ABB MACHINERY DRIVES

ACS180 drives

Hardware manual

ACS180 drives

Hardware manual

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1

Safety instructions

Contents of this chapter

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

Use of warnings and notes

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

The manual uses these warning symbols:

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

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

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

General safety in installation, start-up and maintenance

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

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

- Keep the drive in its package until you install it. After unpacking, protect the drive from dust, debris and moisture.
- Use the required personal protective equipment: safety shoes with metal toe cap, safety glasses, protective gloves and long sleeves, etc. Some parts have sharp edges.
- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, and brake resistors, remain hot for a while after disconnection of the electrical supply.
- Vacuum clean the area around the drive before the start-up to prevent the drive cooling fan from drawing the dust inside the drive.
- Make sure that debris from drilling, cutting and grinding does not enter the drive during the installation. Electrically conductive debris inside the drive may cause damage or malfunction.
- Make sure that there is sufficient cooling. See the technical data.
- Before you connect voltage to the drive, make sure that all covers are in place. Do not remove the covers when voltage is connected.
- Before you adjust the drive operation limits, make sure that the motor and all driven equipment can operate throughout the set operation limits.
- Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or supply break. If these functions are activated, the installation must be clearly marked as defined in IEC/EN 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- The maximum drive power cycles is five times in ten minutes. Power cycling the drive too often can damage the charging circuit of the DC capacitors.
- If you have connected safety circuits to the drive (for example, Safe torque off or emergency stop), validate them at start-up. See separate instructions for the safety circuits.
- Beware of hot air exiting from the air outlets.
- Do not cover the air inlet or outlet when the drive is running.

Note:

- If you select an external source for the start command and it is on, the drive will start immediately after fault reset unless you configure the drive for pulse start. See the firmware manual.
- If the drive is in remote control mode, you cannot stop or start the drive with the control panel.
- Only authorized persons are allowed to repair a malfunctioning drive.

Electrical safety in installation, start-up and maintenance

Electrical safety precautions

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

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

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

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

1. Clearly identify the work location and equipment.
2. Disconnect all possible voltage sources. Make sure that re-connection is not possible. Lock out and tag out.
   - Open the main disconnecting device of the drive.
   - If you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
   - Disconnect all dangerous external voltages from the control circuits.
   - After you disconnect power from the drive, always wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized.
   - Before and after measuring the installation, verify the operation of the voltage tester on a known voltage source.
   - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is zero.
   - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is zero.
   - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero.
6. Install temporary grounding as required by the local regulations.
7. Ask the person in control of the electrical installation work for a permit to work.

Additional instructions and notes

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

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

- Make sure that the electrical power network, motor/generator, and environmental conditions agree with the drive data.
- Do not do insulation or voltage withstand tests on the drive.
- If you have a cardiac pacemaker or other electronic medical device, keep away from the area near motor, drive, and the drive power cabling when the drive is in operation. There are electromagnetic fields present which can interfere with the function of such devices. This can cause a health hazard.

Note:

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

Printed circuit boards

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

Grounding

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

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

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

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

Note:

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

  To comply with standard IEC/EN 61800-5-1 (UL 61800-5-1)

  - use a protective earth conductor with a minimum cross-sectional area of 10 mm^2 Cu or 16 mm^2 Al (as an alternative when aluminum cables are permitted),
    or
  - use a second protective earth conductor of the same cross-sectional area as the original protective earth conductor,
    or
  - use a device that automatically disconnects the supply if the protective earth conductor is damaged.

  If the protective earth conductor is separate (that is, it does not form part of the input power cable or the input power cable enclosure), the minimum cross-sectional area must be:

  - 2.5 mm^2 when the conductor is mechanically protected,
    or
  - 4 mm^2 when the conductor is not mechanically protected.

General safety in operation

These instructions are for all personnel that operate the drive.

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

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

Note:

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

Additional instructions for permanent magnet motor drives

Safety in installation, start-up, maintenance

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

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

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

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

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

- Stop the drive.
- Disconnect the motor from the drive with a safety switch or by other means.

- If you cannot disconnect the motor, make sure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, can rotate the motor directly or through any mechanical connection like felt, nip, rope, etc.
- Do the steps in section *Electrical safety precautions (page 13)*.
- Install temporary grounding to the drive output terminals (T1/U, T2/V, T3/W). Connect the output terminals together as well as to the PE.

During the start up:

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

Safety in operation

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

2

Introduction to the manual

Contents of this chapter

The chapter describes the manual: the applicability, target audience and purpose of the manual. The chapter contains a list of related manuals and a flowchart for installation and commissioning.

Applicability

This manual is applicable to ACS180 drives.

Target audience

The reader is 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.

Purpose of the manual

This manual gives information needed to plan the installation, install, commission and service the drive.

Categorization by frame size

The drives are manufactured in frame sizes R0 and R1. The information that is applicable only to certain frames is labelled with the frame size. The frame size is shown on the type designation label.

Quick installation and commissioning flowchart

Task	See
Identify the frame size: R0, R1.	*Type designation key (page 28)*
Plan the installation. Check the ambient conditions, ratings and required cooling air flow.	*Guidelines for planning the electrical installation (page 37)* *Technical data (page 73)*
Unpack and check the drive.	*Unpacking the delivery (page 34)*
If the drive will be connected to an IT (ungrounded) system, make sure that the internal EMC filter is not connected.	*Earthing system compatibility check (page 52)*
Install the drive mechanically.	*Installing the drive (page 35)*
Route the cables.	*Routing the cables (page 44)*
Measure the insulation of the input cable, motor and motor cable.	*Measuring the insulation (page 52)*
Connect the power cables.	*Connecting the power cables (page 56)*
Connect the control cables.	*Connecting the control cables (page 58)*
Examine the installation.	*Installation checklist (page 65)*
Commission the drive.	Refer to the *ACS180 Quick installation and start-up guide* (3AXD50000510344 [English]) and the *ACS180 Firmware manual* (3AXD50000467860 [English]).

Terms and abbreviations

Term	Description
ACS-AP-…	Assistant control panel
BCBL-01	Optional USB to RJ45 cable
Capacitor bank	The capacitors connected to the DC link
Control board	Circuit board in which the control program runs
DC link	DC circuit between rectifier and inverter
DC link capacitors	Energy storage which stabilizes the intermediate circuit DC voltage
Drive	Frequency converter for controlling AC motors
EFB	Embedded fieldbus
EMC	Electromagnetic compatibility
Frame, frame size	Physical size of the drive or power module
IGBT	Insulated gate bipolar transistor
Intermediate circuit	DC circuit between rectifier and inverter
Inverter	Converts direct current and voltage to alternating current and voltage.

Term	Description
LRFI	Series of optional EMC filters
Macro	A pre-defined set of default values of parameters in a drive control program.
NETA-21	Remote monitoring tool
Parameter	In the drive control program, user-adjustable operation instruction to the drive, or signal measured or calculated by the drive. In some (for example fieldbus) contexts, a value that can be accessed as an object, eg, variable, constant, or signal.
PLC	Programmable logic controller
Rectifier	Converts alternating current and voltage to direct current and voltage
RFI	Radio-frequency interference
SIL	Safety integrity level (1...3) (IEC 61508)
STO	Safe torque off (IEC/EN 61800-5-2)

Related manuals

Name	Code
Drive manuals and guides	
ACS180 drives hardware manual	3AXD50000467945
ACS180 quick installation and start-up guide	3AXD50000510344
ACS180 firmware manual	3AXD50000467860
ACS180 recycling instructions	3AXD50000613342
Option manuals and guides	
ACS-AP-... assistant control panel user’s manual	3AUA0000085685
Tool and maintenance manuals	
Drive composer PC tool user's manual	3AUA0000094606
Converter module capacitor reforming instructions	3BFE64059629

Manuals on internet

You can find manuals and other product documents in PDF format on the Internet. For manuals not available in the Document library, contact your local ABB representative.

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

3

Hardware description

Contents of this chapter

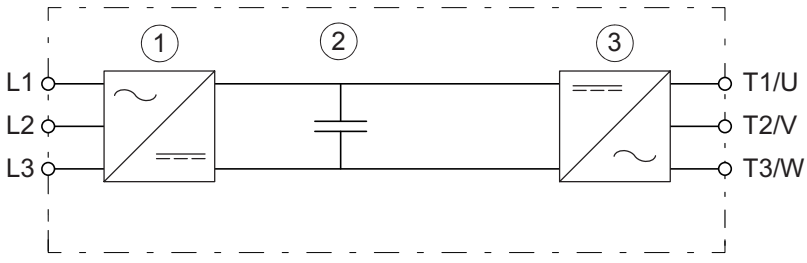
This chapter describes the operation principle, layout, type designation label and type designation information. It shows a general diagram of the power connections and control interfaces.

Operation principle

The ACS180 is a drive for controlling asynchronous AC induction motors and permanent magnet synchronous motors. It is optimized for cabinet mounting.

Simplified main circuit diagram

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



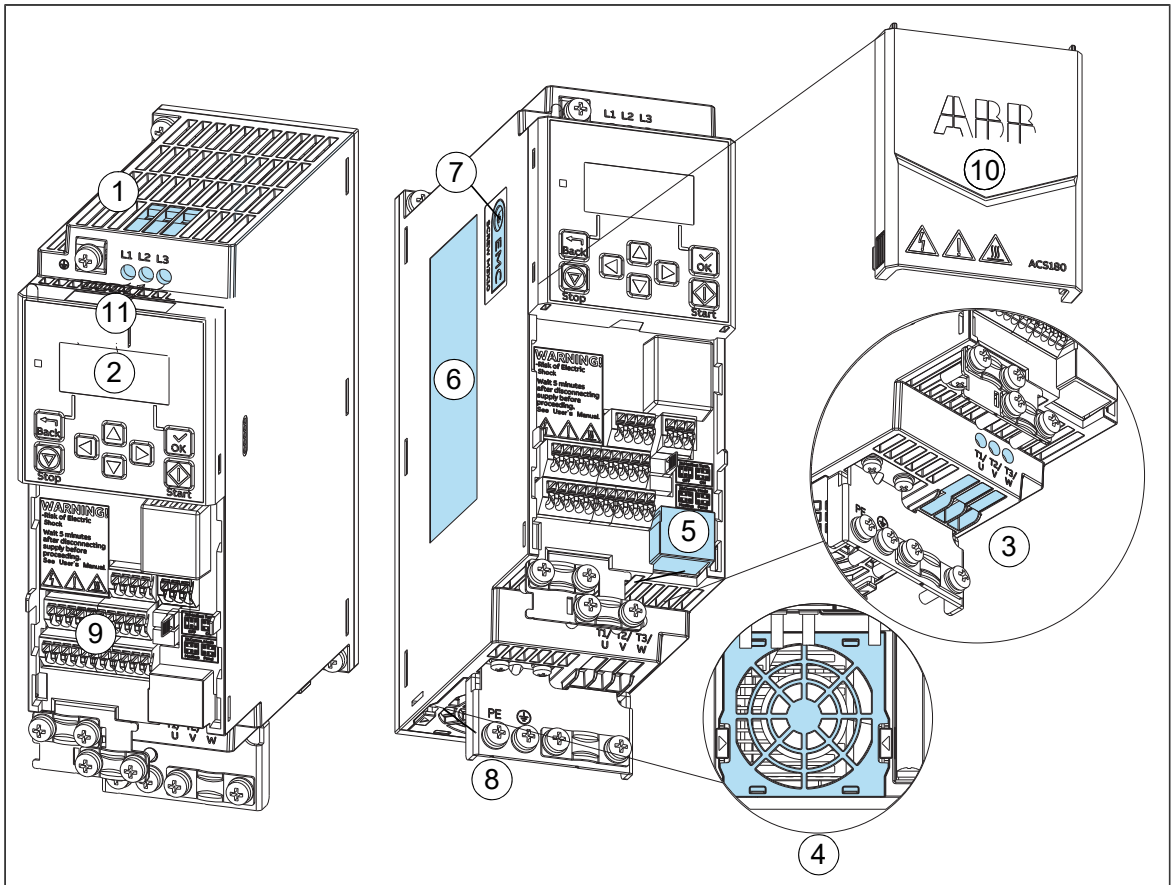
1	Rectifier. Converts alternating current and voltage to direct current and voltage.
2	DC link. DC circuit between rectifier and inverter.
3	Inverter. Converts direct current and voltage to alternating current and voltage.

Product variants

The product has two primary variants:

- Standard variant (ACS180-04S-...) which has integrated Safe torque off (STO) and category C3 or C2 EMC level (C3 for ...-4 type, C2 for ...-1 type).
- Base variant (ACS180-04N-...) which has category C4 EMC level and no integrated STO.

Layout

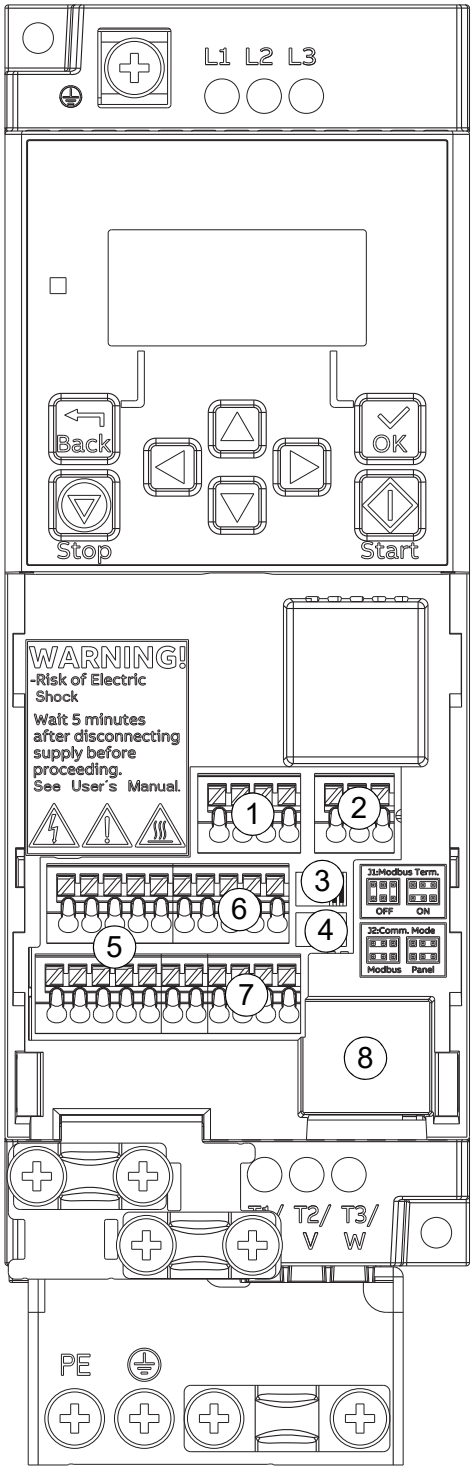


1	Input power connection terminal	7	EMC filter grounding screw [1)]
2	Control panel, display and status LED	8	PE connection (motor)
3	Motor connection terminal	9	Fixed control terminals
4	Cooling fan	10	Front cover
5	Panel and PC tool port (RJ45)	11	Model information label
6	Type designation label		

1) Drive types ACS180-04N-xxxx-x do not have this EMC screw.

Control connections

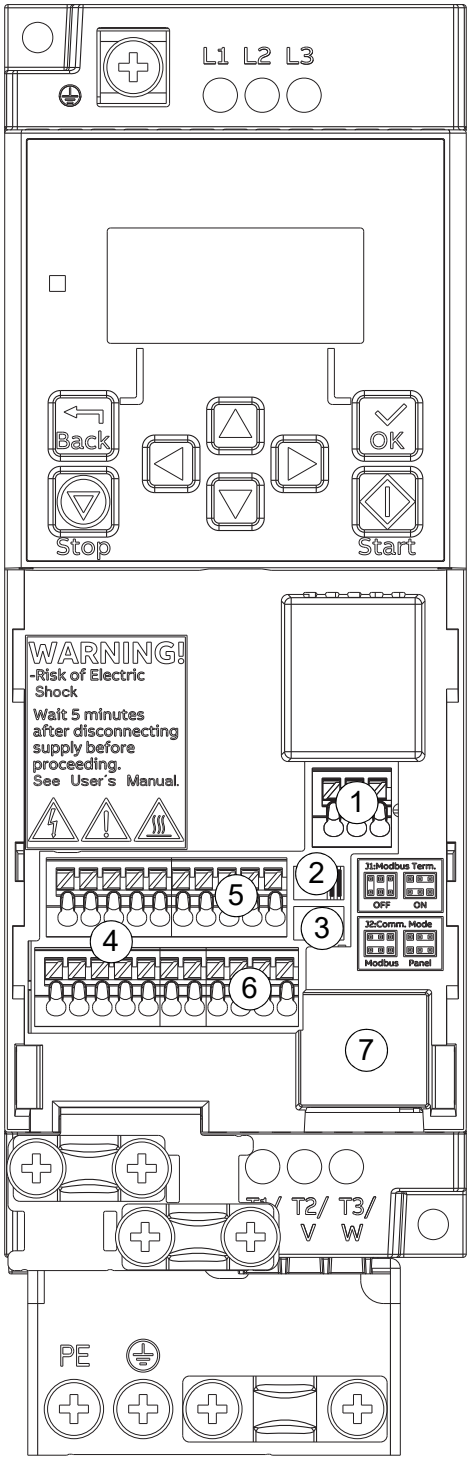
Standard variant (ACS180-04S-...)



Connections:

1. Safe torque-off connections
2. Relay output connection
3. Modbus termination
4. Communication mode jumper
5. Digital inputs and outputs
6. Analog inputs and outputs
7. EIA-485 Modbus RTU
8. Panel connector (external panel or adapter for PC connection)

Base variant (ACS180-04N-...)



Connections:

1. Relay output connection
2. Modbus termination
3. Communication mode jumper
4. Digital inputs and outputs
5. Analog inputs and outputs
6. EIA-485 Modbus RTU
7. Panel connector (external panel or adapter for PC connection)

Control panel options

The drive supports these control panels:

- ACS-AP-I
- ACS-AP-S
- ACS-BP-S
- ACS-AP-W.

For information on the assistant control panels, refer to the *ACX-AP-... Assistant control panels user's manual* (3AUA0000085685 [EN]).

Type designation label

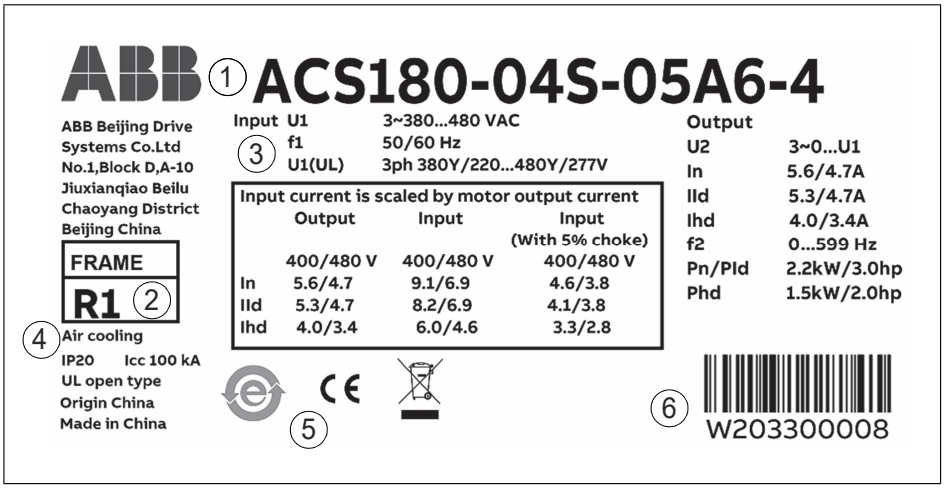
The drive has two labels:

- Model information label at the top of the drive
- Type designation label on the left side of the drive.

Model information label

Code	Description
1	Drive type
2	Serial number
3	QR code for series number

Type designation label



Code	Description
1	Drive type
2	Frame size

Code	Description
3	Nominal ratings
4	Degree of protection
5	Valid markings
6	S/N: Serial number of format MYYWWXXXXX, where M: Manufacturer designation xYY: Year of manufacture: 20, 21, 22, … for 2020, 2021, 2022, … WW: Week of manufacture: 01, 02, 03, … for week 1, week 2, week 3, … XXXXX: Running item number that starts each week from 00001.

Type designation key

The type designation shows the specifications and configuration of the drive. The table below presents the type code digits.

