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ABB DRIVES FOR WATER

# ACQ580-01 drives

## Hardware manual





# ACQ580-01 drives

## Hardware manual

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**Further information**

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# 1

## Safety instructions

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### Contents of this chapter

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



### Use of warnings and notes

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

The manual uses these warning symbols:

**WARNING!**

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

---

**WARNING!**

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

---

**WARNING!**


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

---

## General safety in installation, start-up and maintenance

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

---

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

---

- Keep the drive in its package until you install it. After unpacking, protect the drive from dust, debris and moisture.
- Use the required personal protective equipment: safety shoes with metal toe cap, safety glasses, protective gloves and long sleeves, etc. Some parts have sharp edges.
- Use a lifting device to lift a heavy drive. Use the designated lifting points. Refer to the dimension drawings.
- Be careful when handling a tall module. The module overturns easily because it is heavy and has a high center of gravity. Whenever possible, secure the module with chains. Do not leave an unsupported module unattended especially on a sloping floor.



- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, and brake resistors, can be hot for a period after operation.
  - Before the start-up, vacuum clean the area around the drive to prevent the drive cooling fan from drawing dust inside the drive.
  - Make sure that debris from drilling, cutting and grinding does not go into the drive during installation. Electrically conductive debris inside the drive can cause damage or malfunction.
  - Make sure that there is sufficient cooling. Refer to the technical data.
  - Before you connect voltage to the drive, make sure that all covers are in place. Do not remove the covers when voltage is connected.
-

- Before you adjust the drive operation limits, make sure that the motor and all driven equipment can operate throughout the set operation limits.
- Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or break in the power supply. If these functions are activated, the installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors.
- If the drive has connected safety circuits (for example, Safe torque off or emergency stop), validate them at start-up. Refer to separate instructions for the safety circuits.
- Beware of hot air flow from the cooling outlets.
- Do not cover the air inlet or air outlet when the drive operates.

**Note:**

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



## Electrical safety in installation, start-up and maintenance

### ■ Electrical safety precautions

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

---



#### **WARNING!**

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do 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 a permanent magnet motor connects to the drive, disconnect the motor from the drive with a safety switch or by other means.
    - Open the main isolating device of the drive.
    - Disconnect all dangerous external voltages from the control circuits.
    - After you disconnect power from the drive, wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
  4. Protect other energized parts in the work location against contact and take special precautions when close to bare conductors.
  5. Measure that the installation is de-energized. Use a 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.

Important! Repeat the measurement with the DC voltage setting of the voltage tester. Measure between each phase and ground. There is a risk of dangerous DC voltage charging due to leakage capacitances of the motor circuit. This voltage can remain charged for a long time after the drive power-off. The measurement discharges the voltage.
- 



- 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, and the drive power cabling when the drive is in operation. The equipment produces electromagnetic fields that can cause interference in electronic medical devices. This can cause a health hazard.

#### **Note:**

- When the drive is connected to the input power, the motor cable terminals and the DC bus are at a dangerous voltage.  
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

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### **WARNING!**

Use ESD wristband when you handle printed circuit boards. Do not touch the boards unnecessarily. The boards are sensitive to electrostatic discharge.

---

### ■ **Grounding**

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

---



### **WARNING!**

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

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

---

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





## General safety in operation

These instructions are for all persons that operate the drive.



### WARNING!

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

- If you have a cardiac pacemaker or other electronic medical device, do not go near the motor, drive, and the drive power cabling when the drive is in operation. The equipment produces electromagnetic fields that can cause interference in electronic medical devices. This can cause a health hazard.
- Give a stop command to the drive before you reset a fault. If you have an external source for the start command and the start is on, the drive starts immediately after the fault reset, unless you configure the drive for pulse start. Refer to the firmware manual.
- Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or break in the power supply. If these functions are activated, the installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".



### Note:

- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors. If you need to start or stop the drive, use the control panel keys or commands through the I/O terminals of the drive or the fieldbus interface.
- If the drive is in remote control mode, you cannot stop or start the drive with the control panel.

## Additional instructions for permanent magnet motor drives

### ■ Safety in installation, start-up, maintenance

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



### WARNING!

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

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

## 26 Safety instructions

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

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

- Stop the drive.
- Disconnect the motor from the drive with a safety switch or by other means.
- If you cannot disconnect the motor, make sure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, can rotate the motor directly or through any mechanical connection such as belt, nip, rope, etc.
- Do the steps in section [Electrical safety precautions \(page 22\)](#).
- 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

---



#### **WARNING!**

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

---

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# Introduction to the manual

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## Contents of this chapter

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

## Applicability

This manual applies to the ACQ580-01 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.

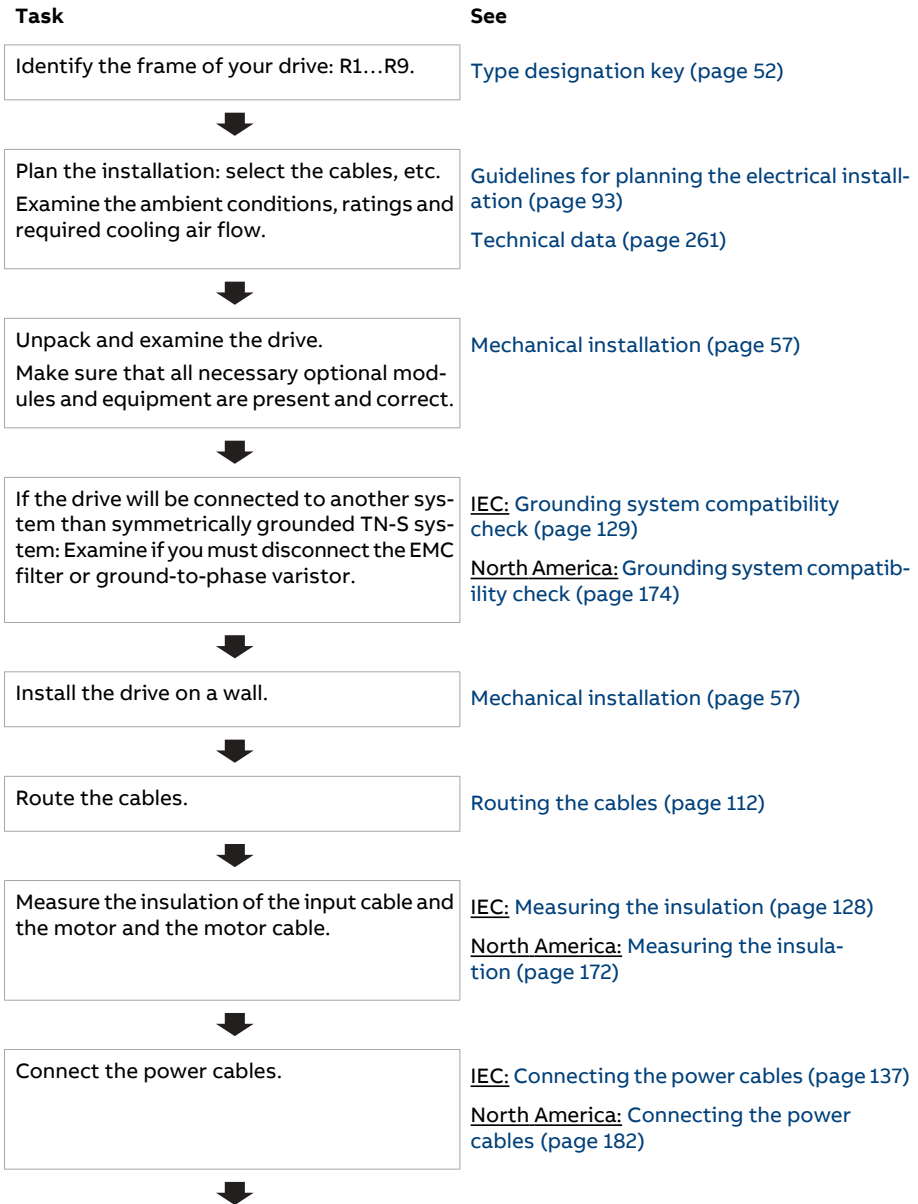
Read the manual before you do work on the drive. You are expected to know the fundamentals of electricity, wiring, electrical components, and electrical schematic symbols.

## Categorization by frame size

The ACQ580-01 is manufactured in frames (frame sizes) R1...R9. Some instructions and other information that concern only certain frames are marked with the symbol of the frame (R1...R9). The frame is marked on the type designation label of the drive, see [Type designation label \(page 50\)](#).

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## Quick installation and commissioning flowchart



**Task****See**

Connect the control cables.

[IEC: Connecting the control cables \(page 157\)](#)

[North America: Connecting the control cables \(page 200\)](#)



Check the installation.

[Installation checklist \(page 233\)](#)



Commission the drive.

[ACQ580 pump control program firmware manual \(3AXD50000035867 \[English\]\)](#)

## Terms and abbreviations

Term	Description
ACH-AP-H	Assistant control panel with Hand-Off-Auto functionality
ACH-AP-W	Assistant control panel with Hand-Off-Auto functionality and Bluetooth interface
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
CAIO-01	CAIO-01 optional bipolar analog input and unipolar analog output extension module
Capacitor bank	The capacitors connected to the DC link
CCA-01	Configuration adapter
CHDI-01	115/230 V digital input extension module
CMOD-01	Multifunction extension module (external 24 V AC/DC and digital I/O extension)
CMOD-02	Multifunction extension module (external 24 V AC/DC and isolated PTC interface)
Control unit	The part in which the control program runs.
CPTC-02	Multifunction extension module (external 24 V and ATEX/UKEX-certified PTC interface)
DC link	DC circuit between rectifier and inverter
DC link capacitors	Energy storage which stabilizes the intermediate circuit DC voltage
DPMP-01	Mounting platform for control panel (flush mounting)
DPMP-02, DPMP-03	Mounting platform for control panel (surface mounting)
DPMP-EXT	Optional mounting platform for door mounting of control panel

30 Introduction to the manual

Term	Description
Drive	Frequency converter for controlling AC motors
EFB	Embedded fieldbus
EMC	Electromagnetic compatibility
FBA	Fieldbus adapter
FCAN	Optional CANopen® adapter module
FDNA-01	Optional DeviceNet™ adapter module
FEIP-21	Optional Ethernet adapter module for EtherNet/IP™
FENA-21	Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
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
FSCA-01	Optional RS-485 (Modbus/RTU) adapter
IGBT	Insulated gate bipolar transistor
Intermediate circuit	DC circuit between rectifier and inverter
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.
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, see <a href="http://www.odva.org">www.odva.org</a> .
Parameter	In the drive control program, user-adjustable operation instruction to the drive, or signal measured or calculated by the drive. In some (for example fieldbus) contexts, a value that can be accessed as an object. For example, variable, constant, or signal.
PLC	Programmable logic controller
PTC	Positive temperature coefficient
Rectifier	Converts alternating current and voltage to direct current and voltage
STO	Safe torque off (IEC/EN 61800-5-2)

## Related documents

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



[ACQ580-01 manuals](#)







# 3

## **Operation principle and hardware description**

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### **Contents of this chapter**

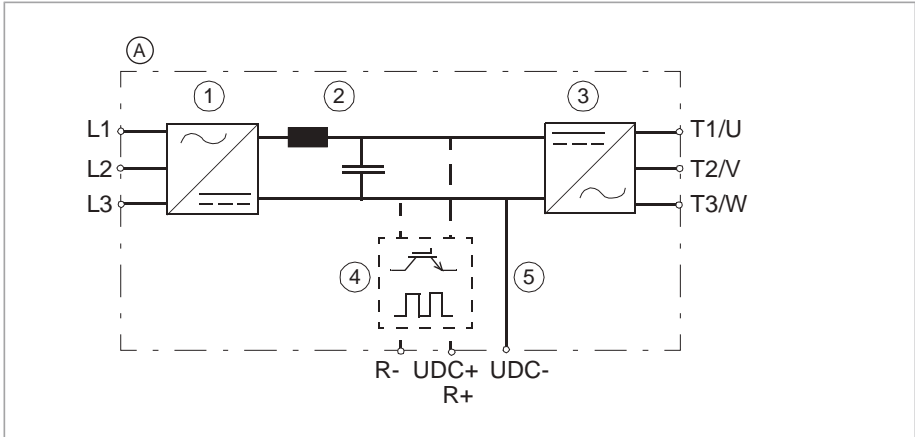
This chapter briefly describes the operation principle and construction of the drive.

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## Operation principle

The ACQ580-01 is a drive for controlling asynchronous AC induction motors, permanent magnet motors and synchronous reluctance motors (SynRM).

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



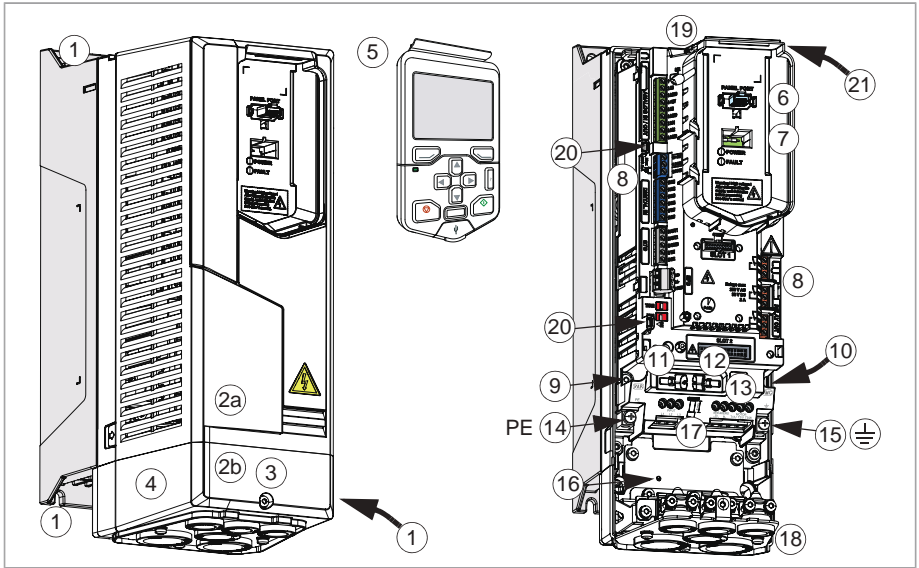
A	Drive
1	Rectifier. Converts alternating current and voltage to direct current and voltage.
2	DC link. DC circuit between rectifier and inverter.
3	Inverter. Converts direct current and voltage to alternating current and voltage.
4	Built-in brake chopper (R-, R+) in frames R1...R3. Conducts the surplus energy from the intermediate DC 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. The user obtains and installs the brake resistor when needed.
5	DC connection (UDC+, UDC-), for an external brake chopper in frames R4...R9.

## Layout

### Frames R1...R2

The layout of a frame R1 drive is presented below. The main structure of frame R2 is similar to R1. IP55 / UL Type 12 frames are also slightly different from IP21 / UL Type 1 frames, for example, IP21 / UL Type 1 front cover has two parts while IP55 / UL Type 12 front cover only has one part.

R1 IP21 / UL Type 1

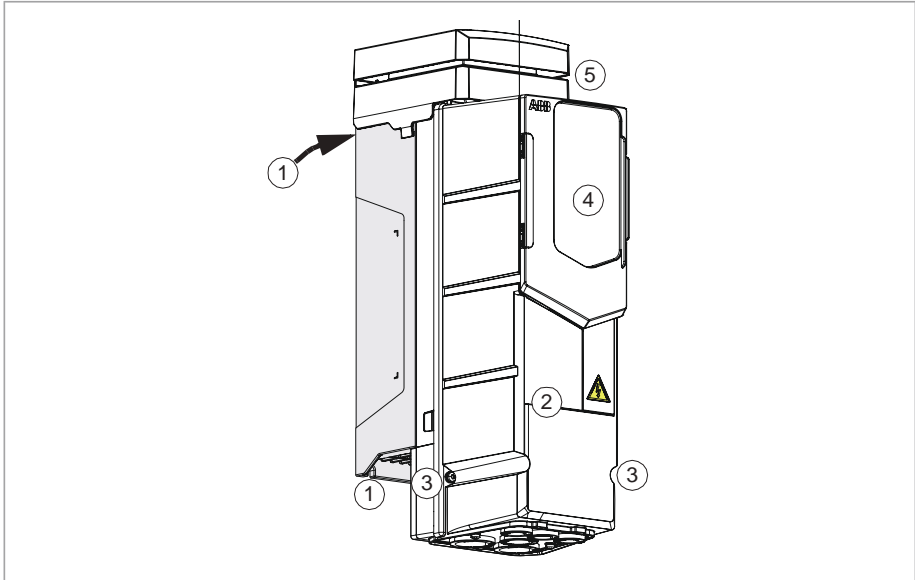


1	Mounting points (4 pieces)	10	EMC filter grounding screw (EMC (DC)). For disconnecting, see page 133 (IEC) or page 178 (North America).
2	Cover: upper part (2a), lower part (2b)	11	Place for storing the removed VAR screw
3	Cover screw	12	Place for storing the removed EMC screw
4	Cable/conduit box	13	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and brake resistor connection (R-, R+)
5	Control panel	14	PE connection (power line)
6	Control panel connection	15	Grounding connection (motor)
7	Cold configuration connection for CCA-01	16	Additional grounding connection
7	Power OK and Fault LEDs. See section LEDs (page 258).	17	Stripping length (8 mm) checker
8	I/O connections. See External control connection terminals, frames R1...R5 (page 47).	18	Cable entry
9	Varistor grounding screw (VAR). For disconnecting, see page 133 (IEC) or page 178 (North America).	19	Main cooling fan
		20	Cable tie mounts for /I/O cables
		21	Auxiliary cooling fan connector

### 36 Operation principle and hardware description

This is an example of IP55 / UL Type 12 frames. They have one-piece front cover, which has a transparent window to leave the control panel visible. UL Type 12 frames have a hood, whose construction depends on the frame size.

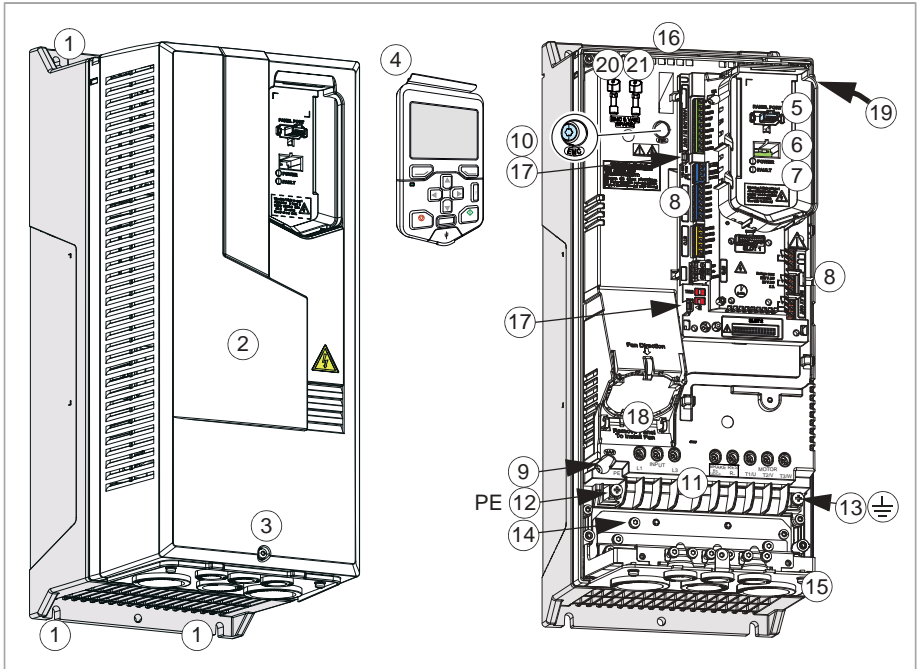
#### R1 IP55 / UL Type 12



1	Mounting points (4 pieces), top points are under the hood, which is installed last.
2	Front cover
3	Cover screws (2 pieces)
4	Control panel behind the transparent window
5	Hood, UL Type 12 only. Hood types vary by the frame size, see page 303.

**Frame R3**

**R3 IP21 / UL Type 1**

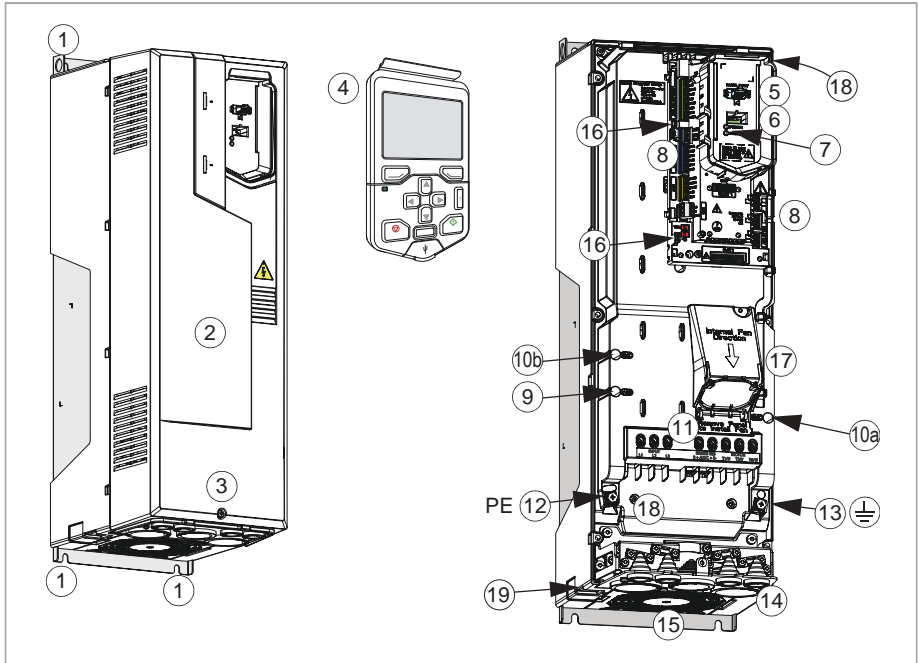


### 38 Operation principle and hardware description

1	Mounting points (4 pieces)	11	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and brake connection (R-, R+)
2	Cover	12	PE connection (power line)
3	Cover screw	13	Grounding connection (motor)
4	Control panel	14	Additional grounding connection
5	Control panel connection	15	Cable entry
6	Cold configuration connection for CCA-01	16	Main cooling fan
7	Power OK and Fault LEDs. See section <a href="#">LEDs (page 258)</a> .	17	Cable tie mounts for /I/O cables
8	I/O connections. See <a href="#">External control connection terminals, frames R1...R5 (page 47)</a> .	18	Auxiliary cooling fan. For IP55/UL Type 12 drives only.
9	Varistor grounding screw (VAR). For disconnecting, see page <a href="#">133 (IEC)</a> or page <a href="#">178 (North America)</a> .	19	Auxiliary cooling fan connector
10	EMC filter grounding screw (EMC (DC)). For disconnecting, see page <a href="#">133 (IEC)</a> or page <a href="#">178 (North America)</a> .	20	Place for storing the removed EMC screw
		21	Place for storing the removed VAR screw

**Frame R4**

**R4 IP21 / UL Type 1**

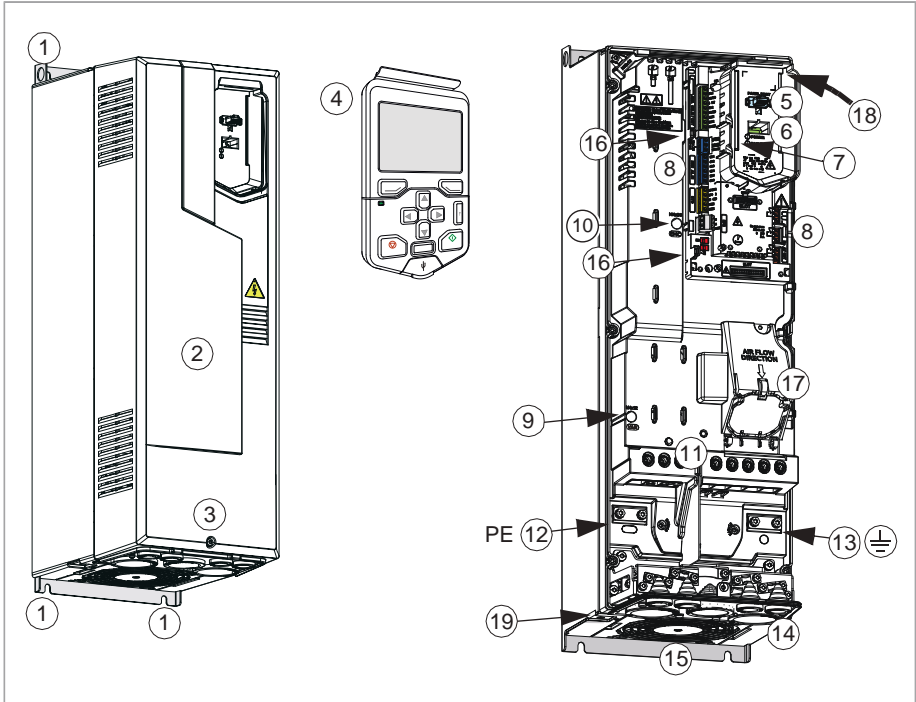


1	Mounting points (4 pieces)	10	Two EMC filter grounding screws (EMC (DC)). For disconnecting, see page 134 (IEC) or page 179 (North America).
2	Cover	11	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and DC connection (UDC+, UDC-)
3	Cover screw	12	PE connection (power line)
4	Control panel	13	Grounding connection (motor)
5	Control panel connection	14	Cable entry
6	Cold configuration connection for CCA-01	15	Main cooling fan
7	Power OK and Fault LEDs. See section LEDs (page 258).	16	Cable tie mounts for /I/O cables
8	I/O connections. See External control connection terminals, frames R1...R5 (page 47).	17	Auxiliary cooling fan. For IP55/UL Type 12 drives only.
9	Varistor grounding screw (VAR). For disconnecting, see page 134 (IEC) or page 179 (North America).	18	Auxiliary cooling fan connector
		19	Additional grounding connection

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## R4 v2 IP21 / UL Type 1

New design of frame R4 types 062A-4, 073A-4 and 089A-4 are marked as R4 v2

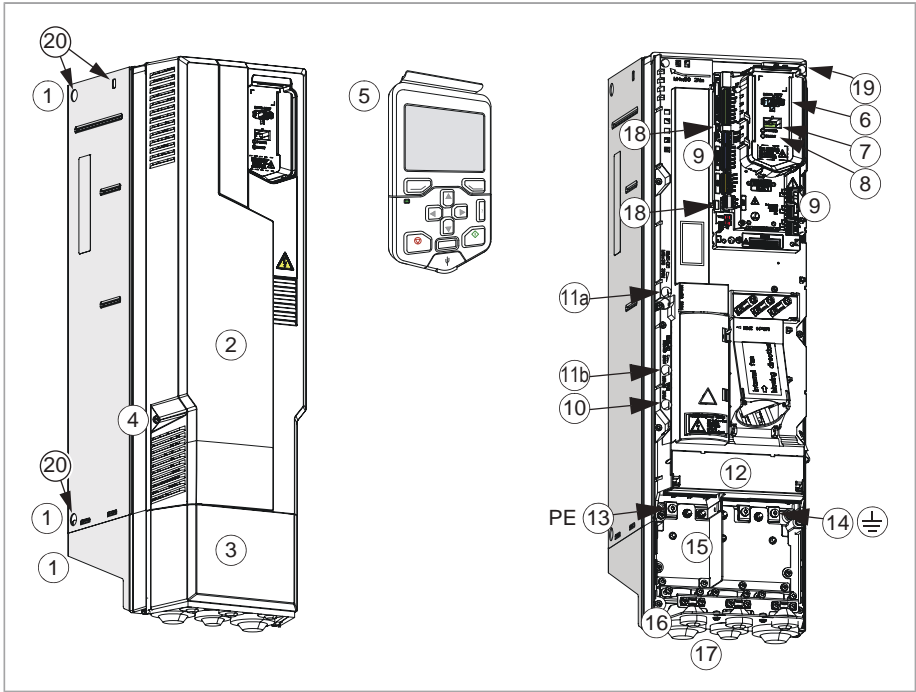




1	Mounting points (4 pieces)	10	EMC filter grounding screw (EMC). For disconnecting, see page 134 (IEC) or page 179 (North America).
2	Cover	11	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and DC connection (UDC+, UDC-)
3	Cover screw	12	PE connection (power line)
4	Control panel	13	Grounding connection (motor)
5	Control panel connection	14	Cable entry
6	Cold configuration connection for CCA-01	15	Main cooling fan
7	Power OK and Fault LEDs. See section LEDs (page 258).	16	Cable tie mounts for /I/O cables
8	I/O connections. See External control connection terminals, frames R1...R5 (page 47).	17	Auxiliary cooling fan. For IP55/UL Type 12 drives only.
9	Varistor grounding screw (VAR). For disconnecting, see page 134 (IEC) or page 179 (North America).	18	Auxiliary cooling fan connector
		19	Additional grounding connection

