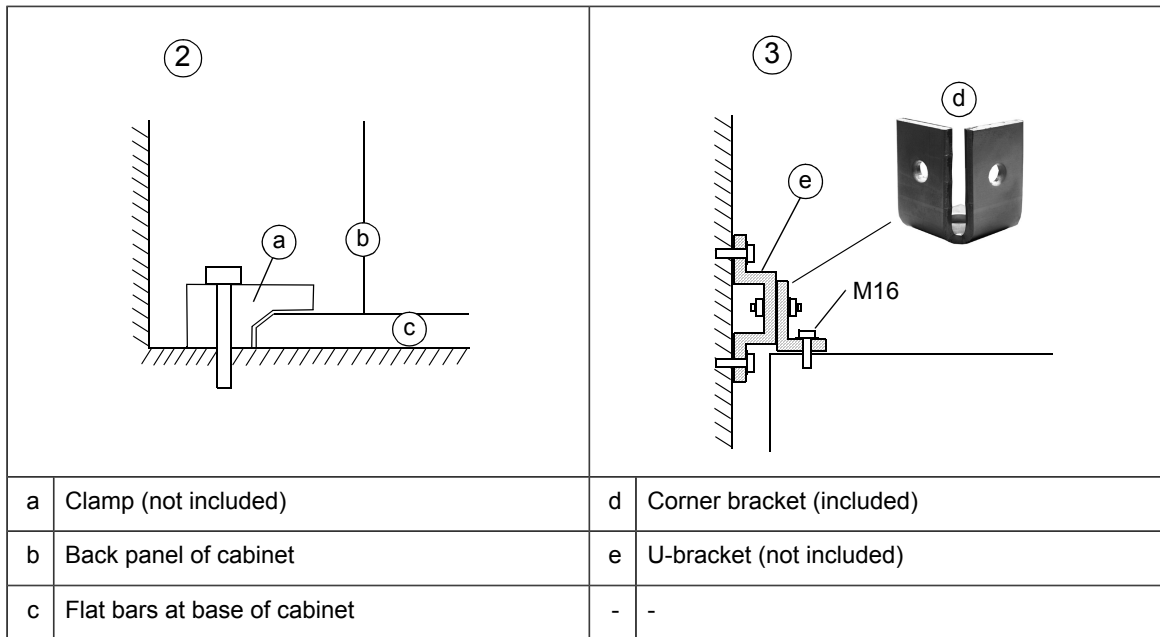


■ **Attaching the cabinet (marine units)**

See the dimension drawing delivered with the drive for details of the fastening points.

Fasten the cabinet to the floor and roof (wall) as follows:

1. Bolt the unit to the floor through the flat bars at the base of the cabinet using M10 or M12 screws.
2. If there is not enough room behind the cabinet for installation, clamp (a) the rear edges of the flat bars (c) to the floor. See the figure below.
3. Attach corner brackets (d) to the lifting eye holes. Fasten the corner brackets to the rear wall and/or roof with suitable hardware such as U-brackets (e).

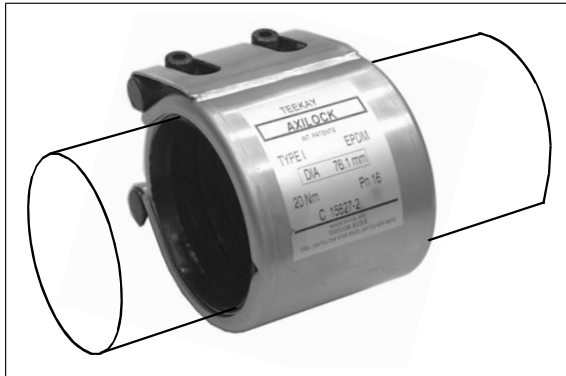




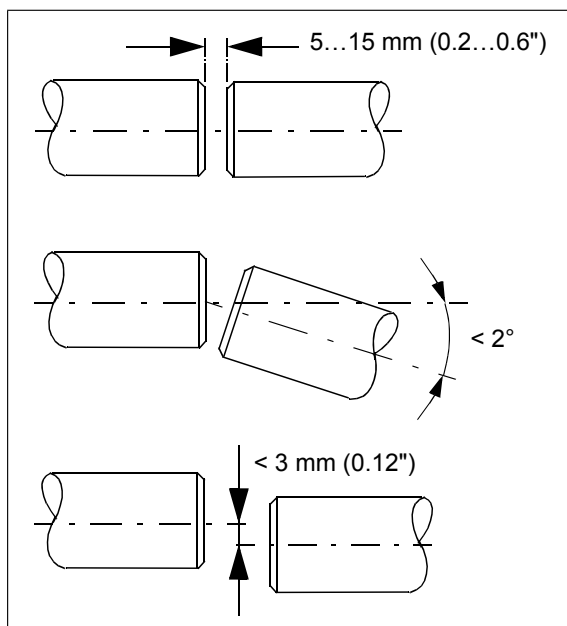
## Joining cabinet sections together

Wide cabinet line-ups are delivered in multiple sections. The sections are to be joined on-site using a joining cubicle at the end of one section (a common motor terminal cubicle can also act as a joining cubicle). The screws required for the joining are enclosed in a plastic bag inside the cabinet.

1. Fasten the first section to the floor.
2. Remove any plates covering the rear post of the joining cubicle.
3. Slide Axilock connectors onto the coolant pipes at the joint.

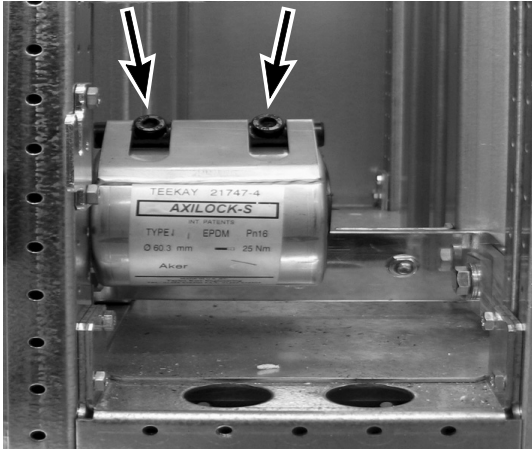


4. Align the two sections.  
The coolant pipe ends must be aligned as shown.

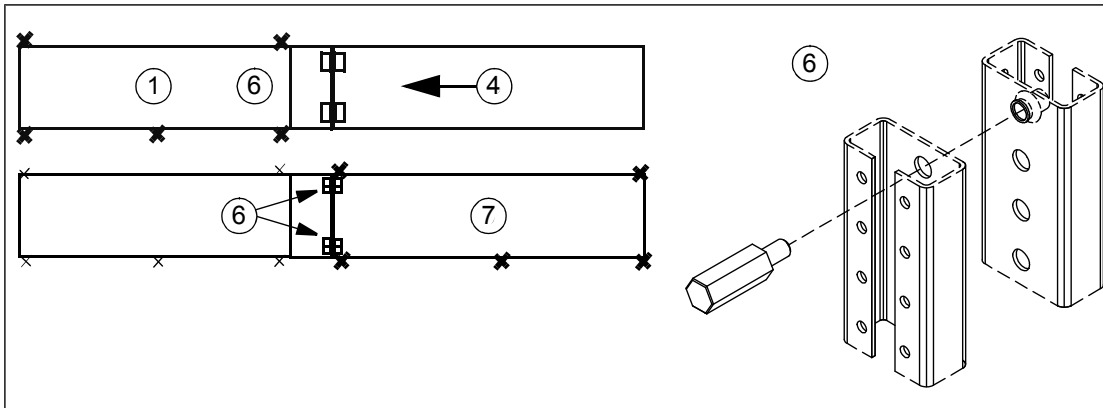


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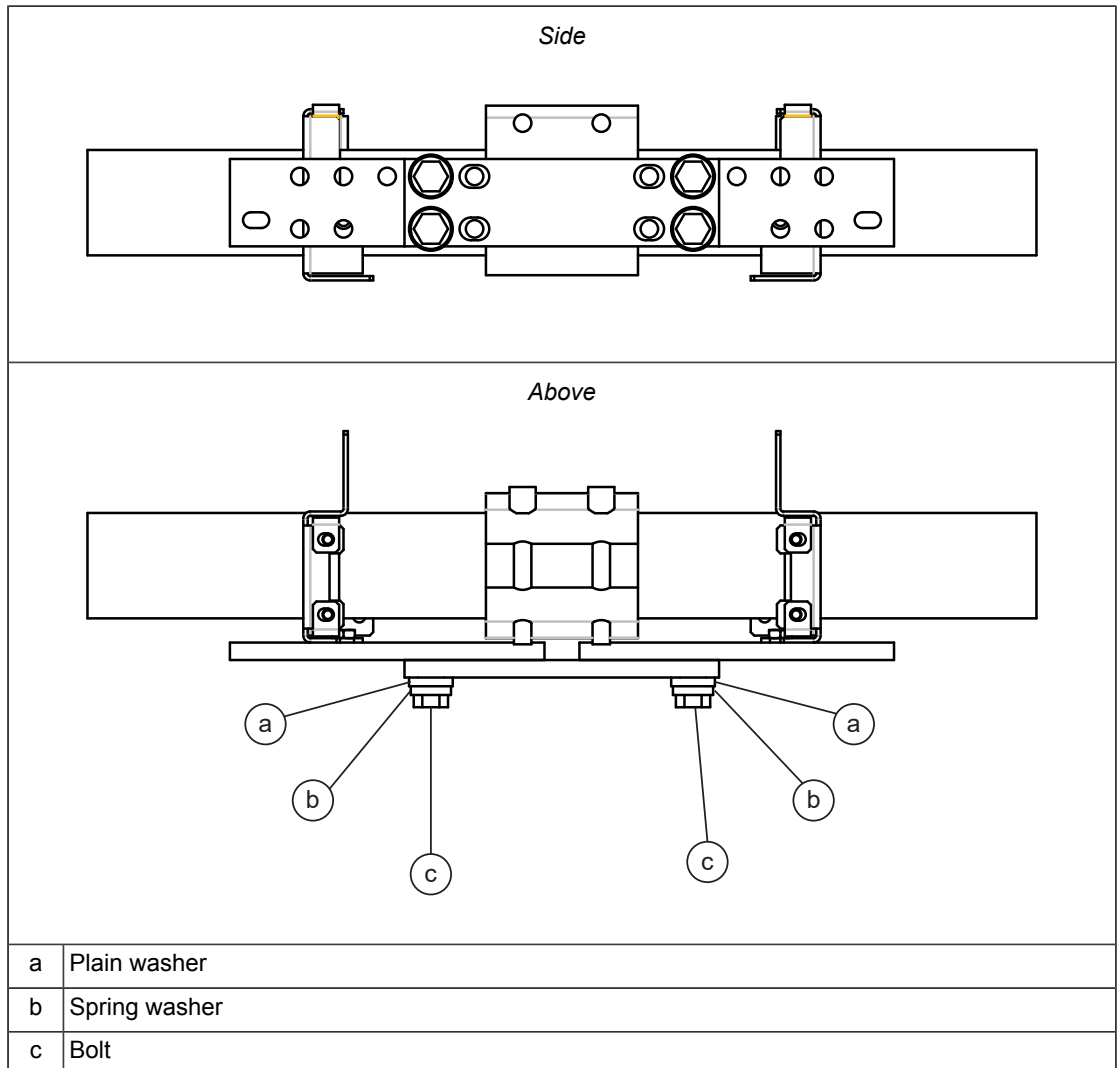
- Center the Axilock connectors onto the gaps between coolant pipe ends. Tighten the connector screws to the torque indicated on the connector label.



- Fasten the front and rear posts of the joining cubicle to the posts of the other section with 16 screws (8 per post). Tighten the screws to 5 N·m (3.7 lbf·ft).
- Fasten the second section to the floor. The numbers in the figure below refer to the installation steps.

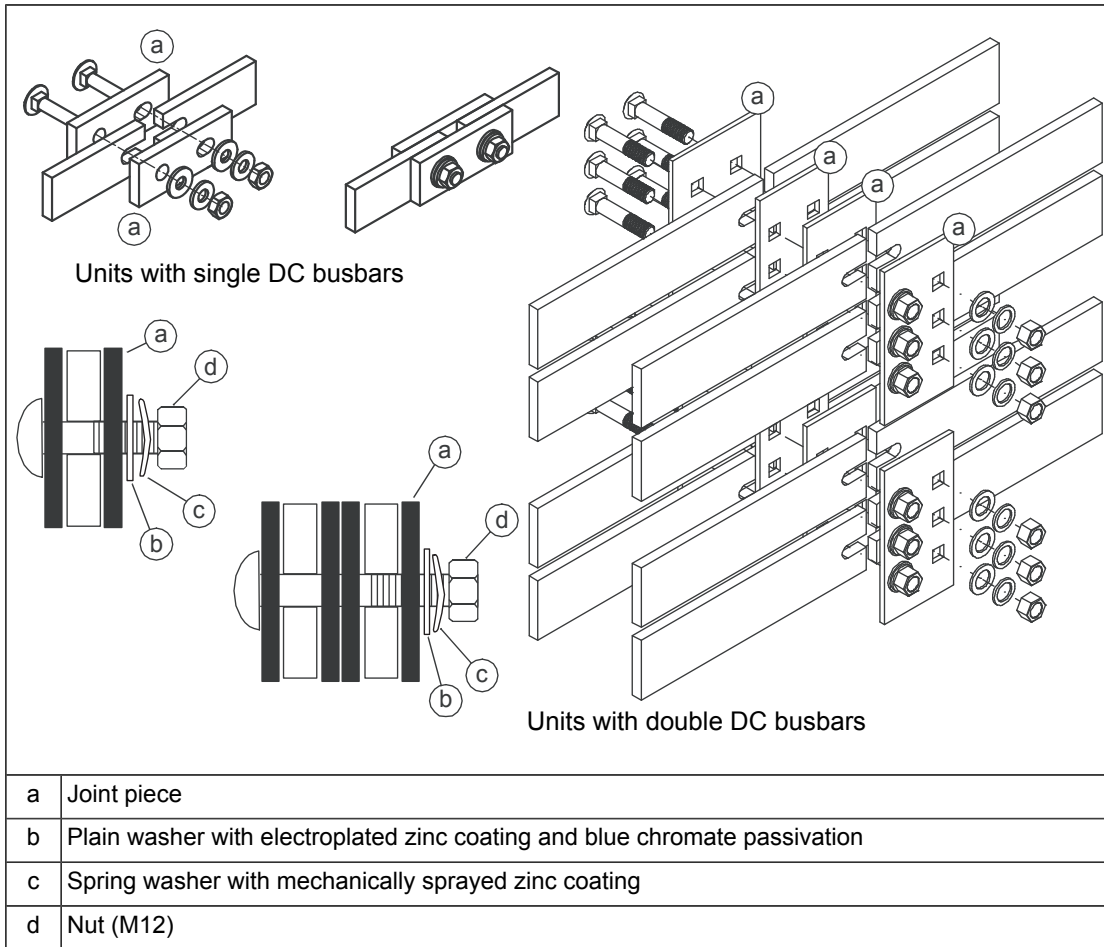


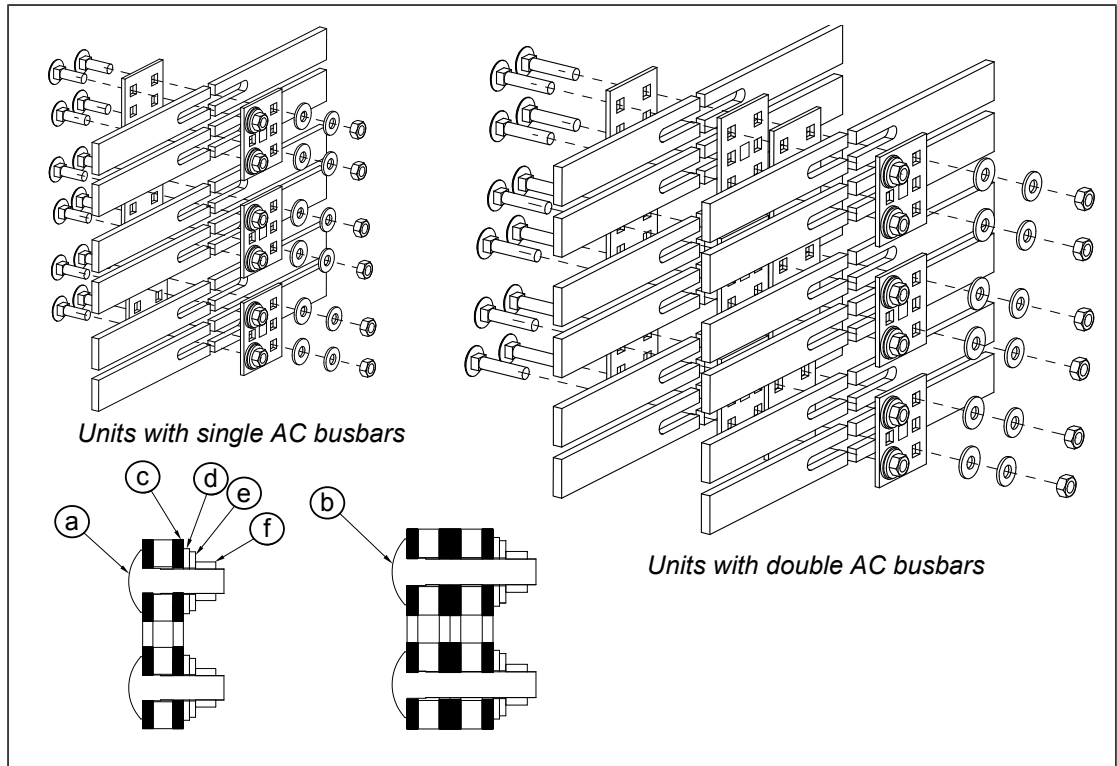
- Connect the PE busbars using the M10 bolts included. Tighten to 35...40 N·m (25...30 lbf·ft).




- Remove the shroud covering the DC busbars in the joining cubicle.


10. Connect the DC and AC busbars. Tighten the bolts to 55...70 N·m (40...50 lbf·ft).





a	Bolt (M12)
b	Bolt (M12)
c	Joint piece
d	Plain washer with electroplated zinc coating and blue chromate passivation
e	Spring washer with mechanically sprayed zinc coating
f	Nut (M12)

**WARNING!**  Make sure you install the washers in the correct order as shown. For example, placing an unpassivated zinc-coated spring washer directly against the joint piece will cause corrosion.

**WARNING!**  Do not use any joining parts other than those delivered with the unit. The parts are carefully selected to match the material of the busbars. Other parts or materials can form a galvanic couple and cause corrosion.

11. Reinstall any shrouding removed earlier.
12. Repeat procedure for any further sections.

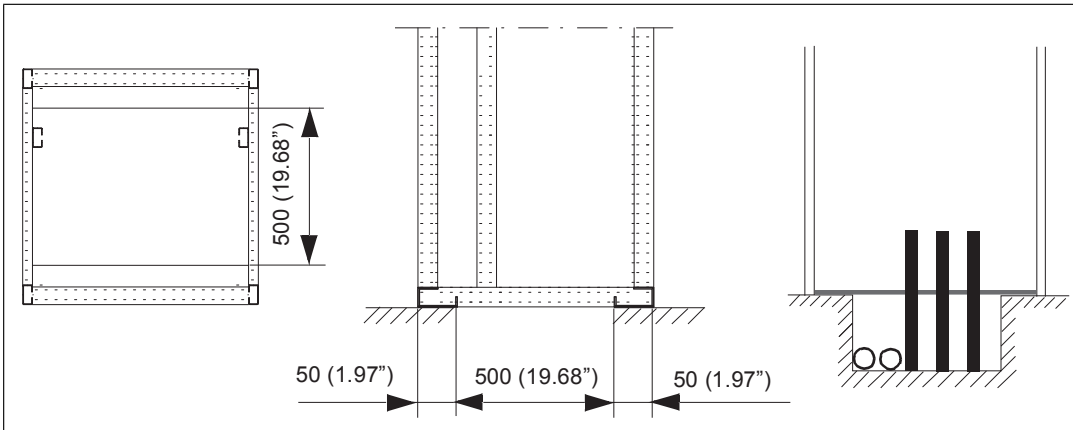


## Miscellaneous

### ■ Cable duct in the floor below the cabinet

A cable duct can be constructed below the 500 mm wide middle part of the cabinet. The cabinet weight lies on the two 50 mm wide transverse sections which the floor must carry.

Prevent the cooling air flow from the cable duct to the cabinet by bottom plates. To ensure the degree of protection for the cabinet, use the original bottom plates delivered with the unit. With user-defined cable entries, take care of the degree of protection, fire protection and EMC compliance.



### ■ Arc welding

ABB does not recommend attaching the cabinet by arc welding. However, if arc welding is the only option, connect the return conductor of the welding equipment to the cabinet frame at the bottom within 0.5 meters (1'6") of the welding point.

**Note:** The cabinet frame is zinc-plated.



#### **WARNING!**

Make sure that the return wire is connected correctly. Welding current must not return via any component or cabling of the drive. If the welding return wire is connected improperly, the welding circuit can damage electronic circuits in the cabinet.



#### **WARNING!**


Do not inhale the welding fumes.

## Lifting lugs and bars

### ■ Certificate of conformity

The certificate is available in ABB Library at [www.abb.com/drives/documents](http://www.abb.com/drives/documents) (document number [3AXD10001061361](http://www.abb.com/drives/documents)).

### ■ Declarations of conformity



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## EU Declaration of Conformity

Machinery Directive 2006/42/EC

We  
 Manufacturer: ABB Oy  
 Address: Hiomotie 13, 00380 Helsinki, Finland.  
 Phone: +358 10 22 11

declare under our sole responsibility that the following products:

**Lifting bars, identified with material codes**

64300971	64301284	64301411	64485342
64301047	64301306	64456695	64485351
64301063	64301314	64456725	64485369
64301080	64301322	64456822	64485377
64301101	64301331	64456881	64485458
64301136	64301349	64456890	68775558
64301152	64301357	64456920	68775540
64301187	64301365	64485296	3AUA5000013498
64301209	64301373	64485300	3AUA5000013504
64301250	64301381	64485318	3AUA0000055356
64301268	64301390	64485326	3AXD50000435524
64301276	64301403	64485334	3AXD50000435548

**Lifting lugs, identified with material codes**

64302621	64327151
----------	----------

used for lifting the following **frequency converters** and **frequency converter components**

<b>ACS800LC</b>	types -x7LC, LC multidrives, -x07LC
<b>ACS580, ACH580, ACQ580</b>	types -07
<b>ACS880</b>	types -x7, multidrives, -x07, -xx07
<b>ACS880LC</b>	types -x7LC, LC multidrives, -x07LC, -xx07

identified with serial numbers beginning with 1 or 8

1/2
3AXD10000665649 rev.A





are in conformity with all the relevant lifting accessory requirements of EU Machinery Directive 2006/42/EC.

Person authorized to compile the technical file:  
Name and address: Vesa Tiihonen, Hiomotie 13, 00380 Helsinki, Finland

Helsinki, 16 Dec 2019

Signed for and on behalf of:

A blue ink signature of Peter Lindgren, consisting of stylized initials and a surname.

Peter Lindgren  
Vice President, ABB Oy

A blue ink signature of Vesa Tiihonen, consisting of stylized initials and a surname.

Vesa Tiihonen  
Manager, Product Engineering and Quality







## Declaration of Conformity

### Supply of Machinery (Safety) Regulations 2008

We

Manufacturer: ABB Oy

Address: Hiomotie 13, 00380 Helsinki, Finland.

Phone: +358 10 22 11

declare under our sole responsibility that the following products:

#### Lifting bars, identified with material codes

64300971	64301284	64301411	64485342
64301047	64301306	64456695	64485351
64301063	64301314	64456725	64485369
64301080	64301322	64456822	64485377
64301101	64301331	64456881	64485458
64301136	64301349	64456890	68775558
64301152	64301357	64456920	68775540
64301187	64301365	64485296	3AUA5000013498
64301209	64301373	64485300	3AUA5000013504
64301250	64301381	64485318	3AUA0000055356
64301268	64301390	64485326	3AXD50000435524
64301276	64301403	64485334	3AXD50000435548

#### Lifting lugs, identified with material codes

64302621	64327151
----------	----------

used for lifting the following **frequency converters** and **frequency converter components**

<b>ACS800LC</b>	types -x7LC, LC multidrives, -x07LC
<b>ACS580, ACH580, ACQ580</b>	types -07
<b>ACS880</b>	types -x7, multidrives, -x07, -xx07
<b>ACS880LC</b>	types -x7LC, LC multidrives, -x07LC, -xx07

identified with serial numbers beginning with 1 or 8





are in conformity with all the relevant lifting accessory requirements of the Supply of Machinery (Safety) Regulations 2008.

Authorized to compile the technical file: ABB Oy, Hiomotie 13, 00380 Helsinki, Finland

Helsinki, 28 May 2021

Signed for and on behalf of:

*Peter Lindgren*

Peter Lindgren  
Vice President, ABB Oy

*Vesa Tiihonen*

Vesa Tiihonen  
Manager, Reliability and Quality, ABB Oy



# 5

## Guidelines for planning the electrical installation

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### Contents of this chapter

This chapter contains instructions for planning the electrical installation of the drive. Some instructions are mandatory to follow in every installation, others provide useful information that only concerns certain applications.

### Limitation of liability

The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations. Furthermore, if the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

### Selecting the supply disconnecting device

The drive is equipped with a main disconnecting device as standard. Depending on the size of the drive, and the selected options, the type of disconnecting device may vary. Examples: switch-disconnector, withdrawable air circuit breaker, etc.

### Selecting the main breaker option

The drive is equipped with an air circuit breaker in the incoming cubicle as standard (+F255).

Optionally, the drive may be ordered without an air circuit breaker (+F255 disabled/deselected). In this case, the supply panel of the drive must be equipped with a main breaker. The control interface for this external breaker is located in the drive's input cubicle.

---

For connecting to power networks with a short rating from 65 kA up to 100 kA, the drive can be ordered with option +F274, which adds an additional 100 kA rated input cubicle to the input section of the drive.

## Examining the compatibility of the motor and drive

Use asynchronous AC induction motors, permanent magnet synchronous motors, AC induction servomotors or ABB synchronous reluctance motors (SynRM motors) with the drive.

Select the motor size and drive type from the rating table on basis of the AC line voltage and motor load. You can find the rating table in the appropriate hardware manual. You can also use the DriveSize PC tool.

Make sure that the motor can be used with an AC drive. See [Requirements table \(page 72\)](#). For basics of protecting the motor insulation and bearings in drive systems, see [Protecting the motor insulation and bearings \(page 72\)](#).

### Note:

- Consult the motor manufacturer before using a motor with nominal voltage that differs from the AC line voltage connected to the drive input.
- The voltage peaks at the motor terminals are relative to the supply voltage of the drive, not to the drive output voltage.

### ■ Protecting the motor insulation and bearings

The drive employs modern IGBT inverter technology. Regardless of frequency, the drive output comprises pulses of approximately the drive DC bus voltage with a very short rise time. The pulse voltage can almost double at the motor terminals, depending on the attenuation and reflection properties of the motor cable and the terminals. This can cause additional stress on the motor and motor cable insulation.

Modern variable speed drives with their fast rising voltage pulses and high switching frequencies can generate current pulses that flow through the motor bearings. This can gradually erode the bearing races and rolling elements.

$du/dt$  filters protect motor insulation system and reduce bearing currents. Common mode filters mainly reduce bearing currents. Insulated N-end (non-drive end) bearings protect the motor bearings.

### ■ Requirements table

These tables show how to select the motor insulation system and when a drive  $du/dt$  and common mode filters and insulated N-end (non-drive end) motor bearings are required. Ignoring the requirements or improper installation may shorten motor life or damage the motor bearings and voids the warranty.

---

This table shows the requirements when an ABB motor is in use.

Motor type	Nominal AC line voltage	Requirement for			
		Motor insulation system	ABB $du/dt$ and common mode filters, insulated N-end motor bearings		
			$P_n < 100$ kW and frame size < IEC 315	$100$ kW $\leq P_n < 350$ kW or IEC 315 $\leq$ frame size < IEC 400	$P_n \geq 350$ kW or frame size $\geq$ IEC 400
$P_n < 134$ hp and frame size < NEMA 500	$134$ hp $\leq P_n < 469$ hp or NEMA 500 $\leq$ frame size $\leq$ NEMA 580	$P_n \geq 469$ hp or frame size > NEMA 580			
Random-wound M2_, M3_ and M4_	$U_n \leq 500$ V	Standard	-	+ N	+ N + CMF
	$500$ V < $U_n \leq 600$ V	Standard	+ $du/dt$	+ N + $du/dt$	+ N + $du/dt$ + CMF
		or			
	$600$ V < $U_n \leq 690$ V (cable length $\leq 150$ m)	Reinforced	-	+ N	+ N + CMF
		Reinforced	+ $du/dt$	+ N + $du/dt$	+ N + $du/dt$ + CMF
$600$ V < $U_n \leq 690$ V (cable length > 150 m)	Reinforced	-	+ N	+ N + CMF	
Form-wound HX_ and AM_	$380$ V < $U_n \leq 690$ V	Standard	n.a.	+ N + CMF	$P_n < 500$ kW: +N + CMF
					$P_n \geq 500$ kW: +N + $du/dt$ + CMF
Old <sup>1)</sup> form-wound HX_ and modular	$380$ V < $U_n \leq 690$ V	Check with the motor manufacturer.	+ N + $du/dt$ with voltages over 500 V + CMF		
Random-wound HX_ and AM_ <sup>2)</sup>	$0$ V < $U_n \leq 500$ V	Enamelled wire with fiber glass taping	+ N + CMF		
	$500$ V < $U_n \leq 690$ V		+ N + $du/dt$ + CMF		
HDP	Consult the motor manufacturer.				

1) manufactured before 1.1.1998

2) For motors manufactured before 1.1.1998, check for additional instructions with the motor manufacturer.

This table shows the requirements when a non-ABB motor is in use.

Motor type	Nominal AC line voltage	Requirement for			
		Motor insulation system	ABB $du/dt$ and common mode filters, insulated N-end motor bearings		
			$P_n < 100 \text{ kW}$ and frame size $< \text{IEC 315}$	$100 \text{ kW} \leq P_n < 350 \text{ kW}$ or $\text{IEC 315} \leq \text{frame size} < \text{IEC 400}$	$P_n \geq 350 \text{ kW}$ or frame size $\geq \text{IEC 400}$
$P_n < 134 \text{ hp}$ and frame size $< \text{NEMA 500}$	$134 \text{ hp} \leq P_n < 469 \text{ hp}$ or $\text{NEMA 500} \leq \text{frame size} \leq \text{NEMA 580}$	$P_n \geq 469 \text{ hp}$ or frame size $> \text{NEMA 580}$			
Random-wound and form-wound	$U_n \leq 420 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	-	+ N or CMF	+ N + CMF
	$420 \text{ V} < U_n \leq 500 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	+ $du/dt$	+ $du/dt$ + (N or CMF)	+ N + $du/dt$ + CMF
		or	Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$ , 0.2 micro-second rise time	-	+ N or CMF
	$500 \text{ V} < U_n \leq 600 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$	+ $du/dt$	+ $du/dt$ + (N or CMF)	+ N + $du/dt$ + CMF
		or	Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	-	+ N or CMF
	$600 \text{ V} < U_n \leq 690 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	+ $du/dt$	+ $du/dt$ + N	+ N + $du/dt$ + CMF
		Reinforced: $\hat{U}_{LL} = 2000 \text{ V}$ , 0.3 micro-second rise time <sup>1)</sup>	-	+ N + CMF	+ N + CMF

<sup>1)</sup> If the intermediate DC circuit voltage of the drive is increased from the nominal level due to long term resistor braking cycles, check with the motor manufacturer if additional output filters are needed.

The abbreviations used in the tables are defined below.

Abbr.	Definition
$U_n$	Nominal AC line voltage
$\hat{U}_{LL}$	Peak line-to-line voltage at motor terminals which the motor insulation must withstand
$P_n$	Motor nominal power
$du/dt$	$du/dt$ filter at the output of the drive
CMF	Common mode filter of the drive
N	N-end bearing: insulated motor non-drive end bearing
n.a.	Motors of this power range are not available as standard units. Consult the motor manufacturer.

**Availability of du/dt filter and common mode filter by drive type**

Product type	Availability of du/dt filter	Availability of common mode filter (CMF)
ACS880-17LC	Standard	Standard

**Additional requirements for explosion-safe (EX) motors**

If you use an explosion-safe (EX) motor, follow the rules in the requirements table above. In addition, consult the motor manufacturer for any further requirements.

**Additional requirements for ABB motors of types other than M2\_, M3\_, M4\_, HX\_ and AM\_**

Use the selection criteria given for non-ABB motors.

**Additional requirements for the regenerative and low harmonics drives**

It is possible to increase the intermediate circuit DC voltage from the nominal (standard) level with a parameter in the control program. If you choose to do this, select the motor insulation system which withstands the increased DC voltage level.

**Additional requirements for ABB high-output and IP23 motors**

The rated output power of high output motors is higher than what is stated for the particular frame size in EN 50347 (2001).

This table shows the requirements for protecting the motor insulation and bearings in drive systems for ABB random-wound motor series (for example, M3AA, M3AP and M3BP).

Nominal AC supply voltage	Requirement for			
	Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings		
		$P_n < 100 \text{ kW}$	$100 \text{ kW} \leq P_n < 200 \text{ kW}$	$P_n \geq 200 \text{ kW}$
		$P_n < 140 \text{ hp}$	$140 \text{ hp} \leq P_n < 268 \text{ hp}$	$P_n \geq 268 \text{ hp}$
$U_n \leq 500 \text{ V}$	Standard	-	+ N	+ N + CMF
$500 \text{ V} < U_n \leq 600 \text{ V}$	Standard	+ du/dt	+ du/dt + N	+ du/dt + N + CMF
	or			
	Reinforced	-	+ N	+ N + CMF
$600 \text{ V} < U_n \leq 690 \text{ V}$	Reinforced	+ du/dt	+ du/dt + N	+ du/dt + N + CMF

**Additional requirements for non-ABB high-output and IP23 motors**

The rated output power of high-output motors is higher than what is stated for the particular frame size in EN 50347 (2001).

If you plan to use a non-ABB high-output motor or an IP23 motor, consider these additional requirements for protecting the motor insulation and bearings in drive systems:

- If motor power is below 350 kW: Equip the drive and/or motor with the filters and/or bearings according to the table below.
- If motor power is above 350 kW: Consult the motor manufacturer.

Nominal AC supply voltage	Requirement for		
	Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings	
		$P_n < 100 \text{ kW}$ or frame size < IEC 315	$100 \text{ kW} < P_n < 350 \text{ kW}$ or IEC 315 < frame size < IEC 400
	$P_n < 134 \text{ hp}$ or frame size < NEMA 500	$134 \text{ hp} < P_n < 469 \text{ hp}$ or NEMA 500 < frame size < NEMA 580	
$U_n \leq 420 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	+ N or CMF	+ N or CMF
$420 \text{ V} < U_n < 500 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	+ du/dt + (N or CMF)	+ N + du/dt + CMF
	or Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$ , 0.2 microsecond rise time	+ N or CMF	+ N or CMF
$500 \text{ V} < U_n \leq 600 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$	+ du/dt + (N or CMF)	+ N + du/dt + CMF
	or Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	+ N or CMF	+ N + CMF
$600 \text{ V} < U_n \leq 690 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	+ N + du/dt	+ N + du/dt + CMF
	Reinforced: $\hat{U}_{LL} = 2000 \text{ V}$ , 0.3 microsecond rise time <sup>1)</sup>	+ N + CMF	+ N + CMF

<sup>1)</sup> If the intermediate DC circuit voltage of the drive is increased from the nominal level due to long term resistor braking cycles, check with the motor manufacturer if additional output filters are needed.

### Additional note for sine filters

A sine filter also protects the motor insulation system. The peak phase-to-phase voltage with a sine filter is approximately  $1.5 \cdot U_n$ .

## Selecting the power cables

### ■ General guidelines

Select the input power and motor cables according to local regulations.

- **Current:** Select a cable capable of carrying the maximum load current and suitable for the prospective short-circuit provided by the supply network. The method of installation and ambient temperature affect the cable current carrying capacity. Obey local regulations and laws.
- **Temperature:** For an IEC installation, select a cable rated for at least 70 °C (158 °F) maximum permissible temperature of conductor in continuous use.  
For North America, select a cable rated for at least 75 °C (167 °F).  
Important: For certain product types or option configurations higher temperature rating may be required. See the technical data for details.
- **Voltage:** 600 V AC cable is accepted for up to 500 V AC. 750 V AC cable is accepted for up to 600 V AC. 1000 V AC cable is accepted for up to 690 V AC.

To comply with the EMC requirements of the CE mark, use one of the preferred cable types. See [Preferred power cable types \(page 77\)](#).

Symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as the stress on motor insulation, bearing currents and wear.



Metal conduit reduces electromagnetic emission of the whole drive system.

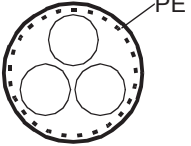
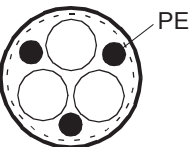
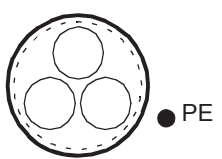
■ **Typical power cable sizes**

See the technical data.

■ **Power cable types**


**Preferred power cable types**

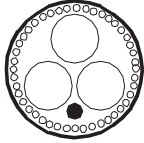
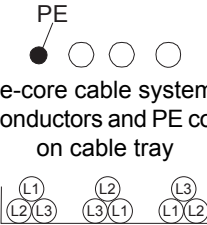

This section presents the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

Cable type	Use as input power cabling	Use as motor cabling
 <p>Symmetrical shielded (or armored) cable with three phase conductors and concentric PE conductor as shield (or armor)</p>	Yes	Yes
 <p>Symmetrical shielded (or armored) cable with three phase conductors and symmetrically constructed PE conductor and a shield (or armor)</p>	Yes	Yes
 <p>Symmetrical shielded (or armored) cable with three phase conductors and a shield (or armor), and separate PE conductor/cable<sup>1)</sup></p>	Yes	Yes

<sup>1)</sup> A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use.


**Alternate power cable types**

Cable type	Use as input power cabling	Use as motor cabling
 <p>Four-conductor cabling in metal conduit (three phase conductors and PE). For example, EMT, or four-conductor armored cable</p>	Yes	Yes with phase conductor smaller than 10 mm <sup>2</sup> (8 AWG) Cu, or motors up to 30 kW (40 hp)

Cable type	Use as input power cabling	Use as motor cabling
 <p>Shielded (Al/Cu shield or armor)<sup>1)</sup> four-conductor cable (three phase conductors and a PE)</p>	Yes	Yes with motors up to 100 kW (135 hp). A potential equalization between the frames of motor and driven equipment is required.
 <p>A single-core cable system: three phase conductors and PE conductor on cable tray</p> <p>Preferable cable arrangement to avoid voltage or current unbalance between the phases</p>	Yes  <b>WARNING!</b> If you use unshielded single-core cables in an IT network, make sure that the non-conductive outer sheath (jacket) of the cables have good contact with a properly grounded conductive surface. For example, install the cables on a properly grounded cable tray. Otherwise voltage may become present on the non-conductive outer sheath of the cables, and there is even a risk of an electric shock.	No

<sup>1)</sup> Armor may act as an EMC shield, as long as it provides the same performance as a concentric EMC shield of a shielded cable. To be effective at high frequencies, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The effectiveness of the shield can be evaluated based on the shield inductance, which must be low and only slightly dependent on frequency. The requirements are easily met with a copper or aluminum shield/armor. The cross-section of a steel shield must be ample and the shield helix must have a low gradient. A galvanized steel shield has a better high-frequency conductivity than a non-galvanized steel shield.

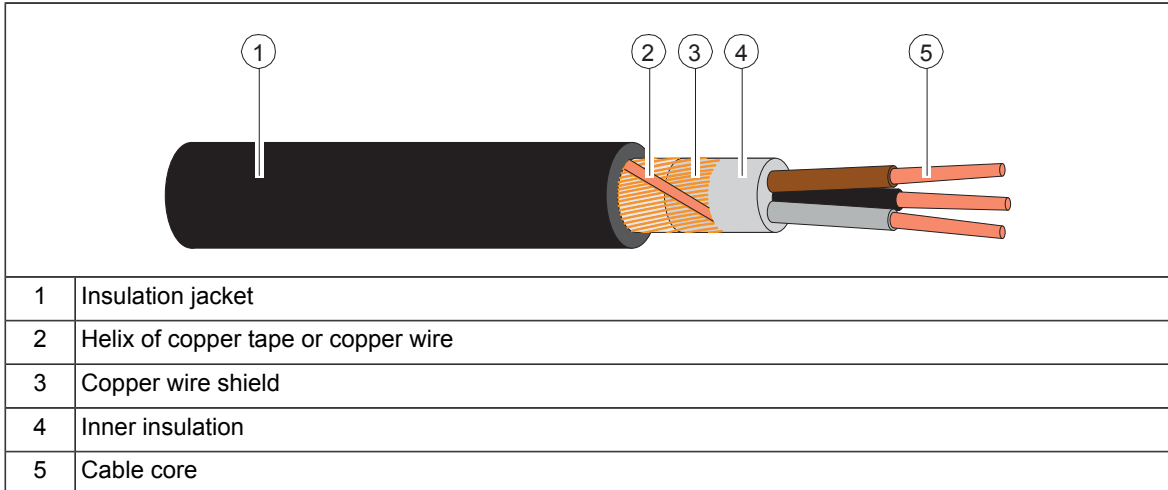
### Not allowed power cable types

Cable type	Use as input power cabling	Use as motor cabling
 <p>Symmetrical shielded cable with individual shields for each phase conductor</p>	No	No

### ■ Power cable shield

If the cable shield is used as the sole protective earth (PE) conductor, make sure that its conductivity agrees with the PE conductor requirements.

To effectively suppress radiated and conducted radio-frequency emissions, the cable shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminum shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires with an open helix of copper tape or copper wire. The better and tighter the shield, the lower the emission level and bearing currents.



## Grounding requirements

This section gives general requirements for grounding the drive. When you plan the grounding of the drive, obey all the applicable national and local regulations.

The conductivity of the protective earth conductor(s) must be sufficient.

Unless local wiring regulations state otherwise, the cross-sectional area of the protective earth conductor must agree with the conditions that require automatic disconnection of the supply required in 411.3.2 of IEC 60364-4-41:2005 and be capable of withstanding the prospective fault current during the disconnection time of the protective device. The cross-sectional area of the protective earth conductor must be selected from the table below or calculated according to 543.1 of IEC 60364-5-54.

This table shows the minimum cross-sectional area of the protective earth conductor related to the phase conductor size according to IEC/UL 61800-5-1 when the phase conductor(s) and the protective earth conductor are made of the same metal. If this is not so, the cross-sectional area of the protective earth conductor must be determined in a manner which produces a conductance equivalent to that which results from the application of this table.

Cross-sectional area of the phase conductors $S$ (mm <sup>2</sup> )	Minimum cross-sectional area of the corresponding protective earth conductor $S_p$ (mm <sup>2</sup> )
$S \leq 16$	$S^1$
$16 < S \leq 35$	16
$35 < S$	$S/2$

<sup>1)</sup> For the minimum conductor size in IEC installations, refer to *Additional grounding requirements – IEC*.

If the protective earth conductor is not part of the input power cable or input power cable enclosure, the minimum permitted cross-sectional area is:

- 2.5 mm<sup>2</sup> if the conductor is mechanically protected,  
or
- 4 mm<sup>2</sup> if the conductor is not mechanically protected. If the equipment is cord-connected, the protective earth conductor must be the last conductor to be interrupted if there is a failure in the strain relief mechanism.

## ■ Additional grounding requirements – IEC

This section gives grounding requirements according to standard IEC/EN 61800-5-1.

Because the normal touch current of the drive is more than 3.5 mA AC or 10 mA DC:

- the minimum size of the protective earth conductor must comply with the local safety regulations for high protective earth conductor current equipment, and
- you must use one of these connection methods:
  1. a fixed connection and:
    - a protective earth conductor with a minimum cross-sectional area of 10 mm<sup>2</sup> Cu or 16 mm<sup>2</sup> Al (as an alternative when aluminum cables are permitted),  
or
    - a second protective earth conductor of the same cross-sectional area as the original protective earth conductor,  
or
    - a device that automatically disconnects the supply if the protective earth conductor is damaged.
  2. a connection with an industrial connector according to IEC 60309 and a minimum protective earth conductor cross-section of 2.5 mm<sup>2</sup> as part of a multi-conductor power cable. Sufficient strain relief must be provided.

If the protective earth conductor is routed through a plug and socket, or similar means of disconnection, it must not be possible to disconnect it unless power is simultaneously removed.

**Note:** You can use power cable shields as grounding conductors only when their conductivity is sufficient.

## ■ Additional grounding requirements – UL (NEC)

This section gives grounding requirements according to standard UL 61800-5-1.

The protective earth conductor must be sized as specified in Article 250.122 and table 250.122 of the National Electric Code, ANSI/NFPA 70.

For cord-connected equipment, it must not be possible to disconnect the protective earth conductor before power is removed.

## Selecting the control cables

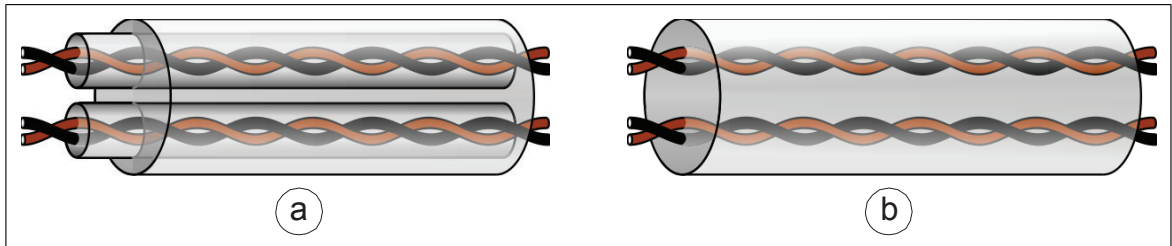
### ■ Shielding

Only use shielded control cables.

Use a double-shielded twisted pair cable for analog signals. ABB recommends this type of cable also for the pulse encoder signals. Use one individually shielded pair for each signal. Do not use common return for different analog signals.

---

A double-shielded cable (a) is the best alternative for low-voltage digital signals, but single-shielded (b) twisted pair cable is also acceptable.



#### ■ Signals in separate cables

Run analog and digital signals in separate, shielded cables. Do not mix 24 V DC and 115/230 V AC signals in the same cable.

#### ■ Signals that can be run in the same cable

If their voltage does not exceed 48 V, relay-controlled signals can be run in the same cables as digital input signals. The relay-controlled signals should be run as twisted pairs.

#### ■ Relay cable

The cable type with braided metallic shield (for example ÖLFLEX by LAPPKABEL, Germany) has been tested and approved by ABB.

#### ■ Control panel to drive cable

Use EIA-485, Cat 5e (or better) cable with male RJ-45 connectors. The maximum length of the cable is 100 m (328 ft).

