ABB INDUSTRIAL DRIVES

# ACS880-04F drive modules

## Hardware manual


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Hardware manual




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# Safety instructions

## Contents of this chapter

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

## Use of warnings and notes

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

The manual uses these warning symbols:

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

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

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

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

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

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

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

- Be careful when handling a tall module. The module overturns easily because it is heavy and has a high center of gravity. Whenever possible, secure the module with chains. Do not leave an unsupported module unattended especially on a sloping floor.

- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, and brake resistors, remain hot for a while after disconnection of the electrical supply.
- 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 16).
- 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.

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# 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 checking the delivery, installing and commissioning the drive. The flowchart refers to chapters/sections in this manual and other manuals.

## Applicability

This manual applies to ACS880-04F drive module units 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.

## Purpose of the manual

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

## Categorization by frame size and option code

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

The instructions and technical data which concern only certain optional selections are marked with option codes, for example +E208. The options included in the drive can be identified from the option codes visible on the type designation label. The option selections are listed in section Type designation key (page 33).

# Quick installation, commissioning and operating flowchart

| Task | See |
|---|---|
| Plan the mechanical and electrical installation and acquire the accessories needed (cables, fuses, etc.). Check 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 37)<br>Guidelines for planning the electrical installation (page 57)<br>Technical data (page 131)<br>Resistor braking (page 191)<br>Option manual (if optional equipment is included) |
| ⬇ | |
| Unpack and check the units.<br>Check that all necessary optional modules and equipment are present and correct.<br>Only intact units can be started up. | Moving and unpacking the unit (page 45)<br>Examining the delivery (page 49)<br>If the drive has not been powered (either in storage or unused) for a year or more, the converter DC link capacitors need to be reformed. (Reforming the capacitors (page 125)) |
| ⬇ | |
| Check the installation site. Fasten the base of the cabinet to the floor. | Examining the installation site (page 45)<br>Ambient conditions (page 150) |
| ⬇ | |
| Route the cables. | Routing the cables (page 71) |
| ⬇ | |
| Check the insulation of the supply cable, the motor and the motor cable and the resistor cable (if present). | Measuring the insulation (page 84) |
| ⬇ | |
| Installing the drive module<br>• Install the drive module into the cabinet.<br>• Install the additional components into the cabinet: for example, main disconnector, main contactor, main AC, fuses, etc.<br>• Connect the motor cables to the drive module terminals.<br>• Connect the brake resistor and DC connection cables (if any) to the drive module terminals.<br>• If the main disconnector is installed into the cabinet, connect it to the drive module terminals and the input power cabling to the disconnector.<br>• Connect the cables from the drive module to the external control unit and install the control unit into the cabinet. | Mechanical installation (page 45)<br>Connecting the power cables (page 86)<br>Connecting the external control unit to the drive module (page 91)<br>Attaching the external control unit (page 53)<br>Manuals for any optional equipment |
| ⬇ | |
| Connect the external control cables to the drive control unit. | Connecting the control cables to the terminals of the external control unit (page 94) |
| ⬇ | |
| Check the installation. | Installation checklist (page 111) |
| ⬇ | |

| Task | See |
|---|---|
| Commission the drive. | Start-up (page 113) |
| ⬇ | |
| Commission the brake chopper (if used). | Resistor braking (page 191) |
| ⬇ | |
| Operate the drive: start, stop, speed control etc. | Appropriate firmware manual |

# Terms and abbreviations

| Term | Description |
|---|---|
| BGDR | Gate driver board |
| DDCS | Distributed drives communication system protocol |
| Drive | Frequency converter for controlling AC motors |
| DTC | Direct torque control, a motor control method |
| EMC | Electromagnetic compatibility |
| EMI | Electromagnetic interference |
| FAIO-01 | Analog I/O extension module |
| FCAN | Optional CANopen® adapter module |
| FCNA-01 | Optional ControlNet™ adapter module |
| FDCO-01 | DDCS communication module with two pairs of 10 Mbit/s DDCS channels |
| FDCO-02 | DDCS communication module with one pair of 10 Mbit/s and one pair of 5 Mbit/s DDCS channels |
| FDIO-01 | Optional digital I/O extension module |
| FDNA-01 | Optional DeviceNet™ adapter module |
| FECA-01 | Optional EtherCAT® adapter module |
| FEN-01 | Optional TTL incremental encoder interface module |
| FEN-11 | Optional TTL absolute encoder interface module |
| FEN-21 | Optional resolver interface module |
| FEN-31 | Optional HTL incremental encoder interface module |
| FENA-11 | Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols |
| FENA-21 | Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port |
| FEPL-01 | Optional Ethernet POWERLINK adapter module |
| FIO-01 | Optional digital I/O extension module |
| FIO-11 | Optional analog I/O extension module |
| FPBA-01 | Optional PROFIBUS DP® adapter module |
| Frame, frame size | Physical size of the drive or power module |
| FSCA-01 | Optional RS-485 (Modbus/RTU) adapter |
| FSE-31 | Optional pulse encoder interface module for safety encoder |
| FSO-12, FSO-21 | Optional functional safety modules |
| FSPS | Optional functional safety module |
| HTL | High-threshold logic |
| IGBT | Insulated gate bipolar transistor |
| IT system | Type of supply network that has no (low-impedance) connection to ground. See IEC 60364-5. |
| 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 |

| Term | Description |
|---|---|
| TTL | Transistor-transistor logic |
| ZCU | Type of control unit |
| ZINT | Main circuit board |
| ZPOW | Power supply board |

## Related documents

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

ACS880-04 manuals

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# Operation principle and hardware description

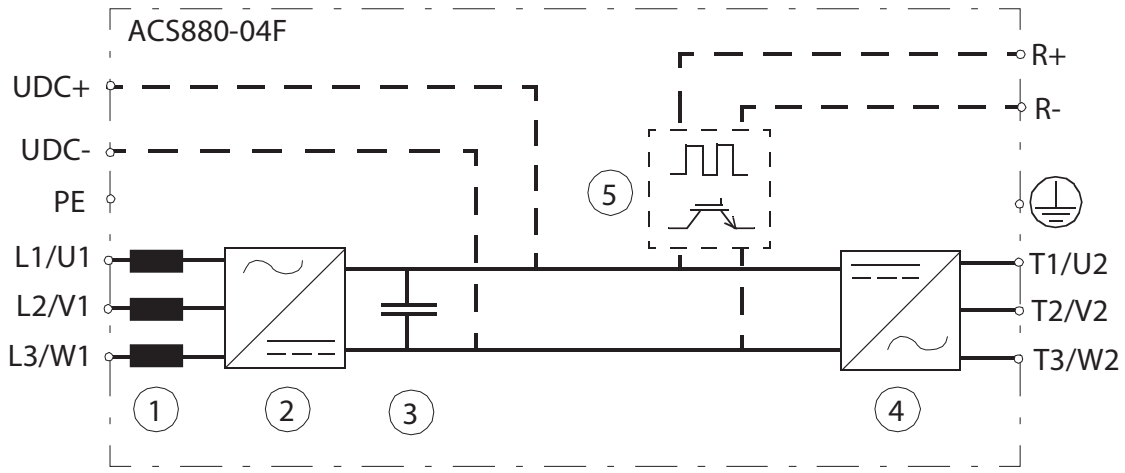
## Contents of this chapter

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

# Product overview

The ACS880-04F is a drive module for controlling asynchronous AC induction motors, permanent magnet motors, AC induction servomotors and ABB synchronous reluctance motors (SynRM motors).

The main circuit of the drive module is shown below.




| | |
|---|---|
| 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. |

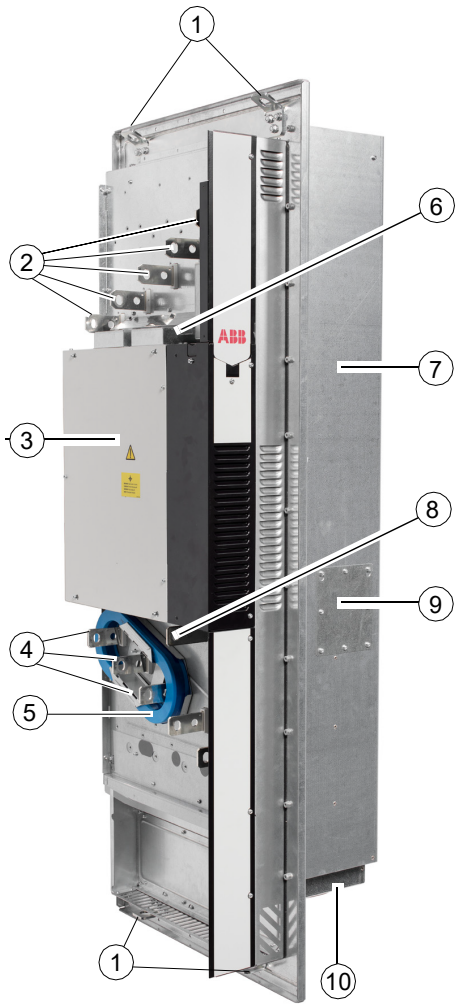
# Layout

## Standard drive module configuration


| | |
|---|---|
| A | Front view |
| B | Back view |
| 1 | Drive module |
| 2 | Upper front cover |
| 3 | Lower front cover |
| 4 | Clear plastic shrouds attached |
| 5 | Heatsink cleaning hole cover |
| 6 | Flange |
| 7 | Hood |
| 8 | External control unit |
| 9 | Control panel |
| See the part descriptions below. | |


| | | | |
|---|---|---|---|
| 1 | Clear plastic shroud to be attached onto the drive module input power cabling (a). Entry shroud for side cabling (b). | 11 | PE (ground) terminal |
| 2 | Clear plastic shroud to be attached onto the drive module output power cabling | 12 | Main cooling fans |
| 3 | Clear plastic shroud to be attached on top of the drive module (entry for top cabling) | 13 | External control unit |
| 4 | Upper back clear plastic shroud | 14 | Control panel |
| 5 | Lower back clear plastic shroud | 15 | Control cable clamp plate |
| 6 | Front clear plastic shroud | 16 | Cables for connecting the control unit to the drive module |
| 7 | Input power cable connection terminals (option +H370) | 17 | Fiber optic cables |
| 8 | Output power cable connection terminals | 18 | Support brackets |
| 9 | Grounding terminal for output power cable shields | 19 | Lifting lugs |
| 10 | Metallic shroud. With option +H370, the shroud includes a ground bar. | - | - |

## Drive module without full-size output cable connection terminals (option +0H371) and IP20 shrouds (option +0B051), with common mode filter (+E208)



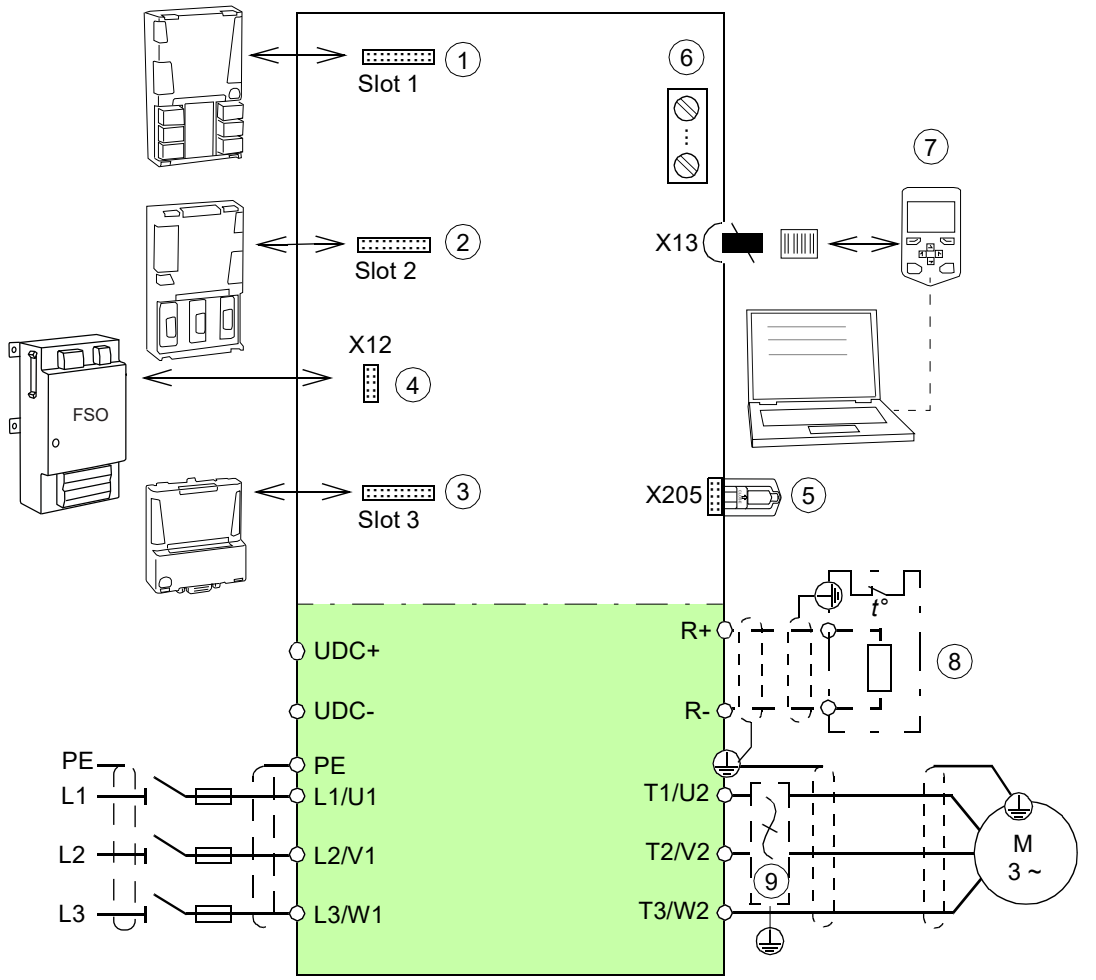

| | |
|---|---|
| 1 | Lifting lugs |
| 2 | Input cable connection busbars (L1/U1, L2/V1, L3/W1) and DC+ and DC- busbars (UDC+, UCD- with option +H356) |
| 3 | Circuit board compartment |
| 4 | Output cable connection busbars (T1/U2, T2/V2, T3/W2) and brake resistor connection busbars (R+ and R- with option +D150) |
| 5 | Common mode filter (option +E208) |
| 6 | Auxiliary cooling fans |
| 7 | Heatsink |
| 8 | PE busbar |
| 9 | Cover on heatsink cleaning hole |
| 10 | Main cooling fans |

## Control unit

See section Standard drive module configuration (page 29)

# Overview of power and control connections

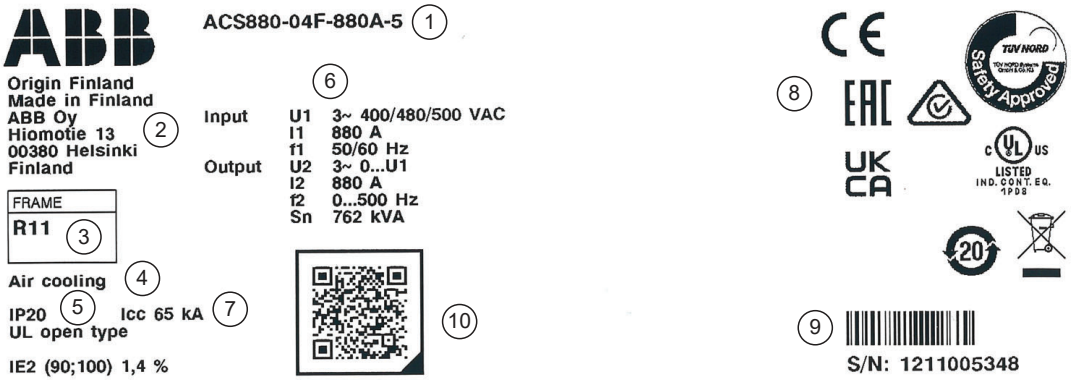
The diagram below shows the power connections and control interfaces of the drive unit.




| | |
|---|---|
| 1,2,3 | Analog and digital I/O extension modules, feedback interface modules and fieldbus communication modules can be inserted into slots 1, 2 and 3. See section Type designation key (page 33). |
| 4 | Connector for the FSO-xx safety functions module (X12). The module can be installed on or above the control unit. |
| 5 | Memory unit, see Replacing the memory unit of ZCU-14 (page 126) |
| 6 | I/O terminal blocks, see section Default I/O diagram of the drive control unit (ZCU-1x) (page 103) |
| 7 | Control panel, see section Connecting a control panel (page 96) |
| 8 | Brake resistor (optional, see chapter Resistor braking (page 191)) |
| 9 | d*u*/d*t* or sine filter (optional, see chapter Filters (page 199)) |

# Type designation label

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




| | |
|---|---|
| 1 | Type designation, see section Type designation key (page 33) |
| 2 | Manufacturer's address |
| 3 | Frame size |
| 4 | Cooling method |
| 5 | Degree of protection |
| 6 | Ratings. See section Electrical ratings (page 131). |
| 7 | Short-circuit withstand strength. See section Electrical power network specification (page 146). |
| 8 | Valid markings |
| 9 | Serial number. The first digit of the serial number refers to the manufacturing plant. The next four digits refer to the unit's manufacturing year and week, respectively. The remaining digits complete the serial number so that there are no two units with the same number. |
| 10 | Link to product information |

# Type designation key

The type designation contains information on the specifications and configuration of the drive. The first digits from left express the basic drive type. The optional selections are given thereafter, separated by plus signs. 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 |
|---|---|
| ACS880 | Product series |
| **Type** | |
| -04F | The standard delivery includes: flange-mounted drive module to be installed in a an enclosure, IP20 (UL Type Open), flat mounting, no pedestal, external control unit, ACS-AP-W Assistant control panel with Bluetooth interface and panel holder, build-in choke, full-size output cable connection terminals, no EMC filter, no DC connection busbars, clear plastic shrouds for covering the input power and motor cable connections, ACS880 primary control program, Safe torque off function, coated boards, printed multilingual quick start-up and installation guides.<br>Refer to section Option codes (page 34) for options. |
| **Size** | |
| -xxxxA | See the rating tables |
| **Voltage range** | |

| Code | Description |
|---|---|
| -3 | 380…415 V AC. This is indicated in the type designation label as typical input voltage level (3~ 400 V AC) |
| -5 | 380…500 V AC. This is indicated in the type designation label as typical input voltage levels (3~ 400/480/500 V AC) |
| -7 | 525…690 V AC. This is indicated in the type designation label as typical input voltage levels (3~ 525/600/690 V AC) |

## Option codes

| Code | Description |
|---|---|
| 0B051 | No IP20 shrouds for cabling area |
| C217 | Wall mounting kit (to be used, if the module is mounted on the wall from its back instead of the flange) |
| D150 | Brake choppers |
| E200 | EMC filter for 2nd environment TN (grounded) system, category C3 |
| E201 | EMC filter for 2nd environment IT (ungrounded) system, category C3 |
| E208 | Common mode filter |
| 0H371 | No full size cable connection terminals for output power cables |
| H356 | DC connection busbars |
| H370 | Full-size input terminals |
| 0J400 | No control panel |
| J410 | DPMP-01 door mounting kit |
| J413 | DPMP-02 door mounting kit (surface mounting) for the panel |
| J425 | ACS-AP-I control panel |
| J461 | ACS-DCP-11 drive connectivity panel (EU variant) |
| K451 | FDNA-01 DeviceNet™ adapter module |
| K454 | FPBA-01 PROFIBUS DP adapter module |
| K457 | FCAN-01 CANopen adapter module |
| K458 | FSCA-01 RS-485 (Modbus/RTU) adapter module |
| K462 | FCNA-01 ControlNet™ adapter module |
| 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 |
| L500 | FIO-11 analog I/O extension module (1, 2 or 3 pcs) |
| L501 | FIO-01 digital I/O extension module |
| L502 | FEN-31 HTL incremental encoder interface module |
| L503 | FDCO-01 optical DDCS communication adapter module |
| L508 | FDCO-02 optical DDCS communication adapter module |
| L516 | FEN-21 resolver interface module |
| L517 | FEN-01 TTL incremental encoder interface module |

| Code | Description |
|---|---|
| L518 | FEN-11 TTL absolute encoder interface module |
| L525 | FAIO-01 analog I/O extension module |
| L526 | FDIO-01 digital I/O extension module |
| L536 | FPTC-01 thermistor protection module |
| L537 | FPTC-02 ATEX-certified thermistor protection module |
| N5000 | Winder control program |
| N5050 | Crane control program |
| N5100 | Winch control program |
| N5150 | Centrifuge control program |
| N5200 | PCP (Progressive Cavity Pump) control program |
| N5250 | Rod pump control program |
| N5350 | Cooling tower control program |
| N5450 | Override control program |
| N5500 | Spinning and traverse control program |
| N5600 | ESP (Electrical Submersible Pump) control program |
| N5650 | Tower crane control program |
| N7502 | Control program for synchronous reluctance motors (SynRM) |
| N8010 | Drive application programming |
| N8200 | High speed license for > 598 Hz operation |
| P904 | Extended warranty (24 months from commissioning or 30 months from delivery) |
| Q971 | ATEX-certified safe disconnection function |
| Q972 | FSO-21 safety functions module |
| Q973 | FSO-12 safety functions module |
| Q982 | PROFIsafe with FSO-xx safety functions module and FENA-21 Ethernet adapter module |
| Q986 | PROFIsafe safety functions module, FSPS-21 |
| R700 | Documentation/manuals in English |
| R701 | German |
| R702 | Italian |
| R703 | Dutch |
| R704 | Danish |
| R705 | Swedish |
| R706 | Finnish |
| R707 | French |
| R708 | Spanish |
| R709 | Portuguese |
| R711 | Russian |
| R712 | Chinese |
| R713 | Polish |
| R714 | Turkish |

4

# 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.

For general instructions, see Cabinet design and construction instructions for drive modules (3AUA0000107668 [English]).

## Installation alternatives

The drive module can be installed from the flange onto a cabinet wall or a mounting plate with the heatsink (degree of protection IP55) in a cooling air channel or outside protected against humidity, dust and chemical gases according to the ambient conditions requirements given in section Ambient conditions (page 150). The control circuit compartment side of the module (degree of protection IP20) is to be installed in clean air. The drive module can also be installed from the heatsink with mounting brackets (option 3AXD50000303533).

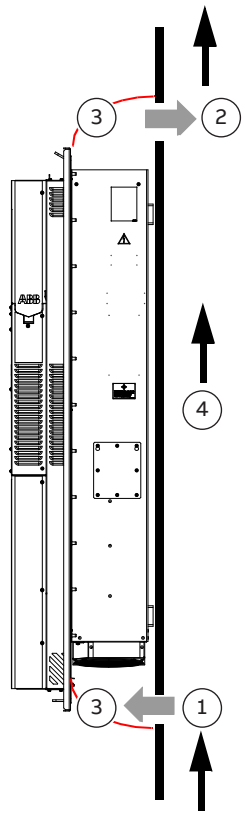
The drive module can be cabled from top or bottom to cable connection terminals or sideways with busbars directly to the module busbars at its side.

## Channel installation

### Basic requirements for the channel wall

The channel wall where the drive module is mounted on must be non-flammable and sturdy enough to carry the weight of the drive module.

## Installation principle

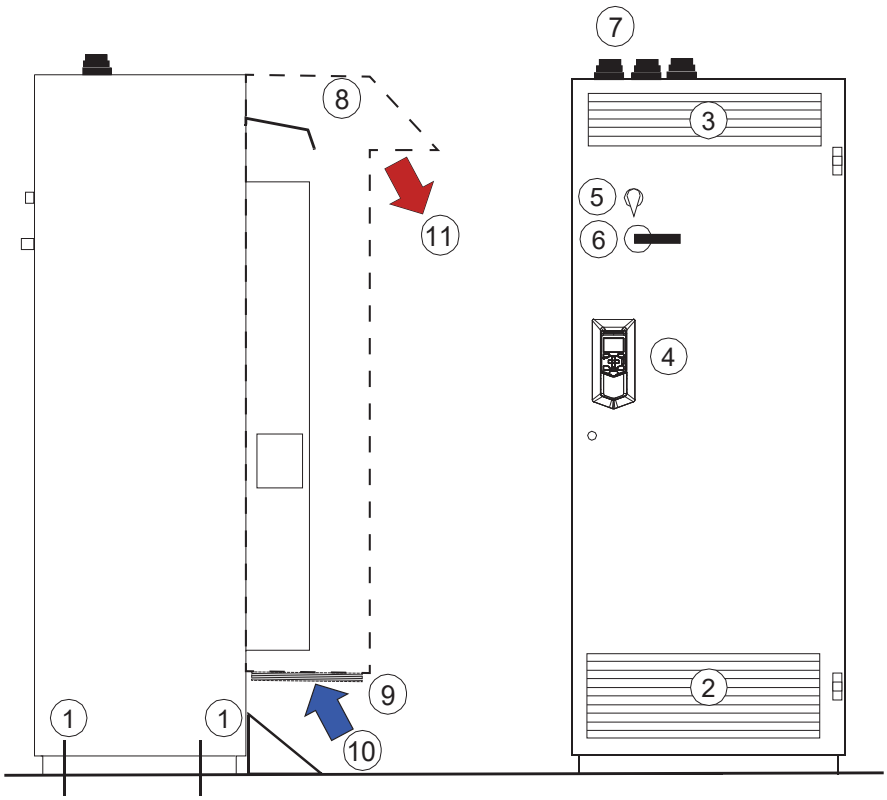



| | |
|---|---|
| 1 | Cool air in, max. 40 °C (104 °F) |
| 2 | Hot air out |
| 3 | Air guide |
| 4 | Air flow in the cooling air channel |

# Cabinet installation

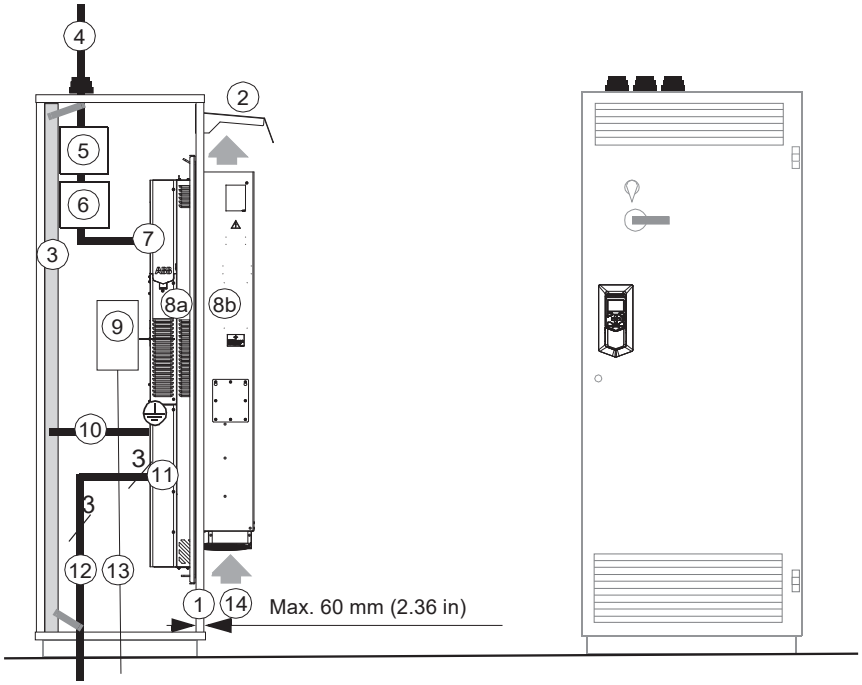
## Layout example, outside view

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




| | |
|---|---|
| 1 | **WARNING!** Attach the cabinet to the floor or prop it up from the back. The module has its center of gravity at the back and the cabinet easily topples over. |
| 2 | Air inlet for the power cable connection and circuit board compartment part of drive module and for other equipment. For losses and cooling data requirements, see the technical data. |
| 3 | Air outlet for the power cable connection and circuit board compartment part of drive module and other equipment |
| 4 | Drive control panel with DPMP-01 mounting platform (option +J410). The control panel is connected to the drive module control unit inside the cabinet. |
| 5 | Contactor control switch and emergency stop switch (connected to the contactor control circuit inside the cabinet) |
| 6 | Operating handle of the disconnector |
| 7 | Rubber grommets for degree of protection |
| 8 | Addtional enclosure for outdoor installation in harsh environment<br><br>**Note:** Heatsink is not suitable for direct outdoor exposure without additional protection against sand, rain or corrosive gases, see Ambient conditions (page 150). |
| 9 | Cooling air filter |
| 10 | Cool air in |
| 11 | Hot air out |

## Layout example, inside view




| | | | |
|---|---|---|---|
| 1 | Cabinet back plate. The maximum allowed depth of the back plate is 60 mm (2.36 in.) in order not to cover the air flow grate at the top of the heatsink. | 8 | Drive module front part (a), drive module heatsink part (b) |
| 2 | Hood | 9 | Drive module control unit |
| 3 | Cabinet grounding busbar (PE) | 10 | Grounding conductor |
| 4 | Input power cable including the protective ground conductor (PE) of the drive | 11 | Motor cable connection terminals/busbars |
| 5 | Disconnector and fuses | 12 | Motor cable including the protective ground conductor of the drive module |
| 6 | Contactor | 13 | External control cables |
| 7 | Input power cable connection terminals/busbars | 14 | Air flow |

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

**Note:** For option +B051: When the bottom grille and clear plastic shrouds around the motor cables are installed, the degree of protection of the drive module from bottom side is IP20.

**Note:** See also Required free space (page 43).

## Mounting the control panel on the cabinet door

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

| Manual | Code (English) |
|---|---|
| DPMP-01 mounting platform for control panels installation guide | 3AUA0000100140 |
| DPMP-02/03 mounting platform for control panels installation guide | 3AUA0000136205 |
| DPMP-04 and DPMP-05 mounting platform for control panels installation guide | 3AXD50000308484 |
| DPMP-06/07 mounting platform for control panels installation guide | 3AXD50000289561 |

| | | |
|---|---|---|
|  |  |  |
| DPMP-01 | DPMP-02 | DPMP-04 |
| IP54 (UL Type 12) when control panel is mounted<br>IP20 (UL Open Type) when control panel is not mounted | IP65 (UL Type 12) when control panel is mounted<br>IP20 (UL Open Type) when control panel is not mounted | IP66 (UL Types 3, 3R and 4) when mounted inside or outside the cabinet door |

| | |
|---|---|
|  |  |
| DPMP-06 | DPMP-07 |
| UL Type 12 when panel is mounted. UL open when panel is not mounted. | UL Type 12 when panel is mounted. UL open when panel is not mounted. |

## Installation positions other than vertical

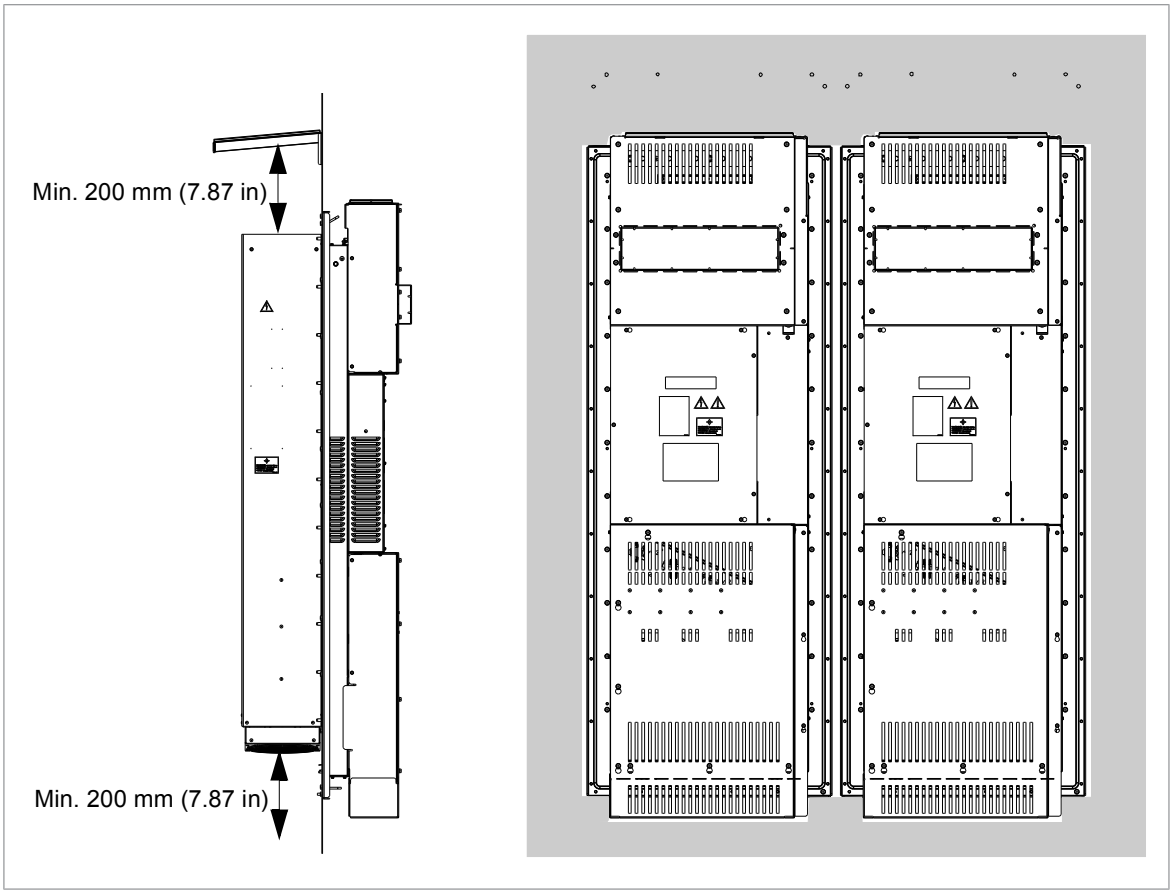
You can install the drive module on its back. Make sure that the hot cooling air which flows upwards from the module does not cause danger.

For other installation positions, contact ABB.

## Required free space

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

The required free space at the top and bottom of the drive module is shown below. The modules can be installed side by side.



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# Mechanical installation

## Contents of this chapter

This chapter describes how to install the drive module mechanically without the clear plastic shrouds. The shrouds are attached after the power cabling.

## 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

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

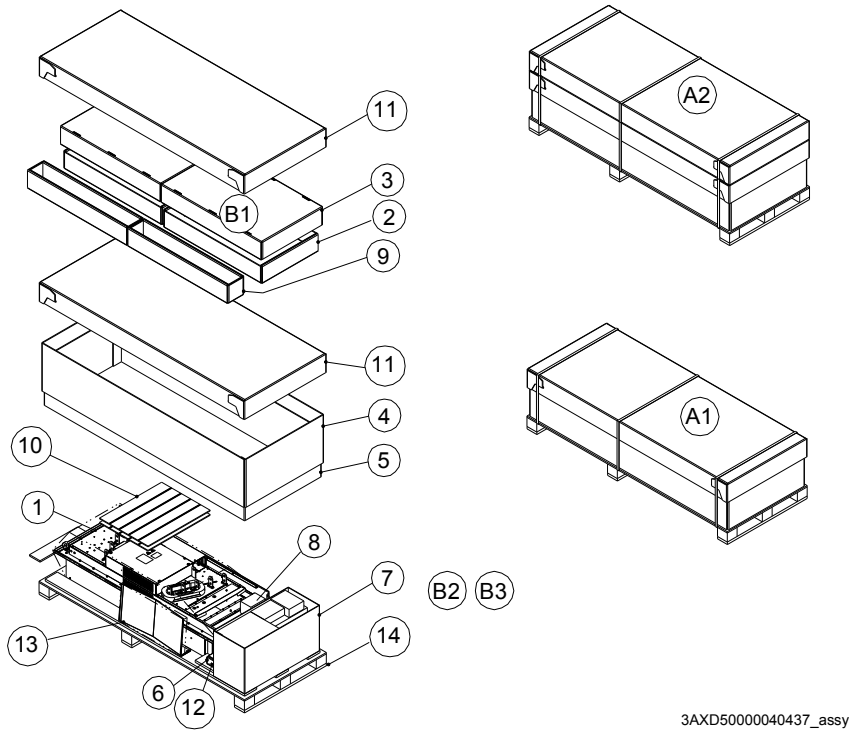
Move the transport package by pallet truck to the installation site.

