ABB DRIVES FOR WATER

ACQ80-04 drives

Hardware manual

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Hardware manual

3AXD50000170661 Rev C
EN
Original instructions
EFFECTIVE: 2024-06-25

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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 show a particular condition or fact, or give information.

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 persons 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.
- Use a lifting device to lift a heavy drive. Use the designated lifting points. Refer to the dimension drawings.
- Be careful when handling a tall module. The module overturns easily because it is heavy and has a high center of gravity. Whenever possible, secure the module with chains. Do not leave an unsupported module unattended especially on a sloping floor.

- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, and brake resistors, can be hot for a period after operation.
- Before the start-up, vacuum clean the area around the drive to prevent the drive cooling fan from drawing dust inside the drive.
- Make sure that debris from drilling, cutting and grinding does not go into the drive during installation. Electrically conductive debris inside the drive can cause damage or malfunction.
- Make sure that there is sufficient cooling. Refer to 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 break in the power supply. If these functions are activated, the installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors.
- If the drive has connected safety circuits (for example, Safe torque off or emergency stop), validate them at start-up. Refer to separate instructions for the safety circuits.
- Beware of hot air flow from the cooling outlets.
- Do not cover the air inlet or air outlet when the drive operates.

Note:

- If you select an external source for the start command and it is on, the drive starts immediately after a fault reset unless you configure the drive for pulse start. Refer to 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 permitted to repair a faulty drive.

Electrical safety in installation, start-up and maintenance

Electrical safety precautions

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

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

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

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

1. Prepare for the work.
   - Make sure that you have a work order.
   - Do an on-site risk assessment or job hazard analysis.
   - Make sure that you have the correct tools available.
   - Make sure that the workers are qualified.
   - Select the correct personal protective equipment (PPE).
   - Stop the drive and motor(s).
2. Clearly identify the work location and equipment.
3. Disconnect all possible voltage sources. Make sure that connection is not possible. Lock out and tag out.
   - Open the main disconnecting device of the drive.
   - If a permanent magnet motor connects to the drive, disconnect the motor from the drive with a safety switch or by other means.
   - Open the main isolating device of the drive.
   - Disconnect all dangerous external voltages from the control circuits.
   - After you disconnect power from the drive, wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
4. Protect other energized parts in the work location against contact and take special precautions when close to bare conductors.
5. Measure that the installation is de-energized. Use a quality voltage tester.
   - Before and after you measure 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 (U, V, 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.

Note: If cables are not connected to the drive DC terminals, measuring the voltage from the DC terminal screws can give incorrect results.

6. Install temporary grounding as required by the local regulations.
7. Ask for a permit to work from the person that is responsible for the electrical installation work.

Additional instructions and notes

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

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

- 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, do not go near the area near motor, drive, and the drive power cabling when the drive is in operation. The equipment produces electromagnetic fields that can cause interference in electronic medical devices. This can cause a health hazard.

Note:

- When the drive is connected to the input power, the motor cable terminals and the DC bus are at a dangerous voltage.
  After you disconnect the drive from the input power, these remain at a dangerous voltage until the intermediate circuit capacitors discharge.
- 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 ESD wristband when you handle printed circuit boards. Do not touch the boards unnecessarily. The boards are sensitive to electrostatic discharge.

Grounding

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

General safety in operation

These instructions are for all persons 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, do not go near the area near motor, drive, and the drive power cabling when the drive is in operation. The equipment produces electromagnetic fields that can cause interference in electronic medical 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 starts immediately after the fault reset, unless you configure the drive for pulse start. Refer to 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 break in the power supply. If these functions are activated, the installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".

Note:

- 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 for 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 such as belt, nip, rope, etc.
- Do the steps in section Electrical safety precautions (page 16).
- Install temporary grounding to the drive output terminals (T1/U, T2/V, T3/W). Connect the output terminals together as well as to the PE.

During the start-up:

- Make sure that the motor cannot run at overspeed, for example, when it is driven by the load. Motor overspeed causes an overvoltage that can cause damage to the capacitors in the intermediate circuit of the drive.

Safety in operation

WARNING!
Make sure that the motor cannot run at overspeed, for example, when it is driven by the load. Motor overspeed causes an overvoltage that can cause damage to the capacitors in the intermediate circuit of the drive.

2

Introduction to the manual

Contents of this chapter

The chapter describes 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 ACQ80-04 drives.

Target audience

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

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

Categorization by frame size

The drives are manufactured in frame sizes (for example, R1). The information that is applicable only to specific frames is identified 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: R1, R2, etc.	Type designation key (page 35)
⬇	
Plan the installation. Check the ambient conditions, ratings and required cooling air flow.	Guidelines for planning the electrical installation (page 41) Technical data (page 87)
⬇	
Unpack and check the delivery.	Unpacking the delivery (page 38)
⬇	
If the supply network is not a symmetrically grounded TN-S system, make sure that the drive is compatible with the grounding system.	Grounding system compatibility check – IEC (page 61)
⬇	
Install the drive.	Installing the drive (page 39)
⬇	
Route the cables.	Routing the cables (page 51)
⬇	
Measure the insulation of the input cable, motor and motor cable.	Measuring the insulation resistance - IEC (page 60)
⬇	
Connect the power cables.	Connecting the power cables – IEC (shielded cables) (page 65)
⬇	
Connect the control cables.	Connecting the control cables - IEC (page 67)
⬇	
Examine the installation.	Installation checklist of the drive (page 75)
⬇	
Commission the drive.	Refer to *ACQ80-04 drives Quick installation and start-up guide* (3AXD50000701247 [English]) and *ACQ80-04 Firmware manual* (3AXD50000170654 [English]).

Terms and abbreviations

Term	Description
ACS-AP-…	Assistant control panel
BCBL-01	Optional USB to RJ45 cable
BIO-01	Optional I/O extension module. Can be installed to the drive together with a fieldbus adapter module.
CCA-01	Configuration adapter
CDPI-01	Communication adapter module
Drive	Frequency converter for controlling AC motors
EFB	Embedded fieldbus
EMC	Electromagnetic compatibility
FBA	Fieldbus adapter
FCAN	Optional CANopen® adapter module
FCNA-01	Optional ControlNet™ adapter module
FDNA-01	Optional DeviceNet™ adapter module
FECA-01	Optional EtherCAT® adapter module
FEIP-21	Optional Ethernet adapter module for EtherNet/IP™
FENA-21	Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
FEPL-02	Optional Ethernet POWERLINK adapter module
FMBT-21	Optional Ethernet adapter module for Modbus TCP protocol
FPBA-01	Optional PROFIBUS DP® adapter module
FPNO-21	Optional PROFINET IO adapter module
Frame, frame size	Physical size of the drive or power module
Intermediate circuit	DC circuit between rectifier and inverter
Inverter	Converts direct current and voltage to alternating current and voltage.
Macro	A pre-defined set of default values of parameters in a drive control program.
MOV	Metal Oxide Varistor. A protection component used in power supply circuits.
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. For example, variable, constant, or signal.
PLC	Programmable logic controller
PV	Parameter value *Photovoltaic*
RFI	Radio-frequency interference
RIIO-01	I/O & EIA-485 module
SIL	Safety integrity level (1…3) (IEC 61508, IEC 62061, IEC 61800-5-2)

Term	Description
STO	Safe torque off (IEC/EN 61800-5-2)
VOC	Open circuit voltage. Maximum voltage available from a solar cell.

Related manuals

Manual	Code (English)
Drive hardware manuals and guides	
ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual	3AUA0000085685
Option manuals and guides	
DPMP-01 mounting platform for ACS-AP control panel	3AUA0000100140
DPMP-04 and DPMP-05 mounting platforms for control panels installation guide	3AXD50000308484
FCAN-01 CANopen adapter module user's manual	3AFE68615500
FECA-01 EtherCAT adapter module user's manual	3AUA0000068940
FPBA-01 PROFIBUS DP adapter module user's manual	3AFE68573271
FSCA-01 RS-485 adapter module user's manual	3AUA0000109533
FMBT-21 Modbus/TCP Adapter Module User's Manual	3AXD50000158607
FEIP-21 EtherNet/IP fieldbus adapter module User's manual	3AXD50000158621
Tool and maintenance manuals and guides	
Drive Composer Start-up and maintenance PC tool user's manual	3AUA0000094606
Converter module capacitor reforming instructions	3BFE64059629

You can find manuals on the Internet. See below for the relevant code/link. For more documentation, go to www.abb.com/drives/documents.

ACQ80-04 manuals

See also,

- Video of ACQ80 solar pump drive.
- QR code on the drive. Scan the QR code to navigate to ABB Access web page and find up-to-date product online data.

3

Operation principle and hardware description

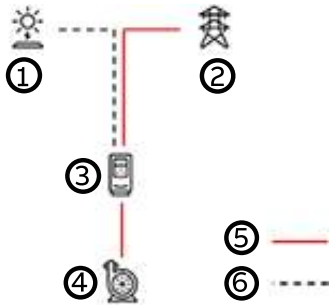
Contents of this chapter

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

Operation principle

The ACQ80-04 is a solar pump drive for controlling asynchronous AC induction motors and permanent magnet synchronous motors. The drive is optimized for cabinet installation.

Block diagram

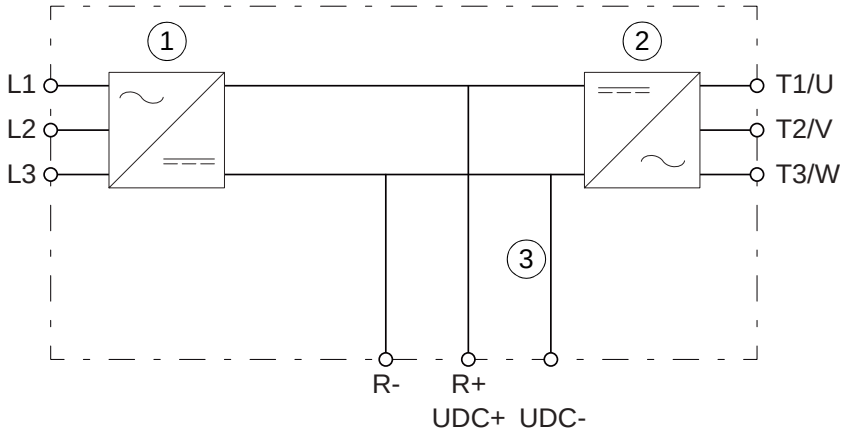


1	Solar panels. The panels provide DC power to the drive.

2	Grid power. The grid provides AC power to the drive. To get maximum water flow throughout the day and to reduce grid power consumption, both the grid and solar panel can be connected.
3	ACQ80 drive. The drive comes with built-in Maximum Power Point Tracking (MPPT) logic. The MPPT logic supports the drive to control the pump motor with variable DC power from the solar panels.
4	Pump motor. The motor is powered by ACQ80 drive.
5	AC power.
6	DC power.

Note: ACQ80 drive is intended to be used for speed control of three-phase AC pump motors and is powered from either AC grid or DC solar array or both AC and DC power together. ABB recommends not to use it as an island grid forming inverter or to supply generic single phase or three-phase loads, other than the three-phase AC pump motors.

Simplified main circuit diagram



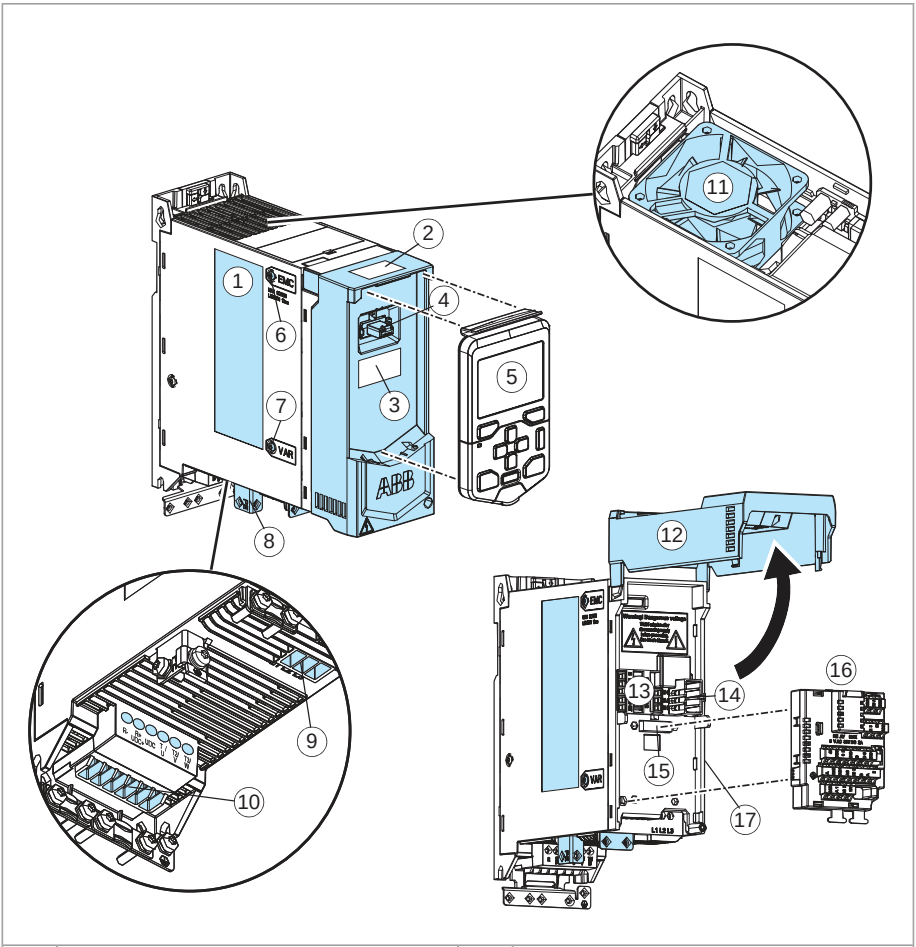
1	Rectifier. Converts alternating current and voltage to direct current and voltage.
2	Inverter. Converts direct current and voltage to alternating current and voltage.
3	DC connection (UDC+, UDC-).

Product variants

The drive has two product variants:

- Standard unit: drive with assistant control panel and RIIO-01 I/O & EIA-485 module
  For example, ACQ80-04-0kW75-4+J400+L540 where J400 indicates assistant control panel and +L450 indicates RIIO module.
- Base unit: drive without control panel and without RIIO-01 I/O & EIA-485 module (ACQ80-04-0KW75-4)
- Solar Pump Drive modules, IP20, 400V without control panel and with RIIO (ACQ80-04-0kW75-4+L540)
- Solar Pump Drive modules, IP20, 400V with Basic control panel and with RIIO (ACQ80-04-0kW75-4+J404+L540) J404 indicates basic control panel.

Layout



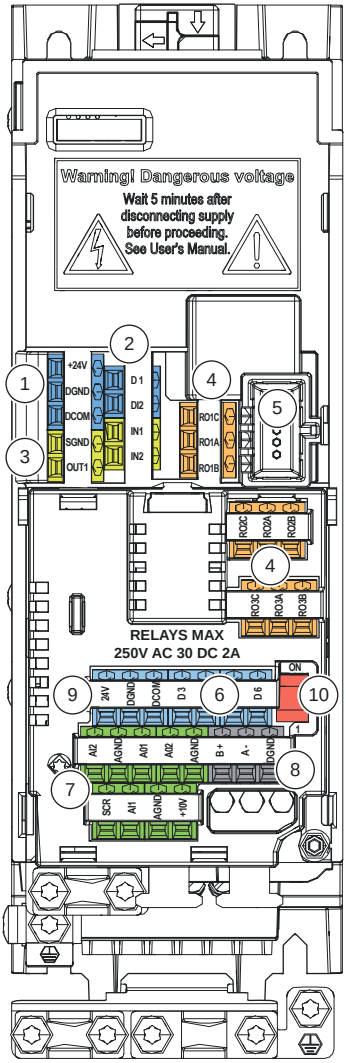
1	Type designation label	10	Motor terminals and DC input power terminals
2	Model information label	11	Cooling fan (on frames R0…R3)
3	Firmware information label	12	Front cover
4	Control panel connection	13	Control terminals
5	Control panel	14	Cold configuration adapter connection (CCA-01)
6	EMC filter grounding screw	15	Front option slot
7	Varistor grounding screw	16	Front option module

8	PE connection (motor)	17	Side option slot for side-mounted options. Not applicable for ACQ80.
9	AC input power terminal		

Control connections

There are fixed control connections on the base unit and additional control connections on the installed option module.

Standard unit (with RIIO-01)



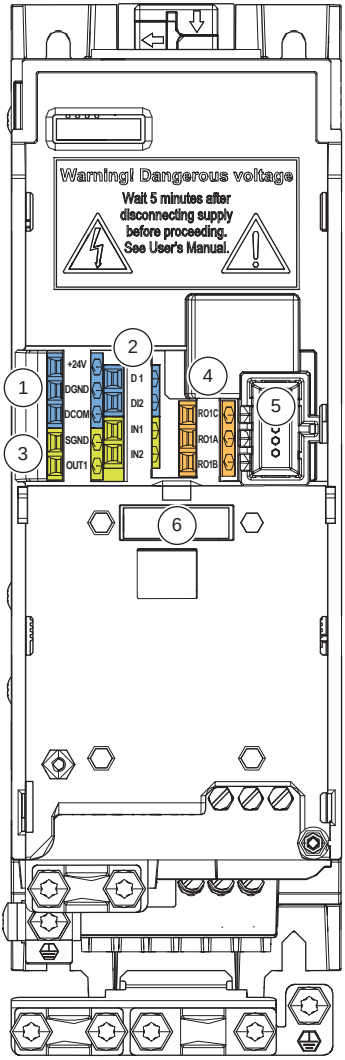
Connections of the base unit:

1. Auxiliary voltage output (24VDC 250mA peak)
2. Digital inputs
3. Safe torque-off connections
4. Relay output connections
5. Cold configuration adapter connection for CCA-01

Connections of the RIIO-01 I/O & EIA-485 module:

6. Digital inputs
7. Analog inputs, analog outputs and +10VDC reference voltage output
8. Embedded fieldbus EIA-485 (Modbus RTU)
9. Auxiliary voltage output
10. EIA-485 end of line termination switch

Base unit



Connections of the base unit:

1. Auxiliary voltage output (24VDC 250mA peak)
2. Digital inputs
3. Safe torque-off connections
4. Relay output connection
5. Cold configuration adapter connection for CCA-01
6. Front option module slot 1

Option modules

The drive supports optional extension modules on the front and on the right side. Refer to Type designation key (page 35).

Control panel options

The drive supports these control panels:

- ACS-AP-S assistant control panel
- ACS-AP-W assistant control panel with Bluetooth
- ACS-AP-I assistant control panel
- ACS-BP-S basic control panel
- RDUM-01 blank panel with RJ-45 connector

In addition, you can order a control panel platform for cabinet door installation. These panel platforms are available:

Type	Description
DPMP-04/-05	Control panel mounting platform (surface mounting) and cable

Drive labels

The drive has these labels:

- type designation label on the left side of the drive
- model information label on the top of the drive
- software information label under the control panel.

Example labels are shown in this section.