#### ■ PC tool cable

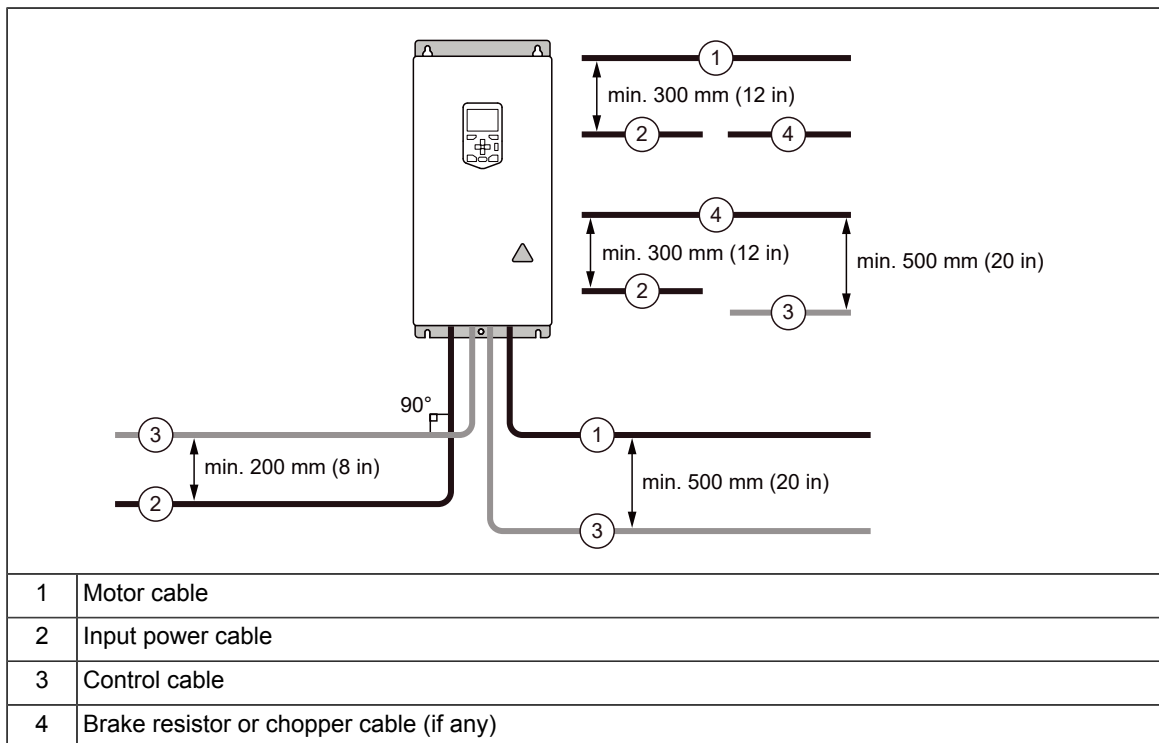
Connect the Drive Composer PC tool to the drive through the USB port of the control panel. Use a USB Type A (PC) - Type Mini-B (control panel) cable. The maximum length of the cable is 3 m (9.8 ft).

## Routing the cables

#### ■ General guidelines – IEC

- Route the motor cable away from other cables. Motor cables of several drives can be run in parallel installed next to each other.
- Install the motor cable, input power cable and control cables on separate trays.
- Avoid long parallel runs of motor cables with other cables.
- Where control cables must cross power cables, make sure that they are arranged at an angle as near to 90 degrees as possible.
- Do not run extra cables through the drive.
- Make sure that the cable trays have good electrical bonding to each other and to the grounding electrodes. Aluminum tray systems can be used to improve local equalizing of potential.

The following figure illustrates the cable routing guidelines with an example drive.



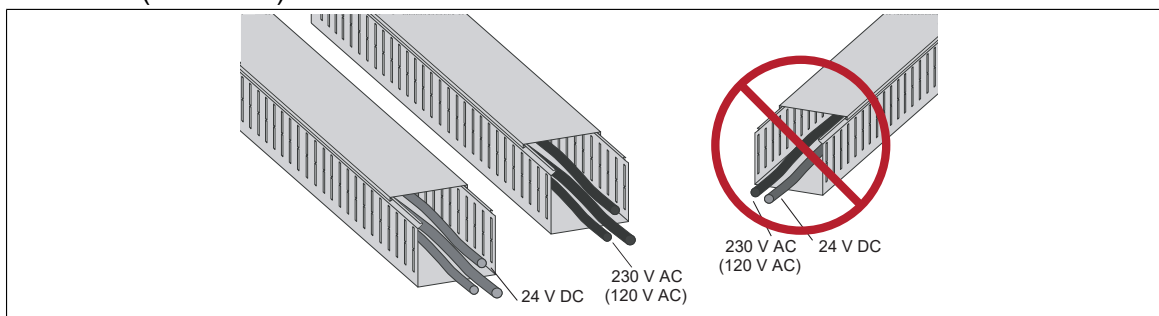
■ **Continuous motor cable shield/conduit or enclosure for equipment on the motor cable**

To minimize the emission level when safety switches, contactors, connection boxes or similar equipment are installed on the motor cable between the drive and the motor:

- Install the equipment in a metal enclosure.
- Use either a symmetrical shielded cable, or install the cabling in a metal conduit.
- Make sure that there is a good and continuous galvanic connection in the shield/conduit between drive and motor.
- Connect the shield/conduit to the protective ground terminal of the drive and the motor.

■ **Separate control cable ducts**

Put 24 V DC and 230 V AC (120 V AC) control cables in separate ducts, unless the 24 V DC cable is insulated for 230 V AC (120 V AC) or insulated with an insulation sleeving for 230 V AC (120 V AC).



## Protecting the drive, input power cable, motor and motor cable in short circuit situations and against thermal overload

### ■ Protecting the input cabling and the drive upon a short-circuit

To protect the input cable in short-circuit situations, install fuses or a suitable circuit breaker at the supply side of the cabling.

The drive is equipped with fuses as standard. In case of a short-circuit inside the drive, the fuses protect the drive, restrict drive damage, and prevent damage to adjoining equipment.

### ■ Protecting the motor and motor cable in short-circuits

The drive protects the motor cable and motor in a short-circuit situation when the motor cable is sized according to the nominal output current of the drive.

### ■ Protecting the drive and the power cables against thermal overload

The drive protects itself and the input and motor cables against thermal overload when the cables are sized according to the nominal current of the drive. No additional thermal protection devices are needed.



#### **WARNING!**

If the drive is connected to multiple motors, use a separate circuit breaker or fuses for protecting each motor cable and motor against overload. The drive overload protection is tuned for the total motor load. It may not trip due to an overload in one motor circuit only.

---

### ■ Protecting the motor against thermal overload

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value, the function either monitors a calculated temperature value (based on a motor thermal model) or an actual temperature indication given by motor temperature sensors.

The motor thermal protection model supports thermal memory retention and speed sensitivity. The user can tune the thermal model further by feeding in additional motor and load data.

The most common temperature sensor types are PTC or Pt100.

For more information, see the firmware manual.

### ■ Protecting the motor against overload without thermal model or temperature sensors

Motor overload protection protects the motor against overload without using motor thermal model or temperature sensors.

Motor overload protection is required and specified by multiple standards including the US National Electric Code (NEC) and the common UL/IEC 61800-5-1 standard in conjunction with UL/IEC 60947-4-1. The standards allow for motor overload protection without external temperature sensors.

---

The protection feature allows the user to specify the class of operation in the same manner as the overload relays are specified in standards UL/IEC 60947-4-1 and NEMA ICS 2.

The motor overload protection supports thermal memory retention and speed sensitivity.

For more information, see drive firmware manual.

## Protecting the drive against ground faults

The drive is equipped with an internal ground fault protective function to protect the unit against ground faults in the motor and motor cable. This function is not a personnel safety or a fire protection feature. See the firmware manual for more information.

An optional ground fault monitoring device (+Q954) is available for IT (ungrounded) systems. The option includes a ground fault indicator on the drive cabinet door.

### ■ Residual current device compatibility

The drive is suitable for use with residual current devices of Type B.

**Note:** As standard, the drive contains capacitors connected between the main circuit and the frame. These capacitors and long motor cables increase the ground leakage current and may cause nuisance faults in residual current devices.

## Implementing the emergency stop function

You can order the drive with an emergency stop function (option).

See the appropriate option manual for more information.

Name	Code
Emergency stop, stop category 0 (option +Q951) for ACS880-07/17/17LC/37/37LC drives user's manual	<a href="#">3AJA0000119895</a>
Emergency stop, stop category 1 (option +Q952) for ACS880-07/17/17LC/37/37LC drives user's manual	<a href="#">3AJA0000119896</a>

## Implementing the Safe torque off function

See chapter *The Safe torque off function (page 213)*.

## Implementing the Prevention of unexpected start-up function

You can order the drive with a Prevention of unexpected start-up (POUS) function. The POUS function disables the control voltage of the power semiconductors of the drive (inverter) output stage. This prevents the drive from generating the torque required to rotate the motor. POUS enables a short-time maintenance work (like cleaning) on the non-electrical parts of the machinery without switching off and disconnecting the drive.

See the appropriate option manual for more information.

Option code	User's manual	Manual code (English)
+Q950	Prevention of unexpected start-up, with FSO-xx safety functions module	<a href="#">3AJA0000145922</a>
+Q957	Prevention of unexpected start-up, with safety relay	<a href="#">3AJA0000119910</a>



## Implementing an ATEX-certified motor thermal protection

With option +Q971, the drive provides ATEX-certified safe motor disconnection without contactor using the drive Safe torque off function. To implement the thermal protection of a motor in explosive atmosphere (Ex motor), you must also:

- use an ATEX-certified Ex motor
- order an ATEX-certified thermistor protection module for the drive (option +L537), or acquire and install an ATEX-compliant protection relay
- do the necessary connections.

For cabinet-built drives, an ATEX-certified motor thermal protection function is also available (option +L513+Q971, or +L514+Q971). The drive is equipped with an ATEX-certified Safe motor disconnection function and with ATEX-compliant protection relays for PTC or Pt100 temperature sensors.

For more information, see:

User's manual	Manual code (English)
ATEX-certified Safe disconnection function, Ex II (2) GD for ACS880 drives (+Q971) application guide	<a href="#">3AJA0000132231</a>
FPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) for ACS880 drives user's manual	<a href="#">3AXD50000027782</a>
ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives (options +L513+Q971 and +L514+Q971) user's manual	<a href="#">3AXD50000014979</a>

## Implementing the functions provided by the FSO safety functions module

You can order the drive with an FSO-12 safety functions module (option +Q973) or FSO-21 safety functions module (option +Q972). An FSO module enables the implementation of functions such as Safe brake control (SBC), Safe stop 1 (SS1), Safe stop emergency (SSE), Safely limited speed (SLS) and Safe maximum speed (SMS).

The settings of the FSO module have default values when delivered from the factory. The wiring of the external safety circuit and configuration of the FSO module are the responsibility of the user.

The FSO module reserves the standard Safe torque off (STO) connection of the drive control unit. STO can still be utilized by other safety circuits through the FSO module.

See the appropriate manual for more information.

Name	Code
FSO-12 safety functions module user's manual	<a href="#">3AXD50000015612</a>
FSO-21 safety functions module user's manual	<a href="#">3AXD50000015614</a>

## Implementing the power loss ride-through function

If the incoming supply voltage is cut off, the drive will continue to operate by utilizing the kinetic energy of the rotating motor. The drive will be fully operational as long as the motor rotates and generates energy to the drive.

---

If the drive is equipped with a main contactor or breaker, it restores the drive input power after a short break. The contactor re-connects after the break automatically. If the drive is equipped with an external uninterruptible auxiliary power supply (option +G307), it keeps the main contactor closed in power-loss situations

**Note:** If the power loss lasts so long that the drive trips on undervoltage, a fault reset and a fresh start command is required to continue operation.

Implement the power-loss ride-through function as follows:

1. Enable the power-loss ride-through function of the drive (parameter 30.31).
2. Enable the automatic restart of the motor after a short power supply break:
  - Set the start mode to automatic (parameter 21.01 or 21.19, depending on the motor control mode being used).
  - Define the automatic restart time (parameter 21.18).



**WARNING!**

Make sure that a flying restart of the motor will not cause any danger. If you are in doubt, do not implement the power loss ride-through function.

---

## Implementing a bypass connection

If bypassing is required, employ mechanically or electrically interlocked contactors between the motor and the drive and between the motor and the power line. Make sure with interlocking that the contactors cannot be closed simultaneously. The installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".

Bypass connection is available as a factory-installed option for some cabinet-installed drive types. Consult ABB for more information.



**WARNING!**

Never connect the drive output to the electrical power network. The connection may damage the drive.

---

## Supplying power for the auxiliary circuits

Power for the auxiliary circuits and cooling fans must be supplied externally, unless the drive has an auxiliary voltage transformer (option +G344) and cooling fan transformer(s) (option +G451).

The user must supply these options from external power sources:

- +G300/+G301: Cabinet heaters and/or lighting
- +G307: Connection for an external uninterruptible power supply
- +G313: Power supply connection for a motor space heater output

For the voltages and fuse sizes, refer to the circuit diagrams delivered with the drive.

## Using power factor compensation capacitors with the drive

Power factor compensation is not needed with AC drives. However, if a drive is to be connected in a system with compensation capacitors installed, note the following restrictions.

---



**WARNING!**

Do not connect power factor compensation capacitors or harmonic filters to the motor cables (between the drive and the motor). They are not meant to be used with AC drives and can cause permanent damage to the drive or themselves.

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If there are power factor compensation capacitors in parallel with the input of the drive:

1. Do not connect a high-power capacitor to the power line while the drive is connected. The connection will cause voltage transients that may trip or even damage the drive.
2. If capacitor load is increased/decreased step by step when the AC drive is connected to the power line, make sure that the connection steps are low enough not to cause voltage transients that would trip the drive.
3. Make sure that the power factor compensation unit is suitable for use in systems with AC drives, ie, harmonic generating loads. In such systems, the compensation unit should typically be equipped with a blocking reactor or harmonic filter.

## Using a safety switch between the drive and the motor

ABB recommends to install a safety switch between the permanent magnet motor and the drive output. The switch is needed to isolate the motor from the drive during maintenance work on the drive.

## Implementing the control of a contactor between drive and motor

Implementing the control of the output contactor depends on the motor control mode and stopping method selected.

When you select the DTC motor control mode and the motor ramp stop mode, use this operation sequence to open the contactor:

1. Give a stop command to the drive.
2. Wait until the drive decelerates the motor to zero speed.
3. Open the contactor.



**WARNING!**

If DTC motor control mode is in use, do not open the output contactor while the drive controls the motor. The motor control operates faster than the contactor, and tries to maintain the load current. This can cause damage to the contactor.

---

When you select the DTC motor control mode and the motor coast stop mode, you can open the contactor immediately after the drive has received the stop command. This is the case also if you use the scalar motor control mode.

## Protecting the contacts of relay outputs

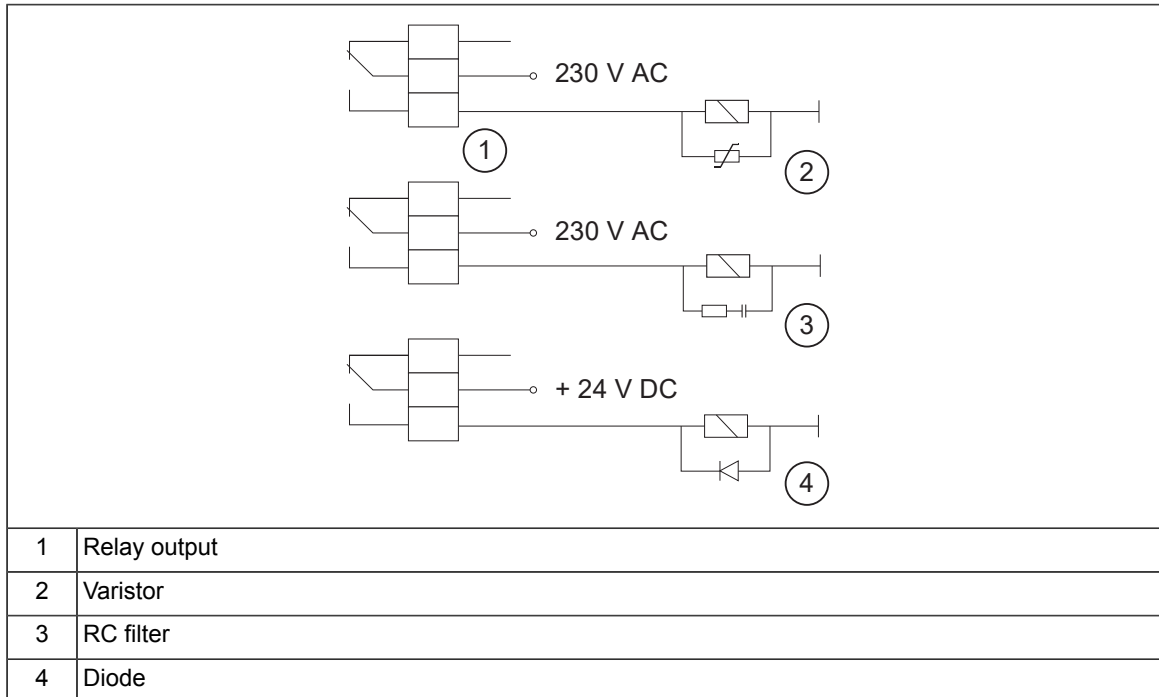
Inductive loads (relays, contactors, motors) cause voltage transients when switched off.

The relay contacts on the drive control unit are protected with varistors (250 V) against overvoltage peaks. In spite of this, it is highly recommended that inductive loads are equipped with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) to minimize the EMC emission at switch-off. If not suppressed, the disturbances may connect capacitively

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or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

Install the protective component as close to the inductive load as possible. Do not install protective components at the relay outputs.



## Implementing a motor temperature sensor connection



### WARNING!

IEC 61800-5-1 requires double or reinforced insulation between live parts and accessible parts when:

- the accessible parts are not conductive, or
- the accessible parts are conductive, but not connected to the protective earth.

Obey this requirement when you plan the connection of the motor temperature sensor to the drive.

You have these implementation alternatives:

1. If there is double or reinforced insulation between the sensor and the live parts of the motor: You can connect the sensor directly to the analog/digital input(s) of the drive. See the control cable connection instructions. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
2. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect the sensor to the drive via an option module. The sensor and the module must form a double or reinforced insulation between the motor live parts and the drive control unit. See [Connecting a motor temperature sensor to the drive through an option module \(page 89\)](#). Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
3. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect a sensor to a digital input of the drive via an external relay. The sensor and the relay must form a double or reinforced insulation

between the motor live parts and the digital input of the drive. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.

■ **Connecting a motor temperature sensor to the drive through an option module**

This table shows:

- option module types that you can use for the motor temperature sensor connection
- insulation or isolation level that each option module forms between its temperature sensor connector and other connectors
- temperature sensor types that you can connect to each option module
- temperature sensor insulation requirement in order to form, together with the insulation of the option module, a reinforced insulation between the motor live parts and the drive control unit.

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	Insulation/Isolation	PTC	KTY	Pt100, Pt1000	
FIO-11	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and other I/O connectors.	x	x	x	Reinforced insulation
FIO-21	Galvanic isolation between sensor connector and other connectors (including drive control unit connector).	x	x	x	Reinforced insulation
FEN-01	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output.	x	-	-	Reinforced insulation
FEN-11	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output.	x	x	-	Reinforced insulation
FEN-21	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output.	x	x	-	Reinforced insulation
FEN-31	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and other connectors.	x	x	-	Reinforced insulation
FAIO-01	Basic insulation between sensor connector and drive control unit connector. No insulation between sensor connector and other I/O connectors.	x	x	x	Reinforced or basic insulation. With basic insulation, the other I/O connectors of the option module must be kept disconnected.

90 Guidelines for planning the electrical installation

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	Insulation/Isolation	PTC	KTY	Pt100, Pt1000	
FPTC-01/02 <sup>1)</sup>	Reinforced insulation between sensor connector and other connectors (including drive control unit connector).	x	-	-	No special requirement

<sup>1)</sup> Suitable for use in safety functions (SIL2 / PL c rated).

For more information, refer to the applicable option module user's manual.

# 6

## Electrical installation

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### Contents of this chapter

This chapter gives instructions on the wiring of the drive.

### Warnings

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**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

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### Measuring the insulation

- **Measuring the insulation resistance of the drive**

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**WARNING!**

Do not do any voltage withstand or insulation resistance tests on any part of the drive as testing can damage the drive. Every drive has been tested for insulation between the main circuit and the chassis at the factory. Also, there are voltage-limiting circuits inside the drive which cut down the testing voltage automatically.

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- **Measuring the insulation resistance of the motor and motor cable**

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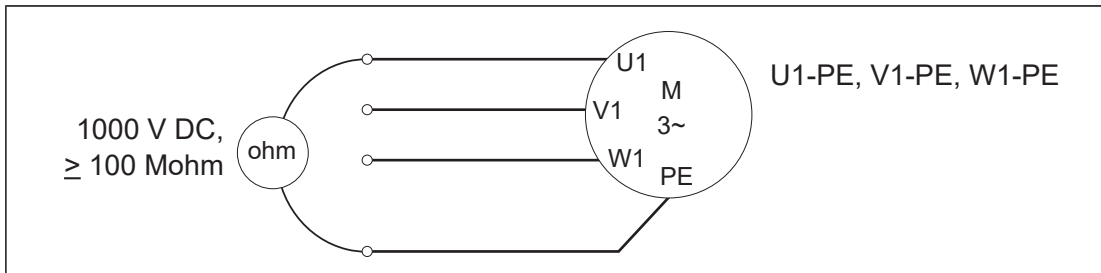
**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

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1. Do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals.
3. Measure the insulation resistance between each phase conductor and the protective earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must be more than 100 Mohm (reference value at 25 °C [77 °F]). For the insulation resistance of other motors, refer to the manufacturer's instructions.

**Note:** Moisture inside the motor reduces the insulation resistance. If you think that there is moisture in the motor, dry the motor and do the measurement again.



#### ■ Measuring the insulation resistance of the input power cable

Before you connect the input power cable to the drive, measure its insulation resistance according to local regulations.





## Connecting the control cables

See chapter *Control units of the drive (page 115)* for the default I/O connections of the inverter unit (with the ACS880 primary control program). The default I/O connections can be different with some hardware options, see the circuit diagrams delivered with the drive for the actual wiring. For other control programs, see their firmware manuals.

### ■ Control cable connection procedure



#### **WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

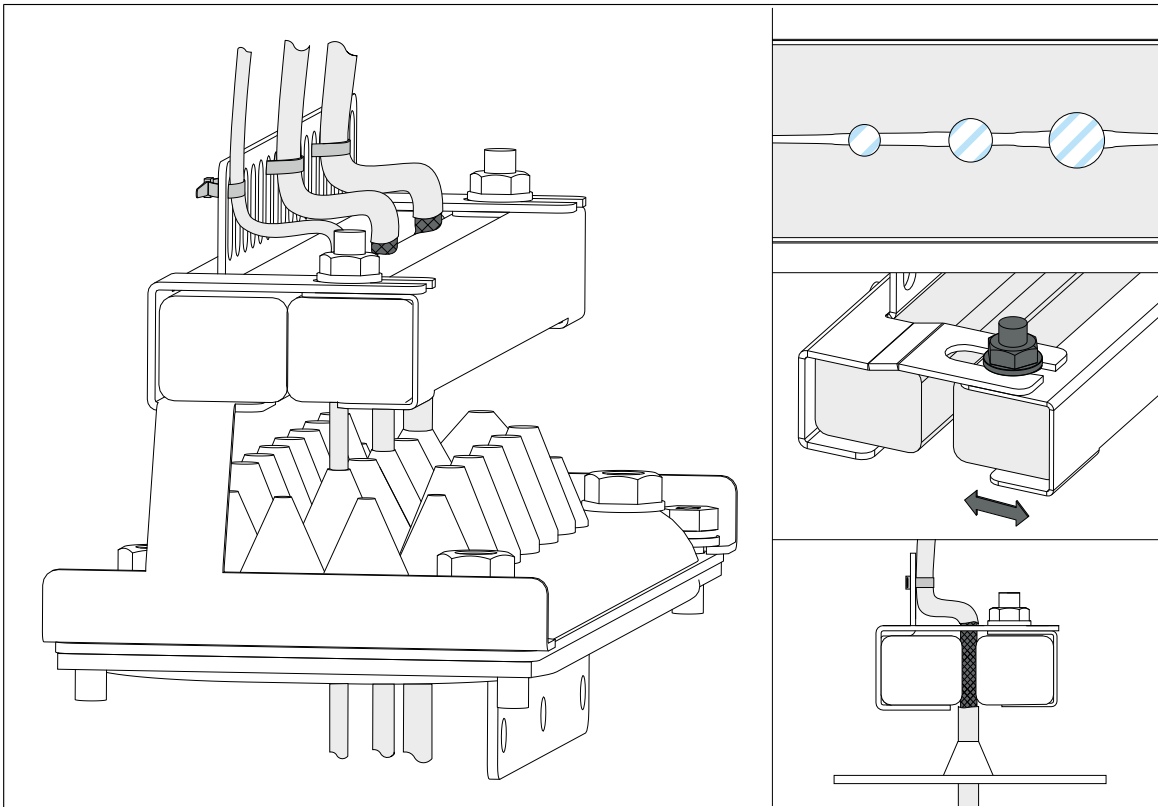
1. Do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Run the control cables into the cabinet as described in section *Grounding the outer shields of the control cables 360° at the cabinet entry* below.
3. Route the control cables as described in section *Routing the control cables inside the cabinet (page 94)*.
4. Connect the control cables as described in section *Connecting control cabling (page 95)*.

#### **Grounding the outer shields of the control cables 360° at the cabinet entry**

Ground the outer shields of all control cables 360 degrees with the EMI conductive cushions at the cabinet entry. The grounding principle is the same for top and bottom entry cables. The illustrations show the bottom entry. The actual design details can vary.

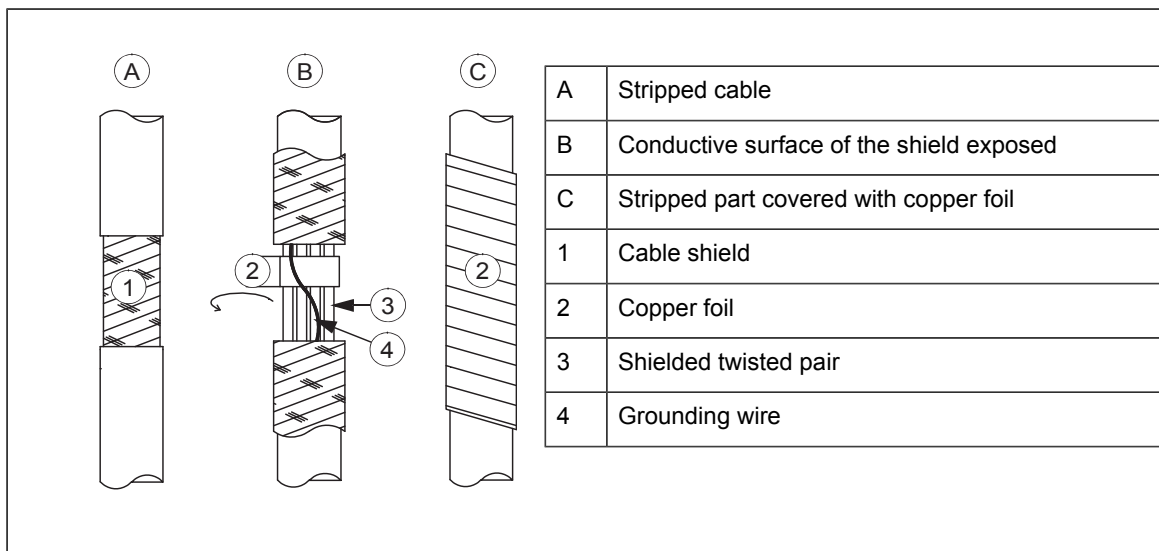
1. If necessary, remove the shrouding in front of the cable entry.
2. Put the cables in sequence from the smallest to the largest. This will help to achieve a good contact with the cushions.
3. Loosen the tightening bolts of the EMI conductive cushions and pull them apart.
4. Cut holes in the grommets and put the cables through the grommets.
5. Peel the insulation from the part of the cable that will be in contact with the EMI conductive cushion.
6. Put the cables between the cushions and attach them with cable ties for strain relief.
7. Move the cushions back together.
8. Tighten the bolts to make sure that the EMI conductive cushions press tightly around the peeled part of the cables.





If the outer surface of the shield is non-conductive:

- Cut the shield at the midpoint of the peeled part. Be careful not to cut the conductors or the grounding wire.
- Turn the conductive side of the shield inside out over the insulation.
- Cover the exposed shield and the peeled cable with copper foil to keep the shielding continuous.



### Routing the control cables inside the cabinet

Use the existing trunking in the cabinet wherever possible. Use sleeving if cables are laid against sharp edges. When running cables to or from a swing-out frame, leave enough slack at the hinge to allow the frame to open fully.

## Connecting control cabling

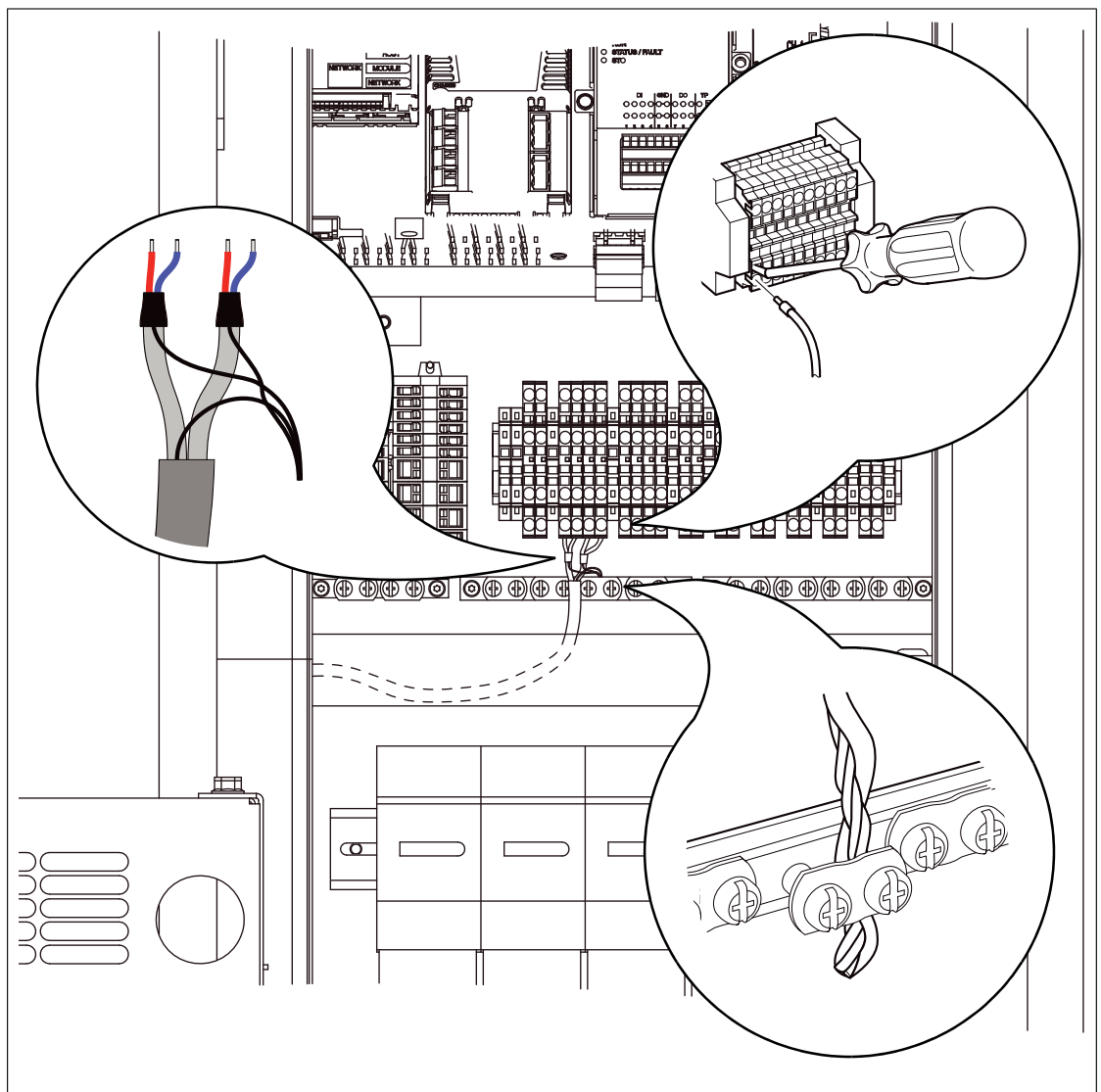
Connect the conductors to the appropriate terminals. Refer to the wiring diagrams delivered with the drive.

Connect the inner twisted pair shields and all separate grounding wires to the grounding clamps closest to the terminals.

The drawing below represents the grounding of the control cabling when connecting to a terminal block inside the cabinet. The grounding is done in the same way when connecting directly to a component such as the control unit.

### Notes:

- Do not ground the outer shield of the cable here since it is grounded at the cable entry.
- Keep any signal wire pairs twisted as close to the terminals as possible. Twisting the wire with its return wire reduces disturbances caused by inductive coupling.



At the other end of the cable, leave the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, eg. 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are in the same ground line with no significant voltage drop between the end points.

## Connecting the motor cables (units without common motor terminal cubicle)

On units without a common motor terminal cubicle, the motor cables connect to busbars located in the inverter module cubicles. To access the terminals, the cooling fans and other equipment in front of the terminals must be removed from the cubicle.

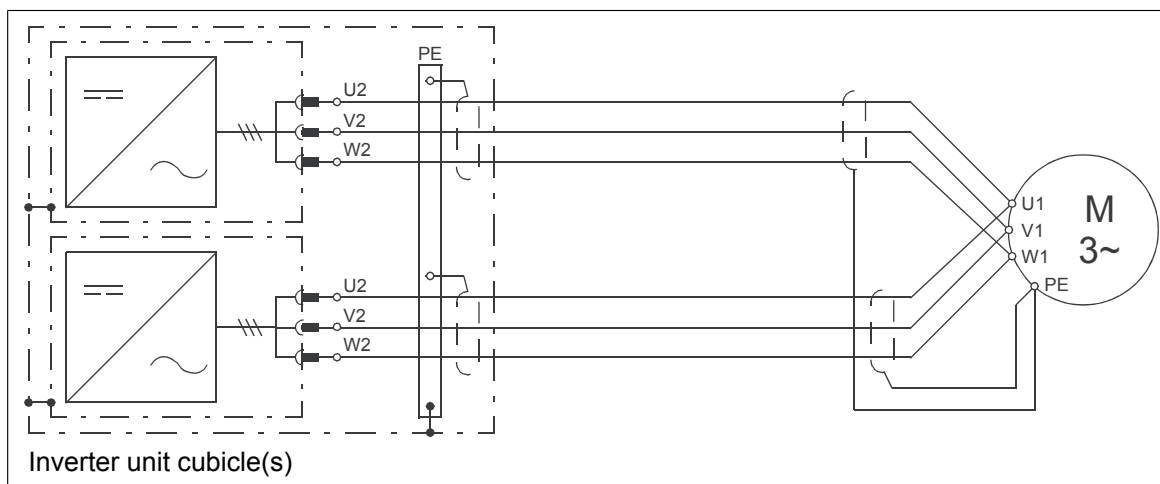
The location and dimensions of the busbars are visible in the dimension drawings delivered with the drive, and in the dimension drawing examples shown in this manual.

If the drive is equipped with a common motor terminal cubicle (option +H359), follow the instructions in section [Connecting the motor cables \(units with common motor terminal cubicle\) \(page 100\)](#).

### ■ Motor connection diagram (without option +H366)

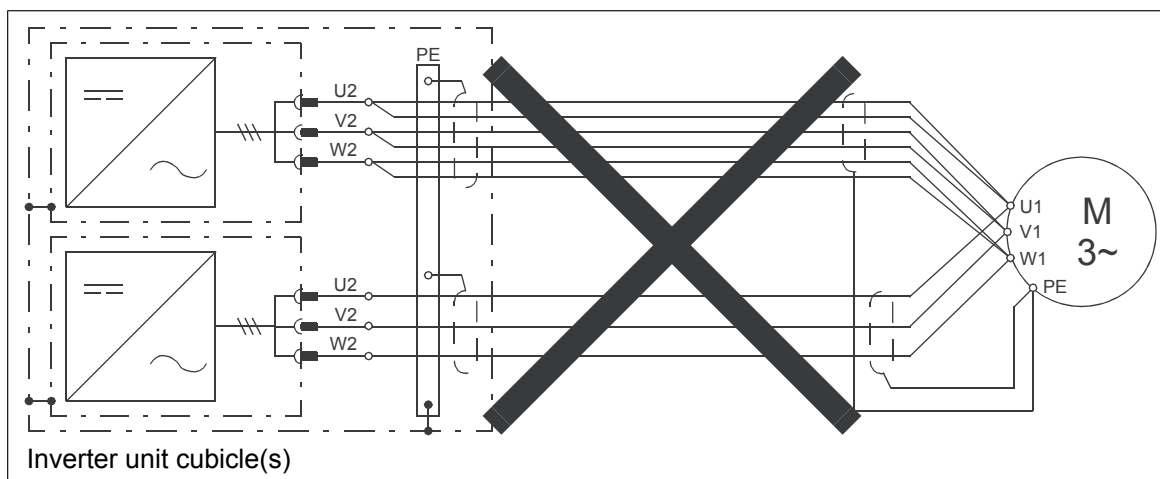
All parallel-connected inverter modules are to be cabled separately to the motor.

360° earthing is to be used at the cable entries.



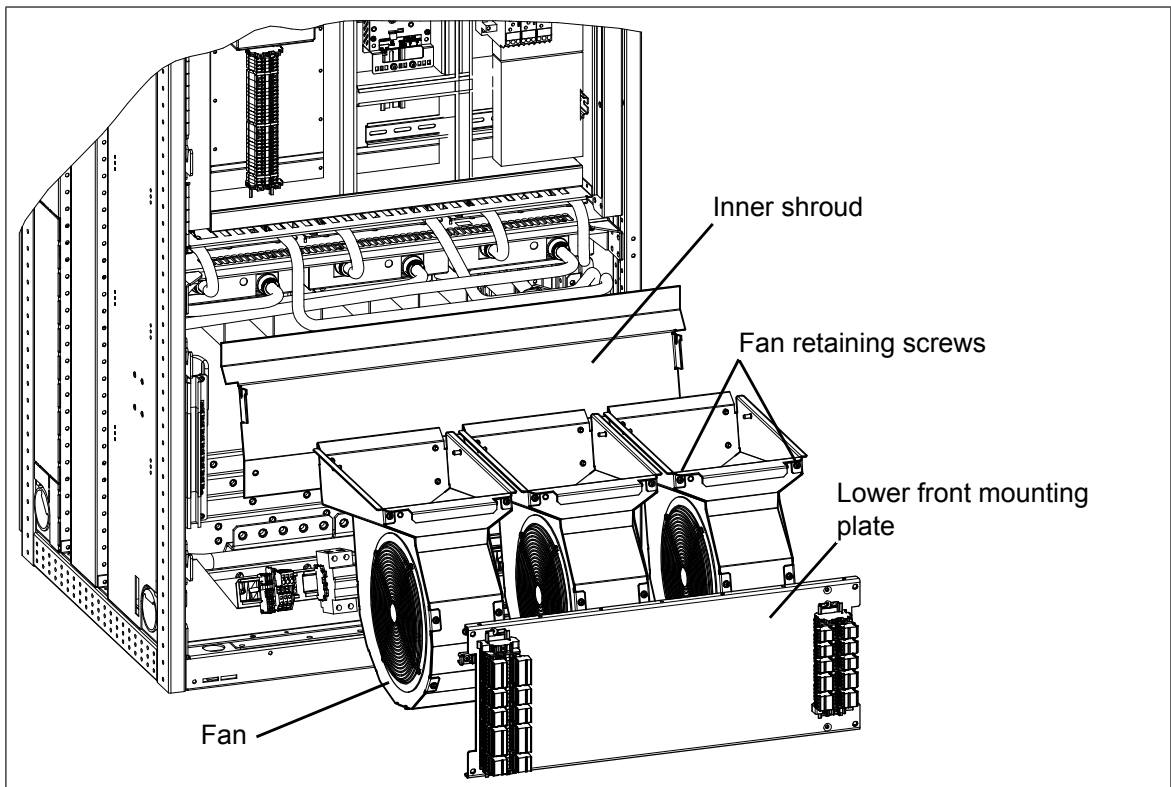
The recommended cable types are given in the technical data.

**⚠ WARNING!** The cabling from all inverter modules to the motor must be physically identical considering cable type, cross-sectional area, and length.



## ■ Procedure

The illustration below shows the parts to be removed.



### WARNING!

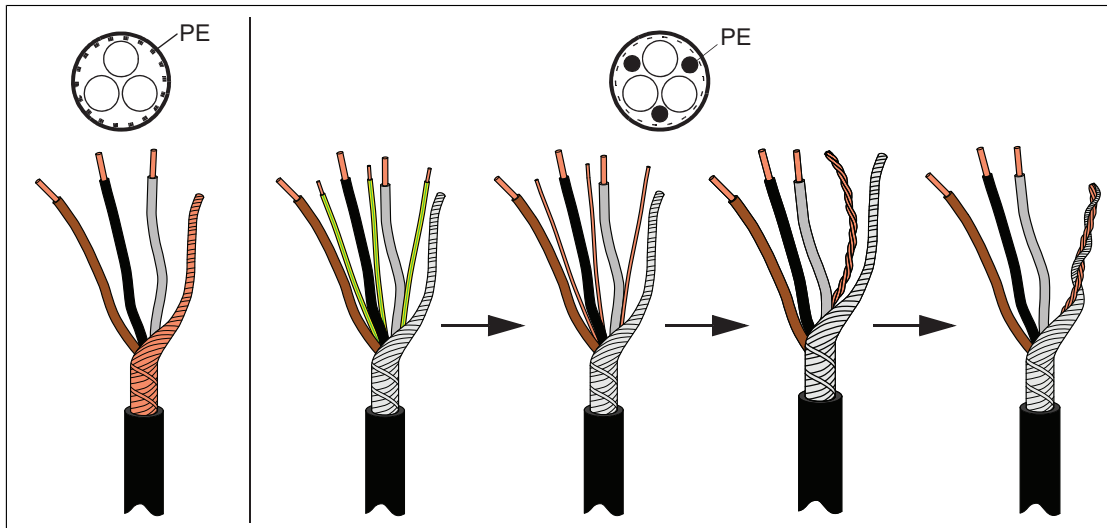
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Open the inverter module cubicle door.
3. Remove the outer shroud at the lower part of the cubicle (not shown).
4. Disconnect the wiring from the lower front mounting plate. Remove the plate.
5. Disconnect the wiring from the cooling fans.
6. Remove the two retaining screws of each fan.
7. Pull each fan outwards to separate them from the heat exchanger housing.
8. Remove the inner shroud.
9. Peel off 3 ... 5 cm (1.2 ... 2 inches) of the outer insulation of the cables above the cable entry plate for 360° high-frequency grounding.
10. Prepare the ends of the cables.

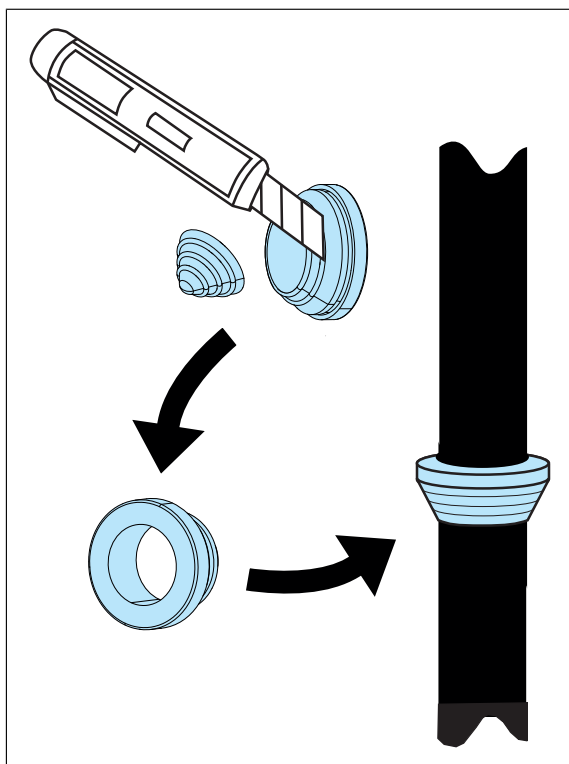


### WARNING!

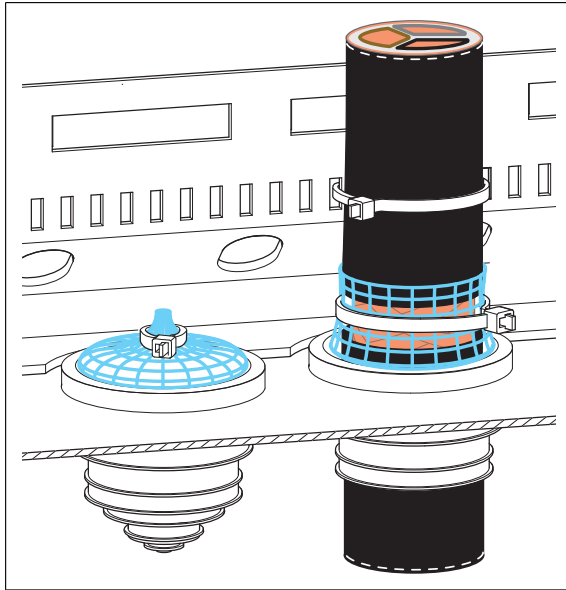
Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.



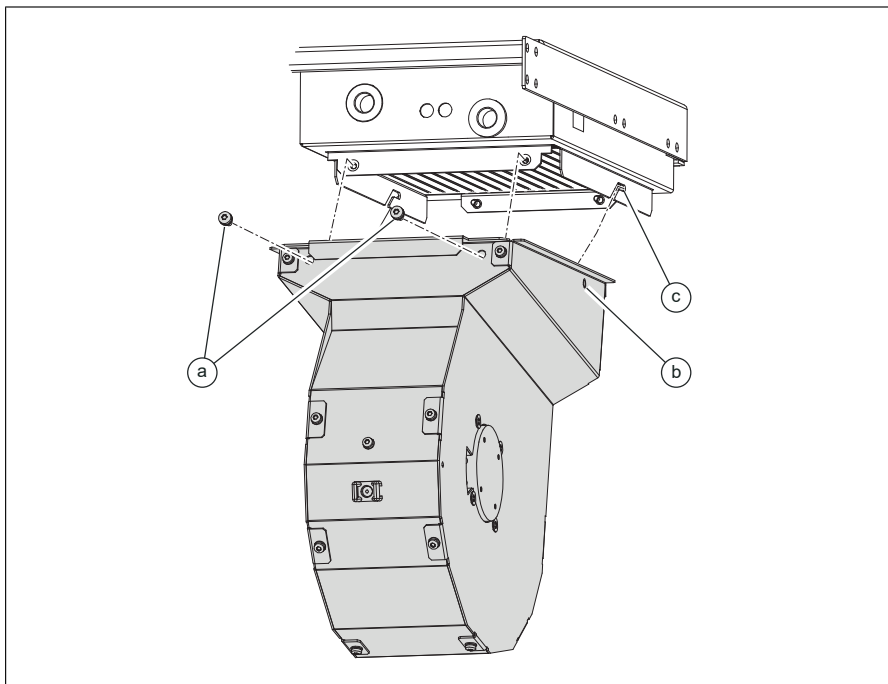
11. Remove the rubber grommets from the cable entries for the cables to be connected. Cut adequate holes into the rubber grommets. Slide the grommets onto the cables. Slide the cables into the cubicle through the conductive sleeves and attach the grommets to the holes.



12. Attach the conductive sleeves to the cable shields with cable ties. Tie up the unused conductive sleeves with cable ties.