**Frame R5**

**R5 IP21 / UL Type 1**

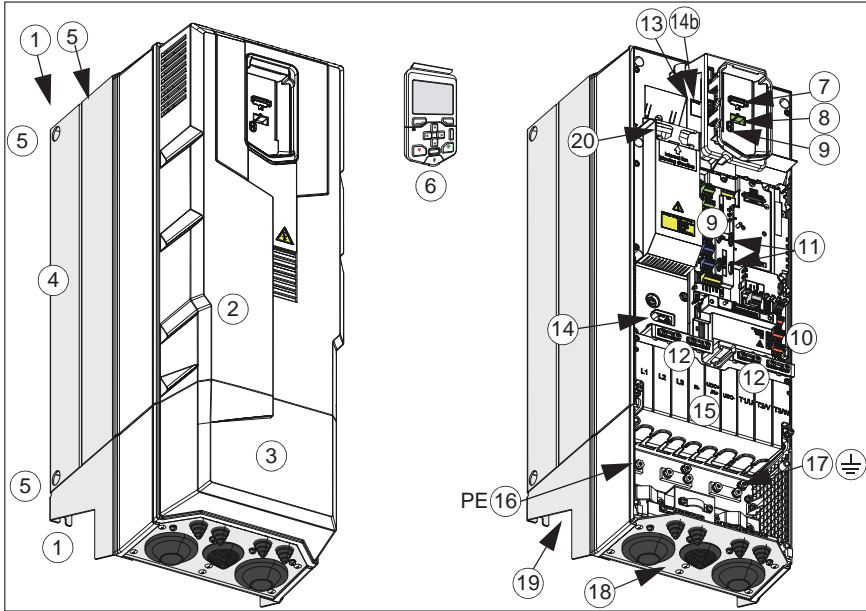


1	Mounting points (6 pieces: 2 at the top, 2 at the bottom of the main part of the frame, 2 at the top of the cable box)	11	Two EMC filter grounding screws, 11a: EMC (DC) and 11b: EMC (AC). For disconnecting, see page 134 (IEC) or page 179 (North America).
2	Cover	12	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and DC connection (UDC+, UDC-)
3	Cable/conduit box	13	PE connection (power line)
4	Cover screws (2 pieces)	14	Grounding connection (motor)
5	Control panel	15	Cable box plate
6	Control panel connection	16	Cable entry
7	Cold configuration connection for CCA-01	17	Main cooling fan
8	Power OK and Fault LEDs. See section LEDs (page 258).	18	Cable tie mounts for /I/O cables
9	I/O connections. See External control connection terminals, frames R1...R5 (page 47).	19	Auxiliary cooling fan connector
10	Varistor grounding screw (VAR). For disconnecting, see page 134 (IEC) or page 179 (North America).	20	Lifting points (6 pieces)

**Frames R6...R9**

**R6 IP21 / UL Type 1**

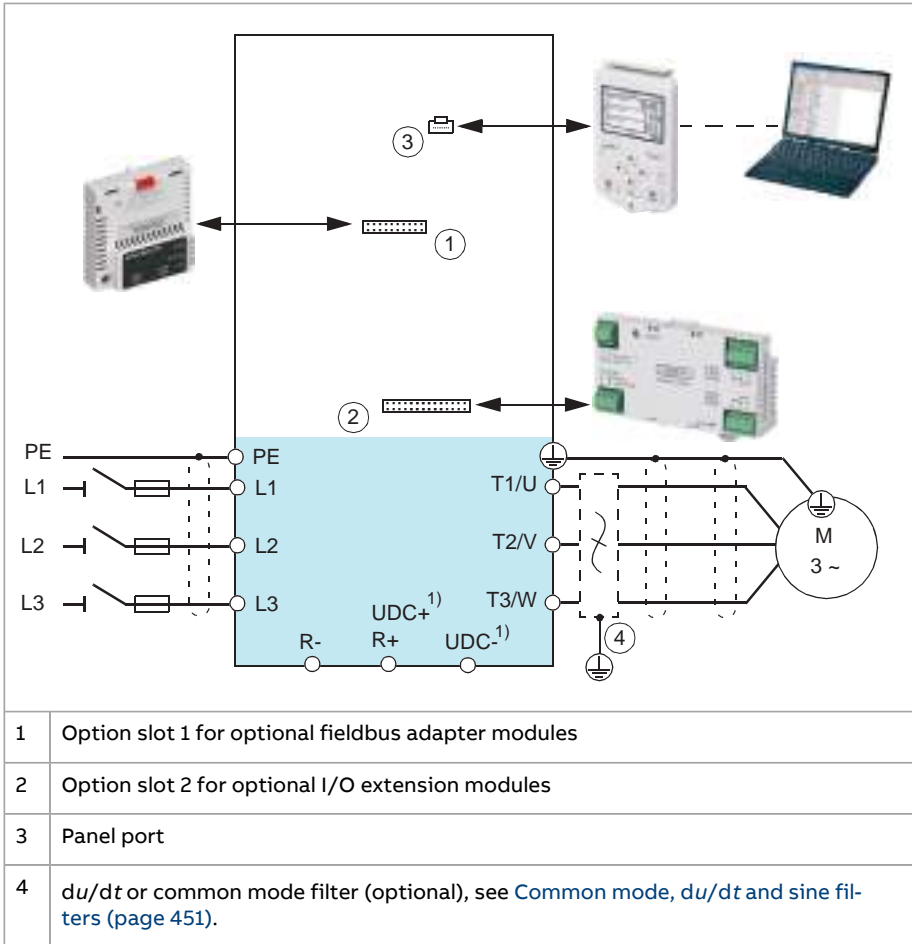
The layout of a frame R6 drive is presented below. The constructions of frames R6...R9 differ to some extent.



1	Mounting points (6 pieces: 2 at the top, 2 at the bottom of the main part of the frame, 2 at the top of the cable box)	13	Varistor grounding screw (VAR), under the control panel platform. For disconnecting, see page 134 (IEC) or page 179 (North America).
2	Cover	14	Two EMC filter grounding screws, 14a: EMC (DC) under the control panel platform and 14b: (EMC (AC) at the left, above the shroud. For disconnecting, see page 134 (IEC) or page 179 (North America).
3	Cable/conduit box	15	Shroud. Under the shroud: Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and DC connection (UDC+, UDC-)
4	Heatsink	16	PE connection (power line)
5	Lifting points (6 pieces)	17	Grounding connection (motor), under the shroud (15)
6	Control panel	18	Cable entry
7	Control panel connection	19	Main cooling fan
8	Cold configuration connection for CCA-01	20	Auxiliary cooling fan
9	Power OK and Fault LEDs. See section LEDs (page 258).		
10	I/O connections. See External control connection terminals, frames R6...R9 (page 48).		
11	Cable tie mounts for /I/O cables		
12	Clamps for I/O cable mechanical support		

## Overview of power and control connections

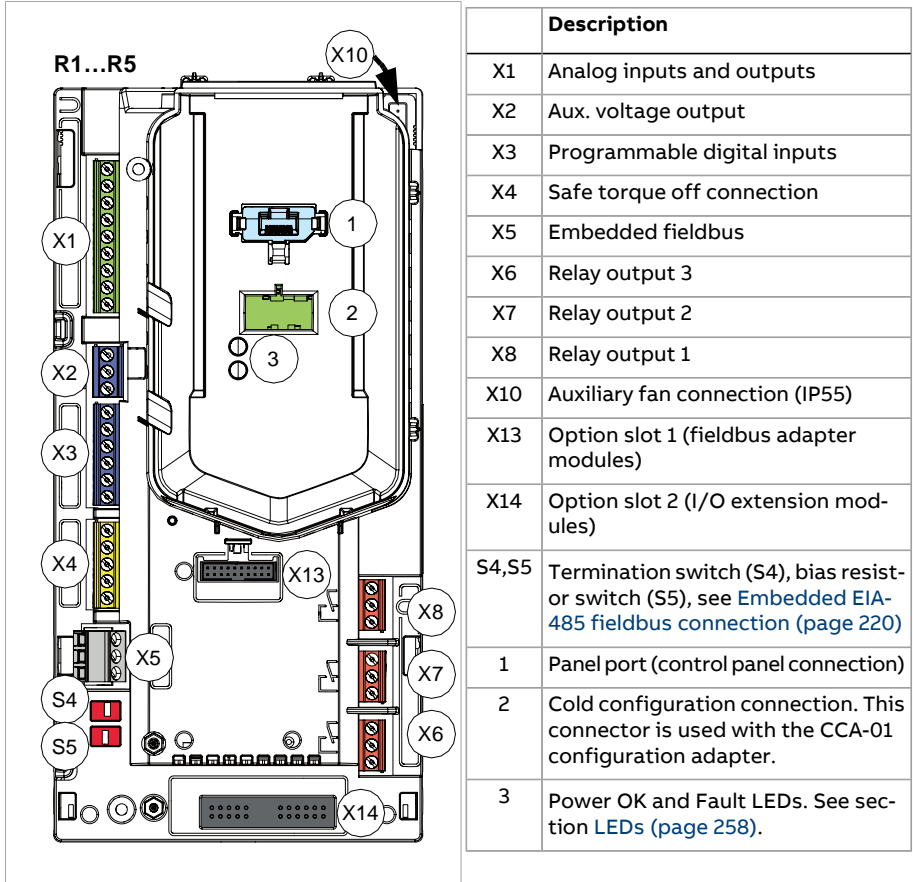
The logical diagram below shows the power connections and control interfaces of the drive.



<sup>1)</sup>Not in all frame sizes

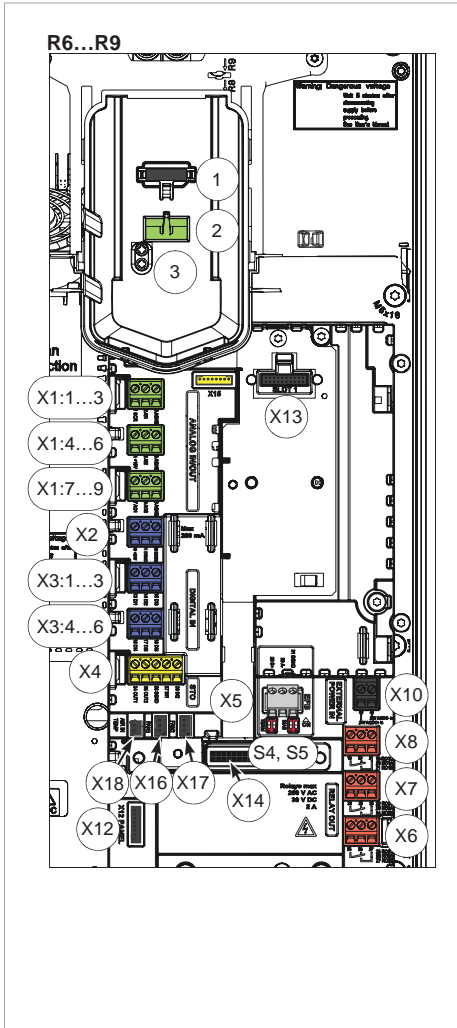
■ External control connection terminals, frames R1...R5

The layout of the external control connection terminals of the R1 frame is shown below. Layout of the external control connection terminals is identical in frames R1...R5 but the location of the control unit with the terminals is different in frames R3...R5.



■ External control connection terminals, frames R6...R9

The layout of the external control connection terminals of frames R6...R9 is shown below.

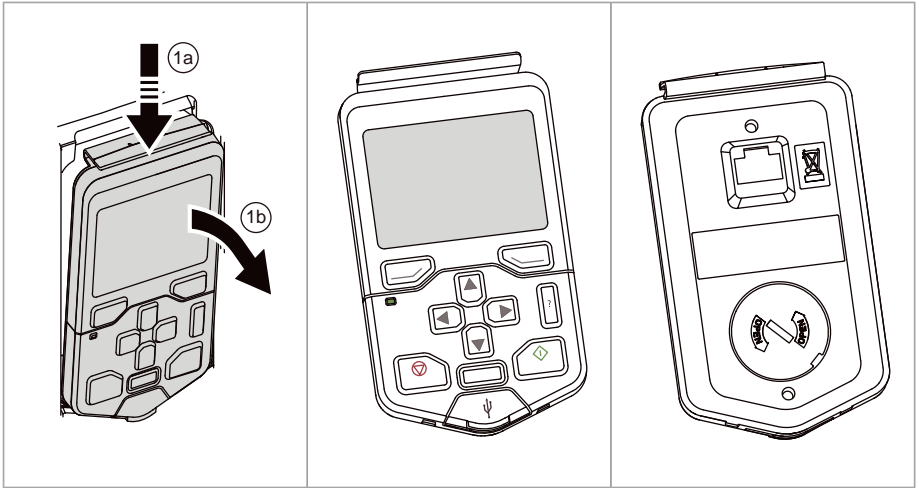


	Description
X1	Analog inputs and outputs
X2	Aux. voltage output
X3	Digital inputs
X4	Safe torque off connection
X5	Connection to embedded EIA-485 fieldbus adapter module
X6	Relay output 3
X7	Relay output 2
X8	Relay output 1
X10	External +24 V AC/DC input connection
X12	Panel connection
X13	Option slot 1 (fieldbus adapter modules)
X14	Option slot 2 (I/O extension modules)
X16	Auxiliary fan 1 connection
X17	Auxiliary fan 2 connection
X18	Air in temperature sensor connection
S4, S5	Termination switch (S4), bias resistor switch (S5), see <a href="#">Embedded EIA-485 fieldbus connection</a> (page 220)
1	Panel port (control panel connection)
2	Cold configuration connection. This connector is used with the CCA-01 configuration adapter.
3	Power OK and Fault LEDs. See section <a href="#">LEDs</a> (page 258).

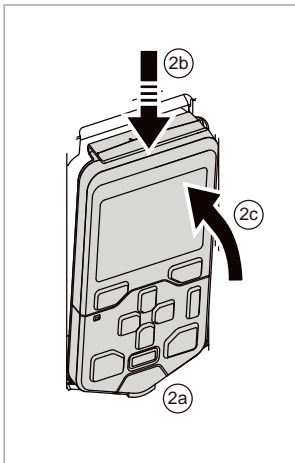


## Control panel

To remove the control panel, press the retaining clip at the top (1a) and pull the panel forward from the top edge (1b).



To install the control panel, put the bottom of the container in position (2a), press the retaining clip at the top (2b) and push the control panel in at the top edge (2c).



For the use of the control panel, see the firmware manual and [ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual \(3AUA0000085685 \[English\]\)](#).

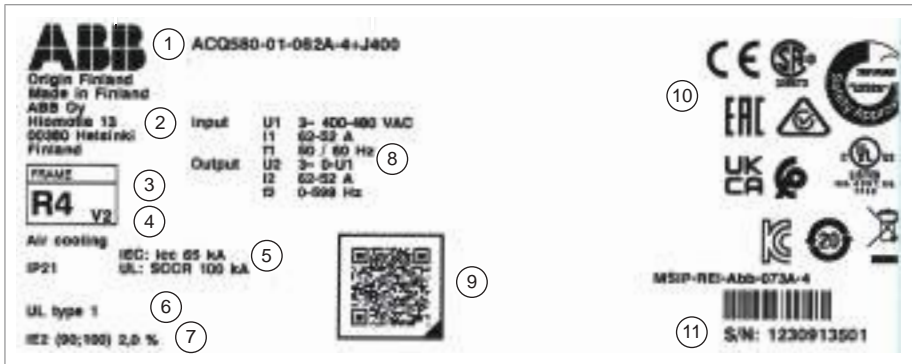
■ **Control panel door mounting kits**

You can use a mounting platform to install the control panel on the cabinet door. Mounting platforms for control panels are available as options from ABB. For more information, see

Manual	Code (English)
DPMP-01 mounting platform for control panels installation guide	3AUA0000100140
DPMP-02/03 mounting platform for control panels installation guide	3AUA0000136205
DPMP-04 and DPMP-05 mounting platform for control panels installation guide	3AXD50000308484
DPMP-06 / 07 mounting platform for control panels installation guide	3AXD50000289561

**Type designation label**

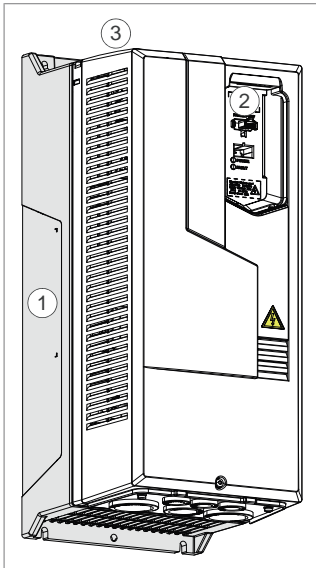
The type designation label includes IEC and UL (NEC) ratings, appropriate markings and the type designation and serial number, which allow identification of each drive. The type designation label is located on the left side of the drive, see section [Locations of the labels on the drive \(page 51\)](#). An example label is shown below.



No.	Description
1	Type designation, see section <a href="#">Type designation key (page 52)</a> .
2	Contact address
3	Frame (size) (New design of frame R4 types are marked as R4 v2)
4	Type of the drive, for example, with Air cooling or Liquid cooling, and so on.
5	IEC: Icc (Rated conditional short-circuit current) = 65 kA, UL (NEC): SCCR (Maximum prospective short circuit current rating) = 100 kA
6	Degree of protection

No.	Description
7	Typical drive losses when it operates at 90% of the motor nominal frequency and 100% of the drive nominal output current (calculated according to IEC61800-9-2).
8	Nominal ratings in the supply voltage range, see <a href="#">Electrical ratings (page 262)</a> , <a href="#">Electrical power network specification (page 339)</a> and <a href="#">Motor connection data (page 341)</a> .
9	Link to the product data sheet
10	Valid markings
11	<p>S/N: Serial number of format MYYWWXXXXX, where</p> <p>M: Manufacturing plant</p> <p>YY: 16, 17, 18, ... for 2016, 2017, 2018, ...</p> <p>WW: 01, 02, 03, ... for week 1, week 2, week 3, ...</p> <p>XXXXX: Digits making the serial number unique</p>

■ **Locations of the labels on the drive**



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1	 <p>ABB Origin Finland Made in Finland ABB Oy Hietoniva 13 00260 Helsinki Finland</p> <p>FRAME <b>R4</b> V2</p> <p>Air cooling IEC: Ice 65 kA IP21 UL: SCCR 100 kA</p> <p>UL type 1 IE2 (90;100) 2,0 %</p> <p>ACQ580-01-062A-4</p> <p>Input U1 3- 400-480 VAC I1 62-82 A T1 60 / 60 Hz</p> <p>Output U2 3- 0-U1 I2 62-82 A D 0-999 Hz</p> <p>CE, EMC, EAC, UK CA, MSIP-REI-Abb-073A-4, S/N: 1230913501</p>
2	 <p>ACQ580-01-062A-4 S/N: 1230913501 SW v2.18.0.0 HW V2</p>
3	 <p>U1 3- 400-480 VAC I2 62-82 A P 30 kW, 40 hp</p> <p>ACQ580-01-062A-4 S/N: 1230913501</p> <p><b>Note:</b> P<sub>n</sub> is not shown in UL (NEC) drive labels</p>

## Type designation key

The type designation contains information on the specifications and configuration of the drive. You find the type designation on the type designation label attached to the drive. The first digits from the left express the basic configuration, for example, ACQ580-01-12A7-4. The optional selections are given after that, separated by plus signs, for example, +L501. The main selections are described below. Not all selections are available for all types.

Code	Description
Basic codes	
ACQ580	Product series
01	When no options are selected: Wall mounted, IP21 (UL Type 1), ACH-AP-H Hand-Off-Auto control panel, choke, EMC C2 filter (internal EMC filter), safe torque off, braking chopper in frames R1, R2, R3, coated boards, cable entry from the bottom, cable box or the conduit plate with cable entries, quick installation and start-up guide (multilingual kit).
<b>Size</b>	

Code	Description
xxxx	See the rating tables
<b>Voltage rating</b>	
4	2 = 208...240 V 4 = 380...480 V 6 = 525...600 V See the technical data for further information.

■ **Option codes**

Code	Description
B056	IP55 (UL Type 12)
B063	IP66
B066	UL Type 4X
C135	Flange mounting
C193	With sun shield. With option +B063 or +B066 only.
E223	EMC C1 filter. Available only for IP55 (+B056)
F253	With disconnect and handle. With option +B063 only.
F254	With disconnect, handle and input fuses. With option +B066 only.
F278	Main switch disconnecter. Available only for IP55 (+B056)
F316	Main switch disconnecter and EMC C1 filter. Available only for IP55 (+B056)
H358	Cable conduit entry (US/UK).
OJ400	No control panel
J400	ACH-AP-H control panel (included as standard)
J424	Blank control panel cover (no control panel)
J425	ACS-AP-I control panel
J429	ACH-AP-W control panel with Bluetooth interface
K451	FDNA-01 DeviceNet™ adapter module

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Code	Description
K454	FPBA-01 PROFIBUS DP adapter module
K457	FCAN-01 CANopen adapter module
K458	FSCA-01 RS-485 (Modbus/RTU) adapter module
K475	FENA-21 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port
K490	FEIP-21 EtherNet/IP adapter module
K491	FMBT-21 Modbus/TCP adapter module
K492	FPNO-21 PROFINET IO adapter module
L501	CMOD-01 External 24 V AC/DC and digital I/O extension (2×RO and 1×DO)
L512	CHDI-01 115/230 V digital input module (six digital inputs and two relay outputs)
L523	CMOD-02 External 24 V and isolated PTC interface
L525	CAIO-01 analog I/O extension module
L537	CPTC-02 ATEX-certified thermistor protection module
N2000	Standard software language set (default; includes EN, DE, ES, PT, FR, ZH, IT, FI, PL, RU, TR)
N2901	European software language set (default for SV, CZ, HU, DA, NL; includes EN, DE, ES, PT, FR, SV, CZ, HU, DA, NL)
N2902	Asian software language set (default for KO, TH; includes EN, DE, ES, PT, FR, ZH, KO, TH)
P932	Extended warranty 60 months from delivery
P944	Version for cabinet mounting (drive module with front covers but without cable box) for frames R5...R9.
P952	European Union Country of Origin
Q971	ATEX-certified safe disconnection function

## Manual kit ordering codes

Hardware and firmware manuals are not included as default. They can be ordered as a kit using the following ordering codes:

Language	Ordering code
EN	3AXD50000688951
DA	-
DE	3AXD50000688968
ES	3AXD50000689002
FI	-
FR	3AXD50000688999
IT	3AXD50000688975
NL	3AXD50000688982
PT	3AXD50000689217
RU	3AXD50000732630
SV	3AXD50000732647
TR	3AXD50000689224

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## 4

# Mechanical installation

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## Contents of this chapter

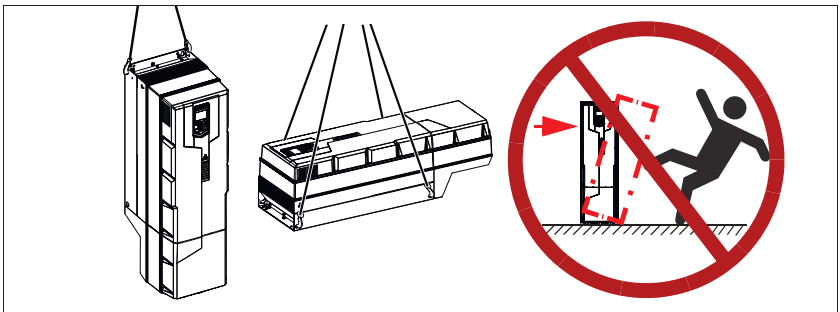
This chapter tells you how to examine the installation site, examine the delivery, and mechanically install the drive.

## Safety

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**WARNING!**

**Frames R5...R9:** Lift the drive with a lifting device. Use the lifting eyes of the drive. Do not tilt the drive. **The drive is heavy and its center of gravity is high. An overturning drive can cause physical injury.**



## Cabinet installation (options +P940 and +P944)

See also [ACS580...](#), [ACH580...](#) and [ACQ580...+P940 and +P944 drive modules supplement \(3AXD50000210305 \[English\]\)](#).

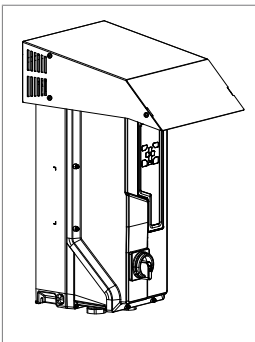
For generic guidelines for planning the installation of the drive modules into a user-defined cabinet, see [Drive modules cabinet design and construction instructions \(3AUA0000107668 \[English\]\)](#).

## 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.
- Make sure that there are no sources of strong magnetic fields such as high-current single-core conductors or contactor coils near the drive. A strong magnetic field can cause interference or inaccuracy in the operation of the drive.
- For IP66 (UL Type 4X) drives: The drive is protected from sun with an optional sun shield to prevent excessive heating.

**Note:** The drive is UV resistant.

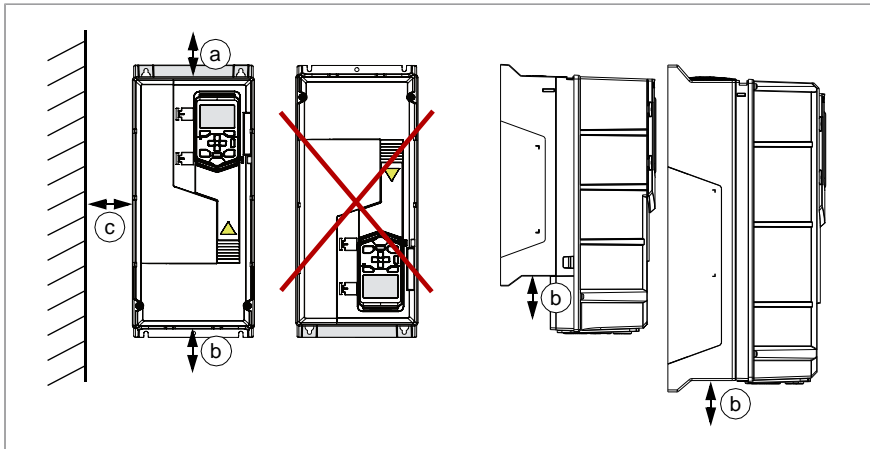


## Installation alternatives

The drive must be installed on the wall or an enclosure. There are three alternative ways to install it:

- Vertical

**Note:** Do not install the drive upside down.



Frame size	Vertical installation - Free space											
	IP21 (UL Type 1)						IP55 (UL Type 12)					
	Above (a) <sup>1)</sup>		Below (b) <sup>2)</sup>		Beside (c) <sup>3)</sup>		Above (a) <sup>1)</sup>		Below (b) <sup>2)</sup>		Beside (c) <sup>3)</sup>	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
R1	65	2.56	86	3.39	150	5.91	137	5.39	116	4.57	150	5.91
R2	65	2.56	86	3.39	150	5.91	137	5.39	116	4.57	150	5.91
R3	65	2.56	53	2.09	150	5.91	200	7.87	53	2.09	150	5.91
R4	53	2.09	200	7.87	150	5.91	53	2.09	200	7.87	150	5.91
R5	75	2.95	200	7.87	150	5.91	100	3.94	200	7.87	150	5.91
R6	155	6.10	300	11.81	150	5.91	155	6.10	300	11.81	150	5.91
R7	155	6.10	300	11.81	150	5.91	155	6.10	300	11.81	150	5.91
R8	155	6.10	300	11.81	150	5.91	155	6.10	300	11.81	150	5.91
R9	200	7.87	300	11.81	150	5.91	200	7.87	300	11.81	150	5.91

<sup>1)</sup> Free space above is measured from the frame, not from the hood used in UL Type 12 frames.



**Note:** The height of the hood for frames R4 and R9 exceeds the requirement of free space above for these frames

Frame size	Hood height (mm)	Hood height (in)
R4	72	2.83
R9	230	9.06

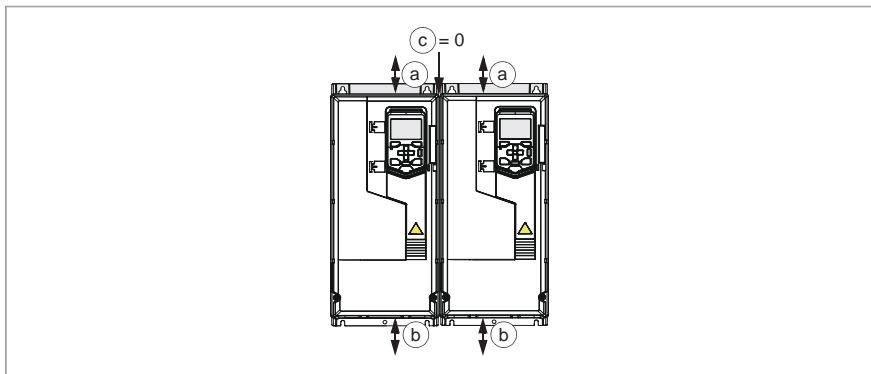
2) Free space below is always measured from the drive frame, not from the cable box.

3) Free space between the drive and other objects, e.g. wall.

**Note:** The recommended free space above and below the drive is for installations where the drive is mounted on a wall indoors. For ABB cabinet-built drives, which are thermally tested and approved for a specified temperature range, free space could vary from this recommendation.

Frame size	Vertical installation - Free space, IP66 (UL Type 4X)					
	Above (a)		Below (b)		Beside (c)	
	mm	in	mm	in	mm	in
R1	65	2.6	50	2.0	150	5.9
R2	65	2.6	50	2.0	150	5.9
R3	65	2.6	50	2.0	150	5.9

• Vertical side by side or between walls



Frame size	Vertical installation side by side - Free space, IP21 (UL Type 1) and IP55 (UL Type 12)					
	Above (a) <sup>1)</sup>		Below (b) <sup>2)</sup>		Between (c) <sup>3)</sup>	
	mm	in	mm	in	mm	in
R1	200	7.87	200	7.87	0	0
R2	200	7.87	200	7.87	0	0
R3	200	7.87	200	7.87	0	0
R4	200	7.87	200	7.87	0	0
R5	200	7.87	200	7.87	0	0
R6	200	7.87	300	11.8	0	0
R7	200	7.87	300	11.8	0	0
R8	200	7.87	300	11.8	0	0
R9	200	7.87	300	11.8	0	0

<sup>1)</sup> Free space above is measured from the frame, not from the hood used in UL Type 12 frames.