Sample type code 1: ACS180-04N-02A6-4

Sample type code 2: ACS180-04S-02A6-4

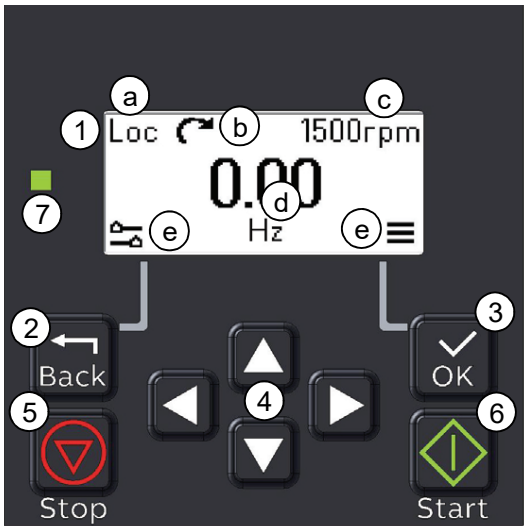
Code	Description
ACS180	Product series
04	Construction. 04=Module, IP20
N/S	EMC&STO. N=Basic variant (without STO; C4 EMC level); S=Standard variant (integrated STO; C3 (3~ 400V) or C2 (1~ 230V) EMC level).
02A6	Current rating. For example, xxxx refers to normal output current of xxA.
4	Voltage rating. 1=1-phase 230 V AC, 4=3-phase 380…480 V AC.

Control panel

The drive has an integrated control panel with a display and control keys.

For quick reference, there is an *ACS180 User interface guide* (3AXD50000606696 [multi lingual]).

Refer to the *ACS180 Firmware manual* (3AXD50000467860 [English]) for information on how to use the interface, start-up the drive and modify settings and parameters.



1	Display (*Home* view): a) Control location: local or remote b) Status icons c) Reference target value d) Actual measured value e) Left and right softkey actions
2	*Back* key (opens the *Options* view in the *Home* view)
3	*OK* key (opens the *Menu* in the *Home* view)
4	Arrow keys (menu navigation and setting values)
5	*Stop* key (when the drive is locally controlled)
6	*Start* key (when the drive is locally controlled)
7	Status LED: •Steady green: Normal operation •Blinking green: Active warning •Steady red: Active fault •Blinking red: Active fault, set power to off to reset

The user interface in brief:

- In the *Home* view, push the *Back* key to open the *Options* view.
- In the *Home* view, push the *OK* key to open the *Menu*.
- Navigate the views with the arrow keys.
- Push the *OK* key to open the highlighted setting or item.
- Use the left and right arrow keys to highlight a value.
- Use the up and down arrow keys to set a value.
- Push the *Back* key to cancel a setting or return to the previous view.

Home view

The *Home* view shows the reading of one of three measured signals. Select the page with the left and right arrow keys.

The status bar at the top of the *Home* view shows:

- The control location (*Loc* for local control and *Rem* for remote control)
- The status icons
- The reference target value

From the Home view, push the *Back* key to open the *Options* view and push the *OK* key to open the *Menu*.

Adjust the current reference value with the up and down arrow keys.

Status icon

Icon	Animation	Description
	None	Local Start/Stop enabled
	None	Stopped
	None	Stopped, start inhibited
	Blinks	Stopped, start commanded but inhibited
	Rotates	Running at reference
	Rotates	Running but not at reference
	Blinks	Running at reference, but reference = 0
	Blinks	Drive fault
	None	Local reference setting enabled

Message view

For fault and warning information, refer to the *ACS180 Firmware manual* (3AXD50000467860 [English]).

To reset a fault, push the *OK* key (with the soft-key label *reset*).

Options view

To open the *Options* view, push the *Back* key in the *Home* view.

In the *Options* view, you can:

- Set the control location
- Set the direction of the motor
- Set the reference
- View the active fault
- View a list of the active warnings

Menu

To open the *Menu*, push the *OK* key in the *Home* view.

To navigate in the *Menu*, push the up and down arrow keys to move between menu items.

Menu items:

- *Motor data view*: Enter the motor specifications.
- *Motor control view*: Set the motor control settings.
- *Control macros view*: Select the connection parameter macro.
- *Diagnostics view*: Read the active faults and warnings.
- *Parameters view*: Open and edit the full list of parameters.

4

Mechanical installation

Contents of this chapter

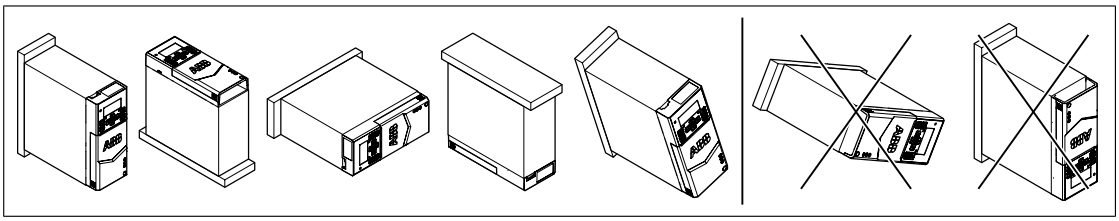
The chapter tells you how to examine the installation site, unpack, check the delivery and install the drive mechanically.

Installation alternatives

You can install the drive on to an assembly plate with screws.

Installation requirements:

- Make sure that there is a minimum of 75 mm of free space at the top and bottom of the drive (at the cooling air inlet and outlet).
- You can install several drives side by side.
- If you install frame R0 drives side-by-side, the maximum ambient temperature is 40 °C.
- Install frame R0 drives upright. Frame R0 drive does not have a cooling fan.
- You can install frame R1 drives tilted by up to 90 degrees, from vertical to fully horizontal orientation.



- Make sure that the hot cooling air from a drive does not go into the cooling air inlet of other equipment.
- Install the drive inside a cabinet or enclosure. The drive has an IP20 ingress protection classification for cabinet installation.

Examining the installation site

Examine the installation site. Make sure that:

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

Required tools

To install the drive mechanically, you need the following tools:

- a drill and suitable drill bits
- a screwdriver or wrench with a set of suitable bits
- a tape measure and spirit level
- personal protective equipment.

Unpacking the delivery

Below is the drive package with its contents. Make sure that all of the items are present and that there are no signs of damage.

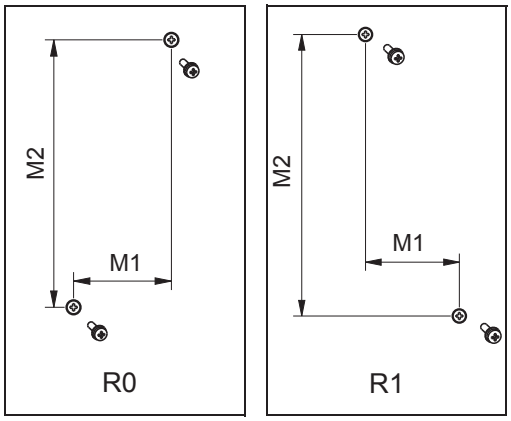
Package contents:

- drive
- installation accessories (cable clamps, metal grounding plate, screws, etc.)
- quick installation and start-up guide.

Installing the drive

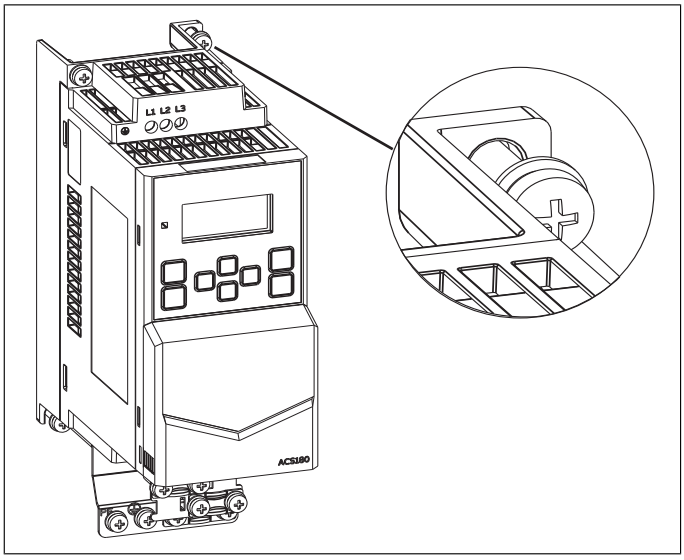
You can install the drive with screws to a suitable surface (wall or assembly plate).

1. Make marks onto the surface for the mounting holes. See the diagram below and *Dimensions and weights (page 80)*.
2. Make the holes for the mounting screws, and fasten the screws. Use plugs or anchors if needed. See section *Dimensions and weights (page 80)* for the max. screw diameter.



Frame size	M1		M2	
	mm	in	mm	in
R0	60	2.36	164	6.46
R1	60	2.36	180	7.09

3. Install the drive onto the mounting screws.
4. Tighten the mounting screws.



5

Guidelines for planning the electrical installation

Contents of this chapter

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

Limitation of liability

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

Selecting the main supply disconnecting device

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

European Union

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

- switch-disconnector of utilization category AC-23B (IEC 60947-3)
- disconnector that has an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector (EN 60947-3)
- a circuit-breaker suitable for isolation in accordance with IEC 60947-2.

North America

Installations must be compliant with NFPA 70 (NEC)[1)] and/or Canadian Electrical Code (CE) along with state and local codes for your location and application.

[1)] National Fire Protection Association 70 (National Electric Code).

Other regions

The disconnecting device must conform to the applicable local safety regulations.

Selecting the main contactor

You can equip the drive with a main contactor.

Follow these guidelines when you select a main contactor:

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

Checking the compatibility of the motor and drive

Use asynchronous AC induction motor, or permanent magnet synchronous motor with the drive. Multiple induction motors can be connected to the drive at a time when using the scalar motor control mode.

Make sure that the motor(s) and the drive are compatible according to the rating table in the technical data.

Selecting the power cables

General guidelines

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

- **Current:** Select a cable capable of carrying the maximum load current.
- **Temperature:** For an IEC installation, select a cable rated for at least 70 °C (158 °F) maximum permissible temperature of conductor in continuous use. For North America, select a cable rated for at least 75 °C (167 °F).
- **Voltage:** 600 V AC cable is accepted for up to 500 V AC. 750 V AC cable is accepted for up to 600 V AC. 1000 V AC cable is accepted for up to 690 V AC.

To comply with the EMC requirements of the CE mark, use one of the preferred cable types. See *Preferred power cable types (page 39)*.

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

Metal conduit reduces electromagnetic emission of the whole drive system.

The protective conductor must always have an adequate conductivity.

Unless local wiring regulations state otherwise, the cross-sectional area of the protective conductor must agree with the conditions that require automatic disconnection of the supply required in 411.3.2. of IEC 60364-4-41:2005 and be capable of withstanding the prospective

fault current during the disconnection time of the protective device. The cross-sectional area of the protective conductor can either be selected from the table below or calculated according to 543.1 of IEC 60364-5-54.

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

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

1) To comply with standard IEC/EN 61800-5-1 (UL 61800-5-1)
- use a protective earth conductor with a minimum cross-sectional area of 10 mm^2 Cu or 16 mm^2 Al (as an alternative when aluminum cables are permitted),
  or
- use a second protective earth conductor of the same cross-sectional area as the original protective earth conductor,
  or
- use a device that automatically disconnects the supply if the protective earth conductor is damaged.

If the protective earth conductor is separate (that is, it does not form part of the input power cable or the input power cable enclosure), the minimum cross-sectional area must be:
- 2.5 mm^2 when the conductor is mechanically protected,
  or
- 4 mm^2 when the conductor is not mechanically protected.

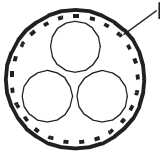
Typical power cable sizes

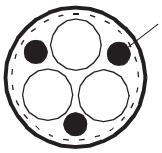
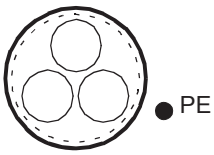
See the technical data.

Power cable types

Preferred power cable types

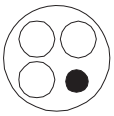
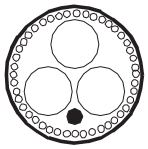
This section presents the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

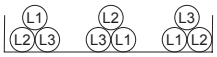
Cable type	**Use as input power cabling**	**Use as motor cabling**
 Symmetrical shielded (or armored) cable with three phase conductors and concentric PE conductor as shield (or armor)	Yes	Yes

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

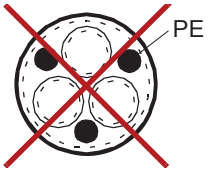
[1)] A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use.

Alternate power cable types

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

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

Not allowed power cable types

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

Additional guidelines, North America

ABB recommends the use of conduit for power wiring to the drive and between the drive and the motor(s). Due to the variety of application needs, metallic and non-metallic conduit can be used. ABB recommends the use of metallic conduit.

The following table shows examples of various materials and methods for wiring the drive in the intended application. See NEC 70 along with state and local codes for the appropriate materials for your application.

In all applications, ABB prefers the use of symmetrical shielded VFD cable between drive and motor(s).

Wiring method	Notes
Conduit - Metallic [1] [2]	
Electrical metallic tubing: Type EMT	Prefer symmetrical shielded VFD cable. Use separate conduit run for each motor. Do not run input power wiring and motor wiring in the same conduit.
Rigid metal conduit: Type RMC	
Liquid-tight flexible metal electrical conduit: Type LFMC	
Conduit - Non-metallic [2] [3]	
Liquid-tight flexible non-metallic conduit: Type LFNC	Prefer symmetrical shielded VFD cable. Use separate conduit run for each motor. Do not run input power wiring and motor wiring in the same conduit.
Wireways [2]	
Metallic	Prefer symmetrical shielded VFD cable. Separate motor wiring from input power wiring and other low voltage wiring. Do not run outputs of multiple drives parallel. Bundle each cable (wiring) together and use separators where possible.
Free air [2]	
Enclosures, air handlers, etc.	Prefer symmetrical shielded VFD cable. Allowed internally in enclosures when in accordance with UL.

[1] Metallic conduit may be used as an additional ground path, provided this path is a solid path capable of handling ground currents.

[2] See NFPA NEC 70, UL, and local codes for your application.

[3] Non-metallic conduit use underground is allowed; however, these installations inherently have an increased chance for nuisance problems due to the potential for water/moisture in the conduit. Water/moisture in the conduit increases the likelihood of VFD faults or warnings. Proper installation is required to make sure there is no intrusion of water/moisture.

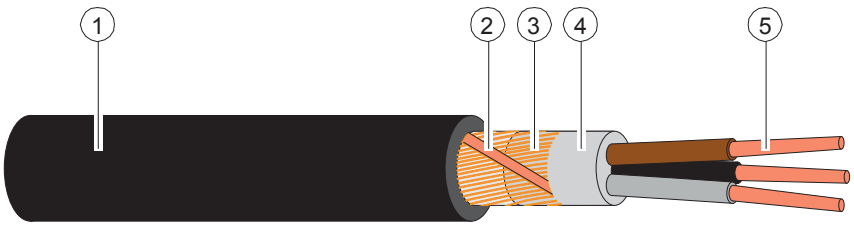
Metal conduit

Couple separate parts of a metal conduit together: bridge the joints with a ground conductor bonded to the conduit on each side of the joint. Also bond the conduits to the drive enclosure and motor frame. Use separate conduits for input power, motor, brake resistor, and control wiring. Do not run motor wiring from more than one drive in the same conduit.

Power cable shield

If the cable shield is used as the sole protective earth (PE) conductor, make sure that its conductivity agrees with the PE conductor requirements.

To effectively suppress radiated and conducted radio-frequency emissions, the cable shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminum shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires with an open helix of copper tape or copper wire. The better and tighter the shield, the lower the emission level and bearing currents.



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

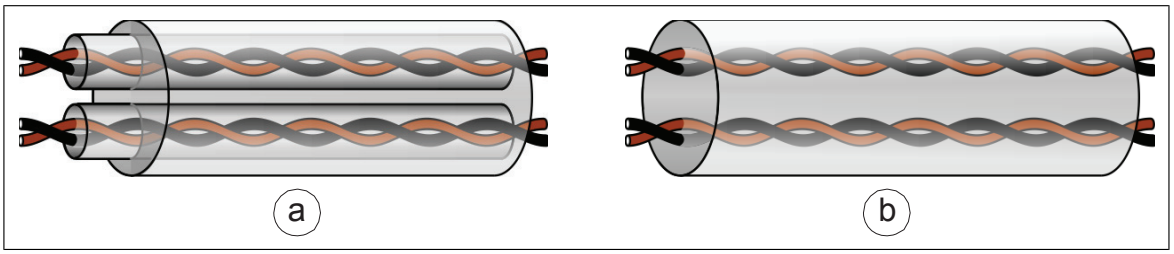
Selecting the control cables

Shielding

Only use shielded control cables.

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

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



Signals in separate cables

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

Signals that can be run in the same cable

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

Relay cable

Recommend to use the cable type with braided metallic shield.

Control panel to drive cable

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

PC tool cable

Connect the Drive composer PC tool to the drive through the USB port of the external assistant control panel. Use a USB Type A (PC) - Type Mini-B (control panel) cable. The maximum length of the cable is 3 m (9.8 ft) or use the BCBL-01 USB to EIA-485 cable to connect the drive with PC directly. .

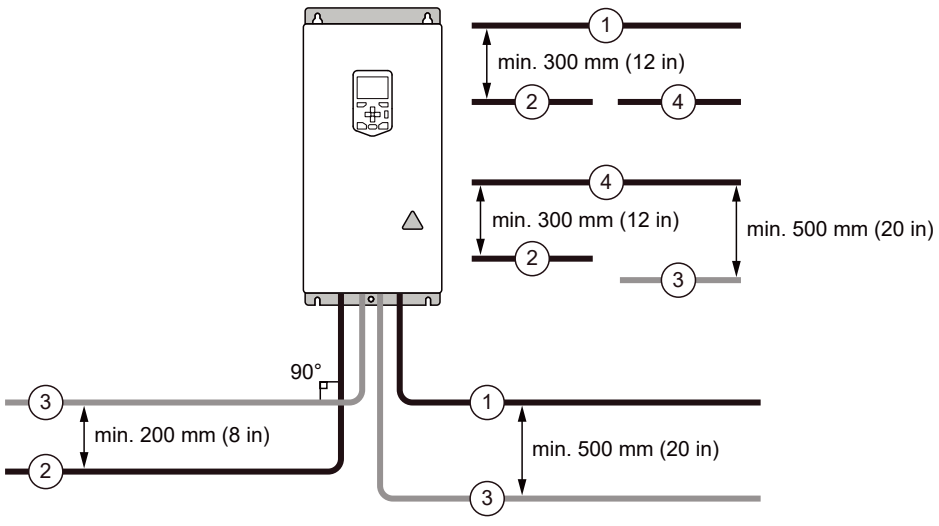
Routing the cables

General guidelines – IEC

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

The following figure illustrates the cable routing guidelines with an example drive. The input power cable entry for ACS180 is from above actually.

Note: When motor cable is symmetrical and shielded and it has short parallel runs with other cables (< 1.5 m / 5 ft), distances between the motor cable and other cables can be reduced by half.