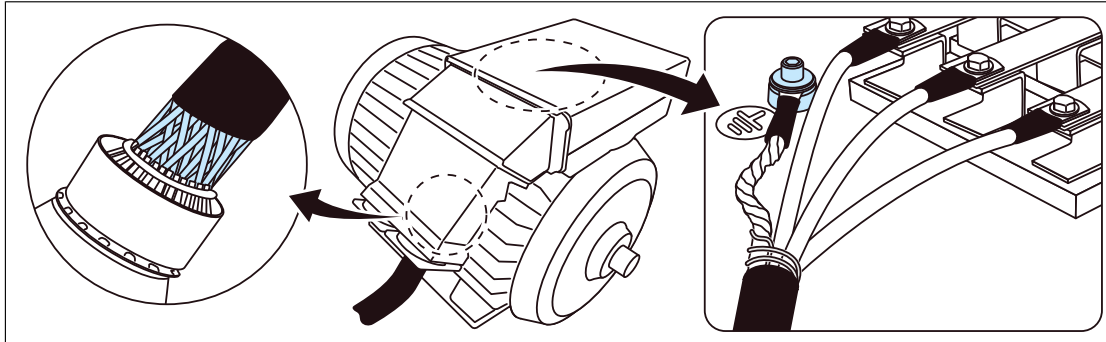


13. Connect the twisted shields of the cables to the PE busbar of the cabinet.
14. Connect the phase conductors of the cables to the appropriate terminals. Tighten the screws to the torque given in section *Tightening torques (page 192)*.
15. Install the inner shroud.
16. With each fan, align the guide pins (b) at the rear of the fan cowling with the slots (c) in the module bottom guide, then reinstall the retaining screws (a).



17. Install the lower front mounting plate. Connect the wiring to the components on the mounting plate.
18. Install the outer shroud.

19. Make sure there are no tools, debris or any other foreign objects in the cubicle. Close the cubicle door.
20. At the motor, connect the cables according to instructions from the motor manufacturer. Pay special attention to the phase order. For minimum radio-frequency interference, ground the cable shield 360 degrees at the cable entry of the motor terminal box, or ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.



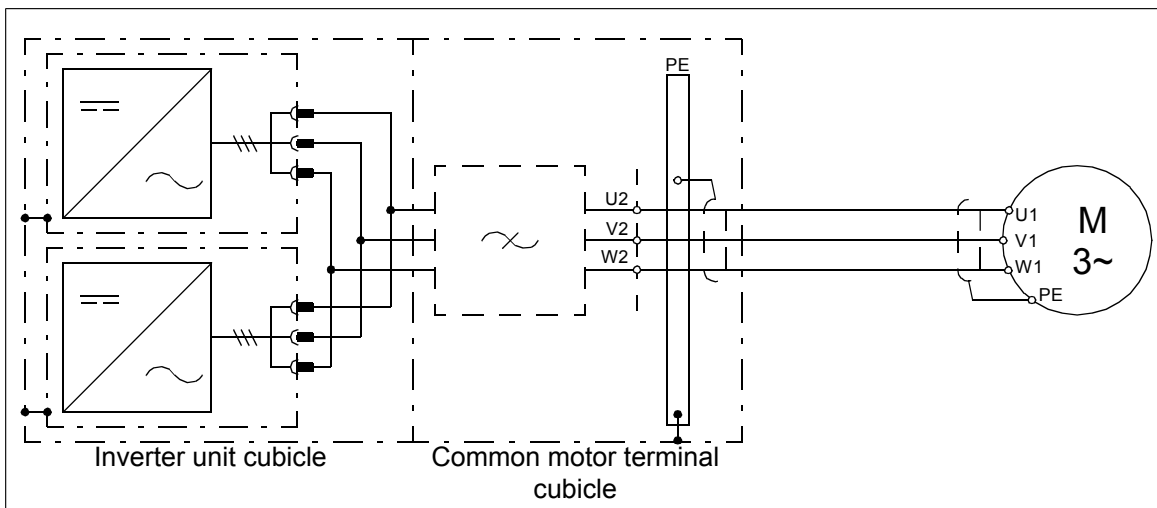
## Connecting the motor cables (units with common motor terminal cubicle)

### ■ Output busbars

If the drive is equipped with option +H359, the motor cables connect to a common motor terminal cubicle.

The location and dimensions of the busbars are visible in the dimensional drawings delivered with the drive.

### ■ Connection diagram



The recommended cable types are given in the technical data.



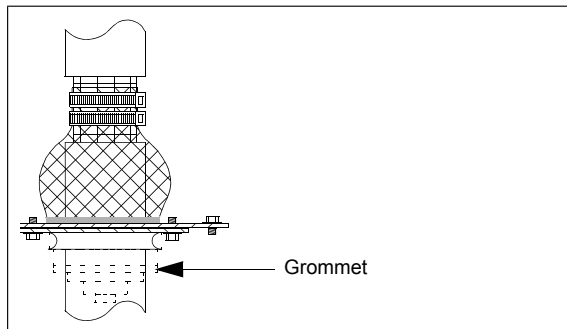
## ■ Procedure



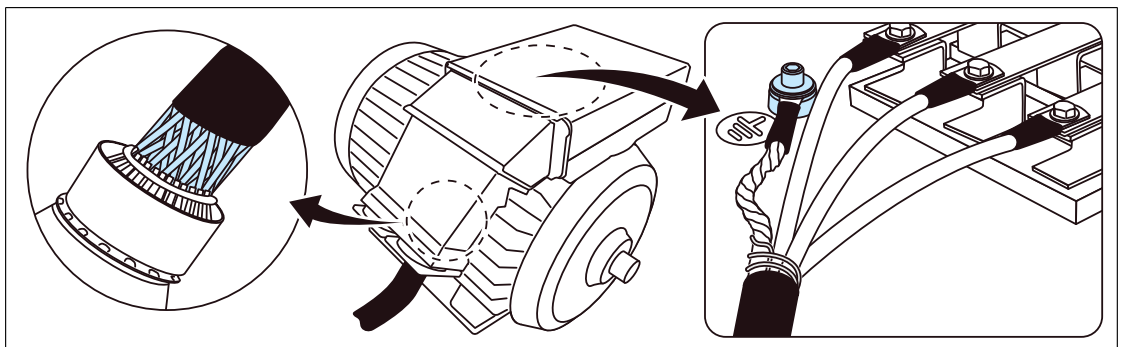
### WARNING!

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Open the door of the cubicle and remove the shrouding.
3. Lead the cables into the cubicle. Make the 360° earthing arrangement at the cable entry as shown.

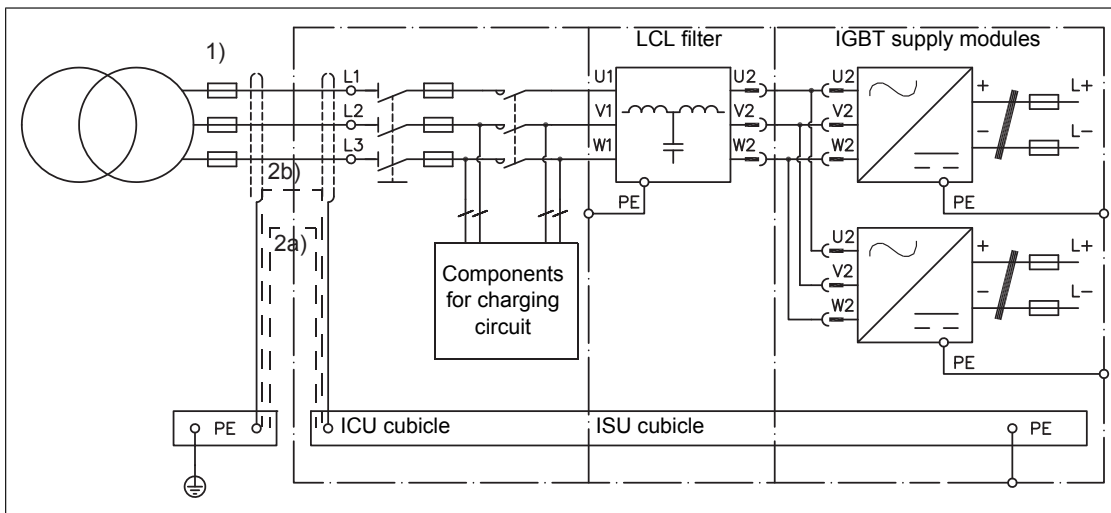


4. Cut the cables to suitable length. Strip the cables and conductors.
5. Twist the cable screens into bundles and connect the bundles to the PE busbar in the cubicle.
6. Connect any separate ground conductors/cables to the PE busbar in the cubicle.
7. Connect the phase conductors to the output terminals. Use the tightening torques specified in section *Tightening torques (page 192)*.
8. Refit any shrouding removed earlier and close the cubicle doors.
9. At the motor, connect the cables according to instructions from the motor manufacturer. Pay special attention to the phase order. For minimum radio-frequency interference, ground the cable shield 360 degrees at the cable entry of the motor terminal box, or ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.



## Connecting the input power cables

### ■ Connection diagram



#### Notes:

1) Fuses or other protection means.

Use a separate grounding (PE) cable (2a) or a cable with separate PE conductor (2b) if the conductivity of the shield does not meet the requirement for the PE conductor. See section [Selecting the power cables \(page 76\)](#).

### ■ Layout of the input cable connection terminals and cable entries

The location and dimensions of the busbars are visible in the dimensional drawings delivered with the drive. Alternatively, see the example dimension drawings in the manual.

### ■ Connection procedure



#### WARNING!

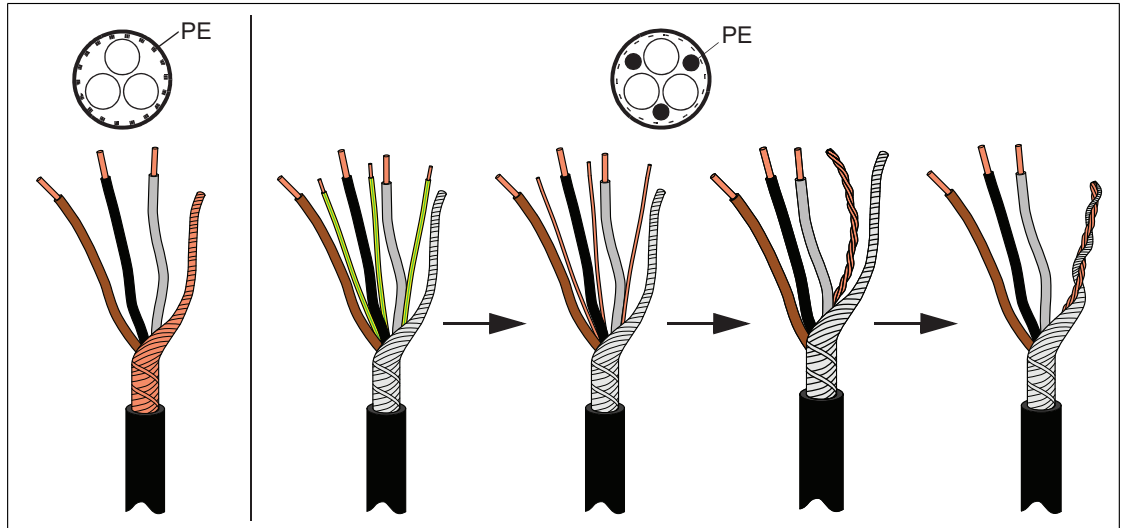
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.
2. Open the door of the incoming cubicle.
3. Remove the shrouding covering the input terminals.
4. Peel off 3 ... 5 cm (1.2 ... 2 inches) of the outer insulation of the cables above the cable entry plate for 360° high-frequency grounding.
5. Prepare the ends of the cables.

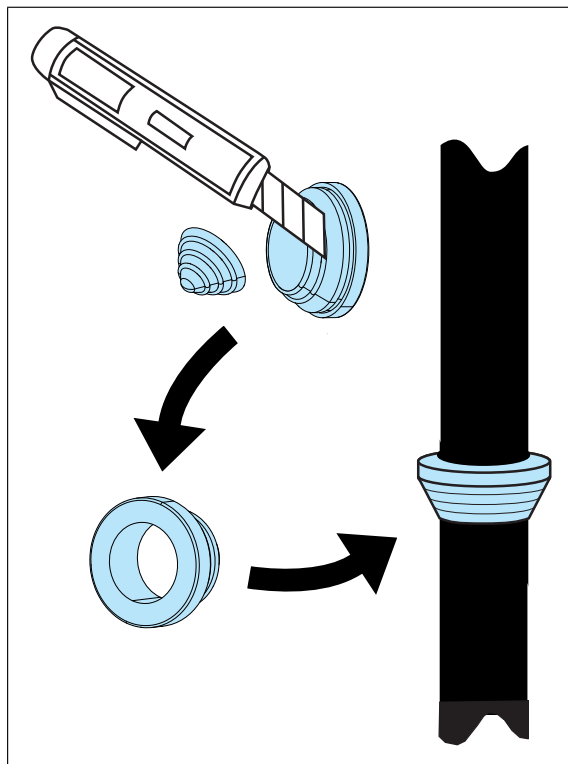


#### WARNING!

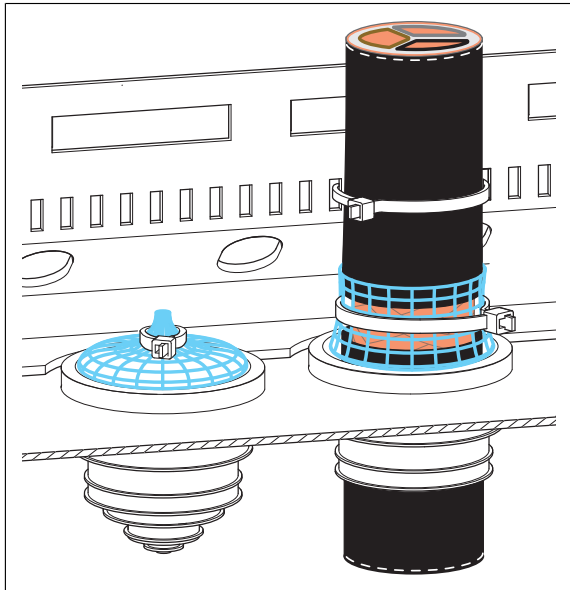
Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.



6. Remove rubber grommets from the cable entries for the cables to be connected. Cut adequate holes into the rubber grommets. Slide the grommets onto the cables. Slide the cables into the cubicle through the conductive sleeves and attach the grommets to the holes.



7. Attach the conductive sleeves to the cable shields with cable ties. Tie up the unused conductive sleeves with cable ties.

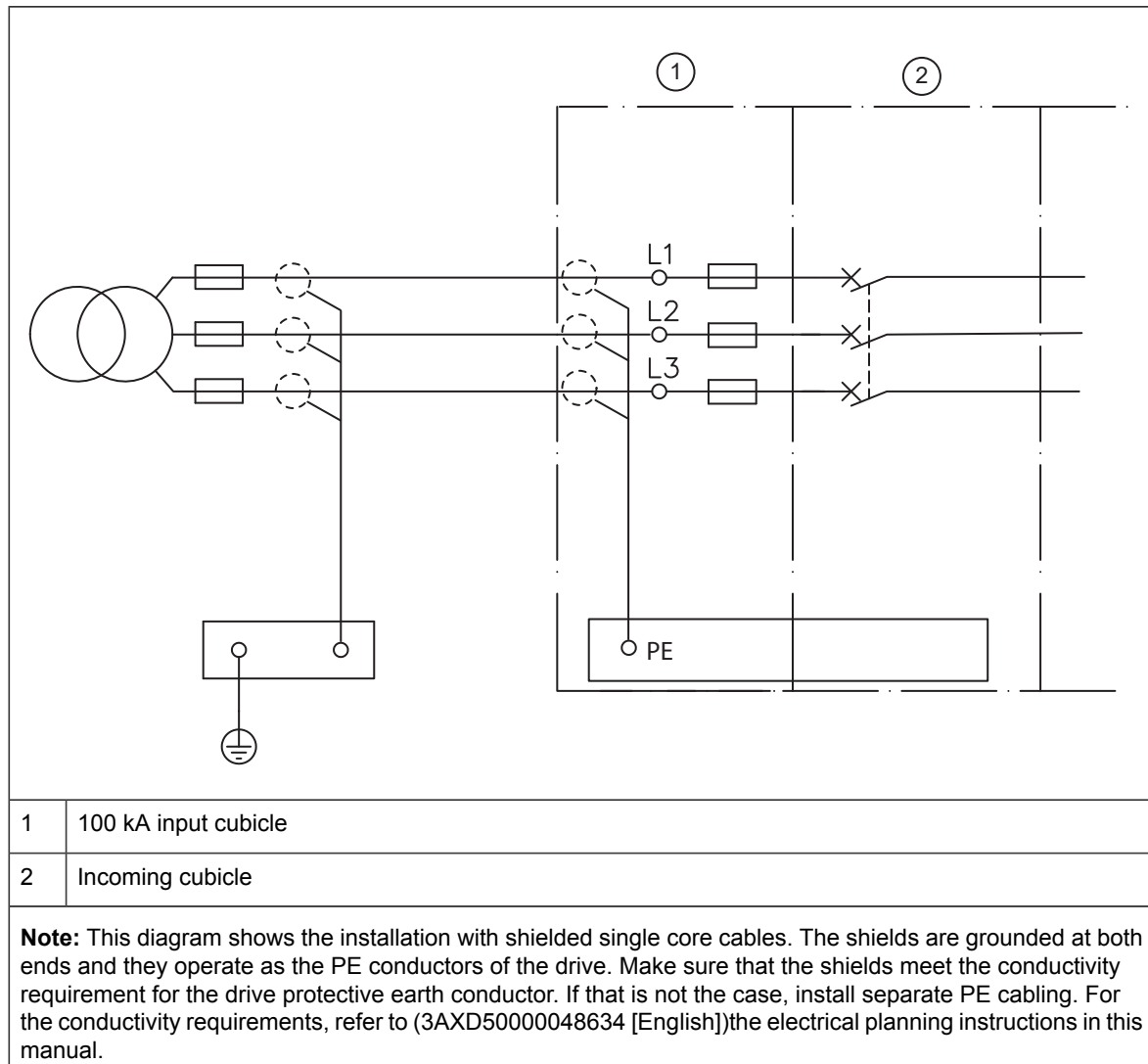


8. Connect the twisted shields of the cables to the PE busbar of the cabinet.
9. Connect the phase conductors of the input cable to the L1, L2 and L3 terminals. Tighten the screws to the torque given under *Tightening torques (page 192)*.
10. Reinstall the shrouding removed earlier.
11. Close the cubicle door.



## Connecting input power cables - cable entry in 100 kA input cubicle (option +F274)

### ■ Connection diagram



### ■ Connection procedure

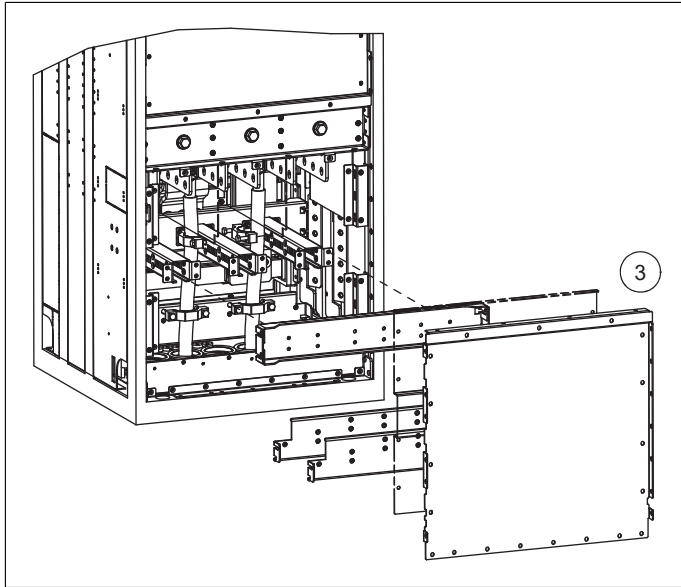


#### **WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.
2. Open the door of the 100 kA input cubicle.

3. Remove the shrouding and assembly plates covering the input terminals.



4. Remove the beams in front of the input terminals.
5. Peel off 3 ... 5 cm (1.2 ... 2 in) of the outer insulation of the cables above the cable entry plate for 360° high-frequency grounding.
6. Prepare the ends of the cables.

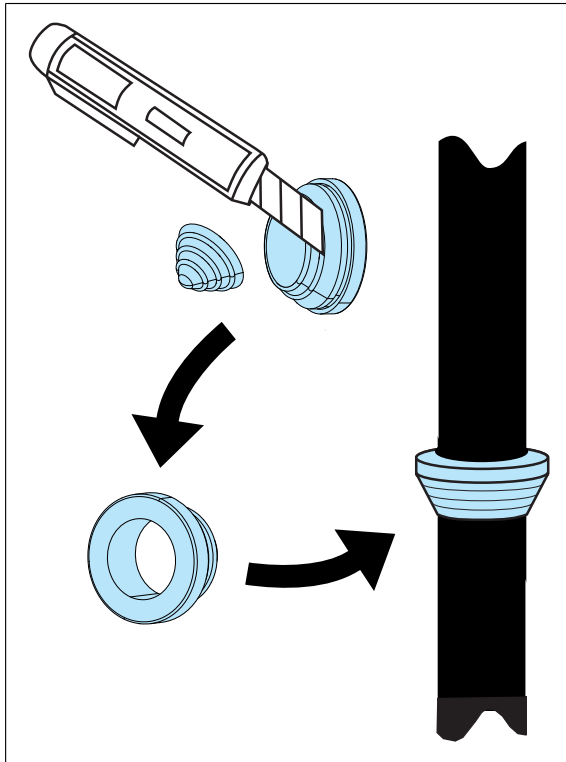


**WARNING!**

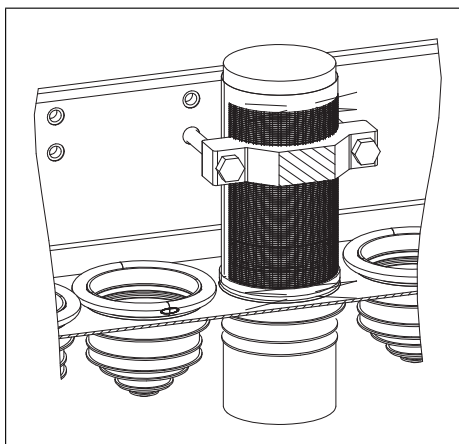
Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.

7. Remove rubber grommets from the cable entries for the cables to be connected. Cut adequate holes into the rubber grommets. Slide the grommets onto the cables. Starting from back, slide the cables into the cubicle through the conductive sleeves and attach the grommets to the holes.





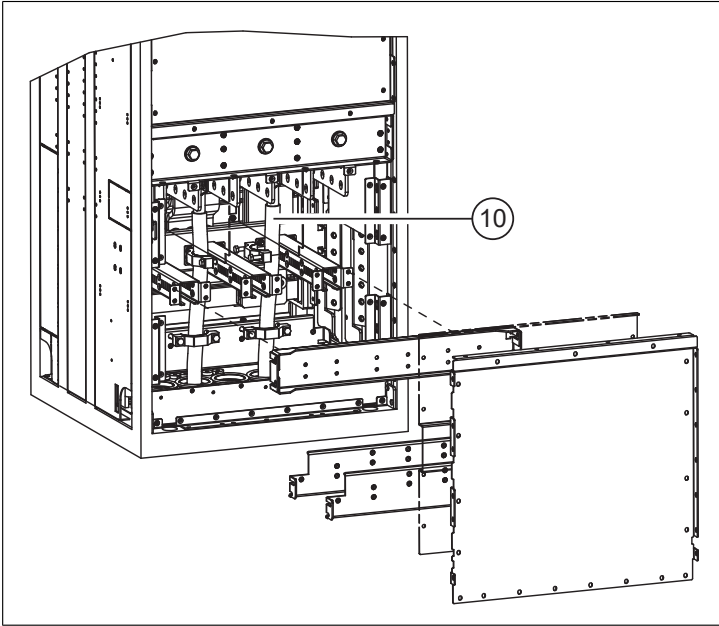
8. Attach the conductive sleeves to the bare cable shields with cable ties. Tie up the unused conductive sleeves with cable ties.



9. Connect the twisted shields of the cables to the PE busbar of the cabinet. Tighten the screws to the torque given in section *Tightening torques (page 192)*.
10. Connect the phase conductors of the input cable to the L1, L2 and L3 terminals. Tighten the screws to the torque given in section *Tightening torques (page 192)*.
11. Reinstall the shrouding and assembly plates removed earlier.
12. Close the cubicle door.



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## Connecting a PC

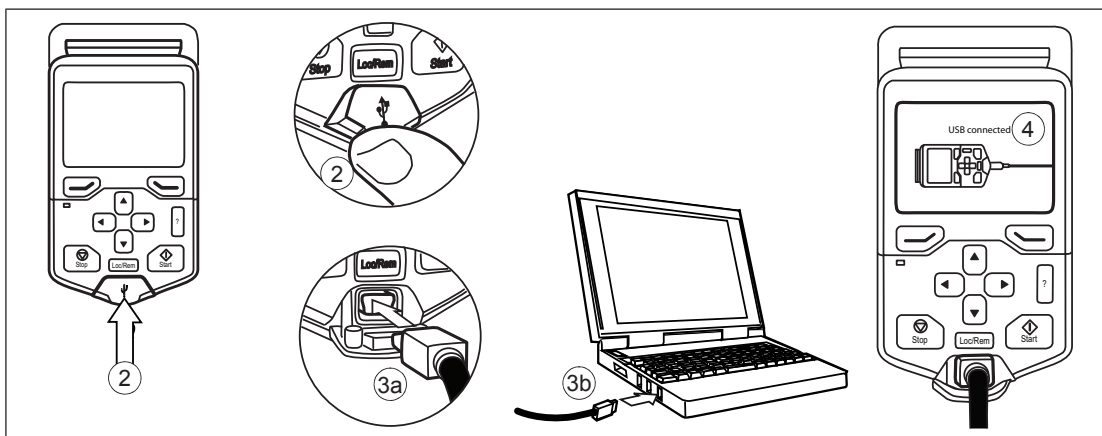


### WARNING!

Do not connect the PC directly to the control panel connector of the control unit as this can cause damage.

A PC (with, for example, the Drive composer PC tool) can be connected as follows:

1. Connect a ACS-AP-... or ACH-AP-... control panel to the unit either
  - by inserting the control panel into the panel holder or platform, or
  - by using an Ethernet (eg, Cat 5e) networking cable.
2. Remove the USB connector cover on the front of the control panel.
3. Connect an USB cable (Type A to Type Mini-B) between the USB connector on the control panel (3a) and a free USB port on the PC (3b).
4. The panel will display an indication whenever the connection is active.
5. See the documentation of the PC tool for setup instructions.



## Panel bus (Control of several units from one control panel)

One control panel (or PC) can be used to control several drives (or inverter units, supply units etc.) by constructing a panel bus. This is done by daisy-chaining the panel connections of the drives. Some drives have the necessary (twin) panel connectors in the control panel holder; those that do not require the installation of an FDPI-02 module (available separately). For further information, see the hardware description and [FDPI-02 diagnostics and panel interface user's manual \(3AUA0000113618 \[English\]\)](#).

The maximum allowed length of the cable chain is 100 m (328 ft).

1. Connect the panel to one drive using an Ethernet (for example Cat 5e) cable.
  - Use Menu - Settings - Edit texts - Drive to give a descriptive name to the drive
  - Use parameter 49.01\* to assign the drive with a unique node ID number
  - Set other parameters in group 49\* if necessary
  - Use parameter 49.06\* to validate any changes.

\*The parameter group is 149 with supply (line-side), brake or DC/DC converter units. Repeat the above for each drive.

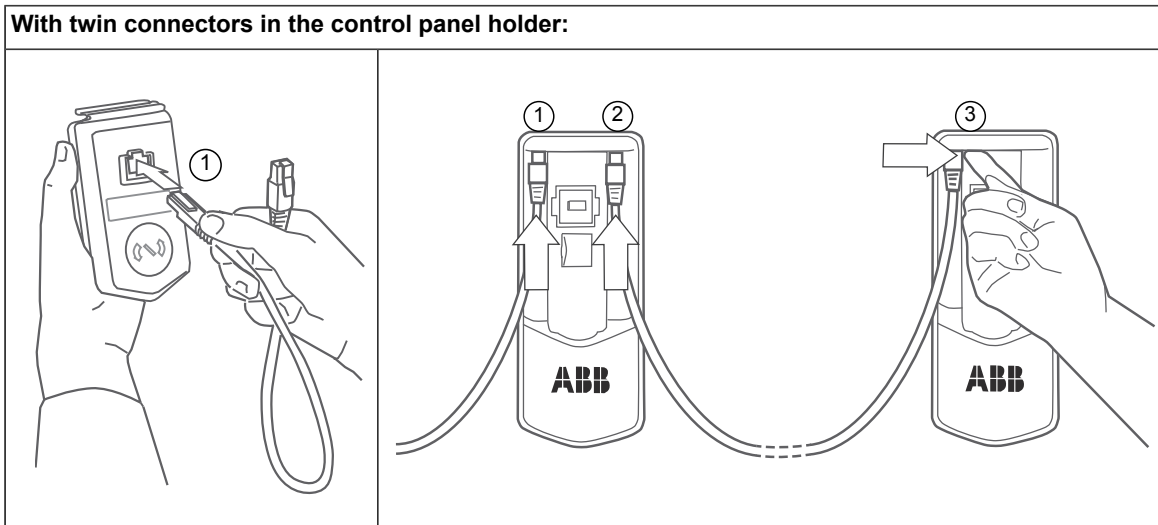
2. With the panel connected to one unit, link the units using Ethernet cables.

3. Switch on the bus termination on the drive that is farthest from the control panel in the chain.
  - With drives that have the panel mounted on the front cover, move the terminating switch into the outer position.
  - With an FDPI-02 module, move termination switch S2 into the TERMINATED position.

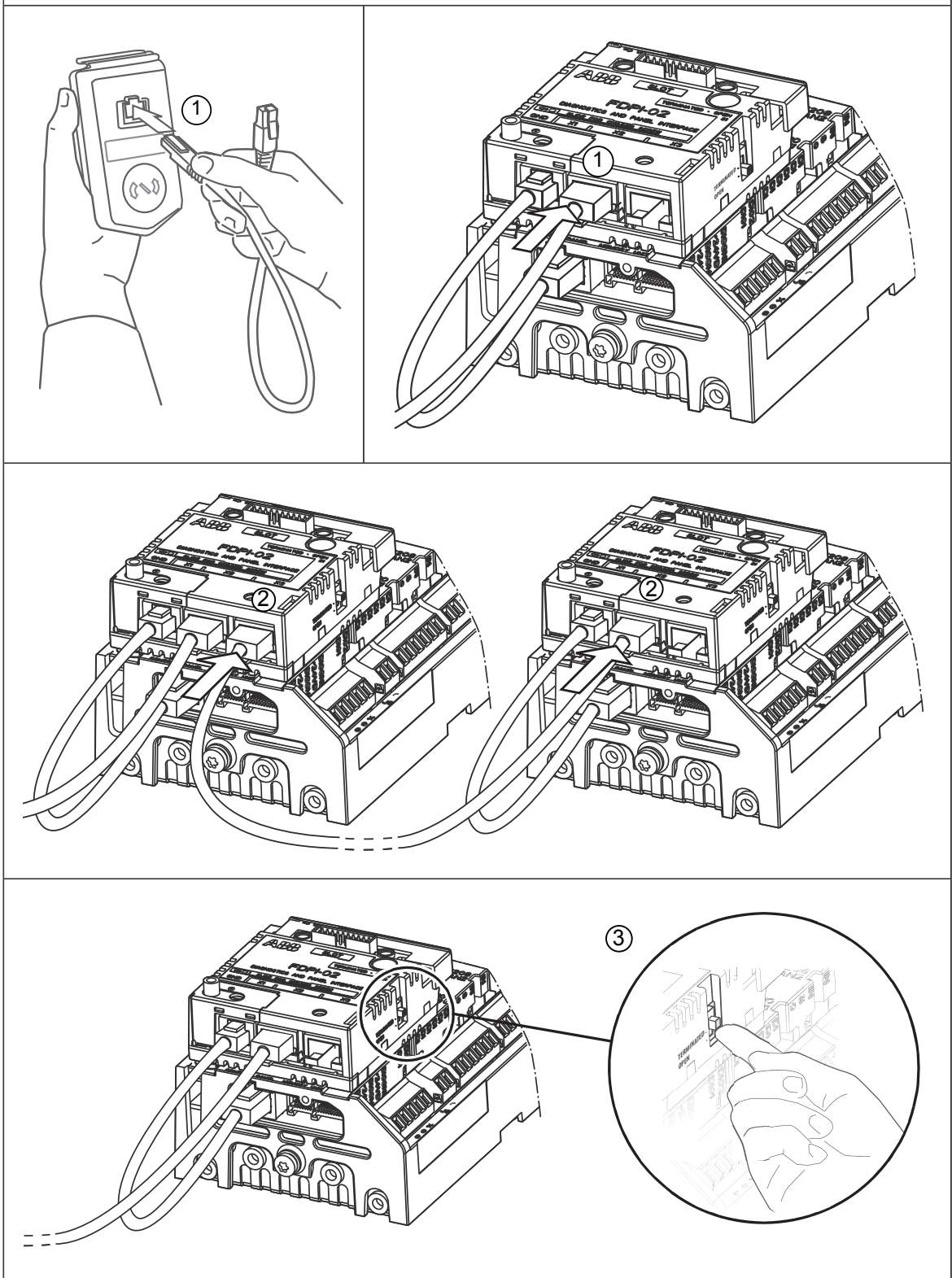
Make sure that bus termination is off on all other drives.

4. On the control panel, switch on the panel bus functionality (Options - Select drive - Panel bus). The drive to be controlled can now be selected from the list under Options - Select drive.

If a PC is connected to the control panel, the drives on the panel bus are automatically displayed in the Drive composer tool.



With FDPI-02 modules:



## Installing option modules

### ■ Mechanical installation of I/O extension, fieldbus adapter and pulse encoder interface modules

See hardware description for the available slots for each module. Install the option modules as follows:



#### **WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

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1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Open the door of the auxiliary control cubicle (ACU).
3. Remove the shrouding at the top of the cubicle.
4. Locate the inverter control unit (A41).
5. Insert the module carefully into its position on the control unit.
6. Fasten the mounting screw.

**Note:** The screw secures and grounds the module. It is essential for fulfilling the EMC requirements and for proper operation of the module.

### ■ Installation of an FSO safety functions module onto BCU



#### **WARNING!**

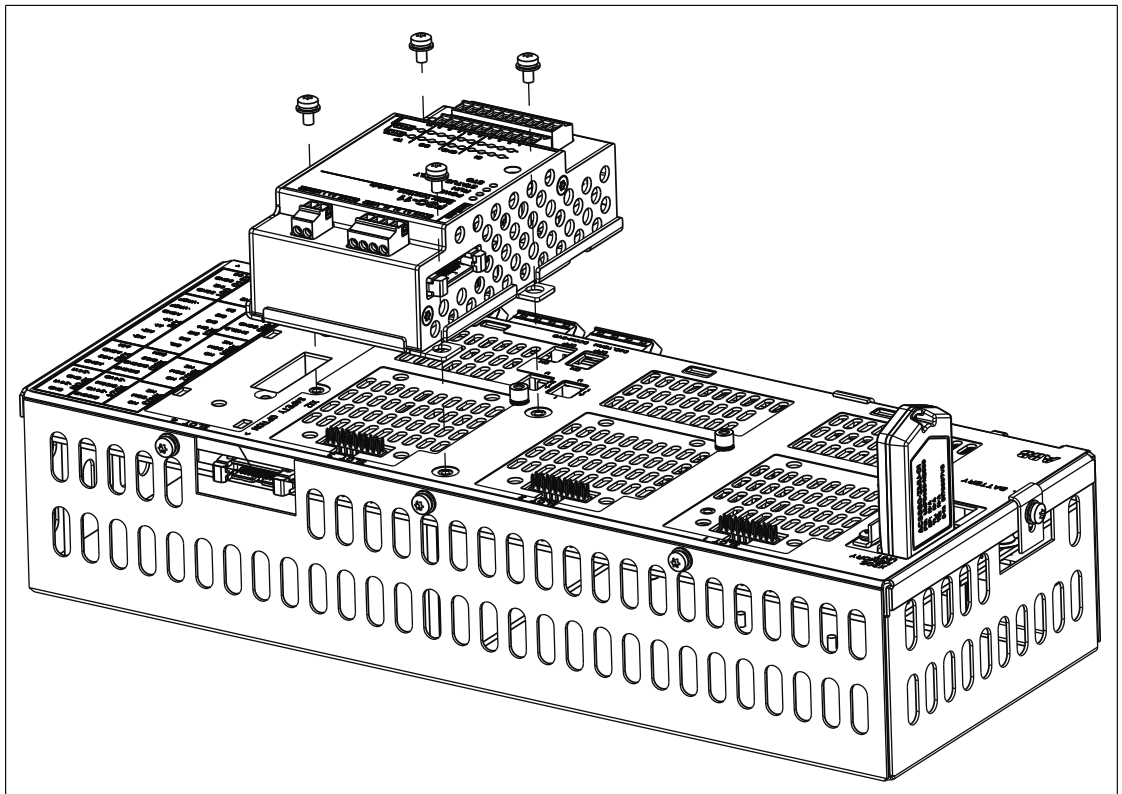
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

---

This procedure describes the installation of an FSO safety functions module onto the BCU control unit. As an alternative, the FSO module can be installed adjacent to the control unit, which is the standard method for factory-installed FSO modules. For instructions, refer to the applicable FSO module user's manual.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
  2. The FSO module comes with alternative bottom plates for installation onto different control units. For installation onto a BCU control unit, the mounting points should be located at the long edges of the module as shown in the illustration below. If necessary, replace the bottom plate of the FSO module.
-

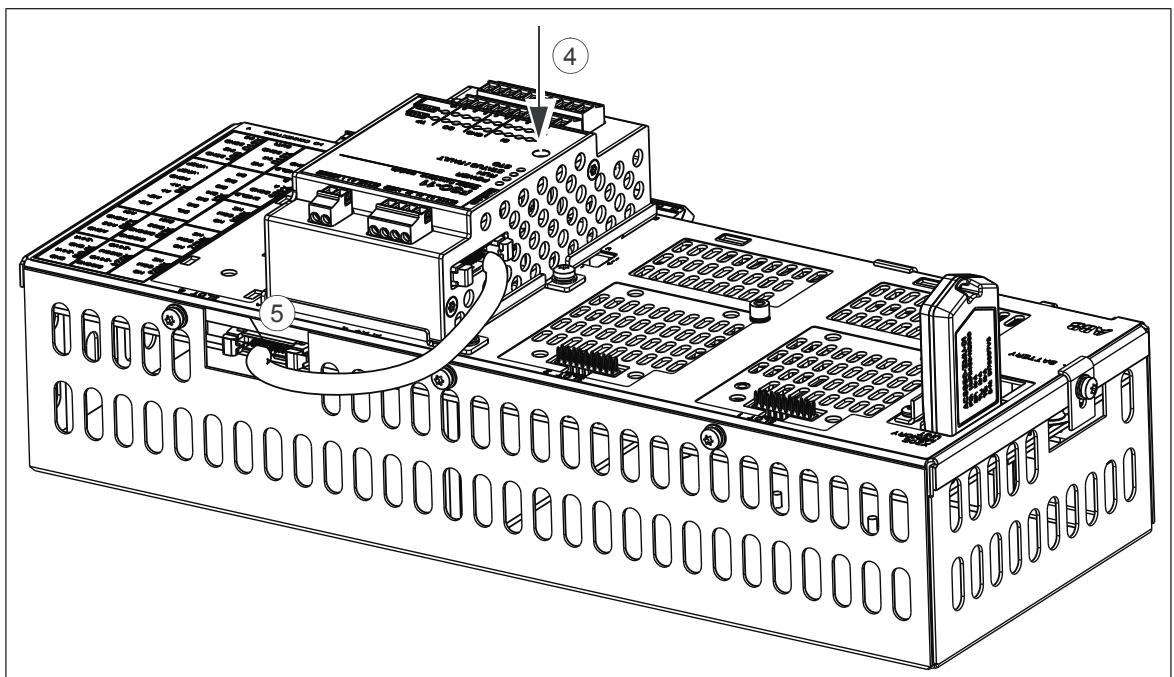
3. Attach the FSO module onto slot 3 of the BCU control unit [A41] with four screws.



4. Tighten the FSO module electronics grounding screw.

**Note:** The screw tightens the connections and grounds the module. It is essential for fulfilling the EMC requirements and for proper operation of the module.

5. Connect the FSO module data cable between FSO connector X110 and BCU connector X12.
6. To complete the installation, refer to the instructions in the applicable FSO module user's manual.



■ **Wiring of option modules**

See the appropriate optional module manual for specific installation and wiring instructions.





## Control units of the drive

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### Contents of this chapter

This chapter

- describes the connections of the control unit(s) used in the drive,
- contains the specifications of the inputs and outputs of the control unit(s).

### General

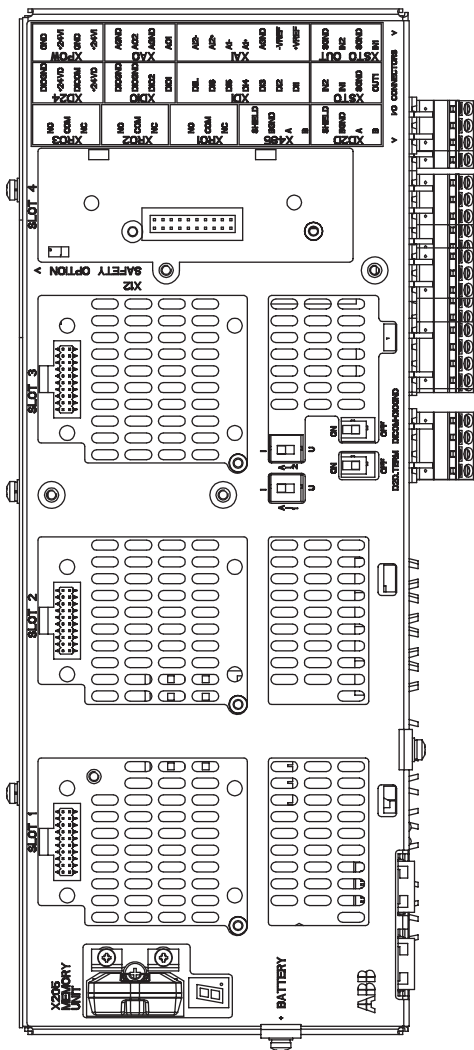
The drive utilizes BCU-x2 control units. The BCU-x2 consists of a BCON-12 control board (and a BIOC-01 I/O connector board and power supply board) built in a metal housing.

The supply and inverter units of the drive are each controlled by a dedicated BCU-x2 control unit. The designation of the supply control unit is A51; the inverter control unit is A41. Both are connected to the power modules (ie. supply and inverter modules respectively) by fiber optic cables.

In this manual, the name "BCU-x2" represents the control unit types BCU-02 and BCU-12. These have a different number of power module connections (2 and 7 respectively) but are otherwise similar.

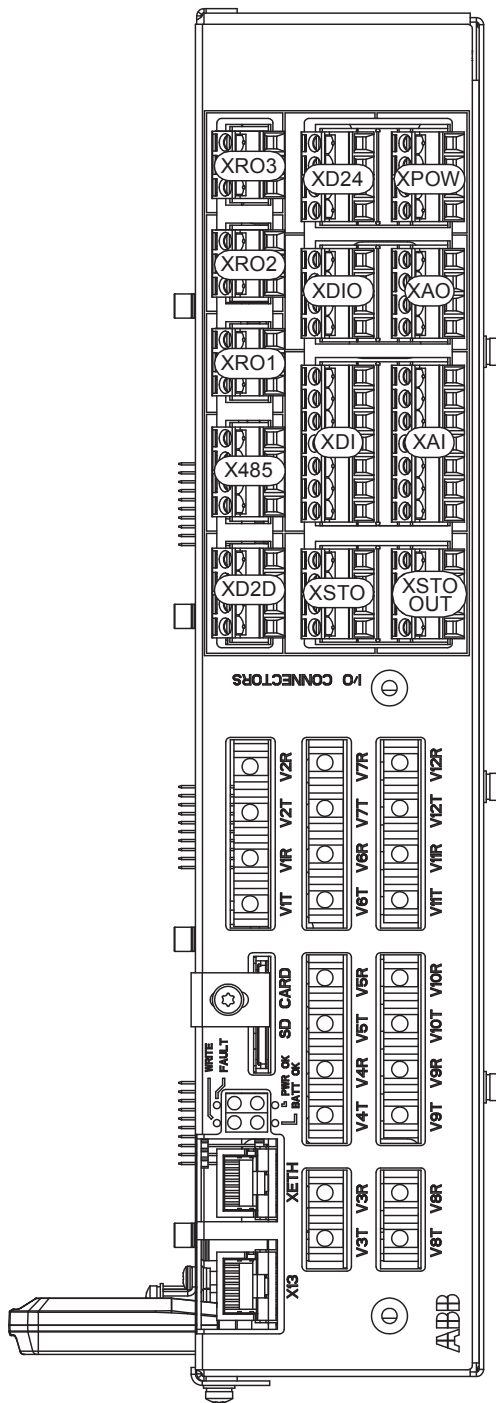
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# BCU-x2 layout



	Description
I/O	I/O terminals (see following diagram)
SLOT 1	I/O extension, encoder interface or fieldbus adapter module connection. (This is the sole location for an FDPI-02 diagnostics and panel interface.)
SLOT 2	I/O extension, encoder interface or fieldbus adapter module connection
SLOT 3	I/O extension, encoder interface, fieldbus adapter or FSO safety functions module connection
SLOT 4	RDCO-0x DDCS communication option module connection
X205	Memory unit connection
BATTERY	Holder for real-time clock battery (BR2032)
AI1	Mode selector for analog input AI1 (I = current, U = voltage)
AI2	Mode selector for analog input AI2 (I = current, U = voltage)
D2D TERM	Termination switch for drive-to-drive link (D2D)
DICOM= DIOGND	Ground selection. Determines whether DICOM is separated from DIOGND (ie. the common reference for the digital inputs floats). See the ground isolation diagram.
<b>7-segment display</b>	
Multicharacter indications are displayed as repeated sequences of characters	
	("U" is indicated briefly before "o".) Control program running
	Control program startup in progress
	(Flashing) Firmware cannot be started. Memory unit missing or corrupted
	Firmware download from PC to control unit in progress
	At power-up, the display may show short indications of eg. "1", "2", "b" or "U". These are normal indications immediately after power-up. If the display ends up showing any other value than those described, it indicates a hardware failure.









	Description
XAI	Analog inputs
XAO	Analog outputs
XDI	Digital inputs, Digital input interlock (DIIL)
XDIO	Digital input/outputs
XD2D	Drive-to-drive link
XD24	+24 V output (for digital inputs)
XETH	Ethernet port – Not in use
XPOW	External power input
XRO1	Relay output RO1
XRO2	Relay output RO2
XRO3	Relay output RO3
XSTO	Safe torque off connection (input signals)
XSTO OUT	Safe torque off connection (to inverter modules)
X12	(On the opposite side) Connection for FSO safety functions module (optional)
X13	Control panel / PC connection
X485	Not in use
V1T/V1R, V2T/V2R	Fiber optic connection to modules 1 and 2 (VxT = transmitter, VxR = receiver)
V3T/V3R ... V7T/V7R	Fiber optic connection to modules 3...7 (BCU-12/22 only) (VxT = transmitter, VxR = receiver)
V8T/V8R ... V12T/V12R	Fiber optic connection to modules 8...12 (BCU-22 only) (VxT = transmitter, VxR = receiver)
SD CARD	Data logger memory card for inverter module communication
BATT OK	Real-time clock battery voltage is higher than 2.8 V. If the LED is off when the control unit is powered, replace the battery.
FAULT	The control program has generated a fault. See the firmware manual of the supply/inverter unit.
PWR OK	Internal voltage supply is OK
WRITE	Writing to memory card in progress. Do not remove the memory card.