Type designation label

1	Type designation
2	Frame (size)
3	Degree of protection
4	Losses according to IEC 61800-9-2
5	Nominal ratings
6	Valid markings
7	S/N: Serial number of format MYYWWXXXXX, where M: Manufacturer YY: Year of manufacture: 19, 20, 21, … for 2019, 2020, 2021, … WW: Week of manufacture: 01, 02, 03, … for week 1, week 2, week 3, … XXXX: Running item number that starts each week from 0001.
8	QR code to product information page

Software information label

1	Drive type
2	Frame size and ratings
3	Serial number and drive software version

Type designation key

The type designation key shows the specifications and the configuration of the drive.

Basic code

Type code example: ACQ80-04-0kW75-4

Code	Description
ACQ80-04	Product series
04	Construction. 04 = Module When no options are selected: cabinet optimized module, IP20 (UL open type), assistant control panel, RIIO-01 I/O & EIA-485 module, EMC category C2 filter, Safe torque off, coated boards, quick installation and start-up guide.
0kW75	kW rating of drive. See the ratings table in the technical data.
4	Input voltage. • 4 = 3-phase 380 … 480 V AC

Option codes

Option codes are separated by plus signs. The table below gives the option codes.

Code	Description
Control panel and panel options	
J400	control panel
J404	ACS-BP-S basic control panel
J424	RDUM-01 blank cover with RJ45 connection, for remote mounting of the control panel
J429	ACS-AP-W control panel with Bluetooth
0J400	Without control panel
I/O options	
L515	BIO-01 I/O extension module (front option, can be used with fieldbus)
L540	RIIO-01 I/O & EIA-485 module (front option, as standard)

Code	Description
0L540	Base unit without RIIO-01 I/O & EIA-485 module
Fieldbus adapters	
K454	FPBA-01 PROFIBUS DP
K457	FCAN-01 CANopen
K458	FSCA-01 Modbus/RTU
K469	FECA-01 EtherCAT
K490	FEIP-21 Ethernet/IP
K491	FMBT-21 Modbus/TCP
Documentation [1)]	
R700	English

1) Manuals are available from ABB website in English language.

4

Mechanical installation

Contents of this chapter

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

Installation alternatives

You can install the drive:

- with screws on to a wall
- with screws on to an assembly plate
- on to a DIN installation rail (IEC/EN 60715, top hat type, width 35 mm [1.4 in] × height 7.5 mm [0.3 in]).

Installation requirements:

- The drive is designed for cabinet installation and has a degree of protection of IP20.
- Make sure that there is a minimum of 75 mm (3 in) of free space at the top and bottom of the drive (at the cooling air inlet and outlet), measured from the frame.
- You can install several drives side by side. Note that side-mounted options require 20 mm (0.8 in) of space on the right side of the drive.
- Do not install the drive upside down.
- Make sure that the hot exhaust air from a drive does not flow into the cooling inlet of other drives or equipment.

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. Refer to the technical data.
- The ambient conditions of the drive meet the specifications. Refer to the technical data.
- The material behind, above, and below the drive is non-flammable.
- There is sufficient free space around the drive for cooling, maintenance work, and operation. Refer to 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.
- The drive cabinet should be IP42 or IP54 and mounted below a solar array or in a closed room so that water never goes into or falls on the drive cabinet.
- A lightning pole is installed near the site (1–2 m [3–7 ft] from the solar structure). This is recommended even if the location is not prone to lightning. Make sure that the height of the lightning pole is more than the total height of the site structure.
- Use two separate earth pits. Use a dedicated earth pit for the lightning rod to ensure isolation from other earthing. Use the second pit for the drive, drive cabinet, pump motor and solar array.
- The length of the cable between the motor and drive is less than 300 m (985 ft). Use a motor choke for cable lengths between 300 m (985 ft) to 350 m (1150 ft). Use a sine filter for cable lengths of more than 350 m (1150 ft).

Required tools

To install the drive mechanically, you need these 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

Keep the drive in its package until you are ready to install it. After unpacking, protect the drive from dust, debris and moisture.

Make sure that these items are included:

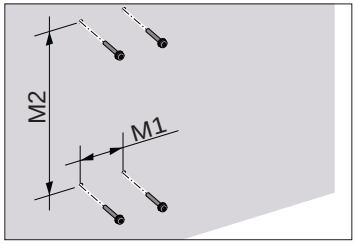
- drive
- options, if ordered with an option code
- mounting template (drives with frame size R3 only)
- installation accessories (cable clamps, cable ties, hardware)
- multilingual warning sticker sheet (residual voltage warning)
- safety instructions
- quick installation and start-up guide
- hardware and firmware manuals, if ordered with an option code.

Make sure that there are no signs of damage to the items.

Installing the drive

To install the drive with screws

1. Make marks onto the surface for the mounting holes. Use the included mounting template for frame R3. For other frames, see the dimension drawings.
2. Drill the holes for the mounting screws.
3. If necessary, install anchors or plugs into the holes.
4. Install the mounting screws into the holes. Leave a gap between the screw head and installation surface.

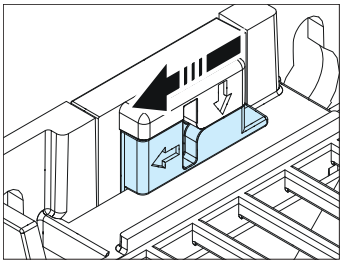


5. Put the drive onto the mounting screws.
6. Tighten the mounting screws.

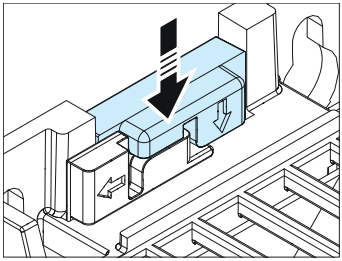
To install the drive to a DIN installation rail

Use an IEC/EN 60715 top hat type installation rail, width × height = 35 × 7.5 mm (1.4 × 0.3 in).

1. Move the locking part to the left.



2. Push and hold the locking button down.



3. Put the top tabs of the drive onto the top edge of the DIN installation rail.
4. Put the drive against the bottom edge of the DIN installation rail.
5. Release the locking button.
6. Move the locking part to the right.
7. Make sure that the drive is correctly installed.

To remove the drive, use a flat-head screwdriver to open the locking part.

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.

To comply with European Union directives and United Kingdom regulations related to standard EN 60204-1, the disconnecting device must be one of these types:

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

DC solar PV power supply

When you perform maintenance or wiring activities in the drive cabinet, make sure that:

- you disconnect the solar PV power supply at the string combiner box level
  or
- remove the solar PV connections before installing the drive cabinet
  or
- remove DC fuse inside the drive cabinet
  or
- switch off the DC main circuit breaker (if available).

Note: DC power is available until the input terminal.

Selecting the main contactor

You can equip the drive with a main contactor.

Follow these guidelines when you select a customer-defined main contactor:

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

Checking the compatibility of the motor and drive

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

To comply with the EMC requirements of the CE mark, use one of the preferred cable types. See Preferred power cable types (page 44).

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

Metal conduit reduces electromagnetic emission of the whole drive system.

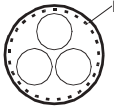
Typical power cable sizes

See the technical data.

Power cable types

Preferred power cable types

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

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

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

Alternate power cable types

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
 Four-conductor cable in plastic 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 armored cable (three phase conductors and PE)	Yes	Yes with phase conductor smaller than 10 mm^2 (8 AWG) Cu, or motors up to 30 kW (40 hp)
 Shielded (Al/Cu shield or armor)[1] four-conductor cable (three phase conductors and a PE)	Yes	Yes with motors up to 100 kW (135 hp). A potential equalization between the frames of motor and driven equipment is required.

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

Not allowed power cable types

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

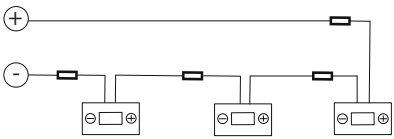
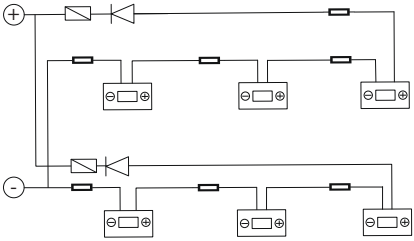
Selecting DC power cables

Consider the following conditions when selecting DC power cables:

- Make sure the DC cable can handle 1000 V open circuit voltage(VOC).

  WARNING! Open joints in DC power cable wiring can cause damage of equipment or injury or loss of life of personal.

- Use MC4 type male and female connectors for all joints in DC cables between the solar module and drive.
- Use blocking and bypass diodes as per the solar module manufacturer's recommendation and local regulatory.

String connection	Parallel connection
	

	Solar cell
	MC4 connector
	Diode
	Contactor

For more information on DC cables and cable bending rule, blocking and bypass diodes, see DC cable recommendation provided by solar cell manufacturer.

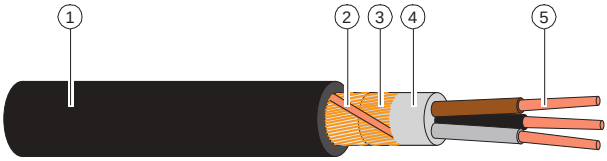
- The maximum length of DC cables between solar cell modules and drive must be decided based on the voltage drop specified by solar cell manufacturer or cable manufacturer.
- The drive needs 560 VDC as Voltage at maximum power ($V_{mp)}$ with motor rated current to operate a 400 VAC motor at nominal speed.
  For information on calculation of required solar cell voltage and short-circuit current (Isc) for a motor at nominal conditions, see page 88
- Unshielded single-core DC cable can be used inside the cabinet. If the DC cables are running outside the cabinet, use shielded three-core cables. The shield is connected only at one end. Maximum length is four meters.
- Consider DC power cable sizing same as the AC power cable sizing.

Power cable shield

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

To effectively suppress radiated and conducted radio-frequency emissions, the cable shield conductivity must be at least 1/10 of the phase conductor conductivity.

The requirements are easily met with a copper or aluminum shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires with an open helix of copper tape or copper wire. The better and tighter the shield, the lower the emission level and bearing currents.



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

Grounding requirements

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

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

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

The table shows the minimum cross-sectional area of the protective earth conductor related to the phase conductor size according to IEC/UL 61800-5-1 when the phase conductor(s) and the protective earth conductor are made of the same metal. If they are different metals, the cross-sectional area of the protective

earth conductor must be determined in a manner which produces a conductance equivalent to that which results from the application of this table.

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

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

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

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

Additional grounding requirements – IEC

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

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

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

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

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

Additional grounding requirements – UL (NEC)

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

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

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

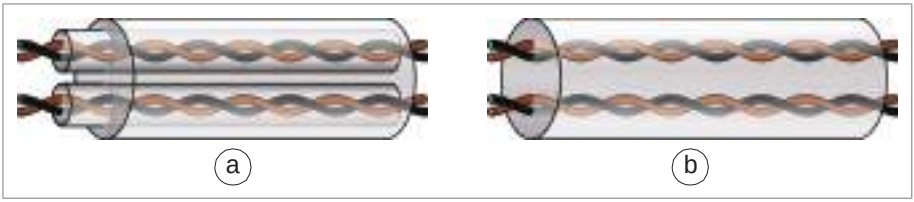
Selecting the control cables

Shielding

Only use shielded control cables.

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

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



Signals in separate cables

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

Signals that can be run in the same cable

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

Relay cable

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

Control panel to drive cable

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

PC tool cable

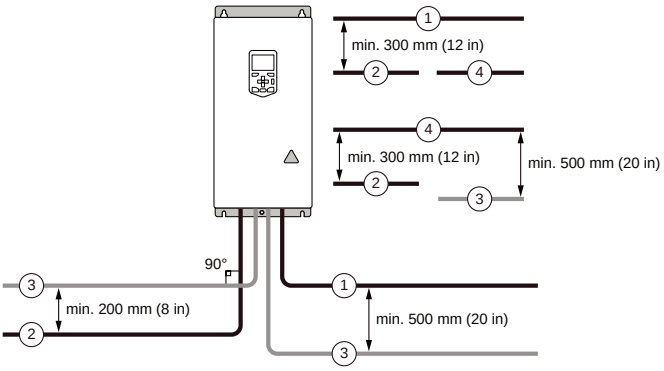
Connect the Drive Composer PC tool to the drive through the USB port of the control panel. Use a USB Type A (PC) - Type Mini-B (control panel) cable. The maximum length of the cable is 3 m (9.8 ft).

Routing the cables

General guidelines – IEC

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

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



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

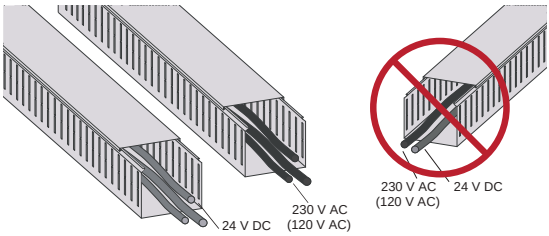
Continuous motor cable shield/conduit and metal enclosure for equipment on the motor cable

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.

DC Solar PV cables should not be routed in parallel with AC main power or motor cables.

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

The electronic power output short-circuit protection circuitry meets the requirements of IEC 60364-4-41:2005 + AMD1:2017.

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 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.

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

For more information, see drive firmware manual.

Implementing a motor temperature sensor connection

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

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

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

You have these implementation alternatives:

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

Protecting the drive against ground faults

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

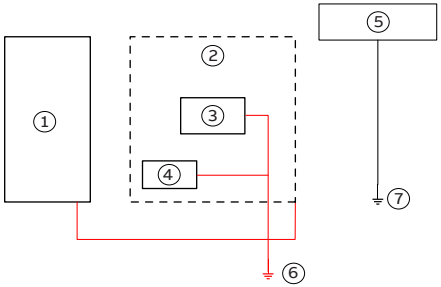
Residual current device compatibility

The drive is suitable for use with residual current devices of Type B.

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

Earth connection (grounding) recommendation

Ground the solar cell or if it does not have ground, connect the solar cell body to the ground. See below figure.



1	Solar cells
2	Drive cabinet
3	Drive
4	Metal Oxide Varistor (MOV)
5	Lightening pole
6	Earth pit 1
7	Earth pit 2

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 129).

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.

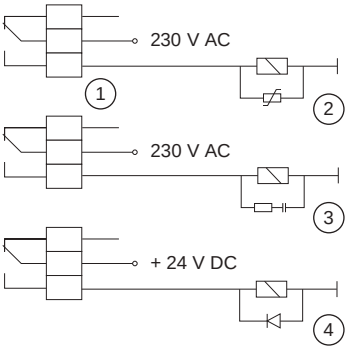
When you select the vector motor control mode and the motor coast stop mode, you can open the contactor immediately after the drive has received the stop command. This is the case also if you use the scalar motor control mode.

Note: In general, this system is not used in irrigation system and is used only if any interlock system is already present or required.

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 – IEC

Contents of this chapter

This chapter describes how to:

- measure the insulation
- do the grounding system compatibility check
- change the EMC filter or ground-to-phase varistor connection
- connect the power and control cables
- install optional modules
- connect a PC.

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
- multimeter and voltage detector
- personal protective equipment.

Measuring the insulation resistance - IEC

Measuring the insulation resistance of the drive

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

Measuring the insulation resistance of the input power cable

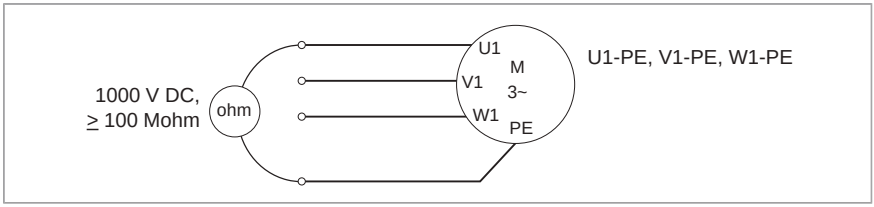
Before you connect the input power cable to the drive, measure its insulation resistance according to local regulations.

Measuring the insulation resistance of the motor and motor cable

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

1. Do the steps in section Electrical safety precautions (page 16) before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals.
3. Measure the insulation resistance between each phase conductor and the protective earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must be more than 100 Mohm (reference value at 25 °C [77 °F]). For the insulation resistance of other motors, refer to the manufacturer's instructions.

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



Grounding system compatibility check – IEC

This section is applicable to the IEC drive types.

EMC filter

The drive has an internal EMC filter as standard. You can install a drive that has the internal EMC filter connected to a symmetrically grounded TN-S system (center-grounded wye). For other systems, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 61).

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 a grounding system that the EMC filter is not compatible with (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.

Ground-to-phase varistor

The drive has a ground-to-phase varistor circuit as standard. You can install a drive that has the varistor circuit connected to a symmetrically grounded TN-S system (center-grounded wye). For other systems, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 61). In some product variants, the varistor circuit is disconnected at the factory.

WARNING!
Do not install the drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. It can cause damage to the varistor circuit.

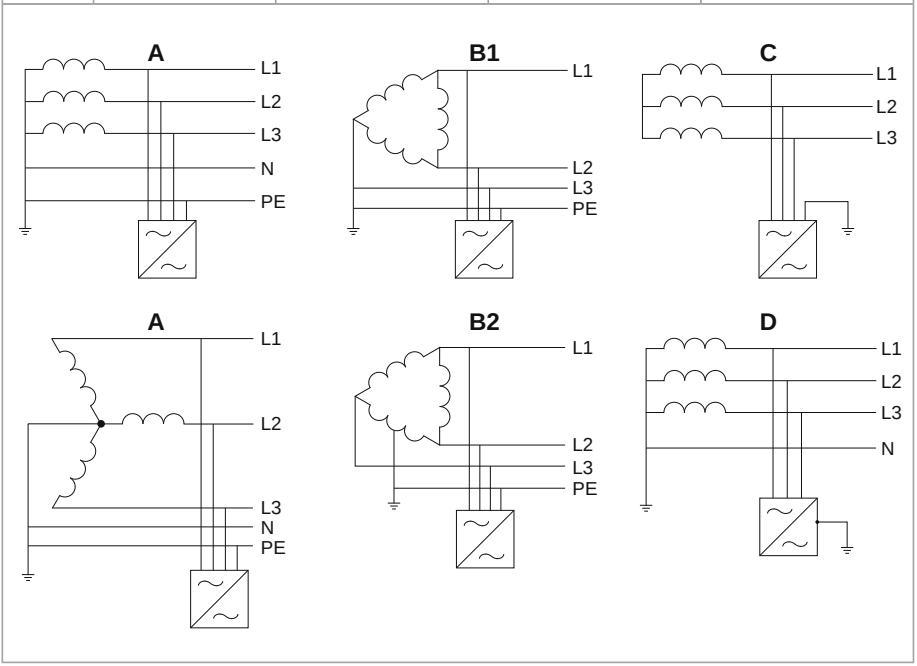
Compatibility of EMC filter and ground-to-phase varistor with the grounding system

WARNING!
If you do not obey these instructions, injury to personnel or damage to the drive can occur.

A metal EMC screw is used to connect the internal EMC filter, and a metal VAR screw is used to connect the ground-to-phase varistor. The screws are installed at the factory. The material of the screws (plastic or metal) depends on the product

variant. Before you connect the drive to the input power, examine the screws and do the necessary actions shown in the table.

Screw label	Screw material	When to remove EMC screw or VAR screw		
		Symmetrically grounded TN-S systems, i.e, center-grounded wye (A)	Corner-grounded delta (B1), mid-point-grounded delta (B2) and TT (D) systems	IT systems (ungrounded or high-resistance grounded) (C)
EMC	Metal	Do not remove	Remove	Remove
	Plastic	Do not remove [1)]	Do not remove	Do not remove
VAR	Metal	Do not remove	Do not remove	Do not remove
	Plastic	Do not remove	Do not remove	Do not remove



1) Can install the metal screw included in the drive delivery to connect the internal EMC filter.