## Unpacking

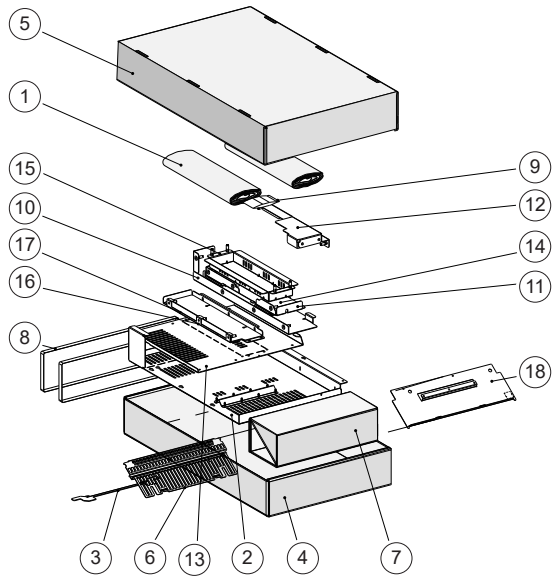
Unpack the package as follows, see section Package drawings (page 47):

- Cut the bands.
- Lift the top lid. If top boxes (B1) are included, lift them off, and remove the lower lid.
- Lift the inner and outer sheathings.
- Remove the additional boxes and supports.

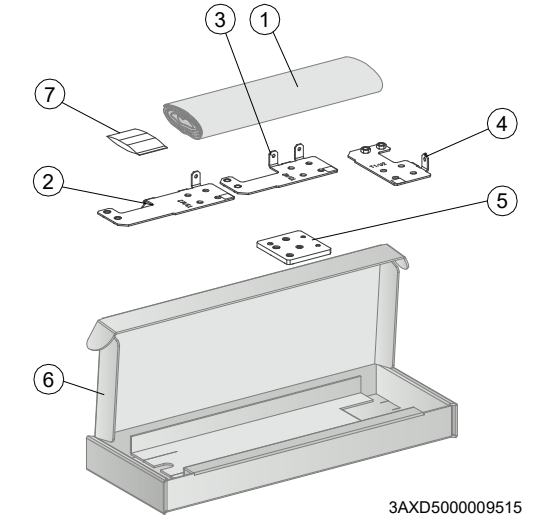
## Package drawings



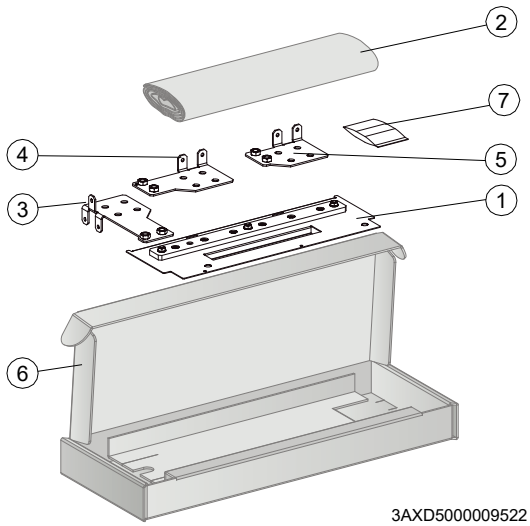

| | |
|---|---|
| A1 | Package with no IP20 shrouds for cabling area (option 0B051) |
| A2 | Standard drive module package |
| 1 | Drive module with factory installed options, delivery documents, multilingual residual voltage warning sticker, printed multilingual installation and start-up guides. Other printed manuals with option +R700. |
| 2 | Cardboard lids |
| 3 | Top box (with standard drive module configuration). Contains IP20 shrouds for cabling area. See below for the box B1 contents. |
| 4 | Outer sheathing |
| 5 | Inner sheathing |
| 6 | Accessories box: screw package, spacers for FSO module installation, rubber grommets for control unit cable entry holes in the middle front cover of the drive module. |
| 7 | Accessory sleeve containing:<br>• external control unit<br>• output cable connection terminal box (B2, see below for the box contents)<br>• input cable connection terminal box (option +H370, B3, see below for the box contents)<br>• control panel door mounting kit |
| 8 | If all options do not fit in the accessory sleeve, the rest are packed in this space on the drive module |
| 9 | Cardboard support tray |
| 10 | Cardboard support |
| 11 | Cardboard lid |
| 12 | Wall mounting brackets with screws for attaching the drive module heatsink by the top and bottom to a mounting plate or wall (option +C217). The brackets bring a gap for cooling air flow and prevent the drive module screws from chafing the plate. See section Attaching the drive module by the heatsink (page 52). |
| 13 | Hood |
| 14 | Pallet |



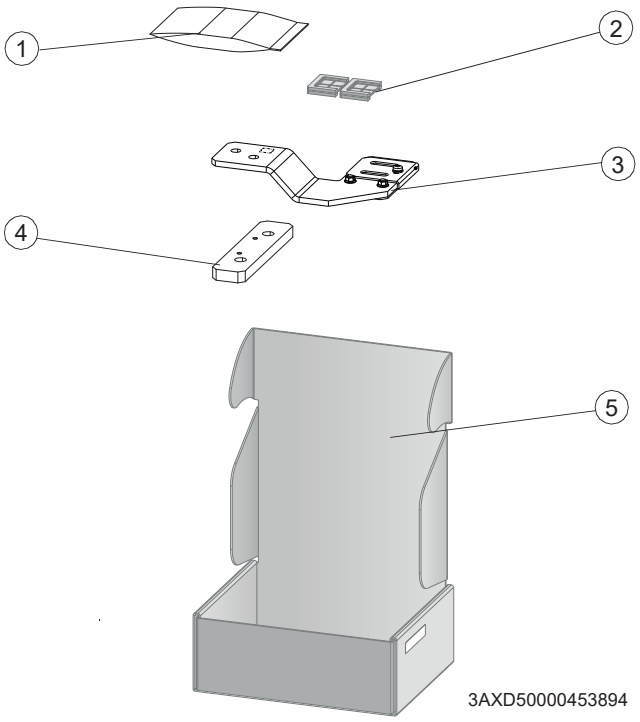

| Box B1 contents (standard drive module configuration) | |
|---|---|
| 1 | Paper fill |
| 2 | Clear plastic shroud for output power cabling |
| 3 | Mounting bracket for bottom grille |
| 4 | Cardboard box bottom |
| 5 | Cardboard box cover |
| 6 | Bottom grille |
| 7 | Support |
| 8 | Straps |
| 9 | Screws in a plastic bag |
| 10 | Back clear plastic shroud (upper) |
| 11 | Back clear plastic shroud (lower) |
| 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 B2 contents (standard drive module configuration) | |
|---|---|
| 1 | Paper fill |
| 2 | Output cable connection terminal T3/W2 |
| 3 | Output cable connection terminal T2/V2 |
| 4 | Output cable connection terminal T1/U2 |
| 5 | Grounding terminal |
| 6 | Cardboard box |
| 7 | Screws and insulators a plastic bag |




| Box B3 contents (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 |

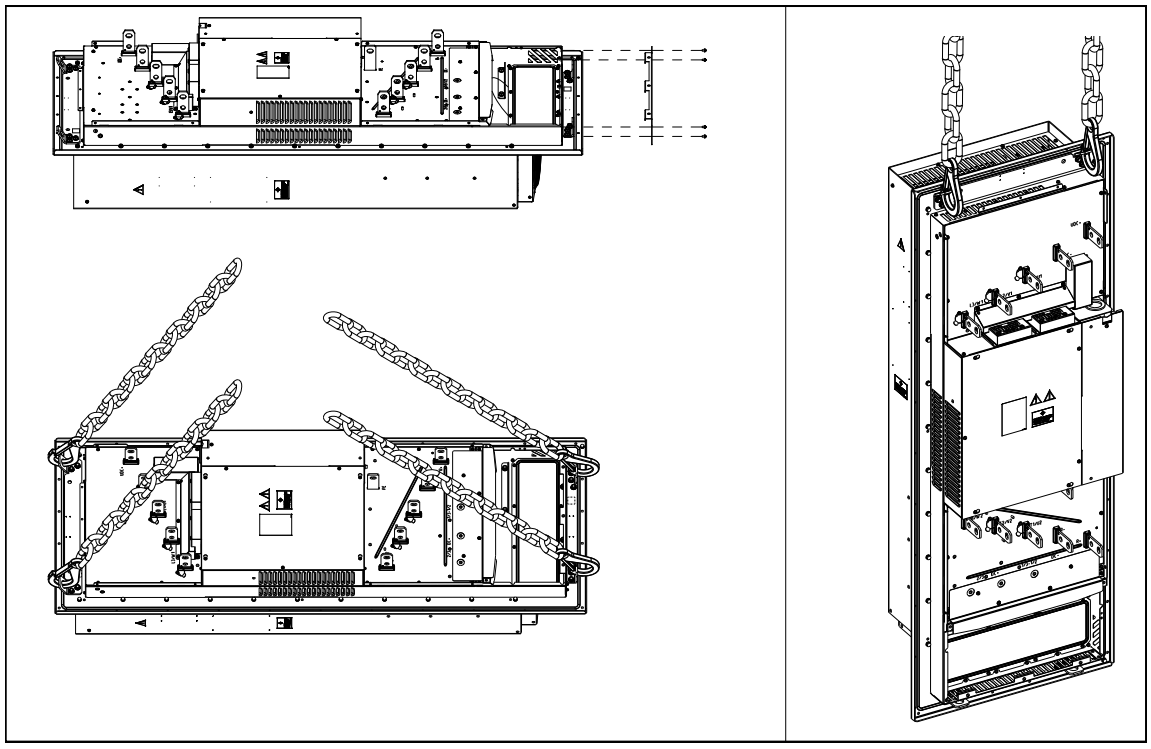
## Examining the delivery

Make sure that all items listed in section Moving and unpacking the unit (page 45) are present.

Make sure that there are no signs of damage. Before you start the installation and operation, see the information on the type designation label of the drive to make sure that it is of the correct type.

## Lifting

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

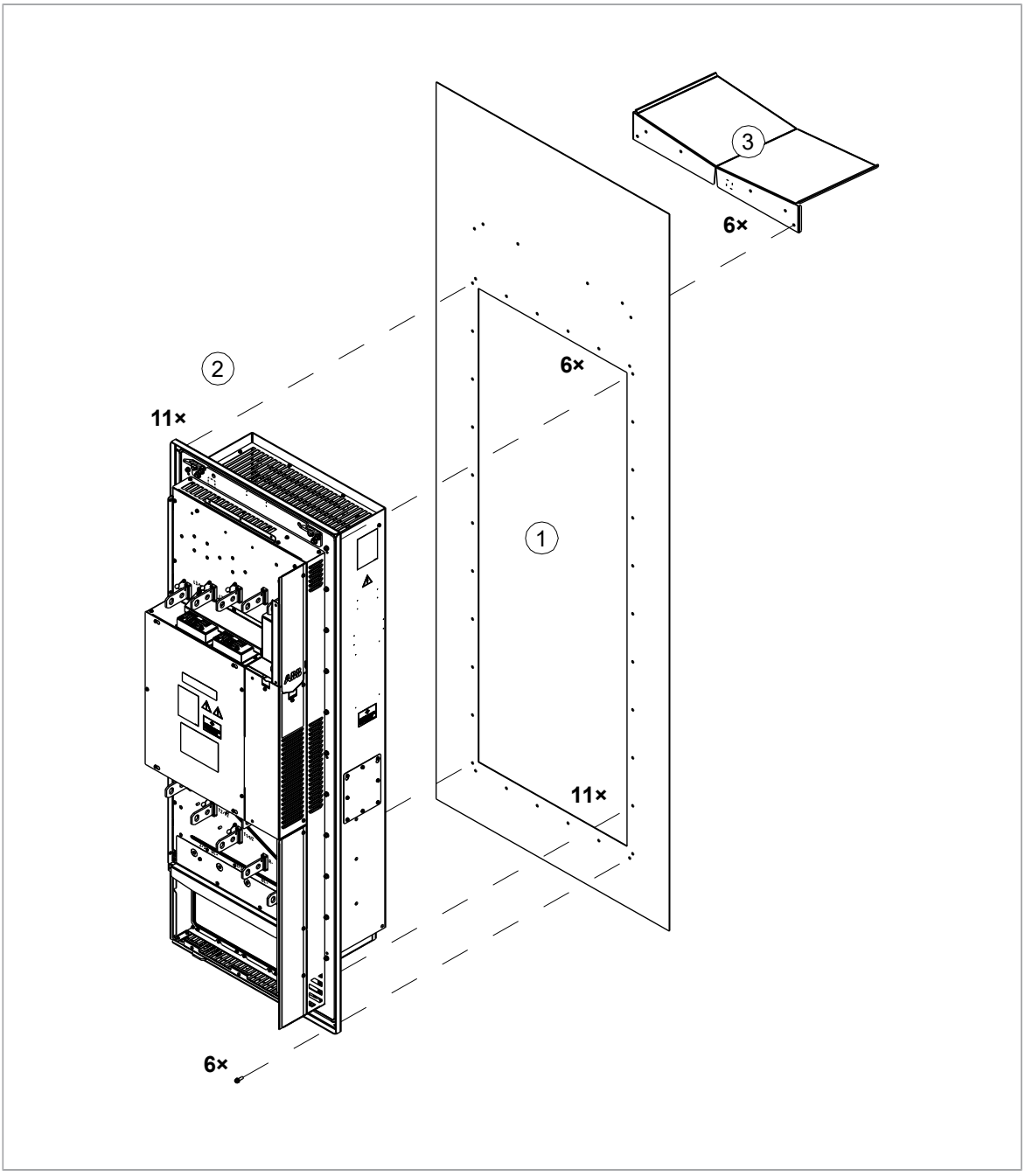


# Attaching alternatives

## Attaching the drive module by the flange

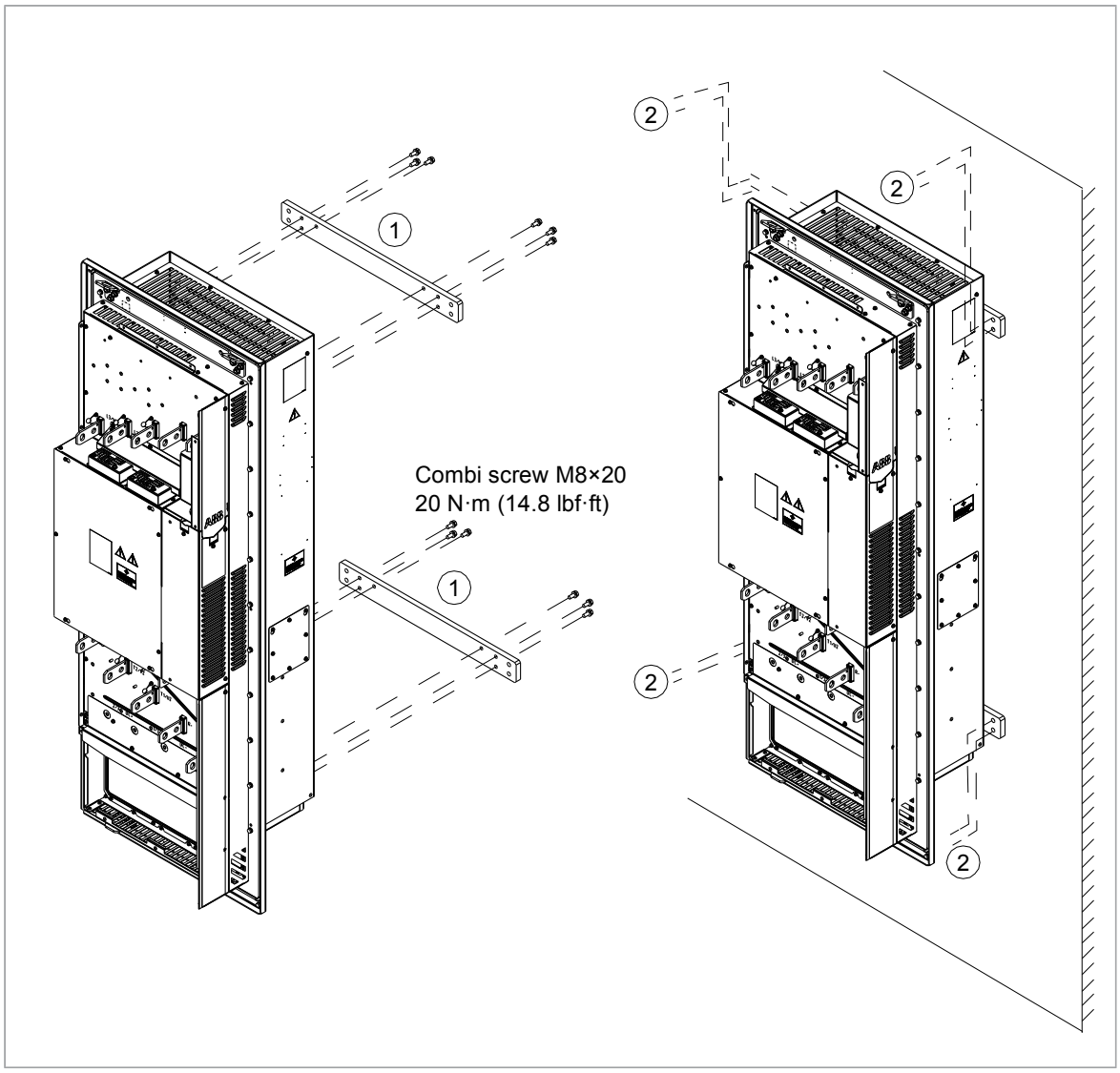
See section Mounting plate opening (page 165) for the mounting point and mounting plate opening dimensions.

1. Make an opening to the mounting plate for the drive module heatsink penetration.
2. Attach the drive module flange to the mounting plate with screws.
3. For UL Type 12 installations and if otherwise needed: Attach the hood.

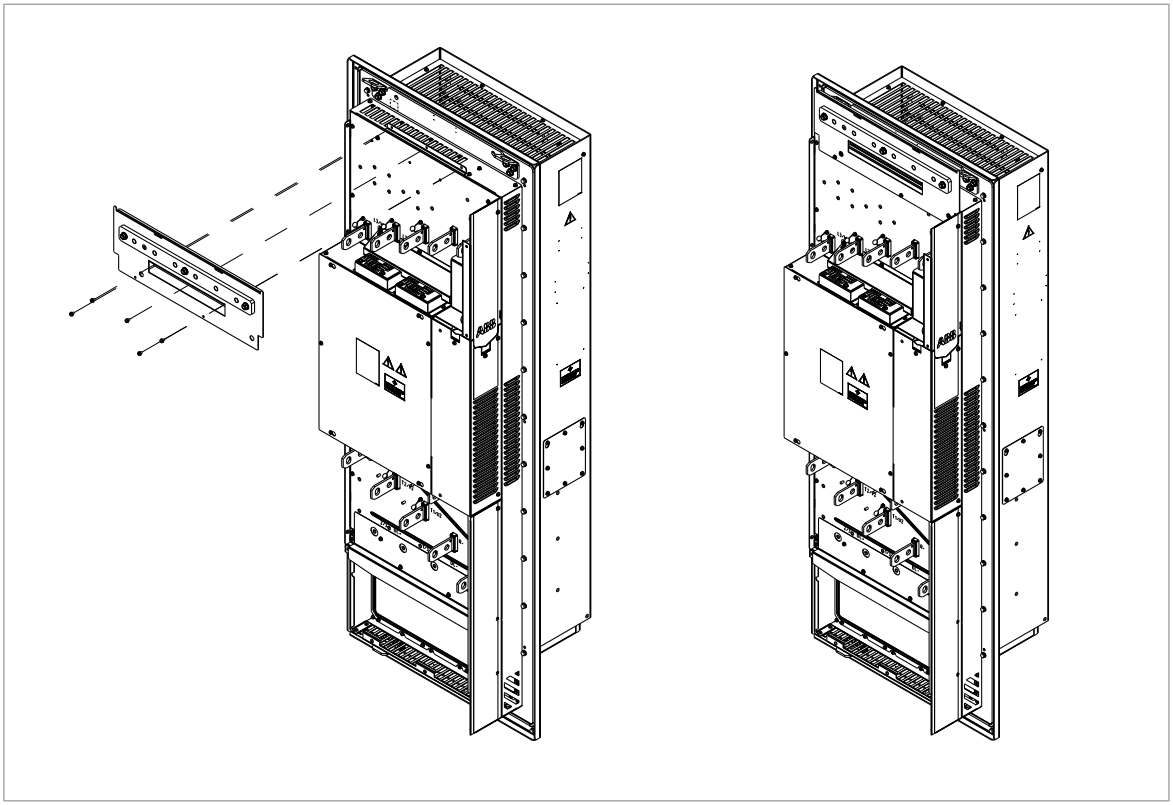


## Attaching the drive module by the heatsink

1. Attach the support brackets to the heatsink back.
2. Attach the support brackets to the wall.



### Attaching the metallic shroud (standard)



## Attaching the external control unit

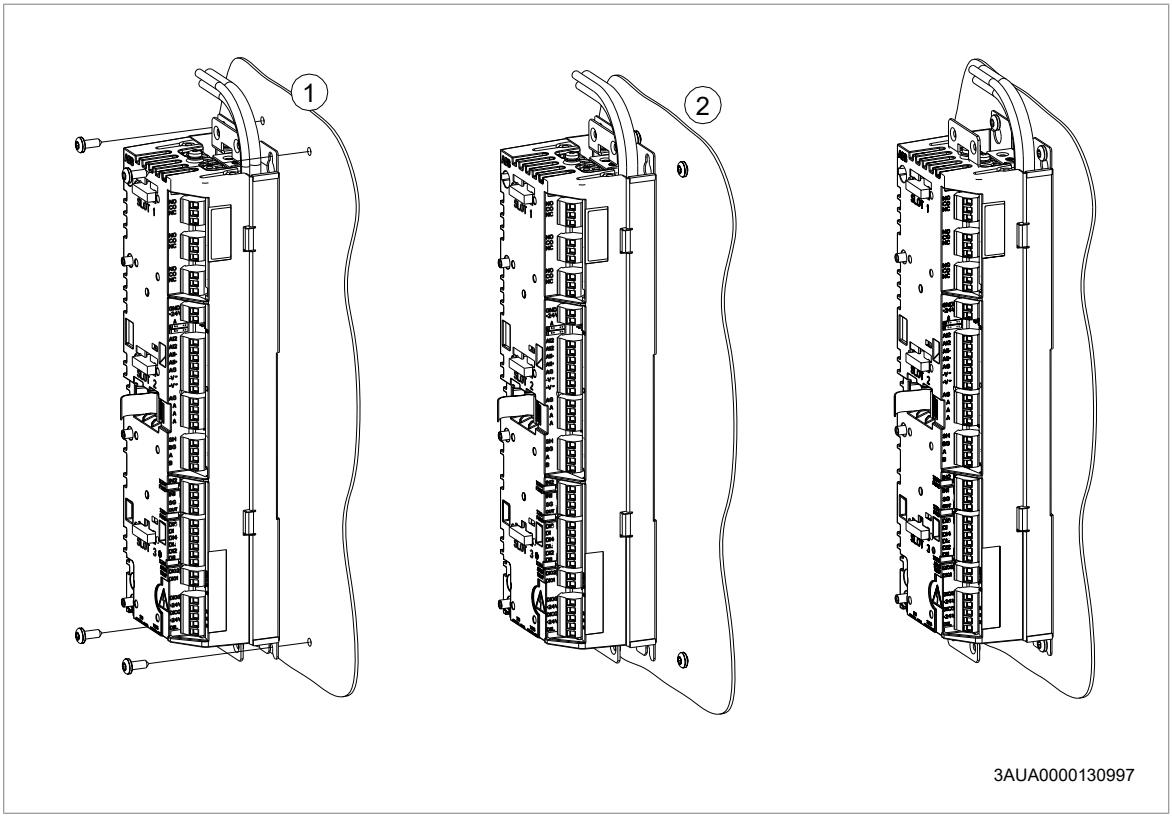
The drive control unit can be attached on a mounting plate or onto a DIN rail.

Connect the fiber optic, power supply and BGDR cables from the drive module to the external control unit before you attach the control unit. See section Connecting the external control unit to the drive module (page 91).

## Attaching the external control unit to a mounting plate or wall

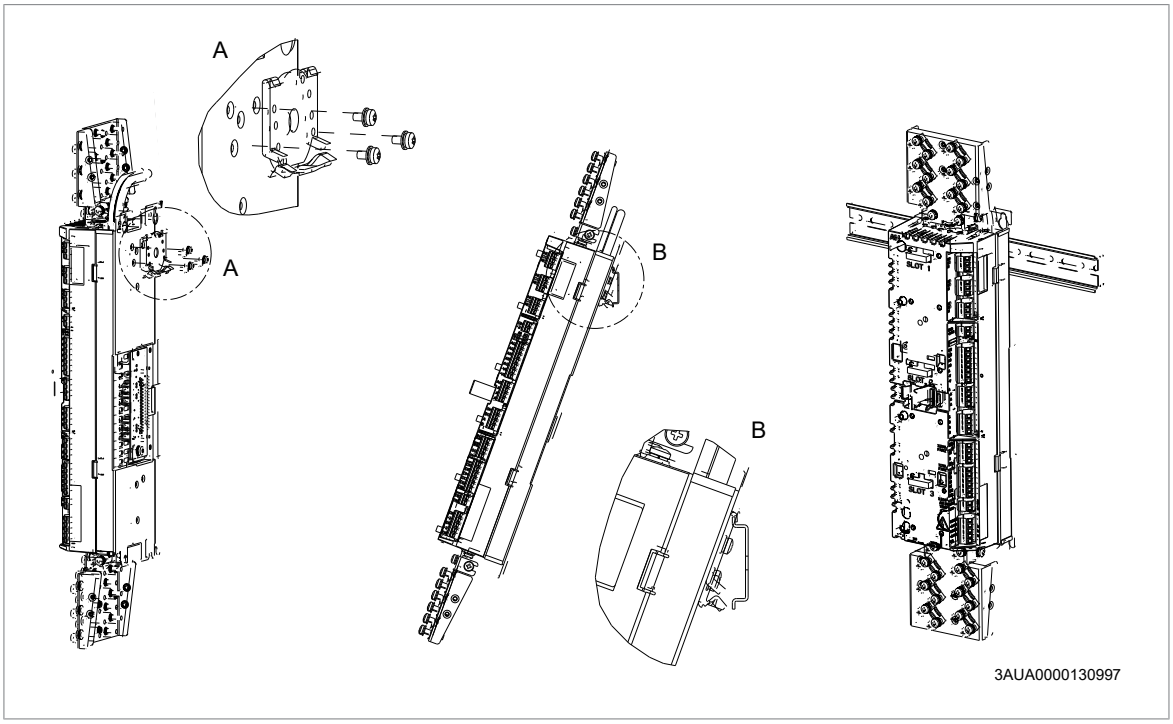
The external control unit and its mounting template are delivered in a cardboard box inside the drive module package. The mounting template contains a mounting pattern for two different control units, one on each side. Make sure to use the ZCU-14 control unit mounting pattern.

1. Mark the positions of the fastening screws to the wall through the mounting template.
2. Attach the screws.
3. Lift the control unit onto the screws and tighten the screws.



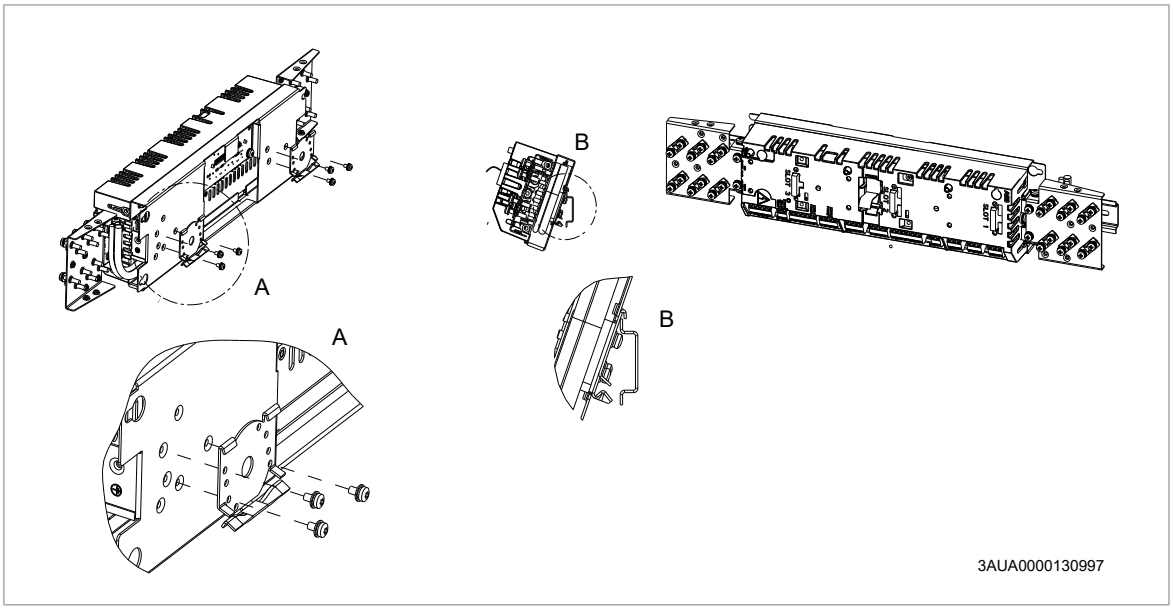

## Attaching the external control unit vertically on a DIN rail

1. Attach the latch (A) to the back of the control unit with three screws.
2. Click the control unit to the rail as shown below (B).




## Attaching the external control unit horizontally on a DIN rail

1. Attach the latches (A) to the back of the control unit with three screws.
2. Click the control unit to the rail as shown below (B).



6

# Guidelines for planning the electrical installation

## Contents of this chapter

This chapter contains 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, AC induction servomotors or ABB synchronous reluctance motors (SynRM motors) with the drive.

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

Make sure that the motor can be used with an AC drive. See Requirements tables (page 59). For basics of protecting the motor insulation and bearings in drive systems, see Protecting the motor insulation and bearings (page 59).

**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 62).

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

[1] manufactured before 1.1.1998

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

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

See also Abbreviations (page 62).

| Motor type | Nominal AC line voltage | Requirement for | | |
|---|---|---|---|---|
| | | Motor insulation system | ABB d$u$/d$t$ 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_ | $U_n$ ≤ 500 V | Standard | + N | + N + CMF |
| | 500 V < $U_n$ ≤ 600 V | Standard | + N + d$u$/d$t$ | + N + d$u$/d$t$ + CMF |
| | | Reinforced | + N | + N + CMF |
| | 600 V < $U_n$ ≤ 690 V (cable length ≤ 150 m) | Reinforced | + N + d$u$/d$t$ | + N + d$u$/d$t$ + CMF |
| | 600 V < $U_n$ ≤ 690 V (cable length > 150 m) | Reinforced | + N | + N + CMF |
| Form-wound HX_ and AM_ | 380 V < $U_n$ ≤ 690 V | Standard | + N + CMF | $P_n$ < 500 kW: +N + CMF |
| | | | | $P_n$ ≥ 500 kW: +N + d$u$/d$t$ + CMF |
| Old[1] form-wound HX_ and modular | 380 V < $U_n$ ≤ 690 V | Check with the motor manufacturer. | + N + d$u$/d$t$ with voltages over 500 V + CMF | |
| Random-wound HX_ and AM_ [2] | 0 V < $U_n$ ≤ 500 V | Enamelled wire with fiber glass taping | + N + CMF | |
| | 500 V < $U_n$ ≤ 690 V | | + N + d$u$/d$t$ + CMF | |
| HDP | Consult the motor manufacturer. | | | |

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

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

See also Abbreviations (page 62).

| Motor type | Nominal AC line voltage | Requirement for | |
|---|---|---|---|
| | | Motor insulation system | ABB d$u$/d$t$ and common mode filters, insulated N-end motor bearings |
| | | | $P_n$ < 100 kW and frame size < IEC 315 |
| | | | $P_n$ < 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 | + d$u$/d$t$ |
| | | Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 µs rise time | - |
| | 500 V < $U_n$ ≤ 600 V | Reinforced: $\hat{U}_{LL}$ = 1600 V | + d$u$/d$t$ |
| | | Reinforced: $\hat{U}_{LL}$ = 1800 V | - |
| | 600 V < $U_n$ ≤ 690 V | Reinforced: $\hat{U}_{LL}$ = 1800 V | + d$u$/d$t$ |
| | | 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 62).

| Motor type | Nominal AC line voltage | Requirement for | | |
|---|---|---|---|---|
| | | Motor insulation system | ABB d$u$/d$t$ 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 | + d$u$/d$t$ + (N or CMF) | + N + d$u$/d$t$ + 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 | + d$u$/d$t$ + (N or CMF) | + N + d$u$/d$t$ + 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 | + d$u$/d$t$ + N | + N + d$u$/d$t$ + 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 |
| d$u$/d$t$ | d$u$/d$t$ 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 d*u*/d*t* filter | Availability of common mode filter (CMF) |
|---|---|---|
| ACS880-04F | Ordered separately, see section d*u*/d*t* filters (page 199) | +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.

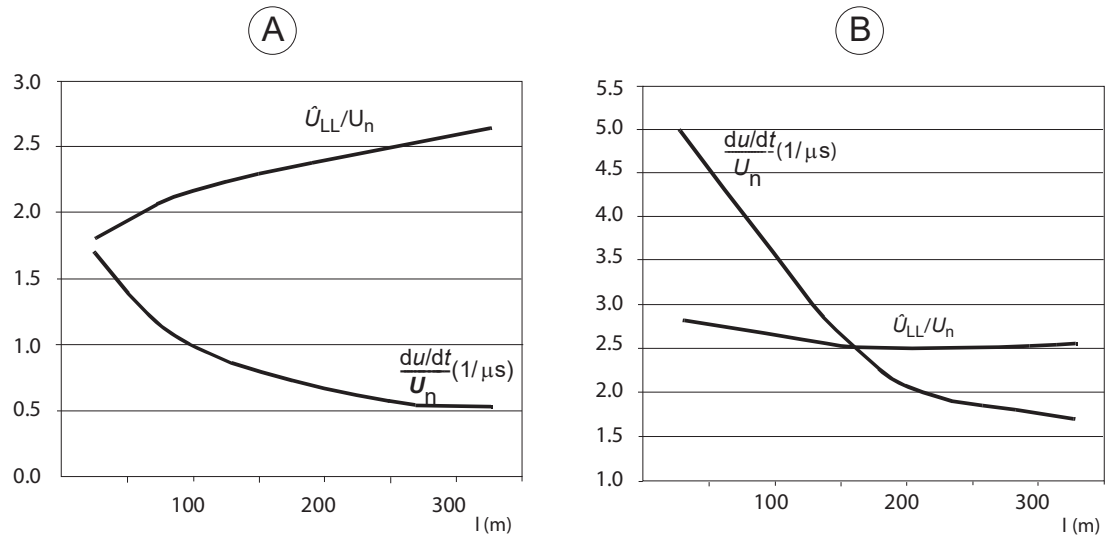
| **Nominal AC supply voltage** | **Requirement for** | | |
|---|---|---|---|
| | **Motor insulation system** | **ABB d*u*/d*t* and common mode filters, insulated N-end motor bearings** | |
| | | **$P_n$ < 100 kW or frame size < IEC 315** | **100 kW < $P_n$ < 350 kW or IEC 315 < frame size < IEC 400**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

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

### 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 · $\hat{U}_{LL}$/(d*u*/d*t*).




| | |
|---|---|
| A | Drive with d*u*/d*t* filter |
| B | 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 with 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 · $U_n$.

# 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 66).

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.

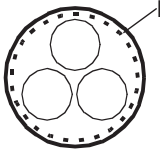
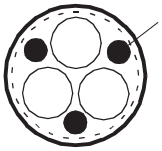
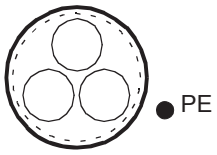
## Typical power cable sizes

See the technical data.

## Power cable types

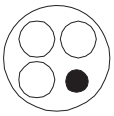
### Preferred power cable types

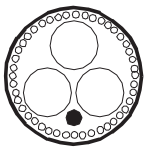
This section presents the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

| 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.

