ABB DRIVES FOR WATER

ACQ580-04 drive modules

Hardware manual

ACQ580-04 drive modules

Hardware manual

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Safety instructions

Contents of this chapter

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

Use of warnings and notes

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

The manual uses these warning symbols:

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

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

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

General safety in installation, start-up and maintenance

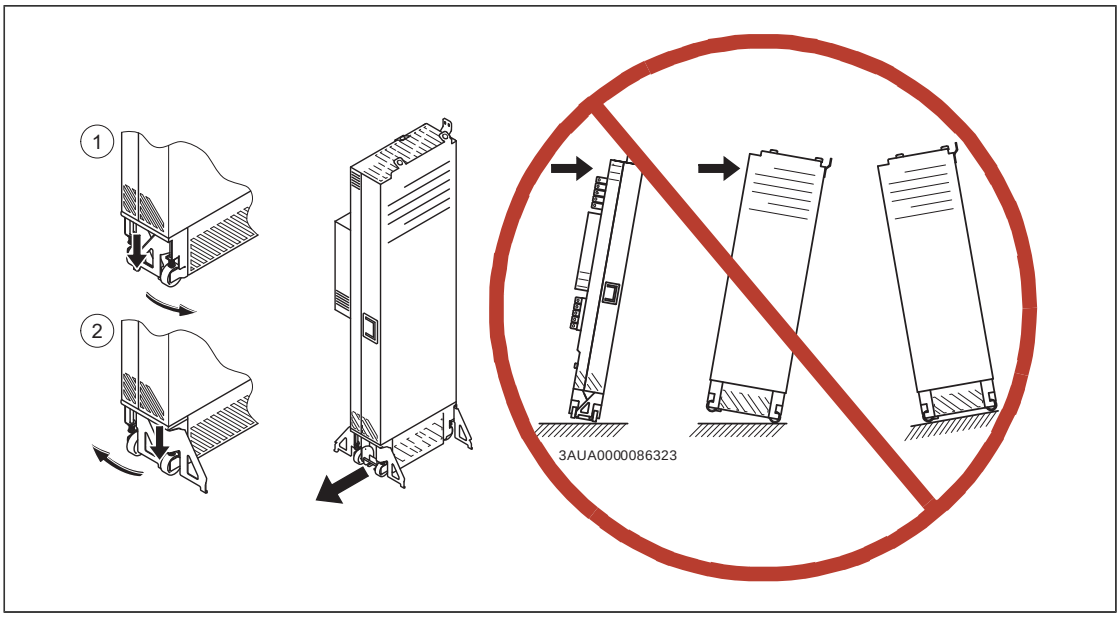
These instructions are for all personnel who do work on the drive.

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

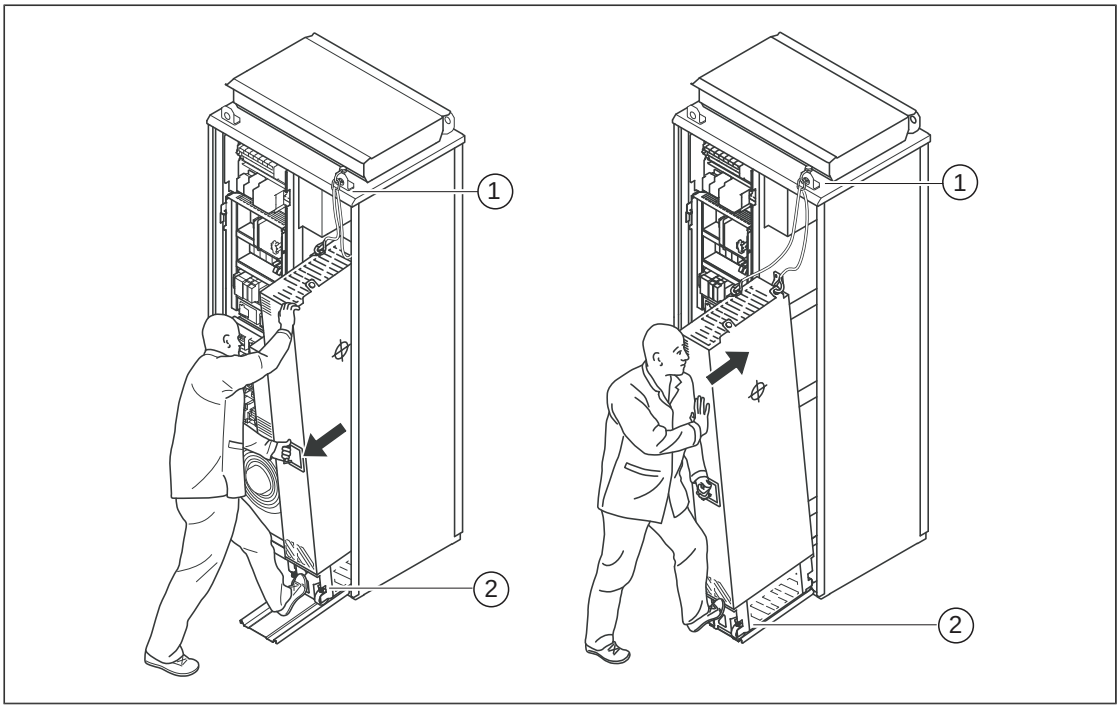
- Keep the drive in its package until you install it. After unpacking, protect the drive from dust, debris and moisture.
- Use the required personal protective equipment: safety shoes with metal toe cap, safety glasses, protective gloves and long sleeves, etc. Some parts have sharp edges.
- Lift a heavy 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. See the technical data.
- Attach the module extraction/installation ramp carefully.

- Make sure that the module does not topple over when you move it on the floor: Open the support legs by pressing each leg a little down (1, 2) and turning it aside. 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 disconnector 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 (R+/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

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

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

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

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).

Printed circuit boards

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.

Grounding

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

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

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

- Always ground the drive, the motor and adjoining equipment. This is necessary for the personnel safety. 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

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

2

Introduction to the manual

Contents of this chapter

This chapter describes the 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 ACQ580-04 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 frame size identifies information which concerns only a certain frame size of the drive. The frame size is shown on the type designation label. All frame sizes are listed in the technical data.

The option code (for example, option +E200) identifies information which concerns only a certain optional selection. The options included in the drive are listed on the type designation label.

Terms and abbreviations

Term	Description
ACH-AP-H	Assistant control panel with Hand-Off-Auto functionality
ACH-AP-W	Assistant control panel with Hand-Off-Auto functionality and Bluetooth interface
CCU-24	Type of control unit
CEIA-01	Embedded EIA-485 fieldbus adapter module
CHDI-01	115/230 V digital input extension module
CMF	Common mode filtering
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)
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
FCAN	Optional CANopen® adapter module
FCNA-01	Optional ControlNet™ adapter module
FDNA-01	Optional DeviceNet™ adapter module
FECA-01	Optional EtherCAT® adapter module
FENA-21	Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP® and PROFINET IO® protocols, 2-port
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
IT system	Type of supply network that has no (low-impedance) connection to ground. See IEC 60364-5.
NETA-21	Remote monitoring tool
PLC	Programmable logic controller
SOIA	Optical interface adapter board
STO	Safe torque off (IEC/EN 61800-5-2)
TN system	Type of supply network that provides a direct connection to ground

Quick installation, commissioning and operating flowchart

Task	See
Plan the mechanical and electrical installation and acquire the accessories needed (cables, fuses, etc.). Examine the ambient conditions, ratings, required cooling air flow, input power connection, compatibility of the motor, motor connection, and other technical data.	*Guidelines for planning the mechanical installation (page 45)* *Guidelines for planning the electrical installation (page 65)* *Technical data (page 135)* Option manual (if optional equipment is included)
⬇	
Unpack and examine the units. Make sure that all necessary optional modules and equipment are present and correct. Only intact units can be started up.	*Moving and unpacking the unit (page 56)* *Examining the delivery (page 60)* If the drive module has been non-operational for more than one year, the converter DC link capacitors need to be reformed. *Reforming the capacitors (page 133)*)
⬇	
Examine the installation site. Attach the base of the cabinet to the floor.	*Examining the installation site (page 55)*
⬇	
Route the cables.	*Routing the cables (page 76)*
⬇	
Measure the insulation of the input cable, the motor and the motor cable and brake assembly (if present).	*Measuring the insulation of the input power cable (page 90)* *Measuring the insulation of the motor and motor cable (page 90)*
⬇	
• Install the additional components into the cabinet: eg, main disconnector, main contactor, main AC fuses, etc. • Install the drive module into the cabinet. • Connect the motor cables to the drive module terminals. • Connect the DC connection cables (if any) to the drive module terminals. • If the main disconnector is installed into the cabinet, connect it to the drive module terminals and the input power cabling to the disconnector.	*Mechanical installation (page 55)* *Electrical installation (page 89)* *Installation example of drive module with IP20 shrouds (option +B051) (page 101)* Manuals for any optional equipment
⬇	
Option +P906): Connect the external control cables to the drive control unit.	*Electrical installation (page 89)*
⬇	
Check the installation.	*Installation checklist (page 119)*
⬇	
Commission the drive.	*Start-up (page 121)*
⬇	
Operate the drive: start, stop, speed control etc.	Appropriate firmware manual

Related documents

Name	Code (English)	Code (Translation)
Drive hardware manuals and guides		
Drive/converter/inverter safety instructions	3AXD50000037978	
Recycling instructions and environmental information for ACS880-04, ACS880-04F, ACS880-14, ACS880-34, ACS580-04, ACQ580-04 and ACH580-04 drives	3AXD50000137688	
Drive firmware manuals and guides		
ACQ580 pump control program quick start-up guide	Multilingual code: 3AXD50000048773	
Drive option manuals and guides		
CDPI-01/-02 panel bus adapters user's manual	3AXD50000009929	
CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (+L537+Q971) user's manual	3AXD50000030058	
DPMP-02/03 mounting platform for control panels installation guide	3AUA0000136205	
DPMP-04/05 mounting platform for control panels installation guide	3AXD50000308484	
External control unit (+P906) for ACH580-04, ACQ580-04 and ACS580-04 drives supplement	3AXD50000167555	
FDNA-01 DeviceNet™ adapter module user's manual	3AFE68573360	
FPNO-21 PROFINET adapter module user's manual	3AXD50000158614	
FSCA-01 RS-485 adapter module user's manual	3AUA0000109533	
Tool and maintenance manuals and guides		
Drive composer PC tool user's manual	3AUA0000094606	
Capacitor reforming instructions	3BFE64059629	
NETA-21 remote monitoring tool user's manual	3AUA0000096939	
NETA-21 remote monitoring tool installation and startup guide	3AUA0000096881	

You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents.

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

ACQ580-04 manuals

3

Operation principle and hardware description

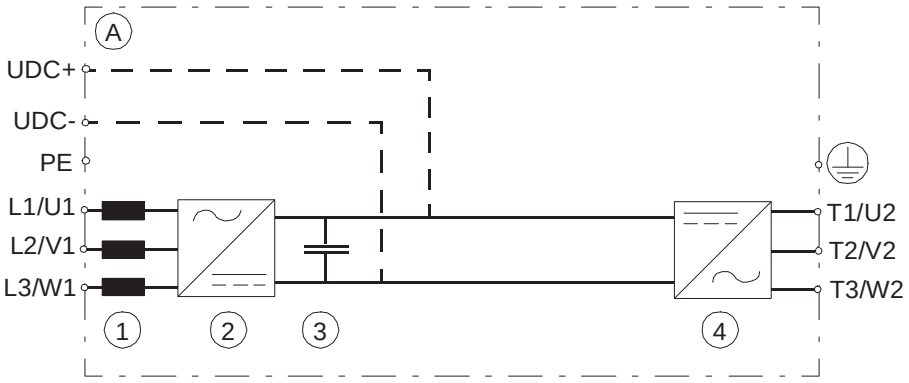
Contents of this chapter

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

Product overview

The ACQ580-04 is a drive module for controlling AC induction motors, synchronous reluctance motors and synchronous permanent magnet motors in open loop control.

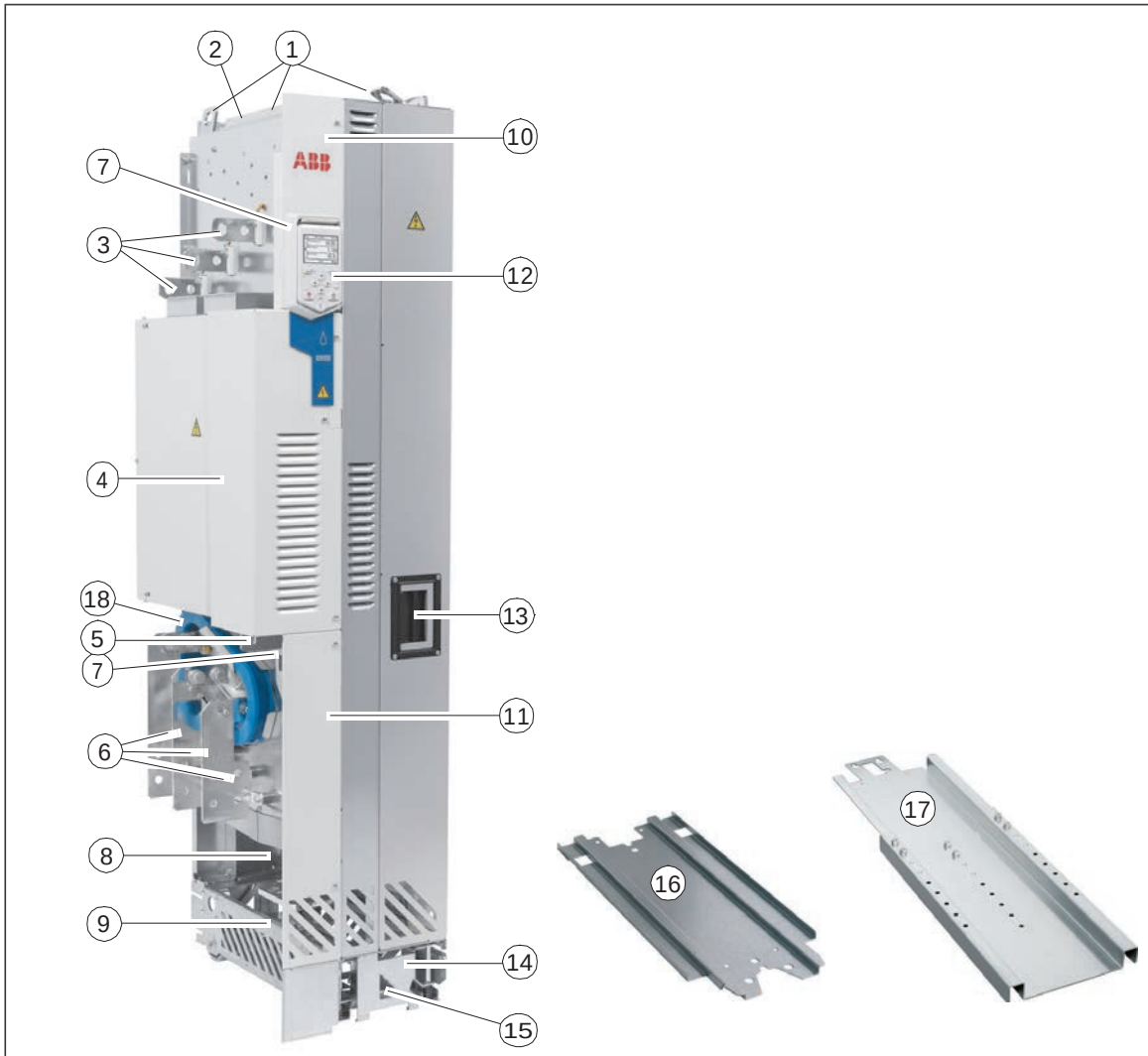
The main circuit of the drive module is shown below.



A	Drive module
1	AC choke
2	Rectifier. Converts alternating current and voltage to direct current and voltage.
3	DC link. DC circuit between rectifier and inverter.
4	Inverter. Converts direct current and voltage to alternating current and voltage.

Layout

Standard drive module configuration

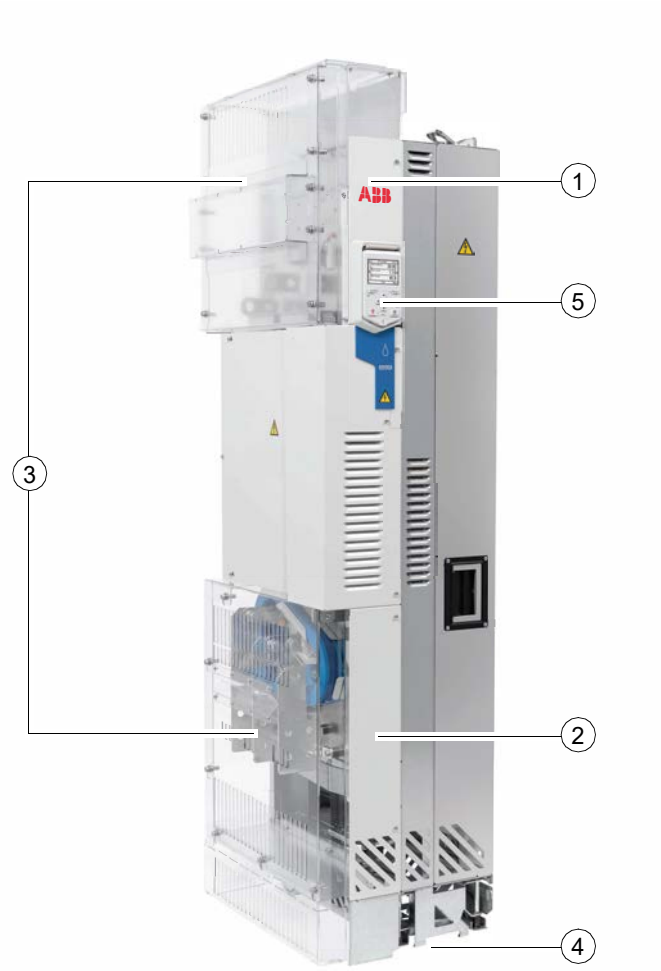


1	Lifting lugs
2	Fastening bracket
3	Input cable connection busbars (L1/U1, L2/V1, L3/W1) and and DC+ and DC- busbars (UDC+, UCD with option +H356)
4	Circuit board compartment
5	PE busbar
6	Output cable connection terminals (T1/U2, T2/V2, T3/W2) attached
7	Control cable duct
8	Main cooling fans
9	Pedestal
10	Upper front cover
11	Lower front cover
12	Control panel. Can also be mounted on the cabinet door as well with the door mounting platform kit.
13	Handle for pulling the drive module out of the cabinet
14	Retractable support legs

15	Base fastening screws behind the retractable support legs
16	Pedestal guide plate
17	Telescopic extraction/installation ramp
18	Common mode filter (+E208)

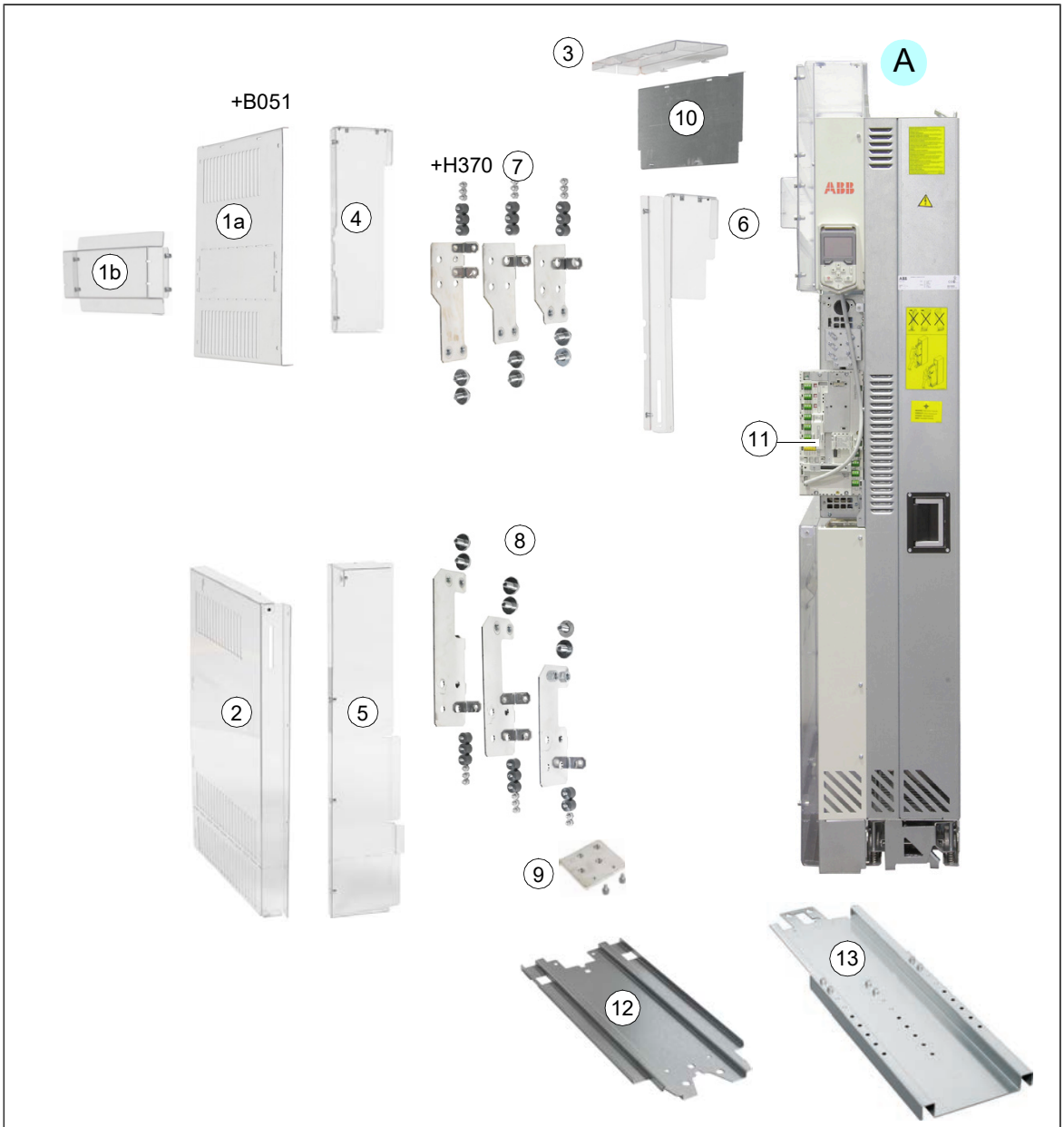
Drive module configuration with option +B051

The drive module configuration with clear plastic shrouds (option +B051) mounted is shown below.



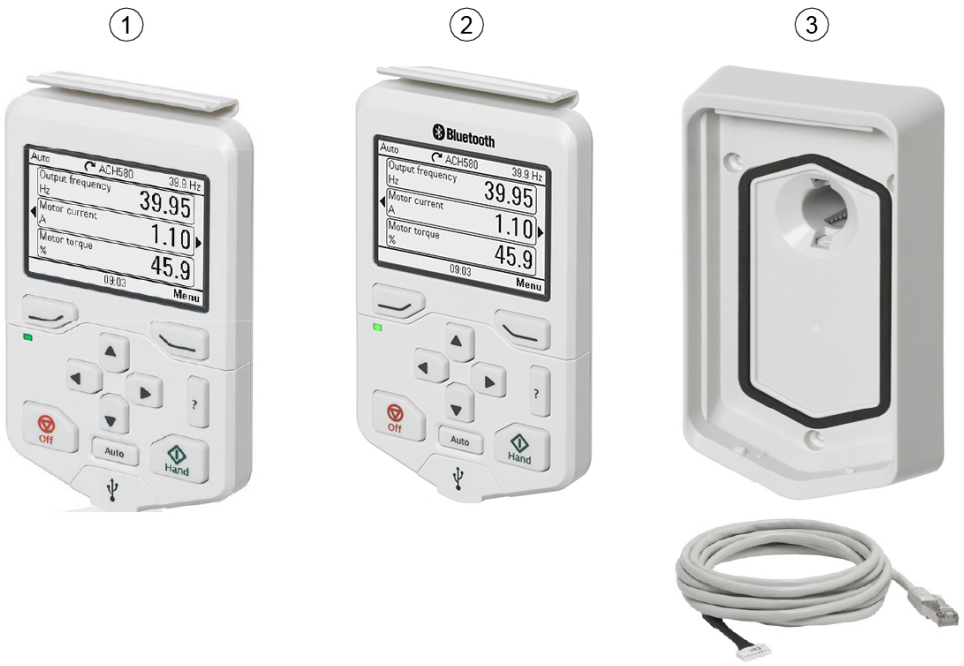
1	Upper front cover	4	Pedestal
2	Lower front cover	5	Control panel
3	Clear plastic shrouds attached (option +B051)	-	-

See the next page for the part descriptions.



1	Clear plastic shroud to be attached onto the drive module input power cabling (a). Lead-through shroud for side cabling (b). Option +B051.	8	Output power cable connection terminals
2	Clear plastic shrouds to be attached onto the drive module output power cabling with option +B051	9	Grounding terminal for output power cable shields
3	Clear plastic shroud to be attached on top of the drive module (lead-through for top cabling) with option +B051	10	Metallic shroud. With option +H370, the shroud includes a ground bar.
4	Upper back clear plastic shroud with option +B051	11	Control unit
5	Lower back clear plastic shroud with option +B051	12	Pedestal guide plate
6	Front clear plastic shroud with option +B051	13	Telescopic extraction/installation ramp
7	Input power cable connection terminals (option +H370)	A	Drive module with clear plastic shrouds mounted (front view)

Control panel



1	ACH-AP-H hand-off-auto control panel (standard)
2	ACH-AP-W hand-off-auto control panel with bluetooth interface (option +J429)
3	DPMP-03 control panel mounting platform

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

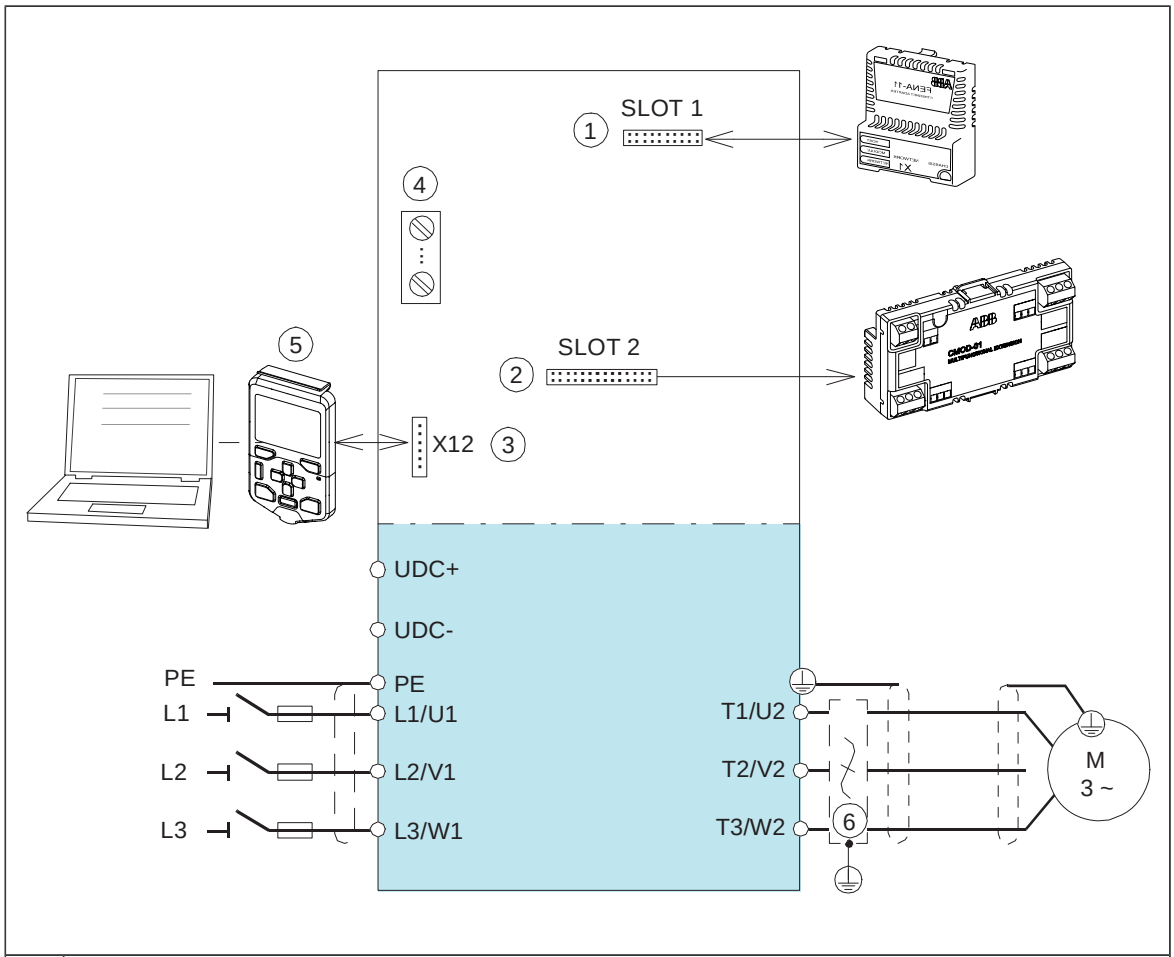
DPMP-03 control panel mounting platform is included in the standard delivery. It allows you to mount the control panel on the cabinet door.

Note: The standard delivery in the US market is with the external control unit (option +P906) and the DPMP-07-Q control panel mounting platform.

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

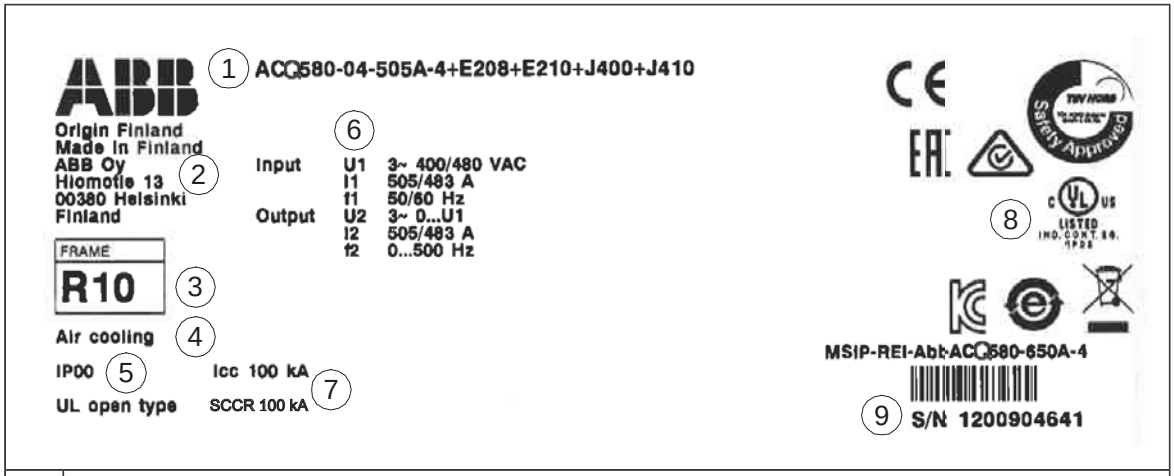
The diagram shows the power connections and control interfaces of the drive module.



1	Option slot 1 for optional fieldbus adapter modules
2	Option slot 2 for optional I/O extension modules
3	Panel port
4	I/O terminal blocks. See chapter *Control unit (page 107)*.
5	Control panel (see section *Connecting a PC (page 97)*)
6	du/dt or sine filter (optional, see chapter *Filters (page 217)*)

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.



1	Type designation, see section *Type designation key (page 35)*.
2	The manufacturer’s address
3	Frame size
4	Cooling method
5	Degree of protection, enclosure type
6	Ratings, see section *Electrical ratings (page 136)*.
7	Short-circuit withstand strength, see section *Electrical power network specification (page 146)*.
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.

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
Type	
-04	When no options are selected: drive module to be installed in a cabinet, IP00 (UL open type), bookshelf mounting with pedestal, integrated control unit (inside the drive module), assistant control panel ACH-AP-H and panel holder, build-in choke, extraction/installation ramp, full-size output cable connection terminals, common mode filter (+E208), DPMP-03 mounting platform, EMC filter for 2nd environment TN (grounded) and IT (ungrounded) systems (+E210), no DC connection busbars, ACQ580 standard pump control program, RS-485 Modbus RTU adapter module (CEIA-01), Safe torque off function, coated boards, printed multilingual quick installation and start-up guides. **Note:** In the US market, the standard offering differs, in that: the door mounting kit is the DPMP-07-Q, the control unit is external (+P906), the DC connection busbars (+H356) are included, and the quick guide contains English language only.
Size	
-xxxxA	See the ratings table.
Voltage range	
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) or IT (ungrounded) system, category C3 (included as standard)
0H354	No pedestal (requires also +0P919, no extraction/installation ramp)
0H371	No full size cable connection terminals for output power cables
H356	DC connection busbars (for US standard as default)
H370	Full-size input terminals
0J400	No control panel
J410	DPMP-03 door mounting kit (included as standard, except in US and China)
J429	ACH-AP-W control panel with Bluetooth interface
K451	FDNA-01 DeviceNet™ adapter module
K454	FPBA-01 PROFIBUS DP adapter module
K457	FCAN-01 CANopen adapter module

Code	Description
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
0P919	No extraction/installation ramp
P906	External control unit (outside the drive module)
P931	Extended warranty 36 months from delivery
P932	Extended warranty 60 months from delivery
Q971	ATEX-certified safe disconnection function
R700	English
R701	German
R702	Italian
R705	Swedish
R707	French
R708	Spanish
R709	Portuguese
R711	Russian
R712	Chinese
R714	Turkish
	3AXD10000580624

Ordering codes

You can order

- IP20 shrouds for frame R10 with code 3AXD50000024563 and for R11 with 3AXD50000024564
- DPMP-05 control panel mounting platform with code 3AXD50000240319
- DPMP-07-Q control panel mounting platform with code 3AXD50000371051 (US market only).

4

Generic cabinet planning instructions

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:

- the cabinet frame is sturdy enough to carry the weight of the components, control circuitry and other equipment installed in it
- the cabinet protects the modules against contact and agrees with the requirements for dust and humidity
- the 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
- the 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	Note
M3	0.5 N·m (4.4 lbf·in)	Strength class 4.6...8.8
M4	1 N·m (9 lbf·in)	Strength class 4.6...8.8
M5	4 N·m (35 lbf·in)	Strength class 8.8
M6	9 N·m (6.6 lbf·ft)	Strength class 8.8
M8	22 N·m (16 lbf·ft)	Strength class 8.8
M10	42 N·m (31 lbf·ft)	Strength class 8.8
M12	70 N·m (52 lbf·ft)	Strength class 8.8
M16	120 N·m (90 lbf·ft)	Strength class 8.8

Mechanical connections

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

Insulation supports

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

Cable lugs

Size	Max. torque	Note
M8	15 N·m (11 lbf·ft)	Strength class 8.8
M10	32 N·m (23.5 lbf·ft)	Strength class 8.8
M12	50 N·m (37 lbf·ft)	Strength class 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 technical data)
- leave enough free space around the components to ensure sufficient cooling. Observe the minimum clearances given for each component, see the technical data.

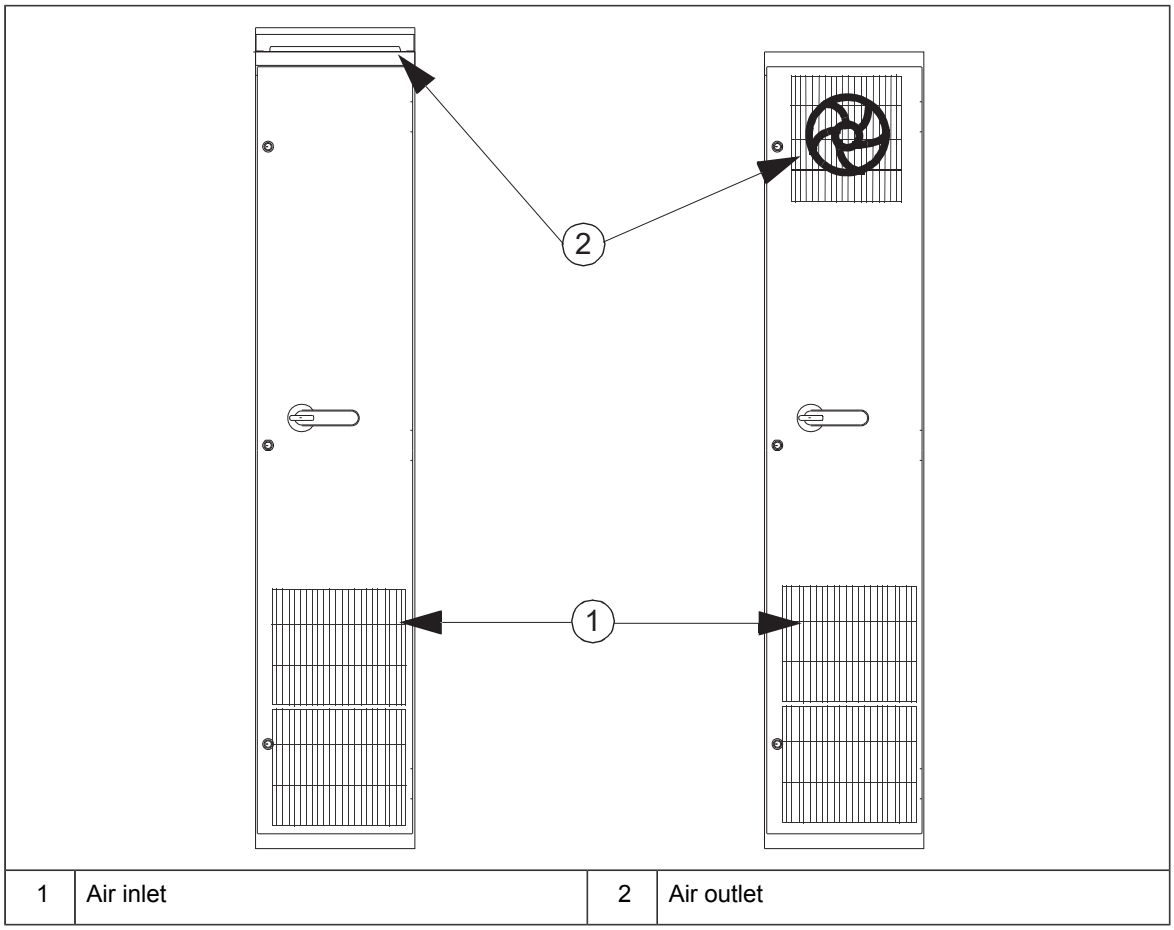
Air inlets and outlets

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.

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



1	Air inlet	2	Air outlet

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

- cooling air flow

  Note: The values stated for each component apply to continuous nominal load. If the load is cyclic or less than nominal, less cooling air may be required.
- allowed surrounding air 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 (UL Type 1) and IP42 (UL Type 1 filtered) 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 (UL Type 12) 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.

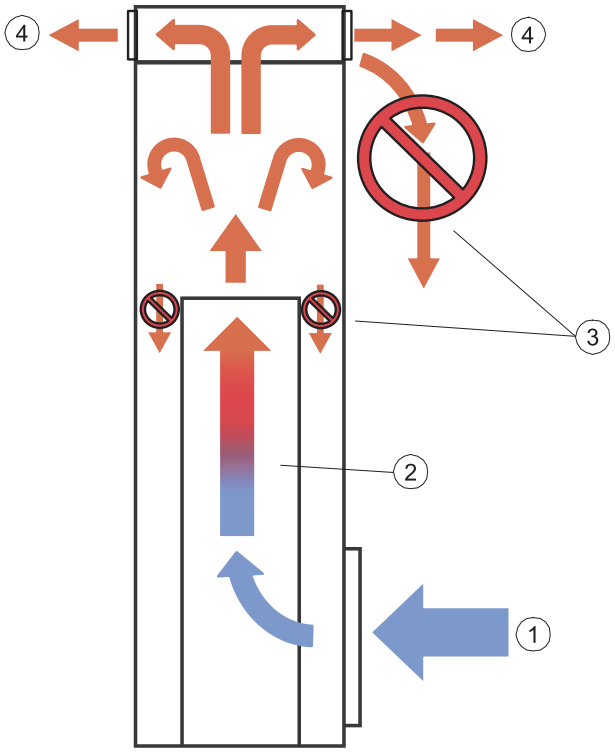
Preventing the recirculation of hot air

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.



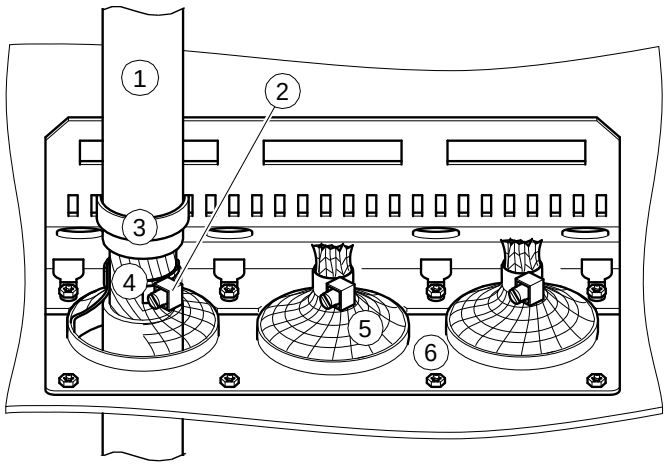
1	Air flow in
2	Power module
3	Hot air circulation to be prevented
4	Air flow out

EMC requirements

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

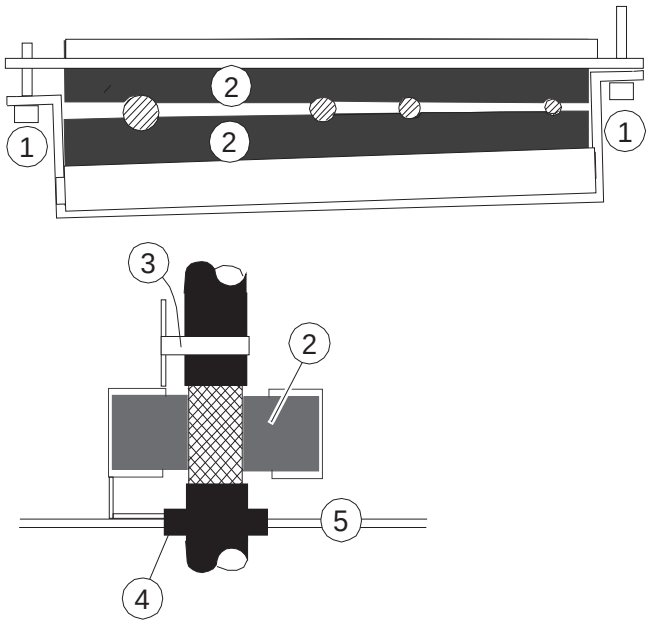
- Generally, the fewer and smaller the holes in the cabinet, the better the interference attenuation. The maximum recommended diameter of a hole in galvanic metal contact in the covering cabinet structure is 100 mm (3.94 in). Pay special attention to the cooling air inlet and outlet gratings.
- The best 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.



1 Cable
2 Cable tie
3 Strain relief
4 Bare cable shield
5 Knitted wire mesh
6 Cabinet entry plate

- 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.



1 Tightening screw
2 EMI conductive cushion
3 Strain relief
4 Grommet
5 Entry plate

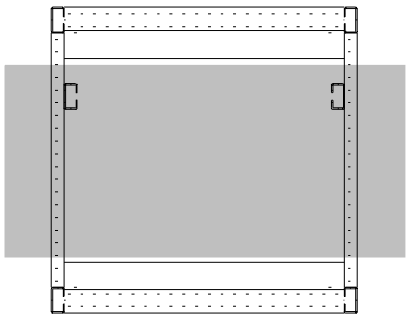
Attaching the cabinet

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.

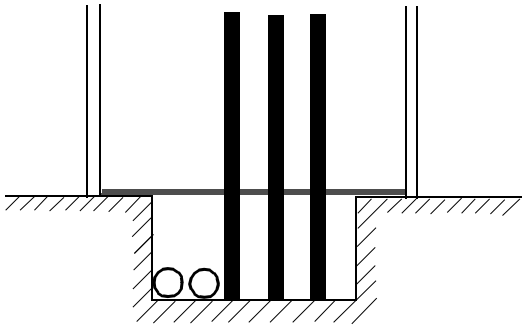
Cabinet placement on a cable channel

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.



The supporting structure on a cable channel



Cabinet side view with a bottom plate

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.

Mounting the control panel on the cabinet door

You can use a mounting platform to mount 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)
DPMP-01 mounting platform for control panels installation guide	3AUA0000100140
DPMP-02/03 mounting platform for control panels installation guide	3AUA0000136205
DPMP-04 and DPMP-05 mounting platform for control panels installation guide	3AXD50000308484
DPMP-06/07 mounting platform for control panels installation guide	3AXD50000289561

		
DPMP-01	DPMP-03	DPMP-05
IP54 (UL Type 12) when control panel is mounted IP20 (UL Type Open) when control panel is not mounted	IP65 (UL Type 12) when control panel is mounted IP20 (UL Type Open) when control panel is not mounted	IP66 (inside and outside the cabinet door)


DPMP-07-Q (US only)
IP54 (UL Type 12) when control panel is mounted IP20 (UL Type Open) when control panel is not mounted

5

Guidelines for planning the mechanical installation

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.

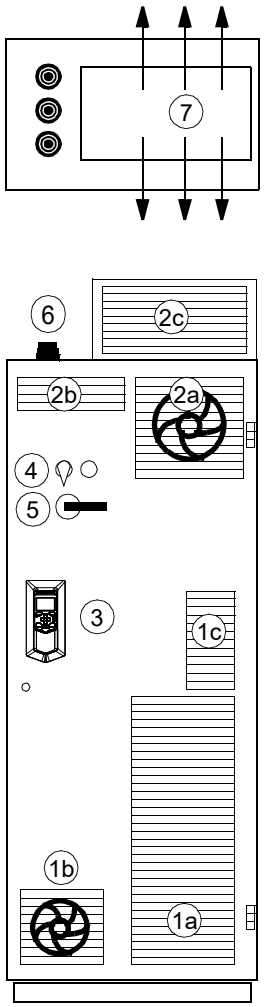
Installation positions of the drive module

You can install the drive module in the bookshelf or flat position or on its back in a cabinet.