**Note:** The height of the hood for frame R9 exceeds the requirement of free space above for these frames

Frame size	Hood height (mm)	Hood height (in)
R9	230	9.06

<sup>2)</sup> Free space below is always measured from the drive frame, not from the cable box.

<sup>3)</sup> Free space between the drives.

**Note:** The recommended free space above and below the drive is for installations where the drive is mounted on a wall indoors. For ABB cabinet-built drives, which are thermally tested and approved for a specified temperature range, free space could vary from this recommendation.

**Note:** IP21 (UL Type 1) frames R1...R2: The cover fastening clips can be removed to make the front cover opening easier.

**Note:** IP55 (UL Type 12) frames R1...R2: Auxiliary fan maintenance cannot be performed without removing every second drive from installation to get access to the fan.



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Frame size	Vertical installation side by side - Free space, IP66 (UL Type 4X)					
	Above (a)		Below (b)		Beside (c)	
	mm	in	mm	in	mm	in
R1	200	7.9	200	7.9	0	0
R2	200	7.9	200	7.9	0	0
R3	200	7.9	200	7.9	0	0

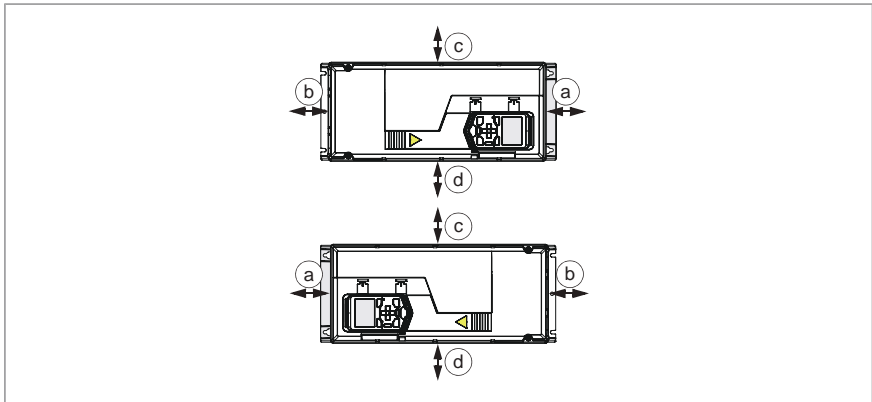
- Horizontal, IP20 and IP55, R1...R5 only

**Note 1:** You can install IP21/UL Type 1 drives horizontally, but the installation meets IP20 requirements only.

**Note 2:** IP55/UL Type 12 drives mounted horizontally meets IP21/UL Type 1 ratings.

**Note 3:** In the horizontal mounting, the drive is not protected from dripping water.

**Note 4:** The vibration specification in [Ambient conditions \(page 346\)](#) may not be fulfilled.



Frame size	Horizontal installation - Free space							
	IP21 (IP20)				IP55 (UL Type 12)			
	Above (a)		Below (b) <sup>1)</sup>		Above (a)		Below (b) <sup>1)</sup>	
	mm	in	mm	in	mm	in	mm	in
R1	150	5.91	86	3.39	137	5.39	116	4.57
R2	150	5.91	86	3.39	137	5.39	116	4.57
R3	200	7.87	53	2.09	200	7.87	53	2.09
R4	30	1.18	200	7.87	30	1.18	200	7.87
R5	30	1.18	200	7.87	30	1.18	200	7.87

Frame size	Side up (c)		Side down (d)		Side up (c)		Side down (d)	
	mm	in	mm	in	mm	in	mm	in
R1	30	1.18	200	7.87	30	1.18	200	7.87
R2	30	1.18	200	7.87	30	1.18	200	7.87
R3	30	1.18	200	7.87	30	1.18	200	7.87
R4	30	1.18	200	7.87	30	1.18	200	7.87
R5	30	1.18	200	7.87	30	1.18	200	7.87

<sup>1)</sup> Free space below is always measured from the drive frame, not from the cable box.

Frame size	Horizontal installation - Free space, IP66 (UL Type 4X)							
	Fan side (a)		Cable box side (b)		Side up (c)		Side down (d)	
	mm	in	mm	in	mm	in	mm	in
R1	150	5.9	50	2.0	30	1.2	200	7.9
R2	150	5.9	50	2.0	30	1.2	200	7.9
R3	200	7.9	50	2.0	30	1.2	200	7.9



## Necessary tools

To move a heavy drive, you need a crane, forklift or pallet truck (examine the load capacity).

To lift a heavy drive, you need a hoist.

To install the drive mechanically, you need these tools:

- drill with suitable bits
- screwdriver set (Torx, Phillips, flat and/or Pozidriv, as appropriate)
- torque wrench
- socket set, Hex key set (metric)
- tape measure, if you will not be using the provided mounting template.

## Moving the drive

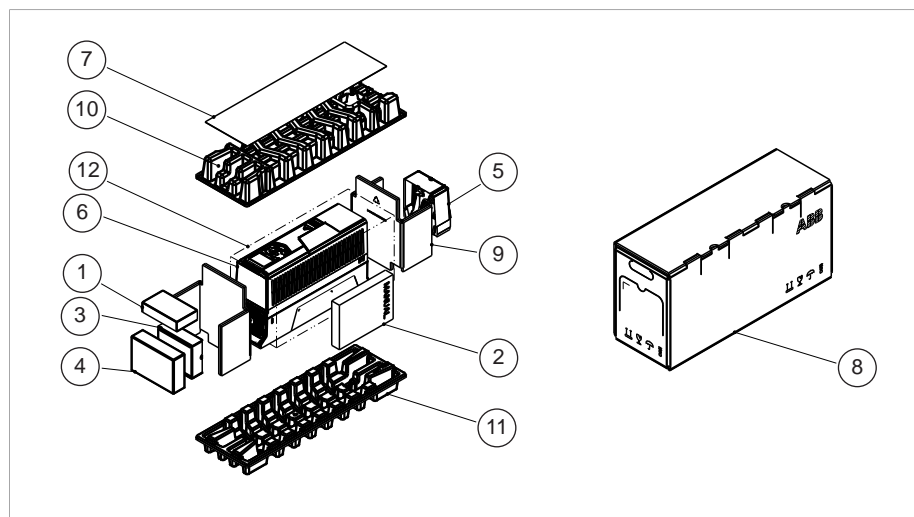
Frames R5...R9: Move the transport package by pallet truck to the installation site.





## Unpacking and examining delivery, frames R1 and R2

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section [Type designation label](#) (page 50).



1	Control panel selected in the order. North America: Control panel factory installed.	5	Cable box  <b>Note:</b> The cable box is mounted to the IP55 drive module frame at the factory.
2	Manuals <ul style="list-style-type: none"> <li>• Europe: Quick installation and start-up guide kit (6 languages)</li> <li>• North America: ACQ580-01 US Quick Installation Guide</li> <li>• Multilingual residual voltage warning stickers</li> </ul>	6	Drive
3	I/O option box	7	Mounting template
4	Fieldbus option box	8	Cardboard box
	<b>Note:</b> Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port EtherNet/IP adapter module) in the fieldbus option box. North America: Options may be ordered as factory installed.	9	End support (2 pcs)
		10	Top cushion
		11	Bottom cushion
		12	Plastic bag
			<b>Note:</b> Hood included with option +B056 (IP55/UL Type 12) in North America  <b>Note:</b> Hardware and firmware manuals can be ordered as a separate kit, see <a href="#">Manual kit ordering codes</a> (page 55)



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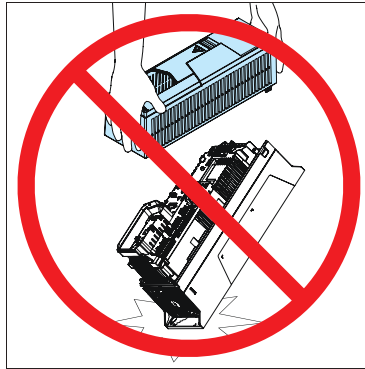
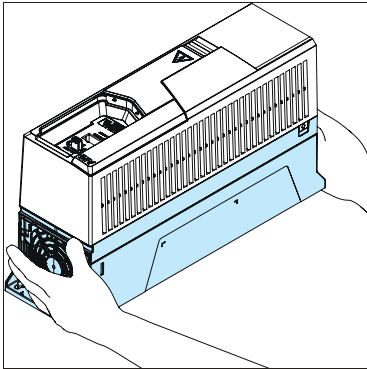
To unpack:

- Open the cardboard box (8)
- Remove the mounting template (7) and top cushion (10)
- Remove the control panel, option boxes and cable box (1,3,4,5)
- Remove the end supports (9)
- Remove the plastic bag (12)
- Lift the drive (6).



### **WARNING!**

**R1...R2, IP21:** Do not lift the drive by holding it from the cover. The drive can fall and become damaged or damage the surroundings.

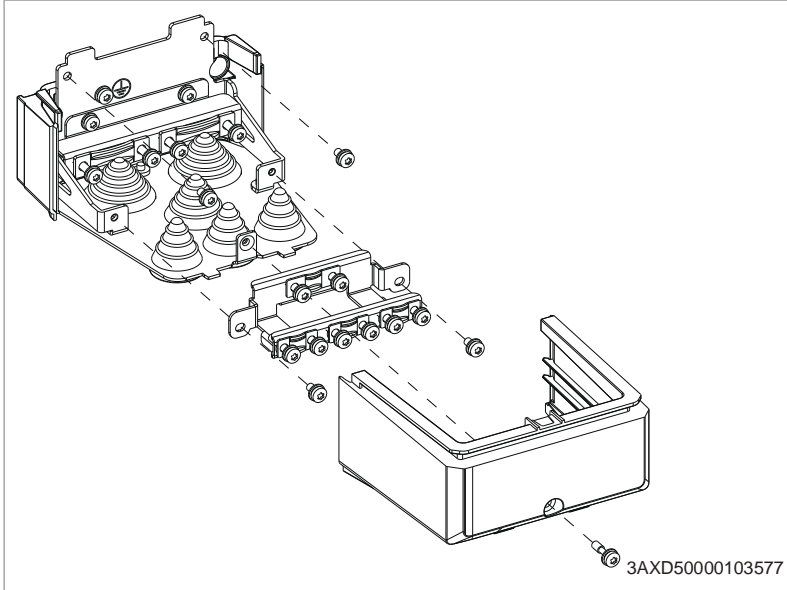


Recycle the package material according to local regulations.

### ■ Frames R1 and R2 cable box (IP21, UL Type 1)

This illustration shows the contents of the cable box package. The package also includes an assembly drawing which shows how to install the cable box to the drive module frame.

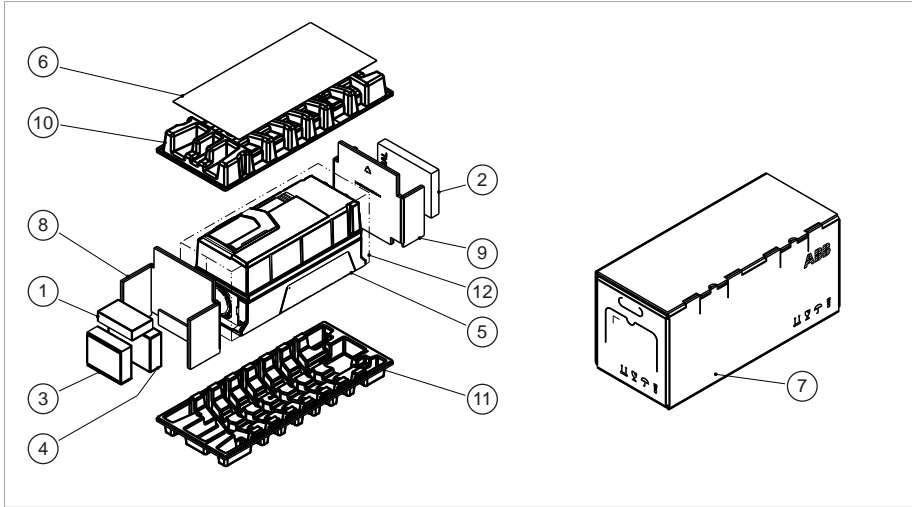
Follow the installation instructions in section [Installing the drive vertically, frames R1...R4](#) (page 84).



**Note:** Cable box is shipped with grommet cones pointing in. They must be removed and inserted back pointing out.

## Unpacking and examining delivery, frame R3

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section [Type designation label](#) (page 50).



1	Control panel selected in the order. North America: Control panel factory installed.	7	Cardboard box
2	Manuals <ul style="list-style-type: none"> <li>• Europe: Quick installation and start-up guide kit (6 languages)</li> <li>• North America: ACQ580-01 US Quick Installation Guide</li> <li>• Multilingual residual voltage warning stickers</li> </ul>	8	End support
3	I/O option box	9	End support
4	Fieldbus option box	10	Top cushion
5	Drive	11	Bottom cushion
6	Mounting template	12	Plastic bag

**Note:** Hood included with option +B056 (IP55/UL Type 12) in North America

**Note:** Hardware and firmware manuals can be ordered as a separate kit, see [Manual kit ordering codes](#) (page 55)

To unpack:

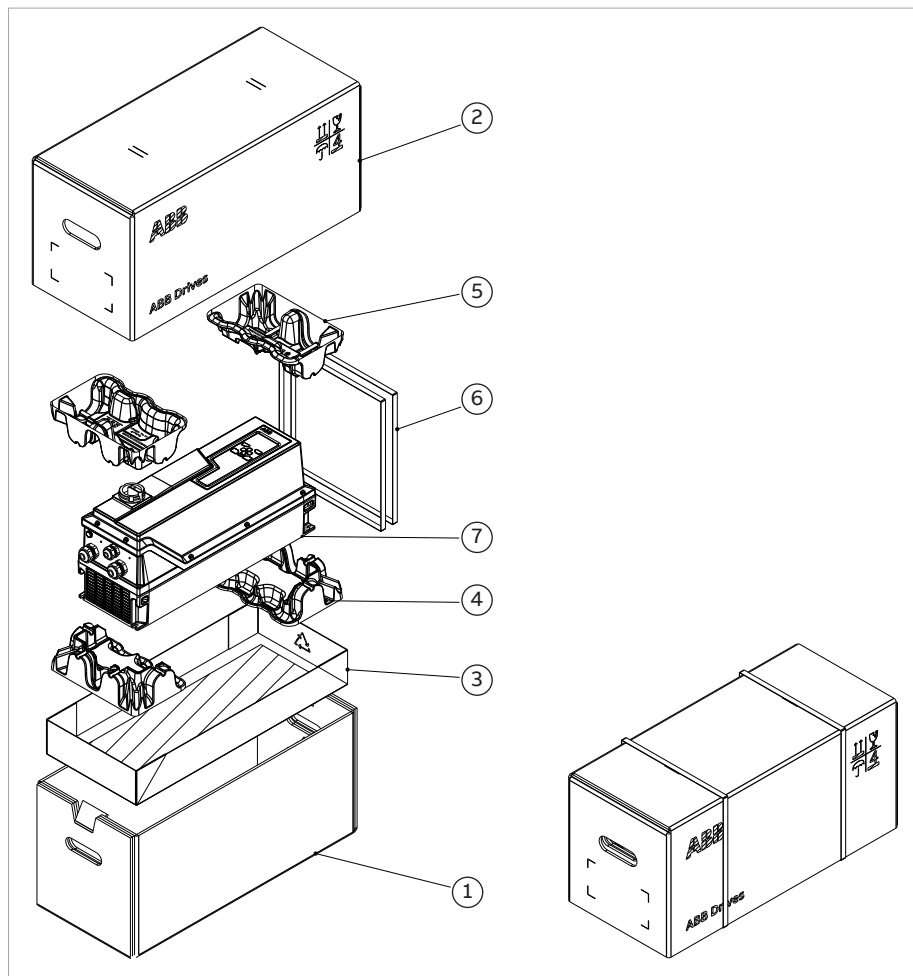
- Open the cardboard box (7)
- Remove the mounting template (6) and top cushion (10)
- Remove the control panel and option boxes (1,3,4)
- Remove the end supports (9)
- Remove the plastic bag (12)
- Lift the drive (5).

Recycle the package material according to local regulations.



## Unpacking and examining delivery, frames R1...R3, IP66 (UL Type 4X)

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section [Type designation label](#) (page 50).



1	Cardboard box bottom
2	Cardboard box lid
3	Cardboard tray
4	Bottom cushion (2 pcs)
5	Top cushion (2 pcs)
6	Straps (2 pcs)
7	Drive

To unpack:

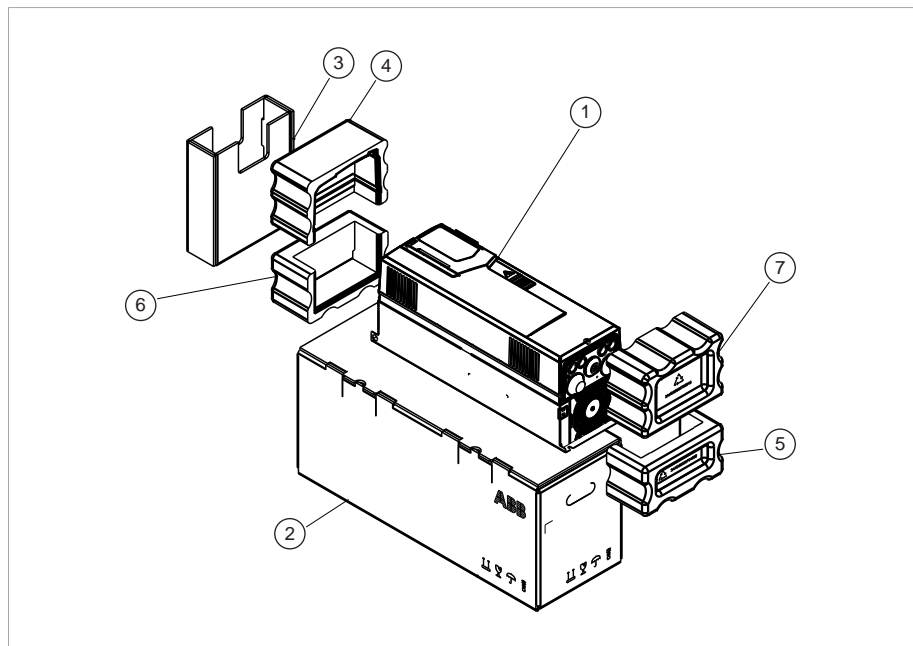
- Cut the straps (6)
- Lift the box lid (2)
- Remove the top cushions (5)
- Lift the drive (7).

Recycle the package material according to local regulations.



## Unpacking and examining delivery, frames R4

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section [Type designation label](#) (page 50).





1	Drive	4	Top cushion
2	Cardboard box. Mounting template in the cardboard box.	5	Bottom cushion
3	<b>Option support:</b> <ul style="list-style-type: none"> <li>• Europe: Quick installation and start-up guide kit (6 languages)</li> <li>• North America: ACQ580-01 US Quick Installation Guide</li> <li>• Multilingual residual voltage warning stickers</li> <li>• Control panel selected in the order (in a separate package) in the option box</li> <li>• North America: Control panel factory installed</li> <li>• Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port Ethernet/IP adapter module) in the option box</li> <li>• North America: Options may be ordered as factory installed.</li> </ul>	6	Bottom cushion
		7	Top cushion
		<p><b>Note:</b> Hood included with option +B056 (IP55/UL Type 12) in North America</p> <p><b>Note:</b> Hardware and firmware manuals can be ordered as a separate kit, see <a href="#">Manual kit ordering codes (page 55)</a></p>	

#### To unpack:

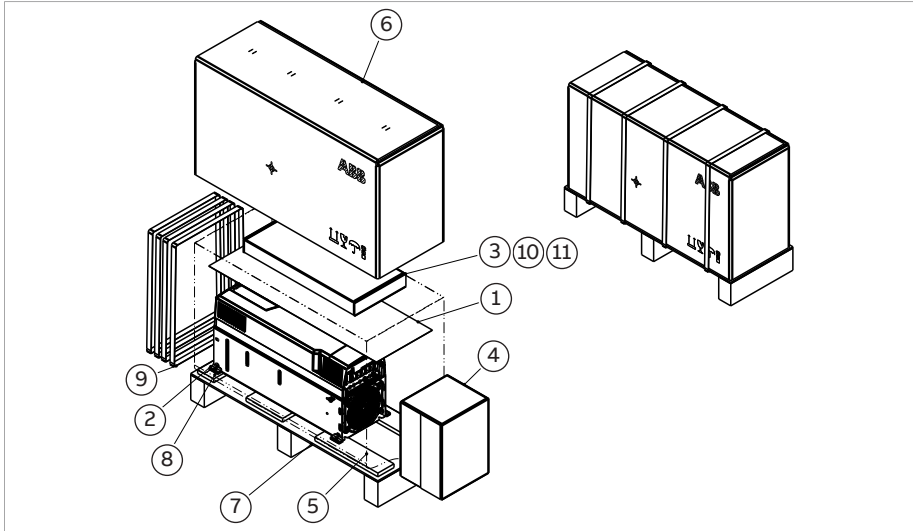
- Open box (2)
- Remove option support (3)
- Remove top cushions (4,7)
- Lift the drive (1) and remove bottom cushions (5,6).

Recycle the package material according to local regulations.



## Unpacking and examining delivery, frame R5 and R6

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section [Type designation label \(page 50\)](#).



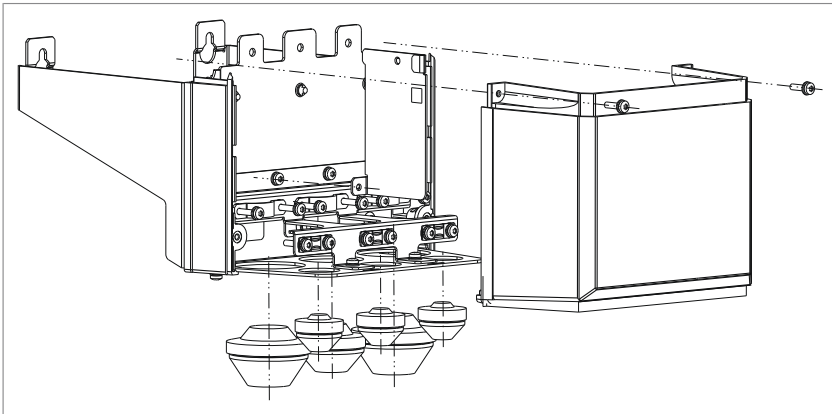
1	Mounting template	8	Screw M5×25, 4 pcs
2	Fixing brackets, 4 pcs	9	Straps
3	In the option box <ul style="list-style-type: none"> <li>• Europe: Quick installation and start-up guide kit (6 languages)</li> <li>• North America: ACQ580-01 US Quick Installation Guide</li> <li>• Multilingual residual voltage warning stickers</li> </ul>	10	Control panel selected in the order (in a separate package) in the option box North America: Control panel factory installed
4	Cable box <b>Note:</b> The cable box is mounted to the IP55 drive module frame at the factory.	11	Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port EtherNet/IP adapter module) in the option box. North America: Options may be ordered as factory installed.
5	VCI bag for protecting against dust and humidity	<b>Note:</b> Hood included with option +B056 (IP55/UL Type 12) in North America	
6	Cardboard box	<b>Note:</b> Hardware and firmware manuals can be ordered as a separate kit, see <a href="#">Manual kit ordering codes (page 55)</a>	
7	Pallet		

To unpack:

- Cut the straps (9).
- Remove the cardboard box (6) and option box (3).
- Remove the cover protecting film (5).
- Remove the fixing brackets (2).
- Lift the drive.

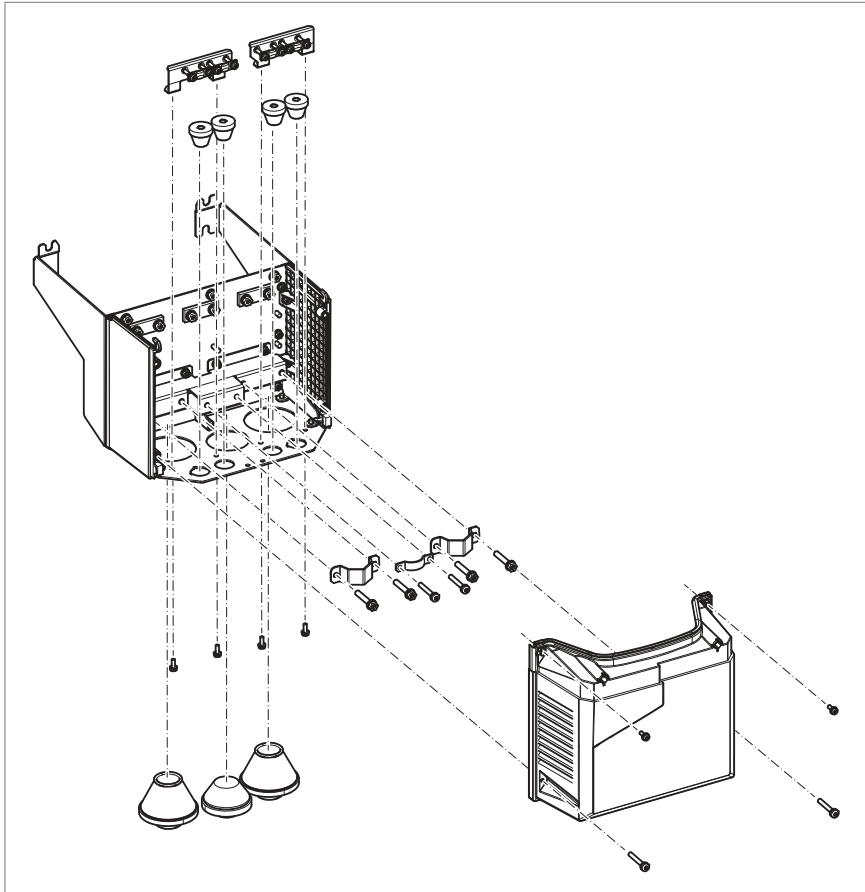
#### ■ Frame R5 cable box (IP21, UL Type 1)

This illustration shows the contents of the cable box package. The package also includes an assembly drawing which shows how to install the cable box to the drive module frame.

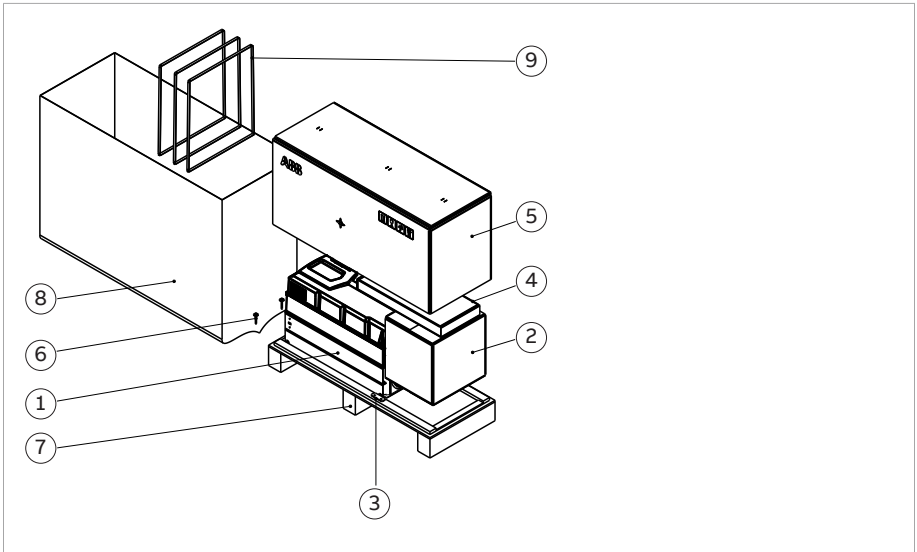


■ **Frame R6 cable box (IP21, UL Type 1)**

The figure below shows the contents of the cable box package. The package also includes an assembly drawing which shows how to install the cable box to the drive frame.