For the locations of the screws, refer to Disconnecting the EMC filter or ground-to-phase varistor (page 63).

Disconnecting the EMC filter or ground-to-phase varistor

Before you continue, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 61).

- To disconnect the EMC filter, remove the metal EMC screw.
- To disconnect the ground-to-phase varistor, remove the metal VAR 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 performance, 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.

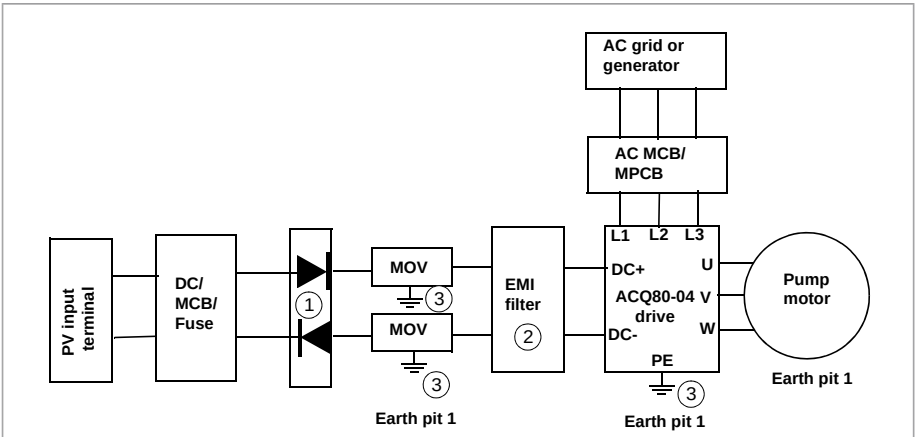
1. input voltage line to line (U_{L-L})
2. input voltage line 1 to ground (U_{L1-G})
3. input voltage line 2 to ground (U_{L2-G})
4. input voltage line 3 to ground (U_{L3-G}).

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	TN-S system (symmetrically grounded)
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 – IEC (shielded cables)

Connection diagram



1	Reverse polarity diodes. For more information, see section Reverse polarity diodes (page 95).
2	EMI filter is optional but is mandatory for EN62920 standard compliance which is required in Europe. For more information, see section Reverse polarity diodes (page 95). To comply to EN62920, refer to EMI filter layout diagram in Dimension drawings (page 113).
3	Ground connection should be common for MOV, drive, and pump.

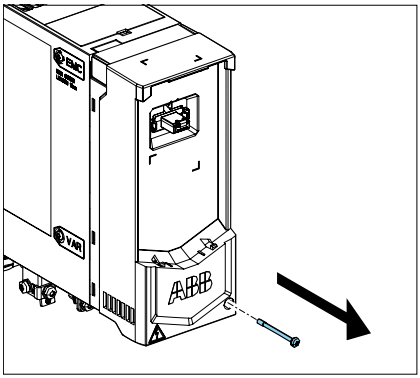
Note: ACQ80 is intended to be used for speed control of three phase AC pump motors and is powered from either AC Grid or DC photo-voltaic array. ABB recommends not to use it as an island grid forming inverter or to supply generic single phase or three phase loads, other than three phase AC pump motors.

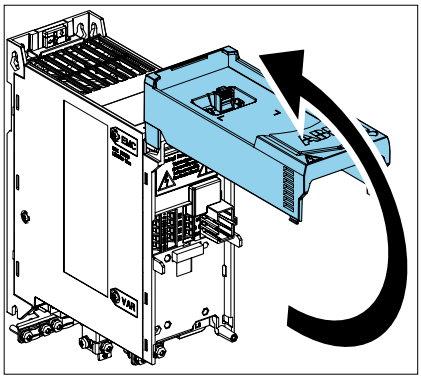
Connection procedure

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, commissioning or maintenance work.

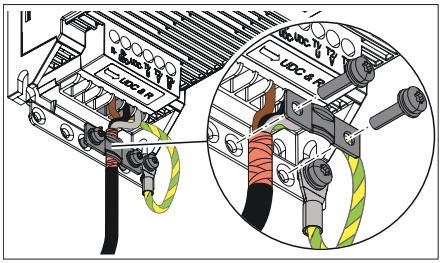
Refer to Terminal data for the power cables (page 99) for the tightening torques.

1. Do the steps in section Electrical safety precautions (page 16) before you start the work.
2. Remove the screw on the drive front cover and lift the front cover up.





3. Attach the residual voltage warning sticker in the local language to the drive.
4. Strip the motor cable.
5. Ground the motor cable shield under the grounding clamp for 360-degree grounding.



6. Twist the motor cable shield into a bundle, mark it with yellow-green insulation tape, install a cable lug, and connect it to the grounding terminal.
7. Connect the phase conductors of the motor cable to terminals T1/U, T2/V and T3/W.
8. Make sure that the R- and UDC+ terminal screws are tightened. Do this step also if you do not connect cables to the terminals.
9. For wiring, obey PV manufacturer's wiring instructions.
10. Mechanically attach all of the cables on the outside of the drive.

Connecting the control cables - IEC

Before you connect the control cables, make sure that all option modules are installed.

Control cable connection procedure

Do the connections according to the control macro (parameter *96.04*) used.

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, commissioning or maintenance work.

1. Do the steps in section Electrical safety precautions (page 16) before you start the work.
2. Strip a part of the outer shield of the control cable for grounding.
3. Use a cable tie to ground the outer shield to the grounding tab. For 360-degree grounding, use metallic cable ties.
4. Strip the control cable conductors.
5. Connect the conductors to the correct control terminals. Torque the terminal connections to 0.5 … 0.6 N·m (4.4 … 5.3 lbf·in).
6. Connect the shields and grounding wires to the SCR terminal. Torque the terminal connection to 0.5 … 0.6 N·m (4.4 … 5.3 lbf·in).
7. Mechanically attach the control cables on the outside of the drive.

Additional information on the control connections

Embedded EIA-485 fieldbus connection

The EIA-485 network uses shielded, twisted-pair cable with a characteristic impedance of 100 … 130 ohm for data signaling. 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.

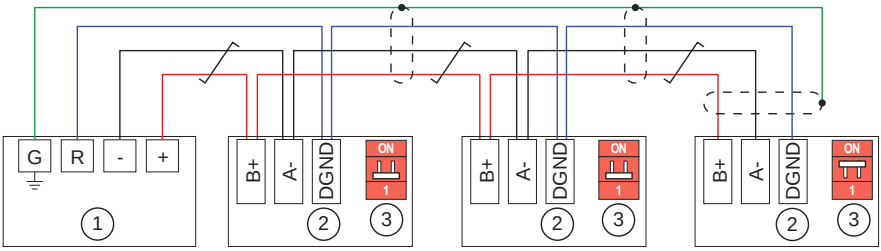
Connect the cable to the EIA-485 terminal on the I/O module. Obey these wiring instructions:

- Attach the cable shields together at each drive, but do not connect them to the drive.

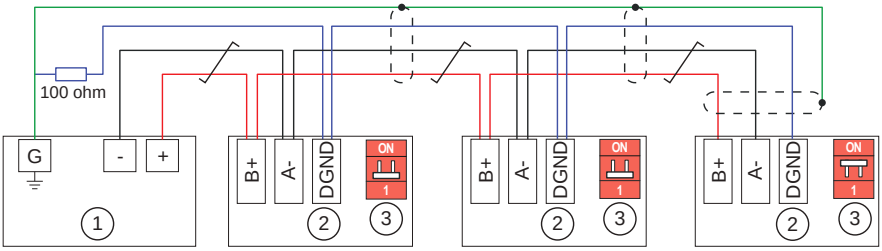
- Connect the cable shields only to the grounding terminal in the automation controller.
- Connect the signal ground (DGND) conductor to the signal ground reference terminal in the automation controller. If the automation controller does not have a signal ground reference terminal, connect the signal ground conductor to the cable shield through a 100 ohm resistor, preferably near the automation controller.

Connection examples are shown below.

With signal ground reference terminal



Without signal ground reference terminal

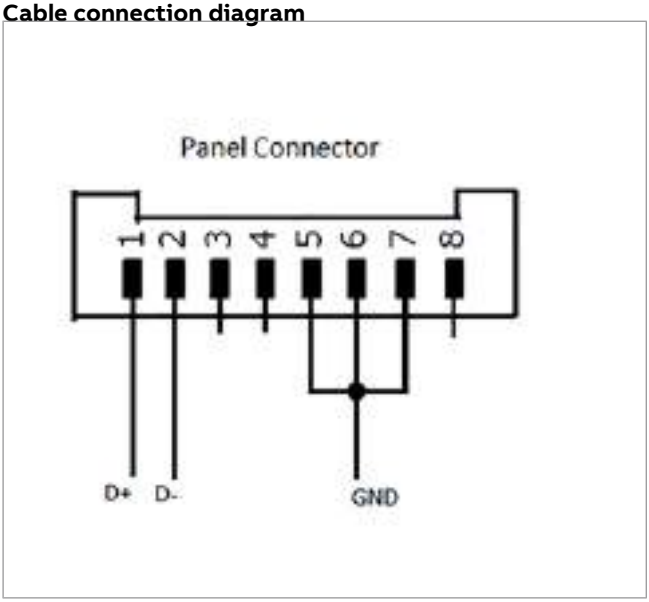


1	Automation controller
2	Drive
3	Termination switch. The devices at the ends of the fieldbus must have termination on. All other devices must have termination off.
4	Biasing switch. One (and only one) device, preferably at the end on the bus must have the bias on.

Change panel port to EFB port

You can use panel port as EFB port. To change panel port to EFB port, set parameter *58.01 Protocol enable* to Modbus RTU and restart the drive. If the changeover of the panel part to EFB port is success, the drive does not detect control panel within 20 seconds. If the drive detects the control panel, remove the control panel and reboot the drive again.

Cable connection diagram

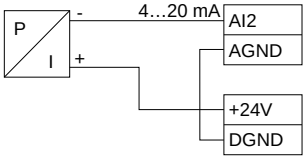


Note:

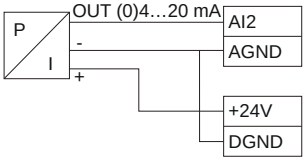
- When an external IO module (RIIO, BIO-01 etc) is connected to drive, this changeover does not happen and only external IO is used for communication.
- This feature is applicable only for R0-R2 frames.

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} = 137 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. 250 mA
DGND	



AI2	Process actual value measurement or reference, 0(4)…20 mA, R_{in} = 137 ohm
AGND	
+24V	Auxiliary voltage output, non-isolated, +24 V DC, max. 250 mA
DGND	

AI and AO (or AI, DI and +10 V) as PTC motor temperature sensor interface

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

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

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

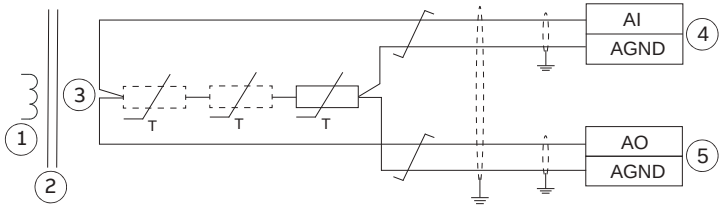
If the motor temperature sensor has a reinforced insulation vs. the motor windings, you can connect it directly to the drive IO interface. This section shows two connection alternatives for the direct I/O connection. If the sensor does not have

reinforced insulation, you must use another type of connection to fulfill the safety requirements. See Implementing a motor temperature sensor connection (page 55).

See the firmware manual for information on the related Motor thermal protection function, and the required parameter settings.

PTC connection 1

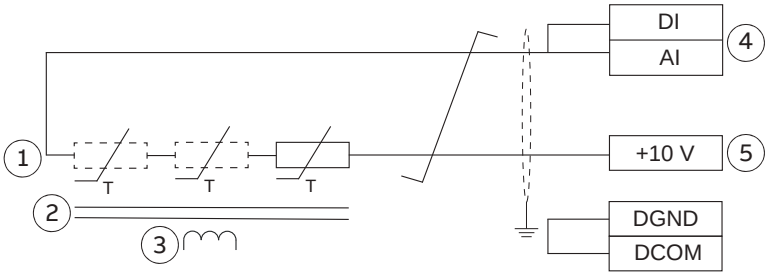
1…3 PTC sensors can be connected in series to an analog input and an analog output. The analog output feeds a constant excitation current of 1.6 mA through the sensor. The sensor resistance increases as the motor temperature rises, as does the voltage over the sensor. The temperature measurement function calculates the resistance of the sensor and generates an indication if overtemperature is detected. Leave the sensor end of the cable shield unconnected.



1	1…3 PTC sensors
2	Analog input. Set the analog input type to V (volt) in parameter group *12 Standard AI*. Define the temperature sensor type, signal source, etc. with parameters *35.11…35.24*. For the sensor type, select: *PTC analog I/O*.
3	Analog output. Select the *Excitation mode* for the analog output in parameter group *13 Standard AO*.

PTC connection 2

If no analog output is available for the PTC connection, it is possible to use a voltage divider connection. 1…3 PTC sensors are connected in series with 10 V reference and digital and analog inputs. The voltage over the digital input internal resistance varies depending on the PTC resistance. The temperature measurement function reads the digital input voltage through the analog input and calculates the PTC resistance.



1	1…3 PTC sensors
2	Digital input and analog input. Set the analog input type to V (volt) in parameter group *12 Standard AI*. Define the temperature sensor type, signal source, etc. with parameters *35.11…35.24*. For the sensor type, select: *PTC AI/DI Voltage Divider tree*. Make sure that the digital input is not configured to any other use by parameters.
3	10 V reference voltage

AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs

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

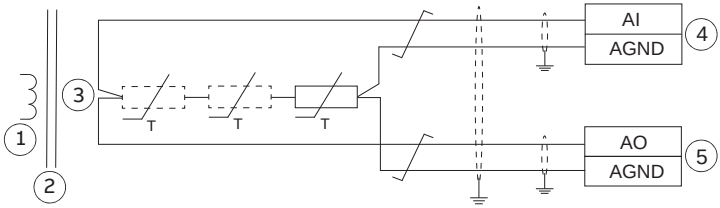
- the accessible parts are not conductive, or
- the accessible parts are conductive, but not connected to the protective earth.

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

If the motor temperature sensor has a reinforced insulation vs. the motor windings, you can connect it directly to the drive IO interface. This section shows the connection. If the sensor has no reinforced insulation, you must use another type of connection to fulfill the safety requirements. See Implementing a motor temperature sensor connection (page 55).

You can connect temperature measurement sensors (one, two or three Pt100 sensors; one, two or three Pt1000 sensors; or one Ni1000, KTY83 or KTY84) between an analog input and output as shown below. Leave the sensor end of the cable shield unconnected.

See the firmware manual for information on the related Motor thermal protection function.



1	1…3 × (Pt100 or Pt1000) or 1 × (Ni1000 or KTY83 or KTY84)
2	Analog input. Set the analog input type to V (volt) in parameter group *12 Standard AI*. Define the temperature sensor type, signal source, etc. with parameters *35.11…35.24*. Set the analog input type to V (volt) in parameter group *12 Standard AI*.
3	Analog output. Select the *Excitation mode* for the analog output in parameter group *13 Standard AO*.

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.

Auxiliary voltage connection

The drive has 24 V DC (±10%) auxiliary power supply terminals both on the base unit and on the module. You can use them:

- to supply auxiliary power from the drive to external control circuits or option modules
- to supply external auxiliary power to the drive to keep the control and cooling in operation if there is a power outage.

See the technical data for the specifications for the auxiliary power supply terminals (input/output).

To supply power to external control circuits or option modules:

1. Connect the load either to the auxiliary power output on the base unit, or on the module (+24V and DGND terminals).
2. Make sure that you do not exceed the load capacity of the output, or the sum load capacity of both outputs.

Installing options

The drive has one front option module slot under the front cover.

For more information, see BIO-01 I/O extension module (page 149).

Installing a front option

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

1. Do the steps in section Electrical safety precautions (page 16) before you start the work.
2. If the option module has a locking tab, pull it up.
3. Carefully align the option module with the option module slot and push it into position.
4. Torque the screw to 0.5 N·m (4.4 lbf·in).
5. If the option module has a locking tab, push it down until it locks.
6. Connect the control cables. See the control cable connection instructions.

Note: If you have the BIO-01 option module, you can add one additional fieldbus module on top of it.

7

Installation checklist of the drive

Contents of this chapter

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

Checklist

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

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

WARNING!
Do the steps in section Electrical safety precautions (page 16) before you start the work.

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

Make sure that ...	☑
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 drive is installed in a shaded location with proper protection from rain and external elements.	☐
The drive cabinet is having a rating IP54 or higher.	☐
The cooling air can flow freely in and out of the drive.	☐
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) 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. Grounding has also been measured according to the regulations.	☐
Solar array direction, earth connection, DC cable connection and usage of string combiner box aligns with the solar array manufacturer's guidelines.	☐
Solar array size is sufficient with respect to the required AC voltage and temperature conditions of the location.	☐
The input power cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	☐
There is an adequately sized protective earth (ground) conductor between the motor and the drive. The conductor is connected to the correct terminal, and the terminal is tightened to the correct torque. Grounding has also been measured according to the regulations.	☐
The motor cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	☐
The motor cable is routed away from other cables.	☐
No power factor compensation capacitors are connected to the motor cable.	☐

Make sure that ...	☑
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 the terminal box cover of the motor are in place.	☐
The motor and the driven equipment are ready for power-up.	☐
The MC4 DC terminals between Drive and solar modules/string combiner box are disconnected	☐
Until the solar array is fully configured and sting combiner box connection is completed (if used), solar array MC4 terminals to drive is not connected.	☐
A string combiner box is used to combine multiple strings when you use multiple strings to meet require current rating of motor.	☐
Output of string combiner box is only two cables, DC+ and DC-. Do not try to use drive terminals for combining multiple strings.	☐

8

Maintenance

Contents of this chapter

The chapter contains maintenance intervals and instructions.

Maintenance intervals

The tables show the maintenance tasks that can be done by the end user. For the ABB Service offering, contact your local ABB Service representative (new.abb.com/contact-centers).

Description of symbols

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

Recommended maintenance intervals after start-up

Recommended action	Annually
Connections and environment	
Quality of the supply voltage	P
Spare parts	
Spare parts	I
Reform DC circuit capacitors (spare modules).	P
Inspections	
Tightness of the cable and busbar terminals.	I
Ambient conditions (dustiness, moisture and temperature)	I
Clean the heatsink.	P

Maintenance task/object	Years from start-up						
	3	6	9	12	15	18	21
Cooling fans							
Main cooling fan (R1, R2 and R3).		R		R		R	
Batteries							
Control panel battery			R			R	

Note:

- The maintenance and component replacement intervals are based on the assumption that the equipment operates 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. Contact your local ABB Service representative for additional maintenance recommendations.

Functional safety components

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

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

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

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

Contact your local ABB service representative for more information.

Cleaning the heatsink

The heatsink of the power module (drive, supply, inverter, converter, etc.) pick up dust from the cooling air. This can cause overtemperature warnings and faults. 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 16) before you start the work.
2. Remove the module cooling fan(s). See the separate instructions.
3. Protect the adjacent equipment from dust.
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.
5. Reinstall the cooling fan.

