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ABB DRIVES FOR WATER

# ACQ580-34 drive modules

## Hardware manual







# ACQ580-34 drive modules

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.

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**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.

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### WARNING!

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

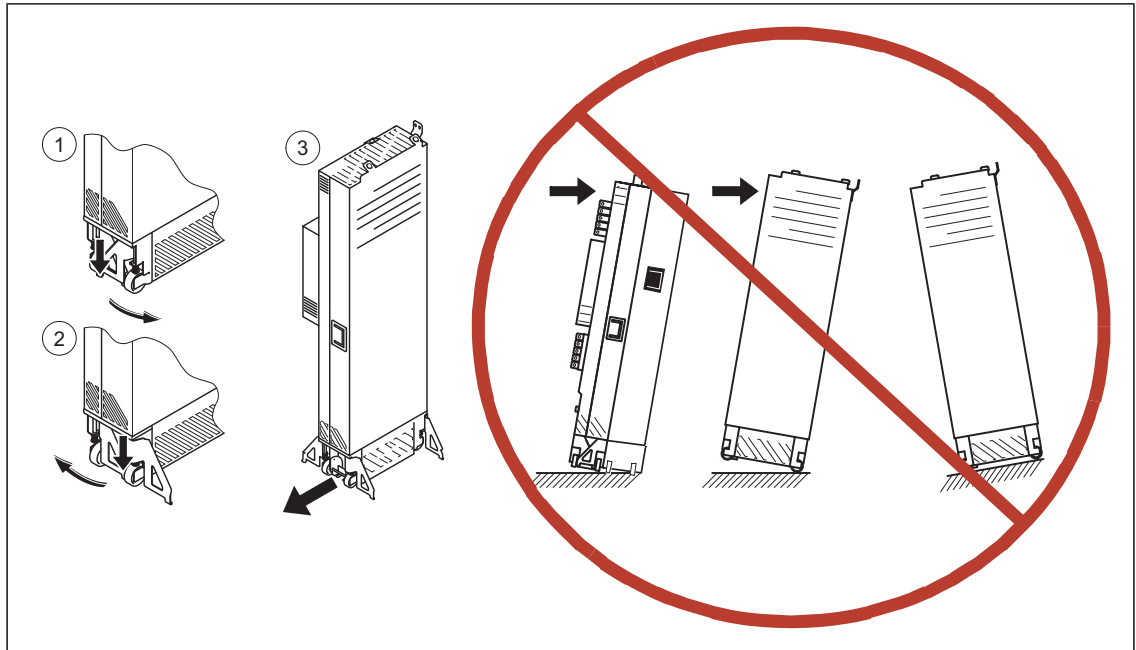
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- Keep the drive in its package until you install it. After unpacking, protect the drive from dust, debris and moisture.
- Use the required personal protective equipment: safety shoes with metal toe cap, safety glasses, protective gloves and long sleeves, 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.
- 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.

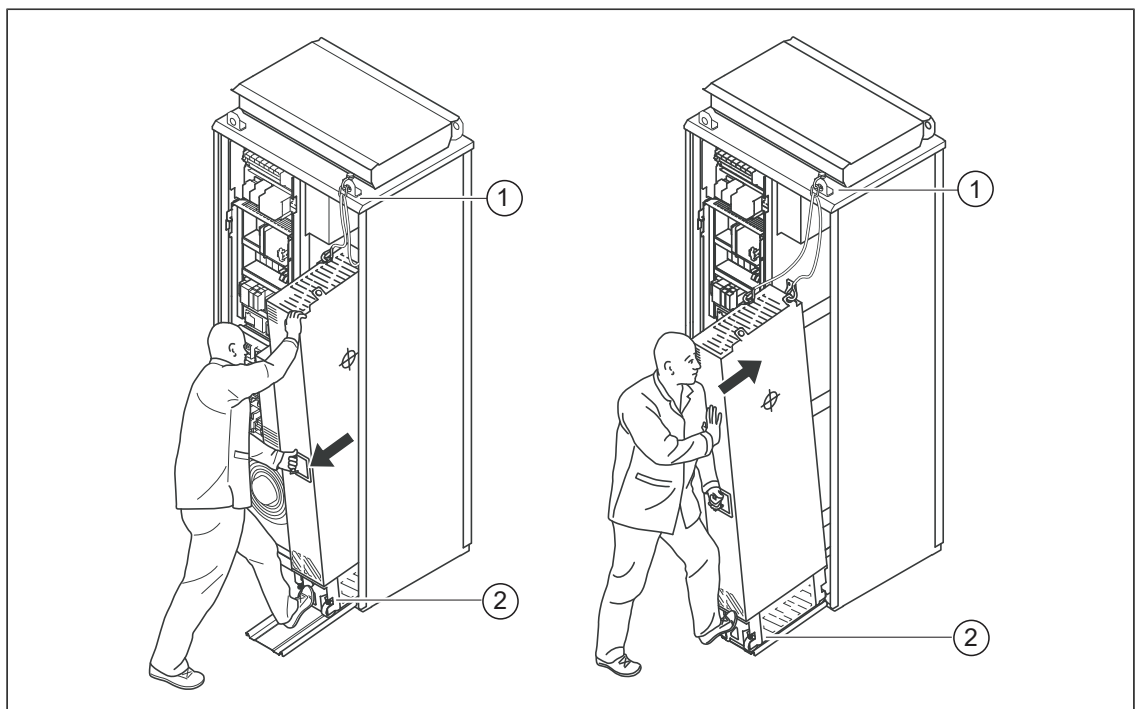


- Do not use the module extraction/installation ramp with plinth heights which exceeds the maximum allowed height.
  - Attach the module extraction/installation ramp carefully.
-

- Make sure that the module does not topple over when you move it on the floor: To open the support legs, press each leg a little down and turn it aside (1, 2). Whenever possible attach the module also with chains. Do not tilt the drive module. It is heavy and its center of gravity is high. The module overturns from a sideways tilt of 5 degrees. Do not leave the module unattended on a sloping floor.



- To prevent the drive module from falling, attach its top lifting lugs with chains to the cabinet (1) before you push the module into the cabinet and pull it from the cabinet. Push the module into the cabinet and pull it from the cabinet carefully preferably with help from another person. Keep a constant pressure with one foot on the base of the module (2) to prevent the module from falling on its back.



- 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.
- Vacuum clean the area around the drive before the start-up to prevent the drive cooling fan from drawing the dust inside the drive.
- 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 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- The maximum drive power cycles is five times in ten minutes. Power cycling the drive too often 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.
- Beware of hot air exiting from the air outlets.
- Do not cover the air inlet or outlet when the drive is running.

**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.

## 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.

Go through 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.)
  - Open the auxiliary voltage switch-disconnector (if present), and all other possible disconnecting devices that isolate the drive from dangerous voltage sources.
  - 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. 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.
  - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero.
6. Install temporary grounding as required by the local regulations.
7. Ask the person in control of the electrical installation work for a permit to 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.

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- 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.
- Remove the code labels attached to mechanical parts such as busbars, shrouds and sheet metal parts before installation. They may cause bad electrical connections, or, after peeling off and collecting dust in time, cause arcing or block the cooling air flow.

### **Note:**

- The motor cable terminals of the drive are at a dangerous voltage when the input power is on, regardless of whether the motor is running or not.
- When the input power is on, the drive DC bus is at a dangerous voltage.
- 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 wrist band 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.

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- Always ground the drive, the motor and adjoining equipment. This is necessary for the personnel safety. Proper grounding also reduces electromagnetic emission and interference.
- Make sure that the conductivity of the protective earth (PE) conductors is sufficient. See the electrical planning instructions of the drive. Obey the local regulations.
- Connect the power cable shields to protective earth (PE) terminals of the drive to make sure of personnel safety.
- Make a 360° grounding of the power and control cable shields at the cable entries to suppress electromagnetic disturbances.
- In a multiple-drive installation, connect each drive separately to the protective earth (PE) busbar of the power supply.

### **Note:**

- You can use power cable shields as grounding conductors only when their conductivity is sufficient.
- As the normal touch current of the drive is higher than 3.5 mA AC or 10 mA DC, you must use a fixed protective earth (PE) connection. The minimum size of the protective earth conductor must comply with the local safety regulations for high protective earth conductor current equipment. See standard IEC/EN 61800-5-1 (UL 61800-5-1) and the electrical planning instructions of the drive.



## 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 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".

### Note:

- The maximum drive power cycles is five times in ten minutes. Power cycling the drive too often 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 \(page 18\)](#).
- 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

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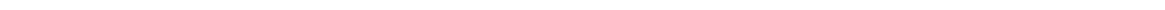


#### **WARNING!**

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.

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# 2

## Introduction to the manual

---

### Contents of this chapter

This chapter describes the intended audience and contents of the manual. It contains a flowchart of steps in examining the delivery, installing and commissioning the drive. The flowchart refers to chapters/sections in this manual and other manuals.

### Applicability

This manual applies to ACQ580-34 drive modules intended for user-defined cabinet installations.

### Target audience

This manual is intended for people who plan the installation, install, start up 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 working on the drive. You are expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

### Purpose of the manual

This manual provides information needed for planning the installation, installing, and servicing the drive.

### Categorization by frame size and option code

The instructions, technical data and dimension drawings which concern only certain drive frame sizes are marked with the symbol of the frame size (R11). The frame size is marked on the type designation label.

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The instructions and technical data which concern only certain optional selections are marked with option codes, eg, +E208. 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 \(page 38\)](#).

## Quick installation, commissioning and operating flowchart

Task	See chapter/section
<p>Plan the mechanical and electrical installation and acquire the accessories needed (cables, fuses, etc.).</p> <p>Examine the ambient conditions, ratings, required cooling air flow, input power connection, compatibility of the motor, motor connection, and other technical data.</p>	<p><a href="#">Guidelines for planning the mechanical installation (page 51)</a></p> <p><a href="#">Guidelines for planning the electrical installation (page 71)</a></p> <p><a href="#">Technical data (page 165)</a></p> <p>Option manual (if optional equipment is included)</p>
<p>Unpack and examine the units.</p> <p>Make sure that all necessary optional modules and equipment are present and correct.</p> <p>Only intact units can be started up.</p>	<p><a href="#">Moving and unpacking (page 61)</a></p> <p><a href="#">Examining the delivery (page 66)</a></p> <p>If the drive module has been non-operational for a year or more, the converter DC link capacitors need to be reformed. (<a href="#">Reforming the capacitors (page 157)</a>)</p>
<p>Examine the installation site. Attach the base of the cabinet to the floor.</p>	<p><a href="#">Examining the installation site (page 61)</a></p> <p><a href="#">Surrounding air conditions (page 176)</a></p>
<p>Route the cables.</p>	<p><a href="#">Routing the cables (page 84)</a></p>
<p>Measure the insulation of the supply cable, the motor and the motor cable and the resistor cable (if present).</p>	<p><a href="#">Measuring the insulation (page 96)</a></p>
<p><b>Standard drive modules</b></p> <ul style="list-style-type: none"> <li>• Install the additional components into the enclosure: for example, main disconnect, main contactor, main AC fuses, etc..</li> <li>• Install the drive module into the enclosure.</li> <li>• Connect the motor cables to the drive module terminals.</li> <li>• Connect the brake resistor and DC connection cables (if any) to the drive module terminals.</li> <li>• If the main disconnect is installed into the enclosure, connect it to the drive module terminals and the input power cabling to the disconnect.</li> </ul>	<p><a href="#">Installing the drive module and LCL filter module into an enclosure (page 135)</a></p> <p><a href="#">Connecting the motor cables and installing the shrouds (option +B051) (page 136)</a></p> <p><a href="#">Connecting the input cables and installing the shrouds (option +B051) (page 137)</a></p> <p><a href="#">Connecting the control cables to the integrated control unit (page 104)</a></p> <p>Manuals for any optional equipment</p>
<p>Drive modules with IP20 shrouds (option +B051)</p>	<p><a href="#">Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure (page 229)</a></p>
<p>Connect the control cables to the drive control unit.</p>	<p><a href="#">Connecting the control cables to the integrated control unit (page 104)</a></p>
<p>Examine the installation.</p>	<p><a href="#">Installation checklist (page 141)</a></p>



Task	See chapter/section
Commission the drive.	<a href="#">Start-up (page 143)</a>
Operate the drive: start, stop, speed control etc.	Appropriate firmware manual

## Terms and abbreviations

Term	Description
CCU-24	Type of control unit
CHDI-01	115/230 V digital input extension module
CMOD-01	Multifunction extension module (external 24 V AC/DC and digital I/O extension)
CMOD-02	Multifunction extension module (external 24 V AC/DC and isolated PTC interface)
Drive	Frequency converter for controlling AC motors
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
FBIP-21	BACnet/IP adapter module
FCAN	Optional CANopen® adapter module
FCNA-01	Optional ControlNet™ adapter module
FDNA-01	Optional DeviceNet™ adapter module
FECA	Optional EtherCAT adapter module
FENA-01	Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols
FEPL-02	Optional Ethernet POWERLINK adapter module
FMBT-21	Optional Ethernet adapter module for Modbus TCP protocol
FPBA-01	Optional PROFIBUS DP® adapter module
FPNO-21	Optional Profinet IO adapter module
Frame, frame size	Physical size of the drive or power module
FSCA-01	Optional RS-485 (Modbus/RTU) adapter
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.
NETA-21	Remote monitoring tool
PLC	Programmable logic controller
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 documents

Name	Code (English/Multi-lingual)	Code (Translation)
<b>Drive hardware manuals and guides</b>		
<i>Drive/converter/inverter safety instructions</i>	<a href="#">3AXD50000037978</a>	
<i>ACQ580-34 drive modules (250 to 500 kW) hardware manual</i>	3AXD50000420025	
<i>ACQ580-34 drive modules (250 to 500 kW) quick installation guide</i>	3AXD50000424634	

Name	Code (English/Multi-lingual)	Code (Translation)
<i>Recycling instructions and environmental information for ACS880-04, ACS880-04F, ACS880-14, ACS880-34, ACS580-04, ACQ580-04 and ACH580-04 drives</i>	<a href="#">3AXD50000137688</a>	
<b>Drive firmware manuals and guides</b>		
<i>ACQ580 pump control program firmware manual</i>	3AXD50000035867	
<i>ACQ580 drives with pump control program quick start-up guide</i>	3AXD50000048773	
<b>Drive option manuals and guides</b>		
<i>ACX-AP-x assistant control panels user's manual</i>	<a href="#">3AUA0000085685</a>	
<i>DPMP-02/03 mounting platform for control panels installation guide</i>	<a href="#">3AUA0000136205</a>	
<i>CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (+L537+Q971) user's manual</i>	<a href="#">3AXD50000030058</a>	
<i>FOCH du/dt filters hardware manual</i>	<a href="#">3AFE68577519</a>	
Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.		
<b>Tool and maintenance manuals and guides</b>		
<i>Drive composer PC tool user's manual</i>	<a href="#">3AUA0000094606</a>	
<i>Capacitor reforming instructions</i>	<a href="#">3BFE64059629</a>	

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.



[ACQ580-34 manuals](#)



# Operation principle and hardware description

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## Contents of this chapter

This chapter describes the operating principle and construction of the drive module.

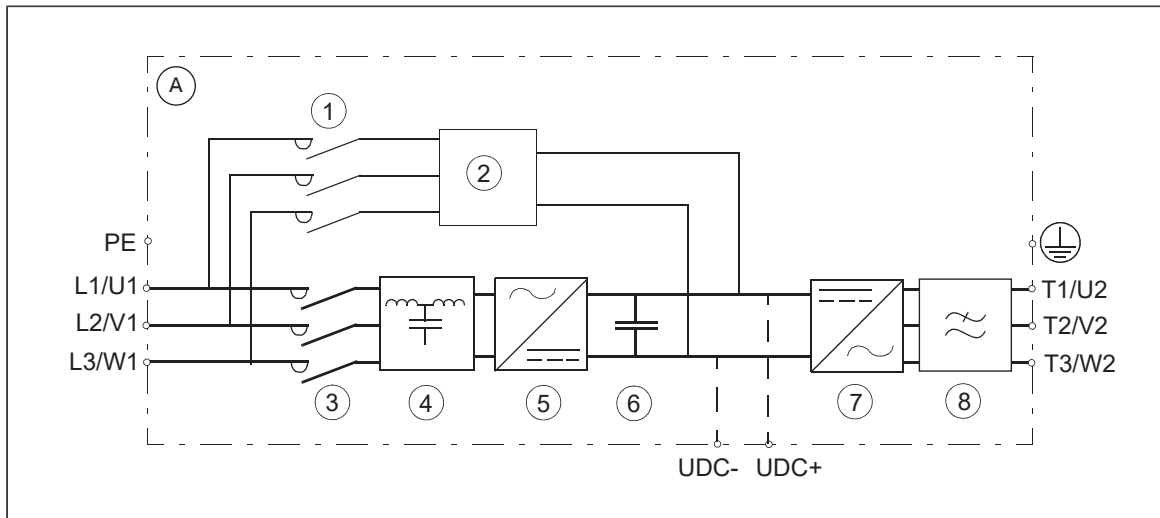
## Operation principle

The ACQ580-34 is an ultra-low harmonic drive module for controlling asynchronous AC induction motors, permanent magnet motors in open loop control and synchronous reluctance motors.

The drive includes a line-side converter and a motor-side inverter. The parameters and signals for both of them are combined into one primary user program.

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■ **Block diagram of the main circuit of the drive module**

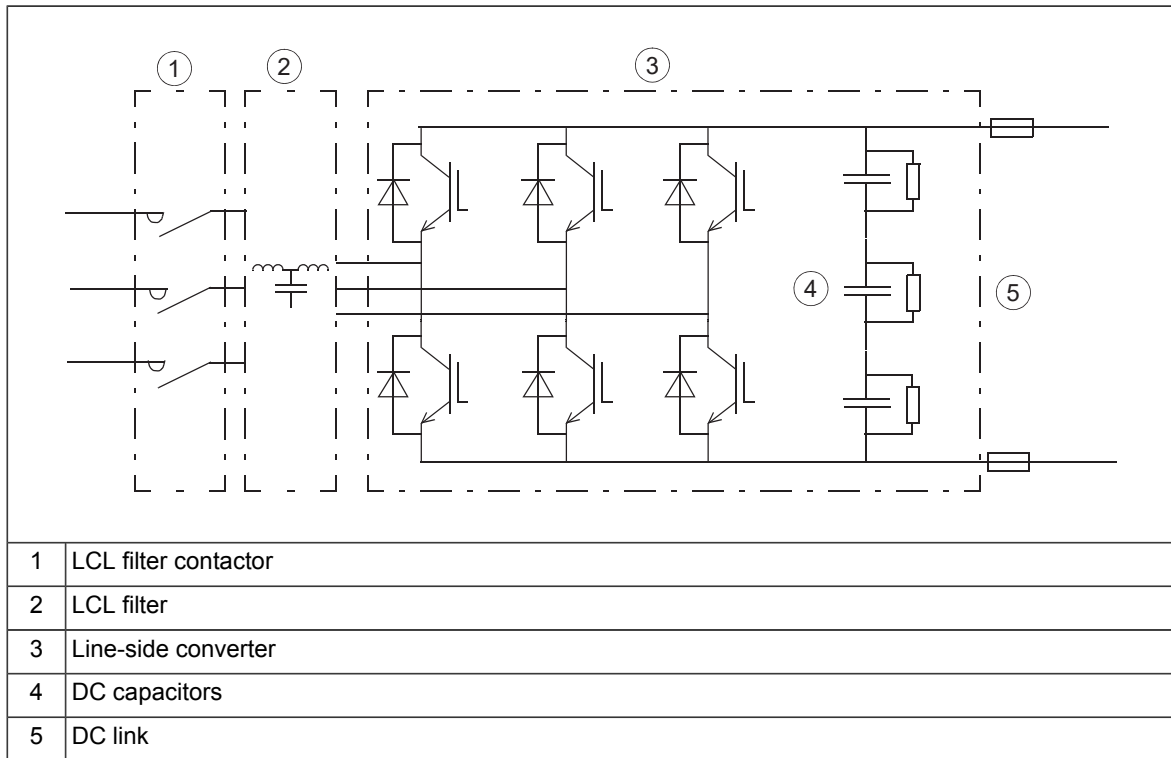


A	ACQ580-34 drive module
1	Charging circuit contactor
2	Charging circuit
3	Line contactor
4	LCL filter
5	Line-side converter
6	DC link. DC circuit between the line-side converter and motor-side converter.
7	Motor-side converter
8	Common mode filter (+E208)

■ **Line-side converter**

The line-side converter rectifies three-phase AC current to direct current for the intermediate DC link of the drive.

The following figure shows the simplified main circuit diagram of the line-side converter. The line-side converter is controlled by a type ZCU control unit.



### 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.

### ■ Motor-side converter

The motor-side converter 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 motor-side converter is controlled by a type CCU-24 control unit. This is called the drive control unit or control unit in this manual.

## Layout

### ■ Standard drive module configuration



A	Drive module. Contains line-side converter and motor side converter.	4	Lower front cover
B	LCL filter module	5	Cooling fan cassette
C	LCL filter module connected to the drive module	6	Support legs
1	Circuit board compartment	7	Pedestal
2	Upper front cover	8	Busbars for connecting the LCL filter module to the drive module
3	Control panel	9	Cover on busbar connections

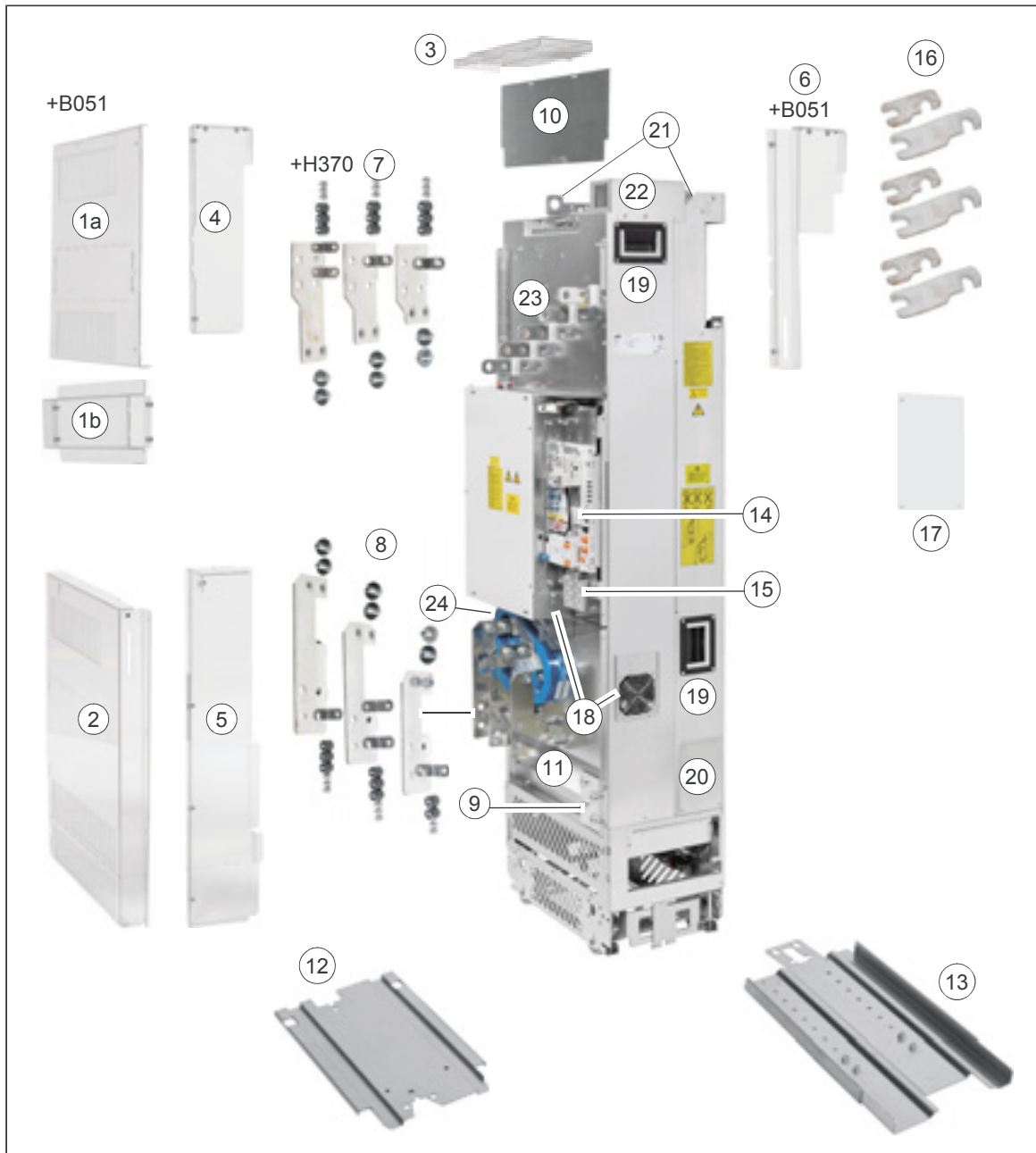
See section [Drive module \(page 34\)](#) for descriptions and photos of the drive module. For LCL filter module, see section [LCL filter module \(page 35\)](#).

■ **Drive with clear plastic shrouds (option +B051)**

For part descriptions, see section [Standard drive module configuration \(page 32\)](#). For clear plastic shrouds, see section [Drive module \(page 34\)](#)



■ Drive module

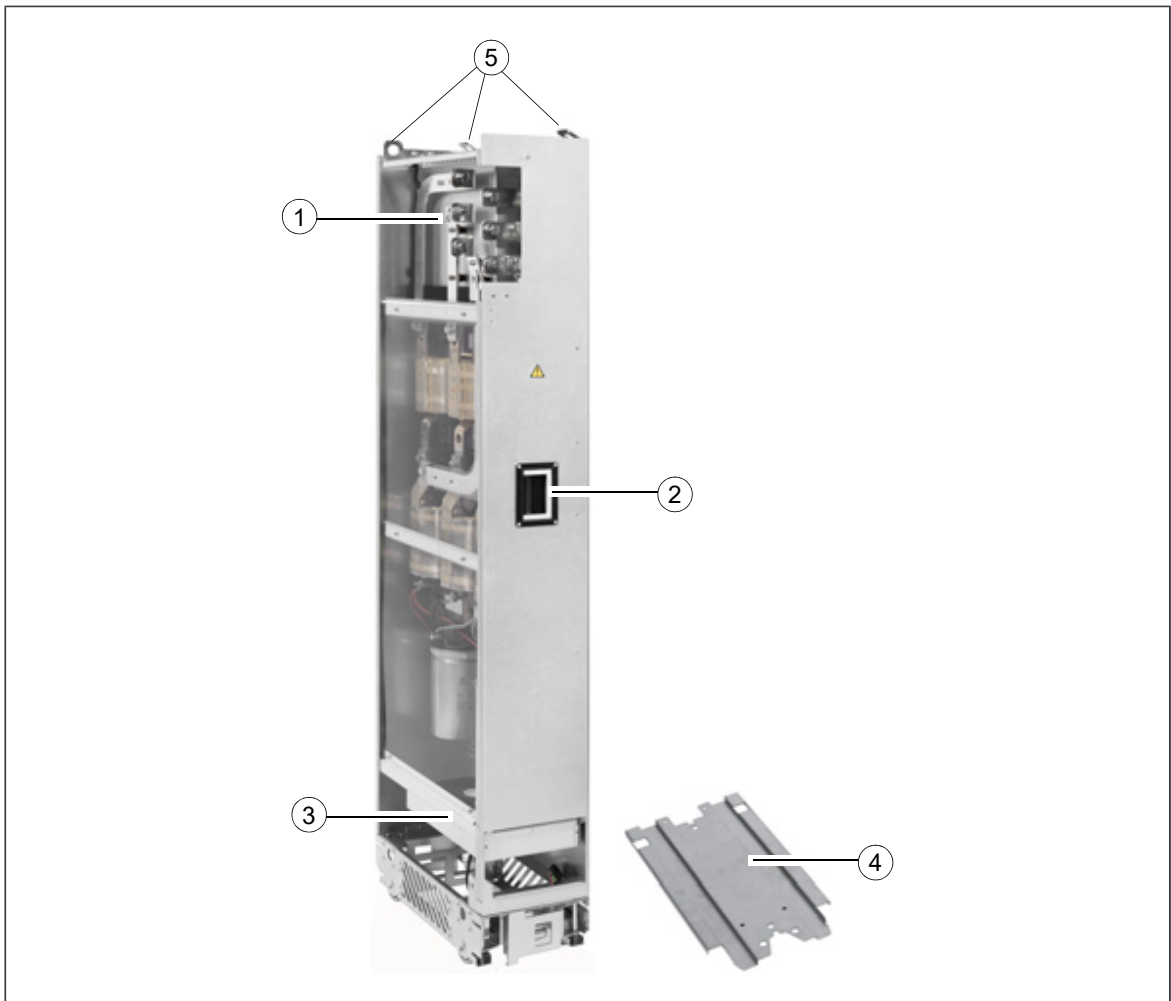


1	Clear plastic shroud to be attached onto the drive module input power cabling (1a). Entry shroud for side cabling (1b) (option +B051).	13	Telescopic extraction and insertion ramp
2	Clear plastic shrouds to be attached onto the drive module output power cabling (option +B051)	14	Control unit
3	Clear plastic shroud to be attached on top of the drive module (entry for top cabling) (option +B051).	15	Control cable clamp plate
4	Upper back clear plastic shroud (option +B051)	16	Busbars for connecting the drive module to the LCL filter electrically
5	Lower back clear plastic shroud (option +B051)	17	Cover for the busbar connection
6	Front clear plastic shroud (option +B051)	18	Auxiliary cooling fan
7	Input power cable connection terminals (option +H370)	19	Handle



8	Output power cable connection terminals (assembled at the factory)	20	Cover. When removed, you can attach the drive module to the LCL filter module.
9	Grounding terminal for output power cable shields	21	Lifting lugs
10	Metallic shroud. With option +H370, the shroud includes a ground bar.	22	Connector for charging circuit switch or contactor
11	Main cooling fans	23	Input power cable connection busbars (L1/U1, L2/V1, L3/W1 and DC+ and DC- busbars (UDC+ and UDC-))
12	Pedestal guide plate for the drive module	24	Common mode filter

■ **LCL filter module**



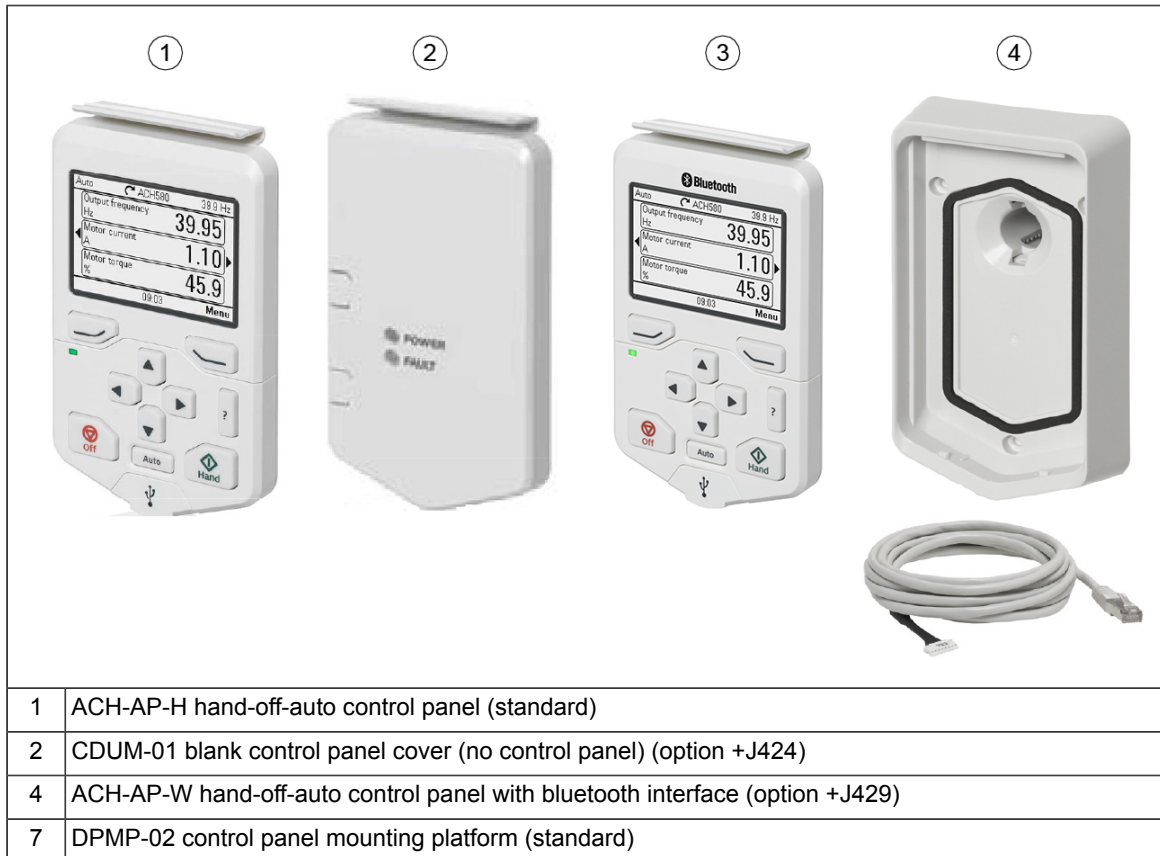
1	Busbars for connecting the LCL filter module to the drive module electrically	4	Pedestal guide plate for the LCL filter module
2	Handle	5	Lifting lugs
3	Main cooling fans	-	-

## ■ Control panel

In the standard drive module configuration, the control panel is located on the front cover of the module.

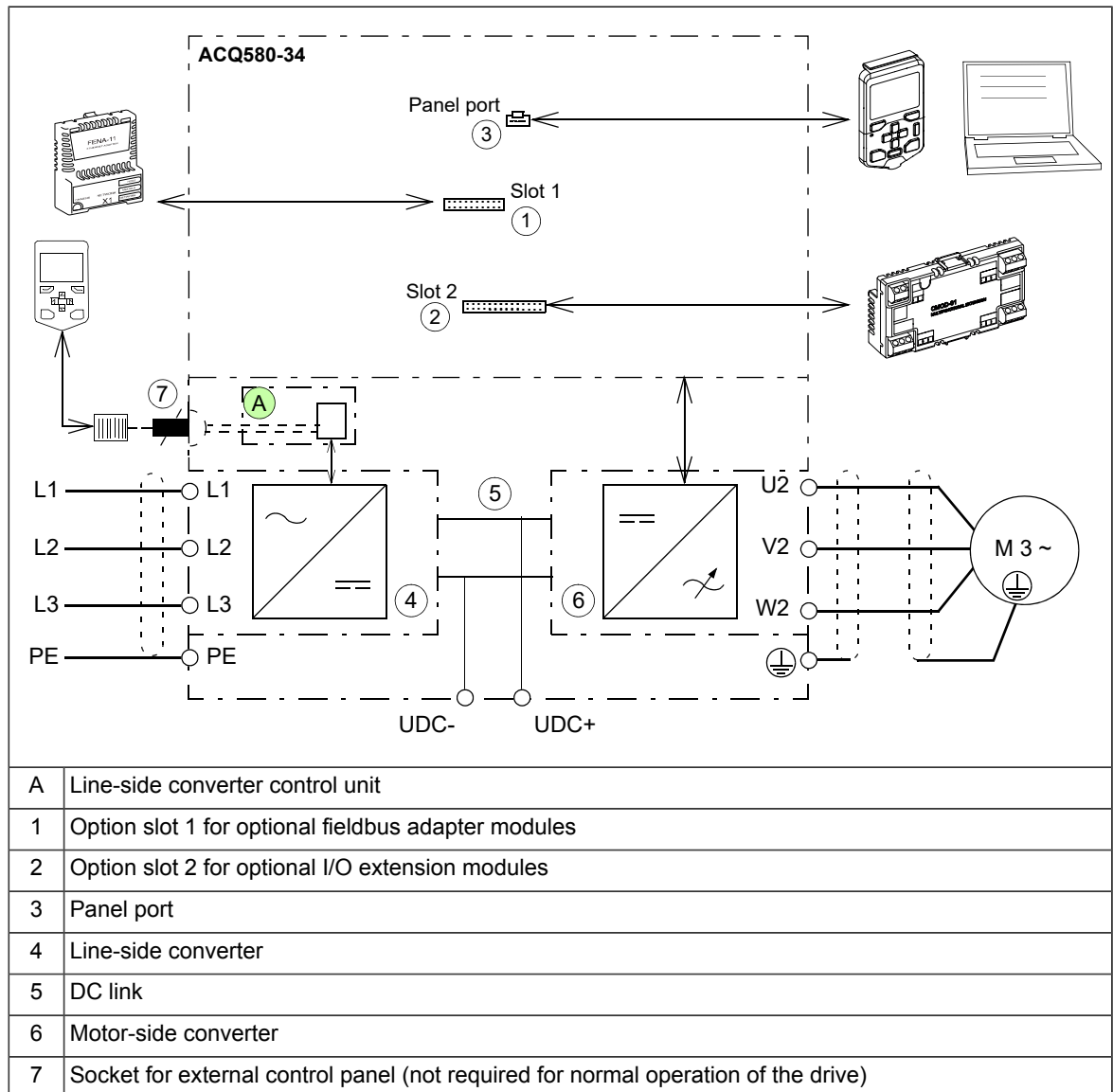
DPMP-02 door mounting platform allows you to mount the control panel on the cabinet door.

For the use of the control panel, see the firmware manual or *ACx-AP-x assistant control panels user's manual (3AUA0000085685 [English])*.



## Overview of power and control connections

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



## Type designation label

The type designation label includes a rating, markings, a type designation and a serial number, which allow individual recognition of each drive module. The type designation label is located on the front cover. An example label is shown below.

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**ABB**  
Origin Finland  
Made in Finland  
ABB Oy  
Hiomotie 13  
00380 Helsinki  
Finland

**ACQ580-34-246A-4+B051+E208+E210+H370+J400+J410+P932**

Input  
U1 3~ 400/480 VAC  
I1 212/209 A  
f1 50/60 Hz

Output  
U2 3~ 0...U1  
I2 246/240 A  
f2 0...500 Hz

FRAME  
**R11**

Air cooling  
IP20 Icc 100 kA  
UL open type

CE EAC TUV/KSB Safety Approved UL US LISTED IND. CONT. EE. SP20

R-R-Abb-ACX580-R11  
S/N: 1200405961

1	Type designation, see section <a href="#">Type designation key</a>
2	Name and address of the manufacturer
3	Frame size
4	Cooling method
5	Degree of protection
6	Ratings, see section <a href="#">Electrical ratings (page 165)</a>
7	Short-circuit withstand strength, see section <a href="#">Electrical power network specification (page 174)</a>
8	Valid markings
9	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.
10	Link to product information

## 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. Codes preceded by zero 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.

### Basic code

Code	Description
ACQ580	Product series
<b>Type</b>	
-34	When no options are selected: low-harmonic single drive module to be installed in an enclosure, IP00 (UL open type), bookshelf mounting with pedestal, integrated control unit with ACH-AP-H Assistant control panel with panel holder, build-in LCL filter, full-size output cable connection terminals, internal EMC filter (+E210), common mode filter (+E208), DC connection busbars, ACQ580 standard pump control program, RS-485 Modbus RTU adapter module, Safe torque off function, coated boards, printed multilingual quick installation and start-up guides, extraction/installation ramp.
<b>Size</b>	

Code	Description
-xxxxA	See the ratings table.
<b>Voltage range</b>	
-4	380...480 V AC. This is indicated in the type designation label as typical input voltage level (3~ 400/480 VAC)

### ■ Option codes

Code	Description
B051	IP20 shrouds for cabling area
E208	Common mode filter (included as standard)
E210	EMC filter for 2nd environment TN (grounded) system, category C3 (Included as standard)
0H371	No full size cable connection terminals for output power cables
H370	Full-size input terminals
0J400	No control panel
J400	ACH-AP-H control panel (included as standard)
J410	DPMP-02 door mounting kit for the control panel (included as standard)
J424	Blank control panel cover (no control panel)
J425	ACS-AP-I control panel
K451	FDNA-01 DeviceNet™ adapter module
K454	FPBA-01 PROFIBUS DP adapter module
K457	FCAN-01 CANopen adapter module
K458	FSCA-01 RS-485 (Modbus/RTU) adapter module
K475	FENA-21 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
K490	FEIP-21 EtherNet/IP adapter module
K491	FMBT-21 Modbus/TCP adapter module
K492	FPNO-21 PROFINET IO adapter module
L501	CMOD-01 External 24 V AC/DC and digital I/O extension (2×RO and 1×DO)
L512	CHDI-01 115/230 V digital input module (six digital inputs and two relay outputs)
L523	CMOD-02 External 24 V and isolated PTC interface
L537	CPTC-02 ATEX-certified thermistor protection module
N2000	Standard language package (default, includes EN,DE,ES,PT,FR,ZH,IT,FI,PL,RU,TR)
N2901	Europe language package (default for SE,CZ,HU,DA,DU, includes EN,DE,ES,PT,FR,SV,CZ,HU,DA,DU)
N2902	Asia language package (default for KR,TH, includes EN,DE,ES,PT,FR,ZH,KR,TH)
0P919	No extraction/installation ramp
P906	External control unit (outside the drive module)
P932	Extended warranty 60 months from delivery
Q971	ATEX-certified safe disconnection function
R700	Documentation/manuals in English
R701	German
R702	Italian

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<b>Code</b>	<b>Description</b>
R705	Swedish
R707	French
R708	Spanish
R709	Portuguese
R711	Russian
R714	Turkish

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# 4

## Generic cabinet planning instructions

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### Contents of this chapter

This chapter contains generic cabinet planning instructions applicable to any user-defined cabinet system. The topics discussed are essential for the safe and trouble-free use of the drive system.

### 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.

### Cabinet construction

Basic requirements for the cabinet construction are listed below. Make sure that:

- cabinet frame is sturdy enough to carry the weight of the components, control circuitry and other equipment installed in it
- cabinet protects the modules against contact and agrees with the requirements for dust and humidity
- cabinet frame and doors are strong enough to provide adequate protection against flames or pressure blast originating from inside the cabinet in case of arc flash or similar failure
- cabinet has air inlet and outlet gratings that allow free flow of cooling air through the modules inside the cabinet.

#### ■ Disposition of the devices

Plan a spacious layout to ensure easy installation and maintenance. Sufficient cooling air flow, obligatory clearances, cables and cable support structures all require space.

---

Place the control board(s) away from:

- main circuit components such as contactors, switches and power cables
- hot parts (heatsink, air outlet of the drive module).

### ■ Grounding of mounting structures

Arrange the grounding of the module by leaving the contact surfaces of the fastening points unpainted (bare metal-to-metal contact). The module frame is grounded to the PE busbar of the cabinet via the fastening surfaces, screws and the cabinet frame. Alternatively, use a separate grounding conductor between the PE terminal of the module and the PE busbar of the cabinet.

Ground also the other components in the cabinet according to the principle above.

### ■ Busbar material and joints

ABB recommends tin-plated copper, but aluminum can also be used.

**Note:** Before joining aluminum busbars, remove the oxide layer and apply suitable anti-oxidant joint compound.

### ■ Shrouds

The installation of shrouds (touch protection) to fulfill applicable safety regulations is the responsibility of the drive system builder.

Ready-made shrouding parts are available from ABB for some cabinet designs, see the ordering information.

### ■ 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

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## 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

## Cooling and degrees of protection

### ■ Planning the cooling

When you plan the cooling of the cabinet:

- make sure that the ventilation of the installation site is sufficient so that the cooling air flow and ambient temperature requirements of the module are met (see the hardware manual)
- leave enough free space around the components to ensure sufficient cooling. Observe the minimum clearances given for each component. For the module specific free space requirements, see the respective hardware and cabinet installation manuals.

### ■ Air-cooled drive systems

#### Air inlets and outlets

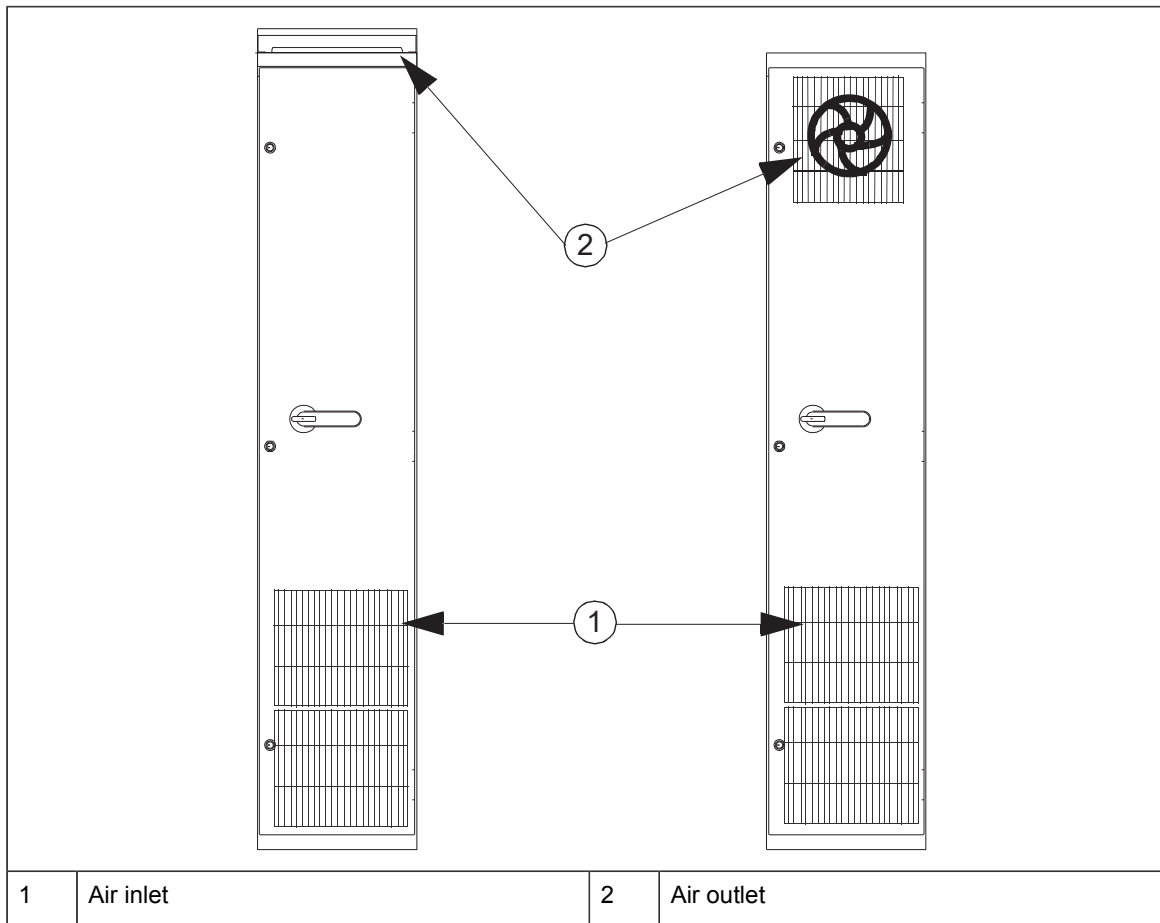
Equip the air inlets and outlets with gratings that:

- are large enough to allow sufficient air flow in and out of the cabinet (critical for correct cooling of the module)
- guide the air flow
- protect against contact
- prevent water splashes from entering the cabinet
- ensure adequate protection against flames or pressure blast originating from inside the cabinet in case of arc flash or similar failure.

The drawing below shows two typical cabinet cooling solutions. The air inlet is at the bottom of the cabinet. The outlet is on the roof or on the upper part of the door if room height is limited.

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**Note:** Use an extra exhaust fan if the air outlet is on the cabinet door.



Arrange the cooling air flow through the components according to the technical data in the respective hardware manual. See the specifications for:

- cooling air flow
  - Note:** The values stated for each component in their respective manuals apply to continuous nominal load. If the load is cyclic or less than nominal, less cooling air is required.
- allowed ambient temperature and temperature rise inside the cabinet
- allowed pressure drop over the cabinet that the cooling fan can overcome
- air inlet and outlet sizes required for cooling and recommended filter material (if used).

**Note:** The heat dissipated by cables and other additional equipment must also be ventilated.

The internal cooling fans of the converter modules and filters are usually sufficient to keep the component temperatures low enough in IP20 and IP42 cabinets. Additional fans are present in the example designs as needed. If you install additional heat-generating components to the cabinet, make sure to upgrade the cooling system accordingly.

In IP54 cabinets, thick filter mats are used to prevent water splashes from entering the cabinet. This requires the installation of additional cooling equipment, such as a hot air exhaust fan.

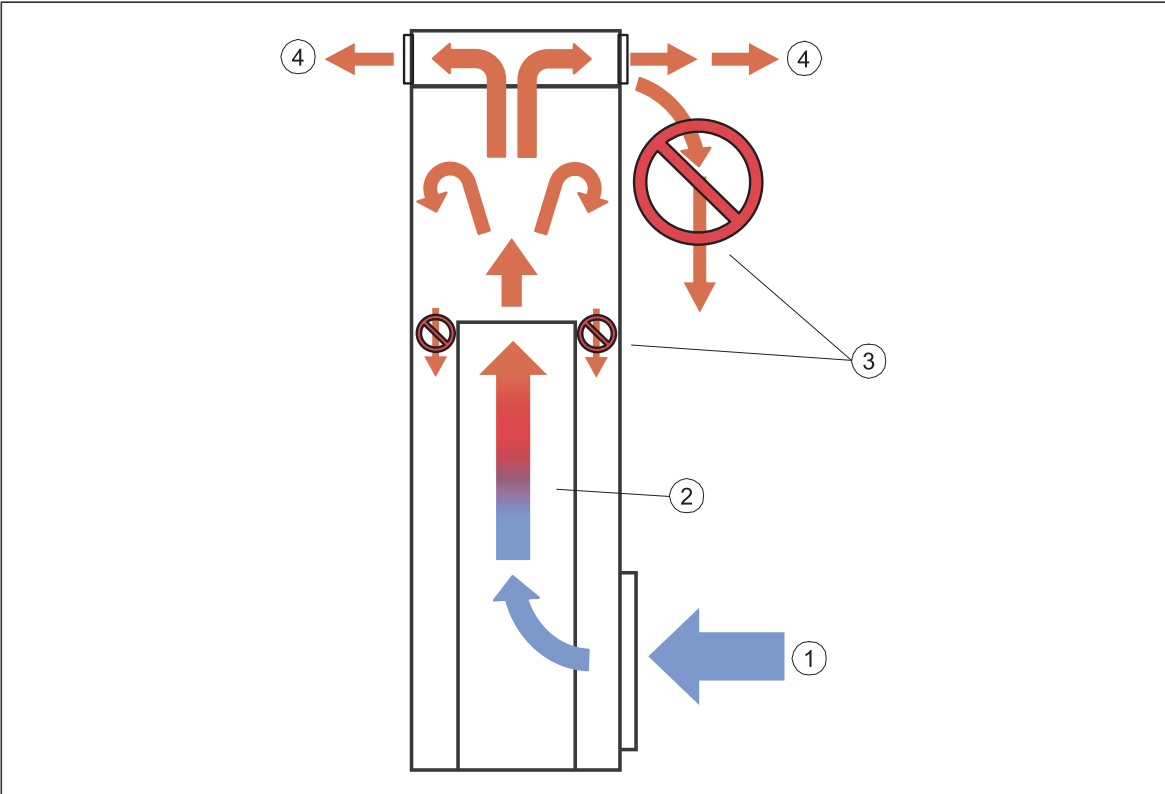
**Preventing the recirculation of hot air**

Prevent hot air circulation outside the cabinet by leading the outgoing hot air away from the area where the inlet air to the cabinet is taken. Possible solutions are listed below:

- gratings that guide air flow at the air inlet and outlet
- air inlet and outlet at different sides of the cabinet
- cool air inlet in the lower part of the front door, and an extra exhaust fan on the roof of the cabinet.

Prevent hot air circulation inside the cabinet with, for example, leak-proof air baffles. No gaskets are usually required.

The drawing below shows the air flow inside and outside the cabinet.

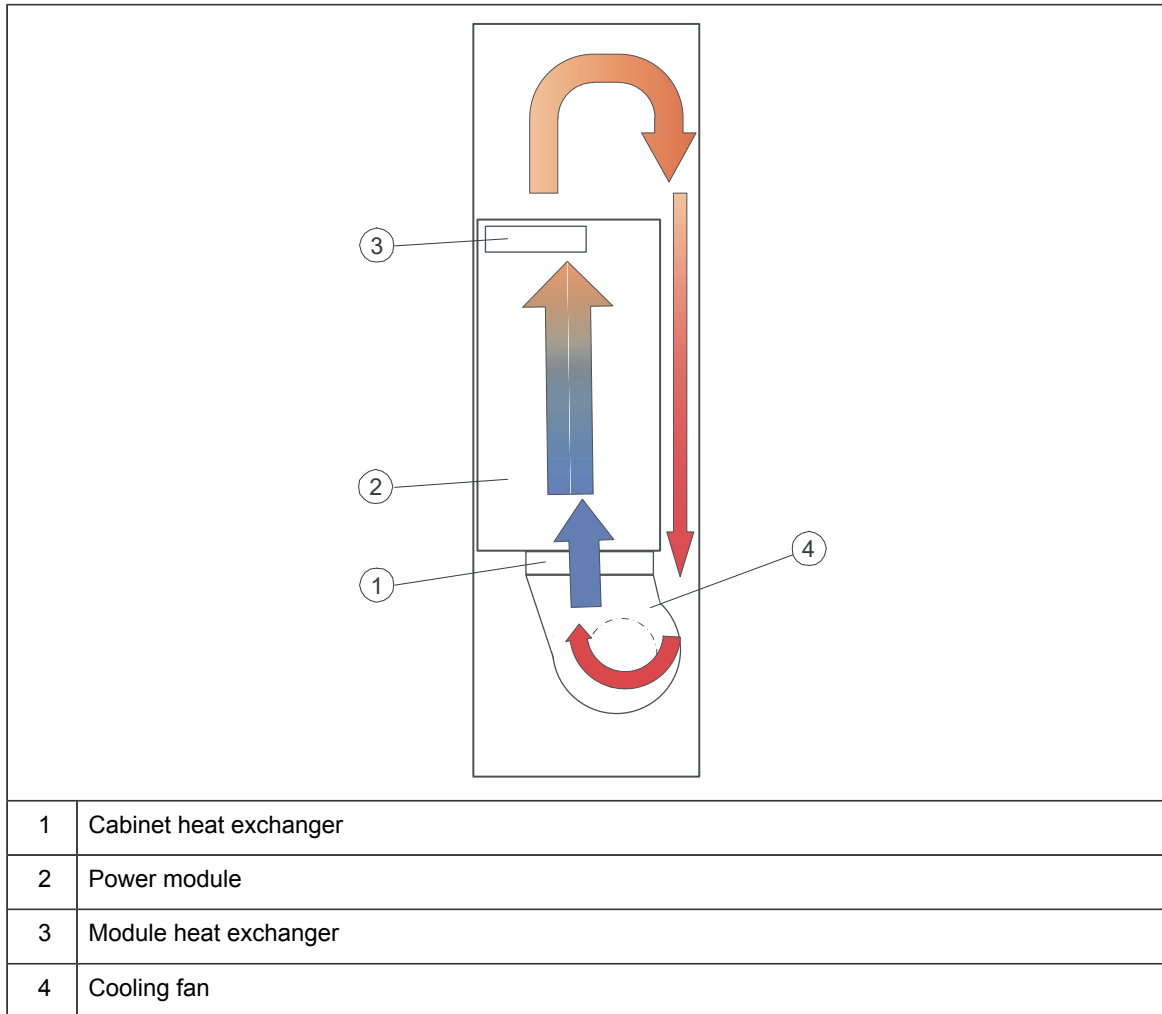


1	Air flow in
2	Power module
3	Hot air circulation to be prevented
4	Air flow out

■ **Liquid-cooled drive systems**

The cabinet can be sealed from the ambient air. The air inside the cabinet must be able to circulate freely. The power module in the cabinet can have a dedicated fan to push air through an air-to-liquid heat exchanger and the module. The returning air flow from the upper part of the cubicle must not be obstructed. A cabinet with diverse components can have a common fan/heat exchanger combination.

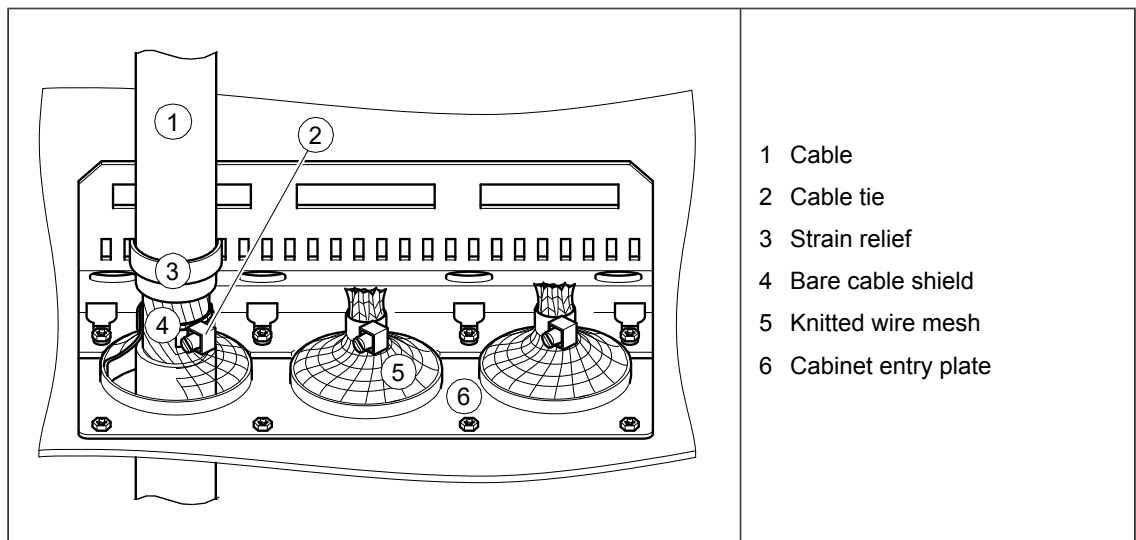
The drawing below shows the air flow inside the cabinet.



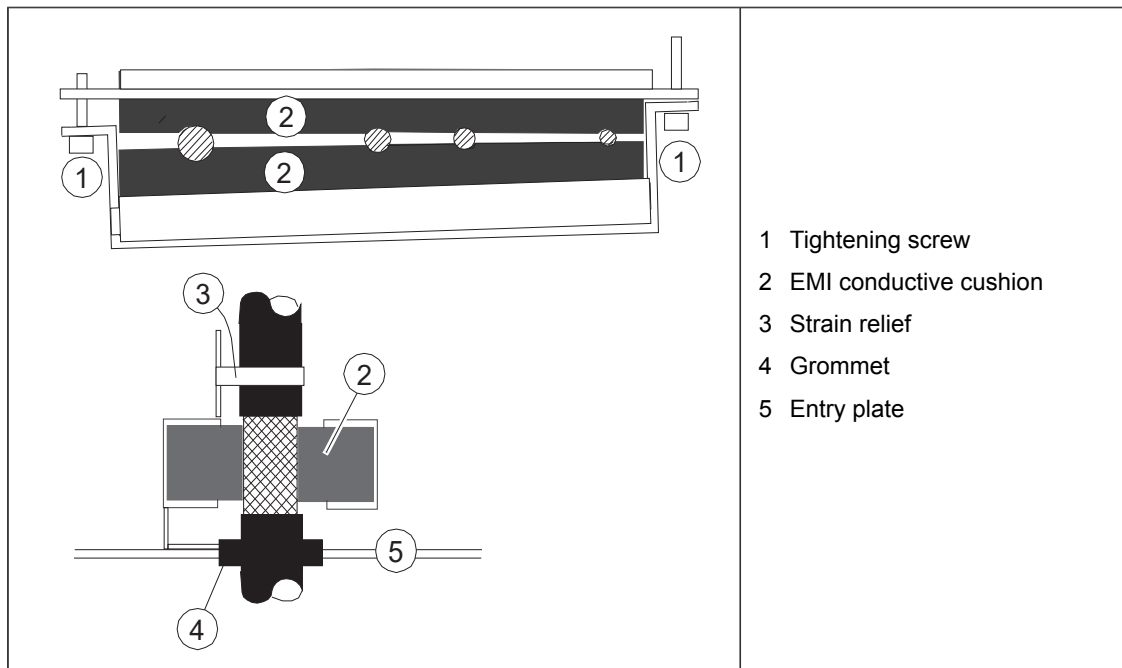
**EMC requirements**

Note the following when you plan the electromagnetic compatibility of the cabinet:

- Generally, the fewer and smaller the holes in the cabinet, the better the interference attenuation. The maximum recommended diameter of a hole in galvanic metal contact in the covering cabinet structure is 100 mm (3.94 in). Pay special attention to the cooling air inlet and outlet gratings.
- The best galvanic connection between the steel panels is achieved by welding them together as no holes are necessary. If welding is not possible, ABB recommends to leave the seams between the panels **unpainted** and equipped with special conductive EMC strips to provide adequate galvanic connection. Usually, reliable strips are made of flexible silicon mass covered with a metal mesh. The non-tightened touch-contact of the metal surfaces is not sufficient, so a conductive gasket between the surfaces is required. The maximum recommended distance between assembly screws is 100 mm (3.94 in).
- Construct sufficient high-frequency grounding network in the cabinet to avoid voltage differences and forming of high-impedance radiator structures. A good high-frequency grounding is made with short flat copper braids for low inductance. One-point high-frequency grounding cannot be used due to the long distances inside the cabinet.
- 360° high-frequency grounding of the cable shields at the cable entries improves the EMC shielding of the cabinet.
- ABB recommends 360° high-frequency grounding of the motor cable shields at their entries. The grounding can be implemented by a knitted wire mesh screening as shown below.



