ABB DRIVES FOR HVAC

ACH580-04 drive modules

Hardware manual

ACH580-04 drive modules

Hardware manual

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Further information

1

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.

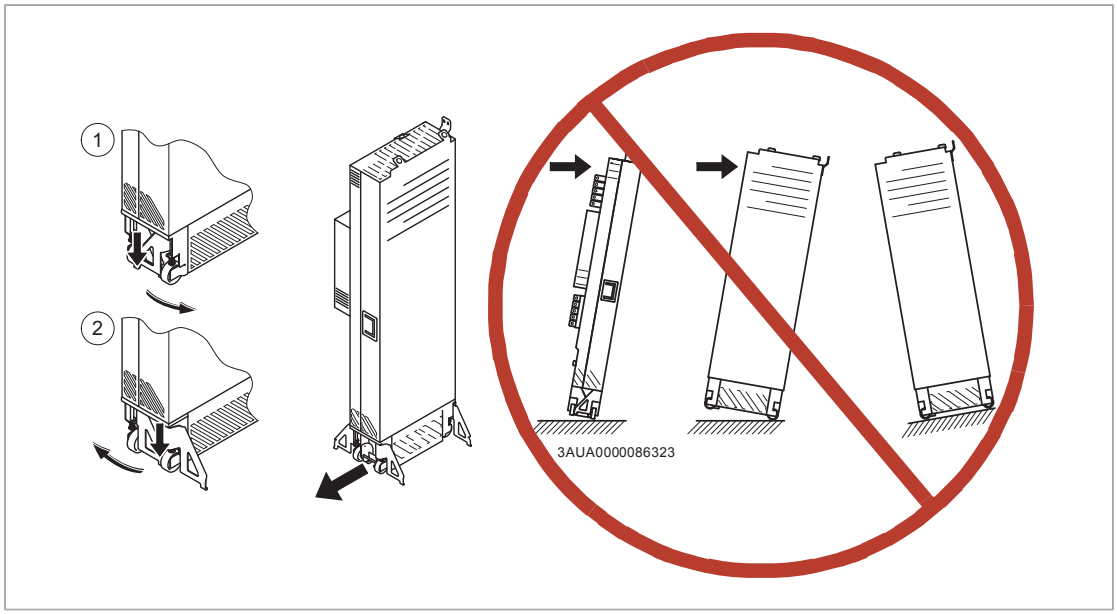
General safety in installation, start-up and maintenance

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

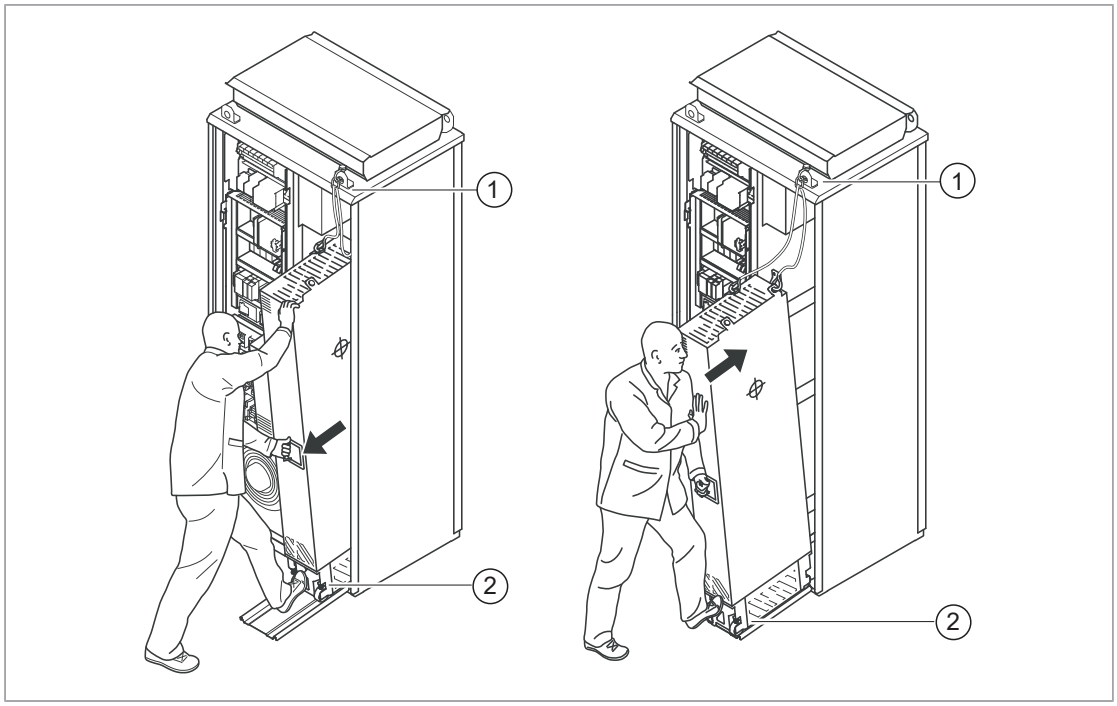
WARNING!
Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

- 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.
- 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. Incorrect lifting can cause danger or damage.
- 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 that exceed the maximum allowed height.
- Attach the module extraction/installation ramp carefully.
- Make sure that the module does not topple over when you move it on the floor: To open the support legs, press each leg a little down and turn it aside (1, 2). Whenever possible attach the module also with chains. Do not tilt the drive module. It is heavy and its center of gravity is high. The module overturns when tilted more than 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 dust inside the drive.

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

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

1. Clearly identify the work location and equipment.
2. Disconnect all possible voltage sources. Make sure that re-connection is not possible. Lock out and tag out.
   - Open the main disconnecting device of the drive.
   - Open the charging switch if present.
   - Open the 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. Use a quality voltage tester. If the measurement requires removal or disassembly of shrouding or other cabinet structures, obey the local laws and regulations applicable to live working (including – but not limited to – electric shock and arc protection).
   - Before and after measuring the installation, verify the operation of the voltage tester on a known voltage source.
   - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is zero.
   - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is zero.

     Important! Repeat the measurement also with the DC voltage setting of the tester. Measure between each phase and ground. There is a risk of dangerous DC voltage charging due to leakage capacitances of the motor circuit. This voltage can remain charged for a long time after the drive power-off. The measurement discharges the voltage.
   - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero.

6. Install temporary grounding as required by the local regulations.
7. Ask for a permit to work from the person in control of the electrical installation work.

Additional instructions and notes

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:

- When the drive is connected to the input power, the motor cable terminals and the DC bus are at a dangerous voltage.
  The brake circuit, including the brake chopper (option +D150) and brake resistor (if installed) are also at a dangerous voltage.
  After disconnecting the drive from the input power, these remain at a dangerous voltage until the intermediate circuit capacitors have discharged.
- External wiring can supply dangerous voltages to the relay outputs of the control units of the drive.
- The Safe torque off function does not remove the voltage from the main and auxiliary circuits. The function is not effective against deliberate sabotage or misuse.

Printed circuit boards

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

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

General safety in operation

These instructions are for all personnel that operate the drive.

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

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

Note:

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

Additional instructions for permanent magnet motor drives

Safety in installation, start-up, maintenance

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

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

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

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

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

- Stop the drive.
- Disconnect the motor from the drive with a safety switch or by other means.
- If you cannot disconnect the motor, make sure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, can rotate the motor directly or through any mechanical connection like belt, nip, rope, etc.
- Do the steps in section Electrical safety precautions (page 21).
- 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 ACH580-04 drive modules intended for user-defined cabinet installations.

Target audience

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

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

Categorization by frame size and option code

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 (A123) 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	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
FBIP-21	BACnet/IP adapter module
FCAN	Optional CANopen® adapter module
FCNA-01	Optional ControlNet™ adapter module
FDNA-01	Optional DeviceNet™ adapter module
FECA-01	Optional EtherCAT® adapter module
FEIP-21	Optional Ethernet adapter module for EtherNet/IP™
FENA-21	Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
FEPL-02	Optional Ethernet POWERLINK adapter module
FLON-01	Optional LonWorks® adapter module
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
SAFUR	Series of brake resistors
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 51) Guidelines for planning the electrical installation (page 73) Technical data (page 177) 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 61) Examining the delivery (page 66) If the drive has not been powered (either in storage or unused) for a year or more, the converter DC link capacitors must be reformed. Reforming the capacitors (page 176))
↓	
Examine the installation site. Attach the base of the cabinet to the floor.	Examining the installation site (page 61)
↓	
Route the cables.	Routing the cables (page 88)
↓	
Measure the insulation of the input cable, the motor and the motor cable and brake assembly (if present).	Measuring the insulation resistance of the input power cable (page 102) Measuring the insulation resistance of the motor and motor cable (page 102) Measuring the insulation resistance of the brake resistor circuit (page 102)
↓	
• 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. • Option +D150: Connect the brake resistor cables. • 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 61) Electrical installation (page 101) Resistor braking (page 241) Drive module with option +B051: Installation example of drive module with IP20 shrouds (option +B051) (page 113) Drive module with option +H381: Installation example with full cabling panels (option +H381) (page 121) Manuals for any optional equipment
↓	
Option +P906: Connect the external control cables to the drive control unit and the control unit to the drive.	External control unit (option +P906) (page 147)
↓	
Check the installation.	Installation checklist (page 159)
↓	
Commission the drive.	Start-up (page 161)
↓	
Operate the drive: start, stop, speed control etc.	Refer to ACH580 HVAC control program firmware manual (3AXD50000027537 [English]).

Related documents

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

The code and link below open an online listing of the manuals applicable to this product.

ACH580-04 related manuals

3

Operation principle and hardware description

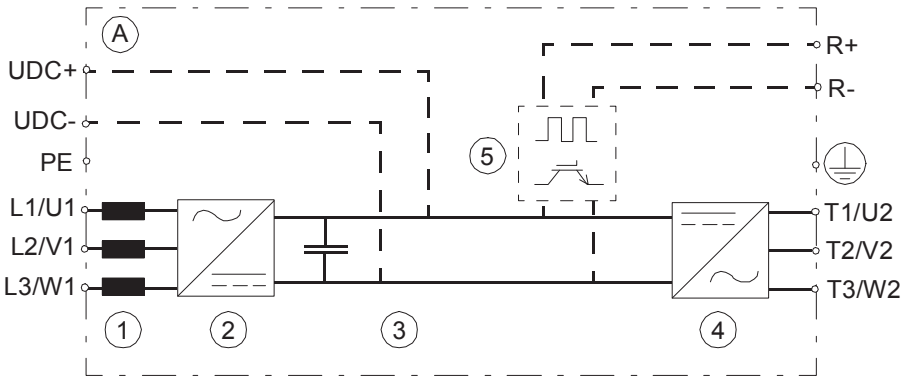
Contents of this chapter

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

Product overview

ACH580-04 is a drive module for controlling AC induction motors, synchronous reluctance (SynRM) motors and synchronous permanent magnet motors in open loop control.

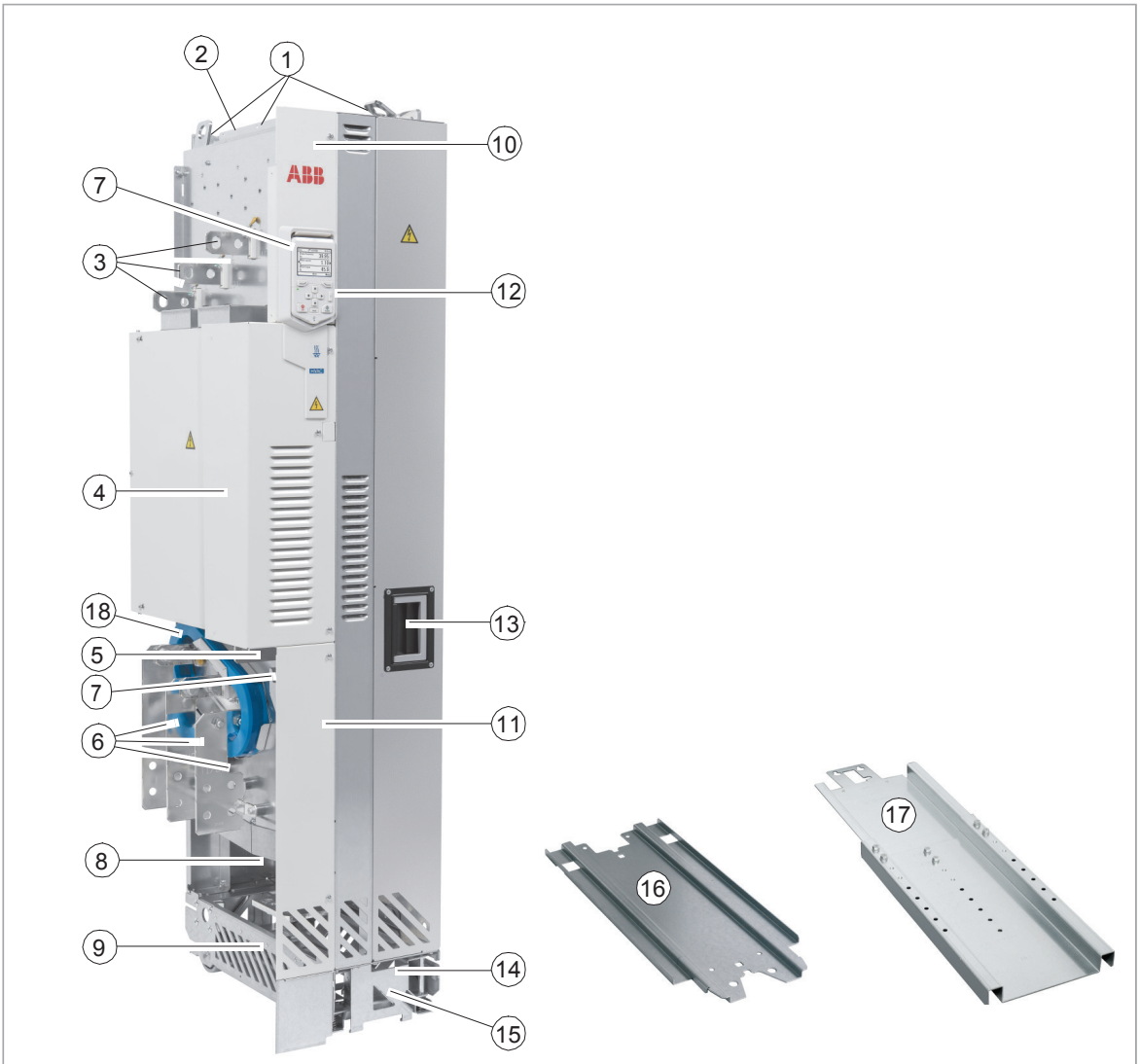
The figure below shows the simplified main circuit diagram of the drive module.



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.
5	Brake chopper (option +D150). Conducts the surplus energy from the intermediate circuit of the drive to the brake resistor when necessary. The chopper operates when the DC link voltage exceeds a certain maximum limit. The voltage rise is typically caused by deceleration (braking) of a high inertia motor.

Layout

Standard drive module configuration

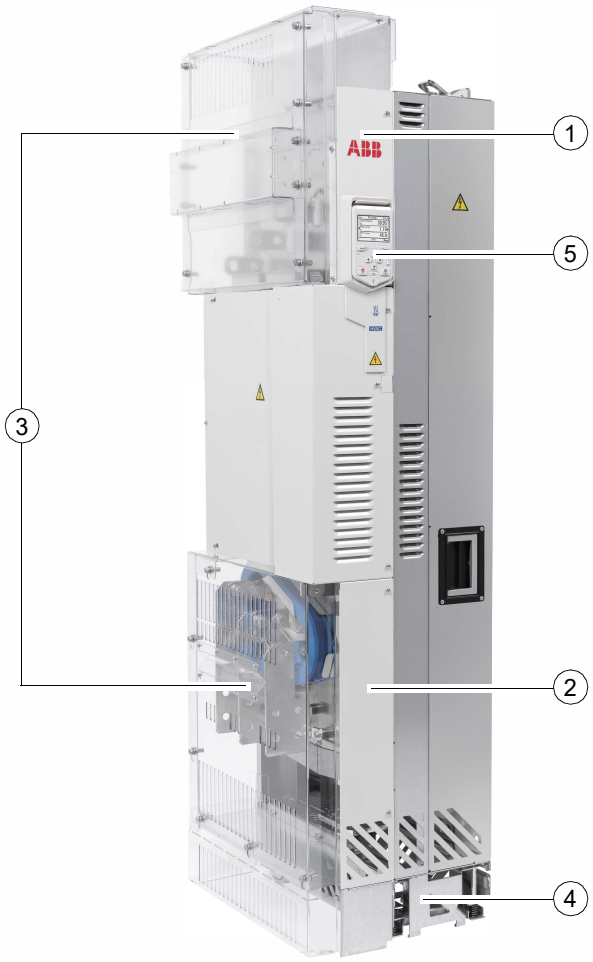


1	Lifting lugs
2	Fastening bracket
3	Input cable connection busbars (L1/U1, L2/V1, L3/W1) and and DC+ and DC- busbars (UDC+, UCD with option +H356)
4	Circuit board compartment
5	PE busbar
6	Output cable connection terminals (T1/U2, T2/V2, T3/W2) attached and brake resistor connection busbars (R+ and R- with option +D150)
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)

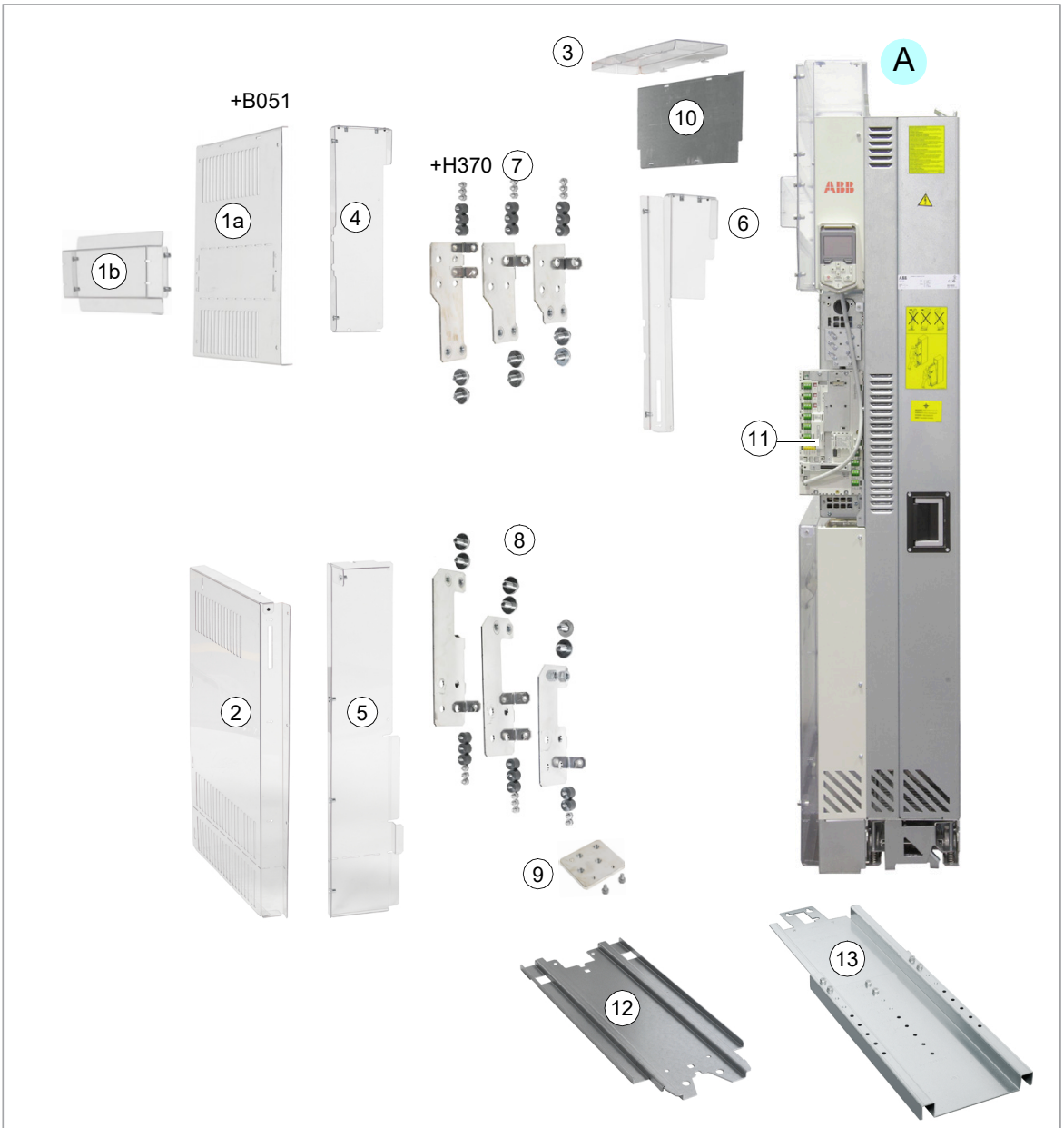
Drive module configuration with option +B051

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



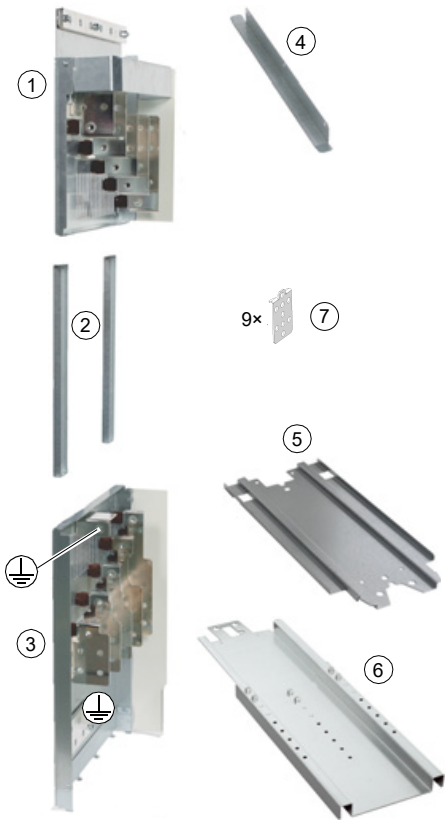
1	Upper front cover	4	Pedestal
2	Lower front cover	5	Control panel
3	Clear plastic shrouds attached (option +B051)	-	-

See the next page for the part descriptions.

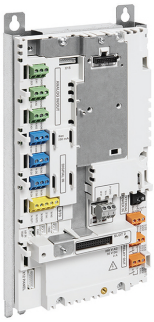


1	Clear plastic shroud to be attached onto the drive module input power cabling (a). Lead-through shroud for side cabling (b). Option +B051.	8	Output power cable connection terminals
2	Clear plastic shrouds to be attached onto the drive module output power cabling with option +B051	9	Grounding terminal 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 attached (front view)

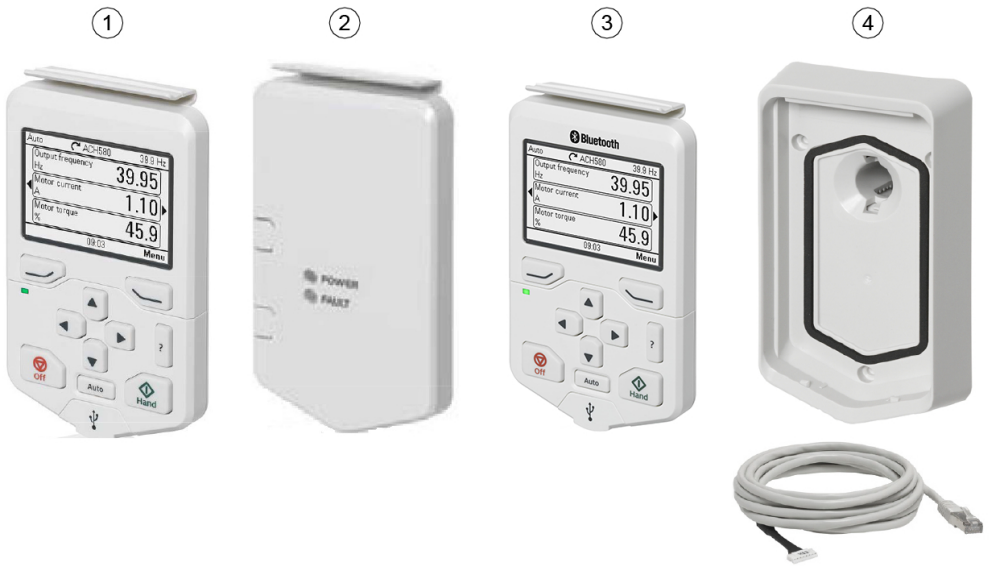
Drive module with full power cabling panels (option +H381)



(12)

Accessories		Assembled drive module	
1	Input power cabling panel	8	Rubber grommet
2	Side guides	9	Input power cabling panel to be attached to the drive cabinet
3	Output power cabling panel	10	Output power cabling panel to be attached to the drive cabinet
4	Top guide plate	11	Front cover
5	Pedestal guide plate	12	External control unit (option +P906) 
6	Telescopic extraction/installation ramp		
7	Shim plates for Rittal VX25 enclosure (9 pcs)		

Control panel



1	ACH-AP-H hand-off-auto control panel (standard)
2	CDUM-01 blank control panel cover (no control panel) (option +J424)
3	ACH-AP-W hand-off-auto control panel with Bluetooth interface (option +J429)
4	DPMP-03 control panel mounting platform (+J410, included as standard). Can be used to install the control panel on the cabinet door.

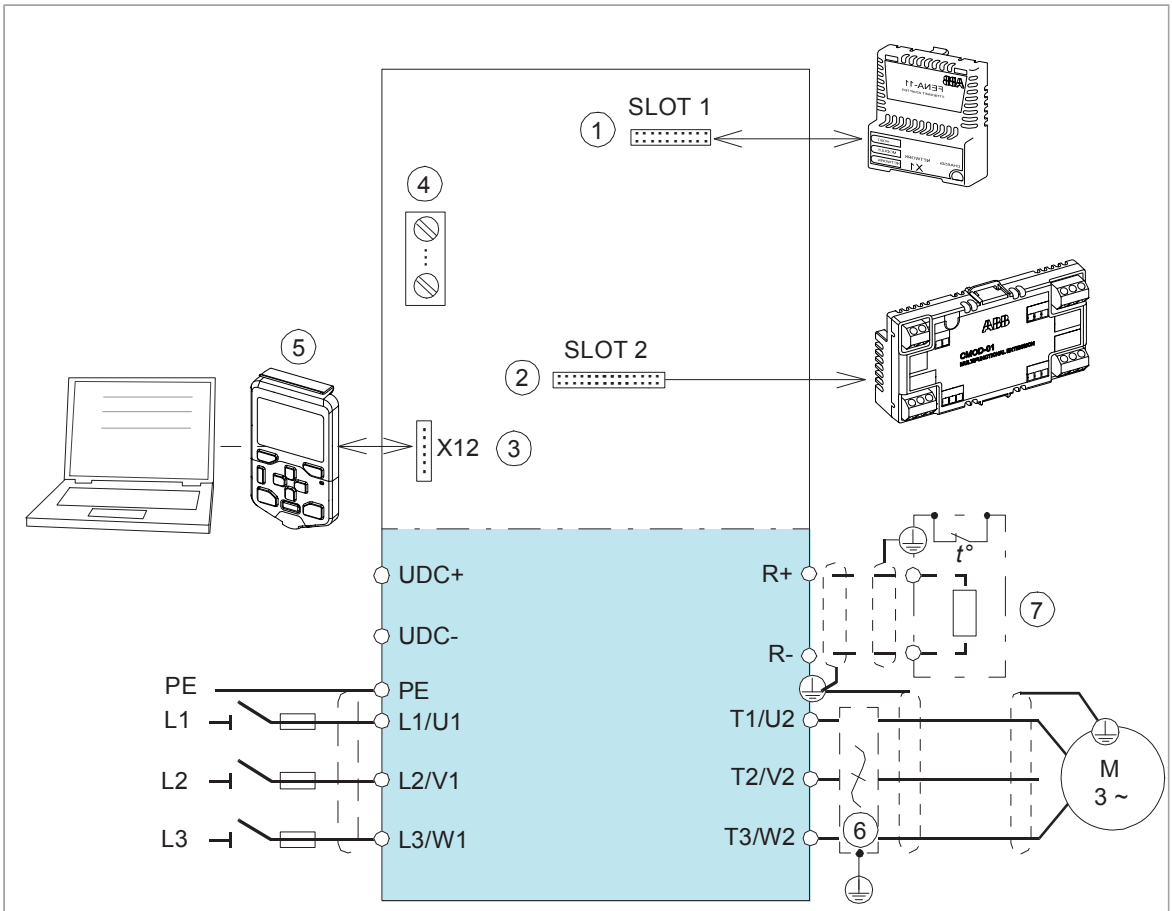
In the standard drive module configuration and with option +B051, the control panel is mounted on the upper front cover of the drive module.

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

For more information on the control panel, refer to ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual (3AUA0000085685 [English]).

Overview of power and control connections

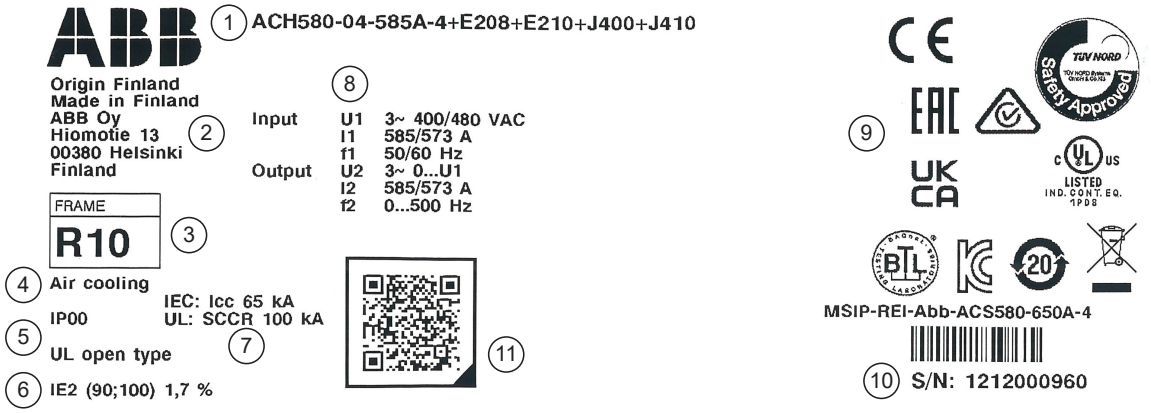
The diagram shows the power connections and control interfaces of the drive module.



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 135).
5	Control panel (see section Connecting a PC (page 110))
6	du/dt or sine filter (optional, see chapter Filters (page 273))
7	Brake resistor. See chapter Resistor braking (page 241).

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. Refer to section Type designation key (page 40).
2	The manufacturer's address
3	Frame size
4	Cooling method
5	Degree of protection, enclosure type
6	Losses according to IEC 61800-9-2
7	Short-circuit withstand strength. Refer to section Electrical power network specification (page 189).
8	Ratings. Refer to section Electrical ratings (page 177).
9	Valid markings
10	S/N: Serial number of format MYYWWXXXXX, where M: Manufacturing location YY: Year of manufacture: 19, 20, 21, … for 2019, 2020, 2021, … WW: Week of manufacture: 01, 02, 03, … for week 1, week 2, week 3, … XXXXX: Running item number that starts each week from 00001.
11	Link to product information

Type designation key

The type designation contains information on the specifications and configuration of the drive. The first digits from left express the basic drive type. The optional selections are given thereafter, separated by plus signs. 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
ACH580	Product series
Type	
-04	The standard delivery includes: 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, ACH580 HVAC standard 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-06-H, the control unit is external (+P906), the DC connection busbars (+H356) are included, and the quick guide contains English language only. Refer to section Option codes (page 40) for options.
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
D150	Brake choppers
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 standard wheeled pedestal. The drive module is equipped with a low pedestal to which the bottom grille can be attached if IP20 degree of protection is needed from bottom. Requires option +0P919.
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. Not to be used with full power cabling panels (option +H381).
H381	Full power cabling panels to be attached to a cabinet. The drive module can be pulled out from the cabinet without disconnecting the power cables. IP20 degree of protection. Requires external control unit (option +P906). Not to be used with full-size input terminals (option +H370).

Code	Description
0J400	No control panel
J400	ACH-AP-H control panel
J410	DPMP-03 door mounting kit (included as standard, except in US and China)
J429	ACH-AP-H control panel with Bluetooth interface
K451	FDNA-01 DeviceNet™ adapter module
K452	FLON-01 LonWorks® adapter module
K454	FPBA-01 PROFIBUS DP adapter module
K457	FCAN-01 CANopen adapter module
K458	FSCA-01 RS-485 (Modbus/RTU) adapter module
K462	FCNA-01 ControlNet™ adapter module
K465	FBIP-01 BACnet/IP adapter module, 2-port
K469	FECA-01 EtherCat adapter module
K470	FEPL-02 EtherPOWERLINK adapter module
K475	FENA-21 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
K490	FEIP-21 EtherNet/IP adapter module
K491	FMBT-21 Modbus/TCP adapter module
K492	FPNO-21 PROFINET IO adapter module
L501	CMOD-01 External 24 V AC/DC and digital I/O extension (2×RO and 1×DO)
L512	CHDI-01 115/230 V digital input module (six digital inputs and two relay outputs)
L523	CMOD-02 External 24 V and isolated PTC interface
L537	CPTC-02 ATEX-certified thermistor protection module
N2000	Standard software language set (default; includes EN, DE, ES, PT, FR, ZH, IT, FI, PL, RU, TR)
N2901	European software language set (default for SV, CZ, HU, DA, NL; includes EN, DE, ES, PT, FR, SV, CZ, HU, DA, NL)
N2902	Asian software language set (default for KO, TH; includes EN, DE, ES, PT, FR, ZH, KO, TH)
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
P952	European Union Country of Origin
Q971	ATEX-certified safe disconnection function
R700	Printed manuals in English
R701	Printed manuals in German[1)]
R702	Printed manuals in Italian[1)]
R707	Printed manuals in French[1)]
R708	Printed manuals in Spanish[1)]
R709	Printed manuals in Portuguese[1)]
R711	Printed manuals in Russian[1)]
R712	Printed manuals in Chinese[1)]
R714	Printed manuals in Turkish[1)]

1) Manuals in English may be included if a translation in the specified language is not available.

Ordering codes

You can order:

- IP20 shrouds for frame R10 with code 3AXD50000024563 and for R11 with code 3AXD50000024564
- DPMP-05 control panel mounting platform with code 3AXD50000240319.
- DPMP-07-H control panel mounting platform with code 3AXD500003710 (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.

Planning the layout of the cabinet

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

Place the control unit(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 attaching 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 bare copper and aluminum can also be used.

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

Shrouds

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

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

Tightening torques

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

Electrical connections

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

Mechanical connections

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

Size	Max. torque	Strength class
M8	24 N·m (17.7 lbf·ft)	8.8

Insulation supports

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

Cable lugs

Size	Max. torque	Strength class
M8	15 N·m (11 lbf·ft)	8.8 (A2-70 or A4-70*)
M10	32 N·m (23.5 lbf·ft)	8.8
M12	50 N·m (37 lbf·ft)	8.8

Cooling and degrees of protection

Planning the cooling

When you plan the cooling of the cabinet:

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

Air-cooled drive systems

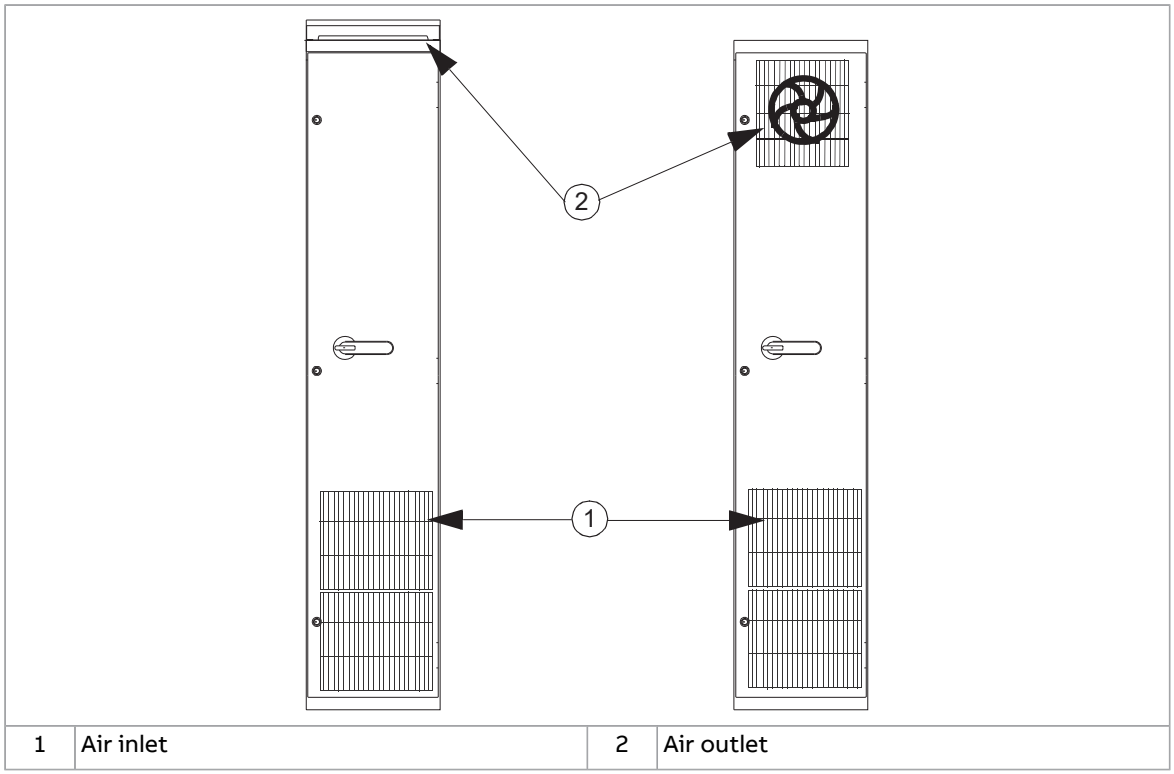
Air inlets and outlets

Equip the air inlets and outlets with gratings that:

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

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

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 in the applicable hardware manual. 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 is required.
- allowed ambient temperature and temperature rise inside the cabinet
- allowed pressure drop over the cabinet that the cooling fan can overcome
- air inlet and outlet sizes required for cooling and recommended filter material (if used).

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

The internal cooling fans of the converter modules and filters are usually sufficient to keep the component temperatures low enough in IP20 and IP42 cabinets. For higher degrees of protection, or if the air outlet is in the cabinet door, extra fans can be necessary. If you install additional heat-generating components to the cabinet, make sure to upgrade the cooling system accordingly.

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

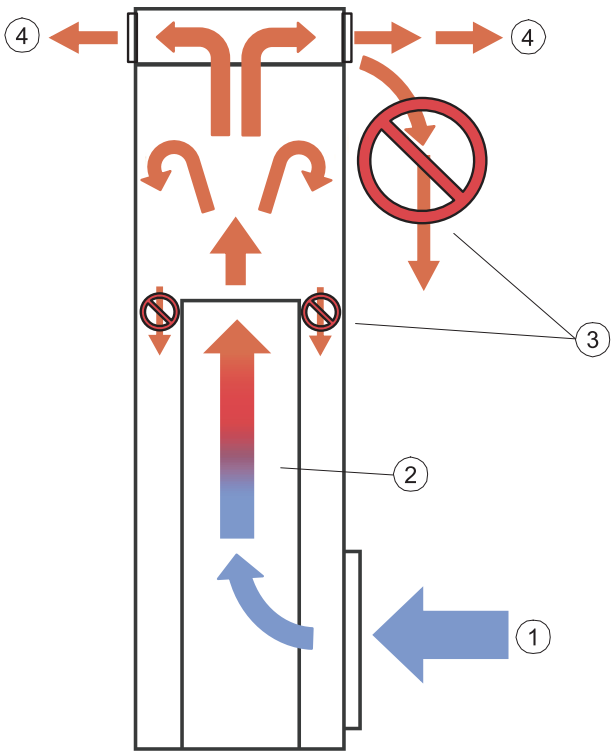
Preventing the recirculation of hot air

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

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

Prevent hot air circulation inside the cabinet with, for example, leak-proof air baffles. Usually, no gaskets are 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

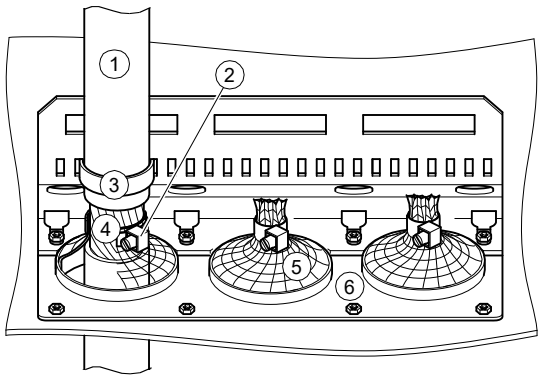
EMC requirements

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

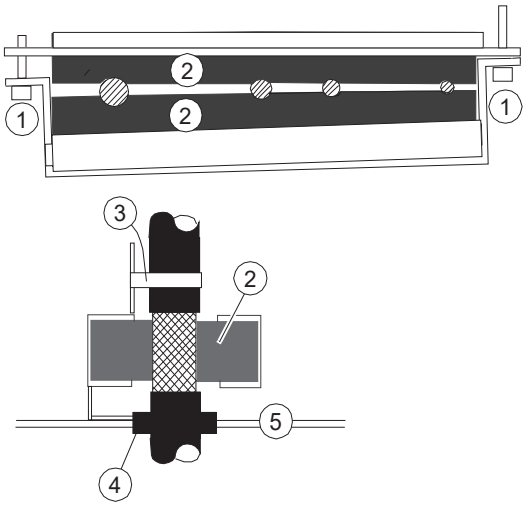
conductive gasket between the surfaces is required. The maximum recommended distance between assembly screws is 100 mm (3.94 in).

- 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

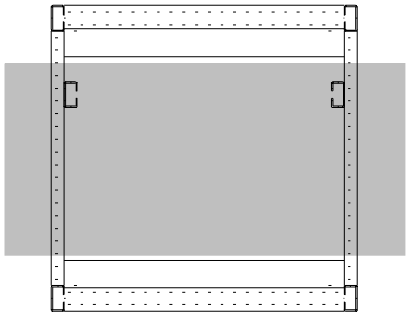
Refer to the cabinet manufacturer's instructions.

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.

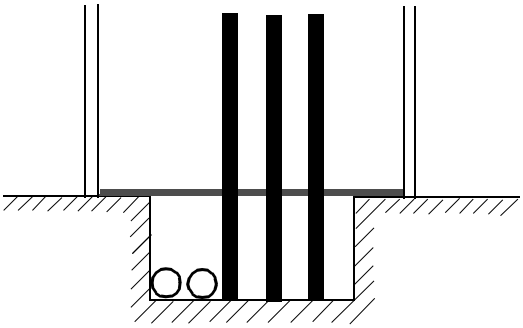
Cabinet placement on a cable duct

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

- 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 duct into the cabinet.



The supporting structure on a cable duct



Cabinet side view with a bottom plate

Cabinet heating elements

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

Attaching the control panel on the cabinet door

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

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

DPMP-01	DPMP-02	DPMP-04/05

5

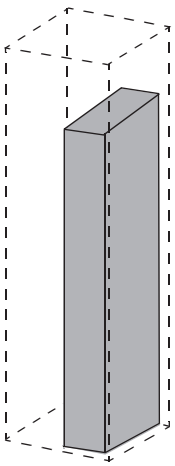
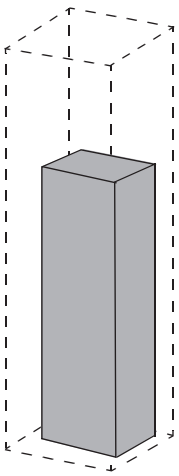
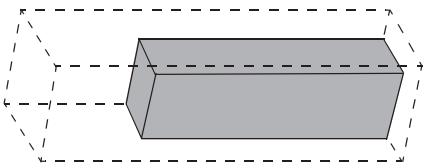
Guidelines for planning the mechanical installation

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 drive-specific guidelines are essential for the safe and trouble-free use of the drive system.

Installation positions of the drive module

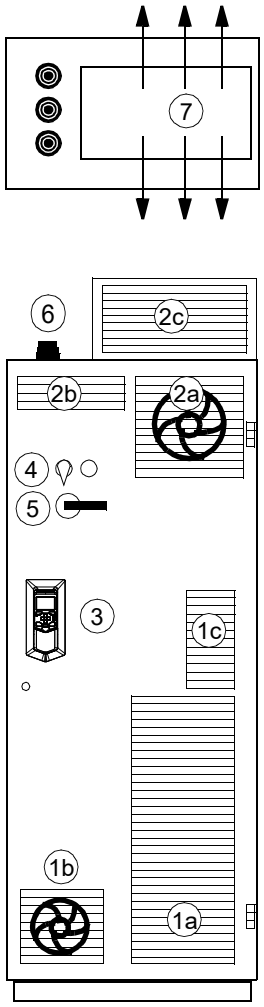
You can install the drive module in a bookshelf or flat position or on its back in a cabinet.

		
Bookshelf	Flat	On its back

Planning the layout

Layout example, door closed

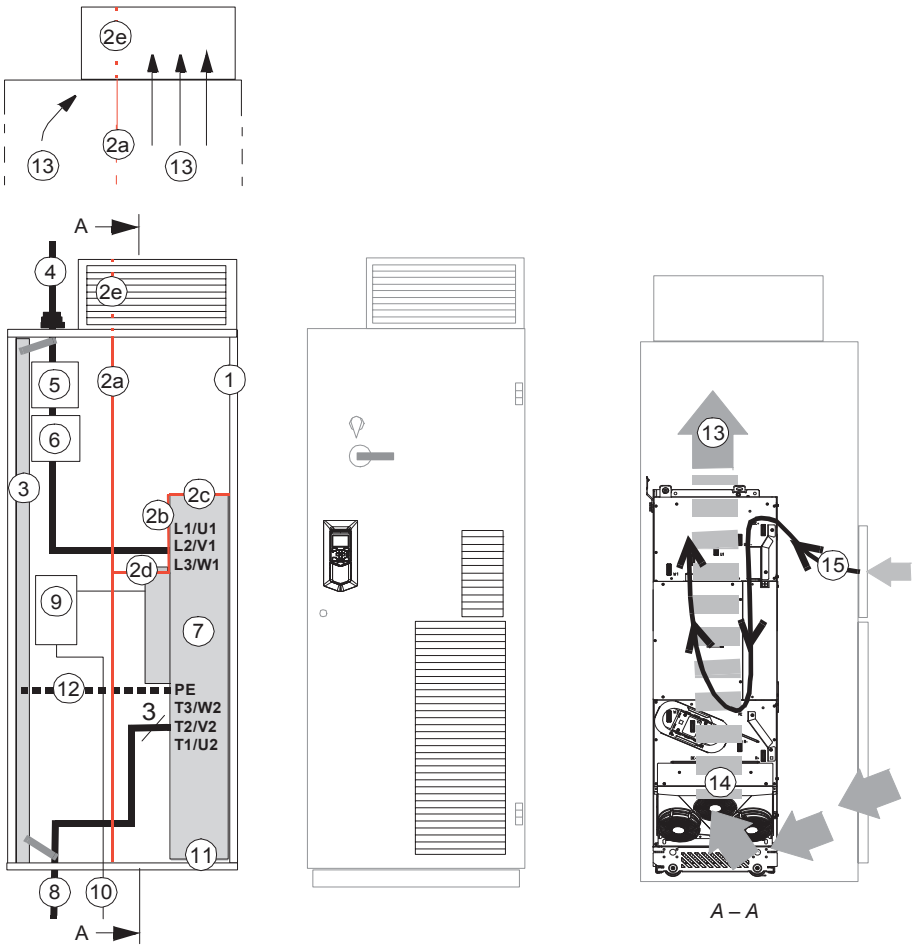
This diagram shows a cabinet layout example with the input power cable entry from top and the motor cable entry from bottom.



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 53).
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 187).

Layout example, door open (standard drive module configuration)

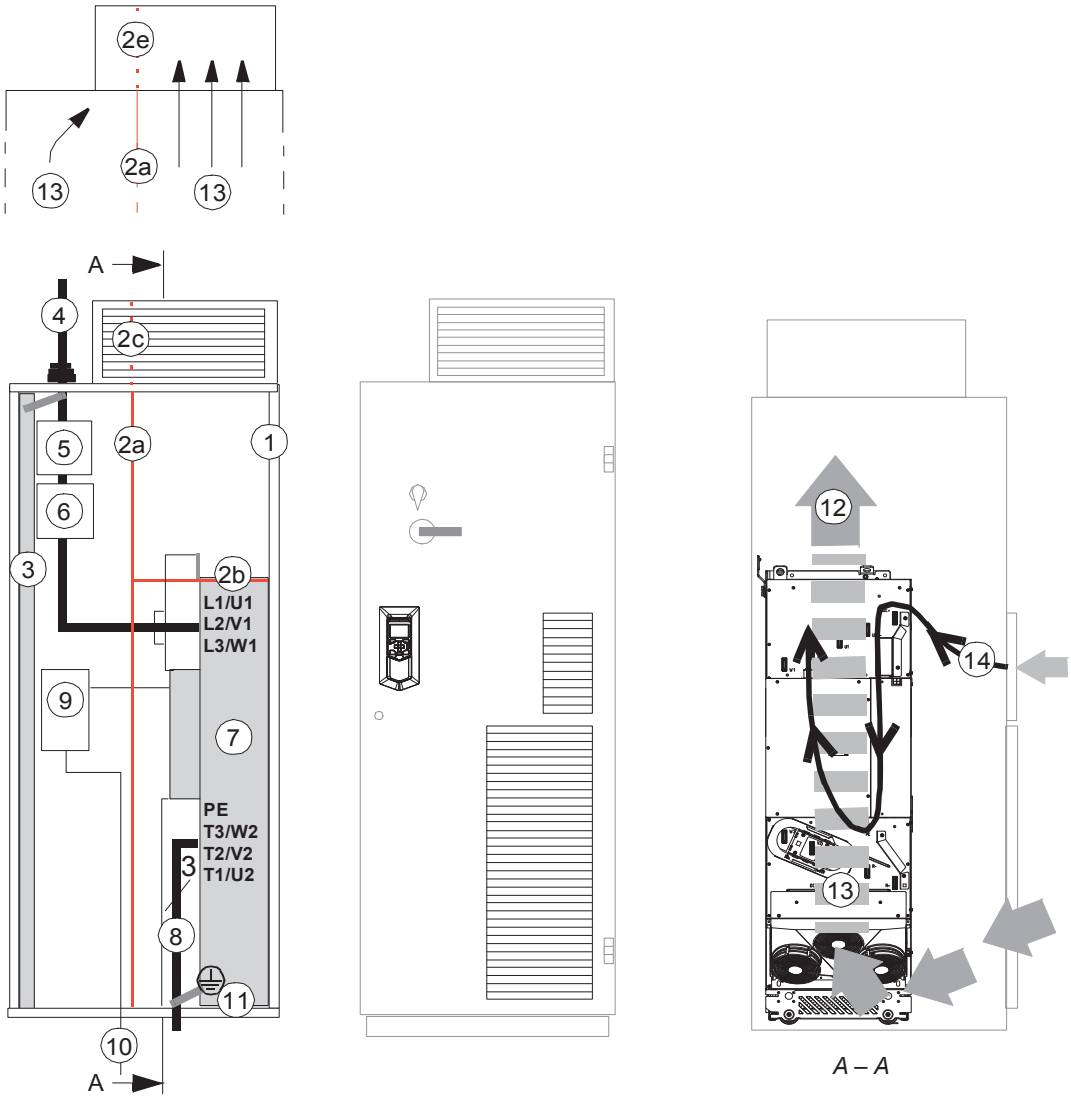


1	Supporting frame of the cabinet	8	Motor cable including the protective ground conductor of the drive module
2	Vertical (2a, 2b) and horizontal (2c, 2d) air baffles with leak-proof cable entries. The air baffles separate the cool and hot areas and prevent recirculation of hot air.	9	External drive module control unit (option +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 52))	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:

- The power cable shields can also be grounded to the drive module grounding terminals.
- See also section Free space requirements (page 58).

Layout example, door open (option +B051)

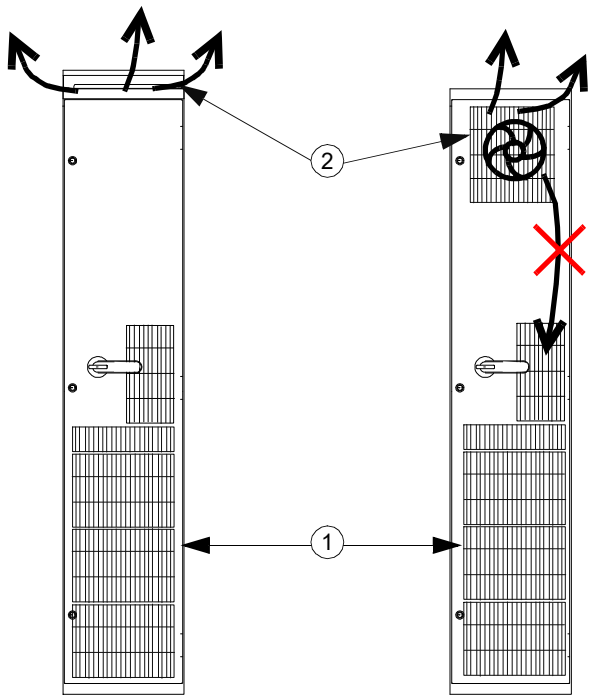


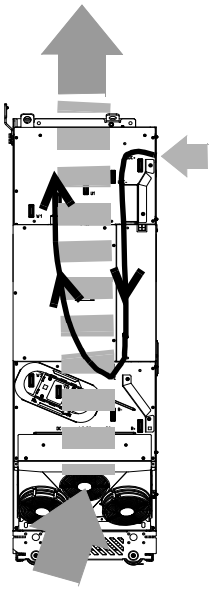
1	Supporting frame of the cabinet	7	Drive module
2a 2b	Vertical (2a) and horizontal (2b) air baffles with leak-proof cable entries. The air baffles separate the cool and hot areas and prevent recirculation of hot air.	8	Motor cable including the protective ground conductor of the drive module
2c	Optional 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 52)).	9	External drive module control unit (option +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 ACH580-04

The drawing below shows two typical cabinet cooling solutions. The air inlet is at the bottom of the cabinet, and the outlet is at the top (on the upper part of the door, or on the roof). ABB recommends that the air outlet is on the cabinet roof. If the air outlet is on the cabinet door, use an extra exhaust fan.



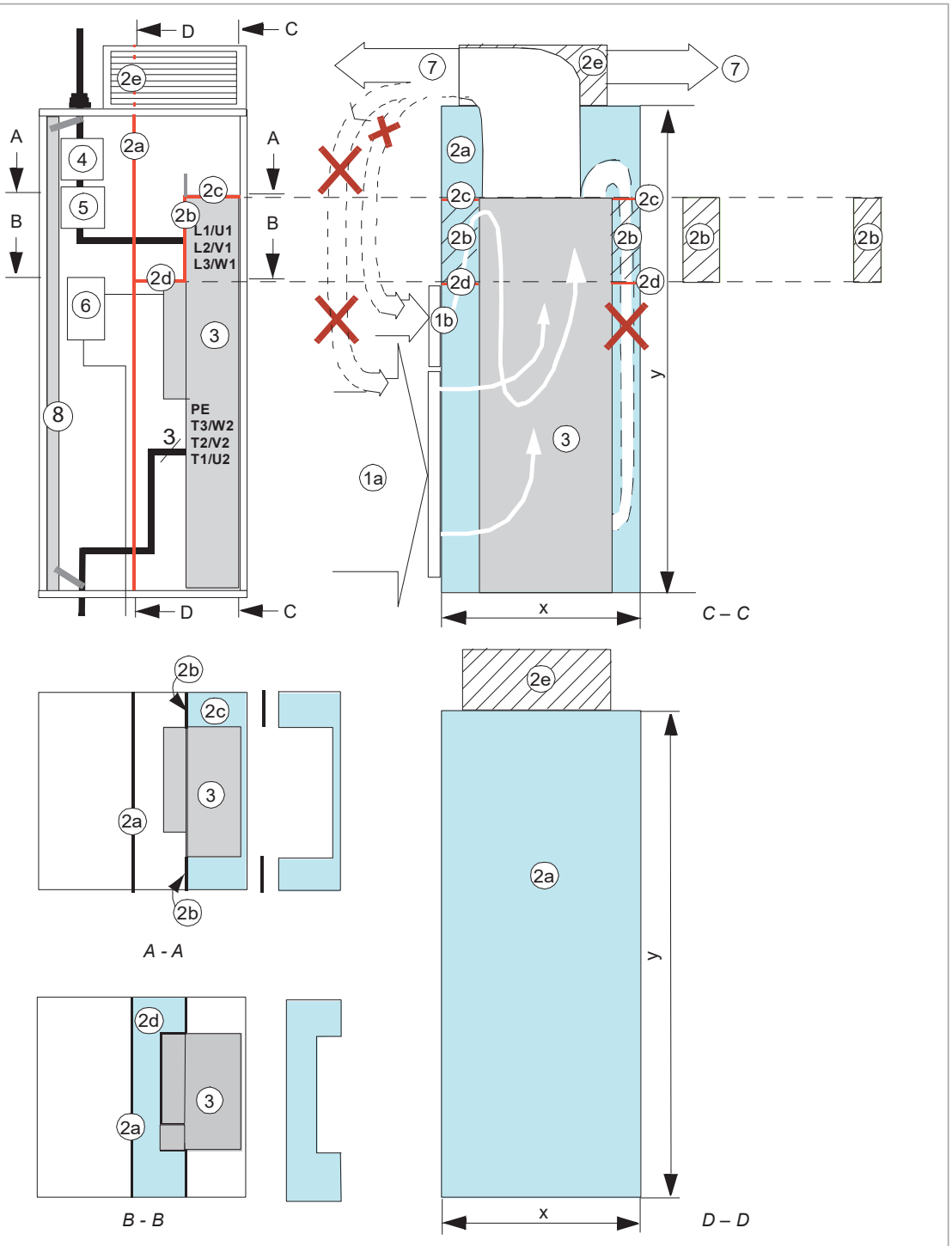


Air inlets and outlets of the cabinet	
1	air inlet
2	air outlet

Air flow inside the drive module

Standard drive module configuration

This diagram shows air baffle positions in an example cabinet.

