ABB INDUSTRIAL DRIVES

ACS880-17LC drives

Hardware manual

ACS880-17LC drives

Hardware manual

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1

Safety instructions

Contents of this chapter

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

Use of warnings and notes

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

The manual uses these warning symbols:

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

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

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

General safety in installation, start-up and maintenance

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

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

- Keep the drive in its package until you install it. After unpacking, protect the drive from dust, debris and moisture.
- Use the required personal protective equipment: safety shoes with metal toe cap, safety glasses, protective gloves, etc.
- Lift a heavy drive with a lifting device. Use the designated lifting points. See the dimension drawings.
- The lifting bars attached to large drive cabinets are heavy. Be careful when removing or reinstalling the bars. Whenever possible, use a lifting device attached to the designated lifting points.
- Secure 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. Secure the cabinet also to the wall when necessary.

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

- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, and brake resistors, remain hot for a while after disconnection of the electrical supply.
- Make sure that debris from borings and grindings does not enter the drive during the installation. Electrically conductive debris inside the drive may cause damage or malfunction.
- Make sure that there is sufficient cooling. See the technical data.
- Keep the cabinet doors closed when the drive is powered. With the doors open, a risk of a potentially fatal electric shock, arc flash or high-energy arc blast exists. If you cannot avoid working on a powered drive, obey the local laws and regulations on live working (including – but not limited to – electric shock and arc protection).
- Before you adjust the drive operation limits, make sure that the motor and all driven equipment can operate throughout the set operation limits.
- Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or supply break. If these functions are activated, the installation must be clearly marked as defined in IEC/EN 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- The maximum drive power cycles is once every 2 minutes. Power cycling the drive too often can damage the charging circuit of the DC capacitors.
- Validate any safety circuits (for example, Safe torque off or emergency stop) in start-up. See separate instructions for the safety circuits.

Note:

- If you select an external source for the start command and it is on, the drive will start immediately after fault reset unless you configure the drive for pulse start. See the firmware manual.
- Depending on the wiring and parametrization of the drive, the stop key on the control panel may not stop the drive.
- Only authorized persons are allowed to repair a malfunctioning drive.

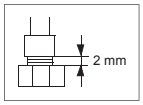
Work on the liquid cooling system

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

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

- Use the required personal protective equipment. See the Safety data sheet for Antifrogen® L coolant by Clariant (www.clariant.com) for the instructions on the respiratory, hand and eye protection when handling the coolant.
- Beware of hot, high-pressure coolant (6 bar, max. 50 °C) that is present in the internal cooling circuit when it is in operation. Before you disconnect a pipe, release the pressure. Close the appropriate stop valve(s). If necessary, stop the cooling circuit pumps.
- Avoid skin contact with coolant. If coolant splashes onto the skin or in the eyes, rinse immediately with plenty of water. Do not syphon it by mouth. If you swallow or get it into the eyes, seek medical advice.
- Before the drive power up, make sure that the internal cooling circuit is filled up with coolant, and the cooling is in operation (coolant circulates).

- Make sure that coolant meets the ABB specification. See the appropriate hardware manual of the drive/unit.
- To avoid breaking the coolant pipes, do not overtighten the nuts of the unions. Leave 2 to 3 millimeters (0.08 to 0.12 inches) of thread visible.



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

Electrical safety in installation, start-up and maintenance

Electrical safety precautions

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

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

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

Go through these steps before you begin any installation or maintenance work.

1. 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.
2. Clearly identify the work location and equipment.
3. Disconnect all possible voltage sources. 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.
   - In the liquid cooling unit (if present), open the motor protective circuit breaker(s) of the cooling pumps.
   - If you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
   - Make sure that re-connection is not possible. Lock out and tag out.
   - Disconnect any 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.
4. Protect any other energized parts in the work location against contact.
5. Take special precautions when close to bare conductors.
6. Measure that the installation is de-energized. If the measurement requires removal or disassembly of shrouding or other cabinet structures, obey the local laws and regulations applicable to live working (including – but not limited to – electric shock and arc protection).
   - Use a multimeter with an impedance greater than 1 Mohm.
   - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is close to 0 V.
   - Make sure that the voltage between the drive DC busbars (+ and -) and the grounding (PE) busbar is close to 0 V.
   - If you have a permanent magnet motor connected to the drive, make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is close to 0 V.

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

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

Additional instructions and notes

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

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

- Make sure that the electrical power network, motor/generator, and environmental conditions agree with the drive data. Verify that the network voltage matches with the input voltage on the drive type designation label.
- Do not do insulation or voltage withstand tests on the drive.
- ABB recommends not to secure the cabinet by arc welding. If you have to, obey the welding instructions in the drive manuals.

Note:
- The motor cable terminals of the drive are at a dangerous voltage when the input power is on, regardless of whether the motor is running or not.
- When the input power is on, the drive DC bus is at a dangerous voltage.
- External wiring can supply dangerous voltages to the relay outputs of the control units of the drive.
- The Safe torque off function does not remove the voltage from the main and auxiliary circuits. The function is not effective against deliberate sabotage or misuse.

Optical components

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

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

Printed circuit boards

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

Grounding

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

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

If you are not a qualified electrician, do not do grounding work.

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

Note:

- You can use power cable shields as grounding conductors only when their conductivity is sufficient.
- As the normal touch current of the drive is higher than 3.5 mA AC or 10 mA DC, you must use a fixed protective earth (PE) connection. The minimum size of the protective earth conductor must comply with the local safety regulations for high protective earth conductor current equipment. See standard IEC/EN 61800-5-1, 4.3.5.5.2., and the electrical planning instructions of the drive.

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 electrician, do not do installation or maintenance work.

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

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

- Stop the drive.
- Disconnect the motor from the drive with a safety switch or by other means.
- If you cannot disconnect the motor, make sure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, can rotate the motor directly or through any mechanical connection like felt, nip, rope, etc.
- Do the steps in section *Electrical safety precautions (page 17)*
- Measure that the installation is de-energized.
  - Use a multimeter with an impedance greater than 1 Mohm.
  - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is close to 0 V.
  - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is close to 0 V.
  - Make sure that the voltage between the drive DC busbars (+ and -) and the grounding (PE) busbar is close to 0 V.
- Install temporary grounding to the drive output terminals (U2, V2, W2). Connect the output terminals together as well as to the PE.

During the start up:

- Make sure that the motor cannot be run into overspeed, eg, 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 be run into overspeed, e.g. driven by the load. Motor overspeed causes overvoltage that can damage or destroy the capacitors in the intermediate circuit of the drive.

2

Introduction to the manual

Contents of this chapter

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

Target audience

This manual is intended for people who plan the installation, install, start up and service the drive, or create instructions for the end user of the drive concerning the installation and maintenance of the drive.

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

The manual is written for readers worldwide. Both SI and imperial units are shown.

Categorization by frame size and option code

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

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

The instructions, technical data and dimension drawings which only concern certain optional selections are marked with option codes (such as "+E205"). The options included in the drive can be identified from the option codes visible on the type designation label. The option selections are listed in section *Type designation key (page 36)*.

Use of component designations

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

Quick installation, commissioning and operation flowchart

Task	See
Plan the electrical installation and acquire the accessories needed (cables, fuses, etc.). Check the ratings, required cooling air flow, input power connection, compatibility of the motor, motor connection, and other technical data.	*Guidelines for planning the electrical installation (page 57)* *Technical data (page 145)*
⬇	
Check the installation site.	*Ambient conditions (page 157)*
⬇	
Unpack and check the drive (only intact units may be started up). Make sure that all necessary optional modules and equipment are present and correct. Install the drive mechanically.	*Mechanical installation (page 41)*
⬇	
Route the cables.	*Routing the cables (page 67)*
⬇	
Connect the power cables. Connect the control cables.	*Electrical installation (page 79)*
⬇	
Check the installation.	*Installation checklist of the drive (page 111)* If the drive has been non-operational for more than one year, reform the DC link capacitors. See *Converter module capacitor reforming instructions* (3BFE64059629 [English]).
⬇	
Start the drive up.	*Start-up (page 113)*
⬇	
Operate the drive: start, stop, speed control etc.	ACS880 quick start-up guide, firmware manual

Terms and abbreviations

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

Related manuals

Name	Code
Drive hardware manuals and guides	
ACS880-17LC drives hardware manual	3AXD50000250295
ACX-AP-x assistant control panels user’s manual	3AUA0000085685
Drive firmware manuals and guides	
ACS880 primary control program firmware manual	3AUA0000085967
Quick start-up guide for ACS880 drives with primary control program	3AUA0000098062
ACS880 IGBT supply control program firmware manual	3AUA0000131562
CIO-01 I/O module for distributed I/O bus control user's manual	3AXD50000126880
Option manuals and guides	
ACS880-1007LC liquid cooling unit user's manual	3AXD50000129607
Drive composer start-up and maintenance PC tool user’s manual	3AUA0000094606
FSO-12 safety functions module user’s manual	3AXD50000015612
FSO-21 safety functions module user’s manual	3AXD50000015614
User’s manual for Prevention of unexpected start-up (+Q950) for ACS880-07/17/37 drives	3AUA0000145922
User’s manual for Emergency stop, stop category 0 (+Q951) for ACS880-07/17/37 drives	3AUA0000119895

Name	Code
User’s manual for Emergency stop, stop category 1 (+Q952) for ACS880-07/17/37 drives	3AUA0000119896
User’s manual for Prevention of unexpected start-up (+Q957) for ACS880-07/17/37 drives	3AUA0000119910
User’s manual for Emergency stop, stop category 0 (+Q963) for ACS880-07/17/37 drives	3AUA0000119908
User’s manual for Emergency stop, stop category 1 (+Q964) for ACS880-07/17/37 drives	3AUA0000119909
User's manual for Safely-limited speed with the encoder interface (+Q965) for ACS880-07/17/37 drives	3AXD50000019727
User's manual for ATEX-certified motor thermal protection functions (+L513+Q971 and +L514+Q971) for cabinet-built ACS880 drives	3AXD50000014979
User’s manual for Emergency stop, configurable stop category 0 or 1 (+Q978) for ACS880-07/17/37 drives	3AUA0000145920
User’s manual for Emergency stop, configurable stop category 0 or 1 (+Q979) for ACS880-07/17/37 drives	3AUA0000145921
Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.	

See www.abb.com/drives/documents for all manuals on the Internet.

3

Operation principle and hardware description

Contents of this chapter

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

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

The drive consists of several cubicles that contain

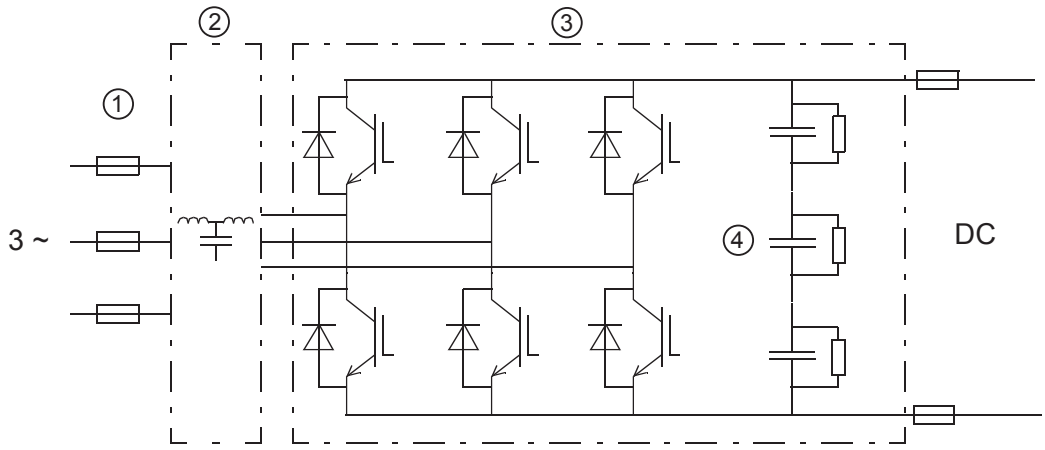
- the supply and motor terminals
- 1 to 8 IGBT supply module(s) forming the supply unit (line-side converter)
- 1 to 8 inverter modules forming the inverter unit (motor-side converter)
- optional equipment.

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

Supply unit

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

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



1	AC fuses
2	LCL filter
3	Supply module (with IGBTs)
4	DC capacitors with discharge resistors

AC voltage and current waveforms

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

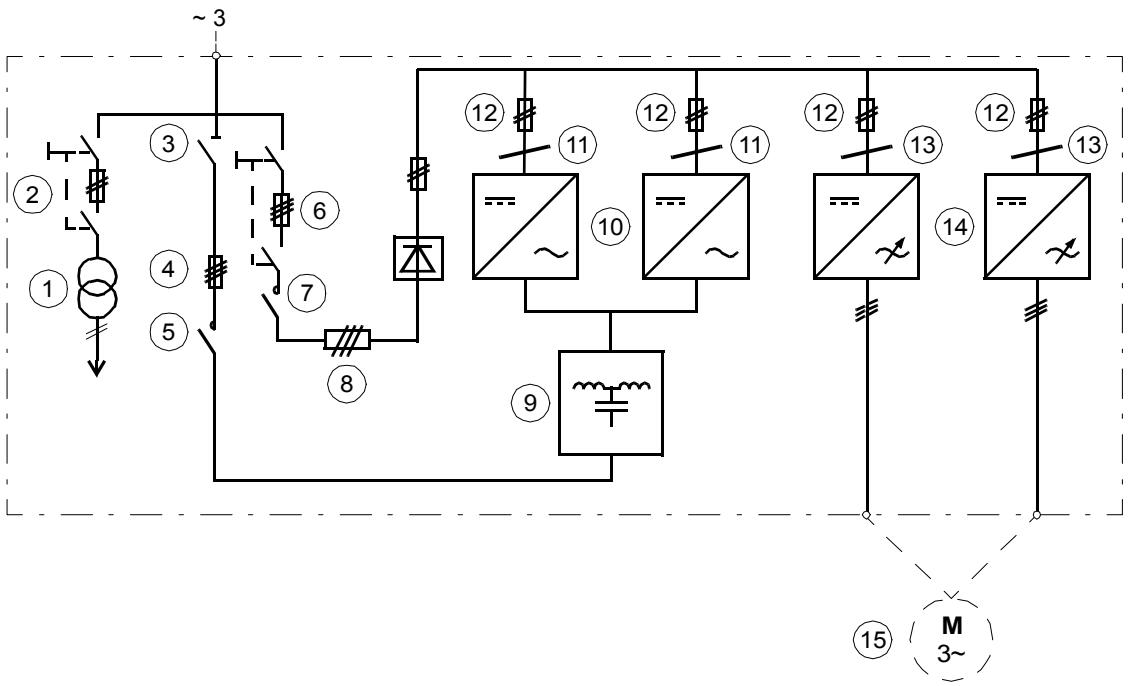
Charging

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

Inverter unit

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

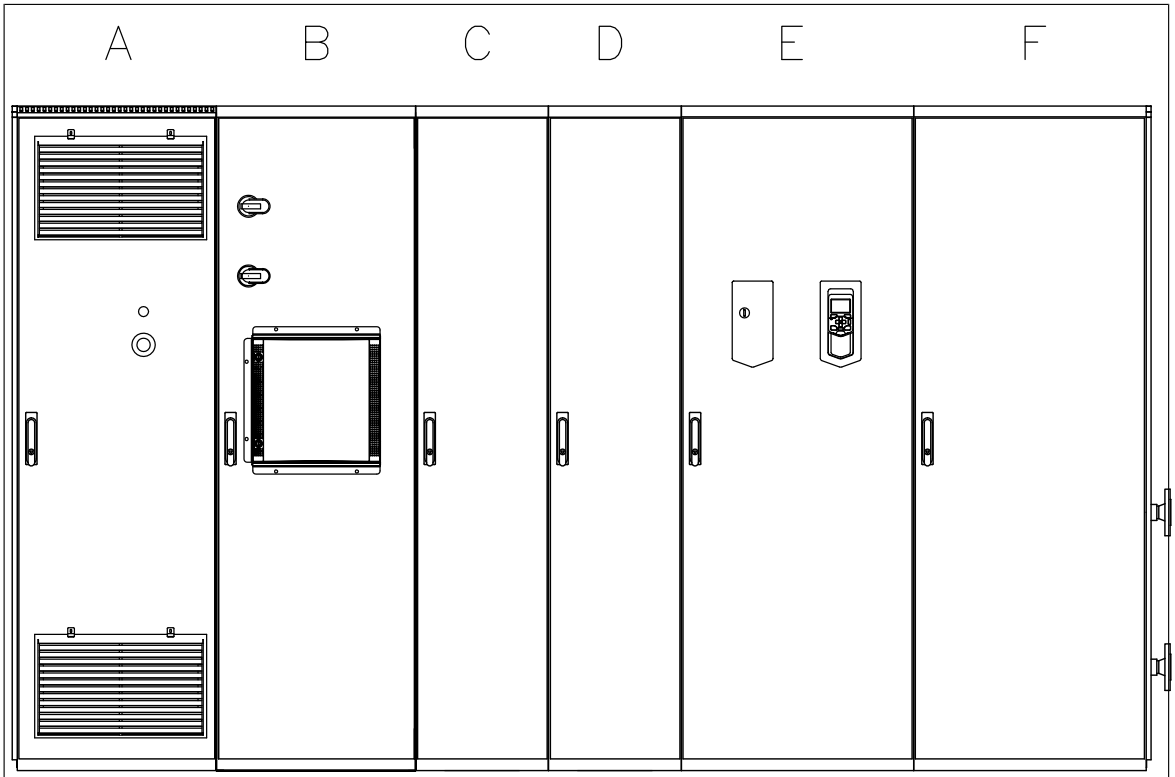
Overview circuit diagram of the drive



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

Cabinet line-up and layout examples

Frame 3×R8i + 3×R8i

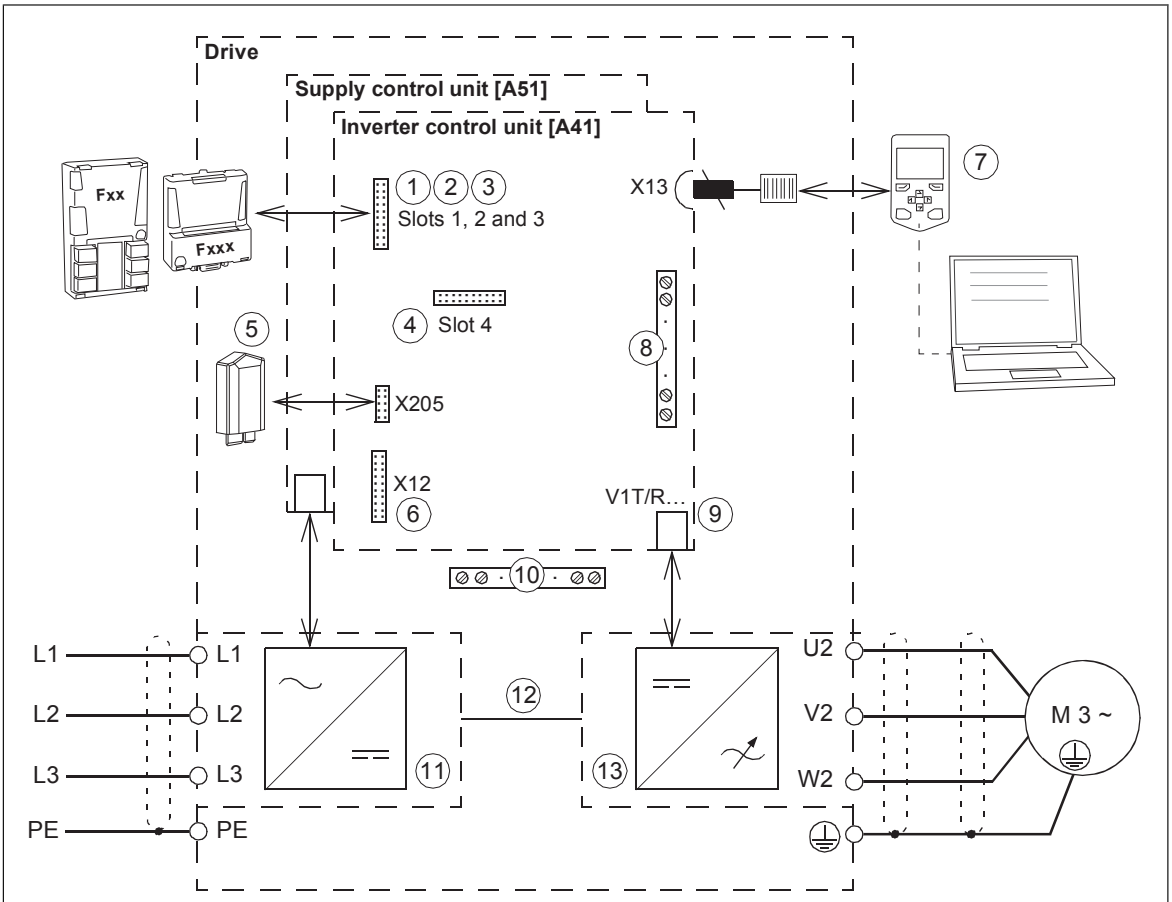


Cabinet line-up example	
A	Control unit (DCU). Contains control electronics. Air-cooled version shown.
B	Incoming cubicle (ICU). Contains the input power cable terminals and switchgear (auxiliary voltage switch, charging switch and circuit breaker shown).
C	LCL filter cubicle (LCL) 1.
D	LCL filter cubicle (LCL) 2.
E	Supply module cubicle (ISU).
F	Inverter module cubicle (INU). Contains the motor cable terminals.

See also sections *Door switches and lights (page 30)* and *Control panel (page 30)*.

Overview of power and control connections

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



1 2 3 4	Option modules can be inserted into slots 1, 2, 3 and 4 as follows: **Module type** — **Slots** Analog and digital I/O extension modules — 1, 2, 3 Feedback interface modules — 1, 2, 3 Fieldbus communication modules — 1, 2, 3 RDCO-xx DDCS communication option module (standard equipment). As standard, a fiber optic link connects the supply and inverter control units. — 4 Additional modules can be installed on an optional FEA-03 extension adapter connected to an RDCO module on slot 4.
5	Memory unit
6	Connection for FSO-xx safety functions module
7	Control panel and PC connection
8	Terminal blocks on the inverter control unit. These terminals are optionally wired to terminal block X504 in the auxiliary control cabinet of the drive.
9	Fiber optic link to each inverter module. Similarly, each supply module is connected to the supply control unit by fiber optic cables.
10	Terminal blocks for customer connections installed in the drive cabinet.
11	Supply unit (consisting of one or more supply modules)
12	DC intermediate link

13	Inverter unit (consisting of one or more inverter modules)

Door switches and lights

Main disconnecting device (Q1.1)

Depending on the configuration of the drive, the main disconnecting device of the drive is either a switch-disconnector or a main circuit breaker. Units with a switch-disconnector also have a main contactor.

The main disconnecting device switches the main supply to the drive on and off. To disconnect the main supply, turn the switch-disconnector to the 0 (OFF) position, or rack out the main breaker (whichever device is installed).

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

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

Auxiliary voltage switch (Q21)

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

Grounding (earthing) switch (Q9.x), optional

The grounding switch (Q9.1, option +F259) connects the main AC power bus to the PE busbar.

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

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

Other devices on the door

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

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

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

Control panel

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

The control panel can be removed by pulling it forward by the top edge and reinstalled in reverse order. For the use of the control panel, see *ACX-AP-x assistant control panel user's manual* (3AUA0000085685 [English]) and the firmware manual.

Control by PC tools

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

Descriptions of options

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

Degree of protection

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

Definitions

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

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

* meaning for protection of persons: against access to hazardous parts with finger

Marine construction (option +C121)

The option includes the following accessories and features:

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

Additional wire markings (see *Additional wire markings*) may be required for classification.

Plinth height (options +C164 and +C179)

The standard height of the cabinet plinth is 50 mm. These options specify a plinth height of 100 mm (+C164) or 200 mm (+C179).

Cabinet heater with external supply (option +G300)

The option contains:

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

The heater prevents humidity condensation inside the cabinet when the drive is not running. The power output of the semiconductor-type heating elements depends on the environmental

temperature. The customer must switch the heating off when it is not needed by cutting the supply voltage off.

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

See also

- circuit diagrams delivered with drive for the actual wiring.

Cabinet lighting (option +G301)

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

Terminals for external control voltage (option +G307)

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

See also sections:

- *Supplying power for the auxiliary circuits (page 74)*
- circuit diagrams delivered with drive for the actual wiring.

Output for motor space heater (option +G313)

The option contains:

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

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

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

See also:

- *Supplying power for the auxiliary circuits (page 74)*
- circuit diagrams delivered with drive for the actual wiring.

Halogen-free wiring and materials (option +G330)

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

V-meter with selector switch (option +G334)

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

A-meter in one phase (option +G335)

The option contains an ammeter that reads the current flowing through one input phase.

Additional wire markings

Standard wire markings

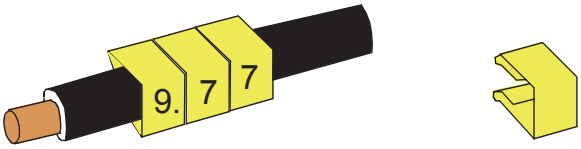
As standard, wires and terminals are marked as follows:

- Plug-in connectors of wire sets: Connectors labeled with designation (eg. "X1"). Both the connector and the individual wires are marked with pin numbers.

- Wires without a connector: Connector designation and pin number printed on wire (eg. "X1:7").
- Fiber optic cables: Component and connector designation printed on marker tape.
- Main input, output and PE terminals: Connector identifier (eg. "U1", "PE") printed on sticker on terminal, or on insulating material close to the terminal. PE cables marked with yellow/green tape. (Main circuit power cables are not marked.)

Additional wire markings

The following additional wire markings are available.

Option	Additional markings
+G338 (class A1)	Equipment pin identifiers are marked with printing (or equivalent) on conductors that connect to equipment, or are part of the wiring between power modules. (Short, obvious connections, main circuit conductors, and conductors going to terminal blocks or plug-type connectors are not marked.) 
+G339 (class A2)	Equipment pin identifiers are marked with printing (or equivalent) on conductors that connect to equipment or terminal blocks, or are part of the wiring between power modules. Main circuit conductors are marked with white tape or printing. (Short, obvious connections, or conductors going to plug-type connectors are not marked.) 
+G340 (class A3)	Equipment pin identifiers are marked with snap-on markers (or equivalent) on conductors that connect to equipment, terminal blocks or detachable plug-type connectors, or are part of the wiring between power modules. Plug-type connector identifications are marked on labels near the connectors. The label holders are attached around conductor bundles. Main circuit conductors are marked with white tape or printing. (Short, obvious connections are not marked.) 
+G341 (class B1)	Equipment designations and pin identifiers are marked with snap-on markers (or equivalent) on conductors that connect to equipment, terminal blocks or detachable plug-type connectors, or are part of the wiring between power modules. Fiber optic cables are marked in the same way. Plug-type connector identifications are marked on labels near the connectors. The label holders are attached around conductor bundles. Main circuit conductors are marked with white tape or printing. Short and obvious connections are marked with printing (or equivalent) only.  **Note:** Even wires with equipment and pin identifiers printed on the wire insulation are marked with rings or tubing.

Option	Additional markings
+G342 (class C1)	Equipment designations and pin identifiers of both ends are marked with snap-on markers (or equivalent) on conductors that connect to equipment, terminal blocks or detachable plug-type connectors, or are part of the wiring between power modules. Fiber optic cables are marked in the same way. Plug-type connector identifications are marked on labels near the connectors. The label holders are attached around conductor bundles. Main circuit conductors are marked with white tape or printing. Short and obvious connections are marked with printing (or equivalent) only.  **Note:** Even wires with equipment and pin identifiers printed on the wire insulation are marked with rings or tubing.

Common motor terminal cubicle (option +H359)

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

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

Starter for auxiliary motor fan (options +M6xx)

What the option contains

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

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

The number of connections must be specified when ordering. The maximum number of connections available depends on the current requirement. The lower current ratings allow up to four fan connections (eg. option +4M602), while the highest current rating only allows one (eg. +M610). For more information, refer to *ACS-880-X7 single drives ordering information* (3AXD10000052815, available on request).

Description

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

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

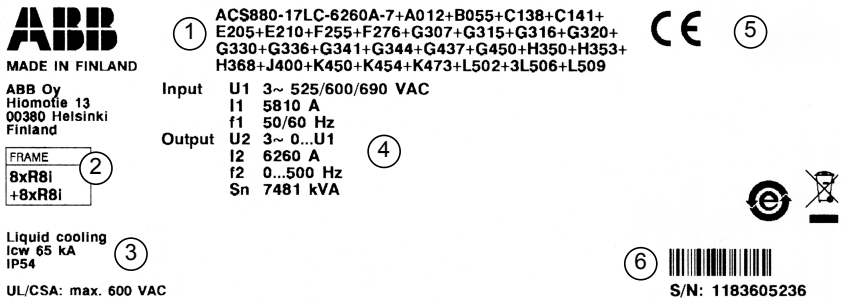
The statuses of both the starter switch and the fan contactor are wired to the terminal block.

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

Type designation label

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

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



1	Type designation (see section *Type designation key (page 36)*).
2	Frame size
3	Short-time withstand current rating (see chapter *Technical data (page 145)*); degree of protection; UL/CSA specifications
4	Ratings. See also chapter *Technical data (page 145)*.
5	Valid markings
6	Serial number. The first digit of the serial number refers to the manufacturing plant. The next four digits refer to the unit's manufacturing year and week, respectively. The remaining digits complete the serial number so that there are no two units with the same number.

Type designation key

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

Code	Description
Basic code	
ACS880	Product series
ACS880-17LC	Default configuration: liquid-cooled cabinet-installed drive, IP42 (UL Type 1), main switch-disconnector (and contactor) or breaker, aR fuses, ACS-AP-W assistant control panel (with Bluetooth), EMC filter (category 3, 2nd Environment), du/dt filters, common mode filtering, ACS880 primary control program, Safe torque off function, coated circuit boards, bottom entry and exit of cables with lead-through-type entries, USB memory stick containing circuit diagrams, dimension drawings and manuals.
Size	
xxxxx	Refer to the rating tables
Voltage range	
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 (plus codes)	
Supply connection	

Code	Description
A012	50 Hz supply frequency
A013	60 Hz supply frequency
Degree of protection	
B054	IP42 (UL Type 1)
B055	IP54 (UL Type 12)
Construction	
C121	Marine construction. See section *Descriptions of options (page 32)*.
C132	Marine type approval. Refer to *ACS880 +C132 marine type-approved cabinet-built drives supplement* (3AXD50000039629 [English]).
C138	ACS880-1007LC cooling unit as part of line-up
C139	ACS880-1007LC cooling unit (separate from line-up)
C140	Single-pump cooling unit
C141	Redundant (twin-pump) cooling unit
C142	Pipe connection through bottom
C143	Pipe connection on right
C144	Pipe connection on left
C145	ANSI flange pipe connection
C146	External cooling circuit suitable for sea water
C164	Plinth height 100 mm. See section *Descriptions of options (page 32)*.
C176	Door hinges on left
C179	Plinth height 200 mm. See section *Descriptions of options (page 32)*.
C205	Marine product certification issued by DNV GL
C206	Marine product certification issued by the American Bureau of Shipping (ABS)
C207	Marine product certification issued by Lloyd's Register (LR)
C209	Marine product certification issued by Bureau Veritas
C213	Cooling unit pumps can run simultaneously
C228	Marine product certification issued by China Classification Society (CCS)
C229	Marine product certification issued by Russian Maritime Register of Shipping (RS)
C242	2-way valve in a dedicated cubicle
Filters	
E205	du/dt filtering
Switching and grounding	
F253	Disconnect switch
F271	Output grounding terminals
Cabinet equipment	
G300	Cabinet and module heating elements (external supply). See section *Descriptions of options (page 32)*.
G301	Cabinet lighting. See section *Descriptions of options (page 32)*.
G304	Control (auxiliary) voltage 115 V AC
G307	Terminals for connecting external control voltage (230 V AC or 115 V AC, eg. UPS). See section *Descriptions of options (page 32)*.
G313	Output for motor space heater (external supply)
G314	Aluminum busbars (standard up to 3200 A)

Code	Description
G315	Tin-plated copper busbars (optional up to 3200 A, standard from 3200 A up)
G316	Cable supply conductors
G320	Control (auxiliary) voltage 230 V AC
G330	Halogen-free wiring and materials
G332	Electrical disconnect push button on the door (black, opens main contactor / ACB)
G333	kW-meter on door
G334	V-meter with selector switch
G335	A-meter in one phase
G338	Additional wire markings. See section *Descriptions of options (page 32)*.
G339	
G340	
G341	
G342	
G344	Auxiliary voltage transformer
G432	Frequency monitoring device. Only for installation altitudes up to 2000 meters (6561 ft).
Cabling	
H359	Common motor terminal cubicle. See section *Descriptions of options (page 32)*.
H364	Gland plate out of 3 mm thick aluminum, blind
H367	Control cable entry through floor of cabinet
Control panel	
J400	ACS-AP-W control panel (with Bluetooth)
Fieldbus adapters, diverse communication options	
K451	FDNA-01 DeviceNet™ adapter module
K452	FLON-01 LonWorks® adapter module
K454	FPBA-01 PROFIBUS DP adapter module
K457	FCAN-01 CANopen adapter module
K458	FSCA-01 RS-485 (Modbus/RTU) adapter module
K462	FCNA-01 ControlNet™ adapter module
K469	FECA-01 EtherCat adapter module
K470	FEPL-02 EtherPOWERLINK adapter module
K473	FENA-11 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols
K475	FENA-21 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
I/O extensions and feedback interfaces	
L500	FIO-11 analog I/O extension module (1, 2 or 3 pcs)
L501	FIO-01 digital I/O extension module (1, 2 or 3 pcs)
L502	FEN-31 HTL incremental encoder interface module
L505	Thermal protection with PTC relays (1 or 2 pcs). See section *Descriptions of options (page 32)*.
Starter for auxiliary motor fan (see section *Descriptions of options (page 32)*)	
4M601	Trip limit setting range: 1.6 … 2.5 A
M602	Trip limit setting range: 2.5 … 4 A
M603	Trip limit setting range: 4 … 6.3 A

Code	Description
M604	Trip limit setting range: 6.3 … 10 A
M605	Trip limit setting range: 10…16 A
M606	Trip limit setting range: 16…20 A
Control program	
N5000	Winder control program
N5050	Crane control program
N5100	Winch control program
N5200	PCP (Progressive Cavity Pump) control program
N5300	Test bench control program
N5600	ESP (Electrical Submersible Pump) control program
N7502	Control program for synchronous reluctance motors (SynRM)
N8010	IEC 61131-3 application programmability
Specialties	
P913	Special color
Safety functions	
Q950	Prevention of unexpected start-up with FSO-xx safety functions module, by activating the Safe torque off function
Q951	Emergency stop (category 0) with safety relays, by opening the main breaker/contactor
Q952	Emergency stop (category 1) with safety relays, by opening the main breaker/contactor
Q957	Prevention of unexpected start-up with safety relays, by activating the Safe torque off function. Only for installation altitudes up to 2000 meters (6561 ft).
Q963	Emergency stop (category 0) with safety relays, by activating the Safe torque off function
Q964	Emergency stop (category 1) with safety relays, by activating the Safe torque off function
Q965	Safely-limited speed with FSO-21 and encoder
Q966	Safely-limited speed without encoder
Q971	ATEX-certified safe disconnection function
Q972	FSO-21 safety functions module
Q973	FSO-12 safety functions module
Q978	Emergency stop (configurable for category 0 or 1) with FSO-xx safety functions module, by opening the main breaker/contactor
Q979	Emergency stop (configurable for category 0 or 1) with FSO-xx safety functions module, by activating the Safe torque off function
Q982	PROFIsafe with FSO-xx safety functions module and FENA-21 Ethernet adapter module
Q984	Emergency stop button monitoring
Full set of printed manuals in the selected language **Note:** The delivery may include manuals in English if the requested language is not available.	
R700	English
R701	German
R702	Italian
R703	Dutch
R704	Danish
R705	Swedish

Code	Description
R706	Finnish
R707	French
R708	Spanish
R709	Portuguese
R711	Russian
R715	Complete documentation, user manuals in memory stick
R716	Hard copies of documentation
R717	Second set of hard copies of documentation

4

Mechanical installation

Contents of this chapter

This chapter describes the mechanical installation procedure of the drive.