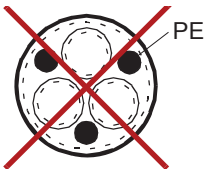
### Alternate power cable types

| 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).<br>**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.<br>Use separate conduit run for each motor.<br>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.<br>Use separate conduit run for each motor.<br>Do not run input power wiring and motor wiring in the same conduit. |
| Wireways [2)] | |
| Metallic | Prefer symmetrical shielded VFD cable.<br>Separate motor wiring from input power wiring and other low voltage wiring.<br>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.<br>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.

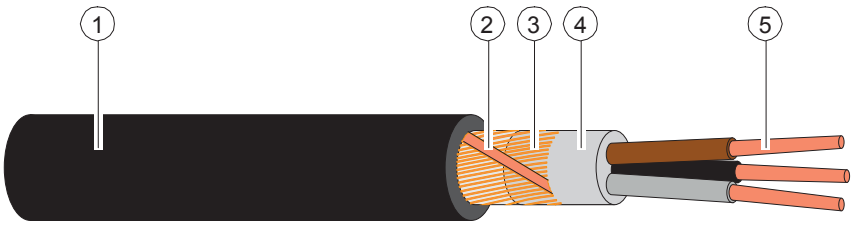
### Metal conduit

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.

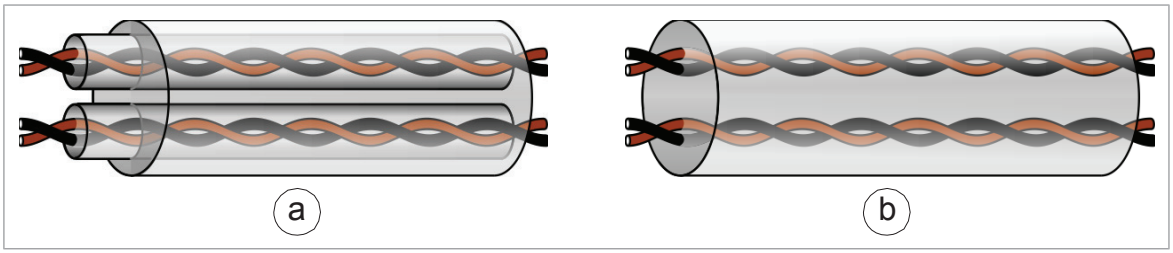
## Selecting the control cables

### 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

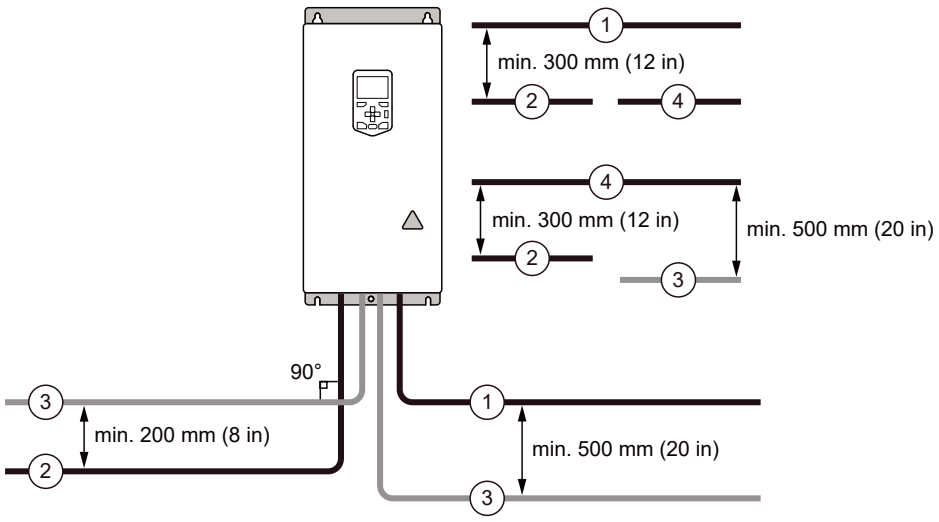
Connect the Drive Composer PC tool to the drive through the USB port of the control panel. Use a USB Type A (PC) - Type Mini-B (control panel) cable. The maximum length of the cable is 3 m (9.8 ft).

## 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.



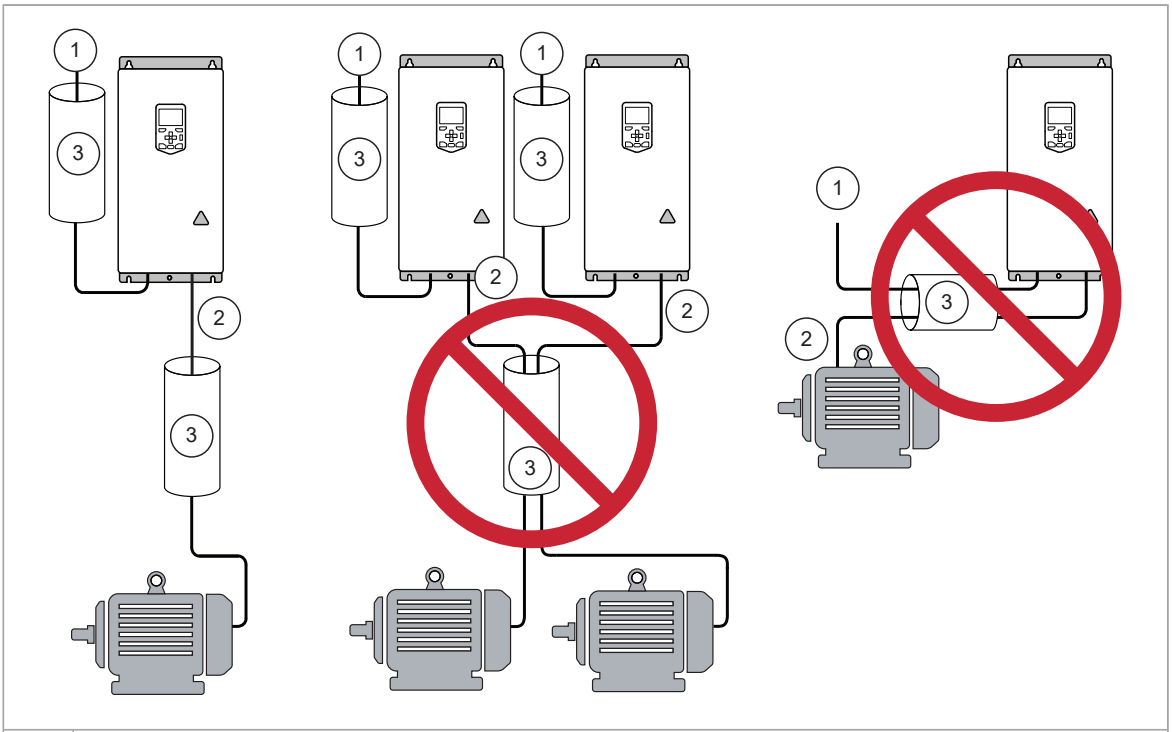

| | |
|---|---|
| 1 | Motor cable |
| 2 | Input power cable |
| 3 | Control cable |
| 4 | Brake resistor or chopper cable (if any) |

## 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 |

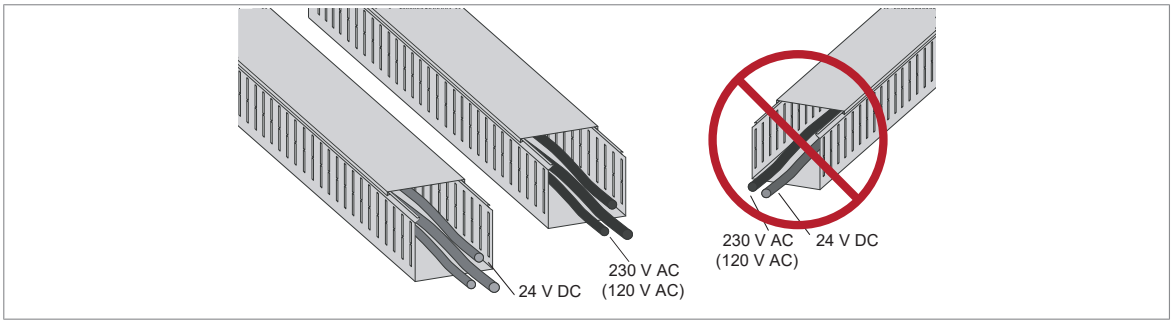
## Continuous motor cable shield/conduit or enclosure for equipment on the motor cable

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

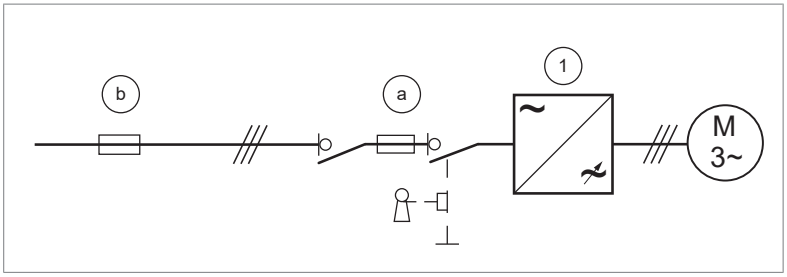
Put 24 V DC and 230 V AC (120 V AC) control cables in separate ducts, unless the 24 V DC cable is insulated for 230 V AC (120 V AC) or insulated with an insulation sleeving for 230 V AC (120 V AC).



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

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

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




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

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.

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

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

## Protecting the 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 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.

## Connecting drive modules to a common DC system

See ACS880-01 drives and ACS880-04 drive modules common DC systems application guide (3AUA0000127818 [English]).

## 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 76). 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** | |
| FIO-11 | Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and other I/O connectors. | x | x | x | Reinforced insulation |
| FIO-21 | Galvanic isolation between sensor connector and other connectors (including drive control unit connector). | x | x | x | Reinforced insulation |
| FEN-01 | Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output. | x | - | - | Reinforced insulation |
| FEN-11 | Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output. | x | x | - | Reinforced insulation |
| FEN-21 | Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and TTL encoder emulation output. | x | x | - | Reinforced insulation |
| FEN-31 | Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and other connectors. | x | x | - | Reinforced insulation |
| FAIO-01 | Basic insulation between sensor connector and drive control unit connector. No insulation between sensor connector and other I/O connectors. | x | x | x | Reinforced or basic insulation. With basic insulation, the other I/O connectors of the option module must be kept disconnected. |
| FPTC-01/02 [1)] | Reinforced insulation between sensor connector and other connectors (including drive control unit connector). | x | - | - | No special requirement |

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

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

## 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 171).

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

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

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

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

See the appropriate manual for more information.

| Name | Code |
|---|---|
| FSO-12 safety functions module user's manual | 3AXD50000015612 |
| FSO-21 safety functions module user's manual | 3AXD50000015614 |

## 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) |
|---|---|
| ATEX-certified Safe disconnection function, Ex II (2) GD for ACS880 drives (+Q971) application guide | 3AUA0000132231 |
| FPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) for ACS880 drives user's manual | 3AXD50000027782 |

## 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.

## 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 DTC motor control mode and the motor ramp stop mode selected, use this operation sequence to open the contactor:

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

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

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

**WARNING!**
When the DTC motor control mode is in use, never open the output contactor while the drive controls the motor. The DTC motor 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 DTC 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.

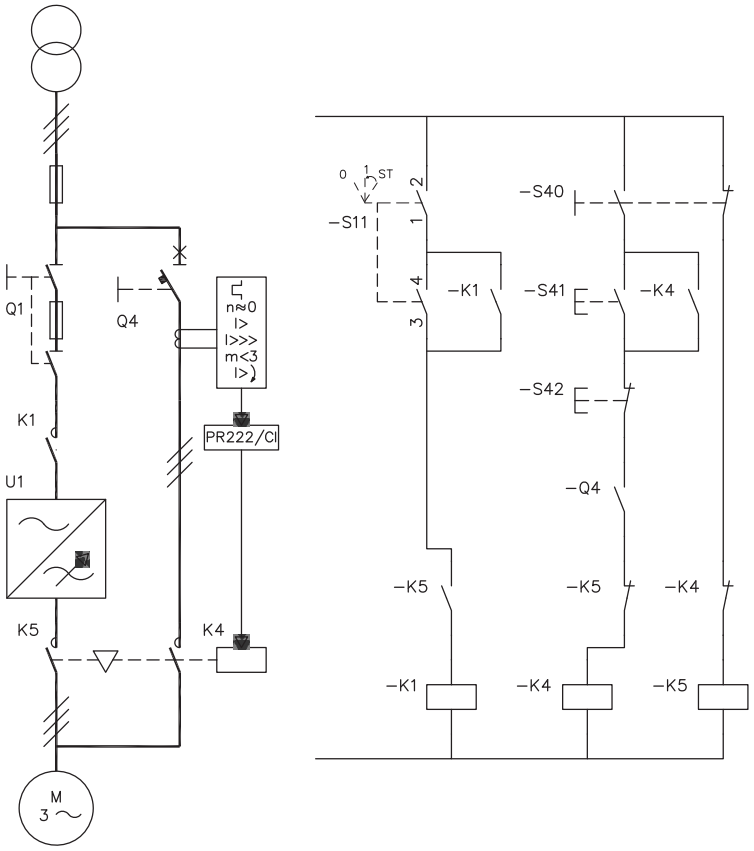
## Implementing a bypass connection

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**

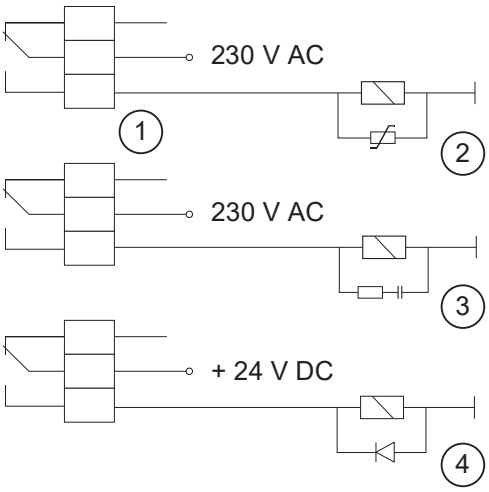
1. Stop the motor with S42.
2. Switch the motor power supply from direct-on-line to the drive with S40.
3. Close the main contactor of the drive with switch S11 (-> turn to position ST for two seconds and leave to position 1).
4. Start the drive and the motor with the drive control panel start key (drive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

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

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




| | |
|---|---|
| 1 | Relay output |
| 2 | Varistor |
| 3 | RC filter |
| 4 | Diode |

7

# Electrical installation

## Contents of this chapter

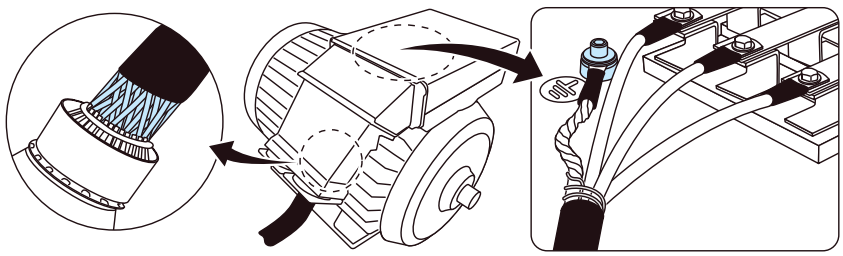
This chapter gives instructions on the wiring of the drive.

## 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

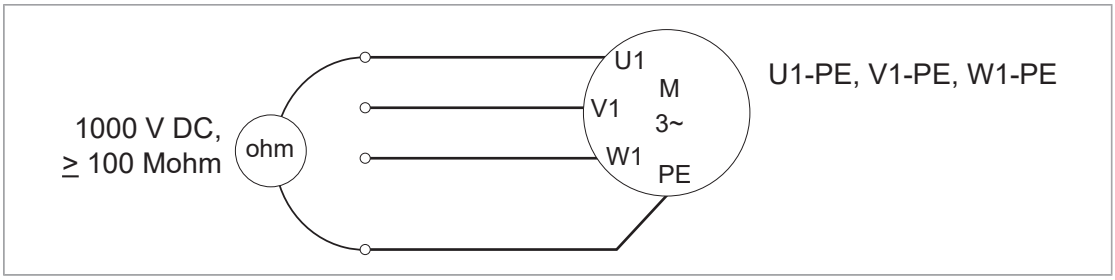
Before you connect the input power cable to the drive, measure its insulation resistance according to local regulations.

## 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 16) 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.

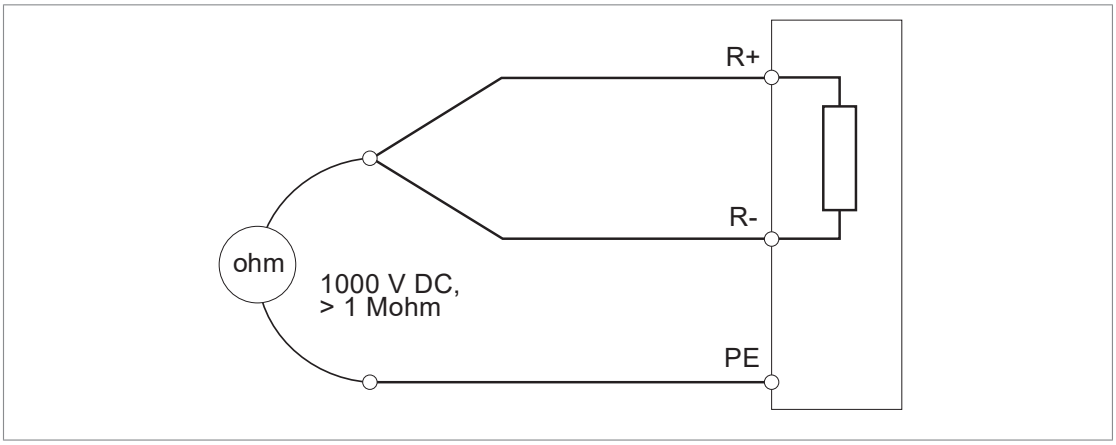
   **Note:** Moisture inside the motor reduces the insulation resistance. If you think that there is moisture in the motor, dry the motor and do the measurement again.




## 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 16) 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

The standard drive with no EMC filter and the ground-to-phase varistor connected can be installed to a symmetrically grounded TN-S system. If you install the drive to another system, you may need to disconnect the EMC filter and ground-to-phase varistor. See ACS880 frames R1 to R11 EMC filter and ground-to-phase varistor disconnecting instructions (3AUA0000125152 [English]).

**WARNING!**
Do not install the drive with EMC filter option +E200 to a system that the filter is not suitable for. This can cause danger, or damage the drive.

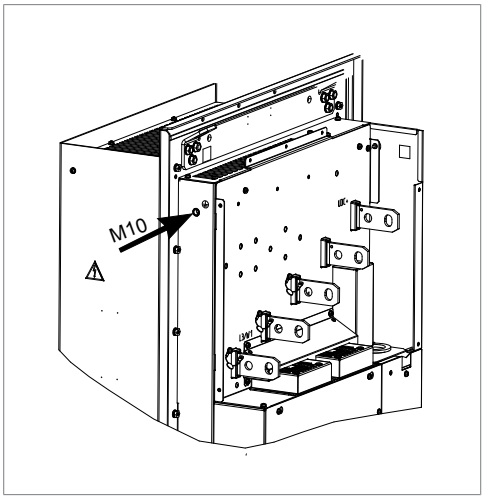
**WARNING!**
Do not install the drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. If you do, the varistor circuit can be damaged.

### Corner-grounded and midpoint-grounded 525…690 V delta systems

**WARNING!**
Do not install the drive on a 525…690 V corner-grounded or midpoint-grounded delta system. Disconnecting the EMC filter and ground-to-phase varistor does not prevent damage to the drive.

## Grounding the drive module

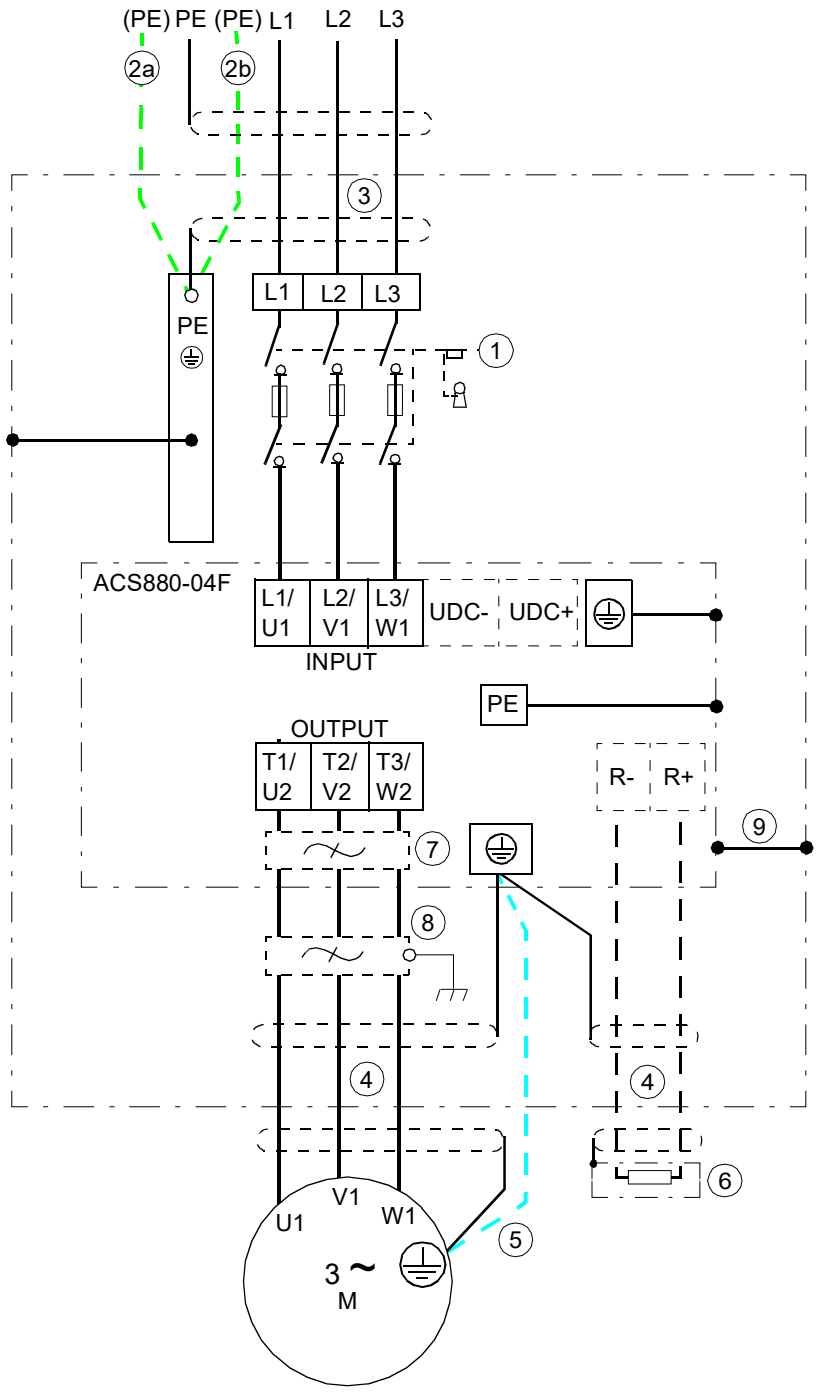
Ground the drive module from its top back grounding hole to the cabinet frame or from the module PE terminal to the cabinet PE busbar.




## Connecting the power cables

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

## Power cable connection diagram

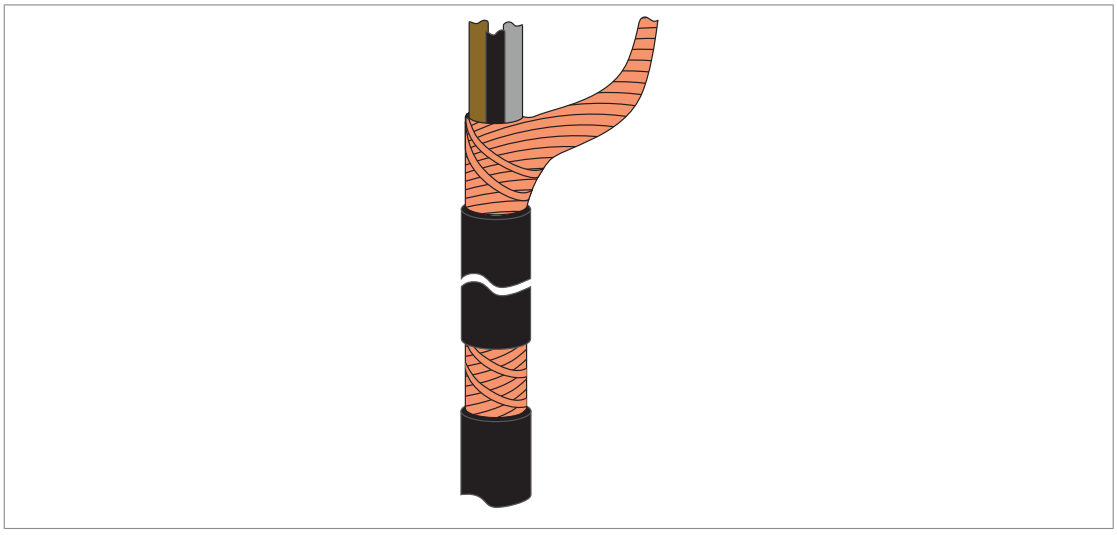



| | |
|---|---|
| 1 | Disconnecting device, see Selecting the main supply disconnecting device (page 57) |
| 2 | If a shielded cable is used (not required but recommended) and the conductivity of the shield is < 50% of the conductivity of the phase conductor, use a separate PE cable (2a) or a cable with a grounding conductor (2b) |
| 3 | ABB recommends 360° 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° grounding at the cabinet entry, see Selecting the power cables (page 65) |

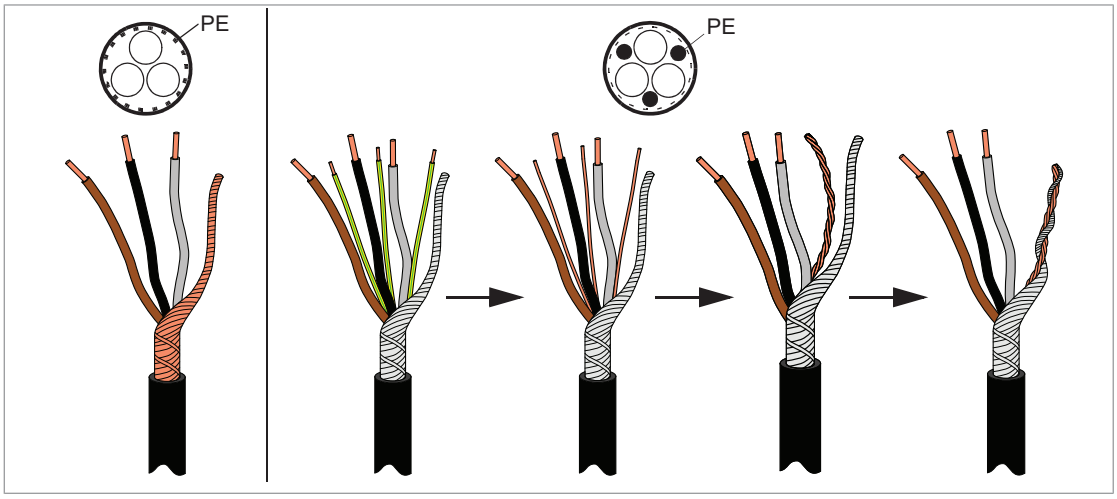
| | |
|---|---|
| 5 | Use a separate grounding cable if the conductivity of the cable shield is < 50% of the conductivity of the phase conductor and there is no symmetrically constructed grounding conductor in the cable, see Power cable types (page 66) |
| 6 | External brake resistor (optional, see Resistor braking (page 191)) |
| 7 | Common mode filter (optional), see Requirements tables (page 59) |
| 8 | d*u*/d*t* filter (optional), see d*u*/d*t* filters (page 199) |
| 9 | The drive module frame must be connected to the cabinet frame, see Grounding the drive module (page 85) |
| If there is a symmetrically constructed grounding conductor in the motor cable in addition to the conductive shield, connect the grounding conductor to the grounding terminal at the drive and motor ends. Do not use an asymmetrically constructed motor cable. Connecting its fourth conductor at the motor end increases bearing currents and causes extra wear. | |

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

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

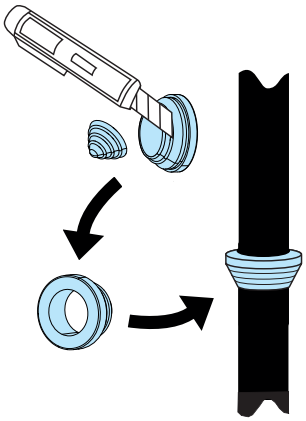


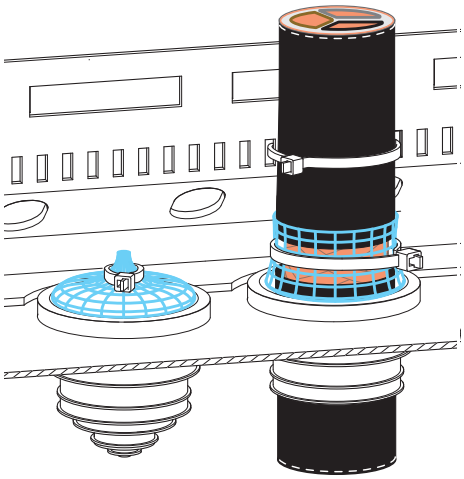
2. Prepare the ends of the cables.



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

3. If fire insulation is used, make an opening in the mineral wool sheet according to the diameter of the cable.
4. Put the cables through the entry plate.
5. If rubber grommets are used, remove them from the entry plate for the cables to be connected. Cut adequate holes into the rubber grommets. Put the grommets onto the cables. Put the cables through the entry plate and attach the grommets to the holes.
6. Attach the conductive sleeves to the cable shields with cable ties. Tie up the unused conductive sleeves with cable ties. An example of bottom entry is shown below. For top entry, put the grommet upwards.





## Power cable connection procedure

For the standard drive module configuration:

- See the step-by-step installation drawings in ACS880-04F quick installation guide (3AXD50000044913 [multilingual]).

For optional input power cable connection terminals and ground busbar assembly (+H370):

- Install the metallic shroud with ground bar as shown in section Attaching the metallic shroud (standard) (page 53)
- Connect the full-size input power cable connection terminals in a similar way as the motor cable connection terminals, see ACS880-04F quick installation guide (3AXD50000044913 [multilingual]).

For drive modules without full-size output cable connection terminals (option +0H371) and IP20 shrouds (option +0B051):

- Connect the power cables directly to the drive module input and output terminals with cable lugs or by busbars.
- Protect the power cable terminals and electrical parts against contact and ground the drive module correctly.

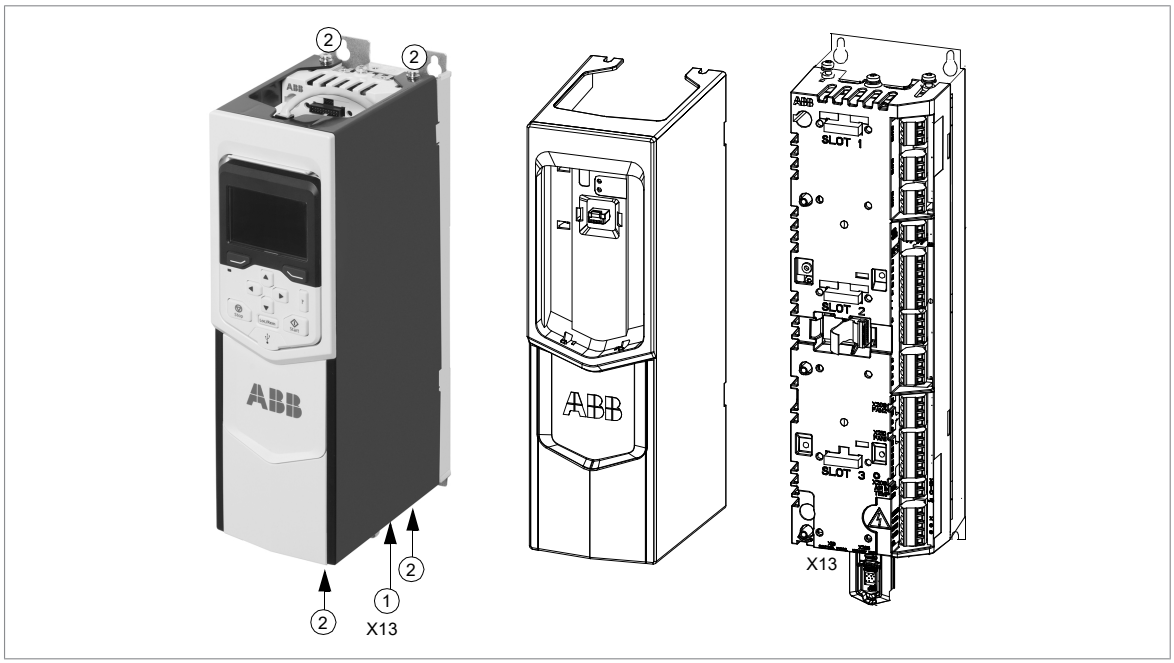
1. Connect the cable shields of the motor cables and any separate ground conductors or cables to the ground terminal of the drive module or to the cabinet ground bar.
2. Connect the phase conductors of the motor cables to terminals T1/U2, T2/V2 and T3/W2 of the drive module. For the tightening torques, see the technical data.
3. Drive modules with option +D150: Connect the brake resistor conductors to the R+ and R- terminals. For the tightening torques, see the technical data.
4. Connect the cable shields of the input cables and any separate ground conductors or cables to the drive module ground terminal or to the cabinet PE busbar.
5. 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.

### DC connection

The UDC+ and UDC– terminals are intended for common DC configurations of a number of drives, allowing regenerative energy from one drive to be utilized by the other drives in the motoring mode. See ACS880-01 drives and ACS880-04 drive modules common DC systems application guide (3AUA0000127818 [English]).

## Removing the control panel holder from the external control unit

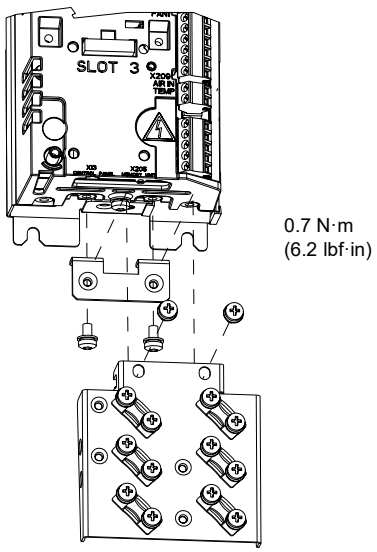
1. Disconnect the control panel cable from connector X13 on the control unit.
2. Loosen the mounting screws of the control panel holder and take the holder off.



# Attaching the control cable clamp plate

Attach the control cable clamp plate either to the top or base of the control unit with four screws as shown below.