Planning the layout

Layout example, door closed

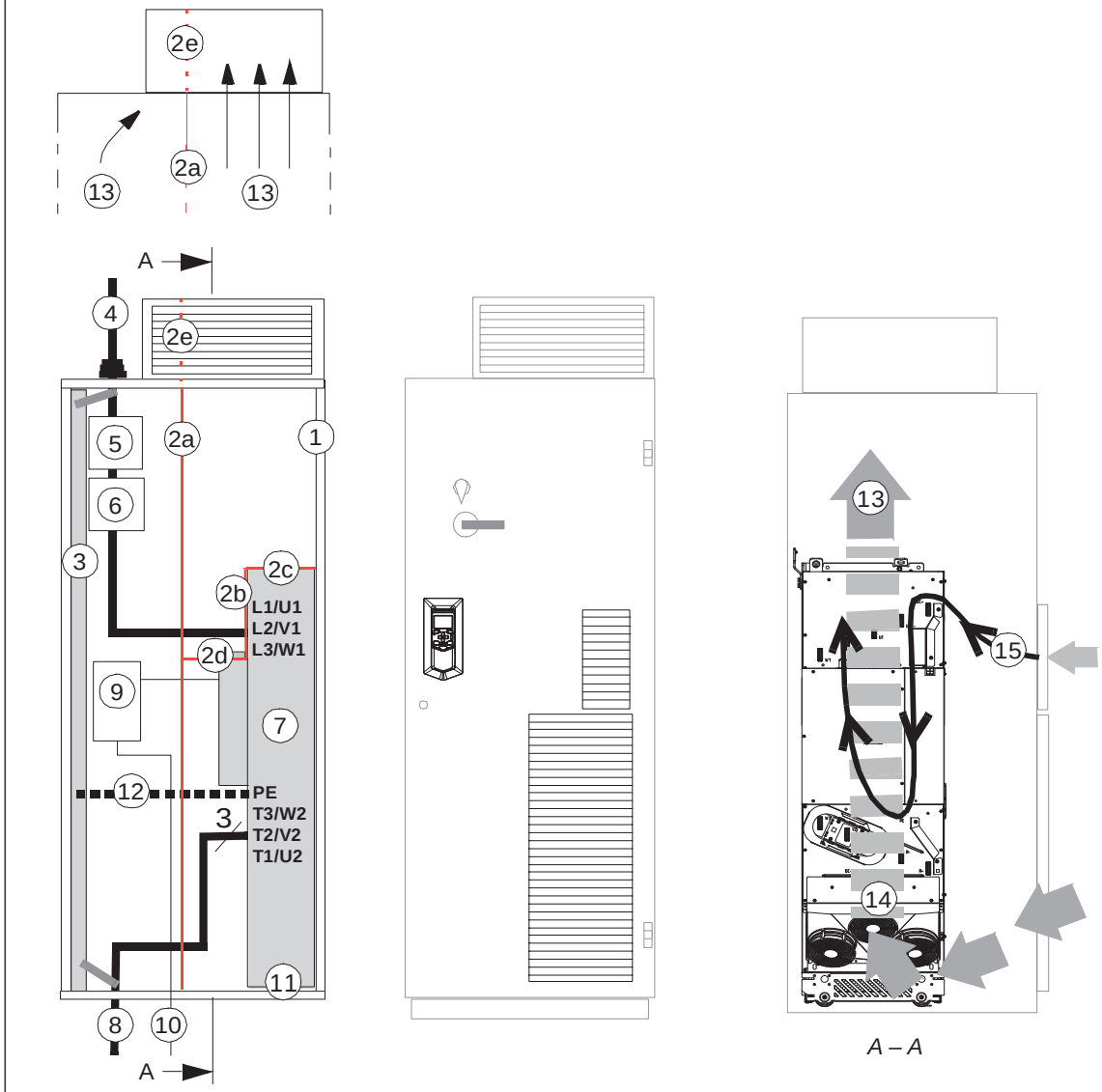
This diagram shows a cabinet layout example with the input power cable entry from top and the motor cable entry from bottom.



1a	Air inlet for the drive module
1b	Air inlet for the other equipment. An extra fan is not necessary if an extra air baffle is used on the cabinet roof, see *Layout example, door open (standard drive module configuration) (page 47)*.
1c	Air inlet for circuit boards and DC and output busbars
2a	Air outlet with an extra exhaust fan for the drive module
2b	Air outlet for the other equipment
2c	Air outlet for the drive module and other equipment on the cabinet roof. An exhaust fan if needed. ABB recommends this alternative instead of 2a.
3	Drive control panel with DPMP-03 mounting platform. The control panel is connected to the drive module control unit inside the cabinet.
4	Contactor control switch and emergency stop switch (connected to the contactor control circuit inside the cabinet)
5	Operating handle of the disconnector
6	Rubber grommets for degree of protection
7	Roof air flow viewed from top

Note: The sizes of the air inlet and outlet gratings are critical for the cooling of the drive module. For losses and cooling data requirements, see section *Losses, cooling data and noise (page 144)*.

Layout example, door open (standard drive module configuration)

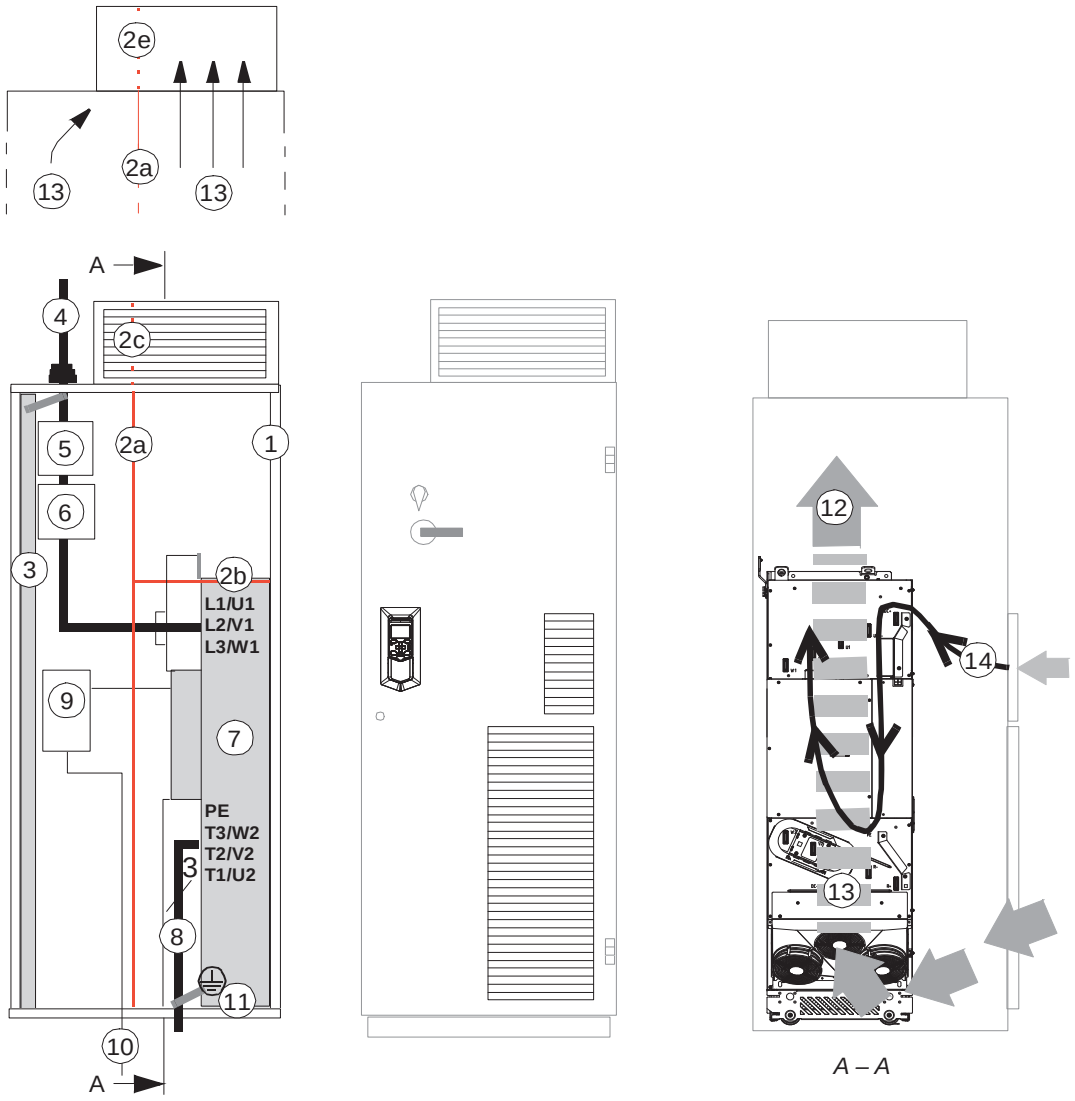


1	Supporting frame of the cabinet	8	Motor cable including the protective ground conductor of the drive module
2	Vertical (2a, 2b) and horizontal (2c, 2d) air baffles with leak-proof cable entries. The air baffles separate the cool and hot areas and prevent recirculation of hot air.	9	External drive module control unit (+P906). **Note**: With the integrated control unit, the upper door air inlet is critical for the 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 (1b in section *Layout example, door closed (page 46)*)	10	External control cables
3	Cabinet grounding busbar (PE)	11	Grounding screws
4	Input power cable including the protective ground conductor (PE) of the drive	12	Alternative to grounding screws (11)
5	Disconnector and fuses	13	Air flow to the roof
6	Contactor	14	Air flow through the drive module
7	Drive module	15	Air flow through circuit boards and to DC output busbars

Note 1: The power cable shields can also be grounded to the drive module grounding terminals.

Note 2: See also section *Free space requirements (page 53)*.

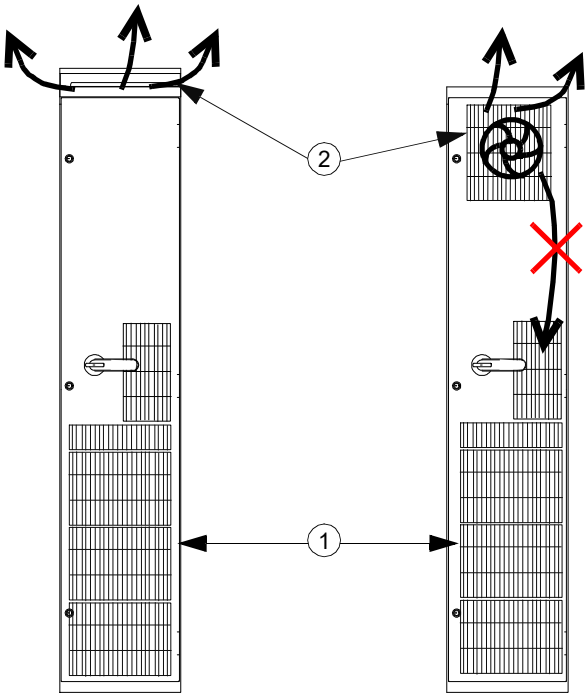
Layout example, door open (option +B051)



1	Supporting frame of the cabinet	7	Drive module
2a 2b	Vertical (2a) and horizontal (2b) air baffles with leak-proof cable entries. The air baffles separate the cool and hot areas and prevent recirculation of hot air.	8	Motor cable including the protective ground conductor of the drive module
2c	Optional air baffle that is needed when there is no fan on the lower part of the cabinet door (1b in section *Layout example, door closed (page 46)*).	9	External drive module control unit (+P906). **Note:** With the integrated control unit, the upper door air inlet is critical for the cooling of the control unit.
3	Cabinet grounding busbar (PE)	10	External control cables
4	Input power cable including the protective ground conductor (PE) of the drive.	11	Grounding screws
		12	Air flow to the roof
5	Disconnector and fuses	13	Air flow through the drive module
6	Contactor	14	Air flow through circuit boards and to DC output busbars

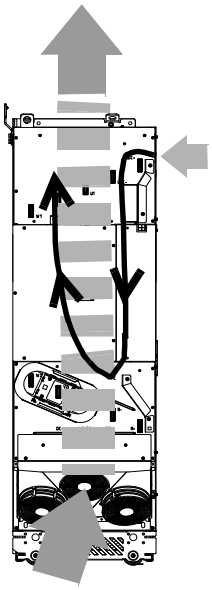
Planning the cooling of the ACQ580-04

The drawing below shows two typical cabinet cooling solutions. The air inlet is at the bottom of the cabinet, while the outlet is at the top, either on the upper part of the door or on the roof. ABB recommends that the air outlet is on the cabinet roof. Use an extra exhaust fan if the air outlet is on the cabinet door.



Air inlets and outlets of the cabinet

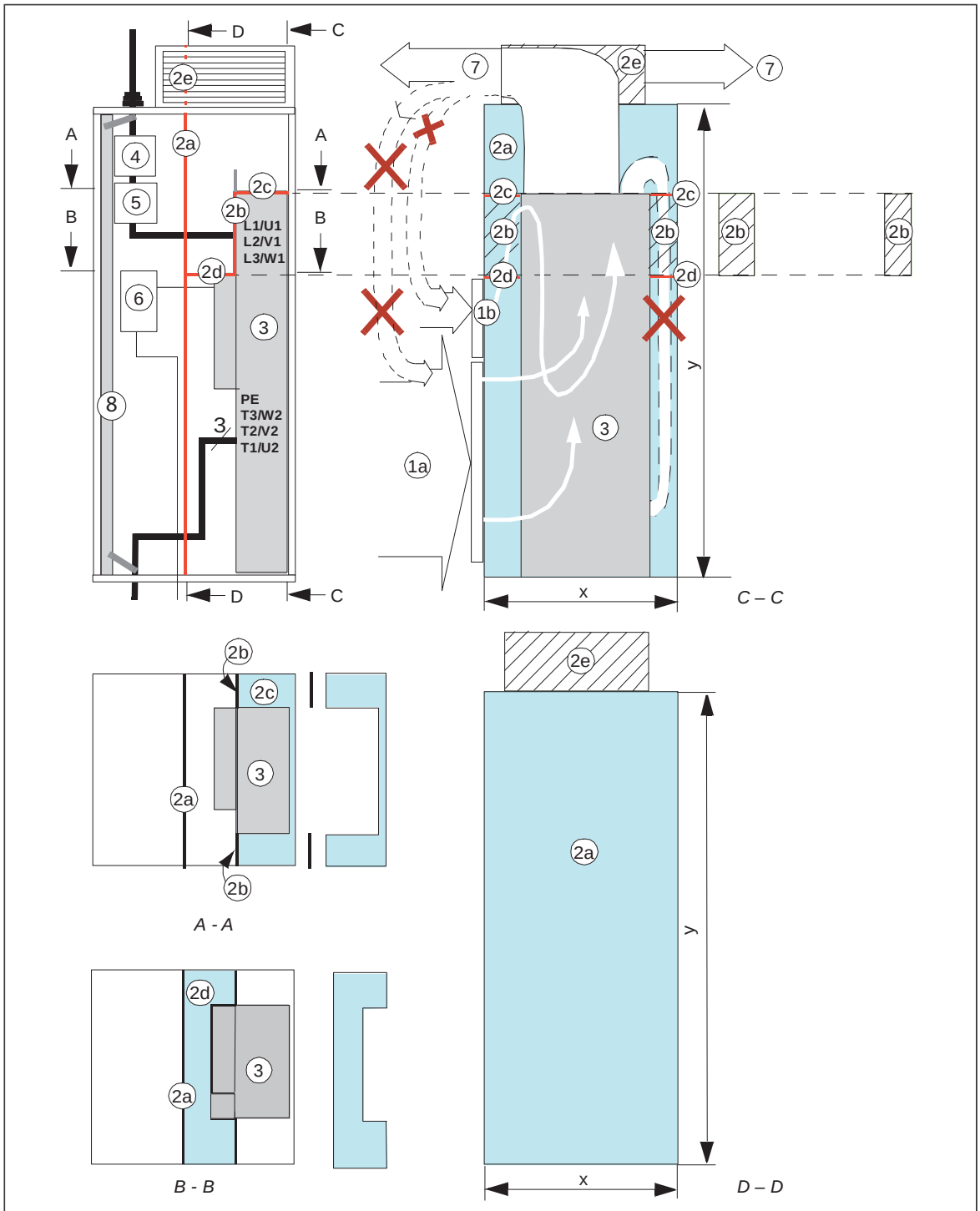
1	air inlet
2	air outlet



Air flow inside the drive module

Standard drive module configuration

This diagram shows air baffle positions in an example cabinet.

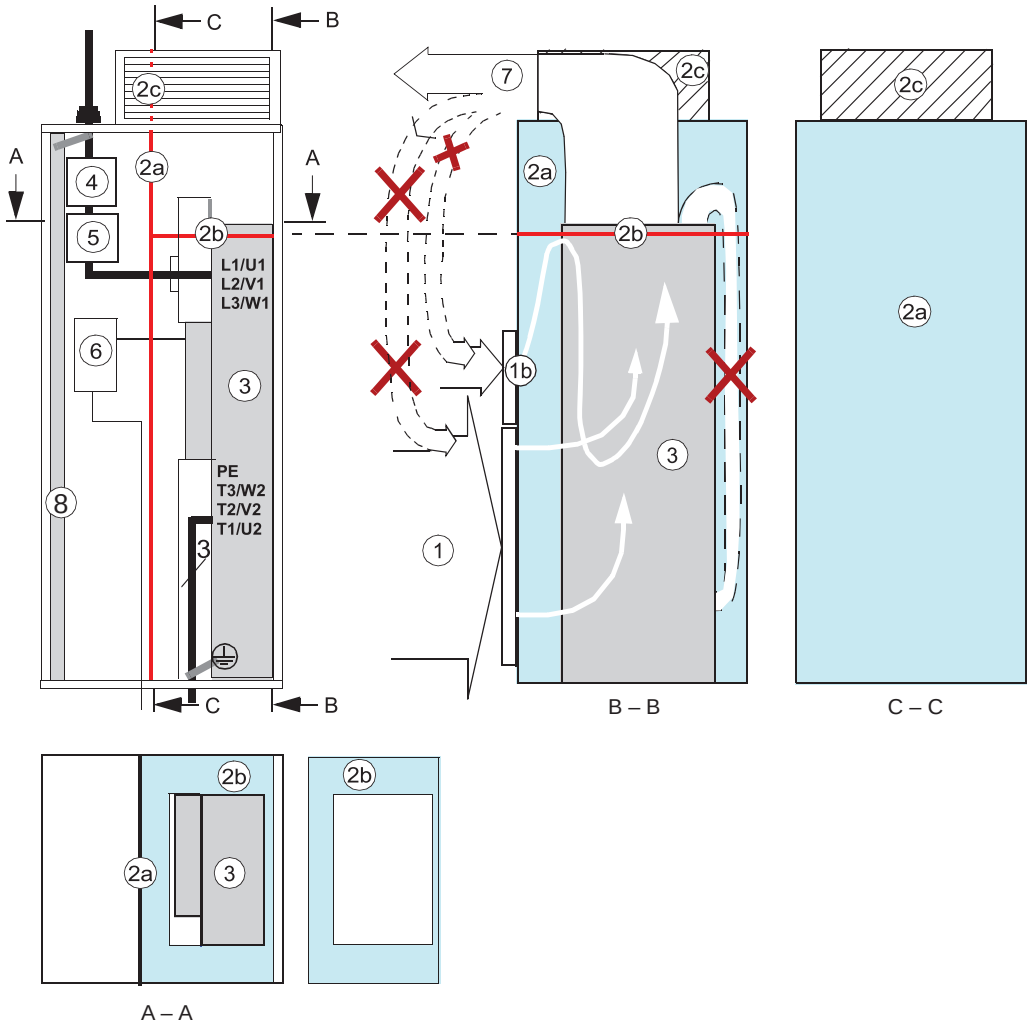


1a	Air flow to the drive module, max. 40 °C (104 °F)	3	Drive module
1b	Air inlet to the drive module circuit boards and DC output busbars	4	Disconnector and fuses
2a	Vertical air baffle that separates the cool and hot areas in the cabinet	5	Contactor
2b	Vertical air baffle	6	External drive module control unit (+P906)
2c	Upper horizontal air baffle. For vertical location, see page 142.	7	Air flow out

2d	Lower horizontal air baffle	8	Cabinet grounding busbar
2e	Optional air baffle that is needed when there is no fan on the lower part of the cabinet door (1b in section *Layout example, door closed (page 46)*).	-	-

Drive module with option +B051

This diagram shows air baffle positions in an example cabinet.



1a	Air flow to the drive module, max. 40 °C (104 °F)	4	Disconnector and fuses
1b	Air inlet to the drive module circuit boards and DC output busbars	5	Contactor
2a	Vertical air baffle that separates the cool and hot areas in the cabinet	6	External drive module control unit (+P906)
2b	Horizontal air baffle, see *Air baffles for the drive module with option +B051 (page 168)*.	7	Air flow out
2c	Optional air baffle that is needed when there is no fan on the lower part of the cabinet door (1b in section *Layout example, door closed (page 46)*	8	Cabinet grounding busbar
3	Drive module	-	-

Other installation positions than vertical

You can install the drive module on its back. Make sure that the hot cooling air that flows upwards from the module does not cause danger.

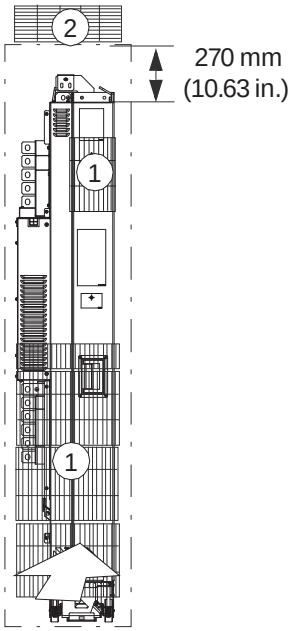
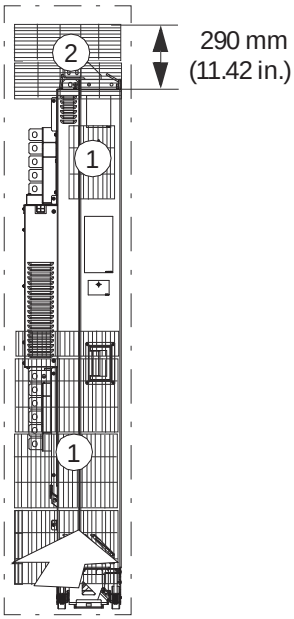
For other installation positions, contact ABB.

Free space requirements

Free space around the drive module is needed to make sure that sufficient cooling air flows through the module and the module cools correctly.

Free space at the top of the drive module

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

Air outlet on the cabinet roof	Air outlet in the upper part of the cabinet door
	

1	Air inlet
2	Air outlet

Free space around the drive module

20 mm (0.79 in) free space 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 400 mm (15.75 in)
- width 500 mm (19.68 in)
- depth 600 mm (23.62 in)
- height 2000 mm (78.74 in).

6

Mechanical installation

Contents of this chapter

This chapter describes how to install the drive module mechanically.

Examining the installation site

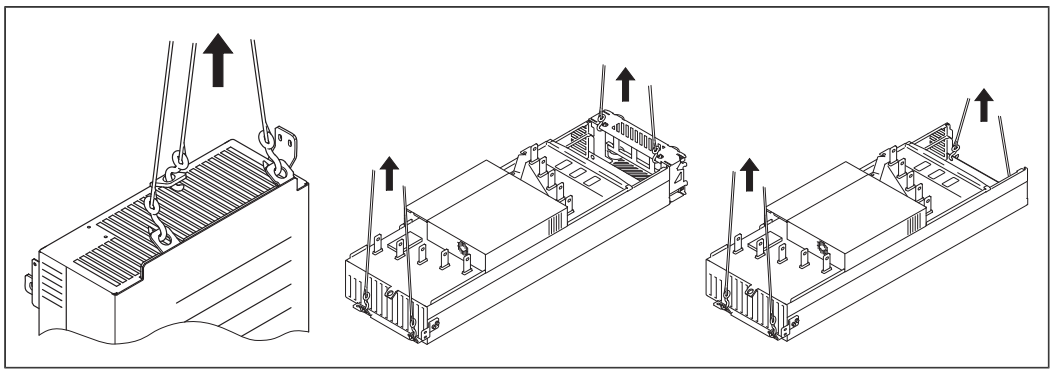
The material below the drive must be non-flammable and strong enough to carry the weight of the drive.

See section *Ambient conditions (page 148)* for the allowed ambient conditions and section *Losses, cooling data and noise (page 144)* for the required cooling air.

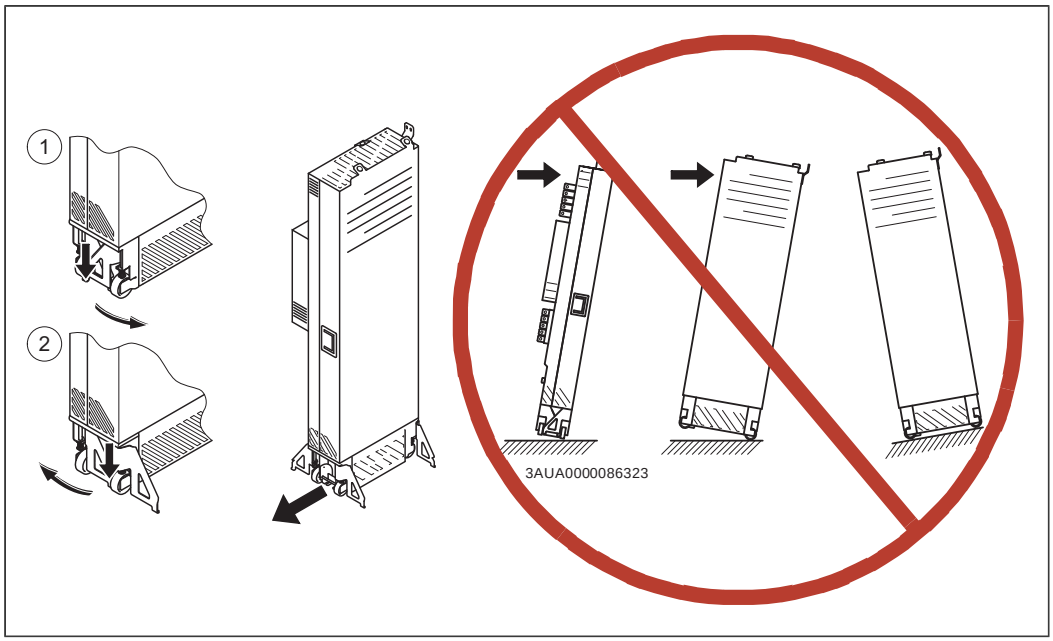
Moving and unpacking the unit

WARNING!

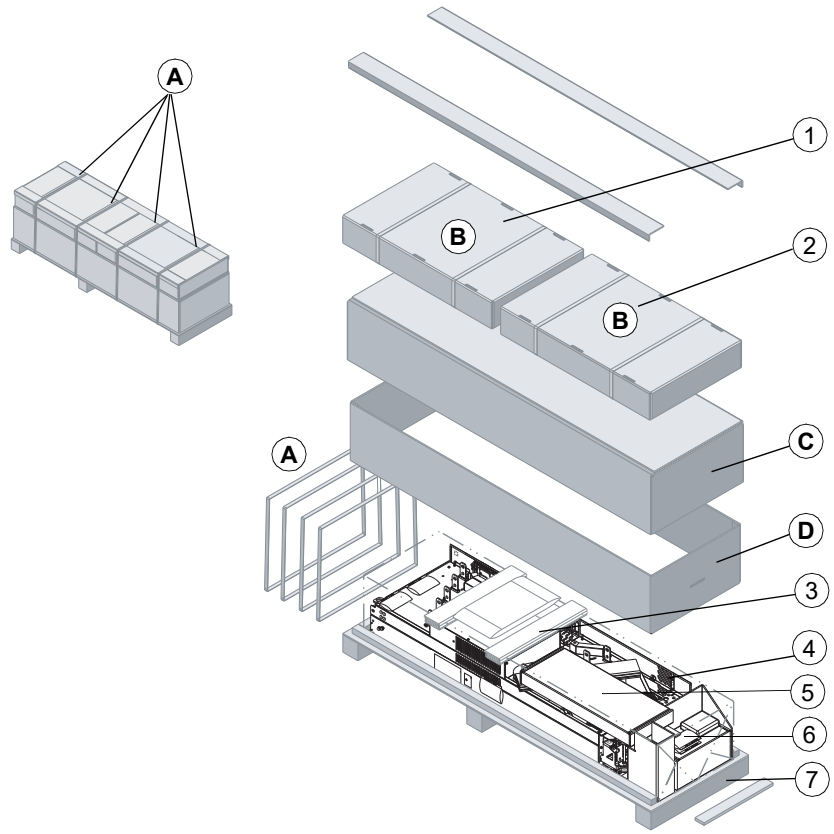
Lift the drive module only by the lifting lugs:



Make sure that the module does not topple over when you move it on the floor: Open the support legs by pressing each leg a little down (1, 2) and turning it aside. Whenever possible attach the module also with chains. Do not tilt the 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.



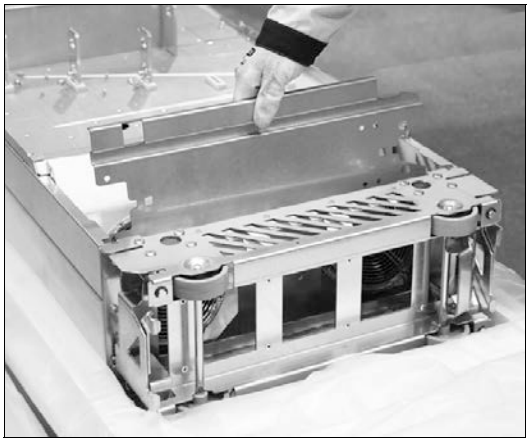
Move the transport package by pallet truck to the installation site.

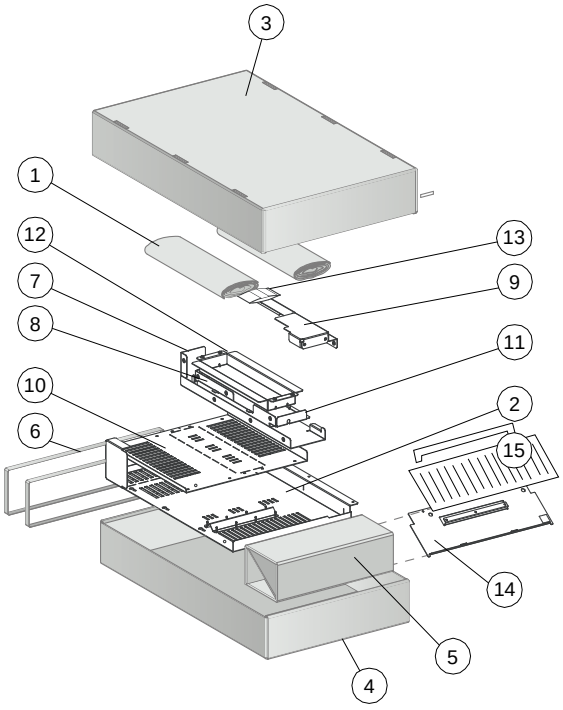


Transport package contents	
1	With option +B051: Clear plastic shrouds. See below for the box contents.
2	With standard drive module configuration: Output cable connection terminals. See below for the box contents.
3	Plywood support
4	Drive module with factory installed options and multilingual residual voltage warning sticker, top guide plate, pedestal guide plate, telescopic ramp package, fastening screws in a plastic bag, control unit options, delivery documents, printed multilingual installation and start-up quick guide. Other printed manuals if ordered.
5	Ramp box. With option +H370: also input cable connection terminals box.
6	Accessories box
7	Pallet

To unpack:

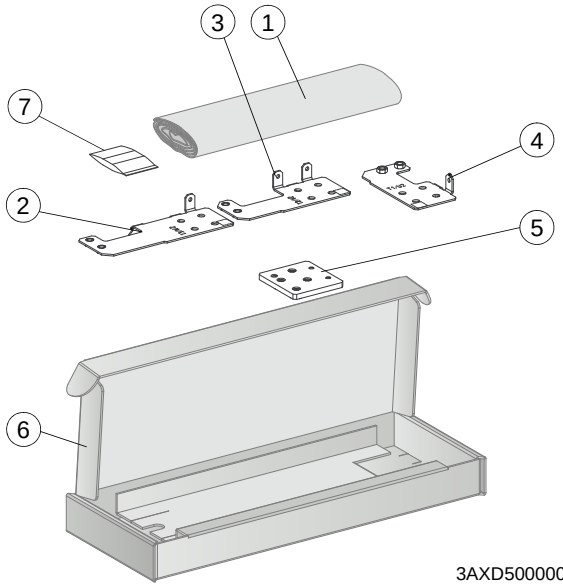
- Cut the bands (A).
- Unpack the additional boxes (B).
- Remove the outer sheathing by lifting it (C).
- Remove the sheathing by lifting it (D).
- Remove the pedestal guide plate (not included with options +0H354 and +0P919) as shown below.





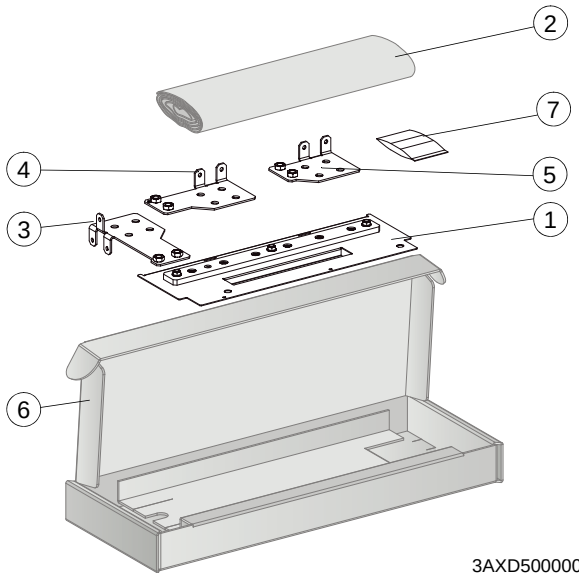
3AXD50000009484

Box B1 contents (option +B051)	
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
15	Bottom grille and mounting bracket



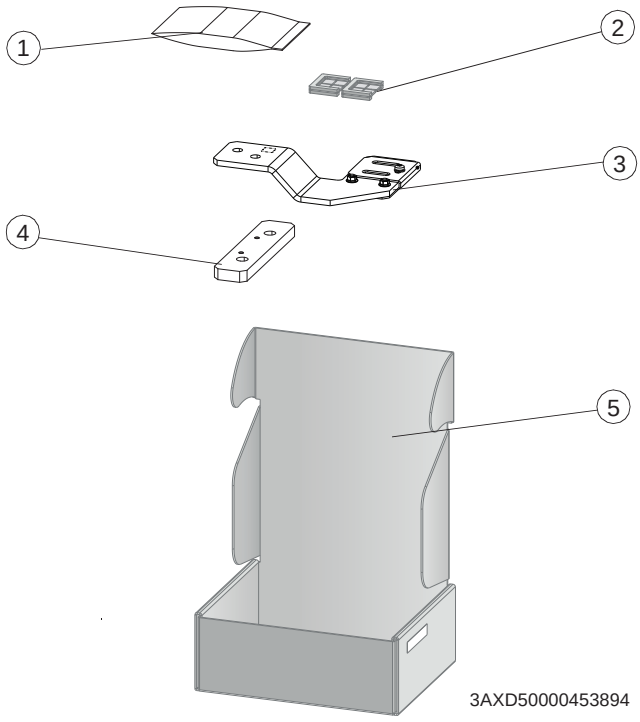
3AXD5000009515

Box B2 contains this box	
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



3AXD5000009522

Box B2 contains additionally this box with option +H370	
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

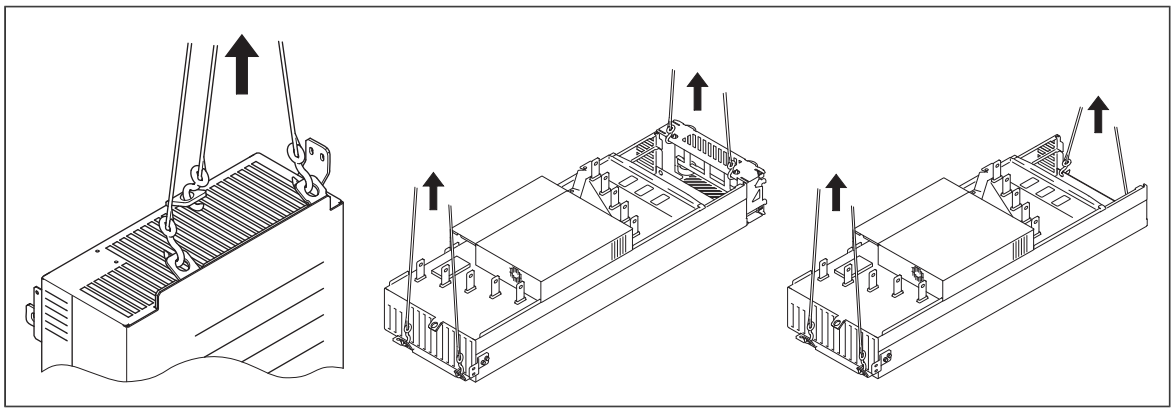


Accessories box contents	
1	Screw package
2	Feed through
3	Bracket for attaching the drive module from top to Rittal cabinet punched section.
4	Support bracket for attaching the drive module from top to a mounting plate or wall. The bracket brings a gap for cooling air flow and prevents the drive module screws from chafing the plate.
5	Cardboard box

See section *Alternatives for grounding the drive module (page 62)*.

Lifting the drive module

Lift the drive module only by the lifting lugs.



Examining the delivery

Examine that all the items are present and there are no signs of damage. Read the data on the type designation label of the drive module to make sure that the module is of the correct type. See section *Type designation key (page 35)*.

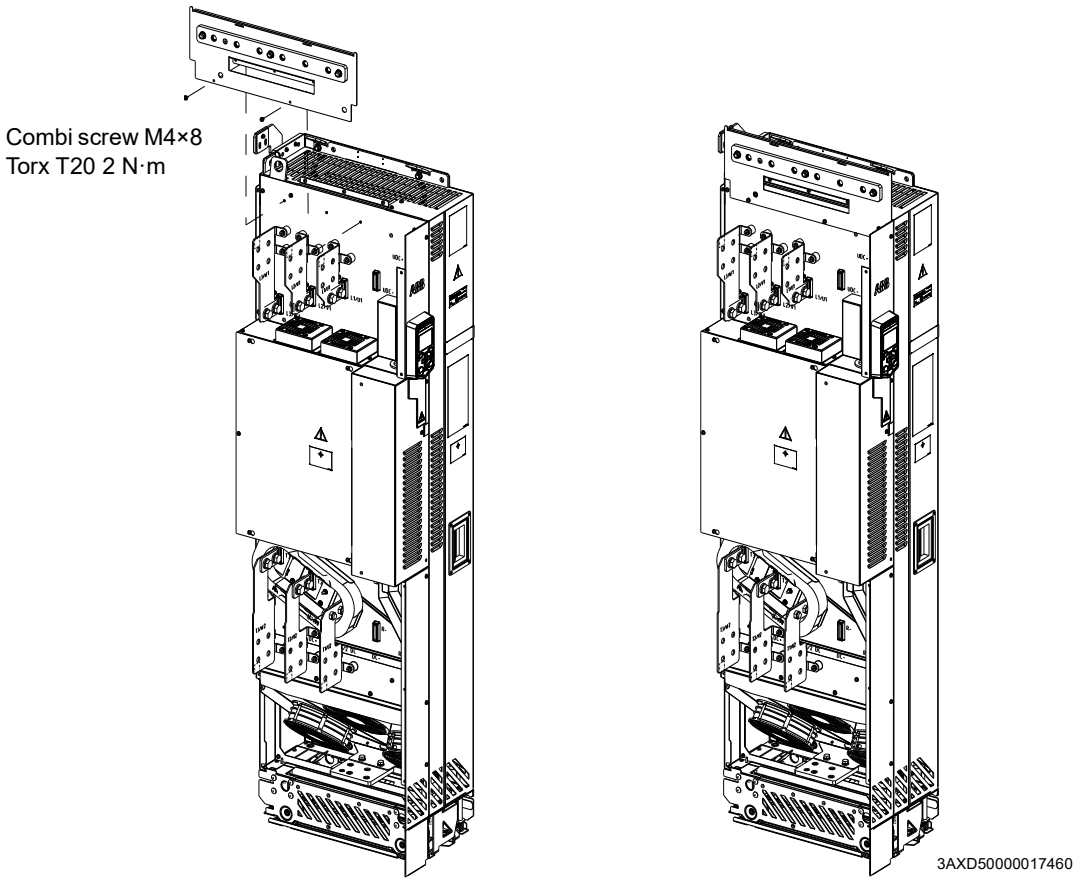
Insert lifting hooks to the drive module lifting eyes and lift the module to the installation place.

Installation alternatives

This manual shows an example installation of the drive module in Rittal VX25 cabinet. See chapter *Installation example of drive module with IP20 shrouds (option +B051) (page 101)*.

Input power cable connection terminals (option +H370) and ground busbar assembly

Connect the input power cable connection terminals in the same way as the motor cable connection terminals. Install the metallic shroud as shown below.



Drive module without output cable connection terminals (option +0H371)

The power cables can be connected directly to the drive module input and output terminals with cable lugs or by busbars.

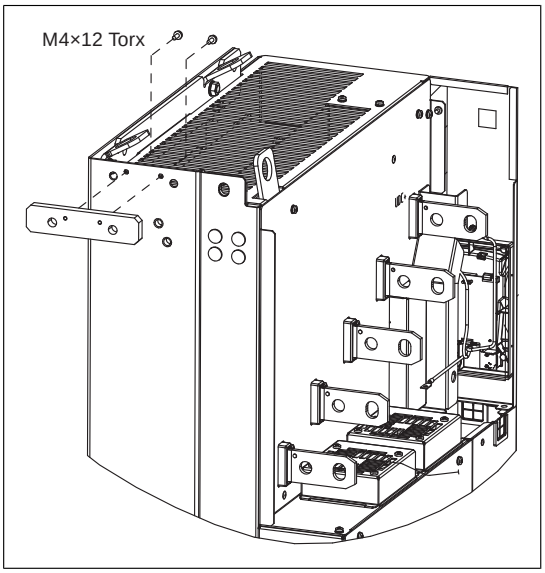
Drive module without pedestal (option +0H354)

The drive module without pedestal can be mounted on a wall or a cabinet with four screws through the mounting holes at the top and bottom of the module.

Make sure that the cabinet mounting plate and frame are strong enough to carry the weight of the drive module.

Attaching the drive module to a mounting plate or wall

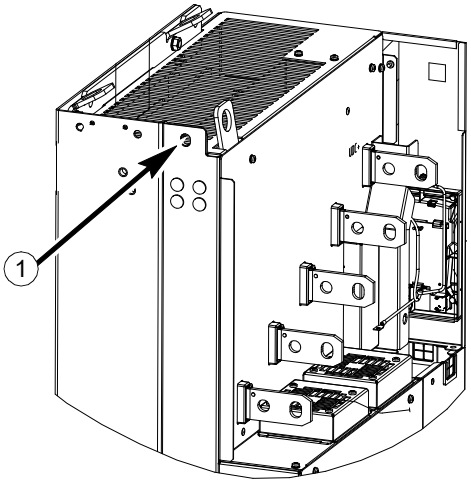
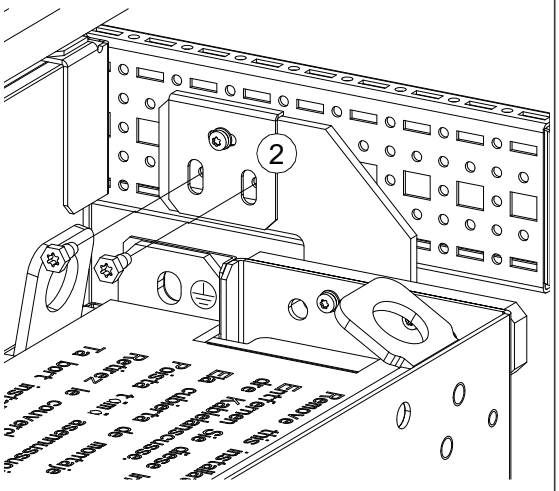
Use the support bracket if you attach the drive module directly to a mounting plate or wall. The support bracket prevents the drive module screws from chafing against the plate.



Alternatives for grounding the drive module

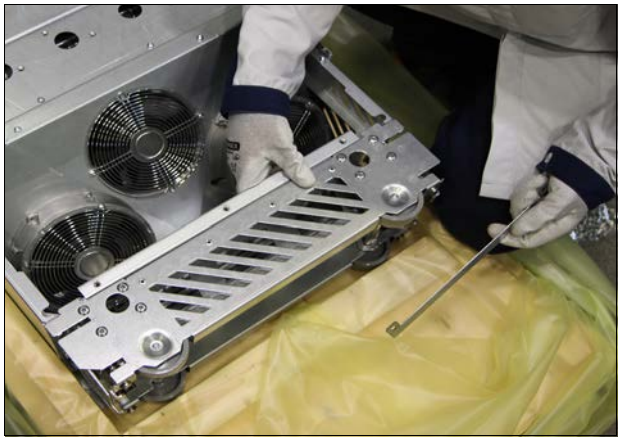
You can ground the drive module from its top back to the cabinet frame with these alternatives:

1. from the grounding hole
2. to a Rittal punched section: with fastening bracket.

	
	Tapping screw M6×12 Torx T30 (Hex) 9 N·m

Installing the bottom grille for IP20 degree protection

For option +B051: If IP20 degree of protection is needed from the bottom side, install the bottom grille as shown below.