Examining the installation site

Examine the installation site:

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

Necessary tools

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

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

Checking the delivery

The drive delivery contains:

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

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

Moving and unpacking the drive

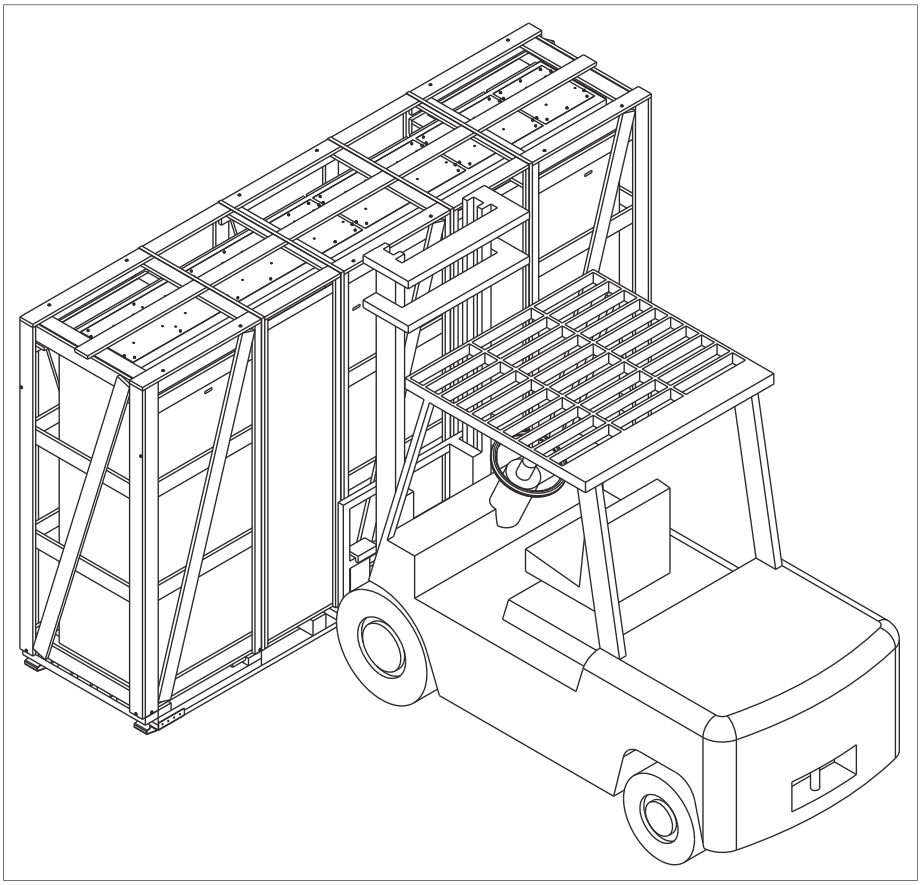
Move the drive in its original packaging to the installation site as shown below to avoid damaging the cabinet surfaces and door devices. When you are using a pallet truck, check its load capacity before you move the drive.

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

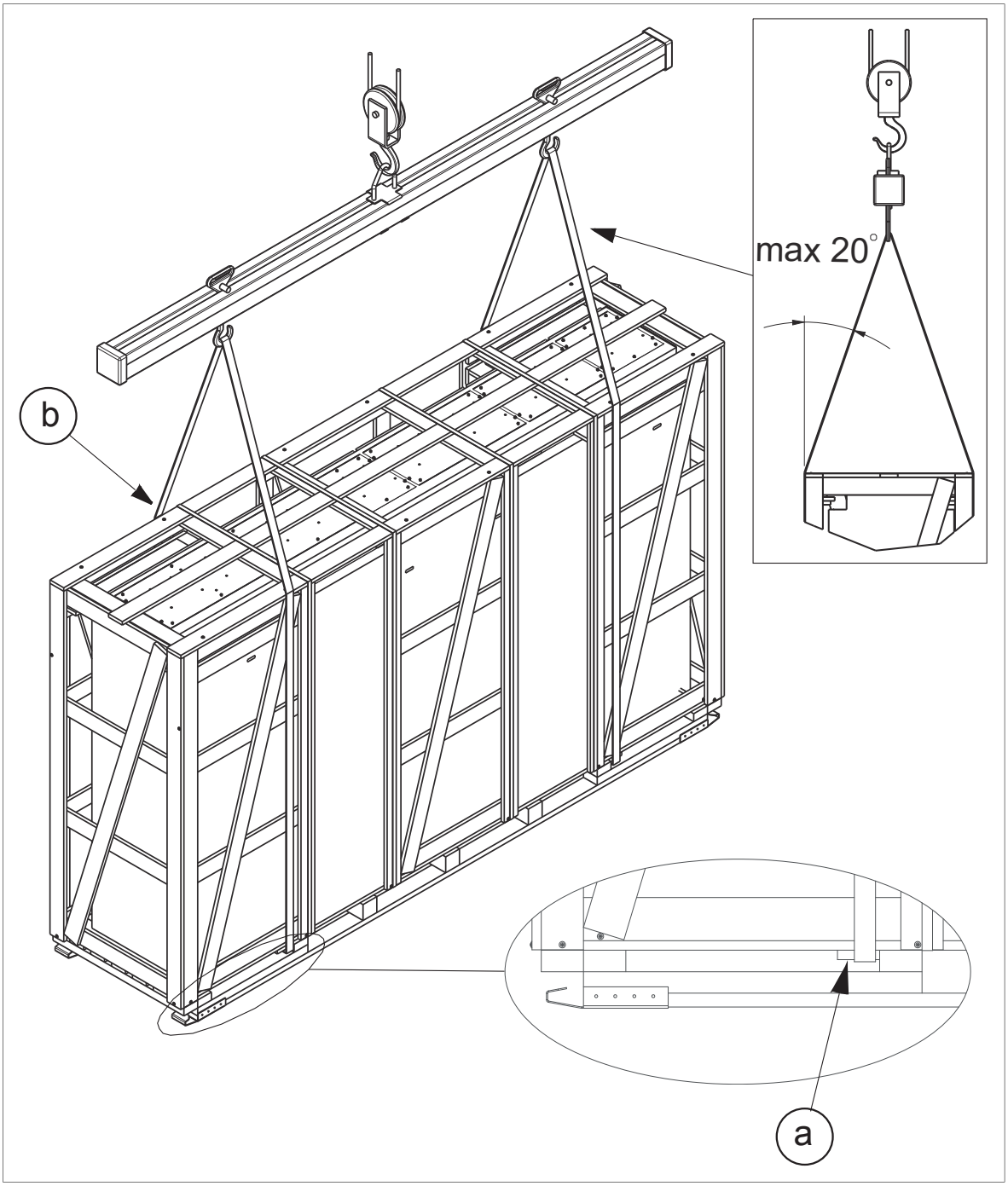
The center of gravity of the cabinet is high. Be therefore careful when moving the unit. Avoid tilting.

Moving the drive in its packaging

Lifting the crate with a forklift



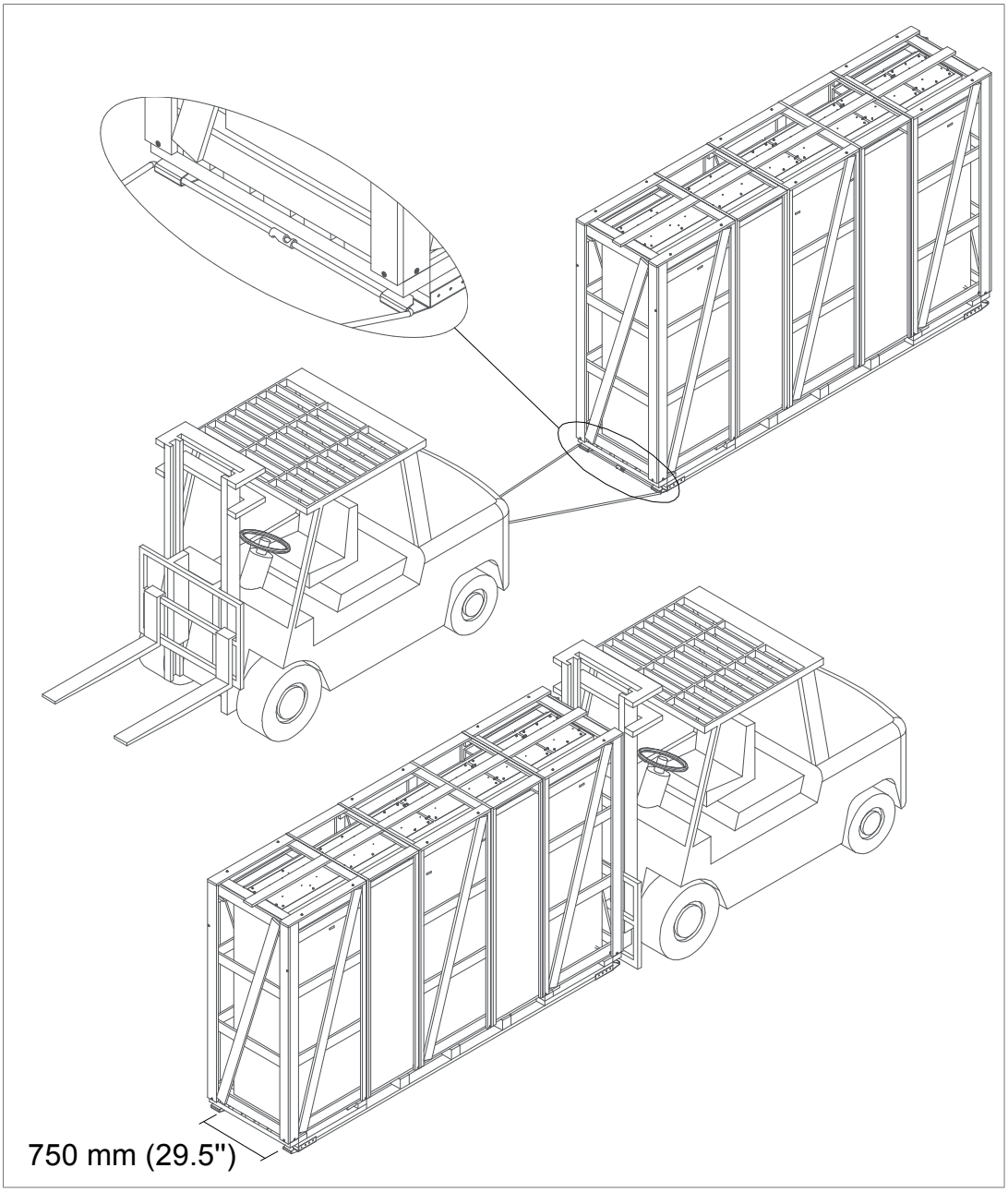
Lifting the crate with a crane



a Lifting point

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

Moving the crate with a forklift



Removing the transport package

Remove the transport package as follows:

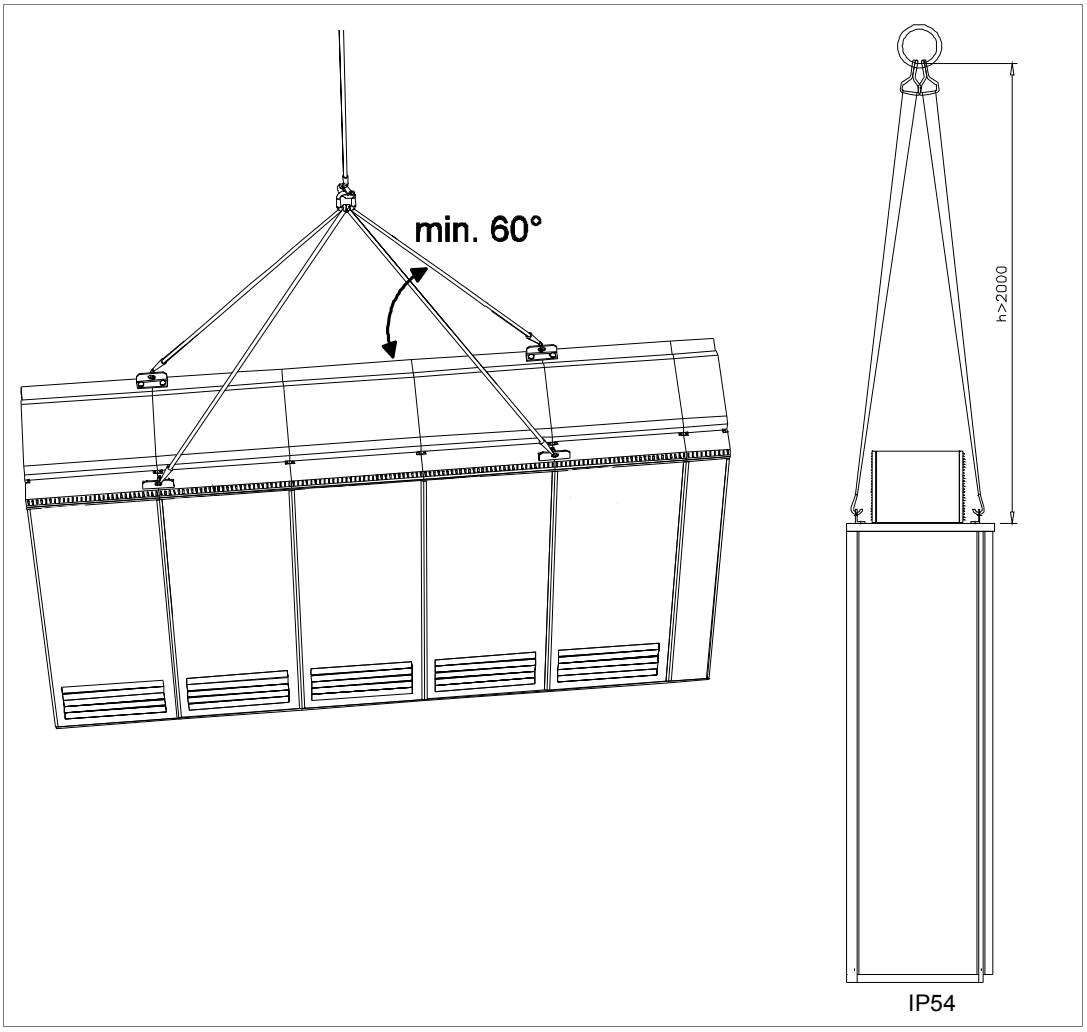
1. Undo the screws that attach the wooden parts of the transport crate to each other.
2. Remove the wooden parts.
3. Remove the clamps with which the drive cabinet is mounted onto the transport pallet by undoing the fastening screws.
4. Remove the plastic wrapping.

Moving the unpacked drive cabinet

Lifting the cabinet with a crane

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

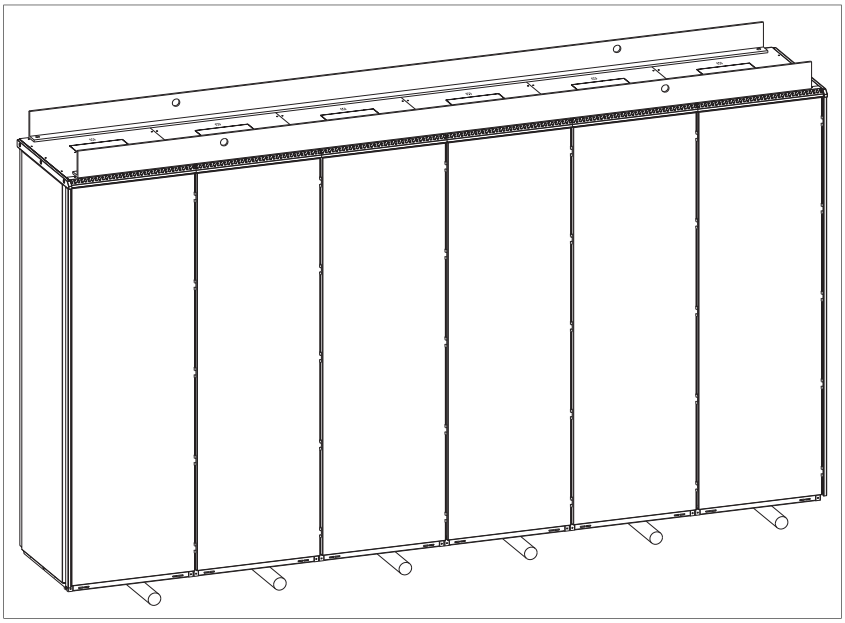
Note:
The minimum allowed height of the lifting slings with IP54 units is 2 meters (6’7”).



Moving the cabinet on rollers

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

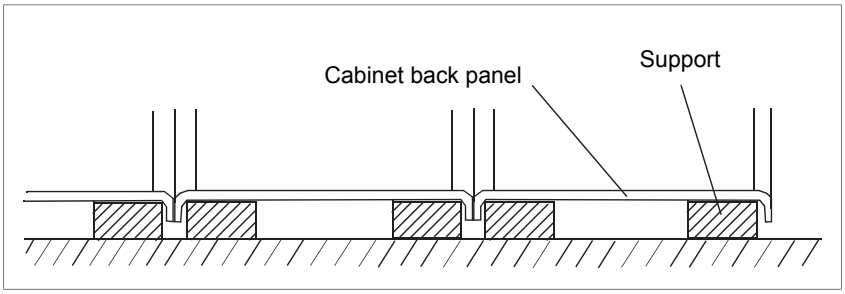
Lay the cabinet on the rollers and move it carefully until close to its final location. Remove the rollers by lifting the unit with a crane, forklift, pallet truck or jack.



Moving the cabinet on its back

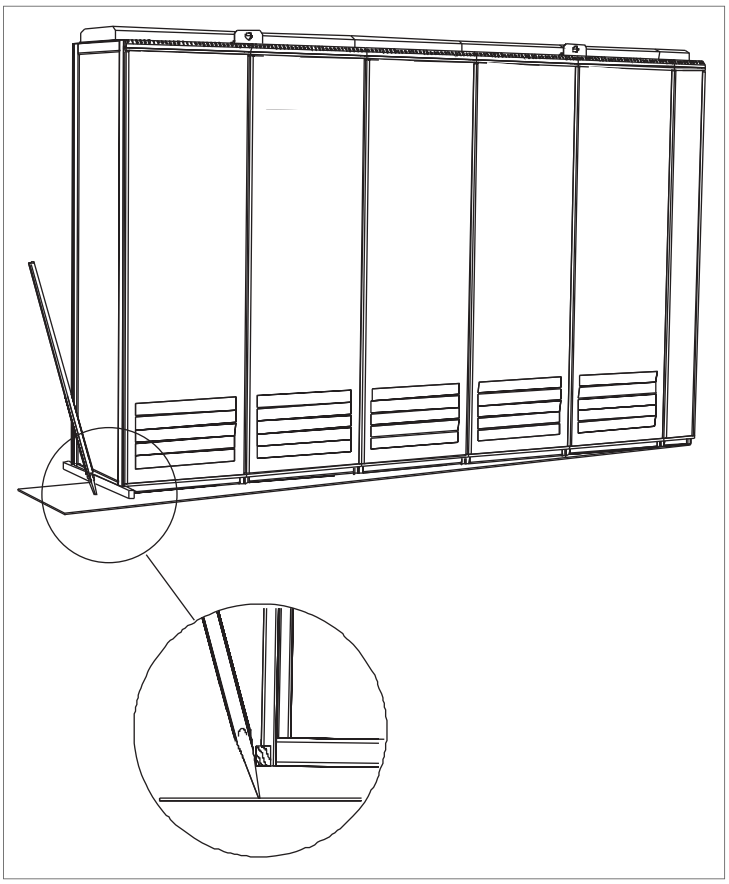
WARNING!
Do not transport the drive with an LCL or L filter on its back. It will damage the filter.

Support the cabinet from below alongside the cubicle seams.



Final placement of the cabinet

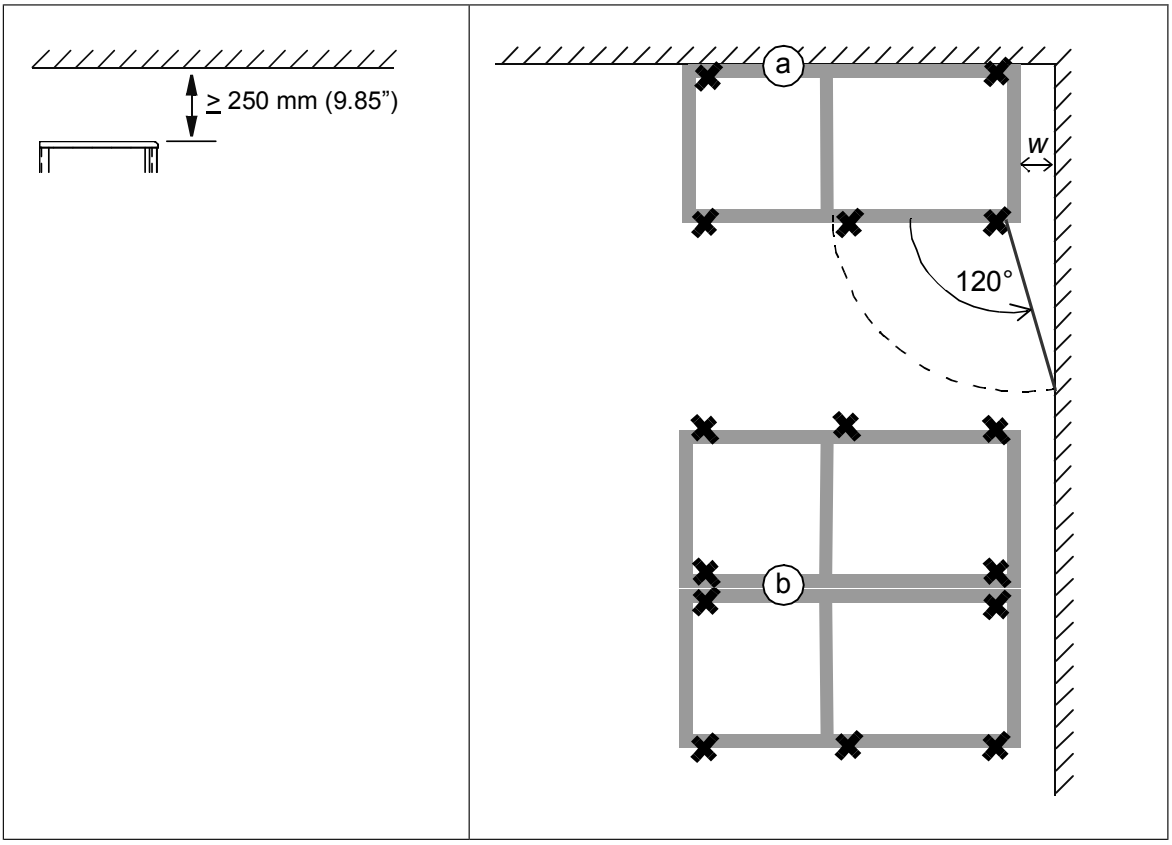
Move the cabinet into its final position with a slate bar (spud bar). Place a piece of wood between the edge of the cabinet and the bar to protect the cabinet frame.



Fastening the cabinet to the floor and wall or roof

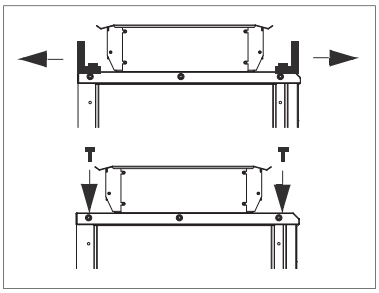
General rules

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



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

Note 2: Depending on the size of the cabinet, it has either bolt-on lifting eyes, or lifting bars with lifting holes. If the cabinet is delivered with lifting bars, remove them. Store the bars for decommissioning. Bolt-on lifting eyes need not be removed unless the holes are used for fastening the cabinet. Plug any unused holes using the existing bolts and sealing rings included. Tighten to 70 N·m (52 lbf·ft).

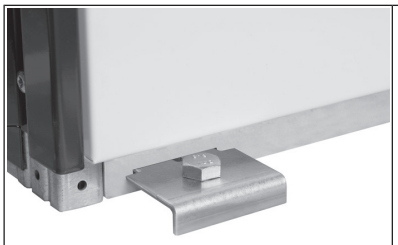


Fastening the cabinet (non-marine units)

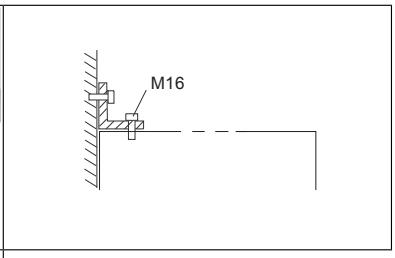
Alternative 1 – Clamping

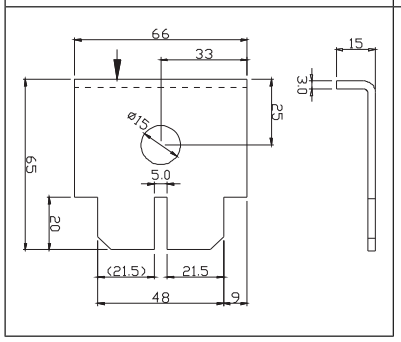
1. Insert the clamps (included) into the twin slots along the front and rear edges of the cabinet frame body and fasten them to the floor with a bolt. The recommended maximum distance between the clamps in the front edge is 800 mm (31.5”).
2. If floor mounting at the back is not possible, fasten the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

Clamping bottom to floor



Fastening top to wall

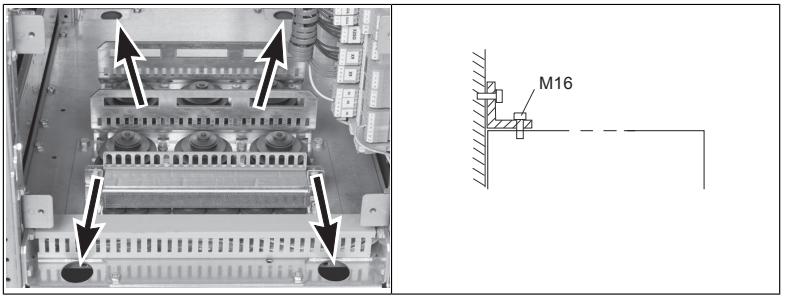




Alternative 2 – Using the holes inside the cabinet

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

Fastening bottom to floor *Fastening top to wall*



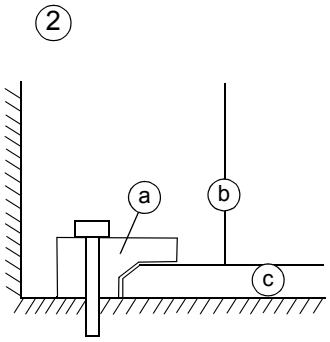
Fastening the cabinet (marine units)

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

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

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

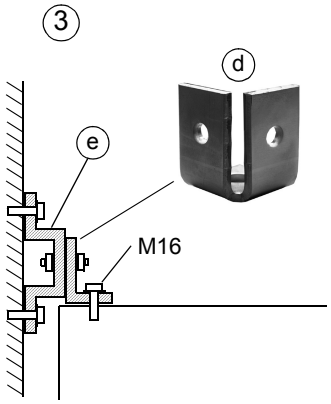
Fastening to floor with a clamp



2. Clamping the cabinet to the floor at the back

a - Clamp (not included)
b - Back panel of cabinet
c - Flat bars at base of cabinet

Fastening to wall



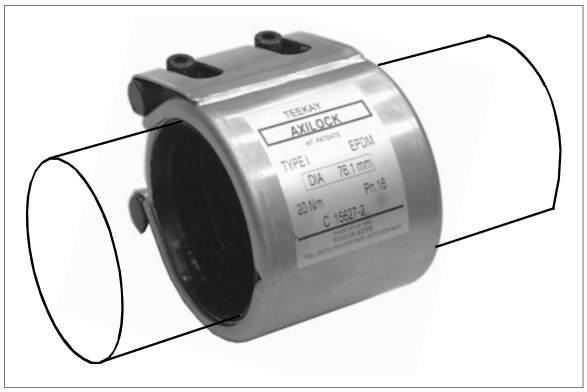
3. Fastening the cabinet at the top

d - Corner bracket (included)
e - U-bracket (not included)

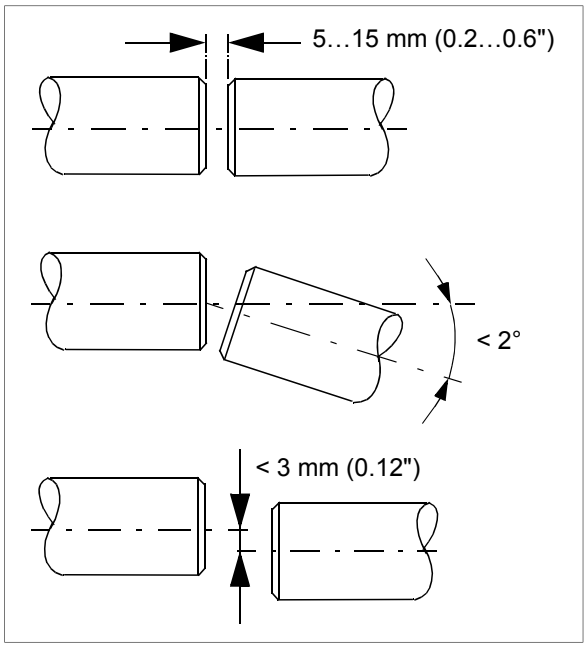
Joining cabinet sections together

Wide cabinet line-ups are delivered in multiple sections. The sections are to be joined on-site using a 200 mm wide joining cubicle at the end of one section (a common motor terminal cubicle can also act as a joining cubicle). The screws required for the joining are enclosed in a plastic bag inside the cabinet. The threaded bushings are already mounted on the cabinet posts.

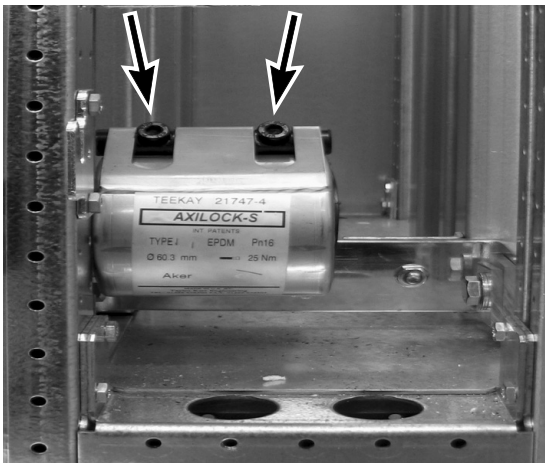
1. Fasten the first section to the floor.
2. Remove any plates covering the rear post of the joining cubicle.
3. Slide Axilock connectors onto the coolant pipes at the joint.



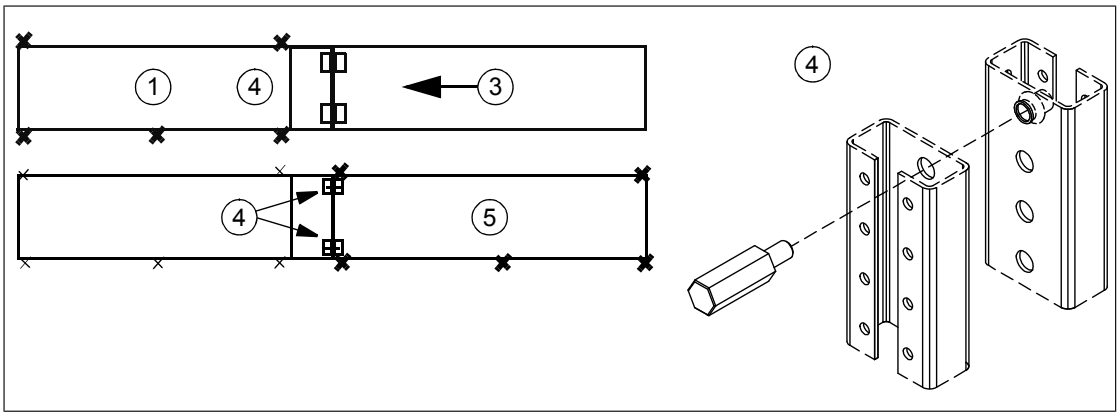
4. Align the two sections.
   The coolant pipe ends must be aligned as shown.



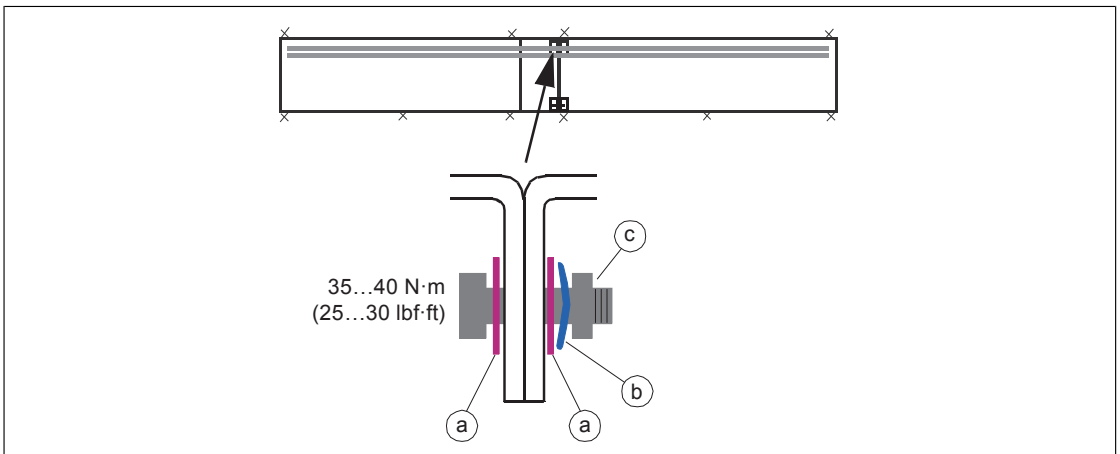
5. Center the Axilock connectors onto the gaps between coolant pipe ends. Tighten the connector screws to the torque indicated on the connector label.



6. Fasten the front and rear posts of the joining cubicle to the posts of the other section with 14 screws (7 per post). Tighten the screws to 5 N·m (3.7 lbf·ft).
7. Fasten the second section to the floor.

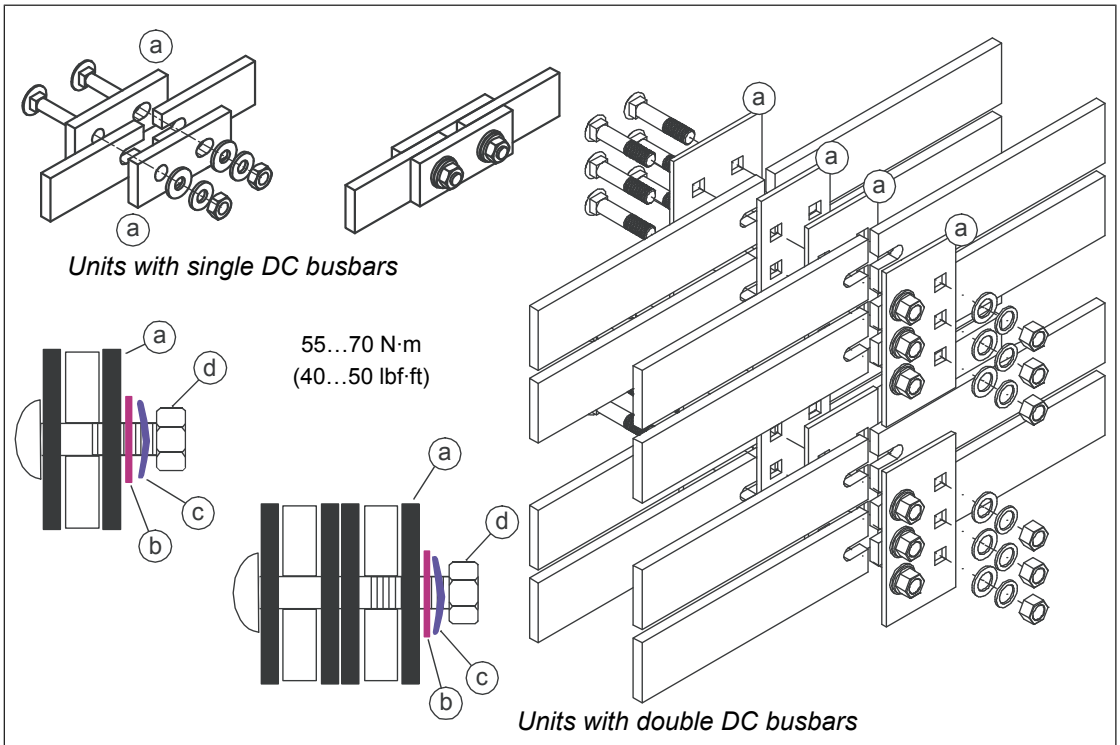


8. Connect the PE busbars using the M10 bolts and nuts included. Tighten to 35…40 N·m (25…30 lbf·ft).



a Plain washer
b Spring washer
c Bolt and nut

9. Remove the shroud covering the DC busbars in the joining cubicle.
10. Use the joint pieces to connect the DC busbars. Tighten the bolts to 55…70 N·m (40…50 lbf·ft).



a Joint piece
b Plain washer with electroplated zinc coating and blue chromate passivation
c Spring washer with mechanically sprayed zinc coating
d Nut

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

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

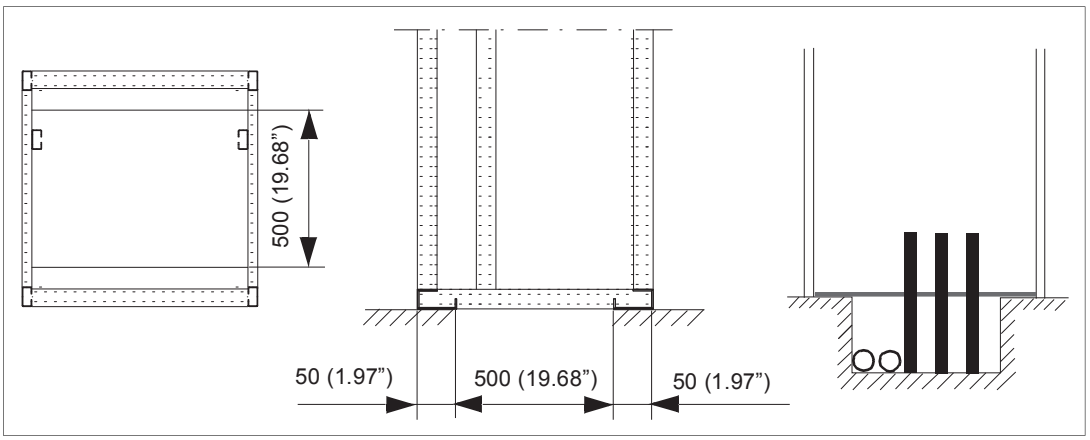
11. Reinstall any covering plates removed earlier.
12. Repeat procedure for any further sections.

