ABB MACHINERY DRIVES

ACS380 drives

Hardware manual

ACS380 drives

Hardware manual

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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.

Safety messages

These safety messages help to prevent personal injury and damage to the equipment. The hazard levels comply with standard ANSI Z535.6.

The manual uses these warning symbols:

DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE Is used to address practices not related to physical injury, but which can result in equipment damage.

General safety in installation, start-up and maintenance

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

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

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

Note:

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

Electrical safety in installation, start-up and maintenance

Electrical safety precautions

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

WARNING Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do 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.

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

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

Additional instructions and notes

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

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

- Make sure that the electrical power network, motor/generator, and environmental conditions agree with the drive data.
- Do not do insulation or voltage withstand tests on the drive.
- If you have a cardiac pacemaker or other electronic medical device, do not go near the motor, drive, or 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.
  The brake circuit, including the brake chopper and brake resistor (if it is installed) are also 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

NOTICE Use an antistatic wrist strap 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, or 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, and 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 the work. Make sure that no other system, such as a hydraulic crawling drive, can rotate the motor directly or through any mechanical connection such as a belt, nip, rope, or similar.
- Do the steps in Electrical safety precautions (page 22).
- 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

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

2

Introduction to the manual

Contents of this chapter

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

Applicability

This manual is applicable to ACS380 drives.

Target audience

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

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

Categorization by frame size

The drives are manufactured in frame sizes (for example, R1). The information that applies only to specific frames is identified with the frame size. Read the frame size from the type designation label of the drive.

Quick installation and commissioning flowchart

Task	See
Identify the frame size: R0, R1, R2, etc.	Type designation key (page 42)
Plan the installation. Check the ambient conditions, ratings and required cooling air flow.	Guidelines for planning the electrical installation (page 55) Technical data (page 139)
Unpack and check the delivery.	Unpacking the delivery (page 51)
If the supply network is not a symmetrically grounded TN-S system, make sure that the drive is compatible with the grounding system.	Grounding system compatibility check – IEC (page 77) Grounding system compatibility check – North America (page 103)
Install the drive.	Installing the drive (page 52)
Route the cables.	Routing the cables (page 65)
Measure the insulation of the input cable, motor and motor cable.	Measuring the insulation resistance - IEC (page 76) Measuring the insulation resistance - North America (page 102)
Connect the power cables.	Connecting the power cables – IEC (shielded cables) (page 82) Connecting the power cables – North America (wiring in conduits) (page 108)
Connect the control cables.	Connecting the control cables - IEC (page 85) Connecting the control cables - North America (page 111)
Examine the installation.	Installation checklist (page 127)

Task	See
Commission the drive.	Refer to ACS380 Quick installation and start-up guide (3AXD50000018553 [English]) and ACS380 Firmware manual (3AXD50000029275 [English]).

Terms and abbreviations

Term	Description
ACS-AP-I	Industrial assistant non-Bluetooth control panel
ACS-AP-S	Standard assistant control panel
ACS-AP-W	Industrial assistant control panel with Bluetooth interface
ACS-BP-S	Basic control panel
BAPO	Optional auxiliary power extension module
BCAN	Optional CANopen® adapter module
BCBL-01	Optional USB to RJ45 cable
BIO-01	Optional I/O extension module. Can be installed to the drive together with a fieldbus adapter module.
BMIO-01	I/O & Modbus extension module
Brake chopper	Conducts the surplus energy from the intermediate circuit of the drive to the brake resistor when necessary. The chopper operates when the DC link voltage exceeds a certain maximum limit. The voltage rise is typically caused by deceleration (braking) of a high inertia motor.
Brake resistor	Dissipates the drive surplus braking energy conducted by the brake chopper to heat
BREL	Optional relay output extension module
BRES	Optional resolver interface module
BTAC	Optional encoder interface module
Capacitor bank	The capacitors connected to the DC link
CCA-01	Configuration adapter
DC link	DC circuit between rectifier and inverter
DC link capacitors	Energy storage which stabilizes the intermediate circuit DC voltage
Drive	Frequency converter for controlling AC motors
EFB	Embedded fieldbus
EMC	Electromagnetic compatibility
FBA	Fieldbus adapter
FCAN-01	Optional CANopen® adapter module
FCNA-01	Optional ControlNet™ adapter module
FDNA-01	Optional DeviceNet™ adapter module
FECA-01	Optional EtherCAT® adapter module
FEIP-21	Optional Ethernet adapter module for EtherNet/IP™
FEPL-02	Optional Ethernet POWERLINK adapter module
FMBT-21	Optional Ethernet adapter module for Modbus TCP protocol
FPBA-01	Optional PROFIBUS DP® adapter module
FPNO-21	Optional PROFINET IO adapter module
Frame, frame size	Physical size of the drive or power module
FSCS-21	CIP Safety™ functions module

Term	Description
FSPS-21	PROFIsafe safety functions module
IGBT	Insulated gate bipolar transistor
Intermediate circuit	DC circuit between rectifier and inverter
Inverter	Converts direct current and voltage to alternating current and voltage.
Macro	A pre-defined set of default values of parameters in a drive control program.
NETA-21	Remote monitoring tool
Network control	With fieldbus protocols based on the Common Industrial Protocol (CIP™), such as DeviceNet and Ethernet/IP, denotes the control of the drive using the Control Supervisor and AC/DC drive objects of the ODVA AC/DC Drive Profile. For more information, refer to www.odva.org.
Parameter	In the drive or converter control program, parameter is a user-adjustable setting, or a read-only monitoring signal. In some (for example fieldbus) contexts, a value that can be accessed as an object. For example, variable, constant, or signal.
PLC	Programmable logic controller
Rectifier	Converts alternating current and voltage to direct current and voltage
RFI	Radio-frequency interference
SIL	Safety integrity level (1…3) (IEC 61508, IEC 62061, IEC 61800-5-2)
STO	Safe torque off (IEC/EN 61800-5-2)

Related documents

For more documentation, go to www.abb.com/drives/documents.

ACS380 manuals link list

3

Operation principle and hardware description

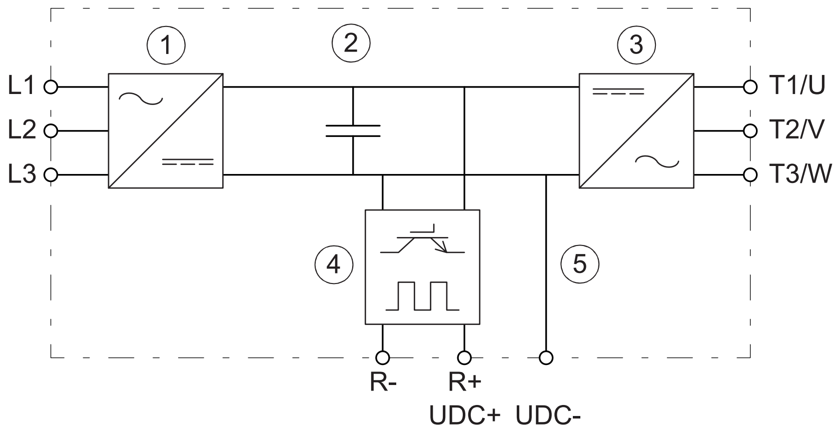
Contents of this chapter

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

Operation principle

The ACS380 is a drive to control asynchronous AC induction motors, permanent magnet synchronous motors, and ABB synchronous reluctance motors (SynRM motors). The drive is designed for cabinet installation.

Simplified main circuit diagram



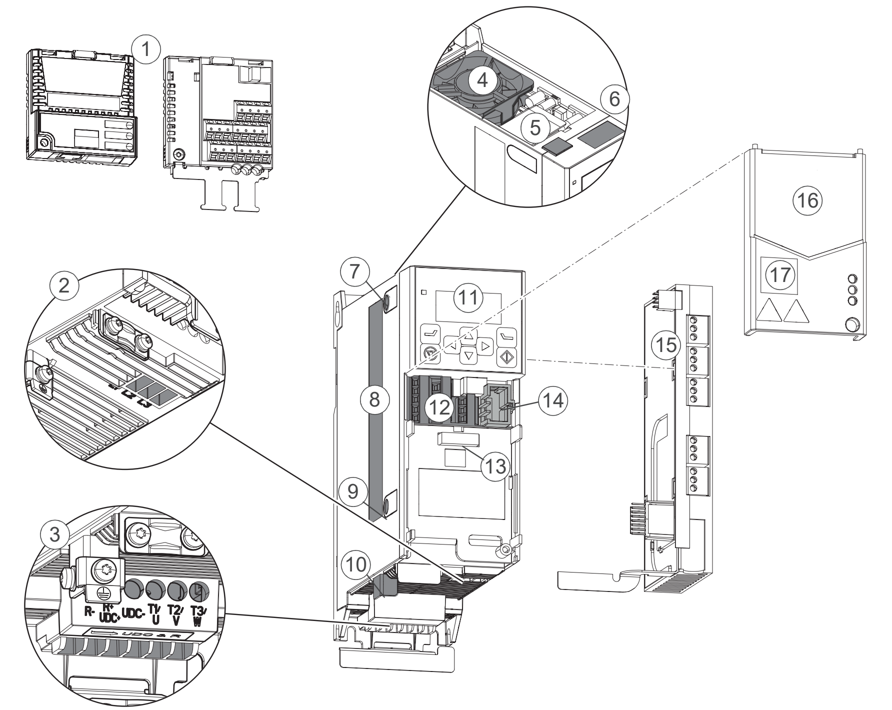
1	Rectifier. Converts alternating current and voltage to direct current and voltage.
2	DC link. DC circuit between the rectifier and inverter.
3	Inverter. Converts direct current and voltage to alternating current and voltage.
4	Brake chopper. Conducts energy from the intermediate DC circuit of the drive to the brake resistor when it is necessary and if an external brake resistor is connected to the drive. The chopper operates when the DC link voltage exceeds a specified limit. This voltage increase is typically caused by the deceleration (braking) of a motor. The user obtains and installs the brake resistor if it is necessary.
5	DC connection (UDC+, UDC-).

Product variants

The drive has three primary product variants:

- Standard variant (ACS380-04xS) with BMIO-01 I/O & Modbus extension module
- Configured variant (ACS380-04xC) for which the extension module, such as the fieldbus adapter, is chosen when ordering
- Base variant (ACS380-04xN) without extension modules.

Layout



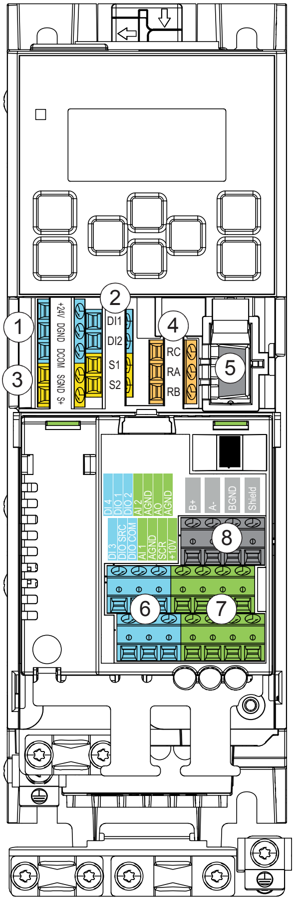
1	Front option modules	10	PE connection (motor)
2	Input power terminals	11	Control panel, display and status LED
3	Motor and brake resistor terminals	12	Control terminals
4	Cooling fan (on frames R1…R4)	13	Front option slot
5	Panel and PC tool port (RJ45)	14	Cold configuration connection for CCA-01
6	Model information label	15	Side option module
7	EMC filter grounding screw	16	Front cover
8	Type designation label	17	QR code to ecodesign tool. Refer to Energy efficiency data (ecodesign) (page 179).
9	Varistor grounding screw		

Control connections

In addition to the fixed control connections in the base unit, the other control connections depend on the drive variant.

Standard variant (I/O and Modbus) (ACS380-04xS)

The standard variant has a type code as follows: ACS380-04x**S**. It is supplied with the BMIO-01 I/O and Modbus extension module.



Connections on the base unit:

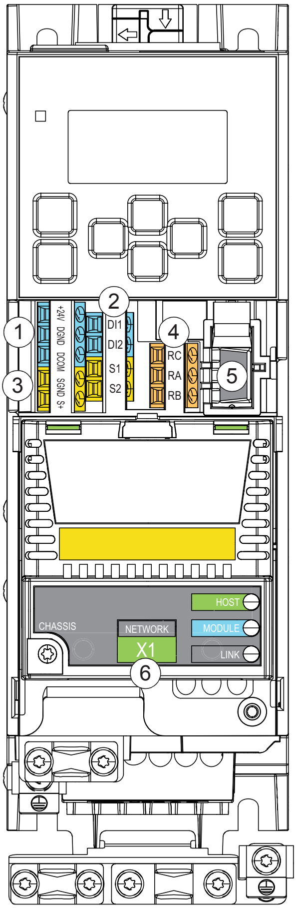
1. Auxiliary voltage outputs
2. Digital inputs
3. Safe torque off connections
4. Relay output connection
5. Cold configuration connection for CCA-01

Connections on BMIO-01:

6. Digital inputs and outputs
7. Analog inputs and outputs
8. EIA-485 Modbus RTU

Configured variant (ACS380-04xC)

The configured variant has a type code as follows: ACS380-04x**C** followed by an option code that indicates the extension module. Use the configured variant to order a product with a specific fieldbus extension module.

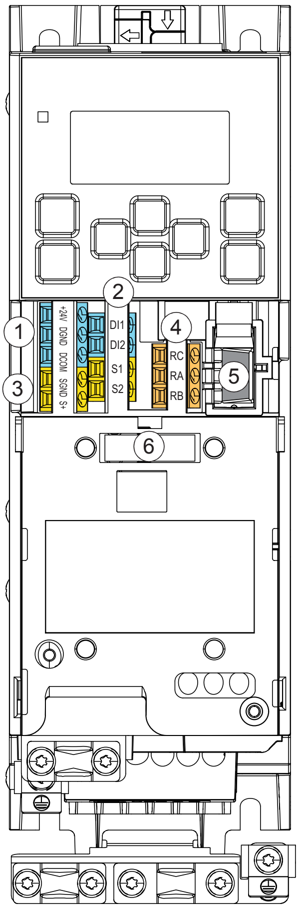


Connections:

1. Auxiliary voltage outputs
2. Digital inputs
3. Safe torque off connections
4. Relay output connection
5. Cold configuration connection for CCA-01
6. Fieldbus connections depending on the module

Base variant (ACS380-04xN)

The base variant has a type code as follows: ACS380-04x**N**. It is supplied without an extension module.



Connections:

1. Auxiliary voltage outputs
2. Digital inputs
3. Safe torque off connections
4. Relay output connection
5. Cold configuration connection for CCA-01
6. Option module slot 1

Option modules

The drive supports option modules (optional extension modules). For a list of option modules, refer to Type designation key (page 42).

You can connect the drive to a fieldbus with an optional fieldbus adapter module. Refer to Type designation key (page 42) for the available adapters

You can use I/O option modules to increase the number of inputs and outputs on the drive. The table shows a comparison between the base unit and different option modules.

I/O	Base unit (ACS380-04xx)	BMIO-01 (ACS380-04xS)	BIO-01	BREL-01
Inputs				
Digital inputs	2 (DI1, DI2)	4 (DI3, DI4, DIO1, DIO2)	3 (DI3, DI4, DI5)	-
Frequency inputs	-	2 (DI3, DI4)	2 (DI4, DI5)	-
Counter inputs	-	1 (DI3)	1 (DI4)	-
Analog inputs mA / V	-	2 (AI1, AI2)	1 (AI1)	-
Outputs				
Relay outputs	1 (RO1)	-	-	4 (RO4, RO5, RO6, RO7)
Digital outputs	-	2 (DIO1, DIO2)	1 (DIO1)	-
Frequency outputs	-	2 (DIO1, DIO2)	1 (DIO1)	-
Analog outputs mA / V	-	1 (AO1)	1 (AO1)	-

Note: The number of inputs and outputs depends on the configuration. For example, DIO can be configured as digital input or output.

Control panel options

The drive supports these control panels:

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

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

UL Type 1 kits

There are UL Type 1 kit options available for the drive. For the ordering codes and installation instructions, refer to the table that follows.

Frame size	Option code	Installation instructions
R0	3AXD50000187034	UL Type 1 kit for ACS380, ACS480 and ACH480 installation guide, frames R0 to R2 (3AXD50000235254)
R1	3AXD50000176779	
R2	3AXD50000178780	
R3	3AXD50000179220	UL Type 1 kit for ACS380, ACS480 and ACH480 installation guide, frames R3 to R4 (3AXD50000242375)
R4	3AXD50000179336	

Note: UL Type 1 kits are not applicable with BRES-01 resolver interface module.

Drive labels

The drive has two labels:

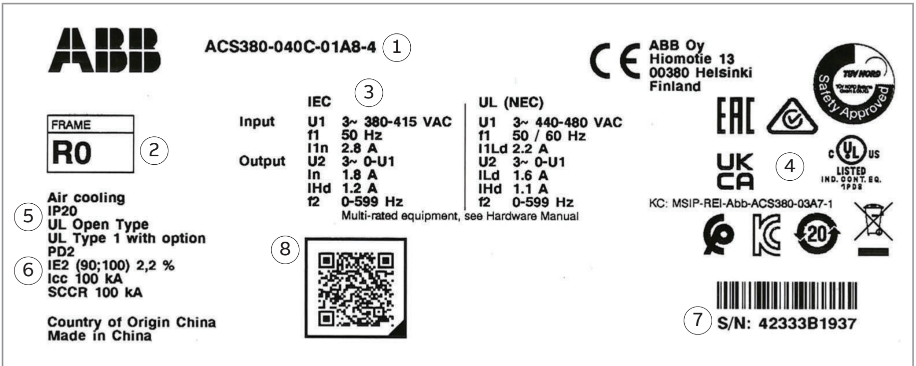
- model information label on the top of the drive
- type designation label on the left side of the drive.

Example labels are shown in this section.

Model information label

1	Drive type
2	Frame size and ratings
3	Serial number
4	QR code to register the drive

Type designation label



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

Type designation key

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

Basic code

Type code example: ACS380-042S-02A6-4.

<table>
<tr><th>Code</th><th colspan="2">Description</th></tr>
<tr><td>ACS380</td><td colspan="2">Product series</td></tr>
<tr><td rowspan="3">042S</td><td>04</td><td>Construction:
• 04 = Module.
When there are no options selected: module optimized for cabinet installation, degree of protection IP20 (UL open type), bottom cable entry, Safe torque off, brake chopper, coated boards, quick installation and start-up guide, user interface guide and safety instructions.</td></tr>
<tr><td>2</td><td>EMC filter variant:
• 0 = Low filtering level, EN 61800-3 category C3 (400 V) or C4 (230 V).[1]
• 2 = High filtering level, EN 61800-3 category C2.[2]</td></tr>
<tr><td>S</td><td>Connectivity:
• S = Standard variant with BMIO-01 I/O and Modbus module.
• C = Configured variant with I/O or fieldbus module, selected with an option code.
• N = Base variant without I/O or fieldbus module.</td></tr>
<tr><td>02A6</td><td colspan="2">Size. See the ratings table in the technical data.</td></tr>
<tr><td>4</td><td colspan="2">Input voltage:
• 1 = 1-phase 200 … 240 V AC
• 2 = 3-phase 200 … 240 V AC
• 4 = 3-phase 380 … 480 V AC.</td></tr>
</table>

[1] 230 V drives with low filtering level do not have an internal EMC filter. 400 V drives have a category C3 filter.

[2] High filtering level is not available for 3-phase 230 V drives.

Option codes

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

Code	Description
Fieldbus adapters	
K451	FDNA-01 DeviceNet
K454	FPBA-01 PROFIBUS DP
K457	FCAN-01 CANopen
K462	FCNA-01 ControlNet
K469	FECA-01 EtherCAT
K470	FEPL-02 Ethernet POWERLINK
K490	FEIP-21 EtherNet/IP
K491	FMBT-21 Modbus/TCP
K492	FPNO-21 PROFINET IO
K495	BCAN-11 CANopen
I/O	
L511	BREL-01 External relay option (4x relay) (side option)
L515	BIO-01 I/O extension module (front option, can be used together with fieldbus)
L516	BRES-01 resolver interface module (side option)
L534	BAPO-01 or BAPO-02 External 24 V DC (side option)
L535	BTAC-02 or BTAC-03 HTL encoder interface + External 24 V DC (side option)
L538	BMIO-01 I/O & Modbus extension module (front option, not available with other front options)
Services	
P992	Pre-assembled options (front and side options), only with C-variant

Code	Description
Functional safety	
Q986	FSPS-21 PROFIsafe safety functions module
Q989	FSCS-21 CIP Safety functions module
Documentation [1)]	
R700	English
R701	German
R702	Italian
R703	Dutch
R704	Danish
R705	Swedish
R706	Finnish
R707	French
R708	Spanish
R709	Portuguese (Portugal)
R711	Russian
R712	Chinese
R713	Polish
R714	Turkish

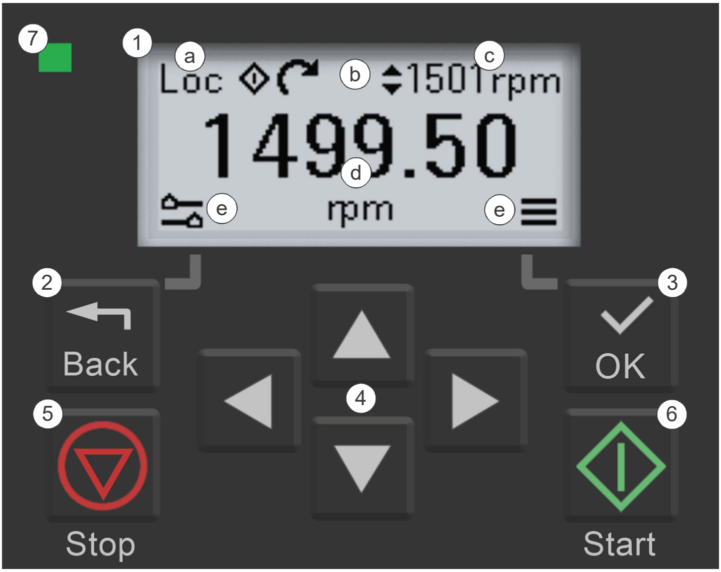
1) The option code determines the language variants of the hardware manual and firmware manual delivered as printed with the drive. The product package includes the user interface guide and quick installation and start-up guide in English, French, German, Italian and Spanish, and in the local language (if available).

Control panel

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

For quick reference, there is a ACS380 User interface guide (3AXD50000022224 [English]) under the main cover of the drive.

Refer to the ACS380 Firmware manual (3AXD50000029275 [English]) for information on how to use the interface, start-up the drive and modify settings and parameters.



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

The user interface in brief:

- In the Home view, push the Back key to open the Options view.
- In the Home view, push the OK key to open the Menu.
- Navigate the views with the arrow keys.

- Push the OK key to open the highlighted setting or item.
- Use the left and right arrow keys to highlight a value.
- Use the up and down keys to set a value.
- Push the Back key to cancel a setting or return to the previous view.

Home view

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

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

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

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

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

Status icons

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

Message view

When a fault or warning occurs, the display shows the Message view. The Message view shows either the active fault as an icon and fault code, or a list of the most recent warnings codes.

Refer to the ACS380 User interface guide (3AXD50000022224 [English]) or ACS380 Quick installation and start-up guide (3AXD50000018553 [English]) for a list of the most typical faults and warnings.

For more detailed fault and warning information, refer to the ACS380 Firmware manual (3AXD50000029275 [English]).

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

Options view

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

In the Options view, you can:

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

Menu

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

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

Menu items:

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

For detailed information on the user interface, refer to the ACS380 Firmware manual (3AXD50000029275 [English]).

4

Mechanical installation

Contents of this chapter

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

Installation alternatives

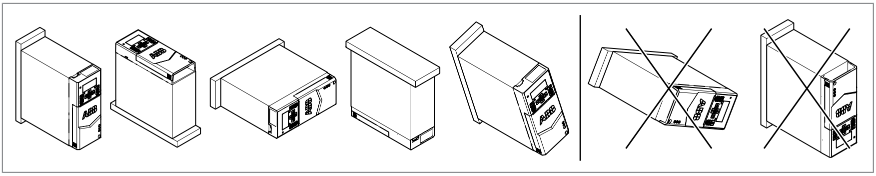
You can install the drive:

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

Installation requirements:

- The drive is designed for cabinet installation and has a degree of protection of IP20 / UL open type as standard. A UL Type 1 kit is available as an option.
- Make sure that there is a minimum of 75 mm (3 in) of free space at the top and bottom of the drive (at the cooling air inlet and outlet), measured from the frame.
  With the optional UL Type 1 kit, make sure that there is a minimum of 50 mm (2 in) of free space at the top (measured from the top of the hood) and 75 mm (3 in) at the bottom of the drive.
- You can install several drives side by side.
- Install R0 drives only vertically because they do not have a cooling fan.

- You can install frames R1, R2, R3, and R4 tilted to a maximum of 90¯degrees, from vertical to fully horizontal orientation.
- Do not install the drive upside down.



- Make sure that the hot exhaust air from drives or equipment does not flow into the cooling inlet of other drives or equipment.
- Drives with the optional UL Type 1 kit: If you install the drives side-by-side, make sure that their air outlets do not face each other.

Examining the installation site

Examine the installation site. Make sure that:

- The installation site is sufficiently ventilated or cooled to remove heat from the drive. Refer to the technical data.
- The ambient conditions of the drive meet the specifications. Refer to the technical data.
- The material behind, above, and below the drive is non-flammable.
- The installation surface is as close to vertical as possible and strong enough to hold the drive.
- There is sufficient free space around the drive for cooling, maintenance work, and operation. Refer to the free space specifications for the drive.
- 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:

- Drill and suitable drill bits
- Screwdriver or wrench with a set of suitable bits
- Tape measure and spirit level
- Personal protective equipment, such as eye protection, gloves, and footwear.

Unpacking the delivery

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

Make sure that these items are included:

- drive
- options, if ordered with an option code
- BMIO-01 I/O module (in standard variant) or other extension module (in configured variant)
- mounting template (drives with frame size R3 or R4 only)
- installation accessories (PE extension plate, cable clamps, cable ties, hardware)
- multilingual warning sticker sheet (residual voltage warning)
- safety instructions
- quick installation and start-up guide
- user interface guide (behind the drive front cover)
- hardware and firmware manuals, if ordered with an option code.

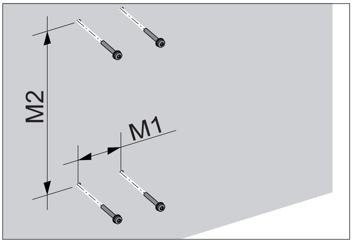
Make sure that there are no signs of damage to the items.

Installing the drive

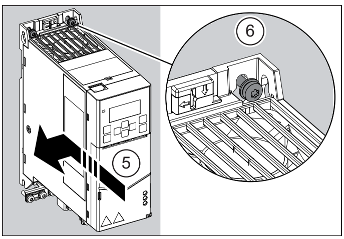
You can install the drive to a suitable surface with screws or to a DIN installation rail.

To install the drive with screws

1. Make marks on the surface for the mounting holes. Use the included mounting template for frames R3 and R4. For other frames, refer to the dimension drawings.
2. Drill the holes for the mounting screws.
3. If it is necessary, install anchors or plugs into the holes.
4. Install the mounting screws into the holes. Leave a gap between the screw head and the installation surface.



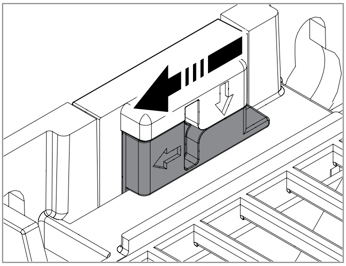
5. Put the drive onto the mounting screws.
6. Tighten the mounting screws.



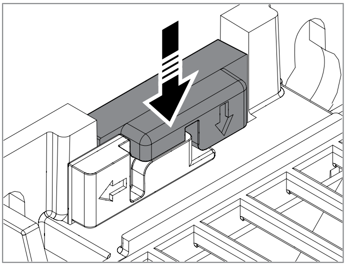
To install the drive to a DIN installation rail

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

1. Move the locking part to the left.



2. Push and hold the locking button down.



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

To remove the drive, use a slotted screwdriver to open the locking part.

5

Guidelines for planning the electrical installation

Contents of this chapter

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

Limitation of liability

The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation that 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

You can equip the drive with a main contactor.

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

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

Checking the compatibility of the motor and drive

Use an asynchronous AC induction motor, a permanent magnet synchronous motor, or an ABB synchronous reluctance motor (SynRM motors) with the drive. With the scalar motor control mode, the drive can control several induction motors.

Refer to the rating tables in the technical data to make sure that the motors and the drive are compatible.

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 58).

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.

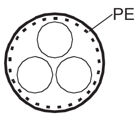
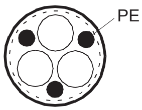
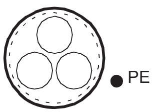
Typical power cable sizes

Refer to the technical data in the applicable hardware manual.

Power cable types

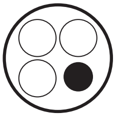
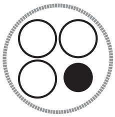
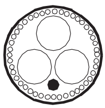
Preferred power cable types

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

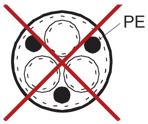
[1] A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use.

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.
 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.

Wiring method	Notes
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.

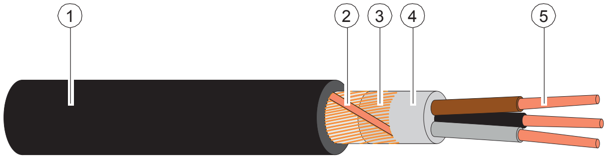
Metal conduit

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 requirements

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

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

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

The table shows the minimum cross-sectional area of the protective earth conductor related to the phase conductor size according to IEC/UL 61800-5-1 when the phase conductor(s) and the protective earth conductor are made of the same metal. If they are different metals, the cross-sectional area of the protective earth conductor must be determined in a manner which produces a conductance equivalent to that which results from the application of this table.

Cross-sectional area of the phase conductors S (mm²)	Minimum cross-sectional area of the corresponding protective earth conductor S_p (mm²)
S ≤ 16	S [1]
16 < S ≤ 35	16
35 < S	S/2

[1] For the minimum conductor size in IEC installations, refer to Additional grounding requirements – IEC (page 63).
If the protective earth conductor is not part of the input power cable or input power cable enclosure, the minimum permitted cross-sectional area is:
- 2.5 mm² if the conductor is mechanically protected,
  or
- 4 mm² if the conductor is not mechanically protected. If the equipment is cord-connected, the protective earth conductor must be the last conductor to be interrupted if there is a failure in the strain relief mechanism.

Additional grounding requirements – IEC

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

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

- the minimum size of the protective earth conductor must comply with the local safety regulations for high protective earth conductor current equipment, and
- you must use one of these connection methods:
  1. a fixed connection and:
     - a protective earth conductor with a minimum cross-sectional area according to local regulations and at the minimum of 10 mm² Cu or 16 mm² Al (as an alternative when aluminum cables are permitted),
       or
     - a second protective earth conductor of the same cross-sectional area as the original protective earth conductor,
       or
     - a device that automatically disconnects the supply if the protective earth conductor is damaged.
  2. a connection with an industrial connector according to IEC 60309 and a minimum protective earth conductor cross-section of 2.5 mm² as part of a multi-conductor power cable. Sufficient strain relief must be provided.

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

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

Additional grounding requirements – UL (NEC)

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

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

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

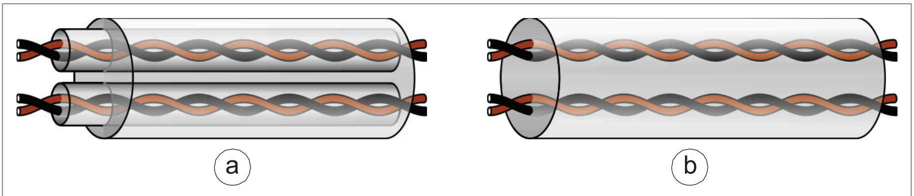
Selecting the control cables

Shielding

Only use shielded control cables.

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

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



Signals in separate cables

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

Signals that can be run in the same cable

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

Relay cable

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

Control panel 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 through the USB port of the control panel. Use a USB Type A (PC) - Type Mini-B (control panel) cable. The maximum length of the cable is 3 m (9.8 ft).

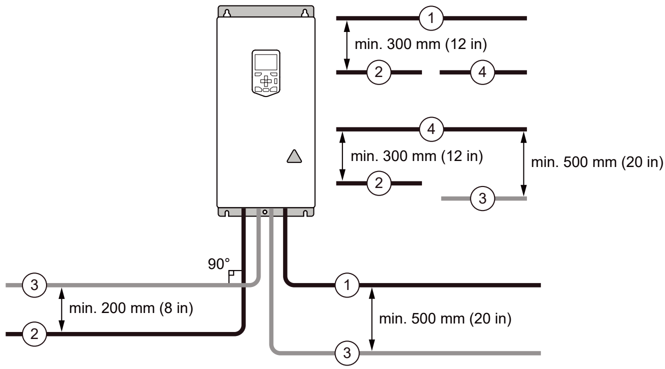
Routing the cables

General guidelines – IEC

- Install the motor cable away from other cables. The motor cables of several drives can be installed in parallel and 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.
- If 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 figure shows the cable routing guidelines with an example drive.

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



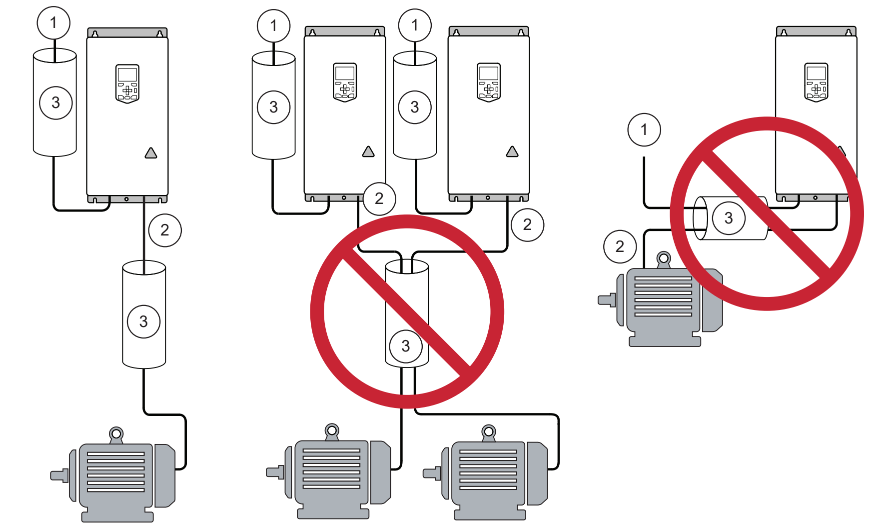
1	Motor cable
2	Input power cable
3	Control cable
4	Brake resistor or chopper cable (if any)

General guidelines – North America

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

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

The figure shows the cable routing guidelines with an example drive.



1	Input power cabling
2	Motor cabling
3	Conduit

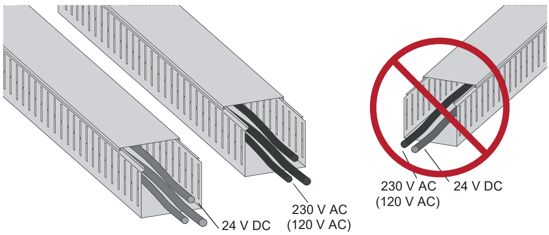
Continuous motor cable shield/conduit and metal enclosure for equipment on the motor cable

To minimize interference 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 strong 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

Install 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 to protect 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, refer to 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, refer to the firmware manual.

Implementing a motor temperature sensor connection

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

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

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

You have these implementation alternatives:

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

Protecting the drive against ground faults

The drive has internal protection against ground faults in the motor and motor cable. This function is not a personnel safety feature or a fire protection feature. Refer to the drive firmware manual.

Leakage currents and residual current device compatibility

ACS380 400 V and 230 V 3-phase drives support the use of TYPE A 30 mA and TYPE B 300 mA residual current devices in front of the mains supply, except for ACS380-040x-050A-4 types that support only 300 mA residual current devices in reliable operation.

Use motor cable types recommended in Selecting the power cables (page 57) and keep the maximum motor cable length at 30 meters to ensure reliable operation.

With 1-phase 230 V drives, support for residual current devices is similar to 400 V models, but reliable operation is only up to 10 meters.

Note: As standard, the drive has capacitors 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.

If nuisance triggering of residual current devices occurs in the application, try to shorten motor cable length or test residual current devices from alternative manufacturers.

ACS380 was tested with these residual current circuit breakers by using MCCMK cables:

- ABB F204B-25/0.03 3 0mA
- ABB F204B-25/0.3 300 mA
- Siemens 5SV3342-4 30 mA
- Siemens 5SV3642-4 300 mA

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 245).

Implementing the functions provided by the FSPS-21 PROFIsafe safety functions module

You can order the drive with an FSPS-21 PROFIsafe safety functions module, which provides PROFINET and PROFIsafe connection to the drive and has two safety functions integrated into it: Safe torque off (STO) and Safe stop 1, time monitored (SS1-t). With the module, it is possible to control the drive via PROFINET and safely stop the drive via PROFIsafe.

The Safe torque off function can be controlled with PROFIsafe. When using FSPS-21 PROFIsafe safety functions module, other safety functions are not available. Use of PROFIsafe and PROFINET is also possible by using FPNO-21 and FSO option modules.

The settings of the module have default values when delivered from the factory. The wiring and configuration of the FSPS-21 module are the responsibility of the user.

For more information, see FSPS-21 PROFIsafe safety functions module user's manual (3AXD50000158638 [English]).

Implementing the functions provided by the FSCS-21 CIP Safety™ functions module

You can order the drive with FSCS-21 CIP Safety™ functions module . The module has two safety functions integrated into it: Safe torque off (STO) and Safe stop 1, time monitored (SS1-t). With the module, you can connect a drive to an Ethernet network and a safety PLC. The module supports the CIP Safety™ communication technology through the EtherNet/IP communication protocol. The intended use of the FSCS module is to safely stop the drive when necessary. A safety PLC can activate the safety functions of the module.

The settings of the FSCS module have default values when delivered from the factory. The wiring and configuration of the FSCS module are the responsibility of the user. The FSCS module reserves the standard Safe torque off (STO) connection of the drive (or inverter) control unit.

For more information, refer to FSCS-21 CIP Safety™ functions module user's manual (3AXD50001065478 [English]).

Using a safety switch between the drive and the motor

ABB recommends that you install a safety switch between a permanent magnet motor and the drive output. The switch is used 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.

NOTICE 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.

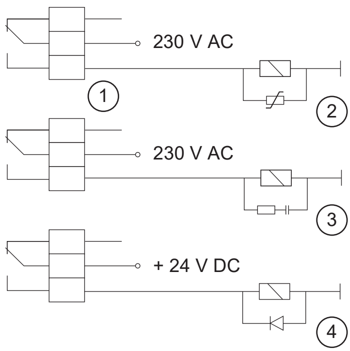
When you select the vector motor control mode and the motor coast stop mode, you can open the contactor immediately after the drive has received the stop command. This is the case also if you use the scalar motor control mode.

Protecting the contacts of relay outputs

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

It is highly recommended that inductive loads are equipped with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) to minimize the EMC emission at switch-off. If not suppressed, the disturbances can connect capacitively or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

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



1	Relay output
2	Varistor
3	RC filter
4	Diode

6

Electrical installation – IEC

Contents of this chapter

This chapter describes how to:

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

Required tools

To do the electrical installation, you need these tools:

- Wire stripper
- Screwdriver or wrench with a set of suitable bits. For motor cable terminals, the recommended screwdriver shaft length is 150 mm (5.9 in).
- Short slotted screwdriver for the I/O terminals
- Torque wrench
- Multimeter and voltage detector
- Personal protective equipment.

Measuring the insulation resistance - IEC

Measuring the insulation resistance of the drive

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

Measuring the insulation resistance of the input power cable

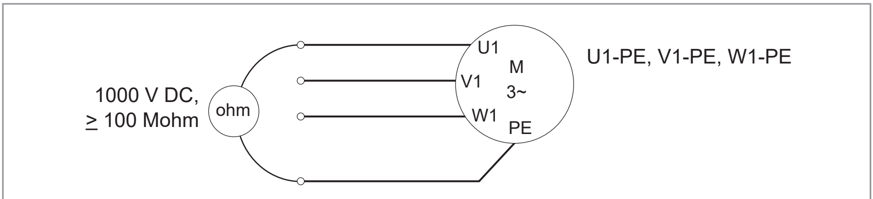
Before you connect the input power cable to the drive, measure its insulation resistance according to local regulations.

Measuring the insulation resistance of the motor and motor cable

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

1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals.
3. Measure the insulation resistance between each phase conductor and the protective earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must be more than 100 Mohm (reference value at 25 °C [77 °F]). For the insulation resistance of other motors, refer to the manufacturer’s instructions.

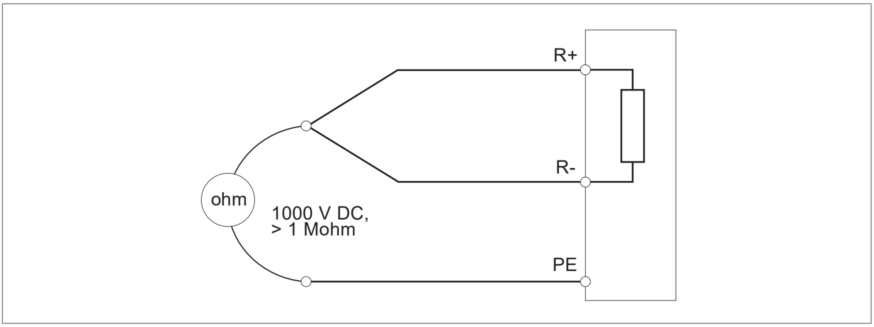
   Note: Moisture inside the motor reduces the insulation resistance. If you think that there is moisture in the motor, dry the motor and do the measurement again.



Measuring the insulation resistance of the brake resistor circuit

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 electrical installation, commissioning or maintenance work.

1. Stop the drive and do the steps in Electrical safety precautions (page 22) before you start the work.
2. Make sure that the resistor cable is connected to the resistor and disconnected from the drive output terminals.
3. At the drive end, connect the R+ and R- conductors of the resistor cable together. Measure the insulation resistance between the conductors and the PE conductor with a measuring voltage of 1000 V DC. The insulation resistance must be more than 1 Mohm.



Grounding system compatibility check – IEC

This section is applicable to the IEC drive types.

EMC filter

Some drive types have an internal EMC filter as standard. You can install a drive with an internal EMC filter connected to a symmetrically grounded TN-S system (center-grounded wye). For other systems, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 78).

Note: 200 … 240 V drives with low filtering level (type ACS380-040x, EMC category C4) do not have an internal EMC filter.

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

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

Ground-to-phase varistor

The drive has a ground-to-phase varistor circuit as standard. You can install a drive that has the varistor circuit connected to a symmetrically grounded TN-S system (center-grounded wye). For other systems, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 78). In some product variants, the varistor circuit is disconnected at the factory.

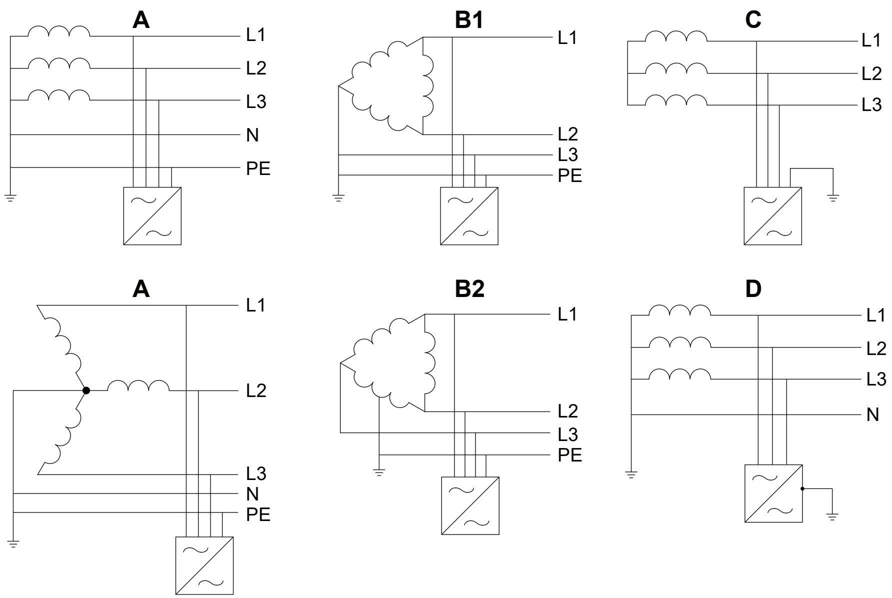
NOTICE Do not install the drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. It can cause damage to the varistor circuit.

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

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

A metal EMC screw is used to connect the internal EMC filter, and a metal VAR screw is used to connect the ground-to-phase varistor. The screws are installed at the factory. The material of the screws (plastic or metal) depends on the product variant. Before you connect the drive to the input power, examine the screws and do the necessary actions shown in the table.

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



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

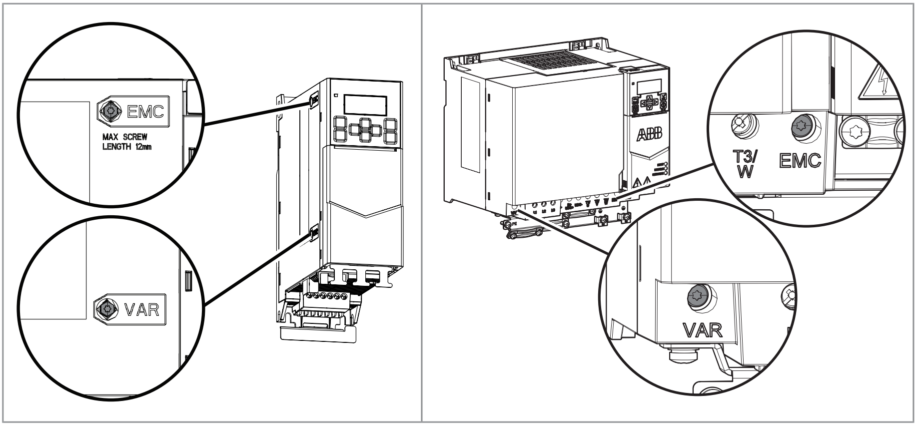
For the locations of the screws, refer to Disconnecting the EMC filter or ground-to-phase varistor (page 80).

Disconnecting the EMC filter or ground-to-phase varistor

Before you continue, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 78).

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

EMC/VAR screw location



Guidelines for installing the drive to a TT system

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

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

Note:

- ABB does not guarantee the EMC performance, because the internal EMC filter is disconnected.
- In a TT system, the built-in ground leakage detector may not correctly detect leakage currents.
- In large systems the residual current device can trip without a real reason.

Identifying the grounding system of the electrical power network

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

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 electrical installation, commissioning or maintenance work.

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.

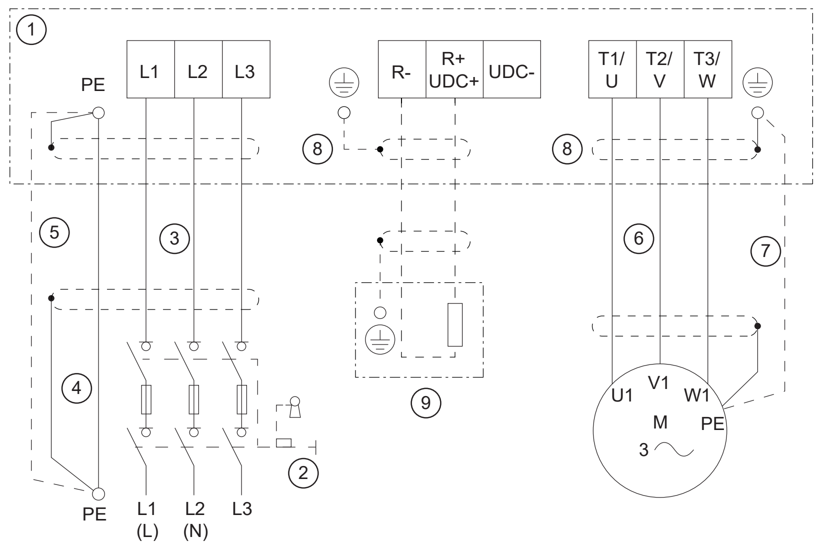
1. input voltage line to line ($U_{L\text{-}L}$)
2. input voltage line 1 to ground ($U_{L1\text{-}G}$)
3. input voltage line 2 to ground ($U_{L2\text{-}G}$)
4. input voltage line 3 to ground ($U_{L3\text{-}G}$).

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

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

Connecting the power cables – IEC (shielded cables)

Connection diagram



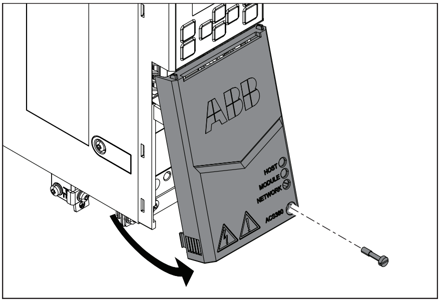
1	Drive
2	Disconnecting device
3	Input power cable
4	Two protective earth (ground) conductors. Drive safety standard IEC/EN 61800-5-1 requires two PE conductors for a fixed connection, if the cross-sectional area of the PE conductor is less than 10 mm^2 Cu or 16 mm^2 Al. For example, you can use the 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 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 (if used), recommended for the input power cable.
9	Brake resistor (optional)

Connection procedure

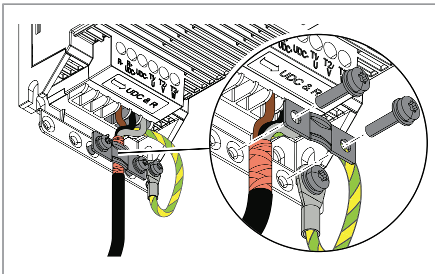
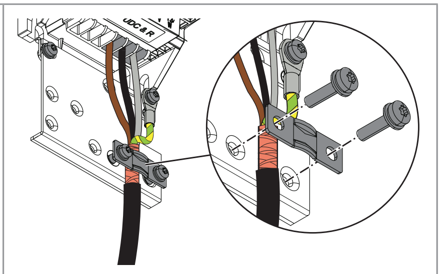
WARNING Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do electrical installation, commissioning or maintenance work.

Refer to Terminal data for the power cables (page 170) for the tightening torques.

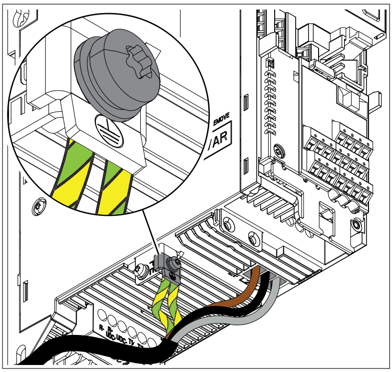
1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the screw on the drive front cover, then remove the front cover.



3. Attach the residual voltage warning sticker in the local language to the drive.
4. Attach the optional PE extension plate to the drive.
5. Strip the motor cable. Refer to Terminal data for the power cables (page 170) for wire stripping lengths.
6. For stranded conductors, install suitable ferrules at the ends of the conductors.
7. Ground the motor cable shield under the grounding clamp for 360-degree grounding.

	
Without the PE extension plate.	With the PE extension plate.

8. Twist the motor cable shield into a bundle, mark it with yellow-green insulation tape, install a cable lug, and connect it to the grounding terminal.
9. Connect the phase conductors of the motor cable to terminals T1/U, T2/V and T3/W.
10. If you use a brake resistor, connect the brake resistor cable to terminals R- and UDC+. Use shielded cable and ground the shield under the grounding clamp for 360-degree grounding.
11. Make sure that the R- and UDC+ terminal screws are tightened. Do this step also if you do not connect cables to the terminals.
12. Strip the input power cable. Refer to Terminal data for the power cables (page 170) for wire stripping lengths.
13. For stranded conductors, install suitable ferrules at the ends of the conductors.
14. If the input power cable has a shield, ground the shield under the clamp for 360-degree grounding. Twist the shield also into a bundle, mark it with yellow-green insulation tape, install a cable lug, and connect it to the grounding terminal.



15. Connect the protective earth (ground) conductor(s) of the input power cable to the grounding terminal.
16. Connect the phase conductors of the input power cable to the drive as follows:
    - 1-phase drives: connect the phase and neutral conductors to terminals L1 and L2. For example, connect phase to L1 and neutral to L2.
    - 3-phase drives: connect the phase conductors to terminals L1, L2, and L3.
17. Mechanically attach the cables with cable ties to prevent mechanical loading at the terminals.
18. Install the front cover.

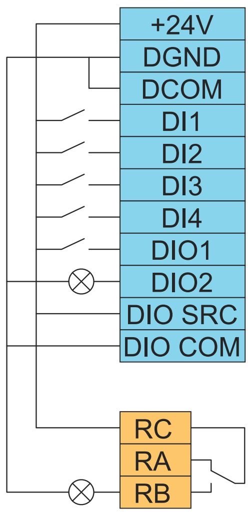
Connecting the control cables - IEC

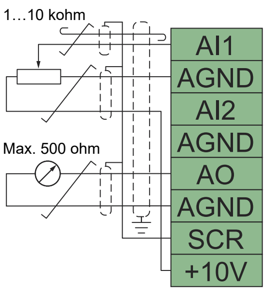
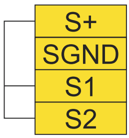
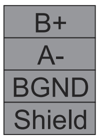
Before you connect the control cables, make sure that all option modules are installed.