## Default I/O diagram of the supply control unit

The diagram below shows the default I/O connections on the supply control unit (A51), and describes the use of the connections in the supply unit. Under normal circumstances, the factory-made wiring should not be changed.

The wire size accepted by all screw terminals (for both stranded and solid wire) is 0.5 ... 2.5 mm<sup>2</sup> (22 ... 12 AWG). The tightening torque is 0.45 N·m (4 lbf·in).

Terminal			Description	
XD2D			Drive-to-drive link	
1	1	B	Not in use by default	
2	2	A		
3	3	BGND		
4	4	Shield		
 D2D.TERM			Drive-to-drive link termination switch <sup>1)</sup>	
X485			RS485 connection	
5	5	B	Cooling fan monitoring (CIO module)	
6	6	A		
7	7	BGND		
8	8	Shield		
XRO1, XRO2, XRO3			Relay outputs	
11	11	NC	Norm. closed	XRO1: <b>Charging</b> <sup>2)</sup> (Energized = Closes charging contactor.) 250 V AC / 30 V DC, 2 A
	12	COM	Common	
13	13	NO	Norm. open	
21	21	NC	Norm. closed	XRO2: <b>Fault (-1)</b> <sup>3)</sup> (Energized = Indicates no fault.) 250 V AC / 30 V DC, 2 A
	22	COM	Common	
23	23	NO	Norm. open	
31	31	NC	Norm. closed	XRO3: <b>MCB ctrl</b> <sup>2)</sup> (Energized = Closes main contactor/breaker.) 250 V AC / 30 V DC, 2 A
	32	COM	Common	
33	33	NO	Norm. open	
XSTO, XSTO OUT			Safe torque off <sup>4)</sup>	
1	1	OUT	XSTO: Factory connection. Both circuits (power module, control unit) must be closed for the supply unit to start (IN1 and IN2 must be connected to OUT).	
	2	SGND		
	3	IN1		
	4	IN2		
5	5	IN1	XSTO OUT: Not in use.	
	6	SGND		
	7	IN2		
	8	SGND		
XDI			Digital inputs	

Terminal		Description	
1 2 3 4 5 6 7	1	DI1	<b>Temp fault</b> <sup>3)</sup> (0 = overtemperature)
	2	DI2	<b>Run / enable</b> <sup>3)</sup> (1 = run / enable)
	3	DI3	<b>MCB feedback</b> <sup>2)</sup> (0 = main contactor/breaker open)
	4	DI4	Not in use by default. Can be used for eg, auxiliary circuit breaker fault.
	5	DI5	Not in use by default. Can be used for eg, earth fault monitoring.
	6	DI6	<b>Reset</b> <sup>3)</sup> (0 -> 1 = fault reset)
	7	DIIL	Not in use by default. Can be used for eg, emergency stop.
XDIO		Digital input/outputs	
1 2 3 4	1	DIO1	Not in use by default
	2	DIO2	Not in use by default
	3	DIOGND	Digital input/output ground
	4	DIOGND	Digital input/output ground
XD24		Auxiliary voltage output	
5 6 7 8	1	+24VD	+24 V DC 200 mA <sup>5)</sup>
	2	DICOM	Digital input ground
	3	+24VD	+24 V DC 200 mA <sup>5)</sup>
	4	DIOGND	Digital input/output ground
	DICOM=DIOGND		Ground selection switch <sup>6)</sup>
XAI		Analog inputs, reference voltage output	
1 2 3 4 5 6 7	1	+VREF	10 V DC, $R_L$ 1...10 kohm
	2	-VREF	-10 V DC, $R_L$ 1...10 kohm
	3	AGND	Ground
	4	AI1+	Not in use by default. 0(2)...10 V, $R_{in} > 200$ kohm <sup>7)</sup>
	5	AI1-	
	6	AI2+	Not in use by default. 0(4)...20 mA, $R_{in} = 100$ ohm <sup>8)</sup>
	7	AI2-	
	AI1		AI1 current/voltage selection switch
	AI2		AI2 current/voltage selection switch
XAO		Analog outputs	
1 2 3 4	1	AO1	<b>Zero</b> (no signal indicated) <sup>3)</sup> 0...20 mA, $R_L < 500$ ohm
	2	AGND	
	3	AO2	<b>Zero</b> (not signal indicated) <sup>3)</sup> 0...20 mA, $R_L < 500$ ohm
	4	AGND	
XPOW		External power input	
1 2 3 4	1	+24VI	24 V DC, 2.05 A
	2	GND	
	3	+24VI	
	4	GND	
X12		Safety functions module connection (not in use in supply units)	
X13		Control panel connection	

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Terminal	Description
X205	Memory unit connection

- 1) Must be set to ON when the supply unit is the first or last unit on the drive-to-drive (D2D) link. On intermediate units, set termination to OFF.
  - 2) Use of the signal in the control program. When parameter 120.30 External charge enable has value Yes (default setting), the control program reserves this I/O terminal for external charging circuit control and monitoring, and parameters 110.24 RO1 source and 110.30 RO3 source are write-protected. If the value is No, you can use the I/O terminal for other purposes.
  - 3) Use of the signal in the control program (fixed). See also the delivery-specific circuit diagrams.
  - 4) This input only acts as a true Safe torque off input in inverter units. In other applications (such as a supply or brake unit), de-energizing the IN1 and/or IN2 terminal will stop the unit but not constitute a true safety function.
  - 5) Total load capacity of these outputs is 4.8 W (200 mA at 24 V) minus the power taken by DIO1 and DIO2.
  - 6) Determines whether DICOM is separated from DIOGND (ie, common reference for digital inputs floats). ON: DICOM connected to DIOGND. OFF: DICOM and DIOGND separate.
  - 7) Current [0(4)...20 mA,  $R_{in} = 100 \text{ ohm}$ ] or voltage [0(2)...10 V,  $R_{in} > 200 \text{ kohm}$ ] input selected by switch AI1. Change of setting requires reboot of control unit.
  - 8) Current [0(4)...20 mA,  $R_{in} = 100 \text{ ohm}$ ] or voltage [0(2)...10 V,  $R_{in} > 200 \text{ kohm}$ ] input selected by switch AI2. Change of setting requires reboot of control unit.
-




## Default I/O diagram of the inverter control unit (A41)

The table below describes the use of the connections in the inverter unit. Under normal circumstances, the factory-made wiring should not be changed.

The wire size accepted by all screw terminals (for both stranded and solid wire) is 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG). The tightening torque is 0.45 N·m (4 lbf·in).

Terminal			Description	
XD2D			Drive-to-drive link	
1	1	B	Drive-to-drive link. Refer to section <a href="#">The XD2D connector (page 126)</a> .	
2	2	A		
3	3	BGND		
4	4	Shield		
	D2D.TERM		Drive-to-drive link termination switch. Must be set to ON when the inverter unit is the first or last unit in the drive-to-drive (D2D) link. On intermediate units, set termination to OFF.	
X485			RS485 connection	
5	5	B	Not in use by default	
6	6	A		
7	7	BGND		
8	8	Shield		
XRO1, XRO2, XRO3			Relay outputs	
11	11	NC	Norm. closed	XRO1: <b>Ready</b> (Energized = Ready) 250 V AC / 30 V DC, 2 A
	12	COM	Common	
13	13	NO	Norm. open	
21	21	NC	Norm. closed	XRO2: <b>Running</b> (Energized = Running) 250 V AC / 30 V DC, 2 A
	22	COM	Common	
	23	NO	Norm. open	
31	31	NC	Norm. closed	XRO3: <b>Fault (-1)</b> (Energized = No fault) 250 V AC / 30 V DC, 2 A
	32	COM	Common	
	33	NO	Norm. open	
XSTO, XSTO OUT			Safe torque off	
1	1	OUT	XSTO: Factory connection. Both circuits must be closed for the drive to start (IN1 and IN2 must be connected to OUT). Refer to chapter <a href="#">The Safe torque off function</a> .	
	2	SGND		
	3	IN1		
	4	IN2		
5	5	IN1	XSTO OUT: Safe torque off output to inverter modules.	
	6	SGND		
	7	IN2		
	8	SGND		
XDI			Digital inputs	

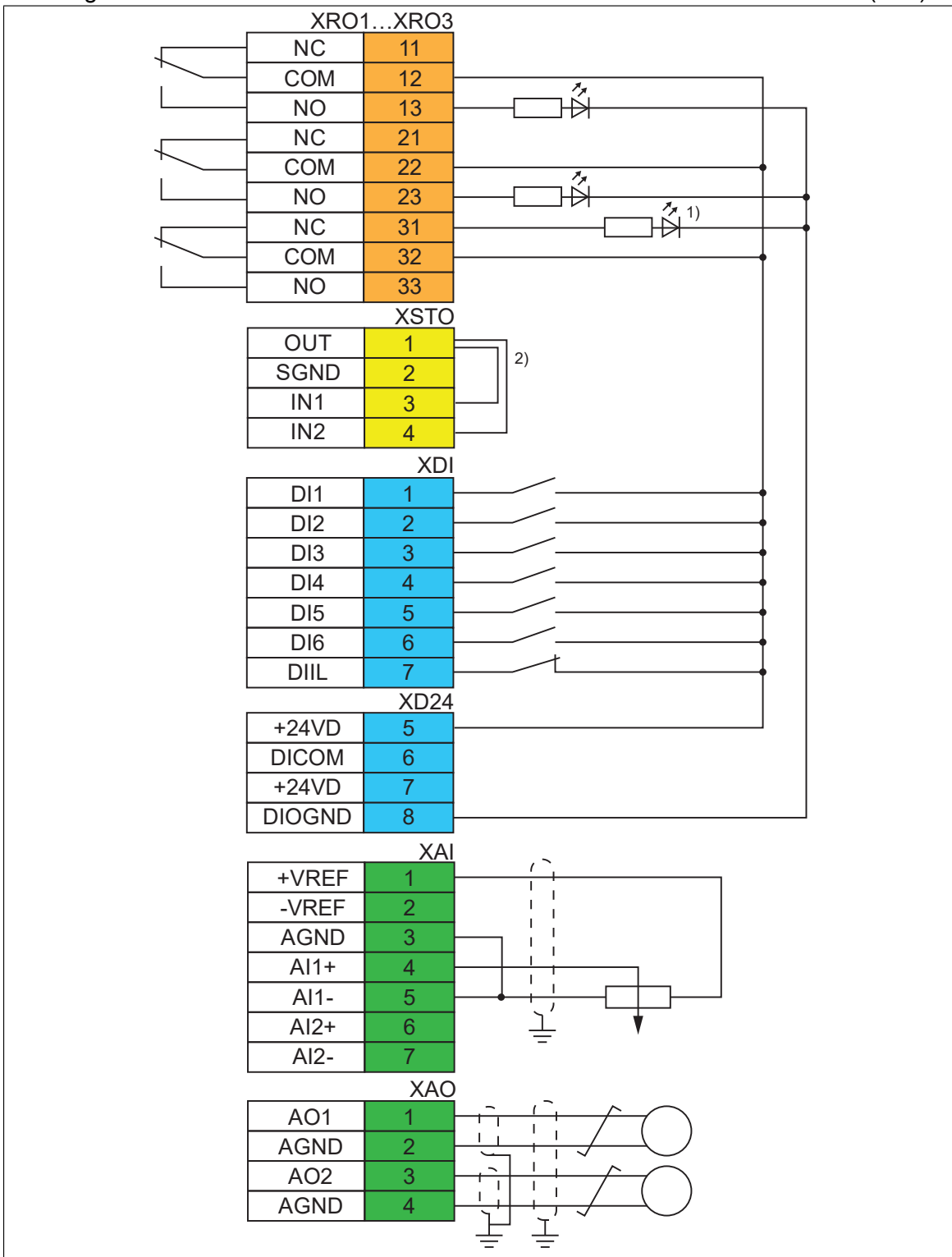
122 Control units of the drive

Terminal		Description	
1 2 3 4 5 6 7	1	DI1	Stop (0) / Start (1)
	2	DI2	Forward (0) / Reverse (1)
	3	DI3	Reset
	4	DI4	Acceleration & deceleration select <sup>1)</sup>
	5	DI5	Constant speed 1 select (1 = on) <sup>2)</sup>
	6	DI6	Not in use by default.
	7	DIIL	Run enable <sup>3)</sup>
XDIO		Digital input/outputs	
1 2 3 4	1	DIO1	Output: Ready
	2	DIO2	Output: Running
	3	DIOGND	Digital input/output ground
	4	DIOGND	Digital input/output ground
XD24		Auxiliary voltage output	
5 6 7 8	5	+24VD	+24 V DC 200 mA <sup>4)</sup>
	6	DICOM	Digital input ground
	7	+24VD	+24 V DC 200 mA <sup>4)</sup>
	8	DIOGND	Digital input/output ground
	DICOM=DIOGND		Ground selection switch. Determines whether DICOM is separated from DIOGND (ie, common reference for digital inputs floats). ON: DICOM connected to DIOGND. OFF: DICOM and DIOGND separate.
XAI		Analog inputs, reference voltage output	
1 2 3 4 5 6 7	1	+VREF	10 V DC, $R_L$ 1 ... 10 kohm
	2	-VREF	-10 V DC, $R_L$ 1 ... 10 kohm
	3	AGND	Ground
	4	AI1+	Speed reference. 0(2)...10 V, $R_{in} > 200$ kohm <sup>5)</sup>
	5	AI1-	
	6	AI2+	Not in use by default. 0(4)...20 mA, $R_{in} = 100$ ohm <sup>6)</sup>
	7	AI2-	
	AI1		AI1 current/voltage selection switch
	AI2		AI2 current/voltage selection switch
XAO		Analog outputs	
1 2 3 4	1	AO1	<b>Motor speed rpm</b> 0 ... 20 mA, $R_L < 500$ ohm
	2	AGND	
	3	AO2	<b>Motor current</b> 0 ... 20 mA, $R_L < 500$ ohm
	4	AGND	
XPOW		External power input	
1 2 3 4	1	+24VI	24 V DC, 2.05 A Two supplies can be connected for redundancy.
	2	GND	
	3	+24VI	
	4	GND	
X12		Safety functions module connection	

Terminal	Description
X13	Control panel connection
X205	Memory unit connection

- 1) 0 = Acceleration/deceleration ramps defined by parameters 23.12/23.13 in use.  
1 = Acceleration/deceleration ramps defined by parameters 23.14/23.15 in use.
  - 2) Constant speed 1 is defined by parameter 22.26.
  - 3) The DIIL input is configured to stop the unit when the input signal is removed. This input does not have a SIL or PL classification.
  - 4) Total load capacity of these outputs is 4.8 W (200 mA at 24 V) minus the power taken by DIO1 and DIO2.
  - 5) Current [0(4)...20 mA,  $R_{in} = 100 \text{ ohm}$ ] or voltage [0(2)...10 V,  $R_{in} > 200 \text{ kohm}$ ] input selected by switch AI1. Change of setting requires reboot of control unit.
  - 6) Current [0(4)...20 mA,  $R_{in} = 100 \text{ ohm}$ ] or voltage [0(2)...10 V,  $R_{in} > 200 \text{ kohm}$ ] input selected by switch AI2. Change of setting requires reboot of control unit.
-

The diagram below shows the default I/O connections on the inverter control unit (A41).



1) Fault

2) If necessary, you can connect an emergency stop button to the XSTO terminal. Refer to chapter [The Safe torque off function](#).



## Additional information on the connections

### ■ External power supply for the control unit (XPOW)

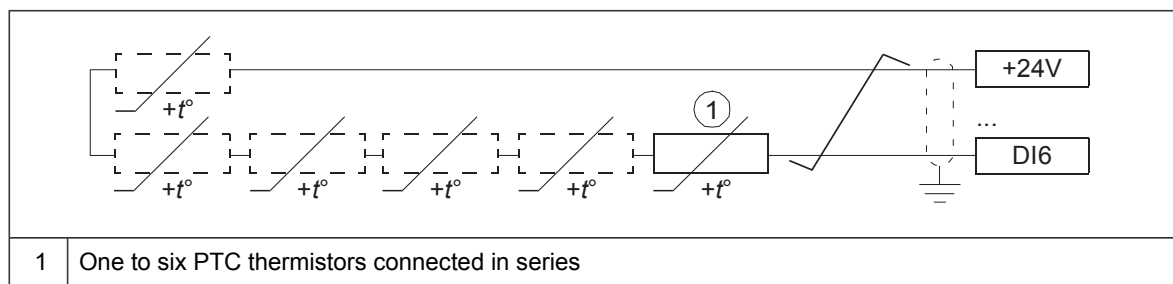
The control unit is powered from a 24 V DC, 2 A supply through terminal block XPOW. With a type BCU control unit, a second supply can be connected to the same terminal block for redundancy.

Using an external supply is recommended if

- the control unit needs to be kept operational during input power breaks, for example, because of continuous fieldbus communication
- immediate restart is needed after a power break (that is, no control unit power-up delay is allowed).

### ■ DI6 as a PTC sensor input

PTC sensors can be connected to this input for motor temperature measurement as follows. The sensor can alternatively be connected to a FEN encoder interface module or FPTC thermistor protection module (option +L536) or PTC relay (option +L505). At the sensor end of the cable, leave the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, for example 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are in the same ground line with no significant voltage drop between the end points. See the firmware manual of the inverter unit for parameter settings.

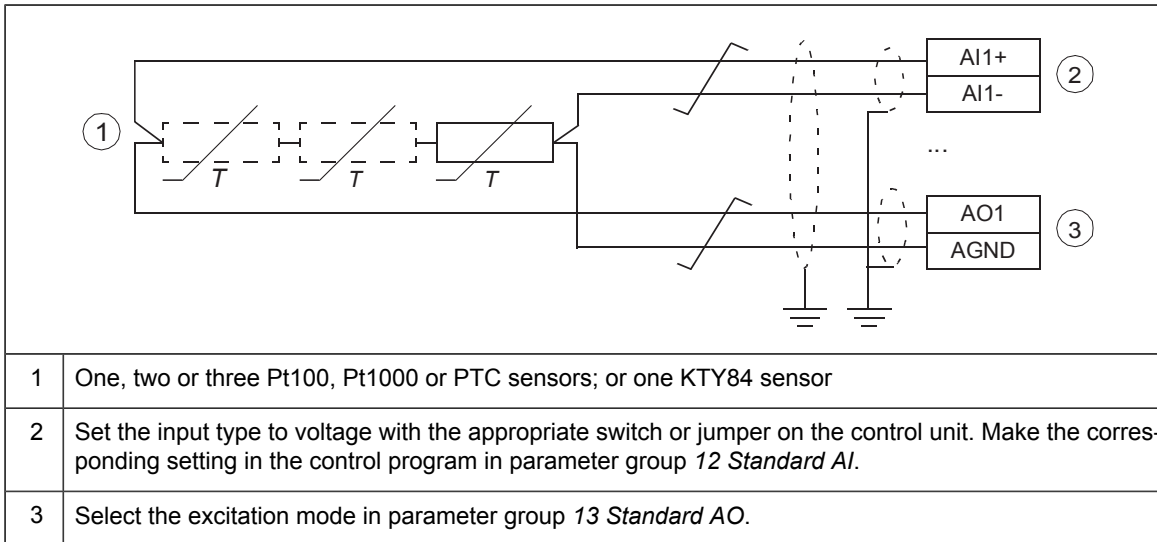


#### **WARNING!**

As the inputs pictured above are not insulated according to IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. Make sure that the voltage does not exceed the maximum allowed voltage over the PTC sensor.

### ■ AI1 or AI2 as a Pt100, Pt1000, PTC or KTY84 sensor input

Sensors for motor temperature measurement can be connected between an analog input and output, an example connection is shown below. (Alternatively, you can connect the KTY to an FIO-11 or FAIO-01 analog I/O extension module or a FEN encoder interface module.) At the sensor end of the cable, leave the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, for example 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are in the same ground line with no significant voltage drop between the end points.

**WARNING!**

As the inputs pictured above are not insulated according to IEC/EN 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. Make sure that the current does not exceed the maximum allowed current through the Pt100/Pt1000 sensor.

### ■ DIIL input

The DIIL input is used for the connection of safety circuits. The input is parametrized to stop the unit when the input signal is lost.

**Note:** This input is NOT SIL or PL certified.

### ■ The XD2D connector

The XD2D connector provides an RS-485 connection that can be used for

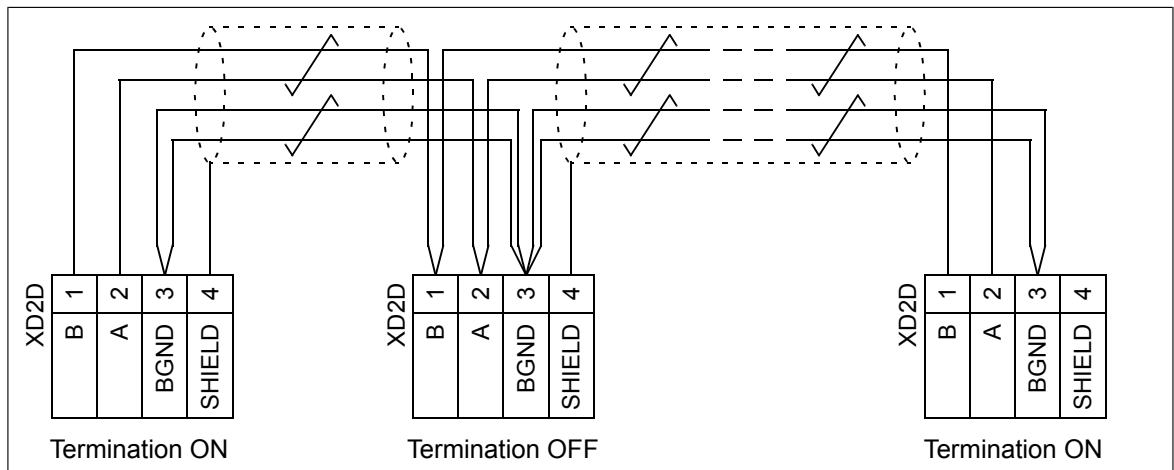
- basic master/follower communication with one master drive and multiple followers,
- fieldbus control through the embedded fieldbus interface (EFB), or
- drive-to-drive (D2D) communication implemented by application programming.

See the firmware manual of the drive for the related parameter settings.

Enable bus termination on the units at the ends of the drive-to-drive link. Disable bus termination on the intermediate units.

Use shielded twisted-pair cable with a twisted pair for data and a wire or another pair for signal ground (nominal impedance 100 ... 165 ohm, for example Belden 9842) for the wiring. For best immunity, ABB recommends high quality cable. Keep the cable as short as possible. Avoid unnecessary loops and parallel runs near power cables such as motor cables.

The following diagram shows the wiring between control units.

**BCU-x2**

- **Safe torque off (XSTO, XSTO OUT)**

See chapter [The Safe torque off function \(page 213\)](#).

**Note:** The XSTO input only acts as a true Safe torque off input on the inverter control unit. De-energizing the IN1 and/or IN2 terminals of other units (supply, DC/DC converter, or brake unit) will stop the unit but not constitute a true safety function.

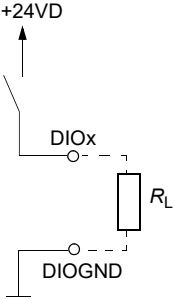
- **FSO safety functions module connection (X12)**

Refer to the applicable FSO module user's manual.

- **SDHC memory card slot**

The BCU-x2 has an on-board data logger that collects real-time data from the power modules to help fault tracing and analysis. The data is stored onto the SDHC memory card inserted into the SD CARD slot and can be analyzed by ABB service personnel.

## Connector data

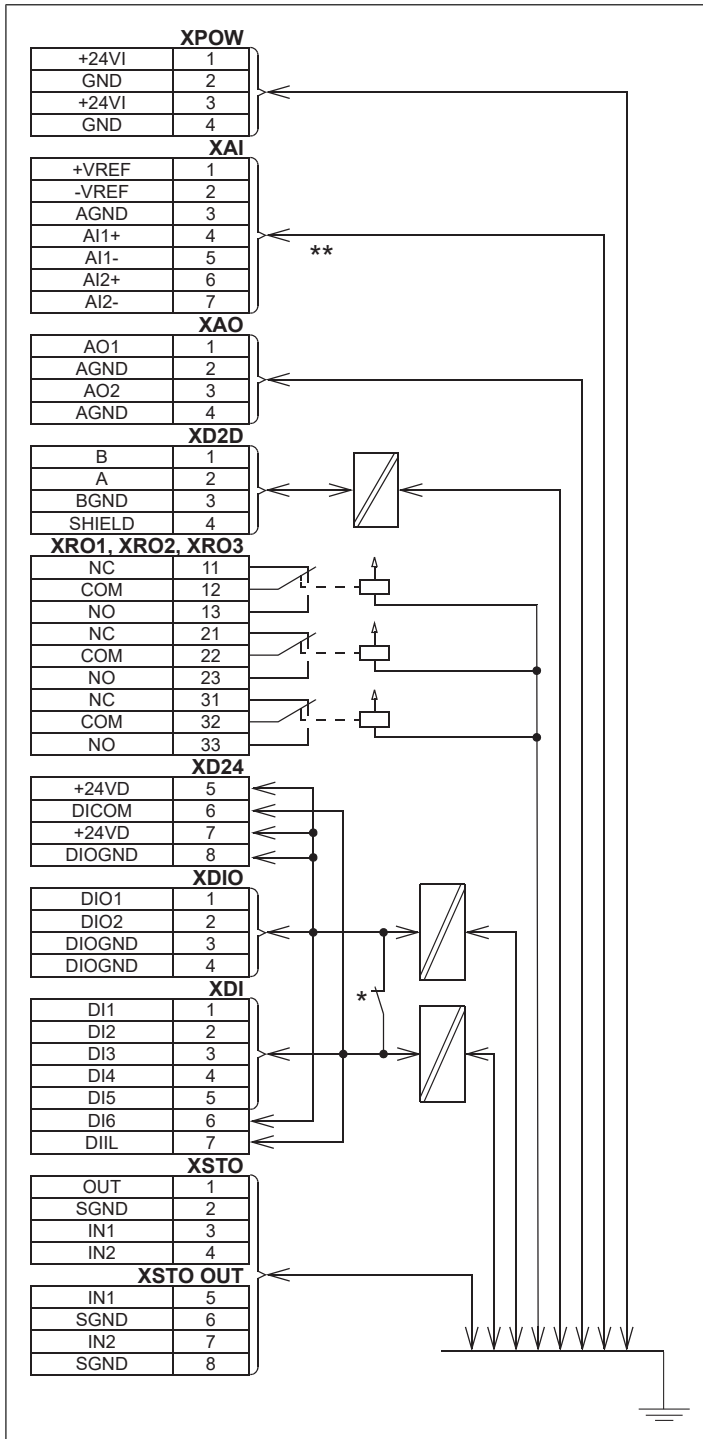
<p>Power supply (XPOW)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG)  Tightening torque 0.45 N·m (4 lbf·in)  24 V (±10%) DC, 2 A  External power input.  Two supplies can be connected to the BCU-x2 for redundancy.</p>
<p>Relay outputs RO1...RO3 (XRO1...XRO3)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG)  Tightening torque 0.45 N·m (4 lbf·in)  250 V AC / 30 V DC, 2 A  Protected by varistors</p>
<p>+24 V output (XD24:2 and XD24:4)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG)  Tightening torque 0.45 N·m (4 lbf·in)  Total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the power taken by DIO1 and DIO2.</p>
<p>Digital inputs DI1...DI6 (XDI:1...XDI:6)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG)  Tightening torque 0.45 N·m (4 lbf·in)  24 V logic levels: "0" &lt; 5 V, "1" &gt; 15 V  <math>R_{in}</math>: 2.0 kohm  Input type: NPN/PNP (DI1...DI5), PNP (DI6)  Hardware filtering: 0.04 ms, digital filtering up to 8 ms  DI6 (XDI:6) can alternatively be used as an input for a PTC sensor. "0" &gt; 4 kohm, "1" &lt; 1.5 kohm.  <math>I_{max}</math>: 15 mA (DI1...DI5), 5 mA (DI6)</p>
<p>Start interlock input DIIL (XDI:7)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG)  Tightening torque 0.45 N·m (4 lbf·in)  24 V logic levels: "0" &lt; 5 V, "1" &gt; 15 V  <math>R_{in}</math>: 2.0 kohm  Input type: NPN/PNP  Hardware filtering: 0.04 ms, digital filtering up to 8 ms</p>
<p>Digital inputs/outputs DIO1 and DIO2 (XDIO:1 and XDIO:2)  Input/output mode selection by parameters.  DIO1 can be configured as a frequency input (0...16 kHz with hardware filtering of 4 microseconds) for 24 V level square wave signal (sinusoidal or other wave form cannot be used). DIO2 can be configured as a 24 V level square wave frequency output. See the firmware manual, parameter group 111/11.</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG)  Tightening torque 0.45 N·m (4 lbf·in)  <u>As inputs:</u> 24 V logic levels: "0" &lt; 5 V, "1" &gt; 15 V. <math>R_{in}</math>: 2.0 kohm. Filtering: 1 ms.  <u>As outputs:</u> Total output current from +24VD is limited to 200 mA</p> 
<p>Reference voltage for analog inputs +VREF and -VREF (XAI:1 and XAI:2)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG)  Tightening torque 0.45 N·m (4 lbf·in)  10 V ±1% and -10 V ±1%, <math>R_{load}</math> 1...10 kohm  Maximum output current: 10 mA</p>

<p>Analog inputs AI1 and AI2 (XAI:4 ... XAI:7). Current/voltage input mode selection by switches</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG) Tightening torque 0.45 N·m (4 lbf·in) Current input: -20...20 mA, <math>R_{in} = 100</math> ohm Voltage input: -10...10 V, <math>R_{in} &gt; 200</math> kohm Differential inputs, common mode range <math>\pm 30</math> V Sampling interval per channel: 0.25 ms Hardware filtering: 0.25 ms, adjustable digital filtering up to 8 ms Resolution: 11 bit + sign bit Inaccuracy: 1% of full scale range</p>
<p>Analog outputs AO1 and AO2 (XAO)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG) Tightening torque 0.45 N·m (4 lbf·in) 0...20 mA, <math>R_{load} &lt; 500</math> ohm Frequency range: 0...500 Hz Resolution: 11 bit + sign bit Inaccuracy: 2% of full scale range</p>
<p>XD2D connector</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG) Tightening torque 0.45 N·m (4 lbf·in) Physical layer: RS-485 Transmission rate: 8 Mbit/s Cable type: Shielded twisted-pair cable with a twisted pair for data and a wire or another pair for signal ground (nominal impedance 100 ... 165 ohm, for example Belden 9842) Maximum length of link: 50 m (164 ft) Termination by switch</p>
<p>RS-485 connection (X485)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG) Tightening torque 0.45 N·m (4 lbf·in) Physical layer: RS-485 Cable type: Shielded twisted-pair cable with a twisted pair for data and a wire or another pair for signal ground (nominal impedance 100 ... 165 ohm, for example Belden 9842) Maximum length of link: 50 m (164 ft)</p>
<p>Safe torque off connection (XSTO)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG) Tightening torque 0.45 N·m (4 lbf·in) Input voltage range: -3...30 V DC Logic levels: "0" &lt; 5 V, "1" &gt; 17 V.  <b>Note:</b> For the unit to start, both connections must be "1". This applies to all control units (including drive, inverter, supply, brake, DC/DC converter etc. control units), but true Safe torque off functionality is only achieved through the XSTO connector of the drive/inverter control unit. Current consumption: 66 mA (continuous) per STO channel per R8i module EMC (immunity) according to IEC 61326-3-1 See also chapter <a href="#">The Safe torque off function (page 213)</a>.</p>
<p>Safe torque off output (XSTO OUT)</p>	<p>Connector pitch 5 mm, wire size 0.5 ... 2.5 mm<sup>2</sup> (22...12 AWG) Tightening torque 0.45 N·m (4 lbf·in) To STO connector of inverter module.</p>
<p>Control panel connection (X13)</p>	<p>Connector: RJ-45 Cable length &lt; 3 m (9.8 ft)</p>
<p>Ethernet connection (XETH)</p>	<p>Connector: RJ-45 This connection is not supported by the firmware.</p>

### 130 Control units of the drive

SDHC memory card slot (SD CARD)	Memory card type: SDHC Maximum memory size: 4 GB
The terminals of the control unit fulfill the Protective Extra Low Voltage (PELV) requirements. The PELV requirements of a relay output are not fulfilled if a voltage higher than 48 V is connected to the relay output.	

■ **BCU-x2 ground isolation diagram**



**\*Ground selector (DICOM=DIOGND) settings**

DICOM=DIOGND: ON

All digital inputs share a common ground (DICOM connected to DIOGND). This is the default setting.

DICOM=DIOGND: OFF

Ground of digital inputs DI1...DI5 and DIIL (DICOM) is isolated from DIO signal ground (DIOGND). Isolation voltage 50 V.

\*\*The maximum common mode voltage between each AI input and AGND is +30 V





## 8

# Installation checklist

## Contents of this chapter

This chapter contains a checklist of the mechanical and electrical installation of the drive.

## Checklist

Examine the mechanical and electrical installation of the drive before start-up. Go through the checklist together with another person.



### WARNING!

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.



### WARNING!

Stop the drive and do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.

<b>Make sure that ...</b>	<input checked="" type="checkbox"/>
The ambient operating conditions meet the drive ambient conditions specification and enclosure rating (IP code).	<input type="checkbox"/>
The supply voltage matches the nominal input voltage of the drive. See the type designation label.	<input type="checkbox"/>
The insulation resistance of the input power cable, motor cable and motor is measured according to local regulations and the manuals of the drive.	<input type="checkbox"/>
The drive cabinet is attached to the floor, and if necessary due to vibration etc, also by its top to the wall or roof.	<input type="checkbox"/>
If the drive is connected to a network other than a symmetrically grounded TN-S system: You have done all the required modifications (for example, you may need to disconnect the EMC filter or ground-to-phase varistor). See the electrical installation instructions.	<input type="checkbox"/>

134 Installation checklist

<b>Make sure that ...</b>	<input checked="" type="checkbox"/>
There is an adequately sized protective earth (ground) conductor(s) between the drive and the switchboard, the conductor is connected to correct terminal, and the terminal is tightened to the correct torque. Proper grounding has also been measured according to the regulations.	<input type="checkbox"/>
The input power cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	<input type="checkbox"/>
There is an adequately sized protective earth (ground) conductor between the motor and the drive, and the conductor is connected to the correct terminal, and the terminal is tightened to the correct torque. Proper grounding has also been measured according to the regulations.	<input type="checkbox"/>
The motor cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	<input type="checkbox"/>
The motor cable is routed away from other cables.	<input type="checkbox"/>
No power factor compensation capacitors are connected to the motor cable.	<input type="checkbox"/>
The control cables are connected to the correct terminals, and the terminals are tightened to the correct torque.	<input type="checkbox"/>
The voltage setting of the auxiliary voltage transformers (if any) is correct. See the electrical installation instructions.	<input type="checkbox"/>
<u>If a drive bypass connection will be used:</u> The Direct On Line contactor of the motor and the drive output contactor are either mechanically and/or electrically interlocked, that is, they cannot be closed at the same time. A thermal overload device must be used for protection when bypassing the drive. Refer to local codes and regulations.	<input type="checkbox"/>
There are no tools, foreign objects or dust from drilling inside the drive.	<input type="checkbox"/>
Cover(s) of the motor connection box are in place. Cabinet shrouds are in place and doors are closed.	<input type="checkbox"/>
The motor and the driven equipment are ready for power-up.	<input type="checkbox"/>
The coolant connections between cubicles (if any) and to the cooling circuit are tight.	<input type="checkbox"/>
<u>If the drive is equipped with a cooling unit:</u> Make sure that the mechanical and electrical installation of the cooling unit is completed. Refer to the cooling unit documentation.	<input type="checkbox"/>

## 9

# Start-up

## Contents of this chapter

This chapter contains the start-up and switch-off procedures of the drive.

## Start-up procedure

The tasks which are needed in certain cases only are marked with underlining, and option codes are given in brackets. Default device designations (if any) are given in brackets after the name, for example “main switch-disconnector [Q1]”. The same device designations are also used in the circuit diagrams.

These instructions cannot and do not cover all possible start-up tasks of a customized drive. Always refer to the delivery-specific circuit diagrams when proceeding with the start-up.



### WARNING!

Only qualified electrical professionals are permitted to do the work described in this chapter.

**Note:** For certain options (such as functional safety options +Q950, +Q951, +Q952, +Q957, +Q963, +Q964, +Q978, +Q979), additional start-up instructions are given in their separate manuals.

Action	<input checked="" type="checkbox"/>
Safety	
<b>WARNING!</b> Obey the safety instructions during the start-up procedure. See chapter <a href="#">Safety instructions (page 13)</a> .	<input type="checkbox"/>
Checks/Settings with no voltage connected	
Make sure that the disconnecter of the supply transformer is locked to the off (0) position, ie. no voltage is, and cannot be connected to the drive accidentally.	<input type="checkbox"/>

<b>Action</b>	<input checked="" type="checkbox"/>
Make sure that the main switch-disconnector [Q1.1] is switched off, or the main breaker [Q1] is racked out.	<input type="checkbox"/>
Check that the grounding switch [Q9.1] (option +F259) is switched on.	<input type="checkbox"/>
Check the mechanical and electrical installation of the drive. See <i>Installation checklist (page 133)</i> .	<input type="checkbox"/>
Check the settings of breakers/switches in the auxiliary circuits. See the circuit diagrams delivered with the drive.	<input type="checkbox"/>
Check the settings of the auxiliary voltage transformers (either internal or external).	<input type="checkbox"/>
Disconnect any unfinished or uninspected auxiliary voltage (115/230 V AC) cables that lead from the terminal blocks to the outside of the equipment.	<input type="checkbox"/>
Check that both channels of the Safe torque off circuit connected to the STO inputs of both the supply control unit [A51] and the inverter control unit [A41] are closed. Refer to the wiring diagrams delivered with the drive.	<input type="checkbox"/>
<u>Drives with ground fault monitoring for IT (ungrounded) systems (option +Q954):</u> Adjust the settings of the ground fault monitor to suit the installation. See the circuit diagrams of the delivery and <i>IRDH275B Ground Fault Monitor Operating Manual</i> by Bender (code: TGH1386en).	<input type="checkbox"/>
<u>Drives with Pt100 relays (option +(n)L506):</u> <ul style="list-style-type: none"> <li>• Check the connections against the circuit diagrams of the delivery.</li> <li>• Set the alarm and trip levels of the Pt100 relays.</li> </ul> Set the alarm and trip levels of the Pt100 relay as low as possible based on the operating temperature and test results of the machine. The trip level can be set, for example, 10 °C higher than what the temperature of the machine is at maximal load in the maximum environmental temperature. ABB recommends to set the operating temperatures of the relay, typically for example, as follows: <ul style="list-style-type: none"> <li>• 120...140 °C when only tripping is in use</li> <li>• alarm 120...140 °C and trip 130...150 °C when both alarm and tripping are used.</li> </ul>	<input type="checkbox"/>
<b>Powering up the auxiliary circuit of the drive</b>	
Make sure that it is safe to connect voltage. Make sure that: <ul style="list-style-type: none"> <li>• nobody is working on the drive or circuits that have been wired from outside into the drive cabinet</li> <li>• the cover of the motor terminal box is in place.</li> </ul>	<input type="checkbox"/>
<u>Drives with an ACS880-1007LC cooling unit (as part of line-up or standalone):</u> Do the start-up tasks of the cooling unit. Refer to <a href="#">ACS880-1007LC liquid cooling unit user's manual (3AXD50000129607 [English])</a> .	<input type="checkbox"/>
<u>Drives with a voltmeter (option +G334):</u> Make sure that the circuit breaker of the measuring circuit (F5.1) is closed.	<input type="checkbox"/>
Close the circuit breakers and/or fuse disconnectors supplying the auxiliary voltage circuits.	<input type="checkbox"/>
Close the cabinet doors.	<input type="checkbox"/>
Close the main breaker of the supply transformer.	<input type="checkbox"/>
Switch on the auxiliary voltage [Q21]. <u>Drives of frame size 1×R8i + 1×R8i:</u> Close the main switch-disconnector [Q1.1]. This will power up the main circuit of the drive as well as the auxiliary voltage circuit.	<input type="checkbox"/>
<b>Setting up the supply unit parameters</b>	
Check the voltage range setting in parameter <i>195.01 Supply voltage</i> . For more information on setting up the supply control program, refer to <a href="#">ACS880 IGBT supply control program firmware manual (3AUA0000131562 [English])</a> . If you need more information on the use of the control panel, refer to <a href="#">ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual (3AUA0000085685 [English])</a> .	<input type="checkbox"/>
<b>Setting up the inverter unit parameters, and performing the first start</b>	
Set up the inverter control program. See the appropriate start-up guide and/or firmware manual. There is a separate start-up guide only for some control programs.	<input type="checkbox"/>
Check that parameter <i>95.09 Switch fuse controller</i> is set to <i>Disabled</i> .	<input type="checkbox"/>



<b>Action</b>	<input checked="" type="checkbox"/>
<u>Drives with an fieldbus adapter module (optional)</u> : Set the fieldbus parameters. Activate the appropriate assistant (if present) in the control program, or see the user's manual of the fieldbus adapter module, and the drive firmware manual. Check that the communication works between the drive and the PLC.	<input type="checkbox"/>
<u>Drives with an encoder interface module (optional)</u> : Set the encoder parameters. Activate the appropriate assistant (if present) in the control program, or see the user's manual of the encoder interface module, and the drive firmware manual.	<input type="checkbox"/>
<b>Powering up the main circuit of the drive</b>	
<u>Switch off the grounding switch [Q9.1] (option +F259).</u>	<input type="checkbox"/>
Close the main switch-disconnector [Q1.1] or main breaker [Q1]. <b>Note:</b> Do not use excessive force. The main switch-disconnector (or main breaker) can only be closed when <ul style="list-style-type: none"> <li>the main input terminals [L1, L2, L3] are powered, and</li> <li>auxiliary voltage is switched on [Q21], and</li> <li><u>grounding switch is off [Q9.1, Q9.2] (option +F259).</u></li> </ul>	<input type="checkbox"/>
Turn the operating switch (S21) to the ON (1) position to activate the run enable signal. Depending on control source settings, this may also close the main contactor (if present). If a main contactor is present and does not close, refer to the circuit diagrams delivered by the drive as well as the appropriate firmware manuals.	<input type="checkbox"/>
<b>On-load checks</b>	
Start the motor to perform the ID run.	<input type="checkbox"/>
Check that the cooling fans rotate freely in the right direction, and the air flows upwards.	<input type="checkbox"/>
Check that the motor starts, stops and follows the speed reference in the correct direction when controlled with the control panel.	<input type="checkbox"/>
Check that the motor starts, stops and follows the speed reference in the correct direction when controlled through the customer-specific I/O or fieldbus.	<input type="checkbox"/>
<u>Drives in which the Safe torque off control circuit is in use</u> : Test and validate the operation of the Safe torque off function. See section <a href="#">Start-up including validation test (page 221)</a> .	<input type="checkbox"/>
<u>Drives with an emergency stop circuit (options +Q951, +Q952, +Q963, +Q964, +Q978, +Q979, +Q984)</u> : Test and validate the operation of the emergency-stop circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	<input type="checkbox"/>
<u>Drives with the Prevention of unexpected start-up with safety relay (option +Q957)</u> : Test and validate the operation of the Prevention of unexpected start-up circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	<input type="checkbox"/>
<u>Drives with the Prevention of unexpected start with FSO safety functions module (option +Q950)</u> : Test and validate the operation of the Prevention of unexpected start-up circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	<input type="checkbox"/>
<u>Drives with the Safely-limited speed with the encoder interface (option +Q965)</u> : Test and validate the operation of the Safely-limited speed circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	<input type="checkbox"/>
<u>Drives with a motor thermal protection function (options +L513, +L514, +L536, +L537)</u> : Test and validate the operation of the motor thermal protection function. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	<input type="checkbox"/>

## Switching off the drive

1. Stop the motor.
2. Turn the Run enable switch (S21) to the off (0) position to deactivate the Run enable signal and to switch the main contactor/breaker off.





## Fault tracing

---

### Contents of this chapter

This chapter describes the fault tracing possibilities of the drive.

### Control unit LEDs

LED	Color	Indication
BATT OK	Green	Battery voltage of the real-time clock is OK (higher than 2.8 V). When the LED is not lit, <ul style="list-style-type: none"> <li>• battery voltage is below 2.8 V,</li> <li>• the battery is missing, or</li> <li>• the control unit is not powered.</li> </ul>
PWR OK	Green	Internal voltage OK
FAULT	Red	The control program indicates that the equipment is faulty. See the appropriate firmware manual.
WRITE	Yellow	Writing to SD card in progress.

### Control panel and panel platform/holder LEDs

The ACS-AP-... control panel has a status LED. The control panel mounting platform or holder has two status LEDs. For their indications, see the following table.

---

Location	LED	Indication
Control panel	Continuous green	The unit is functioning normally.
	Flickering green	Data is transferred between the PC and the unit through the USB connection of the control panel.
	Blinking green	There is an active warning in the unit.
	Continuous red	There is an active fault in the unit.
	Blinking red	There is a fault that requires the stopping and restarting of the drive/converter/inverter.
	Blinking blue (ACS-AP-W only)	The Bluetooth interface is enabled, in discoverable mode, and ready for pairing.
	Flickering blue (ACS-AP-W only)	Data is being transferred through the Bluetooth interface of the control panel.
Control panel mounting platform or holder (with the control panel removed)	Red	There is an active fault in the unit.
	Green	Power supply for the control unit is OK.

## Warning and fault messages

See the firmware manual for the descriptions, causes and remedies of the drive control program warning and fault messages.





# Maintenance

---

## Contents of this chapter

This chapter contains maintenance instructions.

## Maintenance intervals

The tables below show the maintenance tasks which can be done by the end user. The complete maintenance schedule is available on the Internet (<https://new.abb.com/drives/services/maintenance/preventive-maintenance>). For more information, consult your local ABB Service representative ([www.abb.com/searchchannels](http://www.abb.com/searchchannels)).

### ■ Description of symbols

Action	Description
I	Inspection (visual inspection and maintenance action if needed)
P	Performance of on/off-site work (commissioning, tests, measurements or other work)
R	Replacement

---

■ Recommended maintenance intervals after start-up

Maintenance task/object	Years from start-up													
	0	1	2	3	4	5	6	7	8	9	10	11	12	...
<b>Coolant</b>														
Checking coolant antifreeze concentration		P	P	P	P	P	P	P	P	P	P	P	P	P
Checking coolant quality			P		P		P		P		P		P	
Coolant draining and replacement							R						R	
ABB cooling unit (if present)	See ACS880-1007LC liquid cooling unit user's manual (3AXD50000129607 [English])													
<b>Cooling fans</b>														
Supply module cubicle fan (230 V)										R				
Supply module cubicle fan (115 V)							R						R	
Inverter module fan (230 V)									R					
Inverter module fan (115 V)							R						R	
<b>Batteries</b>														
Control panel battery										R				
Control unit battery							R						R	
<b>Connections and environment</b>														
Quality of supply voltage		P	P	P	P	P	P	P	P	P	P	P	P	P
<b>Spare parts</b>														
Spare parts		I	I	I	I	I	I	I	I	I	I	I	I	I
DC circuit capacitor reforming (spare inverter modules and spare capacitors)		P	P	P	P	P	P	P	P	P	P	P	P	P
<b>Inspections</b>														
Checking tightness of cable and busbar terminals. Tightening if needed.		I	I	I	I	I	I	I	I	I	I	I	I	I
Checking ambient conditions (dustiness, corrosion, temperature)		I	I	I	I	I	I	I	I	I	I	I	I	I
Checking coolant pipe connections		I	I	I	I	I	I	I	I	I	I	I	I	I
<b>Functional safety</b>														
Safety function test	I See the maintenance information of the safety function.													
Safety component expiry (Mission time, $T_M$ )	20 years													
3AXD10000578918 F														

**Note:**

- Maintenance and component replacement intervals are based on the assumption that the equipment is operated within the specified ratings and ambient conditions. ABB recommends annual drive inspections to ensure the highest reliability and optimum performance.
  - Long term operation near the specified maximum ratings or ambient conditions may require shorter maintenance intervals for certain components. Consult your local ABB Service representative for additional maintenance recommendations.
-

## Cabinet

### ■ Cleaning the interior of the cabinet

---



**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

---



**WARNING!**

Use a vacuum cleaner with antistatic hose and nozzle, and wear a grounding wristband. Using a normal vacuum cleaner creates static discharges which can damage circuit boards.