Miscellaneous

Cable duct in the floor below the cabinet

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

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



Arc welding

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

Note:
The thickness of the zinc plating of the cabinet frame is 100 to 200 micrometers (4 to 8 mil).

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

WARNING!
Do not inhale the welding fumes.

5

Guidelines for planning the electrical installation

Contents of this chapter

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

Limitation of liability

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

Selecting the supply disconnecting device

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

Selecting the main contactor or breaker

Depending on the drive size, you can order it either with a main contactor (option +F250), or a main breaker (option +F255).

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 drive or inverter unit hardware manual. You can also use the DriveSize PC tool.

Make sure that the motor withstands the maximum peak voltage in the motor terminals. See *Requirements table (page 58)*. For basics of protecting the motor insulation and bearings in drive systems, see *Protecting the motor insulation and bearings (page 58)*.

Note:

- Consult the motor manufacturer before using a motor whose nominal voltage differs from the AC line voltage connected to the drive input.
- The voltage peaks at the motor terminals are relative to the supply voltage of the drive, not the drive output voltage.
- If the motor and drive are not of the same size, consider the operation limits of the drive control program for the motor nominal voltage and current. See the appropriate parameters in the firmware manual.

Protecting the motor insulation and bearings

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

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

d*u*/d*t* filters protect motor insulation system and reduce bearing currents. Common mode filters mainly reduce bearing currents. Insulated N-end (non-drive end) bearings protect the motor bearings.

Requirements table

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

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

<table>
<tr><th rowspan="3">Motor type</th><th rowspan="3">Nominal AC supply voltage</th><th colspan="4">Requirement for</th></tr>
<tr><th rowspan="2">Motor insulation system</th><th colspan="3">ABB du/dt and common mode filters, insulated N-end motor bearings</th></tr>
<tr><th>P_N < 100 kW and frame size < IEC 315</th><th>100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400</th><th>P_N ≥ 350 kW or frame size ≥ IEC 400</th></tr>
<tr><th></th><th></th><th>P_N < 134 hp and frame size < NEMA 500</th><th>134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580</th><th>P_N ≥ 469 hp or frame size > NEMA 580</th></tr>
<tr><td rowspan="6">Random-wound M2_, M3_ and M4_</td><td>U_N ≤ 500 V</td><td>Standard</td><td>-</td><td>+ N</td><td>+ N + CMF</td></tr>
<tr><td rowspan="3">500 V < U_N ≤ 600 V</td><td>Standard</td><td>+ du/dt</td><td>+ N + du/dt</td><td>+ N + du/dt + CMF</td></tr>
<tr><td colspan="4">or</td></tr>
<tr><td>Reinforced</td><td>-</td><td>+ N</td><td>+ N + CMF</td></tr>
<tr><td>600 V < U_N ≤ 690 V (cable length ≤ 150 m)</td><td>Reinforced</td><td>+ du/dt</td><td>+ N + du/dt</td><td>+ N + du/dt + CMF</td></tr>
<tr><td>600 V < U_N ≤ 690 V (cable length > 150 m)</td><td>Reinforced</td><td>-</td><td>+ N</td><td>+ N + CMF</td></tr>
<tr><td rowspan="2">Form-wound HX_ and AM_</td><td rowspan="2">380 V < U_N ≤ 690 V</td><td rowspan="2">Standard</td><td rowspan="2">n.a.</td><td rowspan="2">+ N + CMF</td><td>P_N < 500 kW: +N + CMF</td></tr>
<tr><td>P_N ≥ 500 kW: +N + du/dt + CMF</td></tr>
<tr><td>Old [1] form-wound HX_ and modular</td><td>380 V < U_N ≤ 690 V</td><td>Check with the motor manufacturer.</td><td colspan="3">+ N + du/dt with voltages over 500 V + CMF</td></tr>
<tr><td rowspan="2">Random-wound HX_ and AM_ [2]</td><td>0 V < U_N ≤ 500 V</td><td rowspan="2">Enamelled wire with fiber glass taping</td><td colspan="3">+ N + CMF</td></tr>
<tr><td>500 V < U_N ≤ 690 V</td><td colspan="3">+ N + du/dt + CMF</td></tr>
<tr><td>HDP</td><td colspan="4">Consult the motor manufacturer.</td></tr>
</table>

[1] manufactured before 1.1.1998

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

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

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

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

The abbreviations used in the tables are defined below.

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

Availability of d*u*/d*t* filter and common mode filter by drive or inverter type

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

Additional requirements for explosion-safe (EX) motors

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

Additional requirements for ABB motors of types other than M2_, M3_, M4_, HX_ and AM_

Use the selection criteria given for non-ABB motors.

Additional requirements for braking applications

When the motor brakes the machinery, the intermediate circuit DC voltage of the drive increases, the effect being similar to increasing the motor supply voltage 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 the regenerative and low harmonics drives

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

Additional requirements for ABB high-output and IP23 motors

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

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

Nominal AC supply voltage	Requirement for			
	Motor insulation system	ABB 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**
$U_N \leq 500$ V	Standard: $\hat{U}_{LL}$ = 1300 V	+ N or CMF	+ N or CMF
420 V < U_N < 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ d*u*/d*t* + (N or CMF)	+ N + d*u*/d*t* + CMF
	or		
	Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 microsecond rise time	+ N or CMF	+ N or CMF
500 V < $U_N \leq$ 600 V	Reinforced: $\hat{U}_{LL}$ = 1600 V	+ d*u*/d*t* + (N or CMF)	+ N + d*u*/d*t* + CMF
	or		
	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ N or CMF	+ N + CMF
600 V < $U_N \leq$ 690 V	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ N + d*u*/d*t*	+ N + d*u*/d*t* + CMF
	Reinforced: $\hat{U}_{LL}$ = 2000 V, 0.3 microsecond rise time [1)]	+ N + CMF	+ N + CMF

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

Additional 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. Check the availability of the sine filter from ABB.

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 drive (or motor) nominal current.
- **Temperature:** For IEC, select a cable rated for at least 70 °C (90 °C for IP55 [UL Type 12]) maximum permissible temperature of conductor in continuous use. For North America, power cables must be rated for 90 °C (194 °F) or higher with derating.
- **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.

Use symmetrical shielded power cables. They reduce electromagnetic emissions of the whole drive system as well as the stress on motor insulation, bearing currents and wear. To comply with the European EMC requirements, use a preferred cable type. See *Recommended power cable types (page 64)*.

If the cabling is in a metal conduit, it reduces the electromagnetic emission of the whole drive system.

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

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

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

1) Drive safety standard IEC/EN 61800-5-1:
- use a protective earth conductor with a cross-section of at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al, or
- use a second protective earth conductor of the same cross-sectional area as the original protective earthing conductor, or
- use a device which automatically disconnects the supply if the protective earth conductor breaks.

2) Drive safety standard IEC/EN 61800-5-1: If the protective earth conductor is separate (ie, it does not form part of the input power cable or the input power cable enclosure), the cross section must be at least:
- 2.5 mm^2 (14 AWG) when the conductor is mechanically protected, or
- 4 mm^2 (12 AWG) when the conductor is not mechanically protected.

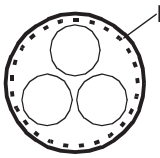
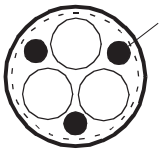
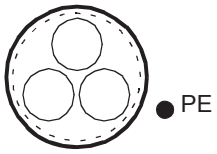
Typical power cable sizes

See the technical data of the drive (or unit).

Power cable types

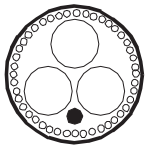
Recommended power cable types

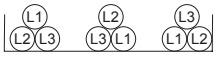
This section presents the recommended cable types. Check with local / state / country electrical codes for allowance.

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

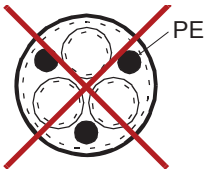
[1)] A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use.

Alternate power cable types

Cable type	Use as input power cabling	Use as motor cabling
 Four-conductor cabling in metal conduit (three phase conductors and PE), eg, EMT, or four-conductor armored cable	Yes	Yes with phase conductor smaller than 10 mm^2 (8 AWG) or motors up to 30 kW (40 hp)
 Well-shielded (Al/Cu shield or armor) four-conductor cable (three phase conductors and a PE)	Yes	Yes with motors up to 100 kW (135 hp). A potential equalization between the frames of motor and driven equipment is required.

Cable type	Use as input power cabling	Use as motor cabling
 A single-core cable system: three phase conductors and PE conductor on cable tray  Preferable cable arrangement to avoid voltage or current unbalance between the phases	Yes  **WARNING!** If you use unshielded single-core cables in an IT network, make sure that the non-conductive outer sheath (jacket) of the cables have good contact with a properly grounded conductive surface. For example, install the cables on a properly grounded cable tray. Otherwise voltage may become present on the non-conductive outer sheath of the cables, and there is even a risk of an electric shock.	No

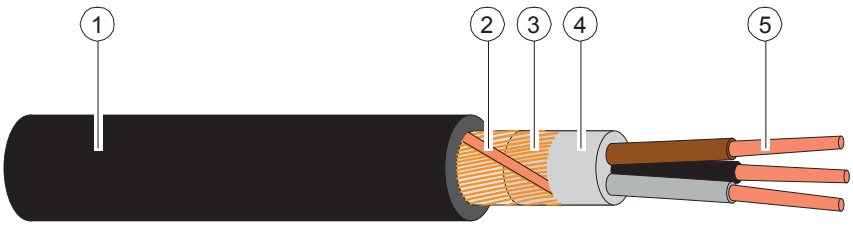
Not allowed power cable types

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

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 screen
4	Inner insulation
5	Cable core

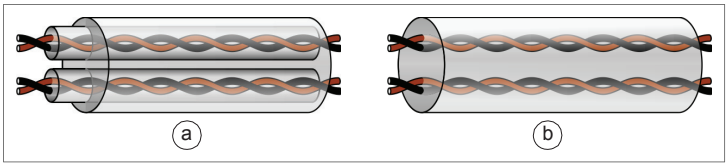
Selecting the control cables

Shielding

Only use shielded control cables.

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

A double-shielded cable (figure a below) 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 type

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

Control panel to drive connection

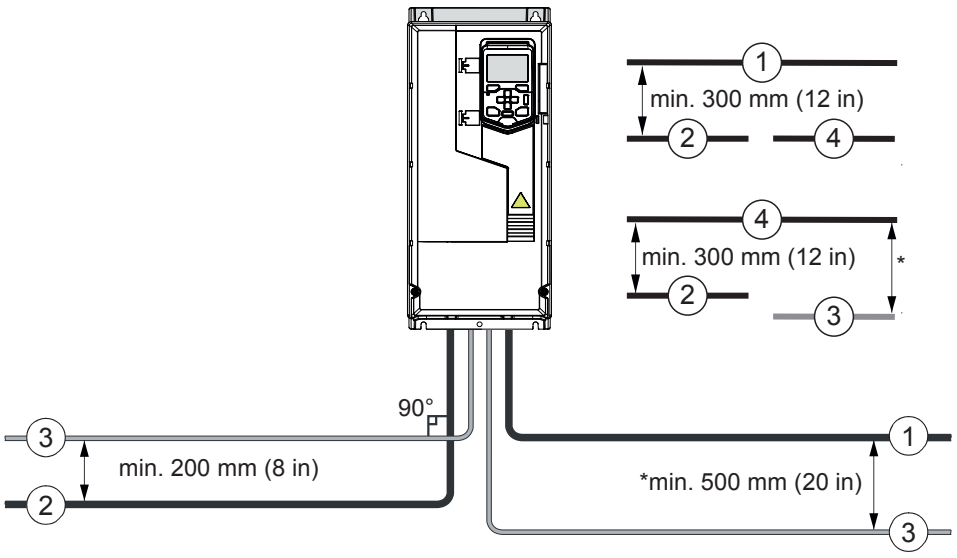
Use EIA-485 with male RJ-45 connector, cable type Cat 5e or better. The maximum permitted length of the cable is 100 m (328 ft).

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 in order to decrease electromagnetic interference caused by the rapid changes in the drive output voltage.
- Where control cables must cross power cables, make sure 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.

This 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)

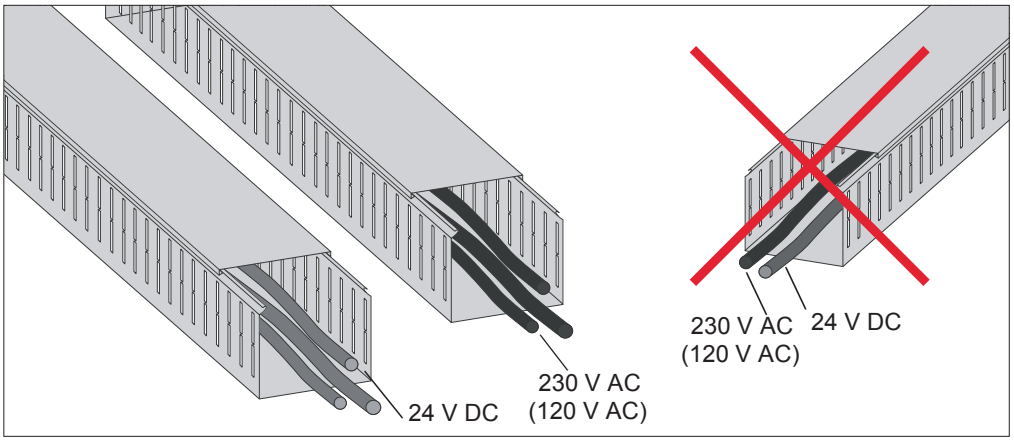
Continuous motor cable shield or enclosure for equipment on the motor cable

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 (preferred alternative), 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

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



Implementing thermal overload and short-circuit protection

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

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

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

Protecting the motor and motor cable in short-circuits

The drive protects the motor cable and motor in a short-circuit situation when the motor cable is sized according to the nominal current of the drive. No additional protection devices are needed.

Protecting the drive and the power cables against thermal overload

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

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

Protecting the motor against thermal overload

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value, the function either monitors a calculated temperature

value (based on a motor thermal model) or an actual temperature indication given by motor temperature sensors.

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

The most common temperature sensors are:

- motor sizes IEC180…225: thermal switch, for example Klixon
- motor sizes IEC200…250 and larger: PTC or Pt100.

See the firmware manual for more information on the motor thermal protection.

Protecting the drive against ground faults

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

Residual current device compatibility

The drive is suitable to be used with residual current devices of Type B.

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

Implementing the emergency stop function

You can order the drive with an emergency stop function.

See the appropriate manual for more information.

Name	Code
Emergency stop, stop category 0 (option +Q951) for ACS880-07/17/17LC/37/37LC drives user's manual	3AUA0000119895
Emergency stop, stop category 1 (option +Q952) for ACS880-07/17/17LC/37/37LC drives user's manual	3AUA0000119896

Implementing the Safe Torque Off function

See chapter *The Safe torque off function* on page *179*.

Implementing the Power loss ride-through function

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

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

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

Using power factor compensation capacitors with the drive

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

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

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

1. Do not connect a high-power capacitor to the power line while the drive is connected. The connection will cause voltage transients that may trip or even damage the drive.
2. If capacitor load is increased/decreased step by step when the AC drive is connected to the power line, make sure that the connection steps are low enough not to cause voltage transients that would trip the drive.
3. Check 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.

Implementing a safety switch between the drive and the motor

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

Using a contactor between the drive and the motor

Implementing the control of the output contactor depends on how you select the drive to operate.

- For vector control mode and motor ramp stop, open the contactor as follows:
  1. Give a stop command to the drive.
  2. Wait until the drive decelerates the motor to zero speed.
  3. Open the contactor.
- For vector control mode and motor coast stop, or scalar control mode, open the contactor as follows:
  1. Give a stop command to the drive.
  2. Open the contactor.

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

Implementing a bypass connection

If bypassing is required, employ mechanically or electrically interlocked contactors between the motor and the drive and between the motor and the power line. Make sure with interlocking that the contactors cannot be closed simultaneously. The installation must be

clearly marked as defined in IEC/EN 61800-5-1, subclause 6.5.3, for example, “THIS MACHINE STARTS AUTOMATICALLY”.

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

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

Implementing the ATEX-certified Safe motor disconnection function (option +Q971)

With option +Q971, the drive provides ATEX-certified safe motor disconnection without contactor using the drive Safe torque off function. For more information, see

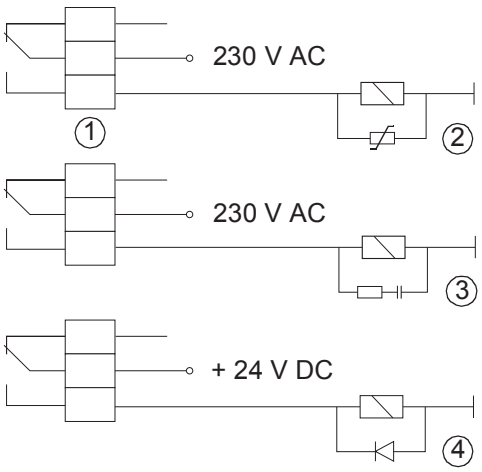
- *ATEX-certified Safe disconnection function, Ex II (2) GD for ACS880 drives (+Q971) Application guide* (3AUA0000132231 [English]).
- *FPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) for ACS880 drives user's manual* (3AXD50000027782 [English]).
- *CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) user's manual* (3AXD50000030058 [English]).

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

Connecting motor temperature sensor to the drive via an option module

This table shows:

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

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	**Insulation/Isolation**	**PTC**	**KTY**	**Pt100, Pt1000**	
FIO-11	Galvanic isolation between sensor connector and other connectors (including drive control unit connector)	-	x	x	Reinforced insulation
FEN-xx	Galvanic isolation between sensor connector and other connectors (including drive control unit connector)	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	Basic insulation. Connectors of option module other than sensor connector must be left unconnected.
FPTC-xx [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).

Protecting the drive against ground faults

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

Residual current device compatibility

The drive is suitable to be used with residual current devices of Type B.

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

Implementing the emergency stop function

You can order the drive with an emergency stop function.

See the appropriate manual for more information.

Name	Code
Emergency stop, stop category 0 (option +Q951) for ACS880-07/17/17LC/37/37LC drives user's manual	3AUA0000119895
Emergency stop, stop category 1 (option +Q952) for ACS880-07/17/17LC/37/37LC drives user's manual	3AUA0000119896

Implementing the Safe torque off function

See chapter *The Safe torque off function (page 179)*.

Implementing the Prevention of unexpected start-up function

You can order the drive with a Prevention of unexpected start-up (POUS) function. The POUS function enables short-time maintenance work (like cleaning) on the non-electrical parts of the machinery without switching off and disconnecting the drive.

See the appropriate manual for more information.

TO BE ADDED

Implementing the functions provided by the FSO-xx safety functions module

You can order the drive with an FSO-12 or FSO-21 safety functions module (option +Q972 or +Q973) which 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-xx module are at default when delivered from the factory. The wiring of the external safety circuit and configuration of the FSO-xx module are the responsibility of the user.

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

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

Implementing the Power-loss ride-through function

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

- Check that the power-loss ride-through function of the drive (inverter unit) is enabled. See the drive firmware manual.
- Make sure that the control of the main contactor/breaker either keeps the contactor closed over the short power break, or closes it after the break automatically.

WARNING!
Make sure that the automatic re-connection of the input power does not cause any danger. If you are in doubt, do not implement the Power-loss ride-through function.

Implementing a bypass connection

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

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

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

Supplying power for the auxiliary circuits

The drive is equipped with an auxiliary voltage transformer which supplies, for example, control unit(s) and cooling fan(s).

The user must supply these options from external power sources:

- +G300/+G301: Cabinet heaters and/or lighting (230 or 115 V AC; external fuse: 16 A gG)
- +G307: Connection for an external uninterruptible power supply (230 or 115 V AC; external fuse 16 A gG)
- +G313: Power supply connection for a motor space heater output (230 V AC; external fuse 16 A gG).

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. Check 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

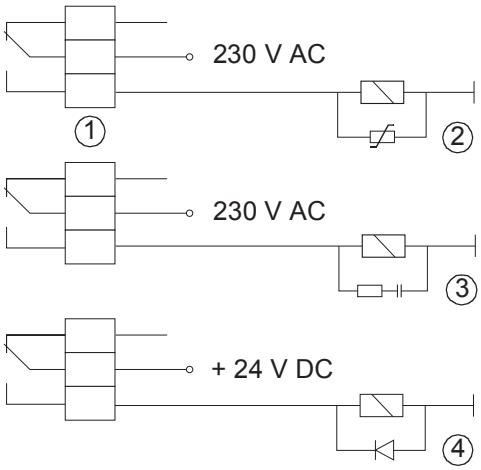
ABB recommends to install a safety switch between the permanent magnet motor and the drive output. The switch is needed to isolate the motor during any maintenance work on the drive.

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

Implementing a motor temperature sensor connection

WARNING!
IEC 60664 and IEC 61800-5-1 require double or reinforced insulation between live parts and the surface of accessible parts of electrical equipment which are either non-conductive or conductive but not connected to the protective earth.

You have four 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.
2. If there is basic insulation between the sensor and the live parts of the motor, you can connect the sensor to the analog/digital input(s) of the drive if all other circuits connected to the digital and analog inputs (typically extra-low voltage circuits) are protected against

contact and insulated with basic insulation from other low-voltage circuits. The insulation must be rated for the same voltage level as the drive main circuit. Note that extra-low voltage circuits (such as 24 V DC) typically do not meet these requirements.
Alternative: You can connect the sensor with a basic insulation to the analog/digital input(s) of the drive if you do not connect any other external control circuits to drive digital and analog inputs.

3. You can connect the sensor to the drive via an option module. The sensor and the module must form a reinforced insulation between the motor live parts and the drive control unit. See *Connecting motor temperature sensor to the drive via an option module (page 72)*.
4. You can connect a sensor to a digital input of the drive via an external relay. The insulation of the relay of must be rated for the main circuit voltage of the motor. See *Connection of motor temperature sensor to the drive via a relay (page 76)*.

Connecting motor temperature sensor to the drive via an option module

This table shows:

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

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	**Insulation/Isolation**	**PTC**	**KTY**	**Pt100, Pt1000**	
FIO-11	Galvanic isolation between sensor connector and other connectors (including drive control unit connector)	-	x	x	Reinforced insulation
FEN-xx	Galvanic isolation between sensor connector and other connectors (including drive control unit connector)	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	Basic insulation. Connectors of option module other than sensor connector must be left unconnected.
FPTC-xx [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).

Connection of motor temperature sensor to the drive via a relay

PTC alternative A: This table shows the insulation requirement for a customer's external relay, and the insulation requirement for the sensor to fulfill decisive voltage class A (double insulation) of IEC 60800-5-1. The table also shows the insulation of the factory-installed

relay (plus code option for a cabinet-installed drive), and the insulation requirement for the sensor.

PTC relay		Temperature sensor insulation requirement
Type	**Insulation**	
External relay	Basic insulation 6 kV	Basic insulation
Drive options +L505 and +L513	Basic insulation 6 kV	Basic insulation

PTC alternative B: Decisive voltage class B of IEC 60800-5-1 (basic insulation) is provided with a 6 kV relay. Circuits connected to all motor protection relay inputs and outputs must be protected against direct contact.

Pt100 alternative A: This table shows the insulation requirement for a customer's external relay, and the insulation requirement for the sensor to fulfill decisive voltage class A (double insulation) of IEC 60800-5-1.The table also shows the insulation of the factory-installed relay (plus code option for a cabinet-installed drive), and the insulation requirement for the sensor.

Pt100 relay		Temperature sensor insulation requirement
Type	**Insulation**	
External relay	Basic insulation 6 kV	Basic insulation
Drive options +L506 and +L514	Basic insulation < 6 kV	Double or reinforced insulation

Pt100 alternative B: Decisive voltage class B of IEC 60800-5-1 (basic insulation) can be achieved when there is basic insulation between the sensor and live parts of the motor. Circuits connected to all motor protection relay inputs and outputs must be protected against direct contact.

6

Electrical installation

Contents of this chapter

This chapter gives instructions on the wiring of the drive.

Warnings

WARNING!
Only qualified electricians are allowed to carry out the work described in this chapter. Follow the safety instructions on the first pages of this manual. Ignoring the safety instructions can cause injury or death.

Checking the insulation of the assembly

Checking the insulation of the drive system

WARNING!
Do not make 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.

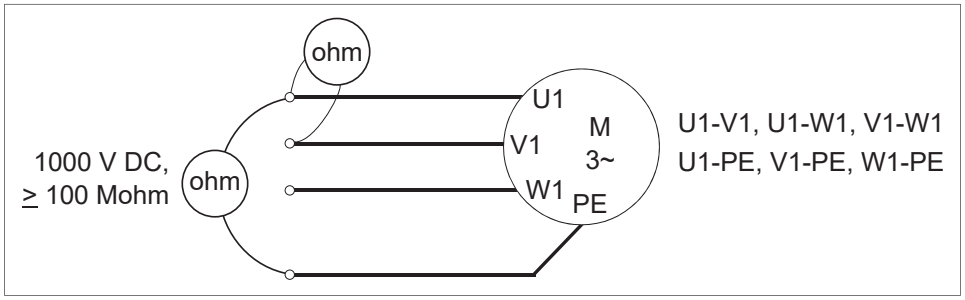
Checking the insulation of the motor and motor cable

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

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Check that the motor cable is disconnected from the drive output terminals.
3. Measure the insulation resistance between the phase conductors and then 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 exceed 100 Mohm (reference value at 25 °C [77 °F]). For the insulation resistance of other motors, consult the manufacturer's instructions.

   Note:
   Moisture inside the motor casing reduces the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.



Connecting the control cables

See chapter *Control units of the drive (page 99)* for the default I/O connections of the inverter unit (with the ACS880 primary control program). The default I/O connections can be different with some hardware options, see the circuit diagrams delivered with the drive for the actual wiring. For other control programs, see their firmware manuals.

Control cable connection procedure

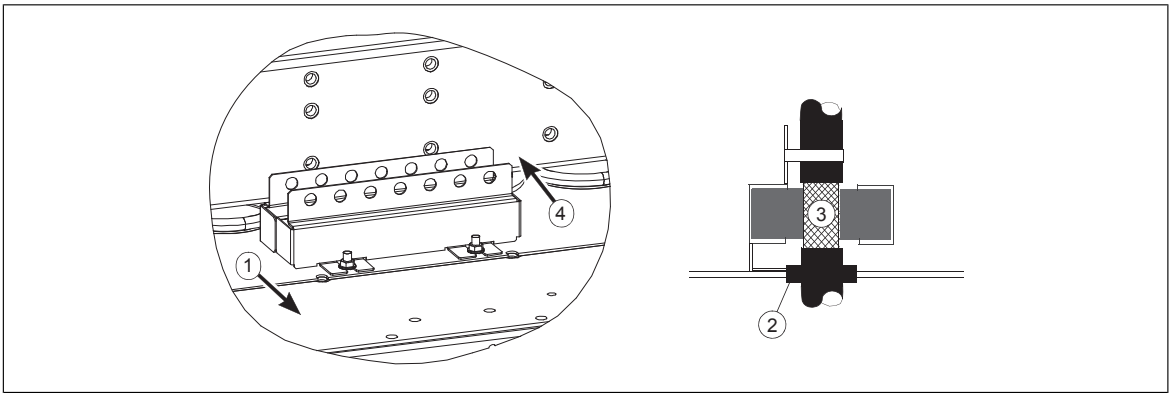
WARNING!
Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Run the control cables into the cabinet as described in section *Grounding the outer shields of the control cables at the cabinet entry* below.
3. Route the control cables as described in section *Routing the control cables inside the cabinet (page 83)*.
4. Connect the control cables as described in section *Connecting control cabling (page 83)*.

Grounding the outer shields of the control cables at the cabinet entry

Ground the outer shields of all control cables 360 degrees at the EMI conductive cushions as follows (example constructions are shown below, the actual hardware may vary):

1. Loosen the tightening screws of the EMI conductive cushions and pull the cushions apart.
2. Cut adequate holes to the rubber grommets in the entry plate and put the cables through the grommets and the cushions.
3. Strip off the cable plastic sheath above the entry plate just enough to ensure proper connection of the bare shield and the EMI conductive cushions.
4. Tighten the two tightening screws so that the EMI conductive cushions press tightly round the bare shield.

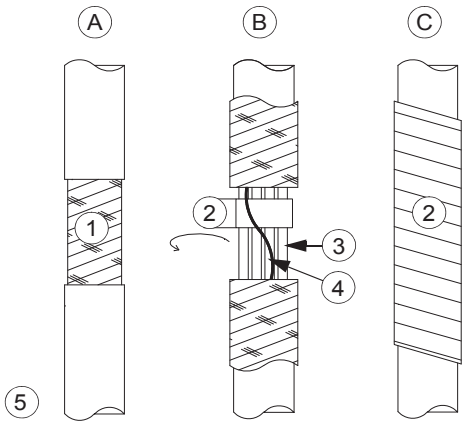


Note 1: Keep the shields continuous as close to the connection terminals as possible. Secure the cables mechanically at the entry strain relief.

Note 2: If the outer surface of the shield is non-conductive:

- Cut the shield at the midpoint of the bare part. Be careful not to cut the conductors or the grounding wire (if present).
- Turn the shield inside out to expose its conductive surface.

- Cover the turned shield and the stripped cable with copper foil to keep the shielding continuous.



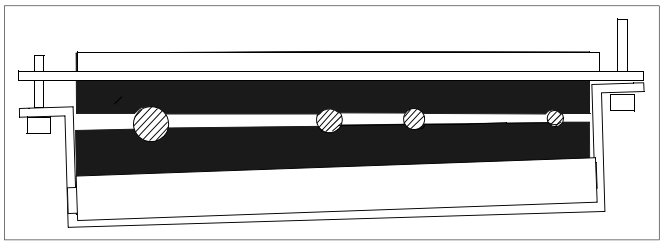
A	Stripped cable
B	Conductive surface of the shield exposed
C	Stripped part covered with copper foil
1	Cable shield
2	Copper foil
3	Shielded twisted pair
4	Grounding wire

Note for top entry of cables: When each cable has its own rubber grommet, sufficient IP and EMC protection can be achieved. However, if very many control cables come to one cabinet, plan the installation beforehand as follows:

1. Make a list of the cables coming to the cabinet.
2. Sort the cables going to the left into one group and the cables going to the right into another group to avoid unnecessary crossing of cables inside the cabinet.
3. Sort the cables in each group according to size.
4. Group the cables for each grommet as follows ensuring that each cable has a proper contact to the cushions on both sides.

Cable diameter in mm	Max. number of cables per grommet
≤ 13	4
≤ 17	3
< 25	2
≥ 25	1

5. Arrange the bunches according to size from thickest to the thinnest between the EMI conductive cushions.



6. If more than one cable go through a grommet, seal the grommet by applying Loctite 5221 (catalogue number 25551) inside the grommet.

Routing the control cables inside the cabinet

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

Connecting control cabling

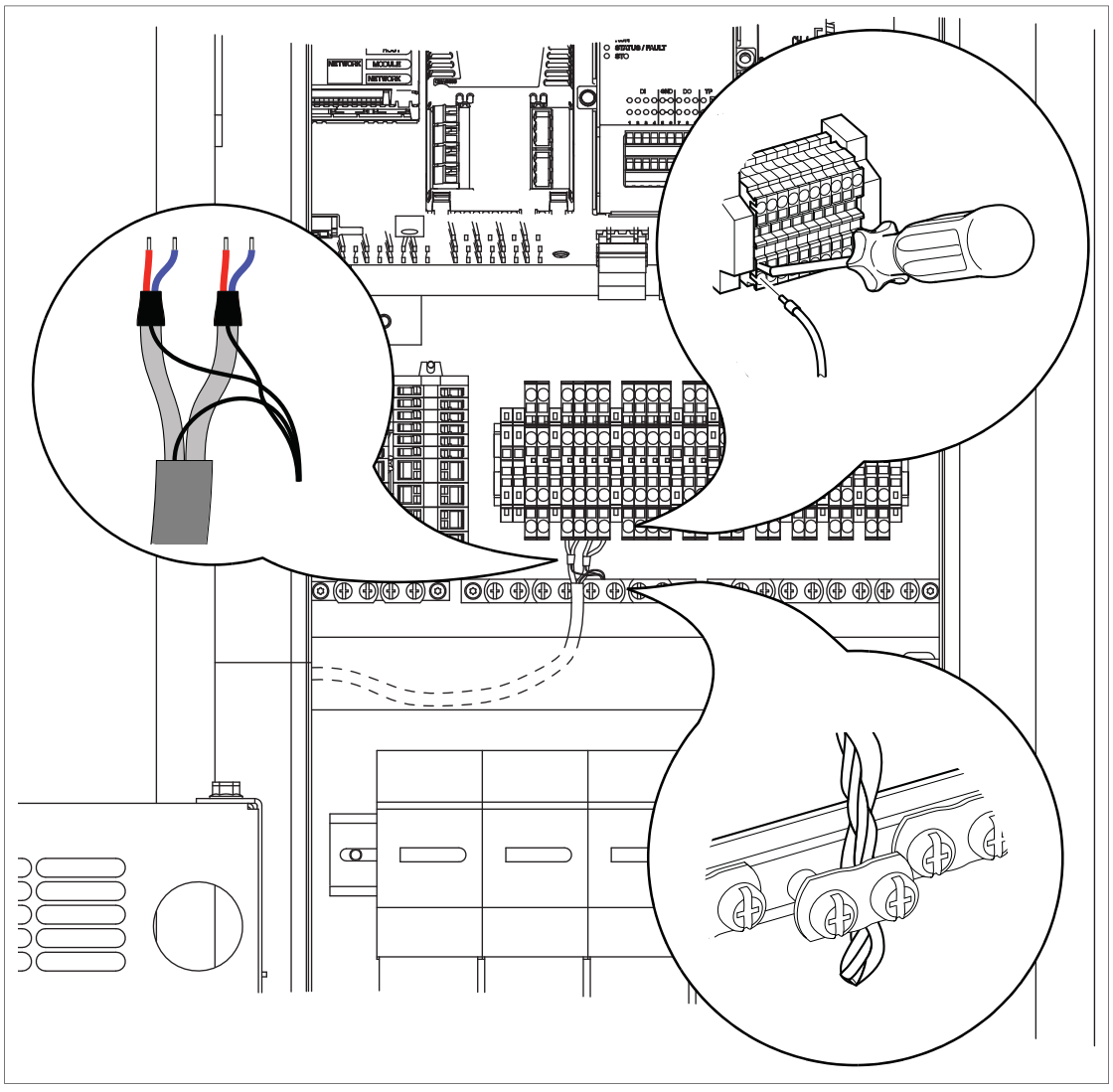
Connect the conductors to the appropriate terminals. Refer to the wiring diagrams delivered with the drive.

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

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

Notes:

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



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

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

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

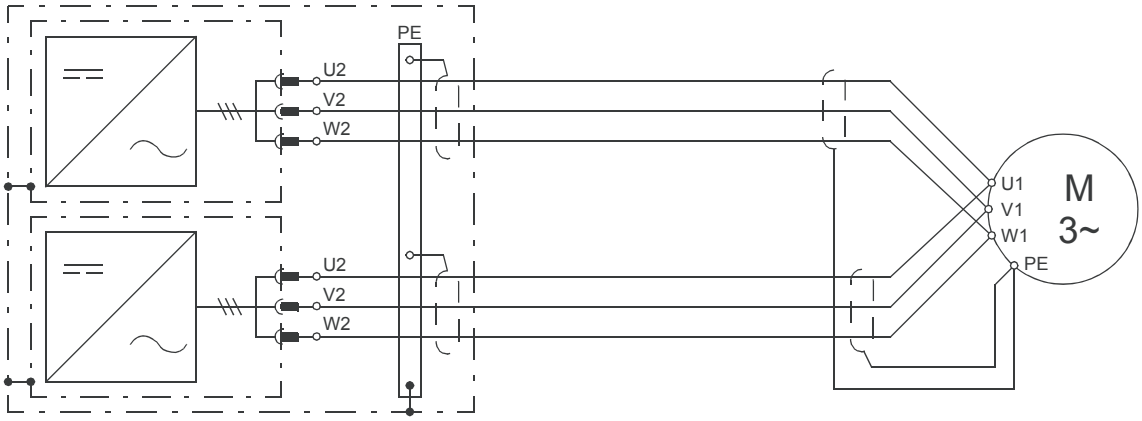
The location and dimensions of the busbars are visible in the dimension drawings delivered with the drive, as well as the example drawings presented in this manual in chapter Dimensions.