Default I/O connection diagram (ABB standard macro)

This connection diagram is valid for drives with the BMIO-01 I/O & Modbus extension module:

- Standard variant (ACS380-04x**S**)
- Configured variant (ACS380-04x**C**) with the BMIO-01 I/O & Modbus extension module (option +L538)

Connection	Term.	Description	1)
Digital I/O and relay output connections			
	+24V	Aux. voltage output +24 V DC, max. 250 mA	
	DGND	Aux. voltage output common	×
	DCOM	Digital input common	×
	DI1	Stop (0) / Start (1)	×
	DI2	Forward (0) / Reverse (1)	×
	DI3	Speed selection	
	DI4	Speed selection	
	DIO1	Digital input: Ramp set 1 (0) / Ramp set 2 (1)	
	DIO2	Digital output: Not ready (0) / Ready run (1)	
	DIO SRC	Digital output auxiliary voltage	
	DIO COM	Digital input/output common	
	RC	Relay output 1 No fault [Fault (-1)]	×
	RA		×
	RB		×

Connection	Term.	Description	1)
Analog inputs and outputs			
	AI1 2)	Output frequency/Speed reference (0 … 10 V / 4 … 20 mA)	
	AGND	Analog input/output circuit common	
	AI2 2)	Not configured	
	AGND	Analog input/output circuit common	
	AO 2)	Output frequency (0 … 20 mA / 4 … 20 mA)	
	AGND	Analog input/output circuit common	
	SCR	Signal cable shield (screen)	
	+10V	Reference voltage	
Safe torque off (STO)			
	S+	Safe torque off function. Factory connection. Both circuits must be closed for the drive to start.	×
	SGND		×
	S1		×
	S2		×
EIA-485 Modbus RTU			
	B+	Embedded Modbus RTU (EIA-485)	
	A-		
	BGND		
	Shield		
	Termina-tion & bi-as		

1) × = base unit, empty = BMIO-01 module

2) Analog channels can be configured to current signal (4…20 mA) and to voltage signal (0…10 V). Refer to parameter group 12 (Standard AI) and 13 (Standard AO) for the configuration details.

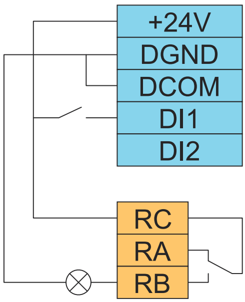
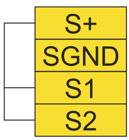
Note: This note is applicable to BMIO-01 option module (material code: 3AXD50000021262), revision D or earlier. The revision is shown on the type label of the module.

The status of the drive main input voltage has an effect on the operation of digital and analog outputs of the BMIO-01 option module:

- Digital output (DIO1/DIO2 configured as output) will be at a high state for a short time (<20 ms) after the main input voltage (L1, L2, L3) is connected.
- Digital output (DIO1/DIO2 configured as output) will be at a high state continuously when the main input voltage (L1, L2, L3) is not connected and an external 24 V DC supply is used for digital output source (DIO SRC).
- Analog output (AO) will be at the maximum voltage reference level (+10 V) for a short time (<20 ms) after the main input voltage (L1, L2, L3) is connected.

Fieldbus connection diagram

This connection diagram is valid for drives with a fieldbus extension module. The type code is ACS380-04xC followed by an option code that designates the extension module.

Connection	Term.	Description
Digital I/O and relay output connections		
	+24V	Aux. voltage output +24 V DC, max. 250 mA
	DGND	Aux. voltage output common
	DCOM	Digital input common
	DI1	Fault reset (operates also through the fieldbus interface)
	DI2	Not configured
	RC	Relay output 1 No fault [Fault (-1)]
	RA	
	RB	
Safe torque off (STO)		
	S+	Safe torque off function. Factory connection. Both circuits must be closed for the drive to start.
	SGND	
	S1	
	S2	
Fieldbus connection		
See the applicable fieldbus adapter manual.	Terminal block	+K451 FDNA-01, DeviceNet
	DSUB9	+K454 FPBA-01 Profibus DP
	DSUB9	+K457 FCAN-01 CANopen
	8P8C×2	+K462 FCNA-01 ControlNet
	RJ45×2	+K469 FECA-01 EtherCAT
	RJ45×2	+K470 FEPL-02, Ethernet Powerlink
	RJ45×2	+K490 FEIP-21 Two-port Modbus/IP adapter
	RJ45×2	+K491 FMBT-21 Two-port Modbus/TCP adapter
	RJ45×2	+K492 FPNO-21 Two-port Profinet IO adapter
	Terminal block	+K495 BCAN-11 CANopen interface

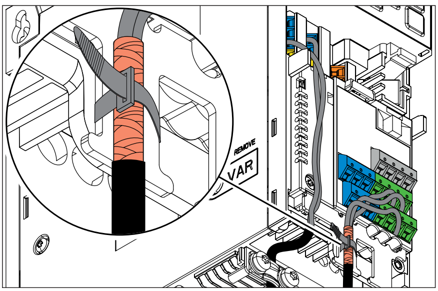
Control cable connection procedure

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

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

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

1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the screw on the drive front cover, then remove the front cover.
3. Strip a part of the outer shield of the control cable for grounding.
4. Use a cable tie to ground the outer shield to the grounding tab. For 360° grounding, use metallic cable ties.
5. Strip the control cable conductors. Refer to Terminal data for the control cables (page 173) for wire stripping lengths.
6. For stranded conductors, install suitable ferrules at the ends of the conductors.
7. Connect the conductors to the control terminals. Torque the terminal connections to 0.4 N·m (3.5 lbf·in).
8. Connect the shields and grounding wires to the SCR terminal. Torque the terminal connection to 0.4 N·m (3.5 lbf·in).
9. Mechanically attach the control cables on the outside of the drive.



Additional information on the control connections

Embedded EIA-485 fieldbus connection

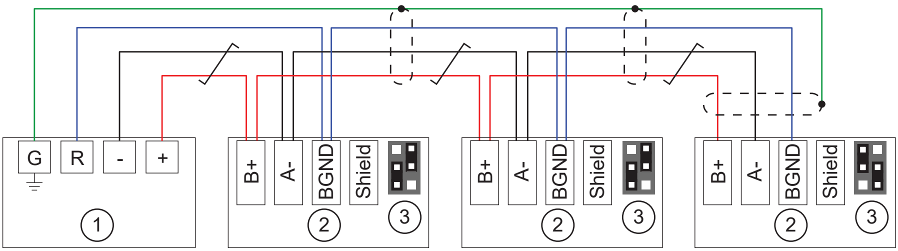
The EIA-485 network uses shielded, twisted-pair cable with a characteristic impedance of 100…130 ohm for data signaling. The distributed capacitance between conductors is less than 100 pF per meter (30 pF per foot). Distributed capacitance between conductors and shield is less than 200 pF per meter (60 pF per foot). Foil or braided shields are acceptable.

Connect the cable to the EIA-485 terminal on the BMIO-01 I/O module. Obey these wiring instructions:

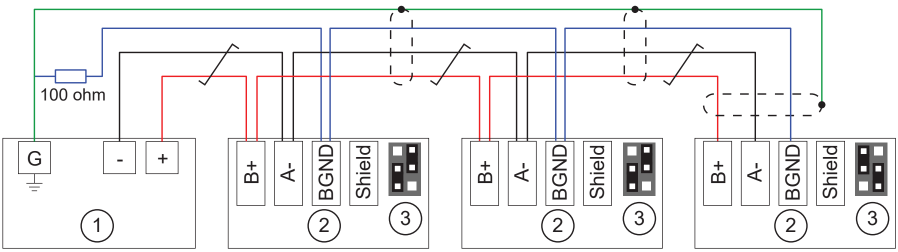
- Attach the cable shields together at each drive, but do not connect them to the drive.
- Connect the cable shields only to the grounding terminal in the automation controller.
- Connect the signal ground (BGND) conductor to the signal ground reference terminal in the automation controller. If the automation controller does not have a signal ground reference terminal, connect the signal ground conductor to the cable shield through a 100 ohm resistor, preferably near the automation controller.

Connection examples are shown below.

With signal ground reference terminal



Without signal ground reference terminal

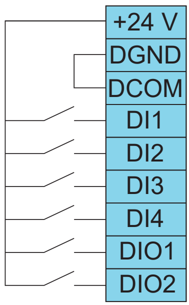
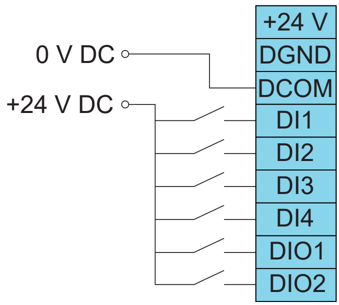


1	Automation controller
2	Drive
3	Termination jumpers. The devices at the ends of the fieldbus must have termination on. All other devices must have termination off.

PNP configuration for digital inputs

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

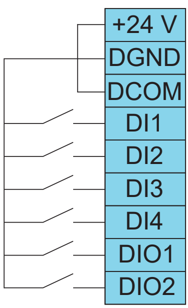
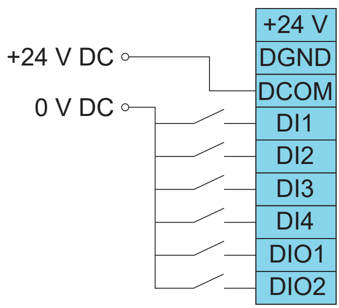
NOTICE If you connect DIO1 or DIO2 as shown in the figures below, make sure that they are configured as inputs. If they are configured as outputs, it can cause damage to the equipment.

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

NPN configuration for digital inputs

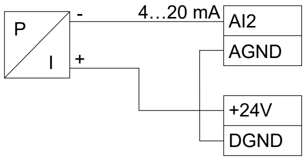
Internal and external +24 V power supply connections for NPN (sink) configuration are shown in the figures below.

NOTICE If you connect DIO1 or DIO2 as shown in the figures below, make sure that they are configured as inputs. If they are configured as outputs, it can cause damage to the equipment.

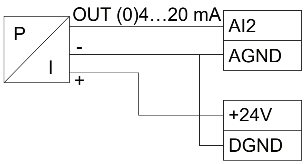
Internal +24 V power supply	External +24 V power supply
	

Connection examples of two-wire and three-wire sensors

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



AI2	Process actual value measurement or reference, 0(4) … 20 mA, R_{in} = 137 ohm. If the sensor power supply comes through its current output circuit, use 4 … 20 mA signal, not 0 … 20 mA.
AGND	
+24V	Auxiliary voltage output, non-isolated, +24 V DC, max. 250 mA
DGND	



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

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

WARNING IEC 61800-5-1 requires double or reinforced insulation between the 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.

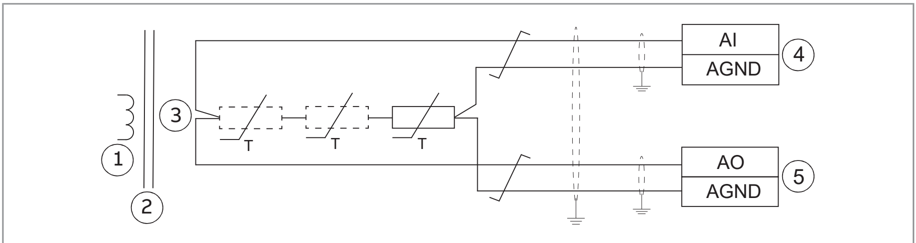
To comply with the drive safety standard IEC 61800-5-1:

If the motor temperature sensor has double or reinforced insulation vs. the motor windings, you can connect it directly to the drive IO interface. This section shows two connection alternatives for the direct I/O connection. If the sensor does not have reinforced insulation, you must use another type of connection to comply with the safety standard. Refer to Implementing a motor temperature sensor connection (page 70).

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

PTC connection 1

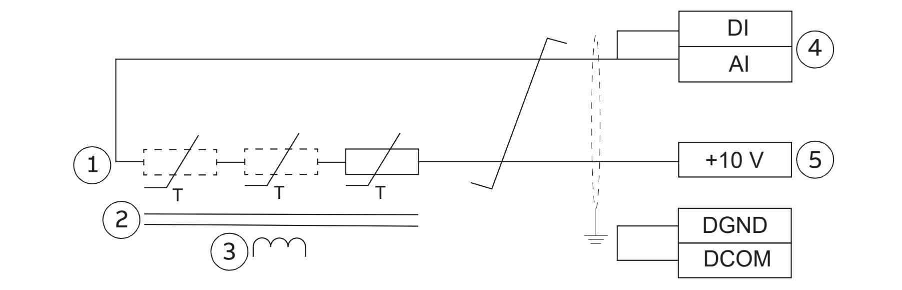
1…3 PTC sensors can be connected in series to an analog input and an analog output. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor. The analog output feeds a constant excitation current of 1.6 mA through the sensor. The sensor resistance increases as the motor temperature rises, as does the voltage over the sensor. The temperature measurement function calculates the resistance of the sensor and generates an indication if overtemperature is detected. Leave the sensor end of the cable shield unconnected.



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

PTC connection 2

If no analog output is available for the PTC connection, it is possible to use a voltage divider connection. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor. 1…3 PTC sensors are connected in series with 10 V reference and digital and analog inputs. The voltage over the digital input internal resistance varies depending on the PTC resistance. The temperature measurement function reads the digital input voltage through the analog input and calculates the PTC resistance.



1	1…3 PTC sensors
2	Double or reinforced insulation
3	Motor winding
4	Digital input and analog input. Set the analog input type to V (volt) in parameter group 12 Standard AI. Define the temperature sensor type, signal source, etc. with parameters 35.11…35.24. For the sensor type, select: PTC AI/DI Voltage Divider tree. Make sure that the digital input is not configured to any other use by parameters.
5	10 V reference voltage

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

WARNING IEC 61800-5-1 requires double or reinforced insulation between the 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.

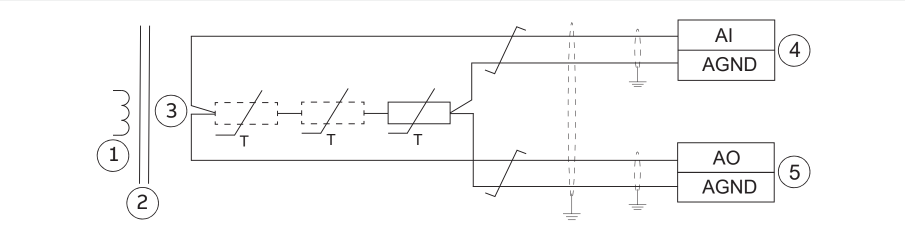
Obey this requirement when you plan the connection of the motor temperature sensor to the drive.

To comply with the drive safety standard IEC 61800-5-1:

If the motor temperature sensor has double or reinforced insulation vs. the motor windings, you can connect it directly to the drive IO interface. This section shows the connection. If the sensor has no reinforced insulation, you must use another type of connection to comply with the safety standard. Refer to Implementing a motor temperature sensor connection (page 70).

You can connect temperature measurement sensors (one, two or three Pt100 sensors; one, two or three Pt1000 sensors; or one Ni1000, KTY83 or KTY84) between an analog input and output as shown below. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor. Leave the sensor end of the cable shield unconnected.

Refer to the firmware manual for information on the related motor thermal protection function.



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

Safe torque off

For the drive to start, both STO connections (S+ to S1 and S+ to S2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting external Safe torque off circuitry to the drive. Refer to The Safe torque off function.

Auxiliary voltage connection

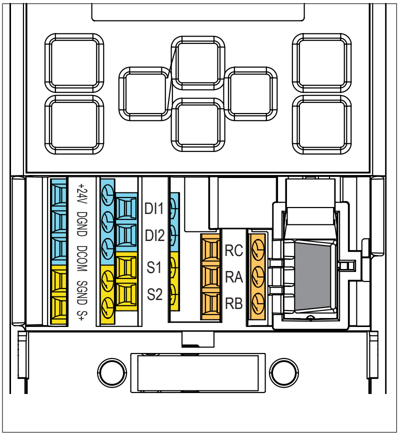
The drive has 24 V DC (±10%) auxiliary power supply terminals on the base unit and on the optional BAPO-02 auxiliary power extension module. You can use them:

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

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

To supply power to external control circuits or option modules:

1. Connect the load to the auxiliary power output on the base unit, or on the BAPO-02 module (+24V and DGND terminals).
2. Make sure that you do not exceed the load capacity of the output, or the sum load capacity of both outputs.



To connect an external auxiliary power supply to the drive:

1. Install a BAPO power extension module to the drive. See Installing options (page 98).
2. Connect an external power supply to the +24V and DGND terminals of the base unit.

For more information on the BAPO modules, refer to BAPO-01 auxiliary power extension module (page 315) or BAPO-02 auxiliary power extension module (page 319).

Connecting a PC

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

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

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

You can use the CCA-01 cold configuration tool to download software and change drive parameters without connecting the drive to the input power. The CCA-01 does not operate if the drive is powered. Refer to CCA-01 communication adapter quick installation guide (3AXD50000018457 [English]) for more information.

Installing options

The drive has two option module slots:

- Front option: Communication module slot under the front cover.
- Side option: Multifunction extension module slot on the side of the drive.

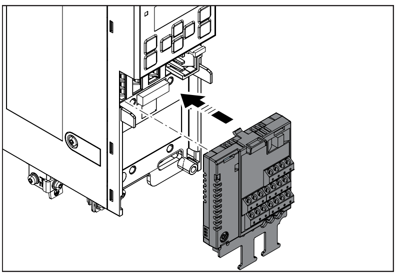
Refer also to the applicable fieldbus module manual for the installation instructions. For other option modules, refer to:

- BTAC-02 pulse encoder interface module (page 265) or BTAC-03 pulse encoder interface module (page 283)
- BRES-01 resolver interface module (page 301)
- BREL-01 relay output extension module (page 309)
- BAPO-01 auxiliary power extension module (page 315) or BAPO-02 auxiliary power extension module (page 319)
- BIO-01 I/O extension module (page 325).

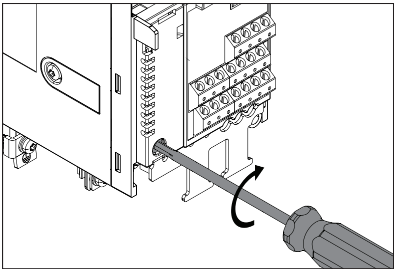
Installing a front option

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

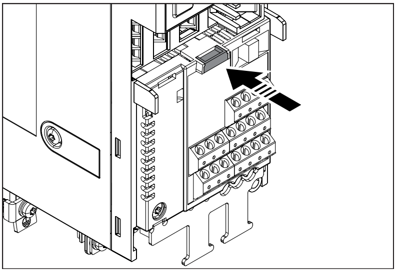
1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the screw on the drive front cover, then remove the front cover.
3. If the option module has a locking tab, pull it up.
4. Carefully align the option module with the option module slot and push it into position.



5. Torque the screw to 0.5 N·m (4.4 lbf·in).



6. If the option module has a locking tab, push it down until it locks.



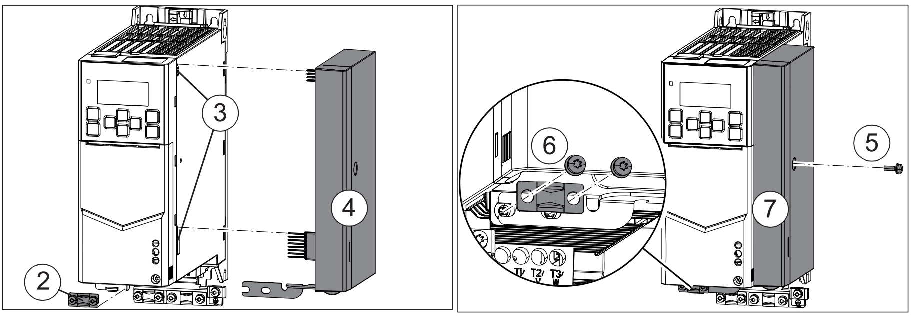
7. Connect the control cables. See the control cable connection instructions.

Note: If you have the BIO-01 option module, you can add one additional fieldbus module on top of it. Replace the drive front cover with the high cover that comes with the BIO-01 module.

Installing a side option

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

1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the two screws from the front-most grounding clamp at the bottom of the drive.
3. Carefully align the side option with the connectors on the right side of the drive.
4. Fully push the option module into position.
5. Torque the screw on the option module to 1 N·m (8.8 lbf·in).
6. Attach the grounding bar to the bottom of the side option and to the front ground tab on the drive. Torque the screws to 1 N·m (8.8 lbf·in).
7. Connect the control cables. See the control cable connection instructions.



7

Electrical installation – North America

Contents of this chapter

This chapter describes how to:

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

Required tools

To do the electrical installation, you need these tools:

- Wire stripper
- Screwdriver or wrench with a set of suitable bits. For motor cable terminals, the recommended screwdriver shaft length is 150 mm (5.9 in).
- Short slotted screwdriver for the I/O terminals
- Torque wrench
- Multimeter and voltage detector

- Personal protective equipment.

Measuring the insulation resistance - North America

Measuring the insulation resistance of the drive

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

Measuring the insulation resistance of the input power cable

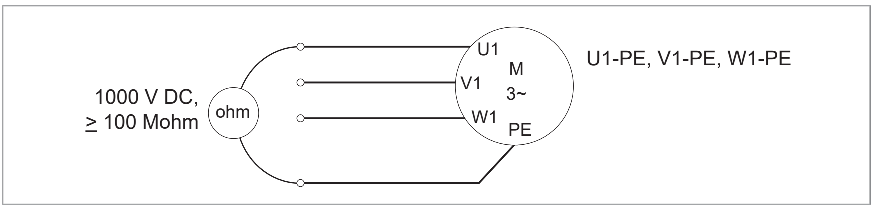
Before you connect the input power cable to the drive, measure its insulation resistance according to local regulations.

Measuring the insulation resistance of the motor and motor cable

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

1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals.
3. Measure the insulation resistance between each phase conductor and the protective earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must be more than 100 Mohm (reference value at 25 °C [77 °F]). For the insulation resistance of other motors, refer to the manufacturer's instructions.

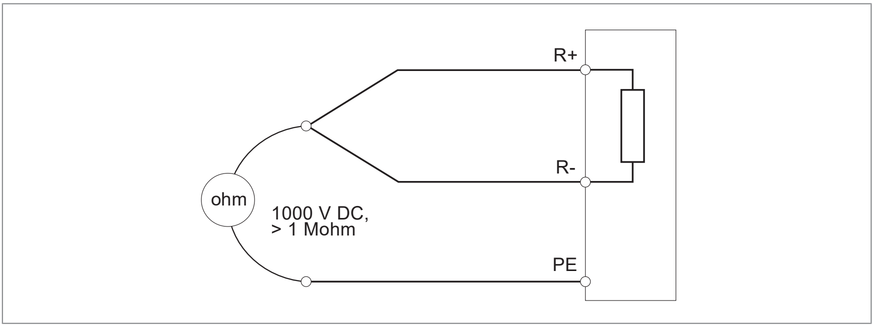
   Note: Moisture inside the motor reduces the insulation resistance. If you think that there is moisture in the motor, dry the motor and do the measurement again.



Measuring the insulation resistance of the brake resistor circuit

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 electrical installation, commissioning or maintenance work.

1. Stop the drive and do the steps in Electrical safety precautions (page 22) before you start the work.
2. Make sure that the resistor cable is connected to the resistor and disconnected from the drive output terminals.
3. At the drive end, connect the R+ and R- conductors of the resistor cable together. Measure the insulation resistance between the conductors and the PE conductor with a measuring voltage of 1000 V DC. The insulation resistance must be more than 1 Mohm.



Grounding system compatibility check – North America

This section is applicable to North American installations.

EMC filter

Some drive types have an internal EMC filter as standard. In the drives sold in North America, the filter is disconnected by default. The filter is typically not necessary in North American installations.

If you are concerned with EMC issues, and install the drive to a symmetrically grounded TN-S system (center-grounded wye), you can connect the internal EMC filter. See Disconnecting the ground-to-phase varistor, or connecting the EMC filter (page 106).

Note: 200 … 240 V drives with low filtering level (type ACS380-040x, EMC category C4) do not have an internal EMC filter.

Note: When the internal EMC filter is disconnected, the electromagnetic compatibility of the drive is decreased.

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

Ground-to-phase varistor

The drive has a ground-to-phase varistor circuit as standard. You can install a drive that has the varistor circuit connected to a symmetrically grounded TN-S system (center-grounded wye). For other systems, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 104). In some product variants, the varistor circuit is disconnected at the factory.

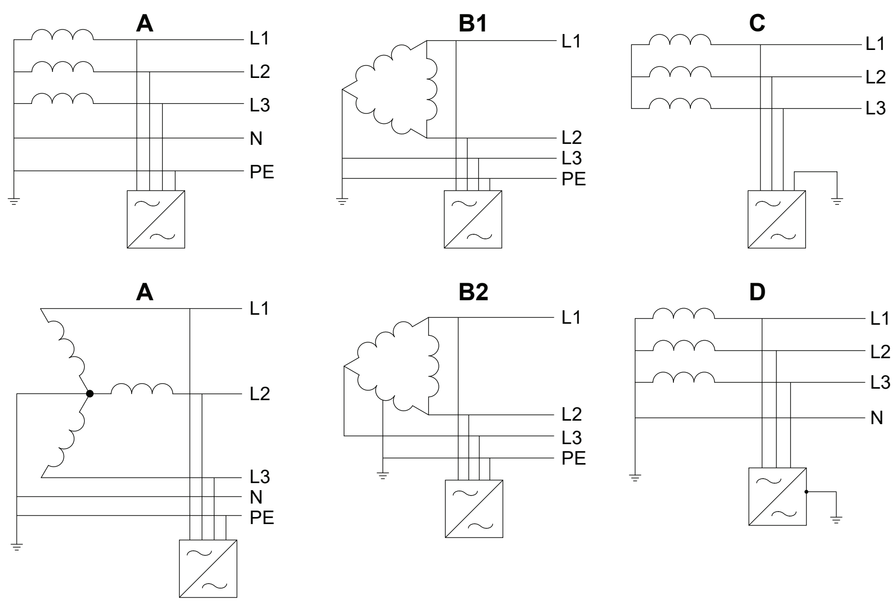
NOTICE Do not install the drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. It can cause damage to the varistor circuit.

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

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

A metal EMC screw is used to connect the internal EMC filter, and a metal VAR screw is used to connect the ground-to-phase varistor. The screws are installed at the factory. The material of the screws (plastic or metal) depends on the product variant. Before you connect the drive to the input power, examine the screws and do the necessary actions shown in the table.

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



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

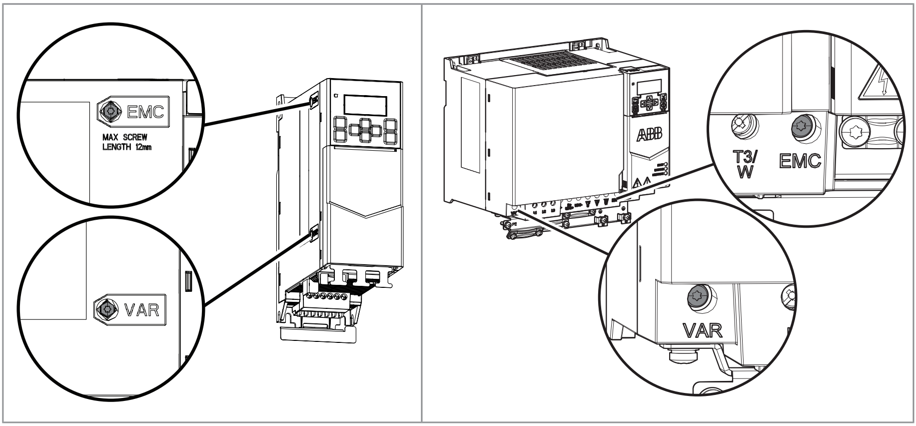
For the locations of the screws, refer to Disconnecting the ground-to-phase varistor, or connecting the EMC filter (page 106).

Disconnecting the ground-to-phase varistor, or connecting the EMC filter

Before you continue, refer to Compatibility of EMC filter and ground-to-phase varistor with the grounding system (page 104).

- To disconnect the ground-to-phase varistor, remove the metal VAR screw.
- To connect the EMC filter, remove the plastic EMC screw, and replace it with the metal screw included in the drive delivery.

EMC/VAR screw location



Guidelines for installing the drive to a TT system

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

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

Note:

- ABB does not guarantee the EMC performance, because the internal EMC filter is disconnected.
- In a TT system, the built-in ground leakage detector may not correctly detect leakage currents.
- In large systems the residual current device can trip without a real reason.

Identifying the grounding system of the electrical power network

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

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 electrical installation, commissioning or maintenance work.

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}).

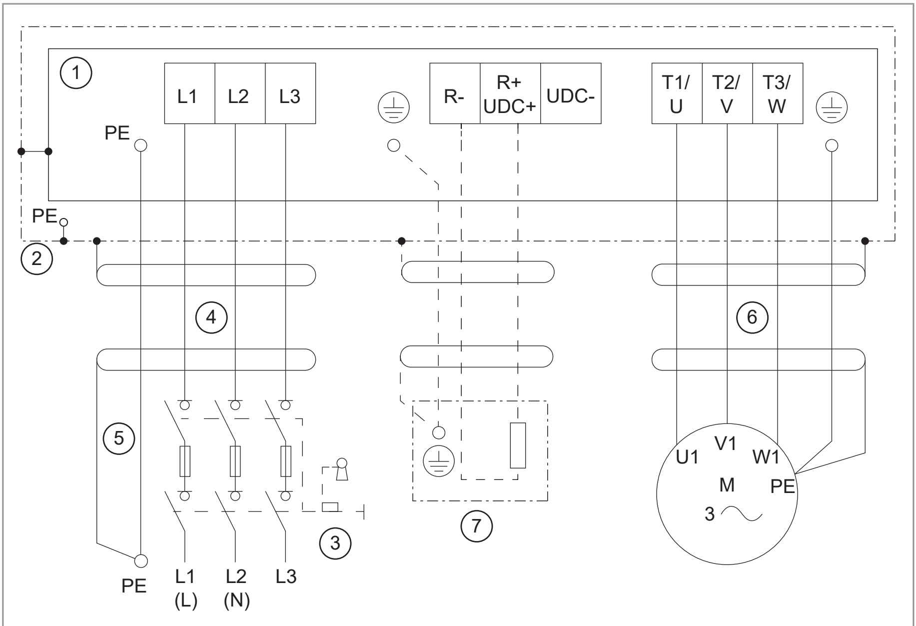
The table below shows the line-to-ground voltages in relation to the line-to-line voltage for each grounding system.

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 – North America (wiring in conduits)

Use insulated wires suitable for installation in electrical conduits. See the National Electric Code and local ordinances.

Connection diagram



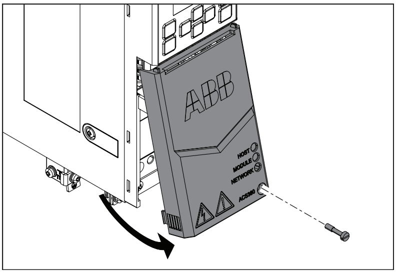
1	Drive
2	Drive enclosure
3	Supply disconnecting device and fuses
4	Input power wiring
5	Protective earth (ground) conductor(s)
6	Motor wiring **Note:** ABB recommends to use a symmetrical shielded cable (VFD cable) as the motor cable.
7	Brake resistor (optional)

Connection procedure

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

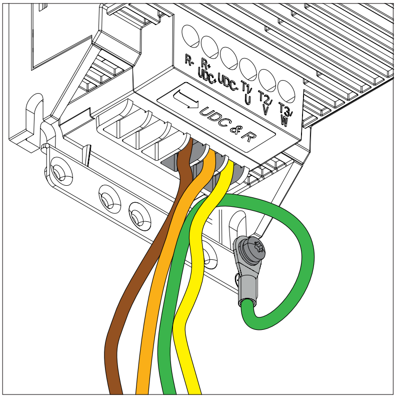
Refer to Terminal data for the power cables (page 170) for the tightening torques.

1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Install the conduits, and attach them to the cable entry plate of the enclosure that the drive is installed in.
3. Make sure that the conduit is correctly grounded at the cable entry.
4. Strip the conductor ends and pull the conductors through the conduits. Refer to Terminal data for the power cables (page 170) for wire stripping lengths.
5. For stranded conductors, install suitable ferrules at the ends of the conductors.
6. Remove the screw on the drive front cover, then remove the front cover.

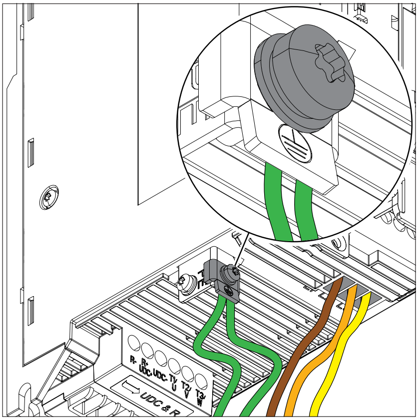


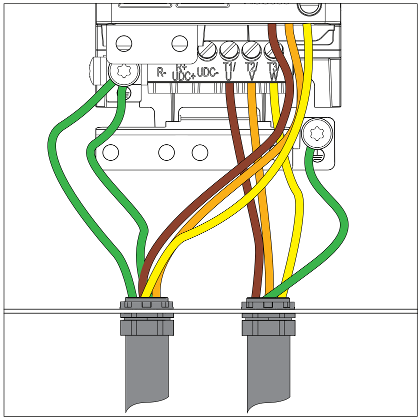
7. Attach the residual voltage warning sticker in the local language to the drive.
8. Connect the protective earth (ground) conductor of the motor wiring to the grounding terminal.

9. Connect the phase conductors of the motor wiring to terminals T1/U, T2/V and T3/W.



10. If you use a brake resistor, connect the brake resistor conductors to terminals R- and UDC+.
11. Make sure that the R- and UDC+ terminal screws are tightened. Do this step also if you do not connect cables to the terminals.
12. Connect the protective earth (ground) conductor(s) of the input power wiring to the grounding terminal.
13. Connect the phase conductors of the input power wiring to the drive as follows:
    - 1-phase drives: connect the phase and neutral conductors to terminals L1 and L2. For example, connect phase to L1 and neutral to L2.
    - 3-phase drives: connect the phase conductors to terminals L1, L2, and L3.





14. Connect the other ends of the conductors.

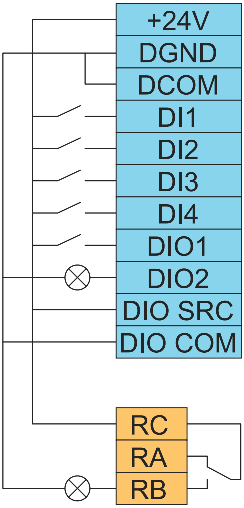
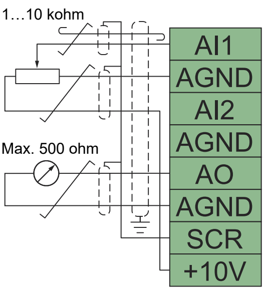
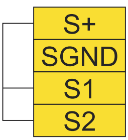
Connecting the control cables - North America

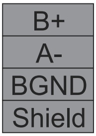
Before you connect the control cables, make sure that all option modules are installed.

Default I/O connection diagram (ABB standard macro)

This connection diagram is valid for drives with the BMIO-01 I/O & Modbus extension module:

- Standard variant (ACS380-04x**S**)
- Configured variant (ACS380-04x**C**) with the BMIO-01 I/O & Modbus extension module (option +L538)

Connection	**Term.**	**Description**	**1)**
Digital I/O and relay output connections			
	+24V	Aux. voltage output +24 V DC, max. 250 mA	
	DGND	Aux. voltage output common	×
	DCOM	Digital input common	×
	DI1	Stop (0) / Start (1)	×
	DI2	Forward (0) / Reverse (1)	×
	DI3	Speed selection	
	DI4	Speed selection	
	DIO1	Digital input: Ramp set 1 (0) / Ramp set 2 (1)	
	DIO2	Digital output: Not ready (0) / Ready run (1)	
	DIO SRC	Digital output auxiliary voltage	
	DIO COM	Digital input/output common	
	RC	Relay output 1 No fault [Fault (-1)]	×
	RA		×
	RB		×
Analog inputs and outputs			
	AI1 2)	Output frequency/Speed reference (0 … 10 V / 4 … 20 mA)	
	AGND	Analog input/output circuit common	
	AI2 2)	Not configured	
	AGND	Analog input/output circuit common	
	AO 2)	Output frequency (0 … 20 mA / 4 … 20 mA)	
	AGND	Analog input/output circuit common	
	SCR	Signal cable shield (screen)	
	+10V	Reference voltage	
Safe torque off (STO)			
	S+	Safe torque off function. Factory connection. Both circuits must be closed for the drive to start.	×
	SGND		×
	S1		×
	S2		×

Connection	Term.	Description	1)
EIA-485 Modbus RTU			
	B+	Embedded Modbus RTU (EIA-485)	
	A-		
	BGND		
	Shield		
	Termination & bias		

1) × = base unit, empty = BMIO-01 module

2) Analog channels can be configured to current signal (4…20 mA) and to voltage signal (0…10 V). Refer to parameter group 12 (Standard AI) and 13 (Standard AO) for the configuration details.

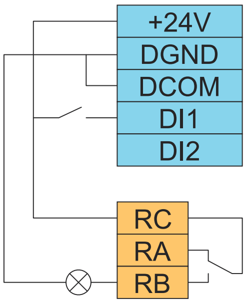
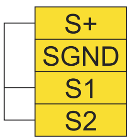
Note: This note is applicable to BMIO-01 option module (material code: 3AXD50000021262), revision D or earlier. The revision is shown on the type label of the module.

The status of the drive main input voltage has an effect on the operation of digital and analog outputs of the BMIO-01 option module:

- Digital output (DIO1/DIO2 configured as output) will be at a high state for a short time (<20 ms) after the main input voltage (L1, L2, L3) is connected.
- Digital output (DIO1/DIO2 configured as output) will be at a high state continuously when the main input voltage (L1, L2, L3) is not connected and an external 24 V DC supply is used for digital output source (DIO SRC).
- Analog output (AO) will be at the maximum voltage reference level (+10 V) for a short time (<20 ms) after the main input voltage (L1, L2, L3) is connected.

Fieldbus connection diagram

This connection diagram is valid for drives with a fieldbus extension module. The type code is ACS380-04xC followed by an option code that designates the extension module.

Connection	Term.	Description
Digital I/O and relay output connections		
	+24V	Aux. voltage output +24 V DC, max. 250 mA
	DGND	Aux. voltage output common
	DCOM	Digital input common
	DI1	Fault reset (operates also through the fieldbus interface)
	DI2	Not configured
	RC	Relay output 1 No fault [Fault (-1)]
	RA	
	RB	
Safe torque off (STO)		
	S+	Safe torque off function. Factory connection. Both circuits must be closed for the drive to start.
	SGND	
	S1	
	S2	
Fieldbus connection		
See the applicable fieldbus adapter manual.	Terminal block	+K451 FDNA-01, DeviceNet
	DSUB9	+K454 FPBA-01 Profibus DP
	DSUB9	+K457 FCAN-01 CANopen
	8P8C×2	+K462 FCNA-01 ControlNet
	RJ45×2	+K469 FECA-01 EtherCAT
	RJ45×2	+K470 FEPL-02, Ethernet Powerlink
	RJ45×2	+K490 FEIP-21 Two-port Modbus/IP adapter
	RJ45×2	+K491 FMBT-21 Two-port Modbus/TCP adapter
	RJ45×2	+K492 FPNO-21 Two-port Profinet IO adapter
	Terminal block	+K495 BCAN-11 CANopen interface

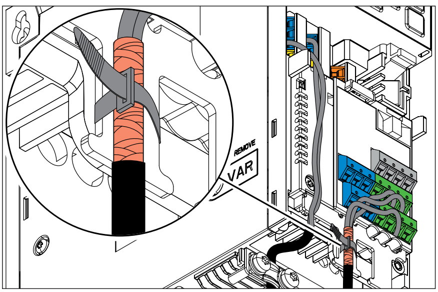
Control cable connection procedure

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

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

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

1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the screw on the drive front cover, then remove the front cover.
3. Strip a part of the outer shield of the control cable for grounding.
4. Use a cable tie to ground the outer shield to the grounding tab. For 360° grounding, use metallic cable ties.
5. Strip the control cable conductors. Refer to Terminal data for the control cables (page 173) for wire stripping lengths.
6. For stranded conductors, install suitable ferrules at the ends of the conductors.
7. Connect the conductors to the control terminals. Torque the terminal connections to 0.4 N·m (3.5 lbf·in).
8. Connect the shields and grounding wires to the SCR terminal. Torque the terminal connection to 0.4 N·m (3.5 lbf·in).
9. Mechanically attach the control cables on the outside of the drive.



Additional information on the control connections

Embedded EIA-485 fieldbus connection

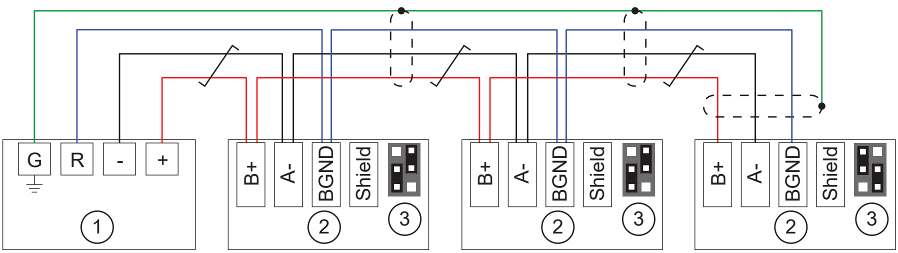
The EIA-485 network uses shielded, twisted-pair cable with a characteristic impedance of 100…130 ohm for data signaling. The distributed capacitance between conductors is less than 100 pF per meter (30 pF per foot). Distributed capacitance between conductors and shield is less than 200 pF per meter (60 pF per foot). Foil or braided shields are acceptable.

Connect the cable to the EIA-485 terminal on the BMIO-01 I/O module. Obey these wiring instructions:

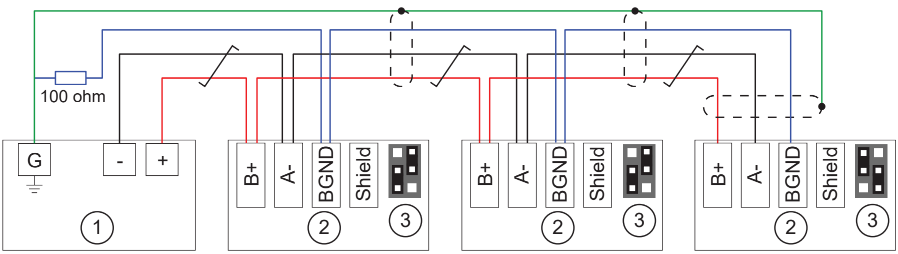
- Attach the cable shields together at each drive, but do not connect them to the drive.
- Connect the cable shields only to the grounding terminal in the automation controller.
- Connect the signal ground (BGND) conductor to the signal ground reference terminal in the automation controller. If the automation controller does not have a signal ground reference terminal, connect the signal ground conductor to the cable shield through a 100 ohm resistor, preferably near the automation controller.

Connection examples are shown below.

With signal ground reference terminal	



Without signal ground reference terminal

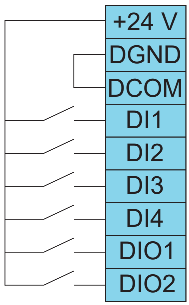
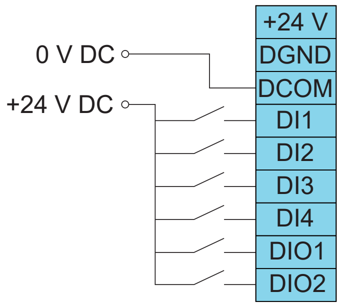


1	Automation controller
2	Drive
3	Termination jumpers. The devices at the ends of the fieldbus must have termination on. All other devices must have termination off.

PNP configuration for digital inputs

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

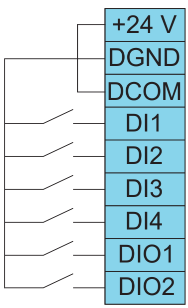
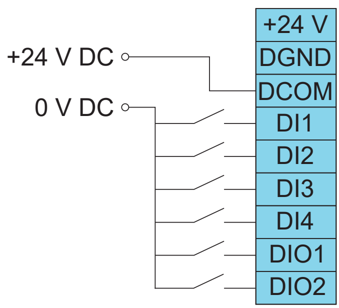
NOTICE If you connect DIO1 or DIO2 as shown in the figures below, make sure that they are configured as inputs. If they are configured as outputs, it can cause damage to the equipment.

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

NPN configuration for digital inputs

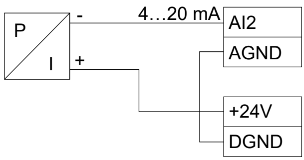
Internal and external +24 V power supply connections for NPN (sink) configuration are shown in the figures below.

NOTICE If you connect DIO1 or DIO2 as shown in the figures below, make sure that they are configured as inputs. If they are configured as outputs, it can cause damage to the equipment.

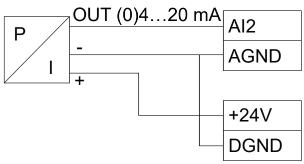
Internal +24 V power supply	External +24 V power supply
	

Connection examples of two-wire and three-wire sensors

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



AI2 AGND	Process actual value measurement or reference, 0(4) … 20 mA, R_{in} = 137 ohm. If the sensor power supply comes through its current output circuit, use 4 … 20 mA signal, not 0 … 20 mA.
+24V DGND	Auxiliary voltage output, non-isolated, +24 V DC, max. 250 mA



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

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

WARNING IEC 61800-5-1 requires double or reinforced insulation between the 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.

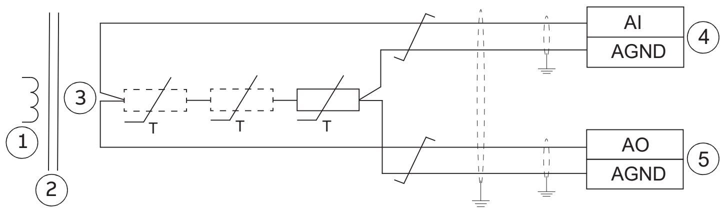
To comply with the drive safety standard IEC 61800-5-1:

If the motor temperature sensor has double or reinforced insulation vs. the motor windings, you can connect it directly to the drive IO interface. This section shows two connection alternatives for the direct I/O connection. If the sensor does not have reinforced insulation, you must use another type of connection to comply with the safety standard. Refer to Implementing a motor temperature sensor connection (page 70).

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

PTC connection 1

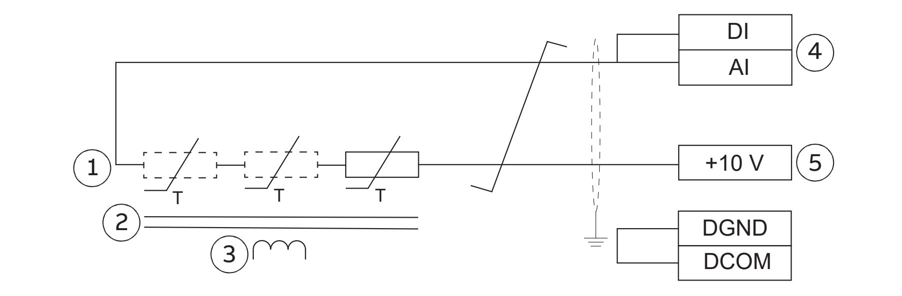
1…3 PTC sensors can be connected in series to an analog input and an analog output. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor. The analog output feeds a constant excitation current of 1.6 mA through the sensor. The sensor resistance increases as the motor temperature rises, as does the voltage over the sensor. The temperature measurement function calculates the resistance of the sensor and generates an indication if overtemperature is detected. Leave the sensor end of the cable shield unconnected.



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

PTC connection 2

If no analog output is available for the PTC connection, it is possible to use a voltage divider connection. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor. 1…3 PTC sensors are connected in series with 10 V reference and digital and analog inputs. The voltage over the digital input internal resistance varies depending on the PTC resistance. The temperature measurement function reads the digital input voltage through the analog input and calculates the PTC resistance.



1	1…3 PTC sensors
2	Double or reinforced insulation
3	Motor winding
4	Digital input and analog input. Set the analog input type to V (volt) in parameter group 12 Standard AI. Define the temperature sensor type, signal source, etc. with parameters 35.11…35.24. For the sensor type, select: PTC AI/DI Voltage Divider tree. Make sure that the digital input is not configured to any other use by parameters.
5	10 V reference voltage

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

WARNING IEC 61800-5-1 requires double or reinforced insulation between the 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.

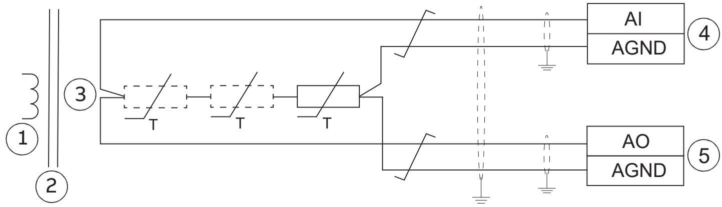
Obey this requirement when you plan the connection of the motor temperature sensor to the drive.

To comply with the drive safety standard IEC 61800-5-1:

If the motor temperature sensor has double or reinforced insulation vs. the motor windings, you can connect it directly to the drive IO interface. This section shows the connection. If the sensor has no reinforced insulation, you must use another type of connection to comply with the safety standard. Refer to Implementing a motor temperature sensor connection (page 70).

You can connect temperature measurement sensors (one, two or three Pt100 sensors; one, two or three Pt1000 sensors; or one Ni1000, KTY83 or KTY84) between an analog input and output as shown below. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor. Leave the sensor end of the cable shield unconnected.

Refer to the firmware manual for information on the related motor thermal protection function.



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

Safe torque off

For the drive to start, both STO connections (S+ to S1 and S+ to S2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting external Safe torque off circuitry to the drive. Refer to The Safe torque off function.

Auxiliary voltage connection

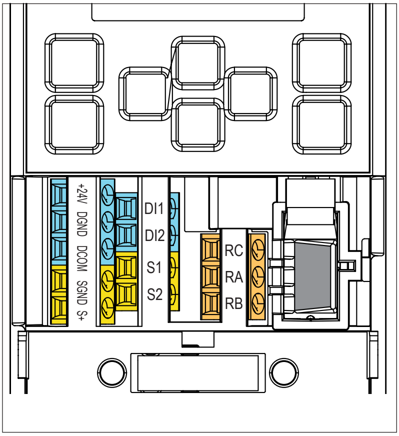
The drive has 24 V DC (±10%) auxiliary power supply terminals on the base unit and on the optional BAPO-02 auxiliary power extension module. You can use them:

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

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

To supply power to external control circuits or option modules:

1. Connect the load to the auxiliary power output on the base unit, or on the BAPO-02 module (+24V and DGND terminals).
2. Make sure that you do not exceed the load capacity of the output, or the sum load capacity of both outputs.



To connect an external auxiliary power supply to the drive:

1. Install a BAPO power extension module to the drive. See Installing options (page 98).
2. Connect an external power supply to the +24V and DGND terminals of the base unit.

For more information on the BAPO modules, refer to BAPO-01 auxiliary power extension module (page 315) or BAPO-02 auxiliary power extension module (page 319).

Connecting a PC

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

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

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

You can use the CCA-01 cold configuration tool to download software and change drive parameters without connecting the drive to the input power. The CCA-01 does not operate if the drive is powered. Refer to CCA-01 communication adapter quick installation guide (3AXD50000018457 [English]) for more information.

Installing options

The drive has two option module slots:

- Front option: Communication module slot under the front cover.
- Side option: Multifunction extension module slot on the side of the drive.

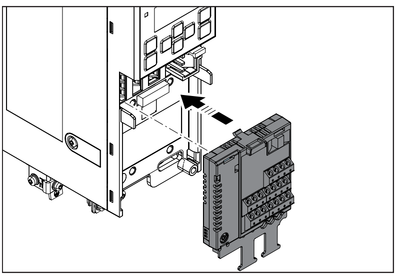
Refer also to the applicable fieldbus module manual for the installation instructions. For other option modules, refer to:

- BTAC-02 pulse encoder interface module (page 265) or BTAC-03 pulse encoder interface module (page 283)
- BRES-01 resolver interface module (page 301)
- BREL-01 relay output extension module (page 309)
- BAPO-01 auxiliary power extension module (page 315) or BAPO-02 auxiliary power extension module (page 319)
- BIO-01 I/O extension module (page 325).

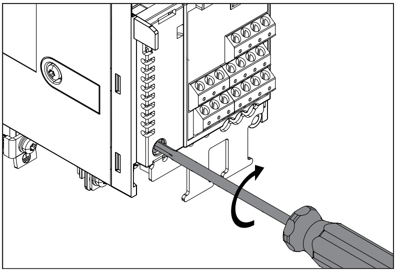
Installing a front option

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

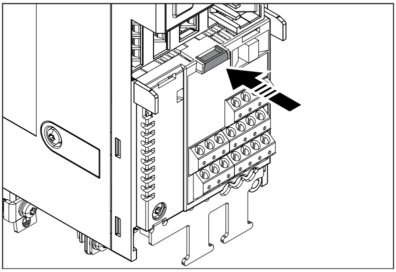
1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the screw on the drive front cover, then remove the front cover.
3. If the option module has a locking tab, pull it up.
4. Carefully align the option module with the option module slot and push it into position.



5. Torque the screw to 0.5 N·m (4.4 lbf·in).



6. If the option module has a locking tab, push it down until it locks.



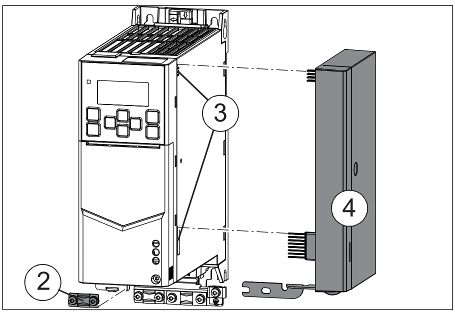
7. Connect the control cables. See the control cable connection instructions.

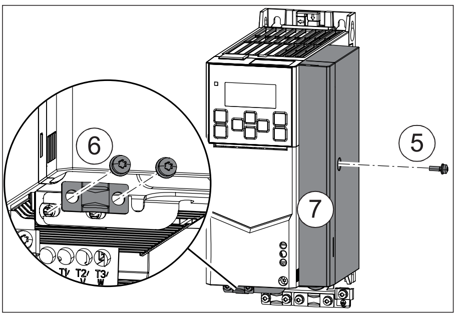
Note: If you have the BIO-01 option module, you can add one additional fieldbus module on top of it. Replace the drive front cover with the high cover that comes with the BIO-01 module.

Installing a side option

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

1. Do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the two screws from the front-most grounding clamp at the bottom of the drive.
3. Carefully align the side option with the connectors on the right side of the drive.
4. Fully push the option module into position.
5. Torque the screw on the option module to 1 N·m (8.8 lbf·in).
6. Attach the grounding bar to the bottom of the side option and to the front ground tab on the drive. Torque the screws to 1 N·m (8.8 lbf·in).
7. Connect the control cables. See the control cable connection instructions.





8

Installation checklist

Contents of this chapter

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

Checklist

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 electrical installation, commissioning or maintenance work.

WARNING Do the steps in Electrical safety precautions (page 22) before you start the work.

Examine the mechanical and electrical installation of the drive before start-up. Do the tasks in the checklist together with a second person.

