ABB MACHINERY DRIVES

ACS280-04LC

Hardware manual

ACS280-04LC

Hardware manual

3AXD50001176129 Rev A
EN
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Table of contents

5 Guidelines for planning the electrical installation

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 personnel who do work on the drive.

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

- Keep the drive in its package until you install it. After unpacking, protect the drive from dust, debris and moisture.
- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, and brake resistors, remain hot for a while after disconnection of the electrical supply.
- 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.
- Vacuum clean the area around the drive before the start-up to prevent the drive cooling fan from drawing dust inside the drive.
- Make sure that debris from drilling, cutting and grinding does not go into the drive during installation. Electrically conductive debris inside the drive can cause damage or malfunction.
- Make sure that 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.
- 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 activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or supply break. If these functions are activated, the installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- If you have connected safety circuits to the drive (for example, Safe torque off or emergency stop), validate them at start-up. See separate instructions for the safety circuits.
- Do not cover the air inlet or outlet when the drive is running.

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 electrical installation or maintenance work. Do these steps before you do 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 there is a permanent magnet motor connected 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 high-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 input power terminals of the drive (L1, L2, L3) and the grounding (PE) busbar is zero.
   - Make sure that the voltage between the output power terminals of the drive (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.
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 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 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:

- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors. If you need to start or stop the drive, use the control panel keys or commands through the I/O terminals of the drive or the fieldbus interface.
- 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 11).
- 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!
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2

Introduction to the manual

Contents of this chapter

This chapter describes the intended audience and contents of the manual. It contains a flowchart of steps in examining the delivery, installing and commissioning the drive. The flowchart refers to chapters/sections in this manual and other manuals.

Applicability

This manual is applicable to ACS280-04LC drives.

Target audience

The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

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

Purpose of the manual

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

Categorization by frame size

The drives are manufactured in frame sizes R1. The instructions and information that is applicable only to certain frames indicate 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.	Type designation key (page 22)
⬇	
Plan the installation. Examine the ambient conditions, ratings and required cooling air flow.	Electrical installation (page 41) Technical data (page 51)
⬇	
Unpack and examine the drive.	Unpacking the delivery (page 25)
⬇	
If the drive will be connected to an IT (ungrounded) system, make sure that the internal EMC filter is not connected.	Grounding system compatibility check (page 41)
⬇	
Install the drive mechanically.	Installing the drive (page 26)
⬇	
Route the cables.	Electrical installation (page 41)
⬇	
Connect the power cables.	Connecting the power cables (page 44)
⬇	
Examine the installation.	Installation checklist (page 47)
⬇	
Commission the drive.	Refer to the ACS280-04LC Firmware manual (3AXD50001176143 [English]).

Terms and abbreviations

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

Related documents

Name	Code
Drive manuals and guides	
ACS280-04LC hardware manual	3AXD50001176129
ACS280-04LC quick installation and startup guide	3AXD50001176112
ACS280-04LC firmware manual	3AXD50001176143
ACS280-04LC recycling instructions and environmental information	3AXD50001176167
Option manuals and guides	
ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panel user’s manual	3AUA0000085685
Tool and maintenance manuals	
Drive Composer Start-up and maintenance PC tool user’s manual	3AUA0000094606
Converter module capacitor reforming instructions	3BFE64059629

Manuals on internet

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

ACS280 manuals

3

Operation principle and hardware description

Contents of this chapter

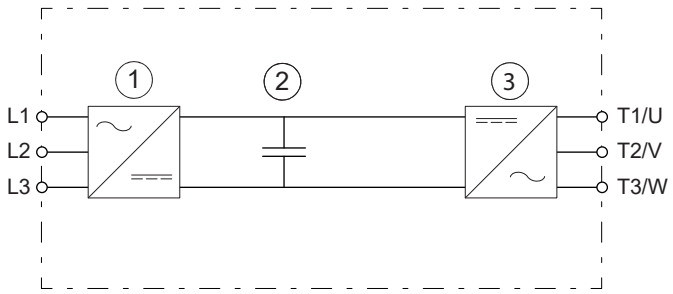
This chapter briefly describes the operation principle and construction of the drive.

Operation principle

The ACS280-04LC is a drive for controlling asynchronous AC induction motors and permanent magnet synchronous motors.

Simplified main circuit diagram

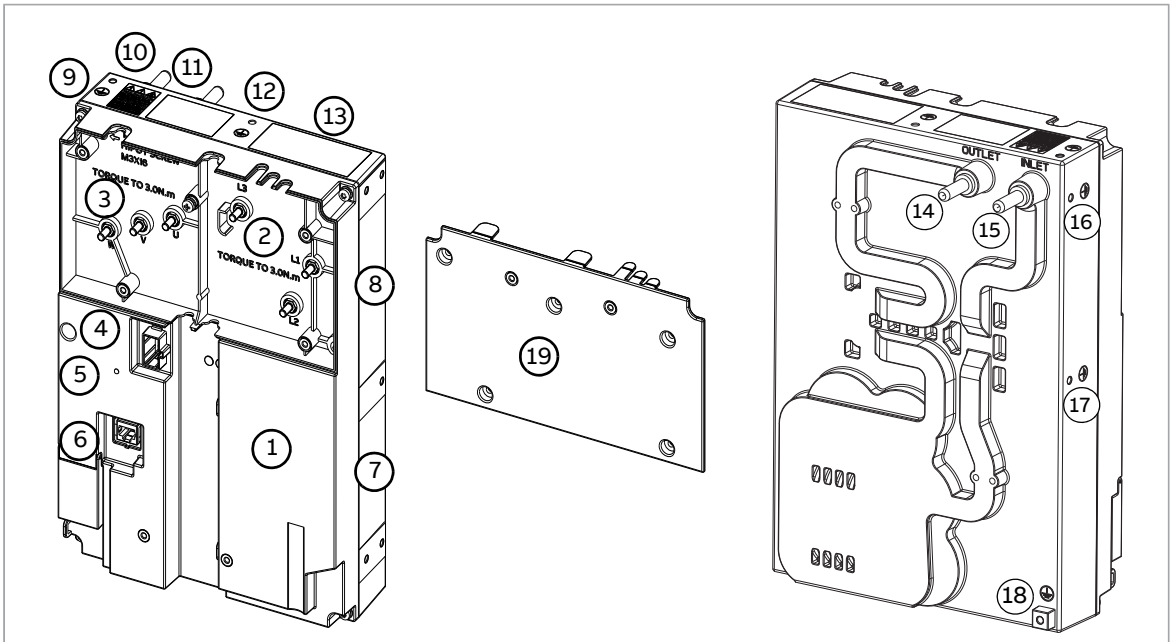
The figure shows the simplified main circuit diagram of the drive.



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

Layout

Frame sizes R1



1	Front enclosure	11	Input voltage lable
2	Input power connection terminals	12	Grounding hole for input power cables
3	Motor connection terminal	13	Type designation lable
4	Cold configuration connection for CCA-01	14	Liquid inlet
5	Power LED	15	Liquid inlet
6	Panel and PC tool port (RJ45)	16	Grounding hole
7	Cold plate	17	Grounding hole
8	M5 mounting holes	18	Grounding hole
9	Grounding hole for motor power cables	19	Top cover
10	Warning label		

Control connections

For detailed information of control connections, please refer to the supplement instruction included with the delivery.

Control panel options

The drive supports these control panels:

- ACS-AP-S assistant control panel
- ACS-AP-W assistant control panel with Bluetooth
- ACS-BP-S basic control panel

For information on the assistant control panels, refer to the *ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual* (3AUA0000085685 [EN]).

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

Type	Description
DPMP-01	Control panel mounting platform (flush mounting) and cable.
DPMP-02	Control panel mounting platform (surface mounting) and cable.
DPMP-04	Lockable mounting platforms for drive control panels in outdoor installations or harsh environments.