If the drive is equipped with a common motor terminal cubicle (option +H359), follow the instructions in section *Connecting the motor cables (units with common motor terminal cubicle) (page 88)*.

Motor connection diagram (without option +H366)

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

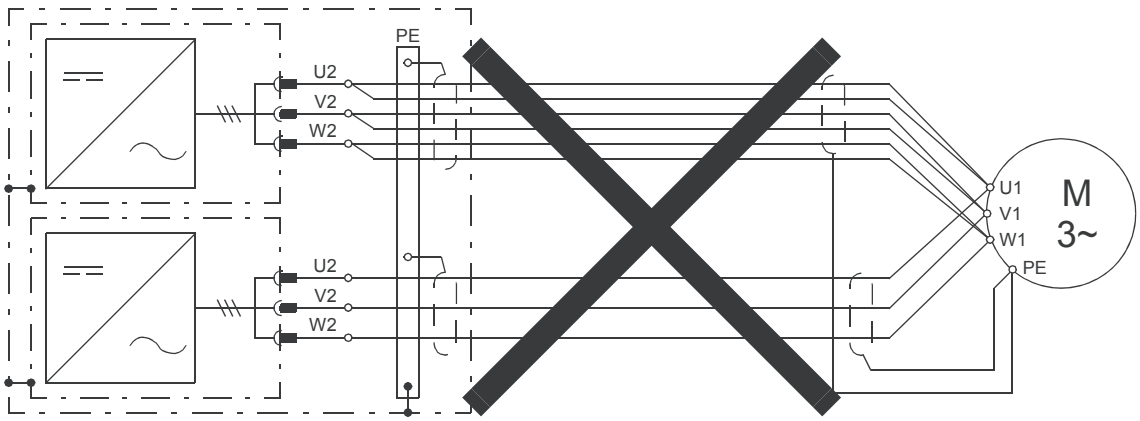
360° earthing is to be used at cable lead-throughs.



Inverter unit cubicle(s)

The recommended cable types are given in chapter *Technical data*.

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



Inverter unit cubicle(s)

Procedure

Refer to the drawings below.

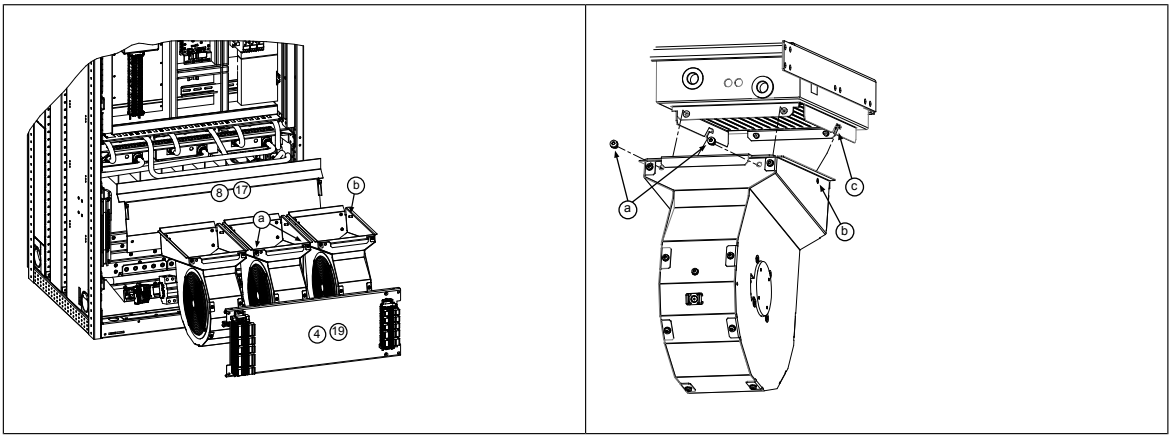
WARNING!
Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

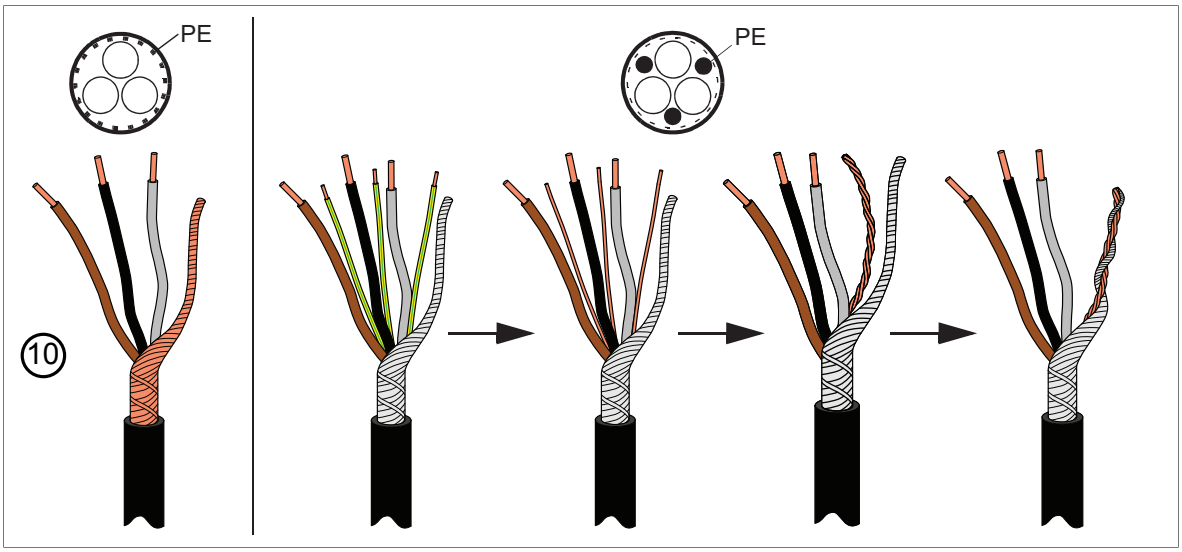
1. Do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Open the inverter module cubicle door.
3. Remove the shrouding at the lower part of the cubicle (not shown).
4. Unplug the wiring from the lower front mounting plate. Remove the plate.
5. Disconnect the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

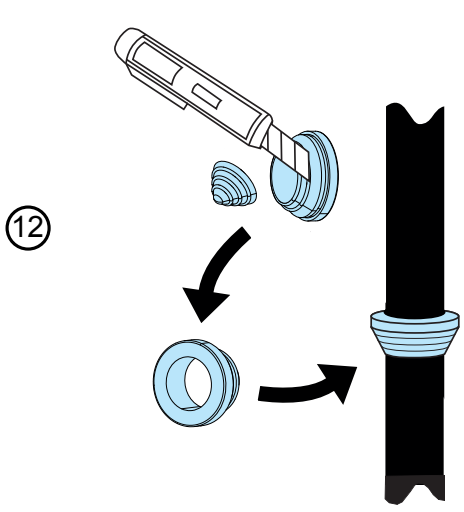
WARNING!
Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.

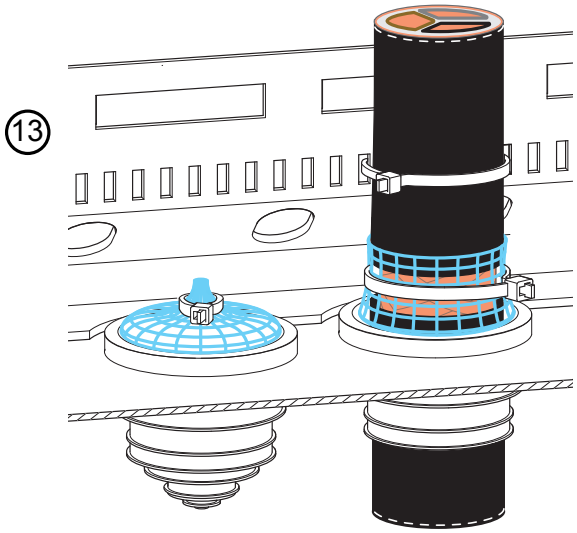
11. If fire insulation is used, make an opening in the mineral wool sheet according to the diameter of the cable.
12. Remove the rubber grommets from the cable entries for the cables to be connected. Cut adequate holes into the rubber grommets. Slide the grommets onto the cables. Slide the cables into the cubicle through the conductive sleeves and attach the grommets to the holes.
13. Attach the conductive sleeves to the cable shields with cable ties. Tie up the unused conductive sleeves with cable ties.
14. Seal the gap between the cable and mineral wool sheet (if used) with sealing compound (eg. CSD-F, ABB brand name DXXT-11, code 35080082).
15. Connect the twisted shields of the cables to the PE busbar of the cabinet.
16. Connect the phase conductors of the cables to the appropriate terminals. Tighten the screws to the torque given under *Tightening torques (page 163)*.
17. Refit the inner shroud.
18. With each fan, align the guide pins (b) at the rear of the fan cowling with the slots (c) in the module bottom guide, then reinstall the retaining screws (a).
19. Refit the lower front mounting plate. Reconnect the wiring to the components on the mounting plate.
20. Refit the outer shroud.
21. Make sure there are no tools, debris or any other foreign objects in the cubicle. Close the cubicle door.
22. At the motor, connect the cables according to instructions from the motor manufacturer. Pay special attention to the phase order. For minimum radio-frequency interference, ground the cable shield 360 degrees at the cable entry of the motor terminal box, or

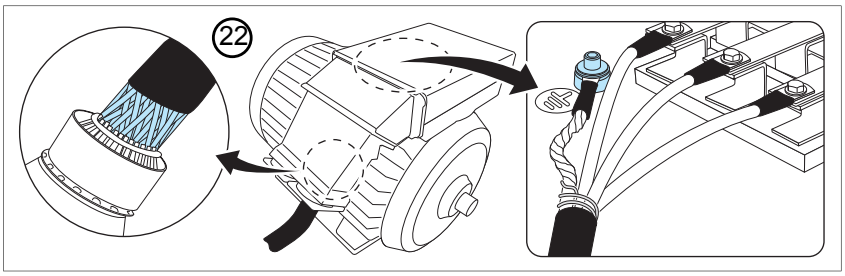
ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.











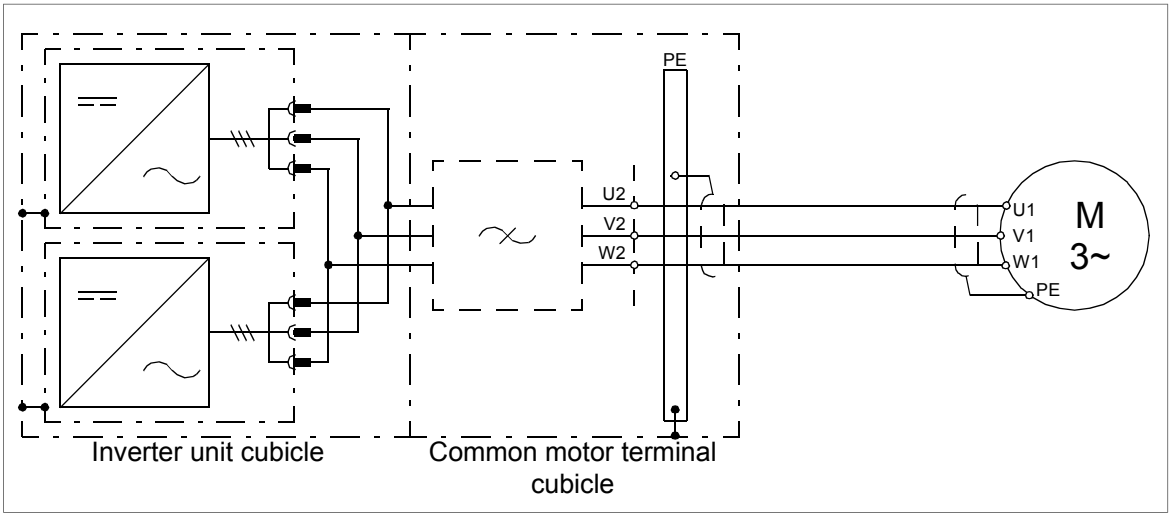
Connecting the motor cables (units with common motor terminal cubicle)

Output busbars

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

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

Connection diagram

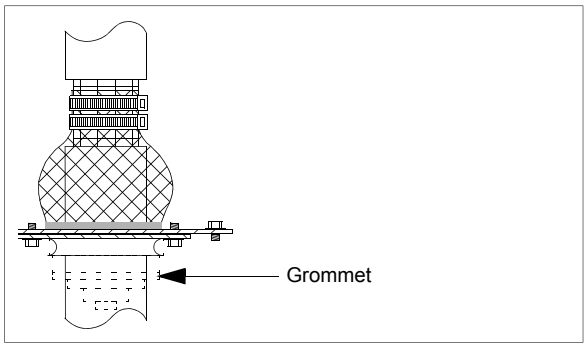


The recommended cable types are given in chapter Technical data.

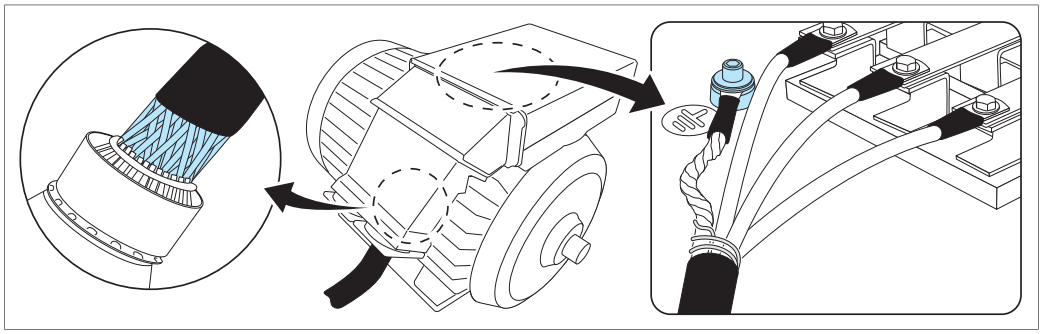
Procedure

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

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

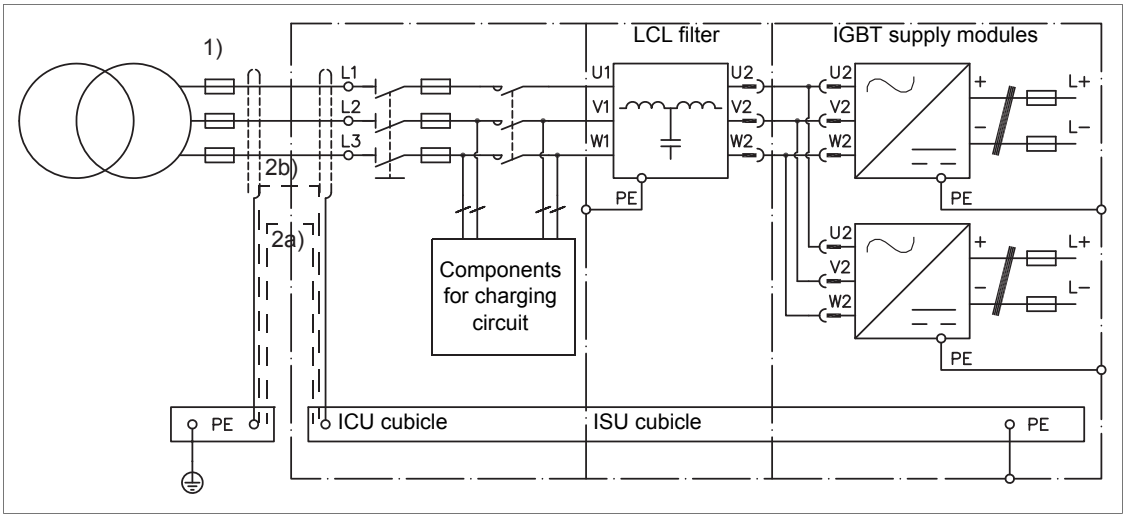


4. Cut the cables to suitable length. Strip the cables and conductors.
5. Twist the cable screens into bundles and connect the bundles to the PE busbar in the cubicle.
6. Connect any separate ground conductors/cables to the PE busbar in the cubicle.
7. Connect the phase conductors to the output terminals. Use the torques specified under *Tightening torques (page 163)*.
8. Refit any shrouding removed earlier and close the cubicle doors.
9. At the motor, connect the cables according to instructions from the motor manufacturer. Pay special attention to the phase order. For minimum radio-frequency interference, ground the cable shield 360 degrees at the lead-through of the motor terminal box, or ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.



Connecting the input power cables

Connection diagram



Notes:

1) Fuses or other protection means.

Use a separate grounding (PE) cable (2a) or a cable with separate PE conductor (2b) if the conductivity of the shield does not meet the requirement for the PE conductor. See section *Selecting the power cables (page 62)*.

Layout of the input cable connection terminals and cable entries

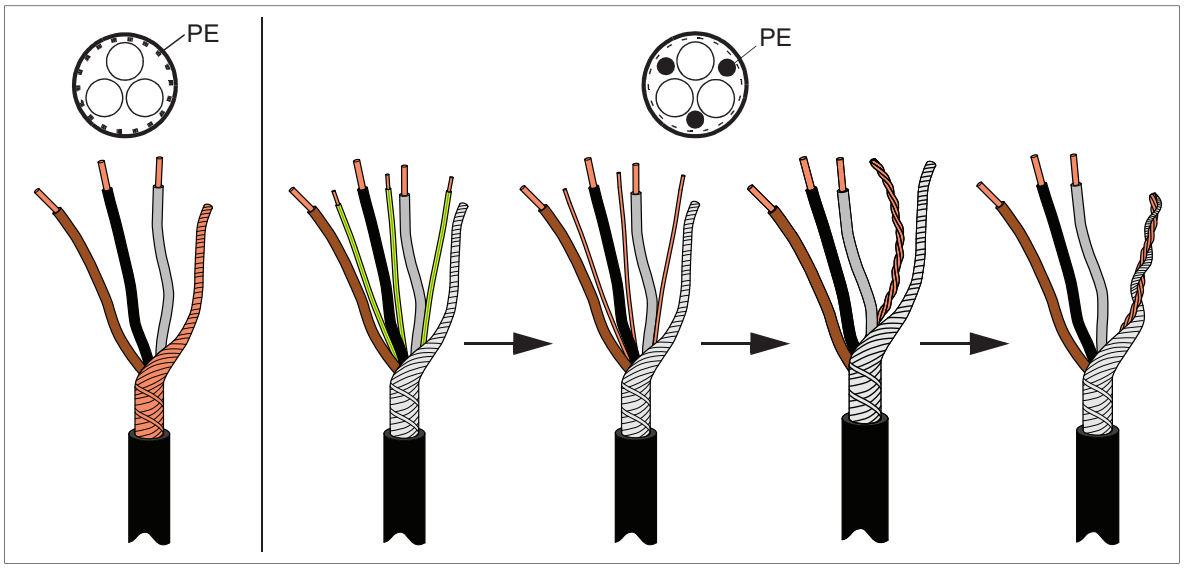
The location and dimensions of the busbars are visible in the dimensional drawings delivered with the drive. Alternatively, see the example dimension drawings in the manual.

Connection procedure

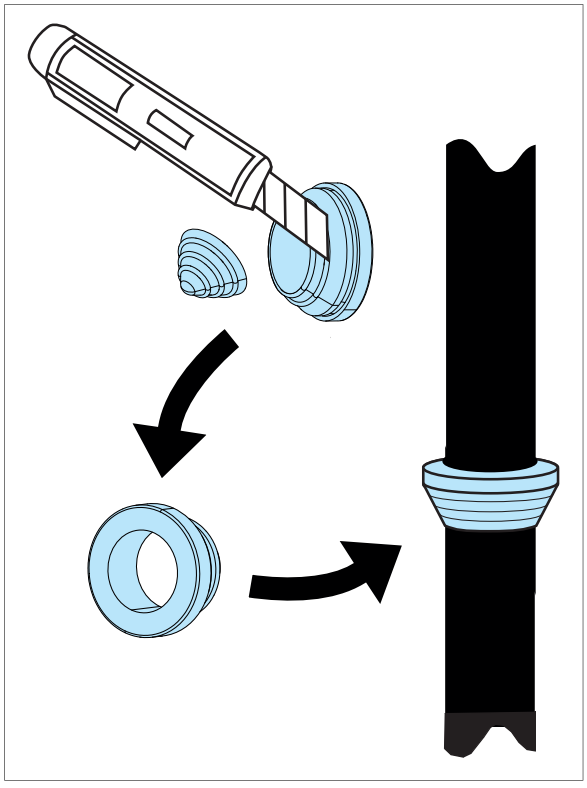
WARNING!
Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

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

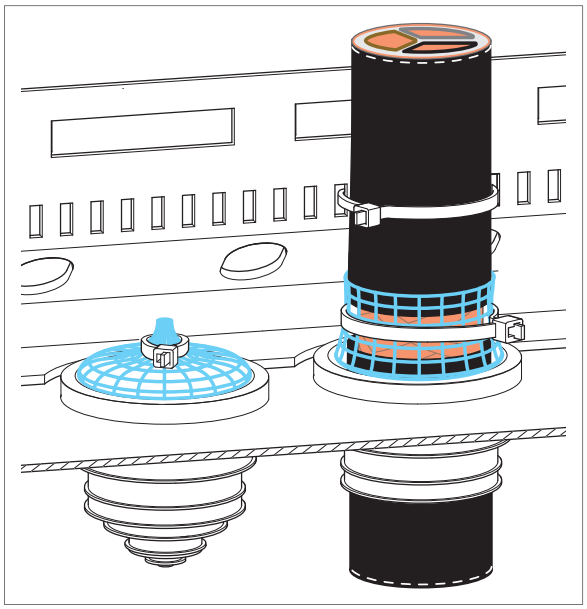
WARNING!
Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.



6. If fire insulation is used, make an opening in the mineral wool sheet according to the diameter of the cable.
7. Remove rubber grommets from the cable entries for the cables to be connected. Cut adequate holes into the rubber grommets. Slide the grommets onto the cables. Slide the cables into the cubicle through the conductive sleeves and attach the grommets to the holes.



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

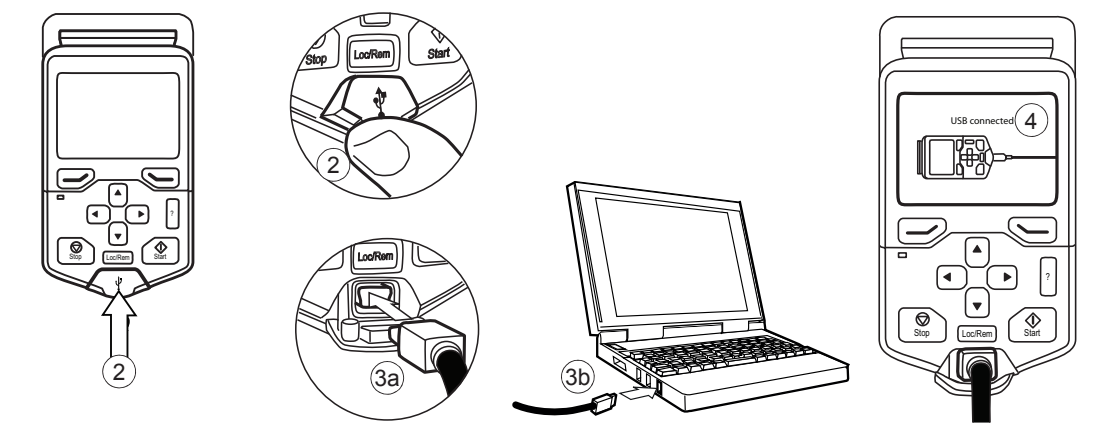


9. Seal the gap between the cable and mineral wool sheet (if used) with sealing compound (eg. CSD-F, ABB brand name DXXT-11, code 35080082).
10. Connect the twisted shields of the cables to the PE busbar of the cabinet.
11. Connect the phase conductors of the input cable to the L1, L2 and L3 terminals. Tighten the screws to the torque given under *Tightening torques (page 163)*.
12. Reinstall the shrouding removed earlier.
13. Close the cubicle door.

Connecting a PC

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

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



5. See the documentation of the PC tool for setup instructions.

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

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

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

1. Connect the panel to one drive using an Ethernet (for example Cat 5e) cable.
   - Use Menu - Settings - Edit texts - Drive to give a descriptive name to the drive
   - Use parameter *49.01** to assign the drive with a unique node ID number
   - Set other parameters in group 49* if necessary
   - Use parameter *49.06** to validate any changes.
     *The parameter group is 149 with supply (line-side), brake or DC/DC converter units.

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

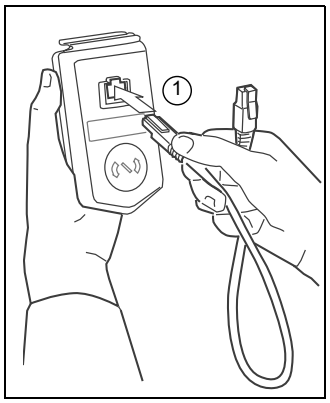
- With an FDPI-02 module, move termination switch S2 into the TERMINATED position.

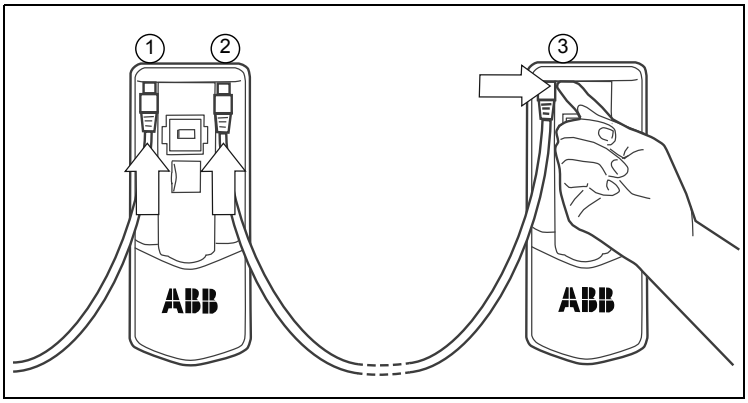
Make sure that bus termination is off on all other drives.

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

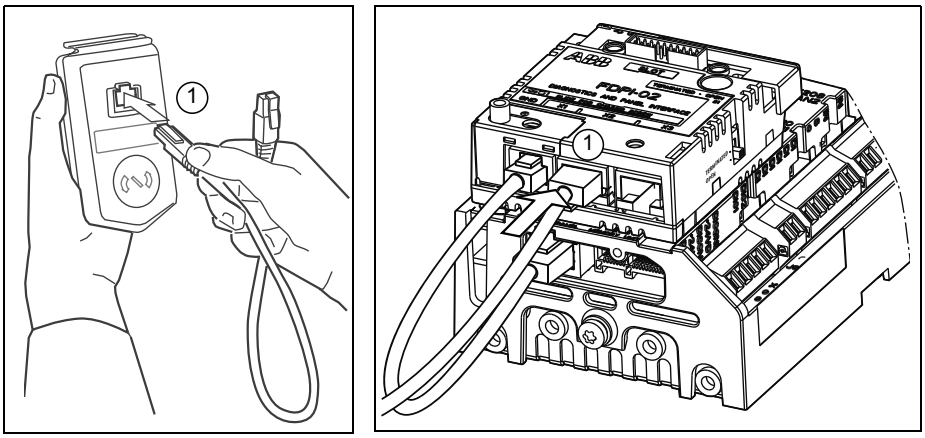
If a PC is connected to the control panel, the drives on the panel bus are automatically displayed in the Drive composer tool.

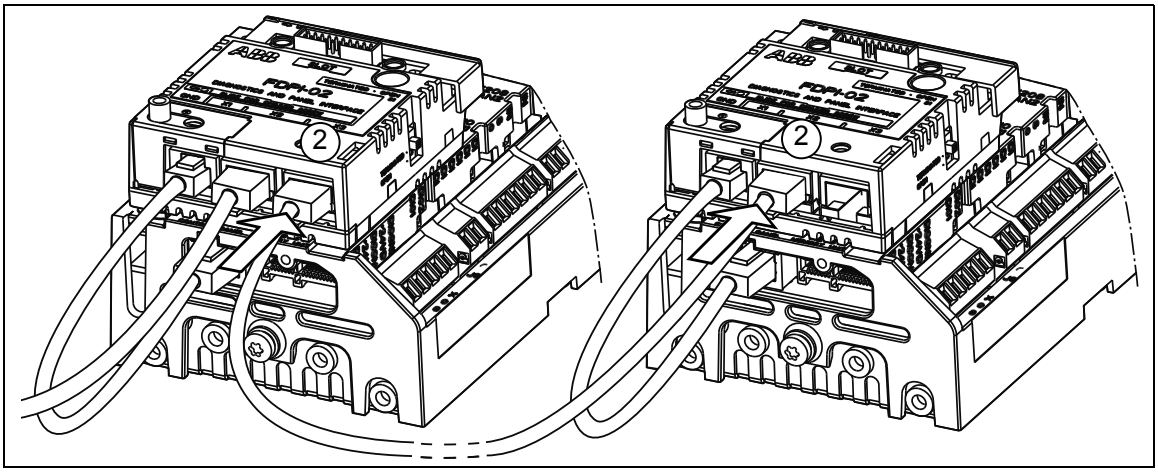
With twin connectors in the control panel holder:

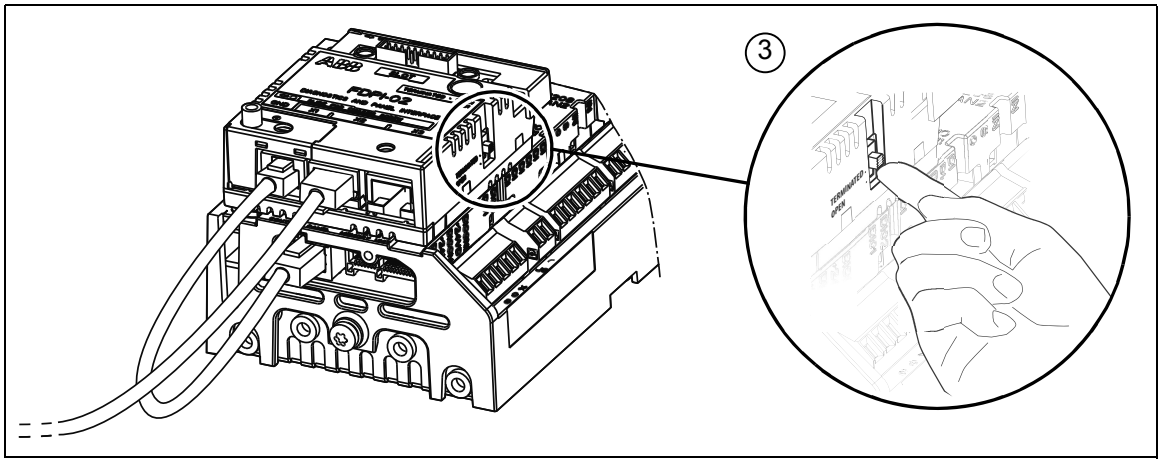




With FDPI-02 modules:







Installing option modules

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

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

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

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

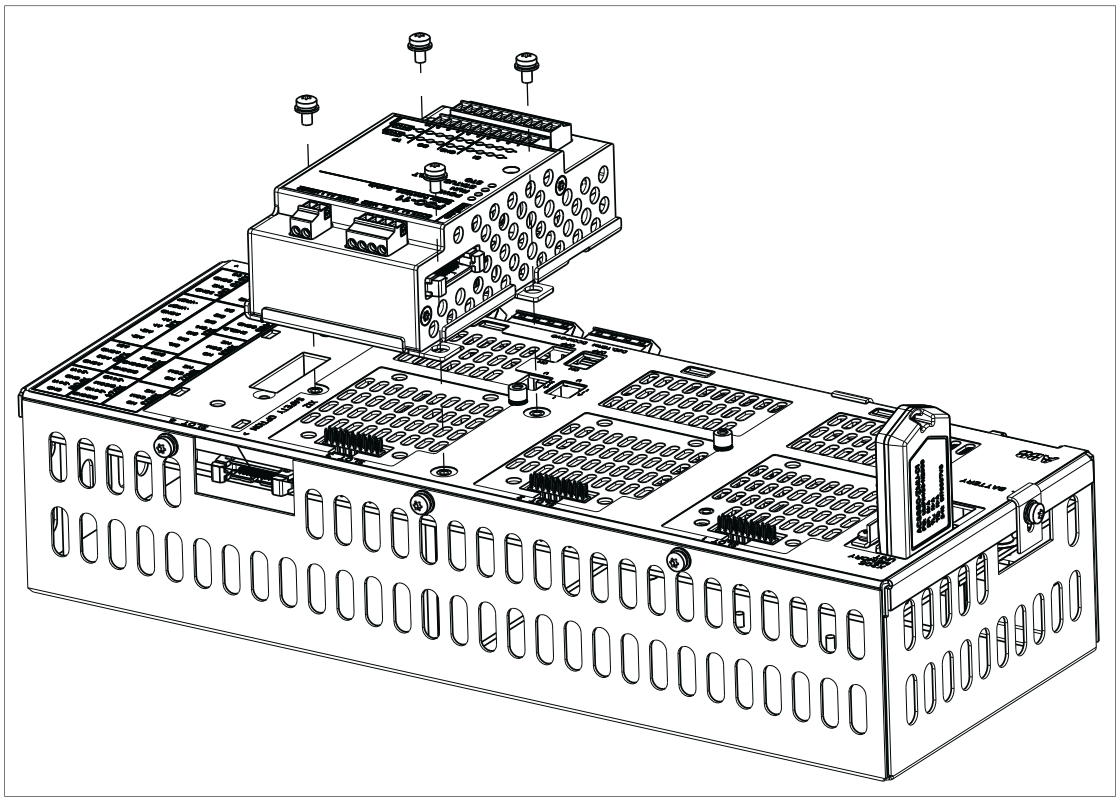
   Note:
   The screw secures and grounds the module. It is essential for fulfilling the EMC requirements and for proper operation of the module.

Installation of an FSO-xx safety functions module onto BCU

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

This procedure describes the installation of an FSO-xx safety functions module onto the BCU control unit. (The FSO-xx can alternatively be installed beside the control unit, which is the standard with factory-installed FSO-xx modules. For instructions, see the FSO-xx manual.)

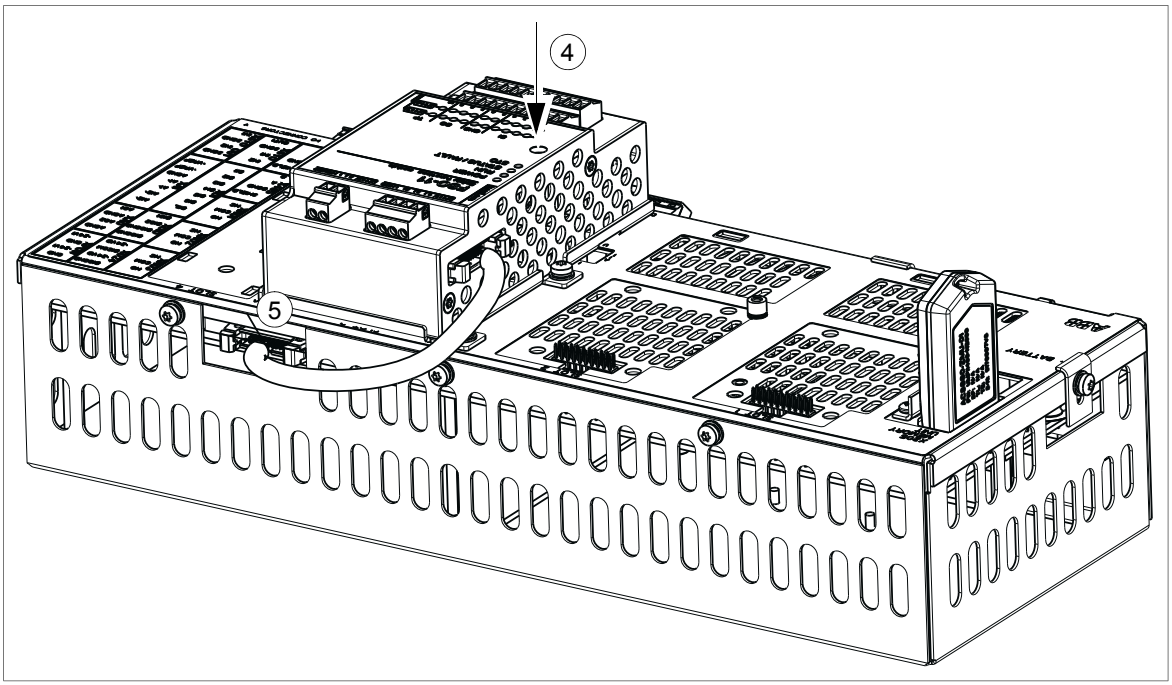
1. Stop the inverter unit and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. The FSO-xx comes with alternative bottom plates for mounting on different units. For mounting on the BCU, the mounting points should be located at the long edges of the module as shown. Replace the bottom plate of the FSO-xx if necessary.
3. Fasten the FSO-xx onto slot 3 of the BCU control unit [A41] with four screws.