Replacing the cooling fans

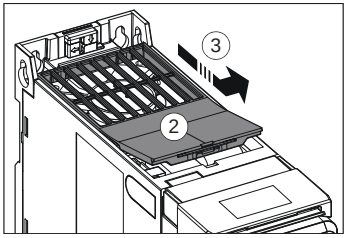
Parameter *05.04 Fan on-time counter* shows the running time of the cooling fan. After you replace the fan, reset the fan counter. Refer to the firmware manual.

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

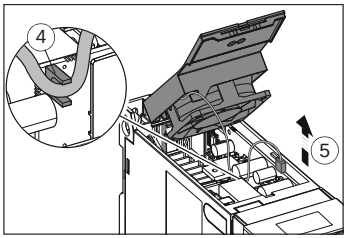
Replacing the cooling fan, frame R0...R2

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

1. Stop the drive and do the steps in section Electrical safety precautions (page 16) before you start the work.
2. Use a suitable flat screwdriver to open the fan cover.
3. Carefully lift the fan cover out of the drive. The fan cover holds the cooling fan.

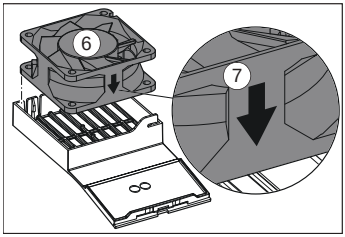


4. Remove the fan power cable from the cable slot in the drive.
5. Disconnect the fan power cable.

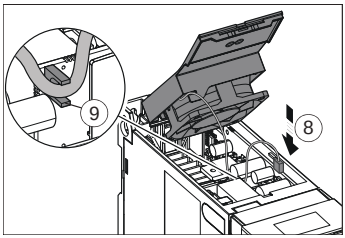


6. Free the fan clips and remove the fan from the fan cover.

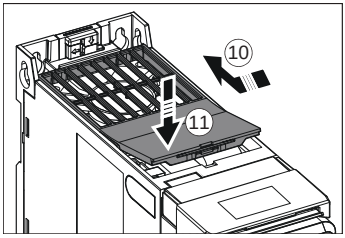
7. Install the new fan into the fan cover. Make sure that the air flow is in the correct direction. The air flows in from the bottom of the drive and out from the top of the drive.



8. Connect the fan power cable.
9. Put the fan power cable into the cable slot in the drive.



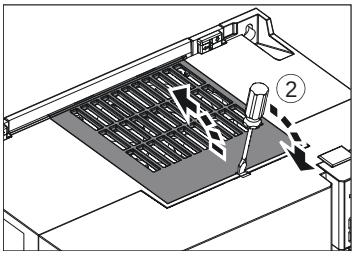
10. Carefully put the fan cover into position in the drive. Make sure that the fan power cable is routed correctly.
11. Push the cover to lock into position.



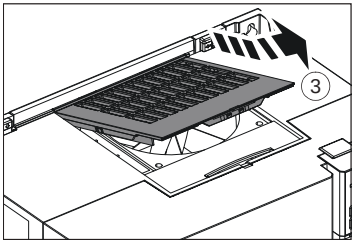
Replacing the cooling fan, frame R3

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

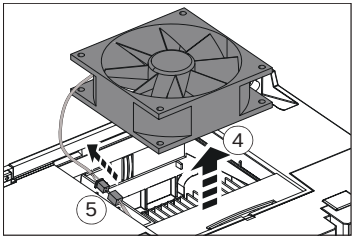
1. Stop the drive and do the steps in section Electrical safety precautions (page 16) before you start the work.
2. Use a suitable flat screwdriver to open the fan cover.



3. Lift out the fan cover and set it aside.

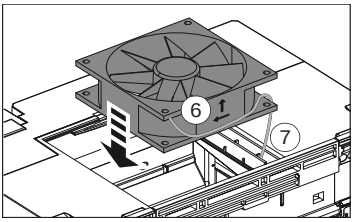


4. Lift and pull the fan from its base.
5. Disconnect the fan power cable from the extension cable connector.

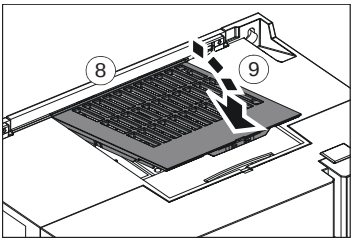


6. Replace the fan. The arrow indicating the air flow direction must point up.

7. Connect the fan power cable.



8. Place the fan cover back on the frame.
9. Push the cover to lock into position.



Capacitors

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

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

Reforming the capacitors

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

9

Technical data

Contents of this chapter

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

Electrical ratings

IEC ratings

Drive Type ACQ80-04-	Nominal Input	Nominal DC input	Max. current	Output ratings			Frame size
				Nominal use			
	I_{1N}	I_{DC}	I_{max}	I_N	P_N		
	A	A	A	A	kW	Hp	
3 phases U_N = 400 V (380…480 V)							
0kW75-4	2.6	3.18	3.2	2.6	0.75	1	R0
01kW1-4	3.3	4.04	4.7	3.3	1.1	1.5	R0
01kW5-4	4.0	4.89	5.9	4.0	1.5	2.0	R0
02kW2-4	5.6	6.85	7.2	5.6	2.2	3.0	R0
03kW0-4	7.2	8.81	10.1	7.2	3.0	4.0	R0

Drive Type ACQ80-04-	Nominal Input	Nominal DC input	Max. current	Output ratings			Frame size
				Nominal use			
	I_{1N}	I_{DC}	I_{max}	I_N	P_N		
	A	A	A	A	kW	Hp	
04kW0-4	9.4	11.50	13.0	9.4	4.0	5.0	R0
05kW5-4	12.6	15.42	16.9	12.6	5.5	7.5	R1
07kW5-4	17.0	20.80	22.7	17.0	7.5	10.0	R2
011kW-4	25.0	30.6	30.6	25.0	11.0	15.0	R2
015kW-4	33.0	40.39	45.0	32.0	15.0	20.0	R3
18kW5-4	39.0	47.74	57.6	38.0	18.5	25.0	R3
022kW-4	50.0	61.2	81.0	50.0	22.0	30.0	R3
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See definitions and notes in section Definitions (page 88).

Definitions

U_N Nominal voltage

I_{1N} Nominal input current (rms) at 50 °C (122 °F)

DC Nominal DC input current

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 Nominal power of the drive. Typical motor power (no overloading). The kilowatt ratings apply to most IEC 4-pole motors. The horsepower ratings apply to most NEMA 4-pole motors.

How to calculate required solar cell voltage and short-circuit current (Isc)

To calculate, required solar cell voltage and short-circuit current (Isc) for a motor at solar cell nominal conditions

Solar array V_{mp}/V_{mpp} = Motor nominal voltage * 1.35

Solar array I_{mp} = Drive nominal current * 0.817

I_{DC} = Drive nominal current * 1.3

Note: Make sure that V_{mp}/ V_{mpp} of solar array does not exceed 600VDC and VoC does not exceed 800VDC.

Definitions

V_{mp}	Voltage at maximum power
V_{mpp}	Maximum power point voltage
I_{mp}	Current at maximum power
DC	Nominal DC input current
ISC	Short circuit current
VOC	Open circuit voltage
VDC	Direct current voltage

Sizing

Drive sizing is based on the rated motor current and power. To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current. Also the rated power of the drive must be higher than or equal to compared to the rated motor power. The power ratings are the same regardless of the supply voltage within one voltage range.

Note: The nominal values of I_N apply to the ambient temperature of 50 °C (122 °F). Derating is needed above this temperature.

Output derating

The load capacity (I_n, I_{Ld}, I_{Hd}) decreases in some situations. In such situations, where full motor power is required, oversize the drive so that the total derated output current is sufficient for the motor to reach the full power.

In an environment where more than one type of derating is necessary (for example, high altitude and high temperature), the effects of derating are cumulative.

Note:

- I_{max} is not derated.
- The motor can also have a derating on it.
- You can also use the DriveSize tool for derating.

See Surrounding air temperature derating (page 91), Altitude derating (page 91) and Switching frequency derating (page 91) for the derating values.

Example 1, IEC: How to calculate the derated current

The drive type is ACQ80-04-018A-4, which has a nominal output current (I_n) of 17 A at 400 V. Calculate the derated output current at 4 kHz switching frequency, at 1500 m altitude and at 55 °C surrounding air temperature.

Switching frequency derating: Derating is not necessary at 4 kHz.

Altitude derating: The derating factor for 1500 m is

$$1 - \frac{1500\ m - 1000\ m}{10000\ m} = 0.95$$

Surrounding air temperature derating: The derating factor for 55 °C surrounding air temperature is

$$1 - \frac{55\ C - 50\ C}{100\ C} = 0.95$$

Multiply the nominal drive output current by all the applicable derating factors. In this example, the derated output current becomes

$$I_N = 17\ A \cdot 0.95 \cdot 0.95 = 15.34\ A$$

Example 2, IEC: How to calculate the required drive

The application requires a nominal motor current of 6.0 A at a switching frequency of 8 kHz. The supply voltage is 400 V, the altitude is 1800 m and the surrounding air temperature is 35 °C.

Altitude derating: The derating factor for 1800 m is

$$1 - \frac{1800\ m - 1000\ m}{10000\ m} = 0.92$$

.

Surrounding air temperature derating: Derating is not necessary at 35 °C surrounding air temperature.

To see if the derated output current of a drive is sufficient for the application, multiply the nominal output current (I_n) by all the applicable derating factors. For example, drive type ACQ80-04-05kW5-4 has a nominal output current of 12.6 A at 400 V. The switching frequency derating factor for this drive type is 0.68 at 8 kHz. Calculate the derated drive output current:

$$I_N = 12.6\ A \cdot 0.68 \cdot 0.92 = 7.88\ A$$

In this example, the derated output current is sufficient, because it is higher than the required current.

Surrounding air temperature derating

Frame	Temperature	Derating
All	Less than 50 °C (122 °F)	No derating
R1…R3	50 … 60 °C (122 … 140 °F)	Output current decreases by 1% for each additional 1 °C (1.8 F).

Altitude derating

230 V drives: At altitudes 1000 … 2000 m (3281 … 6562 ft) above sea level, the derating is 1% for each added 100 m (328 ft) above 1000 m (3281 ft).

400/480 V drives: At altitudes 1000 … 4000 m (3281 … 13123 ft) above sea level, the derating is 1% for each added 100 m (328 ft) above 1000 m (3281 ft). In addition:

- A maximum altitude of 4000 m (13123 ft) is permitted for these grounding systems: TN-S, TT. A maximum altitude of 2000 m (6562 ft) is permitted for these grounding systems: corner-grounded delta, midpoint-grounded delta, IT (ungrounded).
- Above 2000 m (6562 ft), the maximum permitted voltage for the relay output RO1 decreases. At 4000 m (13123 ft), it is 30 V.

To calculate the derated output current, multiply the current in the ratings table with the derating factor *k*, which for *x* meters or feet is:

$$k = 1 - \frac{x - 1000\ m}{10000\ m} \qquad k = 1 - \frac{x - 3281\ ft}{32810\ ft}$$

Switching frequency derating

Derating the drive output current is necessary when using high minimum switching frequencies. If you change parameter *97.02 Minimum switching frequency*, calculate the derated current. Multiply the drive output current with the applicable derating factor from the table.

Derating is not necessary when changing parameter *97.01 Switching frequency reference*.

Frame R3: If the application is cyclic and the surrounding air temperature is constantly more than 40 °C (104 °F), keep parameter *97.02 Minimum switching frequency* at its default value (1.5 kHz). Higher switching frequencies decrease the product life time or the performance in the temperature range 40 … 60°C (104 … 140 °F).

Fuses (IEC)

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.

AC fuses

gG fuses

Drive type ACQ80-04-	Minimum short circuit current [1)]	Input current	gG (IEC 60269)				
			Rated current I_N	I^2t	Rated voltage	ABB designation type	IEC 60269 size
	A	A	A	A^2s	V		
3 phases U_N = 400 V (380...480 V)							
0kW75-4	48	4.2	6	110	500	OFAF000H6	000
01kW1-4	48	5.3	6	110	500	OFAF000H6	000
01kW5-4	80	6.4	10	360	500	OFAF000H10	000
02kW2-4	80	9.0	10	360	500	OFAF000H10	000
03kW0-4	128	11.5	16	740	500	OFAF000H16	000
04kW0-4	128	15.0	16	740	500	OFAF000H16	000
05kW5-4	200	20.2	25	2500	500	OFAF000H25	000
07kW5-4	256	27.2	32	4500	500	OFAF000H32	000
011kW-4	3	40.0	40	15500	500	OFAF000H50	000
015kW-4	320	33.0	40	7700	500	OFAF000H40	000
18kW5-4	400	39.0	50	16000	500	OFAF000H50	000
022kW-4	500	45.0	63	20100	500	OFAF000H63	000

1) minimum short-circuit current of the device

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gR fuses

Drive type ACQ80-04-	Minimum short circuit current [1]	Input current	gR (IEC 60269)				
			Rated current I_N	I^2t	Rated voltage	ABB designation type	IEC 60269 size
	A	A	A	A^2s	V		
3-phase UN = 380…480 V							
0kW75-4	48	4.2	25	125	690	170M2694	00
01kW1-4	48	5.3	25	125	690	170M2694	00
01kW5-4	80	6.4	32	275	690	170M2695	00
02kW2-4	80	9.0	32	275	690	170M2695	00
03kW0-4	128	11.5	40	490	690	170M2696	00
04kW0-4	128	15.0	40	490	690	170M2696	00
05kW5-4	200	20.2	50	1000	690	170M2697	00
07kW5-4	256	27.2	63	1800	690	170M2698	00
011kW-4	400	40.0	80	3600	690	170M2699	00
015kW-4	170	33.0	63	1450	690	170M1565	000
18kW5-4	170	39.0	63	1450	690	170M1565	000
022kW-4	280	45.0	80	2550	690	170M1566	000

[1] minimum short-circuit current of the device

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DC fuses (gG)

Drive Type ACQ80-04-	Input current	Rated current	I2t (A2s)	ABB fuse holder	DC fuse	Bussmann type	ABB designation type	Voltage rating (V)	IEC 60269 size
	I_{1N}	I_N							
	A	A							
3 phases U_N = 400 V (380...480 V)									
0kW75-4	2.6	10	125	E92/32	E 9F10 GG10 (ABB)	170M2694	S802PV-S10	690	00
01kW1-4	3.3	10	125	E92/32	E 9F10 GG10 (ABB)	170M2694	S802PV-S10	690	00
01kW5-4	4.0	10	275	E92/32	E 9F10 GG10 (ABB)	170M2695	S802PV-S10	690	00
02kW2-4	5.6	10	275	E92/32	E 9F10 GG10 (ABB)	170M2695	S802PV-S10	690	00
03kW0-4	7.2	16	490	E92/32	E 9F10 GG16 (ABB)	170M2696	S802PV-S13	690	00
04kW0-4	9.4	20	490	E92/32	E 9F10 GG16 (ABB)	170M2696	S802PV-S25	690	00
05kW5-4	12.6	25	1000	E92/32	E 9F10 GG25 (ABB)	170M2697	S802PV-S25	690	00
07kW5-4	17.0	32	1800	SB00-D (B)	170M2676 35A 1000V (B)	170M2698	S802PV-S40	690	00
011kW-4	25.0	50	3600	SB00-D (B)	170M 2678 63A,1000V (B)	170M2699	170M 2678 63A,1000V	690	00

Drive Type ACQ80-04-	Input current	Rated current	I2t (A2s)	ABB fuse holder	DC fuse	Bussmann type	ABB designation type	Voltage rating (V)	IEC 60269 size
	I_{1N}	I_N							
	A	A							
015kW-4	33.0	50	6650	SB00-D (B)	170M 2678 63A,1000V (B)	170M2700	170M 2678 63A,1000V	690	00
18kW5-4	39.0	63	12000	SB00-D (B)	170M 2678 63A,1000V (B)	170M2701	170M 2678 63A,1000V	690	00
022kW-4	50.0	100	22500	SB00-D (B)	170M 2678 63A,1000V (B)	170M2702	170M 2678 63A,1000V	690	00
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Note: ABB recommends to use above fuses for reverse polarity protection between ACQ80 drive and solar array/solar string.

MOV

Ordering code	Type code (TDK)	VRMS	VDC	i_{max}	W_{max}	P_{max}
B72220P3351K101	S20K350E3K1	350	460	12000	335	1.00
B72220P3381K101	S20K385E3K1	385	505	12000	370	1.00
B72220P3421K101	S20K420E3K1	420	560	12000	405	1.00

Reverse polarity diodes

ACQ80-04	Diode type code (International rectifier make)	Quantity required with heatsink
0kW75-4	SKKD26/16	2

ACQ80-04	Diode type code (International rectifier make)	Quantity required with heatsink
01kW1-4	SKKD26/16	2
01kW5-4	SKKD26/16	2
02kW2-4	SKKD26/16	2
03kW0-4	SKKD26/16	2
04kW0-4	SKKD26/16	2
05kW5-4	SKKD26/16	2
07kW5-4	SKKD26/16	2
011kW-4	IRKE 71 – 1200V	2
015kW-4	IRKE 71 – 1200V	2
18kW5-4	IRKE 71 – 1200V	2
022kW-4	IRKE 71 – 1200V	2

DC EMI filter

Ordering code	Rated current (55°C)	Rated current (40°C)	Typical inverter AC power rating	IP class
	A	A	kW	
FN2200-25-33	25	28	10	IP20
FN2200-50-34	50	57	20	IP20
FN2200-75-34	75	86	30	IP20

Alternate short-circuit protection

The table below lists MCB circuit breakers that can be used with the drive.

Type ACQ80-04-	MCBs					
	ABB type	Max. short-circuit	Tmax frame XT / T class	Tmax rating	Electron-ic re-lease	SACE ordering code for breaker and release unit
		I_{sc}				
		kA	A	A	A	
3-phase U_N = 380...480 V						
0kW75-4	S 203P-B/C/Z 10	20	N/A	N/A	N/A	N/A
01kW1-4	S 203P-B/C/Z 10	20	N/A	N/A	N/A	N/A
01kW5-4	S 203P-B/C/Z 10	20	N/A	N/A	N/A	N/A
02kW2-4	S 203P-B/C/Z 10	20	N/A	N/A	N/A	N/A
03kW0-4	S 203P-B/C/Z 10	20	N/A	N/A	N/A	N/A
04kW0-4	S 203P-B/C/Z 10	20	N/A	N/A	N/A	N/A
05kW5-4	S 203P-B/C/Z 16	20	N/A	N/A	N/A	N/A
07kW5-4	S 203P-B/C/Z 20	20	N/A	N/A	N/A	N/A
011kW-4	S 203P-B/C/Z 25	20	N/A	N/A	N/A	N/A
015kW-4	S 203P-B/C/Z 32	12	N/A	N/A	N/A	N/A
18kW5-4	S 203P-B/C/Z 40	12	N/A	N/A	N/A	N/A
022kW-4	S 203P-B/C/Z 50	12	N/A	N/A	N/A	N/A

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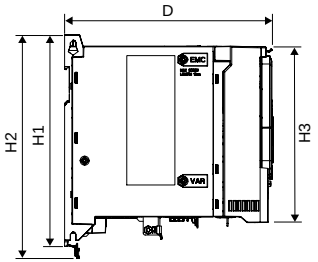
Dimensions and weights

Frame	Dimensions and weights (IP20)															
	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	205	8.1	223	8.8	170	6.7	73	2.9	208	8.2	50	1.97	191	7.52	1.7	3.6
R1	205	8.1	223	8.8	170	6.7	97	3.9	208	8.2	75	2.95	191	7.52	2.2	4.9
R2	205	8.1	220	8.7	170	6.7	172	6.8	208	8.2	148	5.83	191	7.52	2.5	5.6
R3	205	8.1	240	9.5	170	6.7	262	10.3	213	8.2	234	9.21	191	7.52	5.6	12.4



H1	Height back
H2	Height
H3	Height front
W	Width
D	Depth
M1	Mounting hole distance
M2	Mounting hole distance

Free space requirements

Frame	Free space requirement					
	Above		Below		Sides [1]	
	mm	in	mm	in	mm	in
All	75	3	75	3	0	0

[1] A side-mounted option module requires 20 mm (0.8 in) of free space on the right side of the drive.