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 to the type designation label.	☐

Make sure that …	☑
The insulation resistance of the input power cable, motor cable and motor is measured according to local regulations and the manuals of the drive.	☐
The drive is attached securely on an even, vertical and non-flammable wall.	☐
The cooling air can flow freely in and out of the drive.	☐
<u>If the drive is connected to a network other than a symmetrically grounded TN-S system:</u> You have done all the required modifications (for example, you may need to disconnect the EMC filter or ground-to-phase varistor). Refer to 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.	☐
<u>If an external brake resistor is connected to the drive</u>: There is an adequately sized protective earth (ground) conductor between the brake resistor and the drive, and the conductor is connected to the correct terminal, and the terminals are tightened to the correct torque. Grounding has also been measured according to the regulations.	☐
<u>If an external brake resistor is connected to the drive</u>: The brake resistor cable is connected to the correct terminals, and the terminals are tightened to the correct torque.	☐
<u>If an external brake resistor is connected to the drive</u>: The brake resistor cable is routed away from other cables.	☐

Make sure that …	☑
The control cables are connected to the correct terminals, and the terminals are tightened to the correct torque.	☐
If a drive bypass connection will be used: The direct-on-line contactor of the motor and the drive output contactor are either mechanically and/or electrically interlocked, that is, they cannot be closed at the same time. A thermal overload device must be used for protection when bypassing the drive. Refer to local codes and regulations.	☐
There are no tools, foreign objects or dust from drilling inside the drive.	☐
The area in front of the drive is clean: the drive cooling fan cannot draw any dust or dirt inside.	☐
Drive covers and the terminal box cover of the motor are in place.	☐
The motor and the driven equipment are ready for power-up.	☐

9

Maintenance

Contents of this chapter

The chapter contains maintenance intervals and instructions.

Maintenance intervals

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

Description of symbols

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

Recommended maintenance intervals after start-up

Recommended annual actions by the user	
Connections and environment	
Quality of supply voltage	P
Spare parts	
Spare parts	I
DC circuit capacitors reforming for spare modules and spare capacitors	P
Inspections by user	
Tightness of terminals	I
Dustiness, corrosion and temperature	I
Heat sink cleaning	P

Maintenance task/object	Years from start-up						
	3	6	9	12	15	18	21
Cooling fans							
Main cooling fan [1]	(R)	R (R)	(R)	R (R)	(R)	R (R)	(R)
Functional safety							
Safety function test	I See the maintenance information of the safety function.						
Safety component expiry (Mission time T_M)	20 years						

[1] (R) = replacement of component in demanding operating conditions, ie. if surrounding air temperature in continuous operation is over 40 °C (104 °F) or there is a cyclic heavy load.

Note:

- The maintenance and component replacement intervals are valid when the equipment operates within the specified ratings and ambient conditions. ABB recommends annual drive inspections.
- Long-term operation near the specified maximum ratings or ambient conditions may require shorter maintenance intervals for certain components. Contact your local ABB Service representative for additional maintenance recommendations.

Functional safety components

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

The expiry of mission time terminates the certification and SIL/PL classification of the safety function. To certify the components, these options exist:

- Renew the whole drive and all optional functional safety modules and components.
- Renew the components in the safety function circuit. In practice, this is economical only with large drives that have replaceable circuit boards and other components such as relays.

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

For more information, contact ABB.

Cleaning the heatsink

The heatsink of the power module (drive, supply, inverter, converter, and so on) collects dust from the cooling air. This can cause overtemperature warnings and faults. When it is necessary, clean the heatsink as follows.

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

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

1. Stop the drive and do the steps in Electrical safety precautions (page 22) before you start the work.
2. Remove the module cooling fan(s). Refer to the separate instructions.
3. Protect the adjacent equipment from dust.
4. Blow dry, clean, and oil-free compressed air from the bottom to the top, and simultaneously use a vacuum cleaner at the air outlet to collect the dust.

NOTICE Use an antistatic wrist strap and a vacuum cleaner with an antistatic hose and nozzle. A normal vacuum cleaner creates static discharges which can cause damage to circuit boards.

5. Install the cooling fan.

Replacing the cooling fans

These instructions are applicable only to drives with frame size R1…R4. Drives with frame size R0 do not have a cooling fan.

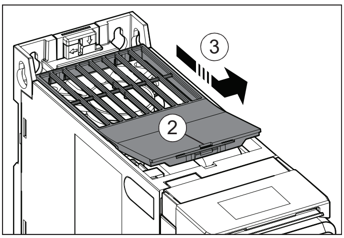
Parameter 05.04 Fan on-time counter shows the running time of the cooling fan. After you replace the fan, reset the fan counter. Refer to the firmware manual.

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

Replacing the cooling fan, frames R1…R3

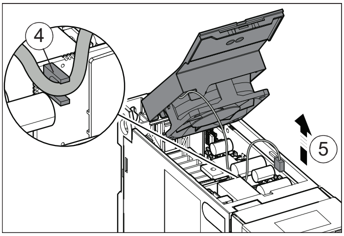
WARNING Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do electrical installation, commissioning or maintenance work.

1. Stop the drive and do the steps in Electrical safety precautions (page 22) before you start the work.
2. Use a suitable slotted screwdriver to open the cooling fan cover.
3. Carefully lift the cooling fan cover out of the drive. The cooling fan cover holds the cooling fan.

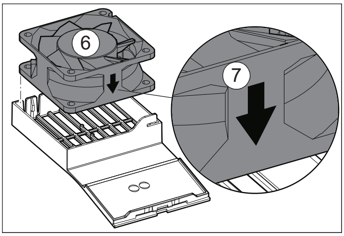


4. Remove the cooling fan power cable from the cable slot in the drive.

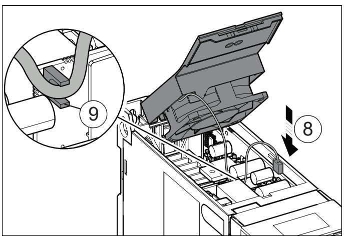
5. Disconnect the cooling fan power cable.



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

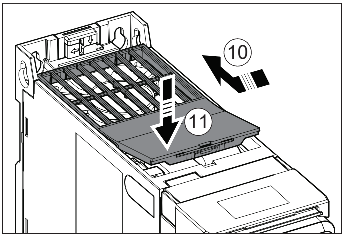


8. Connect the cooling fan power cable.
9. Put the cooling fan power cable into the cable slot in the drive.



10. Carefully put the cooling fan cover into position in the drive. Make sure that the cooling fan power cable is routed correctly.

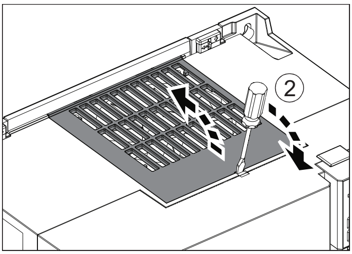
11. Push the cover to lock into position.



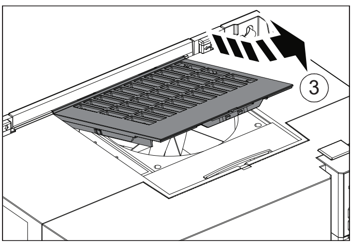
Replacing the cooling fan, frame R4

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 electrical installation, commissioning or maintenance work.

1. Stop the drive and do the steps in Electrical safety precautions (page 22) before you start the work.
2. Use a suitable slotted screwdriver to open the cooling fan cover.

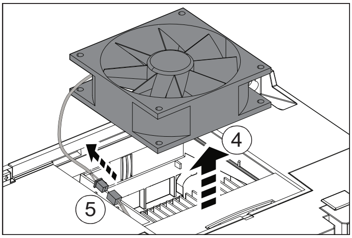


3. Lift out the cooling fan cover and set it aside.

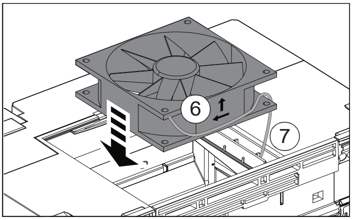


4. Lift and pull the cooling fan from its base.

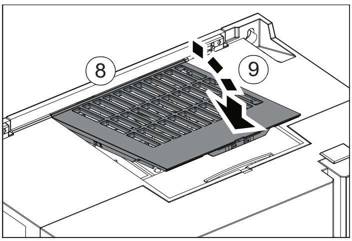
5. Disconnect the cooling fan power cable from the extension cable connector.



6. Replace the cooling fan. The arrow indicating the air flow direction must point up.
7. Connect the cooling fan power cable.



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



Capacitors

The intermediate DC circuit of the drive contains several electrolytic capacitors. The operating time, load, and surrounding air temperature have an effect on the operating life of these capacitors. A lower ambient temperature can increase the operating life of capacitors.

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

Reforming the capacitors

Reform the capacitors if the drive was not powered for a year or more (is in storage or is unused). Read the manufacturing date from the type designation label. For the instructions, refer to Capacitor reforming instructions (3BFE64059629 [English]).

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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.

Electrical ratings

IEC ratings

Type ACS380-04xx-...	Input current		Output ratings							Frame size
	No choke	With choke	Max. cur-rent	Nominal use		Light-duty use		Heavy-duty use		
	I_{1n}	I_{1n}	I_{max}	I_n	P_n	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}	
	A	A	A	A	kW	A	kW	A	kW	
1-phase U_n = 230 V										
02A4-1	5.3	4.2	3.2	2.4	0.37	2.3	0.37	1.8	0.25	R0
03A7-1	7.0	6.4	4.3	3.7	0.55	3.5	0.55	2.4	0.37	R0
04A8-1	8.9	8.3	6.7	4.8	0.75	4.6	0.75	3.7	0.55	R1
06A9-1	11.5	11.9	8.6	6.9	1.1	6.6	1.1	4.8	0.75	R1
07A8-1	14.7	13.5	12.4	7.8	1.5	7.4	1.5	6.9	1.1	R1
09A8-1	19.8	17.0	14.0	9.8	2.2	9.3	2.2	7.8	1.5	R2
12A2-1	25.6	21.1	17.6	12.2	3.0	11.6	3.0	9.8	2.2	R2
3-phase U_n = 230 V										
02A4-2	3.4	2.4	3.2	2.4	0.37	2.3	0.37	1.8	0.25	R1
03A7-2	4.5	3.7	4.3	3.7	0.55	3.5	0.55	2.4	0.37	R1
04A8-2	5.7	4.8	6.7	4.8	0.75	4.6	0.75	3.7	0.55	R1
06A9-2	7.8	6.9	8.6	6.9	1.1	6.6	1.1	4.8	0.75	R1
07A8-2	9.3	7.8	12.4	7.8	1.5	7.5	1.5	6.9	1.1	R1
09A8-2	12.8	9.8	14.0	9.8	2.2	9.3	2.2	7.8	1.5	R1
12A2-2	16.0	12.2	17.6	12.2	3.0	11.6	3.0	9.8	2.2	R2
17A5-2	20.7	17.5	22.0	17.5	4.0	16.7	4.0	12.2	3.0	R3
25A0-2	27.2	25.0	31.5	25.0	5.5	24.2	5.5	17.5	4.0	R3
033A-2	35.0	32.0	45.0	32.0	7.5	30.8	7.5	25.0	5.5	R3
032A-2	34.9	32.0	45.0	32.0	7.5	30.8	7.5	25.0	5.5	R4
048A-2	47.8	48.0	57.6	48.0	11.0	46.2	11.0	32.0	7.5	R4
055A-2	60.0	55.0	86.4	55.0	15.0	52.8	15.0	48.0	11.0	R4
3-phase U_n = 400 V										
01A8-4	2.8	1.8	2.2	1.8	0.55	1.7	0.55	1.2	0.37	R0

Type ACS380-04xx-...	Input current		Output ratings								Frame size
	No choke	With choke	Max. current	Nominal use		Light-duty use		Heavy-duty use			
	I_{1n}	I_{1n}	I_{max}	I_n	P_n	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}		
	A	A	A	A	kW	A	kW	A	kW		
02A6-4	3.5	2.6	3.2	2.6	0.75	2.5	0.75	1.8	0.55		R1
03A3-4	4.8	3.3	4.7	3.3	1.1	3.1	1.1	2.6	0.75		R1
04A0-4	6.1	4.0	5.9	4.0	1.5	3.8	1.5	3.3	1.1		R1
05A6-4	8.5	5.6	7.2	5.6	2.2	5.3	2.2	4.0	1.5		R1
07A2-4	10.1	7.2	10.1	7.2	3.0	6.8	3.0	5.6	2.2		R1
09A4-4	12.9	9.4	13.0	9.4	4.0	8.9	4.0	7.2	3.0		R1
12A6-4	16.5	12.6	16.9	12.6	5.5	12.0	5.5	9.4	4.0		R2
17A0-4	23.4	17.0	22.7	17.0	7.5	16.2	7.5	12.6	5.5		R3
25A0-4	31.8	25.0	30.6	25.0	11.0	23.8	11.0	17.0	7.5		R3
033A-4	40.9	32.0	45.0	32.0	15.0	30.5	15.0	25.0	11.0		R3
032A-4	40.7	32.0	45.0	32.0	15.0	30.5	15.0	25.0	11.0		R4
038A-4	49.0	38.0	57.6	38.0	18.5	36.0	18.5	32.0	15.0		R4
045A-4	55.7	45.0	68.4	45.0	22.0	42.8	22.0	38.0	18.5		R4
050A-4	55.7	50.0	81.0	50.0	22.0	48.0	22.0	45.0	22.0		R4

UL (NEC) ratings

Type ACS380-04xx-...	Input current		Output ratings					Frame size
	No choke	With choke	Max. current	Light-duty use		Heavy-duty use		
	I_{1Ld}	I_{1Ld}	I_{max}	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}	
	A	A	A	A	hp	A	hp	
1-phase U_1 = 208…240 V, P and I_1 at U_n = 208 V								
02A4-1	5.5	4.0	3.2	2.3	0.5	1.8	0.33	R0
03A7-1	7.4	6.1	4.3	3.5	0.75	2.3	0.5	R0
04A8-1	9.1	8.0	6.7	4.6	1.0	3.5	0.75	R1
06A9-1	12.6	11.4	8.6	6.6	1.5	4.6	1.0	R1
07A8-1	14.9	12.8	12.4	7.5	2.0	6.6	1.5	R1
09A8-1	14.8	12.8	14.0	9.3	2.0	7.5	2.0	R2
12A2-1	21.0	20.1	17.6	11.6	3.0	9.3	3.0	R2
3-phase U_1 = 208…240 V, P and I_1 at U_n = 208 V								
02A4-2	3.5	2.3	3.2	2.3	0.5	1.8	0.33	R1
03A7-2	4.8	3.5	4.3	3.5	0.75	2.4	0.5	R1
04A8-2	5.8	4.6	6.7	4.6	1.0	3.2	0.75	R1
06A9-2	8.4	6.6	8.6	6.6	1.5	4.6	1.0	R1
07A8-2	9.4	7.5	12.4	7.5	2.0	6.6	1.5	R1
09A8-2	9.4	7.5	14.0	9.3	2.0	7.5	2.0	R1
12A2-2	13.1	11.6	17.6	11.6	3.0	9.3	3.0	R2
17A5-2	21.0	16.7	22.0	16.7	5.0	11.6	3.0	R3
25A0-2	30.5	24.2	31.5	24.2	7.5	16.7	5.0	R3
033A-2	37.5	30.8	45.0	30.8	10.0	24.2	7.5	R3
032A-2	37.4	30.8	45.0	30.8	10.0	24.2	7.5	R4
048A-2	53.2	46.2	57.6	46.2	15.0	30.8	10.0	R4
055A-2	53.2	46.2	86.4	52.8	15.0	46.2	15.0	R4
3-phase U_n = 480 V								
01A8-4	2.2	1.6	2.2	1.6	0.75	1.1	0.50	R0
02A6-4	2.7	2.1	3.2	2.1	1.0	1.6	0.75	R1
03A3-4	3.9	3.0	4.7	3.0	1.5	2.1	1.0	R1

Type ACS380-04xx-…	Input current		Output ratings					Frame size
	No choke	With choke	Max. current	Light-duty use		Heavy-duty use		
	I_{1Ld}	I_{1Ld}	I_{max}	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}	
	A	A	A	A	hp	A	hp	
04A0-4	4.5	3.4	5.9	3.4	2.0	3.0	1.5	R1
05A6-4	6.6	4.8	7.2	4.8	3.0	3.5	2.0	R1
07A2-4	6.2	6.0	10.1	6.0	3.0	4.8	3.0	R1
09A4-4	9.8	7.6	13.0	7.6	5.0	6.0	3.0	R1
12A6-4	13.9	11.0	16.9	11.0	7.5	7.6	5.0	R2
17A0-4	18.8	14.0	22.7	14.0	10.0	11.0	7.5	R3
25A0-4	26.6	21.0	30.6	21.0	15.0	14.0	10.0	R3
033A-4	33.9	27.0	45.0	27.0	20.0	21.0	15.0	R3
032A-4	33.7	27.0	45.0	27.0	20.0	21.0	15.0	R4
038A-4	41.3	34.0	57.6	34.0	25.0	27.0	20.0	R4
045A-4	46.9	40.0	68.4	40.0	30.0	34.0	25.0	R4
050A-4	46.9	42.0	81.0	42.0	30.0	40.0	30.0	R4

UL Listed drive multiple ratings

National Electric Code (NEC 2020) requires that drive input conductors are sized based on the drive nameplate input current rating and the output conductors are sized based on the full load motor current. There are several scenarios where this sizing procedure is not optimal including multi-motor systems, applications where a larger replacement drive is substituted in an emergency breakdown, and cases where a motor is undersized for the drive. In these situations, power distribution components are often oversized to comply with NEC requirements.

ABB has collaborated with Underwriters Laboratories (UL) to create drive multiple ratings from 50% to 100% in 5% increments for the drive. For more information, refer to Multiple ratings for ABB ACS380-04, ACS580-01, ACQ580-01 and ACS880-01 drives manual supplement (3AXD50000916184 [English]).

Definitions

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

U_n Nominal input voltage of the drive. For input voltage range U1, refer to Electrical power network specification (page 174).

I_{1n}	Nominal input current with typical motor power P_n. Continuous rms input current, for dimensioning cables and fuses. See also Input chokes (page 227).
I_{1Ld}	Light-duty input current (rms) with typical motor power P_{Ld}, for dimensioning cables and fuses.
I_{max}	Maximum output current. Available for 2 seconds every 10 minutes when the output frequency is less than 9 Hz. Otherwise maximum current is 1.5 × I_{Hd}. Maximum current setting (parameter *30.17*) can also limit the value.
I_n	Nominal output current. Maximum continuous rms output current (no overload).
P_n	Typical motor power in nominal use (no overloading). The kilowatt ratings are applicable to most IEC 4-pole motors.
I_{Ld}	Continuous rms output current. Allows 10% overload for 1 minute every 10 minutes.
P_{Ld}	Typical motor power in light-duty use (10% overload). The kilowatt ratings are applicable to most IEC 4-pole motors. The horsepower ratings are applicable to most NEMA 4-pole motors.
I_{Hd}	Continuous rms output current. Allows 50% overload for 1 minute every 10 minutes.
P_{Hd}	Typical motor power in heavy-duty use (50% overload). The kilowatt ratings are applicable to most IEC 4-pole motors. The horsepower ratings are applicable to most NEMA 4-pole motors.

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) (50% for drive type ACS380-04xx-01A8-4). 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 operation conditions. In such operation conditions, 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.
- It is possible that also the motor load capacity needs to be derated.
- You can also use the DriveSize tool for derating.

See Surrounding air temperature derating (page 147), Altitude derating (page 147) and Switching frequency derating (page 148) for the derating values.

Example 1, IEC: How to calculate the derated current

The drive type is ACS380-04xx-17A0-4, which has a nominal output current (I_n) of 17 A at 400 V. Calculate the derated output current at 4 kHz switching frequency, at 1500 m altitude and at 55 °C surrounding air temperature.

<u>Switching frequency derating:</u> Derating is not necessary at 4 kHz.

<u>Altitude derating:</u> The derating factor for 1500 m is

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

<u>Surrounding air temperature derating:</u> The derating factor for 55 °C surrounding air temperature is

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

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

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

Example 1, UL (NEC): How to calculate the derated current

The drive type is ACS380-04xx-17A0-4, which has light-duty output current (I_{Ld}) of 14 A at 480 V. Calculate the derated output current at 4 kHz switching frequency, at 6000 ft altitude and at 131 °F surrounding air temperature.

<u>Switching frequency derating:</u> Derating is not necessary at 4 kHz.

<u>Altitude derating:</u> The derating factor for 6000 ft is

$$1-\frac{6000\ ft-3281\ ft}{32810\ ft}=0.917$$

<u>Surrounding air temperature derating:</u> The derating factor for 131 °F surrounding air temperature is

$$1-\frac{131\ F-122\ F}{180\ F}=0.95$$

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

$$I_{Ld}=14\ A\cdot 0.917\cdot 0.95=12.2\ A$$

Example 2, IEC: How to calculate the required drive

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

Altitude derating: The derating factor for 1800 m is

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

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

To see if the derated output current of a drive is sufficient for the application, multiply the nominal output current (I_n) by all the applicable derating factors. For example, drive type ACS380-04xx-12A6-4 has a nominal output current of 12.6 A at 400 V.

Switching frequency derating: The derating factor for this drive type is 0.68 at 8 kHz. Calculate the derated drive output current:

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

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

Example 2, UL (NEC): How to calculate the required drive

The application requires a maximum of 12.0 A of motor current with a 10% overload for one minute every ten minutes (I_{Ld}) at a switching frequency of 8 kHz. The supply voltage is 480 V, the altitude is 5500 ft and the surrounding air temperature is 95 °F.

Altitude derating: The derating factor for 5500 ft is

$$1-\frac{5500\ ft-3281\ ft}{32810\ ft}=0.932$$

Surrounding air temperature derating: Derating is not necessary at 95 °F surrounding air temperature.

To see if the derated output current of a drive is sufficient for the application, multiply the drive output current for light-duty use (I_{Ld}) by all the applicable derating factors. For example, drive type ACS380-04xx-25A0-4 has an output current of 21 A at 480 V.

Switching frequency derating:The derating factor for this drive type is 0.67 at 8 kHz. Calculate the derated drive output current:

$$I_{Ld}=21\ A\cdot 0.67\cdot 0.932=13.11\ A$$

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

Surrounding air temperature derating

Frame	Temperature	Derating
All	Less than 50 °C (122 °F)	No derating
R1…R3	50 … 60 °C (122 … 140 °F)	Output current decreases by 1% for each additional 1 °C (1.8 F). ACS380-04-033A-2 and ACS380-04-033A-4: • UL standard installations - output current decreases by 2% for each additional 1 °C (1.8 °F). • IEC standard installations - output current decreases by 1% for each additional 1 °C (1.8 F).
R4	50 … 60 °C (122 … 140 °F)	Output current decreases by 1% for each additional 1 °C (1.8 F) on: • ACS380-04xx-032A-2 • ACS380-04xx-048A-2 • ACS380-04xx-032A-4 • ACS380-04xx-045A-4 Output current decreases by 2% for each additional 1 °C (1.8 F) on: • ACS380-04xx-055A-2 • ACS380-04xx-038A-4 • ACS380-04xx-050A-4

Altitude derating

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

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

- A maximum altitude of 4000 m (13123 ft) is permitted for these grounding systems: TN-S, TT. A maximum altitude of 2000 m (6562 ft) is permitted for these grounding systems: corner-grounded delta, midpoint-grounded delta, IT (ungrounded).
- Above 2000 m (6562 ft), the maximum permitted voltage for the relay output RO1 decreases. At 4000 m (13123 ft), it is 30 V.
- Above 2000 m (6562 ft), the maximum permitted potential difference between the adjacent relays of the BREL-01 relay extension module (option +L511) decreases. At 4000 m (13123 ft), it is 30 V.

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

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

$$k = 1 - \frac{x - 3281\ ft}{32810\ ft}$$

Switching frequency derating

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

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

Frame R4: If the application is cyclic and the surrounding air temperature is constantly more than 40 °C (104 °F), keep parameter 97.02 Minimum switching frequency at its default value (1.5 kHz). Higher switching frequencies decrease the product life time or the performance in the temperature range 40 … 60 °C (104 … 140 °F).

Type ACS380-04xx-…	**Derating factor**		
	≤ 4 kHz	**8 kHz**	**12 kHz**
1-phase U_n = 230 V			
02A4-1	1.0	0.80	0.66
03A7-1	1.0	0.80	0.66
04A8-1	1.0	0.81	0.68
06A9-1	1.0	0.81	0.68
07A8-1	1.0	0.85	0.74
09A8-1	1.0	0.85	0.74
12A2-1	1.0	0.82	0.69
3-phase U_n = 230 V			
02A4-2	1.0	0.84	0.73
03A7-2	1.0	0.84	0.73
04A8-2	1.0	0.84	0.73
06A9-2	1.0	0.84	0.73
07A8-2	1.0	0.83	0.70
09A8-2	1.0	0.83	0.70
12A2-2	1.0	0.76	0.61
17A5-2	1.0	0.76	0.61
25A0-2	1.0	0.75	0.60

Type ACS380-04xx-…	Derating factor		
	≤ 4 kHz	8 kHz	12 kHz
033A-2	1.0	0.83	0.70
032A-2	1.0	0.75	0.59
048A-2	1.0	0.74	0.60
055A-2	1.0	0.74	0.60
3-phase U_n = 400 V or 480 V			
01A8-4	1.0	0.65	0.48
02A6-4	1.0	0.65	0.48
03A3-4	1.0	0.65	0.48
04A0-4	1.0	0.65	0.48
05A6-4	1.0	0.65	0.48
07A2-4	1.0	0.65	0.48
09A4-4	1.0	0.65	0.48
12A6-4	1.0	0.68	0.51
17A0-4	1.0	0.68	0.51
25A0-4	1.0	0.67	0.51
033A-4	1.0	0.77	0.60
032A-4	1.0	0.65	0.49
038A-4	1.0	0.65	0.49
045A-4	1.0	0.66	0.49
050A-4	1.0	0.66	0.49

Derating in case of a phase loss

In case of a phase loss the drive will function according to the settings of parameter 31.21 Supply phase loss.

If No action is selected, the drive will eventually overheat or the supply bridge may be damaged if one supply phase is lost, unless 50% derating is done when dimensioning the system.

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.

IEC fuses

Either fuse type can be used if it operates rapidly enough.

gG fuses

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

Type ACS380-04xx-...	Min. short-circuit current 1)	Fuses				
		Nominal current	I^2t	Voltage rating	ABB type	IEC 60269 size
	A	A	A^2s	V		
1-phase U_n = 230 V						
02A4-1	80	10	380	500	OFAF000H10	000
03A7-1	80	10	380	500	OFAF000H10	000
04A8-1	128	16	720	500	OFAF000H16	000
06A9-1	200	20	1500	500	OFAF000H20	000
07A8-1	200	25	2500	500	OFAF000H25	000
09A8-1	256	32	2500	500	OFAF000H32	000
12A2-1	320	35	7000	500	OFAF000H35	000
3-phase U_n = 230 V						
02A4-2	48	6	110	500	OFAF000H6	000
03A7-2	80	10	360	500	OFAF000H10	000
04A8-2	80	10	360	500	OFAF000H10	000
06A9-2	128	16	740	500	OFAF000H16	000
07A8-2	128	16	740	500	OFAF000H16	000
09A8-2	128	16	740	500	OFAF000H16	000
12A2-2	200	25	2500	500	OFAF000H25	000
17A5-2	256	32	4500	500	OFAF000H32	000
25A0-2	400	50	15500	500	OFAF000H50	000
033A-2	504	63	20000	500	OFAF000H63	000
032A-2	504	63	20000	500	OFAF000H63	000
048A-2	800	100	65000	500	OFAF000H100	000
055A-2	800	100	65000	500	OFAF000H100	000
3-phase U_n = 400 V						
01A8-4	32	4	55	500	OFAF000H4	000
02A6-4	48	6	110	500	OFAF000H6	000
03A3-4	48	6	110	500	OFAF000H6	000

Type ACS380-04xx-...	Min. short-circuit current [1]	Fuses				
		Nominal current	I^2t	Voltage rating	ABB type	IEC 60269 size
	A	A	A^2s	V		
04A0-4	80	10	360	500	OFAF000H10	000
05A6-4	80	10	360	500	OFAF000H10	000
07A2-4	128	16	740	500	OFAF000H16	000
09A4-4	128	16	740	500	OFAF000H16	000
12A6-4	200	25	2500	500	OFAF000H25	000
17A0-4	256	32	4500	500	OFAF000H32	000
25A0-4	400	50	15500	500	OFAF000H50	000
033A-4	504	63	20000	500	OFAF000H63	000
032A-4	504	63	20000	500	OFAF000H63	000
038A-4	640	80	36000	500	OFAF000H80	000
045A-4	800	100	65000	500	OFAF000H100	000
050A-4	800	100	65000	500	OFAF000H100	000

[1] Minimum permitted short-circuit current of the electrical power network

gR fuses

Type ACS380-04xx-…	Min. short-circuit current 1)	Fuses				
		Nominal current	I^2t	Voltage rating	Bussmann type	IEC 60269 size
	A	A	A^2s	V		
1-phase U_n = 230 V						
02A4-1	80	32	275	690	170M2695	00
03A7-1	80	32	275	690	170M2695	00
04A8-1	128	40	490	690	170M2696	00
06A9-1	200	50	1000	690	170M2697	00
07A8-1	200	63	1800	690	170M2698	00
09A8-1	256	63	1800	690	170M2698	00
12A2-1	320	63	1800	690	170M2698	00
3-phase U_n = 230 V						
02A4-2	48	25	125	690	170M2694	00
03A7-2	80	32	275	690	170M2695	00
04A8-2	80	32	275	690	170M2695	00
06A9-2	128	40	490	690	170M2696	00
07A8-2	128	40	490	690	170M2696	00
09A8-2	128	40	490	690	170M2696	00
12A2-2	200	50	1000	690	170M2697	00
17A5-2	256	63	1800	690	170M2698	00
25A0-2	400	80	3600	690	170M2699	00
033A-2	504	100	6650	690	170M2700	00
032A-2	504	100	6650	690	170M2700	00
048A-2	800	160	22500	690	170M2702	00
055A-2	800	160	22500	690	170M2702	00
3-phase U_n = 400 V						
01A8-4	32	25	125	690	170M2694	00
02A6-4	48	25	125	690	170M2694	00
03A3-4	48	25	125	690	170M2694	00
04A0-4	80	32	275	690	170M2695	00

Type ACS380-04xx-...	Min. short-circuit current 1)	Fuses				
		Nominal current	I^2t	Voltage rating	Bussmann type	IEC 60269 size
	A	A	A^2s	V		
05A6-4	80	32	275	690	170M2695	00
07A2-4	128	40	490	690	170M2696	00
09A4-4	128	40	490	690	170M2696	00
12A6-4	200	50	1000	690	170M2697	00
17A0-4	256	63	1800	690	170M2698	00
25A0-4	400	80	3600	690	170M2699	00
033A-4	504	100	6650	690	170M2700	00
032A-4	504	100	6650	690	170M2700	00
038A-4	640	125	12000	690	170M2701	00
045A-4	800	160	22500	690	170M2702	00
050A-4	800	160	22500	690	170M2702	00

1) Minimum permitted short-circuit current of the electrical power network

UL (NEC) fuses

The UL listed fuses in the table are the required branch circuit protection. Fuses must be provided as part of the installation.

Type ACS380-04xx-...	Fuses					
	Nominal current	Voltage rating	Bussmann/ Edison type	Type	Max. fuse rating for group install-ation 1)	Max wire thickness
	A	V			A	mm^2
1-phase U_n = 230 V						
02A4-1	10	300	JJN/TJN10	UL class T	10	1.5
03A7-1	10	300	JJN/TJN10	UL class T	10	1.5
04A8-1	15	300	JJN/TJN15	UL class T	25	1.5
06A9-1	20	300	JJN/TJN20	UL class T	25	1.5
07A8-1	25	300	JJN/TJN25	UL class T	25	1.5
09A8-1	20	300	JJN/TJN20	UL class T	30	6
12A2-1	30	300	JJN/TJN30	UL class T	30	6
3-phase U_n = 208 V						
02A4-2	6	600	JJS/TJS6	UL class T	25	1.5
03A7-2	10	600	JJS/TJS10	UL class T	25	1.5
04A8-2	10	600	JJS/TJS10	UL class T	25	1.5
06A9-2	15	600	JJS/TJS15	UL class T	25	1.5
07A8-2	15	600	JJS/TJS15	UL class T	25	1.5
09A8-2	15	600	JJS/TJS15	UL class T	25	1.5
12A2-2	20	600	JJS/TJS20	UL class T	30	6
17A5-2	30	600	JJS/TJS30	UL class T	40	6
25A0-2	40	600	JJS/TJS40	UL class T	40	6
033A-2	50	600	JJS/TJS50	UL class T	60	6
032A-2	50	600	JJS/TJS50	UL class T	100	2.5
048A-2	70	600	JJS/TJS70	UL class T	100	2.5
055A-2	70	600	JJS/TJS70	UL class T	100	2.5
3-phase U_n = 480 V						
01A8-4	3	600	JJS/TJS3	UL class T	10	1.5

Type ACS380-04xx-...	Fuses					
	Nominal current	Voltage rating	Bussmann/ Edison type	Type	Max. fuse rating for group install-ation 1)	Max wire thickness
	A	V			A	mm^2
02A6-4	6	600	JJS/TJS6	UL class T	25	2.5
03A3-4	6	600	JJS/TJS6	UL class T	25	2.5
04A0-4	6	600	JJS/TJS6	UL class T	25	2.5
05A6-4	10	600	JJS/TJS10	UL class T	25	2.5
07A2-4	10	600	JJS/TJS10	UL class T	25	2.5
09A4-4	15	600	JJS/TJS15	UL class T	25	2.5
12A6-4	20	600	JJS/TJS20	UL class T	30	4
17A0-4	25	600	JJS/TJS25	UL class T	40	10
25A0-4	35	600	JJS/TJS35	UL class T	40	10
033A-4	45	600	JJS/TJS45	UL class T	60	10
032A-4	45	600	JJS/TJS45	UL class T	100	25
038A-4	60	600	JJS/TJS60	UL class T	100	25
045A-4	60	600	JJS/TJS60	UL class T	100	25
050A-4	60	600	JJS/TJS60	UL class T	100	25

1) Branch circuit short-circuit protection for group installation by fuses: Suitable for motor group installation on a circuit that is capable of delivering no more than 65000 rms symmetrical amperes, 480 V maximum, when protected by class T fuses. The same fuse size is specified for several consecutive drive types. This is possible since the physical structure of the drive types is identical.

Notes:

1. Fuses are required as part of the installation, are not included in the base drive configuration, and must be provided by others.
2. Fuses with a higher current rating than specified must not be used.
3. The UL-listed fuses recommended by ABB are the required branch circuit protection per NEC.
4. The recommended size or smaller UL-listed 248 fast-acting, time-delay, or high-speed fuses must be used to maintain the UL listing of the drive. Additional protection can be used. Refer to local codes and regulations.
5. A fuse of a different class can be used at the high fault rating where the I_{peak} and I^2t of the new fuse are not more than those of the specified fuse.

6. UL-listed 248 fast-acting, time-delay, or high-speed fuses from other manufacturers can be used if they meet the same class and rating requirements specified in the rules above.
7. When you install a drive, always obey ABB installation instructions, NEC requirements, and local codes.
8. Alternative fuses can be used if they meet certain characteristics. For permitted fuses, see Branch Circuit Protection for ABB drives manual supplement (3AXD50000645015).

Alternative short-circuit protection

Miniature circuit breakers (IEC)

Note: Miniature circuit breakers with or without fuses in the table below have not been evaluated for use as short-circuit protection in North American (UL) environments. Refer to Miniature circuit breakers (UL) (page 160) for UL compatible models.

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

WARNING Pay special attention to the installation and placement of the breakers. Obey the manufacturer's instructions. Hot ionized gases can escape from the breaker enclosure in a short-circuit.

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

Type ACS380-04xx-...	Frame [1)]	Miniature circuit breaker	Network SCC [2)]
		ABB type	kA
1-phase U_n = 230 V			
02A4-1	R0	S301P-B10NA / S301P-C10NA	10
03A7-1	R0	S301P-B10NA / S301P-C10NA	10
04A8-1	R1	S301P-B16NA / S301P-C16NA	10
06A9-1	R1	S301P-B20NA / S301P-C20NA	10
07A8-1	R1	S301P-B25NA / S301P-C25NA	10
09A8-1	R2	S301P-B25NA / S301P-C25NA	10
12A2-1	R2	S301P-B32NA / S301P-C32NA	10
3-phase U_n = 230 V			
02A4-2	R1	S303P-B6 / S303P-C6	10
03A7-2	R1	S303P-B8 / S303P-C8	10
04A8-2	R1	S303P-B10 / S303P-C10	10

Type ACS380-04xx-...	Frame[1]	Miniature circuit breaker	Network SCC [2]
		ABB type	kA
06A9-2	R1	S303P-B16 / S303P-C16	10
07A8-2	R1	S303P-B16 / S303P-C16	10
09A8-2	R1	S303P-B25 / S303P-C25	10
12A2-2	R2	S303P-B25 / S303P-C25	10
17A5-2	R3	S303P-B32 / S303P-C32	10
25A0-2	R3	S303P-B50 / S303P-C50	10
033A-2	R3	S303P-B63 / S303P-C63	10
032A-2	R4	S303P-B63 / S303P-C63	10
048A-2	R4	S803S-B100	5
055A-2	R4	S803S-B100	5
3-phase U_n = 400 V			
01A8-4	R0	S303P-B4 / S303P-C4	10
02A6-4	R1	S303P-B6 / S303P-C6	10
03A3-4	R1	S303P-B6 / S303P-C6	10
04A0-4	R1	S303P-B8 / S303P-C8	10
05A6-4	R1	S303P-B10 / S303P-C10	10
07A2-4	R1	S303P-B16 / S303P-C16	10
09A4-4	R1	S303P-B16 / S303P-C16	10
12A6-4	R2	S303P-B25 / S303P-C25	10
17A0-4	R3	S303P-B32 / S303P-C32	10
25A0-4	R3	S303P-B50 / S303P-C50	10
033A-4	R3	S303P-B63 / S303P-C63	10
032A-4	R4	S303P-B63 / S303P-C63	10
038A-4	R4	S803S-B80	5
045A-4	R4	S803S-B100	5
050A-4	R4	S803S-B100	5

1) Enclosures for all frame sizes must have a solid bottom directly below the drive: Fans (other than internal stirring fans), filters or louvers cannot be mounted directly below the drive but can be mounted in adjacent areas on the bottom of the enclosure.

2) Maximum permitted rated conditional short-circuit current (IEC 61800-5-1) of the electrical power network.

Miniature circuit breakers (UL)

ACS380 drives are suitable for use on a circuit capable of delivering not more than 10 kA symmetrical amperes (RMS) at 240 or 480Y/277 V maximum, when protected by appropriate circuit breakers in the tables below. Additional fuse protection is not required by UL when using circuit breakers herein. Circuit breakers are not required to be in the same enclosure as the drive.

Type ACS380-04xx-...	Frame	Miniature circuit breaker	Minimum enclosure volume 1) 2)
		ABB type	in^3
1-phase U_n = 230 V			
02A4-1	R0	SU202M-C10	1850
03A7-1	R0	SU202M-C10	1850
04A8-1	R1	SU202M-C20	1850
06A9-1	R1	SU202M-C20	1850
07A8-1	R1	SU202M-C20	1850
09A8-1	R2	SU202M-C32	1850
12A2-1	R2	SU202M-C32	1850
3-phase U_n = 230 V			
02A4-2	R1	SU203M-C16	1850
03A7-2	R1	SU203M-C16	1850
04A8-2	R1	SU203M-C16	1850
06A9-2	R1	SU203M-C16	1850
07A8-2	R1	SU203M-C25	1850
09A8-2	R1	SU203M-C25	1850
12A2-2	R2	SU203M-C25	1850
17A5-2	R3	SU203M-C50	1850
25A0-2	R3	SU203M-C50	1850
033A-2	R3	SU203M-C50	1850
032A-2	R4	-	-
048A-2	R4	-	-
055A-2	R4	-	-
3-phase U_n = 400 V			
01A8-4	R0	SU203M-C10	1850
02A6-4	R1	SU203M-C10	1850

Type ACS380-04xx-...	Frame	Miniature circuit breaker	Minimum enclosure volume 1) 2)
		ABB type	in^3
03A3-4	R1	SU203M-C10	1850
04A0-4	R1	SU203M-C10	1850
05A6-4	R1	SU203M-C10	1850
07A2-4	R1	SU203M-C16	1850
09A4-4	R1	SU203M-C16	1850
12A6-4	R2	SU203M-C25	1850
17A0-4	R3	SU203M-C50	1850
25A0-4	R3	SU203M-C50	1850
033A-4	R3	SU203M-C50	1850
032A-4	R4	-	-
038A-4	R4	-	-
045A-4	R4	-	-
050A-4	R4	-	-

1) Drives that have an Minimum Enclosure Volume listed must be mounted in an enclosure ≥ Minimum Enclosure Volume specified in this table.

2) When multiple drives that have an Enclosure Minimum Volume specified are installed in the same enclosure, minimum volume of the enclosure is determined by largest Enclosure Minimum Volume of the drives to be placed in the enclosure, plus the volume(s) of each additional drive.

Manual self-protected combination motor controller – Type E USA (UL (NEC))

You can use the ABB Type E manual motor protectors (MMP) MS132 & S1-M3-25, MS165-xx, and MS5100-100 as an alternative to the recommended fuses as a means of branch circuit protection. This complies with the National Electrical Code (NEC). When the correct ABB Type E manual motor protector is selected from the table and used for branch circuit protection, the drive is suitable for use in a circuit that can deliver no more than 65 kA rms symmetrical amperes at the maximum rated voltage of the drive. Refer to the table for the appropriate MMP types and minimum enclosure volume of IP20 / UL open type drive mounted in an enclosure.

If you use a manual motor protector for the branch circuit protection of the drive, install the drive into a metal enclosure.

Note: The UL Listing of drive and MMP combinations applies only to drives that are mounted in appropriately sized metal enclosures that are capable of containing any drive component failure. Wall-mounted drives with UL Type 1 kits (optional) are not covered by the UL combination listing of drives with MMPs.

WARNING Use fuses for the short-circuit protection of a wall-mounted drive with the UL Type 1 kit (optional). Serious injury, fire, or damage to equipment can result from the use of MMPs instead of fuses.

Type ACS380-04xx-...	Frame 1)	MMP type 2) 3) 4)	Minimum enclosure volume 5)	
			dm³	in³
1-phase U_N = 230 V				
02A4-1	R0	MS132-10 & S1-M3-25 6)	30.3	1850
03A7-1	R0	MS132-10 & S1-M3-25 6)	30.3	1850
04A8-1	R1	MS165-20	30.3	1850
06A9-1	R1	MS165-20	30.3	1850
07A8-1	R1	MS165-20	30.3	1850
09A8-1	R2	MS165-32	30.3	1850
12A2-1	R2	MS165-32	30.3	1850
3-phase U_N = 230 V				
02A4-2	R1	MS132-10 & S1-M3-25 6)	30.3	1850
03A7-2	R1	MS132-10 & S1-M3-25 6)	30.3	1850
04A8-2	R1	MS132-10 & S1-M3-25 6)	30.3	1850
06A9-2	R1	MS132-10 & S1-M3-25 6)	30.3	1850
07A8-2	R1	MS165-16	30.3	1850
09A8-2	R1	MS165-16	30.3	1850
12A2-2	R2	MS165-20	30.3	1850
17A5-2	R3	MS165-42	30.3	1850
25A0-2	R3	MS165-42	30.3	1850
033A-2	R3	MS165-54	30.3	1850
032A-2	R4	MS165-80	75.0	4577
048A-2	R4	MS165-80	75.0	4577
055A-2	R4	MS165-80	75.0	4577
3-phase U_N = 480 V				
01A8-4	R0	MS132-4.0 & S1-M3-25 6)	30.3	1850
02A6-4	R1	MS132-6.3 & S1-M3-25 6)	30.3	1850

Type ACS380-04xx-...	Frame 1)	MMP type 2) 3) 4)	Minimum enclosure volume 5)	
			dm^3	in^3
03A3-4	R1	MS132-6.3 & S1-M3-25 6)	30.3	1850
04A0-4	R1	MS132-10 & S1-M3-25 6)	30.3	1850
05A6-4	R1	MS132-10 & S1-M3-25 6)	30.3	1850
07A2-4	R1	MS165-16	30.3	1850
09A4-4	R1	MS165-16	30.3	1850
12A6-4	R2	MS165-20	30.3	1850
17A0-4	R3	MS165-32	30.3	1850
25A0-4	R3	MS165-42	30.3	1850
033A-4	R3	MS165-54	30.3	1850
032A-4	R4	MS165-54	75.0	4577
038A-4	R4	MS165-65	75.0	4577
045A-4	R4	MS5100-100 / MS165-73	75.0	4577
050A-4	R4	MS5100-100 / MS165-80	75.0	4577

1) Enclosures for all frame sizes must have a solid bottom directly below the drive: Fans (other than internal stirring fans), filters or louvers cannot be mounted directly below the drive but can be mounted in adjacent areas on the bottom of the enclosure.

2) All manual motor protectors listed are Type E self-protected up to 65 kA, except MS165-80 which is Type E self-protected up to 50 kA. See the ABB manual motor starter catalog (1SBC100214C0201) for complete technical data on the ABB Type E manual motor protectors. In order for these manual motor protectors to be used for branch circuit protection, they must be UL listed Type E manual motor protectors, otherwise they can be used only as an At Motor Disconnect. “At Motor Disconnect” is a disconnect just ahead of the motor on the load side of the panel.

3) 480Y/277 V wye systems only: Short-circuit protective devices with slash voltage ratings (e.g. 480Y/277 V AC) can be applied only in solidly grounded networks where the voltage from line-to-ground does not exceed the lower of the two ratings (e.g. 277 V AC), and the voltage from line-to-line does not exceed the higher of the two ratings (e.g. 480 V AC).

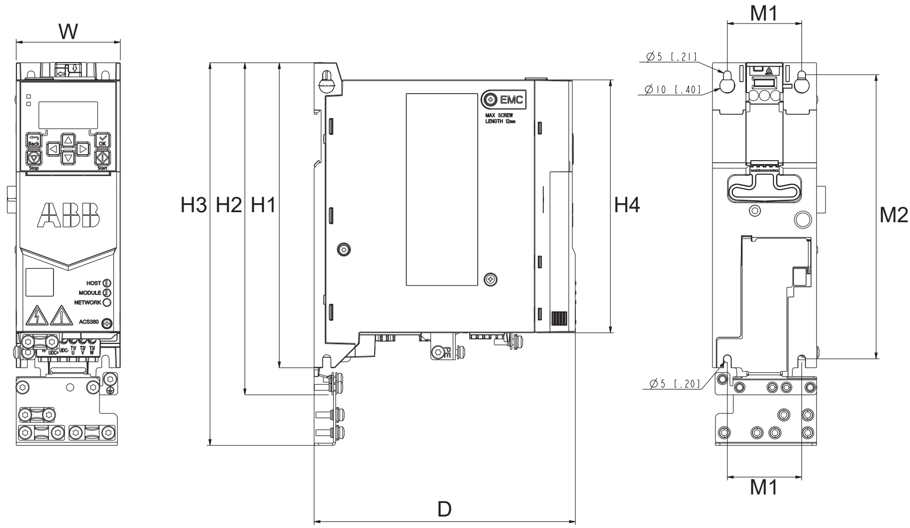
4) Manual motor protectors may require adjusting the trip limit from the factory setting at or above the drive input Amps to avoid nuisance tripping. If the manual motor protector is set to the maximum current trip level and nuisance tripping is occurring, select the next size MMP. (MS132-10 is the highest size in the MS132 frame size to meet Type E at 65 kA; the next size up is MS165-16.)

5) For all drives, the enclosure must be sized to accommodate the specific thermal considerations of the application as well as provide free space for cooling. Refer to the technical data. For UL only: The minimum enclosure volume is specified in the UL listing when applied with the ABB Type E MMP shown in the table. Fuses must be used for wall-mounted drives installed with a UL Type 1 kit.

6) Requires the use of the S1-M3-25 line side feeder terminal with the manual motor protector to meet Type E self-protection class.

Dimensions and weights

Dimensions – IP20 / UL open type with PE extension plate



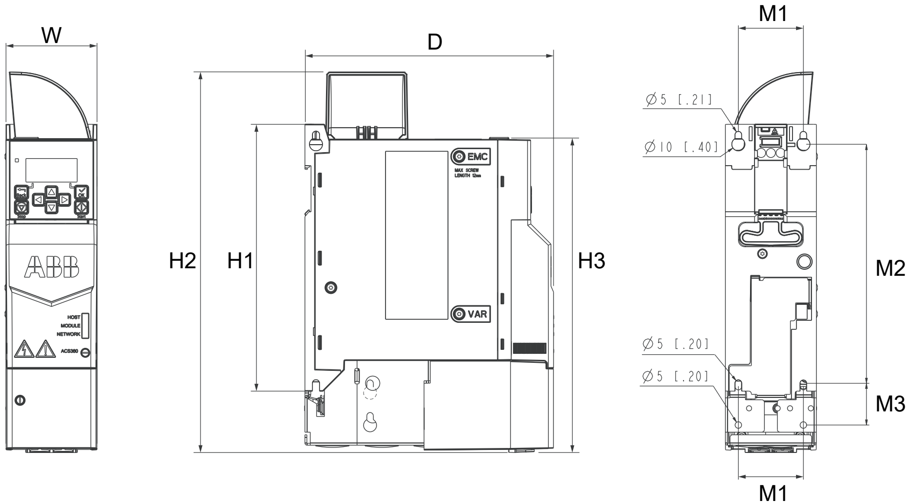
Frame size	Dimensions, IP20 / UL open type															
	H1		H2		H3		H4		W 1)		D 2)		M1		M2	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
R0	205	8.1	223	8.8	257	10.13	170	6.7	70	2.8	176	6.9	50	1.97	191	7.52
R1	205	8.1	223	8.8	257	10.13	170	6.7	70	2.8	176	6.9	50	1.97	191	7.52
R2	205	8.1	223	8.8	257	10.13	170	6.7	95	3.7	176	6.9	75	2.95	191	7.52
R3	205	8.1	241.3	9.5	241.3	9.5	170	6.7	170	6.7	176	6.9	148	5.83	191	7.52
R4	205	8.1	240	9.45	271	10.67	170	6.7	260	10.2	176	6.9	234	9.21	191	7.52

1) A side option increases the width of the drive.
2) The BIO-01 high cover increases the depth of the drive by 15 mm (0.6 in).

H1	Height back
H2	Height
H3	Height with PE extension plate
H4	Height front
W	Width
D	Depth

M1, M2 Mounting hole distance

Dimensions – Drive with UL Type 1 kit



Frame size	Dimensions, drive with UL Type 1 kit															
	H1		H2		H3		W 1)		D		M1		M2		M3	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
R0	205	8.1	285	11.2	247	9.7	70	2.8	191	7.5	50	1.97	191	7.52	32	1.26
R1	205	8.1	293	11.5	247	9.7	70	2.8	191	7.5	50	1.97	191	7.52	32	1.26
R2	205	8.1	293	11.5	247	9.7	95	3.7	191	7.5	75	2.95	191	7.52	32	1.26
R3	205	8.1	329	13.0	261	10.3	170	6.7	191	7.5	148	5.83	191	7.52	36	1.42
R4	205	8.1	391	15.3	312	12.3	260	10.2	196	7.7	234	9.21	191	7.52	38	1.50

1) A side option increases the width of the drive.

H1 Height back

H2 Height

H3 Height front

W Width

D Depth

M1, M2, M3 Mounting hole distance

Weights

Frame size	Weights			
	IP20 / UL open type		UL Type 1	
	kg	lb	kg	lb
R0	1.4	3.1	1.8	4.1
R1	1.4	3.1	1.8	4.1
R2	2.0	4.4	2.5	5.5
R3	3.3	7.3	4.0	8.8
R4	5.3	11.7	6.5	14.4

Free space requirements

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

1) Drives with the optional UL Type 1 kit: 50 mm (2 in), measured from the top of the hood.

Losses, cooling data and noise

Drives with frame size R0 have natural convection cooling. Drives with frame size R1…R4 have a cooling fan. The air flow direction is from bottom to top.

Type ACS380-04xx-...	Typical power loss 1)		Air flow		Noise	Frame size
	W	BTU/h	m^3/h	CFM	dB(A)	
1-phase U_N = 230 V						
02A4-1	33	113	-	-	< 30	R0
03A7-1	49	167	-	-	< 30	R0
04A8-1	67	229	57	33	63	R1
06A9-1	93	317	57	33	63	R1
07A8-1	106	362	57	33	63	R1
09A8-1	92	314	63	37	59	R2
12A2-1	115	392	63	37	59	R2
3-phase U_N = 230 V						
02A4-2	39	133	57	33	63	R1
03A7-2	57	194	57	33	63	R1
04A8-2	72	246	57	33	63	R1
06A9-2	111	379	57	33	63	R1
07A8-2	105	358	57	33	63	R1
09A8-2	140	478	57	33	63	R1
12A2-2	149	508	63	37	59	R2
17A5-2	265	904	128	75	66	R3
25A0-2	398	1358	128	75	66	R3
033A-2	350	1194	128	75	66	R3
032A-2	350	1194	150	88	69	R4
048A-2	561	1914	150	88	69	R4
055A-2	676	2307	150	88	69	R4
3-phase U_N = 400/480 V						
01A8-4	28	96	-	-	<30	R0
02A6-4	44	150	57	33	63	R1
03A3-4	55	188	57	33	63	R1
04A0-4	62	212	57	33	63	R1

Type ACS380-04xx-...	Typical power loss [1]		Air flow		Noise	Frame size
	W	BTU/h	m^3/h	CFM	dB(A)	
05A6-4	91	311	57	33	63	R1
07A2-4	100	341	57	33	63	R1
09A4-4	140	478	57	33	63	R1
12A6-4	165	563	63	37	59	R2
17A0-4	259	884	128	75	66	R3
25A0-4	390	1331	128	75	66	R3
033A-4	396	1351	128	75	66	R3
032A-4	396	1351	150	88	69	R4
038A-4	497	1696	150	88	69	R4
045A-4	582	1986	150	88	69	R4
050A-4	672	2293	150	88	69	R4

1) Typical drive losses when it operates at 90% of the motor nominal frequency and 100% of the drive nominal output current.

Typical power cable sizes

The table in this section gives the typical power cable and conductor sizes for use at the nominal drive current.