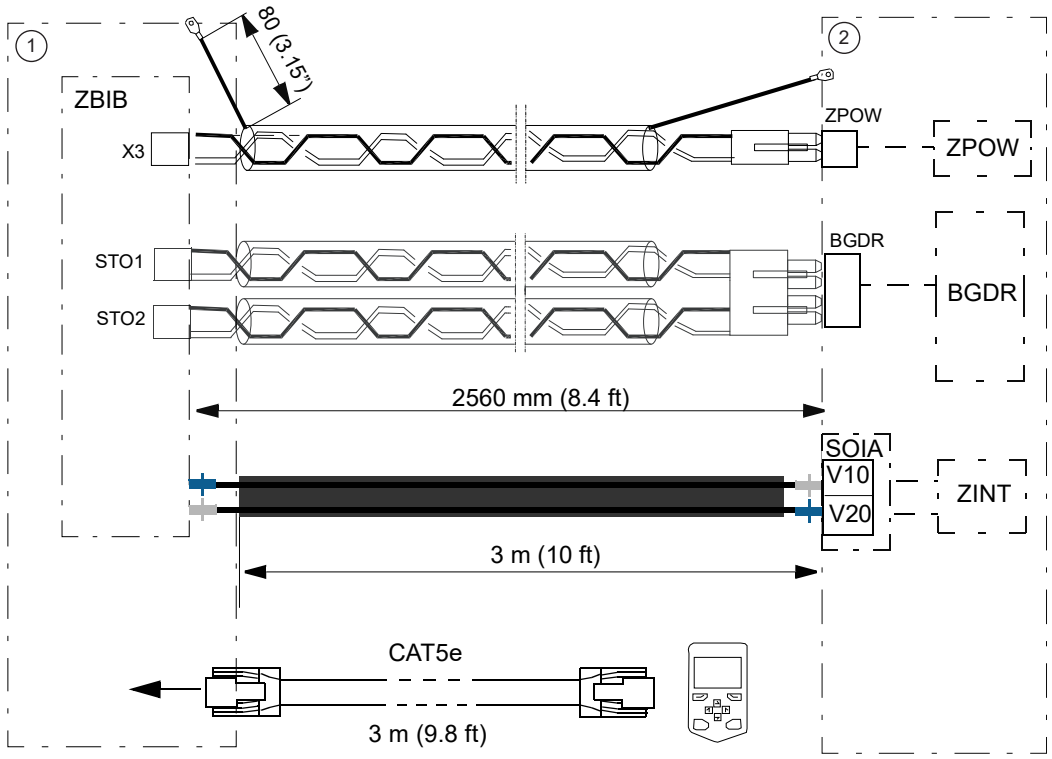
**Note:** If you install the FSO-xx safety functions module above the control unit, attach the control cable clamp plate on the base of the control unit.




# Connecting the external control unit to the drive module

## Control unit connection cables

The cables that are delivered with the drive module for connecting the drive module and control panel to the control unit are shown below.




| | |
|---|---|
| 1 | ZCU control unit |
| 2 | Drive module |

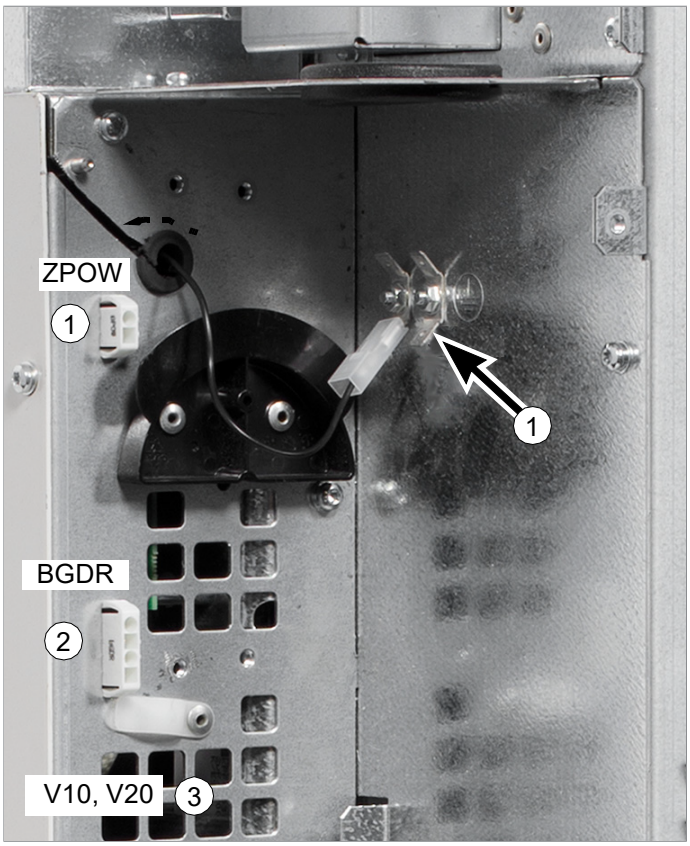
**WARNING!**
Handle the fiber optic cables with care. When you unplug the cables, always grab the connector, not the cable itself. Do not touch the ends of the fibers with bare hands as the ends are extremely sensitive to dirt.

## Routing the control unit cables into the drive module

Route the control unit connection cables to the drive module through the slot in the middle front cover at the front or left side. First, remove the plate which covers the slot. Then, install the rubber grommet (item 2) from the accessories box.

## Connections to the drive module

1. Connect power supply cable of the control unit to the ZPOW connector and the ground wire of the cable to the ground terminal.
2. Connect the BGDR cable to the BGDR connector.
3. Connect the fiber optic cables to the V20 and V10 connectors.




## Connections to the control unit

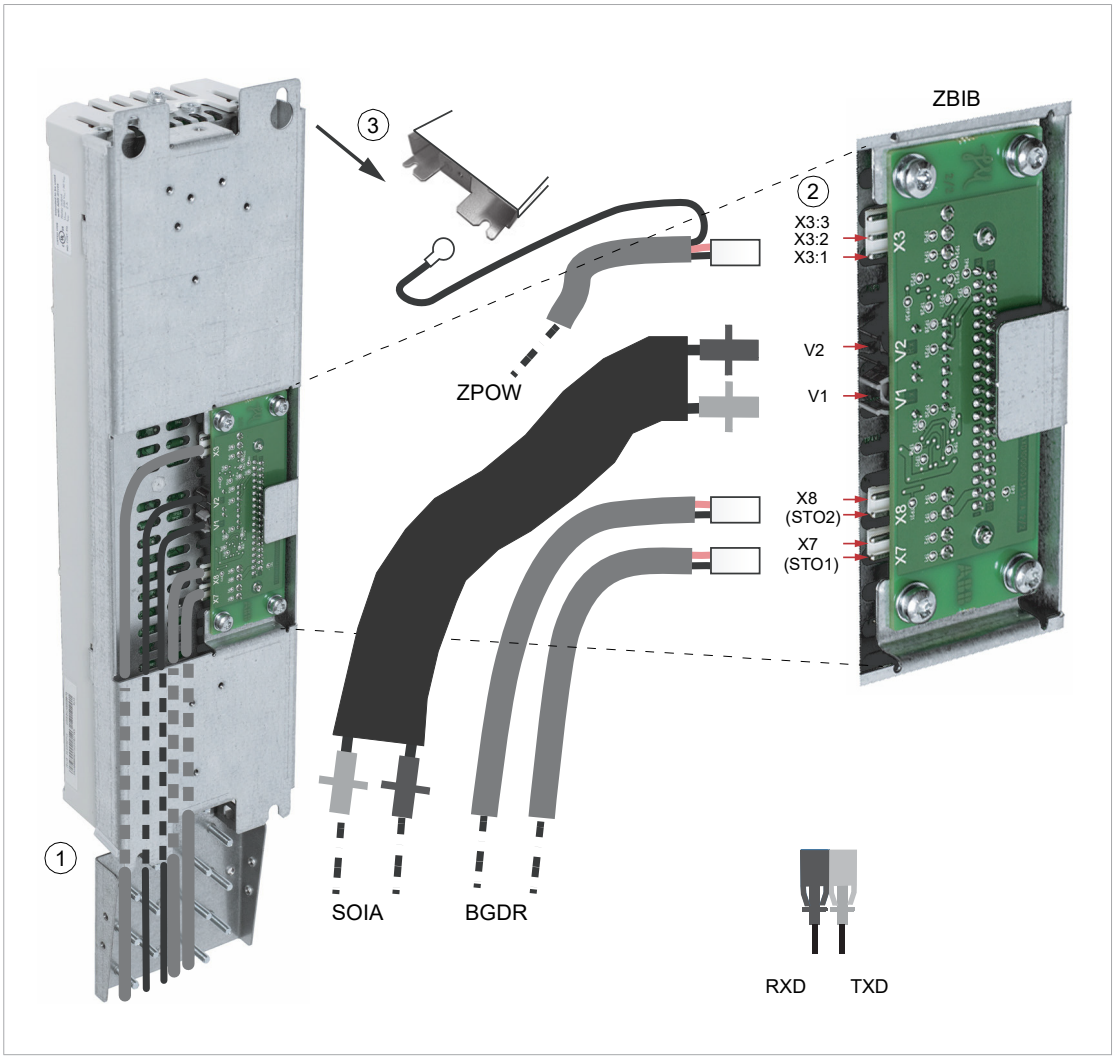
Connect the fiber optic, power supply and BGDR cables to the control unit as follows:

1. Thread the cables inside the back frame of the control unit.
2. Connect the cables to the ZBIB board terminals.

| ZPOW | ZBIB |
|---|---|
| X3:1 | X3:1 |
| X3:2 | X3:2 |
| X3:3 (not used) | X3:3 (not used) |
| **BGDR** | **ZBIB** |
| X7 (STO1) | X7 (STO1) |
| X8 (STO2) | X8 (STO2) |

| SOIA | ZBIB |
|---|---|
| V10 | V1 |
| V20 | V2 |

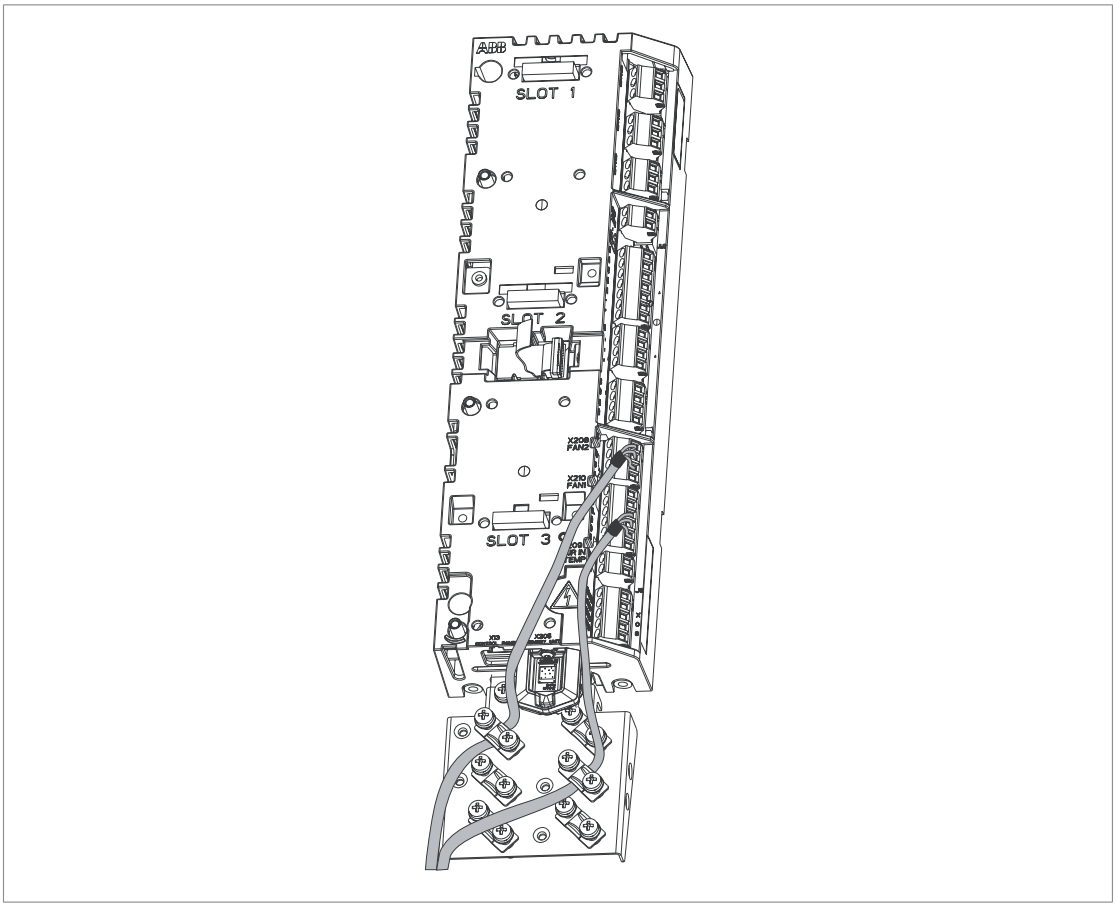
3. Connect the ZPOW cable grounding wire to the grounding terminal at the back top or bottom of the control unit.




RXD = receiver TXD = transmitter

## Connecting the control cables to the terminals of the external control unit

1. Route the cables to the control unit as shown below.




2. Ground the shields of the control cables at the clamp plate. Use torque 1.5 N·m (13 lbf·in). 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.
3. Connect the conductors to the appropriate detachable terminals of the control unit. See the Default I/O diagram of the drive control unit (ZCU-1x) (page 103). Use shrink tubing or insulating tape to contain any strain strands.

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

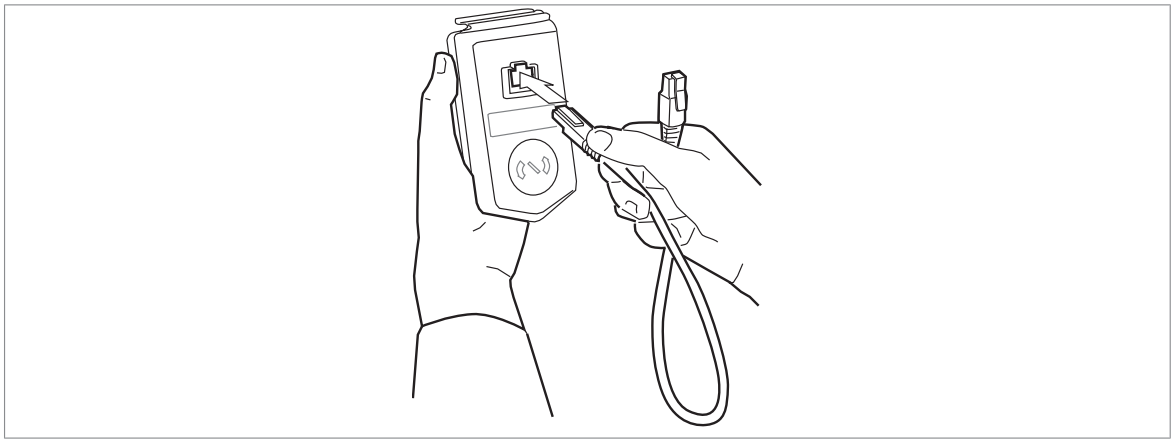
## Installing the control panel holder back onto the external control unit

Install the control panel holder back onto the control unit in reverse order to removing it, see Removing the control panel holder from the external control unit (page 90).

## 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 X13 connector of the control unit.



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

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

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

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

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

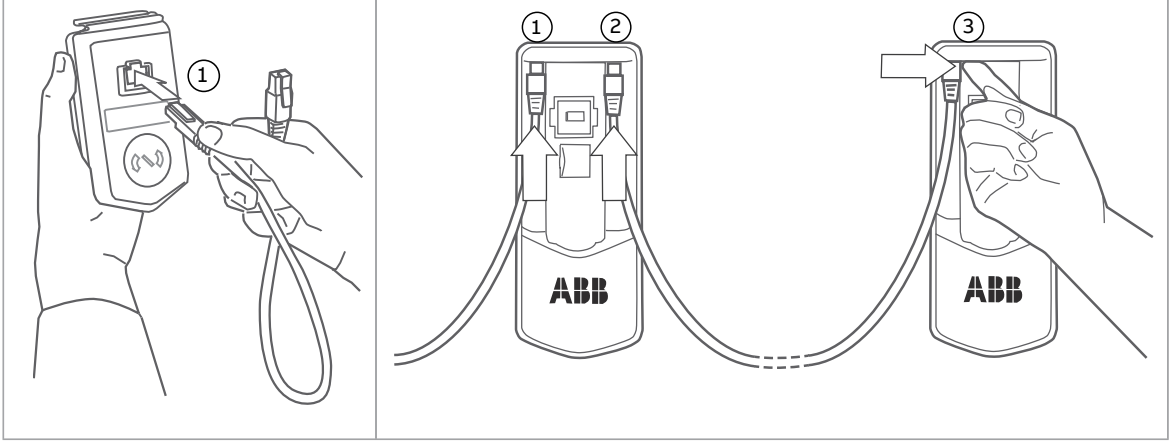
   *The parameter group is 149 with supply (line-side), brake or DC/DC converter units.

   Repeat the above for each drive.
2. With the panel connected to one unit, link the units using Ethernet cables.
3. Switch on the bus termination on the drive that is farthest from the control panel in the chain.
   - With drives that have the panel mounted on the front cover, move the terminating switch into the outer position.
   - With an FDPI-02 module, move termination switch S2 into the TERMINATED position.

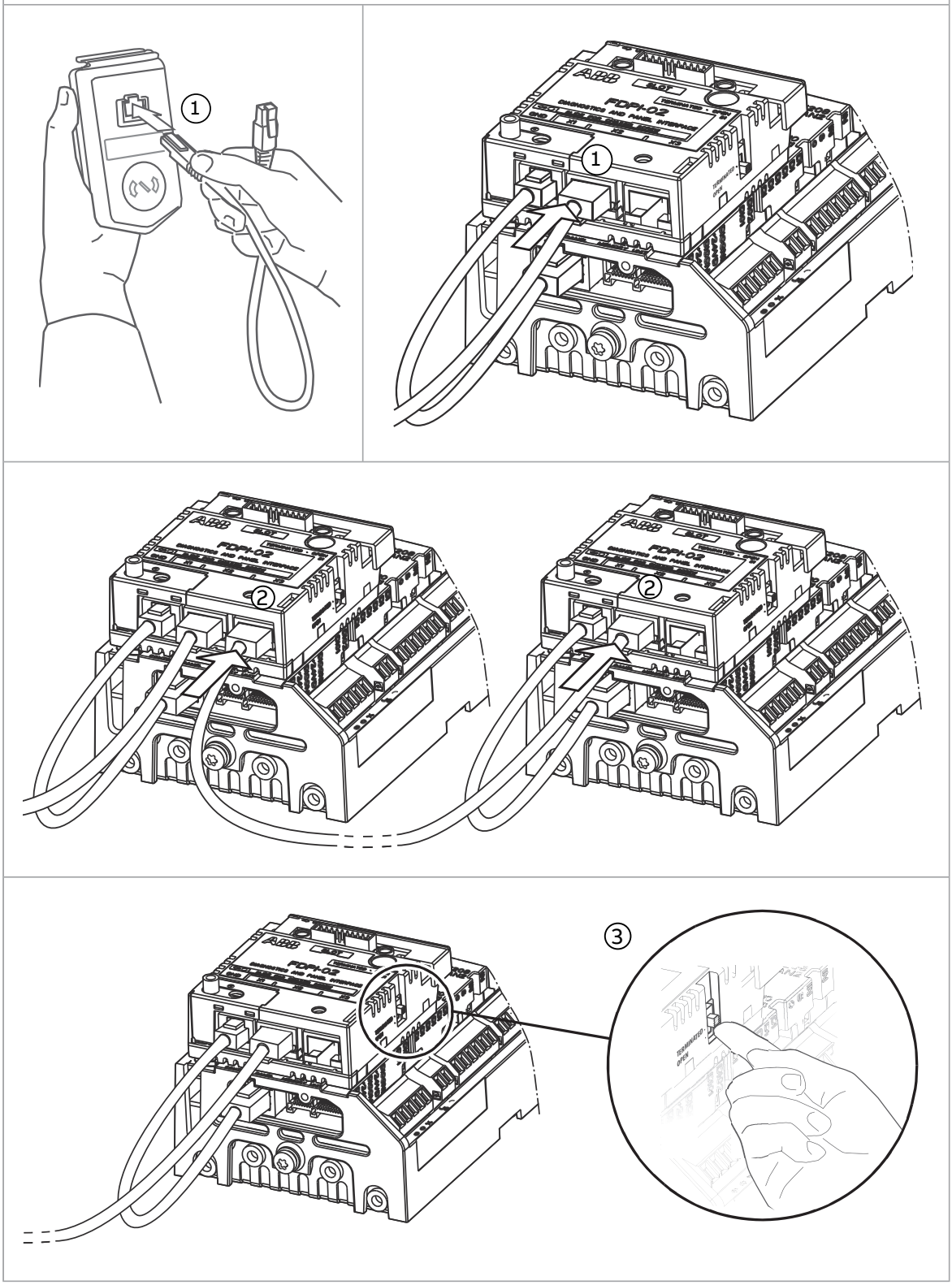
   Make sure that bus termination is off on all other drives.
4. On the control panel, switch on the panel bus functionality (Options - Select drive - Panel bus). The drive to be controlled can now be selected from the list under Options - Select drive.

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

**With twin connectors in the control panel holder:**



**With FDPI-02 modules:**

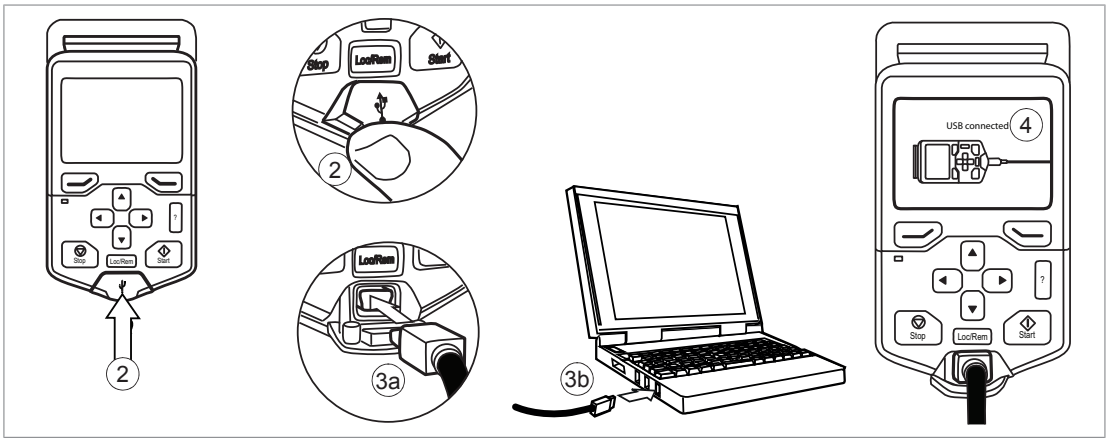



## Connecting a PC

**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.




## 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.

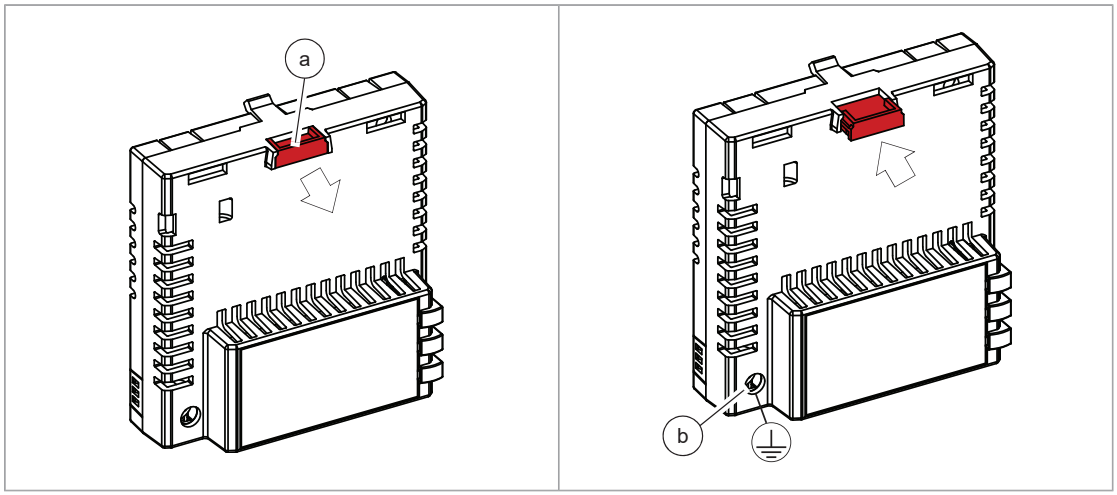
Pay attention to the free space required by the cabling or terminals coming to the option modules.

1. Repeat the steps described in Electrical safety precautions (page 16).
2. Pull out the lock (a).

   **Note:** The location of the lock depends on the module type.
3. Install the module to a free option module slot on the control unit.
4. Push in the lock (a).
5. Tighten the grounding screw (b) to a torque of 0.8 N·m (7 lbf·in).

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

   **WARNING!**
   Do not use excessive force, or leave the screw too loose. Over-tightening can damage the screw or module. A loose screw can cause an operation failure.




6. Connect the wiring to the module. Obey the instructions given in the documentation of the module.

8

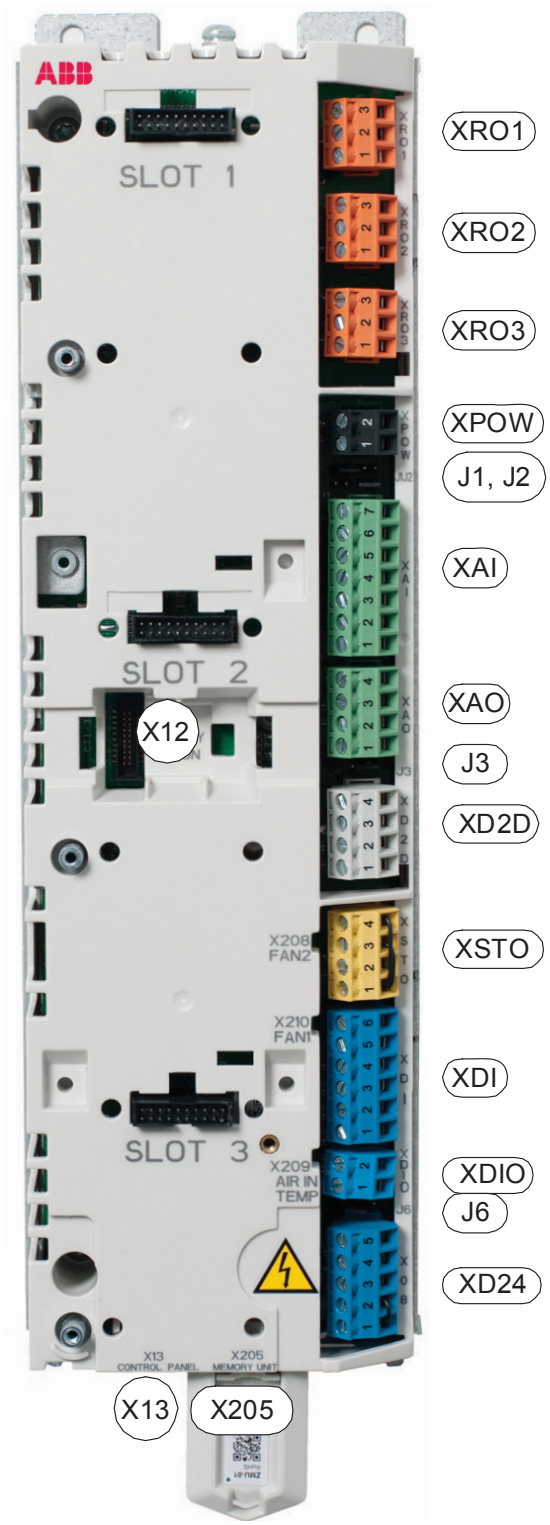
# Control unit of the drive

## Contents of this chapter

This chapter

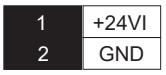
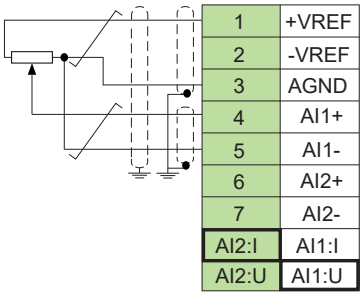
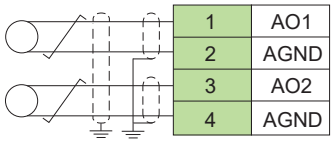
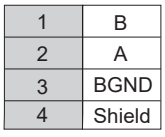
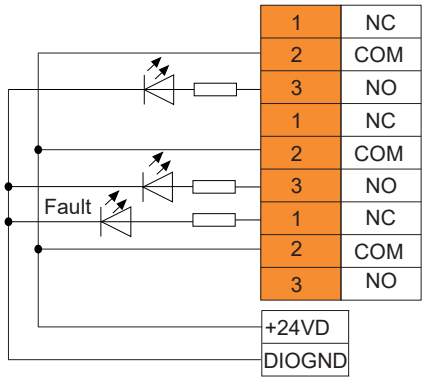
- describes the connections of the control unit(s) used in the drive,
- contains the specifications of the inputs and outputs of the control unit(s).

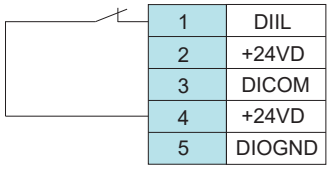
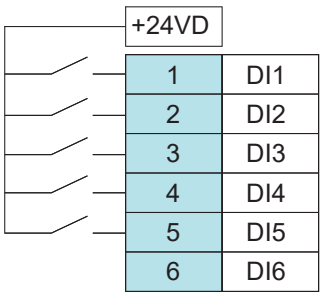
# ZCU-14 layout




| | Description |
|---|---|
| XPOW | External power input |
| XAI | Analog inputs |
| XAO | Analog outputs |
| XD2D | Drive-to-drive link |
| XRO1 | Relay output RO1 |
| XRO2 | Relay output RO2 |
| XRO3 | Relay output RO3 |
| XD24 | Digital input interlock (DIIL) and +24 V output |
| XDIO | Digital input/outputs |
| XDI | Digital inputs |
| XSTO | Safe torque off connection (inverter unit only).<br><br>**Note:** This connection only acts as a true Safe torque off input when the ZCU is controlling an inverter unit. When the ZCU is controlling a supply unit, de-energizing the inputs will stop the unit but will not constitute a true safety function. |
| X12 | Connection for FSO-xx safety functions module (inverter unit only). |
| X13 | Control panel connection |
| X202 | Option slot 1 |
| X203 | Option slot 2 |
| X204 | Option slot 3 |
| X205 | Memory unit connection (memory unit inserted in the drawing) |
| J1, J2 | Voltage/Current selection jumpers (J1, J2) for analog inputs |
| J3 | Drive-to-drive link termination switch (J3) |
| J6 | Common digital input ground selection jumper (J6). |

# Default I/O diagram of the drive control unit (ZCU-1x)

| Connection | Term | Description |
|---|---|---|
| **XPOW** External power input | | |
|  | +24VI<br>GND | 24 V DC, 2 A min. (without optional modules) |
| **XAI** Reference voltage and analog inputs | | |
|  | +VREF | 11 V DC, $R_L$ 1…10 kohm |
| | -VREF | -11 V DC, $R_L$ 1…10 kohm |
| | AGND | Ground |
| | AI1+ | **Speed reference** |
| | AI1- | 0(2)…11 V, $R_{in}$ > 200 kohm [1)] |
| | AI2+ | By default not in use. |
| | AI2- | 0(4)…22 mA, $R_{in}$ = 100 ohm [1)] |
| | J1 | Current (I) / voltage (U) selection jumper for AI1 |
| | J2 | Current (I) / voltage (U) selection jumper for AI2 |
| **XAO** Analog outputs | | |
|  | AO1 | **Motor speed rpm** |
| | AGND | 0…22 mA, $R_L$ < 500 ohm |
| | AO2 | **Motor current** |
| | AGND | 0…22 mA, $R_L$ < 500 ohm |
| **XD2D** Drive-to-drive link | | |
|  | B<br>A<br>BGND<br>Shield | Master/follower, drive-to-drive or embedded fieldbus connection [2)] |
| | **J3** | Drive-to-drive link termination [2)] |
| **XRO1, XRO2, XRO3** Relay outputs | | |
|  | NC<br>COM<br>NO | **Ready run**<br>250 V AC / 30 V DC<br>2 A |
| | NC<br>COM<br>NO | **Running**<br>250 V AC / 30 V DC<br>2 A |
| | NC<br>COM<br>NO | **Fault (-1)**<br>250 V AC / 30 V DC<br>2 A |

| Connection | Term | Description |
|---|---|---|
| **XD24** Auxiliary voltage output, digital interlock [3] | | |
|  | DIIL | Run enable [3] |
| | +24VD | +24 V DC 200 mA [4] |
| | DICOM | Digital input ground |
| | +24VD | +24 V DC 200 mA [4] |
| | DIOGND | Digital input/output ground |
| **XDIO** Digital input/outputs | | |
|  | DIO1 | Output: Ready run |
| | DIO2 | Output: Running |
| | **J6** | Ground selection [5] |
| **XDI** Digital inputs | | |
|  | DI1 | Stop (0) / Start (1) |
| | DI2 | Forward (0) / Reverse (1) |
| | DI3 | Reset |
| | DI4 | Acc/Dec time select [6] |
| | DI5 | Constant speed 1 (1 = On) [7] |
| | DI6 | By default, not in use. |
|  | Safe torque off circuits must be closed for the drive to start. [8] | |
| **X12** | Safety options connection | |
| **X13** | Control panel connection | |
| **X205** | Memory unit connection | |

1) Current [0(4)…22 mA, $R_{in}$ = 100 ohm] or voltage [0(2)…11 V, $R_{in}$ > 200 kohm] input selected by jumper. Change of setting requires reboot of control unit.
2) See section The XD2D connector (page 106)
3) See section DIIL input (page 106).
4) Total load capacity of these outputs is 4.8 W (200 mA at 24 V) minus the power taken by DIO1 and DIO2.
5) Determines whether DICOM is separated from DIOGND (ie. common reference for digital inputs floats; in practice, selects whether the digital inputs are used in current sinking or sourcing mode). See also ZCU-1x ground isolation diagram (page 110). DICOM=DIOGND ON: DICOM connected to DIOGND. OFF: DICOM and DIOGND separate.
6) 0 = Acceleration/deceleration ramps defined by parameters *23.12/23.13* in use. 1 = Acceleration/deceleration ramps defined by parameters *23.14/23.15* in use.
7) Constant speed 1 is defined by parameter *22.26*.
8) See chapter The Safe torque off function (page 171).

The wire size accepted by all screw terminals (for both stranded and solid wire) is 0.5 … 2.5 mm$^2$ (24…12 AWG). The torque is 0.5 N·m (5 lbf·in).

# Additional information on the connections

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

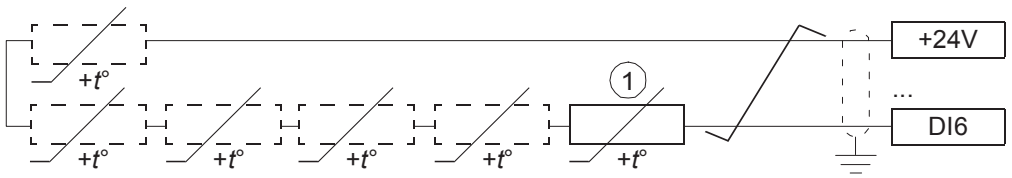
The control unit is powered from a 24 V DC, 2 A supply through terminal block XPOW.

Using an external supply is recommended, if:

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

## DI6 as a PTC sensor input

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



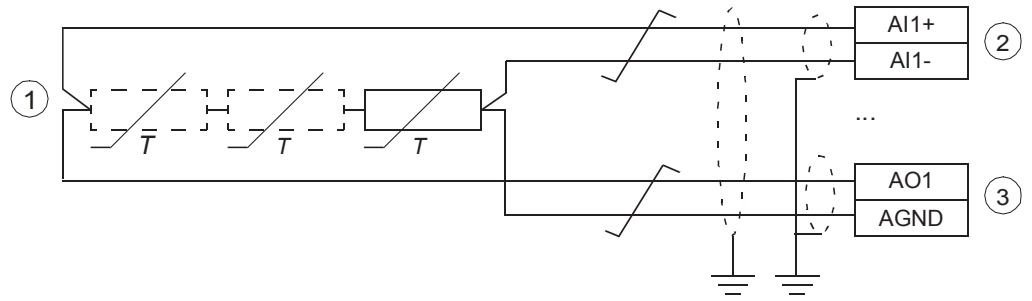

| | |
|---|---|
| 1 | 1…6 PTC thermistors connected in series |

**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.

**WARNING!**
Make sure that the voltage does not exceed the maximum permitted voltage of the PTC sensor.

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

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




| | |
|---|---|
| 1 | One, two or three Pt100, Pt1000 or PTC sensors; or one KTY84 sensor |
| 2 | Set the input type to voltage with the appropriate switch or jumper on the control unit. Make the corresponding setting in the control program 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/EN 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor.

**WARNING!**
Make sure that the excitation current does not exceed the maximum permitted current of the Pt100/Pt1000 sensor.