Removing the protective covering from the drive 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.

Installing external control unit (option +P906)

See chapter *External control unit (option +P906) (page 187)*.

7

Guidelines for planning the electrical installation

Contents of this chapter

This chapter contains generic guidelines for planning the electrical installation of the drive. See the hardware manual for the type-specific instructions.

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)[1)] and/or Canadian Electrical Code (CE) along with state and local codes for your location and application.

[1)] 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.
- 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.

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 withstands the maximum peak voltage in the motor terminals. See *Requirements table (page 67)*. For basics of protecting the motor insulation and bearings in drive systems, see *Protecting the motor insulation and bearings (page 66)*.

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.
- If the motor and drive are not of the same size, consider the operation limits of the drive control program for the motor nominal voltage and current. See the appropriate parameters in the firmware manual.

Protecting the motor insulation and bearings

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

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

d*u*/d*t* 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 d*u*/d*t* and common mode filters and insulated N-end (non-drive end) motor bearings are required. Ignoring the requirements or improper installation may shorten motor life or damage the motor bearings and voids the warranty.

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

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

1) manufactured before 1.1.1998

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

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

Motor type	Nominal AC supply voltage	Requirement for			
		Motor insulation system	ABB d*u*/d*t* and common mode filters, insulated N-end motor bearings		
			P_N < 100 kW and frame size < IEC 315	100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400	P_N ≥ 350 kW or frame size ≥ IEC 400
			P_N < 134 hp and frame size < NEMA 500	134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580	P_N ≥ 469 hp or frame size > NEMA 580
Random-wound and form-wound	U_N ≤ 420 V	Standard: $\hat{U}_{LL}$ = 1300 V	-	+ N or CMF	+ N + CMF
	420 V < U_N ≤ 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ d*u*/d*t*	+ d*u*/d*t* + (N or CMF)	+ N + d*u*/d*t* + CMF
		or			
		Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 micro-second rise time	-	+ N or CMF	+ N + CMF
	500 V < U_N ≤ 600 V	Reinforced: $\hat{U}_{LL}$ = 1600 V	+ d*u*/d*t*	+ d*u*/d*t* + (N or CMF)	+ N + d*u*/d*t* + CMF
		or			
		Reinforced: $\hat{U}_{LL}$ = 1800 V	-	+ N or CMF	+ N + CMF
	600 V < U_N ≤ 690 V	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ d*u*/d*t*	+ d*u*/d*t* + N	+ N + d*u*/d*t* + CMF
		Reinforced: $\hat{U}_{LL}$ = 2000 V, 0.3 micro-second rise time [1)]	-	+ N + CMF	+ N + CMF

1) 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 in the applied drive operation range.

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
d*u*/d*t*	d*u*/d*t* filter at the output of the drive
CMF	Common mode filter
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 d*u*/d*t* filter and common mode filter by drive type

Product type	Availability of du/dt filter	Availability of common mode filter (CMF)
ACQ580-04	Ordered separately, see chapter *Filters (page 217)*	Plus code option +E208

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 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 d*u*/d*t* and common mode filters, insulated N-end motor bearings		
		P_N < 100 kW	100 kW ≤ P_N < 200 kW	P_N ≥ 200 kW
		P_N < 140 hp	140 hp ≤ P_N < 268 hp	P_N ≥ 268 hp
U_N ≤ 500 V	Standard	-	+ N	+ N + CMF
500 V < U_N ≤ 600 V	Standard	+ d*u*/d*t*	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF
	or			
	Reinforced	-	+ N	+ N + CMF
600 V < U_N ≤ 690 V	Reinforced	+ d*u*/d*t*	+ d*u*/d*t* + N	+ d*u*/d*t* + 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.

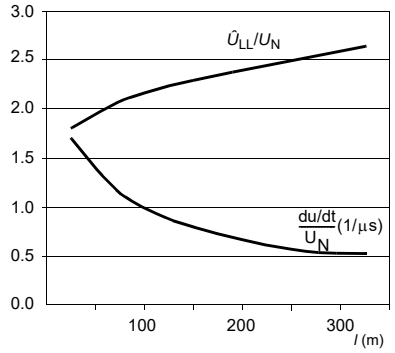
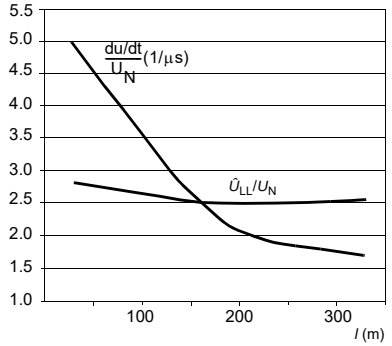
Nominal AC supply voltage	Requirement for		
	Motor insulation system	ABB d*u*/d*t* and common mode filters, insulated N-end motor bearings	
		P_N < 100 kW or frame size < IEC 315	100 kW < P_N < 350 kW or IEC 315 < frame size < IEC 400
		P_N < 134 hp or frame size < NEMA 500	134 hp < P_N < 469 hp or NEMA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

1) 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 in the applied drive operation range.

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 (d*u*/d*t*)/U_N from the diagram below. Multiply the values by the nominal supply voltage (U_N) and substitute into equation $t = 0.8 \cdot \hat{U}_{LL}/(du/dt)$.

		
	Drive with d*u*/d*t* filter	**Drive without d*u*/d*t* filter**
l	Motor cable length	
$\hat{U}_{LL}/U_N$	Relative peak line-to-line voltage	
(d*u*/d*t*)/U_N	Relative d*u*/d*t* value	
Note: $\hat{U}_{LL}$ and d*u*/d*t* values are approximately 20% higher during the resistor braking.		

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.
- **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).
- **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 72)*.

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^2)	Minimum cross-sectional area of the corresponding protective conductor S_p (mm^2)
S ≤ 16	S [1)]
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^2 Cu or 16 mm^2 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^2 when the conductor is mechanically protected,
  or
- 4 mm^2 when the conductor is not mechanically protected.

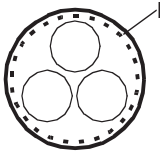
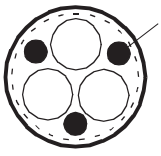
Typical power cable sizes

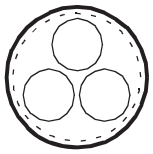
See the technical data.

Power cable types

Preferred power cable types

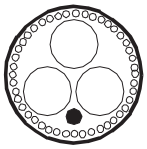
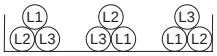
This section presents the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

Cable type	Use as input power cabling	Use as motor cabling
 Symmetrical shielded (or armored) cable with three phase conductors and concentric PE conductor as shield (or armor)	Yes	Yes
 Symmetrical shielded (or armored) cable with three phase conductors and symmetrically constructed PE conductor and a shield (or armor)	Yes	Yes

Cable type	Use as input power cabling	Use as motor cabling
 Symmetrical shielded (or armored) cable with three phase conductors and a shield (or armor), and separate PE conductor/cable [1)]	Yes	Yes

[1)] 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
 Four-conductor cabling in PVC conduit or jacket (three phase conductors and PE)	Yes with phase conductor smaller than 10 mm² (8 AWG) Cu.	Yes with phase conductor smaller than 10 mm² (8 AWG) Cu, or motors up to 30 kW (40 hp). **Note:** Shielded or armored cable, or cabling in metal conduit is always recommended to minimize radio frequency interference.
 Four-conductor cabling in metal conduit (three phase conductors and PE), eg, EMT, or four-conductor armored cable	Yes	Yes with phase conductor smaller than 10 mm² (8 AWG) Cu, or motors up to 30 kW (40 hp)
 Well-shielded (Al/Cu shield or armor) four-conductor cable (three phase conductors and a PE)	Yes	Yes with motors up to 100 kW (135 hp). A potential equalization between the frames of motor and driven equipment is required.
 A single-core cable system: three phase conductors and PE conductor on cable tray  Preferable cable arrangement to avoid voltage or current unbalance between the phases	Yes **WARNING!** If you use unshielded single-core cables in an IT network, make sure that the non-conductive outer sheath (jacket) of the cables have good contact with a properly grounded conductive surface. For example, install the cables on a properly grounded cable tray. Otherwise voltage may become present on the non-conductive outer sheath of the cables, and there is even a risk of an electric shock.	No

Not allowed power cable types

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

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 [1) 2)]	
Electrical metallic tubing: Type EMT	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.
Rigid metal conduit: Type RMC	
Liquid-tight flexible metal electrical conduit: Type LFMC	
Conduit - Non-metallic [2) 3)]	
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 [2)]	
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 [2)]	
Enclosures, air handlers, etc.	Prefer symmetrical shielded VFD cable. Allowed internally in enclosures when in accordance with UL.

1) Metallic conduit may be used as an additional ground path, provided this path is a solid path capable of handling ground currents.
2) See NFPA NEC 70, UL, and local codes for your application.
3) 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.

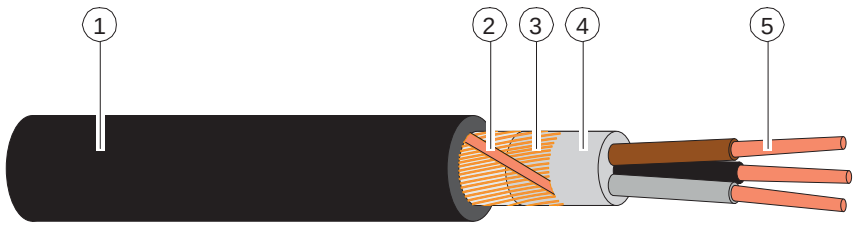
Metal conduit

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.



1	Insulation jacket
2	Helix of copper tape or copper wire
3	Copper wire shield
4	Inner insulation
5	Cable core

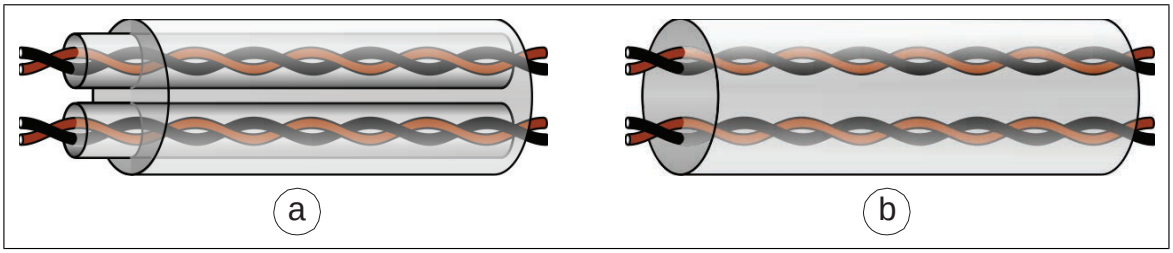
Selecting the control cables

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).

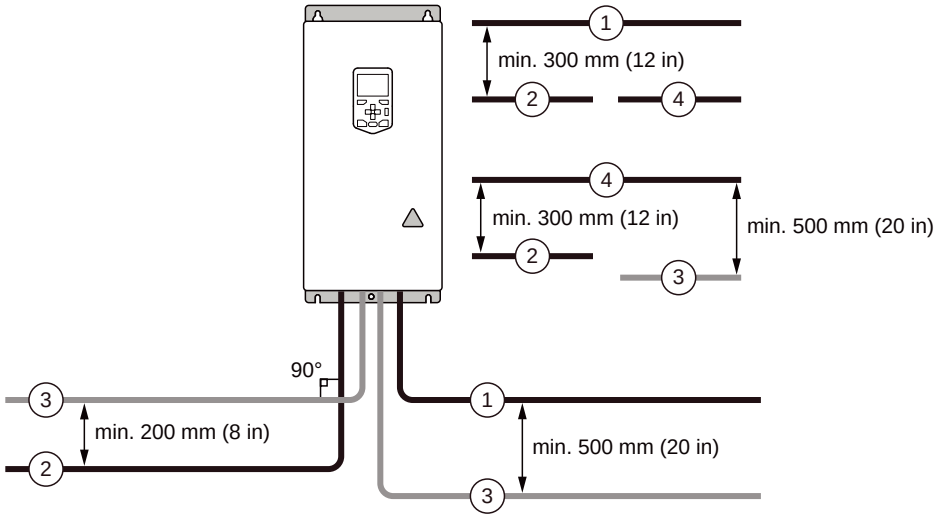
Routing the cables

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.



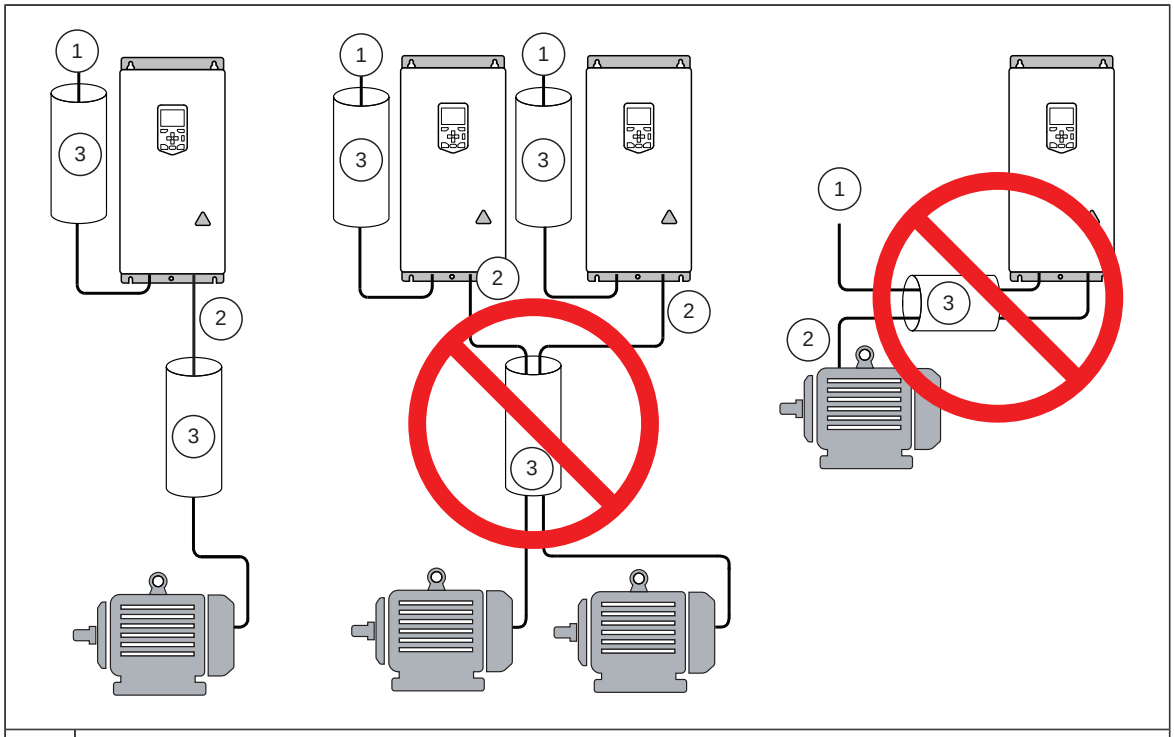
1	Motor cable
2	Input power cable
3	Control cable
4	Brake resistor or chopper cable (if any)

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.



1	Input power cabling
2	Motor cabling
3	Conduit

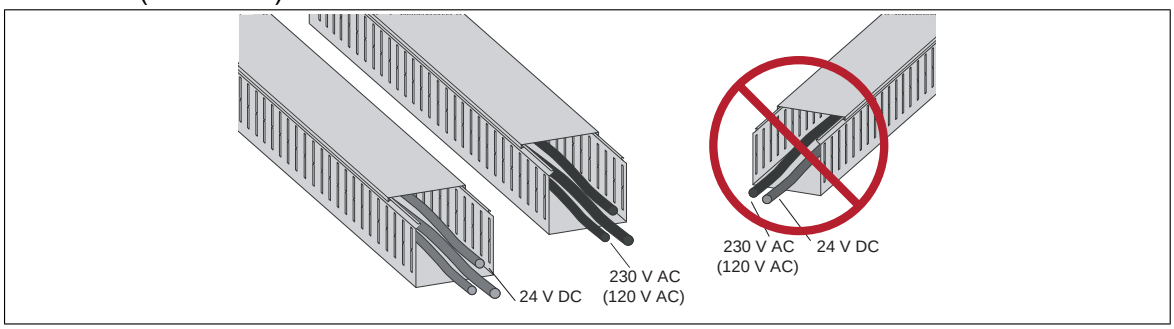
Continuous motor cable shield/conduit or enclosure for equipment on the motor cable

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 current of the drive. No additional protection devices are needed.

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 separate circuit breaker or fuses for protecting each motor cable and motor against overload. Obey the local requirements for motor grouping installations. The drive overload protection is tuned for the total motor load. It may not detect an overload in one motor circuit only.

Protecting the motor against thermal overload

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

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

The most common temperature sensor types are thermal switch (for example Klixon), 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 IEC 60947-4-1. The standards allow for motor overload protection without external temperature sensors.

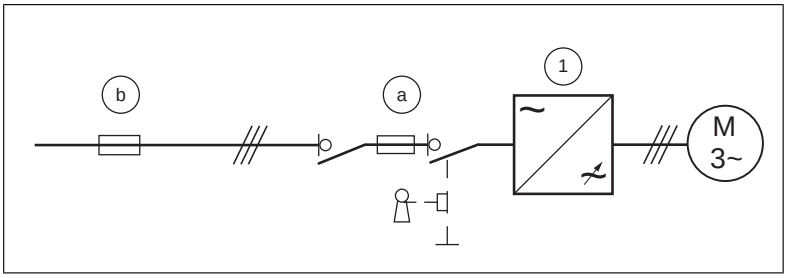
The protection feature allows the user to specify the class of operation in the same manner as the overload relays are specified in standards IEC 60947-4-1 and NEMA ICS 2.

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

For more information, see drive firmware manual.

Protecting the drive and 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: If the fuses for the drive protection are placed at the distribution board and the input cable is dimensioned according to the nominal input current of the drive given in the technical data, the fuses protect also the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive. No separate fuses for the input cable protection are needed.

Circuit breakers

The protective characteristics of circuit breakers depend on the type, construction and settings of the breakers. There are also limitations pertaining to the short-circuit capacity of the supply network. Your local ABB representative can help you in selecting the breaker type when the supply network characteristics are known.

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.

Note: Circuit breakers must not be used without fuses in UL installations.

Tested circuit breakers

You can use the circuit breakers listed in the technical data. Other circuit breakers can be used with the drive if they provide the same electrical characteristics. ABB does not assume any liability whatsoever for the correct function and protection with circuit breakers not listed. Furthermore, if the recommendations given by ABB are not obeyed, the drive can experience problems that the warranty does not cover.

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 171)*.

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.

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 +L357), or acquire and install an ATEX-compliant protection relay
- do the necessary connections.

For more information, see:

User's manual	**Manual code (English)**
CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) user's manual	3AXD50000030058

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.

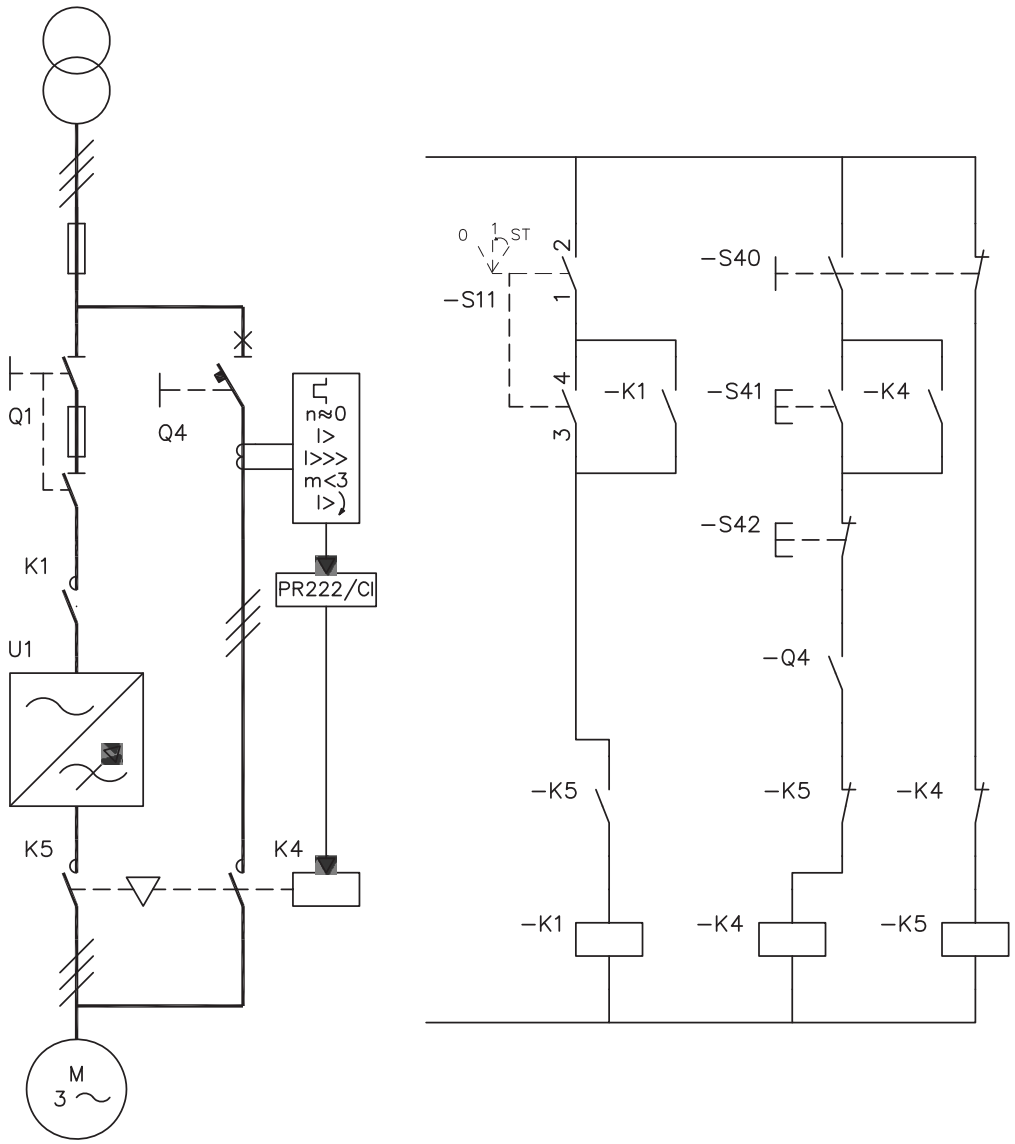
WARNING!
When the vector control mode is in use, never open the output contactor while the drive controls the motor. The vector control operates extremely fast, much faster than it takes for the contactor to open its contacts. When the contactor starts opening while the drive controls the motor, the 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



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 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 die away.
5. Start the motor with S41.

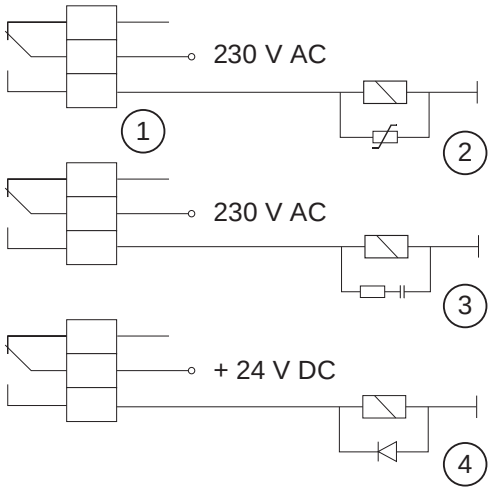
Switching the motor power supply from direct-on-line to drive

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.



1	Relay output
2	Varistor
3	RC filter
4	Diode

Implementing a motor temperature sensor connection

WARNING!
IEC 60664 and IEC 61800-5-1 require 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.
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.
   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 86)*.
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.

Connecting motor temperature sensor to the drive via an option module

This table shows:

- the option module types that you can use for the motor temperature sensor connection
- the insulation or isolation level that each option module forms between its temperature sensor connector and other connectors
- the temperature sensor types that you can connect to each option module
- the 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

8

Electrical installation

Contents of this chapter

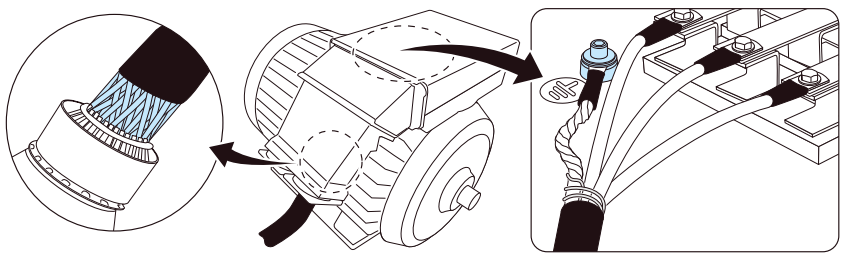
This chapter contains instructions for electrical installation of the drive module. The chapter refers to installation example chapters which contain instructions that depend on the selected drive configuration.

Safety

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.

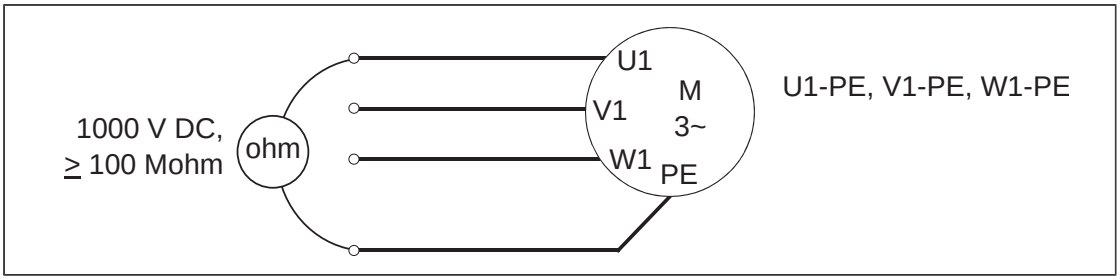
Measuring the insulation of the motor and motor cable

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 – IEC, not North America

This section is valid for the IEC drive types.

Frame	Default wires – Global (IEC) except North America	
	EMC	VAR
R10, R11	Connected	Connected

EMC filter compatibility

The drive has an internal EMC filter (+E210) as standard. You can install the drive with the EMC filter connected to a symmetrically grounded TN-S system, IT system, corner-grounded delta, mid-point-grounded delta and TT system.

Note: If you disconnect the EMC filter, the electromagnetic compatibility of the drive decreases.

Ground-to-phase varistor compatibility

The drive is equipped with an internal ground-to-phase varistor as standard. You can install the drive with the ground-to-phase varistor connected to a symmetrically grounded TN-S system, corner-grounded delta and mid-point-grounded delta system. If you install the drive to an IT system or a TT system, you need to disconnect the varistor. See section *Ground-to-phase varistor disconnecting instructions – IEC, not North America (page 219)*.

WARNING! Do not install the drive with ground-to-phase varistor connected to a system that the varistor is not suitable for. If you do, the varistor circuit can be damaged.

Grounding system compatibility check – North America

This section is valid for the UL (NEC) drive types.

Frame	Default wires – North America	
	EMC	VAR
R10, R11	Not connected	Not connected

EMC filter compatibility

The drive has an internal EMC filter (+E210) as standard. However, for the UL (NEC) drive types, the filter is disconnected as default. The filter is typically not needed in North American installations. If you are concerned with EMC issues, and install the drive to a symmetrically grounded TN-S system, IT system, corner-grounded delta or mid-point-grounded delta system, you can connect the internal EMC filter. See section *Connecting EMC filter – North America (page 225)*.

Note: When the internal EMC filter is disconnected, the electromagnetic compatibility of the drive is reduced.

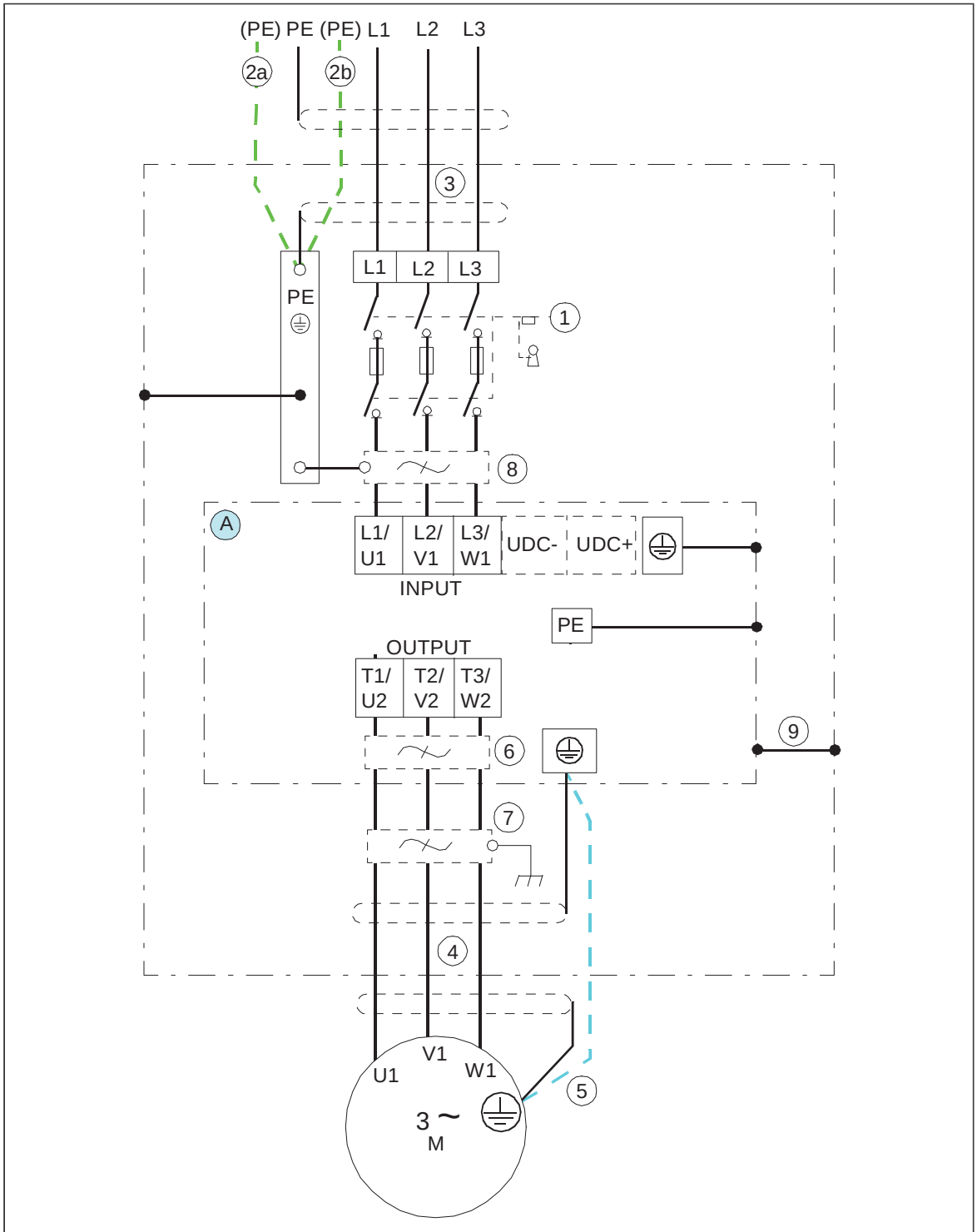
Ground-to-phase varistor compatibility

The drive is equipped with an internal ground-to-phase varistor as standard. However, for the UL (NEC) drive types, the ground-to-phase varistor is disconnected as default.

For connecting the ground-to-phase varistor, see section *Connecting EMC filter and ground-to-phase varistor – North America (page 223)*.

Connecting the power cables

Power cable connection diagram

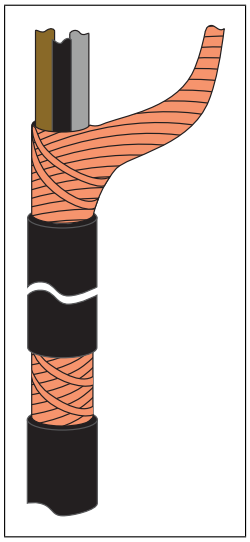


A	Drive module
1	For alternatives, see section *Selecting the main supply disconnecting device (page 65)*.
2	Use a separate grounding PE cable (2a) or a cable with a separate grounding conductor (2b) if the conductivity of the shield does not meet the requirements for the PE conductor. See section *General guidelines (page 71)*.

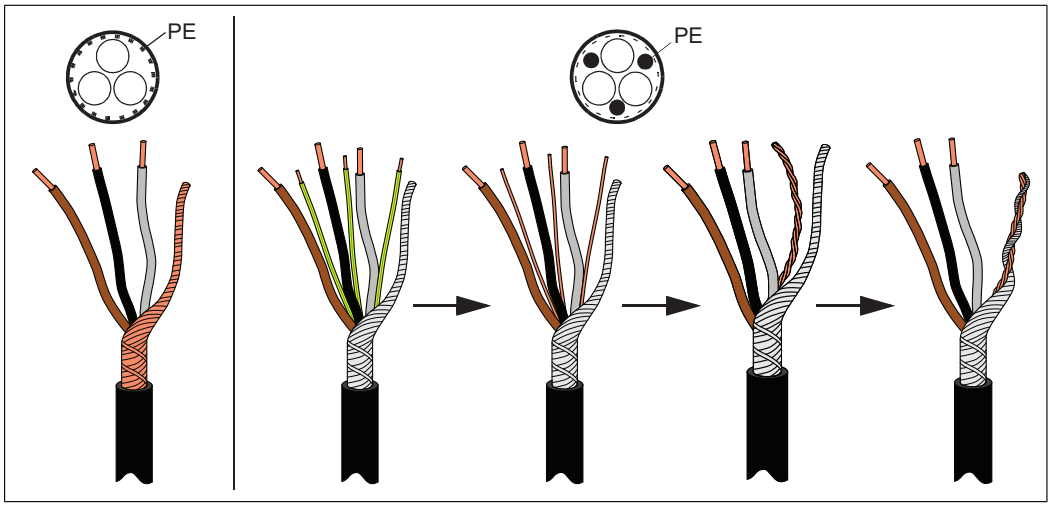
3	ABB recommends 360-degree grounding at the cabinet entry if a shielded cable is used. Ground the other end of the input cable shield or PE conductor at the distribution board.
4	ABB recommends 360-degree grounding at the cabinet entry.
5	Use a separate grounding cable if the conductivity of the shield does not meet the requirements of IEC 61800-5-1 (see section *General guidelines (page 71)*) and there is no symmetrically constructed grounding conductor in the cable.
6	Common mode filter (+E208, see *Requirements table (page 67)*)
7	*du/dt* filter (optional, see *Filters (page 217)*)
8	EMC filter (+E210)
9	The drive module frame must be connected to the cabinet frame. See section *Alternatives for grounding the drive module (page 62)*.
10	External brake resistor
Note: 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. Do not use an asymmetrically constructed motor cable. Connecting its fourth conductor at the motor end increases bearing currents and causes extra wear.	

Preparing the cable ends – Symmetrical shielded cables

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.

Power cable connection process

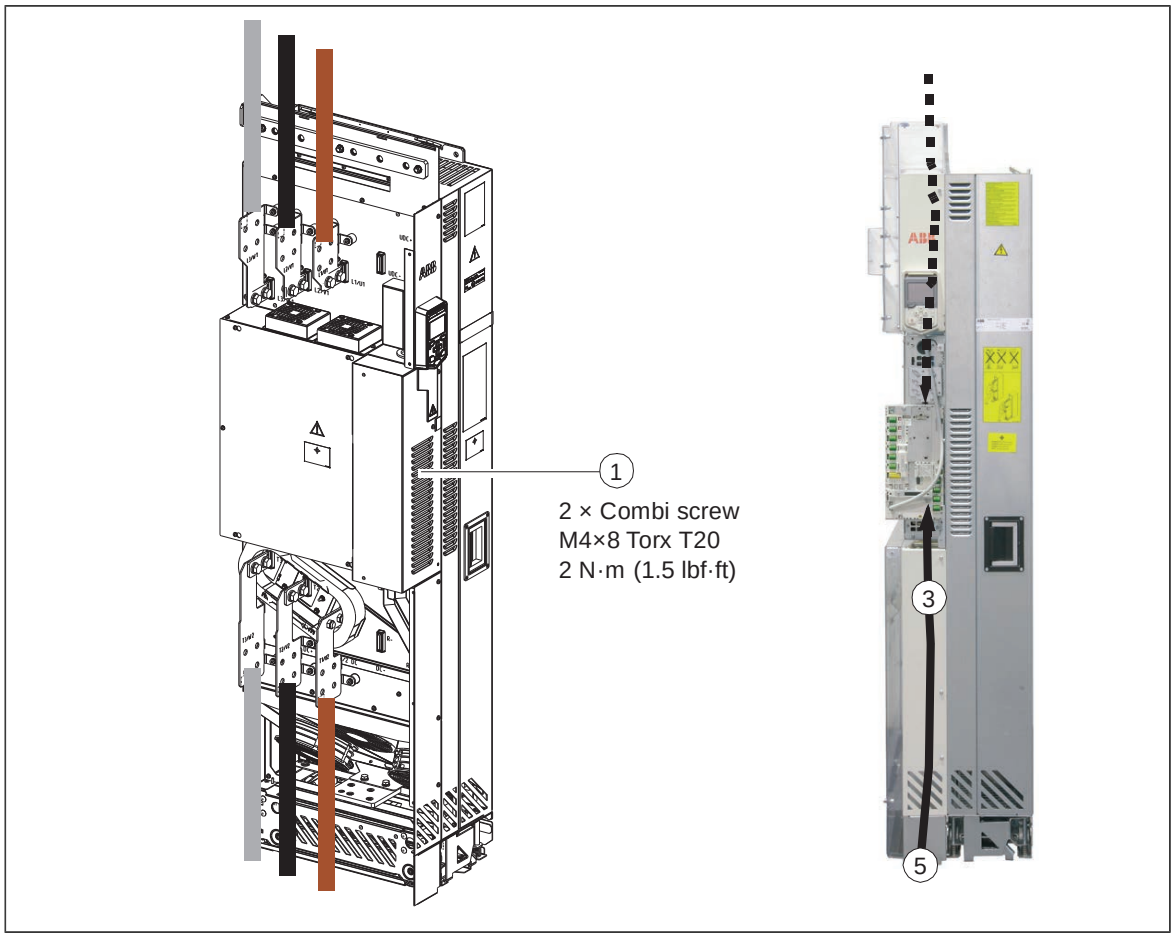
See chapter *Installation example of drive module with IP20 shrouds (option +B051) (page 101)* for instructions on how to connect the input and motor cables.

DC connection

The UDC+ and UDC– terminals are intended for common DC configurations of a number of drives, allowing regenerative energy from one drive to be utilized by the other drives in the motoring mode. For more information, contact your local ABB representative.

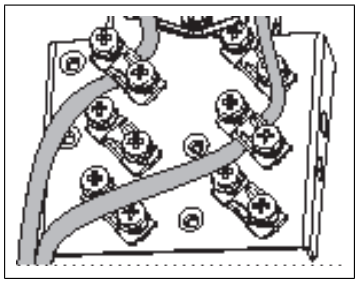
Connecting the control cables

This procedure applies to the standard drive module with integrated control unit. With external control unit (option +P906), the external control cables are connected to the control unit in the same way. In addition, connect the control unit to the drive module as instructed in chapter *External control unit (option +P906) (page 187)*.



1. Remove the middle front cover of the drive module.
2. Attach the option modules if not attached already. See section *Installation example of drive module with IP20 shrouds (option +B051) (page 101)*.
3. Lead the control cables inside the drive cabinet.
4. Ground the outer control cable shields 360 degrees at the cabinet lead-through plate (recommendation).
5. Route the control cables along the control cable duct from bottom or top to the control unit.

6. 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.



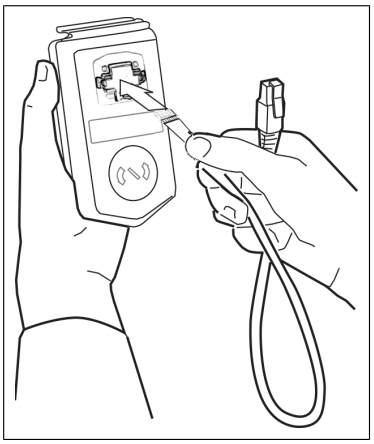
7. Connect the conductors to the appropriate detachable terminals of the control unit. See chapter *Control unit (page 107)* for the default I/O connections of the drive module. Use shrink tubing or insulating tape to contain any stray strands. Tighten the screws to secure the connection.

   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.
8. Install the middle front cover back.

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 X12 connector of the control unit.



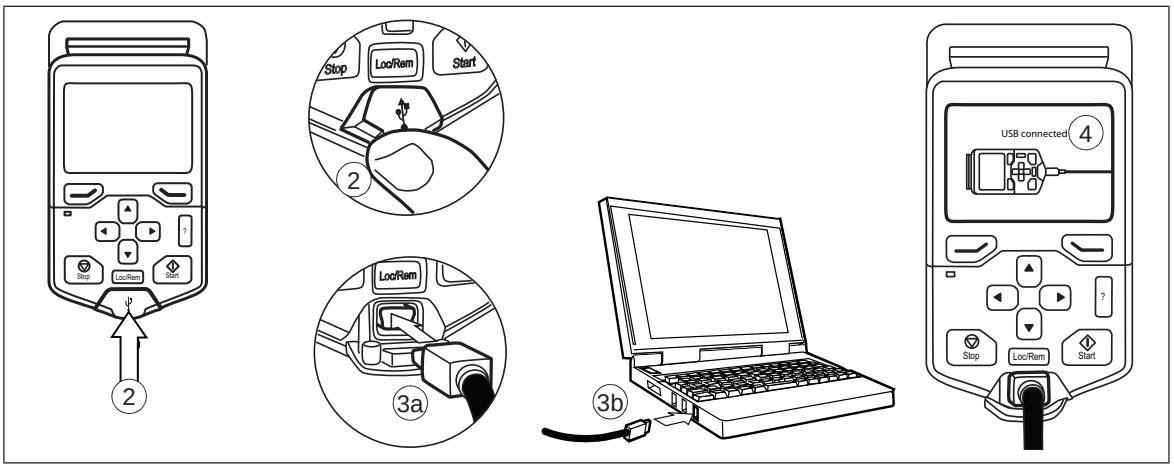
Note: When a PC is connected to the control panel, the control panel keypad is disabled. In this case, the control panel acts as a USB-RS485 adapter.

Connecting a 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.



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

You can connect a remote 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]).

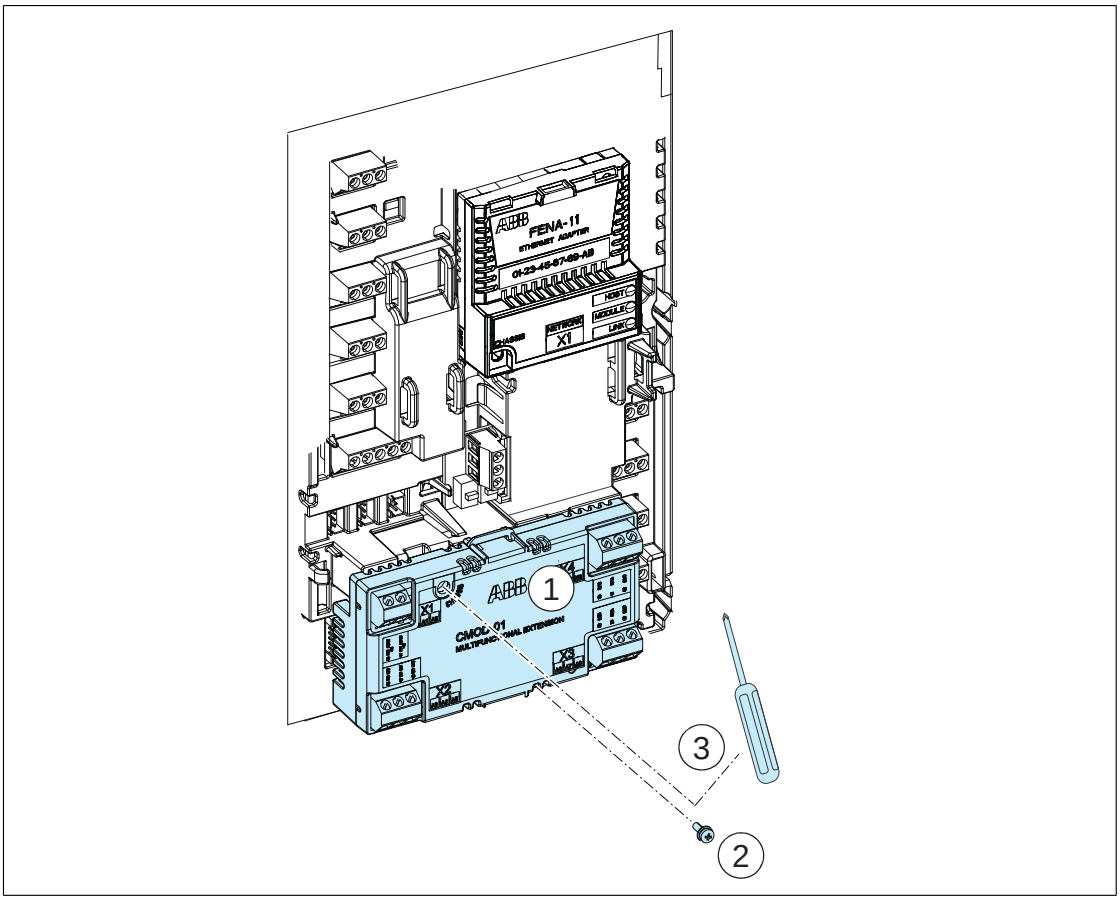
Installing option modules

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.