Note: IEC/EN 61800-5-1 requires two separate PE (ground) conductors for a fixed connection, if the cross-sectional area of the PE conductor is less than 10 mm^2 Cu.

Type ACS380-04xx-...	Cable size, Cu (mm^2) [1]	Conductor size, Cu (AWG)	Frame size
1-phase U_N = 230 V			
02A4-1	3×1.5 + 1.5	14	R0
03A7-1	3×1.5 + 1.5	14	R0
04A8-1	3×1.5 + 1.5	14	R1
06A9-1	3×1.5 + 1.5	14	R1
07A8-1	3×1.5 + 1.5	14	R1
09A8-1	3×2.5 + 2.5	14	R2
12A2-1	3×2.5 + 2.5	14	R2
3-phase U_N = 230 V			
02A4-2	3×1.5 + 1.5	14	R1

Type ACS380-04xx-...	Cable size, Cu (mm^2) [1)]	Conductor size, Cu (AWG)	Frame size
03A7-2	3×1.5 + 1.5	14	R1
04A8-2	3×1.5 + 1.5	14	R1
06A9-2	3×1.5 + 1.5	14	R1
07A8-2	3×1.5 + 1.5	14	R1
09A8-2	3×2.5 + 2.5	14	R1
12A2-2	3×2.5 + 2.5	14	R2
17A5-2	3×6 + 6	10	R3
25A0-2	3×6 + 6	10	R3
033A-2	3×10 + 10	8	R3
032A-2	3×10 + 10	8	R4
048A-2	3×25 + 16	4	R4
055A-2	3×25 + 16	4	R4
3-phase U_N = 400 V or 480 V			
01A8-4	3×1.5 + 1.5	14	R0
02A6-4	3×1.5 + 1.5	14	R1
03A3-4	3×1.5 + 1.5	14	R1
04A0-4	3×1.5 + 1.5	14	R1
05A6-4	3×1.5 + 1.5	14	R1
07A2-4	3×1.5 + 1.5	14	R1
09A4-4	3×2.5 + 2.5	14	R1
12A6-4	3×2.5 + 2.5	14	R2
17A0-4	3×6 + 6	10	R3
25A0-4	3×6 + 6	10	R3
033A-4	3×10 + 10	8	R3
032A-4	3×10 + 10	8	R4
038A-4	3×16 + 16	6	R4
045A-4	3×25 + 16	4	R4
050A-4	3×25 + 16	4	R4

1) Symmetrical, shielded, three-phase copper cable.

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.

Type ACS380-04xx-...	L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/ UDC+				PE			
	Min. solid/ stranded	Max. solid/ stranded	Tighten-ing torque	Strip-ping length 1)	Min. solid/ stranded	Max. solid/ stranded	Tighten-ing torque	Strip-ping length 1)
	mm²	mm²	N·m	mm	mm²	mm²	N·m	mm
1-phase U_n = 230 V								
02A4-1	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
03A7-1	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
04A8-1	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
06A9-1	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
07A8-1	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
09A8-1	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
12A2-1	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
3-phase U_n = 230 V								
02A4-2	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
03A7-2	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
04A8-2	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
06A9-2	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
07A8-2	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
09A8-2	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
12A2-2	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
17A5-2	0.5/0.5	10/6	1.2…1.5	12	4/2.5	6/4	1.2	10
25A0-2	0.5/0.5	10/6	1.2…1.5	12	4/2.5	6/4	1.2	10
033A-2	0.5/0.5	10/6	1.2…1.5	12	4/2.5	6/4	1.2	10
032A-2	0.5/0.5	25/16	2.5…3.7	18	10/6	25/16	2.9	10
048A-2	0.5/0.5	25/16	2.5…3.7	18	10/6	25/16	2.9	10
055A-2	0.5/0.5	25/16	2.5…3.7	18	10/6	25/16	2.9	10
3-phase U_n = 400 V								
01A8-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10

Type ACS380-04xx-...	L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+				PE			
	Min. solid/stranded	Max. solid/stranded	Tightening torque	Stripping length 1)	Min. solid/stranded	Max. solid/stranded	Tightening torque	Stripping length 1)
	mm²	mm²	N·m	mm	mm²	mm²	N·m	mm
02A6-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
03A3-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
04A0-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
05A6-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
07A2-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
09A4-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
12A6-4	0.5/0.5	4/2.5	0.5…0.6	10	4/2.5	6/4	1.2	10
17A0-4	0.5/0.5	10/6	1.2…1.5	12	4/2.5	6/4	1.2	10
25A0-4	0.5/0.5	10/6	1.2…1.5	12	4/2.5	6/4	1.2	10
033A-4	0.5/0.5	10/6	1.2…1.5	12	4/2.5	6/4	1.2	10
032A-4	0.5/0.5	25/16	2.5…3.7	18	10/6	25/16	2.9	10
038A-4	0.5/0.5	25/16	2.5…3.7	18	10/6	25/16	2.9	10
045A-4	0.5/0.5	25/16	2.5…3.7	18	10/6	25/16	2.9	10
050A-4	0.5/0.5	25/16	2.5…3.7	18	10/6	25/16	2.9	10

1) The stripping length is applicable when you terminate wires without ferrules.

Type ACS380-04xx-...	L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+				PE			
	Min.	Max.	Tightening torque	Stripping length 1)	Min.	Max.	Tightening torque	Stripping length 1)
	AWG	AWG	lbf·in	in	AWG	AWG	lbf·in	in
1-phase U_n = 230 V								
02A4-1	18	10	5	0.39	12	10	10.6	0.39
03A7-1	18	10	5	0.39	12	10	10.6	0.39
04A8-1	18	10	5	0.39	12	10	10.6	0.39
06A9-1	18	10	5	0.39	12	10	10.6	0.39
07A8-1	18	10	5	0.39	12	10	10.6	0.39
09A8-1	18	10	5	0.39	12	10	10.6	0.39

Type ACS380-04xx-...	L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/ UDC+				PE			
	Min.	Max.	Tighten-ing torque	Strip-ping length [1)]	Min.	Max.	Tighten-ing torque	Strip-ping length [1)]
	AWG	AWG	lbf·in	in	AWG	AWG	lbf·in	in
12A2-1	18	10	5	0.39	12	10	10.6	0.39
3-phase U_n = 230 V								
02A4-2	18	10	5	0.39	12	10	10.6	0.39
03A7-2	18	10	5	0.39	12	10	10.6	0.39
04A8-2	18	10	5	0.39	12	10	10.6	0.39
06A9-2	18	10	5	0.39	12	10	10.6	0.39
07A8-2	18	10	5	0.39	12	10	10.6	0.39
09A8-2	18	10	5	0.39	12	10	10.6	0.39
12A2-2	18	10	5	0.39	12	10	10.6	0.39
17A5-2	18	6	11…13	0.47	12	10	10.6	0.39
25A0-2	18	6	11…13	0.47	12	10	10.6	0.39
033A-2	18	6	11…13	0.47	12	10	10.6	0.39
032A-2	18	2	22…32	0.71	8	4	25.7	0.39
048A-2	18	2	22…32	0.71	8	4	25.7	0.39
055A-2	18	2	22…32	0.71	8	4	25.7	0.39
3-phase U_n = 480 V								
01A8-4	18	10	5	0.39	12	10	10.6	0.39
02A6-4	18	10	5	0.39	12	10	10.6	0.39
03A3-4	18	10	5	0.39	12	10	10.6	0.39
04A0-4	18	10	5	0.39	12	10	10.6	0.39
05A6-4	18	10	5	0.39	12	10	10.6	0.39
07A2-4	18	10	5	0.39	12	10	10.6	0.39
09A4-4	18	10	5	0.39	12	10	10.6	0.39
12A6-4	18	10	5	0.39	12	10	10.6	0.39
17A0-4	18	6	11…13	0.47	12	10	10.6	0.39
25A0-4	18	6	11…13	0.47	12	10	10.6	0.39
033A-4	18	6	11…13	0.47	12	10	10.6	0.39

Type ACS380-04xx-...	L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/ UDC+				PE			
	Min.	Max.	Tighten-ing torque	Strip-ping length [1]	Min.	Max.	Tighten-ing torque	Strip-ping length [1]
	AWG	AWG	lbf·in	in	AWG	AWG	lbf·in	in
032A-4	18	2	22…32	0.71	8	4	25.7	0.39
038A-4	18	2	22…32	0.71	8	4	25.7	0.39
045A-4	18	2	22…32	0.71	8	4	25.7	0.39
050A-4	18	2	22…32	0.71	8	4	25.7	0.39

[1] The stripping length is applicable when you terminate wires without ferrules.

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.

Terminal data for the control cables

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

Wire size		Torque		Wire stripping length	
mm^2	AWG	N·m	lbf·in	mm	in
0.14…1.5	26…16	0.5…0.6	4.4…5.3	6	0.24

Electrical power network specification

Voltage (U1)	**Input voltage range:** ACS380-04xx-xxxx-1 drives: 1-phase 200 … 240 V AC -15% … +10% ACS380-04xx-xxxx-2 drives: 3-phase 200 … 240 V AC -15% … +10% ACS380-04xx-xxxx-4 drives: 3-phase 380 … 480 V AC -15% … +10%
Network type	Public low-voltage networks. Symmetrically grounded TN-S system, IT (ungrounded), corner-grounded delta. Consult ABB before connecting to other systems (for example, TT, or midpoint grounded delta).
Rated conditional short-circuit current I_{cc}(IEC 61800-5-1)	65 kA when protected by fuses given in the fuse tables.
Maximum prospective short-circuit current rating (SCCR) (UL 61800-5-1, CSA C22.2 No. 274-13)	US and Canada: The drive is suitable for use on a circuit that can deliver no more than 100 kA symmetrical amperes (rms) at 600 V maximum when protected by fuses given in the fuse table.
Harmonic current limits in public network (IEC/EN 61000-3-2, IEC/EN 61000-3-12)	Refer to Compliance with the harmonic current limits in a public network (IEC/EN 61000 3-2, IEC/EN 61000-3-12) (page 185).
Input choke	Refer to Input chokes (page 227) for general guidelines on the use of the choke. Use an input choke, if the short-circuit capacity of the network at the drive terminals is more than specified in the table below. You can use one choke for several drives if the short-circuit capacity at the drive terminals is decreased to the value in the table.
Frequency (f1)	47 … 63 Hz, maximum rate of change 2%/s
Imbalance	Max. ±3% of nominal phase-to-phase input voltage
Fundamental power factor (cos phi)	0.98 (at nominal load)

Input voltage	R0, R1, R2	R3, R4
1-phase 200 … 240 V	>1.5 kA	-
3-phase 200 … 240 V	>5.0 kA	>7.5 kA
3-phase 380 … 480 V	>5.0 kA	>10 kA

Motor connection data

Motor type	Asynchronous AC induction motors, permanent magnet synchronous motors or ABB synchronous reluctance motors (SynRM motors)
Voltage (U2)	0 … U1, 3-phase symmetrical
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 electrical ratings given in this manual.
Switching frequency	2, 4, 8, or 12 kHz

Motor cable length

Operational functionality and motor cable length

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

Note: Conducted and radiated emissions of these motor cable lengths do not comply with the EMC requirements of IEC/EN 61800-3.

Frame	**Maximum motor cable length**	
	m	**ft**
Standard drive, without external options		
R0…R4	100	328

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 requirements of IEC/EN 61800-3, do not exceed these maximum motor cable lengths. The values are valid for 4 kHz switching frequency.

Frame	Maximum motor cable length, 4 kHz					
	C1 [1]		C2 [2]		C3	
	m	ft	m	ft	m	ft
With internal EMC filter						
1-phase 200 … 240 V (ACS380-042x)						
R0	-	-	10	33	10	33
R1	-	-	10	33	10	33
R2	-	-	10	33	10	33
3-phase 380 … 480 V (C2: ACS380-042x, C3: ACS380-040x)						
R0	-	-	10	33	30	98
R1	-	-	10	33	30	98
R2	-	-	10	33	20	66
R3	-	-	10	33	30	98
R4	-	-	10	33	30	98
With optional external EMC filter						
1-phase 200 … 240 V (ACS380-040x)						
R0	10	33	10	33	10	33
R1	10	33	10	33	10	33
R2	-	-	-	-	-	-
3-phase 200 … 240 V (ACS380-040x)						
R1	-	-	20	66	20	66
R2	-	-	20	66	20	66
R3	-	-	20	66	20	66
R4	-	-	20	66	20	66
3-phase 380 … 480 V (ACS380-040x)						
R0	30	98	30	98	30	98
R1	40	131	40	131	40	131
R2	40	131	40	131	40	131
R3	40	131	40	131	40	131

Frame	Maximum motor cable length, 4 kHz					
	C1 1)		C2 2)		C3	
	m	ft	m	ft	m	ft
R4	30	98	30	98	30	98

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

2) ACS380-042x drives frames R1 to R4 with C2 filters: maximum motor cable length is 100 m in C3 environment without external EMC filters.

Note: Radiated emissions are according to C2 with ACS380-042x drives. For ACS380-040x drives, use a metal enclosure to fulfill radiated emissions C2 limits with an external EMC filter.

Control connection data

Analog inputs (AI1, AI2)	Voltage signal, single-ended	0 … 10 V DC (10% overrange, 11 V DC max.) R_{in} = 221.6 kohm
	Current signal, single-ended	0 … 20 mA (10% overrange, 22 mA max.) R_{in} = 137 ohm
	Inaccuracy	≤ 1.0%, of full scale
	Overvoltage protection	up to 30 V DC
	Potentiometer reference value	10 V DC ±1%, max. load current 10 mA
Analog output (AO) 1)	Current output mode	0 … 20 mA (10% overrange, 22 mA max.) into 500 ohm load
	Voltage output mode	0 … 10 V DC (10% overrange, 11 V DC max.) into 200 kohm minimum load (resistive)
	Inaccuracy	≤ 1.0%, of full scale
Auxiliary voltage output/optional input (+24V)	As output	+24 V DC ±10%, max. 250 mA
	As input (optional)	+24 V DC ±10%, max. 1000 mA (incl internal fan load)
Digital inputs (DI1…DI5)	Voltage	12 … 24 V DC (int. or ext. supply) Max. 30 V DC.
	Type	PNP and NPN
	Input impedance	R_{in} = 2 kohm

Programmable digital I/O (DIO1, DIO2)[1)]	**As inputs**	
	Voltage	12 … 24 V DC with internal or external supply. Max. 30 V DC.
	Type	PNP and NPN
	Input impedance	R_{in} = 2 kohm
	As outputs	
	Type	Transistor output PNP
	Max. switching voltage	30 V DC
	Max. switching current	70 mA / 30 DC, short-circuit protected
	Frequency	10 Hz … 16 kHz
	Resolution	1 Hz
Relay output (RA, RB, RC)	Type	1 From C (NO + NC)
	Max. switching voltage	250 V AC / 30 V DC
	Max. switching current	2 A
Frequency input (FI)	10 Hz … 16 kHz DI3 and DI4 can be used as digital or frequency inputs.	
Frequency output (FO)	DIO1 and DIO2 can be used as digital or frequency outputs.	
Safe torque off (STO) interface (SGND, S+, S1, S2)	Input voltage range: 15 V … 25 V, maximum 24 V +10% See also chapter The Safe torque off function (page 245)	
EIA-485 embedded fieldbus (A+, B-, BGND)	Connector pitch 5 mm, maximum wire size 2.5 mm^2 (14 AWG) Physical layer: RS-485 Cable type: Shielded twisted pair cable with twisted pair for data and a wire or pair for signal ground, nominal impedance 100 … 165 ohm, for example Belden 9842 Transmission rate: 9.6 … 115.2 kbit/s Termination by jumper	
Control panel - drive connection	EIA-485, male RJ-45 connector, cable type CAT 5e or better, maximum cable length 100 m (328 ft)	
Control panel - PC connection	USB Type A – Type Mini-B cable, maximum cable length 3 m (9.8 ft)	

1) For information about BMIO-01 output behavior in certain conditions, refer to the default I/O connection diagram in the control cable connection instructions.

Brake resistor connection data

Short-circuit protection (IEC 61800-5-1, IEC 60439-1, UL 61800-5-1)	The brake resistor output is conditionally short-circuit proof by IEC/EN 61800-5-1 and UL 61800-5-1. Rated conditional short-circuit current is as defined in IEC 60439-1.

Energy efficiency data (ecodesign)

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

Energy efficiency data is not provided for the 1~230 V drives. The drives with one phase input are not in the scope of the EU ecodesign requirements (Regulation EU/2019/1781) or the UK ecodesign requirements (Regulation SI 2021 No. 745).

Protection classes

Degree of protection (IEC/EN 60529)	IP20. The drive must be installed in a cabinet to fulfill the requirements for shielding from contact.
Enclosure types (UL 61800-5-1)	UL open type. For indoor use only. UL Type 1 kit is available as an option. **Note:** UL Type 1 kits are not applicable with BRES-01 resolver interface module.
Overvoltage category (IEC 60664-1)	III
Protective classes (IEC/EN 61800-5-1)	I

Ambient conditions

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

Requirement	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
Installation site altitude	**230 V drives**: 0 … 2000 m (0 … 6562 ft) above sea level (with output derating above 1000 m [3281 ft]) **400/480 V drives**: 0 … 4000 m (0 … 13123 ft) above sea level (with output derating above 1000 m [3281 ft]) Refer to Output derating (page 144).	-	-
Surrounding air temperature	-10 … +50 °C (14 … 122 °F). If the temperature is more than 50 °C (122 °F), output derating is necessary. Refer to Output derating (page 144). No frost permitted.	-40 … +70 °C ±2% (-40 … +158 °F ±2%)	-40 … +70 °C ±2% (-40 … +158 °F ±2%)
Relative humidity	5 … 95%	Max. 95%	Max. 95%
	No condensation permitted. Maximum permitted relative humidity is 60% in the presence of corrosive gases.		
Contamination levels (IEC 60721-3-x)	IEC 60721-3-3: 2002	IEC 60721-3-1: 1997	IEC 60721-3-2: 1997
- Chemical gases	Class 3C2	Class 1C2	Class 2C2
- Solid particles	Class 3S2. No conductive dust permitted.	Class 1S3. (packing must support this, otherwise 1S2)	Class 2S2
Pollution degree (IEC/EN 61800-5-1)	Pollution degree 2	-	-

Requirement	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
Sinusoidal vibration (IEC 60068-2-6, Test Fc 2007-12)	frequency 10 … 150 Hz; amplitude ±0.075 mm (0.003 in), 10 … 57,56 Hz; constant peak acceleration 10 m/s^2 (33 ft/s^2), 57,56 … 150 Hz; sweep: 1 oct/min; 10 sweep cycles in each axis with STO active; uncertainty ±5.0%; normal mounting	-	-
Shock/(IEC 60068-2-27, ISTA 1A)	Not permitted	According to ISTA 1A. Max. 100 m/s^2 (330 ft/s^2), 11 ms.	According to ISTA 1A. Max. 100 m/s^2 (330 ft/s^2), 11 ms.
Free fall	-	76 cm (30 in)	76 cm (30 in)

Storage conditions

Store the drive in humidity-controlled enclosed environments. Keep the drive in its package.

Color

NCS 1502-Y (RAL 9002 / PMS 420 C)

Materials

Drive

Refer to ACS380 drives recycling instructions and environmental information (3AXD50000049465 [English]).

Drive package

- Cardboard
- Molded pulp
- PE (suspension film package, plastic bag)

Package materials for options, accessories and spare parts

- Cardboard
- Kraft paper
- PP (straps)
- PE (film, bubble wrap)
- Plywood, wood (only for heavy components)

The materials vary by item type, size, and shape. The typical package is a cardboard box with paper filling or bubble wrap. ESD-safe packaging is used for printed circuit boards and similar items.

Materials of manuals

Printed product manuals are made of recyclable paper.

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.

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

Printed circuit boards and DC capacitors require selective treatment according to IEC 62635 guidelines.

To aid recycling, most plastic parts are marked with an appropriate identification code. Components that contain Substances of Very High Concern (SVHCs) are listed in the European Chemicals Agency 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 more information, contact your local ABB distributor or consult the European Chemicals Agency SCIP database to determine which SVHCs are used in the drive and where the components are located.

Contact your local ABB distributor for more information on environmental aspects. End-of-life treatment must obey 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 60204-1:2006 + A1:2009 + AC:2010	Safety of machinery. Electrical equipment of machines. Part 1: General requirements. Provisions for compliance: The final assembler of the machine is responsible for installing • an emergency-stop device • a supply disconnecting device
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN 61800-3:2004 + A1:2012 IEC 61800-3:2004 + A1:2011	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
IEC/EN 61800-5-1:2007+AMD1:2016 EN 61800-5-1:2007+A1:2017+A11:2021	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy
IEC 61800-9-2:2017	Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Energy efficiency indicators for power drive systems and motor starters
ANSI/UL 61800-5-1:2015	UL Standard for adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy
CSA C22.2 No. 274-17	Adjustable speed drives
IEC 61800-9-2:2023	Adjustable speed electrical power drive systems (PDS) – Part 9-2: Ecodesign for motor systems – Energy efficiency determination and classification

Markings

CE	CE mark The product complies with the applicable European Union legislation. For fulfilling the EMC requirements, refer to the additional information concerning the drive EMC compliance (IEC/EN 61800-3).

UKCA (UK Conformity Assessed) mark

The product complies with the applicable United Kingdom legislation (Statutory Instruments). Marking is required for products being placed on the market in Great Britain (England, Wales, and Scotland).

TÜV Safety Approved mark (functional safety)

The product contains Safe torque off and possibly other (optional) safety functions that 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.

UL Listed mark for USA and Canada

The product was tested and evaluated against the relevant North American standards by the Underwriters Laboratories. The marking is valid for rated voltages of up to 600 V.

RCM mark

The product complies with the regulations in Australia and New Zealand specific to EMC, telecommunications, and electrical safety. To comply with the EMC requirements, refer to the additional information on drive EMC compliance (IEC/EN¯61800-3).

CMIM mark

The product complies with the safety standards of Morocco for the marketing of toys and electrical products.

EAC (Eurasian Conformity) mark

The product complies with the technical regulations of the Eurasian Customs Union. The EAC mark is required in Russia, Belarus, and Kazakhstan.

Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP).

The product complies 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 its life, the product should enter the recycling system at an appropriate collection point and not be placed in the normal waste stream.

	KC mark The product complies with the Korean Registration of Broadcasting and Communications Equipment Clause 3, Article 58-2 of Radio Waves Act.

Compliance with the harmonic current limits in a public network (IEC/EN 61000 3-2, IEC/EN 61000-3-12)

3-phase 230 V, 400 V, or 480 V drive with the input choke

The drive complies with IEC 61000-3-12 provided that the short-circuit ratio R_{sce} is more than or equal to 350 at the interface point between the user's supply and the public system. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the short-circuit ratio R_{sce} is more than or equal to 350.

The R_{sce} value meets the requirement if the short-circuit power at the interface point between the user's supply and the public system is equal or more than the value S_{cs} calculated as follows:

$$S_{cs} = R_{sce} \times S_{eq} = \ 350 \times \sqrt{3} \times I_{1n} \times \ U_1$$

where:

S_{cs}	Minimum short-circuit power limit
R_{sce}	Short-circuit ratio
S_{eq}	Equipment (drive) input power
I_{1n}	Drive nominal input current with the input choke
U_1	Drive input voltage

3-phase 230 V, 400 V, or 480 V drive without the input choke

Refer to 1-phase 230 V drive with or without the input choke (page 185).

1-phase 230 V drive with or without the input choke

Do a harmonic current assessment for the whole system that the drive is part of, and make sure that the harmonic current limits are not exceeded at the interface point between the user's supply and the public system. Based on the results, consider the use of the input choke with the drive. If the assessment is not possible, you can connect the drive to the public network if you have permission from the network operator.

Always use the input choke if the short-circuit capacity of the network at the drive input terminals is more than the limit specified for the drive. Refer to **Input choke** (page 174) in Electrical power network specification (page 174).

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

Definitions

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

The first environment includes establishments connected to a low-voltage network that supplies buildings used for domestic purposes.

The second environment includes establishments connected to a network that do not supply domestic premises.

Drive of Category C1: Drive with a rated voltage of less than 1000 V that is intended for use in the first environment.

Drive of Category C2: Drive with a rated voltage of less than 1000 V that is 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 with the necessary skills to install or start power drive systems, and includes their EMC aspects.

Drive of Category C3: Drive with a rated voltage of less than 1000 V that is intended for use in the second environment and not intended for use in the first environment.

Drive of Category C4: Drive with a rated voltage equal to or more than 1000 V, or a rated current equal to or more than 400 A, or intended for use in complex systems in the second environment.

Category C1

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

1. The optional EMC filter is selected according to External EMC filters (page 233), and the filter is installed as specified in the EMC filter manual.
2. The motor and control cables are selected as specified in this manual. The EMC recommendations are obeyed.
3. The maximum motor cable length does not exceed the specified maximum value. Refer to EMC compatibility and motor cable length (page 176)
4. The drive is installed according to the instructions given in this manual.

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

Category C2

This applies to drives with an internal EMC C2 filter.

The drive complies with the standard with the following provisions:

1. The motor and control cables are selected as specified in this manual. The EMC recommendations are obeyed.
2. The maximum motor cable length does not exceed the specified maximum. Refer to EMC compatibility and motor cable length (page 176)
3. The drive is installed according to the instructions given in this manual.

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

CAUTION 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.

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

Category C3

This applies to 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. The EMC recommendations are obeyed.
2. The maximum motor cable length does not exceed the specified maximum value. Refer to EMC compatibility and motor cable length (page 176)
3. The drive is installed according to the instructions given in this manual.

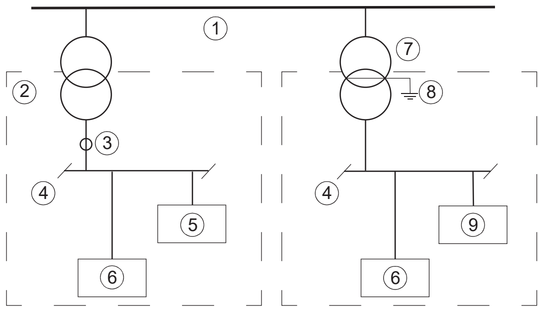
CAUTION Do not install a drive with the internal EMC filter connected to a grounding system that the EMC filter is not compatible with (for example, an IT system). The supply network becomes connected to ground potential through the internal EMC filter capacitors, which can cause danger or damage to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

NOTICE To prevent radio-frequency interference, do not use a drive of category C3 on a low-voltage public network that supplies domestic premises.

Category C4

If the provisions in category 1, 2 or 3 are not met, the requirements of the standard can be met as follows:

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



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

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available in Technical guide No. 3 EMC compliant installation and configuration for a power drive system (3AFE61348280 [English]).

3. The motor and control cables are selected as specified in this manual. For the best EMC performance, the EMC recommendations are obeyed.

4. The drive is installed according to the instructions given in this manual.

CAUTION 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.

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

UL checklist

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

- Make sure that the drive type designation label includes the applicable marking.
- **DANGER! – Risk of electric shock.** After you disconnect the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start work on the drive, motor, or motor cable.
- Use the drive in a heated, indoor, controlled environment. Install the drive in clean air according to the enclosure classification. The cooling air must be clean, free from corrosive materials, and electrically conductive dust.
- The maximum surrounding air temperature is 50 °C at the rated output current. The output current is derated for 50…60 °C in drives with frame size R1…R4.
- The drive is suitable for use in a circuit that can deliver no more than 100000 rms symmetrical amperes, at 480 V maximum (480 V drive types) or 240 V maximum (240 V drive types) when it is protected by the UL fuses given in the technical data. The ampere ratings of the protection are based on fault tests done according to the appropriate UL standard.
- The drive is suitable for use on a circuit that can deliver no more than 65000 rms symmetrical amperes, at 480Y/277 V maximum (480 V drive types), when it is protected by a Type E combination motor controller specified by ABB.
- The cables located within the motor circuit must be rated for at least 75 °C.
- The input cable must be protected with UL-rated fuses, or the ABB Type E manual motor protectors (MMP) listed in this manual. The fuses or the manual motor protectors provide branch circuit protection that complies with the National Electrical Code (NEC) and Canadian Electrical Code. Obey all applicable local or provincial codes.

WARNING An open branch-circuit protective device can be an indication that a fault current was interrupted. To reduce the risk of fire or electric shock, examine all current-carrying parts and other components of the device and replace them if they are damaged.

WARNING LE DÉCLENCHEMENT DU DISPOSITIF DE PROTECTION DU CIRCUIT DE DÉRIVATION PEUT ÊTRE DÛ À UNE COUPURE QUI RÉSULTE D'UN COURANT DE DÉFAUT. POUR LIMITER LE RISQUE D'INCENDIE OU DE CHOC ÉLECTRIQUE, EXAMINER LES PIÈCES PORTEUSES DE COURANT ET LES AUTRES ÉLÉMENTS DU CONTRÔLEUR ET LES REMPLACER S'ILS SONT ENDOMMAGÉS.

- The integral solid-state short-circuit protection of the drive does not provide branch circuit protection. Branch circuit protection must be provided as specified in the National Electrical Code and any additional local codes.
- The drive provides motor overload protection. For adjustment information, refer to the firmware manual.
- The drive overvoltage category according to IEC 60664-1 is III.

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

ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Declarations of conformity

Link to Declaration of conformity according to EU Machinery Directive 2006/42/EU (3AXD10000462189)

Link to Declaration of conformity according to UK Supply of Machinery (Safety) Regulations 2008 (3AXD10001329530)

11

Dimension drawings

Contents of this chapter

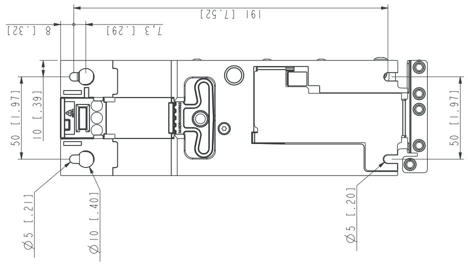
The chapter contains the dimension drawings of the drive. The dimensions are in millimeters and inches.

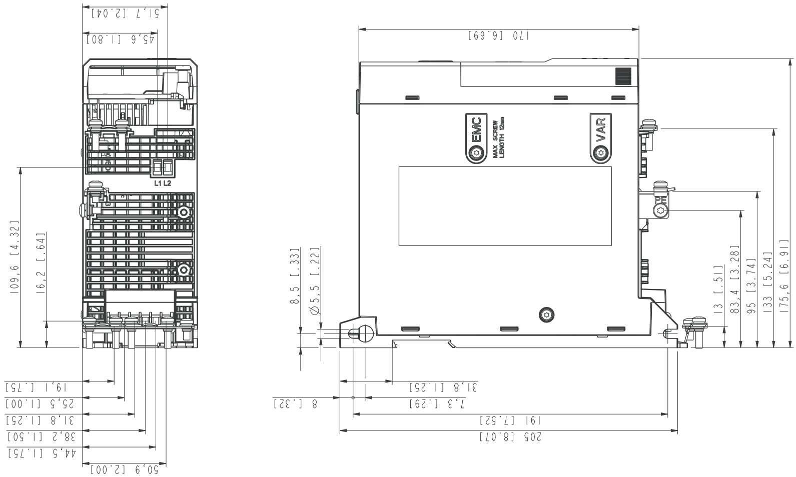
Note: Drives with the BIO-01 I/O extension module (option +L515) are supplied with a high cover part that increases the depth of the drive by 15 mm (0.6 in).

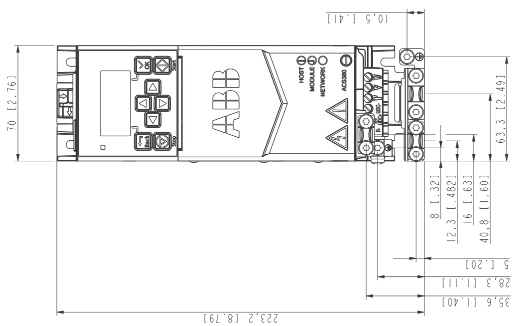
Frame R0

Frame R0, 1-phase 230 V, IP20

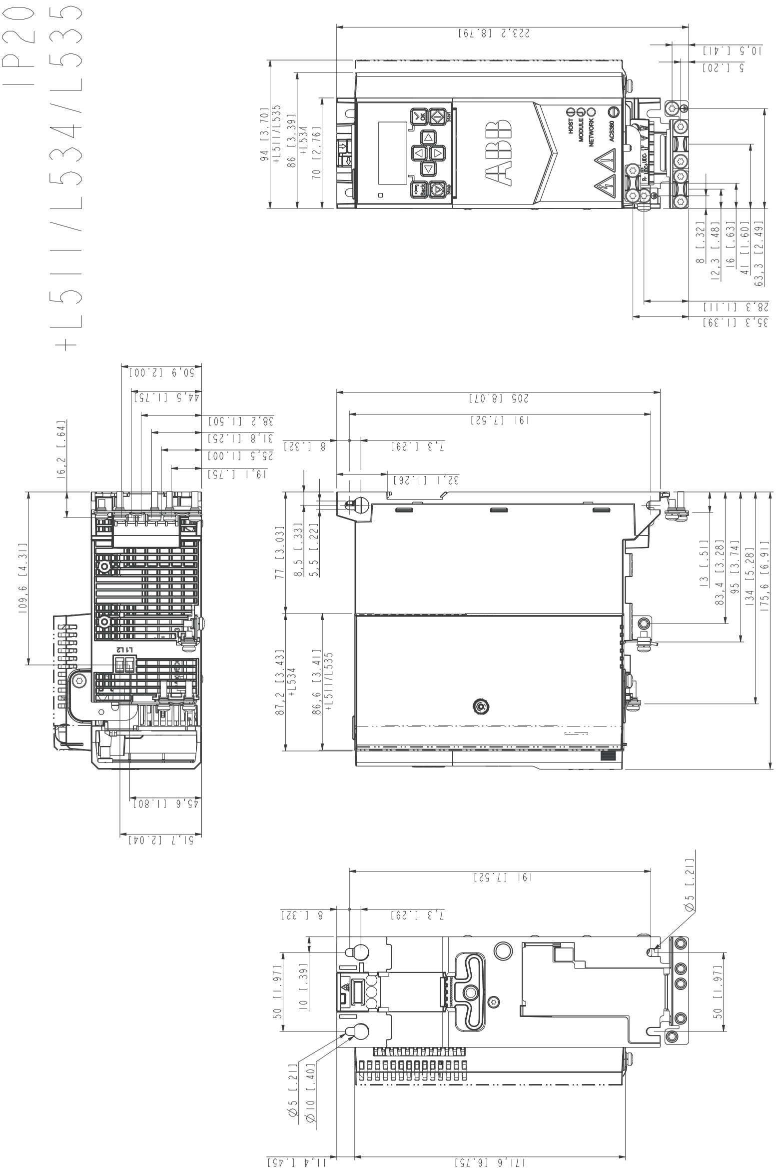
IP20





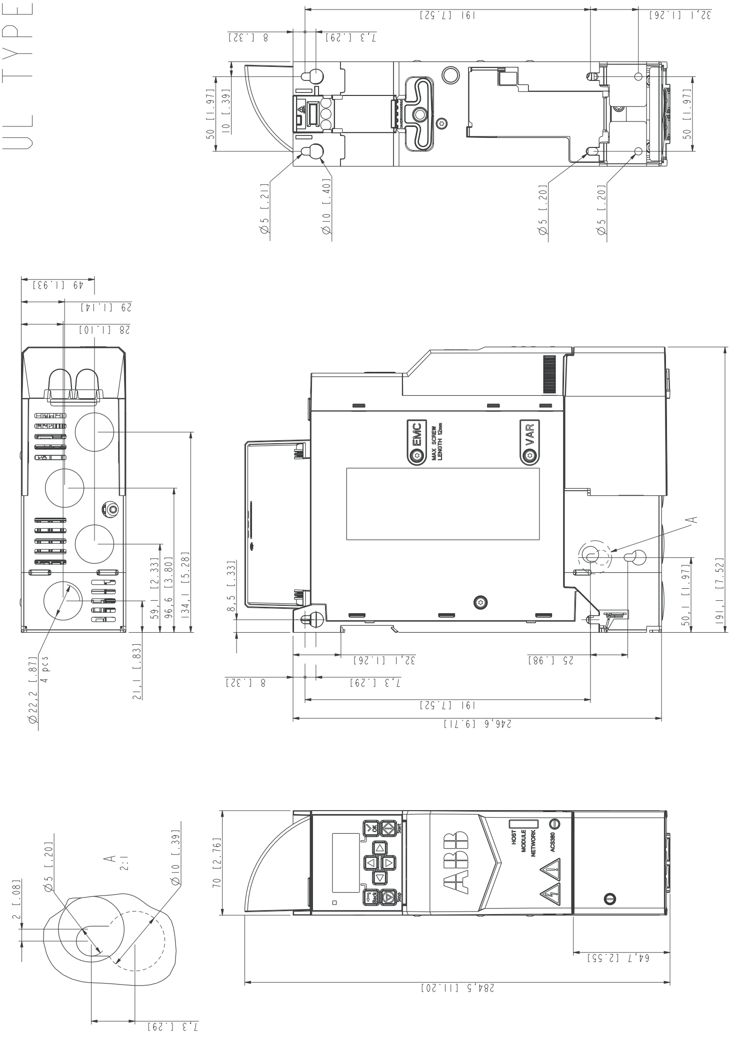


Frame R0, 1-phase 230 V, IP20, with side option

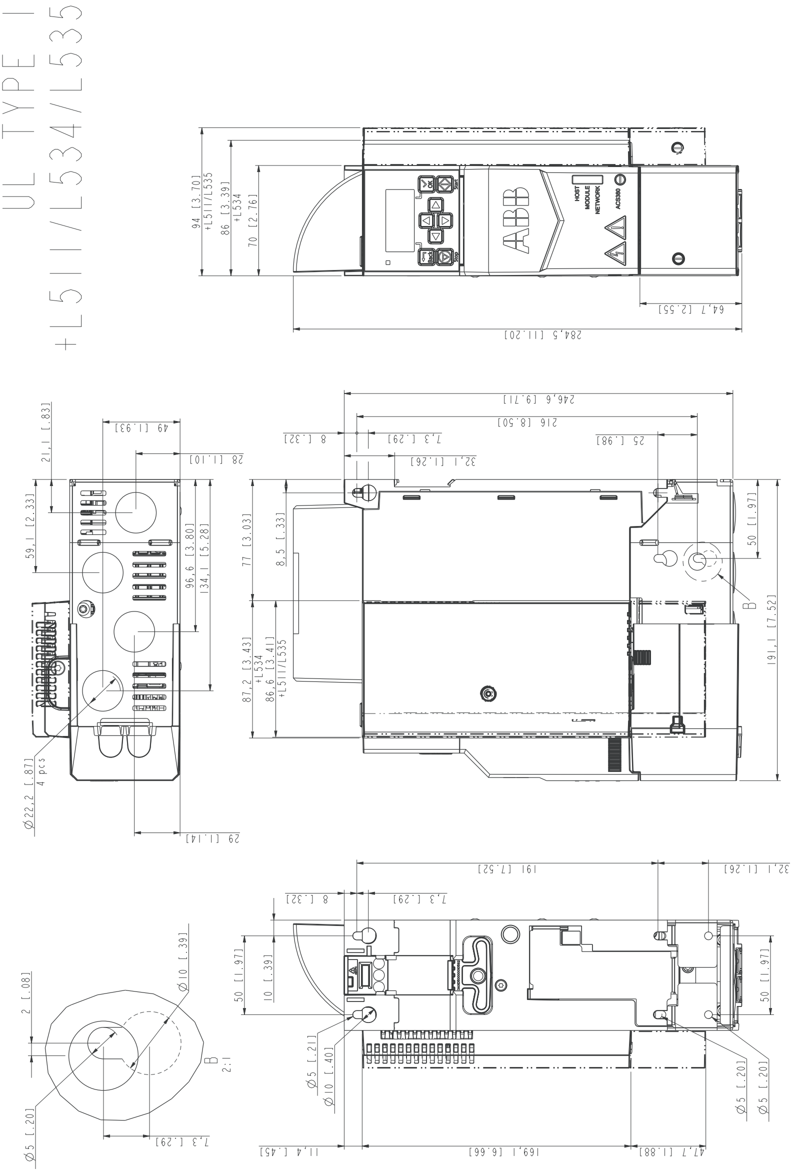


Frame R0, 1-phase 230 V, UL Type 1

UL TYPE 1

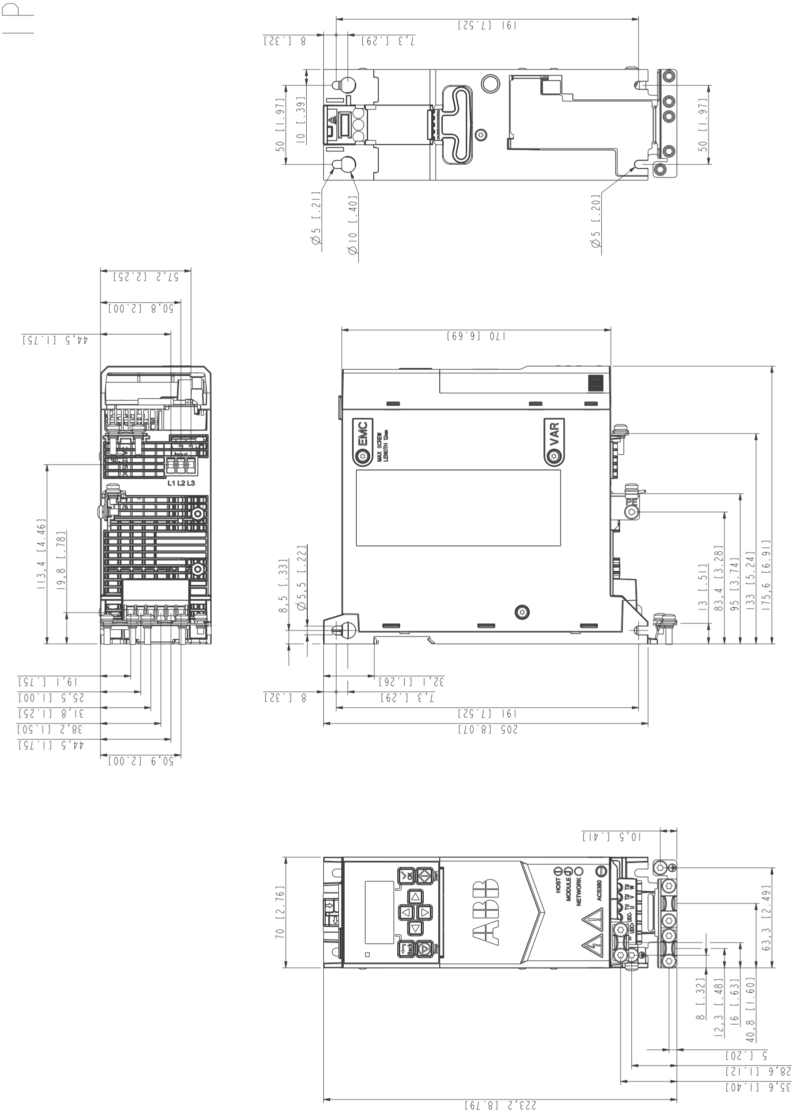


Frame R0, 1-phase 230 V, UL Type 1, with side option

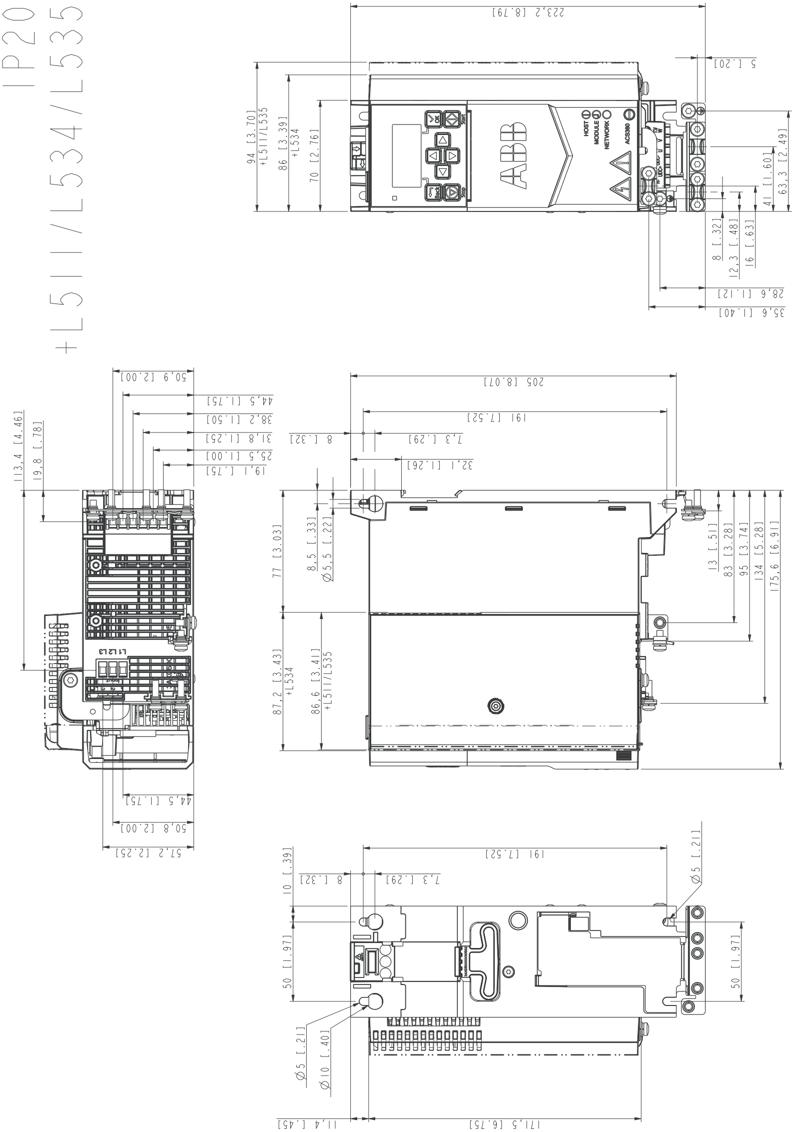


Frame R0, 3-phase 400/480 V, IP20

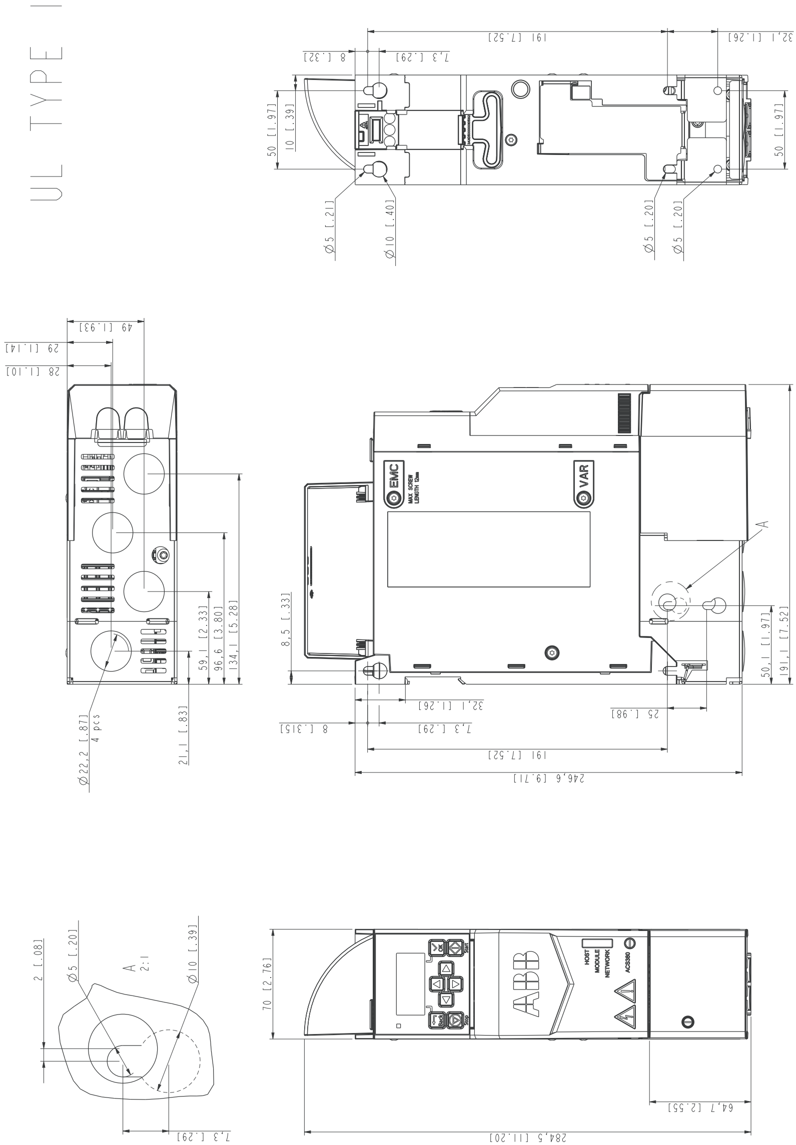
IP20



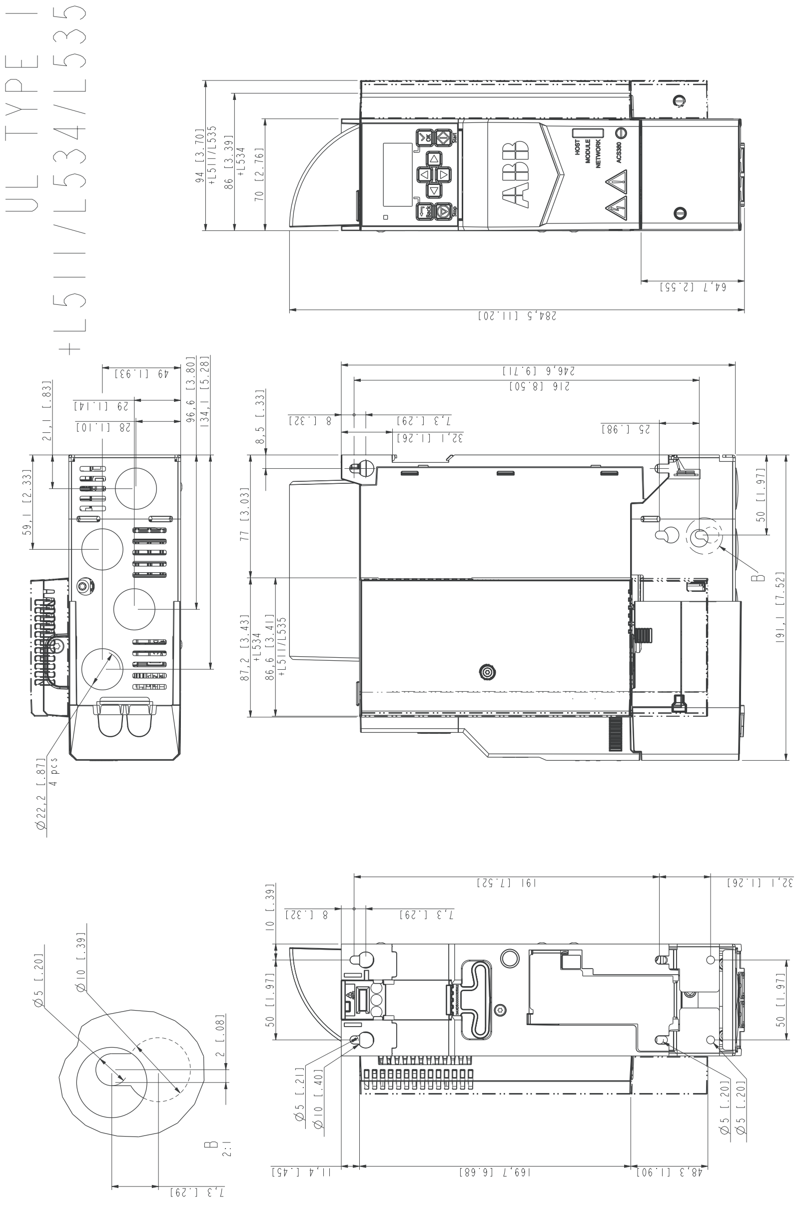
Frame R0, 3-phase 400/480 V, IP20, with side option



■ Frame R0, 3-phase 400/480 V, UL Type 1

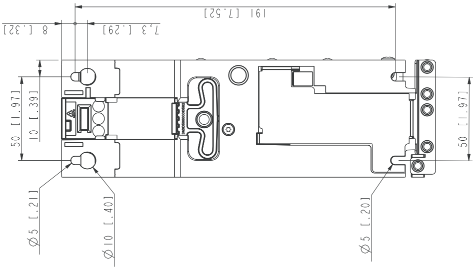


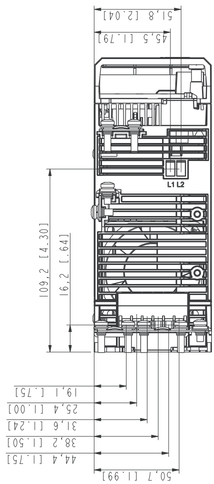
Frame R0, 3-phase 400/480 V, UL Type 1, with side option