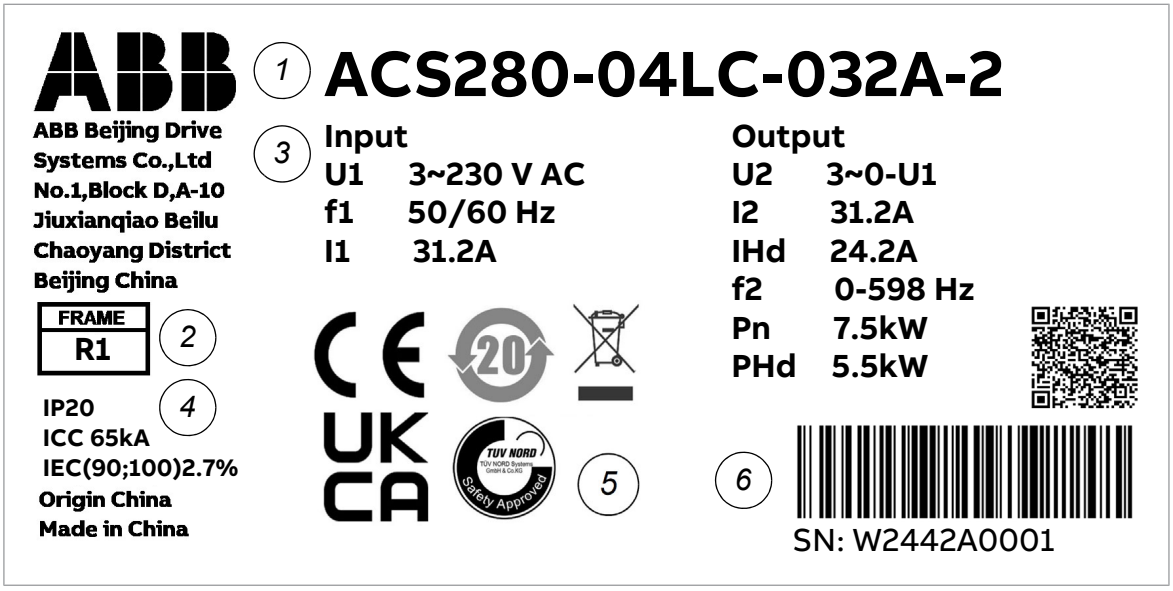
Drive labels

The drive has three labels:

- warning label at the top of the drive
- input voltage label at the top of the drive
- type designation label at the top of the drive

Example labels are shown in this section.

Type designation label



Code	Description
1	Drive type
2	Frame size
3	Nominal ratings
4	Degree of protection
5	Valid markings
6	S/N: Serial number of format MYYWWRXXXX, where M: Manufacturer designation YY: Year of manufacture: 20, 21, 22, … for 2020, 2021, 2022, … WW: Week of manufacture: 01, 02, 03, … for week 1, week 2, week 3, … R: Hardware revision that starts from A. XXXX: Running item number that starts each week from 0001.

Type designation key

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

Sample type code: ACS280-04LC-032A-2

Code	Description
ACS280	Product series
04LC	Construction. 04=Drive module, IP00
032A	Nominal current. See the ratings table in the technical data.
2	Voltage rating. 1=1-phase 230 V AC, 2=3-phase 230V AC, 4=3-phase 380…480 V AC.

Control panel

Control panels (ACS-BP-S, ACS-AP-x, ACS-AP-W) can be used with ACS280-04LC. Refer to the relevant panel manuals.

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 onto a flat plate with screws.

Installation requirements:

- you can install frame R1 drive titled by up to 90 degrees, from vertical to fully horizontal orientation.
- install the drive inside a cabinet or enclosure

Do not cover the air inlet or outlet when the drive is running.

Examining the installation site

- The ambient conditions of the drive meet the specifications. See the technical data.
- The material behind, above and below the drive is non-flammable.
- There is sufficient free space around the drive for cooling, maintenance, and operation. See the free space specifications for the drive.
- Make sure that there are no sources of strong magnetic fields such as high-current single-core conductors or contactor coils near the drive. A strong magnetic field can cause interference or inaccuracy in the operation of the drive.

Required tools

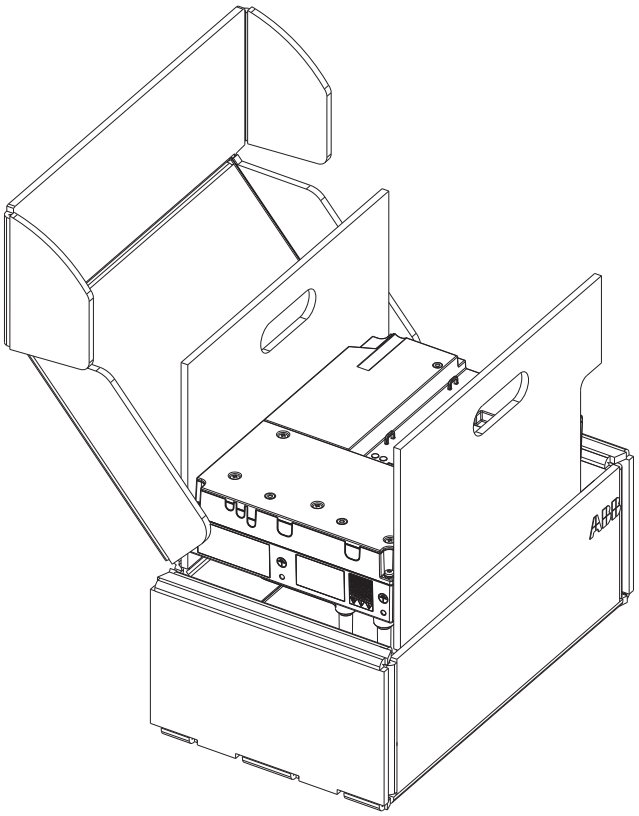
To install the drive mechanically, you need these tools:

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

Unpacking the delivery

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

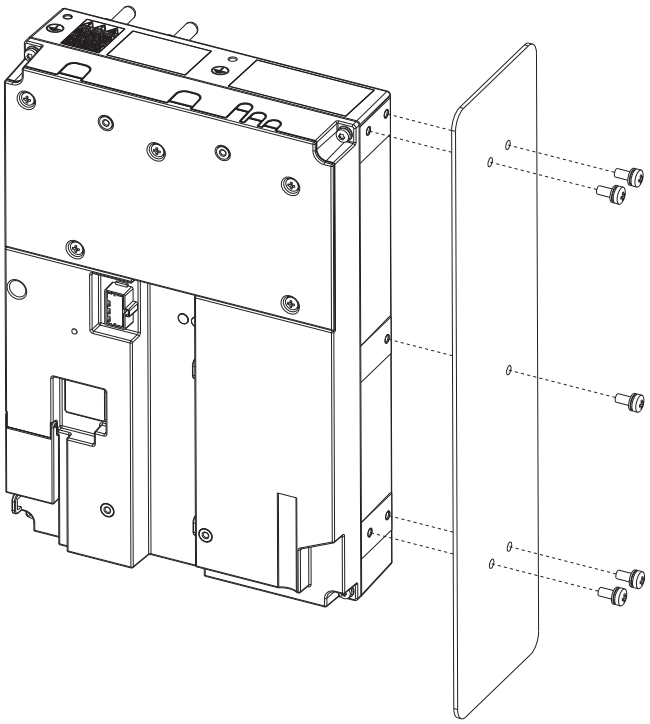
Package contents:



- Drives (Quantity of drives per package varies on different package type)

Installing the drive

ACS280-04LC must be installed onto a suitable flat metallic surface.



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.

- **North America**

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

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

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.

Selecting the main contactor

Follow these guidelines when you select a main contactor:

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

Checking the compatibility of the motor and drive

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 29).

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.

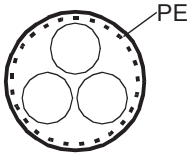
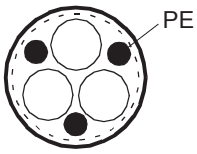
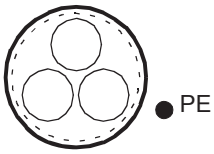
Typical power cable sizes

See the technical data in the appropriate hardware manual.