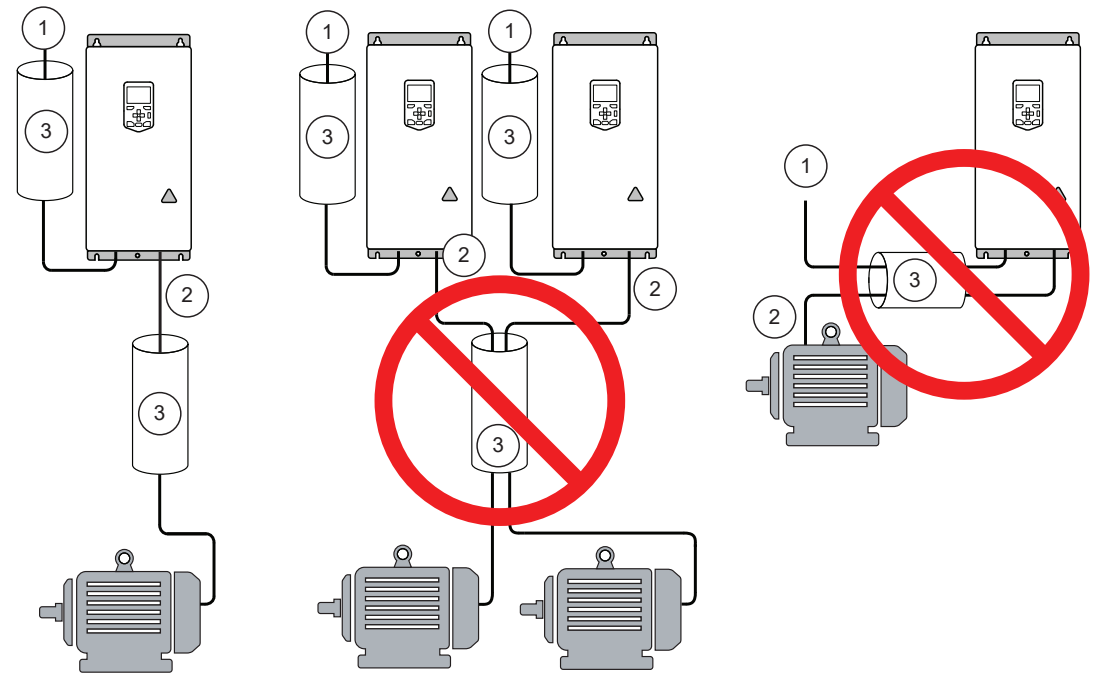
1	Motor cable
2	Input power cable
3	Control cable
4	Brake resistor or chopper cable (if any)

General guidelines – North America

Make sure that the installation is in accordance with national and local codes. Obey these general guidelines:

- Use separate conduits for the input power, motor, brake resistor (optional), and control cabling.
- Use separate conduit for each motor cabling.

The following figure illustrates the cable routing guidelines with an example drive. The input power cable entry for ACS180 is from above actually.



1	Input power cabling
2	Motor cabling
3	Conduit

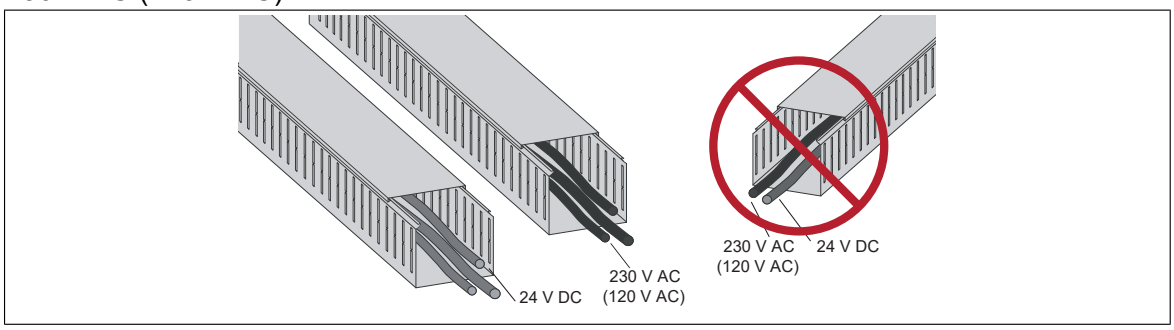
Continuous motor cable shield/conduit or enclosure for equipment on the motor cable

To minimize the emission level when safety switches, contactors, connection boxes or similar equipment are installed on the motor cable between the drive and the motor:

- Install the equipment in a metal enclosure.
- Use either a symmetrical shielded cable, or install the cabling in a metal conduit.
- Make sure that there is a good and continuous galvanic connection in the shield/conduit between drive and motor.
- Connect the shield/conduit to the protective ground terminal of the drive and the motor.

Separate control cable ducts

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



Implementing short-circuit and thermal overload protection

Protecting the drive and input power cable in short-circuits

Use the fuses specified for the drive in the technical data. Make sure that also the electric power supply network meets the specification (minimum allowed short-circuit current that the fuse selection is based on).

The fuses restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive. When located at the distribution board, the fuses also protect the input power cable against short circuits.

See the drive technical data for alternative short-circuit protections.

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 input power and motor cables against thermal overload

If the cables have the correct size for the nominal current, the drive protects itself and the input and motor cables against thermal overload. No additional thermal protection devices are needed.

WARNING!
If the drive is connected to multiple motors, use a separate motor thermal overload device for protecting each motor cable and motor against overload. The drive overload protection is for the sum of the total motor load. It may not trip due to an overload in one motor.

Protecting the motor against thermal overload

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

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

The most common temperature sensor types are thermal switch (for example Klixon), PTC or Pt100.

For more information, see the firmware manual.

Protecting the motor against overload without thermal model or temperature sensors

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

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

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

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

For more information, see drive firmware manual.

Implementing motor temperature sensor connection

WARNING!
IEC 60664 and IEC 61800-5-1 require double or reinforced insulation between live parts and accessible parts when:

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

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

You have these implementation alternatives:

1. If there is double or reinforced insulation between the sensor and the live parts of the motor: You can connect the sensor directly to the analog/digital input(s) of the drive. See the control cable connection instructions.
2. If there is basic insulation between the sensor and the live parts of the motor: You can connect the sensor to the analog/digital input(s) of the drive. All other circuits connected to the digital and analog inputs (typically extra-low voltage circuits) must be:
   - protected against contact, and
   - insulated with basic insulation from other low-voltage circuits. The insulation must be rated for the same voltage level as the drive main circuit.

   Note: Extra-low voltage circuits (for example, 24 V DC) typically do not meet these requirements.
   As an alternative, you can connect the sensor with basic insulation to the analog/digital input(s) of the drive, if you do not connect any other external control circuits to the drive digital and analog inputs.
3. You can connect a sensor to a digital input of the drive via an external relay. The sensor and the relay must form a double or reinforced insulation between the motor live parts and the digital input of the drive.

Protecting the drive against ground faults

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

Residual current device compatibility

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

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

Implementing the Emergency stop function

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

You can use the Safe torque off function of the drive to implement the Emergency stop function.

Note: Pressing the stop (off) key on the control panel of the drive does not generate an emergency stop of the motor or separate the drive from dangerous potential.

Implementing the Safe torque off function

See chapter *The Safe torque off function (page 99)*.

Using a safety switch between the drive and the motor

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

Implementing the control of a contactor between drive and motor

Implementing the control of the output contactor depends on the motor control mode and stopping method selected.

When you select the vector motor control mode and the motor ramp stop mode, use this operation sequence to open the contactor:

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

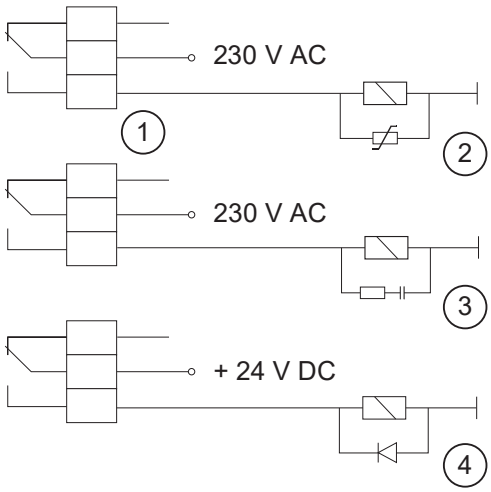
WARNING!
If vector motor control mode is in use, do not open the output contactor while the drive controls the motor. The motor control operates faster than the contactor, and tries to maintain the load current. This can cause damage to the contactor.

When you select the vector motor control mode and the motor coast stop mode, you can open the contactor immediately after the drive has received the stop command. This is the case also if you use the scalar motor control mode.

Protecting the contacts of relay outputs

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

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



1	Relay output
2	Varistor
3	RC filter
4	Diode

6

Electrical installation

Contents of this chapter

This chapter describes how to:

- measure the insulation
- do an earthing system compatibility check
- change the EMC filter connection
- connect the power and control cables
- install optional modules
- connect a PC.

Warnings

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

Required tools

To do the electrical installation, you need the following tools:

- wire stripper
- screwdriver or wrench with a set of suitable bits. For motor cable terminals, the recommended screwdriver shaft length is 150 mm (5.9 in).
- short flat head screwdriver for the I/O terminals
- torque wrench

- voltage tester
- insulation resistance meter
- personal protective equipment.

Measuring the insulation

Measuring the insulation of the drive

WARNING!
Do not do any voltage withstand or insulation resistance tests on any part of the drive as testing can damage the drive. Every drive has been tested for insulation between the main circuit and the chassis at the factory. Also, there are voltage-limiting circuits inside the drive which cut down the testing voltage automatically.

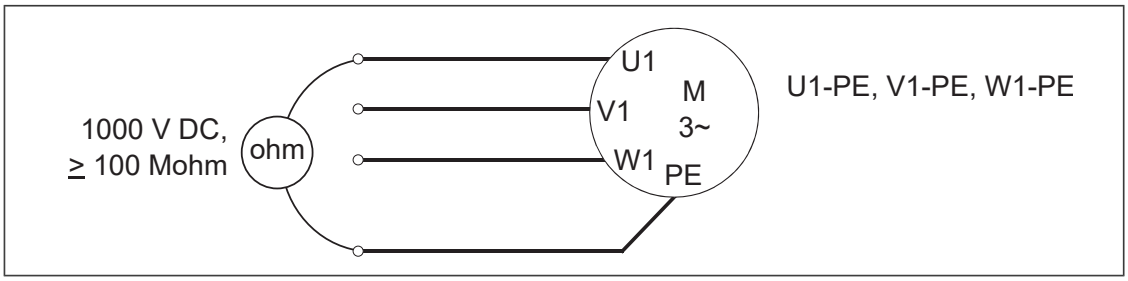
Measuring the insulation of the input power cable

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

Measuring the insulation of the motor and motor cable

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

1. Do the steps in section *Electrical safety precautions (page 13)* before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals.
3. Measure the insulation resistance between each phase conductor and the protective earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must be more than 100 Mohm (reference value at 25 C [77°F]). For the insulation resistance of other motors, refer to the manufacturer's instructions.
   Note: Moisture inside the motor casing reduces the insulation resistance. If you think that there is moisture in the motor, dry the motor and do the measurement again.



Earthing system compatibility check

This section is valid for the IEC drive types.

EMC filter

The drive ACS180-04S-...-1/4 has an internal EMC filter as standard. You can install the drive to a symmetrically grounded TN-S system. If you install the drive to another system, you must disconnect the EMC filter.

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

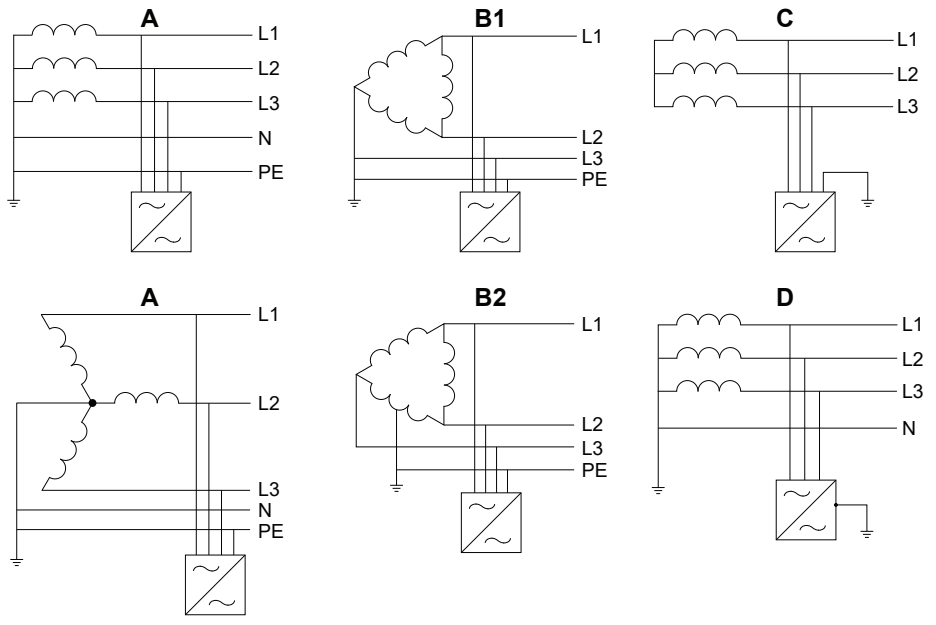
WARNING!
Do not install a drive with the internal EMC filter connected to an earthing system that the EMC filter is not suitable for (for example, an IT system). The supply network becomes connected to ground potential through the internal EMC filter capacitors, which can cause danger or damage to the drive.

When to disconnect the EMC filter

The table shows different earthing systems, and when you need to disconnect the EMC filter (metal EMC screw).

WARNING!
Remove the metal EMC screw in systems other than the symmetrically grounded TN-S systems. If you do not, it can cause danger or damage to the drive.

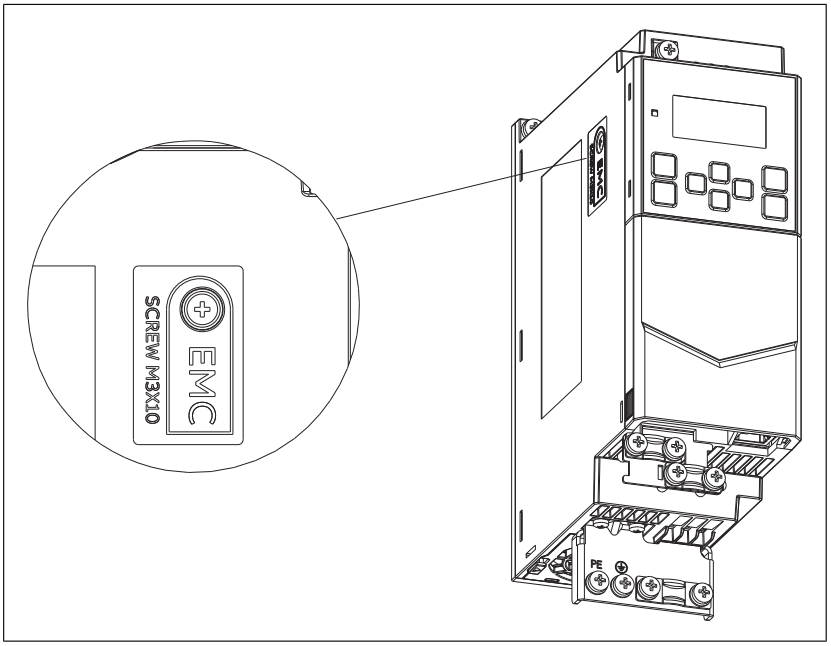
Screw label	Screw material	Earthing systems and the need to remove EMC screw		
		Symmetrically grounded TN-S systems, i.e, center grounded-wye (A)	Corner-grounded delta (B1), midpoint-grounded delta (B2) and TT (D) systems	IT systems (ungrounded or high-resistance grounded) (C)
EMC	Metal	Do not remove	Remove	Remove



Note: ACS180 Drives do not support corner-grounded delta (B1) system.

Disconnecting the EMC filter

1. Do the steps in section *Electrical safety precautions (page 13)* before you start the work.
2. To disconnect the EMC filter, remove the metal EMC screw.



Guidelines for installing the drive to a TT system

You can install the drive to a TT system under these conditions:

1. There is a residual current device in the supply system
2. The internal EMC filter is disconnected. If the EMC filter is not disconnected, its leakage current will cause the residual current device to trip.

Note:

- ABB does not guarantee the EMC category, because the internal EMC filter is disconnected.
- ABB does not guarantee the functioning of the ground leakage detector built inside the drive.
- In large systems the residual current device can trip without a real reason.

Identifying the grounding system of the electrical power network

WARNING!
Only a qualified electrical professional may do the work instructed in this section. Depending on the installation site, the work may even be categorized as live working. Continue only if you are an electrical professional certified for the work. Obey the local regulations. If you ignore them, injury or death can occur.

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

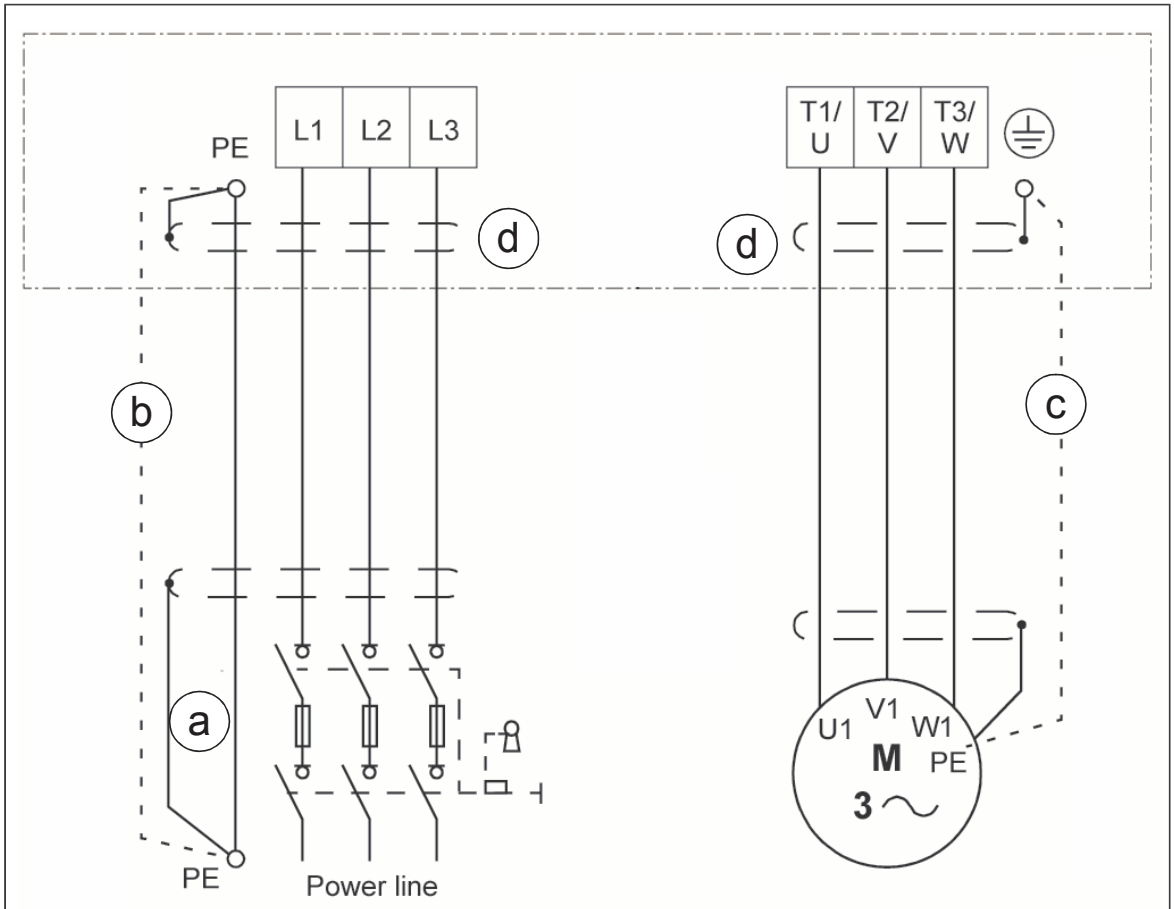
1. input voltage line to line (U_{L-L})
2. input voltage line 1 to ground (U_{L1-G})
3. input voltage line 2 to ground (U_{L2-G})
4. input voltage line 3 to ground (U_{L3-G}).

The table below shows the line-to-ground voltages in relation to the line-to-line voltage for each grounding system.