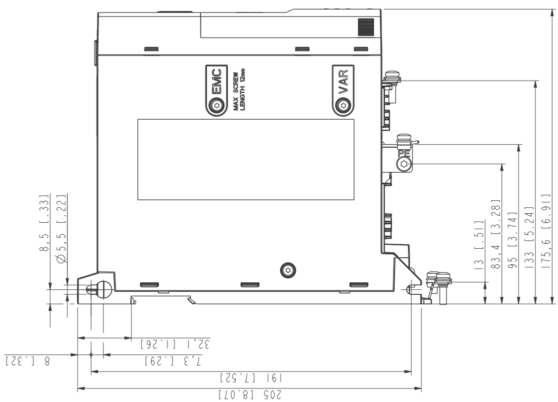


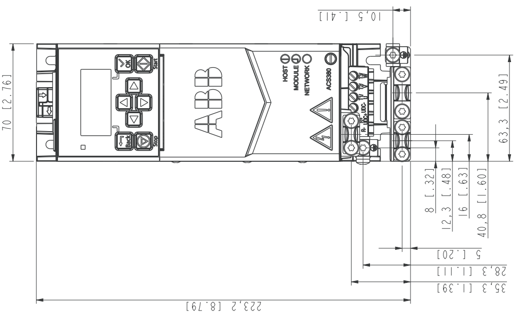
Frame R1

Frame R1, 1-phase 230 V, IP20

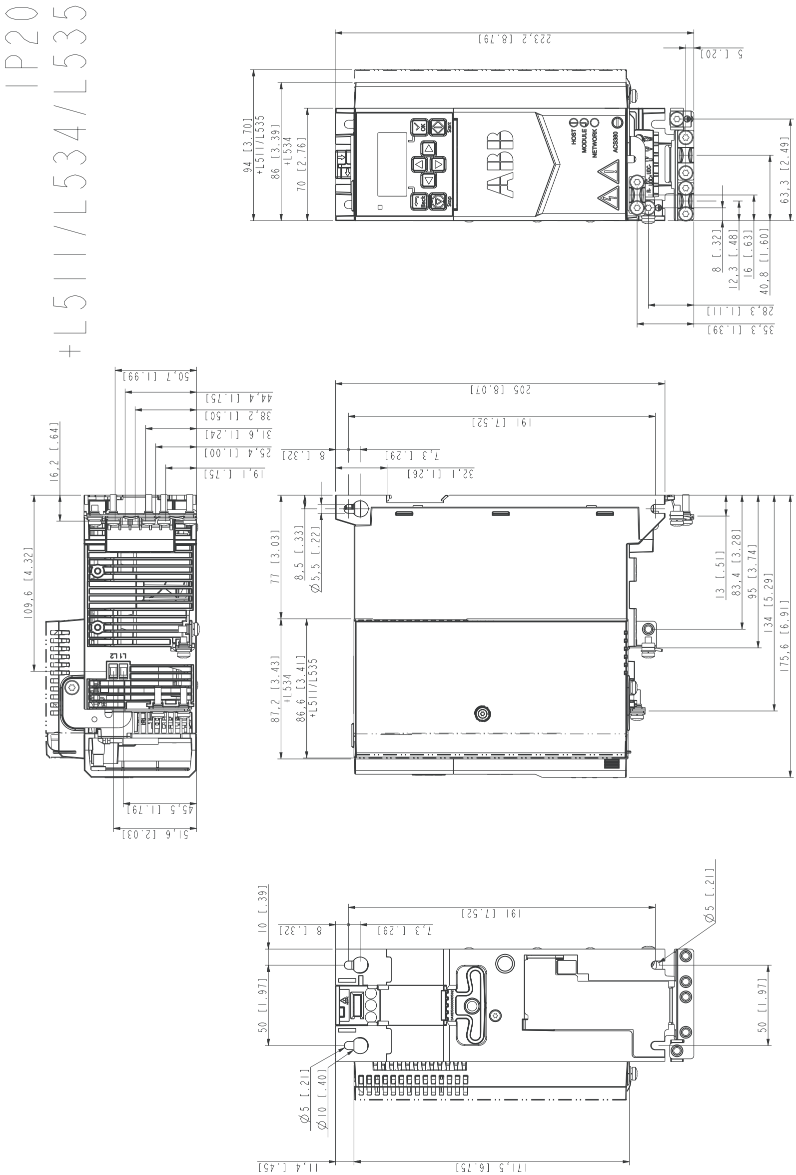






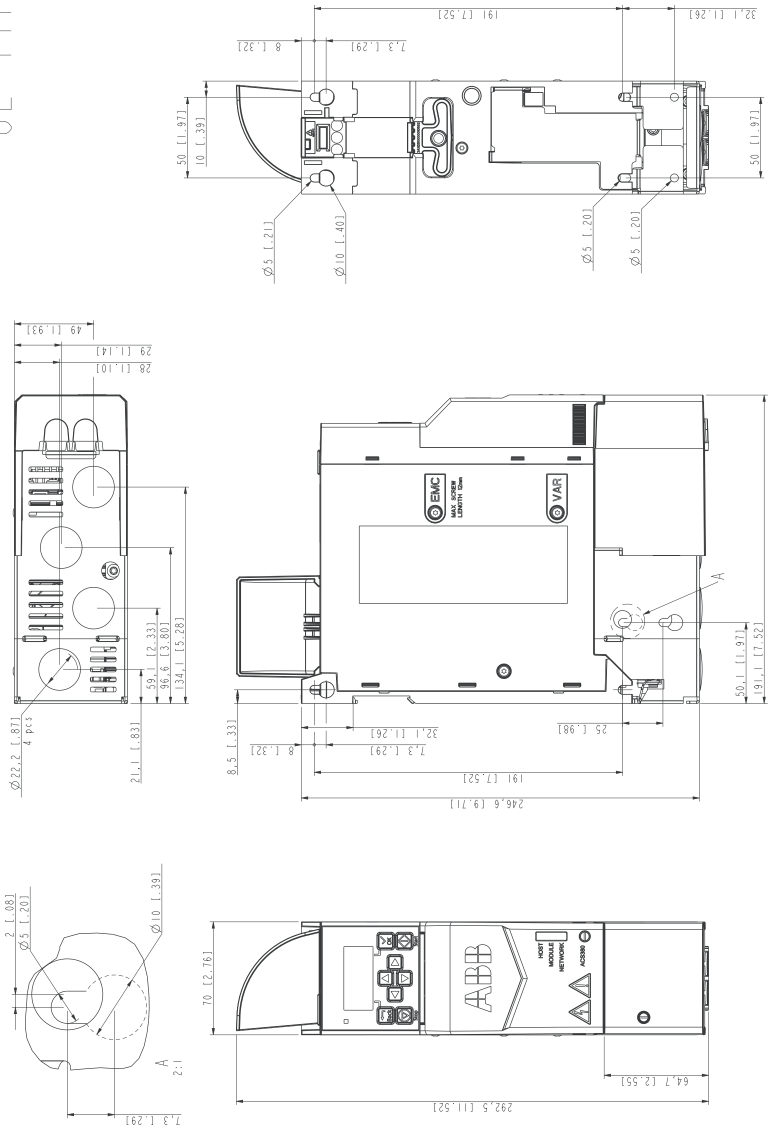


Frame R1, 1-phase 230 V, IP20, with side option

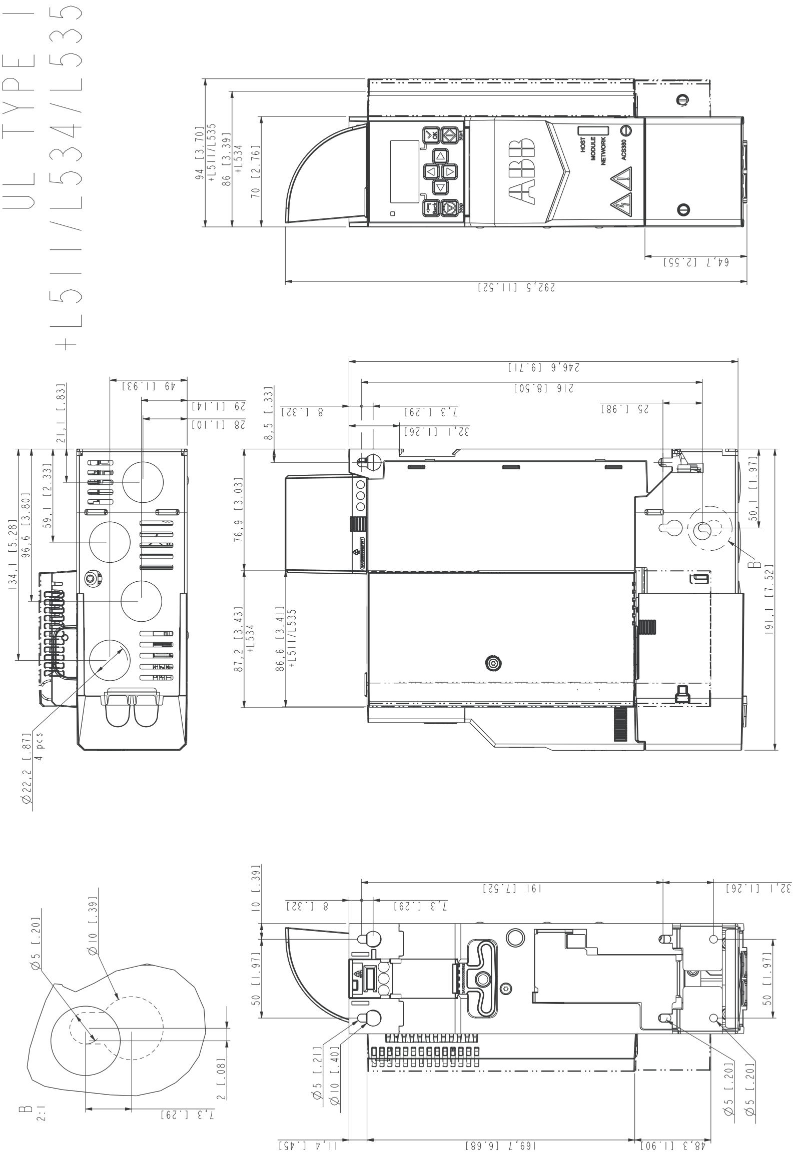


Frame R1, 1-phase 230 V, UL Type 1

UL TYPE 1

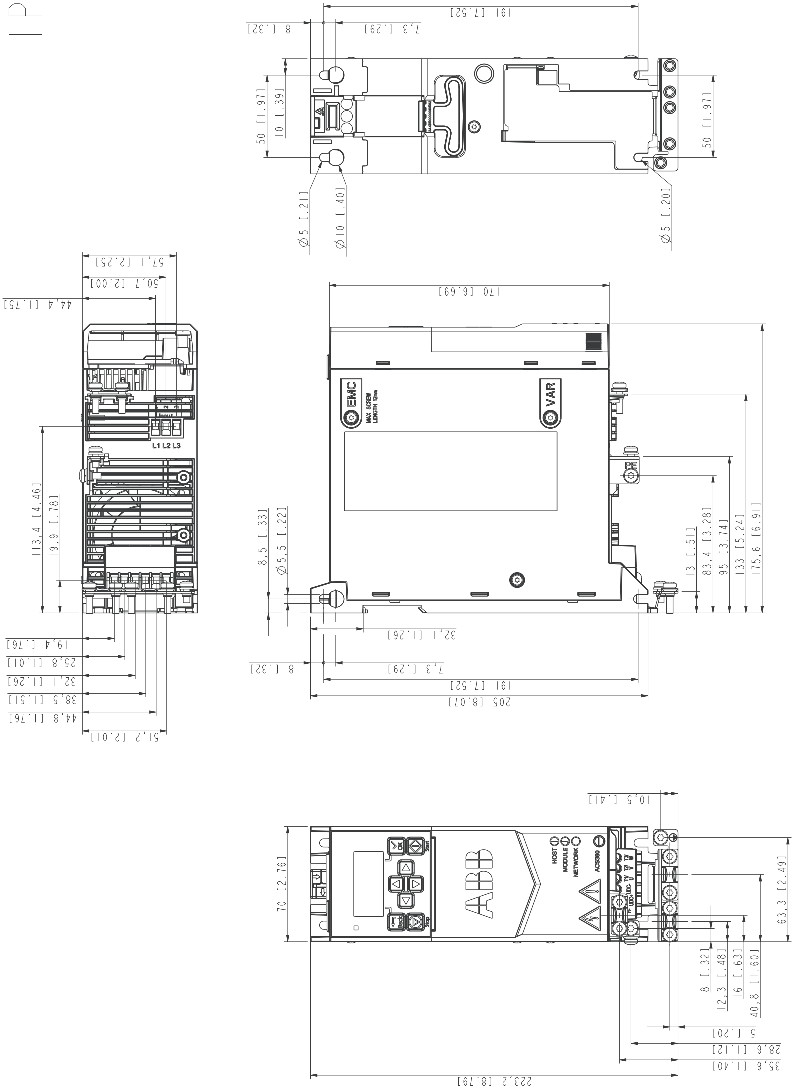


Frame R1, 1-phase 230 V, UL Type 1, with side option



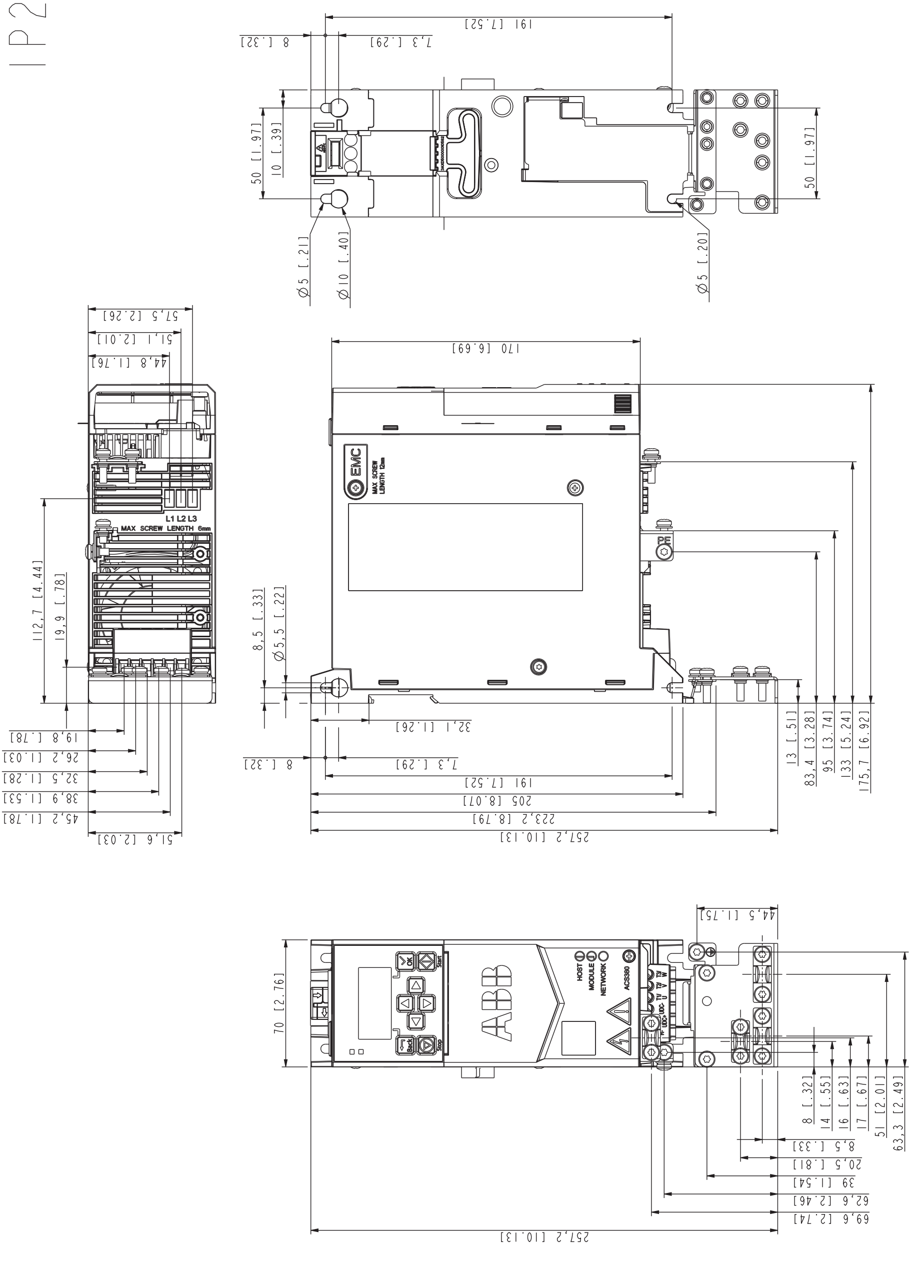
Frame R1, 3-phase 230 V and 400/480 V, IP20

IP20

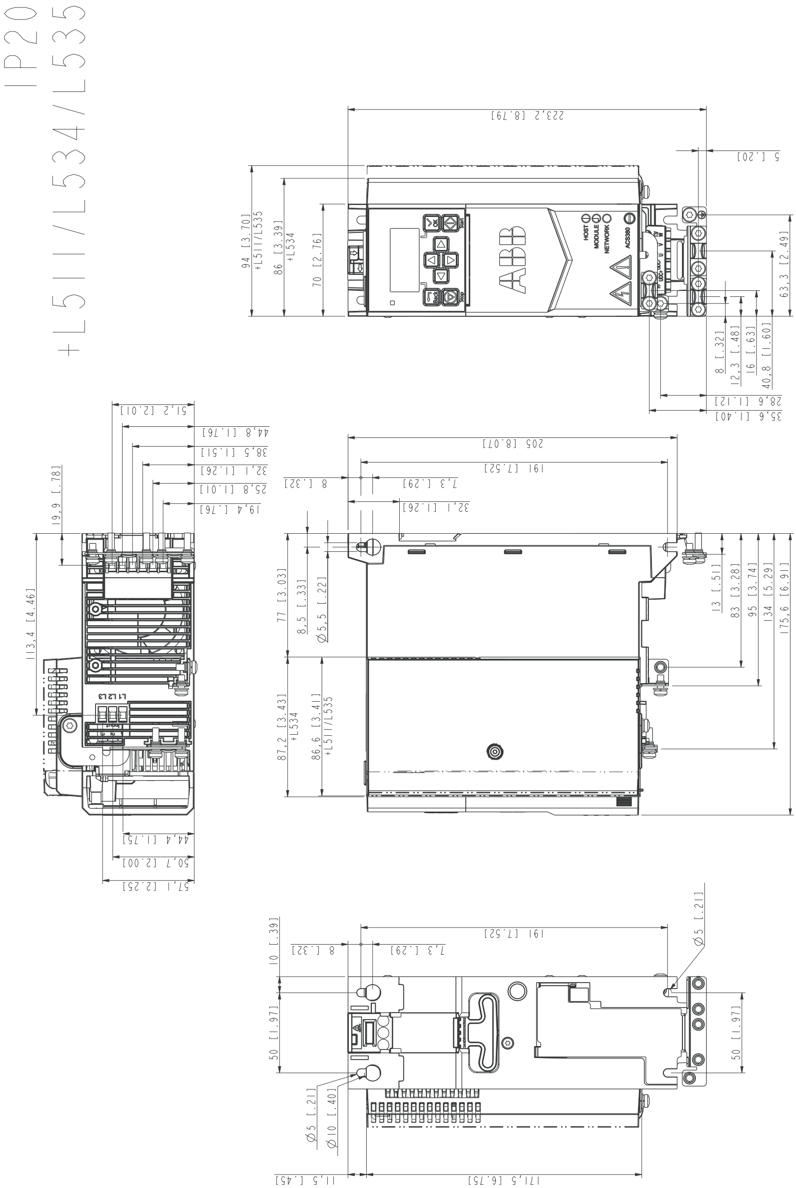


Frame R1, 3-phase 230 V and 400/480 V, IP20, with PE extension plate

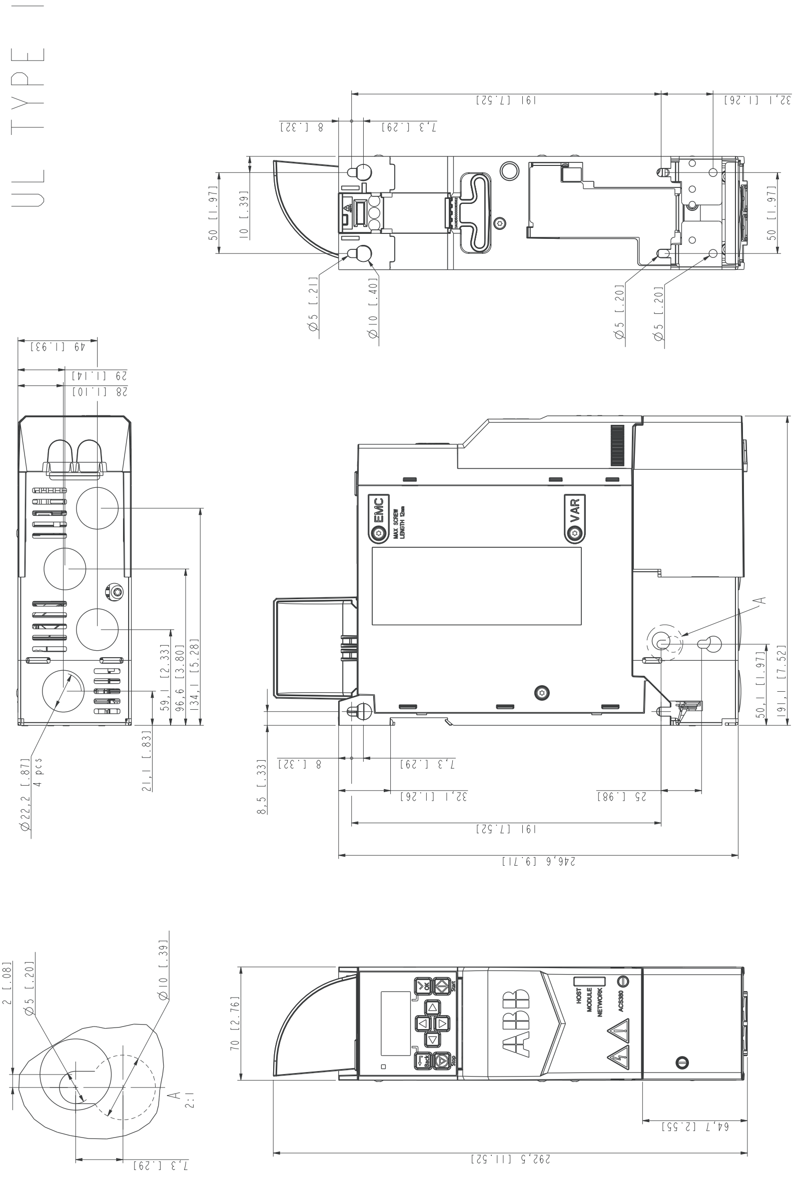
IP20



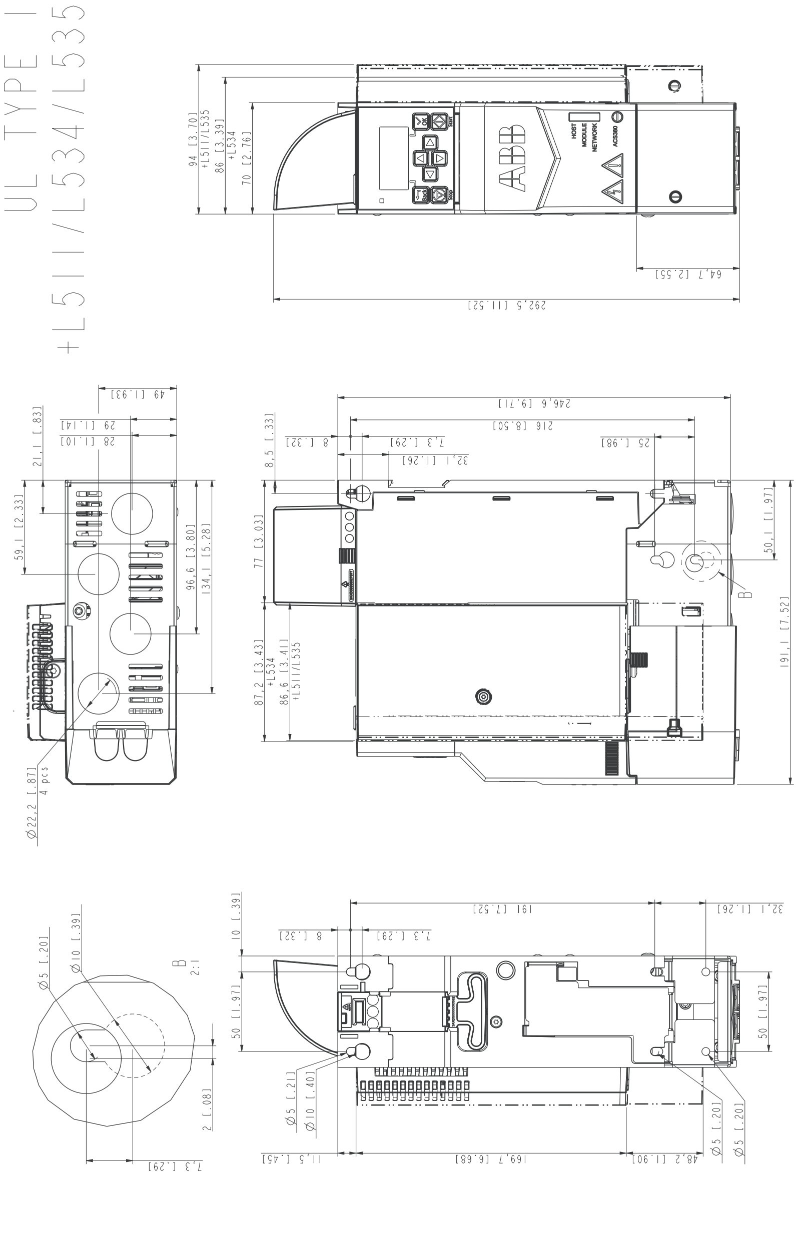
Frame R1, 3-phase 230 V and 400/480 V, IP20, with side option



Frame R1, 3-phase 230 V and 400/480 V, UL Type 1



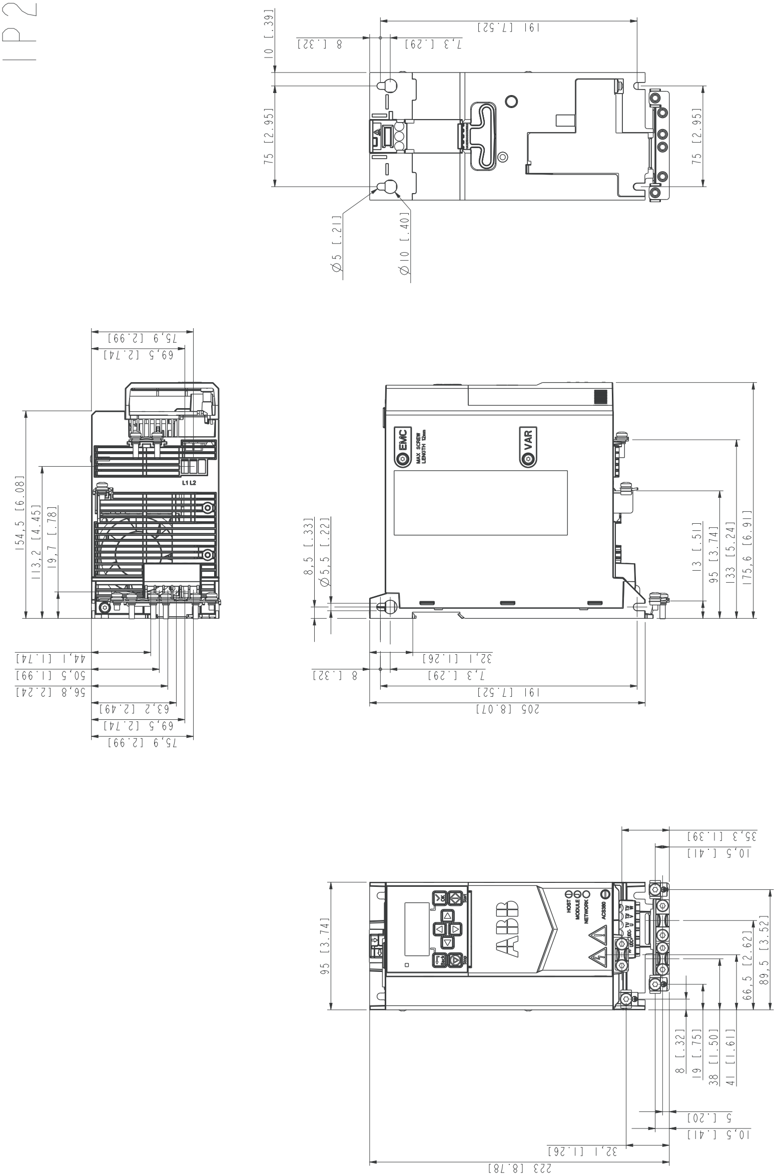
Frame R1, 3-phase 230 V and 400/480 V, UL Type 1, with side option



Frame R2

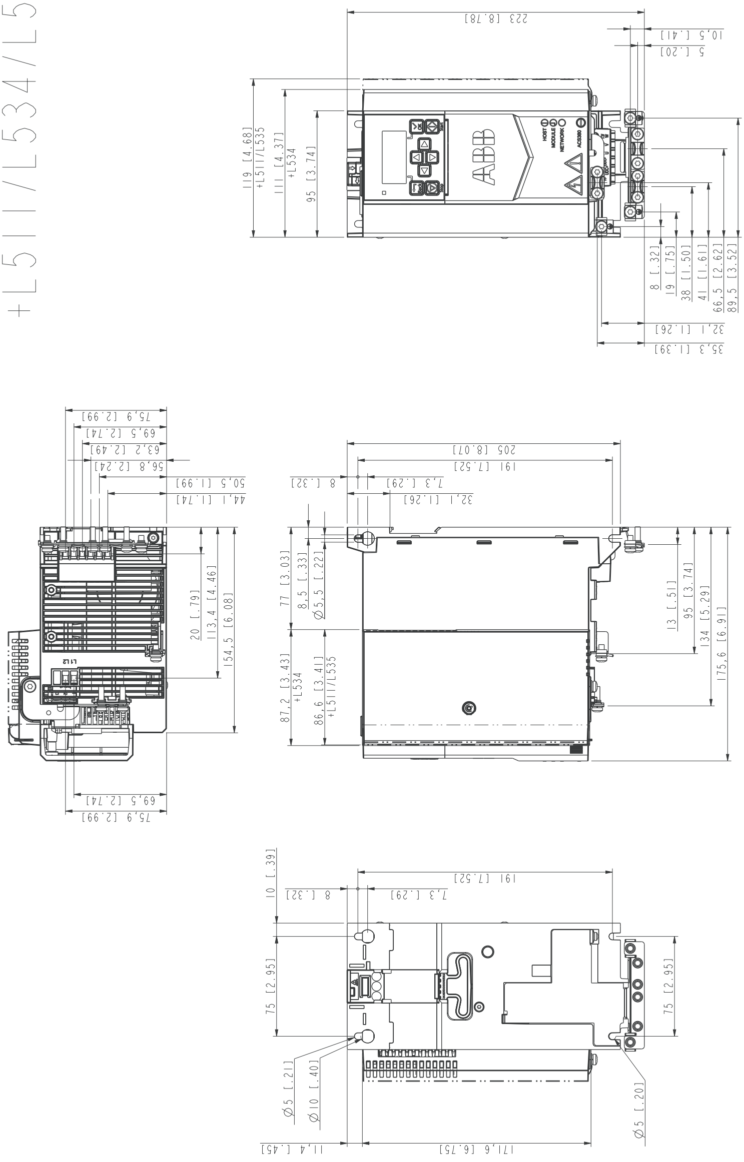
Frame R2, 1-phase 230 V, IP20

IP20



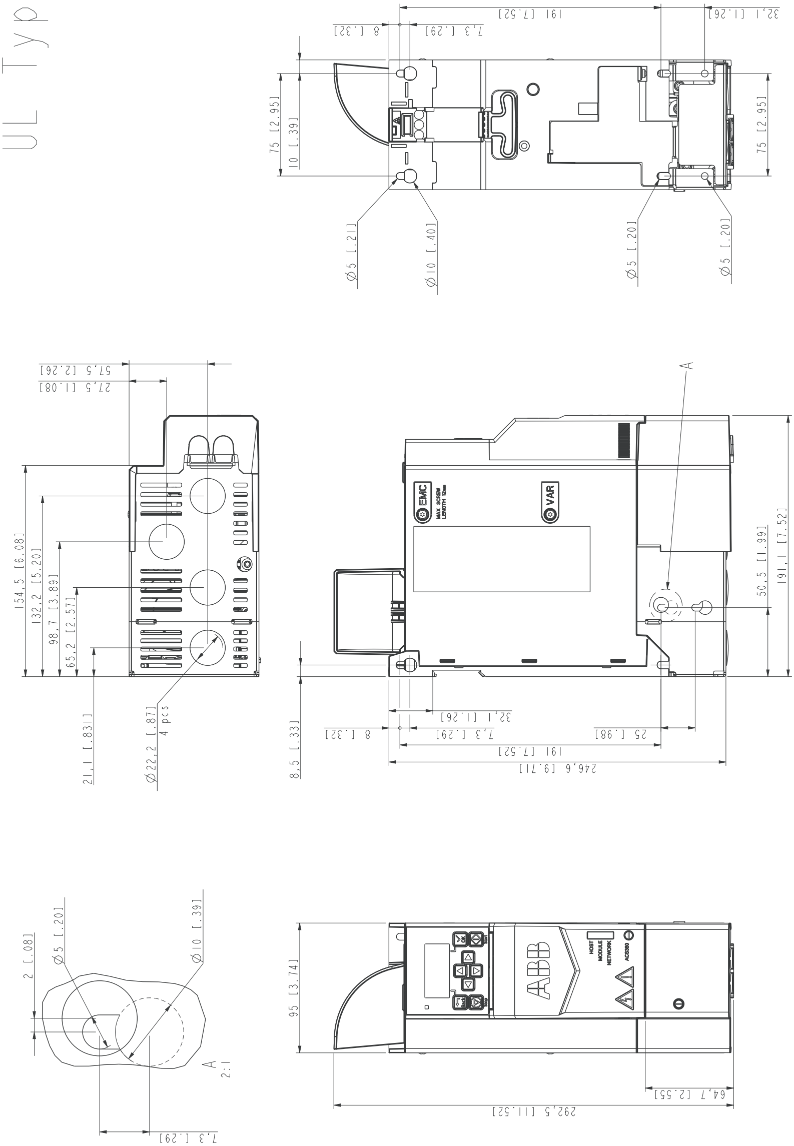
Frame R2, 1-phase 230 V, IP20, with side option

IP20
+L511/L534/L535

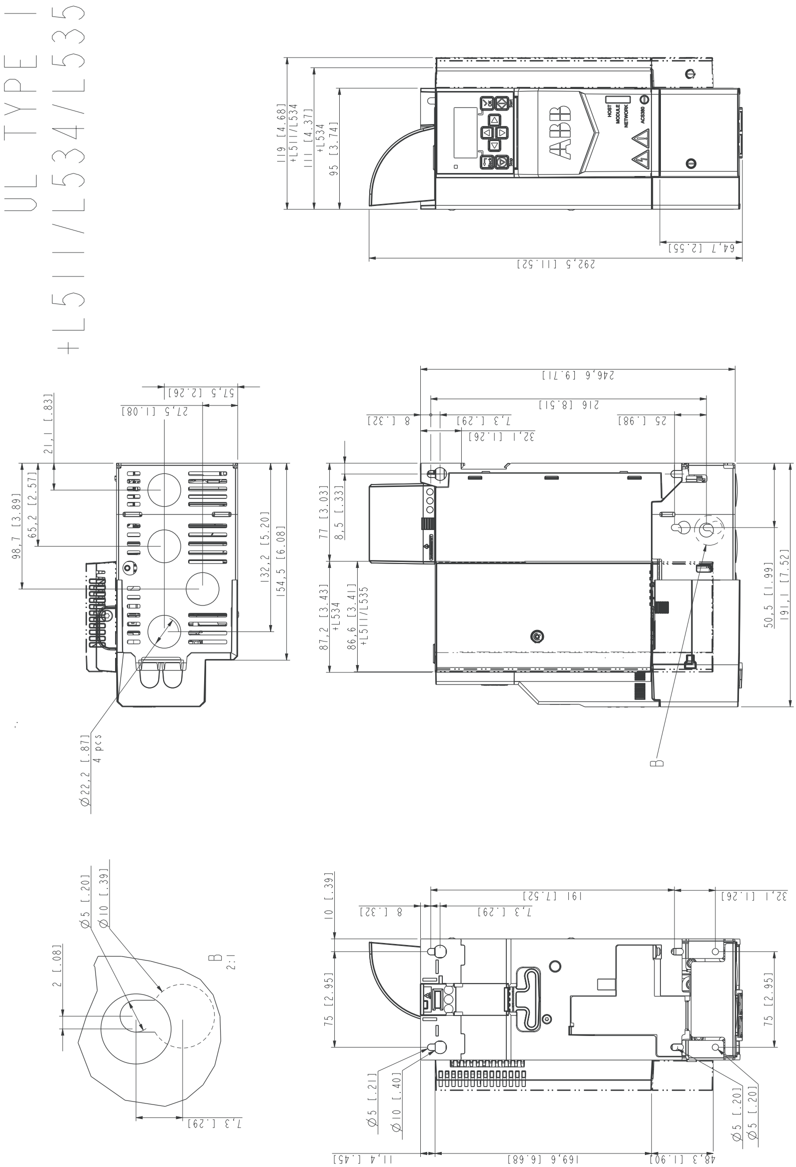


UL Type 1

Frame R2, 1-phase 230 V, UL Type 1

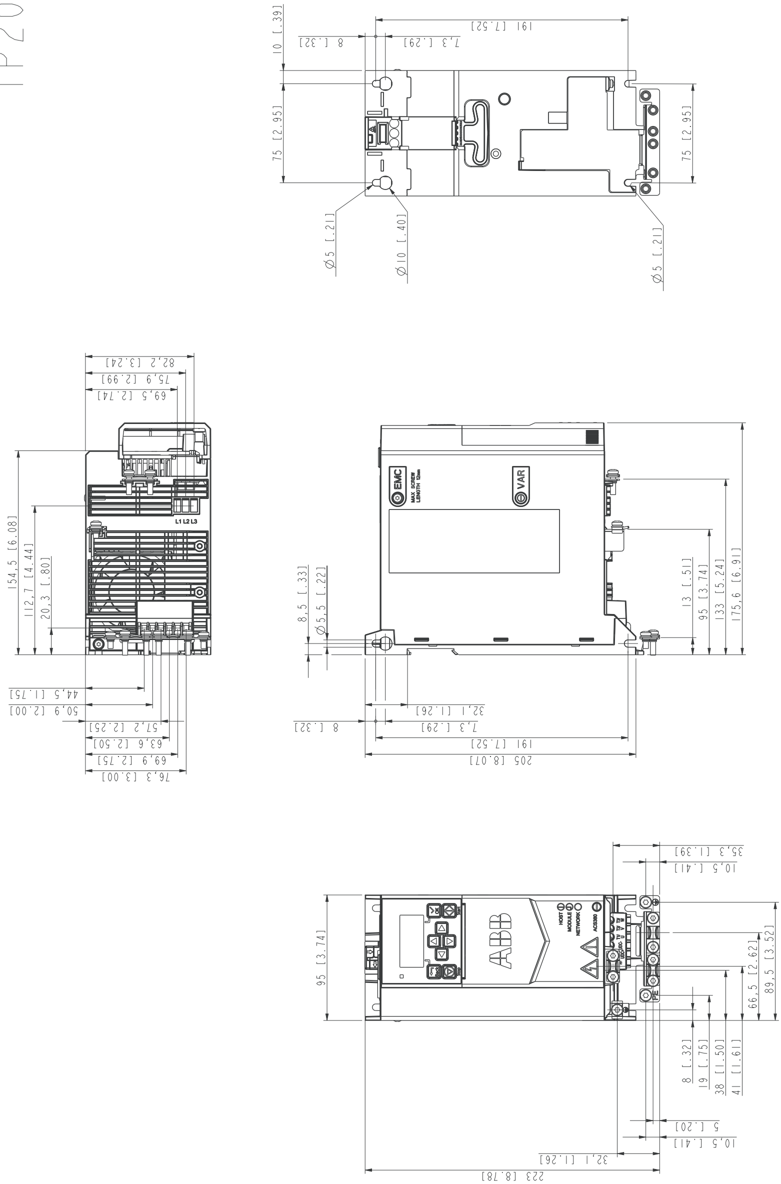


Frame R2, 1-phase 230 V, UL Type 1, with side option



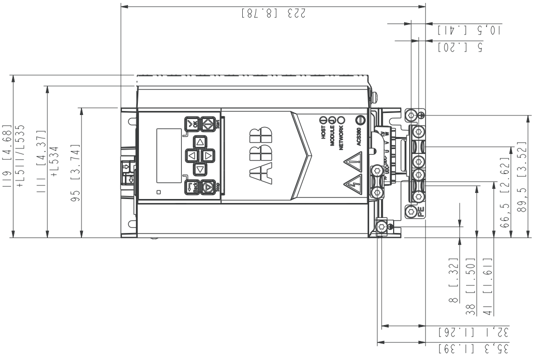
Frame R2, 3-phase 230 V and 400/480 V, IP20

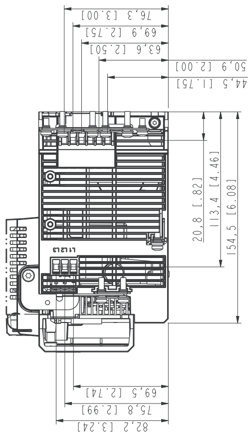
IP20

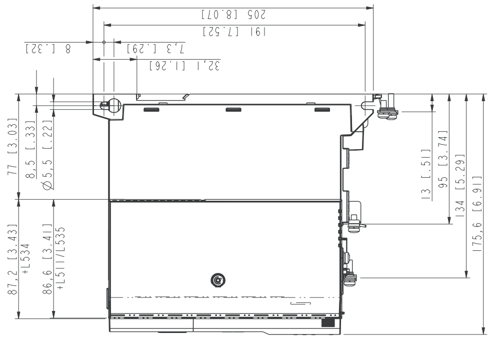


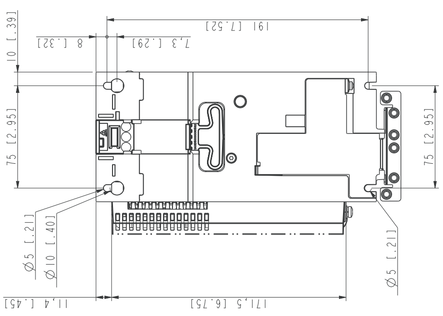
Frame R2, 3-phase 230 V and 400/480 V, IP20, with side option

IP20
+L511/534/L535



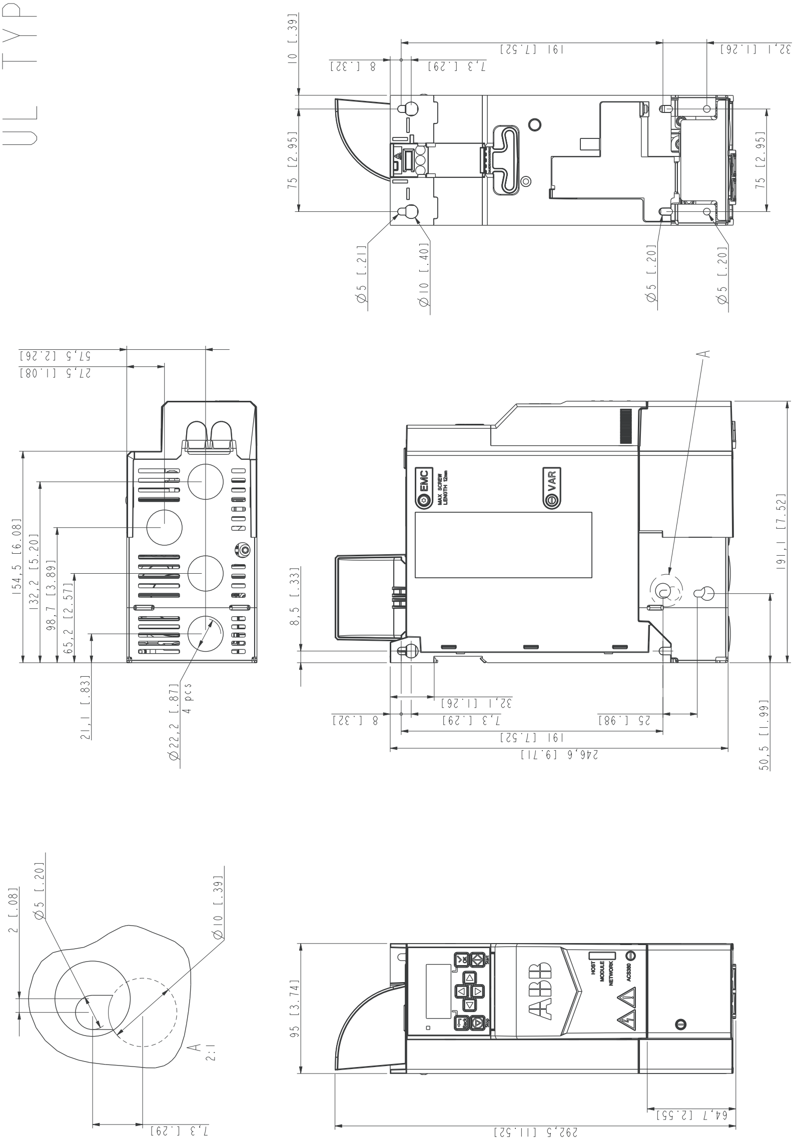




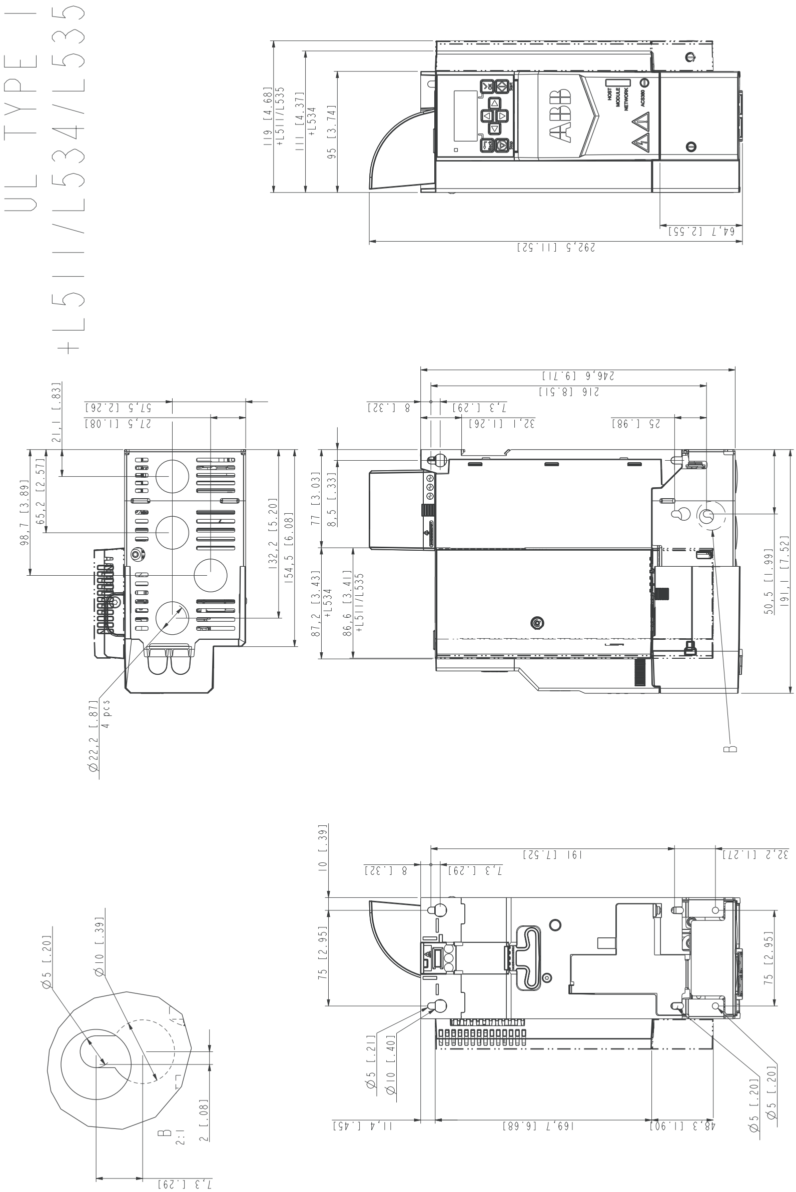


■ Frame R2, 3-phase 230 V and 400/480 V, UL Type 1

UL TYPE 1



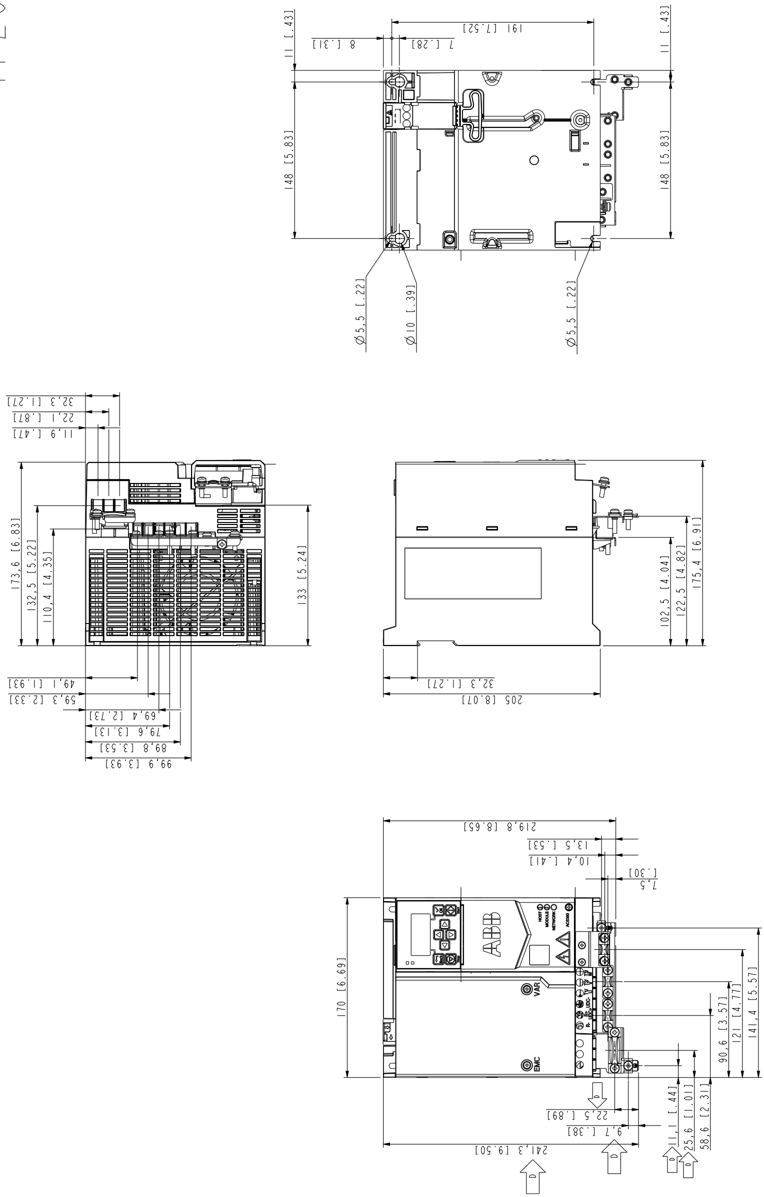
Frame R2, 3-phase 230 V and 400/480 V, UL Type 1, with side option