Power cable types

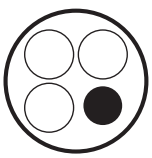
Preferred power cable types

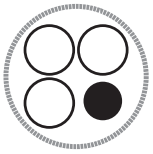
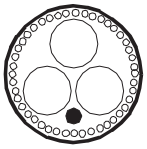
This section shows the preferred cable types. Make sure that the selected cable type also complies with local/state/country electrical codes.

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.

Cable type	Use as input power cabling	Use as motor cabling and as brake resistor cabling
 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

Additional guidelines – North America

ABB recommends the use of metallic conduit for power wiring. ABB also recommends the use of symmetrical shielded VFD cable between drive and motor(s).

This table shows examples of methods for wiring the drive. Refer to NFPA 70 (NEC) along with state and local codes for the appropriate methods for your application.

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

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

2) See NFPA NFPA 70 (NEC), UL, and local codes for your application.

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

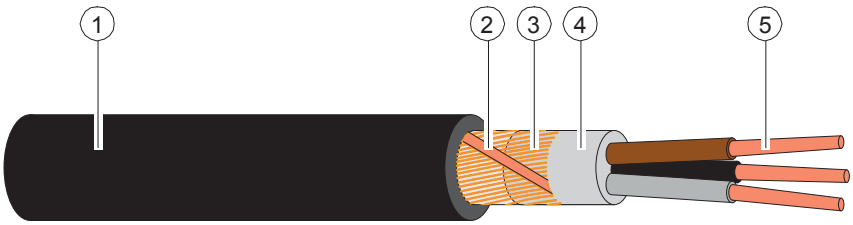
Metal conduit

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

Power cable shield

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

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



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

Grounding

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.

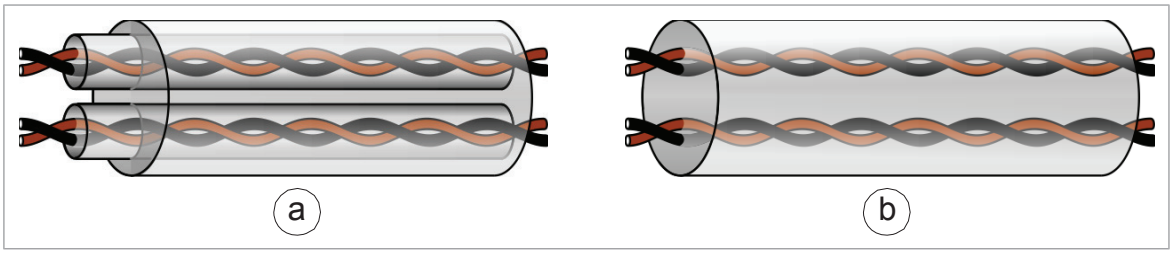
Selecting the control cables

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 RJ45 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).

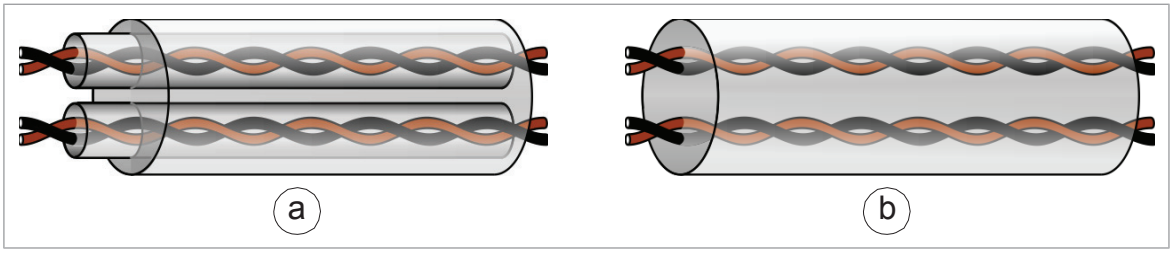
Selecting the control cables

Shielding

Only use shielded control cables.

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

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



Signals in separate cables

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

Signals that can be run in the same cable

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

Relay cable

Recommend to use the cable type with braided metallic shield.

Control panel to drive cable

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

PC tool cable

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

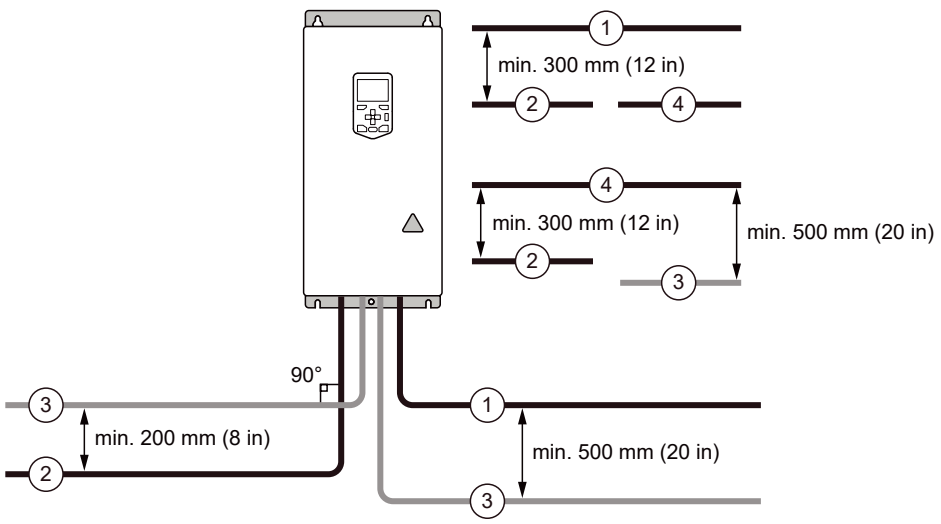
Alternative way is to use the BCBL-01 USB to EIA-485 cable to connect the drive with PC directly

Routing the cables

General guidelines – IEC

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

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



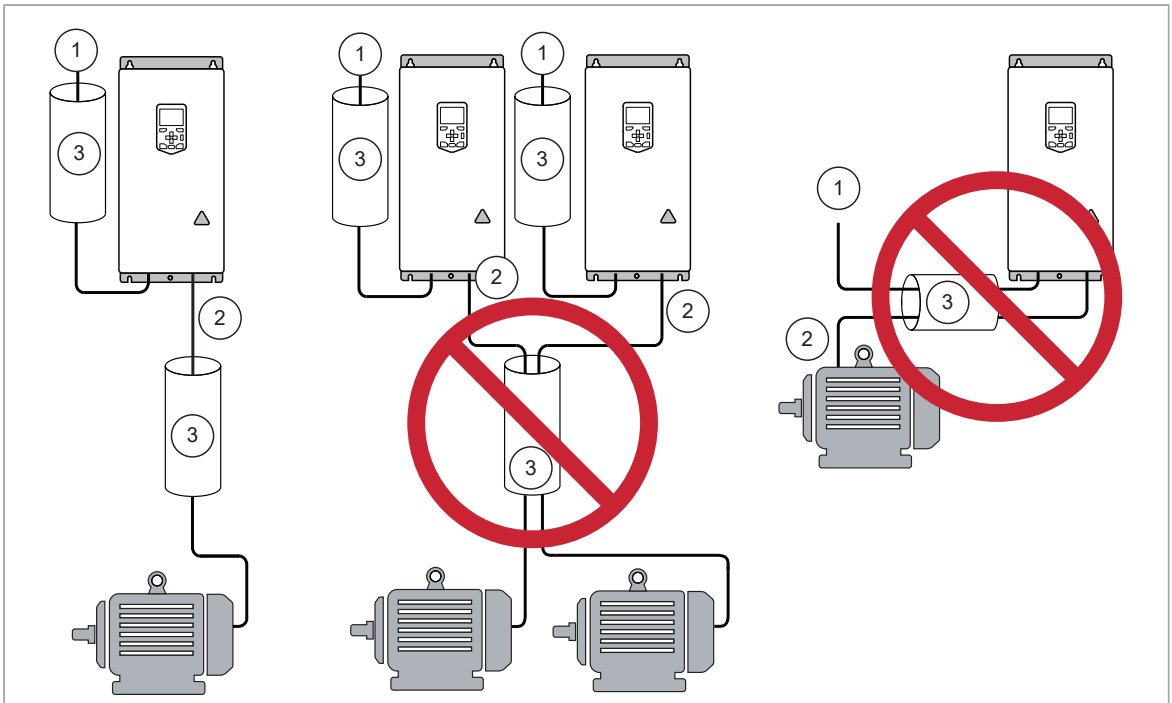
1	Motor cable
2	Input power cable
3	Control cable
4	Brake resistor or chopper cable (if any)