Thermal losses, cooling data and noise

Drives with frame size R0…R3 have a cooling fan. The air flow direction is from bottom to top.

Type ACQ80-04-	Typical power loss [1]		Air flow		Noise	Frame size
	W	BTU/h	m^3/h	CFM	dB(A)	
3-phase U_N = 400 V						
0KW75-4	44	150	57	33	63	R0
01KW1-4	55	188	57	33	63	R0
01KW5-4	62	212	57	33	63	R0
02KW2-4	91	311	57	33	63	R0
03KW0-4	100	341	57	33	63	R0
04KW0-4	140	478	57	33	63	R0
05kW5-4	165	563	63	37	59	R1
07KW5-4	259	884	128	75	66	R2
011KW-4	390	1331	128	75	66	R2
015kW-4	396	1351	150	88	69	R3
18kW5-4	497	1696	150	88	69	R3
022kW-4	672	2293	150	88	69	R3

[1] The table shows the typical drive losses when it operates at 90% of the nominal output frequency and 100% of the nominal output current. See also Energy efficiency data (ecodesign) (page 105).

Terminal data for the power cables

ACQ80-04	L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+			PE		
	Minimum (solid/ stranded)	Maximum (solid/ stranded)	Tightening torque	Minimum (solid/ stranded)	Maximum (solid /stranded)	Tightening torque
	mm^2	mm^2	N·m	mm^2	mm^2	N·m
3-phase U_N = 400 V						
0kW75-4	0.5/0.5	4/2.5	0.5…0.6	4/2.5	6/4	1.2
01kW1-4	0.5/0.5	4/2.5	0.5…0.6	4/2.5	6/4	1.2
01kW5-4	0.5/0.5	4/2.5	0.5…0.6	4/2.5	6/4	1.2
02kW2-4	0.5/0.5	4/2.5	0.5…0.6	4/2.5	6/4	1.2

ACQ80-04	L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+			PE		
	Minimum (solid/stranded)	Maximum (solid/stranded)	Tightening torque	Minimum (solid/stranded)	Maximum (solid/stranded)	Tightening torque
	mm^2	mm^2	N·m	mm^2	mm^2	N·m
03kW0-4	0.5/0.5	4/2.5	0.5…0.6	4/2.5	6/4	1.2
04kW0-4	0.5/0.5	4/2.5	0.5…0.6	4/2.5	6/4	1.2
05kW5-4	0.5/0.5	4/2.5	0.5…0.6	4/2.5	6/4	1.2
07kW5-4	0.5/0.5	10/6	1.2…1.5	4/2.5	6/4	1.2
011kW-4	0.5/0.5	10/6	1.2…1.5	4/2.5	6/4	1.2
015kW-4	0.5/0.5	25/16	2.5…3.7	10/6	25/16	2.9
18kW5-4	0.5/0.5	25/16	2.5…3.7	10/6	25/16	2.9
18kW5-4	0.5/0.5	25/16	2.5…3.7	10/6	25/16	2.9
022kW-4	0.5/0.5	25/16	2.5…3.7	10/6	25/16	2.9

Terminal data for the control cables

This table shows the control cable terminal data of the standard drive variant, that is, the base unit with RIIO-01 I/O & EIA-485 module.

Wire size		Torque	
mm^2	AWG	N·m	lbf·in
0.14…1.5	26…16	0.5…0.6	4.4…5.3

Choke and sine filter

WARNING! For cable distance between 75 m (246 ft) and 100 m (328 ft), an external motor choke must be used and for cable lengths above 100 m (328 ft), an external sine filter must be used. Failing to use choke and sine filter for longer cables can result in driver or motor failure.

Drive Type ACQ80-04-	Nominal In	Nominal In	Sine filter type code	Choke type code	Frame size
	I_{1N}	I_{1N}			
	A	kW			
3 phases U_N = 400 V (380…480 V)					
0kW75-4	2.6	0.75	NSIN0006-5	NOCH0016-60	R0
01kW1-4	3.3	1.1	NSIN0006-5	NOCH0016-60	R0
01kW5-4	4.0	1.5	NSIN0006-5	NOCH0016-60	R0
02kW2-4	5.6	2.2	NSIN0006-5	NOCH0016-60	R0
03kW0-4	7.2	3.0	NSIN0006-5	NOCH0016-60	R0
04kW0-4	9.4	4.0	NSIN0006-5	NOCH0016-60	R0
05kW5-4	12.6	5.5	NSIN0006-5	NOCH0016-60	R1
07kW5-4	17.0	7.5	NSIN0025-5	NOCH0030-60	R2
011kW-4	25.0	11.0	NSIN0025-5	NOCH0030-60	R2
015kW-4	33.0	15.0	NSIN0030-5	NOCH0030-60	R3
18kW5-4	39.0	18.5	NSIN0030-5	NOCH0070-60	R3
022kW-4	50.0	22.0	NSIN0030-5	NOCH0070-60	R3
					3AXD10000651180.xls B

Electrical power network specification

Voltage (U_1)

Input voltage range 3~ 380…480 V AC. This is indicated in the type designation label as typical input voltage levels 3~ 400/480 V AC.

DC voltage max limit is 800 VDC

Network type

Public low voltage networks. TN (grounded), IT (ungrounded) and corner-grounded TN systems. Consult ABB before connecting to other systems (for example, TT, or midpoint grounded delta)

Rated conditional short-circuit current (IEC 61439-1)

65 kA when protected by fuses given in the fuse tables

Frequency	47 to 63 Hz
Imbalance	Max. ± 3% of nominal phase to phase input voltage
Fundamental power factor (cos phi$_1$)	0.98 (at nominal load)

Motor connection data

Motor types	Asynchronous AC induction motor and permanent magnet motors.
Frequency	0....500 Hz
Frequency resolution	0.01 Hz
Current	See the rating information.
Switching frequency	2 kHz, 4 kHz, 8 kHz, 12 kHz (depends on the frame and parameter settings)

Motor cable length

Operational functionality and motor cable length

The drive is designed to operate with optimum performance with these maximum motor cable lengths. The values are valid for 4 kHz switching frequency.

Frame	Maximum motor cable length	
	m	ft
Standard drive, without external options		
R0...R3	100	328

Notes:

- Applicable for cable types mentioned in section Terminal data for the power cables (page 99).
- Conducted and radiated emissions of these motor cable lengths do not comply with the EMC requirements of IEC/EN 61800-3.
- In multimotor systems, the calculated sum of all motor cable lengths must not exceed the maximum motor cable length given in the table.

For flat unshielded cables used in pump motors, maximum recommended motor cable length without choke, with choke and with sine filter is as follows.

Frame	Without choke/filter		With choke or du/dt filter		Sine filter	
	m	ft	m	ft	m	ft
Standard drive, without external options						
R0…R3	75	246	75...100	246...328	100...1000	328...3280

EMC compatibility and motor cable length

To comply with the European EMC Directive (standard EN 61800-3), use the following maximum motor cable lengths at 4 kHz switching frequency. See the table below.

Frame	Maximum motor cable length, 4 kHz					
	C1 [1]		C2		C3	
	m	ft	m	ft	m	ft
With internal EMC filter						
3-phase 380 … 480 V						
R0	-	-	10	33	30	100
R1	-	-	10	33	20	66
R2	-	-	10	33	30	100
R3	-	-	10	33	30	100
With optional external EMC filter						
3-phase 380 … 480 V						
R0	30	100	50	164	50	164
R1	30	100	50	164	50	164
R2	30	100	50	164	50	164
R3	30	100	30	100	50	164

1) Category C1 with conducted emissions only. Radiated emissions are not compatible when measured with the standard emission measurement setup and must be measured on cabinet and machine installations for each case.

Control connection data

The data is valid for the standard drive variant (base unit equipped with the RIIO-01 I/O & EIA-485 module).

Analog inputs (AI1, AI2)	Voltage signal, single-ended	0 … 10 V DC (10% overrange, 11 V DC max.) R_{in} = 221.6 kohm
	Current signal, single-ended	0 … 20 mA (10% overrange, 22 mA max.) R_{in} = 137 ohm
	Inaccuracy	≤ 1.0%, of full scale
	Overvoltage protection	up to 30 V DC
	Potentiometer reference value	10 V DC ±1%, max. load current 10 mA
Analog output (AO1, AO2)	Current output mode	0 … 20 mA (10% overrange, 22 mA max.) into 500 ohm load (AO2 only supports output current)
	Voltage output mode	0 … 10 V DC (10% overrange, 11 V DC max.) into 200 kohm minimum load (resistive)
	Inaccuracy	≤ 2%, of full scale
Auxiliary power output or input (+24V, DGND)	As output	+24 V DC ±10%, max. 250 mA (from base unit and/or RIIO-01 module)
Digital inputs (DI1…DI6)	Voltage	12 … 24 V DC (int. or ext. supply) max. 30 V DC.
	Type	PNP and NPN
	Input impedance	R_{in} = 2 kohm
DI5 (digital or frequency input)	Voltage	12 … 24 V DC (int. or ext. supply) max. 30 V DC.
	Type	PNP and NPN
	Input impedance	R_{in} = 2 kohm
	Max. frequency	10 … 16 kHz
Relay output (RO1, RO2, RO3)	Type	1 form C (NO + NC)
	Max. switching voltage	250 V AC / 30 V DC
	Max. switching current	2 A (non inductive)
STO interface	Refer to The Safe torque off function (page 129)	

EIA-485 embedded fieldbus (A+, B-, DGND)	Connector pitch 5 mm, wire size 2.5 mm^2 (14 AWG) Physical layer: RS-485 Cable type: Shielded twisted pair cable with twisted pair for data and a wire or pair for signal ground, nominal impedance 100 … 165 ohm, for example Belden 9842 Transmission rate: 9.6 … 115.2 kbit/s Termination by switch

Energy efficiency data (ecodesign)

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

Protection classes

Degree of protection (IEC/EN 60529)	IP20. The drive must be installed in a cabinet to fulfill the requirements for shielding from contact.
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	**400/480 V drives**: 0 … 4000 m (0 … 13123 ft) above sea level (with output derating above 1000 m [3281 ft]) See Output derating (page 89).	-	-

Requirement	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
Surrounding air temperature	-10 … +60 °C (14 … 140 °F). If the temperature is more than 50 °C (122 °F), output derating is necessary. See Surrounding air temperature derating (page 91). No frost permitted.	-40 … +70 °C ±2% (-40 … +158 °F ±2%)	-40 … +70 °C ±2% (-40 … +158 °F ±2%)
Relative humidity	5 … 95%	Max. 95%	Max. 95%
	No condensation permitted. Maximum permitted relative humidity is 60% in the presence of corrosive gases.		
Contamination levels (IEC 60721-3-x)	IEC 60721-3-3: 2002	IEC 60721-3-1: 1997	IEC 60721-3-2: 1997
- Chemical gases	Class 3C2	Class 1C2	Class 2C2
- Solid particles	Class 3S2. No conductive dust permitted.	Class 1S3. (packing must support this, otherwise 1S2)	Class 2S2
Pollution degree (IEC/EN 61800-5-1)	Pollution degree 2	-	-
Sinusoidal vibration (IEC 60068-2-6, Test Fc 2007-12)	frequency 10 … 150 Hz; amplitude ±0.075 mm (0.003 in), 10 … 57,56 Hz; constant peak acceleration 10 m/s2 (33 ft/s2), 57,56 … 150 Hz; sweep: 1 oct/min; 10 sweep cycles in each axis with STO active; uncertainty ±5.0%; normal mounting	-	-
Shock/(IEC 60068-2-27, ISTA 1A)	Not permitted	According to ISTA 1A. Max. 100 m/s^2 (330 ft/s^2), 11 ms.	According to ISTA 1A. Max. 100 m/s^2 (330 ft/s^2), 11 ms.
Free fall	-	76 cm (30 in)	76 cm (30 in)

Materials

Drive enclosure	Hot-dip zinc coated steel sheet 1.5 mm (0.06 in). Extruded aluminum AlSi. PC/ABS 2 mm (0.08 in), PC+10%GF 2.5 … 3 mm (0.10 … 0.12 in) and PA66+25%GF 1.5 mm (0.06 in), 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 DC capacitors need selective treatment according to IEC 62635 guidelines.

To aid recycling, most plastic parts are marked with an appropriate identification code. In addition, components containing substances of very high concern (SVHCs) are listed in European Chemicals Agency's SCIP database. SCIP is the database for information on Substances of Concern In articles as such or in complex objects (Products) established under the Waste Framework Directive (2008/98/EC). For further information, contact your local ABB distributor or consult European Chemicals Agency's SCIP database to find out which SVHCs are used in the drive, and to find out where those components are located.

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

For more information on ABB end of life services, refer to new.abb.com/service/end-of-life-services.

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 IEC 61800-3:2004 + A1:2011	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
IEC/EN 61800-5-1:2007	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy
IEC 61800-9-2:2017	Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Energy efficiency indicators for power drive systems and motor starters
ANSI/UL 61800-5-1:2015	UL Standard for adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy
CSA C22.2 No. 274-13	Adjustable speed drives

Markings

The applicable markings are shown on the type designation label of the drive.

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 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.
	Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP). Product is compliant with the People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) about hazardous substances. The EFUP is 20 years. China RoHS II Declaration of Conformity is available from https://library.abb.com.

	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.

	Solar Impulse mark Product complies with Solar Impulse Foundation's regulations.

EMC compliance (IEC/EN 61800-3:2004 + A1:2012)

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 C1

The drive complies with the conducted emission limits of the standard with the following provisions:

1. The optional EMC filter is selected installed as specified in the EMC filter manual.
2. The motor and control cables are selected as specified in this manual. The EMC recommendations are obeyed.

3. The maximum motor cable length does not exceed the specified maximum value. See EMC compatibility and motor cable length (page 103).
4. The drive is installed according to the instructions given in this manual.

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.

Category C2

This is applicable to 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. The EMC recommendations are obeyed.
2. The maximum motor cable length does not exceed the specified maximum. See EMC compatibility and motor cable length (page 103).
3. The drive is installed according to the instructions given in this manual.

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.

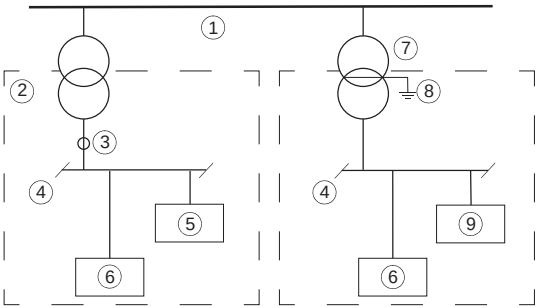
WARNING!
Do not install a drive with the internal EMC filter connected to a grounding system that the EMC filter is not compatible with (for example, an IT system). The supply network becomes connected to ground potential through the internal EMC filter capacitors, which can cause danger or damage to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

WARNING!
To prevent radio-frequency interference, do not use a category C2 drive on a low-voltage public network that supplies domestic premises.

Category C4

If the provisions in category 2 or 3 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 in *Technical guide No. 3 EMC compliant installation and configuration for a power drive system* (3AFE61348280 [English]).
3. The motor and control cables are selected as specified in this manual. For the best EMC performance, the EMC recommendations are obeyed.
4. The drive is installed according to the instructions given in this manual.

WARNING!
Do not install a drive with the internal EMC filter connected to a grounding system that the EMC filter is not compatible with (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.

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

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.

Cyber security 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.

Declarations of conformity

Link to Declaration of conformity according to EU Machinery Directive 2006/42/EU (3AXD10000715412)

10

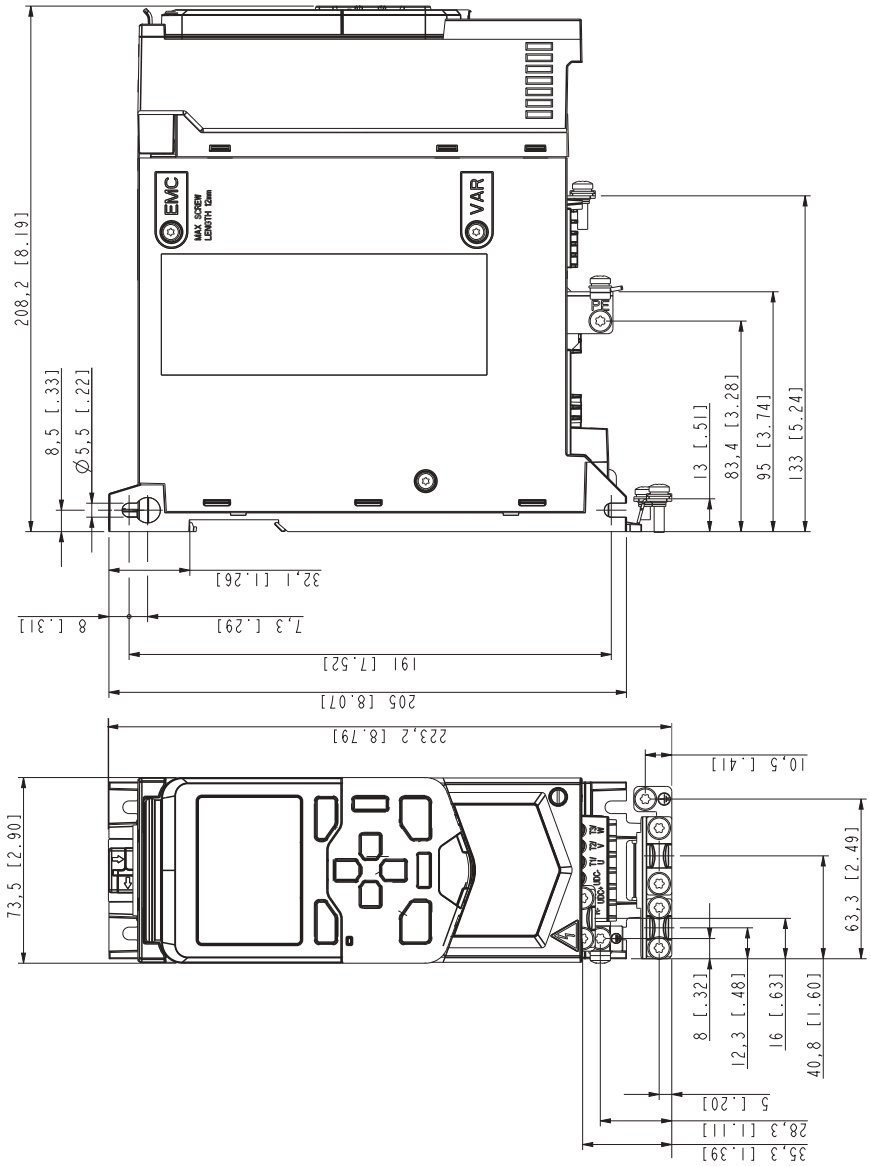
Dimension drawings

Contents of this chapter

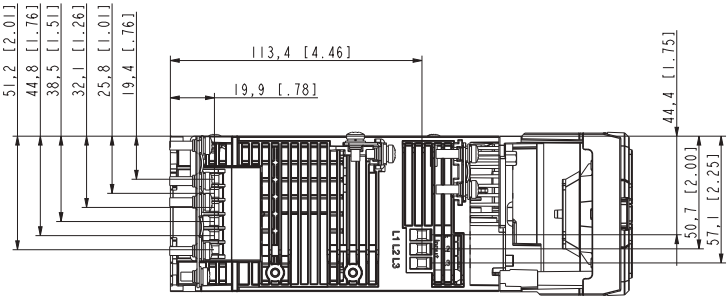
The chapter contains the dimension drawings of the drive. The dimensions are in millimeters and inches.