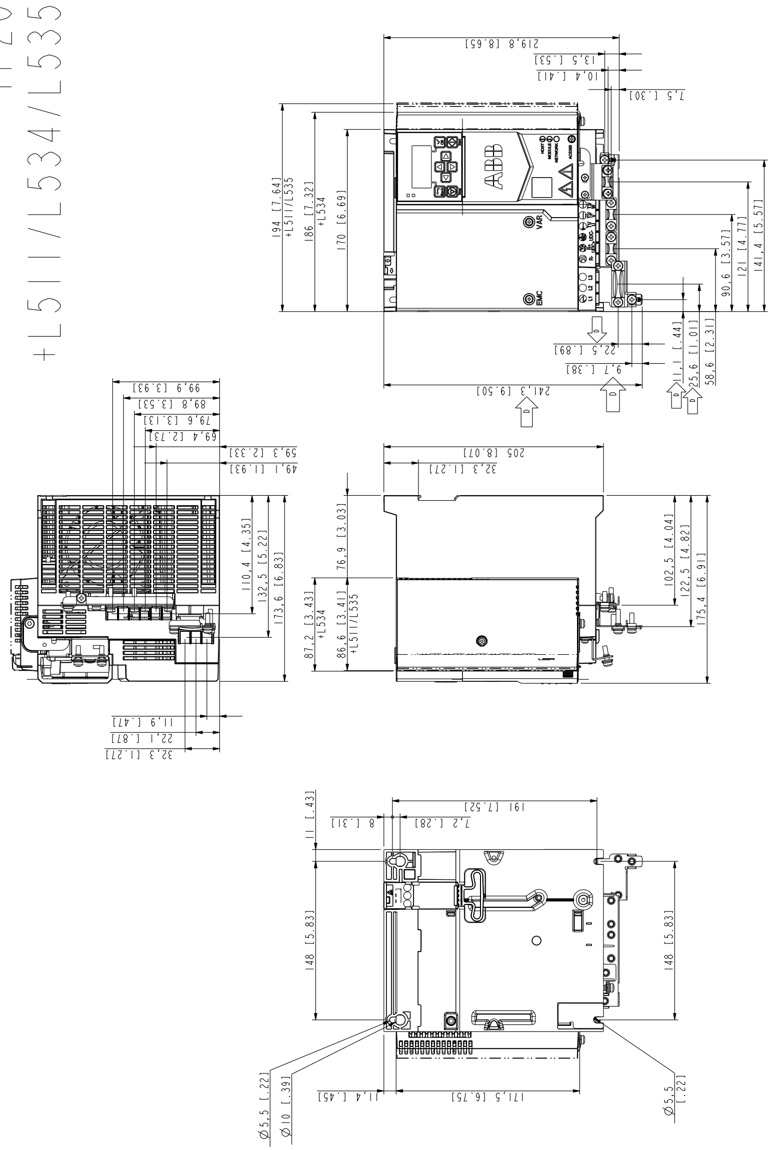
Frame R3

Frame R3, 3-phase 230 V and 400/480 V, IP20

IP20

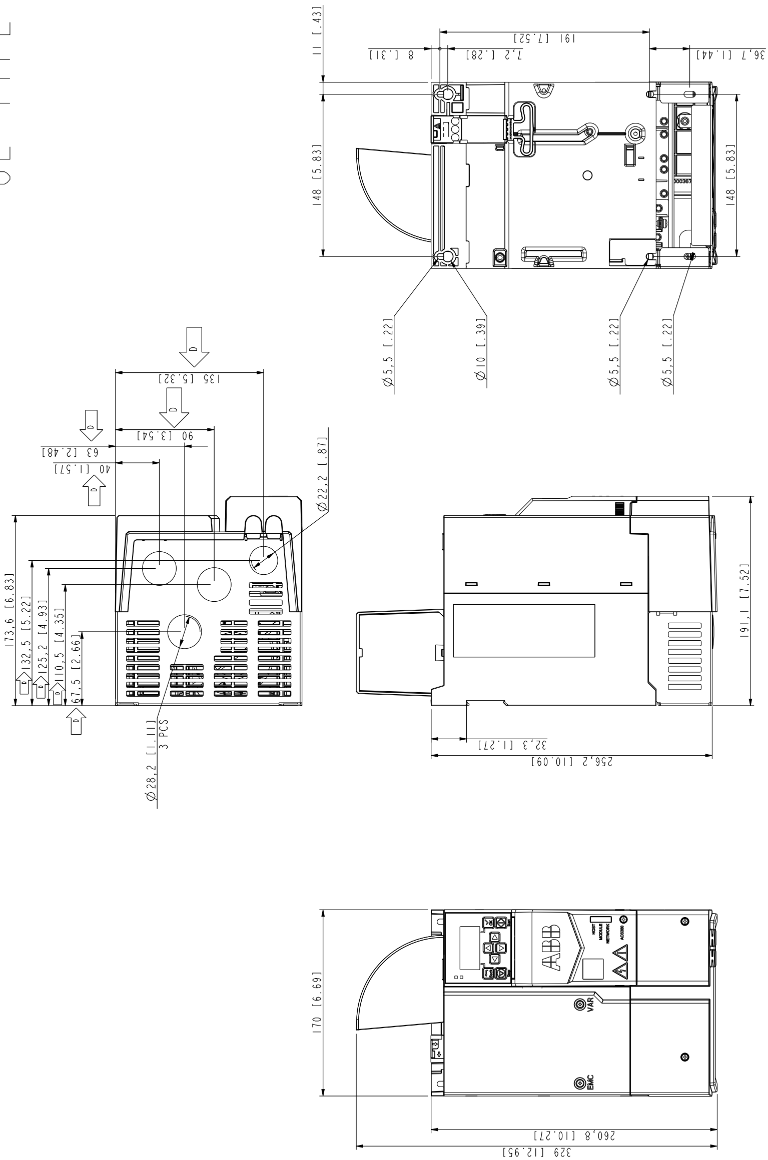


Frame R3, 3-phase 230 V and 400/480 V, IP20, with side option

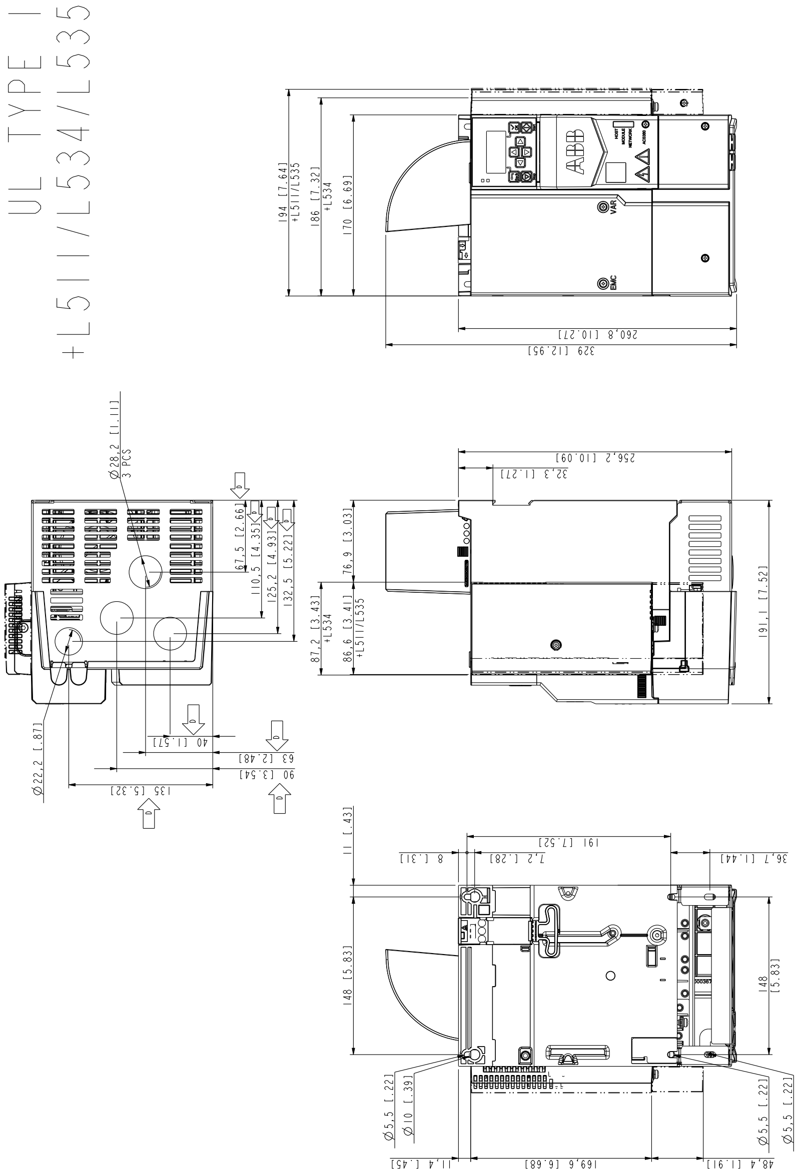


Frame R3, 3-phase 230 V and 400/480 V, UL Type 1

UL TYPE 1

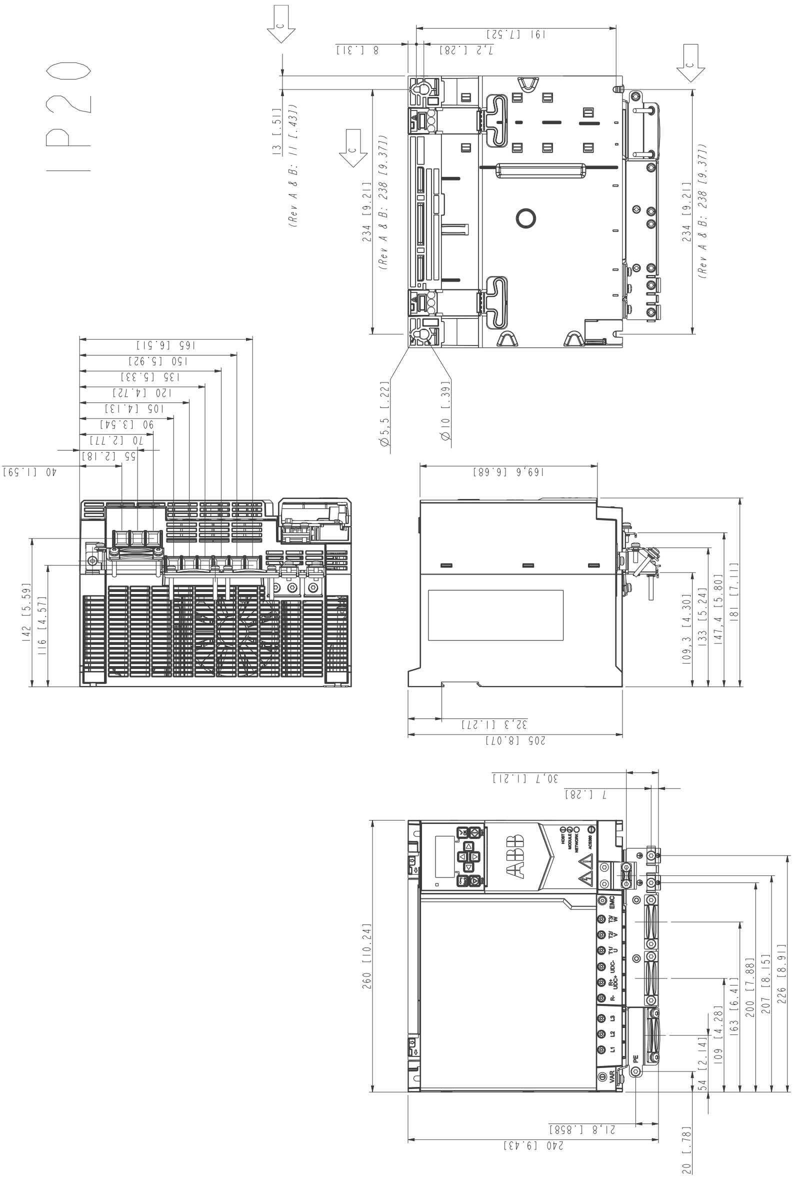


Frame R3, 3-phase 230 V and 400/480 V, UL Type 1, with side option

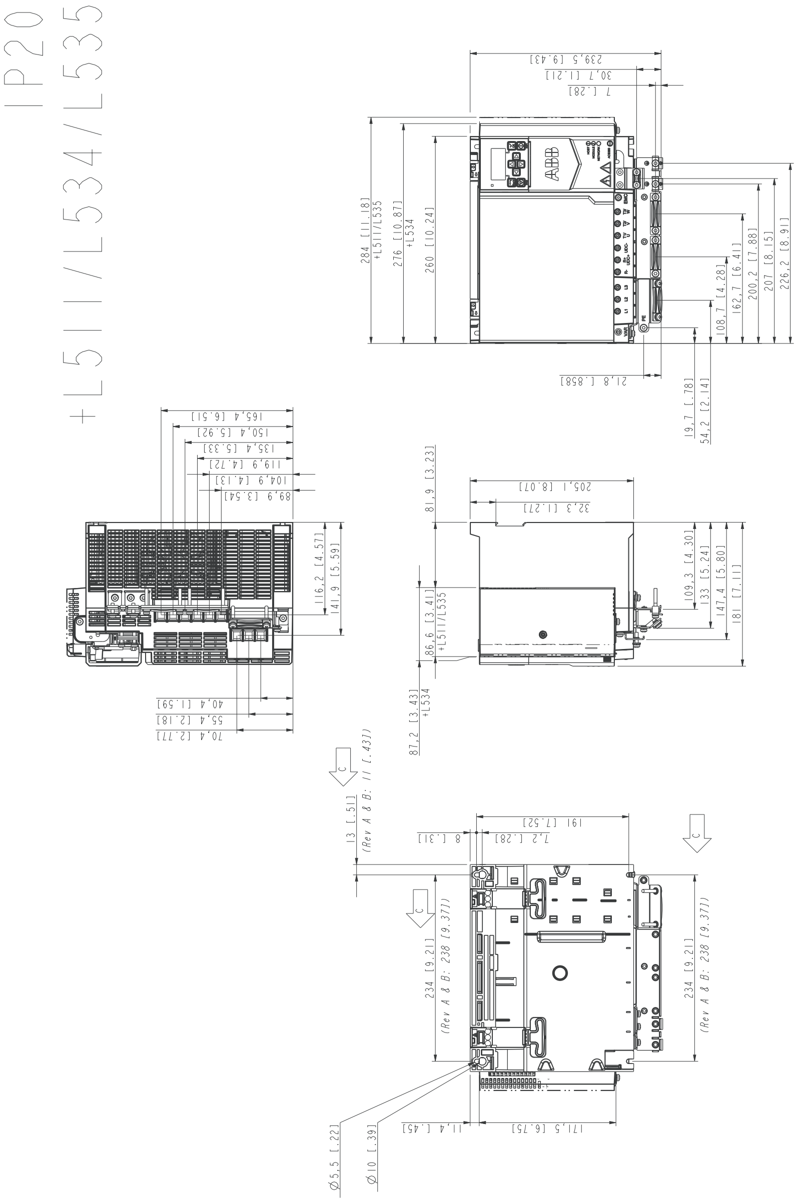


Frame R4

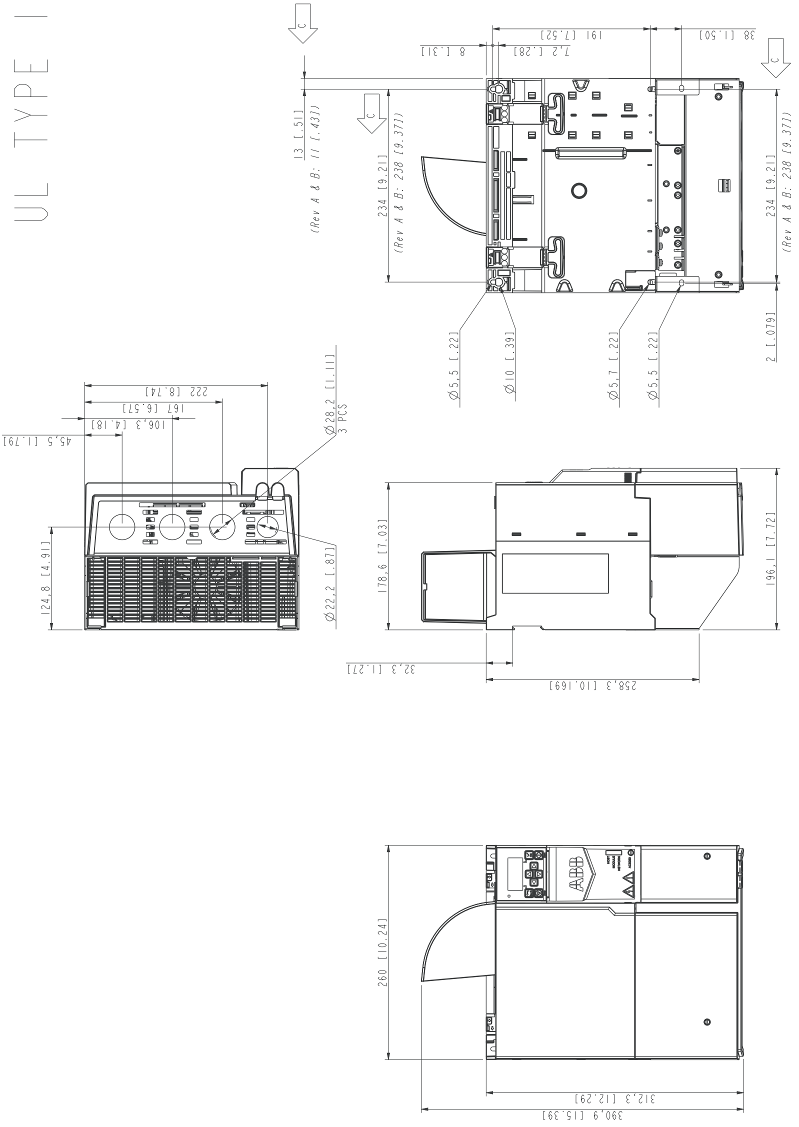
Frame R4, 3-phase 230 V and 400/480 V, IP20



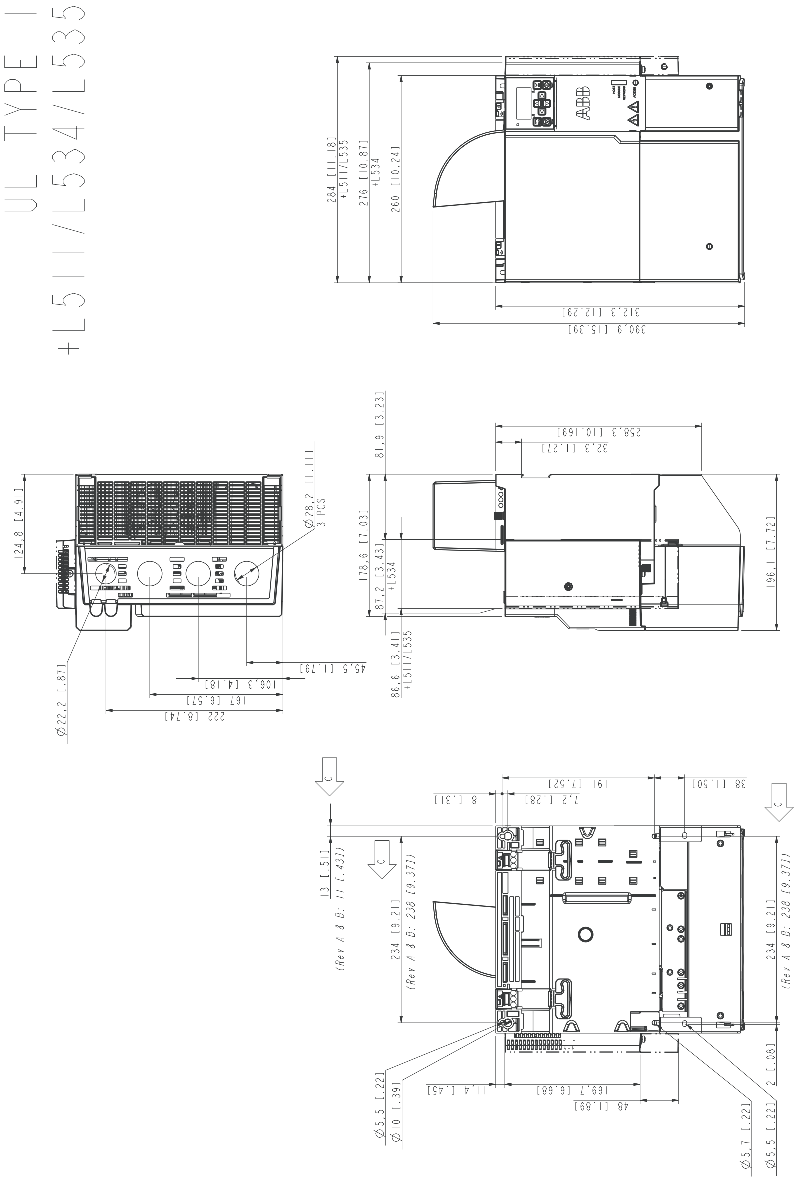
Frame R4, 3-phase 230 V and 400/480 V, IP20, with side option



Frame R4, 3-phase 230 V and 400/480 V, UL Type 1



Frame R4, 3-phase 230 V and 400/480 V, UL Type 1, with side option



12

Input chokes

Contents of this chapter

This chapter describes how to select and install input chokes for the drive. The chapter also contains the technical data of the input chokes.

When is an input choke necessary?

Determine the need for an external input choke at the drive power input on a case-by-case basis. The input chokes are used:

- to protect the drive in networks with high short-circuit capacity. Refer to **Input choke** (page 174) in Electrical power network specification (page 174).
- to reduce harmonic current emissions. Refer to Compliance with the harmonic current limits in a public network (IEC/EN 61000 3-2, IEC/EN 61000-3-12) (page 185).
- to reduce the rms value of input current. Refer to Maximum input current (page 227).
- to reduce supply disturbance and low-frequency interference
- in common DC configurations.

Maximum input current

Input current (I_1) of the drive depends on these items:

- motor actual shaft power and efficiency

- power output (or input) via DC connection to other drives in the common DC setup
- network impedance (short circuit capacity) effect on total harmonics content of the input current. Refer to Electrical power network specification (page 174) for more information.

Below are the maximum continuous input current values (rms) allowed for different drive types. If the actual continuous input current is higher (eg, due to very low efficiency of the motor), it is possible to use an input choke to reduce the input current rms value.

1-phase 200…240 V AC		3-phase 200…240 V AC		3-phase 380…480 V AC	400 V	480 V
ACS380-04xx-…	I_1 A	ACS380-04xx-…	I_1 A	ACS380-04xx-…	I_1 A	I_1 A
02A4-1	5.5	02A4-2	3.5	01A8-4	2.8	2.2
03A7-1	7.4	03A7-2	4.8	02A6-4	3.5	2.7
04A8-1	9.1	04A8-2	5.8	03A3-4	4.8	3.9
06A9-1	12.6	06A9-2	8.4	04A0-4	6.1	4.5
07A8-1	14.9	07A8-2	9.4	05A6-4	8.5	6.6
09A8-1	21.0	09A8-2	12.8	07A2-4	10.1	6.2
12A2-1	25.6	12A2-2	16.0	09A4-4	12.9	9.8
-	-	17A5-2	21.0	12A6-4	16.5	13.9
-	-	25A0-2	30.5	17A0-4	23.4	18.8
-	-	033A-2	37.5	25A0-4	31.8	26.6
-	-	032A-2	37.4	033A-4	40.9	33.9
-	-	048A-2	53.2	032A-4	40.7	33.7
-	-	055A-2	60.0	038A-4	49.0	41.3
-	-	-	-	045A-4	55.7	46.9
-	-	-	-	050A-4	55.7	46.9

Selecting an input choke

Select the input choke according to the drive type.

Type ACS380-04xx-...	Frame	Input choke type										
		CHK-A1	CHK-B1	CHK-C1	CHK-D1	CHK-01	CHK-02	CHK-03	CHK-04	CHK-05	CHK-06	CHK-07
1-phase U_n = 230 V												
02A4-1	R0	x										
03A7-1	R0		x									
04A8-1	R1		x									
06A9-1	R1			x								
07A8-1	R1			x								
09A8-1	R2				x							
12A2-1	R2				x							
3-phase U_n = 230 V												
02A4-2	R1					x						
03A7-2	R1						x					
04A8-2	R1							x				
06A9-2	R1							x				
07A8-2	R1							x				
09A8-2	R1								x			
12A2-2	R2								x			
17A5-2	R3								x			
25A0-2	R3										x	
033A-2	R3										x	
032A-2	R4										x	
048A-2	R4											x
055A-2	R4											x
3-phase U_n = 400 V												
01A8-4	R0					x						
02A6-4	R1					x						
03A3-4	R1					x						
04A0-4	R1						x					

Type ACS380-04xx-...	Frame	Input choke type										
		CHK-A1	CHK-B1	CHK-C1	CHK-D1	CHK-01	CHK-02	CHK-03	CHK-04	CHK-05	CHK-06	CHK-07
05A6-4	R1						x					
07A2-4	R1						x					
09A4-4	R1							x				
12A6-4	R2							x				
17A0-4	R3								x			
25A0-4	R3								x			
033A-4	R3									x		
032A-4	R4									x		
038A-4	R4										x	
045A-4	R4										x	
050A-4	R4											x

The degree of protection of an input choke is IP20. Refer to Dimensions (page 231) for dimensions, wire sizes and tightening torques.

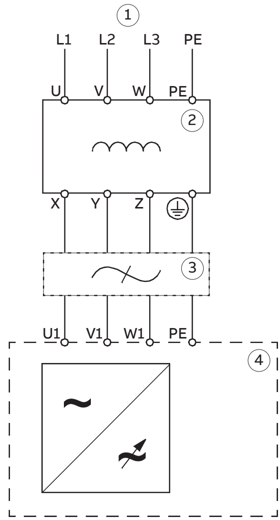
Guidelines for installing an input choke

Obey these guidelines when you install the input choke:

- If an external EMC filter is also installed, connect the input choke between the supply and the filter.
- For optimal operation of the choke, fasten the drive and the choke on the same conductive surface.
- Make sure that the choke does not prevent the airflow through the drive module, and that the hot air rising from the choke cannot enter the air inlet of the drive module.
- Keep the cable between the drive and the choke as short as possible.

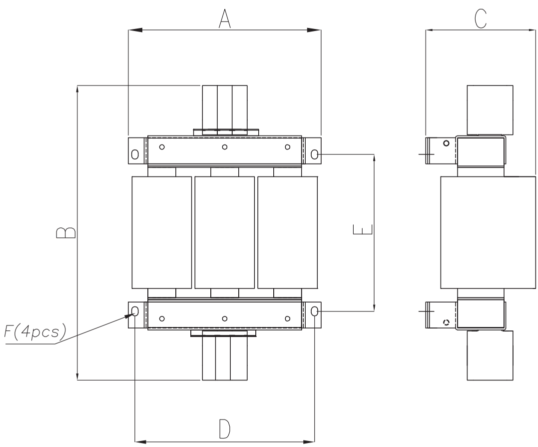
WARNING The input choke is hot when in use and for some time after the use.

Connection diagram



1	AC supply
2	Input choke
3	External EMC filter (if present)
4	Drive

Dimensions



	Input choke type							
	CHK-01	CHK-02	CHK-03	CHK-04	CHK-05	CHK-06	CHK-07	CHK-08
Dim A mm (in.)	120 (4.72)	150 (5.91)	150 (5.91)	150 (5.91)	207 (8.15)	207 (8.15)	249 (9.80)	249 (9.80)
Dim B mm (in.)	146 (5.75)	175 (6.89)	175 (6.89)	175 (6.89)	272 (10.71)	326 (12.83)	326 (12.83)	346 (13.62)
Dim C mm (in.)	79 (3.11)	86 (3.39)	100 (3.94)	100 (3.94)	154 (6.06)	154 (6.06)	167 (6.57)	167 (6.57)
Dim D mm (in.)	77 (3.03)	105 (4.13)	105 (4.13)	105 (4.13)	193 (7.60)	193 (7.60)	235 (9.25)	235 (9.25)
Dim E mm (in.)	114 (4.49)	148 (5.83)	148 (5.83)	148 (5.83)	118 (4.65)	169 (6.65)	125 (4.92)	147 (5.79)
F screw size	M5	M5	M5	M5	M6	M6	M6	M6
Weight kg (lbs)	1.8 (4.0)	3.8 (8.4)	5.4 (11.9)	5.2 (11.5)	10 (22)	12 (26.5)	14 (31)	16 (35)
Wire size Main terminals mm^2 (AWG)	0.5…10 (20…6)	0.5…10 (20…6)	0.5…10 (20…6)	0.5…10 (20…6)	1.5…35 (16…0)	1.5…35 (16…0)	25…50 (6…0)	25…50 (6…0)
Tightening torque Main terminals N·m (lbf·in)	1.5 (13)	1.5 (13)	1.5 (13)	1.5 (13)	3.2 (28)	3.2 (28)	6 (53)	6 (53)
PE/Chassis terminals	M4	M5	M5	M5	M6	M6	M6	M8
Tightening torque PE/Chassis terminals N·m (lbf·in)	3 (26)	4 (35)	4 (35)	4 (35)	8 (70)	8 (70)	8 (70)	15 (135)

13

External EMC filters

Contents of this chapter

This chapter describes how to select external EMC filters for the drive.

Selecting the external EMC filter

If you use an external EMC filter, you must disconnect the internal EMC filter. Refer to the electrical installation instructions.

Select the external EMC filter according to the drive type:

Type ACS380-04xx-...	**EMC filter**			
	ABB type	**Schaffner type**	**ABB alternative**	**Schaffner alternative**
1-phase U_N = 230 V				
02A4-1	RFI-11 1)	FS 21754-6.1-07	-	FN 2410-8-44
03A7-1	RFI-12 1)	FS 21754-16.1-07	-	FN 2410-8-44
04A8-1	RFI-12 1)	FS 21754-16.1-07	-	FN 2410-8-44
06A9-1	RFI-12 1)	FS 21754-16.1-07	-	FN 2410-16-44
07A8-1	RFI-12 1)	FS 21754-16.1-07	-	FN 2410-16-44
09A8-1	Contact ABB			
12A2-1	Contact ABB			

Type ACS380-04xx-...	EMC filter			
	ABB type	**Schaffner type**	**ABB alternative**	**Schaffner alternative**
3-phase U_N = 230 V				
02A4-2	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
03A7-2	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
04A8-2	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
06A9-2	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
07A8-2	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
09A8-2	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
12A2-2	RFI-33	FN 3258-30-33	RFI-321	FS43566-30-33
17A5-2	RFI-33	FN 3258-30-33	RFI-321	FS43566-30-33
25A0-2	RFI-33	FN 3258-30-33	RFI-321	FS43566-30-33
033A-2	RFI-34	FN 3258-100-35	-	-
032A-2	RFI-34	FN 3258-100-35	-	-
048A-2	RFI-34	FN 3258-100-35	-	-
055A-2	RFI-34	FN 3258-100-35	-	-
3-phase U_N = 400 V				
01A8-4	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
02A6-4	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
03A3-4	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
04A0-4	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
05A6-4	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
07A2-4	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
09A4-4	RFI-32	FN 3258-16-44	RFI-311	FS43566-16-44
12A6-4	RFI-33	FN 3258-30-33	RFI-321	FS43566-30-33
17A0-4	RFI-33	FN 3258-30-33	RFI-321	FS43566-30-33
25A0-4	RFI-33	FN 3258-30-33	RFI-321	FS43566-30-33
033A-4	RFI-34	FN 3258-100-35	-	-
032A-4	RFI-34	FN 3258-100-35	-	-
038A-4	RFI-34	FN 3258-100-35	-	-
045A-4	RFI-34	FN 3258-100-35	-	-

Type ACS380-04xx-...	EMC filter			
	ABB type	Schaffner type	ABB alternative	Schaffner alternative
050A-4	RFI-34	FN 3258-100-35	-	-

1) Limited availability. Contact ABB for availability information.

See also EMC compatibility and motor cable length and EMC compliance (IEC/EN 61800-3:2004 + A1:2012) (page 186). For compliance information, refer to Category C1 (page 186).

14

Resistor braking

Contents of this chapter

The chapter describes how to select the brake resistor and cables, protect the system, connect the brake resistor, and enable resistor braking.

Safety

WARNING Do not do work on the brake resistor or the resistor cable when the drive is energized. A dangerous voltage is present in the resistor circuit, even when the brake chopper is not operating, or when it is disabled by a parameter.

Operation principle

The brake chopper handles the extra energy generated by the motor during a quick deceleration. The extra energy increases the DC link voltage of the drive. The chopper connects the brake resistor to the DC link whenever the voltage is more than the operation limit of the chopper. The energy consumed by the resistor losses lowers the voltage until it is less than the limit at which the chopper stops.

Selecting the brake resistor

Drives have a built-in brake chopper as standard equipment. The brake resistor is selected using the table and equations shown in this section.

1. Determine the required maximum braking power P_{Rmax} for the application. P_{Rmax} must be smaller than P_{BRmax}. Refer to Reference brake resistors (page 239).

2. Calculate resistance *R* with Equation 1.
3. Calculate energy E_{Rpulse} with Equation 2.
4. Select the resistor so that the following conditions are met:
   - The rated power of the resistor must be more than or equal to P_{Rmax}.
   - Resistance *R* must be between R_{min} and R_{max} given in the table for the used drive type.
   - The resistor must be able to dissipate energy E_{Rpulse} during the braking cycle *T*.

Equations for selecting the resistor:

Equation 1

When the drive supply voltage is 200 ... 240 V:

$$R = \frac{150\ 000}{P_{Rmax}}$$

When the drive supply voltage is 380 … 415 V:

$$R = \frac{450\ 000}{P_{Rmax}}$$

When the drive supply voltage is 415 ... 480 V:

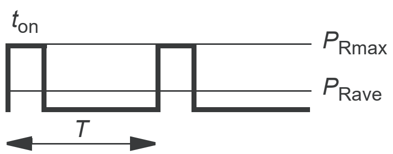
$$R = \frac{615\ 000}{P_{Rmax}}$$

Equation 2

$$E_{Rpulse} = P_{Rmax} \cdot t_{on}$$

Equation 3

$$P_{Rave} = P_{Rmax} \cdot \frac{t_{on}}{T}$$



For conversion, use 1 hp = 746 W.

R	Calculated brake resistor value (ohm). Make sure that: $R_{min} < R < R_{max}$
P_{Rmax}	Maximum power during the braking cycle (W)
P_{Rave}	Average power during the braking cycle (W)
E_{Rpulse}	Energy conducted into the resistor during a single braking pulse (J)
t_{on}	Braking time (one cycle) (s)
T	Braking cycle time (s)

NOTICE Do not use a brake resistor with a resistance that is less than the specified minimum value. It causes an overcurrent that can cause damage to the brake chopper and the drive.

Reference brake resistors

Type ACS380-04xx-…	R_{min}	R_{max}	P_{BRcont}		P_{BRmax}		Example resistor types 1) 2)
	ohm	ohm	kW	hp	kW	hp	Danotherm
1-phase U_N = 230 V							
02A4-1	32.5	468	0.25	0.33	0.38	0.50	CBH 360 C T 406 210R or CAR 200 D T 406 210R
03A7-1	32.5	316	0.37	0.50	0.56	0.74	
04A8-1	32.5	213	0.55	0.75	0.83	1.10	
06A9-1	32.5	145	0.75	1.00	1.10	1.50	CBR-V 330 D T 406 78R UL
07A8-1	32.5	96.5	1.10	1.50	1.70	2.20	
09A8-1	32.5	69.9	1.50	2.00	2.30	3.00	CBR-V 560 D HT 406 39R UL
12A2-1	19.5	47.1	2.20	3.00	3.30	4.40	
3-phase U_N = 230 V							
02A4-2	39	474	0.25	0.33	0.38	0.50	CBH 360 C T 406 210R or CAR 200 D T 406 210R
03A7-2	39	319	0.37	0.50	0.56	0.74	
04A8-2	39	217	0.55	0.75	0.83	1.10	
06A9-2	39	145	0.75	1.00	1.13	1.50	CBR-V 330 D T 406 78R UL
07A8-2	39	105	1.10	1.50	1.65	2.20	
09A8-2	20	71	1.50	2.00	2.25	3.00	CBR-V 560 D HT 406 39R UL
12A2-2	20	52	2.20	2.00	3.30	4.40	
17A5-2	16	38	3.00	3.00	4.50	6.00	CBT-H 560 D HT 406 19R
25A0-2	16	28	4.00	5.00	6.00	8.00	
033A-2	8	17	5.50	7.50	8.25	11.00	CBT-H 560 D HT 406 15R
032A-2	3	20	5.50	7.50	8.25	11.00	CBT-V 760 G H T 282 8R
048A-2	3	14	7.50	10.00	11.25	15.00	
055A-2	3	10	11.00	15.00	16.50	21.99	

Type ACS380-04xx-…	R_{min}	R_{max}	P_{BRcont}		P_{BRmax}		Example resistor types [1) 2)]
	ohm	ohm	kW	hp	kW	hp	Danotherm
3-phase U_N = 400/480 V							
01A8-4	99	933	0.37	0.50	0.56	0.74	CBH 360 C T 406 210R or CAR 200 D T 406 210R
02A6-4	99	628	0.55	0.75	0.83	1.10	
03A3-4	99	428	0.75	1.00	1.13	1.50	
04A0-4	99	285	1.10	1.50	1.65	2.20	
05A6-4	99	206	1.50	2.00	2.25	3.00	
07A2-4	53	139	2.20	2.00	3.30	4.40	CBR-V 330 D T 406 78R UL
09A4-4	53	102	3.00	3.00	4.50	6.00	
12A6-4	32	76	4.00	5.00	6.00	8.00	
17A0-4	32	54	5.50	7.50	8.25	11.00	CBT-H 560 D HT 406 39R
25A0-4	23	39	7.50	10.00	11.25	15.00	
033A-4	16	33	11.00	15.00	17	22.00	CBT-H 560 D HT 406 19R
032A-4	6	29	11.00	15.00	17	22.00	CBT-H 560 D HT 406 19R
038A-4	6	24	15.00	20.00	23	30.00	CBT-H 760 D HT 406 16R
045A-4	6	20	18.50	25.00	28	37.00	
050A-4	6	20	22.00	30.00	30	40.00	

1) Braking cycle differs from that of the drive. Refer to brake resistor manufacturer's documentation.
2) If brake resistors from other manufacturers are used, the characteristics must agree with the values in the table.

Definitions

P_{BRmax}	The maximum braking capacity of the drive, when the length of the braking pulse is at most 1 minute for each 10 minutes (P_{BRcont} × 1.5). Must be more than the desired braking power.
P_{BRcont}	The continuous braking capacity of the drive
R_{max}	The maximum resistance value of the brake resistor that can provide P_{BRcont}
R_{min}	The minimum permitted resistance value of the brake resistor

Selecting and routing the brake resistor cables

Use a shielded cable specified in the technical data.

Minimizing electromagnetic interference

Make sure that the installation complies with the EMC requirements. Obey these rules to minimize electromagnetic interference caused by the rapid voltage and current changes in the resistor cables:

- Shield the brake resistor cable. Use shielded cable or a metallic enclosure. If you use unshielded single-core cables, route them inside a cabinet that efficiently suppresses the radiated emissions.
- Install the cables away from other cable routes.
- Avoid long parallel runs with other cables. The minimum parallel cabling separation distance is 0.3 meters (1 ft).
- Cross the other cables at 90° angles.
- Keep the cable as short as possible to minimize the radiated emissions and stress on the brake chopper. A longer cable produces more radiated emissions, inductive load, and voltage peaks over the IGBT semiconductors of the brake chopper.

Maximum cable length

The maximum length of the resistor cable(s) is 10 m (33 ft).

Selecting the installation location for the brake resistors

Protect the open (IP00) brake resistors against contact. Install the brake resistor in a place where it cools effectively. Arrange the cooling of the resistor so that:

- no danger of overheating is caused to the resistor or nearby materials, and
- the temperature of the space that the resistor is in does not go above the allowed maximum value.

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

Protecting the system in brake circuit fault situations

Protecting the system in cable and brake resistor short-circuit situations

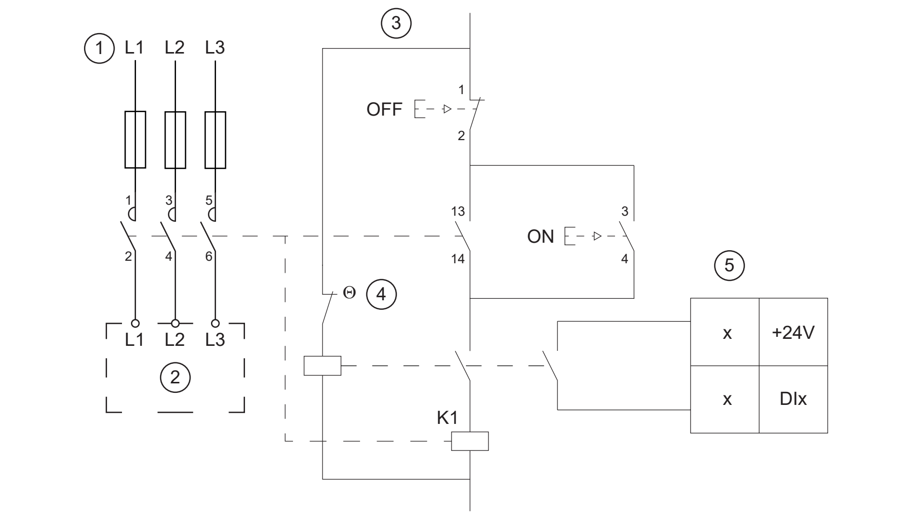
The drive input fuses also protect the resistor cable when it is identical to the input power cable.

Protecting the system against thermal overload

The drive has a brake thermal model that protects the brake resistor against overload. ABB recommends that you enable the thermal model at start up.

ABB recommends that you use a main contactor with the drive for safety reasons even when you have enabled the resistor thermal model. Connect the contactor so that it opens if the resistor overheats. This is essential for safety, since the drive will not otherwise be able to interrupt the main supply if the chopper conducts in a fault situation. The figure shows an example connection diagram. ABB recommends that you use resistors equipped with a thermal switch (1) in the resistor assembly. The switch indicates overtemperature.

ABB recommends that you connect the thermal switch to a digital input of the drive, and configure the input to cause a fault trip at resistor overtemperature indication.



1	Drive input power connection with a main contactor
2	Drive
3	Main contactor control circuit
4	Brake resistor thermal switch
5	Digital input. Monitors the brake resistor thermal switch.

Mechanical and electrical installation of brake resistor

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 electrical installation, commissioning or maintenance work.

WARNING Stop the drive and do the steps in Electrical safety precautions (page 22) before you start the work.

Mechanical installation

Refer to the resistor manufacturer's instructions.

Electrical installation

Measuring the insulation

See the electrical installation instructions of the drive.

Connecting power cables

See the electrical installation instructions of the drive.

Connection the control cables

Connect the thermal switch of the brake resistor as described in Protecting the system against thermal overload (page 242).

Start-up

Set the following parameters:

1. Disable the overvoltage control of the drive with parameter 30.30 Overvoltage control.
2. Set the source of parameter 31.01 External event 1 source to point to the digital input where the thermal switch of the brake resistor is wired.
3. Set parameter 31.02 External event 1 type to Fault.
4. Enable the brake chopper by parameter 43.06 Brake chopper enable. If Enabled with thermal model is selected, set also the brake resistor overload protection parameters 43.08 and 43.09 according to the application.
5. Check the resistance value of parameter 43.10 Brake resistance.

With these parameter settings, the drive generates a fault and coasts to a stop on brake resistor overtemperature.

15

The Safe torque off function

Contents of this chapter

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

Description

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

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

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

The Safe torque off function complies with these standards:

Standard	Name
IEC 60204-1:2021 EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
IEC 61000-6-7:2014	Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
IEC 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2017	Functional safety – Safety instrumented systems for the process industry sector
IEC 61800-5-2:2016 EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation

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

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

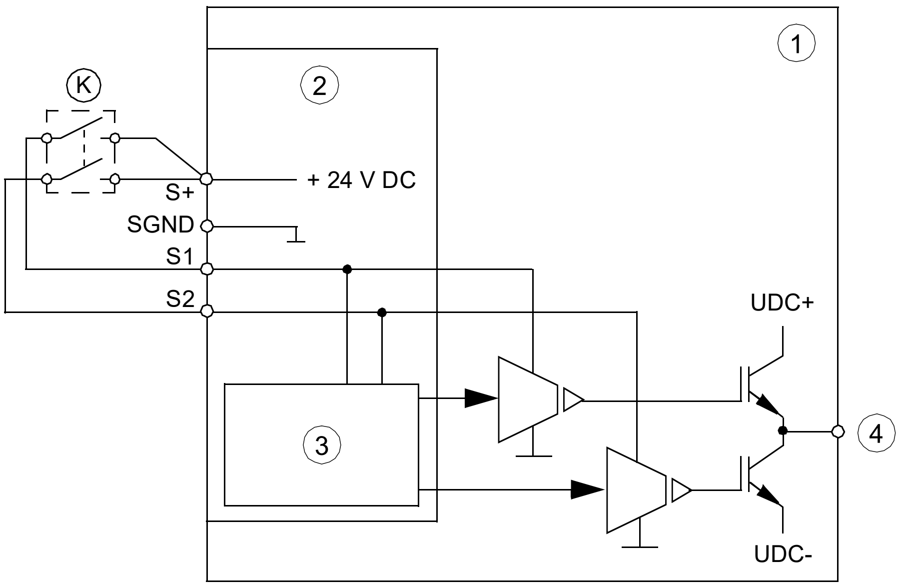
Refer to the technical data.

Wiring

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

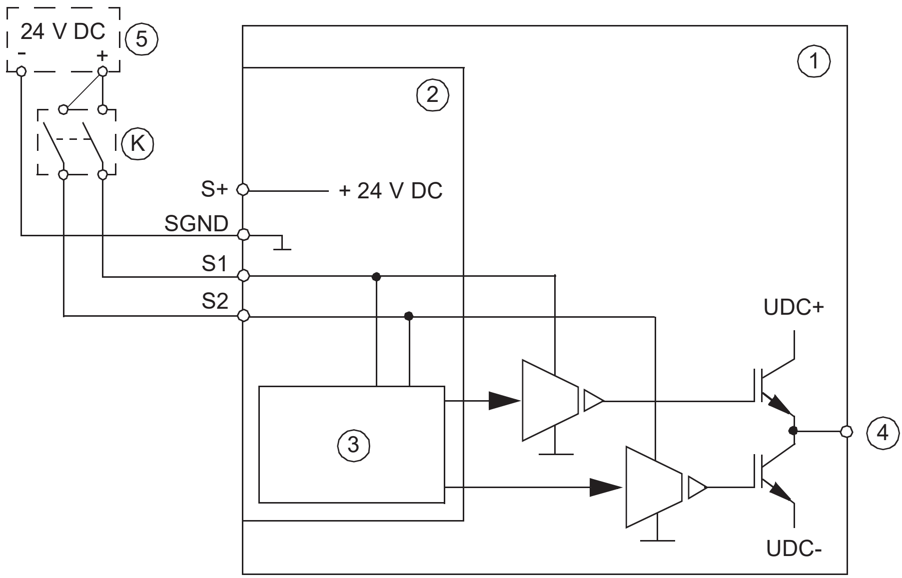
Connection principle

Single ACS380 drive, internal power supply



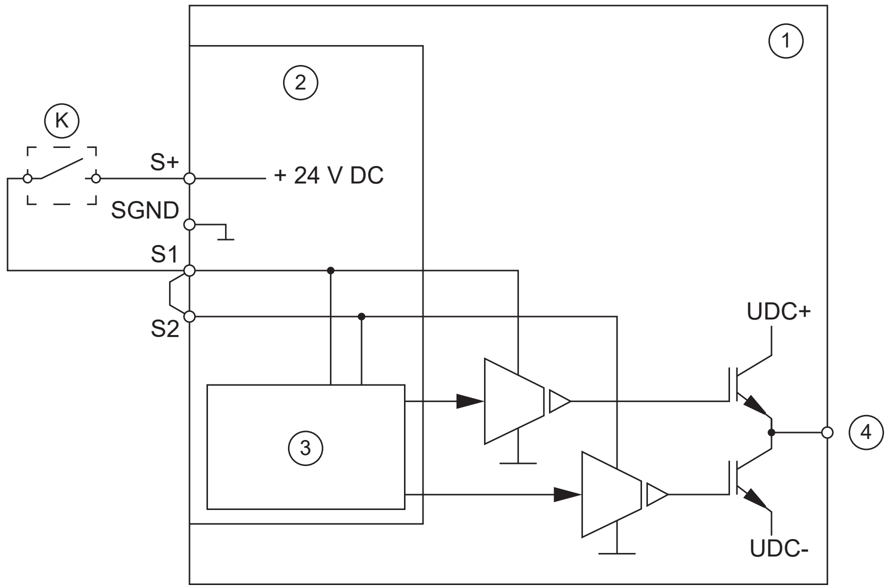
1	Drive
2	Control unit
3	Control logic
4	To motor
K	Activation switch

Single ACS380 drive, external power supply



1	Drive
2	Control unit
3	Control logic
4	To motor
5	Voltage source, maximum voltage 24 V DC +10%
K	Activation switch

Single-channel connection of activation switch



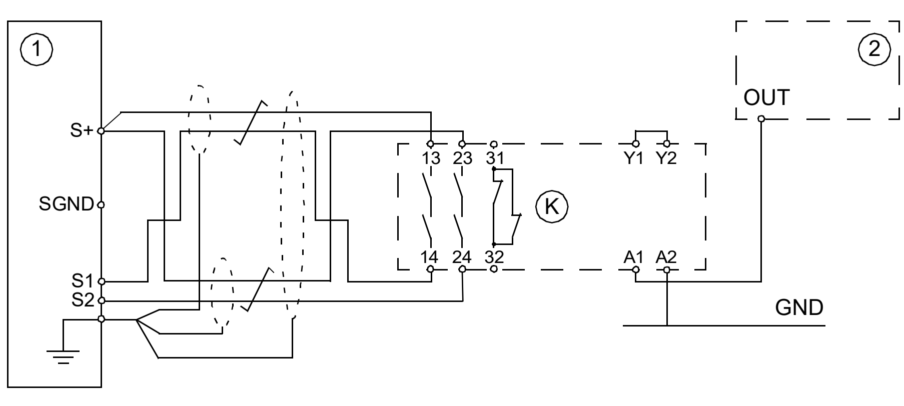
1	Drive
2	Control unit
3	Control logic
4	To motor
K	Activation switch **Note:** A single-channel activation switch can limit the SIL/PL capability of the safety function to a lower level than the SIL/PL capability of the STO function of the drive.

Note:

- Both STO inputs (S1, S2) must be connected to the activation switch. Otherwise, no SIL/PL classification is given.
- Pay special attention to prevent potential failure modes in the wiring. For example, use a shielded cable. For fault exclusion measures for wiring, refer to EN ISO 13849-2:2012, table D.4.

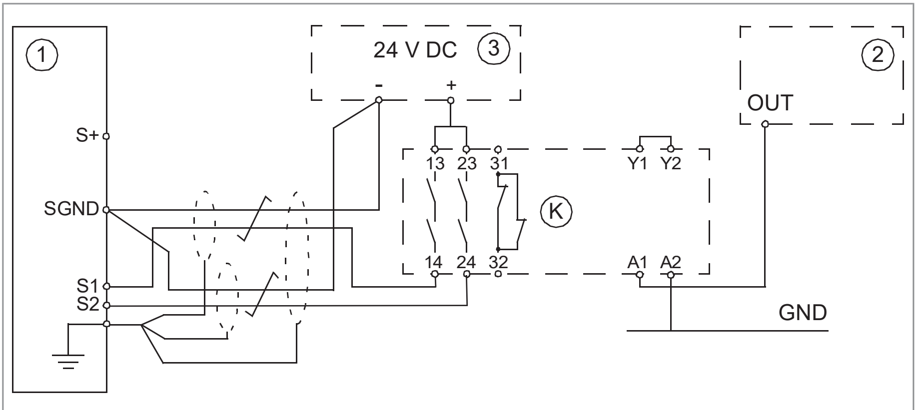
Wiring examples

Single ACS380 drive, internal power supply



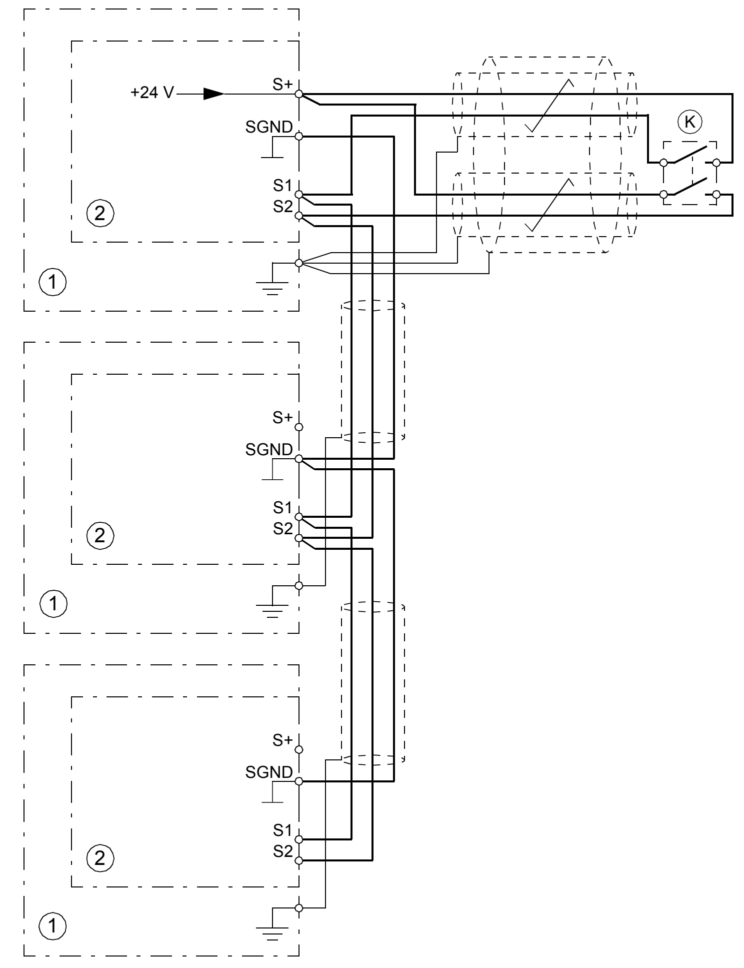
1	Drive
2	Safety PLC
K	Safety relay

Single ACS380 drive, external power supply



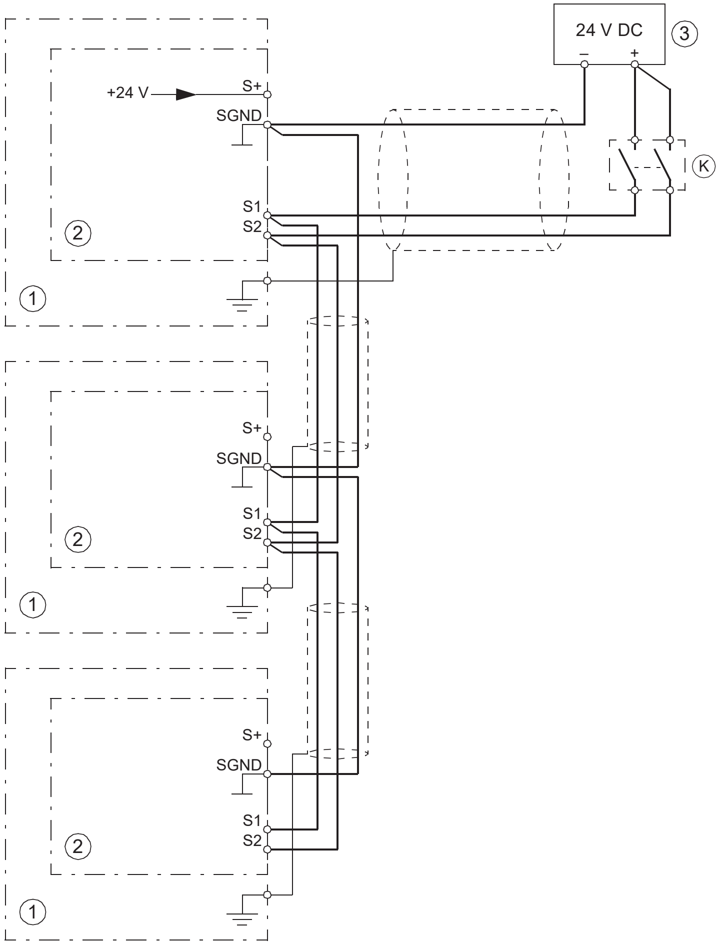
1	Drive
2	Safety PLC
3	Voltage source, maximum voltage 24 V DC +10%
K	Safety relay

Multiple ACS380 drives, internal power supply



1	Drive
2	Control unit
K	Activation switch

Multiple ACS380 drives, external power supply



1	Drive
2	Control unit
3	Voltage source, maximum voltage 24 V DC +10%
K	Activation switch

Activation switch

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

- In case a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.
- The contacts of the switch or relay must open/close within 200 ms of each other.
- An FSPS or FSCS module can also be used. For more information, see the module documentation.

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 voltage at the STO input terminals of the drive must be at least 13 V DC to be interpreted as “1”.
The pulse tolerance of the input channels is 1 ms.

Grounding of protective shields

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

Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety PLC logic output value is 0, or safety relay contacts open).
2. The STO inputs of the drive control unit de-energize.
3. The control unit cuts off the control voltage from the output IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (refer to the firmware manual of the drive).
   The parameter selects which indications are given when one or both STO signals are switched off or lost. The indications also depend on whether the drive is running or stopped when this occurs.

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

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

Start-up including 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.

If an FSCS-21 or FSPS-21 module is installed, refer to its documentation.

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.	☐

<table>
<tr><th>Action</th><th>☑</th></tr>
<tr><td>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 to 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.</td><td>☐</td></tr>
<tr><td>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 (refer to 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.</td><td>☐</td></tr>
<tr><td>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 to 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 to 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.</td><td>☐</td></tr>
<tr><td>Document and sign the validation test report which verifies that the safety function is safe and accepted for operation.</td><td>☐</td></tr>
</table>

Use

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

This is also valid when the drive is only powered by a BAPO-xx auxiliary power extension module.

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 to Safety data (page 261). 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 255).

Note: Refer also to 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 Validation test procedure (page 255).