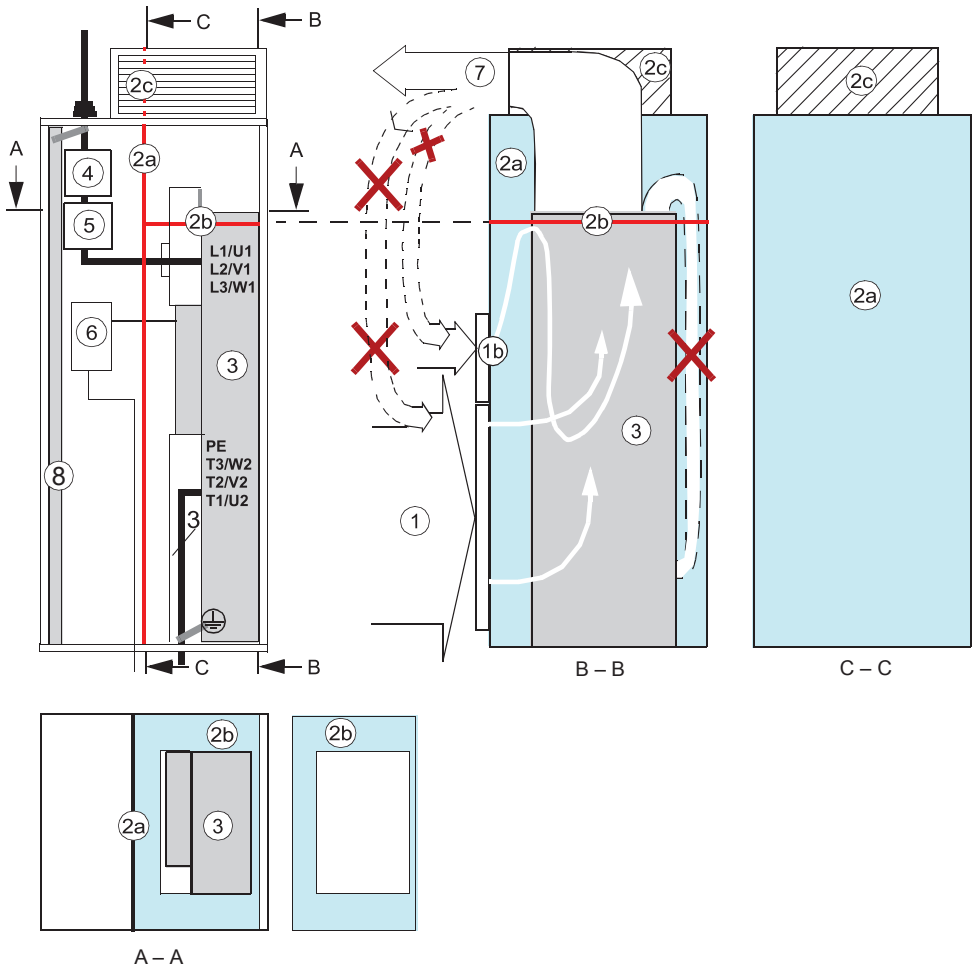


1a	Air flow to the drive module, max. 40 °C (104 °F)	3	Drive module
1b	Air inlet to the drive module circuit boards and DC output busbars	4	Disconnector and fuses
2a	Vertical air baffle that separates the cool and hot areas in the cabinet	5	Contactor
2b	Vertical air baffle	6	External drive module control 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 52)).	-	-

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 216).	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 52)	8	Cabinet grounding busbar
3	Drive module	-	-

Installation positions other than vertical

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

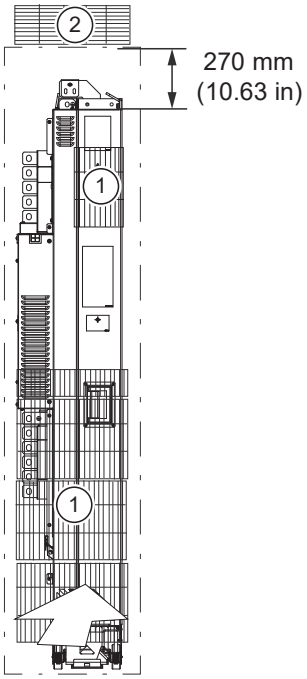
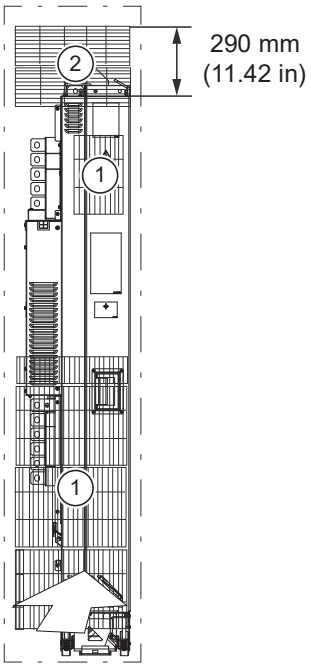
For other installation positions, contact ABB.

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

Bookshelf installation: 10 mm (0.39 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)
- depth 600 mm (23.62 in)
- height 2000 mm (78.74 in).

Free space below the drive module

Standard drive module: No free space for cooling is required at the bottom of the drive module.

No pedestal (option +0H354):

- No free space for cooling is required below the drive module when the module is installed in a cabinet.
- 200 mm (7.87 in) free space is required below the drive module when the module is installed on a wall.

6

Mechanical installation

Contents of this chapter

This chapter tells how to examine the installation site, unpack and examine the delivery and install the drive mechanically.

Examining the installation site

Examine the installation site. Make sure that:

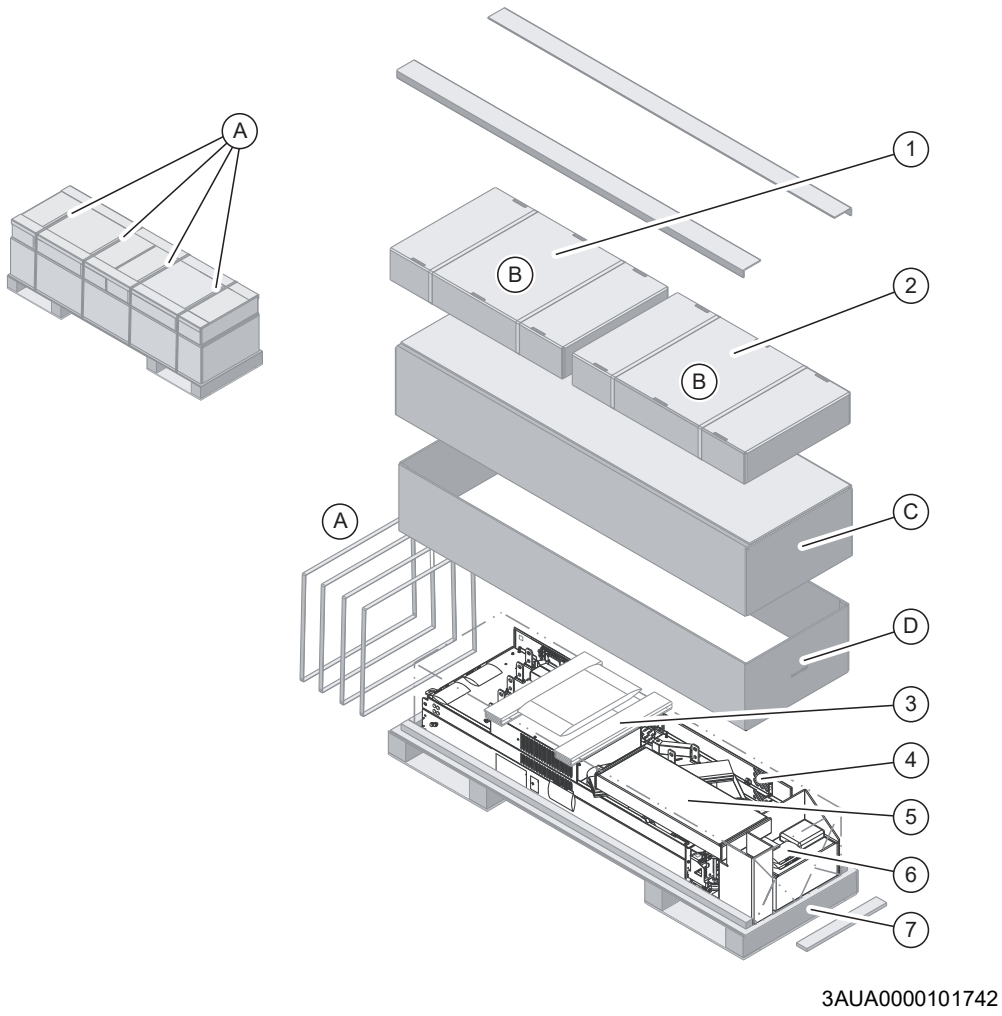
- The installation site is sufficiently ventilated or cooled to remove heat from the drive. See the technical data.
- The ambient conditions of the drive meet the specifications. See the technical data.
- The material behind, above and below the drive is non-flammable.
- There is sufficient free space around the drive for cooling, maintenance, and operation. See the free space specifications for the drive.
- Make sure that there are no sources of strong magnetic fields such as high-current single-core conductors or contactor coils near the drive. A strong magnetic field can cause interference or inaccuracy in the operation of the drive.

Moving and unpacking the unit

Moving the drive module

Move the drive module in its transport package to the installation site.

Unpacking the transport package

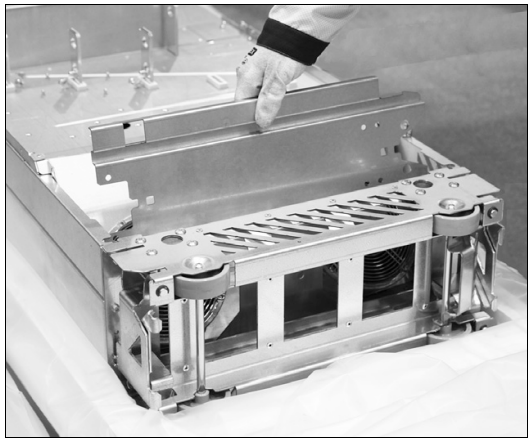


Transport package contents	
A	Bands
B	Additional boxes. For the contents of these boxes, refer to the tables that follow.
C	Outer sheathing
D	Sheathing
1	With option +B051: Clear plastic shrouds. With option +H381: Input cabling panel parts. See below for the box contents.
2	With standard drive module configuration: Output cable connection terminals. With option +H381: Output cabling panel parts. 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.

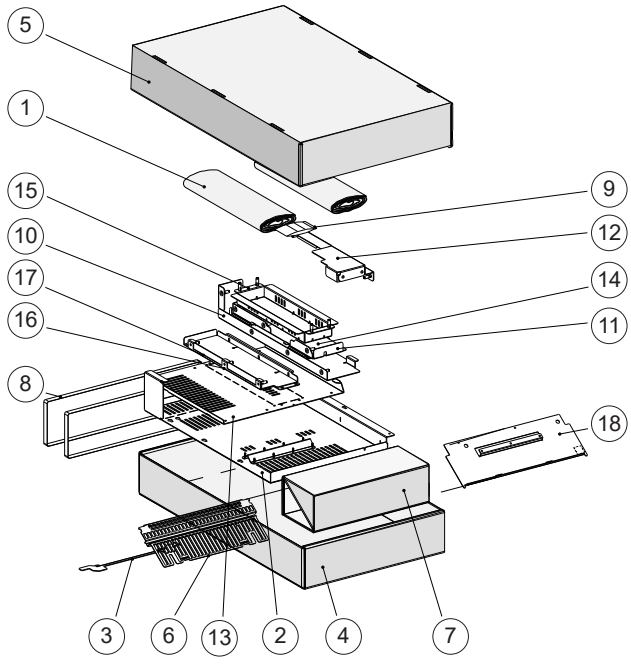
6	Accessories box
7	Pallet

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 as shown below.

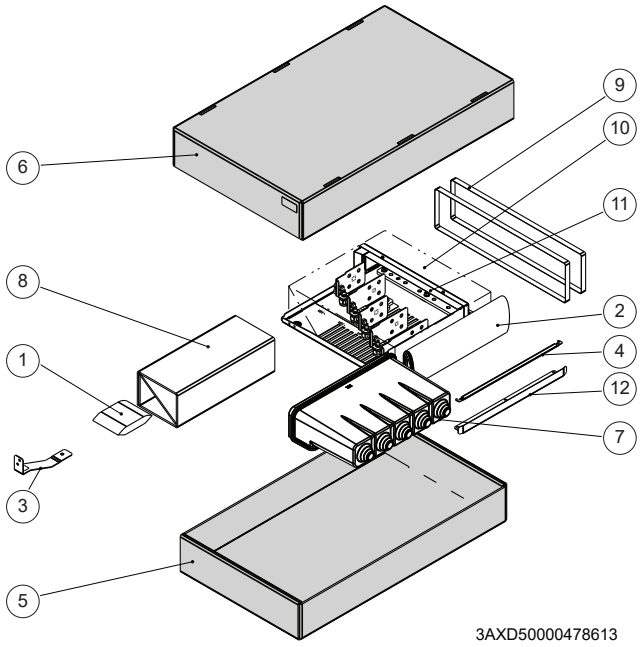


Note: The pedestal guide plate is not included with options +0H354 and +0P919.

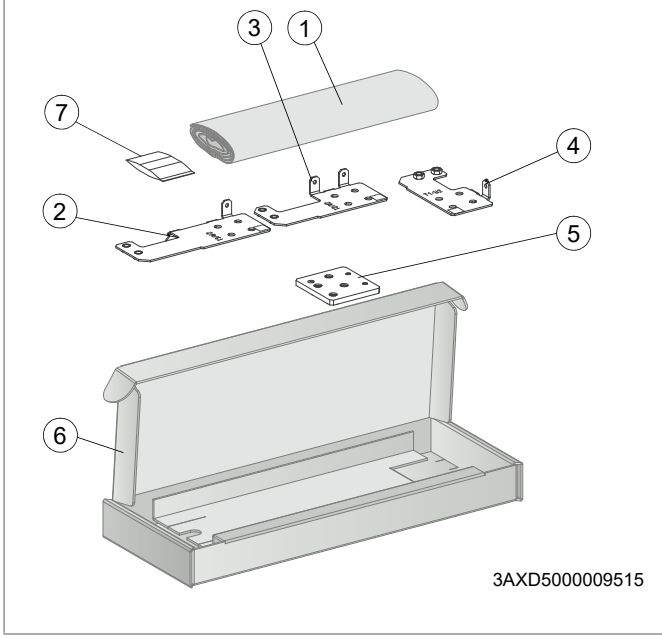


3AXD50000013807

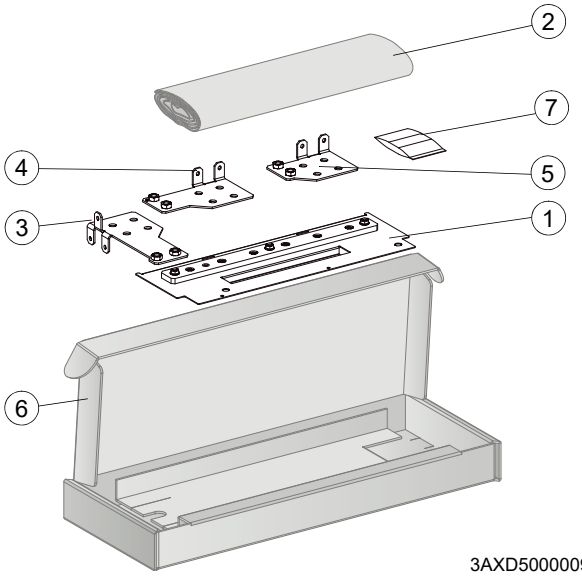
Box B1 contents (option +B051)	
1	Paper fill
2	Clear plastic shroud for output power cabling
3	Mounting bracket for bottom grille
4	Cardboard box bottom
5	Cardboard box cover
6	Bottom grille
7	Support
8	Straps
9	Screws in a plastic bag
10	Back clear plastic shroud (lower)
11	Back clear plastic shroud (upper)
12	Front clear plastic shroud
13	Clear plastic shroud for input power cabling
14	Top clear plastic shroud
15	Entry clear plastic shroud for side input cabling
16	Clear plastic bottom shroud 1
17	Clear plastic bottom shroud 2
18	Metallic shroud



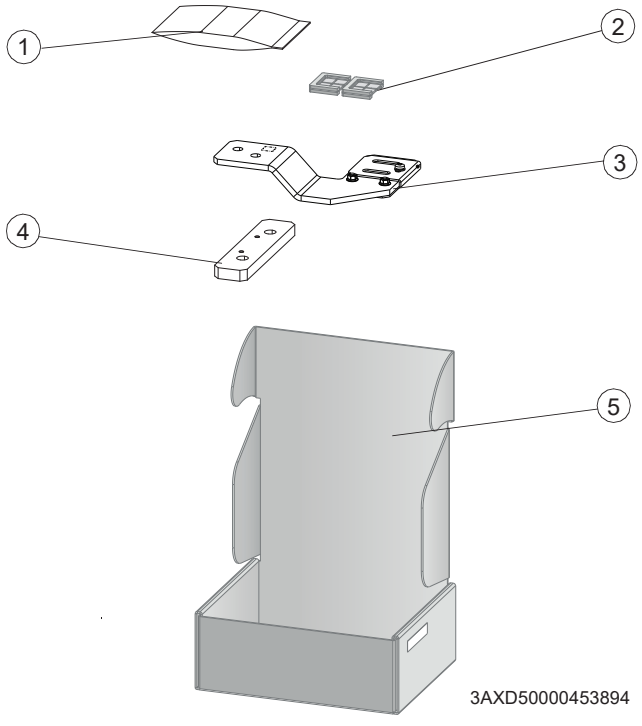
Box B1 contents (option +H381)	
1	Screw package
2	Paper fill
3	Grounding busbar to be connected to the input power cabling panel and the drive module
4	Bracket
5	Cardboard tray
6	Top cardboard cover
7	Rubber grommet
8	Support
9	Bands
10	Plastic bag
11	Input power cabling panel
12	Top guide



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



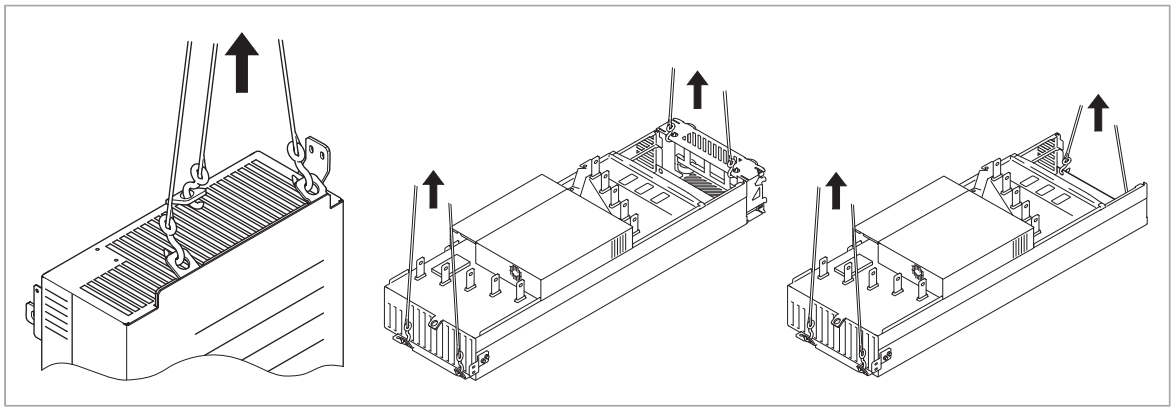
Box B2 contains additionally this box with option +H370	
1	Metallic shroud with ground bar
2	Paper fill
3	Input cable connection terminal L3/W1
4	Input cable connection terminal L2/V1
5	Input cable connection terminal L1/U1
6	Cardboard box
7	Screws and insulators in a plastic bag



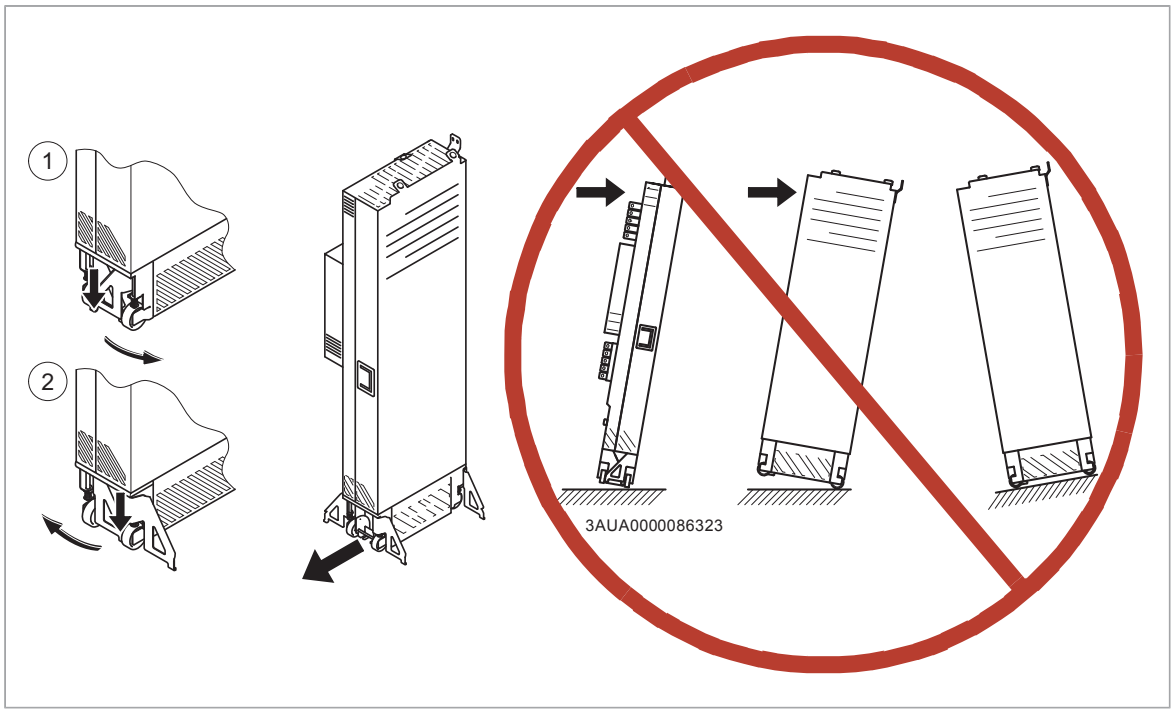
Accessory box contents: Assembly kit 3AXD50000453900	
1	Screw package, includes also spacers for FSO module installation
2	Rubber grommets for control unit cable entry holes in the middle front cover of the drive module
3	Fastener for Rittal VX25 enclosure
4	Bracket for attaching the drive module from top (3AUA0000096082). The bracket brings a gap for cooling air flow and prevents the drive module screws from chafing the plate.
5	Cardboard box

Lifting the drive module

Lift the drive module only by the lifting lugs:



Make sure that the module does not topple over when you move it on the floor: To open the support legs, press each leg a little down (1, 2) and turn 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.



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.

Installation alternatives

Drive module with IP20 shrouds (option +B051)

For an installation example of the drive module with IP20 shrouds (option +B051) into a Rittal VX25 enclosure including power cable connection procedure, see Installation example of drive module with IP20 shrouds (option +B051).

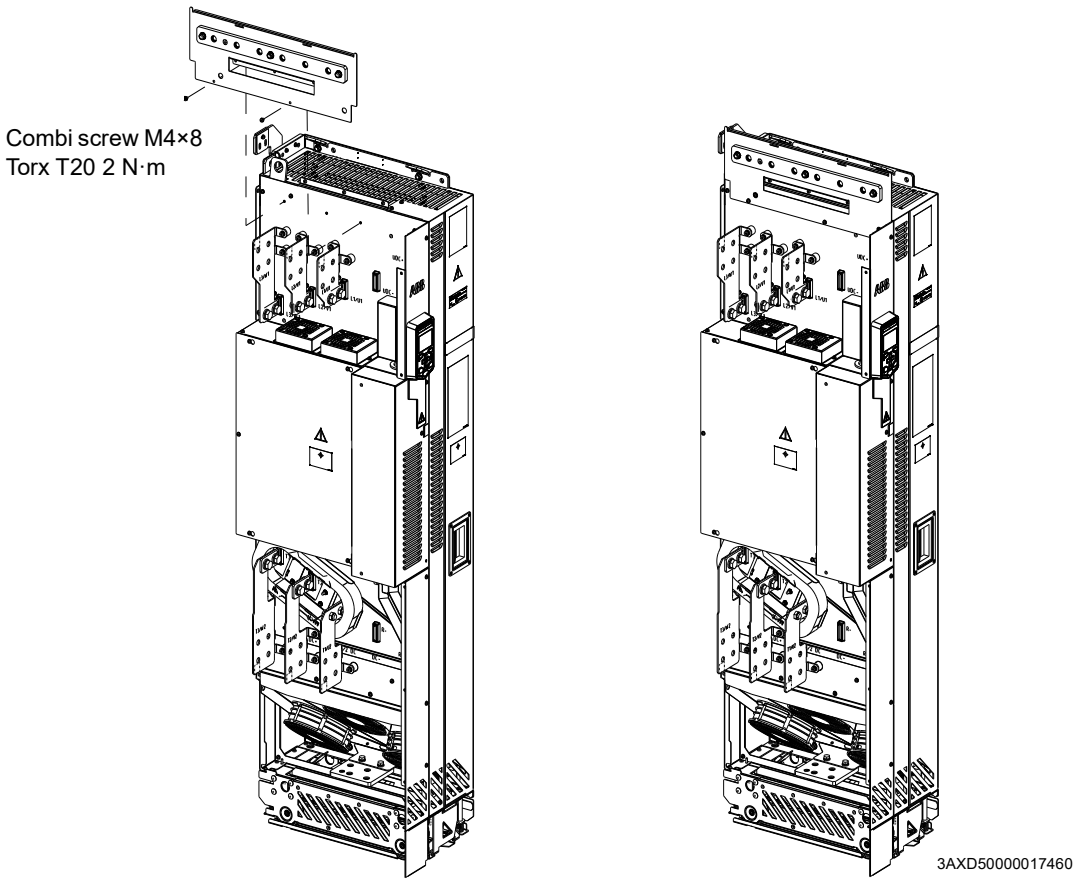
Drive module with full cabling panels (option +H381)

For an installation example of the drive module with full cabling panels (option +H381) into a Rittal VX25 enclosure including power cable connection procedure, see Installation example with full cabling panels (option +H381) (page 121).

Note: This installation alternative is not possible without pedestal (with option +0H354).

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.

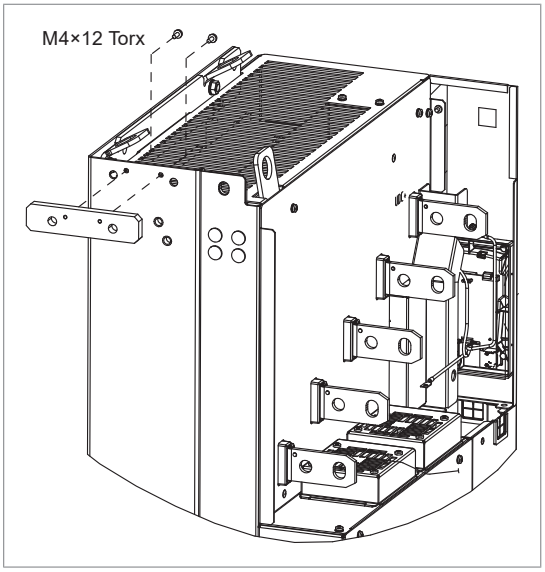
Drive module without pedestal (option +0H354)

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

Make sure that the enclosure 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

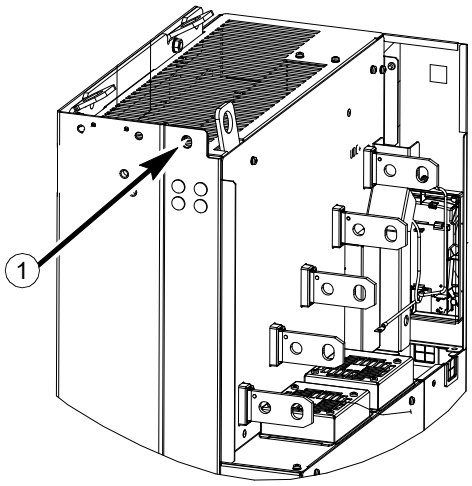
Use the support bracket 3AUA0000096082 (included in the assembly kit 3AXD50000453900) if you attach the drive module directly to a mounting plate or wall. The support bracket prevents the drive module screws from chafing against the plate.

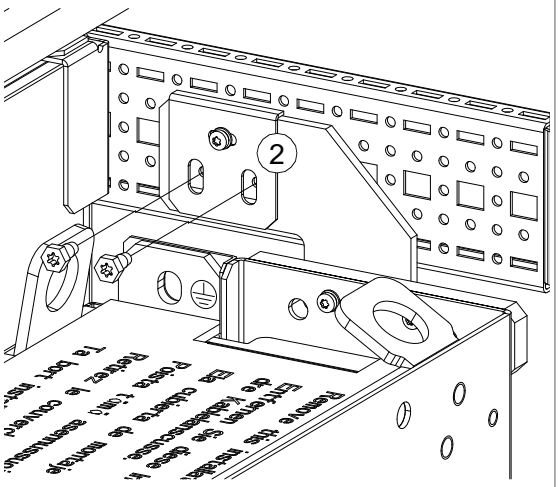


Alternatives for grounding the drive module

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 the fastening bracket.

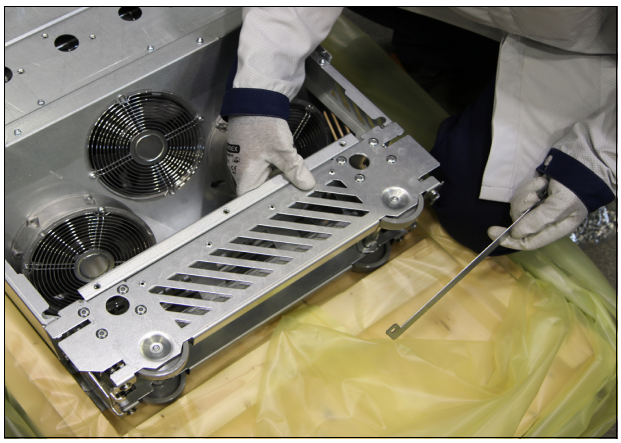




Tapping screw M6×12 Torx T30 (Hex) 9 N·m (6.6 lbf·ft)

Installing the bottom grille for IP20 degree protection (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 overheat.

Installing external control unit (option +P906)

See chapter External control unit (option +P906) (page 147).

7

Guidelines for planning the electrical installation

Contents of this chapter

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

Limitation of liability

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

Selecting the main supply disconnecting device

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

European Union and United Kingdom

To comply with European Union directives and United Kingdom regulations related to standard EN 60204-1, the disconnecting device must be one of these 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)
- 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.
- IEC devices only: Select contactor with utilization category AC-1 (number of operations under load) according to IEC 60947-4.
- Consider the application life time requirements.

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.

Examining the compatibility of the motor and drive

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

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

Make sure that the motor can be used with an AC drive. See Requirements tables (page 75). For basics of protecting the motor insulation and bearings in drive systems, see Protecting the motor insulation and bearings (page 75).

Note:

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

Protecting the motor insulation and bearings

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

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

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 tables

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.

Requirements for ABB motors, P_n < 100 kW (134 hp)

See also Abbreviations (page 79).

Motor type	Nominal AC line voltage	Requirement for	
		Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings
			P_n < 100 kW and frame size < IEC 315
			P_n < 134 hp and frame size < NEMA 500
Random-wound M2_, M3_ and M4_	U_n ≤ 500 V	Standard	-
	500 V < U_n ≤ 600 V	Standard	+ du/dt
		Reinforced	-
	600 V < U_n ≤ 690 V (cable length ≤ 150 m)	Reinforced	+ du/dt
	600 V < U_n ≤ 690 V (cable length > 150 m)	Reinforced	-
Form-wound HX_ and AM_	380 V < U_n ≤ 690 V	Standard	N/A
Old[1] form-wound HX_ and modular	380 V < U_n ≤ 690 V	Check with the motor manufacturer.	+ N + du/dt 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 + du/dt + CMF
HDP	Consult the motor manufacturer.		

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

Requirements for ABB motors, $P_n \geq 100$ kW (134 hp)

See also Abbreviations (page 79).

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

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

Requirements for non-ABB motors, P_n < 100 kW (134 hp)

See also Abbreviations (page 79).

Motor type	Nominal AC line voltage	Requirement for	
		Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings
			P_n < 100 kW and frame size < IEC 315
			P_n < 134 hp and frame size < NEMA 500
Random-wound and form-wound	U_n ≤ 420 V	Standard: $\hat{U}_{LL}$ = 1300 V	-
	420 V < U_n ≤ 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ du/dt
		Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 µs rise time	-
	500 V < U_n ≤ 600 V	Reinforced: $\hat{U}_{LL}$ = 1600 V	+ du/dt
		Reinforced: $\hat{U}_{LL}$ = 1800 V	-
	600 V < U_n ≤ 690 V	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ du/dt
		Reinforced: $\hat{U}_{LL}$ = 2000 V, 0.3 µs rise time [1)]	-

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.

Requirements for non-ABB motors, $P_n \geq 100$ kW (134 hp)

See also Abbreviations (page 79).

Motor type	Nominal AC line voltage	Requirement for		
		Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings	
			100 kW ≤ P_n < 350 kW or IEC 315 ≤ frame size < IEC 400	P_n ≥ 350 kW or frame size ≥ IEC 400
			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	$U_n \leq 420$ V	Standard: $\hat{U}_{LL}$ = 1300 V	+ N or CMF	+ N + CMF
	420 V < $U_n \leq 500$ V	Standard: $\hat{U}_{LL}$ = 1300 V	+ du/dt + (N or CMF)	+ N + du/dt + CMF
		Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 µs rise time	+ N or CMF	+ N + CMF
	500 V < $U_n \leq 600$ V	Reinforced: $\hat{U}_{LL}$ = 1600 V	+ du/dt + (N or CMF)	+ N + du/dt + CMF
		Reinforced: $\hat{U}_{LL}$ = 1800 V	+ N or CMF	+ N + CMF
	600 V < $U_n \leq 690$ V	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ du/dt + N	+ N + du/dt + CMF
		Reinforced: $\hat{U}_{LL}$ = 2000 V, 0.3 µs 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.

Abbreviations

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

Availability of 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)
ACH580-04	Ordered separately, see chapter Filters (page 273)	Plus code option +E208

Additional requirements for explosion-safe (EX) motors

If you use an explosion-safe (EX) motor, obey 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 braking applications

When the motor brakes the machinery, the intermediate circuit DC voltage of the drive increases, the effect being similar to the motor supply voltage increasing by up to 20 percent. Consider this voltage increase when specifying the motor insulation requirements if the motor will be braking a large part of its operation time.

Example: Motor insulation requirement for a 400 V AC line voltage application must be selected as if the drive were supplied with 480 V.

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.

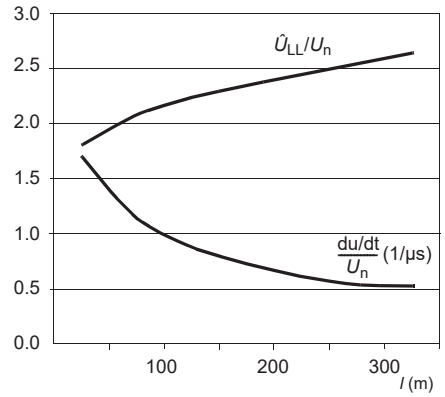
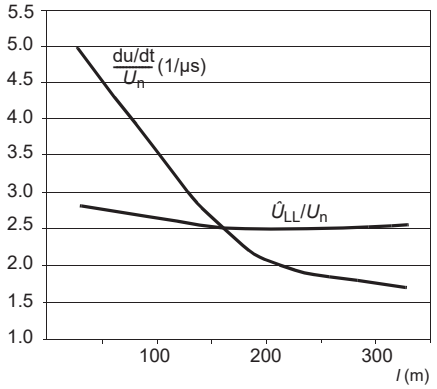
Nominal AC supply voltage	**Requirement for**		
	Motor insulation system	**ABB d*u*/d*t* and common mode filters, insulated N-end motor bearings**	
		P_n < 100 kW or frame size < IEC 315	**100 kW < P_n < 350 kW or IEC 315 < frame size < IEC 400**
		P_n < 134 hp or frame size < NEMA 500	**134 hp < P_n < 469 hp or NEMA 500 < frame size < NEMA 580**
U_n ≤ 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 ≤ 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 ≤ 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.

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.		

Additional note for sine filters

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

Selecting the power cables

General guidelines

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

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

To comply with the EMC requirements of the CE mark, use one of the preferred cable types. See Preferred power cable types (page 83).

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

Metal conduit reduces electromagnetic emission of the whole drive system.

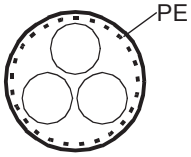
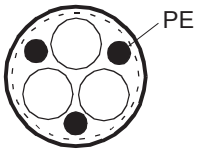
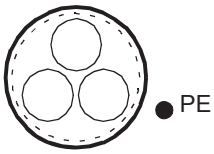
Typical power cable sizes

See the technical data.

Power cable types

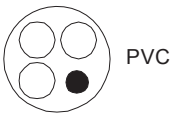
Preferred power cable types

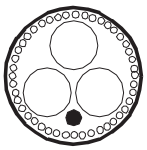
This section presents the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor 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
 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.

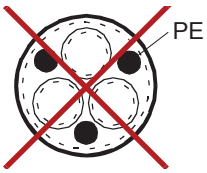
Alternate power cable types

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
 Four-conductor cabling in PVC conduit or jacket (three phase conductors and PE)	Yes with phase conductor smaller than 10 mm^2 (8 AWG) Cu.	Yes with phase conductor smaller than 10 mm^2 (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.

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
Four-conductor cabling in metal conduit (three phase conductors and PE). For example, EMT, or four-conductor armored cable	Yes	Yes with phase conductor smaller than 10 mm^2 (8 AWG) Cu, or motors up to 30 kW (40 hp)
 Shielded (Al/Cu shield or armor) [1] 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.

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

Not allowed power cable types

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

Additional guidelines – North America

ABB recommends the use of metallic conduit for power wiring. ABB also recommends the use of symmetrical shielded VFD cable between drive and motor(s).

This table shows examples of methods for wiring the drive. Refer to NFPA 70 (NEC) along with state and local codes for the appropriate methods for your application.

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 NFPA 70 (NEC), 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.

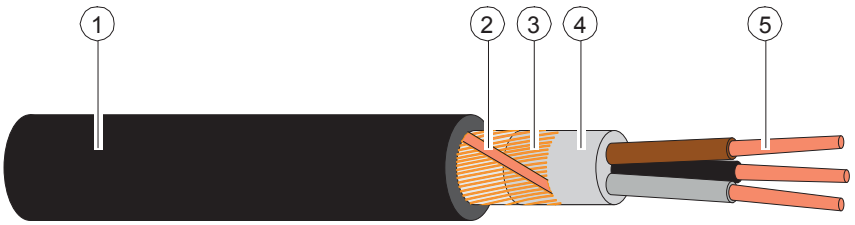
Metal conduit

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

Grounding requirements

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

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

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

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

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

1) For the minimum conductor size in IEC installations, refer to Additional grounding requirements – IEC.

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

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

Additional grounding requirements – IEC

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

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

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

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

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

Additional grounding requirements – UL (NEC)

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

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

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

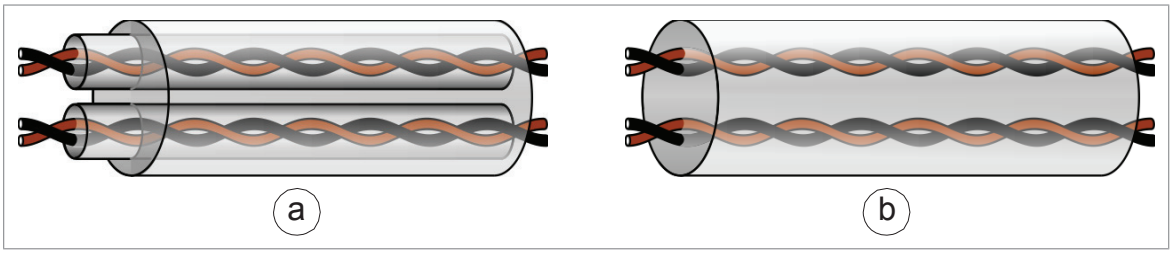
Selecting the control cables

Shielding

Only use shielded control cables.

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

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



Signals in separate cables

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

Signals that can be run in the same cable

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

Relay cable

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

Control panel to drive cable

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

PC tool cable

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

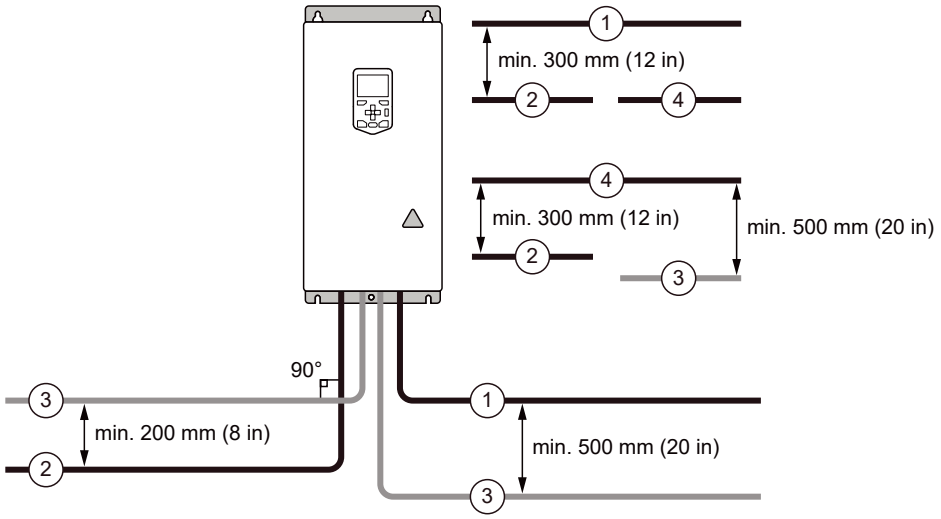
Routing the cables

General guidelines – IEC

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

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

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.



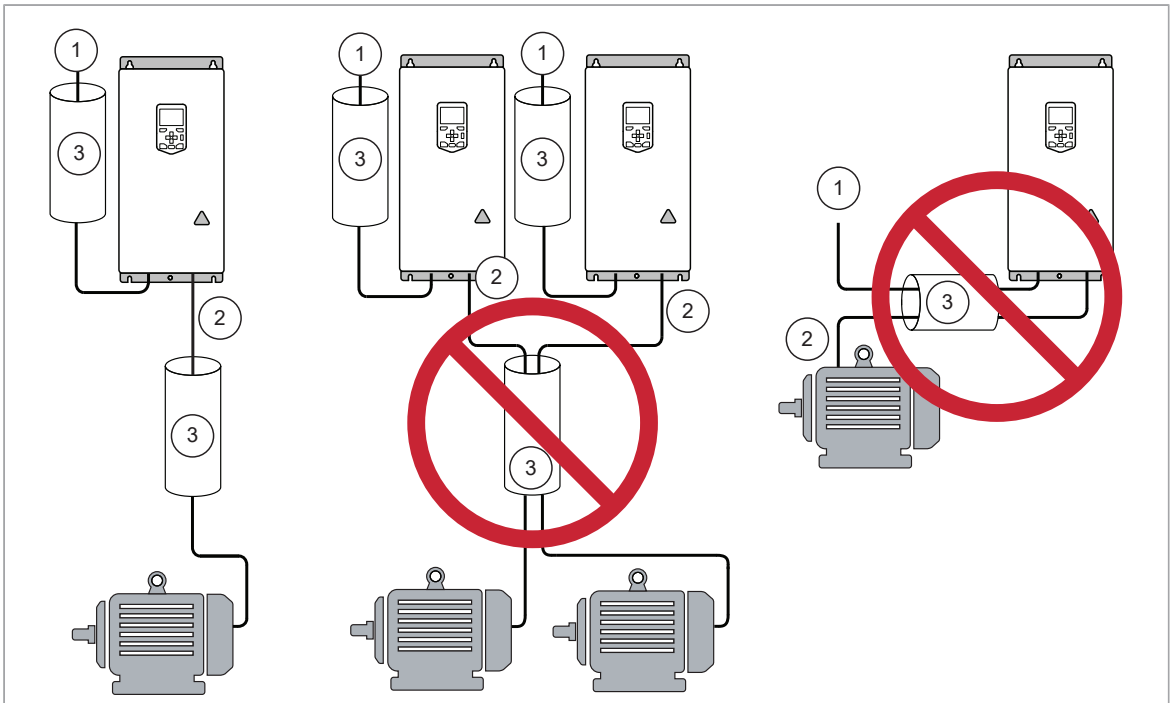
1	Motor cable
2	Input power cable
3	Control cable
4	Brake resistor or chopper cable (if any)

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

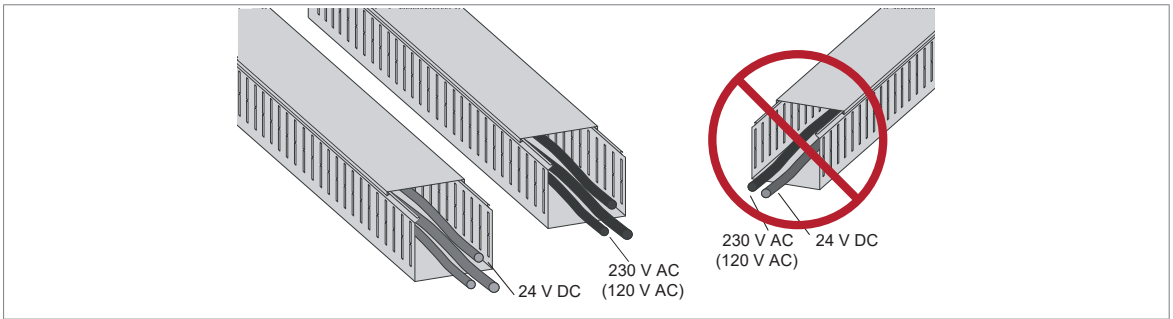
Continuous motor cable shield/conduit or enclosure for equipment on the motor cable

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 correctly
- the motor cable type complies with the motor cable selection guidelines by ABB
- the cable length does not exceed the allowed maximum length specified for the drive
- the setting of parameter 99.10 Motor nominal power in the drive is equal with the value given on the motor rating plate.

The electronic power output short-circuit protection circuitry meets the requirements of IEC 60364-4-41 2005/AMD1.

Protecting the motor cables against thermal overload

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

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

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

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

Protecting the motor against thermal overload

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

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

The most common temperature sensor types are PTC or Pt100.

For more information, see the firmware manual.

Protecting the motor against overload without thermal model or temperature sensors

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

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

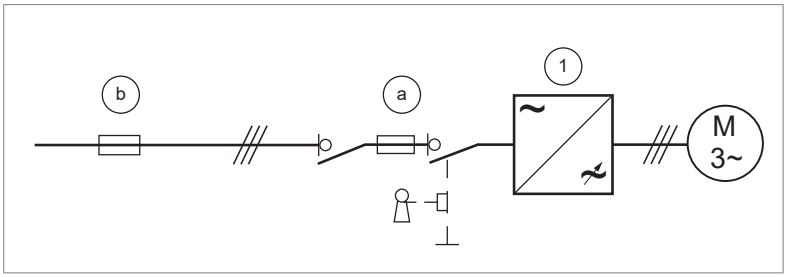
The protection feature of the drive allows the user to specify the class of operation in the same manner as the overload relays are specified in standards UL/IEC 60947-4-1 and NEMA ICS 2.

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

For more information, see drive firmware manual.

Protecting the drive and 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 thermal overload

The drive has overload protection as standard.

Protecting the input power cable against thermal overload

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

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 for use with residual current devices of Type B.

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

Implementing the emergency stop function

For safety reasons, install the emergency stop devices at each operator control station and at other operating stations where the 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 221).

Implementing the power loss ride-through function

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

If you equip the drive with a main contactor or breaker, make sure that it restores the drive input power after a short break. The contactor must either re-connect after the break automatically, or remain closed over the break. Depending on the contactor control circuit design, this can require an additional hold circuit, uninterruptible auxiliary power supply or auxiliary power supply buffering.

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

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

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

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

Using power factor compensation capacitors with the drive

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

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

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

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

Using a safety switch between the drive and the motor

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

Implementing an ATEX-certified motor thermal protection

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

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

For more information, see:

User's manual	Manual code (English)
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 selected, 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.

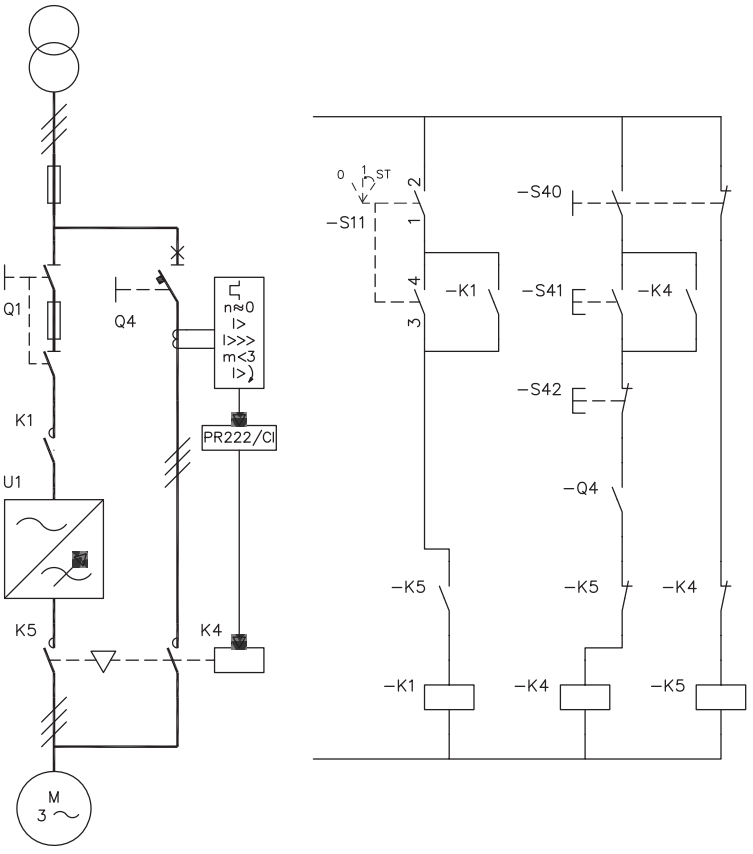
Implementing a bypass connection

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/UL 61800-5-1, subclause 6.5.3, for example, “THIS MACHINE STARTS AUTOMATICALLY”.

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

Example bypass connection

An example bypass connection is shown below.



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

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

1. Stop the drive and the motor with the drive control panel stop key (drive in the local control mode) or the external stop signal (drive in the remote control mode).
2. Open the main contactor of the drive with S11.
3. Switch the motor power supply from the drive to direct-on-line with S40.
4. Wait for 10 seconds to allow the motor magnetization to dissipate.
5. Start the motor with S41.

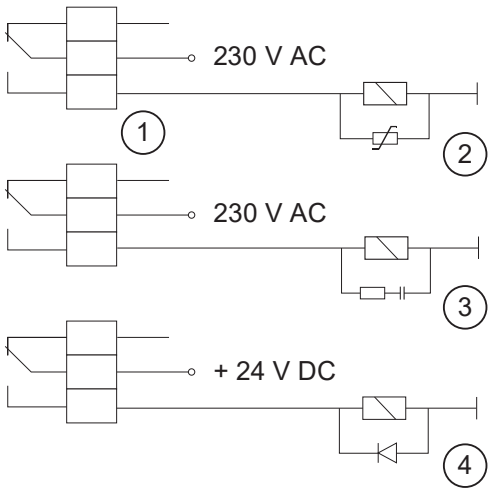
Switching the motor power supply from direct-on-line to drive

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

Protecting the contacts of relay outputs

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

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



1	Relay output
2	Varistor
3	RC filter
4	Diode

Implementing a motor temperature sensor connection

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

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

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

You have these implementation alternatives:

1. If there is double or reinforced insulation between the sensor and the live parts of the motor: You can connect the sensor directly to the analog/digital input(s) of the drive. See the control cable connection instructions. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
2. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known, you can connect the sensor to the drive via an option module. The sensor and the module must form a double or reinforced insulation between the motor live parts and the drive control unit. See Connecting a motor temperature sensor to the drive through an option module (page 98). Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
3. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect a sensor to a digital input of the drive via an external relay. The sensor and the relay must form a double or reinforced insulation between the motor's live parts and the digital input of the drive. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.

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

This table shows:

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

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	**Insulation/Isolation**	**PTC**	**KTY**	**Pt100, Pt1000**	
CMOD-02	Reinforced insulation between the sensor connector and other connectors (including drive control unit connector). 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

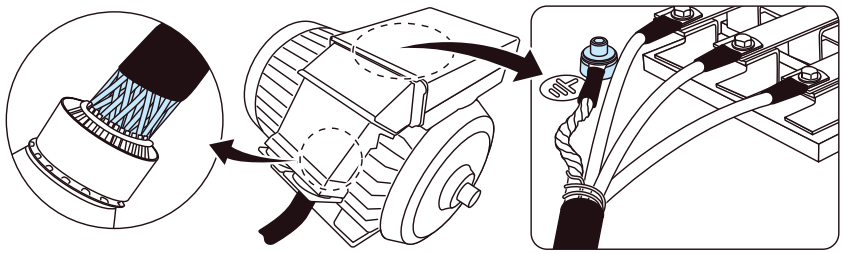
This chapter contains instructions for electrical installation of the drive module. The chapter refers to installation example chapters which contain instructions that depend on the selected drive configuration.

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 resistance 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 resistance of the input power cable

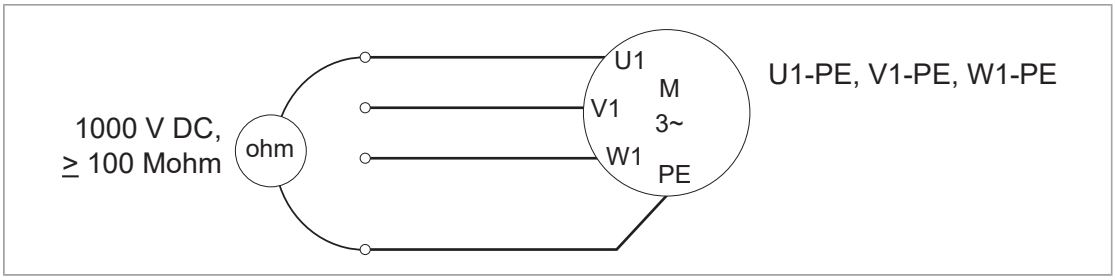
Before you connect the input power cable to the drive, measure its insulation resistance according to local regulations.

Measuring the insulation resistance 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, commissioning or maintenance work.

1. Do the steps in section Electrical safety precautions (page 21) before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals.
3. Measure the insulation resistance between each phase conductor and the protective earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must be more than 100 Mohm (reference value at 25 °C [77 °F]). For the insulation resistance of other motors, refer to the manufacturer's instructions.

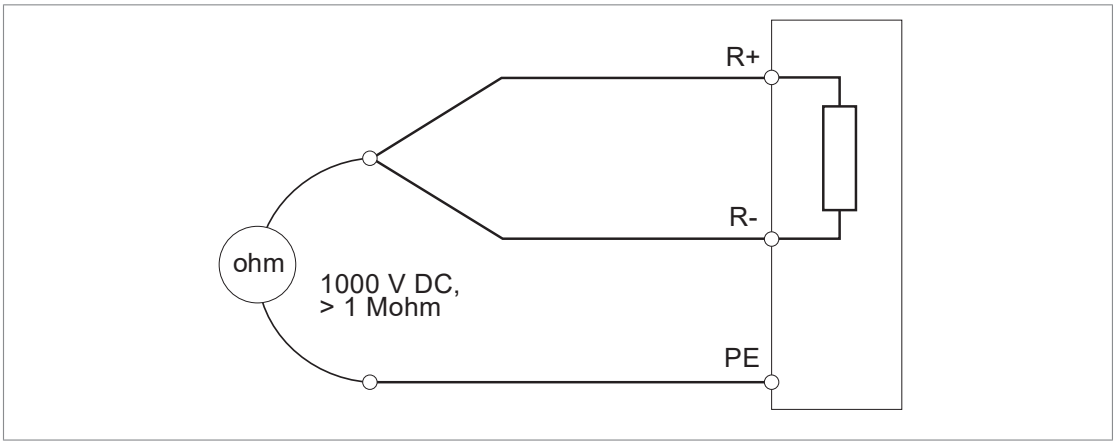
   Note: Moisture inside the motor reduces the insulation resistance. If you think that there is moisture in the motor, dry the motor and do the measurement again.