---

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.
2. Open the cabinet door.
3. Clean the interior of the cabinet. Use a vacuum cleaner and a soft brush.
4. Clean the air inlets of the fans and air outlets of the modules (top).
5. Clean the air inlet gratings (if any) on the door.
6. Close the door.

### ■ Cleaning the exterior of the drive

---



**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

---

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.
  2. Clean the exterior of the drive. Use:
    - vacuum cleaner with an antistatic hose and nozzle
    - soft brush
    - dry or damp (not wet) cleaning cloth. Moisten with clean water, or mild detergent (pH 5-9 for metal, pH 5-7 for plastic).
- 



**WARNING!**

Prevent water from entering the drive. Never use excessive amount of water, a hose, steam, etc.

---

## Power connections and quick connectors

### ■ Retightening the power connections



#### **WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Examine the tightness of the cable connections. Use the tightening torques given in the technical data.

## Fans

The lifespan of the cooling fans of the drive depends on the running time, ambient temperature and dust concentration. See the firmware manual for the actual signal which indicates the running time of the cooling fan. Reset the running time signal after fan replacement.

Replacement fans are available from ABB. Do not use other than ABB specified spare parts.

### ■ Frame R8i fan replacement



#### **WARNING!**

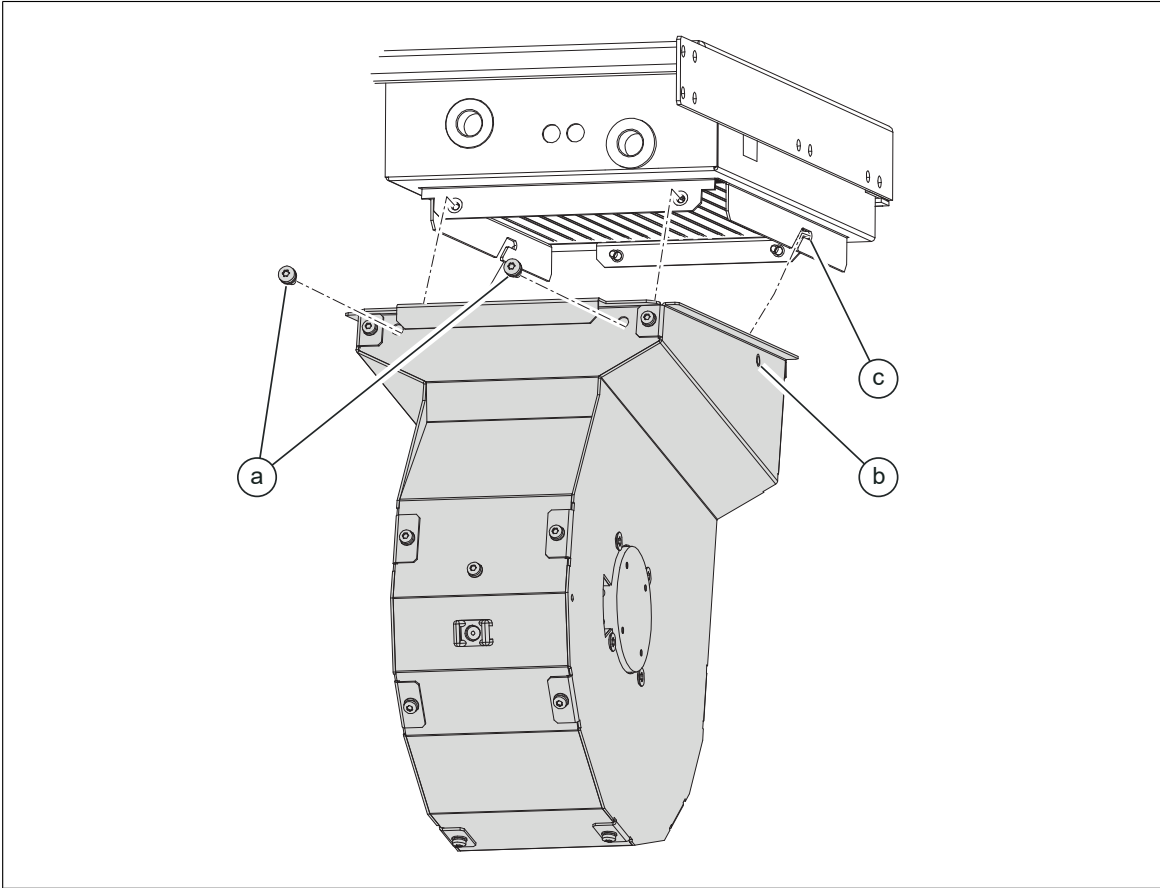
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.



#### **WARNING!**

Use the required personal protective equipment. Wear protective gloves and long sleeves. Some parts have sharp edges.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Remove any shrouding in front of the cooling fan in case of marine construction (+C121).
3. Disconnect the fan wiring. Remove the CIO module.
4. Undo the two retaining screws (a).
5. Pull the fan outwards to separate it from the heat exchanger housing.
6. Install new fan in reverse order. Align the guide pins (b) at the rear of the fan cowling with the slots (c) in the module bottom guide, then reinstall the retaining screws (a).

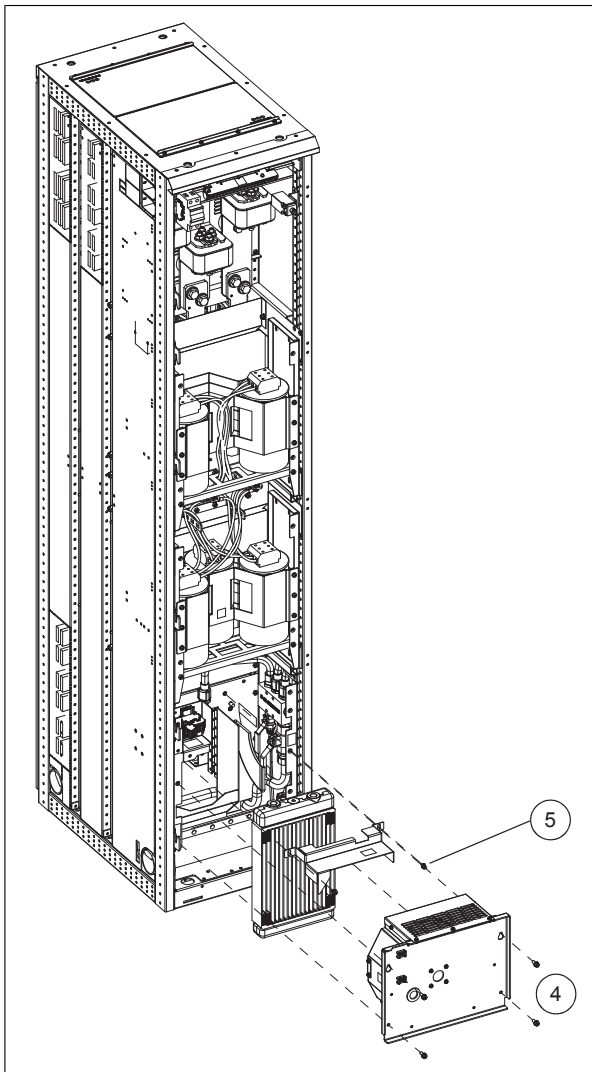


## ■ Replacing the heat exchanger fan in the filter cubicle

**WARNING!**

Wear protective gloves and long sleeves. Some parts have sharp edges.

1. Repeat the steps described in section *Electrical safety precautions (page 17)* before you start the work.
2. Remove the shrouding in front of the fan (if any).
3. Disconnect the fan wiring. Remove the CIO module.
4. Remove the four screws and pull the fan unit out.
5. Remove the two screws in front of the heat exchanger.
6. Install a new fan in reverse order.



## ■ Replacing the fan in the incoming cubicle

---



**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

---



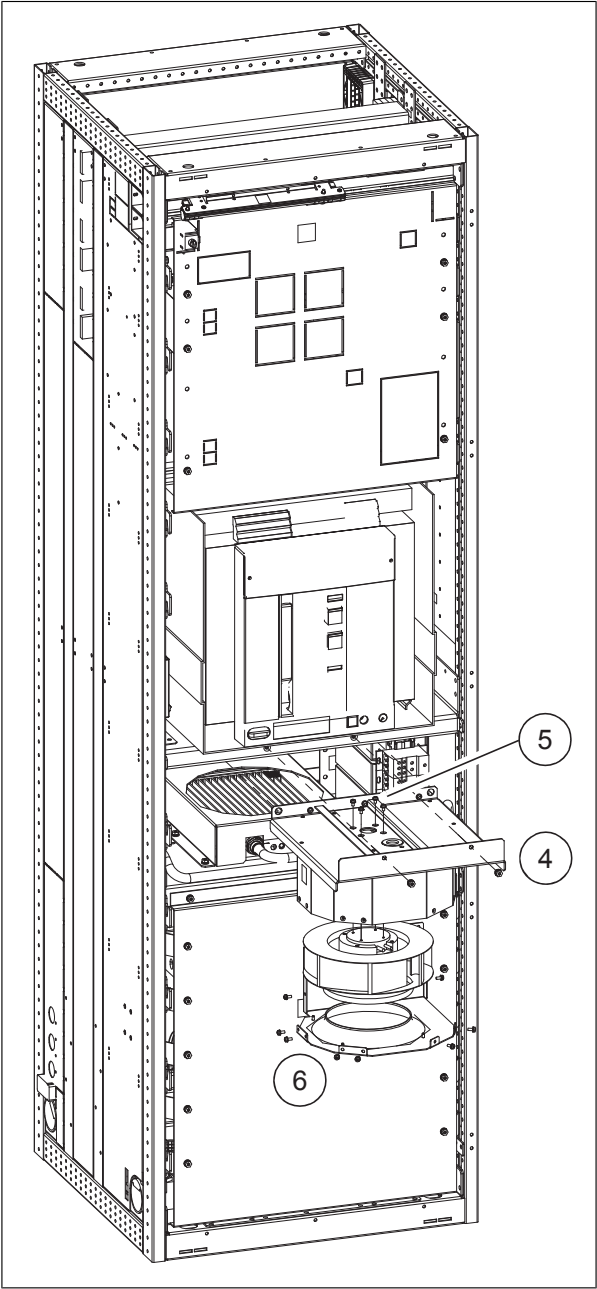
**WARNING!**

Use the required personal protective equipment. Wear protective gloves and long sleeves. Some parts have sharp edges.

---

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
  2. Remove the shrouding in front of the fan (if any).
  3. Disconnect the fan wiring. Remove the CIO module.
  4. Remove the two screws and slide the fan unit out.
  5. Remove the four screws to detach the fan from the fan unit.
  6. Remove the eight screws surrounding the fan unit.
  7. Install a new fan in reverse order.
-





## ■ Replacing the fan in the auxiliary control cubicle

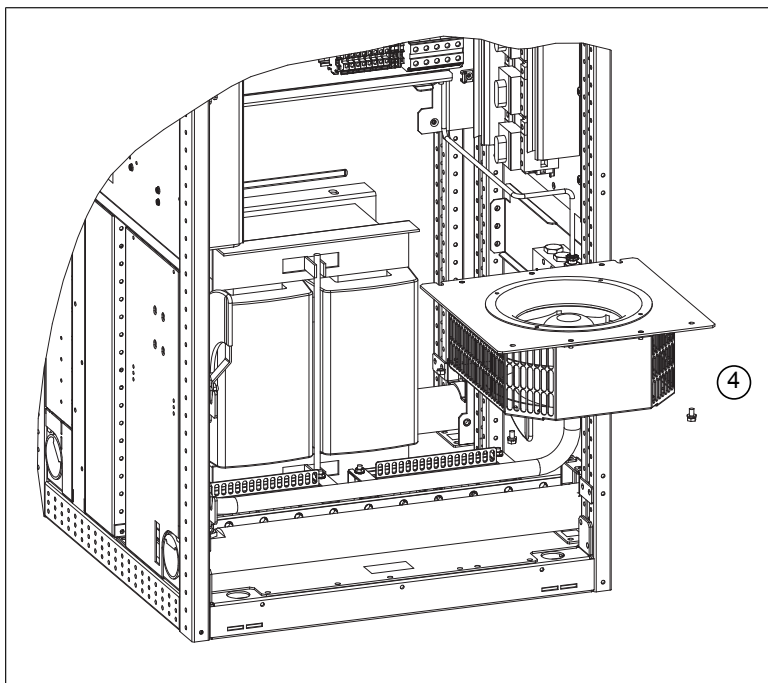
Auxiliary control cubicle has a fan in the lower part of the cubicle.



### WARNING!

Wear protective gloves and long sleeves. Some parts have sharp edges.

1. Repeat the steps described in section *Electrical safety precautions (page 17)* before you start the work.
2. Open the door of the auxiliary control cubicle.
3. Disconnect the fan wiring. Remove the CIO module.
4. Remove the fastening screws of the fan collar and slide the fan with the collar out.
5. Detach the fan from the collar and replace the fan.
6. Install the new fan in reverse order.



## ■ Replacing the common motor terminal cubicle fan



### WARNING!

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

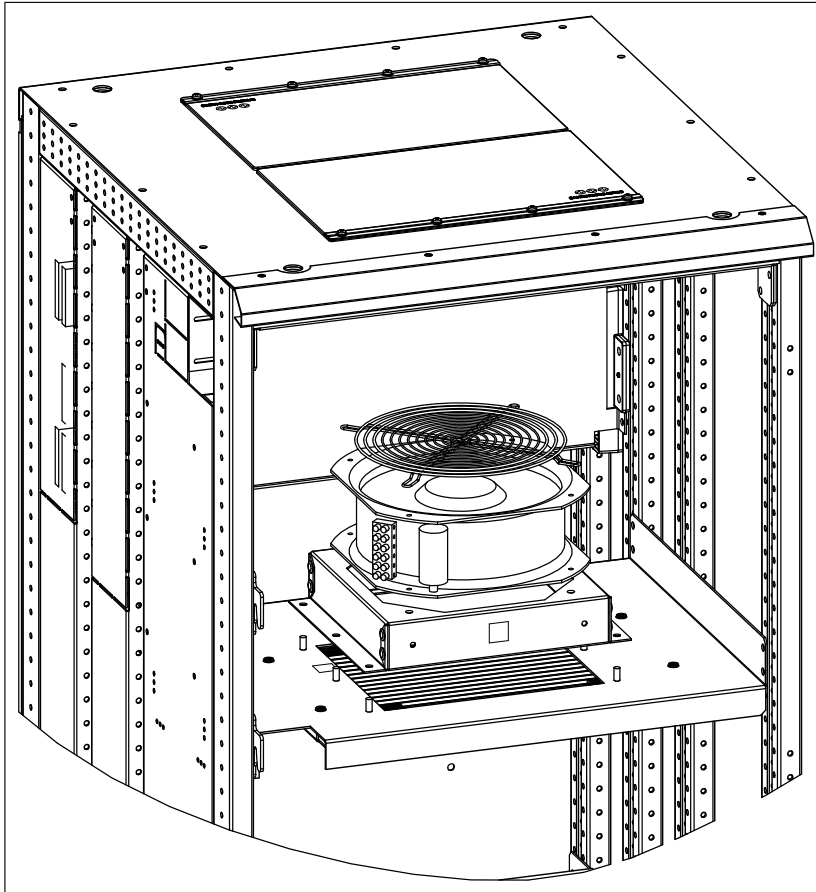


### WARNING!

Use the required personal protective equipment. Wear protective gloves and long sleeves. Some parts have sharp edges.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Remove any shrouding in front of the cooling fan.

3. Disconnect the fan wiring. Remove the CIO module.
4. Undo the fastening screws.
5. Pull the fan housing up and out.
6. Install a new fan in reverse order to the above.

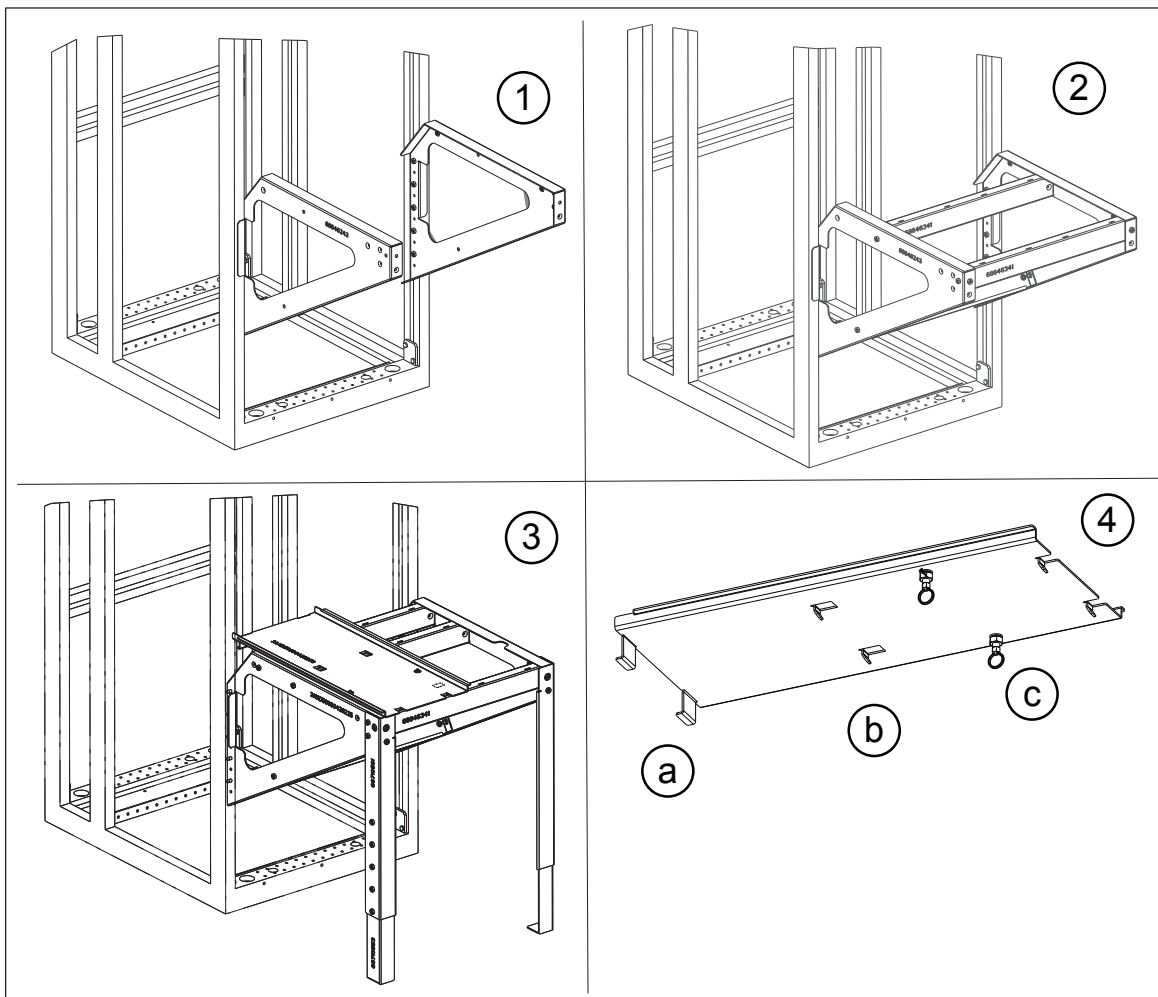


## Supply and inverter modules

### ■ Assembling the service platform

The service platform is included in the cabinet delivery. It can be used when installing or servicing liquid-cooled R8i modules.

1. Fasten the triangular supports to the cabinet frame (5 × M6 screws for each support). Make sure that the guide pins are properly inserted in the holes of the frame. Tighten the screws to torque (max 5.5 N·m / 4 lb·ft).
2. Select the braces (4 pcs) according to the width of the cubicle and attach them to the supports.
3. Attach the support feet to the platform and adjust them to the correct height.
4. Attach the slide plate. Put the hooks (a) at the back of the slide plate through the holes in the cabinet frame. Align the slots (b) in the slide plate with the braces. Fix the slide plate into place with the index screws (c) at the bottom of the slide plate.



### ■ Replacing a supply or inverter module



#### **WARNING!**

Make sure the replacement module has exactly the same type code as the old module.

**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

---

**WARNING!**

Make sure that the replacement module has exactly the same type code as the old module.

---

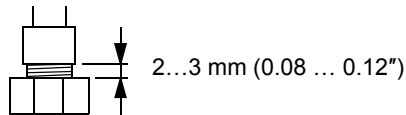
**WARNING!**

Beware of hot coolant. Do not work on the liquid cooling system until the pressure is lowered down by stopping the pumps and draining the coolant. High-pressure warm coolant (6 bar, max. 50 °C) is present in the internal cooling circuit when it is in operation.

---

**WARNING!**

To avoid breaking the coolant pipes, do not overtighten the nuts of the unions. Leave 2 to 3 millimeters (0.08 to 0.12 inches) of thread visible.

**WARNING!**

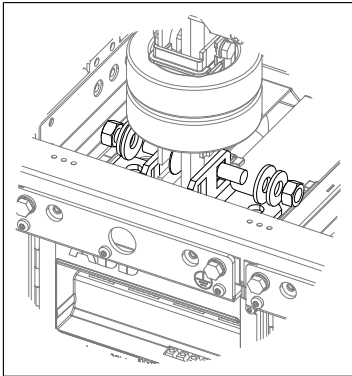
Use the required personal protective equipment. Wear protective gloves and long sleeves. Some parts have sharp edges.

---

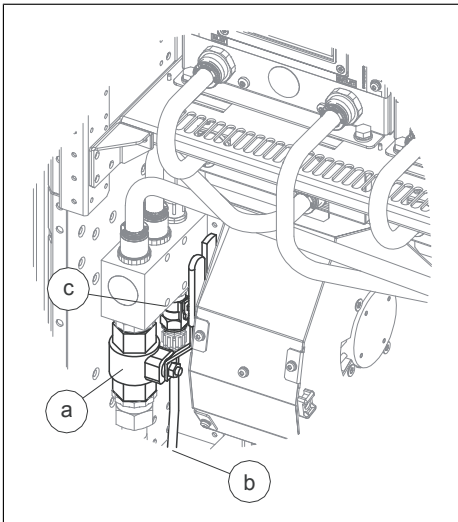
### Removing the module

1. Do the steps in section [Electrical safety precautions \(page 17\)](#).
  2. Assemble the service platform delivered with the drive. For instructions, see [Assembling the service platform for R8iLC cabinets](#).
  3. Remove the shrouding in front of the module.
  4. Undo the locking screws of the swing-out frame (if present) and open it.
  5. Unplug the wiring from the module and move it aside. Use cable ties to keep the wiring out of the way.
-

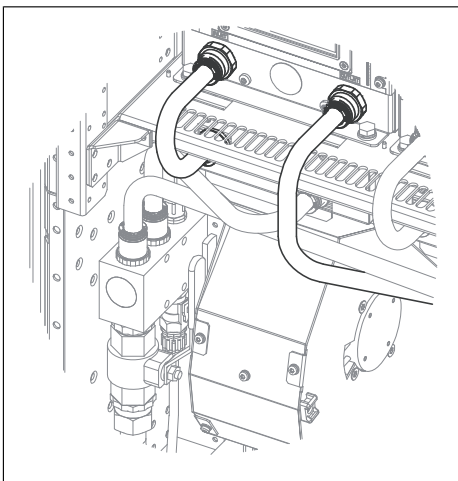
6. Remove the L-shaped DC busbars at the top of the module. Make note of the orientation of the screws as well as the order of the washers.



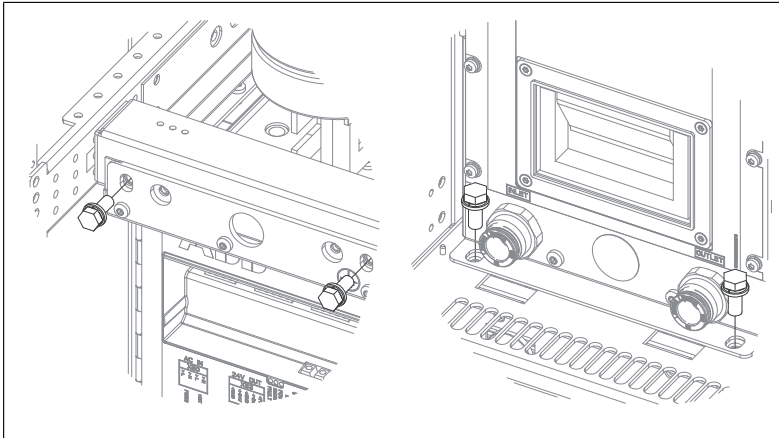
7. Close the inlet valve (a) and outlet valve (located on the right-hand side of the cubicle). Lead the drain hoses (b, on both sides of the cubicle) into a suitable container. Open the drain valves (c, on both sides of the cubicle). This will drain all modules in the cubicle.



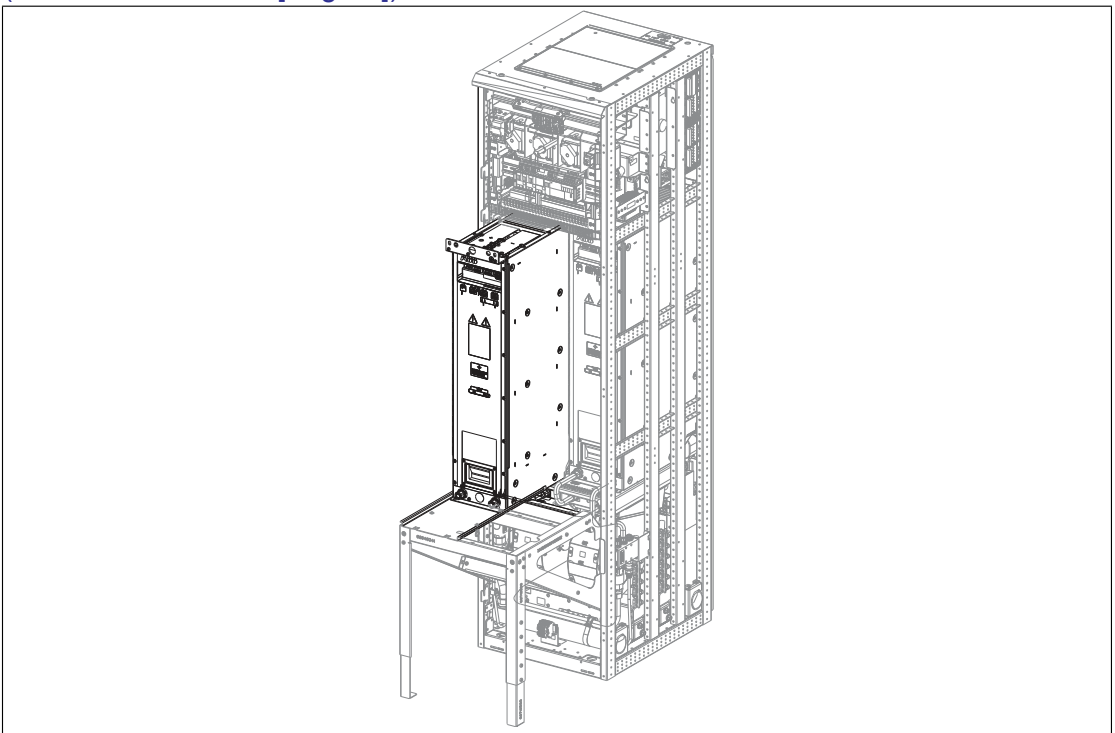
8. After the module has drained, disconnect the piping from the module.



9. Remove the module retaining screws at the top and the bottom of the module.



10. Pull the module carefully out onto the service platform. Keep the module secured to a hoist or equivalent to prevent the module from falling. For information on using the lifting device, see [Converter module lifting device for drive cabinets hardware manual \(3AXD50000210268 \[English\]\)](#).



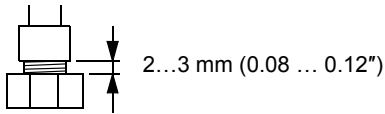
### Reinstalling the module

1. Push the module carefully into its bay.
  2. Fasten the retaining screws at the top and the bottom of the module.
  3. Reinstall the DC busbars at the top of the module.
  4. Reconnect the coolant pipes to the module.
-



**WARNING!**

To avoid breaking the coolant pipes, do not overtighten the nuts of the unions. Leave 2 to 3 millimeters (0.08 to 0.12 inches) of thread visible.



- 
5. Reconnect the control wiring to the module.
  6. Fill up the cooling system. For instructions, see section [Filling up and bleeding the internal cooling circuit](#).
  7. Close the swing-out frame (if present). Reinstall all shrouds removed earlier.
  8. If the module is an inverter module, and the Safe torque off function is in use, perform a validation test as described under [Start-up including validation test \(page 221\)](#).

## Capacitors

The DC link of the drive contains several electrolytic capacitors. Operating time, load, and surrounding air temperature have an effect on the life of the capacitors. Capacitor life can be extended by decreasing the surrounding air temperature.

Capacitor failure is usually followed by damage to the unit and an input cable fuse failure, or a fault trip. If you think that any capacitors in the drive have failed, contact ABB.

### ■ Reforming the capacitors

The capacitors must be reformed if the drive has not been powered (either in storage or unused) for a year or more. The manufacturing date is on the type designation label. For information on reforming the capacitors, refer to [Capacitor reforming instructions \(3BFE64059629 \[English\]\)](#).

---



## Fuses

### ■ Replacing the AC and DC fuses in cabinet

This procedure instructs how to replace the drive AC and DC fuses inside the cabinet. The location of the fuses vary depending on the drive type and options. Locate the fuses to be replaced using the delivery-specific layout drawings and circuit diagrams.

**WARNING!**

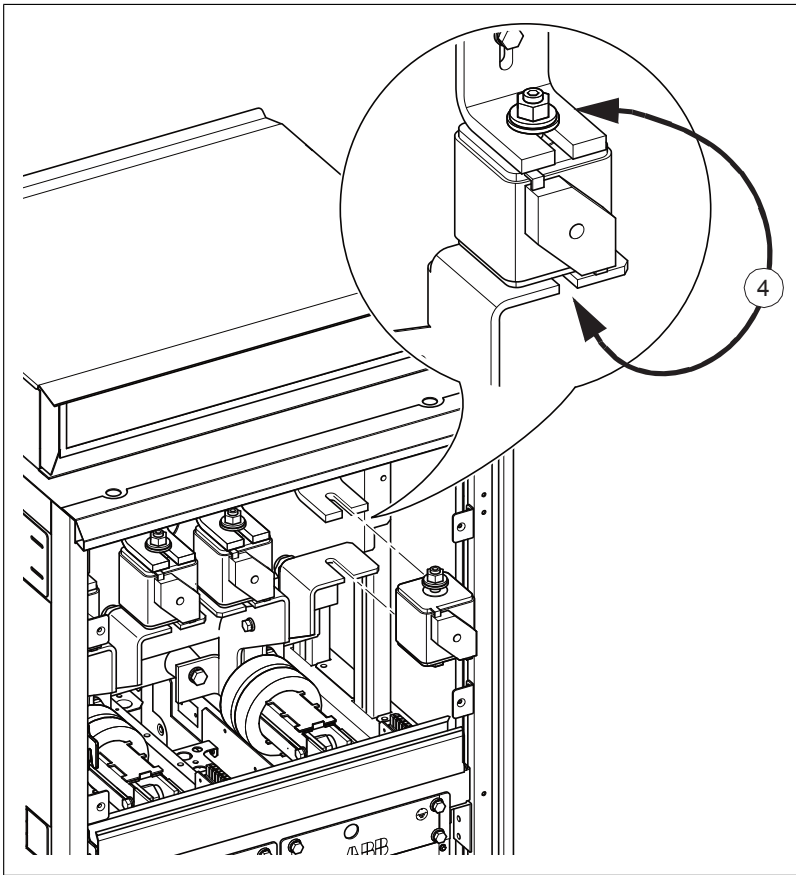
Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

---

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
  2. Open the door of the cubicle in which the fuses are.
  3. Remove the shrouding from in front of the fuses.
  4. Slacken the nuts of the headless screws of the fuses so that you can slide out the fuse blocks. Make note of the order of the washers on the screws.
  5. Remove the screws, nuts and washers from the old fuses and attach them to the new fuses. Make sure to keep the washers in the original order.
  6. Insert the new fuses into their slots in the cubicle. Pre-tighten the nuts first by hand or by applying a torque of no more than 5 N·m (3.7 lbf·ft).
  7. Tighten the nuts to torque as follows:
-

- Bussmann fuses: 50 N·m (37 lbf·ft)
- Mersen (Ferraz-Shawmut): 46 N·m (34 lbf·ft)
- Other: Refer to the fuse manufacturer's instructions.

8. Reinstall the shroud and close the door.



■ **Replacing AC fuses - 100 kA input cubicle (option +F274)**



**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation, commissioning or maintenance work.

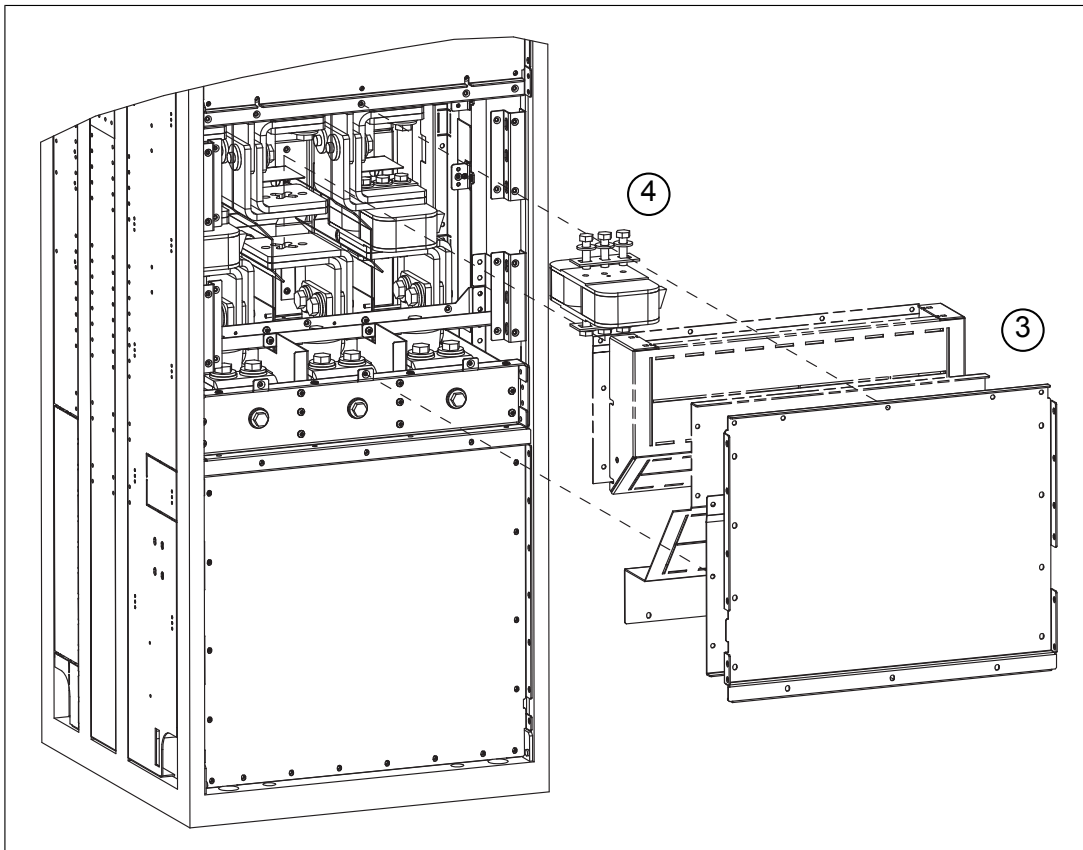


**WARNING!**

Use the required personal protective equipment. Wear protective gloves and long sleeves. Some parts have sharp edges.

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.
2. Open the door of the 100 kA input cubicle.
3. Remove the shrouding in front of the fuses.

4. Check the condition of the fuses. If a fuse is blown, replace all fuses with similar fuses as follows:
  - Loosen the nuts of the fuses and pull the fuses out. Do not remove the nuts completely. If you remove the nuts completely, there is a risk that they fall inside the cubicle.
  - Install the new fuses. Tighten the nuts first by hand or applying maximum 5 N·m force. Tightening torques for M12 nuts are 50 N·m (37 lbf·ft) for Bussmann fuses, and 46 N·m (34 lbf·ft) for Mersen (Ferraz-Shawmut) fuses.
5. Attach the shrouding and close the door.



## Control panel

Refer to [ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual \(3AUA0000085685 \[English\]\)](#).

## Control units

### ■ BCU control unit types

There are three variants of the BCU control unit used in ACS880 drives: BCU-02, BCU-12 and BCU-22. These have a different number of converter module connections (2, 7 and 12 respectively) but are otherwise identical. The three BCU types are interchangeable as long as the number of connections is sufficient. For example, the BCU-22 can be used as a direct replacement for both BCU-02 and BCU-12.

## ■ Replacing the memory unit

After replacing a control unit, you can keep the existing parameter settings by transferring the memory unit from the defective control unit to the new control unit.

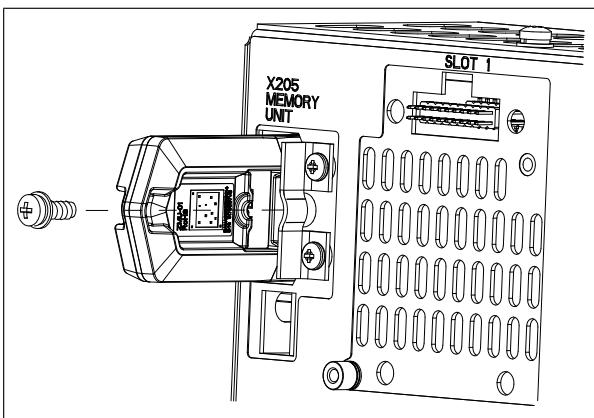


### **WARNING!**

Do not remove or insert the memory unit when the control unit is powered.

---

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.
2. Make sure that the control unit is not powered.
3. Remove the fastening screw and pull the memory unit out.
4. Install a memory unit in reverse order.

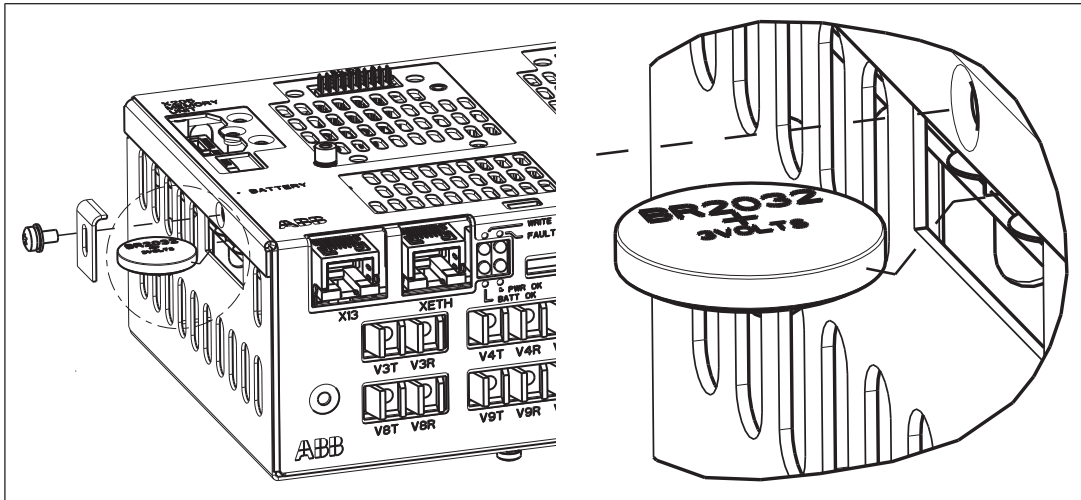


## ■ Replacing the BCU control unit battery

Replace the real-time clock battery if the BATT OK LED is not illuminated when the control unit is powered.

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 17\)](#) before you start the work.
  2. Undo the fastening screw and remove the battery.
  3. Replace the battery with a new BR2032 battery.
-

4. Dispose of the old battery according to local disposal rules or applicable laws.
5. Set the real-time clock.



## Functional safety components

The mission time of functional safety components is 20 years which equals the time during which failure rates of electronic components remain constant. This applies to the components of the standard Safe torque off circuit as well as any modules, relays and, typically, any other components that are part of functional safety circuits.

The expiry of mission time terminates the certification and SIL/PL classification of the safety function. The following options exist:

- Renewal of the whole drive and all optional functional safety module(s) and components.
- Renewal of the components in the safety function circuit. In practice, this is economical only with larger drives that have replaceable circuit boards and other components such as relays.

Note that some of the components may already have been renewed earlier, restarting their mission time. The remaining mission time of the whole circuit is however determined by its oldest component.

Contact your local ABB service representative for more information.



# 12

## Internal cooling circuit

---

### Contents of this chapter

The cooling system of a liquid-cooled drive consists of two circuits: the internal cooling circuit and the external cooling circuit. The internal cooling circuit covers the heat-generating electrical components of the drive and transfers the heat to the cooling unit. In the cooling unit, the heat is transferred to the external cooling circuit which is usually part of a larger external cooling system. This chapter deals with the internal cooling circuit.

### Applicability

The information in this chapter is applicable to cabinet-built ACS880 liquid-cooled drives. Except where otherwise indicated, the information is also applicable to drives built out of ACS880 liquid-cooled multidrive modules.

### Internal cooling system

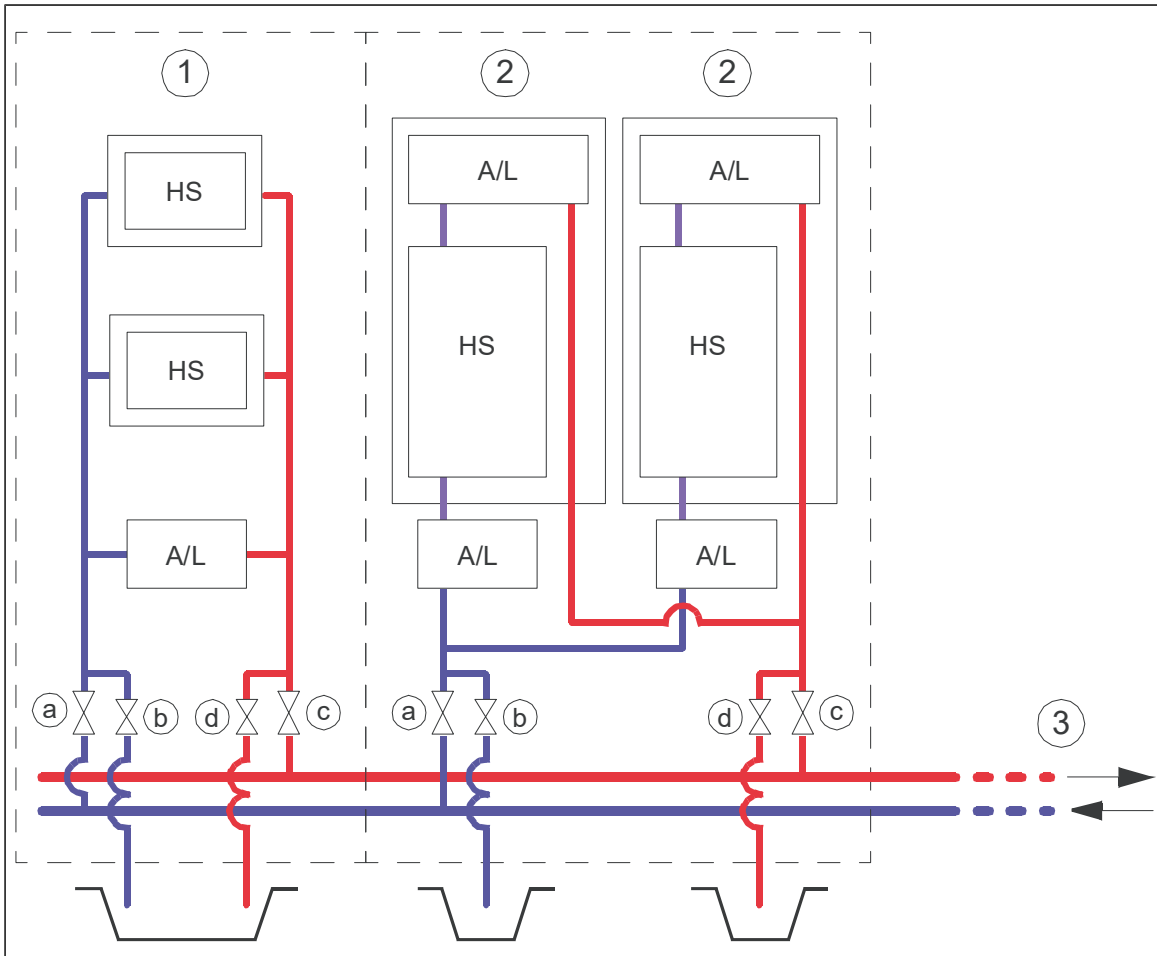
Each cubicle has an inlet and an outlet manifold, fitted with a stop valve and a drain valve. The stop valves can be closed to isolate all modules in the cubicle from the main cooling circuit.

In cabinet line-ups built by ABB, valves are color-coded:

- Blue – Open during operation
- Red – Closed during operation

The following diagram shows the coolant pipe connections in a drive system consisting of a supply unit and an inverter unit. Other units, such as brake units, DC/DC converter units have similar cooling arrangements. Other cubicles containing components that require cooling may also contain heat exchangers.

---



1	Supply modules. The drawing shows the configuration of a diode supply unit with two modules, ie. there is a common air-to-liquid exchanger in the cubicle. With an IGBT supply unit, each module has a dedicated air-to-liquid exchanger as shown for item 2.
2	Inverter modules
3	To/From cooling unit
A/L	Air-to-liquid heat exchanger
HS	Heat sink
a	Inlet valve
b	Inlet-side drain valve
c	Outlet valve
d	Outlet-side drain valve

The coolant used with ACS880 liquid-cooled drive systems is Antifrogen® L 25% or 50% mixture. See [Coolant specification \(page 168\)](#).



## Connection to a cooling unit

### ■ Connection to an ACS880-1007LC cooling unit

Refer to [ACS880-1007LC cooling unit user's manual \(3AXD50000129607 \[English\]\)](#).

### ■ Connection to a custom cooling unit

#### General requirements

Equip the system with an expansion vessel to damp pressure rise due to volume changes when the temperature varies. Equip the system with a pump that provides a nominal flow and pressure. Keep the pressure within the limits specified in *Technical data (page 168)*. Install a pressure regulator to make sure that the maximum permissible operating pressure is not exceeded.

Install a bleed valve at the highest point of the cooling circuit, and a drain valve at the lowest point.

The materials that can be used are listed in *Cooling circuit materials (page 170)*.

#### Coolant temperature control

The temperature of the coolant in the internal cooling circuit must be kept within the limits specified in *Technical data (page 168)*. Note that the minimum temperature is dependent on ambient temperature and relative humidity.