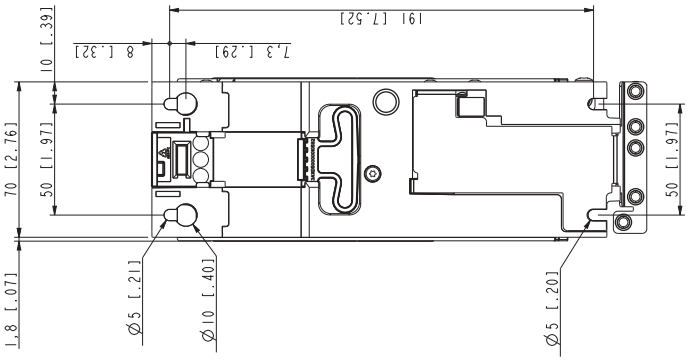
Frame R0

Frame R0(front & side) - IP20



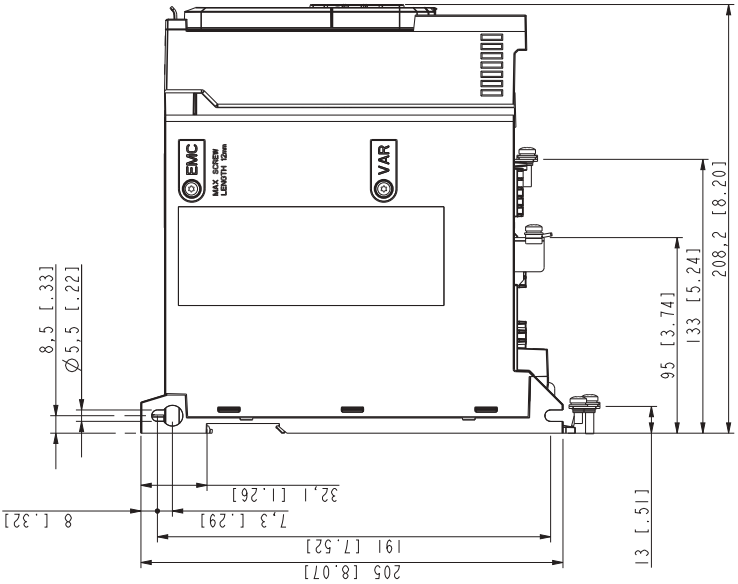
Frame R0(bottom & rear) - IP20

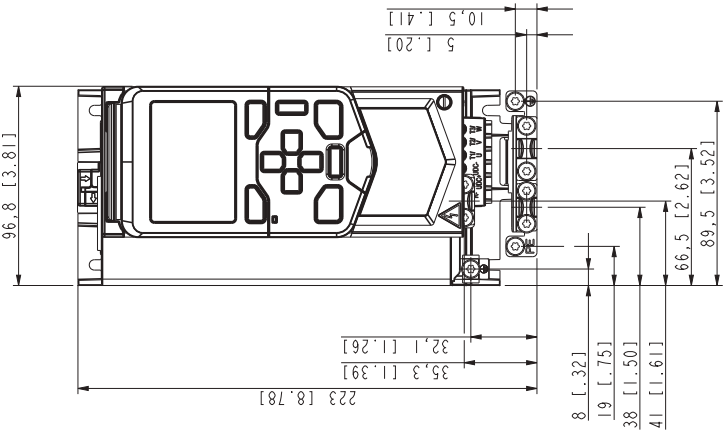




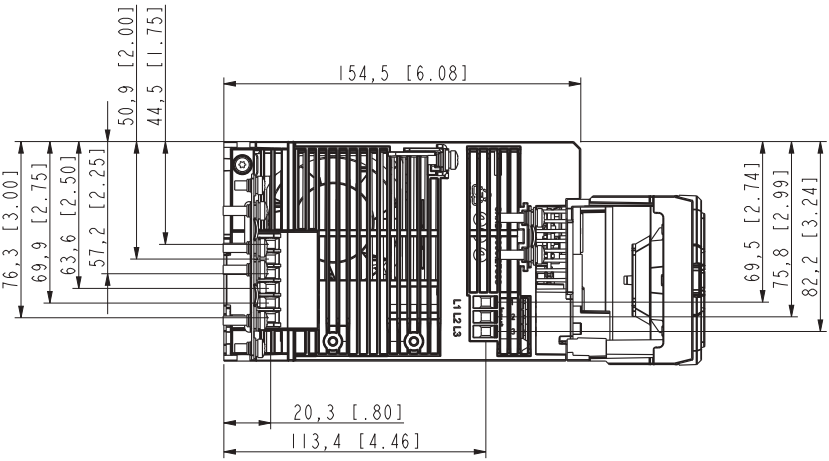
Frame R1

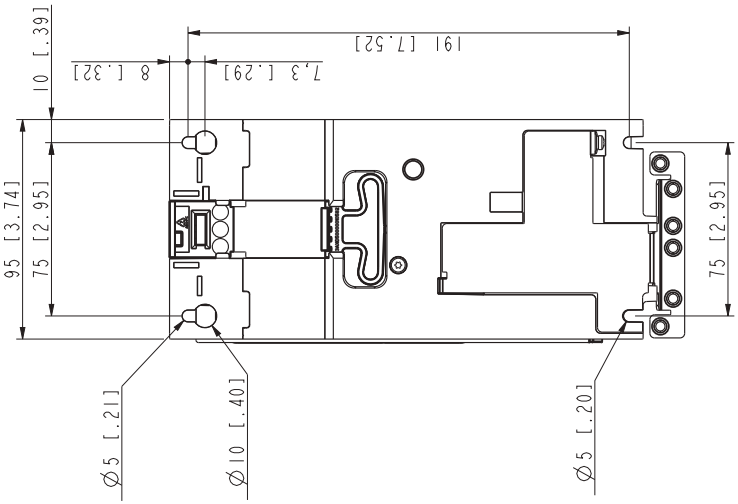
Frame R1(front & side) - IP20





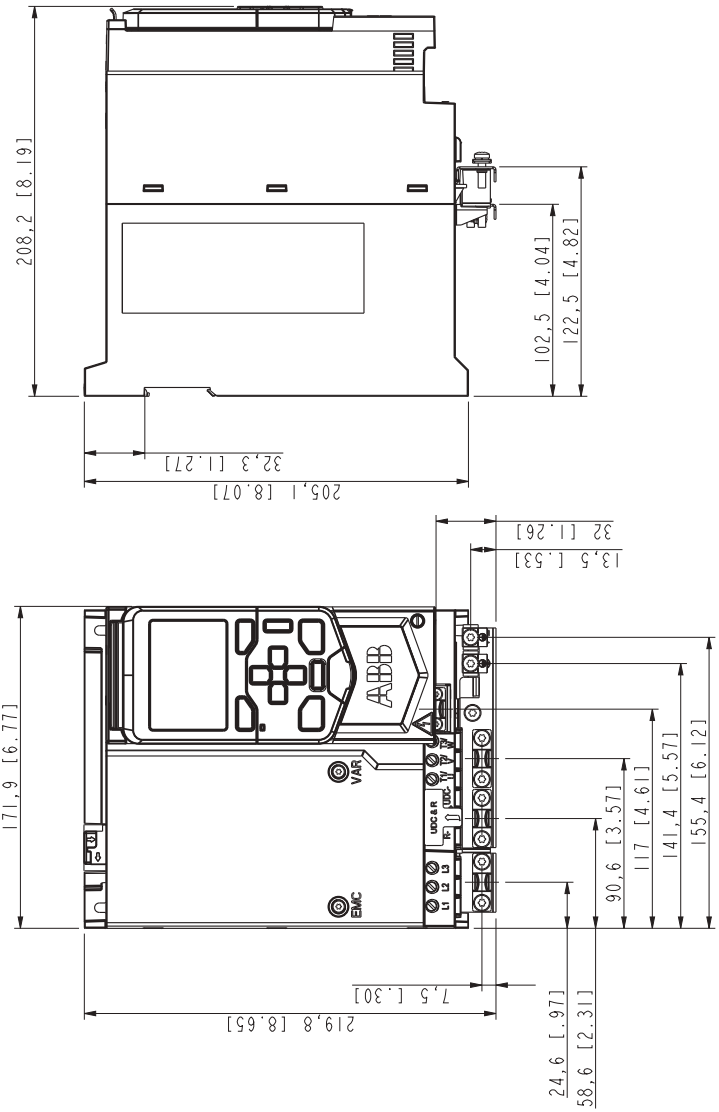
Frame R1(bottom & rear) - IP20



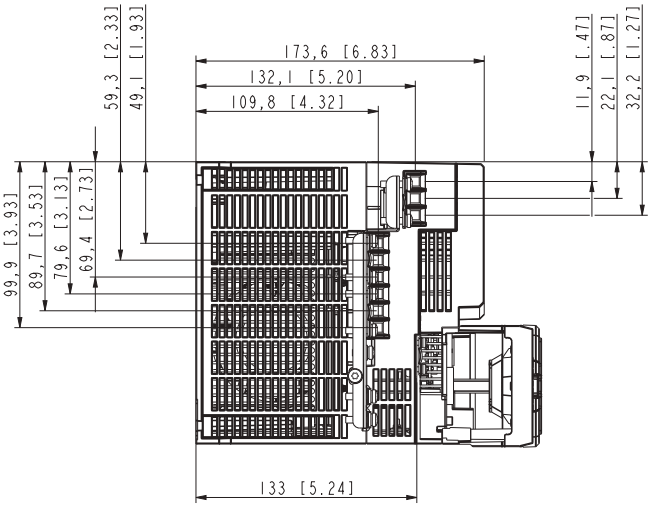


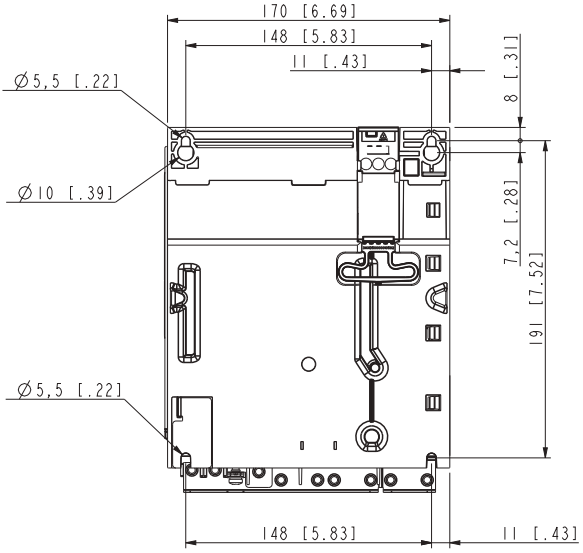
Frame R2

Frame R2(front & side) - IP20



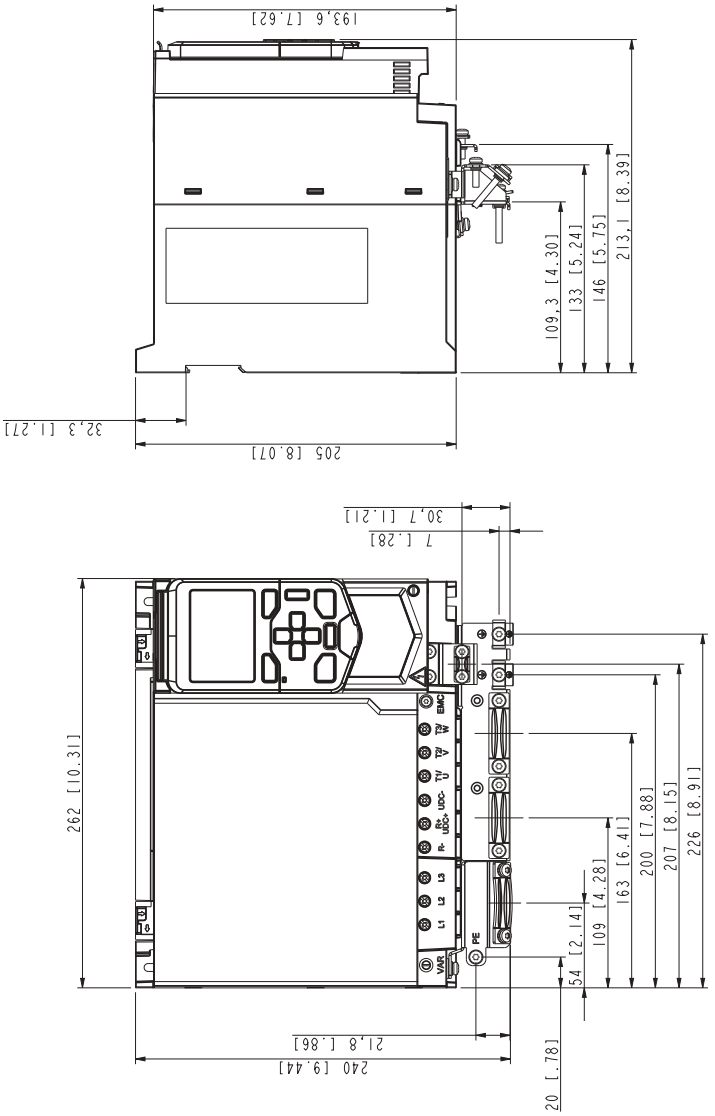
Frame R2(bottom & rear) - IP20



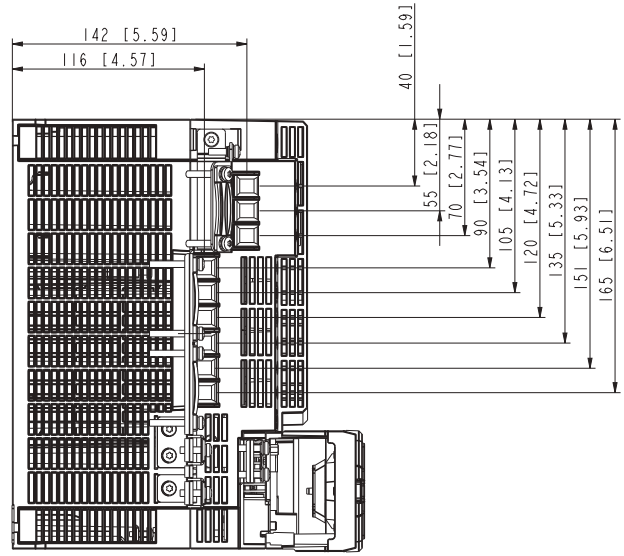


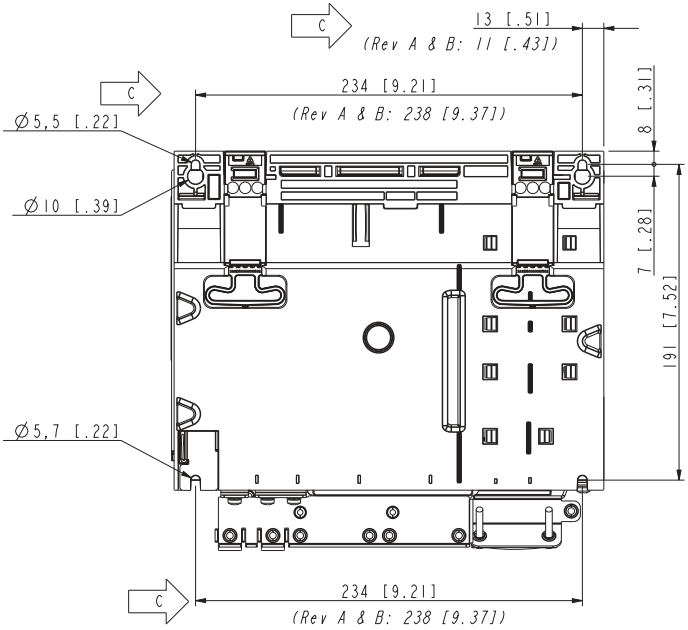
Frame R3

Frame R3(front & side) - IP20



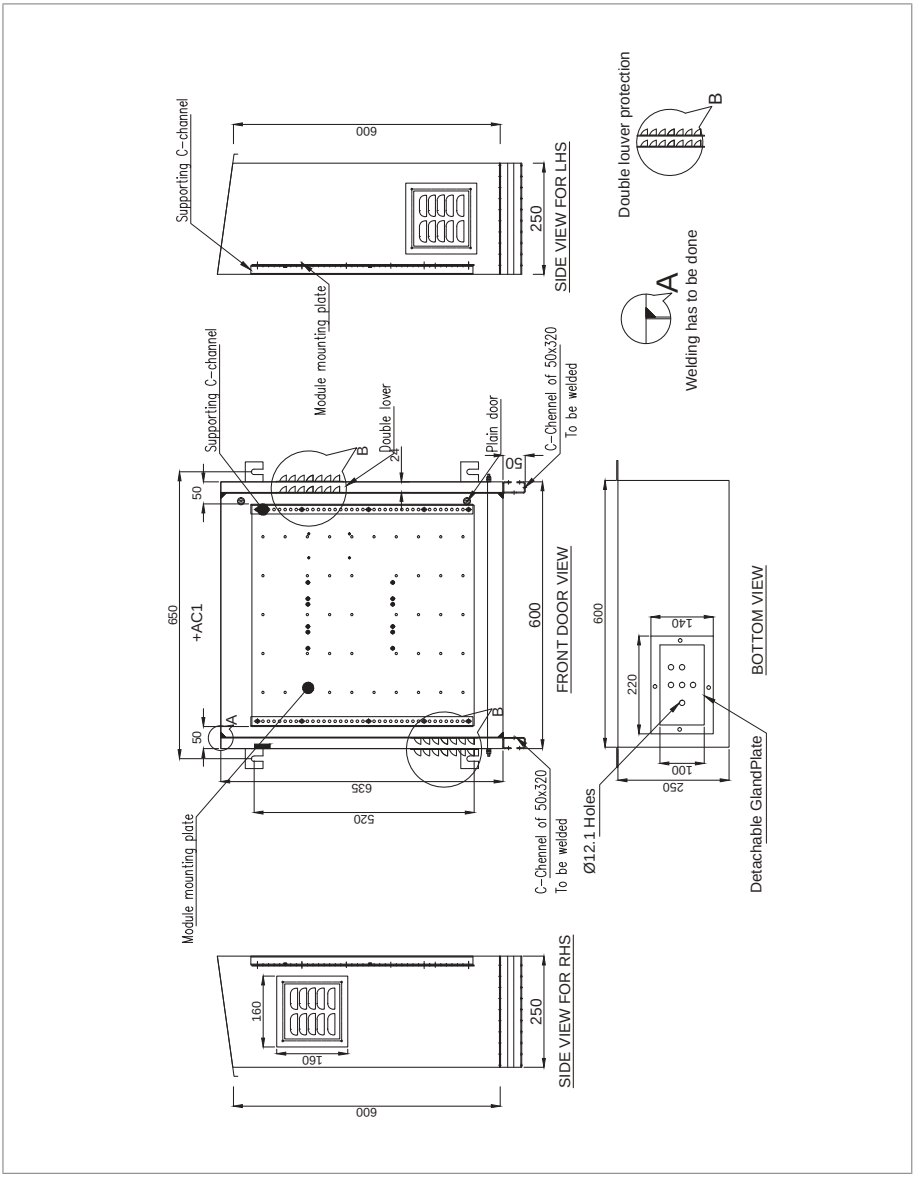
Frame R3(bottom & rear) - IP20

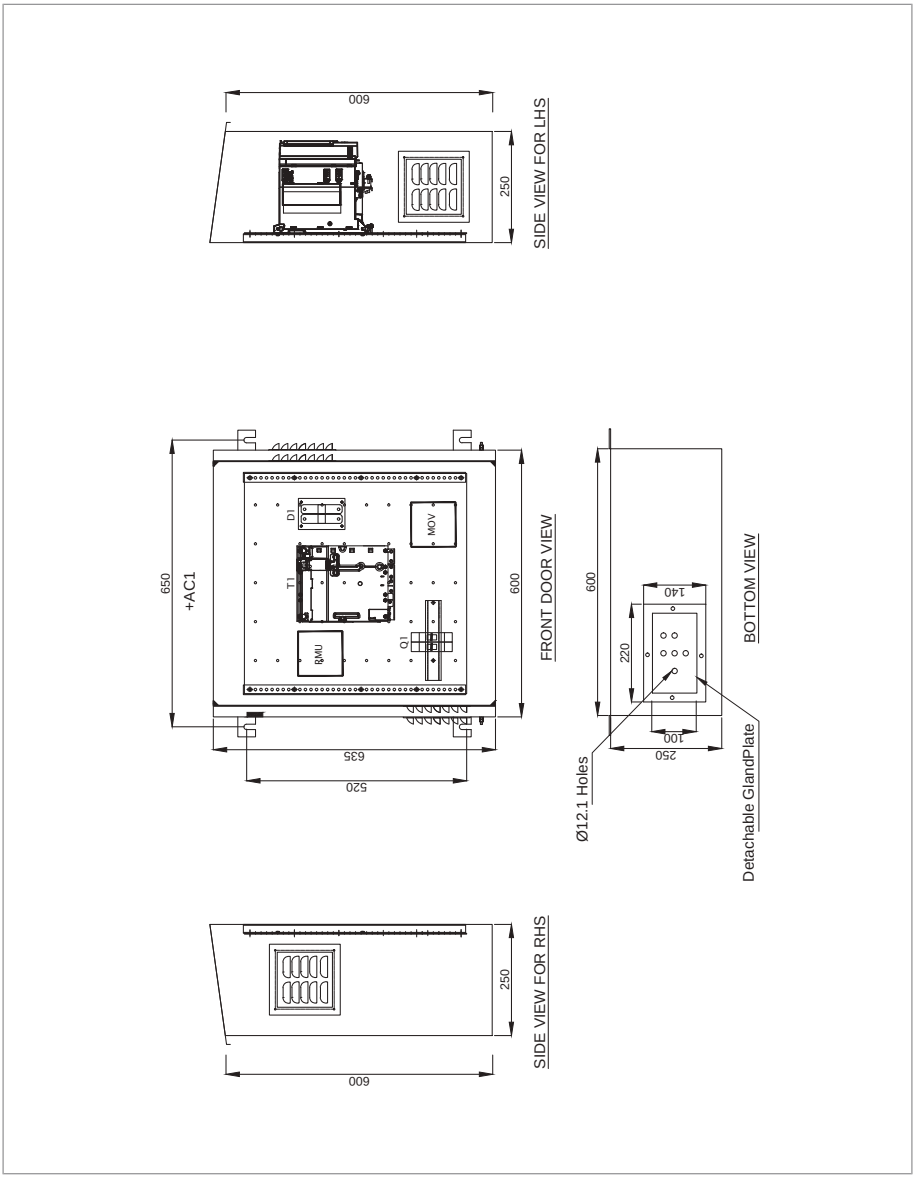




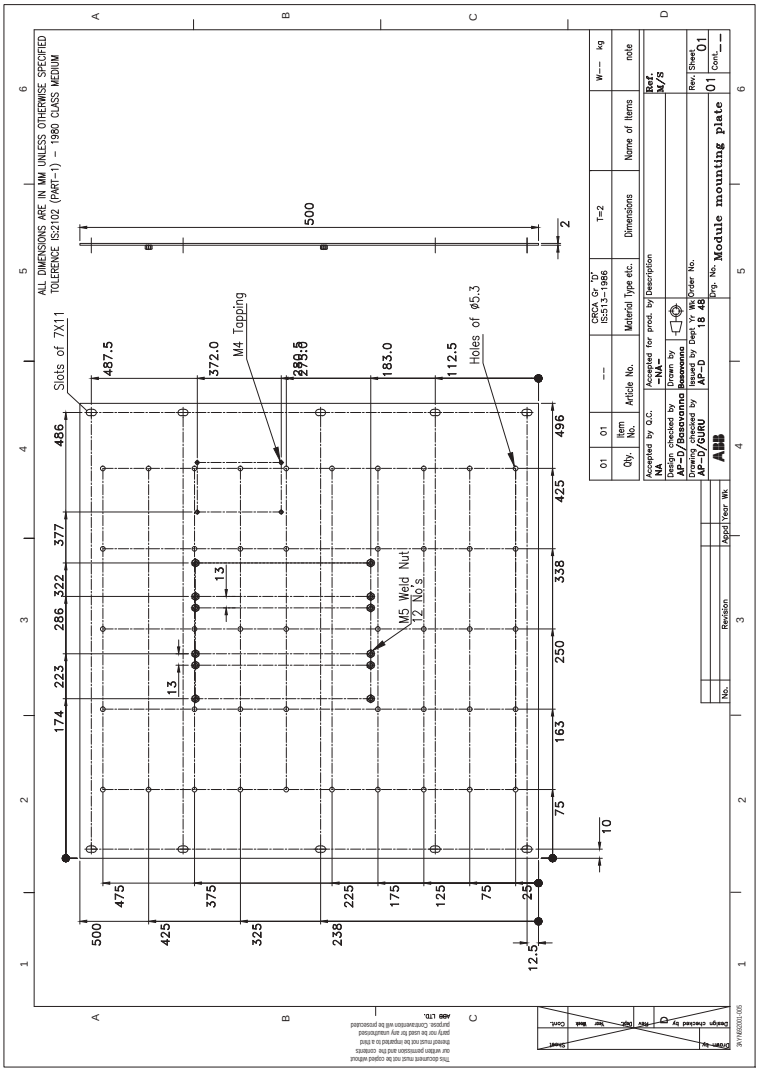
Recommended cabinet design

Cabinet assembly drawings

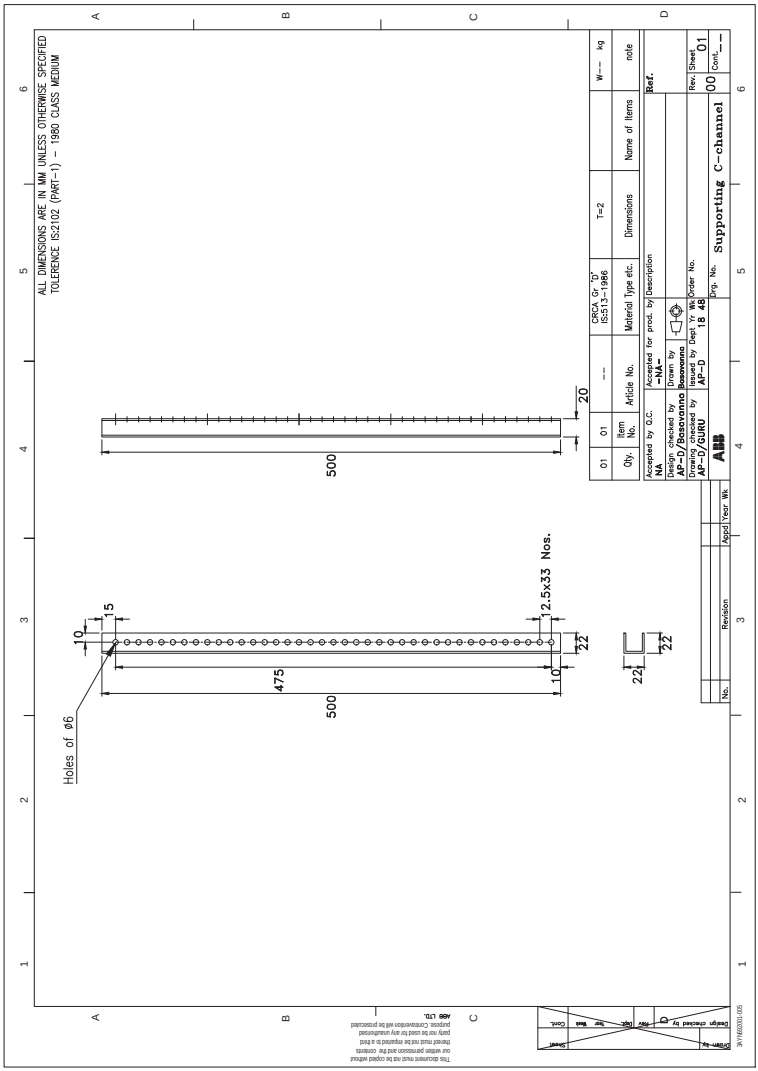



600
250
SIDE VIEW FOR LHS
650
+AC1
D1
MOV
T1
BMU
Q1
600
FRONT DOOR VIEW
635
520
600
140
220
100
250
BOTTOM VIEW
Ø12.1 Holes
Detachable GlandPlate
250
SIDE VIEW FOR RHS
600

Module mounting plate detail drawing

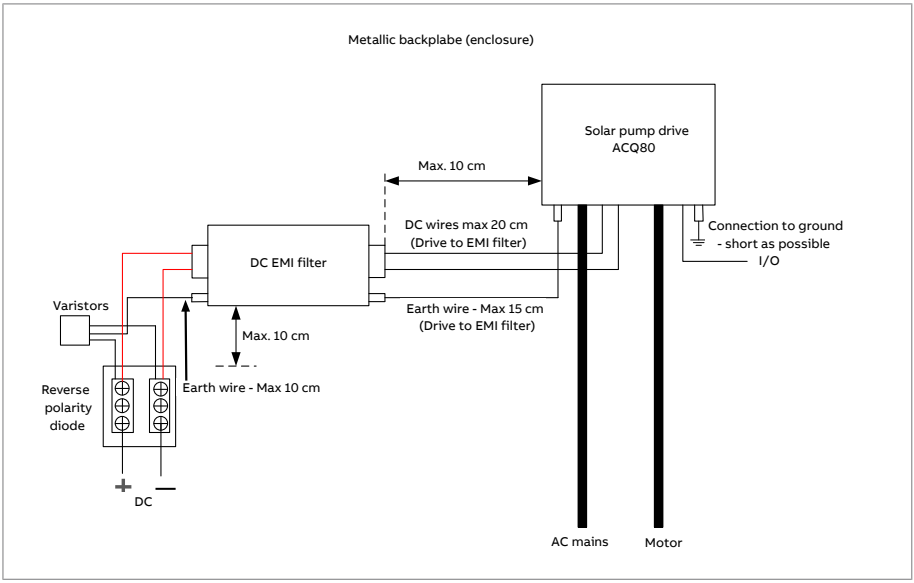