Measuring the insulation resistance of the brake resistor circuit

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

1. Stop the drive and do the steps in section Electrical safety precautions (page 21) before you start the work.
2. Make sure that the resistor cable is connected to the resistor and disconnected from the drive output terminals.
3. At the drive end, connect the R+ and R- conductors of the resistor cable together. Measure the insulation resistance between the conductors and the PE conductor with a measuring voltage of 1000 V DC. The insulation resistance must be more than 1 Mohm.



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 275).

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 necessary 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 281).

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

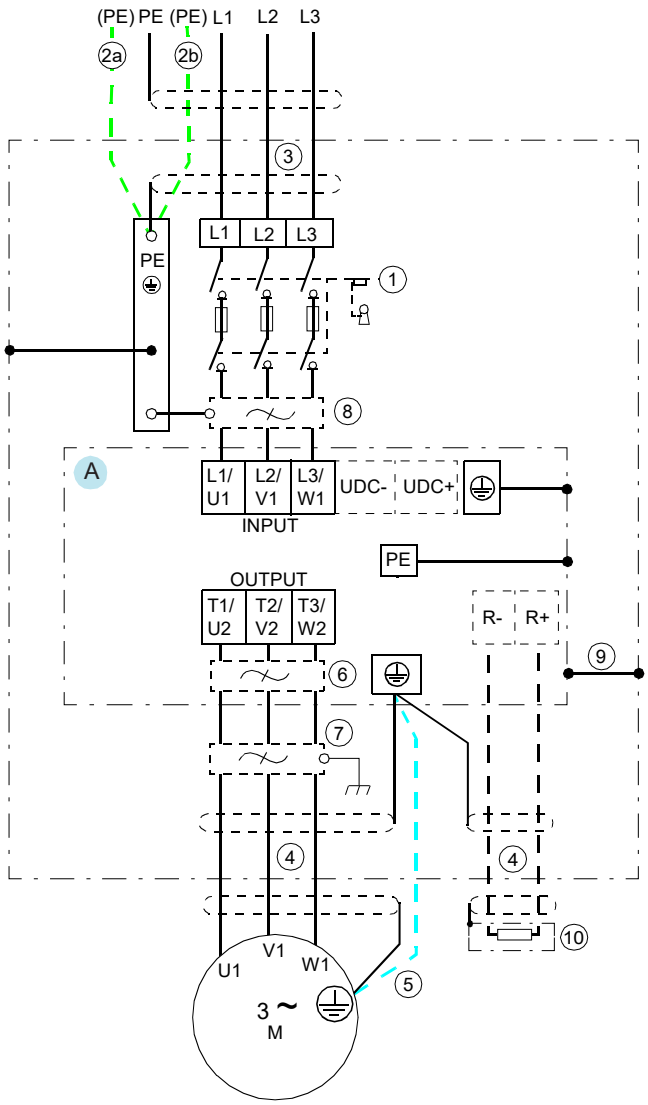
Ground-to-phase varistor compatibility

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 279).

Connecting the power cables

Power cable connection diagram

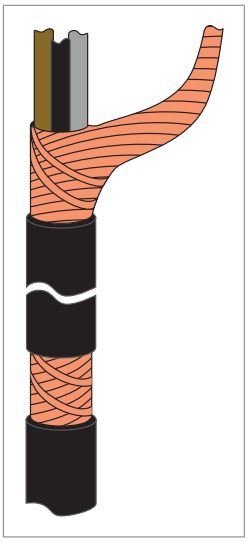


A	Drive module
1	For alternatives, see section Selecting the main supply disconnecting device (page 73).
2	Use a separate grounding PE cable (2a) or a cable with a separate grounding conductor (2b) if the conductivity of the shield does not meet the requirements for the PE conductor. See section General guidelines (page 82).
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 82)) and there is no symmetrically constructed grounding conductor in the cable. 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.

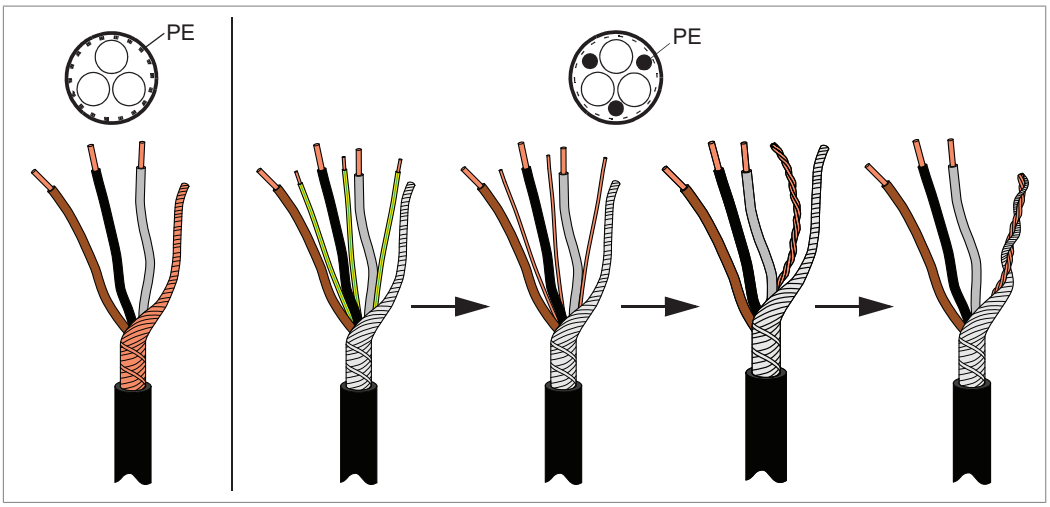
6	Common mode filter (+E208, see Requirements tables (page 75))
7	du/dt filter (optional, see Filters (page 273))
8	EMC filter (+E210)
9	The drive module frame must be connected to the cabinet frame. See section Alternatives for grounding the drive module (page 68).
10	External brake resistor

Preparing the cable ends – Symmetrical shielded cables

1. Peel off 3…5 cm (1¼ … 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 113) for instructions on how to connect the input and motor cables.

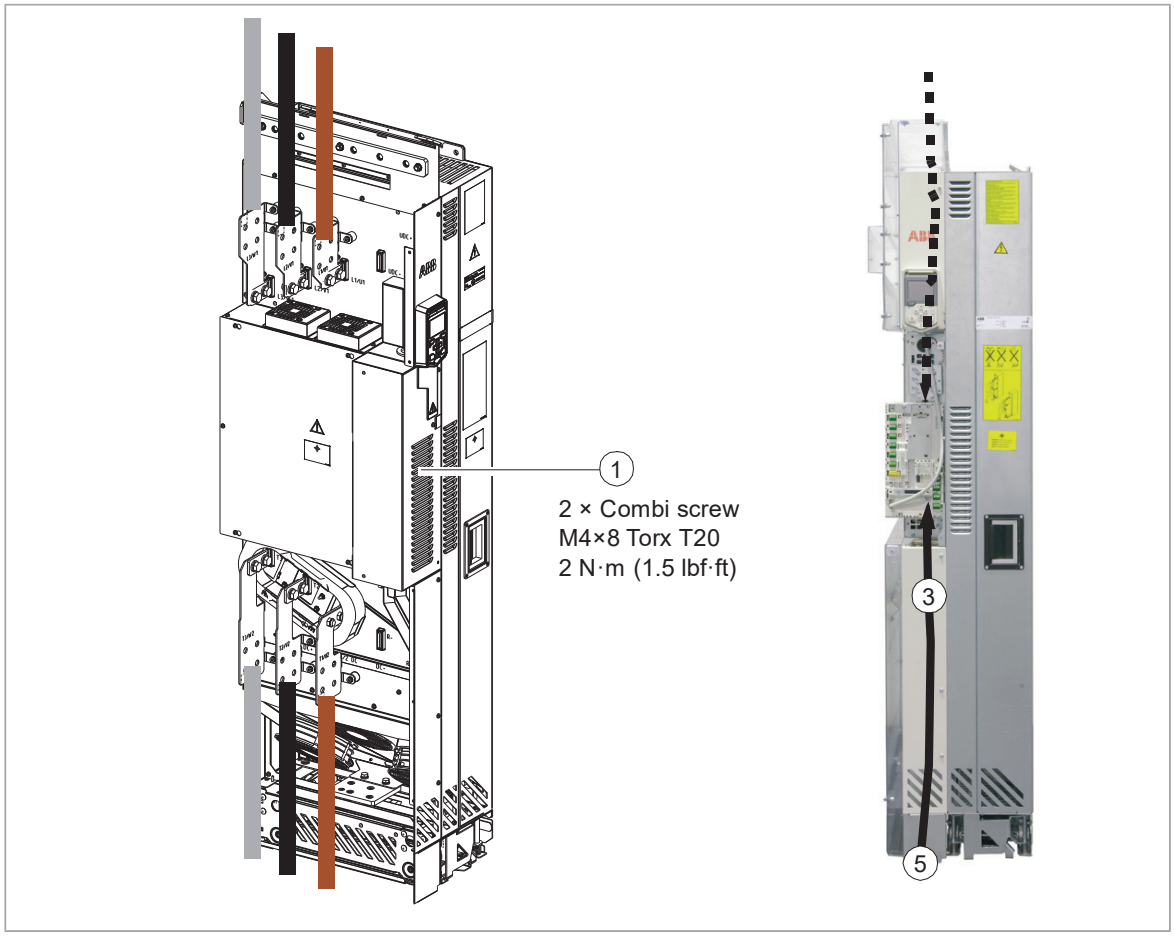
DC connection

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

Connecting the control cables

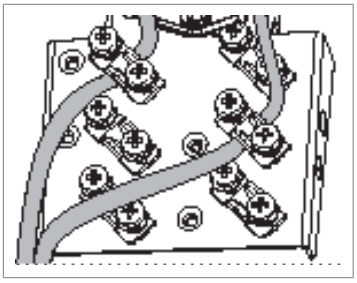
Integrated control unit

This procedure applies to the standard drive module with integrated control unit.



1. Remove the middle front cover of the drive module.
2. Attach the option modules if not attached already. See section Installing option modules (page 110).
3. Lead the control cables inside the drive cabinet.
4. Ground the outer control cable shields 360° at the cabinet cable entry 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 through 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. 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 135) 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.
   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.

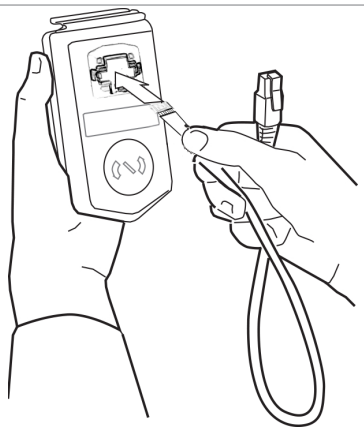
External control unit (option +P906)

Connect the external conductors to the external control unit and the control unit to the drive module as instructed in chapter External control unit (option +P906) (page 147).

Connecting a control panel

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

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



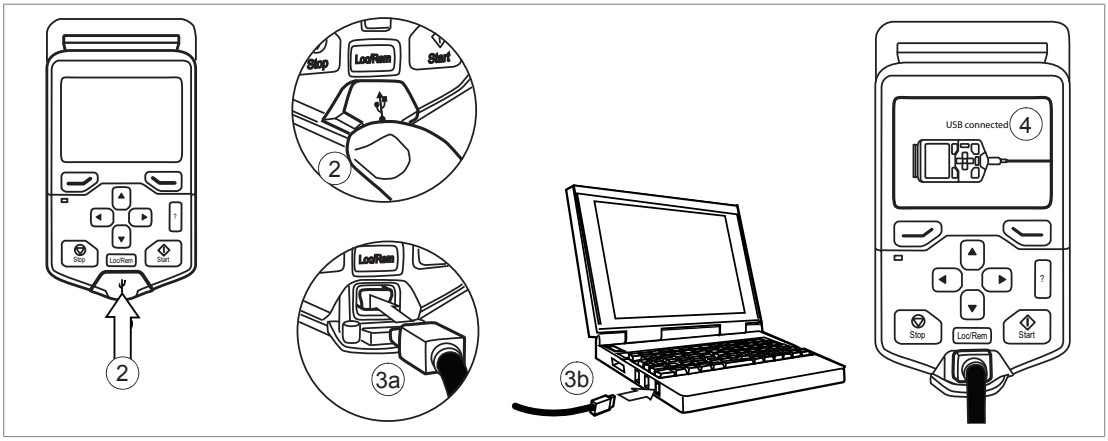
Note: When a PC is connected to the control panel, the control panel keypad is disabled. In this case, the control panel acts as a USB-RS485 adapter.

Connecting a PC

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

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

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



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

You can connect a drive control panel remotely to the drive, or 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]).

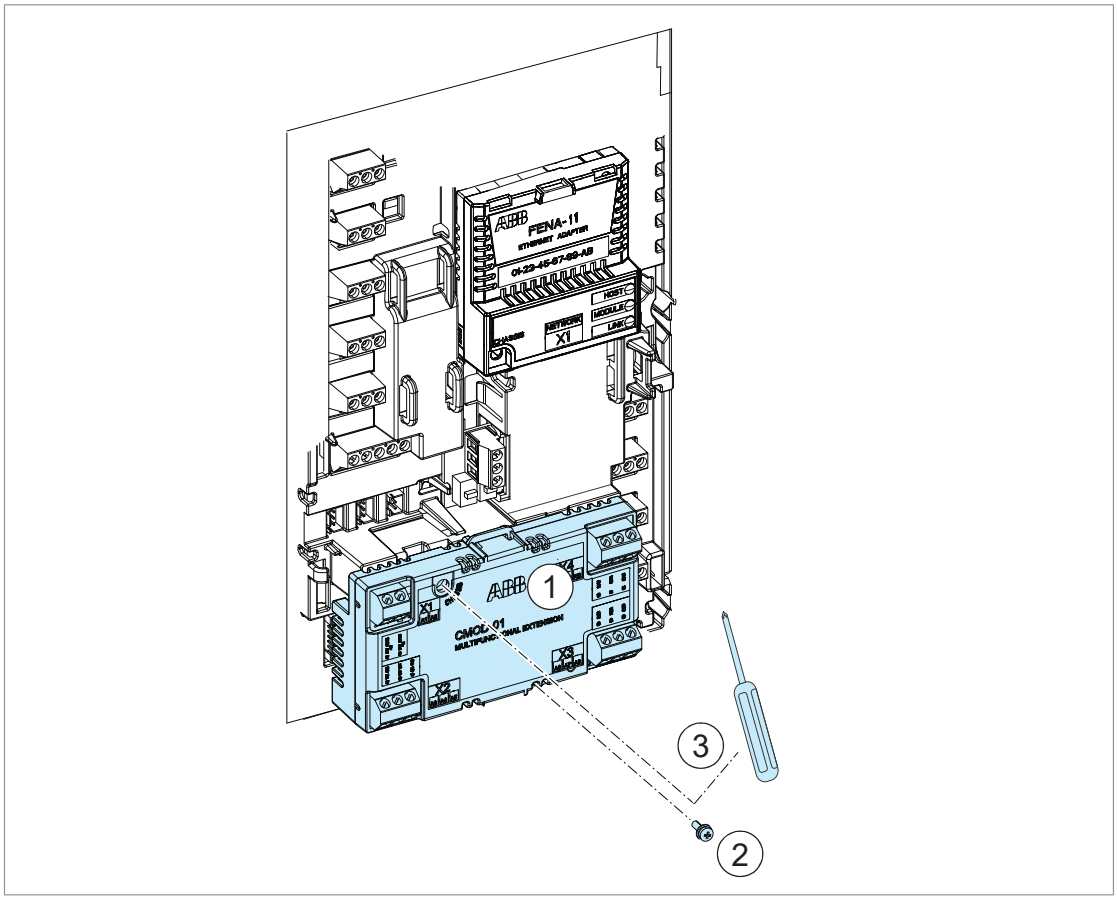
Installing option modules

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 21) before you start the work.

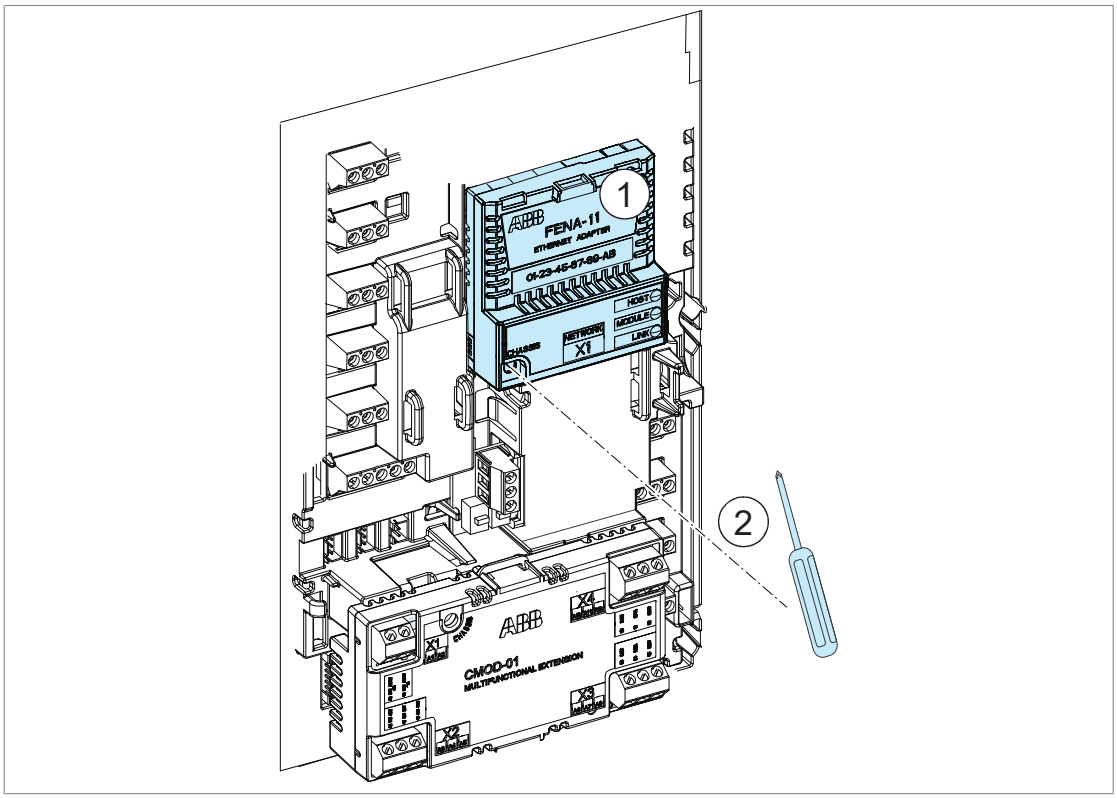
Option slot 2 (I/O extension modules)

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. This 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. This 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 into a 600 mm wide Rittal VX25 enclosure in a bookshelf way of mounting. The module is placed in an upright position on the enclosure bottom with its front facing the cabinet door. Instructions for full-size input terminals (option +H370) 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 section Preventing the recirculation of hot air (page 46).

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 the enclosure (page 114) • Installation drawings
2	Install the auxiliary components (such as mounting plates, air baffles, switches, busbars etc.).	• The component manufacturer's instructions • Planning the cooling of the ACH580-04 (page 55) • 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 283) • Connecting the power cables and installing the shrouds (page 115)
	Attach the drive module to the enclosure	
	Connect the power cables and install the clear plastic shrouds to the drive module.	
3	Connect the control cables.	• Connecting the control cables (page 107).
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 117)

Installing the drive module into the enclosure

For illustrations on how to install the drive module with IP20 shrouds into a enclosure, refer to:

- 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, and
- ACH580-04 drive modules (250 to 500 kW) quick installation guide (3AXD50000821198 [Multilingual]).

Installation procedure:

- Install the punched section to the back of the enclosure frame.
- Install the support rails and pedestal guide plate to the enclosure bottom frame.
- Install the telescopic extraction/installation ramp to the pedestal guide plate.
- Option +H370: Install the full-size input terminals.
- Install the fastening bracket to the drive module.
- Option +B051: Remove the sheeting from the clear plastic shrouds from both sides.
- Option +B051: Install the bottom grille to the drive module if there is no bottom plate in the enclosure and degree of protection of IP20 is needed for the drive module from the bottom side.
- Option +B051: 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 enclosure 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 enclosure back.

  Note: The fastening bracket grounds the drive module to the cabinet frame.
- Install the air baffles. For option +B051, refer to 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 and section Air baffles for the drive module with option +B051 (page 216). For the standard drive module configuration, see section Standard drive module configuration (page 56).

Connecting the power cables and installing the shrouds

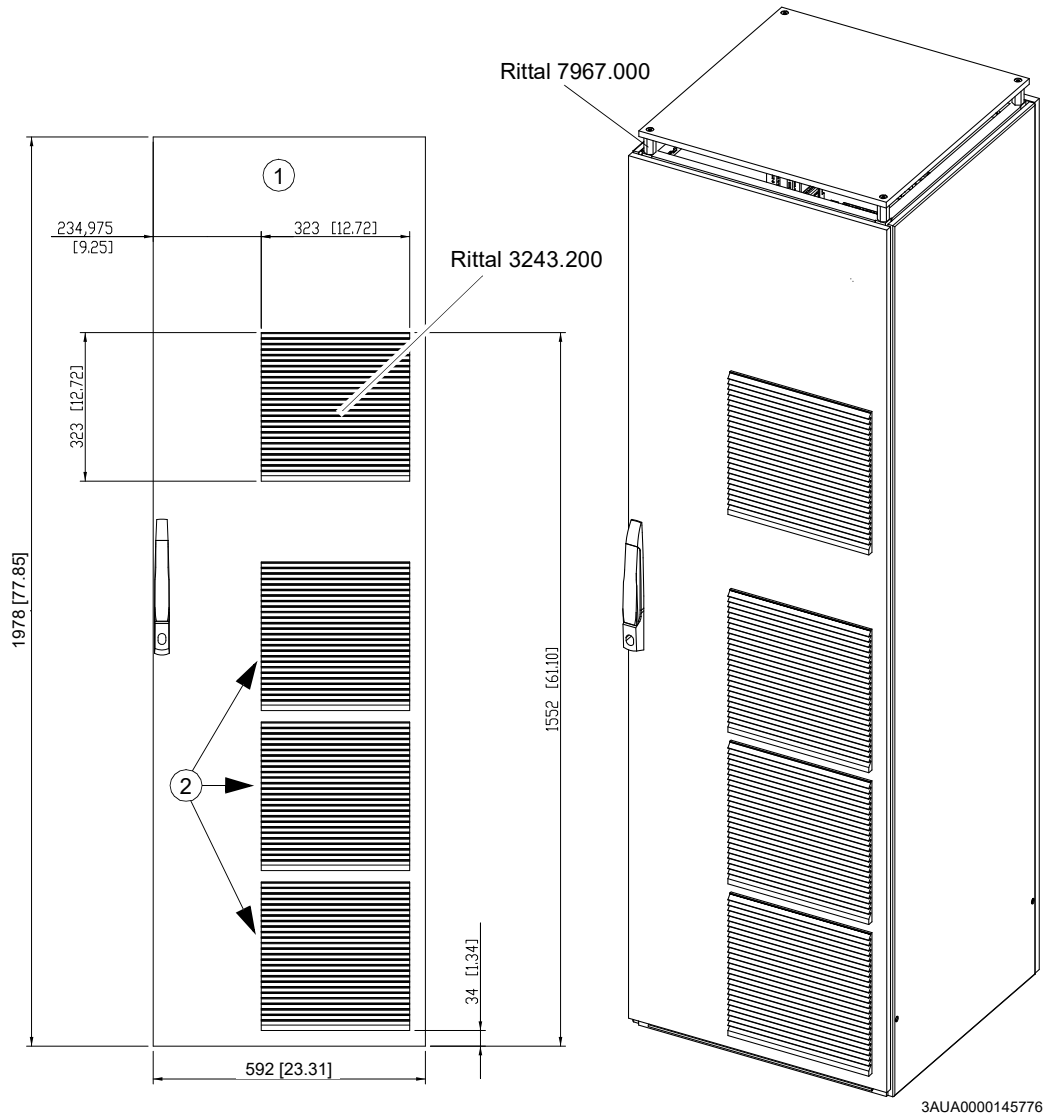
Step	Task (motor cables)
1	Install the grounding terminal to the drive module base.
2	Run the motor cables to the enclosure. Ground the cable shields 360° at the cabinet entry.
3	Connect the twisted shields of the motor cables to the grounding terminal.
4	Screw in and tighten the insulators to the drive module by hand. Install the T3/W2 connection terminal to the insulators. **WARNING!** Do not use longer screws or a larger tightening torque than specified in the installation drawing. They can damage insulator and cause a 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.

Step	Task (motor cables)
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° 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 a larger tightening torque than specified in the installation drawing. They can damage the insulator and cause a dangerous voltage to be present at the module frame.
7	Connect the L1/U1 conductors to the L1/U1 connection terminal.
8	Install the L2/V1 connection terminal to the insulators. See the warning in step 5.
9	Connect the L2/V1 conductors to the L2/V1 connection terminal.
10	Install the L3/W1 connection terminal to the insulators. See the warning in step 5.
11	Connect the L3/W1 conductors to the L3/W1 connection terminal.
12	Install the 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)

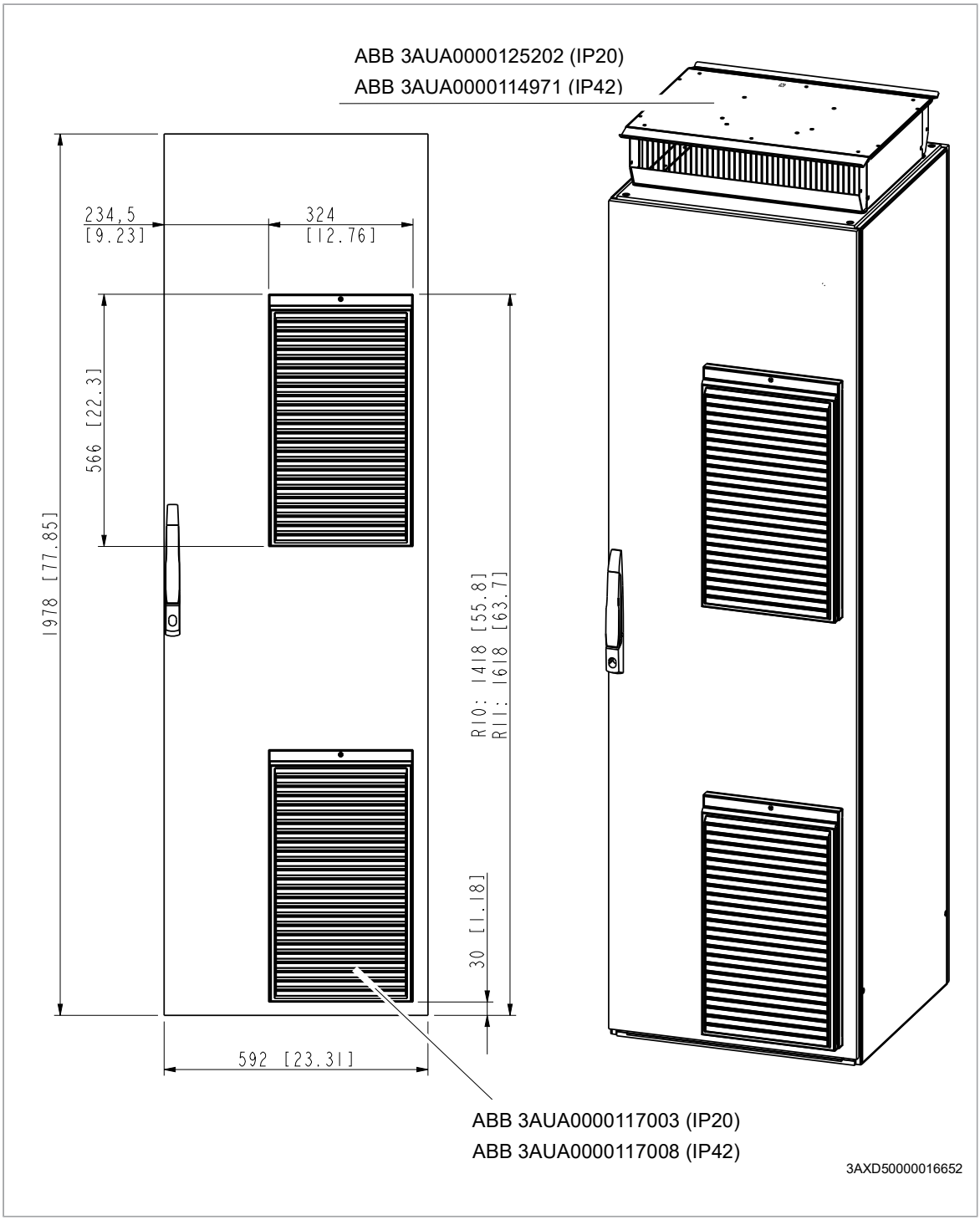
Install the air inlet gratings to the cabinet door and the spacers on top of the cabinet as shown below. This layout has been tested by ABB.



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

Installing the roof and door (ABB air filters and roof)

This drawing shows a layout tested by ABB.



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 overheat.

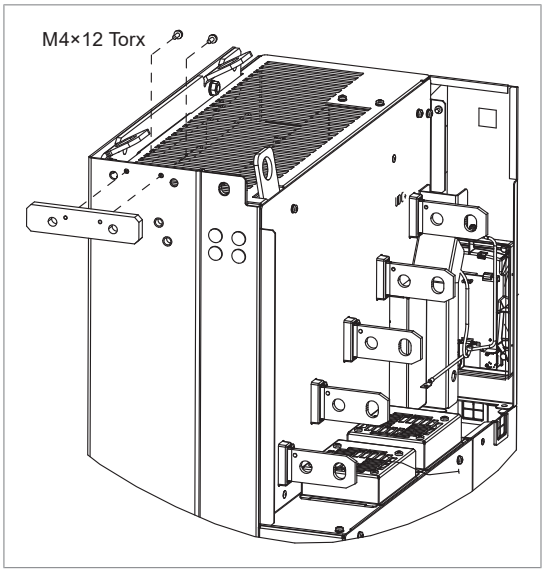
Miscellaneous

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 or wall

Use the support bracket 3AUA0000096082 (included in the assembly kit 3AXD50000453900) 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.



10

Installation example with full cabling panels (option +H381)

Contents of this chapter

In this chapter, the drive module with full cabling panels (option +H381) is installed into a 400 mm wide Rittal VX25 enclosure in a bookshelf way of mounting. The module is placed in an upright position on the enclosure bottom with its front facing the enclosure door. Space for the additional components can be made by connecting two or more VX25 enclosures together. Available alternative ABB parts are also given.

Safety

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

Required parts

Drive module standard parts		
• Drive module • Top guide plate • Fastening bracket • Grounding busbar • Pedestal guide plate • Telescopic extraction and insertion ramp • Fastening screws in a plastic bag • External control unit		
Drive module options		
Option code	**Qty (pcs)**	**Description**
+H381	1	Full power cabling panels
+P906	1	External control unit
Rittal parts / Alternative ABB parts		
Rittal part code	**Qty (pcs)**	**Description**
VX 8406.000	1	Enclosure without mounting plate, bottom plates and side panels
VX 8106.245	1	Side panels for the enclosure
DK 7967.000 (one set = four pieces) ABB 3AUA0000125201 (IP20) ABB 3AUA0000114967 (IP42)	1	Spacers for roof plate / ABB roof
VX 8617.030	5	Punched section with mounting flange, outer mounting level for 600 mm horizontal
VX 8617.010	3	Punched section with mounting flange, outer mounting level for 400 mm horizontal
SK 3243.200 / ABB 3AUA0000117002 (IP20) ABB 3AUA0000117007 (IP42)	4 / 2	Air filter 323 mm × 323 mm. Remove the filter mat according to the manufacturer's instructions.
TS 4396.500	3	Support rail (alternative to a customer-made bottom plate)
Customer-made parts (not ABB or Rittal products)		
Dimension drawing code	**Qty (pcs)**	**Description**
3AXD50000437368	2	Air baffles See section Air baffles for option +H381 in Rittal VX25 400 mm wide enclosure installation (page 217) for the dimension drawings of the air baffles required in the cabinet.
3AXD50000433988	1	Cabinet bottom plate (alternative to Rittal support rails) See section Bottom plate for option +H381 in Rittal VX25 400 mm wide enclosure installation (page 218) for the dimension drawing of a customer-made bottom plate.

Required tools

- Set of screw drivers (Torx and Pozidriv)
- Set of metric magnetic-end hexagon sockets
- Torque wrench with a 500 mm (20 in) or 2 × 250 mm (2 × 10 in) long socket extension.

Overall flowchart of the installation process

Step	Task	For instructions, see
1	Install the Rittal parts and drive module mechanical accessories into the enclosure	Installing the mechanical accessories into the enclosure (page 123) and Step-by-step drawings for installing full cabling panels (option +H381) in a Rittal VX25 400 mm wide enclosure (page 287)
2	Connect the power cables to the cabling panels	Connecting the power cables (page 123)
3	Install the drive module into the enclosure	Installing the drive module into the enclosure (page 125)
4	Install the external control unit	Installation procedure (page 151)
5	Connect the control cables	Connecting the control unit to the drive module (page 155)
6	Install the remaining parts, for example enclosure doors, side plates, air baffles, etc.	The component manufacturer's instructions Air baffles for option +H381 in Rittal VX25 400 mm wide enclosure installation (page 217)

Installing the mechanical accessories into the enclosure

Install the mechanical accessories into the enclosure as shown in Step-by-step drawings for installing full cabling panels (option +H381) in a Rittal VX25 400 mm wide enclosure (page 287)

If you do not use Rittal support rails on the bottom of the enclosure but use a custom bottom plate instead, see the dimension drawings for the correct dimensions of the bottom plate.

If the thickness of the bottom plate is not 2.5 mm (0.1 in), adjust the dimensions accordingly.

Connecting the power cables

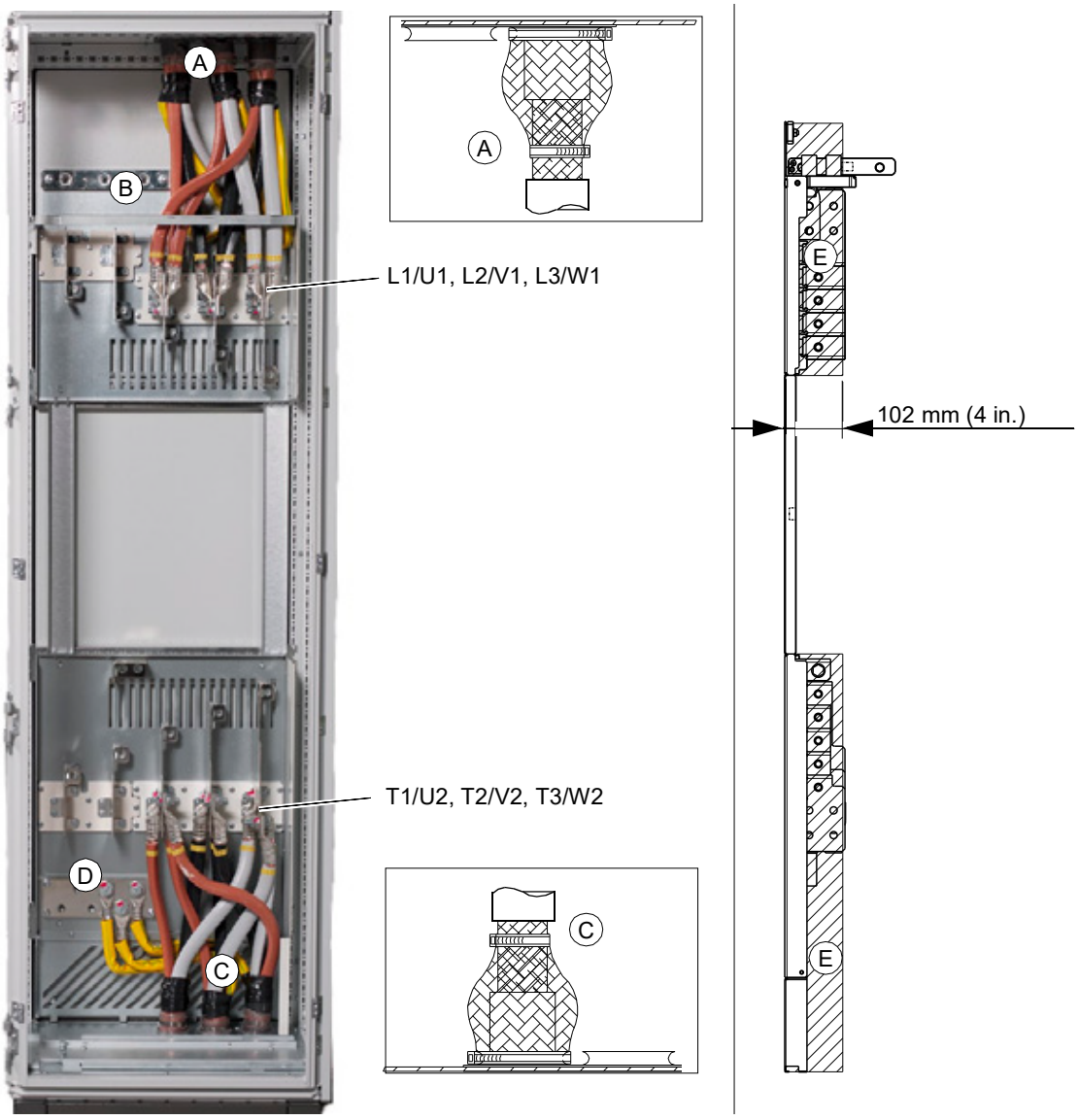
Power cable connection procedure

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

1. Run the motor cables from the motor to the enclosure. Ground the cable shields 360° at the entry plate.
2. Twist the cable shields of the motor cables into bundles and connect them and any separate ground conductors or cables to the ground terminal of the drive module or to the enclosure ground bar.
3. Connect the phase conductors of the motor cables to terminals T1/U2, T2/V2 and T3/W2 of the drive module. For the tightening torques, see the technical data.
4. Drive modules with option +D150: Run the power cables from the brake resistor to the cabinet. Ground the cable shield (if present) 360° at the entry plate. Connect

the conductors to the R+ and R- terminals. For the tightening torques, see the technical data.

5. Make sure that all power is disconnected and reconnection is not possible. Use proper safe disconnect procedures according to local codes.
6. Run the input cables from the supply source to the enclosure. Ground the cable shields 360° at the entry plate.
7. Twist the cable shields of the input cables into bundles and connect them and any separate ground conductors or cables to grounding busbar of the input cabling panel.
8. Connect the phase conductors of the input cables to terminals L1/U1, L2/V1 and L3/W1 of the drive module. For the tightening torques, see the technical data.



View without cabinet side plate in place.

A	360-degree grounding at the entry plate for the input power cables
B	Grounding busbar of the input power cabling panel
C	360-degree grounding at the entry plate for the output power cables

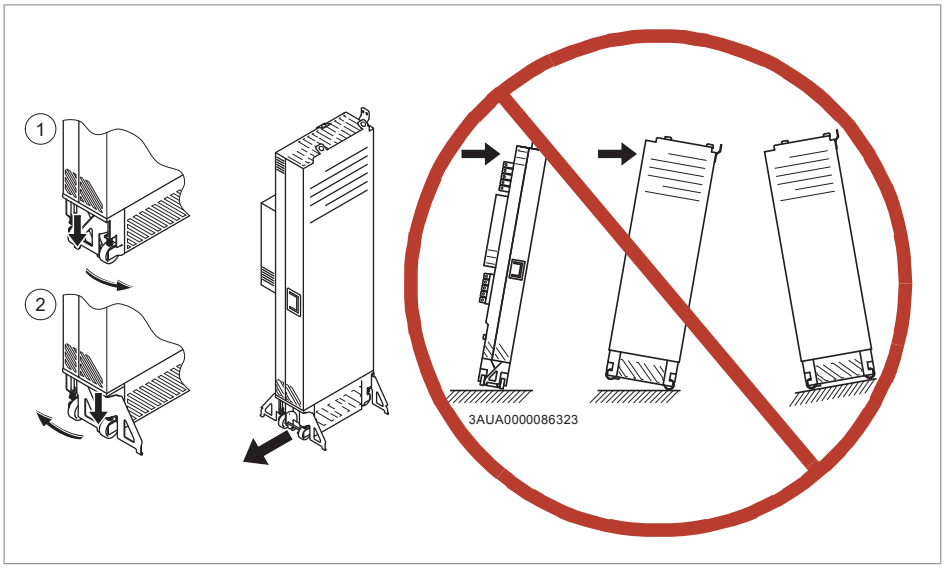
D	Grounding busbar of the output power cabling panel
E	Allowed space for power cables. The input and output power cables must fit inside the area marked with diagonal lines to prevent chafing of the cables when the drive module is inserted into the cabinet.

Installing the drive module into the enclosure

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

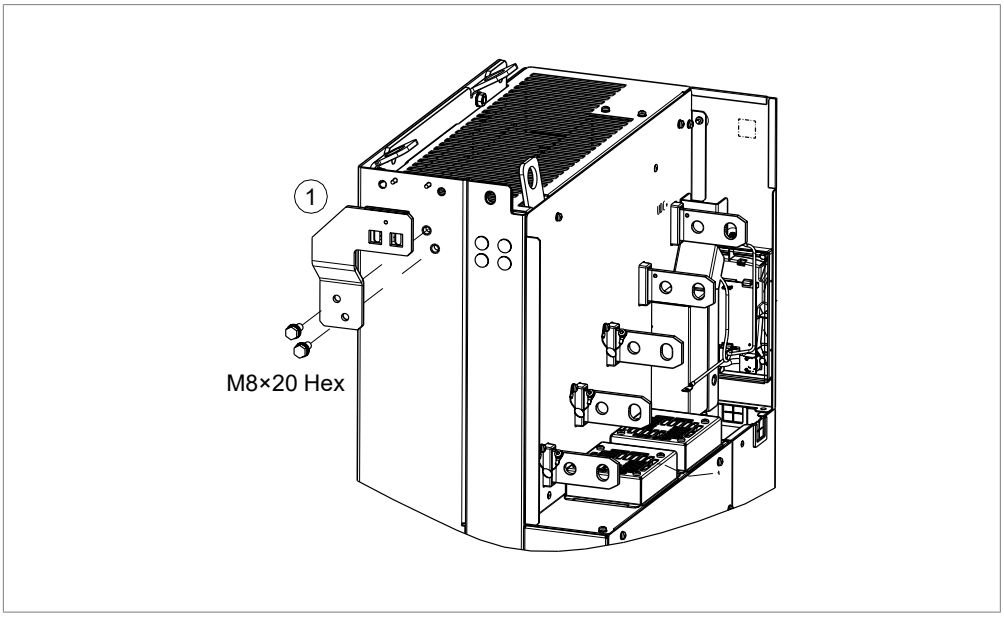
Handle the drive module carefully. Make sure that the module does not fall down when moving it on the floor and during installation and maintenance work: To open the support legs, press each leg a little down and turn it aside (1, 2). When possible, also secure the module with chains from top.

Do not tilt the drive module (A). It is heavy and its center of gravity is high. The module will overturn from a sideways tilt of 5 degrees. Do not leave the module unattended on a sloping floor.



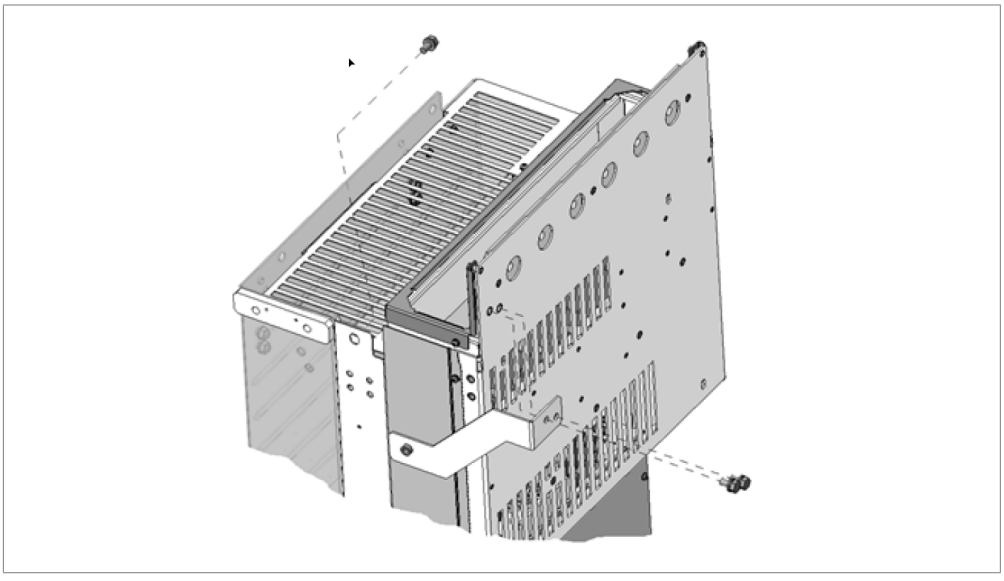
Installation procedure

1. Attach the mounting bracket to the drive module. The bracket will ground the drive module to the cabinet frame.



2. Install the telescopic extraction and insertion ramp to the cabinet base with two screws.
3. Remove the upper and lower left-hand side front covers of the drive module (M4×8 combi screws, 2 N·m [18 lbf·in]).
4. Attach the drive module lifting lugs to the enclosure frame with chains.
5. Push the drive module carefully into to the enclosure preferably with the help from another person.
6. Attach the grounding busbar that has been previously attached to the input cabling panel to the drive module.

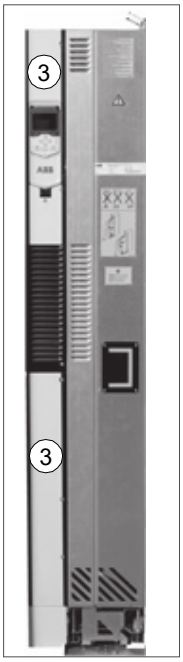
   Note: The design of the grounding busbar can be different from what is shown in the figure.

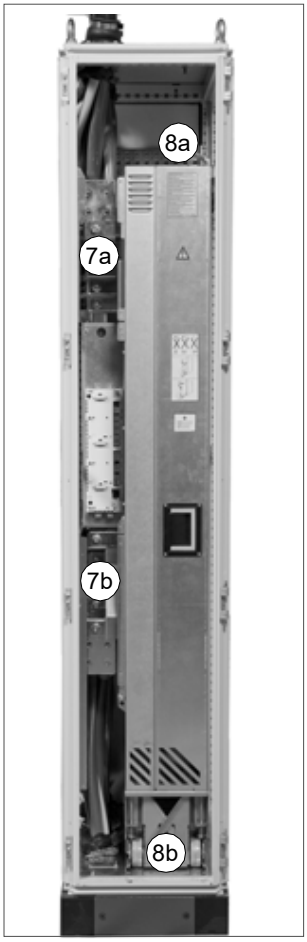


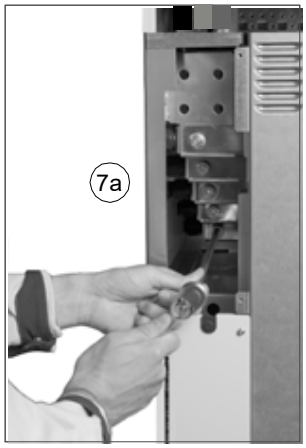
7. Connect the busbars of the drive module to the busbars of the cabling panels (M12 combi screw, 70 N·m [52 lbf·ft]).

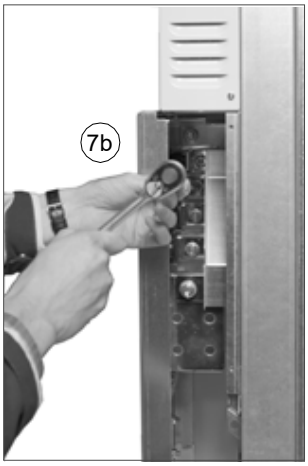
8. Attach the drive module to the enclosure from top and bottom, see Assembly drawing of installing the drive module to the enclosure (frame R10) (page 129) (frame R10) or Assembly drawing of installing the drive module to the enclosure (frame R11) (page 130) (frame R11). The top fastening bracket grounds the drive module to the cabinet frame.
9. Attach the cabinet roof on the spacers and the side panels, see Assembly drawing of installing the roof and door (page 131).
10. Remove the filter mats from the air filters according to Rittal's instructions. Install the filters to the cabinet door, see Assembly drawing of installing the roof and door (page 131).
11. Drive modules with an external control unit (option +P906): Put back the removed front covers of the drive module on the power cable sections, and connect the control cables (see Connecting the control unit to the drive module (page 155).

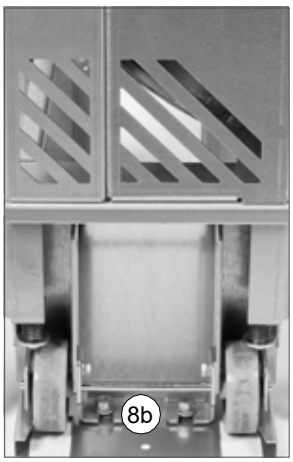
128 Installation example with full cabling panels (option +H381)



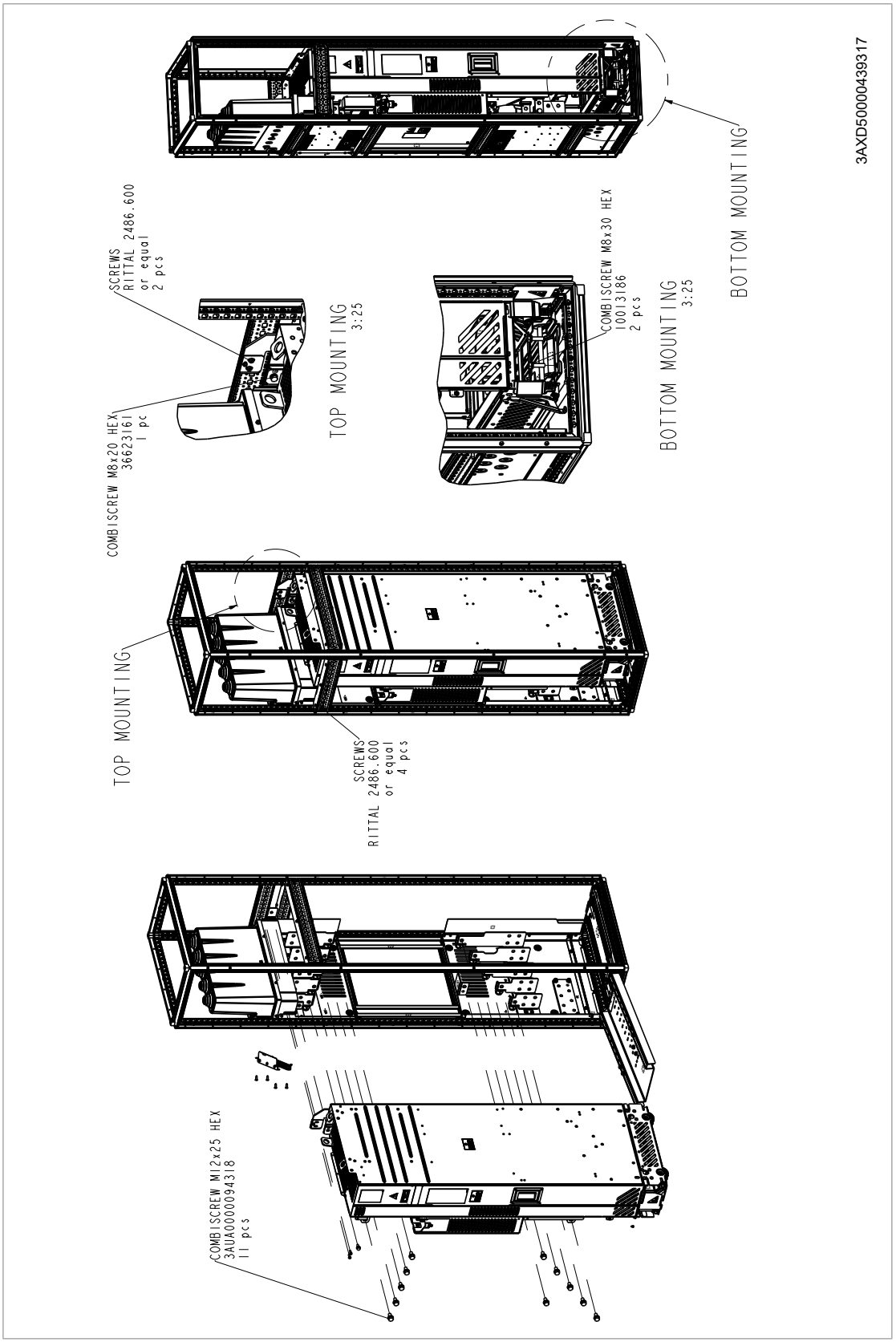




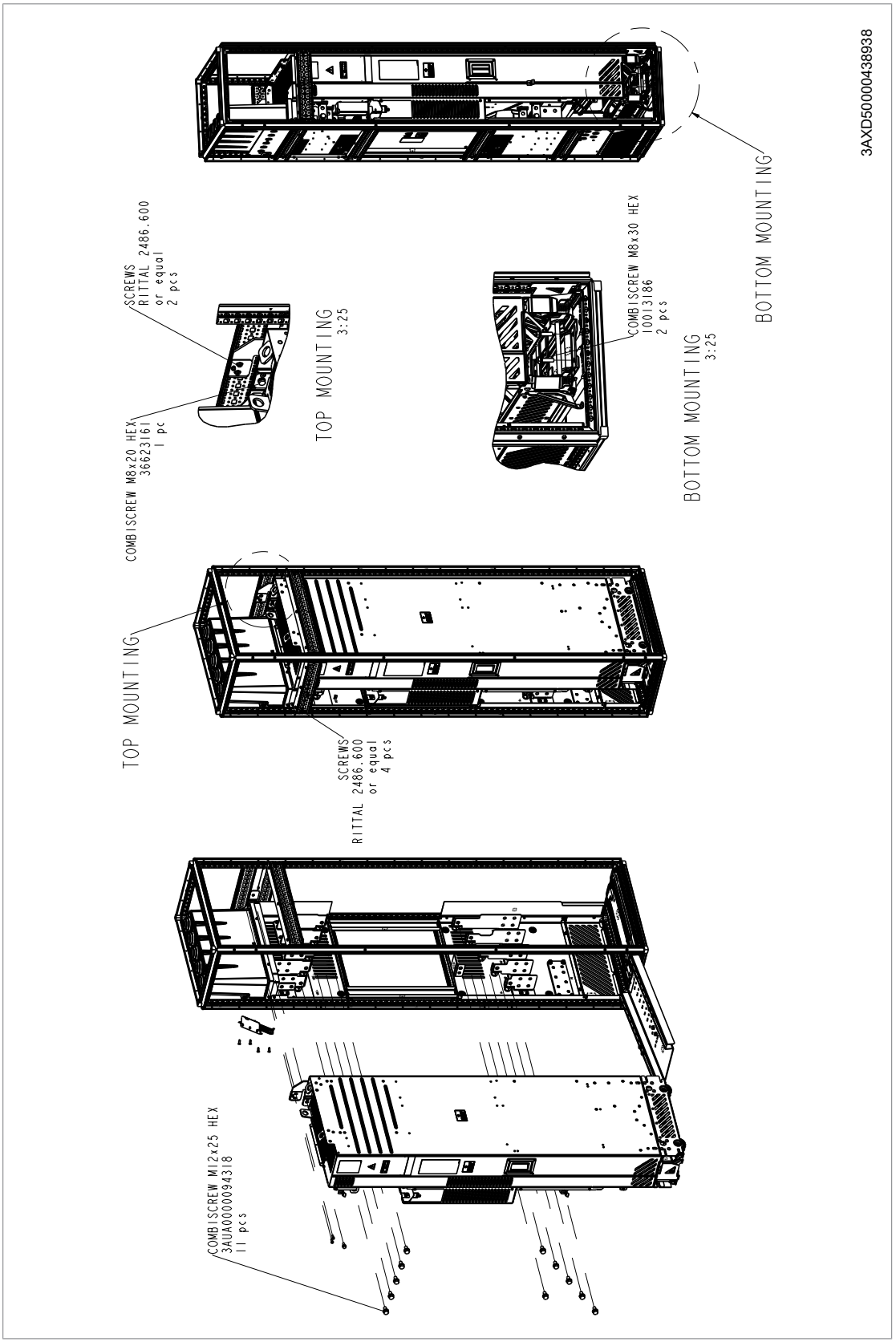




Assembly drawing of installing the drive module to the enclosure (frame R10)

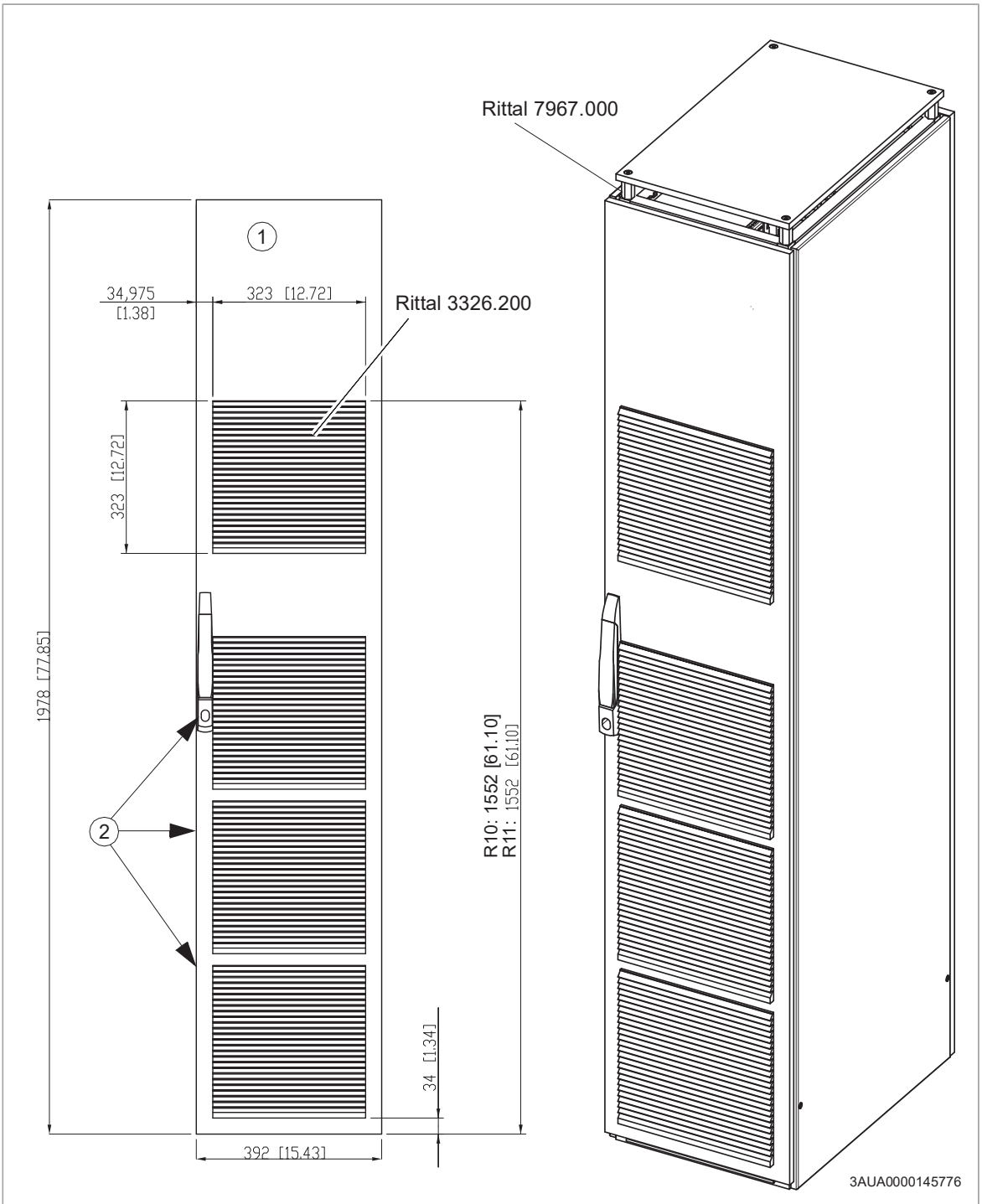


Assembly drawing of installing the drive module to the enclosure (frame R11)



Assembly drawing of installing the roof and door

This drawing shows a layout tested by ABB.