General guidelines – North America

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

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

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



1	Input power cabling
2	Motor cabling
3	Conduit

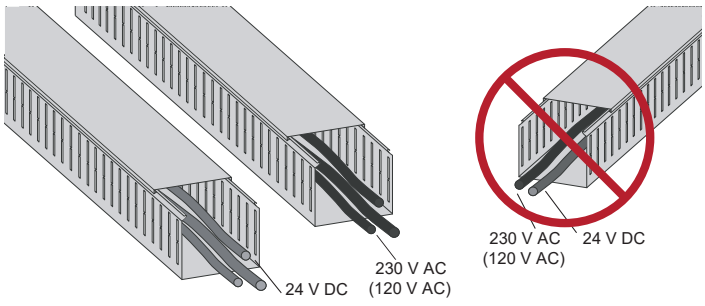
Continuous motor cable shield/conduit and metal enclosure for equipment on the motor cable

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.

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.

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

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

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

For more information, see drive firmware manual.

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

   Note: Extra-low voltage circuits (for example, 24 V DC) typically do not meet these requirements.

As an alternative, you can connect the sensor with basic insulation to the analog/digital input(s) of the drive, if you do not connect any other external control circuits to the drive digital and analog inputs.

3. You can connect a sensor to a digital input of the drive via an external relay. The sensor and the relay must form a double or reinforced insulation between the motor live parts and the digital input of the drive.

Protecting the drive against ground faults

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

Residual current device compatibility

The drive is suitable 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.

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 69).

Using a safety switch between the drive and the motor

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

Implementing the control of a contactor between drive and motor

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

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

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

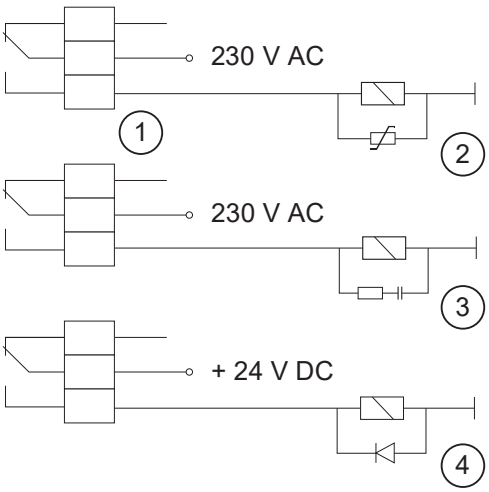
WARNING!
If vector motor control mode is in use, do not open the output contactor while the drive controls the motor. The motor control operates faster than the contactor, and tries to maintain the load current. This can cause damage to the contactor.

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

Protecting the contacts of relay outputs

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

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



1	Relay output
2	Varistor
3	RC filter
4	Diode

6

Electrical installation

Contents of this chapter

This chapter describes how to:

- Do an grounding system compatibility check
- Change the EMC filter connection
- Connect the power and control cables

Warnings

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

Grounding system compatibility check

EMC filter

The drive ACS280-04LC has an internal EMC filter as standard. You can install the drive to a symmetrically grounded TN-S system. If you install the drive to another system, you must disconnect the EMC filter.

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

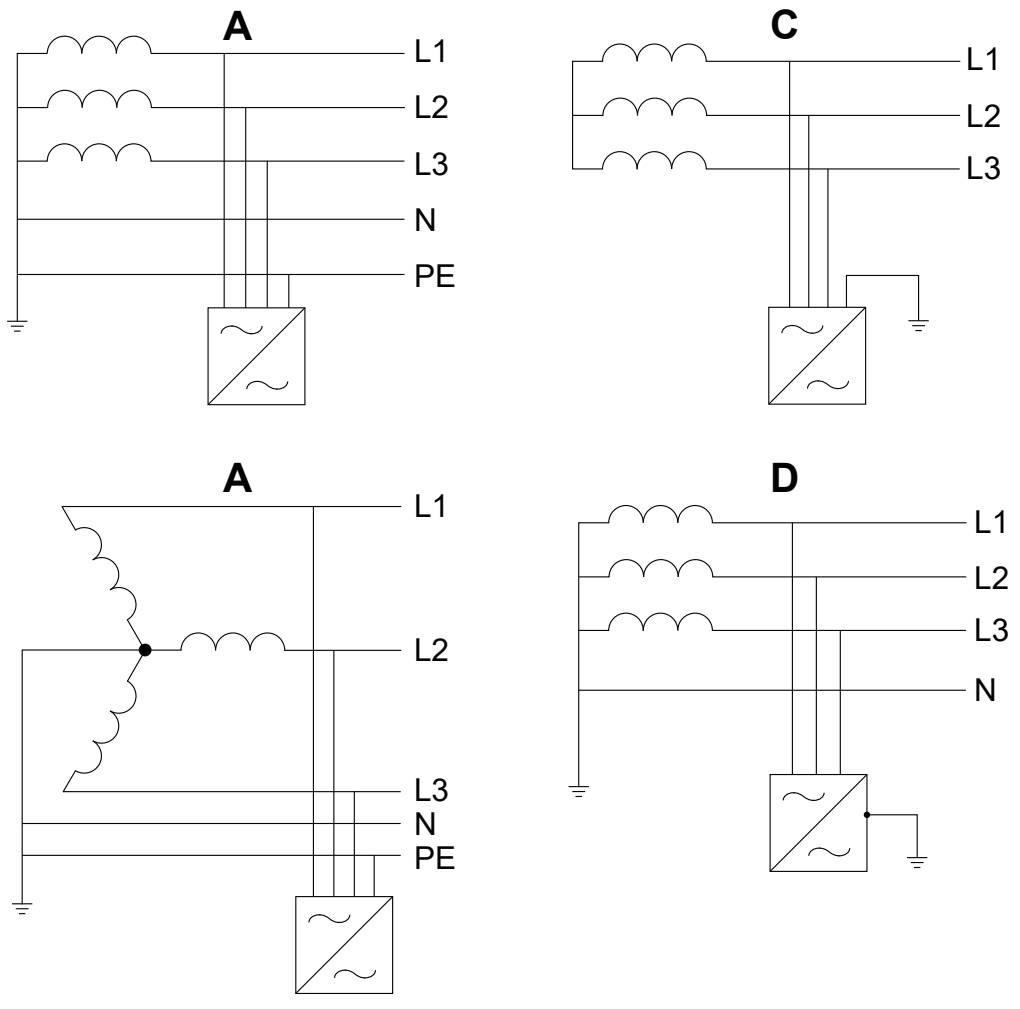
WARNING!
Do not install a drive with the internal EMC filter connected to a grounding system that the EMC filter is not compatible with (for example, an IT system). The supply network becomes connected to ground potential through the internal EMC filter capacitors, which can cause danger or damage to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

When to disconnect the EMC filter

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

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

Screw	Grounding systems	
	Symmetrically grounded TN-S systems (center-grounded wye)	**IT systems (ungrounded or high-resistance grounded)**
EMC	Metal	Plastic
VAR	Metal	Plastic



Note: Not all ACS280-04LC drives have the EMC/VAR screw, check the product layout diagram for details.

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. Refer to 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.