4. Tighten the FSO-xx electronics grounding screw.

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

5. Connect the FSO-xx data cable between FSO-xx connector X110 and BCU-x2 connector X12.
6. To complete the installation, refer to the instructions in the User's manual delivered with the FSO-xx.



Wiring of optional modules

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

7

Control units 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).

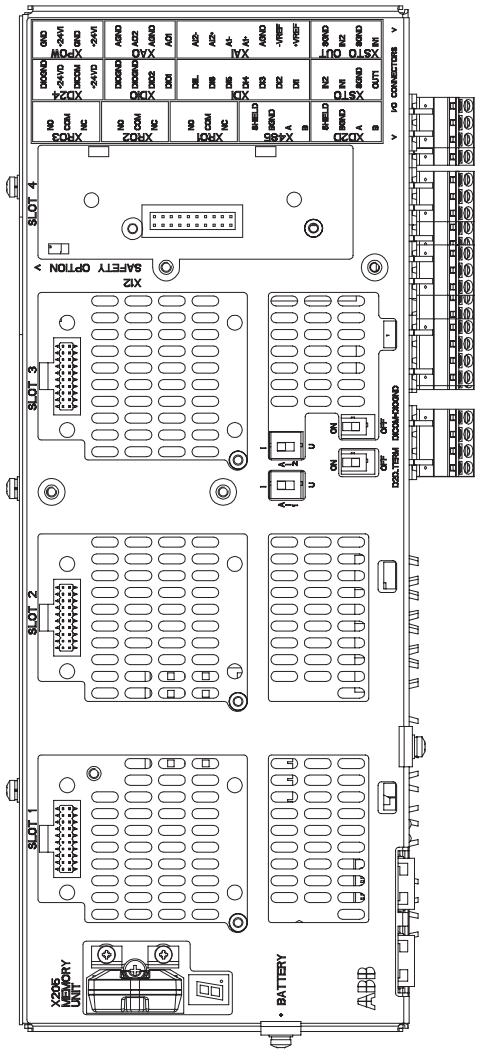
General

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

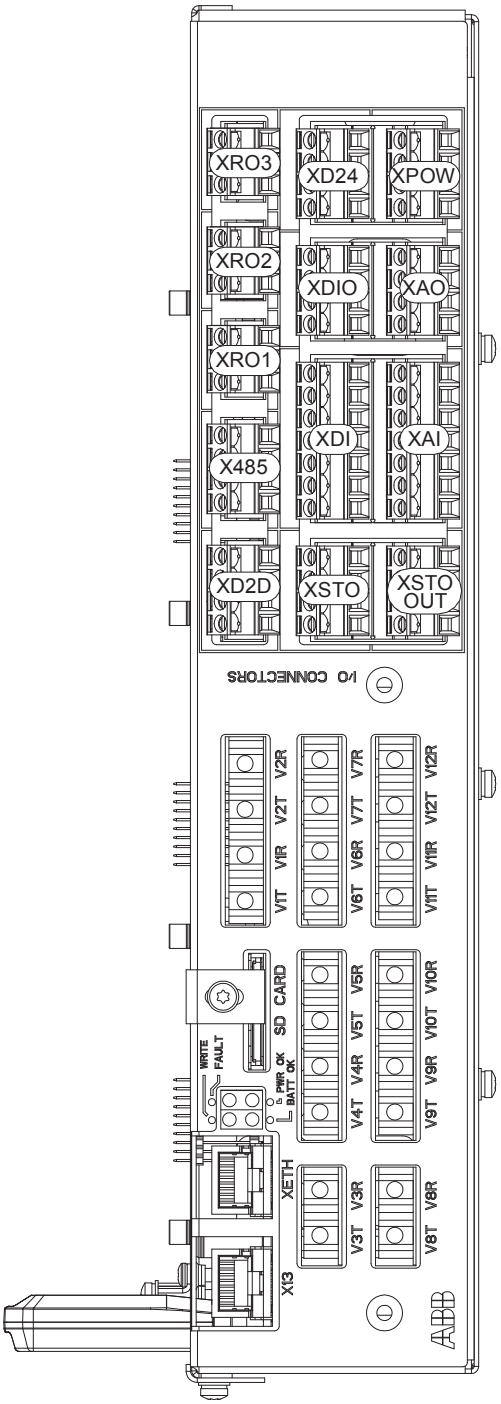
The supply and inverter units of the drive are each controlled by a dedicated BCU-x2 control unit. The designation of the supply control unit is A51; the inverter control unit is A41. Both are connected to the power modules (ie. supply and inverter modules respectively) by fiber optic cables.

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

BCU-x2 control unit layout and connections



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



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

Default I/O diagram of the supply control unit

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

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

XD2D		**Drive-to-drive link**
1	B	Drive-to-drive link (not in use by default)
2	A	
3	BGND	
4	Shield	
D2D.TERM		**Drive-to-drive link termination** [1]
X485		**RS485 connection**
5	B	Not in use (not in use by default)
6	A	
7	BGND	
8	Shield	
XRO1…XRO3		**Relay outputs**
11	NC	XRO1: **Charging** [2] (Energized = Closes charging contactor.) 250 V AC / 30 V DC / 2 A
12	COM	
13	NO	
21	NC	XRO2: **Fault(-1)** [3] (Energized = Indicates no fault.) 250 V AC / 30 V DC / 2 A
22	COM	
23	NO	
31	NC	XRO3: **MCB ctrl** [2] (Energized = Closes main contactor/breaker.) 250 V AC / 30 V DC / 2 A
32	COM	
33	NO	
XSTO		**XSTO connector**
1	OUT	XSTO connector. Both circuits (power module, control unit) must be closed for the supply unit to start. (IN1 and IN2 must be connected to OUT.) [4]
2	SGND	
3	IN1	
4	IN2	
5	IN1	Not in use
6	SGND	
7	IN2	
8	SGND	
XDI		**Digital inputs**
1	DI1	Temp fault [3] (0 = overtemperature)
2	DI2	Run / enable [3] (1 = run / enable)
3	DI3	MCB fb [2] (0 = main contactor/breaker open)
4	DI4	Not in use by default. Can be used for eg, auxiliary circuit breaker fault
5	DI5	Not in use by default. Can be used for eg, earth fault monitoring.
6	DI6	Reset [3] (0 -> 1 = fault reset)
7	DIIL	Not in use by default. Can be used for eg, emergency stop.
XDIO		**Digital input/outputs**
1	DIO1	Not in use by default
2	DIO2	Not in use by default
3	DIOGND	Digital input/output ground
4	DIOGND	Digital input/output ground
XD24		**Auxiliary voltage output**
5	+24VD	+24 V DC 200 mA [5]
6	DICOM	Digital input ground
7	+24VD	+24 V DC 200 mA [5]
8	DIOGND	Digital input/output ground
DICOM=DIOGND		**Ground selection switch** [6]
XAI		**Analog inputs, reference voltage output**
1	+VREF	10 V DC, R_L 1…10 kohm
2	-VREF	-10 V DC, R_L 1…10 kohm
3	AGND	Ground
4	AI1+	Not in use by default.
5	AI1-	0(2)…10 V, R_{in} > 200 kohm [7]
6	AI2+	Not in use by default.
7	AI2-	0(4)…20 mA, R_{in} = 100 ohm [8]
XAO		**Analog outputs**
1	AO1	**Zero** [3] 0…20 mA, R_L < 500 ohm
2	AGND	
3	AO2	**Zero** [3] 0…20 mA, R_L < 500 ohm
4	AGND	
XPOW		**External power input**
1	+24VI	24 V DC, 2.05 A
2	GND	
3	+24VI	
4	GND	
X12		**Safety functions module connection** (not in use in supply units)
X13		**Control panel connection**
X205		**Memory unit connection**

Notes:

[1] Must be set to ON when the supply unit is the first or last unit on the drive-to-drive (D2D) link. On intermediate units, set termination to OFF.

[2] Use of the signal in the control program. When parameter 120.30 External charge enable has value Yes (default setting), the control program reserves this I/O terminal for external charging circuit control and monitoring, and parameters 110.24 RO1 source and 110.30 RO3 source are write-protected. If the value is No, you can use the I/O terminal for other purposes.

[3] Use of the signal in the control program (fixed). See also the delivery-specific circuit diagrams.

[4] This input only acts as a true Safe torque off input in inverter control units. In other applications (such as a supply or brake unit), de-energizing the IN1 and/or IN2 terminal will stop the unit but not constitute a true safety function.

[5] Total load capacity of these outputs is 4.8 W (200 mA at 24 V) minus the power taken by DIO1 and DIO2.

[6] Determines whether DICOM is separated from DIOGND (ie, common reference for digital inputs floats).

DICOM=DIOGND ON: DICOM connected to DIOGND. OFF: DICOM and DIOGND separate.

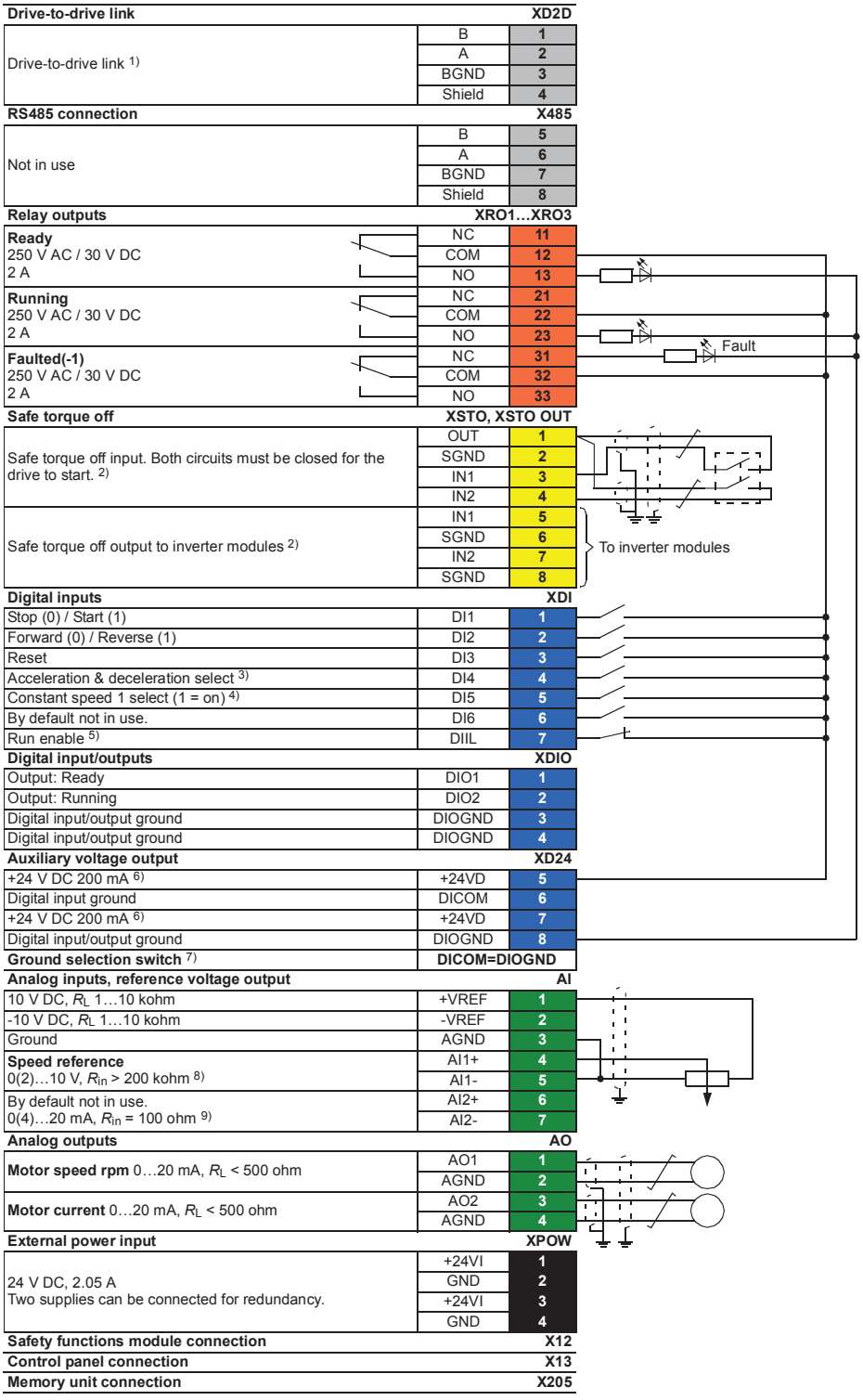
[7] Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by switch AI1. Change of setting requires reboot of control unit.

[8] Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by switch AI2. Change of setting requires reboot of control unit.

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

The diagram below shows the default I/O connections on the inverter control unit (A41), and describes the use of the connections in the inverter unit. Under normal circumstances, the factory-made wiring should not be changed.

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



Notes:

1) See section *The XD2D connector (page 106)*.

2) See chapter *The Safe torque off function (page 179)*.

3) 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.

[4] Constant speed 1 is defined by parameter 22.26.

[5] See section *DIIL input (page 106)*.

[6] Total load capacity of these outputs is 4.8 W (200 mA at 24 V) minus the power taken by DIO1 and DIO2.

[7] 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 *BCU-x2 ground isolation diagram (page 110)*.
DICOM=DIOGND ON: DICOM connected to DIOGND. OFF: DICOM and DIOGND separate.

[8] Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by switch AI1. Change of setting requires reboot of control unit.

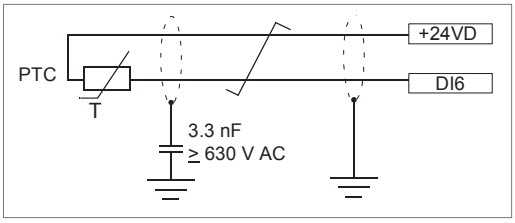
[9] Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by switch AI2. Change of setting requires reboot of control unit.

External power supply for the control unit (XPOW)

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

DI6 as a PTC sensor input

A PTC sensor can be connected to this input for motor temperature measurement as follows. The sensor can alternatively be connected to FEN-xx 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.

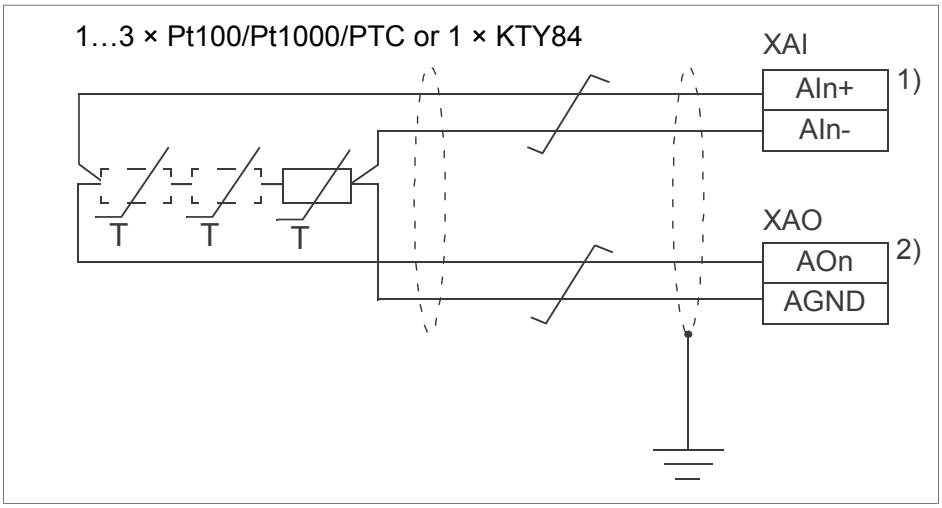


WARNING!
As the inputs pictured above are not insulated according to IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. If the assembly does not fulfill the requirement, the I/O board terminals must be protected against contact and must not be connected to other equipment or the temperature sensor must be isolated from the I/O terminals.

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

Three Pt100/Pt1000 sensors or one KTY84 sensor for motor temperature measurement can be connected between an analog input and output as shown below. (Alternatively, you can connect the KTY to an FIO-11 or FAIO-01 analog I/O extension module or FEN-xx 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) Set the input type to voltage with the appropriate switch or jumper on the inverter control unit. Make the corresponding setting in the inverter unit control program in parameter group **12 Standard AI**.

2) Select the excitation mode in parameter group **13 Standard AO** of inverter unit control program.

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

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 PI certified.

The XD2D connector

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

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

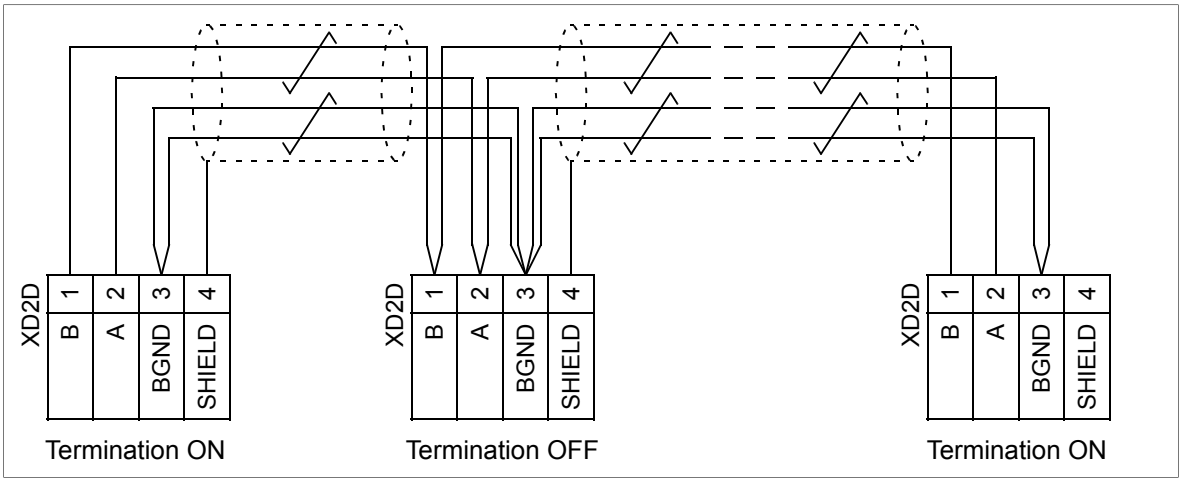
See the firmware manual of the drive for the related parameter settings.

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

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

The following diagram shows the wiring between control units.

BCU-x2



Safe torque off (XSTO, XSTO OUT)

See chapter *The Safe torque off function (page 179)*.

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.

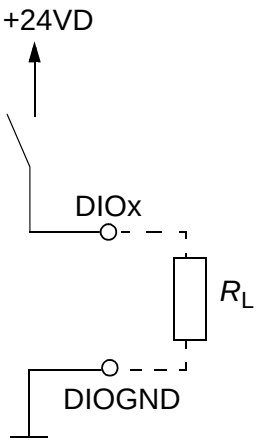
FSO-xx safety functions module connection (X12)

See the user manual of the FSO-xx module. Note that the FSO-xx safety functions module is not in use in supply (or DC/DC converter or brake) units.

SDHC memory card slot

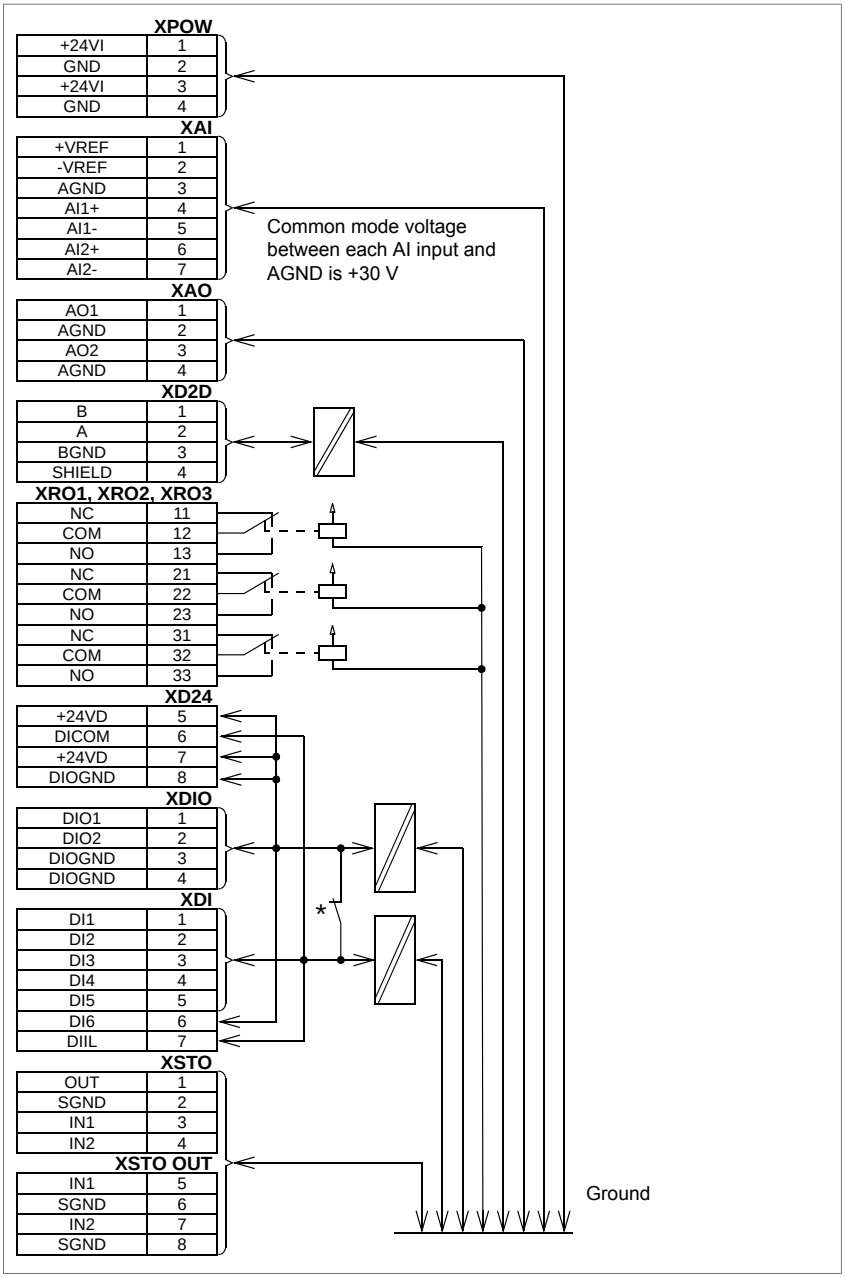
The BCU-x2 has an on-board data logger that collects real-time data from the power modules to help fault tracing and analysis. The data is stored onto the SDHC memory card inserted into the SD CARD slot and can be analyzed by ABB service personnel.

Connector data

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

Analog inputs AI1 and AI2 (XAI:4 … XAI:7). Current/voltage input mode selection by switches	Connector pitch 5 mm, wire size 2.5 mm^2 Current input: –20…20 mA, R_{in} = 100 ohm Voltage input: –10…10 V, R_{in} > 200 kohm Differential inputs, common mode range ±30 V Sampling interval per channel: 0.25 ms Hardware filtering: 0.25 ms, adjustable digital filtering up to 8 ms Resolution: 11 bit + sign bit Inaccuracy: 1% of full scale range
Analog outputs AO1 and AO2 (XAO)	Connector pitch 5 mm, wire size 2.5 mm^2 0…20 mA, R_{load} < 500 ohm Frequency range: 0…500 Hz Resolution: 11 bit + sign bit Inaccuracy: 2% of full scale range
XD2D connector	Connector pitch 5 mm, wire size 2.5 mm^2 Physical layer: RS-485 Termination by switch
RS-485 connection (X485)	Connector pitch 5 mm, wire size 2.5 mm^2 Physical layer: RS-485
Safe torque off connection (XSTO)	Connector pitch 5 mm, wire size 2.5 mm^2 Input voltage range: -3…30 V DC Logic levels: “0” < 5 V, “1” > 17 V. **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. Current consumption: 66 mA (continuous) per STO channel per R8i module EMC (immunity) according to IEC 61326-3-1 See also chapter *The Safe torque off function (page 179)*.
Safe torque off output (XSTO OUT)	Connector pitch 5 mm, wire size 2.5 mm^2 To STO connector of inverter module.
Control panel connection (X13)	Connector: RJ-45 Cable length < 3 m
Ethernet connection (XETH)	Connector: RJ-45 This connection is not supported by the firmware.
SDHC memory card slot (SD CARD)	Memory card type: SDHC Maximum memory size: 4 GB
The terminals of the control unit fulfill the Protective Extra Low Voltage (PELV) requirements. The PELV requirements of a relay output are not fulfilled if a voltage higher than 48 V is connected to the relay output.	

BCU-x2 ground isolation diagram



*Ground selector (DICOM=DIOGND) settings

DICOM=DIOGND: ON All digital inputs share a common ground (DICOM connected to DIOGND). This is the default setting.
DICOM=DIOGND: OFF Ground of digital inputs DI1…DI5 and DIIL (DICOM) is isolated from DIO signal ground (DIOGND). Isolation voltage 50 V.

8

Installation checklist of the drive

Contents of this chapter

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

Checklist

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

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

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

WARNING!
Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.

Make sure that …	☑
The ambient operating conditions meet the drive ambient conditions specification, and enclosure rating (IP code or UL enclosure type).	☐
The supply voltage matches the nominal input voltage of the drive. See the type designation label.	☐
The drive cabinet has been attached to floor, and if necessary due to vibration etc, also by its top to the wall or roof.	☐
If the drive is connected to a network other than a symetrically grounded TN-S system: Check the compatibility. See the electrical installation instructions.	☐
There is an adequately sized protective earth (ground) conductor between the drive and the switchboard, the conductor has been connected to appropriate terminal, and the terminal has been tightened to the proper torque. Proper grounding has also been measured according to the regulations.	☐

Make sure that …	☑
The input power cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened to the proper torque.	☐
There is an adequately sized protective earth (ground) conductor between the motor and the drive, and the conductor has been connected to appropriate terminal, and the terminal has been tightened to the proper torque. (Pull on the conductors to check.). Proper grounding has also been measured according to the regulations.	☐
The motor cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened to the proper torque.	☐
The motor cable has been routed away from other cables.	☐
No power factor compensation capacitors have been connected to the motor cable.	☐
The control cables have been connected to the appropriate terminals, and the terminals have been tightened to the proper torque.	☐
The voltage setting of the auxiliary voltage transformers (if any) is correct. See the electrical installation instructions.	☐
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, ie, cannot be closed simultaneously. 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.	☐
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 start.	☐
The coolant connections between cubicles (if any) and to the cooling circuit are tight.	☐
If the drive is equipped with a cooling unit: Refer to the cooling unit documentation for specific tasks.	☐

9

Start-up

Contents of this chapter

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

Start-up procedure

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

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

WARNING!
Only qualified electricians are allowed to do the work described in this chapter.

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

Action	☑
Safety	
WARNING! Obey the safety instructions during the start-up procedure. See chapter *Safety instructions (page 13)*.	☐
Checks/Settings with no voltage connected	
Ensure that the disconnector of the supply transformer is locked to the off (0) position, ie. no voltage is, and cannot be connected to the drive inadvertently.	☐

Action	☑
Check that the main switch-disconnector (Q1.1) is switched off, or main breaker (Q1) racked out.	☐
Check the mechanical and electrical installation of the drive. See *Installation checklist of the drive (page 111)*.	☐
Check the settings of breakers/switches in the auxiliary circuits. See the circuit diagrams delivered with the drive.	☐
Check the settings of the auxiliary voltage transformers (either internal or external).	☐
Disconnect any unfinished or uninspected auxiliary voltage (115/230 V AC) cables that lead from the terminal blocks to the outside of the equipment.	☐
Check that both channels of the Safe torque off circuit connected to the STO inputs of both the supply control unit [A51] and the inverter control unit [A41] are closed. Refer to the wiring diagrams delivered with the drive.	☐
If the Safe torque off functionality is used, check that the STO OUT output on the inverter control unit (A41) is chained to the STO inputs of all inverter modules. If the Safe torque off functionality is not used, check that the STO input on all inverter modules is correctly wired to +24 V and ground.	☐
Powering up the auxiliary circuit of the drive	
Make sure that it is safe to connect voltage. Ensure that • nobody is working on the drive or circuits that have been wired from outside into the drive cabinet • the cover of the motor terminal box is in place.	☐
Drives with a voltmeter (option +G334): Make sure that the circuit breaker of the measuring circuit (F5.1) is closed.	☐
Close the circuit breakers and/or fuse disconnectors supplying the auxiliary voltage circuits.	☐
Close the cabinet doors.	☐
Close the main breaker of the supply transformer.	☐
Switch on the auxiliary voltage [Q21]. Drives of frame size 1×R8i + 1×R8i: Close the main switch-disconnector [Q1.1]. This will power up the main circuit of the drive as well as the auxiliary voltage circuit.	☐
Setting up the supply unit parameters	
Check the voltage range setting in parameter *195.01 Supply voltage*. For more information on setting up the supply control program, see the *ACS880 IGBT supply control program firmware manual* (3AUA0000131562 [English]). If you need more information on the use of the control panel, see the *ACX-AP-x Assistant control panels user's manual* (3AUA0000085685 [English]).	☐
Setting up the inverter unit parameters, and performing the first start	
Set up the inverter control program. See the appropriate start-up guide and/or firmware manual. There is a separate start-up guide only for some control programs.	☐
Check that parameter *95.09 Switch fuse controller* is set to *Disabled*.	☐
Drives with an fieldbus adapter module (optional): Set the fieldbus parameters. Activate the appropriate assistant (if present) in the control program, or see the user's manual of the fieldbus adapter module, and the drive firmware manual. Check that the communication works between the drive and the PLC.	☐
Drives with an encoder interface module (optional): Set the encoder parameters. Activate the appropriate assistant (if present) in the control program, or see the user's manual of the encoder interface module, and the drive firmware manual.	☐
Powering up the main circuit of the drive	
Close the main switch-disconnector [Q1.1] or main breaker [Q1]. **Note:** Do not use excessive force. The main switch-disconnector (or main breaker) can only be closed when • the main input terminals [L1, L2, L3] are powered, and • auxiliary voltage is switched on [Q21], and	☐

Action	☑
Turn the operating switch (S21) to the ON (1) position to activate the run enable signal. Depending on control source settings, this may also close the main contactor (if present). If a main contactor is present and does not close, refer to the circuit diagrams delivered by the drive as well as the appropriate firmware manuals.	☐
On-load checks	
Start the motor to perform the ID run.	☐
Check that the cooling fans rotate freely in the right direction, and the air flows upwards.	☐
Check that the motor starts. stops and follows the speed reference in the correct direction when controlled with the control panel.	☐
Check that the motor starts. stops and follows the speed reference in the correct direction when controlled through the customer-specific I/O or fieldbus.	☐
Drives in which the Safe torque off control circuit is in use: Test and validate the operation of the Safe torque off function. See section *Start-up including acceptance test (page 187)*.	☐
Drives with an emergency stop circuit (options +Q951, +Q952, +Q963, +Q964, +Q978, +Q979): Test and validate the operation of the emergency-stop circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	☐
Drives with the Prevention of unexpected start-up with safety relay (option +Q957): Test and validate the operation of the Prevention of unexpected start-up circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	☐
Test and validate the operation of Prevention of unexpected start with FSO-xx (option +Q950): Test and validate the operation of the Prevention of unexpected start-up circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option.	☐

Switching off the drive

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

10

Fault tracing

Contents of this chapter

This chapter describes the fault tracing possibilities of the drive.

Control unit LEDs

This table shows the LEDs visible on the BCU-xx control unit.

LED	Color	Indication
BATT OK	Green	Battery voltage of the real-time clock is OK (higher than 2.8 V). When the LED is not lit, • battery voltage is below 2.8 V, • the battery is missing, or • the control unit is not powered.
PWR OK	Green	Internal voltage OK
FAULT	Red	The control program indicates that the equipment is faulty. See the appropriate firmware manual.
WRITE	Yellow	Writing to SD card in progress.

Control panel and panel platform/holder LEDs

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

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

Warning and fault messages

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

11

Maintenance

Contents of this chapter

This chapter contains maintenance instructions.

Maintenance intervals

The table below shows the maintenance tasks which can be done by the end user. The complete maintenance schedule is available on the Internet (www.abb.com/drivesservices). For more information, consult your local ABB Service representative (www.abb.com/searchchannels).

Maintenance task/object	Years from start-up													
	0	1	2	3	4	5	6	7	8	9	10	11	12	…
Coolant														
Checking coolant antifreeze concentration		P	P	P	P	P	P	P	P	P	P	P	P	P
Checking coolant quality			P		P		P		P		P		P	
Coolant draining and replacement							R						R	
ABB cooling unit (if present)	See *ACS880-1007LC liquid cooling unit user's manual* (3AXD50000129607 [English])													
Cooling fans														
Supply module cubicle fan (230 V)										R				
Supply module cubicle fan (115 V)							R						R	
Inverter module fan (230 V)										R				
Inverter module fan (115 V)							R						R	

Maintenance task/object	Years from start-up													
	0	1	2	3	4	5	6	7	8	9	10	11	12	…
Batteries														
Control panel battery										R				
Control unit battery							R						R	
Connections and environment														
Quality of supply voltage		P	P	P	P	P	P	P	P	P	P	P	P	P
Spare parts														
Spare parts		I	I	I	I	I	I	I	I	I	I	I	I	I
DC circuit capacitor reforming (spare inverter modules and spare capacitors)		P	P	P	P	P	P	P	P	P	P	P	P	P
Inspections														
Checking tightness of cable and busbar terminals. Tightening if needed.		I	I	I	I	I	I	I	I	I	I	I	I	I
Checking ambient conditions (dustiness, corrosion, temperature)		I	I	I	I	I	I	I	I	I	I	I	I	I
Checking coolant pipe connections		I	I	I	I	I	I	I	I	I	I	I	I	I
3AXD10000578918 F														

Symbols

I **Inspection** (visual inspection and maintenance action if needed)

P **Performance** of on/off-site work (commissioning, tests, measurements or other work)

R **Replacement**

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

Note:

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

Cabinet

Cleaning the interior of the cabinet

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

WARNING!
Use a vacuum cleaner with an antistatic hose and nozzle, and wear a grounding wristband. Otherwise an electrostatic charge might build up and damage the circuit boards.

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

Power connections and quick connectors

Retightening the power connections

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

1. Repeat the steps described in section *Electrical safety precautions (page 17)*.
2. Check the tightness of the cable connections. Use the tightening torques given in the technical data.

Fans

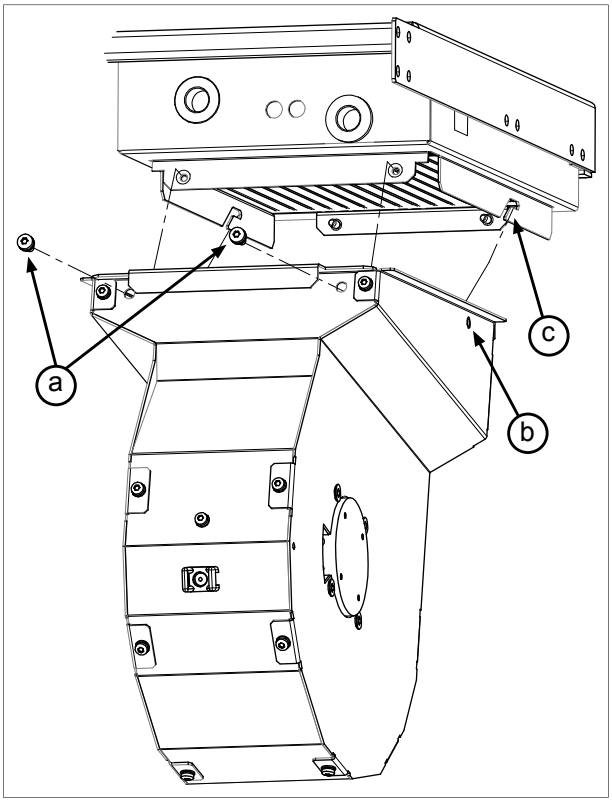
The lifespan of the cooling fans of the drive depends on the running time, ambient temperature and dust concentration. See the firmware manual for the actual signal which indicates the running time of the cooling fan. Reset the running time signal after fan replacement.