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

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 overheat.

Miscellaneous

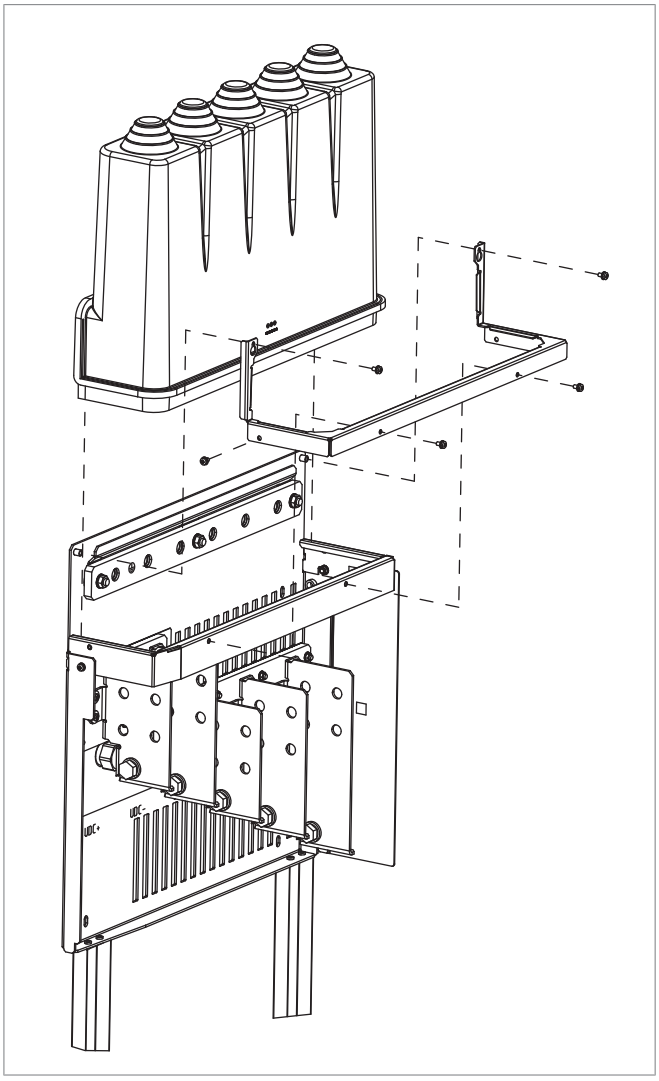
Installations with input and motor cables of size 4 × 240 mm² per phase

If resistor cables are to be connected, the lower side plate of the output cabling panel must be removed and the resistor cables lead from side to the terminals of the output cabling panel.

Installing the rubber grommet

To get IP20 degree of protection for the drive module, install the input power cables through the rubber grommet. Install the grommet as follows:

1. Cut adequate holes into the grommet for the input power cables.
2. Put the cables through the grommet.
3. Attach the grommet to the input cabling panel with five M4×8 Torx T20 screws as shown below.



11

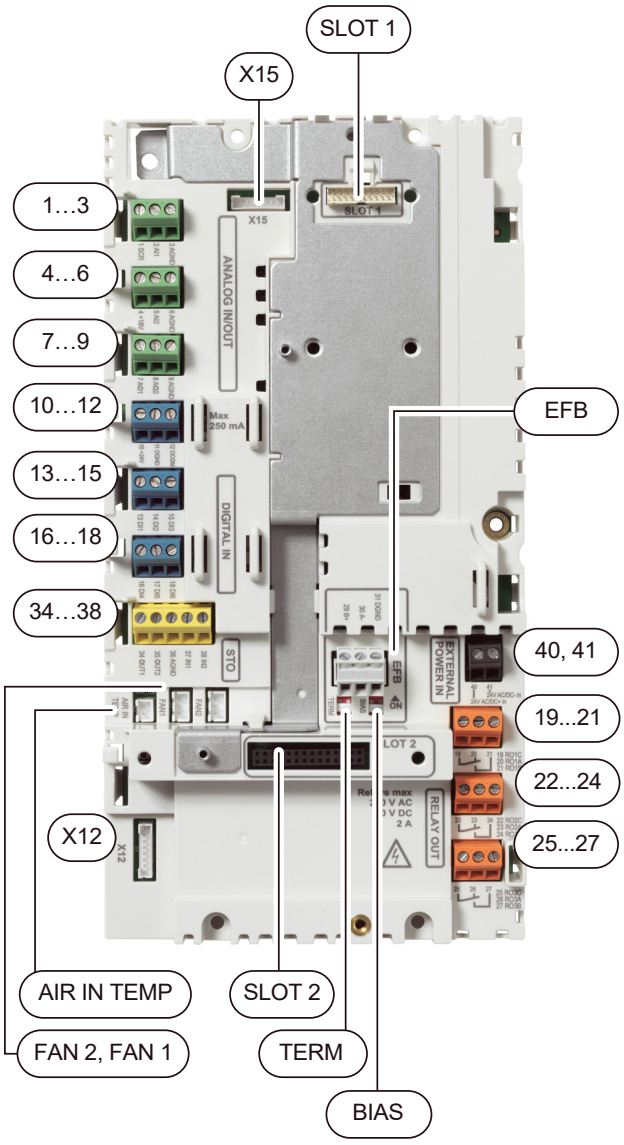
Control unit

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.

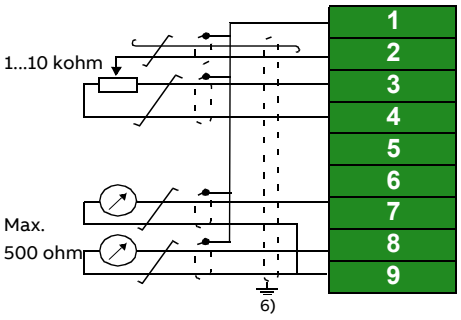
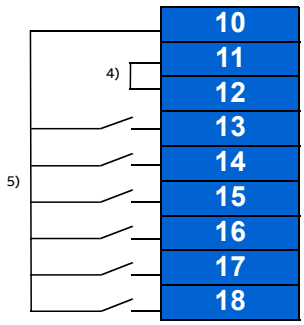
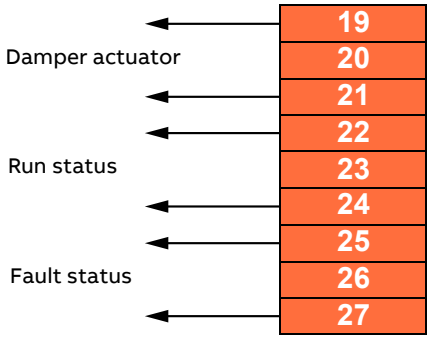
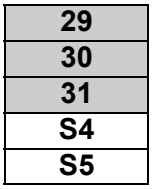


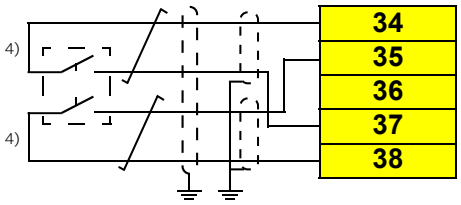
SLOT 1	
Option slot 1 (fieldbus adapter modules)	
ANALOG IN/OUT	
1…3	Analog input 1
4…6	Analog input 2
7…9	Analog outputs
10…12	Auxiliary voltage output, digital input common
DIGITAL IN	
13…18	Digital inputs
STO	
34…38	Safe torque off connection.
AIR IN TEMP	Internal air temperature NTC sensor connection
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

Default I/O connection diagram

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

Connection	Term		Description
X1 Reference voltage and analog inputs and outputs			
	1	SCR	Signal cable shield (screen)
	3	AGND	Analog input circuit common
	4	+10V	Reference voltage 10 V DC
	5	AI2	**Actual feedback:** 0…20 mA [1]
	6	AGND	Analog input circuit common
	7	AO1	**Output frequency:** 0…10 V
	8	AO2	**Motor 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	**Start interlock 1 (1 = allow start)**
	17	DI5	Not configured
	18	DI6	Not configured
X6, X7, X8 Relay outputs			
	19	RO1C	**Damper control** 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			

Connection		Term	Description
	34	OUT1	Safe torque off. Factory connection. Both circuits must be closed for the drive to start.Refer to The Safe torque off function (page 221).
	35	OUT2	
	36	SGND	
	37	IN1	
	38	IN2	
X10 24 V AC/DC			
	40	24 V AC/DC+ in	External 24 V 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…24 V AC.

Terminal sizes (all terminals): 0.14 … 2.5 mm^2 (26…14 AWG)

Tightening torques: 0.5 … 0.6 N·m (4.4 … 5.3 lbf·in)

Wire strip length 7…8 mm (0.3 in)

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.

DI3	Operation/Parameter	
	Scalar control (default)	**Vector control**
0	Set frequency through AI1	Set frequency through AI1
1	28.26 Constant frequency 1	22.26 Constant speed 1

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° at the cabinet entry.

7) **WARNING!** Connect an external AC power supply (24 V AC) only to control unit connectors 40 and 41. If you connect it to connector AGND, DGND or SGND, damage to the power supply or control unit can occur.

Switches

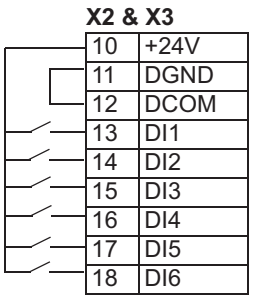
Switch	Description	Position	
TERM **S4**	EFB link termination. Must be set to the terminated (ON) position when the drive (or another device) is the first or last unit on the link.		Bus not terminated **(default)**
			Bus terminated
BIAS **S5**	Switches on the biasing voltages to the bus. One (and only 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

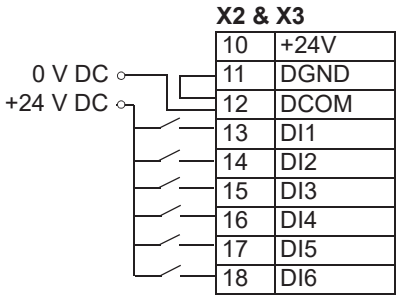
PNP configuration for digital inputs (X2 & X3)

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

Internal +24 V power supply
PNP connection (source)



External +24 V power supply
PNP connection (source)



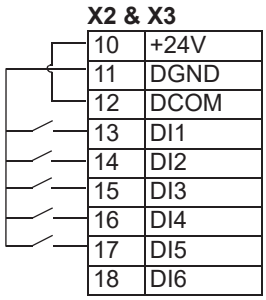
WARNING!
Do not connect the +24 V AC cable to the control unit ground when the control unit is powered from an external 24 V AC supply.

NPN configuration for digital inputs (X2 & X3)

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

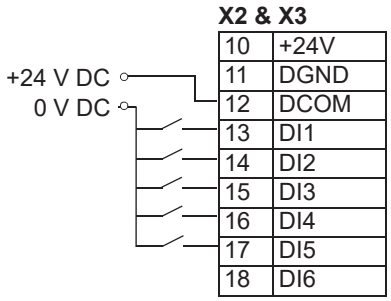
Internal +24 V power supply

NPN connection (sink)



External +24 V power supply

NPN connection (sink)

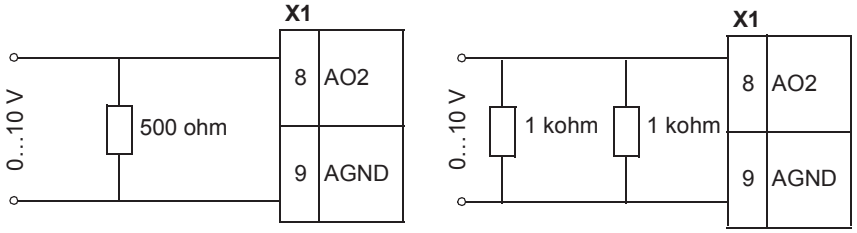


Note: DI6 is not supported in the NPN configuration.

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

Connection for obtaining 0…10 V from analog output 2 (AO2)

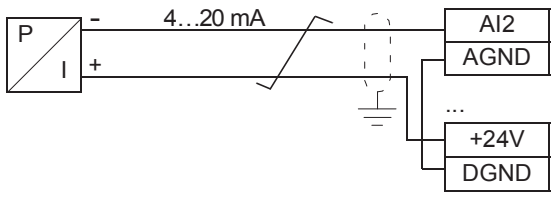
To obtain 0…10 V from analog output AO2, connect a 500 ohm resistor (or two 1 kohm resistors in parallel) between analog output AO2 and analog common ground AGND.



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

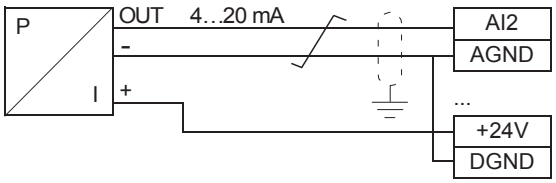
Note: The maximum capability of the auxiliary voltage output (24 V DC [250 mA]) must not be exceeded.

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.



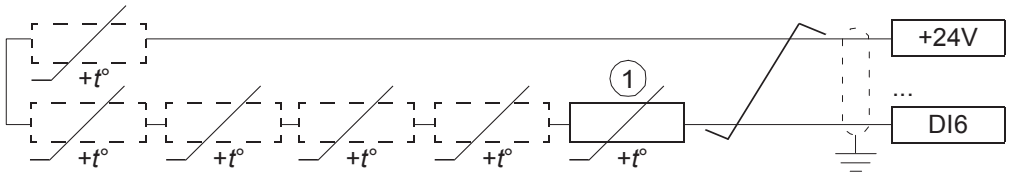
DI5 as frequency input

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.

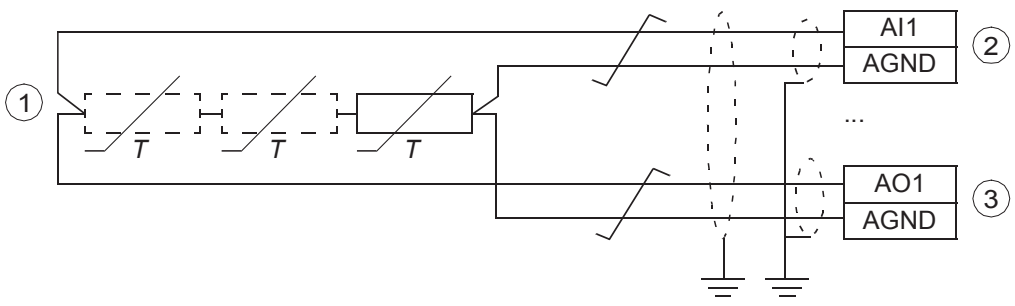
Note: If DI6 is used as a PTC input, the wiring and the PTC sensor need to be double isolated. Otherwise the CMOD-02 I/O extension module must be used.



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	1…3 sensor(s) of type Pt100 or Pt1000, or 1 sensor of type Ni1000/KTY83/KTY84
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 221).

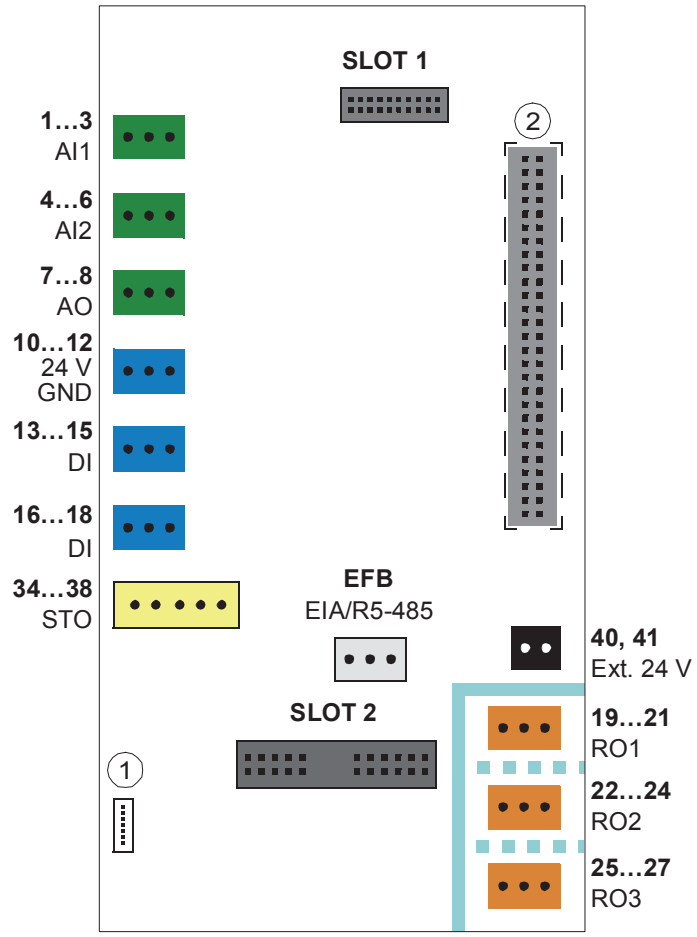
Note: Only 24 V DC can be used for STO. Only PNP input configuration can be used.

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 (26 … 14 AWG)
+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 (26 … 14 AWG)
Digital inputs DI1…DI6 (Term. 13…18)	Input type: NPN/PNP Terminal size: 0.14 … 2.5 mm^2 (26 … 14 AWG) 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 (26 … 14 AWG) See section Isolation areas (page 144).
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 141). 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 (26 … 14 AWG) 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 140). 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 (26 … 14 AWG) 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 (26 … 14 AWG)
Embedded fieldbus (X5)	Connector pitch 5 mm, maximum wire size 2.5 mm^2 (14 AWG) 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 (6.5 ft)

Isolation areas



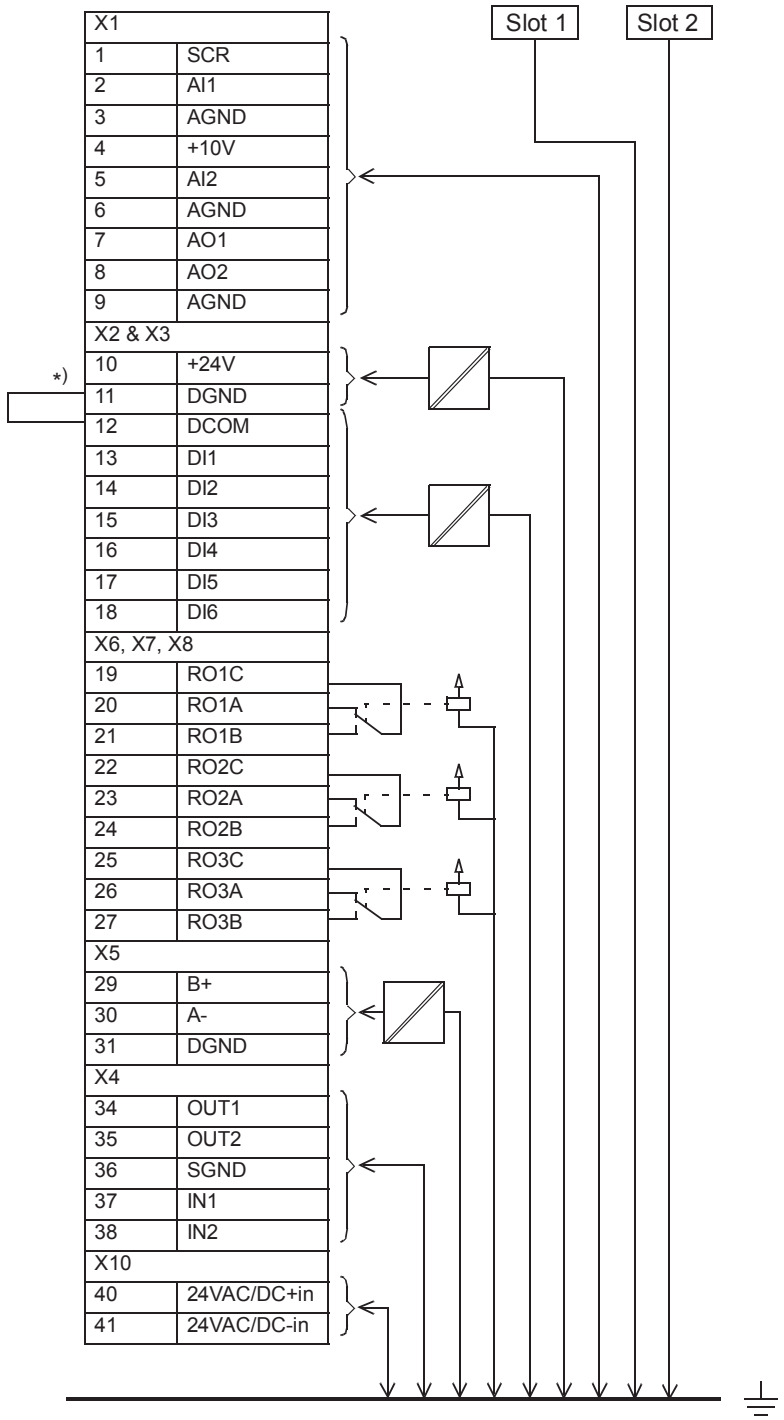
1	Panel port
2	Power unit connection at the bottom of the control unit
	Reinforced insulation (IEC/EN 61800-5-1:2007, UL 61800-5-1 First edition)
	Functional insulation (IEC/EN 61800-5-1:2007, UL 61800-5-1 First edition)

The terminals on the control unit 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

12

External control unit (option +P906)

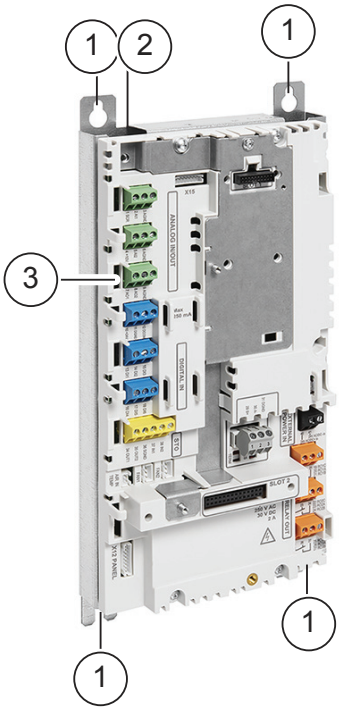
Contents of this chapter

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

Product overview

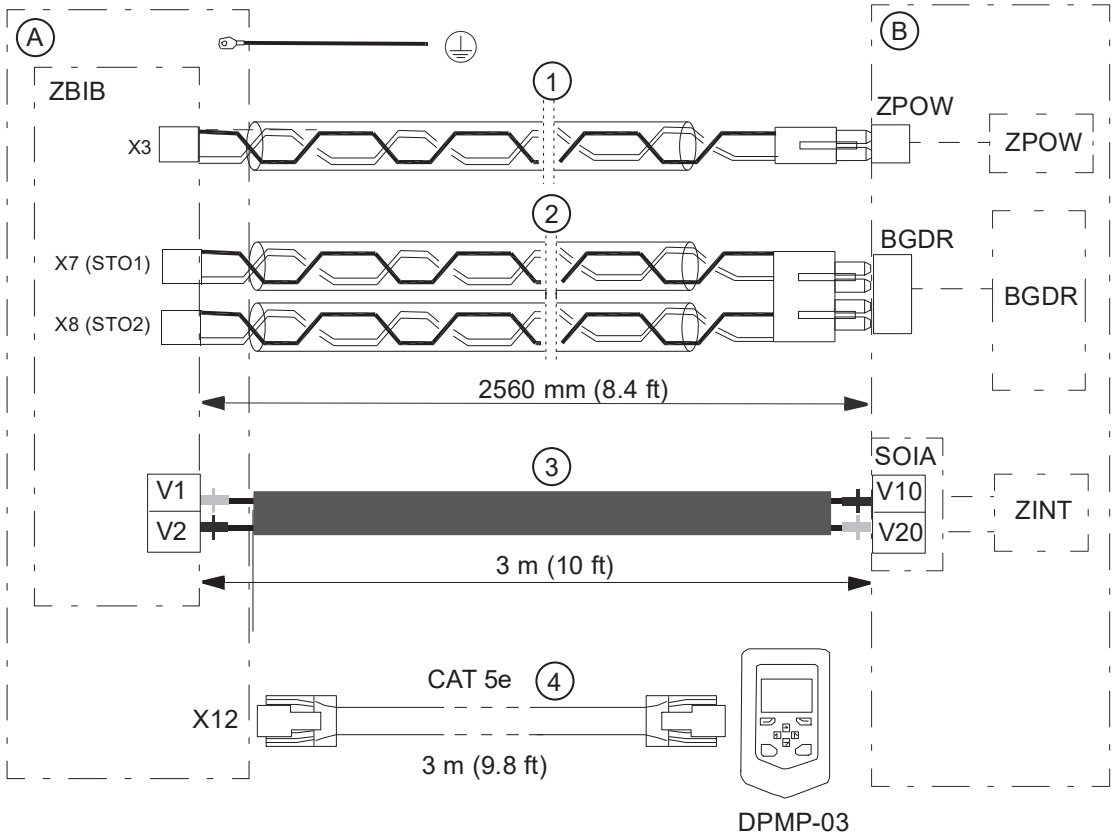
Option +P906 allows the drive control unit CCU-24 to be installed separately from the main drive module, for example, in a separate compartment. The external control unit makes the drive module removal easier, as the customer control cabling can stay in place while the module is removed.

Layout

<table>
<tr><td rowspan="3"> 
</td><td>1</td><td>Attaching points</td></tr>
<tr><td>2</td><td>Duct for cables from drive module to be connected to the ZBIB board at the back of the control unit.</td></tr>
<tr><td>3</td><td>Connectors. For descriptions, see chapter Control unit (page 135).</td></tr>
<tr><td> </td><td colspan="2">Cables for connecting the external control unit to the drive module.</td></tr>
</table>

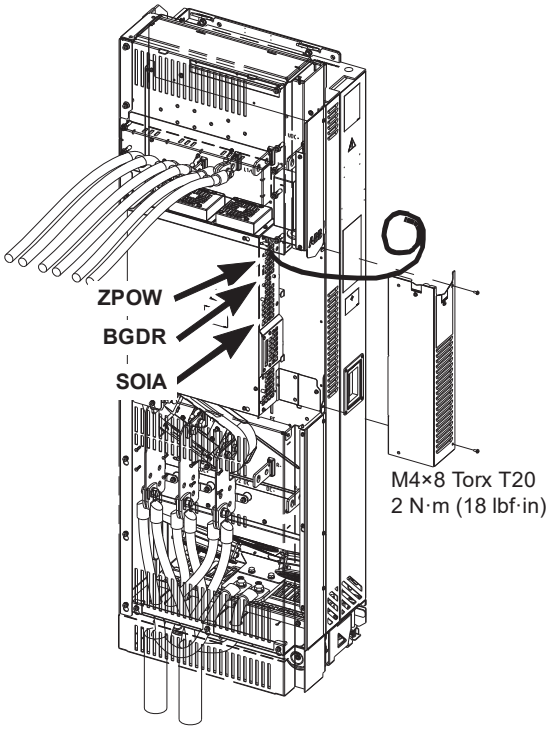
Cables

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 delivered in a cardboard box inside the main drive module package.

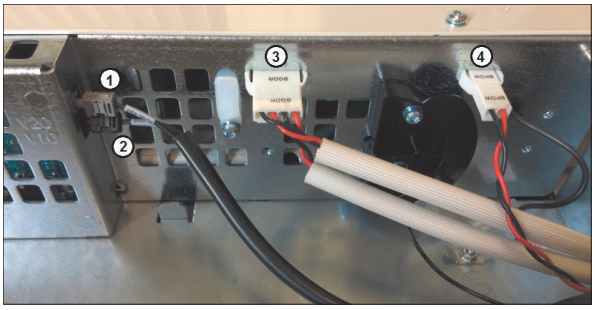
Unpack the external control unit package. Make sure that it contains these items:

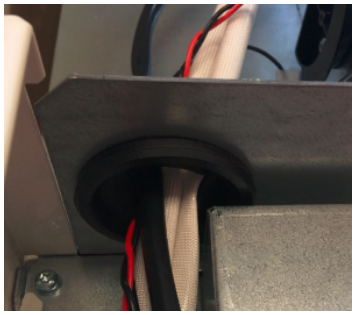
- CCU-24 control unit
- mounting template.

The mounting template contains a mounting pattern for a CCU-24 control unit on one side and a mounting pattern for a ZCU-14 control unit on the other side.

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 and carefully pull them out through the rubber grommet. Wind the cables carefully into the supplied plastic bag for later installation.





1	V20	3	ZPOW
2	V10	4	BGDR

Installing the control unit

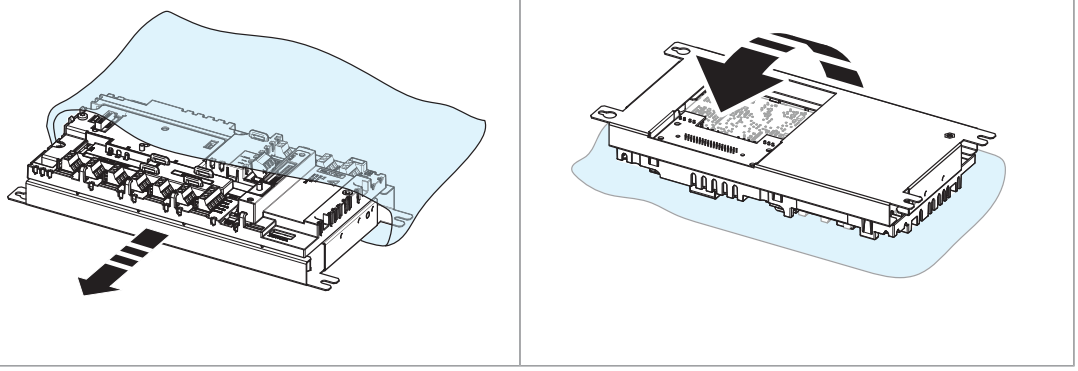
Determine where the control unit is to be located. Take into account the cable lengths, the physical dimensions and mounting points of the control unit assembly (see section Dimension drawing (page 158)). Install the unit inside an enclosure for protection.

Installation procedure

WARNING!
Obey these instructions. If you ignore them, equipment malfunction and damage to the fiber optic cables can occur.

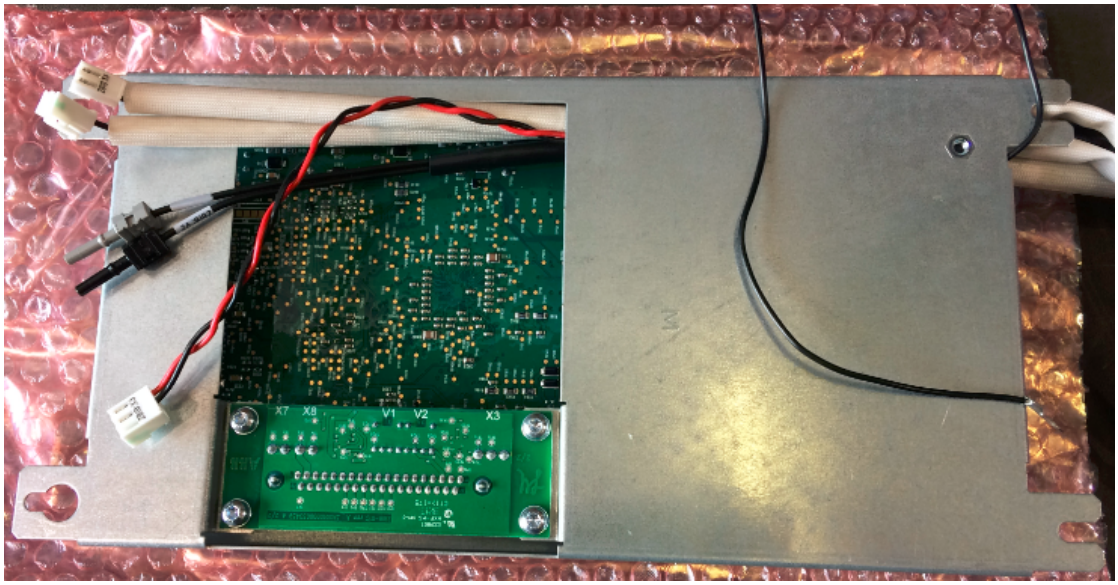
- Handle the fiber optic cables with care.
- When you unplug the cables, always hold the connector, not the cable itself.
- Do not touch the ends of the fibers with bare hands as the ends are extremely sensitive to dirt.
- Do not bend the fiber optic cables too tightly. The minimum allowed bend radius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

1. Remove the control unit from the anti-static bag. Put the control unit onto the anti-static bag, with the rear connections up.

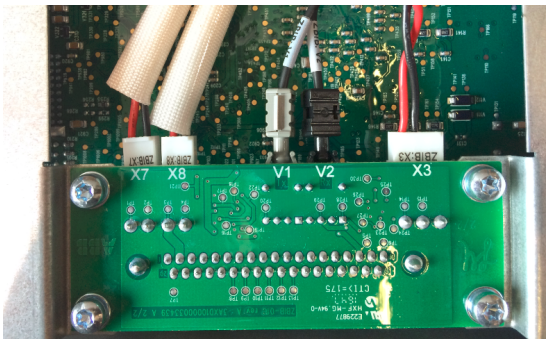


2. Identify the correct ends of the control cables to be connected to the control unit.

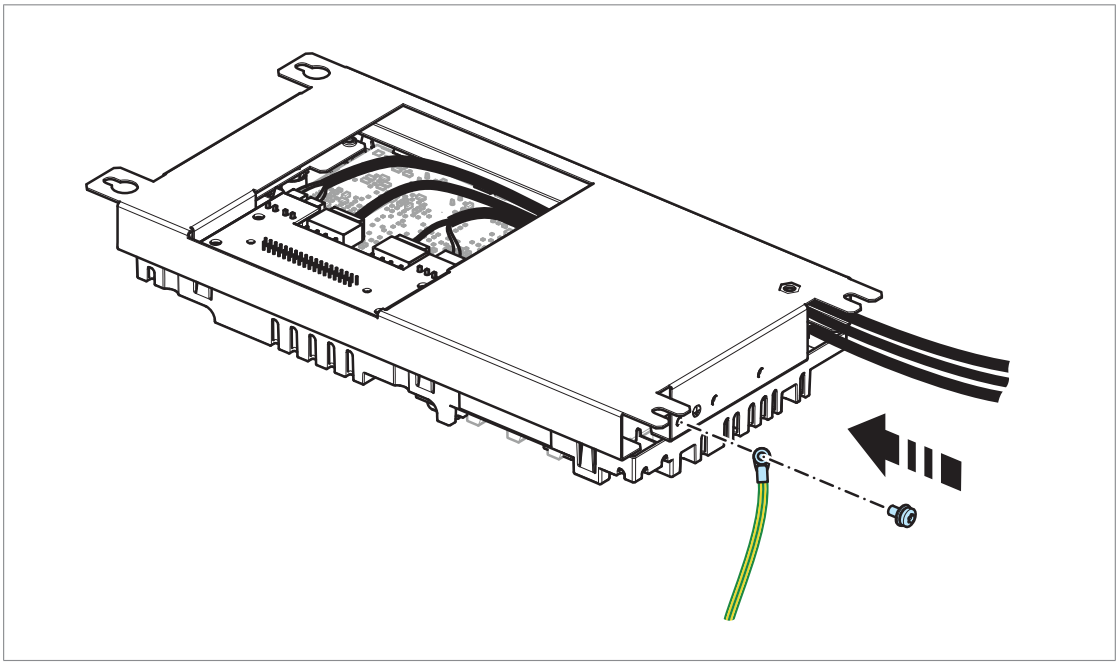
3. Pull the cables through the control unit assembly, so they appear in the opening at the rear of the control unit. Do not pull the ground conductor through but leave it outside of the assembly. Make sure that the cables are not against sharp edges or bare live parts.



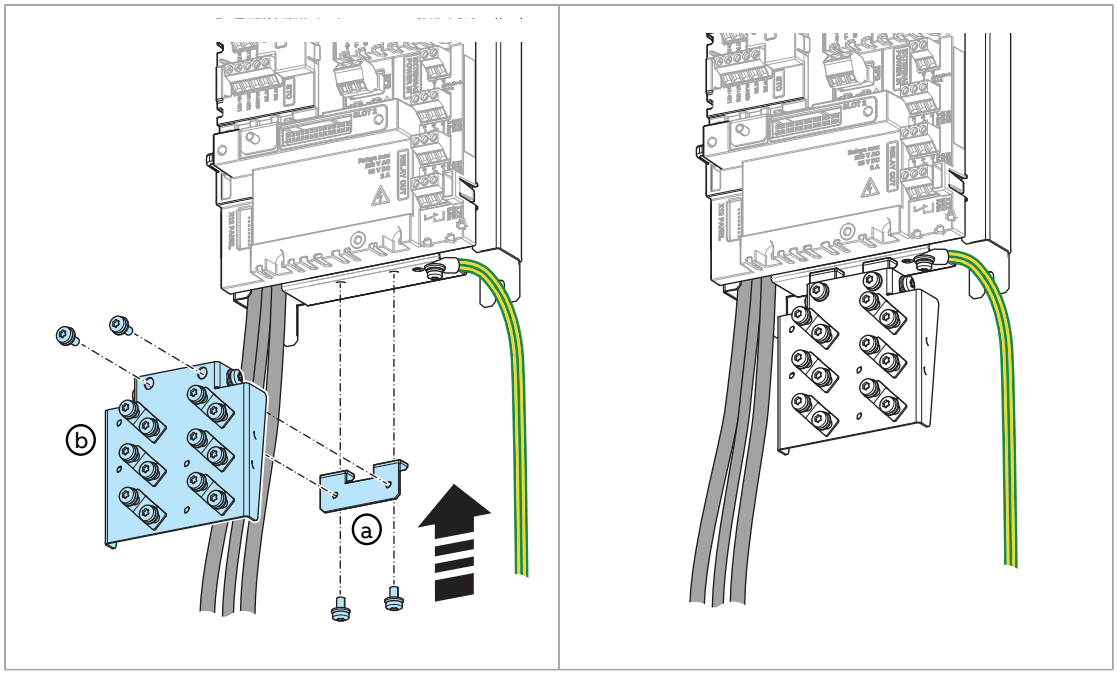
4. Connect the cables to their connectors on the ZBIB board.

View of ZBIB board	ZBIB connectors	Cables from drive module
		**ZPOW**
	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)

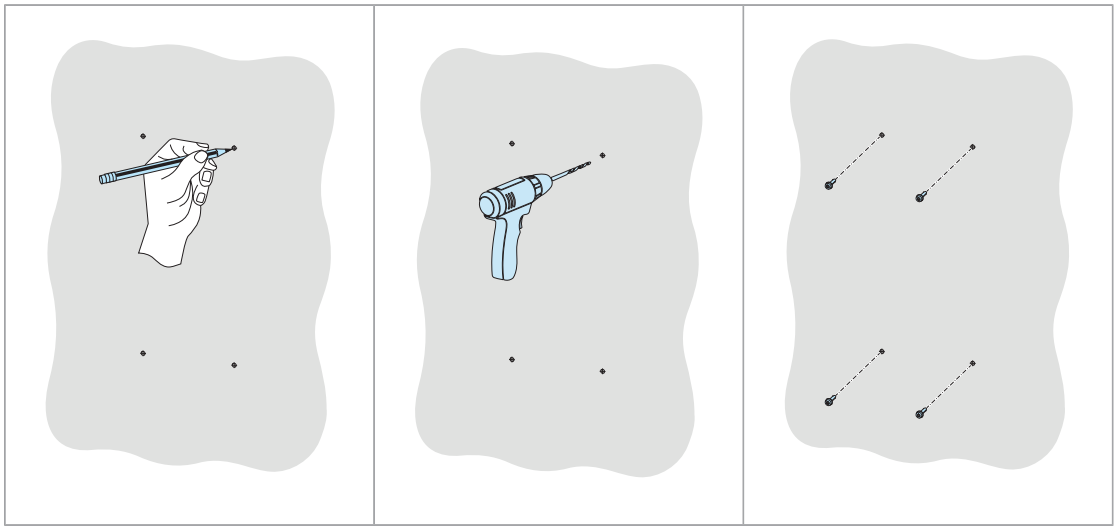
5. Connect the grounding wire.



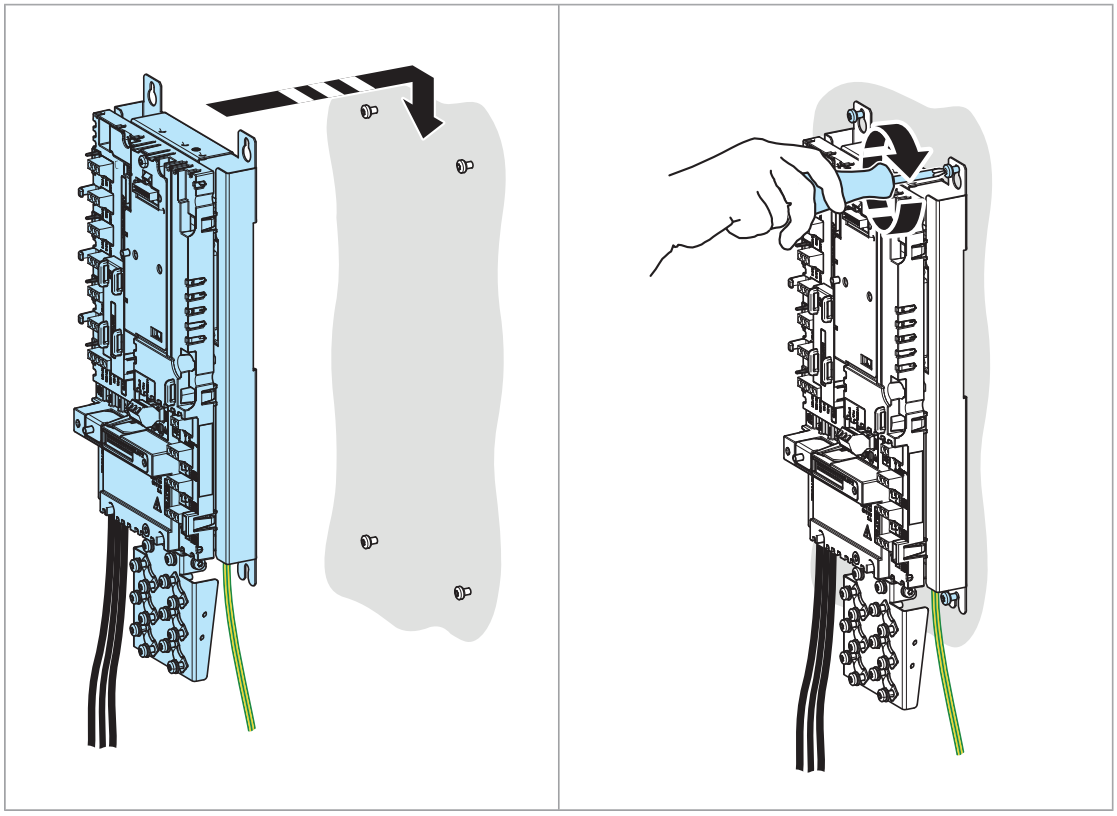
6. The kit includes a plate for the customer cable screens. Attach the small bracket (a) first, then the full clamp plate (b).



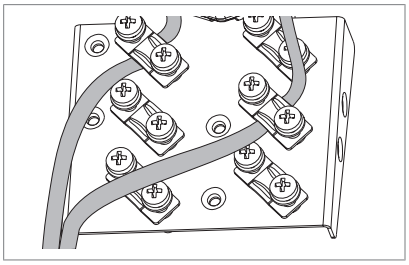
7. Use the mounting template and a pen to make marks on the installation surface. Then drill the holes and install the mounting screws. Make sure that debris from drilling does not go into the drive or control unit.



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



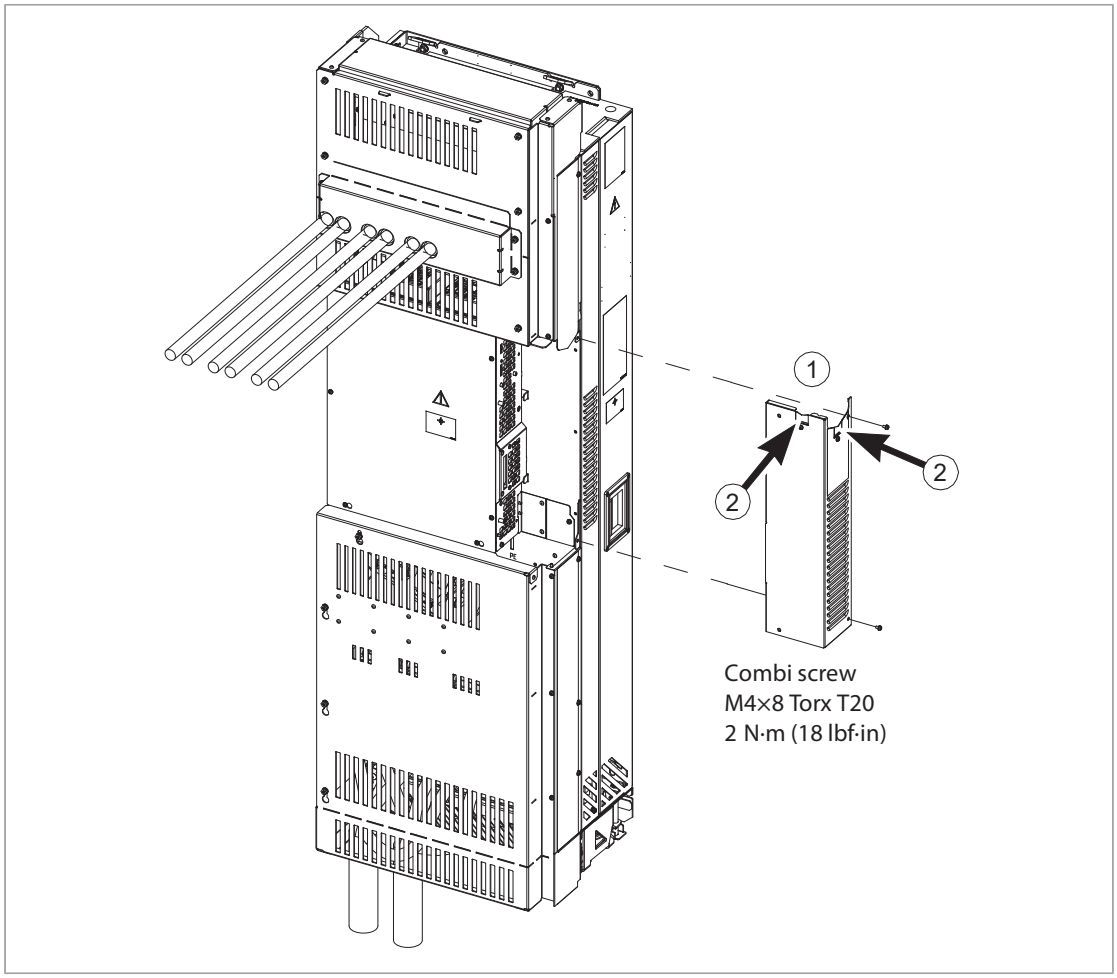
9. Attach the optional modules.
10. Ground the shields of the control cables at the clamp plate. The shields should be continuous as close to the terminals of the control unit as possible. Only remove the outer jacket of the cable at the cable clamp so that the clamp presses on the bare shield. The shield (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 135). Use shrink tubing or insulating tape to contain any stray strands. Tighten the screws to secure the connection.
    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

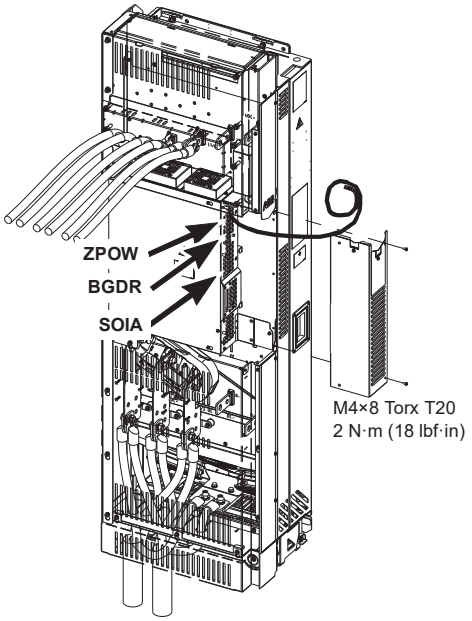
1. Remove the middle front cover of the the drive module. A view of drive module with optional clear plastic shrouds is shown below.
2. Remove the cover plate from the control cable entry and put the rubber grommet in its place. Put the control cables through the grommet.



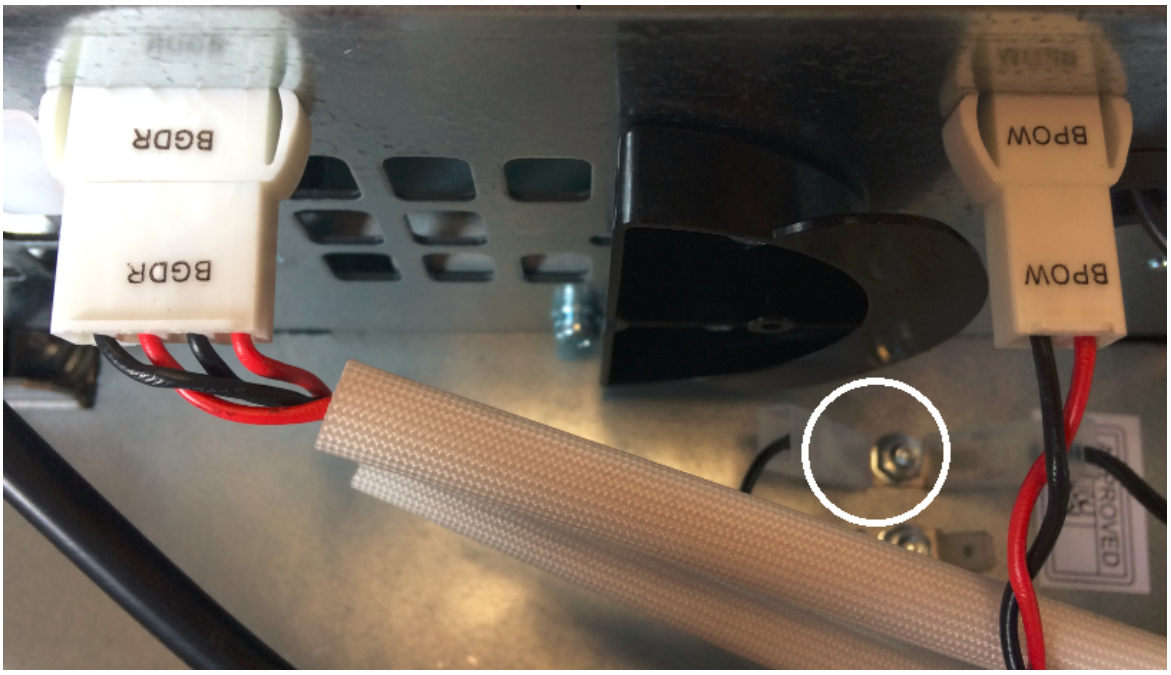
3. Connect the control cables to the drive module. Make sure that the cables are not against sharp edges or bare live parts. Use the holes on top and bottom of the cover to tie the control cables using cable ties.

WARNING!
Obey these instructions. If you ignore them, equipment malfunction and damage to the fiber optic cables can occur.

- Handle the fiber optic cables with care.
- When you unplug the 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).

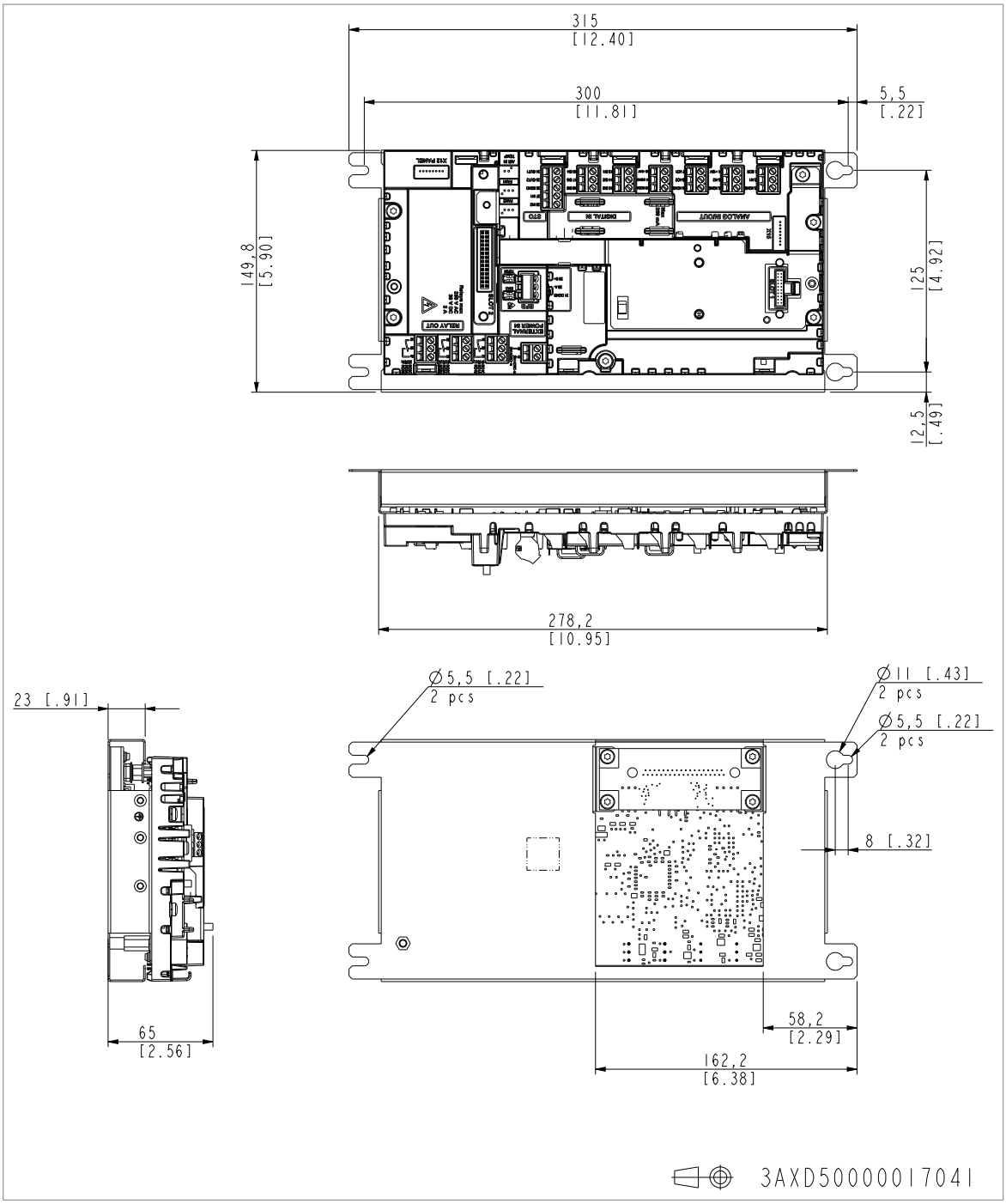
Drive module	ZBIB
	
ZPOW	
X3:1	X3:1
X3:2	X3:2
BGDR	
X7 (STO1)	X7 (STO1)
X8 (STO2)	X8 (STO2)
SOIA	
V10	V1
V20	V2

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


BGDR
BGDR
BPOW
BPOW

Dimension drawing

The dimensions are in millimeters and [inches].