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 to 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)
1-phase U_N = 230 V																	
R0	3	3	e	>99	8.52E-09	7.43E-05	1.86E-04	3.72E-04	1968	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R1	3	3	e	>99	8.52E-09	7.43E-05	1.86E-04	3.72E-04	1968	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R2	3	3	e	>99	8.52E-09	7.43E-05	1.86E-04	3.72E-04	1968	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
3-phase U_N = 230 V																	
R1	3	3	e	>99	7.65E-09	6.71E-05	1.68E-04	3.36E-04	2210	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R2	3	3	e	>99	7.65E-09	6.71E-05	1.68E-04	3.36E-04	2209	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R3	3	3	e	>99	7.61E-09	6.68E-05	1.67E-04	3.34E-04	2569	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R4	3	3	e	>99	7.61E-09	6.68E-05	1.67E-04	3.34E-04	2568	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
3-phase U_N = 400/480 V																	
R0	3	3	e	>99	7.65E-09	6.71E-05	1.68E-04	3.36E-04	2210	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R1	3	3	e	>99	7.65E-09	6.71E-05	1.68E-04	3.36E-04	2210	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R2	3	3	e	>99	7.65E-09	6.71E-05	1.68E-04	3.36E-04	2209	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R3	3	3	e	>99	7.61E-09	6.68E-05	1.67E-04	3.34E-04	2569	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
R4	3	3	e	>99	7.61E-09	6.68E-05	1.67E-04	3.34E-04	2568	≥90	3	1	80	20	6.29E-08	0.00E+00	9.51E-08
																	3AXD10001401865 E

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

Terms and abbreviations

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

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

TÜV certificate

The TÜV certificate is available on the Internet.

16

BTAC-02 pulse encoder interface module

Contents of this chapter

This chapter contains a description and technical data of the optional BTAC-02 pulse encoder interface module and describes how to start up the module.

Safety instructions

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

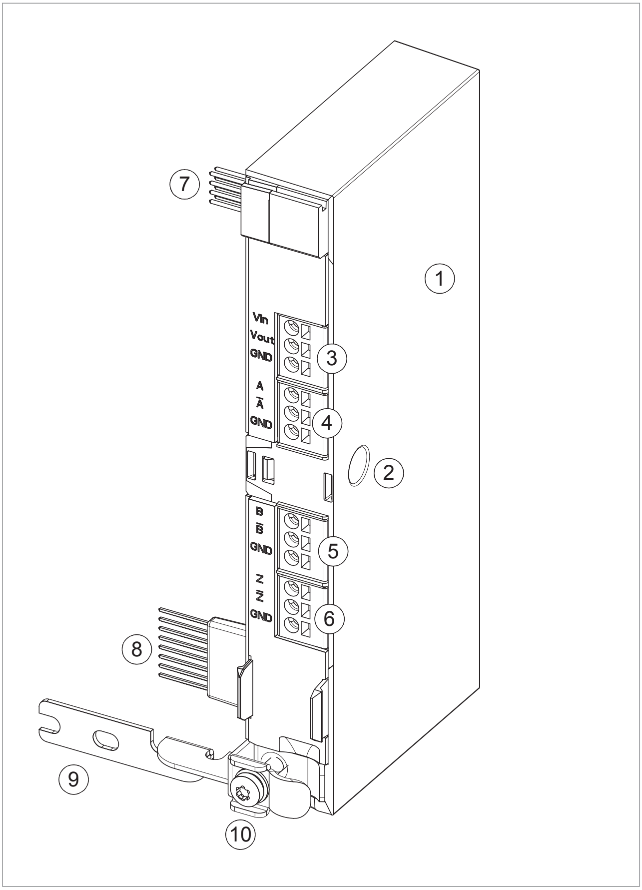
Hardware description

Product overview

The BTAC pulse encoder interface module (option +L535) adds a digital pulse encoder interface to the drive. Use a pulse encoder, if you need accurate speed or position (angle) feedback from the motor shaft. Connect the BTAC module to an external power supply to feed power to the encoder.

The BTAC module has the features of the BAPO auxiliary power extension module. It provides back-up power to the drive.

Layout



1. BTAC module
2. Locking screw hole
3. X103 connector
4. X104 connector
5. X105 connector
6. X106 connector
7. Internal X100 connector
8. Internal X102 connector
9. Grounding rail
10. Grounding screw

Mechanical installation

Refer to Installing options (page 98) and BAPO, BREL, BRES, and BTAC modules quick installation guide (3AXD50000837946 [English]).

Electrical installation

Wiring – General

Connect the pulse encoder to the BTAC module with cables as specified in this table.

<table>
<tr><th>Cable</th><th colspan="2">Maximum connector size</th><th colspan="2">Maximum cable length</th></tr>
<tr><td>4 × (2+1) double-shielded twisted pair cable with individual and overall shields</td><td>2.5 mm²</td><td>12 AWG</td><td>100 m [1)]</td><td>328 ft</td></tr>
</table>

1) If the encoder supply voltage is less than 10 V, the maximum cable length is 50 m (164 ft).

Terminal designations

The user interface of the BTAC module consists of four 1×3-pin terminal blocks.

Use this table for reference when you wire the BTAC module and encoder terminals.

<table>
<tr><th colspan="4">Identification</th><th rowspan="2">Description</th></tr>
<tr><th>BTAC</th><th colspan="3">Encoder</th></tr>
<tr><td colspan="4">X103</td><td></td></tr>
<tr><td>VIN</td><td colspan="3">V_{cc}/PWR</td><td>Encoder power supply input</td></tr>
<tr><td>VOUT</td><td colspan="3">V_{cc}/PWR</td><td>Encoder power passthrough output</td></tr>
<tr><td>GND</td><td colspan="3">0 V / GND</td><td>Encoder ground</td></tr>
<tr><td colspan="4">X104</td><td></td></tr>
<tr><td>A</td><td>1</td><td>A</td><td>A+</td><td>Encoder signal A + terminal</td></tr>
<tr><td>A-</td><td>1-</td><td>A-</td><td>A-</td><td>Encoder signal A - terminal</td></tr>
<tr><td>GND</td><td>-</td><td>-</td><td>-</td><td>Encoder ground</td></tr>
<tr><td colspan="4">X105</td><td></td></tr>
<tr><td>B</td><td>2</td><td>B</td><td>B+</td><td>Encoder signal B + terminal</td></tr>
<tr><td>B-</td><td>2-</td><td>B-</td><td>B-</td><td>Encoder signal B - terminal</td></tr>
<tr><td>GND</td><td>-</td><td>-</td><td>-</td><td>Encoder ground</td></tr>
<tr><td colspan="4">X106</td><td></td></tr>
<tr><td>Z</td><td>3</td><td>Z</td><td>Z+</td><td>Encoder signal Z + terminal</td></tr>
<tr><td>Z-</td><td>3-</td><td>Z-</td><td>Z-</td><td>Encoder signal Z - terminal</td></tr>
<tr><td>GND</td><td>-</td><td>-</td><td>-</td><td>Encoder ground</td></tr>
</table>

<table>
<tr><th colspan="4">Channels</th><th rowspan="2">Description</th></tr>
<tr><th>BTAC</th><th colspan="3">Encoder</th></tr>
<tr><td>A</td><td>1</td><td>A</td><td>A+</td><td rowspan="6">

Maximum signal frequency: 200 kHz
Signal levels:

<table>
<tr><td>Encoder supply voltage</td><td>Logic “1”</td><td>Logic “0”</td></tr>
<tr><td>5 V</td><td>>2.5 V</td><td><1.9 V</td></tr>
<tr><td>15 V</td><td>>7.5 V</td><td><5.3 V</td></tr>
<tr><td>24 V</td><td>>12.1 V</td><td><8.3 V</td></tr>
</table>

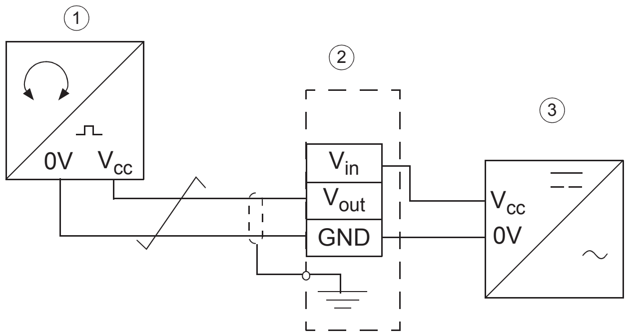
Decision levels are automatically defined based on the daisy chained power supply voltage level.
Input channels are isolated from the logic and ground.
When the drive runs in the Forward direction, channel A should lead channel B by 90° (electrical).
Channel Z: One pulse per revolution (used in positioning applications only).

</td></tr>
<tr><td>A-</td><td>1-</td><td>A-</td><td>A-</td></tr>
<tr><td>B</td><td>2</td><td>B</td><td>B+</td></tr>
<tr><td>B-</td><td>2-</td><td>B-</td><td>B-</td></tr>
<tr><td>Z</td><td>3</td><td>Z</td><td>Z+</td></tr>
<tr><td>Z-</td><td>3-</td><td>Z-</td><td>Z-</td></tr>
</table>

Wiring – Encoder power supply interface

Connect the encoder power supply through the BTAC module. The same power supply feeds power to the signal interface of the BTAC module.

If the encoder power supply is not connected through the BTAC module, a separate power supply must be connected to BTAC module X103 V_{in} connector, which has the same voltage level that is used in the encoder.



1	Encoder
2	BTAC module
3	Encoder power supply

When using a 24 V encoder, it is possible to supply power to the encoder and BTAC module from the 24 V DC auxiliary power output of the drive. If you supply power from the auxiliary power output, make sure that you do not exceed the maximum load capacity.

Use the following table to determine if you can use the auxiliary power output. Add the missing values and calculate the sum. The sum must be less than (or equal to) the maximum output current of the auxiliary power output. For the maximum output current, see the drive technical data.

Loads with the drive 24 V DC auxiliary voltage output			mA
Number of digital inputs used		× 15 mA each	
BTAC-02			50 mA
Encoder current requirement			
Requirements for other user connection(s) to drive 24 V DC auxiliary voltage output			
Total			

Wiring – Encoder

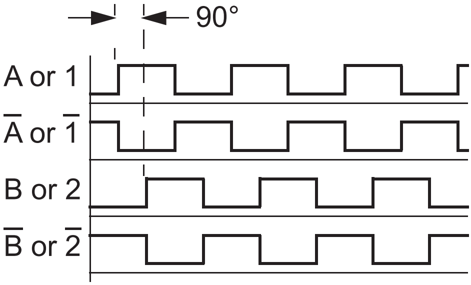
1. Remove the connector cover.
2. Determine the encoder wiring configuration:
   - Refer to Phasing (page 269) to determine if the encoder has a normal pulse order – encoder channel A pulse leads channel B pulse.
   - Refer to Encoder output types (page 270) to determine the encoder output type.
   - For push-pull types, refer to the manufacturer's recommendation for the connection. You can use single-ended or differential output.
3. Refer to Wiring diagrams – Push-pull type encoder output (page 271), Wiring diagrams – Open collector (sinking) encoder output (page 273) or Wiring diagrams – Open emitter (sourcing) encoder output (page 274) to select the applicable diagram, and wire the encoder.

   Obey these guidelines:
   - Normally, ground the cable shield only at the drive end.
   - Do not route the encoder cables in parallel to power cables (for example, motor cables).
4. Make sure that the encoder phasing is correct. Refer to Phasing (page 269).

Phasing

When the encoder is connected correctly, running the drive in the Forward (positive speed reference) direction should produce a positive encoder speed feedback.

Option A: **Oscilloscope test**. On incremental encoders, the two output channels, typically A and B or 1 and 2, are 90° (in phase) apart from each other. When motor rotates clockwise, in most encoders channel A leads channel B. To determine the leading channel, refer to the encoder documentation or use an oscilloscope.



The diagram shows normal phasing: Pulse A leads (rises earlier than) pulse B.

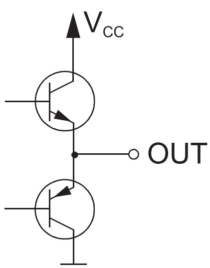
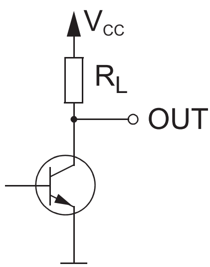
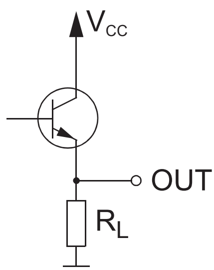
Connect the encoder output channel that leads when the drive runs Forward to BTAC terminal A. Connect the output channel that trails to BTAC terminal B.

Option B: Functional test

For this test:

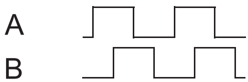
- Temporarily, switch the drive to the scalar mode. Set parameter 99.04 Motor control mode to 1 (SCALAR).
- Run the drive in the forward direction.
- Make sure that the value of parameter 90.13 Encoder 1 revolution extension increases.
- If the value of parameter 90.13 Encoder 1 revolution extension decreases, switch the A+/A- (or 1+/1-) connections.

Encoder output types

Push-pull	Open collector (sinking)	Open emitter (sourcing)
		
V_{CC} = Encoder input power supply voltage R_L = Load resistor at encoder output channel		

Wiring diagrams – Push-pull type encoder output

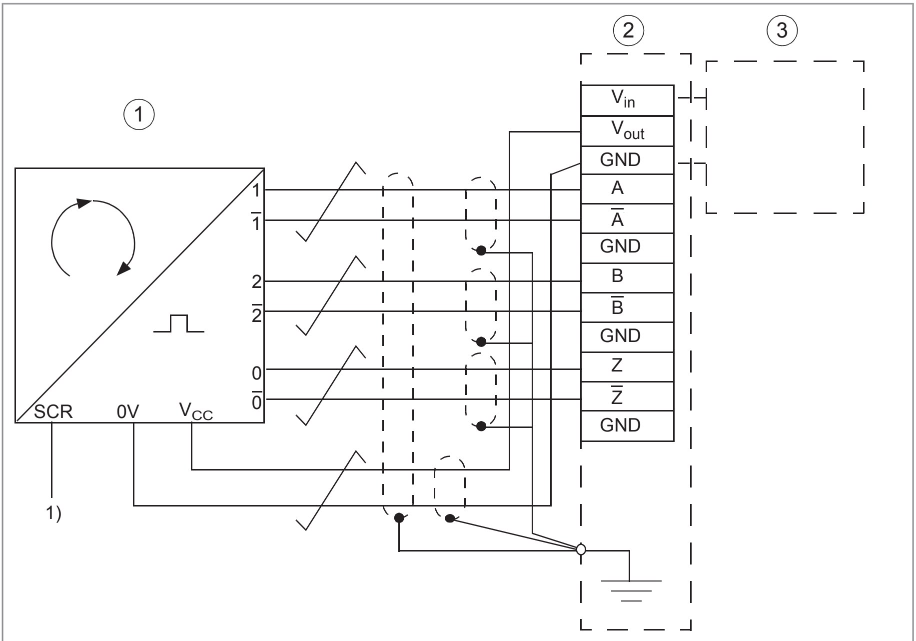
Diagram assumes normal pulse order in Forward rotation: Pulse A leads.



For encoders with pulse B leading, change the diagram:

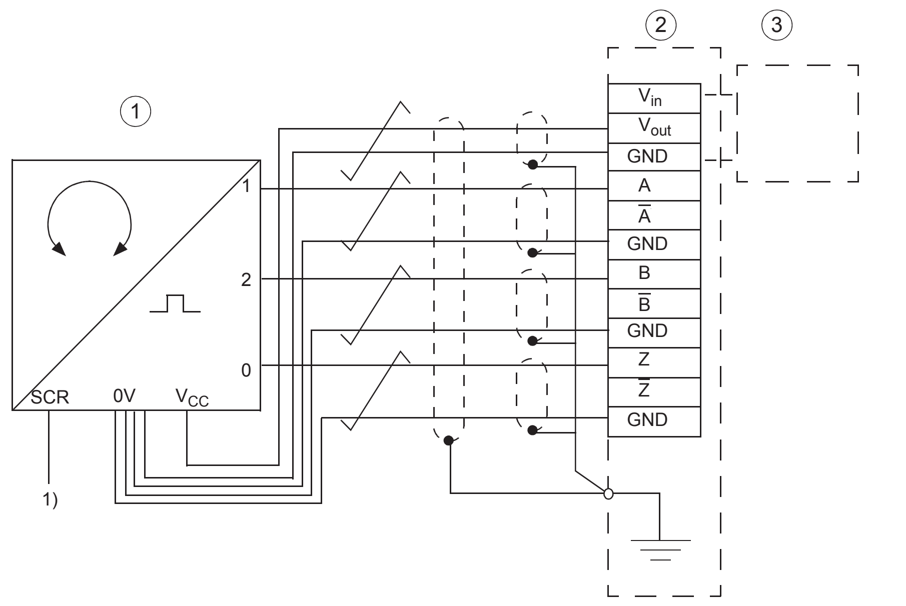
- Wire encoder A and B to BTAC terminals B and A, respectively.
- Wire encoder A- and B- (if present) to BTAC terminals B- and A-, respectively.

Differential connection



1	Encoder
2	BTAC module
3	Encoder power supply

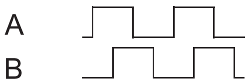
Single-ended connection



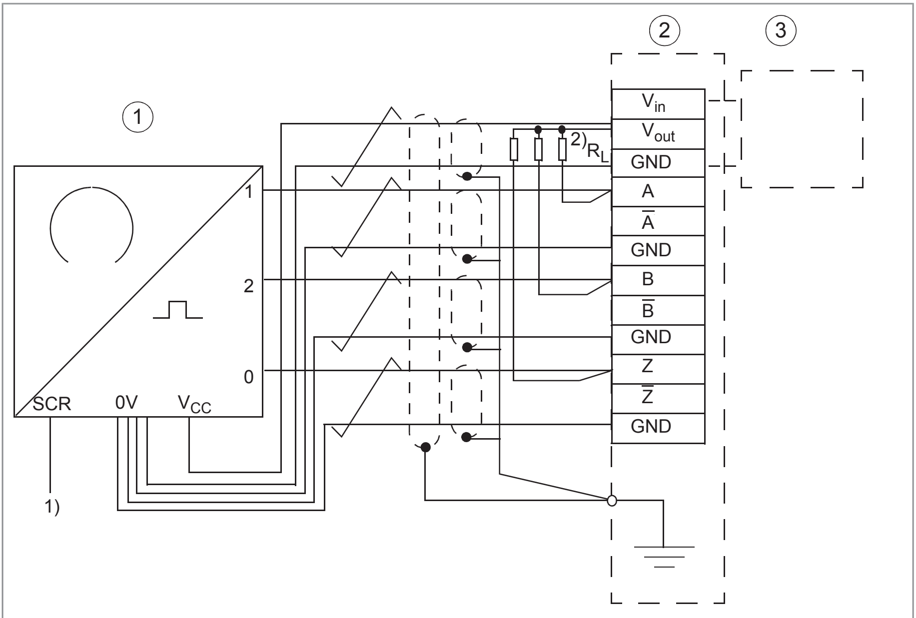
1	Encoder
2	BTAC module
3	Encoder power supply

Wiring diagrams – Open collector (sinking) encoder output

Diagram assumes normal pulse order in Forward rotation: Pulse A leads.



For encoders with pulse B leading, change the diagram: Wire encoder A and B to BTAC terminals B and A, respectively.



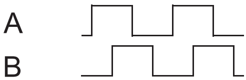
1	Encoder
2	BTAC module
3	Encoder power supply
4	Three identical resistors

The resistor size depends on the encoder power supply $V_{in} = V_{OUT}$:

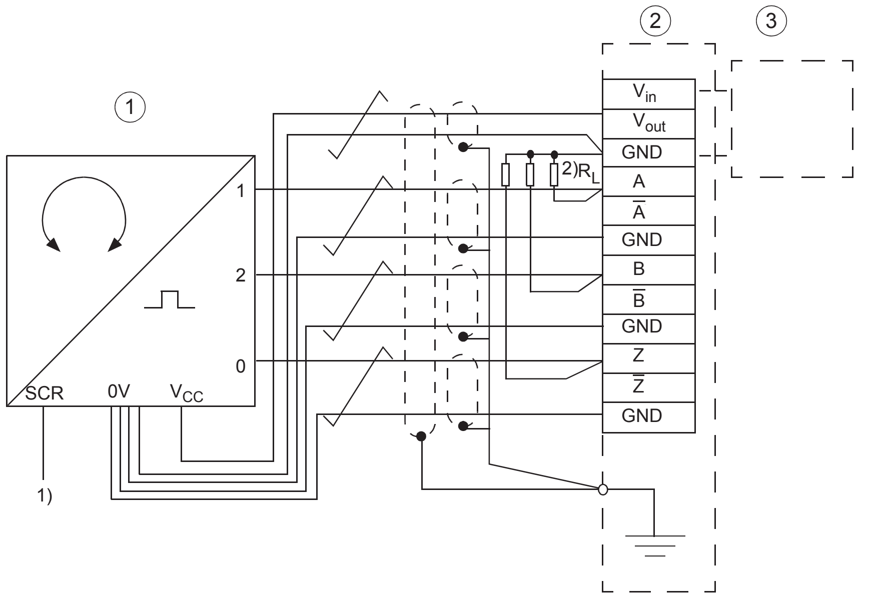
V_{in}= 30 V	R_L = 2.7…3.0 kohm, 0.5 W
V_{in}= 24 V	R_L = 1.8…2.2 kohm, 0.5 W
V_{in}= 15 V	R_L = 1.0…1.5 kohm, 0.5 W
V_{in}= 5 V	R_L = 390…470 kohm, 0.125 W

Wiring diagrams – Open emitter (sourcing) encoder output

Diagram assumes normal pulse order in Forward rotation: Pulse A leads.



For encoders with pulse B leading, change the diagram: Wire encoder A and B to BTAC terminals B and A, respectively.



1	Encoder
2	BTAC module
3	Encoder power supply
4	Three identical resistors

The resistor size depends on the encoder power supply $V_{in} = V_{OUT}$:

V_{in}= 30 V	R_L = 2.7…3.0 kohm, 0.5 W
V_{in}= 24 V	R_L = 1.8…2.2 kohm, 0.5 W
V_{in}= 15 V	R_L = 1.0…1.5 kohm, 0.5 W
V_{in}= 5 V	R_L = 390…470 kohm, 0.125 W

Apply power

1. Turn on the input power to the drive.
2. Continue with Start-up.

Start-up

To configure the operation of the BTAC module:

1. Power up the drive.
2. Set parameters in groups 90 Feedback selection, 91 Encoder adapter settings and 92 Encoder 1 configuration. These parameters display the configuration of the encoder interface modules.

Feedback selection

Use these parameters to select feedback or display feedback from the encoder.

No.	Name/Value	Description	Def/FbEq16/32
86 Axis position			
86.04	Encoder 1 position	Displays the actual absolute position of encoder 1, using the resolution defined by parameter 86.11 Enc1 increments per revolution. The position value is based on values from parameters 90.11 Encoder 1 position and 90.13 Encoder 1 revolution extension. This parameter is read-only	-
	-2 147 483 648 … 2 147 483 647	Absolute position of encoder 1.	1 = 1 (the 16 lowest bits)
86.11	Enc1 increments per revolution	Defines the resolution of encoder 1 in increments per revolution.	4096
	0 … 2 000 000 000 increments	Resolution of encoder 1.	1 = 1 increment
90 Feedback selection			
90.01	Motor speed for control	Displays the estimated or measured motor speed that is used for motor control, ie. final motor speed feedback selected by parameter 90.41 Motor feedback selection and filtered by 90.42 Motor speed filter time. This parameter is read-only.	-

No.	Name/Value	Description	Def/FbEq16/32
	-32768…32767	Motor speed used for control.	1=1 rpm/100=1 rpm
90.02	Motor position	Displays the motor position (within one revolution) received from the source selected by parameter 90.41 Motor feedback selection.	
	0 … 1 rev	Motor position.	32767=1 rev/100000000=1 rev
90.10	Enc1 speed	Displays encoder 1 speed in rpm. This parameter is read-only.	-
	-32768…32767	Encoder 1 speed.	1=1 rpm/100=1 rpm
90.11	Enc1 position	Displays the actual position of encoder 1 within one revolution. This parameter is read-only.	-
	0 … 1 rev	Encoder 1 position within one revolution.	32767=1 rev/100000000=1 rev
90.13	Enc1 revol extension	Displays the revolution counter extension. The counter is incremented when encoder position wraps around in the positive direction, and decremented in the negative direction. The parameter is effective only if the position is absolute.The parameter value is updated for both singleturn and multiturn encoders. This parameter is read-only.	na/1=1
90.41	Motor feedback sel	Selects the source of motor speed and motor position used as feedbacks for speed control and motor model.	estimate
	estimate	A calculated speed estimate	0
	Encoder 1	Actual speed measured by encoder 1.	1
90.42	Motor speed filt time	Defines a filter time for motor speed feedback used for control.	3 ms
	0 … 10000 ms	Motor speed filter time.	1=1 ms/1=1 ms
90.45	Motor feedback fault	Selects how the drive reacts to loss of measured motor feedback.	Fault
	Fault	Drive trips on a 7301 Motor speed feedback fault.	0

No.	Name/Value	Description	Def/FbEq16/32
	Warning	Drive generates a A7B0 Motor speed feedback warning and continues operation using estimated feedbacks. **Note:** Before using this setting, test the stability of the speed control loop with estimated feedback by running the drive on estimated feedback (see 90.41 Motor feedback sel).	1
90.46	Force open loop	Defines the speed feedback used for motor control.	No
	No	The motor model uses the feedback selected by 90.41 Motor feedback sel.	0
	Yes	The motor model uses the calculated speed estimate (regardless of the setting of 90.41 Motor feedback sel, which in this case only selects the source of feedback for the speed controller).	1
90.47	Enable motor encoder drift detection	Enables motor encoder drift detection.	Yes
	No	Does not generate an error if encoder drift is detected.	0
	Yes	Generates fault 7301 Motor speed feedback if encoder drift is detected.	1

Encoder adapter settings

These parameters display the configuration of the encoder interface modules.

No.	Name/Value	Description	Def/FbEq16/32
91 Enc adapter settings			
91.10	Enc par refresh	Validates any changed encoder interface module parameters. This is needed for any parameter changes in groups 90…92 to take effect. After refreshing, the value reverts automatically to Done. **Note:** The parameter cannot be changed while the drive is running.	Done
	Done	Refreshing done.	0
	Configure	Refreshing.	1

Encoder configuration

This parameter group selects the settings for the encoder

No.	Name/Value	Description	Def/FbEq16/32
92 Encoder 1 configuration			
92.10	Pulses/rev	Defines the TTL or HTL pulse number per revolution.	32
	0…65535		1=1
92.20	Encoder cable fault func	Enables encoder cable fault functionality. **Note:** This parameter affects only with BTAC-02, not with BTAC-03 or BRES. Parameter affects only to software level cable fault detection, not onto hardware level protection.	Enable
	Disable	Encoder cable fault functionality is disabled	0
	Enable	Encoder cable fault functionality is enabled	1

Diagnostics

With parameter 90.45 Motor feedback fault, you can select how the drive reacts when it detects that the encoder signal is lost.

- 90.45 = 0 (Fault) – The drive generates a fault (7301 Motor speed feedback), and the motor coasts to a stop.
- 90.45 = 1 (Warning) – The drive generates a warning (A7B0 Motor speed feedback) and continues operation using estimated feedbacks.

If the drive generates this fault or warning:

Code (hex)	**Fault/Warning**	**Cause**
7301	Motor speed feedback	No motor speed feedback is received
	4	Drift detected. Check for slippage between encoder and motor.
	3FC	Incorrect motor feedback configuration
	3FD	Incorrect motor speed
A7B0	Motor speed feedback	No motor speed feedback is received
	4	Encoder drift detected. Check for slippage between encoder and motor.
	3FC	Incorrect motor feedback configuration
	3FD	Incorrect motor speed

Technical data

Encoder interface

The encoder user interface is isolated with reinforced insulation from the DC potential.

Encoder type

- Incremental, TTL/HTL encoders
- Differential, single-ended, open collector, and open emitter encoder outputs (refer to Encoder output types (page 270))
- Three channels A, B and Z
- Maximum pulse frequency: 200 kHz
- Encoder power supply range: 5…30 V

Encoder interface connectors

Four 3-pin (1×3) spring-clamp type terminal blocks, tin plated, 2.5 mm^2 wire size (14 AWG), pitch 5.0 mm.

Cable

The maximum permitted cable length is 100 m (328 ft).

Encoder and BTAC module power supply

- 50 mA (BTAC) + encoder current consumption (refer to the encoder data sheet)
- Voltage: 5…30 V DC (Depends on the encoder. Refer to the encoder data sheet.)

Back-up power supply for the drive

Refer to electrical installation instructions.

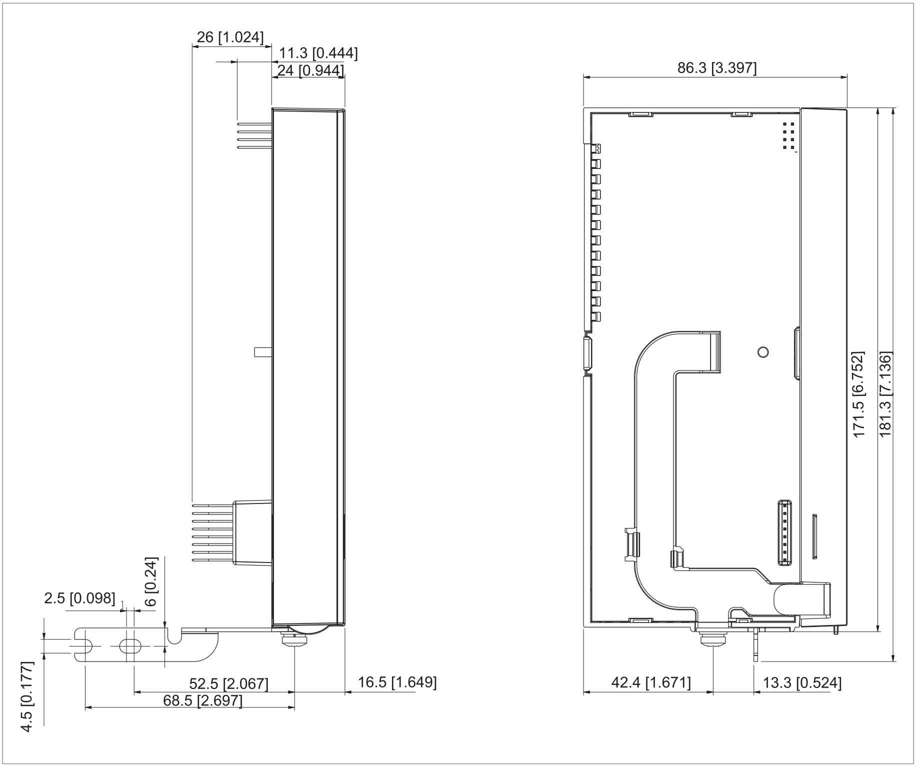
Internal connectors

Connector X102 provides encoder interface signals to the drive control board. Connector X102 data: 1×8 pin header, pitch 2.54 mm, height 33.53 mm.

Connector X100 serves as power supply interface between the BTAC module and the drive's control board. It provides back-up power supply in main power loss situations.

Connector X100 data: 2×4 pin header, pitch 2.54 mm, height 15.75 mm.

Dimensions


26 [1.024]
11.3 [0.444]
24 [0.944]
2.5 [0.098]
6 [0.24]
4.5 [0.177]
52.5 [2.067]
68.5 [2.697]
16.5 [1.649]
86.3 [3.397]
171.5 [6.752]
181.3 [7.136]
42.4 [1.671]
13.3 [0.524]

17

BTAC-03 pulse encoder interface module

Contents of this chapter

This chapter contains a description and technical data of the optional BTAC-03 pulse encoder interface module and describes how to start up the module.

Safety instructions

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

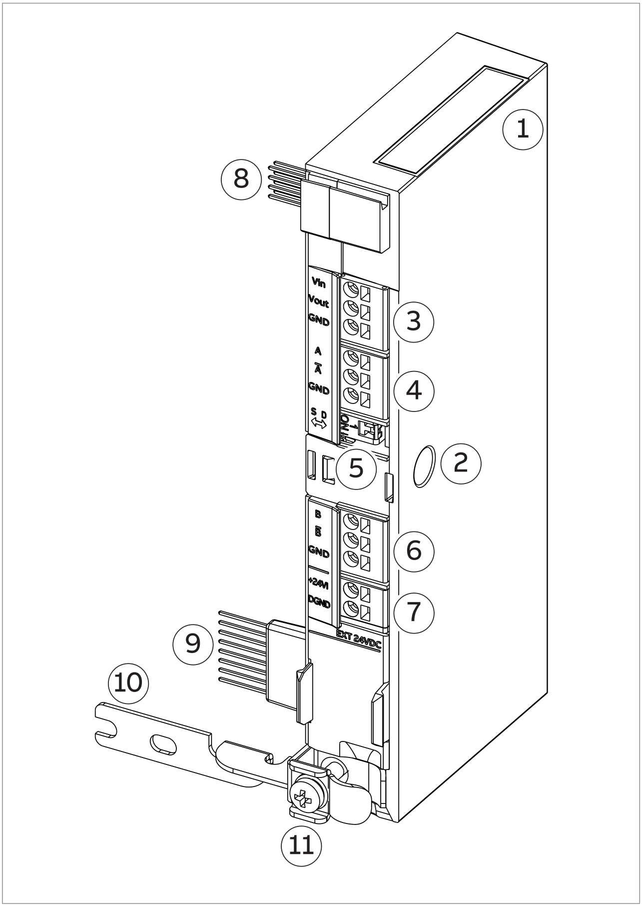
Hardware description

Product overview

The BTAC pulse encoder interface module (ordering code: 3AXD50001249298) adds a digital pulse encoder interface to the drive. Use a pulse encoder, if you need accurate speed or position (angle) feedback from the motor shaft. Connect the BTAC module to an external power supply to feed power to the encoder.

The BTAC module has the features of the BAPO auxiliary power extension module. It provides back-up power to the drive.

Layout



1. BTAC-03 module
2. Locking screw hole
3. X103 connector
4. X104 connector
5. Selection switch for differential signals
6. X105 connector
7. X101 connector
8. Internal X100 connector
9. Internal X102 connector
10. Grounding rail
11. Grounding screw

Mechanical installation

Refer to Installing options (page 98) and BAPO, BREL, BRES, and BTAC modules quick installation guide (3AXD50000837946 [English]).

Electrical installation

Wiring – General

Connect the pulse encoder to the BTAC module with cables as specified in this table.

Cable	Maximum connector size		Maximum cable length	
3 × (2+1) double-shielded twisted pair cable with individual and overall shields	2.5 mm^2	12 AWG	100 m [1)]	328 ft

1) If the encoder supply voltage is less than 10 V, the maximum cable length is 50 m (164 ft).

Terminal designations

The user interface of the BTAC module consists of four 1×3-pin terminal blocks.

Use this table for reference when you wire the BTAC module and encoder terminals.

Identification				Description
BTAC	**Encoder**			
X103				
VIN	V_{cc}/PWR			Encoder power supply input
VOUT	V_{cc}/PWR			Encoder power passthrough output
GND	0 V / GND			Encoder ground
X104				
A	1	A	A+	Encoder signal A + terminal
A-	1-	A-	A-	Encoder signal A - terminal
GND	-	-	-	Encoder ground
X105				
B	2	B	B+	Encoder signal B + terminal
B-	2-	B-	B	Encoder signal B - terminal
GND	-	-	-	Encoder ground
X101				
+24VI				External 24 V supply for ACS380 (+24 V)
DGND				External 24 V supply for ACS380 (ground)

<table>
<tr><th colspan="4">Channels</th><th rowspan="2">Description</th></tr>
<tr><th>BTAC</th><th colspan="3">Encoder</th></tr>
<tr><td>A</td><td>1</td><td>A</td><td>A+</td><td rowspan="4">

Maximum signal frequency: 200 kHz
Signal levels:

<table>
<tr><td>Encoder supply voltage V_{CC}</td><td>Logic “1”</td><td>Logic “0”</td></tr>
<tr><td>5 V</td><td>>2/3 V_{CC}</td><td><1/3 VCC</td></tr>
<tr><td>15 V</td><td>>2/3 V_{CC}</td><td><1/3 VCC</td></tr>
<tr><td>24 V</td><td>>2/3 V_{CC}</td><td><1/3 VCC</td></tr>
</table>

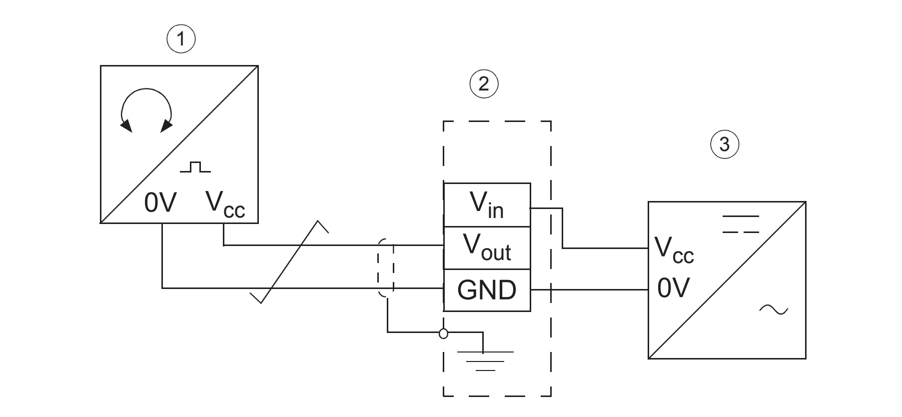
Decision levels are automatically defined based on the daisy-chained power supply voltage level.
Input channels are isolated from the logic and ground.
When the drive runs in the Forward direction, channel A should lead channel B by 90° (electrical).
Voltage range between Logic "1" and Logic "0" is considered as cable fault

</td></tr>
<tr><td>A-</td><td>1-</td><td>A-</td><td>A-</td></tr>
<tr><td>B</td><td>2</td><td>B</td><td>B+</td></tr>
<tr><td>B-</td><td>2-</td><td>B-</td><td>B-</td></tr>
</table>

Wiring – Encoder power supply interface

Connect the encoder power supply through the BTAC module. The same power supply feeds power to the signal interface of the BTAC module.

If the encoder power supply is not connected through the BTAC module, a separate power supply must be connected to BTAC module X103 V_{in} connector, which has the same voltage level that is used in the encoder.



1	Encoder
2	BTAC module
3	Encoder power supply

When using a 24 V encoder, it is possible to supply power to the encoder and BTAC module from the 24 V DC auxiliary power output of the drive. If you supply power from the auxiliary power output, make sure that you do not exceed the maximum load capacity.

Use the following table to determine if you can use the auxiliary power output. Add the missing values and calculate the sum. The sum must be less than (or equal to) the maximum output current of the auxiliary power output. For the maximum output current, see the drive technical data.

Loads with the drive 24 V DC auxiliary voltage output			mA
Number of digital inputs used		× 15 mA each	
BTAC-03			50 mA
Encoder current requirement			
Requirements for other user connection(s) to drive 24 V DC auxiliary voltage output			
Total			

Wiring – Encoder

1. Remove the connector cover.
2. Determine the encoder wiring configuration:
   - Refer to Phasing (page 288) to determine if the encoder has a normal pulse order – encoder channel A pulse leads channel B pulse.

- Refer to Encoder output types (page 289) to determine the encoder output type.
- For push-pull types, refer to the manufacturer's recommendation for the connection. You can use single-ended or differential output.

3. Refer to Wiring diagrams – Push-pull type encoder output (page 289), Wiring diagrams – Open emitter (sourcing) encoder output (page 292) or Wiring diagrams – Open collector (sinking) encoder output (page 291) to select the applicable diagram, and wire the encoder.

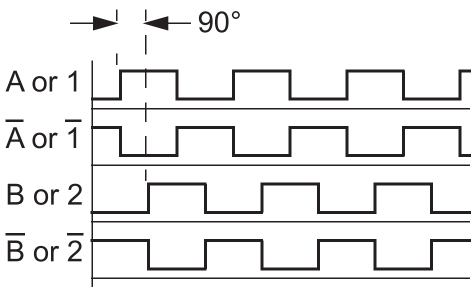
   Obey these guidelines:
   - Normally, ground the cable shield only at the drive end.
   - Do not route the encoder cables in parallel to power cables (for example, motor cables).

4. Make sure that the encoder phasing is correct. Refer to Phasing (page 288).

Phasing

When the encoder is connected correctly, running the drive in the Forward (positive speed reference) direction should produce a positive encoder speed feedback.

Option A: **Oscilloscope test**. On incremental encoders, the two output channels, typically A and B or 1 and 2, are 90° (in phase) apart from each other. When motor rotates clockwise, in most encoders channel A leads channel B. To determine the leading channel, refer to the encoder documentation or use an oscilloscope.



The diagram shows normal phasing: Pulse A leads (rises earlier than) pulse B.

Connect the encoder output channel that leads when the drive runs Forward to BTAC terminal A. Connect the output channel that trails to BTAC terminal B.

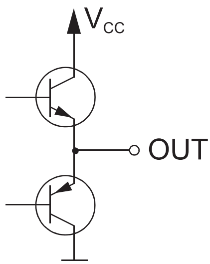
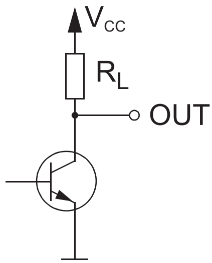
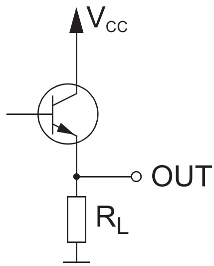
Option B: Functional test

For this test:

- Temporarily, switch the drive to the scalar mode. Set parameter 99.04 Motor control mode to 1 (SCALAR).
- Run the drive in the forward direction.

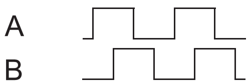
- Make sure that the value of parameter 90.13 Encoder 1 revolution extension increases.
- If the value of parameter 90.13 Enconder 1 revolution extension **decreases**, switch the A+/A- (or 1+/1-) connections.

Encoder output types

Push-pull	Open collector* (sinking)	Open emitter* (sourcing)
		
V_{CC} = Encoder input power supply voltage R_L = Load resistor at encoder output channel *) Cable fault diagnostics are working properly only with push-pull type of encoder. Make sure that the selection switch for differential signals is on the single-ended mode with open collector and open emitter types.		

Wiring diagrams – Push-pull type encoder output

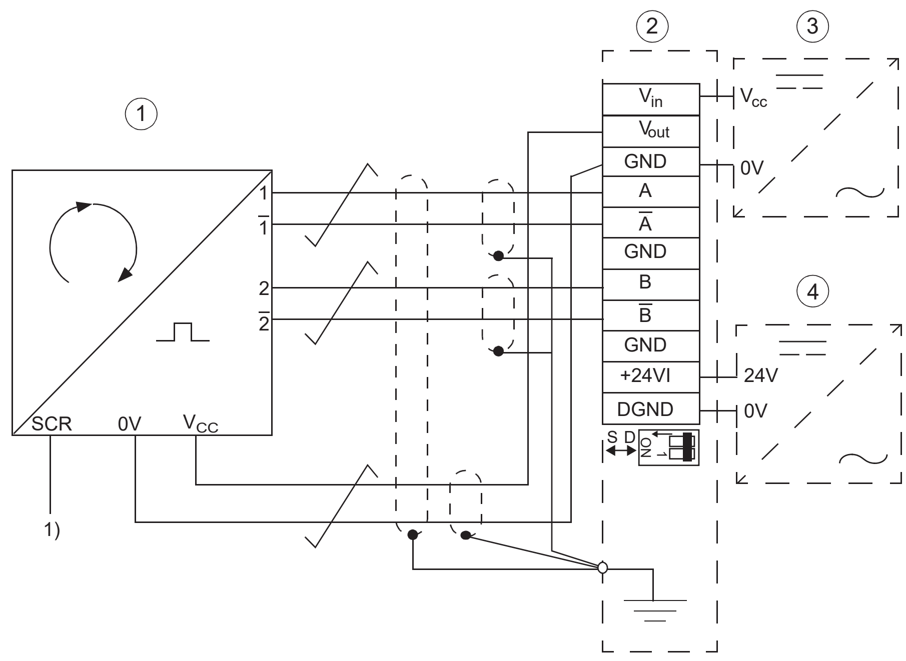
Diagram assumes normal pulse order in Forward rotation: Pulse A leads.



For encoders with pulse B leading, change the diagram:

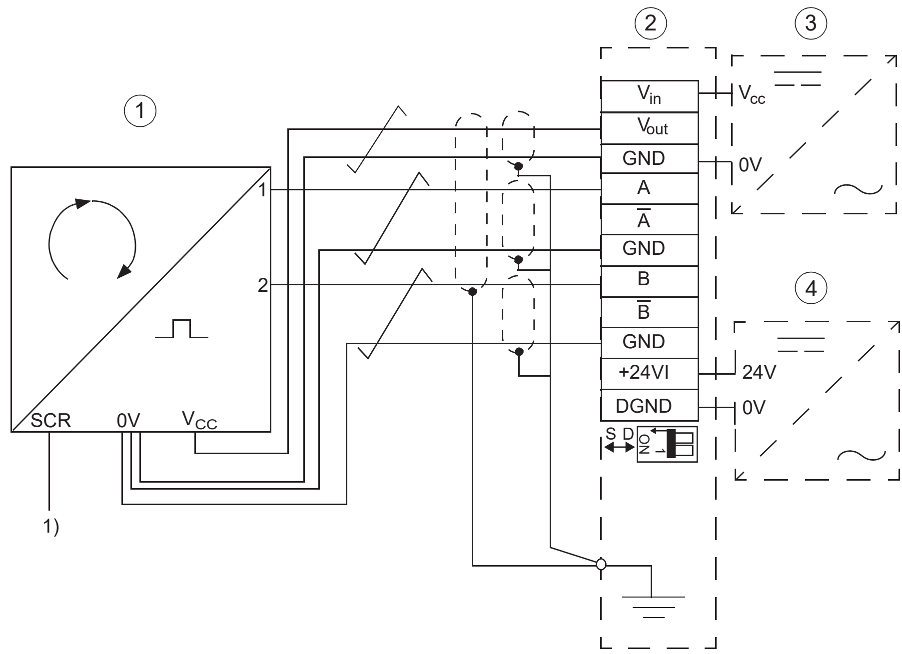
- Wire encoder A and B to BTAC terminals B and A, respectively.
- Wire encoder A- and B- (if present) to BTAC terminals B- and A-, respectively.

Differential connection



1	Encoder
2	BTAC module
3	Encoder power supply
4	Auxiliary voltage supply for the drive (optional)

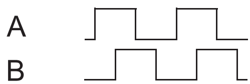
Single-ended connection



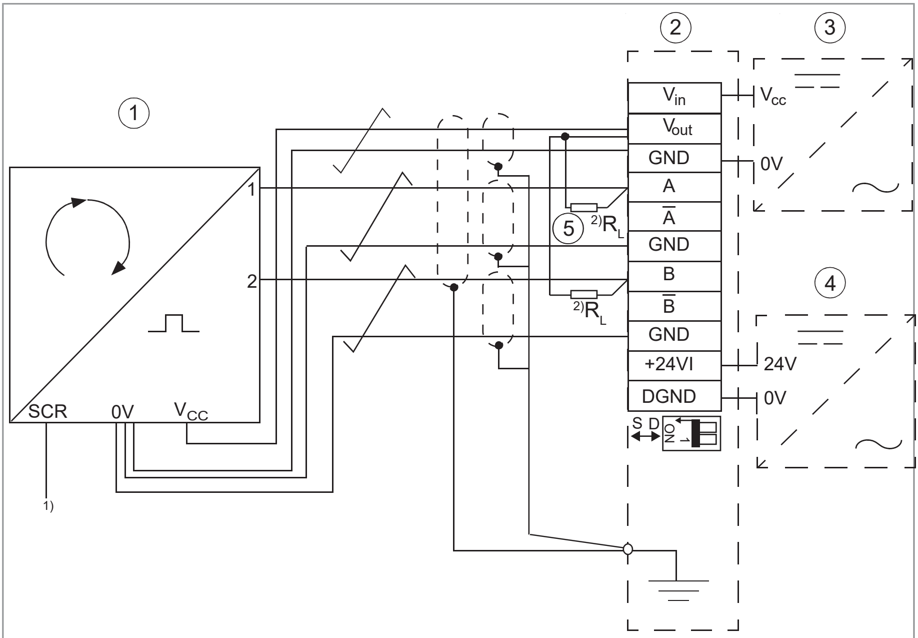
1	Encoder
2	BTAC module
3	Encoder power supply
4	Auxiliary voltage supply for the drive (optional)

Wiring diagrams – Open collector (sinking) encoder output

Diagram assumes normal pulse order in Forward rotation: Pulse A leads.



For encoders with pulse B leading, change the diagram: Wire encoder A and B to BTAC terminals B and A, respectively.



1	Encoder
2	BTAC module
3	Encoder power supply
4	Auxiliary voltage supply for the drive
5	Two identical resistors

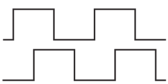
The resistor size depends on the encoder power supply $V_{in} = V_{OUT}$:

V_{in}= 30 V	R_L = 2.7…3.0 kohm, 0.5 W
V_{in}= 24 V	R_L = 1.8…2.2 kohm, 0.5 W
V_{in}= 15 V	R_L = 1.0…1.5 kohm, 0.5 W
V_{in}= 5 V	R_L = 390…470 ohm, 0.125 W

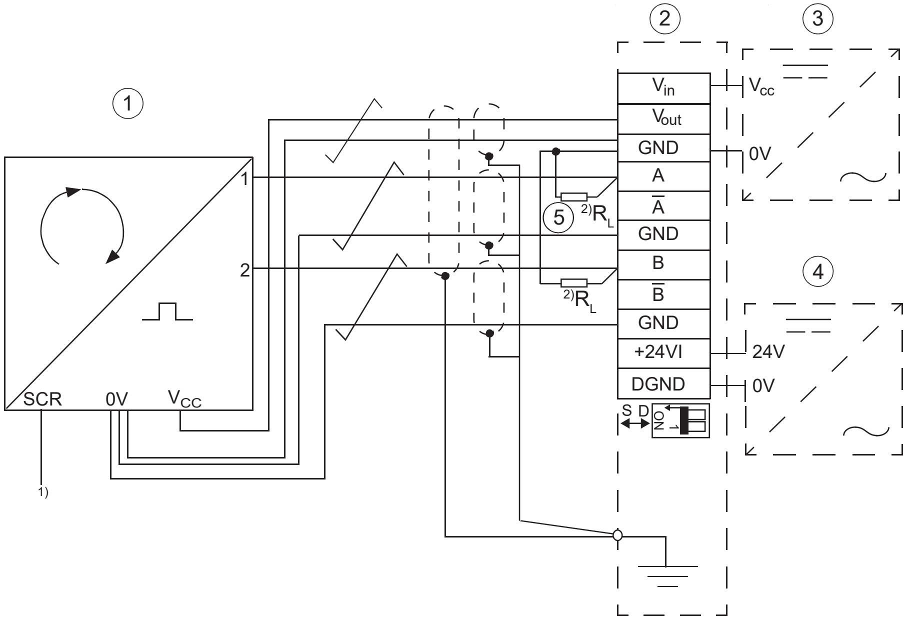
Wiring diagrams – Open emitter (sourcing) encoder output

Diagram assumes normal pulse order in Forward rotation: Pulse A leads.

A
B



For encoders with pulse B leading, change the diagram: Wire encoder A and B to BTAC terminals B and A, respectively.



1	Encoder
2	BTAC module
3	Encoder power supply
4	Auxiliary voltage supply for the drive
5	Two identical resistors

The resistor size depends on the encoder power supply $V_{in} = V_{OUT}$:

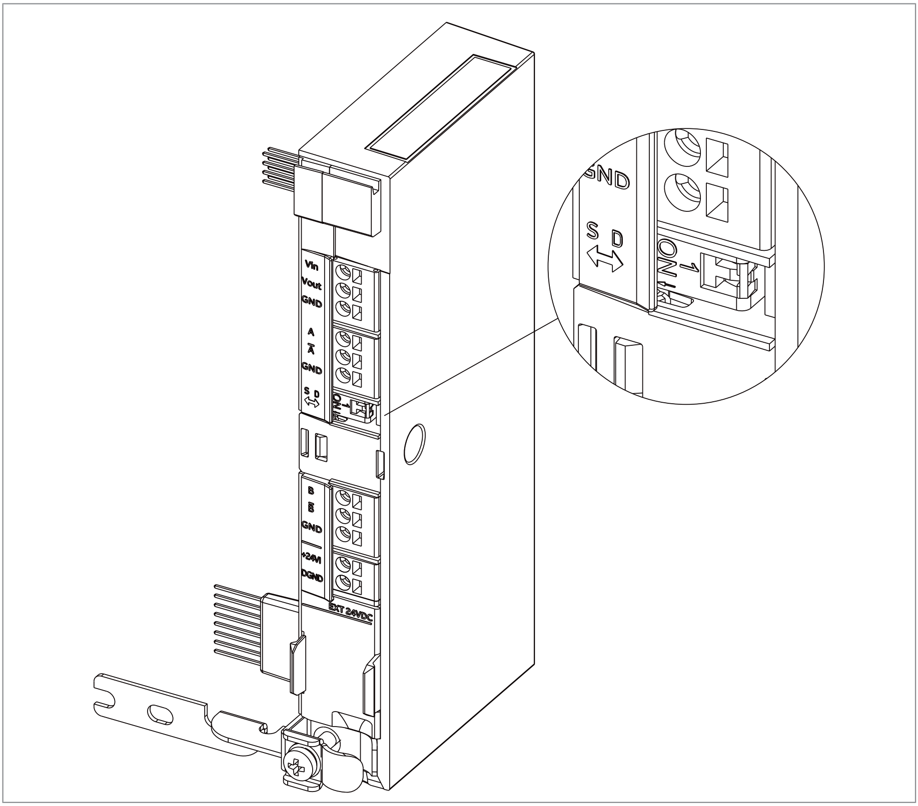
V_{in}= 30 V	R_L = 2.7…3.0 kohm, 0.5 W
V_{in}= 24 V	R_L = 1.8…2.2 kohm, 0.5 W
V_{in}= 15 V	R_L = 1.0…1.5 kohm, 0.5 W
V_{in}= 5 V	R_L = 390…470 ohm, 0.125 W

Selection switch for differential signals

Make sure to set the selection switch for differential signals according to the encoder type. Wrong selection causes cable faults or lack of diagnostics functionality.

D = Differential encoder (default selection)

S = Single-ended encoder



Apply power

1. Turn on the input power to the drive.
2. Continue with Start-up.

Start-up

To configure the operation of the BTAC module:

1. Power up the drive.
2. Set parameters in groups 90 Feedback selection, 91 Encoder module settings and 92 Encoder 1 configuration. These parameters display the configuration of the encoder interface modules.

Feedback selection

Use these parameters to select feedback or display feedback from the encoder.