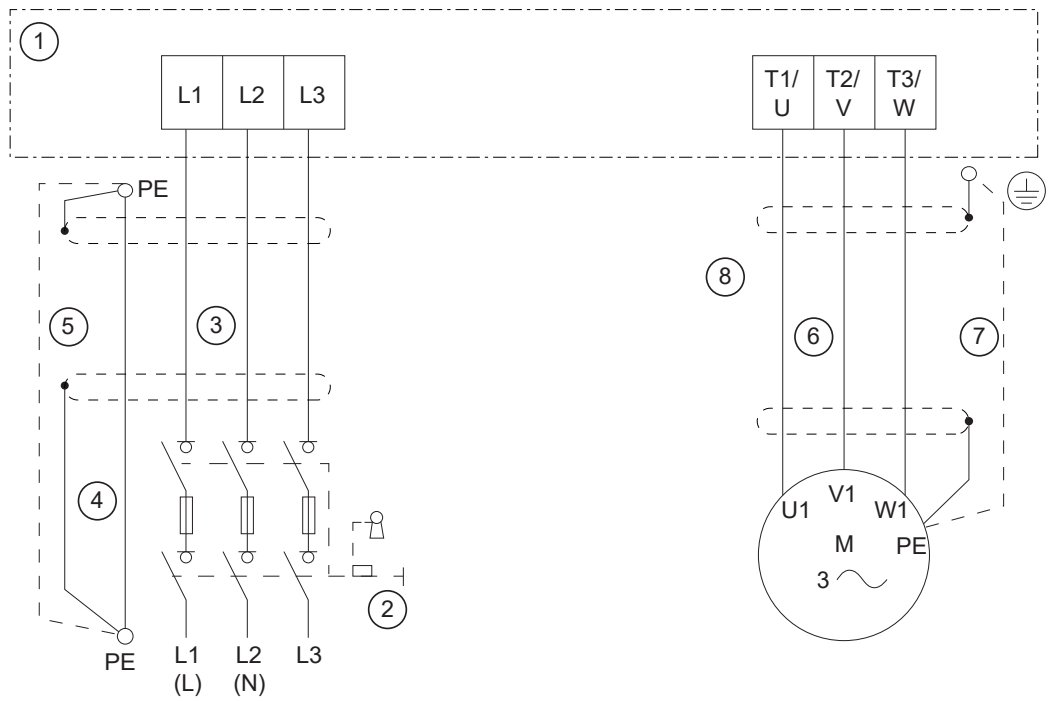
1. input voltage line to line (U_{L-L})
2. input voltage line 1 to ground (U_{L1-G})
3. input voltage line 2 to ground (U_{L2-G})
4. input voltage line 3 to ground (U_{L3-G}).

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

Connection diagram



1	Drive
2	Disconnecting device
3	Input power cable
4	Two protective earth (ground) conductors. Drive safety standard IEC/EN/UL 61800-5-1 requires two PE conductors for a fixed connection, if the cross-section of grounding conductor is less than 10 mm^2 Cu or 16 mm^2 Al. For example, you can use the cable shield in addition to the fourth conductor.
5	Separate PE cable (line side). Use a separate grounding cable or a cable with a separate PE conductor for the line side, if the conductivity of the fourth conductor or shield does not meet the requirements for the PE conductor.
6	Motor cable. **Note**: ABB recommends to use a symmetrical shielded cable (VFD cable) as the motor cable.
7	Separate PE cable (motor side). Use a separate grounding cable for the motor side, if the conductivity of the shield is not sufficient, or if there is no symmetrically constructed PE conductor in the cable.
8	360-degree grounding of the cable shield. Required for the motor cable and brake resistor cable, recommended for the input power cable.

Connection procedure

For detailed information of connection procedure, please refer to the supplement instruction included with the delivery.

Connecting the control cables

Refer to Default I/O connection diagram (ABB standard macro) for the default I/O connections of the ABB standard macro.

Full configuration of the I/O wire harnesses

Signals	Descriptions
Digital inputs and outputs	
DI1	Digital input 1
DI2	Digital input 2
DI3	Digital input 3
DI4	Digital input 4
DO+	Digital output
DO-	Digital output
DCOM2	Digital input common for all
24 V_A (1 A)	24 V DC switch mode power supply A
24 V_B (3 A)	24 V DC switch mode power supply B
Analog inputs and outputs	
AI1	Analog input 1
AI2	Analog input 2
AO	Analog output
10 V_A	Reference voltage +10 V DC
AGND	Analog input circuit common
Ashield	Signal cable shield (screen)
Safe torque off (STO)	
24 V_STO	Safe torque off function. Connected at the factory. Drive starts only when both circuits are closed.
AGND	
STO_CH1	
STO_CH2	
Relay output	
RO1_NO	Relay output 1 (NO)
RO1_NC	Relay output 1 (NC)
RO2_NC	Relay output 2 (NC)
RO2_COM	Relay output 2 common
RO2_NO	Relay output 2 (NO)
RO3_NC	Relay output 3 (NC)
RO3_COM	Relay output 3 common
RO3_NO	Relay output 3 (NO)
EIA-485 Modbus RTU	
Modbus_A-	Embedded Modbus RTU (EIA-485)
Modbus_B+	
AGND	
Shield	

Control cable connection procedure

Do the connections according to the macro in use.

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

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

1. Stop the drive and do the steps in section Electrical safety precautions (page 11) before you start the work.
2. Strip a part of the outer shield of the control cable for 360-degree grounding.
3. Use a 360-degree grounding clamp to connect the cable to the grounding tab.
4. Strip the ends of the control cable conductors. For stranded (multi-wire) conductors, install ferrules at the bare conductor ends.
5. Connect the conductors to the correct control terminals.
6. Mechanically attach the control cables on the outside of the drive.

7

Installation checklist

Contents of this chapter

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

Checklist

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

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

WARNING!
Do the steps in section Electrical safety precautions (page 11) before you start the work.

Make sure that ...	☑
The ambient operating conditions meet the drive ambient conditions specification and enclosure rating (IP code).	☐
The supply voltage matches the nominal input voltage of the drive. Refer 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.	☐
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.	☐
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.	☐
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 motor and the driven equipment are ready for power-up.	☐

8

Maintenance

Contents of this chapter

The chapter contains the preventive maintenance instructions.

Maintenance intervals

The tables below show the maintenance tasks which can be done by the end user. The complete maintenance schedule is available on the Internet (https://new.abb.com/drives/services/maintenance/preventive-maintenance). For more information, consult your local ABB Service representative (www.abb.com/searchchannels).

Description of symbols

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

Recommended maintenance intervals after start-up

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

Note:

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

9

Technical data

Contents of this chapter

This chapter contains the technical specifications of the drive including the ratings, sizes and technical requirements, provisions for fulfilling the requirements for CE, UL and other approval marks.

Ratings

IEC ratings

ACS280-04LC...	Input	Output							Current in different temps (at 4kHz ref, 1kHz min)			
	I_{1N}	I_N	I_{Hd}	I_{max}	P_N		P_{Hd}		35ºC	40ºC	45ºC	50ºC
	A	A	A	A	kW	hp	kW	hp	multi-plier	multi-plier	multi-plier	multi-plier
3-phase UN = 380...480 V (380, 400, 415, 440, 460, 480 V)												
-017A-4	17.0	17.0	12.6	22.7	7.5	10	5.5	7.5	1.0	1.0	1.0	R1
-025A-4	25.0	25.0	17.0	30.6	11.0	15.0	7.5	10.0	1.0	1.0	1.0	R1
-032A-4	32.0	32.0	24.6	44.3	15.0	20.0	11	15.0	1.0	1.0	1.0	R1
3-phase UN = 200…240 V (200, 208, 220, 230, 240 V)												
-032A-2	31.2	24.2	24.2	43.6	7.5	10.0	5.5	7.5	1.0	1.0	1.0	R1
-048A-2	46.7	46.7	30.8	62.4	11.0	15.0	7.5	10.0	1.0	1.0	1.0	R1
-055A-2	55	55	46.2	83.2	15.0	20.0	11	15.0	1.0	1.0	1.0	R1

Definitions

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

U_n	Nominal supply voltage. For input voltage range *U*1.
I_1	Nominal input current with typical motor power *P*n. Continuous rms input current, for dimensioning cables and fuses.
I_{max}	Maximum output current. Available for two seconds at start.
I_n	Nominal output current. Maximum continuous rms output current allowed (no overload).
P_n	Typical motor power in nominal use (no overloading). The kilowatt ratings are applicable to most IEC 4-pole (400 V, 50 Hz) motors. The horsepower ratings are applicable to most NEMA 4-pole (460V 60Hz) motors
I_{Ld}	Maximum output current with 10% overload, allowed for one minute every ten minutes.
P_{Ld}	Typical motor power in light-duty use (10% overload).
I_{Hd}	Maximum output current with 50% overload, allowed for one minute every ten minutes.
P_{Hd}	Typical motor power in heavy-duty use (50% overload)

Sizing

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

The minimum recommended nominal current of the motor is 40% of the drive nominal output current (I_n) . If the motor has a lower nominal current rating than this, the drive cannot accurately measure the motor current.