Supporting C clamp detail drawing



EMI filter layout diagram

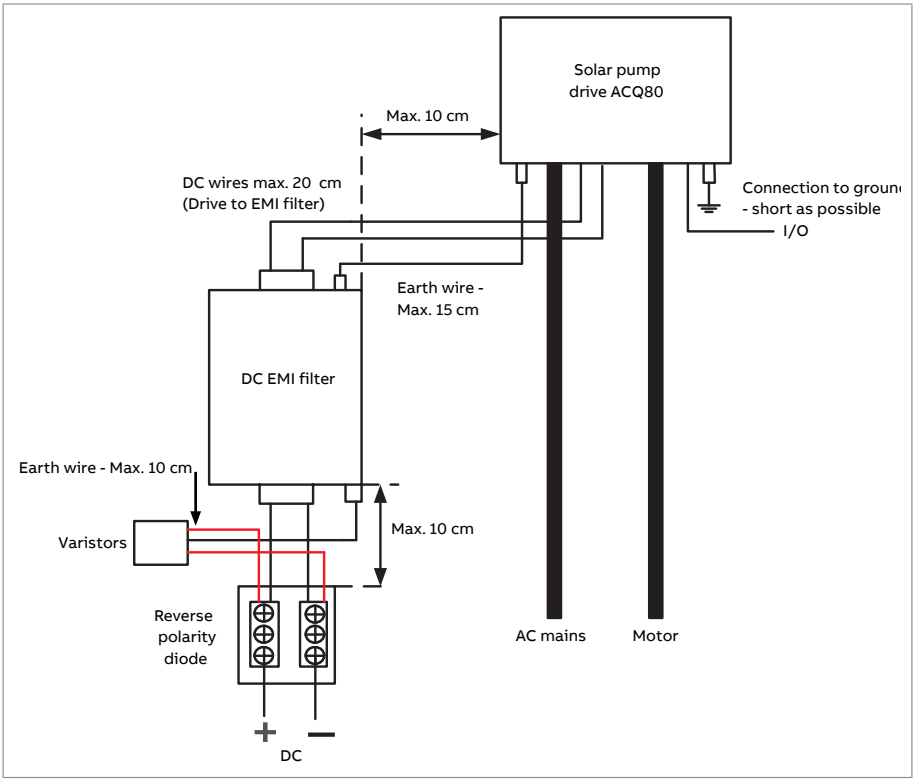
EMI filter layout - Horizontal position

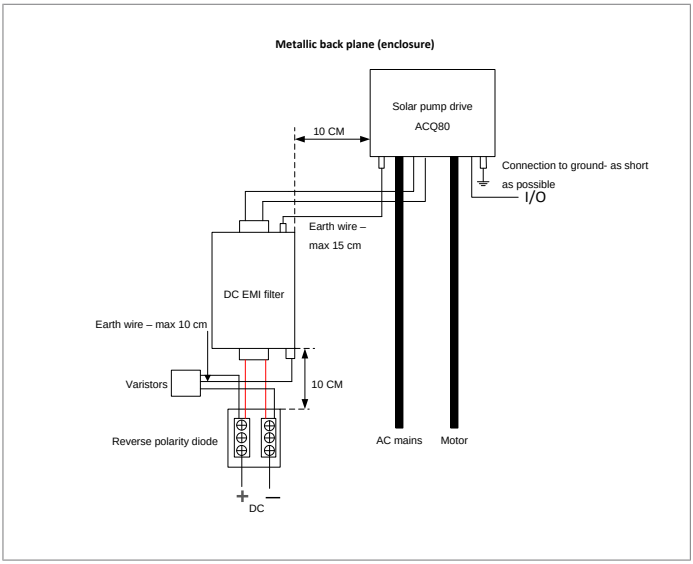


Note:

- Keep AC, DC and motor cables separated to avoid interferences.
- Do not connect reverse polarity diodes directly to ground.

EMI filter layout - Vertical position





Note:

- Keep AC, DC and motor cables separated to avoid interferences.
- Do not connect reverse polarity diodes directly to ground.

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

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

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

The Safe torque off function complies with these standards:

Standard	Name
IEC 60204-1:2021 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
IEC 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2017	Functional safety – Safety instrumented systems for the process industry sector
IEC 61800-5-2:2016 EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation

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

Compliance with the European Machinery Directive and the UK Supply of Machinery (Safety) Regulations

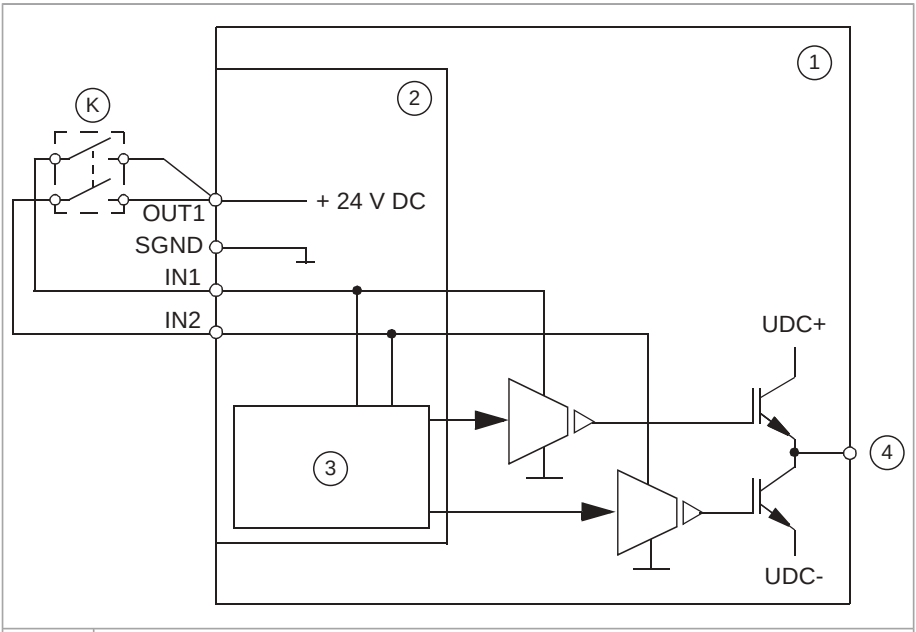
See the technical data.