## DIIL input

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

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

## The XD2D connector

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

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

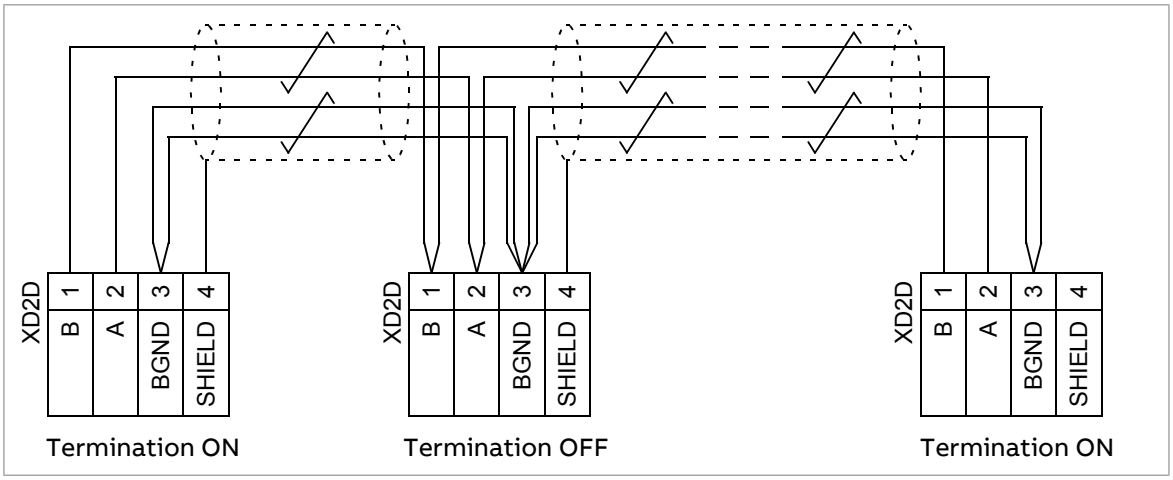
See the firmware manual of the drive for the related parameter settings.

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

Use a high-quality shielded twisted-pair cable for the wiring, fro exmple, Belden 9842. The nominal impedance of the cable should be 100…165 ohm. You can use one pair for the data wiring and another pair or a wire for the grounding. Avoid unnecessary loops and parallel runs near power cables.

The following diagram shows the wiring between control units.

**ZCU-14**




## Safe torque off (XSTO)

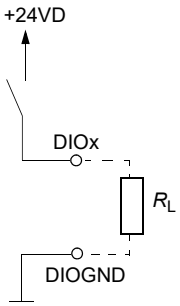
See chapter The Safe torque off function (page 171).

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

## FSO safety functions module connection (X12)

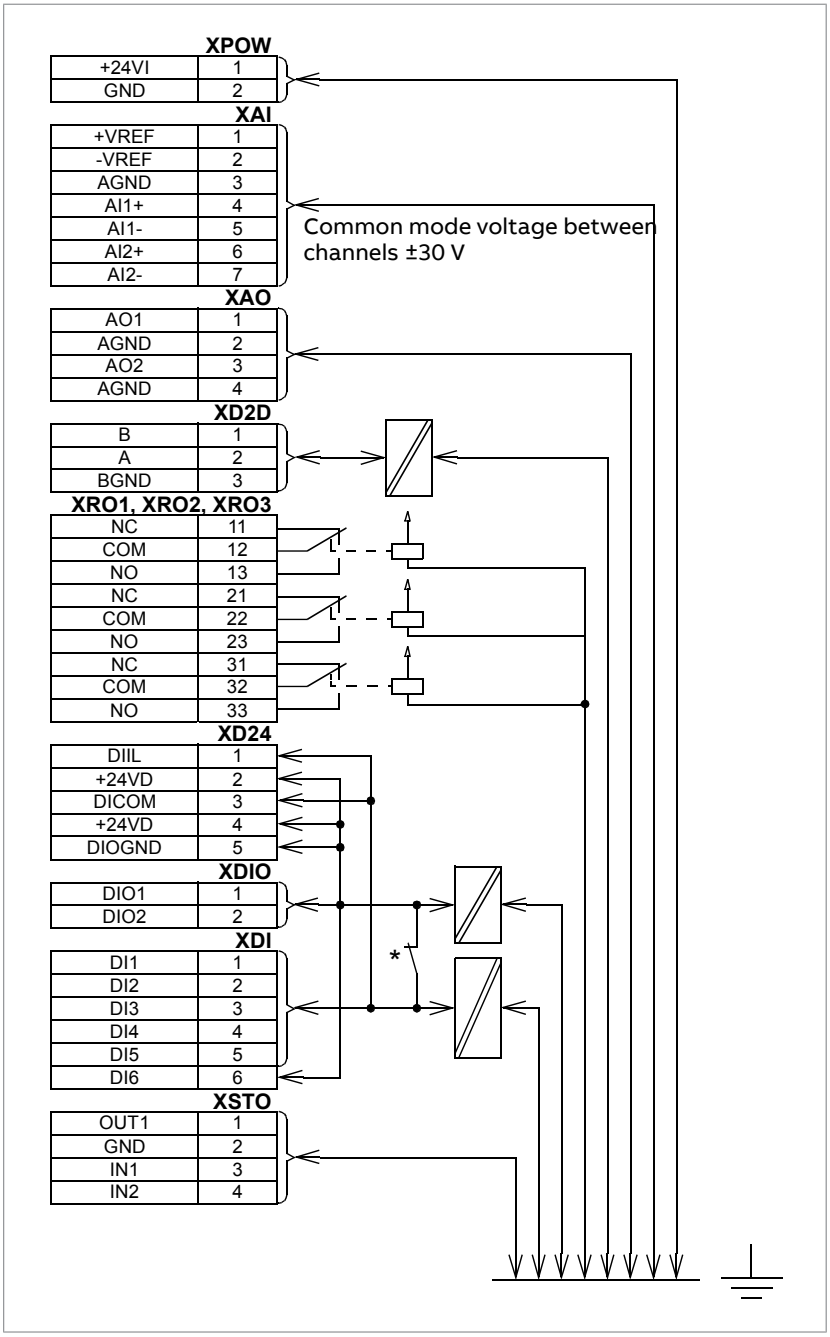
Refer to the applicable FSO module user's manual.

# Connector data

| | |
|---|---|
| Power supply (XPOW) | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>24 V (±10%) DC, 2 A<br>External power input. |
| Relay outputs RO1…RO3 (XRO1…XRO3) | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>250 V AC / 30 V DC, 2 A<br>Protected by varistors |
| +24 V output (XD24:2 and XD24:4) | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>Total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the power taken by DIO1 and DIO2. |
| Digital inputs DI1…DI6 (XDI:1…XDI:6) | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>24 V logic levels: “0” < 5 V, “1” > 15 V<br>$R_{in}$: 2.0 kohm<br>Input type: NPN/PNP (DI1…DI5), PNP (DI6)<br>Hardware filtering: 0.04 ms, digital filtering up to 8 ms<br>DI6 (XDI:6) can alternatively be used as an input for a PTC sensor. "0" > 4 kohm, "1" < 1.5 kohm.<br>$I_{max}$: 15 mA (DI1…DI5), 5 mA (DI6) |
| Start interlock input DIIL (XD24:1) | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>24 V logic levels: "0" < 5 V, "1" > 15 V<br>$R_{in}$: 2.0 kohm<br>Input type: NPN/PNP<br>Hardware filtering: 0.04 ms, digital filtering up to 8 ms |
| Digital inputs/outputs DIO1 and DIO2 (XDIO:1 and XDIO:2)<br>Input/output mode selection by parameters.<br>DIO1 can be configured as a frequency input (0…16 kHz with hardware filtering of 4 microseconds) for 24 V level square wave signal (sinusoidal or other wave form cannot be used). DIO2 can be configured as a 24 V level square wave frequency output. See the firmware manual, parameter group 111/11. | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>As inputs: 24 V logic levels: "0" < 5 V, "1" > 15 V. $R_{in}$: 2.0 kohm. Filtering: 1 ms.<br>As outputs: Total output current from +24VD is limited to 200 mA<br>  |
| Reference voltage for analog inputs +VREF and -VREF (XAI:1 and XAI:2) | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>10 V ±1% and -10 V ±1%, $R_{load}$ 1…10 kohm<br>Maximum output current: 10 mA |
| Analog inputs AI1 and AI2 (XAI:4 … XAI:7).<br>Current/voltage input mode selection by jumpers | Connector pitch 5 mm, wire size 0.5 … 2.5 mm² (22…12 AWG)<br>Current input: -20…20 mA, $R_{in}$ = 100 ohm<br>Voltage input: -10…10 V, $R_{in}$ > 200 kohm<br>Differential inputs, common mode range ±30 V<br>Sampling interval per channel: 0.25 ms<br>Hardware filtering: 0.25 ms, adjustable digital filtering up to 8 ms<br>Resolution: 11 bit + sign bit<br>Inaccuracy: 1% of full scale range |

| | |
|---|---|
| Analog outputs AO1 and AO2 (XAO) | Connector pitch 5 mm, wire size 0.5 … 2.5 $mm^2$ (22…12 AWG)<br>0…20 mA, $R_{load}$ < 500 ohm<br>Frequency range: 0…300 Hz<br>Resolution: 11 bit + sign bit<br>Inaccuracy: 2% of full scale range |
| XD2D connector | Connector pitch 5 mm, wire size 0.5 … 2.5 $mm^2$ (22…12 AWG)<br>Physical layer: RS-485<br>Transmission rate: 8 Mbit/s<br>Cable type: Shielded twisted-pair cable with a twisted pair for data and a wire or another pair for signal ground (nominal impedance 100 … 165 ohm, for example Belden 9842)<br>Maximum length of link: 50 m (164 ft)<br>Termination by jumper |
| Safe torque off connection (XSTO) | Connector pitch 5 mm, wire size 0.5 … 2.5 $mm^2$ (22…12 AWG)<br>Input voltage range: -3…30 V DC<br>Logic levels: "0" < 5 V, "1" > 17 V.<br>**Note:** For the unit to start, both connections must be “1”. This applies to all control units (including drive, inverter, supply, brake, DC/DC converter etc. control units), but true Safe torque off functionality is only achieved through the XSTO connector of the drive/inverter control unit.<br>Current consumption: 66 mA (continuous) per STO channel<br>EMC (immunity) according to IEC 61326-3-1 and IEC 61800-5-2 |
| Control panel connection (X13) | Connector: RJ-45<br>Cable length < 100 m (328 ft) |
| The terminals of the control unit fulfill the Protective Extra Low Voltage (PELV) requirements. The PELV requirements of a relay output are not fulfilled if a voltage higher than 48 V is connected to the relay output. | |

## ZCU-1x ground isolation diagram




* Ground selector (J6) settings

• 

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

• 

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

9

# 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 16) 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.<br>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.<br>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. | ☐ |

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# 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. Only qualified electrical professionals are allowed to start-up the drive.
2. Make sure that the installation of the drive module has been checked according to the checklist in chapter *Installation checklist*, and that the motor and driven equipment are ready for start.
3. Perform the start-up tasks instructed by the cabinet-installer of the drive module.
4. Switch the power on, setup the drive control program, and perform the first start of the drive and motor. See Quick start-up guide for ACS880 drives with primary control program (3AUA0000098062 [English]) or ACS880 primary control program firmware manual (3AUA0000085967 [English]). If you need more information on the use of the control panel, see ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual (3AUA0000085685 [English]).

- For drives with resistor braking (option +D150): See also section Start-up in chapter Resistor braking.
- For drives with ABB d*u*/d*t* filter: Make sure that bit 13 of parameter 95.20 HW options word 1 is switched on.
- For drives with ABB sine filter: Make sure that parameter 95.15 Special HW settings is set to ABB sine filter. For other sine filters: See Sine filter hardware manual (3AXD50000016814 [English]).

5. For drives with ABB motors in explosive atmospheres: See also ACS880 drives with ABB motors in explosive atmospheres (3AXD50000019585 [English]).
6. For drive modules in which the Safe torque off function is in use: Test and validate the operation of the Safe torque off function. See Validation test procedure (page 179).
7. For drive modules with an FSO-xx safety functions module (options +Q972 and Q973): Test and validate the operation of the safety functions. See the delivery-specific circuit diagrams and FSO-12 safety functions module user's manual (3AXD50000015612 [English]) or FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

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# Fault tracing

## Contents of this chapter

This chapter describes the fault tracing possibilities of the drive.

## LEDs

The table below describes the LEDs of the drive module with option +J410.

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

## Warning and fault messages

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

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# Maintenance

## Contents of this chapter

This chapter contains maintenance instructions of the drive modules.

## Maintenance intervals

The tables below show the maintenance tasks which can be done by the end user. The complete maintenance schedule is available on the Internet (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 maintenance intervals after start-up

| Component | Years from start-up | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | ... |
| **Cooling** | | | | | | | | | | | | | |
| Main cooling fan | | | | | | | | | R | | | | |
| Circuit board compartment cooling fan | | | | | | | | | R | | | | |
| NSIN filter cooling fan | | | | | | | | | R | | | | |
| **Batteries** | | | | | | | | | | | | | |
| Control panel battery | | | | | | | | | R | | | | |
| Control unit battery | | | | | | R | | | | | | R | |
| **Connections and environment** | | | | | | | | | | | | | |
| Cabinet door filters (IP54) | R | R | R | R | R | R | R | R | R | R | R | R | R |
| Quality of supply voltage | P | P | P | P | P | P | P | P | P | P | P | P | P |
| **Spare parts** | | | | | | | | | | | | | |
| Spare part stock | I | I | I | I | I | I | I | I | I | I | I | I | I |
| Reforming DC circuit capacitors (spare modules and spare capacitors) | P | P | P | P | P | P | P | P | P | P | P | P | P |
| **Inspections by user** | | | | | | | | | | | | | |
| Air inlet and outlet meshes (IP22/IP42) | I | I | I | I | I | I | I | I | I | I | I | I | I |
| Tightness of terminals | I | I | I | I | I | I | I | I | I | I | I | I | I |
| Ambient conditions (dustiness, moisture, corrosion, temperature) | I | I | I | I | I | I | I | I | I | I | I | I | I |
| Cleaning of heatsinks | I | I | I | I | I | I | I | I | I | I | I | I | I |
| **Funtional safety** | | | | | | | | | | | | | |
| Safety function test | I<br>See the maintenance information of the safety function. | | | | | | | | | | | | |
| Safety component expiry (Mission time, $T_M$) | 20 years | | | | | | | | | | | | |

**Note:**

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

# Cabinet

## Cleaning the interior of the cabinet

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

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

1. Stop the drive and do the steps in section Electrical safety precautions (page 16) 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

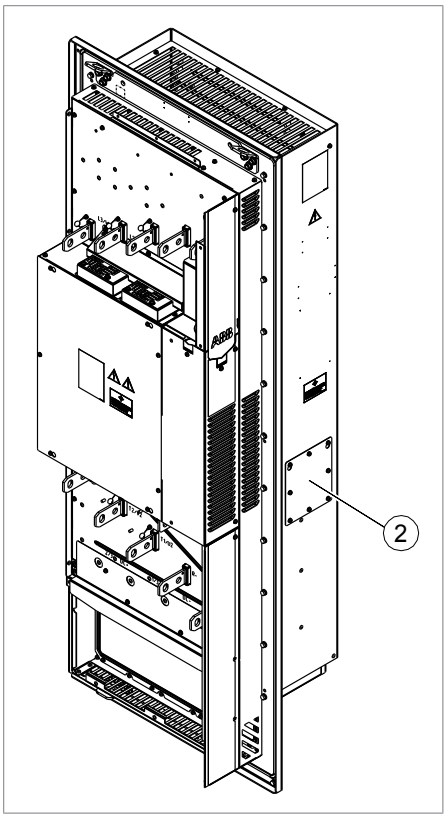
The drive module heatsink collects dust from the cooling air. If the heatsink is not clean, the drive can generate overtemperature warnings and faults. When necessary, clean the heatsink as described in this section.

## 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 16) before you start the work.
2. Undo the attaching screws of the cover plate on the service opening.
3. Remove the plate.
4. 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.
5. Reinstall the cover plate.



# Fans

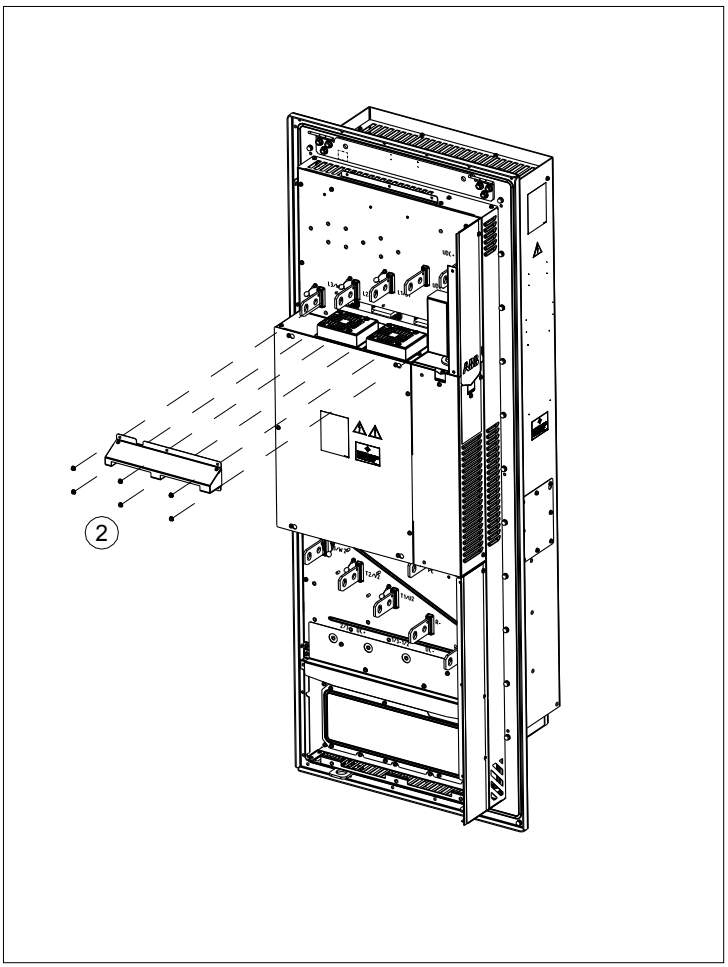
The lifespan of the cooling fans of the drive depends on running time, ambient temperature and dust concentration. See the firmware manual for the actual signal which indicates the running time of the cooling fan. Reset the running time signal after fan replacement.

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

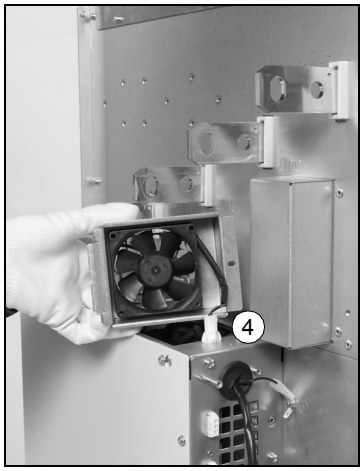
## Replacing the circuit board compartment cooling fans

**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 16) before you start the work.
2. Remove the cover.
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.


2


3


4

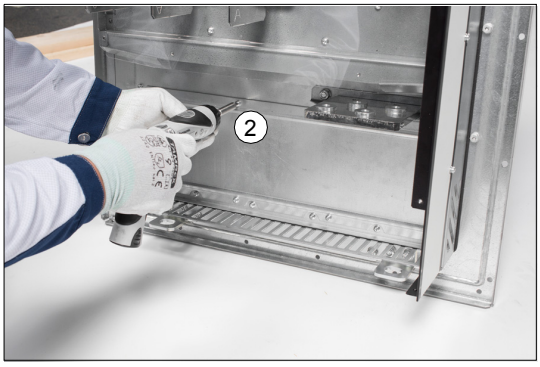
## Replacing the main cooling fans

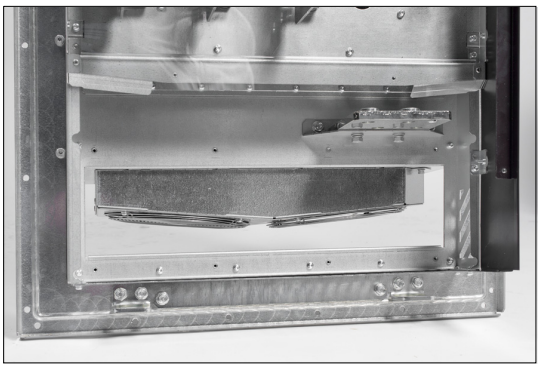
The main cooling fans can be replaced from the front side and the back side.

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

To replace the main cooling fans from the front side:

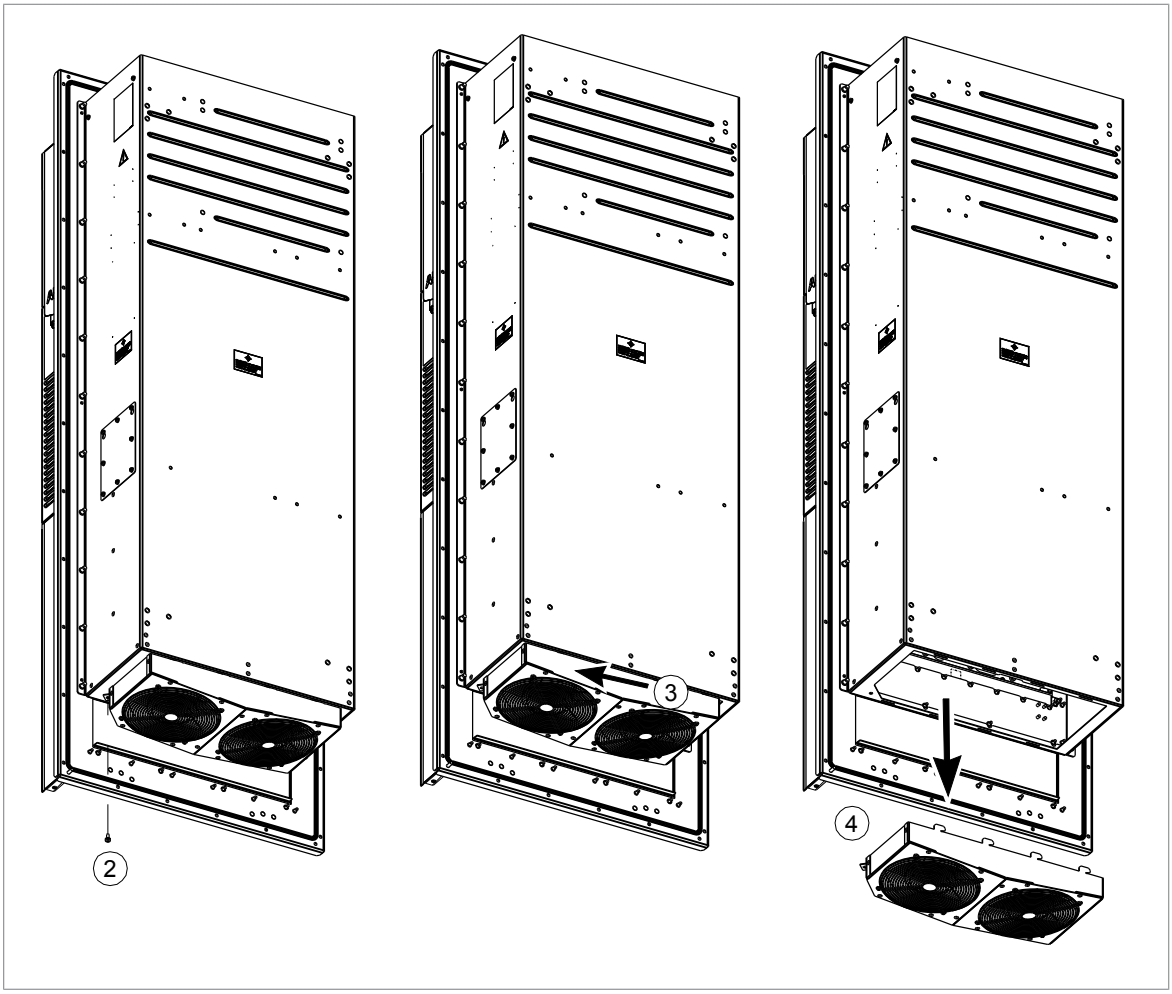
1. Stop the drive and do the steps in section Electrical safety precautions (page 16) before you start the work.
2. If motor cables are connected to the output terminals, disconnect them.
3. Undo the mounting screws of the fan cassette cover and remove the cover.
4. Disconnect the power supply wires of the fans.
5. Pull the fan cassette out.
6. Install the new fan cassette in reverse order to the above.
7. Reset the counter (if used) in group 5 in the primary control program.



To replace the main cooling fans from the back side:

1. Stop the drive and do the steps in section Electrical safety precautions (page 16) before you start the work.
2. Undo the locking screw.
3. Push the fan cassette to the left.
4. Take the cassette down.
5. Disconnect the power supply wires of the fans, see the previous page.
6. Install the new fan cassette in reverse order to the above.
7. Reset the counter (if used) in group 5 in the primary control program.




## Replacing the standard drive module

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

**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.

1. Stop the drive and do the steps in section Electrical safety precautions (page 16) before you start the work.
2. Disconnect the power cables.
3. Disconnect the power supply, BGDR and fiber optic cables from the drive module.
4. Disconnect the power supply cable and the fiber optic cables from the external control unit and coil them on the top of the drive module.
5. Remove the screws that attach the drive module to the cabinet.
6. Install the new module in reverse order.

## Capacitors

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

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

### Reforming the capacitors

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

## Control panel

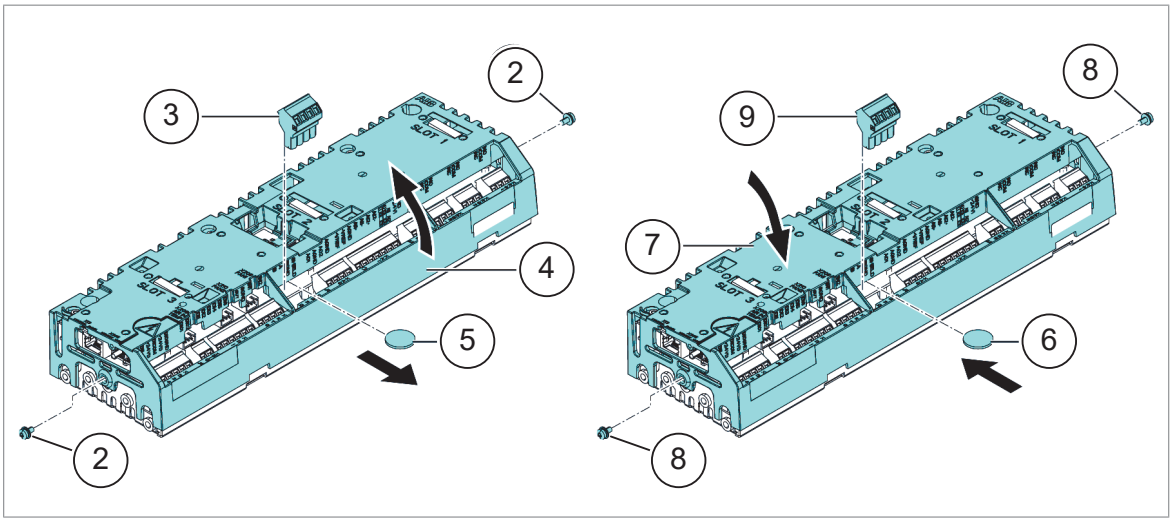
See ACS-AP-I, -S, -W and ACH-AP-H, -W assistant control panels user's manual (3AUA0000085685 [English]).

## Replacing the ZCU-14 control unit battery

**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 16) before you start the work.
2. Remove the M4×8 (T20) screws at the ends of the control unit.
3. To see the battery, remove the XD2D terminal block.
4. Carefully lift the edge of the control unit cover on the side with the I/O terminal blocks.
5. Carefully pull the battery out of the battery holder.
6. Carefully put a new CR2032 battery into the battery holder.
7. Close the control unit cover.

8. Tighten the M4×8 (T20) screws.
9. Install the XD2D terminal block.



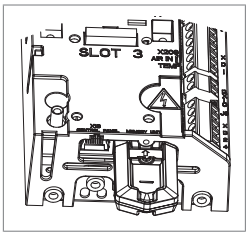

## Replacing the memory unit of ZCU-14

After replacing a control unit, you can retain the existing parameter settings by transferring the memory unit from the defective control unit to the new control unit. After power-up, the drive will scan the memory unit. This can take several minutes.

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

**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 16) before you start the work.
2. Pull the clip of the memory forward.




3. Take the unit off.
4. Replace the unit in reverse order.

See BCU-02/12/22 control units hardware manual (3AUA0000113605 [English]).

# Functional safety components

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

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

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

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

Contact your local ABB service representative for more information.

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# Ordering information

## Contents of this chapter

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

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

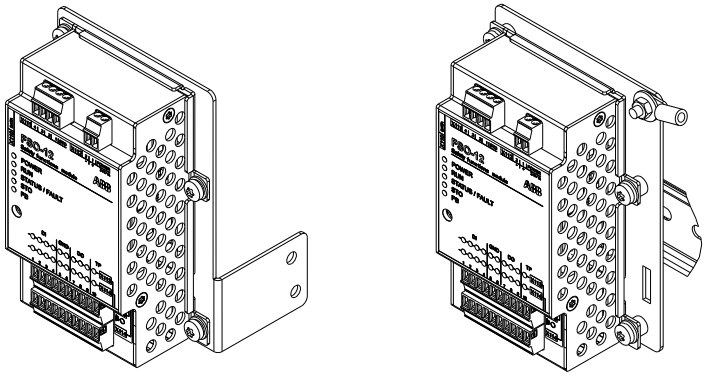
## Output (d*u*/d*t*) filters

See section d*u*/d*t* filters (page 199).

## Sine filters

See section Sine filters (page 200).

# FSO accessories kit

| Kit code | Ordering code | Illustration |
|---|---|---|
| A-X-X-279 | 3AXD50000025495 |  Instruction code: 3AXD50000025583 |

# Retrofit accessory kits

| Kit | Option code | Ordering code |
|---|---|---|
| Common mode filter kit | +E208 | 3AXD50000026145 |
| Full size cable connection terminals for input power cables | +H370 | 3AXD50000019542 |
| Full size cable connection terminals for output power cables | 1) | 3AXD50000019544 |
| For frame R11: IP20 shrouds for covering the input and motor cabling area | 2) | 3AXD50000019538 |

1) The drive module is delivered with full size cable connection terminals for output power cables as standard. They can be excluded with option +0H371.

2) The drive module is delivered with IP20 shrouds for covering the input and motor cabling area as standard. The shrouds can be excluded with option +0B051.

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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

The ratings of the drive module packages with 50 Hz and 60 Hz supply are given below.

| IEC RATINGS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACS880-04F-... | Frame size | Input current | Output ratings | | | | | | | | |
| | | | Nominal use | | | | | Light-duty use | | Heavy-duty use | |
| | | $I_1$ | $I_{max}$ | $I_{max\_start}$ | $I_2$ | $P_n$ | $S_n$ | $I_{Ld}$ | $P_{Ld}$ | $I_{Hd}$ | $P_{Hd}$ |
| | | A | A | A | A | kW | kVA | A | kW | A | kW |
| $U_n$ = 400 V | | | | | | | | | | | |
| 504A-3 | R11 | 504 | 560 | 671 | 504 | 250 | 349 | 485 | 250 | 361 | 200 |
| 584A-3 | R11 | 584 | 730 | 828 | 584 | 315 | 405 | 575 | 315 | 429 | 250 |
| 649A-3 | R11 | 649 | 730 | 954 | 649 | 355 | 450 | 634 | 355 | 477 | 250 |
| 725A-3 | R11 | 725 | 1020 | 1100 | 725 | 400 | 502 | 715 | 400 | 566 | 315 |
| 820A-3 | R11 | 820 | 1020 | 1100 | 820 | 450 | 568 | 810 | 450 | 625 | 355 |
| 880A-3 | R11 | 880 | 1100 | 1100 | 880 | 500 | 610 | 865 | 500 | 725* | 400 |
| $U_n$ = 500 V | | | | | | | | | | | |
| 459A-5 | R11 | 459 | 560 | 671 | 459 | 315 | 398 | 450 | 315 | 330 | 200 |
| 502A-5 | R11 | 502 | 560 | 671 | 502 | 355 | 435 | 483 | 315 | 361 | 250 |
| 582A-5 | R11 | 582 | 730 | 828 | 582 | 400 | 504 | 573 | 400 | 414 | 250 |
| 634A-5 | R11 | 634 | 730 | 954 | 634 | 450 | 549 | 623 | 450 | 477 | 315 |

| IEC RATINGS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACS880-04F-... | Frame size | Input current | Output ratings | | | | | | | | |
| | | | Nominal use | | | | | Light-duty use | | Heavy-duty use | |
| | | $I_1$ | $I_{max}$ | $I_{max\_start}$ | $I_2$ | $P_n$ | $S_n$ | $I_{Ld}$ | $P_{Ld}$ | $I_{Hd}$ | $P_{Hd}$ |
| | | A | A | A | A | kW | kVA | A | kW | A | kW |
| 715A-5 | R11 | 715 | 850 | 1100 | 715 | 500 | 619 | 705 | 500 | 566 | 400 |
| 820A-5 | R11 | 820 | 1020 | 1100 | 820 | 560 | 710 | 807 | 560 | 625 | 450 |
| 880A-5 | R11 | 880 | 1100 | 1100 | 880 | 560 | 762 | 857 | 560 | 697* | 500 |
| $U_n$ = 690 V | | | | | | | | | | | |
| 329A-7 | R11 | 329 | 480 | 510 | 329 | 315 | 393 | 320 | 315 | 255 | 250 |
| 369A-7 | R11 | 369 | 520 | 650 | 369 | 355 | 441 | 360 | 355 | 325 | 315 |
| 429A-7 | R11 | 429 | 520 | 720 | 429 | 400 | 513 | 420 | 400 | 360** | 355 |
| 470A-7 | R11 | 470 | 655 | 830 | 470 | 450 | 562 | 455 | 450 | 415 | 400 |
| 522A-7 | R11 | 522 | 655 | 910 | 522 | 500 | 624 | 505 | 500 | 455 | 450 |
| 590A-7 | R11 | 590 | 800 | 1010 | 590 | 560 | 705 | 571 | 560 | 505 | 500 |
| 650A-7 | R11 | 650 | 820 | 1100 | 650 | 630 | 777 | 630 | 630 | 571** | 560 |
| 721A-7 | R11 | 721 | 820 | 1100 | 721 | 710 | 862 | 705 | 630 | 571** | 560 |
| 3AXD00000588487 | | | | | | | | | | | |

| UL/NEC RATINGS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ACS880-04F-... | Frame size | Input current | Max. current | | Output ratings | | | | |
| | | | | | App. power | Light-duty use | | Heavy-duty use | |
| | | $I_1$ | $I_{max}$ | $I_{max\_start}$ | $S_n$ | $I_{Ld}$ | $P_{Ld}$ | $I_{Hd}$ | $P_{Hd}$ |
| | | A | A | A | kVA | A | hp | A | hp |
| $U_n$ = 480 V | | | | | | | | | |
| 459A-5 | R11 | 459 | 560 | 671 | - | - | - | - | - |
| 502A-5 | R11 | 502 | 560 | 671 | 435 | 483 | 400 | 361 | 300 |
| 582A-5 | R11 | 582 | 730 | 828 | 504 | 573 | 450 | 414 | 350 |
| 634A-5 | R11 | 634 | 730 | 954 | 549 | 623 | 500 | 477 | 400 |
| 715A-5 | R11 | 715 | 850 | 1100 | 619 | 705 | 600 | 566 | 450 |
| 820A-5 | R11 | 820 | 1020 | 1100 | 710 | 807 | 700 | 625 | 500 |
| 880A-5 | R11 | 880 | 1100 | 1100 | 762 | 857 | 700 | 697** | 600 |
| $U_n$ = 575 V | | | | | | | | | |
| 329A-7 | R11 | 329 | 480 | 510 | 393 | 320 | 300 | 255 | 250 |
| 369A-7 | R11 | 369 | 520 | 650 | 441 | 360 | 350 | 325 | 300 |
| 429A-7 | R11 | 429 | 520 | 720 | 513 | 420 | 450 | 360*** | 350 |
| 470A-7 | R11 | 470 | 655 | 830 | 562 | 455 | 450 | 415 | 450 |
| 522A-7 | R11 | 522 | 655 | 910 | 624 | 505 | 500 | 455 | 450 |
| 590A-7 | R11 | 590 | 800 | 1010 | 705 | 571 | 600 | 505 | 500 |
| 650A-7 | R11 | 650 | 820 | 1100 | 777 | 630 | 700 | 571*** | 600 |
| 721A-7 | R11 | 721 | 820 | 1100 | 862 | 705 | 700 | 571*** | 600 |
| 3AXD00000588487 | | | | | | | | | |

| | |
|---|---|
| $U_n$ | Nominal voltage of the drive. For input voltage range, see the type designation key. |
| $I_1$ | Nominal input current (rms) at 40 °C (104 °F) |
| $I_{max}$ | Maximum output current. Available for 10 seconds at start, otherwise as long as allowed by drive temperature. 140% … 200% of $I_{Hd}$, depending on power rating. |
| $I_{max\_start}$ | Maximum output current at start. Available for two seconds only at start every five seconds if start current limit is activated by parameter 30.15 Maximum start current enable. |
| $I_2$ | Continuous rms output current. No overload capability at 40 °C (104 °F). This is indicated in the type designation label as output current $I_2$. |
| $P_n$ | Typical motor power in no-overload use |
| $S_n$ | Apparent power (no overload) |
| $I_{Ld}$ | Continuous rms output current allowing 10% overload for 1 minute every 5 minutes |
| $P_{Ld}$ | Typical motor power for light-overload use |
| $I_{Hd}$ | Continuous rms output current allowing 50% overload for 1 minute every 5 minutes<br>* Continuous rms output current allowing 40% overload for 1 minute every 5 minutes<br>** Continuous rms output current allowing 45% overload for 1 minute every 5 minutes<br>*** Continuous rms output current allowing 44% overload for 1 minute every 5 minutes |
| $P_{Hd}$ | Typical motor power for heavy-duty use |
| **Note:** To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current. The power ratings apply to most IEC 34 motors at the nominal voltage of the drive.<br>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

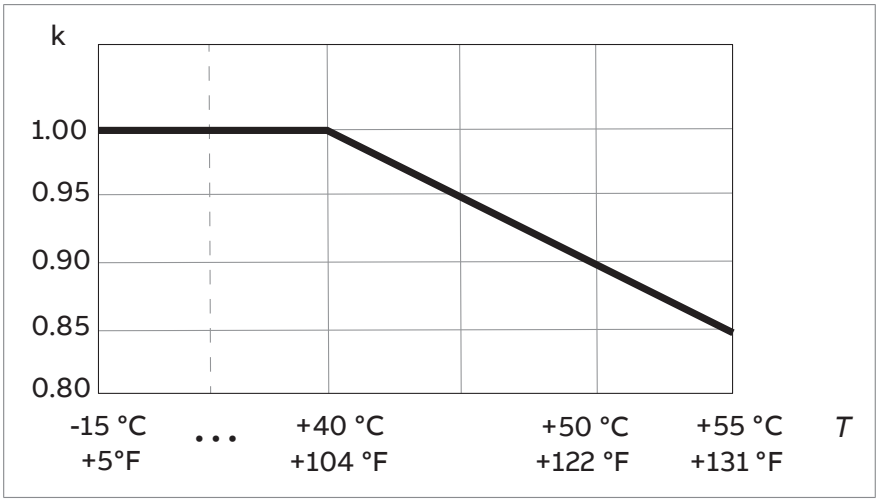
Derate the continuous output current of the drive if

- ambient temperature exceeds +40 °C (+104 °F) or
- drive is installed higher than 1000 m (3280 ft) above sea level
- switching frequency is other than default
- the minimum requirements of motor cable length are not met (see chapter Filters (page 199)).