- ABB recommends 360° high-frequency grounding of the control cable shields at their entries. The shields can be grounded by means of conductive shielding cushions pressed against the cable shield from both directions as shown below.



## Attaching the cabinet



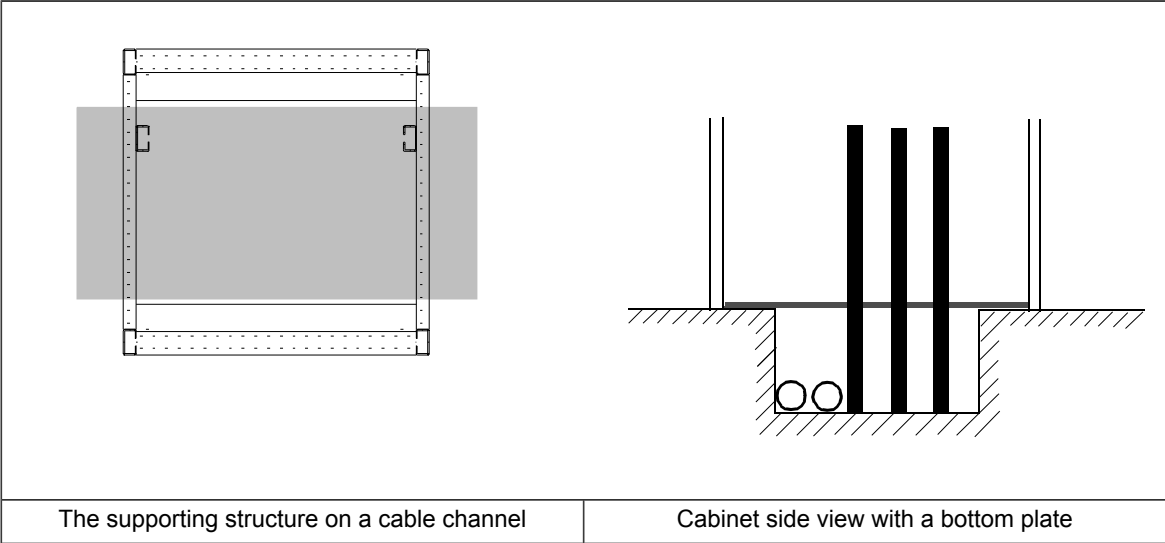
### **WARNING!**

Do not attach the cabinet by electric welding. ABB does not assume any liability for damages caused by electric welding as the welding circuit can damage electronic circuits in the cabinet.

## Cabinet placement on a cable channel

Note the following when you plan to place the cabinet on a cable channel:

- The cabinet structure must be sturdy enough. If the whole cabinet base is not supported from below, the cabinet weight will lie on the sections that the floor carries.
- Equip the cabinet with a sealed bottom plate and cable entries to ensure the degree of protection and to prevent the cooling air flow from the cable channel into the cabinet.



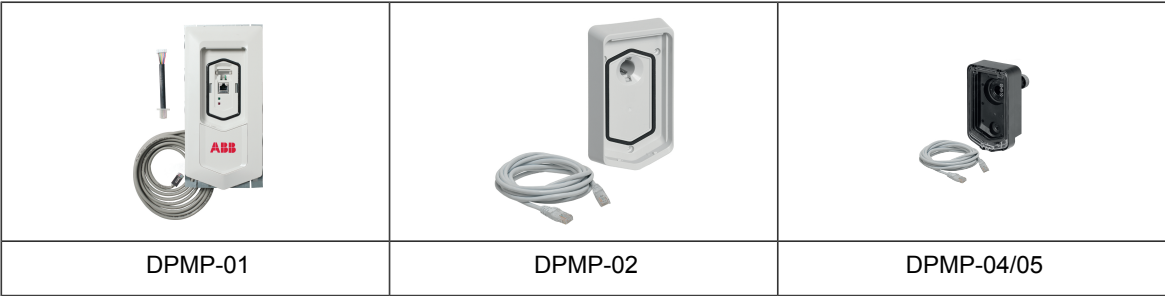
### Cubicle heaters

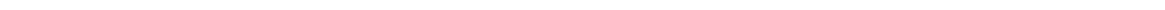
Use a heater if there is a risk of condensation in the cabinet. Although the primary function of the heater is to keep the air dry, it may also be required for heating at low temperatures.

### Attaching the control panel on the cabinet door

You can use a mounting platform to attach the control panel on the cabinet door. Mounting platforms for control panels are available as options from ABB. For more information, see

Manual	Code (English)
<i>DPMP-01 mounting platform for control panels installation guide</i>	3AUA0000100140
<i>DPMP-02/03 mounting platform for control panels installation guide</i>	3AUA0000136205
<i>DPMP-04/05 mounting platform for control panels installation guide</i>	3AXD50000308484









# 5

## **Guidelines for planning the mechanical installation**

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### **Contents of this chapter**

This chapter guides in planning drive cabinets and installing the drive module into a user-defined cabinet. The chapter gives cabinet layout examples and free space requirements around the module for cooling. These guidelines are essential for the safe and trouble-free use of the drive system.

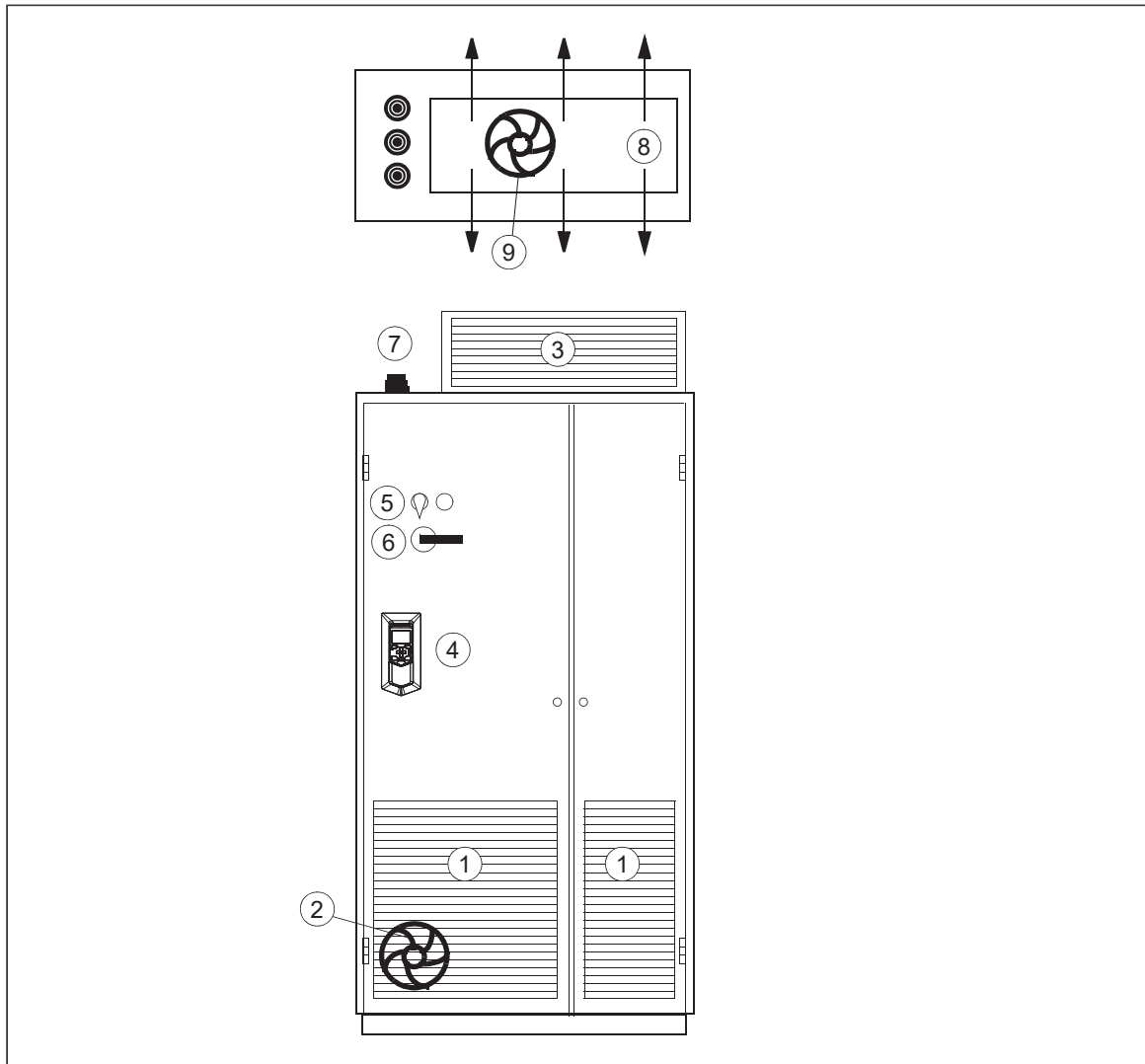
### **Installation positions of the drive module**

The drive module must be installed in an upright bookshelf position in a cabinet.

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## Layout example, door closed

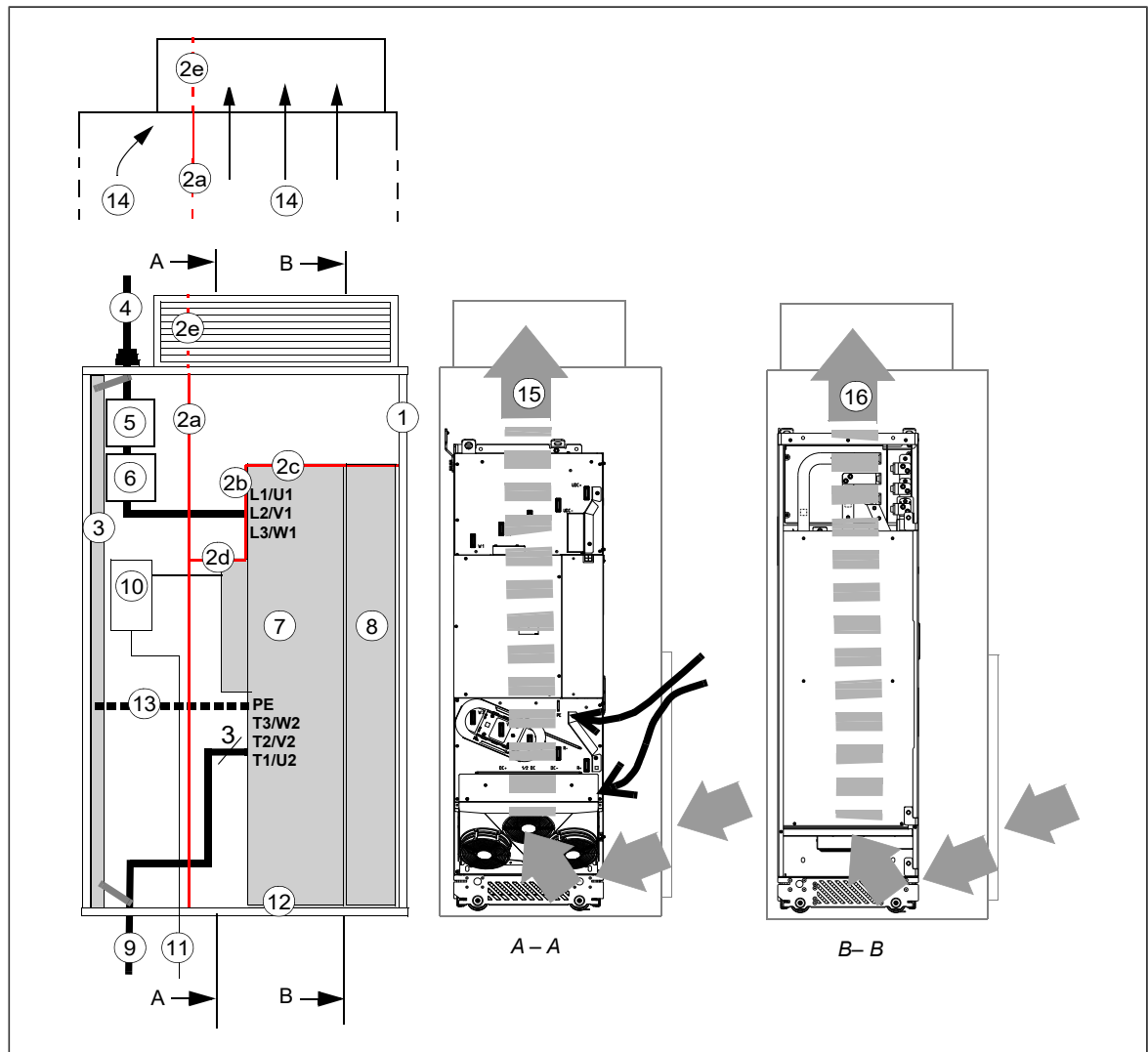
This diagram shows a cabinet layout example with the input power cable entry from top and the motor cable entry from bottom.



1	Air inlet for the drive module	6	Operating handle of the disconnecter
2	An extra fan is not necessary if an extra air baffle is used on the cabinet roof (see the following layout examples)	7	Rubber grommets for degree of protection
3	Air outlet for the drive module and LCL filter module and other equipment on the cabinet roof. An exhaust fan if needed.	8	Roof air flow viewed from top
4	Drive control panel with DPMP-01 mounting platform. The control panel is connected to the drive module control unit inside the cabinet.	9	Fan required for IP20, IP42 or IP54 air outlet kit, has to be ordered separately. See <a href="#">Cooling fans (page 163)</a> .
5	Contacter control switch and emergency stop switch (connected to the contactor control circuit inside the cabinet)	-	

**Note:** The sizes of the air inlet and outlet gratings are critical for proper cooling of the drive module. For losses and cooling data requirements, see the technical data.

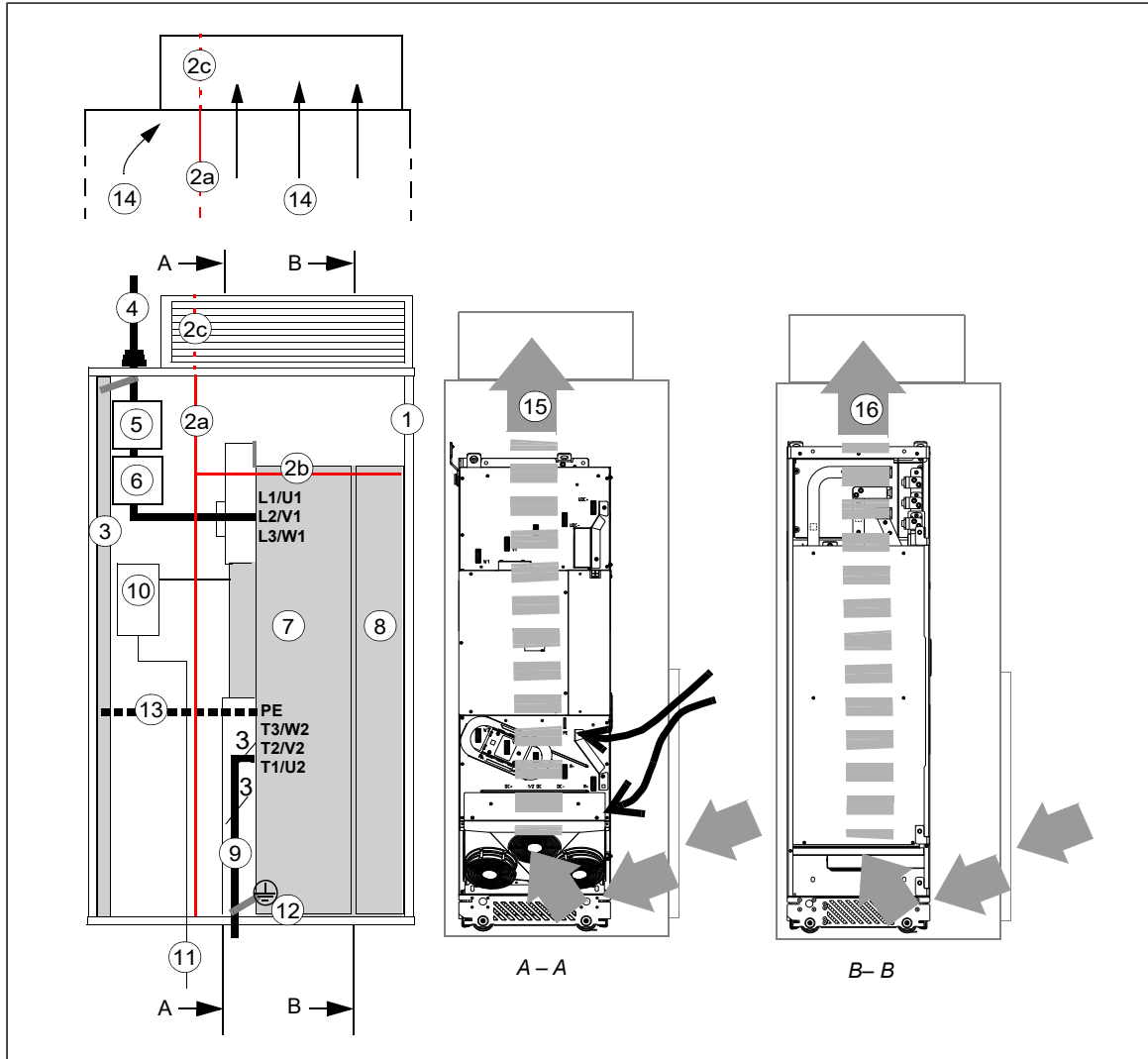
## Layout example, door open (standard drive module configuration)



1	Supporting frame of the cabinet	9	Motor cable including the protective ground conductor of the drive module
2	Vertical (2a, 2b) and horizontal (2c, 2d) air baffles that separate the cool and hot areas (leak-proof lead-throughs). See section <i>Preventing the recirculation of hot air</i> (page 55).	10	Drive module control unit. <b>Note:</b> The upper door air inlet is critical for proper cooling of the control unit.
2e	Optional air baffle that is needed when there is no fan on the lower part of the cabinet door. See section <i>Preventing the recirculation of hot air</i> (page 55).	11	External control cables
3	Cabinet grounding busbar (PE)	12	Grounding screws
4	Input power cable including the protective ground conductor (PE) of the drive	13	Alternative to grounding screws (12)
5	Disconnecter and fuses	14	Air flow to the roof
6	Contactors	15	Air flow through the drive module
7	Drive module	16	Air flow through the LCL filter
8	LCL filter module	-	-
<b>Note:</b> The power cable shields can also be grounded to the drive module grounding terminals.			

**Note:** See also section *Required free space* (page 58).

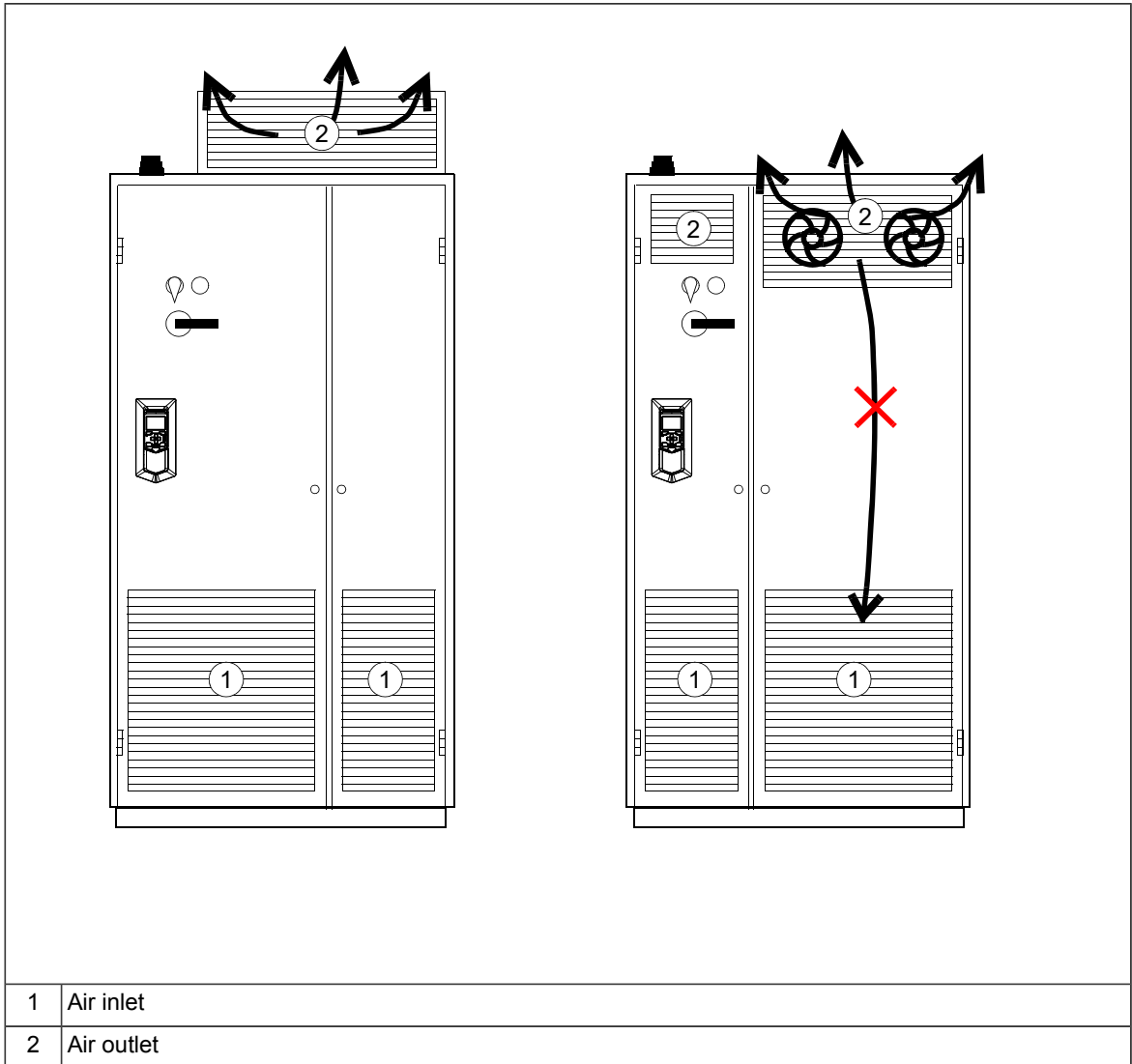
## Layout example, door open (option +B051)



1	Supporting frame of the cabinet	8	LCL filter module
2a	Vertical (2a) and horizontal (2b) air baffles that separate the cool and hot areas (leakproof entries). See section <i>Preventing the recirculation of hot air</i> (page 55).	9	Motor cable including the protective ground conductor of the drive module
2b		10	Drive module control unit. <b>Note:</b> The upper door air inlet is critical for proper cooling of the control unit.
2c	Optional air baffle that is needed when there is no fan on the lower part of the cabinet door. See section <i>Preventing the recirculation of hot air</i> (page 55).	11	External control cables
3	Cabinet grounding busbar (PE)	12	Grounding screws
4	Input power cable including the protective ground conductor (PE) of the drive	13	Alternative to grounding screws (12)
5	Disconnecter and fuses	14	Air flow to the roof
6	Contacteur	15	Air flow through the drive module
7	Drive module	16	Air flow through the LCL filter

## Cooling solutions

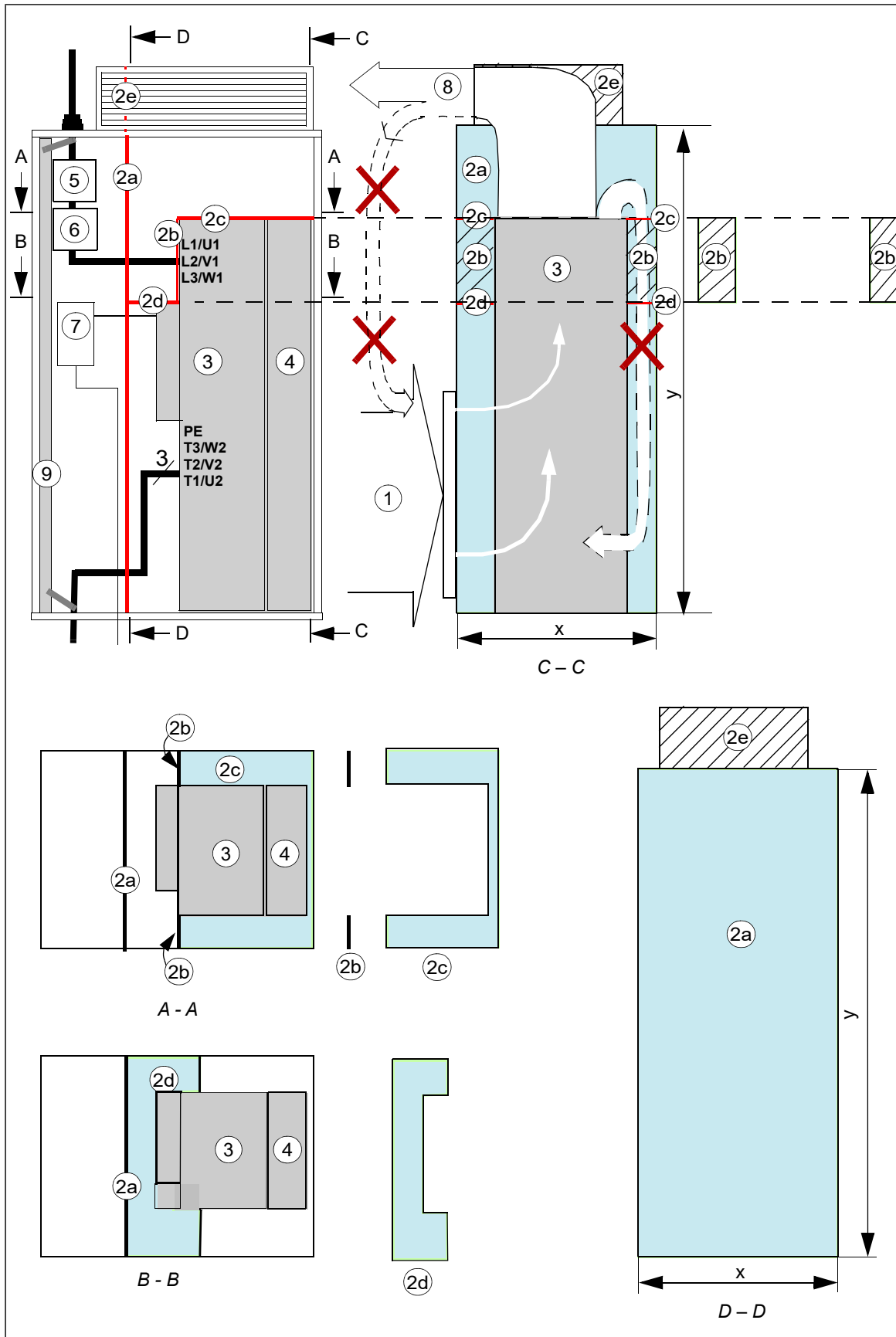
The drawing below shows typical cabinet cooling solutions. The air inlet is at the bottom of the cabinet, while the outlet is on the roof or on the upper part of the door. Use extra exhaust fans if the air outlet is on the cabinet door, see the technical data for the required cooling air flow.



## Preventing the recirculation of hot air

■ **Bookshelf mounting (standard drive module configuration)**

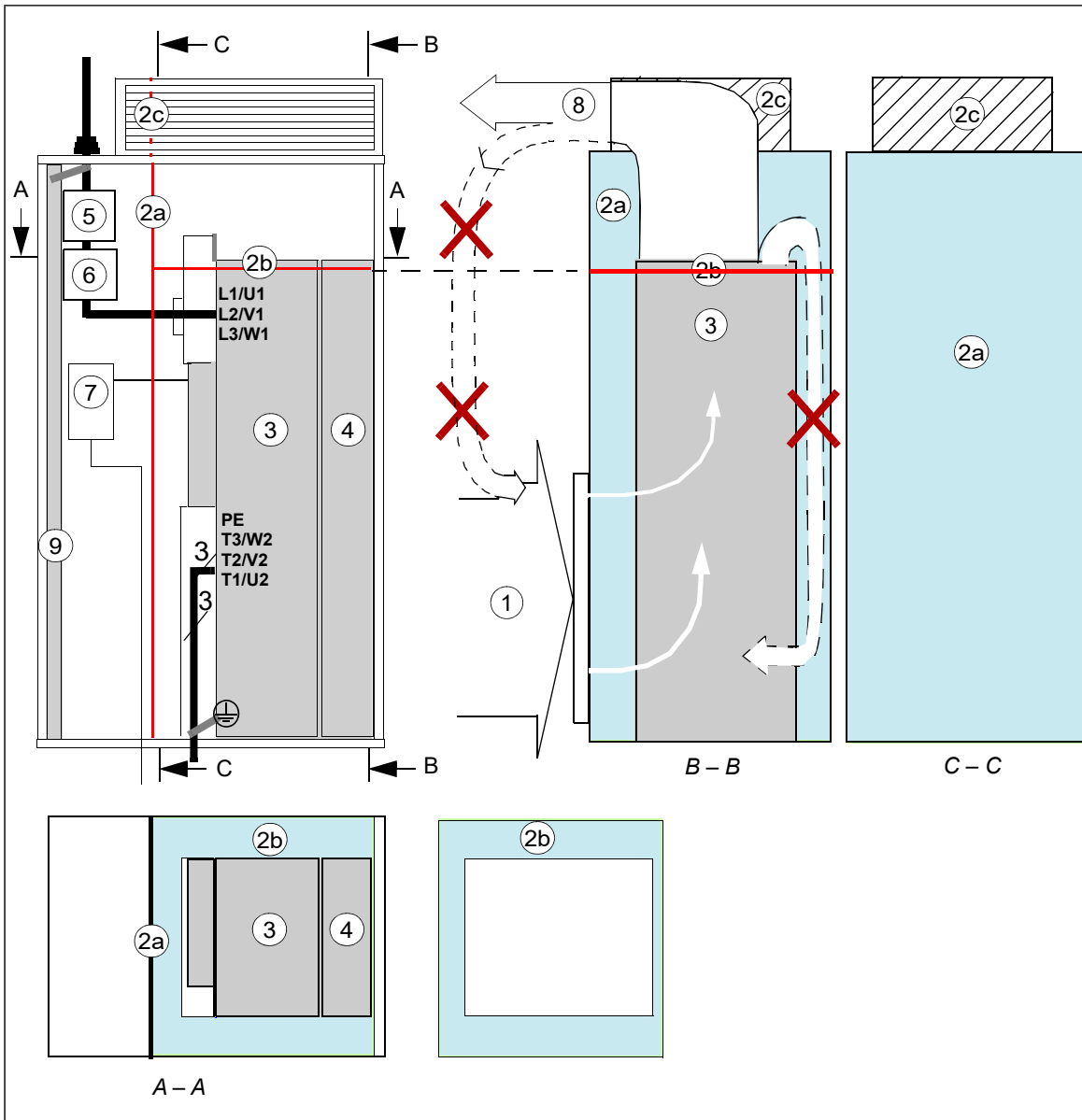
This diagram shows air baffle positions inside an example cabinet. For the descriptions, see the next page.



1	Air flow to the drive modules, max. 40 °C (104 °F)	4	LCL filter module
2a	Vertical air baffle that separates the cool and hot areas in the cabinet	5	Disconnecter and fuses
2b	Vertical air baffle	6	Contactactor
2c	Upper horizontal air baffle	7	Drive control unit
2d	Lower horizontal air baffle	8	Air flow out
2e	Optional air baffle that is needed when there is no fan on the lower part of the cabinet door	9	Cabinet grounding busbar (PE)
3	Drive module	-	-

■ **Bookshelf mounting (option +B051)**

This diagram shows the air baffle position inside an example cabinet. For dimensions of the baffle, see the dimension drawings.



1	Air flow to the drive modules, max. 40 °C (104 °F)	5	Disconnecter and fuses
2a	Vertical air baffle that separates the cool and hot areas in the cabinet	6	Contactors
2b	Horizontal air baffle	7	Drive control unit
2c	Optional air baffle that is needed when there is no fan on the lower part of the cabinet door	8	Air flow out
3	Drive module	9	Cabinet grounding busbar (PE)
4	LCL filter module	-	-

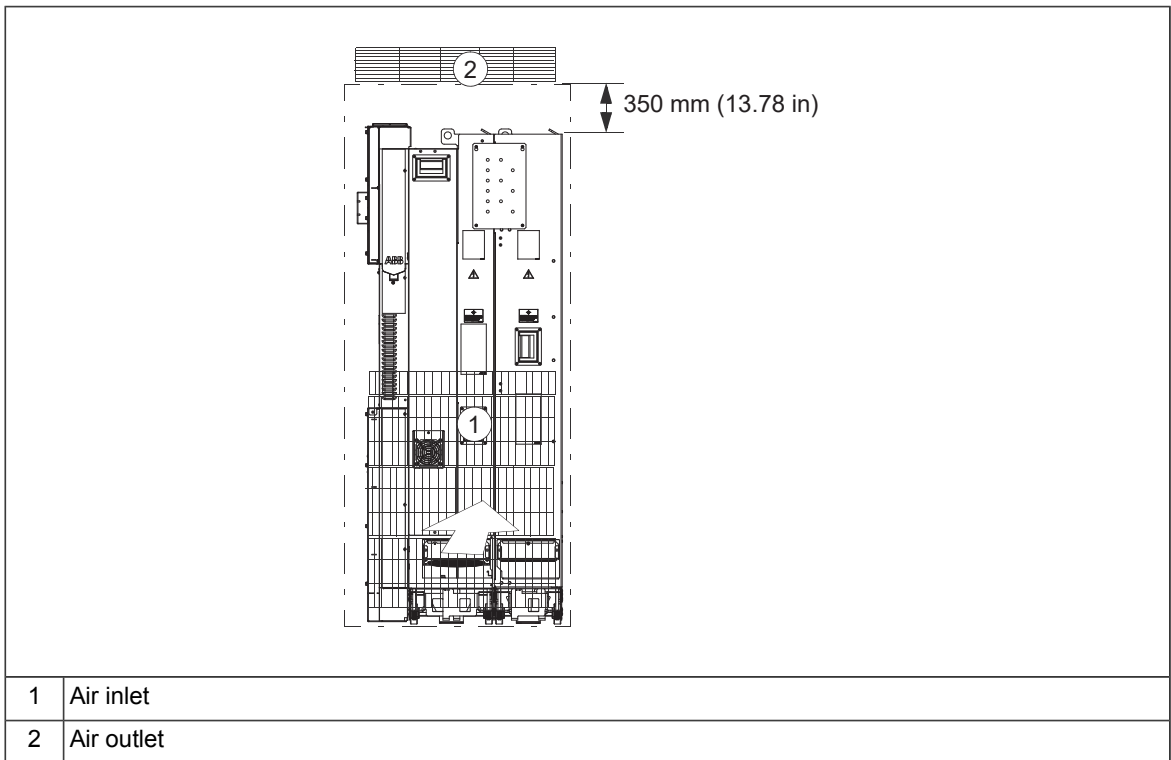
**Required free space**

Free space around the drive module is needed for ensuring that sufficient cooling air flows through the module and the module cools correctly.



■ **Free space at the top of the drive module**

The required free space at the top of the drive module is shown below.



■ **Free space around the drive module**

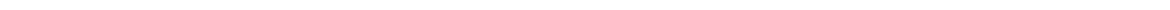
A free space of 20 mm (0.79 in) around the drive module is required from the cabinet back panel and front door. No free space for cooling is required on the left- and right-hand sides of the module.

The module can be installed in a cabinet with the following dimensions:

- width 800 mm (31.50 in)
- depth 600 mm (23.62 in)
- height 2000 mm (78.74 in).

**ABB air inlet and outlet kits**

See chapter [Ordering information \(page 159\)](#).



# 6

## Mechanical installation

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### Contents of this chapter

This chapter describes alternatives of the mechanical installation of the drive module. It refers to the installation example chapters which contain instructions that depend on the selected drive configuration.



### Examining the installation site

The material below the drive must be non-flammable and strong enough to carry the weight of the drive.

See section [Surrounding air conditions \(page 176\)](#) for the allowed ambient conditions and section [Losses, cooling data and noise \(page 172\)](#) for the required cooling air.

### Moving and unpacking

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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.

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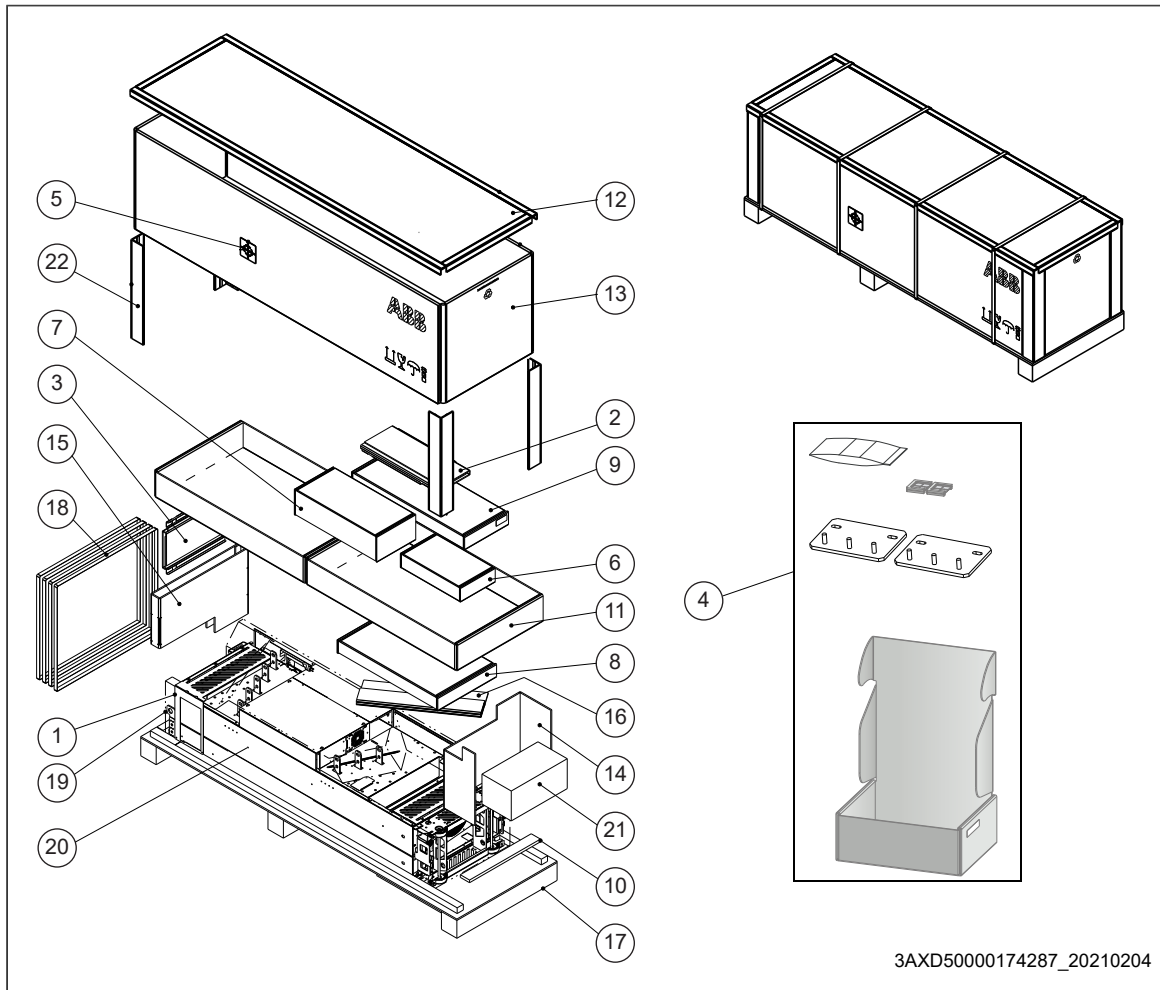
Move the transport package by pallet truck to the installation site.

To unpack the package:

- Cut the straps.
  - Lift the lid.
  - Lift the sleeve.
  - Unpack the top boxes (drive module package).
  - Insert lifting hooks to the drive and LCL filter module lifting lugs and lift the modules to the installation place.
-

■ Package drawings

Drive module package



3AXD50000174287\_20210204

**Transport package contents**

1	Finger guard
2	Pedestal guide plate for the LCL filter module
3	Pedestal guide plate for the drive module
4	Accessories box See the box contents on the following pages.
5	Center of gravity symbol
6	Package for LCL filter fan
7	Package for LCL filter pedestal
8	Telescopic extraction/installation ramp
9	<u>Package for option +H370:</u> Full-size input power cable connection terminals and PE busbar.
10	Plywood support
11	<u>With option +B051:</u> Clear plastic shrouds box and output cable connection terminals box. <u>With option +H370:</u> Also Input cable connection terminals box. See the box contents on the following pages.
12	Lid for sleeve
13	Cardboard sleeve
14–16	Cardboard support

17	Pallet
18	Strap
19	VCI film or bag
20	Drive module with factory installed options and multilingual residual voltage warning sticker, fastening screws in a plastic bag, integrated control unit, control panel and cable or control panel with door mounting kit (option +J410), delivery documents, printed multilingual installation and start-up quick guides. Other printed manuals with option +R700.
21	External control unit(option +P906)
22	Edgeboard supports

**Boxes**

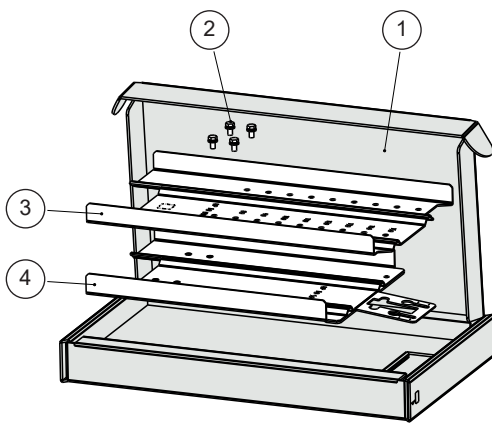
3AXD5000009484

Shroud box with standard drive module configuration	
1	Paper fill
2	Clear plastic shroud for output cabling
3	Cardboard box cover
4	Cardboard box bottom
5	Support
6	Bands
7	Back clear plastic shroud (lower)
8	Back clear plastic shroud (upper)
9	Front clear plastic shroud
10	Clear plastic shroud for input cabling
11	Top clear plastic shroud
12	Clear plastic shroud for input cable entry from side
13	Screws in a plastic bag
14	Metallic shroud without ground bar

Output connection terminals box with standard drive module configuration	
1	Paper fill
2	Output cable connection terminal T3/W2
3	Output cable connection terminal T2/V2
4	Output cable connection terminal T1/U2
5	Grounding terminal
6	Cardboard box
7	Screws and insulators in a plastic bag

Option +H370: input cable connection terminals box	
1	Metallic shroud with ground bar
2	Paper fill
3	Input cable connection terminal L3/W1
4	Input cable connection terminal L2/V1
5	Input cable connection terminal L1/U1
6	Cardboard box
7	Screws and insulators in a plastic bag

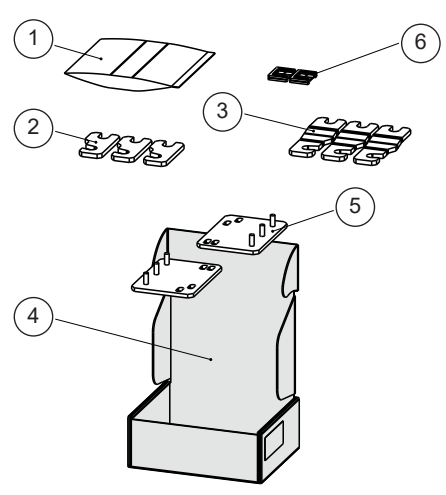




The diagram shows a perspective view of a ramp box assembly. It consists of a main cardboard box (1) with a lid. Two combi screws (2) are shown being inserted into the lid. Two ramp extensions (3) are shown being inserted into the front of the box. A ramp up to 50 mm (4) is shown being inserted into the bottom of the box. The assembly is shown in a partially disassembled state to illustrate the components.

3AXD50000476145

<b>Ramp box</b>	
1	Cardboard box
2	Combi screws (4 pcs)
3	Ramp extension (50 to 150 mm)
4	Ramp up to 50 mm



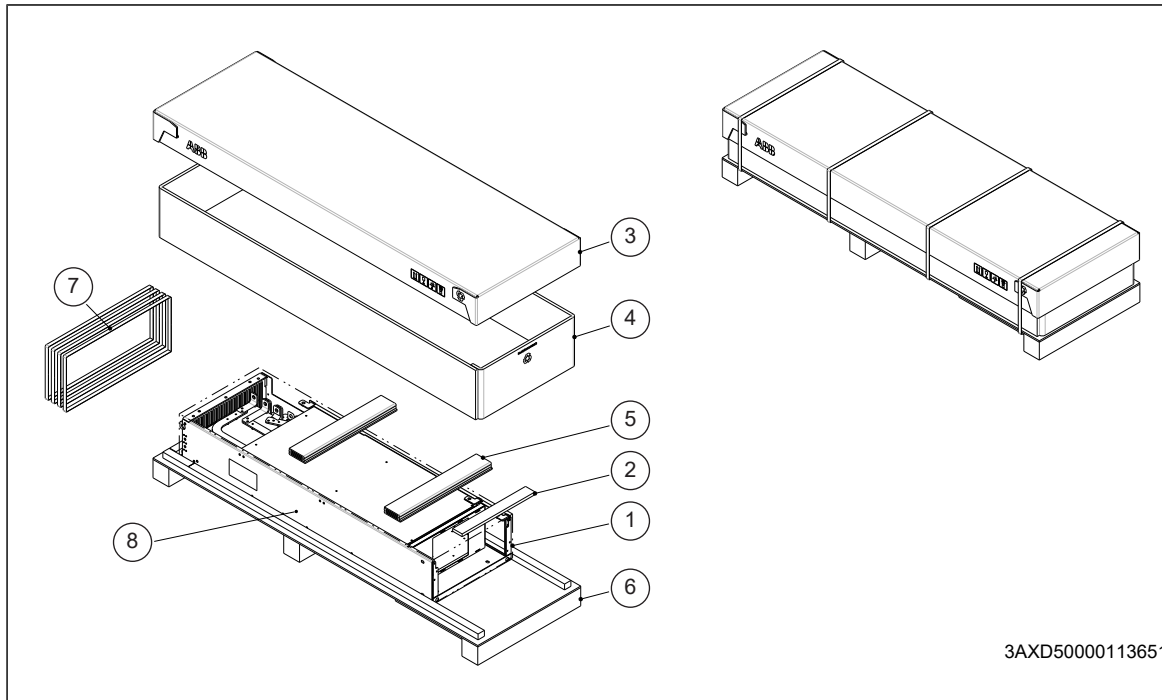
The diagram shows a perspective view of an accessories box assembly. It consists of a cardboard box (4) with a lid. Two installation brackets (5) are shown being inserted into the lid. Two feed throughs (6) are shown being inserted into the front of the box. The assembly is shown in a partially disassembled state to illustrate the components.

3AXD50000477104

<b>Accessories box</b>	
1	Screw package
2	Busbar for main contactor - LCL connection (3 pcs)
3	Busbar for IGBT - LCL connection (3 pcs)
4	Cardboard box
5	Installation bracket (2 pcs)
6	Feed through (2 pcs)



### LCL filter module package



1	VCI bag
2	Plywood support
3	Lid for cardboard sleeve
4	Cardboard sleeve
5	Cardboard support
6	Pallet
7	Strap
8	LCL filter module

### Examining the delivery

Make sure that all items listed in *Moving and unpacking (page 61)* are present.

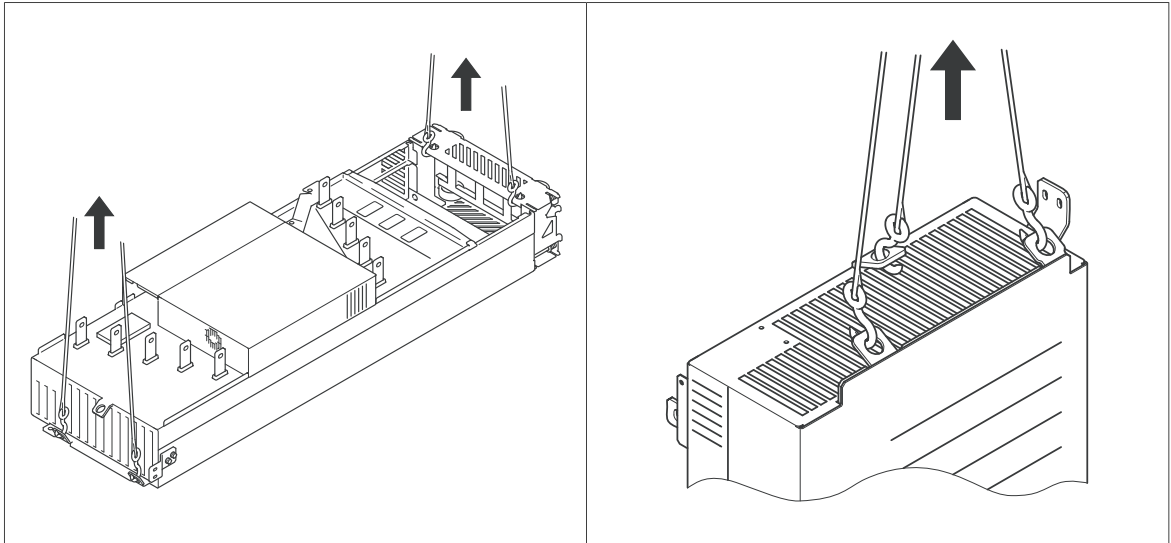
Make sure that there are no signs of damage. Before attempting installation and operation, examine the information on the type designation label of the drive to verify that the unit is of the correct type.

### Lifting

Lift the drive module only by the lifting lugs.

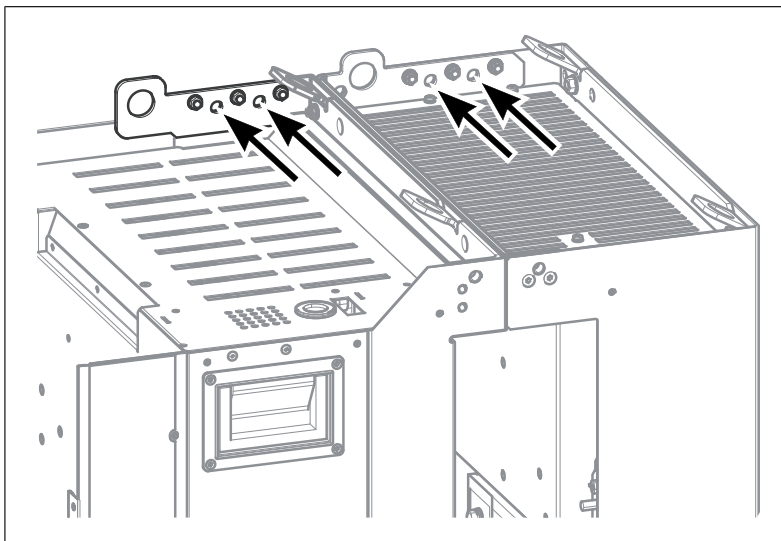






## Attaching the drive module and LCL filter module to a mounting plate or wall

Attach the LCL filter module and the drive module to wall or a mounting plate at the points shown below.



You can attach the modules to Rittal VX25 enclosure with the mounting brackets delivered with the drive, see [Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure \(page 229\)](#).

## Attaching the drive module to the LCL filter module

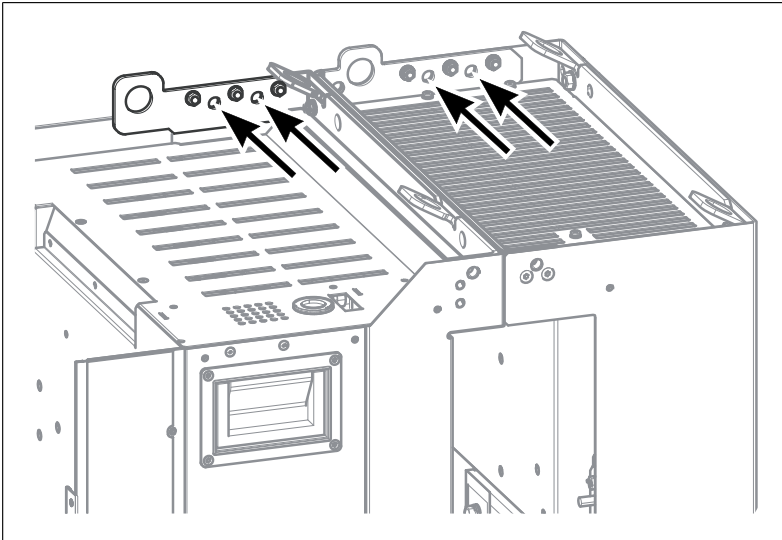
See [Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure \(page 229\)](#).

## Attaching the drive module and the LCL filter module to the enclosure base

See [Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure \(page 229\)](#).

## Grounding the drive module and the LCL filter module

Ground the drive module and the LCL filter module from the fastening points:



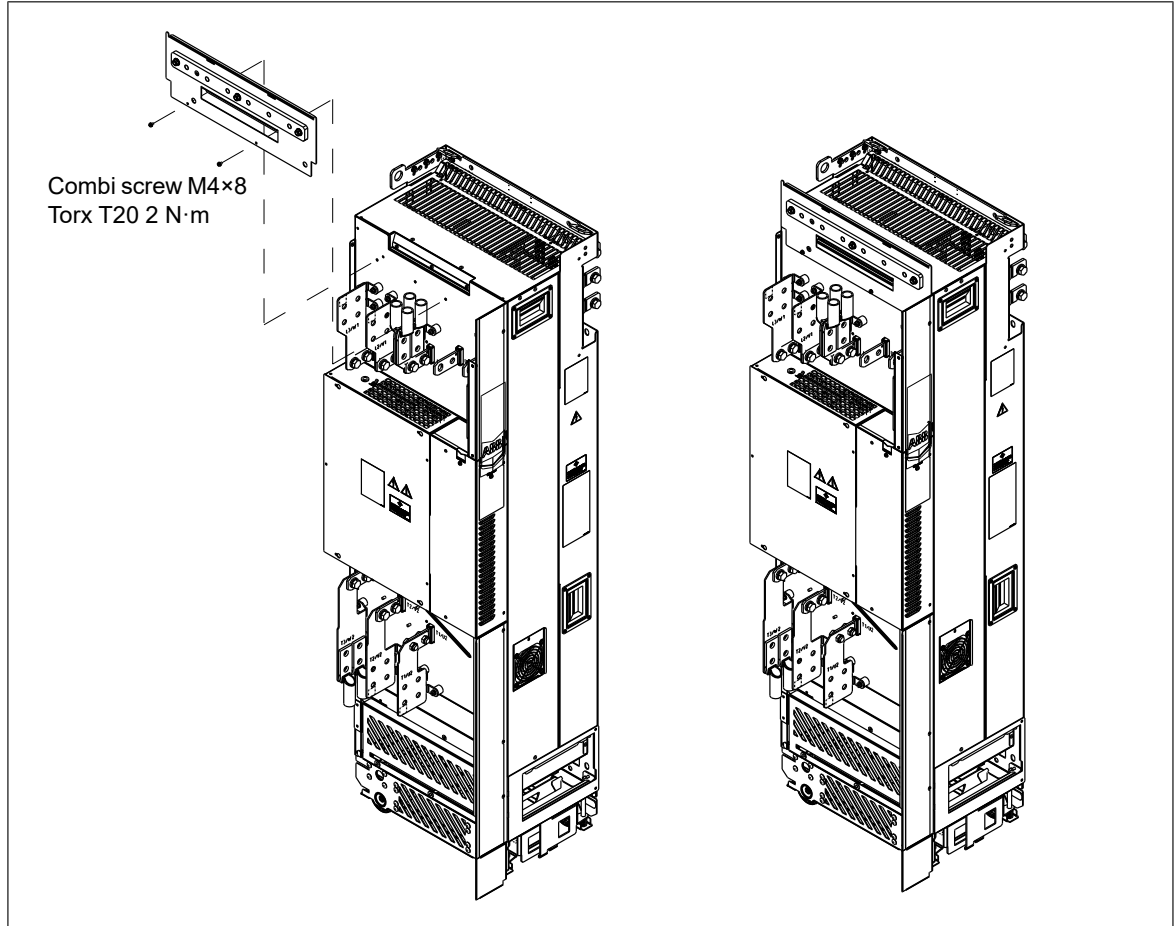
## Installing the drive in Rittal VX25 enclosure

For an installation example on how to install the drive module into a Rittal VX25 enclosure, see [Installation example in Rittal VX25 enclosure \(page 133\)](#) and [Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure \(page 229\)](#).



## Optional input power cable connection terminals and ground busbar assembly (+H370)

Install the metallic shroud with ground bar as shown below.



Connect the input power cable connection terminals as shown in [Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure \(page 229\)](#).





# 7

## Guidelines for planning the electrical installation

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### Contents of this chapter

This chapter contains generic guidelines for planning the electrical installation of the drive.

### 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 main supply disconnecting device

You must equip the drive with a main supply disconnecting device which meets the local safety regulations. You must be able to lock the disconnecting device to the open position for installation and maintenance work.

#### ■ European Union

To meet the European Union Directives, according to standard EN 60204-1, Safety of Machinery, the disconnecting device must be one of the following types:

- switch-disconnector of utilization category AC-23B (IEC 60947-3)
  - disconnector that has an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector (EN 60947-3)
  - a circuit-breaker suitable for isolation in accordance with IEC 60947-2.
-

## ■ North America

Installations must be compliant with NFPA 70 (NEC)<sup>1)</sup> and/or Canadian Electrical Code (CE) along with state and local codes for your location and application.

<sup>1)</sup> National Fire Protection Association 70 (National Electric Code).

## ■ Other regions

The disconnecting device must conform to the applicable local safety regulations.

## Selecting the main contactor

You can equip the drive with a main contactor.

Follow these guidelines when you select a customer-defined main contactor:

- Dimension the contactor according to the nominal voltage and current of the drive. Also consider the environmental conditions such as surrounding air temperature.
- IEC devices only: Select contactor with utilization category AC-1 (number of operations under load) according to IEC 60947-4, *Low-voltage switch gear and control gear*.
- Consider the application life time requirements.

## ■ North America

Installations must be compliant with NFPA 70 (NEC)<sup>1)</sup> and/or Canadian Electrical Code (CE) along with state and local codes for your location and application.

<sup>1)</sup> National Fire Protection Association 70 (National Electric Code).

## ■ Other regions

The disconnecting device must conform to the applicable local safety regulations.

## 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 \(page 73\)](#). 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 whose nominal voltage 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 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

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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.