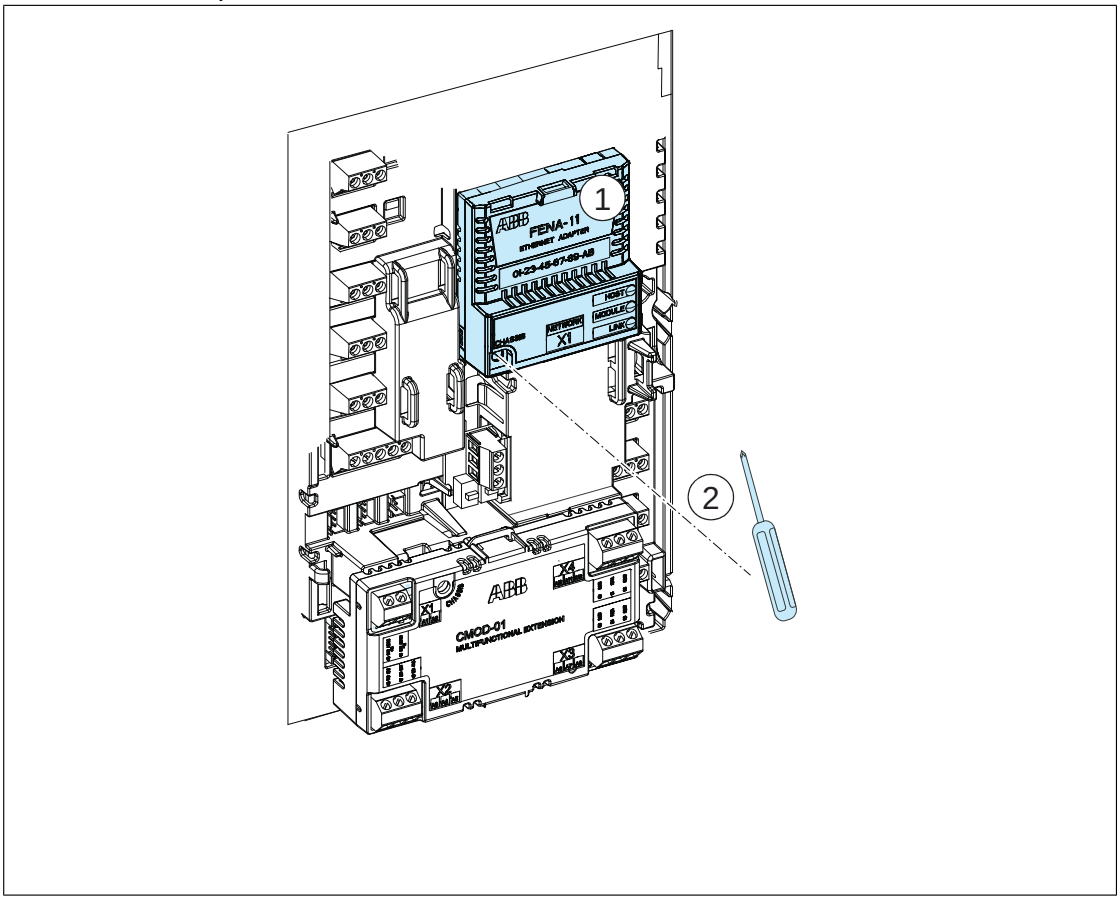
Option slot 2 (I/O extension modules)

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

Installation example of drive module with IP20 shrouds (option +B051)

Contents of this chapter

In this chapter, the drive module with IP20 shrouds (option +B051) is installed in a 600 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. Instructions for option +H370 (full-size input terminals) are also given.

Safety

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.

Required parts

Drive module standard parts		
• Drive module • Fastening bracket • Pedestal guide plate • Telescopic extraction/installation ramp • Fastening screws and insulators in a plastic bag • Integrated control unit		
Rittal part code	**Qty (pcs)**	**Description**
VX 8606.000	1	Enclosure without mounting plate, bottom plates and side panels.
DK 7967.000 (one set = four pieces)	1	Spacers for roof plates.
VX 8617.030	5	Punched section with mounting flange, outer mounting level for 600 mm horizontal
TS 4396.500		Support rails
SK 3243.200	4	Air filter 323 mm × 323 mm. Remove the filter mats.
Customer-made parts (not ABB or Rittal parts)		
Air baffles	2	See sections *Preventing the recirculation of hot air (page 40)* and *Air baffles for the drive module with option +B051 (page 168)*.

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.

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.	• *Installing the drive module into a cabinet (page 103)* • Installation drawings
2	Install the auxiliary components (such as mounting plates, air baffles, switches, busbars etc.). Attach the drive module to the cabinet Connect the power cables and install the clear plastic shrouds to the drive module.	• The component manufacturer's instructions • *Planning the cooling of the ACQ580-04 (page 50)* • *Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure (page 227)* • *Connecting the power cables and installing the shrouds (page 104)*
3	Connect the control cables.	• *Connecting the control cables (page 95)*.
4	Install the remaining parts, for example, cabinet doors, side plates, etc.	• The component manufacturer's instructions. • *Installing the roof and door (Rittal parts) (page 105)*

Installing the drive module into a cabinet

See appendix *Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure (page 227)* and the quick installation guide.

- Install the punched section to the back of the cabinet frame.
- Install the support rails and pedestal guide plate to the cabinet bottom frame.
- Install the telescopic extraction/installation ramp to the pedestal guide plate.
- Option +B051: Remove the sheeting from the clear plastic shrouds from both sides.
- Option +H370: Install the top metallic shroud to the drive module.
- Option +B051:Install the back shrouds to the drive module.
- To prevent the drive module from falling, attach its lifting lugs with chains to the cabinet frame.
- Push the drive module carefully into the cabinet along the telescopic extraction/installation ramp.
- Remove the ramp.
- Attach the drive module to the pedestal guide plate.
- Attach the drive module from top to the punched section at the cabinet back.

  Note: The fastening bracket grounds the drive module to the cabinet frame.
- Install the air baffles. For option + B051, see chapter *Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure (page 227)* and *Air baffles for the drive module with option +B051 (page 168)*. For standard drive module configuration, see section *Standard drive module configuration (page 51)*.

Connecting the power cables and installing the shrouds

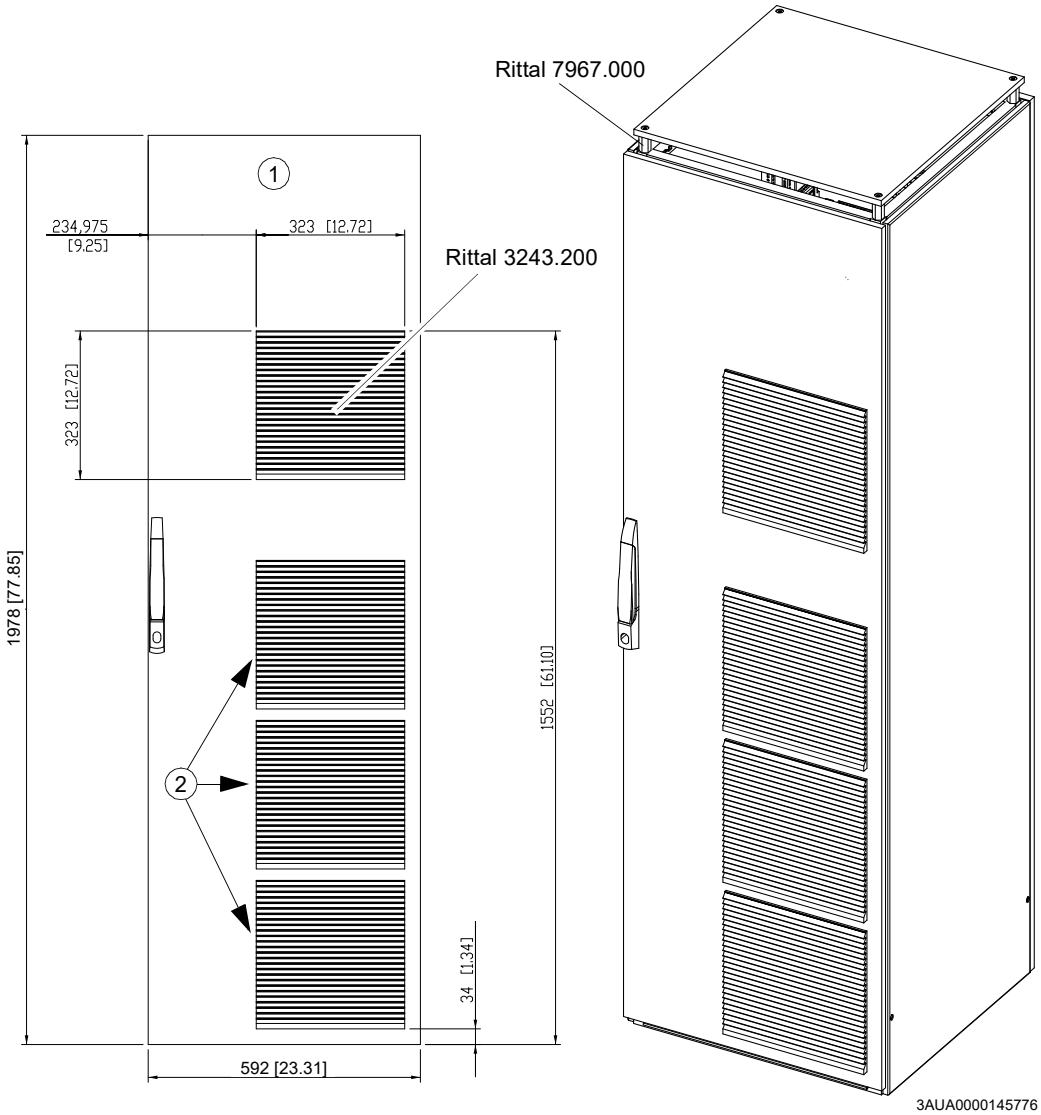
Step	Task (motor cables)
1	Install the grounding terminal to the drive module base.
2	Run the motor cables to the cabinet. Ground the cable shields 360 degrees at the cabinet entry.
3	Connect the twisted shields of the motor cables to the grounding terminal.
4	Screw in and tighten the insulators to the drive module by hand. Install the T3/W2 connection terminal to the insulators.  **WARNING!** 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. 
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 output clear plastic shroud from both sides.
11	Install the shroud to the drive module.
12	Install the lower front cover to the drive module.

Step	Task (input cables)
1	Ground the input cable shields (if present) 360 degrees at the cabinet entry.
2	Connect the twisted shields of the input cables and separate ground cable (if present) to the cabinet grounding busbar.
3	Step drill carefully sufficiently big holes to the lead-through clear plastic shroud for the cables to the 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 cabinet 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	For drive modules without option +H370: Connect the input cable conductors to the drive module L1/U1, L2/V1 and L3/W1 connection busbars, Go to step 12.
For option +H370: Perform steps 6 to 11.	
6	Screw in and tighten the insulators to the drive module by hand. Install the L1/U1 connection terminal to the insulators.  **WARNING!** 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.

Step	Task (input cables)
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 lead-through clear plastic shroud. Install the front clear plastic shroud and upper front cover. Remove the cardboard protective covering from the drive module air outlet.
13	Install the side and top clear plastic shrouds to the drive module.

Installing the roof and door (Rittal parts)

Install the air inlet gratings to the cabinet door and the spacers on top of the cabinet as shown below. This layout has been tested by ABB.



1	Door
2	Install these gratings as close to each other as possible. Remove the filter mats.

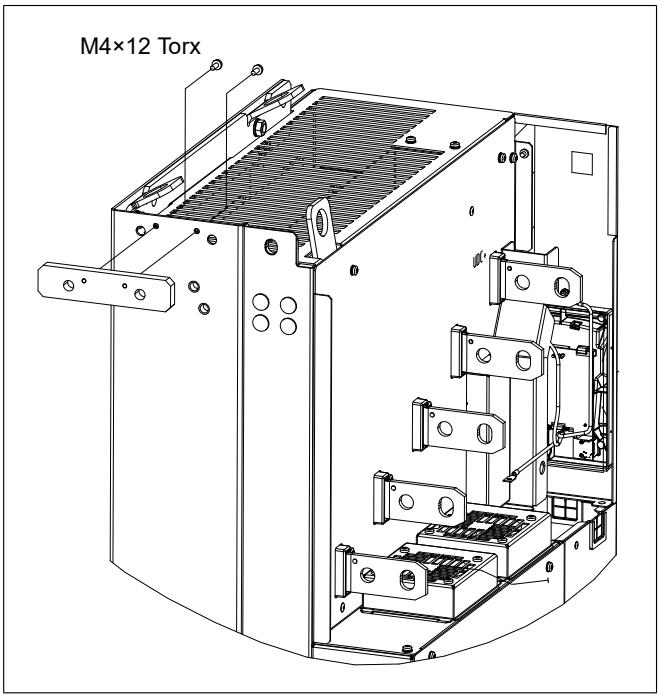
Miscellaneous

Input power cable entry from top

If you run the input cables from top to the drive module, drill the entry holes to the top clear plastic shroud.

Attaching the drive module to a mounting plate

Use the assembly support if you attach the drive module directly to the cabinet back plate. The support prevents the drive module screws from chafing the plate.



10

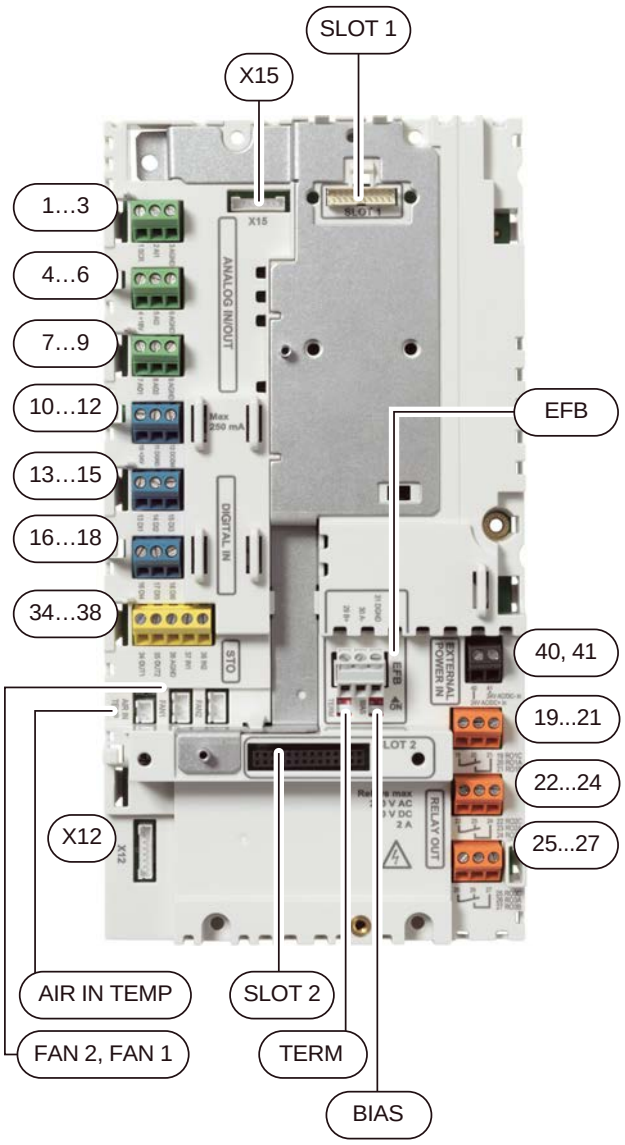
Control unit

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).

Layout

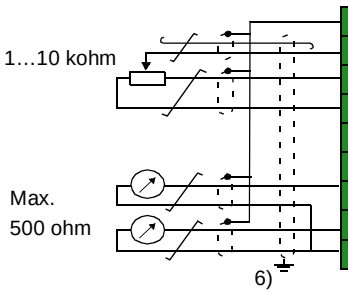
The layout of the external control connection terminals on the drive module control unit is shown below.



SLOT 1	
Option slot 1 (fieldbus adapter modules)	
ANALOG IN/OUT	
1…3	Analog input 1
4…6	Analog input 2
7…9	Analog outputs
10…12	Auxiliary voltage output, digital input common
DIGITAL IN	
13…18	Digital inputs
STO	
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.
EFB	
EIA/RS-485 fieldbus connector	
BIAS	Bias resistor switch
TERM	End termination switch
29…31	Connection terminals
SLOT 2	
Option slot 2 (I/O extension modules)	
40, 41	24 V AC/DC external power input
RO1 … RO3	
19…21	Relay output 1 (RO1)
22…24	Relay output 2 (RO2)
25…27	Relay output 3 (RO3)

Default I/O connection diagram

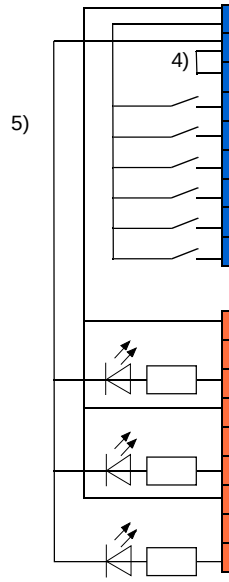
The default control connections for the Water default are shown below.



X1 Reference voltage and analog inputs and outputs

1	SCR	Signal cable shield (screen)
2	AI1	**Output frequency/speed reference**: 0…10 V [1)]
3	AGND	Analog input circuit common
4	+10V	Reference voltage 10 V DC
5	AI2	**Actual feedback:** 0…10 V [1)]
6	AGND	Analog input circuit common
7	AO1	**Output frequency:** 0…10 V
8	AO2	**Output current:** 0…20 mA
9	AGND	Analog output circuit common

X2 & X3 Aux. voltage output and programmable digital inputs



10	+24V	Aux. voltage output +24 V DC, max. 250 mA [2)]
11	DGND	Aux. voltage output common
12	DCOM	Digital input common for all
13	DI1	**Stop (0) / Start (1)**
14	DI2	Not configured
15	DI3	**Constant frequency/speed selection** [3)]
16	DI4	Not configured
17	DI5	Not configured
18	DI6	Not configured

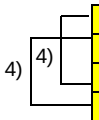
X6, X7, X8 Relay outputs

19	RO1C	**Ready run** 250 V AC / 30 V DC 2 A
20	RO1A	
21	RO1B	
22	RO2C	**Running** 250 V AC / 30 V DC 2 A
23	RO2A	
24	RO2B	
25	RO3C	**Fault (-1)** 250 V AC / 30 V DC 2 A
26	RO3A	
27	RO3B	

X5 Embedded fieldbus

29	B+	Embedded fieldbus, EFB (EIA-485)
30	A-	
31	DGND	
S4	TERM	Termination switch
S5	BIAS	Bias resistors switch

X4 Safe torque off



34	OUT1	Safe torque off. Factory connection. Both circuits must be closed for the drive to start. See chapter *Safe torque off function*
35	OUT2	
36	SGND	
37	IN1	
38	IN2	

X10 24 V AC/DC

40	24 V AC/DC+ in	Ext. 24V AC/DC input to power up the control unit when the main supply is disconnected. [7)]
41	24 V AC/DC- in	

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^2 (all terminals)

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

Notes:

1) Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} >200 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.

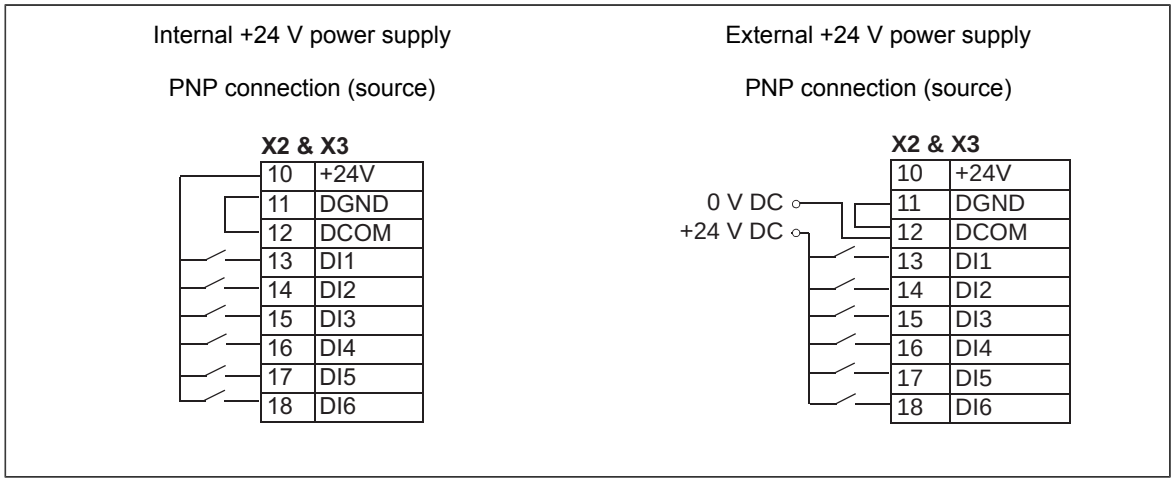
Switches

Switch	Description	Position	
TERM **S4**	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 **(default)**
			Bus terminated
BIAS **S5**	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 (**default**)
			Bias on

Additional information on I/O connections

PNP configuration for digital inputs (X2 & X3)

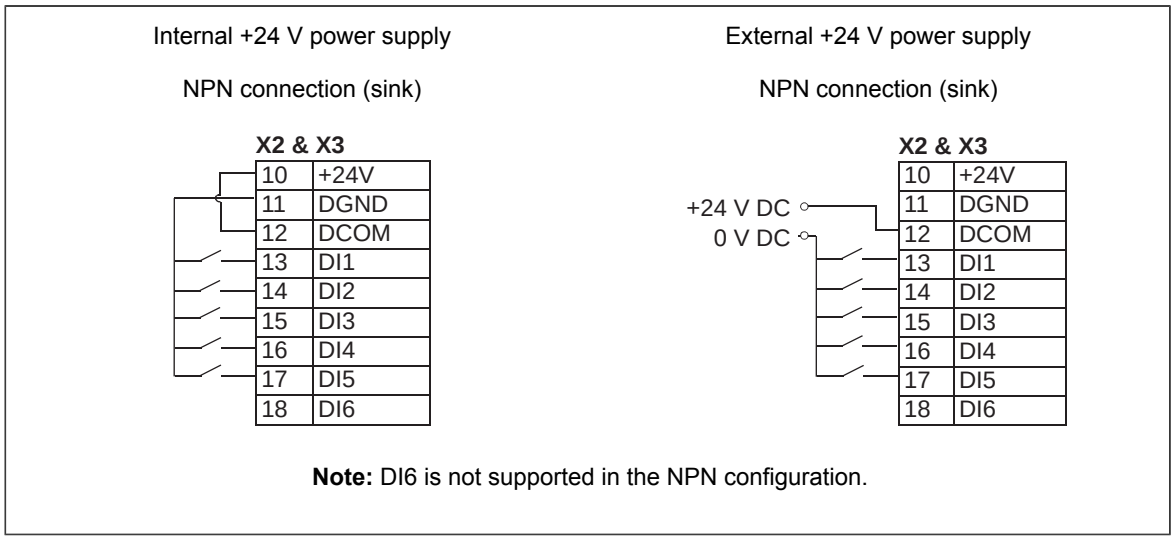
Internal and external +24 V power supply connections for PNP configuration are shown in the figure below.



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.

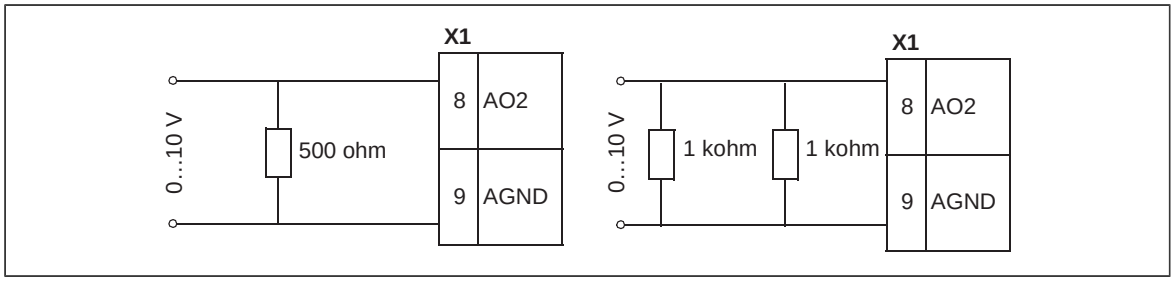


Note: DI6 is not supported in the NPN configuration.

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)

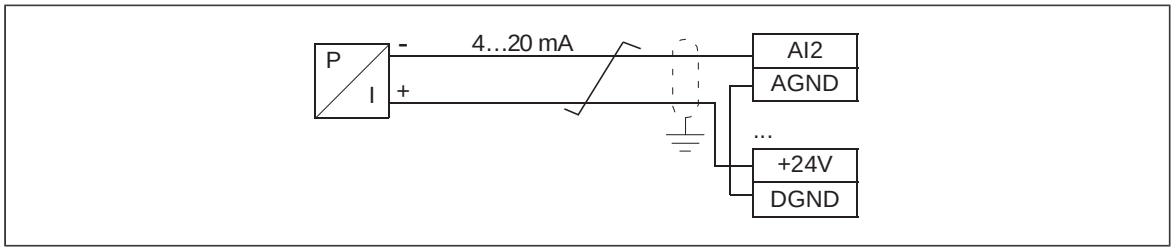
To obtain 0…10 V from analog output AO2, connect a 500 ohm resistor (or two 1 kohm resistors in parallel) between analog output AO2 and analog common ground AGND.



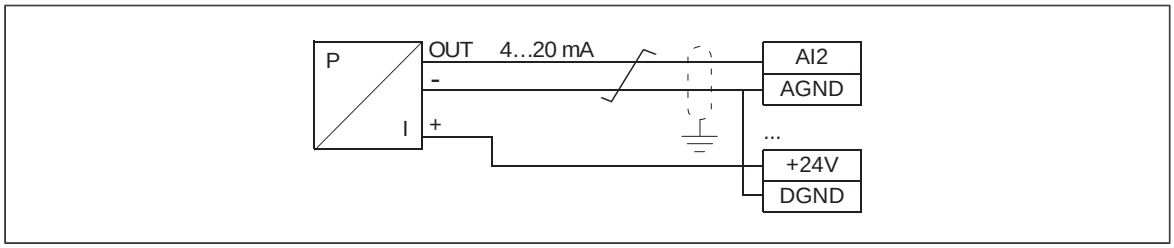
Connection examples of two-wire and three-wire sensors to analog input (AI2)

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.



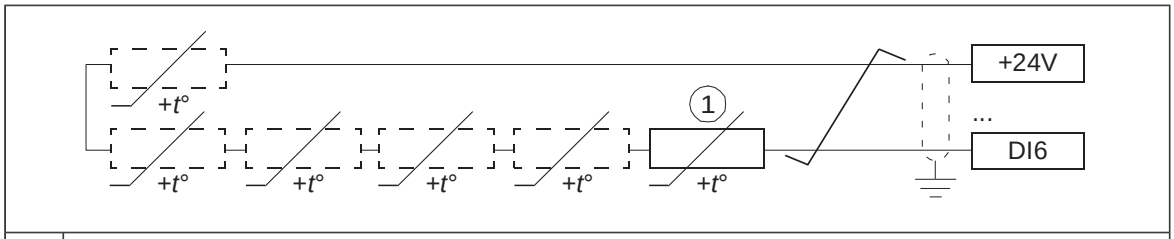
DI5 as frequency input

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.

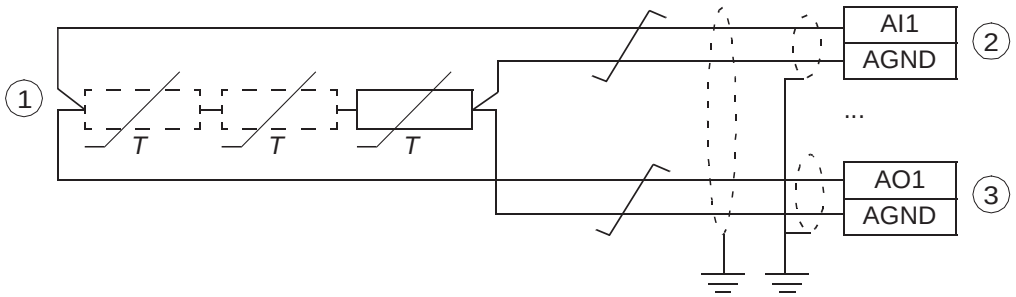
Note: If DI6 is used as a PTC input, the wiring and the PTC sensor need to be double isolated. Otherwise the CMOD-02 I/O extension module must be used.



1	One to six PTC thermistors connected in series

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.



1	One, two or three Pt100 sensors; one, two or three Pt1000 sensors; or one Ni1000, KTY83 or KTY84 sensor
2	Set the input type to voltage for analog input AI1 or analog input AI2 with parameters. Set the appropriate analog input unit to V (volt) in parameter group *12 Standard AI*.
3	Select the excitation mode in parameter group *13 Standard AO*.

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 171)*.

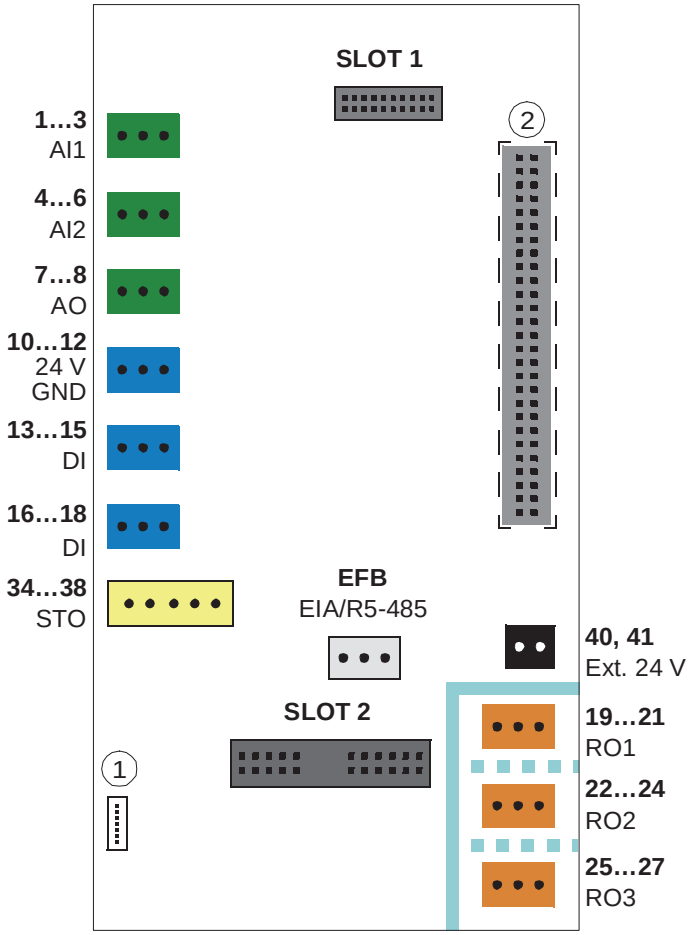
Note: Only 24 V DC can be used for STO. Only PNP input configuration can be used.

Technical data

External power supply Term. 40, 41	Maximum power: 36 W, 1.50 A at 24 V AC/DC ±10% as standard Terminal size: 0.14…2.5 mm^2
+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^2
Digital inputs DI1…DI6 (Term. 13…18)	Input type: NPN/PNP Terminal size: 0.14…2.5 mm^2 DI1…DI4 (Term.13…16) 12/24 V DC logic levels: "0" < 4 V, "1" > 8 V R_{in}: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling DI5 (Term.17) Can be used as a digital or frequency input. 12/24 V DC logic levels: "0" < 4 V, "1" > 8 V R_{in}: 3 kohm Max. frequency 16 kHz Symmetrical signal (duty cycle D = 0.50) DI6 (Term.18) Can be used as a digital or PTC input. 12/24 V DC logic levels: "0" < 3 V, "1" > 8 V R_{in}: 3 kohm Max. frequency 16 kHz Symmetrical signal (duty cycle D = 0.50) Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling **Note:** DI6 is not supported in the NPN configuration. PTC mode – PTC thermistor can be connected between DI6 and +24 V DC: < 1.5 kohm = '1' (low temperature), > 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
Relay outputs RO1…RO3 (Term. 19…27)	250 V AC / 30 V DC, 2 A Terminal size: 0.14…2.5 mm^2 See section *Isolation areas (page 116)*.
Analog inputs AI1 and AI2 (Term. 2 and 5)	Current/voltage input mode selected with a parameter, see *AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs (X1) (page 113)*. 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^2 Inaccuracy: typical ±1%, max. ±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 *Connection for obtaining 0…10 V from analog output 2 (AO2) (page 111)*. Current output: 0…20 mA, R_{load}: < 500 ohm Voltage input: 0…10 V, R_{load}: > 100 kohm (AO1 only) Terminal size: 0.14…2.5 mm^2 Inaccuracy: ±1% of full scale (in voltage and current modes)
Reference voltage output for analog inputs +10V DC (Term. 4)	Max. 20 mA output Inaccuracy: ±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^2
Embedded fieldbus (X5)	Connector pitch 5 mm, wire size 2.5 mm^2 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)

Isolation areas



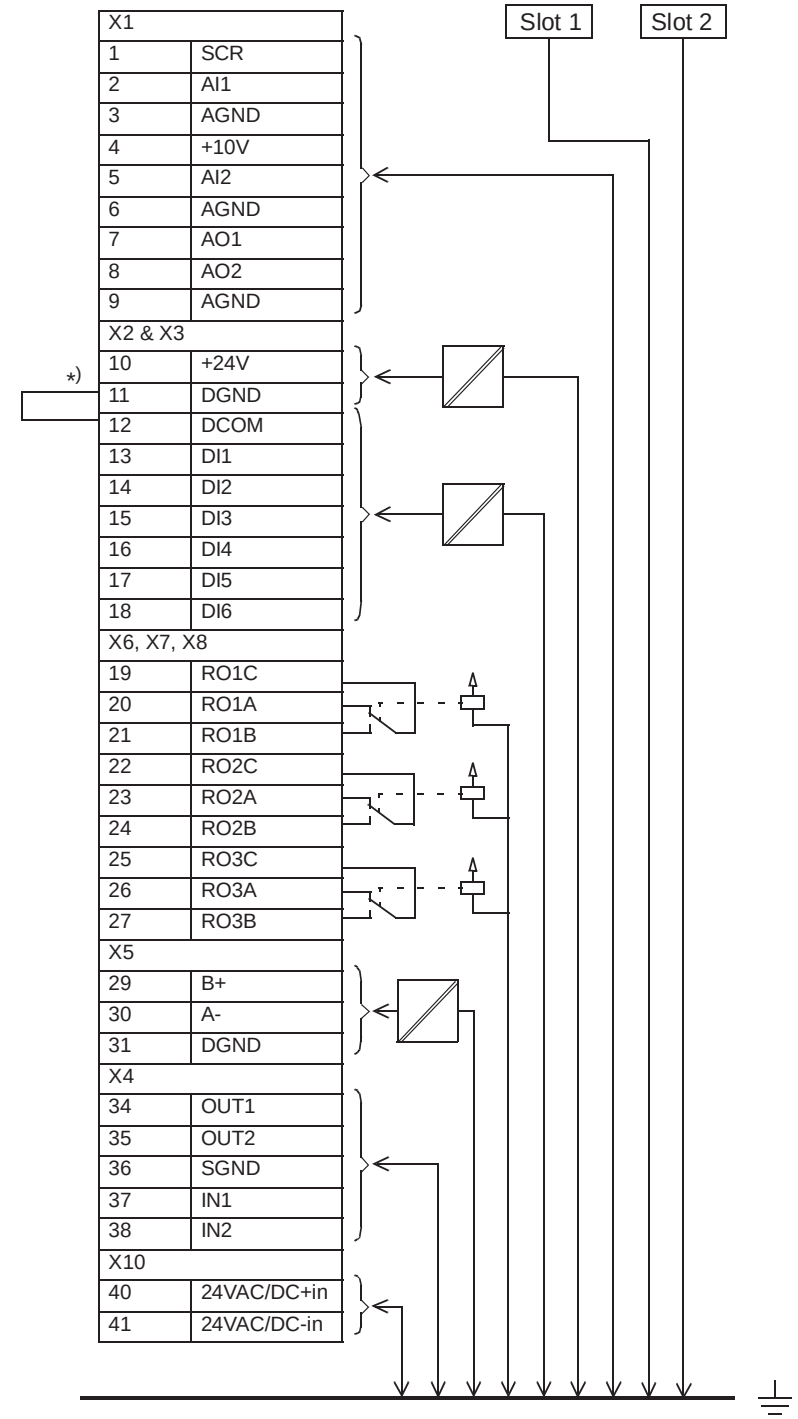
1	Panel port
2	Power unit connection at the bottom of the control unit
	Reinforced insulation (IEC/EN 61800-5-1:2007)
	Functional insulation (IEC/EN 61800-5-1:2007)

The terminals on the control board fulfill the Protective Extra Low Voltage (PELV) requirements (EN 50178): There is reinforced insulation between the user terminals which only accept ELV voltages and terminals that accept higher voltages (relay outputs).

Note: There is functional insulation also between the individual relay outputs.

Note: There is reinforced insulation on the power unit.

Ground isolation diagram



*) Jumper installed at factory

11

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.

Make sure that …	☑
The ambient operating conditions meet the drive ambient conditions specification, and enclosure rating (IP code or UL enclosure type).	☐
The supply voltage matches the nominal input voltage of the drive. See the type designation label.	☐
The insulation resistance of the input power cable, motor cable and motor is measured according to local regulations and the manuals of the drive.	☐
The drive cabinet is attached to the floor, and if necessary due to vibration etc, also by its top to the wall or roof.	☐
The drive module is fastened properly to the cabinet.	☐

Make sure that …	☑
The cooling air flows freely in and out of the drive. Air recirculation inside the cabinet is not be possible (air baffle plates are on place, or there is another air guiding solution).	☐
If the drive is connected to a network other than a symmetrically grounded TN-S system: You have done all the required modifications (for example, you may need to disconnect the EMC filter or ground-to-phase varistor). See the electrical installation instructions.	☐
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.	☐
The main circuit connections inside the drive cabinet correspond to the circuit diagrams.	☐
The control unit has been connected. See the circuit diagrams.	☐
Appropriate AC fuses and main disconnecting device are installed.	☐
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.	☐
The input power cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	☐
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.	☐
The motor cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	☐
The motor cable is routed away from other cables.	☐
No power factor compensation capacitors are connected to the motor cable.	☐
The control cables are connected to the correct terminals, and the terminals are tightened to the correct torque.	☐
If a drive bypass connection will be used: 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.	☐
There are no tools, foreign objects or dust from drilling inside the drive.	☐
The area in front of the drive is clean: the drive cooling fan cannot draw any dust or dirt inside.	☐
Cover(s) of the motor connection box are in place. Cabinet shrouds are in place and doors are closed.	☐
The motor and the driven equipment are ready for power-up.	☐

12

Start-up

Contents of this chapter

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

Start-up procedure

1. Make sure that the installation of the drive module has been checked according to the checklist in chapter *Installation checklist (page 119)*, and that the motor and driven equipment are ready for start.
2. Perform the start-up tasks instructed by the cabinet-installer of the drive module.
3. Run setup of the drive control program according to the start-up instructions given in the quick start-up guide or firmware manual.
4. 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 *Acceptance test procedure (page 179)*.

13

Fault tracing

Contents of this chapter

This chapter describes the fault tracing possibilities of the drive.

LEDs

Where	LED	Color	When the LED is lit
Control panel mounting platform	POWER	Green	Control unit is powered and +15 V is supplied to the control panel
	FAULT	Red	Drive in fault state

Warning and fault messages

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

14

Maintenance

Contents of this chapter

This chapter contains maintenance instructions of the drive module.

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). For more information, consult your local ABB Service representative www.abb.com/searchchannels).

Maintenance tasks, every year:

Item	Tasks
Connections and environment	
Quality of supply voltage	P
Spare parts	
Spare parts	I
DC circuit capacitors reforming for spare modules and spare capacitors	P
Inspections by user	
Tightness of terminals	I
Dustiness, corrosion and temperature	I
Cleaning of heatsinks	I

Maintenance tasks, every 9 years:

Component	Years from start-up						
	3	6	9	12	15	18	21
Cooling							
Main cooling fan			R			R	
Circuit board compartment cooling fans LONGLIFE			R			R	
Aging							
Control panel battery			R			R	
							4FPS10000309652

Legend:

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

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

Cabinet

Cleaning the interior of the cabinet

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

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

Heatsink

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

Cleaning the interior of the heatsink

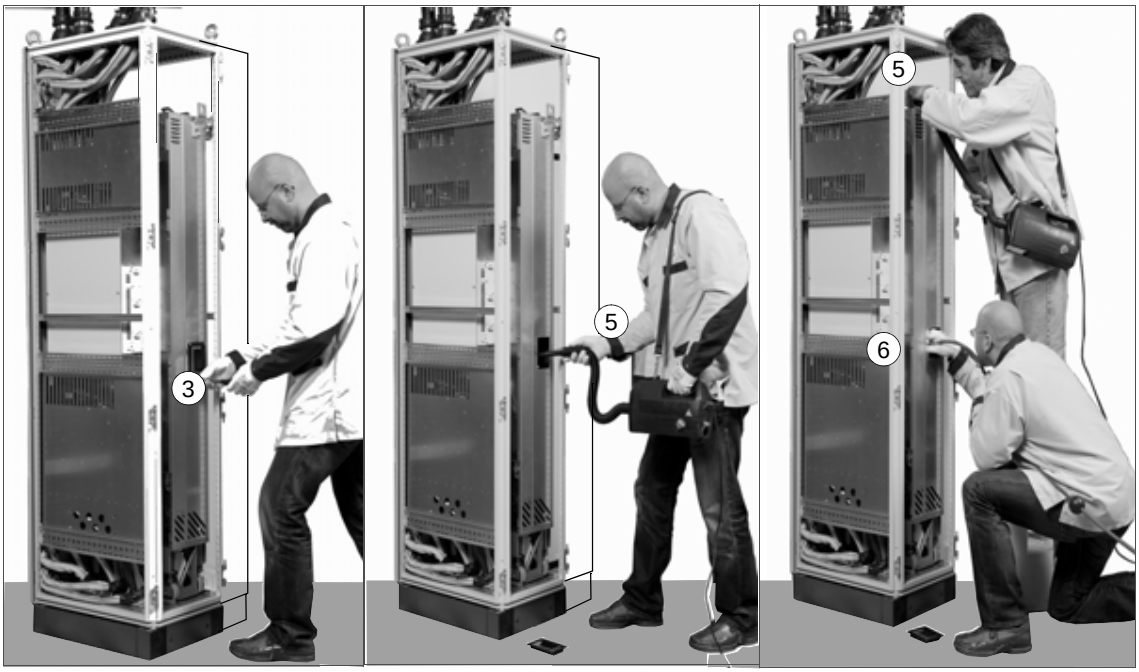
The module heatsink fins pick up dust from the cooling air. The drive runs into overtemperature warnings and faults if the heatsink is not clean.

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* 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 handle plate.


3
5
5
6

Fans

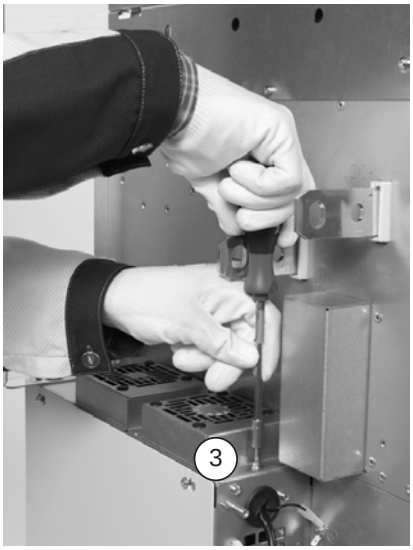
The lifespan of the cooling fans of the drive depends on the running time, ambient temperature and dust concentration. See the firmware manual for the actual signal which indicates the running time of the cooling fan. Reset the running time signal after fan replacement.

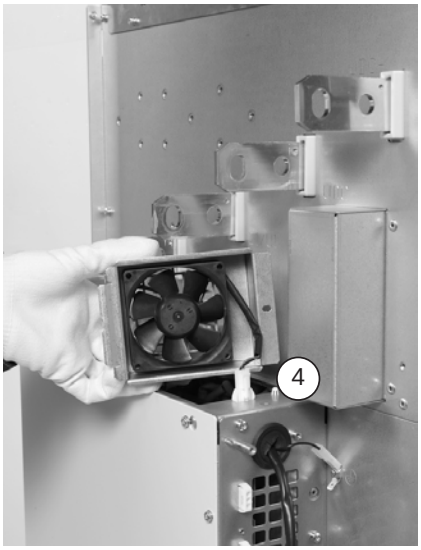
Replacement fans are available from ABB. Do not use other than ABB specified spare parts.

Replacing the circuit board compartment 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. Remove the drive module out of the cabinet as described in module replacement instructions.
3. Undo the fastening screw of the fan enclosure.
4. Unplug the power supply cable of the fan.
5. Install the new fan in reverse order to the above.
6. Reset the counter (if used) in group 5 in the control program.

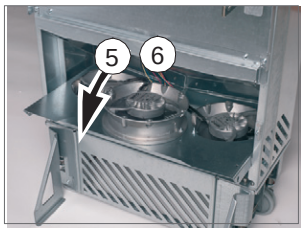


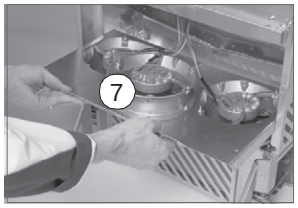


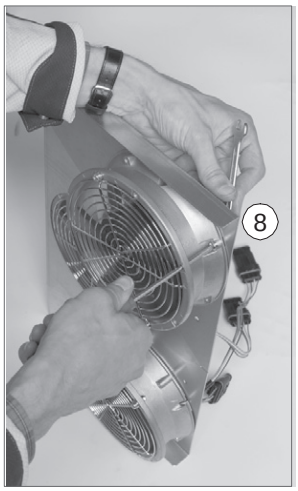
Replacing the main cooling fans

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. Remove the drive module out of the cabinet as described in module replacement instructions.
3. Open the support legs of the pedestal.
4. Undo the two screws that fasten the fan assembly plate.
5. Tilt the fan assembly plate down.
6. Disconnect the power supply wires of the fans.
7. Remove the fan assembly from the drive module.
8. Undo the fastening screws of the fan(s) and remove the fan(s) from the assembly plate.
9. Install the new fan in reverse order to the above.
10. Reset the counter (if used) in parameter group 5 in the control program.