U_{L-L}	U_{L1-G}	U_{L2-G}	U_{L3-G}	**Electrical power system type**
X	0.58·X	0.58·X	0.58·X	Symmetrically grounded TN system (TN-S system)
X	1.0·X	1.0·X	0	Corner-grounded delta system (nonsymmetrical)
X	0.866·X	0.5·X	0.5·X	Midpoint-grounded delta system (nonsymmetrical)
X	Varying level versus time	Varying level versus time	Varying level versus time	IT systems (ungrounded or high-resistance-grounded [>30 ohms]) nonsymmetrical
X	Varying level versus time	Varying level versus time	Varying level versus time	TT system (the protective earth connection for the consumer is provided by a local earth electrode, and there is another independently installed at the generator)

Connecting the power cables

Connection diagram

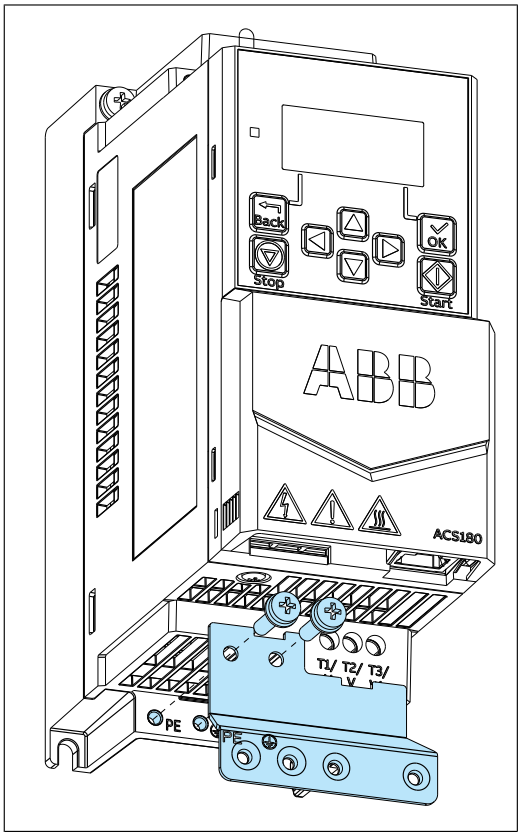


a	Two grounding conductors. Use two conductors, if the cross-section of grounding conductor is less than 10 mm² Cu or 16 mm² Al (IEC/EN 61800-5-1). For example, use the cable shield in addition to the fourth conductor.
b	Separate grounding cable (line side). Use it if the conductivity of the fourth conductor or shield is not sufficient for the protective grounding.
c	Separate grounding cable (motor side). Use it if the conductivity of the shield is not sufficient for the protective grounding, or there is no symmetrically constructed grounding conductor in the cable.
d	360-degree grounding of the cable shield. Required for the motor cable, recommended for the input power cable.

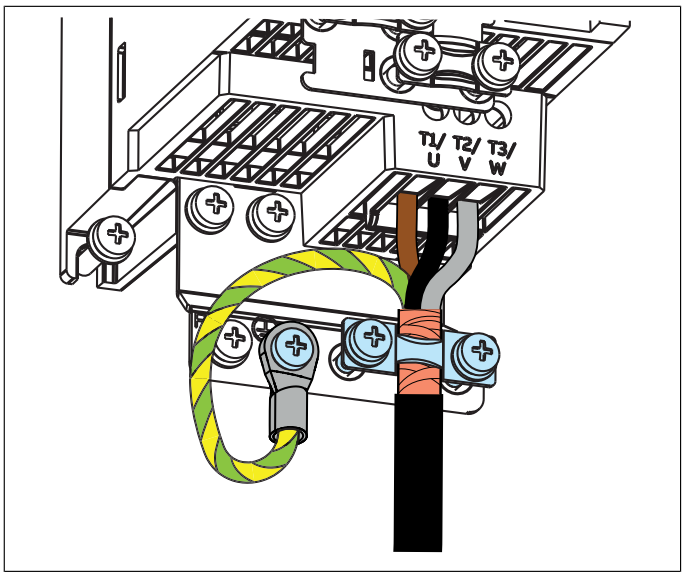
Connection procedure

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 13)* before you start the work.
2. Install the grounding plate and fasten it with screw.

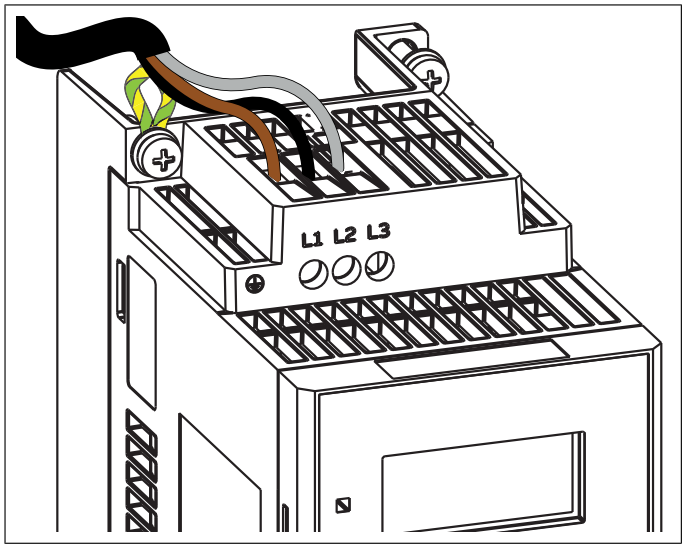


3. Strip the motor cable.
4. Ground the motor cable shield under the grounding clamp.



5. Twist the motor cable shield into a bundle, mark it with yellow-green and connect it to the grounding terminal.
6. Connect the phase conductors of the motor cable to the T1/U, T2/V and T3/W motor terminals. Torque the terminals to 0.8 N·m (7 lbf·in).

7. Strip the input power cable.
8. If the input power cable has a shield, twist it into a bundle, mark it with yellow-green and connect it to the grounding terminal.

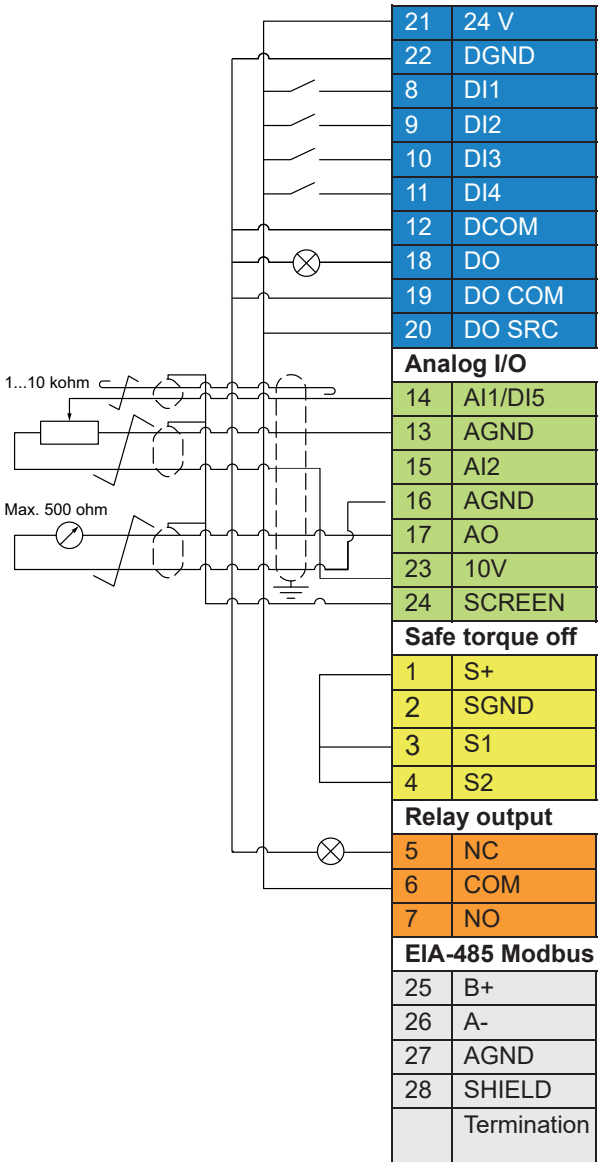


9. Mark the second grounding connector of the input side with the yellow-green and connect it to the PE terminal. (Second PE conductor is required by the drive safety standards IEC61800-5 and UL 61800-5.)
10. Connect the phase conductors of the input power cable to the L1, L2 and L3 input terminals. Torque the terminals to 0.8 N·m (7 lbf·in).
11. Mechanically attach the cables on the outside of the drive.

Connecting the control cables

Refer to Default I/O connection diagram (ABB standard macro) for the default I/O connections of the ABB standard macro. For other macros, refer to the *ACS180 firmware manual* (3AXD50000467860 [English]).

Default I/O connection diagram (ABB standard macro)



Term. [1]	Description
Digital I/O connections	
24 V	Aux. +24 V DC, max 200 mA
DGND	Aux. voltage output common
DI1	Stop (0) / Start (1)
DI2	Forward (0) / Reverse (1)
DI3	Constant speed selection
DI4	Constant speed selection
DCOM	Digital input common
DO	Running
DO COM	Digital output common
DO SRC	Digital output auxiliary voltage
Analog I/O	
AI1/DI5	Speed reference (0…10V)
AGND	Analog input circuit common
AI2	Not used
AGND	Analog output circuit common
AO	Output frequency (0...20mA)
10V	Ref. voltage +10 V DC
SCREEN	Signal cable shield (screen)
Safe torque off (STO)(only on ACS180-04S)	
S+	Safe torque off function. Connected at the factory. Drive starts only when both circuits are closed.
SGND	
S1	
S2	
Relay output	
NC	No fault [Fault (-1)]
COM	
NO	
EIA-485 Modbus RTU	
B+	Embedded Modbus RTU (EIA-485)
A-	
AGND	
SHIELD	
Termination	

[1] Terminal size: 0.5 mm² … 1 mm²

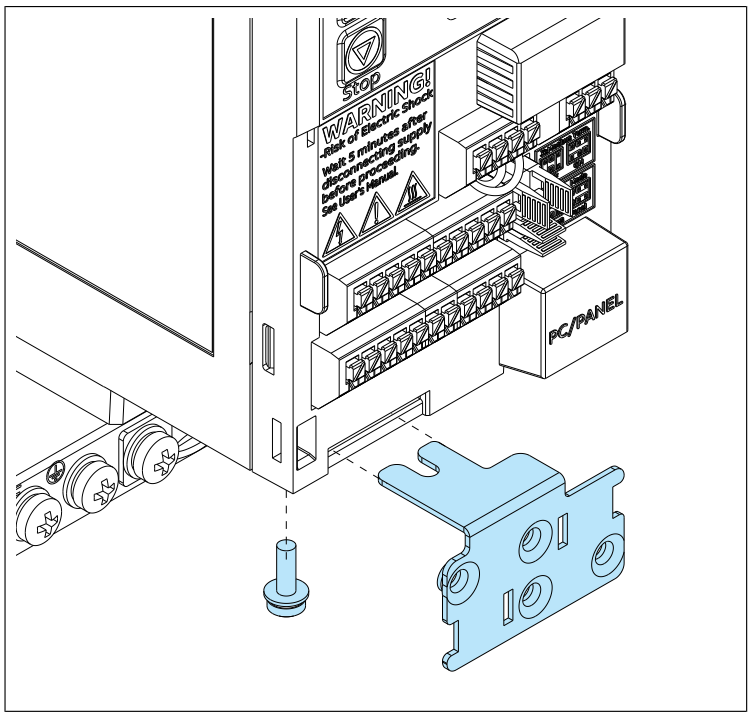
Control cable connection procedure

Do the connections according to the macro in use.

Keep the signal wire pairs twisted as near to the terminals as possible to prevent inductive coupling.

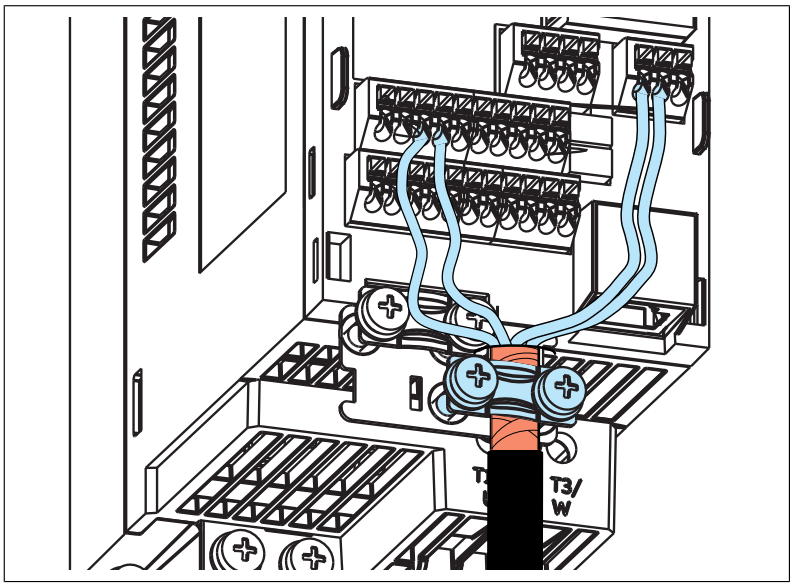
WARNING!
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation or maintenance work.

1. Stop the drive and do the steps in section *Electrical safety precautions (page 13)* before you start the work.
2. Remove the front cover.
3. Insert the grounding clamp into the slot and fasten it with screw.



4. Strip a part of the outer shield of the control cable for 360-degree grounding.
5. Use a 360-degree grounding clamp to connect the cable to the grounding tab.
6. Strip the ends of the control cable conductors. For stranded (multi-wire) conductors, install ferrules at the bare conductor ends.

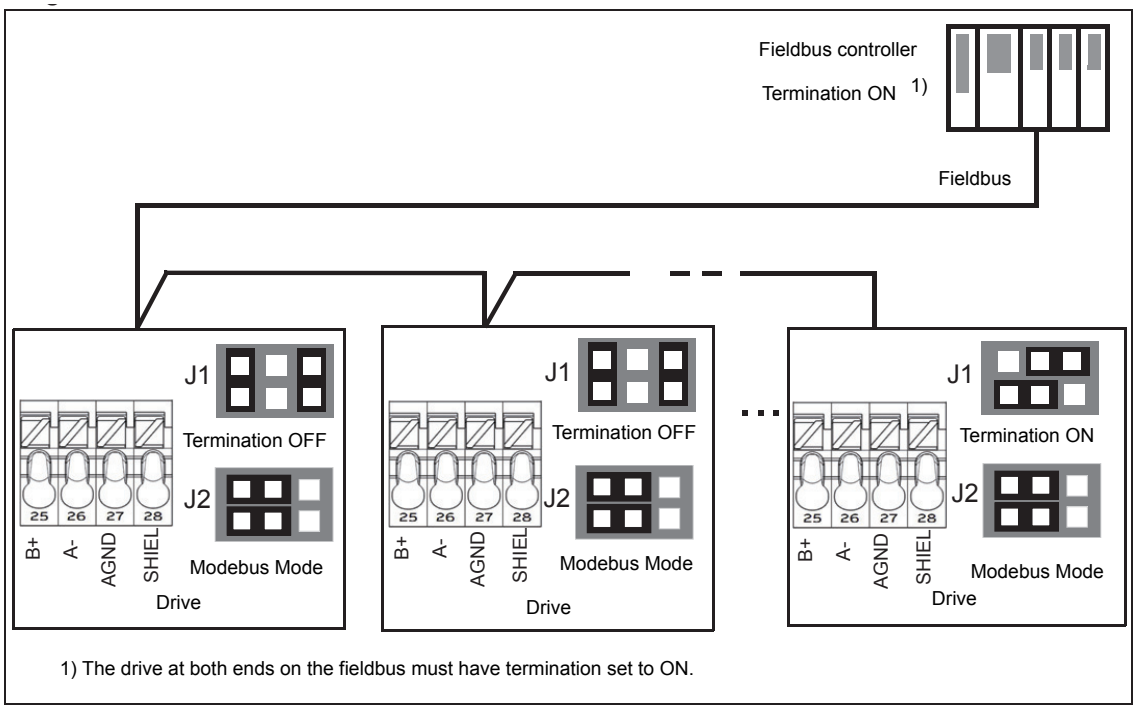
7. Connect the conductors to the correct control terminals.
8. Mechanically attach the control cables on the outside of the drive.



Additional information on the control connections

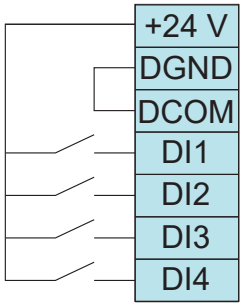
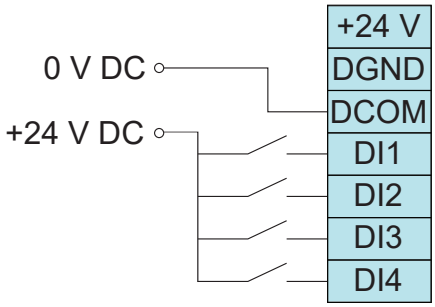
Connecting EIA-485 fieldbus cable to the drive

Connect the fieldbus to the EIA-485 Modbus RTU terminal on the front of the drive. The EIA-485 network uses shielded, twisted-pair cable for data signaling with characteristic impedance between 100 and 130 ohm. The distributed capacitance between conductors is less than 100 pF per meter (30 pF per foot). Distributed capacitance between conductors and shield is less than 200 pF per meter (60 pF per foot). Foil or braided shields are acceptable. The connection diagram is shown below.



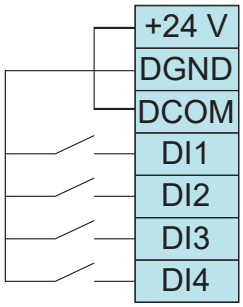
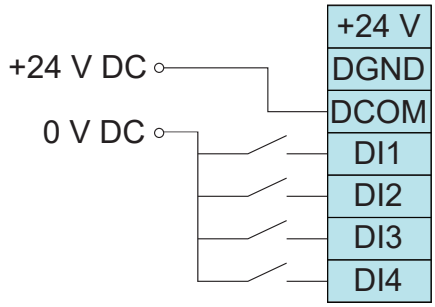
PNP configuration for digital inputs

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

Internal +24 V power supply	External +24 V power supply
	

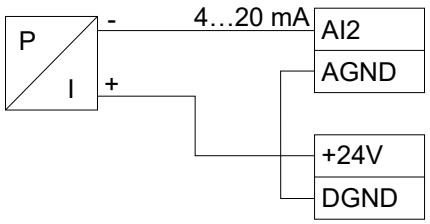
NPN configuration for digital inputs

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

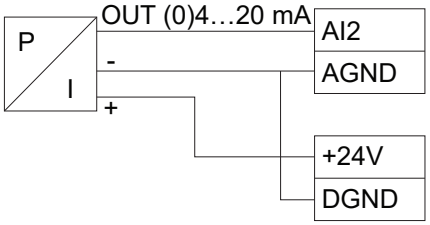
Internal +24 V power supply	External +24 V power supply
	

Connection examples of two-wire and three-wire sensors

The figures give examples of connections for a two-wire or three-wire sensor/transmitter that is supplied by the auxiliary voltage output of the drive.



AI2	Process actual value measurement or reference, 0(4) … 20 mA, R_{in} = 205 ohm. If the sensor power supply comes through its current output circuit, use 4 … 20 mA signal, not 0 … 20 mA.
AGND	
+24V	Auxiliary voltage output, non-isolated, +24 V DC, max. 100 mA
DGND	



AI2	Process actual value measurement or reference, 0(4)…20 mA, R_{in} = 205 ohm
AGND	
+24V	Auxiliary voltage output, non-isolated, +24 V DC, max. 100 mA
DGND	

Safe torque off

For the drive to start, both STO connections must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting external Safe torque off circuitry to the drive. See chapter *The Safe torque off function*.

Connecting a PC

To connect a PC to the drive, there are two alternatives:

- Use an ACS-AP-I/S/W assistant control panel as a converter. Use a USB type A (PC) – type B (control panel) cable. The maximum permitted length of the cable is 3 m (9.8 ft).
- Use a USB to RJ45 converter. You can order it from ABB (BCBL-01, 3AXD50000032449). Connect the cable to the Panel and PC tool port (RJ45).

For information on the Drive composer PC tool, refer to *Drive composer PC tool user's manual* (3AUA0000094606 [English]).

7

Installation checklist

Contents of this chapter

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

Checklist

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

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

WARNING!
Stop the drive and do the steps in section *Electrical safety precautions (page 13)* before you start the work.