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

Frame R8i fan replacement

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

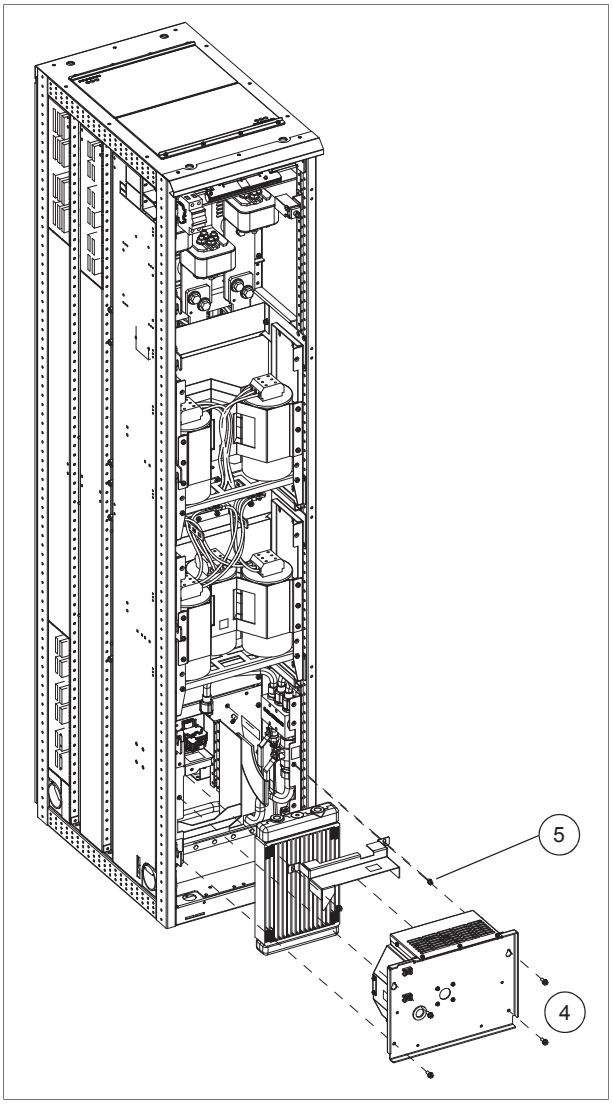
1. Repeat the steps described in section *Electrical safety precautions (page 17)*.
2. Remove any shrouding in front of the cooling fan.
3. Disconnect the fan wiring.
4. Undo the two retaining screws (a).
5. Pull the fan outwards to separate it from the heat exchanger housing.
6. Install new fan in reverse order. Align the guide pins (b) at the rear of the fan cowling with the slots (c) in the module bottom guide, then reinstall the retaining screws (a).



Replacing the heat exchanger fan in the filter cubicle

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

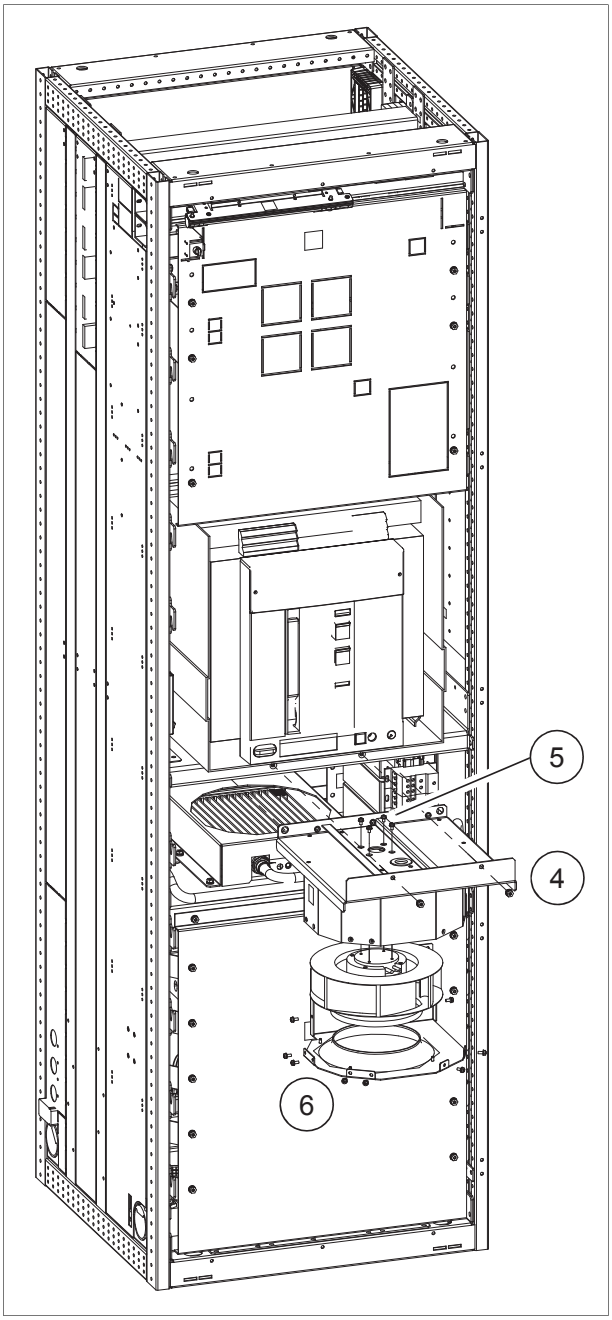
1. Repeat the steps described in section *Electrical safety precautions (page 17)* before you start the work.
2. Remove the shrouding in front of the fan (if any).
3. Disconnect the fan wiring.
4. Remove the four screws and pull the fan unit out.
5. Remove the two screws in front of the heat exchanger.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



Replacing the fan in the incoming cubicle

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

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

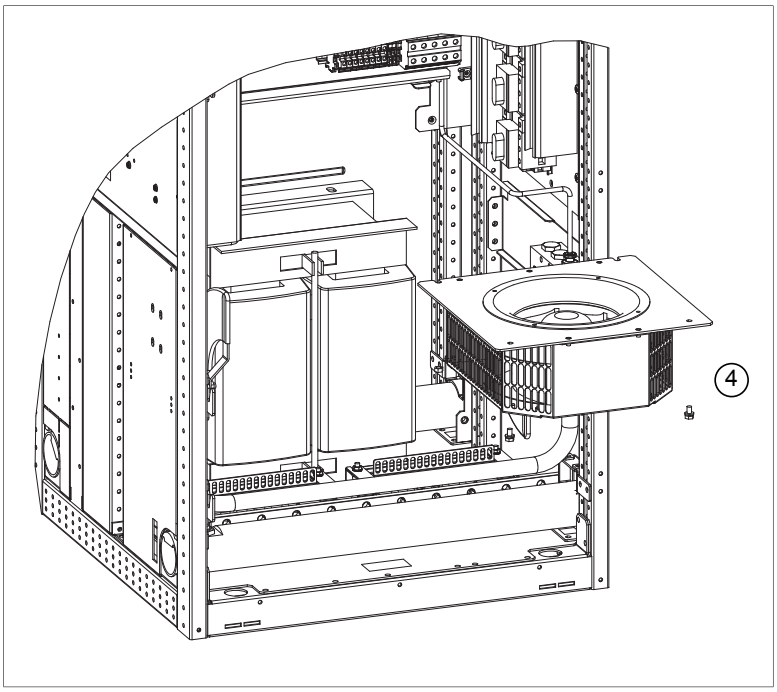


Replacing the fan in the auxiliary control cubicle

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

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

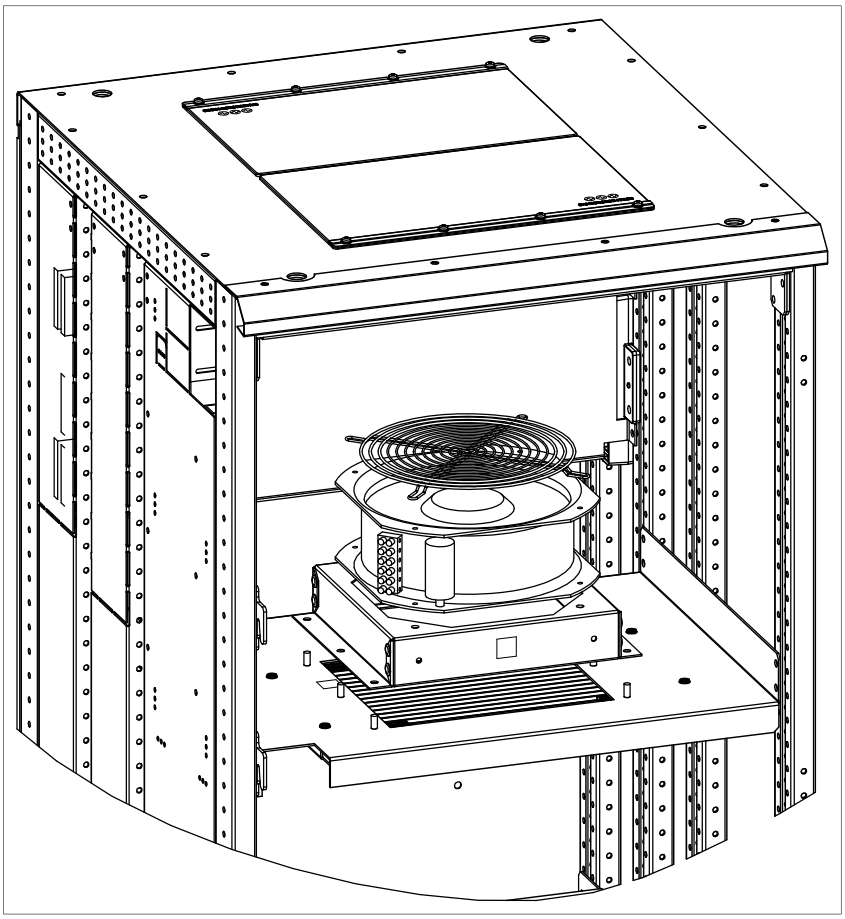
1. Repeat the steps described in section *Electrical safety precautions (page 17)* before you start the work.
2. Open the door of the auxiliary control cubicle.
3. Disconnect the fan wiring.
4. Remove the fastening screws of the fan collar and slide the fan with the collar out.
5. Detach the fan from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



Replacing the common motor terminal cubicle fan

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Remove any shrouding in front of the cooling fan.
3. Disconnect the fan wiring.
4. Undo the fastening screws.
5. Pull the fan housing up and out.
6. Install a new fan in reverse order to the above.



Supply and inverter modules

Replacing a supply or inverter module

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

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

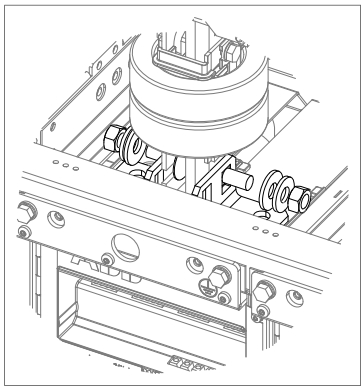
WARNING!
Make sure that the replacement module has exactly the same type code as the old module.

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

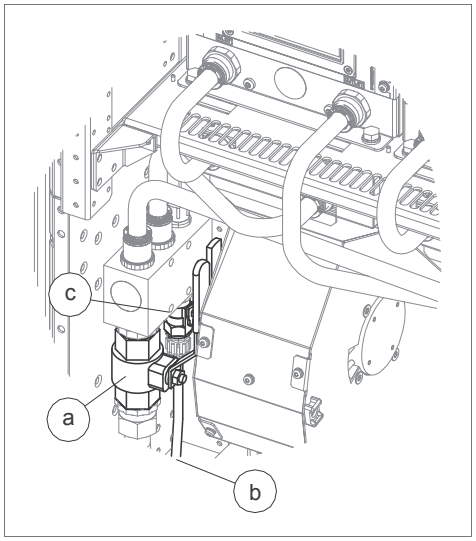
WARNING!
Use the required personal protective equipment. Wear protective gloves and long sleeves. Some parts have sharp edges.

Removing the module

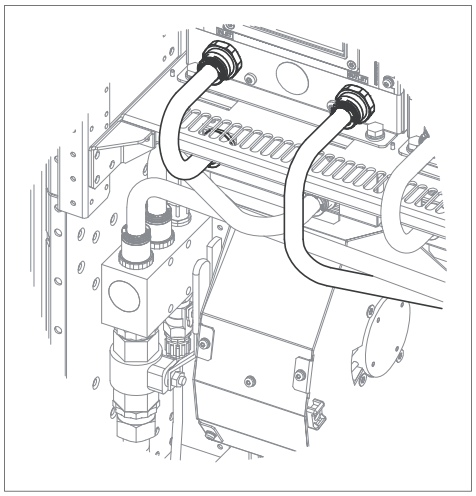
1. Repeat the steps described in section Electrical safety precautions.
2. Remove the shrouding in front of the module.
3. Undo the locking screws of the swing-out frame (if present) and open it.
4. Unplug the wiring from the module and move it aside. Use cable ties to keep the wiring out of the way.
5. Remove the L-shaped DC busbars at the top of the module. Make note of the orientation of the screws as well as the order of the washers.



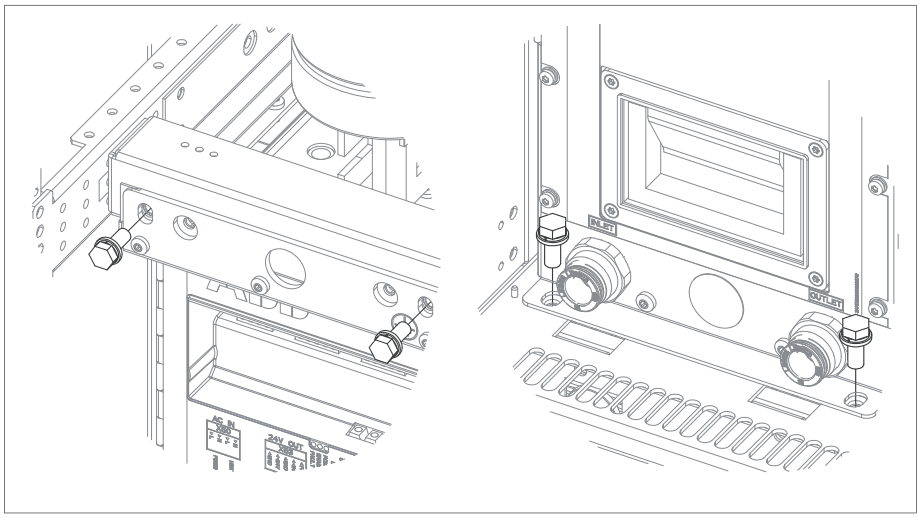
6. Close the inlet valve (a) and outlet valve (located on the right-hand side of the cubicle) valves. Lead the drain hoses (b, on both sides of the cubicle) into a suitable container. Open the drain valves (c, on both sides of the cubicle). This will drain all modules in the cubicle.



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



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



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

Reinstalling the module

1. Push the module carefully into its bay.
2. Fasten the retaining screws at the top and the bottom of the module.
3. Reinstall the DC busbars at the top of the module.
4. Reconnect the coolant pipes to the module.
5. Reconnect the control wiring to the module.
6. Fill up the cooling system. For instructions, see section *Filling up and bleeding the internal cooling circuit*.
7. Close the swing-out frame (if present). Reinstall all shrouds removed earlier.
8. If the module is an inverter module, and the Safe torque off function is in use, perform an acceptance test as described under *Start-up including acceptance test (page 187)*.

Cleaning the heatsink

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

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 electrician, do not do installation or maintenance work.

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Remove the drive module from the cabinet.
3. Remove the module cooling fan(s). See the separate instructions.
4. Blow dry, clean and oil-free compressed air from bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust.

   Note:

   If there is a risk of dust entering adjoining equipment, perform the cleaning in another room.

5. Reinstall the cooling fan.

Capacitors

The DC circuit of the power modules of the drive contain several electrolytic capacitors. Their lifespan depends on the operating time of the drive, loading and ambient temperature. Capacitor life can be prolonged by lowering the ambient temperature.

Capacitor failure is usually followed by damage to the unit and an input cable fuse failure, or a fault trip. Contact ABB if capacitor failure is suspected. Replacements are available from ABB. Do not use other than ABB specified spare parts. Contact an ABB service representative for spare parts and repair services.

Reforming the capacitors

The capacitors must be reformed if the drive has not been powered (either in storage or unused) for a year or more. The manufacturing date is on the type designation label. For information on reforming the capacitors, see *Converter module capacitor reforming instructions* (3BFE64059629 [English]) in the ABB Library (https://library.abb.com/en).

If the drive module has been stored for one to three years, turn on the mains power for 30 minutes without load, then continue as usual.

If the drive module has been stored for less than a year, continue as usual.

Fuses

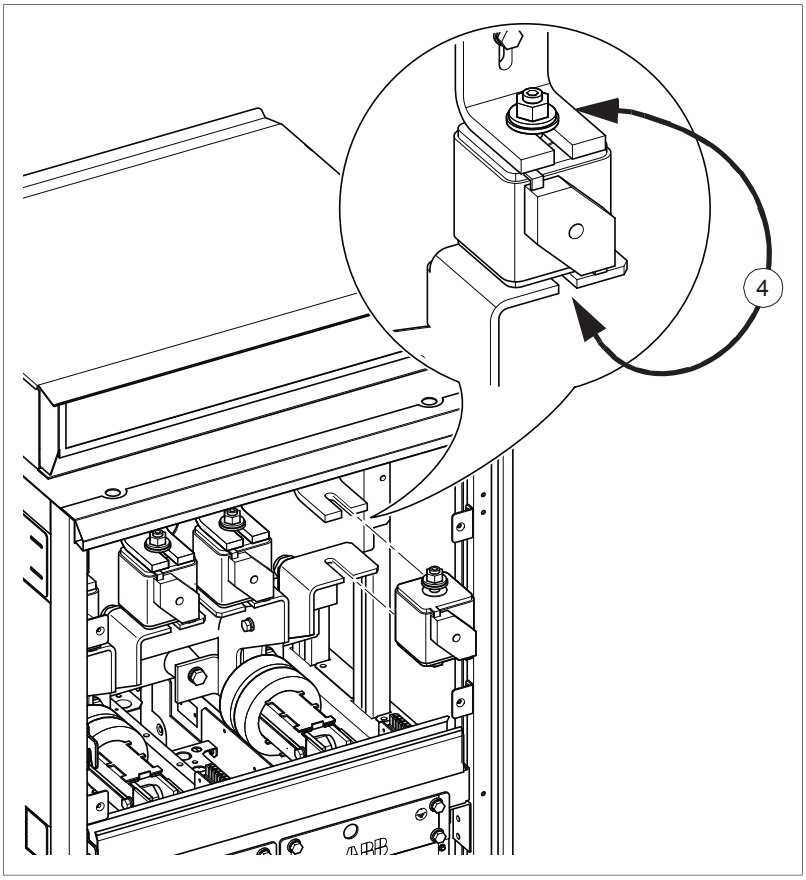
Replacing the AC and DC fuses in cabinet

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

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Open the door of the cubicle in which the fuses are.
3. Remove the shrouding from in front of the fuses.
4. Slacken the nuts of the headless screws of the fuses so that you can slide out the fuse blocks. Make note of the order of the washers on the screws.
5. Remove the screws, nuts and washers from the old fuses and attach them to the new fuses. Make sure to keep the washers in the original order.
6. Insert the new fuses into their slots in the cubicle. Pre-tighten the nuts first by hand or by applying a torque of no more than 5 N·m (3.7 lbf·ft).
7. Tighten the nuts to torque as follows:
   - Cooper-Bussmann fuses: 50 N·m (37 lbf·ft)
   - Mersen (Ferraz-Shawmut): 46 N·m (34 lbf·ft)
   - Other: Refer to the fuse manufacturer’s instructions.

8. Reinstall the shroud and close the door.



Control panel

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

Cleaning the control panel

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

Replacing the control panel battery

For instructions on how to replace the control panel battery, see the separate *ACx-AP-x assistant control panels user's manual* document (3AUA0000085685 [English]).

Control units

BCU control unit types

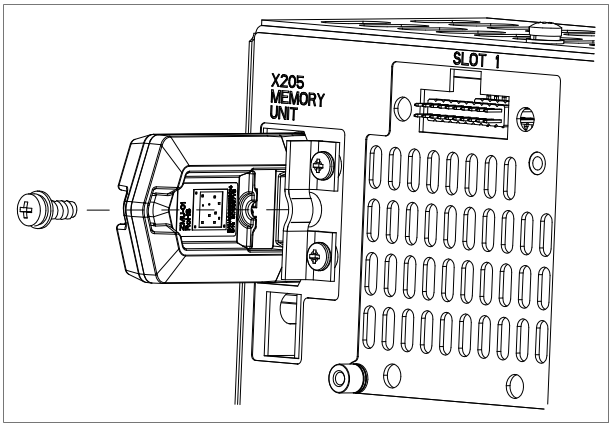
There are three variants of the BCU control unit used in ACS880 drives: BCU-02, BCU-12 and BCU-22. These have a different number of converter module connections (2, 7 and 12 respectively) but are otherwise identical. The three BCU types are interchangeable as long as the number of connections is sufficient.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

Replacing the memory unit

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

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

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

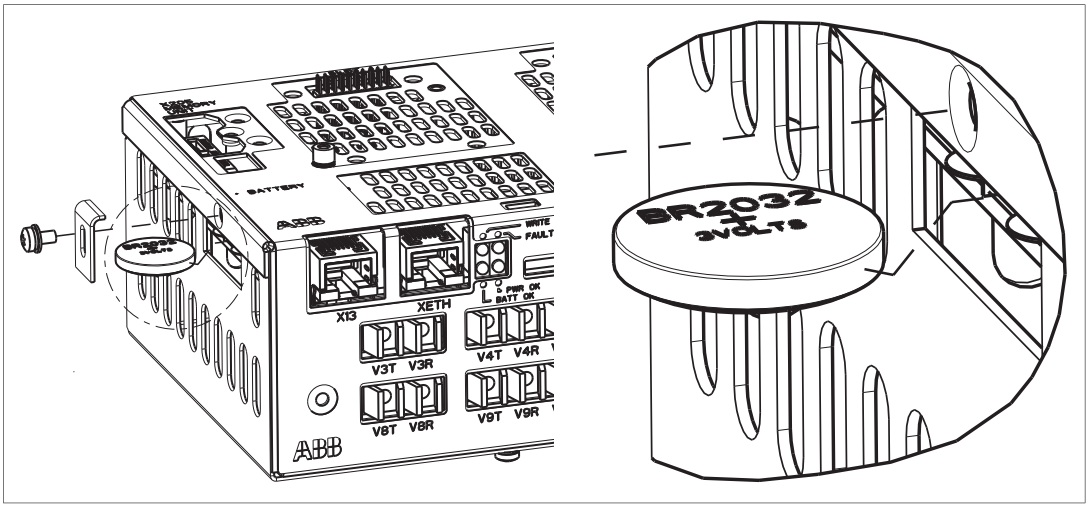


Replacing the BCU control unit battery

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 17)* before you start the work.
2. Undo the fastening screw and remove the battery
3. Replace the battery with a new BR2032 battery.
4. Dispose of the old battery according to local disposal rules or applicable laws.

5. Set the real-time clock.



12

Internal cooling circuit

Contents of this chapter

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

Applicability

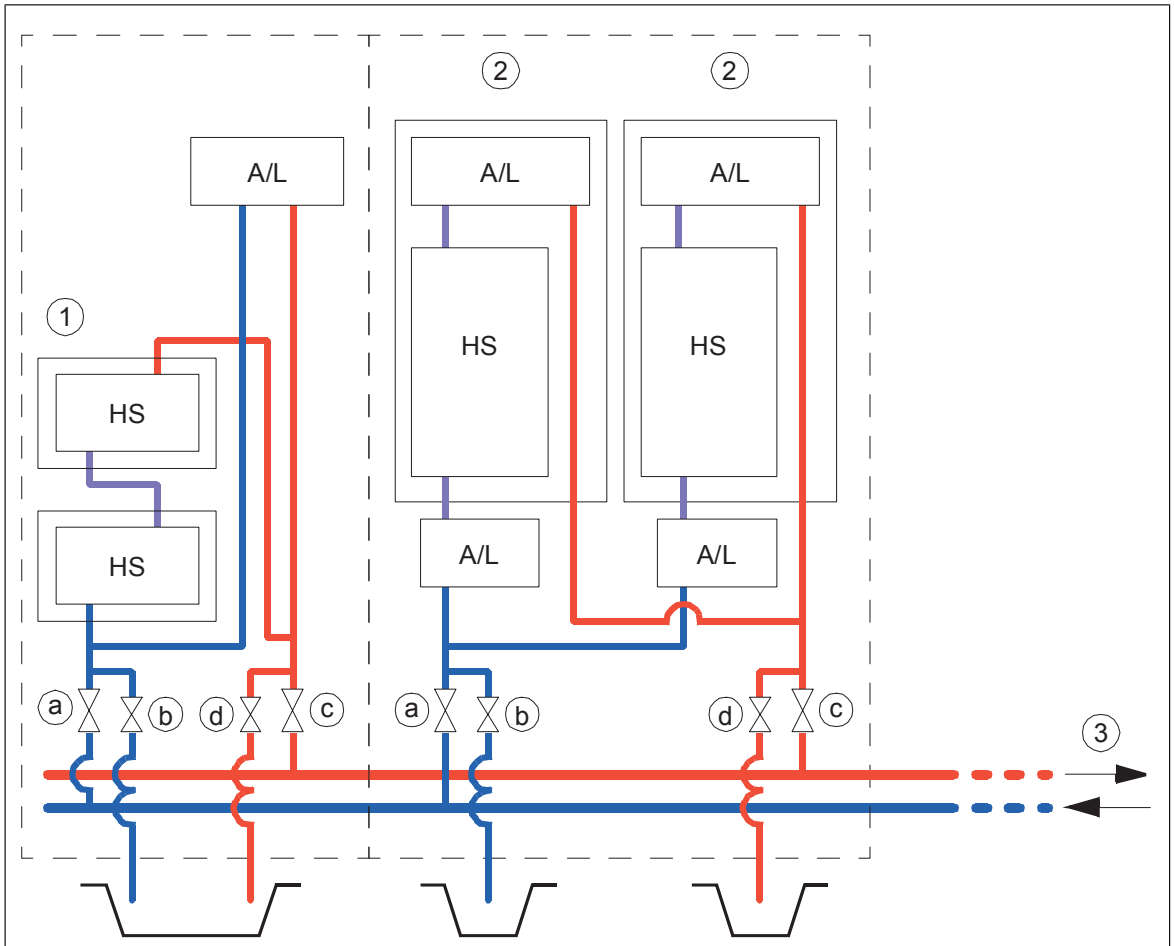
The information in this chapter is applicable to cabinet-built ACS880 liquid-cooled drives. Except where otherwise indicated, the information is also applicable to drives built out of ACS880 liquid-cooled multidrive modules.

Internal cooling system

Note: This section describes cabinet-built, liquid-cooled ACS880 drives. The information in this section can be used as guidelines for building a drive system out of ACS880 liquid-cooled modules.

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

The following diagram shows the coolant pipe connections in a drive system consisting of a supply unit and an inverter unit.



1	Supply modules
2	Inverter modules
3	To/From cooling unit
A/L	Air-to-liquid heat exchanger
HS	Heat sink
a	Inlet valve
b	Inlet-side drain valve
c	Outlet valve
d	Outlet-side drain valve

The coolant used with ACS880 liquid-cooled drive systems is Antifrogen® L 25% or 50% water mixture. See *Coolant specification (page 140)*.

Connection to a cooling unit

Connection to an ACS880-1007LC cooling unit

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

Connection to a custom cooling unit

General requirements

Equip the system with an expansion tank to damp pressure rise due to volume changes when the temperature varies. Equip the system with a pump that provides a nominal flow and pressure. Keep the pressure within the limits specified in *Technical data (page 140)*. Install a pressure regulator to make sure that the maximum permissible operating pressure is not exceeded.

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

The materials that can be used are listed in *Cooling circuit materials (page 142)*.

Coolant temperature control

The temperature of the coolant in the internal cooling circuit must be kept within the limits specified in *Technical data (page 140)*. Note that the minimum temperature is dependent on ambient temperature and relative humidity.

Filling up and bleeding the internal cooling circuit

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

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

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

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

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

Drive line-ups with a custom cooling unit

Note:

- In filling up the system, the drain valves in the line-up are used only to vent the air from the circuit so that it can be displaced by the coolant. The actual bleeding of the circuit must be done via an external bleed valve installed at the highest point of the cooling circuit. The most practical location for the valve is usually near or at the cooling unit.
- Observe the instructions given by the manufacturer of the cooling unit. Pay special attention to filling up and bleeding the pumps properly as they may be damaged if operated when dry.
- Draining coolant into the sewer system is not allowed.

1. Open the bleed valve at the cooling unit.
2. Open the inlet valve and the outlet-side drain valve of one cubicle. Keep the outlet valve and the inlet-side drain valve closed.
3. Attach a hose to the outlet-side drain valve and lead it into a suitable container.
4. Fill the circuit with coolant. For coolant specification, see *Coolant specification (page 140)*.

   Note: To minimize foaming, do not exceed the filling flow rate of 5 l/min (1.3 US gallon/min).

5. As the piping and modules in the cubicle fills up, coolant starts to flow from the hose. Let some coolant flow out, then close the drain valve.
6. Close the inlet valve.
7. Repeat steps 2 to 6 for all cubicles in the line-up.
8. Open the inlet and outlet valves in all cubicles. Let any air remaining in the system out through the bleed valve at the cooling unit.
9. Close the bleed valve at the cooling unit.
10. Continue to fill in coolant until a base pressure of 100…150 kPa is achieved.
11. Open the bleed valve of the pump to let out any air.
12. Re-check the pressure and add coolant if necessary.

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

Draining the internal cooling circuit

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

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

1. Attach hoses to each drain valve in the cubicle to be drained. Lead the hoses into a suitable container. Make sure the ends of the hoses are not immersed in coolant at any point so that air can displace the coolant in the system.
2. Open the drain valves. Wait until all coolant has drained.

   Note: Draining coolant into the sewer system is not allowed.

3. If required, dry the piping with compressed oil-free air of less than 6 bar.
4. If the drive is to be stored in temperatures below 0 °C (32 °F),
   - dry the cooling circuit with air,
   - fill the cooling circuit with coolant specified under *Coolant specification (page 140)*.
   - drain the cooling circuit again.

Maintenance intervals

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

Technical data

Coolant specification

Coolant type

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

Antifrogen® L 25% mixture is usable in storage temperatures down to -16 °C (3.2 °F).
Antifrogen® L 50% mixture is usable in storage temperatures down to -40 °C (-40 °F).

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

WARNING!
The warranty does not cover damage occurring from use of improper coolant.

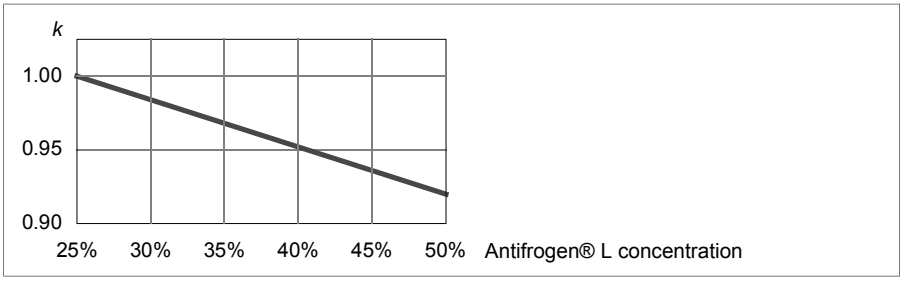
Temperature limits

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

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

The higher the concentration of heat transfer fluid, the higher the viscosity of the coolant. This results in a higher pressure loss in the system. See *Pressure limits (page 142)*.

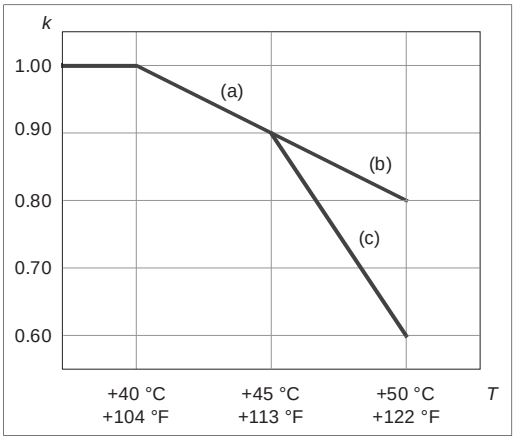
The nominal current ratings of drive system modules apply to an Antifrogen® L / water solution of 25/75% (volume). With the Antifrogen® L concentration between 25% and 50%, the drive output current must be derated by 1/3 percentage point per 1 p.p. increase in Antifrogen® L concentration. The drawing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



Incoming coolant temperature:

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

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



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

T_{air} (°C)	Min. $T_{coolant}$ (°C)				
	RH = 95%	**RH = 80%**	**RH = 65%**	**RH = 50%**	**RH = 40%**
5	4.3	1.9	-0.9	-4.5	-7.4

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

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

Pressure limits

Base pressure: 100 … 150 kPa (recommended); 200 kPa (maximum). “Base pressure” denotes the pressure of the system compared with the atmospheric pressure when the cooling circuit is filled with coolant.

Air counterpressure in the expansion tank: 40 kPa

Design pressure (PS): 600 kPa

Nominal pressure difference (between main in/out lines): 120 kPa with 25/75% (volume) coolant solution, 150 kPa with 50/50% (volume) coolant solution. This has to be taken into account when dimensioning the liquid cooling circuit.

Maximum pressure difference (between main in/out lines): 200 kPa

Coolant flow rate limits

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

Cooling circuit materials

Materials used in the internal cooling circuit are listed below. These are also the only materials that can be used in the external cooling circuit.

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

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

- rubber gasketing NBR (nitrile rubber).

WARNING!
If connecting external piping to the internal cooling circuit, use only materials that are specified above. Copper, brass or bronze must not be used under any circumstances. Even minor dissolution of copper can cause copper precipitation on aluminum and subsequent galvanic corrosion. The liquid cooling system must not contain any zinc (eg. galvanized pipes).

If the plant incorporates normal iron pipes or cast iron accessories (eg. motor housings), a cooling unit with a heat exchanger (such as the ACS880-1007LC) must be used to separate the systems.

13

Technical data

Contents of this chapter

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

Ratings

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

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

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

Definitions

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

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

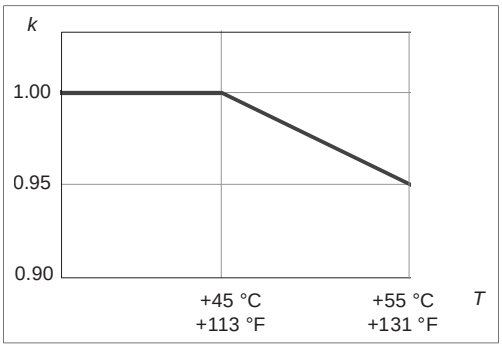
Note 2: To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current.

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

Derating

Ambient temperature derating

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



Coolant temperature derating

See section *Temperature limits (page 140)*.

Antifreeze content derating

See section *Temperature limits (page 140)*.

Altitude derating

At altitudes from 1000 to 4000 m (3281 to 13123 ft) above sea level, the output current derating is 1 percentage point for every added 100 m (328 ft). For example, the derating factor for 1500 m (4921 ft) is 0.95.

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

Switching frequency derating

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

Output frequency derating

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

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

Frame sizes and power module types

ACS880-17LC-…	Frame size	Supply module(s) used		LCL filter(s) used		Inverter modules used	
		Qty	Type ACS880-104LC-…	Qty	Type	Qty	Type ACS880-104LC-…
U_N = 690 V							
0390A-7	1×R8i + 1×R8i	1	0390A-7	1	BLCL-15LC-7	1	0390A-7+E205
0430A-7	1×R8i + 1×R8i	1	0430A-7	1	BLCL-15LC-7	1	0430A-7+E205
0480A-7	1×R8i + 1×R8i	1	0480A-7	1	BLCL-15LC-7	1	0480A-7+E205
0520A-7	1×R8i + 1×R8i	1	0530A-7	1	BLCL-15LC-7	1	0530A-7+E205
0600A-7	1×R8i + 1×R8i	1	0600A-7	1	BLCL-15LC-7	1	0600A-7+E205
0670A-7	1×R8i + 1×R8i	1	0670A-7	1	BLCL-15LC-7	1	0670A-7+E205
0750A-7	1×R8i + 1×R8i	1	0750A-7	1	BLCL-15LC-7	1	0750A-7+E205
0830A-7	1×R8i + 1×R8i	1	0850A-7	1	BLCL-15LC-7	1	0850A-7+E205
1000A-7	2×R8i + 2×R8i	2	0530A-7	1	BLCL-24LC-7	2	0530A-7+E205
1170A-7	2×R8i + 2×R8i	2	0600A-7	1	BLCL-24LC-7	2	0600A-7+E205

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

Fuses

AC fuses

Notes:

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

ACS880-17LC-…	AC fuses					
	Qty	A	A^2s at 660 V	V	Manufacturer	Type
U_N = 690 V						
0390A-7	3	630	210000	690	Bussmann	170M6410
0430A-7	3	700	300000	690	Bussmann	170M6411
0480A-7 0520A-7	3	800	465000	690	Bussmann	170M6412
0600A-7	3	900	670000	690	Bussmann	170M6413
0670A-7	3	1000	945000	690	Bussmann	170M6414
0750A-7	3	1250	1950000	690	Bussmann	170M6416
0830A-7	3	1400	2450000	690	Bussmann	170M6417
1000A-7	3	1600	2050000	690	Bussmann	170M7061
1170A-7 1270A-7	3	2000	3950000	690	Bussmann	170M7062
1470A-7 1620A-7	3	2500	7800000	690	Bussmann	170M7063
1940A-7	6	1600	2050000	690	Bussmann	170M7061
2180A-7 2390A-7	6	2000	3950000	690	Bussmann	170M7062

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

DC fuses

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

Notes:

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

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

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

Charging circuit fuses

Bussmann 170M4831 (3 pcs).