13

Installation checklist

Contents of this chapter

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

Checklist

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

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

WARNING!
Stop the drive and do the steps in section Electrical safety precautions (page 21) before you start the work.

Make sure that ...	☑
The ambient operating conditions meet the drive ambient conditions specification and enclosure rating (IP code).	☐
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.	☐

Make sure that ...	☑
The drive module is fastened properly to the enclosure.	☐
The cooling air flows freely in and out of the drive. Air recirculation inside the cabinet is not possible (air baffle plates are installed, 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 (un-painted) 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. 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. The conductor is connected to the correct terminal, and the terminal is tightened to the correct torque. 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.	☐
If an external brake resistor is connected to the drive: There is an adequately sized protective earth (ground) conductor between the brake resistor and the drive, and the conductor is connected to the correct terminal, and the terminals are tightened to the correct torque. Proper grounding has also been measured according to the regulations.	☐
If an external brake resistor is connected to the drive: The brake resistor cable is connected to the correct terminals, and the terminals are tightened to the correct torque.	☐
If an external brake resistor is connected to the drive: The brake resistor cable is routed away from other cables.	☐
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.	☐
The 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.	☐

14

Start-up

Contents of this chapter

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

Reforming the capacitors

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

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 159), 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 drives with option +D150, see chapter Resistor braking (page 241).
5. For drive modules in which the Safe torque off function is in use: Test and validate the operation of the Safe torque off function. See section Start-up including validation test (page 229).

15

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 quick installation and start-up guide or the firmware manual for the descriptions, causes and remedies of the control program warning and fault messages.

16

Maintenance

Contents of this chapter

This chapter contains maintenance instructions for 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 (https://new.abb.com/drives/services/maintenance/preventive-maintenance). For more information, consult your local ABB Service representative (www.abb.com/searchchannels).

Description of symbols

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

Recommended annual actions by the user	
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

Recommended annual actions by the user	
Dustiness, corrosion and temperature	I
Heatsink cleaning	P

Component	**Years from start-up**						
	3	**6**	**9**	**12**	**15**	**18**	**21**
Cooling							
Main cooling fans			R			R	
Circuit board compartment cooling fans LONGLIFE			R			R	
Aging							
Control panel battery			R			R	
Functional safety							
Safety function test	I See the maintenance information of the safety function.						
Safety component expiry (Mission time, T_M)	20 years						

Maintenance and component replacement intervals are based on the assumption that the equipment is operated within the specified ratings and ambient conditions. ABB recommends annual drive inspections to ensure the highest reliability and optimum performance.

Note: Long term operation near the specified maximum ratings or ambient conditions may require shorter maintenance intervals for certain components. Consult your local ABB Service representative for additional maintenance recommendations.

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.

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 21) 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

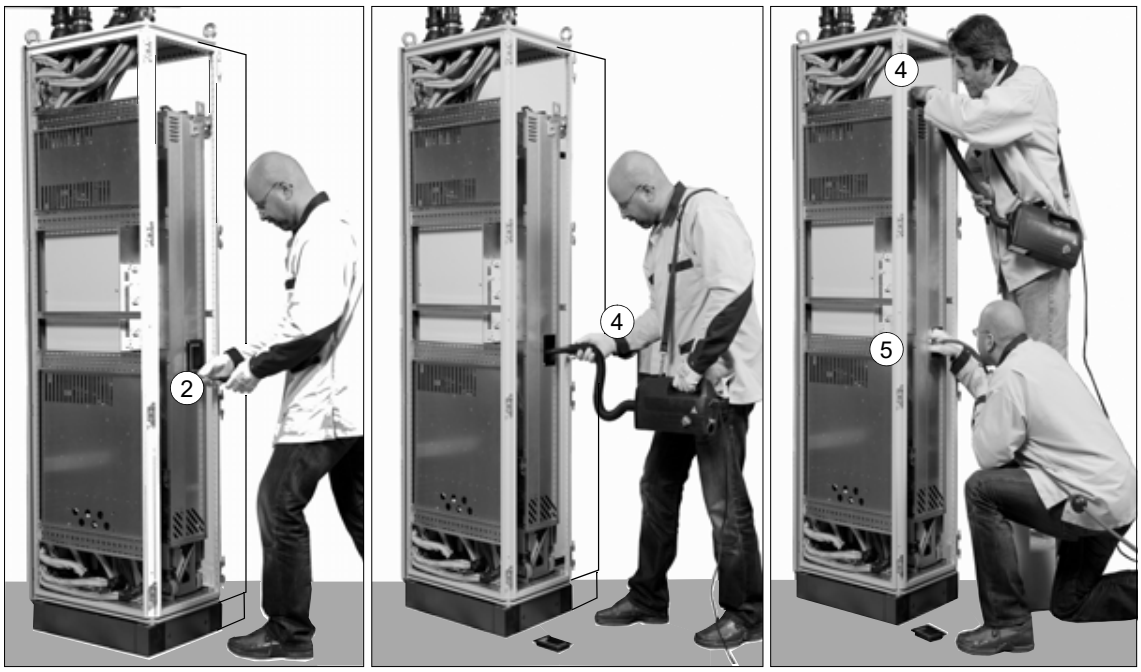
The drive module heatsink collects dust from the cooling air. If the heatsink is not clean, the drive can generate overtemperature warnings and faults. When necessary, clean the heatsink as described in this section.

Cleaning the interior of the heatsink

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 21) before you start the work.
2. Remove the attaching screws of the handle plate of the drive module.
3. Remove the handle plate.
4. Vacuum the interior of the heatsink from the opening.
5. Carefully 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. Prevent dust from entering adjoining equipment.
6. Reinstall the handle plate.



Fans

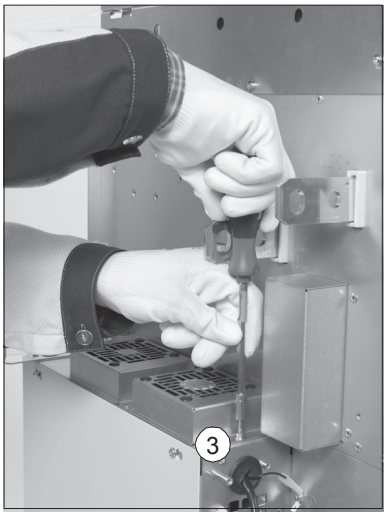
The lifespan of the cooling fans of the drive depends on running time, ambient temperature and dust concentration. See the firmware manual for the actual signal which indicates the running time of the cooling fan. Reset the running time signal after fan replacement.

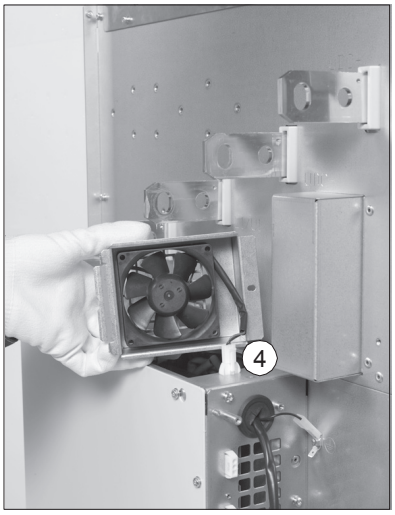
Replacement fans are available from ABB. Do not use other than ABB-specified spare parts.

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 21) 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.

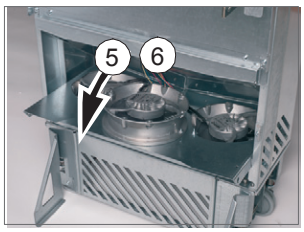


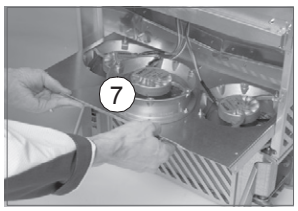


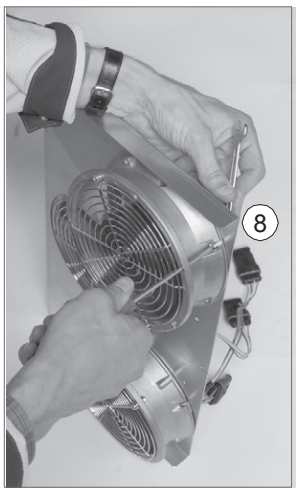
Replacing the main cooling fans

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 21) 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. Remove 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. Remove the fastening screws of the fan(s) and remove the fan(s) from the assembly plate.
9. Install the new fan(s) in reverse order to the above.
10. Reset the counter (if used) in parameter group 5 in the control program.





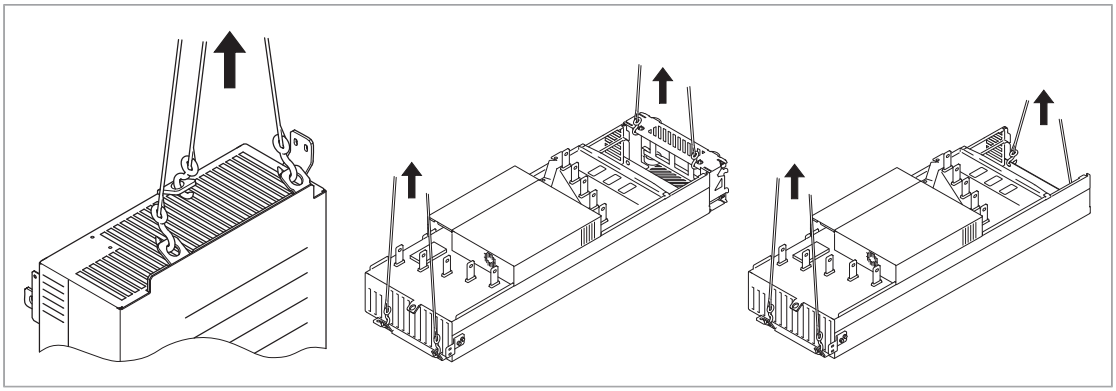


Replacing the drive module

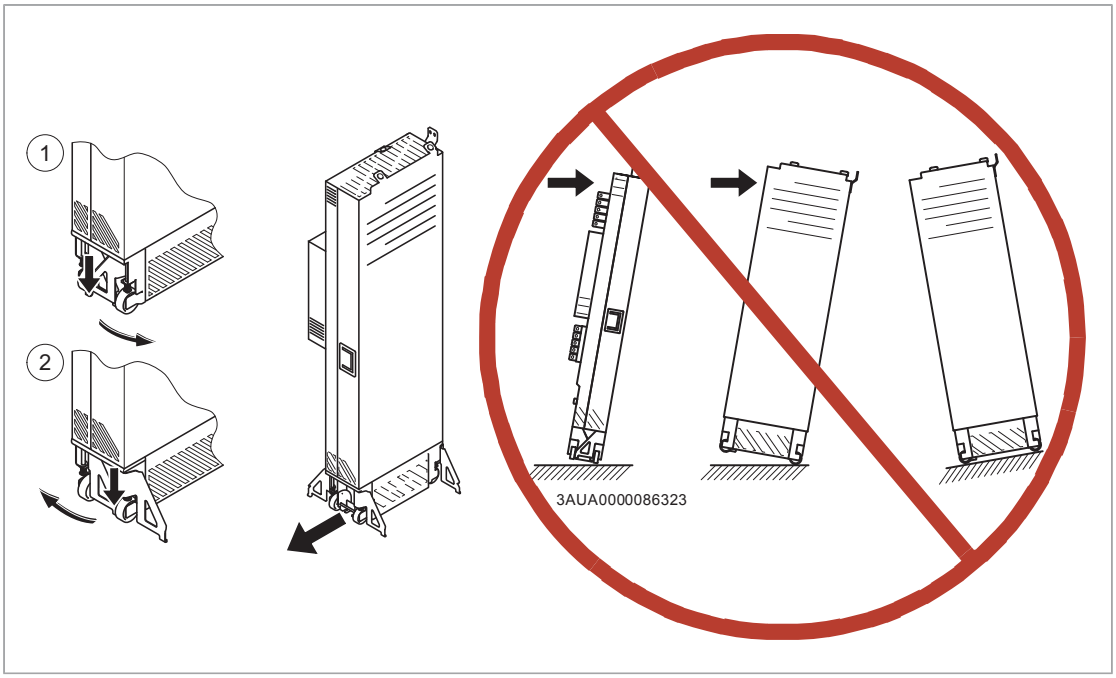
WARNING!
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

Handle the drive module carefully:

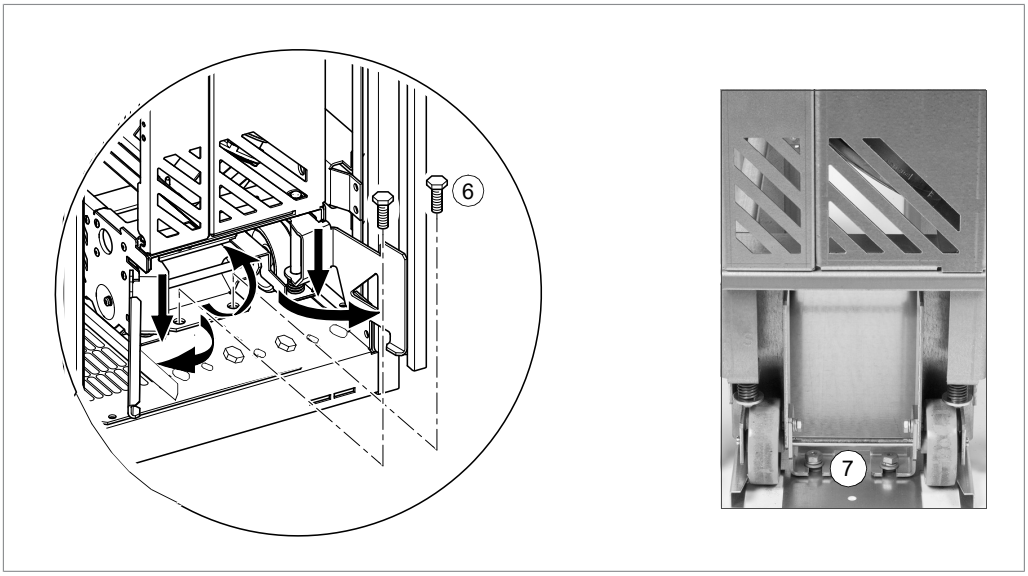
- Use safety shoes with a metal toe cap to prevent foot injury.
- Lift the drive module only by the lifting lugs.



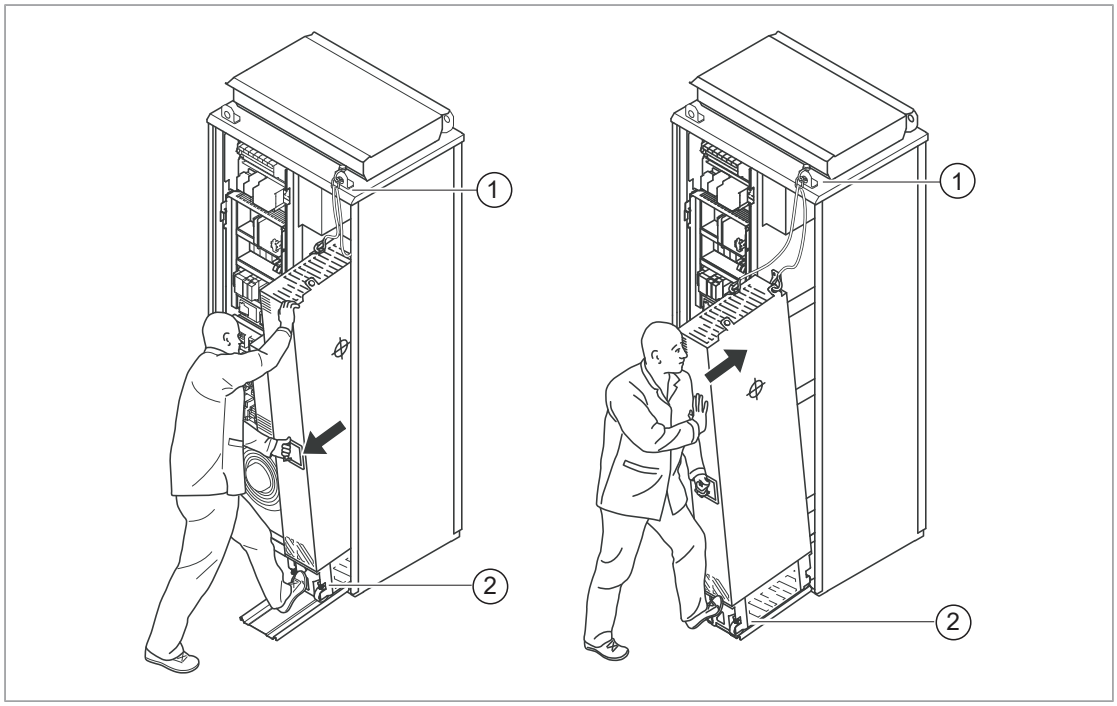
- Make sure that the module does not topple over when you move it on the floor: Open the support legs by pressing each leg a little down (1, 2) and turning it aside. Whenever possible attach the module also with chains. Do not tilt the drive module. It is heavy and its center of gravity is high. The 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 21) before you start the work.
2. Make sure that all other precautions described in section Grounding (page 23) 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. If the drive is equipped with an external control unit (option +P906), disconnect the power supply cables, STO cables and the fiber optic cables from the external control unit and wind them on the top of the drive module. 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).
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.

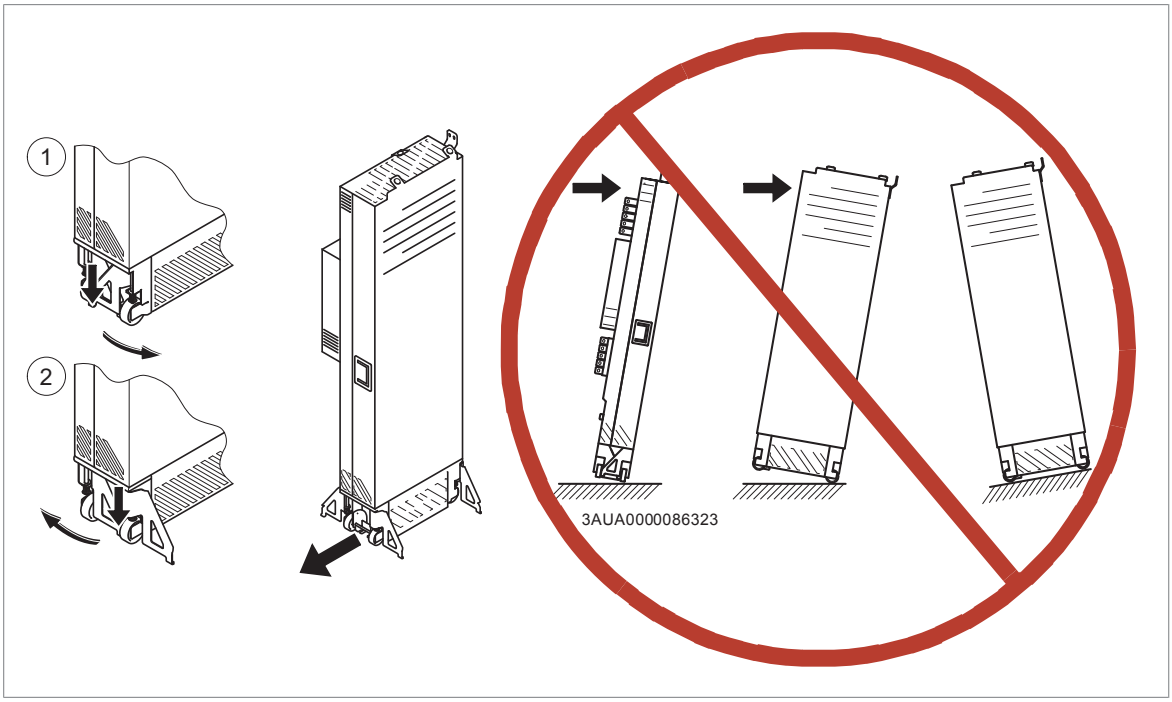
Replacing the drive module with option +H381

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

Note: The replacement module must be of the same type as the original module: same type code and same option codes.

Handle the drive module carefully:

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



1. Stop the drive and do the steps in section Electrical safety precautions (page 21) before you start the work.
2. Undo the fastening screws to remove the left-hand side upper and lower front covers of the drive module. M4×10 combi screws, 2 N·m (18 lbf·in).
3. Disconnect the drive module busbars from the input cabling panel. Combi screw M12, 70 N·m (52 lbf·ft).
4. Disconnect the drive module busbars from the output cabling panel. Combi screw M12, 70 N·m (52 lbf·ft).
5. Undo the screws that attach the drive module to the cabinet at the top (a) and behind the front support legs (b).
6. Remove the front air baffle.
7. Attach the extraction/installation ramp to the cabinet base with two screws.
8. Disconnect the power supply cables, STO cables and the fiber optic cables from the external control unit and wind them on the top of the drive module. 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).
9. To prevent the drive module from falling, attach its top lifting lugs with chains to the cabinet frame.
10. Pull the drive module carefully out of the cabinet, preferably with help from another person.
11. Install the new module in reverse order to the above.

Functional safety components

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

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

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

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

Contact your local ABB service representative for more information.

Capacitors

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

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

Reforming the capacitors

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

Control panel

Refer to ACS-AP-I, -S, -W and ACH-AP-H, -W 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

ACH580-04-...	Frame size	Input current	Output ratings				
			Max. current	Nominal use		Light-duty use	
		I_1	I_{max}	I_2	P_n	I_{Ld}	P_{Ld}
		A	A	A	kW	A	kW
U_n = 400 V							
505A-4	R10	505	560	505	250	485	250
585A-4	R10	585	730	585	315	575	315
650A-4	R10	650	730	650	355	634	355
725A-4	R11	725	1020	725	400	715	400
820A-4	R11	820	1020	820	450	810	450
880A-4	R11	880	1100	880	500	865	500

ACH580-04-...	Frame size	Input current	Output ratings				
			Max. current	Nominal use		Light-duty use	
		I_1	I_{max}	I_2	P_n	I_{Ld}	P_{Ld}
		A	A	A	hp	A	hp
U_n = 480 V							
505A-4	R10	483	560	505	400	483	400
585A-4	R10	573	730	585	450	573	450
650A-4	R10	623	730	650	500	623	500
725A-4	R11	705	850	725	600	705	600
820A-4	R11	807	1020	820	700	807	700
880A-4	R11	807	1020	880	700	807	700

UL (NEC) ratings

ACH580-04-...	Frame size	Input current	Output ratings				
			Max. current	Nominal use		Light-duty use	
		I_1	I_{max}	I_2	P_n	I_{Ld}	P_{Ld}
		A	A	A	hp	A	hp
U_n = 480 V							
505A-4	R10	483	560	505	400	483	400
585A-4	R10	573	730	585	450	573	450
650A-4	R10	623	730	650	500	623	500
725A-4	R11	705	850	725	600	705	600
820A-4	R11	807	1020	820	700	807	700
880A-4	R11	807	1020	880	700	807	700

Definitions

U_n	Nominal voltage of the drive. For the input voltage range, see section Electrical power network specification (page 189). 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 the minimum switching frequency (parameter 97.02) is set to 2 kHz or less.
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.

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}) decreases when the drive is installed into a high altitude or high temperature environment, and also when the application requires a high minimum switching frequency. In an environment where more than one type of derating is necessary (for example, high altitude and high temperature), the effects of derating are cumulative. If necessary, oversize the drive so that the total derated output current is sufficient for the motor to reach the full power.

Note:

- The motor can also have a derating on it.
- You can also use the DriveSize tool (http://new.abb.com/drives/software-tools/drivesize) for derating.

Example 1, IEC: How to calculate the derated current

The IP00 drive type is ACH580-04-725A-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 181):
   The derating factor for 4 kHz switching frequency is 0.78. The derated drive output current then becomes: $I_2 = 0.78 \cdot 725 \text{ A} = 565.5 \text{ A}$
2. Altitude derating (page 181):
   The derating factor for 1500 m is 1 - 1/10 000 m · (1500 - 1000) m = 0.95. The derated drive output current then becomes: $I_2 = 0.95 \cdot 565.5 \text{ A} = 537.2 \text{ A}$.
3. Surrounding air temperature derating (page 180):
   The derating factor for 50 °C ambient temperature is 0.90. The derated drive output current then becomes: $I_2 = 0.90 \cdot 575.2 \text{ A} = 483.5 \text{ A}$.

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 181):
   The minimum size required is $I_2 = 585 \text{ A} / 0.78 = 750 \text{ A}$, where 0.78 is the derating for 4 kHz switching frequency.
2. Altitude derating (page 181):

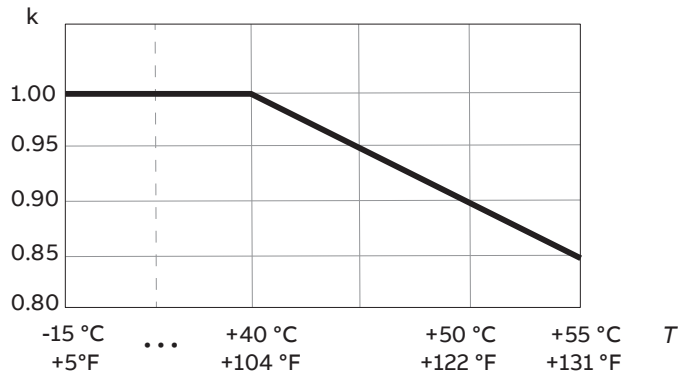
The derating factor for 1500 m is 1 - 1/10 000 m · (1500 - 1000) m = 0.95. Because the surrounding air temperature is less than 40 °C, the altitude derating can be reduced from 0.95 to 1. Thus, no derating is necessary for 1500 m altitude.

3. Surrounding air temperature derating (page 180):
   No derating is necessary for 35 °C surrounding air temperature.

From the table in section IEC ratings (page 177), drive type ACH580-04-820A-4 exceeds the I_2 requirement of 750 A.

Surrounding air temperature derating

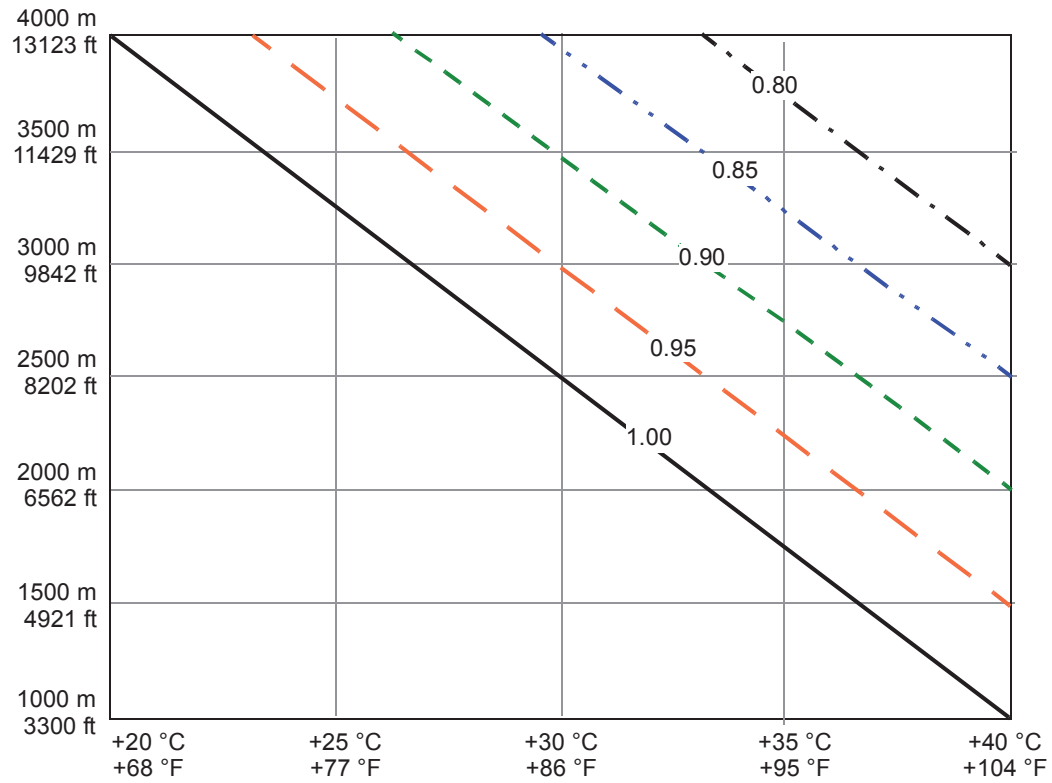
In the temperature range +40 … 55 °C (+104 °F … 131 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F) as follows. Calculate the output current by multiplying the current given in the rating table by the derating factor.



Altitude derating

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

If the surrounding air temperature is less than +40 °C (104 °F), the derating can be reduced by 1.5 percentage points for every 1 °C (1.8 °F) 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, calculate the derated output current by multiplying the current given in the rating table by the derating factor given in the table below. Changing the switching frequency reference with parameter 97.01 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.

ACH580-04-...	Min. short-circuit current [1]	Input current	Ultrarapid (aR) fuses, type DIN 43653 (bolted style)			
			Nominal current	I^2t	Voltage rating	Fuse
	A	A	A	A^2s	V	Bussmann
U_n = 400 V						
505A-4	4500	505	800	465000	690	170M6012
585A-4	6500	585	1000	945000	690	170M6014
650A-4	6500	650	1000	945000	690	170M6014
725A-4	9100	725	1250	1950000	690	170M6016
820A-4	13000	820	1600	3900000	690	170M6269
880A-4	13000	880	1600	3900000	690	170M6269
U_n = 480 V						
505A-4	4500	483	800	465000	690	170M6012
585A-4	6500	573	1000	945000	690	170M6014
650A-4	6500	623	1000	945000	690	170M6014
725A-4	9100	705	1250	1950000	690	170M6016
820A-4	13000	807	1600	3900000	690	170M6269
880A-4	13000	807	1600	3900000	690	170M6269

[1] Minimum permitted short-circuit current of the electrical power network.

ACH580-04-...	Min. short-circuit current [1]	Input current	Ultrarapid (aR) fuses, type DIN 43620 (blade style)			
			Nominal current	I^2t	Voltage rating	Fuse
	A	A	A	A^2s	V	Bussmann
U_n = 400 V						
505A-4	11000	505	1600	4150000	690	170M8557D
585A-4	11000	585	1600	4150000	690	170M8557D
650A-4	11000	650	1600	4150000	690	170M8557D
725A-4	-	725	-	-	-	-
820A-4	-	820	-	-	-	-
880A-4	-	880	-	-	-	-
U_n = 480 V						
505A-4	11000	483	1600	4150000	690	170M8557D
585A-4	11000	573	1600	4150000	690	170M8557D
650A-4	11000	623	1600	4150000	690	170M8557D
725A-4	-	705	-	-	-	-
820A-4	-	807	-	-	-	-
880A-4	-	807	-	-	-	-

[1] Minimum permitted short-circuit current of the electrical power network.

Note: See also section Protecting the drive and input power cable in short-circuits (page 92).

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.

Calculating the short-circuit current of the installation

Make sure that the short-circuit current of the installation is at least the value given in the fuse table.

The short-circuit current of the installation can be calculated as follows:

$$I_{k2\text{-}ph} = \frac{U}{2 \cdot \sqrt{R_c^2 + (Z_k + X_c)^2}}$$

where

$I_{k2\text{-}ph}$	Short-circuit current in symmetrical two-phase short-circuit
U	Network line-to-line voltage (V)
R_c	Cable resistance (ohm)
Z_k	$Z_k = z_k \cdot U_n^2 / S_n$ = transformer impedance (ohm)
z_k	Transformer impedance (%)
U_n	Transformer rated voltage (V)
S_n	Nominal apparent power of the transformer (kVA)
X_c	Cable reactance (ohm)

Example:

The drive type is ACH580-04-725A-4 with a nominal voltage (U) of 400 V.

The supply transformer specifications are:

- rated power S_n = 1000 kVA
- rated voltage (drive supply voltage) U_n = 410 V
- impedance z_k = 5%.

The supply cable specifications are:

- length = 100 m
- resistance/length = 0.125 ohm/km
- reactance/length = 0.074 ohm/km.

Calculate the short-circuit current as follows:

$$Z_k = z_k \cdot \frac{U_N^2}{S_N} = 0.05 \cdot \frac{(410\ V)^2}{1000\ kVA} = 8.41\ m\Omega$$

$$R_c = 100\ m \cdot 0.125 \frac{\Omega}{km} = 12.5\ m\Omega$$

$$X_c = 100\ m \cdot 0.074 \frac{\Omega}{km} = 7.4\ m\Omega$$

$$I_{k2-ph} = \frac{400\ V}{2 \cdot \sqrt{(12.5\ m\Omega)^2 + (8.41\ m\Omega + 7.4\ m\Omega)^2}} = 9920\ A$$

In this example, the calculated short-circuit current is 9920 A. This is more than the minimum required short-circuit current for the drive aR fuse type 170M6016 (9100 A). Thus, the fuse 170M6016 can be used.

Fuses (UL)

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

ACH580-04-...	Input current (A)	UL fuses				
		A	V	Manufacturer	UL class	Type
U_n = 480 V						
505A-4	483	600	600	Bussmann	T	JJS-600
585A-4	573	800	600	Ferraz	L	A4BY800
650A-4	623	800	600	Ferraz	L	A4BY800
725A-4	705	1000	600	Ferraz	L	A4BY1000
820A-4	807	1000	600	Ferraz	L	A4BY1000
880A-4	807	1000	600	Ferraz	L	A4BY1000

1. Fuses are required as part of the installation, are not included in the base drive configuration and must be provided by others.
2. Fuses with a higher current rating than specified must not be used.
3. The UL listed fuses recommended by ABB are the required branch circuit protection per NEC. Circuit breakers listed in section Circuit breakers (UL) are also acceptable as branch circuit protection.
4. The recommended size or smaller UL listed 248 fast acting, time delay, or high speed fuses must be used to maintain the UL listing of the drive. Additional protection can be used. Refer to local codes and regulations.
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. UL listed 248 fast acting, time delay, or high speed fuses from other manufacturers can be used if they meet the same class and rating requirements specified in the rules above.
7. When installing a drive, always follow ABB installation instructions, NEC requirements and local codes.
8. 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.

ACH580-04-...	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

[1] Maximum permitted rated conditional short-circuit current (IEC 61800-5-1) of the electrical power network.

ACH580-04-...	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

[1] Maximum permitted 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 shrouds)				
Frame size	Height	Width	Depth	Weight*
	mm	mm	mm	kg
R10	1462	350	529	161
R11	1662	350	529	199

Standard drive module configuration (IP00) and option +B051 (IP20 shrouds)				
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**	**+H381**
	kg	**kg**	**kg**	**kg**	**kg**	**kg**
R10	-7	3	2	-2.9	2.9	30
R11	-7	3	2	-2.9	2.9	30

Weight of optional selections						
Frame size	**+0H354**	**+E208**	**+H356**	**+0H371**	**+H370**	**+H381**
	lb	**lb**	**lb**	**lb**	**lb**	**lb**
R10	-15	7	4	-6	6	66
R11	-15	7	4	-6	6	66

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 58).

Losses, cooling data and noise

ACH580-04...	Frame size	Air flow		Typical power loss [1]	Noise
		m³/h	cfm	W	dB(A)
505A-4	R10	1200	707	6492	72
585A-4	R10	1200	707	6840	72
650A-4	R10	1200	707	8046	72
725A-4	R11	1200	707	8108	72
820A-4	R11	1200	707	9652	72
880A-4	R11	1420	848	10887	71

[1] Typical drive losses when it operates at 90% of the motor nominal frequency and 100% of the motor nominal current.

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 MCM) only with special cable lugs and additional insulation. For more information, contact your local ABB representative.

Drive modules with optional cabling panels (+H381)

The maximum accepted cable size is 4 × (3 × 240) mm² or 4 × (3 × 500 MCM). The cabling panels are connected to the drive module busbars with M12 serpress nuts, tightening torque 30 N·m (20 lbf·ft).

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 187).

ACH580-04-...	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)

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.

ACH580-04-...	UL (NEC) [1]
	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

[1] 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 135).

Electrical power network specification

Voltage (U_1)	ACH580-04-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 permitted 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 permitted 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 100000 rms symmetrical amperes at 480 V maximum when protected by the fuses given in the fuse table.
Frequency	48…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…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 177).
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 mode **Note:** A motor cable that is longer than 100 m (328 ft) may not fulfill the EMC Directive requirements of Category C3. **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.

Brake resistor connection data

See chapter Resistor braking (page 241).

DC connection data

ACH580-04-…	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 40).

Control unit data

See chapter Control unit (page 135).

Efficiency

Approximately 98% at nominal power level.

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

Energy efficiency data (ecodesign)

Energy efficiency data according to IEC-61800-9-2 is available from the ecodesign tool (https://ecodesign.drivesmotors.abb.com).

Protection classes for module

Degrees of protection (IEC/EN 60529)	IP00 (standard) IP20 (option +B051 and bottom grille installed)
Enclosure types (UL 50/50E)	UL Open Type
Overvoltage category (IEC/EN 60664-1)	III
Protective class (IEC/EN 61800-5-1)	I

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 … 4000 m (13123 ft) above sea level For TN, TT and IT corner-grounded network systems: 0 … 2000 m (6561 ft) above sea level Above 1000 m (3281 ft): refer to the derating information	-	-

Surrounding air temperature	-15…+55 °C (5…+131 °F). Derating is necessary if the temperature is more than 40 °C (104 °F). Refer to the derating information. No frost permitted.	-40 … 70 °C (-40 … +158 °F)	-40…+70 °C (-40 … +158 °F)
Relative humidity	5…95%	Max. 95%	Max. 95%
	No condensation permitted. Maximum permitted 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 permitted.	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 permitted	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 permitted	100 mm (4 in) for weight over 100 kg (220 lb)	100 mm (4 in) for weight over 100 kg (220 lb)

Colors

Enclosure	NCS 1502-Y (RAL 9002 / PMS 420 C)

Materials

Drive module

For information on the materials used in the drive module, refer to Recycling instructions and environmental information for ACS880-04, ACS580-04, ACH580-04 and ACQ580-04 (3AXD50000137688 [English]).

Package materials for module products

This is a complete list of the package materials. The materials vary depending on the frame size (packages do not contain all materials listed below).

- Cardboard[1)]
- Molded pulp
- Plywood
- Wood
- PP (strapping)
- EPP (foam)

- PE (plastic bag and/or VCI foil)
- Metal (fixing clamps, screws).

1) Cardboard heavy duty quality with wet strength glue in large modules.

Package materials for options, accessories and spare parts

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

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

Materials of manuals

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

Disposal

The main parts of the drive can be recycled to preserve natural resources and energy. Product parts and materials should be dismantled and separated.

Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and large electrolytic capacitors need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code.

Contact your local ABB distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations.

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: • an emergency-stop device • a supply disconnecting device • the 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).
BTL	BTL (BACnet Testing Laboratories) mark Product has BACnet conformance certificate.
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.
UK CA	UKCA (UK Conformity Assessed) mark Product complies with the applicable United Kingdom's legislation (Statutory Instruments). Marking is required for products being placed on the market in Great Britain (England, Wales and Scotland).
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	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).
20	Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP). Product is compliant with the People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) about hazardous substances. The EFUP is 20 years. China RoHS II Declaration of Conformity is available from https://library.abb.com.
KC	KC mark Product complies with Korean Registration of Broadcasting and Communications Equipment Clause 3, Article 58-2 of Radio Waves Act.

	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)

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:

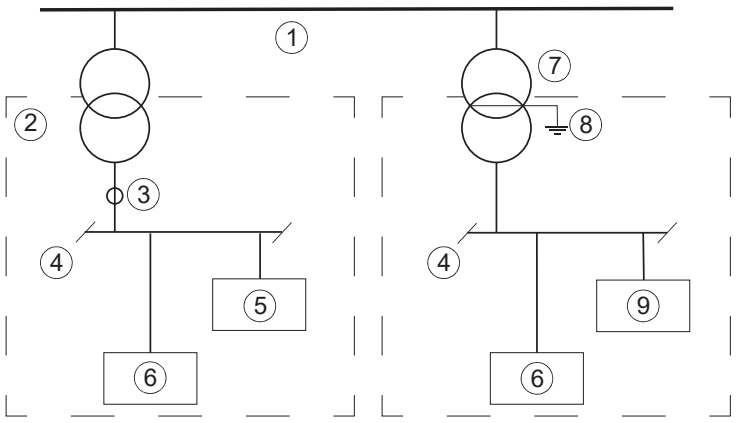
1. The drive is equipped with EMC filter (+E210) and common mode filter (+E208).
2. The motor and control cables are selected as specified in the hardware manual.
3. The drive is installed according to the instructions given in the hardware manual.
4. Maximum motor cable length is 100 m (328 ft).
5.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

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 made sure 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, a 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.

Declarations of conformity

The declarations of conformity for Machinery Directive 2006/42/EC and Supply of Machinery (Safety) Regulations (UK) are shown in chapter The Safe torque off function. For other declarations of conformity, visit www.abb.com/drives/documents.

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

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

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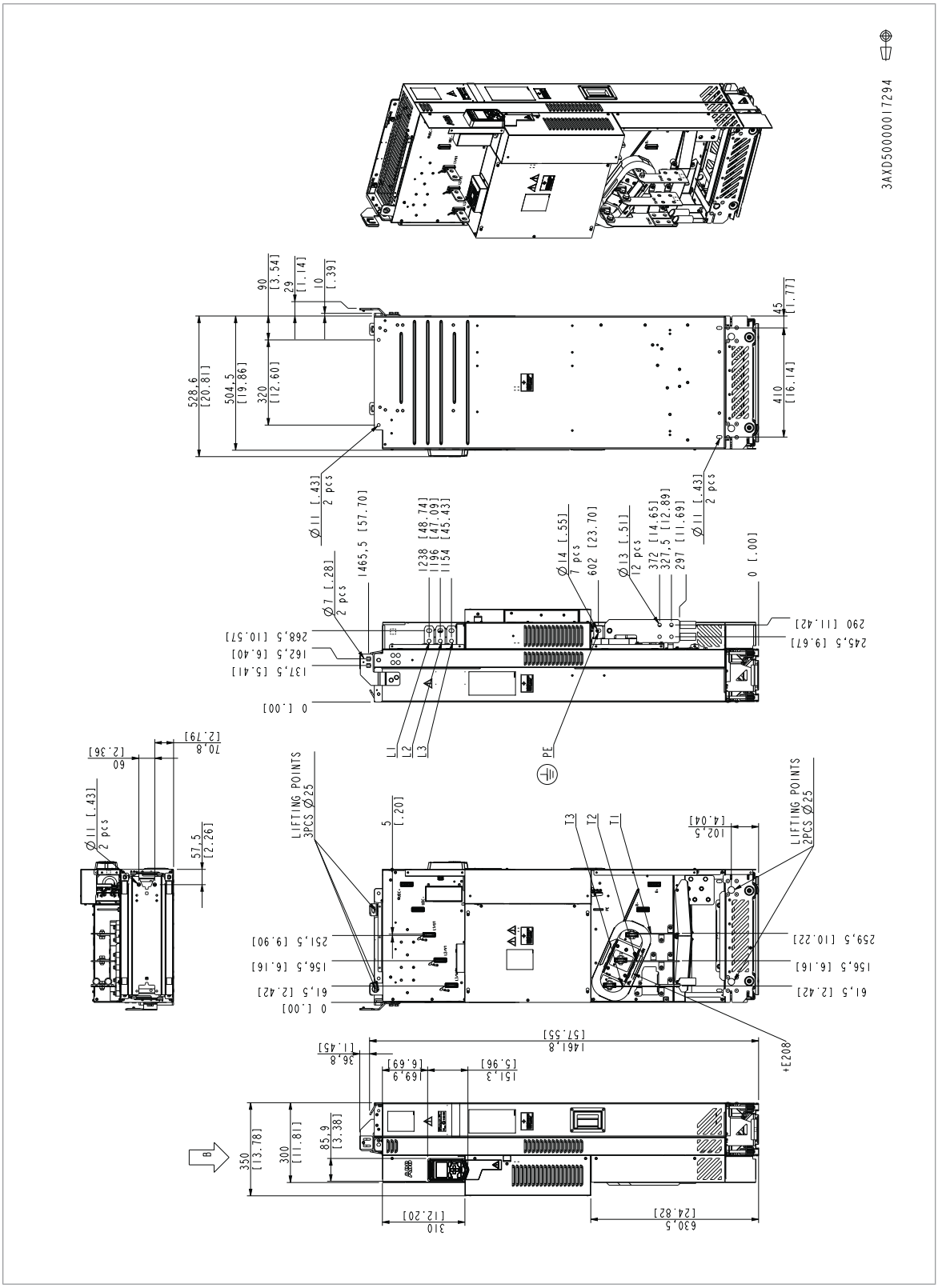
Dimension drawings

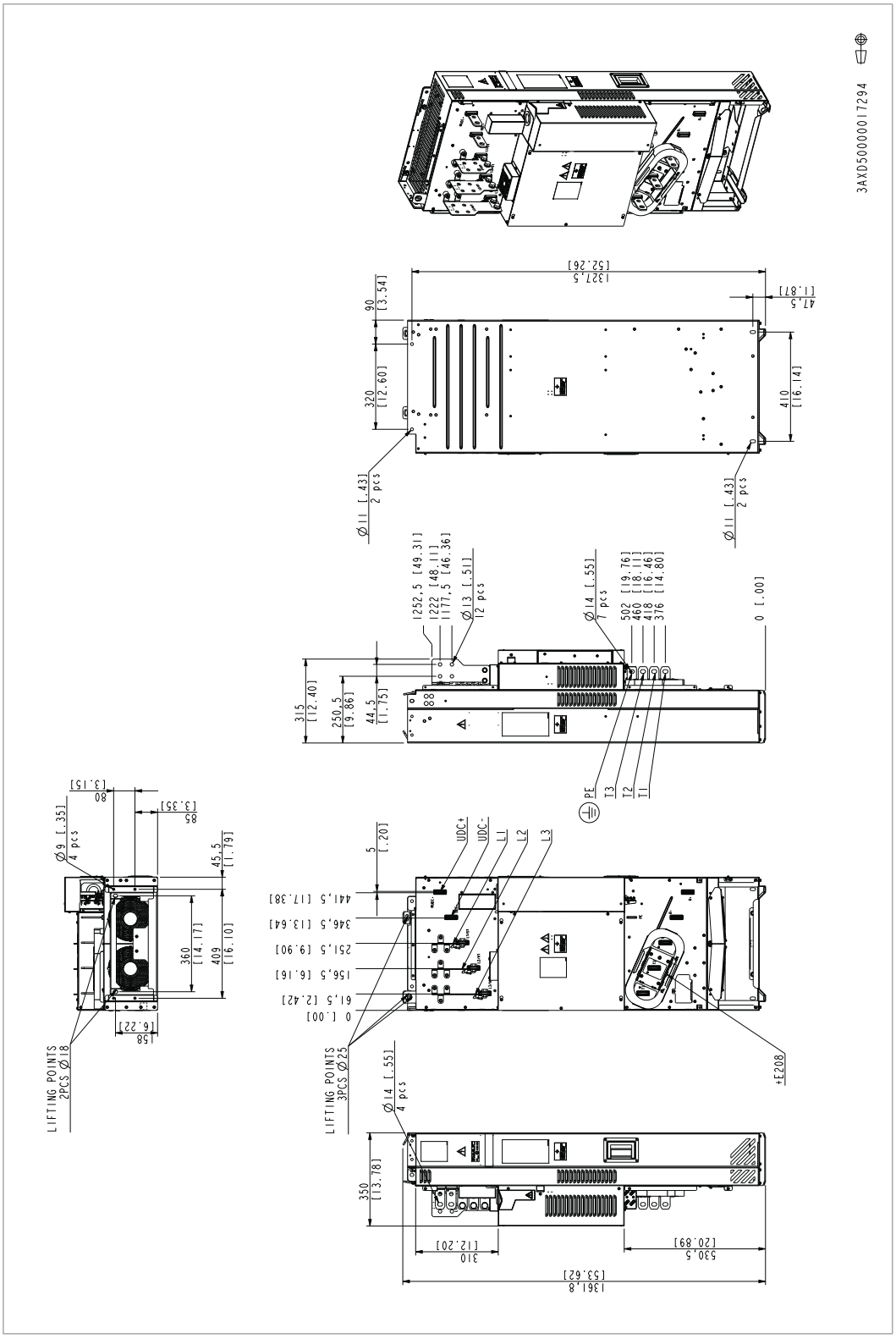
Contents of this chapter

This chapter contains dimension drawings of the drive modules. The dimensions are in mm and [inches].