## Unpacking and examining delivery, frame R7



1	Drive with factory installed options
2	Cable box (not with option +B056, +C135 or +P944). <b>Note:</b> The cable box is mounted to the IP55 drive module frame at the factory.
3	Packing brackets, 2 pcs
4	In the option tray: <ul style="list-style-type: none"> <li>• Europe: Quick installation and start-up guide kit (6 languages)</li> <li>• North America: ACQ580-01 US Quick Installation Guide</li> <li>• Multilingual residual voltage warning stickers</li> </ul>
5	Cardboard box
6	Fixing screws, 2 pcs
7	Pallet
8	VCI bag for protecting against corrosion
9	Straps



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To unpack:

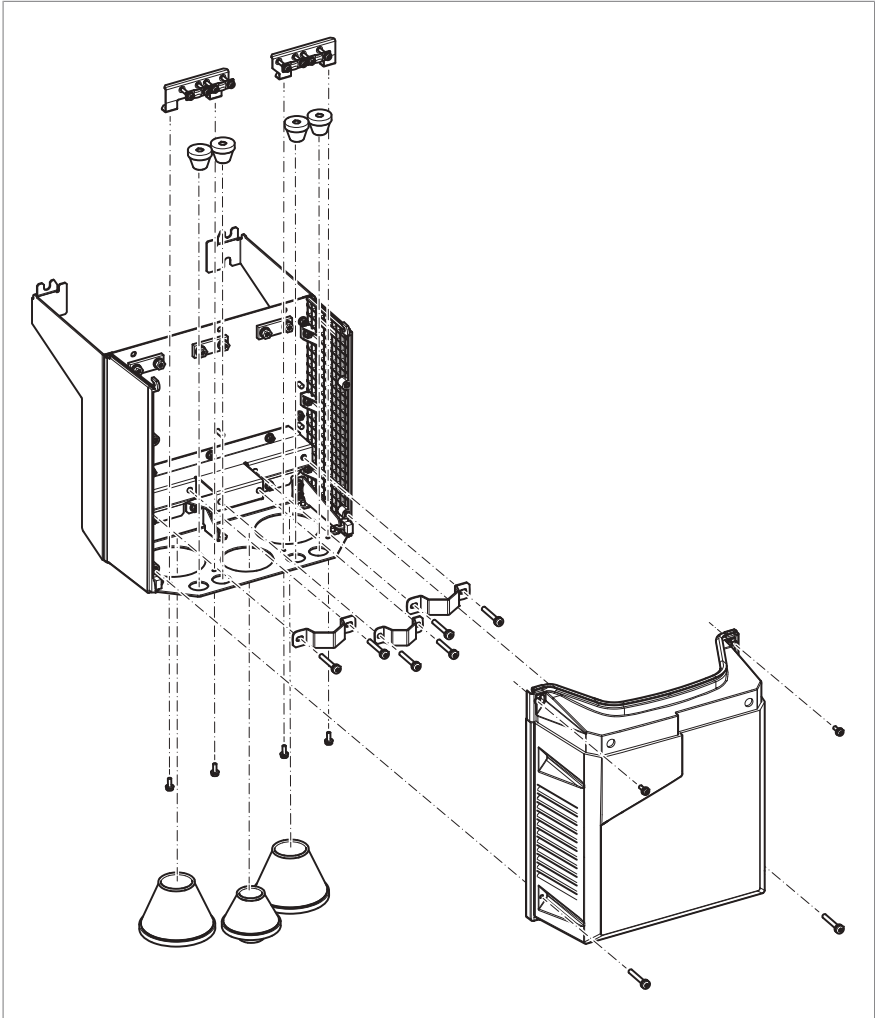
- Cut the straps (9).
- Remove the cardboard box (5) and option tray (4).
- Remove the VCI bag (8).
- Attach lifting hooks to the lifting eyes of the drive (see the figure in section [Safety \(page 57\)](#)).
- Lift the drive with a hoist.

Recycle the package material according to local regulations.



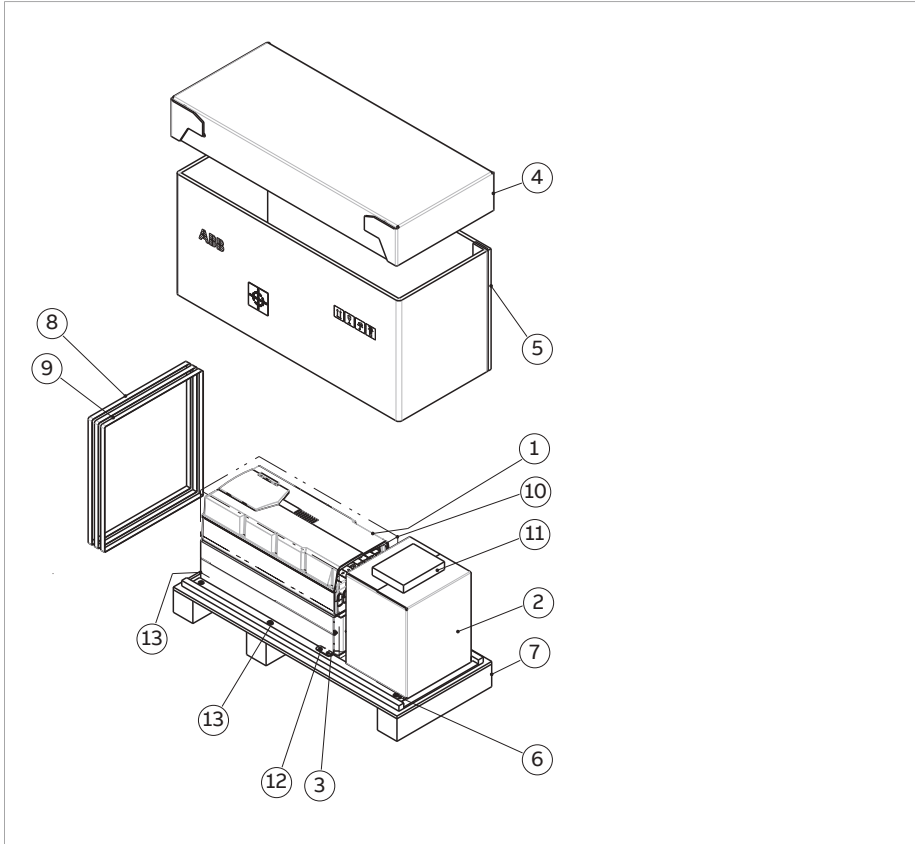
### ■ Frame R7 cable box (IP21, UL Type 1)

The figure below shows the contents of the cable box package. The package also includes an assembly drawing which shows how to install cable box to the drive frame.



## Unpacking and examining delivery, frames R8 and R9

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section [Type designation label \(page 50\)](#).





1	Drive with factory installed options	10	Control panel selected in the order (in a separate package) in the option tray North America: Control panel factory installed VCI bag for protecting against corrosion
2	Cable box. Power and control cable grounding shelves in a plastic bag, assembly drawing.  <b>Note:</b> The cable box is mounted to the IP55 drive module frame at the factory.	11	Documentation <ul style="list-style-type: none"> <li>• Europe: Quick installation and start-up guide kit (6 languages)</li> <li>• North America: ACQ580-01 US Quick Installation Guide</li> <li>• Multilingual residual voltage warning stickers</li> </ul>
3	Packing bracket	12, 13	Screws for fixing
4	Cardboard tray	<b>Note:</b> Hood included with option +B056 (IP55/UL Type 12) in North America	
5	Cardboard sleeve	<b>Note:</b> Hardware and firmware manuals can be ordered as a separate kit, see <a href="#">Manual kit ordering codes (page 55)</a>	
6	Plywood support		
7	Pallet		
8, 9	Straps		

To unpack:

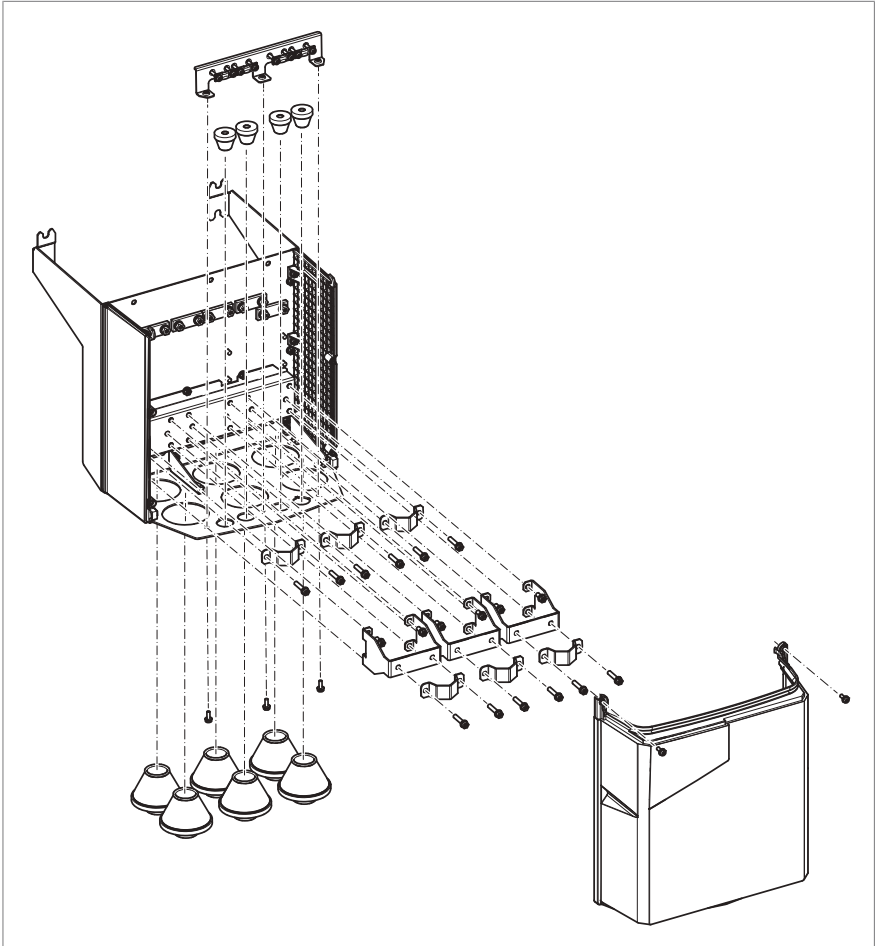
- Cut the straps (8, 9).
- Remove the cardboard tray (4) and sleeve (5).
- Remove the VCI bag (10).
- Attach lifting hooks to the lifting eyes of the drive (see the figure in section [Safety \(page 57\)](#)).
- Lift the drive with a hoist.

Recycle the package material according to local regulations.



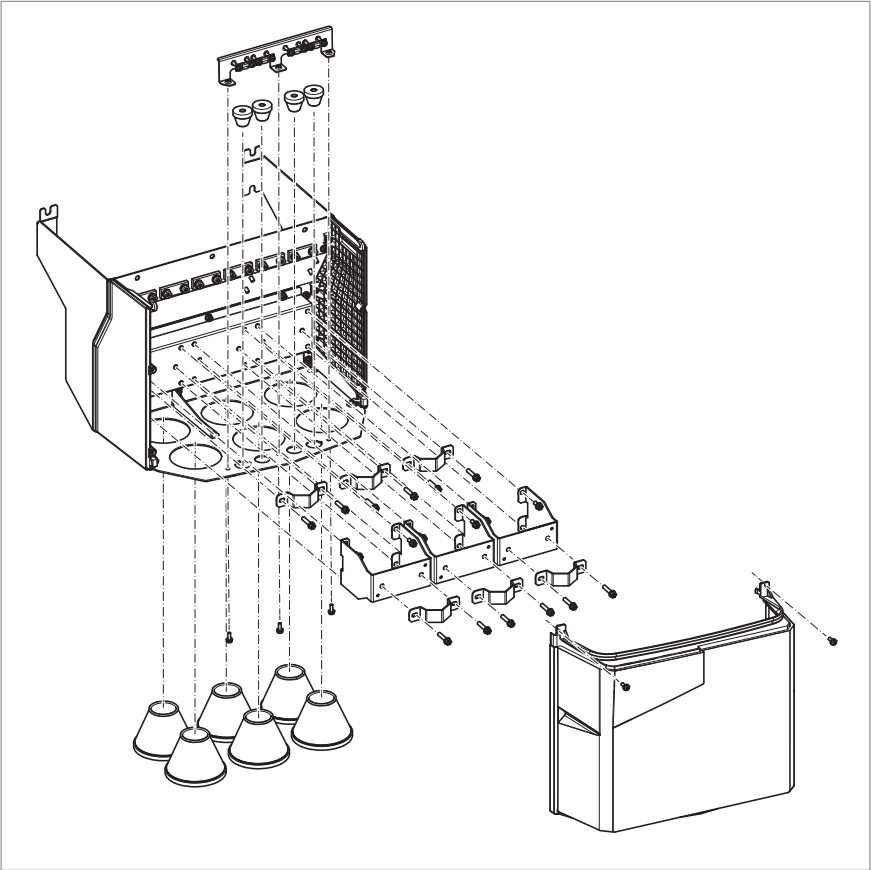
■ **Frame R8 cable box (IP21, UL Type 1)**

The figure below shows the contents of the cable box package. The package also includes an assembly drawing which shows how to install the cable box to the drive frame.



■ **Frame R9 cable box (IP21, UL Type 1)**

The figure below shows the contents of the cable box package. The package also includes an assembly drawing which shows how to install the cable box to the drive frame.



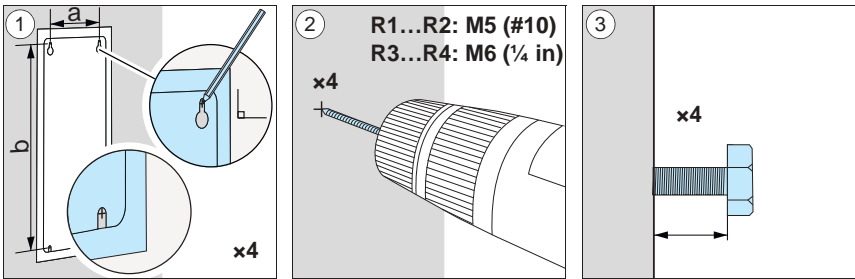
## Installing the drive

### ■ Installing the drive vertically, frames R1...R4

The figures show frame R3 as an example.

Select fasteners and their application to meet local requirements appropriate to wall surface materials, drive weight and application.

1. Mark the hole locations using the mounting template included in the package. Do not leave the mounting template under the drive. The drive dimensions and hole locations are also shown in the drawings in chapter [Dimension drawings \(page 361\)](#).
2. Drill the mounting holes.
3. Insert anchors or plugs into the holes and start the bolts into the anchors or plugs.



	R1		R2		R3		R4		R4 v2	
	mm	in	mm	in	mm	in	mm	in	mm	in
<b>a</b>	98	3.86	98	3.86	160	6.30	160	6.30	160	6.30
<b>b</b>	317	12.48	417	16.42	473	18.62	619	24.37	619	24.37
<b>Weight IP21 (UL Type 1)</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
	4.6	10.1	6.6	14.6	11.8	26.0	19.0	41.9	22.0	48.5
<b>Weight IP55 (UL Type 12)</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
	4.8	10.6	6.8	15.0	13.0	28.7	20.0	44.1	23.0	50.7

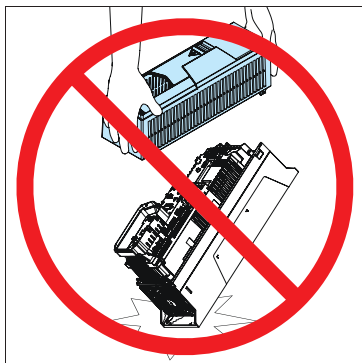
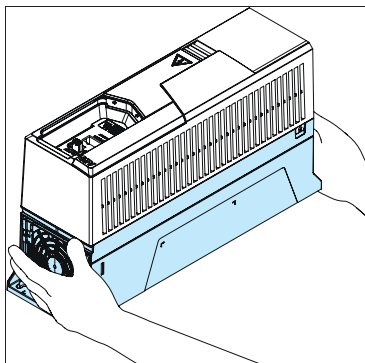
IP66 (UL Type 4X)	R1		R2		R3	
	mm	in	mm	in	mm	in
<b>a</b>	175	6.89	175	6.89	244	9.61
<b>b</b>	497	19.57	581	22.87	622	24.49
<b>Weight</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
	11.8	26	14.5	32	26.4	58

4. Position the drive onto the lower bolts (4a) on the wall to support the weight of the drive. Rotate drive to the wall and place drive over the upper bolts (4b).

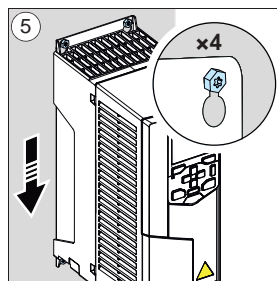
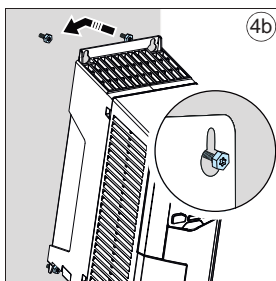
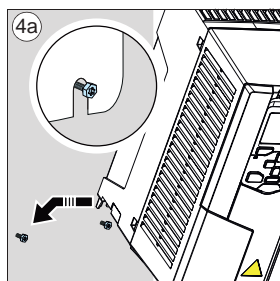


**WARNING!**

R1...R2, IP21: Do not lift the drive by holding it from the cover. The drive can fall and become damaged or damage the surroundings.



5. Tighten the bolts in the wall securely.

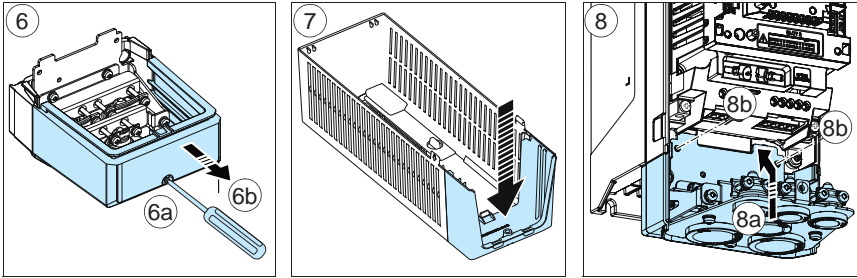


**Installing the cable box, frames R1...R2**

6. Remove the screw (6a) and lift the cover off (6b) from the separate cable box.

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7. Attach the cable box cover to the front cover.
8. Install the cable box to the frame. Position the cable box (8a) and tighten the screws (8b).



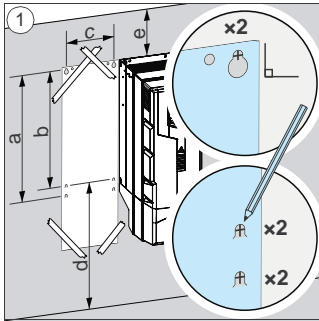
**Note:** Install the hood to UL Type 12 drives after you have installed the drive electrically and reinstalled covers, see [Installing UL Type 12 hood \(page 210\)](#).

### ■ Installing the drive vertically, frame R5

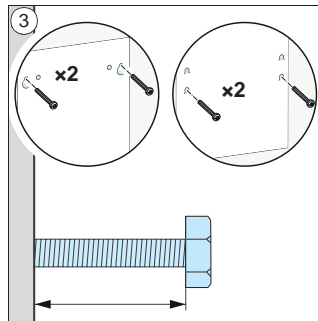
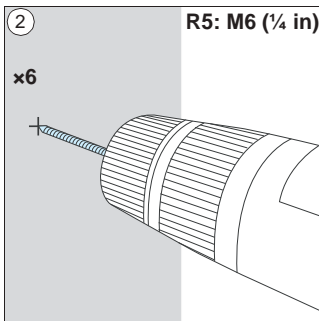
Select fasteners and their application to meet local requirements appropriate to wall surface materials, drive weight and application.

1. Mark the hole locations using the mounting template included in the package. Do not leave the mounting template under the drive. The drive dimensions and hole locations are also shown in the drawings in chapter [Dimension drawings \(page 361\)](#).
2. Drill the mounting holes.
3. Insert fixing anchors or plugs into the holes. Start the two upper bolts and the two lowest bolts into the anchors or plugs.





	R5 IP21 (UL Type 1)		R5 IP55 (UL Type 12)	
	mm	in	mm	in
<b>a</b>	612	24.09	612	24.09
<b>b</b>	581	22.87	581	22.87
<b>c</b>	160	6.30	160	6.30
<b>d &gt;</b>	200	7.87	200	7.87
<b>e &gt;</b>	100	3.94	100	3.94
	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
	28.3	62.4	29.0	64.0

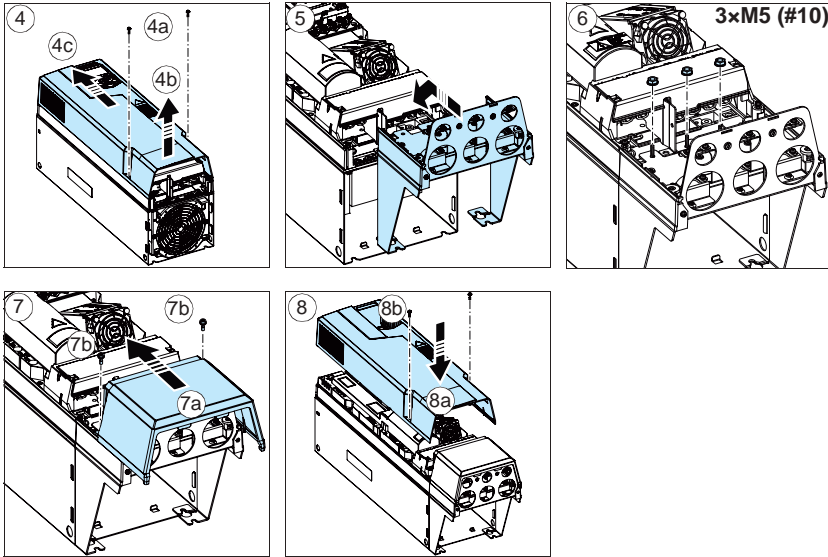


### IP21 (UL Type 1)

4. Remove the front cover: Remove the fastening screws (4a) with a T20 Torx screwdriver and lift the cover from the bottom upwards (4b) and then to the top side (4c).
5. Attach the cable box to the drive frame.
6. Tighten the box nuts.
7. Slide the box cover from the bottom (7a) and tighten the retaining screws (7b).



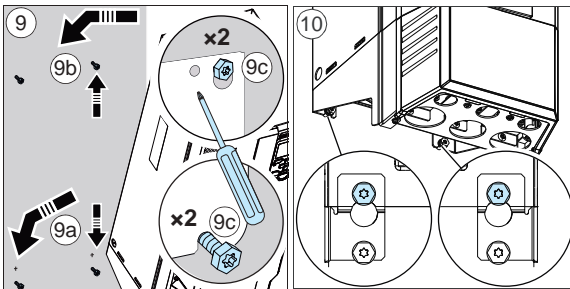
- Put the tabs at the top of the front cover in their counterparts on the housing and then press at the bottom (8a) and tighten the retaining screws (8b).



**IP21 (UL Type 1), IP55 (UL Type 12)**



- Position the drive onto the lower bolts (9a) on the wall to support the weight of the drive. Rotate drive to the wall and place drive over the upper bolts (9b). Lift the drive with another person or with a lifting device as it is heavy. Tighten the bolts in the wall securely (9c).
- Tighten the two remaining bolts securely.



**Note:** Install the hood to UL Type 12 drives after you have installed the drive electrically and reinstalled covers, see [Installing UL Type 12 hood \(page 210\)](#).

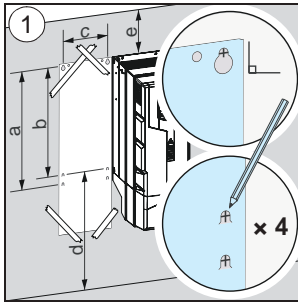


## ■ Installing the drive vertically, frames R6...R9

Select fasteners and their application to meet local requirements appropriate to wall surface materials, drive weight and application.

1. Mark the hole locations for the six mounting holes using the mounting template included in the package. Do not leave the mounting template under the drive. The drive dimensions and hole locations are also shown in the drawings in chapter [Dimension drawings \(page 361\)](#).

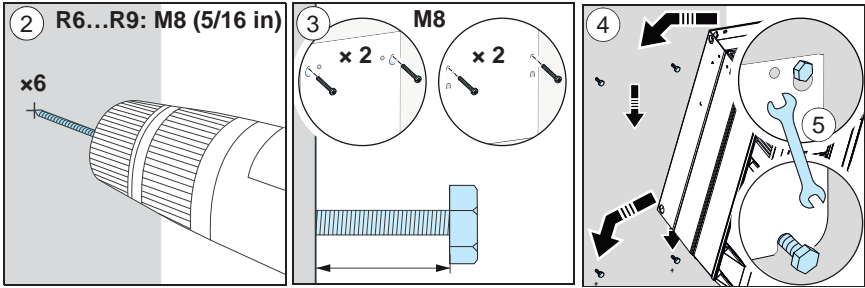
**Note:** You can use only two bolts instead of four to attach the lower part of the drive.



	R6		R7		R8		R9	
	mm	in	mm	in	mm	in	mm	in
<b>a</b>	571	22.5	623	24.5	701	27.6	718	28.3
<b>b</b>	531	20.9	583	23.0	658	25.9	658	25.9
<b>c</b>	213	8.4	245	9.7	263	10.3	345	13.6
<b>d</b>	300	11.8	300	11.8	300	11.8	300	11.8
<b>e</b>	155	6.1	155	6.1	155	6.19	200	7.9
<b>IP21, UL Type 1</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
	42.4	93.5	54	119.1	69	152.2	97	213.9
<b>IP55, UL Type 12</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
	43	94.8	56	123.5	77	169.8	103	227.1

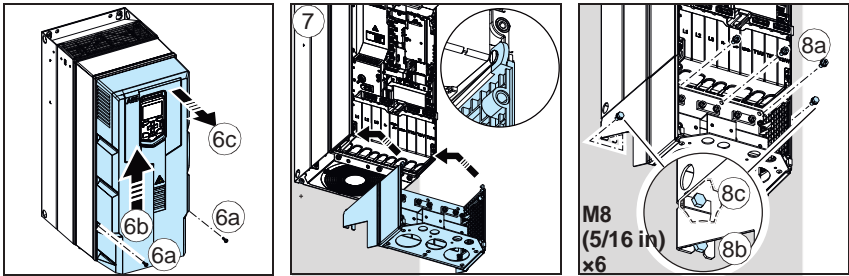
2. Drill the mounting holes.
3. Insert fixing anchors or plugs into the holes and start the bolts into the anchors or plugs.
4. Position the drive onto the bolts on the wall. Lift the drive with a lifting device as it is heavy.
5. Tighten the top two bolts in the wall securely.





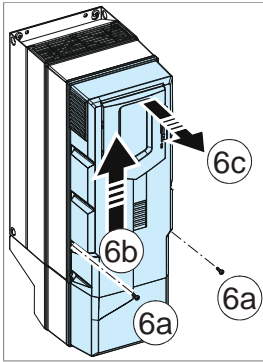
**IP21 (UL Type 1)**

6. Remove the front cover: Remove the fastening screws (a) with a T20 Torx screwdriver, move the cover to the top side (b) and then up (c).
7. Attach the cable box to the drive frame.
8. Tighten the box bolts: three at the top (8a) and two at the bottom (8b). Also tighten the bottom bolts started in step 3 (8c).



## IP55 (UL Type 12)

- Remove the front cover: Remove the fastening screws (a) with a T20 Torx screwdriver, move the cover to the top side (b) and then up (c).



**Note:** Install the hood to UL Type 12 drives after you have installed the drive electrically and reinstalled covers, see [Installing UL Type 12 hood \(page 210\)](#).

### ■ Installing the drive vertically side by side

Install the drive following the steps in the appropriate section [Installing the drive vertically, frames R1...R4 \(page 84\)](#), [Installing the drive vertically, frame R5 \(page 86\)](#) or [Installing the drive vertically, frames R6...R9 \(page 89\)](#).

### ■ Installing the drive horizontally, frames R1...R5

Install the drive following the steps in the appropriate section [Installing the drive vertically, frames R1...R4 \(page 84\)](#) or [Installing the drive vertically, frame R5 \(page 86\)](#). The drive can be installed either the left or right side up.

### ■ Installing the IP66 (UL Type 4X) drive outdoors

When the IP66 (UL Type 4X) drive is installed in an environment where development of dew or frost is possible, take extra precautions to prevent condensation within the drive.

- Maintain power to the drive at all times. Whenever the drive is powered up, even when the motor is not being controlled, the drive will generate heat and the internal fan will run. This will help to prevent condensation.
- Seal the conduit openings. Cold damp air can enter the drive through the conduit under the right conditions causing frost to form in the cable box. Use a sealant around the wires to prevent air infiltration through the conduit.



3. Close the drive cover with dry air. Very little air is allowed to enter the drive once the cover is secured. Closing the drive cover when the ambient air is dry will help to prevent condensation inside the drive. ABB recommends closing the drive cover when the ambient air is cold (below freezing) or when it is warm and the relative humidity (RH) is low. For example, RH < 40 % in air at 21 °C (70 °F); RH < 30 % in air at 27 °C (80 °F).

### Flange mounting

Instructions for flange mounting are delivered with the flange mounting kit:

[Flange mounting kit quick installation guide for ACX580-01 frames R1 to R3 \(3AXD50000119172 \[English\]\)](#)

[Flange mounting kit quick installation guide for ACX580-01 frames R4 to R5 \(3AXD50000287093 \[English\]\)](#)

[Flange mounting kit quick installation guide for ACS880-01 and ACX580-01 frames R6 to R9 \(3AXD50000019099 \[English\]\)](#)

[Flange mounting quick installation guide for ACX580-01 IP66 \(Type 4X\) frames R1 to R3 \(3AXD50001019310\) \[English\]](#)

For more information on flange mounting, see [ACS580-01](#), [ACH580-01](#) and [ACQ580-01 +C135 drives with flange mounting kit supplement \(3AXD50000349821 \[English\]\)](#).

### Strut channel installation (US only)



Contents of the mounting kit:

- Upper mounting clip labeled “Top”
- Lower mounting clip labeled “Bottom”

#### ■ Installation instructions

Install clips when mounting frame sizes R1...R3 to strut channel.

1. Slide clips onto respective upper and lower mounting flanges of the drive.
2. Push until they click into place.

# 5

## Guidelines for planning the electrical installation

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### Contents of this chapter

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

### Limitation of liability

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

#### ■ North America

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

<sup>1)</sup> 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.

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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.

## Examining the compatibility of the motor and drive

Use asynchronous AC induction motors, permanent magnet synchronous motors or ABB synchronous reluctance motors (SynRM motors) with the drive.

Select the motor size and drive type from the rating table on basis of the AC line voltage and motor load. You can find the rating table in the appropriate hardware manual. You can also use the DriveSize PC tool.