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 Altitude derating (page 53) and Switching frequency derating (page 53) for the derating values.

Altitude derating

1000...2000 m(or 4000m for some frame size) above sea level, the derating is 1% for every 100 m (330 ft).

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

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

Switching frequency derating

Derating the drive output current is necessary if you use 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. The drive will decrease the switching frequency to minimum switching frequency automatically if the IGBT temperature is high.

Derating is not necessary if you change parameter 97.01 Switching frequency reference.

Besides the switching frequency setting in parameter 97.02, activate LS mode by using parameter 97.35 will also increase the effective switching frequency. After activate the LS mode, the actual switching frequency will become 1.5 times to default condition. For example, if set the 97.01=4kHz, and activate the LS mode, then the equivalent switching frequency in IGBT will be 6kHz.

Type ACS280-04LC...	Derating factor (k) with different switching frequencies (at 50 °C)				
	2 kHz	4 kHz	6 kHz (4 kHz + LS mode)	8 kHz	12 kHz
3-phase UN = 380...480 V (380, 400, 415, 440, 460, 480 V)					
-017A-4	1	1	0.9	0.8	0.7
-025A-4	1	1	0.9	0.8	0.7
-032A-4	1	1	0.9	0.8	0.7
3-phase UN = 200…240 V (200, 208, 220, 230, 240 V)					
-032A-2	1	1	0.9	0.8	0.7
-048A-2	1	1	0.9	0.8	0.7
-055A-2	1	1	0.9	0.8	0.7

Fuses

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

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

gG fuses (IEC)

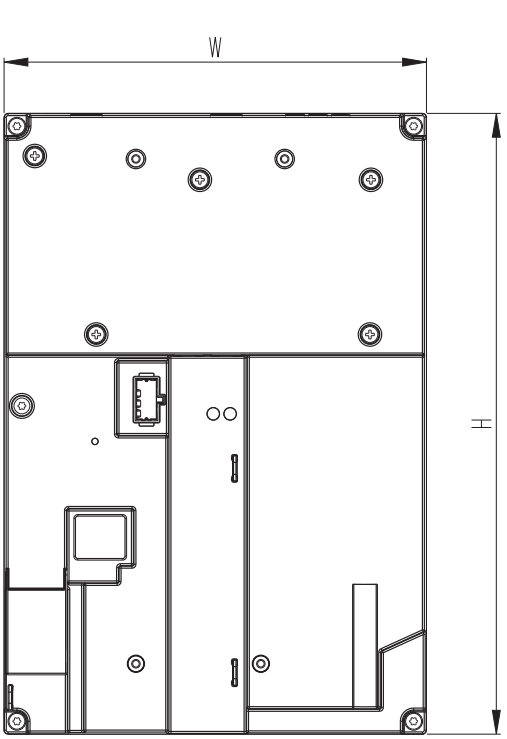
Make sure that the operating time of the fuse is less than 0.5 seconds. Obey the local regulations.

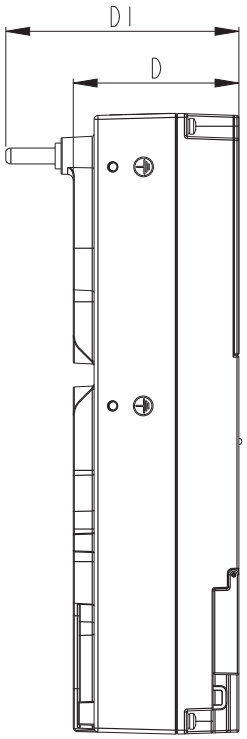
ACS280-04LC...	Input current	Min. short-circuit current	I_N	I^2t	Voltage rating	ABB type
	A	A	A	A^2s	V	
3-phase UN = 380...480 V (380, 400, 415, 440, 460, 480 V)						
-017A-4	17	200	25	2500	500	OFAFC000GG25
-025A-4	25	256	32	4000	500	OFAFC000GG32
-032A-4	32	320	40	7700	500	OFAFC000GG40
3-phase UN = 200…240 V (200, 208, 220, 230, 240 V)						
-032A-2	31.2	320	31.2	7700	500	OFAFC000GG40
-048A-2	46.7	500	46.7	20100	500	OFAFC000GG63
-055A-2	60.0	500	63.0	20100	500	OFAFC000GG63

gR or aR -type fuses (IEC)

ACS280-04LC...	Input current	Min. short-circuit current	I_N	I^2t	Voltage rating	Bussmann type
	A	A	A	A^2s	V	
3-phase UN = 380...480 V (380, 400, 415, 440, 460, 480 V)						
-017A-4	17	120	40	460	690	170M1563
-025A-4	25	120	40	460	690	170M1563
-032A-4	32	170	63	1450	690	170M1565
3-phase UN = 200…240 V (200, 208, 220, 230, 240 V)						
-032A-2	31.2	170	63	1450	690	170M1565
-048A-2	46.7	280	80	2550	690	170M1566
-055A-2	60.0	280	80	2550	690	170M1566

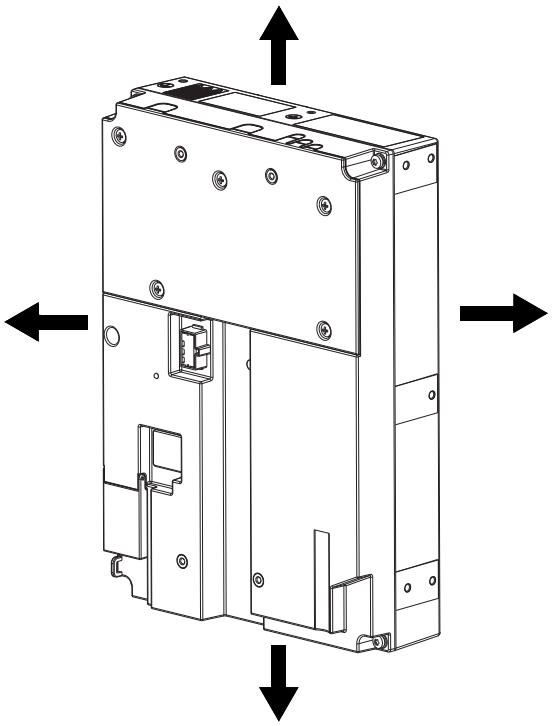
Dimensions and weights





Dimensions										
ACS280-04LC	W		H		D		D1		Weight	
	mm	in	mm	in	mm	in	mm	in	kg	lb
R1	213	8.39	313	12.32	83.5	3.29	117.5	4.63	6.9	15.15

Free space requirements



Frame size	Above		Below		Left side		Front	
	mm	in	mm	in	mm	in	mm	in
R1	40	1.57	40	1.57	10	0.39	10	0.39

Losses, cooling data and noise

Note: Power losses are given for nominal supply voltage, default switching frequency, and rated output current/power. Changing these factors may result in increased power losses.

ACS280-04LC...	Typical power loss		Frame size
	Main loss	Control parts	
	W	W	
3-phase UN = 380...480 V (380, 400, 415, 440, 460, 480 V)			
-017A-4	187.1	4.3	R1
-025A-4	274.6	4.3	R1
-032A-4	389.5	4.3	R1
3-phase UN = 200…240 V (200, 208, 220, 230, 240 V)			
-032A-2	334.7	4.3	R1
-048A-2	499.1	4.3	R1
-055A-2	628.8	4.3	R1

Terminal data for the power cables

The first table shows the terminal data in SI units. The second table shows the terminal data in imperial units.