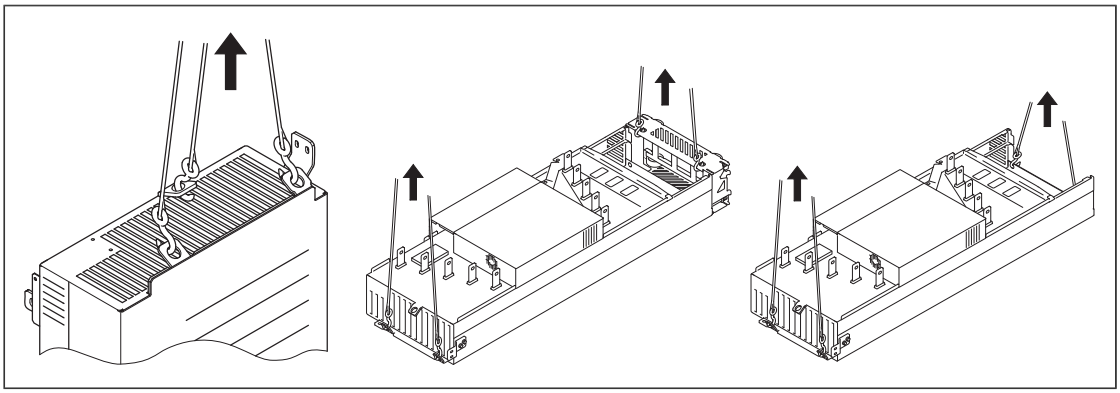


Replacing the drive module

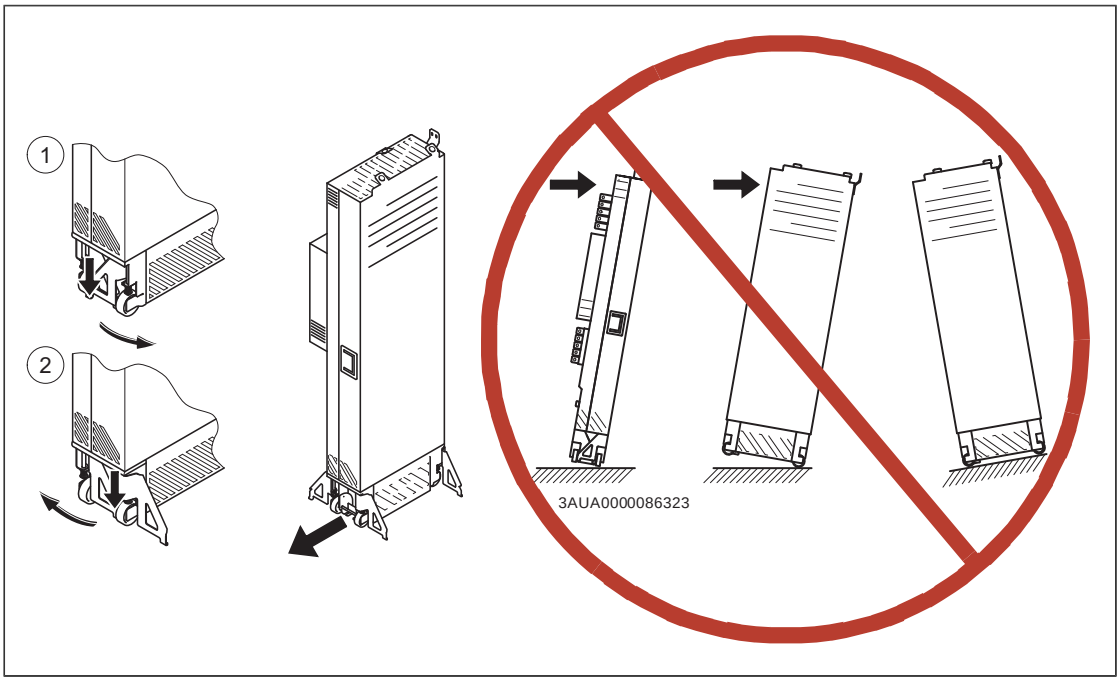
WARNING!
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

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.

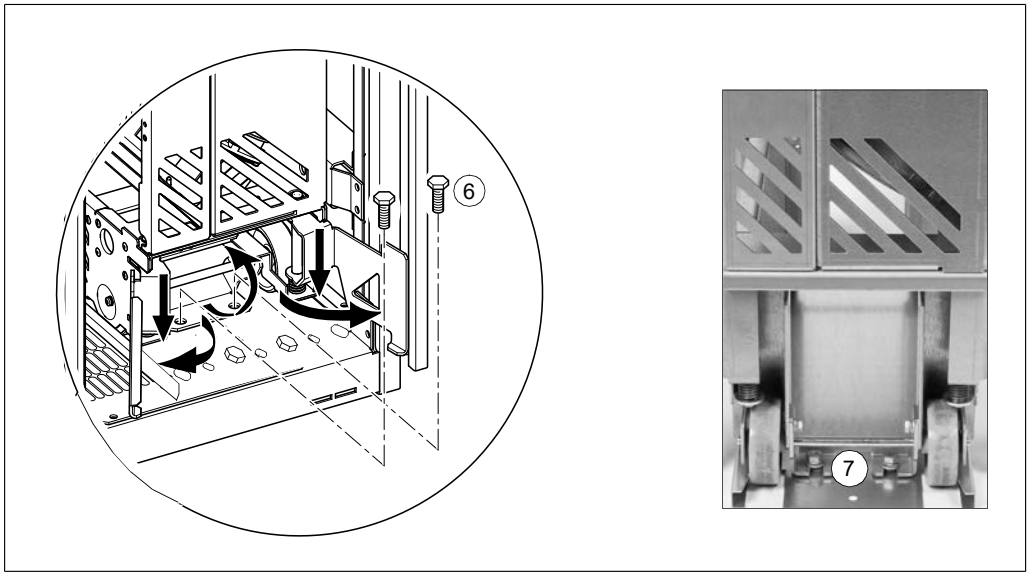


- Make sure that the module does not topple over when you move it on the floor: Open the support legs by pressing each leg a little down (1, 2) and turning it aside. Whenever possible attach the module also with chains. Do not tilt the drive module. It is heavy and its center of gravity is high. The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

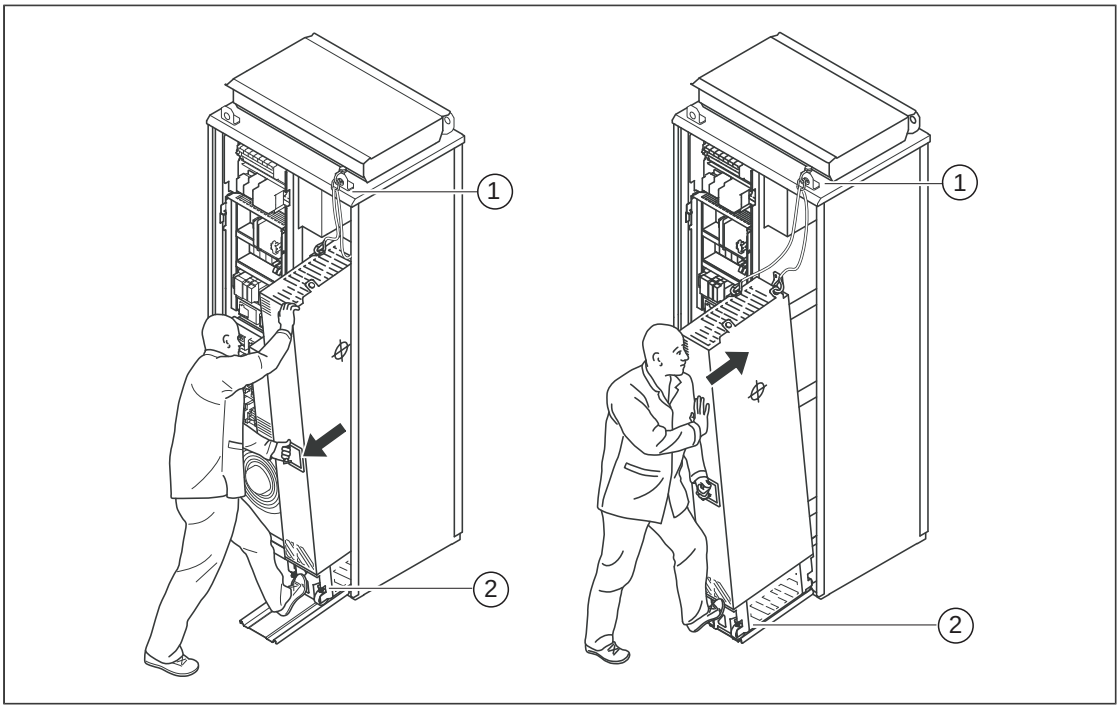


1. Stop the drive and do the steps in section *Electrical safety precautions (page 18)* before you start the work.
2. Make sure that all other precautions described in section *Grounding (page 20)* have been taken into consideration.

3. For option +B051, remove the clear plastic shrouds on the power cables and parts in front of the drive module.
4. Disconnect the power cables.
5. Disconnect the external control cables from 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. Attach the extraction/installation ramp to the cabinet base with two screws.
8. 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.



9. Install the new module in reverse order to the above.

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 [English]) in the ABB Library (https://library.abb.com/en) .

Control panel

See *ACx-AP-x assistant control panels user's manual* (3AUA0000085685 [English]).

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Technical data

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

IEC ratings

ACQ580-04-…	Frame size	Input current	Max. current	Output ratings					
				Nominal use		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 V									
505A-4	R10	505	560	505	250	485	250	361	200
585A-4	R10	585	730	585	315	575	315	429	250
650A-4	R10	650	730	650	355	634	355	477	250
725A-4	R11	725	1020	725	400	715	400	566	315
820A-4	R11	820	1020	820	450	810	450	625	355
880A-4	R11	880	1100	880	500	865	500	725**	400
									3AXD00000586715

ACQ580-04-…	Frame size	Input current	Max. current	Output ratings					
				Nominal use		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 V									
505A-4	R10	483	560	505	400	483	400	361	300
585A-4	R10	573	730	585	450	573	450	414	350
650A-4	R10	623	730	650	500	623	500	477	400
725A-4	R11	705	850	725	600	705	600	566	450
820A-4	R11	807	1020	820	700	807	700	625	500
880A-4	R11	807	1020	880	700	807	700	625	500
									3AXD00000586715

UL (NEC) ratings

ACQ580-04-…	Frame size	Input current	Max. current	Output ratings					
				Nominal use		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 V									
505A-4	R10	483	560	505	400	483	400	361	300
585A-4	R10	573	730	585	450	573	450	414	350
650A-4	R10	623	730	650	500	623	500	477	400
725A-4	R11	705	850	725	600	705	600	566	450
820A-4	R11	807	1020	820	700	807	700	625	500
880A-4	R11	807	1020	880	700	807	700	625	500
									3AXD00000586715

Definitions

U_n	Nominal voltage of the drive. For the input voltage range, see section *Electrical power network specification (page 146)*. 50 Hz for IEC ratings and 60 Hz for UL (NEC) ratings.
I_1	Nominal rms input current at 40 °C (104 °F). Continuous rms input current for dimensioning the cables and fuses.
I_{max}	Maximum output current. Available for 10 seconds at start, otherwise as long as allowed by drive temperature.
I_2	Continuous rms output current. Available continuously with no over-loading.
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 Minimum switching frequency* is set to 2 kHz or less * Typical ratings used for pumps and fans
P_{Ld}	Typical motor power for light-overload use (10% overload). The kilowatt ratings apply to most IEC 4-pole motors. The horsepower ratings apply to most NEMA 4-pole 460 V motors. * Typical ratings used for pumps and fans
I_{Hd}	Continuous rms output current allowing 50% overload for 1 minute every 10 minutes ** Continuous rms output current allowing 40% overload for 1 minute every 10 minutes
P_{Hd}	Typical motor power for heavy-duty use

Note:

- 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.
- ABB recommends to select the drive, motor and gear combination for the required motion profile with the DriveSize dimensioning tool available from ABB.

Output derating

When is derating necessary?

The output load capacity (I_2, I_{Ld}, I_{Hd}) decreases in certain situations. In such situations, and where full motor power is required, oversize the drive so that the total derated output current provides sufficient capacity to supply the required nominal voltage to run the motor.

Note: The DriveSize dimensioning PC tool available from ABB (http://new.abb.com/drives/software-tools/drivesize) is also suitable for derating.

Note: If several situations are present at a time, the effects of derating are cumulative:

I_2 (derated) or I_{Ld} (derated) or I_{Hd} (derated) = (I_2 or I_{Ld} or I_{Hd}) x (switching frequency derating) x (altitude derating) x (surrounding air temperature derating), where no derating = 1.0.

Note: The motor may have a derating on it too.

Example 1, IEC: How to calculate the derated current

The IP00 drive type is ACQ580-04-725A-4, which has drive output current of 725 A. Calculate the derated drive output current (I_2) at 4 kHz switching frequency, at 1500 m altitude and at 50 °C surrounding air temperature as follows:

1. *Switching frequency derating (page 139)*:
   The derating factor is 0.78. The derated drive output current becomes then I_2 = 0.78 · 725 A = 565.5 A.
2. *Altitude derating (page 139)*:
   The derating factor for 1500 m is 1 - 1/10 000 m · (1500 - 1000) m = 0.95. The derated drive output current becomes I_2 = 0.95 · 565.5 A = 537.2 A.
3. *Surrounding air temperature derating (page 138)*:
   The derating factor for 50 °C ambient temperature = 0.90. The derated drive output current becomes then I_2 = 0.90 · 575.2 A = 483.5 A.

Example 2, IEC: How to calculate the required drive

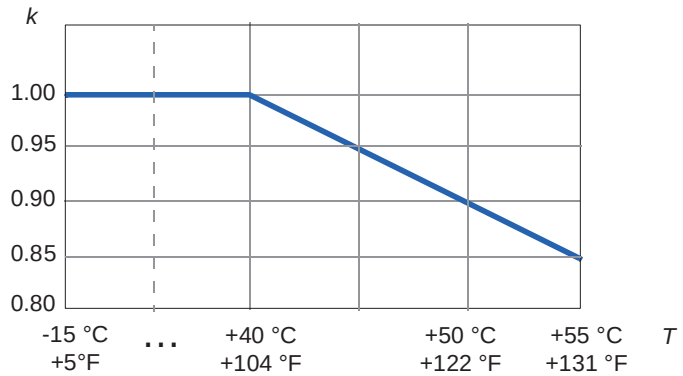
If your application requires continuous 585 A of motor current (I_2) at 4 kHz switching frequency, the supply voltage is 400 V and the drive is situated at 1500 m altitude and at 35 °C surrounding air temperature, calculate the appropriate IP00 drive size requirement as follows:

1. *Switching frequency derating (page 139)*:
   The minimum size required is I_2 = 585 A / 0.78 = 750 A, where 0.78 is the derating for 4 kHz switching frequency.
2. *Altitude derating (page 139)*:
   The derating factor for 1500 m is 1 - 1/10 000 m · (1500 - 1000) m = 0.95. Because the surrounding air temperature is below 40 °, the altitude derating can be reduced from 0.95 to 1 -> no derating is necessary for 1500 m altitude.
3. *Surrounding air temperature derating (page 138)*:
   No derating is necessary for 35 °C surrounding air temperature.

From the table in section *IEC ratings (page 136)*, drive type ACQ580-04-820A-4 exceeds the I_2 requirement of 750 A.

Surrounding air temperature derating

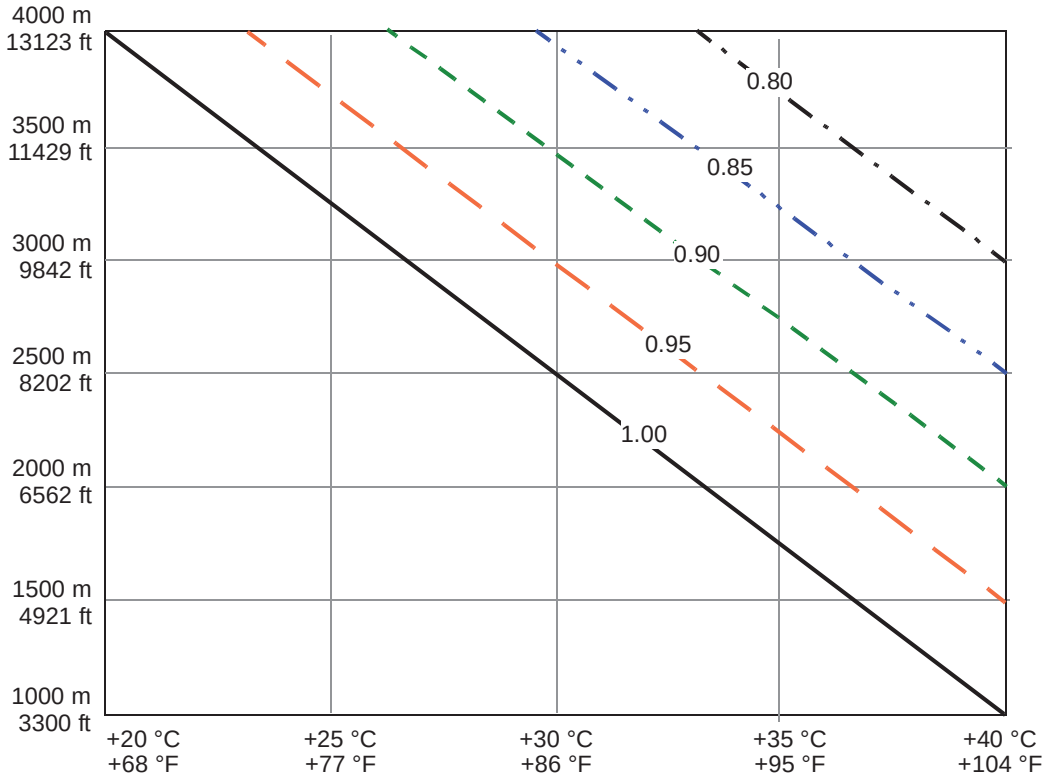
In the temperature range +40…55 °C, the rated output current is derated by 1% for every added 1 °C as follows. Calculate the output current by multiplying the current given in the rating table by the derating factor.



Altitude derating

At altitudes 1000 … 2000 m (3281 … 6562 ft) above sea level, the output current derating is 1 percentage point for every added 100 m (328 ft). For example, the derating factor for 1500 m (4921 ft) is 0.95. For altitudes above 2000 m (6562 ft), contact ABB.

If surrounding air temperature is below +40 °C, the derating can be reduced by 1.5 percentage points for every 1 °C reduction in temperature. A few altitude derating curves are shown below.



	Derating factor 1.00
	Derating factor 0.95
	Derating factor 0.90
	Derating factor 0.85
	Derating factor 0.80

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

Switching frequency derating

Switching frequencies other than 1.5 kHz can require output current derating. If you change the minimum switching frequency with parameter *97.02 Minimum switching frequency*, calculate the derated output current by multiplying the current given in the rating table by the derating factor given in the table below. Changing parameter *97.01 Switching frequency reference* does not require derating.

Derating factor (k) for the minimum switching frequencies			
1 kHz	**2 kHz**	**4 kHz**	**8 kHz**
1	0.92	0.78	0.58

Fuses (IEC)

aR fuses for protection against short-circuit in the input power cable or drive are listed below. Manufacturer Bussmann. Type (IEC 60269) = 3. Voltage rating 690 V.

ACQ580-04-…	Input current (A)	Ultrarapid (aR) fuses					
		Type DIN 43653 (bolted style)			Type DIN 43620 (blade style) 		
		Nominal current	I^2t	Fuse	Nominal current	I^2t	Fuse
		A	A^2s		A	A^2s	
U_n = 400 V							
505A-4	505	800	465000	170M6012	1600	4150000	170M8557D
585A-4	585	1000	945000	170M6014	1600	4150000	170M8557D
650A-4	650	1000	945000	170M6014	1600	4150000	170M8557D
725A-4	725	1250	1950000	170M6016	-	-	-
820A-4	820	1600	3900000	170M6269	-	-	-
880A-4	880	1600	3900000	170M6269	-	-	
U_n = 480 V							
505A-4	505	800	465000	170M6012	1600	4150000	170M8557D
585A-4	585	1000	945000	170M6014	1600	4150000	170M8557D
650A-4	650	1000	945000	170M6014	1600	4150000	170M8557D
725A-4	725	1250	1950000	170M6016	-	-	-
820A-4	820	1600	3900000	170M6269	-	-	-
880A-4	880	1600	3900000	170M6269	-	-	-
							3AXD00000586715

Note: See also section *Protecting the drive and input power cable in short-circuits (page 80)*.

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 meet 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 fuses for branch circuit protection per NEC are listed below. Obey local regulations.

ACQ580-04-…	Input current (A)	UL fuses				
		A	V	Manufacturer	UL class	Type
U_n = 480 V						
505A-4	505	600	600	Bussmann	T	JJS-600
585A-4	585	800	600	Ferraz	L	A4BY800
650A-4	650	800	600	Ferraz	L	A4BY800
725A-4	725	1000	600	Ferraz	L	A4BY1000
820A-4	820	1000	600	Ferraz	L	A4BY1000
880A-4	880	1000	600	Ferraz	L	A4BY1000

Notes:

1 The UL listed fuses in this hardware manual are the required branch circuit protection per NEC.

2 Fuses are required as part of the installation. Fuses are not included in the base drive configuration and must be provided by others.

3 Fuses with a higher current rating than specified must not be used.

4 Fuses with a lower current rating than specified may be used if they are of the same voltage and are UL 248 listed fast acting or high-speed fuses.

5 A fuse of a different class can be used at the high fault rating where the I_{peak} and I^2t of the new fuse is not greater than that of the specified fuse.

6 Recommended drive fuses must be used to maintain drive UL listing. Additional protection can be used. Refer to local codes and regulations.

7 When installing a drive always follow installation instructions and NEC requirements.

8 UL 248 listed, fast acting or high-speed fuses from other manufacturers can be used if they meet the rating requirements specified in the rules above.

9 Alternative fuses can be used if they meet certain characteristics. For acceptable fuses, see the manual supplement (3AXD50000645015).

In multicable installations, install only one fuse per phase (not one fuse per conductor).

Circuit breakers (IEC)

The table below lists the circuit breakers that can be used with the drive.

ACQ580-04-…	Frame size	ABB molded case circuit breaker (Tmax)	kA [1]
		Product ID (Type)	
U_n = 400 V			
505A-4	R10	1SDA054412R1 (T5H 630 PR221DS-LS/I In=630 3p F F)	30
585A-4	R10	1SDA069428R1 (T6V 800 PR221DS-LS/I In=800 3p F F)	30
650A-4	R10	1SDA069428R1 (T6V 800 PR221DS-LS/I In=800 3p F F)	30
725A-4	R11	1SDA062770R1 (T7H 1000 PR231/P LS/I In=1000A 3p F F)	50
820A-4	R11	1SDA062770R1 (T7H 1000 PR231/P LS/I In=1000A 3p F F)	50
880A-4	R11	1SDA062770R1 (T7H 1000 PR231/P LS/I In=1000A 3p F F)	50
			3AXD00000588487
[1] Maximum allowed rated conditional short-circuit current (IEC 61800-5-1) of the electrical power network			

ACQ580-04-…	Frame size	ABB molded case circuit breaker (Tmax)	kA [1]
		Product ID (Type)	
U_n = 480 V			
505A-4	R10	1SDA054412R1 (T5H 630 PR221DS-LS/I In=630 3p F F)	30
585A-4	R10	1SDA054412R1 (T5H 630 PR221DS-LS/I In=630 3p F F)	30
650A-4	R10	1SDA062770R1 (T7H 1000 PR231/P LS/I In=1000A 3p F F)	50
725A-4	R11	1SDA062770R1 (T7H 1000 PR231/P LS/I In=1000A 3p F F)	50
820A-4	R11	1SDA062770R1 (T7H 1000 PR231/P LS/I In=1000A 3p F F)	50
880A-4	R11	1SDA062770R1 (T7H 1000 PR231/P LS/I In=1000A 3p F F)	50
			3AXD00000588487
[1] Maximum allowed rated conditional short-circuit current (IEC 61800-5-1) of the electrical power network			

Dimensions, weights and free space requirements

Standard drive module configuration (IP00) and option +B051 (IP20 shrounds)				
Frame size	Height	Width	Depth	Weight*
	mm	mm	mm	kg
R10	1462	350	529	161

Standard drive module configuration (IP00) and option +B051 (IP20 shrounds)				
R11	1662	350	529	199

Standard drive module configuration (IP00) and option +B051 (IP20 shrounds)				
Frame size	**Height**	**Width**	**Depth**	**Weight***
	in	**in**	**in**	**lb**
R10	57.55	13.78	20.81	355
R11	65.43	13.78	20.81	439

Drive module with external control unit (option +P906)				
Frame size	**Height**	**Width**	**Depth**	**Weight***
	mm	**mm**	**mm**	**kg**
R10	1462	305	510	156
R11	1662	305	510	156

Drive module with external control unit (option +P906)				
Frame size	**Height**	**Width**	**Depth**	**Weight***
	in	**in**	**in**	**lb**
R10	57.55	12.01	20.08	345
R11	65.43	12.01	20.08	429

Weight of optional selections					
Frame size	**+0H354**	**+E208**	**+H356**	**+0H371**	**+H370**
	kg	**kg**	**kg**	**kg**	**kg**
R10	-7	3	2	-2.9	2.9
R11	-7	3	2	-2.9	2.9

Weight of optional selections					
Frame size	**+0H354**	**+E208**	**+H356**	**+0H371**	**+H370**
	lb	**lb**	**lb**	**lb**	**lb**
R10	-15	7	4	-6	6
R11	-15	7	4	-6	6

Height of drive module without pedestal (option +H354)	
Frame size	**mm**
R10/R11	-100

Height of drive module without pedestal (option +H354)	
Frame size	**in**
R10/R11	-3.94

* approximate (depends on the selected options)

For required free space around the drive module, see section *Free space requirements (page 53)*.

Losses, cooling data and noise

ACQ580-04…	Frame size	Air flow		Heat dissipation	Noise
		m³/h	cfm	W	dB(A)
505A-4	R10	1200	707	5602	72
585A-4	R10	1200	707	6409	72
650A-4	R10	1200	707	8122	72
725A-4	R11	1200	707	8764	72
820A-4	R11	1200	707	9862	72
880A-4	R11	1420	848	10578	71
3AXD00000586715					

Terminal and entry data for the power cables

The maximum accepted cable size is 4 × (3 × 240) mm² 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).

Drive modules without output cable connection terminals (+0H371) and with a common mode filter (+E208)

It is possible to use the maximum cable size 4 × (3 × 240) mm² or 4 ×(3 × 500 AWG) only with special cable lugs and additional insulation. For more information, contact your local ABB representative.

Typical power cable sizes

The table below gives copper and aluminium cable types with concentric copper shield for the drives with nominal current. See also section *Terminal and entry data for the power cables (page 144)*.

ACQ580-04-…	IEC [1]	
	Cu cable	Al cable
	mm²	mm²
U_n = 400 V		
505A-4	3 × (3×95)	3 × (3×150)
585A-4	3 × (3×120)	3 × (3×185)
650A-4	3 × (3×150)	3 × (3×240)
725A-4	3 × (3×185)	4 × (3×185)
820A-4	3 × (3×240)	4 × (3×240)
880A-4	3 × (3×240)	4 × (3×240)
U_n = 480 V		
505A-4	3 × (3×95)	3 × (3×150)
585A-4	3 × (3×95)	3 × (3×150)
650A-4	3 × (3×120)	3 × (3×185)
725A-4	3 × (3×150)	3 × (3×240)
820A-4	3 × (3×185)	4 × (3×185)
880A-4	3 × (3×240)	4 × (3×240)
		3AXD00000588487

ACQ580-04-…	UL (NEC) [2]
	Cu cable
	AWG/kcmil per phase
U_n = 400 V	
505A-4	2 × 500 MCM or 3 × 250 MCM
585A-4	2 × 600 MCM or 3 × 300 MCM
650A-4	2 × 700 MCM or 3 × 350 MCM
725A-4	3 × 500 MCM or 4 × 300 MCM
820A-4	3 × 600 MCM or 4 × 400 MCM
880A-4	3 × 600 MCM or 4 × 400 MCM
U_n = 480 V	
505A-4	2 × 400 MCM or 3 × 4/0
585A-4	2 × 500 MCM or 3 × 250 MCM
650A-4	2 × 600 MCM or 3 × 300 MCM
725A-4	2 × 700 MCM or 3 × 350 MCM
820A-4	3 × 500 MCM or 4 × 300 MCM
880A-4	3 × 600 MCM or 4 × 400 MCM
	3AXD00000588487

1) 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 PVC insulation, surface temperature 70 °C (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.

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

Terminal data for the control cables

See chapter *Control unit (page 107)*.

Electrical power network specification

Voltage (U_1)	ACQ580-04-xxxx-4 drive modules: 380...480 V AC 3-phase ±10%. This is indicated in the type designation label as typical input voltage levels 3~400/480 V AC.
Network type	TN (grounded) and IT (ungrounded) systems
Rated conditional short-circuit current I_{cc} (IEC 61439-1)	Maximum allowable prospective short-circuit current is 65 kA when protected by the fuses given in the fuse table.
Prospective short-circuit current rating Pscc (IEC 61800-5-1)	Maximum allowable prospective short-circuit current is 65 kA when protected by the fuses given in the fuse table.
Prospective short-circuit current rating SCCR (UL 61800-5-1)	The drive is suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes at 480 V maximum when protected by the fuses given in the fuse table.
Frequency	48 to 63 Hz, maximum rate of change 17%/s
Imbalance	Max. ± 3% of nominal phase to phase input voltage
Fundamental power factor (cos phi$_1$)	0.98 (at nominal load)

Motor connection data

Motor types	Asynchronous AC induction motors, synchronous reluctance motors and synchronous permanent magnet motors
Voltage (U_2)	0 to U_1, 3-phase symmetrical. This is indicated in the type designation label as typical output voltage level as 3~0…U_1.
Frequency	0…500 Hz. For drives with du/dt filter: 200 Hz
Frequency resolution	0.01 Hz
Current	See section *Electrical ratings (page 136)*.
Switching frequency	1 kHz, 2 kHz, 4 kHz, 8 kHz (depends on the parameter settings). See the firmware manual.

Maximum recommended motor cable length	300 m (984 ft) in vector and scalar control **Note:** Motor cable longer than 100 m (328 ft) is allowed but then the EMC Directive requirements of Category C3 may not be fulfilled. **Note:** Long 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.

DC connection data

ACQ580-04-…	I_{DC} (A)	Capacitance (mF)
U_N = 400 V		
505A-4	640	14
585A-4	714	14
650A-4	870	14
725A-4	909	21
820A-4	1033	21
880A-4	1120	21

Control panel type

See section *Type designation key (page 35)*.

Control unit data

See chapter *Control unit (page 107)*.

Efficiency

Approximately 98% at nominal power level

Protection classes

IP00 / UL Type Open. With clear plastic shrouds (option +B051) and bottom grille installed: IP20 / UL Type 1

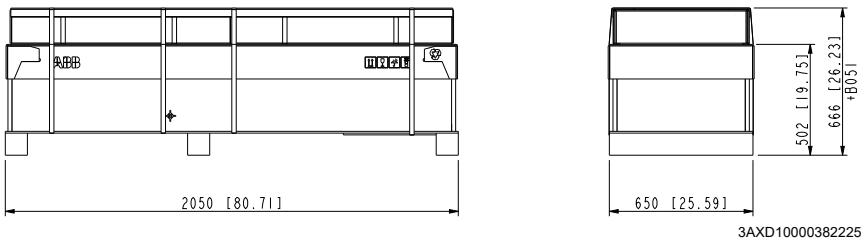
Ambient conditions

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

	Operation	Storage in the protective package	Transportation in the protective package
Installation site altitude	For TN and TT neutral-grounded network systems and IT non-corner-grounded network systems: 0 to 4000 m (13123 ft) above sea level For TN, TT and IT corner-grounded network systems: 0 to 2000 m (6561 ft) above sea level Above 1000 m (3281 ft): see section *When is derating necessary*	-	-
Surrounding air temperature	-15…+55 °C. No frost allowed. See section *When is derating necessary*	-40… 70 °C	-40…+70 °C
Relative humidity	5…95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination	IEC/EN 60721-3-3:2002	IEC 60721-3-1:1997	IEC 60721-3-2:1997
Chemical gases	Class 3C2	Class 1C2	Class 2C2
Solid particles	Class 3S2. No conductive dust allowed.	Class 1S3. (packing must support this, otherwise 1S2)	Class 2S2
Pollution degree	2		
Atmospheric pressure	70…106 kPa (0.7 … 1.05 atmospheres)	70…106 kPa (0.7 … 1.05 atmospheres)	60…106 kPa 0.6 … 1.05 atmospheres
Vibration IEC 60068-2-6:2007, EN 60068-2-6:2008	Max. 0.1 mm (0.004 in) (10…57 Hz), max. 10 m/s^2 (33 ft/s^2) (57…150 Hz) sinusoidal	Max. 1 mm (0.04 in) (5 … 13.2 Hz), max. 7 m/s^2 (23 ft/s^2) (13.2…100 Hz) sinusoidal	Max. 3.5 mm (0.14 in) (2…9 Hz), max. 15 m/s^2 (49 ft/s^2) (9…200 Hz) sinusoidal
Shock IEC 60068-2-27:2008, EN 60068-2-27:2009	Not allowed	With packing max. 100 m/s^2 (330 ft/s^2), 11 ms	With packing max. 100 m/s^2(330 ft/s^2), 11 ms
Free fall	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

Drive enclosure	PC/ABS 2.5 mm, color NCS 1502-Y (RAL 9002 / PMS 420 C) hot-dip zinc coated steel sheet 1.5 to 2.5 mm, thickness of coating 100 micrometers, color NCS 1502-Y

Package	Plywood and cardboard, bands PP. 
Disposal	The main parts of the drive can be recycled to preserve natural resources and energy. Product parts and materials should be dismantled and separated. Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and large electrolytic capacitors need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code. Contact your local ABB distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations.

Applicable standards

The drive complies with the following standards.

IEC/EN 61800-5-1:2007	*Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy*
EN 60204-1:2006 + A1:2009 + AC:2010	*Safety of machinery. Electrical equipment of machines. Part 1: General requirements*. Provisions for compliance: The final assembler of the machine is responsible for installing - emergency-stop device - supply disconnecting device - IP00 drive module into a cabinet.
IEC 60529:1989 + A1:1999 + A2:2013 **EN 60529:1991 + A1:2000 + A2:2013**	*Degrees of protection provided by enclosures (IP code)*
IEC 61800-3:2017 **EN 61800-3:2018**	*Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods*
UL 61800-5-1: First edition	*Standard for Safety, Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy*
CSA C22.2 No. 0-10	*General Requirements - Canadian Electrical Code, Part II*
CSA C22.2 No. 274-17	*Adjustable speed drives*

Markings

CE	CE mark Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).

c UL us LISTED	UL Listed mark for USA and Canada Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories. Valid with rated voltages up to 600 V.
EAC	EAC (Eurasian Conformity) mark Product complies with the technical regulations of the Eurasian Customs Union. EAC mark is required in Russia, Belarus and Kazakhstan.
	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).
	Electronic Information Products (EIP) green mark The product complies with *the People's Republic of China Electronic Industry Standard* (SJ/T 11364-2014). 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.
KC	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.
TÜV NORD Safety Approved	TÜV Safety Approved mark (functional safety) Product contains Safe Torque Off and possibly other (optional) safety functions which are certified by TÜV according to the relevant functional safety standards. Applicable to drives and inverters; not applicable to supply, brake or DC/DC converter units or modules.
	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.

EMC compliance (IEC/EN 61800-3:2004 + A2012)

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:

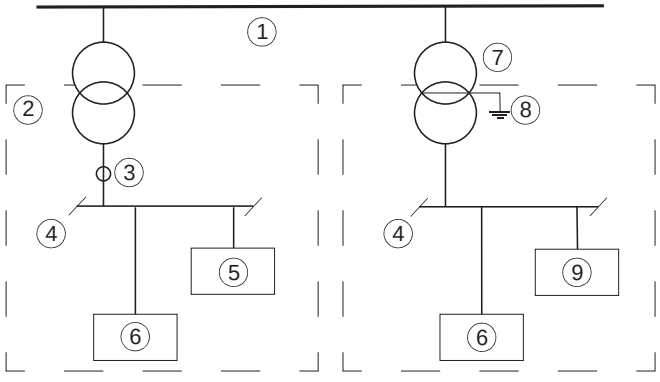
1. The drive is equipped with EMC filter (+E210) and common mode filter (+E208).
2. The motor and control cables are selected as specified in the hardware manual.
3. The drive is installed according to the instructions given in the hardware manual.
4. Maximum motor cable length is 100 meters (328 ft).
5. The value of parameter *97.01 Switching frequency reference* is set to 2 kHz or lower.

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

Category C4

The drive complies with the C4 category with these provisions:

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



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

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available in *Technical guide No. 3 EMC compliant installation and configuration for a power drive system* (3AFE61348280 (English)).

3. The motor and control cables are selected, and routed according to the electrical planning guidelines of the drive. The EMC recommendations are obeyed.
4. The drive is installed according to its installation instructions. The EMC recommendations are obeyed.

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

Compliance with the European Machinery Directive

The drive is an electronic product which is covered by the European Low Voltage Directive. However, the drive includes the Safe torque off function and can be equipped with other safety functions for machinery which, as safety components, are in the scope of the Machinery Directive. These functions of the drive comply with European harmonized standards such as EN 61800-5-2. The declaration of conformity is shown in chapter *The Safe torque off function (page 171)*.

UL and CSA checklist

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.

- 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, 480 V maximum when protected by the UL fuses given elsewhere in this chapter. The ampere rating is based on tests done according to the appropriate UL standard.
- 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.

- 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.

Disclaimers

Generic disclaimer

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

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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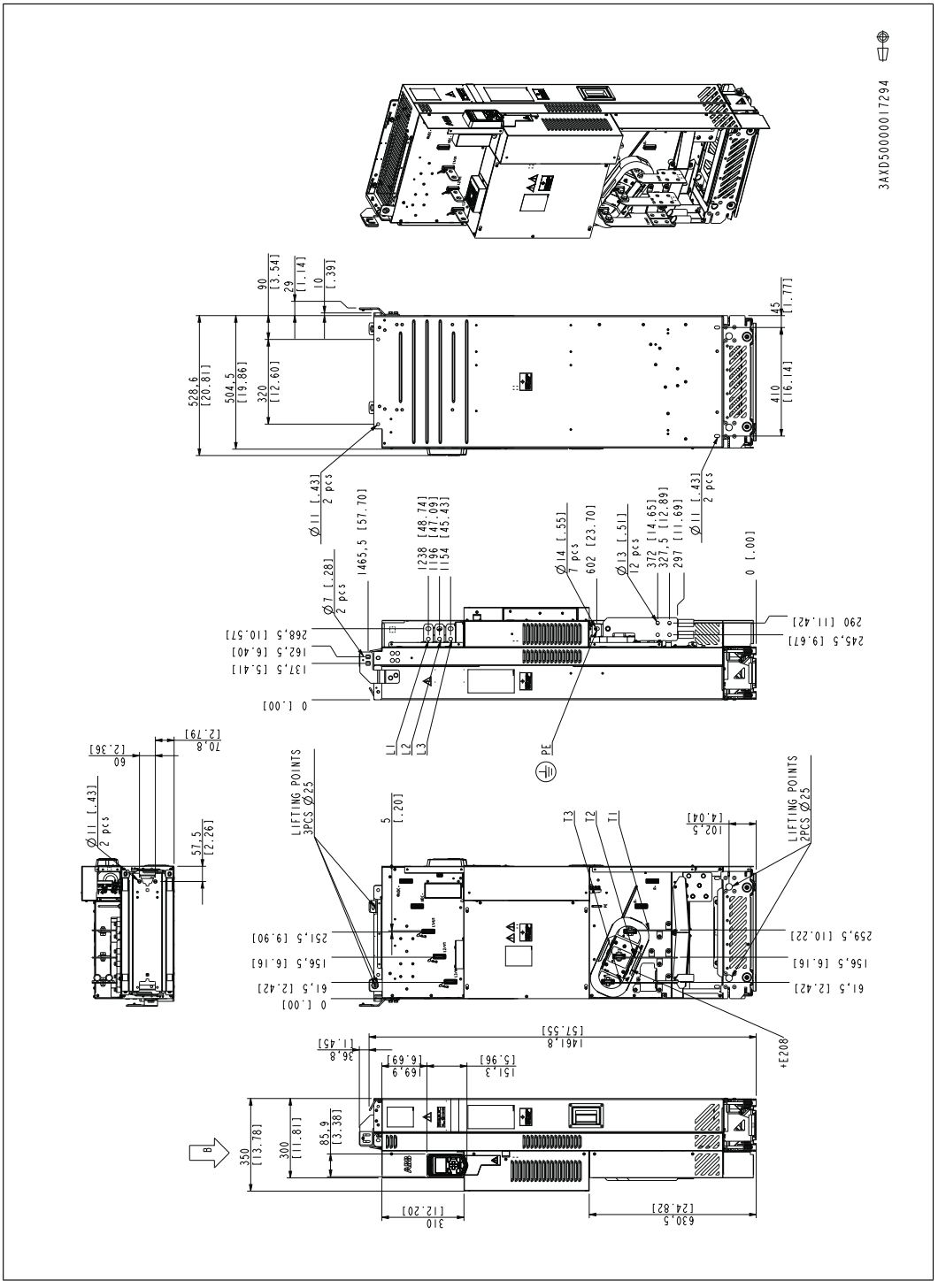
Dimension drawings

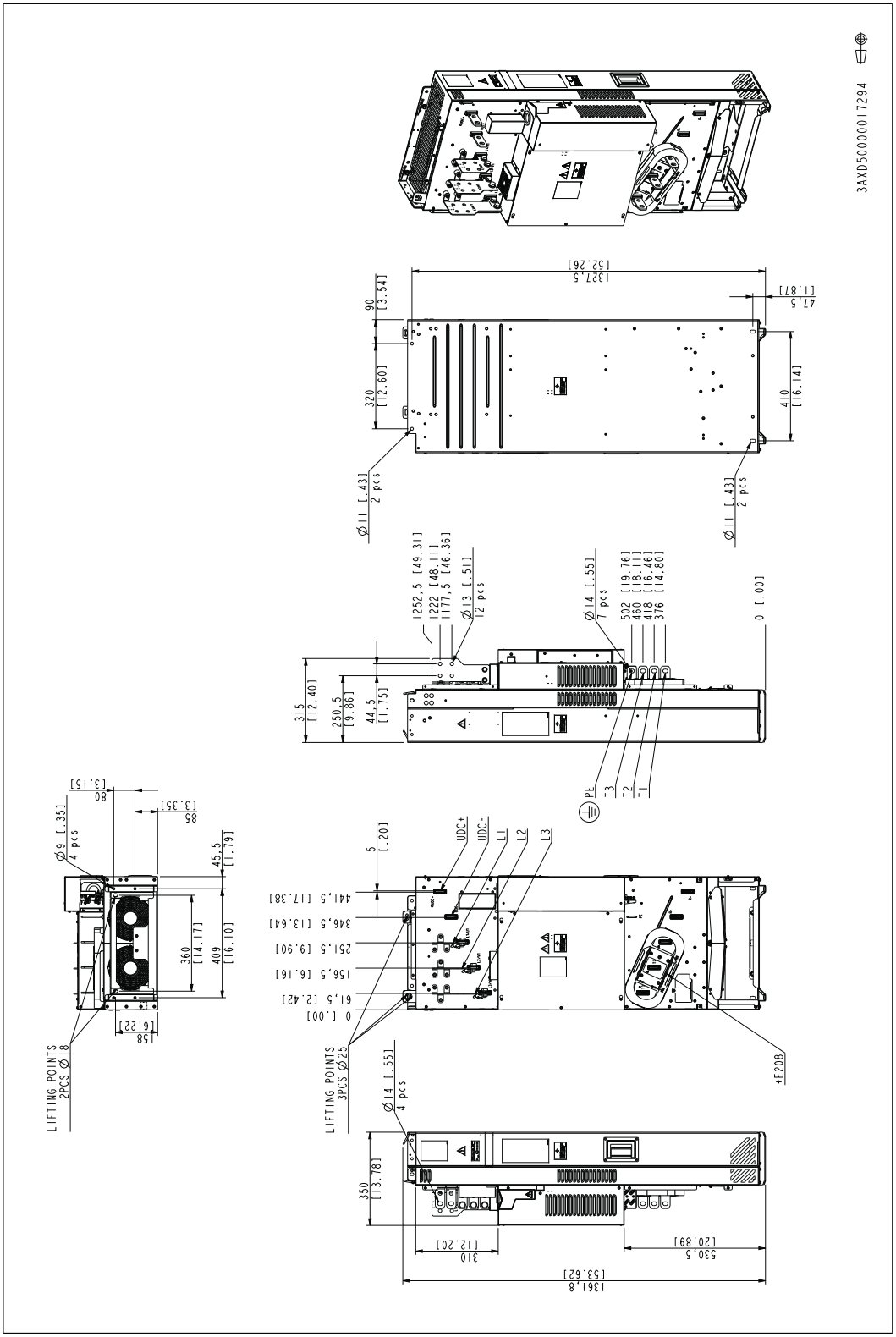
Contents of this chapter

This chapter contains dimension drawings of the drive modules.

