ABB industrial drives

Hardware manual
ACS880-07CLC drives

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Hardware manual

ACS880-07CLC drives

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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 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.

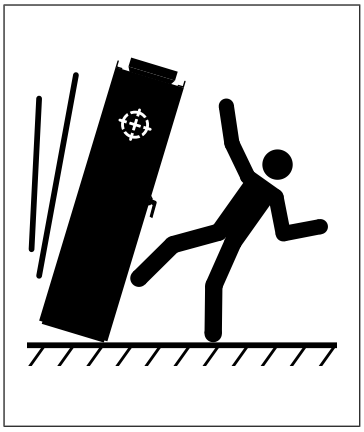
General safety in installation, start-up and maintenance

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 the drive with a lifting device. Use the designated lifting points. See the dimension drawings.
- 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.



- 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 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 number of drive power-ups is five in ten minutes. Too frequent power-ups 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.

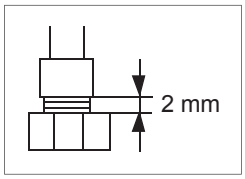
Work on the liquid cooling system

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 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.
- 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 power switch-on, 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 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 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.
3. Disconnect all possible voltage sources. Lock and tag.
   - Open the main disconnecting device of the drive.
   - Open the charging switch if present.

     WARNING!

     The charging switch is not necessarily located within or nearby the drive cubicle.

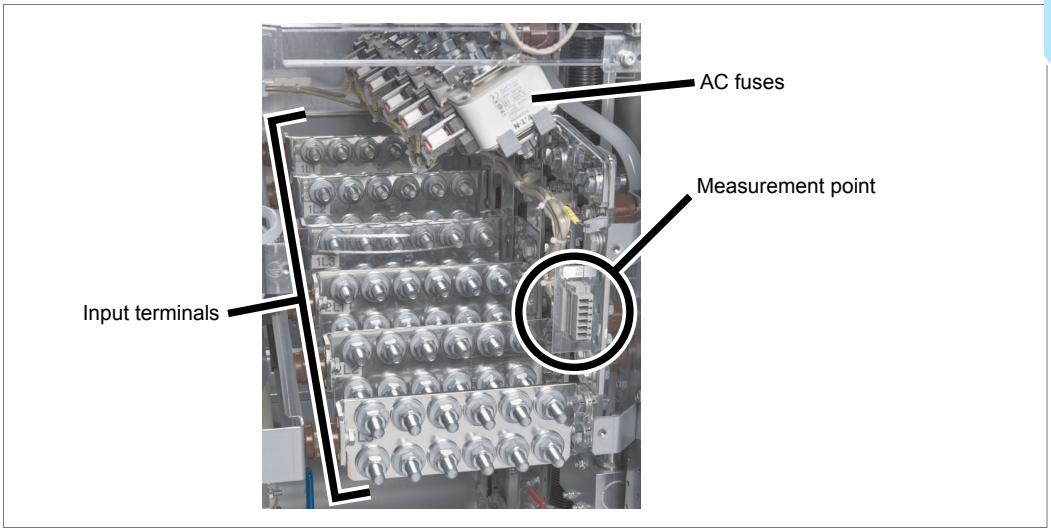
   - Open the auxiliary voltage switch-disconnector (if present), and all other possible disconnecting devices that isolate the drive from dangerous voltage sources.
   - In the liquid cooling unit (if present), open the motor protective circuit breaker(s) of the cooling pumps.
   - If you have a permanent 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.
   - Disconnect any external power sources from the control circuits.
   - After you disconnect 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 of at least 1 Mohm.

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.

   - Make sure that the voltage between the drive input power terminals and the grounding (PE) busbar is close to 0 V.
     - Open the door(s) of the supply module cubicle(s).
     - Locate the measurement points (XACx) in front of each array of input terminals. Each input terminal is connected to a specific pin of the measurement point. For example, a drive with six supply modules has two supply module cubicles, and three measurement points (XAC1, XAC2, XAC3). The picture below shows a cubicle with two modules.



     - Measure the voltage of each individual pin of each measurement point against PE.
     - If the voltage of all pins of all measurement points is close to 0 V, remove the plastic shroud(s) from in front of the input terminals.
     - Working from outside to inside, measure the voltage between each input terminal and PE.

WARNING!

Do not touch the AC fuses or the busbars they are connected to.

   - Make sure that the voltage between the drive DC busbars (+ and -) and the grounding (PE) busbar is close to 0 V.

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 electrical installation or maintenance work.
- Do not install the drive if the electrical power network, motor/generator, or environmental conditions do not agree with the drive data.
- We do not recommend that you secure the cabinet by arc welding. If you have to, obey the separate welding instructions in the drive manuals.
- Do not do insulation or voltage withstand tests on the drive.

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.
- If brake chopper and resistor are in use, they are at a dangerous voltage. (Option +D150)
- 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.

- When you unplug the fibre 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 grounding conductors is sufficient. See the electrical planning instructions of the drive. Obey the local regulations.
- Connect the power cable shields to protective earth (PE) 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 switch board or the supply transformer.

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 connection. The minimum size of the protective earthing conductor must comply with the local safety regulations for high protective earthing conductor current equipment. See standard IEC/EN 61800-5-1, 4.3.5.5.2.

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 and damage to the equipment can occur.

- Do not do work on the drive when the permanent magnet motor is rotating. A rotating permanent magnet motor energizes the drive including its input power terminals.

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

- Stop the drive and do the steps in section *Electrical safety precautions (page 16)*.
- 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.
- Measure that the installation is de-energized.
- 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, e.g. 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, use and service 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×D8D + 2×R8i” refers to a drive that has a supply unit consisting of two frame D8D 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 45)*.

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 65)* *Technical data (page 151)*
⬇	
Check the installation site.	*Ambient conditions (page 167)*
⬇	
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 49)*
⬇	
Route the cables.	*Routing the cables (page 75)*
⬇	
Connect the power cables. Connect the control cables.	*Electrical installation (page 83)*
⬇	
Check the installation.	*Installation checklist (page 117)* 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 119)*
⬇	
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
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	Functional safety modules (not available for the ACS880-07CLC at the time of publishing)
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	
ACS880-07CLC drives hardware manual	3AXD50000131457
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 diode supply control program firmware manual	3AUA0000103295
ACS880 distributed I/O bus supplement	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
User’s manual for Emergency stop, stop category 0 (+Q951) for ACS880-07CLC drives	3AXD50000123384
User’s manual for Emergency stop, stop category 0 (+Q951+Q984) for ACS880-07CLC drives	3AXD50000207848
Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.	

ACS880-07CLC manuals

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.

Operation principle

The ACS880-07CLC is a liquid-cooled cabinet-installed drive for controlling asynchronous AC induction motors, permanent magnet synchronous motors and AC induction servomotors.

The drive consists of several cubicles that contain the supply and motor terminals, 1 to 8 diode supply module(s), 1 to 8 inverter modules, and optional equipment. The actual arrangement of the cubicles varies from type to type and the selected options.

The diode supply unit of the drive is uncontrolled: it cannot control the DC link voltage or limit the charging current of the DC link capacitors at the power-up.

Notes:

- The installer must provide an external main disconnecting device which meets the local safety regulations.
- The installer must provide an external main contactor or breaker as the drive does not have an internal main contactor or breaker.
- The installer must either provide an external charging circuit, or specify option +F272 for a built-in charging circuit. The external charging circuit can be eg. combined into one unit that also magnetizes the supply transformer.
- The supply unit of the drive does not have the means to control, limit or cut off the load current.
- The installer must arrange for overload and short-circuit protection of the supply cable, typically with fuses.

- The supply unit of the drive does not have AC or DC chokes. Therefore, the installer must arrange for a sufficient inductance at the AC side of each supply module with suitable cabling. The minimum length of the supply cable per each supply module is 5 meters (16.4 feet). The inductances between the parallel-connected supply modules must be identical, ie. the cabling to each module must be identical in regard to cable type and length.

Charging

A charging circuit powers up the DC capacitors of the drive smoothly. Discharged capacitors cannot be directly connected to full supply voltage. The charging current must be limited until the capacitors are charged and ready for normal use.

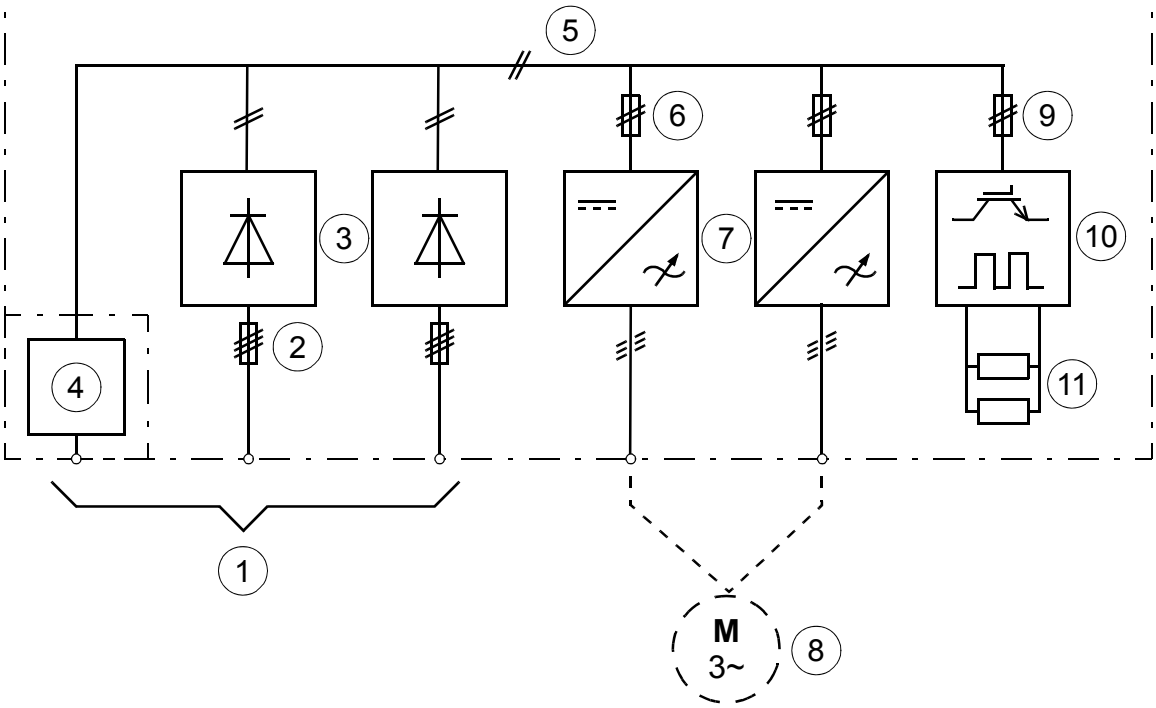
An internal charging circuit is available by specifying option +F272. Drives with +F272 have a charging switch on the supply unit cubicle door as well as terminals for the connection of a 3-phase supply for the charging circuit.

Drives without +F272 must be charged through an external charging circuit. If practical, the circuit can be combined with the transformer magnetizing circuit.

Overview diagrams

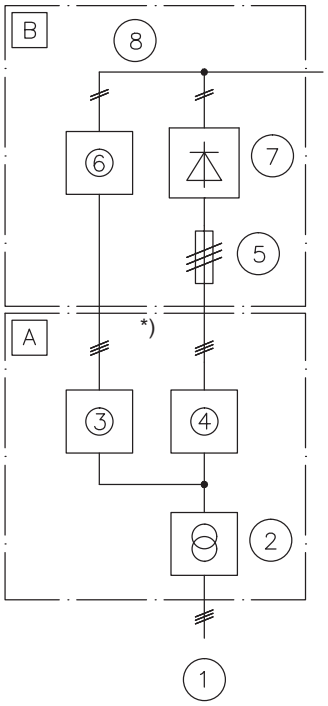
This section contains examples of main circuit overview diagrams. The diagrams show the power line connection, and the connections between the parts of the drive.

Overview diagram of the drive



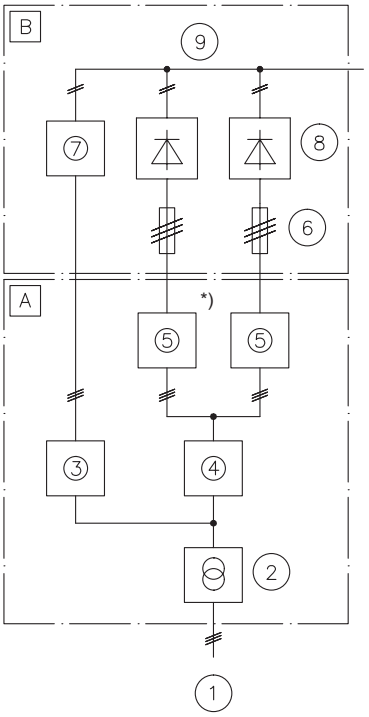
1	AC supply. See detailed diagrams below.
2	AC fuses. Installed at the input of each supply module.
3	Supply modules. Depending on drive type, there is only one module, or several modules connected in parallel.
4	Charging circuit. The drive must be fitted with a charging circuit so that the DC capacitors of the drive are smoothly charged at power-up. See section *Charging (page 26)*.
5	DC bus
6	Inverter DC fuses
7	Inverter modules. Converts direct current and voltage to alternating current and voltage. Depending on drive type, there is only one module, or several modules connected in parallel.
8	Motor
9	*Brake chopper DC fuses
10	**Brake chopper. Conducts surplus energy from the intermediate DC circuit of the drive to the brake resistor when necessary. The chopper operates when the DC voltage exceeds a certain maximum limit.The voltage rise is typically caused by deceleration (braking) of a high inertia motor.
11	**Brake resistors
*Brake chopper (+D150) and resistors (+D151) are optionally available for certain drive types. See chapter *Resistor braking (page 203)*.	

Supply connection detail – one D8D module, 6-pulse connection, internal charging



1	Medium voltage / low voltage switchboard
A	External installation outside drive cabinet
2	Supply transformer
3	Charging switchgear including: • Disconnecting device
4	Dedicated supply switchgear including: • Disconnecting device • Breaker/contactor • Overcurrent and short-circuit protection of input cabling
B	Supply module cubicle of drive
5	AC fuses for protecting supply unit against short circuit
6	Internal charging kit (option +F272)
7	Diode supply module
8	DC link
*Minimum length of supply cabling: 5 m (16.4 ft)	

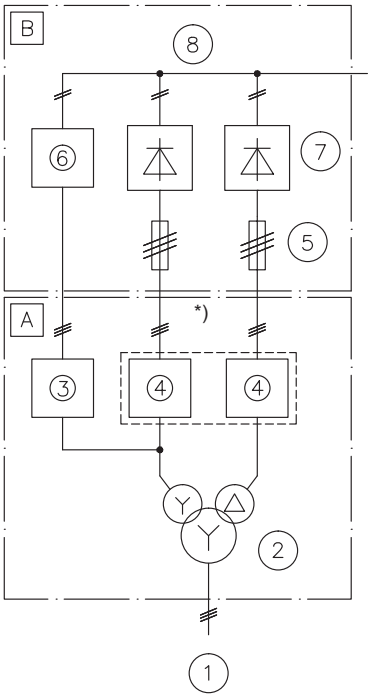
Supply connection detail – two D8D modules, 6-pulse connection, internal charging



1	Medium voltage / low voltage switchboard
A	External installation outside drive cabinet
2	Supply transformer
3	Charging switchgear including: • Disconnecting device
4	Dedicated supply switchgear including: • Disconnecting device • Breaker/contactor
5	Overcurrent and short-circuit protection of input cabling
B	Supply module cubicle of drive
6	AC fuses for protecting supply unit against short circuit
7	Internal charging kit (option +F272)
8	Diode supply modules
9	DC link

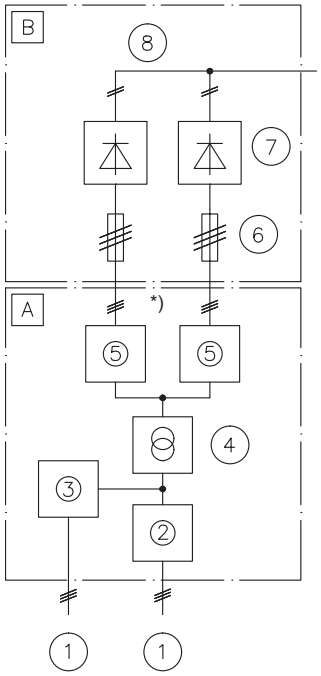
*Each module must have its own input AC cable with a minimum length of 5 m (16.4 ft). Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges.

Supply connection detail – two D8D modules, 12-pulse connection, internal charging



1	Medium voltage / low voltage switchboard
A	External installation outside drive cabinet
2	Supply transformer
3	Charging switchgear including: • Disconnecting device
4	Interlocked, dedicated supply switchgear including: • Disconnecting device • Breaker/contactor • Overcurrent and short-circuit protection of input cabling
B	Supply module cubicle of drive
6	AC fuses for protecting supply unit against short circuit
7	Internal charging kit (option +F272)
8	Diode supply modules
9	DC link
*Each module must have its own input AC cable with a minimum length of 5 m (16.4 ft). Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges.	

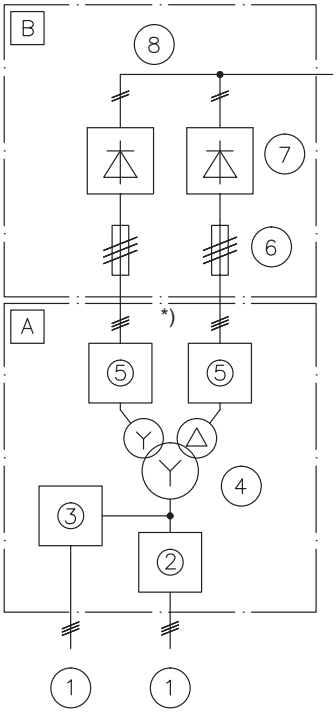
Supply connection detail – two D8D modules, 6-pulse connection, external charging and pre-magnetizing



1	Medium voltage / low voltage switchboard
A	External installation outside drive cabinet
2	Switchgear including: • Disconnecting device • Breaker/contactor
3	Combined transformer pre-magnetizing circuit and drive charging circuit
4	Supply transformer
5	Overcurrent and short-circuit protection of input cabling
B	Supply module cubicle of drive
6	AC fuses for protecting supply unit against short circuit
7	Diode supply modules
8	DC link

*Each module must have its own input AC cable with a minimum length of 5 m (16.4 ft). Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges.

Supply connection detail – two D8D modules, 12-pulse connection, external charging and pre-magnetizing



1	Medium voltage / low voltage switchboard
A	External installation outside drive cabinet
2	Switchgear including: • Disconnecting device • Breaker/contactor
3	Combined transformer pre-magnetizing circuit and drive charging circuit
4	Supply transformer
5	Overcurrent and short-circuit protection of input cabling
B	Supply module cubicle of drive
6	AC fuses for protecting supply unit against short circuit
7	Diode supply modules
8	DC link
*Each module must have its own input AC cable with a minimum length of 5 m (16.4 ft). Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges.	

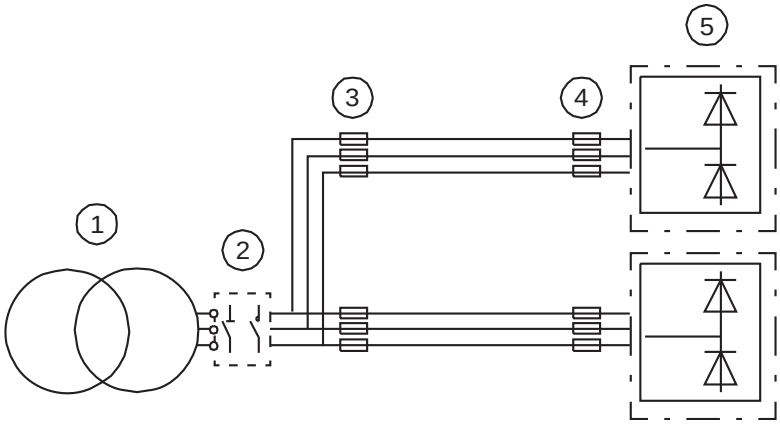
6-pulse, 12-pulse and 24-pulse connections

The figure below illustrates the difference between 6-pulse and 12-pulse AC supply connections. 6-pulse connection is standard.

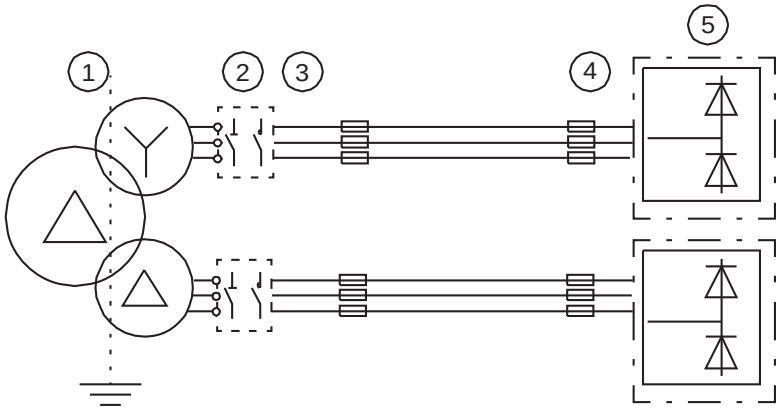
Some drive types are available as a 12-pulse version (option +A004), some as a 24-pulse version (option +A006).

12-pulse supply connection eliminates the fifth and seventh harmonics, which remarkably reduces the harmonic distortion of the line current and the conducted emissions. 12-pulse connection requires a three-winding transformer, or two separate transformers. There is a 30-degree phase shift between the two 6-pulse supply lines, which are connected to different supply modules through electrically separate switching equipment.

6-pulse connection



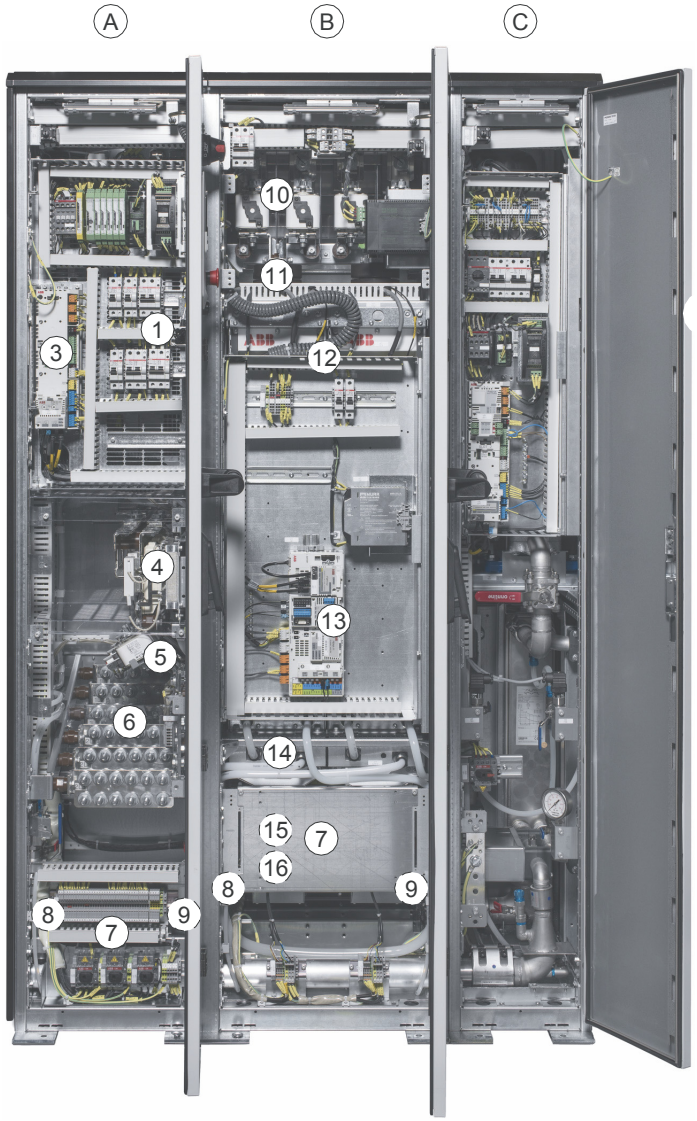
12-pulse connection



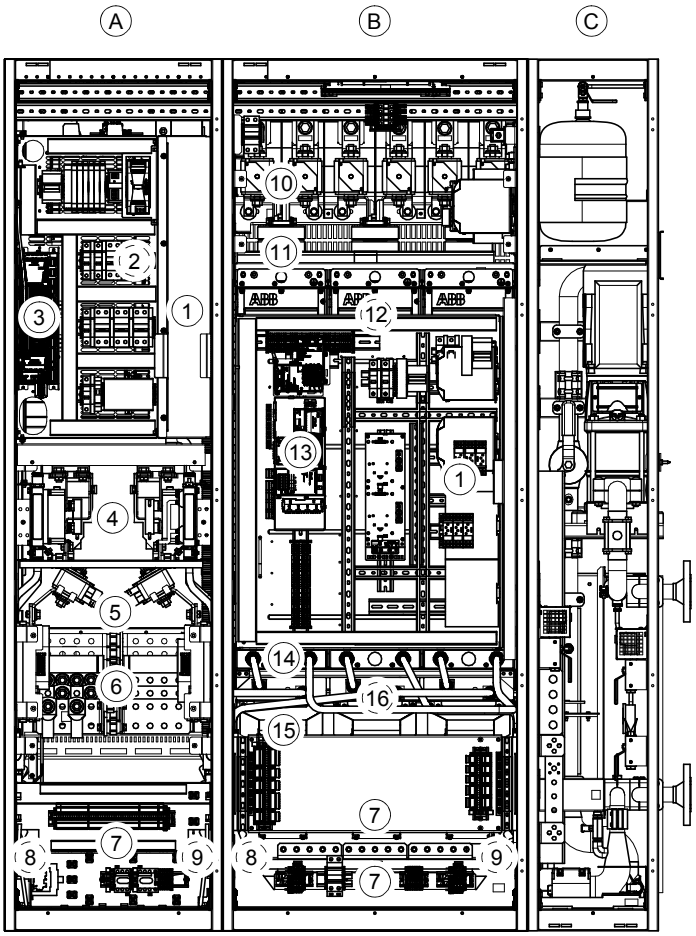
1.	Supply transformer
2.	Switching equipment and fuses
3	Fuses for protecting input cabling
4.	AC fuses for protecting supply unit against short circuit
5.	Diode supply modules

Cabinet line-up and layout examples

Frame 2×D8D + 2×R8i



Frame 3×D8D + 3×R8i

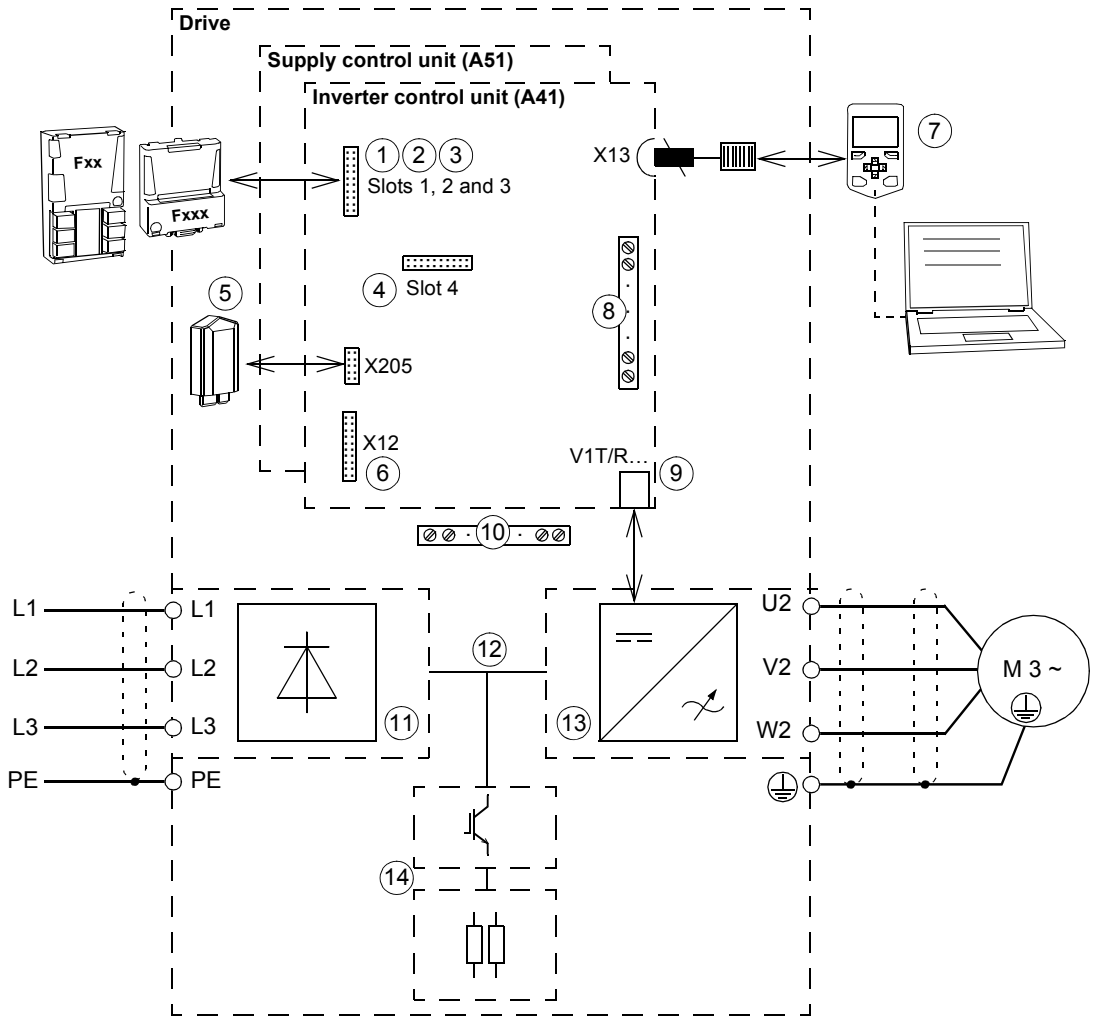


No.	Description
A	Supply module cubicle
B	Inverter module cubicle
C	Optional liquid cooling unit. See *ACS880-1007LC liquid cooling unit user's manual* (3AXD50000129607 [English]).
1	Swing-out frame for installation of control equipment. The frame is hinged and can be turned aside.
2	(Behind the swing-out frame) Fan and air-to-liquid heat exchanger. The fan forces air inside the cubicle through the heat exchanger. See chapter *Internal cooling circuit (page 143)*.
3	ZCU-14 supply control unit. See chapter *Control units of the drive (page 103)*.
4	Frame D8D supply modules
5	AC fuses
6	Input terminals. Each supply module has its own input terminals, and must be cabled individually and identically from the supply switchgear. The input cables must be at least 5 meters (16.4 ft) in length.
7	Mounting plates with terminal blocks for customer connections and space for auxiliary equipment
8	(Behind the mounting plate) Inlet manifold with stop and drain valve. See chapter *Internal cooling circuit (page 143)*.
9	(Behind the mounting plate) Outlet manifold with stop and drain valve. See chapter *Internal cooling circuit (page 143)*.
10	DC fuses

11	Common mode filters installed on the DC busbars
12	(Behind the swing-out frame) Inverter modules
13	BCU-x2 inverter control unit. See chapter *Control units of the drive (page 103)*.
14	Air-to-liquid heat exchanger installed below each inverter module. See chapter *Internal cooling circuit (page 143)*.
15	(Behind mounting plate) Fan. Forces air inside the cubicle through the heat exchanger. See chapter *Internal cooling circuit (page 143)*.
16	(Behind mounting plate and inverter module fans) Output terminals. Each inverter module must be individually connected to the motor using separate cables unless the drive is equipped with option +H359 (common motor terminal cubicle) or +H366 (common output terminals).

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 (not available at the time of publishing)
7	Control panel and PC connection
8	Terminal blocks on the inverter control unit.
9	Fiber optic link to each inverter module.

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)
14	Optional brake chopper (+D150) and resistors (+D151)

Door switches and lights

No.	Description
1	Run enable switch for the drive. The switch has to be set to "1" for the drive to start. Turning the switch into the off position will stop the drive.
2	Emergency stop push button (with emergency stop options only)
3	Emergency stop active light and reset (with emergency stop options only)
4	Charging switch (with charging circuit option only). At start-up, the charging switch is closed. After the DC voltage rises to operating level, the supply control unit opens the charging circuit, and the main supply voltage can be connected to the drive.

The layout depends on the options selected.

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).

Resistor braking (options +D150 and +D151)

See chapter *Resistor braking (page 203)*.

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).

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 external supply and heating element(s) connection

The heater is off when the drive is running. The customer controls the heating elements in the motor windings on and off with the external supply. The power and voltage of the motor heater depend on the motor.

See also sections:

- *Supplying power for the auxiliary circuits (page 78)*
- 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.

Additional wire markings

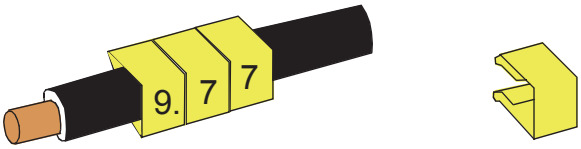
Standard wire markings

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.

Cable conduit entry (option +H358)

The option provides US/UK conduit plates (plain 3 mm thick steel plates without any ready-made holes). US/UK conduit plates are provided as standard with options +C129 and +C134 instead of the normal cable entries.

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.

Common output terminal (option +H366)

As standard, each inverter module must be individually cabled to the motor. This option adds bridging that connects the outputs of multiple (in practice, two or three) inverter modules mounted in the same cubicle. The bridging balances the motor current between the modules, which allows more cabling options. For example, it is possible to use a number of cables that could not otherwise be evenly distributed between the inverter modules.

WARNING!

The bridging can carry the nominal output of one inverter module. In case of three parallel modules, ensure that the load capacity of the bridging is not exceeded. For example, if the cabling connects to the output busbars at one module only, use the module in the middle.

Note:

The +H366 option only interconnects the outputs of inverter modules within the same cubicle, not modules installed in different cubicles. Therefore, when the drive has more than three inverter modules, make sure that the load is distributed evenly between the modules:

- In case of two inverter cubicles of two modules, connect the same number of cables to each cubicle.
- In case of one inverter cubicle with three modules and another with two, each cubicle requires a number of cables proportional to the number of modules within. For example,

connect three out of five (or six out of ten, etc.) cables to the cubicle with three modules, the remaining two out of five (four out of ten) cables to the cubicle with two modules.

Additional terminal block X504 (option +L504)

The standard terminal blocks of the drive control unit are wired to the additional terminal block at the factory for customer control wiring. The terminals are spring loaded.

Cables accepted by the terminals:

- solid wire 0.08 to 4 mm2
- stranded wire with ferrule 0.14 to 2.5 mm2
- stranded wire without ferrule 0.08 to 2.5 mm2 (28 to 12 AWG).

Stripping length: 10 mm.

Note:
The optional modules inserted in the slots of the control unit (or optional FEA-03 extension adapter) are not wired to the additional terminal block. The customer must connect the optional module control wires directly to the modules.

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.

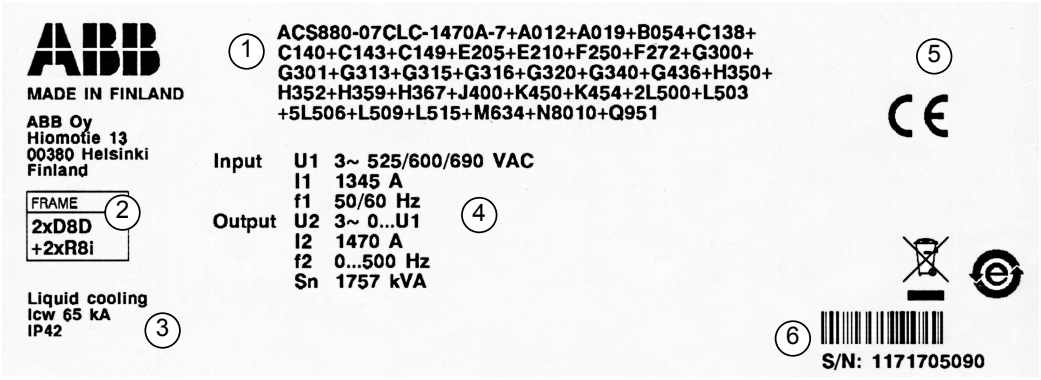
The statuses of both the starter switch and the fan contactor are wired to the terminal block.

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 45)*).
2	Frame size
3	Short-time withstand current rating (see chapter *Technical data (page 151)*); degree of protection; UL/CSA specifications
4	Ratings. See also chapter *Technical data (page 151)*.
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
ACS880-07CLC	Default configuration: liquid-cooled cabinet-installed drive, marine type approval, 50 Hz supply frequency, no main switch or breaker, no input chokes, connection for 230 V AC auxiliary voltage, no capacitor pre-charging circuit, halogen-free wiring, ACS-AP-W assistant control panel, EMC filter (category 3, 2nd Environment), du/dt filters, common mode filtering, ACS880 primary control program, Safe torque off function, cubicle heater elements, coated circuit boards, bottom entry and exit of cables with lead-through-type entries, multilingual door device label sticker, USB memory stick containing circuit diagrams, dimension drawings and manuals.
Size	
xxxxx	Refer to the rating tables

Code	Description
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	
A004	12-pulse supply connection
A006	24-pulse supply connection
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 40)*.
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
C144	Pipe connection on left
C146	External cooling circuit suitable for sea water
C164	Plinth height 100 mm. See section *Descriptions of options (page 40)*.
C176	Door hinges on left
C179	Plinth height 200 mm. See section *Descriptions of options (page 40)*.
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
Resistor braking	
D150	Brake choppers
D151	Brake resistors
Filters	
E205	du/dt filtering
E210	EMC filter for 2nd environment TN (grounded) or IT (ungrounded) system, category C3
Switching and grounding	
F271	Output grounding terminals
F272	Internal charging circuit

Code	Description
Cabinet equipment	
G300	Cabinet and module heating elements (external supply). See section *Descriptions of options (page 40)*.
G301	Cabinet lighting. See section *Descriptions of options (page 40)*.
G313	Output for motor space heater (external supply)
G330	Halogen-free wiring and materials
G338	Additional wire markings. See section *Descriptions of options (page 40)*.
G339	
G340	
G341	
G342	
Cabling	
H350	Supply cabling direction down
H352	Motor cabling direction down
H358	Cable conduit entry (US/UK). See section *Descriptions of options (page 40)*.
H359	Common motor terminal cubicle. See section *Descriptions of options (page 40)*.
H364	Gland plate out of 3 mm thick aluminum, blind
H366	Common output terminals (for inverter modules mounted in the same cubicle). See section *Descriptions of options (page 40)*.
H367	Control cable entry through floor of cabinet
Control panel	
J400	Control panel
Fieldbus adapters, diverse communication options	
K450	Panel bus (control of several units from one control panel)
K451	FDNA-01 DeviceNet™ adapter module
K454	FPBA-01 PROFIBUS DP adapter module
K457	FCAN-01 CANopen adapter module
K458	FSCA-01 RS-485 (Modbus/RTU) adapter module
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
L501	FIO-01 digital I/O extension module
L502	FEN-31 HTL incremental encoder interface module
L503	FDCO-01 optical DDCS communication adapter module
L504	Additional I/O terminal block. See section *Descriptions of options (page 40)*.
L508	FDCO-02 optical DDCS communication adapter module
L525	FAIO-01 analog I/O extension module
L526	FDIO-01 digital I/O extension module

Code	Description
Starter for auxiliary motor fan (see section *Descriptions of options (page 40)*)	
M600	Trip limit setting range: 1 … 1.6 A
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
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
M610	Trip limit setting range: 20…25 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	
Q951	Emergency stop (category 0) with safety relays, by opening the main breaker/contactor
Q954	Earth fault monitoring for IT (ungrounded) systems
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
R706	Finnish
R707	French
R708	Spanish
R709	Portuguese
R711	Russian

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.
- The wall behind the unit is of non-flammable material.
- There is enough free space above the drive to enable cooling, maintenance, and operation of the pressure relief (if present).
- The floor that the unit 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

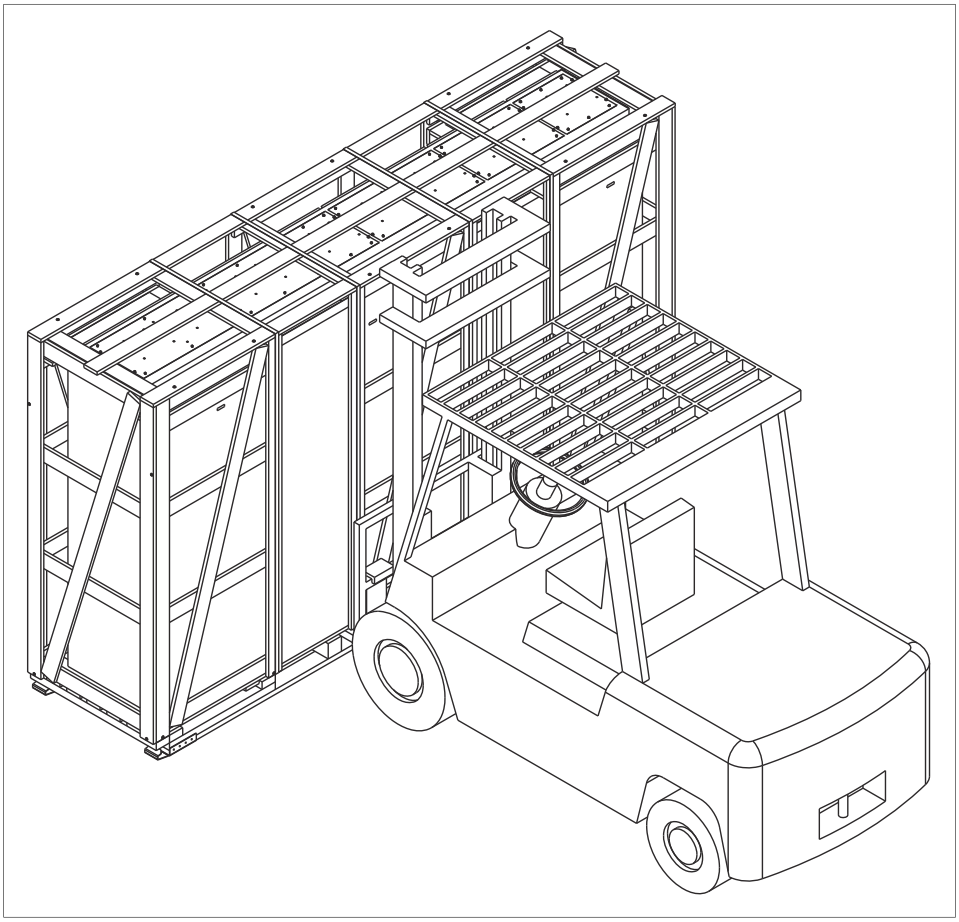
Move the drive in its original packaging to the installation site as shown below to avoid damaging the cabinet surfaces and door devices. When you are using a pallet truck, check its load capacity before you move the drive.