---

## Filling up and bleeding the internal cooling circuit

Both the drive and coolant must be at room temperature before filling up the cooling circuit.

---



### **WARNING!**

Make sure that the maximum permissible operating pressure is not exceeded. When necessary regulate the pressure to appropriate level by draining excess coolant out of the system.

---



### **WARNING!**

Bleeding of the cooling circuit is very important and has to be done with great care. Air bubbles in the cooling circuit may reduce or completely block coolant flow and lead to overheating. Let the air out of the cooling system while filling in coolant and, eg. after any power module replacements.

---

### ■ Drive line-ups with an ACS880-1007LC cooling unit

Obey the filling up and bleeding instructions in [ACS880-1007LC cooling unit user's manual \(3AXD50000129607 \[English\]\)](#).

### ■ Drive line-ups with a custom cooling unit

#### **Note:**

- In filling up the system, the drain valves in the line-up are used only to vent the air from the circuit so that it can be displaced by the coolant. The actual bleeding of the circuit must be done via an external bleed valve installed at the highest point of the cooling circuit. The most practical location for the valve is usually near or at the cooling unit.
  - Observe the instructions given by the manufacturer of the cooling unit. Pay special attention to filling up and bleeding the pumps properly as they may be damaged if operated when dry.
  - Draining coolant into the sewer system is not allowed.
1. Open the bleed valve at the cooling unit.
  2. Open the inlet valve and the outlet-side drain valve of one cubicle. Keep the outlet valve and the inlet-side drain valve closed.
  3. Attach a hose to the outlet-side drain valve and lead it into a suitable container.
  4. Fill the circuit with coolant. For coolant specification, see [Coolant specification \(page 168\)](#). To minimize foaming, do not exceed the filling flow rate of 5 l/min (1.3 US gallon/min).
  5. As the piping and modules in the cubicle fills up, coolant starts to flow from the hose. Let some coolant flow out, then close the drain valve.
  6. Close the inlet valve.
  7. Repeat steps 2 to 6 for all cubicles in the line-up.
  8. Open the inlet and outlet valves in all cubicles. Let any air remaining in the system out through the bleed valve at the cooling unit.
  9. Close the bleed valve at the cooling unit.
  10. Continue to fill in coolant until a base pressure of 100...150 kPa is achieved.
  11. Open the bleed valve of the pump to let out any air.
-

12. Re-check the pressure and add coolant if necessary.
  13. Start the coolant pump. Let any air remaining in the system out through the bleed valve at the cooling unit.
  14. After one to two minutes, stop the pump or block the coolant flow with a valve.
  15. Re-check the pressure and add coolant if necessary.
  16. Repeat steps 13 to 15 a few times until all air is let out of the cooling circuit. Listen for a humming sound and/or feel the piping for vibration to find out if there is still air left in the circuit.
-

## Draining the internal cooling circuit

The modules in each cubicle can be drained through the drain valves without draining the whole internal cooling circuit.



### WARNING!

Hot, pressurized coolant can be present in the cooling circuit. Do not work on the cooling circuit before the pressure is released by stopping the pumps and draining coolant.

---

1. Attach hoses to each drain valve in the cubicle to be drained. Lead the hoses into a suitable container. Make sure the ends of the hoses are not immersed in coolant at any point so that air can displace the coolant in the system.
2. Open the drain valves. Wait until all coolant has drained.  
**Note:** Draining coolant into the sewer system is not allowed.
3. If required, dry the piping with compressed oil-free air of less than 6 bar.
4. If the drive is to be stored in temperatures below 0 °C (32 °F),
  - dry the cooling circuit with air,
  - fill the cooling circuit with coolant specified under *Coolant specification (page 168)*.
  - drain the cooling circuit again.

## Maintenance intervals

As a general rule, the quality of the coolant should be checked at intervals of two years. This can be done by distributors of Antifrogen® L (see [www.clariant.com](http://www.clariant.com)) if a 250 milliliter sample is provided.

## Technical data

### ■ Coolant specification

#### Coolant type

Antifrogen® L (by Clariant International Ltd, [www.clariant.com](http://www.clariant.com)) 25% or 50% mixture, available from Clariant distributors and ABB Service representatives.

**Note:** Do not dilute the coolant. It is ready to use.

Antifrogen® L 25% mixture is usable in storage temperatures down to -16 °C (3.2 °F).

Antifrogen® L 50% mixture is usable in storage temperatures down to -40 °C (-40 °F).

Note that operation below 0 °C (32 °F) is not permitted regardless of the freezing point of the coolant.



### WARNING!

The warranty does not cover damage that occurs from the use of incorrect coolant.

---

### ■ Temperature limits

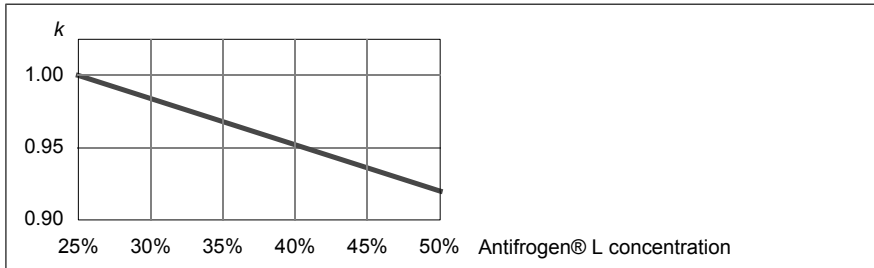
**Ambient temperature:** See the technical data of the drive/unit.

---

**Freeze protection:** The freezing point of the coolant is determined by the concentration of heat transfer fluid in the mixture.

The higher the concentration of heat transfer fluid, the higher the viscosity of the coolant. This results in a higher pressure loss in the system. See [Pressure limits \(page 170\)](#).

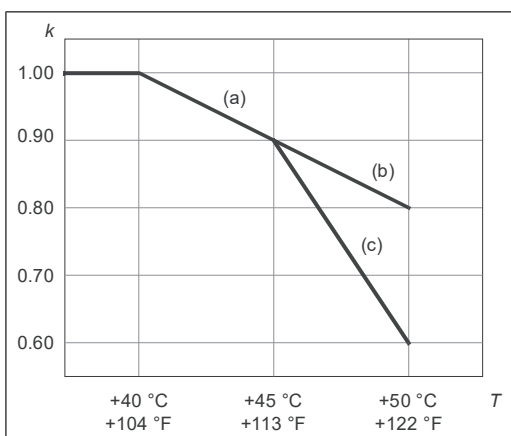
The nominal current ratings of drive system modules apply to an Antifrogen® L / water solution of 25/75% (volume). With the Antifrogen® L concentration between 25% and 50%, the drive output current must be derated by 1/3 percentage point per 1 p.p. increase in Antifrogen® L concentration. The drawing below shows the derating factor ( $k$ ) in relation to Antifrogen® L concentration.



#### Incoming coolant temperature:

- 0...40 °C (32...104 °F): no drive output current derating required
- 40...45 °C (104...113 °F): drive output current must be derated by 2 percentage points per 1 °C (1.8 °F) temperature increase, as shown by curve (a).
- 45...50 °C (113...122 °F):
  - If components with a maximum operating temperature of 55 °C (131 °F) are installed in the same space as the drive modules, drive output current must be derated by 6 percentage points per 1 °C (1.8 °F) temperature increase, as shown by curve (c).
  - If there are no components with a maximum operating temperature of 55 °C (131 °F) installed in the same space as the drive modules, drive output current must be derated by 2 percentage points per 1 °C (1.8 °F) temperature increase, as shown by curve (b).

The drawing below shows the derating factor ( $k$ ) in relation to coolant temperature.



Condensation is not permitted. The minimum coolant temperature to avoid condensation (at an atmospheric pressure of 1 bar) is shown below as a function of relative humidity (RH) and ambient temperature ( $T_{\text{air}}$ ).

$T_{\text{air}}$ (°C)	Min. $T_{\text{coolant}}$ (°C)				
	RH = 95%	RH = 80%	RH = 65%	RH = 50%	RH = 40%
5	4.3	1.9	-0.9	-4.5	-7.4
10	9.2	6.7	3.7	-0.1	-3.0
15	14.2	11.5	8.4	4.6	1.5
20	19.2	16.5	13.2	9.4	6.0
25	24.1	21.4	17.9	13.8	10.5
30	29.1	26.2	22.7	18.4	15.0
35	34.1	31.1	27.4	23.0	19.4
40	39.0	35.9	32.2	27.6	23.8
45	44.0	40.8	36.8	32.1	28.2
50	49.0	45.6	41.6	36.7	32.8
55	53.9	50.4	46.3	42.2	37.1
	= Not permitted as standard but the coolant temperature must be 0 °C (32 °F) or more.				
Example:	At an air temperature of 45 °C and relative humidity of 65% the coolant temperature must not be less than +36.8 °C				

**Maximum temperature rise:** Depends on heat losses and mass flow. Typically 10 °C (18 °F) with nominal losses and flow.

### ■ Pressure limits

**Base pressure:** 250 kPa (recommended); 300 kPa (maximum). “Base pressure” denotes the pressure of the system compared with the atmospheric pressure when the cooling circuit is filled with coolant.

**Air counterpressure in expansion vessel (with ACS880-1007LC cooling unit):** 80 kPa

**Design pressure (PS):** 600 kPa

**Nominal pressure difference:** 120 kPa with Antifrogen® L 25% coolant solution, 140 kPa with Antifrogen® L 50% coolant solution. This has to be taken into account when dimensioning the liquid cooling circuit.

**Maximum pressure difference:** 160 kPa

### ■ Coolant flow rate limits

The maximum coolant flow rate for all drive equipment is 1.3 × nominal. See the technical data chapter for nominal values.

### ■ Cooling circuit materials

Materials used in the internal cooling circuit are listed below.

- stainless steel AISI 316L (UNS 31603)
- heavy gauge aluminum
- plastic materials such as PA, PEX and PTFE

**Note:** PVC hoses are not suitable for use with antifreeze.

- rubber gasketing NBR (nitrile rubber).



**WARNING!**

If you connect external piping to the internal cooling circuit, use only materials that are specified above. Other materials can cause galvanic corrosion. If the external piping contains other materials, use a cooling unit with a heat exchanger (for example, ACS880-1007LC) to keep the external piping separate from the internal cooling circuit.

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# 13

## Technical data

### Contents of this chapter

This chapter contains the technical specifications of the drive, for example, the ratings, fuse data, sizes and technical requirements, provisions for fulfilling the requirements for CE and other markings.

### Ratings

The nominal ratings for the drives with 50 Hz and 60 Hz supply are given below. The symbols are described below the table.

ACS880-17LC-...	Input rating	Output ratings											
		No-overload use					Light-overload use			Heavy-duty use			
		$I_1$	$I_2$	$I_{max}$	$P_N$		$S_N$	$I_{Ld}$	$P_{Ld}$		$I_{Hd}$	$P_{Hd}$	
		A	A	A	kW	hp	kVA	A	kW	hp	A	kW	hp
<b><math>U_N = 690 V</math></b>													
0390A-7	360	390	590	355	400	466	374	355	350	292	250	300	
0430A-7	400	430	650	400	450	514	413	355	400	322	250	300	
0480A-7	450	480	720	450	500	574	461	400	450	359	315	350	
0520A-7	480	520	780	500	550	621	499	450	500	389	355	400	
0600A-7	560	600	900	560	600	717	576	500	600	449	400	450	
0670A-7	620	670	1010	630	700	801	643	560	700	501	450	500	
0750A-7	700	750	1130	710	800	896	720	630	700	561	500	600	
0830A-7	770	830	1250	800	900	992	797	710	900	621	560	600	
1000A-7	930	1000	1500	1000	1000	1195	960	900	1000	748	710	800	
1170A-7	1090	1170	1760	1100	1250	1398	1123	1000	1000	875	800	900	
1270A-7	1180	1270	1910	1200	1250	1518	1219	1200	1250	950	900	1000	

ACS880-17LC-...	Input rating	Output ratings										
		No-overload use					Light-overload use			Heavy-duty use		
	$I_1$	$I_2$	$I_{max}$	$P_N$		$S_N$	$I_{Ld}$	$P_{Ld}$		$I_{Hd}$	$P_{Hd}$	
	A	A	A	kW	hp	kVA	A	kW	hp	A	kW	hp
1470A-7	1360	1470	2210	1400	1500	1757	1411	1200	1500	1100	1000	1000
1620A-7	1500	1620	2430	1600	1750	1936	1555	1400	1750	1212	1200	1250
1940A-7	1800	1940	2910	1800	2000	2319	1862	1800	2000	1451	1400	1500
2180A-7	2020	2180	3270	2000		2605	2093	2000		1631	1600	1750
2390A-7	2220	2390	3590	2300		2856	2294	2200		1788	1800	2000
2880A-7	2670	2880	4320	2700		3442	2765	2600		2154	2000	
3160A-7	2930	3160	4740	3000		3777	3034	2900		2364	2300	
3580A-7	3320	3580	5370	3400		4279	3437	3200		2678	2500	
4050A-7	3760	4050	6080	3800		4840	3888	3600		3029	2800	
4700A-7	4360	4700	7050	4400		5617	4512	4400		3516	3400	
5650A-7	5240	5650	8480	5200		6752	5424	5000		4226	4000	
6260A-7	5810	6260	9390	6000		7481	6010	6000		4682	4500	

## ■ Definitions

$U_N$	Supply voltage range.
$I_1$	Nominal rms input current
$I_2$	Nominal output current (available continuously with no over-loading)
$I_{max}$	Maximum output current. Available for 10 seconds at start, then as long as allowed by drive temperature.
$P_N$	Typical motor power in no-overload use. The horsepower ratings are typical NEMA motor sizes at 575 V.
$S_N$	Apparent power in no-overload use.
$I_{Ld}$	Continuous rms output current allowing 10% overload for 1 minute every 5 minutes.
$P_{Ld}$	Typical motor power in light-overload use
$I_{Hd}$	Continuous rms output current allowing 50% overload for 1 minute every 5 minutes.
$P_{Hd}$	Typical motor power in heavy-duty use

**Note 1:** The ratings apply at an ambient temperature of 40 °C (104 °F).

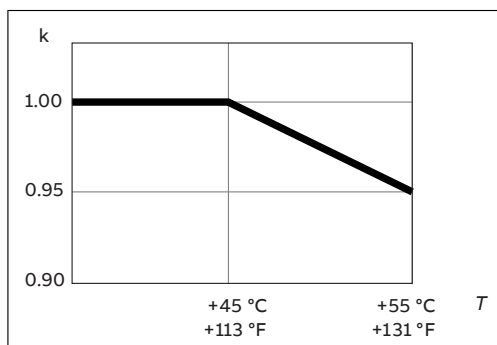
**Note 2:** To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current.

The DriveSize dimensioning tool available from ABB is recommended for selecting the drive, motor and gear combination.

## ■ Derating

### Surrounding air temperature derating

In the temperature range +45...55 °C (+113...131 °F), the rated output current is derated by 0.5 percentage points for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor ( $k$ ):



### Coolant temperature derating

See section [Temperature limits \(page 168\)](#).

### Antifreeze content derating

See section [Temperature limits \(page 168\)](#).

### Altitude derating

At altitudes above 1000 m (3281 ft) above sea level, the output current derating is 1 percentage point for every added 100 m (328 ft). For example, the derating factor for 1500 m (4921 ft) is 0.95. The maximum permitted installation altitude is given in the technical data.

For a more accurate derating, use the DriveSize PC tool.

### Switching frequency derating

In the switching frequency range of 3.0 to 7.5 kHz, the output current is derated by 8 percentage points per each kHz. For example, the derating factor for 5 kHz is 0.84.

### Output frequency derating

Below the output frequency of 12 Hz, the output current is derated by 3.5 percentage points per each Hz. For example, the derating factor for 9 Hz is 0.895.

Above the output frequency of 150 Hz, the output current is derated by 1 percentage point per each 10 Hz. For example, the derating factor for 175 Hz is 0.975.

## Frame sizes and power module types

ACS880-17LC-...	Frame size	Supply module(s) used		LCL filter(s) used		Inverter modules used	
		Qty	Type ACS880-104LC-...	Qty	Type	Qty	Type ACS880-104LC-...
<b><math>U_N = 690 \text{ V}</math></b>							
0390A-7	1×R8i + 1×R8i	1	0390A-7	1	BLCL-15LC-7	1	0390A-7+E205
0430A-7	1×R8i + 1×R8i	1	0430A-7	1	BLCL-15LC-7	1	0430A-7+E205
0480A-7	1×R8i + 1×R8i	1	0480A-7	1	BLCL-15LC-7	1	0480A-7+E205
0520A-7	1×R8i + 1×R8i	1	0530A-7	1	BLCL-15LC-7	1	0530A-7+E205
0600A-7	1×R8i + 1×R8i	1	0600A-7	1	BLCL-15LC-7	1	0600A-7+E205
0670A-7	1×R8i + 1×R8i	1	0670A-7	1	BLCL-15LC-7	1	0670A-7+E205
0750A-7	1×R8i + 1×R8i	1	0750A-7	1	BLCL-15LC-7	1	0750A-7+E205
0830A-7	1×R8i + 1×R8i	1	0850A-7	1	BLCL-15LC-7	1	0850A-7+E205
1000A-7	2×R8i + 2×R8i	2	0530A-7	1	BLCL-24LC-7	2	0530A-7+E205

ACS880-17LC-...	Frame size	Supply module(s) used		LCL filter(s) used		Inverter modules used	
		Qty	Type ACS880-104LC-...	Qty	Type	Qty	Type ACS880-104LC-...
1170A-7	2×R8i + 2×R8i	2	0600A-7	1	BLCL-24LC-7	2	0600A-7+E205
1270A-7	2×R8i + 2×R8i	2	0670A-7	1	BLCL-24LC-7	2	0670A-7+E205
1470A-7	2×R8i + 2×R8i	2	0750A-7	1	BLCL-25LC-7	2	0750A-7+E205
1620A-7	2×R8i + 2×R8i	2	0850A-7	1	BLCL-25LC-7	2	0850A-7+E205
1940A-7	3×R8i + 3×R8i	3	0670A-7	2	BLCL-24LC-7	3	0670A-5+E205
2180A-7	3×R8i + 3×R8i	3	0750A-7	2	BLCL-24LC-7	3	0750A-7+E205
2390A-7	3×R8i + 3×R8i	3	0850A-7	2	BLCL-24LC-7	3	0850A-7+E205
2880A-7	4×R8i + 4×R8i	4	0750A-7	2	BLCL-25LC-7	4	0750A-7+E205
3160A-7	4×R8i + 4×R8i	4	0850A-7	2	BLCL-25LC-7	4	0850A-7+E205
3580A-7	5×R8i + 5×R8i	5	0750A-7	3	BLCL-24LC-7	5	0750A-7+E205
4050A-7	6×R8i + 5×R8i	6	0850A-7	4	BLCL-24LC-7	5	0850A-7+E205
4700A-7	6×R8i + 6×R8i	6	0850A-7	4	BLCL-24LC-7	6	0850A-7+E205
5650A-7	8×R8i + 7×R8i	8	0850A-7	4	BLCL-25LC-7	7	0850A-7+E205
6260A-7	8×R8i + 8×R8i	8	0850A-7	4	BLCL-25LC-7	8	0850A-7+E205

## Fuses

### ■ AC fuses

#### Notes:

- Fuses with higher current rating than the recommended ones must not be used.
- Fuses from other manufacturers can be used if they meet the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

ACS880-17LC-...	AC fuses					
	Qty	A	A <sup>2</sup> s at 660 V	V	Manufacturer	Type
<b>U<sub>N</sub> = 690 V</b>						
0390A-7	3	630	210000	690	Bussmann	170M6410
0430A-7	3	700	300000	690	Bussmann	170M6411
0480A-7 0520A-7	3	800	465000	690	Bussmann	170M6412
0600A-7	3	900	670000	690	Bussmann	170M6413
0670A-7	3	1000	945000	690	Bussmann	170M6414
0750A-7	3	1250	1950000	690	Bussmann	170M6416
0830A-7	3	1400	2450000	690	Bussmann	170M6417
1000A-7	3	1600	2050000	690	Bussmann	170M7061
1170A-7 1270A-7	3	2000	3950000	690	Bussmann	170M7062
1470A-7 1620A-7	3	2500	7800000	690	Bussmann	170M7063
1940A-7	6	1600	2050000	690	Bussmann	170M7061

ACS880-17LC-...	AC fuses					
	Qty	A	A <sup>2</sup> s at 660 V	V	Manufacturer	Type
2180A-7 2390A-7	6	2000	3950000	690	Bussmann	170M7062
2880A-7 3160A-7	6	2500	7800000	690	Bussmann	170M7063
3580A-7	9	2000	3950000	690	Bussmann	170M7062
4050A-7	12	1600	2050000	690	Bussmann	170M7061
4700A-7	12	2000	3950000	690	Bussmann	170M7062
5650A-7 6260A-7	12	2500	7800000	690	Bussmann	170M7063

### ■ DC fuses

The drives has DC fuses at the output of each supply module and at the input of each inverter module.

#### Notes:

- Fuses with higher current rating than the recommended ones must not be used.
- Fuses from other manufacturers can be used if they meet the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

ACS880-17LC-...	DC fuses at inverter module input					
	Qty	A	A <sup>2</sup> s (Clearing at 1000 V)	V	Manufacturer	Type
<b><math>U_N = 690 \text{ V}</math></b>						
0390A-7 0430A-7	2 + 2	800	995000	1250	Bussmann	170M6546
0480A-7	2 + 2	900	1500000	1100	Bussmann	170M6547
0520A-7	2 + 2	1000	2150000	1100	Bussmann	170M6548
0600A-7	2 + 2	1100	2800000	1000	Bussmann	170M6549
0670A-7	2 + 2	1250	3950000	1100	Bussmann	170M6500
0750A-7 0830A-7	2 + 2	1400	6000000	1100	Bussmann	170M6501
1000A-7	4 + 4	1000	2150000	1100	Bussmann	170M6548
1170A-7	4 + 4	1100	2800000	1000	Bussmann	170M6549
1270A-7	4 + 4	1250	3950000	1100	Bussmann	170M6500
1470A-7 1620A-7	4 + 4	1400	6000000	1100	Bussmann	170M6501
1940A-7	6 + 6	1250	3950000	1100	Bussmann	170M6500

ACS880-17LC-...	DC fuses at inverter module input					
	Qty	A	A <sup>2</sup> s (Clearing at 1000 V)	V	Manufacturer	Type
2180A-7 2390A-7	6 + 6	1400	6000000	1100	Bussmann	170M6501
2880A-7 3160A-7	8 + 8					
3580A-7	10 + 10					
4050A-7	12 + 10					
4700A-7	12 + 12					
5650A-7	16 + 14					
6260A-7	16 + 16					

### ■ Charging circuit fuses

Bussmann 170M4831 (3 pcs).

## Dimensions and weights

See chapter [Dimensions \(page 195\)](#).

## Free space requirements

The values are as required by cooling, maintenance and/or operation of the pressure relief (if present). Also obey the general mechanical installation instructions.

Front		Sides		Above	
mm	in.	mm	in.	mm	in.
1500	59	0	0	250	9.85

## Cooling data, noise

ACS880-17LC-...	Coolant volume		Coolant flow		Heat dissipation	Noise
	l	US gal	l/min	US gal/min	kW	dB(A)
<b>U<sub>N</sub> = 690 V</b>						
0390A-7	12	3.2	68	18.0	15	68
0430A-7	12	3.2	68	18.0	17	68
0480A-7	12	3.2	68	18.0	19	68
0520A-7	12	3.2	68	18.0	21	68
0600A-7	12	3.2	68	18.0	24	68
0670A-7	12	3.2	68	18.0	27	68
0750A-7	12	3.2	68	18.0	31	68
0830A-7	12	3.2	68	18.0	35	68
1000A-7	19	5.0	120	31.7	38	70
1170A-7	19	5.0	120	31.7	44	70

ACS880-17LC-...	Coolant volume		Coolant flow		Heat dissipation kW	Noise dB(A)
	l	US gal	l/min	US gal/min		
1270A-7	19	5.0	120	31.7	50	70
1470A-7	19	5.0	120	31.7	55	70
1620A-7	19	5.0	120	31.7	63	70
1940A-7	29	7.7	192	51	70	72
2180A-7	29	7.7	192	51	81	72
2390A-7	29	7.7	192	51	93	72
2880A-7	38	10.0	224	59	105	73
3160A-7	38	10.0	224	59	121	73
3580A-7	48	12.7	296	78	132	74
4050A-7	52	13.7	360	95	151	75
4700A-7	58	15	376	99	182	75
5650A-7	68	18	424	112	208	76
6260A-7	89	20	504	133	286	76

## Typical power cable sizes

The tables below give current carrying capacity ( $I_{Lmax}$ ) for aluminum and copper PVC/XLPE insulated cables. A correction factor  $K = 0.70$  is used. Time const is the temperature time constant of the cable.

The cable sizing is based on max. 9 cables laid on the cable trays side by side, three ladder type trays one on top of the other, ambient temperature 30 °C (EN 60204-1 and IEC 60364-5-52).

Aluminum cable		PVC insulation Conductor temperature 70 °C		XLPE insulation Conductor temperature 90 °C	
Size	∅ [mm]	$I_{Lmax}$ [A]	Time const. [s]	$I_{Lmax}$ [A]	Time const. [s]
3 × 35 + 10 Cu	26	67	736	84	669
3 × 50 + 15 Cu	29	82	959	102	874
3 × 70 + 21 Cu	32	105	1182	131	1079
3 × 95 + 29 Cu	38	128	1492	159	1376
3 × 120 + 41 Cu	41	148	1776	184	1637
3 × 150 + 41 Cu	44	171	2042	213	1881
3 × 185 + 57 Cu	49	196	2422	243	2237
3 × 240 + 72 Cu	54	231	2967	286	2740
3 × 300 + 88 Cu	58	267	3478	330	3229
2 × (3 × 70 + 21 Cu)	2 × 32	210	1182	262	1079
2 × (3 × 95 + 29 Cu)	2 × 38	256	1492	318	1376
2 × (3 × 120 + 41 Cu)	2 × 41	297	1776	368	1637
2 × (3 × 150 + 41 Cu)	2 × 44	343	2042	425	1881
2 × (3 × 185 + 57 Cu)	2 × 49	392	2422	486	2237
2 × (3 × 240 + 72 Cu)	2 × 54	462	2967	572	2740
2 × (3 × 300 + 88 Cu)	2 × 58	533	3478	659	3229
3 × (3 × 150 + 41 Cu)	3 × 44	514	2042	638	1881
3 × (3 × 185 + 57 Cu)	3 × 49	588	2422	728	2237
3 × (3 × 240 + 72 Cu)	3 × 54	693	2967	859	2740
3 × (3 × 300 + 88 Cu)	3 × 58	800	3478	989	3229
4 × (3 × 185 + 57 Cu)	4 × 49	784	2422	971	2237
4 × (3 × 240 + 72 Cu)	4 × 54	924	2967	1145	2740
4 × (3 × 300 + 88 Cu)	4 × 58	1067	3478	1319	3229
5 × (3 × 185 + 57 Cu)	5 × 49	980	2422	1214	2237
5 × (3 × 240 + 72 Cu)	5 × 54	1155	2967	1431	2740
5 × (3 × 300 + 88 Cu)	5 × 58	1333	3478	1648	3229
6 × (3 × 240 + 72 Cu)	6 × 54	1386	2967	1718	2740
6 × (3 × 300 + 88 Cu)	6 × 58	1600	3478	1978	3229
7 × (3 × 240 + 72 Cu)	7 × 54	1617	2967	2004	2740
7 × (3 × 300 + 88 Cu)	7 × 58	1867	3478	2308	3229
8 × (3 × 240 + 72 Cu)	8 × 54	1848	2967	2290	2740
8 × (3 × 300 + 88 Cu)	8 × 58	2133	3478	2637	3229
9 × (3 × 240 + 72 Cu)	9 × 54	2079	2967	2577	2740
9 × (3 × 300 + 88 Cu)	9 × 58	2400	3478	2967	3229
10 × (3 × 240 + 72 Cu)	10 × 54	2310	2967	2867	2740
10 × (3 × 300 + 88 Cu)	10 × 58	2667	3478	3297	3229



Copper cable		PVC insulation Conductor temperature 70 °C		XLPE insulation Conductor temperature 90 °C	
Size	∅ [mm]	I <sub>Lmax</sub> [A]	Time const. [s]	I <sub>Lmax</sub> [A]	Time const. [s]
3 × 1.5 + 1.5	13	13	85	16	67
3 × 2.5 + 2.5	14	18	121	23	88
(3 × 4 + 4)	16	24	175	30	133
3 × 6 + 6	18	30	251	38	186
3 × 10 + 10	21	42	359	53	268
3 × 16 + 16	23	56	514	70	391
3 × 25 + 16	24	71	791	89	598
3 × 35 + 16	26	88	1000	110	760
3 × 50 + 25	29	107	1308	134	990
3 × 70 + 35	32	137	1613	171	1230
3 × 95 + 50	38	167	2046	209	1551
3 × 120 + 70	41	193	2441	241	1859
3 × 150 + 70	44	223	2820	279	2139
3 × 185 + 95	50	255	3329	319	2525
3 × 240 + 120	55	301	4073	376	3099
3 × 300 + 150	58	348	4779	435	3636
2 × (3 × 70 + 35)	2 × 32	274	1613	342	1230
2 × (3 × 95 + 50)	2 × 38	334	2046	418	1551
2 × (3 × 120 + 70)	2 × 41	386	2441	482	1859
2 × (3 × 150 + 70)	2 × 44	446	2820	558	2139
2 × (3 × 185 + 95)	2 × 50	510	3329	638	2525
2 × (3 × 240 + 120)	2 × 55	602	4073	752	3099
2 × (3 × 300 + 150)	2 × 58	696	4779	869	3636
3 × (3 × 120 + 70)	3 × 41	579	2441	723	1859
3 × (3 × 150 + 70)	3 × 44	669	2820	837	2139
3 × (3 × 185 + 95)	3 × 50	765	3329	957	2525
3 × (3 × 240 + 120)	3 × 55	903	4073	1128	3099
3 × (3 × 300 + 150)	3 × 58	1044	4779	1304	3636
4 × (3 × 150 + 70)	4 × 44	892	2820	1116	2139
4 × (3 × 185 + 95)	4 × 50	1020	3329	1276	2525
4 × (3 × 240 + 120)	4 × 55	1204	4073	1504	3099
4 × (3 × 300 + 150)	4 × 58	1391	4779	1304	3636
5 × (3 × 185 + 95)	5 × 50	1275	3329	1595	2525
5 × (3 × 240 + 120)	5 × 55	1505	4073	1880	3099
5 × (3 × 300 + 150)	5 × 58	1739	4779	2173	3636
6 × (3 × 185 + 95)	6 × 50	1530	3329	1914	2525
6 × (3 × 240 + 120)	6 × 55	1806	4073	2256	3099
6 × (3 × 300 + 150)	6 × 58	2087	4779	2608	3636
7 × (3 × 240 + 120)	7 × 55	2107	4073	2632	3099
7 × (3 × 300 + 150)	7 × 58	2435	4779	3043	3636
8 × (3 × 240 + 120)	8 × 55	2408	4073	3008	3099
8 × (3 × 300 + 150)	8 × 58	2783	4779	3477	3636

## Terminal and cable entry data for the power cables

The locations and sizes of the cable entries are shown in the dimension drawings delivered with the drive, and the dimension drawing examples in this manual.

Busbar terminal material: Tin-plated copper.

## Terminal data for the supply and inverter control units

See chapter *Control units of the drive (page 115)*.

## Electrical power network specification

Voltage ( $U_1$ )	690 V units: 525...690 V AC 3-phase $\pm 10\%$ (525...600 V AC $\pm 10\%$ in UL/CSA installations, or corner-grounded TN systems). This is indicated in the type designation label as typical input voltage levels (3~ 525/600/690 V AC).
Network type	TN (grounded) and IT (ungrounded) systems
Frequency	50/60 Hz, variation $\pm 5\%$ of nominal frequency
Imbalance	Max. $\pm 3\%$ of nominal phase-to-phase input voltage
Short-circuit withstand strength (IEC/EN 61439-1)	<u>With main circuit breaker (option +F255) and without grounding/earthing switch (without option +F259):</u> Rated peak withstand current ( $I_{pk}$ ): 143 kA Rated short-time withstand current ( $I_{cw}$ ): 65 kA/1 s <u>All other configurations:</u> Rated peak withstand current ( $I_{pk}$ ): 105 kA Rated short-time withstand current ( $I_{cw}$ ): 50 kA/1 s
Short-circuit withstand strength for supply unit with 100 kA input unit (option +F274) (IEC/EN 61439-1)	Rated peak withstand current ( $I_{pk}$ ): 220 kA Rated short-time withstand current ( $I_{cw}$ ): 100 kA/1 s <b>Note:</b> Options +F259 and +F274 are mutually exclusive for some drive types. Consult ABB for availability.
Short-circuit current protection (UL 508A, CSA C22.2 No. 14-13)	The drive is suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes at 600 V maximum when the input cable is protected with class T fuses.
Fundamental power factor ( $\cos \phi_1$ )	0.99

Harmonic distortion	Harmonics are below the limits defined in IEEE519.		
	$R_{sc}$	THD Voltage [%]	THD Current [%]
	20	3	2.5 <sup>1)</sup>
	100	0.8	2.5 (4.0 with types -0390A...-0520A-7) <sup>1)</sup>
$THD = \sqrt{\sum_{n=2}^{50} \left( \frac{I_n}{I_N} \right)^2}$			
<p><sup>1)</sup> Other loads may influence the THD value.                  THD = Total Harmonic Distortion (THD). The voltage THD depends on the short-circuit ratio (<math>R_{sc}</math>). The spectrum of the distortion also contains interharmonics.  <math>R_{sc} = I_{sc}/I_N</math>  <math>I_{sc}</math> = short-circuit current at point of common coupling (PCC)  <math>I_N</math> = supply unit nominal current  <math>I_n</math> = n<sup>th</sup> harmonic current component</p>			

## Motor connection data

Motor types	Asynchronous AC induction motors, permanent magnet synchronous motors and AC induction servomotors, ABB synchronous reluctance (SynRM) motors
Voltage ( $U_2$ )	0 ... $U_1$ , 3-phase symmetrical, $U_{max}$ at the field weakening point
Frequency ( $f_2$ )	0...500 Hz <ul style="list-style-type: none"> <li>For higher operational output frequencies, please contact your local ABB representative.</li> <li>Operation outside the range of 12...150 Hz requires derating. See the derating information.</li> </ul>
Current	See the rating tables.
Switching frequency	3 kHz (typical). The switching frequency can vary per frame and voltage. For exact values, contact your local ABB representative.
Maximum recommended motor cable length	500 m (1640 ft). <b>Note:</b> Longer cables cause a motor voltage decrease which limits the available motor power. The decrease depends on the motor cable length and characteristics. Contact ABB for more information. <b>Note:</b> With motor cables longer than 150 m (492 ft) the EMC Directive requirements may not be fulfilled.

## Relay contact data for control of external main contactor/breaker

### ■ General

The external main contactor or breaker is controlled by the drive through relay K3. The relay has one normally-open (NO) and one normally-closed (NC) contact.

Emergency stop options add a relay (K62) to the drive. To trip the main breaker upon an emergency stop, one of the output switchover contacts of the relay must be wired to the undervoltage coil.

The contacts of both relays are wired to a terminal block in the drive cubicle; see the drive-specific circuit diagrams for details. The external voltage switched by the contacts is to be connected to the same terminal block.

### ■ K3 contact data

- Rated operational AC current ( $I_e$ ) (IEC/EN 60947-5-1 AC 15):
  - 24...127 V, 50/60 Hz: 6 A
  - 220...240 V, 50/60 Hz: 4 A
  - 400...440 V, 50/60 Hz: 3 A
  - 500 V, 50/60 Hz: 2 A
  - 690 V, 50/60 Hz: 2 A
- Rated making/breaking capacity (IEC/EN 60947-5-1 AC 15):  $10 \times I_e$  AC
- Rated operational DC current ( $I_e$ ) (IEC/EN 60947-5-1 DC 13):
  - 24 V DC: 6 A / 144 W
  - 48 V DC: 2.8 A / 134 W
  - 72 V DC: 1 A / 72 W
  - 110 V DC: 0.55 A / 60 W
  - 125 V DC: 0.55 A / 69 W
  - 220 V DC: 0.27 A / 60 W
  - 250 V DC: 0.27 A / 68 W
  - 400 V DC: 0.15 A / 60 W
  - 500 V DC: 0.13 A / 65 W
  - 600 V DC: 0.1 A / 60 W
- Rated short-time withstand current: 100 A for 1.0 s, 140 A for 0.1 s
- Minimum switching capacity: 12 V / 3 mA

### ■ K62 contact data

- Switching power: 3 VA or 3 W minimum, 2000 VA or 200 W maximum
- Switching capacity, AC (IEC/EN 60947-5-1 AC 15):
  - NC: 230 V, 1 A
  - NO: 230 V, 3 A
- Switching capacity, DC (IEC/EN 60947-5-1 DC 13):
  - NC / NO: 24 V, 2 A
- Switching capacity (UL 508): R300

## Efficiency

96.8 ... 98.6% at nominal power level depending on drive type

The efficiency is not calculated according to the ecodesign standard IEC 61800-9-2.

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## Energy efficiency data (ecodesign)

Energy efficiency data is not provided for the drive. The regenerative drives are exempt from the EU ecodesign requirements (Regulation EU/2019/1781, §2.3.c) and the UK ecodesign requirements (Regulation SI 2021 No. 745).

## Optical components

The specifications of the optic cable are as follows:

- Storage temperature: -55 ... +85 °C (-67 ... +185 °F)
- Installation temperature: -20 ... +70 °C (-4 ... +158 °F)
- Maximum short-term tensile force: 50 N (11.2 lbf)
- Minimum short-term bend radius: 25 mm (1.0 in)
- Minimum long-term bend radius: 35 mm (1.4 in)
- Maximum long-term tensile load: 1 N (3.6 ozf)
- Flexing: Max. 1000 cycles

ABB drive products in general utilize 5 and 10 MBd (megabaud) optical components from Avago Technologies' Versatile Link range. Note that the optical component type is not directly related to the actual communication speed.

**Note:** The optical components (transmitter and receiver) on a fiber optic link must be of the same type.

Plastic optical fiber (POF) cables can be used with both 5 MBd and 10 MBd optical components. 10 MBd components also enable the use of Hard Clad Silica (HCS®) cables, which allow longer connection distances thanks to their lower attenuation. HCS® cables cannot be used with 5 MBd optical components.

The maximum lengths of fiber optic links for POF and HCS® cables are 20 and 200 meters (65.6 ft and 656 ft) respectively.

## Protection classes

<b>Degrees of protection (IEC/EN 60529)</b>	IP42 (standard), IP54 (option +B055)
<b>Enclosure types (UL50)</b>	UL Type 1 (standard), UL Type 12 (option +B055). For indoor use only.
<b>Overvoltage category (IEC/EN 60664-1)</b>	III, except for auxiliary power connections (fan, control, heating, lighting, cooling unit pump etc) which are category II.
<b>Protective class (IEC/EN 61800-5-1)</b>	I

## Ambient conditions

Environmental limits for the drive are given below. The drive is to be used in a heated, indoor, controlled environment.

	<b>Operation installed for stationary use</b>	<b>Storage in the protective package</b>	<b>Transportation in the protective package</b>
Installation site altitude	0...2000 m (0...6562 ft) above sea level. For alti- tudes over 2000 m, contact ABB. Output derated above 1000 m (3281 ft).	-	-
Air temperature	0 ... +45 °C (+32 ... +113 °F), no con- densation allowed. Output derated in the range +45 ... +55 °C (+113 ... +131 °F). For UL and CSA compliant installations, the maximum surrounding air temperat- ure is 40 °C (104 °F).	-40 to +70 °C (-40 to +158 °F)	-40 to +70 °C (-40 to +158 °F)
Relative humidity	Max. 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination	IEC/EN 60721-3-3:2002 Chemical gases: Class 3C2 Solid particles: Class 3S2. No conductive dust al- lowed.	IEC 60721-3-1:1997 Chemical gases: Class 1C2 Solid particles: Class 1S3 (packing must support this, otherwise 1S2)	IEC 60721-3-2:1997 Chemical gases: Class 2C2 Solid particles: Class 2S2
Pollution degree IEC/EN 60664-1	2		
Vibration IEC/EN 61800-5-1 IEC 60068-2-6:2007, EN 60068-2-6:2008	IEC/EN 60721-3-3:2002 10...57 Hz: max. 0.075 mm amplitude 57...150 Hz: 1 g Units with marine construc- tion (option +C121): Max. 1 mm (0.04 in) (5 ... 13.2 Hz), max. 0.7 g (13.2 ... 100 Hz) sinusoidal	IEC/EN 60721-3-1:1997 10...57 Hz: max. 0.075 mm amplitude 57...150 Hz: 1 g	IEC/EN 60721-3-2:1997 2...9 Hz: max. 3.5 mm amplitude 9...200 Hz: 10 m/s <sup>2</sup> (32.8 ft/s <sup>2</sup> )
Shock IEC 60068-2-27:2008, EN 60068-2-27:2009	Not allowed	With packing max. 100 m/s <sup>2</sup> (328 ft/s <sup>2</sup> ) 11 ms	With packing max. 100 m/s <sup>2</sup> (328 ft/s <sup>2</sup> ) 11 ms

## Colors

RAL Classic 7035, RAL Classic 9017.

## Materials

### ■ Drive

Refer to [Recycling instructions and environmental information for ACS880 cabinet-installed drives and multidrive modules \(3AXD50000153909 \[English\]\)](#).

### ■ Packaging of drive

- Plywood<sup>1)</sup>
- Wood
- PET (strapping)
- PE (VCI foil)
- Metal (fixing clamps, screws)
- VCI emitter capsules
- Clay desiccant.

<sup>1)</sup> Seaworthy package only

### ■ Packaging of options

- Cardboard
- Kraft paper
- PP (straps)
- PE (foil, bubble wrap)
- Plywood, wood (only for heavy components).

Materials vary according to the item type, size and shape. Typical package consists of a cardboard box with paper filling or bubble wrap. ESD-safe packing materials are used for printed circuit boards and similar items.

### ■ Manuals

Printed product manuals are recyclable paper. Product manuals are available on the Internet.

## Disposal

The main parts of the drive can be recycled to preserve natural resources and energy. Product parts and materials should 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, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and large electrolytic capacitors need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code.

Contact your local ABB distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations. See [ACS880 cabinet-installed drives and multidrive modules recycling instructions and environmental information \(3AXD50000153909 \[English\]\)](#).





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## Applicable standards





Standard	Information
<b>European electrical safety</b>	
EN 61800-5-1:2007 IEC 61800-5-1:2007 + Amd1:2016	<i>Adjustable speed electrical power drive systems - Part 5-1: Safety requirements – Electrical, thermal and energy</i>
EN 62477-1:2012 + Amd11:2014 IEC 62477-1:2012 + Amd1:2016	<i>Safety requirements for power electronic converter systems and equipment - Part 1: General</i>
<b>EMC performance</b>	
EN 61800-3:2004 + A1:2012 *IEC 61800-3 ed. 2.1 (2007 + Amd1:2011)	<i>Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods</i> *For compliance with IEC 61800-3 ed. 3.0 (2017), please contact ABB.
IEC 60533:2015	<i>Electrical and electronic installations in ships - Electromagnetic compatibility (EMC) - Ships with a metallic hull</i>
<b>Product requirements in North America</b>	
UL 508A: 2nd edition	<i>Industrial Control Panels</i>
CSA C22.2 No. 14-18, 13th edition	<i>Industrial Control Equipment</i>
<b>Enclosure and environmental protection</b>	
EN 60529:1991 + A2:2013 + AC:2019 IEC 60529:1989 + Amd1:1999 + Amd2:2013	<i>Degrees of protection provided by enclosures (IP code)</i>
UL 50: 12th edition	<i>Enclosures for Electrical Equipment, Non-Environmental Considerations</i>
UL 50E: 1st edition	<i>Enclosures for Electrical Equipment, Environmental Considerations</i>
CSA C22.2 No. 94.1-15	<i>Enclosures for Electrical Equipment, Non-Environmental Considerations</i>
CSA C22.2 No. 94.2-15	<i>Enclosures for Electrical Equipment, Environmental Considerations</i>

## Markings

These markings are attached to the drive:

	CE mark Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).
	UKCA (UK Conformity Assessed) mark Product complies with the applicable United Kingdom's legislation (Statutory Instruments). Marking is required for products being placed on the market in Great Britain (England, Wales and Scotland).
	UL Listed mark for USA and Canada Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories. Valid with rated voltages up to 600 V.
	TÜV Safety Approved mark (functional safety) Product contains Safe torque off and possibly other (optional) safety functions which are certified by TÜV according to the relevant functional safety standards. Applicable to drives and inverters; not applicable to supply, brake or DC/DC converter units or modules.



	<p>EAC (Eurasian Conformity) mark Product complies with the technical regulations of the Eurasian Customs Union. EAC mark is required in Russia, Belarus and Kazakhstan.</p>
	<p>Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP) Product is compliant with the People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) about hazardous substances. The EFUP is 20 years.</p>
	<p>RCM mark Product complies with Australian and New Zealand requirements specific to EMC, telecommunications and electrical safety. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).</p>
	<p>WEEE mark At the end of life the product should enter the recycling system at an appropriate collection point and not placed in the normal waste stream.</p>

## EMC compliance (IEC/EN 61800-3)

### ■ Definitions

EMC stands for Electromagnetic Compatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

*First environment* includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

*Second environment* includes establishments connected to a network not supplying domestic premises.

*Drive of category C1:* drive of rated voltage less than 1000 V and intended for use in the first environment.

*Drive of category C2:* drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment.

**Note:** A professional is a person or organization having necessary skills in installing and/or starting up power drive systems, including their EMC aspects.

*Drive of category C3:* drive of rated voltage less than 1000 V and intended for use in the second environment and not intended for use in the first environment.

*Drive of category C4:* drive of rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

### ■ Category C3

The drive complies with the standard with the following provisions:

1. The drive is installed according to the instructions given in the appropriate drive hardware manual.
2. Maximum motor cable length is 100 meters (328 ft).



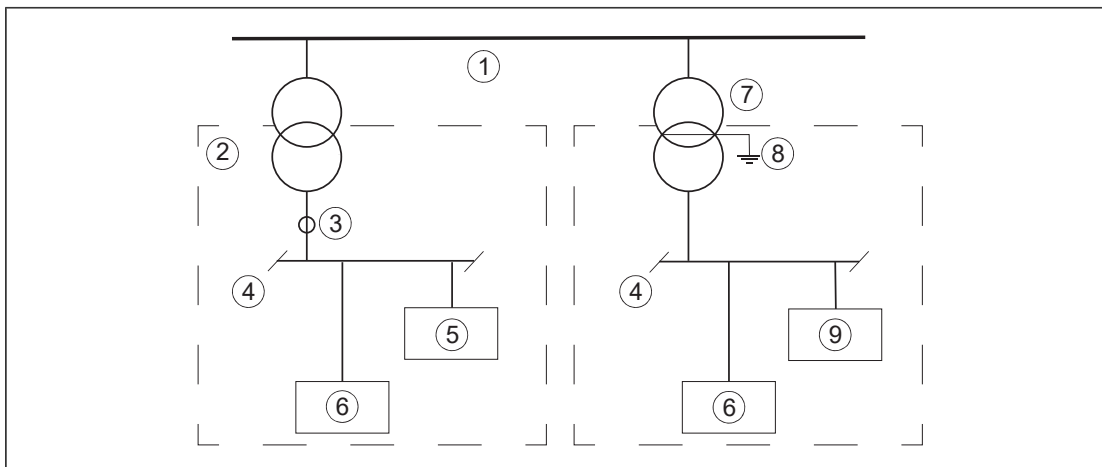
**WARNING!**

A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

■ **Category C4**

The drive complies with the C4 category with these provisions:

1. It is ensured that no excessive emission is propagated to neighboring low-voltage networks. In some cases, the natural suppression in transformers and cables is sufficient. If in doubt, the supply transformer with static screening between the primary and secondary windings can be used.