ACS280-04LC...	U1, V1, W1, U2, V2, W2 terminals							PE/ground terminals		
	Maximum cable outside diameter	Min (solid/stranded)		Max (solid/stranded)		Tightening torque		Min size (solid/stranded)	Max size (solid/stranded)	Tightening torque
	mm	mm²	AWG	mm²	AWG	N·m	lbf·ft	mm²	mm²	N·m
3-phase UN = 380...480 V (380, 400, 415, 440, 460, 480 V)										
-017A-4	30	0.2/0.2	30	6/4	8	0.6	5	0.75/0.75	16/16	1.5
-025A-4	30	0.5/0.5	20	10/6	6	1.5	13	0.75/0.75	16/16	1.5
-032A-4	30	0.5/0.5	20	25/16	6	2,5…3,7	22…32	0.75/0.75	16/16	1.5
3-phase UN = 200…240 V (200, 208, 220, 230, 240 V)										
-032A-2	30	0.5/0.5	20	25/16	6	2,5…3,7	22…32	0.75/0.75	16/16	1.5
-048A-2	30	0.5/0.5	20	25/16	6	2,5…3,7	22…32	0.75/0.75	35/35	1.5
-055A-2	30	0.5/0.5	20	25/16	6	2,5…3,7	22…32	0.75/0.75	35/35	1.5

Note:

- The minimum specified wire size does not necessarily have sufficient current carrying capacity at maximum load.
- The terminals do not accept a conductor that is one size larger than the maximum specified wire size.
- The maximum number of conductors per terminal is 1.

Typical power cable sizes

ACS280-04LC...	Cable conductor sizes (mm²) [1)]	AWG	Frame
3-phase UN = 380...480 V (380, 400, 415, 440, 460, 480 V)			
-017A-4	3x6+6	8	R1
-025A-4	3x6+6	8	R1
-032A-4	3x10+10	8	R1
3-phase UN = 200…240 V (200, 208, 220, 230, 240 V)			
-032A-2	3x10+10	6	R1
-048A-2	3x10+10	6	R1
-055A-2	3x10+10	6	R1

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

Terminal data for the control cables

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

Electrical power network specification

Voltage (U1)	ACS280-04LC-xxxx-2 drives: 3-phase 200 ... 240 V AC -15% ... +10% ACS280-04LC-xxxx-4 drives: 3-phase 380 ... 480 V AC -15% ... +10%
Network type	Public low-voltage networks. Symmetrically grounded TN-S system, IT (un-grounded), corner-grounded delta. Consult ABB before connecting to other systems (for example, TT, or midpoint grounded delta).
Rated conditional short-circuit current (IEC 61800-5-1)	65 kA when protected by fuses given in the fuse tables.
Short-circuit current protection	US and Canada: The drive is suitable for use on a circuit capable of delivering not more than 65 kA symmetrical amperes (rms) at 480 V maximum when protected by fuses given in the fuse table.
Mains choke	Use a mains choke if the network's line impedance is low (less than 0.3% total system impedance of all the ACS280 drives in the installation), or has voltage imbalance, or harmonic distortion that make the input current bigger than the nominal input current ratings. You can use one choke for several drives as long as the choke current rating is not exceeded.
Frequency (f1)	47 to 63 Hz, maximum rate of change 17%/s
Imbalance	Max. ±3% of nominal phase to phase input voltage
Fundamental power factor (cos phi)	0.98 (at nominal load)

Motor connection data

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

Motor cable length

Operational functionality and motor cable length

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

Frame	Maximum motor cable length	
	m	ft
Standard drive, without external options		
R1	20	65
With external output chokes		
R1	30	98

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

EMC compatibility and motor cable length

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

Frame	Maximum motor cable length, 4 kHz			
	C2*		C3	
	m	ft	m	ft
With internal EMC filter				
3-phase U_N = 200...240 V (200, 208, 220, 230, 240 V)				
R1	1.5	-	5	16
3-phase U_n = 380...480 V (380, 400, 415, 440, 460, 480 V)				
R1	1.5	-	10	33

* For conductive emission only, Radiated emissions are according to C3.

Control connection data

Analog inputs (AI1, AI2)	Voltage signal, single-ended	0 … 10 V DC (10% overrange, 11 V DC max.) R_{in} = 38 kohm
	Current signal, single-ended	0 … 20 mA (10% overrange, 22 mA max.) R_{in} = 205 ohm
	Inaccuracy	≤ 1.0%, of full scale
	Potentiometer reference value	10 V DC ±1%, max. load current 10 mA
Analog output (AO)	Voltage output mode	0 … 10 V DC (10% overrange, 11 V DC max.) into 200 kohm minimum load (resistive)
	Inaccuracy	≤ 1.5%, of full scale
Auxiliary voltage output (+24V)	As output	+24 V DC ±10%, max. 100 mA 24V_A 1A 24V_B 3A
Digital inputs (DI1…DI4)	Voltage	12 … 24 V DC (int. or ext. supply) max. 30 V DC.
	Type	PNP
	Input impedance	R_{in} = 2 kohm

Digital output(DO)	As outputs	
	Type	Transistor output PNP
	Max. switching voltage	30 V DC
	Max. switching current	60 mA / 30 V DC, short-circuit protected
Relay output (RA, RB, RC))	Type	1 form C (NO + NC)
	Max. switching voltage	30 V DC
	Max. switching current	2 A
STO interface (SGND, S+, S1, S2)	Refer to The Safe torque off function (page 69)	

Energy efficiency data (ecodesign)

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

Degrees of protection

Degree of protection (IEC/EN 60529)	IP20 (cabinet installation): Standard enclosure. The drive must be installed in a cabinet to fulfill the requirements for shielding from contact.
Enclosure types (UL 50/50E)	UL Open Type. For indoor use only.
Overvoltage category (IEC/EN 60664-1)	III
Protective classes (IEC/EN 61800-5-1)	I

Ambient conditions

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

Requirement	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
Installation site altitude	0 … 1000 m above sea level without derating. 1000 … 2000 m above sea level with derating. ACS280-04LC frame: 1000...4000m above sea level with derating.	-	-
Surrounding air temperature at heavy duty rating	-10... +50 °C (14 … 122 °F) without derating. No frost allowed.	-40...+70 °C (-40...158 °F)	-40...+70 °C (-40...158 °F)
Relative humidity	<95% (IEC 60068-2-78) without condensation		

Requirement	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
Contamination levels (IEC 60721-3-3)	Class C3	Class 1C2	Class 2C2
	Class 3S2	Class 1S2	Class 2S2
Sinusoidal vibration **(IEC 61800-5-1 to comply with EN 50178)**	Class 3M4	-	-
Shock **(EN 60068-2-31 to comply with EN 50178)**	Not allowed	According to ISTA 1A. Max. 100 m/s2 (330 ft/s2), 11 ms.	According to ISTA 1A. Max. 100 m/s2 (330 ft/s2), 11 ms.
Free fall	Not allowed	76 cm (30 in)	76 cm (30 in)

Materials

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

Disposal

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

Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery.

Printed circuit boards and 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 13849-1:2023	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 60204-1:2018	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 IEC 62061:2021	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN 61800-3:2004 + A1:2012 IEC61800-3:2017	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
EN 61800-5-1:2007+A1:2017+A11:2021	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy

Markings

CE	CE mark Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).
UKCA	UKCA (UK Conformity Assessed) mark Product complies with the applicable United Kingdom's legislation (Statutory Instruments). Marking is required for products being placed on the market in Great Britain (England, Wales and Scotland).
TÜV NORD Safety Approved	TÜV Safety Approved mark (functional safety) Product contains Safe torque off and possibly other (optional) safety functions which are certified by TÜV according to the relevant functional safety standards. Applicable to drives and inverters; not applicable to supply, brake or DC/DC converter units or modules.
20	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.

Compliance with EN 61800-3

Definitions

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

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

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

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

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

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

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

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

Category C1

If without extra measures, the ACS280-04LC drive do not compliance with EMC category C1. Contact ABB for more information.

Category C2

This is applicable to ACS280-04LC-...-1 drives with an internal EMC C2 filter.

The drive complies with the standard with the following provisions:

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

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

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

Category C3

This is applicable to ACS280-04LC-…-2 drives with an internal EMC C3 filter.