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

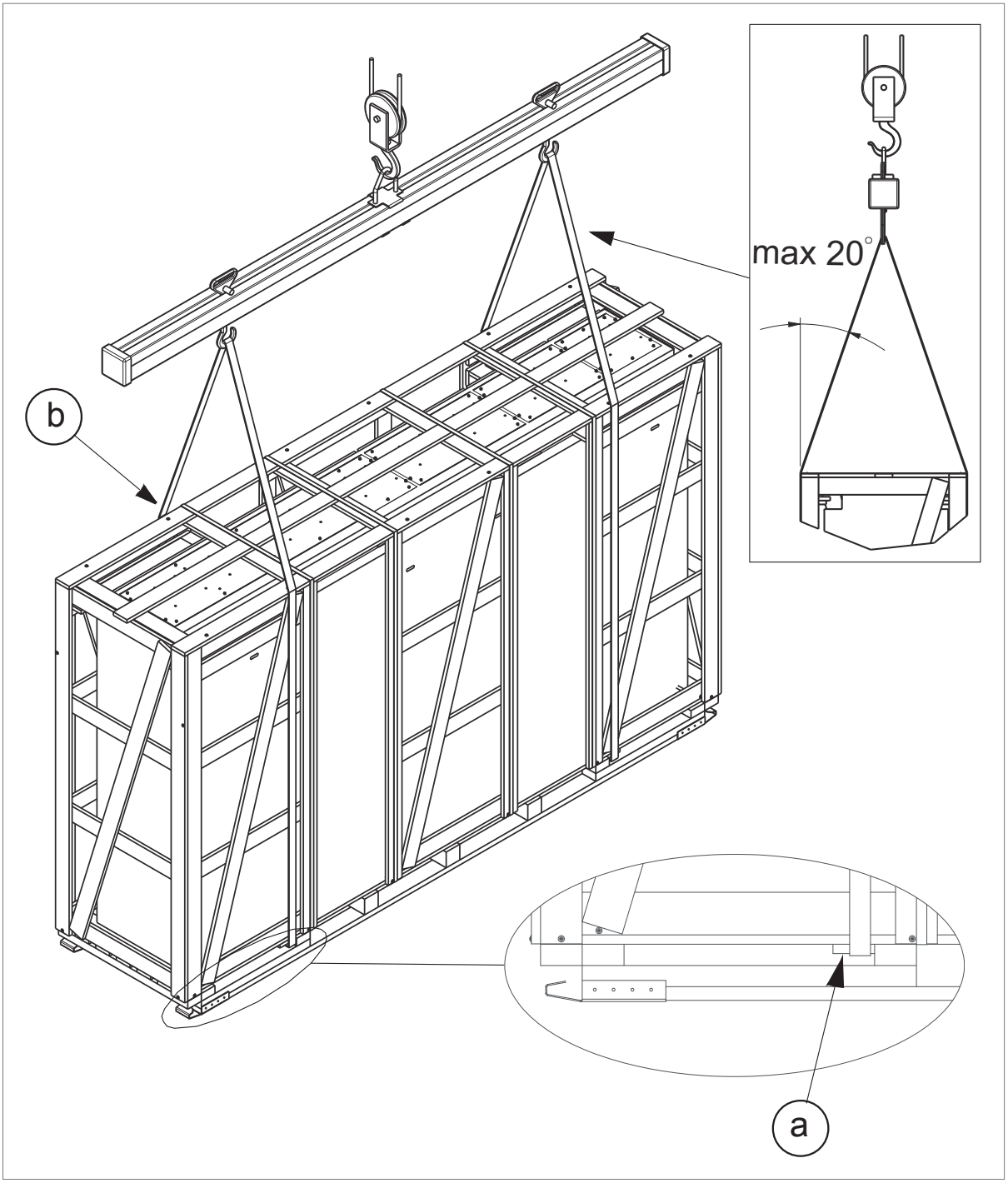
The center of gravity of the cabinet is high. Be therefore careful when moving the unit. Avoid tilting.

Moving the drive in its packaging

Lifting the crate with a forklift



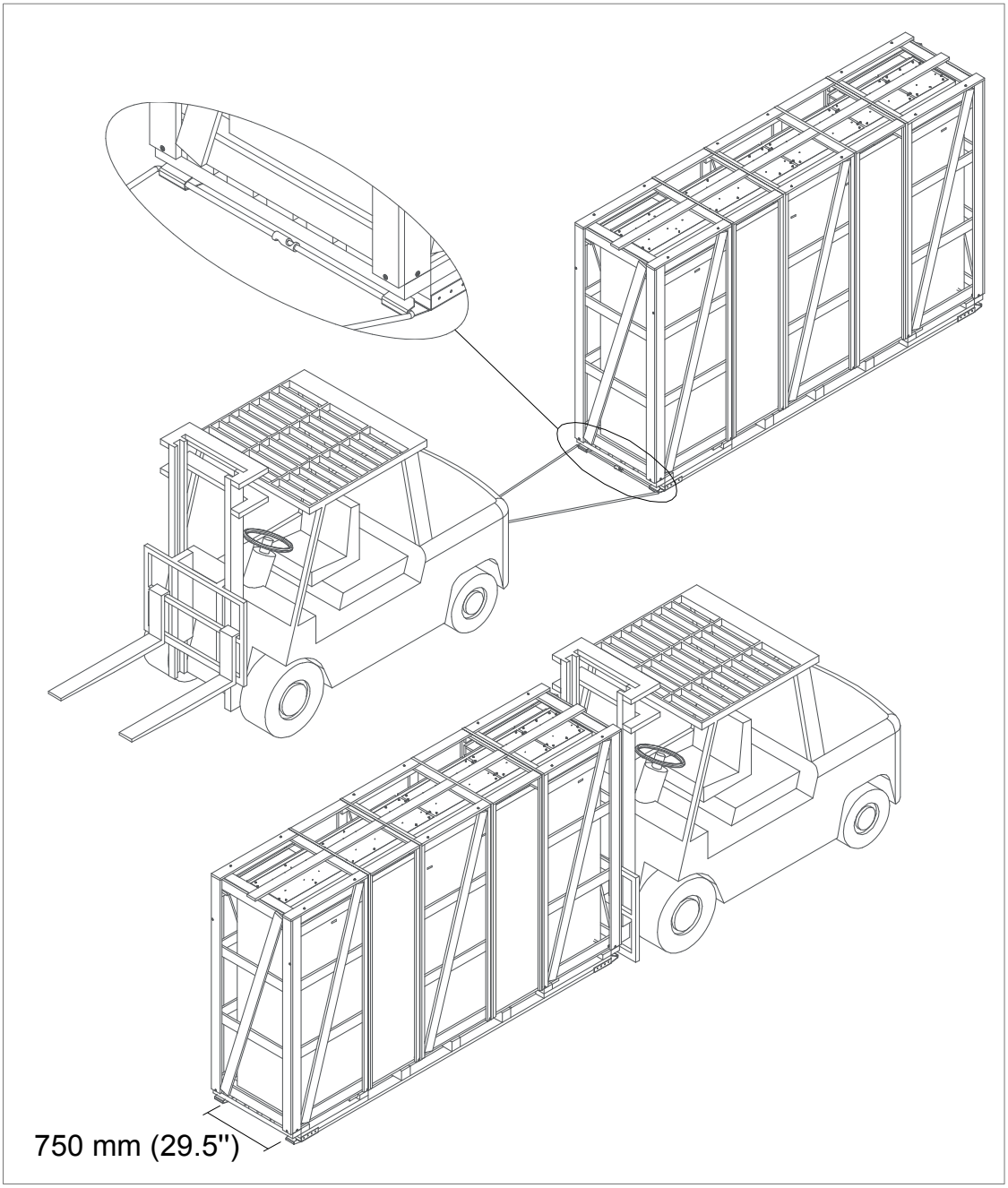
Lifting the crate with a crane



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:

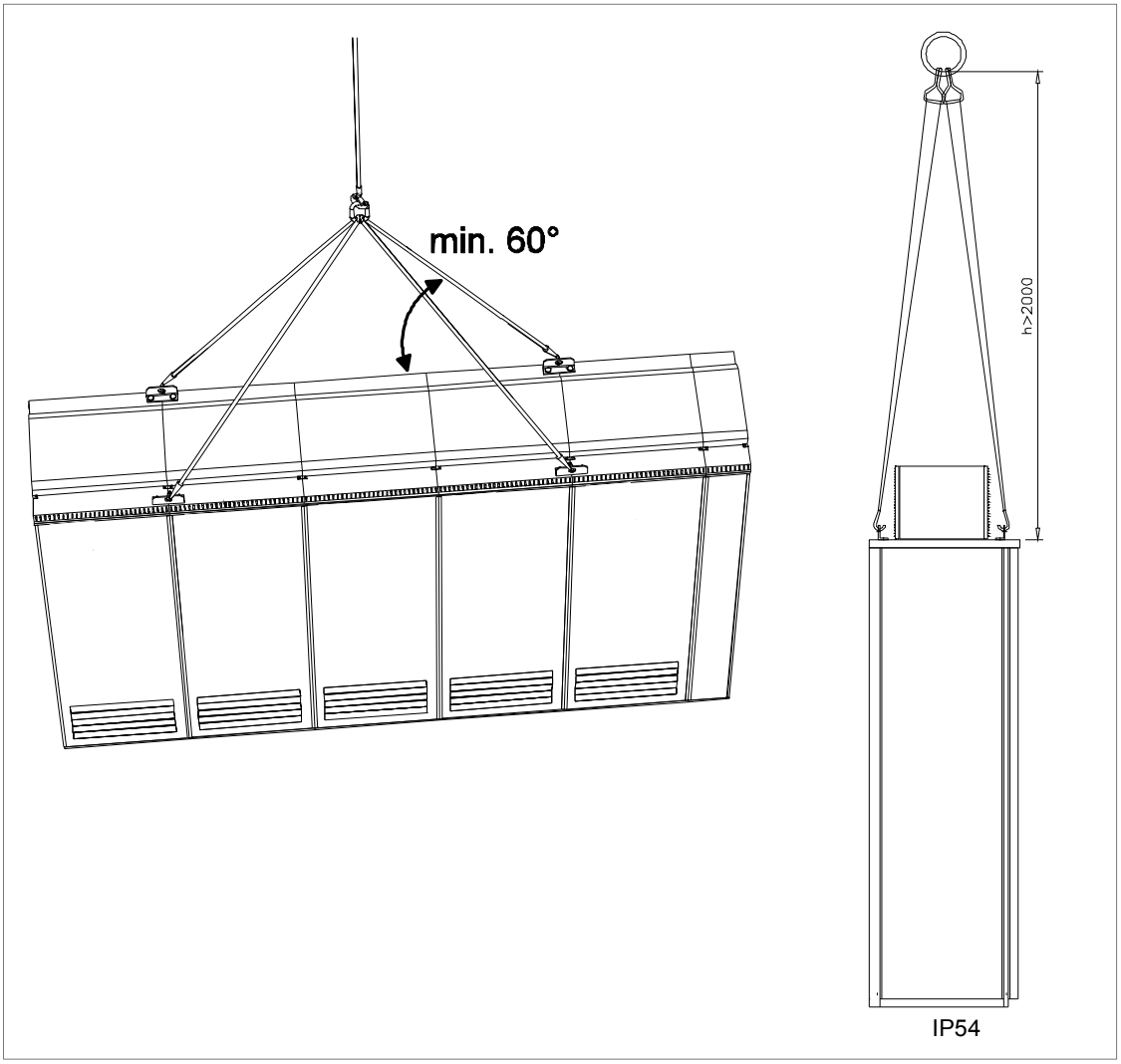
1. Undo the screws that attach the wooden parts of the transport crate to each other.
2. Remove the wooden parts.
3. Remove the clamps with which the drive cabinet is mounted onto the transport pallet by undoing the fastening screws.
4. Remove the plastic wrapping.

Moving the unpacked drive cabinet

Lifting the cabinet with a crane

Lift the drive cabinet using its lifting eyes. The lifting eyes can be removed after the cabinet is in its final position, but their mounting holes must be blocked to retain the degree of protection.

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

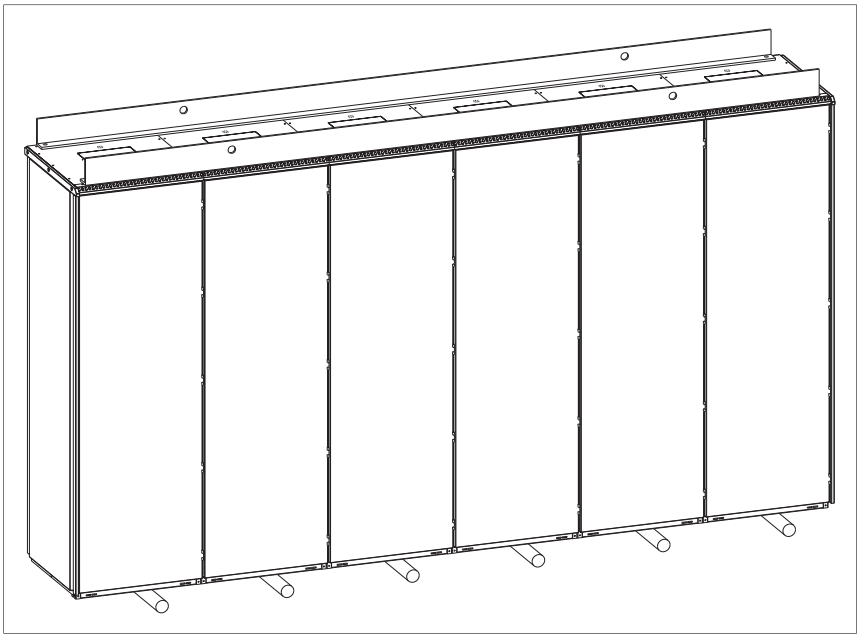


Moving the cabinet on rollers

WARNING!

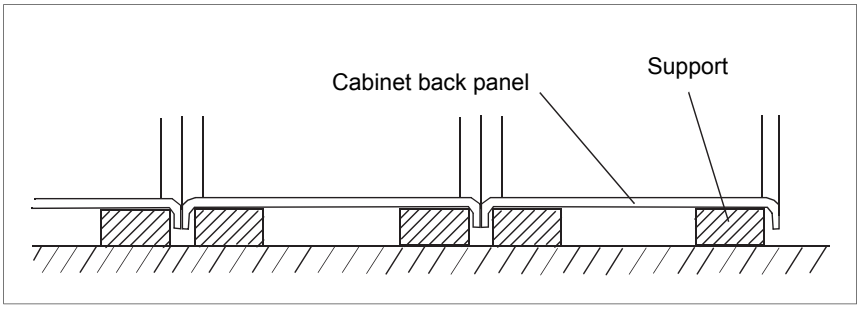
Do not move marine versions (option +C121) on rollers.

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.



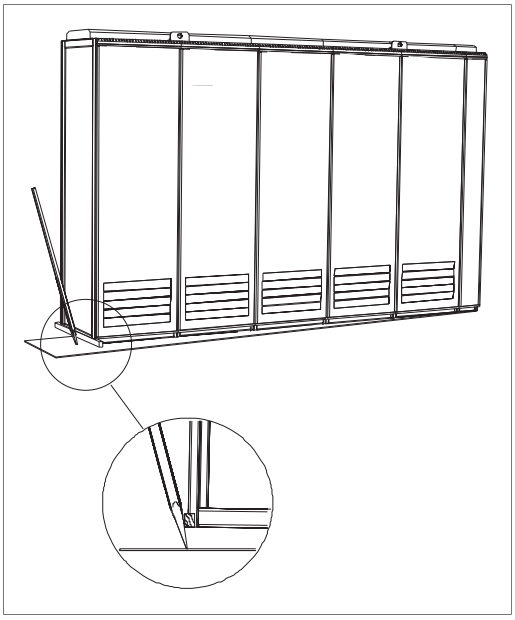
Moving the cabinet on its back

Support the cabinet from below alongside the cubicle seams.



Final placement of the cabinet

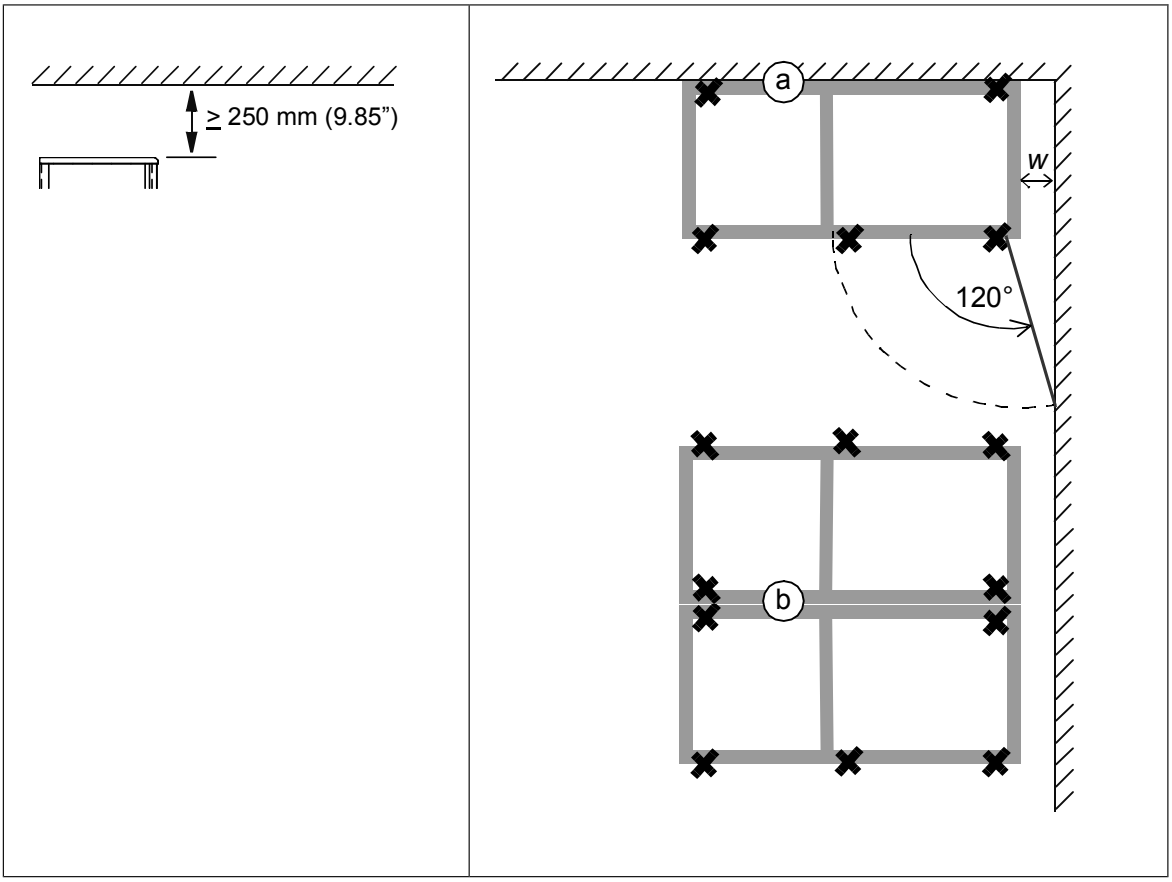
Move the cabinet into its final position with a slate bar (spud bar). Place a piece of wood between the edge of the cabinet and the bar to protect the cabinet frame.



Fastening the cabinet to the floor and wall or roof

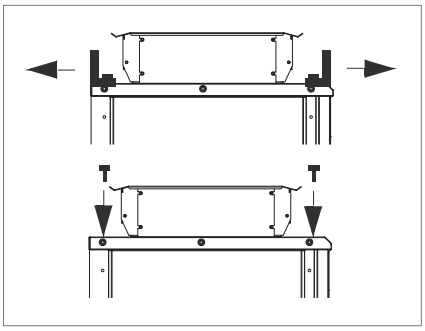
General rules

- 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 units or shipping splits together. Height adjustment can be done by using metal shims between the cabinet bottom and floor.

Note 2: If the cabinet is delivered with lifting bars, remove them. 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).



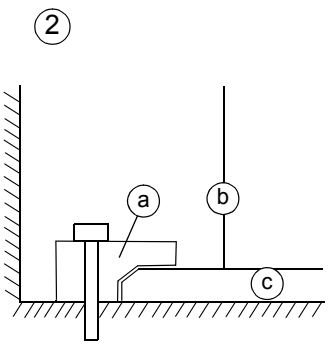
Fastening the cabinet (marine units)

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).

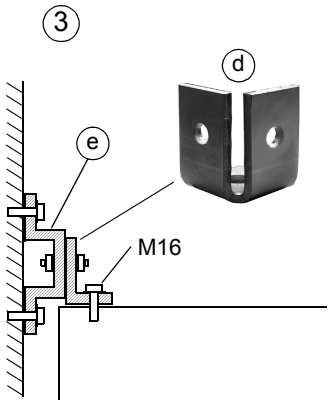
Fastening to floor with a clamp



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



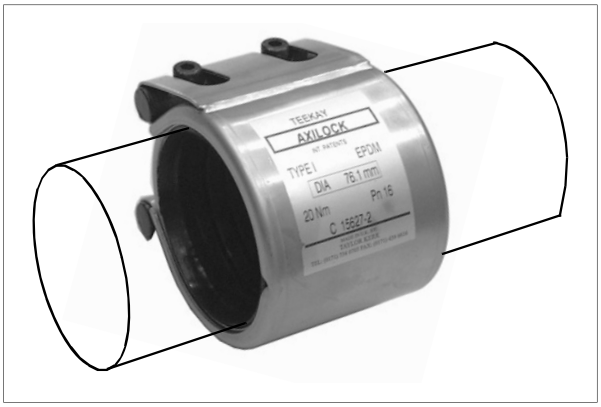
3. Fastening the cabinet at the top

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

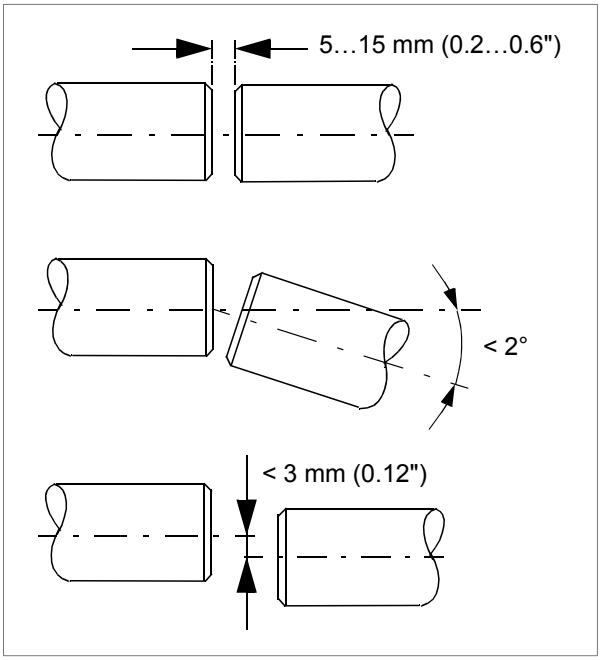
Joining cabinet sections together

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.

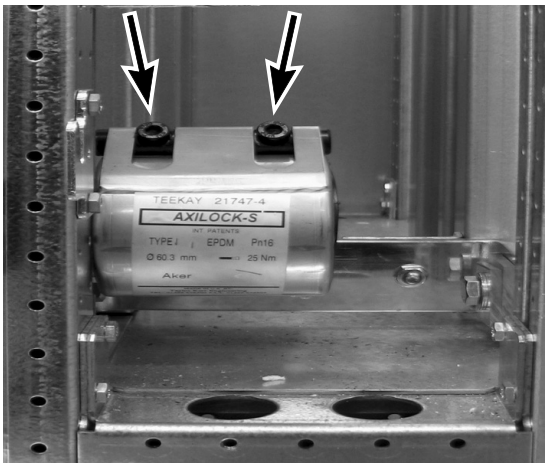
1. Fasten the first section to the floor.
2. Remove any plates covering the rear post of the joining cubicle.
3. Slide Axilock connectors onto the coolant pipes at the joint.



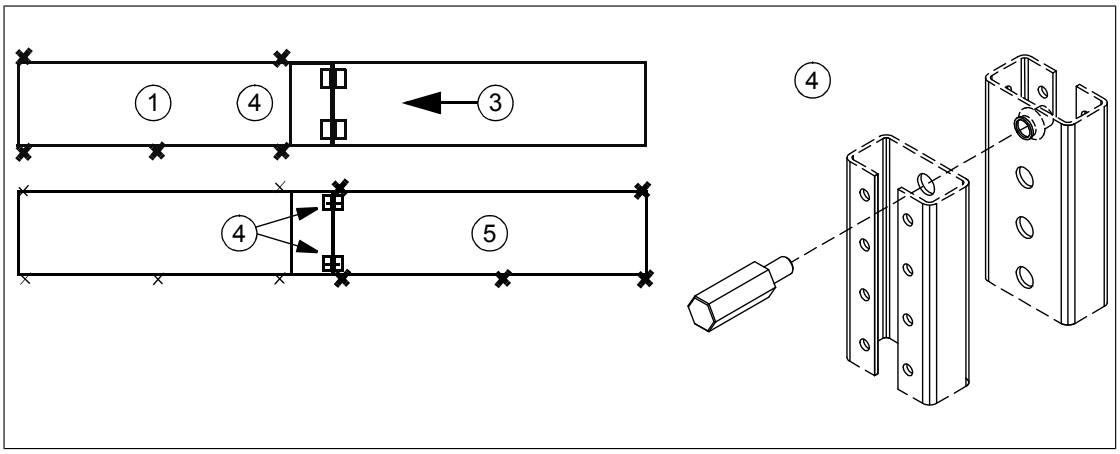
4. Align the two sections.
   The coolant pipe ends must be aligned as shown.



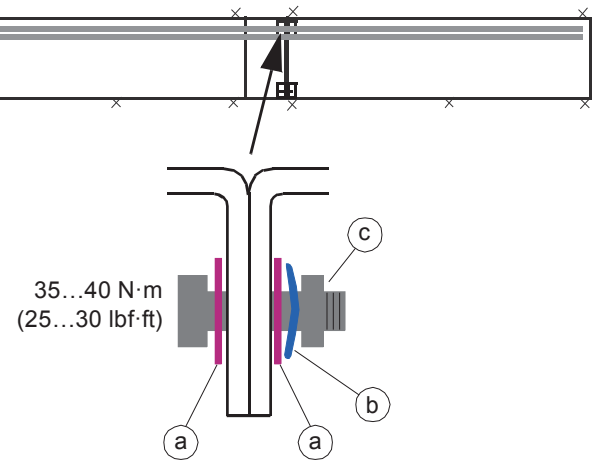
5. Center the Axilock connectors onto the gaps between coolant pipe ends. Tighten the connector screws to the torque indicated on the connector label.



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.



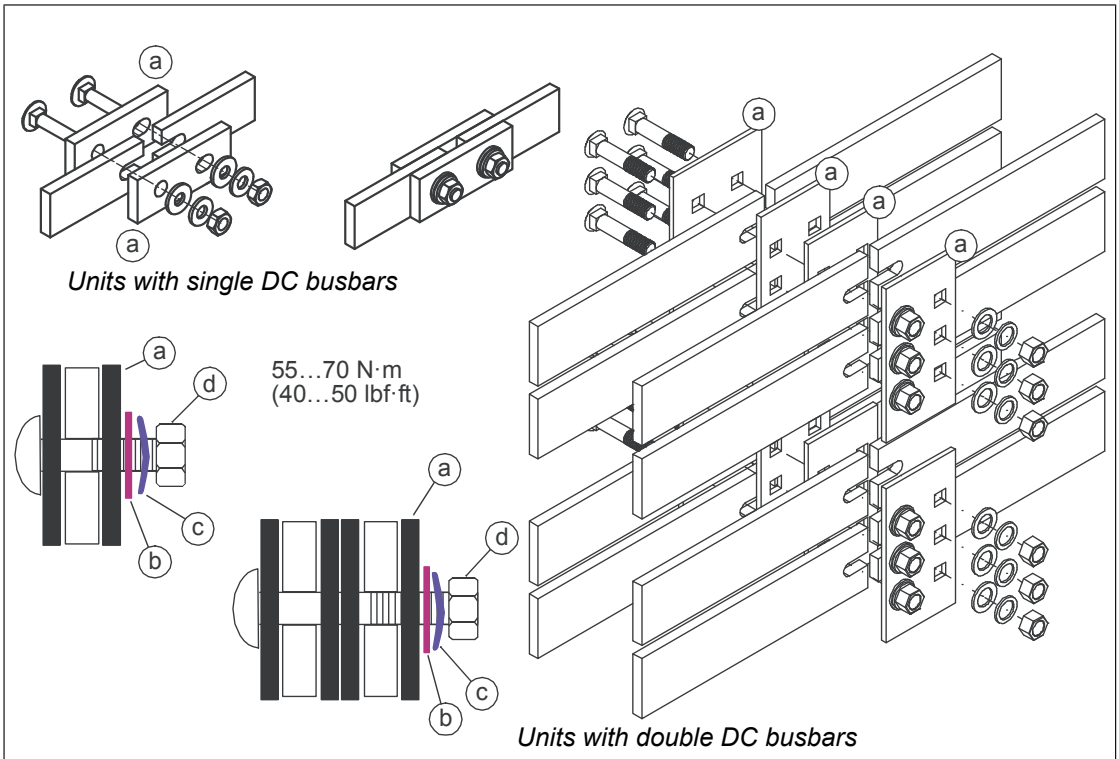
8. Connect the PE busbars using the M10 bolts and nuts included. Tighten to 35…40 N·m (25…30 lbf·ft).



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.

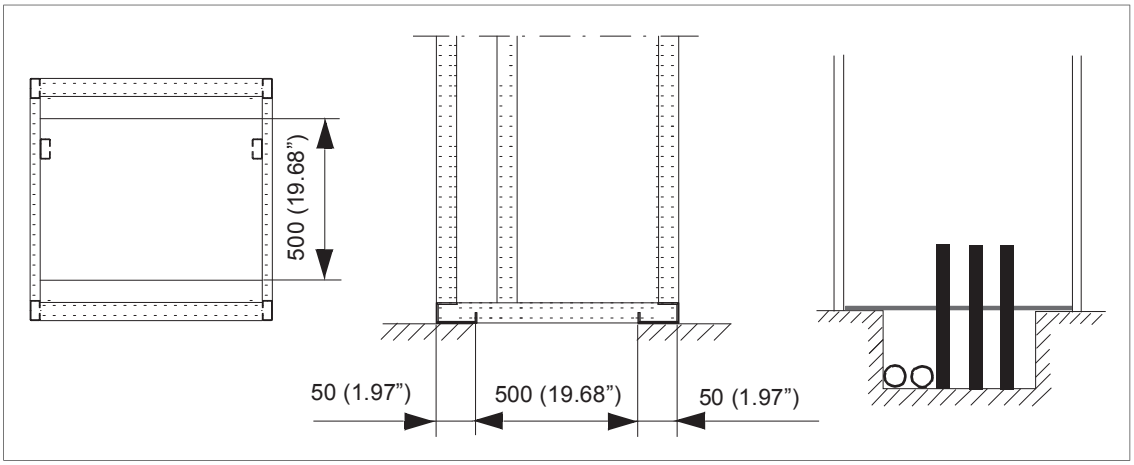
11. Reinstall any covering plates removed earlier.
12. Repeat procedure for any further sections.

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 transformer

The drive does not have input chokes. For this reason, the following requirements for the supply transformer apply:

- Transformer impedance must suit the supply rectifier of the drive,
- transformer reactance (X_k) must be at least 4%, and
- nominal apparent power of the transformer should not exceed 2 × S_N of the drive.

Selecting the main disconnecting device

You must equip the drive with a main disconnecting device which meets the local safety regulations.

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

- switch-disconnector, with or without fuses, in accordance with IEC 60947-3, utilization category AC-23B or DC-23B
- control and protective switching device suitable for isolation, in accordance with IEC 60947-6-2
- a circuit-breaker suitable for isolation in accordance with IEC 60947-2
- any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements and the appropriate utilization category and/or specified endurance requirements defined in the product standard.

Selecting the main contactor or breaker

The installer must provide an external main contactor or breaker as the drive does not have an internal main contactor or breaker.

Obey these guidelines when you select the main contactor (breaker):

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

See also section *Contact data for main contactor/breaker control (page 164)*.

Examining the compatibility of the motor and drive

Use an 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 tables on basis of the AC line voltage and motor load. Use the DriveSize PC tool if you need to tune the selection more in detail.

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

Note:

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

Protecting the motor insulation and bearings

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

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

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

Requirements table

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

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

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

1) manufactured before 1.1.1998

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

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

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

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

The abbreviations used in the tables are defined below.

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

Availability of du/dt filter and common mode filter by drive type

Product type	Availability of d*u*/d*t* filtering	Availability of common mode filtering (CMF)
ACS880-07	Optional (+E205)	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 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 + du/dt	+ N + d*u*/d*t* + CMF
	Reinforced: $\hat{U}_{LL}$ = 2000 V, 0.3 microsecond rise time [1)]	+ N + CMF	+ N + CMF

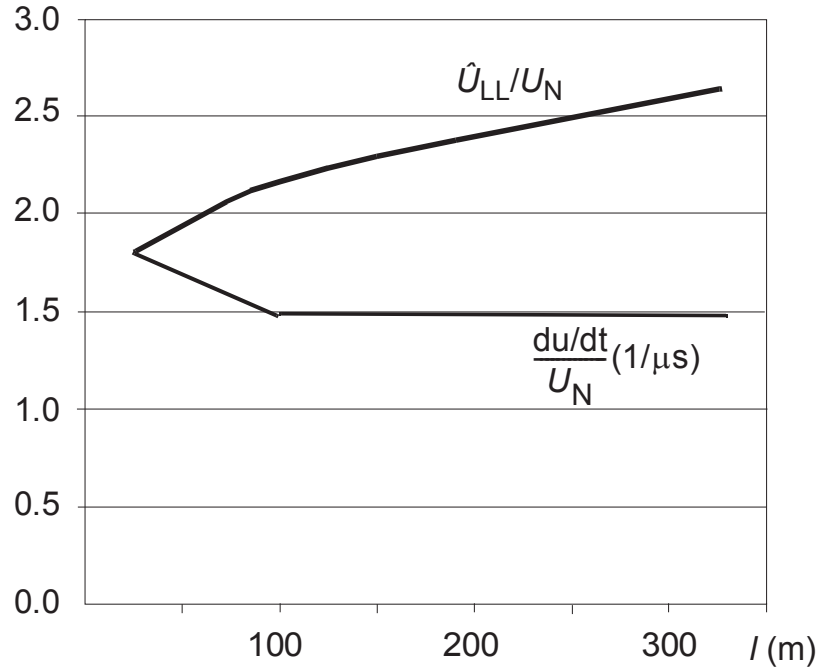
1) If the intermediate DC circuit voltage of the drive is increased from the nominal level due to long term resistor braking cycles, check with the motor manufacturer if additional output filters are needed in the applied drive operation range.

Additional data for calculating the rise time and the peak line-to-line voltage

If you need to calculate the actual peak voltage and voltage rise time considering the actual cable length, proceed as follows:

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

The peak voltage and voltage change rate are shown below.



l	Motor cable length
$\hat{U}_{LL}/U_N$	Relative peak line-to-line voltage
(d*u*/d*t*)/U_N	Relative d*u*/d*t* value

Note:
$\hat{U}_{LL}$ and d*u*/d*t* values are approximately 20% higher during resistor braking.

Selecting the power cables

General rules

Select the input power and motor cables according to local regulations. Obey these rules:

- Select a cable capable of carrying the nominal current.
- Select a cable rated for at least 70 °C maximum permissible temperature of conductor in continuous use.
- The inductance and impedance of the PE conductor/cable (grounding wire) must be rated according to permissible touch voltage appearing under fault conditions (so that the fault point voltage will not rise excessively when a ground fault occurs).
- 600 V AC cable is accepted for up to 500 V AC. 750 V AC cable is accepted for up to 600 V AC. For 690 V AC rated equipment, the rated voltage between the conductors of the cable should be at least 1 kV.
- With US installations, consider the additional US requirements.

Use symmetrical shielded input power cables. The cabling has to be identical (length and cross-sectional area) between all the parallel-connected supply modules. Each module must have its own shielded 3-conductor input AC cable with the minimum length of 5 m (16.4 ft). This ensures uniform loading of all the three input phases. Single-conductor cables cannot be used.

Use symmetrical shielded motor cable. Ground motor cable shields 360° at both ends. Keep the motor cable and its PE pigtail (twisted shield) as short as possible to reduce high-frequency electromagnetic emissions.

Note: When continuous metal conduit is employed, shielded cable is not required. The conduit must have bonding at both ends.

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 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 Sp (mm^2)
S ≤ 16	S
16 < S ≤ 35	16
35 < S	S/2

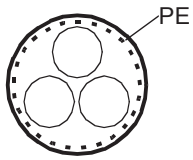
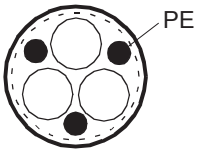
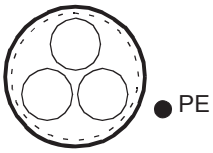
Typical power cable sizes

See chapter *Technical data* for the typical power cable sizes for each drive type.

Alternative 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 cable with three phase conductors and a concentric PE conductor as shield.	Yes.	Yes.
 Symmetrical shielded cable with three phase conductors and symmetrically constructed PE conductor, and a shield.	Yes.	Yes.
 Symmetrical shielded cable with three phase conductors and a shield, and a separate PE conductor/cable	Yes. A separate PE conductor is required if the shield does not agree with the PE conductor requirements. **Note:** If the shield size is smaller than 10 mm^2 Cu (or 16 mm^2 Al), you need two PE conductors typically, for example, the shield and a separate conductor/cable. This is due to the safety regulations related to the leakage current. See IEC/EN 61800-5-1, or the drive safety instructions for more information.	Yes. A separate PE conductor is required if the shield does not agree with the PE conductor requirements.

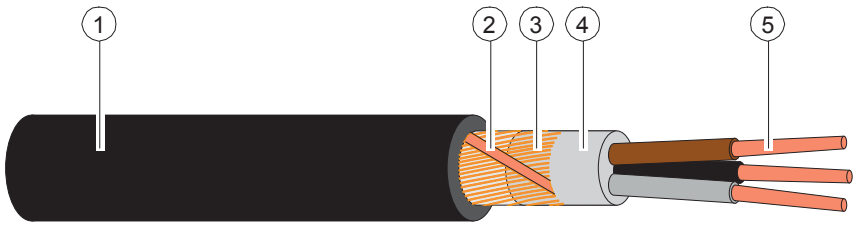
Not allowed power cable types

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 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

Planning the resistor braking system

See chapter *Resistor braking (page 203)*.