Make sure that the motor can be used with an AC drive. See [Requirements tables \(page 95\)](#). For basics of protecting the motor insulation and bearings in drive systems, see [Protecting the motor insulation and bearings \(page 94\)](#).

### Note:

- Consult the motor manufacturer before using a motor with nominal voltage that differs from the AC line voltage connected to the drive input.
- The voltage peaks at the motor terminals are relative to the supply voltage of the drive, not to the drive output voltage.

### ■ Protecting the motor insulation and bearings

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

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the terminals. This can cause additional stress on the motor and motor cable insulation.

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

$du/dt$  filters protect motor insulation system and reduce bearing currents. Common mode filters mainly reduce bearing currents. Insulated N-end (non-drive end) bearings protect the motor bearings.

### ■ Requirements tables

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

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**Requirements for ABB motors,  $P_n < 100$  kW (134 hp)**

See also [Abbreviations \(page 100\)](#).

Motor type	Nominal AC line voltage	Requirement for	
		Motor insulation system	ABB $du/dt$ and common mode filters, insulated N-end motor bearings
			$P_n < 100$ kW and frame size < IEC 315
			$P_n < 134$ hp and frame size < NEMA 500
Random-wound M2_, M3_ and M4_	$U_n \leq 500$ V	Standard	-
	$500$ V < $U_n \leq 600$ V	Standard	+ $du/dt$
		Reinforced	-
	$600$ V < $U_n \leq 690$ V (cable length $\leq 150$ m)	Reinforced	+ $du/dt$
$600$ V < $U_n \leq 690$ V (cable length > 150 m)	Reinforced	-	
Form-wound HX_ and AM_	$380$ V < $U_n \leq 690$ V	Standard	N/A
Old <sup>1)</sup> form-wound HX_ and modular	$380$ V < $U_n \leq 690$ V	Check with the motor manufacturer.	+ N + $du/dt$ with voltages over 500 V + CMF
Random-wound HX_ and AM_ <sup>2)</sup>	$0$ V < $U_n \leq 500$ V	Enamelled wire with fiber glass taping	+ N + CMF
	$500$ V < $U_n \leq 690$ V		+ N + $du/dt$ + CMF
HDP	Consult the motor manufacturer.		

1) manufactured before 1.1.1998

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



**Requirements for ABB motors,  $P_n \geq 100$  kW (134 hp)**See also [Abbreviations \(page 100\)](#).

Motor type	Nominal AC line voltage	Requirement for		
		Motor insulation system	ABB $du/dt$ and common mode filters, insulated N-end motor bearings	
			$100 \text{ kW} \leq P_n < 350 \text{ kW}$ or $IEC 315 \leq \text{frame size} < IEC 400$	$P_n \geq 350 \text{ kW}$ or frame size $\geq IEC 400$
		$134 \text{ hp} \leq P_n < 469 \text{ hp}$ or $NEMA 500 \leq \text{frame size} \leq NEMA 580$	$P_n \geq 469 \text{ hp}$ or frame size $> NEMA 580$	
Random-wound M2_, M3_ and M4_	$U_n \leq 500 \text{ V}$	Standard	+ N	+ N + CMF
	$500 \text{ V} < U_n \leq 600 \text{ V}$	Standard	+ N + $du/dt$	+ N + $du/dt$ + CMF
		Reinforced	+ N	+ N + CMF
	$600 \text{ V} < U_n \leq 690 \text{ V}$ (cable length $\leq 150 \text{ m}$ )	Reinforced	+ N + $du/dt$	+ N + $du/dt$ + CMF
$600 \text{ V} < U_n \leq 690 \text{ V}$ (cable length $> 150 \text{ m}$ )	Reinforced	+ N	+ N + CMF	
Form-wound HX_ and AM_	$380 \text{ V} < U_n \leq 690 \text{ V}$	Standard	+ N + CMF	$P_n < 500 \text{ kW}$ : + N + CMF
				$P_n \geq 500 \text{ kW}$ : + N + $du/dt$ + CMF
Old <sup>1)</sup> form-wound HX_ and modular	$380 \text{ V} < U_n \leq 690 \text{ V}$	Check with the motor manufacturer.	+ N + $du/dt$ with voltages over 500 V + CMF	
Random-wound HX_ and AM_ <sup>2)</sup>	$0 \text{ V} < U_n \leq 500 \text{ V}$	Enamelled wire with fiber glass taping	+ N + CMF	
	$500 \text{ V} < U_n \leq 690 \text{ V}$		+ N + $du/dt$ + CMF	
HDP	Consult the motor manufacturer.			

1) manufactured before 1.1.1998

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

**Requirements for non-ABB motors,  $P_n < 100$  kW (134 hp)**

See also [Abbreviations \(page 100\)](#).

Motor type	Nominal AC line voltage	Requirement for	
		Motor insulation system	ABB $du/dt$ and common mode filters, insulated N-end motor bearings
			$P_n < 100$ kW and frame size < IEC 315
		$P_n < 134$ hp and frame size < NEMA 500	
Random-wound and form-wound	$U_n \leq 420$ V	Standard: $\hat{U}_{LL} = 1300$ V	-
	$420$ V < $U_n \leq 500$ V	Standard: $\hat{U}_{LL} = 1300$ V	+ $du/dt$
		Reinforced: $\hat{U}_{LL} = 1600$ V, 0.2 $\mu$ s rise time	-
	$500$ V < $U_n \leq 600$ V	Reinforced: $\hat{U}_{LL} = 1600$ V	+ $du/dt$
		Reinforced: $\hat{U}_{LL} = 1800$ V	-
	$600$ V < $U_n \leq 690$ V	Reinforced: $\hat{U}_{LL} = 1800$ V	+ $du/dt$
		Reinforced: $\hat{U}_{LL} = 2000$ V, 0.3 $\mu$ s rise time <sup>1)</sup>	-

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

**Requirements for non-ABB motors,  $P_n \geq 100$  kW (134 hp)**

See also [Abbreviations \(page 100\)](#).

Motor type	Nominal AC line voltage	Requirement for		
		Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings	
			$100 \text{ kW} \leq P_n < 350 \text{ kW}$ or $IEC 315 \leq \text{frame size} < IEC 400$	$P_n \geq 350 \text{ kW}$ or frame size $\geq IEC 400$
		$134 \text{ hp} \leq P_n < 469 \text{ hp}$ or $NEMA 500 \leq \text{frame size} \leq NEMA 580$	$P_n \geq 469 \text{ hp}$ or frame size $> NEMA 580$	
Random-wound and form-wound	$U_n \leq 420 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	+ N or CMF	+ N + CMF
	$420 \text{ V} < U_n \leq 500 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	+ du/dt + (N or CMF)	+ N + du/dt + CMF
		Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$ , 0.2 $\mu\text{s}$ rise time	+ N or CMF	+ N + CMF
	$500 \text{ V} < U_n \leq 600 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$	+ du/dt + (N or CMF)	+ N + du/dt + CMF
		Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	+ N or CMF	+ N + CMF
	$600 \text{ V} < U_n \leq 690 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	+ du/dt + N	+ N + du/dt + CMF
		Reinforced: $\hat{U}_{LL} = 2000 \text{ V}$ , 0.3 $\mu\text{s}$ rise time <sup>1)</sup>	+ N + CMF	+ N + CMF

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

**Abbreviations**

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

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

See chapter [Common mode,  \$du/dt\$  and sine filters](#)

**Additional requirements for explosion-safe (EX) motors**

If you use an explosion-safe (EX) motor, obey the rules in the requirements table above. In addition, consult the motor manufacturer for any further requirements.

**Additional requirements for ABB motors of types other than M2\_, M3\_, M4\_, HX\_ and AM\_**

Use the selection criteria given for non-ABB motors.

**Additional requirements for braking applications**

When the motor brakes the machinery, the intermediate circuit DC voltage of the drive increases, the effect being similar to the motor supply voltage increasing by up to 20 percent. Consider this voltage increase when specifying the motor insulation requirements if the motor will be braking a large part of its operation time.

Example: Motor insulation requirement for a 400 V AC line voltage application must be selected as if the drive were supplied with 480 V.

**Additional requirements for ABB high-output and IP23 motors**

The rated output power of high output motors is higher than what is stated for the particular frame size in EN 50347 (2001).

This table shows the requirements for protecting the motor insulation and bearings in drive systems for ABB random-wound motor series (for example, M3AA, M3AP and M3BP).

Nominal AC supply voltage	Requirement for			
	Motor insulation system	ABB $du/dt$ and common mode filters, insulated N-end motor bearings		
		$P_n < 100 \text{ kW}$	$100 \text{ kW} \leq P_n < 200 \text{ kW}$	$P_n \geq 200 \text{ kW}$
		$P_n < 140 \text{ hp}$	$140 \text{ hp} \leq P_n < 268 \text{ hp}$	$P_n \geq 268 \text{ hp}$
$U_n \leq 500 \text{ V}$	Standard	-	+ N	+ N + CMF
$500 \text{ V} < U_n \leq 600 \text{ V}$	Standard	+ $du/dt$	+ $du/dt$ + N	+ $du/dt$ + N + CMF
	Reinforced	-	+ N	+ N + CMF
$600 \text{ V} < U_n \leq 690 \text{ V}$	Reinforced	+ $du/dt$	+ $du/dt$ + N	+ $du/dt$ + N + CMF

### Additional requirements for non-ABB high-output and IP23 motors

The rated output power of high-output motors is higher than what is stated for the particular frame size in EN 50347 (2001).

If you plan to use a non-ABB high-output motor or an IP23 motor, consider these additional requirements for protecting the motor insulation and bearings in drive systems:

- If motor power is below 350 kW: Equip the drive and/or motor with the filters and/or bearings according to the table below.
- If motor power is above 350 kW: Consult the motor manufacturer.

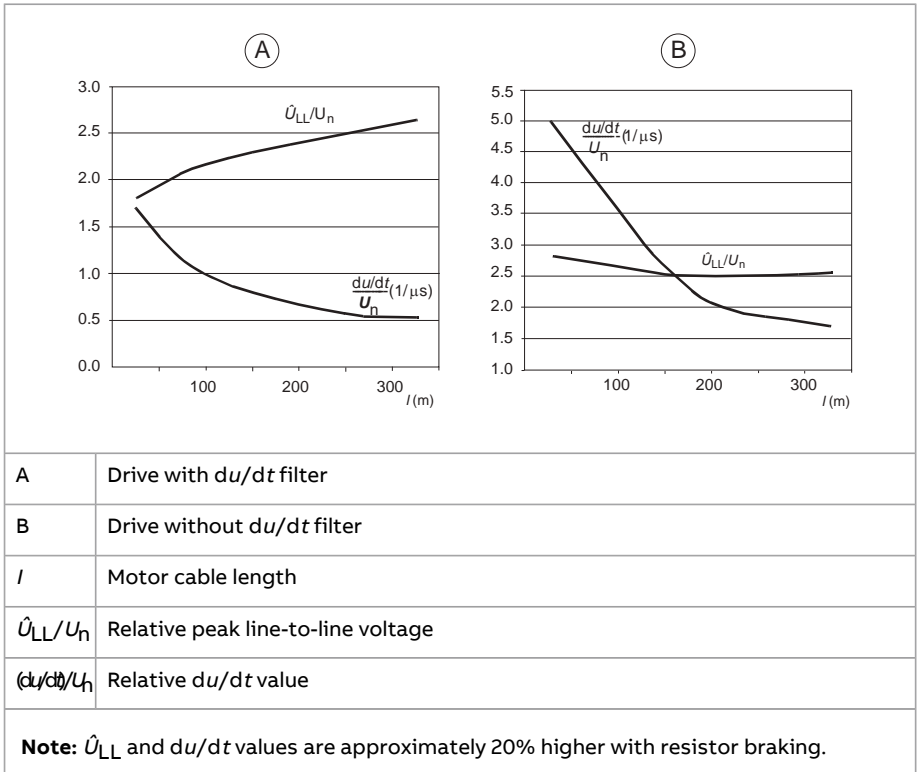
Nominal AC supply voltage	Requirement for		
	Motor insulation system	ABB du/dt and common mode filters, insulated N-end motor bearings	
		$P_n < 100 \text{ kW}$ or frame size < IEC 315	$100 \text{ kW} < P_n < 350 \text{ kW}$ or IEC 315 < frame size < IEC 400
	$P_n < 134 \text{ hp}$ or frame size < NEMA 500	$134 \text{ hp} < P_n < 469 \text{ hp}$ or NEMA 500 < frame size < NEMA 580	
$U_n \leq 420 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	+ N or CMF	+ N or CMF
$420 \text{ V} < U_n < 500 \text{ V}$	Standard: $\hat{U}_{LL} = 1300 \text{ V}$	+ du/dt + (N or CMF)	+ N + du/dt + CMF
	Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$ , 0.2 micro-second rise time	+ N or CMF	+ N or CMF
$500 \text{ V} < U_n \leq 600 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1600 \text{ V}$	+ du/dt + (N or CMF)	+ N + du/dt + CMF
	Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	+ N or CMF	+ N + CMF
$600 \text{ V} < U_n \leq 690 \text{ V}$	Reinforced: $\hat{U}_{LL} = 1800 \text{ V}$	+ N + du/dt	+ N + du/dt + CMF
	Reinforced: $\hat{U}_{LL} = 2000 \text{ V}$ , 0.3 micro-second rise time <sup>1)</sup>	+ N + CMF	+ N + CMF

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

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

The diagrams below show the relative peak line-to-line voltage and rate of change of voltage as a function of the motor cable length. If you need to calculate the actual peak voltage and voltage rise time considering the actual cable length, proceed as follows:

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



**Additional note for sine filters**

A sine filter also protects the motor insulation system. The peak phase-to-phase voltage with a sine filter is approximately  $1.5 \cdot U_n$ .

## 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 \(page 105\)](#).

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

Metal conduit reduces electromagnetic emission of the whole drive system.

### ■ Typical power cable sizes

See the technical data in the appropriate hardware manual.

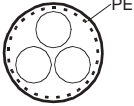


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■ **Power cable types**




**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
 <p>Symmetrical shielded (or armored) cable with three phase conductors and concentric PE conductor as shield (or armor)</p>	Yes	Yes
 <p>Symmetrical shielded (or armored) cable with three phase conductors and symmetrically constructed PE conductor and a shield (or armor)</p>	Yes	Yes
 <p>Symmetrical shielded (or armored) cable with three phase conductors and a shield (or armor), and separate PE conductor/cable<sup>1)</sup></p>	Yes	Yes


<sup>1)</sup> 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
 <p>Four-conductor cable in plastic jacket (three phase conductors and PE)</p>	<p>Yes with phase conductor smaller than 10 mm<sup>2</sup> (8 AWG) Cu.</p>	<p>Yes with phase conductor smaller than 10 mm<sup>2</sup> (8 AWG) Cu, or motors up to 30 kW (40 hp). <b>Note:</b> Shielded or armored cable, or cabling in metal conduit is always recommended to minimize radio frequency interference.</p>
 <p>Four-conductor armored cable (three phase conductors and PE)</p>	<p>Yes</p>	<p>Yes with phase conductor smaller than 10 mm<sup>2</sup> (8 AWG) Cu, or motors up to 30 kW (40 hp)</p>
 <p>Shielded (Al/Cu shield or armor)<sup>1)</sup> four-conductor cable (three phase conductors and a PE)</p>	<p>Yes</p>	<p>Yes with motors up to 100 kW (135 hp). A potential equalization between the frames of motor and driven equipment is required.</p>

<sup>1)</sup> 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
 <p data-bbox="143 395 420 470">Symmetrical shielded cable with individual shields for each phase conductor</p>	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 <sup>1) 2)</sup>	
Electrical metallic tubing: Type EMT	Prefer symmetrical shielded VFD cable.
Rigid metal conduit: Type RMC	Use separate conduit run for each motor.
Liquid-tight flexible metal electrical conduit: Type LFMC	Do not run input power wiring and motor wiring in the same conduit.
Conduit - Non-metallic <sup>2) 3)</sup>	
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 <sup>2)</sup>	
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.

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Wiring method	Notes
Free air <sup>2)</sup>	
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.

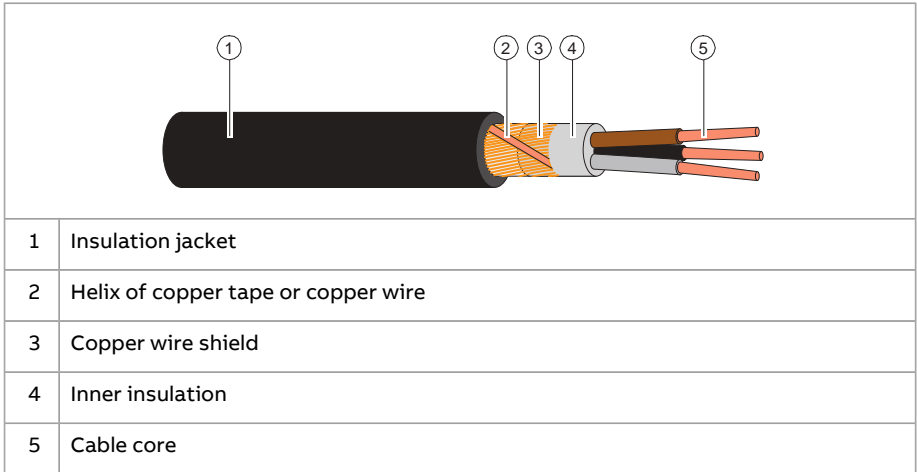
## Metal conduit

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.



## Grounding requirements

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

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

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

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

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

Cross-sectional area of the phase conductors $S$ (mm <sup>2</sup> )	Minimum cross-sectional area of the corresponding protective earth conductor $S_p$ (mm <sup>2</sup> )
$S \leq 16$	$S^{1)}$
$16 < S \leq 35$	16
$35 < S$	$S/2$

<sup>1)</sup> For the minimum conductor size in IEC installations, refer to [Additional grounding requirements – IEC](#).

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

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

■ **Additional grounding requirements – IEC**

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

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

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

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

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

### ■ Additional grounding requirements – UL (NEC)

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

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

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

## Selecting the control cables

### ■ Shielding

Only use shielded control cables.

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

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



### ■ Signals in separate cables

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

### ■ Signals that can be run in the same cable

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

■ **Relay cable**

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

■ **Control panel to drive cable**

Use EIA-485, Cat 5e (or better) cable with male RJ45 connectors. The maximum length of the cable is 100 m (328 ft).

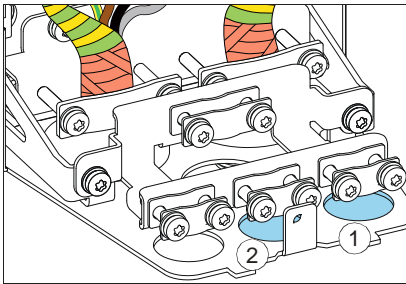
■ **PC tool cable**

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

■ **FPBA-01 PROFIBUS DP adapter module connectors**

Frames R1...R3: The following connector types have been tested to fit in the tight space for option slot 1.

- Phoenix Contact SUBCON-PLUS-PROFIB/PG/SC2, part number 2708245. Lead the cable through the control cable hole on the right in the entry plate (1).
- Siemens, part number 6GK1 500 0EA02. Lead the cable through the middle control cable hole in the entry plate (2).



## Routing the cables

■ **General guidelines – IEC**

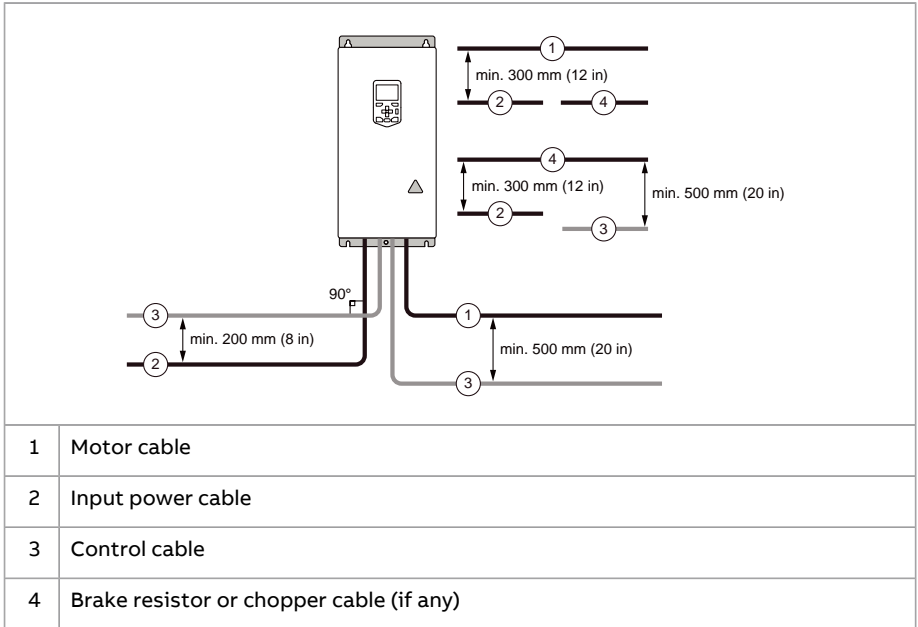
- Route the motor cable away from other cables. Motor cables of several drives can be run in parallel installed next to each other.
  - Install the motor cable, input power cable and control cables on separate trays.
  - Avoid long parallel runs of motor cables with other cables.
  - Where control cables must cross power cables, make sure that they are arranged at an angle as near to 90 degrees as possible.
-



- Do not run extra cables through the drive.
- Make sure that the cable trays have good electrical bonding to each other and to the grounding electrodes. Aluminum tray systems can be used to improve local equalizing of potential.

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

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

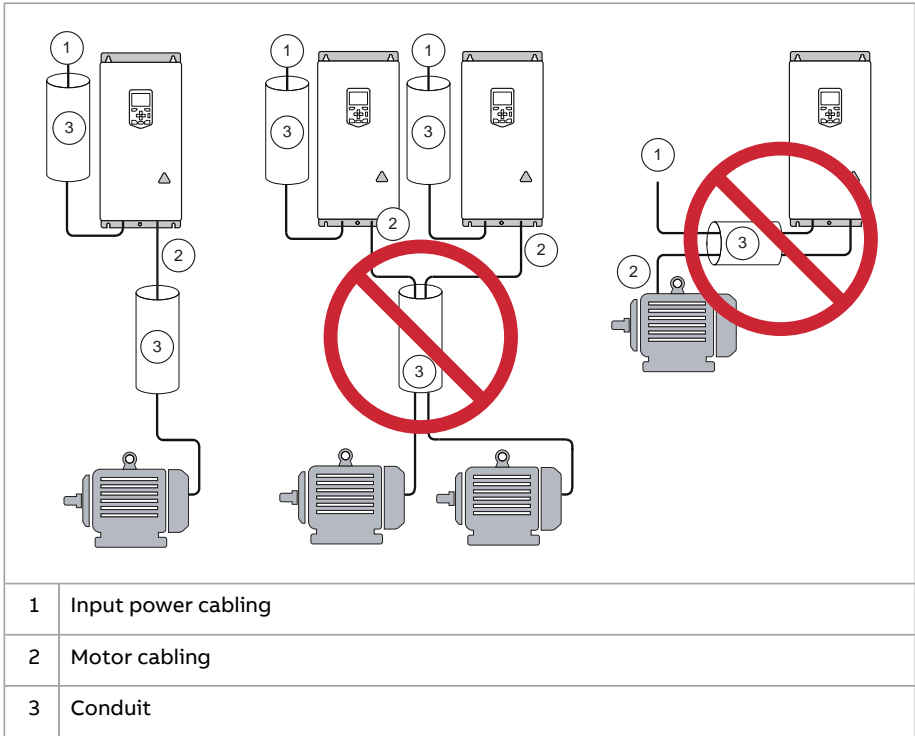


### ■ General guidelines – North America

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

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

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



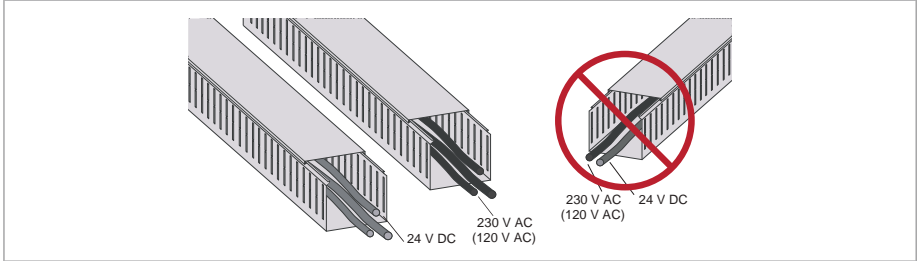
■ **Continuous motor cable shield/conduit and metal enclosure for equipment on the motor cable**

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

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

### ■ Separate control cable ducts

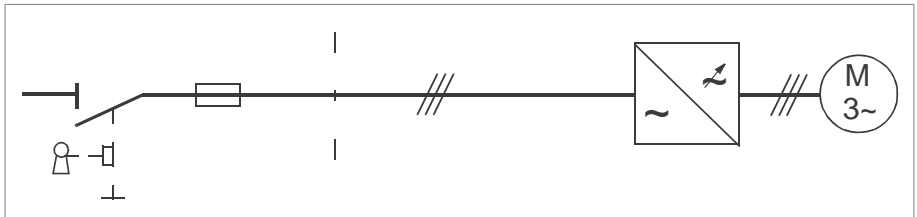
Put 24 V DC and 230 V AC (120 V AC) control cables in separate ducts, unless the 24 V DC cable is insulated for 230 V AC (120 V AC) or insulated with an insulation sleeving for 230 V AC (120 V AC).



## Implementing short-circuit and thermal overload protection

### ■ Protecting the drive and the input power cable in short-circuits

Protect the drive and the input cable with fuses or a circuit breaker.



Select the fuses or circuit breakers according to local regulations for the input cable protection. Select the fuses or circuit breakers for the drive according to the instructions given in the technical data. The fuses or circuit breakers for the drive protection will restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive.

**Note:** If the fuses or circuit breakers for the drive protection are placed at the distribution board and the input cable is selected according to the nominal input current of the drive given in the technical data, the fuses or circuit breakers protect also the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive. No separate fuses or circuit breakers for the input cable protection are required.



**WARNING!**

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

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■ **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 motor cables against thermal overload**

The drive protects the motor cables against thermal overload when the cables are sized according to the nominal output current of the drive. No additional thermal protection devices are needed.

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**WARNING!**

If the drive is connected to multiple motors, use a separate overload protection for each motor cable and motor. The drive overload protection is tuned for the total motor load. It may not detect an overload in one motor circuit only.

North America: The local code (NEC) requires an overload protection and a short-circuit protection for each motor circuit. Use, for example:

- manual motor protector
  - circuit breaker, contactor and overload relay or
  - fuses, contactor and overload relay.
- 

■ **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

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a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value, the function either monitors a calculated temperature value (based on a motor thermal model) or an actual temperature indication given by motor temperature sensors.

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

The most common temperature sensor types are PTC or Pt100.

For more information, see the firmware manual.

### ■ **Protecting the motor against overload without thermal model or temperature sensors**

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

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

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

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

For more information, see drive firmware manual.

## **Protecting the drive against ground faults**

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

### ■ **Residual current device compatibility**

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

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

---

## Implementing the emergency stop function

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

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

## Implementing the Safe torque off function

Refet to chapter [The Safe torque off function \(page 407\)](#).

## Using power factor compensation capacitors with the drive

Power factor compensation is not needed with AC drives. However, if a drive is to be connected in a system with compensation capacitors installed, note the following restrictions.



### **WARNING!**

Do not connect power factor compensation capacitors or harmonic filters to the motor cables (between the drive and the motor). They are not meant to be used with AC drives and can cause permanent damage to the drive or themselves.

---

If there are power factor compensation capacitors in parallel with the input of the drive:

1. Do not connect a high-power capacitor to the power line while the drive is connected. The connection will cause voltage transients that may trip or even damage the drive.
2. If capacitor load is increased/decreased step by step when the AC drive is connected to the power line, make sure that the connection steps are low enough not to cause voltage transients that would trip the drive.
3. Make sure that the power factor compensation unit is suitable for use in systems with AC drives, ie, harmonic generating loads. In such systems, the compensation unit should typically be equipped with a blocking reactor or harmonic filter.

## Controlling a contactor between drive and motor

The control of the output contactor depends on how you use the drive, that is, which motor control mode and which motor stop mode you select.

If you have the vector control mode and motor ramp stop selected, open the contactor as follows:

---

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

If you have the vector control mode and motor coast stop selected, or scalar control mode selected, open the contactor as follows:

1. Give a stop command to the drive.
2. Open the contactor.



### **WARNING!**

When the vector control mode is in use, never open the output contactor while the drive controls the motor. The vector control operates extremely fast, much faster than it takes for the contactor to open its contacts. When the contactor starts opening while the drive controls the motor, the vector control will try to maintain the load current by immediately increasing the drive output voltage to the maximum. This will damage, or even burn, the contactor completely.

## **Implementing an ATEX-certified motor thermal protection**

With option +Q971, the drive provides ATEX-certified safe motor disconnection without contactor using the drive Safe torque off function. To implement the thermal protection of a motor in explosive atmosphere (Ex motor), you must also:

- use an ATEX-certified Ex motor
- order an ATEX-certified thermistor protection module for the drive (option +L537), or acquire and install an ATEX-compliant protection relay
- do the necessary connections.