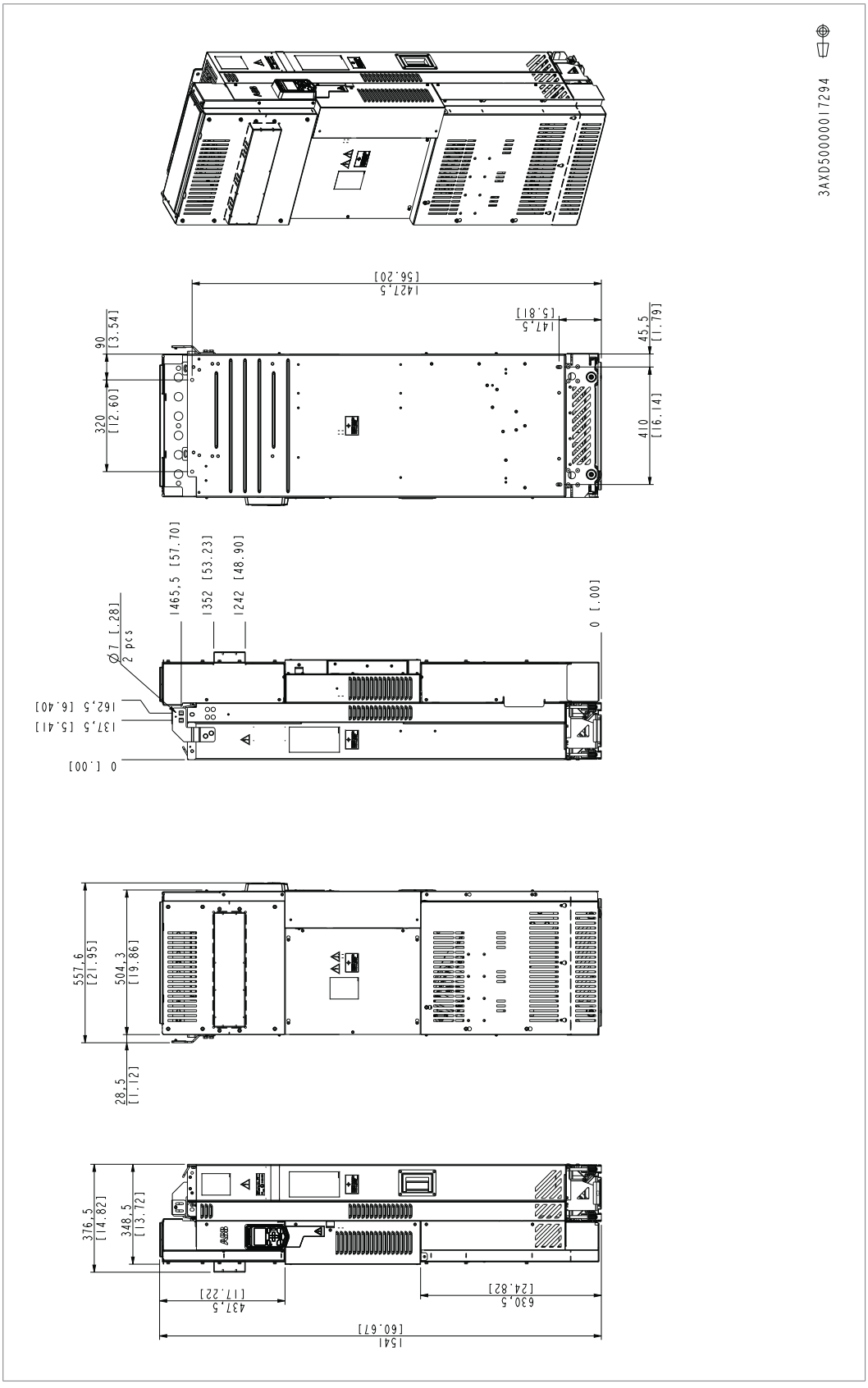
R10, standard configuration



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



R10 with option +B051



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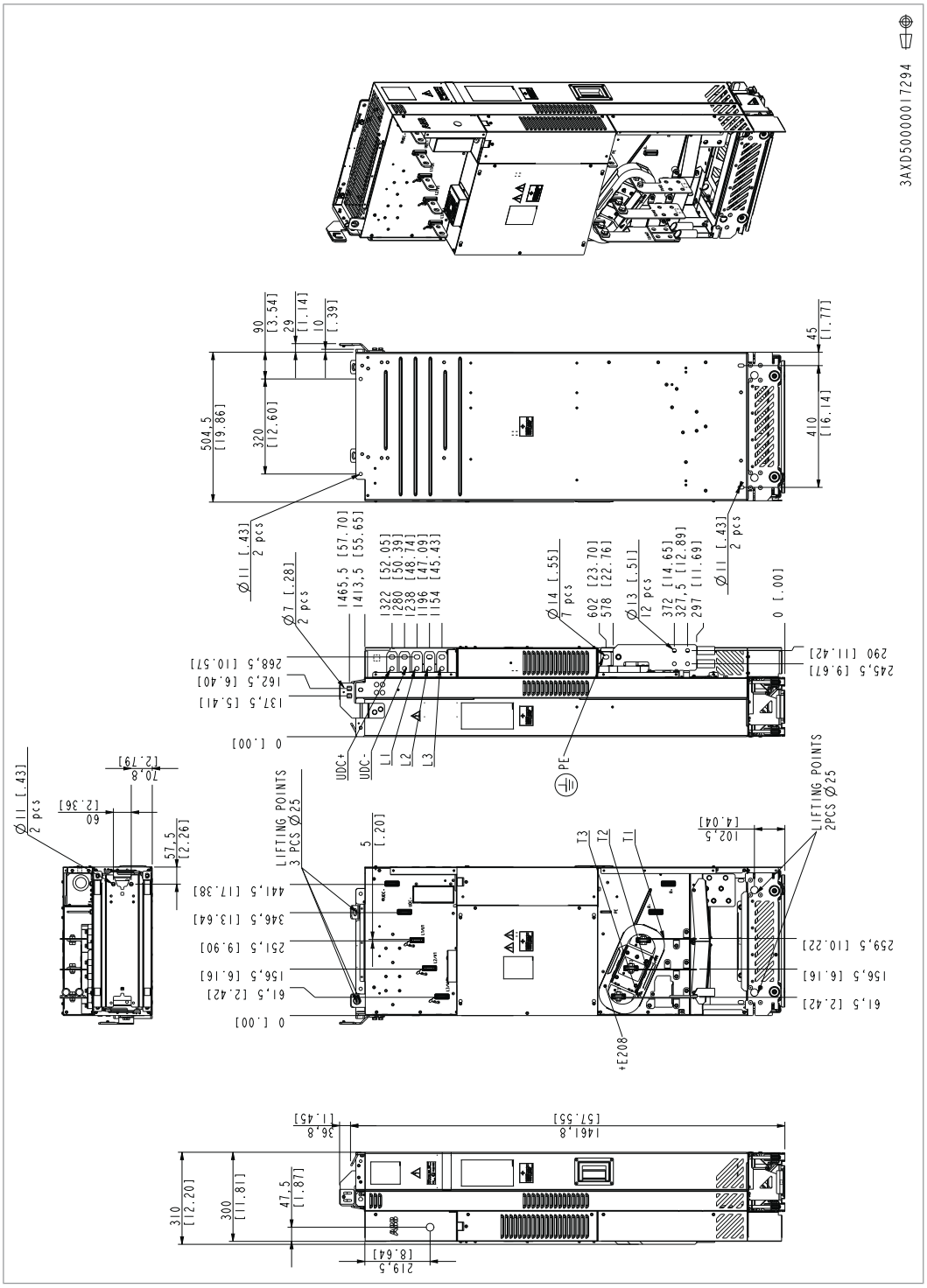
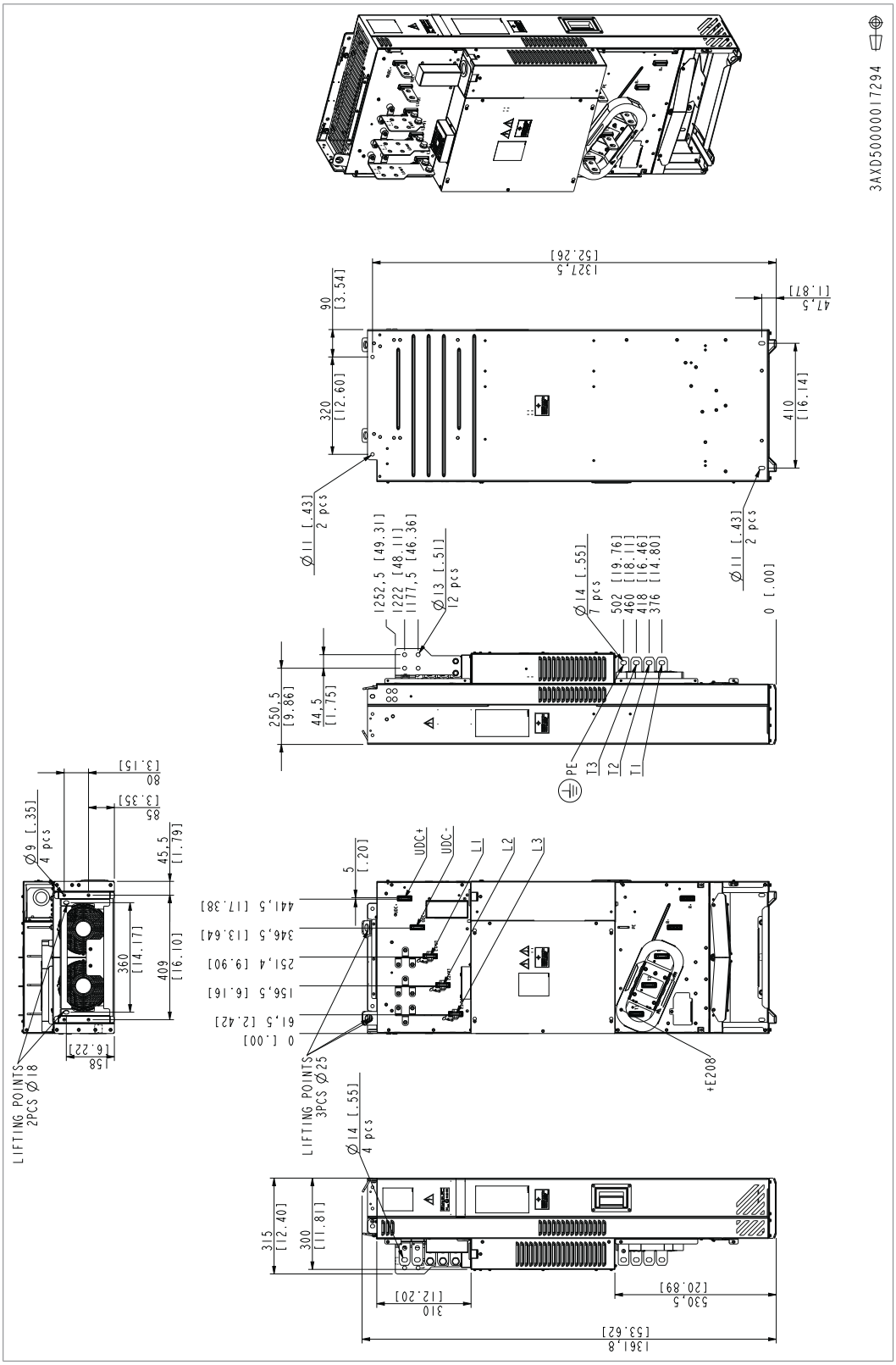
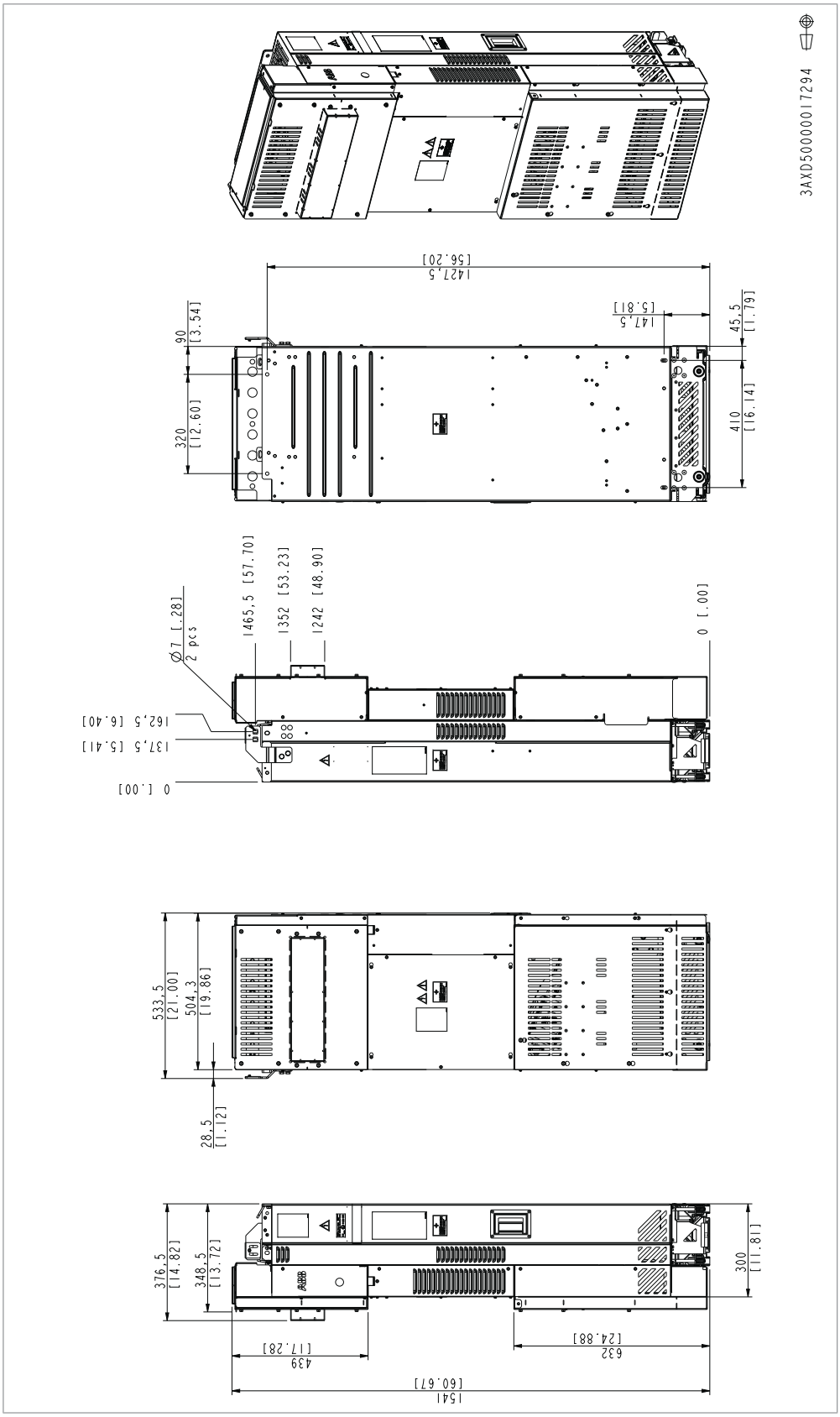


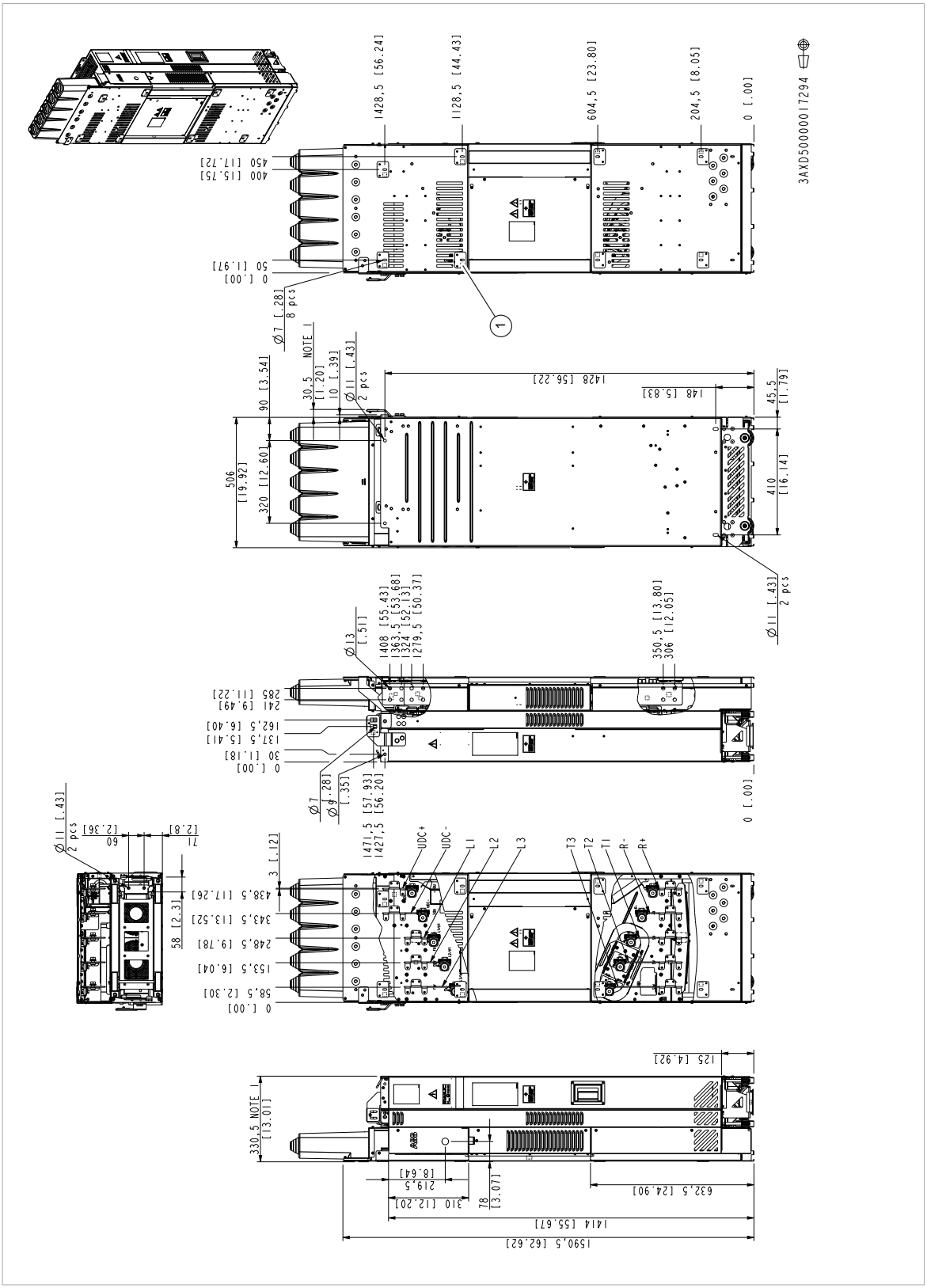
R10 with options +E208+0H371+H356+0H354+H370+P906



R10 with options +B051+P906

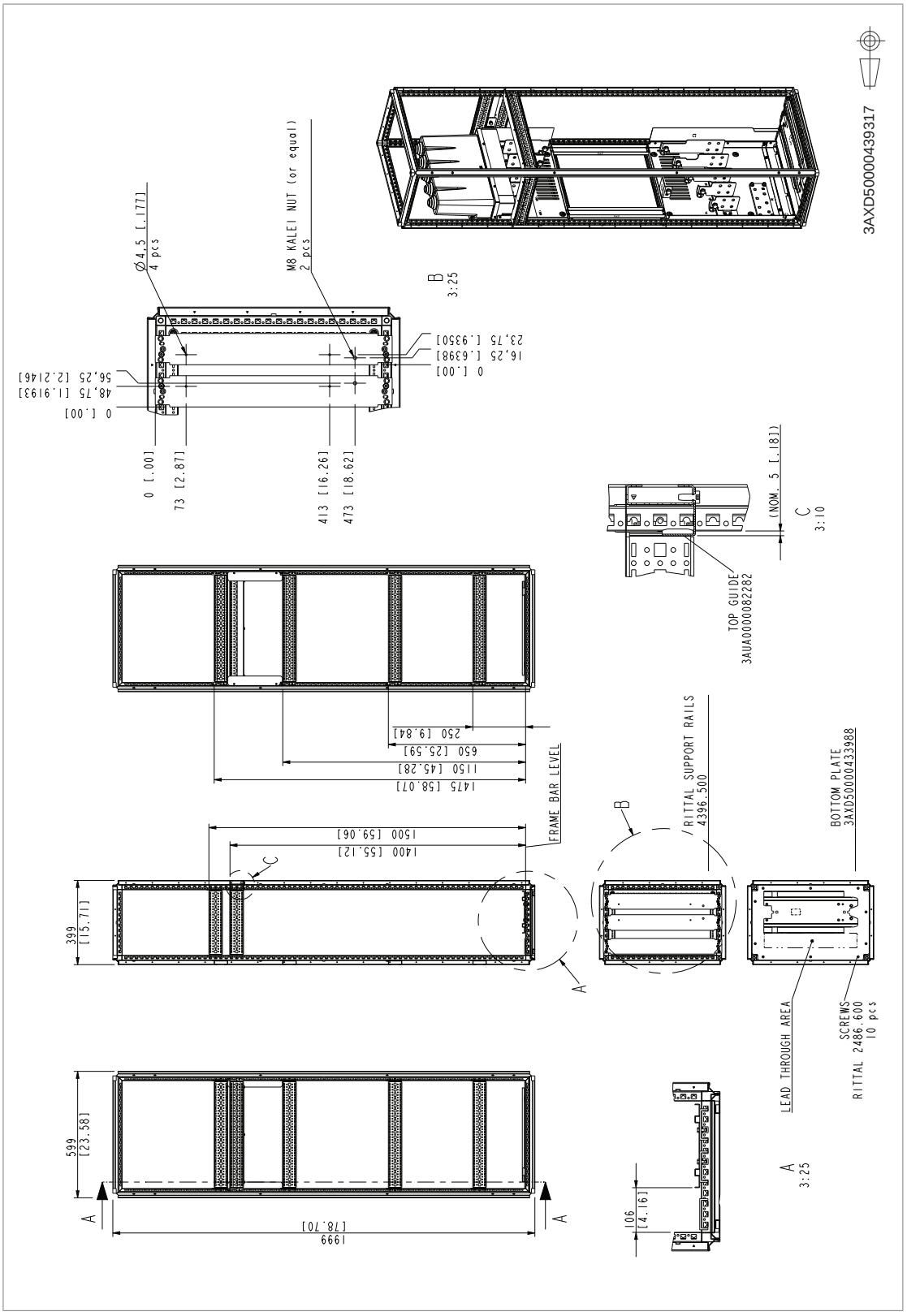


R10 with options +E208+H356+H381+P906

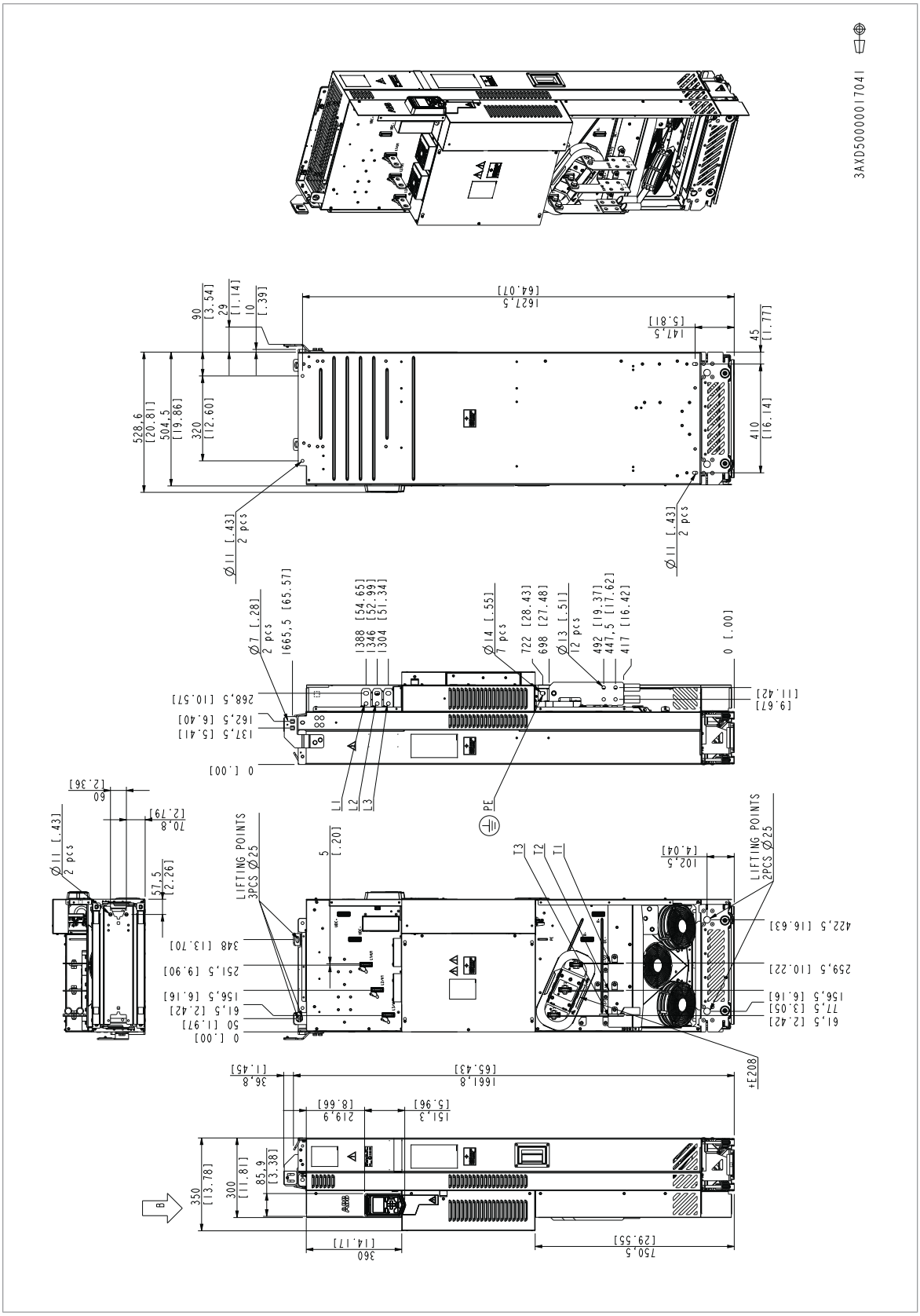


1) Shim plate (3AXD50000546336) for Rittal VX25 enclosure. There are 8 shim plates attached to the drive module. If the drive module is installed into a Rittal TS8 enclosure, remove the shim plates.

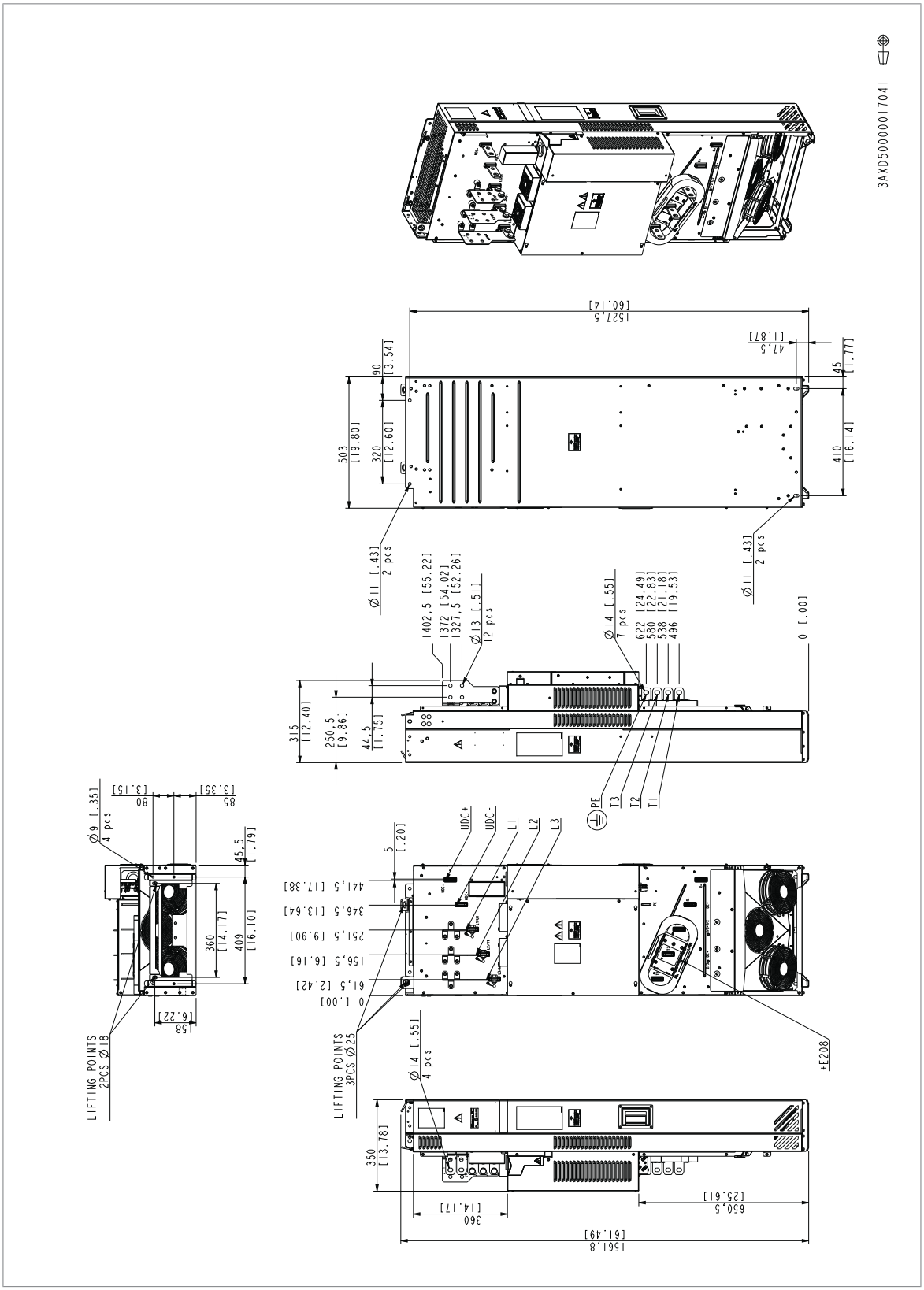
R10 – Cabling panels (+H381) installed into a Rittal VX25 enclosure



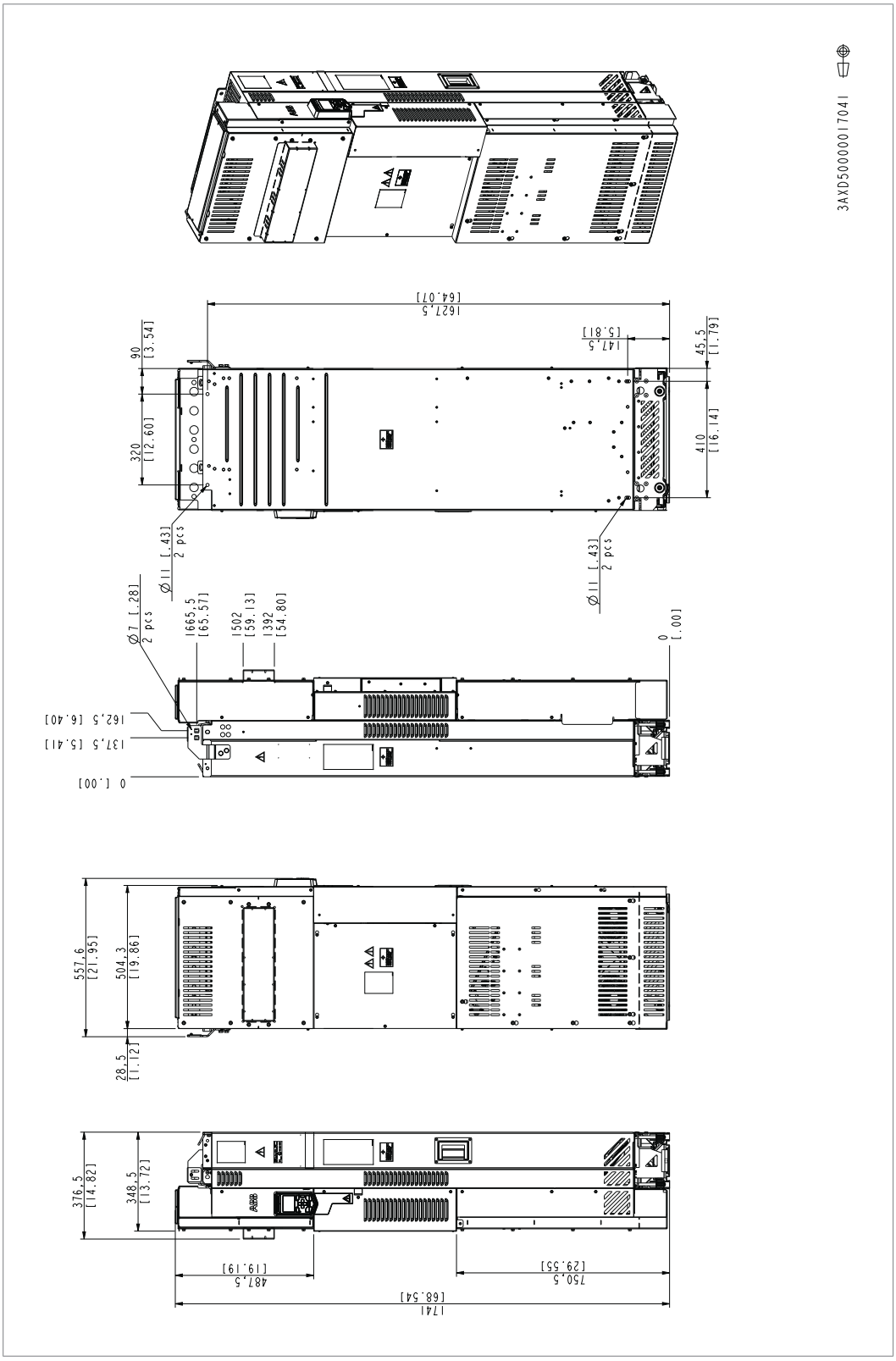
R11, standard configuration



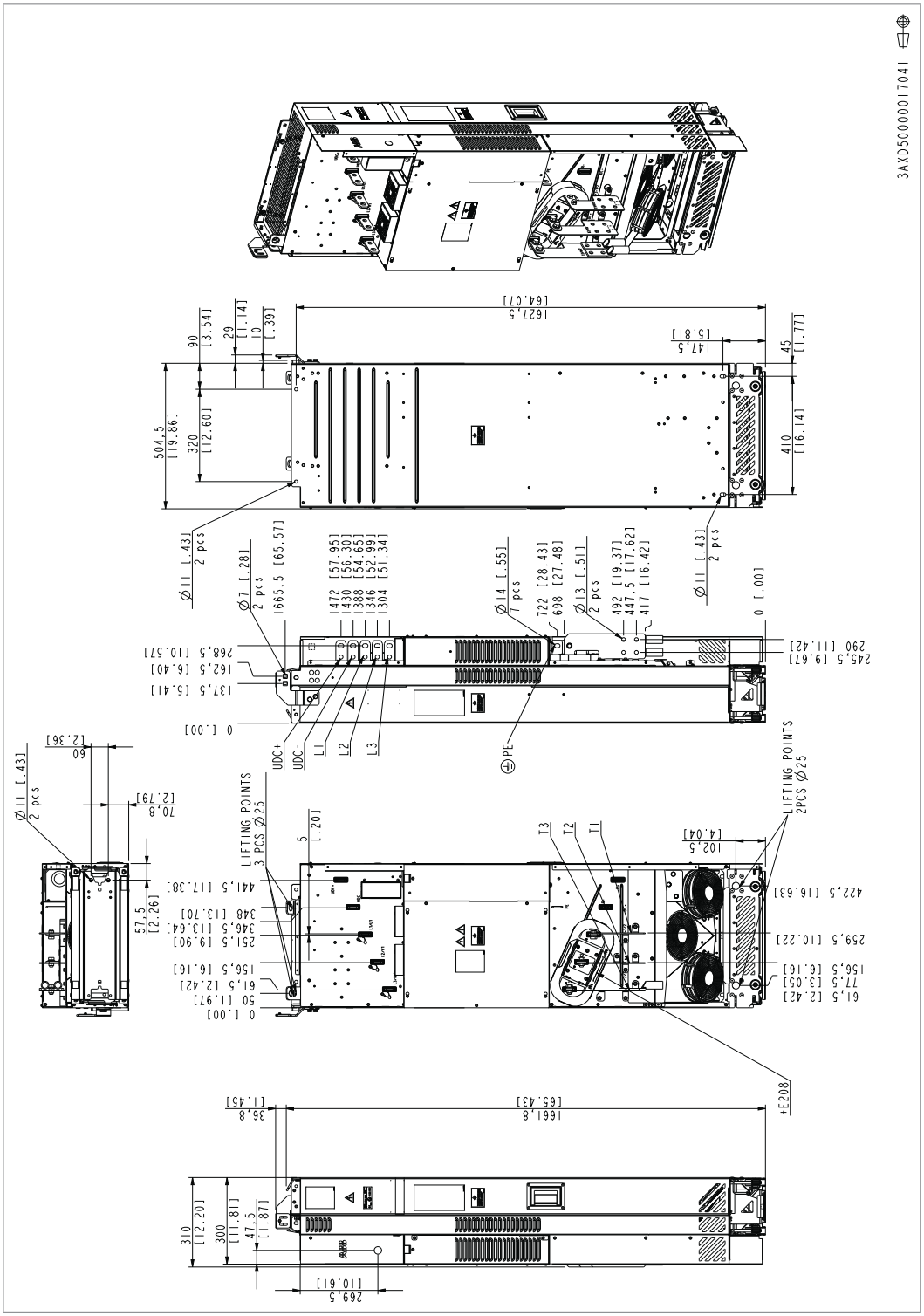
R11 with options +E208+0H371+H356+0H354+H370



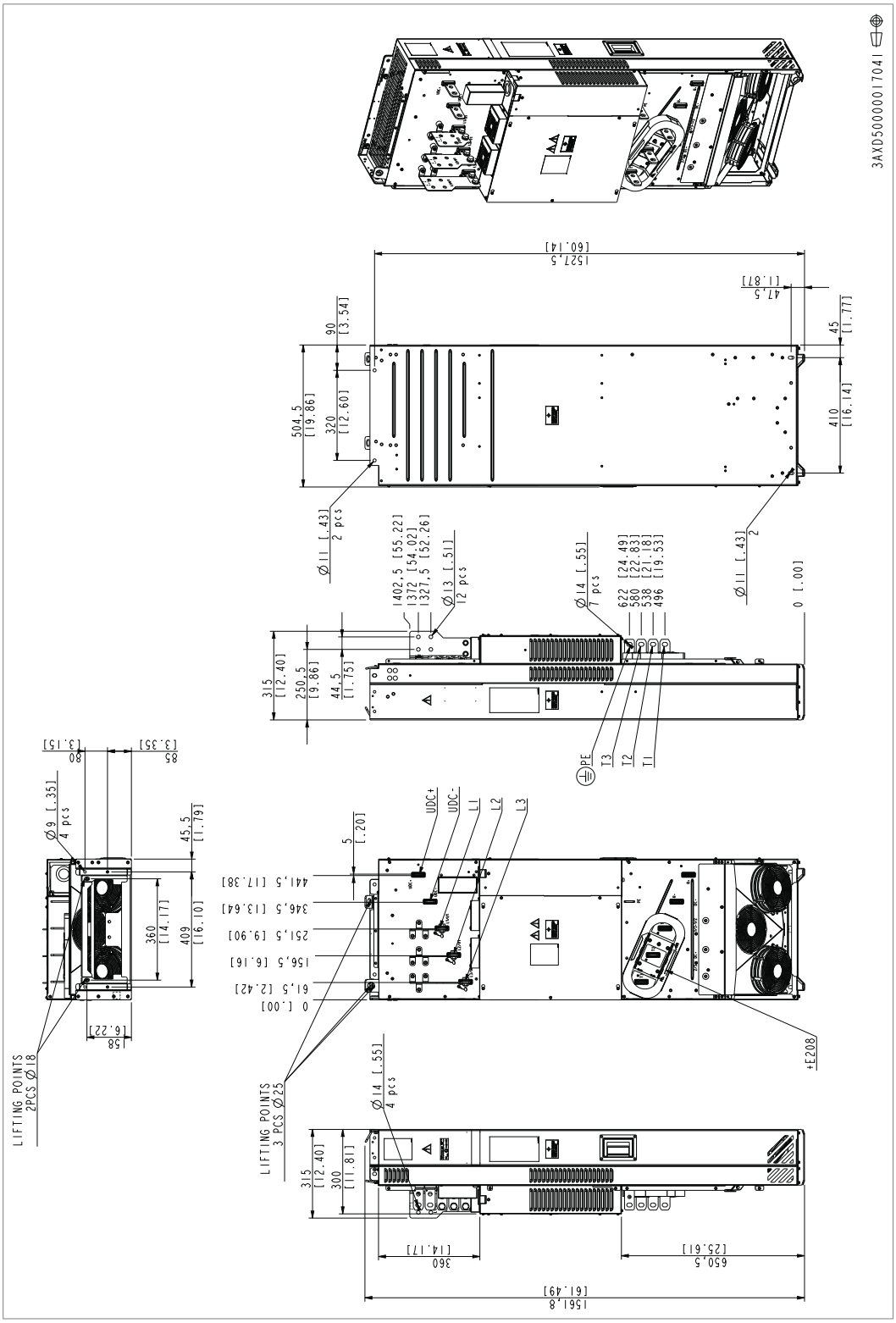
R11 with option +B051



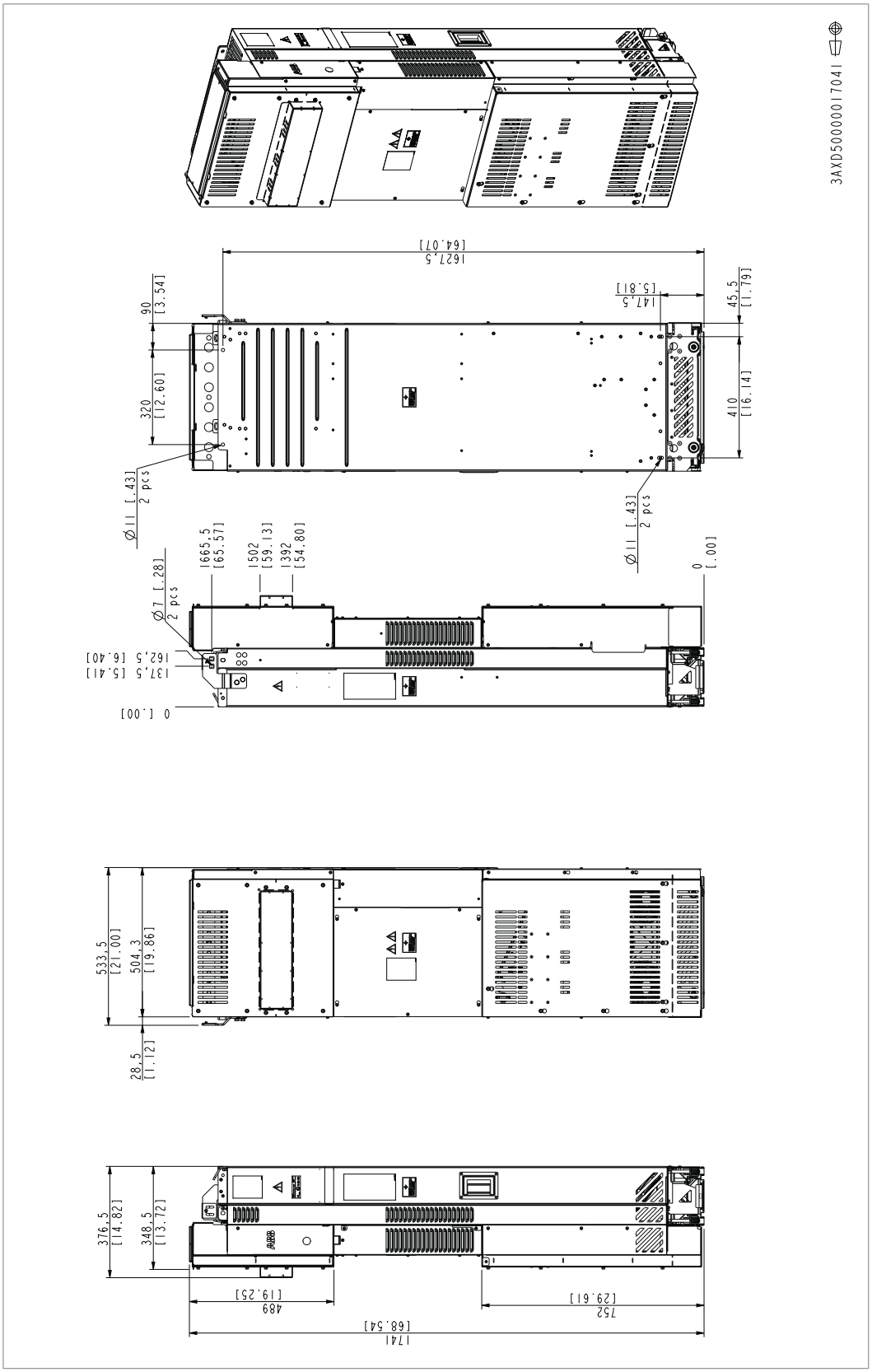
R11 with options +E208+H356+P906



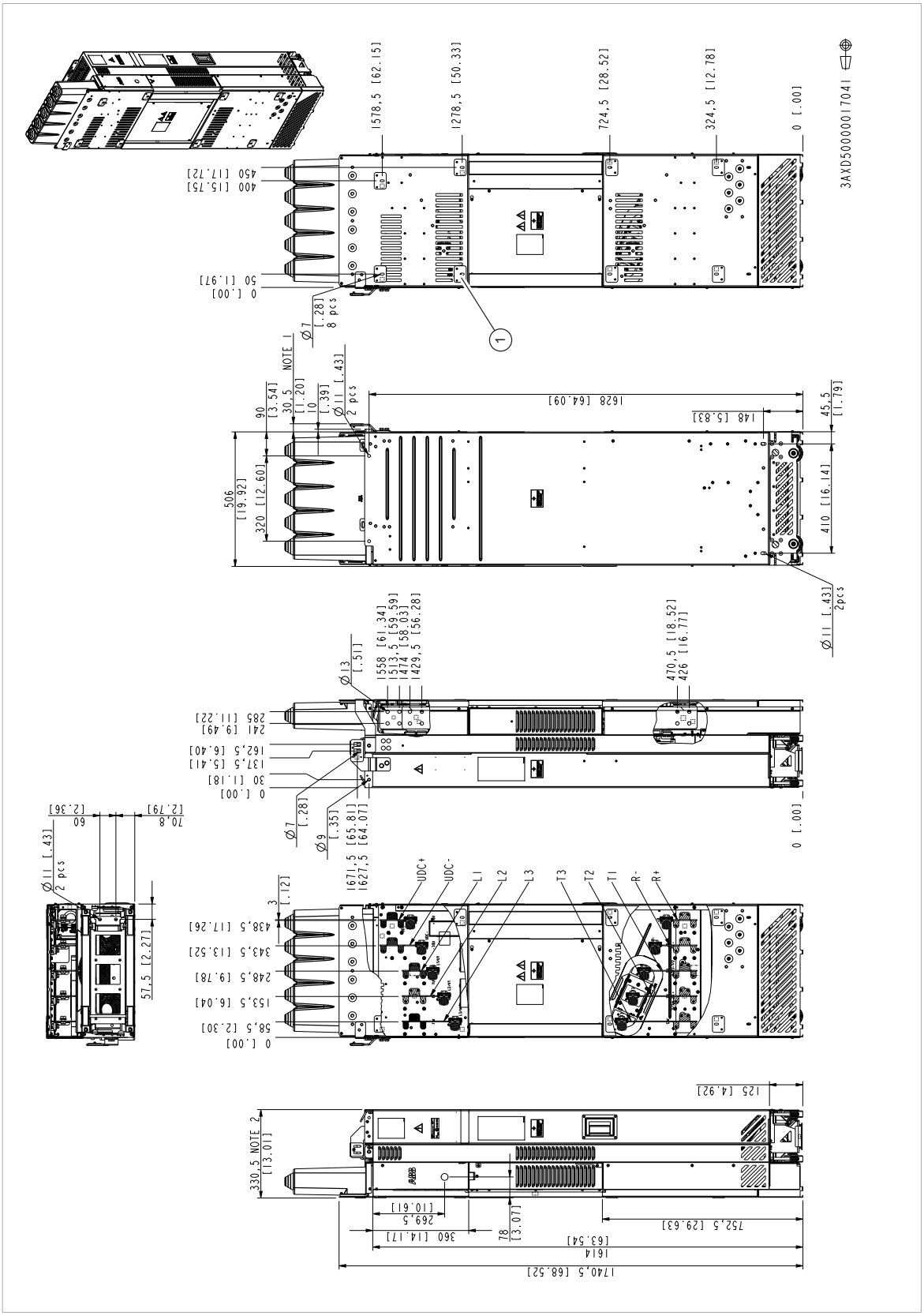
R11 with options +E208+0H371+H356+0H354+H370+P906



R11 with options +B051+P906

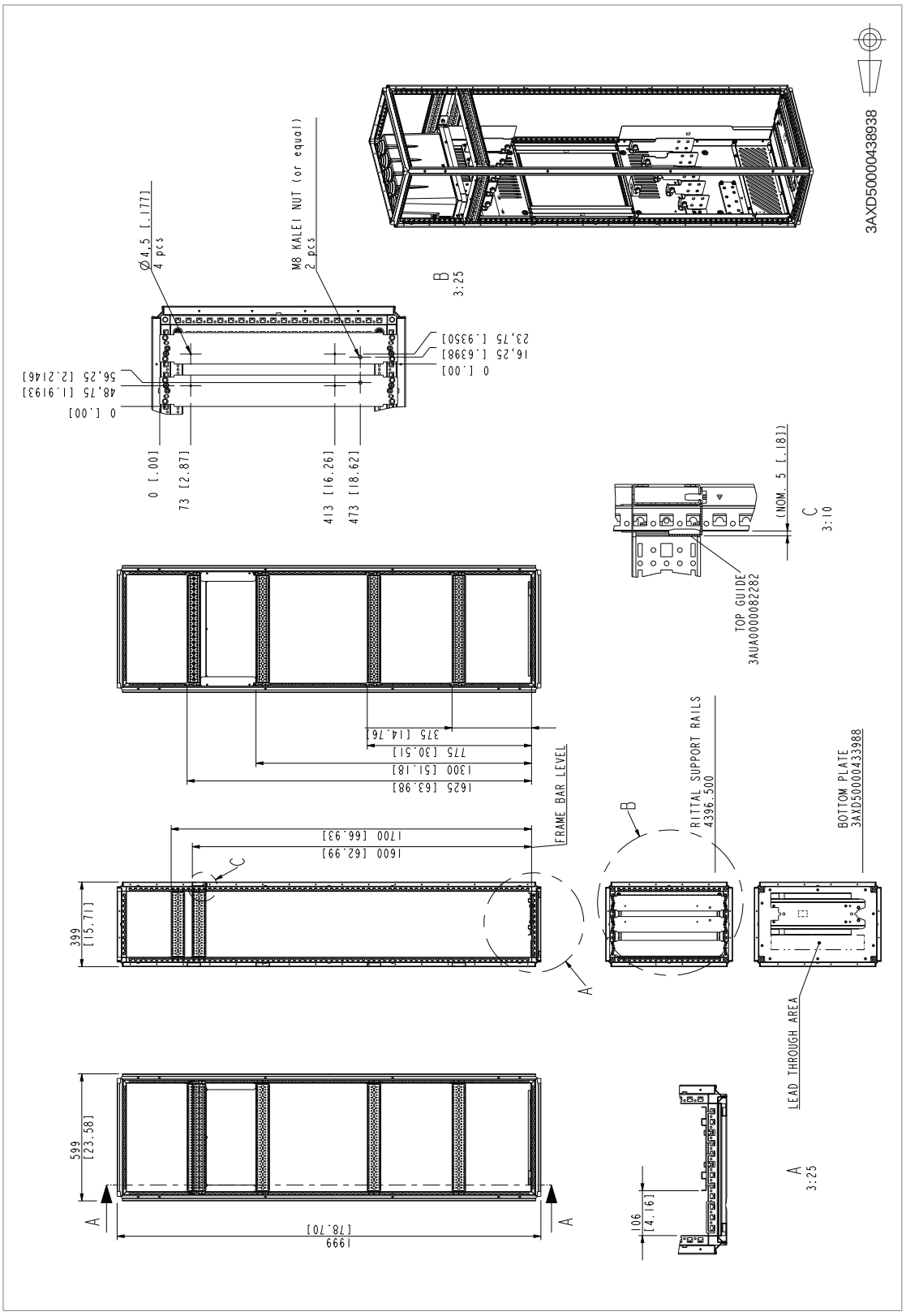


R11 with options +E208+H356+H381+P906



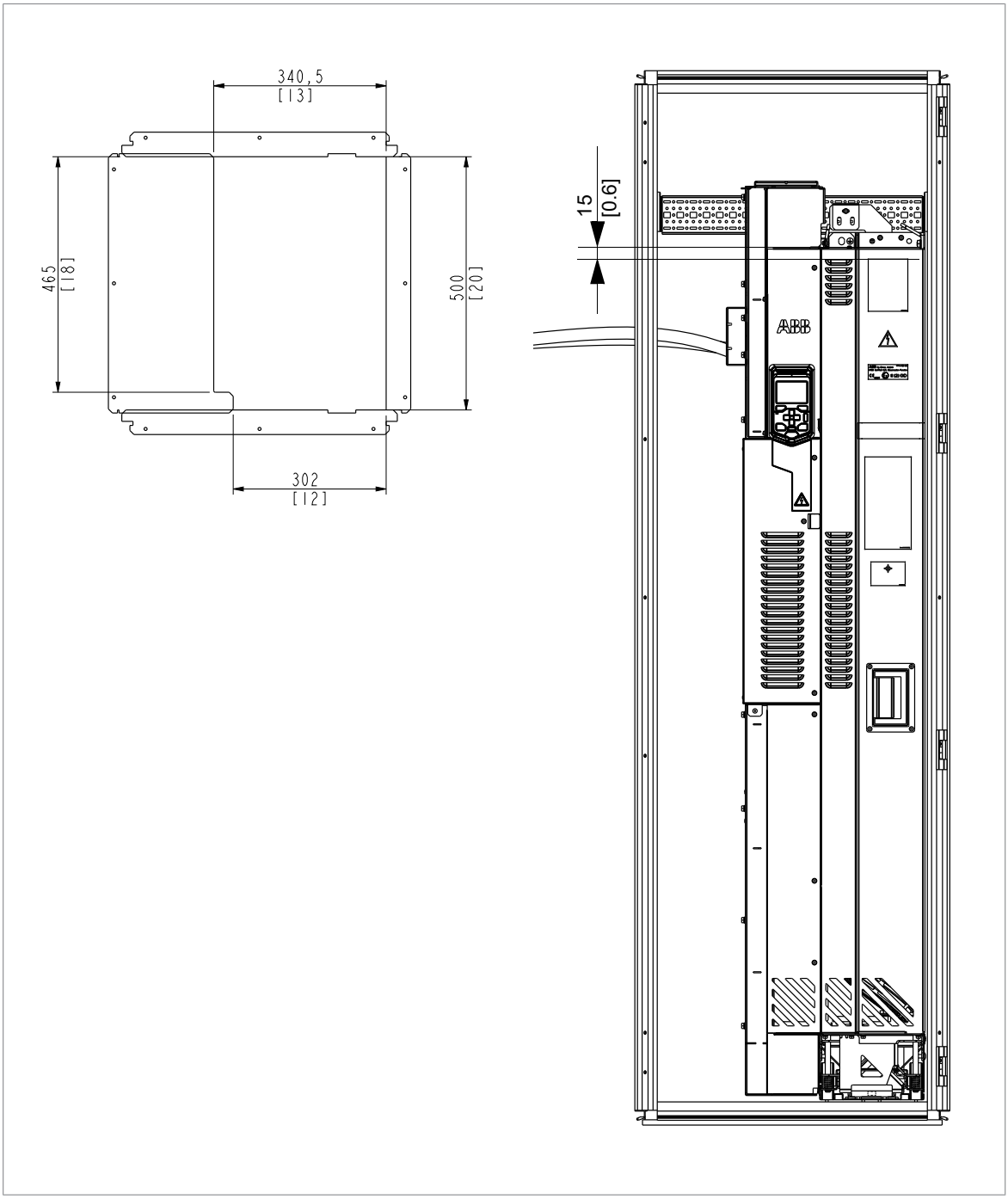
1) Shim plate (3AXD50000546336) for Rittal VX25 enclosure. There are 8 shim plates attached to the drive module. If the drive module is installed into a Rittal TS8 enclosure, remove the shim plates.

R11 – Cabling panels (+H381) installed into a Rittal VX25 enclosure



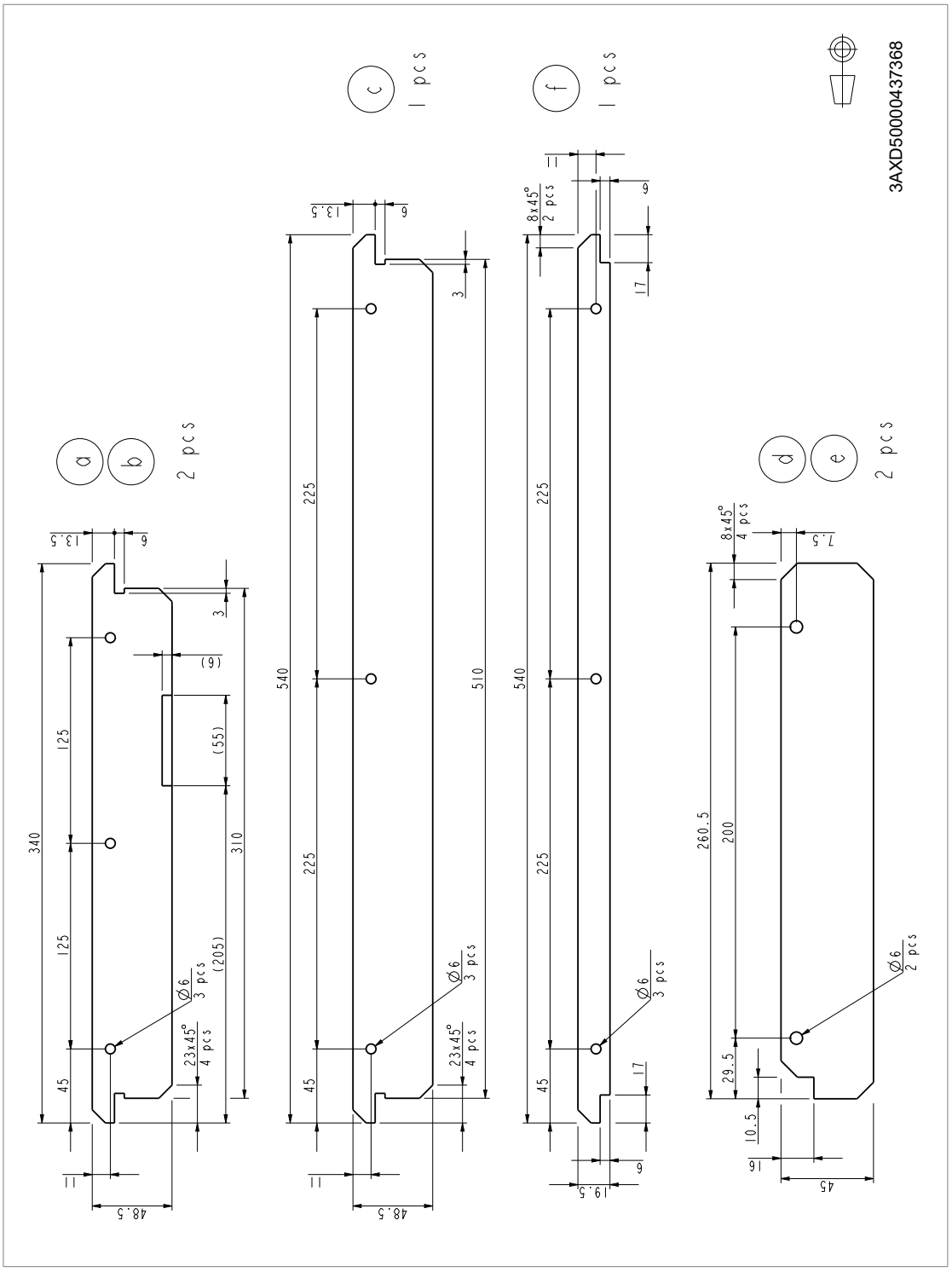
Air baffles for the drive module with option +B051

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.



Air baffles for option +H381 in Rittal VX25 400 mm wide enclosure installation

Note: These air baffles are not ABB parts.

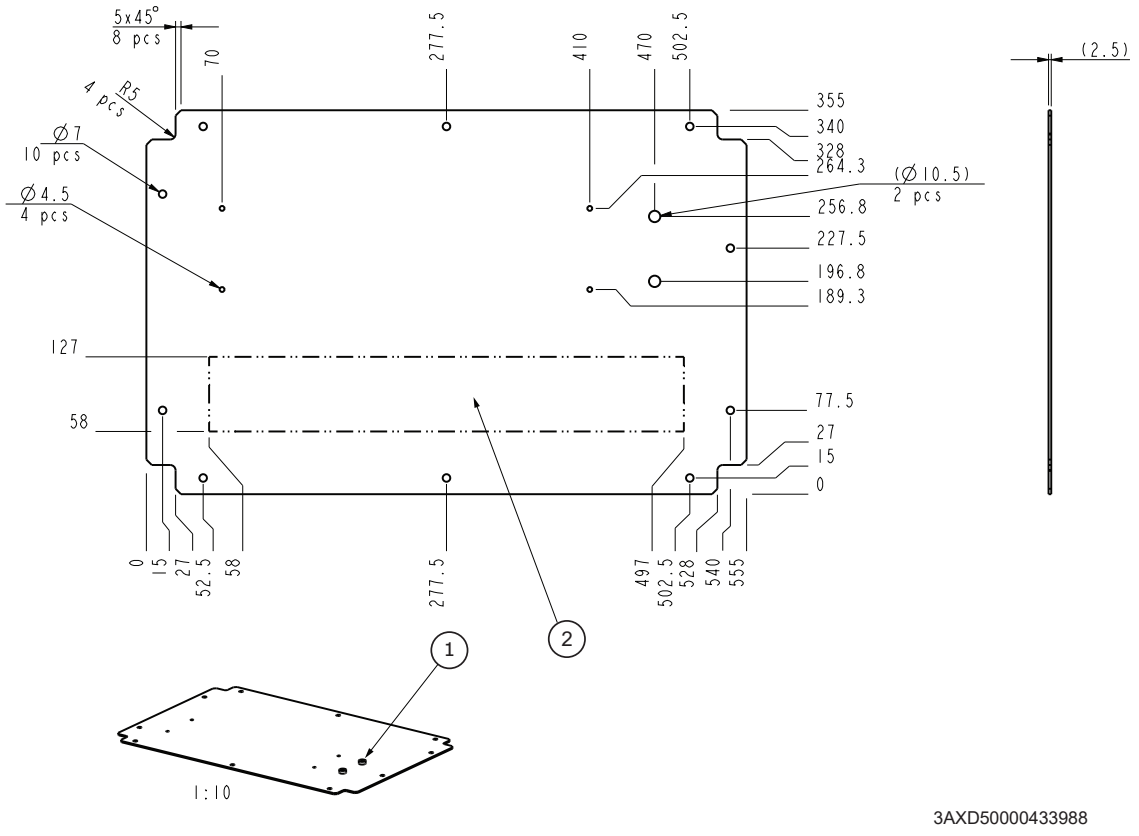


Material of the air baffles

0.75 mm polycabonate (PC) film LEXAN® FR60 (GE) with UL94 V–0 listing, UV stability. Unmarked bend radii 0.6 mm.

Bottom plate for option +H381 in Rittal VX25 400 mm wide enclosure installation

Note: The bottom plate is not an ABB part.