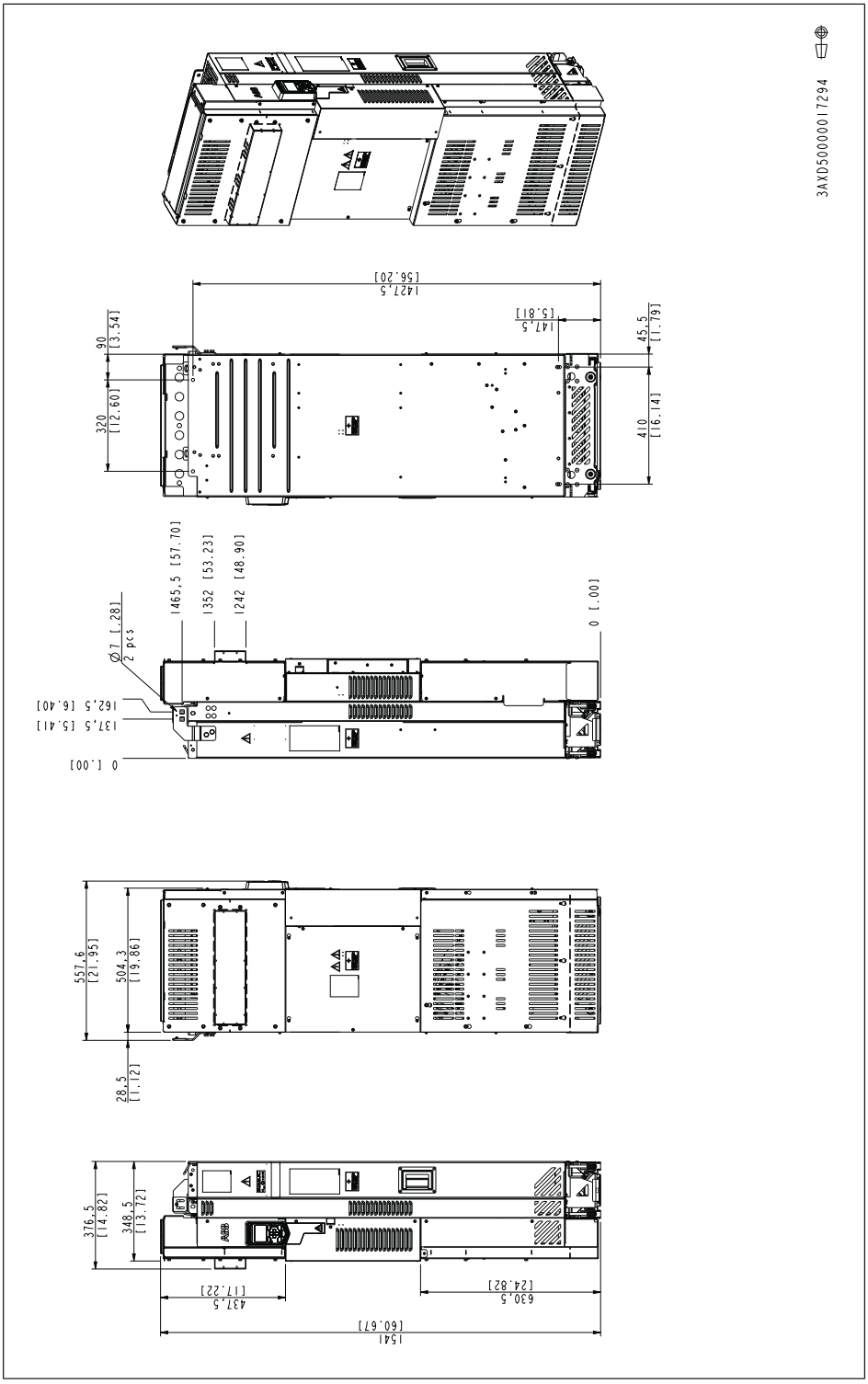
R10 standard configuration



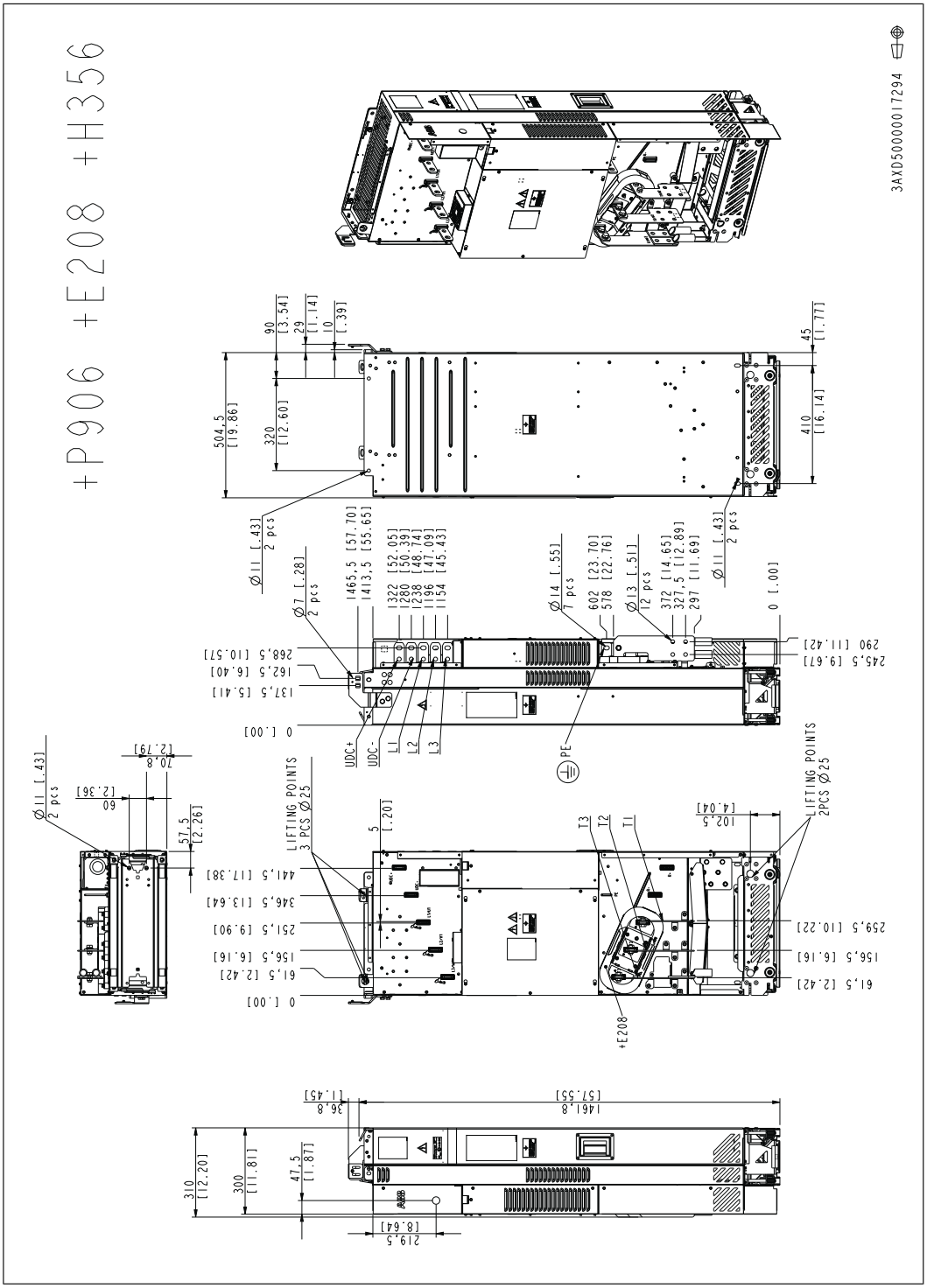
R10 with +E208+0H354+H356+H370+0H371



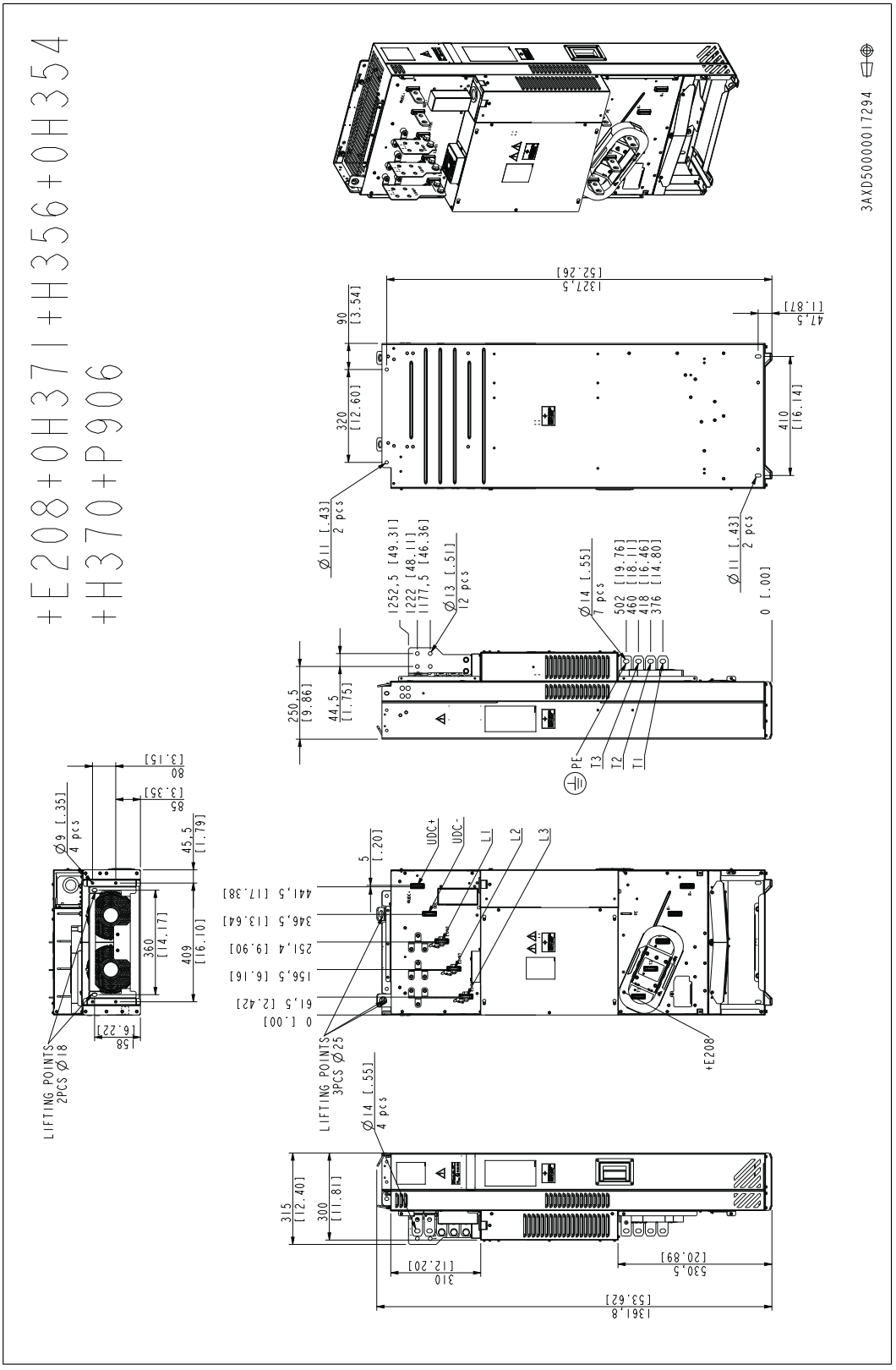
R10 with option +B051



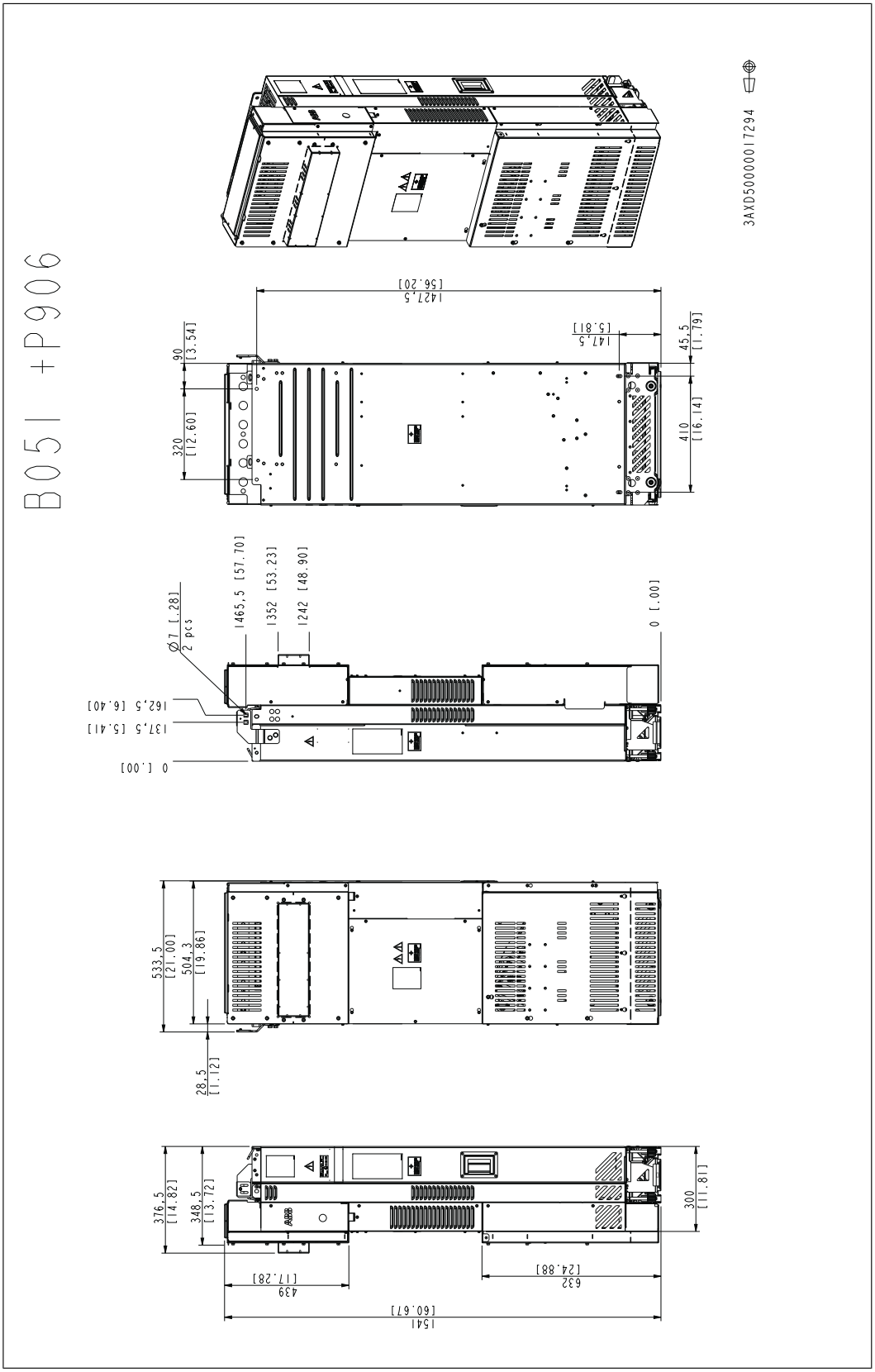
R10 with option +E208 +H356 +P906



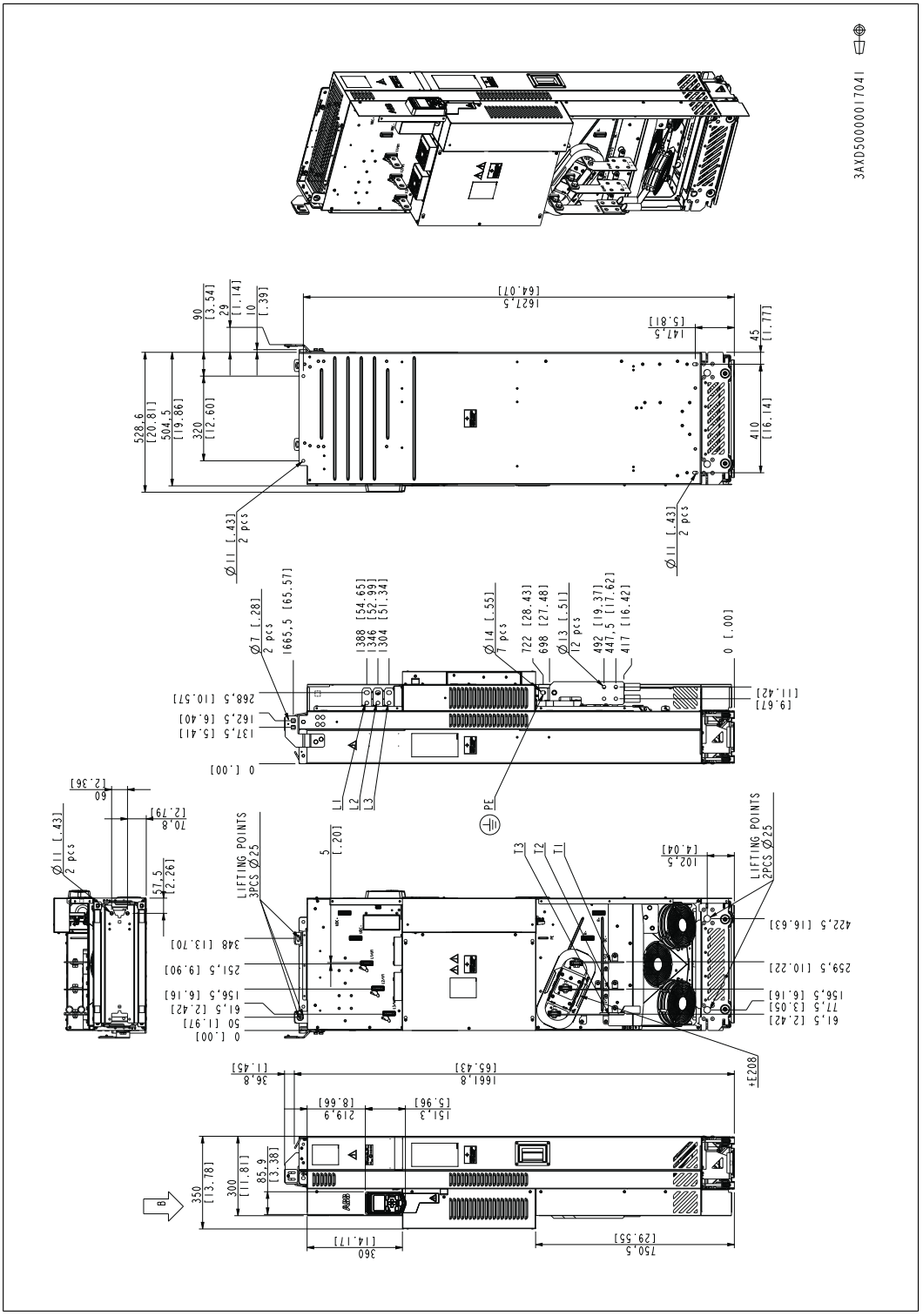
R10 with option +E208+0H371+H356+0H354+H370+P906



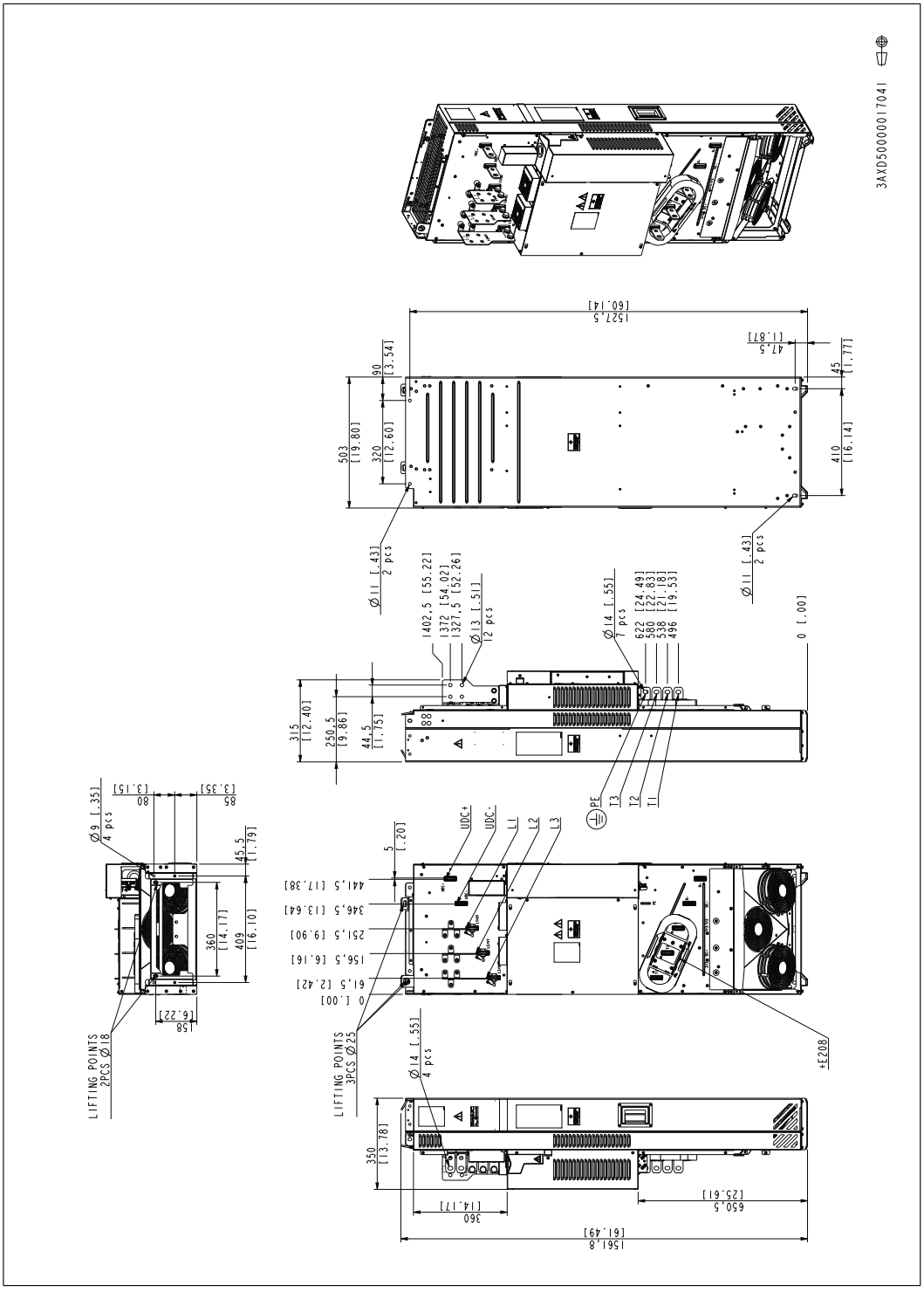
R10 with option +B051 +P906



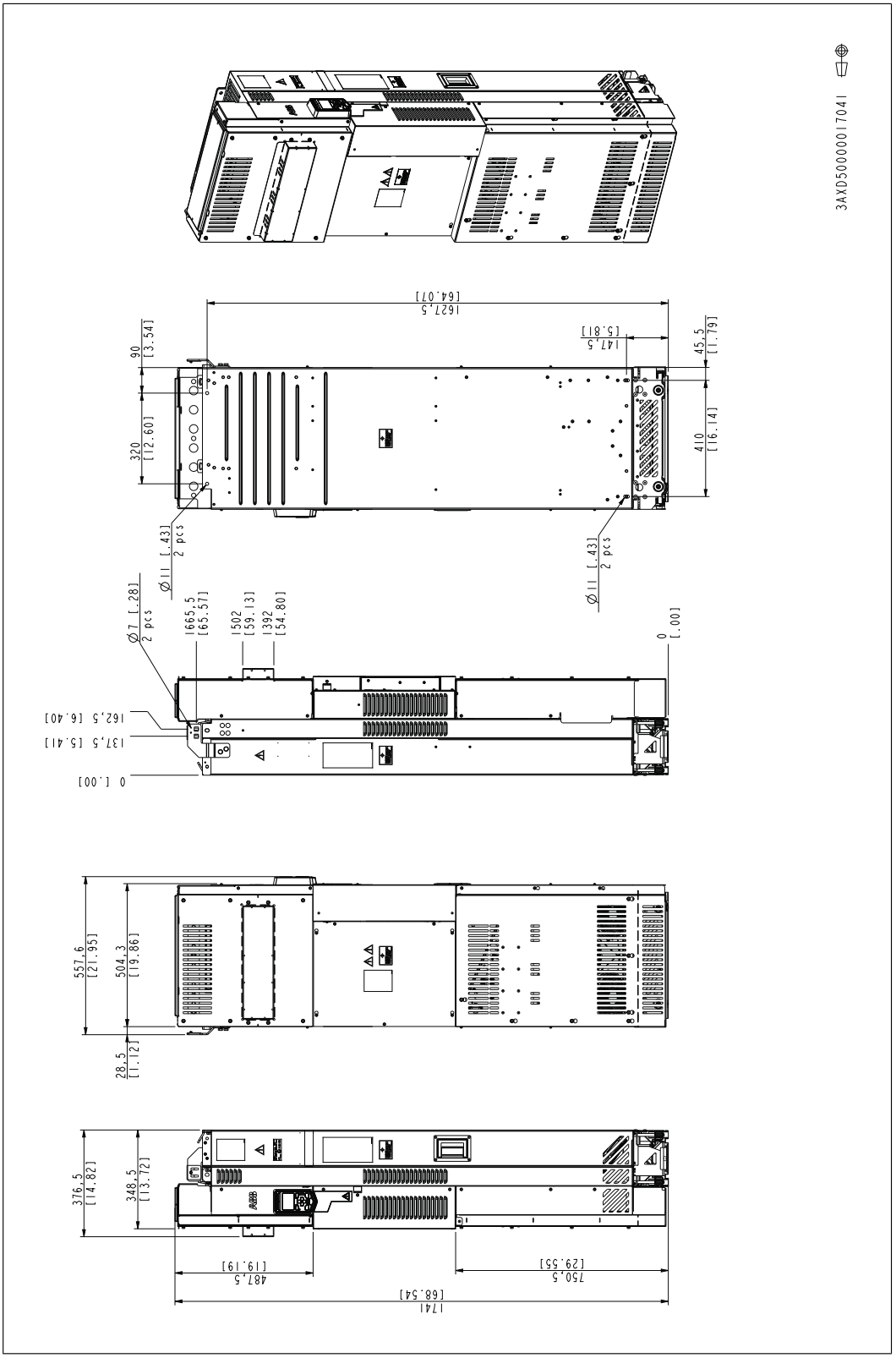
R11 standard configuration



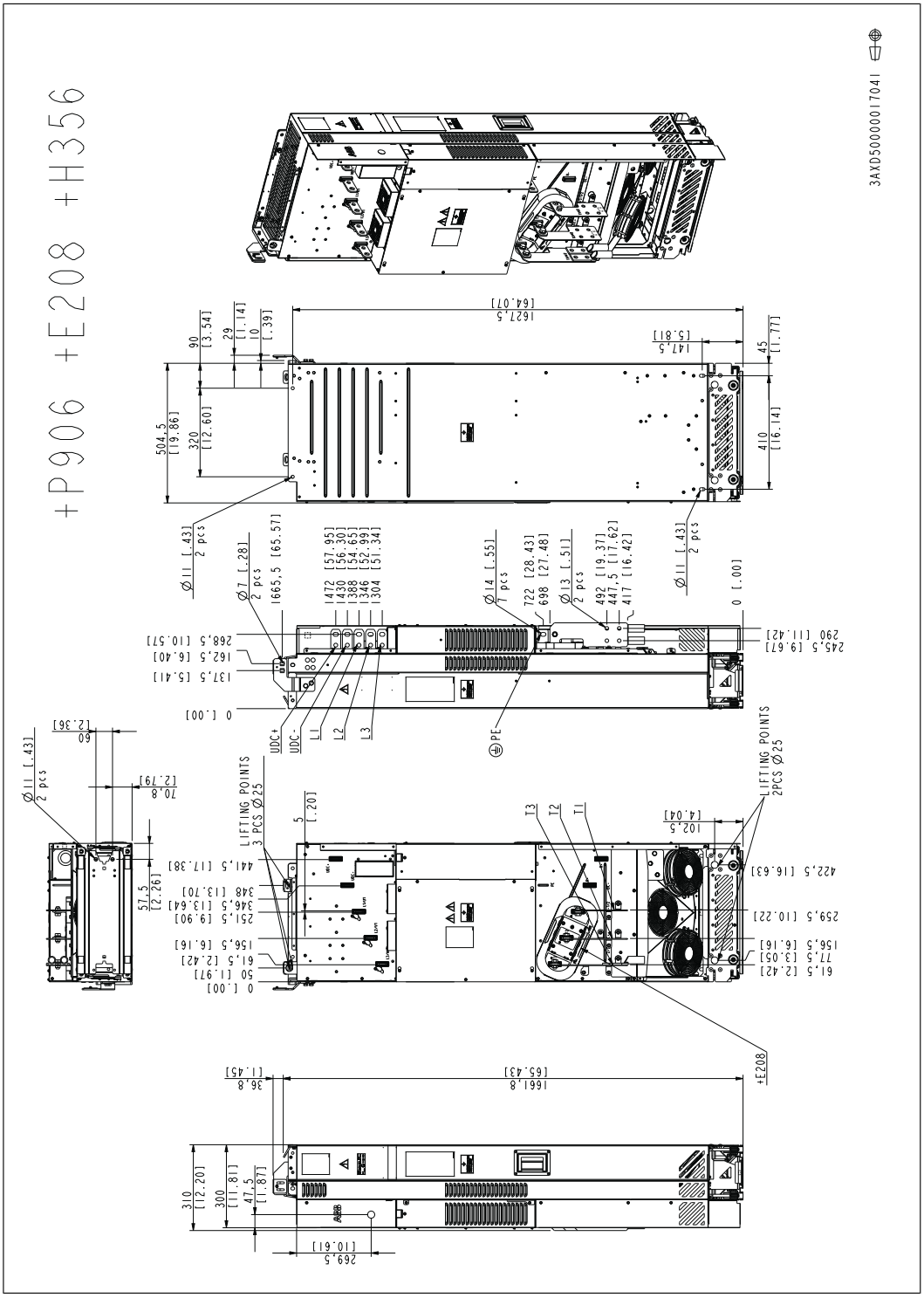
R11 with option +E208+0H371+H356+0H354+H370



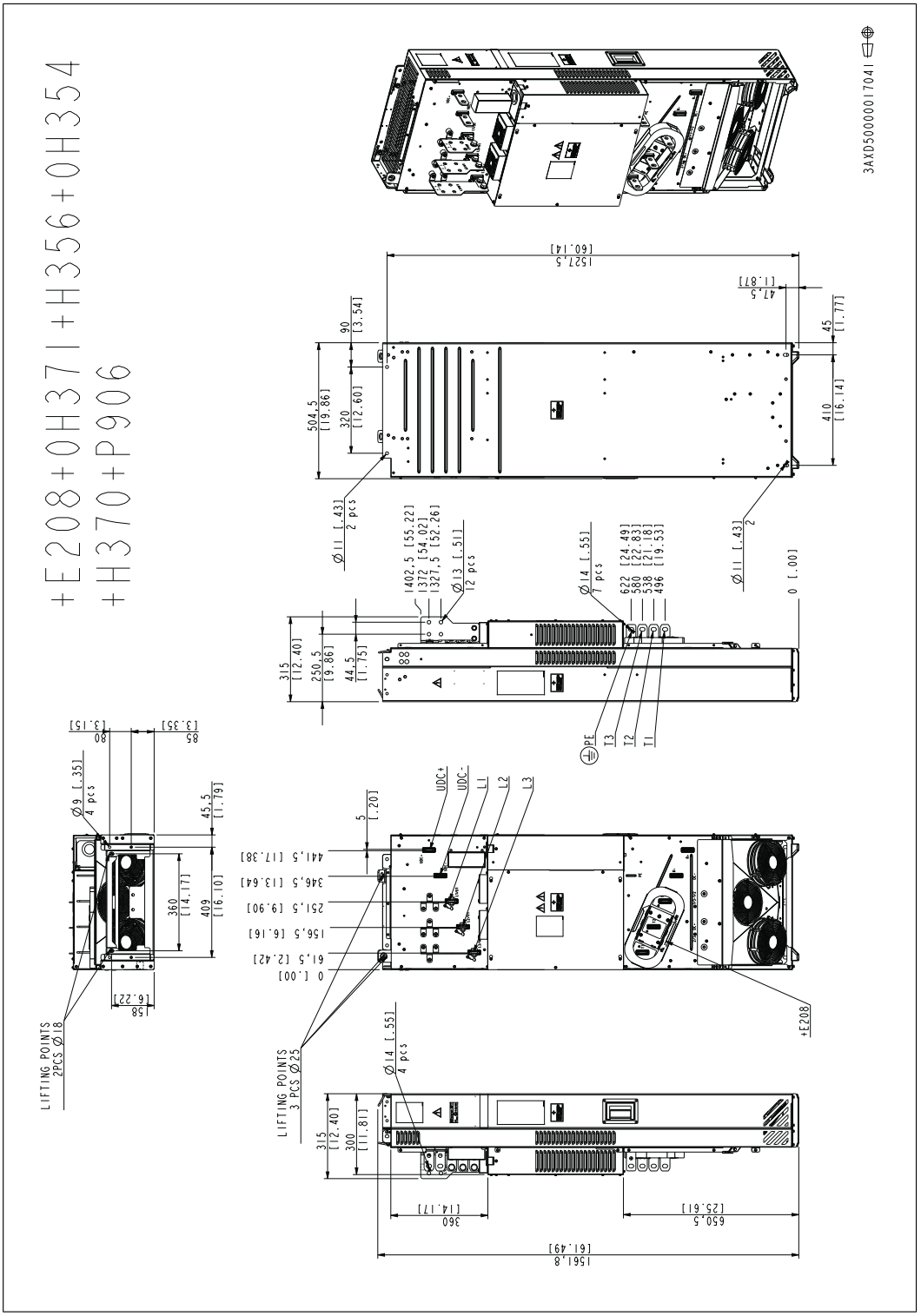
R11 with option +B051



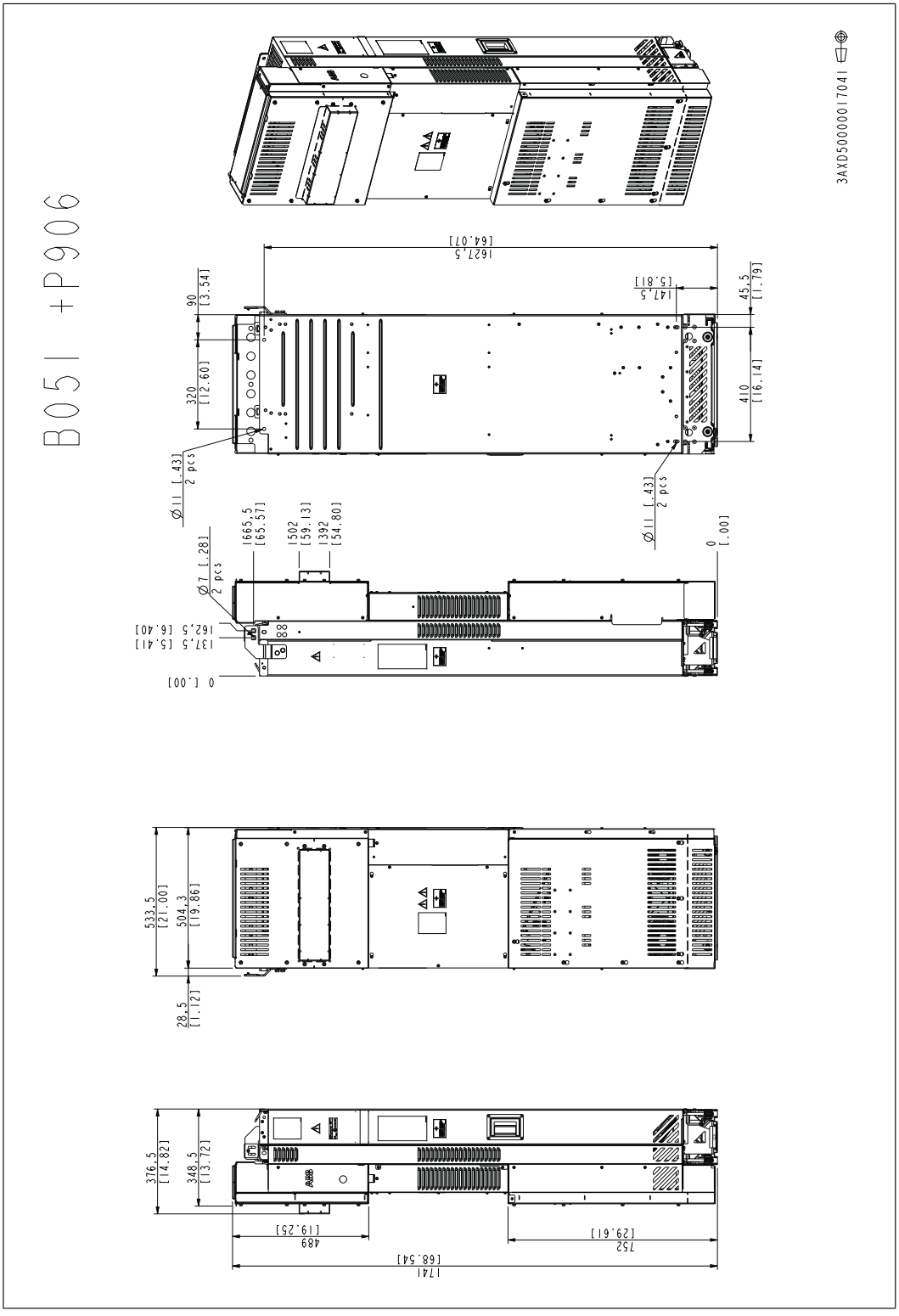
R11 with option +E208 +H356 +P906



R11 with option +E208+0H371+H356+0H354+H370+P906

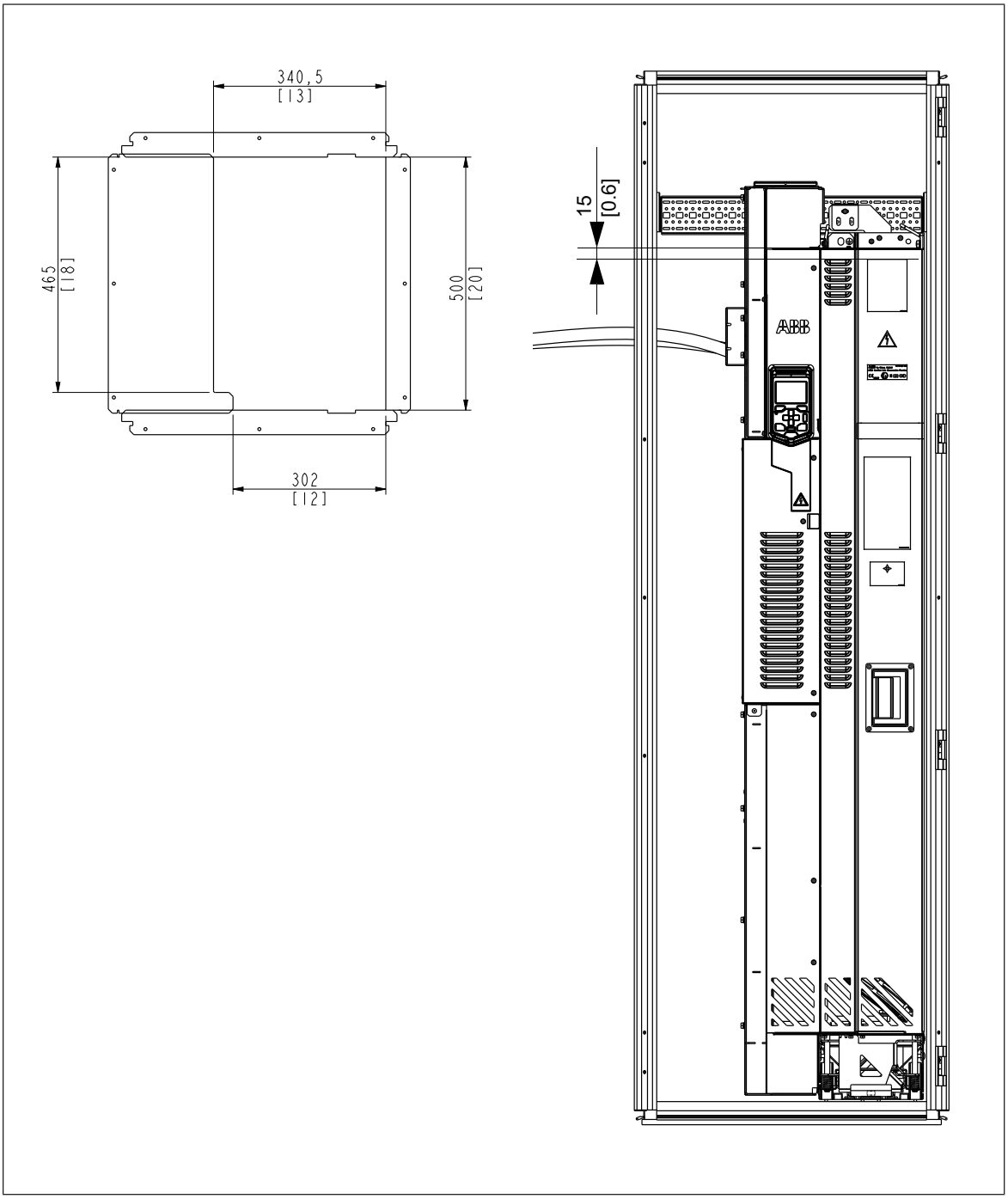


R11 with option +B051 +P906



Air baffles for the drive module with option +B051

This drawing shows the dimensions of the hole in the air baffle around the drive module with option +B051. The drawing also shows the correct vertical location area of the air baffle as measured from the top grill.



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Example circuit diagram

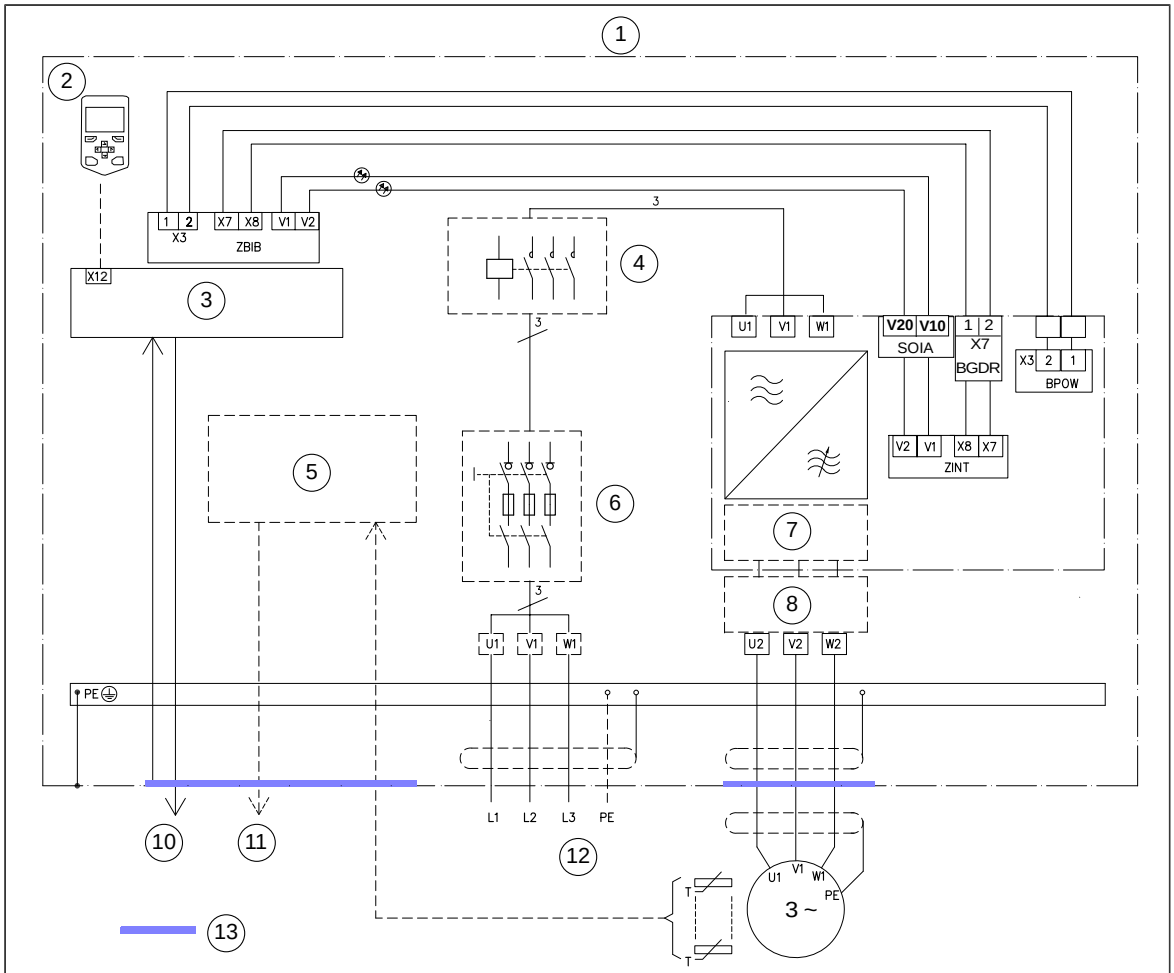
Contents of this chapter

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

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).

170 Example circuit diagram



1	Cabinet
2	Control panel
3	CCU control unit
4	***Main contactor
5	**Motor temperature supervision
6	***Switch fuse disconnector
7	*Common mode filter
8	**d*u*/d*t* filter or sine filter
9	Drive module
10	Input and output signals
11	Alarm
12	Supply
13	360 degree grounding recommended
14	**Brake resistor

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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	*Safety of machinery – Electrical equipment of machines – Part 1: General requirements*
IEC 61000-6-7:2014	*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*

Standard	Name
IEC 61326-3-1:2017	*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*
IEC 61508-1:2010	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*
IEC 61508-2:2010	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*
IEC 61511-1:2016	*Functional safety – Safety instrumented systems for the process industry sector*
IEC 61800-5-2:2016 EN 61800-5-2:2007	*Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional*
IEC 62061:2005 + A1:2012 + A2:2015 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	*Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*
EN ISO 13849-1:2015	*Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*
EN ISO 13849-2:2012	*Safety of machinery – Safety-related parts of control systems – Part 2: Validation*

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.