For more information, see:

<b>User's manual</b>	<b>Manual code (English)</b>
CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) user's manual	<a href="#">3AXD50000030058</a>
CPTC-02 ATEX-certified thermistor protection module, instructions for pairing the module with an ATEX-certified drive	<a href="#">3AXD10001243391</a>

## **Implementing the power loss ride-through function**

If the incoming supply voltage is cut off, the drive will continue to operate by utilizing the kinetic energy of the rotating motor. The drive will be fully operational as long as the motor rotates and generates energy to the drive.

If you equip the drive with a main contactor or breaker, make sure that it restores the drive input power after a short break. The contactor must either re-connect after the break automatically, or remain closed over the break. Depending on the contactor control circuit design, this can require an additional hold circuit, uninterruptible auxiliary power supply or auxiliary power supply buffering.

**Note:** If the power loss lasts so long that the drive trips on undervoltage, a fault reset and a fresh start command is required to continue operation.

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

1. Enable the power-loss ride-through function of the drive (parameter 30.31).
2. If the installation is equipped with a main contactor, prevent its tripping at the input power break. For example, use a time delay relay (hold) in the contactor control circuit.
3. Enable the automatic restart of the motor after a short power supply break:
  - Set the start mode to automatic (parameter 21.01 or 21.19, depending on the motor control mode being used).
  - Define the automatic restart time (parameter 21.18).



**WARNING!**

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

---

## Using a safety switch between the drive and the motor

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

## Implementing a bypass connection

If bypassing is required, employ mechanically or electrically interlocked contactors between the motor and the drive and between the motor and the power line. Make sure with interlocking that the contactors cannot be closed simultaneously. The installation must be clearly marked as defined in IEC/EN/UL 61800-5-1, subclause 6.5.3, for example, “THIS MACHINE STARTS AUTOMATICALLY”.



**WARNING!**

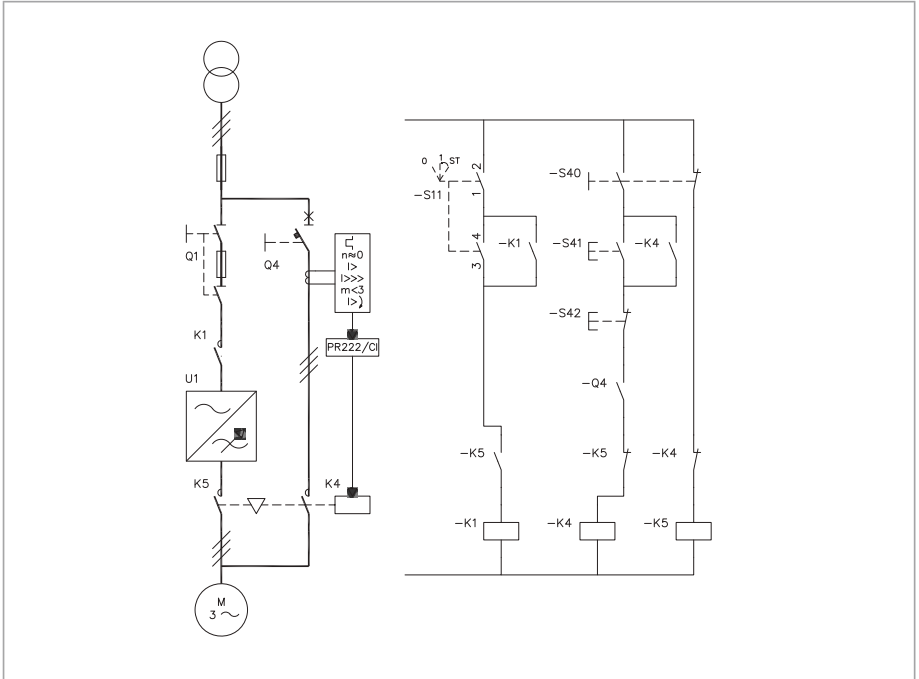
Never connect the drive output to the electrical power network. The connection may damage the drive.

---



■ **Example bypass connection**

An example bypass connection is shown below.



Q1	Drive main switch
Q4	Bypass circuit breaker
K1	Drive main contactor
K4	Bypass contactor
K5	Drive output contactor
S11	Drive main contactor on/off control
S40	Motor power supply selection (drive or direct-on-line)
S41	Start when motor is connected direct-on-line
S42	Stop when motor is connected direct-on-line

### **Switching the motor power supply from drive to direct-on-line**

1. Stop the drive and the motor with the drive control panel stop key (drive in the local control mode) or the external stop signal (drive in the remote control mode).
2. Open the main contactor of the drive with S11.
3. Switch the motor power supply from the drive to direct-on-line with S40.
4. Wait for 10 seconds to allow the motor magnetization to dissipate.
5. Start the motor with S41.

### **Switching the motor power supply from direct-on-line to drive**

1. Stop the motor with S42.
2. Switch the motor power supply from direct-on-line to the drive with S40.
3. Close the main contactor of the drive with switch S11 (-> turn to position ST for two seconds and leave to position 1).
4. Start the drive and the motor with the drive control panel start key (drive in the local control mode) or the external start signal (drive in remote control mode).

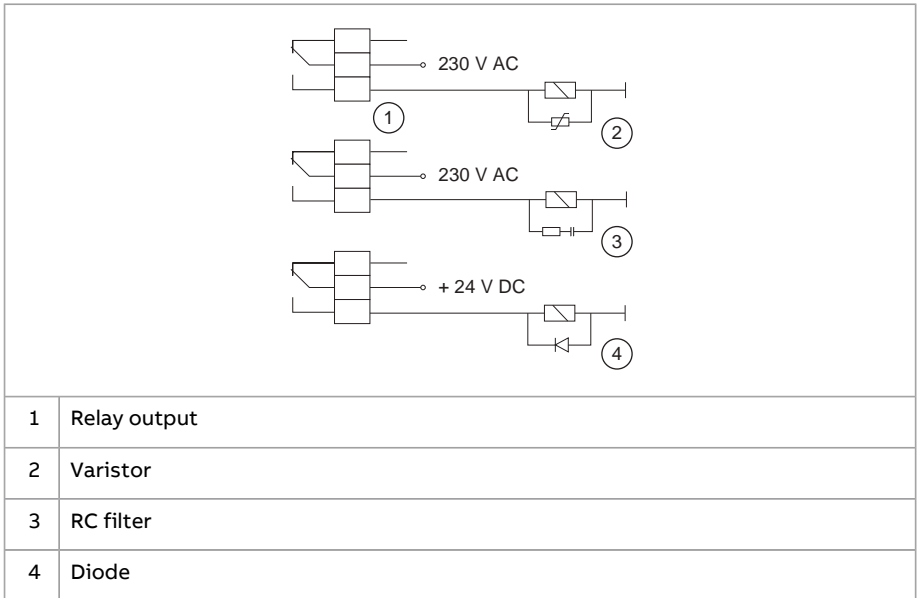
## **Protecting the contacts of relay outputs**

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.

---



## Limiting relay output maximum voltages at high installation altitudes

See [Isolation areas \(page 227\)](#) for frames R1...R5 and [Isolation areas \(page 231\)](#) for frames R6...R9.

## Implementing a motor temperature sensor connection



### WARNING!

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

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

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

You have these implementation alternatives:

1. If there is double or reinforced insulation between the sensor and the live parts of the motor: You can connect the sensor directly to the analog/digital input(s) of the drive. See the control cable connection instructions. Make sure that the voltage is not more than the maximum allowed voltage over the sensor.

2. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect the sensor to the drive via an option module. The sensor and the module must form a double or reinforced insulation between the motor live parts and the drive control unit. See [Connecting a motor temperature sensor to the drive through an option module \(page 124\)](#). Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
3. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect a sensor to a digital input of the drive via an external relay. The sensor and the relay must form a double or reinforced insulation between the motor's live parts and the digital input of the drive. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.

■ **Connecting a motor temperature sensor to the drive through an option module**

This table shows:

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

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	Insulation/Isolation	PTC	KTY	Pt100, Pt1000	
CMOD-02	Reinforced insulation between the sensor connector and other connectors (including drive control unit connector).  The drive control unit is PELV compatible also when the module and a thermistor protection circuit are installed.	x	-	-	No special requirement
CPTC-02		x	-	-	No special requirement

For more information, refer to

- [Connecting motor temperature sensors to the drive \(page 221\)](#)

- CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface) (page 445)
  - CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537+Q971) user's manual (3AXD50000030058 [English]).
-



# 6

## Electrical installation – Global (IEC)

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### 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:

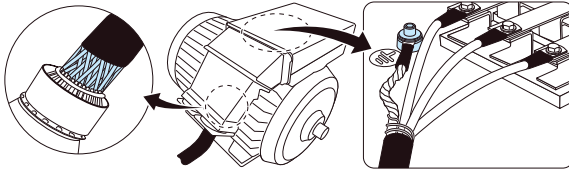
- wire stripper
- screwdriver set (Torx, Phillips, flat and/or Pozidriv, as appropriate)
- torque wrench.

### Grounding the motor cable shield at the motor end

For minimum radio-frequency interference, ground the cable shield 360° at the cable entry of the motor terminal box.

---





## Measuring the insulation

### ■ Measuring the insulation resistance of the drive

---



**WARNING!**

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

---

### ■ Measuring the insulation resistance of the input power cable

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

### ■ Measuring the insulation resistance of the motor and motor cable


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**WARNING!**

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

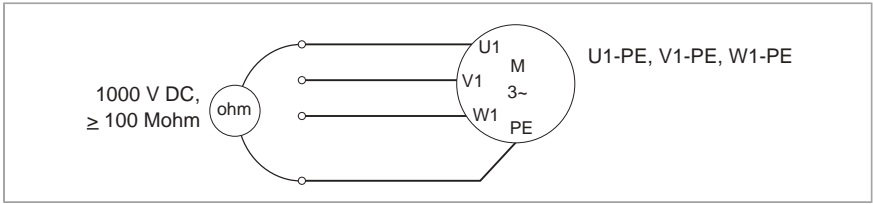
---

- 
1. Do the steps in section [Electrical safety precautions \(page 22\)](#) 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.

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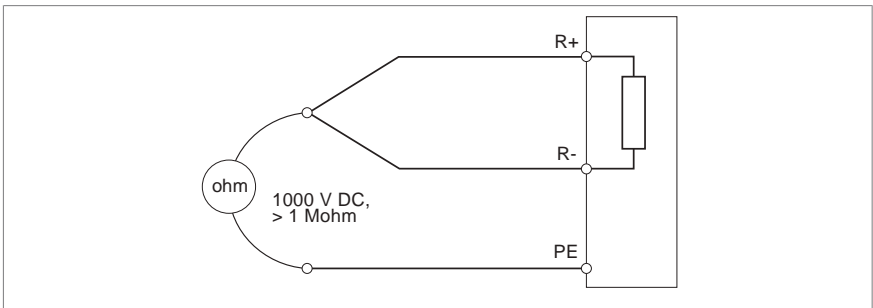
### ■ Brake resistor assembly for R1...R3



#### **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 installation, commissioning or maintenance work.

1. Stop the drive and do the steps in section [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

The standard drive can be installed to a symmetrically grounded TN-S system. For other systems, see sections [EMC filter](#) and [Ground-to-phase varistors \(page 130\)](#) below.

### ■ EMC filter

A drive with EMC filter connected can be installed to a symmetrically grounded TN-S system. If you install the drive to another system, you may need to disconnect the EMC filter. See sections [When to disconnect EMC filter or ground-to-phase](#)

varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems (page 130), and Guidelines for installing the drive to a TT system (page 131).



**WARNING!**

Do not install the drive with the EMC filter connected to a system that the filter is not suitable for. This can cause danger, or damage the drive.

**Note:** When the internal EMC filter is disconnected, the drive EMC compatibility is considerably reduced. See **EMC compatibility and motor cable length** (page 343).

■ **Ground-to-phase varistors**

A drive with the ground-to-phase varistor connected can be installed to a symmetrically grounded TN-S system. If you install the drive to another system, you may need to disconnect the varistor. See sections [When to disconnect EMC filter or ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems](#) (page 130), and [Guidelines for installing the drive to a TT system](#) (page 131).



**WARNING!**

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

■ **When to disconnect EMC filter or ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems**

Requirements for disconnecting EMC filter and varistor and additional requirements for different electrical power systems are given below.

Frame size	Symmetrically grounded TN systems (TN-S systems) ie. center-grounded wye (A)	Corner-grounded (B1) and midpoint-grounded delta systems (B2) ≤ 600 V	IT systems (ungrounded or high-resistance grounded [>30 ohms]) (C)
R1...R3 R4 v2	Do not disconnect EMC or VAR screws.	Disconnect EMC screw. Do not disconnect VAR screw.	Disconnect EMC and VAR screws.
R4...R5	Do not disconnect EMC or VAR screws.	Not evaluated <sup>1)</sup>	Disconnect EMC screws (2 pcs) and VAR screw.
R6...R9	Do not disconnect EMC or VAR screws.	Do not disconnect EMC AC or VAR screws. Disconnect EMC DC screw.	Disconnect EMC screws (2 pcs) and VAR screw.



Frame size	Symmetrically grounded TN systems (TN-S systems) ie. center-grounded wye (A)	Corner-grounded (B1) and midpoint-grounded delta systems (B2) $\leq 600\text{ V}$	IT systems (ungrounded or high-resistance grounded [ $>30\text{ ohms}$ ]) (C)

1) Frames R4 and R5 are not evaluated for use on corner-grounded systems or midpoint-grounded delta systems by IEC standards.

**Note:** These are the EMC filter and varistor screws of different drive frame sizes.

Frame size	EMC filter screws	Ground-to-phase varistor screws
R1...R3 R4 v2	EMC screw	VAR
R4...R5	Two EMC screws	VAR
R6...R9	Two EMC screws	VAR

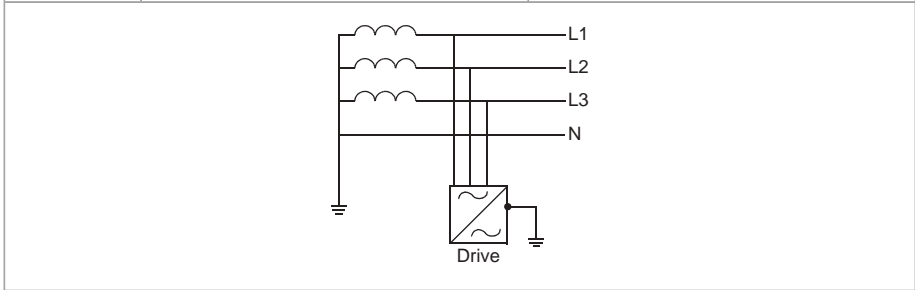
### ■ Guidelines for installing the drive to a TT system

The drive can be installed to a TT system under these conditions:

1. Residual current device has been installed in the supply system.

2. These screws have been disconnected. Otherwise, EMC filter and ground-to-phase varistor capacitor leakage current will cause the residual current device to trip.

Frame size	EMC filter screws	Ground-to-phase varistor screws
R1...R3 R4 v2	EMC screw	VAR
R4...R5	Two EMC screws	VAR
R6...R9	Two EMC screws	VAR



**Note:**

- Because the EMC filter screws have been disconnected, ABB does not guarantee the EMC category.
- ABB does not guarantee the functioning of the ground leakage detector built inside the drive.
- In large systems the residual current device can trip without a reason.



## ■ Identifying the grounding system of the electrical power network



### WARNING!

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

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

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

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

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

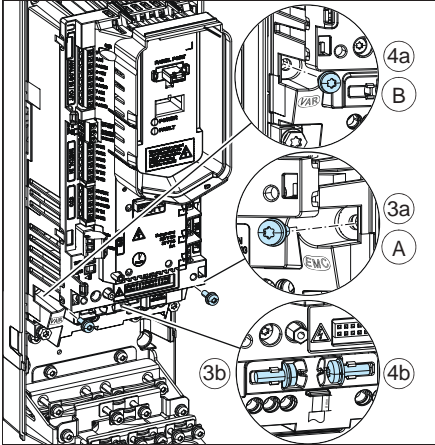
## ■ Disconnecting internal EMC filter or ground-to-phase varistor - frames R1...R3

To disconnect the internal EMC filter or ground-to-phase varistor, if needed, do as follows:

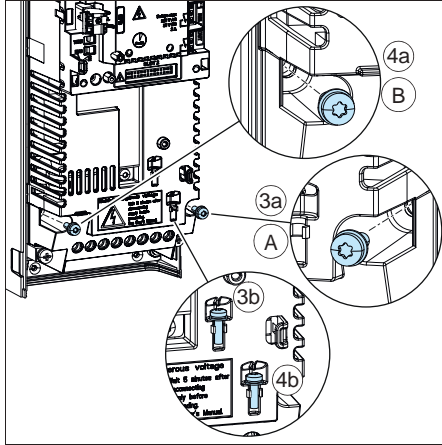
1. Switch off the power from the drive.

2. Open the front cover, if not already opened, see page 138.
3. To disconnect the internal EMC filter, remove the EMC screw (3a) and place it in the storage place (3b).
4. To disconnect the ground-to-phase varistor, remove the varistor screw (4a) and place it in the storage place (4b)

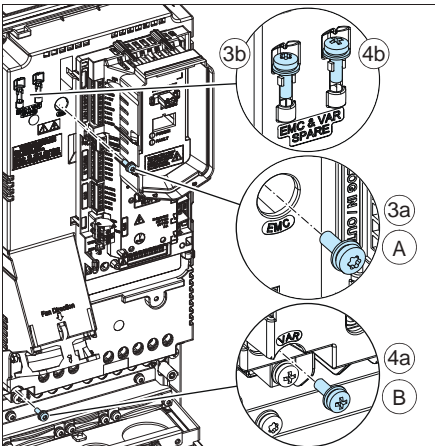
R1



R2



R3



	Screw
A	EMC (DC)
B	VAR

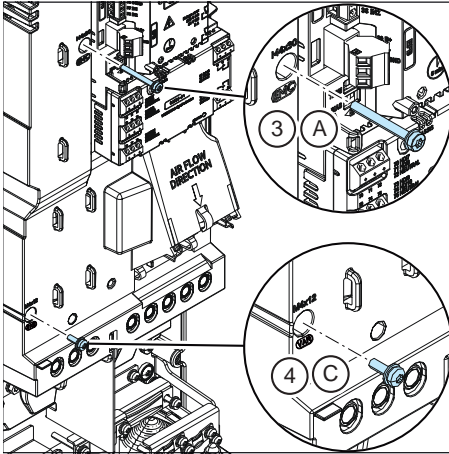
■ **Disconnecting internal EMC filter or ground-to-phase varistor - frames R4...R9**

To disconnect the internal EMC filter or ground-to-phase varistor, if needed, do as follows:

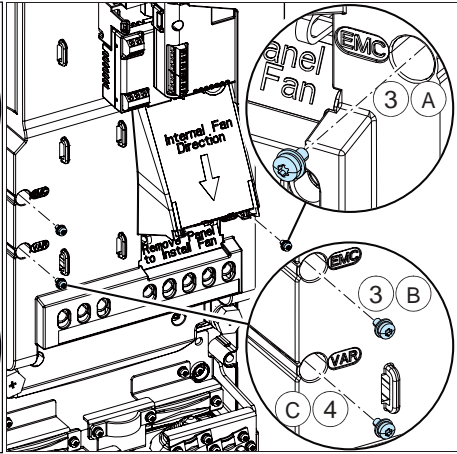
1. Switch off the power from the drive.
2. Open the cover, if not already opened. Frame R4: see page [138](#), frame R5: see page [146](#), frames R6...R9: see page [90](#).
3. To disconnect the internal EMC filter, remove the EMC screw(s).
4. To disconnect the ground-to-phase varistor, remove the varistor screw.



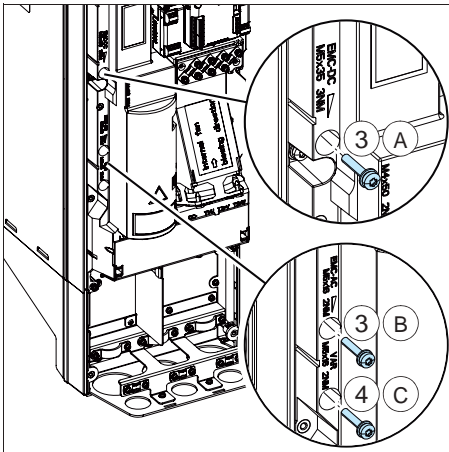
R4 v2



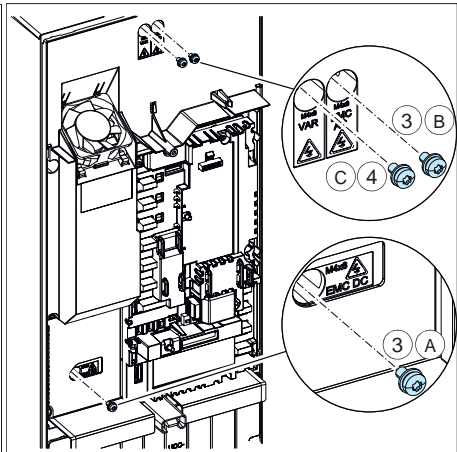
R4



R5



R6...R9



**Screw**

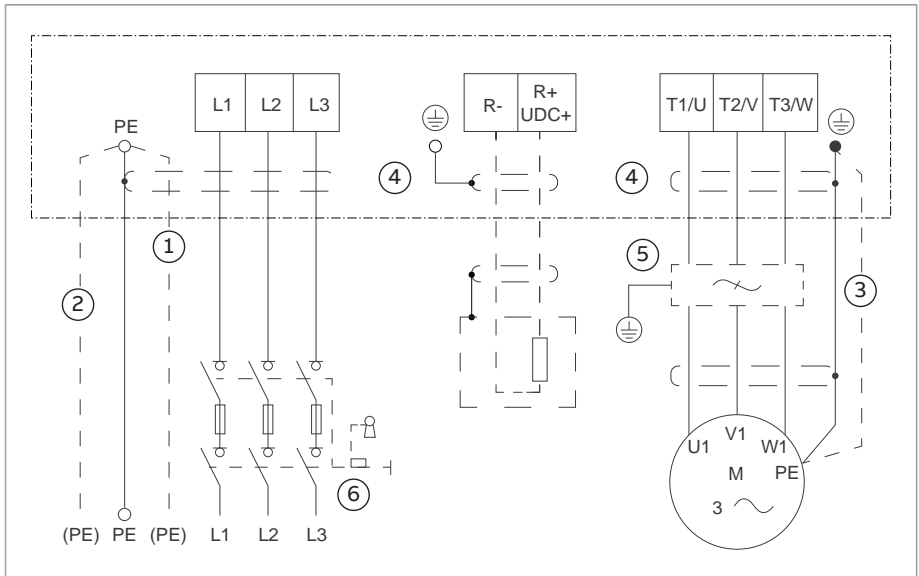
- |   |          |
|---|----------|
| A | EMC (DC) |
| B | EMC (AC) |
| C | VAR      |





## Connecting the power cables

### ■ Connection diagram



1	Two protective earth (ground) conductors. Drive safety standard IEC/EN/UL 61800-5-1 requires two PE conductors if the cross-sectional area of the PE conductor is less than $10 \text{ mm}^2$ Cu or $16 \text{ mm}^2$ Al. For example, you can use the cable shield in addition to the fourth conductor.
2	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.
3	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.
4	360-degree grounding of the cable shield is required for the motor cable and brake resistor cable (if used). It is also recommended for the input power cable.
5	If necessary, install an external filter ( $du/dt$ , common mode, or sine filter). Filters are available from ABB.
6	For IP66 (UL Type 4X) drive with optional disconnect, wire to terminals 2T1, 4T2 and 6T3. External disconnect is not needed, but external fuses are still required.



**Note:** Frames R1...R3 have a built-in brake chopper. If necessary, you can connect a brake resistor to terminals R-and UDC+/R+. The brake resistor is not included in the drive delivery. In frames R4...R9, you can connect an external brake chopper to terminals UDC+ and UDC-. The brake chopper is not included in the drive delivery.

Do not use an asymmetrically constructed motor cable for motors above 30 kW (see section [General guidelines \(page 104\)](#)). Connecting its fourth conductor at the motor end increases bearing currents and causes extra wear.

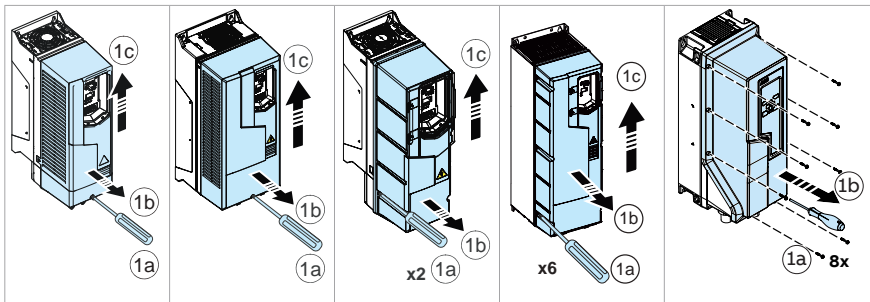
For a single phase connection, use terminals L1 and L2.

■ **Connection procedure, frames R1...R4**

1. Remove the front cover: Loosen the retaining screws with a T20 Torx screwdriver (1a) and lift the cover from the bottom outwards (1b) and then up (1c).

**IP66 (UL Type 4X):** Loosen the retaining screws with a Pozidriv #2 screwdriver (1a) and take the cover off (1b).

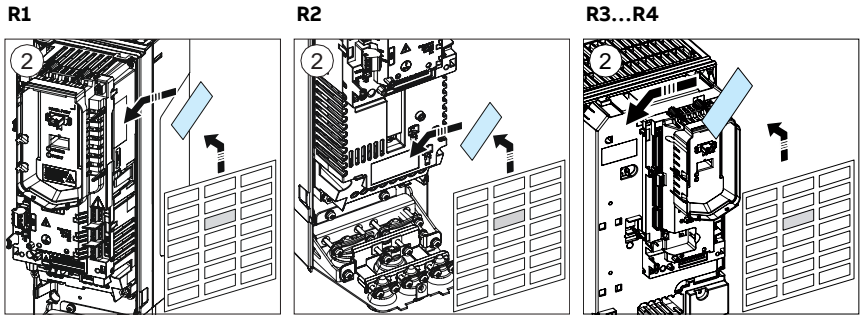
**IP21 (UL Type 1), R1...R2**, **IP21 (UL Type 1), R3...R4**, **IP55 (UL Type 12), R1...R3**, **IP55 (UL Type 12), R4**, **IP66 (UL Type 4X), R1...R3**



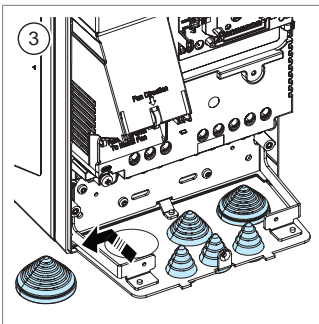
**WARNING!**

If you install the drive on any other system than symmetrically grounded TN-S system, see [Grounding system compatibility check \(page 129\)](#) if you have to disconnect the EMC filter and ground-to-phase varistor.

- Attach the residual voltage warning sticker in the local language.



- Remove the rubber grommets for the motor and input power cables, as well as brake resistor cable, if used.  
Remove the grommets for the control cables when you are connecting them.



**Note:** The drive is shipped with grommet cones pointing up. They must be removed and inserted back pointing down.

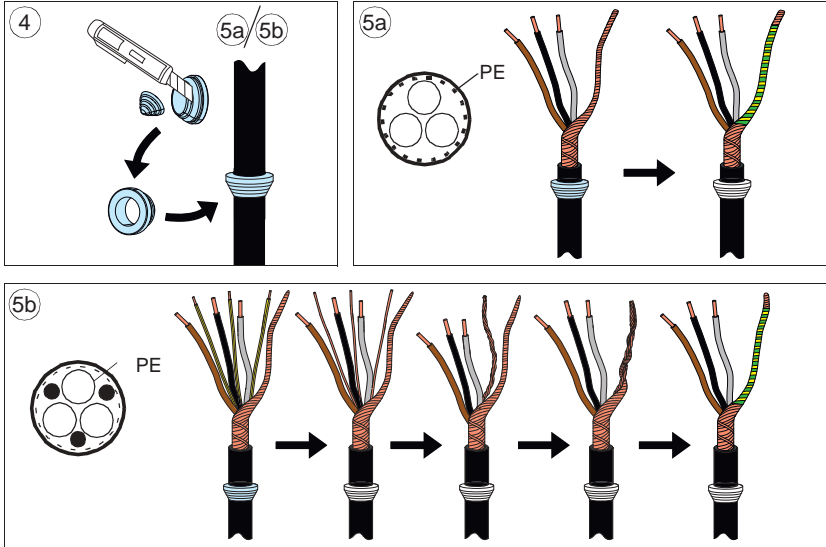
### Motor cable

- Cut an adequate hole into the rubber grommet. Slide the grommet onto the cable.
- Prepare the ends of the cable as illustrated in the figures. In frames R1 and R2 there are markings on the drive frame near the power cable terminals helping you to strip the wires to the correct length of 8 mm.

Two different motor cable types are shown (5a, 5b).

IP66 (UL Type 4X) drives: Attach the cable gland to the hole and tighten nut on the inside.

**Note:** The bare shield will be grounded 360 degrees. Mark the pigtail made from the shield as a PE conductor with yellow-and-green color.



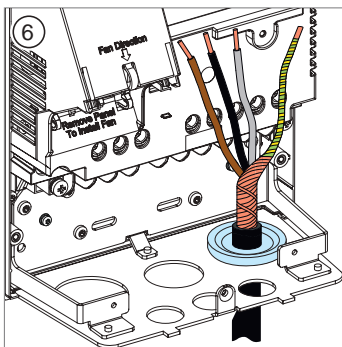
- Slide the cable through the hole in the cable entry and attach the grommet to the hole.