Make sure that …	☑
The ambient operating conditions meet the drive ambient conditions specification, and enclosure rating (IP code or UL enclosure type).	☐
The supply voltage matches the nominal input voltage of the drive. See the type designation label.	☐
The insulation resistance of the input power cable, motor cable and motor is measured according to local regulations and the manuals of the drive.	☐
The drive is attached securely on an even, vertical and non-flammable wall.	☐
The cooling air flows freely in and out of the drive.	☐

Make sure that …	☑
If the drive is connected to a network other than a symmetrically grounded TN-S system: You have done all the required modifications (for example, you may need to disconnect the EMC filter or ground-to-phase varistor). See the electrical installation instructions.	☐
Appropriate AC fuses and main disconnecting device are installed.	☐
There is an adequately sized protective earth (ground) conductor(s) between the drive and the switchboard, the conductor is connected to correct terminal, and the terminal is tightened to the correct torque. Proper grounding has also been measured according to the regulations.	☐
The input power cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	☐
There is an adequately sized protective earth (ground) conductor between the motor and the drive, and the conductor is connected to the correct terminal, and the terminal is tightened to the correct torque. Proper grounding has also been measured according to the regulations.	☐
The motor cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	☐
The motor cable is routed away from other cables.	☐
No power factor compensation capacitors are connected to the motor cable.	☐
The control cables are connected to the correct terminals, and the terminals are tightened to the correct torque.	☐
If a drive bypass connection will be used: The direct-on-line contactor of the motor and the drive output contactor are either mechanically and/or electrically interlocked, that is, they cannot be closed at the same time. A thermal overload device must be used for protection when bypassing the drive. Refer to local codes and regulations.	☐
There are no tools, foreign objects or dust from drilling inside the drive.	☐
The area in front of the drive is clean: the drive cooling fan cannot draw any dust or dirt inside.	☐
Drive covers and cover of the motor connection box are in place.	☐
The motor and the driven equipment are ready for power-up.	☐

8

Maintenance

Contents of this chapter

The chapter contains the preventive 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).

Recommended annual actions by the user	
Connections and environment	
Quality of the supply voltage	P
Spare parts	
Spare parts	I
Reforming DC circuit capacitors of spare modules	P
Inspections	
Tightness of terminals	I
Dustiness, corrosion and temperature	I
Cleaning the heatsink	P

Maintenance task/object	**Years from start-up**						
	3	**6**	**9**	**12**	**15**	**18**	**21**
Cooling fans							
Main cooling fan (frames R1)		R		R		R	

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**

Note:

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

Cleaning the heatsink

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

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

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 13)* before you start the work.
2. Remove the drive module from the cabinet.
3. Remove the module cooling fan(s). See the separate instructions.
4. Blow dry, clean and oil-free compressed air from bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust. If there is a risk of dust entering adjoining equipment, do the cleaning in another room.
5. Reinstall the cooling fan.

Replacing the cooling fans

These instructions are applicable only to frame size R1. Frame R0 units do not have a cooling fan.

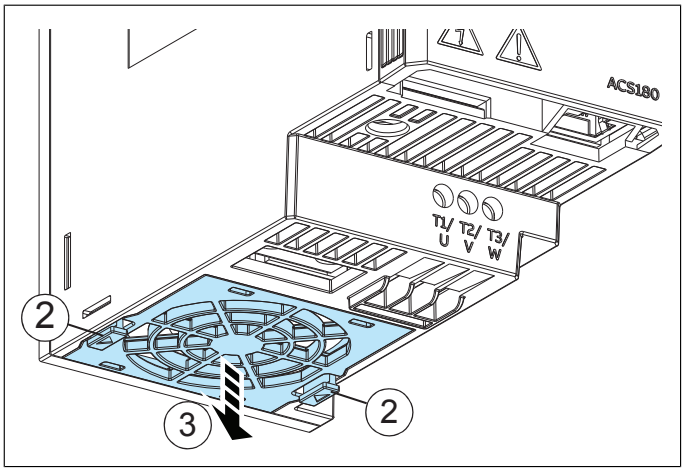
Parameter *05.04 Fan on-time counter* shows the running time of the cooling fan. After you replace the fan, reset the fan counter. Refer to the firmware manual.

You can get replacement fans from ABB. Use only ABB specified spare parts.

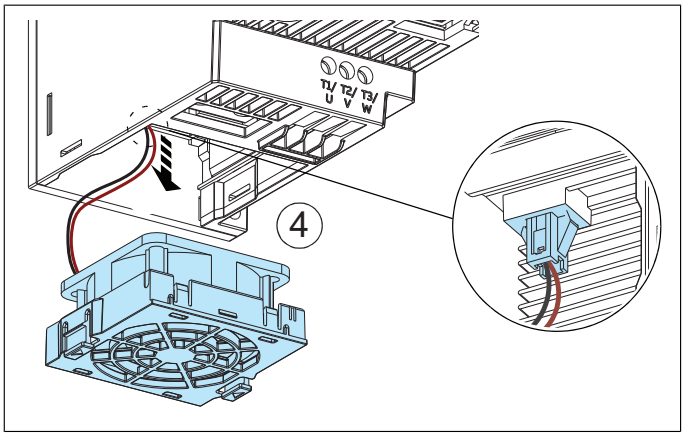
To replace the cooling fan for frame sizes R1

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

1. Stop the drive and do the steps in section *Electrical safety precautions (page 13)* before you start the work.
2. Press the two clips by fingers to open the fan cover.
3. Carefully lift the fan cover out of the drive. Note that the fan cover holds the cooling fan.

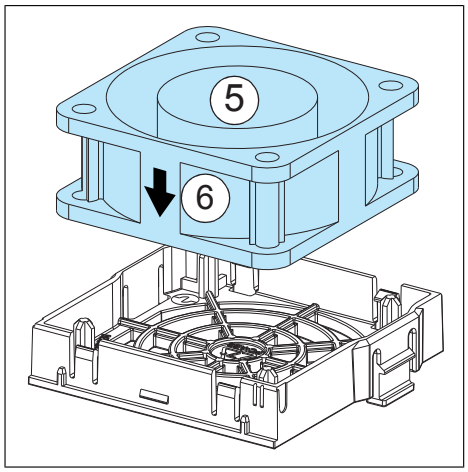


4. Disconnect the fan power cable.

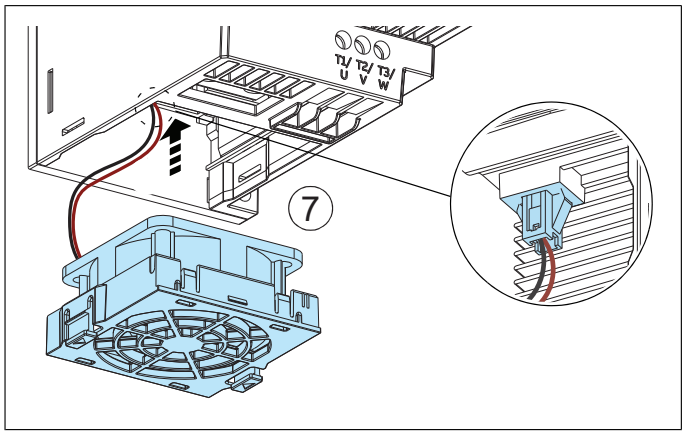


5. Free the fan clips and remove the fan from the fan cover.

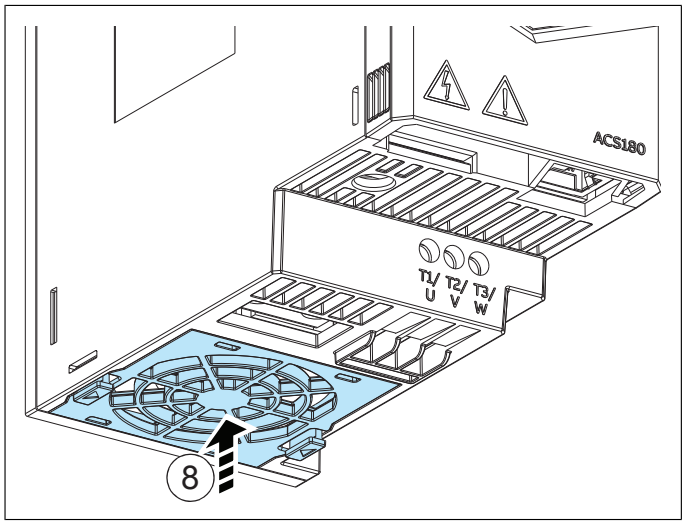
6. Install the new fan into the fan cover. Make sure that the air flow is in the correct direction. The air flows in from the bottom of the drive and out from the top of the drive.



7. Connect the fan power cable.



8. Carefully put the fan cover into position in the drive. Make sure that the fan power cable is routed correctly. Push the cover to lock into position.



Capacitors

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

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

Reforming the capacitors

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

9

Technical data

Contents of this chapter

The chapter contains the technical specifications of the drive, such as ratings, sizes and technical requirements as well as provisions for fulfilling the requirements for CE, UL and other approval marks.

Ratings

IEC ratings

Type ACS180-04...	Input current	Input with choke	Output ratings							Frame size
			Max. current	Nominal use		Light-duty use		Heavy-duty use		
	I_{1N}	I_{1N}	I_{max}	I_N	P_N	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}	
	A	A	A	A	kW	A	kW	A	kW	
3-phase U_N = 400 V (range 380 ... 480 V)										
-01A8-4	2.8	1.5	2.2	1.8	0.55	1.7	0.55	1.2	0.37	R0
-02A6-4	3.6	1.9	3.2	2.6	0.75	2.5	0.75	1.8	0.55	R0
-03A3-4	4.9	2.5	4.3	3.3	1.1	3.1	1.1	2.4	0.75	R0
-04A0-4	6.3	3.3	5.9	4.0	1.5	3.8	1.5	3.3	1.1	R1
-05A6-4	9.1	4.6	7.2	5.9	2.2	5.3	2.2	4.0	1.5	R1
-07A2-4	12	5.9	10.1	7.2	3	6.8	3	5.6	2.2	R1
-09A4-4	14	7.9	13	9.4	4	8.9	4	7.2	3	R1
1-phase U_N = 230 V (range 200 ... 240 V)										
-02A4-1	5.0	3.3	3.2	2.4	0.37	2.3	0.37	1.8	0.25	R0
-03A7-1	6.9	4.8	4.3	3.7	0.55	3.5	0.55	2.4	0.37	R0

Type ACS180-04...	Input current	Input with choke	Output ratings							Frame size
			Max. current	Nominal use		Light-duty use		Heavy-duty use		
	I_{1N}	I_{1N}	I_{max}	I_N	P_N	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}	
	A	A	A	A	kW	A	kW	A	kW	
-04A8-1	9.0	6.2	6.7	4.8	0.75	4.6	0.75	3.7	0.55	R0
-06A9-1	12.6	9.2	8.1	6.9	1.1	6.6	1.1	4.5	0.75	R1
-07A8-1	17.3	12	11.9	7.8	1.5	7.4	1.5	6.6	1.1	R1
-09A8-1	21.8	17	13.3	9.8	2.2	9.3	2.2	7.4	1.5	R1

UL (NEC) ratings

Type ACS180-04...	Input current	Input with choke	Output ratings					Frame size
			Max. current	Light-duty use		Heavy-duty use		
	I_{1N}	I_{1N}	I_{max}	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}	
	A	A	A	A	hp	A	hp	
3-phase U_N = 460 V (range 440 ... 480 V)								
-01A8-4	1.9	1.3	2.2	1.6	0.75	1.1	0.5	R0
-02A6-4	2.4	1.6	3.2	2.1	1	1.6	0.75	R0
-03A3-4	3.5	2.1	4.3	3.0	1.5	2.1	1	R0
-04A0-4	4.6	2.8	5.9	3.5	2.0	3.0	1.5	R1
-05A6-4	6.9	3.8	7.2	4.7	3	3.4	2	R1
-07A2-4	9.2	5.0	10.1	6.0	3	4.8	3	R1
-09A4-4	10.3	6.7	13	7.6	5	6.3	3	R1
1-phase U_N = 230 V (range 200 ... 240 V)								
-02A4-1	5.0	3.3	3.2	2.3	0.5	1.8	0.33	R0
-03A7-1	6.9	4.8	4.3	3.5	0.75	2.4	0.5	R0
-04A8-1	9.0	6.2	6.7	4.6	1	3.7	0.75	R0
-06A9-1	12.6	9.2	8.1	6.6	1.5	4.5	1	R1
-07A8-1	17.3	12	11.9	7.4	2	6.6	1.5	R1
-09A8-1	21.8	17	13.3	9.3	3	7.4	2	R1

Definitions

The heavy duty ratings are valid at a surrounding air temperature of 50 °C (122 °F) and the light duty ratings are valid at a surrounding air temperature of 40 °C (104 °F) with the default drive switching frequency of 4 kHz (parameter *97.01*), and with an installation altitude below 1000 m (3281 ft).

U_N Nominal supply voltage.

I_1 Nominal input current. Continuous rms input current (for dimensioning cables and fuses).

I_{max} Maximum output current. Available for two seconds at start.

I_N Nominal output current. Maximum continuous rms output current allowed (no overload).

P_N	Typical motor power in nominal use (no overloading). The kilowatt ratings are applicable to most IEC 4-pole (400 V, 50 Hz) motors. The horsepower ratings are applicable to most NEMA 4-pole motors
I_{Ld}	Maximum output current with 110% overload, allowed for one minute every ten minutes.
P_{Ld}	Typical motor power in light-duty use (110% overload).
I_{Hd}	Maximum output current with 150% overload, allowed for one minute every ten minutes.
P_{Hd}	Typical motor power in heavy-duty use (150% overload)

Sizing

ABB recommends the DriveSize tool for selecting the drive, motor and gear combination (http://new.abb.com/drives/software-tools/drivesize). You can also use the ratings tables.

Derating

The load capacity (I_N, I_{Ld}, I_{Hd}; note that I_{max} is not derated) decreases in certain situations. In such situations, where full motor power is required, oversize the drive so that the derated value provides sufficient capacity.

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

Example:

If your application requires continuous 3.3 A three phase motor current (I_N) at 8 kHz switching frequency, the supply voltage is 400 V and the drive is situated at 1500 m, calculate the appropriate drive size requirement as follows:

Switching frequency derating:

From the table,The nominal current of 05A6-4 drive at 8kHz is 5.6x0.59=3.304A. So the minimum size required is IN=5.6A.

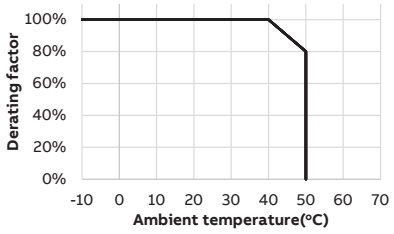
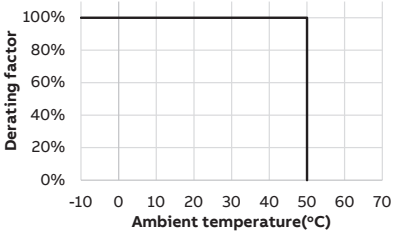
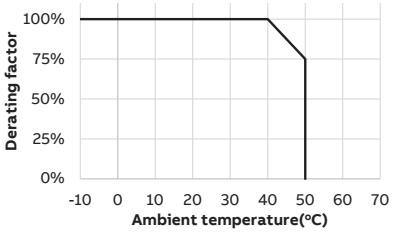
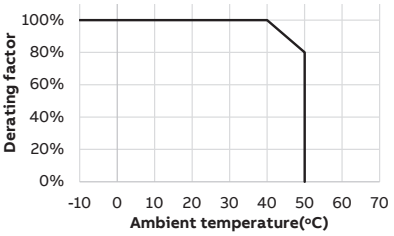
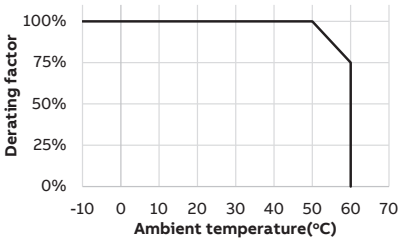
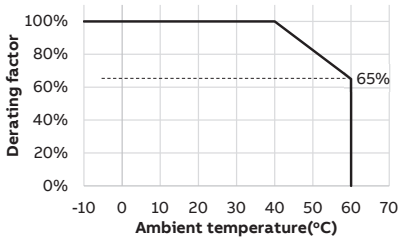
Altitude derating:

The derating factor for 1500 m is 1 - 1/10 000 m · (1500 - 1000) m = 0.95.

The minimum size required becomes then I_N = 5.6 A / 0.95 = 5.9 A.

Referring to I_N in the ratings tables, drive type ACS180-04x-07A2-4 exceeds the I_N requirement of 5.9 A.

Surrounding air temperature derating

Frame		Install side-by-side	Installation with 50mm space between
R0	Derating factor for I_{Hd} (Heavy duty rating, 150% overloadability)		
	Derating factor for I_N and I_{Ld} (Normal and light duty rating, no or 110% overloadability)		
R1	Derating factor for I_{Hd} (Heavy duty rating, 150% overloadability)		
	Derating factor for I_N and I_{Ld} (Normal and light duty rating, no or 110% overloadability)		

Altitude derating

1000...2000 m above sea level, the derating is 1% for every 100 m (330 ft).

To calculate the output current, multiply the current in the rating table with the derating factor k, which for x meters (1000 m <= x <= 2000 m) is:

$$k = 1 - \frac{x - 1000\ m}{10000\ m}$$

Switching frequency derating

Type ACS180-04...	Current multiplier with different switching frequencies			
	2 kHz	4 kHz	8 kHz	12 kHz
3-phase U_N = 400 V (range 380 ... 480 V)				
-01A8-4	1.0	1.0	0.59	0.42
-02A6-4	1.0	1.0	0.59	0.42
-03A3-4	1.0	1.0	0.59	0.42

Type ACS180-04...	Current multiplier with different switching frequencies			
	2 kHz	4 kHz	8 kHz	12 kHz
-04A0-4	1.0	1.0	0.59	0.42
-05A6-4	1.0	1.0	0.59	0.42
-07A2-4	1.0	1.0	0.62	0.45
-09A4-4	1.0	1.0	0.62	0.45
1-phase U_N = 230 V (range 200 ... 240 V)				
-02A4-1	1.0	1.0	0.82	0.69
-03A7-1	1.0	1.0	0.82	0.69
-04A8-1	1.0	1.0	0.81	0.68
-06A9-1	1.0	1.0	0.81	0.68
-07A8-1	1.0	1.0	0.80	0.67
-09A8-1	1.0	1.0	0.82	0.70

Fuses

The tables list the fuses for protection against short-circuits in the input power cable or drive. The operating time depends on the supply network impedance, and the cross-sectional area and length of the supply cable.

Do not use fuses that have a higher current rating than specified in the table. You can use fuses from other manufacturers, if they meet the ratings, and if the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

gG fuses (IEC)

Make sure that the operating time of the fuse is less than 0.5 seconds. Obey the local regulations.