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

## Ambient temperature derating

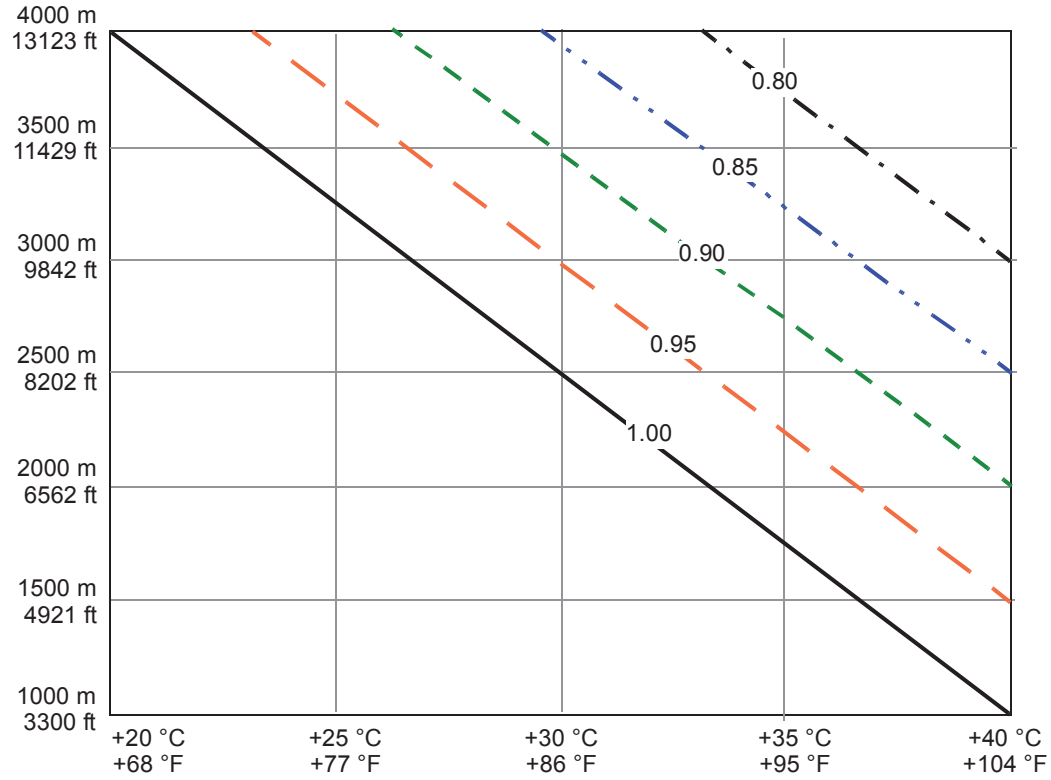
In the temperature range +40…55 °C (+104…131 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F) as follows. Calculate the output current by multiplying the current given in the rating table by the derating factor.




## Altitude derating

At altitudes 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.

## Deratings for special settings in the drive control program

Enabling special settings in the drive control program can require output current derating.

**Ex motor, sine filter, low noise**

Table below gives the deratings for these cases:

- drive is used with an ABB motor for explosive atmospheres (Ex) and EX motor in parameter 95.15 Special HW settings is enabled
- sine filter given in the selection table in section Sine filters (page 200) is used and ABB sine filter in parameter 95.15 Special HW settings is enabled
- Low noise optimization is selected in parameter 97.09 Switching freq mode.

With other than recommended sine filters (see Sine filters (page 200)) and non-ABB Ex motors, contact ABB.

| ACS880-04F-... | Output ratings for special settings | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ex motor (ABB Ex motor) | | | | ABB sine filter | | | | Low noise mode | | | |
| | Nominal use | | Light-duty use | Heavy-duty use | Nominal use | | Light-duty use | Heavy-duty use | Nominal use | | Light-duty use | Heavy-duty use |
| | $I_2$ | $P_n$ | $I_{Ld}$ | $I_{Hd}$ | $I_2$ | $P_n$ | $I_{Ld}$ | $I_{Hd}$ | $I_2$ | $P_n$ | $I_{Ld}$ | $I_{Hd}$ |
| | A | kW | A | A | A | kW | A | A | A | kW | A | A |
| $U_n$ = 400 V | | | | | | | | | | | | |
| 504A-3 | 479 | 250 | 459 | 345 | 470 | 250 | 450 | 340 | 390 | 200 | 370 | 290 |
| 584A-3 | 551 | 250 | 533 | 395 | 540 | 250 | 518 | 383 | 437 | 250 | 419 | 311 |
| 649A-3 | 612 | 315 | 591 | 438 | 600 | 315 | 576 | 425 | 485 | 250 | 466 | 346 |
| 725A-3 | 667 | 355 | 650 | 493 | 647 | 355 | 628 | 468 | 519 | 250 | 496 | 390 |
| 820A-3 | 753 | 400 | 737 | 544 | 731 | 400 | 712 | 517 | 587 | 315 | 562 | 431 |
| 880A-3 | 809 | 450 | 786 | 631 | 785 | 450 | 760 | 600 | 630 | 355 | 600 | 500* |
| $U_n$ = 500 V | | | | | | | | | | | | |
| 459A-5 | 437 | 250 | 427 | 316 | 430 | 250 | 419 | 311 | 357 | 250 | 345 | 265 |
| 502A-5 | 478 | 315 | 458 | 345 | 470 | 315 | 450 | 340 | 390 | 250 | 370 | 290 |
| 582A-5 | 531 | 355 | 509 | 364 | 514 | 355 | 487 | 347 | 400 | 250 | 380 | 298 |
| 634A-5 | 579 | 400 | 553 | 419 | 560 | 400 | 530 | 400 | 410 | 250 | 392 | 298 |
| 715A-5 | 657 | 450 | 641 | 522 | 637 | 450 | 620 | 507 | 462 | 315 | 428 | 362 |
| 820A-5 | 753 | 500 | 734 | 576 | 730 | 500 | 710 | 560 | 530 | 355 | 490 | 400 |
| 880A-5 | 768 | 500 | 747 | 594 | 730 | 500 | 710 | 560 | 550 | 400 | 510 | 410 |
| $U_n$ = 690 V | | | | | | | | | | | | |
| 329A-7 | 310 | 250 | 300 | 217 | 303 | 250 | 293 | 204 | 232 | 200 | 222 | 157 |
| 369A-7 | 347 | 315 | 338 | 276 | 340 | 315 | 330 | 260 | 260 | 250 | 250 | 200 |
| 429A-7 | 377 | 355 | 368 | 315 | 360 | 355 | 350 | 300** | 290 | 250 | 280 | 236** |
| 470A-7 | 388 | 355 | 376 | 335 | 360 | 355 | 349 | 308 | 270 | 250 | 261 | 238 |
| 522A-7 | 431 | 400 | 417 | 370 | 400 | 355 | 388 | 342 | 300 | 250 | 290 | 262 |
| 590A-7 | 485 | 450 | 470 | 449 | 450 | 400 | 436 | 385 | 340 | 315 | 330 | 300 |
| 650A-7 | 575 | 500 | 555 | 480 | 550 | 500 | 530 | 450** | 450 | 400 | 430 | 350** |
| 721A-7 | 593 | 500 | 574 | 480 | 550 | 500 | 530 | 450** | 450 | 400 | 430 | 350** |
| | | | | | | | | | | | | 3AXD00000588487 |

| | |
|---|---|
| $U_n$ | Nominal voltage of the drive |
| $I_2$ | Nominal output current (rms) at 40 °C (104 °F) |
| $P_n$ | Typical motor power in no-overload use |
| $I_{Ld}$ | Continuous rms output current allowing 10% overload for 1 minute every 5 minutes<br>*Continuous rms output current allowing 40% overload for 1 minute every 5 minutes<br>**Continuous rms output current allowing 44% overload for 1 minute every 5 minutes |
| $I_{Hd}$ | Continuous rms output current allowing 50% overload for 1 minute every 5 minutes |

**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.

## High speed mode

The selection **High speed mode** of parameter 95.15 Special HW settings improves control performance at high output frequencies. ABB recommends it to be selected with output frequency of 120 Hz and above.

This table gives the drive module ratings for 120 Hz output frequency and the maximum output frequency when **High speed mode** in parameter 95.15 Special HW settings is enabled. With output frequencies lower than the maximum output frequency, the current derating is less than the value given in the table. Contact ABB for operation above the recommended maximum output frequency or for the output current derating with output frequencies above 120 Hz and below the maximum output frequency.

| ACS880-04F-... | Deratings with selection High speed mode of parameter 95.15 Special HW settings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 120 Hz output frequency | | | | | Maximum output frequency | | | | |
| | Frequency | Nominal use | | Light-duty use | Heavy-duty use | Maximum frequency | Nominal use | | Light-duty use | Heavy-duty use |
| | $f$ | $I_2$ | $P_n$ | $I_{Ld}$ | $I_{Hd}$ | $f_{max}$ | $I_2$ | $P_n$ | $I_{Ld}$ | $I_{Hd}$ |
| | Hz | A | kW | A | A | Hz | A | kW | A | A |
| $U_n$ = 400 V | | | | | | | | | | |
| 504A-3 | 120 | 504 | 250 | 485 | 361 | 500 | 390 | 200 | 370 | 290 |
| 584A-3 | 120 | 584 | 315 | 575 | 429 | 500 | 437 | 250 | 419 | 311 |
| 649A-3 | 120 | 649 | 355 | 634 | 477 | 500 | 485 | 250 | 466 | 346 |
| 725A-3 | 120 | 725 | 400 | 715 | 566 | 500 | 519 | 250 | 496 | 390 |
| 820A-3 | 120 | 820 | 450 | 810 | 625 | 500 | 587 | 315 | 562 | 431 |
| 880A-3 | 120 | 880 | 500 | 865 | 725* | 500 | 630 | 355 | 600 | 500* |
| $U_n$ = 500 V | | | | | | | | | | |
| 459A-5 | 120 | 459 | 315 | 450 | 330 | 500 | 357 | 250 | 345 | 265 |
| 502A-5 | 120 | 502 | 355 | 483 | 361 | 500 | 390 | 250 | 370 | 290 |
| 582A-5 | 120 | 582 | 400 | 573 | 414 | 500 | 400 | 250 | 380 | 298 |
| 634A-5 | 120 | 634 | 450 | 623 | 477 | 500 | 410 | 250 | 392 | 298 |
| 715A-5 | 120 | 715 | 500 | 705 | 566 | 500 | 462 | 315 | 428 | 362 |
| 820A-5 | 120 | 820 | 560 | 807 | 625 | 500 | 530 | 355 | 490 | 400 |
| 880A-5 | 120 | 880 | 630 | 857 | 697** | 500 | 550 | 400 | 510 | 410 |
| $U_n$ = 690 V | | | | | | | | | | |
| 329A-7 | 120 | 329 | 315 | 320 | 255 | 375 | 232 | 200 | 222 | 157 |
| 369A-7 | 120 | 369 | 355 | 360 | 325 | 375 | 260 | 250 | 250 | 200 |
| 429A-7 | 120 | 429 | 400 | 420 | 360*** | 375 | 290 | 250 | 280 | 236*** |
| 470A-7 | 120 | 470 | 450 | 455 | 415 | 375 | 270 | 250 | 261 | 238 |
| 522A-7 | 120 | 522 | 500 | 505 | 455 | 375 | 300 | 250 | 290 | 262 |
| 590A-7 | 120 | 590 | 560 | 571 | 505 | 375 | 340 | 315 | 330 | 300 |

| ACS880-04F-... | Deratings with selection High speed mode of parameter 95.15 Special HW settings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 120 Hz output frequency | | | | | Maximum output frequency | | | | |
| | Frequency | Nominal use | | Light-duty use | Heavy-duty use | Maximum frequency | Nominal use | | Light-duty use | Heavy-duty use |
| | $f$ | $I_2$ | $P_n$ | $I_{Ld}$ | $I_{Hd}$ | $f_{max}$ | $I_2$ | $P_n$ | $I_{Ld}$ | $I_{Hd}$ |
| | Hz | A | kW | A | A | Hz | A | kW | A | A |
| 650A-7 | 120 | 650 | 630 | 630 | 571*** | 375 | 450 | 400 | 430 | 350*** |
| 721A-7 | 120 | 721 | 710 | 705 | 571*** | 375 | 450 | 400 | 430 | 350*** |
| | | | | | | | | | | 3AXD00000588487 |

| | |
|---|---|
| $f$ | Output frequency |
| $f_{max}$ | Maximum output frequency with High speed mode |
| $U_n$ | Nominal voltage of the drive |
| $I_2$ | Continuous rms output current. No overload capability at 40 °C (104 °F). |
| $P_n$ | Typical motor power in no-overload use |
| $I_{Ld}$ | Continuous rms output current allowing 10% overload for 1 minute every 5 minutes |
| $I_{Hd}$ | Continuous rms output current allowing 50% overload for 1 minute every 5 minutes<br>*Continuous rms output current allowing 40% overload for 1 minute every 5 minutes<br>**Continuous rms output current allowing 45% overload for 1 minute every 5 minutes<br>***Continuous rms output current allowing 44% overload for 1 minute every 5 minutes |

# Fuses (IEC)

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

| Drive type ACS880-04F-... | Ultrarapid (aR) fuses per drive module | | | | | | |
|---|---|---|---|---|---|---|---|
| | Min. short-circuit current | Input current | Fuse | | | | |
| | A | A | A | $A^2s$ | V | Type DIN 43653 | Size |
| $U_n$ = 400 V | | | | | | | |
| 504A-3 | 4500 | 504 | 800 | 465000 | 690 | 170M6012 | 3 |
| 584A-3 | 6500 | 584 | 1000 | 945000 | 690 | 170M6014 | 3 |
| 649A-3 | 6500 | 649 | 1000 | 945000 | 690 | 170M6014 | 3 |
| 725A-3 | 9100 | 725 | 1250 | 1950000 | 690 | 170M6016 | 3 |
| 820A-3 | 11000 | 820 | 1600 | 3900000 | 690 | 170M6019 | 3 |
| 880A-3 | 11000 | 880 | 1600 | 3900000 | 690 | 170M6019 | 3 |
| $U_n$ = 500 V | | | | | | | |
| 459A-5 | 3000 | 459 | 630 | 210000 | 690 | 170M6010 | 3 |
| 502A-5 | 4500 | 502 | 800 | 465000 | 690 | 170M6012 | 3 |
| 582A-5 | 6500 | 582 | 1000 | 945000 | 690 | 170M6014 | 3 |
| 634A-5 | 6500 | 634 | 1000 | 945000 | 690 | 170M6014 | 3 |
| 715A-5 | 9100 | 715 | 1250 | 1950000 | 690 | 170M6016 | 3 |
| 820A-5 | 11000 | 820 | 1600 | 3900000 | 690 | 170M6019 | 3 |
| 880A-5 | 11000 | 880 | 1600 | 3900000 | 690 | 170M6019 | 3 |
| $U_n$ = 690 V | | | | | | | |
| 329A-7 | 3600 | 329 | 700 | 300000 | 690 | 170M6011 | 3 |
| 369A-7 | 5600 | 369 | 900 | 670000 | 690 | 170M6013 | 3 |
| 429A-7 | 6500 | 429 | 1000 | 945000 | 690 | 170M6014 | 3 |
| 470A-7 | 7800 | 470 | 1100 | 1300000 | 690 | 170M6015 | 3 |
| 522A-7 | 9100 | 522 | 1250 | 1950000 | 690 | 170M6016 | 3 |
| 590A-7 | 10200 | 590 | 1400 | 2450000 | 690 | 170M6017 | 3 |
| 650A-7 | 10500 | 650 | 1500 | 3100000 | 690 | 170M6018 | 3 |
| 721A-7 | 10500 | 721 | 1500 | 3100000 | 690 | 170M6018 | 3 |

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

Fuses with higher current rating than the recommended ones must not be used. Fuses with lower current rating can be used.

Fuses from other manufacturers can be used if they agree with the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

## 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) |

**Calculation example**

Drive:

- ACS880-04F-715A-5
- Supply voltage = 500 V

Transformer:

- rated power $S_n$ = 5000 kVA
- rated voltage (drive supply voltage) $U_N$ = 480 V
- transformer impedance $z_k$ = 10%.

Supply cable:

- length = 170 m
- resistance/length = 0.125 ohm/km
- reactance/length = 0.074 ohm/km.

$$Z_k = z_k \cdot \frac{U_N^2}{S_N} = 0.1 \cdot \frac{(480\ \text{V})^2}{5000\ \text{kVA}} = 4.61\ \text{mohm}$$

$$R_c = 170\ \text{m} \cdot 0.125\ \frac{\text{ohm}}{\text{km}} = 21.25\ \text{mohm}$$

$$X_c = 170\ \text{m} \cdot 0.074\ \frac{\text{ohm}}{\text{km}} = 12.58\ \text{mohm}$$

$$I_{k2\text{-}ph} = \frac{500\ \text{V}}{2 \cdot \sqrt{(21.25\ \text{mohm})^2 + (4.61\ \text{mohm} + 12.58\ \text{mohm})^2}} = 9.15\ \text{kA}$$

The calculated short-circuit current 9.15 kA is higher than the minimum short-circuit current of the drive aR fuse type 170M6016 (9100 A). -> The 690 V aR fuse (170M6016) can be used.

# Fuses (UL)

UL fuses for branch circuit protection per NEC per drive module are listed below. Obey the local regulations. The listed fuses do not include trip indicators by default.

| Drive type | UL fuses per drive module | | | | | |
|---|---|---|---|---|---|---|
| | Input current (A) | Fuse | | | | |
| | | A | V | Manufacturer | UL class | Type |
| $U_n$ = 480 V | | | | | | |
| ACS880-04F-459A-5 | 459 | 600 | 600 | Bussmann | T | JJS-600 |
| ACS880-04F-502A-5 | 502 | 600 | 600 | Bussmann | T | JJS-600 |
| ACS880-04F-582A-5 | 582 | 800 | 600 | Ferraz | L | A4BY800 |
| ACS880-04F-634A-5 | 634 | 800 | 600 | Ferraz | L | A4BY800 |
| ACS880-04F-715A-5 | 715 | 1000 | 600 | Ferraz | L | A4BY1000 |
| ACS880-04F-820A-5 | 820 | 1000 | 600 | Ferraz | L | A4BY1000 |
| ACS880-04F-880A-5 | 880 | 1000 | 600 | Ferraz | L | A4BY1000 |
| $U_n$ = 575 V | | | | | | |
| ACS880-04F-329A-7 | 329 | 500 | 600 | Bussmann | T | JJS-500 |
| ACS880-04F-369A-7 | 369 | 500 | 600 | Bussmann | T | JJS-500 |
| ACS880-04F-429A-7 | 429 | 500 | 600 | Bussmann | T | JJS-500 |
| ACS880-04F-470A-7 | 470 | 600 | 600 | Bussmann | T | JJS-600 |
| ACS880-04F-522A-7 | 522 | 600 | 600 | Bussmann | T | JJS-600 |
| ACS880-04F-590A-7 | 590 | 800 | 600 | Ferraz | L | A4BY800 |
| ACS880-04F-650A-7 | 650 | 800 | 600 | Ferraz | L | A4BY800 |
| ACS880-04F-721A-7 | 721 | 800 | 600 | Ferraz | L | A4BY800 |

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

Circuit breakers must not be used without fuses.

# Dimensions, weights and free space requirements

| Standard drive module configuration (including flange and shrouds) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frame size | Height[1] | | Width | | Depth[2] | | Weight* | |
| | mm | in | mm | in | mm | in | kg | lb |
| R11 | 1733 | 68.23 | 620 | 24.41 | 477 | 18.78 | 224 | 494 |

| Optional selection +0B051+0H371 (without shrouds, full-size output power cable connection terminals but with flange) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frame size | Height[3] | | Width | | Depth[4] | | Weight* | |
| | mm | in | mm | in | mm | in | kg | lb |
| R11 | 1647 | 64.84 | 620 | 24.41 | 405 | 15.94 | 219 | 483 |

| Optional selection +0B051+0H371 (without shrouds, full-size output power cable connection terminals and flange) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frame size | Height[5] | | Width | | Depth[4] | | Weight* | |
| | mm | in | mm | in | mm | in | kg | lb |
| R11 | 1525 | 60.05 | 535 | 21.06 | 405 | 15.94 | 219 | 483 |

| Optional selection +0B051+E208+0H371+C217 (without shrouds, full-size output power cable connection terminals and with wall mounting kit instead of flange) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frame size | Height[3] | | Width | | Depth[4] | | Weight* | |
| | mm | in | mm | in | mm | in | kg | lb |
| R11 | 1647 | 64.84 | 620 | 24.41 | 405 | 15.94 | 222 | 489 |

[1] Height of standard drive module with hood: 1930 mm (75.98 in)

[2] Depth of standard drive module with hood: 556 mm (21.89 in)

[3] Height with optional selection +0B051+0H371, flange (or wall mounting kit) and hood: 1877 mm (73.90 in).

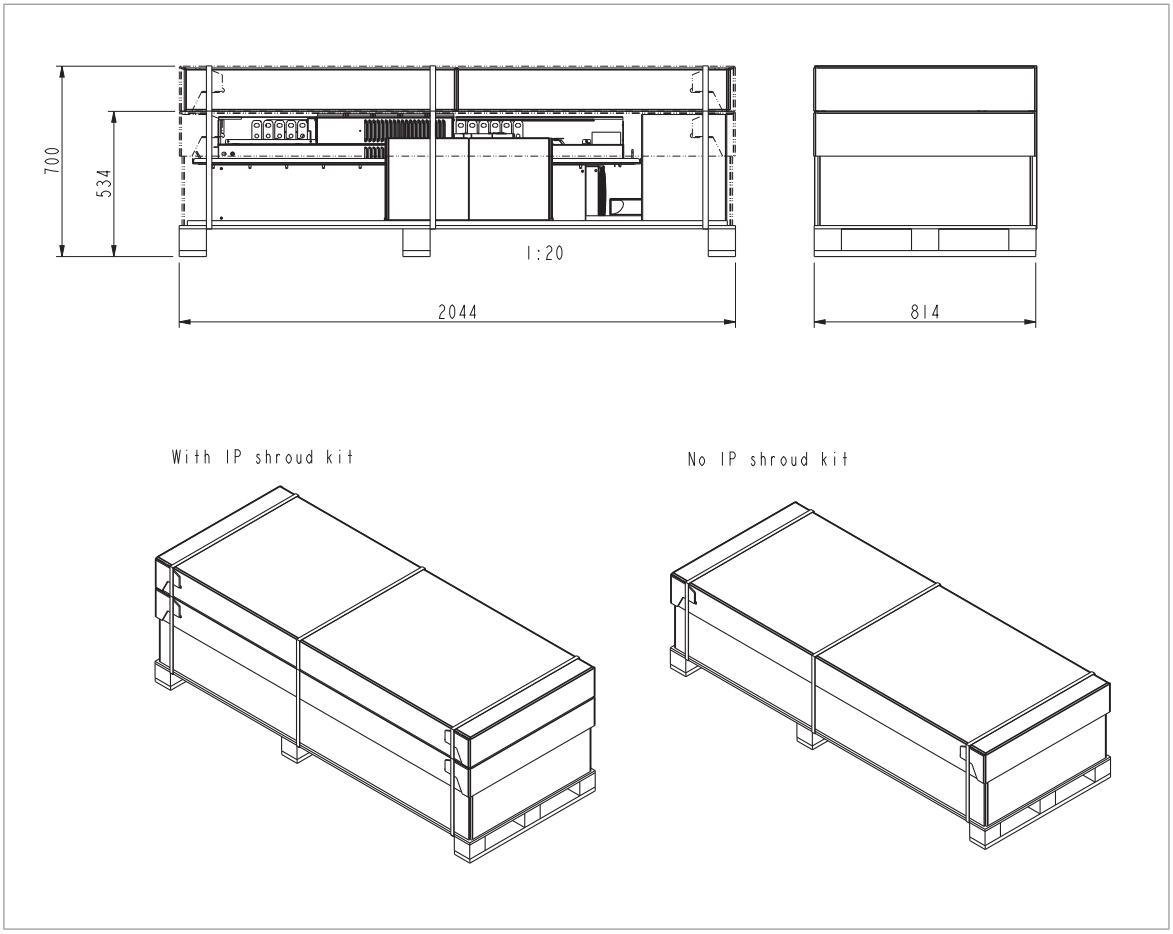
[4] Depth with optional selection +0B051+0H371 and hood: 479 mm (18.87 in)

[5] Height with optional selection +0B051+0H371 and hood, but without flange: 1755 mm (69.09 in). The height is the same with the wall mounting kit instead of flange.

| Effect of optional selections on drive weight | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Frame size | +E208 | | +D150 | | +H356 | | +0H371 | | +H370 | | +0B051 | |
| | kg | lb | kg | lb | kg | lb | kg | lb | kg | lb | kg | lb |
| R11 | 3 | 7 | 9 | 20 | 2 | 4 | -2.9 | -6 | 2.9 | 6 | -1.5 | -3 |

For the free space requirements, refer to section Required free space (page 43).

## Package dimensions




Package dimensions without IP shroud kit.

# Losses, cooling data and noise

| Drive type | Frame size | Air flow | | Heat dissipation [1)] | Noise |
|---|---|---|---|---|---|
| | | Heatsink | Front | | |
| | | m³/h | m³/h | W | dB(A) |
| $U_n$ = 400 V | | | | | |
| ACS880-04F-504A-3 | R11 | 1400 | 120 | 4693 | 75 |
| ACS880-04F-584A-3 | R11 | 1400 | 120 | 5827 | 75 |
| ACS880-04F-649A-3 | R11 | 1400 | 120 | 6793 | 75 |
| ACS880-04F-725A-3 | R11 | 1400 | 120 | 7989 | 75 |
| ACS880-04F-820A-3 | R11 | 1400 | 120 | 9649 | 75 |
| ACS880-04F-880A-3 | R11 | 1400 | 120 | 10782 | 75 |
| $U_n$ = 500 V | | | | | |
| ACS880-04F-459A-5 | R11 | 1400 | 120 | 4311 | 75 |
| ACS880-04F-502A-5 | R11 | 1400 | 120 | 4774 | 75 |
| ACS880-04F-582A-5 | R11 | 1400 | 120 | 5857 | 75 |
| ACS880-04F-634A-5 | R11 | 1400 | 120 | 6579 | 75 |
| ACS880-04F-715A-5 | R11 | 1400 | 120 | 7965 | 75 |
| ACS880-04F-820A-5 | R11 | 1400 | 120 | 9981 | 75 |
| ACS880-04F-880A-5 | R11 | 1400 | 120 | 10956 | 75 |
| $U_n$ = 690 V | | | | | |
| ACS880-04F-329A-7 | R11 | 1400 | 120 | 3266 | 75 |
| ACS880-04F-369A-7 | R11 | 1400 | 120 | 3725 | 75 |
| ACS880-04F-429A-7 | R11 | 1400 | 120 | 4539 | 75 |
| ACS880-04F-470A-7 | R11 | 1400 | 120 | 5198 | 75 |
| ACS880-04F-522A-7 | R11 | 1400 | 120 | 5984 | 75 |
| ACS880-04F-590A-7 | R11 | 1400 | 120 | 7115 | 75 |
| ACS880-04F-650A-7 | R11 | 1400 | 120 | 8289 | 75 |
| ACS880-04F-721A-7 | R11 | 1400 | 120 | 9628 | 75 |

1) Typical drive losses when it operates at 90% of the motor nominal frequency and 100% of the drive nominal output current (calculated according to IEC61800-9-2).

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

# Typical power cable sizes

The table below gives typical copper and aluminum cable types with concentric copper shield for the drive modules with nominal current. See also section Terminal and entry data for the power cables (page 146).

| ACS880-04F-... | IEC[1] | | US[2] | |
|---|---|---|---|---|
| | Cu cable type | Al cable type | Cu cable type | Al cable type |
| | mm² | mm² | AWG/kcmil | AWG/kcmil |
| $U_n$ = 400 V | | | | |
| 504A-3 | 3×(3×95) | 3×(3×150) | 2×500 MCM or 3×250 MCM | 2×700 MCM or 3×350 MCM |
| 584A-3 | 3×(3×120) | 3×(3×185) | 2×600 MCM or 3×300 MCM | 3×400 MCM or 4×250 MCM |
| 649A-3 | 3×(3×150) | 3×(3×240) | 2×700 MCM or 3×350 MCM | 3×400 MCM or 4×250 MCM |
| 725A-3 | 3×(3×185) | 4×(3×185) | 3×500 MCM or 4×300 MCM | 3×500 MCM or 4×300 MCM |
| 820A-3 | 3×(3×240) | 4×(3×240) | 3×600 MCM or 4×400 MCM | 3×700 MCM or 4×500 MCM |
| 880A-3 | 3×(3×240) | 4×(3×240) | 3×600 MCM or 4×400 MCM | 4×500 MCM |
| $U_n$ = 500 V | | | | |
| 459A-5 | 3×(3×95) | 3×(3×150) | 2×400 MCM or 3×4/0 | 2×600 MCM or 3×300 MCM |
| 502A-5 | 3×(3×95) | 3×(3×150) | 2×500 MCM or 3×250 MCM | 2×700 MCM or 3×350 MCM |
| 582A-5 | 3×(3×120) | 3×(3×185) | 2×600 MCM or 3×300 MCM | 3×500 MCM or 4×300 MCM |
| 6354-5 | 3×(3×150) | 3×(3×240) | 2×700 MCM or 3×350 MCM | 3×600 MCM or 4×400 MCM |
| 715A-5 | 3×(3×185) | 4×(3×185) | 3×500 MCM or 4×300 MCM | 3×600 MCM or 4×400 MCM |
| 820A-5 | 3×(3×240) | 4×(3×240) | 3×600 MCM or 4×400 MCM | 4×500 MCM |
| 880A-5 | 3×(3×240) | 4×(3×240) | 3×600 MCM or 4×400 MCM | 4×500 MCM |
| $U_n$ = 690 V | | | | |
| 329A-7 | 2×(3×120) | 3×(3×120) | 2×250 MCM or 3×2/0 | 2×350 MCM or 3×4/0 |
| 369A-7 | 2×(3×120) | 3×(3×120) | 2×300 MCM or 3×3/0 | 2×400 MCM or 3×4/0 |
| 429A-7 | 2×(3×95) | 2×(3×120) | 2×350 MCM or 3×4/0 | 2×500 MCM or 3×250 MCM |
| 470A-7 | 3×(3×95) | 3×(3×150) | 2×400 MCM or 3×4/0 | 2×600 MCM or 3×300 MCM |
| 522A-7 | 3×(3×120) | 3×(3×185) | 2×500 MCM or 3×250 MCM | 2×700 MCM or 3×350 MCM |
| 590A-7 | 3×(3×150) | 3×(3×185) | 2×600 MCM or 3×300 MCM | 3×500 MCM or 4×300 MCM |
| 650A-7 | 3×(3×150) | 3×(3×240) | 2×700 MCM or 3×350 MCM | 3×500 MCM or 4×300 MCM |
| 721A-7 | 3×(3×185) | 4×(3×185) | 3×500 MCM or 4×300 MCM | 3×600 MCM or 4×400 MCM |

[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 (86 °F) PVC insulation, surface temperature 70 °C (158 °F) (EN 60204-1 and IEC 60364-5-52). For other conditions, dimension the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

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

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

**Voltage:** 600 V AC cable is accepted for up to 500 V AC. 750 V AC cable is accepted for up to 600 V AC. 1000 V AC cable is accepted for up to 690 V AC.

# Terminal and entry data for the power cables

The maximum accepted cable size is 4×(3×240) mm$^2$ 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).

## Units without full-size output cable connection terminals and with a common mode filter (+E208)

It is possible to use the maximum cable size (4×[3×240] mm$^2$ or 4×[3×500 MCM]) only with special cable lugs and additional insulation. For more information, contact your local ABB representative.