**IP66 (UL Type 4X) drives:** Tighten the cable gland nut on the outside.



**WARNING!**

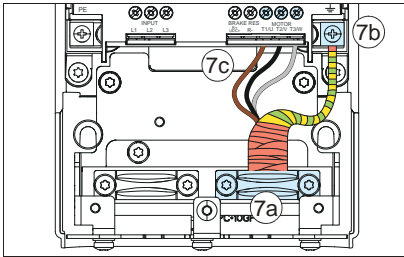
If you install IP66 (UL Type 4X) drive indoors or outdoors in a wet, dirty, dusty, corrosive or similar environment, all cables, conduits and fittings must be approved for use in this type of environment. Tighten the fittings properly to the drive to prevent leakage. If you ignore these instructions, injury or death, or damage to the equipment can occur.



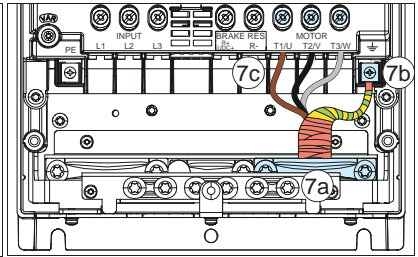
7. Connect the motor cable:

- Ground the shield 360 degrees by tightening the clamp of the power cable grounding shelf onto the stripped part of the cable (7a).
- If you need more working space, open the screw (7d) and lift the EMC plate off. Remember to put it back after you have installed motor and input power cables.
- Connect the twisted shield of the cable to the grounding terminal (7b).
- Connect the phase conductors of the cable to the T1/U, T2/V and T3/W terminals. Tighten the screws to the torque given in the table below (7c).

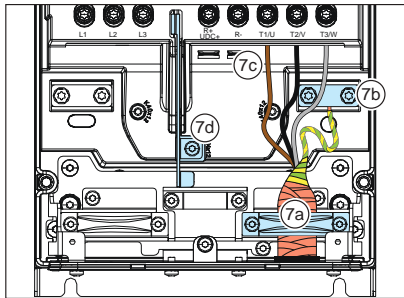
R1...R2



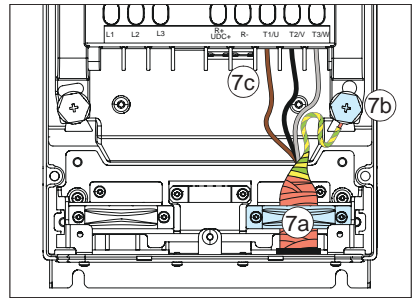
R3





R4 v2



R4



Frame size	R1		R2		R3		R4		R4 v2	
	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft
T1/U, T2/V, T3/W	1.0	0.7	1.5	1.1	3.5	2.6	4.0	3.0	5.5	4.0
PE, 	1.5	1.1	1.5	1.1	1.5	1.1	2.9	2.1	2.9	2.1
	1.2	0.9	1.2	0.9	1.2	0.9	1.2	0.9	1.2	0.9

Input power cable



8. Cut an adequate hole into the rubber grommet. Slide the grommet onto the cable.

**Frame R1:** Make sure there is no optional I/O extension module installed in option slot 2 at this point.

**IP66 (UL Type 4X) drives:** Attach the cable gland to the hole and tighten nut on the inside.

9. Prepare the ends of the cable as illustrated in the figure.

**Note:** The bare shield will be grounded 360 degrees. Mark the pigtail made from the shield as a PE conductor with yellow-and-green color.

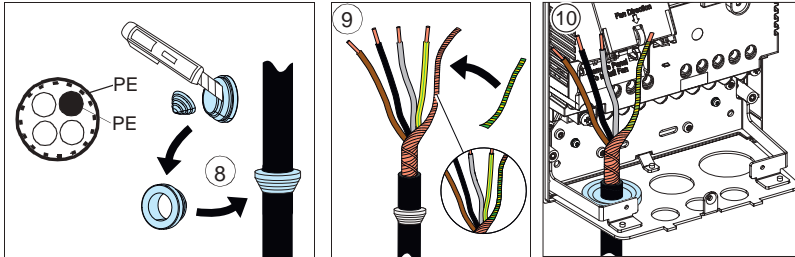
10. Slide the cable through the hole in the cable entry and attach the grommet to the hole.

**IP66 (UL Type 4X) drives:** Tighten the cable gland nut on the outside.



**WARNING!**

If you install IP66 (UL Type 4X) drive indoors or outdoors in a wet, dirty, dusty, corrosive or similar environment, all cables, conduits and fittings must be approved for use in this type of environment. Tighten the fittings properly to the drive to prevent leakage. If you ignore these instructions, injury or death, or damage to the equipment can occur.

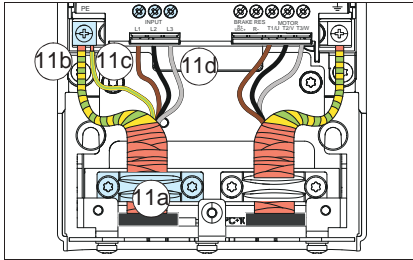


11. Connect the input power cable:

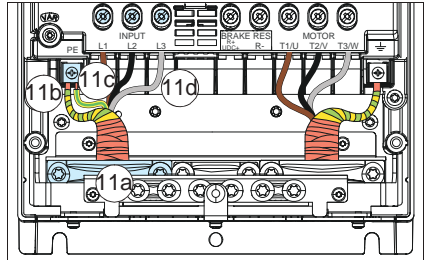
- Ground the shield 360 degrees by tightening the clamp of the power cable grounding shelf onto the stripped part of the cable (11a).
- Connect the twisted shield of the cable to the grounding terminal (11b).
- Connect the additional PE conductor of the cable (11c) (see the note in section [Additional instructions and notes \(page 23\)](#)).
- Connect the phase conductors of the cable to the L1, L2 and L3 terminals. Tighten the screws to the torque given below in the table (11d).

**For IP66 (UL Type 4X) with disconnect:** See torques in the table in page 326.

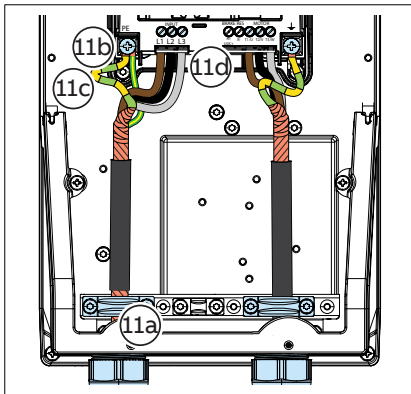
R1...R2



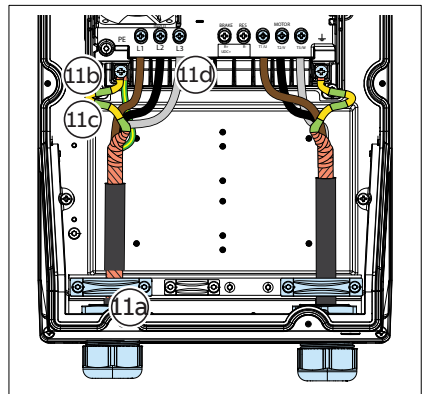
R3



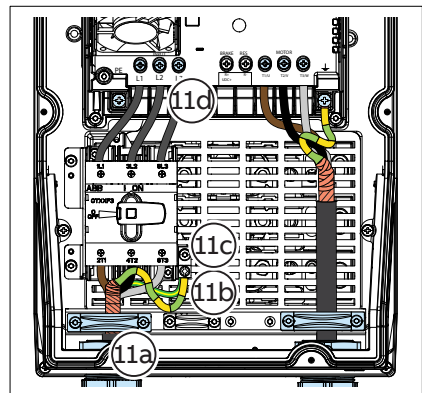
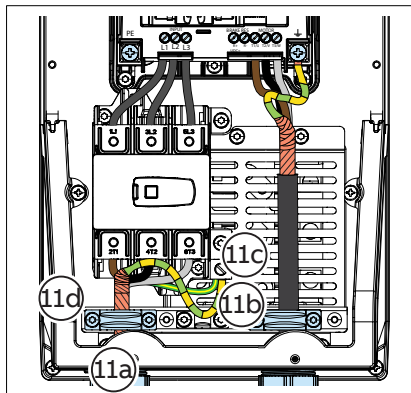
R1...R2 IP66 (UL Type 4X)



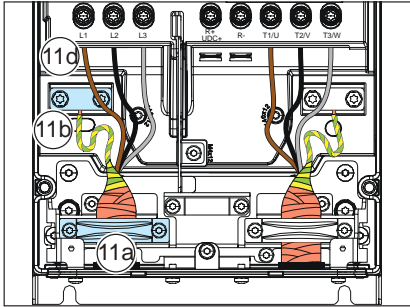
R3 IP66 (UL Type 4X)



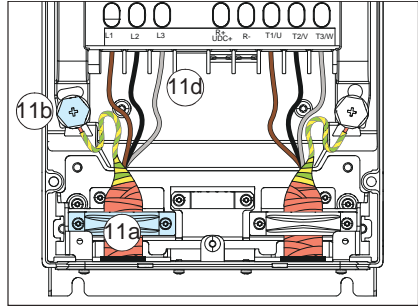
R1...R2 IP66 (UL Type 4X) with disconnect R3 IP66 (UL Type 4X) with disconnect





R4 v2



R4

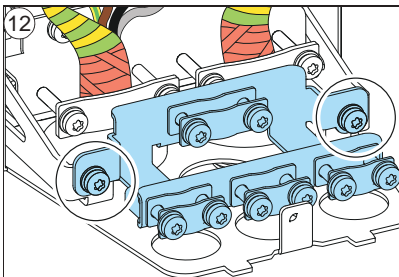


Frame size	R1		R2		R3		R4	
	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft
L1, L2, L3	1.0	0.7	1.5	1.1	3.5	2.6	4.0	3.0
PE, 	1.5	1.1	1.5	1.1	1.5	1.1	2.9	2.1
	1.2	0.9	1.2	0.9	1.2	0.9	1.2	0.9

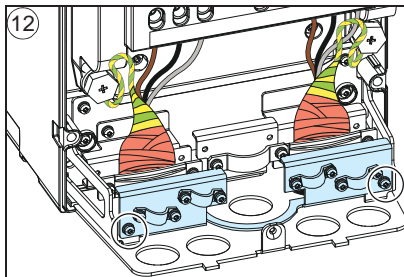
**Grounding shelf**

12. **Frames R1...R2, R4:** Install the grounding shelf (included with the mounting screws in a plastic bag in the delivery).

R1...R2



R4

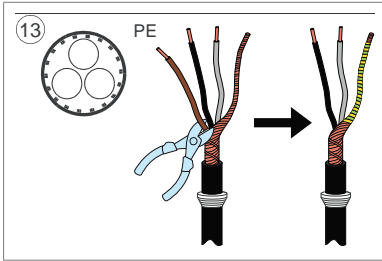


**Brake resistor cable (if used)**

Frames R1...R3 only

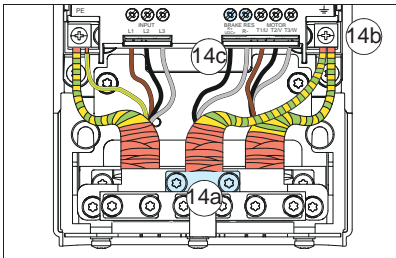
13. Repeat steps 4...6 for the brake resistor cable. Cut off one phase conductor.



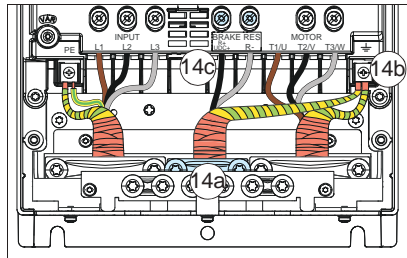


14. Connect the cable as the motor cable in step 7. Ground the shield 360 degrees (14a). Connect the twisted shield to the grounding terminal (14b) and the conductors to the R+ and R- terminals (14c) and tighten to the torque given in the table.

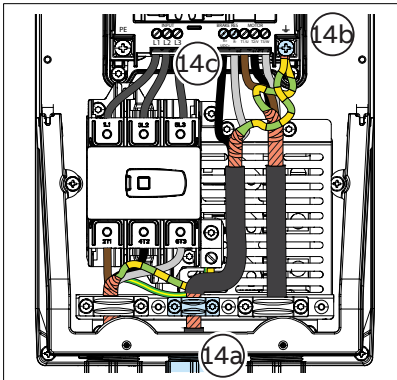
**R1...R2**



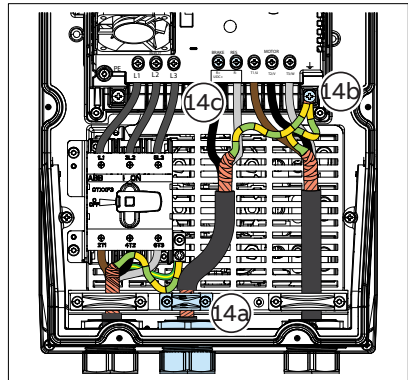
**R3**





**R1...R2 IP66 (UL Type 4X)**



**R3 IP66 (UL Type 4X)**

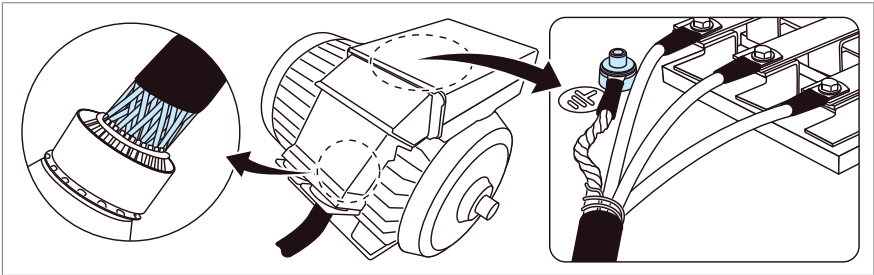


Frame size	R1		R2		R3	
	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft
R+, R-	1.0	0.7	1.5	1.1	3.5	2.6
PE, 	1.5	1.1	1.5	1.1	1.5	1.1
	1.2	0.9	1.2	0.9	1.2	0.9

**Finalization**

**Note: Frame R1:** You have to install any optional I/O extension module, if used, in options slot 2 at this point. See section [Installing option modules \(page 162\)](#).

- Secure the cables outside the unit mechanically.
- Ground the motor cable shield at the motor end. For minimum radio frequency interference, ground the motor cable shield 360 degrees at the cable entry of the motor terminal box.



■ **Connection procedure, frame R5**

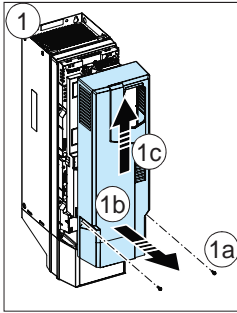
 **IP21 (UL Type 1)**

- Remove the module cover: Loosen the retaining screws with a T20 Torx screwdriver (1a) and lift the cover from the bottom outwards (1b) and then up (1c).  
Remove the box cover: Loosen the retaining screws with a screwdriver (1d) and slide the cover downwards (1e).

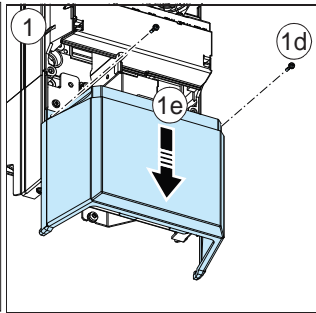
**IP55 (UL Type 12)**

- Remove the front cover: Loosen the retaining screws with a T20 Torx screwdriver (1a) and lift the cover from the bottom outwards (1b) and then up (1c).

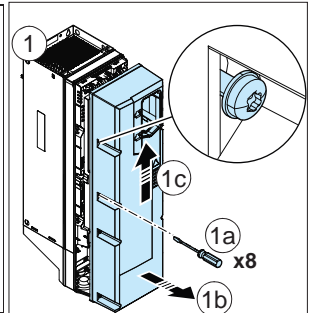
IP21 (UL Type 1)



IP21 (UL Type 1)



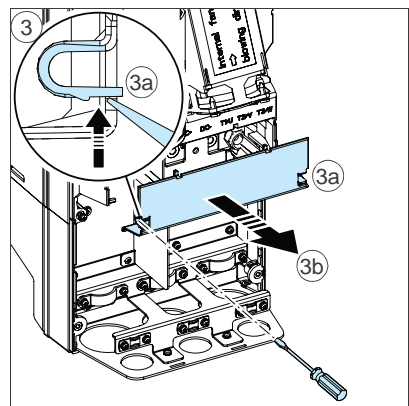
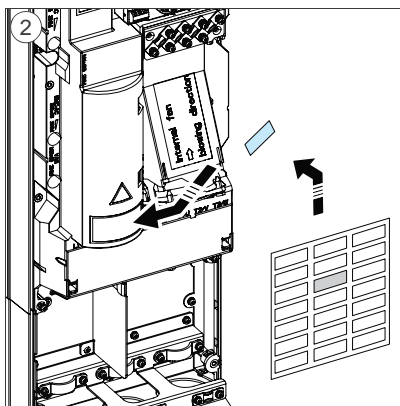
IP55 (UL Type 12)



**WARNING!**

If you install the drive on any other system than symmetrically grounded TN-S system, see [Grounding system compatibility check \(page 129\)](#) if you have to disconnect the EMC filter and ground-to-phase varistor.

2. Attach the residual voltage warning sticker in the local language next to the control unit.
3. Remove the shroud on the power cable terminals by releasing the clips with a screwdriver (3a) and pulling the shroud out (3b).

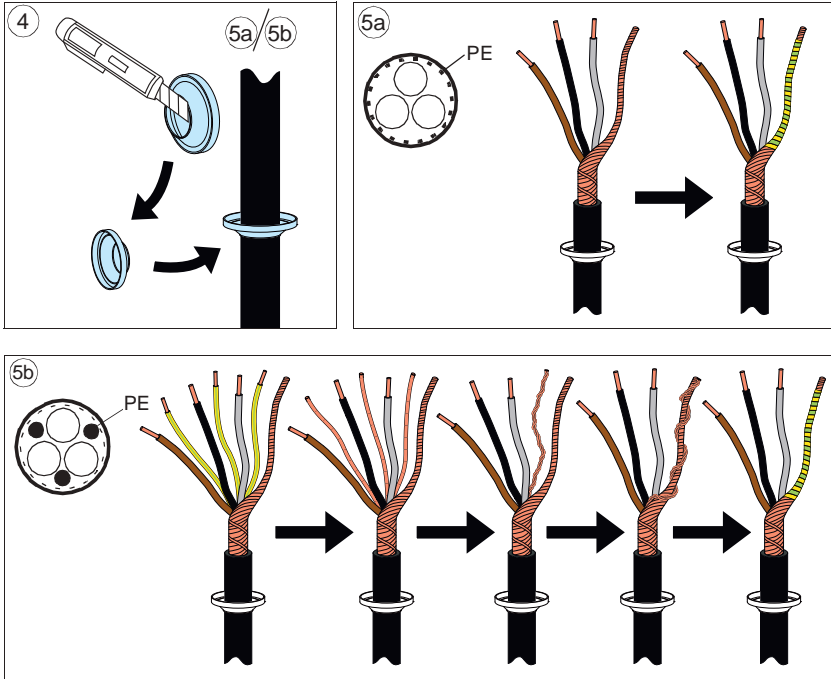


**Motor cable**

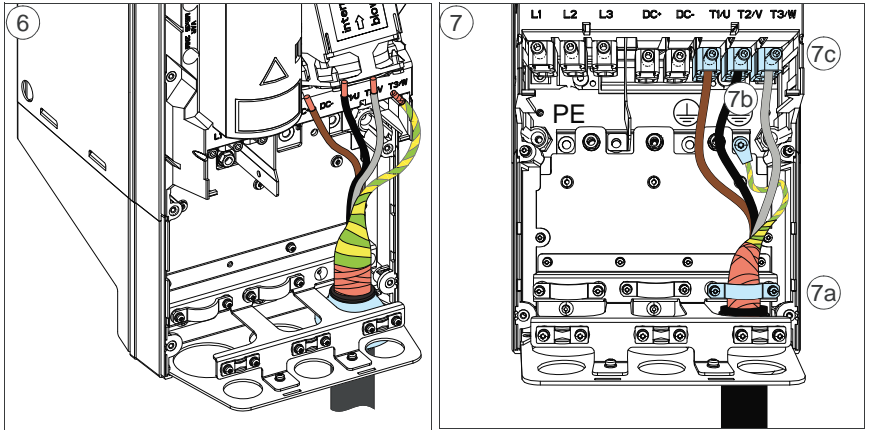
4. Cut an adequate hole into the rubber grommet. Slide the grommet onto the cable.



5. Prepare the ends of the motor cable as illustrated in figures 5a and 5b (two different motor cable types are shown). If you use aluminum cables, put grease to the peeled aluminum cable before connecting it to the drive.

**Note:** The bare shield will be grounded 360 degrees. Mark the pigtail made from the shield as a PE conductor with yellow-and-green color.



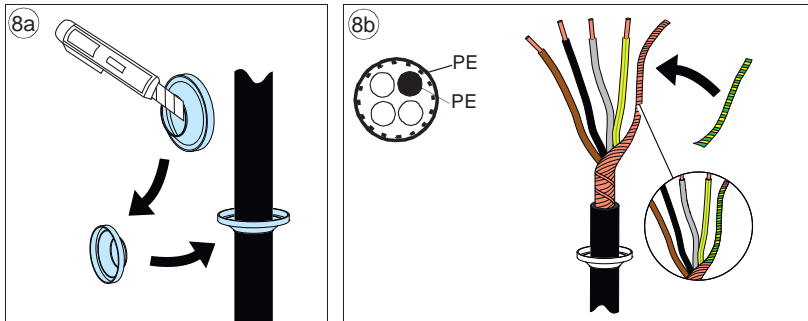
6. Slide the cable through the hole of the bottom plate and attach the grommet to the hole.
7. Connect the motor cable:
- Ground the shield 360 degrees by tightening the clamp of the power cable grounding shelf onto the stripped part of the cable (7a).
  - Connect the twisted shield of the cable to the grounding terminal (7b).
  - Connect the phase conductors of the cable to the T1/U, T2/V and T3/W terminals (7c). Tighten the screws to the torque given in the table.



Frame size	T1/U, T2/V, T3/W		PE, 				
	N·m	lbf·ft	M	N·m	lbf·ft	N·m	lbf·ft
R5	15	11.1	M5	2.2	1.6	1.2	0.9

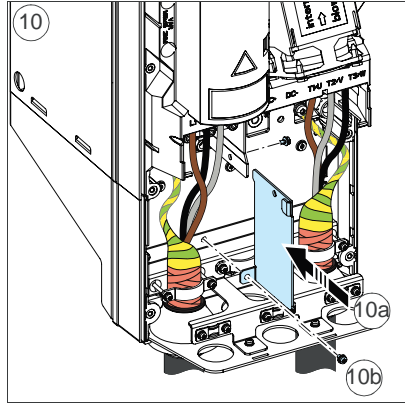
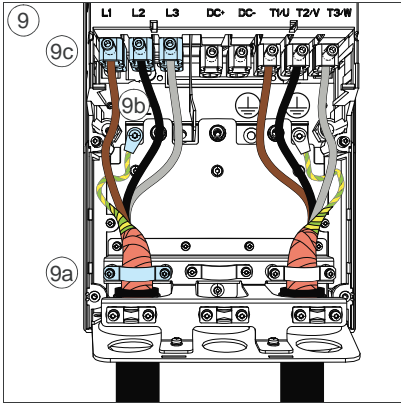
**Input power cable**

8. Repeat steps 4...6 for the input power cable



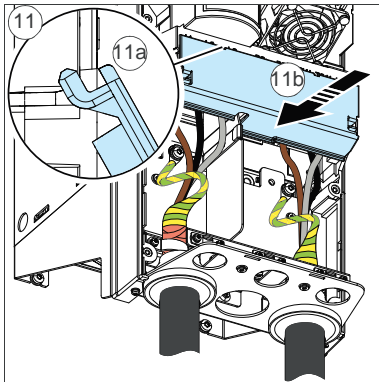
9. Connect the input power cable. Use terminals L1, L2 and L3. Tighten the screws to the torque given in the table.

10. Install the cable box plate. Position the plate (10a) and tighten the screw (10b).



Frame size	L1, L2, L3		PE, $\oplus$				
	N-m	lbf-ft	M	N-m	lbf-ft	N-m	lbf-ft
R5	15	11.1	M5	2.2	1.6	1.2	0.9

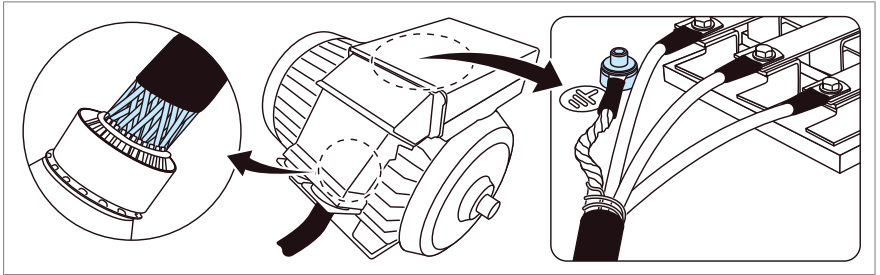
11. Reinstall the shroud on the power terminals by putting the tabs at the top of the shroud in their counterparts on the drive frame (11a) and then pressing the shroud in place (11b).



**Finalization**

12. Secure the cables outside the unit mechanically.

- Ground the motor cable shield at the motor end. For minimum radio frequency interference, ground the motor cable shield 360 degrees at the cable entry of the motor terminal box.



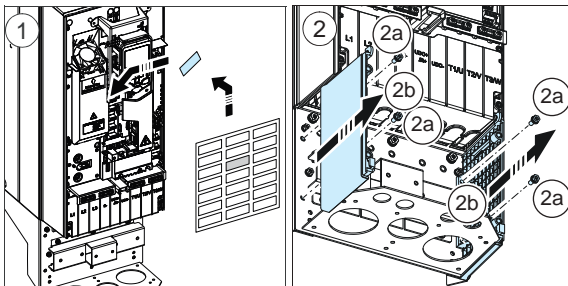
### ■ Connection procedure, frames R6...R9



#### **WARNING!**

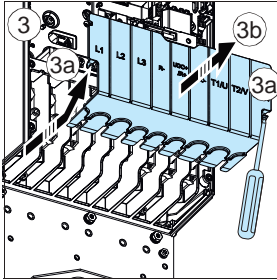
If you install the drive on any other system than symmetrically grounded TN-S system, see [Grounding system compatibility check \(page 129\)](#) if you have to disconnect the EMC filter and ground-to-phase varistor.

- Attach the residual voltage warning sticker in the local language next to the control unit.
- Remove the side plates of the cable box: Remove the retaining screws (2a) and slide the walls out (2b).

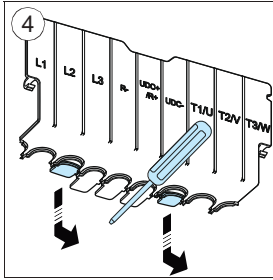


- Remove the shroud on the power cable terminals by releasing the clips with a screwdriver (3a) and pulling the shroud out (3b).
- Knock out holes in the shroud for the cables to be installed.
- Frames R8...R9: If you install parallel cables, also knock out holes in the lower shroud for the cables to be installed.

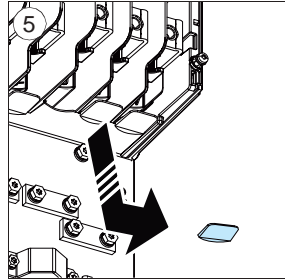
R6...R9



R6...R9



R8...R9



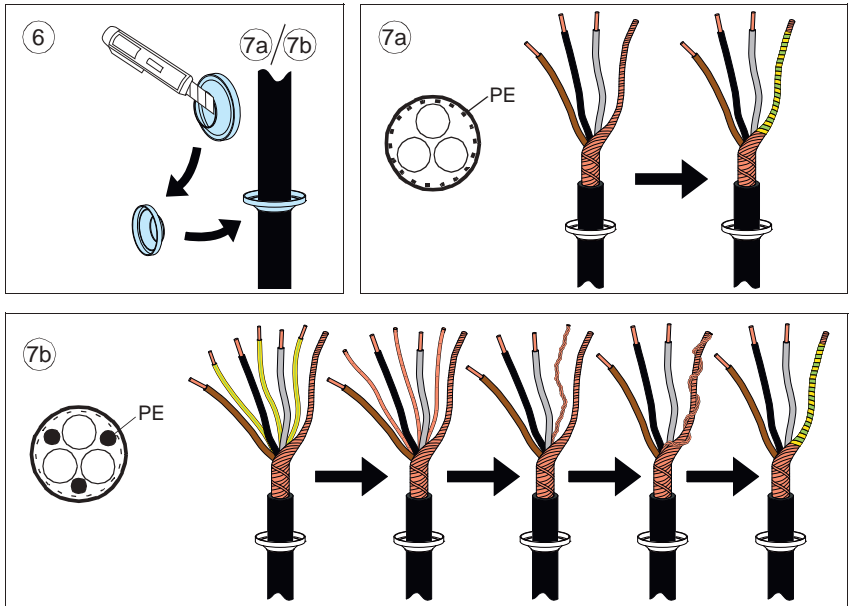
### Motor cable

6. Cut an adequate hole into the rubber grommet. Slide the grommet onto the cable.
7. Prepare the ends of the input power cable and motor cable as illustrated in the figure. If you use aluminum cables, put grease to the peeled aluminum cable before connecting it to the drive. Two different motor cable types are shown in the figures (7a, 7b).