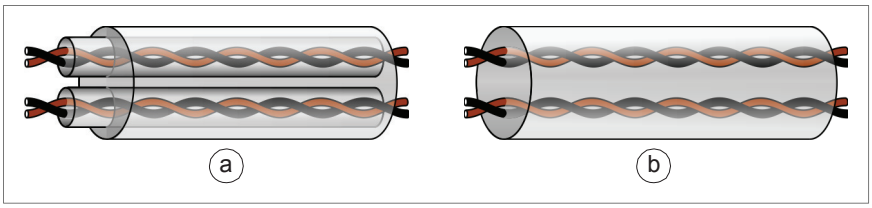
Selecting the control cables

Shielding

All control cables must be shielded.

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. Never mix 24 V DC and 115/230 V AC signals in the same cable.

Signals allowed to be run in the same cable

Relay-controlled signals, providing their voltage does not exceed 48 V, 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 cable length and type

In remote use, the cable connecting the control panel to the drive must not be longer than three meters (10 ft). Cable type: shielded CAT 5e or better Ethernet patch cable with RJ-45 ends.

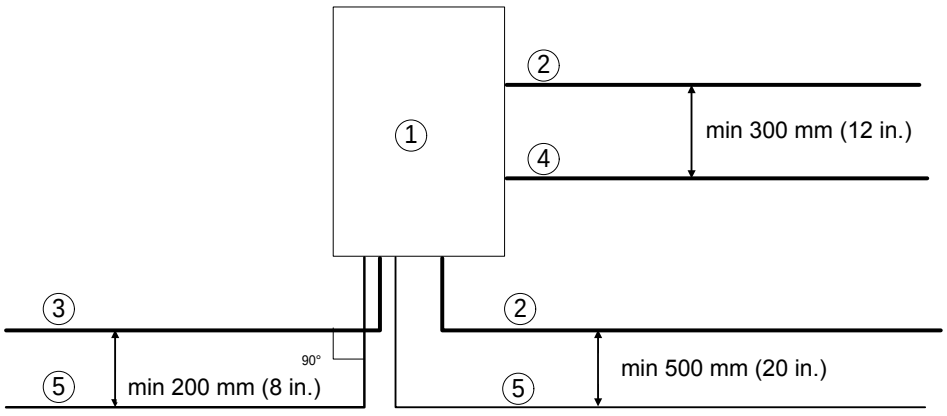
Routing the cables

Route the motor cable away from other cable routes. Cables of several motors can be run in parallel installed next to each other. The motor cable, input power cable and control cables should be installed 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.

The cable trays must have good electrical bonding to each other and to the grounding electrodes. Aluminum tray systems can be used to improve local equalizing of potential.

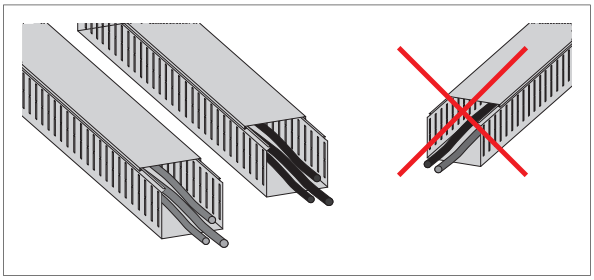
A diagram of the cable routing is shown below.



1	Drive
2	Motor cable
3	Input power cable
4	Power cable
5	Control cable

Separate control cable ducts

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



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:

- European Union: Install the equipment in a metal enclosure with 360 degree grounding for the shields of both the incoming and outgoing cable, or connect the shields of the cables otherwise together.
- US: Install the equipment in a metal enclosure in a way that the conduit or motor cable shielding runs consistently without breaks from the drive to the motor.

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 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, eg. Klixon
- motor sizes IEC200…250 and larger: PTC or Pt100.

See the firmware manual for more information on the motor thermal protection, and the connection and use of the temperature sensors.

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 in TN (grounded) networks. This is not a personnel safety or a fire protection feature. The ground fault protective function can be disabled with a parameter, refer to the firmware manual.

An optional ground fault monitoring device (+Q954) is available for IT (ungrounded) systems. The option includes a ground fault indicator on the drive cabinet door.

Residual current device compatibility

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

Note:
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 fault current circuit breakers to function.

Implementing the emergency stop function

You can order the drive with a category 0 or category 1 emergency stop function.

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

Note:

Pressing the stop key ⛛ on the control panel of the drive, or turning the operating switch of the drive from position “1” to “0” does not generate an emergency stop of the motor or separate the drive from dangerous potential.

See the appropriate emergency stop user’s manual for the wiring, start-up and operation instructions.

Option code	User’s manual	Manual code (English)
+Q951	Emergency stop, stop category 0 (using main contactor/breaker)	3AXD50000207848
+Q951+Q984	Emergency stop, stop category 0 (using main contactor/breaker) with push button monitoring	

Implementing the Safe torque off function

See chapter *The Safe torque off function (page 189)*.

Implementing the Power-loss ride-through

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

- Check that the power-loss ride-through function of the inverter unit is enabled with parameter *30.31 Undervoltage control* in the ACS880 primary control program.
- 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.

WARNING!

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

Implementing 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 certain cabinet-built drive types. Consult ABB for more information.

WARNING!

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

Supplying power for the auxiliary circuits

The customer/installer must provide the auxiliary voltage from an external supply to the drive. For details, see the circuit diagrams delivered with the drive.

The following options are to be supplied from external power sources:

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

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 three phase 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

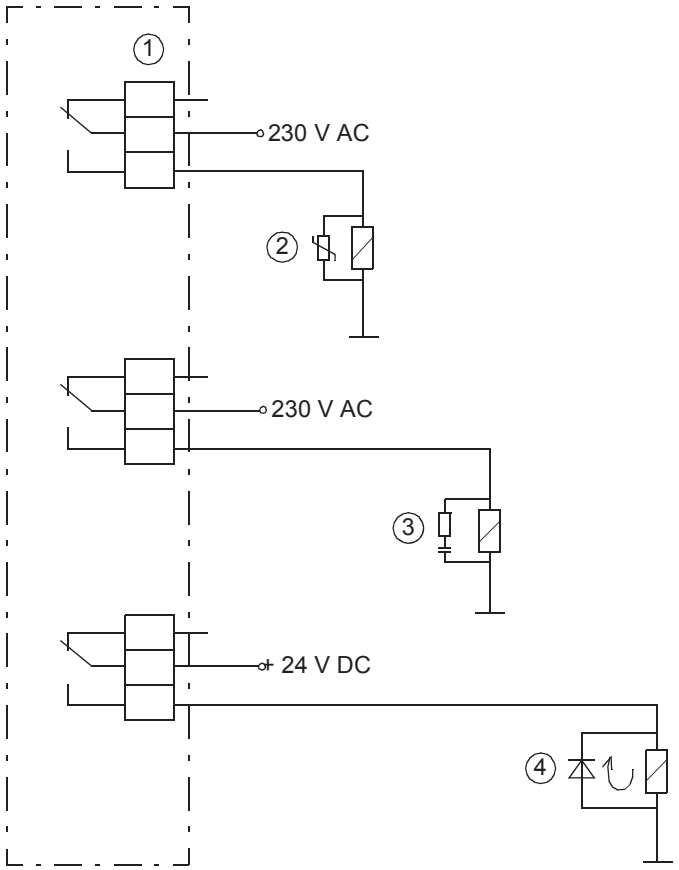
We recommend to install a safety switch between the permanent magnet synchronous motor and the drive output. The switch is needed to isolate the motor during any maintenance work on the drive.

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]) in order 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 outputs
2	Varistor
3	RC filter
4	Diode

Implementing a motor temperature sensor connection

WARNING!

IEC/EN 60664 requires 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.
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 *Connection of motor temperature sensor to the drive via an option module (page 81)*.

4. You can connect a sensor to a digital input of the drive via an external thermistor relay. The insulation of the relay of must be rated for the main circuit voltage of the motor.

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

Extension 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 extension 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).

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 drive

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.

Connecting the control cables

See chapter *Control units of the drive (page 103)* 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.

WARNING!

The alarm indication connections of optional ground fault monitoring (+Q954) at terminal block X22.2 are decisive voltage class DVC-C. Do not connect these terminals to, for example, the 24 V DC circuit.

Control cable connection procedure

WARNING!

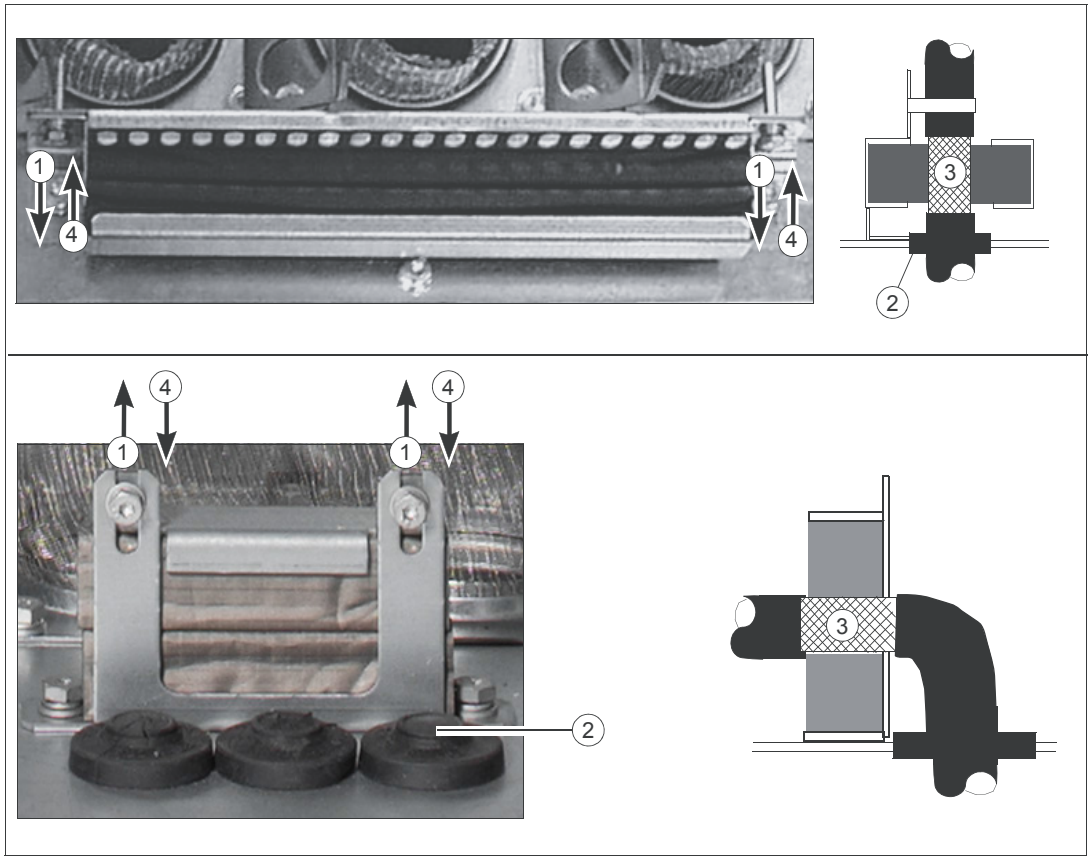
Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section *Electrical safety precautions (page 16)* 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 86)*.
4. Connect the control cables as described in section *Connecting control cabling (page 86)*.

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):

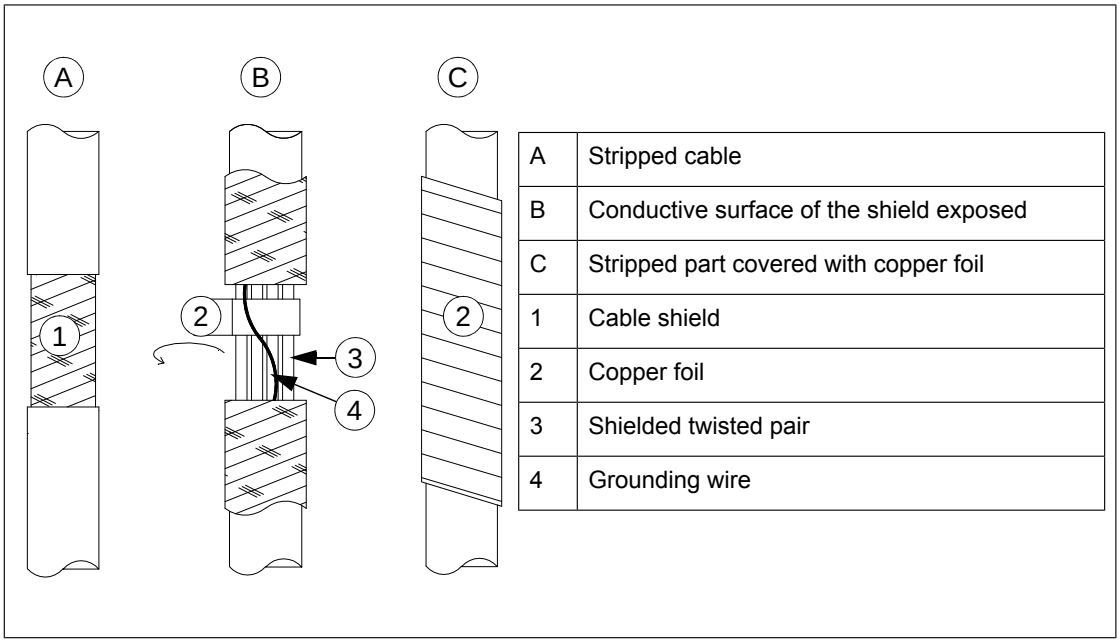
1. Loosen the tightening screws of the EMI conductive cushions and pull the cushions apart.
2. Cut adequate holes to the rubber grommets in the entry plate and put the cables through the grommets and the cushions.
3. Strip off the cable plastic sheath above the entry plate just enough to ensure proper 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.



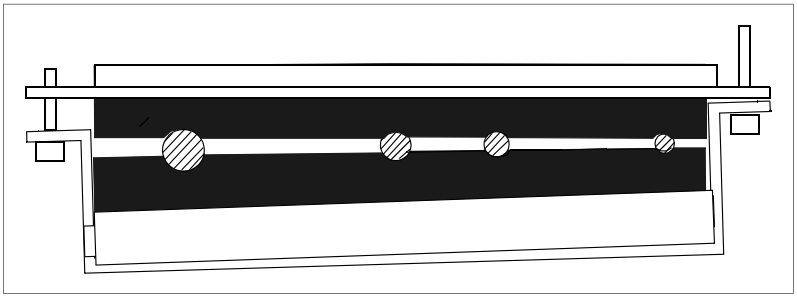
A	Stripped cable
B	Conductive surface of the shield exposed
C	Stripped part covered with copper foil
1	Cable shield
2	Copper foil
3	Shielded twisted pair
4	Grounding wire

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.

With option +L504, the terminals of the inverter control unit are available on terminal block X504.

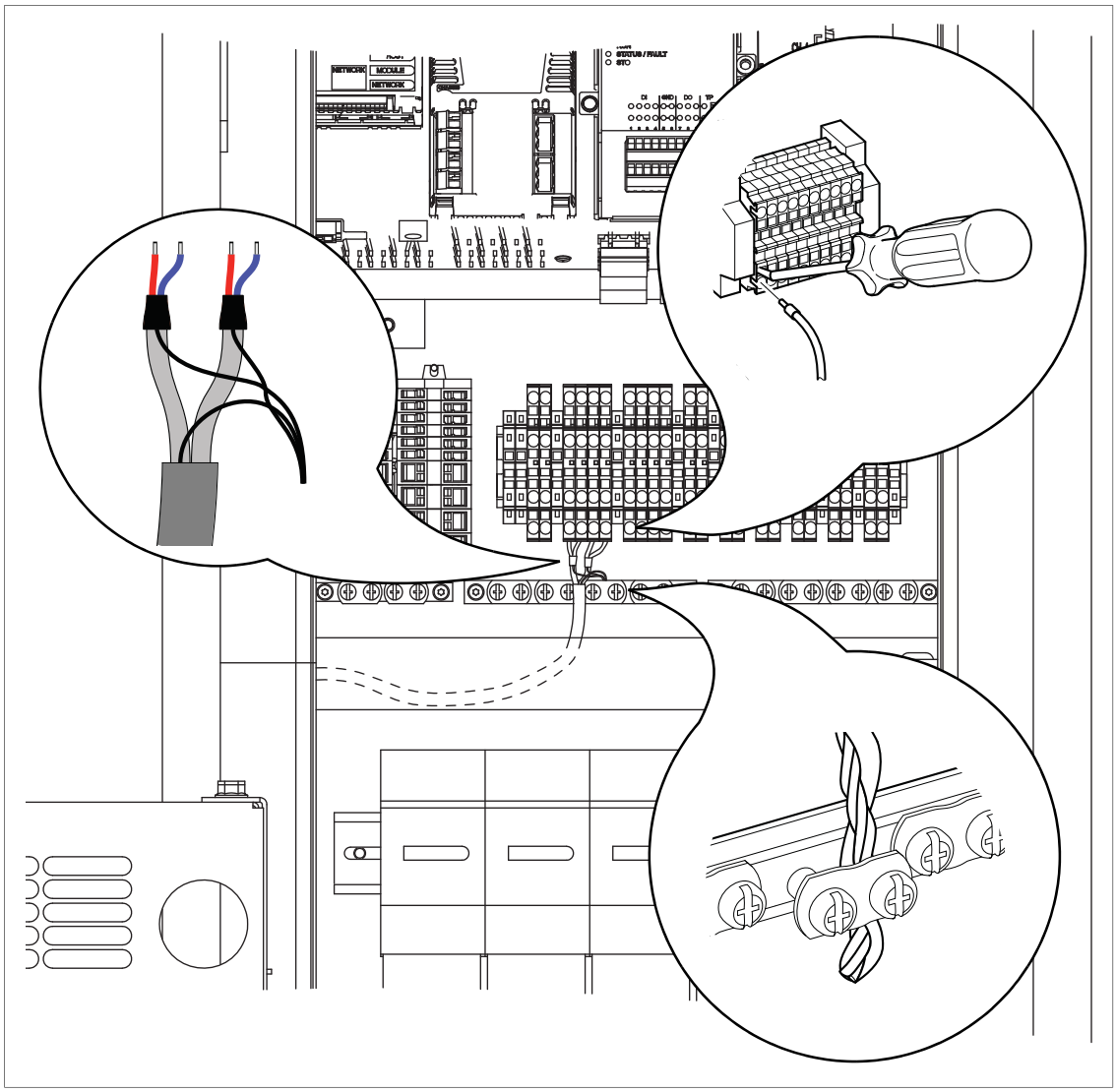
Connect the inner twisted pair shields and all separate grounding wires to the grounding clamps closest to the terminals.

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)

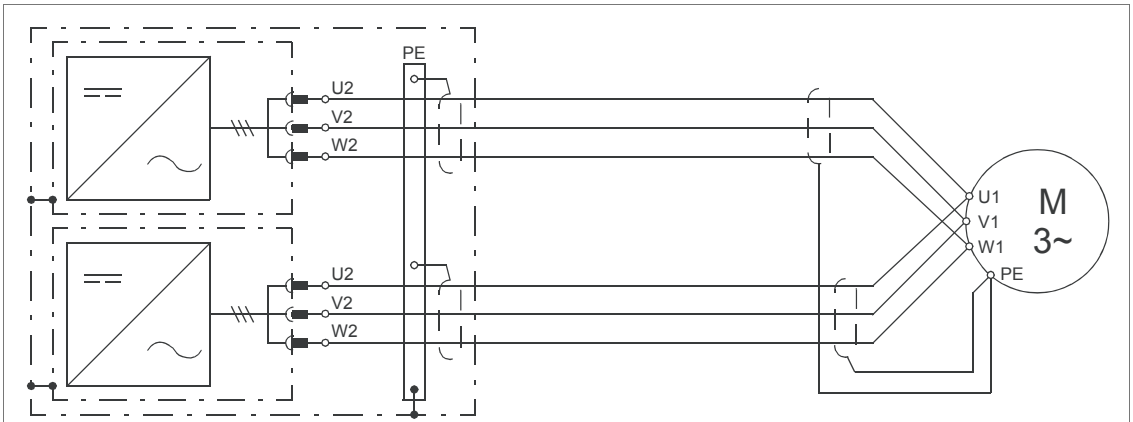
On units without a common motor terminal cubicle, the motor cables connect to busbars located in the inverter module cubicles. To access the terminals, the cooling fans and other equipment in front of the terminals must be removed from the cubicle.

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 92)*.

Motor connection diagram (without option +H366)

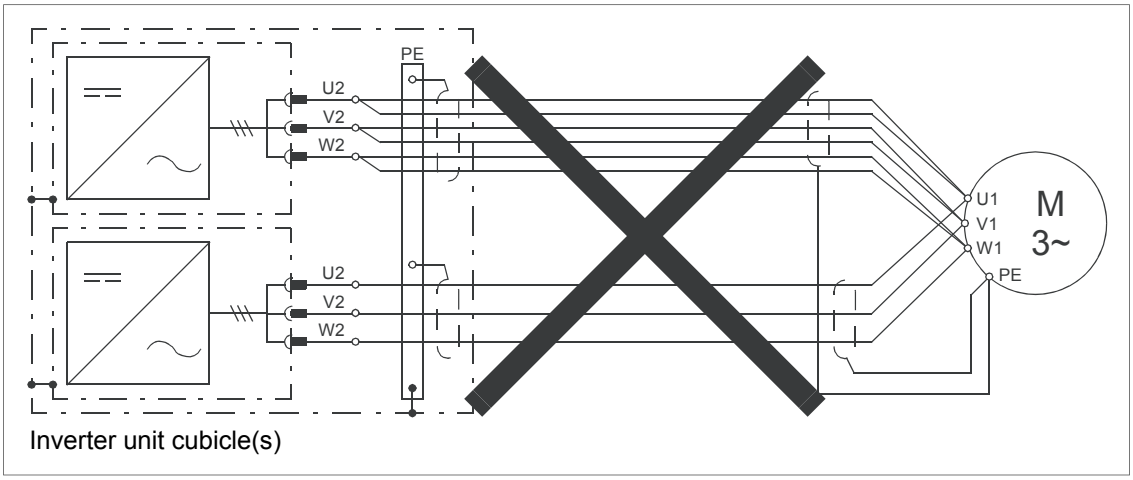
All parallel-connected inverter modules are to be cabled separately to the motor. 360° earthing is to be used at cable lead-throughs.



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

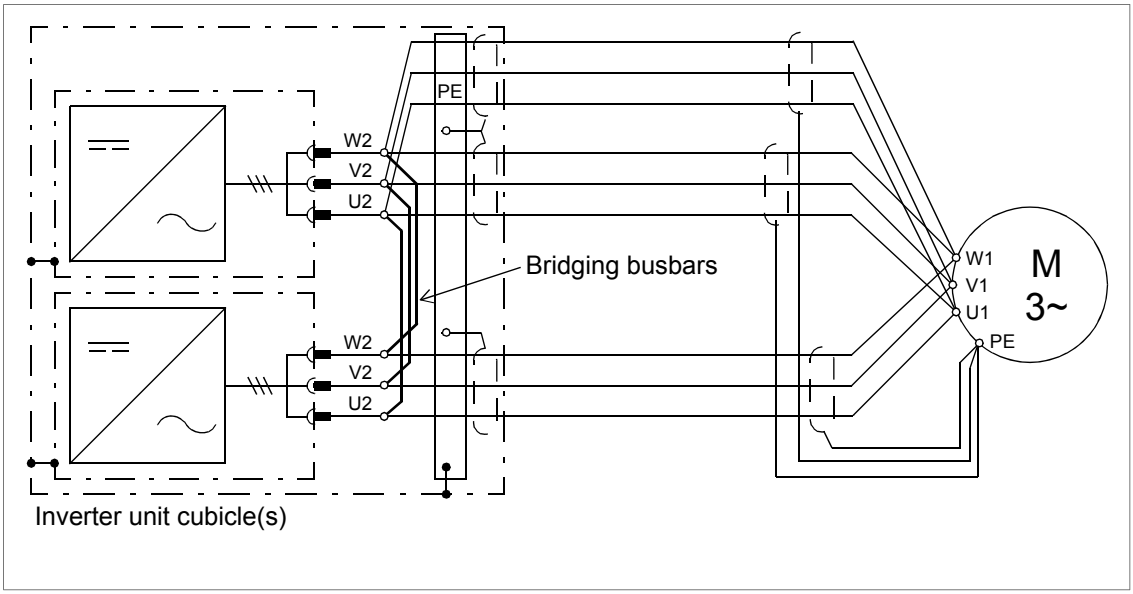
WARNING!

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



Motor connection diagram (with option +H366)

With option +H366, the output busbars of the inverter modules **within the same cubicle** are connected by bridging busbars. The bridging balances the motor current between the modules, which allows more cabling options. For example, it is possible to use a number of cables that could not otherwise be evenly distributed between the inverter modules.



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

WARNING!

The bridging can carry the nominal output of one inverter module. In case of three parallel modules, ensure that the load capacity of the bridging is not exceeded. For example, if the cabling connects to the output busbars at one module only, use the module in the middle.

Note:

The +H366 option only interconnects the outputs of inverter modules within the same cubicle, not modules installed in different cubicles. Therefore, when the drive has multiple inverter cubicles (ie. two cubicles of two modules each), make sure that the motor cabling is identical for both cubicles.

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.

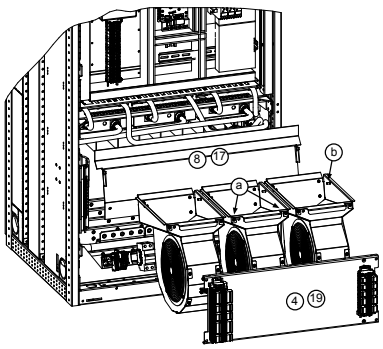
1. Do the steps in section *Electrical safety precautions (page 16)* before you start the work.
2. Open the inverter module cubicle door.
3. Remove the shrouding at the lower part of the cubicle (not shown).
4. Unplug the wiring from the lower front mounting plate. Remove the plate.
5. Disconnect the wiring from the cooling fans.
6. Undo the two retaining screws (a) of each fan.

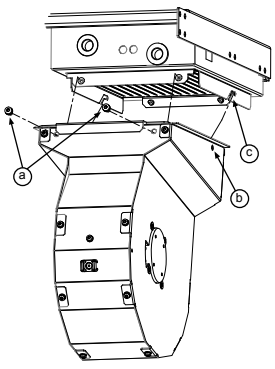
7. Pull each fan outwards to separate them from the heat exchanger housing.
8. Remove the inner shroud.
9. Peel off 3 to 5 cm (1.2 to 2 inches) of the outer insulation of the cables above the lead-through plate for 360° high-frequency grounding.
10. Prepare the ends of the cables.

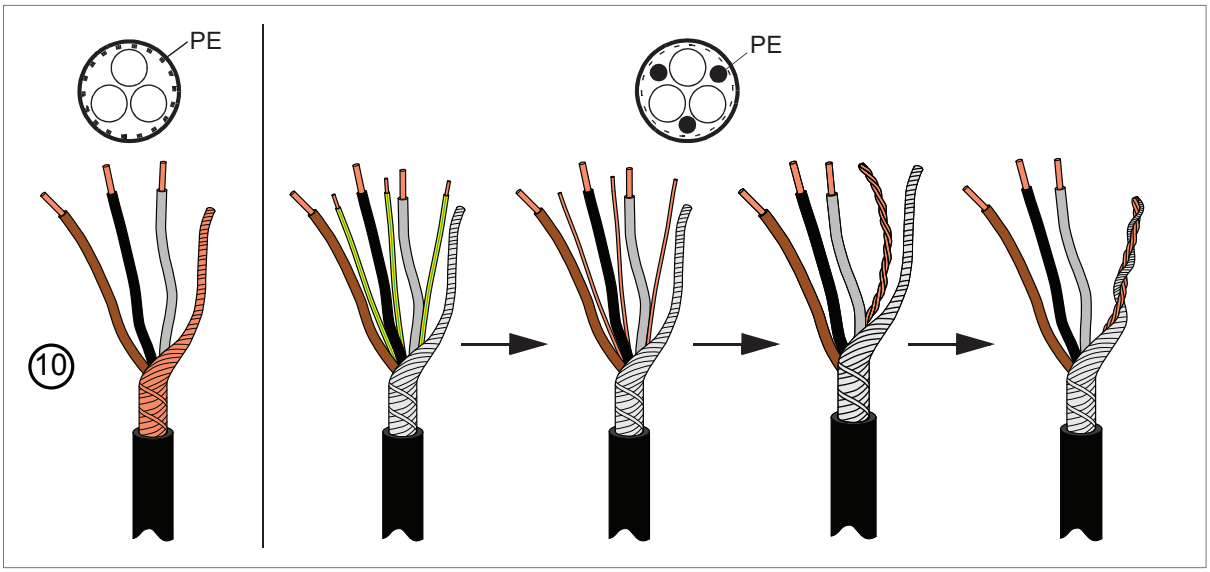
WARNING!

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 171)*.
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.



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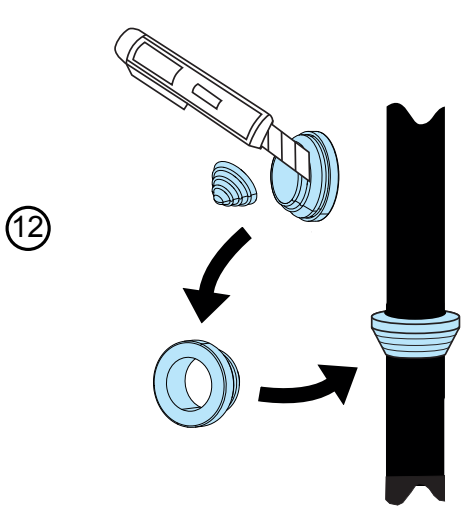
PE
10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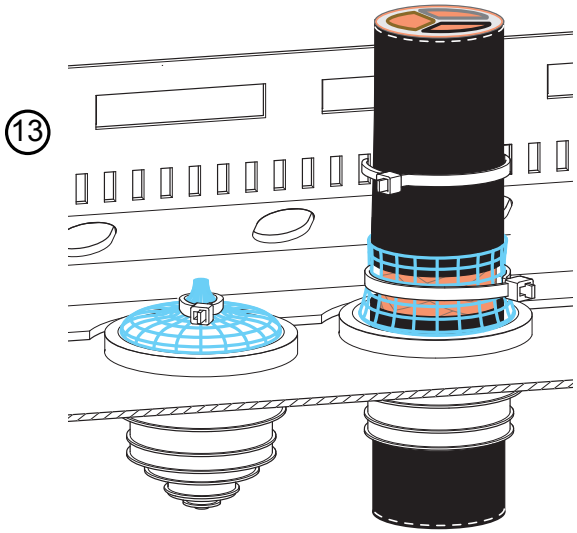
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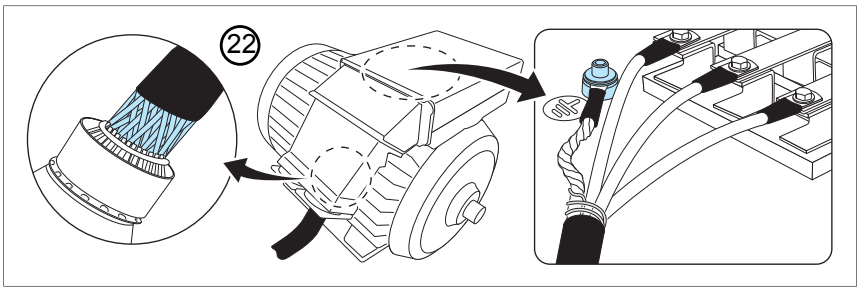

22

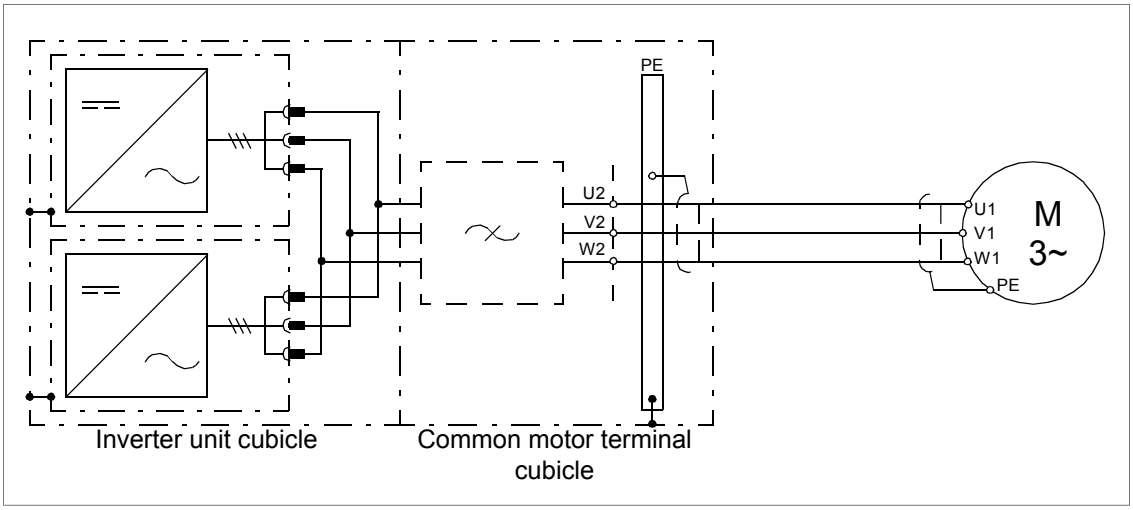
Connecting the motor cables (units with common motor terminal cubicle)

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 for either case are visible in the dimensional drawings delivered with the drive, as well as the example dimension drawings in the manual.

Connection diagram



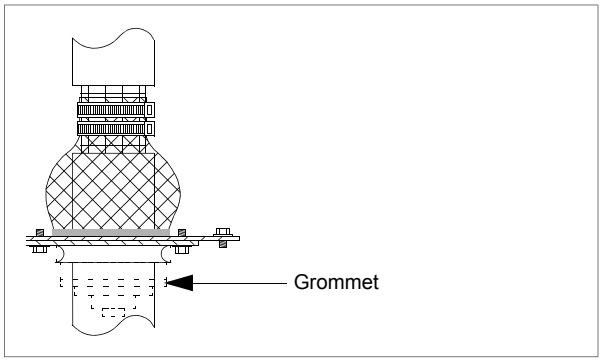
The recommended cable types are given in chapter *Technical data*.

Procedure

WARNING!

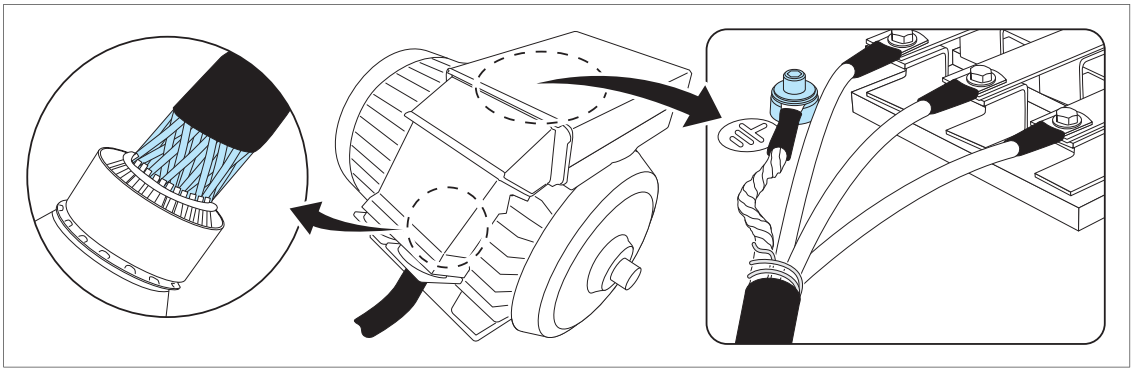
Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions (page 16)* 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 171)*.
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 an external brake resistor assembly

See section *Electrical installation of custom brake resistors (page 209)*.

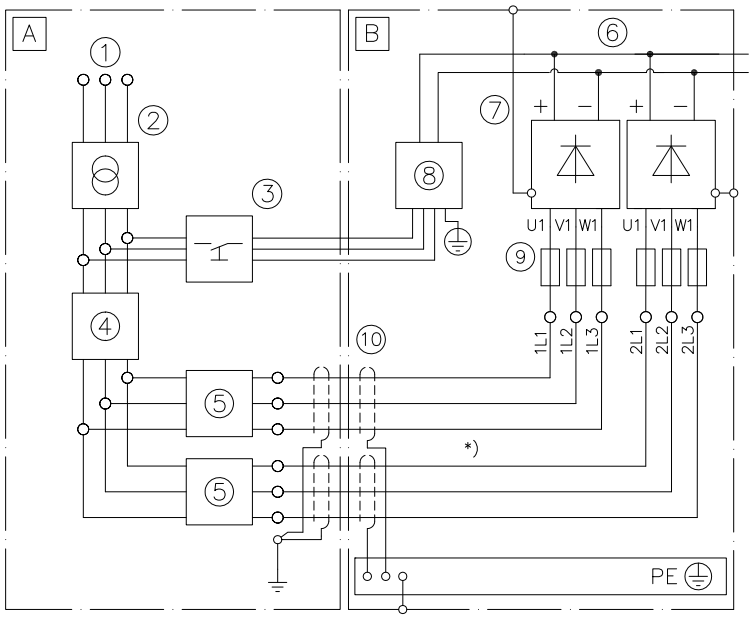
For the location of the terminals, refer to the dimension drawings delivered with the unit or the dimension drawing examples in chapter .

Connecting the input power cables

Connection diagrams

The connection diagrams below show the input power connections as well as the external equipment required. The diagrams are simplified. The designer of the drive system must provide the final, detailed circuit diagrams to the installer.

Connection diagram – 2×D8D, 6-pulse, internal charging



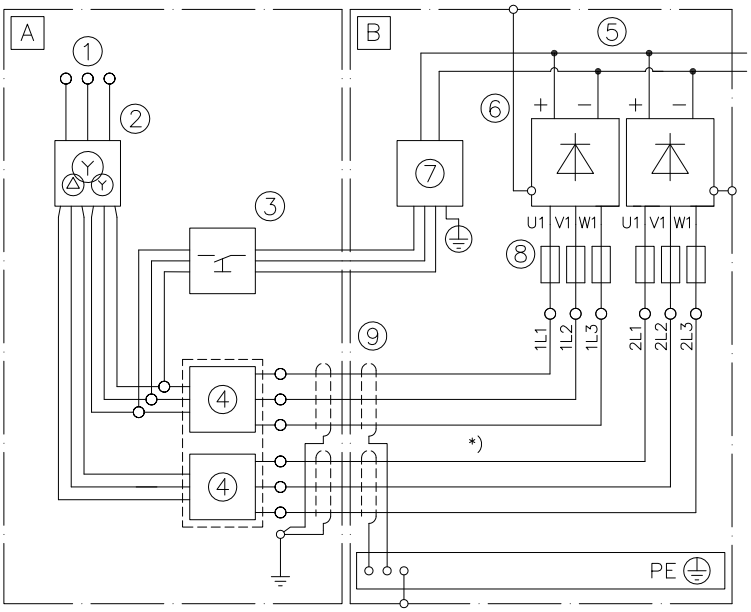
A	External installation outside drive cabinet	B	Supply unit cubicle of drive
1	Medium voltage/low voltage switchboard	6	DC link
2	Supply transformer	7	Supply modules
3	Charging switchgear including: • Disconnecting device	8	Charging circuit (option +F272)
4	Supply switchgear including: • Disconnecting device • Breaker/contactor	9	AC fuses
5	Overcurrent and short-circuit protection of input cabling	10	360 degrees grounding

Note:

*) Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges. Required minimum length of the cables is 5 meters.

For cable and component selection information, see chapter *Guidelines for planning the electrical installation*.

Connection diagram – 2×D8D, 12-pulse, internal charging



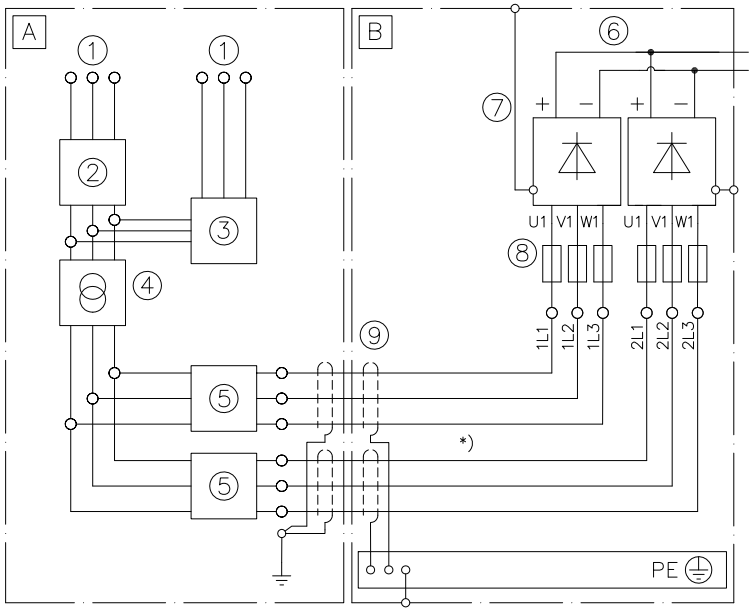
A	External installation outside drive cabinet	B	Supply unit cubicle of drive
1	Medium voltage/low voltage switchboard	5	DC link
2	Supply transformer	6	Supply modules
3	Charging switchgear including: • Disconnecting device	7	Charging circuit (option +F272)
4	Interlocked dedicated supply unit switchgear including: • Disconnecting device • Breaker/contactor • Overcurrent and short-circuit protection of input cabling	8	AC fuses
		9	360 degrees grounding

Note:

*) Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges. Required minimum length of the cables is 5 meters.