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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		
			$P_n < 100 \text{ kW}$ and frame size < IEC 315	$100 \text{ kW} \leq P_n < 350 \text{ kW}$ or IEC 315 $\leq$ frame size < IEC 400	$P_n \geq 350 \text{ kW}$ or frame size $\geq$ IEC 400
$P_n < 134 \text{ hp}$ and frame size < NEMA 500	$134 \text{ hp} \leq P_n < 469 \text{ hp}$ or NEMA 500 $\leq$ frame size $\leq$ NEMA 580	$P_n \geq 469 \text{ hp}$ or frame size > NEMA 580			
Random-wound M2_, M3_ and M4_	$U_n \leq 500 \text{ V}$	Standard	-	+ N	+ N + CMF
	$500 \text{ V} < U_n \leq 600 \text{ V}$	Standard	+ du/dt	+ N + du/dt	+ N + du/dt + CMF
		or	Reinforced	-	+ N
	$600 \text{ V} < U_n \leq 690 \text{ V}$ (cable length $\leq 150 \text{ m}$ )	Reinforced	+ du/dt	+ N + du/dt	+ N + du/dt + CMF
	$600 \text{ V} < U_n \leq 690 \text{ V}$ (cable length > 150 m)	Reinforced	-	+ N	+ N + CMF
Form-wound HX_ and AM_	$380 \text{ V} < U_n \leq 690 \text{ V}$	Standard	n.a.	+ N + CMF	$P_n < 500 \text{ kW}$ : +N + CMF
					$P_n \geq 500 \text{ kW}$ : +N + du/dt + CMF
Old <sup>1)</sup> form-wound HX_ and modular	$380 \text{ V} < U_n \leq 690 \text{ V}$	Check with the motor manufacturer.	+ N + du/dt with voltages over 500 V + CMF		
Random-wound HX_ and AM_ <sup>2)</sup>	$0 \text{ V} < U_n \leq 500 \text{ V}$	Enamelled wire with fiber glass taping	+ N + CMF		
	$500 \text{ V} < U_n \leq 690 \text{ V}$		+ N + du/dt + CMF		
HDP	Consult the motor manufacturer.				

<sup>1)</sup> manufactured before 1.1.1998

<sup>2)</sup> 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	
	du/dt filter	Common mode filter (CMF)
ACQ580-34	Ordered separately, see chapter <i>Filters</i> (page 227)	Standard

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

If you will 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.

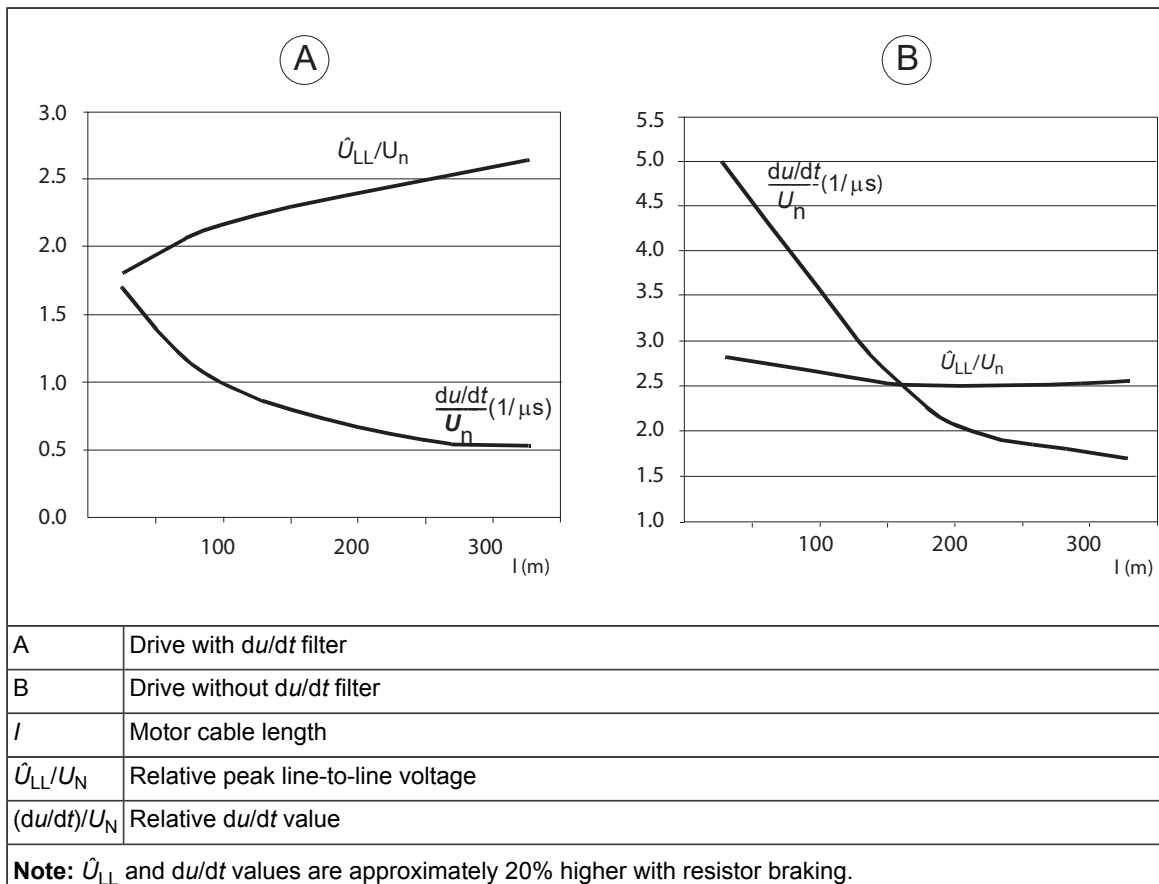
Nominal AC supply voltage	Requirement for		
	Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings	
		$P_n < 100 \text{ kW}$ or frame size < IEC 315	$100 \text{ kW} < P_n < 350 \text{ kW}$ or IEC 315 < frame size < IEC 400
	$P_n < 134 \text{ hp}$ or frame size < NEMA 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 data for calculating the rise time and the peak line-to-line voltage

The diagrams below show the relative peak line-to-line voltage and rate of change of voltage as a function of the motor cable length. If you need to calculate the actual peak voltage and voltage rise time considering the actual cable length, proceed as follows:

- Peak line-to line voltage: Read the relative  $\hat{U}_{LL}/U_n$  value from the diagram below and multiply it by the nominal supply voltage ( $U_n$ ).
- Voltage rise time: Read the relative values  $\hat{U}_{LL}/U_n$  and  $(du/dt)/U_n$  from the diagram below. Multiply the values by the nominal supply voltage ( $U_n$ ) and substitute into equation  $t = 0.8 \cdot \hat{U}_{LL}/(du/dt)$ .



## 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 \(page 79\)](#).

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.

The protective conductor must always have an adequate conductivity.

Unless local wiring regulations state otherwise, the cross-sectional area of the protective 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 conductor can either 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 conductor related to the phase conductor size according to IEC/UL 61800-5-1 when the phase conductor and the protective conductor are made of the same metal. If this is not so, the cross-sectional area of the protective grounding conductor shall 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 conductor S <sub>p</sub> (mm <sup>2</sup> )
S ≤ 16	S <sup>1)</sup>
16 < S ≤ 35	16
35 < S	S/2

1) To comply with standard IEC/EN 61800-5-1 (UL 61800-5-1)

- use 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
- use a second protective earth conductor of the same cross-sectional area as the original protective earth conductor,  
or
- use a device that automatically disconnects the supply if the protective earth conductor is damaged.

If the protective earth conductor is separate (that is, it does not form part of the input power cable or the input power cable enclosure), the minimum cross-sectional area must be:

- 2.5 mm<sup>2</sup> when the conductor is mechanically protected,  
or
- 4 mm<sup>2</sup> when the conductor is not mechanically protected.

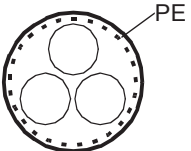
### ■ Typical power cable sizes

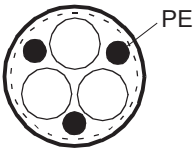
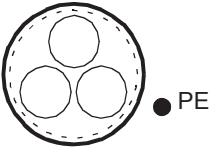
See the technical data.

### ■ Power cable types

#### Preferred power cable types



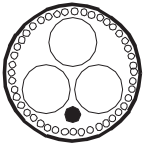
This section presents the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

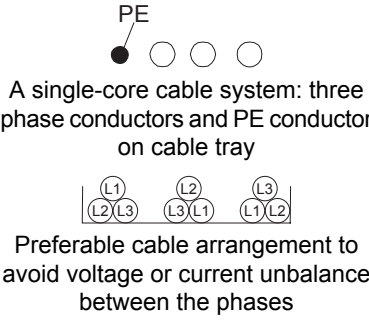

Cable type	Use as input power cabling	Use as motor cabling
 <p>Symmetrical shielded (or armored) cable with three phase conductors and concentric PE conductor as shield (or armor)</p>	Yes	Yes

Cable type	Use as input power cabling	Use as motor cabling
 <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.

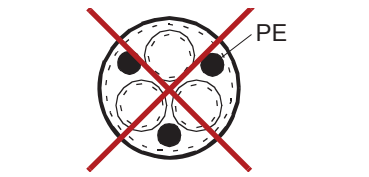
### Alternate power cable types

Cable type	Use as input power cabling	Use as motor cabling
 <p>Four-conductor cabling in PVC conduit or jacket (three phase conductors and PE)</p>	Yes with phase conductor smaller than 10 mm <sup>2</sup> (8 AWG) Cu.	Yes with phase conductor smaller than 10 mm <sup>2</sup> (8 AWG) Cu, or motors up to 30 kW (40 hp). <b>Note:</b> Shielded or armored cable, or cabling in metal conduit is always recommended to minimize radio frequency interference.
 <p>Four-conductor cabling in metal conduit (three phase conductors and PE), eg, 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)
 <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.

Cable type	Use as input power cabling	Use as motor cabling
 <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>	<p>Yes</p>  <p><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.</p>	<p>No</p>

1) Armor may act as an EMC shield, as long as it provides the same performance than 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. Cross-section of a steel shield has to be ample and the shield helix low gradient. Galvanizing increases the high-frequency conductivity.

**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>	<p>No</p>	<p>No</p>

■ **Additional guidelines, North America**

ABB recommends the use of conduit for power wiring to the drive and between the drive and the motor(s). Due to the variety of application needs, metallic and non-metallic conduit can be used. ABB recommends the use of metallic conduit.

The following table shows examples of various materials and methods for wiring the drive in the intended application. See NEC 70 along with state and local codes for the appropriate materials for your application.

In all applications, ABB prefers the use of symmetrical shielded VFD cable between drive and motor(s).

Wiring method	Notes
Conduit - Metallic <sup>1) 2)</sup>	
Electrical metallic tubing: Type EMT	Prefer symmetrical shielded VFD cable.
Rigid metal conduit: Type RMC	Use separate conduit run for each motor.
Liquid-tight flexible metal electrical conduit: Type LFMC	Do not run input power wiring and motor wiring in the same conduit.
Conduit - Non-metallic <sup>2) 3)</sup>	
Liquid-tight flexible non-metallic conduit: Type LFNC	Prefer symmetrical shielded VFD cable. Use separate conduit run for each motor. Do not run input power wiring and motor wiring in the same conduit.
Wireways <sup>2)</sup>	
Metallic	Prefer symmetrical shielded VFD cable. Separate motor wiring from input power wiring and other low voltage wiring. Do not run outputs of multiple drives parallel. Bundle each cable (wiring) together and use separators where possible.
Free air <sup>2)</sup>	
Enclosures, air handlers, etc.	Prefer symmetrical shielded VFD cable. Allowed internally in enclosures when in accordance with UL.

<sup>1)</sup> Metallic conduit may be used as an additional ground path, provided this path is a solid path capable of handling ground currents.

<sup>2)</sup> See NFPA NEC 70, UL, and local codes for your application.

<sup>3)</sup> Non-metallic conduit use underground is allowed; however, these installations inherently have an increased chance for nuisance problems due to the potential for water/moisture in the conduit. Water/moisture in the conduit increases the likelihood of VFD faults or warnings. Proper installation is required to make sure there is no intrusion of water/moisture.

## Metal conduit

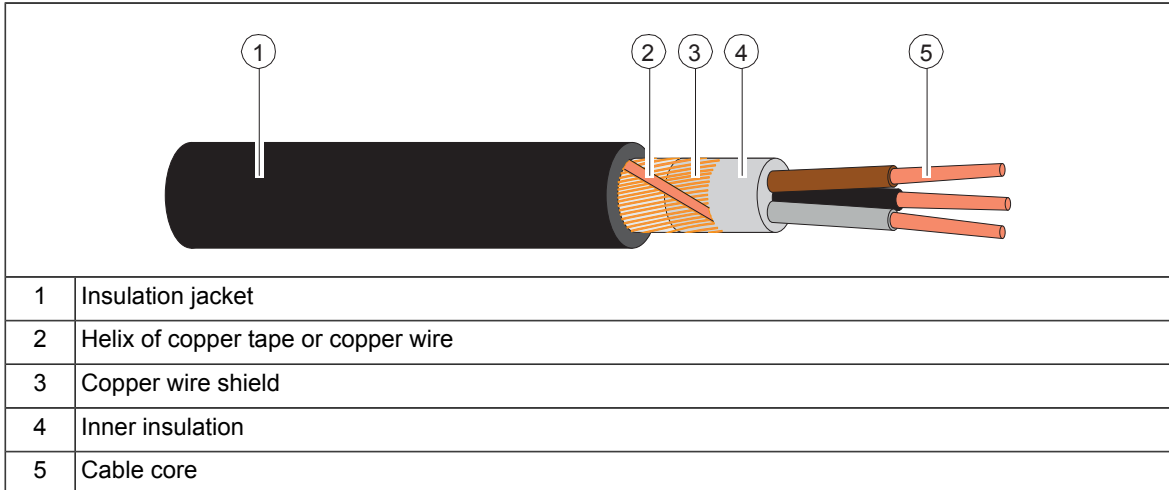
Couple separate parts of a metal conduit together: bridge the joints with a ground conductor bonded to the conduit on each side of the joint. Also bond the conduits to the drive enclosure and motor frame. Use separate conduits for input power, motor, brake resistor, and control wiring. Do not run motor wiring from more than one drive in the same conduit.

### ■ 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.





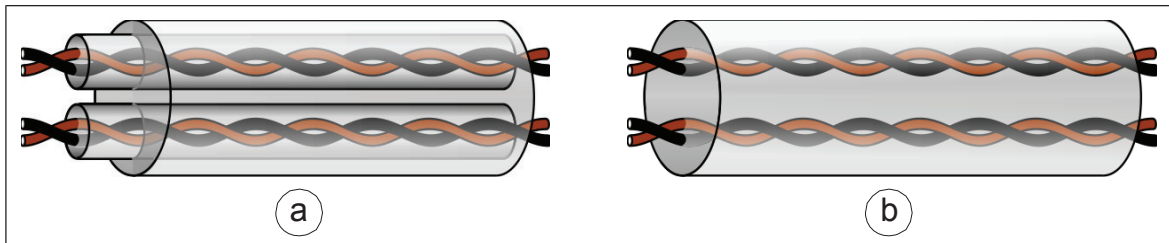
## Selecting the control cables

### ■ Shielding

Only use shielded control cables.

Use a double-shielded twisted pair cable for analog signals. This type of cable is recommended for the pulse encoder signals also. 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 with male RJ-45 connector, cable type Cat 5e or better. The maximum permitted 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).

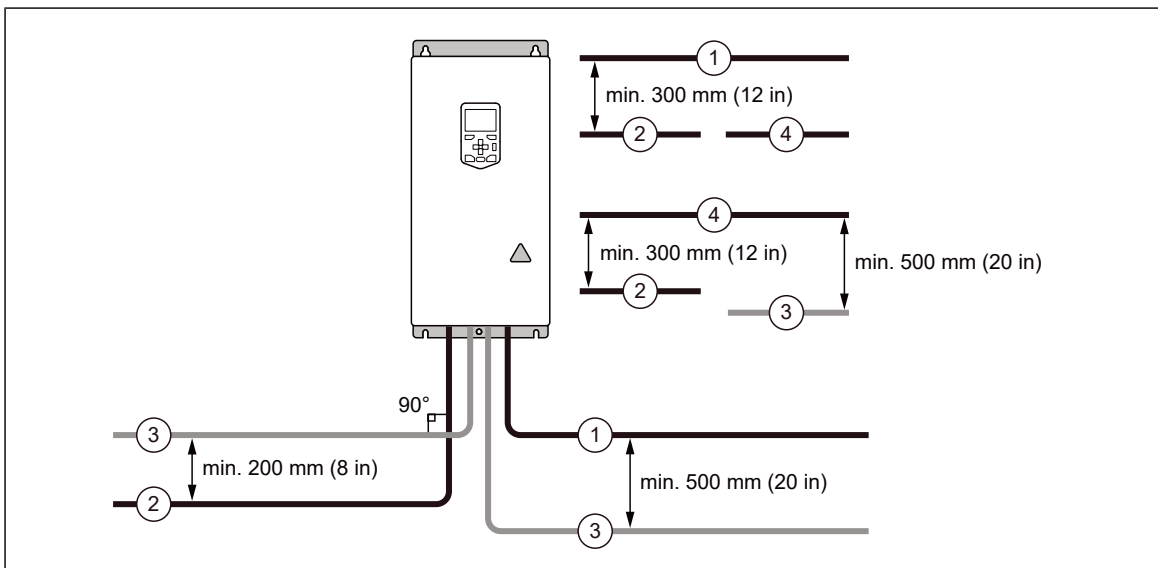
**Routing the cables**

■ **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.

**Note:** When motor cable is symmetrical and shielded and it has short parallel runs with other cables (< 1.5 m / 5 ft), distances between the motor cable and other cables can be reduced by half.



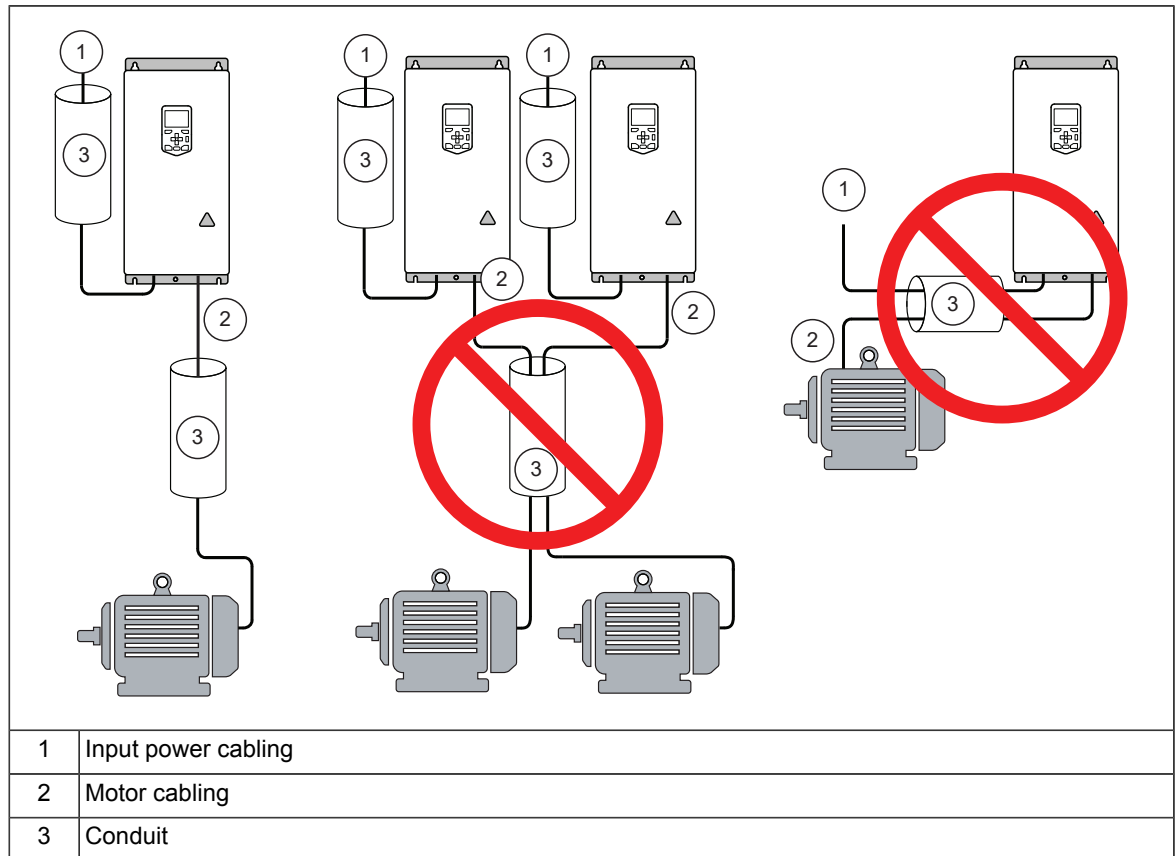
1	Motor cable
2	Input power cable
3	Control cable
4	Brake resistor or chopper cable (if any)

■ **General guidelines – North America**

Make sure that the installation is in accordance with national and local codes. Obey these general guidelines:

- Use separate conduits for the input power, motor, brake resistor (optional), and control cabling.
- Use separate conduit for each motor cabling.

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



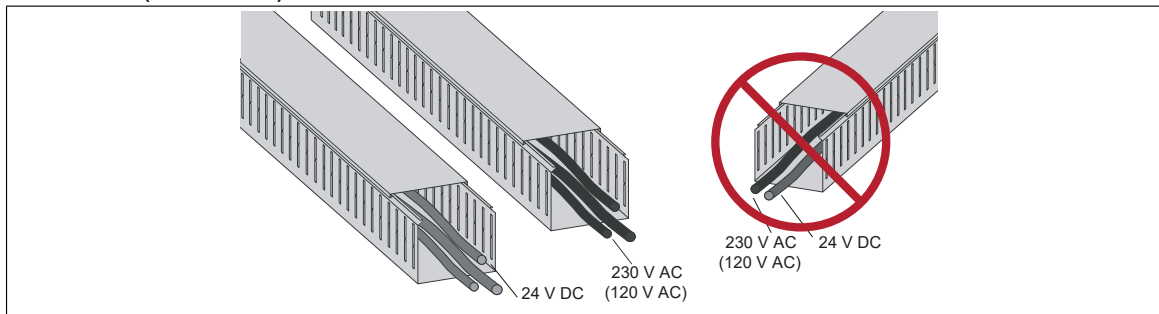
■ **Continuous motor cable shield/conduit or enclosure for equipment on the motor cable**

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).



## Implementing motor and motor cable short-circuit and thermal overload protection

### ■ 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 motor cables against thermal overload

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



#### **WARNING!**

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

North America: The local code (NEC) requires an overload protection and a short-circuit protection for each motor circuit. Use, for example:

- a manual motor protector
- circuit breaker, contactor and overload relay or
- fuses, contactor and overload relay.

### ■ 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.

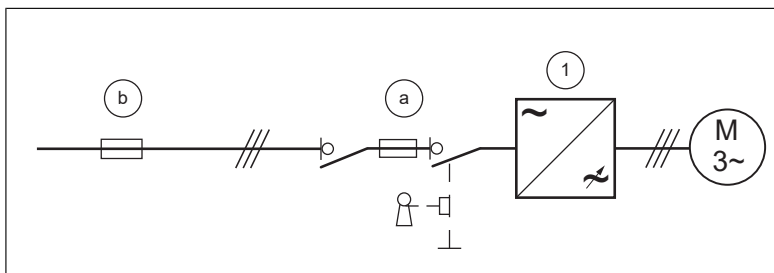
The protection feature allows the user to specify the class of operation in the same manner as the overload relays are specified in standards UL/IEC 60947-4-1 and NEMA ICS 2.

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

For more information, see drive firmware manual.

## Protecting the drive and the input power cable in short-circuits

Protect the drive (1) with fuses (a) and the input cable with fuses (b) or a circuit breaker.



Size the fuses or the circuit breaker according to local regulations for the input cable protection. Select the fuses for the drive according to the instructions given in the technical data. The fuses for the drive protection will restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive.

**Note:** Circuit breakers must not be used without fuses.



#### **WARNING!**

Due to the inherent operating principle and construction of circuit breakers, independent of the manufacturer, hot ionized gases can escape from the breaker enclosure in case of a short-circuit. To ensure safe use, pay special attention to the installation and placement of the breakers. Obey the manufacturer's instructions.

## Protecting the drive against thermal overload

The drive has overload protection as standard.

## Protecting the input power cable against thermal overload

The drive has overload protection as standard. If the sizing of the input power cable is correct, the drive overload protection protects also the cable against overload. In case of parallel input power cables, it may be necessary to protect each cable separately. Obey the local regulations.

## 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: You can connect the sensor to the analog/digital input(s) of the drive. All other circuits connected to the digital and analog inputs (typically extra-low voltage circuits) must be:
  - protected against contact, and
  - insulated with basic insulation from other low-voltage circuits. The insulation must be rated for the same voltage level as the drive main circuit.

**Note:** Extra-low voltage circuits (for example, 24 V DC) typically do not meet these requirements.

Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.

As an alternative, you can connect the sensor with basic insulation to the analog/digital input(s) of the drive, if you do not connect any other external control circuits to the drive digital and analog inputs.

3. 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 motor temperature sensor to the drive via an option module \(page 88\)](#). Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
4. 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 motor temperature sensor to the drive via 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	
CMOD-02	Reinforced insulation between the sensor connector and the other connectors of the module (including drive control unit connector). → No special requirements for the thermistor insulation level.  (The drive control unit is PELV compatible also when the module and a thermistor protection circuit are installed.)	x	-	-	No special requirement
CPTC-02		x	-	-	No special requirement

## 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.

### ■ Residual current device compatibility

The drive is suitable to be used 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

For safety reasons, install the emergency stop devices at each operator control station and at other operating stations where emergency stop may be needed. Implement the emergency stop according to relevant standards.

**Note:** You can use the Safe torque off function of the drive to implement the Emergency stop function.

## Implementing the Safe torque off function

See *The Safe torque off function (page 193)*.

## Implementing the undervoltage control (Power-loss ride-through)

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

- Check that the power-loss ride-through function of the drive is enabled with parameter *30.31 Undervoltage control*.
- Set parameter *21.01 Vector start mode* to Automatic (in vector mode) or parameter *21.19 Scalar start mode* to Automatic (in scalar mode) to make flying start (starting into a rotating motor) possible. If the installation is equipped with a main contactor, prevent its tripping at the input power break. For example, use a time delay relay (hold) in the contactor control circuit.



### **WARNING!**

Make sure that the 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 the functions provided by the FSO-xx safety functions module

You can order a safety function module from ABB. The cabinet builder can use the module for implementing various safety functions.

## 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.

---

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 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 more information, see:

User's manual	Manual code (English)
<i>CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) user's manual</i>	<a href="#">3AXD50000030058</a>

## Controlling a contactor between drive and motor

The control of the output contactor depends on how you use the drive, that is, which motor control mode and which motor stop mode you select.

If you have the vector control mode and motor ramp stop selected, open the contactor as follows:

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

If you have the vector control mode and motor coast stop, or scalar control mode selected, open the contactor as follows:

1. Give a stop command to the drive.
2. Open the contactor.



### **WARNING!**

When the vector control mode is in use, never open the output contactor while the drive controls the motor. The vector control operates extremely fast, much faster than it takes for the contactor to open its contacts. When the contactor starts opening while the drive controls the motor, the vector control will try to maintain the load current by immediately increasing the drive output voltage to the maximum. This will damage, or even burn the contactor completely.

## 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 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".

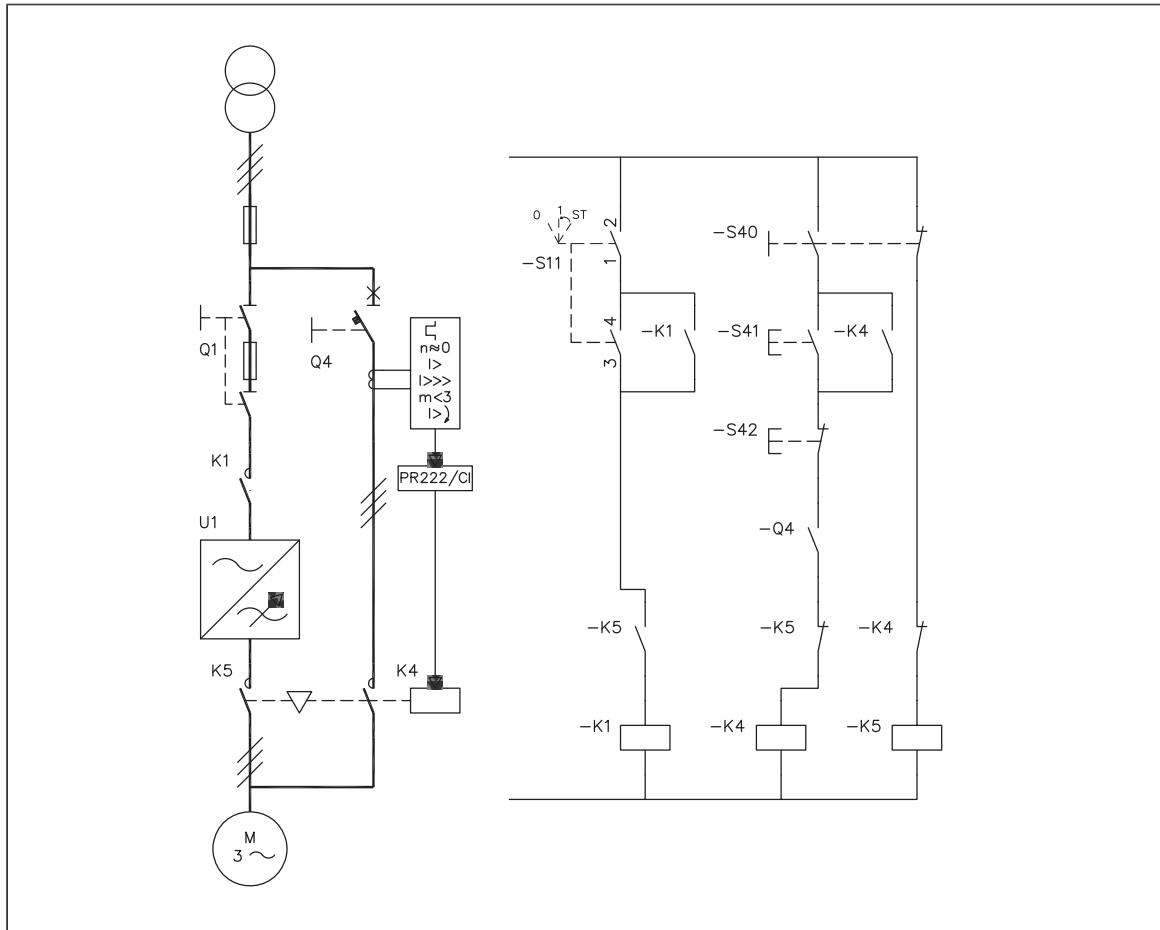


**WARNING!**

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

■ **Example bypass connection**

An example bypass connection is shown below.



Q1	Drive main switch
Q4	Bypass circuit breaker
K1	Drive main contactor
K4	Bypass contactor
K5	Drive output contactor
S11	Drive main contactor on/off control
S40	Motor power supply selection (drive or direct-on-line)
S41	Start when motor is connected direct-on-line
S42	Stop when motor is connected direct-on-line

**Switching the motor power supply from drive to direct-on-line**

1. Stop the drive and the motor with the drive control panel stop key (drive in the local control mode) or the external stop signal (drive in the remote control mode).
2. Open the main contactor of the drive with S11.
3. Switch the motor power supply from the drive to direct-on-line with S40.

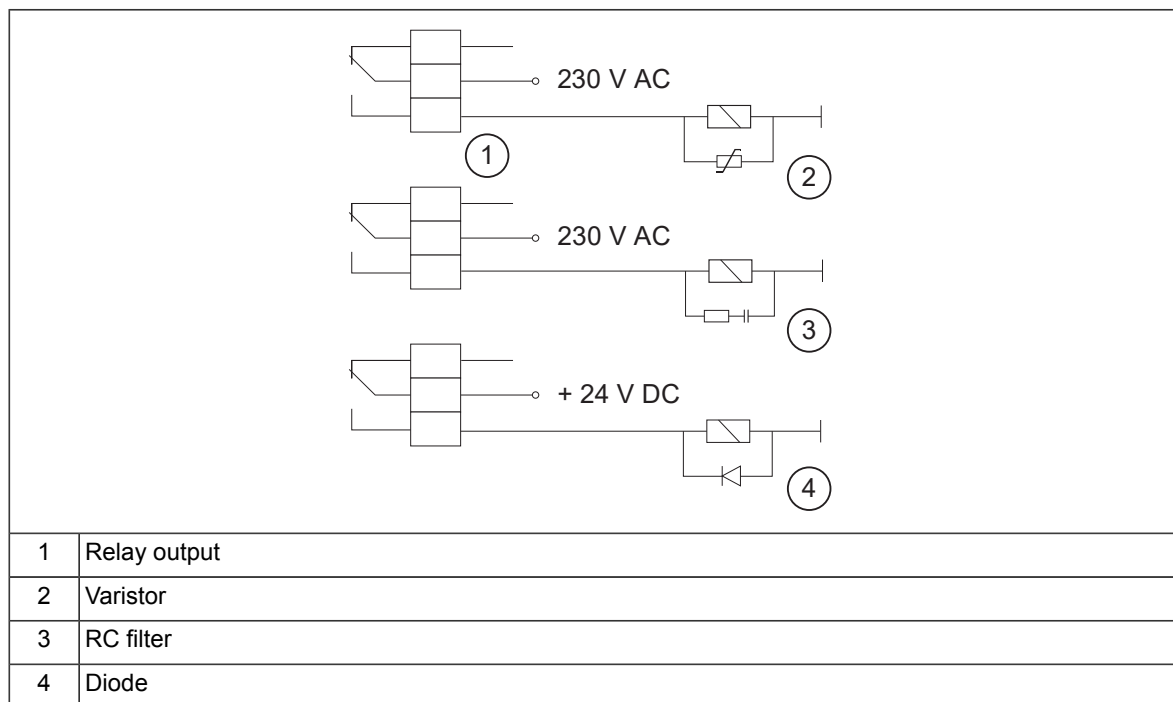
4. Wait for 10 seconds to allow the motor magnetization to dissipate.
5. Start the motor with S41.

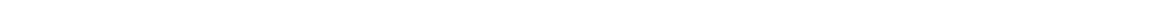
### Switching the motor power supply from direct-on-line to drive

1. Stop the motor with S42.
2. Switch the motor power supply from direct-on-line to the drive with S40.
3. Close the main contactor of the drive with switch S11 (-> turn to position ST for two seconds and leave to position 1).
4. Start the drive and the motor with the drive control panel start key (drive in the local control mode) or the external start signal (drive in the remote control mode).

### Protecting the contacts of relay outputs

Inductive loads (relays, contactors, motors) cause voltage transients when switched off. Install the protective component as close to the inductive load as possible. Do not install protective components at the relay outputs.





## 8

## Electrical installation

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### Contents of this chapter

This chapter gives instructions on the wiring of the drive.

### Safety

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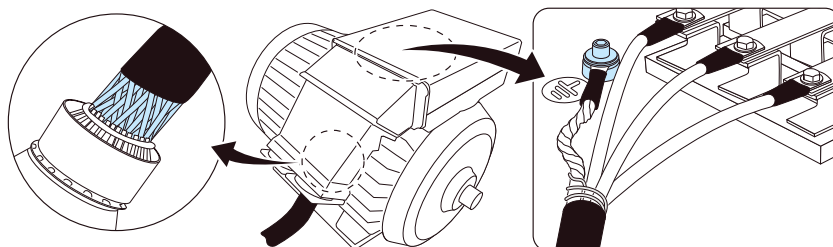
**WARNING!**

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

---

### Grounding the motor cable shield at the motor end

For minimum radio-frequency interference, ground the cable shield 360 degrees at the cable entry of the motor terminal box.



## Measuring the insulation

### ■ Measuring the insulation of the drive



**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.

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

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

### ■ Measuring the insulation of the motor and motor cable

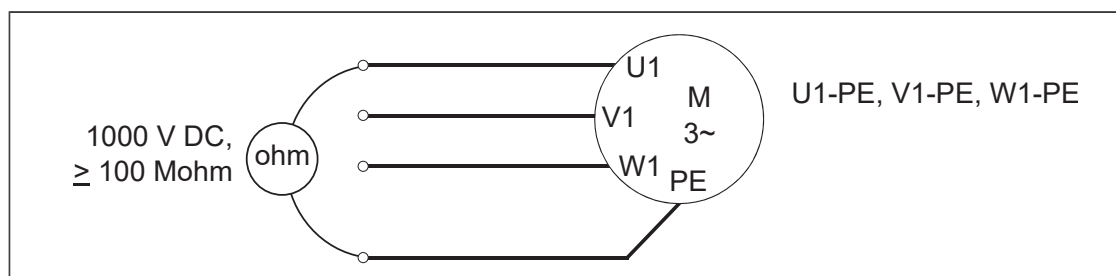


**WARNING!**

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 or maintenance work.

1. Do the steps in section *Electrical safety precautions (page 18)* 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 casing reduces the insulation resistance. If you think that there is moisture in the motor, dry the motor and do the measurement again.



## Grounding system compatibility check

The standard drive with internal EMC filter +E210 and the ground-to-phase varistor connected can be installed to a symmetrically grounded TN-S system. If you install the drive to another system, you may need to disconnect the EMC filter and ground-to-phase varistor.



**WARNING!** Do not install the drive with the EMC filter and the ground-to-phase varistor connected to a system that they are not suitable for. If you do, it can cause danger or damage the drive.

## ■ Corner-grounded and midpoint-grounded delta systems



**WARNING!** Do not install the drive on a corner-grounded or midpoint-grounded delta system. Disconnecting the EMC filter and ground-to-phase varistor does not prevent damage to the drive.

## ■ Identifying the grounding system of the electrical power network



### **WARNING!**

Only a qualified electrical professional may do the work instructed in this section. Depending on the installation site, the work may even be categorized as live working. Continue only if you are an electrical professional certified for the work. Obey the local regulations. If you ignore them, injury or death can occur.

To identify the grounding system, examine the supply transformer connection. See the applicable electrical diagrams of the building. If that is not possible, measure these voltages at the distribution board, and use the table to define the grounding system type.

1. input voltage line to line ( $U_{L-L}$ )
2. input voltage line 1 to ground ( $U_{L1-G}$ )
3. input voltage line 2 to ground ( $U_{L2-G}$ )
4. input voltage line 3 to ground ( $U_{L3-G}$ ).

The table below shows the line-to-ground voltages in relation to the line-to-line voltage for each grounding system.

$U_{L-L}$	$U_{L1-G}$	$U_{L2-G}$	$U_{L3-G}$	Electrical power system type
X	$0.58 \cdot X$	$0.58 \cdot X$	$0.58 \cdot X$	Symmetrically grounded TN system (TN-S system)
X	$1.0 \cdot X$	$1.0 \cdot X$	0	Corner-grounded delta system (nonsymmetrical)
X	$0.866 \cdot X$	$0.5 \cdot X$	$0.5 \cdot X$	Midpoint-grounded delta system (nonsymmetrical)
X	Varying level versus time	Varying level versus time	Varying level versus time	IT systems (ungrounded or high-resistance-grounded [ $>30$ ohms]) nonsymmetrical
X	Varying level versus time	Varying level versus time	Varying level versus time	TT system (the protective earth connection for the consumer is provided by a local earth electrode, and there is another independently installed at the generator)

■ **When to disconnect EMC filter and ground-to-phase varistor: TN-S, IT, corner-grounded delta, and midpoint-grounded delta systems**

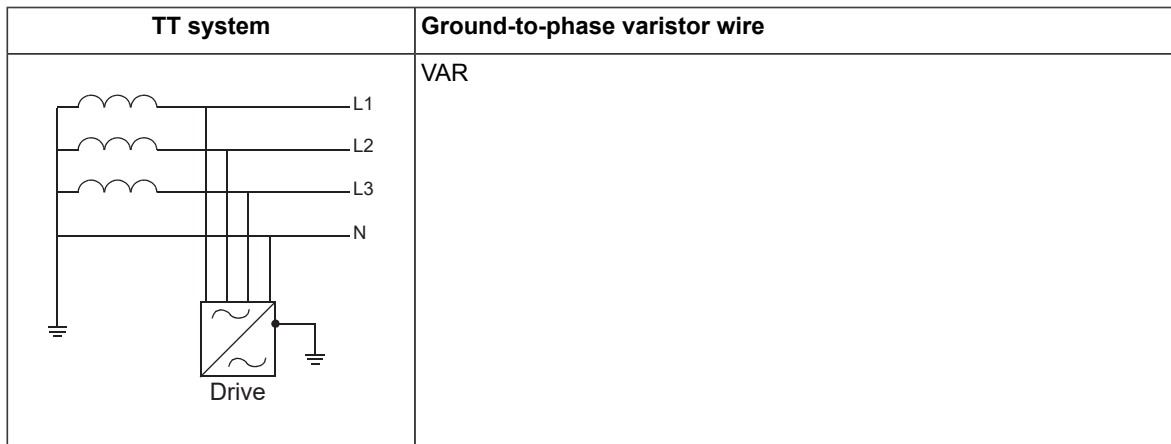
<b>Symmetrically grounded TN systems (TN-S systems)</b>	
	Do not disconnect EMC AC and VAR wires.
<b>Corner-grounded delta systems</b>	
	Do not install the drive on a corner-grounded system.
<b>Midpoint-grounded delta systems</b>	
	Do not install the drive on a midpoint grounded system.
<b>IT systems (ungrounded or high-resistance grounded [<math>&gt;30</math> ohms])</b>	
	Disconnect EMC AC and VAR wires.

■ **Guidelines for installing the drive to a TT system**

The drive can be connected to a TT system under these conditions:



1. Residual current device has been installed in the supply system.
2. These wires have been disconnected. Otherwise ground-to-phase varistor capacitor leakage current will cause the residual current device to trip.



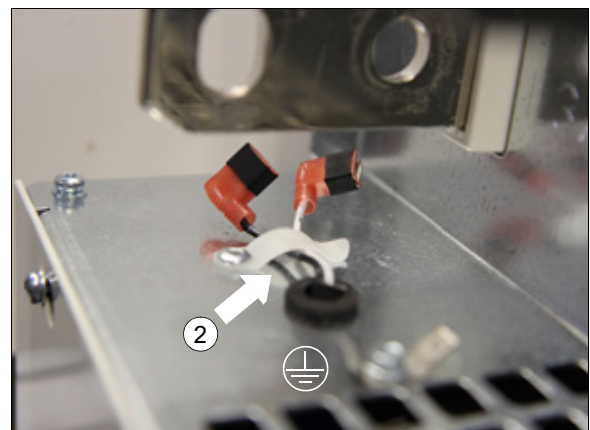
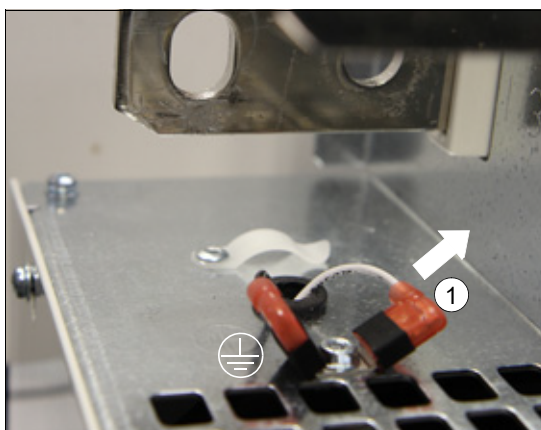
**Note:**

- Because the varistor wire has been disconnected, ABB does not guarantee the EMC category.
- ABB does not guarantee the functioning of the ground leakage detector built inside the drive.
- In large systems the residual current device can trip without a real reason.

Source document on TT system: 3AXD10000681917

■ **Disconnecting instructions**

EMC AC and varistor (VAR) grounding wires are located at the top of the circuit board compartment. Disconnect them (1) and attach them with the nearby plastic clamp (2).



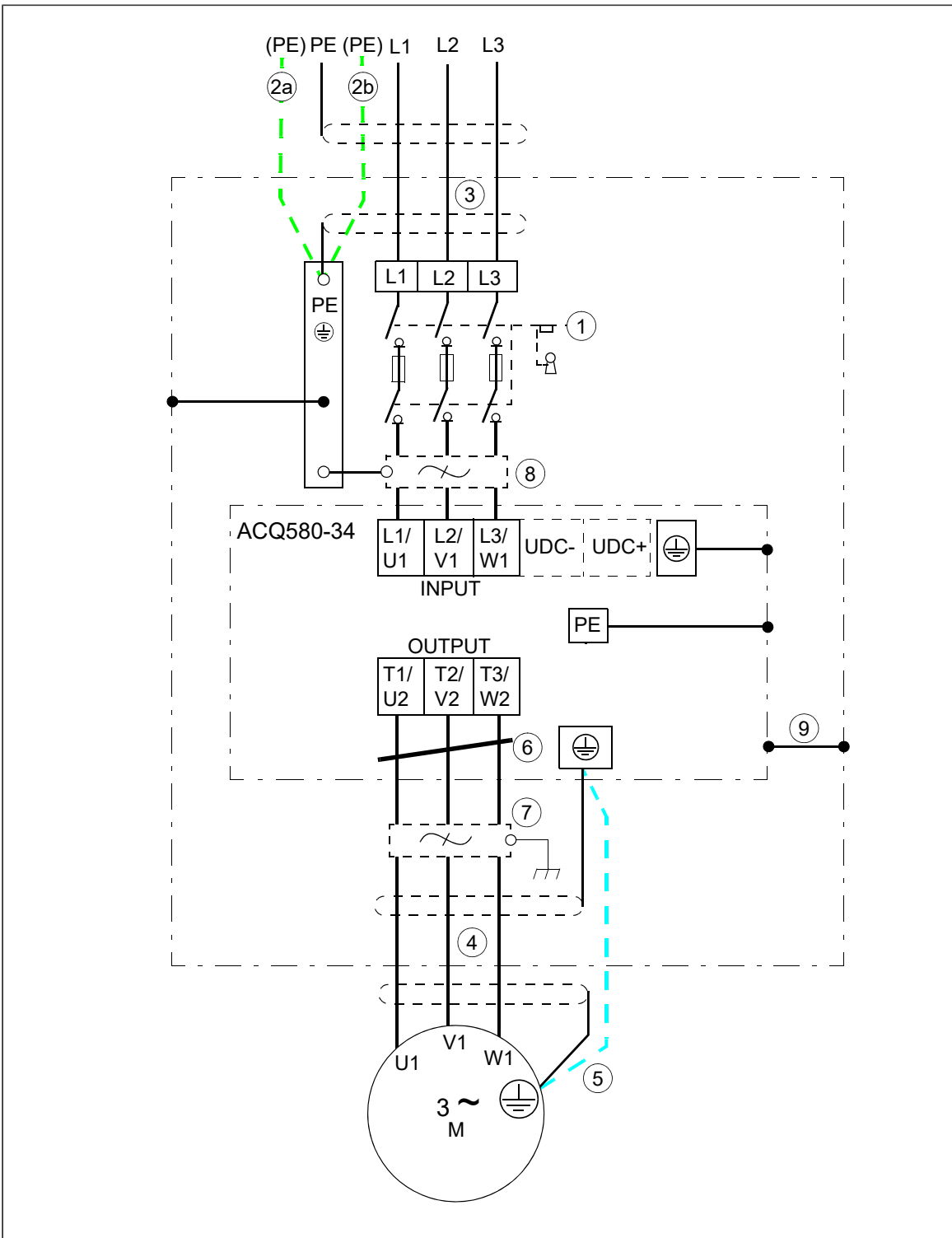
**Connecting the power cables**



**WARNING!**

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

■ Power cable connection diagram



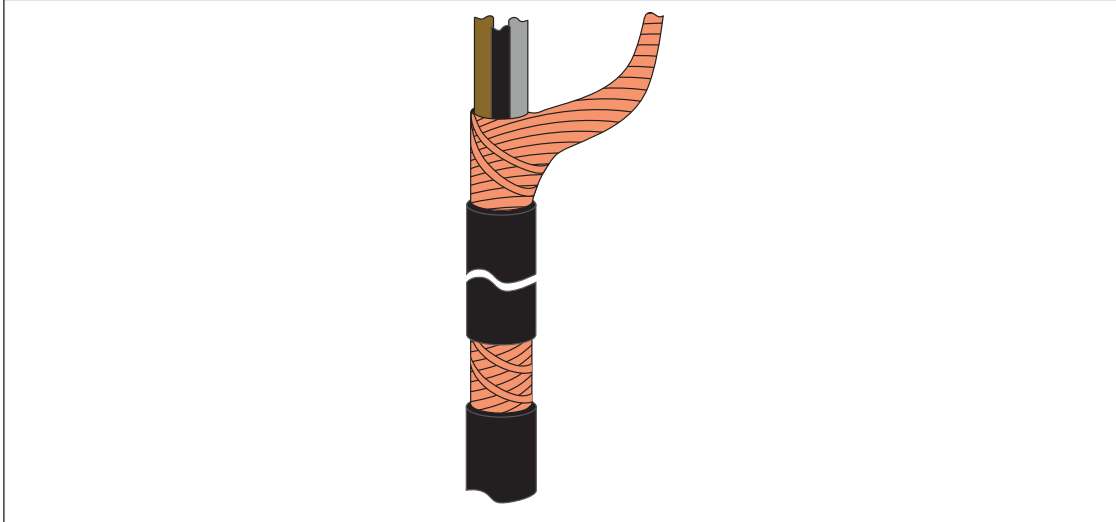
1	For alternatives, see <a href="#">Guidelines for planning the electrical installation (page 71)</a> . In the installing example of this chapter, the disconnecting device is not in the same cubicle with the drive module.
2	If a shielded cable is used (not required but recommended) and the conductivity of the shield is < 50% of the conductivity of the phase conductor, use a separate PE cable (2a) or a cable with a grounding conductor (2b)
3	ABB recommends 360-degree grounding at the cabinet entry if a shielded cable is used. Ground the other end of the input cable shield or PE conductor at the distribution board.
4	ABB recommends 360-degree grounding at the cabinet entry

5	Use a separate grounding cable if the conductivity of the cable shield is < 50% of the conductivity of the phase conductor and there is no symmetrically constructed grounding conductor in the cable (see <a href="#">Guidelines for planning the electrical installation (page 71)</a> )
6	Common mode filter
7	du/dt filter (option)
8	EMC filter
9	The drive module frame must be connected to the cabinet frame. See <a href="#">Drive modules cabinet design and construction instructions (3AUA0000107668 [English])</a> and section <a href="#">Grounding the drive module and the LCL filter module (page 68)</a> .
<p><b>Note:</b> If there is a symmetrically constructed grounding conductor in the motor cable in addition to the conductive shield, connect the grounding conductor to the grounding terminal at the drive and motor ends.</p> <p>Do not use an asymmetrically constructed motor cable. Connecting its fourth conductor at the motor end increases bearing currents and causes extra wear.</p>	

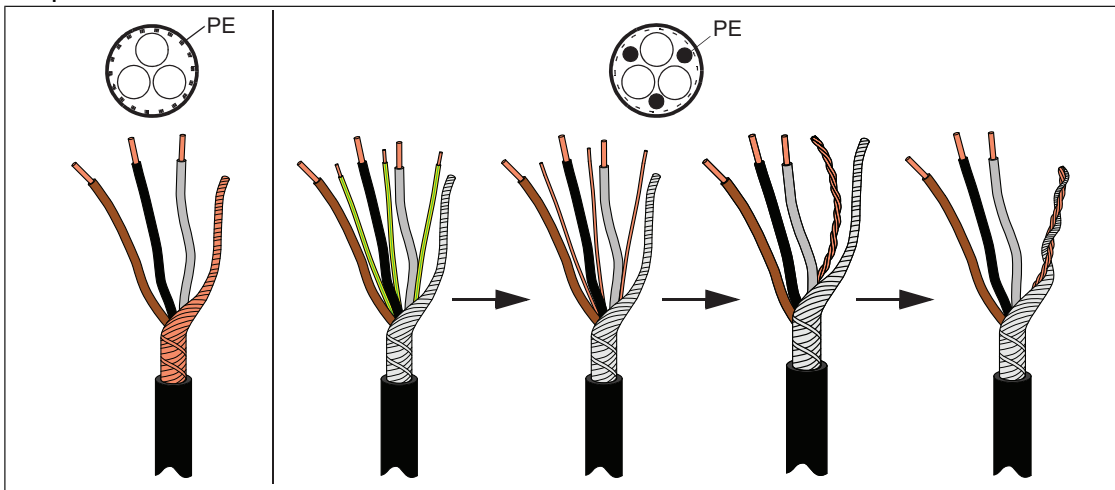


## ■ Preparing the cable ends and making 360-degree grounding at the cable entry

1. Peel off 3...5 cm (1 1/4 ... 2 in) of the outer insulation of the cables at the cable entries with the conductive sleeves for the 360° high-frequency grounding.



2. Prepare the ends of the cables.

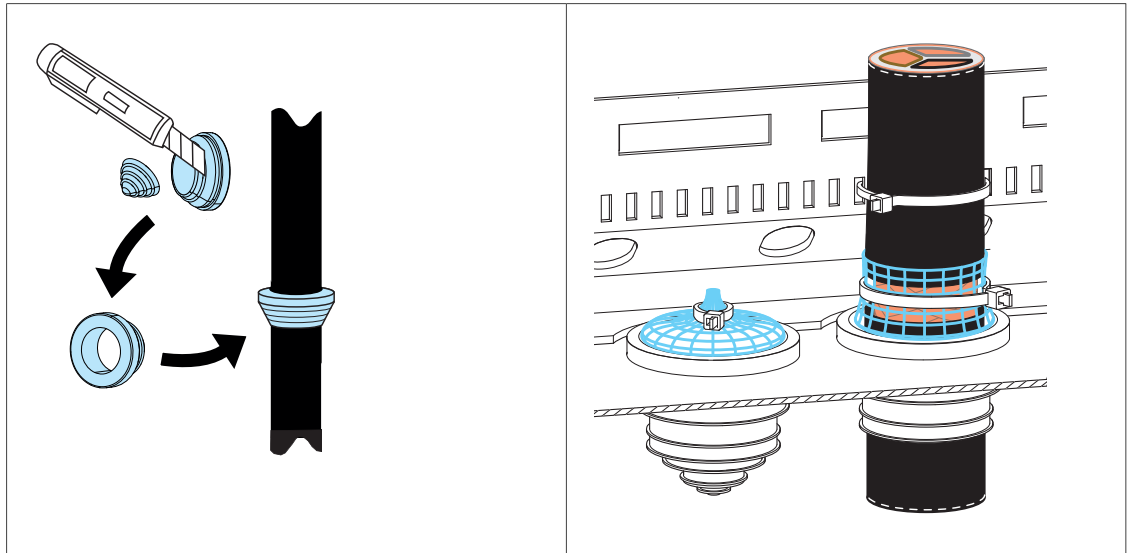


### **WARNING!**

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.

3. If fire insulation is used, make an opening in the mineral wool sheet according to the diameter of the cable.
4. Put the cables through the entry plate.

5. Remove rubber grommets from the entry plate for the cables to be connected. Cut adequate holes into the rubber grommets. Slide the grommets onto the cables. Slide the cables through the entry plate and attach the grommets to the holes.
6. Attach the conductive sleeves to the cable shields with cable ties. Tie up the unused conductive sleeves with cable ties. An example of bottom entry is shown below. For top entry, place the grommet upwards.



### ■ Power 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.



#### **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.

1. Run the motor cables from the motor to the cabinet. Ground the cable shields 360° at the entry plate.
2. Twist the cable shields of the motor cables into bundles and connect them and any separate ground conductors or cables to the ground terminal of the drive module or to the cabinet ground bar.
3. Connect the phase conductors of the motor cables to terminals T1/U2, T2/V2 and T3/W2 of the drive module. For the tightening torques, see the technical data.
4. Make sure that all power is disconnected and reconnection is not possible. Use correct safe disconnect procedures according to local codes.
5. Run the input cables from the supply source to the cabinet. Ground the cable shields 360° at the entry plate.

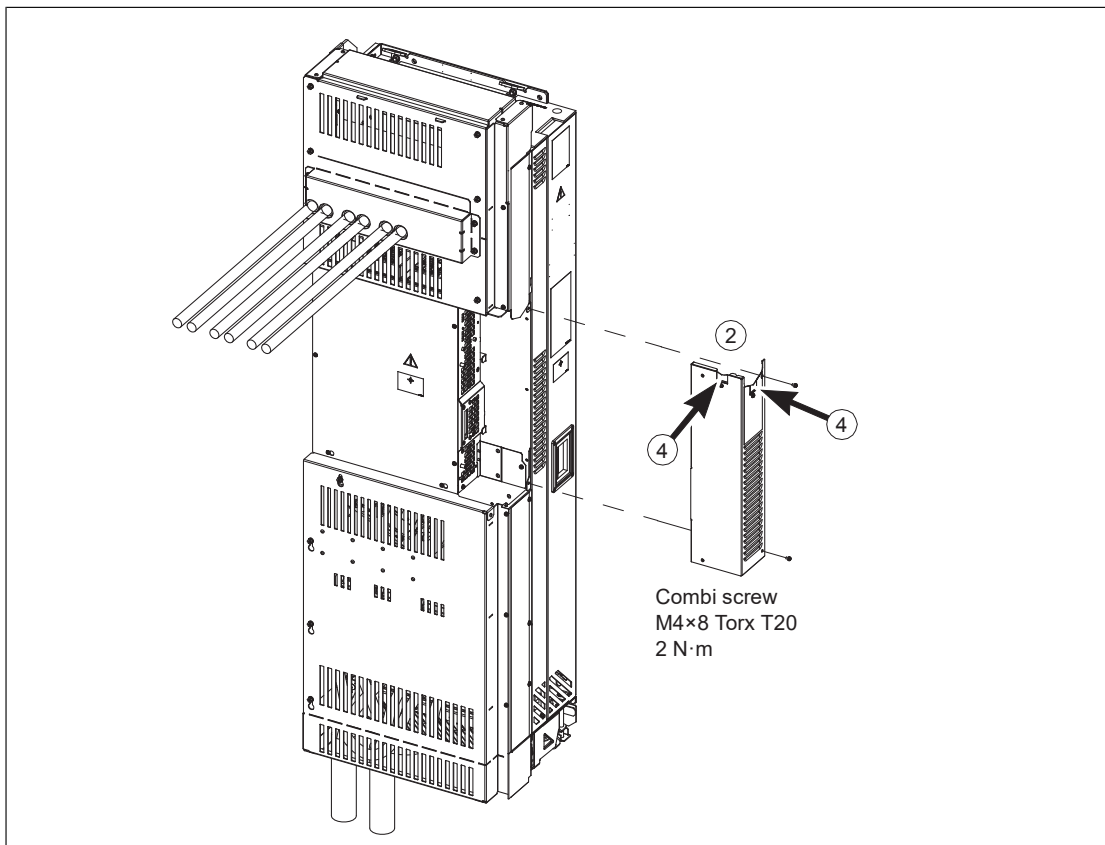
- Twist the cable shields of the input cables into bundles and connect them and any separate ground conductors or cables to the drive module ground terminal or to the cabinet PE busbar.
- Connect the phase conductors of the input cables to terminals L1/U1, L2/V1 and L3/W1 of the drive module. For the tightening torques, see the technical data.

## Connecting the control cables to the integrated control unit

See chapter *Control unit (page 111)* for the default I/O connections of the drive 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.

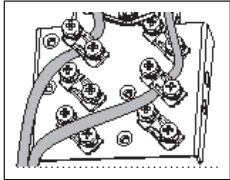
- Ground the outer control cable shields 360 degrees at the cabinet entry plate (recommendation).
- Remove the middle front cover of the drive module.
- Attach the option modules if not attached already.
- Remove the cover plate from the control cable entry plate and put the rubber grommet in its place. Put the control cables through the grommet.

**Note:** Drive module with IP20 shrouds (option +B051): If you route the control cables from top or bottom instead of front or side, you need to make holes for the entry plates to the clear plastic shrouds.



IP20 shrouds (option +B051) included in the drawing

5. Ground the shields of the control cables at the clamp plate. The shields should be continuous as close to the terminals of the control unit as possible. Only remove the outer jacket of the cable at the cable clamp so that the clamp presses on the bare shield. The shield (especially in case of multiple shields) can also be terminated with a lug and fastened with a screw at the clamp plate. Leave the other end of the shield unconnected or ground it indirectly via a few nanofarads high-frequency capacitor, 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. Tighten the screws to secure the connection.



6. Connect the conductors to the appropriate detachable terminals of the control unit, see chapter [Control unit \(page 111\)](#). Use shrink tubing or insulating tape to contain any stray strands. Tighten the screws to secure the connection.