Type ACS180-04...	Input current	Min. short-circuit current	Nominal current	I^2t	Voltage rating	ABB type	Type (IEC 60269)
	A	A	A	A^2s	V		
3-phase U_N = 400 V (range 380 ... 480 V)							
-01A8-4	2.8	47	4	110	500	C10G4	000
-02A6-4	3.6	59	6	155	500	C10G6	000
-03A3-4	4.9	87	10	310	500	C10G10	000
-04A0-4	6.3	116	10	310	500	C10G10	000
-05A6-4	9.1	174	16	680	500	C10G16	000
-07A2-4	12.0	230	20	1200	500	C10G20	000
-09A4-4	14.0	258	25	2300	500	C10G25	000
1-phase U_N = 230 V (range 200 ... 240 V)							
-02A4-1	5.0	108	10	310	500	C10G10	000
-03A7-1	6.9	150	16	680	500	C10G16	000
-04A8-1	9.0	193	16	680	500	C10G16	000

Type ACS180-04...	Input current	Min. short-circuit current	Nominal current	I^2t	Voltage rating	ABB type	Type (IEC 60269)
	A	A	A	A^2s	V		
-06A9-1	12.6	275	20	1200	500	C10G20	000
-07A8-1	17.3	372	25	2300	500	C10G25	000
-09A8-1	21.8	545	40	-	500	C14G40	000

gR or aR -type fuses

Type ACS180-04...	Input current	Min. short-circuit current	Nominal current	I^2t	Voltage rating	Bussmann type	Type (IEC 60269)
	A	A	A	A^2s	V		
3-phase U_N = 400 V (range 380 ... 480 V)							
-01A8-4	2.8	47	12	170	690	FWP-20G14F	000
-02A6-4	3.6	59	16	170	690	FWP-20G14F	000
-03A3-4	4.9	87	16	170	690	FWP-20G14F	000
-04A0-4	6.3	116	16	333	690	FWP-25G14F	000
-05A6-4	9.1	174	20	333	690	FWP-25G14F	000
-07A2-4	12.0	230	25	679	690	FWP-32G14F	000
-09A4-4	14.0	258	32	679	690	FWP-32G14F	000
1-phase U_N = 230 V (range 200 ... 240 V)							
-02A4-1	5.0	108	16	679	690	FWP-32G10F	000
-03A7-1	6.9	150	20	679	690	FWP-32G10F	000
-04A8-1	9.0	193	25	1331	690	FWP-40G10F	000
-06A9-1	12.6	275	25	2200	690	FWP-50G10F	000
-07A8-1	17.3	372	32	2200	690	FWP-50G10F	000
-09A8-1	21.8	545	32	2200	690	FWP-50G10F	000

UL fuses (UL(NEC))

Type ACS180-04...	Input current	Min. short-circuit current	Nominal current	Voltage rating	Bussmann type	Type
	A	A	A	V		
3-phase U_N = 400 V (range 380 ... 480 V)						
-01A8-4	2.8	47	6	600	JJS-6	UL class T
-02A6-4	3.6	59	6	600	JJS-6	UL class T
-03A3-4	4.9	87	10	600	JJS-10	UL class T
-04A0-4	6.3	116	10	600	JJS-10	UL class T
-05A6-4	9.1	174	20	600	JJS-20	UL class T
-07A2-4	12.0	230	20	600	JJS-20	UL class T
-09A4-4	14.0	258	25	600	JJS-25	UL class T
1-phase U_N = 230 V (range 200 ... 240 V)						
-02A4-1	5.0	108	10	300	JJN-10	UL class T
-03A7-1	6.9	150	10	300	JJN-10	UL class T
-04A8-1	9.0	193	20	300	JJN-20	UL class T

Type ACS180-04...	Input current	Min. short-circuit current	Nominal current	Voltage rating	Bussmann type	Type
	A	A	A	V		
-06A9-1	12.6	275	20	300	JJN-20	UL class T
-07A8-1	17.3	372	25	300	JJN-25	UL class T
-09A8-1	21.8	545	35	300	JJN-35	UL class T

Alternate short-circuit protection

Miniature circuit breakers (IEC)

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

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

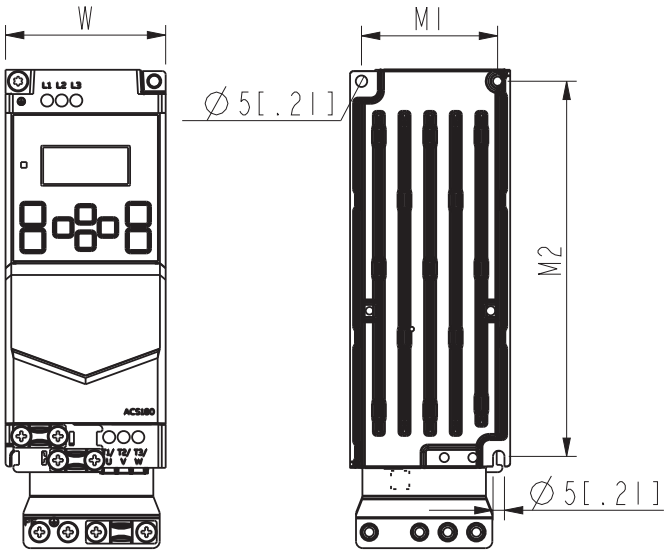
You can use the circuit breakers listed below. You can also use other circuit breakers with the drive if they provide the same electrical characteristics. ABB does not assume any liability whatsoever for the correct function and protection with circuit breakers not listed below. Furthermore, if the recommendations given by ABB are not obeyed, the drive can experience problems the warranty does not cover.

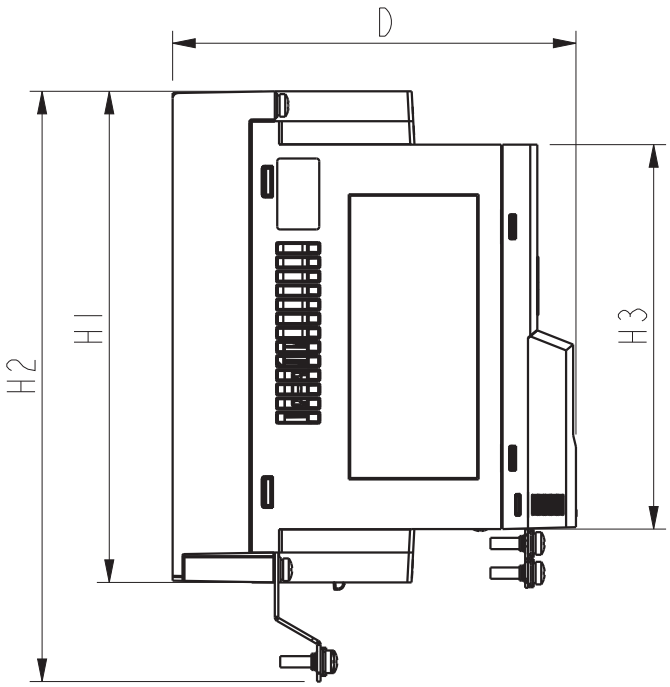
Note: Miniature circuit breakers with or without fuses have not been evaluated for use as short circuit protection in USA (UL) environments.

Type ACS180-04...	Frame	ABB miniature circuit breaker
		Type
3-phase U_N = 400 V (range 380 ... 480 V)		
-01A8-4	R0	S 203P-B6
-02A6-4	R0	S 203P-B6
-03A3-4	R0	S 203P-B6
-04A0-4	R1	S 203P-B8
-05A6-4	R1	S 203P-B10
-07A2-4	R1	S 203P-B16
-09A4-4	R1	S 203P-B20
1-phase U_N = 230 V (range 200 ... 240 V)		
-02A4-1	R0	S 201P-B10NA
-03A7-1	R0	S 201P-B10NA
-04A8-1	R0	S 201P-B16NA
-06A9-1	R1	S 201P-B20NA
-07A8-1	R1	S 201P-B25NA
-09A8-1	R1	S 201P-B32NA

Dimensions and weights

Frame size	ACS180 IP20/UL open type															
	H1		H2		H3		W		D		M1		M2		Weight	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	kg	lb
R0	174	6.85	209	8.23	136	5.35	70	2.76	143	5.63	60	2.36	164	6.46	1.27	2.80
R1	190	7.48	220	8.66	152	5.98	70	2.76	143	5.63	60	2.36	180	7.09	1.59	3.51





Symbols

H1 Height back

H2 Height with grounding plate

H3 Height front

W Width

D Depth

M1 Mounting hole distance 1

M2 Mounting hole distance 2

Free space requirements

Frame size	Above		Below		Sides	
	mm	in	mm	in	mm	in
R0	75	3	75	3	50[1)]	2
R1	75	3	75	3	0	0

Note: 1) If ambinet temperature is below 40°C (104 F), modules can be installed side-by-side.

Losses, cooling data and noise

Frame size R0 has natural convection cooling. Frame sizes R1 have a cooling fan. The air flow direction is from bottom to top.

The table below specifies the heat dissipation in the main circuit at nominal load and in the control circuit with minimum load (I/O and panel not in use) and maximum load (all digital inputs in the on state and the panel, fieldbus and fan in use). The total heat dissipation is the sum of the heat dissipation in the main and control circuits

	Heat dissipation				Air flow	Noise	Frame size
Type ACS180-04...	Main circuit at rated current	Control circuit min.	Control circuit max.	Main and control Board max.			
	W	W	W	W	m³/h	dB(A)	
3-phase U_N = 400 V (range 380 ... 480 V)							
-01A8-4	30	7	18	48	-	-	R0
-02A6-4	40	7	18	58	-	-	R0
-03A3-4	51	7	18	69	-	-	R0
-04A0-4	67	7	18	85	36.29	50.9	R1
-05A6-4	97	7	18	115	36.29	50.9	R1
-07A2-4	103	7	18	121	36.29	50.9	R1
-09A4-4	136	7	18	154	36.29	50.9	R1
1-phase U_N = 220 V (range 200 ... 240 V)							
-02A4-1	32	7	18	50	-	-	R0
-03A7-1	44	7	18	62	-	-	R0
-04A8-1	53	7	18	71	-	-	R0
-06A9-1	80	7	18	98	27.26	51.8	R1
-07A8-1	82	7	18	100	27.26	51.8	R1
-09A8-1	106	7	18	124	27.26	51.8	R1

Terminal data for the power cables

Type ACS180-04...	U1, V1, W1 / U2, V2, W2						PE terminal	
	Minimum (solid/stranded)		Maximum (solid/stranded)		Torque		Torque	
	mm²	AWG	mm²	AWG	N·m	lbf·in	N·m	lbf·in
3-phase U_N = 400 V (range 380 ... 480 V)								
-01A8-4	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-02A6-4	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-03A3-4	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-04A0-4	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-05A6-4	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-07A2-4	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-09A4-4	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
1-phase U_N = 220 V (range 200 ... 240 V)								
-02A4-1	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-03A7-1	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-04A8-1	0.2/0.2	18	6/4	10	0,5...0,6	5	1.2	10.6
-06A9-1	0.2/0.2	24	6/6	10	0.8	7	1.2	10.6
-07A8-1	0.2/0.2	24	6/6	10	0.8	7	1.2	10.6
-09A8-1	0.2/0.2	24	6/6	10	0.8	7	1.2	10.6

Typical power cable sizes

IEC type ACS180-04...	Cable conductor sizes (mm²) [1]	AWG	Frame
3-phase U_N = 400 V (range 380 ... 480 V)			
-01A8-4	3×1.5 + 1.5	16	R0
-02A6-4	3×1.5 + 1.5	16	R0
-03A3-4	3×1.5 + 1.5	16	R0
-04A0-4	3×1.5 + 1.5	16	R1
-05A6-4	3×1.5 + 1.5	16	R1
-07A2-4	3×2.5 + 2.5	14	R1
-09A4-4	3×2.5 + 2.5	14	R1
1-phase U_N = 220 V (range 200 ... 240 V)			
-02A4-1	3×1.5 + 1.5	16	R0
-03A7-1	3×1.5 + 1.5	16	R0
-04A8-1	3×1.5 + 1.5	16	R0
-06A9-1	3×1.5 + 1.5	16	R1
-07A8-1	3×2.5 + 2.5	14	R1
-09A8-1	3×2.5 + 2.5	14	R1

[1] Size of typical power cable (symmetrical, shielded, three-phase copper cable). Note that for the input power connection, you may have to use two separate PE conductors (IEC 61800-5-1).

Terminal data for the control cables

Wire size		Torque	
mm²	**AWG**	**N·m**	**lbf·in**
0.5 - 1.5	22 - 16	n/a	n/a

Electrical power network specification

Voltage (U1)	200/208/220/230/240 V AC 1-phase for 200 V AC drives 380/400/415/440/460/480 V AC 3-phase for 400 V AC drives +10%/-15% variation from converter nominal voltage is allowed as default.
Network type	Public low-voltage networks. TN (grounded) and IT (ungrounded) systems.
Rated conditional short-circuit current (IEC 61800-5-1)	65 kA when protected by fuses given in the fuse tables.
Short-circuit current protection (UL 61800-5-1, CSA C22.2 No. 274-13)	US and Canada: The drive is suitable for use on a circuit capable of delivering not more than 100 kA symmetrical amperes (rms) at 480 V maximum when protected by fuses given in the fuse table.
Mains choke	Use a mains choke if the network's line impedance is low (less than 0.3% total system impedance of all the ACS180 drives in the installation), or has voltage imbalance, or harmonic distortion that make the input current bigger than the nominal input current ratings. You can use one choke for several drives as long as the choke current rating is not exceeded.
Frequency (f1)	47 to 63 Hz, maximum rate of change 17%/s
Imbalance	Max. ±3% of nominal phase to phase input voltage
Fundamental power factor (cos phi)	0.98 (at nominal load)

Motor connection data

Motor type	Asynchronous induction motor or permanent magnet synchronous motor
Voltage (U2)	0 to U_1, 3-phase symmetrical, U_{max} at the field weakening point
Short-circuit protection (IEC 61800-5-1, UL 61800-5-1)	The motor output is short-circuit proof by IEC 61800-5-1 and UL 61800-5-1.
Frequency (f2)	0…599 Hz
Frequency resolution	0.01 Hz
Current	See the rating information.
Switching frequency	4, 8, or 12 kHz

Motor cable length

Operational functionality and motor cable length

The drive is designed to operate with optimum performance with the following maximum motor cable lengths. The motor cable lengths may be extended with output chokes as shown in the table.

Frame	Maximum motor cable length	
	m	ft
Standard drive, without external options		
R0	30	98
R1	50	164
With external output chokes		
R0	50	164
R1	75	246

Note: In multimotor systems, the calculated sum of all motor cable lengths must not exceed the maximum motor cable length given in the table.

EMC compatibility and motor cable length

To comply with the EMC limits in the European EMC Directive (standard IEC/EN 61800-3), use these maximum motor cable lengths for the 4 kHz switching frequency.

Frame	Maximum motor cable length, 4 kHz			
	C2		C3	
	m	ft	m	ft
With internal EMC filter				
3-phase U_N = 400/480 V AC (380, 400, 415, 440, 460, 480 V)				
R0	-	-	10	32.8
R1	-	-	10	32.8
1-phase U_N = 230 V AC (200, 208, 220, 230, 240 V)				
R0	5	16.4	10	32.8
R1	5	16.4	10	32.8

Note:

- Radiated emissions are according to C2 with single phase ACS180-04S...-1 drives.
- For 3-phase 380...480 V ACS180-04S... drives, the maximum motor cable lengths are according to C3 in the above table with an internal EMC filter.
- For ACS180-04N... drives, the maximum motor cable lengths are according to the motor cable length table. The EMC category for these drives is C4.

Control connection data

Analog inputs (AI1, AI2)	Voltage signal, single-ended	0 … 10 V DC (10% overrange, 11 V DC max.) R_{in} = 38 kohm
	Current signal, single-ended	0 … 20 mA (10% overrange, 22 mA max.) R_{in} = 205 ohm
	Inaccuracy	≤ 1.0%, of full scale
	Potentiometer reference value	10 V DC ±1%, max. load current 10 mA

Analog output (AO)	Current output mode	0 … 20 mA (10% overrange, 22 mA max.) into maximum 500 ohm load
	Voltage output mode	0 … 10 V DC (10% overrange, 11 V DC max.) into 200 kohm minimum load (resistive)
	Inaccuracy	≤ 1.5%, of full scale
Auxiliary voltage output (+24V)	As output	+24 V DC ±10%, max. 100 mA
Digital inputs (DI1…DI4)	Voltage	12 … 24 V DC (int. or ext. supply) max. 30 V DC.
	Type	PNP and NPN
	Input impedance	R_{in} = 2 kohm
Digital output(DO)	As outputs	
	Type	Transistor output PNP
	Max. switching voltage	30 V DC
	Max. switching current	60 mA / 30 V DC, short-circuit protected
Relay output (RA, RB, RC))	Type	1 form C (NO + NC)
	Max. switching voltage	250 V AC / 30 V DC
	Max. switching current	2 A
Frequency input (FI)	10 Hz…16 kHz DI3 and DI4 can be used as digital or frequency inputs.	
STO interface (SGND, S+, S1, S2)	Refer to *The Safe torque off function (page 99)*	

Efficiency

Approximately 98% at nominal power level.

Degrees of protection

Degree of protection (IEC/EN 60529)	IP20 (cabinet installation): Standard enclosure. The drive must be installed in a cabinet to fulfill the requirements for shielding from contact.
Enclosure types (UL 61800-5-1)	UL Open Type. For indoor use only.
Overvoltage category (IEC 60664-1)	III
Protective classes (IEC/EN 61800-5-1)	I

Ambient conditions

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

Requirement	**Operation installed for stationary use**	**Storage in the protective package**	**Transportation in the protective package**
Installation site altitude	0 … 1000 m above sea level without derating. 1000 … 2000 m above sea level with derating.	-	-

Requirement	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
Surrounding air temperature at heavy duty rating	For frame size R0: -10 … +50 °C (14 …1122 °F) without derating. Temperature above 50 °C not allowed. For frame size R1: -10 … +50 °C (14 … 122 °F) without derating. 50 … 60 °C (122 … 140 °F) with derating. No frost allowed.	-40 … +70 °C (-40 … 158 °F)	-40 … +70 °C (-40 … 158 °F)
Surrounding air temperature at light duty rating	For frame size R0: -10 … +40 °C (14 …104 °F) without derating. +40 … +50 °C (104 …122°F) with derating. For frame size R1: -10 … +40 °C (14 …104 °F) without derating. +40 … +60 °C (104 …140°F) with derating. No frost allowed.		
Relative humidity	<95% (IEC 60068-2-78) without condensation		
Contamination levels (IEC 60721-3-3)	Class 3C2	Class 1C2	Class 2C2
	Class 3S2	Class 1S2	Class 2S2
Sinusoidal vibration (IEC 61800-5-1 to comply with EN 50178)	Class 3M4	-	-
Shock (EN 60068-2-31 to comply with EN 50178)	Not allowed	According to ISTA 1A. Max. 100 m/s2 (330 ft/s2), 11 ms.	According to ISTA 1A. Max. 100 m/s2 (330 ft/s2), 11 ms.
Free fall	Not allowed	76 cm (30 in)	76 cm (30 in)

Materials

Drive enclosure	Hot-dip zinc coated steel sheet 1.5 mm, thickness of coating 20 micrometers. Die casting and extruded aluminum AlSi. PC/ABS 2...3 mm, PC+10%GF 2.5…3 mm, all in color NCS 1502-Y (RAL 9002 / PMS 420 C).
Package	Corrugated cardboard

Disposal

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

Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and large electrolytic capacitors need

selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code.

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

Applicable standards

The drive complies with the following standards:

EN ISO 13849-1:2015	Safety of machinery – Safety related parts of the control systems – Part 1: general principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of the control systems – Part 2: Validation
EN 60204-1:2006 + A1:2009 + AC:2010	Safety of machinery. Electrical equipment of machines. Part 1: General requirements. Provisions for compliance: The final assembler of the machine is responsible for installing •an emergency-stop device •a supply disconnecting device
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 61800-3:2004 + A1:2012 IEC61800-3:2017	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
EN 61800-5-1:2007 IEC61800-5-1:2007+AMD1:2016	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy
ANSI/UL 61800-5-1:2018	UL Standard for adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy
CSA C22.2 No. 274-17	Adjustable speed drives

Markings

CE	CE mark Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).
TÜV NORD Safety Approved	TÜV Safety Approved mark (functional safety) Product contains Safe Torque Off and possibly other (optional) safety functions which are certified by TÜV according to the relevant functional safety standards. Applicable to drives and inverters; not applicable to supply, brake or DC/DC converter units or modules.
c UL us LISTED	UL Listed mark for USA and Canada Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories. Valid with rated voltages up to 600 V.
	Electronic Information Products (EIP) green mark The product complies with *the People's Republic of China Electronic Industry Standard* (SJ/T 11364-2014). The product does not contain toxic and hazardous substances or elements above the maximum concentration values, and it is an environmentally-friendly product which can be recycled.

WEEE mark

At the end of life the product should enter the recycling system at an appropriate collection point and not placed in the normal waste stream.

Compliance with EN 61800-3

Definitions

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

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

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

Drive of category C1: drive of rated voltage less than 1000 V and intended for use in the first environment.

Drive of category C2: drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment.

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

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

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

Category C2

This is applicable to ACS180-04S-...-1 drives with an internal EMC C2 filter.

The drive complies with the standard with the following provisions:

1. The motor and control cables are selected as specified in this manual.
2. The drive is installed according to the instructions given in this manual.
3. The maximum motor cable length specification has not been exceeded.

This product can cause radio-frequency inference. In a residential or domestic environment, supplementary mitigation measures may be required in addition to the requirements listed above for the CE compliance.

WARNING!
You can install a drive with the internal EMC filter connected only on a symmetrically grounded TN-S system.

Category C3

This is applicable to ACS180-04S-...-4 drives with an internal EMC C3 filter.

The drive complies with the standard with the following provisions:

1. The motor and control cables are selected as specified in this manual.
2. The drive is installed according to the instructions given in this manual.
3. The maximum motor cable length specification has not been exceeded.

WARNING!
To prevent radio-frequency interference, do not use a category C3 drive on a low-voltage public network which supplies domestic premises.

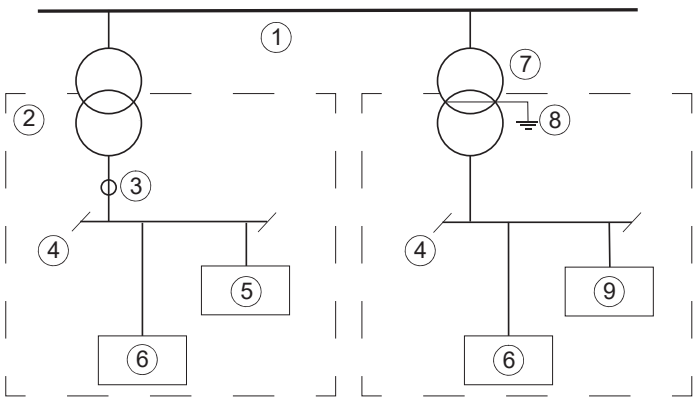
WARNING!
You can install a drive with the internal EMC filter connected only on a symmetrically grounded TN-S system.