1	Medium voltage network	6	Equipment
2	Neighboring network	7	Supply transformer
3	Point of measurement	8	Static screen
4	Low voltage	9	Drive
5	Equipment (victim)	-	-

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available in [Technical guide No. 3 EMC compliant installation and configuration for a power drive system \(3AFE61348280 \[English\]\)](#).
3. The motor and control cables are selected, and routed according to the electrical planning guidelines of the drive. The EMC recommendations are obeyed.
4. The drive is installed according to its installation instructions. The EMC recommendations are obeyed.



**WARNING!**

A drive of category C4 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

## UL checklist

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**WARNING!**

Operation of this drive requires detailed installation and operation instructions provided in the hardware and software manuals. The manuals are provided in electronic format in the drive package or on the Internet. Keep the manuals with the drive at all times. Hard copies of the manuals can be ordered through the manufacturer.

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- Make sure that the drive type designation label includes the applicable marking.
- **DANGER - Risk of electric shock.** After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
- The drive is to be used in a heated, indoor controlled environment. The drive must be installed in clean air according to the enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust.
- The maximum surrounding air temperature is 45 °C at rated output current. The output current is derated for 45...55 °C.

**Note:** For cabinet-built drives, the maximum surrounding air temperature is 40 °C (104 °F).

- The drive is suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes, 600 V maximum when protected by the UL fuses given elsewhere in this chapter.
  - The cables located within the motor circuit must be rated for at least 75 °C in UL-compliant installations.
  - The input cable must be protected with fuses or circuit breakers. These protective devices provide branch circuit protection in accordance with the national regulations (National Electrical Code (NEC) or Canadian Electrical Code). Obey also any other applicable local or provincial codes.
- 

**WARNING!**

The opening of the branch-circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the device should be examined and replaced if damaged.

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- The drive is equipped with UL listed fuses which provide branch circuit protection in accordance with the National Electrical Code (NEC) and Canadian Electrical Code. The fuses are listed elsewhere in this chapter.
  - The drive provides motor overload protection. The protection is not enabled when the drive leaves the ABB factory. For enabling the protection, see the firmware manual.
  - The drive overvoltage category according to IEC 60664-1 is III, except for auxiliary power connections (fan, control, heating, lighting, cooling unit pump etc) which are of category II.
-

## Tightening torques

Unless a tightening torque is specified in the text, the following torques can be used.

### ■ Electrical connections

Size	Torque	Strength class
M3	0.5 N·m (4.4 lbf-in)	4.6...8.8
M4	1 N·m (9 lbf-in)	4.6...8.8
M5	4 N·m (35 lbf-in)	8.8
M6	9 N·m (6.6 lbf-ft)	8.8
M8	22 N·m (16 lbf-ft)	8.8
M10	42 N·m (31 lbf-ft)	8.8
M12	70 N·m (52 lbf-ft)	8.8
M16	120 N·m (90 lbf-ft)	8.8

### ■ Mechanical connections

Size	Max. torque	Strength class
M5	6 N·m (53 lbf-in)	8.8
M6	10 N·m (7.4 lbf-ft)	8.8
M8	24 N·m (17.7 lbf-ft)	8.8

### ■ Insulation supports

Size	Max. torque	Strength class
M6	5 N·m (44 lbf-in)	8.8
M8	9 N·m (6.6 lbf-ft)	8.8
M10	18 N·m (13.3 lbf-ft)	8.8
M12	31 N·m (23 lbf-ft)	8.8

### ■ Cable lugs

Size	Max. torque	Strength class
M8	15 N·m (11 lbf-ft)	8.8
M10	32 N·m (23.5 lbf-ft)	8.8
M12	50 N·m (37 lbf-ft)	8.8

## Disclaimers

### ■ Generic disclaimer

The manufacturer shall have no obligation with respect to any product which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to the manufacturer's instructions; or (iv) has failed as a result of ordinary wear and tear.

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## ■ **Cybersecurity disclaimer**

This product can be connected to and to communicate information and data via a network interface. The HTTP protocol, which is used between the commissioning tool (Drive Composer) and the product, is an unsecured protocol. For independent and continuous operation of product such connection via network to commissioning tool is not necessary. However it is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, prevention of physical access, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Notwithstanding any other provision to the contrary and regardless whether the contract is terminated or not, ABB and its affiliates are under no circumstances liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

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## Dimensions

### Cabinet line-up dimensions

The drive consists of cubicles built into a cabinet line-up. The table below shows the width and weight of basic drive types without options (for example, the cooling unit is not included). The table is followed by selected dimension drawing examples.

The dimensions are in millimeters (for inches, divide by 25.4).

The data given is preliminary. ABB reserves the right to modify the design at any time without notice. Consult ABB for up-to-date, drive-specific information.

ACS880-17LC-...	Width	Weight	
	mm	kg	lbs
<b><math>U_N = 690 \text{ V}</math></b>			
0390A-7 0430A-7 0480A-7 0520A-7 0600A-7 0670A-7 0750A-7 0830A-7	2000	2040	4500
1000A-7 1170A-7 1270A-7	2400	2300	5070
1470A-7 1620A-7	2500	2450	5400
1940A-7 2180A-7 2390A-7	3200	3290	7250
2880A-7 3160A-7	4000	4110	9060

196 Dimensions

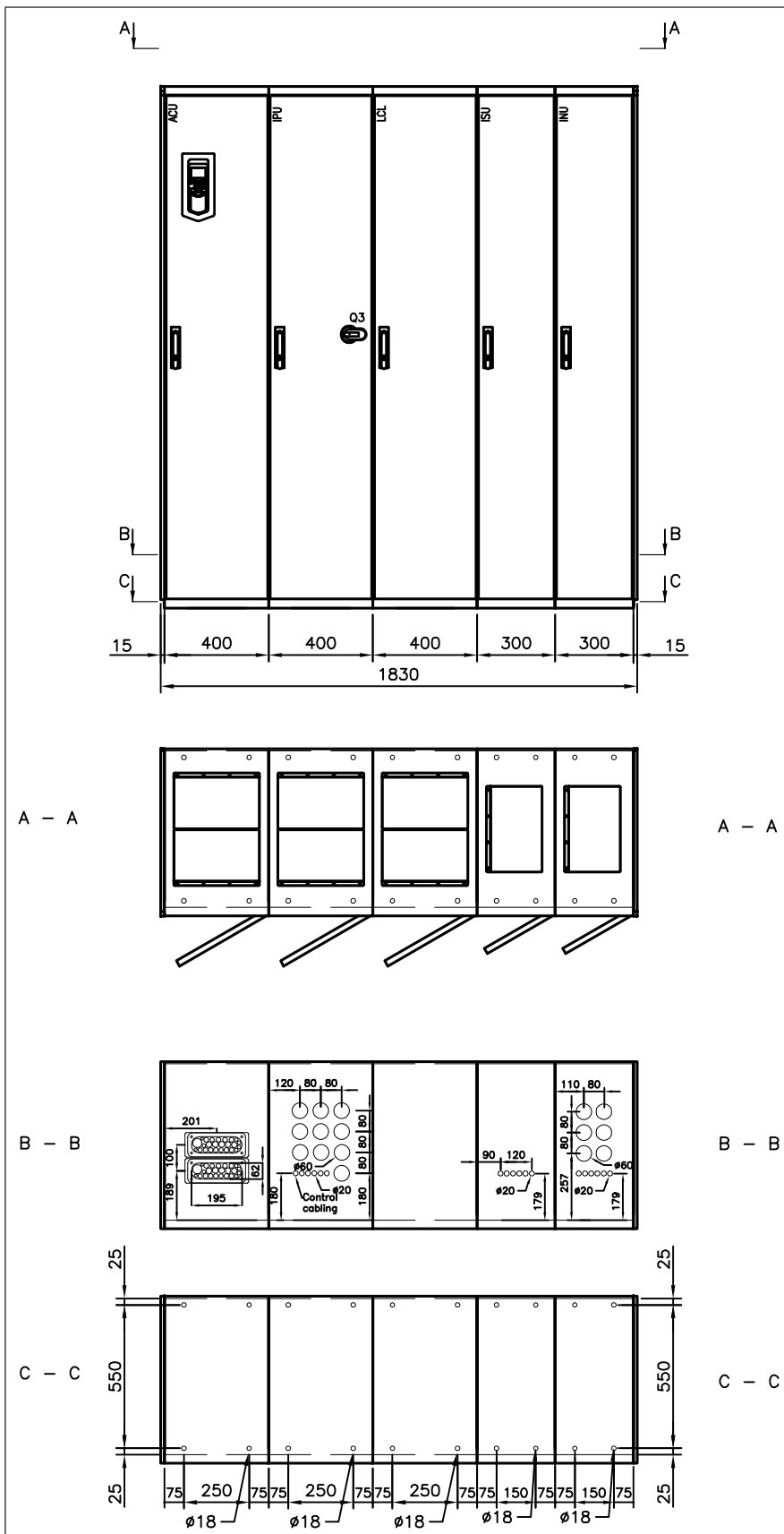
ACS880-17LC-...	Width	Weight	
	mm	kg	lbs
3580A-7	4600	4750	10470
4050A-7	5800	6170	13600
4700A-7	6000	6340	13980
5650A-7	7300	7720	17020
6260A-7	7600	7980	17590

**Note:** The 100 kA input cubicle (option +F274) adds 600 mm to the width.

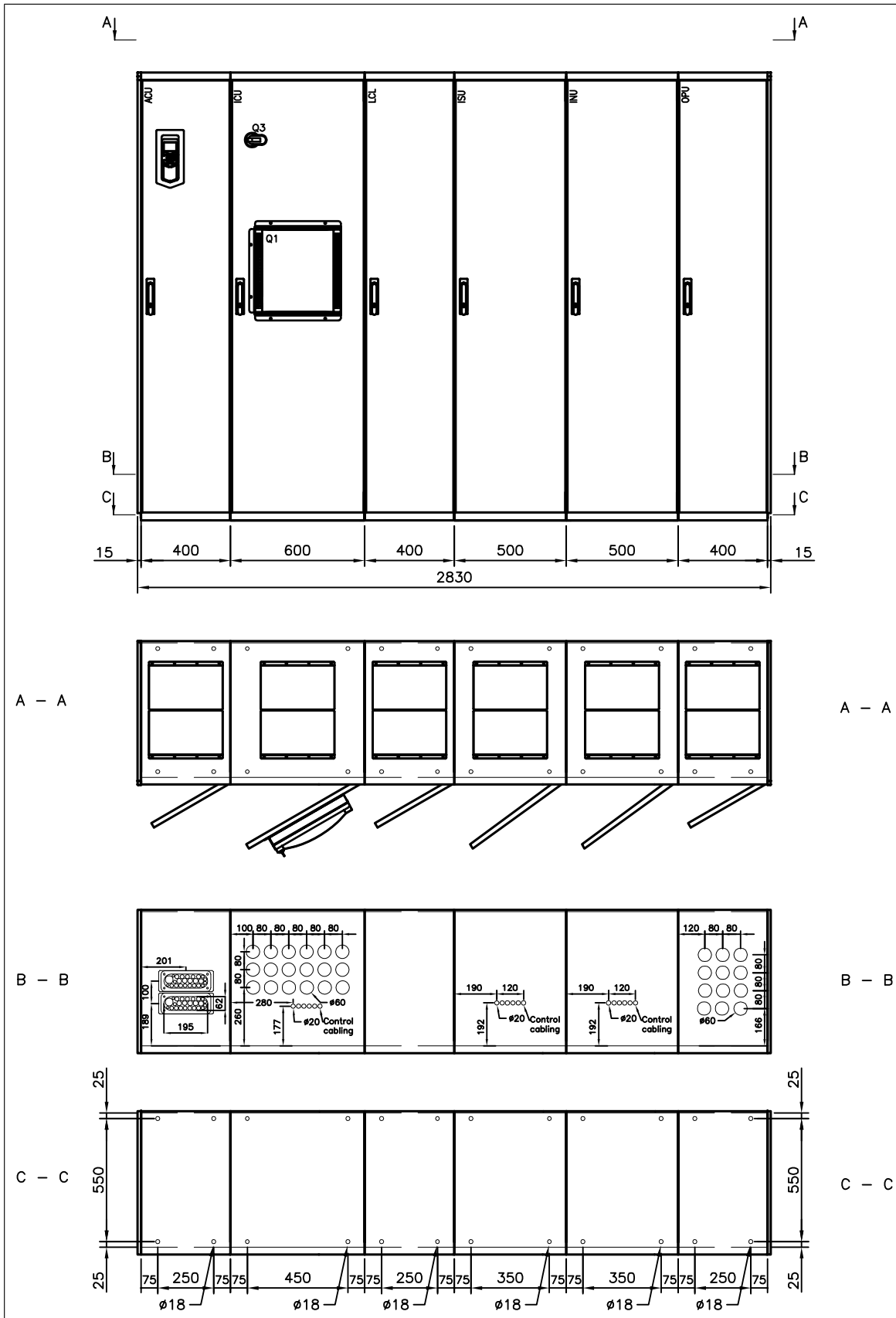


■ Dimension drawing examples

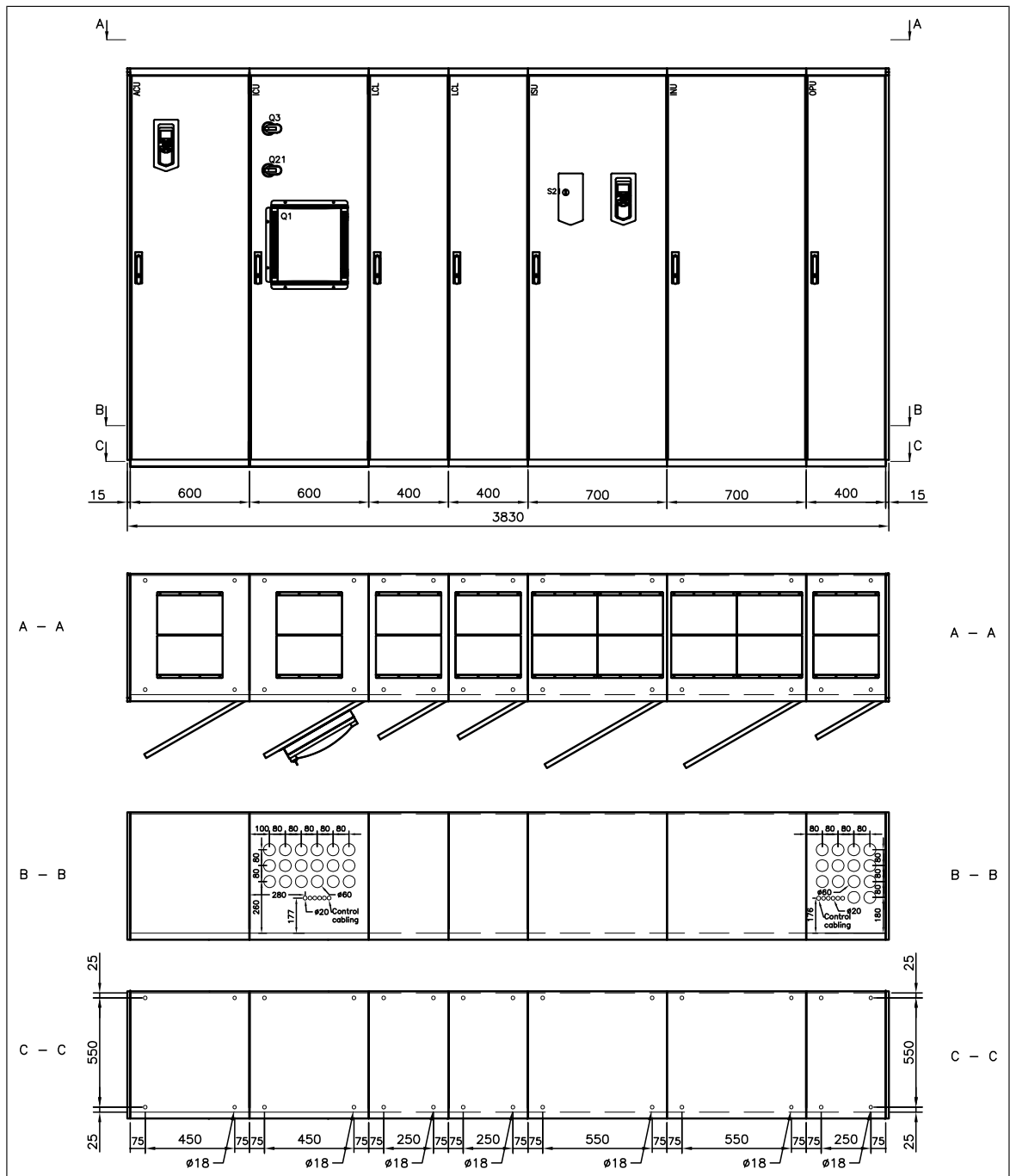
ACS880-17LC-0390A-7 with main contactor



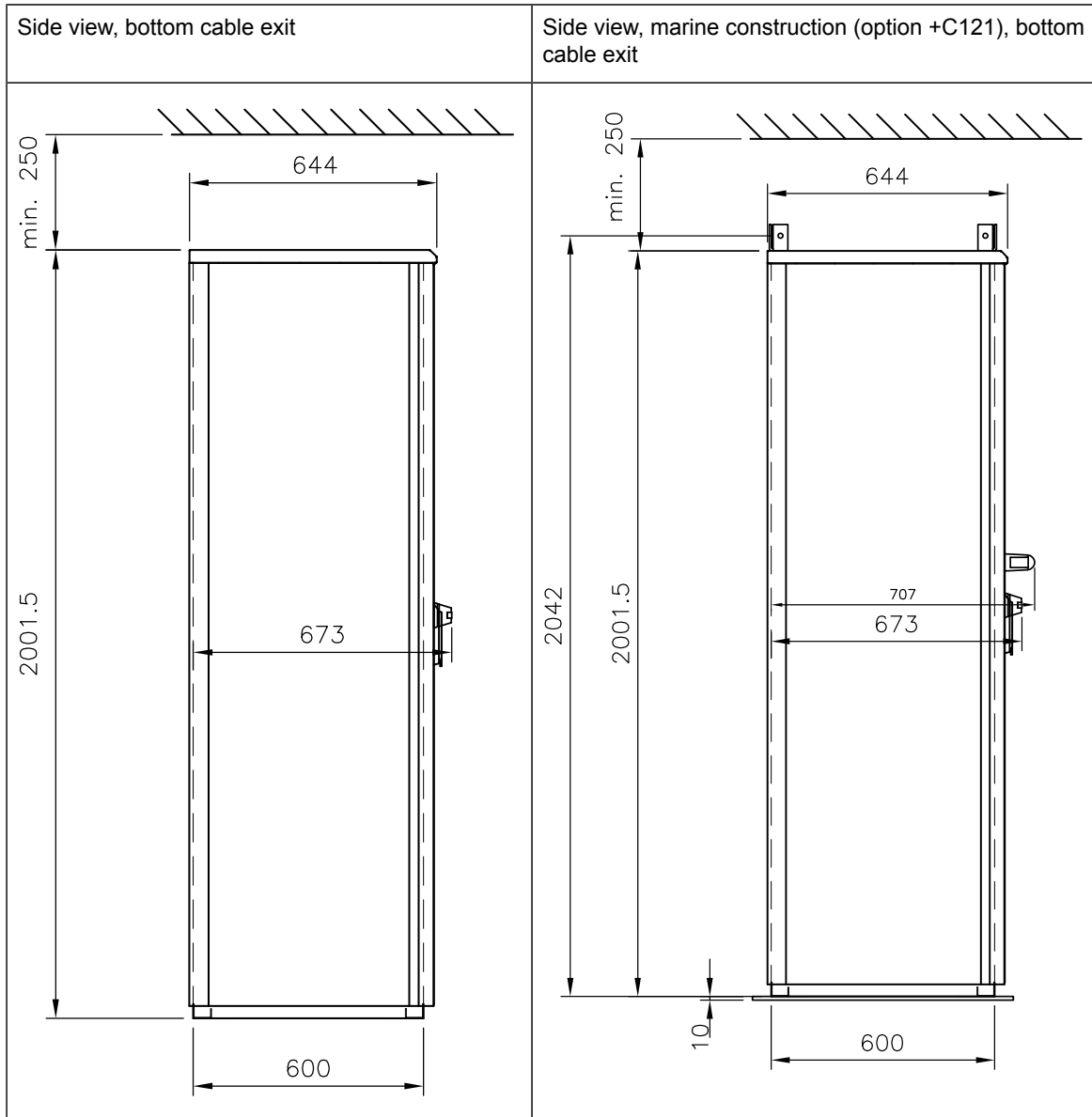
ACS880-17LC-1270A-7 with common motor terminal cubicle

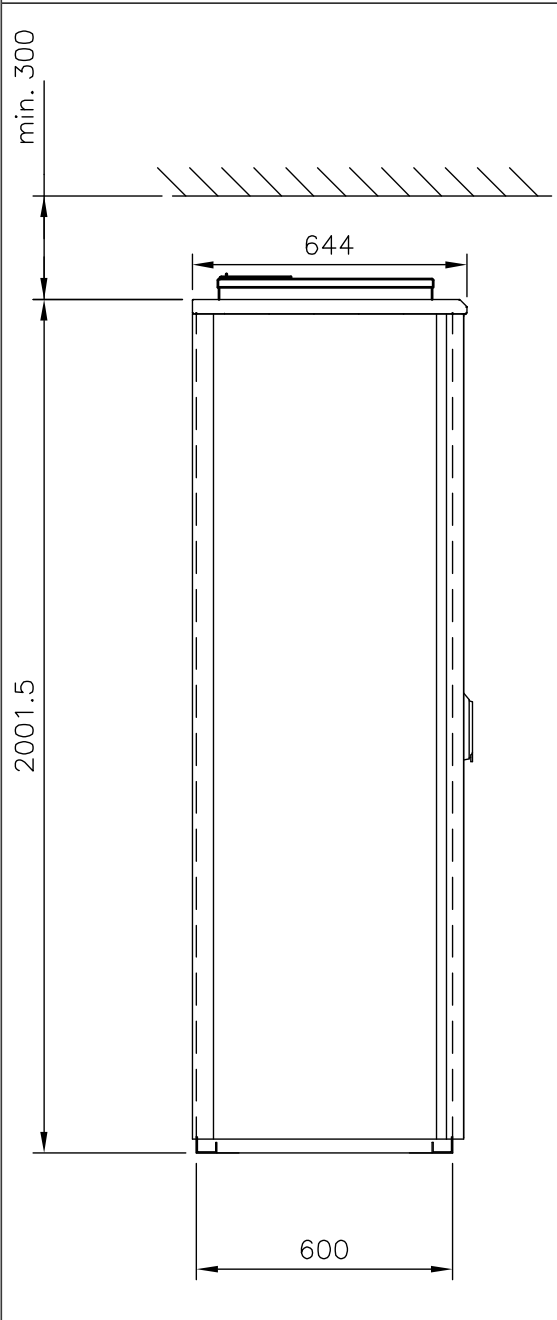
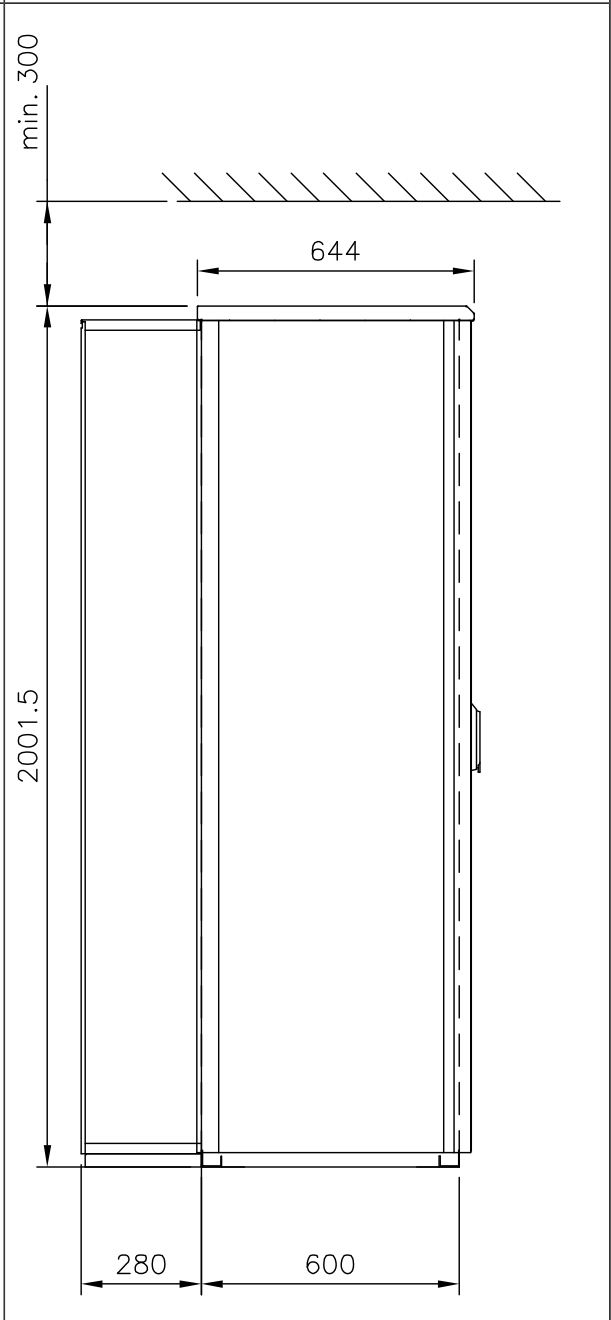


ACS880-17LC-1940A-7 with common motor terminal cubicle



**Cabinet height and depth**



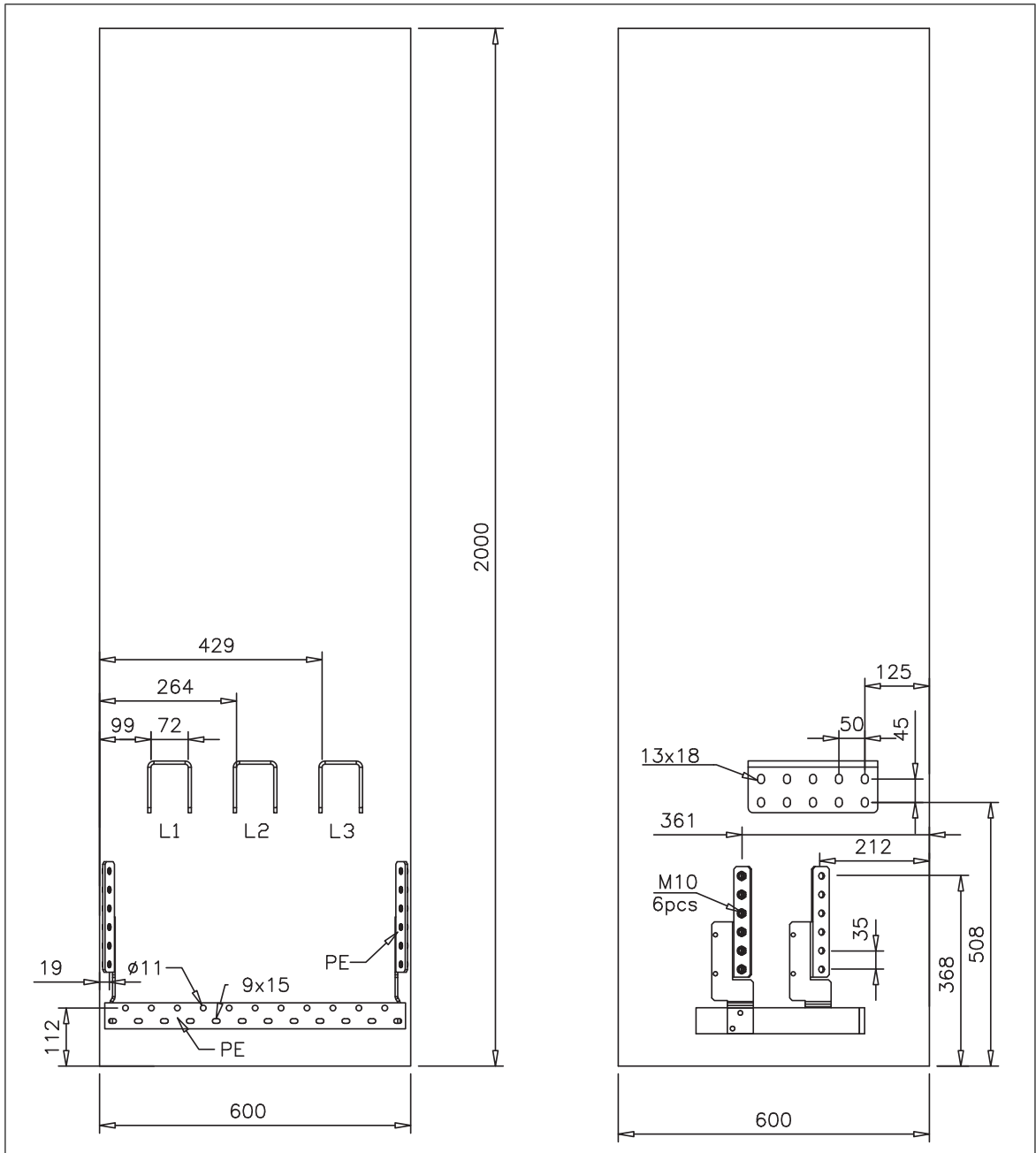
Side view, top cable exit with common motor terminal cubicle	Side view, top cable exit without common motor terminal cubicle
 <p>min. 300</p> <p>2001.5</p> <p>644</p> <p>600</p>	 <p>min. 300</p> <p>2001.5</p> <p>644</p> <p>280</p> <p>600</p>

## **Location and size of input terminals**

Contact ABB for details.



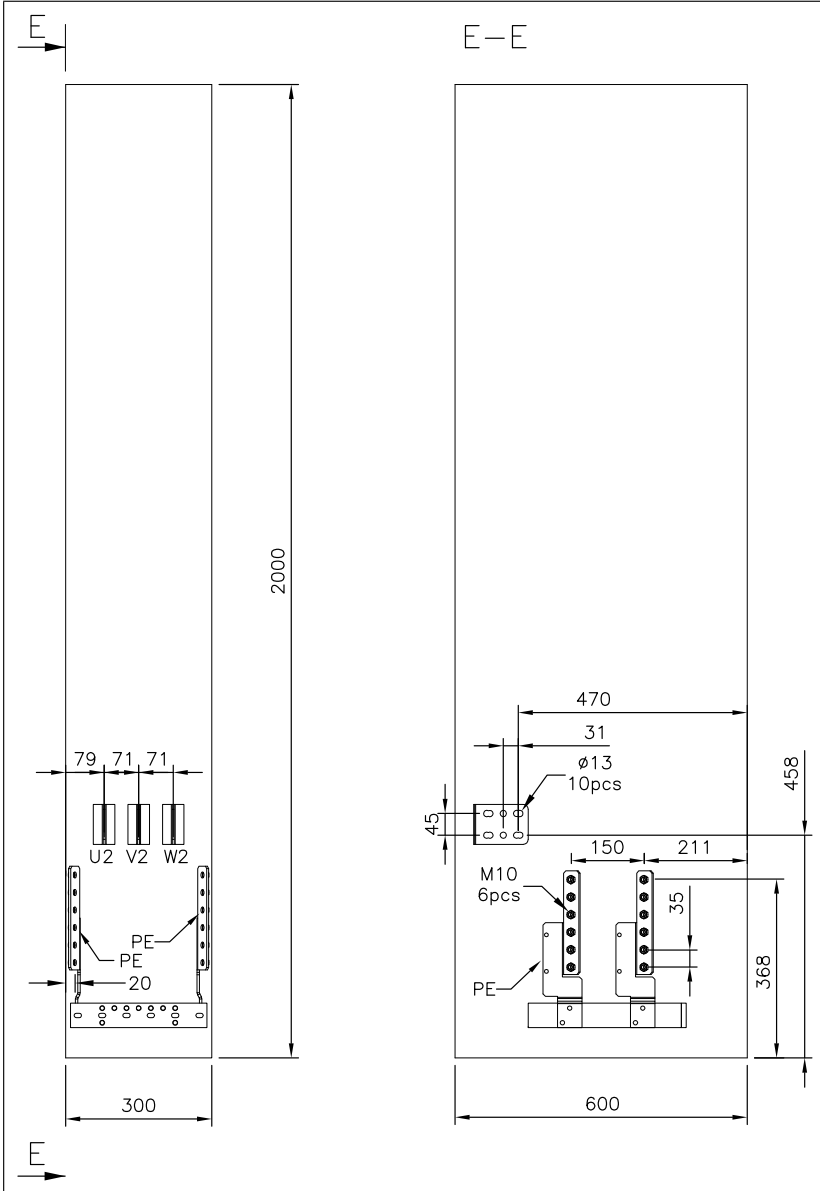
■ 100 kA input cubicle (option +F274)



## Location and size of output terminals

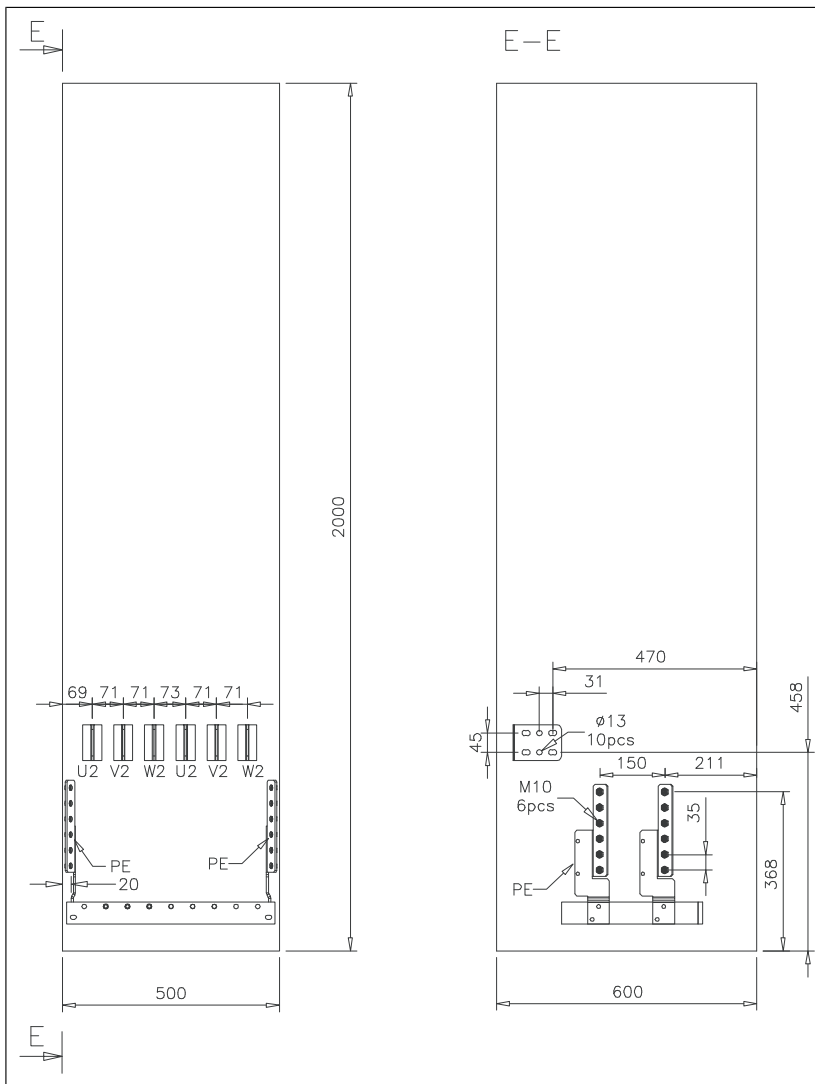
### ■ Units without common motor terminal cubicle

Inverter module cubicle with one R8i module, bottom cable exit

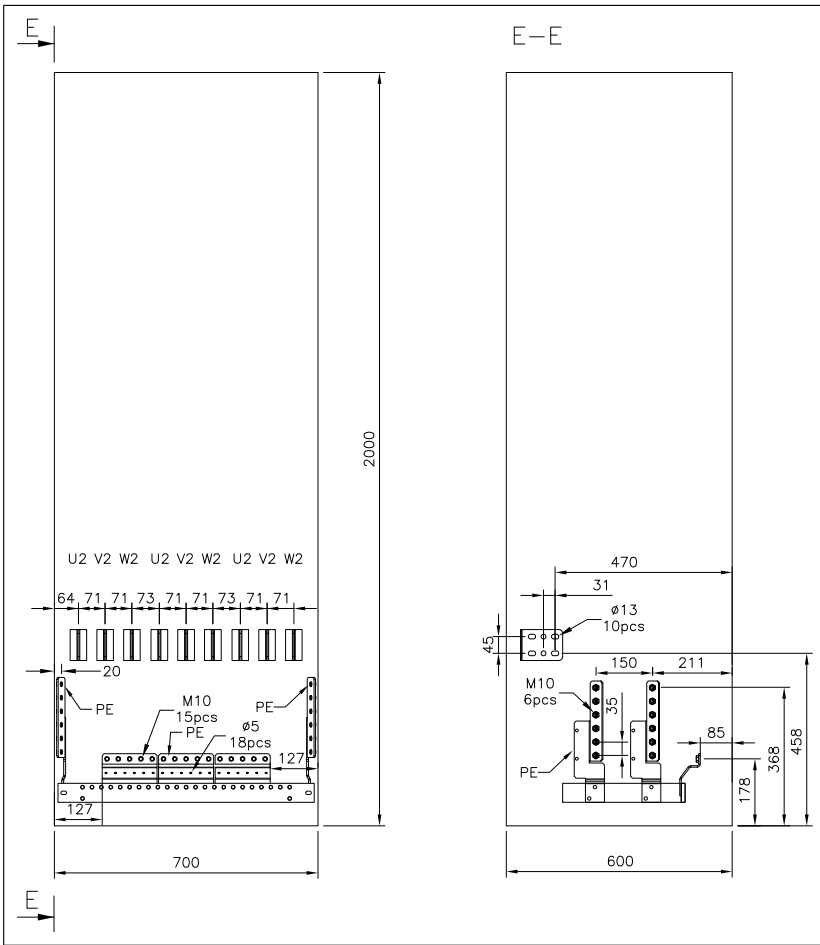




**Inverter module cubicle with two R8i modules, bottom cable exit**

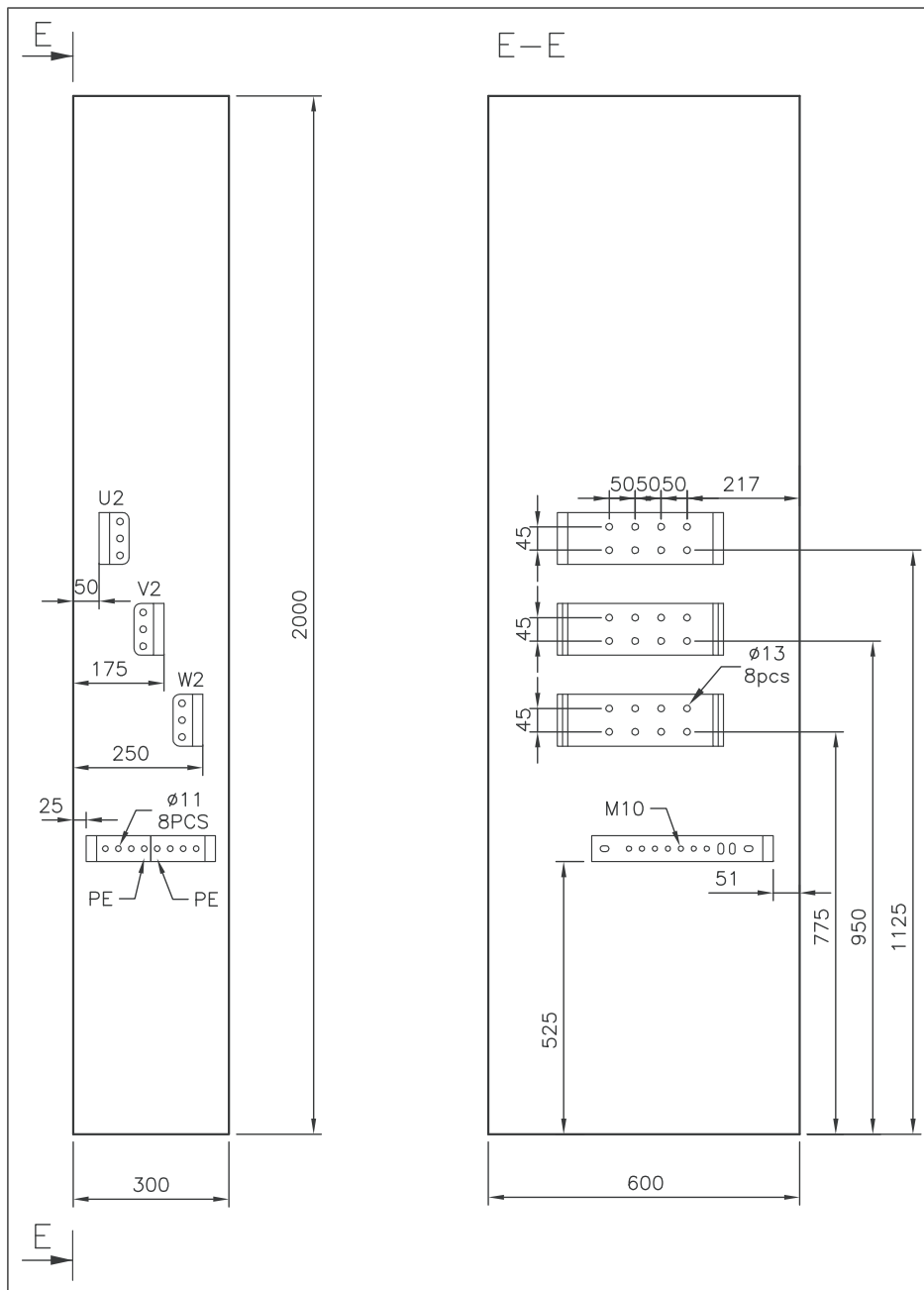


**Inverter module cubicle with three R8i modules, bottom cable exit**

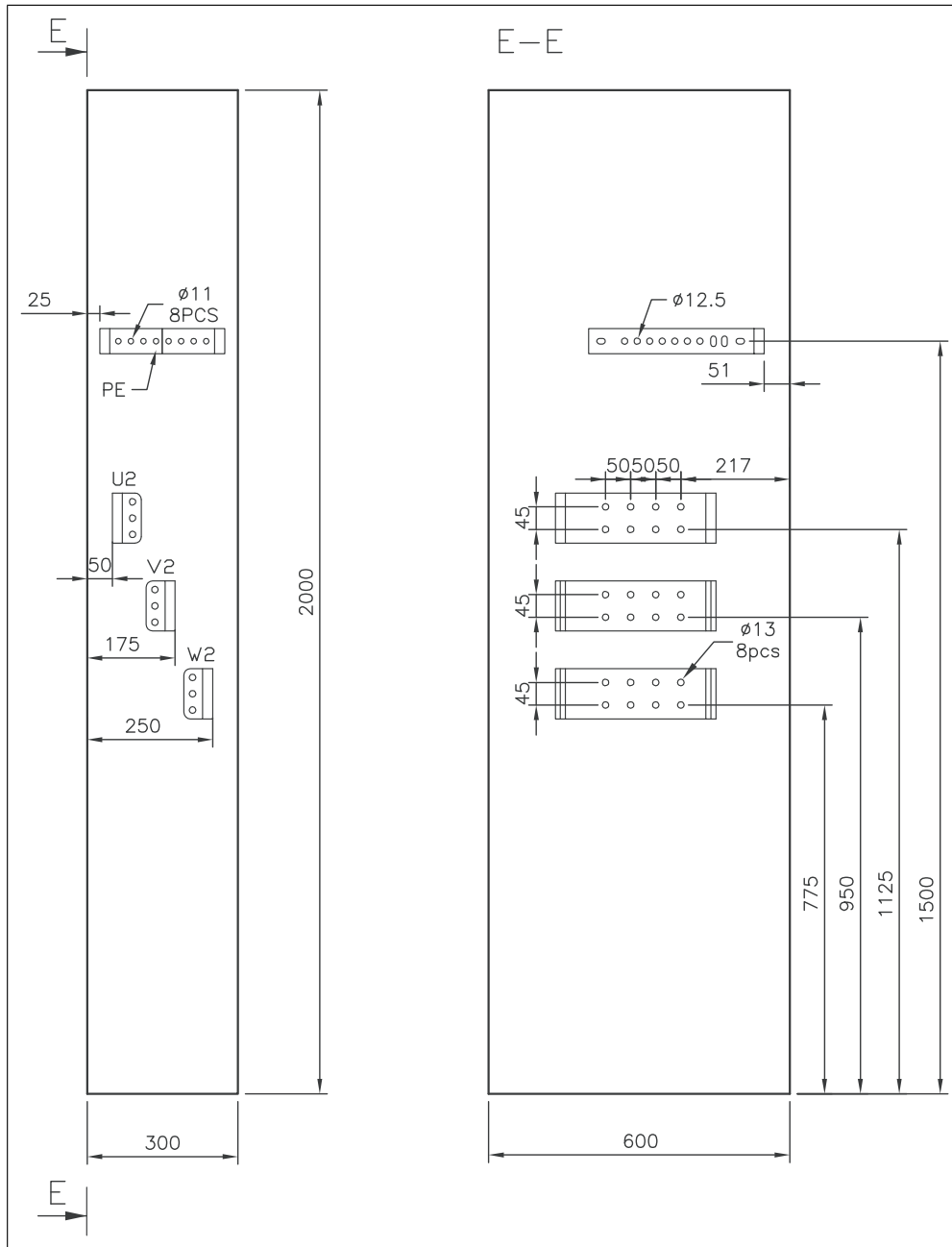


■ Units with common motor terminal cubicle (+H359)