**Note:** 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.

7. Install the middle front cover back.

#### ■ Connecting external power supply wires to the control units

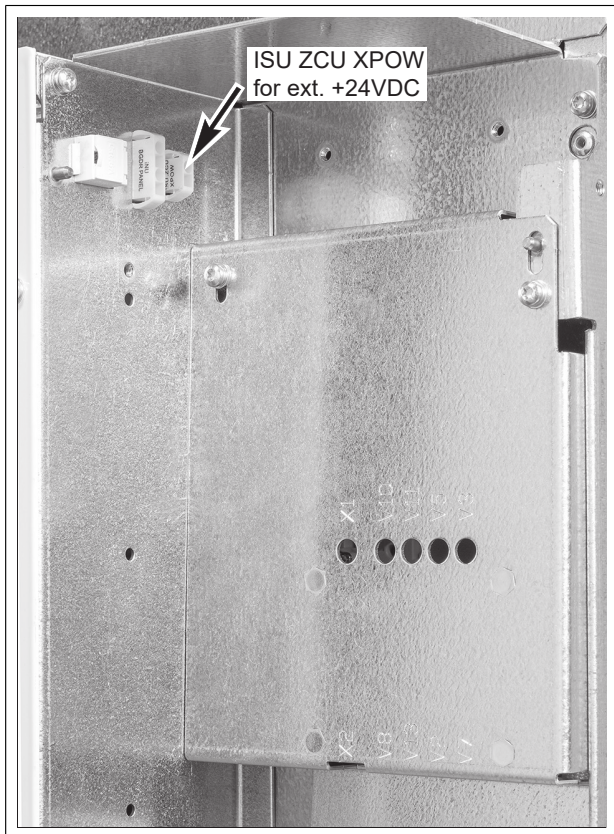
The external power supply is used to keep the drive control unit (CCU) and line-side converter control unit (ZCU) powered when the main power is off.

When external power supply is used, both control units should be connected to the external supply.

1. To connect CCU to external power: Connect external power supply cables to terminals 40 and 41 on the CCU control unit.
2. To connect ZCU to external power: Connect the provided wire harness from the “ISU ZCU XPOW” plug connector to CCU terminals 40 and 41, or directly to an external power supply.

RED wire = (+) and BLACK wire = (-)

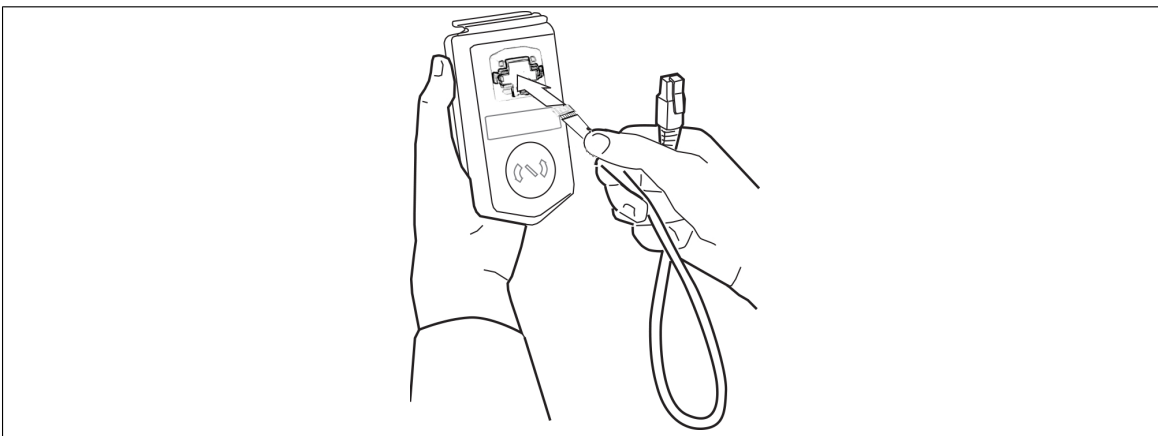




## Connecting a control panel

With control panel door mounting platform, connect the control panel as follows:

1. Connect an Ethernet cable to the RJ-45 connector of the control panel.
2. Connect the other end of the cable to the panel port (X12) of the control unit.



**Note:** When a PC is connected to the control panel, the control panel keypad is disabled. In this case, the control panel acts as a USB-RS485 adapter.

## Connecting a remote panel, or chaining one panel to several drives

You can connect a remote ACH-AP-H control panel to the drive, or to chain the control panel or a PC to several drives on a panel bus with a CDPI-01 communication adapter module. See *CDPI-01 communication adapter module user's manual* (3AXD50000009929 [English]).



## Connecting a PC

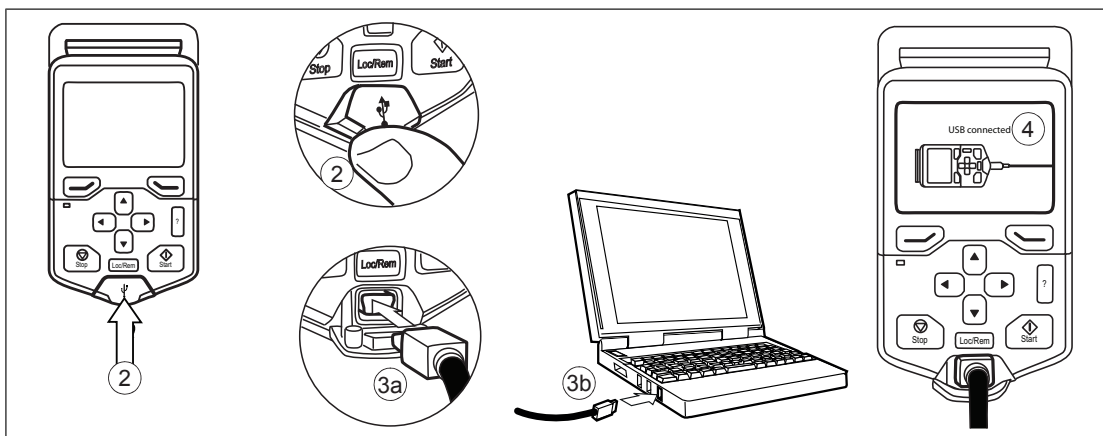


### WARNING!

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

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

1. Connect an ACx-AP-x 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.



## Installing option modules



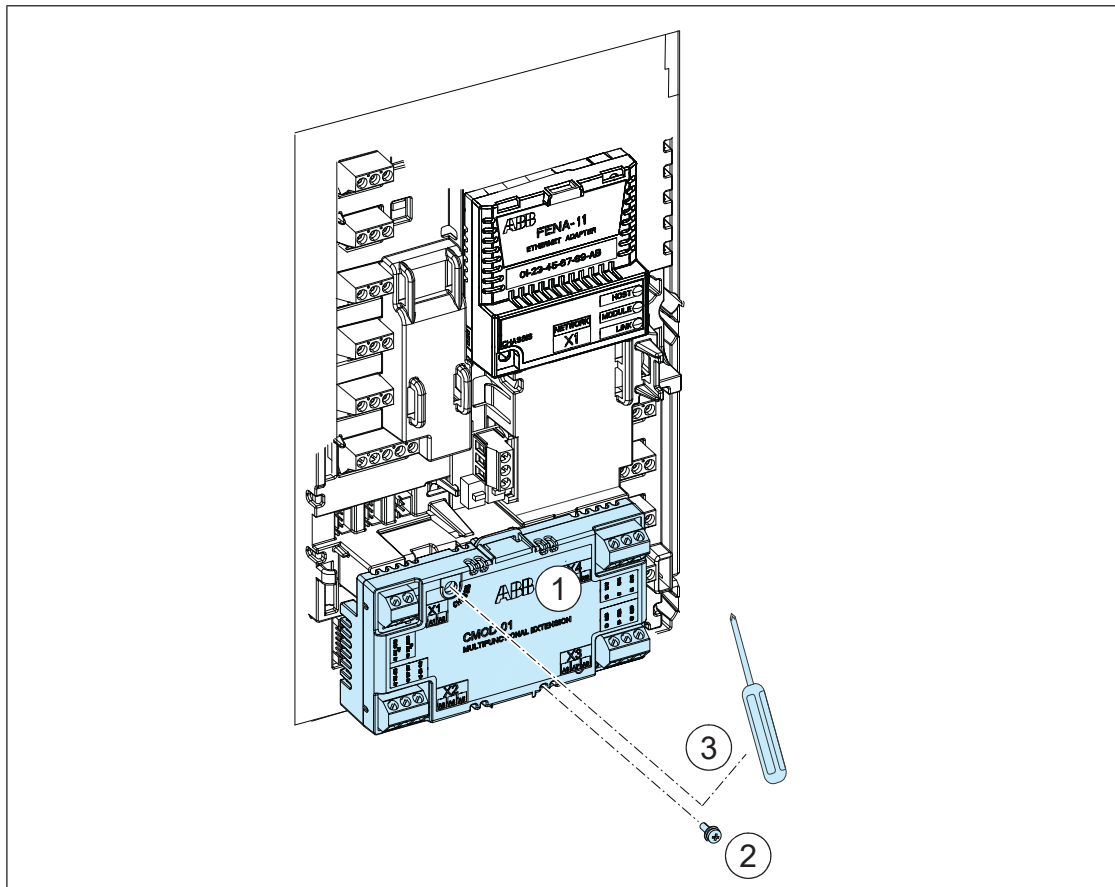
### WARNING!

Obey the safety instructions of the drive. 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 \(page 18\)](#) before you start the work.

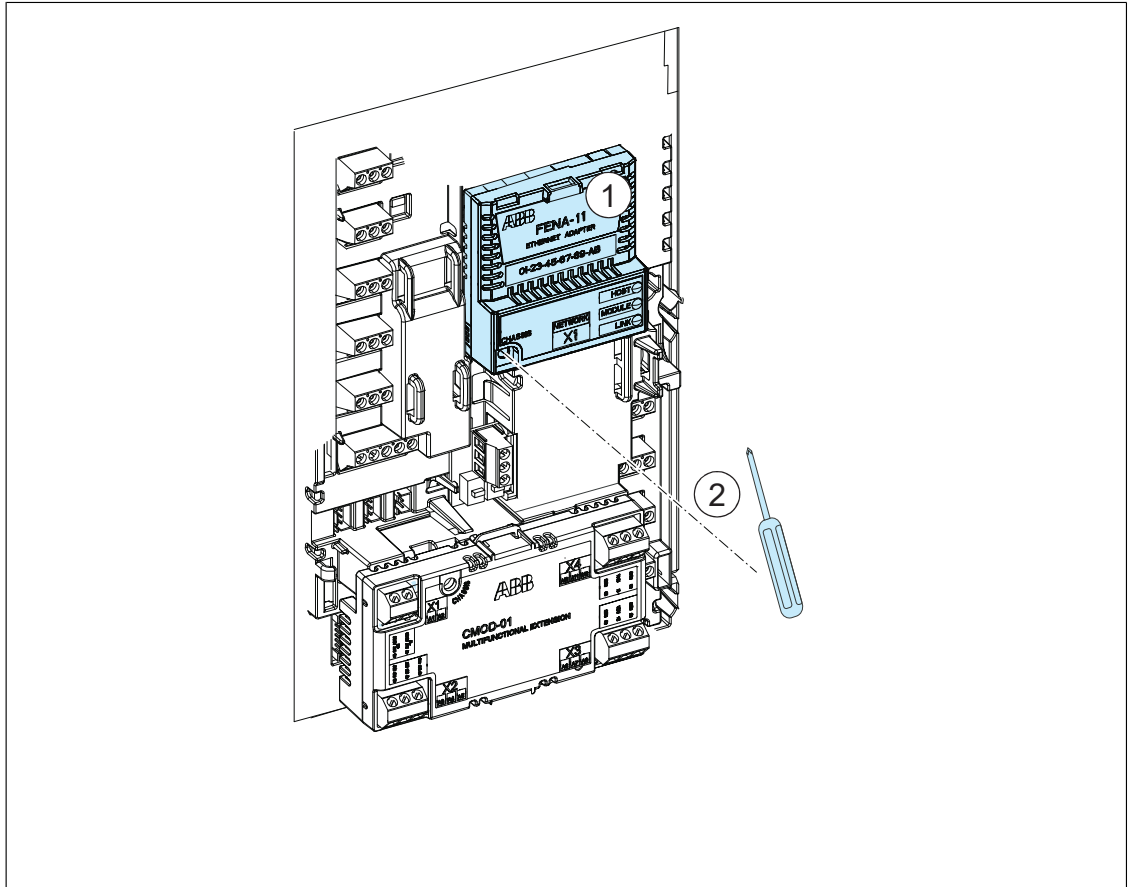
### ■ Option slot 2 (I/O extension modules)

1. Put the module carefully into its position on the control unit.
2. Tighten the mounting screw.
3. Tighten the grounding screw (CHASSIS) to 0.8 N·m (7 lbf-in). The screw grounds the module. It is necessary for fulfilling the EMC requirements and for correct operation of the module.



### ■ Option slot 1 (fieldbus adapter modules)

1. Put the module carefully into its position on the control unit.
2. Tighten the mounting screw (CHASSIS) to 0.8 N·m (7 lbf·in). The screw tightens the connections and grounds the module. It is necessary for fulfilling the EMC requirements and for correct operation of the module.



### ■ Wiring the optional modules

See the appropriate option module manual or for I/O options the appropriate chapter in this manual.





# 9

## Control unit

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### Contents of this chapter

This chapter contains the default I/O connection diagram, descriptions of the terminals and technical data for the drive control unit (CCU-24).

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## Layout

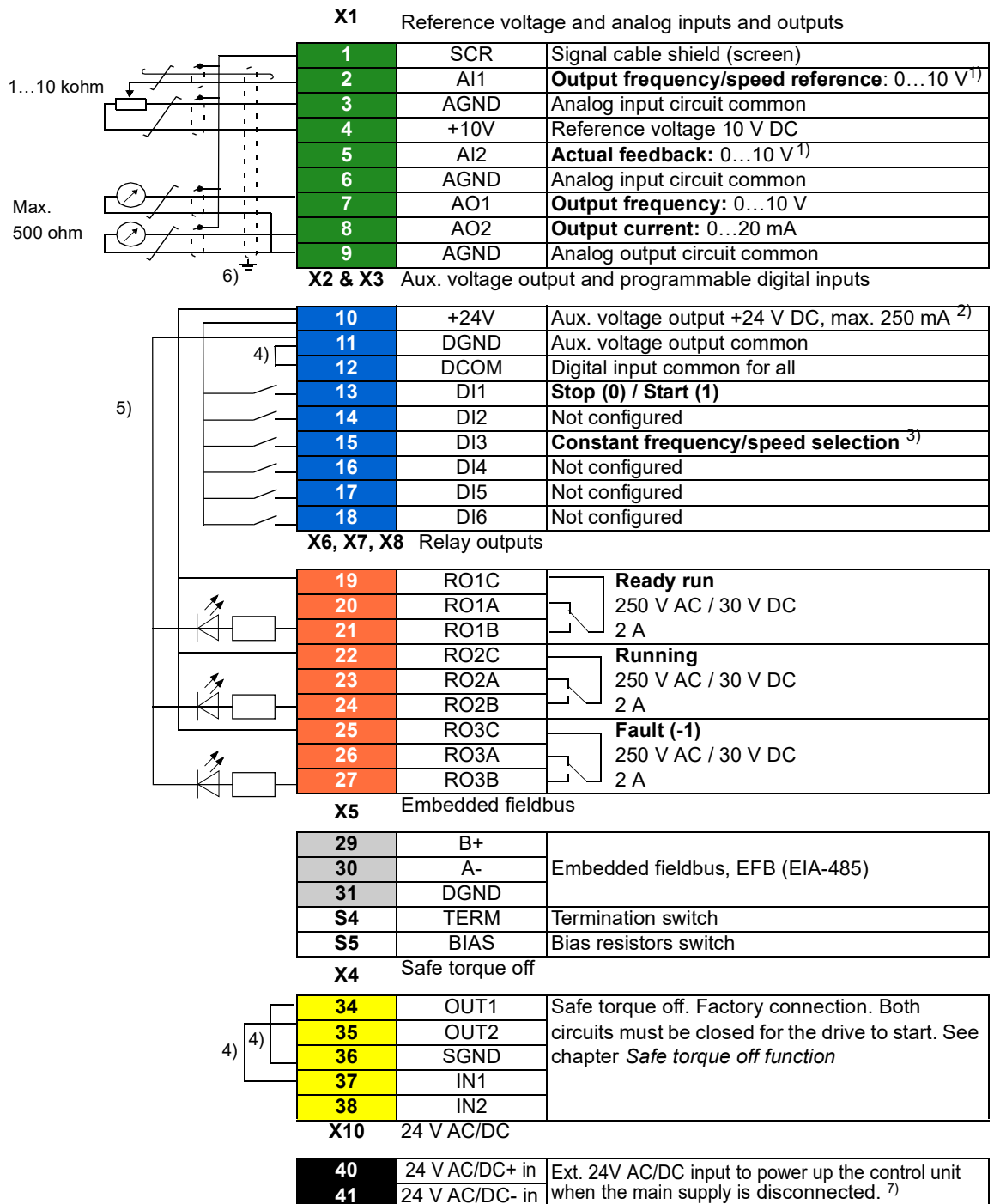
The layout of the external control connection terminals on the drive module control unit is shown below.

The diagram shows the physical layout of the control unit with callouts for various terminal blocks and components. The callouts include: 1...3, 4...6, 7...9, 10...12, 13...15, 16...18, 34...38, X12, AIR IN TEMP, FAN 2, FAN 1, SLOT 2, TERM, BIAS, X15, SLOT 1, EFB, 40, 41, 19...21, 22...24, 25...27, and LOT 2.

<b>SLOT 1</b>	
Option slot 1 (fieldbus adapter modules)	
<b>ANALOG IN/OUT</b>	
1...3	Analog input 1
4...6	Analog input 2
7...9	Analog outputs
10...12	Auxiliary voltage output, digital input common
<b>DIGITAL IN</b>	
13...18	Digital inputs
<b>STO</b>	
34...38	Safe torque off connection.
AIR IN TEMP	Internal air temperature NTC sensor connection
FAN2	Internal fan 2 connection
FAN1	Internal fan 1 connection
X12	Panel port (control panel connection, wired at the factory to the control panel)
X15	Reserved to internal use.
<b>EFB</b>	
EIA/RS-485 fieldbus connector	
BIAS	Bias resistor switch
TERM	End termination switch
29...31	Connection terminals
<b>SLOT 2</b>	
Option slot 2 (I/O extension modules)	
40, 41	24 V AC/DC external power input
<b>RO1 ... RO3</b>	
19...21	Relay output 1 (RO1)
22...24	Relay output 2 (RO2)
25...27	Relay output 3 (RO3)

## Default I/O connection diagram

The default control connections for the Water default are shown below.




Total load capacity of the Auxiliary voltage output +24V (X2:10) is 6.0 W (250 mA / 24 V DC).

Digital inputs DI1...DI5 also support 10 to 24 V AC





Terminal sizes: 0.14...2.5 mm<sup>2</sup> (all terminals)

Tightening torques: 0.5...0.6 N·m (0.4 lbf·ft)

**Notes:**

- 1) Current [0(4)...20 mA,  $R_{in} = 100 \text{ ohm}$ ] or voltage [0(2)...10 V,  $R_{in} > 200 \text{ kohm}$ ]. Change of setting requires changing the corresponding parameter.
- 2) Total load capacity of the Auxiliary voltage output +24V (X2:10) is 6.0 W (250 mA / 24 V) minus the power taken by the option modules installed on the board.
- 3) **In scalar control:** See **Menu > Primary settings > Start, stop, reference > Constant speeds / constant frequencies** or parameter group 28 Frequency reference chain.  
**In vector control:** See **Menu > Primary settings > Start, stop, reference > Constant speeds / constant frequencies** or parameter group 22 Speed reference selection.
- 4) Connected with jumpers at the factory.
- 5) Use shielded twisted-pair cables for digital signals.
- 6) Ground the outer shield of the cables 360 degrees at the cabinet entry.
- 7)  **WARNING!** Connect external AC power supply (24 V AC) to control unit connectors 40 and 41. If you connect it to connector AGND, DGND or SGND, the power supply or the control unit can get damaged.

■ **Switches**

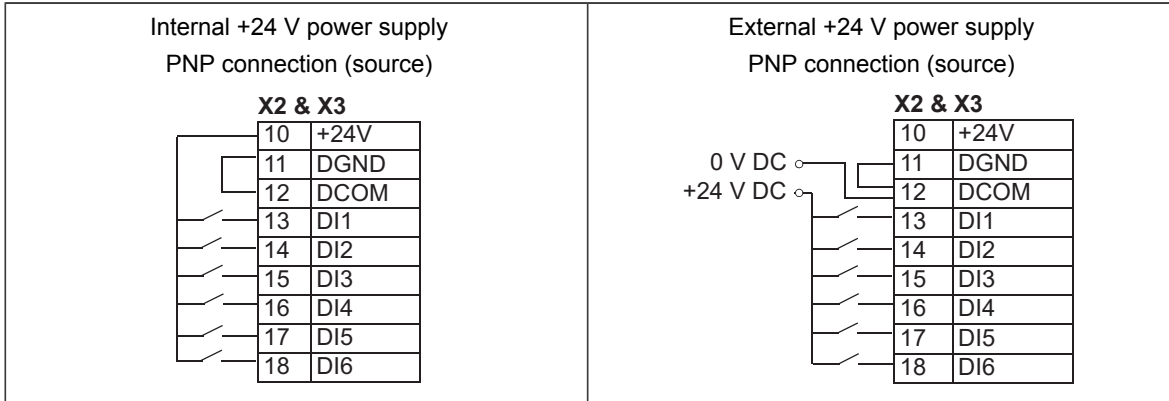
Switch	Description	Position	
<b>TERM S4</b>	EFB link termination. Must be set to the terminated (ON) position when the drive (or another device) is the first or last unit on the link.		Bus not terminated ( <b>default</b> )
			Bus terminated
<b>BIAS S5</b>	Switches on the biasing voltages to the bus. One (and only one) device, preferably at the end of the bus must have the bias on.		Bias off ( <b>default</b> )
			Bias on

**Additional information on I/O connections**

■ **PNP configuration for digital inputs (X2 & X3)**

Internal and external +24 V power supply connections for PNP configuration are shown in the figure below.



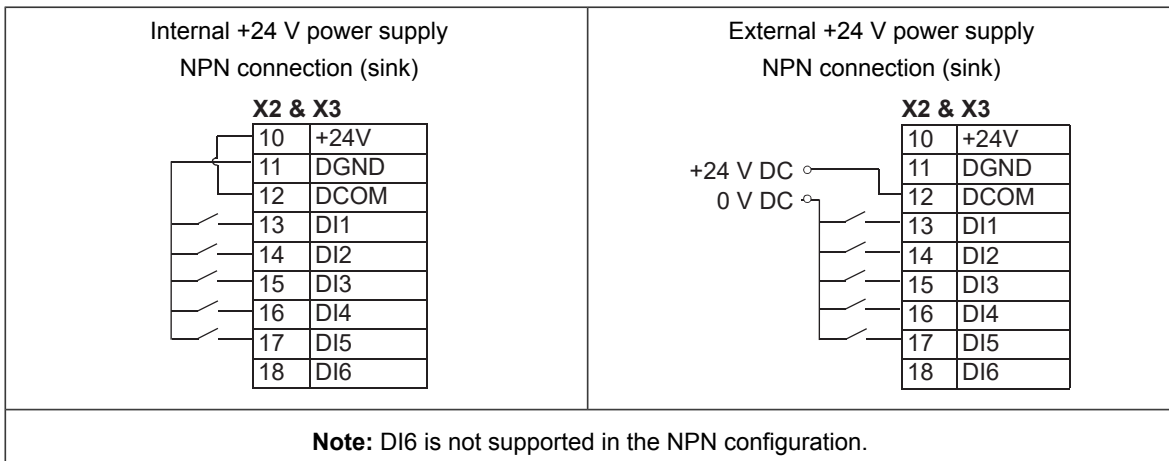


**WARNING!**

Do not connect the +24 V AC cable to the control board ground when the control board is powered using an external 24 V AC supply.

■ **NPN configuration for digital inputs (X2 & X3)**

Internal and external +24 V power supply connections for NPN configuration are shown in the figure below.

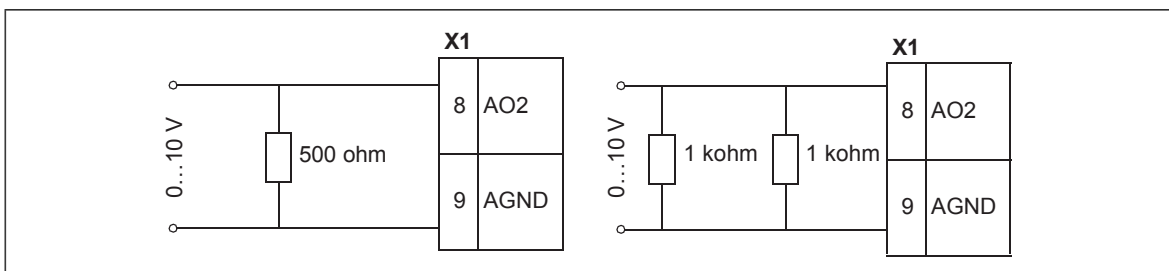


**WARNING!**

Do not connect the +24 V AC cable to the control board ground when the control board is powered using an external 24 V AC supply.

■ **Connection for obtaining 0...10 V from analog output 2 (AO2)**

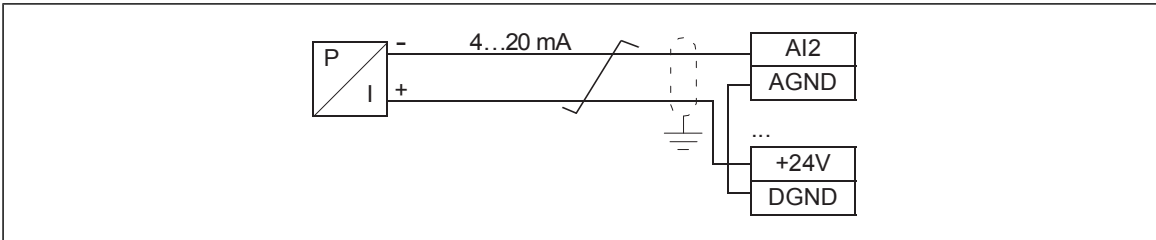
To obtain 0...10 V from analog output AO2, connect a 500 ohm resistor (or two 1 kohm resistors in parallel) between analog output AO2 and analog common ground AGND.



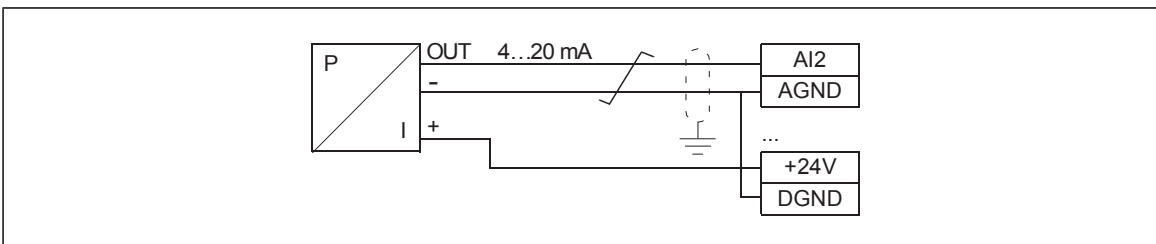
■ **Connection examples of two-wire and three-wire sensors to analog input (AI2)**

**Note:** The maximum capability of the auxiliary voltage output (24 V DC [250 mA]) must not be exceeded.

An example of a two-wire sensor/transmitter supplied by the drive auxiliary voltage output is shown below. Set the input signal to 4...20 mA, not 0...20 mA.



An example of a three-wire sensor/transmitter supplied by the drive auxiliary voltage output is shown below. The sensor is supplied through its current output and the drive feeds the supply voltage (+24 V DC). Thus the output signal must be 4...20 mA, not 0...20 mA.



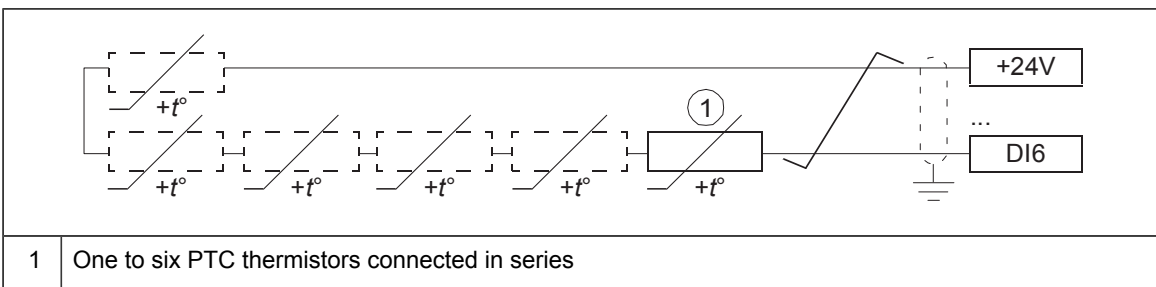
■ **DI5 as frequency input**

For setting the parameters for the digital frequency input, see the firmware manual.

■ **DI6 as PTC input**

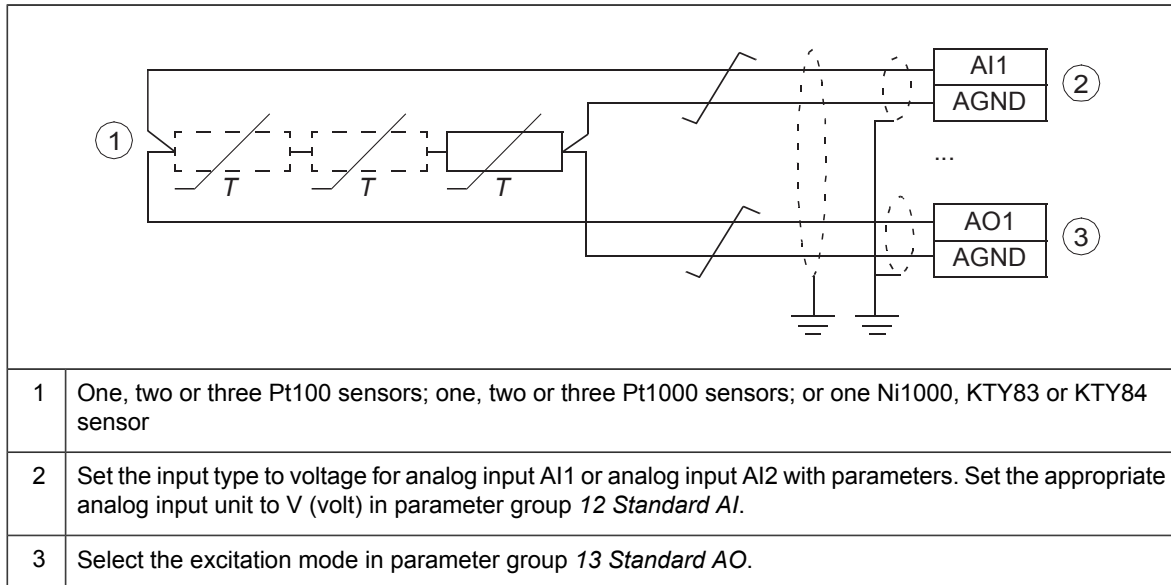
If DI6 is used as a PTC input, see firmware manual for how to set parameters accordingly.

**Note:** If DI6 is used as a PTC input, the wiring and the PTC sensor need to be double isolated. Otherwise the CMOD-02 I/O extension module must be used.



■ **AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs (X1)**

Sensors for motor temperature measurement can be connected between an analog input and output, an example connection is shown below. Leave the other end of the shield unconnected or ground it indirectly via a few nanofarads high-frequency capacitor, 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 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor.

If the assembly does not fulfill this requirement, the I/O board terminals must be protected against contact and must not be connected to other equipment or the temperature sensor must be isolated from the I/O terminals.

#### ■ Safe torque off (X4)

For the drive to start, both connections (+24 V DC to IN1 and +24 V DC to IN2) must be closed. By default, the terminal block has jumpers to close the circuit.

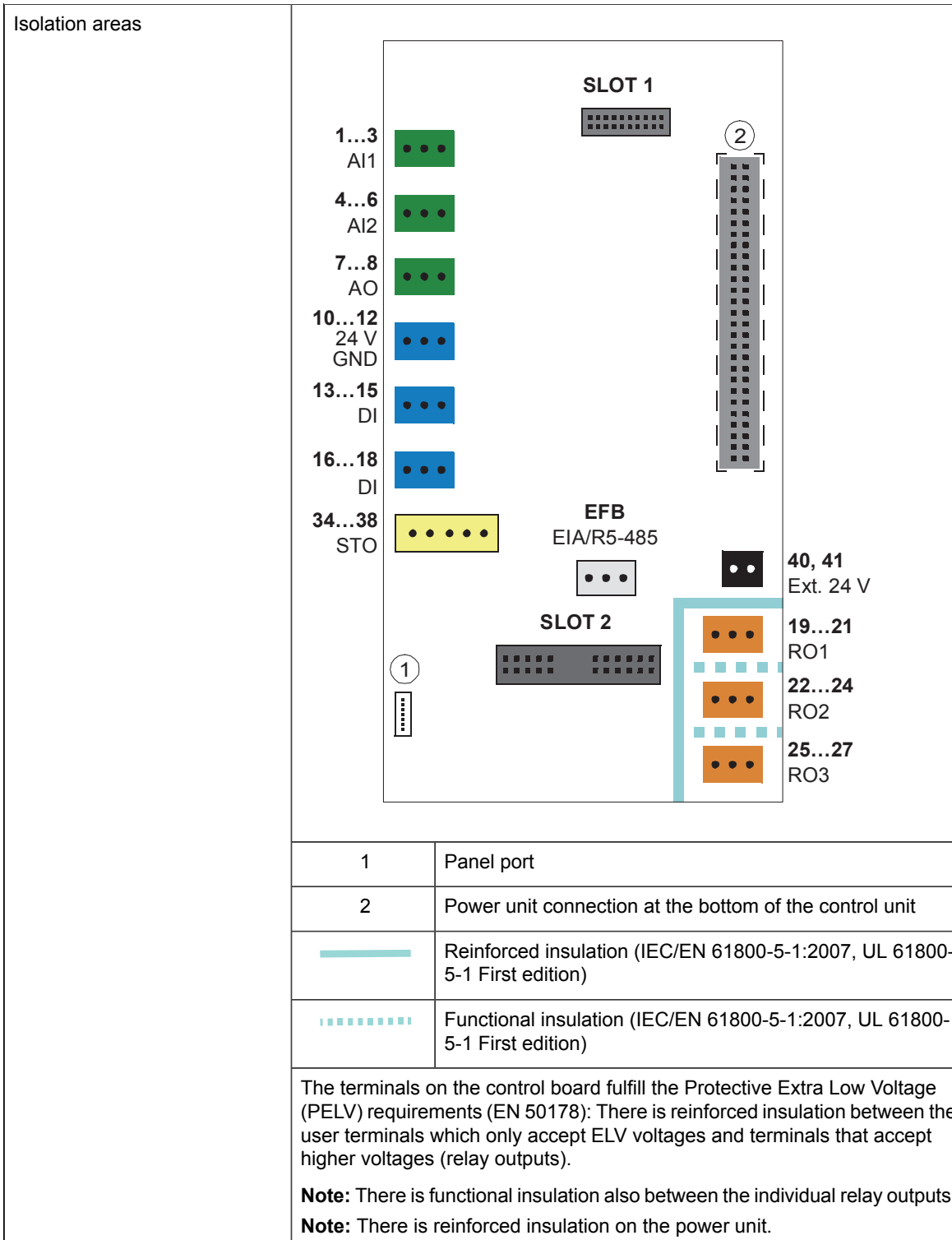
Remove the jumpers before connecting an external Safe torque off circuitry to the drive. See also chapter [The Safe torque off function \(page 193\)](#).

**Note:** Only 24 V DC can be used for STO. Only PNP input configuration can be used.

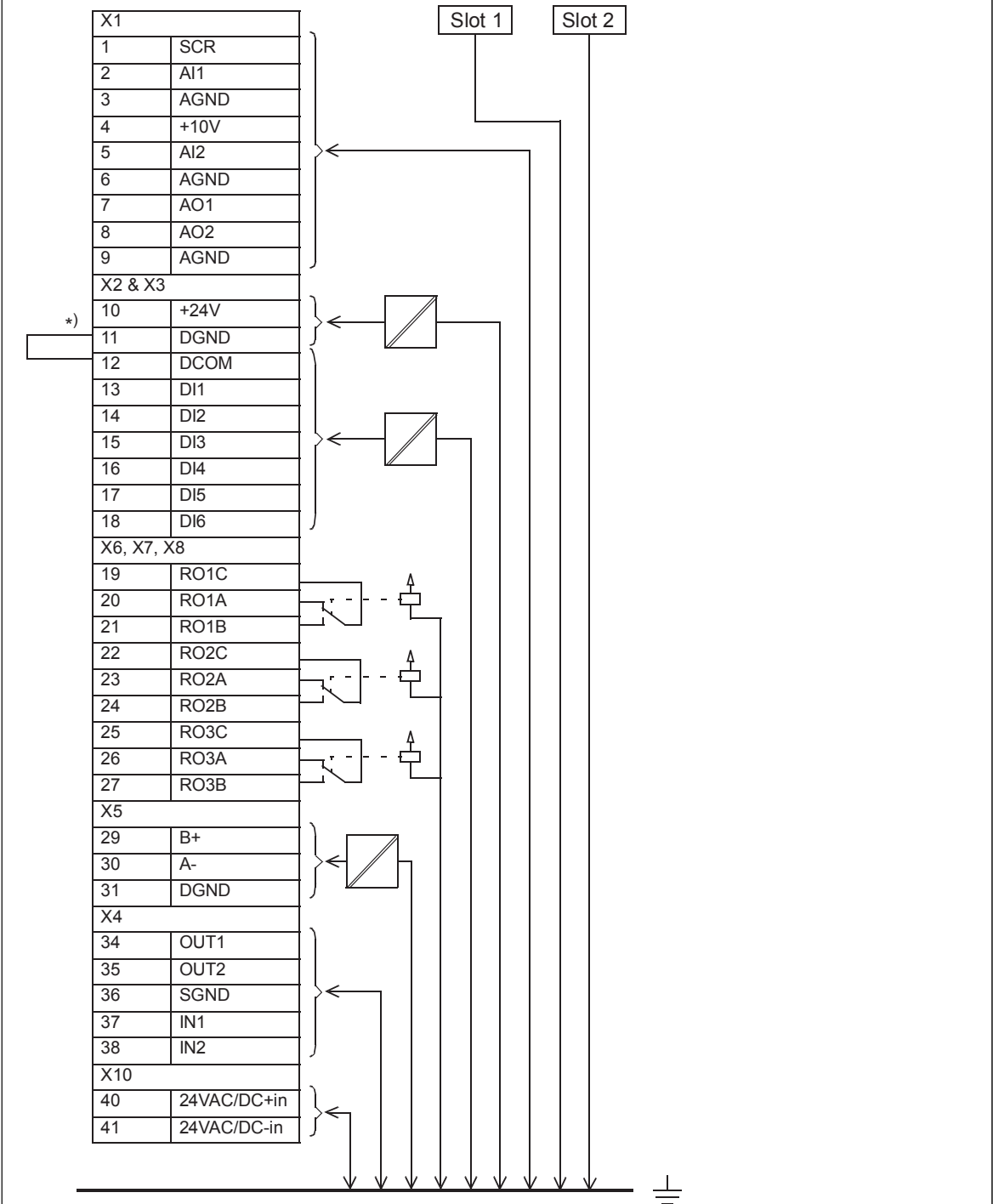
## Technical data

External power supply Term. 40, 41	Maximum power: 36 W, 1.50 A at 24 V AC/DC $\pm 10\%$ as standard Terminal size: 0.14...2.5 mm <sup>2</sup>
+24 V DC output (Term. 10)	Total load capacity of this outputs is 6.0 W (250 mA / 24 V) minus the power taken by the option modules installed on board. Terminal size: 0.14...2.5 mm <sup>2</sup>
Digital inputs DI1...DI6 (Term. 13...18)	<p>Input type: NPN/PNP Terminal size: 0.14...2.5 mm<sup>2</sup></p> <p><u>DI1...DI4 (Term.13...16)</u> 12/24 V DC logic levels: "0" &lt; 4 V, "1" &gt; 8 V <math>R_{in}</math>: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling</p> <p><u>DI5 (Term.17)</u> Can be used as a digital or frequency input. 12/24 V DC logic levels: "0" &lt; 4 V, "1" &gt; 8 V <math>R_{in}</math>: 3 kohm Max. frequency 16 kHz Symmetrical signal (duty cycle D = 0.50)</p> <p><u>DI6 (Term.18)</u> Can be used as a digital or PTC input. 12/24 V DC logic levels: "0" &lt; 3 V, "1" &gt; 8 V <math>R_{in}</math>: 3 kohm Max. frequency 16 kHz Symmetrical signal (duty cycle D = 0.50) Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling</p> <p><b>Note:</b> DI6 is not supported in the NPN configuration. PTC mode – PTC thermistor can be connected between DI6 and +24 V DC: &lt; 1.5 kohm = '1' (low temperature), &gt; 4 kohm = '0' (high temperature), open circuit = '0' (high temperature). DI6 is not a reinforced/double insulated input. Connecting the motor PTC sensor to this input requires usage of a reinforced/double insulated PTC sensor inside the motor</p>
Relay outputs RO1...RO3 (Term. 19...27)	250 V AC / 30 V DC, 2 A Terminal size: 0.14...2.5 mm <sup>2</sup> See section <i>Isolation areas (page 120)</i> .
Analog inputs AI1 and AI2 (Term. 2 and 5)	Current/voltage input mode selected with a parameter, see <i>AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs (X1) (page 116)</i> . Current input: 0(4)...20 mA, $R_{in}$ : 100 ohm Voltage input: 0(2)...10 V, $R_{in}$ : > 200 kohm Terminal size: 0.14...2.5 mm <sup>2</sup> Inaccuracy: typical $\pm 1\%$ , max. $\pm 1.5\%$ of full scale Inaccuracy for Pt100 sensors: 10 °C (50 °F)
Analog outputs AO1 and AO2 (Term. 7 and 8)	Current/voltage output mode for AO1 selected with a parameter, see <i>Connection for obtaining 0...10 V from analog output 2 (AO2) (page 115)</i> . Current output: 0...20 mA, $R_{load}$ : < 500 ohm Voltage output: 0...10 V, $R_{load}$ : > 100 kohm (AO1 only) Terminal size: 0.14...2.5 mm <sup>2</sup> Inaccuracy: $\pm 1\%$ of full scale (in voltage and current modes)
Reference voltage output for analog inputs +10V DC (Term. 4)	Max. 20 mA output Inaccuracy: $\pm 1\%$

Safe torque off (STO) inputs IN1 and IN2 (Term. 37 and 38)	24 V DC logic levels: "0" < 5 V, "1" > 13 V $R_{in}$ : 2.47 kohm Terminal size: 0.14...2.5 mm <sup>2</sup>
Embedded fieldbus (X5)	Connector pitch 5 mm, wire size 2.5 mm <sup>2</sup> Physical layer: EIA-485 Cable type: Shielded twisted pair cable with twisted pair for data and a wire or pair for signal ground, nominal impedance 100...165 ohms, for example Belden 9842 Transmission rate: 9.6...115.2 kbit/s Termination by switch
Control panel - drive connection	EIA-485, male RJ-45 connector, max. cable length 100 m (328 ft)
Control panel - PC connection	USB Type Mini-B, max. cable length 2 m (7 ft)



Ground isolation diagram



\*) Jumper installed at factory





# 10

## External control unit (option +P906)

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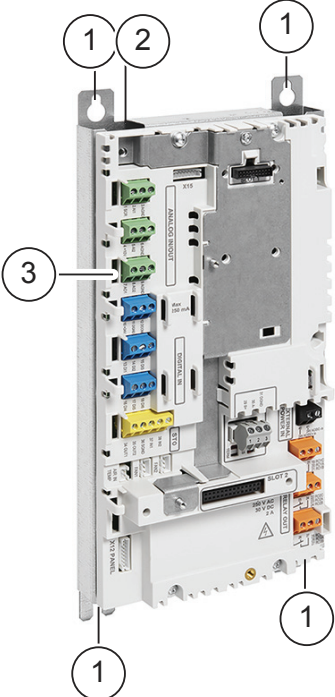

### Contents of this chapter

This chapter describes the external control unit option +P906 and its installation. The dimension drawing is included.

### Product overview

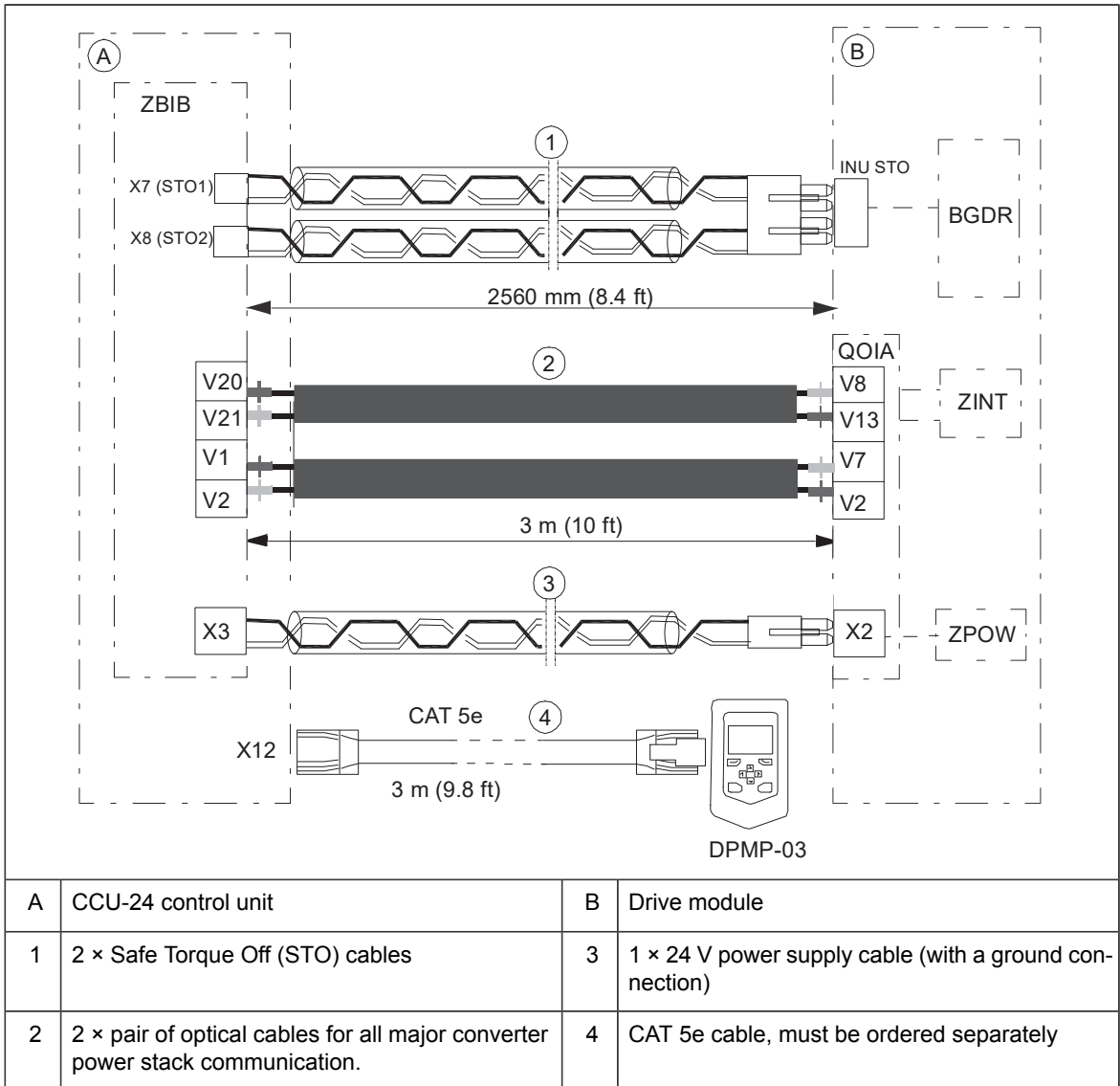
Option +P906 allows the drive control unit CCU-24 to be installed separately from the main drive module, for instance in a separate compartment. The external control unit makes the drive module removal easier, as the customer control cabling can stay in place while the module is removed.

■ **Layout**

	<table border="1"> <tr> <td data-bbox="726 295 778 340">1</td> <td data-bbox="785 295 1299 340">Attaching points</td> </tr> <tr> <td data-bbox="726 349 778 394">2</td> <td data-bbox="785 349 1299 394">Duct for cables from drive module to be connected to the ZBIB board at the back of the control unit.</td> </tr> <tr> <td data-bbox="726 403 778 448">3</td> <td data-bbox="785 403 1299 448">Connectors. For descriptions, see chapter <a href="#">Control unit (page 111)</a>.</td> </tr> </table>	1	Attaching points	2	Duct for cables from drive module to be connected to the ZBIB board at the back of the control unit.	3	Connectors. For descriptions, see chapter <a href="#">Control unit (page 111)</a> .
1	Attaching points						
2	Duct for cables from drive module to be connected to the ZBIB board at the back of the control unit.						
3	Connectors. For descriptions, see chapter <a href="#">Control unit (page 111)</a> .						
	<p>Cables for connecting the external control unit to the drive module:</p>						

■ **Cables**

These cables connect the control unit and the drive. They are supplied with the module and come with plugs and sockets that allow disconnection at either end.



## Unpacking the delivery

The external control unit is in a separate box inside the main drive module box.

## Installing the control unit

Determine where the control unit is to be located. Take into account the cable lengths, the physical dimensions and mounting points of the control unit assembly (see section [Dimension drawing \(page 132\)](#)). Install the unit inside an enclosure for protection.

## ■ Installation procedure

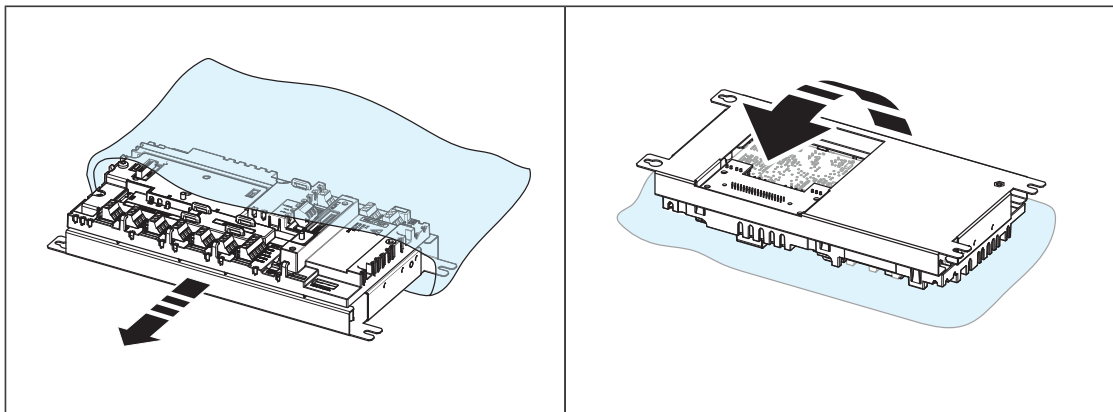
### Optical components



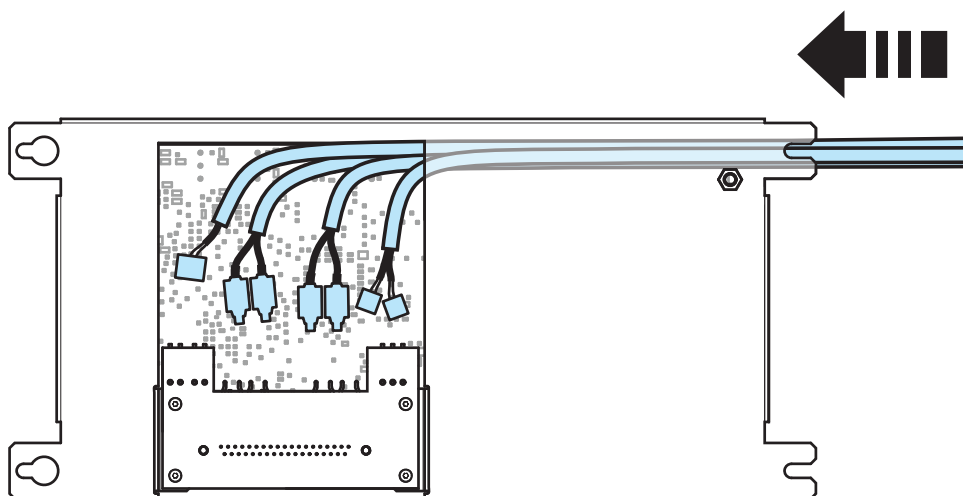
#### **WARNING!**

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

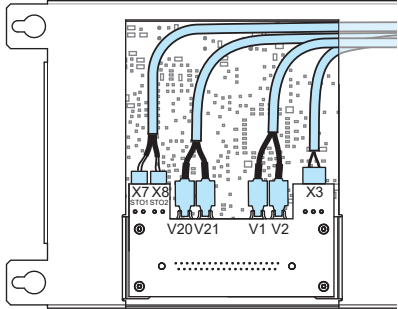
- Handle the fiber optic cables with care.
  - When you unplug the fiber optic cables, always hold the connector, not the cable itself.
  - Do not touch the ends of the fibers with bare hands as the ends are extremely sensitive to dirt.
  - Do not bend the fiber optic cables too tightly. The minimum allowed bend radius is 35 mm (1.4 in).
1. Remove the control unit from the anti-static bag and place it on top of it, then turn it over to find the rear connections.



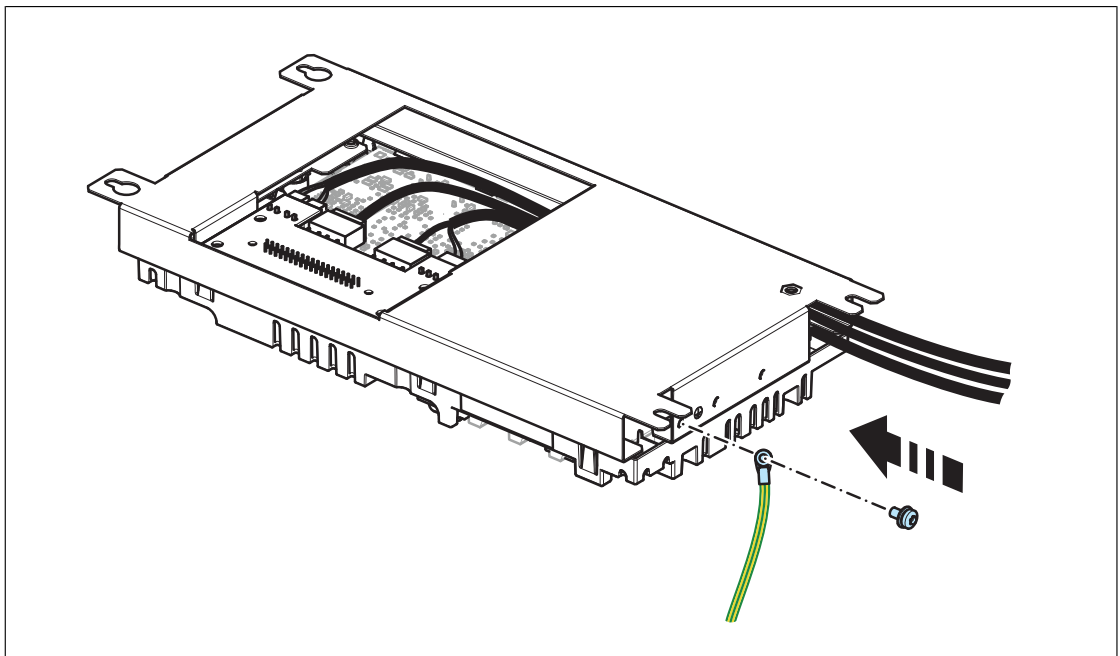
2. Identify the correct ends of the control cables to be connected to the control unit.
3. Pull the cables through the control unit assembly, so they appear in the opening at the rear of the control unit. Do not pull the ground conductor through, leave it outside the assembly. Check that the cables are not against sharp edges or bare live parts.



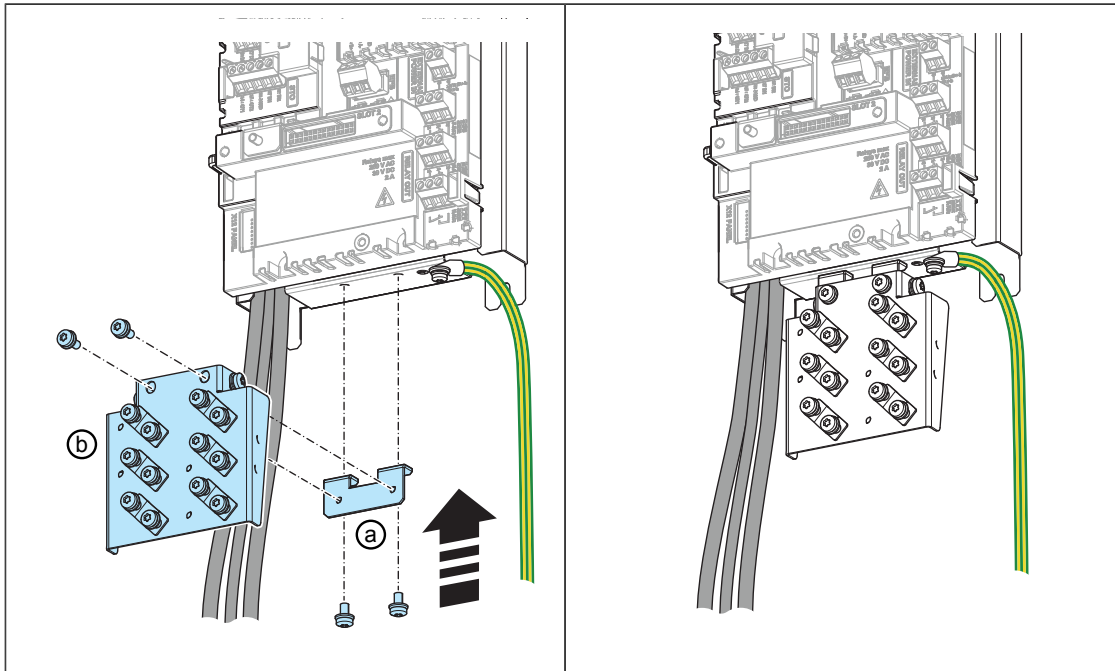
4. Connect the cables to their connectors on the ZBIB board.

View of ZBIB	ZBIB connectors	Cables from QOIA
	X7 (STO 1)	INU STO
	X8 (STO 2)	INU STO
	V20	V8
	V21	V13
	V1	V7
	V2	V2
	X3	X2

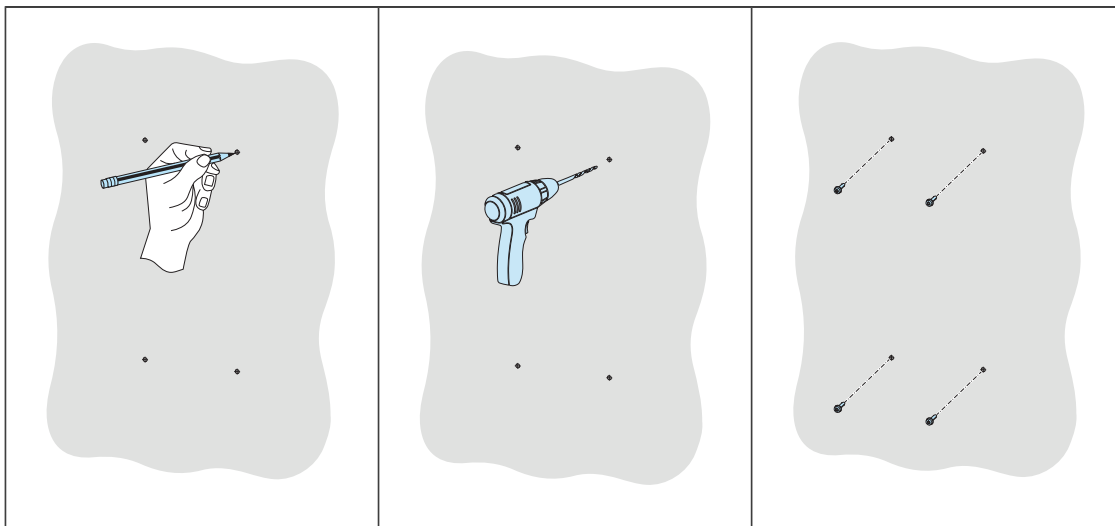
5. Connect the grounding wire.