# Terminal data for the control cables

See section Default I/O diagram of the drive control unit (ZCU-1x) (page 103)

# Electrical power network specification

| | |
|---|---|
| Voltage ($U_1$) | ACS880-04F-xxxx-3 drives: 380…415 VAC 3-phase +10%…-15%. This is indicated in the type designation label as typical input voltage level 3~400 V AC.<br>ACS880-04F-xxxx-5 drives: 380…500 V AC 3-phase +10%…-15%. This is indicated in the type designation label as typical input voltage levels 3~400/480/500 V AC.<br>ACS880-04F-xxxx-7 drives: 525…690 V AC 3-phase +10%…-15%. This is indicated in the type designation label as typical input voltage levels 3~525/600/690 V AC. |
| Network type | TN (grounded) and IT (ungrounded) systems |
| Rated conditional short-circuit current $I_{cc}$ (IEC 61439-1) | Maximum allowable prospective short-circuit current is 65 kA when protected by the fuses given in the fuse table. |
| Short-circuit current protection (UL 61800-5-1, CSA C22.2 No. 274-17) | The drive is suitable for use on a circuit capable of delivering not more than 100 kA rms symmetrical amperes at 600 V maximum when protected by the fuses given in the fuse table. |
| Frequency ($f_1$) | 50/60 Hz. Variation ±5% of nominal frequency. |
| 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, permanent magnet motors and AC induction servomotors. |
| Voltage ($U_2$) | This is indicated in the type designation label as typical output voltage level 3~0…$U_1$. |
| Frequency ($f_2$) | 0…500 Hz<br>For drives with d$u$/d$t$ filter: 200 Hz<br>For drives with sine filter: 120 Hz |
| Frequency resolution | 0.01 Hz |

| | |
|---|---|
| Current | See section Electrical ratings (page 131). |
| Switching frequency | 3 kHz (typically) |
| Maximum recommended motor cable length | DTC control: 500 m (1640 ft)<br>Scalar control: 500 m (1640 ft)<br>**Note:** With motor cables longer than 100 m (328 ft), the EMC Directive requirements may not be fulfilled.<br>**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. |
| Minimum recommended motor cable length | For drive modules without d*u*/d*t* filter: 2 m (7 ft) from each drive module to the motor or 4 m (13 ft) between the drive modules, possible only with special precautions, see section d*u*/d*t* filters (page 199). The motor cabling must be symmetrical. |

## Brake resistor data

See section Ratings (page 197).

## d*u*/d*t* and sine filters

See section Filters (page 199).

# DC connection data

| Drive type | $I_{DC}$ (A) | Capacitance (mF) |
|---|---|---|
| $U_n$ = 400 V | | |
| ACS880-04F-504A-3 | 640 | 14.0 |
| ACS880-04F-584A-3 | 714 | 14.0 |
| ACS880-04F-649A-3 | 870 | 14.0 |
| ACS880-04F-725A-3 | 909 | 21.0 |
| ACS880-04F-820A-3 | 1033 | 21.0 |
| ACS880-04F-880A-3 | 1120 | 21.0 |
| $U_n$ = 500 V | | |
| ACS880-04F-459A-5 | 487 | 14.0 |
| ACS880-04F-502A-5 | 640 | 14.0 |
| ACS880-04F-582A-5 | 714 | 14.0 |
| ACS880-04F-634A-5 | 870 | 14.0 |
| ACS880-04F-715A-5 | 906 | 21.0 |
| ACS880-04F-820A-5 | 1033 | 21.0 |
| ACS880-04F-880A-5 | 1120 | 21.0 |
| $U_n$ = 690 V | | |
| ACS880-04F-329A-7 | 428 | 4.7 |
| ACS880-04F-369A-7 | 480 | 4.7 |
| ACS880-04F-429A-7 | 558 | 4.7 |
| ACS880-04F-470A-7 | 611 | 9.3 |
| ACS880-04F-522A-7 | 679 | 9.3 |
| ACS880-04F-590A-7 | 767 | 9.3 |
| ACS880-04F-650A-7 | 845 | 9.3 |
| ACS880-04F-721A-7 | 937 | 9.3 |

# Control panel type

ACS-AP-W assistant control panel with Bluetooth connection.

# 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) | IP20 (standard)<br>IP00 (option +0B051)<br>Heatsink: IP55 |
| Enclosure types (UL 50/50E) | UL Open Type<br>Heatsink: UL Type 12 |
| 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 or the heatsink can be placed outdoors when it is protected according to these limitations.

| | **Operation (installed for stationary use)** | **Storage (in the protective package)** | **Transportation (in the protective package)** |
|---|---|---|---|
| Installation site altitude | For TN and TT neutral-grounded network systems and IT non-corner-grounded network systems: 0 to 4000 m (13123 ft) above sea level<br>For corner-grounded network systems: 0 to 2000 m (6561 ft) above sea level<br>Above 1000 m (3281 ft): see section When is derating necessary (page 133) | - | - |
| Surrounding air temperature | -15…+55 °C (5…131 °F). No frost allowed. See section When is derating necessary (page 133) | -40… 70 °C (-40…+158 °F) | -40…+70 °C (-40…+158 °F) |
| Relative humidity | 5…95% | Max. 95% | Max. 95% |
| | No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases. | | |
| **Contamination levels** | IEC/EN 60721-3-3:2002 | IEC 60721-3-1:1997 | IEC 60721-3-2:1997 |
| Chemical gases | Class 3C2 | Class 1C2 | Class 2C2 |
| Solid particles | Class 3S2. No conductive dust allowed. | Class 1S3. (packing must support this, otherwise 1S2) | Class 2S2 |
| Pollution degree IEC/EN 60664-1 | 2 | | |
| Atmospheric pressure | 70…106 kPa (0.7 … 1.05 atmospheres) | 70…106 kPa (0.7 … 1.05 atmospheres) | 60…106 kPa (0.6 … 1.05 atmospheres) |
| Vibration IEC 60068-2-6:2007, EN 60068-2-6:2008 | Max. 0.1 mm (0.004 in) (10…57 Hz), max. 10 $m/s^2$ (33 $ft/s^2$) (57…150 Hz) sinusoidal | Max. 1 mm (0.04 in) (5 … 13.2 Hz), max. 7 $m/s^2$ (23 $ft/s^2$) (13.2…100 Hz) sinusoidal | Max. 3.5 mm (0.14 in) (2…9 Hz), max. 15 $m/s^2$ (49 $ft/s^2$) (9…200 Hz) sinusoidal |
| Shock IEC 60068-2-27:2008, EN 60068-2-27:2009 | Not allowed | With packing max. 100 $m/s^2$ (330 $ft/s^2$), 11 ms | With packing max. 100 $m/s^2$ (330 $ft/s^2$), 11 ms |
| Free fall | Not allowed | 100 mm (4 in) for weight over 100 kg (220 lb) | 100 mm (4 in) for weight over 100 kg (220 lb) |

# Colors

RAL 9002

# Materials

## Drive

See Recycling instructions and environmental information for ACS880-04, ACS880-04F, ACS880-14, ACS880-34, ACS580-04, ACH580-04, ACH580-34, ACQ580-04 and ACQ580-34 drives (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 +A1:2010 | Safety of machinery. Electrical equipment of machines. Part 1: General requirements.<br>Provisions for compliance: The final assembler of the machine is responsible for installing<br>• emergency-stop device<br>• supply disconnecting device<br>• IP00 drive module into a cabinet. |
| IEC 60529:1989 + A1:1999 + A2:2013<br>EN 60529:1991 + A1:2000 + A2:2013 | Degrees of protection provided by enclosures (IP code) |
| IEC 61800-3:2004 + A1:2011<br>EN 61800-3:2004 + A1:2012 | Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods |
| UL 61800-5-1 First edition | Standard for 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

These markings are attached to the drive:

| | |
|---|---|
| CE | CE mark<br>Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3). |
| c UL us LISTED | UL Listed mark for USA and Canada<br>Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories. Valid with rated voltages up to 600 V. |
| TÜV NORD Safety Approved | TÜV Safety Approved mark (functional safety)<br>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. |

| | |
|---|---|
|  | CSA certification mark for USA and Canada<br>Product has been tested and evaluated against the relevant North American standards by the CSA Group. Valid with rated voltages up to 600 V. |
|  | EAC (Eurasian Conformity) mark<br>Product complies with the technical regulations of the Eurasian Customs Union. EAC mark is required in Russia, Belarus and Kazakhstan. |
|  | Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP).<br>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. |
|  | RCM mark<br>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). |
|  | WEEE mark<br>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. |
|  | UKCA (UK Conformity Assessed) mark<br>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). |

# 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:

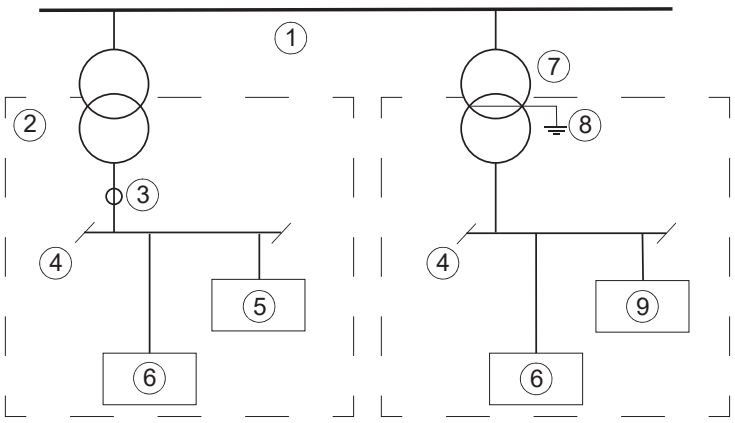
1. The drive is equipped with EMC filter +E200 or +E201.
2. The motor and control cables are selected as specified in the hardware manual.
3. The drive is installed according to the instructions given in the hardware manual.
4. Maximum motor cable length is 100 meters.

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

## Category C4

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.

## Compliance with the European Machinery Directive

See chapter The Safe torque off function (page 171).

# 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, 600 V maximum when protected by the UL fuses given elsewhere in this chapter.
- The cables located within the motor circuit must be rated for at least 75 °C in UL-compliant installations.
- The input cable must be protected with fuses. 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. The protection is not enabled when the drive leaves the ABB factory. For enabling the protection, see the firmware manual.
- The drive overvoltage category according to IEC 60664-1 is III.

# 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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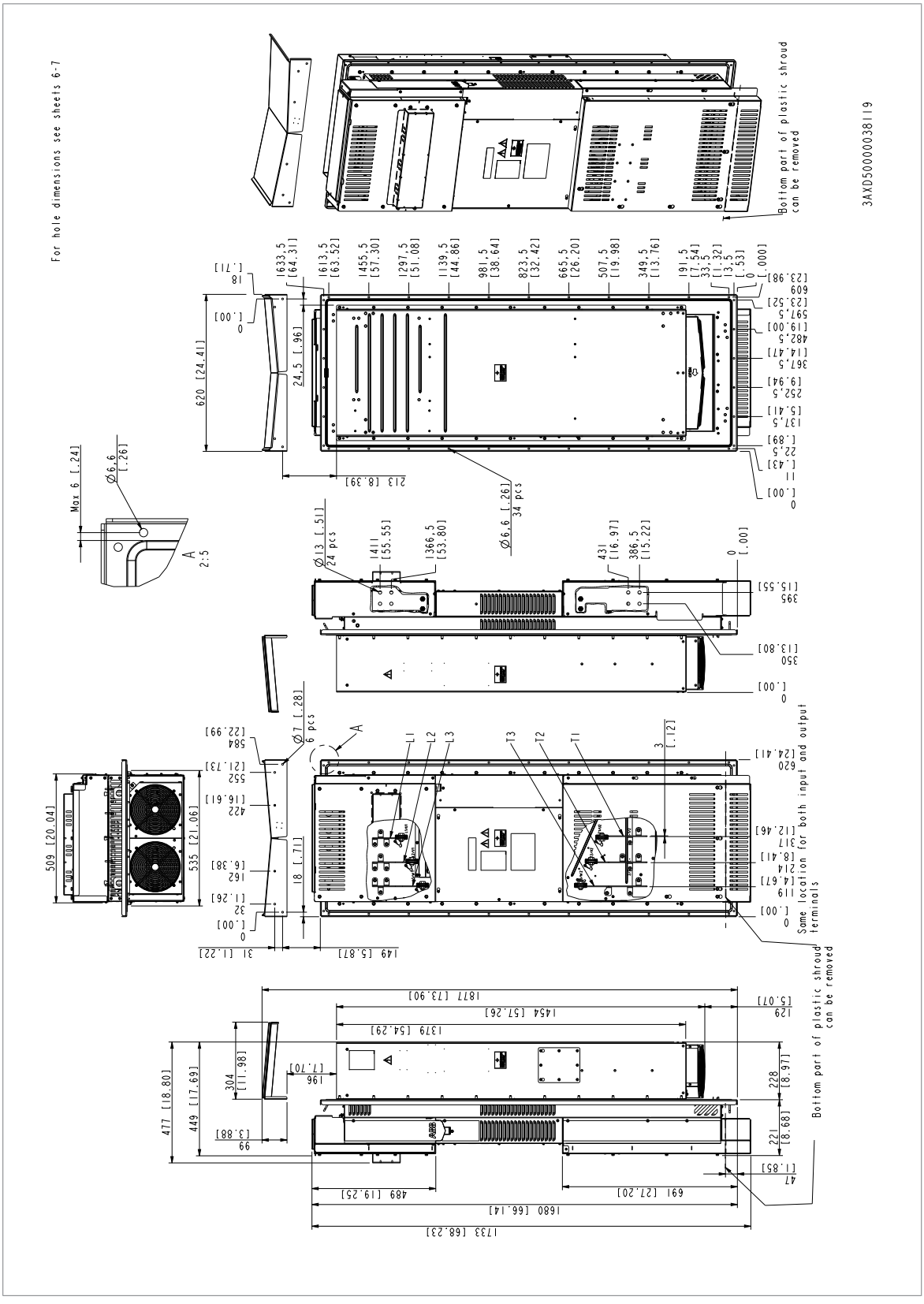
# Dimension drawings

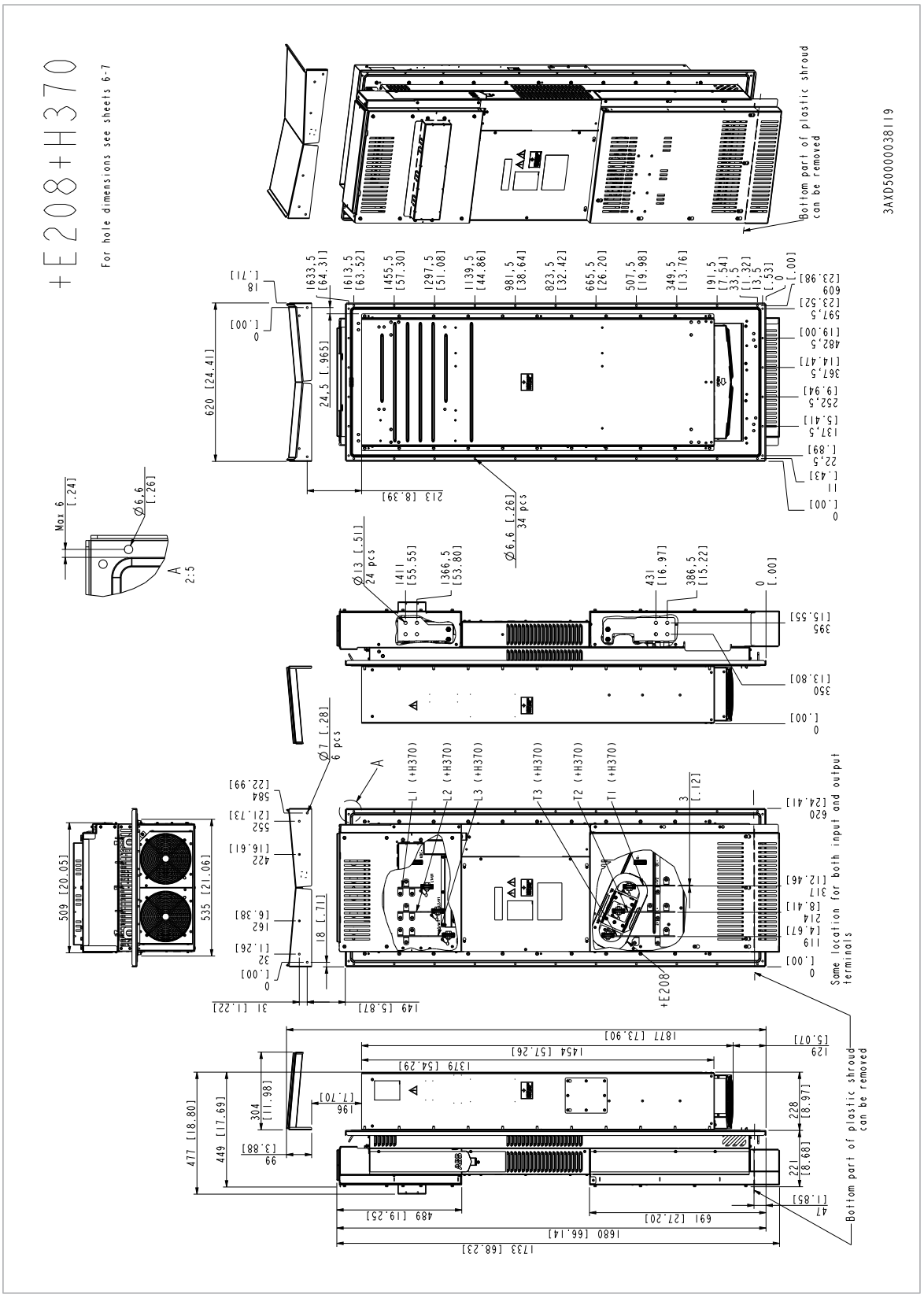
## Contents of this chapter

This chapter contains dimension drawings of the drive modules.

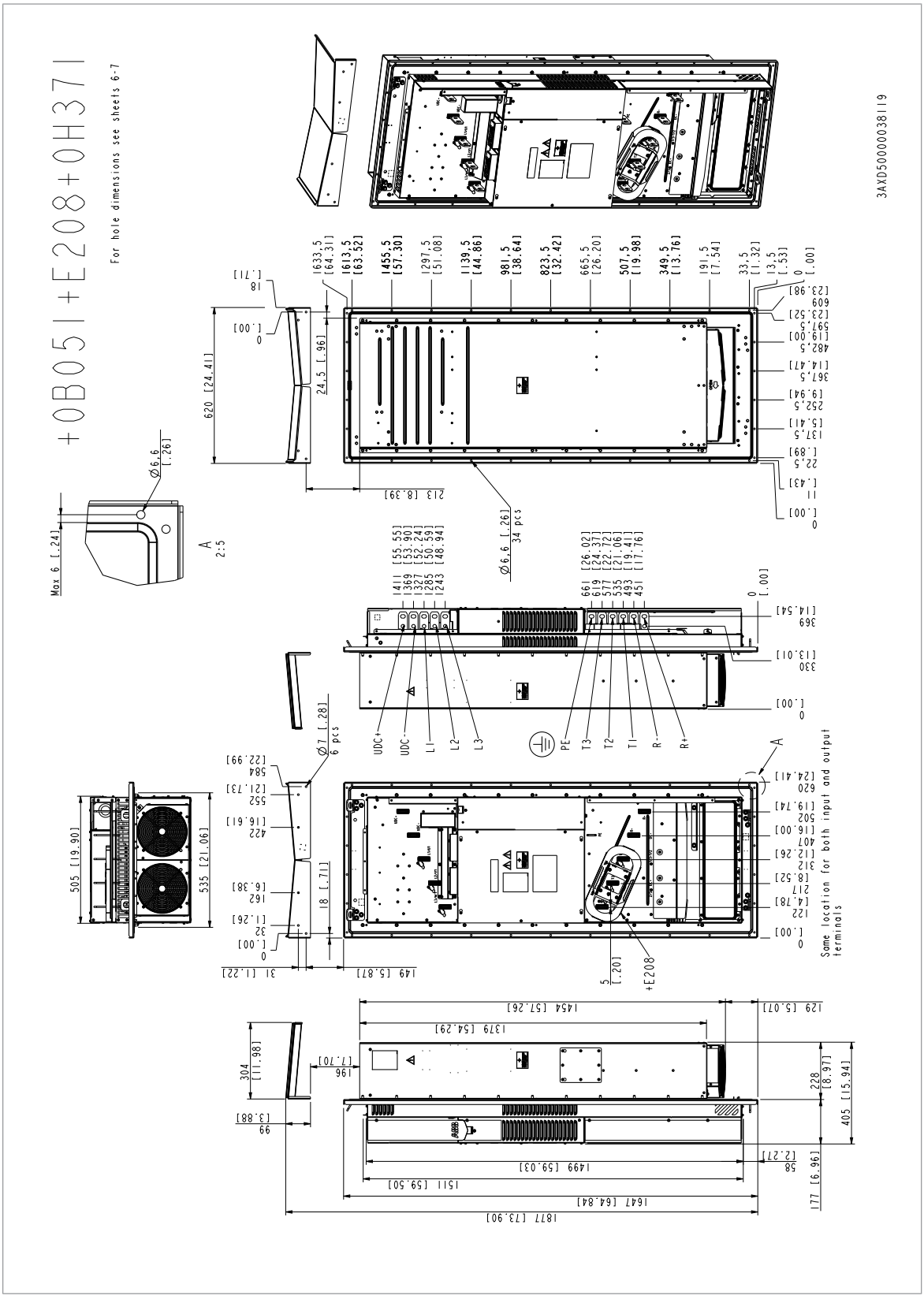
# Standard configuration – IP20 (UL Type Open)



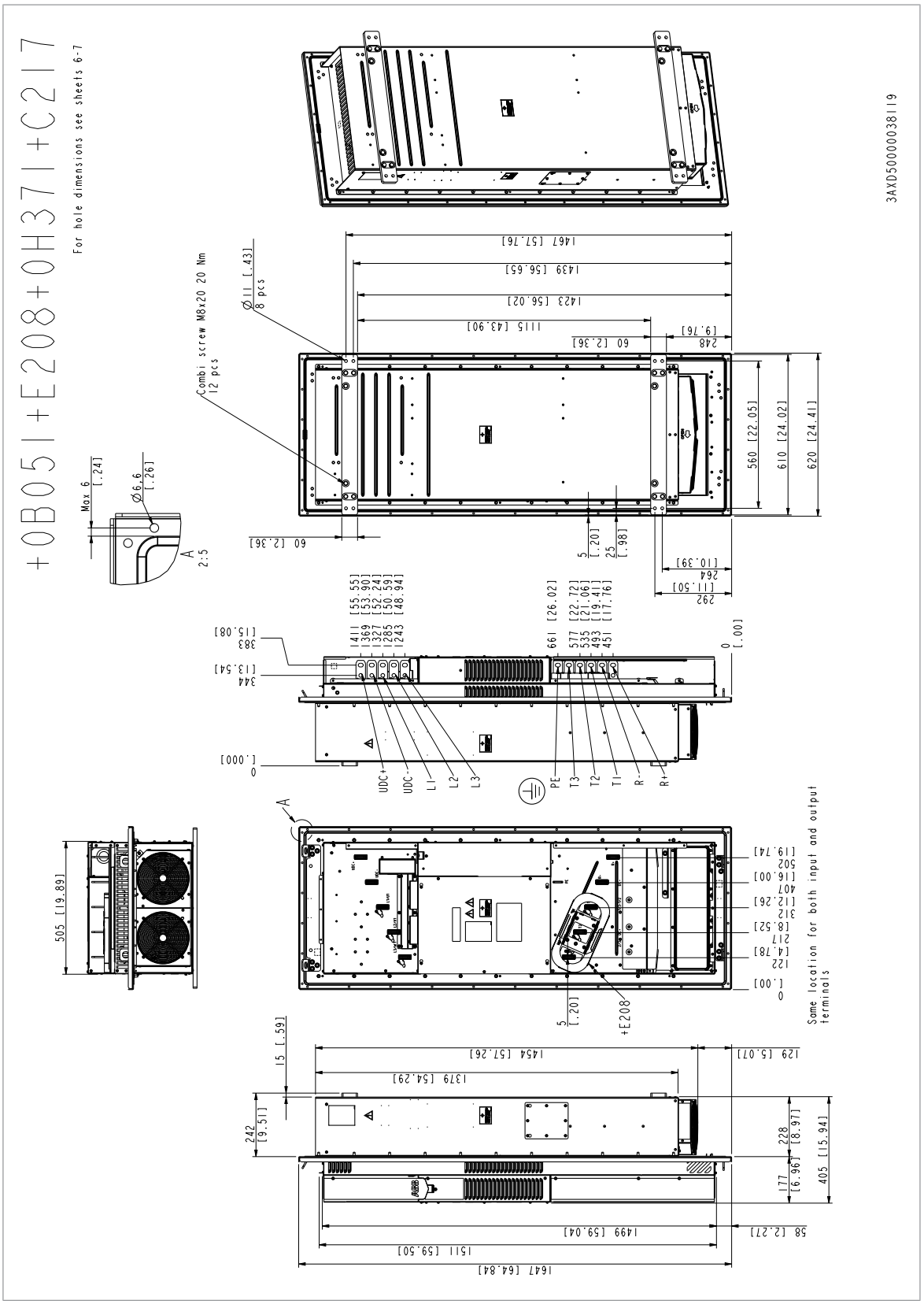
# Drive module with options +E208 and +H370 – IP20 (UL Type Open)



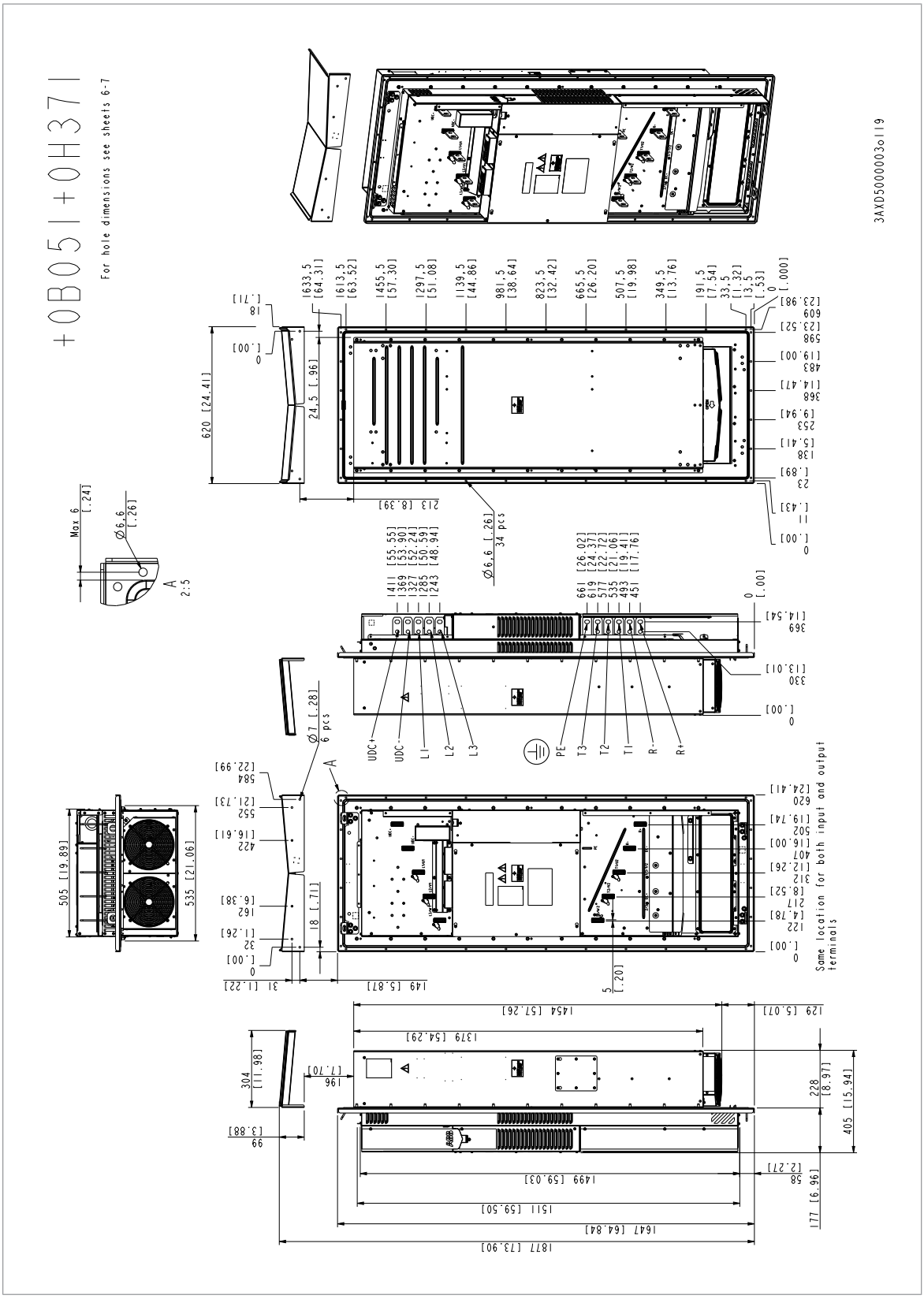
# Drive module with options +0B051+E208+0H371 – IP00 (UL Type Open)



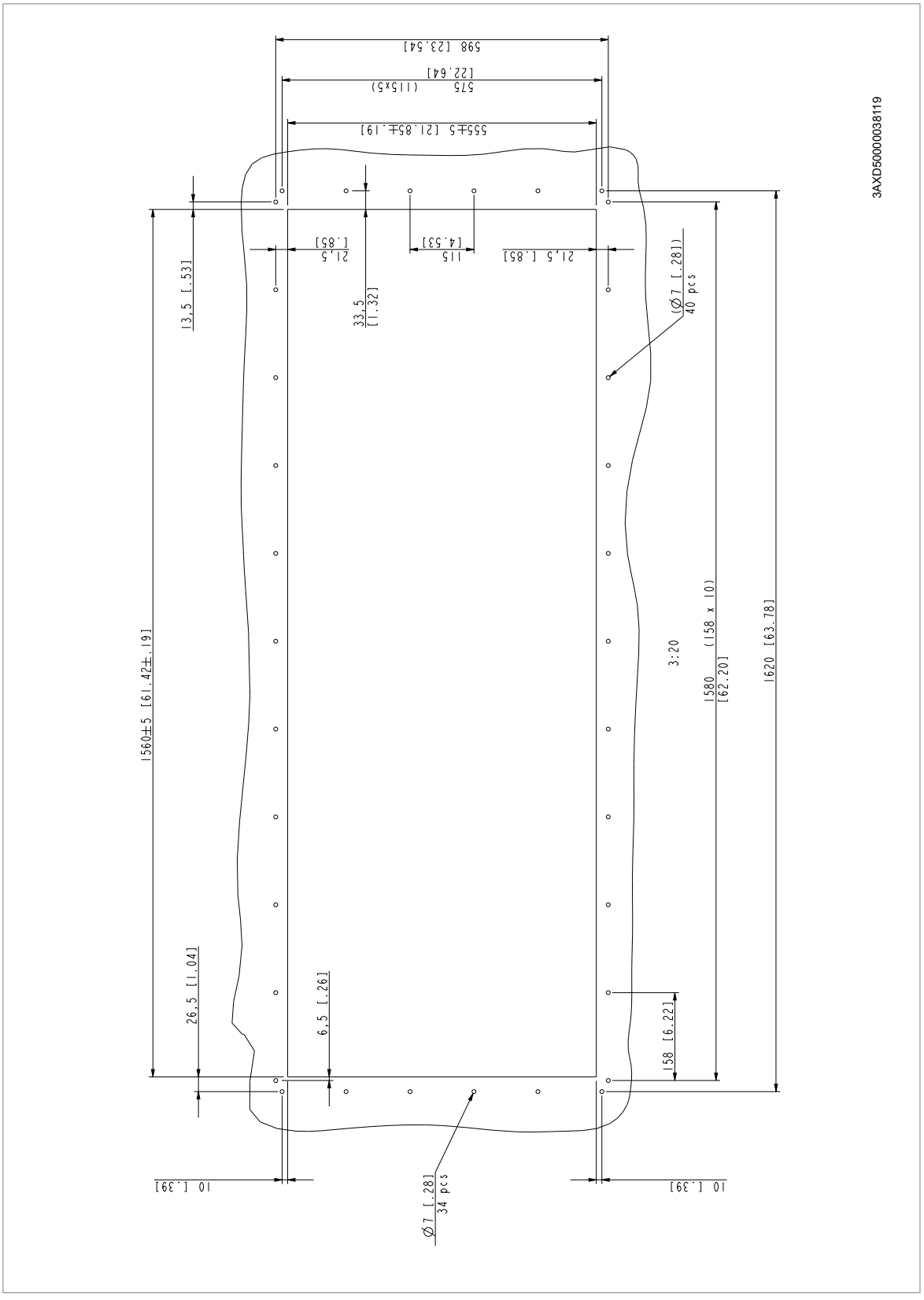
# Drive module with options +0B051+E208+0H371+C217 – IP00 (UL Type Open)