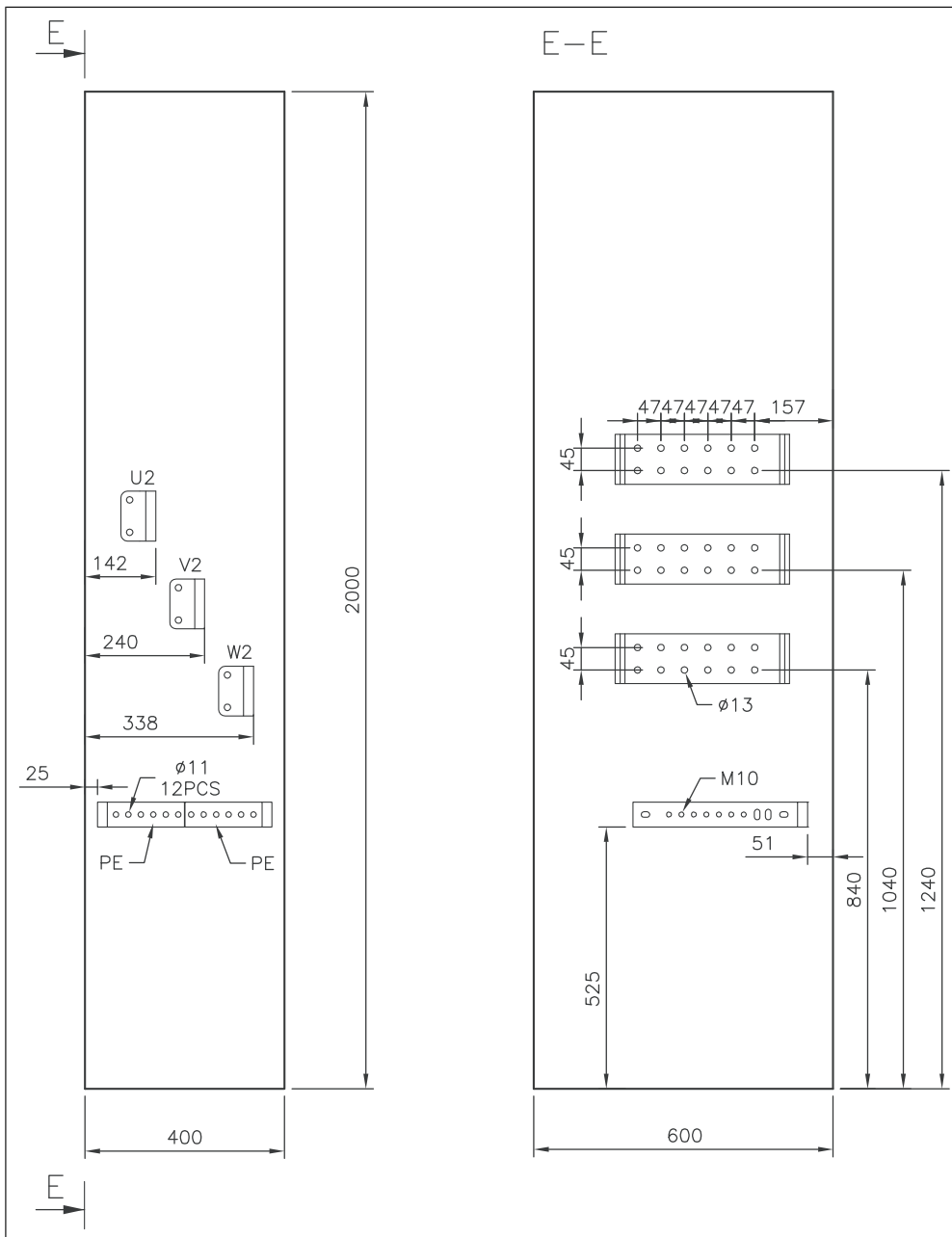
Cubicle width 300 mm, bottom cable exit



**Cubicle width 300 mm, top cable exit**

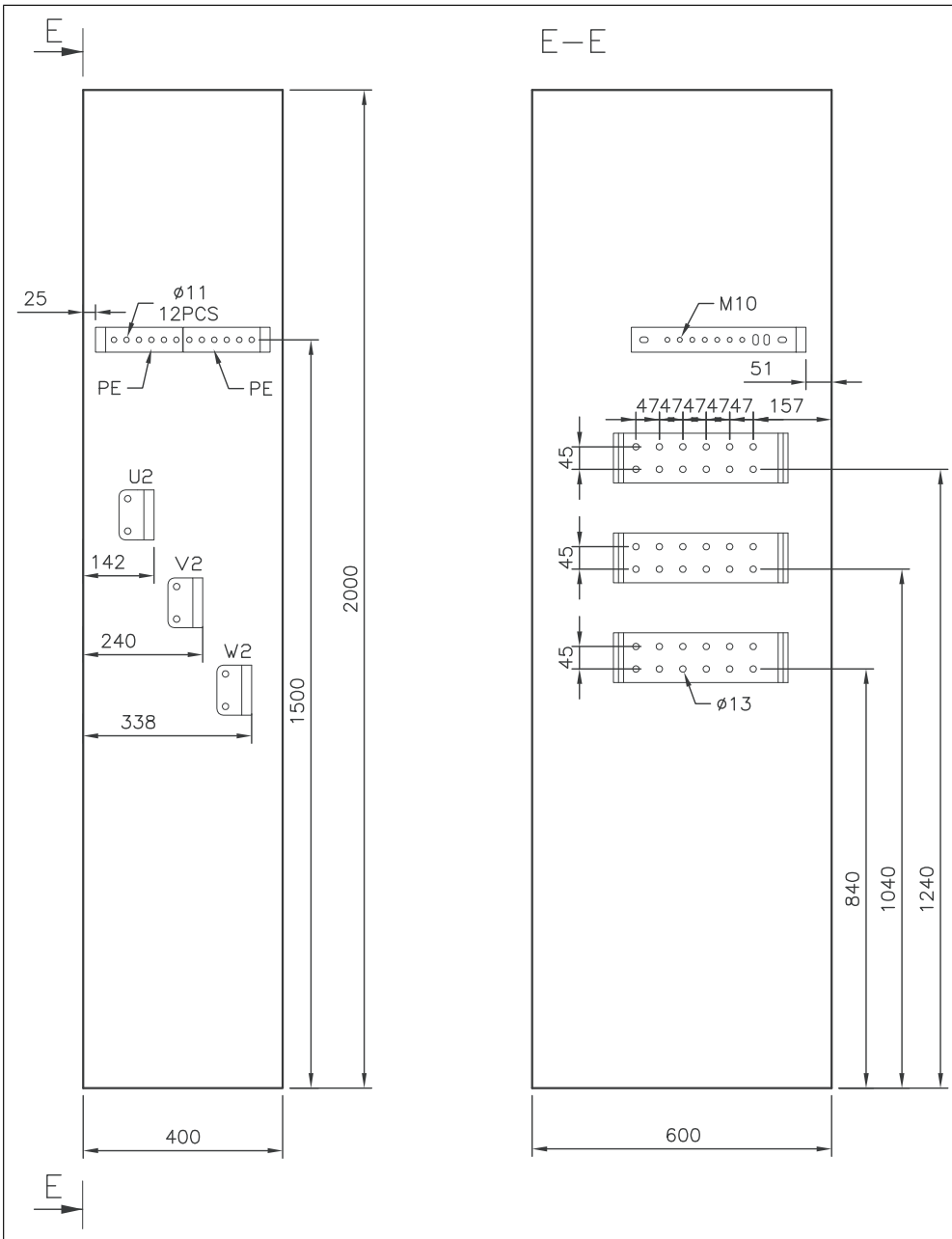


**Cubicle width 400 mm, bottom cable exit**

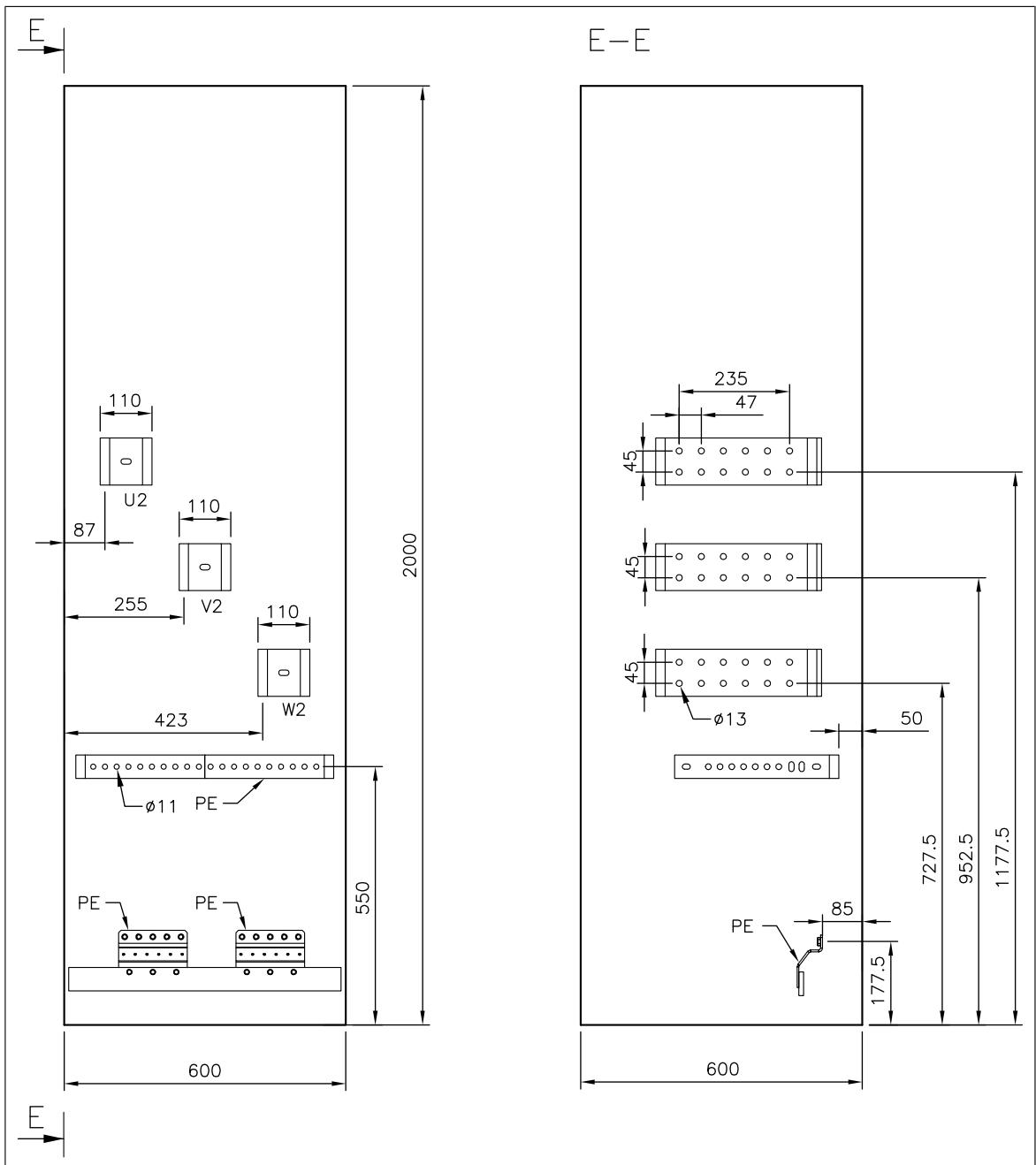


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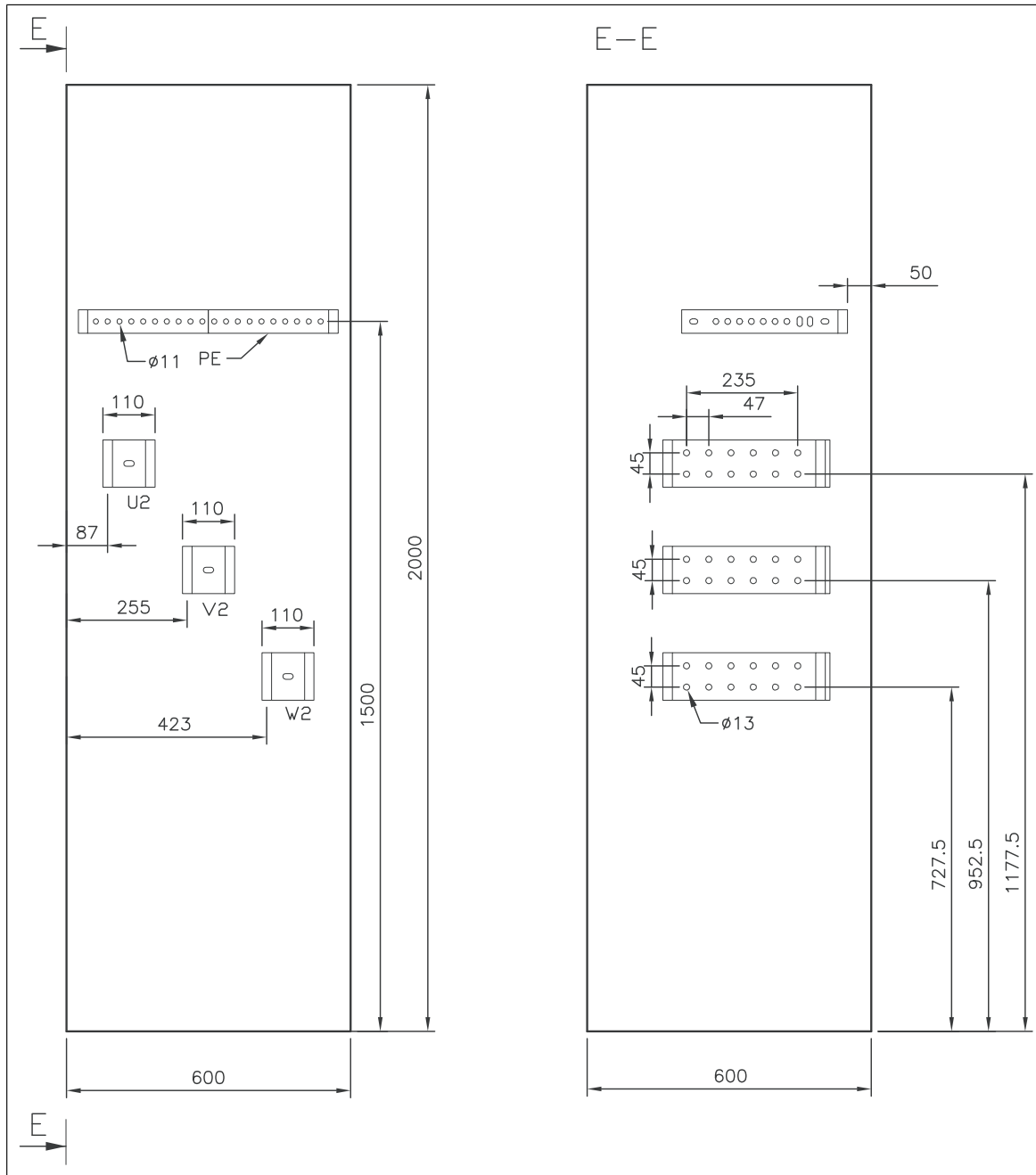
Cubicle width 400 mm, top cable exit



Cubicle width 600 mm, bottom cable exit



**Cubicle width 600 mm, top cable exit**





# 15

## The Safe torque off function

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### Contents of this chapter

This chapter describes the Safe torque off (STO) function of the drive and gives instructions for its use.

### Description

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**WARNING!**

In case of parallel-connected drives or dual-winding motors, the STO must be activated on each drive to remove the torque from the motor.

---

The Safe torque off function can be used, for example, as the final actuator device of safety circuits that stop the drive in case of danger (such as an emergency stop circuit). Another typical application is a prevention of unexpected start-up function that enables short-time maintenance operations like cleaning or work on non-electrical parts of the machinery without switching off the power supply to the drive.

When activated, the Safe torque off function disables the control voltage for the power semiconductors of the drive output stage, thus preventing the drive from generating the torque required to rotate the motor. If the motor is running when Safe torque off is activated, it coasts to a stop.

The Safe torque off function has a redundant architecture, that is, both channels must be used in the safety function implementation. The safety data given in this manual is calculated for redundant use, and does not apply if both channels are not used.

The Safe torque off function complies with these standards:

Standard	Name
IEC 60204-1:2016 EN 60204-1:2018	<i>Safety of machinery – Electrical equipment of machines – Part 1: General requirements</i>

<b>Standard</b>	<b>Name</b>
IEC 61000-6-7:2014	<i>Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations</i>
IEC 61326-3-1:2017	<i>Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications</i>
IEC 61508-1:2010	<i>Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements</i>
IEC 61508-2:2010	<i>Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems</i>
IEC 61511-1:2017	<i>Functional safety – Safety instrumented systems for the process industry sector</i>
IEC 61800-5-2:2016 EN 61800-5-2:2007	<i>Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional</i>
IEC 62061:2021 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	<i>Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems</i>
EN ISO 13849-1:2015	<i>Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design</i>
EN ISO 13849-2:2012	<i>Safety of machinery – Safety-related parts of control systems – Part 2: Validation</i>

The function also corresponds to Prevention of unexpected start-up as specified by EN ISO 14118:2018 (ISO 14118:2017), and Uncontrolled stop (stop category 0) as specified in EN/IEC 60204-1.

### ■ **Compliance with the European Machinery Directive and the UK Supply of Machinery (Safety) Regulations**

See the technical data.

The Declarations of conformity are shown at the end of this chapter.

## Wiring

For the electrical specifications of the STO connection, see the technical data of the control unit.

### ■ Activation switch

In the wiring diagrams, the activation switch has the designation [K]. This represents a component such as a manually operated switch, an emergency stop push button switch, or the contacts of a safety relay or safety PLC.

- In case a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.
- The contacts of the switch or relay must open/close within 200 ms of each other.
- An FSO safety functions module, an FSPS safety functions module or an FPTC thermistor protection module can also be used. For more information, see the module documentation.

### ■ Cable types and lengths

- Double-shielded twisted-pair cable is recommended.
- Maximum cable lengths:
  - 300 m (1000 ft) between activation switch [K] and drive control unit
  - 60 m (200 ft) between multiple drives
  - 60 m (200 ft) between external power supply and first control unit
  - 30 m (100 ft) between BCU control unit and last inverter module in the chain.

**Note:** A short-circuit in the wiring between the switch and an STO terminal causes a dangerous fault. Therefore, it is recommended to use a safety relay (including wiring diagnostics) or a wiring method (shield grounding, channel separation) which reduces or eliminates the risk caused by the short-circuit.

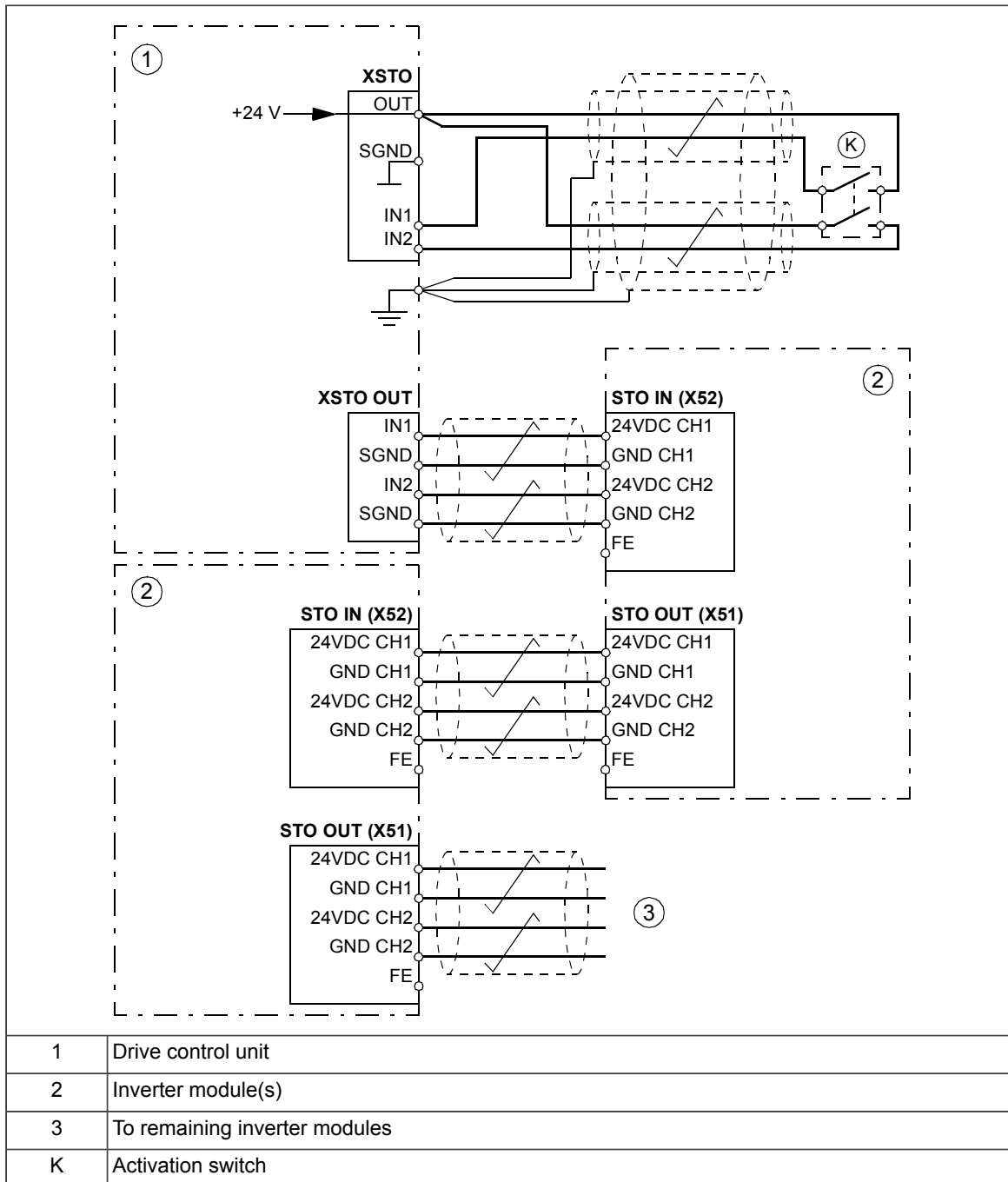
**Note:** The voltage at the STO input terminals of the control unit (or frame R8i inverter module) must be at least 17 V DC to be interpreted as “1”.

The pulse tolerance of the input channels is 1 ms.

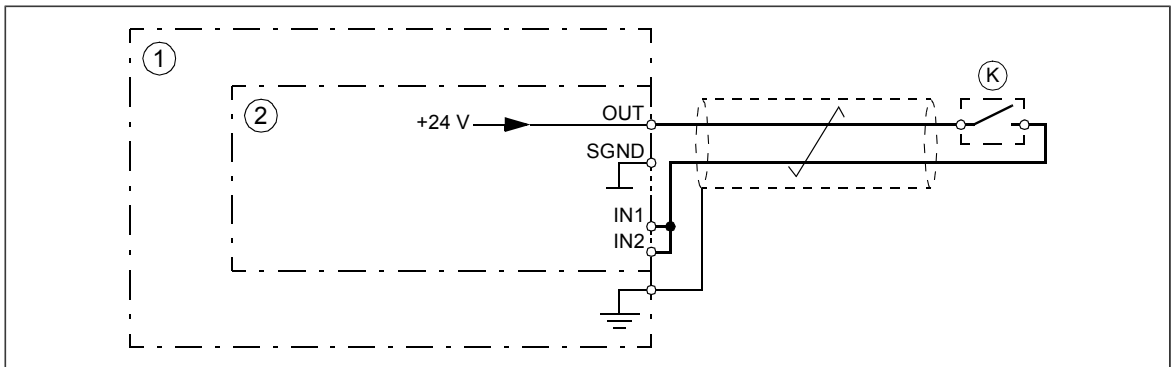
### ■ Grounding of protective shields

- Ground the shield in the cabling between the activation switch and the control unit at the control unit only.
  - Ground the shield in the cabling between two control units at one control unit only.
  - Do not ground the shield in the cabling between BCU and R8i module, or between R8i modules.
-

■ Dual-channel connection with internal power supply



■ Single-channel connection of activation switch



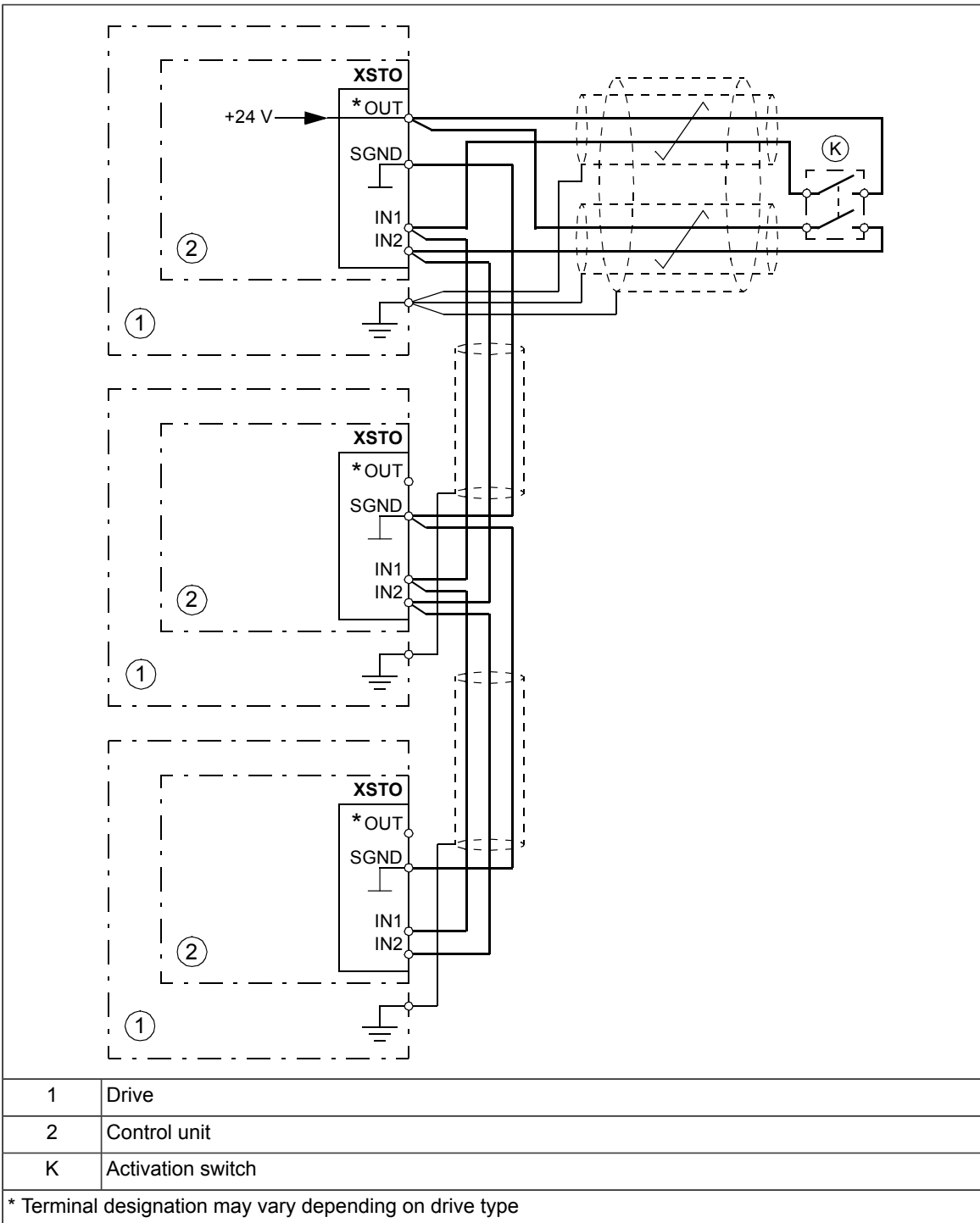
**Note:**

- Both STO inputs (IN1, IN2) must be connected to the activation switch. Otherwise, no SIL/PL classification is given.
- Pay special attention to avoiding any potential failure modes for the wiring. For example, use shielded cable. For measures for fault exclusion of wiring, see eg. EN ISO 13849-2:2012, table D.4.

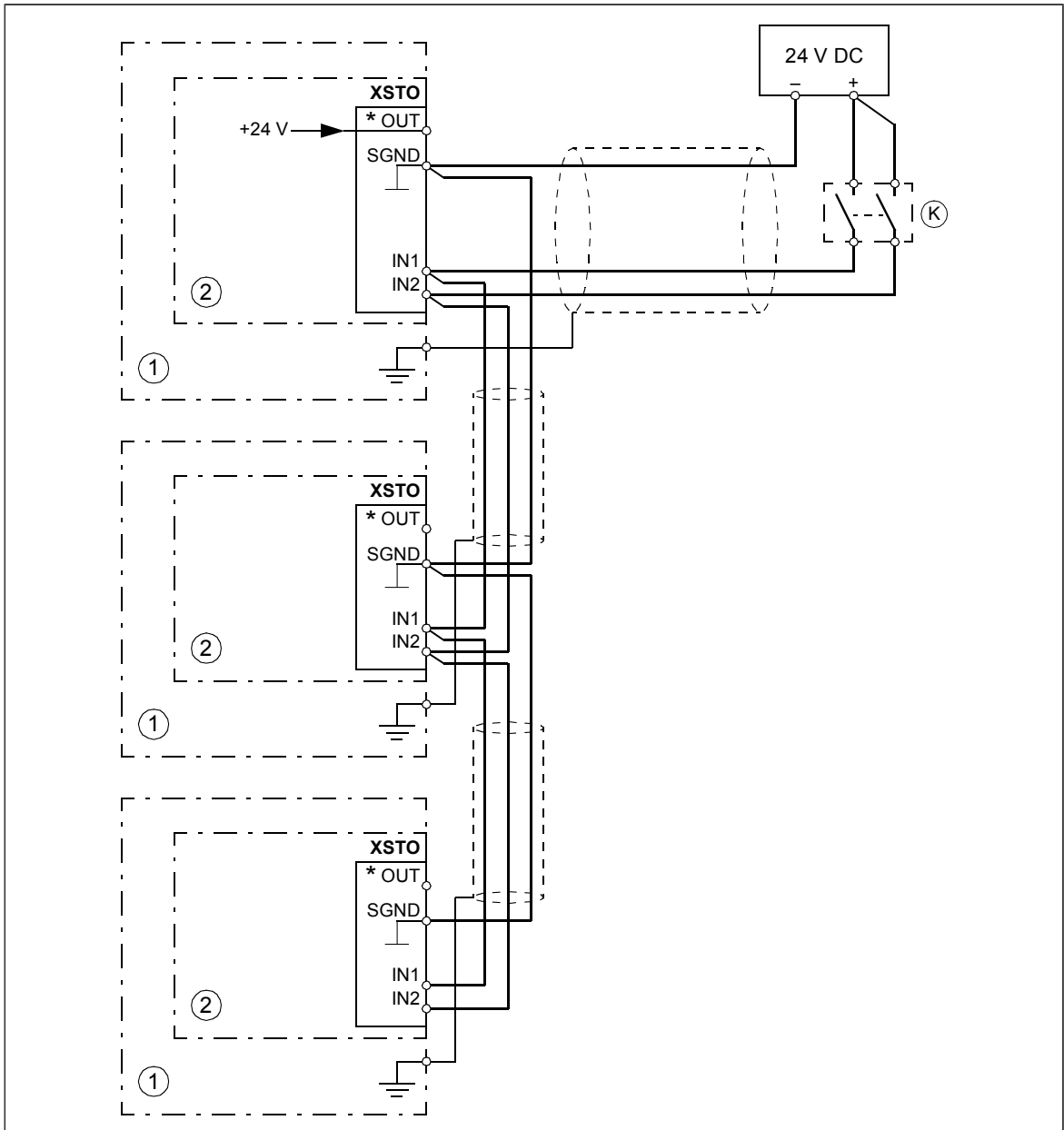
1	Drive
2	Control unit
K	Activation switch

■ Multiple drives

Internal power supply



### External power supply



1	Drive
2	Control unit
K	Activation switch
* Terminal designation may vary depending on drive type	

## Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety relay contacts open).
2. The STO inputs of the drive control unit de-energize.
3. The control unit cuts off the control voltage from the output IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (see the firmware manual of the drive).

The parameter selects which indications are given when one or both STO signals are switched off or lost. The indications also depend on whether the drive is running or stopped when this occurs.

**Note:** This parameter does not affect the operation of the STO function itself. The STO function will operate regardless of the setting of this parameter: a running drive will stop upon removal of one or both STO signals, and will not start until both STO signals are restored and all faults reset.

**Note:** The loss of only one STO signal always generates a fault as it is interpreted as a malfunction of STO hardware or wiring.

5. The motor coasts to a stop (if running). The drive cannot restart while the activation switch or safety relay contacts are open. After the contacts close, a reset may be needed (depending on the setting of parameter 31.22). A new start command is required to start the drive.
-



## Start-up including validation test

To ensure the safe operation of a safety function, validation is required. The final assembler of the machine must validate the function by performing a validation test. The test must be performed

- at initial start-up of the safety function
- after any changes related to the safety function (circuit boards, wiring, components, settings, etc.)
- after any maintenance work related to the safety function
- at the proof test of the safety function
- after a drive firmware update.

### ■ Competence

The validation test of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

### ■ Validation test reports

Signed validation test reports must be stored in the logbook of the machine. The report shall include documentation of start-up activities and test results, references to failure reports and resolution of failures. Any new validation tests performed due to changes or maintenance shall be logged into the logbook.


### ■ Validation test procedure

After wiring the Safe torque off function, validate its operation as follows.

**Note:** If the drive is equipped with safety option +L513, +L514, +L536, +L537, +Q950, +Q951, +Q952, +Q957, +Q963, +Q964, +Q965, +Q978, +Q979 or +Q984, also do the procedure shown in the documentation of the option.

If an FSPS-21 module is installed, refer to its documentation.

**Note:** All inverter modules of the drive must be powered and connected to the STO circuit during the validation test.

<b>Action</b>	<input checked="" type="checkbox"/>
 <b>WARNING!</b> Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	<input type="checkbox"/>
Make sure that the drive can be run and stopped freely during start-up.	<input type="checkbox"/>
Stop the drive (if running), switch the input power off and isolate the drive from the power line using a disconnecter.	<input type="checkbox"/>
Check the STO circuit connections against the wiring diagram.	<input type="checkbox"/>
Close the disconnecter and switch the power on.	<input type="checkbox"/>

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<p><b>Action</b></p>	<input checked="" type="checkbox"/>
<p>Test the operation of the STO function when the motor is stopped.</p> <ul style="list-style-type: none"> <li>• Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill.</li> </ul> <p>Make sure that the drive operates as follows:</p> <ul style="list-style-type: none"> <li>• Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter 31.22 (see the firmware manual).</li> <li>• Give a start command to verify that the STO function blocks the drive's operation. The drive generates a warning. The motor should not start.</li> <li>• Close the STO circuit.</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> </ul>	<input type="checkbox"/>
<p>Test the operation of the STO function when the motor is running.</p> <ul style="list-style-type: none"> <li>• Start the drive and make sure the motor is running.</li> <li>• Open the STO circuit. The motor should stop. The drive generates an indication if one is defined for the 'running' state in parameter 31.22 (see the firmware manual).</li> <li>• Reset any active faults and try to start the drive.</li> <li>• Make sure that the motor stays at a standstill and the drive operates as described above in testing the operation when the motor is stopped.</li> <li>• Close the STO circuit.</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> </ul>	<input type="checkbox"/>
<p>Test the operation of the failure detection of the drive. The motor can be stopped or running.</p> <ul style="list-style-type: none"> <li>• Open the 1st channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates a <i>FA81 Safe Torque Off 1 loss</i> fault indication (see the firmware manual).</li> <li>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.</li> <li>• Close the STO circuit.</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> <li>• Open the 2nd channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates a <i>FA82 Safe Torque Off 2 loss</i> fault indication (see the firmware manual).</li> <li>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.</li> <li>• Close the STO circuit.</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> </ul>	<input type="checkbox"/>
<p>Document and sign the validation test report which verifies that the safety function is safe and accepted for operation.</p>	<input type="checkbox"/>

## Use

1. Open the activation switch, or activate the safety functionality that is wired to the STO connection.
2. The STO inputs on the drive control unit de-energize, and the control unit cuts off the control voltage from the output IGBTs.
3. The control program generates an indication as defined by parameter 31.22 (see the firmware manual of the drive).
4. The motor coasts to a stop (if running). The drive will not restart while the activation switch or safety relay contacts are open.
5. Deactivate the STO by closing the activation switch, or resetting the safety functionality that is wired to the STO connection.
6. Reset any faults before restarting.



### WARNING!

The Safe torque off function does not disconnect the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on electrical parts of the drive or the motor can only be carried out after isolating the drive from the supply and all other voltage sources.

---



### WARNING!

The Safe torque off functionality is only achieved through the XSTO connector of the inverter control unit (A41). True Safe torque off functionality is not achieved through the XSTO connectors of other control units (such as the supply control unit or the brake control unit).

The Safe torque off function is supported by any ACS880 inverter or drive control program. It is not supported by supply, DC/DC converter or brake firmware.

---



### WARNING!

The drive cannot detect or memorize any changes in the STO circuitry when the drive control unit is not powered. If both STO circuits are closed and a level-type start signal is active when the power is restored, it is possible that the drive starts without a fresh start command. Take this into account in the risk assessment of the system.

---



### WARNING!

(With permanent magnet or synchronous reluctance [SynRM] motors only)

In case of a multiple IGBT power semiconductor failure, the drive can produce an alignment torque which maximally rotates the motor shaft by  $180/p$  degrees (with permanent magnet motors) or  $180/2p$  degrees (with synchronous reluctance [SynRM] motors) regardless of the activation of the Safe torque off function.  $p$  denotes the number of pole pairs.

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### Notes:

- If a running drive is stopped by using the Safe torque off function, the drive will cut off the motor supply voltage and the motor will coast to a stop. If this causes danger or is
-

not otherwise acceptable, stop the drive and machinery using the appropriate stop mode before activating the Safe torque off function.

- The Safe torque off function overrides all other functions of the drive.
  - The Safe torque off function is ineffective against deliberate sabotage or misuse.
  - The Safe torque off function has been designed to reduce the recognized hazardous conditions. In spite of this, it is not always possible to eliminate all potential hazards. The assembler of the machine must inform the final user about the residual risks.
-

## Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 5 or 2 years; see section [Safety data \(page 227\)](#). It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the [Validation test procedure \(page 221\)](#).

**Note:** See also the Recommendation of Use CNB/M/11.050 (published by the European co-ordination of Notified Bodies) concerning dual-channel safety-related systems with electromechanical outputs:

- When the safety integrity requirement for the safety function is SIL 3 or PL e (cat. 3 or 4), the proof test for the function must be performed at least every month.
- When the safety integrity requirement for the safety function is SIL 2 (HFT = 1) or PL d (cat. 3), the proof test for the function must be performed at least every 12 months.

The STO function of the drive does not contain any electromechanical components.

In addition to proof testing, it is a good practice to check the operation of the function when other maintenance procedures are carried out on the machinery.

Include the Safe torque off operation test described above in the routine maintenance program of the machinery that the drive runs.

If any wiring or component change is needed after start-up, or the parameters are restored, do the test given in section [Validation test procedure \(page 221\)](#).

Use only spare parts approved by ABB.

Record all maintenance and proof test activities in the machine logbook.

### ■ Competence

The maintenance and proof test activities of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6.

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## **Fault tracing**

The indications given during the normal operation of the Safe torque off function are selected by drive control program parameter 31.22.

The diagnostics of the Safe torque off function cross-compare the status of the two STO channels. In case the channels are not in the same state, a fault reaction function is performed and the drive trips on an “STO hardware failure” fault. An attempt to use the STO in a non-redundant manner, for example activating only one channel, will trigger the same reaction.

See the firmware manual of the drive control program for the indications generated by the drive, and for details on directing fault and warning indications to an output on the control unit for external diagnostics.

Any failures of the Safe torque off function must be reported to ABB.

## Safety data

The safety data for the Safe torque off function is given below.

**Note:** The safety data is calculated for redundant use, and does not apply if both STO channels are not used.

Frame size	SIL	PL	SFF (%)	PFH ( $T_1 = 20$ a) (1/h)	PFD <sub>avg</sub> ( $T_1 = 2$ a)	PFD <sub>avg</sub> ( $T_1 = 5$ a)	MTTF <sub>D</sub> (a)	DC (%)	Cat.	SC	HFT	CCF	T <sub>M</sub> (a)
R8i	3	e	>99	5.0E-11	4.5E-07	1.1E-06	23970	≥90	3	3	1	80	20
2×R8i	3	e	>99	6.2E-11	5.5E-07	1.3E-06	16330	≥90	3	3	1	80	20
3×R8i	3	e	>99	7.3E-11	6.5E-07	1.6E-06	12390	≥90	3	3	1	80	20
4×R8i	3	e	>99	8.4E-11	7.6E-07	1.9E-06	9980	≥90	3	3	1	80	20
5×R8i	3	e	>99	9.5E-11	8.6E-07	2.1E-06	8360	≥90	3	3	1	80	20
6×R8i	3	e	>99	1.1E-10	9.6E-07	2.4E-06	7190	≥90	3	3	1	80	20
7×R8i	3	e	>99	1.2E-10	1.1E-06	2.6E-06	6310	≥90	3	3	1	80	20
8×R8i	3	e	>99	1.3E-10	1.2E-06	2.8E-06	5620	≥90	3	3	1	80	20

3AXD10000078136 G

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with  $\Delta T = 71.66 \text{ }^\circ\text{C}$
  - 1340 on/off cycles per year with  $\Delta T = 61.66 \text{ }^\circ\text{C}$
  - 30 on/off cycles per year with  $\Delta T = 10.0 \text{ }^\circ\text{C}$
  - $32 \text{ }^\circ\text{C}$  board temperature at 2.0% of time
  - $60 \text{ }^\circ\text{C}$  board temperature at 1.5% of time
  - $85 \text{ }^\circ\text{C}$  board temperature at 2.3% of time.
- The STO is a type B safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested
  - A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO response times:
  - STO reaction time (shortest detectable break): 1 ms
  - STO response time: 2 ms (typical), 25 ms (maximum)
  - Fault detection time: Channels in different states for longer than 200 ms
  - Fault reaction time: Fault detection time + 10 ms
- Indication delays:
  - STO fault indication (parameter 31.22) delay: < 500 ms
  - STO warning indication (parameter 31.22) delay: < 1000 ms

## ■ Terms and abbreviations

Term or abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage
HFT	IEC 61508	Hardware fault tolerance
MTTF <sub>D</sub>	EN ISO 13849-1	Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD <sub>avg</sub>	IEC 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time



Term or abbreviation	Reference	Description
PFH <sub>diag</sub>	IEC/EN 62061	Average frequency of dangerous failures per hour for the diagnostic function of STO
PL	EN ISO 13849-1	Performance level. Levels a...e correspond to SIL
Proof test	IEC 61508, IEC 62061	Periodic test performed to detect failures in a safety-related system so that, if necessary, a repair can restore the system to an "as new" condition or as close as practical to this condition
SC	IEC 61508	Systematic capability
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1...3)
STO	IEC/EN 61800-5-2	Safe torque off
$T_1$	IEC 61508-6	Proof test interval. $T_1$ is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of $T_1$ is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. See also section Maintenance.
$T_M$	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any $T_M$ values given cannot be regarded as a guarantee or warranty.
$\lambda_{\text{Diag}_d}$	IEC 61508-6	Dangerous failure rate (per hour) of the diagnostics function of STO
$\lambda_{\text{Diag}_s}$	IEC 61508-6	Safe failure rate (per hour) of the diagnostics function of STO

### ■ TÜV certificate

The TÜV certificate is available on the Internet at [www.abb.com/drives/documents](http://www.abb.com/drives/documents).

## ■ Declarations of conformity



# EU Declaration of Conformity

Machinery Directive 2006/42/EC

We

Manufacturer: ABB Oy

Address: Hiomotie 13, 00380 Helsinki, Finland.

Phone: +358 10 22 11

declare under our sole responsibility that the following products:

### Frequency converters and frequency converter components

**ACS880-04, -14, -34** (frames nxR8i)

**ACS880-04XT, -04FXT**

**ACS880-07, -17, -37, -107**

**ACS880-104**

**ACS880 multidrives**

**ACS880-104LC** (frames nxR8i)

**ACS880-07CLC, -07LC, -17LC, -37LC, -107LC** (frames nxR8i)

**ACS880 liquid-cooled multidrives**

identified with serial numbers beginning with 1 or 8

with regard to the safety functions

### Safe torque off

**Safe motor temperature** with FPTC-01 module (option code +L536)

**Safe Stop 1 (SS1-t)** with FSPS-21 module (+Q986)

**Safe stop 1 (SS1-t and SS1-r), Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Prevention of unexpected start-up**, with FSO-12 module (option code +Q973)

**Safe stop 1 (SS1-t and SS1-r), Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Safe Speed monitor, Safe direction, Prevention of unexpected start-up**, with FSO-21 and FSE-31 modules (option codes +Q972 and +L521)



**ACS880-07, -17, -37, -07CLC, -07LC, -17LC, -37LC, ACS880 multidrives and ACS880 liquid-cooled multidrives: Prevention of unexpected start-up** (option codes +Q950; +Q957), **Emergency stop** (option codes +Q951; +Q952; +Q963; +Q964; +Q978; +Q979), **Safely-limited speed** (option codes +Q965; Q966)

are in conformity with all the relevant safety component requirements of EU Machinery Directive 2006/42/EC, when the listed safety functions are used for safety component functionality.

The following harmonized standards have been applied:

EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems. Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of the control systems. Part 2: Validation
EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements

The following other standard has been applied:

IEC 61508:2010, parts 1-3	Functional safety of electrical / electronic / programmable electronic safety-related systems
IEC 61800-5-2:2016	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional

The products referred in this Declaration of conformity fulfil the relevant provisions of other European Union Directives which are notified in Single EU Declaration of conformity 3AXD10000497305.

Authorized to compile the technical file: ABB Oy, Hiomotie 13, 00380 Helsinki, Finland

Helsinki, 28 May 2021

Signed for and on behalf of:

*Peter Lindgren*  
Peter Lindgren  
Vice President, ABB Oy

*Vesa Tiihonen*  
Vesa Tiihonen  
Manager, Reliability and Quality, ABB Oy



## Declaration of Conformity

### Supply of Machinery (Safety) Regulations 2008

We

Manufacturer: ABB Oy

Address: Hiomotie 13, 00380 Helsinki, Finland.

Phone: +358 10 22 11

declare under our sole responsibility that the following products:

#### Frequency converters and frequency converter components

**ACS880-04, -14, -34** (frames nxR8i)

**ACS880-04XT, -04FXT**

**ACS880-07, -17, -37, -107**

**ACS880-104**

**ACS880 multidrives**

**ACS880-104LC** (frames nxR8i)

**ACS880-07CLC, -07LC, -17LC, -37LC, -107LC** (frames nxR8i)

**ACS880 liquid-cooled multidrives**

identified with serial numbers beginning with 1 or 8

with regard to the safety functions

#### Safe torque off

**Safe motor temperature** with FPTC-01 module (option code +L536)

**Safe Stop 1 (SS1-t)** with FSPS-21 module (+Q986)

**Safe stop 1 (SS1-t and SS1-r), Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Prevention of unexpected start-up**, with FSO-12 module (option code +Q973)

**Safe stop 1 (SS1-t and SS1-r), Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Safe Speed monitor, Safe direction, Prevention of unexpected start-up**, with FSO-21 and FSE-31 modules (option codes +Q972 and +L521)



**ACS880-07, -17, -37, -07CLC, -07LC, -17LC, -37LC, ACS880 multidrives and ACS880 liquid-cooled multidrives: Prevention of unexpected start-up** (option codes +Q950; +Q957), **Emergency stop** (option codes +Q951; +Q952; +Q963; +Q964; +Q978; +Q979), **Safely-limited speed** (option codes +Q965; Q966)

are in conformity with all the relevant safety component requirements of the Supply of Machinery (Safety) Regulations 2008, when the listed safety functions are used for safety component functionality.

The following designated standards have been applied:

EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems. Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of the control systems. Part 2: Validation
EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements

The following other standards have been applied:

EN 61508:2010, parts 1-3	Functional safety of electrical / electronic / programmable electronic safety-related systems
EN 61800-5-2:2017	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional

The products referred in this declaration of conformity fulfil the relevant provisions of other UK statutory requirements, which are notified in a single declaration of conformity 3AXD10001346556.

Authorized to compile the technical file:

ABB Limited, Daresbury Park, Cheshire, United Kingdom, WA4 4BT

Helsinki, 28 May 2021

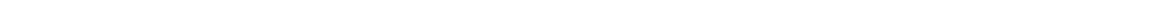
Signed for and on behalf of:

*Peter Lindgren*

Peter Lindgren  
Vice President, ABB Oy

*Vesa Tiihonen*

Vesa Tiihonen  
Manager, Reliability and Quality, ABB Oy



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# Further information

## **Product and service inquiries**

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to [www.abb.com/searchchannels](http://www.abb.com/searchchannels).

## **Product training**

For information on ABB product training, navigate to [new.abb.com/service/training](http://new.abb.com/service/training).

## **Providing feedback on ABB manuals**

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## **Document library on the Internet**

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