The drive complies with the standard with the following provisions:

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

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

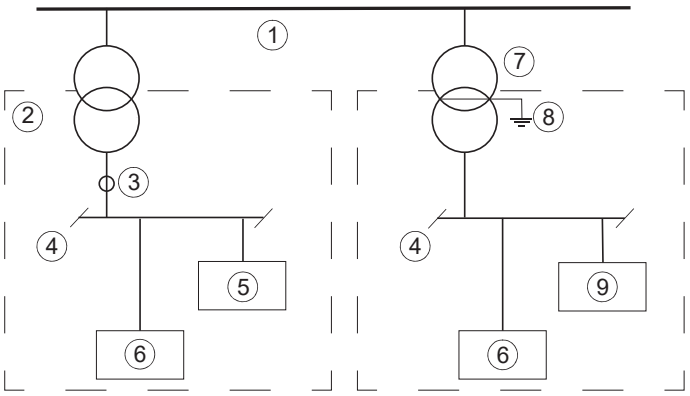
WARNING!
You can install a drive with the internal EMC filter connected only on a symmetrically grounded TN-S system.

Category C4

This is applicable to ACS280-04LC-...-1/4 drives.

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

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



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

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available from the local ABB representative.

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

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

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

Compliance with the European Machinery Directive

The drive includes the Safe torque off function and can be equipped with other safety functions for machinery which, as safety components, are in the scope of the Machinery Directive. These functions of the drive comply with European harmonized standards such as EN 61800-5-2. Refer to The Safe torque off function (page 69).

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.

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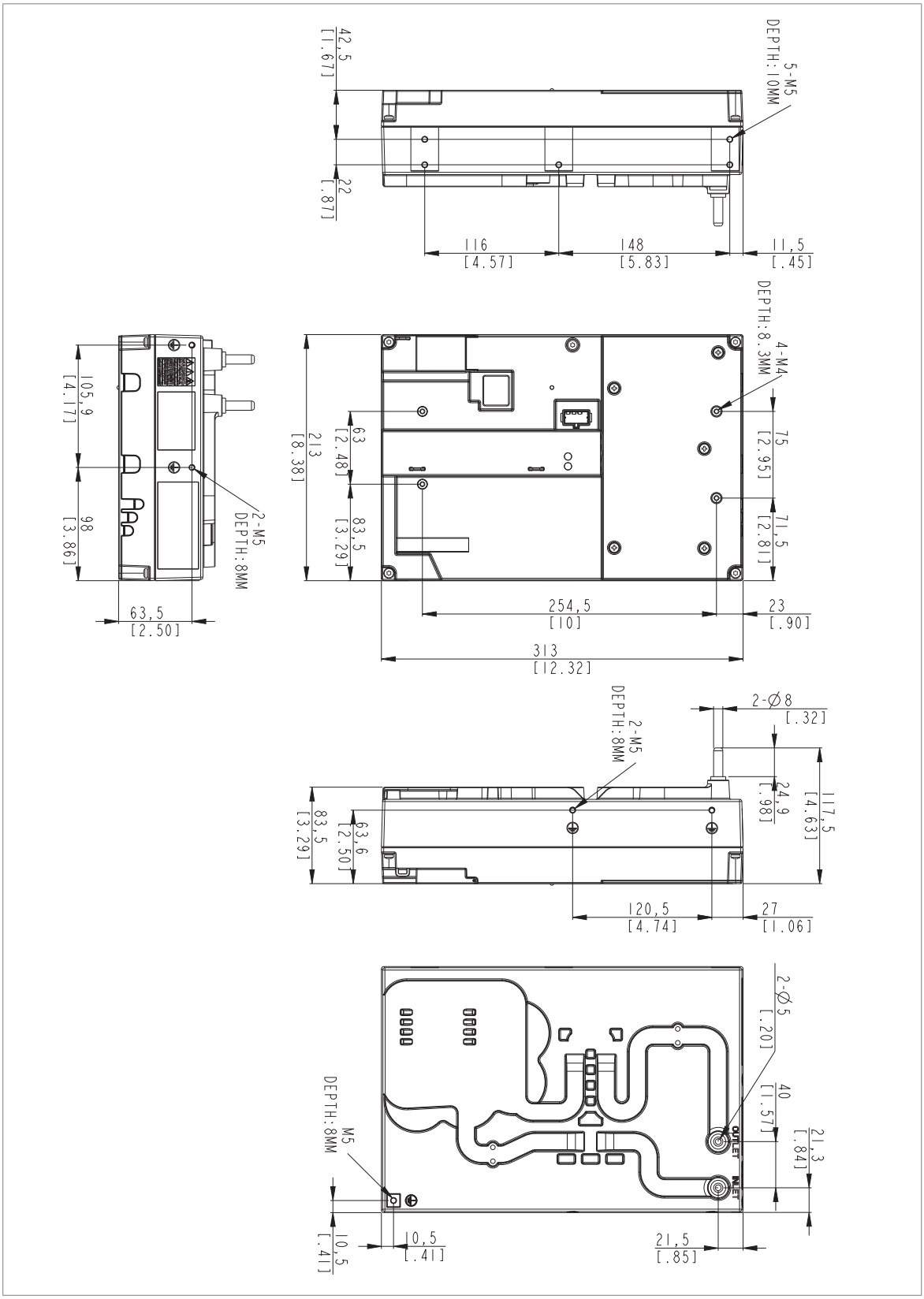
Dimension drawings

Contents of this chapter

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

Frame R1


42,5
[1.67]
22
[.87]
5-M5
DEPTH:10MM
116
[4.57]
148
[5.83]
11,5
[.45]
105,9
[4.17]
98
[3.86]
2-M5
DEPTH:8MM
63,5
[2.50]
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63
[2.48]
83,5
[3.29]
4-M4
DEPTH:8.3MM
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71,5
[2.81]
254,5
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[.90]
313
[12.32]
2-Ø8
[.32]
2-M5
DEPTH:8MM
24,9
[.98]
117,5
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83,5
[3.29]
63,6
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120,5
[4.74]
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[.20]
40
[1.57]
21,3
[.84]
OUTLET
INLET
M5
DEPTH:8MM
10,5
[.41]
10,5
[.41]
21,5
[.85]

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

Standard	Name
IEC 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2017	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

Refer to the technical data.

Wiring

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

Activation switch

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

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

Cable types and lengths

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

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

Note: The 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 (refer 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.	☐
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 (refer 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.	☐

Action	☑
Test the operation of the STO function when the motor is running. • Start the drive and make sure the motor is running. • Open the STO circuit. The motor should stop. The drive generates an indication if one is defined for the 'running' state in parameter 31.22 (see the firmware manual). • Reset any active faults and try to start the drive. • Make sure that the motor stays at a standstill and the drive operates as described above in testing the operation when the motor is stopped. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the failure detection of the drive. The motor can be stopped or running. • Open the 1st input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA81 fault indication (refer 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 (refer 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 (refer 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 180/2*p* degrees (with synchronous reluctance [SynRM] motors) regardless of the activation of the Safe torque off function. *p* denotes the number of pole pairs.

Notes:

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

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 10 years; refer section Safety data (page 78). 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 73).

Note: Refer 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 73).

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.

Refer 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)
R1	3	3	e	>90	5.92E-09	5.19E-05	1.30E-05	2.59E-05	6200	≥90	3	1	80	20	8.36E-08	1.04E-07	1.95E-08

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- 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
  - Fault detection time: Channels in different states for longer than 200 ms
  - Fault reaction time: Fault detection time + 10 ms.
- Indication delays:
  - STO fault indication (parameter 31.22) delay: < 500 ms
  - STO warning indication (parameter 31.22) delay: < 1000 ms.

Terms and abbreviations

Term or abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage (%)
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	EN ISO 13849-1	Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD_{avg}	IEC 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time
PFH_{diag}	IEC/EN 62061	Average frequency of dangerous failures per hour for the diagnostic function of STO
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL
Proof test	IEC 61508, IEC 62061	Periodic test performed to detect failures in a safety-related system so that, if necessary, a repair can restore the system to an "as new" condition or as close as practical to this condition
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.

Term or abbreviation	Reference	Description
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.

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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