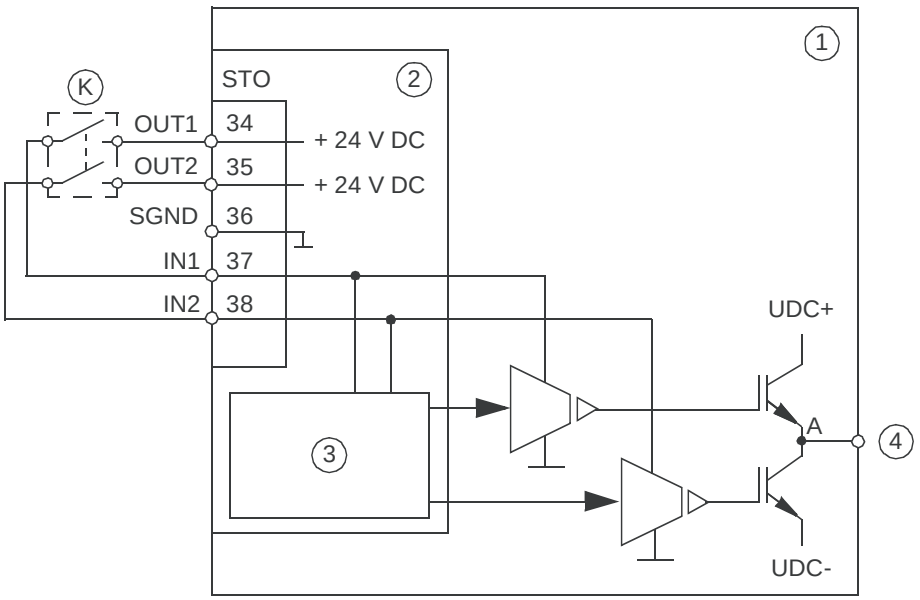
The Declaration of conformity is shown at the end of this chapter.

Wiring

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

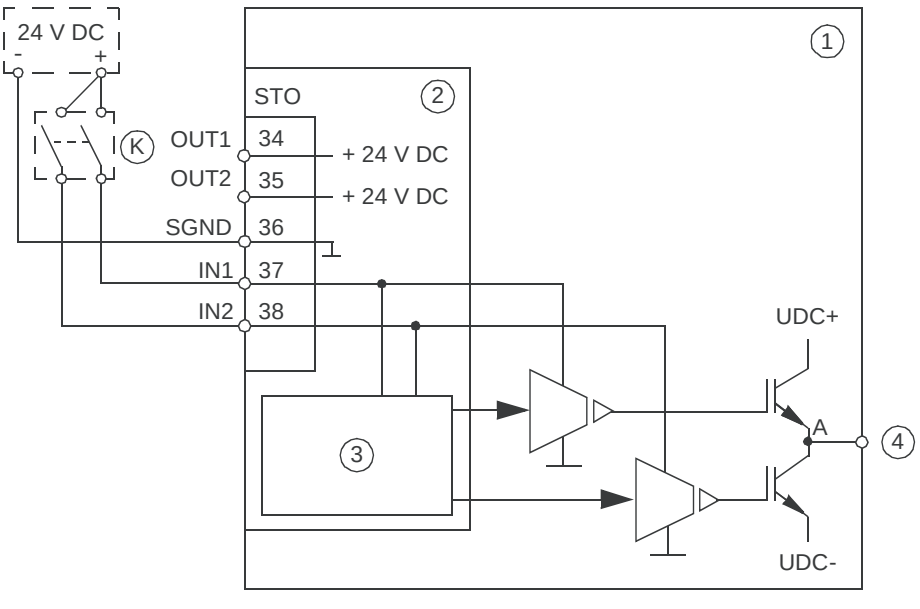
Connection principle

Single ACQ580-04 drive, internal power supply



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

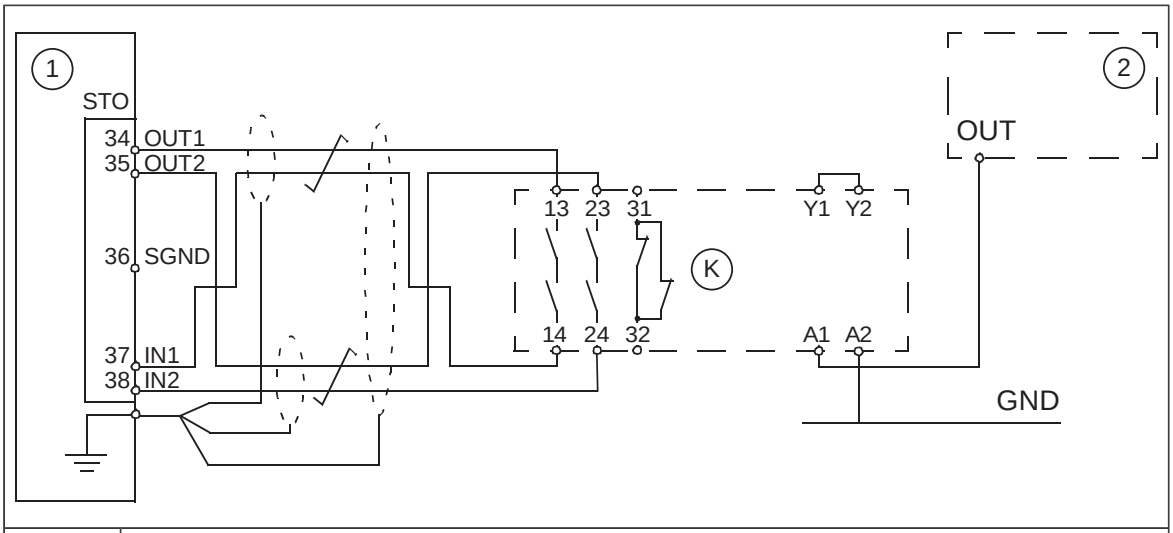
Single ACQ580-04 drive, external power supply



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

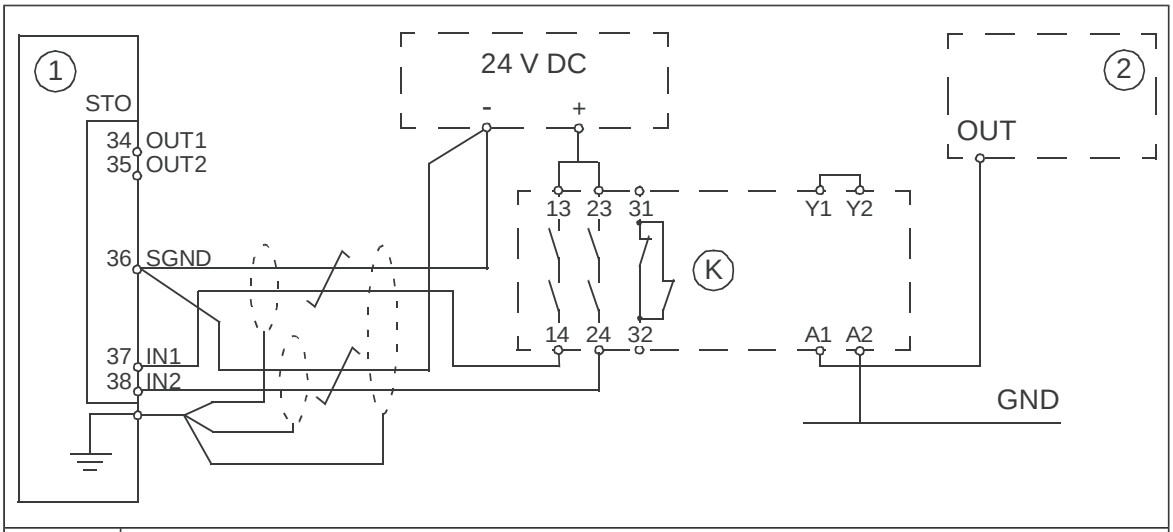
Wiring examples

Single ACQ580-04 drive, internal power supply



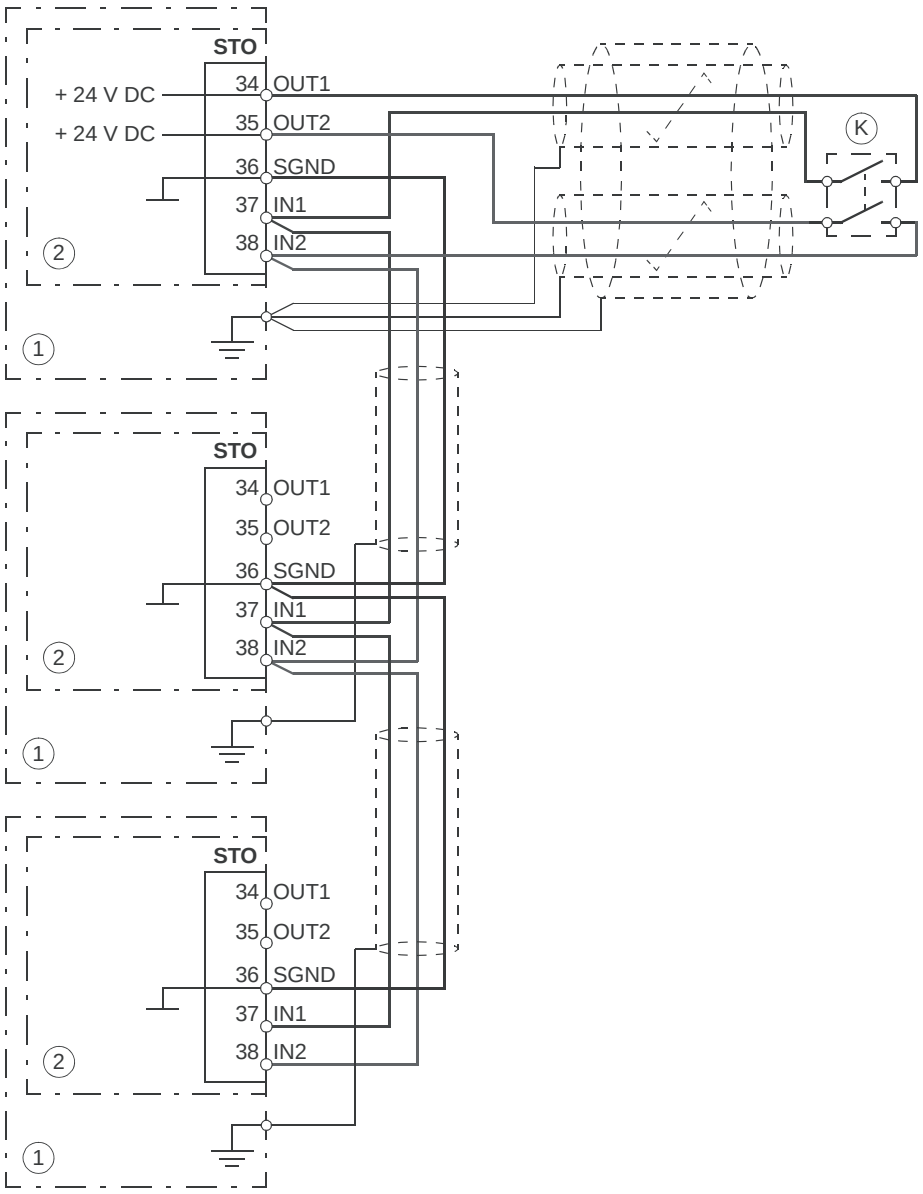
1	Drive
2	Safety PLC
K	Safety relay

Single ACQ580-04 drive, external power supply



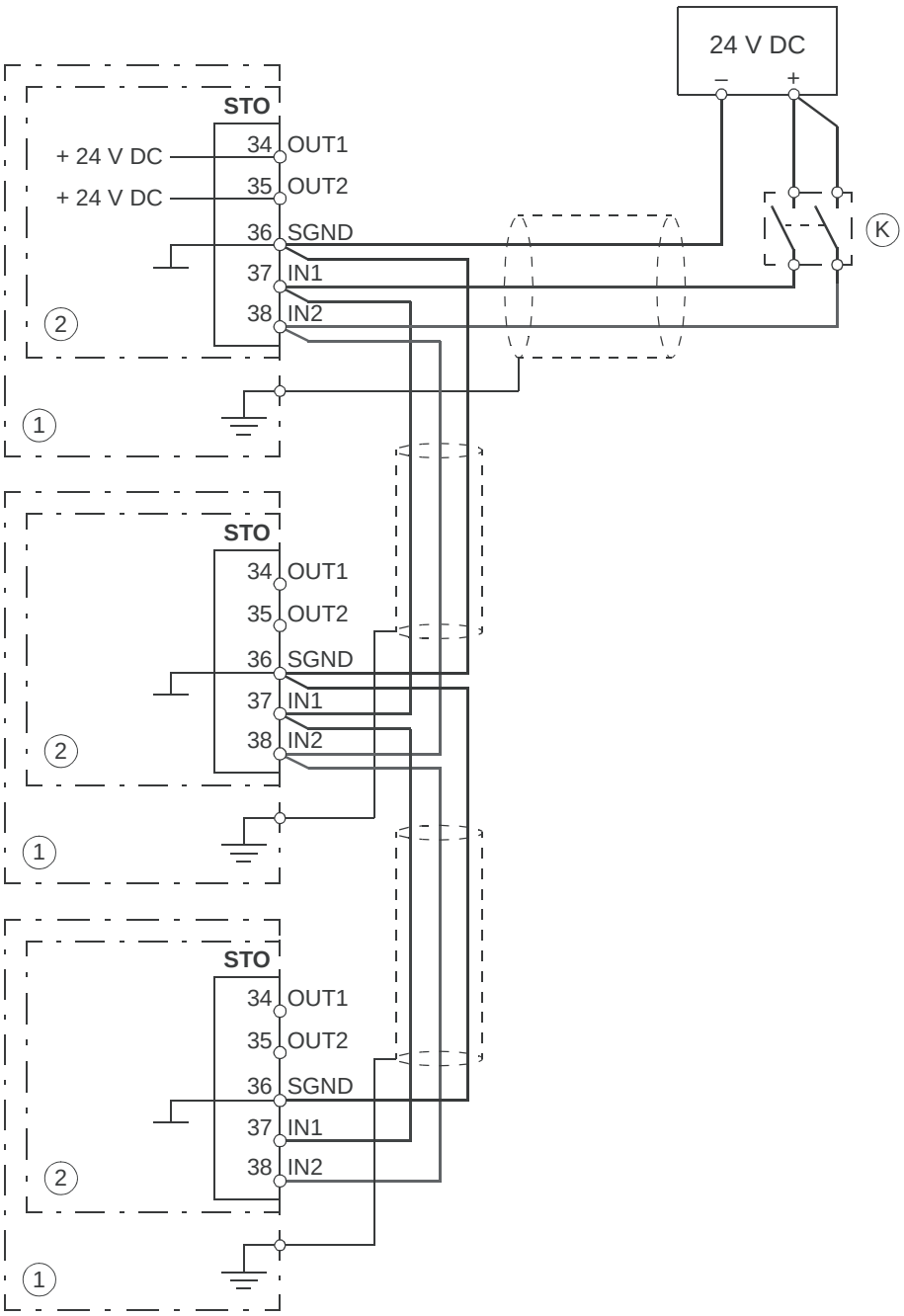
1	Drive
2	Safety PLC
K	Safety relay

Multiple ACQ580-04 drives, internal power supply



1	Drive
2	Control unit
K	Activation switch

Multiple ACQ580-04 drives, external power supply



1	Drive
2	Control unit
K	Activation switch

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 acceptance 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 an acceptance test. The acceptance 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.

Competence

The acceptance 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.

Acceptance test reports

Signed acceptance 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 acceptance tests performed due to changes or maintenance shall be logged into the logbook.

Acceptance 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.

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Make sure that the drive can be run and stopped freely during start-up.	☐
Stop the drive (if running), switch the input power off and isolate the drive from the power line using a disconnector.	☐
Check the STO circuit connections against the wiring diagram.	☐
Close the disconnector and switch the power on.	☐
Test the operation of the STO function when the motor is stopped. • Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Make sure that the drive operates as follows: • 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). • 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. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐

Action	☑
Test the operation of the STO function when the motor is running. • Start the drive and make sure the motor is running. • 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). • Reset any active faults and try to start the drive. • 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. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the failure detection of the drive. The motor can be stopped or running. • Open the 1st channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates a *FA81 Safe Torque Off 1 loss* fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally. • Open the 2nd channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates a *FA82 Safe Torque Off 2 loss* fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Document and sign the acceptance test report which verifies that the safety function is safe and accepted for operation.	☐

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!
(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 180/2*p* degrees (with synchronous reluctance [SynRM] motors) regardless of the activation of the Safe torque off function. *p* denotes the number of pole pairs.

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.
- The Safe torque off diagnostics are not available during power outages, or when the drive is only powered by a CMOD-xx multifunction extension module.

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 184)*. It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the *Acceptance test procedure (page 179)*.

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 *Acceptance test procedure (page 179)*.

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_{avg} (T_1 = 2 a)	PFD_{avg} (T_1 = 5 a)	$MTTF_D$ (a)	DC (%)	Cat.	SC	HFT	CCF	T_M (a)
R10 R11	3	e	99.55	4.18E-09	3.66E-05	9.15E-05	14729	≥90	3	3	1	80	20
3AXD10000410558 E													

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with ΔT = 71.66 °C
  - 1340 on/off cycles per year with ΔT = 61.66 °C
  - 30 on/off cycles per year with ΔT = 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.
- 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 (%)
DC	EN ISO 13849-1	Diagnostic coverage
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	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

Abbr.	Reference	Description
PFD_{avg}	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.

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

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External control unit (option +P906)

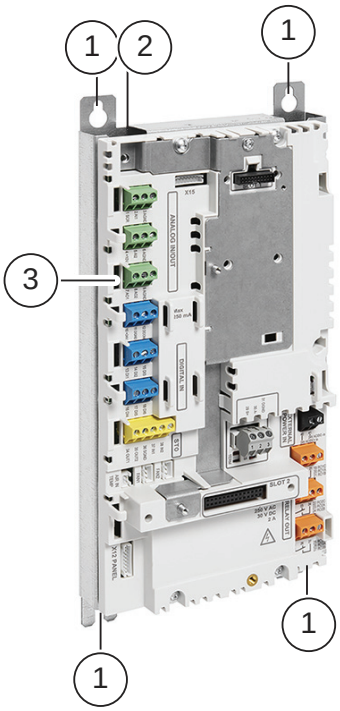
Contents of this chapter

This chapter describes how to install CCU-24 as external control unit (option +P906). Dimension drawing is included.

Product overview

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

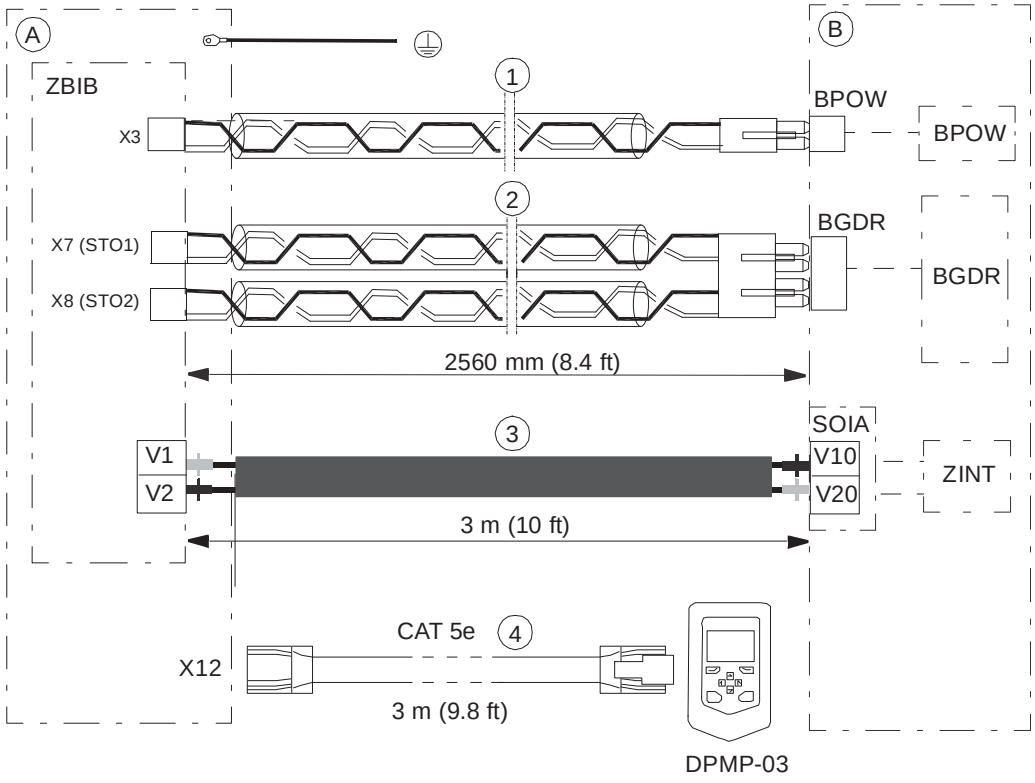
Layout



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 *Control unit*.

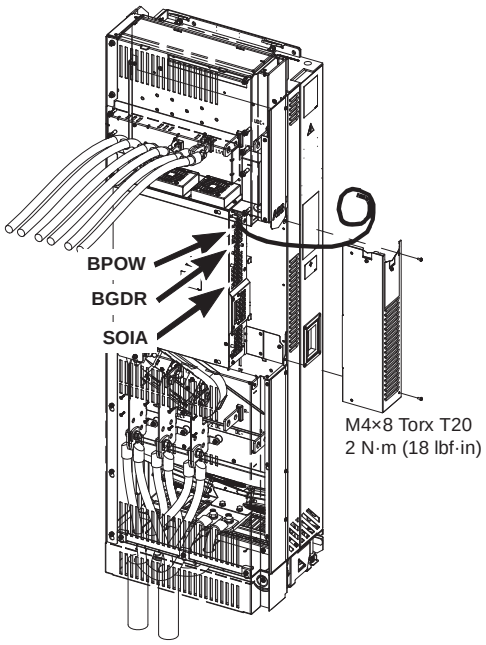
Cables

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.



A	CCU-24 control unit	B	Drive module
1	1 × 24 V power supply cable (with a ground connection)	3	1 × pair of optical cables for all major converter power stack communication.
2	2 × Safe Torque Off (STO) cables	4	CAT 5e cable, must be ordered separately

The connectors at the drive module end are located behind the middle front cover.

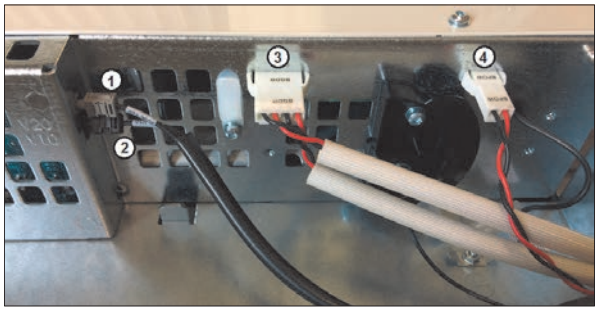


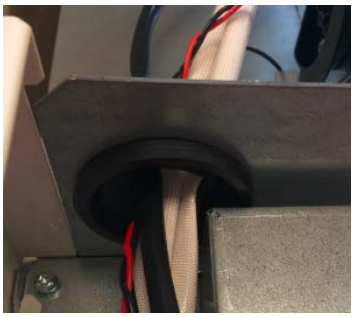
Unpacking the delivery

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

The control cables that will connect the external control unit to the drive module are connected to the drive module for safe transit. ABB recommends that you disconnect them before you install the drive module:

1. Remove the middle front cover of the drive module.
2. Disconnect the cables. Then, carefully pull them out via the rubber grommet. Wind the cables carefully into the plastic bag supplied, ready for installation later.





1	V20	3	BPOW
2	V10	4	BGDR

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 198)*). Install the unit inside an enclosure for protection.

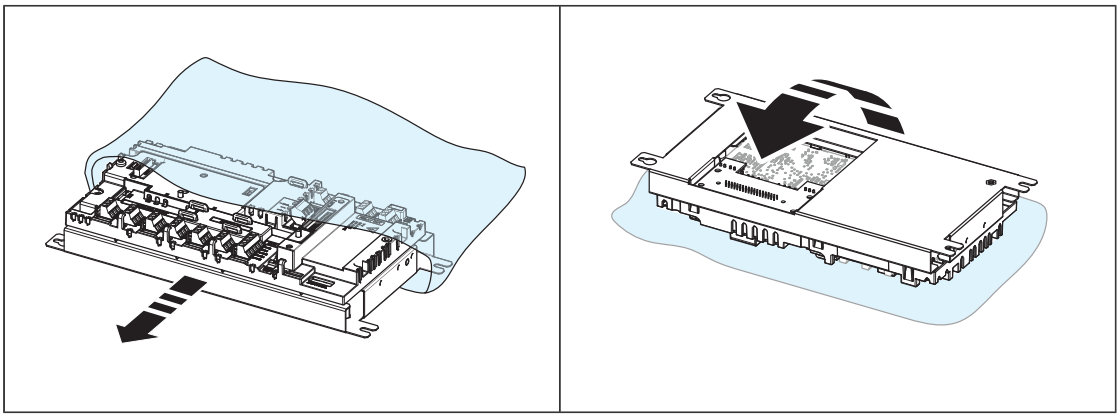
Installation procedure

Optical components

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

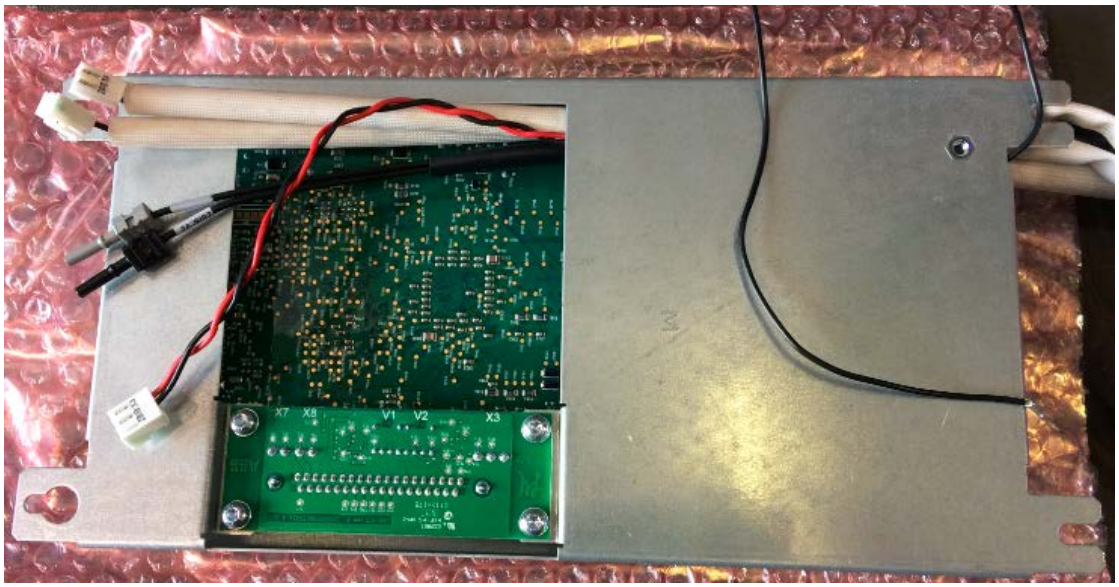
- Handle the fiber optic cables with care.
- When you unplug the fiber optic cables, always hold the connector, not the cable itself.
- Do not touch the ends of the fibers with bare hands as the ends are extremely sensitive to dirt.
- Do not bend the fiber optic cables too tightly. The minimum allowed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

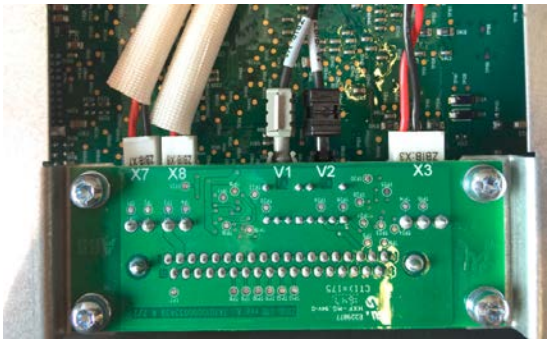


2. Identify the correct ends of the control cables to be connected to the control unit.

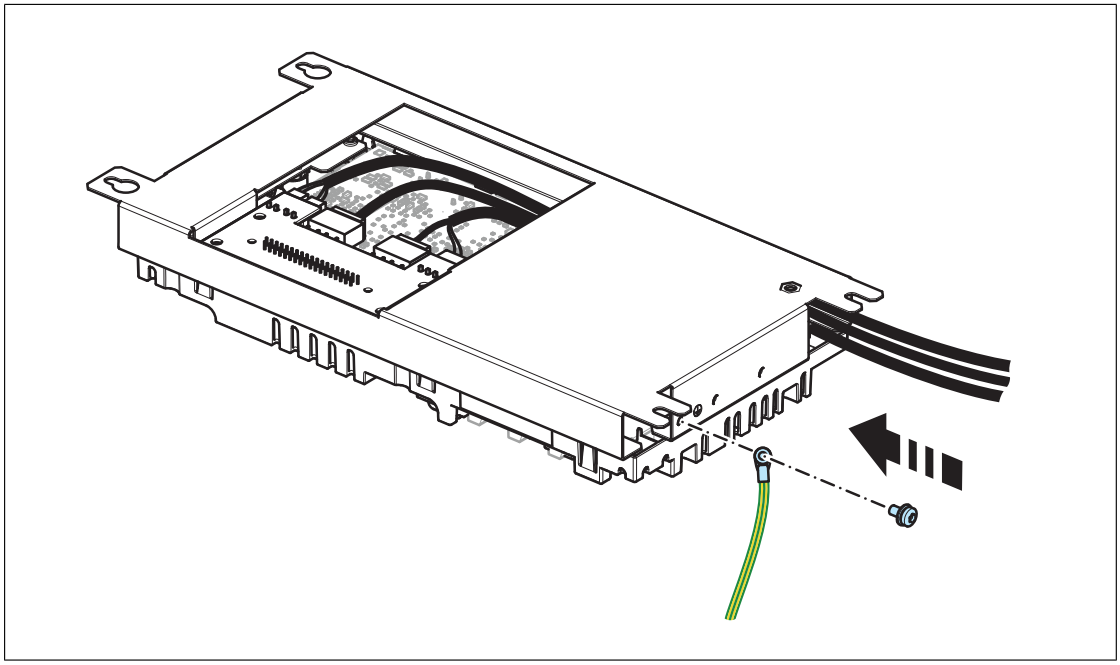
3. Pull the cables through the control unit assembly, so they appear in the opening at the rear of the control unit. Do not pull the ground conductor through, leave it outside the assembly. Check that the cables are not against sharp edges or bare live parts.



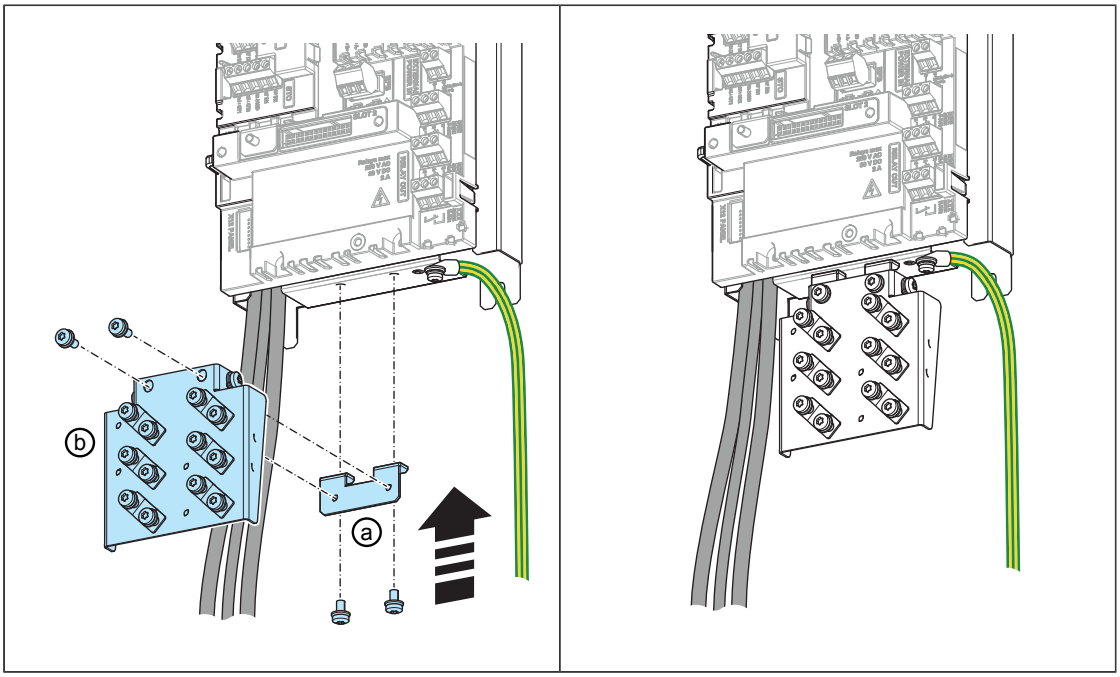
4. Connect the cables to their connectors on the ZBIB board.

View of ZBIB	**ZBIB connectors**	**Cables from drive module**
		**BPOW**
	X3:1	X3:1
	X3:2	X3:2
		BGDR
	X7 (STO 1)	X7 (STO 1)
	X8 (STO 2)	X8 (STO 2)
		SOIA
	V1 (gray)	V10 (black)
	V2 (black)	V20 (grey)

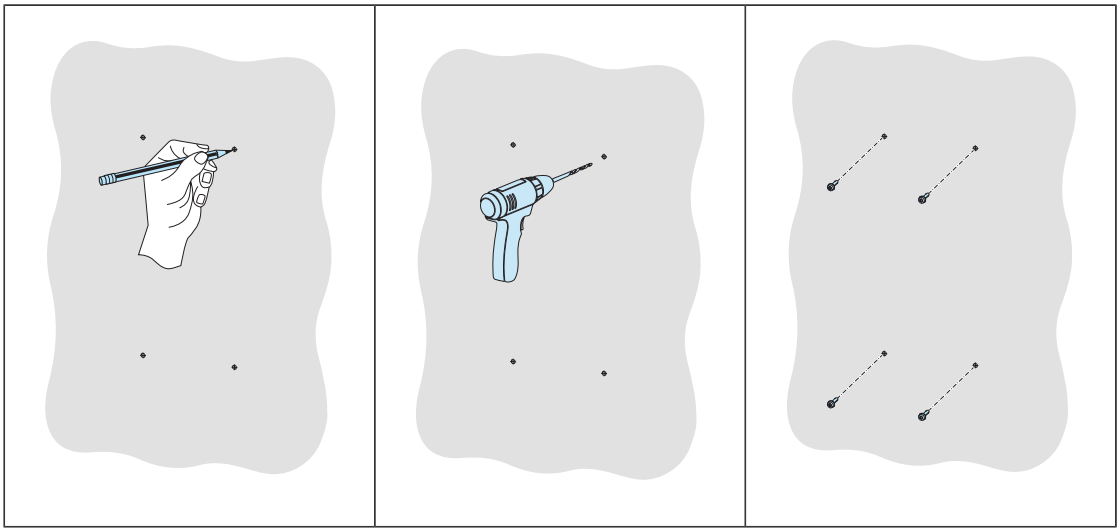
5. Connect the grounding wire.



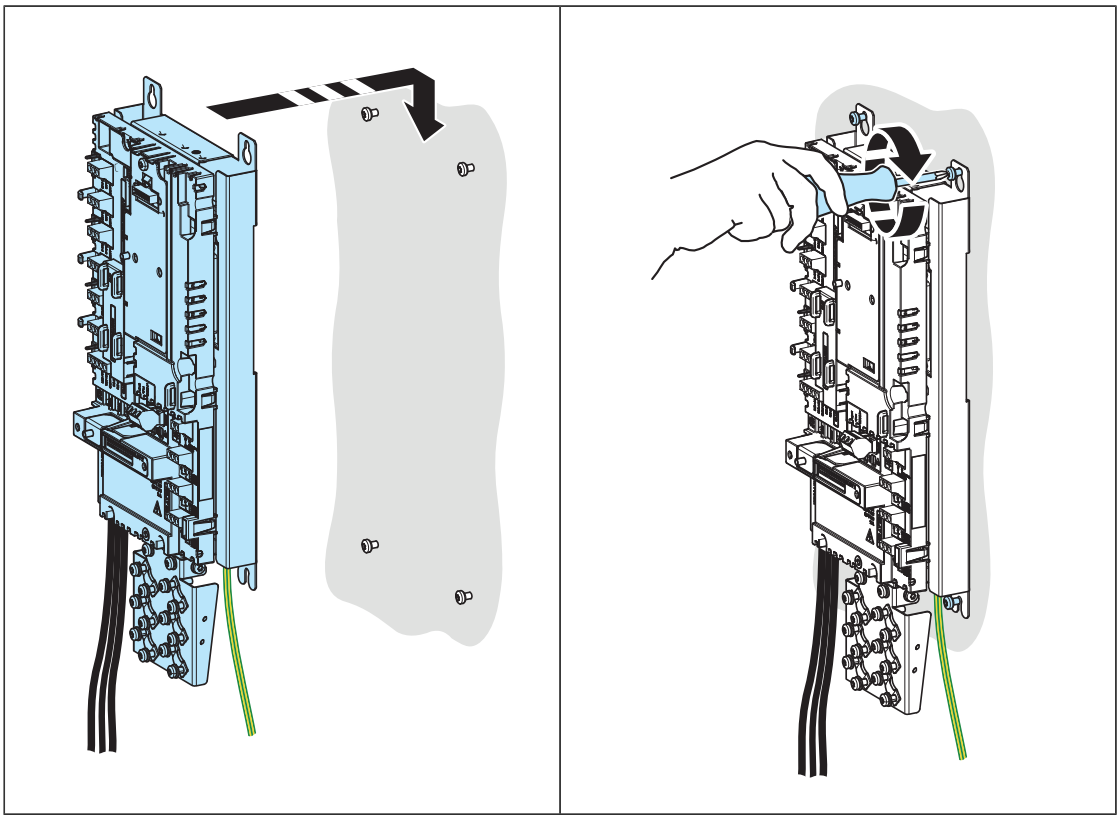
6. The kit includes a plate for the customer cable screens. Attach the small bracket (a) first, then the full clamp plate (b).



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.

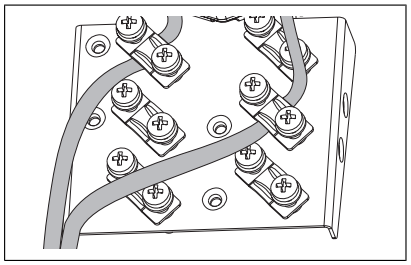


8. Lift the control unit onto the mounting screws. Tighten the screws.



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.

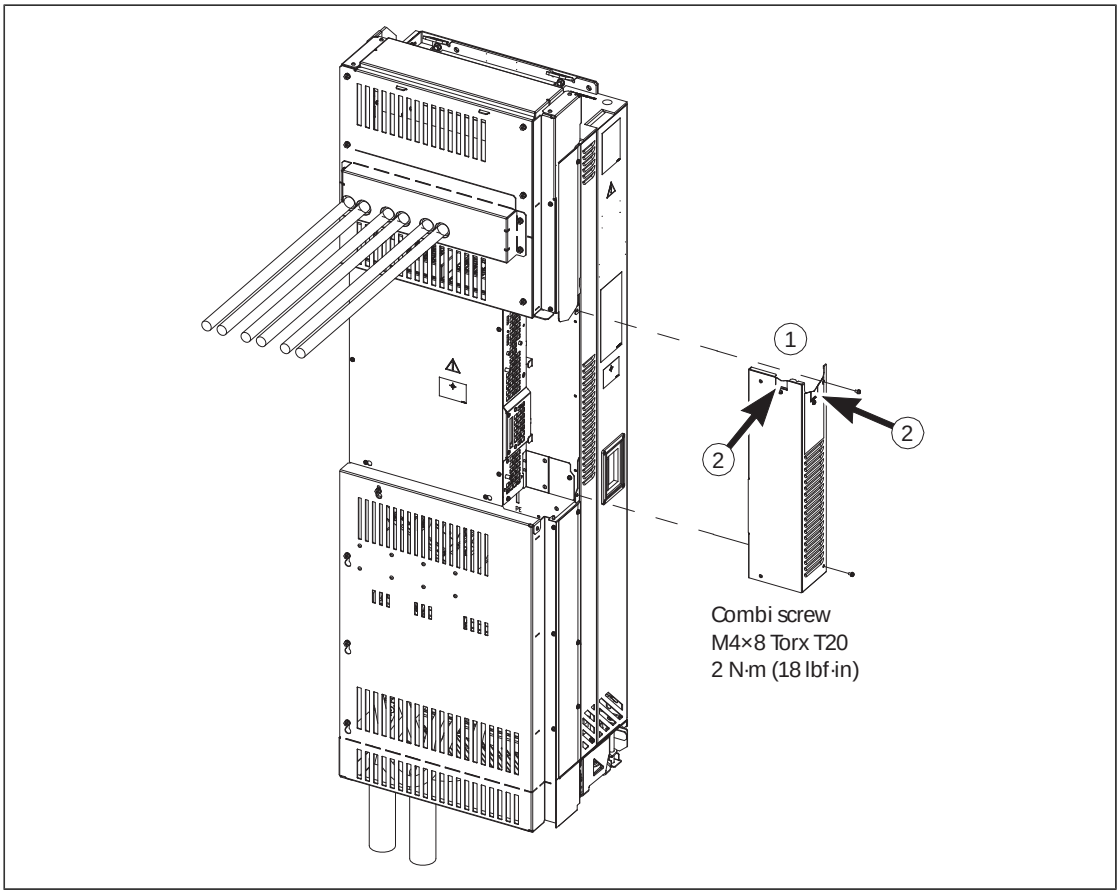


11. Connect the conductors to the appropriate detachable terminals of the control unit. See the default I/O diagram in chapter *Control unit (page 107)*. Use shrink tubing or insulating tape to contain any stray strands. Tighten the screws to secure the connection.

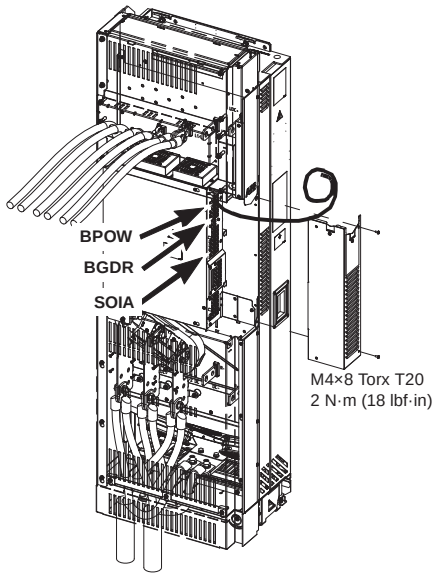
    Note: Keep any signal wire pairs twisted as close to the terminals as possible. Twisting the wire with its return wire reduces disturbances caused by inductive coupling.

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
	
BPOW	
X3:1	X3:1
X3:2	X3:2
BGDR	
X7 (STO1)	X7 (STO1)
X8 (STO2)	X8 (STO2)
SOIA	
V10	V1
V20	V2

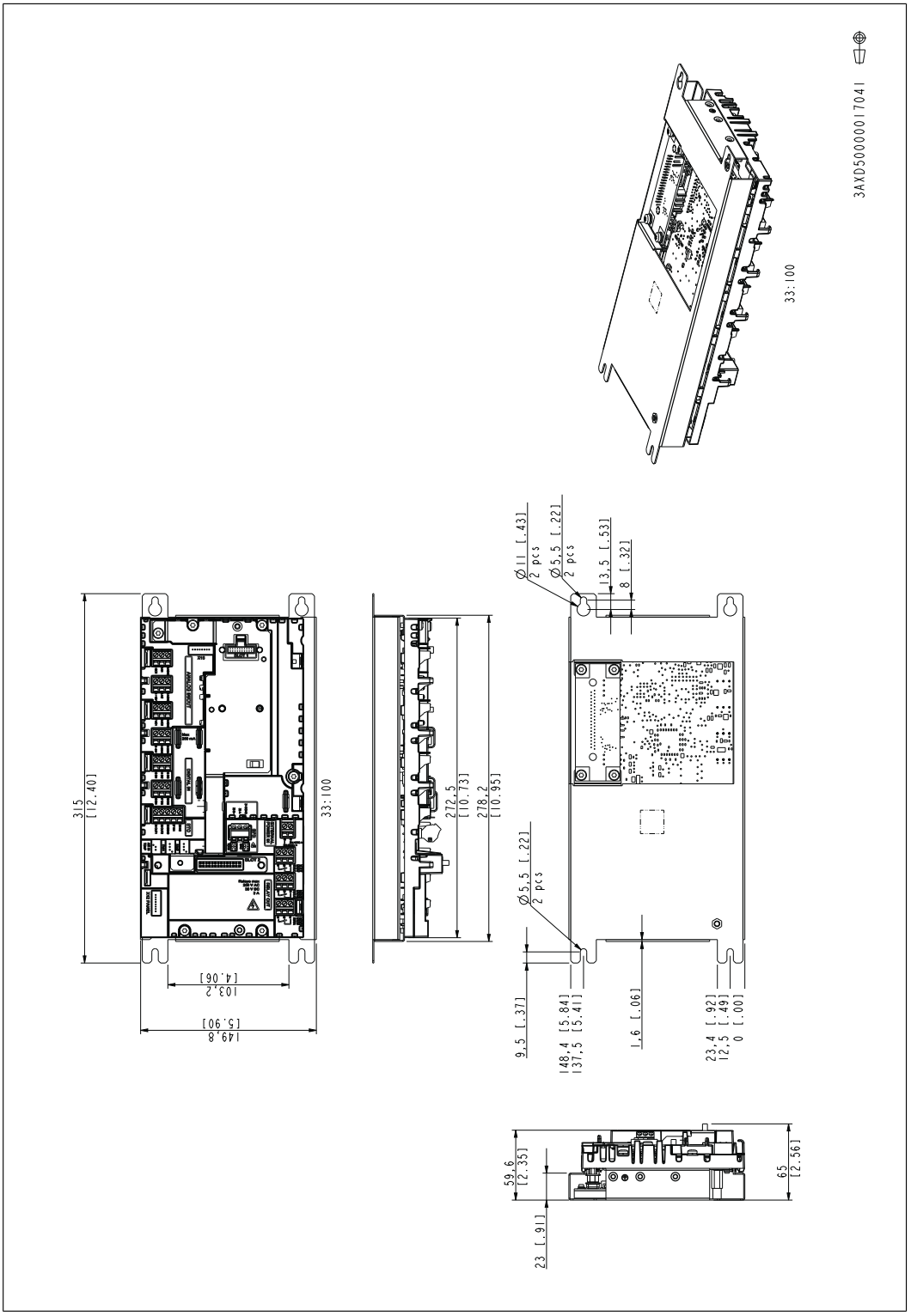
4. Connect the ground connection at the drive module end.