Wiring

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

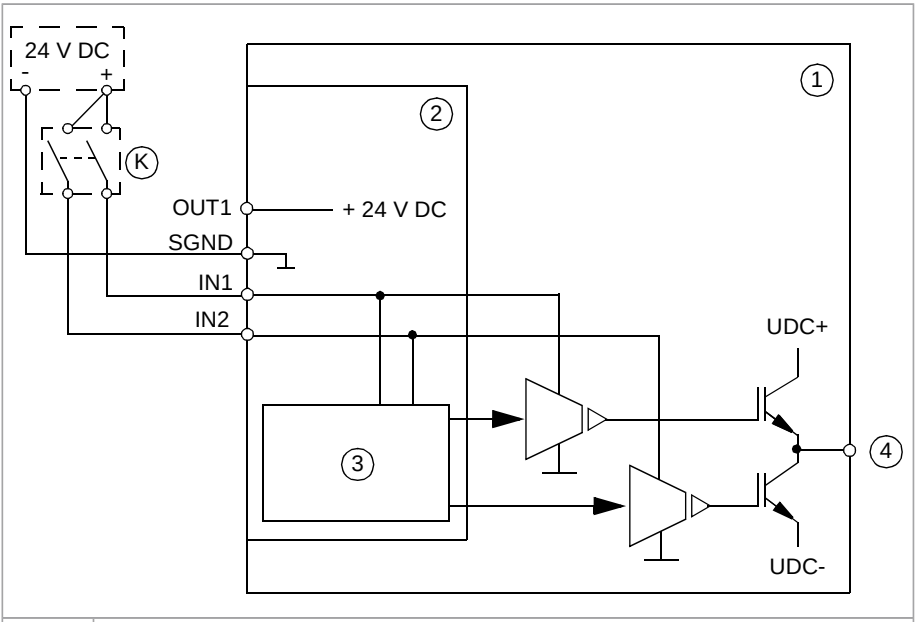
Connection principle

Single ACQ80-04 drive, internal power supply



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

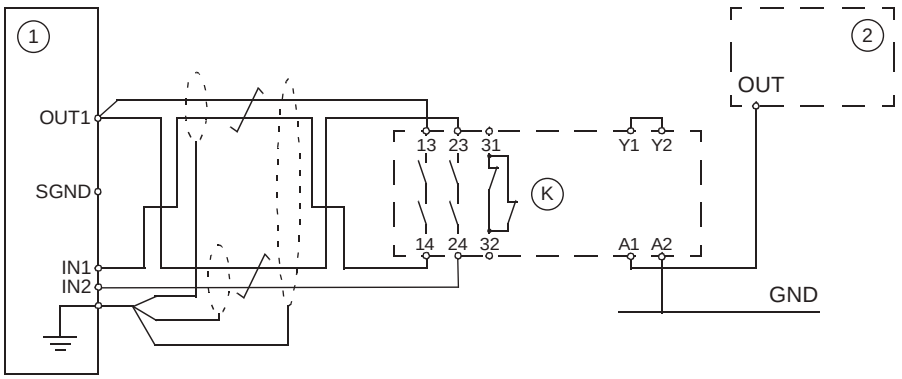
Single ACQ80-04 drive, external power supply



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

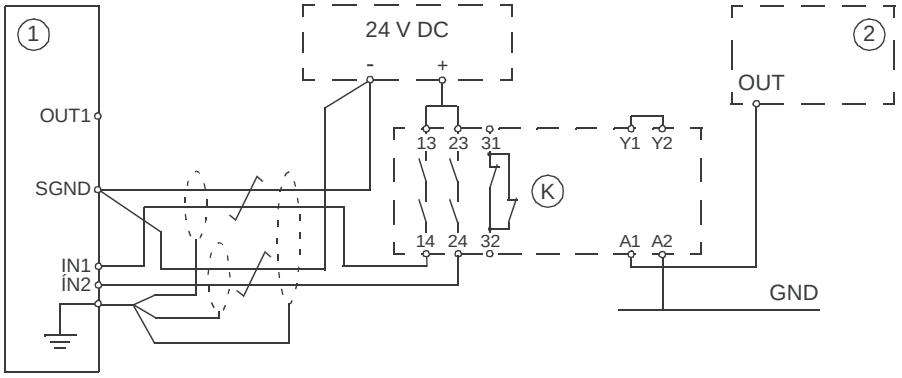
Wiring examples

Single ACQ80-04 drive, internal power supply



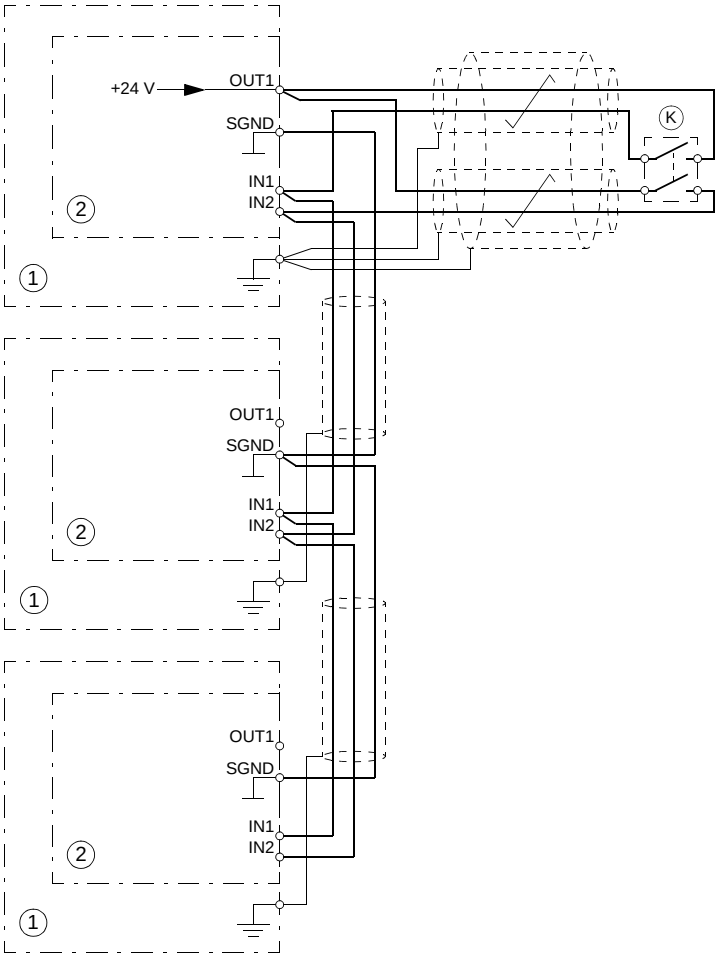
1	Drive
2	Safety PLC
K	Safety relay

Single ACQ80-04 drive, external power supply



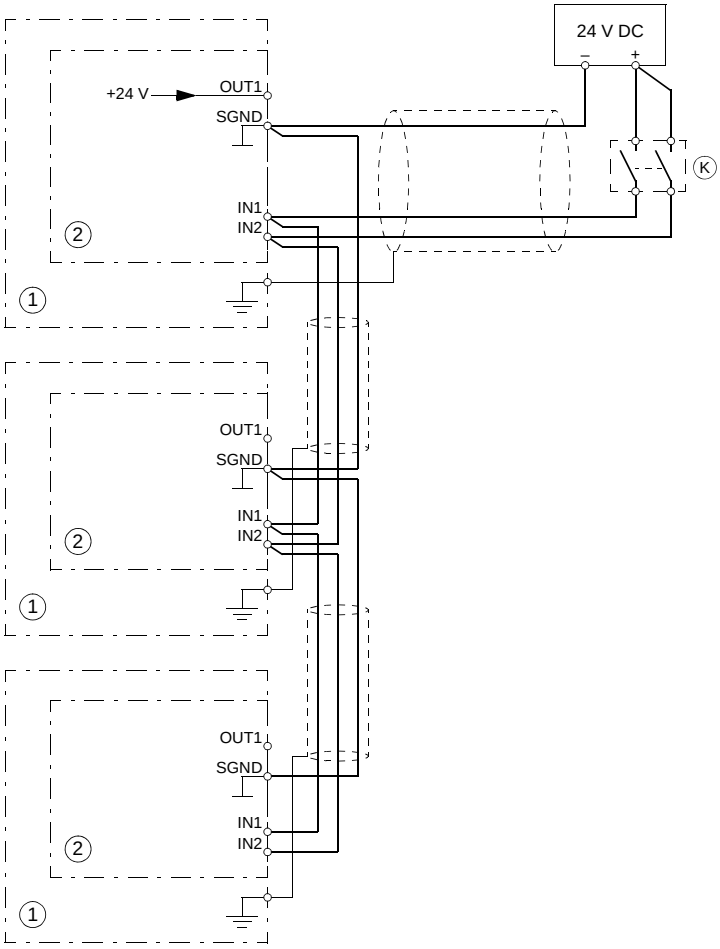
1	Drive
2	Safety PLC
K	Safety relay

Multiple ACQ80-04 drives, internal power supply



1	Drive
2	Control unit
K	Activation switch

Multiple ACQ80-04 drives, external power supply



1	Drive
2	Control unit
K	Activation switch

Activation switch

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

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

Cable types and lengths

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

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

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

The pulse tolerance of the input channels is 1 ms.

Grounding of protective shields

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

Operation principle

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

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

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

Start-up including validation test

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

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

Competence

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

Validation test reports

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

Validation test procedure

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

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

Action	☑
Test the operation of the STO function when the motor is stopped. • Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Make sure that the drive operates as follows: • Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter 31.22 (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the STO function when the motor is running. • Start the drive and make sure the motor is running. • Open the STO circuit. The motor should stop. The drive generates an indication if one is defined for the 'running' state in parameter 31.22 (see the firmware manual). • Reset any active faults and try to start the drive. • Make sure that the motor stays at a standstill and the drive operates as described above in testing the operation when the motor is stopped. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the failure detection of the drive. The motor can be stopped or running. • Open the 1st input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA81 fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Open the STO circuit (both channels). • Give a reset command. • Close the STO circuit (both channels). • Reset any active faults. Restart the drive and check that the motor runs normally. • Open the 2nd input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA82 fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The motor should not start. • Open the STO circuit (both channels). • Give a reset command. • Close the STO circuit (both channels). • 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 or when the main power to the drive is off. If both STO circuits are closed and a level-type start signal is active when the power is restored, it is possible that the drive starts without a fresh start command. Take this into account in the risk assessment of the system.

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

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

Notes:

- If a running drive is stopped by using the Safe torque off function, the drive will cut off the motor supply voltage and the motor will coast to a stop. If this causes danger or is not otherwise acceptable, stop the drive and machinery using the appropriate stop mode before activating the Safe torque off function.
- The Safe torque off function overrides all other functions of the drive.

- The Safe torque off function is ineffective against deliberate sabotage or misuse.
- The Safe torque off function has been designed to reduce the recognized hazardous conditions. In spite of this, it is not always possible to eliminate all potential hazards. The assembler of the machine must inform the final user about the residual risks.

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 10 years; see section Safety data (page 144). 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 138).

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 138).

Use only spare parts approved by ABB.

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

Competence

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

Fault tracing

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

The diagnostics of the Safe torque off function cross-compare the status of the two STO channels. In case the channels are not in the same state, a fault reaction function is performed and the drive trips on an FA81 or FA82 fault. An attempt to use the STO in a non-redundant manner, for example activating only one channel, will trigger the same reaction.

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

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

Safety data

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

Note: The safety data is calculated for redundant use, and applies only if both STO channels are used.

Frame size	SIL	SC	PL	SFF (%)	PFH (T_1 = 20 a) (1/h)	PFD_{avg} (T_1 = 2 a)	PFD_{avg} (T_1 = 5 a)	PFD_{avg} (T_1 = 10 a)	$MTTF_D$ (a)	DC (%)	Cat.	HFT	CCF	T_M (a)	PFH_{diag} (1/h)	λ_{Diag_s} (1/h)	λ_{Diag_d} (1/h)
R0	3	3	e	>99	7.65E-09	6.71E-05	1.68E-04	3.36E-04	2210	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R1	3	3	e	>99	7.65E-09	6.71E-05	1.68E-04	3.36E-04	2209	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R2	3	3	e	>99	7.61E-09	6.68E-05	1.67E-04	3.34E-04	2569	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R3	3	3	e	>99	2.62E-09	2.31E-05	5.75E-05	1.15E-04	2823	≥90	3	1	80	20	1.53E-08	6.06E-08	2.89E-08
3AXD10001401865 E, 3AXD10001613533 C																	

- The STO is a type B safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested
  - A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO response times:
  - STO reaction time (shortest detectable break): 1 ms
  - STO response time: 5 ms (typical), 15 ms (maximum)
  - Fault detection time: Channels in different states for longer than 200 ms
  - Fault reaction time: Fault detection time + 10 ms.
- Indication delays:
  - STO fault indication (parameter 31.22) delay: < 500 ms
  - STO warning indication (parameter 31.22) delay: < 1000 ms.

Terms and abbreviations

Term or abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage (%)
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	EN ISO 13849-1	Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD_{avg}	IEC 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs

Term or abbreviation	Reference	Description
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time
PFH_{diag}	IEC/EN 62061	Average frequency of dangerous failures per hour for the diagnostic function of STO
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL
Proof test	IEC 61508, IEC 62061	Periodic test performed to detect failures in a safety-related system so that, if necessary, a repair can restore the system to an "as new" condition or as close as practical to this condition
SC	IEC 61508	Systematic capability (1…3)
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1…3)
STO	IEC/EN 61800-5-2	Safe torque off
T_1	IEC 61508-6	Proof test interval. T_1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T_1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. See also section Maintenance.
T_M	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any T_M values given cannot be regarded as a guarantee or warranty.
λ_{Diag_d}	IEC 61508-6	Dangerous failure rate (per hour) of the diagnostics function of STO
λ_{Diag_s}	IEC 61508-6	Safe failure rate (per hour) of the diagnostics function of STO

TÜV certificate

The TÜV certificate is available on the Internet.

12

BIO-01 I/O extension module

Contents of this chapter

This chapter contains a description and technical data of the optional BIO-01 I/O extension module.

Safety instructions

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

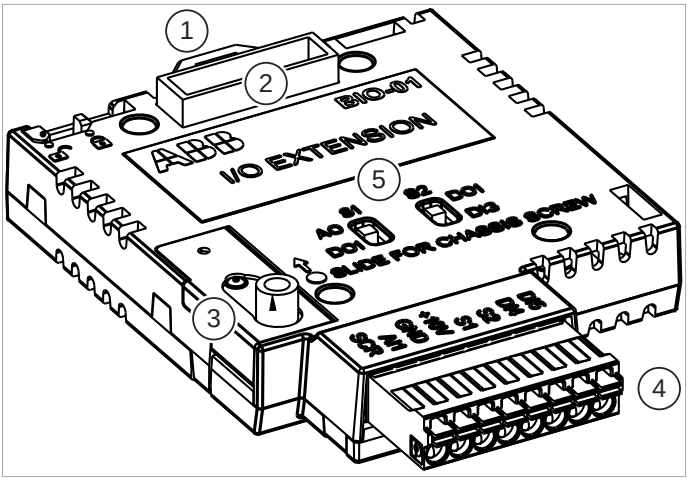
Hardware description

Product overview

BIO-01 (option +L515) is an I/O extension module to be used with a fieldbus adapter module. The BIO-01 module is installed between the drive and the fieldbus module.

BIO-01 has two digital inputs (DI4, DI5) and one analog input (A1). It also has two terminals (S1, S2) that can be configured with the switches on the module. S1 can be configured as analog output (AO1) or digital output (DO1). S2 can be configured as digital output (DO1) or digital input (DI3).

Layout



1. Locking tab
2. Option module slot
3. Chassis screw
4. I/O connector
5. Switches for configuring terminals S1 and S2

Mechanical installation

See the electrical installation instructions of the drive.

Before you install the BIO-01 option module, make sure that the chassis screw slider is in the top position. After the option module is installed, tighten the chassis screw and move the slider to the bottom position.

The BIO-01 option module kit comes with a higher cable clamp plate. Use this cable clamp plate to ground the wires that connect to the BIO-01 option module.

Terminal configuration

You must configure terminals S1 and S2 before you install the fieldbus module. Refer to the table that follows for the possible configurations:

Setting		**Result**		
Switch S1	**Switch S2**	**Terminal S1 functions as**	**Terminal S2 functions as**	**Supported configuration**
DO1 (default)	DI3 (default)	Digital output DO1	Digital input DI3	Yes
AO1	DI3 (default)	Analog output AO1	Digital input DI3	Yes
AO1	DO1	Analog output AO1	Digital output DO1	Yes
DO1 (default)	DO1	-	-	No

If you change the switch configuration while the drive is powered on, the drive will trip on a fault. Also, an unsupported configuration will cause the drive to trip on a fault.

Electrical installation

The BIO-01 module has removable spring clamp terminals. Use ferrules on the multistranded conductor ends.

The connection diagram below is applicable to drives with the BIO-01 I/O extension module when the ABB standard macro is selected (parameter 96.04).

Start-up

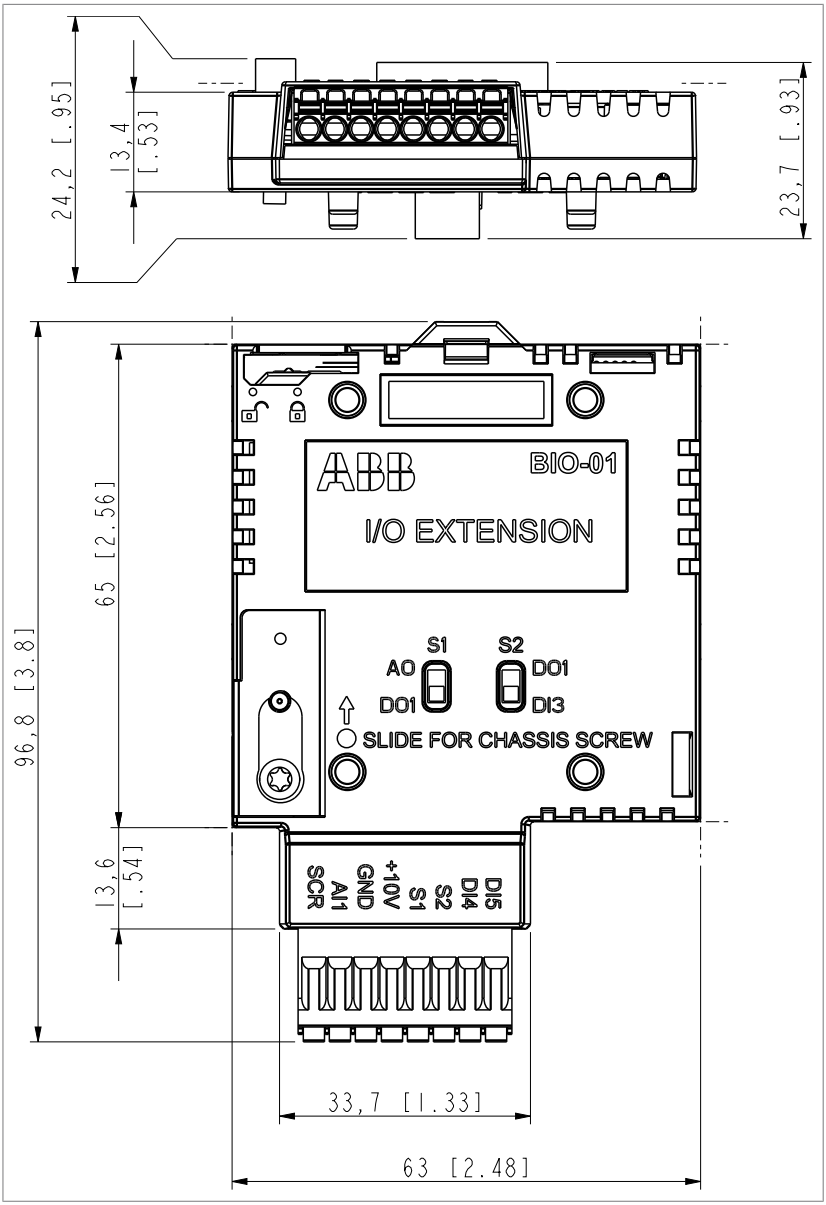
The BIO-01 module is automatically identified by the drive firmware. To configure the inputs and outputs, refer to the drive firmware manual.

Technical data

Control connection data: Spring type terminal blocks. Conductor size accepted by the terminals: 0.2 … 1.5 mm^2 (24 … 16 AWG). Exception: max. 0.75 mm^2 (18 AWG) for a multistranded conductor with a ferrule and plastic sleeve.

Internal connections of GND and SCR terminals

Dimensions



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/contact-centers.

Product training

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

Providing feedback on ABB manuals

Your comments on our manuals are welcome. Navigate to forms.abb.com/form-26567.

Document library on the Internet

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

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