Category C4

This is applicable to ACS180-04N-...-1/4 drives.

If the provisions in Category C2 or C3 are not met, the requirements of the standard can be met as follows:

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



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 motor and control cables are selected as specified in this manual.
4. The drive is installed according to the instructions given in this manual.

WARNING!
To prevent radio-frequency interference, do not use a category C4 drive on a low-voltage public network which supplies domestic premises.

WARNING!
You can install a drive with the internal EMC filter connected only on a symmetrically grounded TN-S system.

UL checklist

WARNING!
Operation of this drive requires detailed installation and operation instructions provided in the hardware and software manuals. The manuals are provided in electronic format in the drive package or on the Internet. Keep the manuals with the drive at all times. Hard copies of the manuals can be ordered through the manufacturer.

- Make sure that the drive type designation label includes the applicable marking.
- **DANGER - Risk of electric shock.** After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
- The drive is to be used in a heated, indoor controlled environment. The drive must be installed in clean air according to the enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust.
- The maximum surrounding air temperature is 50 °C at rated output current.
- The drive is suitable for use in a circuit capable of delivering not more than 100000 rms symmetrical amperes, 480 V maximum (480 V drive types) or 240 V maximum (240 V drive types) when protected by the UL fuses given elsewhere in this chapter. The ampere rating is based on tests done according to the appropriate UL standard.
- The cables located within the motor circuit must be rated for at least 75 °C in UL-compliant installations.
- The input cable must be protected with UL-rated fuses listed in this manual. The fuses provide branch circuit protection in accordance with the National Electrical Code (NEC). Obey also any other applicable local or provincial codes.

WARNING!
The opening of the branch-circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the device should be examined and replaced if damaged.

- The drive provides motor overload protection. For adjustments, see the firmware manual.
- To maintain the environment integrity of the enclosure, replace the cable grommets with field-installed industrial conduit hubs or closure plates required by the enclosure type (or better).

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. Refer to *The Safe torque off function (page 99)*.

Disclaimers

Generic disclaimer

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

Cybersecurity disclaimer

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

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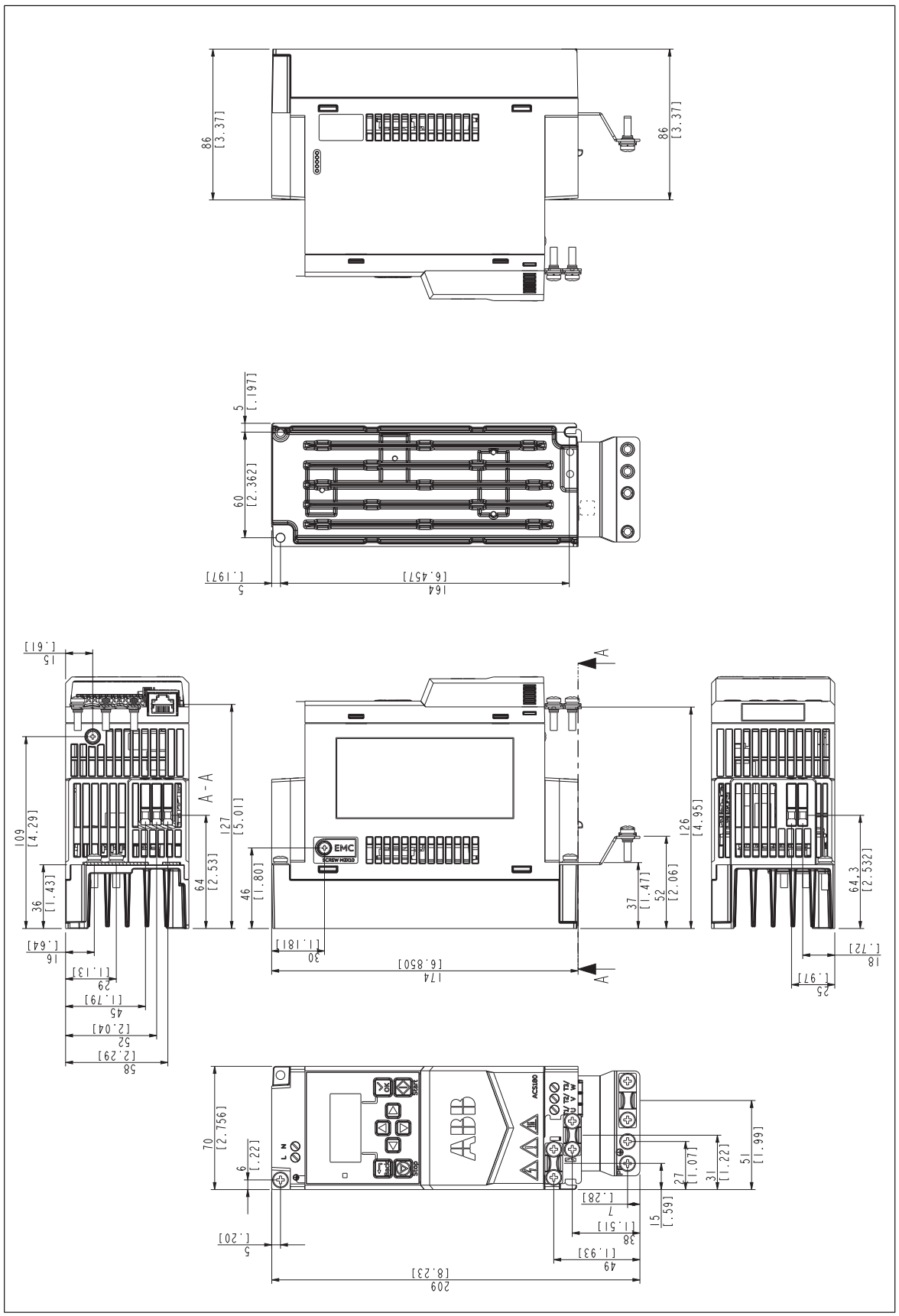
Dimension drawings

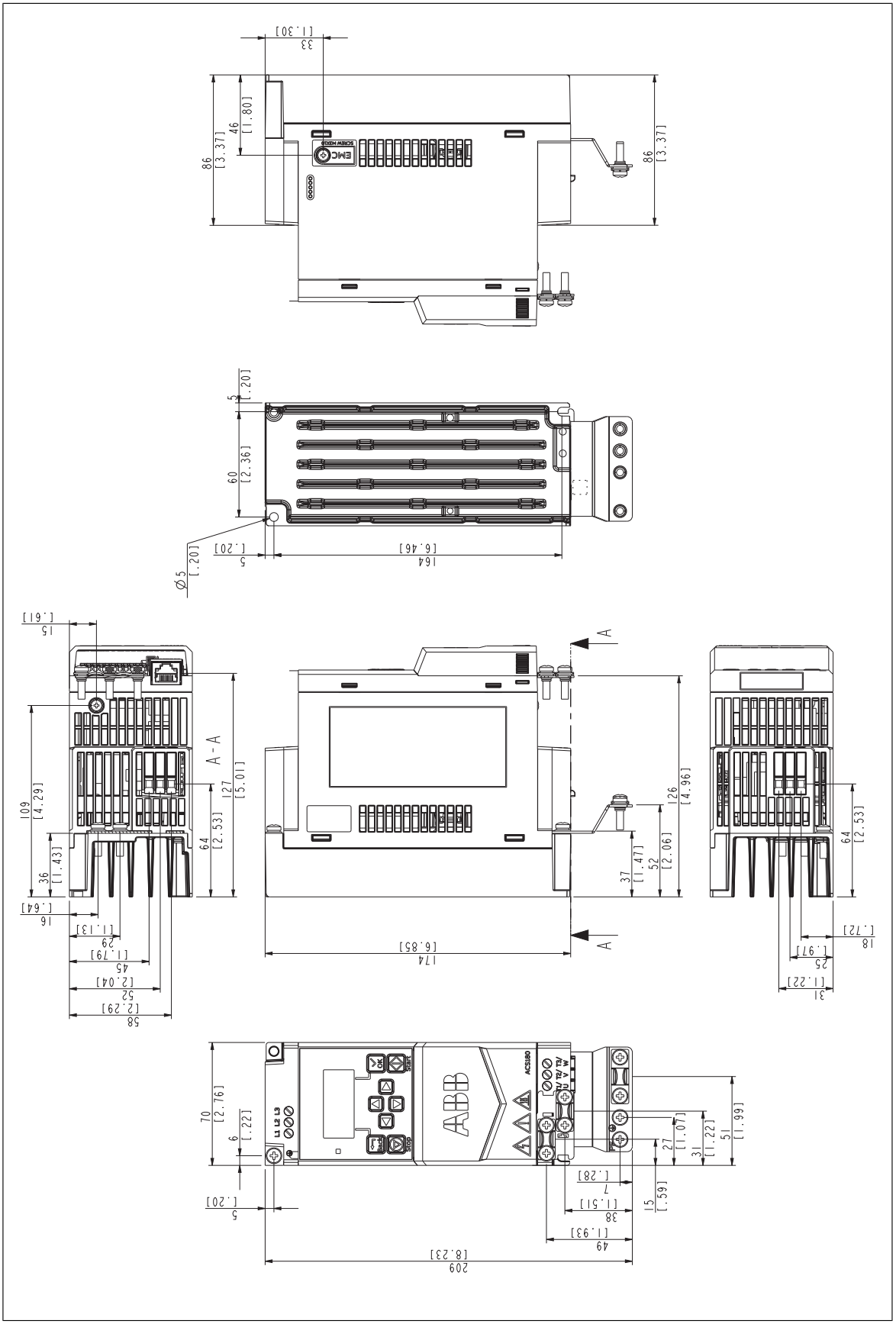
Contents of this chapter

The chapter contains the dimension drawings of the drive. The dimensions are in millimeters and inches.

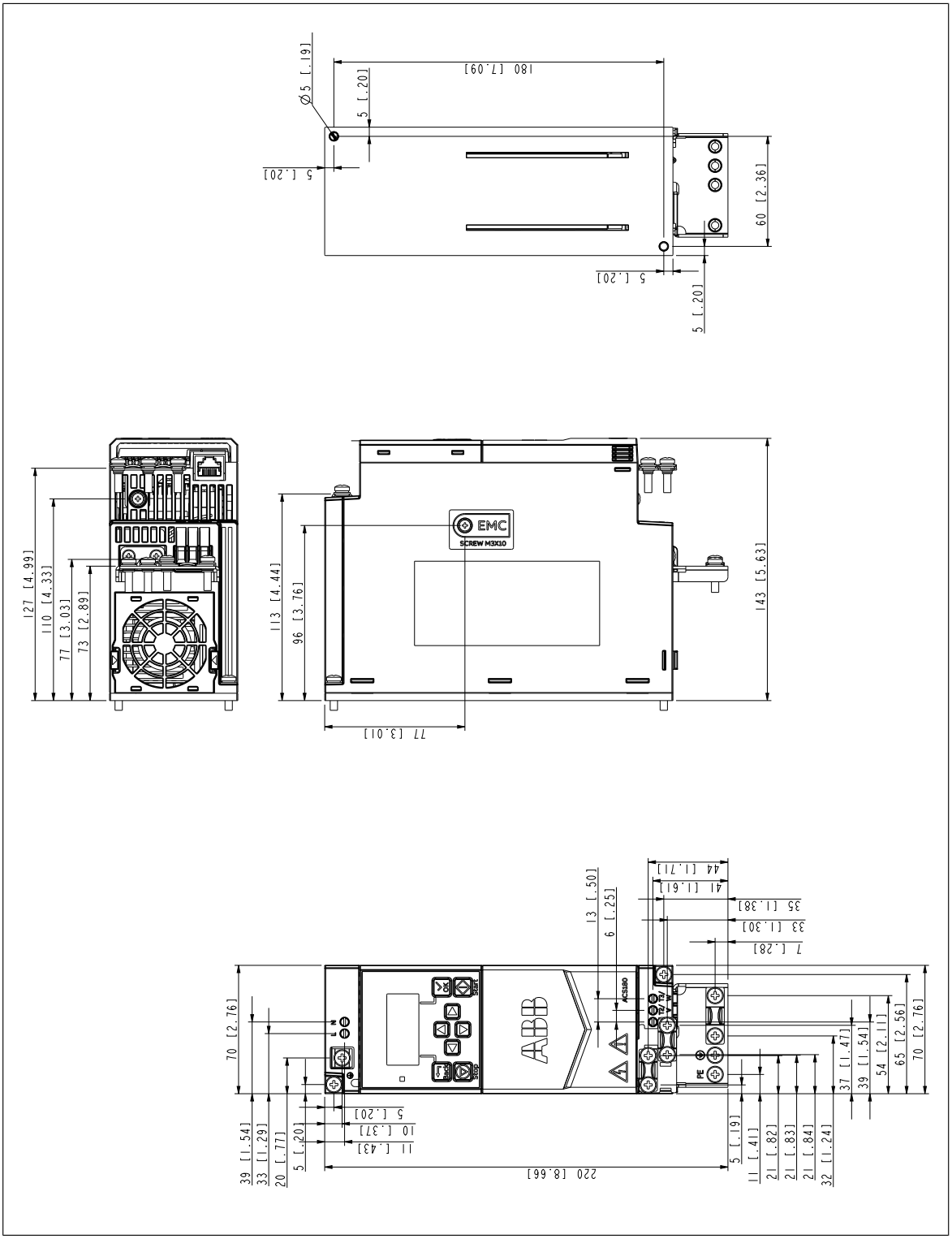
Frame R0 (230 V)



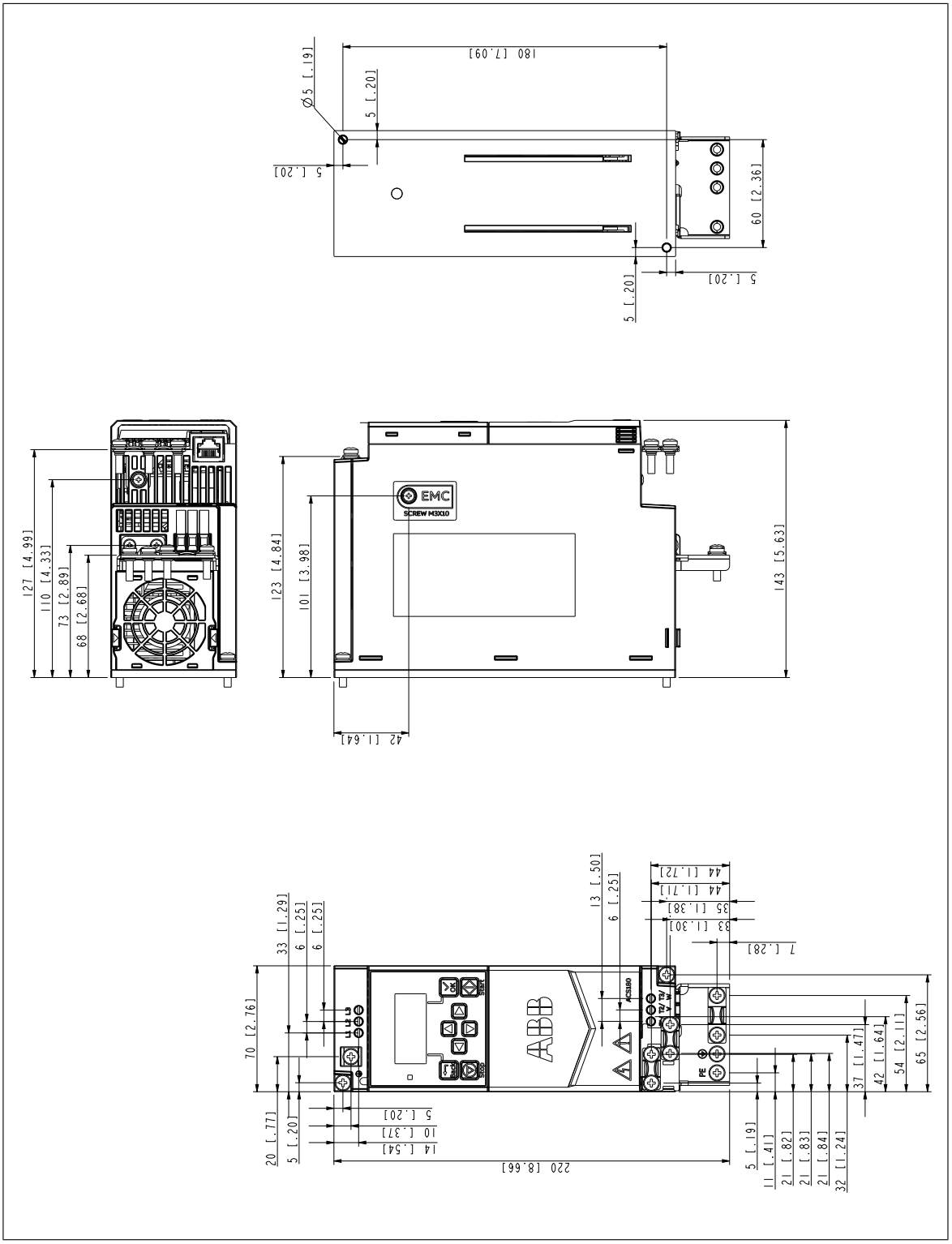
Frame R0 (400 V)



Frame R1 (230 V)



Frame R1 (400 V)



11

The Safe torque off function

Contents of this chapter

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

Description

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

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

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

The Safe torque off function complies with these standards:

Standard	**Name**
IEC 60204-1:2016 EN 60204-1:2018	*Safety of machinery – Electrical equipment of machines – Part 1: General requirements*
IEC 61000-6-7:2014	*Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

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

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

Compliance with the European Machinery Directive

See the technical data.

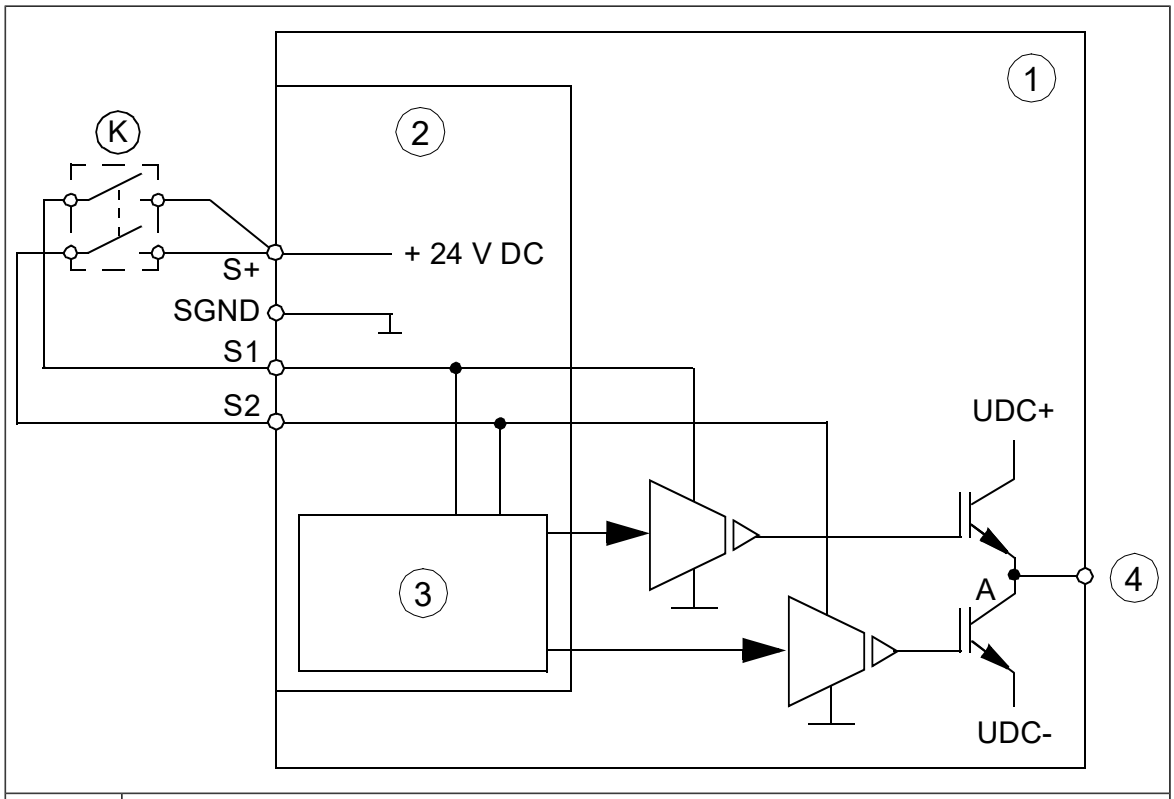
The Declaration of conformity is shown at the end of this chapter.