For cable and component selection information, see chapter *Guidelines for planning the electrical installation*.

Connection diagram – 2×D8D, 6-pulse, external charging and pre-magnetizing



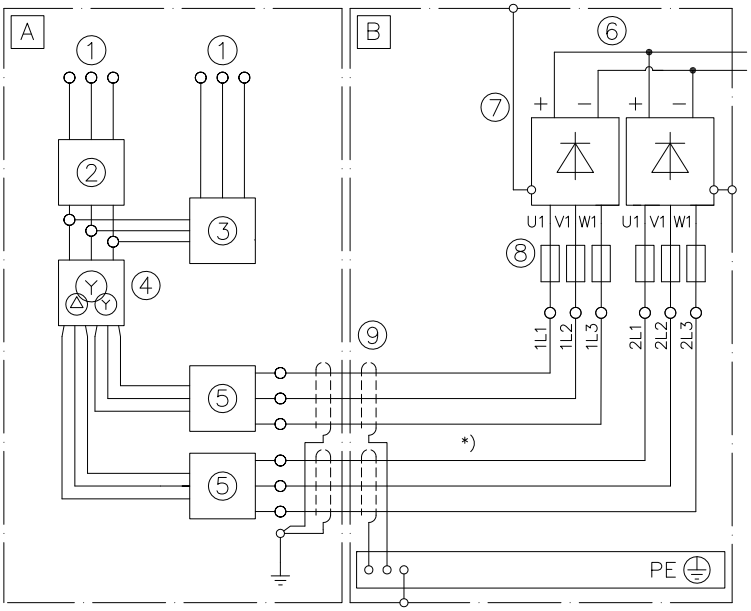
A	External installation outside drive cabinet	B	Supply unit cubicle of drive
1	Medium voltage/low voltage switchboard	6	DC link
2	Switchgear including: • Disconnecting device • Breaker/contactor	7	Supply modules
3	Combined transformer pre-magnetizing circuit and drive charging circuit	8	AC fuses
4	Supply transformer	9	360 degrees grounding
5	Overcurrent and short-circuit protection of input cabling		

Note:

*) Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges. Required minimum length of the cables is 5 meters.

For cable and component selection information, see chapter *Guidelines for planning the electrical installation*.

Connection diagram – 2×D8D, 12-pulse, external charging and pre-magnetizing



A	External installation outside drive cabinet	B	Supply unit cubicle of drive
1	Medium voltage/low voltage switchboard	6	DC link
2	Switchgear including: • Disconnecting device • Breaker/contactor	7	Supply modules
3	Combined transformer pre-magnetizing circuit and drive charging circuit	8	AC fuses
4	Supply transformer	9	360 degrees grounding
5	Overcurrent and short-circuit protection of input cabling		

Note:
*) Use symmetrical supply cabling to ensure equal current sharing between parallel diode bridges. Required minimum length of the cables is 5 meters.
For cable and component selection information, see chapter *Guidelines for planning the electrical installation*.

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!

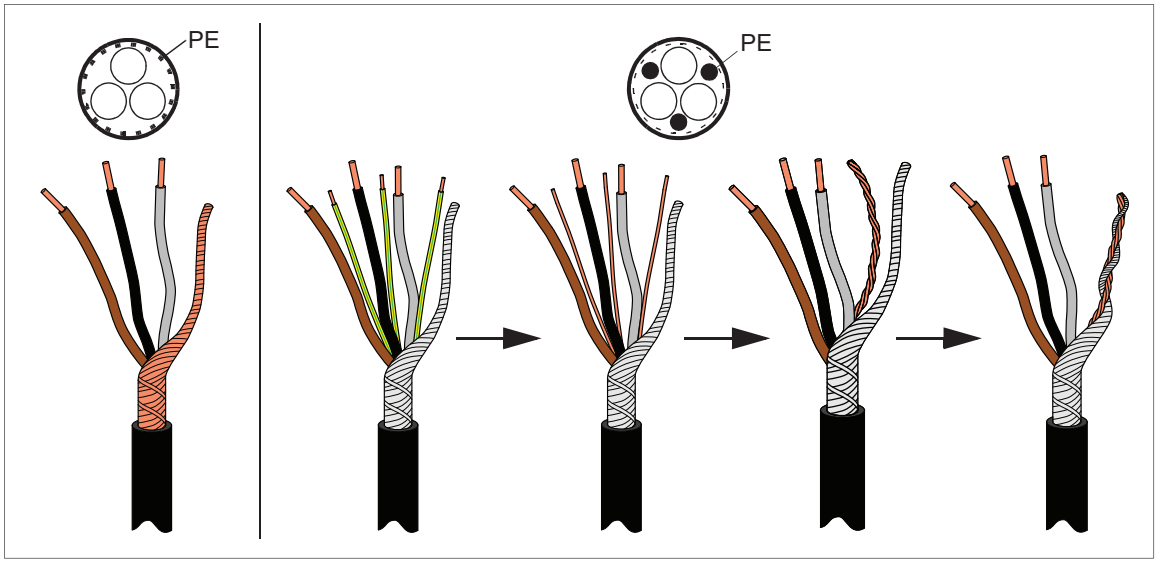
Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions (page 16)* before you start the work.
2. Open the door of the incoming cubicle.

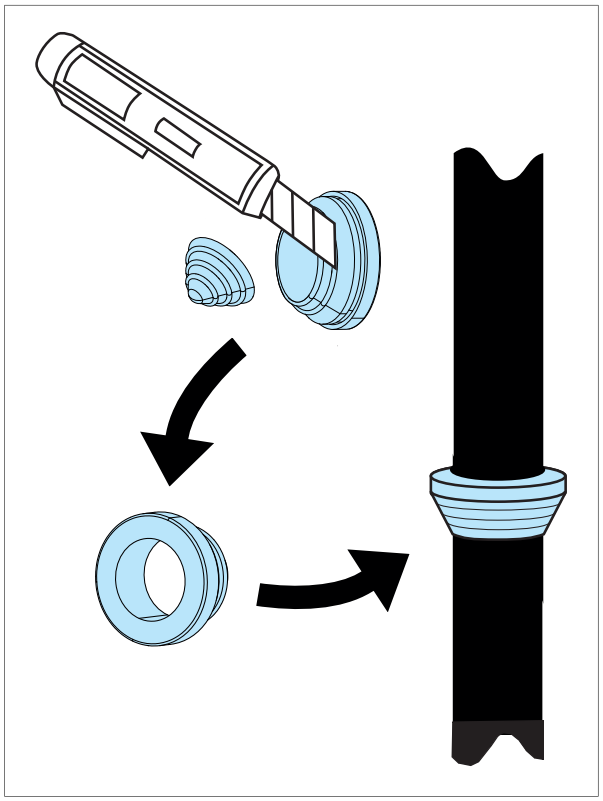
3. Remove the shrouding covering the input terminals.
4. Peel off 3 to 5 cm of the outer insulation of the cables above the lead-through plate for 360° high-frequency grounding.
5. Prepare the ends of the cables.

WARNING!

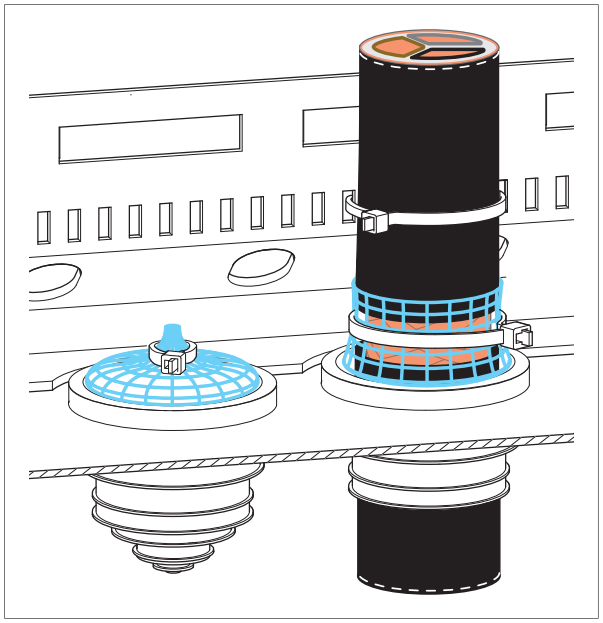
Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.



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.

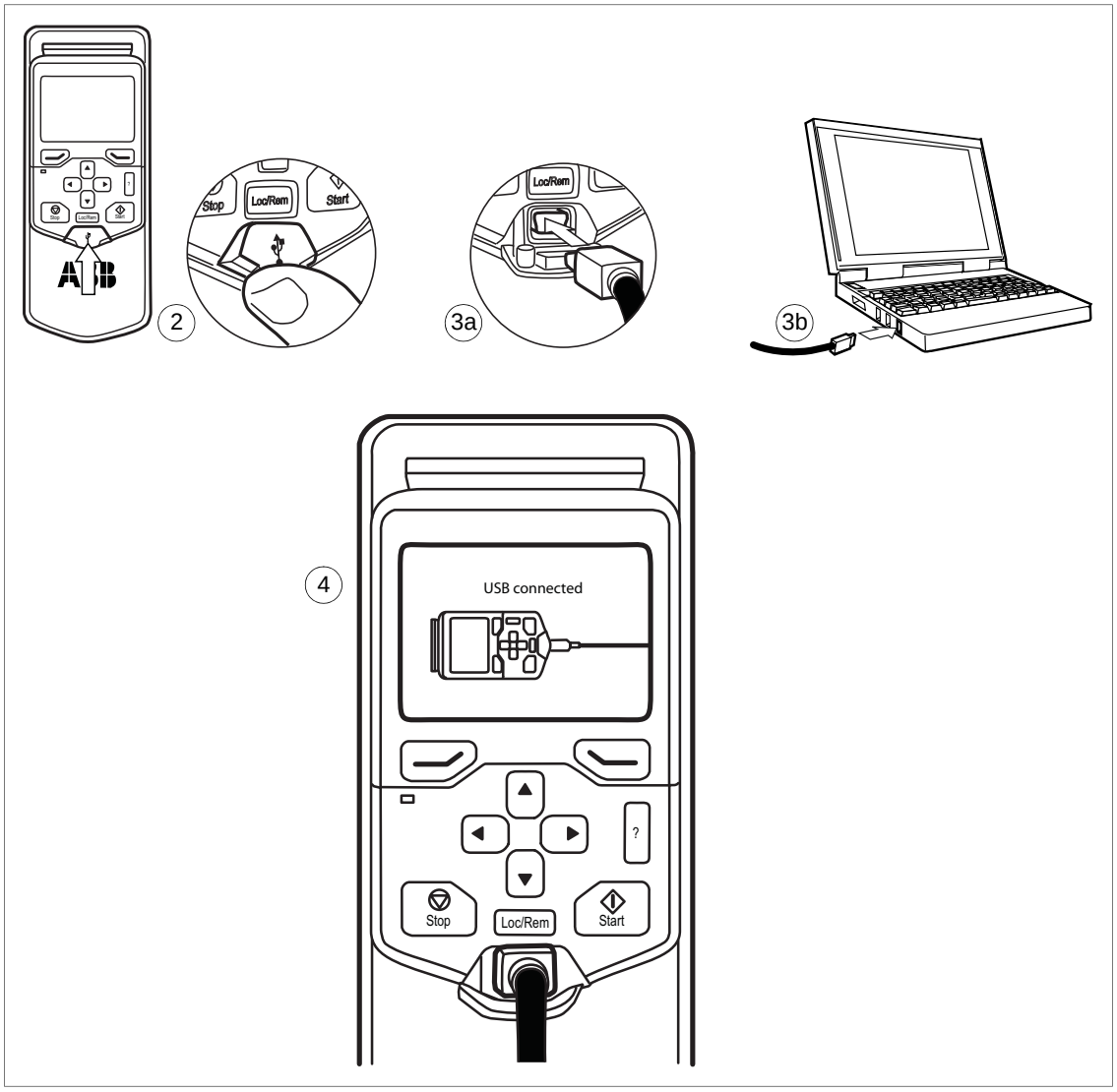


9. Seal the gap between the cable and mineral wool sheet (if used) with sealing compound (eg. CSD-F, ABB brand name DXXT-11, code 35080082).
10. Connect the twisted shields of the cables to the PE busbar of the cabinet.
11. Connect the phase conductors of the input cable to the L1, L2 and L3 terminals. (With 12-pulse connection, the terminals are 1L1, 1L2 and 1L3 for one 6-pulse supply line, 2L1, 2L2 and 2L3 for the other.) Tighten the screws to the torque given under *Tightening torques (page 171)*.
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 ACS-AP-W or ACS-AP-I 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. CAT5E) 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 by constructing a panel bus. This is done by daisy-chaining the panel connections of the drives. Some drives have the necessary panel connectors in the control panel holder. Others, including the ACS880-07CLC, require the installation of an FDPI-02 module (available separately). For

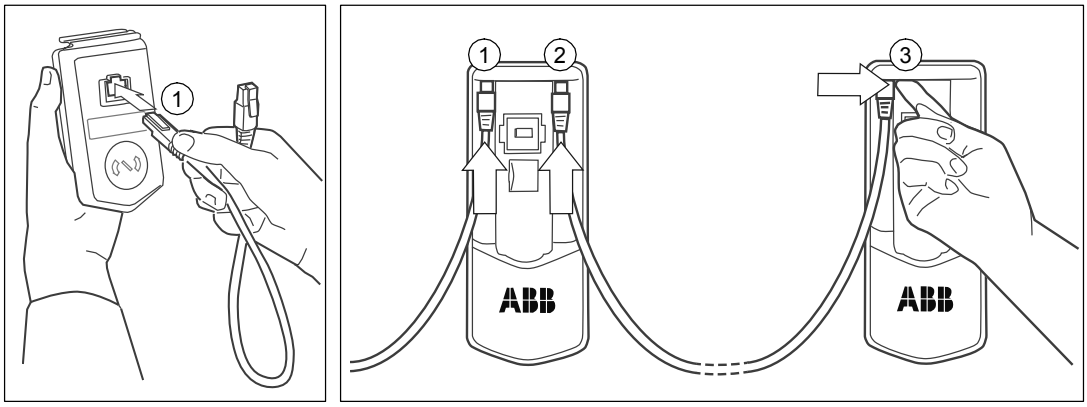
further information, see *FDPI-02 diagnostics and panel interface user's manual* (3AUA0000113618 [English]).

1. Connect the panel to one drive using an Ethernet (eg. CAT5E) 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.

   Repeat the above for each drive.
2. Chain the panel and the drives together 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.



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 16)* 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 tightens the connections and grounds the module. It is essential for fulfilling the EMC requirements and for proper operation of the module.

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 units used in the drive,
- contains the specifications of the inputs and outputs of the control units.

General

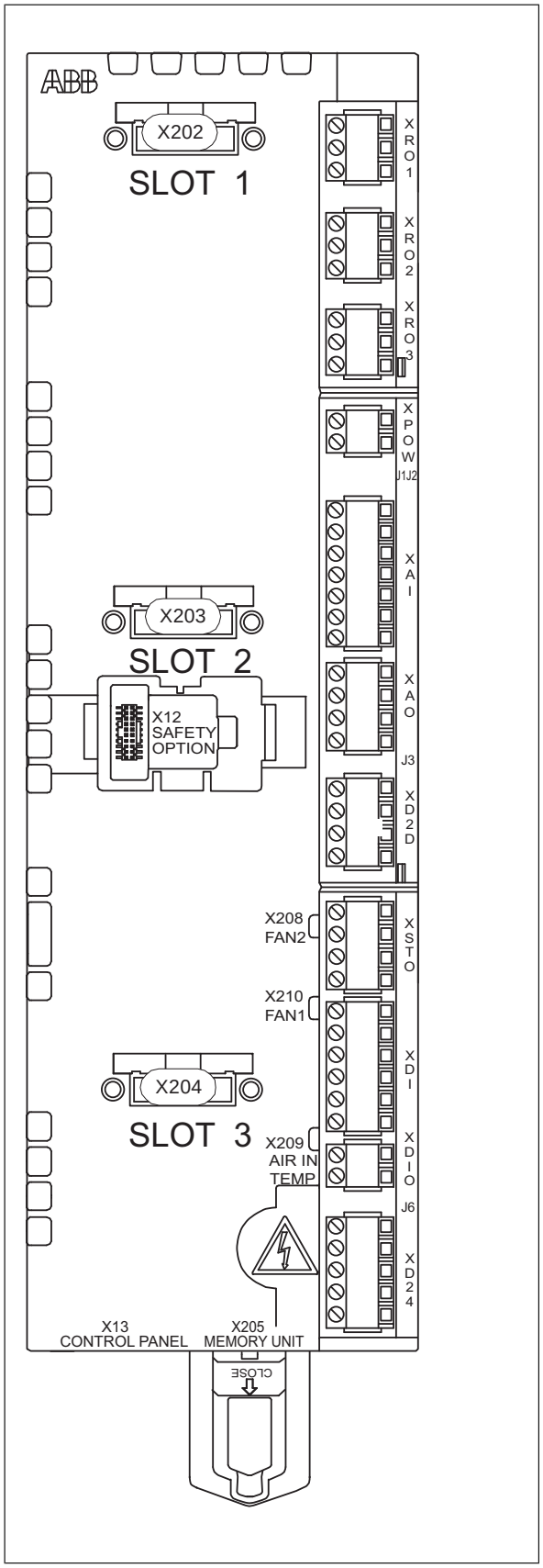
The supply unit of the drive is controlled by a dedicated ZCU-14 control unit (component designation A51). The ZCU-14 unit consists of a ZCON control board contained in a plastic housing.

The inverter unit of the drive is controlled by a dedicated BCU-x2 control unit (component designation A41). The BCU-x2 consists of a BCON control board (and a BIOC I/O connector board and power supply board) built in a metal housing.

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.

ZCU-14 layout and connections

The layout and connections of the ZCU-14 are shown below.



	Description
XPOW	External power input
XAI	Analog inputs
XAO	Analog outputs
XD2D	Drive-to-drive link
XRO1	Relay output RO1
XRO2	Relay output RO2
XRO3	Relay output RO3
XD24	Digital input interlock (DIIL) and +24 V output
XDIO	Digital input/outputs
XDI	Digital inputs
XSTO	Safe torque off connection. Safe torque off functionality is not available in the supply units.
X12	Connection for FSO-xx safety functions module. Connection for safety functions modules is not available in the supply units.
X13	Control panel connection
X202	Option slot 1
X203	Option slot 2
X204	Option slot 3
X205	Memory unit connection (memory unit inserted in the drawing)
J1, J2	Voltage/Current selection jumpers (J1, J2) for analog inputs
J3	Drive-to-drive link termination jumper (J3)
J6	Common digital input ground selection jumper (J6).

ZCU-14 default I/O connection diagram

The diagram shows the control connections of the supply unit, and the default meaning or use of the signals in the supply unit control program.

Relay outputs		**XRO1…XRO3**
XRO1: **Charging** (Charging contactor control) 250 V AC / 30 V DC 2 A	NO	3
	COM	2
	NC	1
XRO2: **Fault(-1)** / **Started** [1] 250 V AC / 30 V DC 2 A	NO	3
	COM	2
	NC	1
XRO3: **MCB** (Main contactor/breaker control) 250 V AC / 30 V DC 2 A	NO	3
	COM	2
	NC	1
Power supply		**XPOW**
24 V DC, 2 A	GND	2
	+24VI	1
Reference voltage and analog inputs		**J1, J2, XAI**
AI1/AI2 current/voltage selection	AI1: U	AI2: U
	AI1: I	AI2: I
Not in use by default 0(4)…20 mA, R_{in} = 100 ohm [2]	AI2-	7
	AI2+	6
Not in use by default 0(2)…10 V, R_{in} > 200 kohm [3]	AI1-	5
	AI1+	4
Ground	AGND	3
-10 V DC, R_L 1…10 kohm	-VREF	2
10 V DC, R_L 1…10 kohm	+VREF	1
Analog outputs		**XAO**
Zero (not in use by default) (0…20 mA, R_L < 500 ohm)	AGND	4
	AO2	3
Zero (not in use by default) (0…20 mA, R_L < 500 ohm)	AGND	2
	AO1	1
Distributed I/O bus		**J3, XD2D**
Termination (ON on units at end of link)	ON ▪ OFF	
Distributed I/O bus for cooling fan monitoring	Shield	4
	BGND	3
	A	2
	B	1
XSTO connector		**XSTO**
For the supply unit to start, both IN1 and IN2 must be connected to OUT. **Note:** De-energizing this input will stop the supply unit but will not constitute a true Safe torque off (STO) function.	IN2	4
	IN1	3
	SGND	2
	OUT	1
Digital inputs		**XDI**
Fault reset (0⟶1 = reset)	DI6	6
Not in use / **Ground fault** [4]	DI5	5
Auxiliary circuit breaker fault (0 = tripped)	DI4	4
MCB feedback (1 = main breaker/contactor closed)	DI3	3
Run enable (1 = Run enable on)	DI2	2
Temperature fault (0 = overtemperature)	DI1	1
Digital input/outputs		**XDIO**
Input: **AC fuse monitoring** (0 = tripped)	DIO2	2
Not in use / Input: **Brake chopper fault** (0 = fault) [5]	DIO1	1
Ground selection [6]	▪	
Auxiliary voltage output, digital input interlock		**XD24**
Digital input/output ground	DIOGND	5
+24 V DC 200 mA [7]	+24VD	4
Digital input ground (common)	DICOM	3
+24 V DC 200 mA [7]	+24VD	2
Emergency stop (0 = actuated)	DIIL	1
Safety functions module connection (not used)		**X12**
Control panel connection		**X13**
Memory unit connection		**X205**

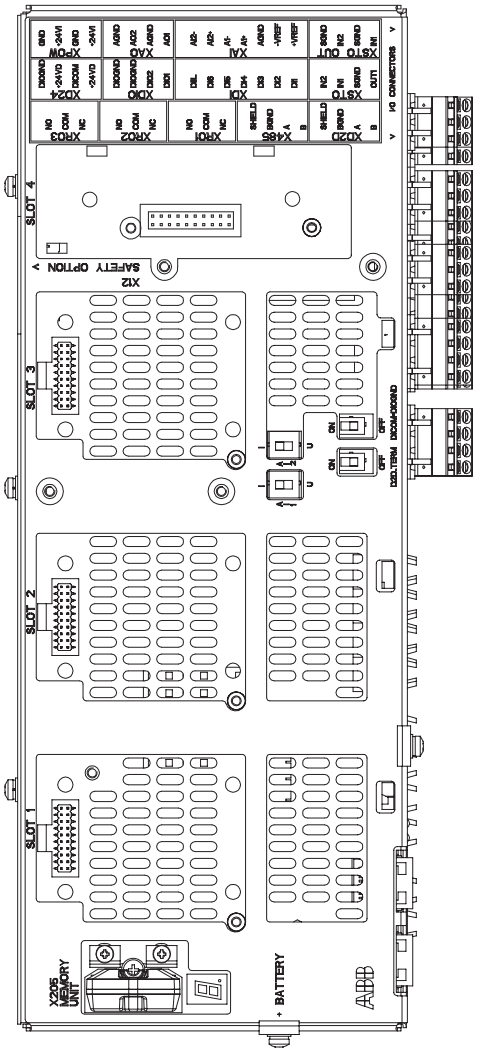
Note:
Wire sizes and tightening torques: 0.5…2.5 mm^2 (24…12 AWG) and 0.5 N·m (5 lbf·in) for both stranded and solid wire.

1. **Started** (Cooling unit control) if the drive is equipped with optional cooling unit.
2. Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by jumper **J2**. Change of setting requires reboot of control unit.
3. Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by jumper **J1**. Change of setting requires reboot of control unit.
4. **Ground fault** if the drive is equipped with optional ground fault monitoring.
5. **Brake chopper fault** if the drive is equipped with optional brake chopper.
6. Determines whether DICOM is separated from DIOGND (ie. common reference for digital inputs floats). See also section *ZCU-14 ground isolation diagram (page 116)*.

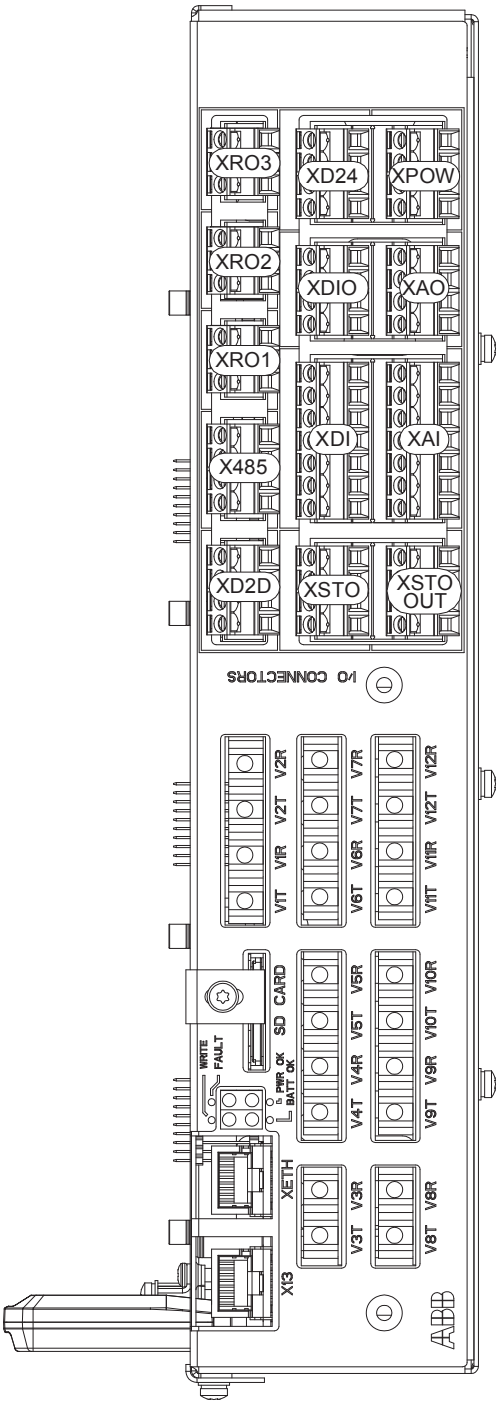
   DICOM connected to DIOGND  DICOM and DIOGND separate 

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

BCU-x2 control unit layout and connections



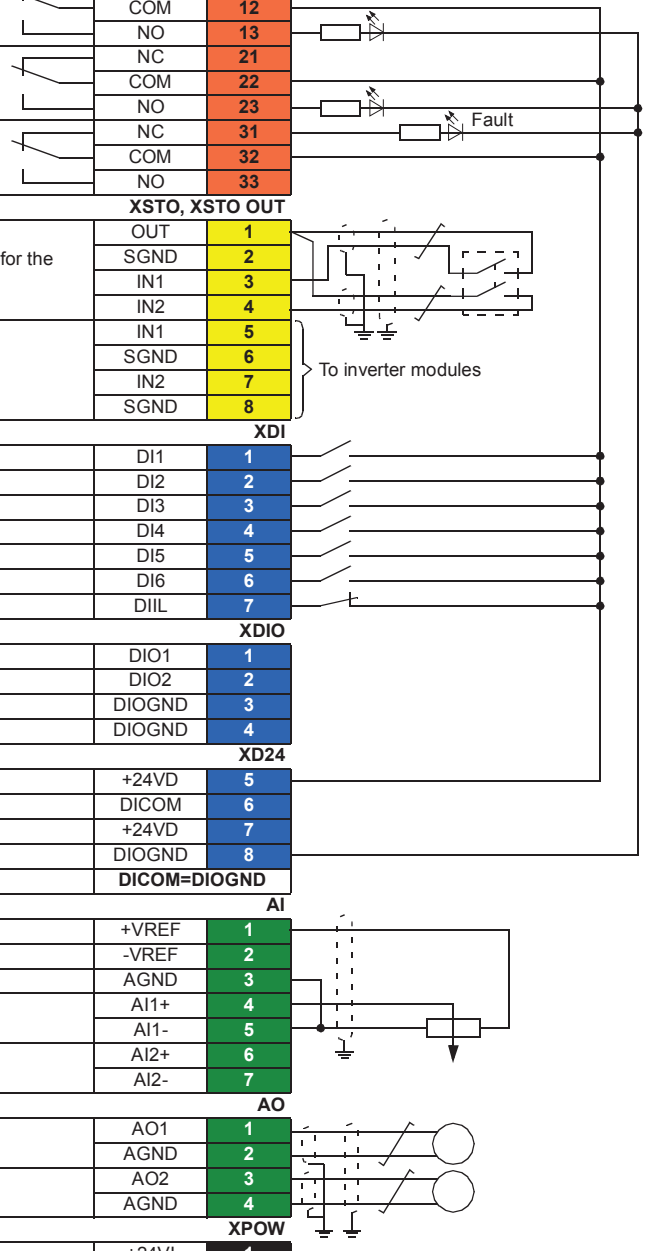
	Description
I/O	I/O terminals (see following diagram)
SLOT 1	I/O extension, encoder interface or fieldbus adapter module connection. (This is the sole location for an FDPI-02 diagnostics and panel interface.)
SLOT 2	I/O extension, encoder interface or fieldbus adapter module connection
SLOT 3	I/O extension, encoder interface or fieldbus adapter 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
L	(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
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) Not in use
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 inverter control unit (A41)

Drive-to-drive link		**XD2D**
Drive-to-drive link [1]	B	1
	A	2
	BGND	3
	Shield	4
RS485 connection		**X485**
Not in use	B	5
	A	6
	BGND	7
	Shield	8
Relay outputs		**XRO1…XRO3**
Ready 250 V AC / 30 V DC 2 A	NC	11
	COM	12
	NO	13
Running 250 V AC / 30 V DC 2 A	NC	21
	COM	22
	NO	23
Faulted(-1) 250 V AC / 30 V DC 2 A	NC	31
	COM	32
	NO	33
Safe torque off		**XSTO, XSTO OUT**
Safe torque off input. Both circuits must be closed for the drive to start. [2]	OUT	1
	SGND	2
	IN1	3
	IN2	4
Safe torque off output to inverter modules [2]	IN1	5
	SGND	6
	IN2	7
	SGND	8
Digital inputs		**XDI**
Stop (0) / Start (1)	DI1	1
Forward (0) / Reverse (1)	DI2	2
Reset	DI3	3
Acceleration & deceleration select [3]	DI4	4
Constant speed 1 select (1 = on) [4]	DI5	5
By default not in use.	DI6	6
Run enable [5]	DIIL	7
Digital input/outputs		**XDIO**
Output: Ready	DIO1	1
Output: Running	DIO2	2
Digital input/output ground	DIOGND	3
Digital input/output ground	DIOGND	4
Auxiliary voltage output		**XD24**
+24 V DC 200 mA [6]	+24VD	5
Digital input ground	DICOM	6
+24 V DC 200 mA [6]	+24VD	7
Digital input/output ground	DIOGND	8
Ground selection switch [7]		**DICOM=DIOGND**
Analog inputs, reference voltage output		**AI**
10 V DC, R_L 1…10 kohm	+VREF	1
-10 V DC, R_L 1…10 kohm	-VREF	2
Ground	AGND	3
Speed reference 0(2)…10 V, R_{in} > 200 kohm [8]	AI1+	4
	AI1-	5
By default not in use. 0(4)…20 mA, R_{in} = 100 ohm [9]	AI2+	6
	AI2-	7
Analog outputs		**AO**
Motor speed rpm 0…20 mA, R_L < 500 ohm	AO1	1
	AGND	2
Motor current 0…20 mA, R_L < 500 ohm	AO2	3
	AGND	4
External power input		**XPOW**
24 V DC, 2.05 A Two supplies can be connected for redundancy.	+24VI	1
	GND	2
	+24VI	3
	GND	4
Safety functions module connection		**X12**
Control panel connection		**X13**
Memory unit connection		**X205**



Notes:

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).

1) See section *Drive-to-drive link (XD2D) (page 111)*.

2) See chapter *The Safe torque off function (page 189)*.

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 111)*.

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 115)*. 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.

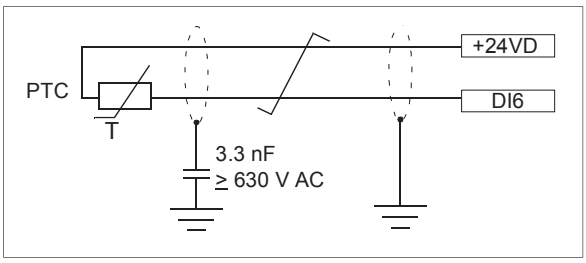
9) Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by switch AI2. Change of setting requires reboot of control unit.

External power supply for the control unit (XPOW)

The BCU-x2 is powered from a 24 V DC, 2 A supply through terminal block XPOW. 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, 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. See the firmware manual of the inverter unit for parameter settings.

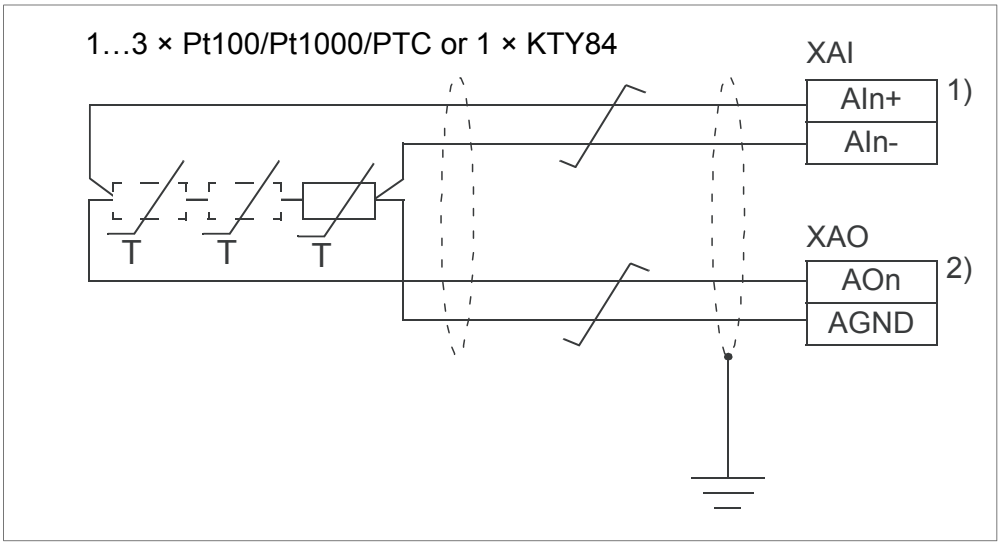


WARNING!

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, 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.



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.

Drive-to-drive link (XD2D)

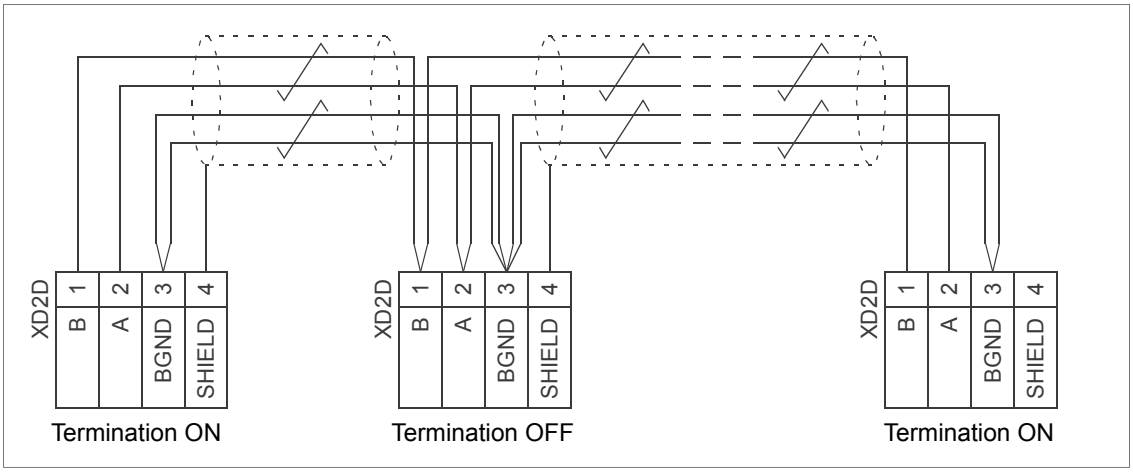
Note:
On the ACS880-07CLC, the XD2D connector on the supply control unit (A51) is reserved for cooling fan monitoring. See the *ACS880 distributed I/O bus* supplement (3AXD50000126880 [English]).

The drive-to-drive link is a daisy-chained RS-485 transmission line that allows basic master/follower communication with one master drive and multiple followers.

Enable bus termination on the inverters at the ends of the drive-to-drive link by setting switch D2D TERM on the control unit to ON. On intermediate inverters, disable bus termination.

Use shielded twisted-pair cable (~100 ohm, for example, PROFIBUS-compatible cable) for the wiring. For best immunity, high quality cable is recommended. Keep the cable as short as possible; the maximum length of the link is 50 meters (164 ft). Avoid unnecessary loops and running the cable near power cables (such as motor cables). Ground the cable shields.

The following diagram shows the wiring of the drive-to-drive link.



Safe torque off (XSTO, XSTO OUT)

On the inverter control unit (A41), the XSTO input can be used to implement a safe torque off (STO) function. For the drive to start, both connections (OUT1 to IN1 and IN2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting an external Safe torque off circuit to the drive.

For information on the implementation of a Safe torque off function, see chapter *The Safe torque off function (page 189)*.

Note:
The XSTO input only acts as a true Safe torque off input on the inverter control unit [A41]. De-energizing the IN1 and/or IN2 terminals on the supply control unit [A51] will stop the supply unit but not constitute a true safety function.

The XSTO OUT connector is wired to the STO IN connector of one inverter module. In case the inverter unit consists of multiple modules, the STO OUT connector of the first module is wired to the STO IN connector of the next module etc. so that all modules are part of the chain.

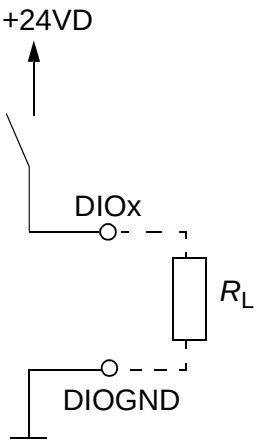
FSO-xx safety functions module connection (X12)

Not in use at the time of publishing.

SDHC memory card slot

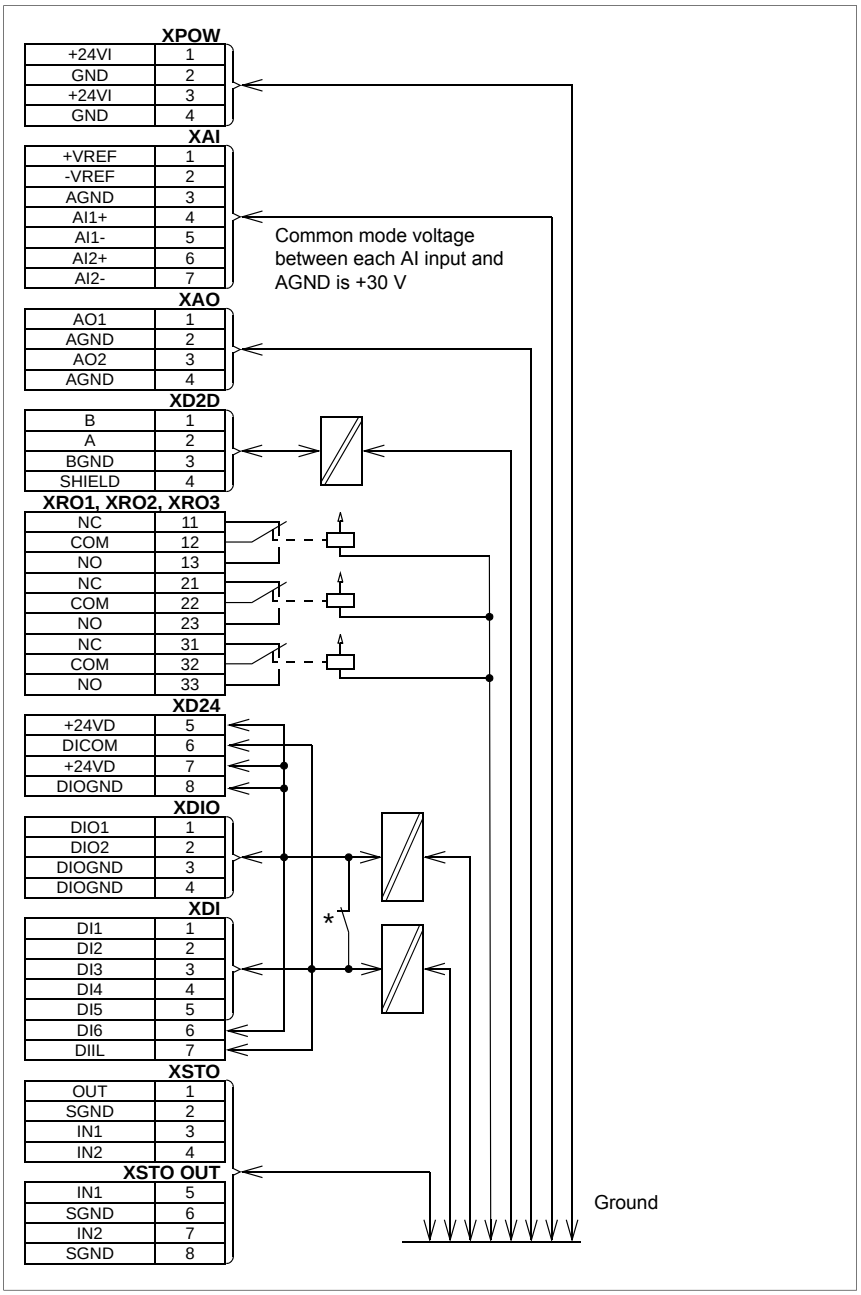
The BCU-x2 has an on-board data logger that collects real-time data from the power modules to help fault tracing and analysis. The data is stored onto the SDHC memory card inserted into the SD CARD slot and can be analyzed by ABB service personnel.