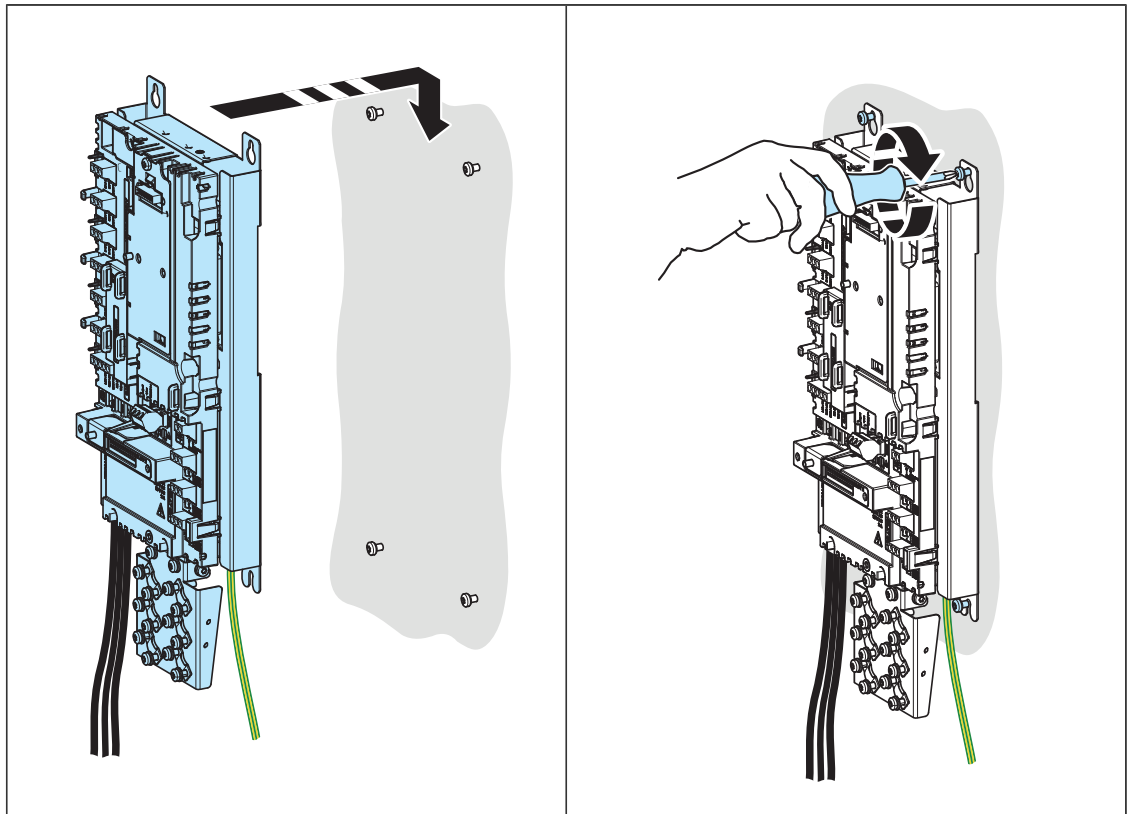
6. The kit includes a plate for the customer cable screens. Attach the small bracket (a) first, then the full clamp plate (b).



7. Mark and drill the required holes in the mounting plate for attaching the control unit. Be careful to control the swarf from the drill.

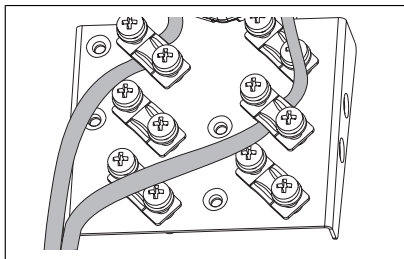


8. Lift the control unit onto the mounting screws. Tighten the screws.



9. Attach the optional modules.

10. Ground the shields of the control cables at the clamp plate. The shields should be continuous as close to the terminals of the control unit as possible. Only remove the outer jacket of the cable at the cable clamp so that the clamp presses on the bare shield. The shield (especially in case of multiple shields) can also be terminated with a lug and fastened with a screw at the clamp plate. Leave the other end of the shield unconnected or ground it indirectly via a few nanofarads high-frequency capacitor, 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. Tighten the screws to secure the connection.

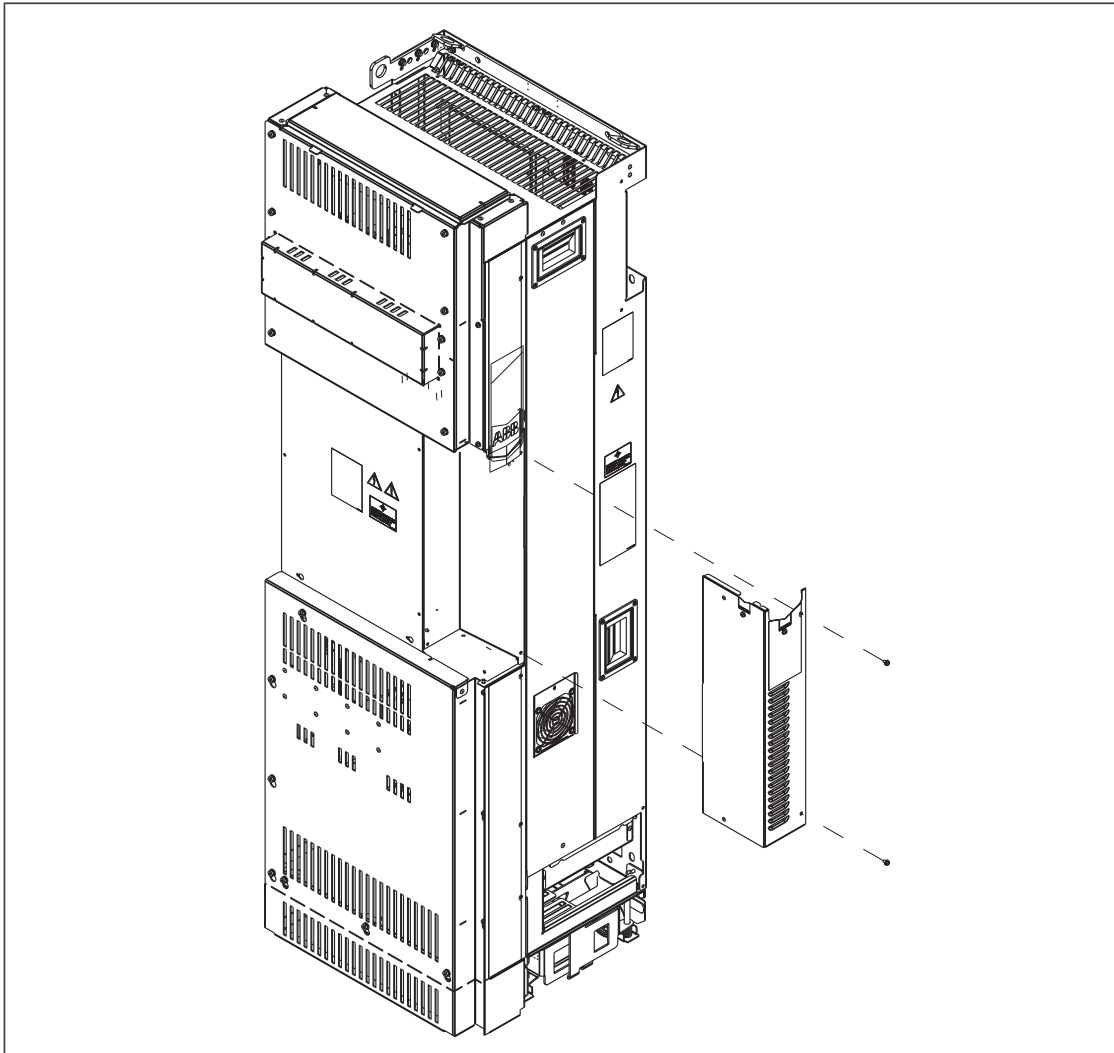


11. Connect the conductors to the appropriate detachable terminals of the control unit. See the default I/O diagram in chapter [Control unit \(page 111\)](#). Use shrink tubing or insulating tape to contain any stray strands. Tighten the screws to secure the connection.

**Note:** 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.

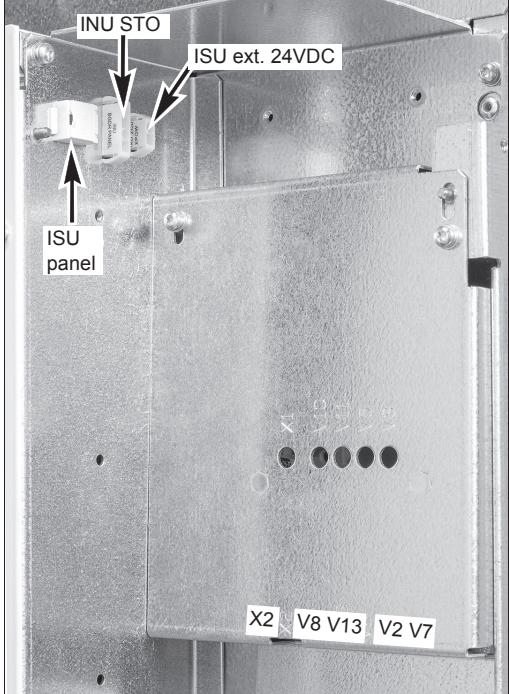
■ **Connecting the control unit to the drive module**

1. Remove the middle front cover of the the drive module. A view of drive module with optional clear plastic shrouds is shown below.
2. Remove the cover plate from the control cable entry and put the rubber grommet in its place. Put the control cables through the grommet.





3. Connect the control cables to the drive module . Make sure that that cables are not against sharp edges or bare live parts

Drive module	ZBIB
	
INU STO	X7 (STO1)
INU STO	X8 (STO2)
X2	X3
V2	V2
V7	V1
V8	V20
V13	V21

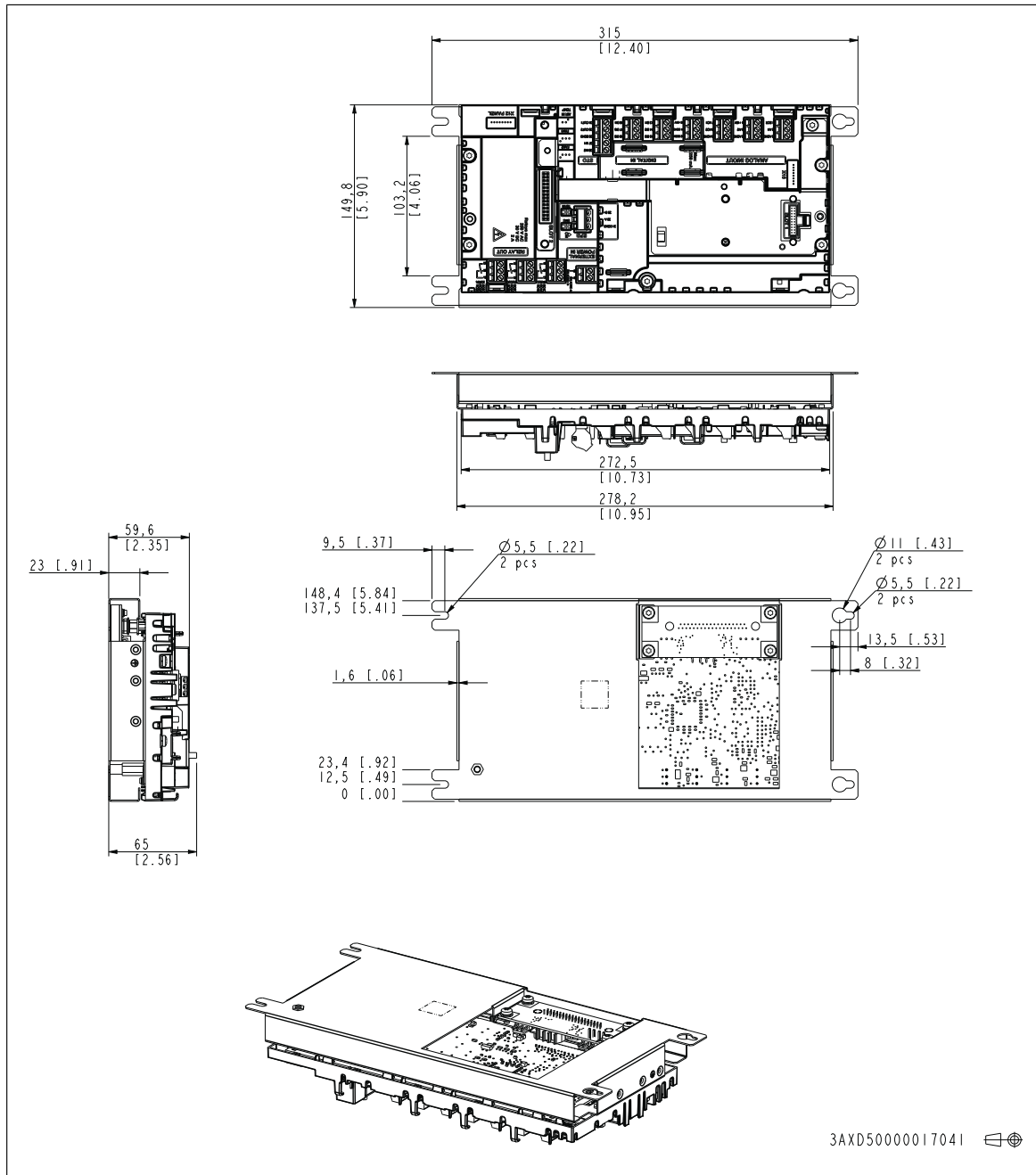
4. Connect the ground connection at the drive module end.

## Maintenance

With the external control unit option +P906, the drive module removal procedure differs slightly from the instructions given in chapter *Maintenance*: before you detach the drive module, you must disconnect the control unit cables from the drive module in the following way:

1. Remove the middle front cover of the drive module to be able to disconnect the cables.  
2 × combi screws M4×8 T20, 2 N·m (18 lbf·in).
2. Disconnect the optical, 2 × STO, 24 V, and ground connections from the drive module, and carefully remove the cables from the drive.
3. Wind the cables so they will not be damaged as the drive module is removed.
4. Continue the drive module removal procedure as described in chapter *Maintenance*.

## Dimension drawing



# 11

## Installation example in Rittal VX25 enclosure

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### Contents of this chapter

In this chapter, the drive module is installed in a 800 mm wide Rittal VX25 enclosure in a bookshelf way of mounting. The module is placed in an upright position on the cabinet bottom with its front facing the cabinet door. Available alternative ABB parts are also given. For control cable installation, see chapter [Electrical installation \(page 95\)](#).

### 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.

### Safety

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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.

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## Required parts

Drive module standard parts		
<ul style="list-style-type: none"> <li>• Drive module and LCL filter module</li> <li>• Fastening brackets (2 pcs)</li> <li>• Pedestal guide plates (2 pcs)</li> <li>• Telescopic extraction/installation ramp</li> <li>• Fastening screws and insulators in a plastic bag</li> </ul>		
Rittal parts / Alternative ABB parts		
Rittal part code	Qty (pcs)	Description
8806.000	1	Enclosure without bottom plates and side panels. Includes supports for installing air baffles.
7967.000 (one set = four pieces)	1	Spacers for roof plates / ABB roof
8100.743	1	Punched section with mounting flange, inner mounting level for 800 mm horizontal
Contact ABB for the suitable filter	4	Air filter. Remove the filter mats.
Alternative ABB parts for Rittal parts		
ABB air inlet kit 800 mm 3AUA0000117005 (IP20) 3AUA0000117009 (IP42)	2	See section <a href="#">Air inlet kits (page 160)</a>
ABB air outlet kit 800 mm 3AUA0000125203 (IP20 ) 3AUA0000114968 (IP42)	2	See section <a href="#">Air outlet kits (page 162)</a>
Customer-made parts (not ABB or Rittal products)		
Air baffles	4	See section <a href="#">Air baffles (page 189)</a>
Bottom plate	1	See section <a href="#">Bottom plate (page 188)</a>

## Required tools

- Set of screw drivers (Torx and Pozidriv)
- Set of metric magnetic-end hexagon sockets
- Torque wrench
- Step drill bit for drilling the holes in the clear plastic shroud for input power cables (option +B051)

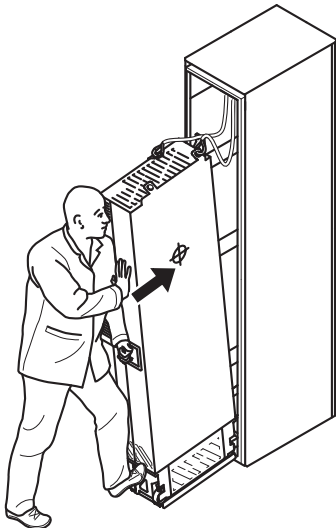
## Overall flowchart of the installation process

Step	Task	For instructions, see
1	Install the Rittal parts, drive bottom guide plate and loose drive options in the drive module cubicle	<a href="#">Installing the drive module and LCL filter module into an enclosure (page 135)</a>
2	Install the auxiliary components (such as mounting plates, switches, busbars etc.)	The component manufacturer's instructions <a href="#">Preventing the recirculation of hot air (page 55)</a>
3	Attach the drive module and LCL filter module into the enclosure	<a href="#">Installing the drive module and LCL filter module into an enclosure (page 135)</a>

Step	Task	For instructions, see
4	Connect the power cables and clear plastic shrouds to the drive module. Connect the power supply cable to the LCL filter cooling fan.	<i>Connecting the motor cables and installing the shrouds (option +B051) (page 136)</i> <i>Connecting the input cables and installing the shrouds (option +B051) (page 137)</i> <i>Connecting the power cables (page 99)</i>
5	Install the remaining parts, for example, air baffles, cabinet doors, side plates, etc.	The component manufacturer's instructions

## Installing the drive module and LCL filter module into an enclosure



See *Installing the drive module and LCL filter module into a Rittal VX25 enclosure (page 231)*

Step	Tasks
<b>Mechanical accessories</b>	
1	Attach the plinth to the floor.
2	Attach the enclosure frame to the plinth.
3	Make the bottom plate with 360-degree grounding entries for power cables. Attach the bottom plate to the enclosure frame.
4	Attach the punched section to the back of enclosure frame.
5	Attach the mounting brackets to the punched section.
<b>LCL filter module</b>	
6	Install the pedestal to the LCL filter module.
7	Install the cooling fan to the LCL filter module.
8	Attach the LCL filter module pedestal guide plate to the enclosure bottom plate.
9	Attach the drive module pedestal guide plate to the enclosure bottom plate.
10	Attach the extraction/installation ramp to the LCL filter module pedestal guide plate.
11	To prevent the LCL filter module from falling, attach its lifting lugs with chains to the enclosure frame.
12	Push the LCL filter module carefully into the enclosure along the extraction/installation ramp. Work preferably with help from another person as shown below. Keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back.
	

13	Unfasten the extraction/installation ramp and attach the LCL filter module to bottom plate.
<b>Drive module</b>	
14	Attach the extraction/installation ramp to the drive module pedestal guide plate.
15	Remove the sheeting from the clear plastic shrouds (option +B051) of the drive module from both sides.
16	Install the top metallic shroud to the drive module.
17	Install the back shrouds to the drive module.
18	To prevent the drive module from falling, attach its lifting lugs with chains to the enclosure frame.
19	Push the drive module carefully into the enclosure along the extraction/installation ramp. Work preferably with help from another person as shown above. Keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back.
20	Unfasten the extraction/installation ramp and attach the drive module to the bottom plate.
<b>LCL filter module and drive module attachments and intermediate electrical connections</b>	
21	Attach the LCL filter module and drive module to the punched section.
22	Attach the LCL filter module to the side of drive module from top. Reinstall the cover.
23	Attach the drive module and LCL filter module to the bottom plate.
24	Connect the LCL filter busbars to the drive module busbars with the connecting busbars.
25	Attach the LCL filter module to the drive module side from bottom.
26	Connect the LCL filter fan power supply cable to connector FAN3:LCL.
<b>Air baffles</b>	
-	After the electrical installation has been done, install the air baffles. For instructions, see section <a href="#">Installing the air baffles (page 137)</a> .

## Connecting the motor cables and installing the shrouds (option +B051)



See [Connecting the motor cables and installing the shrouds \(page 236\)](#)

Step	Tasks (motor cables)
1	Install the grounding terminal to the drive module base.
2	Run the motor cables to the enclosure. Ground the cable shields 360 degrees at the enclosure entry.
3	Connect the twisted shields of the motor cables to the grounding terminal.
4	<p>Screw in and tighten the insulators to the drive module by hand. Install the T3/W2 connection terminal to the insulators.</p> <div style="display: flex; align-items: center;">  <div> <p><b>WARNING!</b> Do not use longer screws or bigger tightening torque than given in the installation drawing. They can damage the insulator and cause dangerous voltage to be present at the module frame.</p>  </div> </div>
5	Connect the phase T3/W2 conductors to the T3/W2 terminal.
6	Install the T2/V2 connection terminal to the insulators. See the warning in step 4.
7	Connect the phase T2/V2 conductors to the T2/V2 connection terminal.
8	Install the T1/U2 connection terminal to the insulators. See the warning in step 4.
9	Connect the phase T1/U2 conductors to the T1/U2 terminal.

10	Remove the plastic sheeting from the motor cable clear plastic shroud (option +B051) from both sides.
11	Install the shroud (option +B051) on the motor cable connections,
12	Install the lower front cover to the drive module.
13	Drill holes for the power cables to the bottom clear plastic shrouds.
14	Remove the plastic sheeting from the bottom clear plastic shrouds.
15	Install the bottom first shroud on the motor cable entry.
16	Install the second shroud on the motor cable entry.

## Connecting the input cables and installing the shrouds (option +B051)

See [Connecting the input power cables and installing the shrouds \(page 239\)](#)

Step	Tasks (input cables)
1	Ground the input cable shields (if present) 360 degrees at the enclosure entry.
2	Connect the twisted shields of the input cables and separate ground cable (if present) to the enclosure grounding busbar.
3	Step drill carefully sufficiently big holes to the entry clear plastic shroud for the cables to be connected. Align the holes in the vertical direction according to the alignment holes in the shroud. Smooth the hole edges. Remove the plastic sheeting from both sides of the shroud. Attach the cables firmly to the enclosure frame to prevent chafing against the hole edges.
4	Put the conductors of the input cables through the drilled holes in the clear plastic shroud.
5	<u>For drive modules without option +H370:</u> Connect the input cable conductors to the drive module L1/U1, L2/V1 and L3/W1 connection busbars, Go to step 12.
<b>Tasks with option +H370: Do steps 6 to 11.</b>	
6	Screw in and tighten the insulators to the drive module by hand. Install the L1/U1 connection terminal to the insulators.   <b>WARNING!</b> Do not use longer screws or bigger tightening torque than given in the installation drawing. They can damage the insulator and cause dangerous voltage to be present at the module frame.  
7	Connect the L1/U1 conductors to the L1/U1 connection terminal.
8	Install the L2/V1 connection terminal to the insulators. See the warning in step 5.
9	Connect the L2/V1 conductors to the L2/V1 connection terminal.
10	Install the L3/W1 connection terminal to the insulators. See the warning in step 5.
11	Connect the L3/W1 conductors to the L3/W1 connection terminal.
12	Install the side clear plastic shroud and the upper front cover of the drive module.
13	Install the entry clear plastic shroud (option +B051). and motor cable shroud (option +B051).
14	Install the top clear plastic shroud (option +B051) to the drive module.

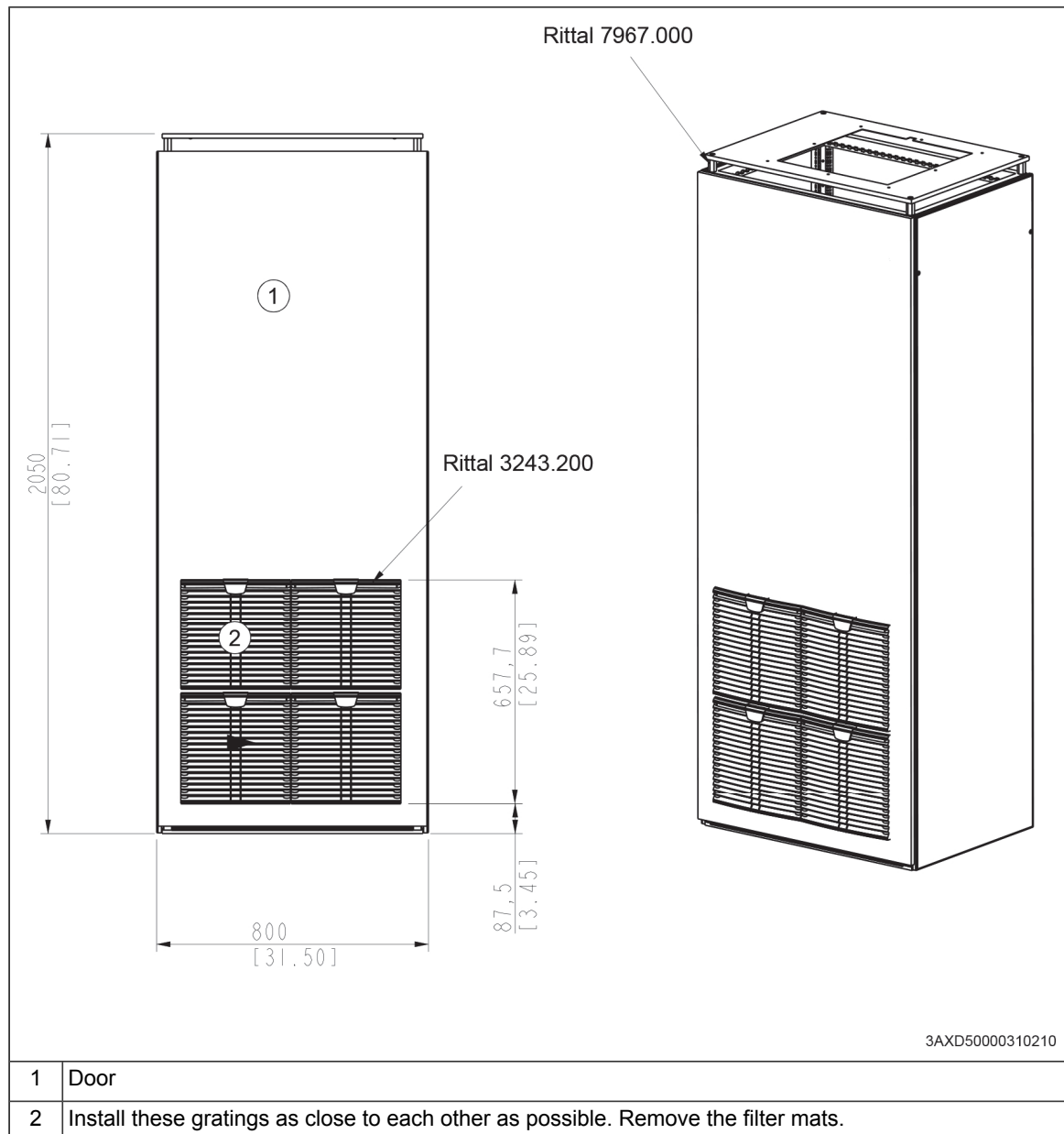
## Installing the air baffles

See:

- [Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure \(page 229\)](#)
- [Air baffles \(page 189\)](#)

## Installing the roof and door (Rittal parts)

This drawing shows a layout tested by ABB.





## Removing the protective covering from the drive module and LCL filter module air outlet



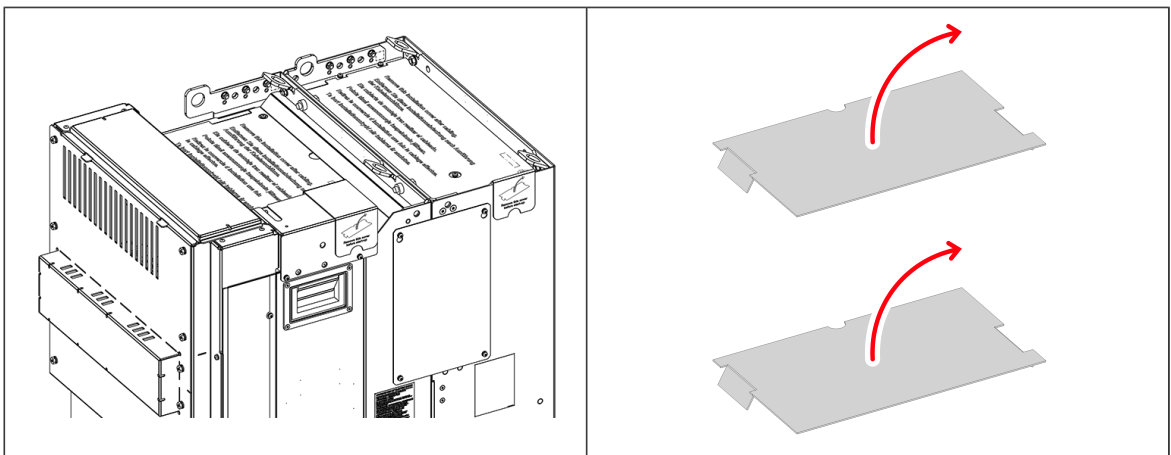
**WARNING!**

Remove the protective covering from the top of the drive module after the installation. If the covering is not removed, the cooling air cannot flow freely through the module and the drive will run to overtemperature.



**WARNING!**

Remove the protective covering from the top of the LCL filter module after the installation. If the covering is not removed, the cooling air cannot flow freely through the module and the drive will run to overtemperature.





# 12

## 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 or maintenance work.



#### **WARNING!**

Stop the drive and do the steps in section [Electrical safety precautions \(page 18\)](#) 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 or UL enclosure type).	<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"/>
The drive module is fastened properly to the enclosure.	<input type="checkbox"/>

---

142 Installation checklist

<b>Make sure that ...</b>	<input checked="" type="checkbox"/>
The cooling air flows freely in and out of the drive. Air recirculation inside the cabinet is not possible (air baffle plates are on place, or there is another air guiding solution).	<input type="checkbox"/>
<b>If the drive is connected to a network other than a symmetrically grounded TN-S system:</b> 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"/>
The enclosures of the equipment in the cabinet have proper galvanic connection to the cabinet protective earth (ground) busbar; The connection surfaces at the fastening points are bare (unpainted) and the connections are tight, or separate grounding conductors have been installed.	<input type="checkbox"/>
The main circuit connections inside the drive cabinet correspond to the circuit diagrams.	<input type="checkbox"/>
The control unit has been connected. See the circuit diagrams.	<input type="checkbox"/>
Appropriate AC fuses and main disconnecting device are installed.	<input 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"/>
<b>If a drive bypass connection will be used:</b> 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"/>
The area in front of the drive is clean: the drive cooling fan cannot draw any dust or dirt inside.	<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"/>

# 13

## Start-up

---

### Contents of this chapter

This chapter describes the start-up procedure of the drive.

### Start-up procedure

1. Only qualified electrical professionals are allowed to start-up the drive.
2. Make sure that the installation of the drive module has been checked according to the checklist in chapter *Installation checklist*, and that the motor and driven equipment are ready for start.
3. Perform the start-up tasks instructed by the cabinet-installer of the drive module.
4. Switch the power on, setup the drive control program, and perform the first start of the drive and motor. See ACQ580 pump control program quick startup guide (3AXD50000048773 [English]) or *ACQ580 pump control program firmware manual* (3AXD50000035867 [English])
5. For drive modules in which the Safe torque off function is in use: Test and validate the operation of the Safe torque off function. See [Validation test procedure \(page 201\)](#).





# 14

## Fault tracing

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### Contents of this chapter

This chapter describes the fault tracing possibilities of the drive.

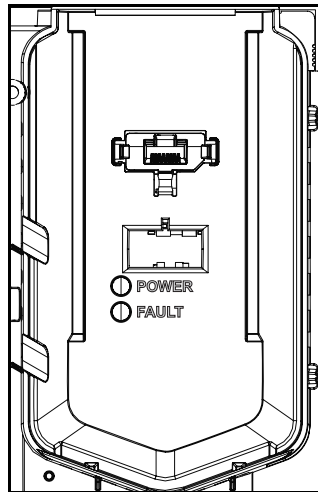
### LEDs

- **Drive LEDs**

There is a green POWER and a red FAULT LED visible when the control panel is removed. If a control panel is attached to the drive, switch to remote control (otherwise a fault will be generated), and then remove the panel to be able to see the LEDs.

---

The table below describes the drive LED indications.



LEDs off	LED lit and steady		LED blinking	
No power	Green (POWER)	Power supply of the unit is on	Green (POWER)	<p><u>Blinking:</u> Drive in an alarm state</p> <p><u>Blinking for one second:</u> Drive selected on the control panel when multiple drives are connected to the same panel bus.</p>
	Red (FAULT)	Active fault in the drive. To reset the fault, press RESET from the control panel or switch off the drive power.	Red (FAULT)	Active fault in the drive. To reset the fault, switch off the drive power.

### ■ Control panel LEDs

The assistant control panel has one LED. For the meaning of the LED indications, see *ACx-AP-x assistant control panels user's manual* (3AUA0000085685 [English]).

## Warning and fault messages

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



# 15

## Maintenance

---

### Contents of this chapter

This chapter contains maintenance instructions of the drive modules.

### 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 ([www.abb.com/drivesservices](http://www.abb.com/drivesservices)). For more information, consult your local ABB Service representative ([www.abb.com/searchchannels](http://www.abb.com/searchchannels)).

The 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.

**Note:** 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.

#### ■ Descriptions 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 annual maintenance actions by the user

ABB recommends these annual inspections to ensure the highest reliability and optimum performance.

---

Recommended annual actions by the user	Annually
<b>Connections and environment</b>	
Quality of supply voltage	P
<b>Spare parts</b>	
Spare parts	I
DC circuit capacitors reforming, spare modules and spare capacitors	P
<b>Inspections by the user</b>	
Tightness of terminals	I
Dustiness, corrosion and temperature	I
Heat sink cleaning	I

■ **Recommended maintenance intervals after start-up**

Component	Years from start-up						
	3	6	9	12	15	18	21
<b>Cooling</b>							
<b>Main cooling fan</b>							
Main cooling fan (R10 and R11)			R			R	
<b>Auxiliary cooling fan</b>							
Circuit board compartment cooling fans (R10 and R11) LONG-LIFE			R			R	
<b>Aging</b>							
ZCU control unit battery (real-time clock)		R		R		R	
Control panel battery (real-time clock)			R			R	
4FPS10000239703							

■ **Recommended functional safety actions**

Functional safety actions	
Safety function test interval	I
Safety component expiry (Mission time $T_M$ ) 20 years	R

**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 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 \(page 18\)](#) 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 interior of the heatsink

The module heatsink fins pick up dust from the cooling air. The drive runs into overtemperature warnings and faults if the heatsink is not clean.



### WARNING!

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

---



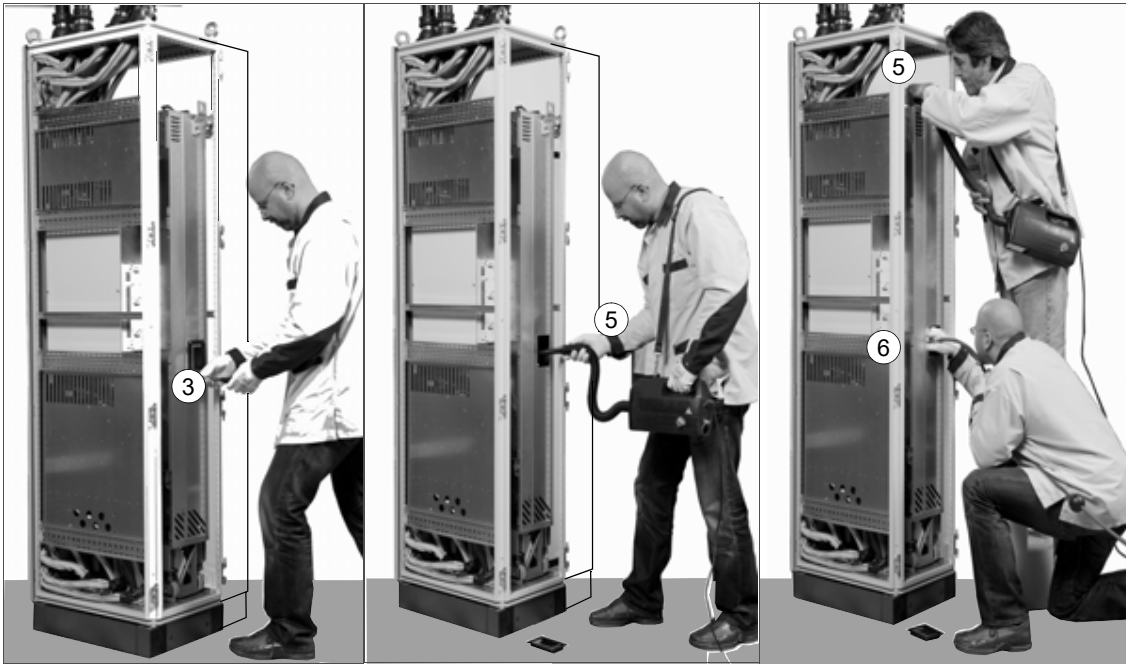
### WARNING!

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 \(page 18\)](#) before you start the work.
  2. Make sure that the drive is disconnected from the power line and all other precautions described under [Grounding \(page 21\)](#) have been taken into consideration.
  3. Undo the attaching screws of the handle plate of the drive module.
  4. Remove the handle plate.
  5. Vacuum the interior of the heatsink from the opening.
  6. Blow clean compressed air (not humid or oily) upwards from the opening and, at the same time, vacuum from the top of the drive module.
 

**Note:** If there is a risk of dust entering adjoining equipment, perform the cleaning in another room.
  7. Reinstall the cover plate.
-



## Cleaning the interior of the LCL filter

Clean the interior of the LCL filter in the same way as the heatsink in section [Cleaning the interior of the heatsink \(page 149\)](#).

## 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.

### ■ Replacing the auxiliary cooling fans of the drive module

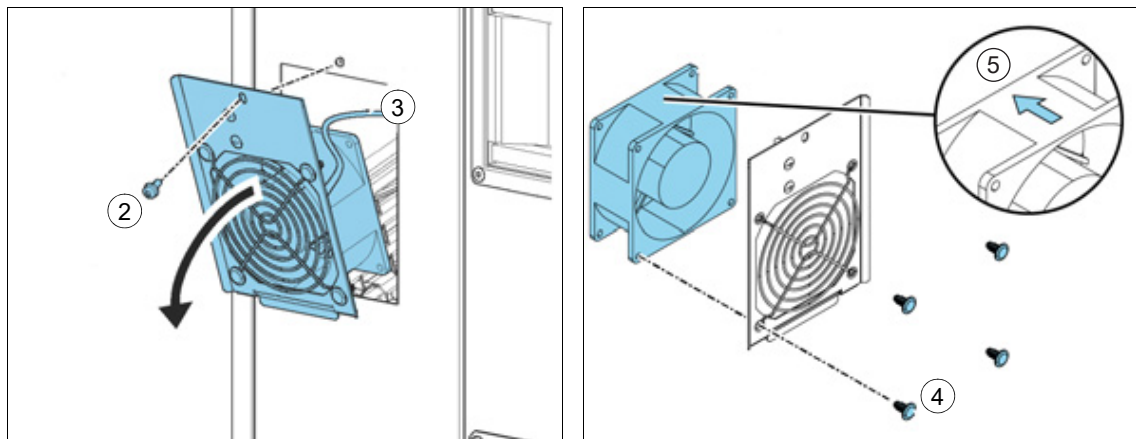


#### **WARNING!**

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

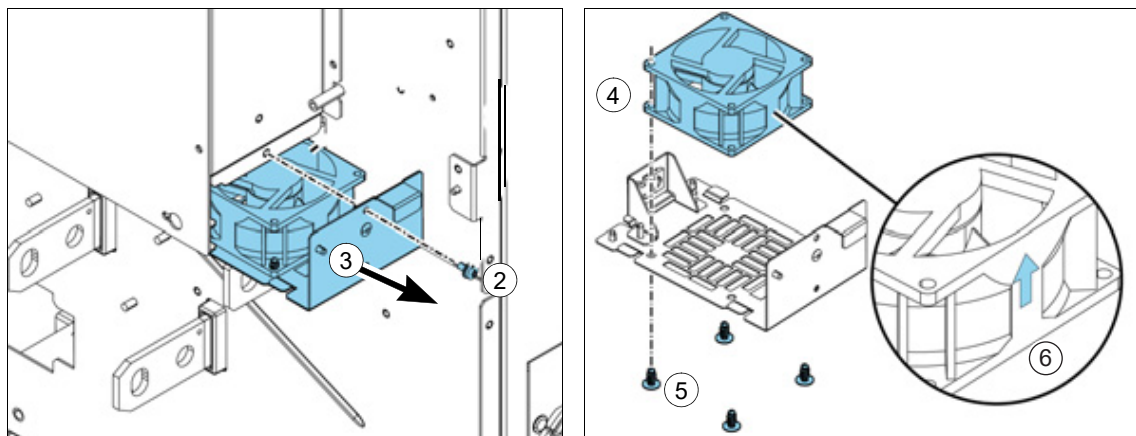
#### Fan in the front panel:

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 18\)](#) before you start the work.
2. Undo the mounting screw of the fan cassette.
3. Unplug the power supply cable of the fan.
4. Undo the mounting screws of the fan.
5. Install the new fan in reverse order. Make sure that the arrow in the fan points to the drive module.
6. Reset the counter (if used) in group 5 in the primary control program.



### Fan at the bottom of the circuit board compartment:

1. Stop the drive and do the steps in section *Electrical safety precautions (page 18)* before you start the work.
2. Undo the mounting screw of the fan cassette.
3. Pull the fan cassette out:
4. Unplug the power supply cable of the fan.
5. Undo the mounting screws of the fan.
6. Install the new fan in reverse order. Make sure that the arrow in the fan points up.
7. Reset the counter (if used) in group 5 in the primary control program.



### ■ Replacing the drive module main cooling fans

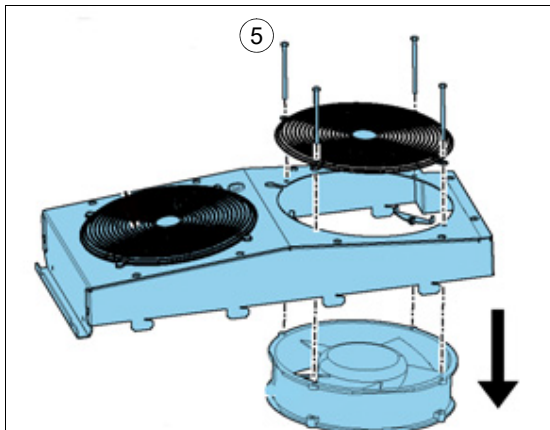
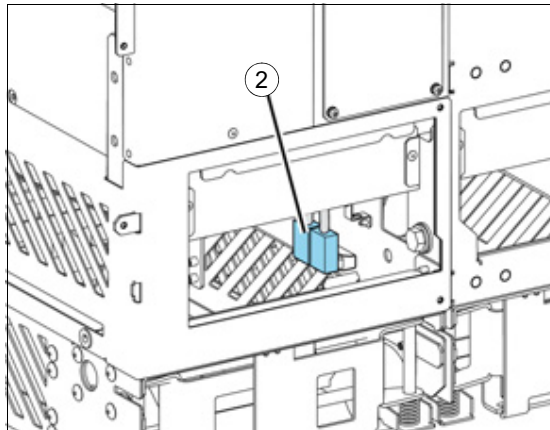
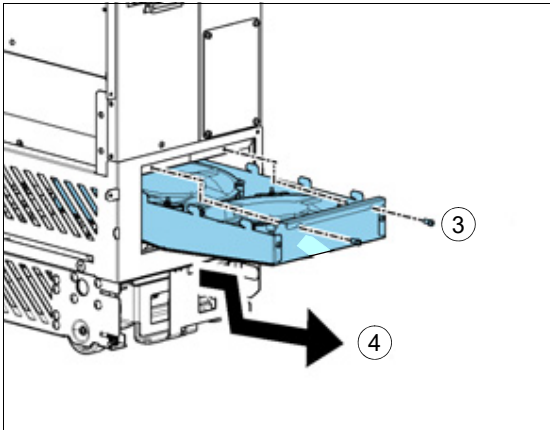


#### **WARNING!**

Obey the safety instructions of the drive. 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 18)* before you start the work.
2. Disconnect the power supply wires of the fans from the connector. FAN1:PWR1 and FAN2:PWR2.

3. Undo the mounting screws of the fan cassette.
4. Pull the fan cassette out.
5. Undo the mounting screws of the fan(s).
6. Install the new fans in reverse order.
7. Reset the counter (if used) in group 5 in the primary control program.



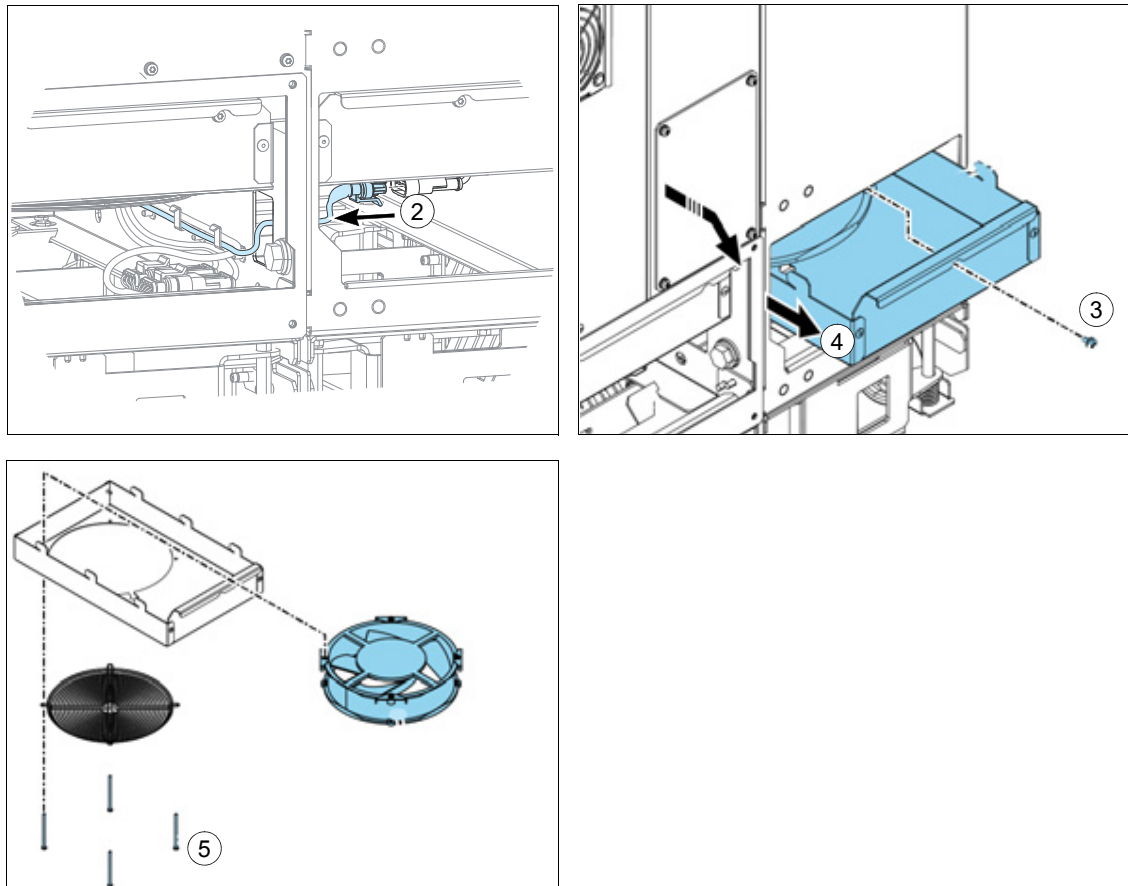
### ■ Replacing the LCL filter module cooling fan



#### **WARNING!**

Obey the safety instructions of the drive. 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 \(page 18\)](#) before you start the work.
2. Disconnect the power supply wire of the fan from connector FAN3:LCL.
3. Undo the attaching screw of the fan cassette.
4. Pull the fan cassette out.
5. Undo the mounting screws of the fan. The finger guard of the fan is attached by the same screws and is removed at the same time. Keep the finger guard for reuse
6. Install the new fan in reverse order. Make sure that the arrow in the fan points up.



## Replacing the standard drive module



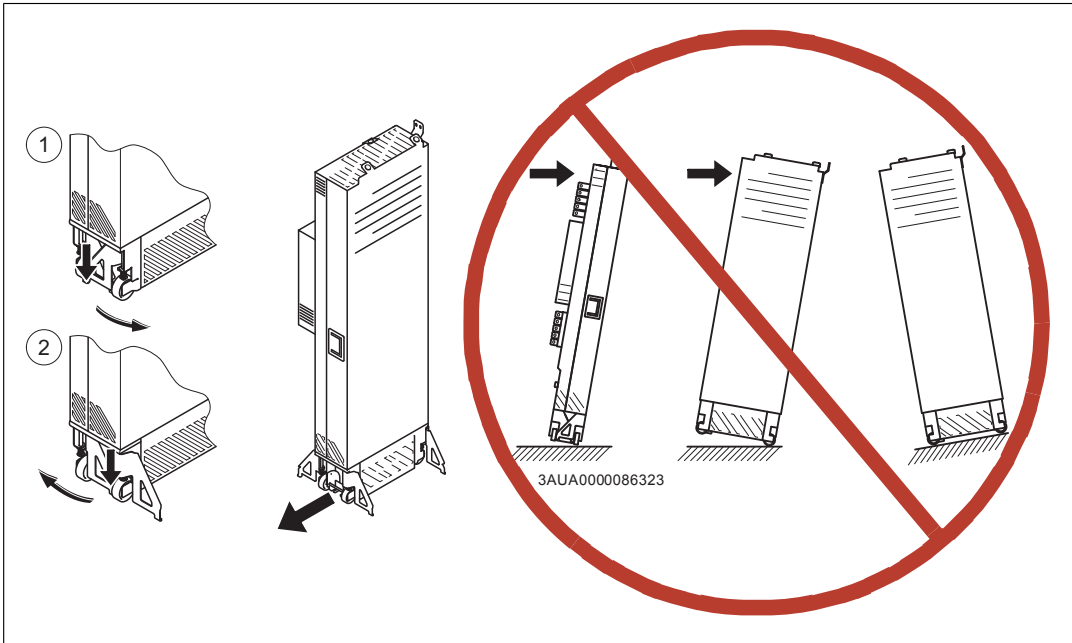
### WARNING!

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

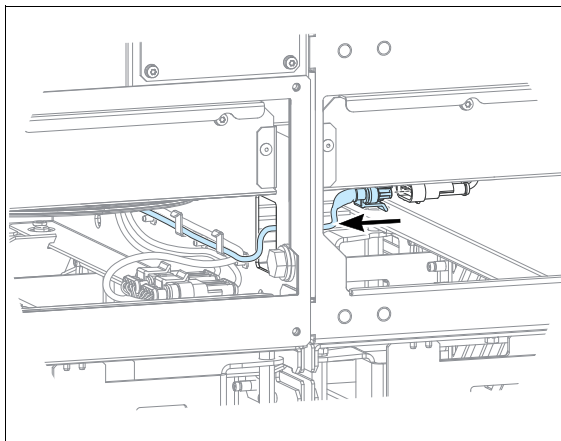
Handle the drive module carefully:

- Use safety shoes with a metal toe cap to prevent foot injury.
- Lift the drive module only by the lifting lugs.
- Make sure that the module does not topple over when you move it on the floor: To open the support legs, press each leg a little down and turn it aside (1, 2). Whenever possible secure the module also with chains.
- Do not tilt the drive module. It is heavy and its center of gravity is high. The module overturns from a sideways tilt of 5 degrees. Do not leave the module unattended on a sloping floor





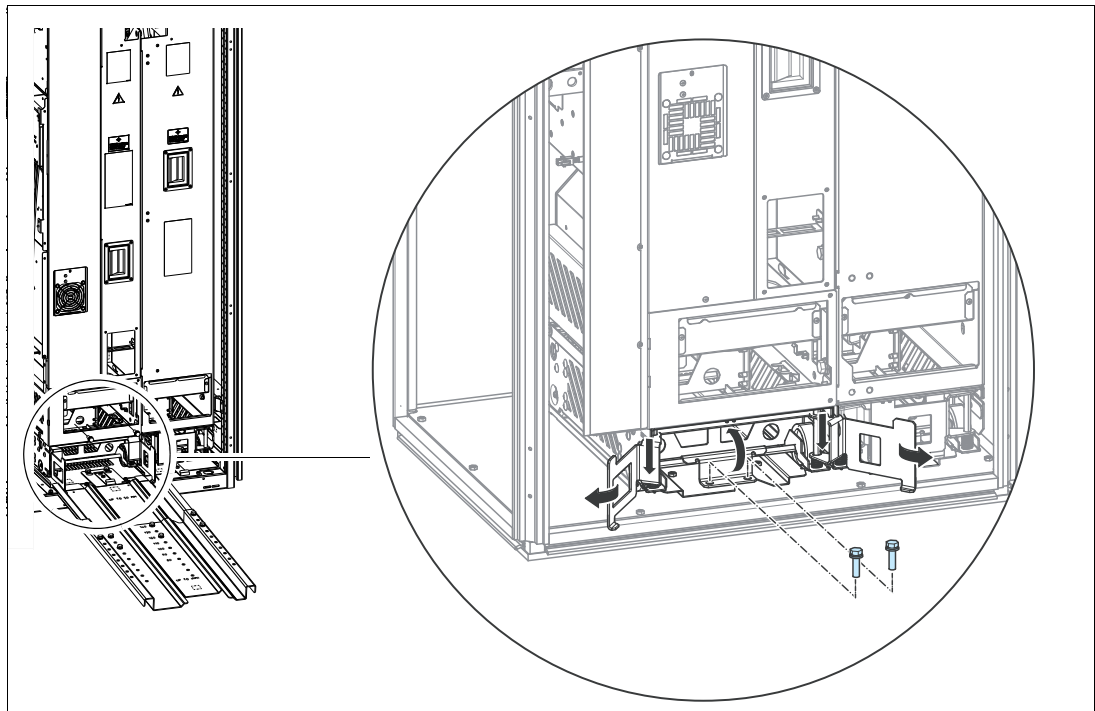
1. Stop the drive and do the steps in section *Electrical safety precautions (page 18)* before you start the work.
2. Remove the clear plastic shrouds on the power cables and parts in front of the drive module (if present).
3. Disconnect the power cables.
4. Disconnect the external control cables connected to the control unit.
5. Disconnect the cooling fan power supply cable from the LCL filter module. Pull the cable inside the drive module.



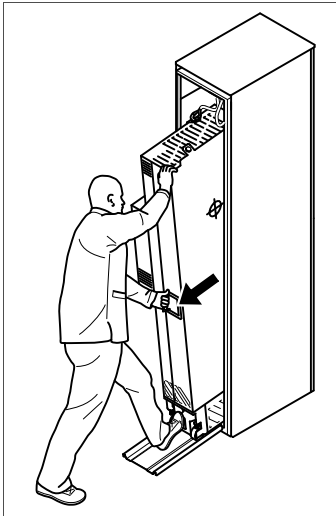
6. Remove the screws that attach the drive module to the cabinet at the top and behind the front support legs.
7. Remove the screws that connect the drive module to the LCL filter module from top and at the side.
8. To prevent the drive module from falling, attach its top lifting lugs with chains to the cabinet frame.
9. To open the support legs 90 degrees, press each leg a little down and turn it aside.



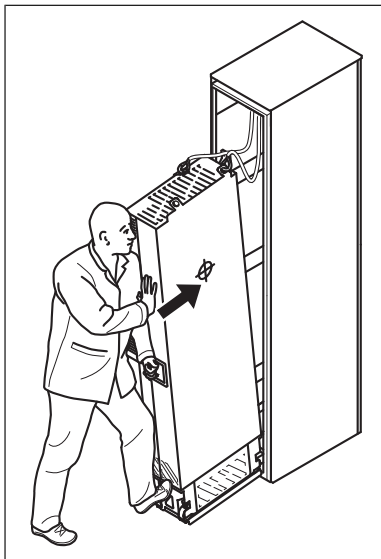
10. Adjust the extraction/installation ramp to the correct height and attach it to the cabinet base with the two mounting screws.



11. Pull the drive module carefully out of the cabinet preferably with help from another person.



12. Install the new module in reverse order.



## Replacing the LCL filter module

Replace the LCL filter module in the same way as the drive module.

---

## 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, see *Capacitor reforming instructions* ([3BFE64059629](https://library.abb.com/en) [English]) in the ABB Library (<https://library.abb.com/en>).

## Control panel

For detailed information on the control panel, see *ACx-AP-x assistant control panels user's manual* ([3AUA0000085685](https://library.abb.com/en) [English]).

### ■ Cleaning the control panel

Use a soft damp cloth to clean the control panel. Avoid harsh cleaners which could scratch the display window.

### ■ Replacing the battery

The instructions below describe how to replace the battery that powers the real-time clock of the control panel.

1. Turn the lid on the back of the control panel counter-clockwise until the lid opens.
  2. Remove the battery gently.
  3. Replace the battery with a new CR2032 battery. The battery holder has grip nails. First slide the battery and then press on the other side. The battery will snap in.
  4. Make sure that the battery polarity shows positive on the upside.
  5. Put the lid back and tighten it by turning it clockwise.
  6. Dispose of the old battery according to local disposal rules or applicable laws.
-



## 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.

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# 16

## Ordering information

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### Contents of this chapter


This chapter gives ordering information on additional components available from ABB for the drive module installation.

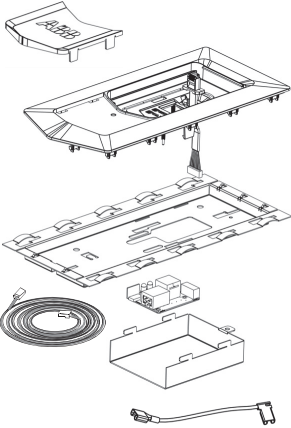
**Note:** This chapter only lists the installation accessories available from ABB. All other parts must be sourced from a third party by the system integrator.

### Control panel options

The control panel can be mounted on the cabinet door with the help of a door mounting kit.

For more information on the control panel, see *ACx-AP-x assistant control panels user's manual* (3AUA0000085685 [English]).

Type	Description	Ordering code	Illustration
ACH-AP-W	Control panel with Bluetooth and Hand-Off-Auto operation logic	3AXD50000030360	
ACS-AP-W	Control panel with Bluetooth and Starts/Stop, Local/Remote operation logic	3AXD50000025965	

Type	Description	Ordering code	Illustration
DPMP-01	Door mounting kit for flush mounting. Includes a control panel mounting platform, an IP54 cover and a 3- meter panel connection cable.	3AJA0000108878	

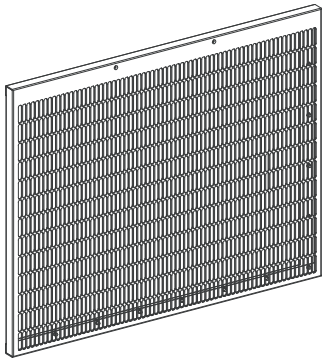
## Output ( $du/dt$ ) filters

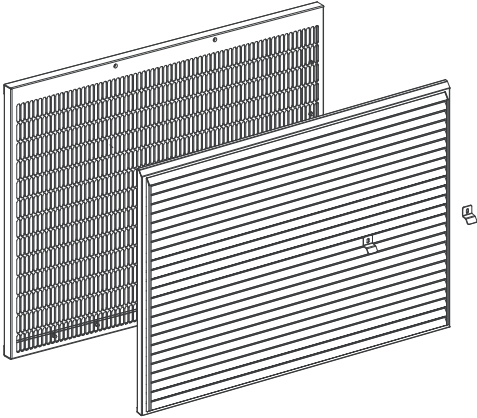
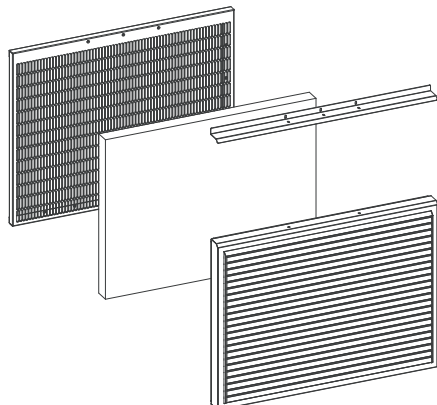
See section *du/dt filters*.