1	Insert nut PEM-S-M8-2 or equivalent (2 pcs)
2	Cable entry area

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Example circuit diagram

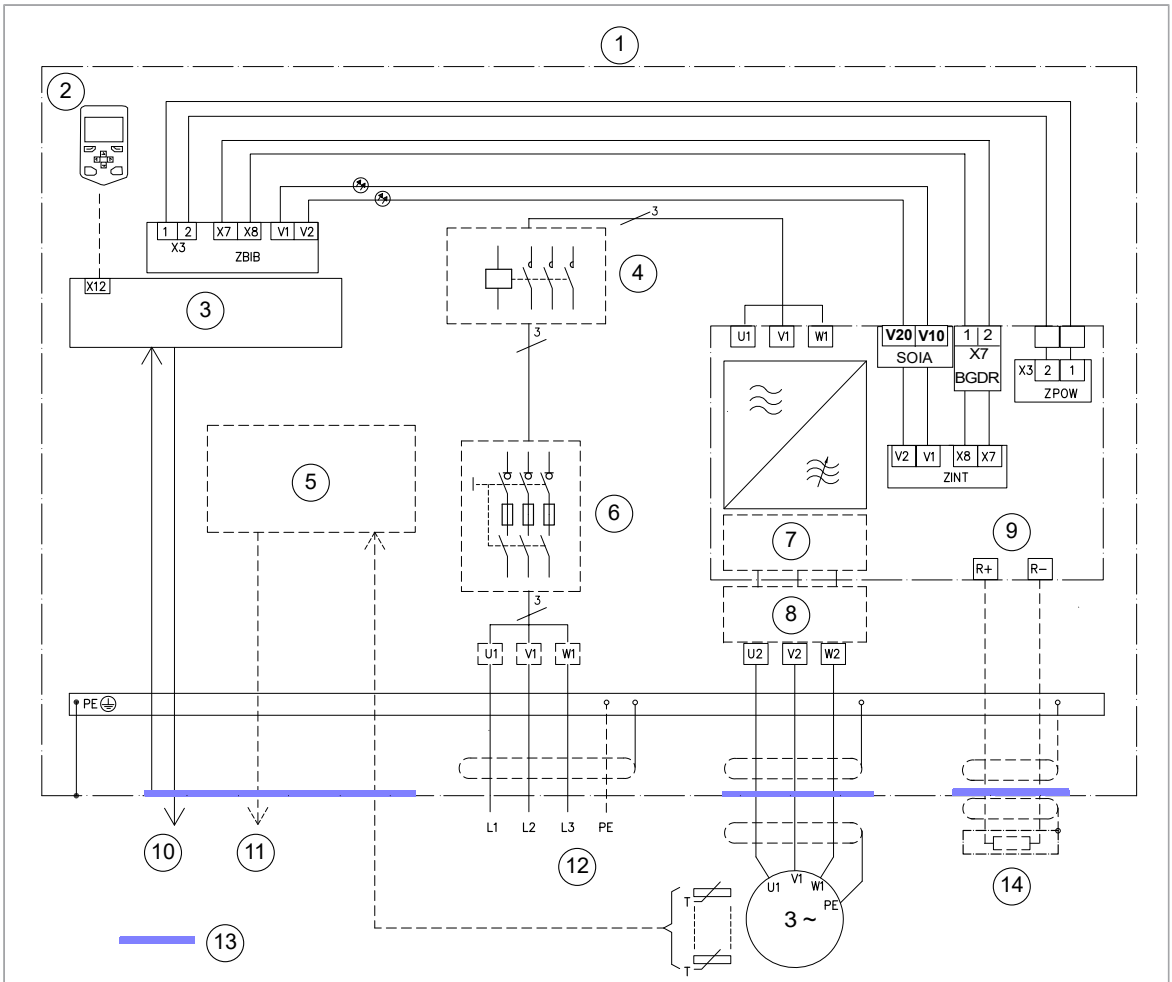
Contents of this chapter

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

Example circuit diagram

This diagram is an example for the main wiring of a drive cabinet. Note that the diagram includes components which are not included in a basic delivery.

220 Example circuit diagram



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

1) Must be acquired by the customer.
2) Optional (can be installed by the customer).
3) Optional (can be selected with an option code).

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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 (such as an emergency stop circuit) that stop the drive in case of danger. Another typical application is a prevention of unexpected start-up function that enables short-time maintenance operations like cleaning or work on non-electrical parts of the machinery without switching off the power supply to the drive.

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

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

The Safe torque off function complies with these standards:

Standard	Name
IEC 60204-1:2016 EN 60204-1:2018	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 61511-1:2017	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
EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related 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 and the UK Supply of Machinery (Safety) Regulations

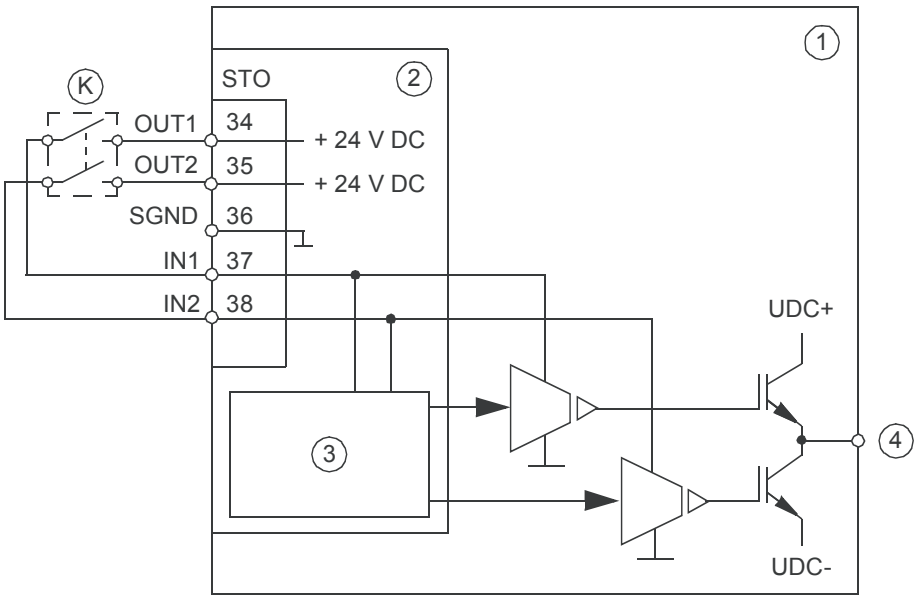
The Declarations of conformity are shown at the end of this chapter.

Wiring

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

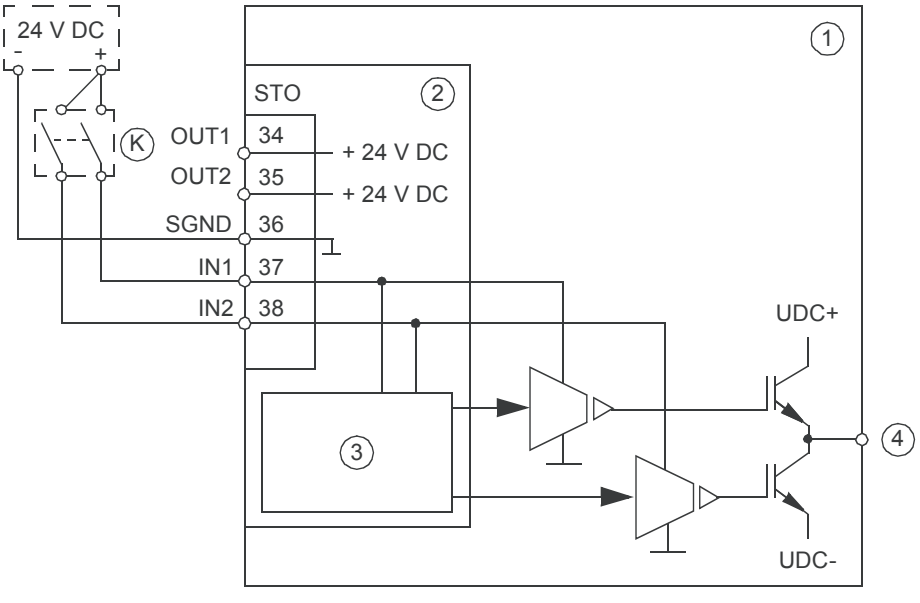
Connection principle

Single ACH580-04 drive, internal power supply



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

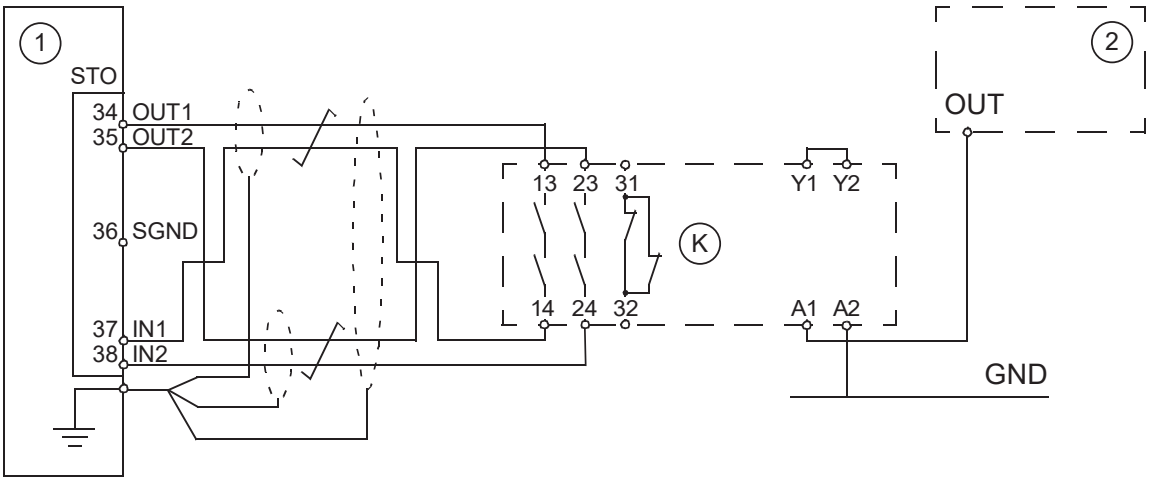
Single ACH580-04 drive, external power supply



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

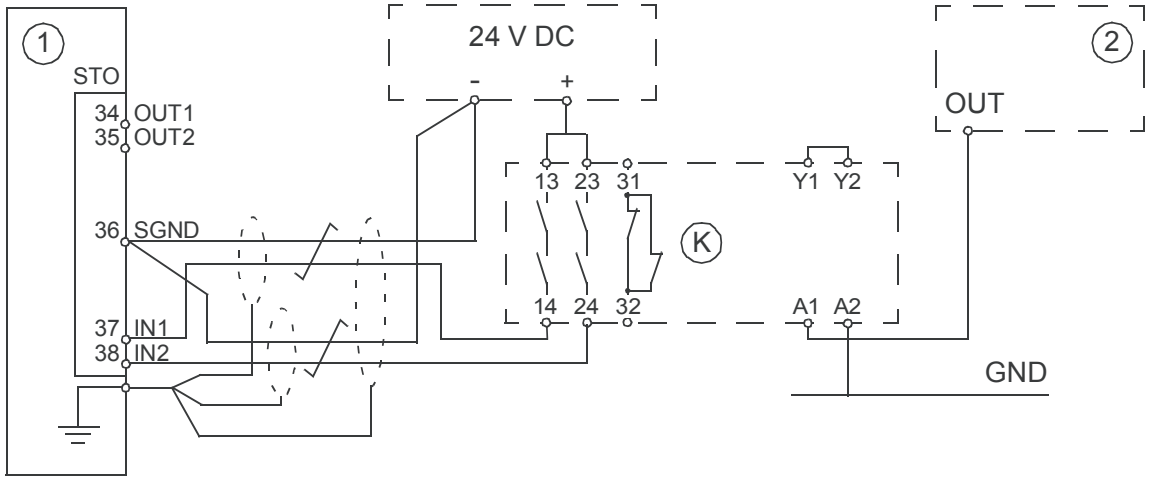
Wiring examples

Single ACH580-04 drive, internal power supply



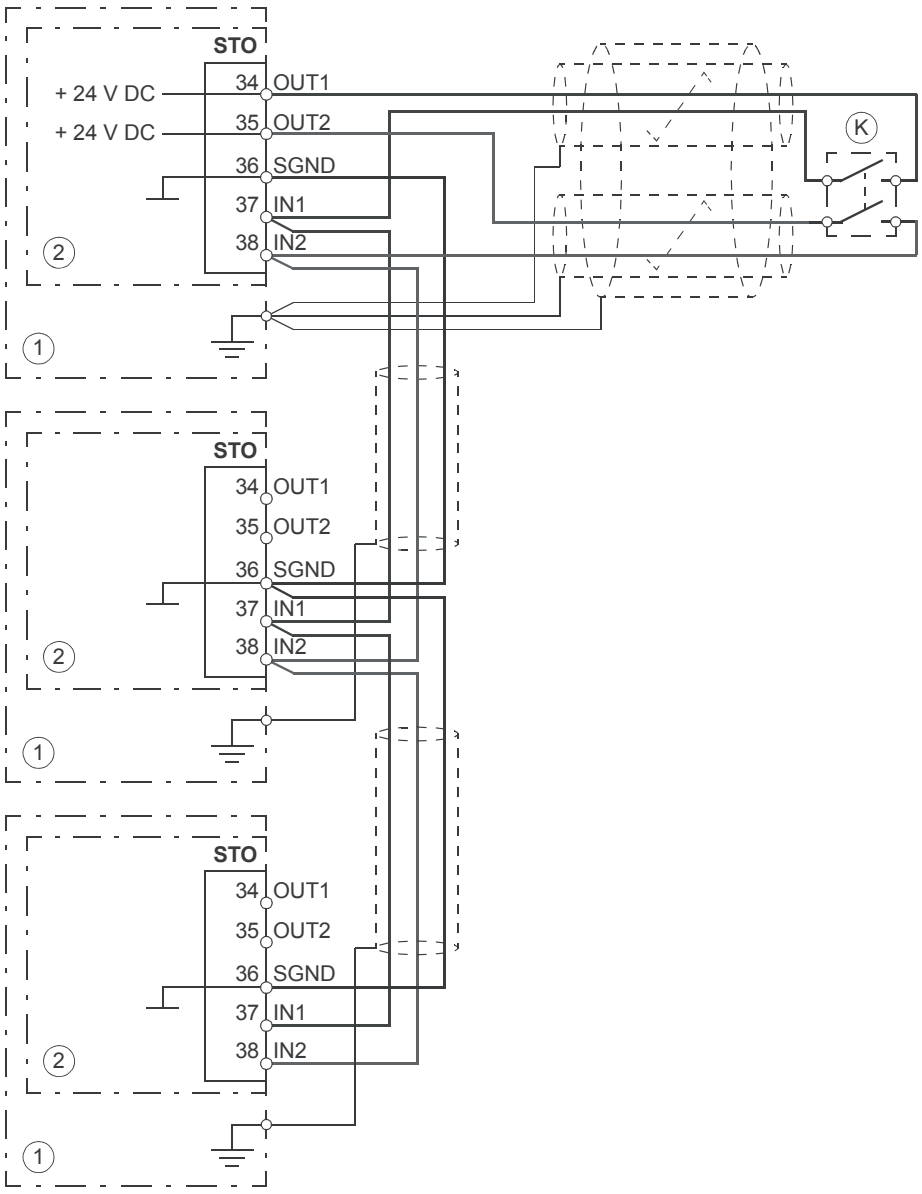
1	Drive
2	Safety PLC
K	Safety relay

Single ACH580-04 drive, external power supply



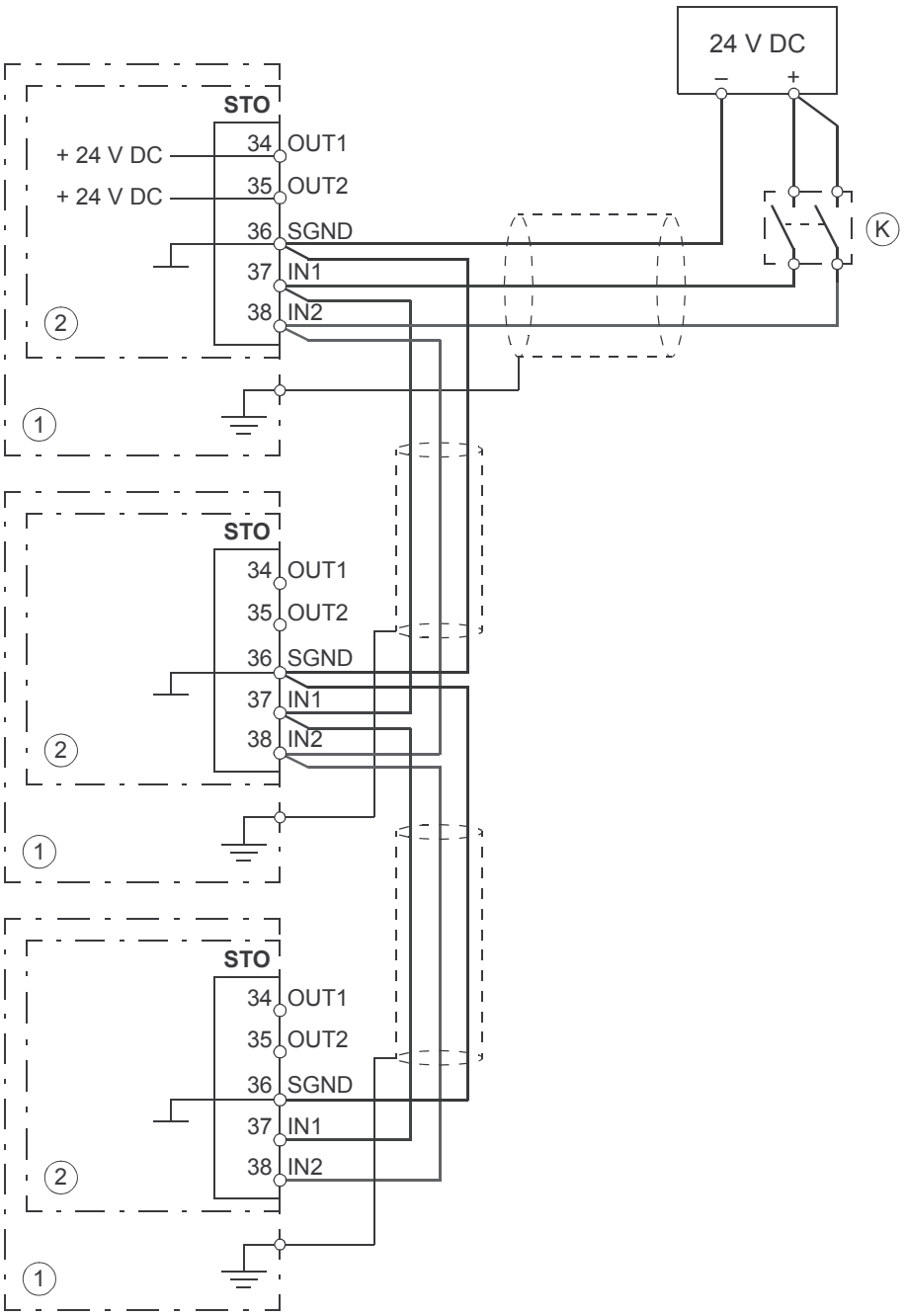
1	Drive
2	Safety PLC
K	Safety relay

Multiple ACH580-04 drives, internal power supply



1	Drive
2	Control unit
K	Activation switch

Multiple ACH580-04 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 thermistor protection module or an FSPS safety functions module can also be used. For more information, see the module documentation.

Cable types and lengths

- ABB recommends double-shielded twisted-pair cable.
- Maximum cable lengths:
  - 300 m (1000 ft) between activation switch [K] and drive control unit
  - 60 m (200 ft) between multiple drives
  - 60 m (200 ft) between external power supply and first control unit

Note: A short-circuit in the wiring between the switch and an STO terminal causes a dangerous fault. Therefore, it is recommended to use a safety relay (including wiring diagnostics) or a wiring method (shield grounding, channel separation) which reduces or eliminates the risk caused by the short-circuit.

Note: The voltage at the STO input terminals of the drive must be at least 13 V DC to be interpreted as “1”.

The pulse tolerance of the input channels is 1 ms.

Grounding of protective shields

- Ground the shield in the cabling between the activation switch and the control unit at the control unit only.
- Ground the shield in the cabling between two control units at one control unit only.

Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety relay contacts open).
2. The STO inputs of the drive control unit de-energize.
3. The control unit cuts off the control voltage from the output IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (see the firmware manual of the drive).
   The parameter selects which indications are given when one or both STO signals are switched off or lost. The indications also depend on whether the drive is running or stopped when this occurs.

   Note: This parameter does not affect the operation of the STO function itself. The STO function will operate regardless of the setting of this parameter: a running drive will stop upon removal of one or both STO signals, and will not start until both STO signals are restored and all faults reset.

   Note: The loss of only one STO signal always generates a fault as it is interpreted as a malfunction of STO hardware or wiring.
5. The motor coasts to a stop (if running). The drive cannot restart while the activation switch or safety relay contacts are open. After the contacts close, a reset may be needed (depending on the setting of parameter 31.22). A new start command is required to start the drive.

Start-up including validation test

To ensure the safe operation of a safety function, validation is required. The final assembler of the machine must validate the function by performing a validation test. The test must be performed

1. at initial start-up of the safety function
2. after any changes related to the safety function (circuit boards, wiring, components, settings, replacement of inverter module, etc.)
3. after any maintenance work related to the safety function
4. after a drive firmware update
5. at the proof test of the safety function.

Competence

The validation test of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

Validation test reports

Signed validation test reports must be stored in the logbook of the machine. The report shall include documentation of start-up activities and test results, references to failure reports and resolution of failures. Any new validation tests performed due to changes or maintenance shall be logged into the logbook.

Validation test procedure

After wiring the Safe torque off function, validate its operation as follows.

Note: If a CPTC-02 or an FSPS-21 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 motor 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 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 input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA81 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 input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA82 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 validation 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!
The drive cannot detect or memorize any changes in the STO circuitry when the drive control unit is not powered. If both STO circuits are closed and a level-type start signal is active when the power is restored, it is possible that the drive starts without a fresh start command. Take this into account in the risk assessment of the system.

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

WARNING!
Permanent magnet or synchronous reluctance [SynRM] motors only:

In case of a multiple IGBT power semiconductor failure, the drive can produce an alignment torque which maximally rotates the motor shaft by $180/p$ degrees (with permanent magnet motors) or $180/2p$ degrees (with synchronous reluctance [SynRM] motors) regardless of the activation of the Safe torque off function. p denotes the number of pole pairs.

Notes:

- If a running drive is stopped by using the Safe torque off function, the drive will cut off the motor supply voltage and the motor will coast to a stop. If this causes danger or is not otherwise acceptable, stop the drive and machinery using the appropriate stop mode before activating the Safe torque off function.
- The Safe torque off function overrides all other functions of the drive.
- The Safe torque off function is ineffective against deliberate sabotage or misuse.
- The Safe torque off function has been designed to reduce the recognized hazardous conditions. In spite of this, it is not always possible to eliminate all

potential hazards. The assembler of the machine must inform the final user about the residual risks.

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 10 years; see section Safety data (page 235). It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the Validation test procedure (page 229).

Note: See also the Recommendation of Use CNB/M/11.050 (published by the European co-ordination of Notified Bodies) concerning dual-channel safety-related systems with electromechanical outputs:

- When the safety integrity requirement for the safety function is SIL 3 or PL e (cat. 3 or 4), the proof test for the function must be performed at least every month.
- When the safety integrity requirement for the safety function is SIL 2 (HFT = 1) or PL d (cat. 3), the proof test for the function must be performed at least every 12 months.

The STO function of the drive does not contain any electromechanical components.

In addition to proof testing, it is a good practice to check the operation of the function when other maintenance procedures are carried out on the machinery.

Include the Safe torque off operation test described above in the routine maintenance program of the machinery that the drive runs.

If any wiring or component change is needed after start-up, or the parameters are restored, do the test given in section Validation test procedure (page 229).

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 FA81 or FA82 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 applies only if both STO channels are used.

Frame size	SIL	SC	PL	PFH (T_1 = 20 a) (1/h)	PFD_{avg} (T_1 = 2 a)	PFD_{avg} (T_1 = 5 a)	PFD_{avg} T_1 = 10 a	$MTTF_D$ (a)	DC (%)	SFF (%)	Cat.	HFT	CCF	T_M (a)	PFH_{diag} (1/h)	λ_{Diag_s} (1/h)	λ_{Diag_d} (1/h)
R10 R11	3	3	e	4.18E-09	3.66E-05	9.14E-05	1.83E-04	15080	≥90	99.55	3	1	80	20	6.44E-11	7.52E-07	6.44E-09
3AXD10001613536 A																	

- 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.

Terms and abbreviations

Term or abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage (%)
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	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
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
PFH_{diag}	IEC/EN 62061	Average frequency of dangerous failures per hour for the diagnostic function of STO
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL
Proof test	IEC 61508, IEC 62061	Periodic test performed to detect failures in a safety-related system so that, if necessary, a repair can restore the system to an "as new" condition or as close as practical to this condition
SC	IEC 61508	Systematic capability (1…3)
SFF	IEC 61508	Safe failure fraction (%)

Term or abbreviation	Reference	Description
SIL	IEC 61508	Safety integrity level (1…3)
STO	IEC/EN 61800-5-2	Safe torque off
T_1	IEC 61508-6	Proof test interval. T_1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T_1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. See also section Maintenance.
T_M	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any T_M values given cannot be regarded as a guarantee or warranty.
λ_{Diag_d}	IEC 61508-6	Dangerous failure rate (per hour) of the diagnostics function of STO
λ_{Diag_s}	IEC 61508-6	Safe failure rate (per hour) of the diagnostics function of STO

TÜV certificate

The TÜV certificate is available on the Internet at www.abb.com/drives/documents.

Declarations of conformity

EU Declaration of Conformity

Machinery Directive 2006/42/EC

We

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

declare under our sole responsibility that the following product:

Frequency converters

ACH580-04/-34

with regard to the safety function

Safe Torque Off

is 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 IEC 62061:2021	Safety of machinery – Functional safety of safety-related 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 60204-1:2018	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 3AXD10000497691.

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

Helsinki, August 31, 2022
Signed for and on behalf of:

Mika Vartiainen
Local Division Manager
ABB Oy

Harri Mustonen
Product Unit Manager
ABB Oy

Document number 3AXD10000611401

Declaration of Conformity

Supply of Machinery (Safety) Regulations 2008

We

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

declare under our sole responsibility that the following product:

Frequency converters

ACH580-04/-34

with regard to the safety function

Safe Torque Off

is in conformity with all the relevant safety component requirements of the Supply of Machinery (Safety) Regulations 2008, when the listed safety function is used for safety component functionality.

The following designated standards have been applied:

EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional
EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related 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 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements

The following other standards have been applied:

EN 61508:2010, parts 1-2	Functional safety of electrical / electronic / programmable electronic safety-related systems
EN 61800-5-2:2017	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional

The product(s) referred in this declaration of conformity fulfil(s) the relevant provisions of other UK statutory requirements, which are notified in a single declaration of conformity 3AXD10001325928.

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Helsinki, August 31, 2022
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Document number 3AXD10001329522

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Resistor braking

Contents of this chapter

This chapter describes how to select, protect and wire brake choppers and resistors. The chapter also contains the technical data.

When is resistor braking necessary?

Resistor braking is necessary for high capacity braking if a regenerative drive cannot be used.

Operation principle and hardware description

The drive can be equipped with optional built-in brake chopper (+D150). Brake resistors are available as add-on kits.

The brake chopper handles the energy generated by a decelerating motor. The extra energy increases the DC link voltage. The chopper connects the brake resistor to the intermediate DC circuit whenever the voltage in the circuit exceeds the limit defined by the control program. Energy consumption by the resistor losses lowers the voltage until the resistor can be disconnected.

Planning the braking system

Generic guidelines

This section contains generic brake cable type, length and placing instructions, rules on how to minimize electromagnetic interference and descriptions and requirements for protections.

Resistor cables

Cable type

Use the same cable type for the resistor cabling as for the drive input cabling or, alternatively, a two conductor shielded cable with the same cross-sectional area.

Maximum cable length

The maximum length of the resistor cable(s) is 10 m (33 ft).

Minimizing electromagnetic interference

Obey these rules in order to minimize electromagnetic interference caused by the rapid current changes in the resistor cables:

- Shield the braking power line completely, either by using shielded cable or a metallic enclosure. Unshielded single-core cable can only be used if it is routed inside a cabinet that efficiently suppresses the radiated emissions.
- Install the cables away from other cable routes.
- Avoid long parallel runs with other cables. The minimum parallel cabling separation distance is 0.3 meters (1 ft).
- Cross the other cables at 90 degree angles.
- Keep the cable as short as possible in order to minimize the radiated emissions and stress on chopper IGBTs. The longer the cable the greater the radiated emissions, inductive load and voltage peaks over the IGBT semiconductors of the brake chopper.

Note: ABB has not verified that the EMC requirements are fulfilled with custom brake resistors and cabling. The customer must consider the EMC compliance of the complete installation.

Protecting the resistor cable against short-circuits

The input fuses of the drive will also protect the resistor cable when it is identical with the input cable.

Resistor thermal switch

Use a resistor with a thermal switch (standard in ABB resistors).

Make sure that the cable in the resistor thermal switch circuit meets the following requirements:

- shielded cable
- rated operating voltage between a core and ground > 750 (U_0)
- insulation test voltage > 2.5 kV
- jacket material for at least 90 °C (194 °F). Take into account further requirements due to resistor construction and temperature.

Protecting the system against thermal overload

The brake chopper protects itself and the resistor cables against thermal overload when the cables are dimensioned according to the nominal current of the drive. The drive control program includes a resistor overload protection function which can be tuned by the user. See the firmware manual.

EMC compliance of the complete installation

ABB cannot test that the EMC requirements are fulfilled with custom brake resistors and cabling. The customer must consider the EMC compliance of the complete installation.

Placing the brake resistors

Install the resistor assembly outside the drive in a place where it is able to cool effectively.

Arrange the cooling of the resistor so that:

- no danger of overheating is caused to the resistor or nearby materials, and
- the temperature of the room the resistor is located in does not exceed the allowed maximum.

Supply the resistor with cooling air or coolant according to the resistor manufacturer's instructions.

WARNING!
The materials near the brake resistor must be non-flammable. The surface temperature of the resistor is high. Air flowing from the resistor is of hundreds of degrees Celsius. If the exhaust vents are connected to a ventilation system, make sure that the material withstands high temperatures. Protect the resistor against contact.

Protecting the system in fault situations

A main contactor is not required for protecting against resistor overheating when the resistor is dimensioned according to the instructions and the internal brake chopper is in use. The drive will disable power flow through the input bridge if the chopper remains conductive in a fault situation but the charging resistor may fail.

Note: If an external brake chopper (outside the drive module) is used, ABB always requires a main contactor.

Selecting the default brake system components

1. Calculate the maximum power generated by the motor during braking.
2. Select a suitable drive, brake chopper and brake resistor combination for the application from the brake ratings table in the technical data. The braking power of the chopper must be greater than or equal to the maximum power generated by the motor during the braking.
3. Make sure that the resistor selection is correct: The energy generated by the motor during a 400-second period must not exceed the resistor heat dissipation capacity E_R.

   Note: If the E_R value is not sufficient, it is possible to use a four-resistor assembly in which two standard resistors are connected in parallel, two in series. The E_R value of the four-resistor assembly is four times the value specified for the standard resistor.

Calculation example

Drive: ACH580-04-04-585A-4. Maximum continuous braking power (P_{brcont}) of the internal brake chopper is 315 kW. Preselected ABB resistor is 2×SAFUR200F500. Braking

power of the motor (P_{br}) is 300 kW. The duration of a braking cycle (T) is 3 minutes. Thus, the number of braking pulses in 400 s is 2.2. The braking time (t_{br}) is 20 s.

P_{br} (300 kW) is less than P_{brcont} (315 kW). This is permitted.

The energy generated by the motor during a 400 s period is 2.2 × 300 kW × 20 s = 13200 kJ. The preselected brake resistor withstands an energy pulse of 10800 kJ in a 400 s period. In this case, the resistor is too small. Decrease the braking power or braking time, or select a custom brake resistor as described in section Selecting a custom brake resistor (page 244).

Selecting a custom brake resistor

If you use other than ABB resistor,

1. make sure that the resistance of the custom resistor is greater than or equal to the resistance of the default ABB resistor.

   $$R \geq R_{min}$$

   where

R	Resistance of the custom resistor
R_{min}	Resistance of the default resistor

   WARNING!
   Never use a brake resistor with a resistance smaller than R_{min}. This will cause overcurrent that will damage the brake chopper and the drive.

2. make sure that the resistance of the custom resistor does not restrict the braking capability needed, ie.

   $$P_{max} < \frac{U_{DC}^2}{R}$$

   where

P_{max}	Maximum power generated by the motor during braking
U_{DC}	Drive intermediate DC circuit voltage. 1.35 · 1.2 · 415 V DC (when supply voltage is 380 … 415 V AC) 1.35 · 1.2 · 500 V DC (when supply voltage is 440 … 500 V AC) or 1.35 · 1.2 · 690 V DC (when supply voltage is 525 … 690 AC)
R	Resistance of the custom resistor

3. make sure that the resistor can dissipate the energy transferred to it during the braking:
   - Braking energy is not greater than the resistor heat dissipation capacity (E_r) during the period specified. See the custom resistor specification.
   - The resistor is installed in a correctly ventilated and cooled space. Otherwise the resistor cannot meet its heat dissipation capacity and overheats.
4. make sure that the instantaneous load capacity of the custom resistor is greater than the maximum power taken by the resistor when it is connected to the drive intermediate DC circuit by the chopper:

   $$P_{R,inst} > \frac{U_{DC}^2}{R}$$

where

$P_{R, inst}$	Instantaneous load capacity of the custom resistor
U_{DC}	Drive intermediate DC circuit voltage: 1.35 · 1.2 · 415 V DC (when supply voltage is 380 … 415 V AC) 1.35 · 1.2 · 500 V DC (when supply voltage is 440 … 500 V AC) or 1.35 · 1.2 · 690 V DC (when supply voltage is 525 … 690 AC)
R	Resistance of the custom resistor

Mechanical installation of resistors

All brake resistors must be installed outside the drive. Obey the resistor manufacturer's instructions.

Electrical installation

Measuring the insulation of the brake resistor circuit

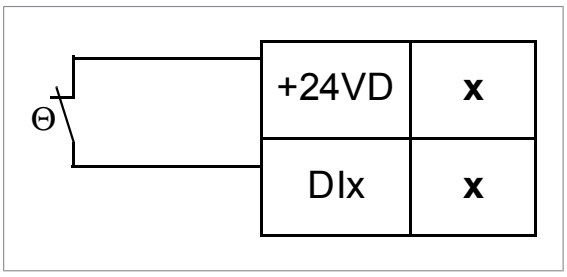
Obey the instructions given in section Measuring the insulation resistance of the brake resistor circuit (page 102)

Connection diagram

See section Power cable connection diagram (page 105).

Connection procedure

- Connect the resistor cables to the R+ and R- terminals in the same way as the other power cables. If a shielded three-conductor cable is used, cut the third conductor and ground the twisted shield of the cable (protective earth conductor of the resistor assembly) at both ends.
- Wire the thermal switch to a digital input on the drive control unit. Consider connecting the thermal switch in the Run enable loop connected to the DIIL input. See the circuit diagrams of the drive.



Start-up

Note: New brake resistors may be coated with storage grease. As the brake chopper operates for the first time, the grease burns off and may produce some smoke. Make sure there is sufficient ventilation.

Parameter settings

Set the following parameters:

- Disable the overvoltage control of the drive with parameter 30.30 Overvoltage control.
- If the thermal switch is wired to the DIIL input, an overheating resistor will, by default, remove the Run enable signal from the drive. See also parameters 20.11 Run enable stop mode, 20.12 Run enable 1 source and 95.20 HW options word 1.
- If the thermal switch is wired to another digital input input, set the following parameters.
  1. Set the source of parameter 31.01 External event 1 source to point to the digital input where the thermal switch of the brake resistor is wired.
  2. Enable the brake chopper by parameter 43.06 Brake chopper enable. If Enabled with thermal model is selected, set also the brake resistor overload protection parameters 43.08 and 43.09 according to the application.
  3. Set parameter 31.02 External event 1 type to Fault.
  4. Set parameter 43.07 Brake chopper run enable to Other [bit] and select from parameter 10.01 DI status the digital input where the thermal switch of the brake resistor is wired.
  5. Set the resistance value of the resistor to parameter 43.10 Brake resistance.

  With these parameter settings, the drive generates a fault and coasts to a stop on brake resistor overtemperature.

WARNING!
If the drive is equipped with a brake chopper but the chopper is not enabled by the parameter setting, the internal thermal protection of the drive against resistor overheating is not in use. In this case, the brake resistor must be disconnected.

Technical data

Ratings

The table below gives the ratings for resistor braking.

ACH580-04-...	Internal brake chopper		Example brake resistor(s)			
	P_{brcont}	R_{min}	Type	R	E_R	P_{Rcont}
	kW	ohm		ohm	kJ	kW
U_n = 400 V						
505A-4	250	2.0	2×SAFUR125F500	2.0	7200	18
584A-4	315	1.3	2×SAFUR200F500	1.3	10800	27
650A-4	315	1.3	2×SAFUR200F500	1.3	10800	27
725A-4	400	0.7	3×SAFUR200F500	0.9	16200	40
820A-4	400	0.7	3×SAFUR200F500	0.9	16200	40
880A-4	400	0.7	3×SAFUR200F500	0.9	16200	40

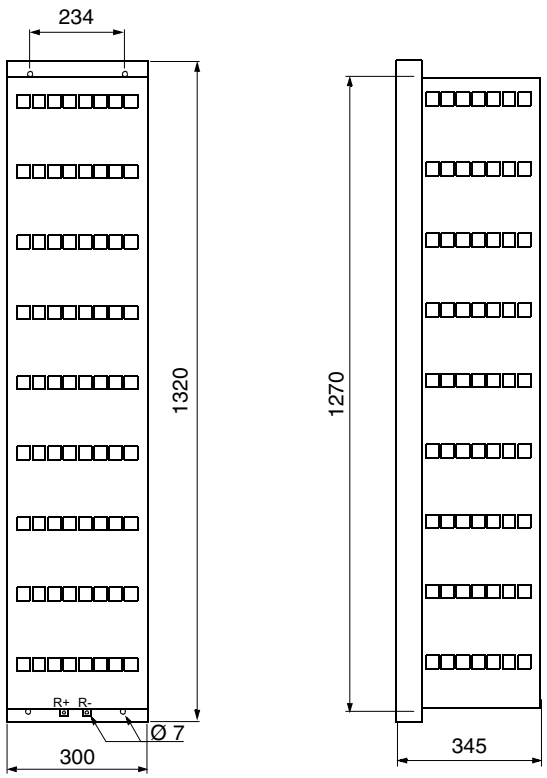
P_{brcont}	Maximum continuous braking power. The braking is considered continuous if the braking time exceeds 30 seconds.
R_{min}	The minimum permitted resistance value of the brake resistor
R	Resistance value for the listed resistor assembly
E_R	Short energy pulse that the resistor assembly withstands every 400 seconds
P_{Rrcont}	Continuous power (heat) dissipation of the resistor when placed correctly

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

SAFUR resistors

The degree of protection of SAFUR resistors is IP00. The resistors are not UL listed. The thermal time constant of the resistors is 555 seconds.

Dimensions, weights and ordering codes



Brake resistor type	Weight	ABB ordering code
SAFUR125F500	25 kg (55 lb)	68759285
SAFUR200F500	30 kg (66 lb)	68759340

Terminals and cable entry data

See section Terminal and entry data for the power cables (page 187).

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CAIO-01 bipolar analog I/O adapter module

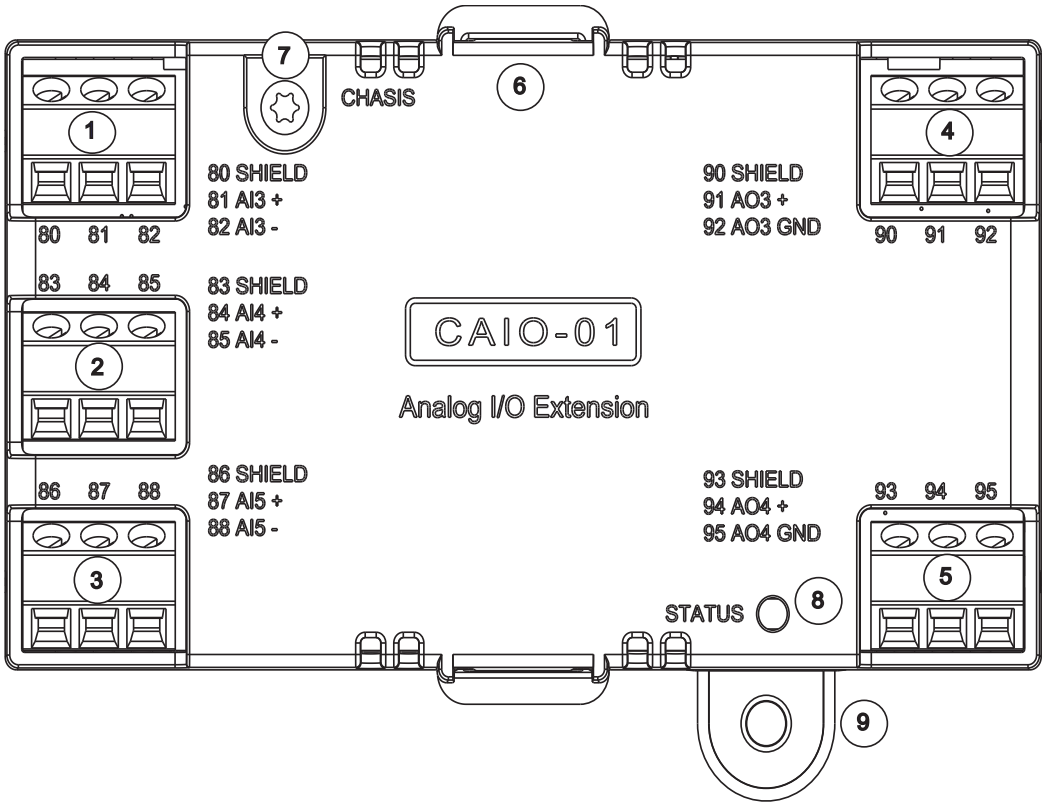
Contents of this chapter

This chapter describes how to install and start up the optional CAIO-01 multifunction extension module. The chapter also contains diagnostics and technical data.

Product overview

The CAIO-01 bipolar analog I/O module expands the inputs and outputs of the drive control unit. It has three bipolar current/voltage inputs and two unipolar current/voltage outputs. The inputs can handle positive and negative signals. The way the drive interprets the negative range of the inputs depends on the parameter settings of the drive. The voltage/current selection of the inputs is done with a parameter.

Layout



1, 2, 3	Analog inputs		4, 5	Analog outputs	
80	SHIELD	Cable shield connection	90	SHIELD	Cable shield connection
81	AI3+	Analog input 3 positive signal	91	AO3	Analog output 3 signal
82	AI3-	Analog input 3 negative signal	92	AGND	Analog ground potential
83	SHIELD	Cable shield connection	93	SHIELD	Cable shield connection
84	AI4+	Analog input 4 positive signal	94	AO4	Analog output 4 signal
85	AI4-	Analog input 4 negative signal	95	AGND	Analog ground potential
86	SHIELD	Cable shield connection			
87	AI5+	Analog input 5 positive signal			
88	AI5-	Analog input 5 negative signal			
6	Control unit slot interface				
7	Grounding hole				
8	Diagnostic LED				
9	Mounting hole				

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 110).

Electrical installation

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

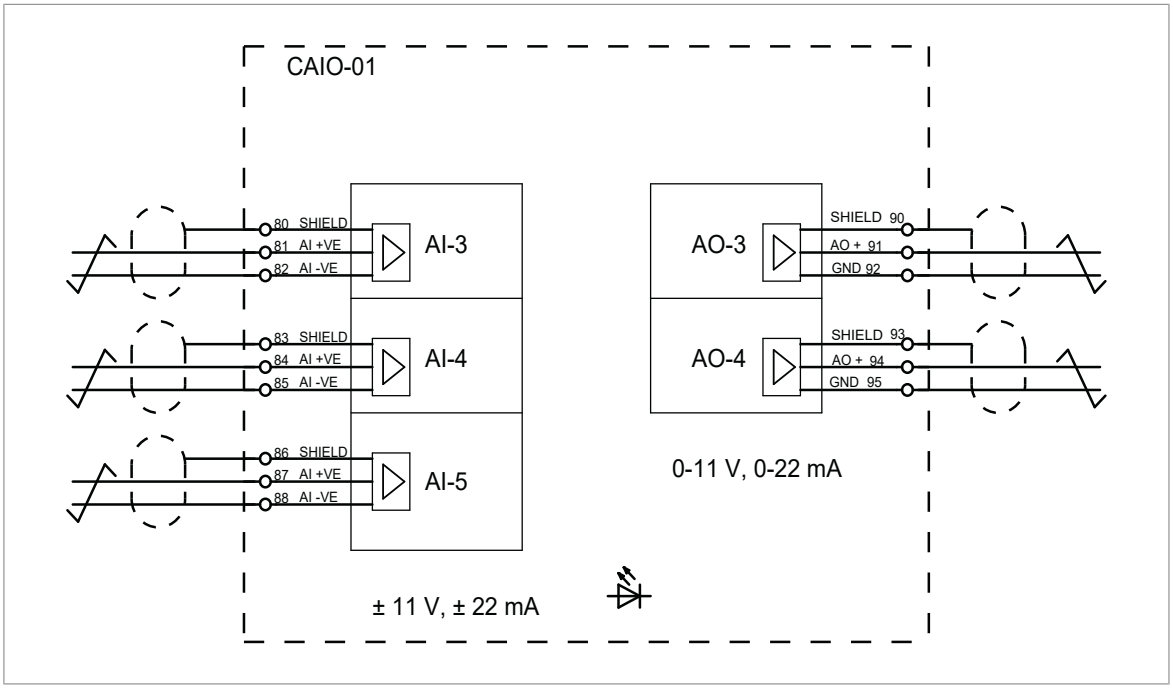
Stop the drive and do the steps in section Electrical safety precautions (page 21) before you start the work.

Necessary tools

- Screwdriver and a set of suitable bits.

Wiring

Connect the external cables to the applicable module terminals. Ground the outer shield of the cables to the SHIELD terminal.



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 CAIO-01.

   If warning A7AB Extension I/O configuration failure is shown,
   - make sure that the value of 15.02 is CAIO-01
   - set the value of parameter 15.01 to CAIO-01.

   You can now see the parameters of the extension module in group 15 I/O extension module.
3. Set the parameters of analog inputs AI3, AI4, AI5 or analog outputs AO3 or AO4 to applicable values, see the firmware manual.

Example: To connect supervision 1 to AI3 of the extension module:

- Select the mode of the supervision function (32.05 Supervision function 1).
- Set limits for the supervision function (32.09 Supervision 1 low and 32.10 Supervision 1 high).
- Select the supervision action (32.06 Supervision 1 action).
- Connect 32.07 Supervision 1 signal to 15.52 AI3 scaled value.

Diagnostics

LEDs

The adapter module has one diagnostic LED.

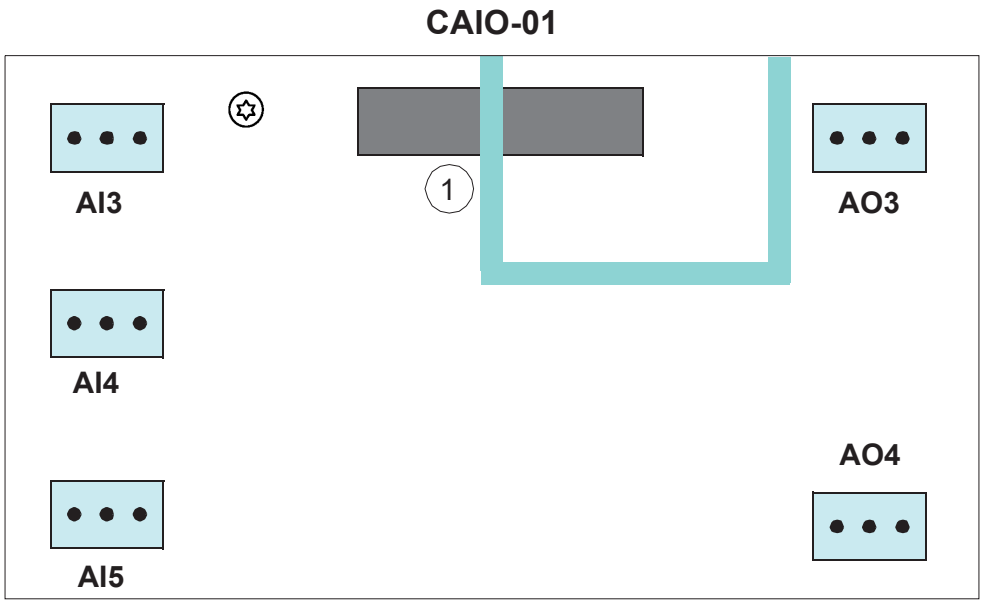
Color	Description
Green	The adapter module is powered up.
Red	There is no communication with the drive control unit or the adapter module has detected an error.

Technical data

Installation	Into slot 2 of drive control unit
Degree of protection	IP20 / UL 1 Type
Ambient conditions	See the drive technical data.
Package	Cardboard
Analog inputs (80..82, 83..85, 86..88)	
Maximum wire size	1.5 mm^2
Input voltage (AI+ and AI-)	-11 V … +11 V
Input current (AI+ and AI-)	-22 mA … +22 mA
Input resistance	>200 kohm (voltage mode), 100 ohm (current mode)
Optional cable shield connections	
Analog outputs (90..92, 93..95)	

Maximum wire size	1.5 mm^2
Output voltage (AO+ and AO-)	0 V … +11 V
Output current (AO+ and AO-)	0 mA … +22 mA
Output resistance	< 20 ohm
Recommended load	>10 kohm
Inaccuracy	± 1% Typical, ± 1.5% Max of full-scale value
Optional cable shield connections	

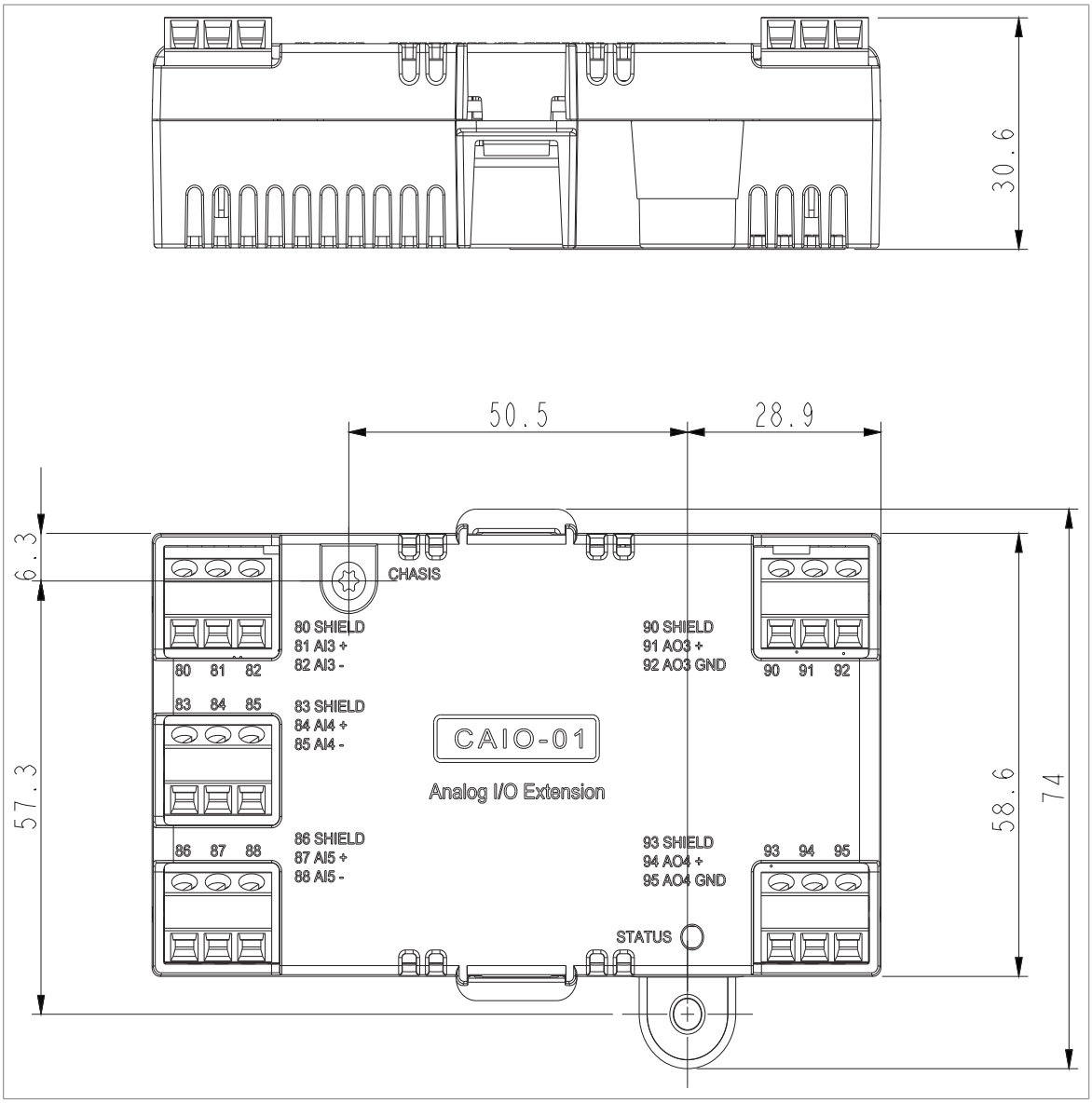
Isolation areas



1	Plugged to drive control unit SLOT 2
	Reinforced insulation (IEC 61800-5-1:2007)

Dimension drawings

The dimensions are in millimeters.



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CHDI-01 115/230 V digital input extension module

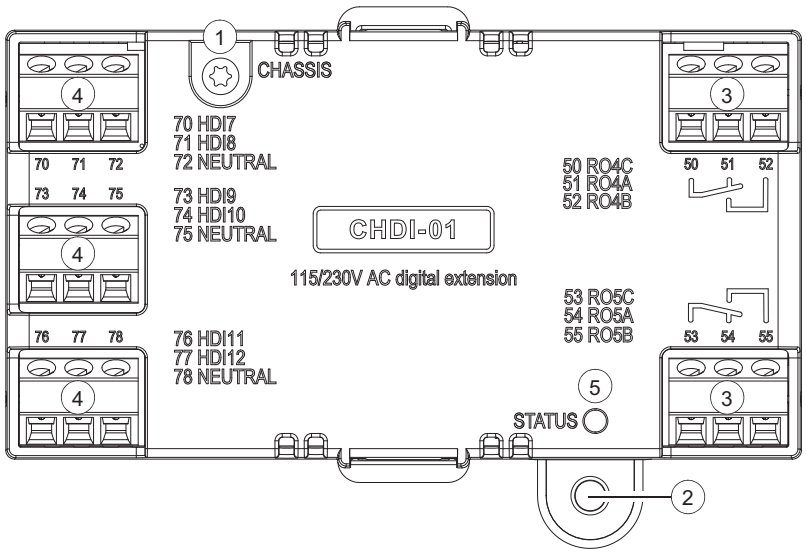
Contents of this chapter

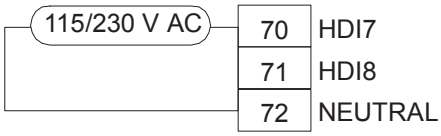
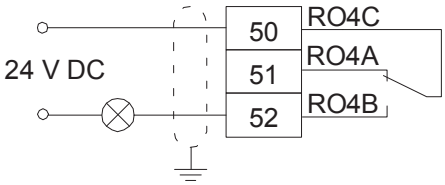
This chapter describes how to install and start up the optional CHDI-01 multifunction extension module. The chapter also contains diagnostics and technical data.

Product overview

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

Layout and connection examples



4	3-pin terminal blocks for 115/230 V inputs		3	Relay outputs	
					
70	HDI7	115/230 V input 1	50	RO4C	Common, C
71	HDI8	115/230 V input 2	51	RO4B	Normally closed, NC
72	NEUTRAL [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	1	**Grounding screw**	
77	HDI12	115/230 V input 5	2	**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 110).

Electrical installation

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

Stop the drive and do the steps in section Electrical safety precautions (page 21) before you start the work.

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 control cables at the cabinet entry.