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
Drive-to-drive link (XD2D)	Connector pitch 5 mm, wire size 2.5 mm^2 Physical layer: RS-485 Termination by jumper or 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. For the unit to start, both connections must be “1”. Current consumption: 66 mA (continuous) per STO channel per R8i inverter module EMC (immunity) according to IEC 61326-3-1
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
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.	

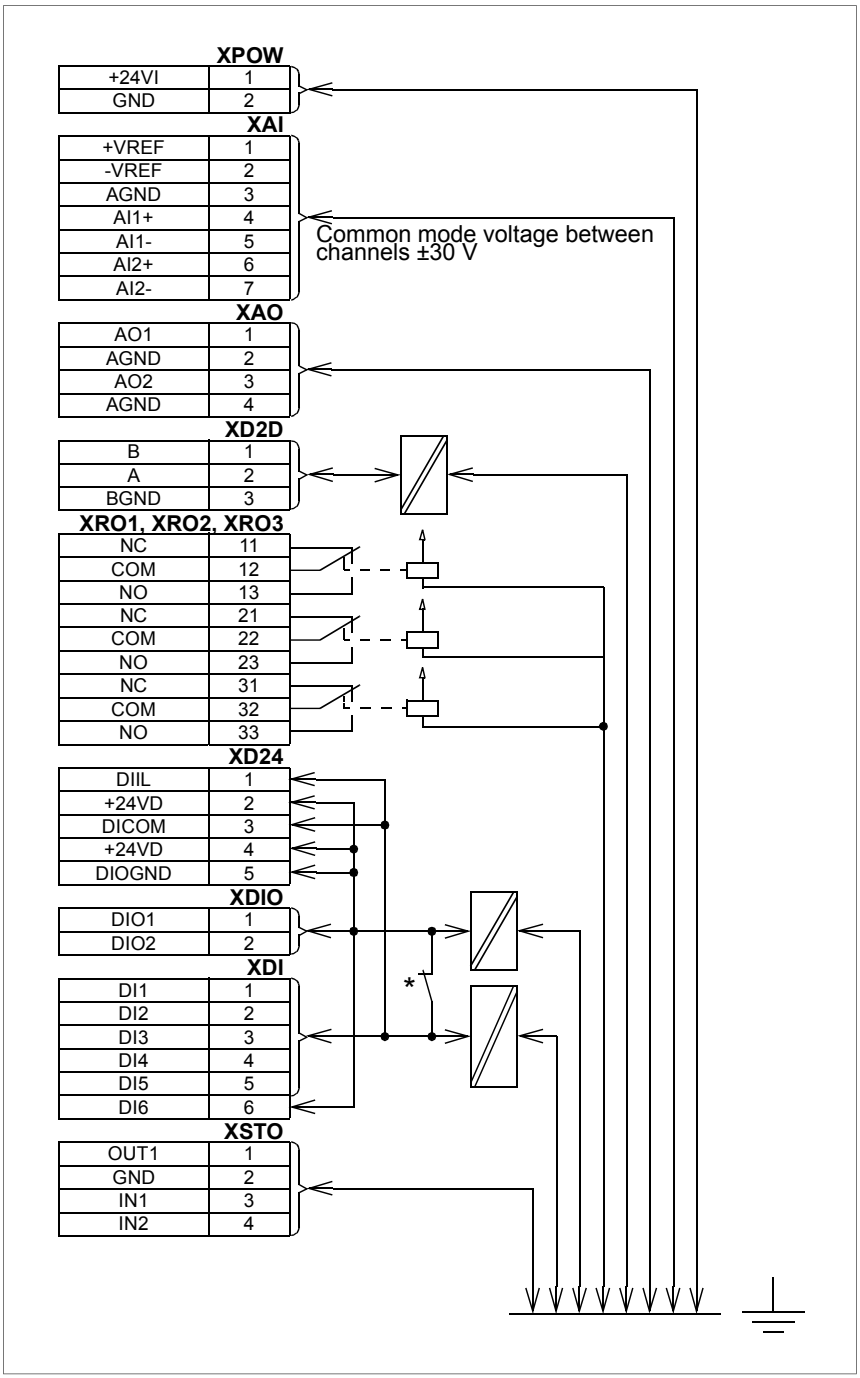
BCU-x2 ground isolation diagram



*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.

ZCU-14 ground isolation diagram



* Ground selector (J6) settings

(ZCU-12) • (ZCU-14)

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

(ZCU-12) • (ZCU-14)

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

8

Installation checklist

Contents of this chapter

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

Checklist

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

WARNING!

Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur. Do the steps in section *Electrical safety precautions (page 16)* before you start the work. Go through the checklist together with another person.

Check that …	☑
The ambient operating conditions meet the specifications. See the technical data.	☐
The drive cabinet has been fixed to floor, and if necessary due to vibration etc, also by its top to the wall or roof.	☐
If the drive will be connected to an IT (ungrounded) or a corner grounded TN network: The EMC filter of the drive has been disconnected. Contact your local ABB representative for instructions.	☐
There is an adequately sized protective earth (ground) conductor between the drive and the switchboard, and the conductor has been connected to appropriate terminal, and the terminal have been tightened. (Pull the conductor to check.) Proper grounding has also been measured according to the regulations.	☐
The input power cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull on the conductors to check.)	☐
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 have been tightened. (Pull on the conductors to check.). Proper grounding has also been measured according to the regulations.	☐

Check that …	☑
The motor cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull on the conductors to check.)	☐
The motor cable has been routed away from other cables.	☐
No power factor compensation capacitors have been connected to the motor cable.	☐
If an external brake resistor has been connected to the drive: There is an adequately sized protective earth (ground) conductor between the brake resistor and the drive, and the conductor has been connected to appropriate terminal. Proper grounding has also been measured according to the regulations.	☐
If an external brake resistor has been connected to the drive: The brake resistor has been connected to the appropriate terminals, and the terminals have been tightened. (Pull on the conductors to check.)	☐
If an external brake resistor has been connected to the drive: The brake resistor cable has been routed away from other cables.	☐
The control cables have been connected to the appropriate terminals, and the terminals have been tightened. (Pull on the conductors to check.)	☐
The supply voltage matches the nominal input voltage of the drive. Check the type designation label.	☐
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 or electrically interlocked, ie, cannot be closed simultaneously.	☐
There are no tools, foreign objects or dust from drilling inside the drive.	☐
All shrouds and cover of the motor connection box are in place. Cabinet doors have been 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.	☐
The drain valves in each cubicle are closed.	☐
Refer to the cooling unit documentation for specific tasks.	☐

9

Start-up

Contents of this chapter

This chapter contains the start-up procedure 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.

If the drive is equipped with a cooling unit, also refer to its manual.

Action	☑
Safety	
WARNING! Obey the safety instructions during the start-up procedure. See chapter *The Safe torque off function (page 189)*.	☐

Action	☑
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.	☐
Check that the main switch-disconnector is switched off, or main breaker racked out. Both are external customer equipment. **Note:** 12-pulse and 24-pulse units may have multiple switch-disconnectors or breakers – check that all are open before you proceed.	☐
Check the mechanical and electrical installation of the drive. See *Installation checklist (page 117)*.	☐
Check the settings of breakers/switches in the auxiliary circuits. See the circuit diagrams delivered with the drive.	☐
Check that the auxiliary voltage selector [X59] on the front plate of the inverter modules is set according to actual auxiliary voltage (230 or 115 V AC).	☐
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.	☐
Drives with ground fault monitoring for IT (ungrounded) systems (option +Q954): Adjust the settings of the ground fault monitor to suit the installation. See the circuit diagrams of the delivery and *IRDH275B Ground Fault Monitor Operating Manual* by Bender (code: TGH1386en).	☐
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.	☐
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 [Q20]. Also switch on the voltage to any other externally-supplied options (such as the cooling fan supply, lighting, heating). If the drive is equipped with a cooling unit, close the main switch of the coolant pump [Q200].	☐
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 diode supply control program firmware manual* (3AUA0000103295 [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 a brake chopper (option +D150): See chapter *Resistor braking (page 203)*.	☐
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.	☐

Action	☑
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	
Set the Run enable switch into the "1" position. Close the charging switch [Q3].	☐
On-load checks	
Start the motor to perform the ID run. Starting will close the main contactor or main breaker.	☐
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 196)*.	☐
Drives with an emergency stop circuit (option +Q951): 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.	☐

10

Fault tracing

Contents of this chapter

This chapter describes the fault tracing possibilities of the drive.

LEDs

This table shows the LEDs visible on the control panel mounting platform on cabinet door (when panel has been removed), and on the BCU-xx control unit inside the cabinet.

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

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														
Coolant draining and replacement							R						R	
Checking coolant quality			P		P		P		P		P		P	
Checking coolant antifreeze concentration		P	P	P	P	P	P	P	P	P	P	P	P	P
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	
Batteries														
Control panel battery										R				

Maintenance task/object	Years from start-up													
	0	1	2	3	4	5	6	7	8	9	10	11	12	…
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

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.

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. Stop the drive and do the steps in section *Electrical safety precautions (page 16)* before you start the work.
2. Check the tightness of the cable connections. Use the tightening torques given in chapter Technical data.

Cooling fans

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

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

Replacing the cooling fan in the supply module cubicle

WARNING!

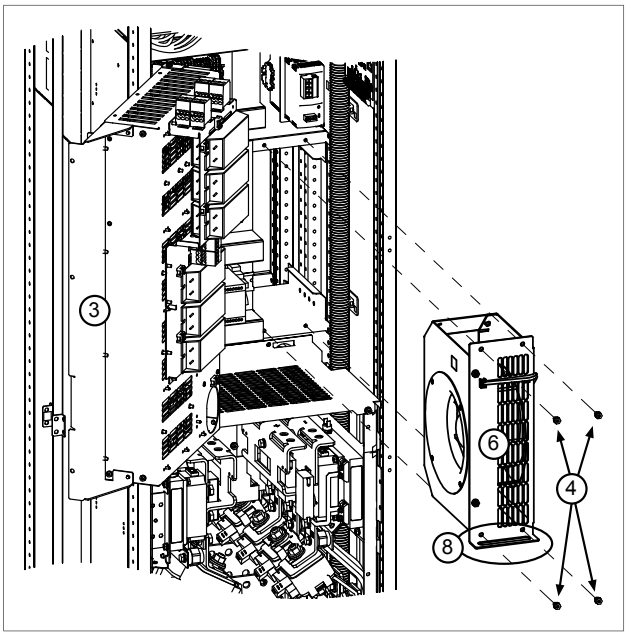
Read the safety instructions given in *Safety instructions for ACS880 liquid-cooled multidrive cabinets and modules* (3AXD50000048633 [English]). If you ignore them, injury or death, or damage to the equipment can occur.

WARNING!

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

Refer to the drawing below.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 16)* before you start the work.
2. Open the door to the supply module cubicle.
3. Open the swing-out frame.
4. Remove the retaining screws of the fan box.
5. Disconnect the fan wiring.
6. Pull out the fan box.
7. Disassemble the fan box to access the fan.
8. Install a new fan in reverse order. Note the orientation of the fan box.



Replacing the cooling fan of an inverter module

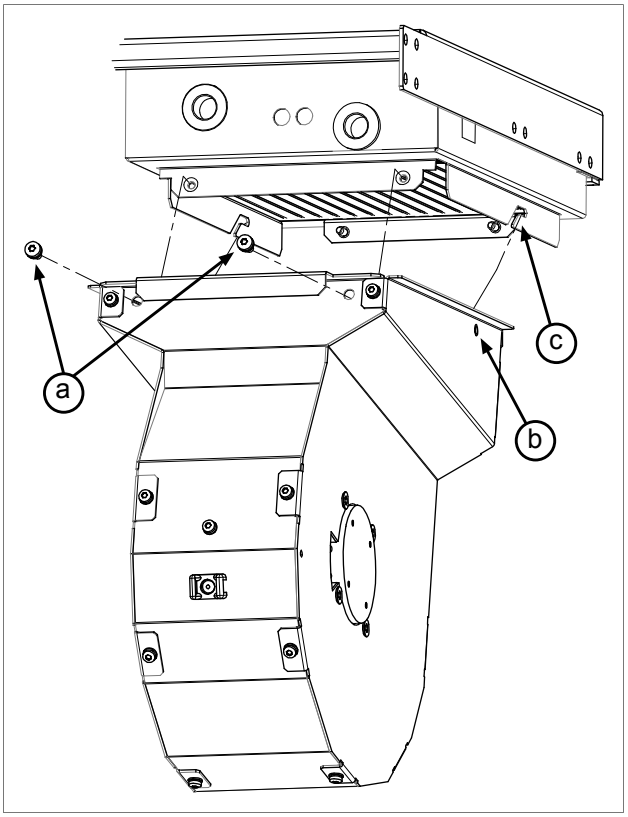
WARNING!

Read the safety instructions given in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

WARNING!

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

1. Repeat the steps described in section *Electrical safety precautions (page 16)*.
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).



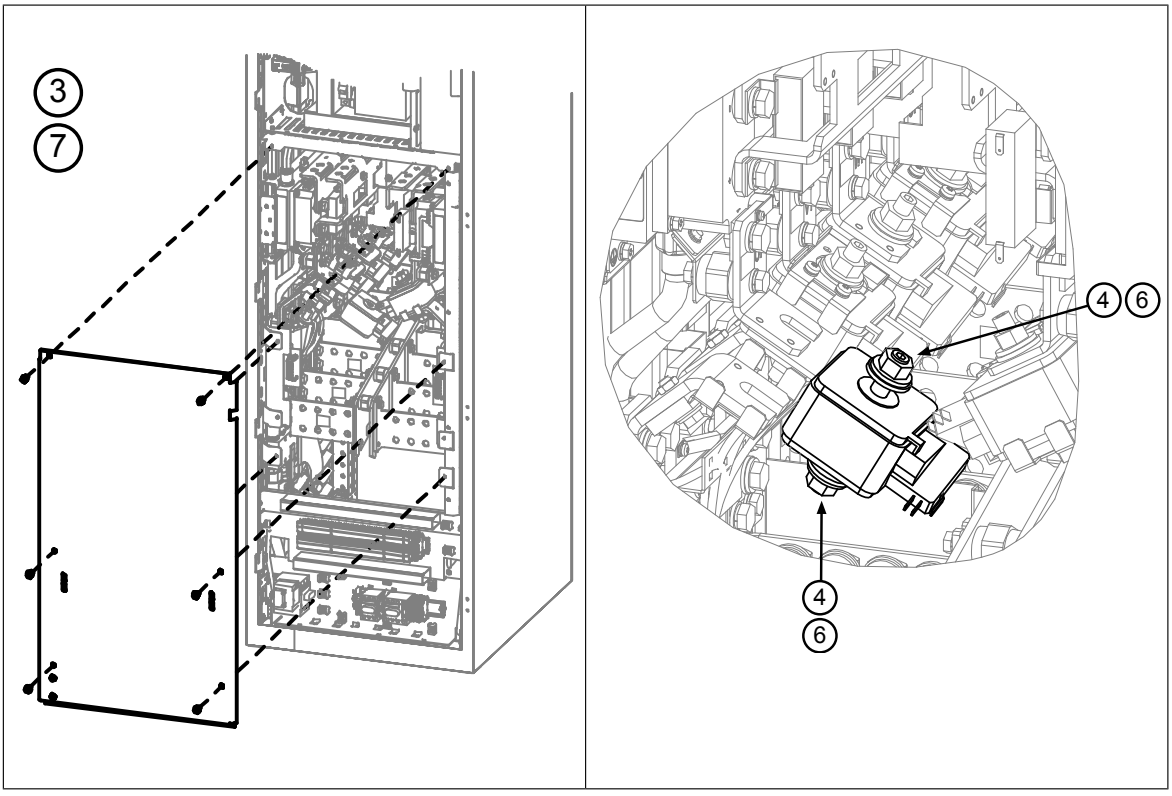
Fuses

Replacing the AC fuses

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 16)* before you start the work.
2. Open the door of the supply module cubicle.
3. Remove the shroud at the lower part of the cubicle.
4. Slacken the nuts of the fuses until you can slide the fuse blocks out. Make note of the order of the washers.
5. Move the screws, nuts and washers from the old fuse blocks to the new fuse blocks. Make sure to keep the washers in the original order.
6. Slide the new fuse blocks into place. Tighten the nuts to 50 N·m (37 lbf·ft) (Bussmann fuses) or 46 N·m (34 lbf·ft) (Ferraz Shawmut fuses).
7. Re-install the shrouding removed earlier and close the door.



Replacing the DC fuses

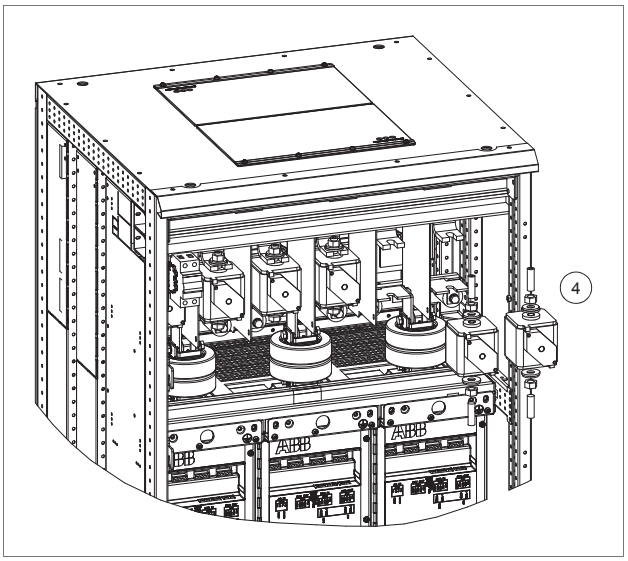
WARNING!

Read the safety instructions given in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

WARNING!

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

1. Repeat the steps described in section *Electrical safety precautions (page 16)* before you start the work.
2. Open the door of the module cubicle.
3. Remove the shrouding in front of the fuses (if any).
4. Check the condition of the fuses. In case of a blown fuse, replace all fuses with similar fuses: slacken the nuts of the fuses and pull the fuses out. Do not unscrew the nuts completely, not to drop them inside the module(s) below. Tighten the nuts first by hand or applying maximum 5 N·m force. Tightening torques for M12 nuts are 50 N·m (37 lbf·ft) for Bussmann fuses, and 46 N·m (34 lbf·ft) for Ferraz Shawmut fuses.
5. Attach the shrouding (if any) and close the door.



Supply and inverter modules

Replacing a supply module

WARNING!

Read the safety instructions given in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

WARNING!

Hot, pressurized coolant may be present in the cooling circuit. Do not work on any section of the cooling system before it has been depressurized and drained.

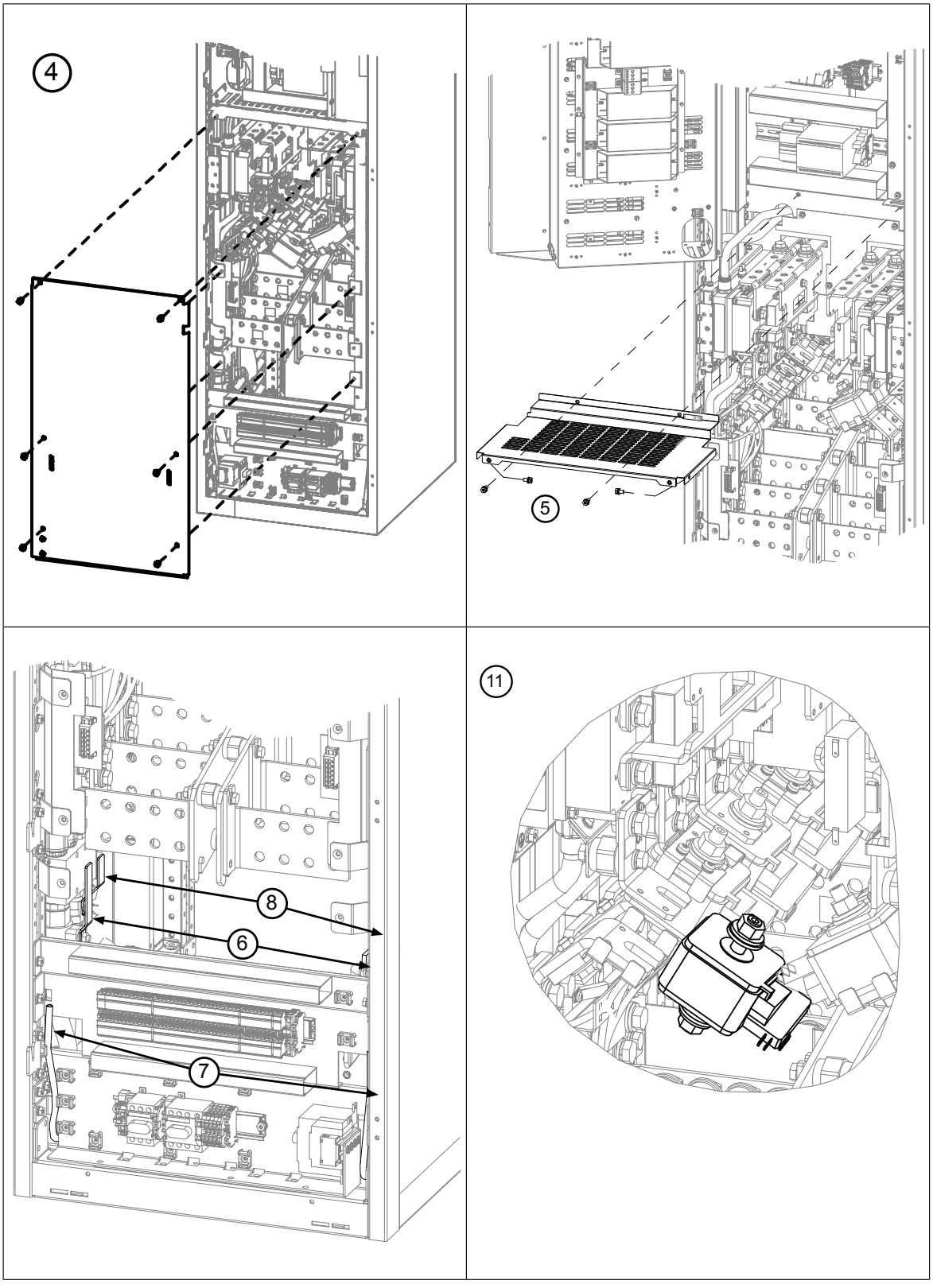
WARNING!

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

The removal of a module mounted at the rear requires that the module at the front (if present) is removed first.

Refer to the drawings below.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 16)* before you start the work.
2. Open the door to the supply module cubicle.
3. Open the swing-out frame.
4. Remove the shroud at the lower part of the cubicle.
5. Remove the shroud above the supply modules. Note that two of the screws are fastened from below.
6. Close the inlet and outlet valves of the supply cubicle.
7. Lead the drain hoses into a suitable container.
8. Open the drain valves located behind the inlet and outlet valves. Make sure the ends of the hoses are not immersed at any point of the draining so that air can displace the coolant in the system. Wait until all coolant has drained.
9. Disconnect the wiring from the thermal switch on the module.
10. Disconnect the coolant pipes from the module.
11. Slacken the nuts of the AC fuse blocks and slide the fuses out.
12. Remove the DC bus screws.
13. Remove the four mounting screws of the module and lift the module out.
14. If you need to remove the module in the rear, remove the shroud between the front and rear modules.
15. Remove the transverse beam.
16. Remove the insulator plate.
17. Repeat steps 9 to 13 for the module in the rear.
18. Reinstall the modules in reverse order to the above. See also *Filling up and bleeding the internal cooling circuit (page 145)*.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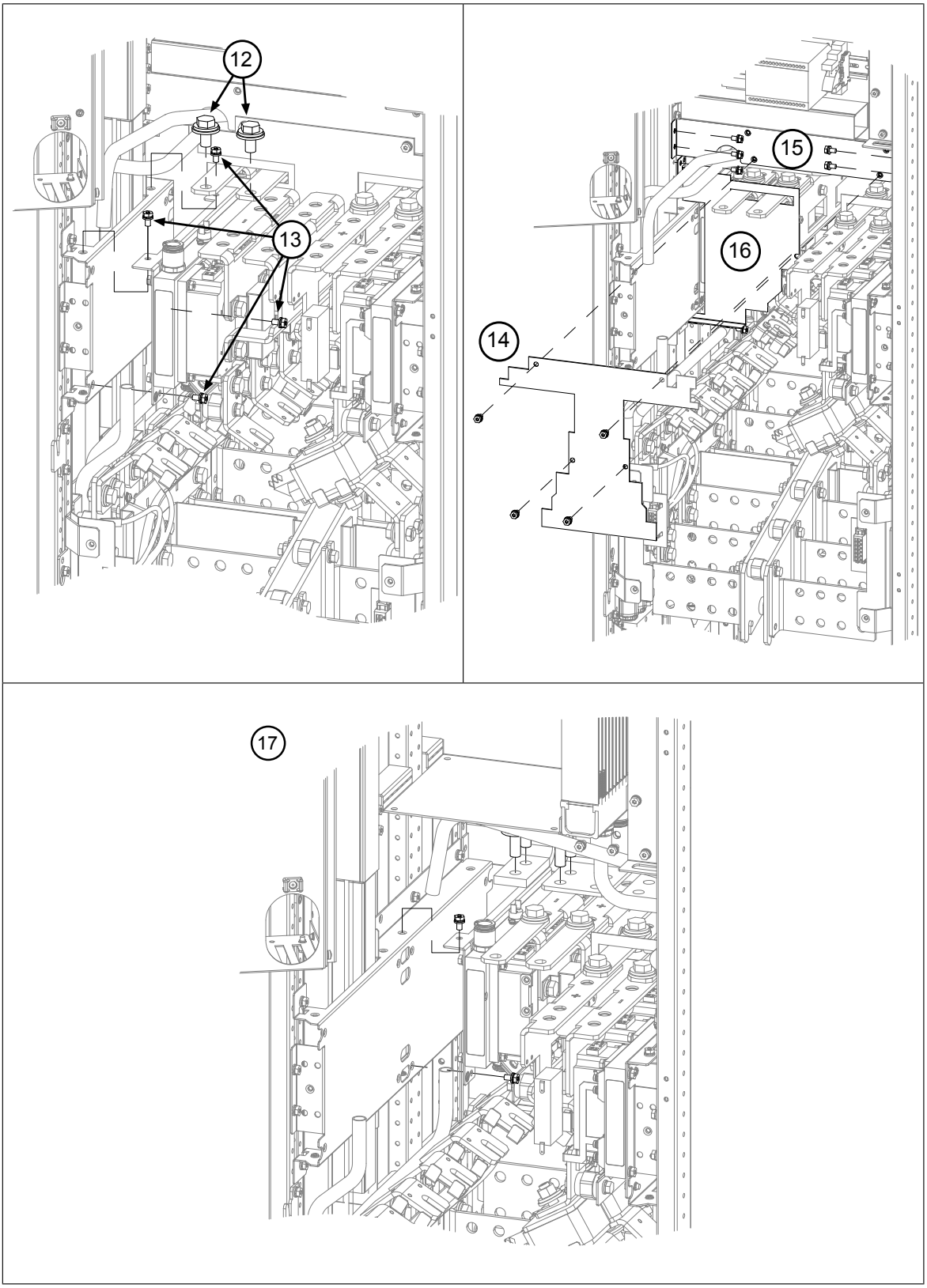
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Replacing an inverter module

WARNING!

Read the safety instructions given in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

WARNING!

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

WARNING!

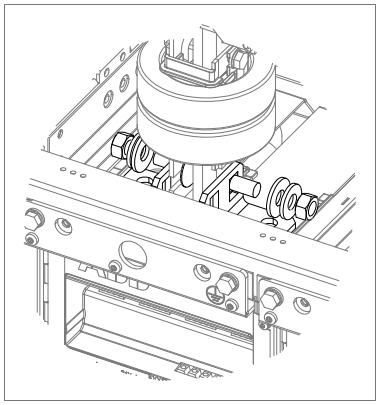
Hot, pressurized coolant may be present in the cooling circuit. Do not work on any section of the cooling system before it has been depressurized and drained.

WARNING!

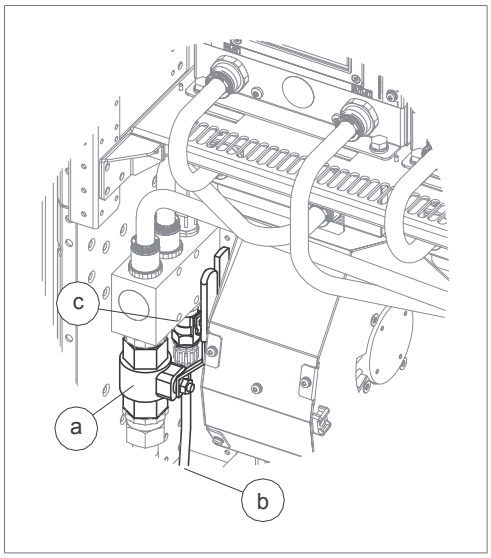
Use the required personal protective equipment. Wear protective gloves and long sleeves. Some parts have sharp edges.

Removing the module

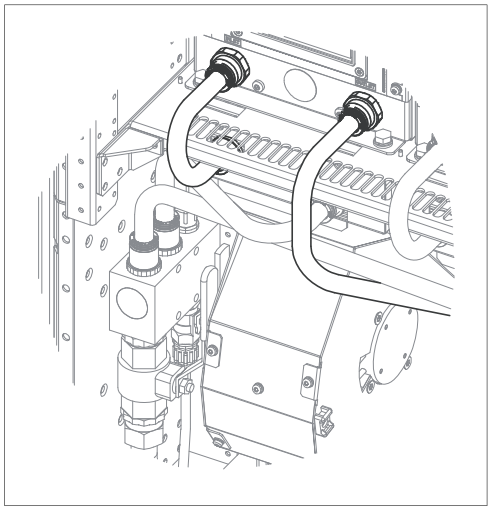
1. Repeat the steps described in section *Electrical safety precautions (page 16)*.
2. Remove the shrouding in front of the module.
3. Undo the locking screws of the swing-out frame (if present) and open it.
4. Unplug the wiring from the module and move it aside. Use cable ties to keep the wiring out 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.



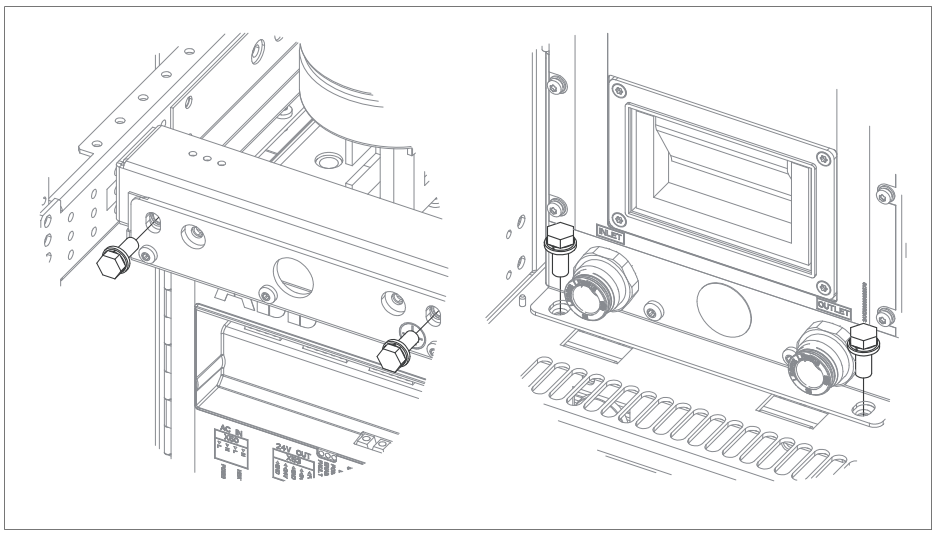
6. Close the inlet valve (a) and outlet valve (located on the right-hand side of the cubicle) valves. Lead the drain hoses (b, on both sides of the cubicle) into a suitable container. Open the drain valves (c, on both sides of the cubicle). This will drain all modules in the cubicle.



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.

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.

WARNING!

For a reliable connection, the end of the pipe entering the connector must be completely intact for a length of at least 5 cm (2”). Make sure that the pipe is perfectly round where it enters the connector, and not deformed eg. by any bends nearby. The piping must not exert any tension or torque on the connector.

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 (page 145)*.
7. Close the swing-out frame (if present). Reinstall all shrouds removed earlier.
8. If the Safe torque off function is in use, perform an acceptance test as described under chapter Start-up including acceptance test.

Activating the reduced run of the inverter unit

A “reduced run” function is available for inverter units consisting of parallel-connected inverter modules. The function makes it possible to continue operation with limited current even if one (or more) module is out of service, for example, because of maintenance work. In principle, reduced run is possible with only one module, but the physical requirements of operating the motor still apply; for example, the modules remaining in use must be able to provide the motor with enough magnetizing current.

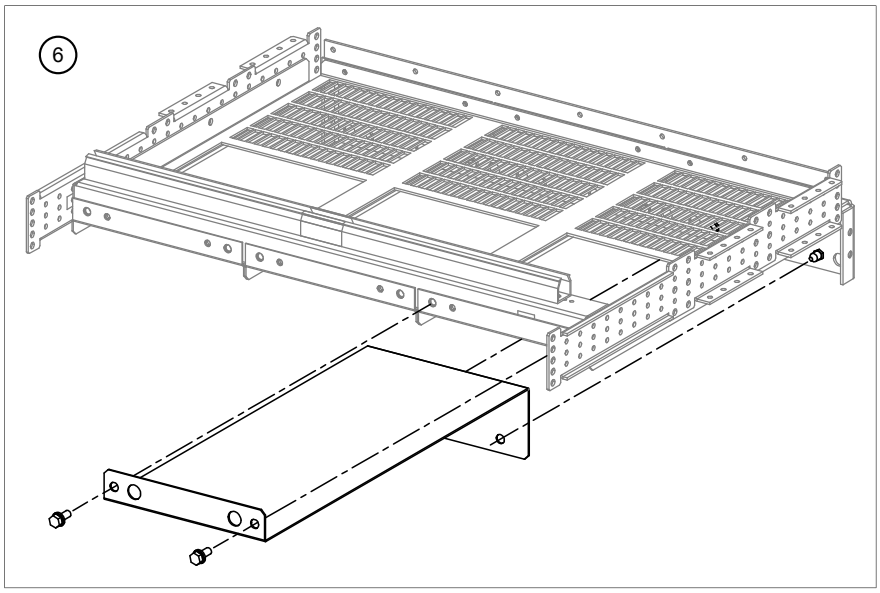
Note:
The wiring accessories and the air baffle needed during the procedure are included in the delivery, and separately available from ABB.

WARNING!

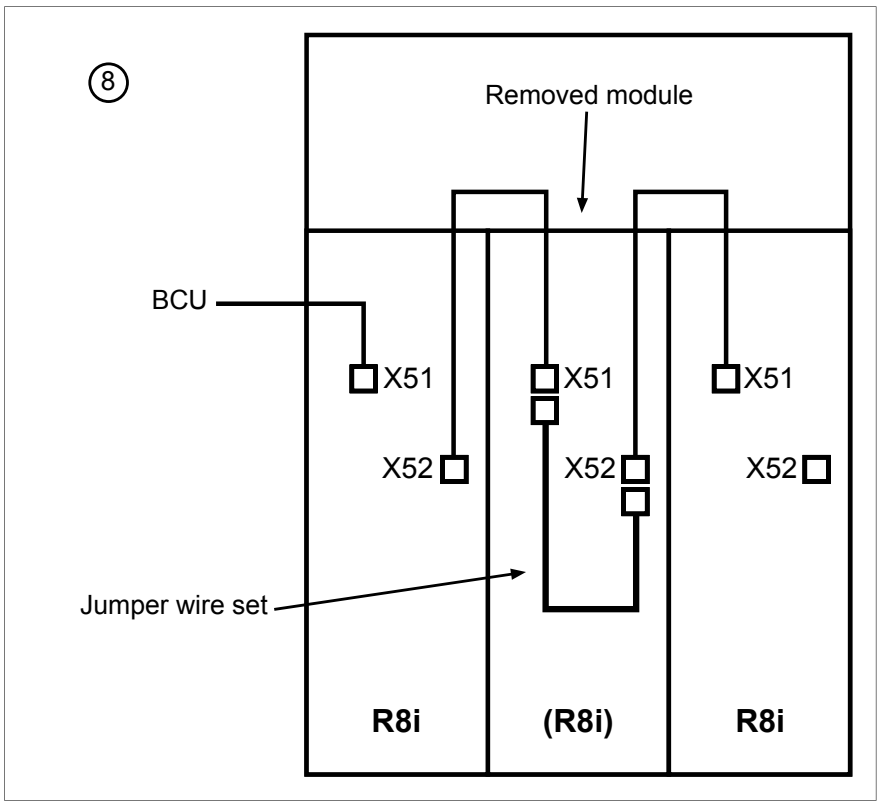
Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 16)* before you start the work.
2. Remove the shrouding above the module bay (in front of the DC fuses).
3. Remove the DC fuses and the busbar assembly connecting the fuses to the inverter module. Store these parts – they are to be reinstalled only with the inverter module. Make note of the order of washers.
4. Remove the faulty module from its bay. See the *Replacing an inverter module (page 134)*.
5. Plug the coolant pipes disconnected from the module using the plugs that are included in the drive delivery.

6. Install the air baffle (included) to the underside of the top module guide. Align the holes at the rear edge of the baffle with the guide pins of the rear support. Fasten the front edge of the baffle to the module mounting holes using the module mounting screws (2 × M8). Tighten to 9 N·m (6.6 lbf·ft).



7. If the inverter control unit (A41) is powered from the faulty module, connect the power supply wiring to another module using the extension wire set included.
8. If the Safe torque off (STO) function is in use, install the jumper wire set included in the STO wiring in place of the missing module. (This is not needed if the module was the last on the STO wire chain.)



9. Open the circuit breaker of the cooling fan of the removed module. Disconnect the control and power wiring of the fan.

10. Cover or remove the cooling fan.
11. Deactivate the control IOs of the fan in parameters *206.20 … 206.23*.
12. Reinstall all shrouding removed earlier.

    Note:
    Do not reinstall the DC fuses or busbars but store them elsewhere until the module can be reinstalled.

13. In case the inverter unit has a DC switch/disconnector with a charging circuit, locate the BSFC-xx charging controller. On the controller, disable the channel of the removed module by using the appropriate DIP switch.
14. Switch on the power to the drive.
15. Enter the number of inverter modules present into parameter *95.13 Reduced run mode*.
16. Reset all faults and start the drive.
17. If the Safe torque off (STO) function is in use, perform an acceptance test. See the instructions in chapter *The Safe torque off function (page 189)*.

The maximum current is now automatically limited according to the new inverter configuration. A mismatch between the number of detected modules (parameter *95.14*) and the value set in *95.13* will generate a fault.