No.	Name/Value	Description	Def/FbEq16/32
86 Axis position			
86.04	Encoder 1 position	Displays the actual absolute position of encoder 1, using the resolution defined by parameter 86.11 Enc1 increments per revolution. The position value is based on values from parameters 90.11 Encoder 1 position and 90.13 Encoder 1 revolution extension. This parameter is read-only	-
	-2 147 483 648 … 2 147 483 647	Absolute position of encoder 1.	1 = 1 (the 16 lowest bits)
86.11	Enc1 increments per revolution	Defines the resolution of encoder 1 in increments per revolution.	4096
	0 … 2 000 000 000 increments	Resolution of encoder 1.	1 = 1 increment
90 Feedback selection			
90.01	Motor speed for control	Displays the estimated or measured motor speed that is used for motor control, ie. final motor speed feedback selected by parameter 90.41 Motor feedback selection and filtered by 90.42 Motor speed filter time. This parameter is read-only.	-
	-32768…32767	Motor speed used for control.	1=1 rpm/100=1 rpm
90.02	Motor position	Displays the motor position (within one revolution) received from the source selected by parameter 90.41 Motor feedback selection.	

No.	Name/Value	Description	Def/FbEq16/32
	0 … 1 rev	Motor position.	32767=1 rev/ 100000000=1 rev
90.10	Enc1 speed	Displays encoder 1 speed in rpm. This parameter is read-only.	-
	-32768…32767	Encoder 1 speed.	1=1 rpm/100=1 rpm
90.11	Enc1 position	Displays the actual position of encoder 1 within one revolution. This parameter is read-only.	-
	0 … 1 rev	Encoder 1 position within one revolution.	32767=1 rev/ 100000000=1 rev
90.13	Enc1 revol extension	Displays the revolution counter extension. The counter is incremented when encoder position wraps around in the positive direction, and decremented in the negative direction. The parameter is effective only if the position is absolute.The parameter value is updated for both singleturn and multiturn encoders. This parameter is read-only.	na/1=1
90.41	Motor feedback sel	Selects the source of motor speed and motor position used as feedbacks for speed control and motor model.	estimate
	estimate	A calculated speed estimate	0
	Encoder 1	Actual speed measured by encoder 1.	1
90.42	Motor speed filt time	Defines a filter time for motor speed feedback used for control.	3 ms
	0 … 10000 ms	Motor speed filter time.	1=1 ms/1=1 ms
90.45	Motor feedback fault	Selects how the drive reacts to loss of measured motor feedback.	Fault
	Fault	Drive trips on a 7301 Motor speed feedback fault.	0
	Warning	Drive generates a A7B0 Motor speed feedback warning and continues operation using estimated feedbacks. **Note:** Before using this setting, test the stability of the speed control loop with estimated feedback by running the drive on estimated feedback (see 90.41 Motor feedback sel).	1

No.	Name/Value	Description	Def/FbEq16/32
90.46	Force open loop	Defines the speed feedback used for motor control.	No
	No	The motor model uses the feedback selected by 90.41 Motor feedback sel.	0
	Yes	The motor model uses the calculated speed estimate (regardless of the setting of 90.41 Motor feedback sel, which in this case only selects the source of feedback for the speed controller).	1
90.47	Enable motor encoder drift detection	Enables motor encoder drift detection.	Yes
	No	Does not generate an error if encoder drift is detected.	0
	Yes	Generates fault 7301 Motor speed feedback if encoder drift is detected.	1

Encoder adapter settings

These parameters display the configuration of the encoder interface modules.

No.	Name/Value	Description	Def/FbEq16/32
91 Enc adapter settings			
91.10	Enc par refresh	Validates any changed encoder interface module parameters. This is needed for any parameter changes in groups 90…92 to take effect. After refreshing, the value reverts automatically to Done. **Note:** The parameter cannot be changed while the drive is running.	Done
	Done	Refreshing done.	0
	Configure	Refreshing.	1

Encoder configuration

This parameter group selects the settings for the encoder

No.	Name/Value	Description	Def/FbEq16/32
92 Encoder 1 configuration			
92.10	Pulses/rev	Defines the TTL or HTL pulse number per revolution.	32

No.	Name/Value	Description	Def/FbEq16/32
	0…65535		1=1
92.20	Encoder cable fault func	Enables encoder cable fault functionality. **Note:** This parameter affects only with BTAC-02, not with BTAC-03 or BRES. Parameter affects only to software level cable fault detection, not onto hardware level protection.	Enable
	Disable	Encoder cable fault functionality is disabled.	0
	Enable	Encoder cable fault functionality is enabled.	1

Diagnostics

With parameter 90.45 Motor feedback fault, you can select how the drive reacts when it detects that the encoder signal is lost.

- 90.45 = 0 (Fault) – The drive generates a fault (7381 Encoder feedback fault), and the motor coasts to a stop.
- 90.45 = 1 (Warning) – The drive generates a warning (A7E1 Encoder) and continues operation using estimated feedback.

If the drive generates this fault or warning:

Code (hex)	Fault/Warning	Cause
7381	Encoder feedback fault	No motor speed feedback is received
A7E1	Encoder error	No motor speed feedback is received
	0001	Cable fault. Check the encoder cable connection. If the encoder was working previously, check the encoder, encoder cable, and encoder interface module for damage.

Technical data

Encoder interface

The encoder user interface is isolated with reinforced insulation from the DC potential.

Encoder type

- Incremental, TTL/HTL encoders
- Differential, single-ended, open collector, and open emitter encoder outputs (refer to Encoder output types (page 289))
- Two channels: A and B
- Maximum pulse frequency: 200 kHz
- Encoder power supply range: 5…30 V

Encoder interface connectors

Three 3-pin (1×3) and one 2-pin (1×2) spring-clamp type terminal blocks, tin plated, 2.5 mm^2 wire size (14 AWG), pitch 5.0 mm.

Cable

The maximum permitted cable length is 100 m (328 ft).

Encoder and BTAC module power supply

- 50 mA (BTAC) + encoder current consumption. Refer to the encoder data sheet.
- Voltage: 5…30 V DC (depends on the encoder). Refer to the encoder data sheet.

Back-up power supply for the drive

Refer to electrical installation instructions.

Internal connectors

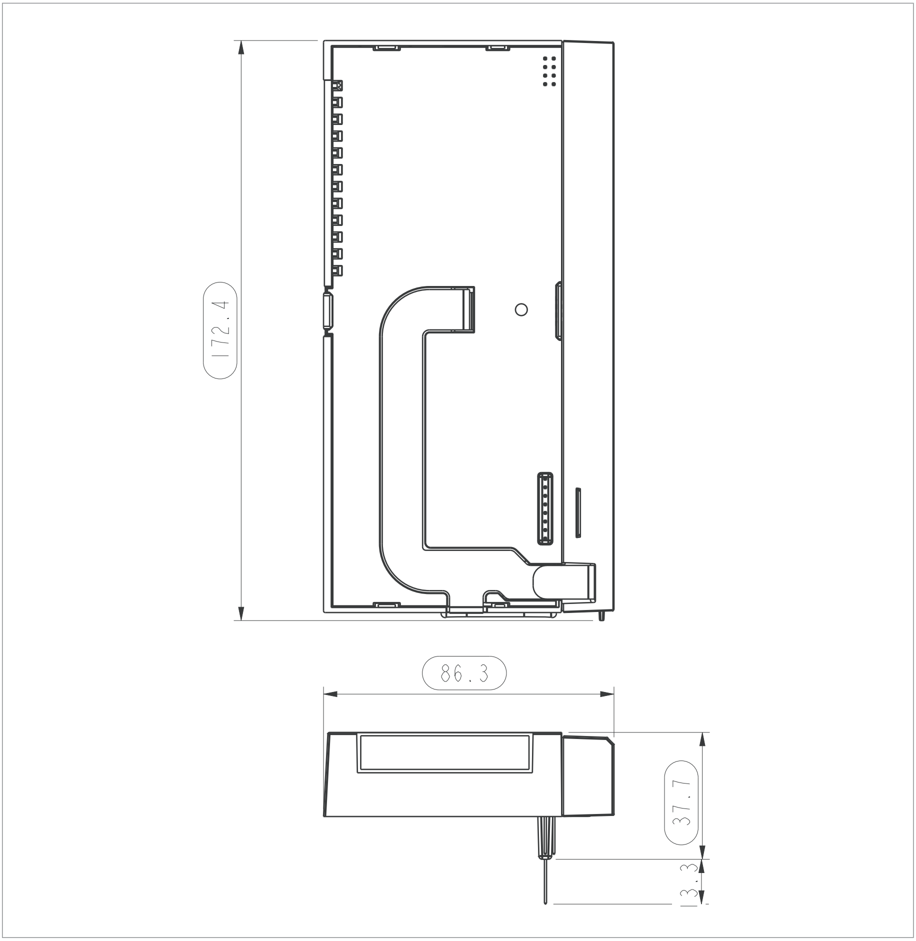
Connector X102 provides encoder interface signals to the drive control board.

Connector X102 data: 1×8 pin header, pitch 2.54 mm, height 33.53 mm.

Connector X100 serves as power supply interface between the BTAC module and the drive's control board. It provides back-up power supply in main power loss situations.

Connector X100 data: 2×4 pin header, pitch 2.54 mm, height 15.75 mm.

Dimensions



18

BRES-01 resolver interface module

Contents of this chapter

This chapter contains a description and technical data of the optional BRES-01 resolver interface module and describes how to connect and start up the module.

Safety instructions

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

Hardware description

Product overview

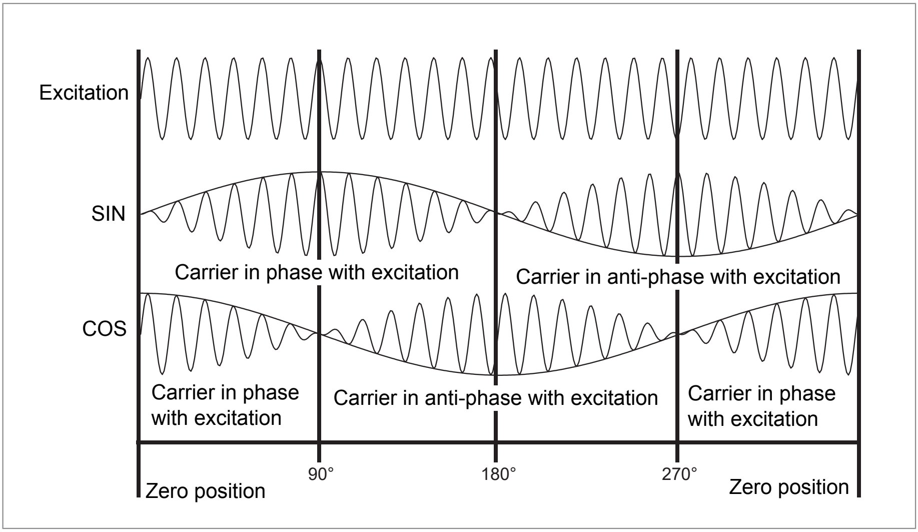
BRES-01 resolver interface module (option +L516) adds a resolver interface to the drive. Resolver can be used, if a more accurate speed or position (angle) feedback is needed from the motor shaft.

BRES-01 has the features of the BAPO auxiliary power extension module. It provides back-up power to the drive (with the external 24 VDC supply) to keep the control unit and communication operational without mains supply to the drive.

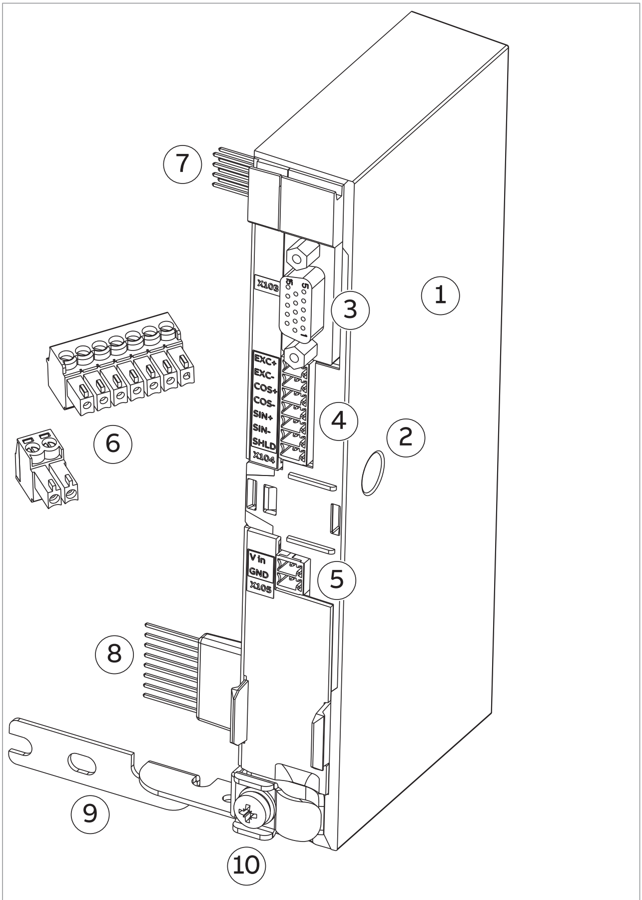
Functional description

BRES-01 feeds the excitation signal to the resolver and reads from the resolver analog sine and cosine signals. Based on the sine and cosine signals, the resolver position (angle) and speed can be defined. Position (absolute) of resolver is read at start and then updated based on the speed signal. The speed signal (Encoder 1 speed) is based on the pulses (counts) from the BRES-01 module.

The following figure shows the SIN and COS outputs and the excitation signal.



Layout



1. BRES-01 module
2. Locking screw hole
3. X103 connector (D connector for resolver feedback)
4. X104 terminal for resolver feedback
5. X105 terminal for external 24 VDC supply
6. Connectors for X104 and X105
7. Internal X100 connector
8. Internal X102 connector
9. Grounding rail
10. Grounding screw

Mechanical installation

Refer to Installing options (page 98) and BAPO, BREL, BRES, and BTAC modules quick installation guide (3AXD50000837946 [English]).

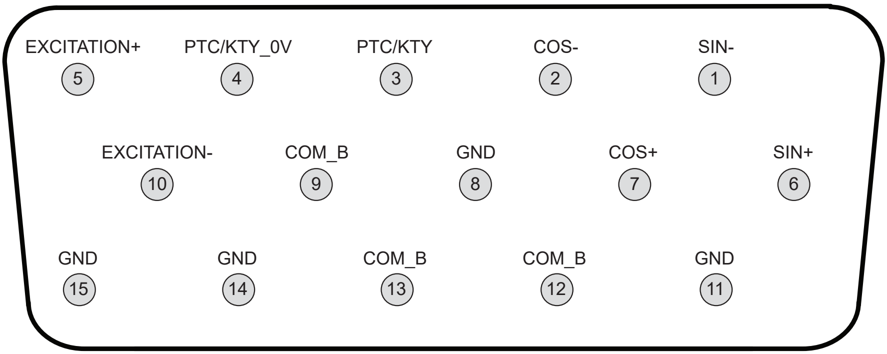
Electrical installation

Terminal designations

The resolver user interface of the BRES-01 module has two connectors for resolver feedback and one connector for external power supply. Resolver feedback can be connected with D-connector (X103) or screw terminal block (X104).

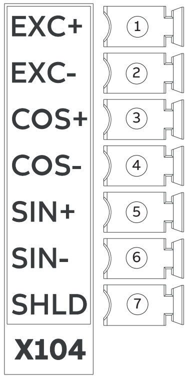
Resolver input (X103, X104)

X103



D-connector (X103)	Signal	Description
1	SIN-	Inverted SIN signal
2	COS-	Inverted COS signal
3	PTC/KTY	Not connected
4	PTC/KTY_0V	Not connected
5	EXCITATION+	Excitation signal +
6	SIN+	SIN signal
7	COS+	COS signal
8	GND	Ground for shield (SHLD) connection
9	COM_B	Not connected
10	EXCITATION-	Excitation signal -
11	GND	Ground for shield (SHLD) connection
12	COM_B	Not connected
13	COM_B	Not connected
14	GND	Ground for shield (SHLD) connection
15	GND	Ground for shield (SHLD) connection

X104



Terminal block (X104)	Signal	Description
1	EXC+	Excitation signal +
2	EXC-	Excitation signal -
3	COS+	COS signal
4	COS-	Inverted COS signal
5	SIN+	SIN signal
6	SIN-	Inverted SIN signal
7	SHLD	Ground for shield (SHLD) connection

External power supply (X105)

Usually, BRES-01 module is powered by the drive internal power supply. BRES-01 can also be supplied from the external 24 VDC power supply via terminal X105, when the capacity of internal power supply in the drive is limited due to other options in use.

Use the following table to determine if you can use the auxiliary power output. Add the missing values and calculate the sum. The sum must be less than (or equal to) the maximum output current of the auxiliary power output. For the maximum output current, see the drive technical data.

Loads with the drive 24 V DC auxiliary voltage output			mA
Number of digital inputs used		× 15 mA each	
BRES-01			50 mA
Encoder current requirement			
Requirements for other user connection(s) to drive 24 V DC auxiliary voltage output			
Total			

Connecting the resolver cable

1. Do not route the resolver cable in parallel to power cables (for example, motor cables). Refer to Routing the cables (page 65) for more information.
2. Use the recommended cable type. Refer to Resolver cable (page 307). Make sure that the cable has 3 twisted pairs.
3. Connect the resolver signals to correct terminal pins via D-connector (X103) or terminal block (X104). Refer to Terminal designations (page 303).
   - Additional GND pins with the D-connector (X103) are reserved for connecting cable shields. Connection of the shields to GND (chassis) can also be made through the D-connector hood cable clamping.
   - With terminal block (X104), connect the shields via pin 7 (SHLD).
4. Ground the cable shields under a grounding clamp (usually only at the drive end).
5. Mechanically attach the cables on the outside of the drive.

Start-up

To configure the operation of the BRES-01 module:

1. Power up the drive.
2. Set parameters in groups 15 I/O Extension module, 90 Feedback selection, 91 Encoder module settings and 92 Encoder 1 configuration. Refer to ACS380 machinery control program firmware manual (3AXD50000029275 [English]).
3. Make sure that the resolver rotation direction is correct before using it as feedback for the speed control. This can be done by comparing estimated speed with encoder 1 speed. If these are opposite, then can invert the direction by parameter, or change resolver signal wiring.

Technical data

Resolver interface

The resolver interface is isolated with reinforced insulation from the DC potential.

Resolver type

- 1 pole pair
- Excitation frequency: 3…12 kHz (adjustable with 1 kHz step by drive parameter)
- Excitation voltage: 5/7/12 Vrms (adjustable by drive parameter)
- Excitation current: 75 mA max.
- Transformation ratio: 0,5
- Maximum speed: 10000 rpm.

Contact ABB for resolvers that do not match the above ratings.

Resolver interface connectors (X103, X104)

- D connector: 15-pin high density D-sub, female.
- 7-pin screw terminal block:

Wire size and type [1]	Cable size
With ferrule, without plastic sleeve	0.25 mm^2…1.5 mm^2 (28…16 AWG)
With ferrule and plastic sleeve	0.25 mm^2…0.5 mm^2 (28…20 AWG), pitch 3.5 mm
Conductor cross section rigid / single strand	0.14 mm^2…1.5 mm^2 (26…16 AWG)
Conductor cross section flexible / multi-strand	0.14 mm^2…1.5 mm^2 (26…16 AWG)

1) ABB recommends to use ferrule.

Resolver cable

- Recommended cable type: shielded twisted pair cable with 3 pairs.
- The maximum permitted cable length: 100 m (328 ft).

Power supply connection (X105)

- Input voltage: 24 V +/-10%
- Input current: max. 65 mA at 24 V. For resolvers that consume power more than 65 mA at 24 V, use the external power supply only when the resolver excitation current exceeds 65 mA.

Back-up power supply for the drive

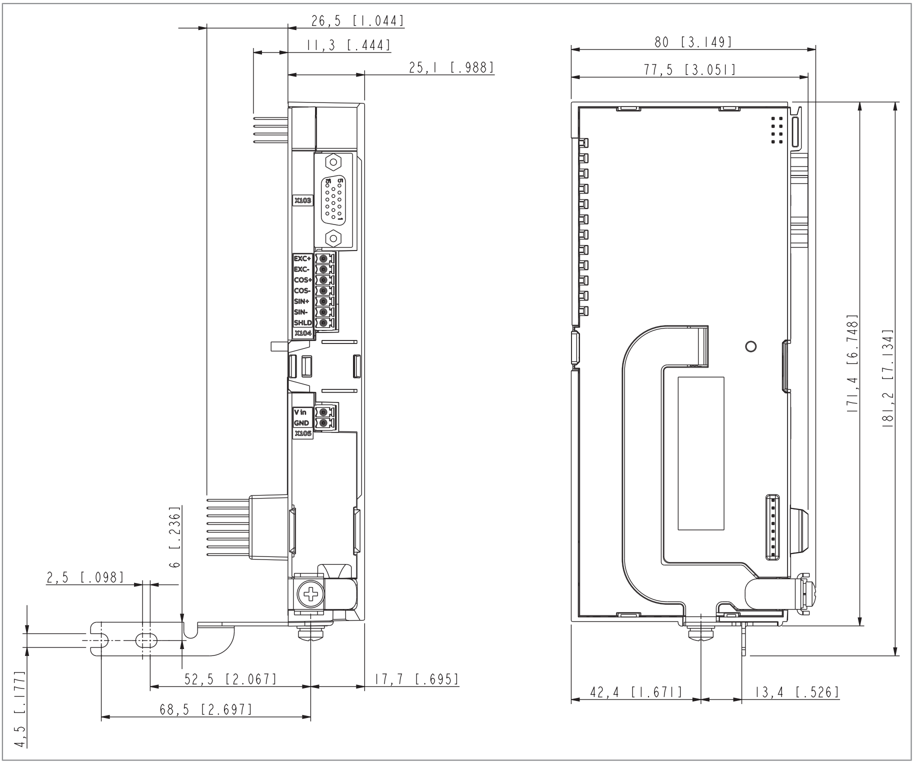
Refer to BAPO-01 auxiliary power extension module (page 315) or BAPO-02 auxiliary power extension module (page 319).

Internal connectors

Connector X102 provides encoder interface signals to the drive control unit. Connector X102 data: 1×8 pin header, pitch 2.54 mm, height 33.53 mm.

Connector X100 serves as power supply interface between the BRES-01 module and the drive's control unit. It provides back-up power supply in main power loss situations. Connector X100 data: 2×4 pin header, pitch 2.54 mm, height 15.75 mm.

Dimensions



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BREL-01 relay output extension module

Contents of this chapter

This chapter contains a description and technical data of the optional BREL-01 relay output extension module.

Safety instructions

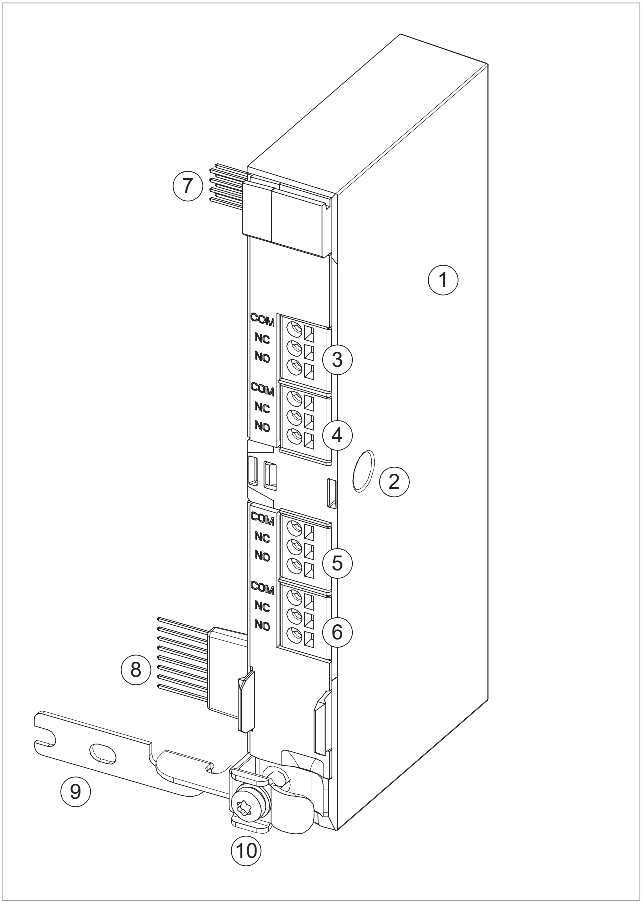
WARNING Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

Hardware description

Product overview

BREL-01 relay output extension module (option +L511) adds four relay outputs to the drive.

Layout



1. BREL-01 module
2. Locking screw hole
3. X103 connector
4. X104 connector
5. X105 connector
6. X106 connector
7. Internal X100 connector
8. Internal X102 connector
9. Grounding rail
10. Grounding screw

Mechanical installation

Refer to Installing options (page 98) and BAPO, BREL, BRES, and BTAC modules quick installation guide (3AXD50000837946 [English]).

Electrical installation

Use 0.5 … 2.5 mm^2 (20 … 14 AWG) cable with a sufficient voltage rating.

If you connect an inductive load (relay or contactor coil, motor) protect the relay contacts with a varistor, RC filter (AC) or diode (DC). Install the protective component as close to the inductive load as possible. Do not install protective components at the relay output terminals.

Identification		Description	
X103	4		Relay outputs RO4…RO7: Max. switching voltage: 250 V AC / 30 V DC Max. switching current: 2 A Galvanically isolated.
1	COM	Common	
2	NC	Normally closed	
3	NO	Normally open	
X104	5		
1	COM	Common	
2	NC	Normally closed	
3	NO	Normally open	
X105	6		
1	COM	Common	
2	NC	Normally closed	
3	NO	Normally open	
X106	7		
1	COM	Common	
2	NC	Normally closed	
3	NO	Normally open	

Start-up

To configure the operation of the relays added with the BREL-01 module:

1. Power up the drive.
2. Set the parameter 15.01 Extension module type to 5 (BREL).
3. Use the control panel on the drive and set the parameters for relay outputs RO4…RO7 in 15 I/O extension module. Refer to the ACS380 Firmware manual (3AXD50000029275 [English]) for parameter descriptions.

Configuration parameters

The configuration parameters of the BREL-01 module are in group 15 I/O extension module.

No.	Name/Value	Description	Def / FbEq16/32
15 I/O extension module			
15.01	Extension module type	Activates (and specifies the type of) I/O extension module.	None

No.	Name/Value	Description	Def / FbEq16/32
	BREL	External relay option BREL-01.	5
15.02	Detected extension module	I/O extension module detected on the drive.	None
	BREL	External relay option BREL-01.	5
15.04	RO status	Displays the status of the relay outputs. This parameter is read-only.	1 = 1
	Bit 0 RO4	1 = Relay output 4 is ON.	-
	Bit 1 RO5	1 = Relay output 5 is ON.	-
	Bit 2 RO6	1 = Relay output 6 is ON.	-
	Bit 3 RO7	1 = Relay output 7 is ON.	-
15.05	RO force selection	The electrical statuses of the relay/digital outputs can be overridden for e.g. testing purposes. A bit in parameter 15.06 RO forced data is provided for each relay or digital output, and its value is applied whenever the corresponding bit in this parameter is 1.	1 = 1
	Bit 0 RO4	1 = Force relay output 4 to value of bit 0 of parameter 15.06 RO forced data.	-
	Bit 1 RO5	1 = Force relay output 5 to value of bit 0 of parameter 15.06 RO forced data.	-
	Bit 2 RO6	1 = Force relay output 6 to value of bit 0 of parameter 15.06 RO forced data.	-
	Bit 3 RO7	1 = Force relay output 7 to value of bit 0 of parameter 15.06 RO forced data.	-
15.06	RO forced data	Allows the data value of a forced relay or digital output to be changed from 0 to 3.	1 = 1
	Bit 0 RO4	Force the value of this bit to RO4, if so defined in parameter 15.05 RO force selection.	-
	Bit 1 RO5	Force the value of this bit to RO5, if so defined in parameter 15.05 RO force selection.	-
	Bit 2 RO6	Force the value of this bit to RO6, if so defined in parameter 15.05 RO force selection.	-
	Bit 3 RO7	Force the value of this bit to RO7, if so defined in parameter 15.05 RO force selection.	-
15.07	RO4 source	Selects a drive signal to be connected to relay output RO4.	Not energized

No.	Name/Value	Description	Def / FbEq16/32
	Not energized	Output is not energized.	0
	Energized	Output is energized.	1
	For the complete parameter list, refer to the drive firmware manual.		…
15.08	RO4 ON delay	Defines the activation delay for relay output RO4.	0.0 s
	0.0 … 3000.0 s	Activation delay for RO4.	10 = 1 s
15.09	RO4 OFF delay	Defines the deactivation delay for relay output RO4.	0.0 s
	0.0 … 3000.0 s	Deactivation delay for RO4.	10 = 1 s
15.10	RO5 source	Selects a drive signal to be connected to relay output RO5.	Not energized
	Not energized	Output is not energized.	0
	Energized	Output is energized.	1
	For the complete parameter list, refer to the drive firmware manual.		…
15.11	RO5 ON delay	Defines the activation delay for relay output RO5.	0.0 s
	0.0 … 3000.0 s	Activation delay for RO5.	10 = 1 s
15.12	RO5 OFF delay	Defines the deactivation delay for relay output RO5.	0.0 s
	0.0 … 3000.0 s	Deactivation delay for RO5.	10 = 1 s
15.13	RO6 source	Selects a drive signal to be connected to relay output RO6.	Not energized
	Not energized	Output is not energized.	0
	Energized	Output is energized.	1
	For the complete parameter list, refer to the drive firmware manual.		…
15.14	RO6 ON delay	Defines the activation delay for relay output RO6.	0.0 s
	0.0 … 3000.0 s	Activation delay for RO6.	10 = 1 s
15.15	RO6 OFF delay	Defines the deactivation delay for relay output RO6.	0.0 s
	0.0 … 3000.0 s	Deactivation delay for RO6.	10 = 1 s
15.16	RO7 source	Selects a drive signal to be connected to relay output RO7.	Not energized
	Not energized	Output is not energized.	0
	Energized	Output is energized.	1
	For the complete parameter list, refer to the drive firmware manual.		…
15.17	RO7 ON delay	Sets the activation delay for relay output 7.	0.0 s
	0.0…3000.0 s	Activation delay for relay output 7.	10 = 1 s

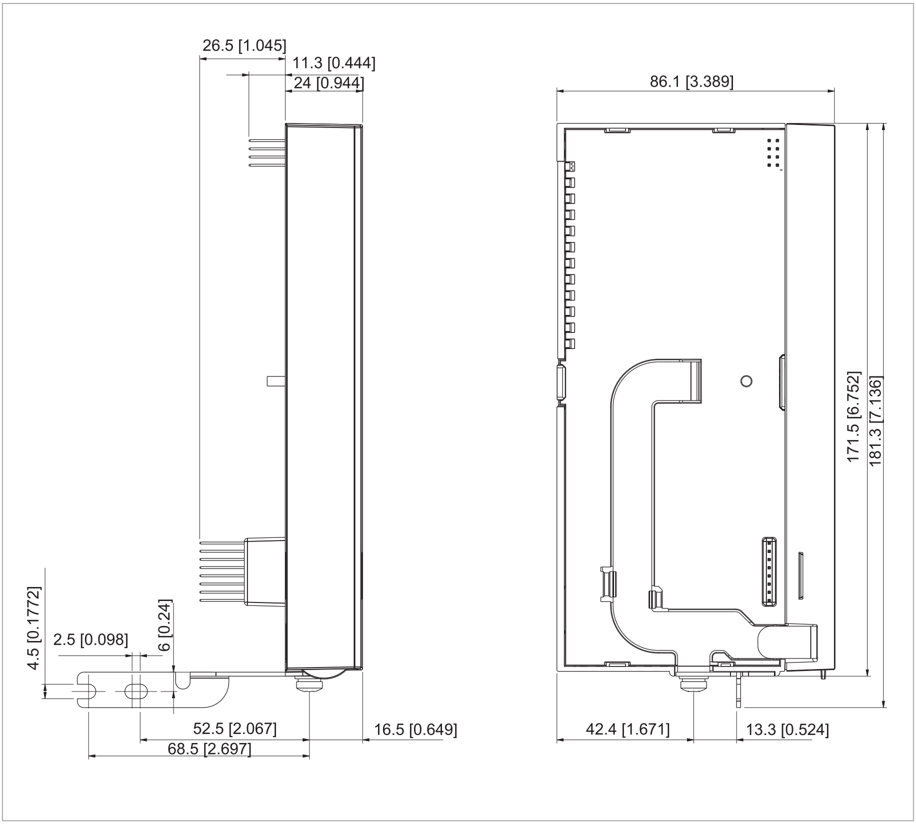
No.	Name/Value	Description	Def / FbEq16/32
15.18	RO7 OFF delay	Sets the deactivation delay for relay output 7.	0.0 s
	0.0…3000.0 s	Deactivation delay for relay output 7.	10 = 1 s

Technical data

External connectors: Four 3-pin (1×3) spring-clamp type terminal blocks, tin plated, 2.5 mm^2 (14 AWG) wire size, pitch 5.0 mm.

Internal connectors: Connector X102 provides relay control signals from the control board: 1×8 pin header, pitch 2.54 mm, height 33.53 mm. Connector X100 is not in use in BREL-01: 2×4 pin header, pitch 2.54 mm, height 15.75 mm.

Dimensions:



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BAPO-01 auxiliary power extension module

Contents of this chapter

This chapter contains a description and technical data of the optional BAPO-01 auxiliary power extension module.

Safety instructions

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

Hardware description

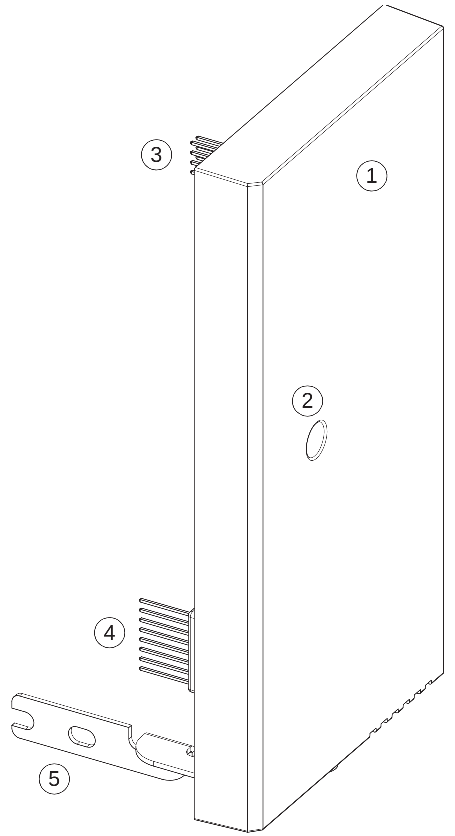
The BAPO-01 auxiliary power extension module (option +L534) lets you use an external 24 V DC power supply with the drive. An external power supply is used to keep the drive control board energized during a power outage.

The BAPO-01 module has internal connections to provide back-up power to the control board (I/O, fieldbus). There is a DC to DC flyback converter power supply inside the module. This power supply takes 24 V DC as input and outputs 5 V DC to the control board to keep the processor and communication links on at all times.

Note: The BAPO-01 is not a battery.

If you change drive parameters when the control board is energized by the BAPO-01 module, force parameter saving by setting the value of parameter 96.07 Parameter save manually to (1) Save. Otherwise, changed data will not be saved.

Layout



1	BAPO-01 module
2	Locking screw hole
3	Internal X100 connector
4	Internal X102 connector
5	Grounding rail

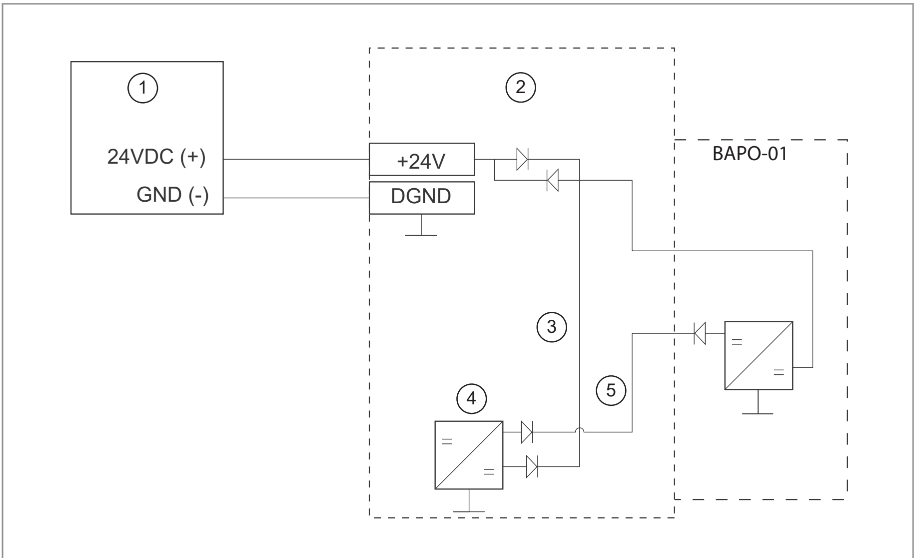
Mechanical installation

Refer to Installing options (page 98) and BAPO, BREL, BRES, and BTAC modules quick installation guide (3AXD50000837946 [English]).

Electrical installation

Connect the external power supply to the +24 V and DGND terminals on the drive. Refer the electrical installation instructions of the drive.

Do not chain an external 24 V DC power supply to several drives. Each drive must be powered by a single 24 V DC power supply, or a separate 24 V DC output of one auxiliary power source.



1	External power supply
2	Drive
3	+24 V internal
4	Main power supply
5	+5 V internal

Start-up

To configure the BAPO-01 module:

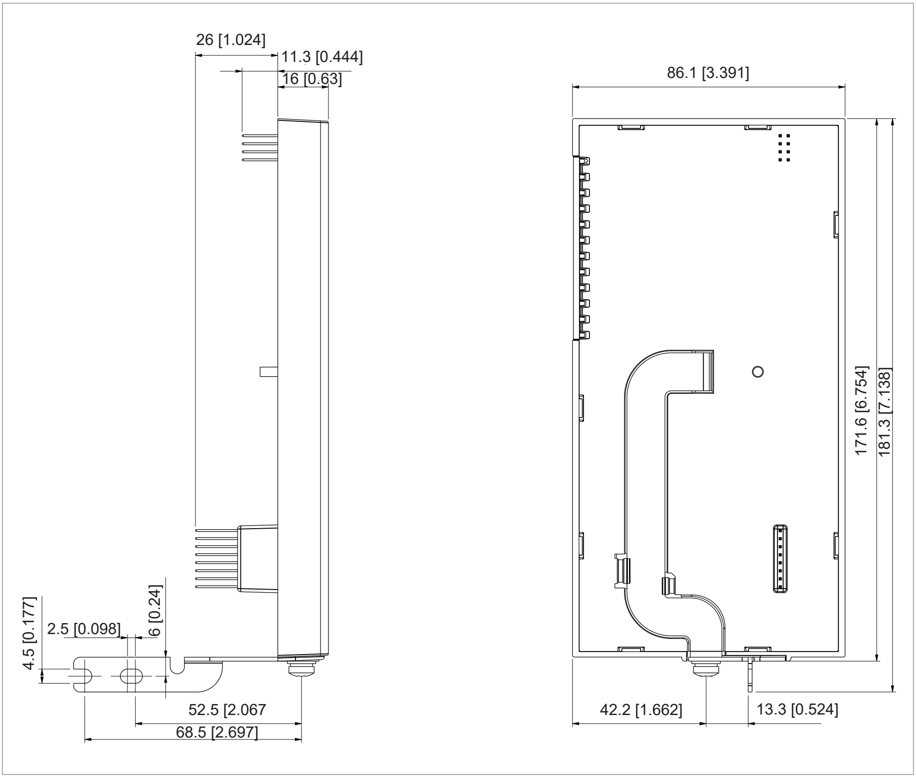
1. Power up the drive.
2. Set the parameter 95.04 Control board supply to 1 (External 24V).

Technical data

Voltage and current rating for the auxiliary power supply: +24 V DC ±10%, max. 1000 mA (including internal fan load).

Power loss: Power losses with maximum load 4 W.

Dimensions:



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BAPO-02 auxiliary power extension module

Contents of this chapter

This chapter contains a description and technical data of the optional BAPO-02 auxiliary power extension module.

Safety instructions

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

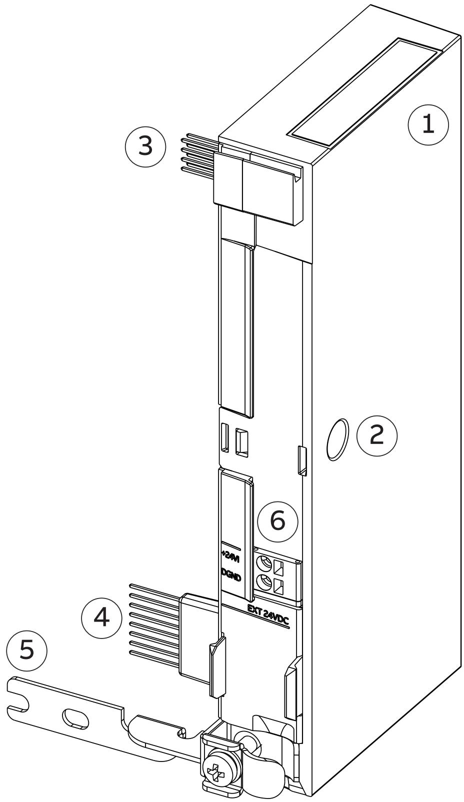
Hardware description

The BAPO-02 auxiliary power extension module (ordering code: 3AXD50001270193) lets you use an external 24 V DC power supply with the drive. An external power supply is used to keep the drive control board energized during a power outage.

The BAPO-02 module has internal connections to provide back-up power to the control board (I/O, fieldbus). There is a DC to DC flyback converter power supply inside the module. This power supply takes 24 V DC as input and outputs 5 V DC to the control board to keep the processor and communication links on at all times.

If you change drive parameters when the control board is energized by the BAPO-02 module, force parameter saving by setting the value of parameter 96.07 Parameter save manually to (1) Save. Otherwise, changed data will not be saved.

Layout



1	BAPO-02 module
2	Locking screw hole
3	Internal X100 connector
4	Internal X102 connector
5	Grounding rail
6	EXT24VDC input

Mechanical installation

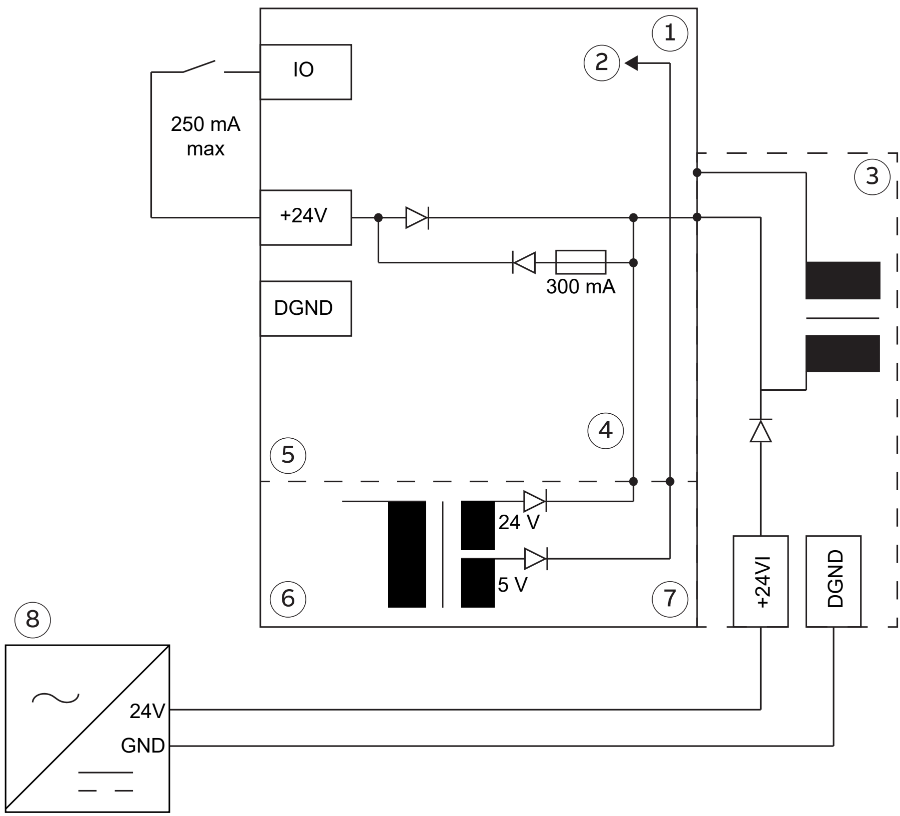
Refer to Installing options (page 98) and BAPO, BREL, BRES, and BTAC modules quick installation guide (3AXD50000837946 [English]).

Electrical installation

Connect the external power supply to the +24VI and DGND terminals on the BAPO-02. Refer to the electrical installation instructions of the drive.

Note: The BAPO-02 is not a battery.

Do not chain an external 24 V DC power supply to several drives. Each drive must be powered by a single 24 V DC power supply, or a separate 24 V DC output of one auxiliary power source.



1	Drive
2	+5 V internal
3	BAPO-02 / BTAC-03
4	+24 V internal
5	Control unit
6	DC intermediate circuit
7	Power unit
8	External power supply

Start-up

To configure the BAPO-02 module:

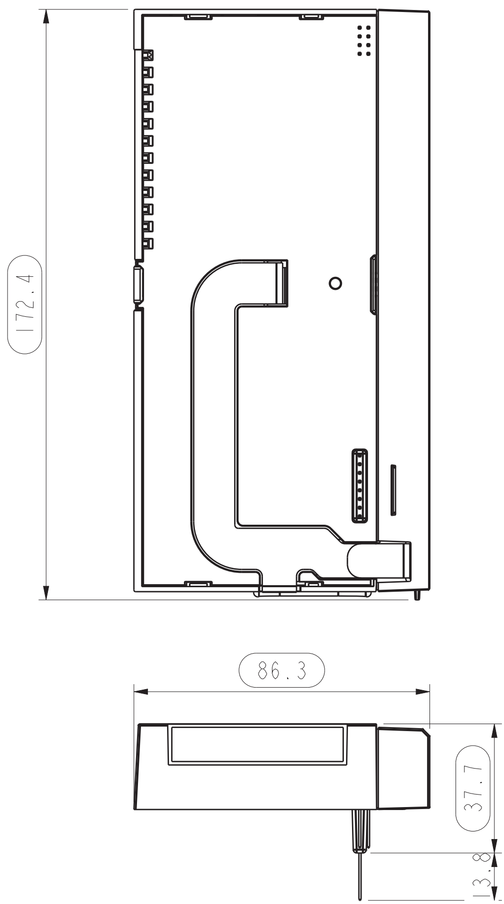
1. Power up the drive.
2. Set the parameter 95.04 Control board supply to 1 (External 24V).

Technical data

Voltage and current rating for the auxiliary power supply: +24 V DC ±10%, max. 1300 mA (including internal fan load).

Power loss: Power losses with maximum load 4 W.

Dimensions:



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BIO-01 I/O extension module

Contents of this chapter

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

Safety instructions

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

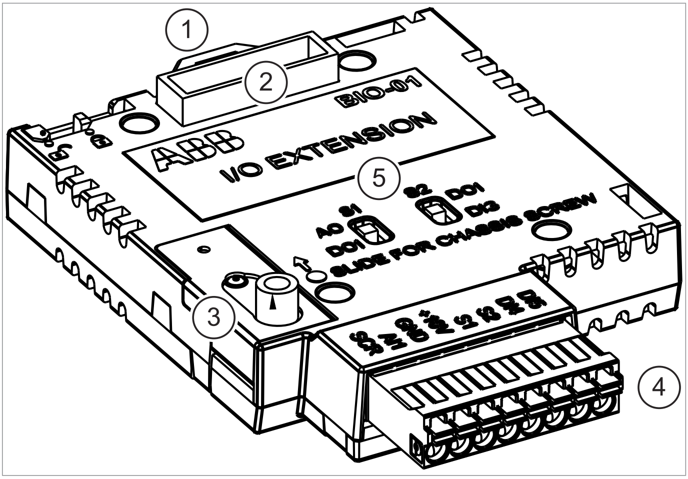
Hardware description

Product overview

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

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

Layout



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

Mechanical installation

See the electrical installation instructions of the drive.

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

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

Terminal configuration

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

Setting		Result		
Switch S1	**Switch S2**	**Terminal S1 functions as**	**Terminal S2 functions as**	**Supported configuration**
DO1 (default)	DI3 (default)	Digital output DO1	Digital input DI3	Yes
AO1	DI3 (default)	Analog output AO1 [1]	Digital input DI3	Yes
AO1	DO1	Analog output AO1 [1]	Digital output DO1	Yes
DO1 (default)	DO1	-	-	No

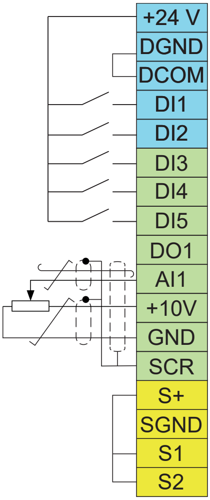
[1] Configurable current (4…20 mA) or voltage (0…10 V) signal.

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

Electrical installation

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

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



Connection	Terminal	Description	1)
	+24 V	Auxiliary voltage output +24 V DC, max. 250 mA	×
	DGND	Auxiliary voltage output common	×
	DCOM	Digital input common for all	×
	DI1	Stop (0) / Start (1)	×
	DI2	Forward (0) / Reverse (1)	×
	S2 (DI3)	Constant frequency/speed selection	
	DI4	Constant frequency/speed selection	
	DI5	Ramp set 1 (0) / Ramp set 2 (1)	
	S1 (DO1)	Not configured (DIO1)	
	AI1 [2)]	Output frequency/speed reference (0 … 10 V / 4 … 20 mA)	
	+10V	Reference voltage +10 V DC (max. 10 mA)	
	GND	Analog circuit common / DO common	
	SCR	Signal cable shield	
	S+	Safe torque off. Both S1 and S2 circuits must be closed for the drive to start. (Factory connection.)	×
	SGND		×
	S1		×
	S2		×

1) × = on base unit, blank = on BIO-01 module.

2) Analog channels can be configured to current signal (4…20 mA) and to voltage signal (0…10 V). Refer to parameter group 12 (Standard AI) and 13 (Standard AO) for the configuration details.

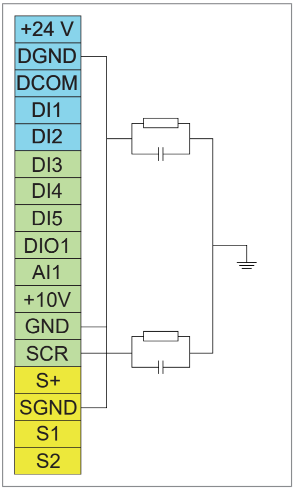
Start-up

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

Technical data

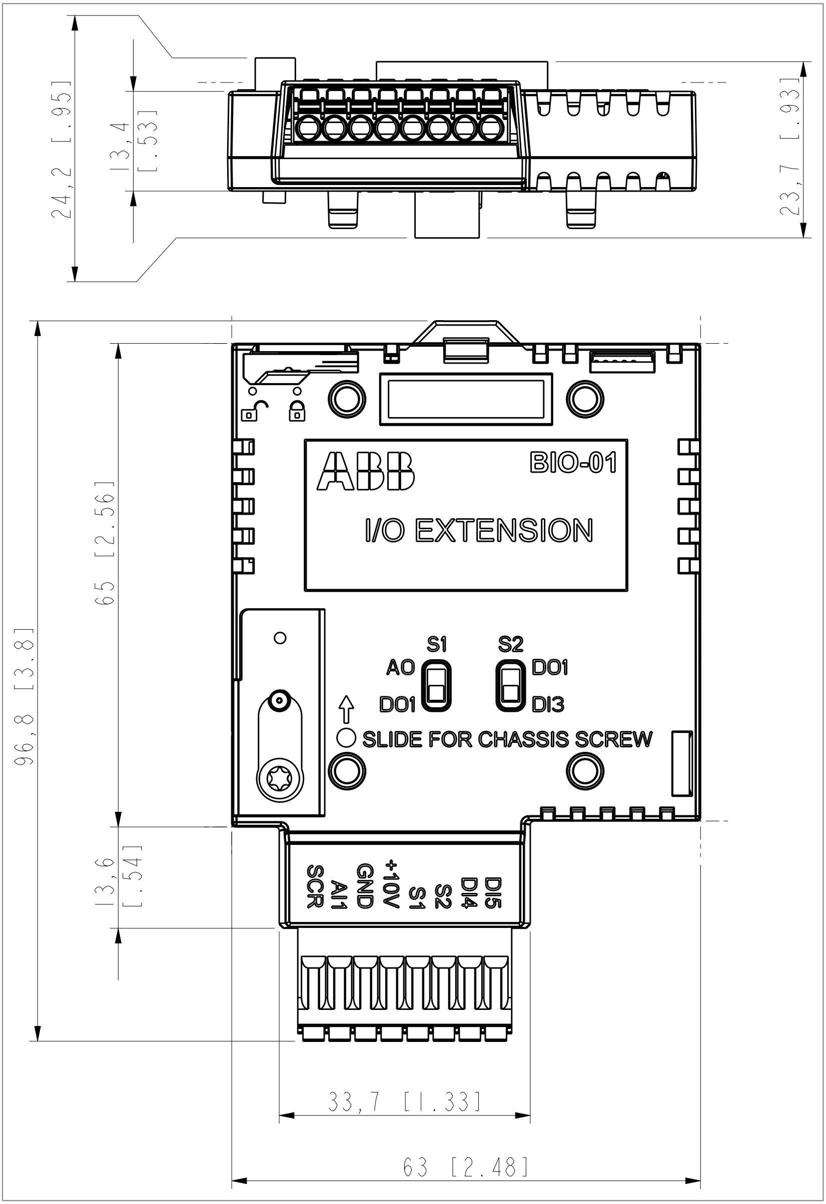
Control connection data: Spring type terminal blocks. Conductor size accepted by the terminals: 0.2 … 1.5 mm^2 (24 … 16 AWG). Exception: max. 0.75 mm^2 (18 AWG) for a multistranded conductor with a ferrule and plastic sleeve.

Internal connections of GND and SCR terminals



Dimensions

Note: Make sure to order a high cover part (part number 3AXD50000190188) for the BIO-01 when it is used with a fieldbus, FSPS-21 or FSCS-21. The high cover part increases the drive depth by 15 mm (0.6 in).



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 new.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.

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3AXD50000029274H

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