Wiring

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

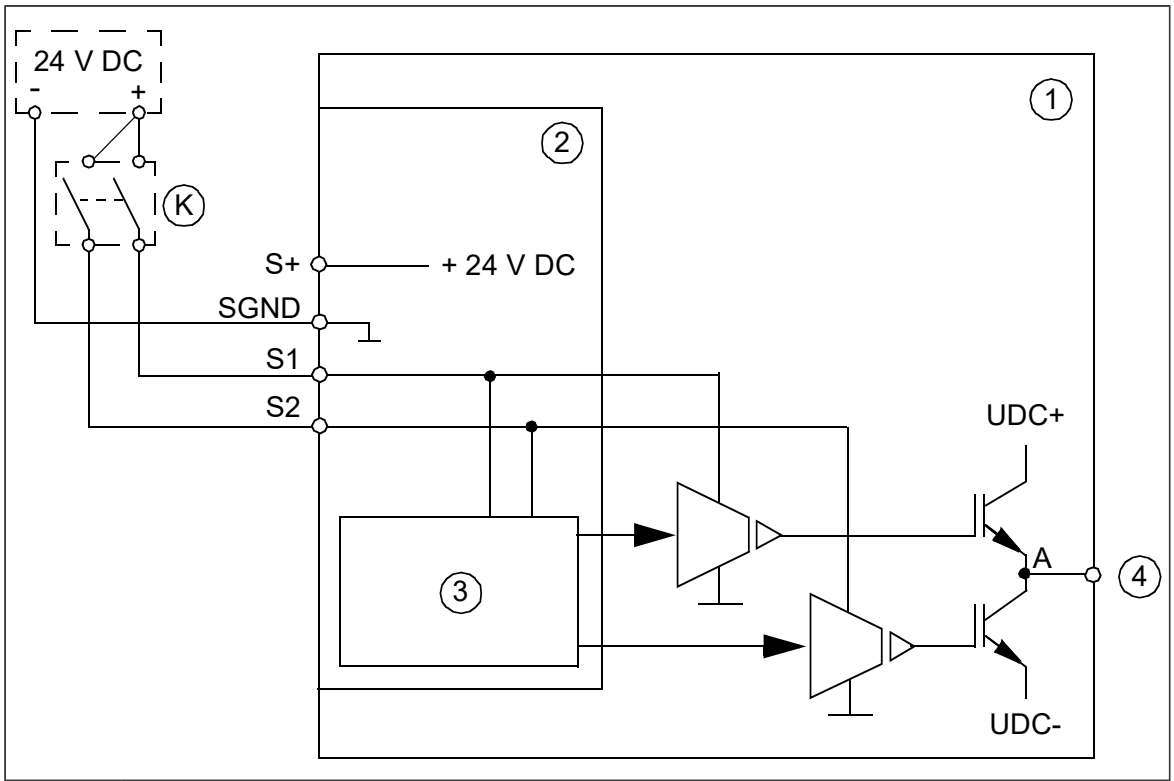
Connection principle

Single ACS180 drive, internal power supply



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

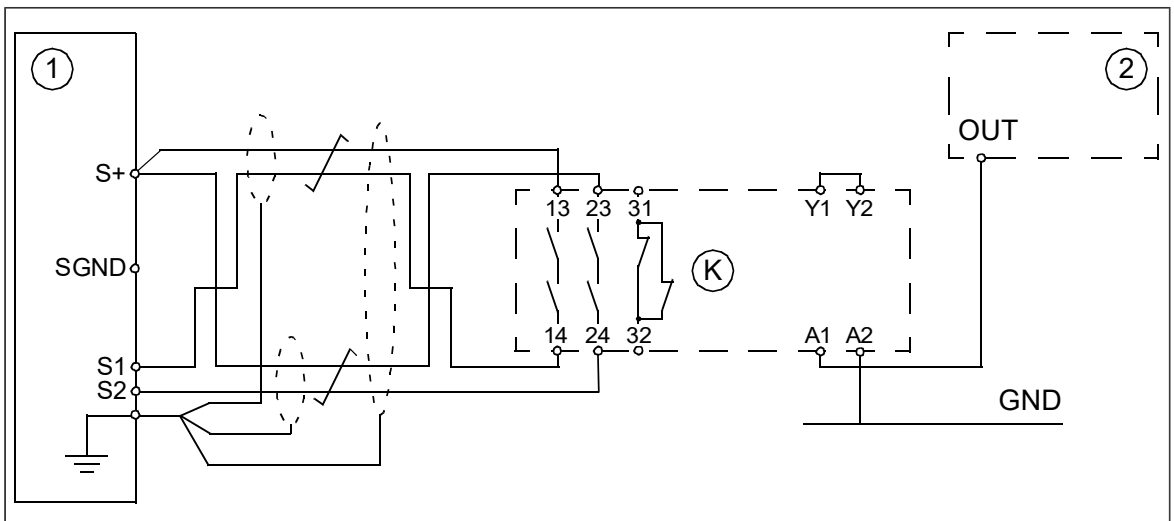
Single ACS180 drive, external power supply



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

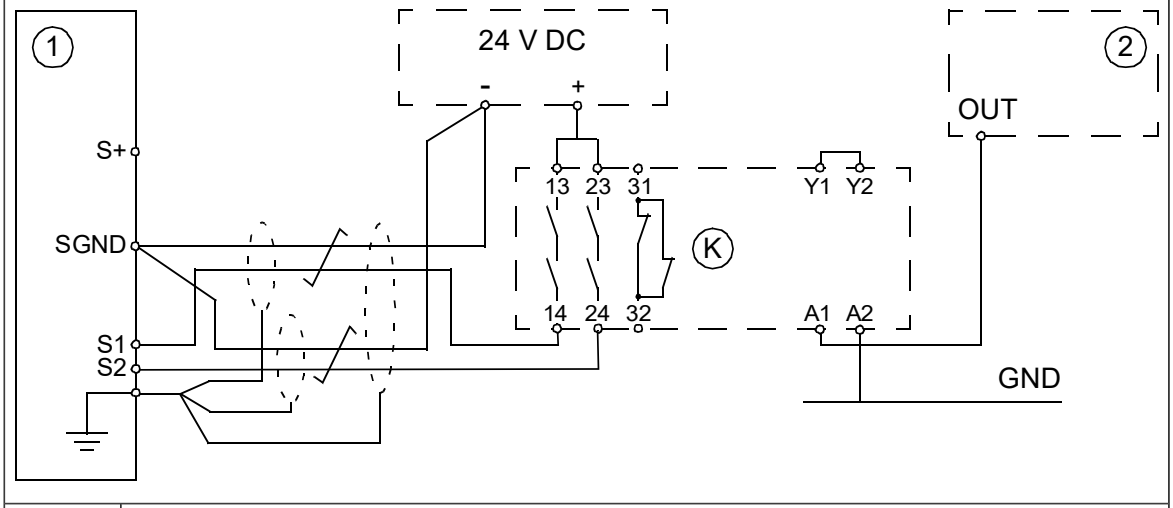
Wiring examples

Single ACS180 drive, internal power supply



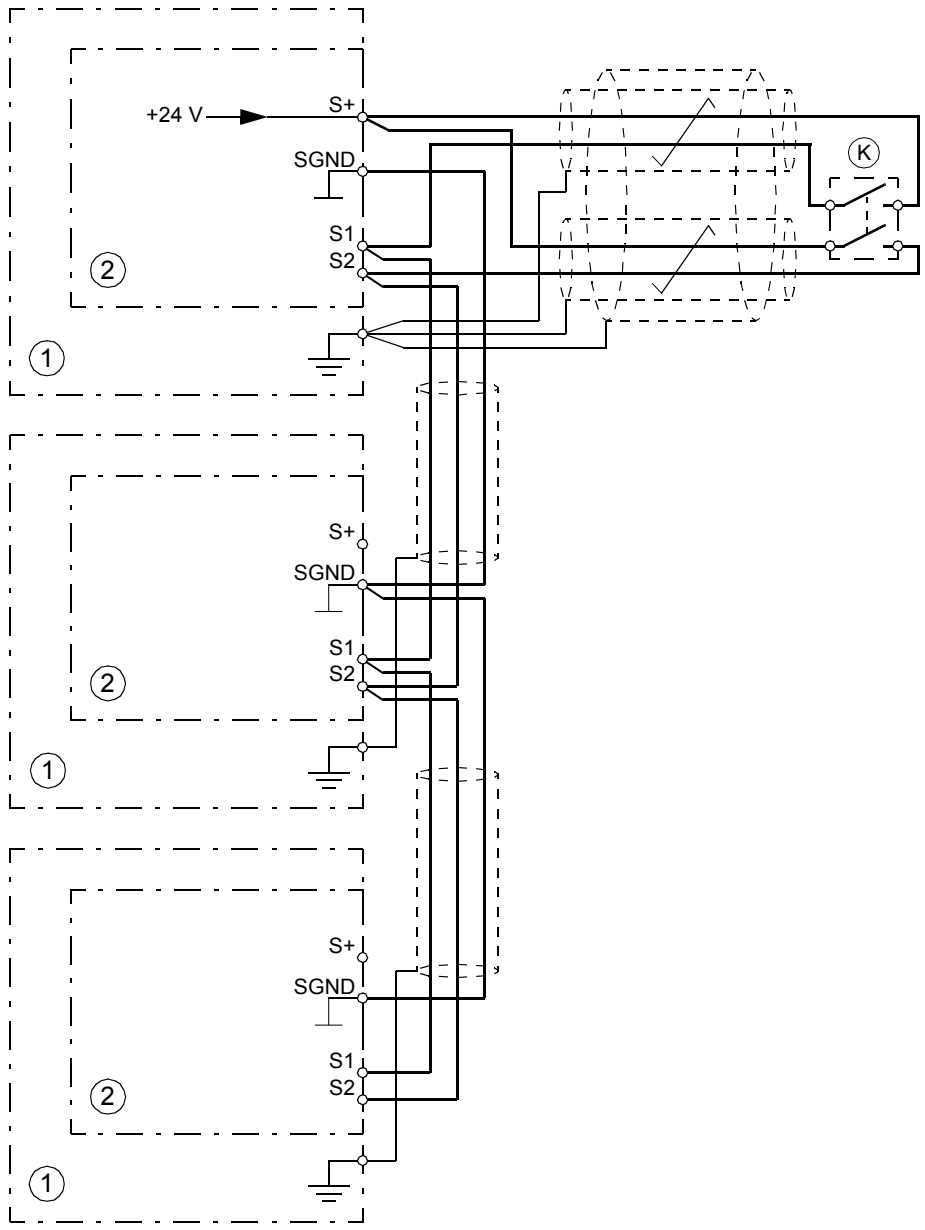
1	Drive
2	Safety PLC
K	Safety relay

Single ACS180 drive, external power supply



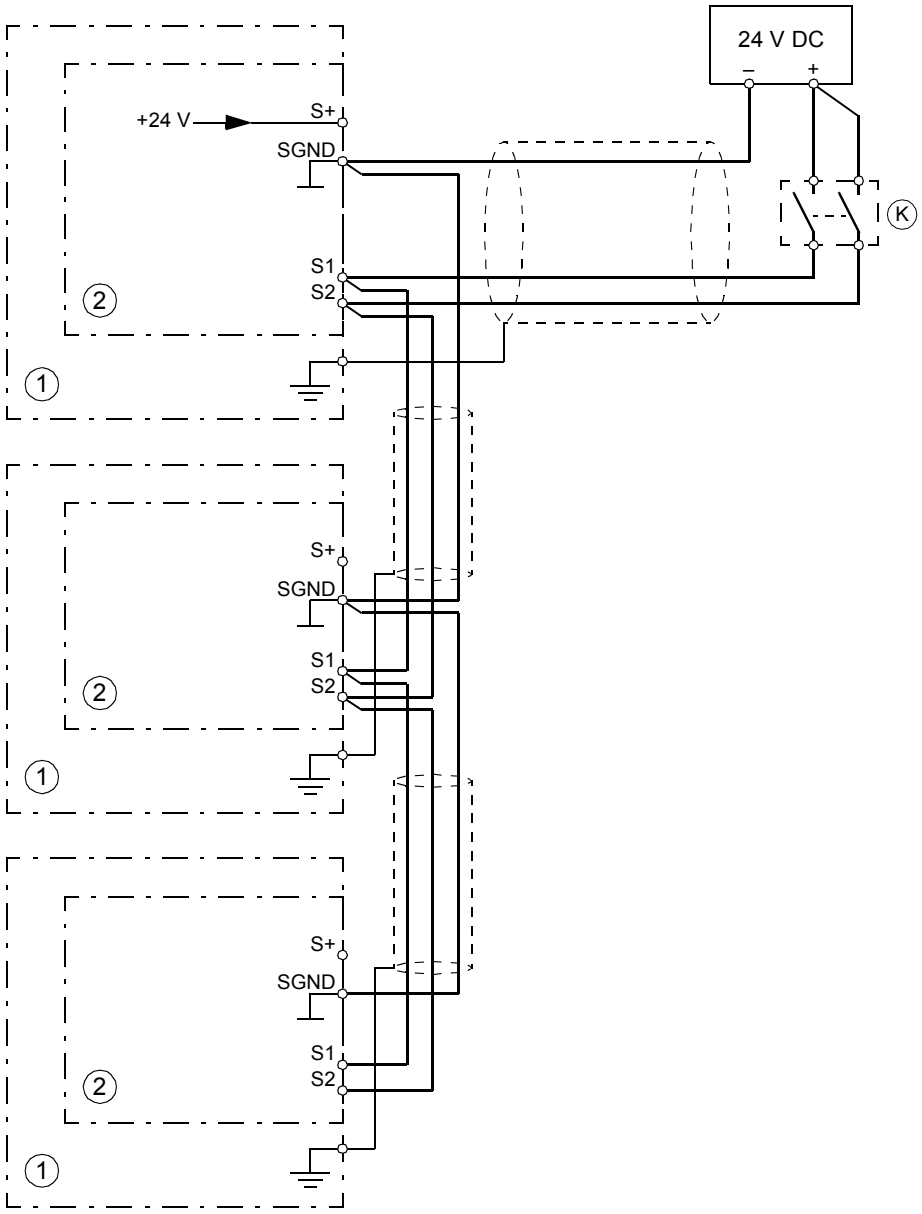
1	Drive
2	Safety PLC
K	Safety relay

Multiple ACS180 drives, internal power supply



1	Drive
2	Control unit
K	Activation switch

Multiple ACS180 drives, external power supply



1	Drive
2	Control unit
K	Activation switch

Activation switch

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

- In case a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.
- The contacts of the switch or relay must open/close within 200 ms of each other.

Cable types and lengths

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

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

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

The pulse tolerance of the input channels is 1 ms.

Grounding of protective shields

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

Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety relay contacts open).
2. The STO inputs of the drive control unit de-energize.
3. The control unit cuts off the control voltage from the output IGBTs.
4. The control program generates an indication as defined by parameter *31.22* (see the firmware manual of the drive.

   The parameter selects which indications are given when one or both STO signals are switched off or lost. The indications also depend on whether the drive is running or stopped when this occurs.

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

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

Start-up including validation test

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

- 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
- after a drive firmware update.

Competence

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

Validation test reports

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

Validation test procedure

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

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Make sure that the drive can be run and stopped freely during start-up.	☐
Stop the drive (if running), switch the input power off and isolate the drive from the power line using a disconnector.	☐
Check the STO circuit connections against the wiring diagram.	☐
Close the disconnector and switch the power on.	☐
Test the operation of the STO function when the motor is stopped. •Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Make sure that the drive operates as follows: •Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter *31.22* (see the firmware manual). •Give a start command to verify that the STO function blocks the drive's operation. The drive generates a warning. The motor should not start. •Close the STO circuit. •Reset any active faults. Restart the drive and check that the motor runs normally.	☐

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

Use

1. Open the activation switch, or activate the safety functionality that is wired to the STO connection.
2. The STO inputs on the drive control unit de-energize, and the control unit cuts off the control voltage from the output IGBTs.
3. The control program generates an indication as defined by parameter *31.22* (see the firmware manual of the drive).
4. The motor coasts to a stop (if running). The drive will not restart while the activation switch or safety relay contacts are open.
5. Deactivate the STO by closing the activation switch, or resetting the safety functionality that is wired to the STO connection.
6. Reset any faults before restarting.

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

WARNING!
The drive cannot detect or memorize any changes in the STO circuitry when the drive control unit is not powered. If both STO circuits are closed and a level-type start signal is active when the power is restored, it is possible that the drive starts without a fresh start command. Take this into account in the risk assessment of the system.

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

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

Notes:

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

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 5 or 2 years; see section *Safety data (page 113)*. It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the *Validation test procedure (page 108)*.

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

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

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

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

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

If any wiring or component change is needed after start up, or the parameters are restored, do the test given in section *Validation test procedure (page 108)*.

Use only spare parts approved by ABB.

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

Competence

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

Fault tracing

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

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

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

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

Safety data

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

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

Frame size	SIL/ SILCL	PL	SFF (%)	PFH (T_1 = 20 a) (1/h)	PFD_{avg} (T_1 = 2 a)	PFD_{avg} (T_1 = 5 a)	$MTTF_D$ (a)	DC (%)	Cat.	SC	HFT	CCF	T_M (a)
1-phase U_N = 200…240 V													
R0	3	e	>90	2.33E-09	2.05E-05	5.12E-05	2092	≥90	3	3	1	80	20
R1	3	e	>90	1.76E-09	1.55E-05	3.86E-05	2109	≥90	3	3	1	80	20
3-phase U_N = 380…480 V													
R0	3	e	>90	2.33E-09	2.05E-05	5.12E-05	2092	≥90	3	3	1	80	20
R1	3	e	>90	1.76E-09	1.55E-05	3.86E-05	2109	≥90	3	3	1	80	20
3AXD10000802392 C													

- 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 A safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested
  - A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO response times:
  - STO reaction time (shortest detectable break): 1 ms
  - STO response time: 5 ms (typical), 10 ms (maximum)
  - Fault detection time: Channels in different states for longer than 200 ms
  - Fault reaction time: Fault detection time + 10 ms
- Indication delays:
  - STO fault indication (parameter *31.22*) delay: < 500 ms
  - STO warning indication (parameter *31.22*) delay: < 1000 ms

Abbreviations

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

TÜV certificate

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

Declaration of conformity

EU Declaration of Conformity

Machinery Directive 2006/42/EC

We
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Declare under our sole responsibility that the following products:

Frequency converters

ACS180-04x-xxAx-1 (Frame R0, 1ph 200-240Vac)

ACS180-04x-xxAx-4 (Frame R0, 3ph 380-480Vac)

ACS180-04x-xxAx-1 (Frame R1, 1ph 200-240Vac)

ACS180-04x-xxAx-4 (Frame R1, 3ph 380-480Vac)

with regard to the safety function

Safe torque-off

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

The following harmonized standards have been applied:

EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems. Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of the control systems. Part 2: Validation
EN 60204-1:2006 + A1:2009 + AC:2010	Safety of machinery – Electrical equipment of machines – Part 1: General requirements

The following other standards have been applied:

IEC 61508:2010, parts 1-2	Functional safety of electrical / electronic / programmable electronic safety-related systems
IEC 61800-5-2:2016	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional

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The products referred in this Declaration of conformity fulfil the relevant provisions of other European Union Directives which are notified in Single EU Declaration of conformity 3AXD10001186568.

Person authorized to compile the technical file (3AXD10001117588):

Name and address: Jussi Vesti, Hiomotie 13, 00380 Helsinki, Finland

Beijing, 19 August 2020

Signed for and on behalf of:

Petri Sullstrom
Local Business Line Manager
ABB Beijing Drive Systems Co., Ltd.

XuMing Wang
Product Engineering manager
ABB Beijing Drive Systems Co., Ltd.

Further information

Product and service inquiries

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

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