Returning the module

1. Install the module in reverse order. Use the following tightening torques:
   - DC busbar assembly to upper insulators (2 × M8): 9 N·m (6.6 lbf·ft)
   - DC busbar assembly to lower insulators (2 × M10): 18 N·m (13.3 lbf·ft)
   - Fuses to DC busbars: 50 N·m (37 lbf·ft) (Bussmann), 46 N·m (34 lbf·ft) (Mersen/Ferraz-Shawmut)
   - Module to cabinet frame (4 × M8): 22 N·m (16 lbf·ft)
   - DC busbar assembly to module DC input (2 × M12): 70 N·m (52 lbf·ft)
2. Remove the plugs from the coolant pipes and reconnect the pipes to the module. See the *Replacing an inverter module (page 134)*.
3. Restore the original wiring (STO and control unit power supply whenever needed).
4. Reinstall any removed fan(s). Reconnect the control and power supply wiring of the fan.
5. Set parameter *95.13* to 0 to disable the reduced run function.
6. Activate the control IOs of the fan in parameters *206.20 … 206.23*.
7. If the Safe torque off (STO) function is in use, perform an acceptance test. See the instructions in chapter *The Safe torque off function (page 189)*.

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.

Reforming the capacitors

The capacitors must be reformed if the drive has been stored 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]).

Control panel

Replacing the control panel battery

1. Turn the lid on the back of the panel counter-clockwise until the lid opens.
2. Replace the battery with a new CR2032 battery.
3. Put the lid back and tighten it by turning it clockwise.
4. Dispose of the old battery according to local disposal rules or applicable laws.

Cleaning the control panel

See *ACX-AP-x assistant control panels user's manual* (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.

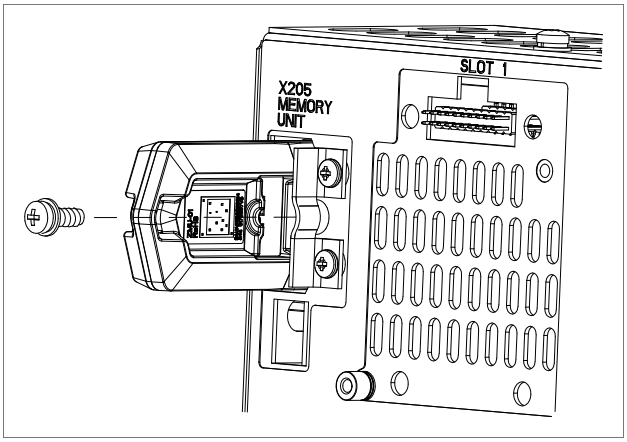
Replacing the memory unit

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 16)* 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.

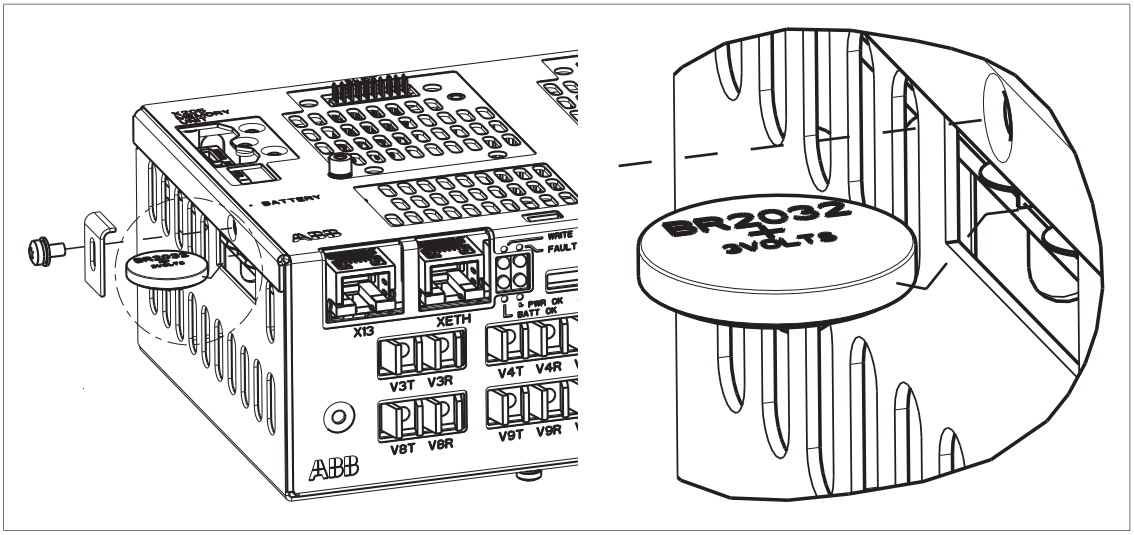


Replacing the BCU control unit battery

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 16)* 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

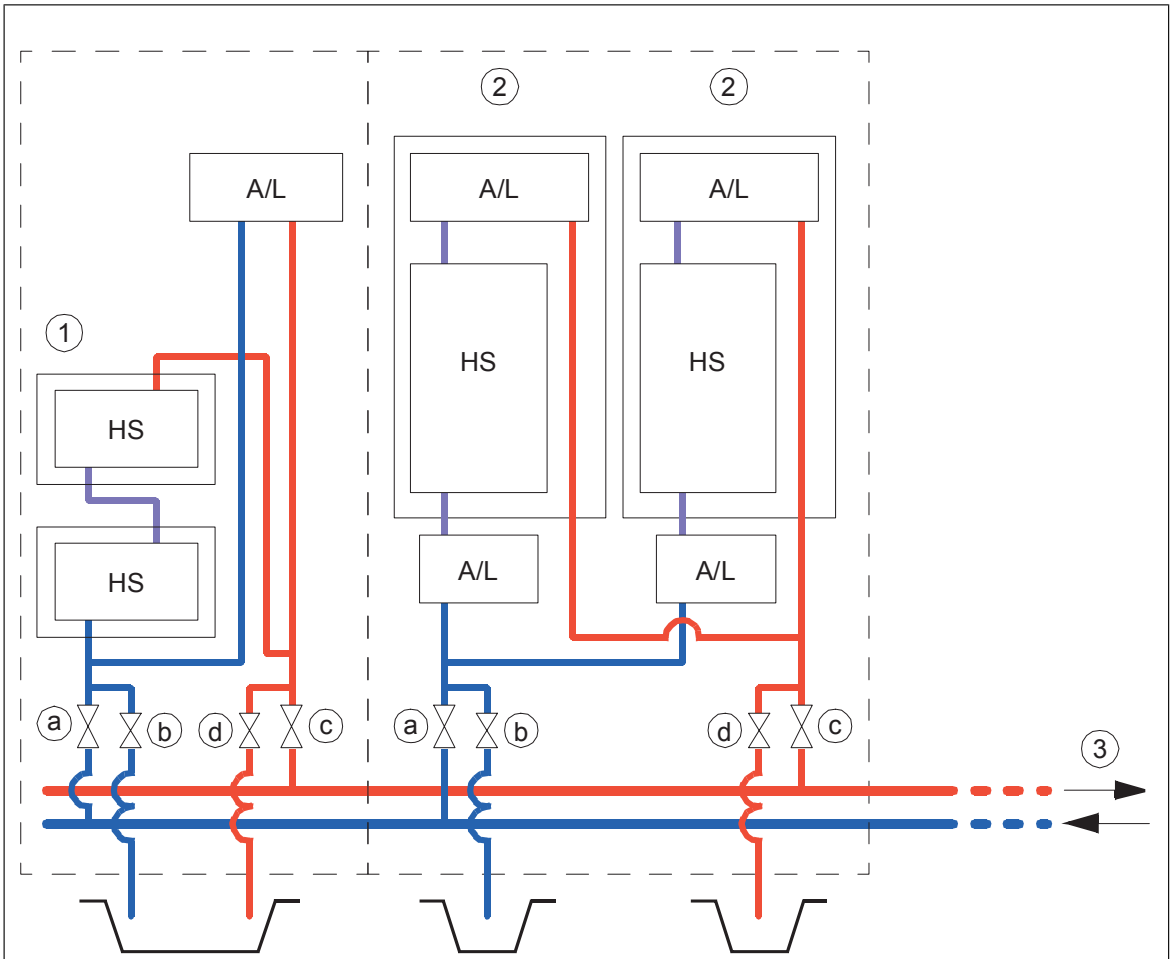
The information in this chapter is applicable to cabinet-built ACS880 liquid-cooled multidrive. Except where otherwise indicated, the information is also applicable to drives built out of ACS880 liquid-cooled multidrive modules.

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 by Clariant International Ltd (www.clariant.com), mixed with water. See *Coolant specification (page 147)*.

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 147)*. 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 149)*.

Coolant temperature control

The temperature of the coolant in the internal cooling circuit must be kept within the limits specified in *Technical data (page 147)*. 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 147)*.
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 147)*.
   - 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), mixed with water.

Ready-mixed coolant is available from Clariant distributors and ABB Service representatives. The standard Antifrogen® L / water solution of 25/75% (volume) is usable down to a storage temperature of -16 °C (3.2 °F). 50/50% coolant is optionally available for 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.

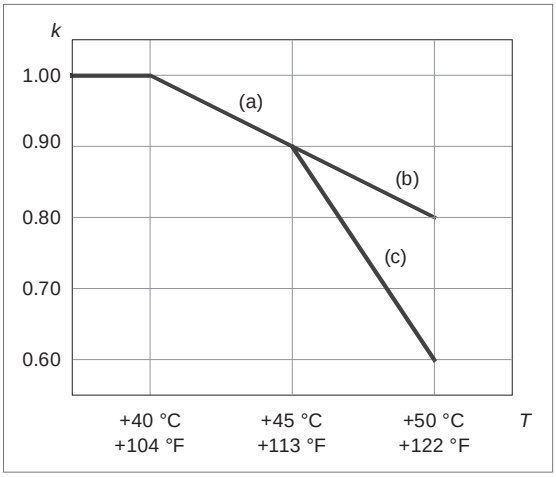
The higher the concentration of heat transfer fluid, the higher the viscosity of the coolant. This results in a higher pressure loss in the system. An operating pressure of more than 150 kPa is required for sufficient flow.

The nominal current ratings of drive system modules apply to an Antifrogen® L / water solution of 25/75% (volume). For derating with other ratios, contact your local ABB representative.

Incoming coolant temperature:

- 4…40 °C (39…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
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 4 °C (39 °F) or above. Consult an ABB representative if operation below coolant temperature 4 °C is required.				
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

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

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 definitions are described below the table.

ACS880-07CLC-…	Input rating	Output ratings										
		No-overload use					Light-overload use			Heavy-duty use		
	I_1	I_N	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, 6-pulse connection												
0390A-7	357	390	585	355	400	466	374	355	350	292	250	300
0430A-7	394	430	645	400	450	514	413	355	450	322	250	300
0480A-7	439	480	720	450	500	574	461	400	450	359	315	350
0530A-7	485	530	795	500	550	633	509	450	500	396	355	400
0600A-7	549	600	900	560	600	717	576	560	600	449	400	450
0670A-7	613	670	1005	630	700	801	643	630	700	501	450	500
0750A-7	686	750	1125	710	800	896	720	710	700	561	500	600
0850A-7	778	850	1275	800	900	1016	816	800	900	636	560	600
1030A-7	943	1030	1545	1000	1000	1231	989	900	1000	770	710	800
1170A-7	1071	1170	1755	1100	1250	1398	1123	1100	1250	875	800	900
1310A-7	1199	1310	1965	1200	1250	1566	1258	1200	1250	980	900	1000

ACS880-07CLC-…	Input rating	Output ratings										
		No-overload use					Light-overload use			Heavy-duty use		
	I_1	I_N	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	1345	1470	2205	1400	1500	1757	1411	1200	1500	1100	1000	1000
1660A-7	1519	1660	2490	1600	1750	1984	1594	1400	1750	1242	1200	1250
1940A-7	1775	1940	2910	1800	2000	2319	1862	1800	2000	1451	1400	1500
2180A-7	1995	2180	3270	2000	TBA	2605	2093	2000	TBA	1631	1400	1750
2470A-7	2261	2470	3705	2300	TBA	2952	2371	2300	TBA	1848	1800	2000
2880A-7	2636	2880	4320	2700	TBA	3442	2765	2700	TBA	2154	2000	TBA
3260A-7	2984	3260	4890	3000	TBA	3896	3130	3000	TBA	2438	2300	TBA
U_N = 690 V, 12-pulse connection												
0530A-7+A004	485	530	795	500	550	633	509	450	500	396	355	400
0600A-7+A004	549	600	900	560	600	717	576	560	600	449	400	450
0670A-7+A004	613	670	1005	630	700	801	643	630	700	501	450	500
0750A-7+A004	686	750	1125	710	800	896	720	710	700	561	500	600
0850A-7+A004	778	850	1275	800	900	1016	816	800	900	636	560	600
1030A-7+A004	943	1030	1545	1000	1000	1231	989	900	1000	770	710	800
1170A-7+A004	1071	1170	1755	1100	1250	1398	1123	1100	1250	875	800	900
1310A-7+A004	1199	1310	1965	1200	1250	1566	1258	1200	1250	980	900	1000
1470A-7+A004	1345	1470	2205	1400	1500	1757	1411	1200	1500	1100	1000	1000
1660A-7+A004	1519	1660	2490	1600	1750	1984	1594	1400	1750	1242	1200	1250
1940A-7+A004	1775	1940	2910	1800	2000	2319	1862	1800	2000	1451	1400	1500
2180A-7+A004	1995	2180	3270	2000	TBA	2605	2093	2000	TBA	1631	1400	1750
2470A-7+A004	2261	2470	3705	2300	TBA	2952	2371	2300	TBA	1848	1800	2000
2880A-7+A004	2636	2880	4320	2700	TBA	3442	2765	2700	TBA	2154	2000	TBA
3260A-7+A004	2984	3260	4890	3000	TBA	3896	3130	3000	TBA	2438	2300	TBA
3580A-7+A004	3276	3580	5370	3400	TBA	4279	3437	3200	TBA	2678	2600	TBA
4050A-7+A004	3707	4050	6075	3800	TBA	4840	3888	3800	TBA	3029	2800	TBA
4840A-7+A004	4430	4840	7260	4400	TBA	5784	4646	4400	TBA	3620	3500	TBA
5650A-7+A004	5171	5650	8475	5200	TBA	6752	5424	5200	TBA	4226	4000	TBA
6460A-7+A004	5912	6460	9690	6000	TBA	7720	6202	6000	TBA	4832	4700	TBA
U_N = 690 V, 24-pulse connection												
2470A-7+A006	2261	2470	3705	2300	TBA	2952	2371	2300	TBA	1848	1800	TBA
3260A-7+A006	2984	3260	4890	3000	TBA	3896	3130	3000	TBA	2438	2300	TBA
4840A-7+A006	4430	4840	7260	4400	TBA	5784	4646	4400	TBA	3620	3500	TBA
5650A-7+A006	5171	5650	8475	5200	TBA	6752	5424	5200	TBA	4226	4000	TBA
6460A-7+A006	5912	6460	9690	6000	TBA	7720	6202	6000	TBA	4832	4700	TBA

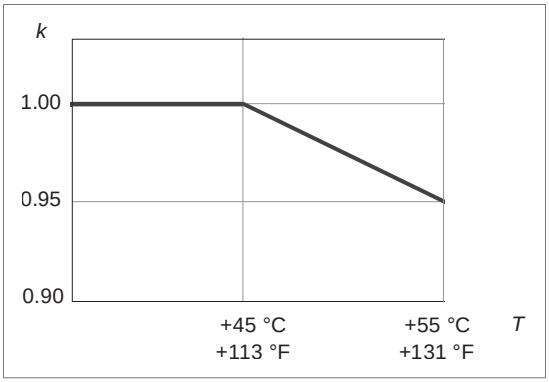
Definitions

U_N	Supply voltage range
I_1	Nominal rms input current
I_N	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.
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 air temperature of 45 °C (113 °F) and a coolant 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 147)*.

Antifreeze content derating

See section *Temperature limits (page 147)*.

Altitude derating

At altitudes from 0 to 2000 m (0 to 6562 ft), no derating is required. For altitudes above 2000 m (6562 ft), contact ABB.

Switching frequency derating

Switching frequencies other than default can require output current derating. Contact ABB for more information.

Output frequency derating

Motor operation above 150 Hz can require type-specific output current derating. Contact ABB for more information.

Frame sizes and power module types

ACS880-07CLC-…	Frame size	Supply modules used		Inverter modules used	
		Qty	Type	Qty	Type
U_N = 690 V, 6-pulse connection					
0390A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0390A-7
0430A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0430A-7
0480A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0480A-7
0530A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0530A-7
0600A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0600A-7
0670A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0670A-7
0750A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0750A-7
0850A-7	1×D8D + 1×R8i	1	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0850A-7
1030A-7	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0530A-7
1170A-7	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0600A-7
1310A-7	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0670A-7
1470A-7	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0750A-7
1660A-7	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0850A-7
1940A-7	3×D8D + 3×R8i	3	ACS880-304LC-0820A-7+A019	3	ACS880-104LC-0670A-7
2180A-7	3×D8D + 3×R8i	3	ACS880-304LC-0820A-7+A019	3	ACS880-104LC-0750A-7
2470A-7	3×D8D + 3×R8i	3	ACS880-304LC-0820A-7+A019	3	ACS880-104LC-0850A-7
2880A-7	4×D8D + 4×R8i	4	ACS880-304LC-0820A-7+A019	4	ACS880-104LC-0750A-7
3260A-7	4×D8D + 4×R8i	4	ACS880-304LC-0820A-7+A019	4	ACS880-104LC-0850A-7
U_N = 690 V, 12-pulse connection					
0530A-7+A004	2×D8D + 1×R8i	2	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0530A-7
0600A-7+A004	2×D8D + 1×R8i	2	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0600A-7
0670A-7+A004	2×D8D + 1×R8i	2	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0670A-7
0750A-7+A004	2×D8D + 1×R8i	2	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0750A-7

ACS880-07CLC-…	Frame size	Supply modules used		Inverter modules used	
		Qty	Type	Qty	Type
0850A-7+A004	2×D8D + 1×R8i	2	ACS880-304LC-0820A-7+A019	1	ACS880-104LC-0850A-7
1030A-7+A004	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0530A-7
1170A-7+A004	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0600A-7
1310A-7+A004	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0670A-7
1470A-7+A004	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0750A-7
1660A-7+A004	2×D8D + 2×R8i	2	ACS880-304LC-0820A-7+A019	2	ACS880-104LC-0850A-7
1940A-7+A004	4×D8D + 3×R8i	4	ACS880-304LC-0820A-7+A019	3	ACS880-104LC-0670A-7
2180A-7+A004	4×D8D + 3×R8i	4	ACS880-304LC-0820A-7+A019	3	ACS880-104LC-0750A-7
2470A-7+A004	4×D8D + 3×R8i	4	ACS880-304LC-0820A-7+A019	3	ACS880-104LC-0850A-7
2880A-7+A004	4×D8D + 4×R8i	4	ACS880-304LC-0820A-7+A019	4	ACS880-104LC-0750A-7
3260A-7+A004	4×D8D + 4×R8i	4	ACS880-304LC-0820A-7+A019	4	ACS880-104LC-0850A-7
3580A-7+A004	6×D8D + 5×R8i	6	ACS880-304LC-0820A-7+A019	5	ACS880-104LC-0750A-7
4050A-7+A004	6×D8D + 5×R8i	6	ACS880-304LC-0820A-7+A019	5	ACS880-104LC-0850A-7
4840A-7+A004	6×D8D + 6×R8i	6	ACS880-304LC-0820A-7+A019	6	ACS880-104LC-0850A-7
5650A-7+A004	8×D8D + 7×R8i	8	ACS880-304LC-0820A-7+A019	7	ACS880-104LC-0850A-7
6460A-7+A004	8×D8D + 8×R8i	8	ACS880-304LC-0820A-7+A019	8	ACS880-104LC-0850A-7
U_N = 690 V, 24-pulse connection					
2470A-7+A006	4×D8D + 3×R8i	4	ACS880-304LC-0820A-7+A019	3	ACS880-104LC-0850A-7
3260A-7+A006	4×D8D + 4×R8i	4	ACS880-304LC-0820A-7+A019	4	ACS880-104LC-0850A-7
4840A-7+A006	8×D8D + 6×R8i	8	ACS880-304LC-0820A-7+A019	6	ACS880-104LC-0850A-7
5650A-7+A006	8×D8D + 7×R8i	8	ACS880-304LC-0820A-7+A019	7	ACS880-104LC-0850A-7
6460A-7+A006	8×D8D + 8×R8i	8	ACS880-304LC-0820A-7+A019	8	ACS880-104LC-0850A-7

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.

ACS880-07CLC-…	Ultrarapid (aR) fuses at supply module input					
	Qty	A	A^2s at 660 V	V	Manufacturer	Type
U_N = 690 V, 6-pulse connection						
0390A…0850A-7	3	1400	2450000	690	Bussmann	170M6467
1030A…1660A-7	6					
1940A…2470A-7	9					
2880A…3260A-7	12					
U_N = 690 V, 12-pulse connection						
0530A…1660A-7+A004	6	1400	2450000	690	Bussmann	170M6467
1940A…3260A-7+A004	12					
3580A…4840A-7+A004	18					
5650A…6460A-7+A004	24					
U_N = 690 V, 24-pulse connection						
2470A…3260A-7+A006	12	1400	2450000	690	Bussmann	170M6467
4840A…6460A-7+A006	24					

DC fuses

The drive has DC fuses 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.

ACS880-07CLC-…	DC fuses at inverter module input				
	Qty	A	V	Manufacturer	Type
U_N = 690 V, 6-pulse connection					
0390A-7	2	800	1250	Ferraz Shawmut	PC73UD13C800TF
0430A-7					
0480A-7	2	900	1100	Bussmann	170M6547
0530A-7	2	1000	1100	Bussmann	170M6548
0600A-7	2	1100	1000	Bussmann	170M6549
0670A-7	2	1250	1100	Bussmann	170M6500

ACS880-07CLC-…	DC fuses at inverter module input				
	Qty	A	V	Manufacturer	Type
0750A-7	2	1400	1100	Bussmann	170M6501
0850A-7					
1030A-7	4	1000	1100	Bussmann	170M6548
1170A-7	4	1100	1000	Bussmann	170M6549
1310A-7	4	1250	1100	Bussmann	170M6500
1470A-7	4	1400	1100	Bussmann	170M6501
1660A-7	4				
1940A-7	6	1250	1100	Bussmann	170M6500
2180A-7	6	1400	1100	Bussmann	170M6501
2470A-7	6				
2880A-7	8				
3260A-7	8				
U_N = 690 V, 12-pulse connection					
0530A-7+A004	2	1000	1100	Bussmann	170M6548
0600A-7+A004	2	1100	1000	Bussmann	170M6549
0670A-7+A004	2	1250	1100	Bussmann	170M6500
0750A-7+A004	2	1400	1100	Bussmann	170M6501
0850A-7+A004					
1030A-7+A004	4	1000	1100	Bussmann	170M6548
1170A-7+A004	4	1100	1000	Bussmann	170M6549
1310A-7+A004	4	1250	1100	Bussmann	170M6500
1470A-7+A004	4	1400	1100	Bussmann	170M6501
1660A-7+A004					
1940A-7+A004	6	1250	1100	Bussmann	170M6500
2180A-7+A004	6	1400	1100	Bussmann	170M6501
2470A-7+A004	6				
2880A-7+A004	8				
3260A-7+A004	8				
3580A-7+A004	10				
4050A-7+A004	10				
4840A-7+A004	12				
5650A-7+A004	14				
6460A-7+A004	16				
U_N = 690 V, 24-pulse connection					
2470A-7+A006	6	1400	1100	Bussmann	170M6501
3260A-7+A006	8				
4840A-7+A006	12				
5650A-7+A006	14				
6460A-7+A006	16				

Brake chopper DC fuses

Optional (+D150) brake choppers have two DC fuses each. The fuse type is Bussmann 170M8635 (630 A 1000 V).

Dimensions and weights

See chapter *Dimensions (page 173)*.

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 and noise

ACS880-07CLC-…	Coolant flow		Heat dissipation	Noise
	l/min	US gal/min	kW	dB(A)
U_N = 690 V, 6-pulse connection				
0390A-7	28	7.4	8.6	66
0430A-7	28	7.4	9.3	66
0480A-7	28	7.4	10	66
0530A-7	28	7.4	11	66
0600A-7	28	7.4	13	66
0670A-7	28	7.4	14	66
0750A-7	28	7.4	16	66
0850A-7	28	7.4	18	66
1030A-7	54	14.3	22	68
1170A-7	54	14.3	25	68
1310A-7	54	14.3	27	68
1470A-7	54	14.3	31	68
1660A-7	54	14.3	35	68
1940A-7	72	19	41	69
2180A-7	72	19	46	69
2470A-7	72	19	53	69
2880A-7	98	26	61	70
3260A-7	98	26	69	70
U_N = 690 V, 12-pulse connection				
0530A-7+A004	38	10.0	11	66
0600A-7+A004	38	10.0	13	66
0670A-7+A004	38	10.0	14	66
0750A-7+A004	38	10.0	16	66

ACS880-07CLC-…	Coolant flow		Heat dissipation	Noise
	l/min	US gal/min	kW	dB(A)
0850A-7+A004	38	10.0	18	66
1030A-7+A004	54	14.3	22	68
1170A-7+A004	54	14.3	25	68
1310A-7+A004	54	14.3	27	68
1470A-7+A004	54	14.3	31	68
1660A-7+A004	54	14.3	35	68
1940A-7+A004	82	22	41	69
2180A-7+A004	82	22	46	69
2470A-7+A004	82	22	53	69
2880A-7+A004	98	26	61	70
3260A-7+A004	98	26	69	70
3580A-7+A004	126	33	76	72
4050A-7+A004	126	33	87	72
4840A-7+A004	142	38	104	72
5650A-7+A004	170	45	121	73
6460A-7+A004	186	49	138	73
U_N = 690 V, 24-pulse connection				
2470A-7+A006	82	22	53	69
3260A-7+A006	98	26	69	70
4840A-7+A006	154	41	103	72
5650A-7+A006	170	45	121	73
6460A-7+A006	186	49	138	73

Input cable sizes

This table gives typical cable sizes for:

- Marine-type cable with copper conductors such as Nexans MPRXCX® FLEXISHIP® EMC 0.6/1 (1.2) kV
- Industrial-type aluminum and copper cable types. 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). A correction factor K = 0.70 is used.

ACS880-07CLC-…	Marine-type cable	Industrial-type cable		
	Copper	Aluminum with XLPE insulation	Aluminum with PVC insulation	Copper with PVC insulation
	mm²	mm²	mm²	mm²
U_N = 690 V, 6-pulse connection				
0390A-7	3 × (3 × 95)	2 × (3 × 120 + 41 Cu)	2 × (3 × 185 + 57 Cu)	2 × (3 × 150 + 70)
0430A-7	3 × (3 × 95)	2 × (3 × 150 + 41 Cu)	2 × (3 × 240 + 72 Cu)	2 × (3 × 150 + 70)
0480A-7	3 × (3 × 95)	2 × (3 × 185 + 57 Cu)	2 × (3 × 240 + 72 Cu)	2 × (3 × 150 + 70)
0530A-7	3 × (3 × 95)	2 × (3 × 185 + 57 Cu)	3 × (3 × 150 + 41 Cu)	2 × (3 × 185 + 95)
0600A-7	4 × (3 × 95)	2 × (3 × 240 + 72 Cu)	3 × (3 × 185 + 57 Cu)	2 × (3 × 240 + 120)
0670A-7	4 × (3 × 95)	3 × (3 × 150 + 41 Cu)	3 × (3 × 240 + 72 Cu)	3 × (3 × 150 + 70)
0750A-7	5 × (3 × 95)	3 × (3 × 185 + 57 Cu)	3 × (3 × 240 + 72 Cu)	3 × (3 × 185 + 95)
0850A-7	5 × (3 × 95)	3 × (3 × 240 + 72 Cu)	4 × (3 × 185 + 57 Cu)	4 × (3 × 150 + 70)
1030A-7	2 × 3 × (3 × 95)	2 × 2 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 150 + 41 Cu)	2 × 2 × (3 × 185 + 95)
1170A-7	2 × 4 × (3 × 95)	2 × 2 × (3 × 240 + 72 Cu)	2 × 3 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 240 + 120)
1310A-7	2 × 4 × (3 × 95)	2 × 3 × (3 × 150 + 41 Cu)	2 × 3 × (3 × 240 + 72 Cu)	2 × 2 × (3 × 240 + 120)
1470A-7	2 × 5 × (3 × 95)	2 × 3 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 240 + 72 Cu)	2 × 3 × (3 × 185 + 95)
1660A-7	2 × 5 × (3 × 95)	2 × 3 × (3 × 240 + 72 Cu)	2 × 4 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 185 + 95)
1940A-7	3 × 4 × (3 × 95)	3 × 4 × (3 × 120 + 41 Cu)	3 × 3 × (3 × 240 + 72 Cu)	3 × 2 × (3 × 240 + 120)
2180A-7	3 × 4 × (3 × 120)	3 × 4 × (3 × 150 + 41 Cu)	3 × 3 × (3 × 240 + 72 Cu)	3 × 3 × (3 × 150 + 70)
2470A-7	3 × 4 × (3 × 120)	3 × 4 × (3 × 150 + 41 Cu)	3 × 4 × (3 × 185 + 57 Cu)	3 × 3 × (3 × 185 + 95)
2880A-7	4 × 3 × (3 × 150)	4 × 3 × (3 × 185 + 57 Cu)	4 × 3 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 150 + 70)
3260A-7	4 × 4 × (3 × 150)	4 × 3 × (3 × 240 + 72 Cu)	–	4 × 3 × (3 × 185 + 95)
U_N = 690 V, 12-pulse connection				
0530A-7+A004	2 × 2 × (3 × 95)	2 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 95 + 29 Cu)	2 × (3 × 185 + 95)
0600A-7+A004	2 × 2 × (3 × 95)	2 × (3 × 240 + 72 Cu)	2 × 2 × (3 × 120 + 41 Cu)	2 × (3 × 240 + 120)
0670A-7+A004	2 × 2 × (3 × 95)	2 × 2 × (3 × 95 + 29 Cu)	2 × 2 × (3 × 150 + 41 Cu)	2 × 2 × (3 × 95 + 50)

ACS880-07CLC-…	Marine-type cable	Industrial-type cable		
	Copper	Aluminum with XLPE insulation	Aluminum with PVC insulation	Copper with PVC insulation
	mm²	mm²	mm²	mm²
0750A-7+A004	2 × 3 × (3 × 95)	2 × 2 × (3 × 120 + 41 Cu)	2 × 2 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 120 + 70)
0850A-7+A004	2 × 3 × (3 × 95)	2 × 2 × (3 × 150 + 41 Cu)	2 × 2 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 150 + 70)
1030A-7+A004	2 × 3 × (3 × 95)	2 × 2 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 150 + 41 Cu)	2 × 2 × (3 × 185 + 95)
1170A-7+A004	2 × 4 × (3 × 95)	2 × 2 × (3 × 240 + 72 Cu)	2 × 3 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 240 + 120)
1310A-7+A004	2 × 4 × (3 × 95)	2 × 3 × (3 × 150 + 41 Cu)	2 × 3 × (3 × 240 + 72 Cu)	2 × 2 × (3 × 240 + 120)
1470A-7+A004	2 × 5 × (3 × 95)	2 × 3 × (3 × 185 + 57 Cu)	2 × 4 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 185 + 95)
1660A-7+A004	2 × 5 × (3 × 95)	2 × 3 × (3 × 240 + 72 Cu)	2 × 4 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 185 + 95)
1940A-7+A004	4 × 3 × (3 × 95)	4 × 2 × (3 × 185 + 57 Cu)	4 × 2 × (3 × 240 + 72 Cu)	4 × 2 × (3 × 150 + 70)
2180A-7+A004	4 × 3 × (3 × 120)	4 × 2 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 185 + 57 Cu)	4 × 2 × (3 × 185 + 95)
2470A-7+A004	4 × 3 × (3 × 120)	4 × 2 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 185 + 57 Cu)	4 × 2 × (3 × 240 + 120)
2880A-7+A004	4 × 3 × (3 × 150)	4 × 3 × (3 × 185 + 57 Cu)	4 × 3 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 150 + 70)
3260A-7+A004	4 × 4 × (3 × 150)	4 × 3 × (3 × 240 + 72 Cu)	–	4 × 3 × (3 × 185 + 95)
3580A-7+A004	6 × 4 × (3 × 95)	6 × 2 × (3 × 240 + 72 Cu)	6 × 3 × (3 × 185 + 57 Cu)	6 × 2 × (3 × 240 + 120)
4050A-7+A004	6 × 4 × (3 × 95)	6 × 3 × (3 × 150 + 41 Cu)	6 × 3 × (3 × 240 + 72 Cu)	6 × 3 × (3 × 150 + 70)
4840A-7+A004	6 × 4 × (3 × 120)	6 × 3 × (3 × 240 + 72 Cu)	6 × 4 × (3 × 185 + 57 Cu)	6 × 3 × (3 × 185 + 95)
5650A-7+A004	8 × 3 × (3 × 150)	8 × 3 × (3 × 185 + 57 Cu)	8 × 3 × (3 × 240 + 72 Cu)	8 × 3 × (3 × 150 + 70)
6460A-7+A004	8 × 4 × (3 × 150)	8 × 3 × (3 × 240 + 72 Cu)	–	8 × 3 × (3 × 185 + 95)
U_N = 690 V, 24-pulse connection				
2470A-7+A006	4 × 3 × (3 × 120)	4 × 2 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 185 + 57 Cu)	4 × 2 × (3 × 240 + 120)
3260A-7+A006	4 × 4 × (3 × 150)	4 × 3 × (3 × 240 + 72 Cu)	–	4 × 3 × (3 × 185 + 95)
4840A-7+A006	6 × 4 × (3 × 120)	8 × 3 × (3 × 150 + 41 Cu)	8 × 3 × (3 × 185 + 57 Cu)	6 × 3 × (3 × 185 + 95)
5650A-7+A006	8 × 3 × (3 × 150)	8 × 3 × (3 × 185 + 57 Cu)	8 × 3 × (3 × 240 + 72 Cu)	8 × 3 × (3 × 150 + 70)
6460A-7+A006	8 × 4 × (3 × 150)	8 × 3 × (3 × 240 + 72 Cu)	–	8 × 3 × (3 × 185 + 95)

Output cable sizes

This table gives typical cable sizes for:

- Marine-type cable with copper conductors such as Nexans MPRXCX® FLEXISHIP® EMC 0.6/1 (1.2) kV
- Industrial-type aluminum and copper cable types. 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). A correction factor K = 0.70 is used.

ACS880-07CLC-…	Marine-type cable	Industrial-type cable	
	Copper	Aluminum with PVC insulation	Copper with PVC insulation
	mm²	mm²	mm²
U_N = 690 V, 6-pulse connection			
0390A-7	3 × (3 × 95)	2 × (3 × 185 + 57 Cu)	2 × (3 × 150 + 70)
0430A-7	3 × (3 × 95)	2 × (3 × 240 + 72 Cu)	2 × (3 × 150 + 70)
0480A-7	3 × (3 × 95)	3 × (3 × 150 + 41 Cu)	2 × (3 × 185 + 95)
0530A-7	4 × (3 × 95)	3 × (3 × 185 + 57 Cu)	2 × (3 × 240 + 120)
0600A-7	4 × (3 × 95)	3 × (3 × 240 + 72 Cu)	2 × (3 × 240 + 120)
0670A-7	4 × (3 × 120)	3 × (3 × 240 + 72 Cu)	3 × (3 × 185 + 95)
0750A-7	4 × (3 × 120)	4 × (3 × 185 + 57 Cu)	3 × (3 × 185 + 95)
0850A-7	4 × (3 × 120)	4 × (3 × 240 + 72 Cu)	4 × (3 × 150 + 70)
1030A-7	2 × 4 × (3 × 95)	2 × 3 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 240 + 120)
1170A-7	2 × 4 × (3 × 95)	2 × 3 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 240 + 120)
1310A-7	2 × 4 × (3 × 95)	2 × 4 × (3 × 150 + 41 Cu)	2 × 3 × (3 × 150 + 70)
1470A-7	2 × 4 × (3 × 120)	2 × 4 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 185 + 95)
1660A-7	2 × 4 × (3 × 120)	2 × 4 × (3 × 240 + 72 Cu)	2 × 3 × (3 × 240 + 120)
1940A-7	3 × 4 × (3 × 95)	3 × 3 × (3 × 240 + 72 Cu)	3 × 3 × (3 × 150 + 70)
2180A-7	3 × 4 × (3 × 120)	3 × 4 × (3 × 185 + 57 Cu)	3 × 3 × (3 × 185 + 95)
2470A-7	3 × 4 × (3 × 150)	3 × 4 × (3 × 240 + 72 Cu)	3 × 3 × (3 × 240 + 120)
2880A-7	4 × 4 × (3 × 120)	4 × 4 × (3 × 185 + 57 Cu)	4 × 3 × (3 × 185 + 95)
3260A-7	4 × 4 × (3 × 150)	4 × 4 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 240 + 120)
U_N = 690 V, 12-pulse connection			
0530A-7+A004	4 × (3 × 95)	3 × (3 × 185 + 57 Cu)	2 × (3 × 240 + 120)
0600A-7+A004	4 × (3 × 95)	3 × (3 × 240 + 72 Cu)	2 × (3 × 240 + 120)
0670A-7+A004	4 × (3 × 120)	3 × (3 × 240 + 72 Cu)	3 × (3 × 185 + 95)
0750A-7+A004	4 × (3 × 120)	4 × (3 × 185 + 57 Cu)	3 × (3 × 185 + 95)
0850A-7+A004	4 × (3 × 120)	4 × (3 × 240 + 72 Cu)	4 × (3 × 150 + 70)
1030A-7+A004	2 × 4 × (3 × 95)	2 × 3 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 240 + 120)
1170A-7+A004	2 × 4 × (3 × 95)	2 × 3 × (3 × 185 + 57 Cu)	2 × 2 × (3 × 240 + 120)
1310A-7+A004	2 × 4 × (3 × 95)	2 × 4 × (3 × 150 + 41 Cu)	2 × 3 × (3 × 150 + 70)
1470A-7+A004	2 × 4 × (3 × 120)	2 × 4 × (3 × 185 + 57 Cu)	2 × 3 × (3 × 185 + 95)
1660A-7+A004	2 × 4 × (3 × 120)	2 × 4 × (3 × 240 + 72 Cu)	2 × 3 × (3 × 240 + 120)
1940A-7+A004	3 × 4 × (3 × 95)	3 × 3 × (3 × 240 + 72 Cu)	3 × 3 × (3 × 150 + 70)

ACS880-07CLC-…	Marine-type cable	Industrial-type cable	
	Copper	Aluminum with PVC insulation	Copper with PVC insulation
	mm²	mm²	mm²
2180A-7+A004	3 × 4 × (3 × 120)	3 × 4 × (3 × 185 + 57 Cu)	3 × 3 × (3 × 185 + 95)
2470A-7+A004	3 × 4 × (3 × 150)	3 × 4 × (3 × 240 + 72 Cu)	3 × 3 × (3 × 240 + 120)
2880A-7+A004	4 × 4 × (3 × 120)	4 × 4 × (3 × 185 + 57 Cu)	4 × 3 × (3 × 185 + 95)
3260A-7+A004	4 × 4 × (3 × 150)	4 × 4 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 240 + 120)
3580A-7+A004	5 × 4 × (3 × 120)	5 × 4 × (3 × 185 + 57 Cu)	5 × 3 × (3 × 185 + 95)
4050A-7+A004	5 × 4 × (3 × 150)	5 × 4 × (3 × 240 + 72 Cu)	5 × 3 × (3 × 240 + 120)
4840A-7+A004	6 × 4 × (3 × 150)	6 × 4 × (3 × 240 + 72 Cu)	6 × 4 × (3 × 150 + 70)
5650A-7+A004	7 × 4 × (3 × 150)	7 × 4 × (3 × 240 + 72 Cu)	7 × 3 × (3 × 240 + 120)
6460A-7+A004	8 × 4 × (3 × 150)	8 × 4 × (3 × 240 + 72 Cu)	8 × 4 × (3 × 185 + 95)
U_N = 690 V, 24-pulse connection			
2470A-7+A006	3 × 4 × (3 × 150)	3 × 4 × (3 × 240 + 72 Cu)	3 × 3 × (3 × 240 + 120)
3260A-7+A006	4 × 4 × (3 × 150)	4 × 4 × (3 × 240 + 72 Cu)	4 × 3 × (3 × 240 + 120)
4840A-7+A006	6 × 4 × (3 × 150)	6 × 4 × (3 × 240 + 72 Cu)	6 × 4 × (3 × 150 + 70)
5650A-7+A006	7 × 4 × (3 × 150)	7 × 4 × (3 × 240 + 72 Cu)	7 × 3 × (3 × 240 + 120)
6460A-7+A006	8 × 4 × (3 × 150)	8 × 4 × (3 × 240 + 72 Cu)	8 × 4 × (3 × 185 + 95)

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 103)*.

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 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)	Rated peak withstand current (I_{pk}): 143 kA Rated short-time withstand current (I_{cw}): 65 kA/1 s
Short-circuit current protection (UL 08A, 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)	0.97 … 0.98 (at nominal load)

Transformer specification for 12-pulse supply (IEC 60076-1:2011)	Connection: Dy 11 d0 or Dyn 11 d0 Phase shift between secondaries: 30° electrical Voltage difference between secondaries: < 0.5% Short-circuit impedance of secondaries: > 5% Short-circuit impedance difference between secondaries: ≤ 10% of the percentage impedance No grounding of the secondaries allowed. Static shield recommended.