## Cabinet ventilation

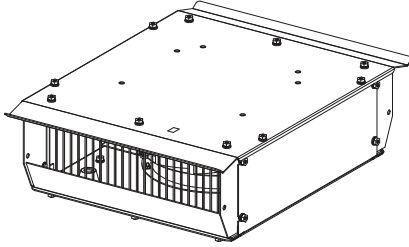
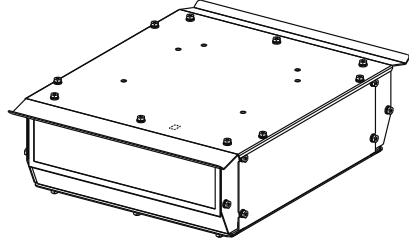
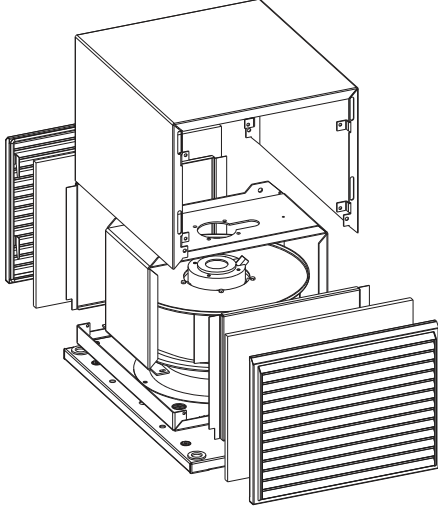
### ■ Air inlet kits

Mounting screws are included.

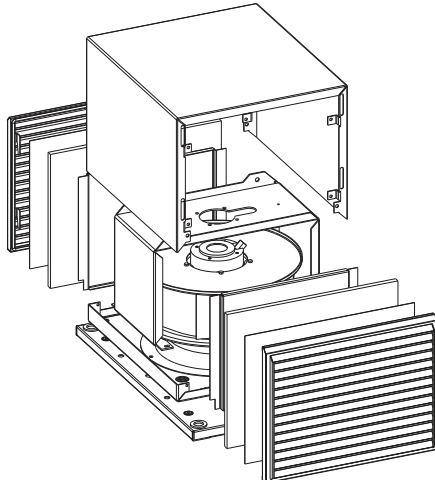
Enclosure width / Degree of protection	Kit code	Ordering code	Illustration
800 mm / IP20	A-8-X-023	3AJA0000117005	 <p data-bbox="847 1579 1225 1608">Instruction code: 3AJA0000116887</p>

Enclosure width / Degree of protection	Kit code	Ordering code	Illustration
800 mm / IP42	A-8-X-026	3AUA0000117009	 <p data-bbox="997 757 1380 788">Instruction code: 3AUA0000116875</p>
800 mm / IP54	A-8-X-029	3AXD50000009186	 <p data-bbox="989 1243 1388 1274">Instruction code: 3AXD50000010001</p>

■ Air outlet kits

Enclosure width / Degree of protection	Qty	Kit code	Ordering code	Illustration
800 mm / IP20	2	A-4-X-062	3AUA0000125201	 <p data-bbox="869 654 1264 680">Instruction code: 3AXD50000001982</p> <p data-bbox="874 696 1259 723"><b>Note:</b> Fan to be ordered separately</p>
800 mm / IP42	2	A-4-X-060	3AUA0000114967	 <p data-bbox="869 1012 1264 1039">Instruction code: 3AUA0000115290</p> <p data-bbox="874 1055 1259 1081"><b>Note:</b> Fan to be ordered separately</p>
800 mm / IP54 (IEC)	2	A-4-X-064	3AXD50000009187	 <p data-bbox="869 1630 1264 1657">Instruction code: 3AXD50000010284</p> <p data-bbox="874 1673 1259 1700"><b>Note:</b> Fan to be ordered separately</p>



Enclosure width / Degree of protection	Qty	Kit code	Ordering code	Illustration
800 mm / IP54 (UL)	2	A-4-X-067	3AXD50000010362	 <p>Instruction code: 3AXD50000010284</p> <p><b>Note:</b> Fan to be ordered separately</p>

## Cooling fans

Two cooling fans must be installed inside the air outlet compartment to ensure sufficient cooling of the cabinet.

Enclosure width / Degree of protection	Component		Qty	Ordering code
	Name	Data		
800 mm / IP20, IP42	Fan	R2E225-RA92-17 (230 V)	2	3AXD50000000514
	Capacitor	MSB MKP 3,5/603/E1679	2	3AXD50000000882
	Connector	SPB2,5/7 (2.5 mm <sup>2</sup> , 12AWG)	2	3AXD50000000723
	Connector	SC 2,5-RZ/7 (2.5 mm <sup>2</sup> , 12AWG)	2	3AXD50000000724
800 mm / IP54	Fan	RB4C-355/170	2	3AXD50000006934
	Capacitor	MSB MKP 6/603/E1679	2	3AXD50000006959
	Connector	SPB2,5/7 (2.5 mm <sup>2</sup> , 12AWG)	2	3AXD50000000723
	Connector	SC 2,5-RZ/7 (2.5 mm <sup>2</sup> , 12AWG)	2	3AXD50000000724

## Control panel mounting platforms

Kit	Ordering code
DPMP-04 control panel mounting platform	3AXD50000217717
DPMP-05 control panel mounting platform	3AXD50000240319

## Retrofit accessory kits

Kit	Option code	Ordering code
Common mode filter kit (included as standard)	+E208	3AXD50000026145
Full size cable connection terminals for input power cables	+H370	3AXD50000019542



# 17

## Technical data

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### Contents of this chapter

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

### Electrical ratings

The nominal rating for the drive modules with 50 Hz and 60 Hz supply are given below.

IEC RATINGS									
Drive type ACQ580- 34-...	Frame size	Input rating	Max current	Output ratings					
				Nominal ratings		Light-duty use		Heavy-duty use	
		$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
A	A	A	kW	A	kW	A	kW		
$U_n = 400\text{ V}$									
246A-4	R11	212	350	246	132	234	132	206	110
293A-4	R11	257	418	293	160	278	160	246	132
365A-4	R11	321	498	365	200	347	200	293	160
442A-4	R11	401	621	442	250	420	250	365	200
505A-4	R11	401	631	505	250	480	250	365	200
585A-4	R11	505	751	585	315	556	315	442	250

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IEC RATINGS									
Drive type ACQ580-34-...	Frame size	Input rating	Max current	Output ratings					
				Nominal ratings		Light-duty use		Heavy-duty use	
		$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
A	A	A	kW	A	kW	A	kW		
650A-4	R11	569	859	650	355	618	355	505	250

IEC RATINGS									
Drive type ACQ580-34-	Frame size	Input rating	Max. current	Output ratings					
				Nominal ratings		Light-duty use		Heavy-duty use	
		$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
A	A	A	hp	A	hp	A	hp		
$U_n = 480\text{ V}$									
246A-4	R11	209	350	240	200	240	200	180	150
293A-4	R11	233	418	260	200	260	200	240	200
365A-4	R11	307	498	361	300	361	300	302	250
442A-4	R11	363	621	414	350	414	350	361	300
505A-4	R11	363	631	414	350	414	350	361	300
585A-4	R11	389	751	430	350	430	350	414	350
650A-4	R11	441	859	483	400	483	400	430	350
3AXD00000586715									

UL (NEC) RATINGS									
Drive type ACQ580-34-	Frame size	Input rating	Max. current	Output ratings					
				Nominal ratings		Light-duty use		Heavy-duty use	
		$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
A	A	A	hp	A	hp	A	hp		
$U_n = 480\text{ V}$									
240A-4	R11	209	350	240	200	240	200	180	150
302A-4	R11	258	498	302	250	302	250	240	200
361A-4	R11	307	542	361	300	361	300	302	250
414A-4	R11	363	614	414	350	414	350	361	300
477A-4	R11	418	704	477	400	477	400	414	350
3AXD00000586715									

$U_n$	Nominal voltage of the drive
$I_1$	Nominal input current (rms) at 40 °C (104 °F)
$I_{max}$	Maximum output current. Available for 10 seconds at start, otherwise as long as allowed by drive temperature. 140% ... 200% of $I_{Hd}$ , depending on power rating.
$I_2$	Continuous rms output current. No overload capability at 40 °C (104 °F). This is indicated in the type designation label as output current $I_2$ .
$P_n$	Typical motor power in no-overload use
$I_{Ld}$	Continuous rms output current allowing 10% overload for 1 minute every 10 minutes when parameter 97.02 <i>Minimum switching frequency</i> is set to 2 kHz or less.

$P_{Ld}$	Typical motor power in light-duty use
$I_{Hd}$	Continuous rms output current allowing 50% overload for 1 minute every 10 minutes when parameter 97.02 <i>Minimum switching frequency</i> is set to 2 kHz or less.
$P_{Hd}$	Typical motor power in heavy-duty use
<p><b>Note:</b> 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 power ratings apply to most IEC 34 motors at the nominal voltage of the drive.</p> <p>ABB recommends to select the drive, motor and gear combination for the required motion profile with the DriveSize dimensioning tool available from ABB.</p>	

■ **When is derating necessary**

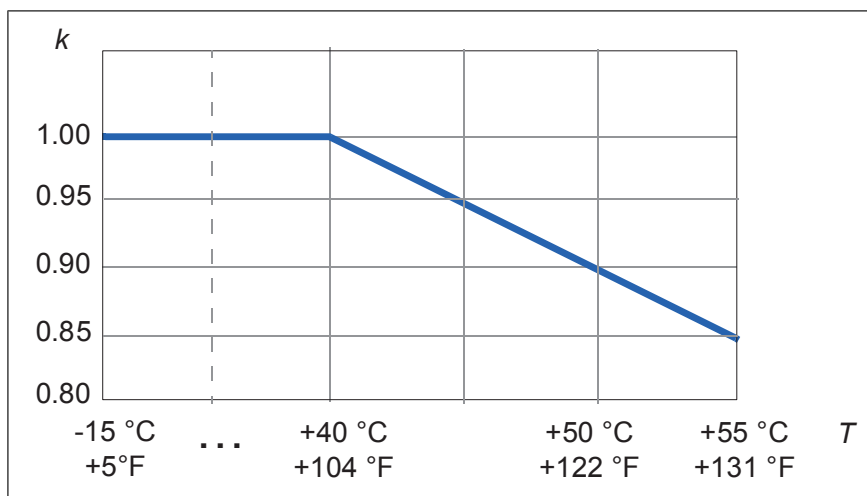
Derate the continuous output current of the drive if

- ambient temperature exceeds +40 °C (+104 °F) or
- drive is installed higher than 1000 m (3280 ft) above sea level
- the minimum requirements of motor cable length are not met (see [Filters \(page 227\)](#)).

**Note:** The final derating factor is a multiplication of all applicable derating factors.

■ **Surrounding air temperature derating**

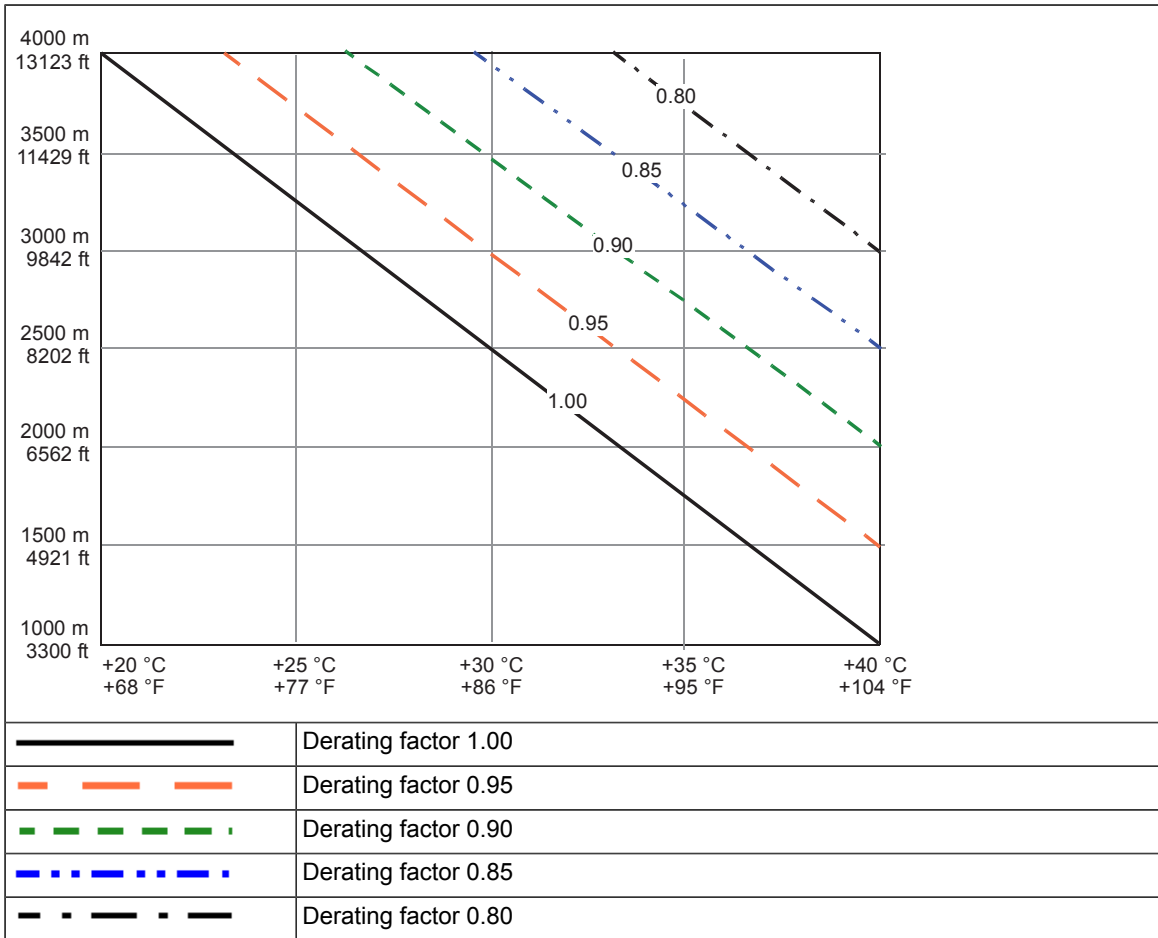
In the temperature range +40...55 °C (+104...131 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F) as follows. Calculate the output current by multiplying the current given in the rating table by the derating factor.



■ **Altitude derating**

At altitudes from 1000 to 4000 m (3300 to 13123 ft) above sea level, the derating is 1% for every 100 m (328 ft). If ambient temperature is below +40 °C (+104 °F), the derating can be reduced by 1.5% for every 1 °C reduction in temperature. For a more accurate derating, use the DriveSize PC tool. A few altitude derating curves are shown below.

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

## Fuses (IEC)

aR fuses by Cooper Bussmann for protection against short-circuit in the input power cable of drive are listed below.

Ultrarapid (aR) fuses						
Drive type ACQ580-34-	Input current (A)	Fuse				
		A	A <sup>2</sup> s	V	Type DIN 43653	Size
<i>U<sub>n</sub></i> = 400 V, IEC						
246A-4	212	400	74000	690	170M5408	2
293A-4	257	500	145000	690	170M5410	2
365A-4	321	630	210000	690	170M6410	3
442A-4	401	700	300000	690	170M6411	3
505A-4	401	800	465000	690	170M6412	3
585A-4	505	1000	945000	690	170M6414	3
650A-4	569	1000	945000	690	170M6414	3
<i>U<sub>n</sub></i> = 480 V, IEC						
246A-4	209	315	42000	690	170M4410	1
293A-4	233	400	74000	690	170M5408	2
365A-4	307	500	145000	690	170M5410	2
442A-4	363	630	210000	690	170M6410	3
505A-4	363	700	300000	690	170M6411	3
585A-4	389	700	300000	690	170M6411	3
650A-4	441	800	465000	690	170M6412	3
3AXD00000586715						

### Note:

- See also sections:
  - [Protecting the drive and the input power cable in short-circuits \(page 87\)](#)
  - [Protecting the drive against thermal overload \(page 87\)](#)
  - [Protecting the input power cable against thermal overload \(page 88\)](#).
- In multicable installations, install only one fuse per phase (not one fuse per conductor).
- Fuses with higher current rating than the recommended ones must not be used. Fuses with lower current rating can be used.
- Fuses from other manufacturers can be used if they agree with the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

## Fuses (UL)

UL 248-13 Recognized fuses for branch circuit protection per NEC are listed below. Obey local regulations.

Drive type ACQ580-34-	Input current (A)	Ultrarapid (aR, semiconductor) fuses					
		A	V	Type Flush End	Type DIN 43653	Type US Style	Type French Style
$U_n = 480 \text{ V}$							
240A-4	209	400	690	170M5408	170M5008	170M5608	170M5308
302A-4	258	500	690	170M5410	170M5010	170M5610	170M5310
361A-4	307	630	690	170M6410	170M6010	170M6610	170M6310
414A-4	363	700	690	170M6411	170M6011	170M6611	170M6311
477A-4	418	800	690	170M6412	170M6012	170M6612	170M6312
3AXD50000645015							

### Note:

- See also sections:
  - *Protecting the drive and the input power cable in short-circuits (page 87)*
  - *Protecting the drive against thermal overload (page 87)*
  - *Protecting the input power cable against thermal overload (page 88).*
- In multicable installations, install only one fuse per phase (not one fuse per conductor).
- Fuses with higher current rating than the recommended ones must not be used. Fuses with lower current rating can be used.
- Alternative fuses can be used if they meet certain characteristics. For acceptable fuses, see the technical note ([3AXD50000645015](#)).



## Dimensions, weights and free space requirements

Standard drive module configuration (drive module + LCL filter module)								
Frame size	Height		Width		Depth		Weight	
	mm	in	mm	in	mm	in	kg	lb
R11	1722	67.8	637	25.1	505	19.9	365	805

Weight of the drive module: 185 kg (409 lb)

Weight of the LCL filter module: 180 kg (396 lb)

Drive module + LCL filter module with options +B051 and +H370								
Frame size	Height		Width		Depth		Weight	
	mm	in	mm	in	mm	in	kg	lb
R11	1741	68.5	685	27.0	505	19.9	367 <sup>1)</sup>	808 <sup>1)</sup>
							370 <sup>2)</sup>	814 <sup>2)</sup>

1)+B051

2)+B051 and +H370

For requirements of free space around the drive module, see [Required free space \(page 58\)](#).

## Losses, cooling data and noise

The air flow direction is from bottom to top.

This table shows typical heat loss values, required air flow and noise at the nominal ratings of the drive. The heat loss values can vary depending on voltage, cable conditions, motor efficiency and power factor. To obtain more accurate values for given conditions, use ABB DriveSize tool (<http://new.abb.com/drives/software-tools/drivesize>).

Drive type ACQ580-34-	Frame size	Air flow		Heat dissipation	Noise
		m <sup>3</sup> /h	ft <sup>3</sup> /min	W	dB(A)
<i>U<sub>n</sub></i> = 400 V, IEC					
246A-4	R11	2100	1279	5280	72
293A-4	R11	2100	1279	6400	72
365A-4	R11	2100	1279	8000	72
442A-4	R11	2100	1279	10000	72
505A-4	R11	2100	1279	10000	72
585A-4	R11	2100	1279	12600	72
650A-4	R11	2100	1279	14200	72
<i>U<sub>n</sub></i> = 480 V, IEC					
246A-4	R11	2100	1279	5220	72
293A-4	R11	2100	1279	5220	72
365A-4	R11	2100	1279	7830	72
442A-4	R11	2100	1279	9135	72
505A-4	R11	2100	1279	9135	72
585A-4	R11	2100	1279	9135	72
650A-4	R11	2100	1279	10440	72
<i>U<sub>n</sub></i> = 480 V, UL (NEC)					
240A-4	R11	2100	1279	5280	72
302A-4	R11	2100	1279	6525	72
361A-4	R11	2100	1279	7830	72
414A-4	R11	2100	1279	9135	72
477A-4	R11	2100	1279	10440	72
3AXD00000586715					

These losses are not calculated according to IEC 61800-9-2.

The cooling air temperature rises 30 degrees Celsius when it goes through the drive module if the temperature of the input cooling air is 40 degrees Celsius and the drive is operating with nominal load.

## Terminal and entry data for the power cables

The maximum accepted cable size is 4 × (3 × 240) mm<sup>2</sup> or 4 × (3 × 500 MCM). Screw size for connecting busbars to the drive module input and output busbars: M12, tightening torque 50...75 N·m (37...55 lbf·ft).

## Power cables

The table below gives typical copper and aluminum cable types with concentric copper shield for the drives with nominal current. The value separated by the plus sign means the diameter of the PE conductor. See also section [Terminal and entry data for the power cables \(page 172\)](#).

Drive type ACQ580-34-	IEC <sup>1)</sup>		UL (NEC) <sup>2)</sup>
	Cu cable type	Al cable type	Cu cable type
	mm <sup>2</sup>	mm <sup>2</sup>	AWG/kcmil
<i>U<sub>n</sub></i> = 400 V, 480 V (IEC)			
246A-4	2 × (3 × 70 + 35)	2 × (3 × 95)	2 × 2/0
293A-4	2 × (3 × 95 + 50)	2 × (3 × 150)	2 × 3/0
365A-4	2 × (3 × 120 + 70)	2 × (3 × 185)	2 × 250 MCM
442A-4	2 × (3 × 150 + 70)	2 × (3 × 240)	2 × 400 MCM
505A-4	3 × (3 × 95 + 50)	3 × (3 × 150)	2 × 500 MCM or 3 × 250 MCM
585A-4	3 × (3 × 120 + 70)	3 × (3 × 185)	2 × 600 MCM or 3 × 300 MCM
650A-4	3 × (3 × 150 + 70)	3 × (3 × 240)	2 × 700 MCM or 3 × 350 MCM
<i>U<sub>n</sub></i> = 480 V, UL (NEC)			
240A-4	2 × (3 × 70 + 35)	2 × (3 × 95)	2 × 2/0
302A-4	2 × (3 × 95 + 50)	2 × (3 × 150)	2 × 4/0
361A-4	2 × (3 × 120 + 70)	2 × (3 × 185)	2 × 250 MCM
414A-4	2 × (3 × 150 + 70)	2 × (3 × 240)	2 × 350 MCM
477A-4	3 × (3 × 95 + 50)	3 × (3 × 150)	2 × 500 MCM or 3 × 250 MCM
			3AXD00000586175

<sup>1)</sup> The cable sizing is based on max. 9 cables laid on a cable ladder side by side, three ladder type trays one on top of the other, ambient temperature 30 °C (86 °F) PVC insulation, surface temperature 70 °C (158 °F) (EN 60204-1 and IEC 60364-5-52). For other conditions, dimension the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

<sup>2)</sup> The cable sizing is based on NEC Table 310-16 for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly buried). For other conditions, dimension the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

**Temperature:** For IEC, select a cable rated for at least 70 °C maximum permissible temperature of conductor in continuous use. For North America, power cables must be rated for 75 °C (167 °F) or higher.

**Voltage:** 600 V AC cable is accepted for up to 500 V AC.

## Terminal data for the control cables

See section [Technical data \(page 118\)](#).

## Electrical power network specification

<b>Voltage (<math>U_1</math>)</b>	ACQ580-34-xxxx-4 drive modules: 380...480 V AC 3-phase +10%...-15%. This is indicated in the type designation label as typical input voltage levels 3~400/480 V AC.
<b>Network type</b>	TN (grounded) and IT (ungrounded) systems
<b>Short-circuit withstand strength (IEC 61439-1)</b>	Maximum allowable prospective short-circuit current is 65 kA when protected by the fuses given in the fuse table. For the maximum allowable prospective short-circuit current with circuit breakers, see section <i>Protecting the drive and the input power cable in short-circuits (page 87)</i> .
<b>Short-circuit current protection (UL 61800-5-1, CSA C22.2 No. 274-17)</b>	The drive is suitable for use on a circuit capable of delivering not more than 100 kA rms symmetrical amperes at 600 V maximum when protected by the fuses given in the fuse table.
<b>Frequency (<math>f_1</math>)</b>	50/60 Hz. Variation $\pm 5\%$ of nominal frequency.
<b>Imbalance</b>	Max. $\pm 3\%$ of nominal phase to phase input voltage
<b>Fundamental power factor (<math>\cos \phi_1</math>)</b>	1.0 (at nominal load)

<b>Harmonic distortion</b>	<p>Harmonics are below the limits defined in IEEE 519-2014, and G5/4. The drive complies with IEC 61000-3-2, IEC 61000-3-4 and IEC 61000-3-12. The table below shows typical values of the drive for short-circuit ratio (<math>I_{sc}/I_1</math>) of 20 to 100. The values will be met if the supply network voltage is not distorted by other loads and when the drive operates at nominal load.</p>		
	<b>Nominal bus voltage V at PCC</b>	<b>THDi (%)</b>	<b>THDv (%)</b>
	V ≤ 690 V	3*	< 3**
	<p><b>PCC</b> Point on a public power supply system, electrically nearest to a particular load, at which other loads are, or could be, connected. The PCC is a point located upstream of the considered installation.</p> <p><b>THDi</b> Indicates the total harmonic current distortion of the wave form. This value is defined as the ratio (in %) of the harmonic current to the fundamental (non-harmonic) current measured at a load point at the particular moment when the measurement is taken:</p> $THDi = \frac{\sqrt{\sum_{n=2}^{40} I_n^2}}{I_1} \cdot 100\%$ <p><b>THDv</b> Indicates the total magnitude of the voltage distortion. This value is defined as the ratio (in %) of the harmonic voltage to the fundamental (non-harmonic) voltage:</p> $THDv = \frac{\sqrt{\sum_{n=2}^{40} U_n^2}}{U_1} \cdot 100\%$ <p><math>I_{sc}/I_1</math> Short-circuit ratio  <math>I_{sc}</math> Maximum short-circuit current at PCC  <math>I_1</math> Continuous rms input current of the drive  <math>I_n</math> Amplitude of the current harmonic n  <math>U_1</math> Supply voltage  <math>U_n</math> Amplitude of the voltage harmonic n</p> <p>* The short-circuit ratio can influence the THDi value                  ** Other loads can influence the THDv value</p>		

## Motor connection data

<b>Motor types</b>	Asynchronous AC induction motors, permanent magnet motors and ABB synchronous reluctance motors (SynRM motors)
<b>Voltage (<math>U_2</math>)</b>	0 to $U_1$ nominal, can be boosted higher but requires derating. Contact ABB for more information.
<b>Frequency (<math>f_2</math>)</b>	0...500 Hz  <b>Note:</b> Operation above 150 Hz can require type-specific derating. For more information, contact your local ABB representative. <u>For drives with du/dt filter:</u> 0...120 Hz <u>For drives with sine filter:</u> 0...120 Hz
<b>Frequency resolution</b>	0.01 Hz
<b>Current</b>	See section <i>Ratings</i>

<b>Switching frequency</b>	2 kHz, 4 kHz, 8 kHz (depends on the parameter settings)
<b>Maximum recommended motor cable length</b>	<p>Scalar control: 300 m (984 ft)</p> <p><b>Note:</b> For restrictions due to EMC compatibility, see section <i>EMC compliance (IEC/EN 61800-3:2004) (page 179)</i>.</p> <p>Longer motor 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. Note that a sine filter (optional) at the drive output also causes a voltage decrease.</p>

## Control panel type

ACH-AP-H assistant control panel

## Efficiency

Approximately 96.5% at nominal power level.

## Energy efficiency data (EU ecodesign)

Energy efficiency data is not provided for the drive. The low-harmonic drives are exempt from the EU ecodesign requirements (EU Regulation C/2019/2125).

## Protection classes for module

Degrees of protection (IEC/EN 60529)	IP00 (standard) IP20 (option +B051)
Enclosure types (UL 61800-5-1)	UL Type Open
Overvoltage category (IEC/EN 60664-1)	III
Protective class (IEC/EN 61800-5-1)	I

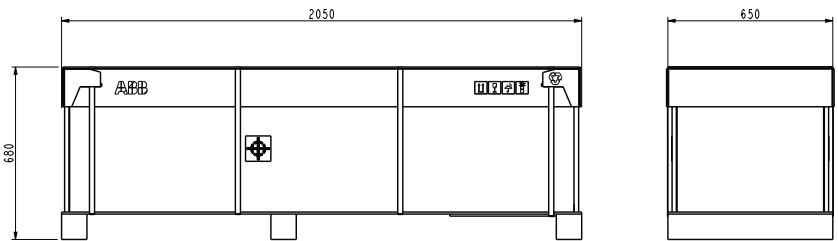
## Surrounding air conditions

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

	<b>Operation</b>	<b>Storage</b>	<b>Transportation</b>
	installed for stationary use	in the protective package	in the protective package
<b>Installation site altitude</b>	<p>For TN and TT neutral-grounded network systems and IT ungrounded network systems: 0 to 4000 m (13123 ft) above sea level</p> <p>Above 1000 m [3281 ft]: see <i>When is derating necessary (page 167)</i></p>	-	-
<b>Surrounding air temperature</b>	-15...+55 °C (5...131 °F). No frost allowed. See <i>When is derating necessary (page 167)</i>	-40...+70 °C (-40...+158 °F)	-40...+70 °C (-40...+158 °F)

<b>Relative humidity</b>	5...95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
<b>Contamination</b>	IEC/EN 60721-3-3:2002	IEC 60721-3-1:1997	IEC 60721-3-2:1997
<b>Chemical gases</b>	Class 3C2	Class 1C2	Class 2C2
<b>Solid particles</b>	Class 3S2. No conductive dust allowed.	Class 1S3. (packing must support this, otherwise 1S2)	Class 2S2
<b>Pollution degree</b>	2		
<b>Atmospheric pressure</b>	70...106 kPa 0.7 ... 1.05 atmospheres	70...106 kPa 0.7 ... 1.05 atmospheres	60...106 kPa 0.6 ... 1.05 atmospheres
<b>Vibration</b> IEC 60068-2-6:2007, EN 60068-2-6:2008	Max. 0.1 mm (0.004 in) (10...57 Hz), max. 10 m/s <sup>2</sup> (33 ft/s <sup>2</sup> ) (57...150 Hz) sinusoidal	Max. 1 mm (0.04 in) (5 ... 13.2 Hz), max. 7 m/s <sup>2</sup> (23 ft/s <sup>2</sup> ) (13.2 ... 100 Hz) sinusoidal	Max. 3.5 mm (0.14 in) (2...9 Hz), max. 15 m/s <sup>2</sup> (49 ft/s <sup>2</sup> ) (9...200 Hz) sinusoidal
<b>Shock</b> IEC 60068-2-27:2008, EN 60068-2-27:2009	Not allowed	With packing max. 100 m/s <sup>2</sup> (330 ft/s <sup>2</sup> ), 11 ms	With packing max. 100 m/s <sup>2</sup> (330 ft/s <sup>2</sup> ), 11 ms
<b>Free fall</b>	Not allowed	100 mm (4 in) for weight over 100 kg (220 lb)	100 mm (4 in) for weight over 100 kg (220 lb)

## Materials

<b>Drive enclosure</b>	<ul style="list-style-type: none"> <li>•PC/ABS 2.5 mm (0.098 in), color NCS 1502-Y (RAL 9002 / PMS 420 C)</li> <li>•hot-dip zinc coated steel sheet 1.5 ... 2.5 mm (0.059 ... 0.098 in), thickness of coating 100 micrometers, color NCS 1502-Y</li> </ul>
<b>Air baffles for Rittal cabinet</b>	See section <a href="#">Material of the air baffles</a> .
<b>Package</b>	<p>Plywood and cardboard, bands PP.</p>  <p style="text-align: right;">3AXD50000174287</p>

<b>Disposal</b>	<p>The main parts of the drive can be recycled to preserve natural resources and energy. Product parts and materials should be dismantled and separated.</p> <p>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.</p> <p>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.</p>
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## Applicable standards

The drive complies with the following standards.






European electrical safety requirements product standards	
EN 61800-5-1:2007	<i>Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy</i>
EN 60204-1:2006 +A1:2010	<p><i>Safety of machinery. Electrical equipment of machines. Part 1: General requirements.</i></p> <p>Provisions for compliance: The final assembler of the machine is responsible for installing:</p> <ul style="list-style-type: none"> <li>•emergency-stop device</li> <li>•supply disconnecting device</li> <li>•IP00 drive module into a cabinet.</li> </ul>
EN 60529:1991 + A2:2013	<i>Degrees of protection provided by enclosures (IP code)</i>
EN 61800-3:2004 + A1:2012	<i>Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods</i>
UL 61800-5-1: 1st Edition	<i>Standard for Safety, Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy</i>
CSA C22.2 No. 0-10	<i>General Requirements - Canadian Electrical Code, Part II</i>
CSA C22.2 No. 274-7	<i>Adjustable Speed Drives</i>

## Markings

These markings are attached to the drive:

	<p>CE mark</p> <p>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).</p>
	<p>TÜV Safety Approved mark (functional safety)</p> <p>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>
	<p>UL Listed mark for USA and Canada</p> <p>Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories. Valid with rated voltages up to 600 V.</p>



	<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) green mark The product complies with <i>the People's Republic of China Electronic Industry Standard (SJ/T 11364-2014)</i>. The product does not contain toxic and hazardous substances or elements above the maximum concentration values, and it is an environmentally-friendly product which can be recycled.</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>KC mark Product complies with Korea's product safety requirements for electrical and electronic equipment and components that utilize power from 50...1000 V AC.</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 61800-3:2004)

### ■ 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 equipped with internal EMC filter (+E210).
2. The motor and control cables are selected as specified in the hardware manual.
3. The drive is installed according to the instructions given in the hardware manual.
4. Maximum motor cable length is 100 meters.



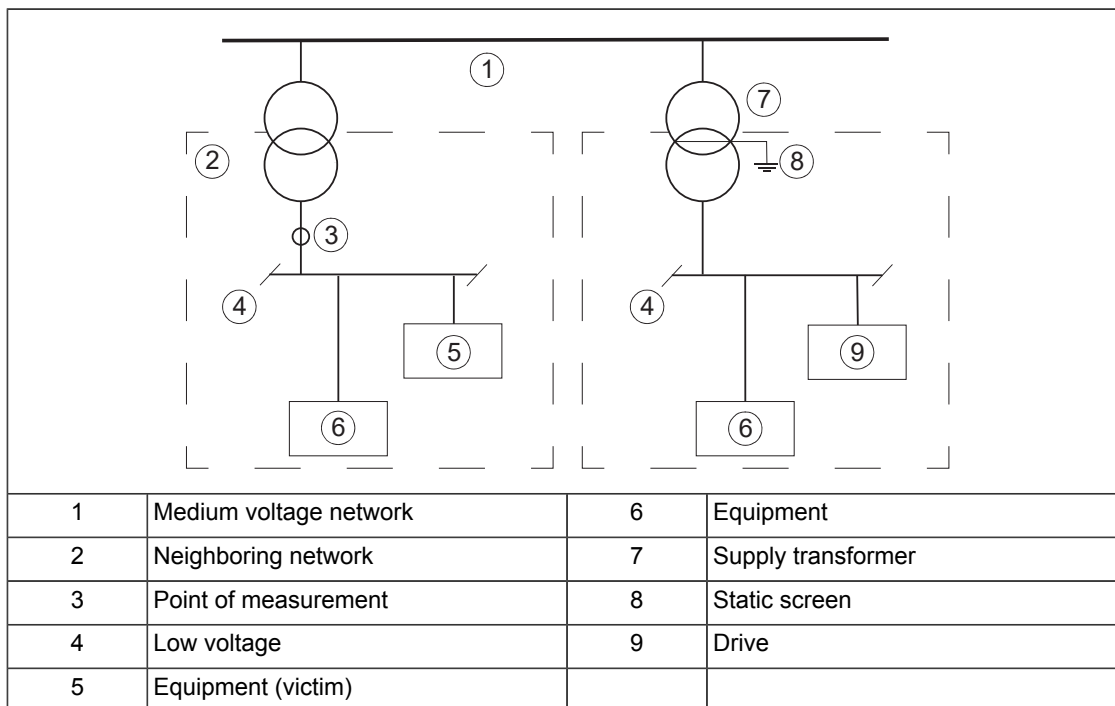
**WARNING!**

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**

If the provisions under Category C3 cannot be met, the requirements of the standard can be met as follows:

1. It is ensured that no excessive emission is propagated to neighboring low-voltage networks. In some cases, the inherent 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.



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 as specified in the hardware manual.
4. The drive is installed according to the instructions given in the hardware manual.



**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 and CSA 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 40 °C at rated output current. The output current is derated for 40 ... 55 °C.
  - 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 provides motor overload protection. For adjustments, see the firmware manual.
- The drive overvoltage category according to IEC 60664-1 is III

## Design lifetime expectancy

The design lifetime expectancy of the drive and its overall components exceeds ten (10) years in normal operating environments. In some cases, the drive can last 20 years or more. To achieve a long lifetime of the product the manufacturer's instructions for sizing the drive, installation, operational conditions and preventive maintenance schedule shall be followed.

## EU Declaration of Conformity (Machinery Directive)

See [The Safe torque off function \(page 193\)](#)

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## **Disclaimer**

### ■ **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.

### ■ **Cybersecurity disclaimer**

This product is designed to be connected to and to communicate information and data via a network interface. 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, 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. ABB and its affiliates are not 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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# 18

## Dimension drawings

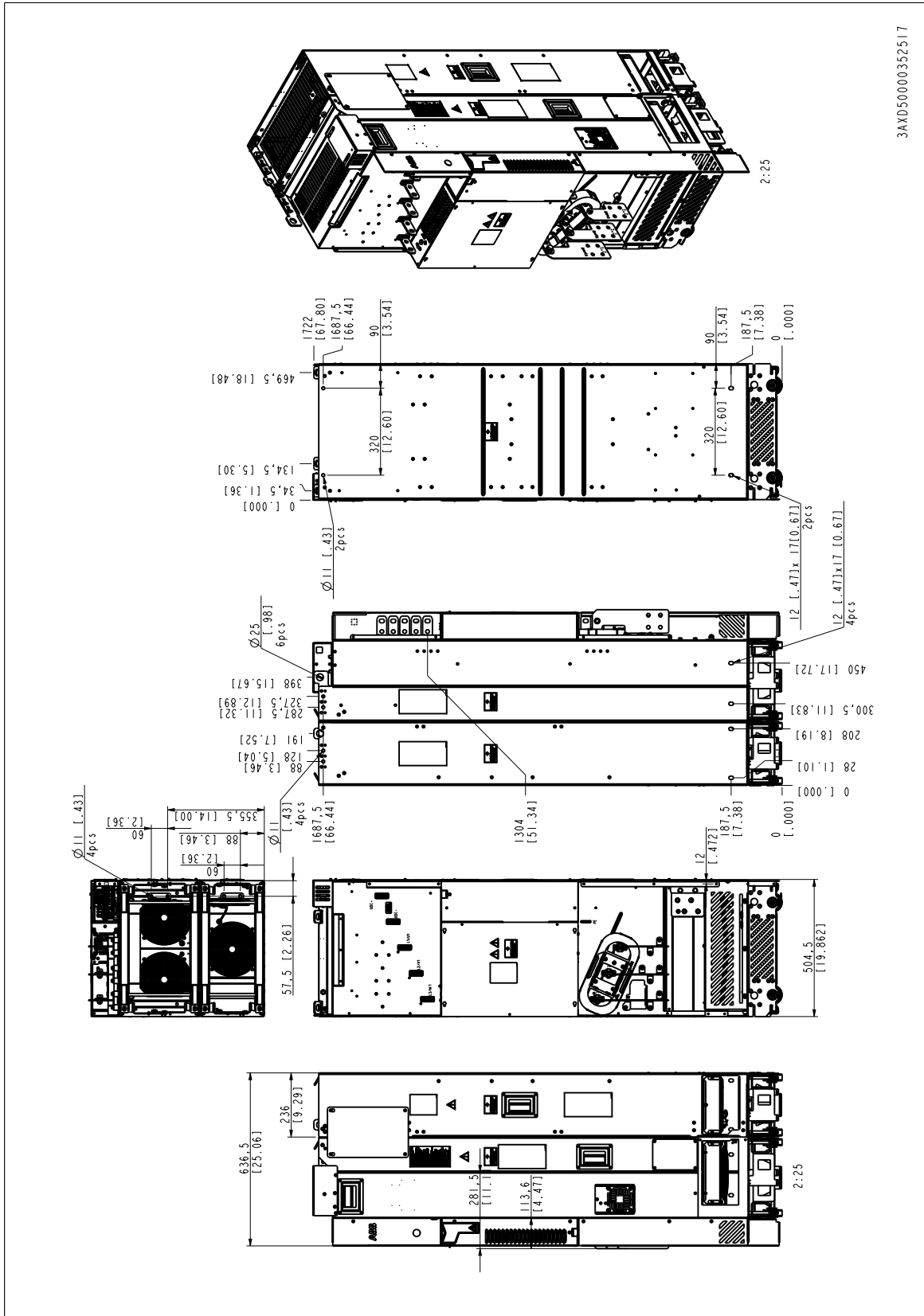
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### Contents of this chapter

This chapter contains dimension drawings of the drive modules with optional parts for Rittal VX25 cabinet assembly.

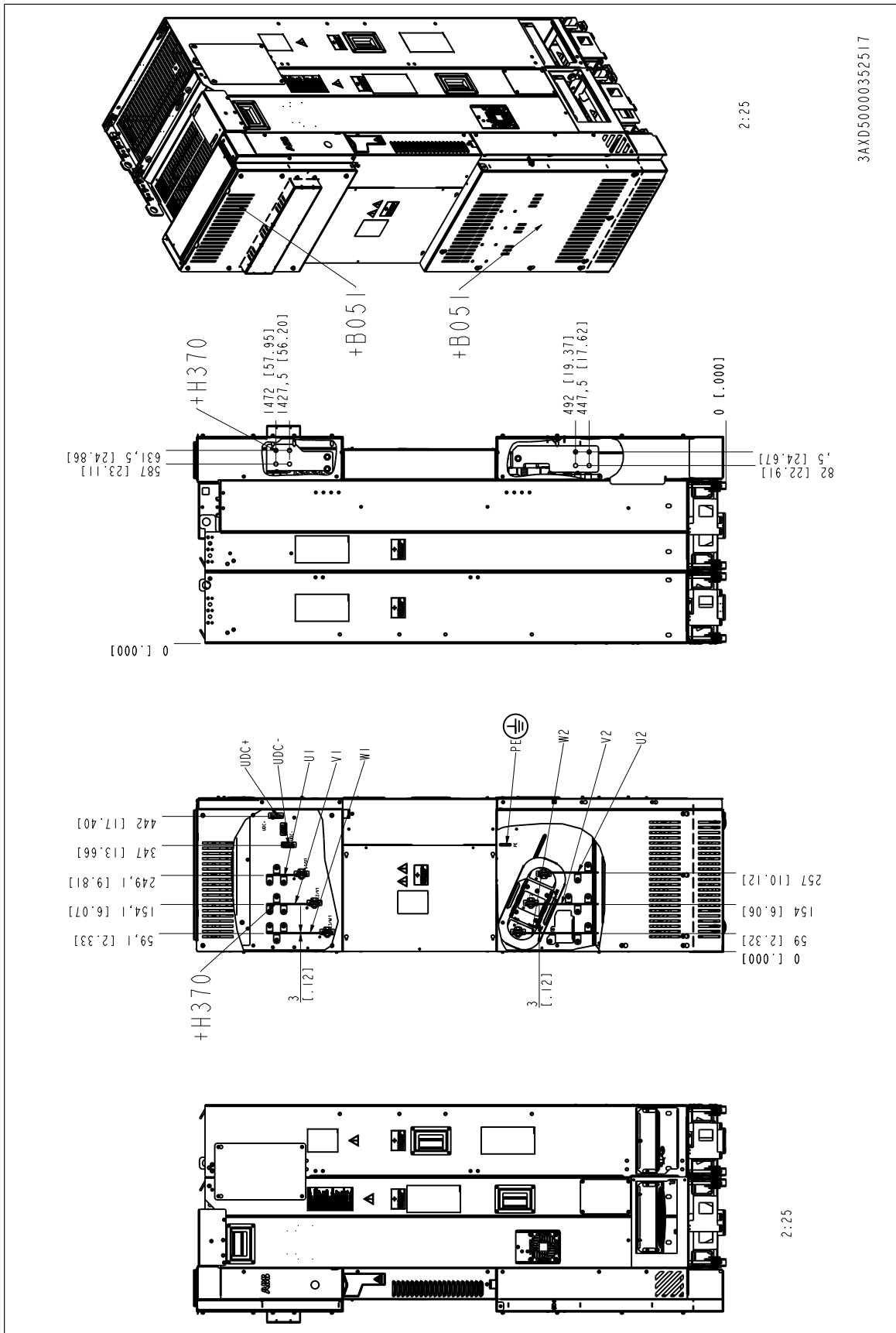
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# Standard configuration (+E208 and +E210 included)





# Drive module with options +B051, +H370

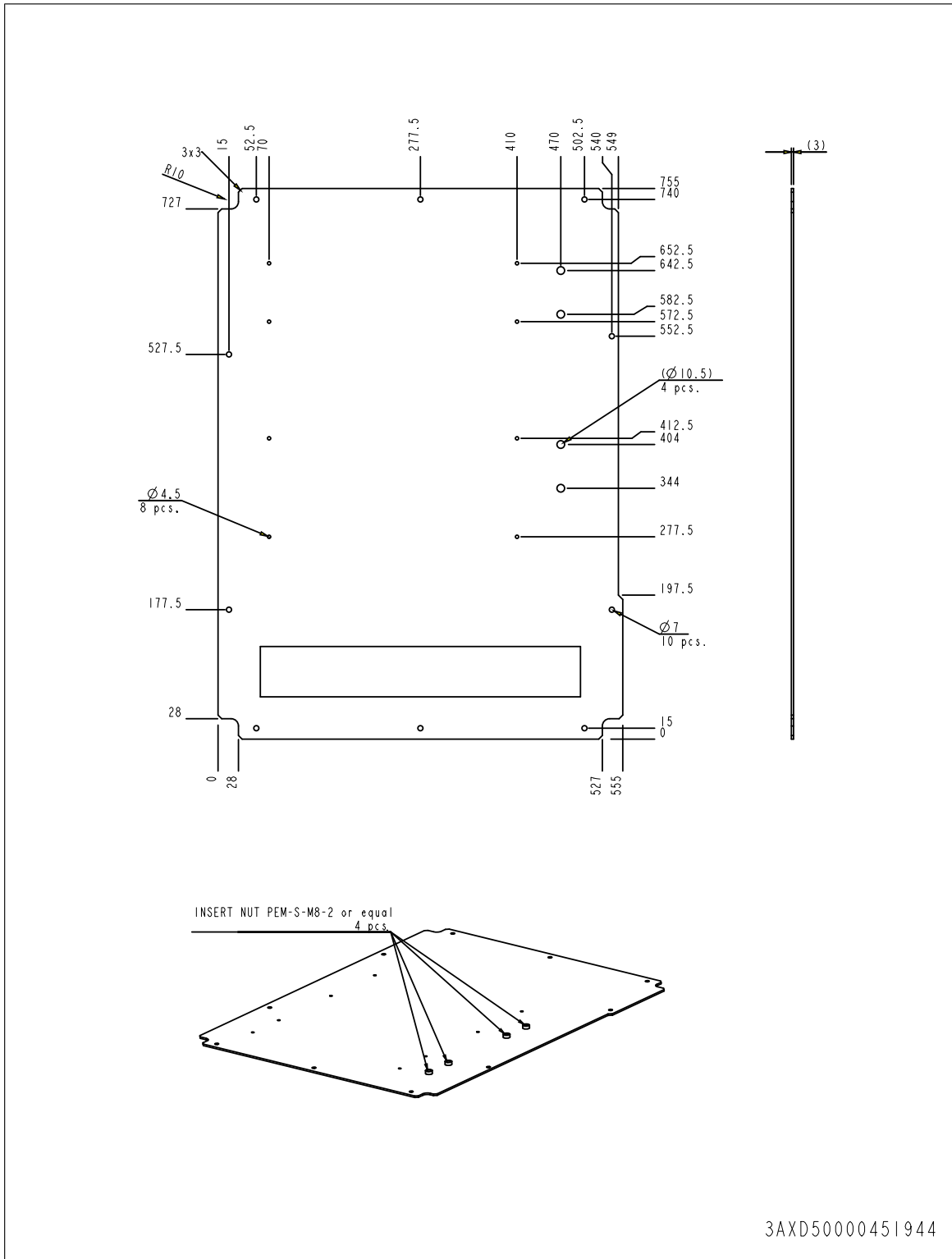






## Bottom plate

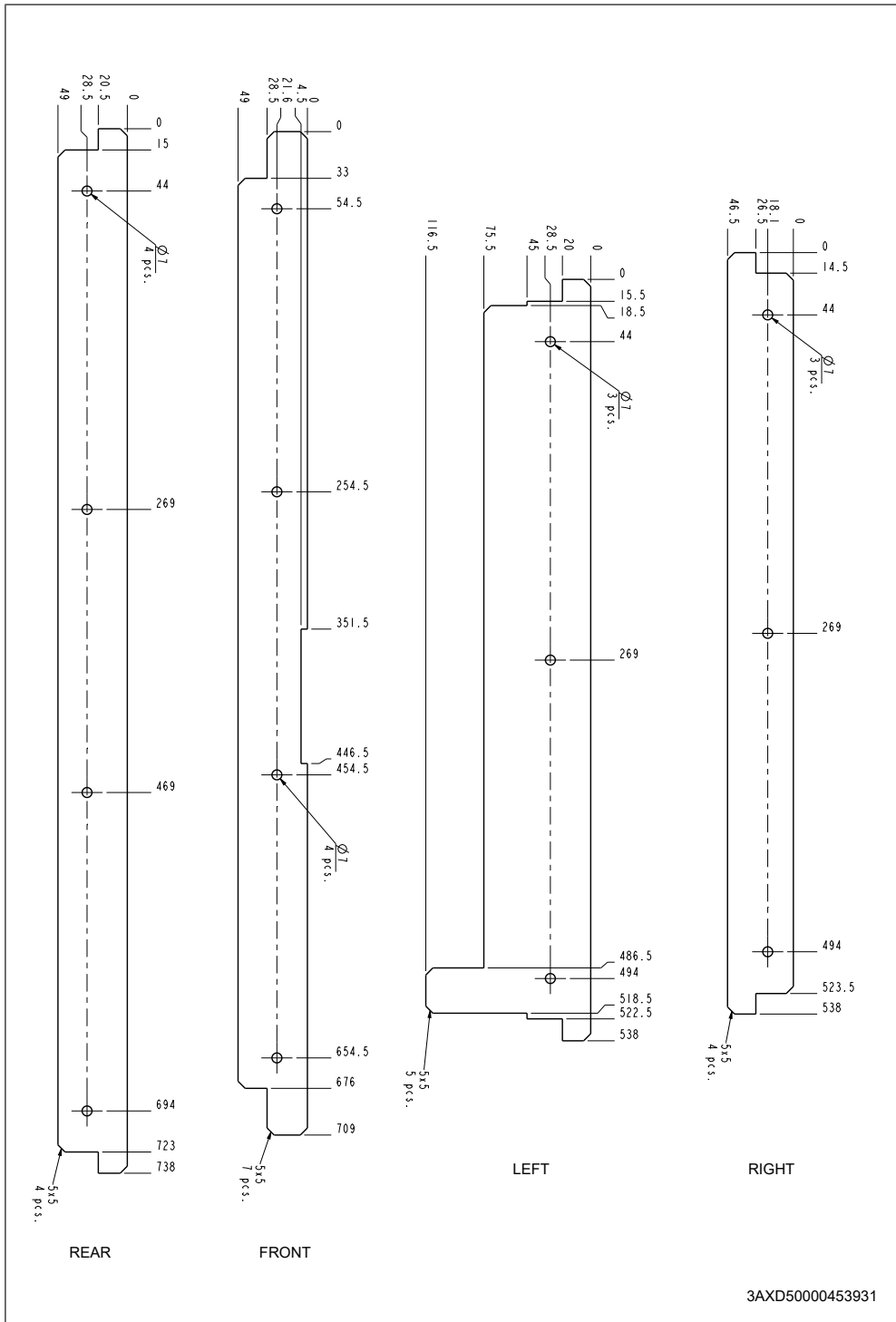
This drawing shows the dimensions of the bottom plate for 800 mm Rittal VX25 enclosure. It is not an ABB product.



## Air baffles

This drawing shows the dimensions of the air baffles around the drive module with option +B051 for 800 mm Rittal VX25 enclosure.

These are not ABB products.



### ■ Material of the air baffles

0.75 mm polycarbonate (PC) film LEXAN® FR60 (GE) with UL94 V-0 listing, UV stability. (LEXAN® FR700 or Valox FR1 only with special permission). Unmarked bend radii 0.6 mm.



# 19

## Example circuit diagrams

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### Contents of this chapter

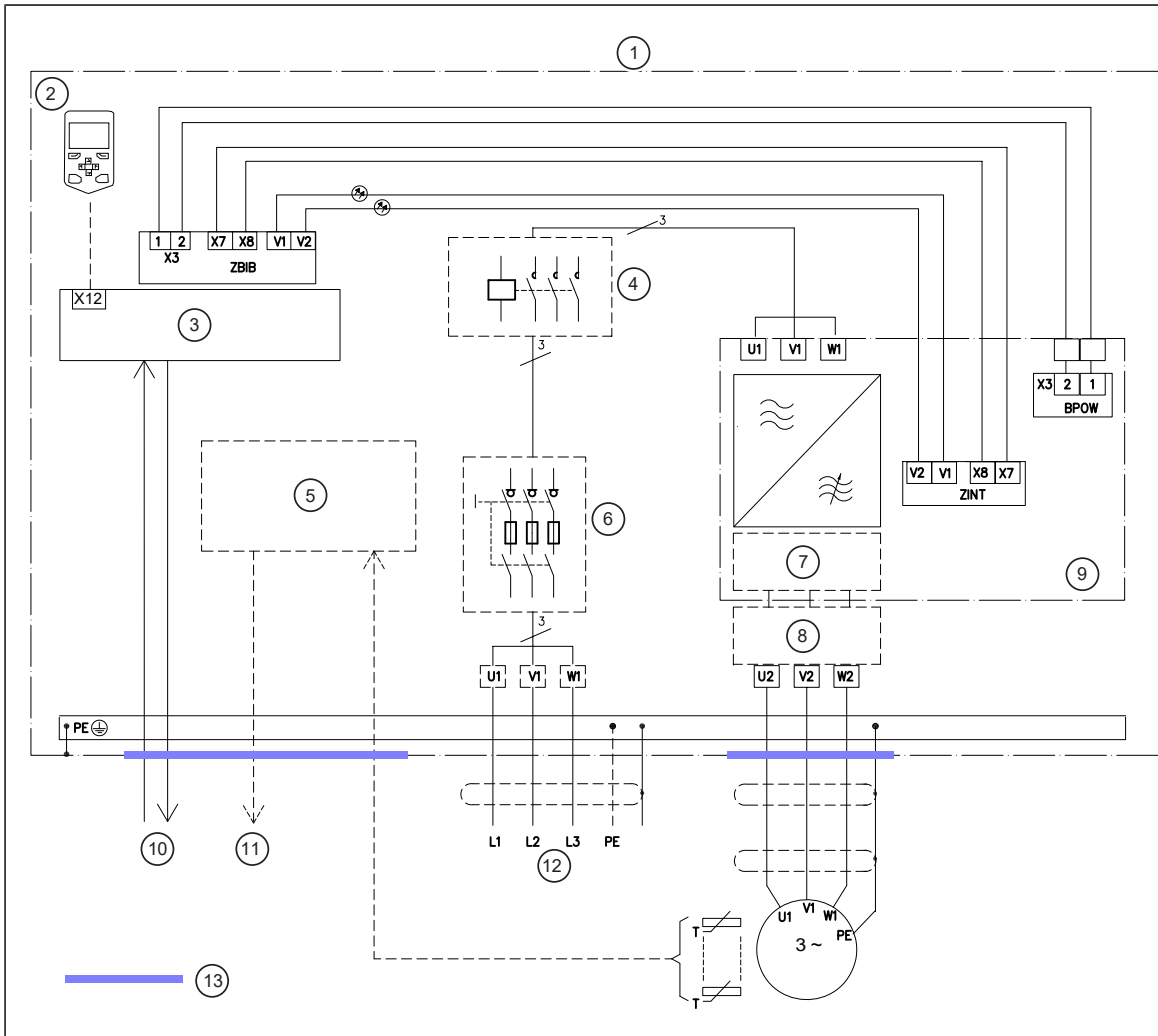
This chapter shows an example circuit diagram for a cabinet-installed drive module.

### Example circuit diagram

This diagram is an example for the main wiring of a drive cabinet. Note that the diagram includes components which are not included in a basic delivery (\* plus code options, \*\* other options, \*\*\* to be acquired by the customer).

---

192 Example circuit diagrams



1	Cabinet
2	*ACx-AP-x control panel
3	CCU control unit
4	***Main contactor
5	**Motor temperature supervision
6	***Switch fuse disconnecter
7	Common mode filter
8	**du/dt filter or sine filter
9	Drive module
10	Input and output signals
11	Alarm
12	Supply
13	360 degree grounding recommended

# 20

## The Safe torque off function

---

### Contents of this chapter

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

### Description

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 of the power semiconductors of the drive output stage (A, see the diagrams below), 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>
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>

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<b>Standard</b>	<b>Name</b>
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 62061:2005 + A1:2012 + A2:2015 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**

See the technical data.

The Declaration of conformity is shown at the end of this chapter.

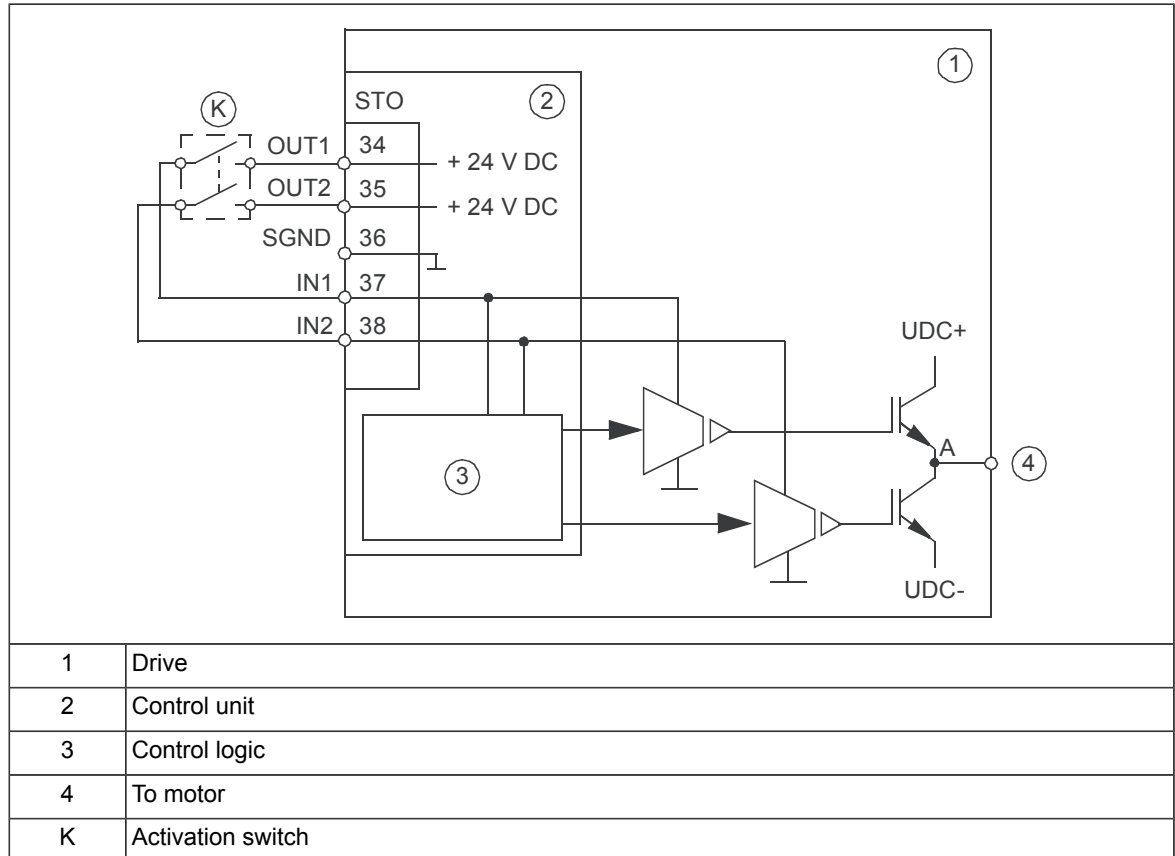


## Wiring

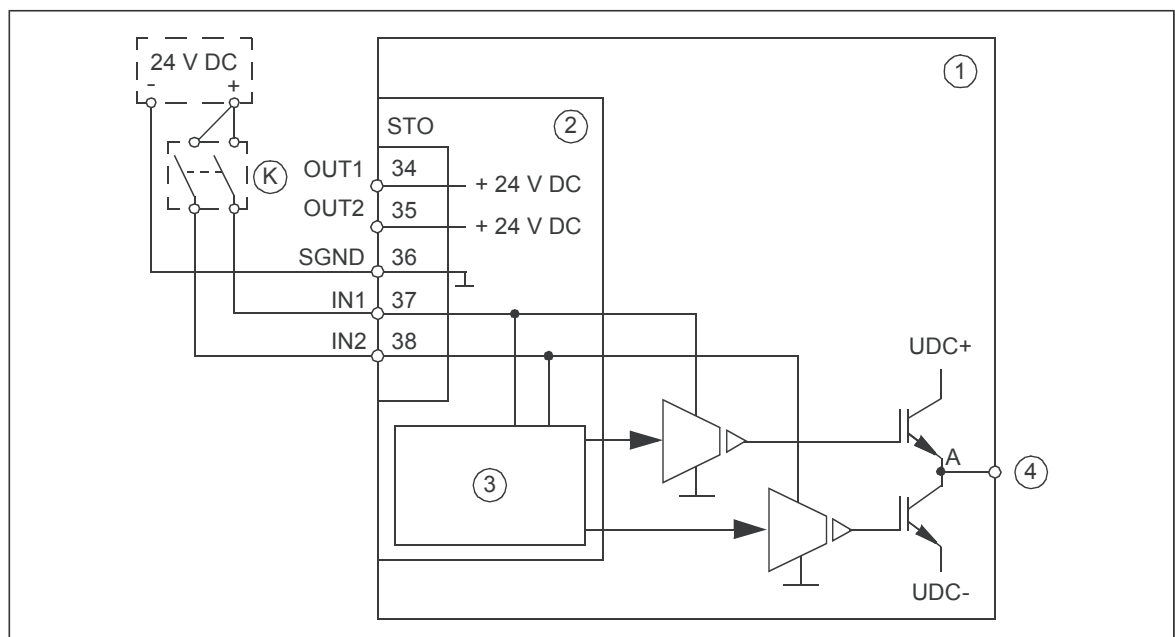
For the electrical specifications of the STO connection, see the technical data of the control unit.