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 the 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

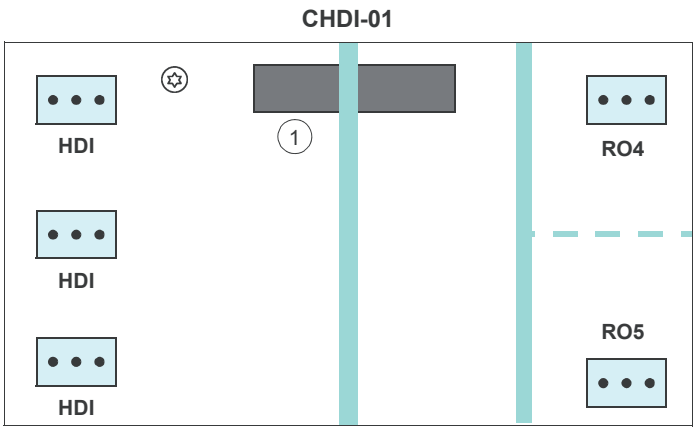
This example shows how make the relay output RO4 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

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

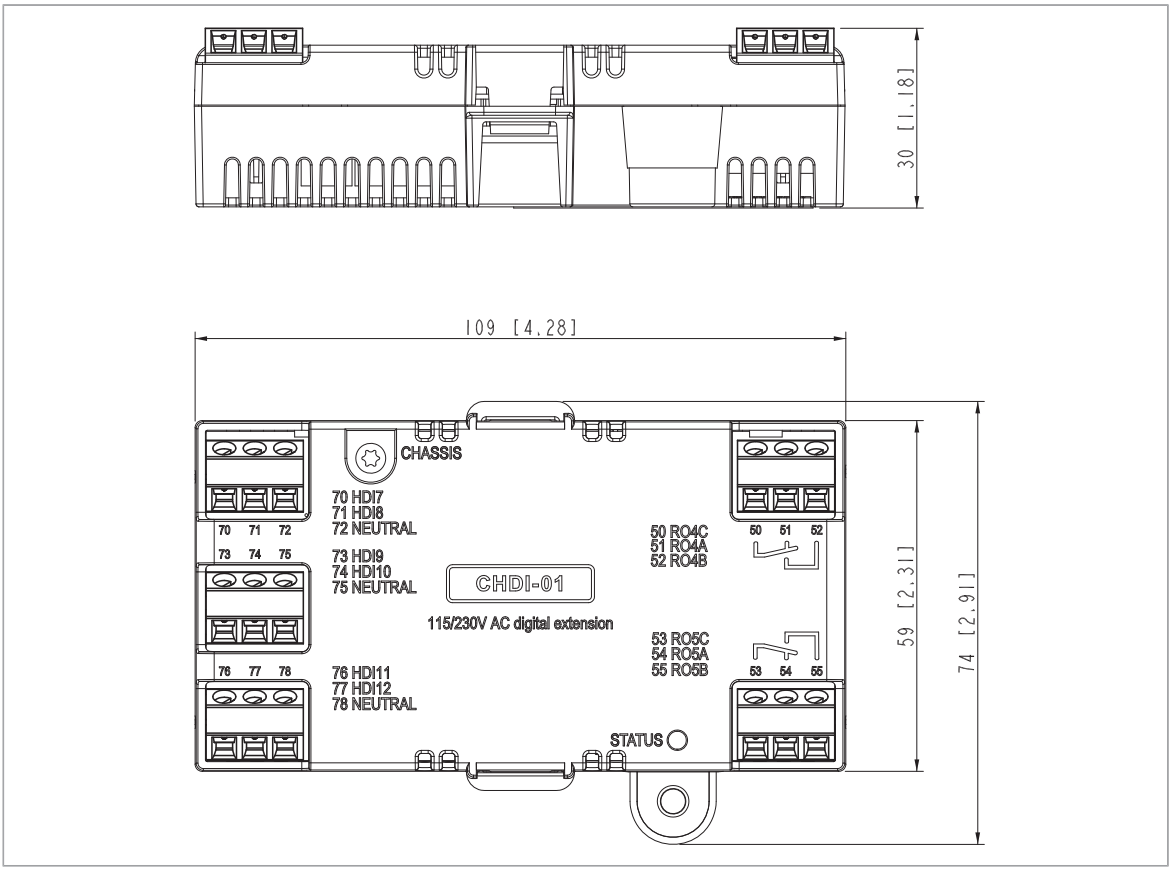
Warning A7AB Extension I/O configuration failure.

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	
	
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].


30 [1.18]
109 [4.28]
CHASSIS
70 HDI7
71 HDI8
72 NEUTRAL
73 HDI9
74 HDI10
75 NEUTRAL
76 HDI11
77 HDI12
78 NEUTRAL
70 71 72
73 74 75
76 77 78
CHDI-01
115/230V AC digital extension
50 RO4C
51 RO4A
52 RO4B
53 RO5C
54 RO5A
55 RO5B
50 51 52
53 54 55
STATUS
59 [2.31]
74 [2.91]

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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 how to install and start up the optional CMOD-01 multifunction extension module. The chapter also contains diagnostics and technical data.

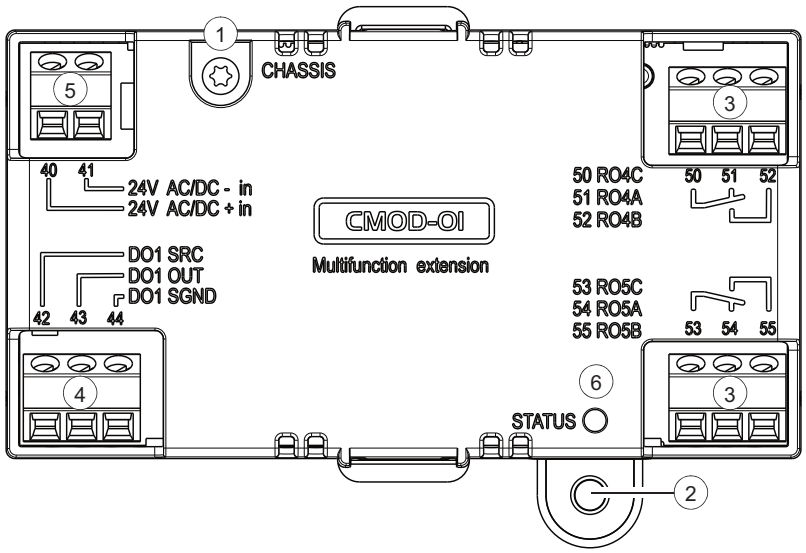
Product overview

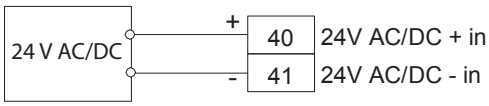
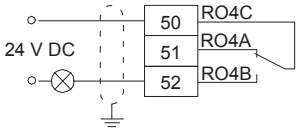
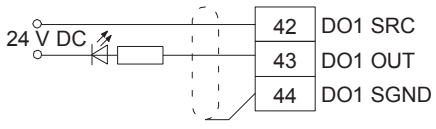
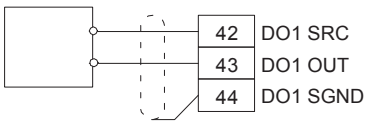
The CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O) expands the outputs of the drive control unit. It has two relay outputs and one transistor output, which can operate as a digital or frequency output.

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 backup power supply, you do not have to connect it because the module is powered from the drive control unit by default.

With CCU-24 control unit, a CMOD-01 module is not necessary for external 24 V AC/DC supply connection. The external supply is connected directly to terminals 40 and 41 on the control unit.

Layout and example connections



1	**Grounding screw**		**6**	**Diagnostic LED**	
2	**Hole for mounting screw**				
5	**2-pin terminal block for external power supply**		**3**	**3-pin terminal blocks for relay outputs**	
					
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
4	**3-pin terminal block for for transistor output**		52	RO4B	Normally open, NO
 1)  2)					
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 110).

Electrical installation

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

Stop the drive and do the steps in section Electrical safety precautions (page 21) before you start the work.

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 control cables at the cabinet entry.

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 the 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.

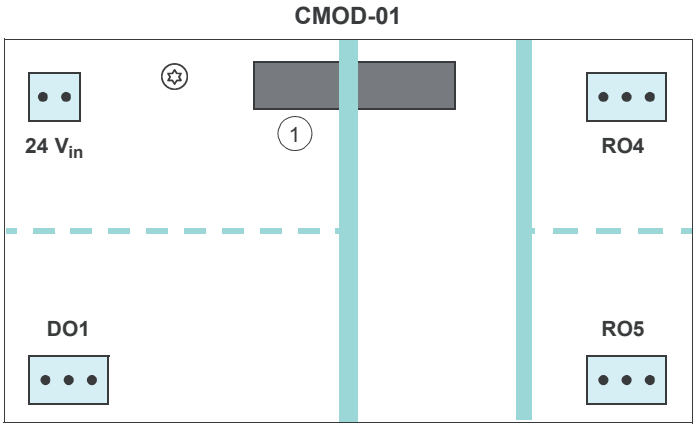
LEDs

The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

Technical data

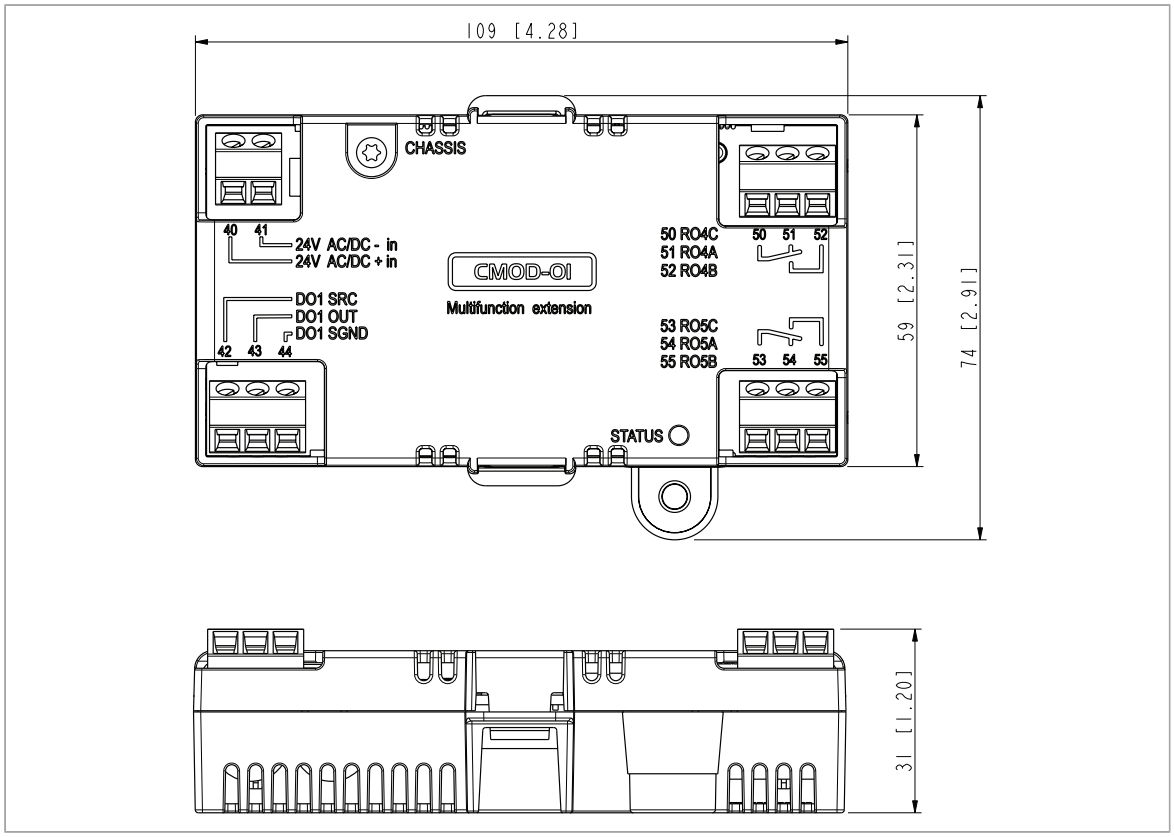
Installation	Into an option slot on the drive control unit
Degree of protection	IP20 / UL Type 1

Ambient conditions	See the drive technical data.
Package	Cardboard
Reley outputs (50…52, 53…55)	
Maximum wire size	1.5 mm²
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 mm²
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 mm²
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].

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



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

Contents of this chapter

This chapter describes how to install and start up the optional CMOD-02 multifunction extension module. The chapter also contains diagnostics and technical data.

Product overview

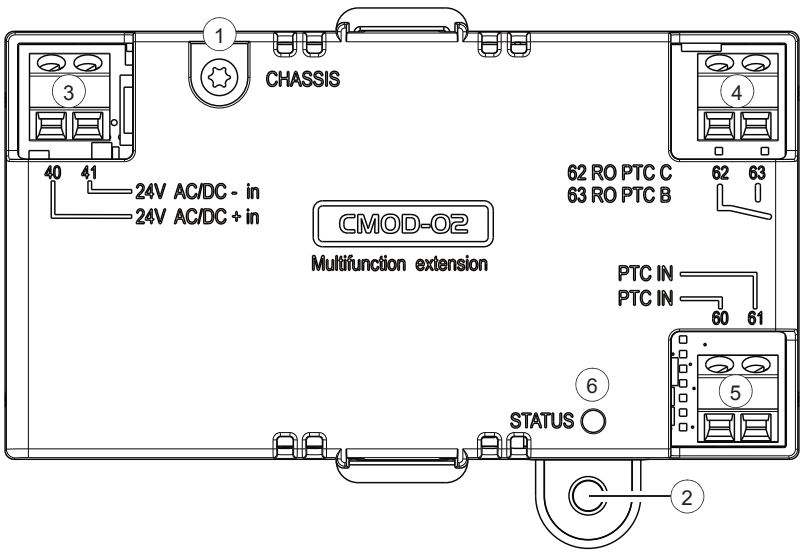
The CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface) has a motor thermistor connection for supervising the motor temperature and one relay output, which indicates the thermistor status. In case the thermistor overheats, the drive trips on motor overtemperature. 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.

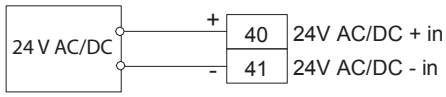
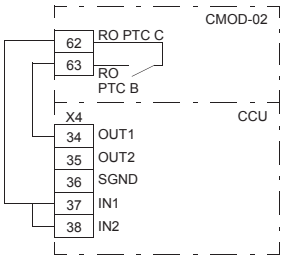
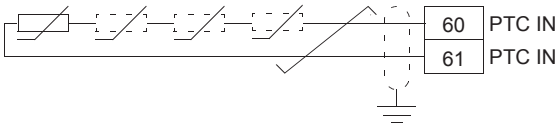
In addition, the extension module has an external power supply interface, which can be used to power up the drive control unit in case the drive power supply is not on. If you do not need the back-up power supply, you do not have to connect it because the module is powered from the drive control unit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

With CCU-24 control unit, a CMOD-02 module is not necessary for external 24 V AC/DC supply connection. The external supply is connected directly to terminals 40 and 41 on the control unit.

Layout and example connections



3	2-pin terminal block for external power supply		4	2-pin terminal block for relay output	
					
40	24 V AC/DC + in	External 24 V (AC/DC) input	62	RO PTC C	Common, C
41	24 V AC/DC - in	External 24 V (AC/DC) input	63	RO PTC B	Normally open, NO
5	**Motor thermistor connection**		**1**	**Grounding screw**	
 One to six PTC thermistors connected in series.					
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 110).

Electrical installation

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

Stop the drive and do the steps in section Electrical safety precautions (page 21) before you start the work.

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 control cables at the cabinet entry.

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 the 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.

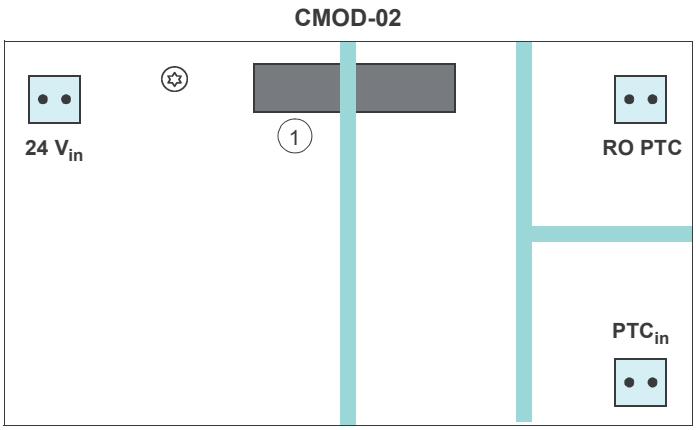
LEDs

The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

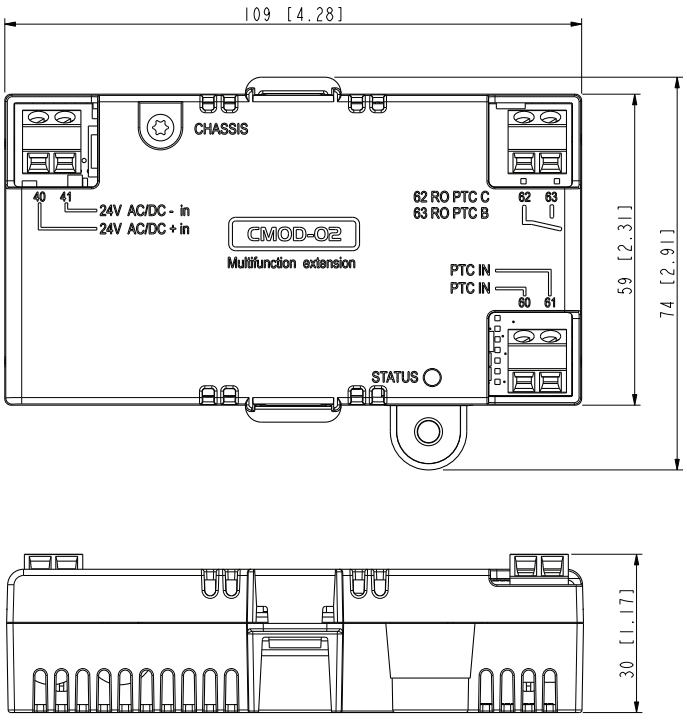
Technical data

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].



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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 74).

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	68550505
FOCH-0875-70	3AUA0000129544

Description, installation and technical data of the FOCH filters

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

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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.

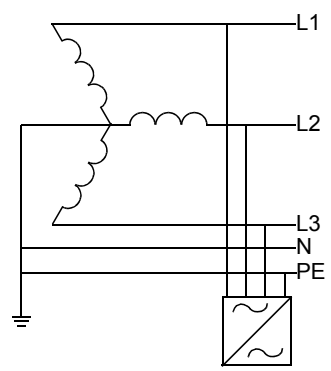
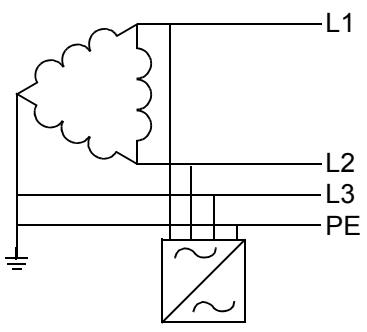
To identify the grounding system, examine the supply transformer connection. See the applicable electrical diagrams of the building. If that is not possible, measure these voltages at the distribution board, and use the table to define the grounding system type.

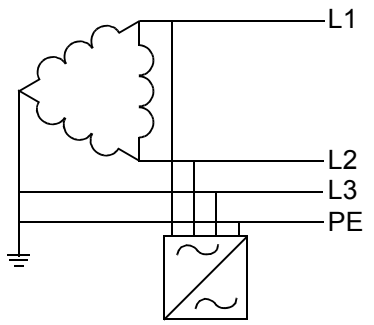
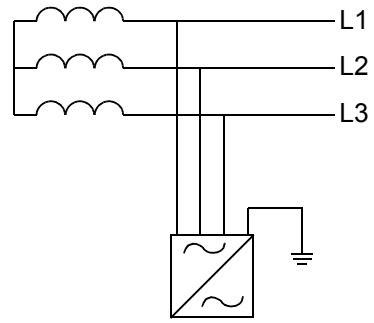
1. input voltage line to line (U_{L-L})
2. input voltage line 1 to ground (U_{L1-G})
3. input voltage line 2 to ground (U_{L2-G})
4. input voltage line 3 to ground (U_{L3-G}).

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 the ground-to-phase varistor.
Corner-grounded delta systems	
	Do not disconnect the ground-to-phase varistor.

Midpoint-grounded delta systems	
	Do not disconnect the ground-to-phase varistor.
IT systems (ungrounded or high-resistance grounded [>30 ohms])	
	Disconnect the ground-to-phase varistor.

Guidelines for installing the drive to a TT system

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

1. There is a residual current device in the supply system
2. The ground-to-phase varistor is disconnected. If the varistor is not disconnected, its leakage current will cause the residual current device to trip.

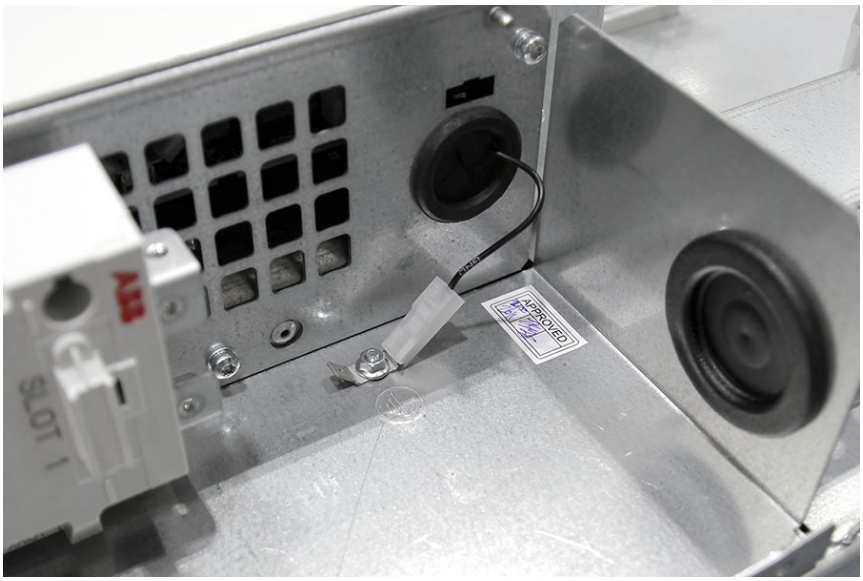
Note:

- 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 the ground-to-phase varistor – IEC, not North America

To disconnect the ground-to-phase varistor:

1. Disconnect the varistor (VAR) grounding wire. The varistor grounding wire is adjacent to the control circuit compartment. Refer to the image that follows.
2. Insulate the end of the varistor grounding wire. Attach the wire to the module frame with a cable tie.



28

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.

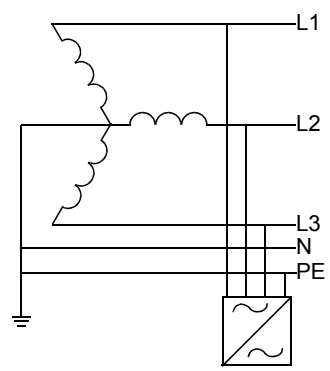
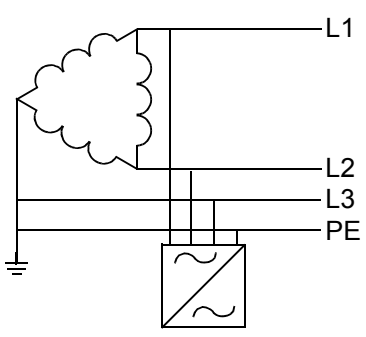
To identify the grounding system, examine the supply transformer connection. See the applicable electrical diagrams of the building. If that is not possible, measure these voltages at the distribution board, and use the table to define the grounding system type.

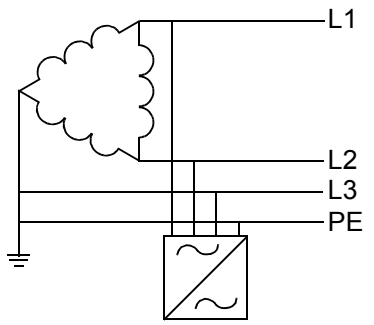
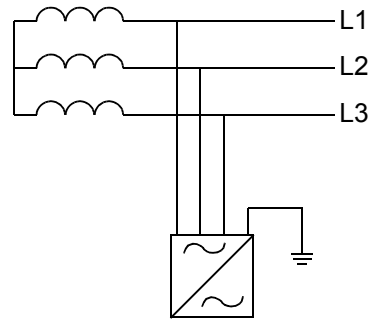
1. input voltage line to line (U_{L-L})
2. input voltage line 1 to ground (U_{L1-G})
3. input voltage line 2 to ground (U_{L2-G})
4. input voltage line 3 to ground (U_{L3-G}).

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 the ground-to-phase varistor.
Corner-grounded delta systems	
	You can connect the ground-to-phase varistor.

Midpoint-grounded delta systems	
	You can connect the ground-to-phase varistor.
IT systems (ungrounded or high-resistance grounded [>30 ohms])	
	Do not connect the ground-to-phase varistor.

Connecting EMC filter – North America

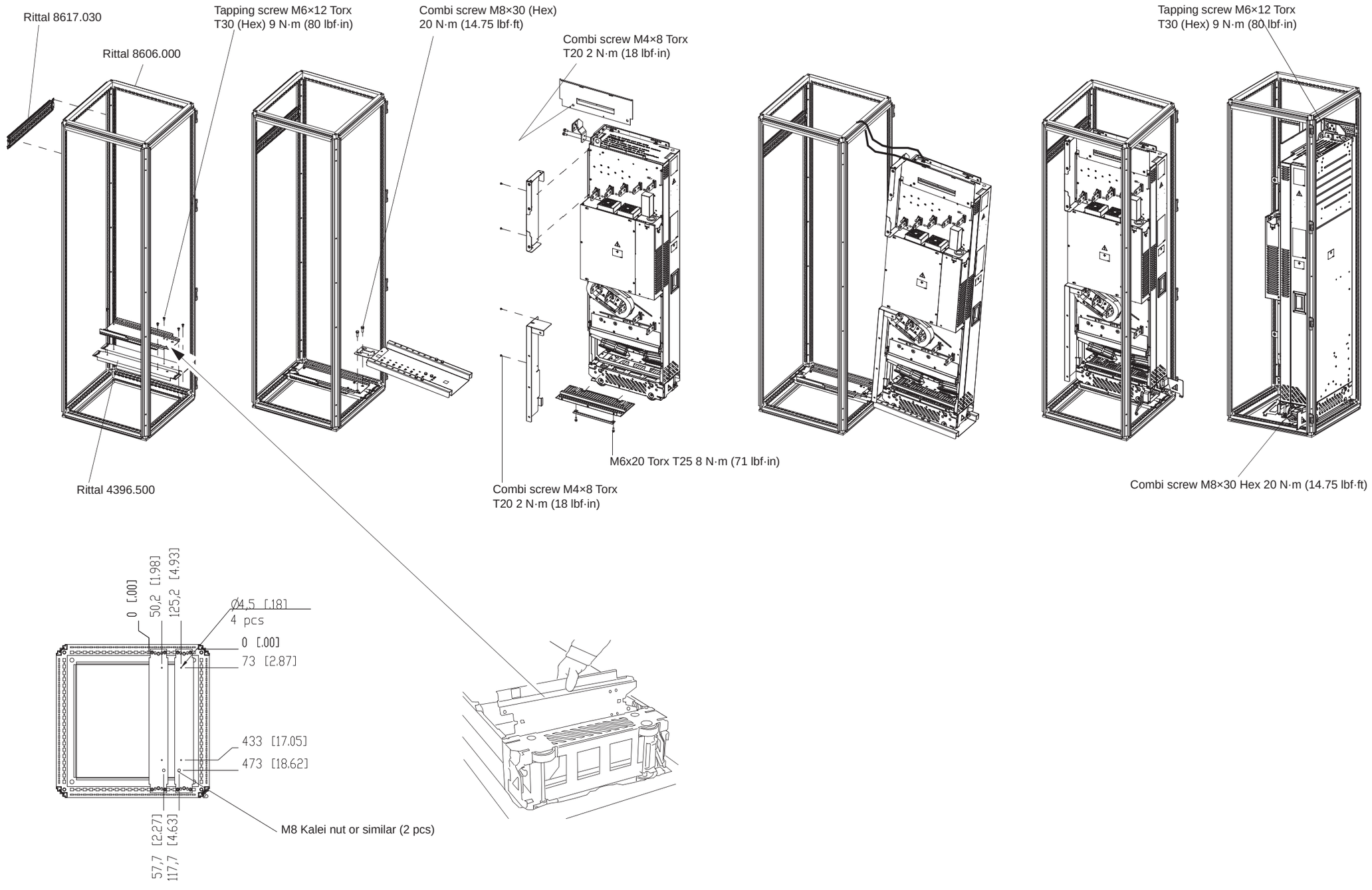
This section is valid for the UL (NEC) drive types. The internal EMC filter of the drive is disconnected as default. If you are concerned with EMC issues, and install the drive to a symmetrically grounded TN-S system, corner-grounded delta or mid-point-grounded delta system, you can connect the internal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

Connecting ground-to-phase varistor – North America

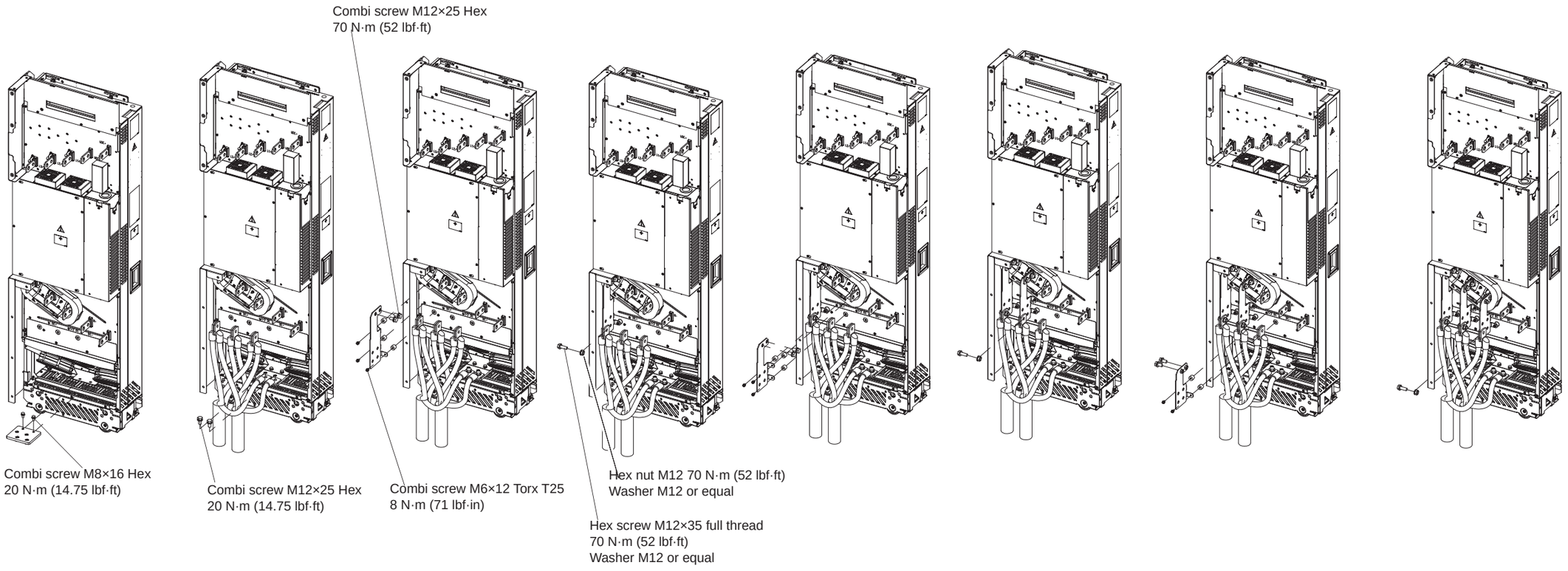
This section is valid the UL (NEC) drive types. The internal ground-to-phase varistor of the drive is disconnected as default. If you install the drive to TN-S system, corner-grounded delta or mid-point-grounded delta system, you can connect the ground-to-phase varistor. Contact ABB for the connection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

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

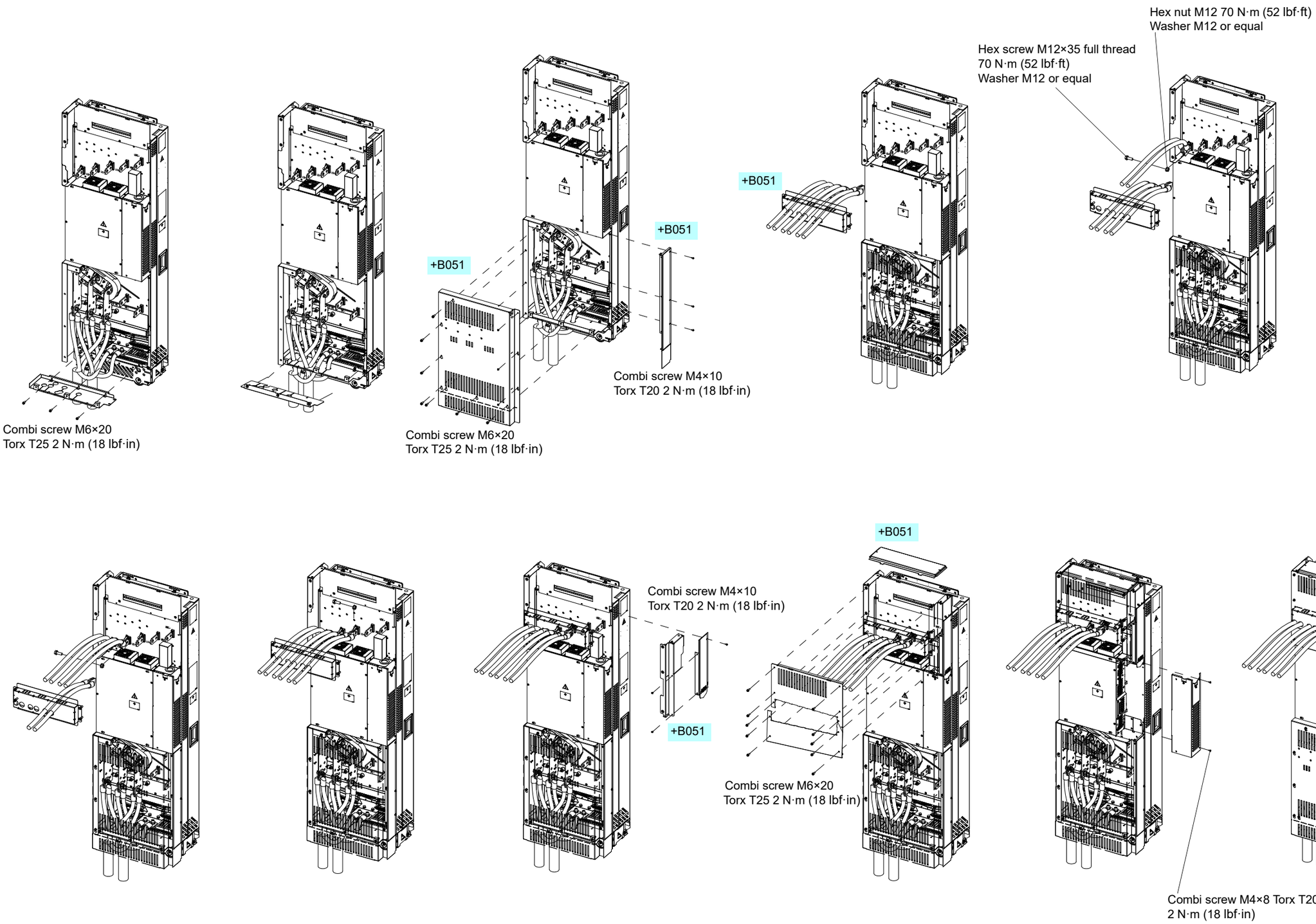
Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure



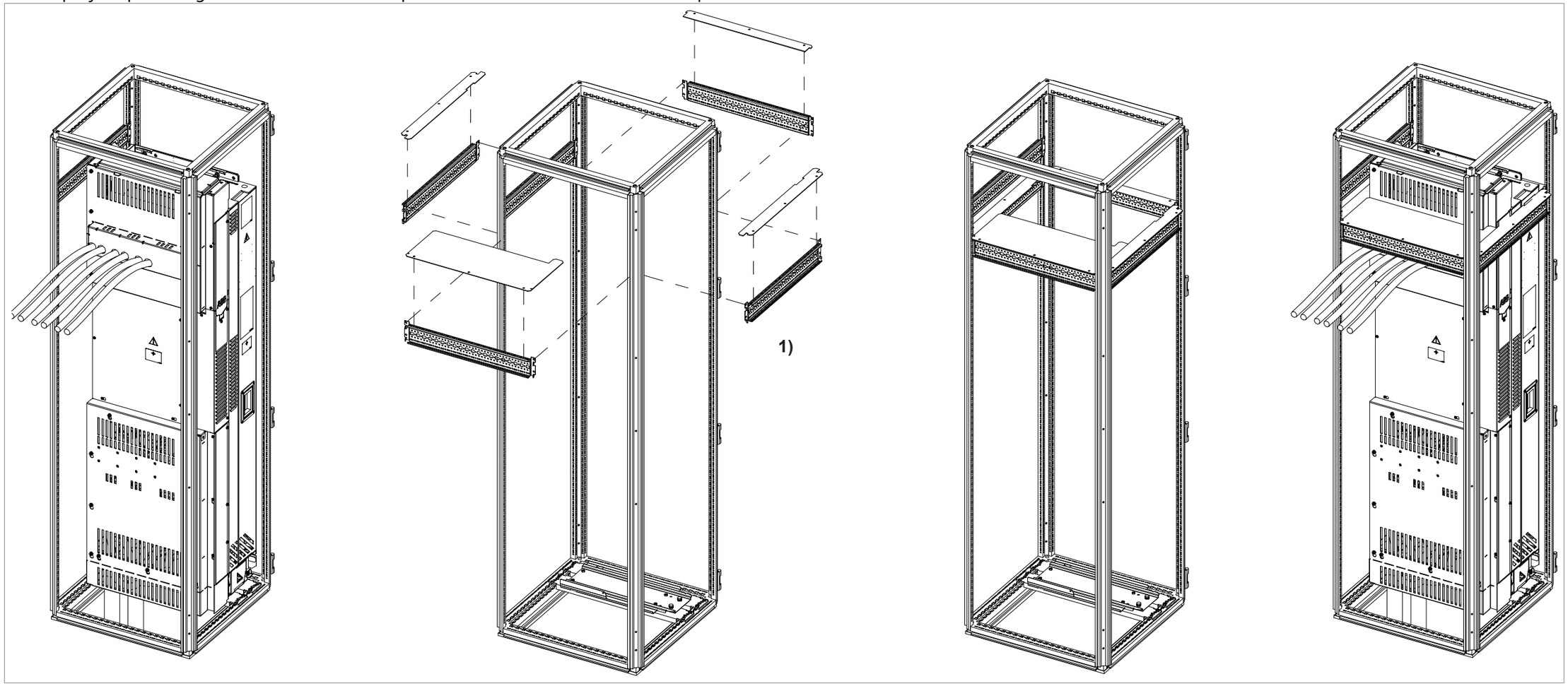
284 Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure



Step-by-step drawings for an installation example of a drive module with the +B051 option in a Rittal VX25 600 mm wide enclosure 285



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



1) These air baffles are compatible with option +B051 only.

Step-by-step drawings for installing full cabling panels (option +H381) in a Rittal VX25 400 mm wide enclosure

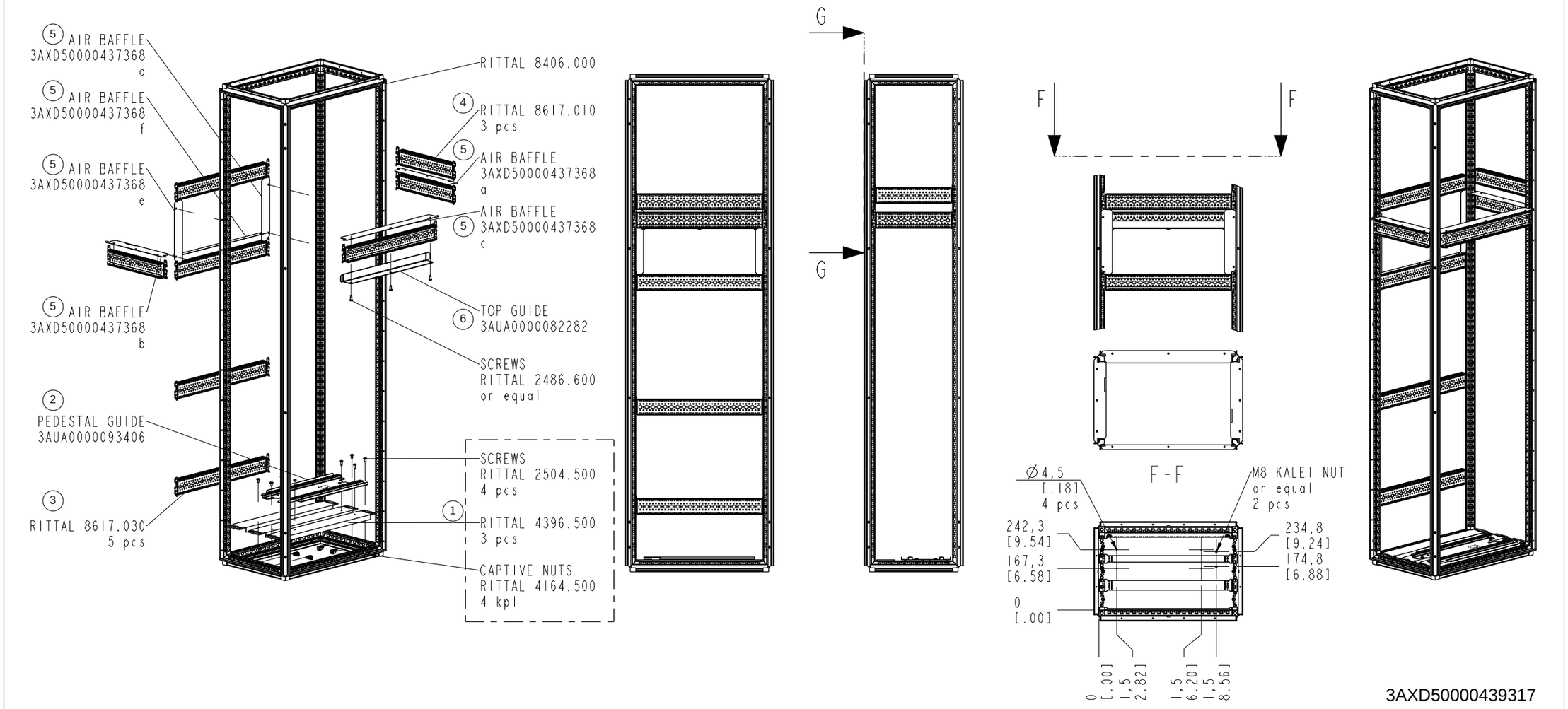
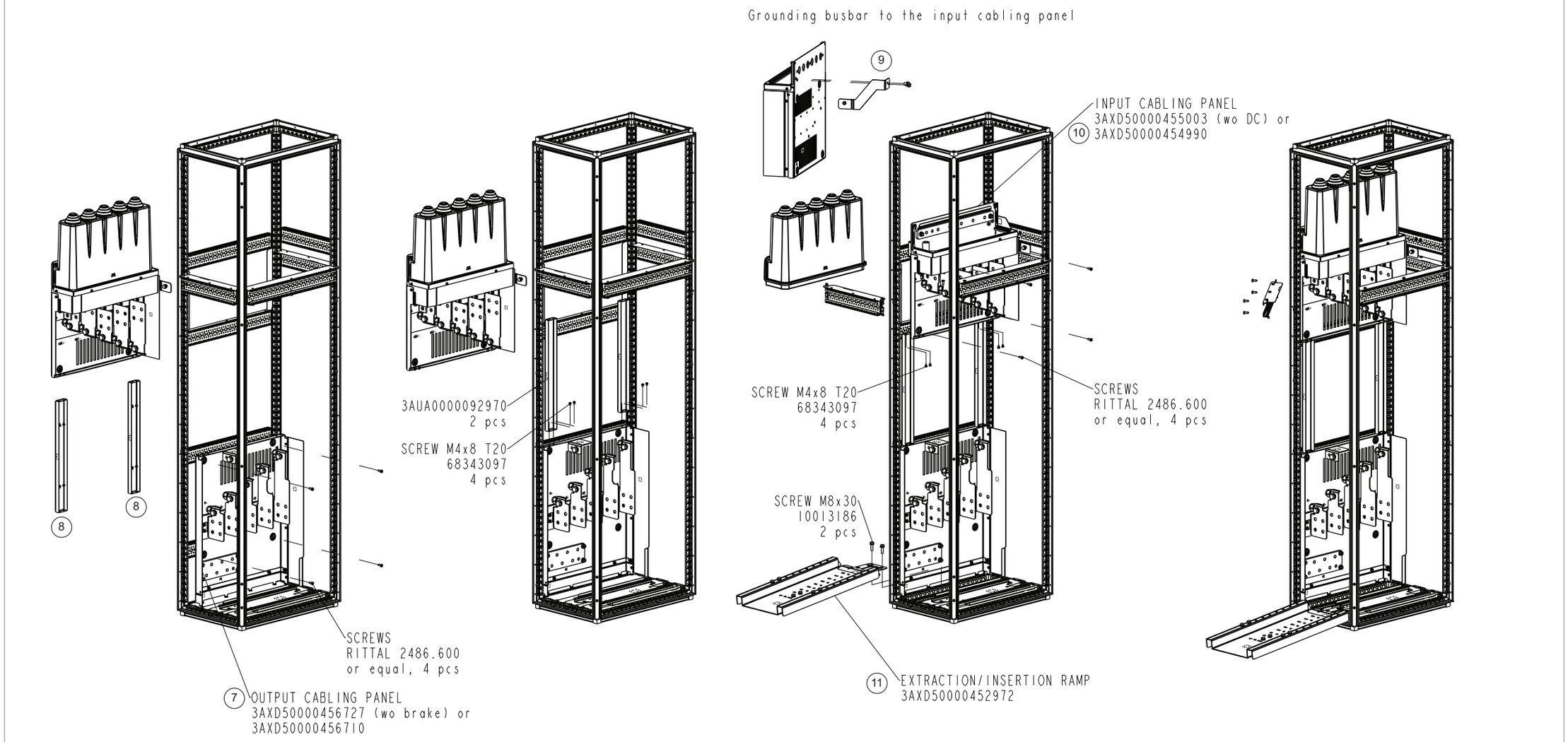


ABB parts	
2	Pedestal guide plate
6	Top guide plate
Customer-made parts (not ABB or Rittal product)	
5	Air baffles

Installation procedure

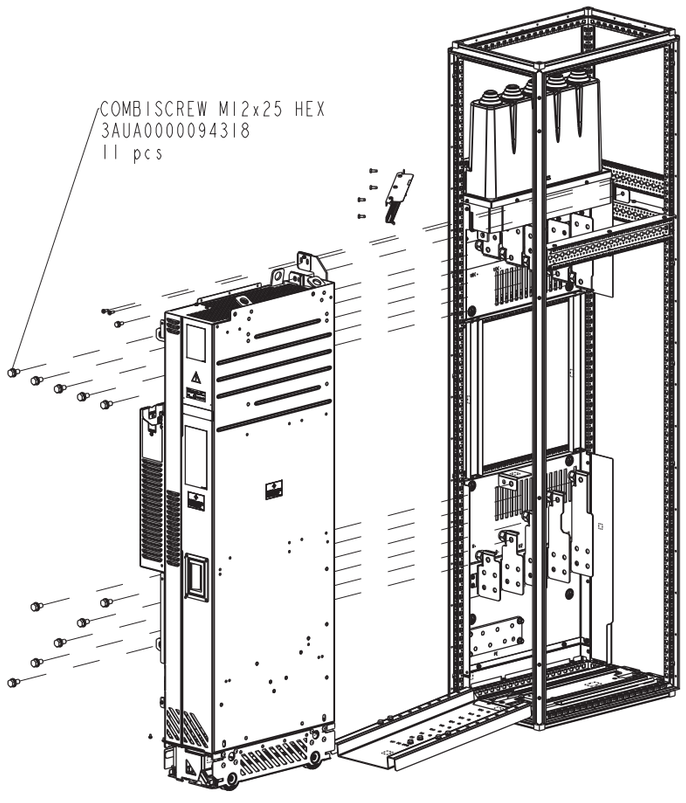
1. Install three Rittal support rails (4396.500) on the bottom of the enclosure.
2. Install the pedestal guide onto the support rails.
3. Install the Rittal punched sections 8617.030 (5 pcs).
4. Install the Rittal punched sections 8617.010 (3 pcs).

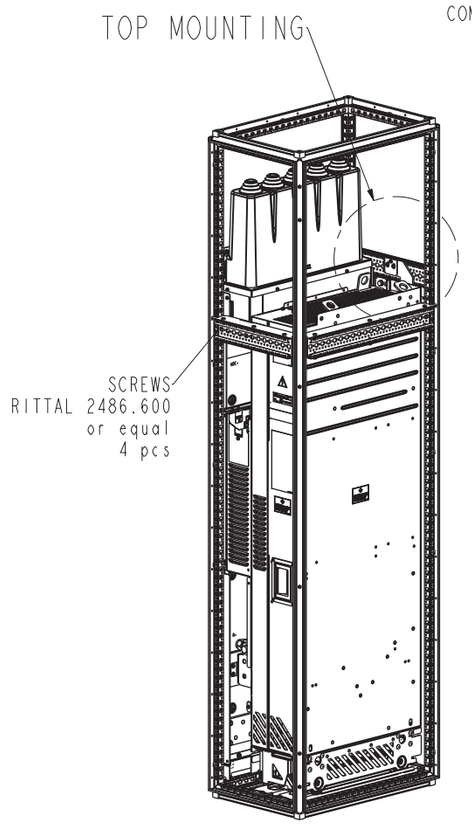
5. Install the air baffles.
6. Install the top guide plate.

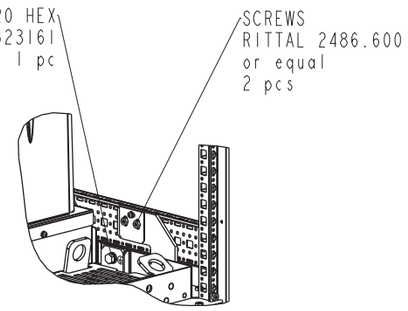


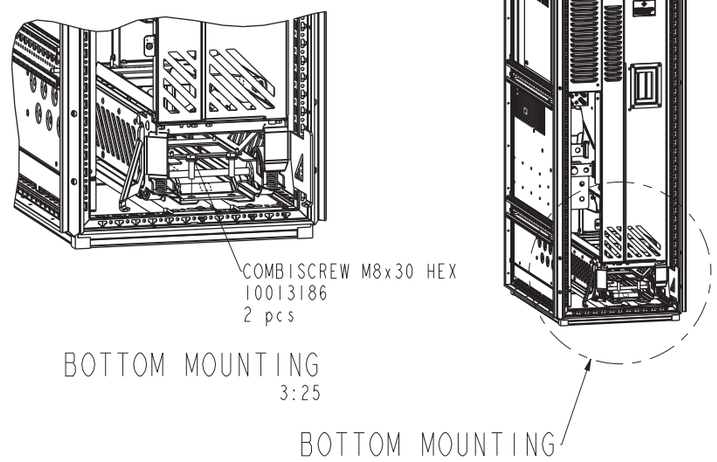
Installation procedure (continued)

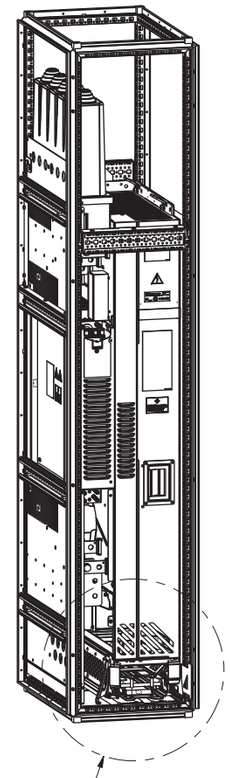
7. Install the output cabling panel.
8. Install the side guides to the output cabling panel (2 screws for each side guide).
9. Attach the grounding busbar to the input cabling panel. Back view is shown above.
10. Attach the input cabling panel to the punched section.
11. Install the telescopic extraction and insertion ramp.











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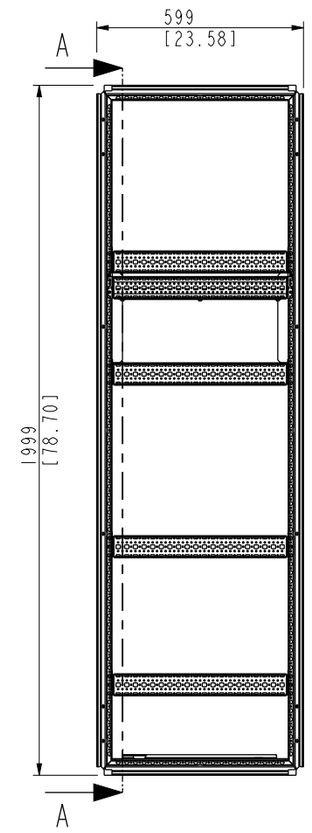
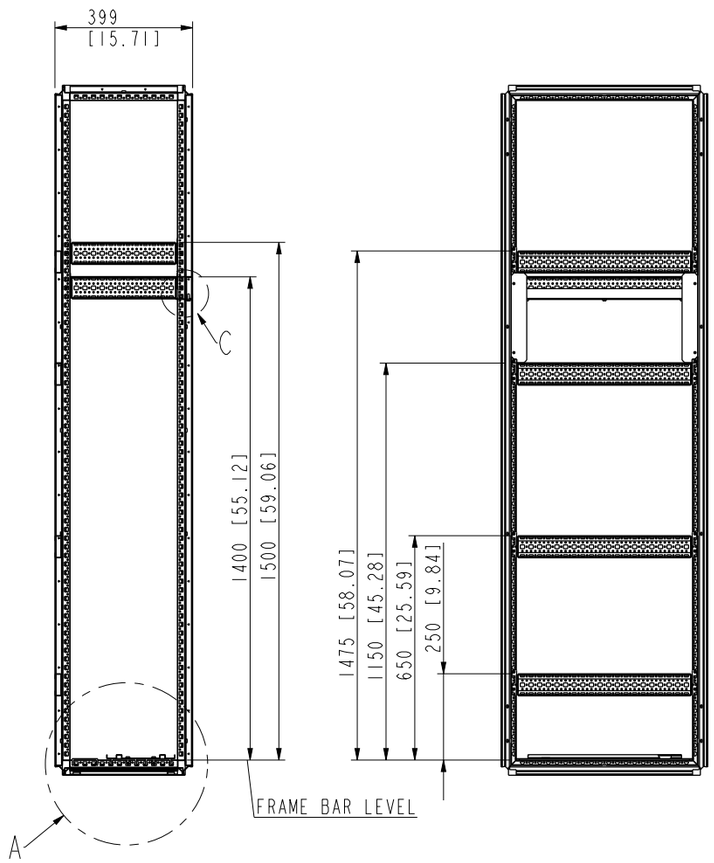
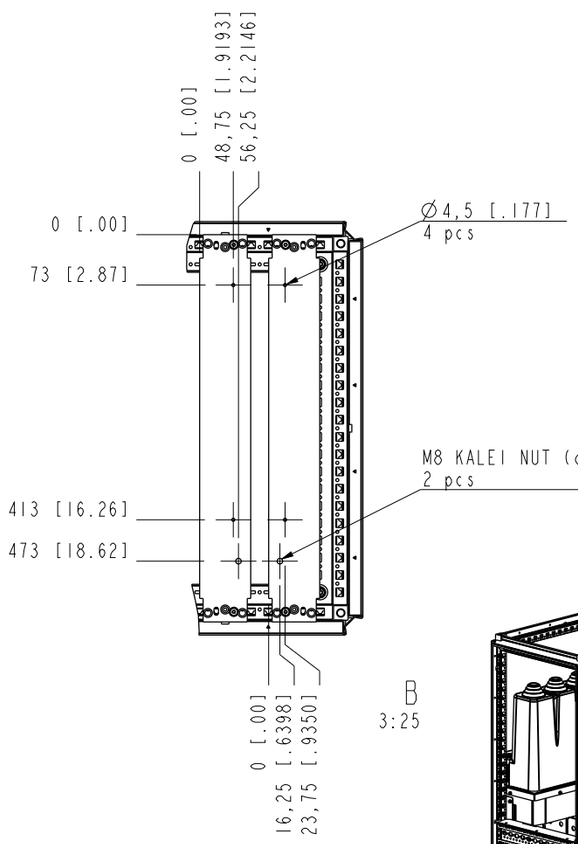
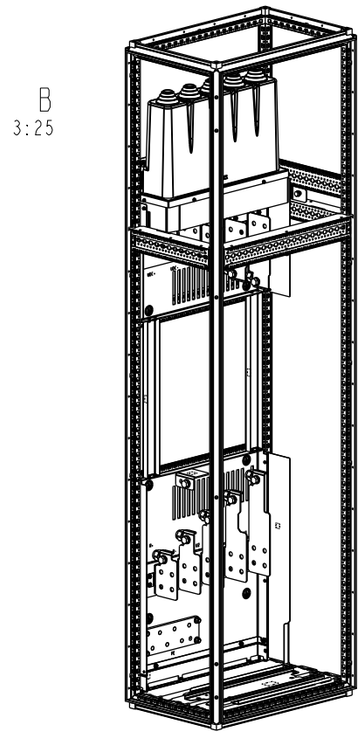
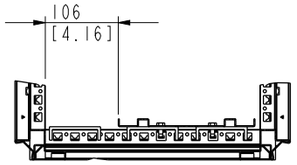
290 Step-by-step drawings for installing full cabling panels (option +H381) in a Rittal VX25 400 mm wide enclosure

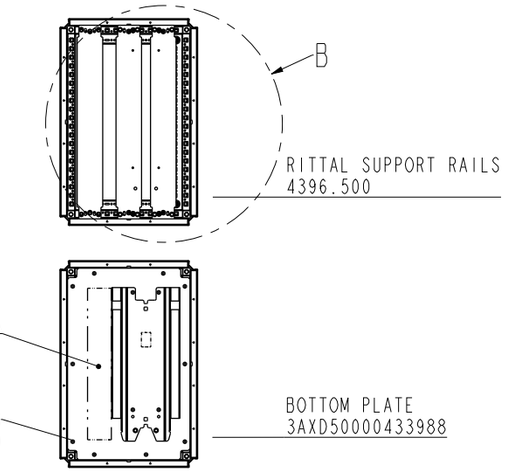


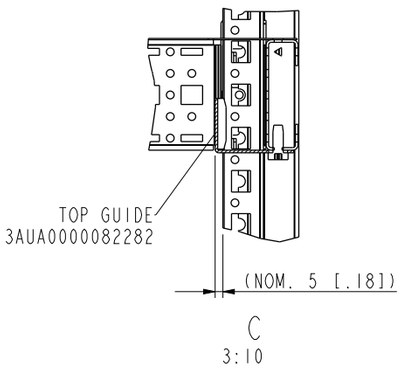












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Further information

Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/searchchannels.

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