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 above 150 Hz may require type-specific derating. For more information, contact your local ABB representative.
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:** With motor cables longer than 150 m (492 ft) the EMC Directive requirements may not be fulfilled.

Efficiency

Efficiency	97.2 … 98.0% at nominal power level depending on drive type

Protection classes

Degrees of protection (IEC/EN 60529)	IP42 (standard), IP54 (optional)
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	Hot-dip zinc coated 1.5 mm thick steel sheet (thickness of coating approximately 20 micrometers). Polyester thermosetting powder coating (thickness approximately 80 micrometers) on visible surfaces, color RAL 7035 and RAL 9017.
Busbars	Tin-plated copper
Liquid cooling system	See *Cooling circuit materials (page 149)*
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 all 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 *Compliance with EN 61800-3:2004 (page 169)*.

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 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 input power cables, motor cables and control cables are selected as specified in the appropriate drive manual(s).
2. The drive is installed according to the instructions given in the appropriate drive manual(s).
3. Maximum motor cable length is 100 meters (328 ft).

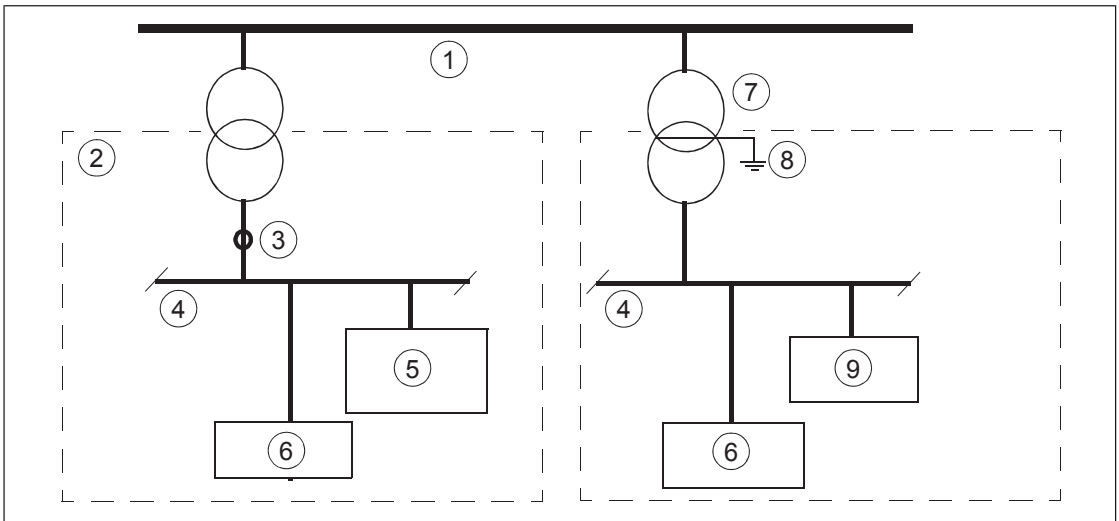
WARNING!

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.

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.

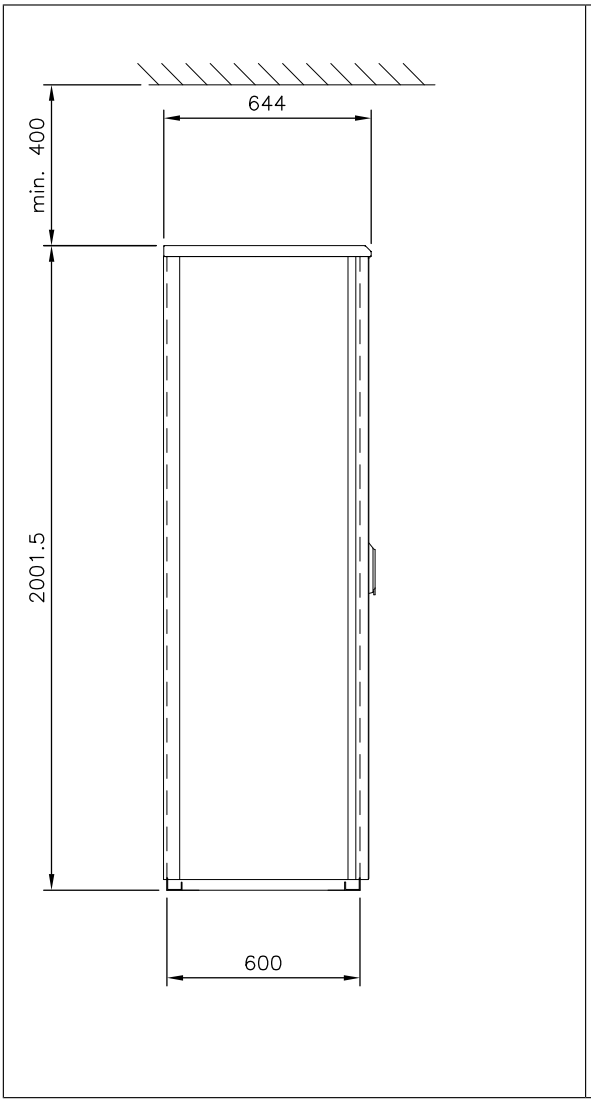
ACS880-07CLC-…	Width	Weight	
	mm	kg	lbs
U_N = 690 V, 6-pulse connection			
0390A-7	730	560	1235
0430A-7	730	560	1235
0480A-7	730	560	1235
0530A-7	730	560	1235
0600A-7	730	560	1235
0670A-7	730	560	1235
0750A-7	730	560	1235
0850A-7	730	560	1235
1030A-7	930	710	1565
1170A-7	930	710	1565
1310A-7	930	710	1565
1470A-7	930	710	1565
1660A-7	930	710	1565
1940A-7	1230	1030	2270

ACS880-07CLC-…	Width	Weight	
	mm	kg	lbs
2180A-7	1230	1030	2270
2470A-7	1230	1030	2270
2880A-7	1530	1290	2845
3260A-7	1530	1290	2845
U_N = 690 V, 12-pulse connection			
0530A-7+A004	730	560	1235
0600A-7+A004	730	560	1235
0670A-7+A004	730	560	1235
0750A-7+A004	730	560	1235
0850A-7+A004	730	560	1235
1030A-7+A004	930	710	1565
1170A-7+A004	930	710	1565
1310A-7+A004	930	710	1565
1470A-7+A004	930	710	1565
1660A-7+A004	930	710	1565
1940A-7+A004	1230	1030	2270
2180A-7+A004	1230	1030	2270
2470A-7+A004	1230	1030	2270
2880A-7+A004	1530	1290	2845
3260A-7+A004	1530	1290	2845
3580A-7+A004	2230	1890	4165
4050A-7+A004	2230	1890	4165
4840A-7+A004	2430	2060	4540
5650A-7+A004	2730	2320	5115
6460A-7+A004	2930	2490	5490
U_N = 690 V, 24-pulse connection			
2470A-7+A006	1230	1030	2270
3260A-7+A006	1530	1290	2845
4840A-7+A006	2430	2060	4540
5650A-7+A006	2730	2320	5115
6460A-7+A006	2930	2490	5490

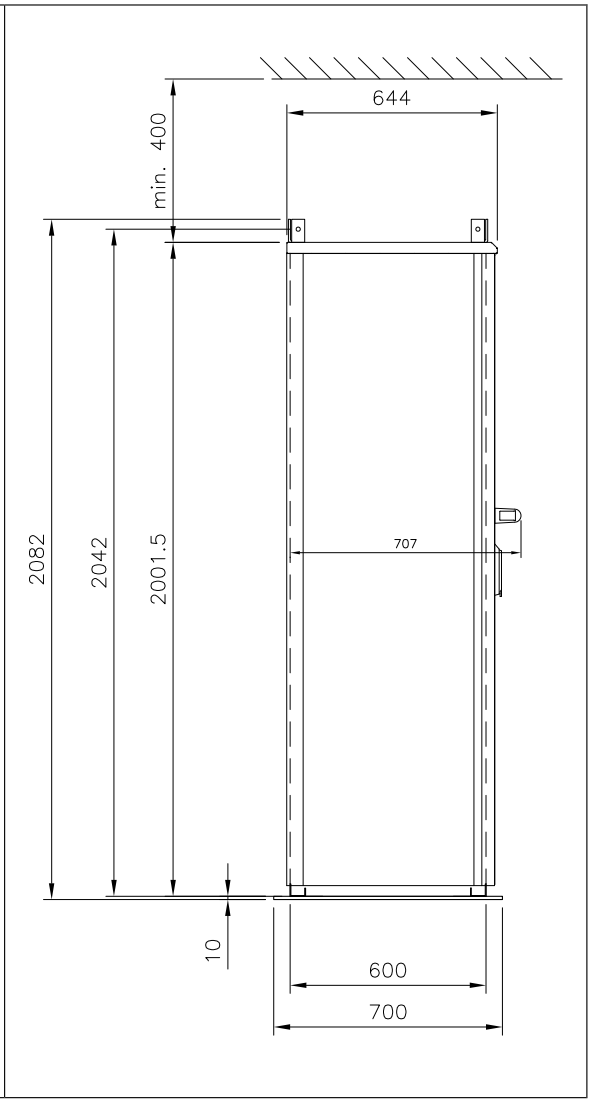
Dimension drawing examples

Cabinet height and depth

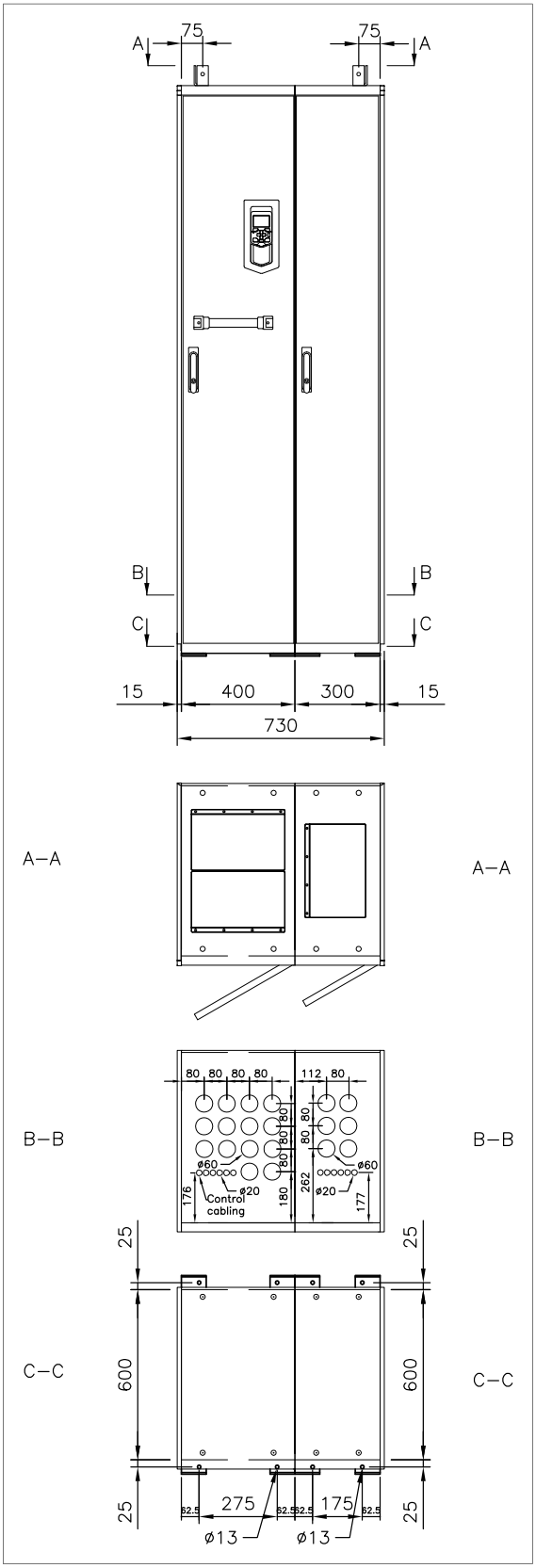
Non-marine, IP42, side view



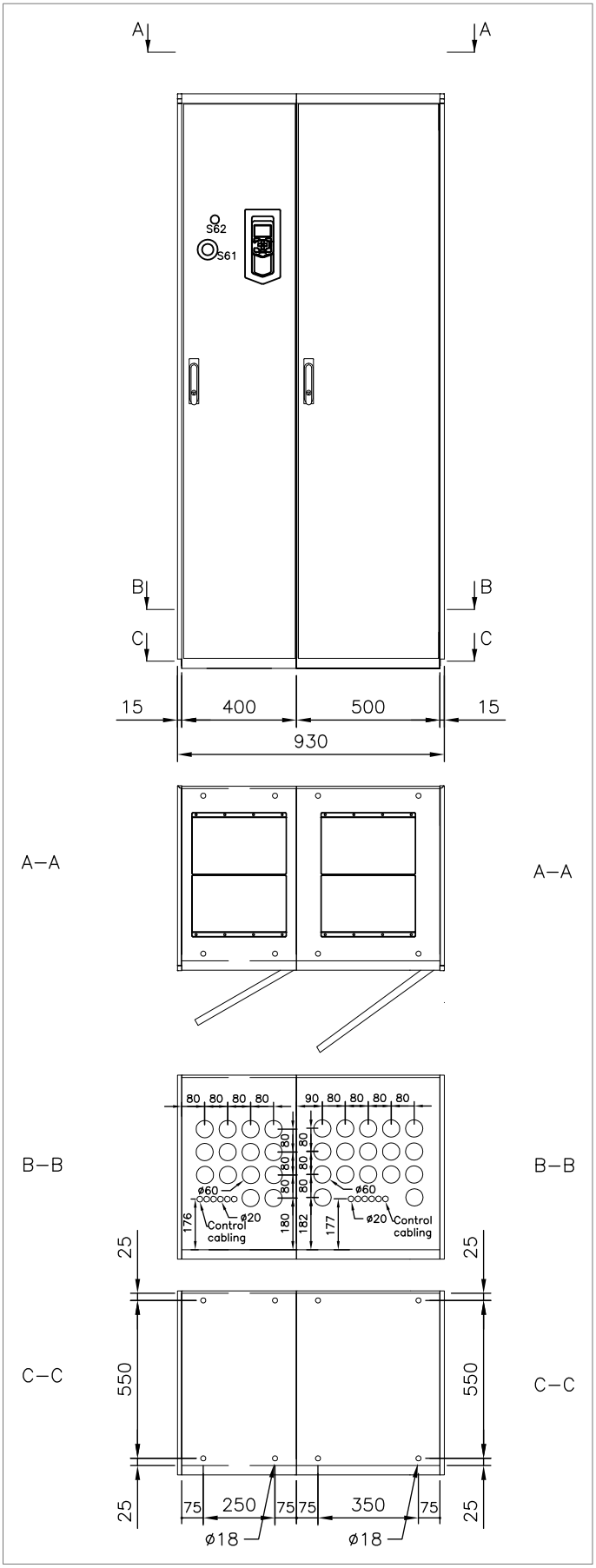
Marine construction (option +C121), IP42, side view



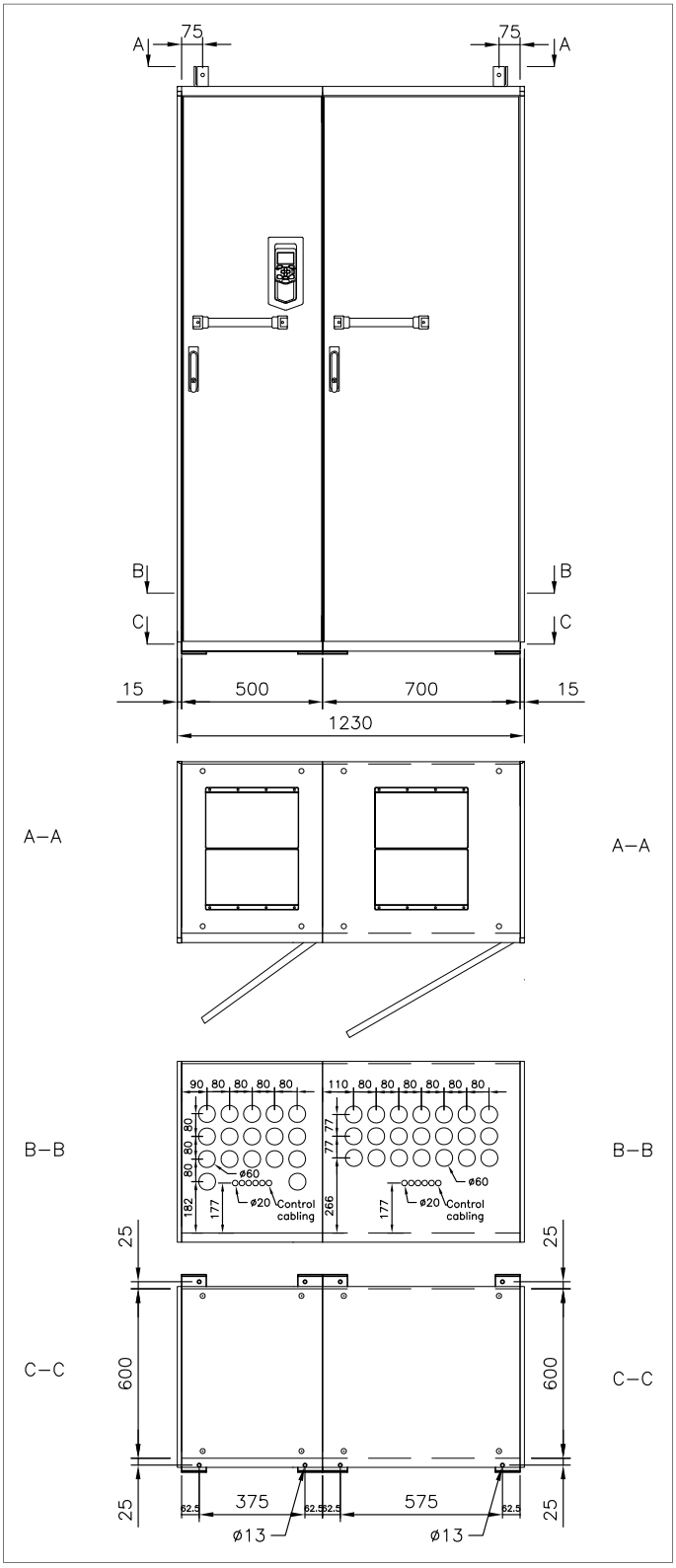
ACS880-07CLC-0390A-7 +C121 (marine construction)



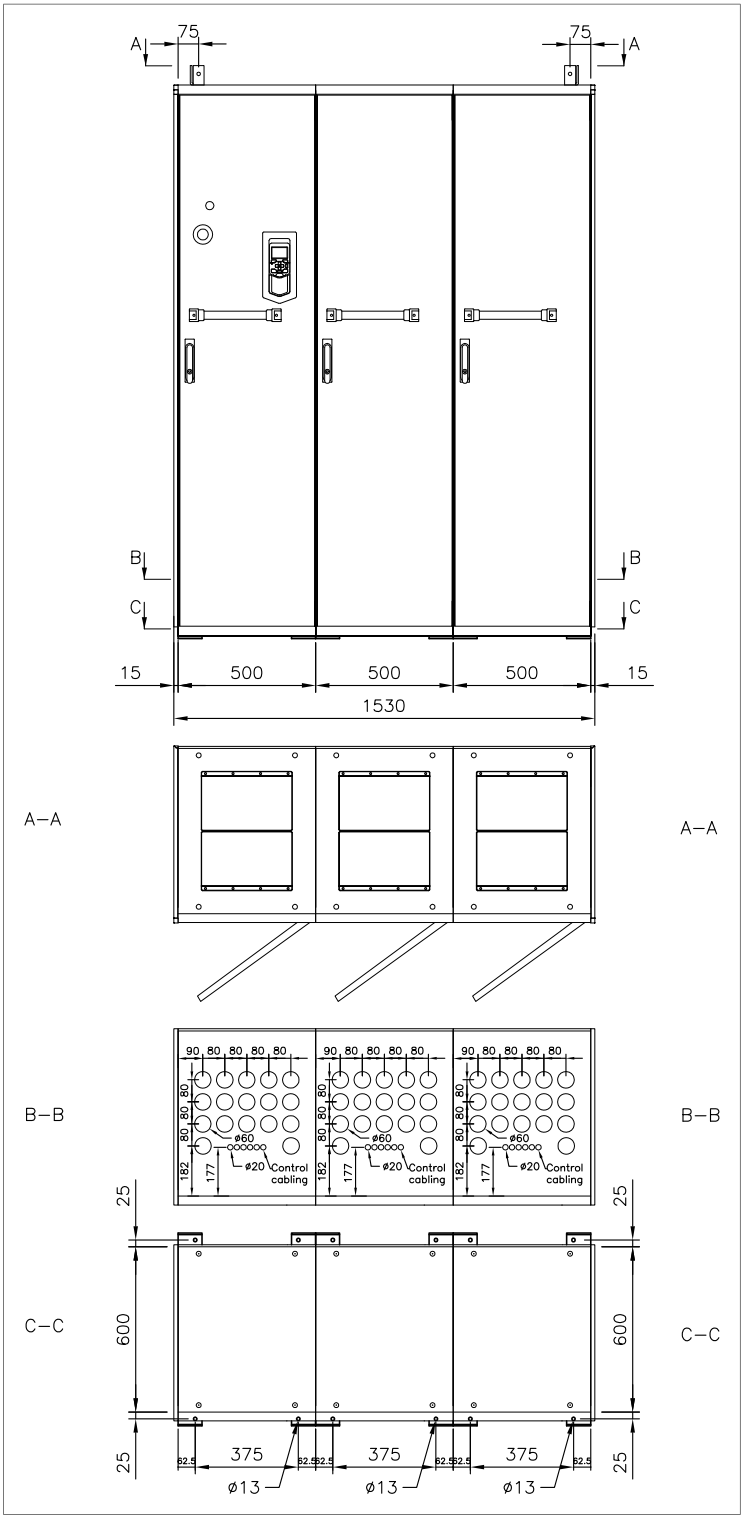
ACS880-07CLC-1310A-7



ACS880-07CLC-2180A-7 +C121 (marine construction)



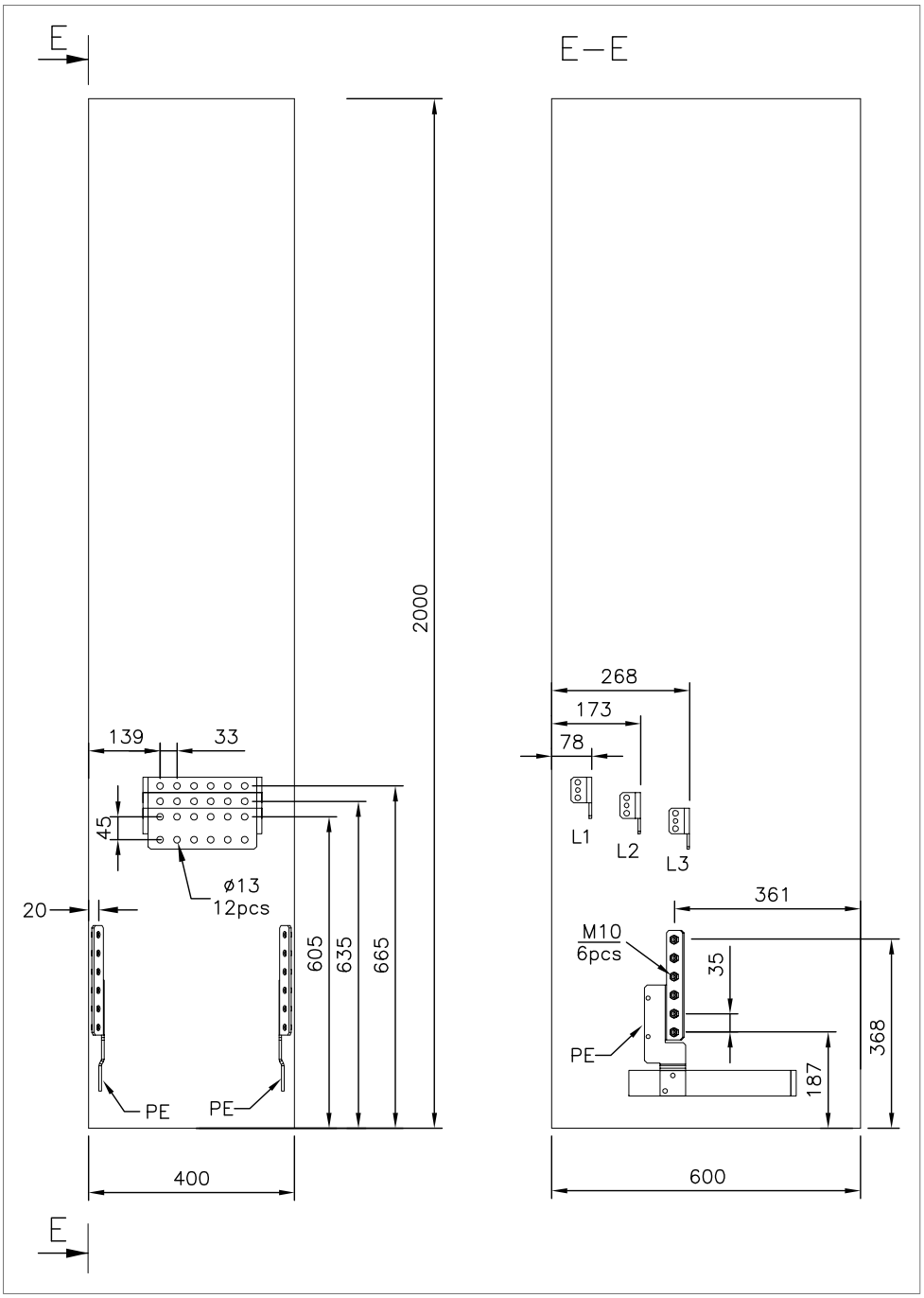
ACS880-07CLC-3260A-7 +C121 (marine construction)



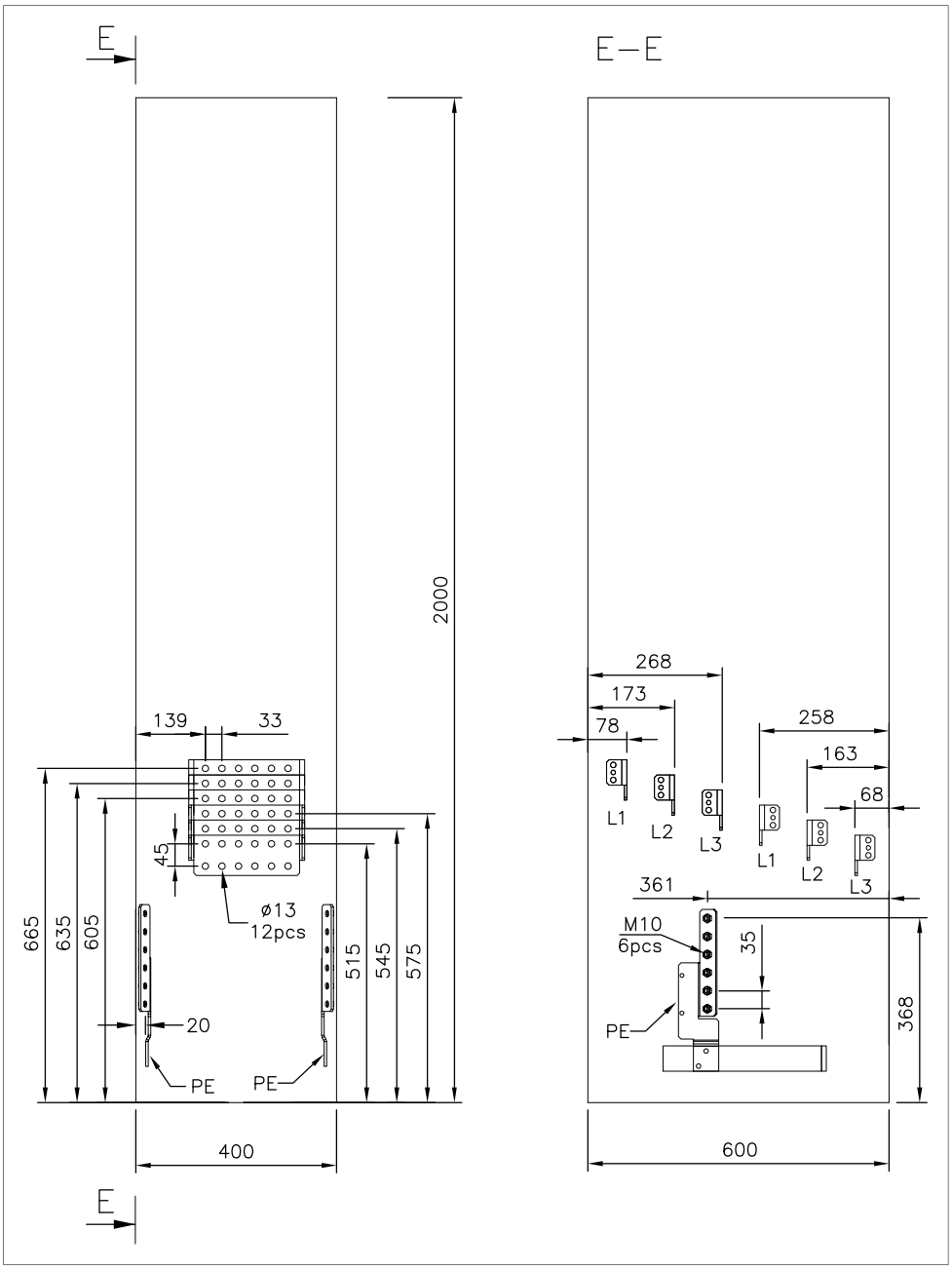
Location and size of input terminals

Drives with up to four supply modules have one supply module cubicle while drives with more modules have two. For the quantity of supply modules in each drive type, see *Frame sizes and power module types (page 155)*.

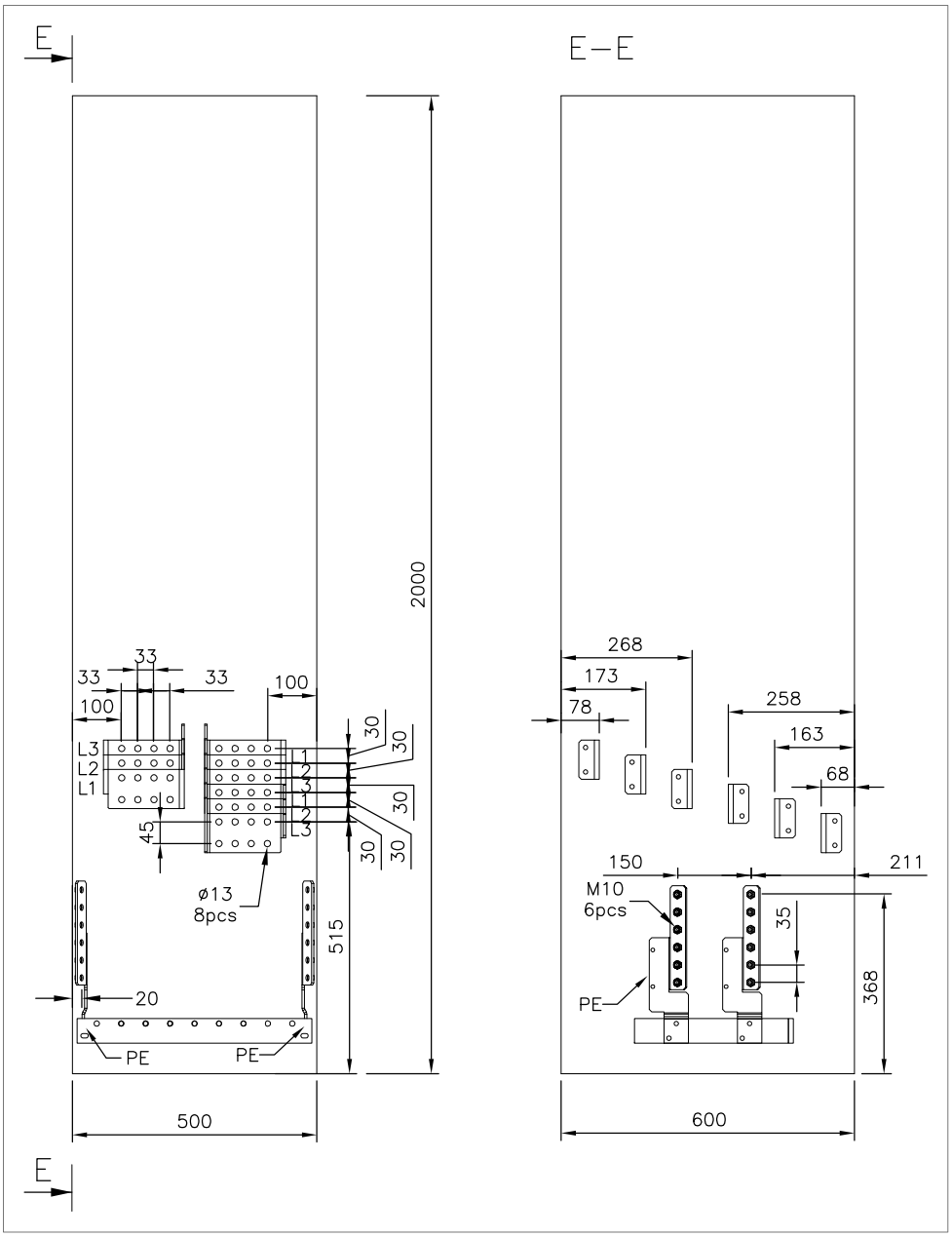
1×D8D



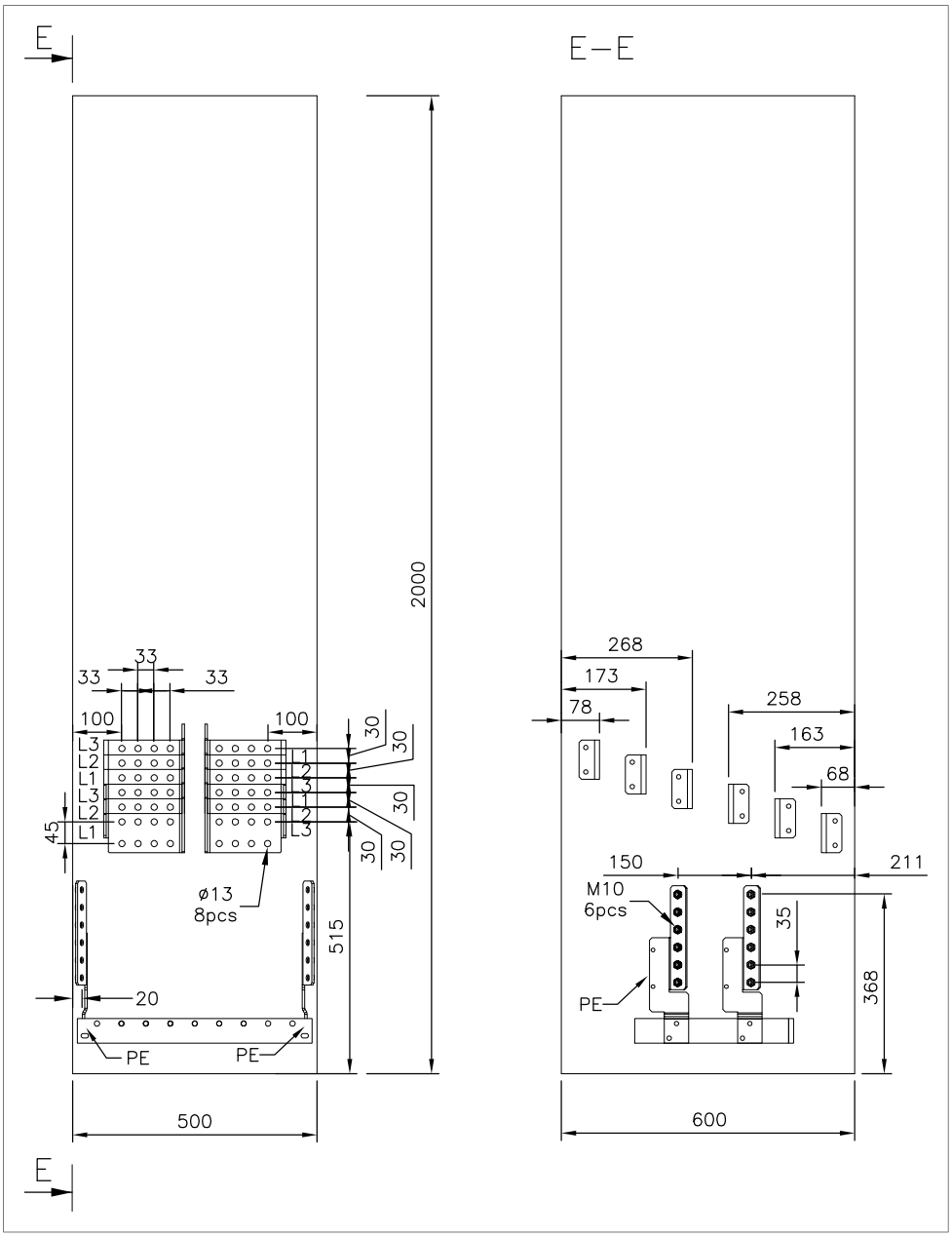
2×D8D


E
E–E
2000
139
33
45
ø13
12pcs
665
635
605
515
545
575
20
PE
PE
400
E
268
173
78
258
163
68
L1
L2
L3
L1
L2
L3
361
M10
6pcs
35
PE
368
600

3×D8D


E
E—E
2000
33
33
33
100
100
L3
L2
L1
30
30
30
30
30
45
ø13
8pcs
515
20
PE
PE
500
268
173
78
258
163
68
150
211
M10
6pcs
35
PE
368
600
E

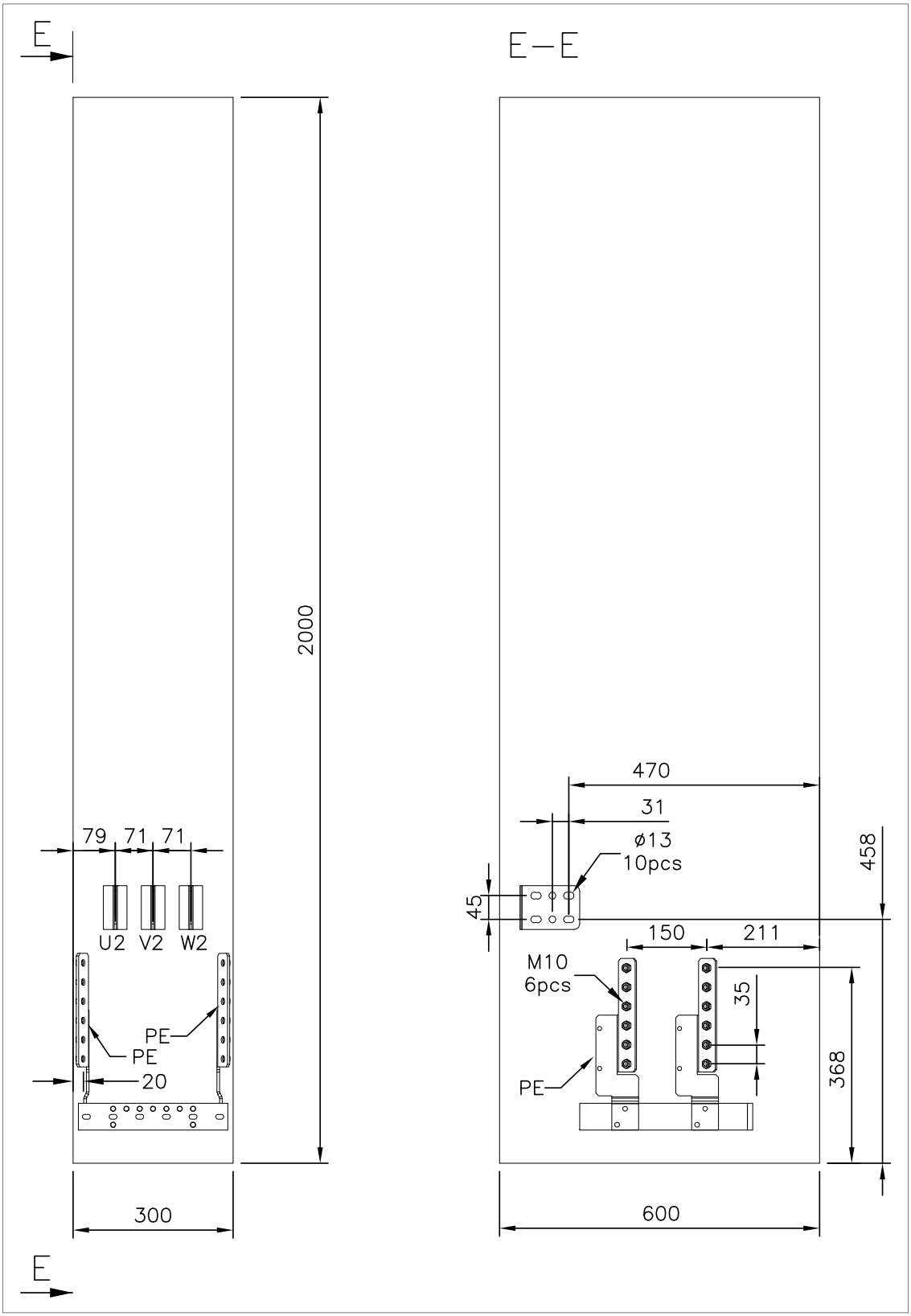
4×D8D


E
E–E
2000
33
33
33
100
100
30
30
30
30
30
30
L3
L2
L1
L3
L2
L1
1
2
3
1
2
3
45
ø13
8pcs
515
20
PE
PE
500
268
173
78
258
163
68
150
211
M10
6pcs
35
PE
368
600
E