Dimensions and weights

See chapter *Dimensions (page 165)*.

Free space requirements

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

Front		Sides		Above	
mm	in.	mm	in.	mm	in.
150	5.90	0	0	250	9.85

Cooling data, noise

ACS880-17LC-…	Coolant volume		Coolant flow		Heat dissipation	Noise
	l	US gal	l/min	US gal/min	kW	dB(A)
U_N = 690 V						
0390A-7	12	3.2	68	18.0	15	59
0430A-7	12	3.2	68	18.0	17	59
0480A-7	12	3.2	68	18.0	19	59
0520A-7	12	3.2	68	18.0	21	59
0600A-7	12	3.2	68	18.0	24	59
0670A-7	12	3.2	68	18.0	27	59
0750A-7	12	3.2	68	18.0	31	59
0830A-7	12	3.2	68	18.0	35	59
1000A-7	19	5.0	120	31.7	38	61
1170A-7	19	5.0	120	31.7	44	61

ACS880-17LC-…	Coolant volume		Coolant flow		Heat dissipation	Noise
	l	US gal	l/min	US gal/min	kW	dB(A)
1270A-7	19	5.0	120	31.7	50	61
1470A-7	19	5.0	120	31.7	55	61
1620A-7	19	5.0	120	31.7	63	61
1940A-7	29	7.7	192	51	70	62
2180A-7	29	7.7	192	51	81	62
2390A-7	29	7.7	192	51	93	62
2880A-7	38	10.0	224	59	105	63
3160A-7	38	10.0	224	59	121	63
3580A-7	48	12.7	296	78	132	64
4050A-7	52	13.7	360	95	151	64
4700A-7	58	15	376	99	182	65
5650A-7	68	18	424	112	208	66
6260A-7	75	20	440	116	238	66

Typical power cable sizes

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

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

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

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

Terminal and lead-through data for the power cables

The locations and sizes of lead-throughs are shown by the dimension drawings delivered with the drive, and the dimension drawing examples in this manual.

Terminal data for the supply and inverter control units

See chapter *Control units of the drive (page 99)*.

Contact data for main contactor/breaker control

General

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

Emergency stop options add a relay (K640) to the drive. To trip the main breaker upon an emergency stop, one of the output switchover contacts of K640 must be wired to the undervoltage coil.

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

K3 contact data

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

K640 contact data

- Switching power: 3 VA or 3 W minimum, 2000 VA or 200 W maximum
- Switching capacity, AC (IEC/EN 60947-5-1 AC 15):

  - NC: 230 V, 1 A
  - NO: 230 V, 3 A
- Switching capacity, DC (IEC/EN 60947-5-1 DC 13):
  - NC / NO: 24 V, 2 A

Electrical power network specification

Voltage (U_1)	690 V units: 525…690 V AC 3-phase ± 10% (525…600 V AC ± 10% in UL/CSA installations, or corner-grounded TN systems). This is indicated in the type designation label as typical input voltage levels (3~ 525/600/690 V AC).
Network type	TN (grounded) and IT (ungrounded) systems
Frequency	50/60 Hz, variation ± 5% of nominal frequency
Imbalance	Max. ± 3% of nominal phase-to-phase input voltage
Short-circuit withstand strength (IEC/EN 61439-1)	Contact your local ABB representative.
Short-circuit current protection (UL 508A, CSA C22.2 No. 14-13)	The drive is suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes at 600 V maximum when the input cable is protected with class T fuses.
Fundamental power factor (cos phi$_1$)	0.99
Harmonic distortion	Harmonics are below the limits defined in IEEE519.

R_{sc}	THD Voltage [%]	THD Current [%]
20	3	2.5 1)
100	0.8	2.5 (4.0 with types -0390A…-0520A-7)1)
$THD = \sqrt{\sum_{2}^{50}\left(\frac{I_n}{I_N}\right)^2}$	I_n nth harmonic component I_N nominal current	

1) Other loads may influence the THD value.

THD = Total Harmonic Distortion (THD). The voltage THD depends on the short-circuit ratio (R_{sc}). The spectrum of the distortion also contains interharmonics.

$R_{sc} = I_{sc}/I_N$

I_{sc} = short-circuit current at point of common coupling (PCC)

I_N = IGBT supply unit nominal current

Motor connection data

Motor types	Asynchronous AC induction motors, permanent magnet synchronous motors and AC induction servomotors, ABB synchronous reluctance (SynRM) motors
Voltage (U_2)	0 to U_1, 3-phase symmetrical, U_{max} at the field weakening point
Frequency (f_2)	0…500 Hz • For higher operational output frequencies, please contact your local ABB representative. • Operation outside the range of 12…150 Hz requires derating. See section Derating.
Current	See the rating tables.
Switching frequency	3 kHz (typical). The switching frequency can vary per frame and voltage. For exact values, please contact your local ABB representative.

Maximum recommended motor cable length	500 m (1640 ft). **Note:** Longer cables cause a motor voltage decrease which limits the available motor power. The decrease depends on the motor cable length and characteristics. Contact ABB for more information. **Note:** With motor cables longer than 150 m (492 ft) the EMC Directive requirements may not be fulfilled.

Efficiency

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

Optical components

The specifications of the optic cable are as follows:

- Storage temperature: -55 … +85 °C
- Installation temperature: -20 … +70 °C
- Maximum short-term tensile force: 50 N
- Minimum short-term bend radius: 25 mm
- Minimum long-term bend radius: 35 mm
- Maximum long-term tensile load: 1 N
- Flexing: Max. 1000 cycles

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

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

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

The maximum lengths of fiber optic links for POF and HCS® cables are 20 and 200 meters respectively.

Protection classes

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

Ambient conditions

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

	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
Installation site altitude	0…2000 m (0…6562 ft) above sea level. For altitudes over 2000 m, contact ABB. Output derated above 1000 m (3281 ft).	-	-
Air temperature	0 … +45 °C (+32 … +113 °F), no condensation allowed. Output derated in the range +45 … +55 °C (+113 … +131 °F).	-40 to +70 °C (-40 to +158 °F)	-40 to +70 °C (-40 to +158 °F)
Relative humidity	Max. 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination	IEC/EN 60721-3-3:2002: Classification of environmental conditions - Part 3-3: Classification of groups of environmental parameters and their severities - Stationary use of weather protected locations Chemical gases: Class 3C2 Solid particles: Class 3S2. No conductive dust allowed.	IEC 60721-3-1:1997 Chemical gases: Class 1C2 Solid particles: Class 1S3 (packing must support this, otherwise 1S2)	IEC 60721-3-2:1997 Chemical gases: Class 2C2 Solid particles: Class 2S2
Vibration IEC/EN 61800-5-1 IEC 60068-2-6:2007, EN 60068-2-6:2008 Environmental testing Part 2: Tests –Test Fc: Vibration (sinusoidal)	IEC/EN 60721-3-3:2002 10…57 Hz: max. 0.075 mm amplitude 57…150 Hz: 1 *g* Units with marine construction (option +C121): Max. 1 mm (0.04 in) (5 … 13.2 Hz), max. 0.7 *g* (13.2 … 100 Hz) sinusoidal	IEC/EN 60721-3-1:1997 10…57 Hz: max. 0.075 mm amplitude 57…150 Hz: 1 *g*	IEC/EN 60721-3-2:1997 2…9 Hz: max. 3.5 mm amplitude 9…200 Hz: 10 m/s^2 (32.8 ft/s^2)
Shock IEC 60068-2-27:2008, EN 60068-2-27:2009 Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	Not allowed	With packing max. 100 m/s^2 (328 ft/s^2) 11 ms	With packing max. 100 m/s^2 (328 ft/s^2) 11 ms

Materials

Cabinet	• Zinc coated steel sheet • Polyester thermosetting powder coating on visible surfaces, color RAL 7035 and RAL 9017
Busbars for user power connections	Tin-plated copper
Liquid cooling system	See *Cooling circuit materials (page 142)*
Fire safety of materials (IEC 60332-1)	Insulating materials and non-metallic items: mostly self-extinctive
Package	Standard package: • timber, polyethylene sheet (thickness 0.15 mm), stretch film (thickness 0.023 mm), PP tape, PET strap, sheet metal (steel) • for land and air transport when planned storage time is less than 2 months or when storage can be arranged in clean and dry conditions less than 6 months • can be used when products will not be exposed to corrosive atmosphere during transport or storage Container package: • timber, VCI sheet film (PE, thickness 0.10 mm), VCI stretch film (PE, thickness 0.04 mm), VCI emitter bags, PP tape, PET strap, sheet metal (steel) • for sea transport in containers • recommended for land and air transport when storage time prior to installation exceeds 6 months or storage is arranged in partially weather-protected conditions Seaworthy package: • timber, plywood, VCI sheet film (PE, thickness 0.10 mm), VCI stretch film (PE, thickness 0.04 mm), VCI emitter bags, PP tape, PET strap, sheet metal (steel) • for sea transport with or without containerization • for long storage periods in environments where roofed and humidity-controlled storage cannot be arranged Cabinets are fastened to the pallet with screws and braced from the top end to the package walls to prevent swaying inside the package. Package elements are attached to each other with screws.
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

Standard	**Information**
European electrical safety requirements product standards	
IEC/EN 61800-5-1:2007	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy
IEC 60146-1-1:2009 EN 60146-1-1:2010	Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specification of basic requirements
IEC/EN 60664-1:2007	Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests
IEC 60529:1989 EN 60529:1991	Degrees of protection provided by enclosures (IP code).

Standard	Information
IEC 60204-1:2005 + A1:2008 EN 60204-1:2006 + AC:2010	Safety of machinery. Electrical equipment of machines. Part 1: General requirements.
IEC/EN 61439-1:2009	Low-voltage switchgear and controlgear assemblies -- Part 1: General rules
EMC performance	
IEC/EN 61800-3:2004	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
Product requirements in North America	
UL 508A 1st edition:2001	Industrial Control Panels
UL 50 12th edition:2007	Enclosures for Electrical Equipment, Non-Environmental Considerations
CSA C22.2 No. 14-13:2013	Industrial control equipment
CSA C22.2 No. 274-13:2013	Adjustable speed drives

CE marking

A CE marking is attached to the product to signify that it conforms to the applicable European Union legislation.

Compliance with the European Low Voltage Directive

The compliance with the European Low Voltage Directive has been verified according to appropriate European harmonized standards.

Compliance with the European EMC Directive

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard (EN 61800-3:2004) covers requirements stated for drives. See also the separate section about the Compliance with EN 61800-3.

Compliance with the European RoHS Directive

The RoHS Directive defines the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Compliance with the European WEEE Directive

The WEEE Directive defines the regulated disposal and recycling of electric and electrical equipment.

Compliance with the European Machinery Directive

The drive includes the Safe torque off function and can be equipped with other safety functions for machinery which, as safety components, are in the scope of the Machinery Directive. These functions of the drive comply with European harmonized standards such as EN 61800-5-2.

Declaration of Conformity (According to Machinery Directive)

The Declaration of Conformity is delivered with the drive.

Compliance with EN 61800-3:2004

Definitions

EMC stands for **E**lectro**m**agnetic **C**ompatibility. 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 C2: drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment.

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

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

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

Category C3

The drive complies with the standard with the following provisions:

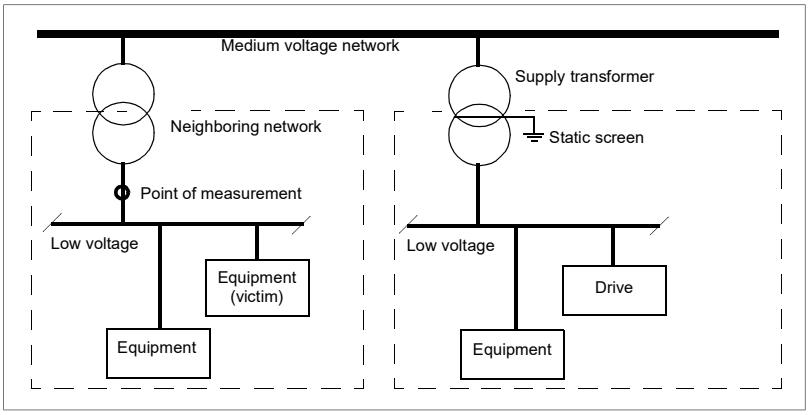
1. The drive is equipped with EMC filter (+E210) and common mode filter (+E208).
2. The motor and control cables are selected as specified in the hardware manual.
3. The drive is installed according to the instructions given in the hardware manual.
4. Maximum motor cable length is 100 meters.
5. The value of parameter 97.01 Switching frequency reference must be set to 2 kHz or lower.
6. 

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

Category C4

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

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



2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available from the local ABB representative.
3. The motor and control cables are selected as specified in the hardware manual.
4. The drive is installed according to the instructions given in the hardware manual.

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

Compliance with EN 61800-3:2004

Definitions

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

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

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

Drive of category C2: drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment. **Note:** A professional is a person or organization having necessary skills in installing and/or starting up power drive systems, including their EMC aspects.

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

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

Category C3

The drive complies with the standard with the following provisions:

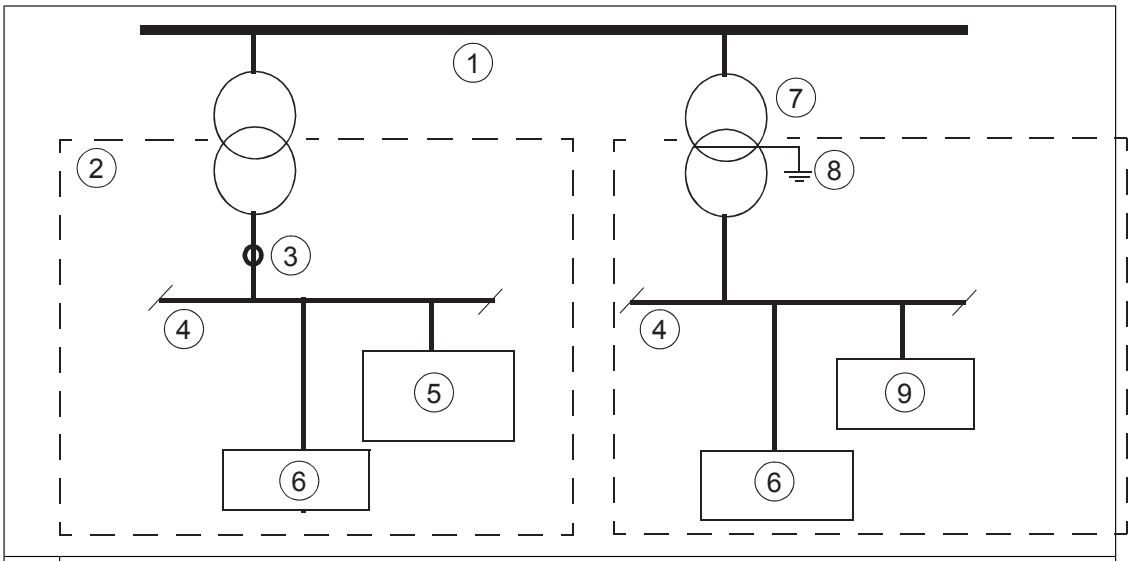
1. The drive is installed according to the instructions given in the appropriate drive hardware manual.
2. Maximum motor cable length is 100 meters (328 ft).

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

Category C4

If the provisions under Category 3 cannot be met, the requirements of the standard can be met as follows:

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



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

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available from the local ABB representative.
3. The input power cables, motor cables and control cables are selected as specified in the appropriate drive manual(s).
4. The drive is installed according to the instructions given in the appropriate drive manual(s).

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.

RCM marking

	RCM mark Product complies with Australian and New Zealand requirements specific to EMC, telecommunications and electrical safety. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).

EAC (Eurasian Conformity) marking

EAC	EAC (Eurasian Conformity) mark Product complies with the technical regulations of the Eurasian Customs Union. EAC mark is required in Russia, Belarus and Kazakhstan.

Tightening torques

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

Electrical connections

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

Mechanical connections

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

Insulation supports

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

Size	Max. torque	Note
M12	31 N·m (23 lbf·ft)	Strength class 8.8

Cable lugs

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

Disclaimers

Generic disclaimer

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

Cybersecurity disclaimer

This product is designed to be connected to and to communicate information and data via a network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

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Dimensions

Cabinet line-up dimensions

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

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

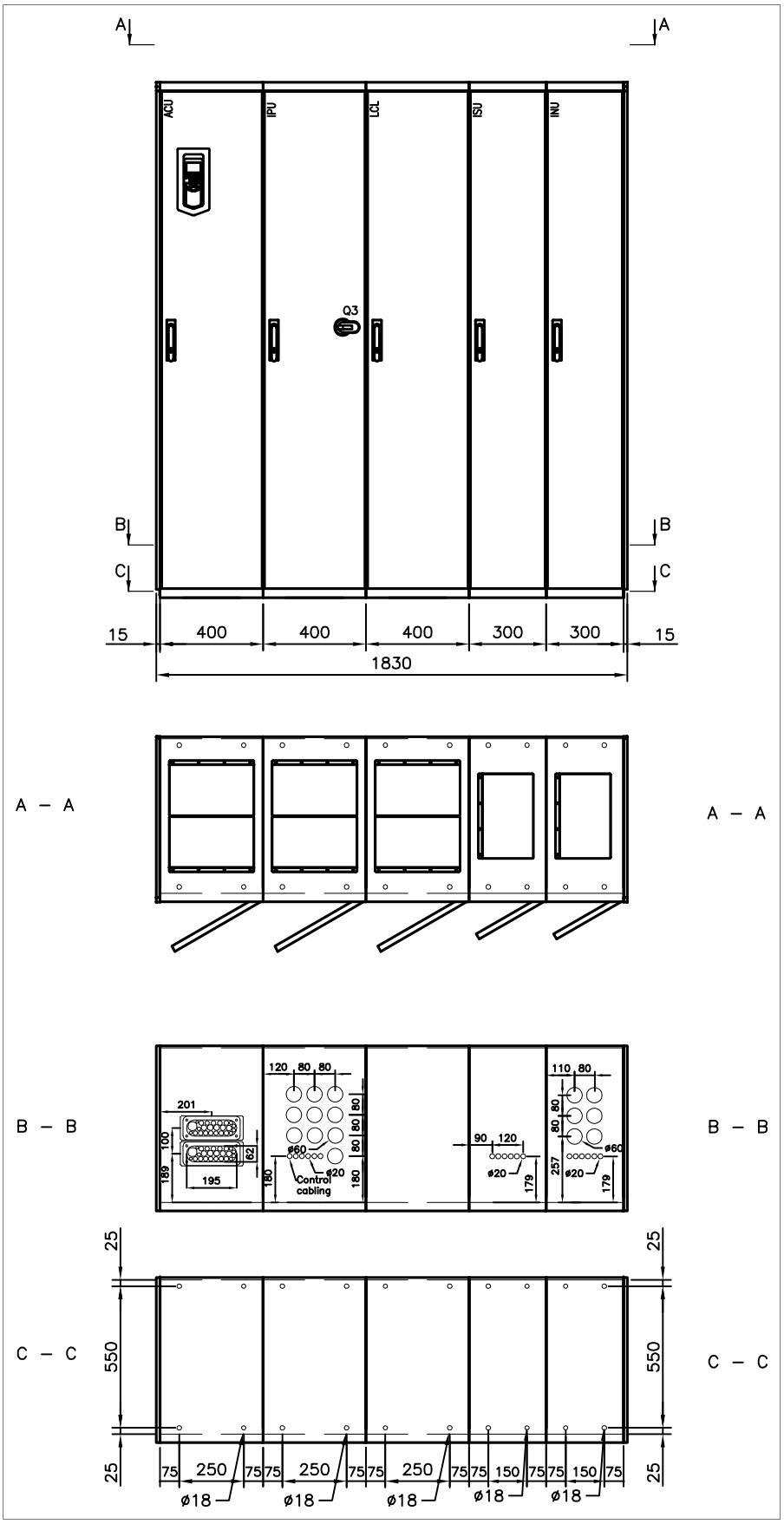
The data given is preliminary. ABB reserves the right to modify the design at any time without notice. Consult ABB for up-to-date, drive-specific information.

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

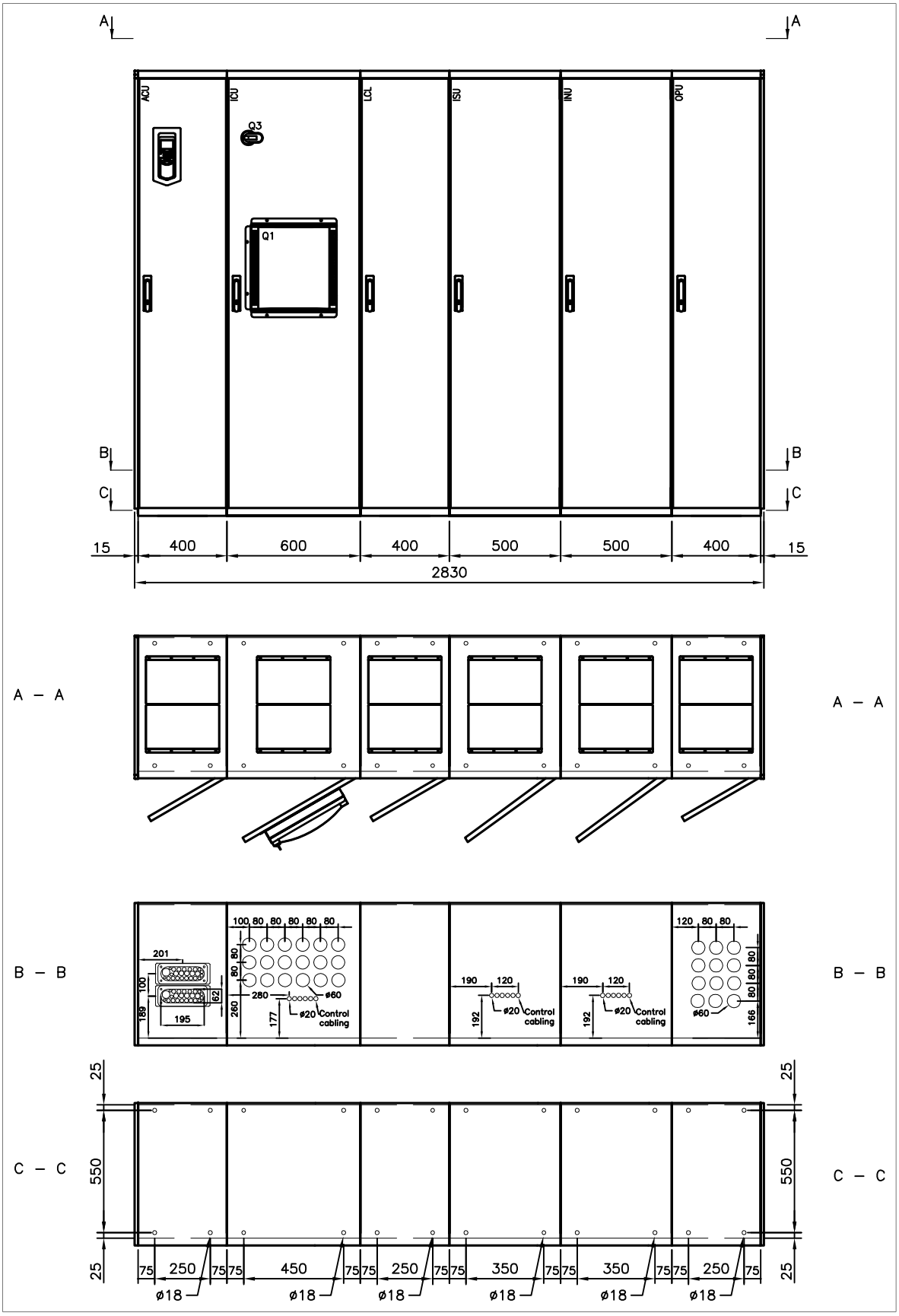
ACS880-17LC-…	Width	Weight	
	mm	kg	lbs
3580A-7	4600	4750	10470
4050A-7	5800	6170	13600
4700A-7	6000	6340	13980
5650A-7	7300	7720	17020
6260A-7	7600	7980	17590

Dimension drawing examples

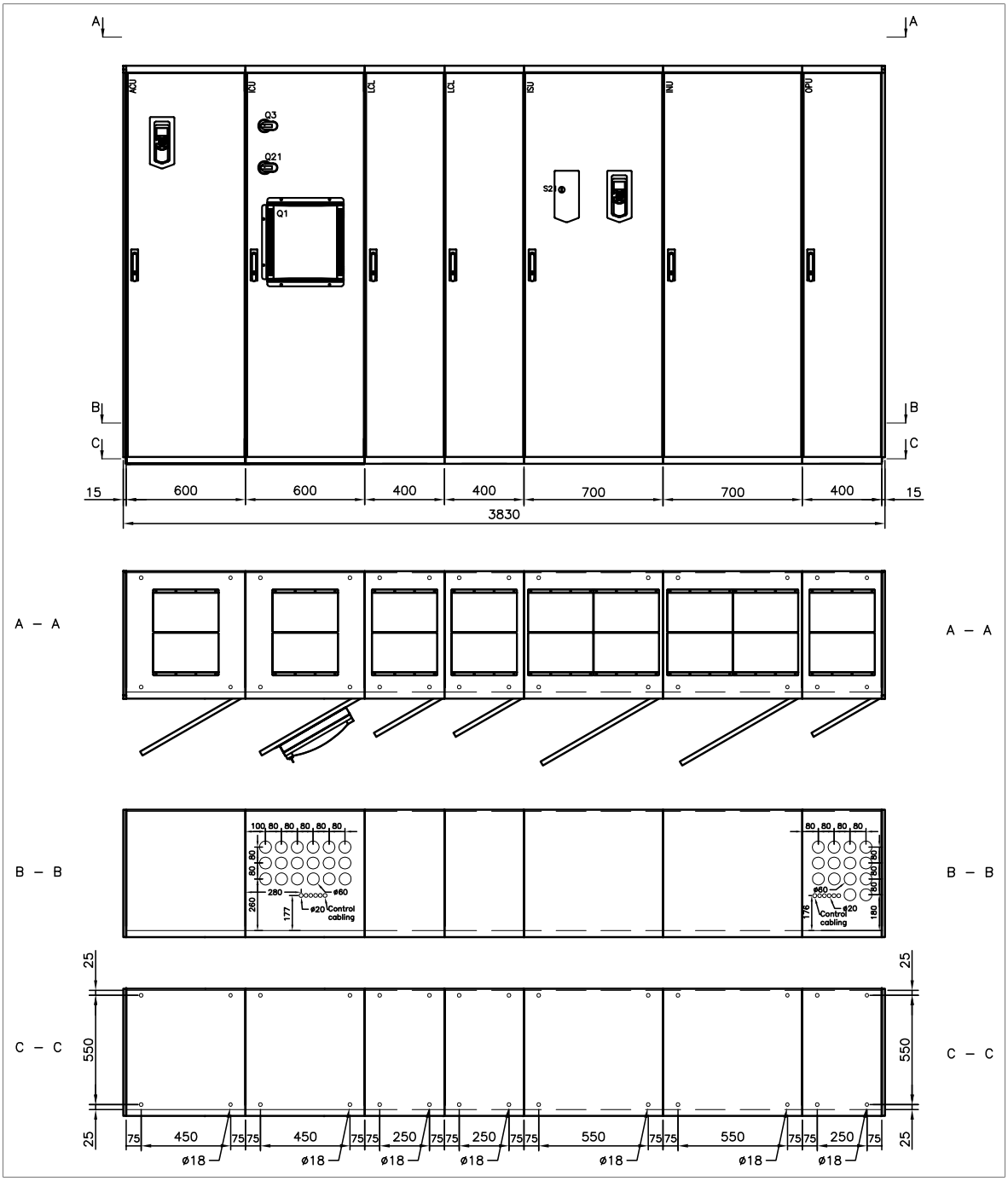
ACS880-17LC-0390A-7 with main contactor



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

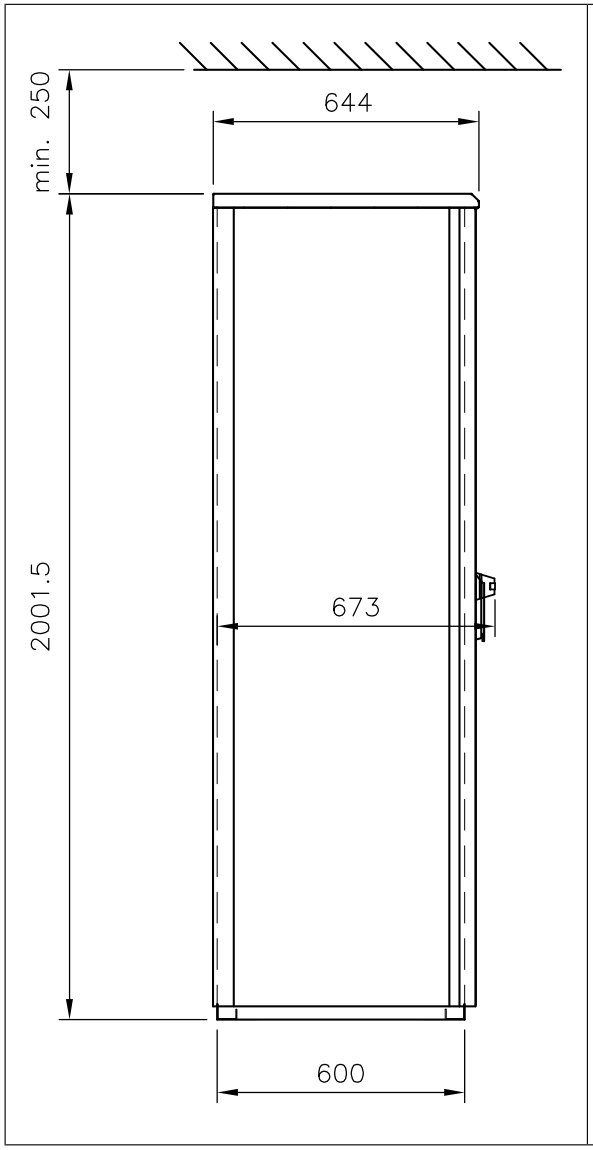


ACS880-17LC-1940A-7 with common motor terminal cubicle

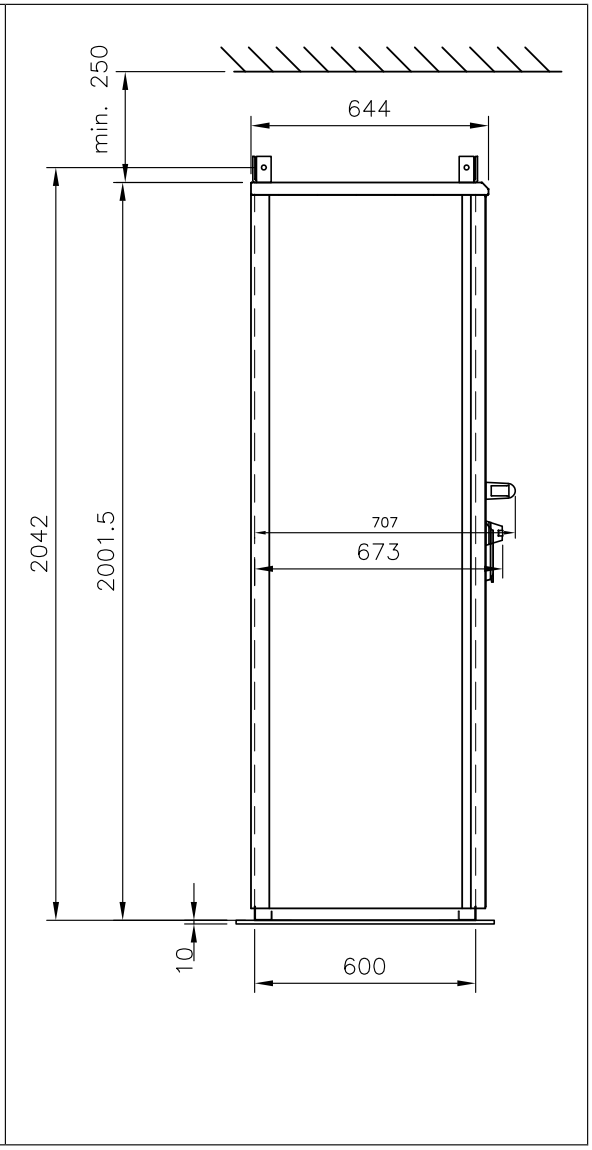


Cabinet height and depth

Non-marine, IP42, side view



Marine construction (option +C121), IP42, side view



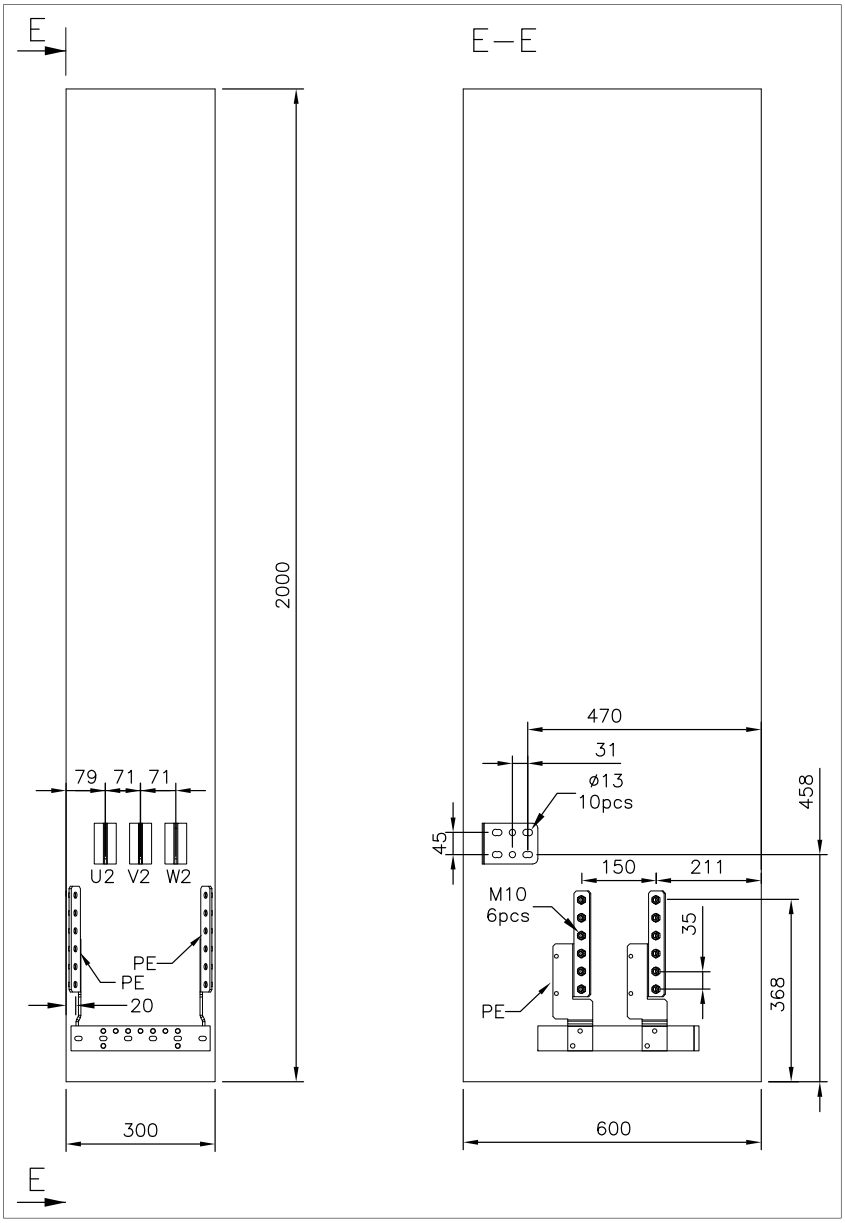
Location and size of input terminals

Contact ABB for details.