### ■ Connection principle

#### Single ACQ580-34 drive, internal power supply



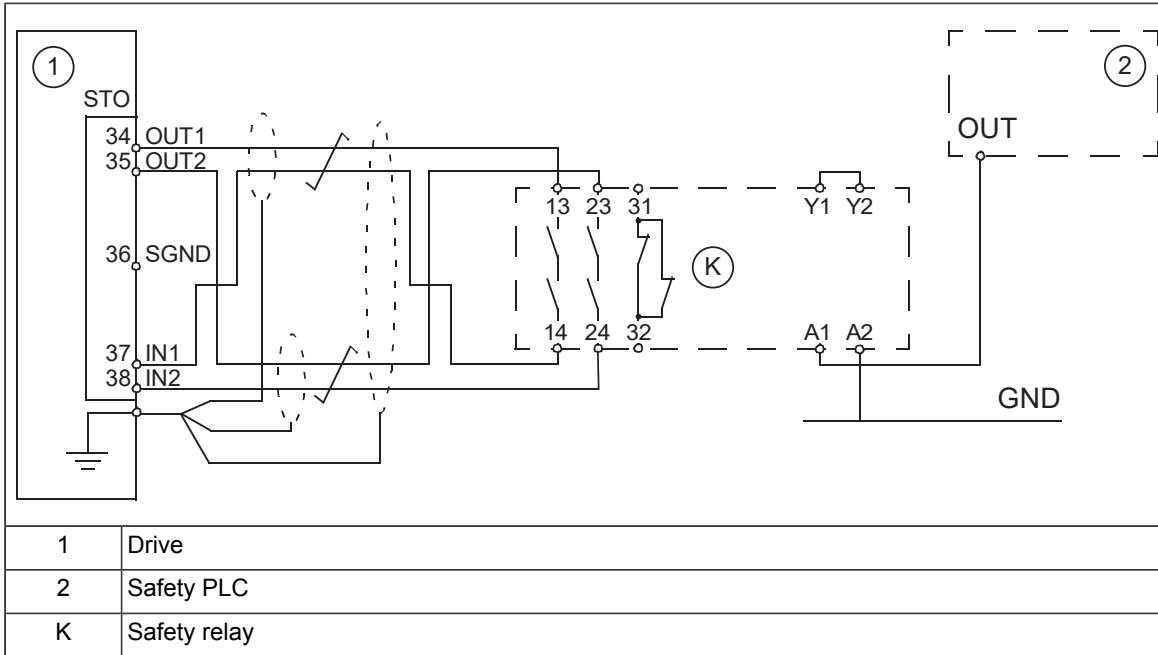
#### Single ACQ580-34 drive, external power supply



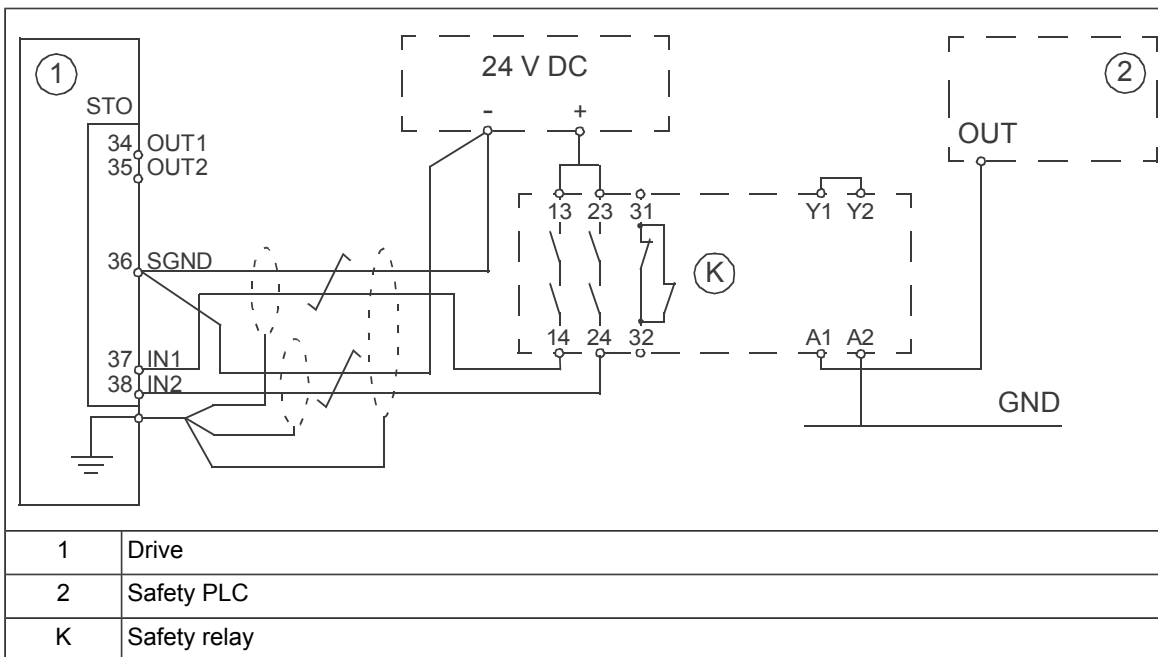
1	Drive
2	Control unit
3	Control logic
4	To motor
K	Activation switch

■ **Wiring examples**

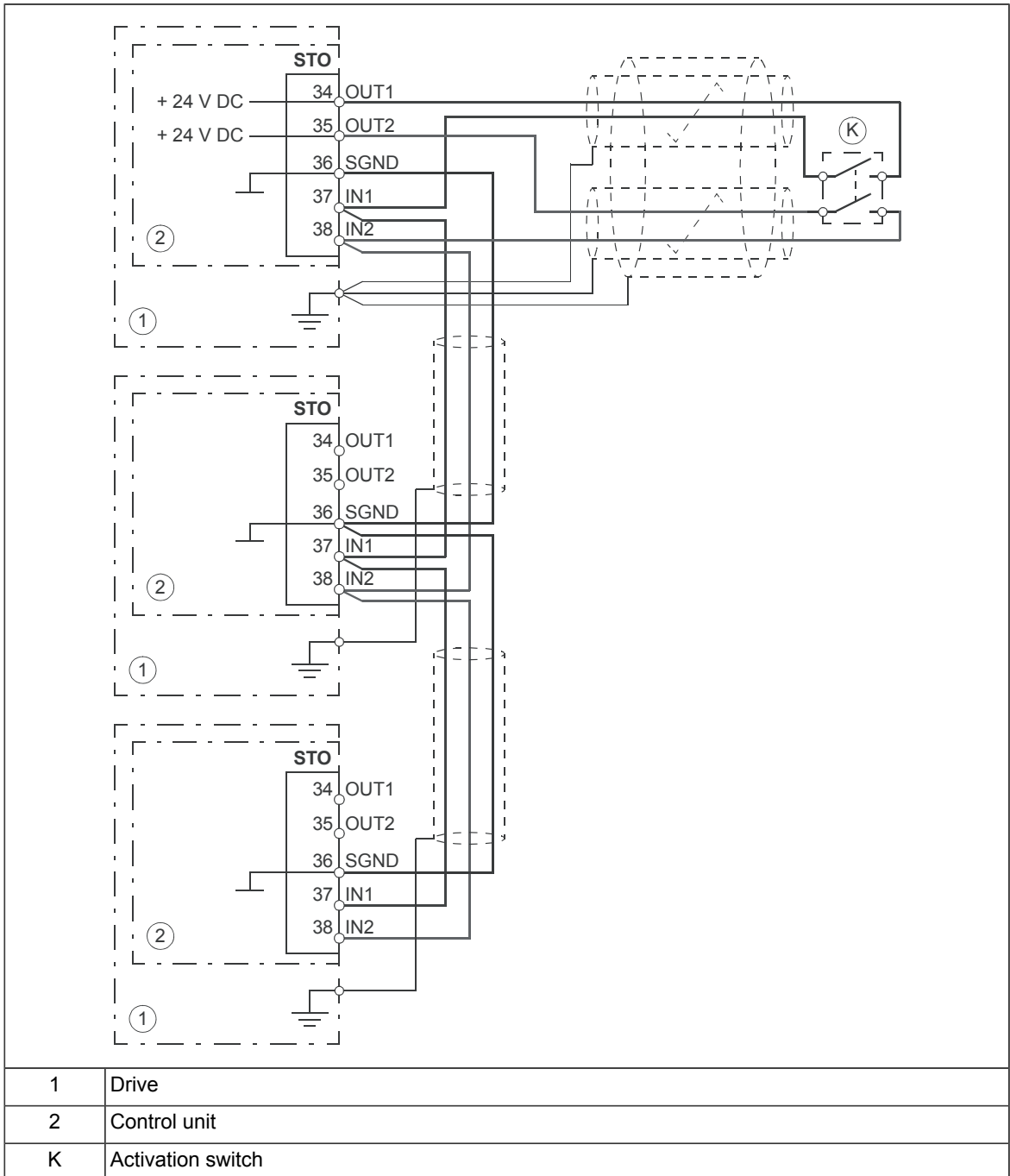
**Single ACQ580-34 drive, internal power supply**



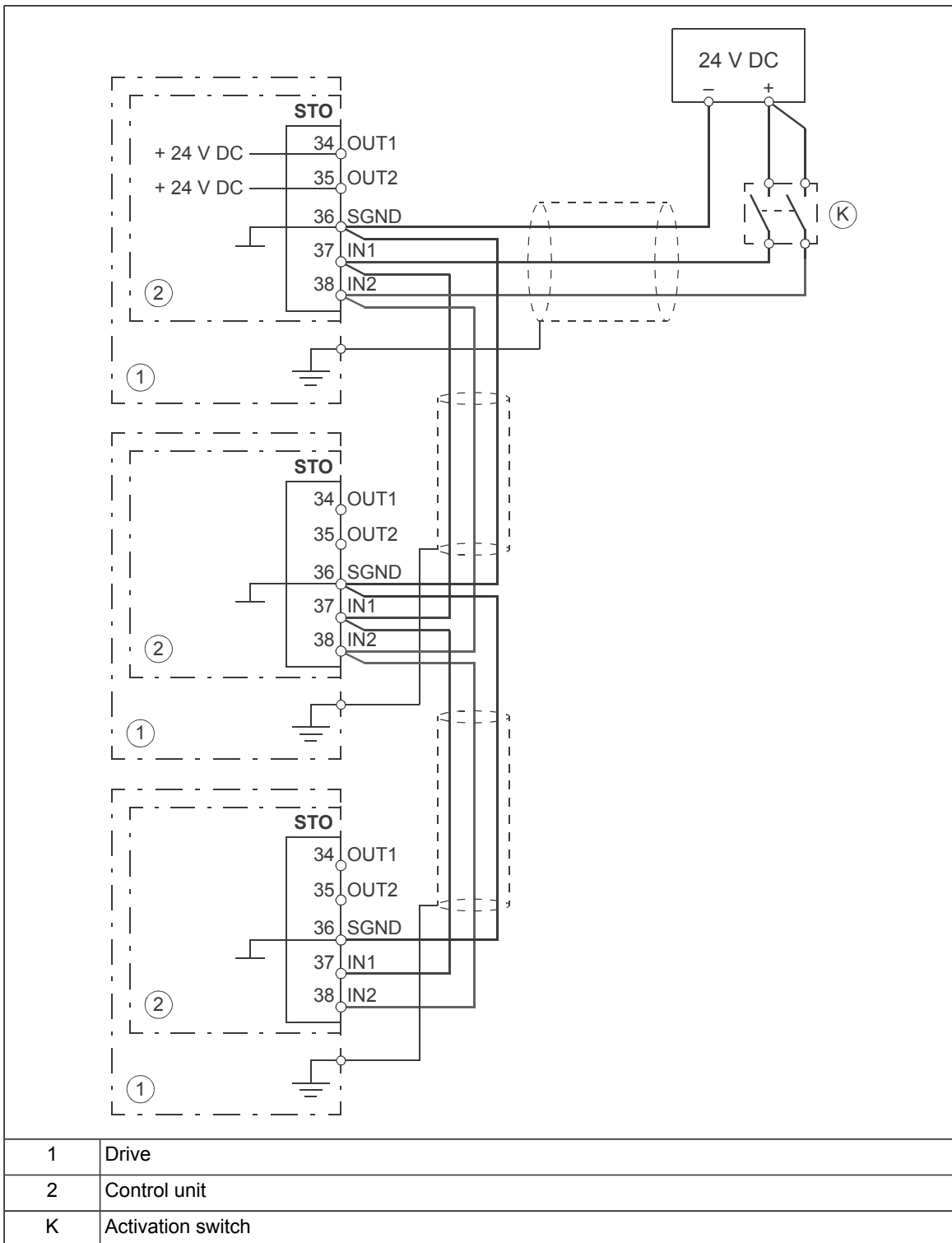
**Single ACQ580-34 drive, external power supply**



**Multiple ACQ580-34 drives, internal power supply**



**Multiple ACQ580-34 drives, external power supply**



■ **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.
- A CPTC-02 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

**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 drive must be at least 13 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.
-

## 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
- 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 a CPTC-02 module is installed, refer to its documentation.

<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"/>
Test the operation of the STO function when the motor is stopped. <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> Make sure that the drive operates as follows: <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"/>

202 The Safe torque off function

<b>Action</b>	<input checked="" 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 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.

This is also valid when the drive is only powered by a CMOD-xx multifunction extension module.

---



### 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 206)*. 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 201)*.

**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 201)*.

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.

---

## **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/ SILCL	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	$T_M$ (a)
R11	3	e	99.61	4.14E-09	3.63E-05	9.08E-05	16398	≥90	3	3	1	80	20
3AXD10000410558 F													

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with  $\Delta T = 71.66$  °C
  - 1340 on/off cycles per year with  $\Delta T = 61.66$  °C
  - 30 on/off cycles per year with  $\Delta T = 10.0$  °C
  - 32 °C board temperature at 2.0% of time
  - 60 °C board temperature at 1.5% of time
  - 85 °C board temperature at 2.3% of time.
- The STO is a type A 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), 30 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

### ■ Abbreviations

Abbr.	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 (%)

Abbr.	Reference	Description
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
PF <sub>D</sub> <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
PL	EN ISO 13849-1	Performance level. Levels a...e correspond to SIL
SC	IEC 61508	Systematic capability
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1...3)
SILCL	IEC/EN 62061	Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem
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.

### ■ TÜV certificate

The TÜV certificate is available on the Internet at [www.abb.com/drives/documents](http://www.abb.com/drives/documents).

■ Declaration 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 product:

**Frequency converter(s)**  
**ACQ580-04/-34**

with regard to the safety function(s)

**Safe Torque Off**

is/are in conformity with all the relevant safety component requirements of EU Machinery Directive 2006/42/EC, when the listed safety function is 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 requirements
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of the control systems. Part 2: Validation
EN 60204-1: 2006 + A1:2009 + AC:2010	Safety of machinery – Electrical equipment of machines – Part 1: General requirements


The following other standards have been applied:

IEC 61508:2010, parts 1-2	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 product(s) referred in this Declaration of conformity fulfil(s) the relevant provisions of other European Union Directives which are notified in Single EU Declaration of conformity 3AXD10000497692.

Person authorized to compile the technical file:  
Name and address: Jussi Vesti, Hiomotie 13, 00380 Helsinki, Finland.

Helsinki, 07.02.2020  
Signed for and on behalf of:

  
Tuomo Tarula  
Vice president, ABB Oy

  
Vesa Tuomainen  
Product Engineering manager, ABB Oy

Document number 3AXD10000611400

# 21

## **CHDI-01 115/230 V digital input extension module**

---

### **Contents of this chapter**

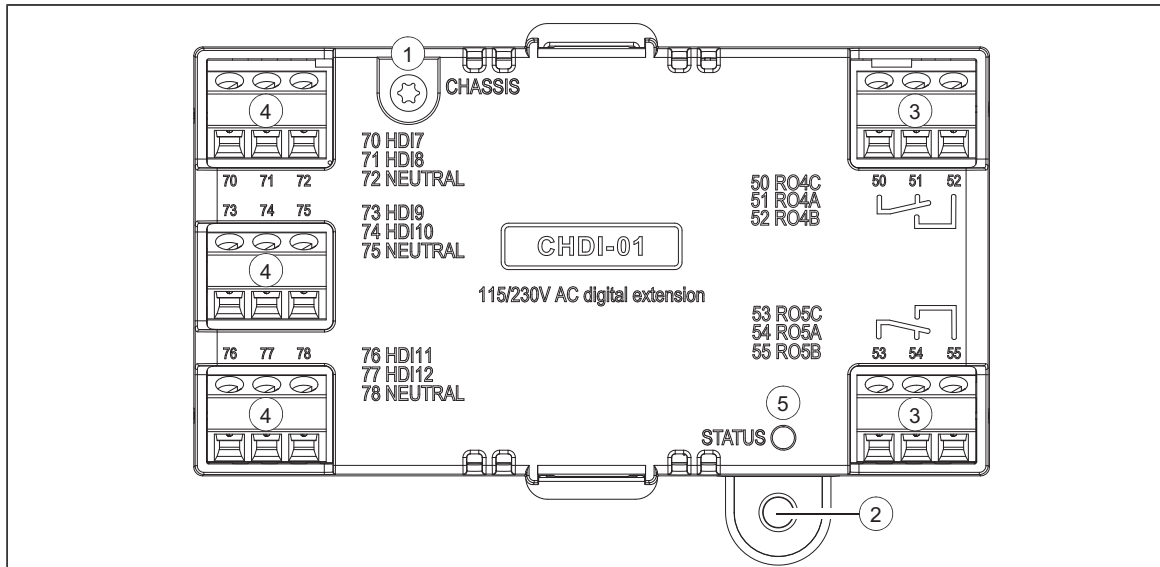
This chapter describes the optional CHDI-01 115/230 V digital input extension module.

### **Product overview**

The CHDI-01 115/230 V digital input extension module expands the inputs of the drive control unit. It has six high voltage inputs and two relay outputs.

---

## Layout and connection examples



4 3-pin terminal blocks for 115/230 V inputs			3 Relay outputs		
70	HDI7	115/230 V input 1	50	RO4C	Common, C
71	HDI8	115/230 V input 2	51	RO4B	Normally closed, NC
72	NEUTRAL <sup>1)</sup>	Neutral point	52	RO4A	Normally open, NO
73	HDI9	115/230 V input 3	53	RO5C	Common, C
74	HDI10	115/230 V input 4	54	RO5B	Normally closed, NC
75	NEUTRAL <sup>1)</sup>	Neutral point	55	RO5A	Normally open, NO
76	HDI11	115/230 V input 5	1	<b>Grounding screw</b>	
77	HDI12	115/230 V input 5	2	<b>Hole for mounting screw</b>	
78	NEUTRAL <sup>1)</sup>	Neutral point	5	<b>Diagnostic LED.</b> Green = The extension module is powered up.	
<sup>1)</sup> Neutral points 72, 75 and 78 are connected.					



## Mechanical installation

### ■ Necessary tools

- Screwdriver and a set of suitable bits.

### ■ Unpacking and examining the delivery

1. Open the option package. Make sure that the package contains:
  - the option module
  - a mounting screw.
2. Make sure that there are no signs of damage.

### ■ Installing the module

See section *Installing option modules (page 107)*.

## Electrical installation



### **WARNING!**

Obey the instructions in chapter *Safety instructions (page 15)*. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrician, do not do electrical work.

**Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.**

---

### ■ Necessary tools

- Screwdriver and a set of suitable bits.

### ■ Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the cables 360 degrees under a grounding clamp on the grounding shelf of the control cables.

---

## Start-up

### ■ Setting the parameters

1. Power up the drive.
2. If no warning is shown,
  - make sure that the value of both parameters *15.01 Extension module type* and *15.02 Detected extension module* is CHDI-01.

If warning *A7AB Extension I/O configuration failure* is shown,

- make sure that the value of parameter *15.02* is CHDI-01.
- set parameter *15.01* value to CHDI-01.

You can now see the parameters of the extension module in parameter group *15 I/O extension module*.

3. Set the parameters of the extension module to applicable values.

### Parameter setting example for relay output

This example shows how make relay output RO4 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

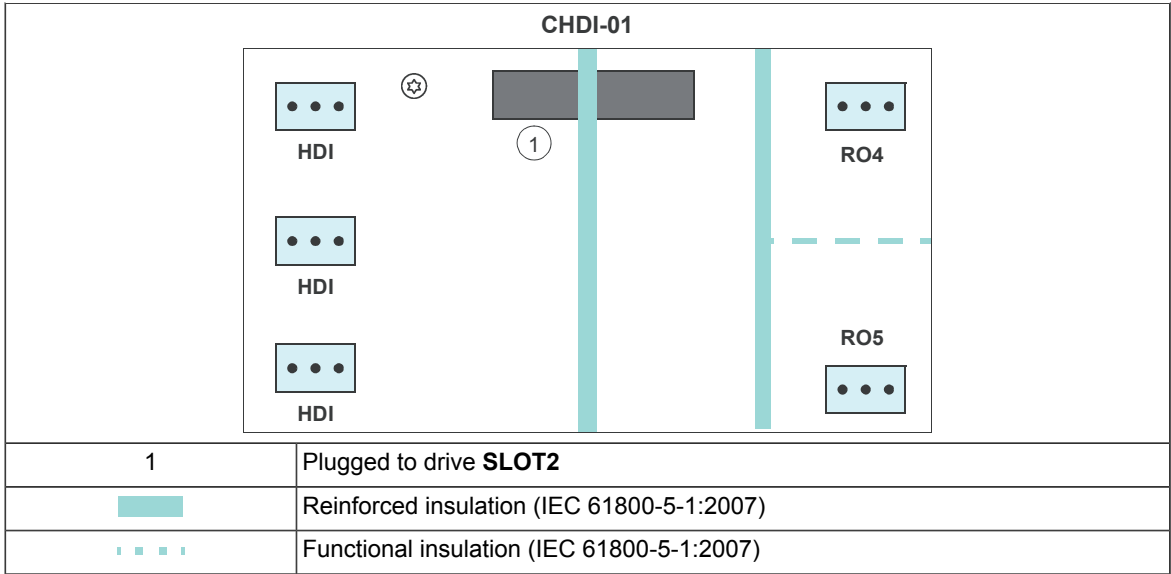
Parameter	Setting
15.07 RO4 source	Reverse
15.08 RO4 ON delay	1 s
15.09 RO4 OFF delay	1 s

## Fault and warning messages

Warning *A7AB Extension I/O configuration failure*.

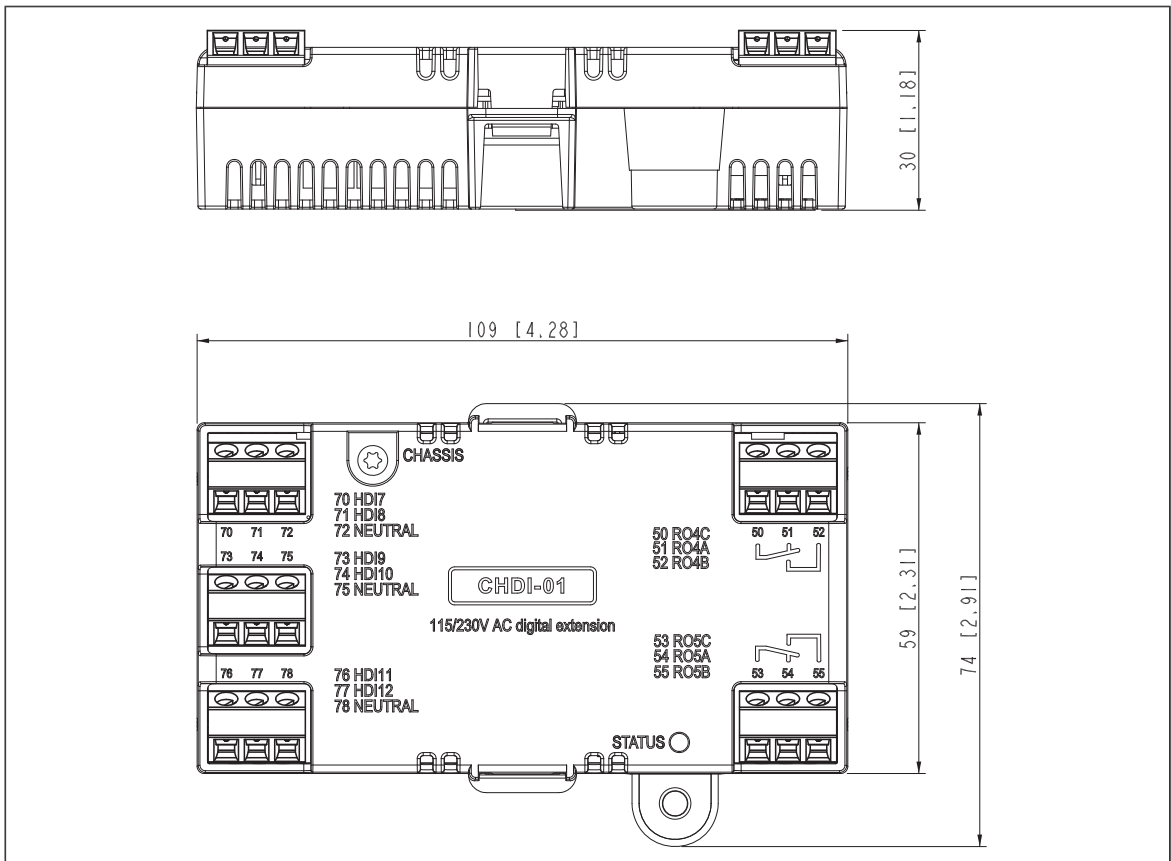
## Technical data

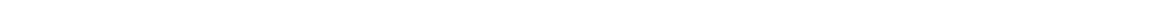
Installation	Into an option slot on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
<b>Relay outputs (50...52, 53...55)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Minimum contact rating	12 V / 10 mA
Maximum contact rating	250 V AC / 30 V DC / 2 A
Maximum breaking capacity	1500 VA
<b>115/230 V inputs (70...78)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Input voltage	115 to 230 V AC ±10%
Maximum current leakage in digital off state	2 mA
<b>Isolation areas</b>	



## Dimension drawing

The dimensions are in millimeters and [inches].





# 22

## **CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O)**

---

### **Contents of this chapter**

This chapter describes the optional CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O).

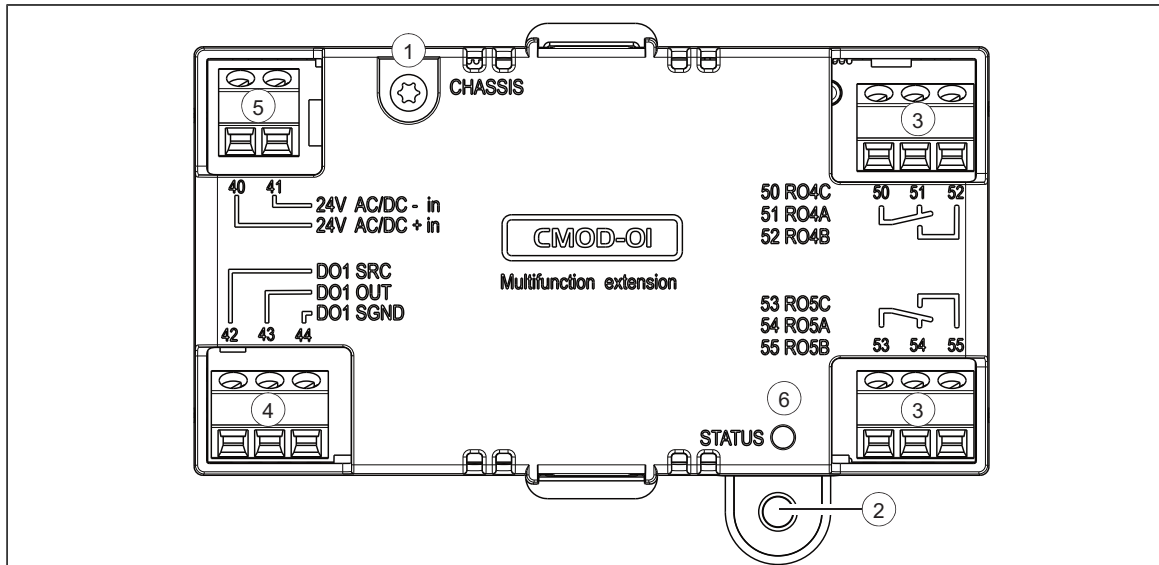
### **Product overview**

The CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O) expands the outputs of the drive control unit. It has two relay outputs and one transistor output, which can function as a digital or frequency output.

In addition, the extension module has an external power supply interface, which can be used to power up the drive control unit in case the drive power supply is not on. If you do not need the back-up power supply, you do not have to connect it because the module is powered from the drive control unit by default.

---

## Layout and example connections



<b>1</b>	<b>Grounding screw</b>		<b>6</b>	<b>Diagnostic LED</b>	
<b>2</b>	<b>Hole for mounting screw</b>				
<b>5</b>	<b>2-pin terminal block for external power supply</b>		<b>3</b>	<b>3-pin terminal blocks for relay outputs</b>	
40	24 V AC/DC + in	External 24 V (AC/DC) input	50	RO4C	Common, C
41	24 V AC/DC - in	External 24 V (AC/DC) input	51	RO4A	Normally closed, NC
<b>4</b>	<b>3-pin terminal block for for transistor output</b>		52	RO4B	Normally open, NO
42	DO1 SRC	Source input	53	RO5C	Common, C
43	DO1 OUT	Digital or frequency output	54	RO5A	Normally closed, NC
44	DO1 SGND	Ground (earth) potential	55	RO5B	Normally open, NO

1) Digital output connection example

2) An externally supplied frequency indicator which provides, for example:

- a 40 mA / 12 V DC power supply for the sensor circuit (CMOD frequency output)
- suitable voltage pulse input (10 Hz ... 16 kHz).

## Mechanical installation

### ■ Necessary tools

- Screwdriver and a set of suitable bits.

### ■ Unpacking and examining the delivery

1. Open the option package. Make sure that the package contains:
  - the option module
  - a mounting screw.
2. Make sure that there are no signs of damage.

### ■ Installing the module

See section *Installing option modules (page 107)*.

## Electrical installation



### **WARNING!**

Obey the instructions in chapter *Safety instructions (page 15)*. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrician, do not do electrical work.

**Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.**

---

### ■ Necessary tools

- Screwdriver and a set of suitable bits

### ■ Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the cables 360 degrees under a grounding clamp on the grounding shelf of the control cables.

---



### **WARNING!**

Do not connect the +24 V AC cable to the control unit ground when the control unit is powered using an external 24 V AC supply.

---

## Start-up

### ■ Setting the parameters

1. Power up the drive.
2. If no warning is shown,
  - make sure that the value of both parameters *15.01 Extension module type* and *15.02 Detected extension module* is CMOD-01.

If warning *A7AB Extension I/O configuration failure* is shown,

- make sure that the value of parameter *15.02* is CMOD-01.
- set the parameter *15.01* value to CMOD-01.

You can now see the parameters of the extension module in parameter group *15 I/O extension module*.

3. Set the parameters of the extension module to applicable values.

Examples are given below.

#### Parameter setting example for relay output

This example shows how make relay output RO4 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

Parameter	Setting
15.07 RO4 source	Reverse
15.08 RO4 ON delay	1 s
15.09 RO4 OFF delay	1 s

#### Parameter setting example for digital output

This example shows how to make digital output DO1 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

Parameter	Setting
15.22 DO1 configuration	Digital output
15.23 DO1 source	Reverse
15.24 DO1 ON delay	1 s
15.25 DO1 OFF delay	1 s

#### Parameter setting example for frequency output

This example shows how to make digital output DO1 of the extension module indicate the motor speed 0... 1500 rpm with a frequency range of 0...10000 Hz.

Parameter	Setting
15.22 DO1 configuration	Frequency output
15.33 Freq out 1 source	01.01 Motor speed used
15.34 Freq out 1 src min	0
15.35 Freq out 1 src max	1500.00
15.36 Freq out 1 at src min	1000 Hz
15.37 Freq out 1 at src max	10000 Hz



## ■ Diagnostics

### Faults and warning messages

Warning A7AB Extension I/O configuration failure.

### LEDs

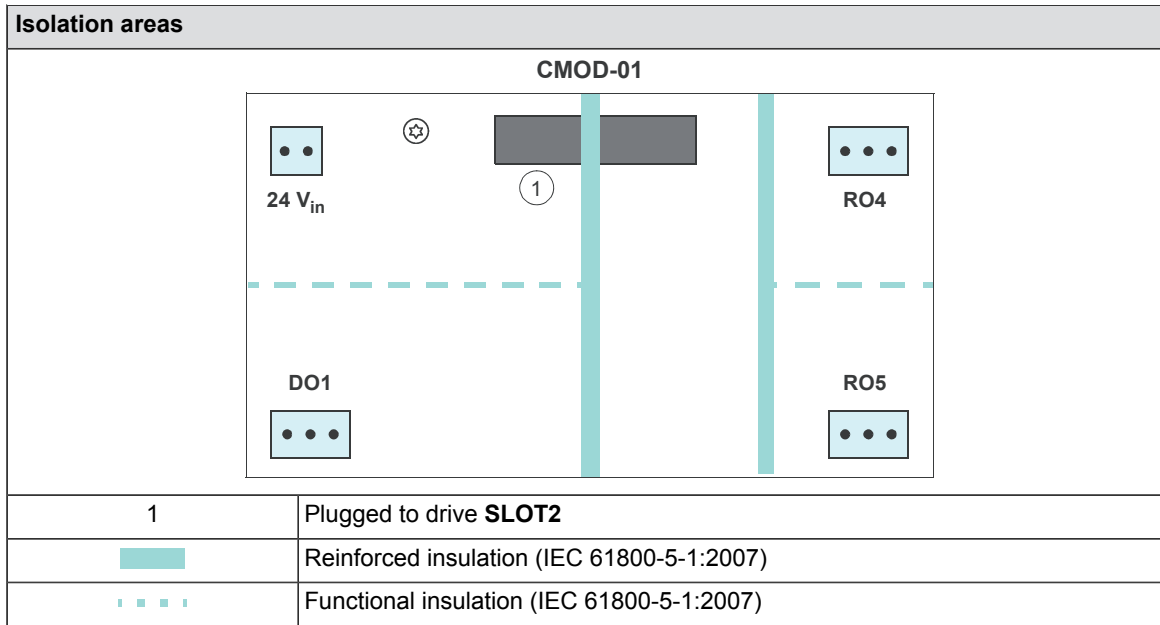
The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

## Technical data

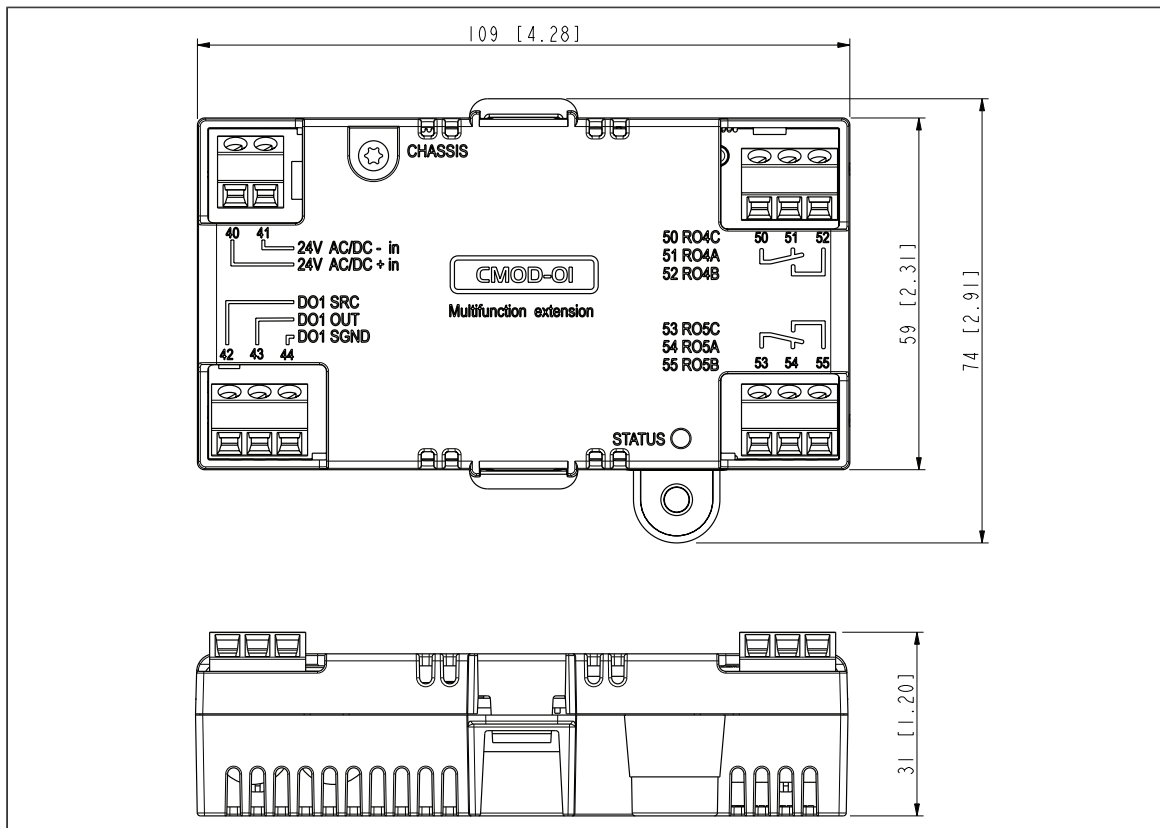
Installation	Into an option slot on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
<b>Relay outputs (50...52, 53...55)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Minimum contact rating	12 V / 10 mA
Maximum contact rating	250 V AC / 30 V DC / 2 A
Maximum breaking capacity	1500 VA
<b>Transistor output (42...44)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Type	Transistor output PNP
Maximum load	4 kohm
Maximum switching voltage	30 V DC
Maximum switching current	100 mA / 30 V DC, short-circuit protected
Frequency	10 Hz ... 16 kHz
Resolution	1 Hz
Inaccuracy	0.2%
<b>External power supply (40...41)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Input voltage	24 V AC / V DC ±10% (GND, user potential)
Maximum power consumption	25 W, 1.04 A at 24 V DC

220 CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O)



## Dimension drawing

The dimensions are in millimeters and [inches].



# 23

## **CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface)**

---

### **Contents of this chapter**

This chapter describes the optional CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface).

### **Product overview**

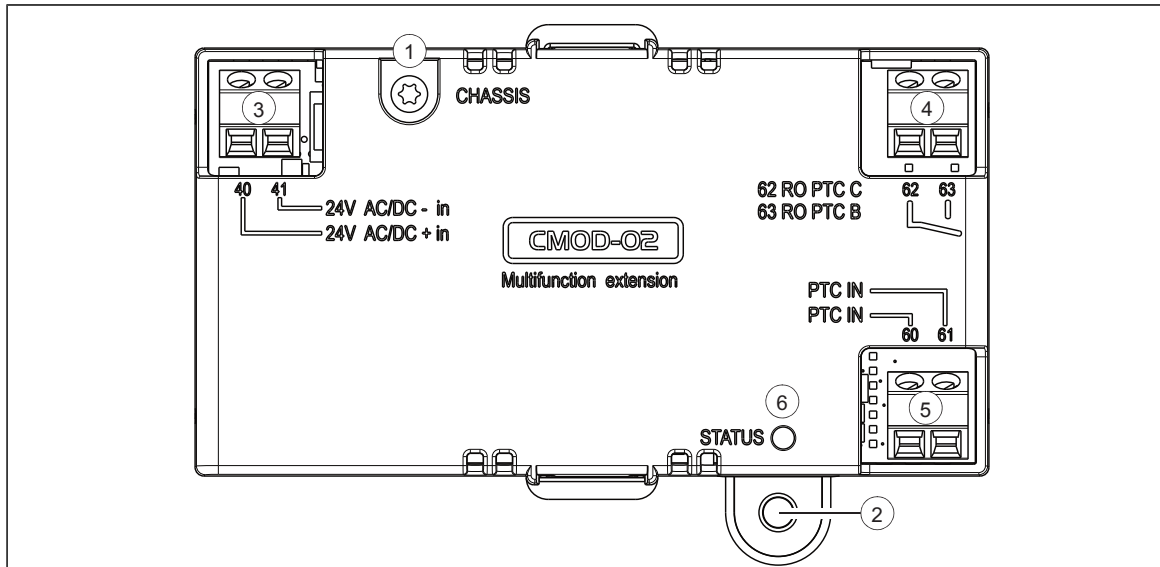
The CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface) has a motor thermistor connection for supervising the motor temperature and one relay output, which indicates the thermistor status. In case the thermistor overheats, the drive trips on motor overtemperature. If Safe torque off tripping is required, the user must wire the overtemperature indication relay to the certified Safe torque off input of the drive.

In addition, the extension module has an external power supply interface, which can be used to power up the drive control unit in case the drive power supply is not on. If you do not need the back-up power supply, you do not have to connect it because the module is powered from the drive control unit by default.

There is reinforced insulation between the motor thermistor connection, the relay output and the drive control unit interface. Thus, you can connect a motor thermistor to the drive through the extension module.

---

## Layout and example connections



3		2-pin terminal block for external power supply	4		2-pin terminal block for relay output	
40	24 V AC/DC + in	External 24 V (AC/DC) input	62	RO PTC C	Common, C	
41	24 V AC/DC - in	External 24 V (AC/DC) input	63	RO PTC B	Normally open, NO	
5		Motor thermistor connection	1			Grounding screw
		<p>One to six PTC thermistors connected in series.</p>				
60	PTC IN	PTC connection	2		Hole for mounting screw	
61	PTC IN	Ground (earth) potential	6		Diagnostic LED	

## Mechanical installation

### ■ Necessary tools

- Screwdriver and a set of suitable bits.

## ■ Unpacking and examining the delivery

1. Open the option package. Make sure that the package contains:
  - the option module
  - a mounting screw.
2. Make sure that there are no signs of damage.

## ■ Installing the module

See section *Installing option modules (page 107)*.

## Electrical installation

---



### **WARNING!**

Obey the instructions in chapter *Safety instructions (page 15)*. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrician, do not do electrical work.

**Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.**

---

## ■ Necessary tools and instructions

- Screwdriver and a set of suitable bits

## ■ Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the cables 360 degrees under a grounding clamp on the grounding shelf of the control cables.

---



### **WARNING!**

Do not connect the +24 V AC cable to the control unit ground when the control unit is powered using an external 24 V AC supply.

---

## Start-up

### ■ Setting the parameters

1. Power up the drive.
2. If no warning is shown,
  - make sure that the values of both parameters *15.01 Extension module type* and *15.02 Detected extension module* are CMOD-02.

If warning *A7AB Extension I/O configuration failure* is shown,

- make sure that the value of parameter *15.02* is CMOD-02.
- set the parameter *15.01* value to CMOD-02.

You can now see the parameters of the extension module in parameter group *15 I/O extension module*.

---

## Diagnostics

### ■ Faults and warning messages

Warning A7AB Extension I/O configuration failure.

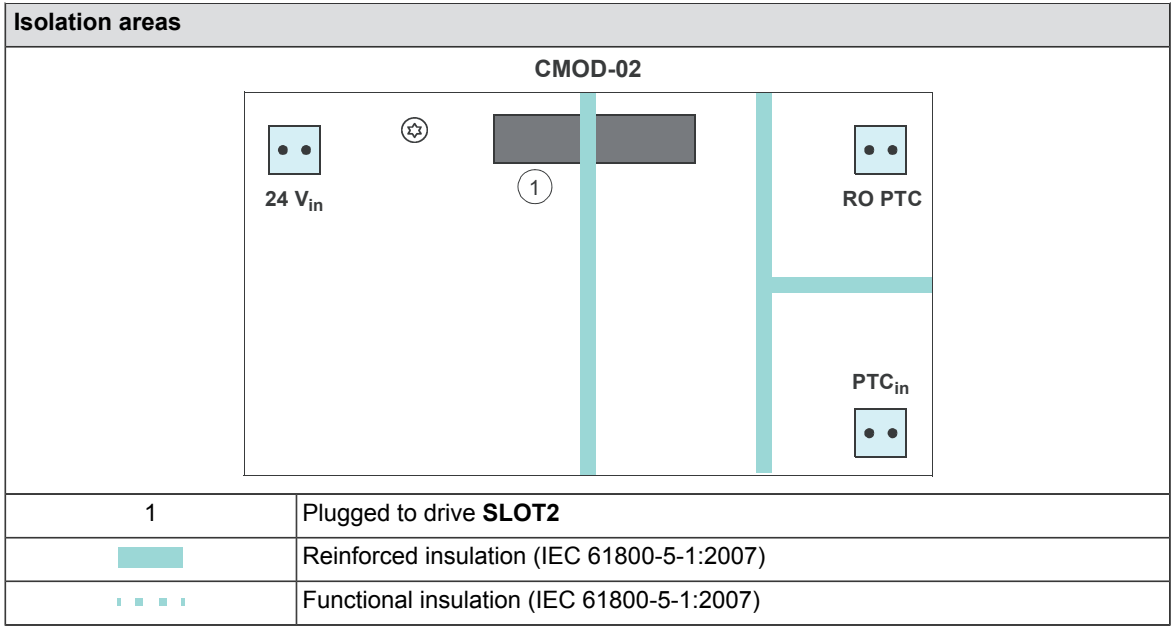
### ■ LEDs

The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

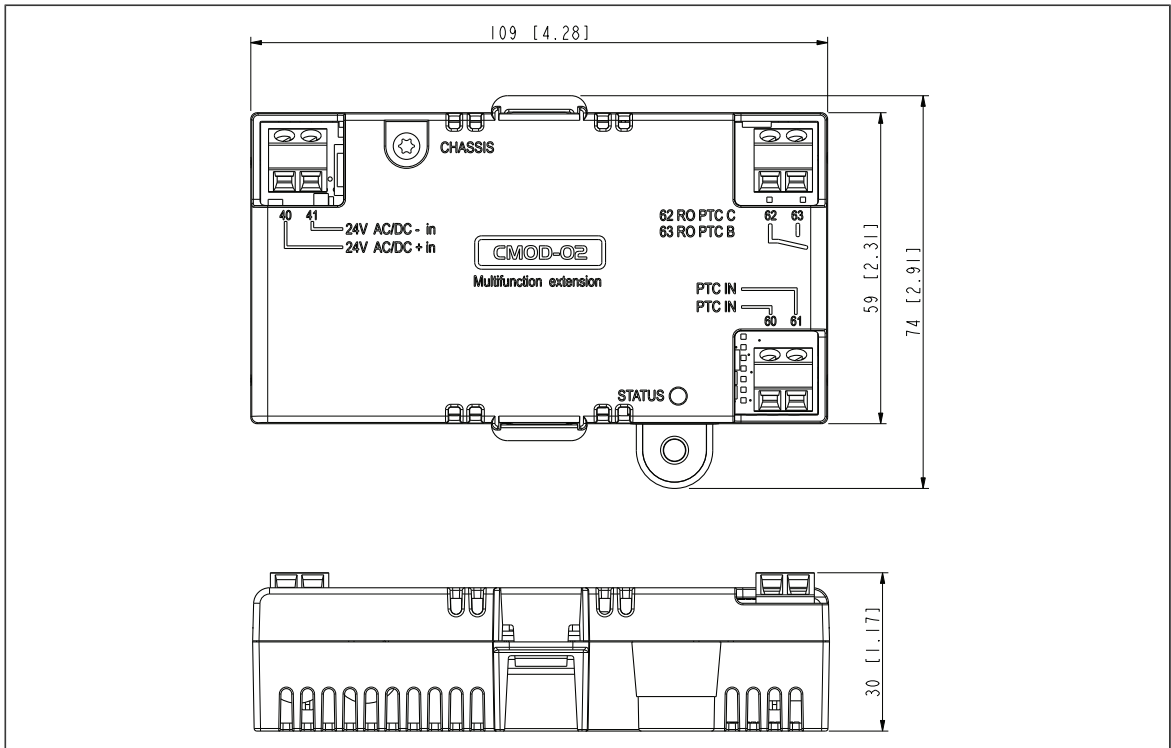
## Technical data

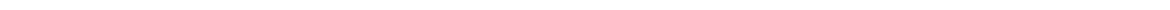
Installation	Into option slot 2 on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
<b>Motor thermistor connection (60...61)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Supported standards	DIN 44081 and DIN 44082
Triggering threshold	3.6 kohm ±10%
Recovery threshold	1.6 kohm ±10%
PTC terminal voltage	≤ 5.0 V
PTC terminal current	< 1 mA
Short-circuit detection	< 50 ohm ±10%
<p>The PTC input is reinforced/double insulated. If the motor part of the PTC sensor and wiring are reinforced/double insulated, voltages on the PTC wiring are within SELV limits.</p> <p>If the motor PTC circuit is not reinforced/double insulated (ie, it is basic insulated), it is mandatory to use reinforced/double insulated wiring between the motor PTC and CMOD-02 PTC terminal.</p>	
<b>Relay output (62...63)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Maximum contact rating	250 V AC / 30 V DC / 5 A
Maximum breaking capacity	1000 VA
<b>External power supply (40...41)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Input voltage	24 V AC / V DC ±10% (GND, user potential)
Maximum power consumption	25 W, 1.04 A at 24 V DC



## Dimension drawing

The dimensions are in millimeters and [inches].







# 24

## Filters

---

### Contents of this chapter

This chapter describes how to select  $du/dt$  filters for the drive.

#### $du/dt$ filters

- **When is a  $du/dt$  filter necessary?**

See section [Examining the compatibility of the motor and drive \(page 72\)](#).

- **Selection table**

$du/dt$  filter types for the drive modules are given below.

ACQ580-34-...	$du/dt$ filter type	ACQ580-34-...	$du/dt$ filter type	ACQ580-34-...	$du/dt$ filter type
U <sub>n</sub> = 400 V, IEC		U <sub>n</sub> = 480 V, IEC		U <sub>n</sub> = 480 V, UL (NEC)	
246A-4	FOCH0260-7x	246A-4	FOCH0260-7x	240A-4	FOCH0260-7x
293A-4	FOCH0260-7x	293A-4	FOCH0320-50	302A-4	FOCH0320-5x
365A-4	FOCH0320-5x	365A-4	FOCH0320-50	361A-4	FOCH0320-5x
442A-4	FOCH0320-5x	442A-4	FOCH0320-50	414A-4	FOCH0320-5x
505A-4	FOCH0610-70	505A-4	FOCH0610-70	477A-4	FOCH0610-70
585A-4	FOCH0610-70	585A-4	FOCH0610-70	-	-
650A-4	FOCH0610-70	650A-4	FOCH0610-70	-	-

---

■ **Ordering codes**

Drive module type	Ordering code
ACQ580-34-	
246A-4...725A-4	3AUA0000125245

■ **Description, installation and technical data of the FOCH filters**

See *FOCH du/dt filters hardware manual* (3AFE68577519 [English]).

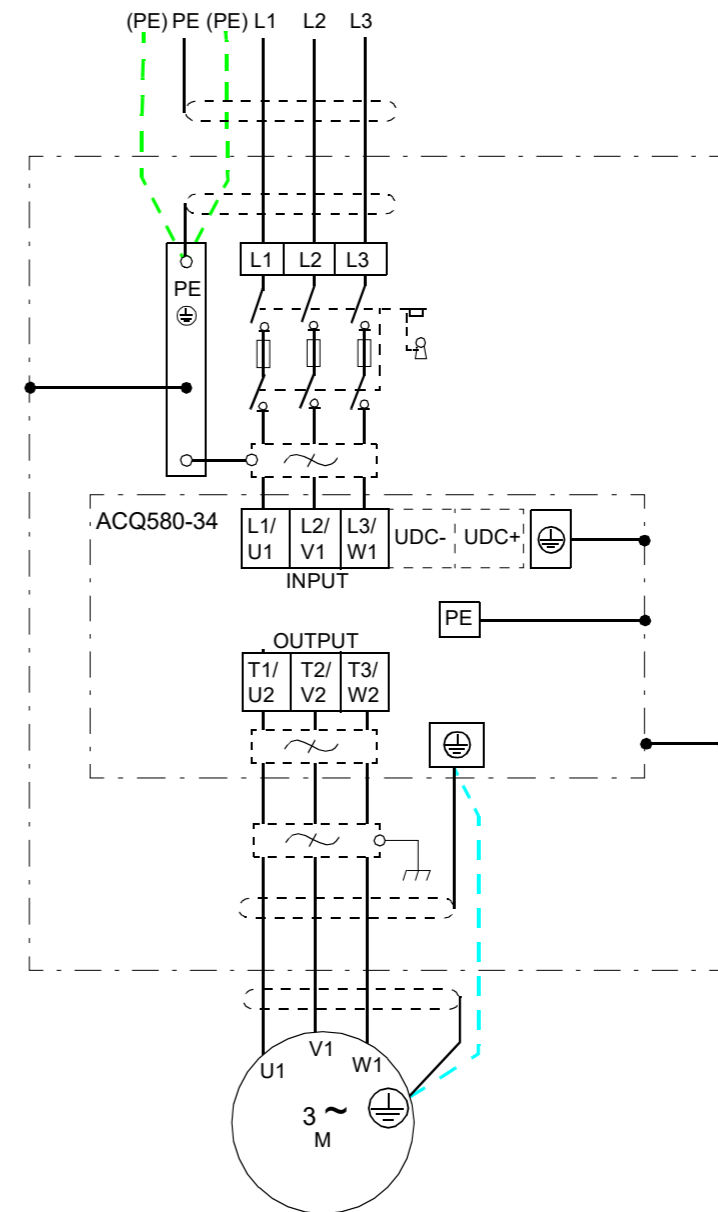
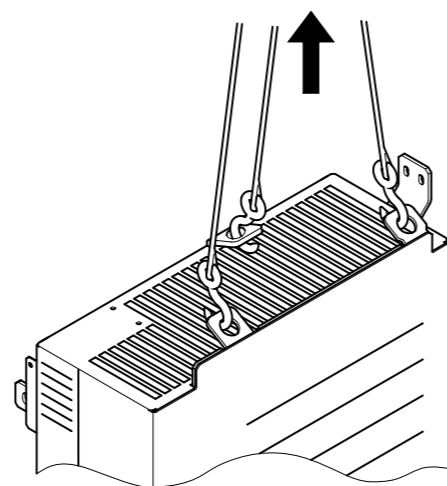
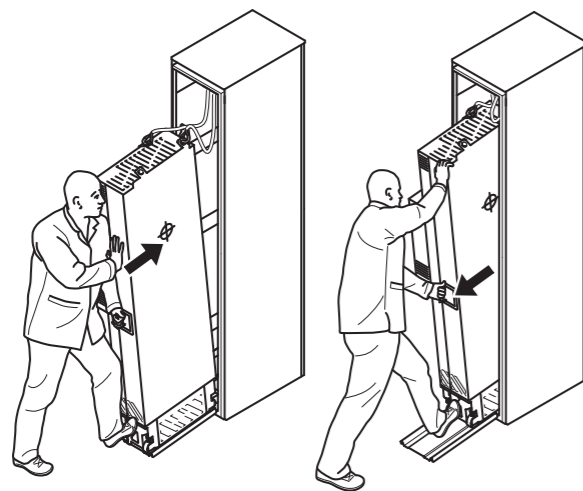
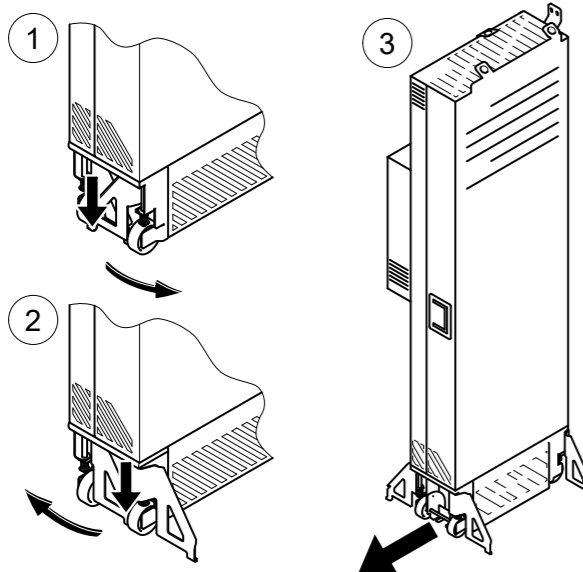
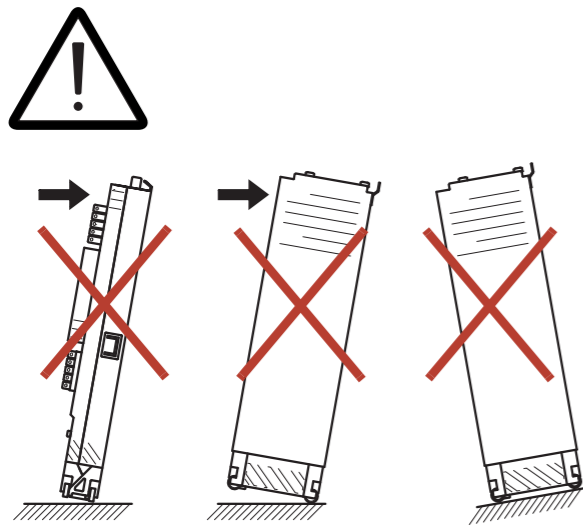
## 25. Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure

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See:

- [Handling the drive module, power cable connection diagram \(page 229\)](#)
- [Installing the drive module and LCL filter module into a Rittal VX25 enclosure \(page 231\)](#)
- [Connecting the motor cables and installing the shrouds \(page 236\)](#)
- [Connecting the input power cables and installing the shrouds \(page 239\)](#)
- [Installing the air baffles and removing the cardboard covers \(page 240\)](#)

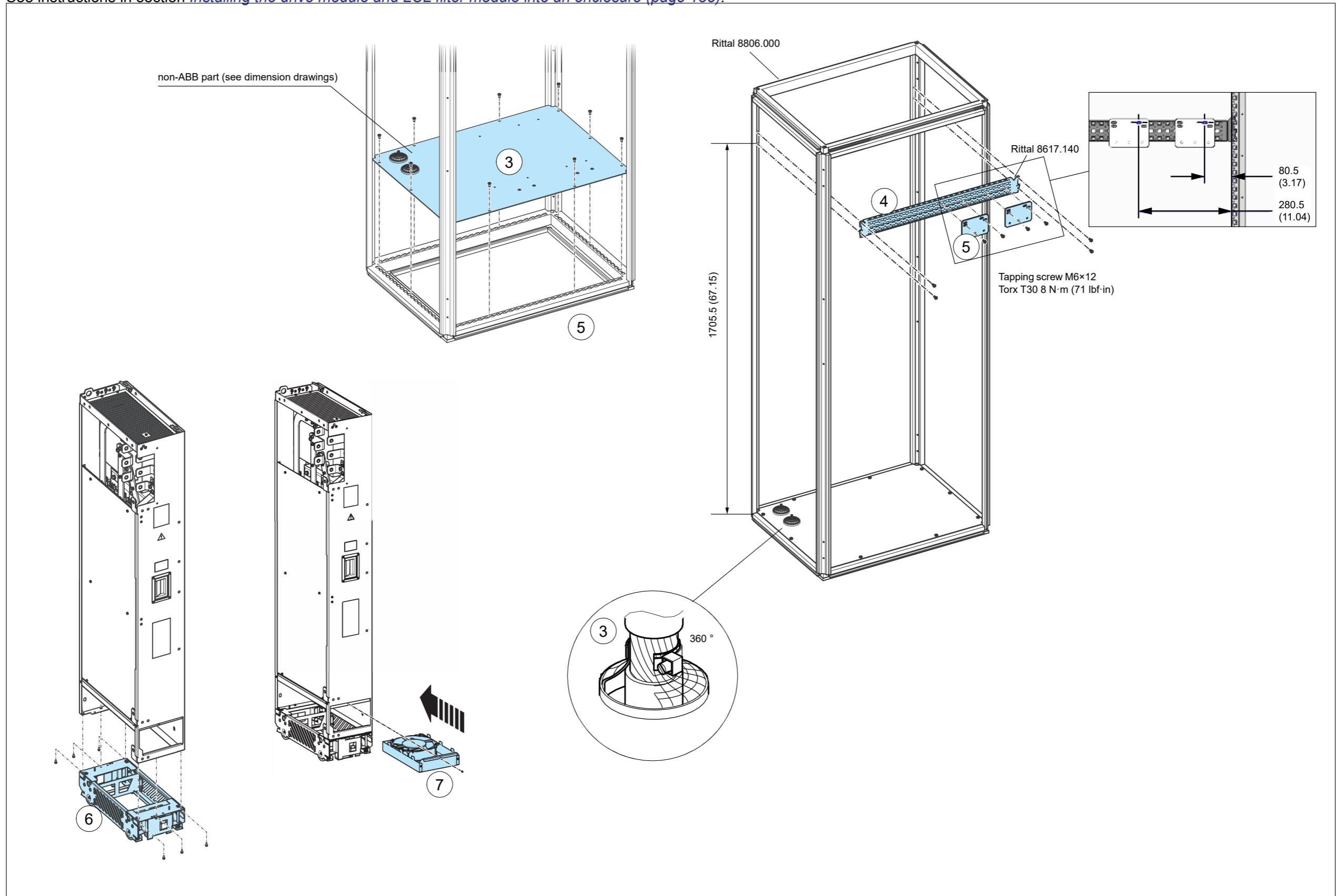
## Handling the drive module, power cable connection diagram

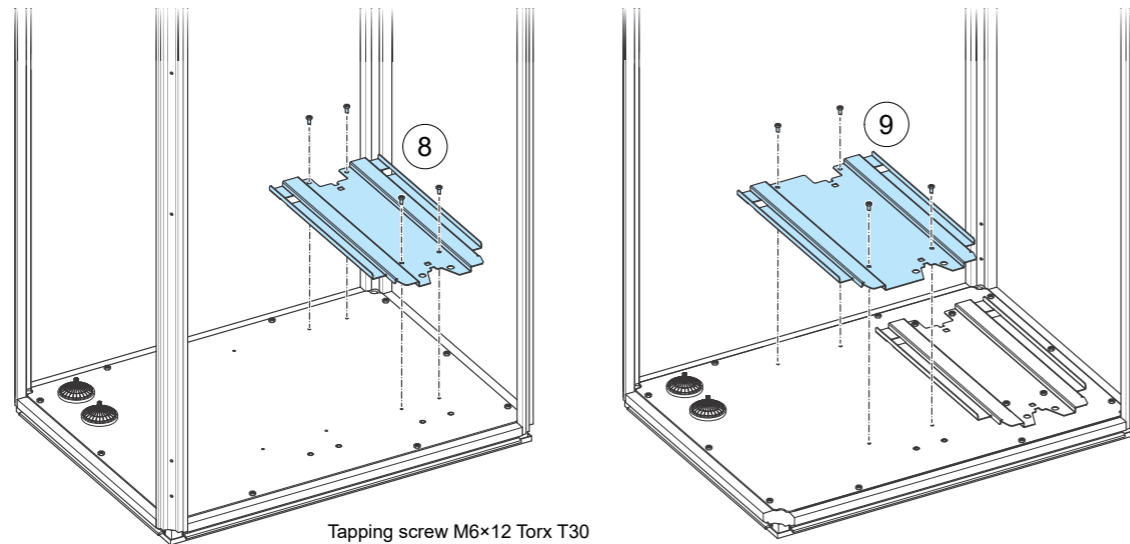


**WARNING!** The UDC+ and UDC- terminals of the drive module must not be used for any other than optional external brake chopper connection.