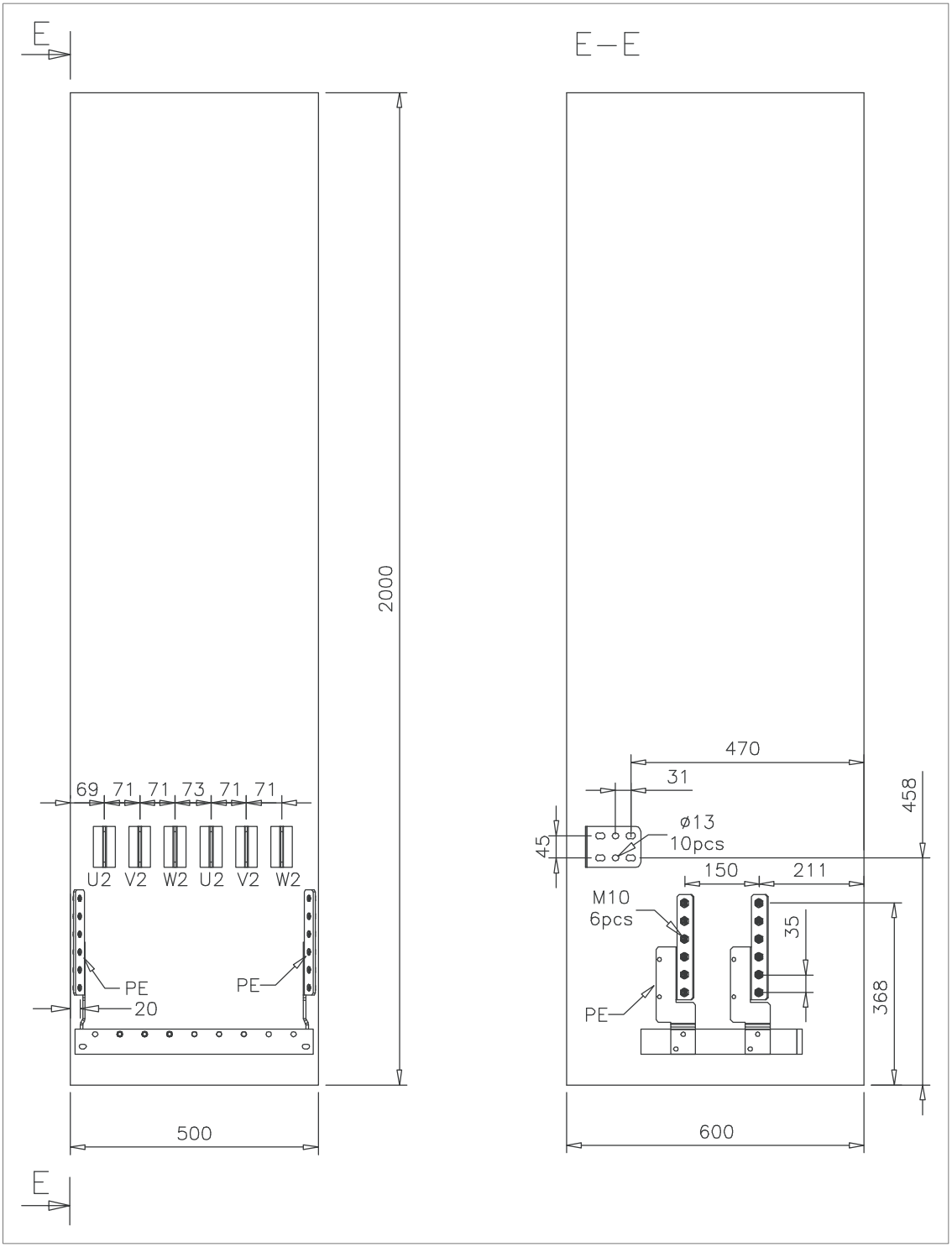
Location and size of output terminals

Units without common motor terminal cubicle

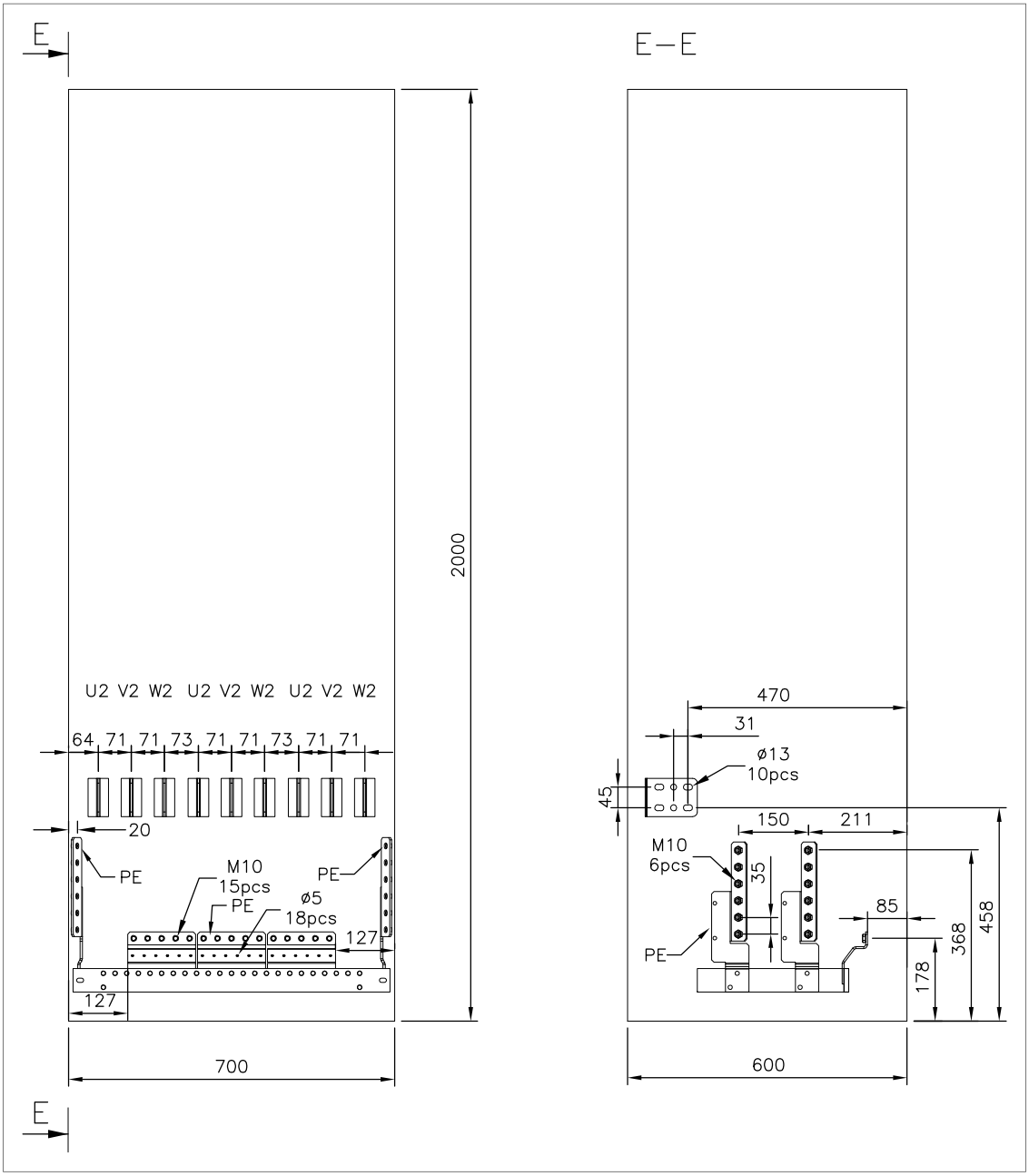
Inverter module cubicle with one R8i module, bottom cable exit



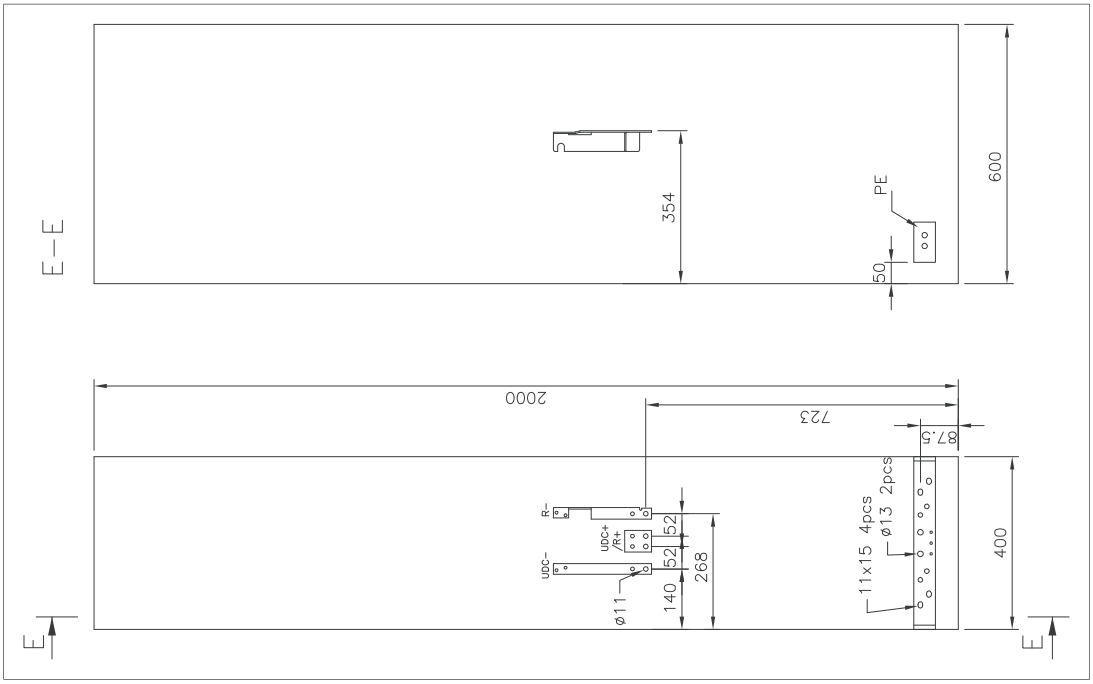
Inverter module cubicle with two R8i modules, bottom cable exit



Inverter module cubicle with three R8i modules, bottom cable exit



Brake chopper cubicle (+D150)



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The Safe torque off function

Contents of this chapter

This chapter describes the Safe torque off (STO) function of the inverter unit of the ACS880-07CLC 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 circuit 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 diagram 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 61326-3-1:2008	*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*

Standard	Name
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 1037:1995 + A1:2008 and Uncontrolled stop (stop category 0) as specified in EN/IEC 60204-1.

Compliance with the European Machinery Directive

See *Compliance with the European Machinery Directive (page 169)*.

Wiring

The following diagrams present examples of Safe torque off wiring for

- a frame n×R8i inverter unit (page *192*)
- multiple inverter units (page *194*)
- multiple inverter units when an external 24 V DC power supply is used (page *195*).

For the specification of the STO input, see the control unit description.

Activation switch

In the wiring diagrams below, 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.

Cable types and lengths

- Double-shielded twisted-pair cable is recommended.
- Maximum cable lengths:
  - 300 m (1000 ft) between activation switch [K] and inverter control unit
  - 60 m (200 ft) between multiple inverter units

- 60 m (200 ft) between external power supply and first inverter unit
- 30 m (100 ft) between BCU control unit and last inverter module in the chain.

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

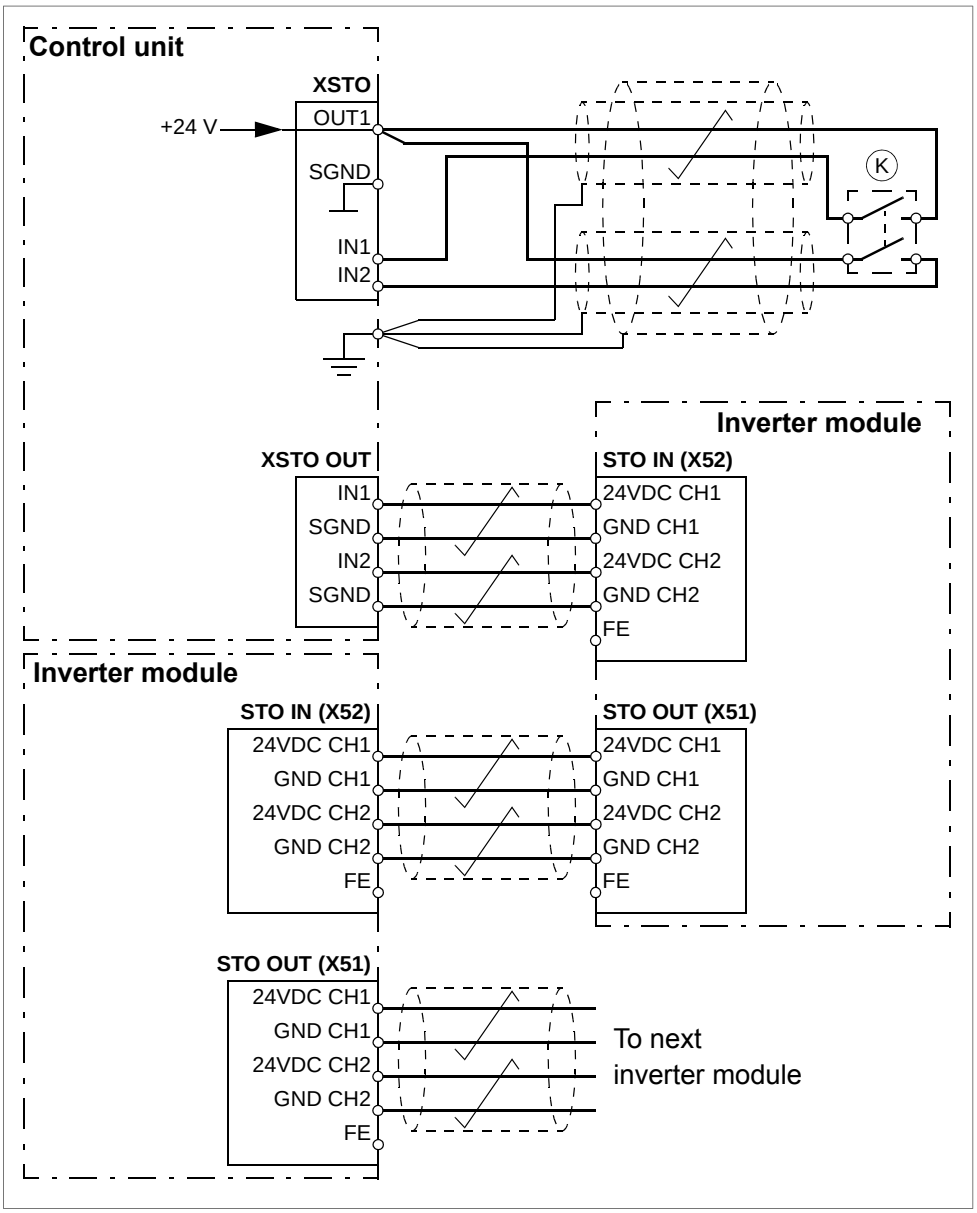
Grounding of protective shields

- Ground the shield in the cabling between the activation switch and the control unit at the control unit.
- 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.

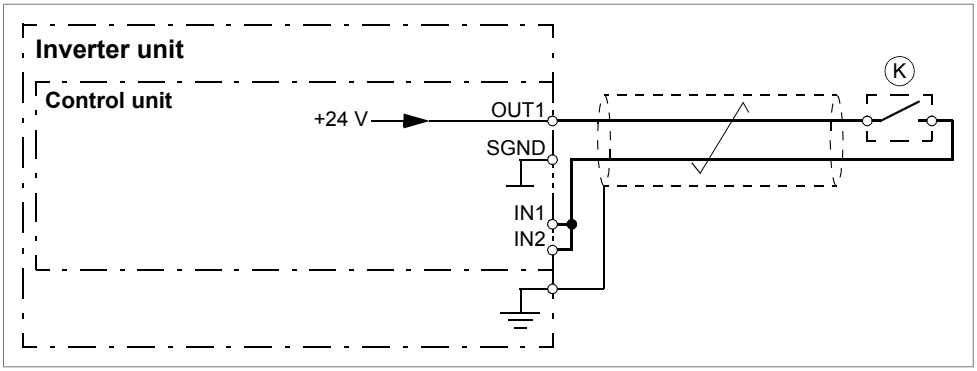
Frame n×R8i inverter unit (internal power supply)

WARNING!

Frame R8i inverter modules are as standard delivered with a jumper wire set that supplies 24 V from connector X53 to X52. The jumper wire set must be removed before wiring the Safe torque off circuit.



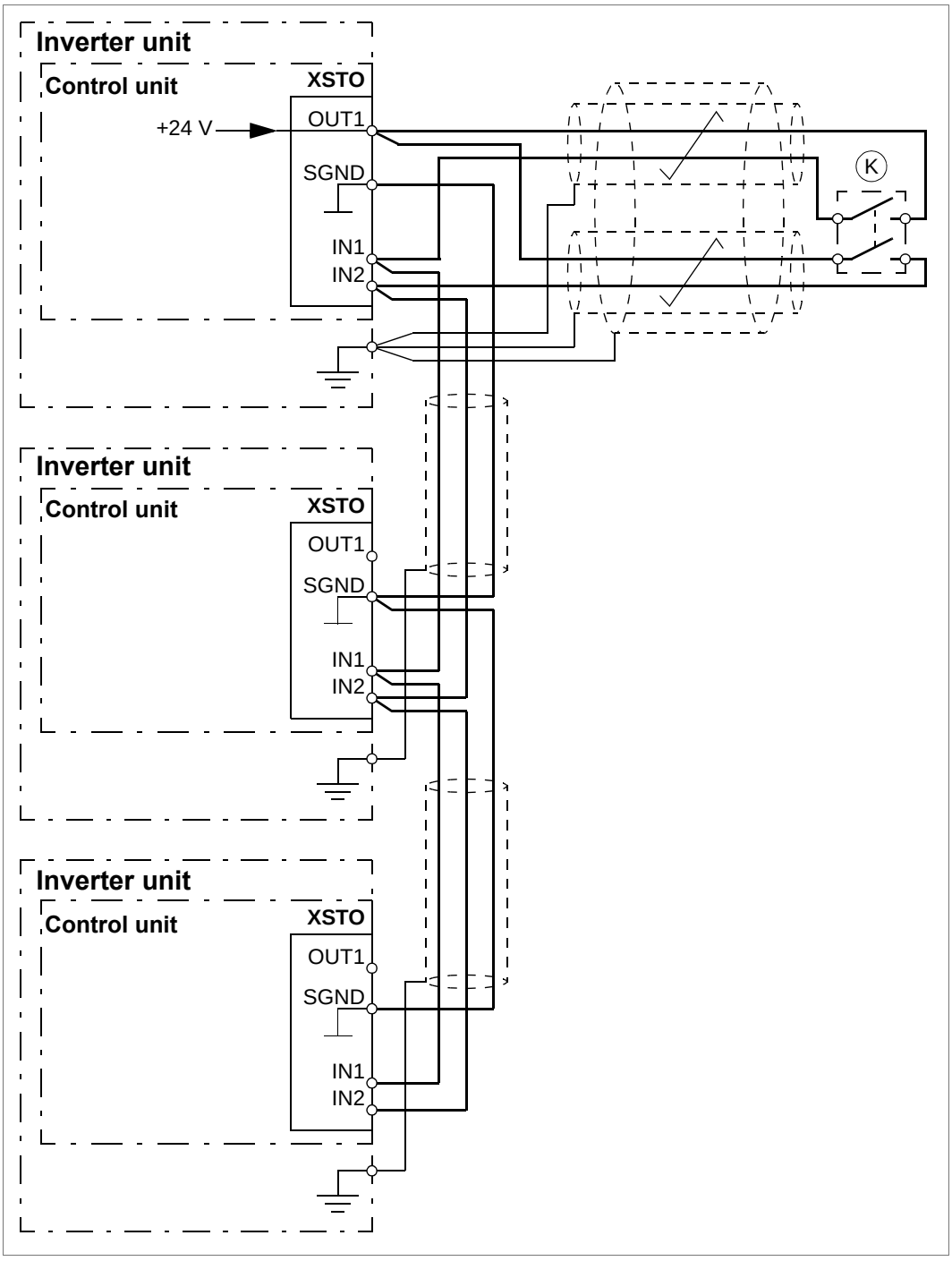
Single-channel connection of activation switch



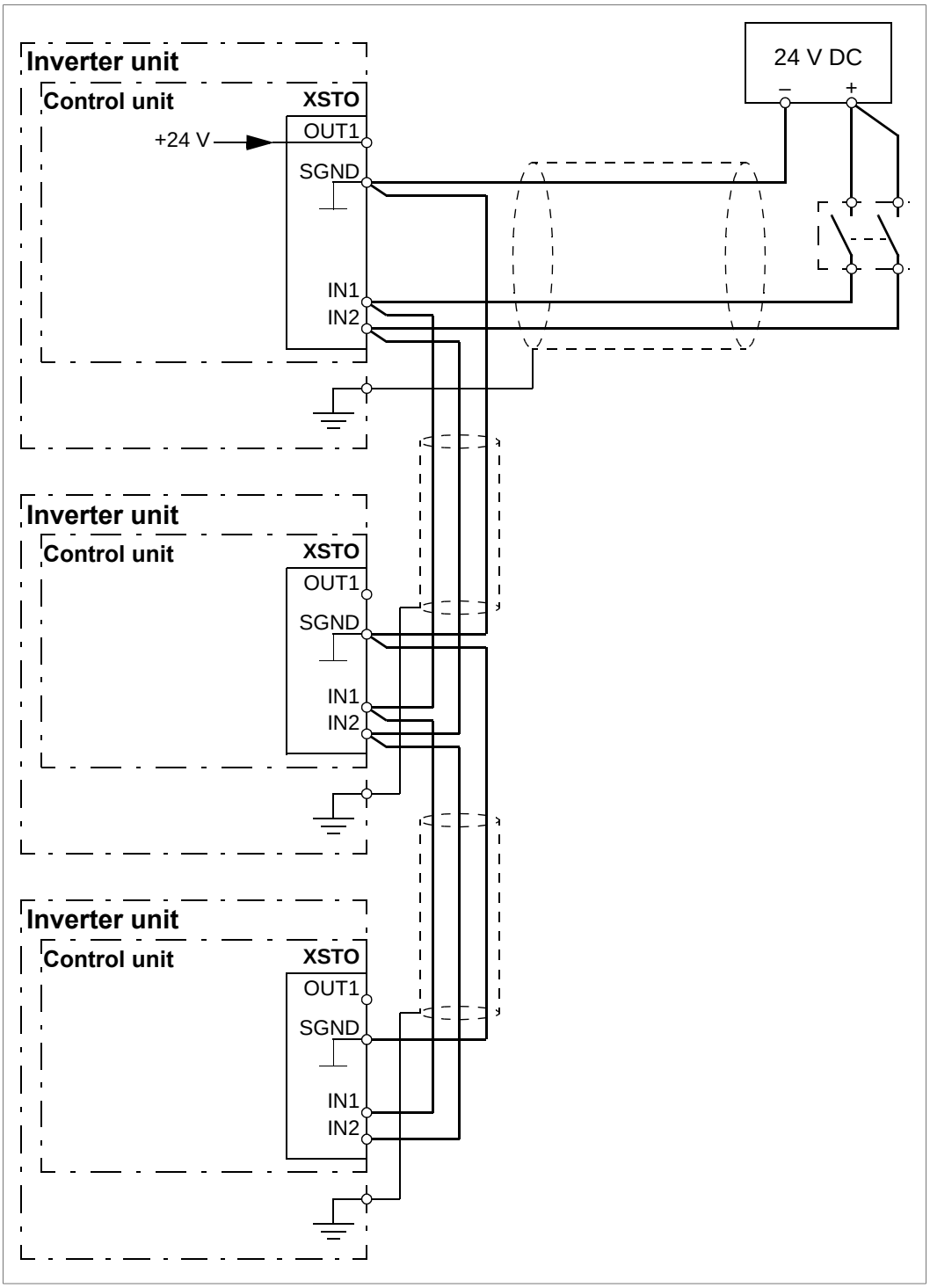
Note:

- 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.

Multiple inverter units (internal power supply)



Multiple inverter units (external power supply)



Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety relay contacts open).
2. The STO inputs on the inverter control unit de-energize.
3. The control unit cuts off the control voltage from the inverter IGBTs.
4. The control program generates an indication as defined by parameter *31.22* (refer to the firmware manual of the inverter).
5. Motor coasts to a stop (if running). The inverter cannot restart while the activation switch or safety relay contacts are open. After the contacts close, 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 +Q951, 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 given in *Safety instructions*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.	☐

Action	☑
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 by a disconnector.	☐
Check the Safe torque off circuit connections against the wiring diagram.	☐
Close the disconnector and switch the power on.	☐
Test the operation of the STO function when the motor is stopped. • Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Ensure that the drive operates as follows: • Open the STO circuit. The drive generates an indication if one is defined for 'stopped' state in parameter *31.22* (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
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 '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. STO inputs on the inverter control unit de-energize, and the inverter control unit cuts off the control voltage from the inverter IGBTs.

3. The control program generates an indication as defined by parameter *31.22* (refer to the firmware manual of the inverter).
4. The motor coasts to a stop (if running). The inverter 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 main supply.

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 the ACS880 inverter control program. It is not supported by supply or brake firmware.

WARNING!

(With permanent magnet or synchronous reluctance [SynRM] motors only) In case of a multiple IGBT power semiconductor failure, the inverter system can produce an alignment torque which maximally rotates the motor shaft by 180/*p* (with permanent magnet motors) or 180/2*p* (with synchronous reluctance [SynRM] motors) degrees 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 inverter unit.
- 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 200)*. 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 196)*.

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 inverter 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 196)*.

Use only ABB approved spare parts.

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 inverter 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 inverter 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 inverter control program for the indications generated by the inverter, 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/SIL-CL	SC	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.	HFT	CCF	Life-time (a)
R8i	3	3	e	>99	5.0E-11	4.5E-07	1.1E-06	23970	≥90	3	1	80	20
2×R8i	3	3	e	>99	6.2E-11	5.5E-07	1.3E-06	16330	≥90	3	1	80	20
3×R8i	3	3	e	>99	7.3E-11	6.5E-07	1.6E-06	12390	≥90	3	1	80	20
4×R8i	3	3	e	>99	8.4E-11	7.6E-07	1.9E-06	9980	≥90	3	1	80	20
5×R8i	3	3	e	>99	9.5E-11	8.6E-07	2.1E-06	8360	≥90	3	1	80	20
6×R8i	3	3	e	>99	1.1E-10	9.6E-07	2.4E-06	7190	≥90	3	1	80	20
7×R8i	3	3	e	>99	1.2E-10	1.1E-06	2.6E-06	6310	≥90	3	1	80	20
8×R8i	3	3	e	>99	1.3E-10	1.2E-06	2.8E-06	5620	≥90	3	1	80	20
3AXD10000078136 D													

- 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 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
- 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. Note that any T_1 values given cannot be regarded as a guarantee or warranty. See also section *Maintenance (page 198)*.

16

Resistor braking

Contents of this chapter

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

Operating principle

The brake chopper handles the energy generated by a decelerating motor. During the deceleration, motor generates energy back to the drive and the voltage in the drive intermediate DC link starts to rise. The chopper connects the brake resistor to the intermediate DC circuit whenever the voltage in the circuit exceeds the limit defined by the control program. Energy consumption by the resistor losses lowers the voltage until the resistor can be disconnected.

Factory-installed brake choppers and resistors

Brake choppers (option +D150) and resistors (+D151) are available for the drive as factory-installed. The factory-installed chopper unit can also be used with a custom resistor assembly.

The required braking power can be selected according to the application. The ratings of standard choppers and chopper/resistor combinations are listed under *Technical data*. For other braking powers, contact your local ABB representative.

"ACS880-607LC" refers to the brake unit type.

Technical data

Ratings of chopper units (without resistors)

ACS880-607LC-…	Module type	P_{brmax}	R_n	I_{max}	I_{rms}	P_{cont}	Duty cycle (1/5 min)		Duty cycle (10/60 s)	
							P_{br}	I_{rms}	P_{br}	I_{rms}
		kW	ohm	A	A	kW	kW	A	kW	A
U_N = 690 V (Range 525…690 V)										
0400-7	NBRW-669C	404	2.72	414	107	119	298	267	404	361
0800-7	2 × NBRW-669C	807	2.72	828	214	238	596	534	808	722
1200-7	3 × NBRW-669C	1211	2.72	1242	321	357	894	801	1212	1083
1600-7	4 × NBRW-669C	1615	2.72	1656	428	476	1192	1068	1616	1444
2000-7	5 × NBRW-669C	2019	2.72	2070	535	595	1490	1335	2020	1805
2400-7	6 × NBRW-669C	2422	2.72	2484	642	714	1788	1602	2424	2166

Ratings of standard chopper/resistor combinations

ACS880-607LC-…	Module type	Resistor type	P_{brmax}	R_{min}	I_{max}	I_{rms}	P_{brcont}	Duty cycle (1/5 min)		Duty cycle (10/60 s)		E_R
								P_{br}	I_{rms}	P_{br}	I_{rms}	
			kW	ohm	A	A	kW	kW	A	kW	A	kJ
U_N = 690 V (Range 525…690 V)												
0400-7	NBRW-669C	2 × SAFUR200F500	404	1.35	835	97	54	167	149	287	257	10800
0800-7	2 × NBRW-669C	2 × (2 × SAFUR200F500)	807	1.35	1670	194	108	333	298	575	514	21600
1200-7	3 × NBRW-669C	3 × (2 × SAFUR200F500)	1211	1.35	2505	291	162	500	447	862	771	32400
1600-7	4 × NBRW-669C	4 × (2 × SAFUR200F500)	1615	1.35	3340	388	216	667	596	1150	1028	43200
2000-7	5 × NBRW-669C	5 × (2 × SAFUR200F500)	2019	1.35	4175	485	270	833	745	1437	1285	54000

ACS880-607LC-…	Module type	Resistor type	P_{brmax}	R_{min}	I_{max}	I_{rms}	P_{brcont}	Duty cycle (1/5 min)		Duty cycle (10/60 s)		E_R
								P_{br}	I_{rms}	P_{br}	I_{rms}	
			kW	ohm	A	A	kW	kW	A	kW	A	kJ
2400-7	6 × NBRW-669C	6 × (2 × SAFUR200F500)	2422	1.35	5010	582	324	1000	894	1724	1542	64800

Definitions

U_N	Nominal voltage
R_n	Nominal (recommended) resistance of the resistor assembly of one chopper module
R_{min}	Resistance of specified resistors (per chopper module). This is also the minimum allowed resistance for the resistor assembly.
P_{brmax}	Maximum short-term (1 min in every 10 min) braking power
P_{brcont}	Maximum continuous power rating
I_{max}	Maximum peak current
P_{br}	Maximum braking power for the specified duty cycle
I_{rms}	Rms current for the specified duty cycle

SAFUR resistor data

The following SAFUR resistors are available separately.

Type	U_N	R	E_R	P_{Rcont}	IPxx
	V	ohm	kJ	kW	
SAFUR125F500	500	4.0	3600	9.0	IP00
SAFUR210F575	575	3.4	4200	10.5	IP00
SAFUR200F500	500	2.7	5400	13.5	IP00
SAFUR180F460	460	2.4	6000	15.0	IP00

U_N	Nominal voltage
R	Resistance
E_R	Short energy pulse that the resistor assembly will withstand each 400 seconds
P_{Rcont}	Continuous power (heat) dissipation of the resistor when placed correctly. Energy E_R dissipates in 400 seconds.
IPxx	Degree of protection

Terminals and cable lead-through data of factory-installed chopper/resistor cubicles

See the dimension drawings delivered with the unit.

Planning the braking system

Verifying the load capacity of the braking equipment

1. Calculate the maximum power generated by the motor during braking (P_{max}).
2. Ensure that the maximum power rating of the braking equipment is equal to or greater than P_{max}.
   The P_{brmax} values specified in the ratings table are for the reference braking cycle (1 minute of braking, 9 minutes of rest). If the actual duty cycle does not correspond to the reference cycle, either use the power rating given for the other two reference cycles (P_{br}), or calculate the maximum braking power for a custom braking cycle. See below for instructions on calculating P_{br} for other braking cycles.
3. Check the resistor selection. The energy generated by the motor during a 400-second period must not exceed the heat dissipation capacity of the resistor (E_R). If you use custom resistor(s), see also the separate instructions below.
   If the E_R value of the resistor is not sufficient, it is possible to use a four-resistor assembly in which two resistors are connected in parallel, two in series. The E_R value of the four-resistor assembly is four times that of a single resistor.

Custom resistor

Resistors other than those available as option +D151 can be used provided that

- the resistance is not lower than the value given in the ratings table

WARNING!

Never use a brake resistor with a resistance below the value specified for the particular drive / brake chopper / resistor combination. The drive and the chopper would not able to handle the overcurrent caused by the low resistance.

- the resistance of the custom resistor does not restrict the braking capacity needed, ie. $P_{max} < U_{DC}^2/R$
  where

P_{max}	Maximum power generated by the motor during braking
U_{DC}	Voltage over the resistor during braking. UDC equals 1.35 · 1.25 · 415 V DC (when supply voltage is 380 to 415 V AC) 1.35 · 1.25 · 500 V DC (when supply voltage is 440 to 500 V AC) or 1.35 · 1.25 · 690 V DC (when supply voltage is 525 to 690 V AC)
R	Resistor resistance (ohm)

- the heat dissipation capacity E_R of the resistor is sufficient for the application (see step 3 above).

Calculating the maximum braking power for a custom duty cycle

These rules must be met during any braking cycle:

1. Braking energy transferred during any ten minute period must be less than or equal to the energy transferred during the reference braking cycle (1/9 min).
2. The maximum braking power for a custom braking cycle (P_{br}) must not exceed the rated maximum value P_{brmax}.

The rules as equations:

1. $n \times P_{br} \times t_{br} \leq P_{brmax} \times 60\ s \Rightarrow P_{br} \leq (P_{brmax} \times 60\ s)/(n \times t_{br})$

2. $P_{br} \leq P_{brmax}$

n	Number of braking pulses during a 10-minute period
P_{br}	Maximum braking power (kW) for a custom braking cycle
t_{br}	Braking time (s)
P_{brmax}	Maximum braking power for a reference braking cycle (1 minute of braking, 9 minutes of rest)

Example 1

The duration of a braking cycle is 30 minutes. The braking time is 15 minutes.

Result: If the braking time exceeds 10 minutes, the braking is considered continuous. The allowed continuous braking power is 10% of maximum braking power (P_{brmax}).

Example 2

The duration of a braking cycle (T) is three minutes. The braking time (t_{br}) is 40 seconds.

1. $n \times P_{br} \times t_{br} \leq P_{brmax} \times 60\ s \Rightarrow P_{br} \leq (P_{brmax} \times 60\ s) / (4 \times 40\ s) = 0.375 \times P_{brmax}$
2. $P_{br} \leq P_{brmax} \Leftrightarrow 0.375 \times P_{brmax} \leq P_{brmax}$ **OK**

Result: The maximum braking power for the custom braking cycle is 37% of the rated value given for the reference cycle.

Selecting and routing the cables of a custom resistor

Use the same cable type for the resistor cabling as for the drive input cabling to ensure that the input fuses also protect the resistor cable. Alternatively, a two conductor shielded cable with the same cross-sectional area can be used.

Minimizing electromagnetic interference

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

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

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

Maximum cable length

The maximum length of the resistor cable(s) is 50 m (164 ft).

Placing custom brake resistors

Install the resistors outside the drive in a place where they are able to cool effectively.

Arrange the cooling of the resistor in a way that

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

Supply the resistor with cooling air/water according to the resistor manufacturer's instructions.

WARNING!

The materials near the brake resistor must be non-flammable. The surface temperature of the resistor is high. The temperature of the air flowing from the resistor is hundreds of degrees Celsius. If the exhaust vents are connected to a ventilation system, ensure that the materials withstand high temperatures. Protect the resistor against contact.

Protecting the brake system against thermal overload

The brake chopper protects itself and the resistor cables against thermal overload when the cables are dimensioned according to the nominal current of the drive. By default, a brake chopper fault is wired to stop the supply unit of the drive.

Thermal protection of the resistors

The standard resistors available as option +D151 are equipped with a thermal switch. The switches of the resistors are wired in series and connected to the Enable input of the brake chopper. The relay output of the chopper is wired to the supply control unit so that a chopper fault condition stops the supply unit.

With custom resistors, user must implement a similar protection. Use cable rated as follows:

- twisted pair, shielding recommended
- rated operating voltage between a conductor and ground (U_0) > 750 V
- insulation test voltage > 2.5 kV.

Keep the cable as short as possible.

Protecting the resistor cable against short-circuits

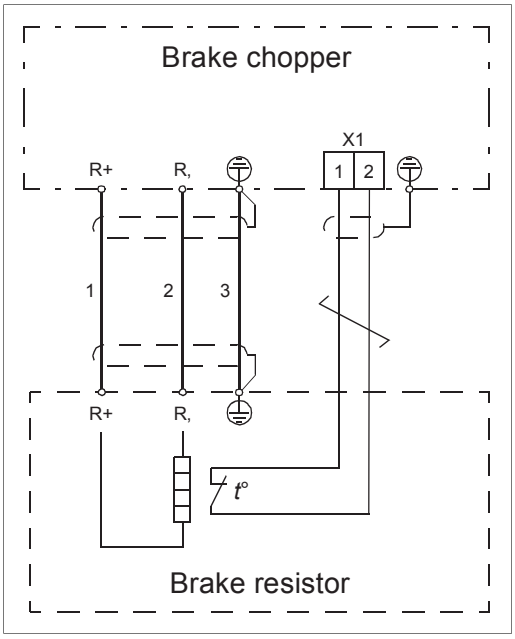
The input fuses of the drive will also protect the resistor cable provided that the resistor cable is of the same type as the input cable.

Mechanical installation of custom brake resistors

Obey the resistor manufacturer's instructions.

Electrical installation of custom brake resistors

Connection diagram

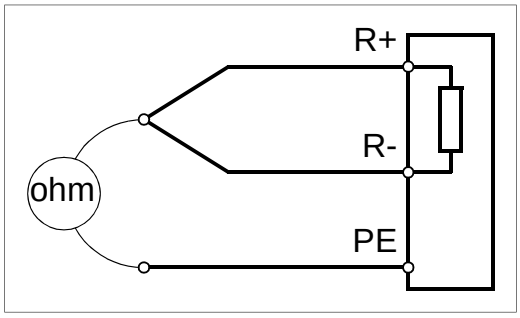


Connection procedure

WARNING!

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

- Do the steps in section Electrical safety precautions in chapter Safety instructions before you start the work.
- Connect the resistor cable at the resistor end only. If a shielded three-conductor cable is used, cut off the third conductor. Ground the twisted shield of the cable as well as any separate PE conductor (if present).
- At the chopper end of the cable, connect the R+ and R- conductors of the resistor cable together. Measure the insulation resistance between the combined conductors and the PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.



- Connect the resistor cable to the R+ and R- terminals of the chopper. If a shielded three-conductor cable is used, cut off the third conductor. Ground the twisted shield of the cable as well as any separate PE conductor (if present).

- Connect the thermal switch of the brake resistor to the enable input (X1) on the brake chopper control board. Use cable specified under *Thermal protection of the resistors (page 208)*. If there are multiple thermal switches, connect them in series.

WARNING!

The ENABLE input terminal block of the brake chopper is at intermediate circuit potential when the supply unit of the drive is running. This voltage is extremely dangerous and can cause serious damage or injury if the isolation level and protection conditions for the thermal switches are not sufficient. The thermal switches must always be properly insulated (over 2.5 kV) and shrouded against contact.

Brake system start-up

Check the settings of the following inverter control program parameters (ACS880 primary control program):

- *30.30 Overvoltage control*: Overvoltage control disabled.

For settings of other control programs, see the appropriate firmware manual.

Note:

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

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.

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