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



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CHDI-01 115/230 V digital input extension module

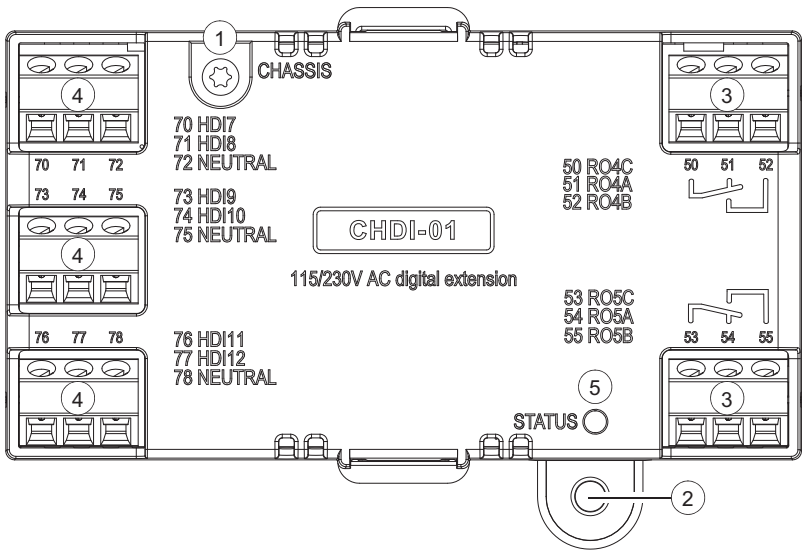
Contents of this chapter

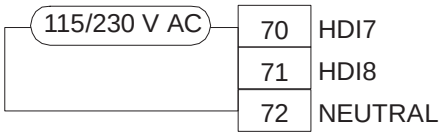
This chapter describes the optional CHDI-01 115/230 V digital input extension module.

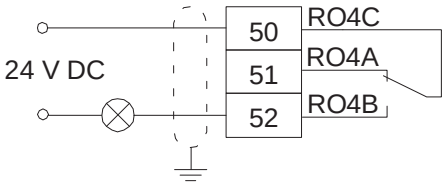
Product overview

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







3-pin terminal blocks for 115/230 V inputs (1)			**Relay outputs (2)**		
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 [1]	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 [1]	Neutral point	55	RO5A	Normally open, NO
76	HDI11	115/230 V input 5	3	**Grounding screw**	
77	HDI12	115/230 V input 5	4	**Hole for mounting screw**	
78	NEUTRAL [1]	Neutral point	5	**Diagnostic LED**. Green = The extension module is powered up.	
[1] 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 97)*.

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

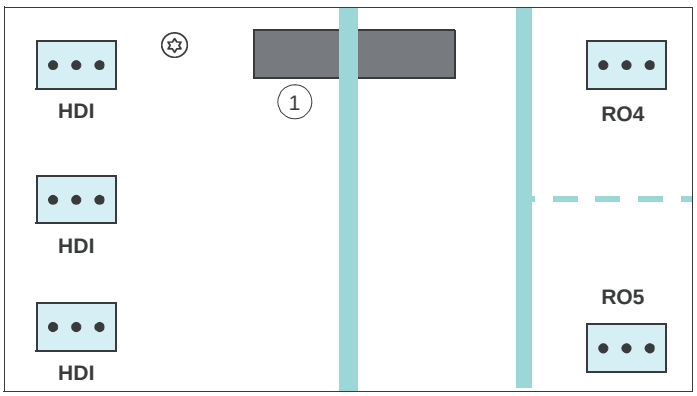
This example shows how make relay output RO4 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

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

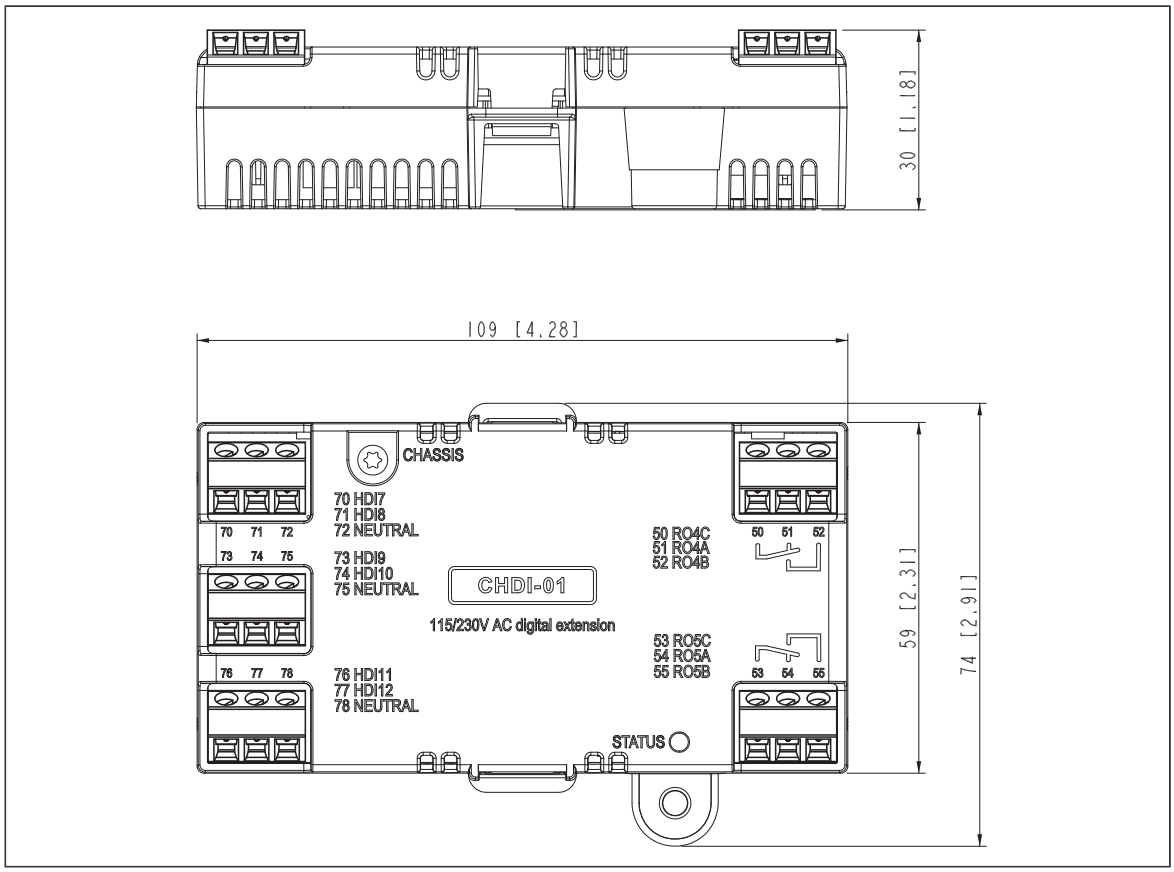
Warning A7AB *Extension I/O configuration failure*.

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
Reley outputs (50…52, 53…55)	
Maximum wire size	1.5 mm^2
Minimum contact rating	12 V / 10 mA
Maximum contact rating	250 V AC / 30 V DC / 2 A
Maximum breaking capacity	1500 VA
115/230 V inputs (70…78)	
Maximum wire size	1.5 mm^2
Input voltage	115 to 230 V AC ±10%
Maximum current leakage in digital off state	2 mA
Isolation areas	
CHDI-01 	
1	Plugged to drive **SLOT2**
	Reinforced insulation (IEC 61800-5-1:2007)
	Functional insulation (IEC 61800-5-1:2007)

Dimension drawing

The dimensions are in millimeters and [inches].



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

Contents of this chapter

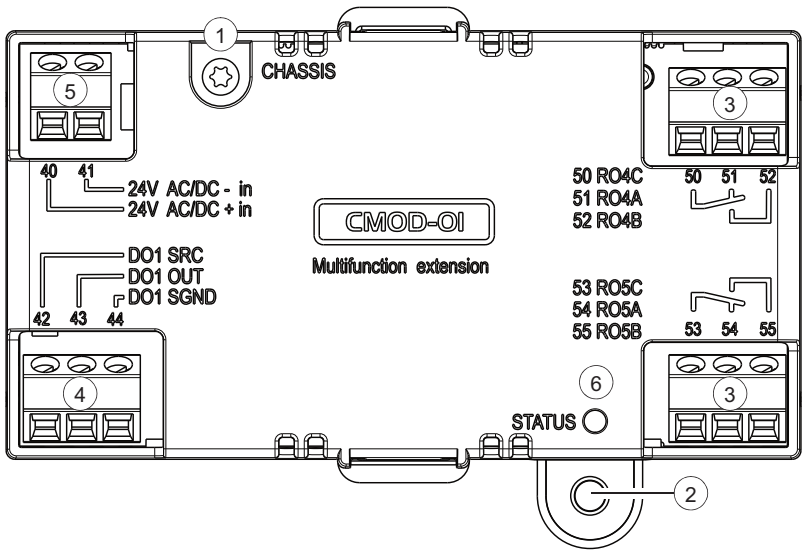
This chapter describes the optional CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O).

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.

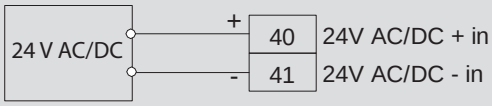
In addition, the extension module has an external power supply interface, which can be used to power up the drive control unit in case the drive power supply is not on. If you do not need the back-up power supply, you do not have to connect it because the module is powered from the drive control unit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

Layout and example connections

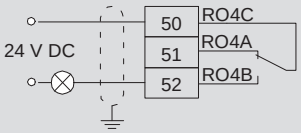


1	Grounding screw	6	Diagnostic LED
2	Hole for mounting screw		

2-pin terminal block for external power supply (5)

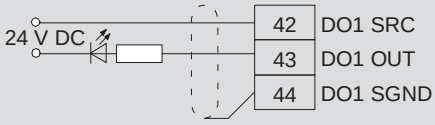


3-pin terminal blocks for relay outputs (3)

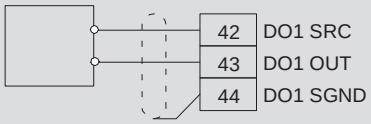


40	24 V AC/DC + in	External 24 V (AC/DC) input	50	RO4C	Common, C
41	24 V AC/DC - in	External 24 V (AC/DC) input	51	RO4A	Normally closed, NC

3-pin terminal block for for transistor output (4)



1)



2)

			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 97)*.

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.

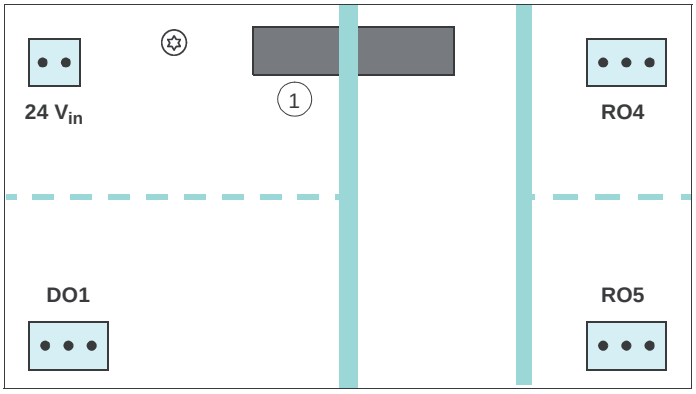
LEDs

The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

Technical data

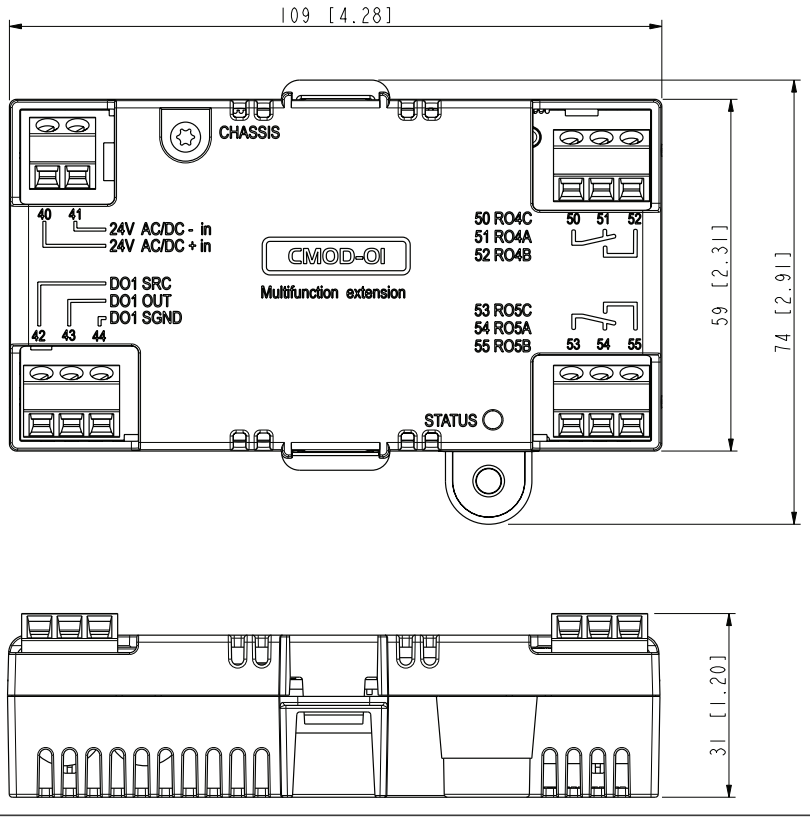
Installation	Into an option slot on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
Reley outputs (50…52, 53…55)	
Maximum wire size	1.5 mm^2
Minimum contact rating	12 V / 10 mA
Maximum contact rating	250 V AC / 30 V DC / 2 A
Maximum breaking capacity	1500 VA
Transistor output (42…44)	
Maximum wire size	1.5 mm^2
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%
External power supply (40…41)	
Maximum wire size	1.5 mm^2
Input voltage	24 V AC / V DC ±10% (GND, user potential)
Maximum power consumption	25 W, 1.04 A at 24 V DC
Isolation areas	



1	Plugged to drive **SLOT2**
	Reinforced insulation (IEC 61800-5-1:2007)
	Functional insulation (IEC 61800-5-1:2007)

Dimension drawing

The dimensions are in millimeters and [inches].



22

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).

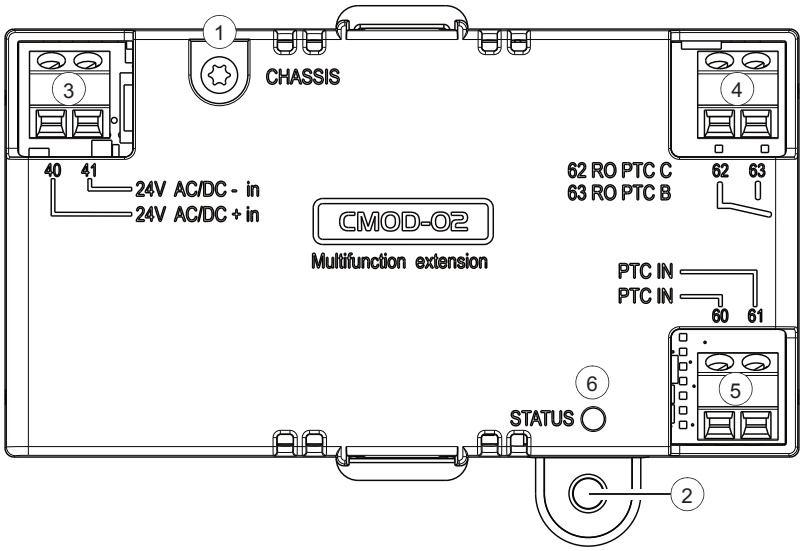
Product overview

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.

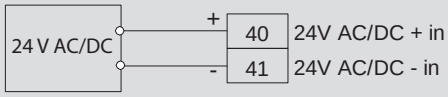
In addition, the extension module has an external power supply interface, which can be used to power up the drive control unit in case the drive power supply is not on. If you do not need the back-up power supply, you do not have to connect it because the module is powered from the drive control unit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

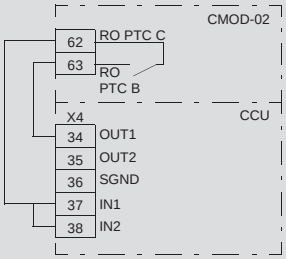
Layout and example connections



2-pin terminal block for external power supply (3)

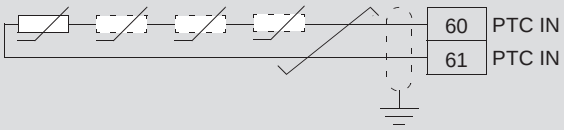


2-pin terminal block for relay output (4)



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

Motor thermistor connection (5)



One to six PTC thermistors connected in series.

			1	Grounding screw	
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 97)*.

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.

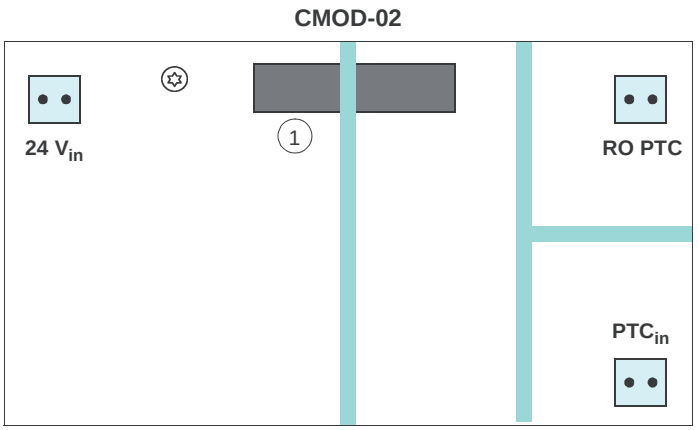
LEDs

The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

Technical data

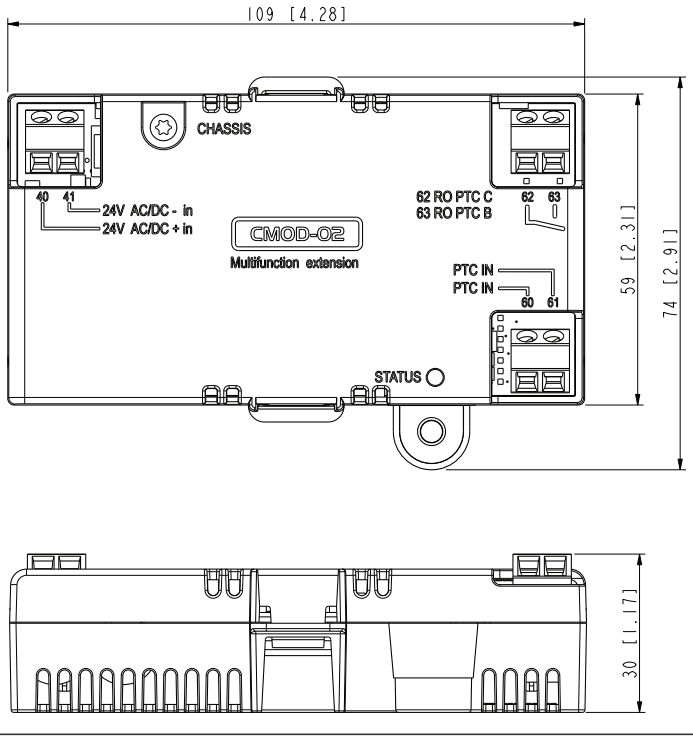
Installation	Into option slot 2 on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
Motor thermistor connection (60…61)	
Maximum wire size	1.5 mm^2
Supported standards	DIN 44081 and DIN 44082
Triggering threshold	3.6 kohm ±10%
Recovery threshold	1.6 kohm ±10%
PTC terminal voltage	≤ 5.0 V
PTC terminal current	< 1 mA
Short-circuit detection	< 50 ohm ±10%
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. 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.	
Relay output (62…63)	
Maximum wire size	1.5 mm^2
Maximum contact rating	250 V AC / 30 V DC / 5 A
Maximum breaking capacity	1000 VA
External power supply (40…41)	
Maximum wire size	1.5 mm^2
Input voltage	24 V AC / V DC ±10% (GND, user potential)
Maximum power consumption	25 W, 1.04 A at 24 V DC
Isolation areas	



1	Plugged to drive **SLOT2**
	Reinforced insulation (IEC 61800-5-1:2007)
	Functional insulation (IEC 61800-5-1:2007)

Dimension drawing

The dimensions are in millimeters and [inches].



23

Filters

Contents of this chapter

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

When is a du/dt filter necessary?

See section *Examining the compatibility of the motor and drive (page 66)*.

Selection table

The du/dt filter types for the drive module types are given below.

Frame	du/dt filter type
R10	FOCH0610-70
R11	FOCH0875-70

Ordering codes

Filter type	ABB ordering code
FOCH-0610-70	68550483
FOCH-0875-70	3AUA0000125245

Description, installation and technical data of the FOCH filters

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

24

Ground-to-phase varistor disconnecting instructions – IEC, not North America

Contents of this chapter

This chapter describes when and how to disconnect the ground-to-phase varistor. It gives guidelines for identifying power system types.

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.

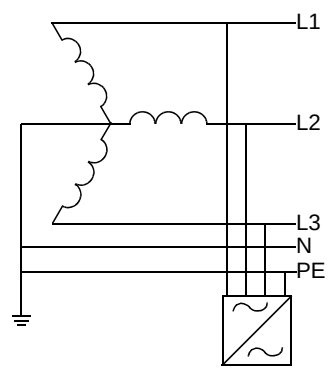
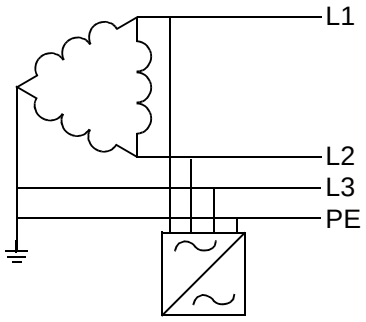
To identify the grounding system, examine the supply transformer connection. See the applicable electrical diagrams of the building. If that is not possible, measure these voltages at the distribution board, and use the table to define the grounding system type.

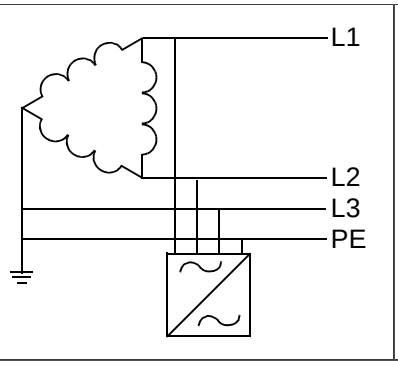
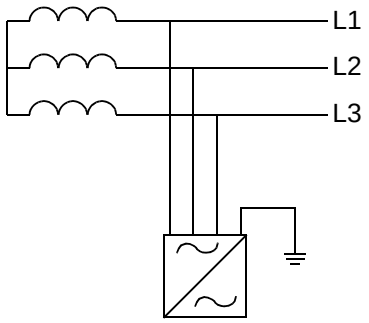
1. input voltage line to line (U_{L-L})
2. input voltage line 1 to ground (U_{L1-G})
3. input voltage line 2 to ground (U_{L2-G})
4. input voltage line 3 to ground (U_{L3-G}).

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·X	0.58·X	0.58·X	Symmetrically grounded TN system (TN-S system)
X	1.0·X	1.0·X	0	Corner-grounded delta system (nonsymmetrical)
X	0.866·X	0.5·X	0.5·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 ground-to-phase varistor: TN-S, IT, corner-grounded delta and mid-point-grounded delta systems

Symmetrically grounded TN systems (TN-S systems)	
	Do not disconnect VAR wire.
Corner-grounded delta systems	
	Do not disconnect VAR wire.
Midpoint-grounded delta systems	

	Do not disconnect VAR wire.
IT systems (ungrounded or highresistance-grounded [>30 ohms])	
	Disconnect VAR wire.

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. The VAR wire has been disconnected. Otherwise ground-to-phase varistor capacitor leakage current will cause the residual current device to trip.

Note:

- 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.

Disconnecting instruction – IEC, not North America

Varistor (VAR) grounding wire is attached next to the control circuit compartment. Disconnect it. Insulate the end and attach it.

25

Connecting EMC filter and ground-to-phase varistor – North America

Contents of this chapter

This chapter describes when and how to Connect the EMC filter and ground-to-phase varistor. It gives guidelines for identifying power system types.

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.

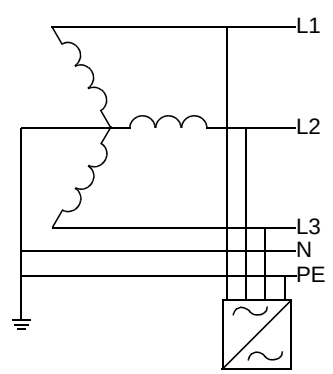
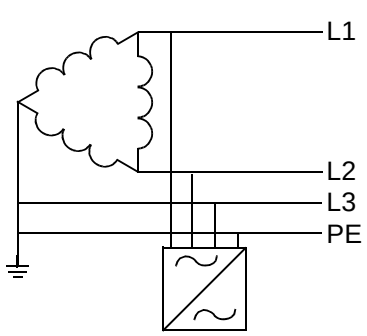
To identify the grounding system, examine the supply transformer connection. See the applicable electrical diagrams of the building. If that is not possible, measure these voltages at the distribution board, and use the table to define the grounding system type.

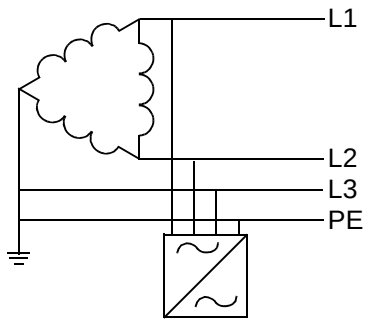
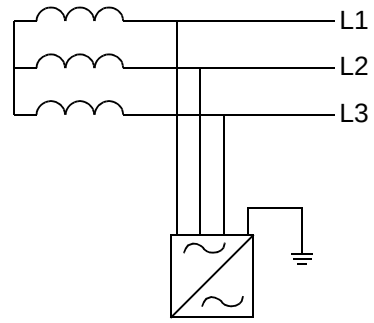
1. input voltage line to line (U_{L-L})
2. input voltage line 1 to ground (U_{L1-G})
3. input voltage line 2 to ground (U_{L2-G})
4. input voltage line 3 to ground (U_{L3-G}).

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·X	0.58·X	0.58·X	Symmetrically grounded TN system (TN-S system)
X	1.0·X	1.0·X	0	Corner-grounded delta system (nonsymmetrical)
X	0.866·X	0.5·X	0.5·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 you can connect the EMC filter and ground-to-phase varistor: TN-S, IT, corner-grounded delta and mid-point-grounded delta systems

Symmetrically grounded TN systems (TN-S systems)	
	You can connect VAR wire.
Corner-grounded delta systems	
	You can connect VAR wire.
Midpoint-grounded delta systems	

	You can connect VAR wire.
IT systems (ungrounded or highresistance-grounded [>30 ohms])	
	Do not connect VAR wire.

Connecting EMC filter – North America

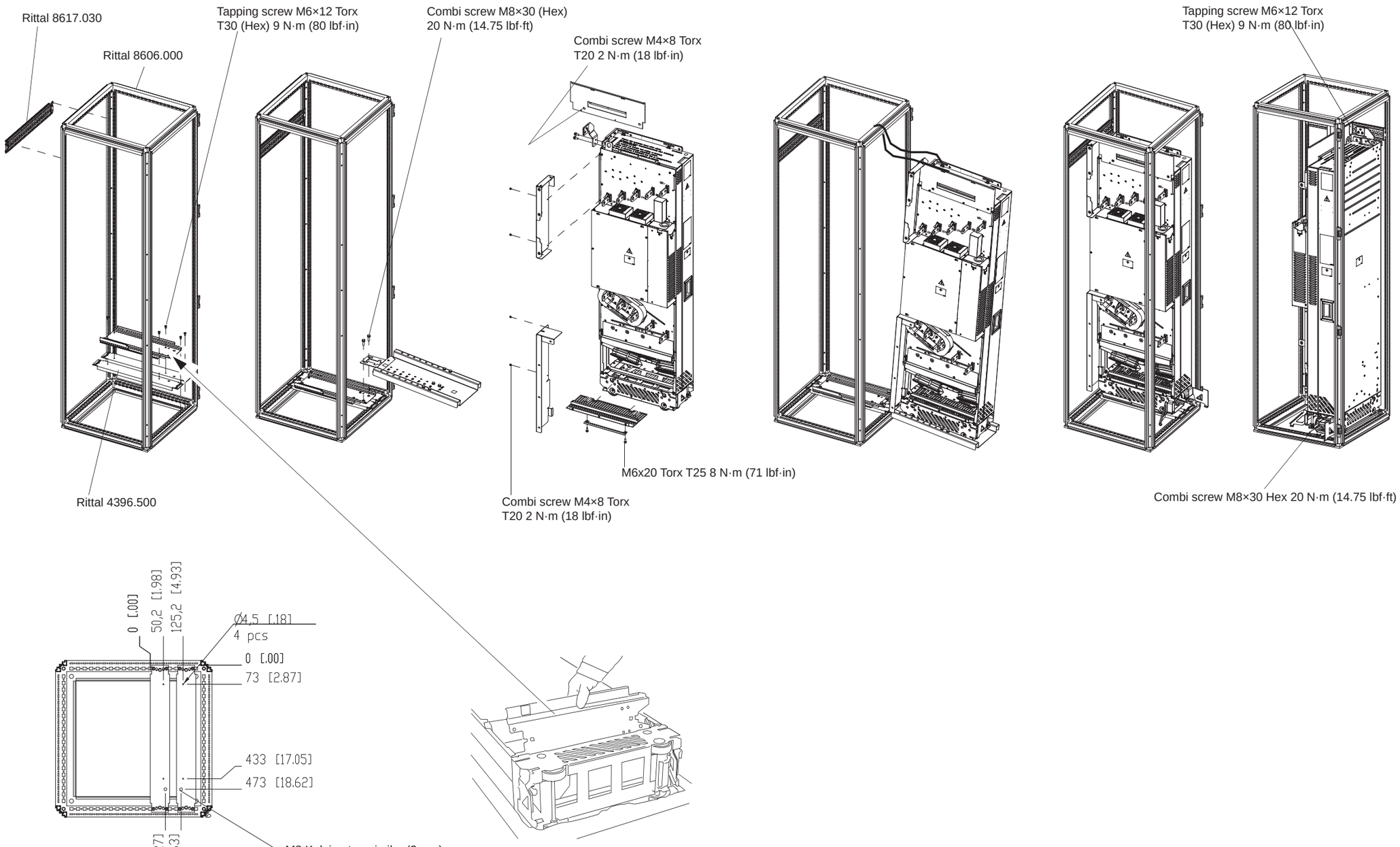
This section is valid for the UL (NEC) drive types. The internal EMC filter of the drive is disconnected as default. If you are concerned with EMC issues, and install the drive to a symmetrically grounded TN-S system, corner-grounded delta or mid-point-grounded delta system, you can connect the internal EMC filter. Contact ABB for the connection instructions.

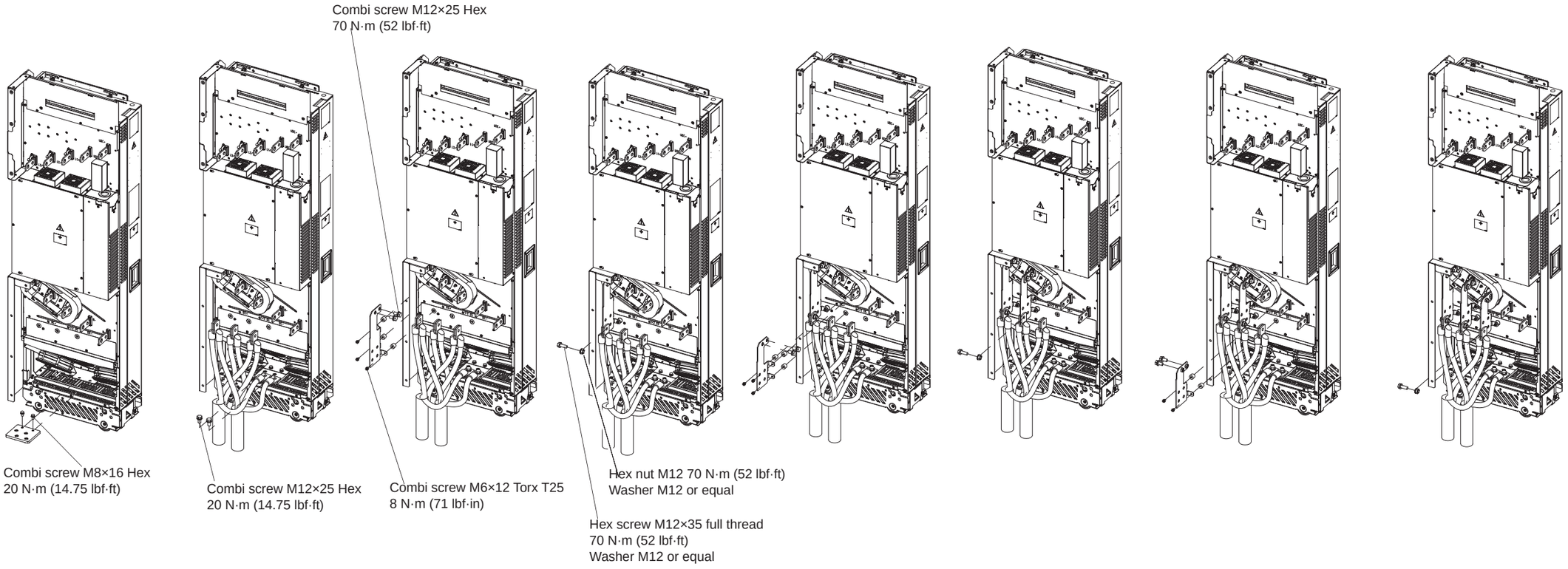
Connecting ground-to-phase varistor – North America

This section is valid the UL (NEC) drive types. The internal ground-to-phase varistor of the drive is disconnected as default. If you install the drive to TN-S system, corner-grounded delta or mid-point-grounded delta system, you can connect the ground-to-phase varistor. Contact ABB for the connection instructions.

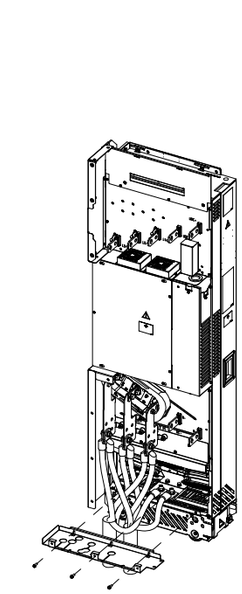
26. Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure

228 Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure

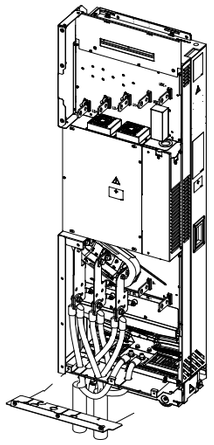


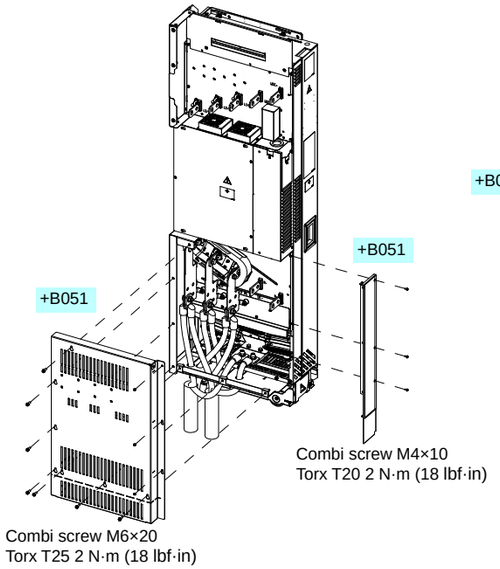

Combi screw M12×25 Hex
70 N·m (52 lbf·ft)
Combi screw M8×16 Hex
20 N·m (14.75 lbf·ft)
Combi screw M12×25 Hex
20 N·m (14.75 lbf·ft)
Combi screw M6×12 Torx T25
8 N·m (71 lbf·in)
Hex nut M12 70 N·m (52 lbf·ft)
Washer M12 or equal
Hex screw M12×35 full thread
70 N·m (52 lbf·ft)
Washer M12 or equal

230 Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure



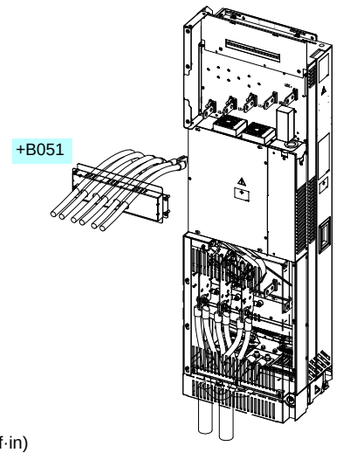
Combi screw M6×20
Torx T25 2 N·m (18 lbf·in)

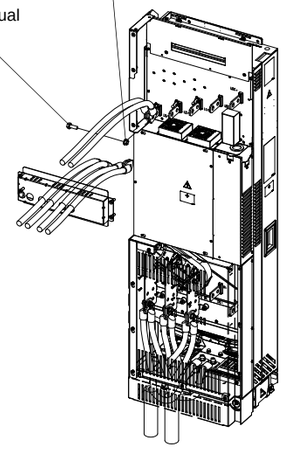


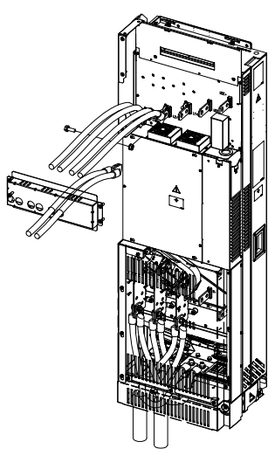


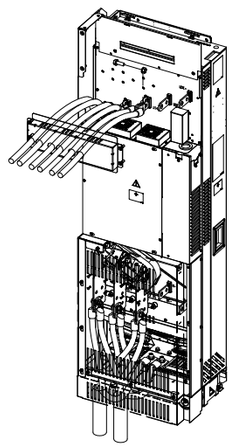
Combi screw M6×20
Torx T25 2 N·m (18 lbf·in)

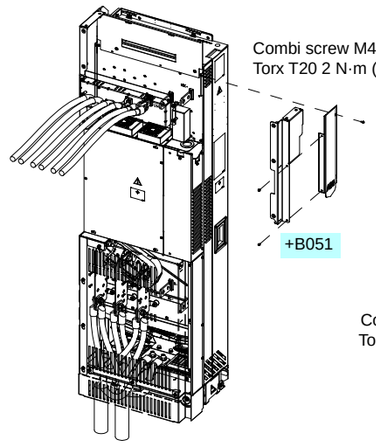
Combi screw M4×10
Torx T20 2 N·m (18 lbf·in)



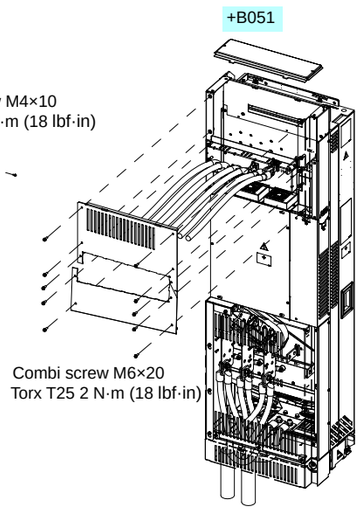




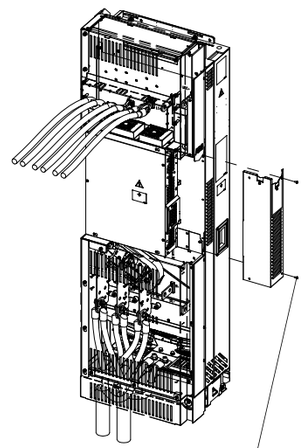


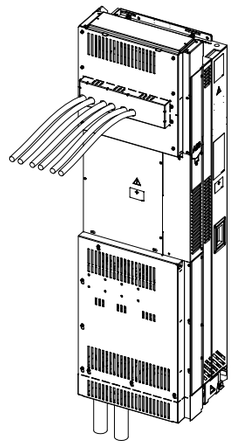


Combi screw M4×10
Torx T20 2 N·m (18 lbf·in)

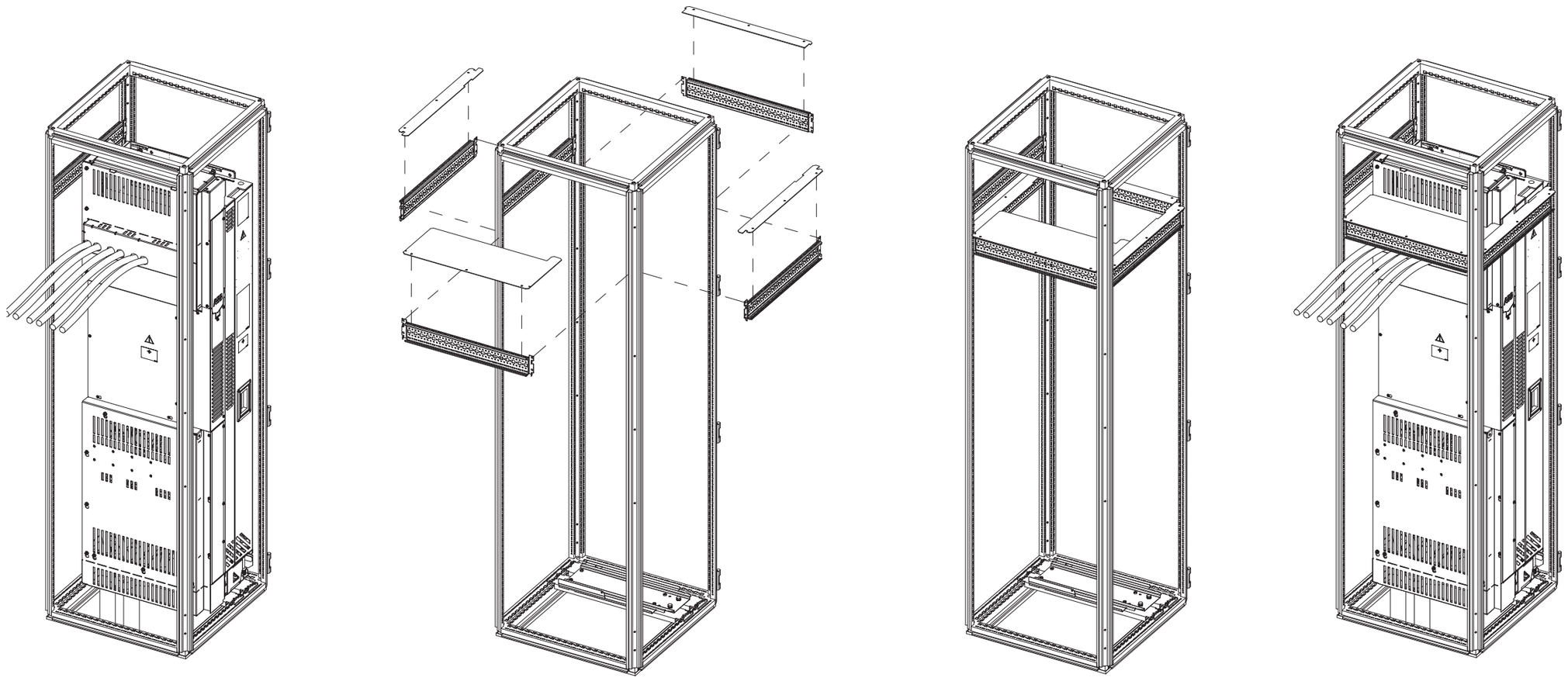


Combi screw M6×20
Torx T25 2 N·m (18 lbf·in)





Combi screw M4×8 Torx T20
2 N·m (18 lbf·in)



Note: These air baffles are compatible with option +B051 only.
For the standard drive module configuration see section
Standard drive module configuration.

Note: These air baffles are compatible with option +B051 only. For the standard drive module configuration, see section *Standard drive module configuration (page 29)*.

232 Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure

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.

Product training

For information on ABB product training, navigate to new.abb.com/service/training.

Providing feedback on ABB manuals

Your comments on our manuals are welcome. Navigate to new.abb.com/drives/manuals-feedback-form.

Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents.

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www.abb.com/drives

3AXD50000048677B

3AXD50000048677 Rev B (EN) EFFECTIVE 2020-08-10