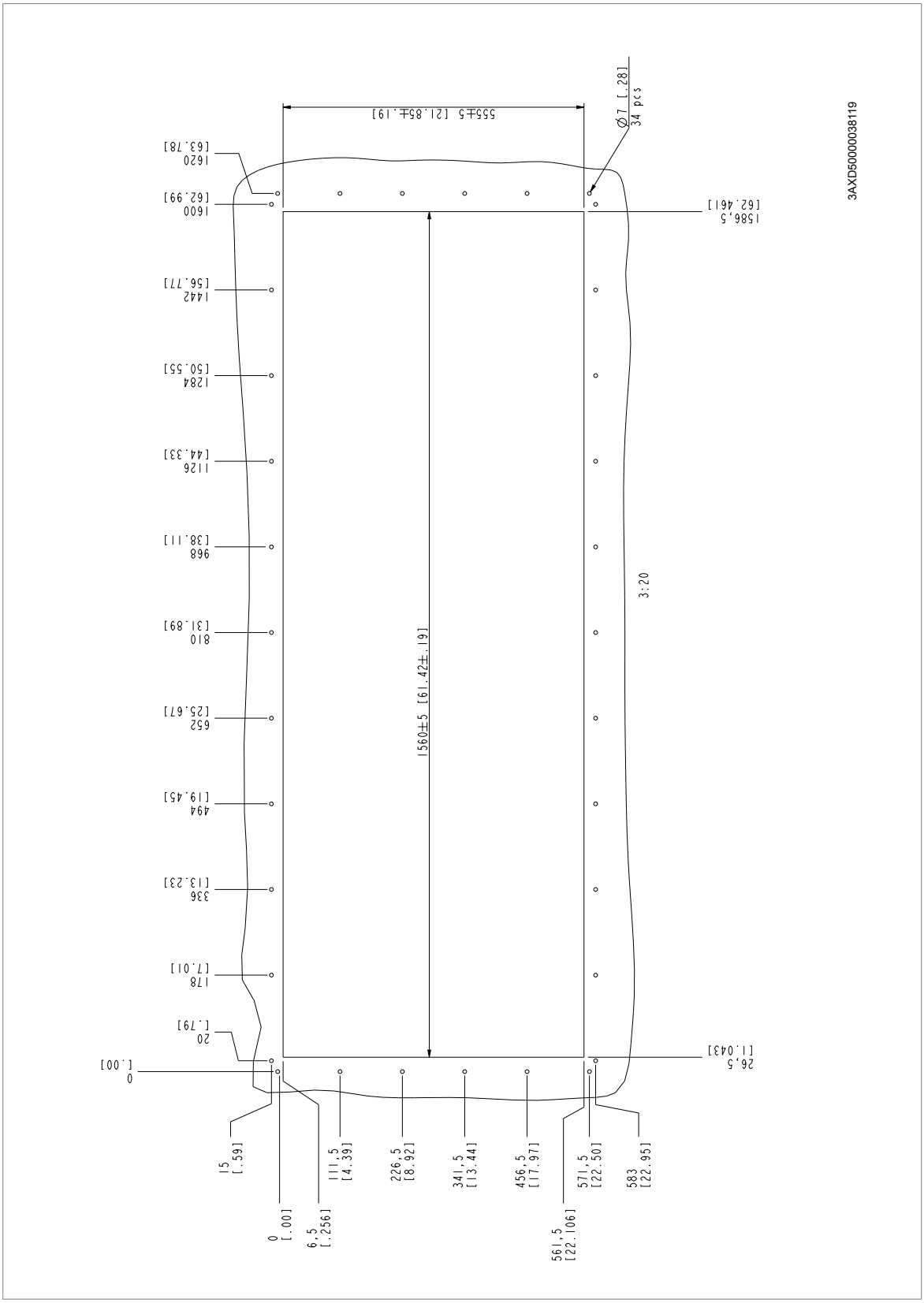


# Drive module with options +0B051+0H371 – IP00 (UL Type Open)

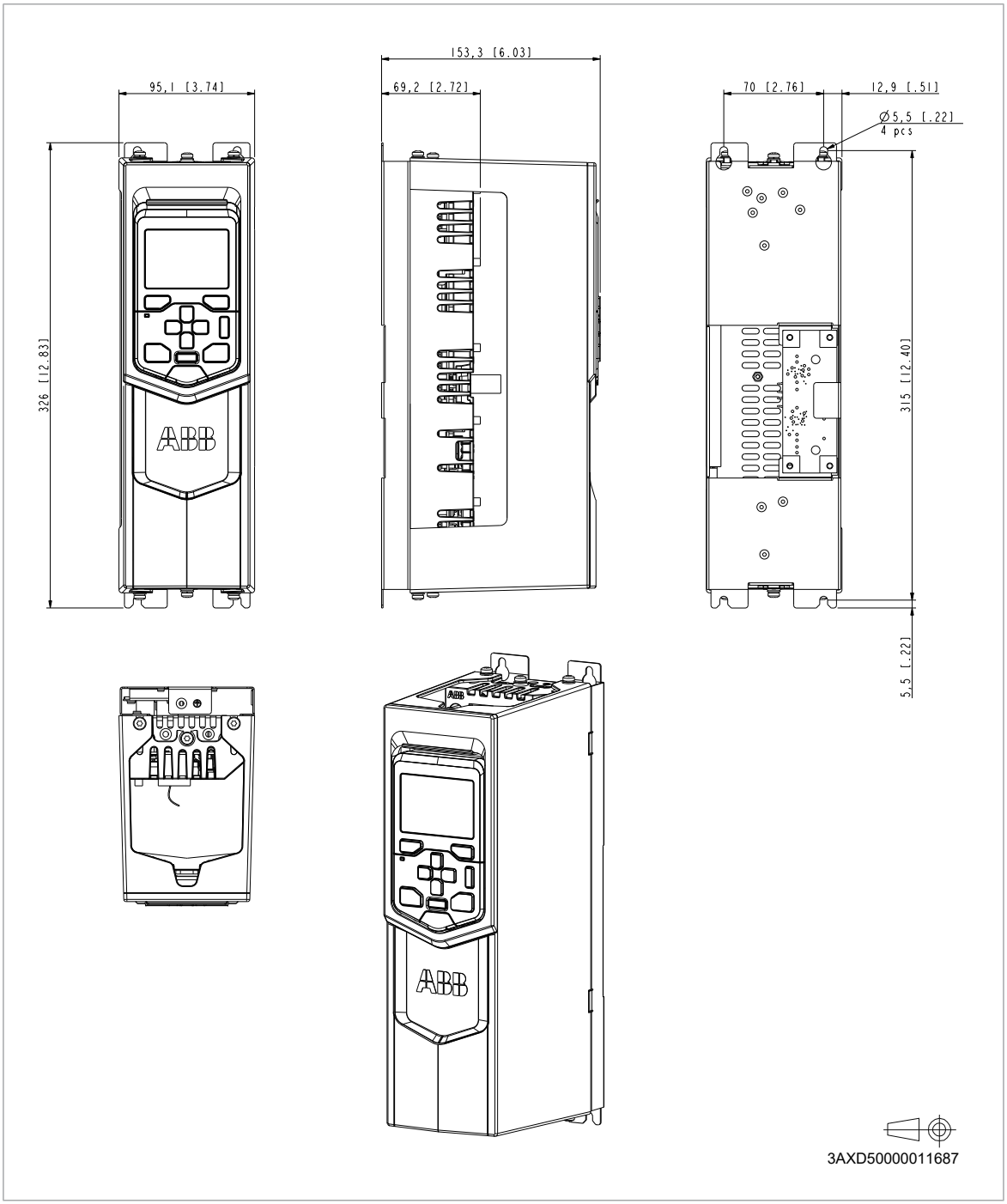


# Mounting plate opening




3AXD50000038119
555±5 [21.85±.19]
Ø7 [.28]
34 pcs
1620
[63.78]
1600
[62.99]
1586,5
[62.461]
1442
[56.77]
1284
[50.55]
1126
[44.33]
968
[38.11]
810
[31.89]
652
[25.67]
494
[19.45]
336
[13.23]
178
[7.01]
20
[.79]
0
[.00]
26,5
[1.043]
1560±5 [61.42±.19]
3:20
15
[.59]
0
[.00]
6,5
[.256]
111,5
[4.39]
226,5
[8.92]
341,5
[13.44]
456,5
[17.97]
561,5
[22.106]
571,5
[22.50]
583
[22.95]

# External control unit



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# Example circuit diagram

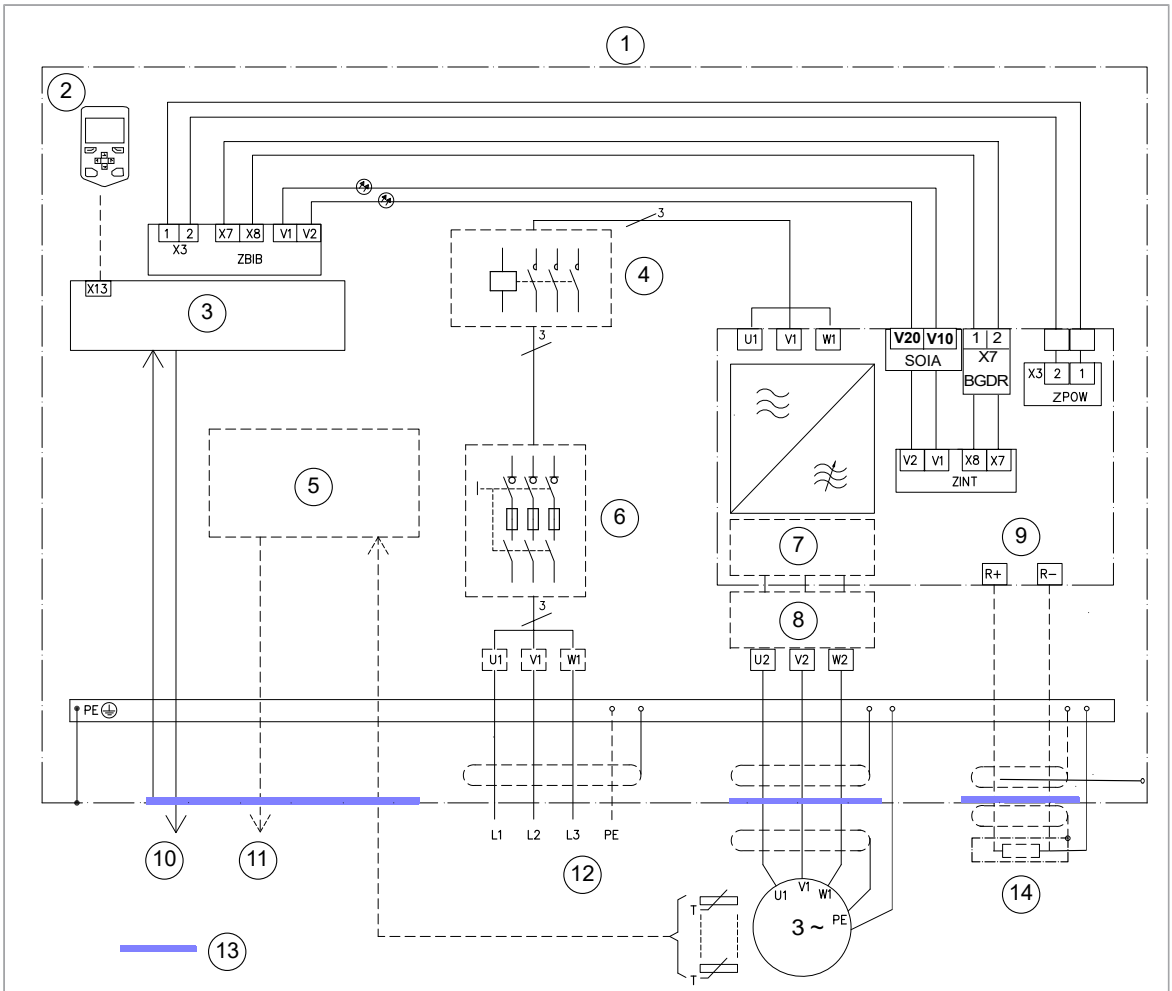
## Contents of this chapter

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.

## 170 Example circuit diagram




| | |
|---|---|
| 1 | Cabinet |
| 2 | Control panel |
| 3 | ZCU control unit |
| 4 | Main contactor [1)] |
| 5 | Motor temperature supervision [2)] |
| 6 | Switch fuse disconnector [1)] |
| 7 | Common mode filter [3)] |
| 8 | *du*/*dt* 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

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

The Safe torque off function can be used, for example, as the final actuator device of safety circuits (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<br>EN 60204-1:2018 | Safety of machinery – Electrical equipment of machines – Part 1: General requirements |

| Standard | Name |
|---|---|
| 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 |
| 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<br>EN 61800-5-2:2007 | Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional |
| IEC 62061:2021<br>EN 62061:2021 | Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems |
| EN ISO 13849-1:2015 | Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design |
| EN ISO 13849-2:2012 | Safety of machinery – Safety-related parts of control systems – Part 2: Validation |

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

## Compliance with the European Machinery Directive 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.

## Activation switch

In the wiring diagrams, the activation switch has the designation [K]. This represents a component such as a manually operated switch, an emergency stop push button switch, or the contacts of a safety relay or safety PLC.

- In case a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.
- The contacts of the switch or relay must open/close within 200 ms of each other.
- An FSO safety functions module, an FSPS safety functions module or an FPTC thermistor protection module can also be used. For more information, see the module documentation.

## Cable types and lengths

- 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 control unit must be at least 17 V DC to be interpreted as “1”.

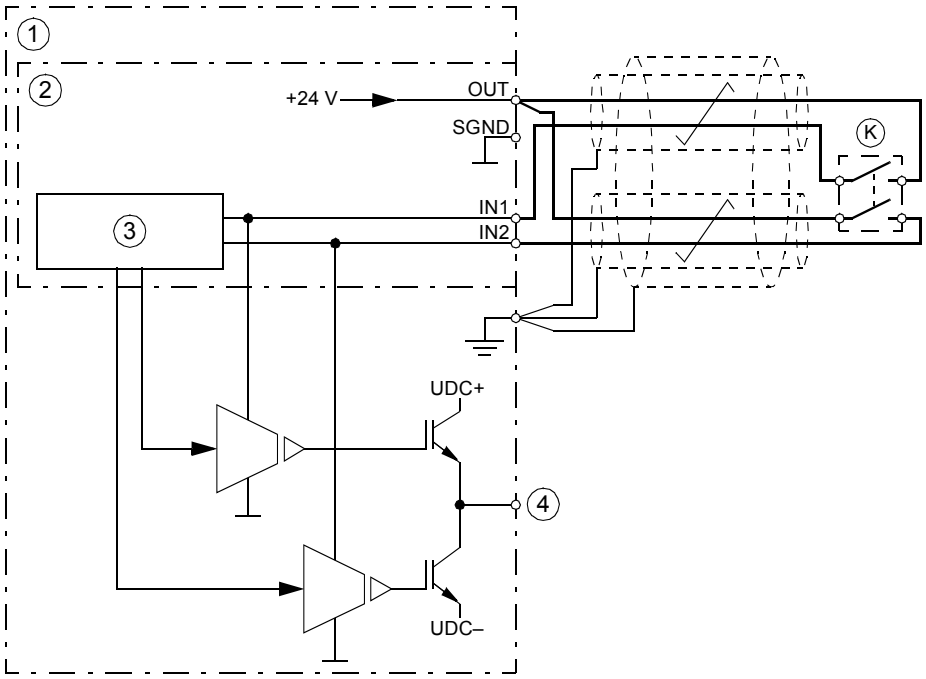
The pulse tolerance of the input channels is 1 ms.

## Grounding of protective shields

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

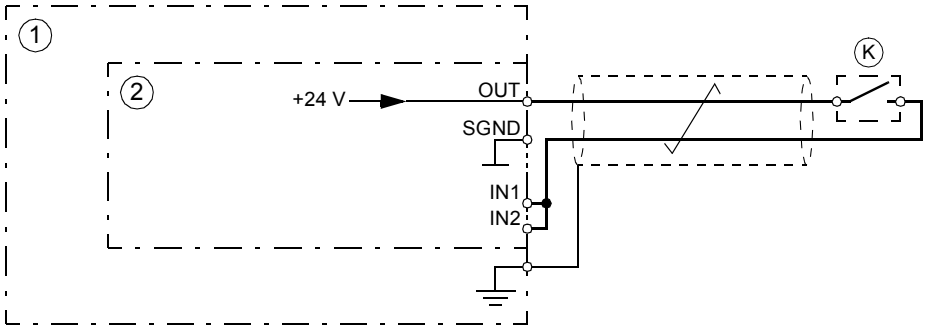
## Single drive (internal power supply)

### Dual-channel connection




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

### Single-channel connection



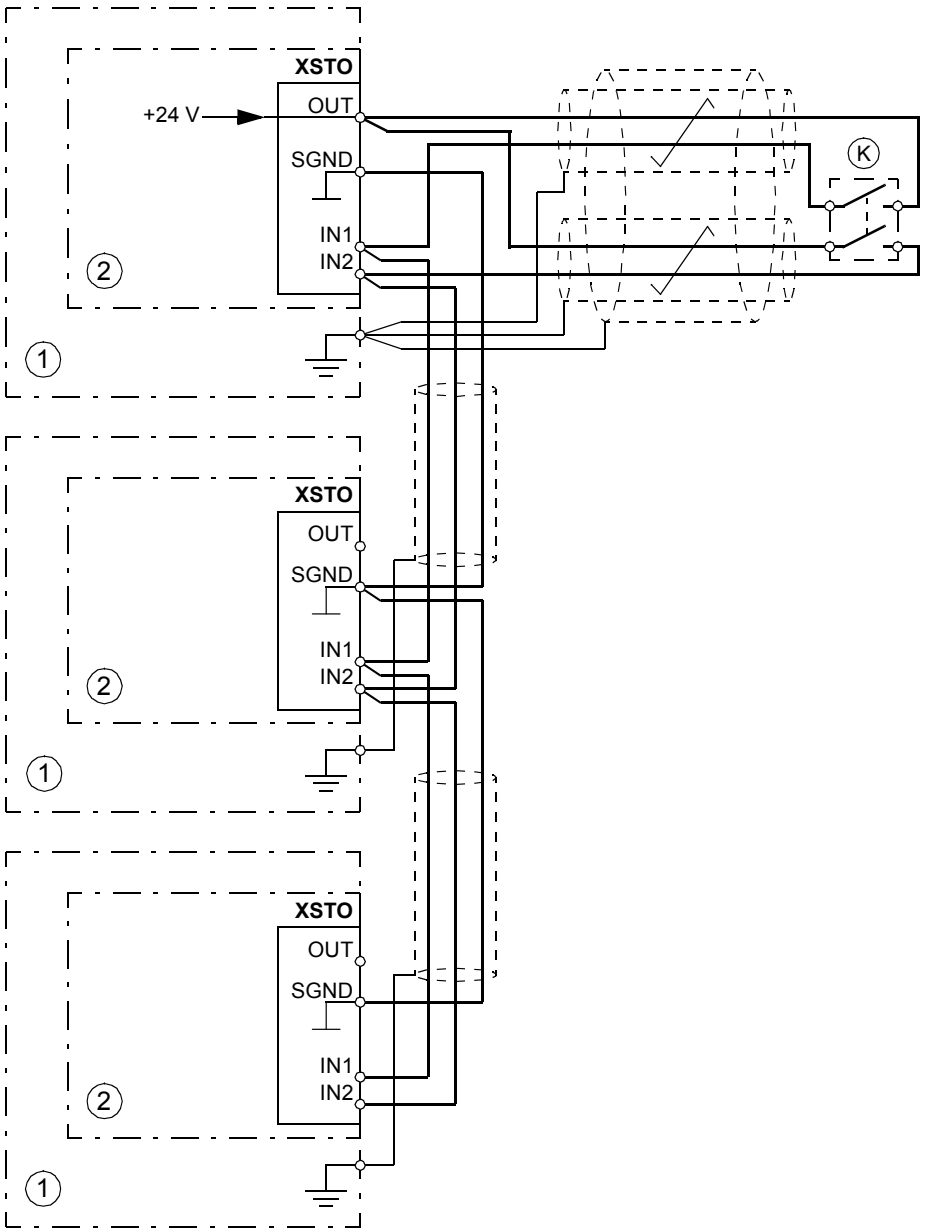

**Note:**

- Both STO inputs (IN1, IN2) must be connected to the activation switch. Otherwise, no SIL/PL classification is given.
- Pay special attention to avoiding any potential failure modes for the wiring. For example, use shielded cable. For measures for fault exclusion of wiring, see eg. EN ISO 13849-2:2012, table D.4.

| | |
|---|---|
| 1 | Drive |
| 2 | Control unit |
| K | Activation switch<br><br>**Note:** A single-channel activation switch can limit the SIL/PL capability of the safety function to a lower level than the SIL/PL capability of the STO function of the drive. |

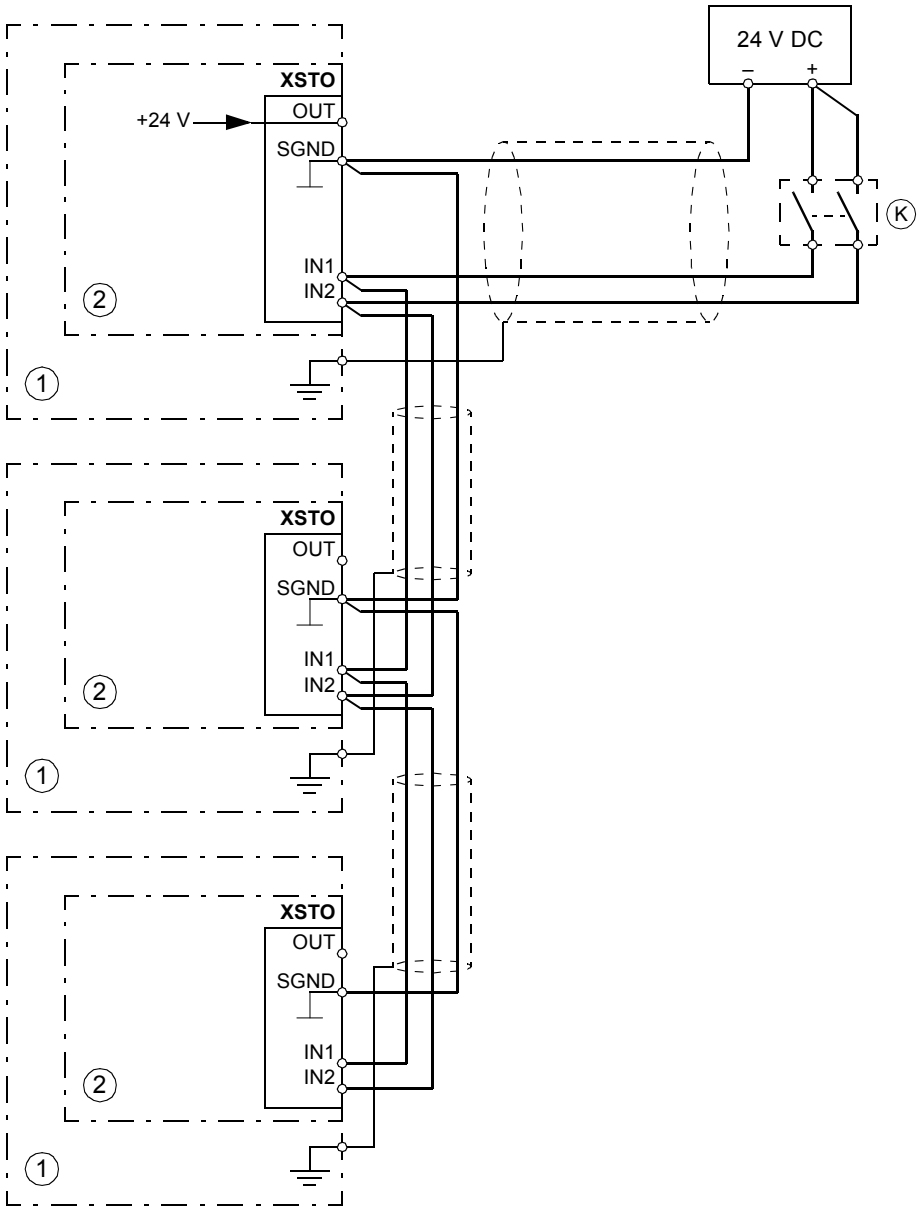
## Multiple drives

### Internal power supply




| | |
|---|---|
| 1 | Drive |
| 2 | Control unit |
| K | Activation switch |

## External power supply




| | |
|---|---|
| 1 | Drive |
| 2 | Control unit |
| K | Activation switch |

## 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 the drive is equipped with safety option +Q972, +Q973 or +Q982, also do the procedure shown in the FSO module documentation.

If 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. | ☐ |

| **Action** | ☑ |
|---|---|
| Test the operation of the STO function when the motor is stopped.<br>• Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill.<br>Make sure that the drive operates as follows:<br>• 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).<br>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.<br>• Close the STO circuit.<br>• Reset any active faults. Restart the drive and check that the motor runs normally. | ☐ |
| Test the operation of the STO function when the motor is running.<br>• Start the drive and make sure the motor is running.<br>• 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).<br>• Reset any active faults and try to start the drive.<br>• 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.<br>• Close the STO circuit.<br>• 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.<br>• 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).<br>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.<br>• Close the STO circuit.<br>• Reset any active faults. Restart the drive and check that the motor runs normally.<br>• 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).<br>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.<br>• Close the STO circuit.<br>• 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.

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

**Notes:**

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

# 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 185).

There are two alternative procedures for proof testing:

1. Perfect proof testing. It is assumed that all dangerous failures of the STO circuit are detected during the test. $PFD_{avg}$ values for STO with the perfect proof testing procedure are given in the safety data section.
2. Simplified proof testing. This procedure is faster and simpler than perfect proof testing. Not all dangerous failures of the STO circuit are detected during the test. The $PFD_{avg}$ value for STO with the simplified proof testing procedure is given in the safety data section.

**Note:** The proof testing procedures are only valid for proof testing (periodic test, item 5 under section Start-up including validation test) but not for re-validation after changes made in the circuit. Re-validation (items 1…4 under Start-up including validation test) must be done according to the initial validation procedure.

**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 179).

Use only spare parts approved by ABB.

Record all maintenance and proof test activities in the machine logbook.

## Competence

The maintenance and proof test activities of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6.

## Perfect proof test procedure

| Action | ☑ |
|---|---|
| **WARNING!** Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur. | ☐ |
| Test the operation of the STO function. If the motor is running, it will stop during the test.<br>• Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill.<br>Make sure that the drive operates as follows:<br>• 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).<br>• Close the STO circuit.<br>• 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.<br>• 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).<br>• Close the STO circuit.<br>• Reset any active faults.<br>• 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).<br>• Close the STO circuit.<br>• Reset any active faults. Restart the drive and check that the motor runs normally. | ☐ |
| Document and sign the test report to verify that the safety function has been tested according to the procedure. | ☐ |

## Simplified proof test procedure

| Action | ☑ |
|---|---|
| **WARNING!** Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur. | ☐ |
| Test the operation of the STO function. If the motor is running, it will stop during the test.<br>• Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill.<br>Make sure that the drive operates as follows:<br>• 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).<br>• Close the STO circuit.<br>• Reset any active faults. Restart the drive and check that the motor runs normally. | ☐ |
| Document and sign the test report to verify that the safety function has been tested according to the procedure. | ☐ |

# 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) | $PFD_{avg}$ | | | $MTTF_D$ (a) | DC (%) | SFF (%) | Cat. | HFT | CCF | $T_M$ (a) | $PFH_{diag}$ (1/h) | $\lambda_{Diag\_s}$ (1/h) | $\lambda_{Diag\_d}$ (1/h) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Perfect proof test | | Simplified proof test | | | | | | | | | | |
| | | | | | $T_1$ = 5 a | $T_1$ = 10 a | $T_1$ = 5 or 10 a | | | | | | | | | | |
| R11 | 3 | 3 | e | 3.65E-09 | 8.00E-05 | 1.60E-04 | 3.20E-04 | 18327 | ≥90 | 99.65 | 3 | 1 | 80 | 20 | 7.50E-11 | 7.70E-07 | 7.50E-09 |
| 3AXD10001609376 A | | | | | | | | | | | | | | | | | |

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with $\Delta T$ = 71.66 °C
  - 1340 on/off cycles per year with $\Delta T$ = 61.66 °C
  - 30 on/off cycles per year with $\Delta T$ = 10.0 °C
  - 32 °C board temperature at 2.0% of time
  - 60 °C board temperature at 1.5% of time
  - 85 °C board temperature at 2.3% of time.
- The STO is a type B safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested
  - A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO response times:
  - STO reaction time (shortest detectable break): 1 ms
  - STO response time: 2 ms (typical), 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 |

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

**Frequency converters**

**ACS880-01/-11/-31**
**ACS880-04/-04F/-M04/-14/-34**

with regard to the safety functions

- **Safe Torque Off**
- **Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Prevention of unexpected start-up (with FSO-12 option module, +Q973, encoderless)**
- **Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Safe speed monitor, Safe direction, Prevention of unexpected start-up (with FSO-21 and FSE-31 option modules, +Q972 and +L521, encoder supported)**
- **Safe motor temperature (with FPTC-01 thermistor protection module, +L536)**
- **Safe stop 1 (SS1-t, with FSPS-21 PROFIsafe module, +Q986)**

are in conformity with all the relevant safety component requirements of EU Machinery Directive 2006/42/EC, when the listed safety functions are used for safety component functionality.

The following harmonized standards have been applied:

| | |
|---|---|
| EN 61800-5-2:2007 | Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional |
| EN 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 3AXD10000497831.

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

Aaron D. Wade
Product Unit Manager
ABB Oy

Document number 3AXD10000099646

# Declaration of Conformity

Supply of Machinery (Safety) Regulations 2008

We

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

declare under our sole responsibility that the following products:

**Frequency converters**

**ACS880-01/-11/-31**
**ACS880-04/-04F/-M04/-14/-34**

with regard to the safety functions

**- Safe Torque Off**

**- Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Prevention of unexpected start-up (with FSO-12 option module, +Q973, encoderless)**

**- Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Safe speed monitor, Safe direction, Prevention of unexpected start-up (with FSO-21 and FSE-31 option modules, +Q972 and +L521, encoder supported)**

**- Safe motor temperature (with FPTC-01 thermistor protection module, +L536)**

**- Safe stop 1 (SS1-t, with FSPS-21 PROFIsafe module, +Q986)**

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

The following designated standards have been applied:

| | |
|---|---|
| EN 61800-5-2:2007 | Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional |
| EN 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 3AXD10001326405.

Authorized to compile the technical file: ABB Limited, Daresbury Park, Cheshire, United Kingdom, WA4 4BT.

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

Mika Vartiainen
Local Division
Manager
ABB Oy

Aaron D. Wade
Product Unit Manager
ABB Oy

Document number 3AXD10001329538

18

# 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: ACS880-04F-582A-5+P943. Maximum continuous braking power ($P_{brcont}$) of the internal brake chopper = 315 kW. Preselected ABB resistor = 2×SAFUR200F50. Braking

power of the motor is 300 kW. The duration of a braking cycle (T) is three minutes -> number of braking pulses in 400 seconds = 2.2. The braking time ($t_{br}$) is 20 seconds.

$P_{br}$ = 300 kW < $P_{brcont}$ = 315 kW. This is ok.

The energy generated by the motor during a 400-second period = 2.2 × 300 kW × 20 s = 13200 kJ. The brake resistor withstands an energy pulse of 10800 kJ in every 400 seconds period. 13200 kJ > 10800 kJ. -> 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 194).

## 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.<br>1.35 · 1.2 · 415 V DC (when supply voltage is 380 … 415 V AC)<br>1.35 · 1.2 · 500 V DC (when supply voltage is 440 … 500 V AC) or<br>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:<br>1.35 · 1.2 · 415 V DC (when supply voltage is 380 … 415 V AC)<br>1.35 · 1.2 · 500 V DC (when supply voltage is 440 … 500 V AC) or<br>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 assembly

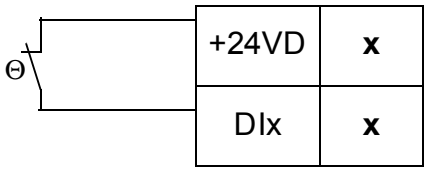
Obey the instructions given in section Measuring the insulation resistance of the brake resistor circuit (page 84).

## Connection diagram

See section Power cable connection diagram (page 87).

## 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 as shown below.




# 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.

| ACS880-04F-... | 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 | | | | | | |
| 504A-3 | 250 | 2.0 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| 584A-3 | 315 | 1.3 | 2×SAFUR200F500 | 1.3 | 10800 | 27 |
| 649A-3 | 315 | 1.3 | 2×SAFUR200F500 | 1.3 | 10800 | 27 |
| 725A-3 | 400 | 0.7 | 3×SAFUR200F500 | 0.9 | 16200 | 40 |
| 820A-3 | 400 | 0.7 | 3×SAFUR200F500 | 0.9 | 16200 | 40 |
| 880A-3 | 400 | 0.7 | 3×SAFUR200F500 | 0.9 | 16200 | 40 |
| $U_n$ = 500 V | | | | | | |
| 459A-5 | 250 | 2.0 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| 502A-5 | 250 | 2.0 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| 582A-5 | 315 | 1.3 | 2×SAFUR200F500 | 1.3 | 10800 | 27 |
| 634A-5 | 315 | 1.3 | 2×SAFUR200F500 | 1.3 | 10800 | 27 |
| 715A-5 | 400 | 0.7 | 3×SAFUR200F500 | 0.9 | 16200 | 40 |
| 820A-5 | 400 | 0.7 | 3×SAFUR200F500 | 0.9 | 16200 | 40 |
| 880A-5 | 400 | 0.7 | 3×SAFUR200F500 | 0.9 | 16200 | 40 |
| $U_n$ = 690 V | | | | | | |
| 329A-7 | 285 | 2.2 | SAFUR200F500 | 2.7 | 3600 | 13 |
| 369A-7 | 285 | 2.2 | SAFUR200F500 | 2.7 | 3600 | 13 |
| 429A-7 | 285 | 2.2 | SAFUR200F500 | 2.7 | 3600 | 13 |
| 470A-7 | 350 | 2.0 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| 522A-7 | 350 | 2.0 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| 590A-7 | 400 | 1.8 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| 650A-7 | 400 | 1.8 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| 721A-7 | 400 | 1.8 | 2×SAFUR125F500 | 2.0 | 7200 | 18 |
| | | | | | | 3AXD00000588487 |

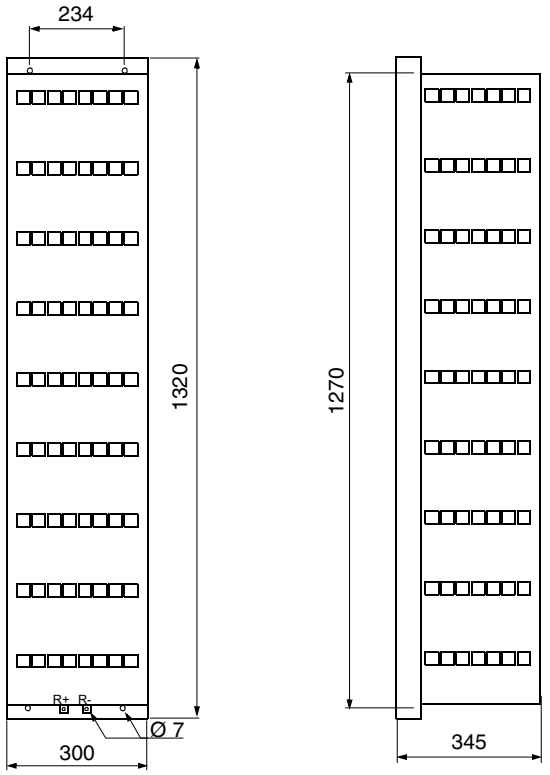
| | |
|---|---|
| $P_{brcont}$ | Maximum continuous braking power. The braking is considered continuous if the braking time exceeds 30 seconds. |
| $R_{min}$ | The minimum allowed resistance value of the brake resistor |
| $R$ | Resistance value for the listed resistor assembly |
| $E_R$ | Short energy 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 b) | 68759340 |

## Terminals and cable entry data

See section Terminal and entry data for the power cables (page 146).

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# Filters

## Contents of this chapter

This chapter describes how to select d*u*/d*t* and sine filters for the drive.

## d*u*/d*t* filters

### When is a d*u*/d*t* filter necessary?

See Examining the compatibility of the motor and drive (page 58).

### Selection table

d*u*/d*t* filter types for the drive modules are given below.

| Drive module type ACS880-04F-... | d*u*/d*t* filter type | Drive module type ACS880-04F-... | d*u*/d*t* filter type | Drive module type ACS880-04F-... | d*u*/d*t* filter type |
|---|---|---|---|---|---|
| $U_n$ = 400 V | | $U_n$ = 500 V | | $U_n$ = 690 V | |
| 504A-3 | FOCH0610-70 | 459A-5 | FOCH0610-70 | 329A-7 | FOCH0610-70 |
| 584A-3 | FOCH0610-70 | 502A-5 | FOCH0610-70 | 369A-7 | FOCH0610-70 |
| 649A-3 | FOCH0610-70 | 582A-5 | FOCH0610-70 | 429A-7 | FOCH0610-70 |
| 725A-3 | FOCH0875-70 | 634A-5 | FOCH0610-70 | 470A-7 | FOCH0610-70 |
| 820A-3 | FOCH0875-70 | 715A-5 | FOCH0875-70 | 522A-7 | FOCH0610-70 |
| 880A-3 | FOCH0875-70 | 820A-3 | FOCH0875-70 | 590A-7 | FOCH0610-70 |
| - | - | 880A-5 | FOCH0875-70 | 650A-7 | FOCH0875-70 |
| - | - | - | - | 721A-7 | FOCH0875-70 |
| | | | | | 3AXD00000588487 |

### Ordering codes

| Filter type | ABB ordering code |
|---|---|
| FOCH0610-70 | 68550505 |
| FOCH0875-70 | 3AUA0000129544 |

### Description, installation and technical data of the FOCH filters

See FOCH d*u*/d*t* filters hardware manual (3AFE68577519 [English]).

## Sine filters

### When is a sine filter necessary?

See section Examining the compatibility of the motor and drive (page 58).

### Selection table

Sine filter types for the drive modules are given below.

| Drive module type ACS880-04F-... | sine filter type | Drive module type ACS880-04F-... | sine filter type | Drive module type ACS880-04F-... | sine filter type |
|---|---|---|---|---|---|
| $U_n$ = 400 V | | $U_n$ = 500 V | | $U_n$ = 690 V | |
| 504A-3 | NSIN0900-6 | 459A-5 | NSIN0485-6 | 329A-7 | NSIN0485-6 |
| 584A-3 | NSIN0900-6 | 502A-5 | NSIN0900-6 | 369A-7 | NSIN0485-6 |
| 649A-3 | NSIN0900-6 | 582A-5 | NSIN0900-6 | 429A-7 | NSIN0485-6 |
| 725A-3 | NSIN0900-6 | 634A-5 | NSIN0900-6 | 470A-7 | NSIN0485-6 |
| 820A-3 | NSIN0900-6 | 715A-5 | NSIN0900-6 | 522A-7 | NSIN0485-6 |
| 880A-3 | NSIN0900-6 | 820A-3 | NSIN0900-6 | 590A-7 | NSIN0900-6 |
| - | - | 880A-5 | NSIN0900-6 | 650A-7 | NSIN0900-6 |
| - | - | - | NSIN0900-6 | 721A-7 | NSIN0900-6 |
| | | | | | 3AXD00000588487 |

### Ordering codes

| Filter type | ABB ordering code |
|---|---|
| NSIN0485-6 | 64254936 |
| NSIN0900-6 | 64254961 |

### Derating

See section Deratings for special settings in the drive control program (page 135).

### Description, installation and technical data of the sine filters

See Sine filters hardware manual (3AXD50000016814 [English]). For more information, contact ABB.

# Further information

## Product and service inquiries

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

## Product training

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

## Providing feedback on ABB manuals

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

## Document library on the Internet

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

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3AXD50000034664D



3AXD50000034664 Rev D (EN) 2022-08-31