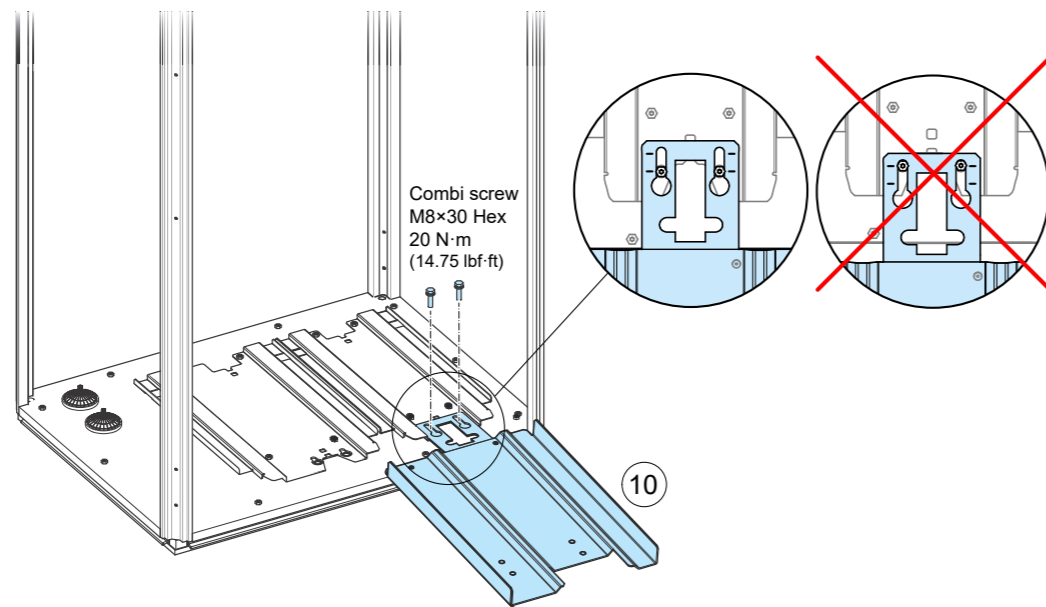
## Installing the drive module and LCL filter module into a Rittal VX25 enclosure

See instructions in section [Installing the drive module and LCL filter module into an enclosure \(page 135\)](#).

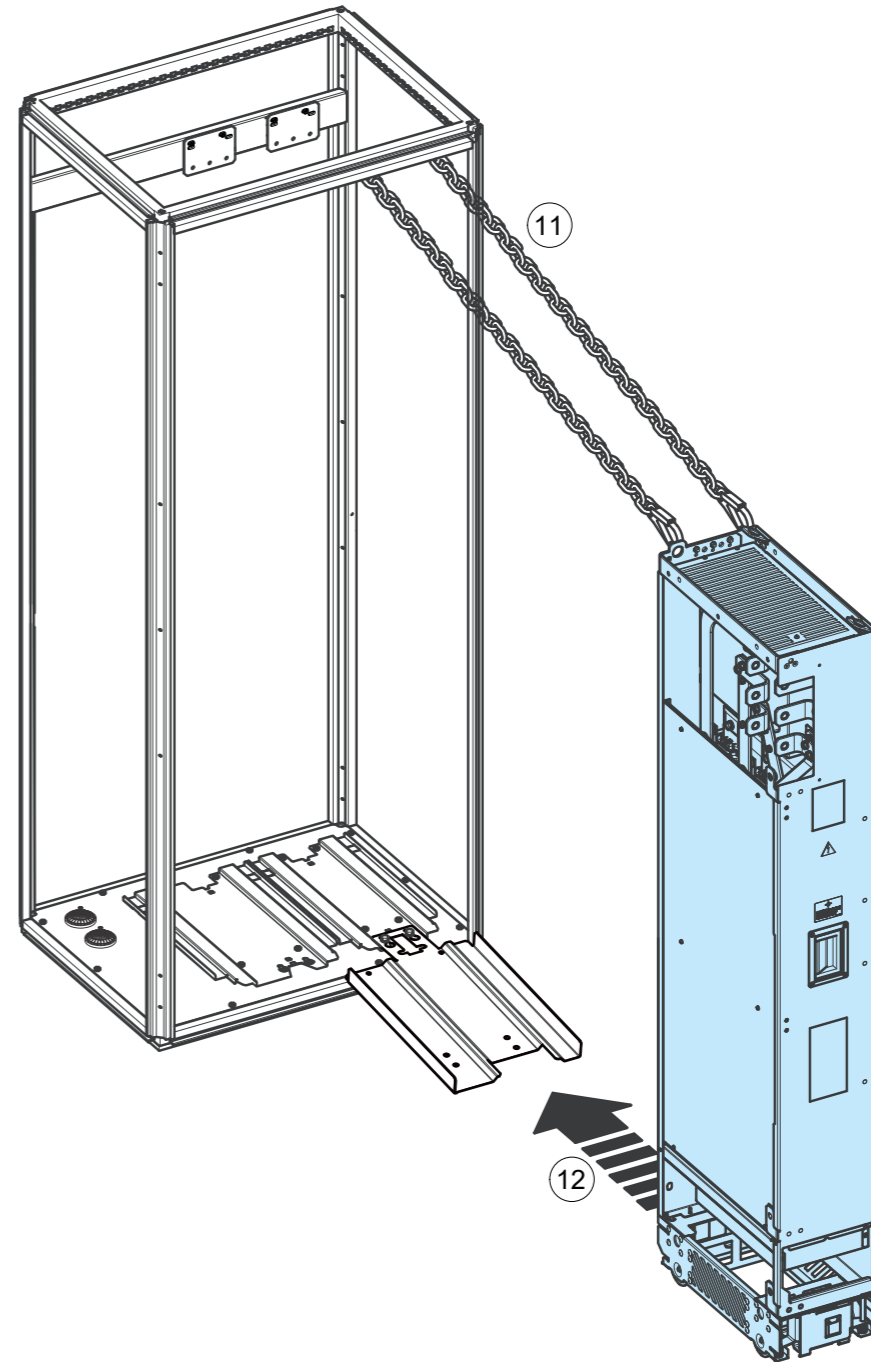


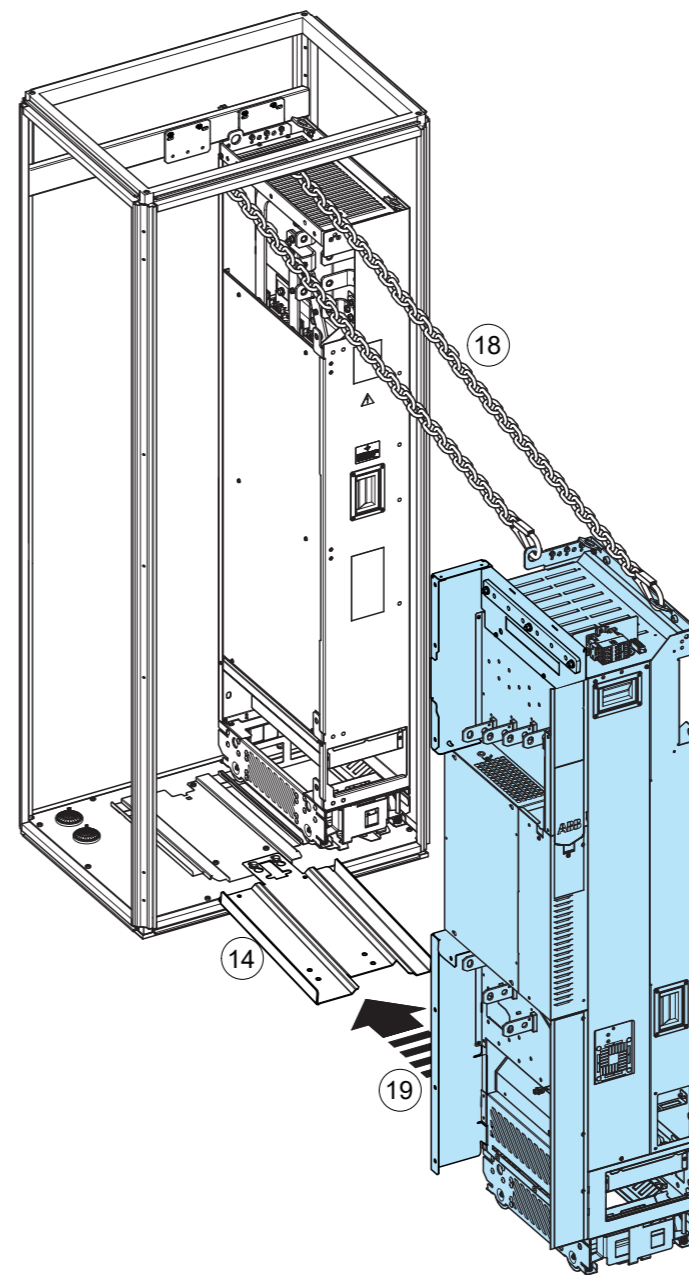
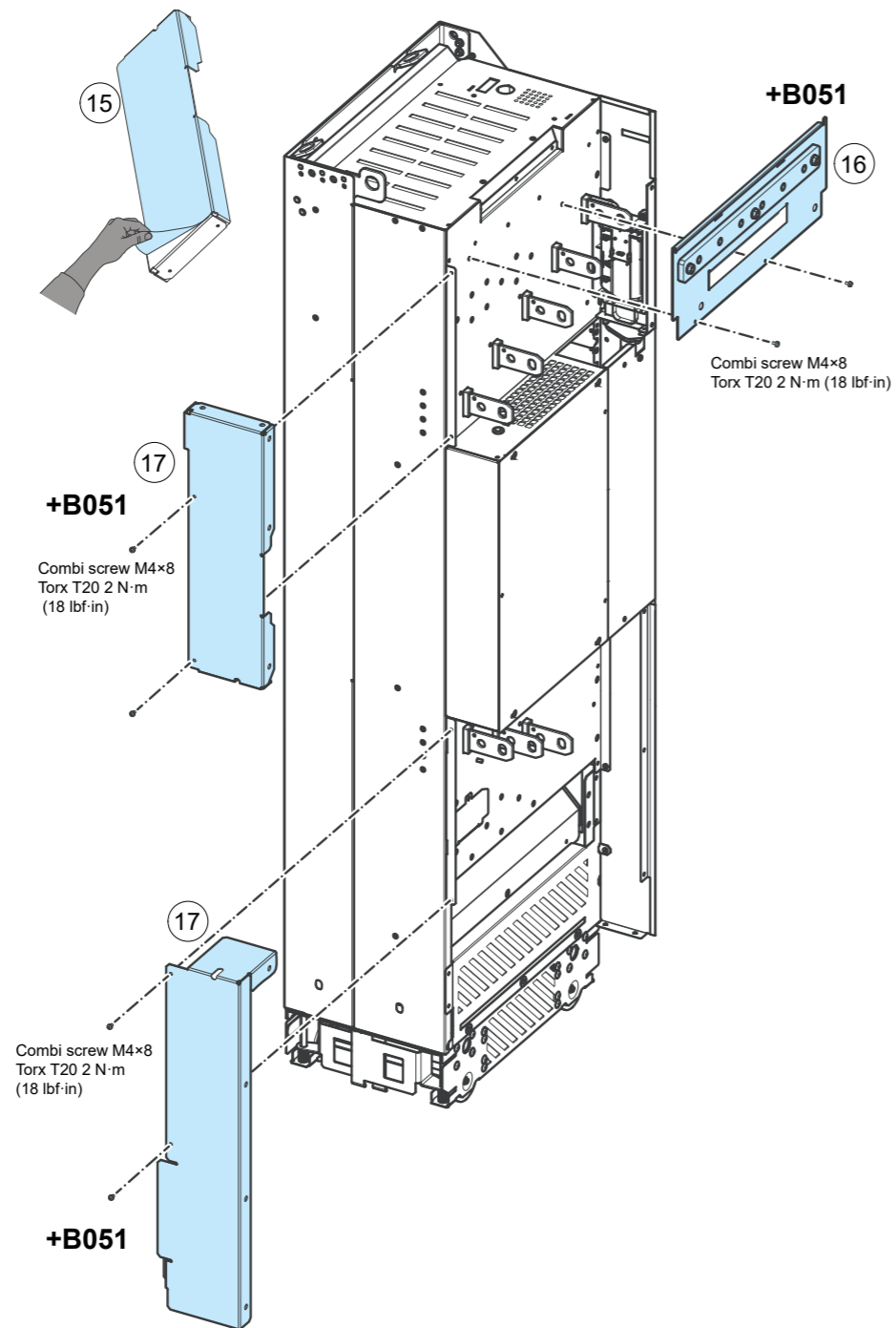


Tapping screw M6×12 Torx T30  
(Hex) 8 N·m (71 lbf-in)

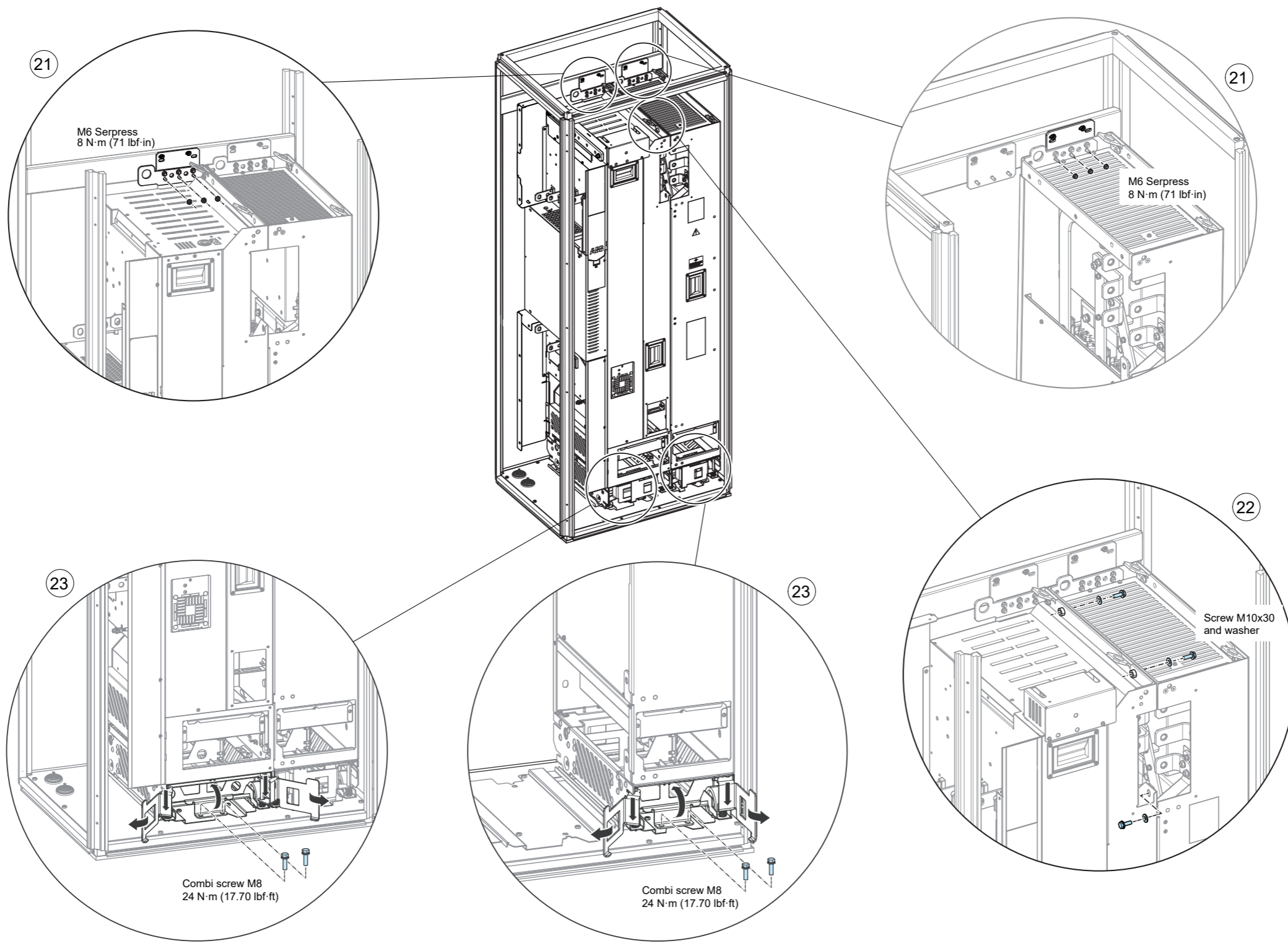


Combi screw  
M8×30 Hex  
20 N·m  
(14.75 lbf-ft)

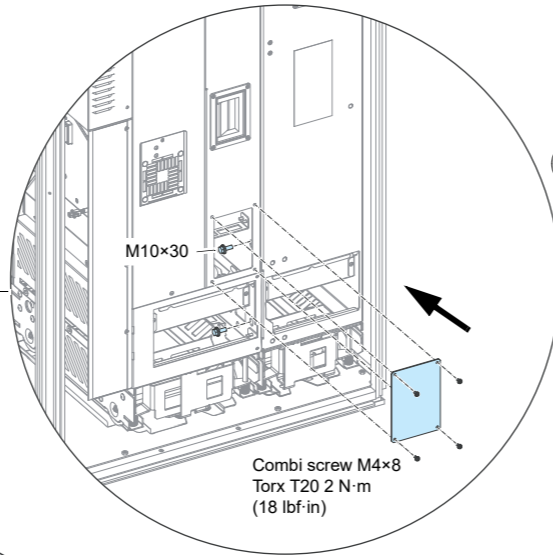
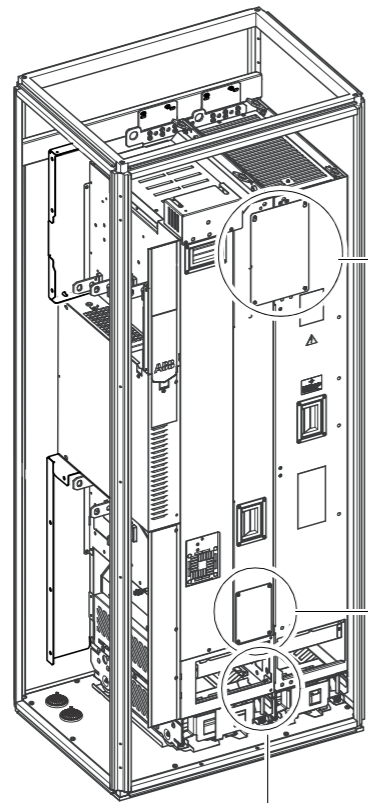




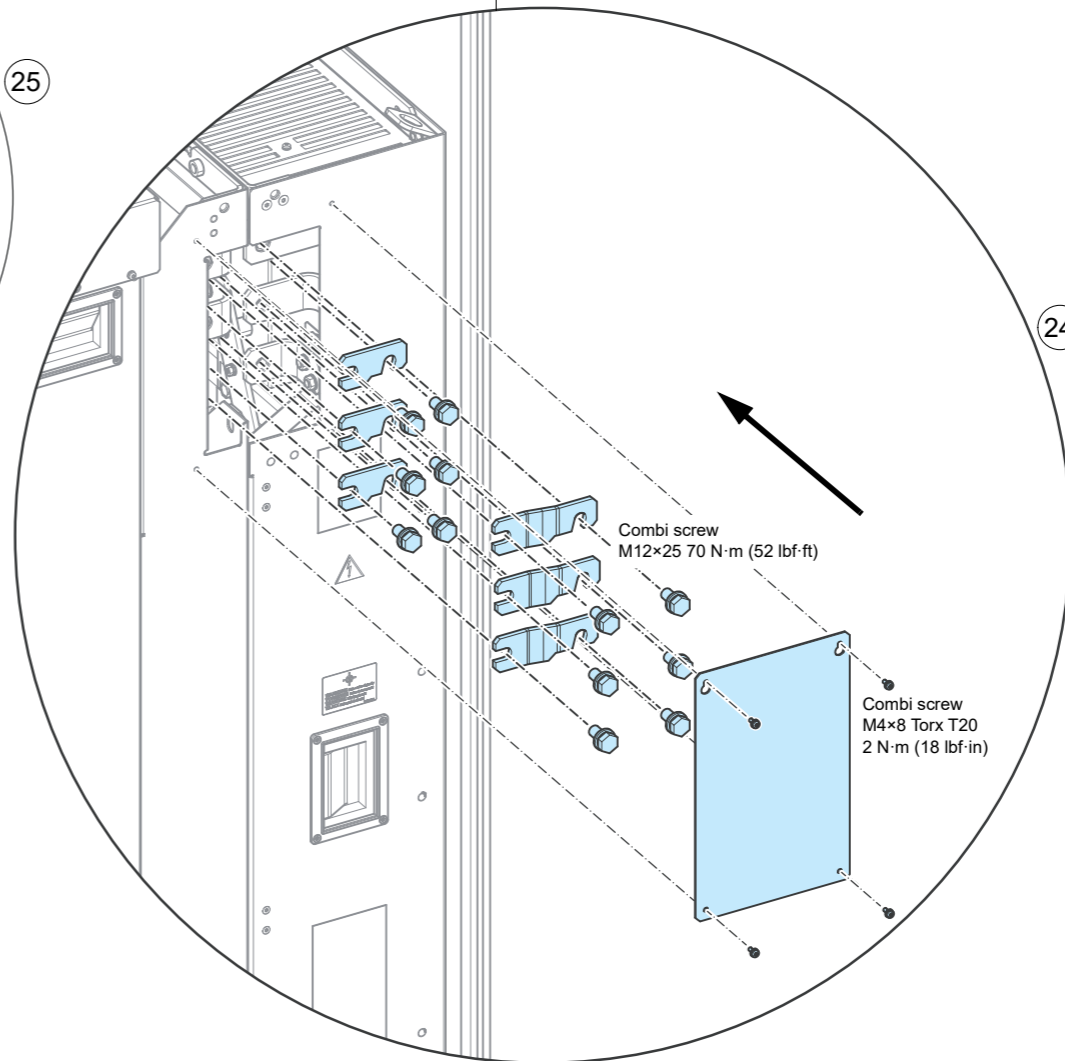




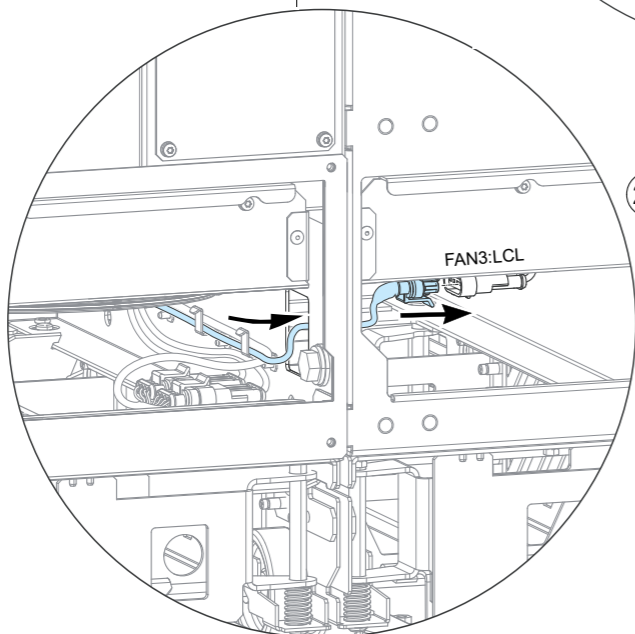




25



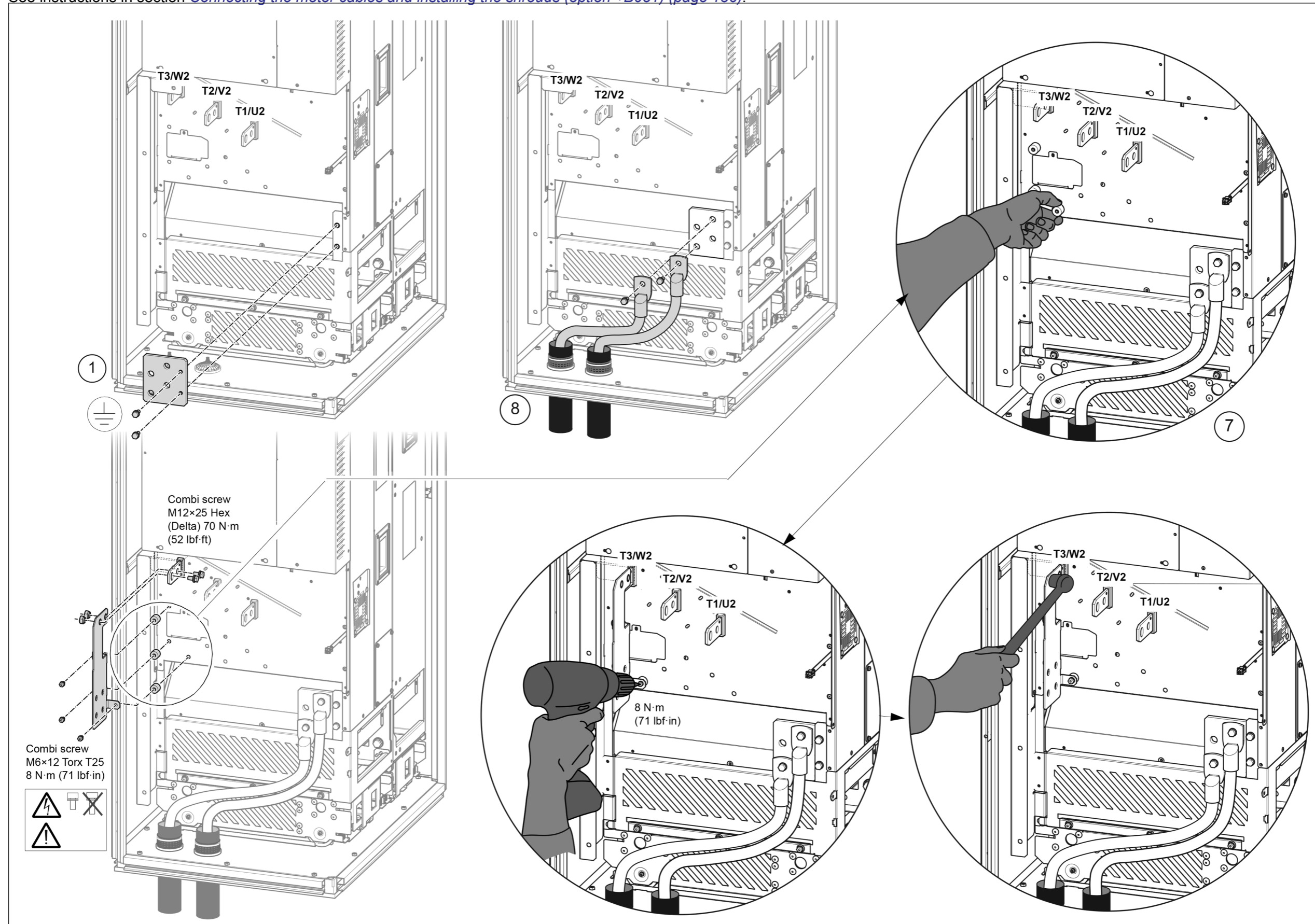
24



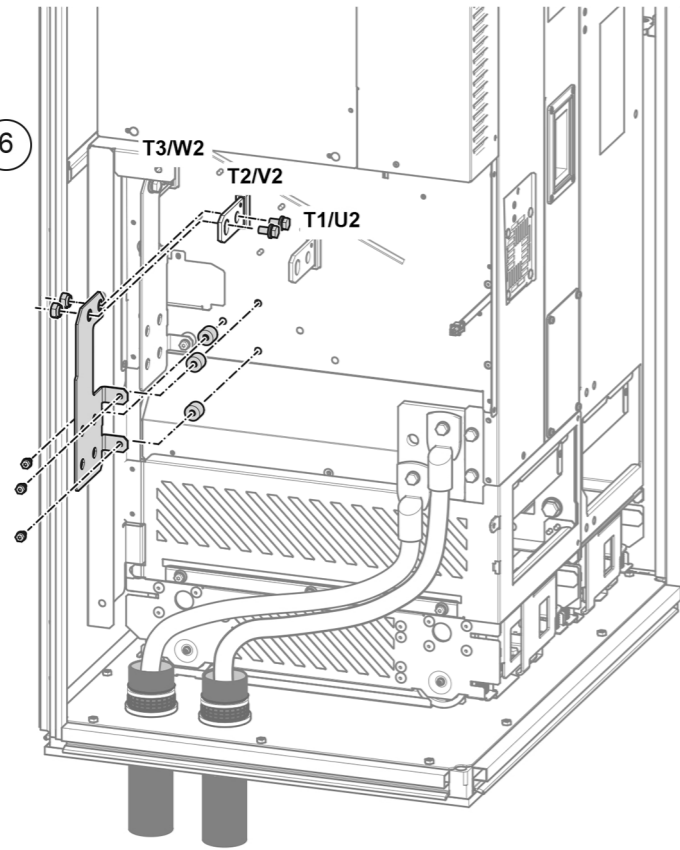
26

## Connecting the motor cables and installing the shrouds

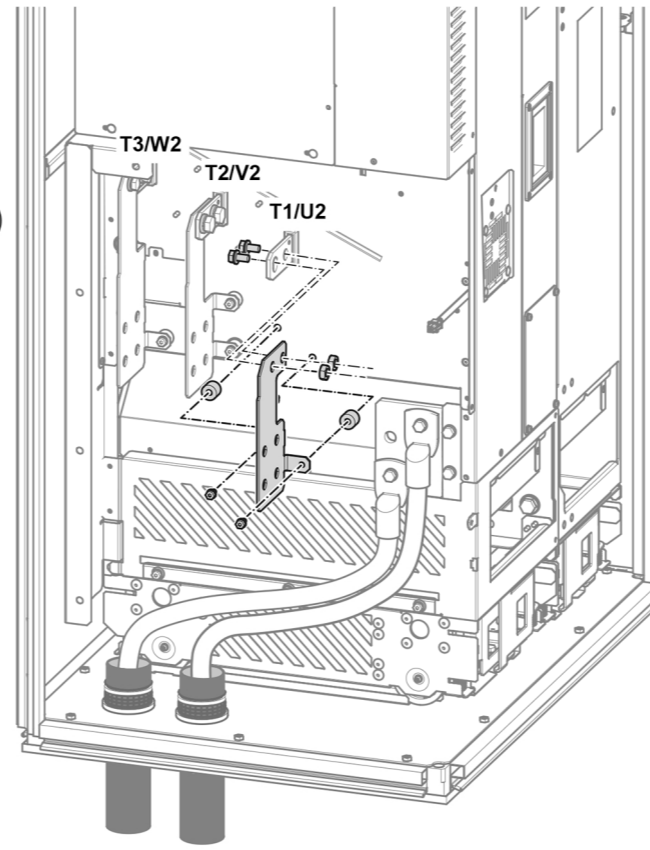
See instructions in section [Connecting the motor cables and installing the shrouds \(option +B051\) \(page 136\)](#).



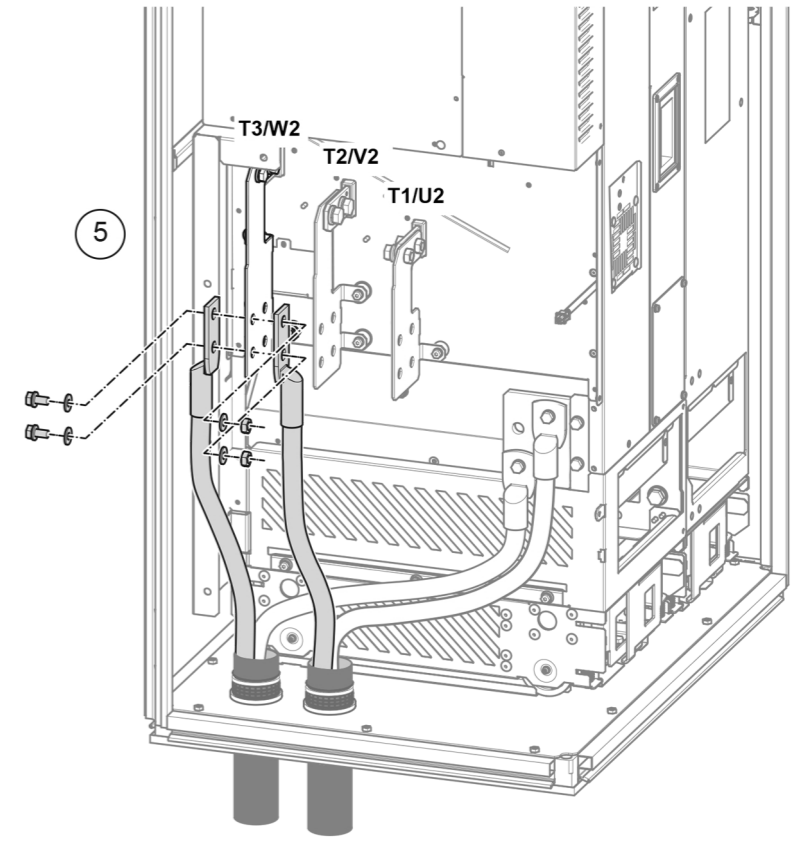
6



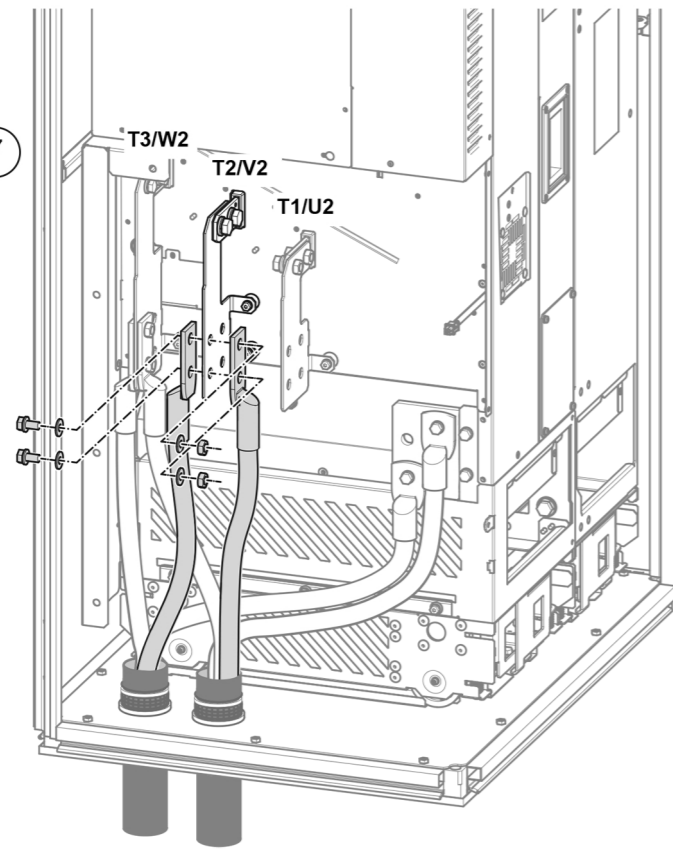
8



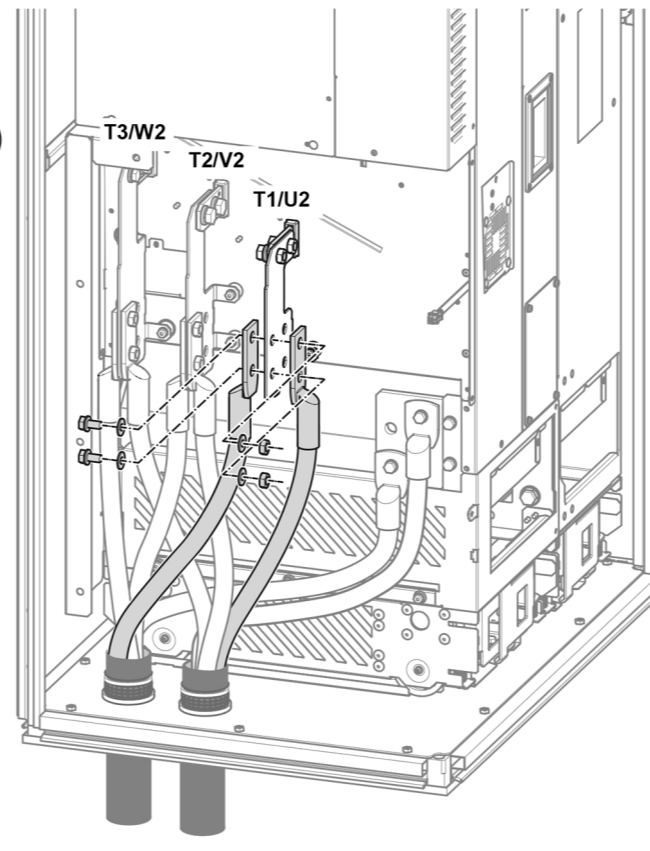
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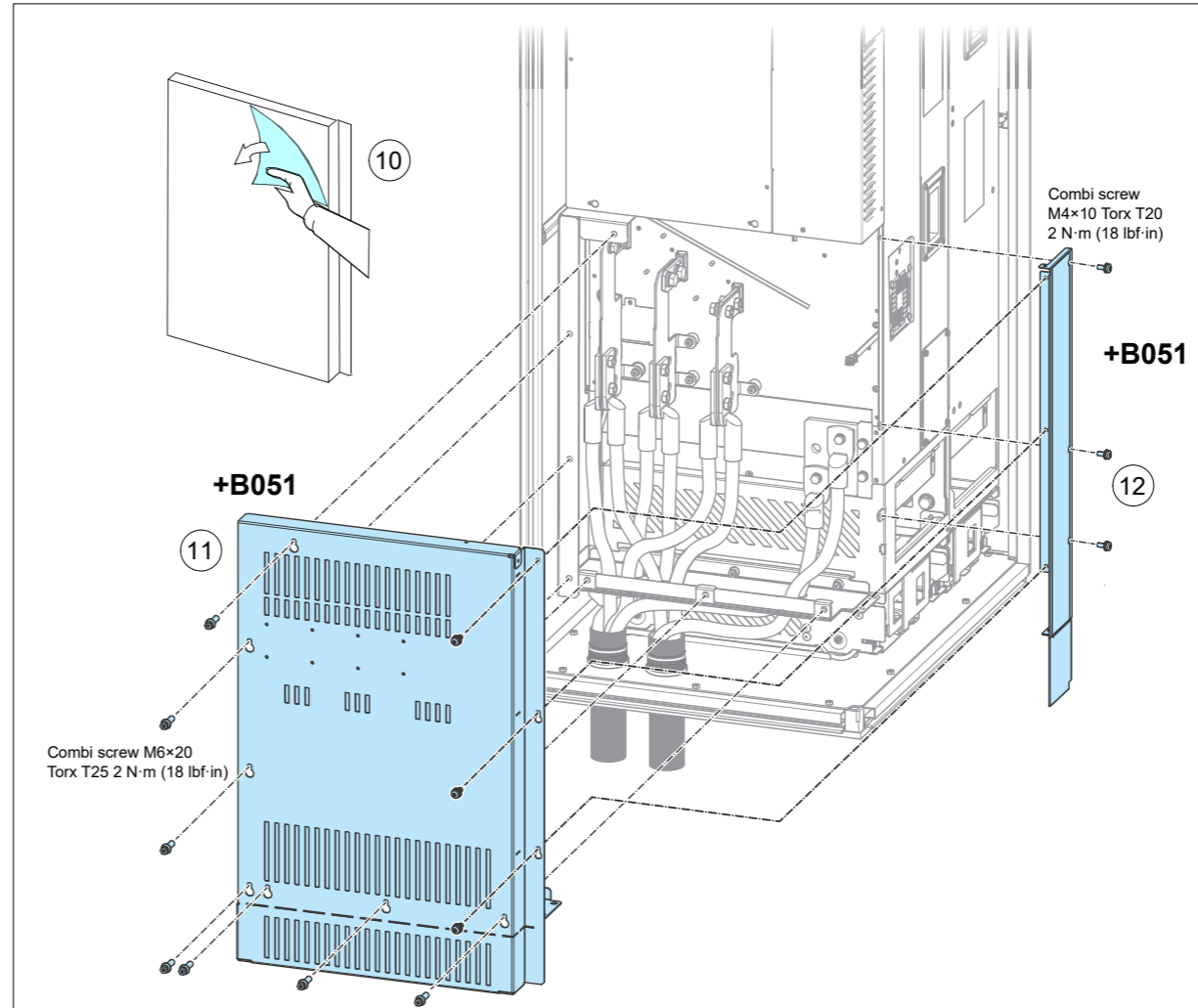
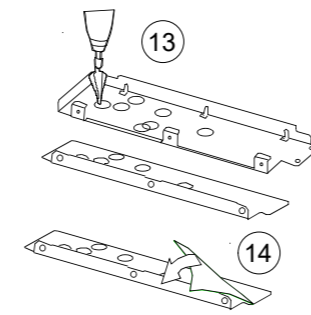
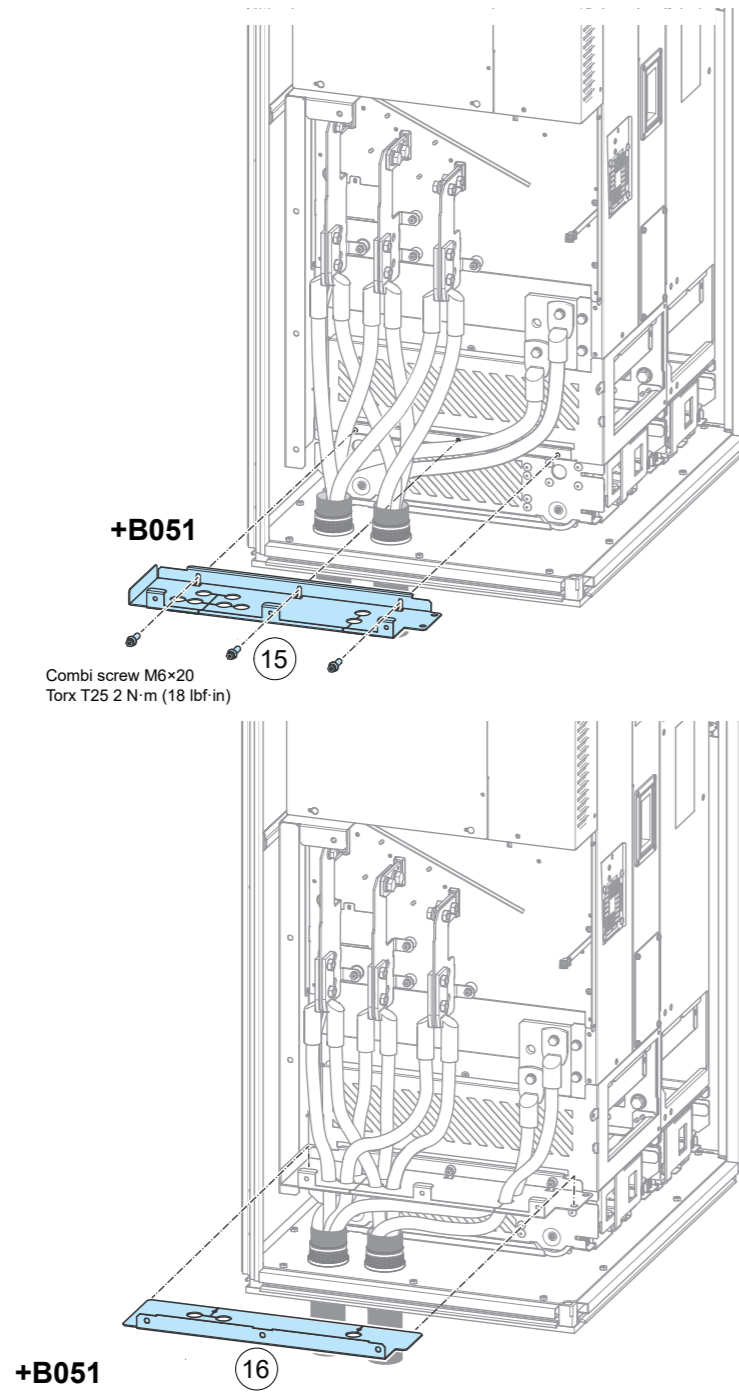


7



9

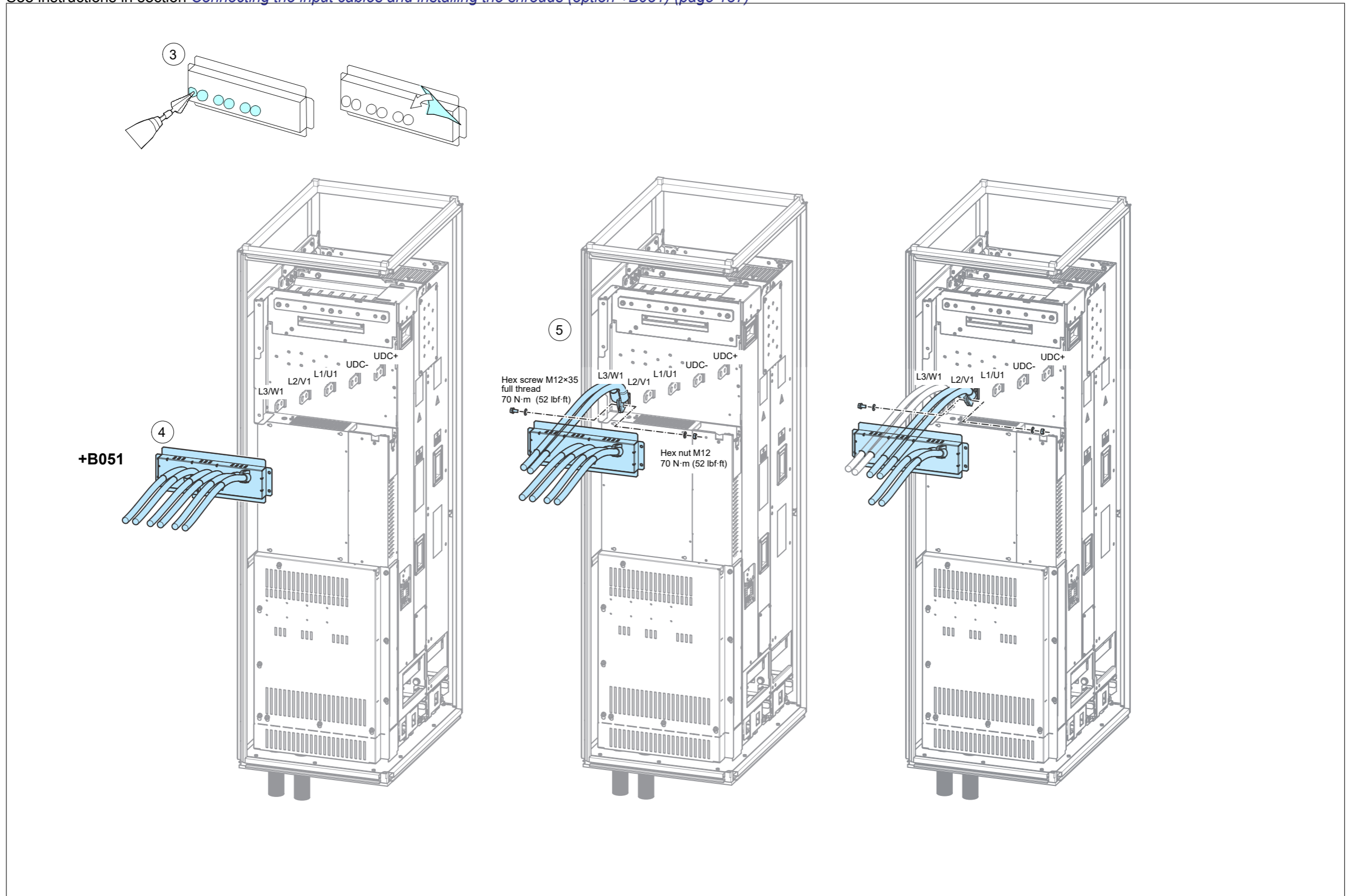


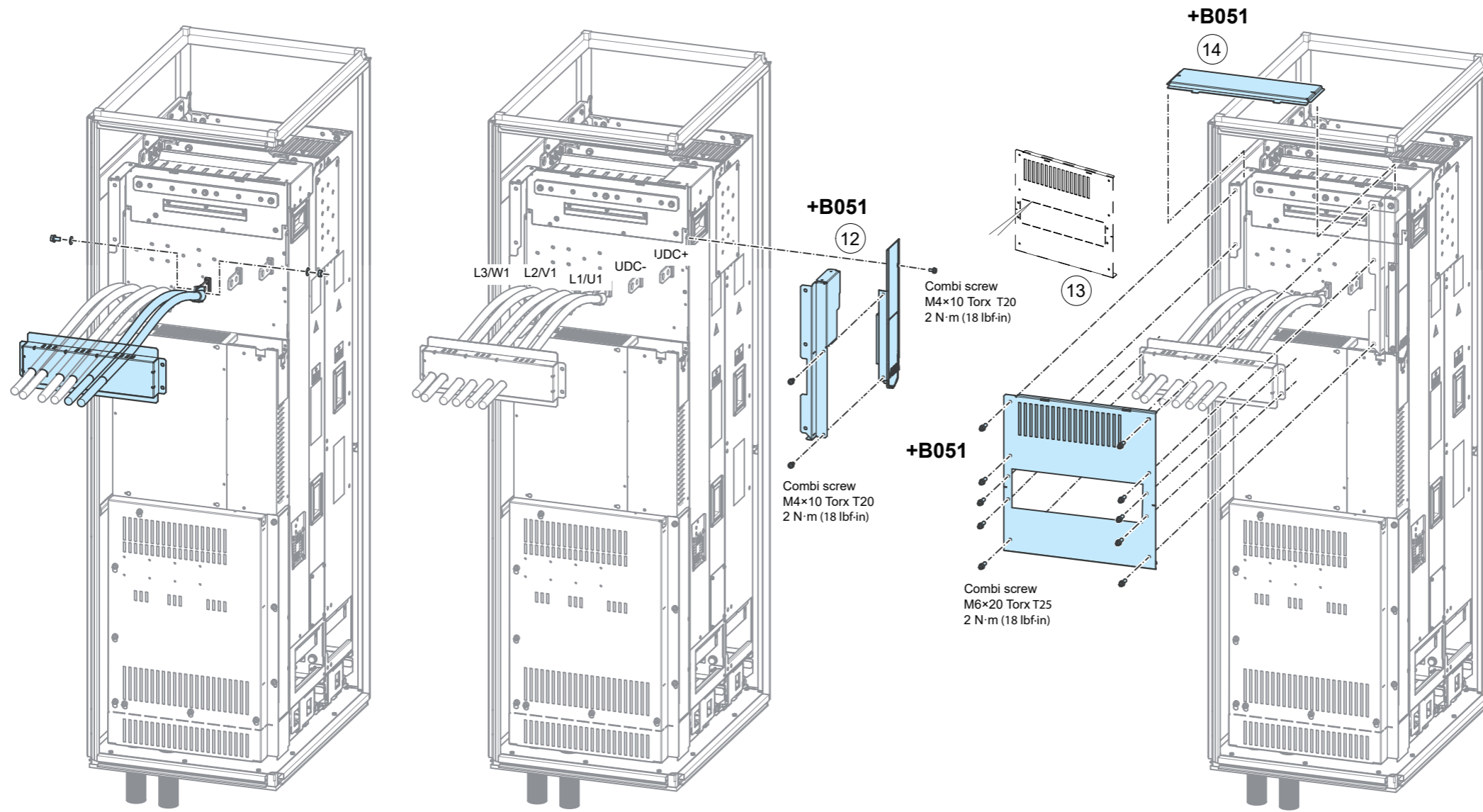




## Connecting the input power cables and installing the shrouds

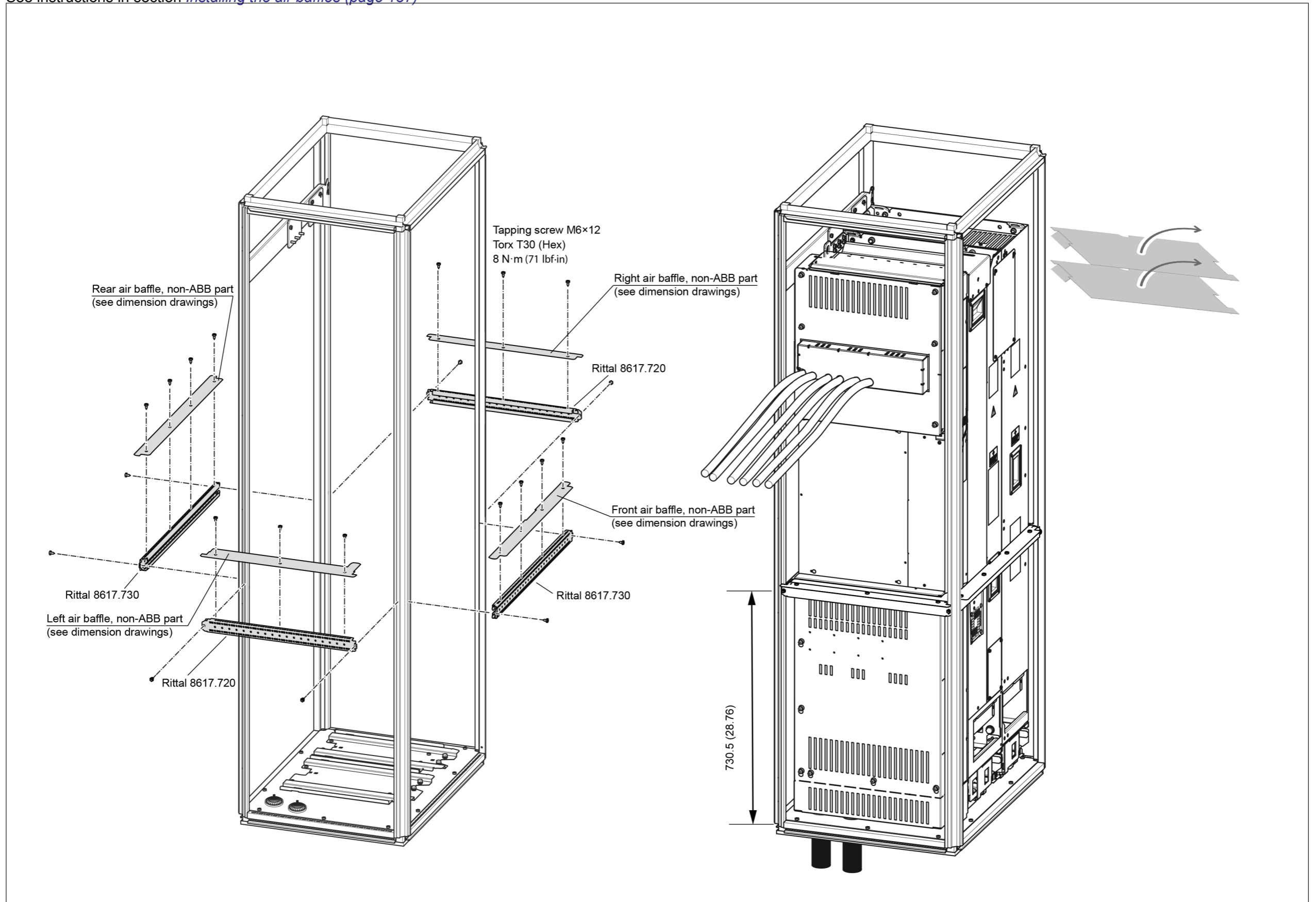
See instructions in section [Connecting the input cables and installing the shrouds \(option +B051\) \(page 137\)](#)





## Installing the air baffles and removing the cardboard covers

See instructions in section [Installing the air baffles \(page 137\)](#)



242 Step-by-step drawings for an installation example of standard drive configuration in Rittal VX25 800 mm wide enclosure



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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).

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