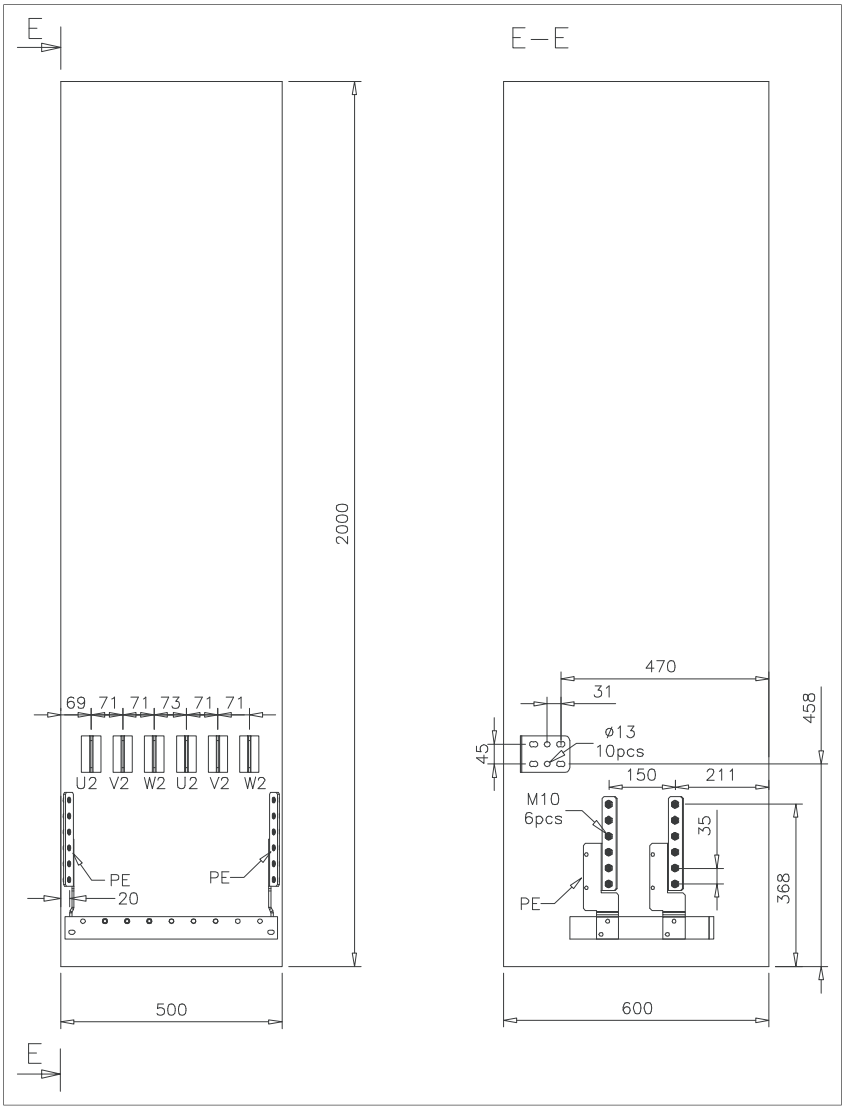
Location and size of output terminals

Units without common motor terminal cubicle

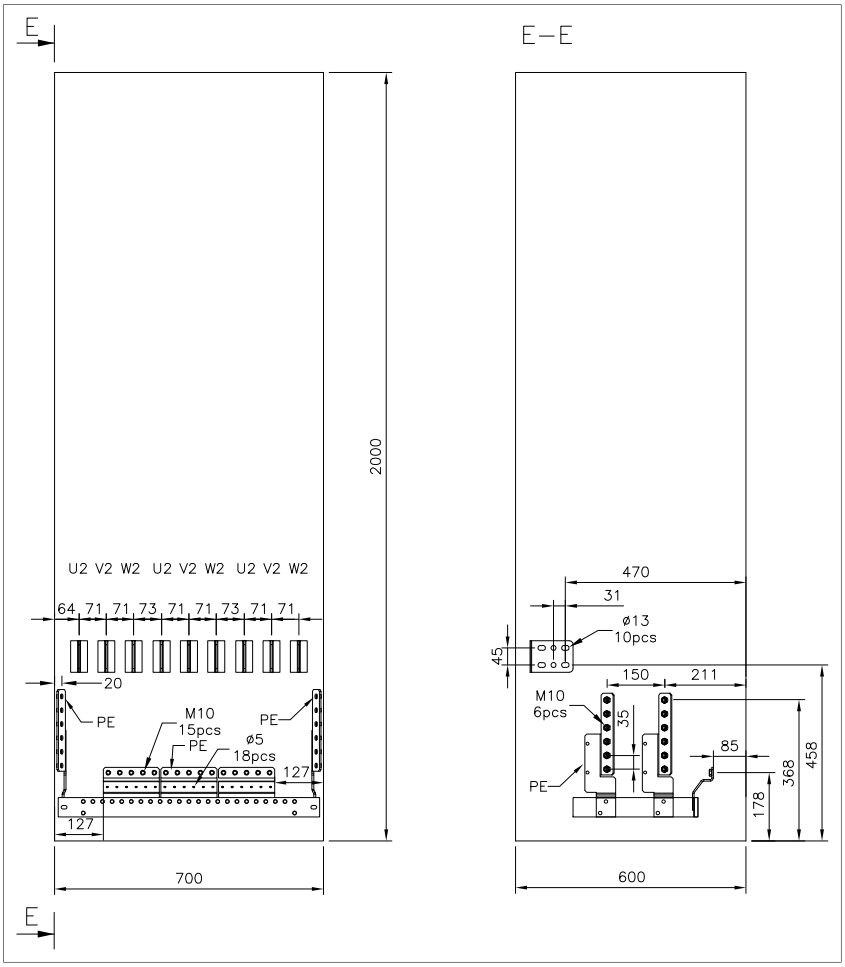
Inverter module cubicle with one R8i module, bottom cable exit



Inverter module cubicle with two R8i modules, bottom cable exit

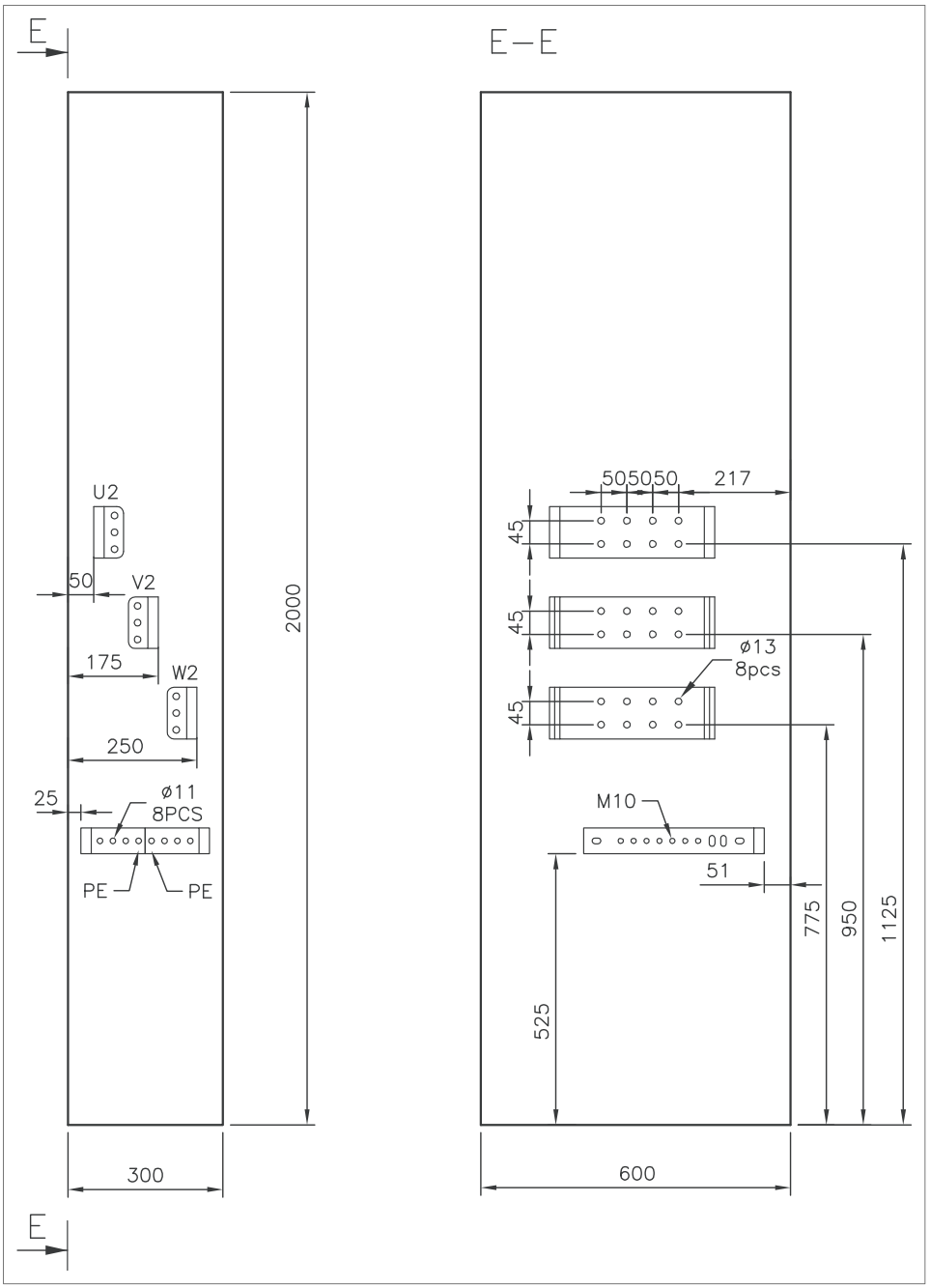


Inverter module cubicle with three R8i modules, bottom cable exit

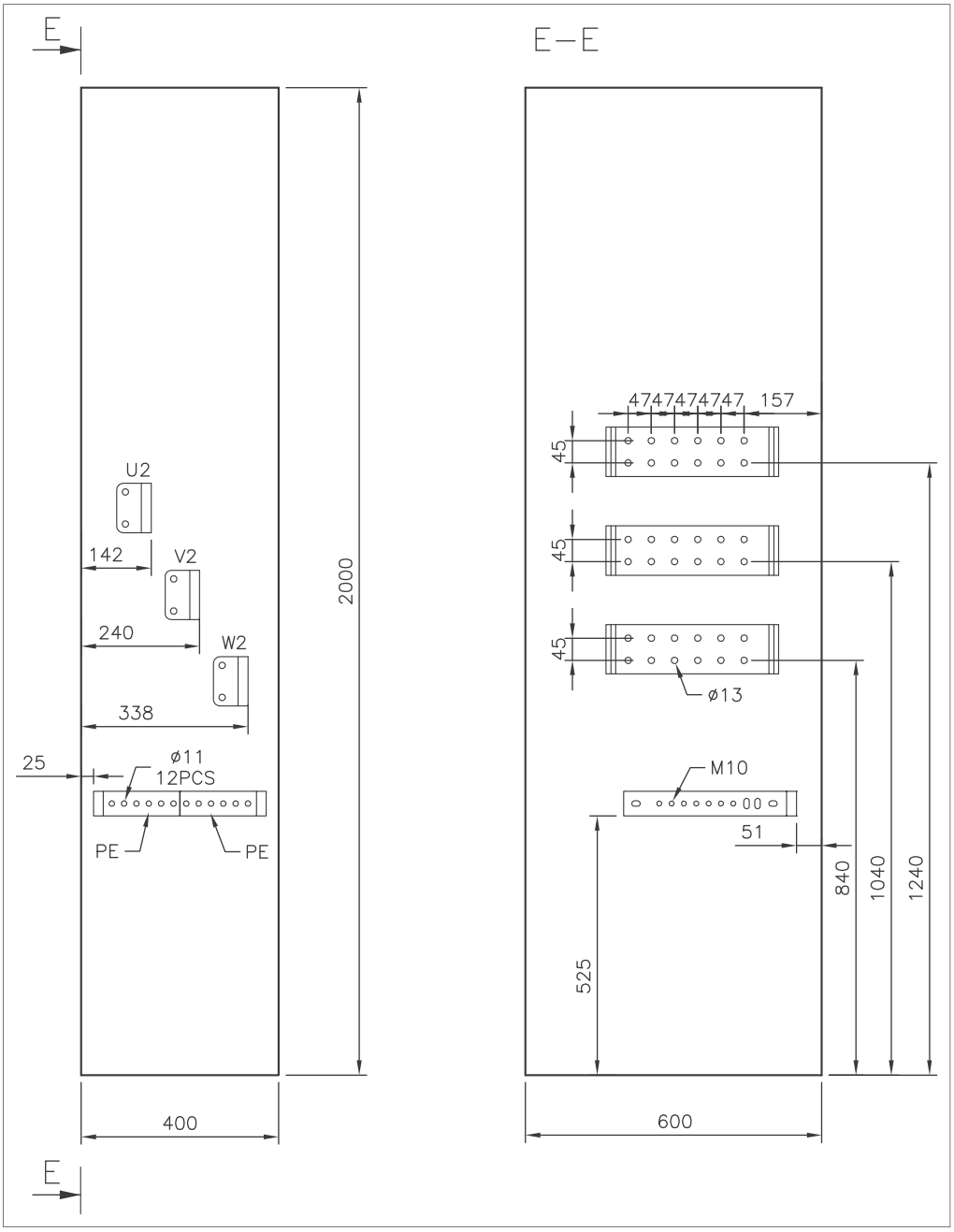


Units with common motor terminal cubicle (+H359)

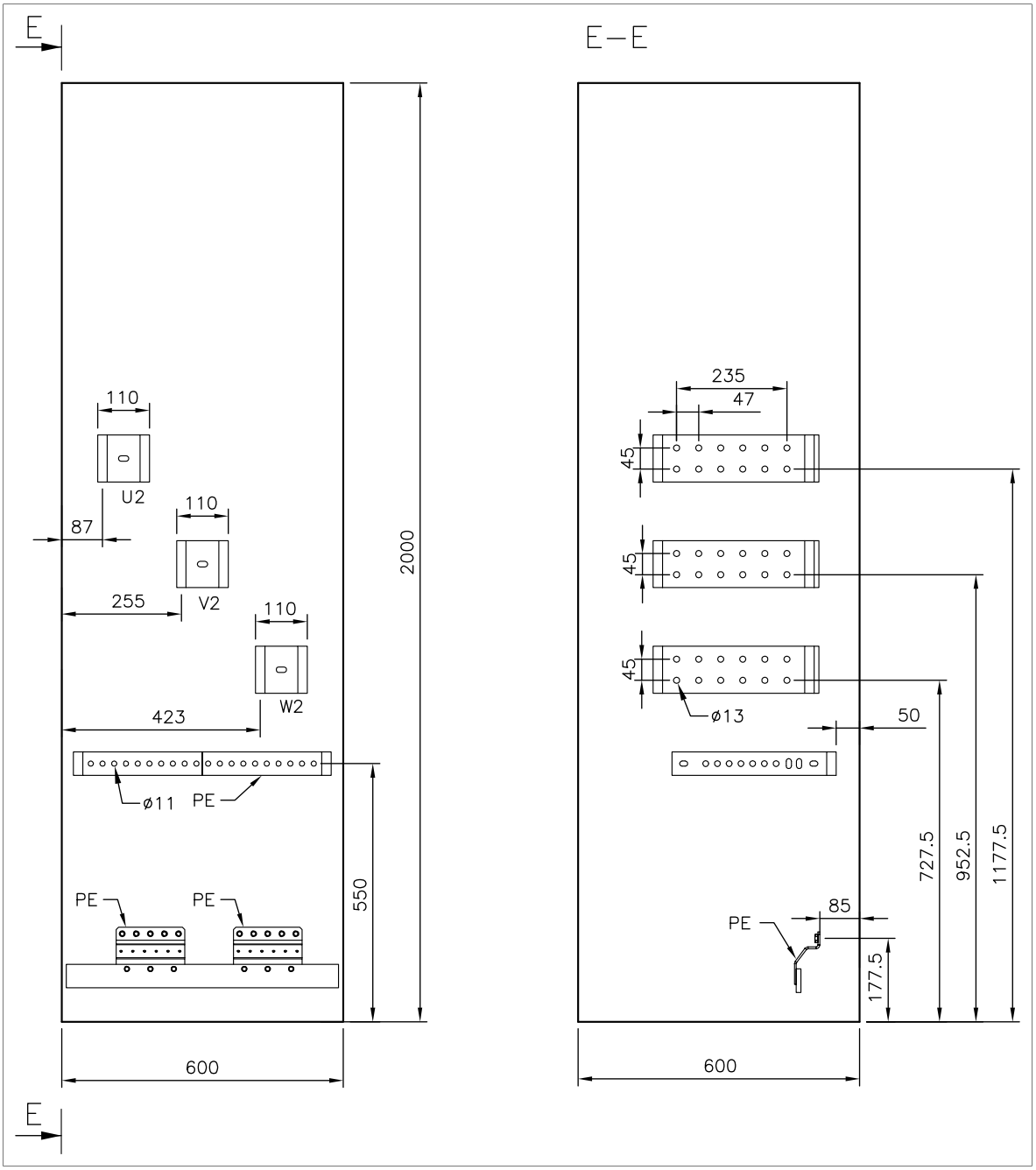
Cubicle width 300 mm, bottom cable exit



Cubicle width 400 mm, bottom cable exit



Cubicle width 600 mm, bottom cable exit



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The Safe torque off function

Contents of this chapter

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

Description

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

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

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

The Safe torque off function complies with these standards:

Standard	Name
IEC 60204-1:2016 EN 60204-1:2006 + A1:2009 + AC:2010	*Safety of machinery – Electrical equipment of machines – Part 1: General requirements*
IEC 61000-6-7:2014	*Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

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

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

Compliance with the European Machinery Directive

See the technical data.

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

Wiring

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

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-xx safety functions module or and FPTC-0x thermistor protection module can also be used. For more information, see the module documentation.

Cable types and lengths

- Double-shielded twisted-pair cable is recommended.
- Maximum cable lengths:
  - 300 m (1000 ft) between activation switch [K] and drive control unit
  - 60 m (200 ft) between multiple drives or inverter units
  - 60 m (200 ft) between external power supply and first control unit
  - 30 m (100 ft) between BCU control unit and last inverter module in the chain.

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

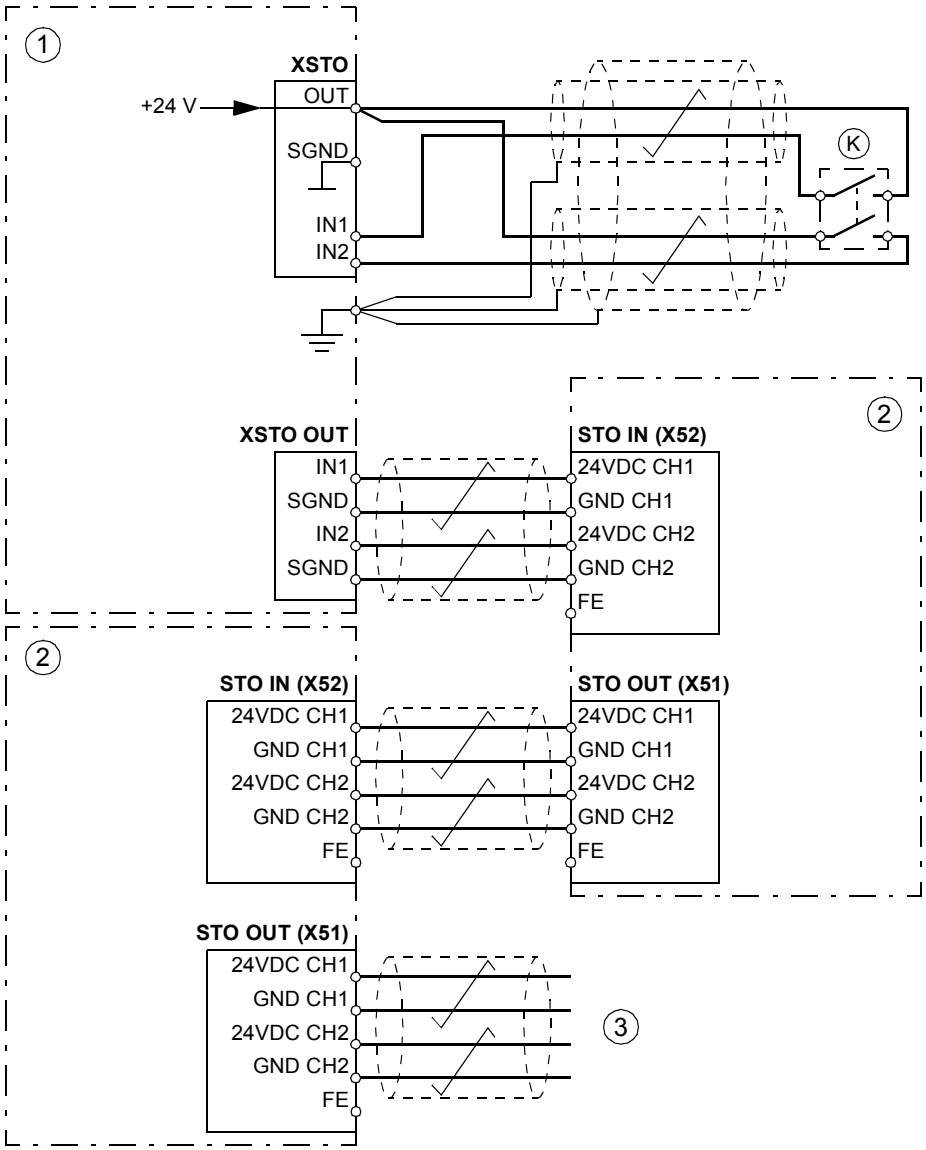
Note:
The voltage at the STO input terminals of the control unit (or frame R8i inverter module) must be at least 17 V DC to be interpreted as “1”.

The pulse tolerance of the input channels is 1 ms.

Grounding of protective shields

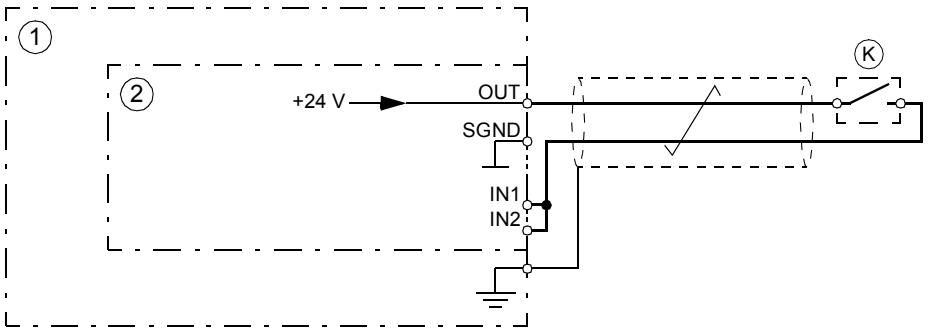
- Ground the shield in the cabling between the activation switch and the control unit at the control unit only.
- Ground the shield in the cabling between two control units at one control unit only.
- Do not ground the shield in the cabling between BCU and R8i module, or between R8i modules.

Dual-channel connection with internal power supply



1	Inverter control unit
2	Inverter module(s)
3	To remaining inverter modules
K	Activation switch

Single-channel connection of activation switch



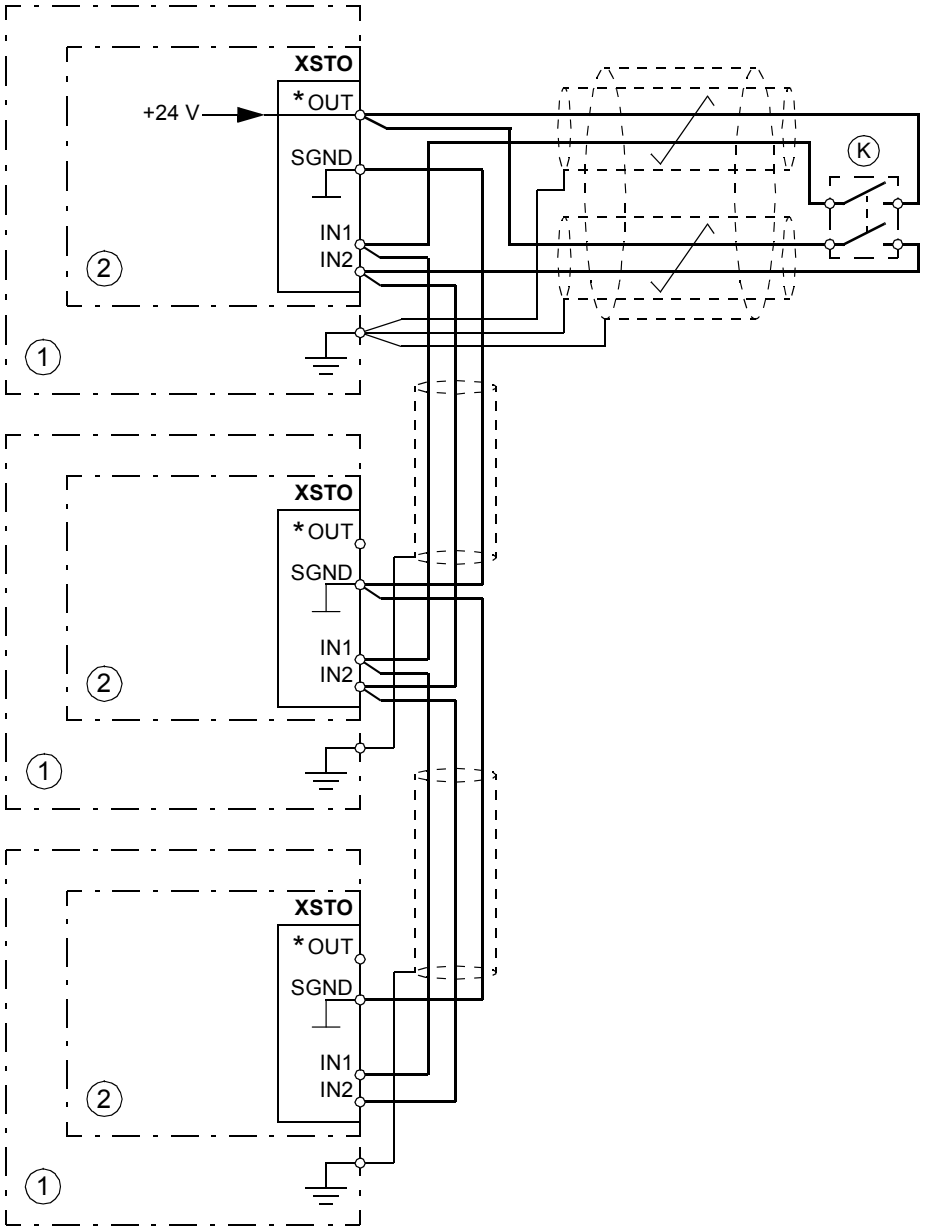
Note:

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

1	Inverter unit
2	Control unit
K	Activation switch

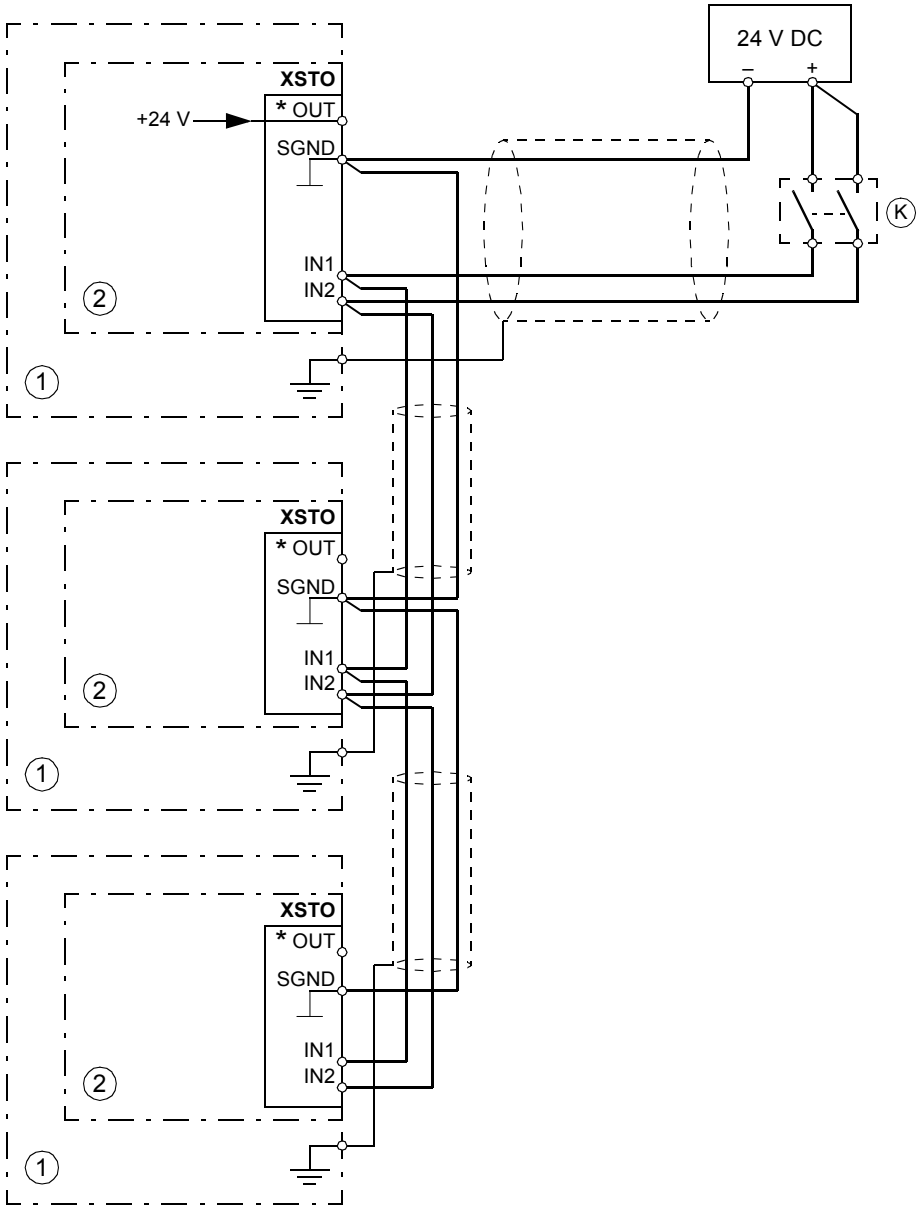
Multiple drives

Internal power supply



1	Drive/Inverter unit
2	Control unit
K	Activation switch
* Terminal designation may vary depending on drive/inverter unit type	

External power supply



1	Drive/Inverter unit
2	Control unit
K	Activation switch
* Terminal designation may vary depending on drive/inverter unit type	

Operation principle

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

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

   Note:
   The loss of only one STO signal always generates a fault as it is interpreted as a malfunction of STO hardware or wiring.

5. The motor coasts to a stop (if running). The drive cannot restart while the activation switch or safety relay contacts are open. After the contacts close, a reset may be needed (depending on the setting of parameter *31.22*). A new start command is required to start the drive.

Start-up including acceptance test

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

- at initial start-up of the safety function
- after any changes related to the safety function (circuit boards, wiring, components, settings, etc.)
- after any maintenance work related to the safety function.

Competence

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

Acceptance test reports

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

Acceptance test procedure

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

Note:
If the drive is equipped with safety option +L536, +L537, +Q950, +Q951, +Q952, +Q957, +Q963, +Q964, +Q978 or +Q979, do the procedure shown in the documentation of the option.

Note:
All inverter modules of the inverter unit must be powered and connected to the STO circuit during the acceptance test.

Action	☑
WARNING! Follow the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Ensure that the drive can be run and stopped freely during start-up.	☐
Stop the drive (if running), switch the input power off and isolate the drive from the power line using a disconnector.	☐
Check the STO circuit connections against the wiring diagram.	☐
Close the disconnector and switch the power on.	☐

Action	☑
Test the operation of the STO function when the motor is stopped. • Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Ensure that the drive operates as follows: • Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter *31.22* (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The drive generates a warning. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the STO function when the motor is running. • Start the drive and ensure the motor is running. • Open the STO circuit. The motor should stop. The drive generates an indication if one is defined for the 'running' state in parameter *31.22* (see the firmware manual). • Reset any active faults and try to start the drive. • Ensure that the motor stays at a standstill and the drive operates as described above in testing the operation when the motor is stopped. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the failure detection of the drive. The motor can be stopped or running. • Open the 1st channel of the STO circuit (wire coming to IN1). If the motor was running, it should coast to a stop. The drive generates a *FA81 Safe Torque Off 1 loss* fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally. • Open the 2nd channel of the STO circuit (wire coming to IN2). If the motor was running, it should coast to a stop. The drive generates a *FA82 Safe Torque Off 2 loss* fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Document and sign the acceptance test report which verifies that the safety function is safe and accepted for operation.	☐

Use

1. Open the activation switch, or activate the safety functionality that is wired to the STO connection.
2. The STO inputs on the drive control unit de-energize, and the control unit cuts off the control voltage from the output IGBTs.
3. The control program generates an indication as defined by parameter *31.22* (refer to 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 reseting the safety functionality that is wired to the STO connection.
6. Reset any faults before restarting.

WARNING!
The Safe torque off function does not disconnect the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on electrical parts of the drive or the motor can only be carried out after isolating the drive from the supply and all other voltage sources.

WARNING!
The Safe torque off functionality is only achieved through the XSTO connector of the inverter control unit (A41). True Safe torque off functionality is not achieved through the XSTO connectors of other control units (such as the supply control unit or the brake control unit).

The Safe torque off function is supported by any ACS880 inverter or drive control program. It is not supported by supply, DC/DC converter or brake firmware.

WARNING!
(With permanent magnet or synchronous reluctance [SynRM] motors only)

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

Notes:

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

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 5 or 2 years; see section *Safety data (page 192)*. It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the *Acceptance test procedure (page 187)*.

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, follow the test given in section *Acceptance test procedure (page 187)*.

Use only spare parts approved by ABB.

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

Competence

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

Fault tracing

The indications given during the normal operation of the Safe torque off function are selected by drive control program parameter *31.22*.

The diagnostics of the Safe torque off function cross-compare the status of the two STO channels. In case the channels are not in the same state, a fault reaction function is performed and the drive trips on an “STO hardware failure” fault. An attempt to use the STO in a non-redundant manner, for example activating only one channel, will trigger the same reaction.

See the firmware manual of the drive control program for the indications generated by the drive, and for details on directing fault and warning indications to an output on the control unit for external diagnostics.

Any failures of the Safe torque off function must be reported to ABB.

Safety data

The safety data for the Safe torque off function is given below.

Note:
The safety data is calculated for redundant use, and does not apply if both STO channels are not used.

Frame size	SIL/ SILCL	PL	SFF (%)	PFH (T_1 = 20 a) (1/h)	PFD_{avg} (T_1 = 2 a)	PFD_{avg} (T_1 = 5 a)	$MTTF_D$ (a)	DC (%)	Cat.	SC	HFT	CCF	T_M (a)
R8i	3	e	>99	5.0E-11	4.5E-07	1.1E-06	23970	≥90	3	3	1	80	20
2×R8i	3	e	>99	6.2E-11	5.5E-07	1.3E-06	16330	≥90	3	3	1	80	20
3×R8i	3	e	>99	7.3E-11	6.5E-07	1.6E-06	12390	≥90	3	3	1	80	20
4×R8i	3	e	>99	8.4E-11	7.6E-07	1.9E-06	9980	≥90	3	3	1	80	20
5×R8i	3	e	>99	9.5E-11	8.6E-07	2.1E-06	8360	≥90	3	3	1	80	20
6×R8i	3	e	>99	1.1E-10	9.6E-07	2.4E-06	7190	≥90	3	3	1	80	20
7×R8i	3	e	>99	1.2E-10	1.1E-06	2.6E-06	6310	≥90	3	3	1	80	20
8×R8i	3	e	>99	1.3E-10	1.2E-06	2.8E-06	5620	≥90	3	3	1	80	20
													3AXD10000078136 F

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with ΔT = 71.66 °C
  - 1340 on/off cycles per year with ΔT = 61.66 °C
  - 30 on/off cycles per year with ΔT = 10.0 °C
  - 32 °C board temperature at 2.0% of time
  - 60 °C board temperature at 1.5% of time
  - 85 °C board temperature at 2.3% of time.
- The STO is a type B safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested
  - A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO response times:
  - STO reaction time (shortest detectable break): 1 ms
  - STO response time: 2 ms (typical), 25 ms (maximum)
  - Fault detection time: Channels in different states for longer than 200 ms
  - Fault reaction time: Fault detection time + 10 ms
- Indication delays:
  - STO fault indication (parameter *31.22*) delay: < 500 ms
  - STO warning indication (parameter *31.22*) delay: < 1000 ms

Abbreviations

Abbr.	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	EN ISO 13849-1	Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD_{avg}	IEC 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL
SC	IEC 61508	Systematic capability
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1…3)
SILCL	IEC/EN 62061	Maximum SIL (level 1…3) that can be claimed for a safety function or subsystem
STO	IEC/EN 61800-5-2	Safe torque off
T_1	IEC 61508-6	Proof test interval. T_1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T_1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. See also section Maintenance.
T_M	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any T_M values given cannot be regarded as a guarantee or warranty.

Declaration of conformity

The Declaration of Conformity is delivered with the drive.

TÜV certificate

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

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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