**Note:** The bare shield will be grounded 360 degrees. Mark the pigtail made from the shield as a PE conductor with yellow-and-green color.







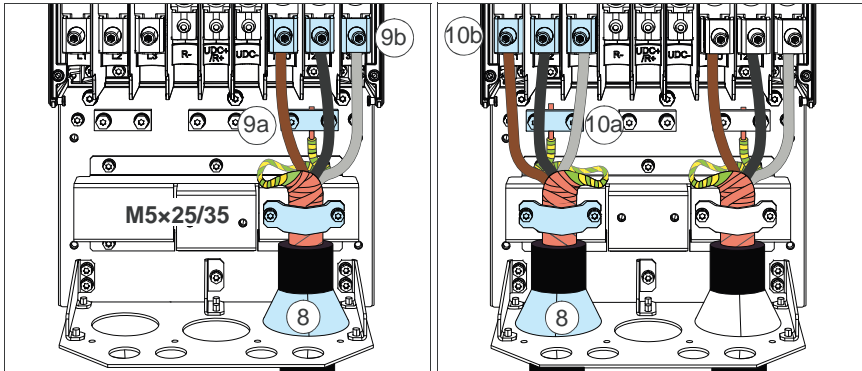
8. Slide the cables through the holes in the cable entry and attach the grommets to the holes (the motor cable to the right and the input power cable to the left).
9. Connect the motor cable:
  - Ground the shield 360 degrees under the grounding clamps.
  - Connect the twisted shield of the cable to the grounding terminal (9a).
  - Connect the phase conductors of the cable to terminals T1/U, T2/V and T3/W. Tighten the screws to the torque given in the table (9b).

**Note 1 for frames R8...R9:** If you connect only one conductor to the connector, ABB recommends that you put it under the upper pressure plate. If you use parallel power cables, put the first conductor under the lower pressure plate and the second under the upper one.

**Note 2 for frames R8...R9:** The connectors are detachable, but ABB does not recommend that you detach them. If you do, detach and reinstall the connectors as described in [Detaching and reinstalling the connectors \(page 154\)](#).

### Input power cable

10. Connect the input power cable as in step 9. Use terminals L1, L2, L3.



Frame size	L1, L2, L3, T1/U, T2/V, T3/W		PE,			
	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft
R6	30	22	9.8	7.2	1.2	0.9
R7	40	30	9.8	7.2	1.2	0.9
R8	40	30	9.8	7.2	1.2	0.9
R9	70	52	9.8	7.2	1.2	0.9

### Detaching and reinstalling the connectors

This is possible but not recommended.

#### Terminals T1/U, T2/V and T3/W

- Remove the nut that attaches the connector to its busbar.
- Put the conductor under the connector pressure plate and pre-tighten the conductor.
- Put the connector back to its busbar. Start the nut, and turn it at least two rotations by hand.



#### **WARNING!**

Before you use tools, make sure that the nut or screw is not cross-threading. Cross-threading can damage the drive and cause danger.

- Tighten the nut to a torque of 30 N·m (22 lbf·ft).
- Tighten the conductor(s) to 40 N·m (30 lbf·ft) for frame R8 or to 70 N·m (52 lbf·ft) for frame R9.

#### Terminals L1, L2 and L3

- Remove the combi screw that attaches the connector to its terminal post, and pull the connector off.
- Put the conductor under the connector pressure plate and pre-tighten the conductor.

- Put the connector back onto the terminal post. Start the combi screw, and turn it at least two rotations by hand.



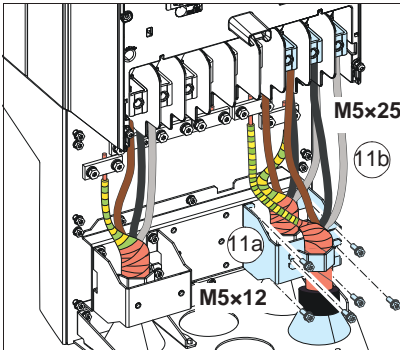
**WARNING!**

Before you use tools, make sure that the nut or screw is not cross-threading. Cross-threading can damage the drive and cause danger.

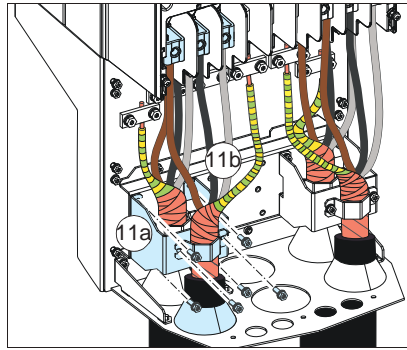
- Tighten the combi screw to a torque of 30 N·m (22 lbf·ft).
- Tighten the conductor(s) to 40 N·m (30 lbf·ft) for frame R8 or to 70 N·m (52 lbf·ft) for frame R9.

11. Frames R8...R9: If you install parallel cables, install the second grounding shelf for the parallel power cables (11a). Repeat steps 6...11 (11b).

R8...R9



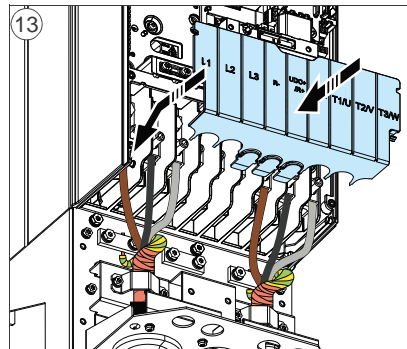
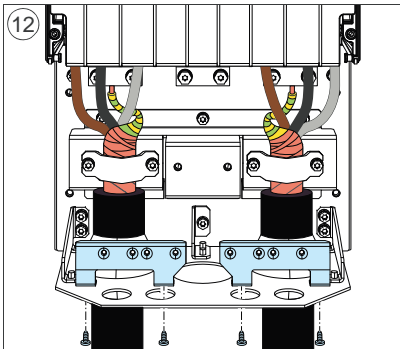
R8...R9



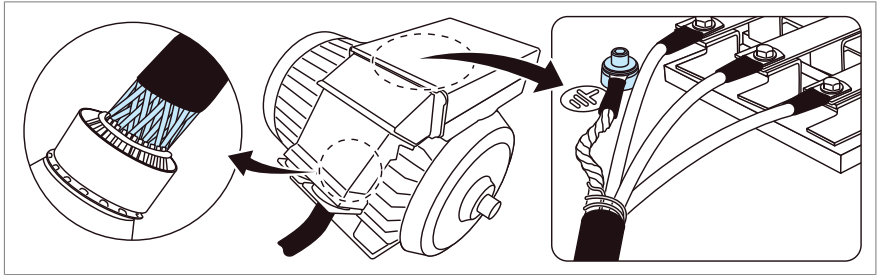
12. Install the grounding shelf of the control cables.

13. Reinstall the shroud on the power terminals.

14. Secure the cables outside the unit mechanically.



- 15. Ground the motor cable shield at the motor end. For minimum radio frequency interference, ground the motor cable shield 360 degrees at the cable entry of the motor terminal box.



### DC connection

The UDC+ and UDC- terminals (as standard in frames R4...R9) are for using external brake chopper units.



## Connecting the control cables

### ■ Connection diagram

See [Default I/O connection diagram \(page 216\)](#) for the default I/O connections of the drive.

### ■ Control cable connection procedure R1...R9



#### **WARNING!**

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

1. Do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the front cover(s) if not already removed. See page [138 \(R1...R4\)](#), page [146 \(R5\)](#) or page [90 \(R6...R9\)](#).  
Analog signals  
 The figures for frames R1...R2 and R3 (page [159](#)), R4 (page [160](#)), R5 (page [161](#)) and R6...R9 (page [162](#)) show an example of connecting a cable. Make the connections according to the default configuration.
3. Cut an adequate hole into the rubber grommet and slide the grommet onto the cable. Slide the cable through a hole in the cable entry and attach the grommet to the hole.
4. Ground the outer shield of the cable 360 degrees under the grounding clamp. Keep the cable unstripped as close to the terminals of the control unit as possible.  
Frames R5...R9: Secure the cables mechanically at the clamps below the control unit.  
 Ground also the pair-cable shields and grounding wire at the SCR terminal.
5. Route the cable as shown in the figures for frames R1...R2 and R3 (page [159](#)), R4 (page [160](#)), R5 (page [161](#)) and R6...R9 (page [162](#)).
6. Connect the conductors to the appropriate terminals of the control unit and tighten to 0.5...0.6 N·m (0.4 lbf·ft).  
Digital signals  
 The figures for frames R1...R2 and R3 (page [159](#)), R4 (page [160](#)), R5 (page [161](#)) and R6...R9 (page [162](#)) show an example of connecting a cable. Make the connections according to the default configuration.
7. Cut an adequate hole into the rubber grommet and slide the grommet onto the cable. Slide the cable through the hole in the cable entry and attach the grommet to the hole.



8. Ground the outer shield of the cable 360 degrees under the grounding clamp. Keep the cable unstripped as close to the terminals of the control unit as possible.

Frames R5...R9: Secure the cables mechanically at the clamps below the control unit.

If you use double-shielded cables, ground also the pair-cable shields and grounding wire at the SCR terminal.

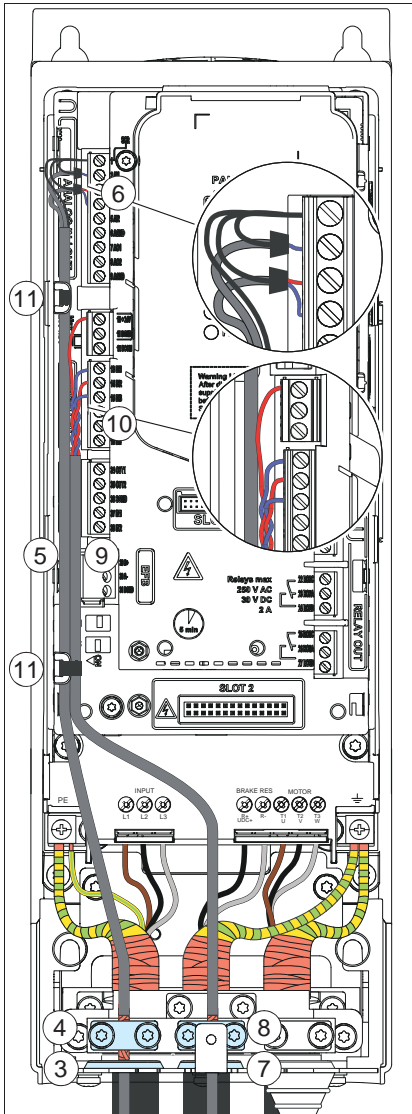
9. Route the cable as shown in the figures for frames R1...R2 and R3 (page 159), R4 (page 160), R5 (page 161) and R6...R9 (page 162).
10. Connect the conductors to the appropriate terminals of the control unit and tighten to 0.5...0.6 N·m (0.4 lbf·ft).
11. Tie all control cables to the provided cable tie mounts.

**Note:**

- Leave the other ends of the control cable shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, eg, 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are in the same ground line with no significant voltage drop between the end points.
- Keep any signal wire pairs twisted as close to the terminals as possible. Twisting the wire with its return wire reduces disturbances caused by inductive coupling.

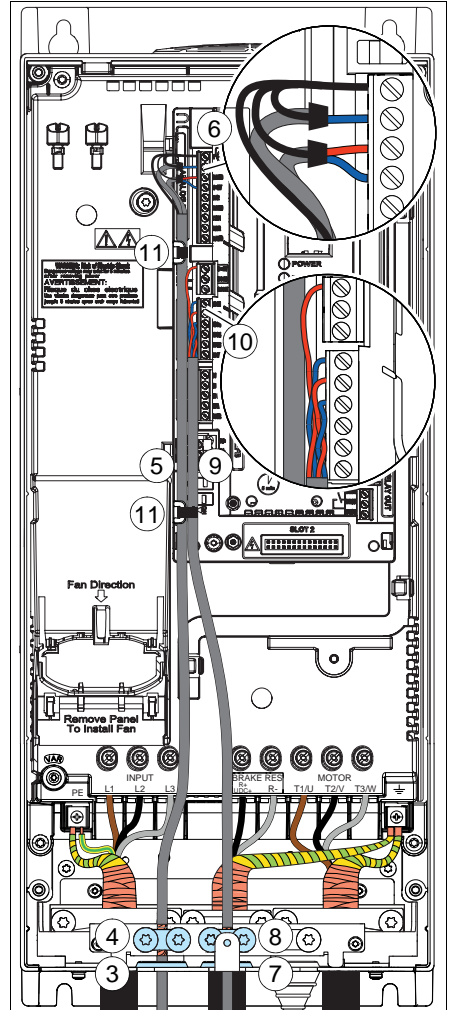


R1...R2



R1...R2: 0.5...0.6 N·m (0.4 lbf·ft)

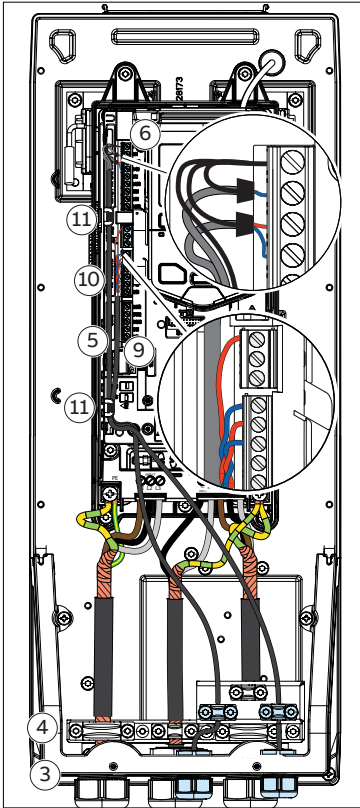
R3



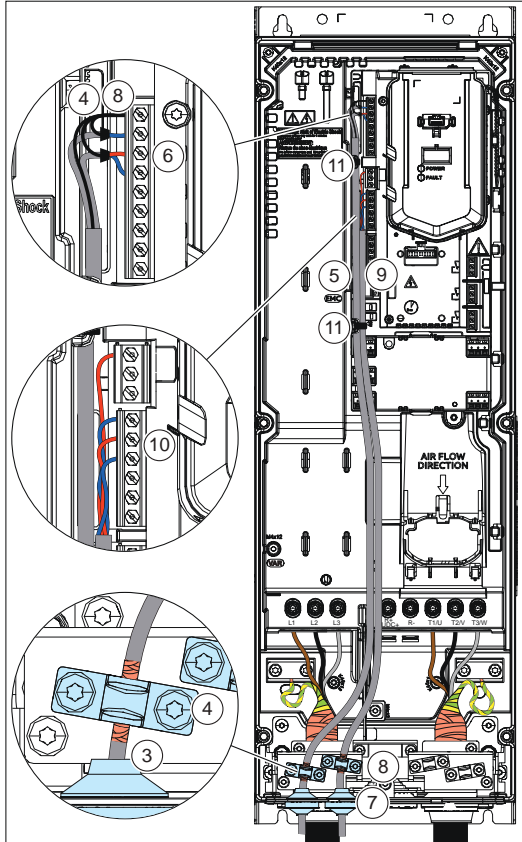
R3: 0.5...0.6 N·m (0.4 lbf·ft)

R1...R3 IP66 (UL Type 4X)

R4



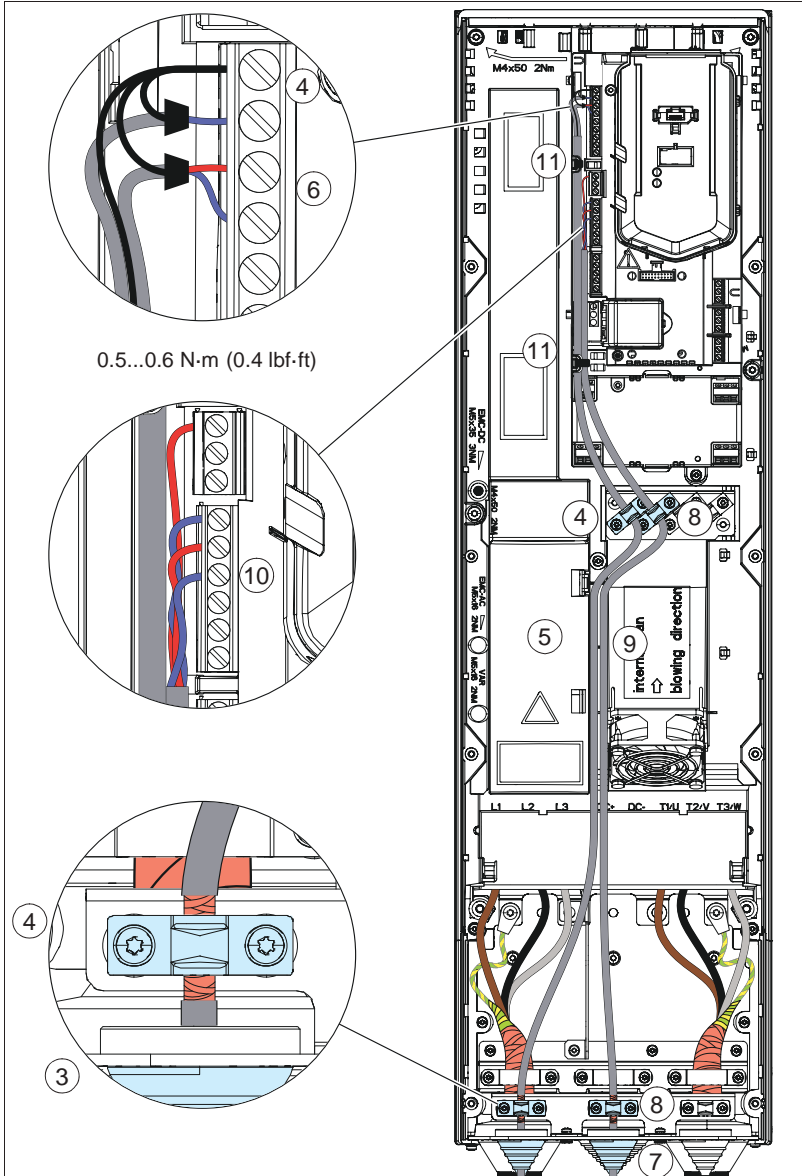
R1...R3 IP66: 0.5...0.6 N·m (0.4 lbf·ft)



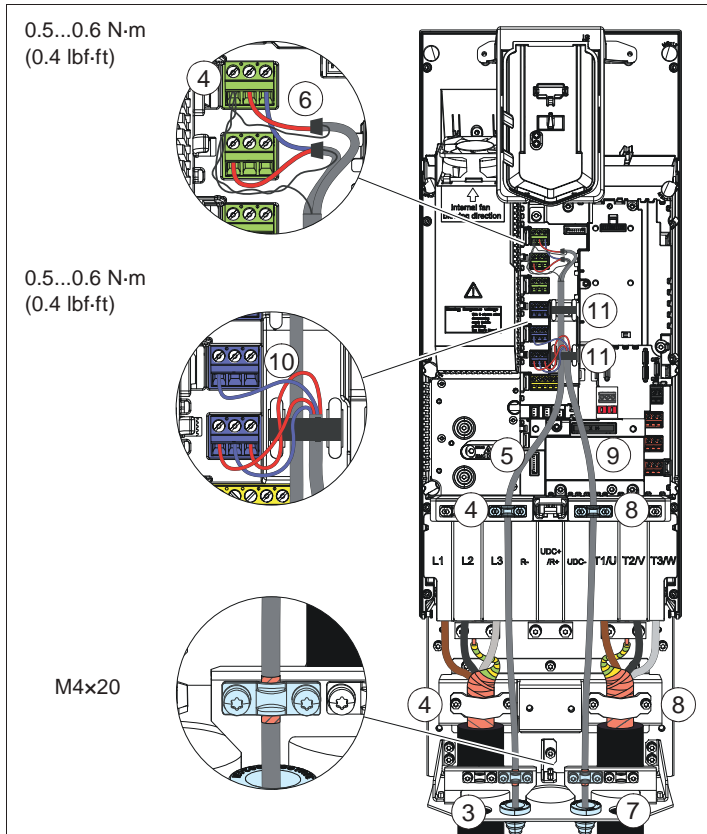
R4: 0.5...0.6 N·m (0.4 lbf·ft)



R5



R6...R9



## Installing option modules

### ■ Option slot 1 (fieldbus adapter modules)

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

**⚠ WARNING!**  
Use ESD wristband when you handle printed circuit boards. Do not touch the boards unnecessarily. The boards are sensitive to electrostatic discharge.

Pay attention to the free space required by the cabling or terminals coming to the option modules.

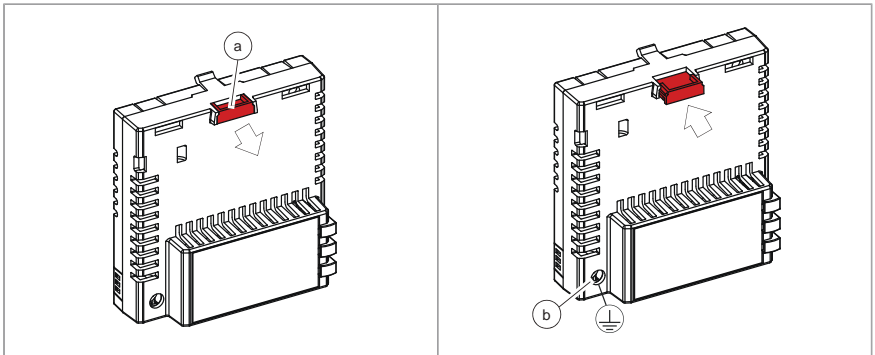
1. Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.
  2. Pull out the lock (a) with a screw driver.
- Note:** The location of the lock depends on the module type.
3. Install the module to a free option module slot on the control unit.
  4. Push in the lock (a).
  5. Tighten the grounding screw (b) to a torque of 0.8 N·m (7 lbf·in).

**Note:** The screw tightens the connections and grounds the module. It is essential for fulfilling the EMC requirements and for proper operation of the module.



**WARNING!**

Do not use excessive force, or leave the screw too loose. Over-tightening can cause damage to the screw or module. A loose screw can cause an operation failure.



6. Connect the wiring to the module. Obey the instructions given in the documentation of the module.

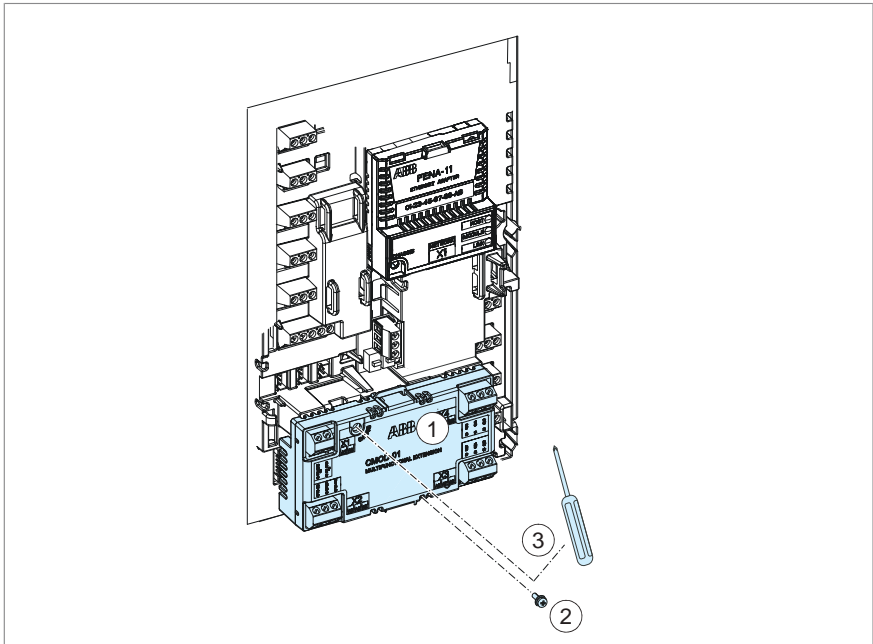
If you must remove the option module after it is installed into the drive, use a suitable tool (for example, small pliers) to carefully pull out the lock.

### ■ Option slot 2 (I/O extension modules)

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

**WARNING!**  
Use ESD wristband when you handle printed circuit boards. Do not touch the boards unnecessarily. The boards are sensitive to electrostatic discharge.

1. Put the module carefully into its position on the control unit.
2. Tighten the mounting screw.
3. Tighten the grounding screw (CHASSIS) to 0.8 N·m (7 lbf·in). The screw grounds the module. This is necessary for fulfilling the EMC requirements and for correct operation of the module.

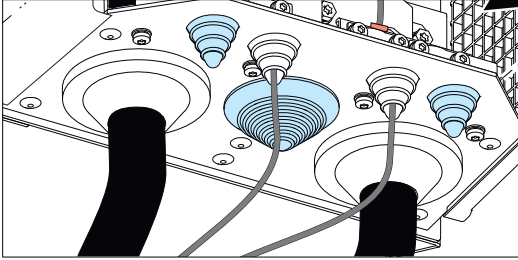


### ■ Wiring the optional modules

See the appropriate option module manual or for I/O options the appropriate chapter in this manual.

## Reinstalling grommets

**UL Type 12:** To maintain UL Type 12, reinstall grommets (top of the grommets downwards) to all cable entry holes without conduits.



**IP66 (UL Type 4X):** Plug unused holes with a hole plug with IP66 (UL Type 4X) or better protection rating and tighten securely.

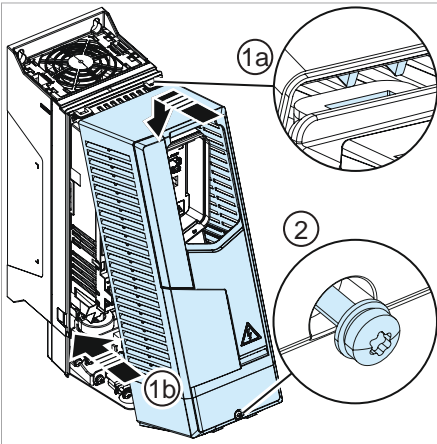


## Reinstalling covers

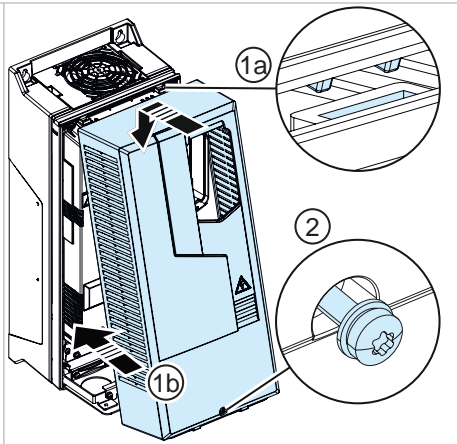
### ■ Reinstalling cover, frames R1...R4

1. Reinstall the cover: Put the tabs on the cover top in their counterparts on the housing (1a) and then press the cover (1b).  
IP66 (UL Type 4X): Reinstall the cover.
2. Tighten the retaining screw at the bottom with a T20 Torx screwdriver.  
IP66 (UL Type 4X): Tighten and secure the 8 screws to 2.5 N·m (1.8 lbf·in) with a Pozidriv #2 screwdriver.

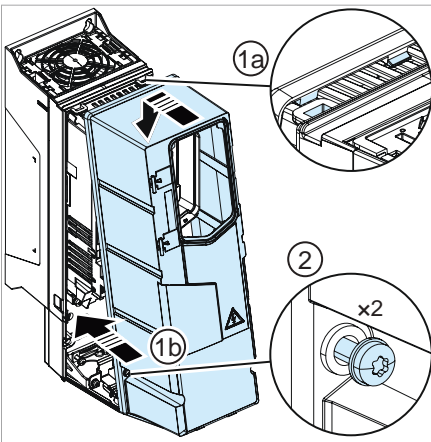
IP21 (UL Type 1) R1...R2



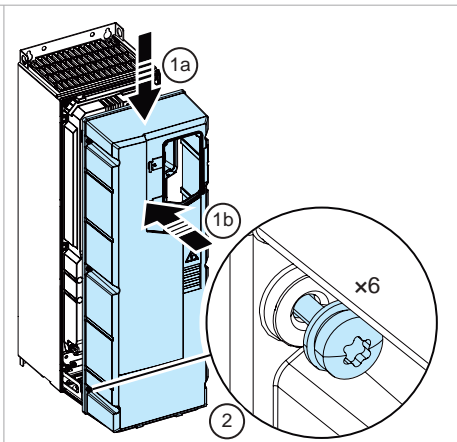
IP21 (UL Type 1) R3...R4



IP55 (UL Type 12) R1...R3



IP55 (UL Type 12) R4



■ Reinstalling covers, frame R5

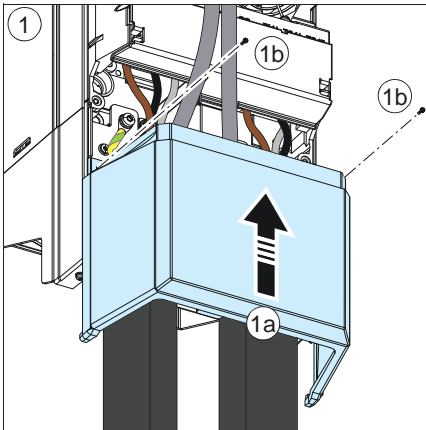
**IP21 (UL Type 1)**

1. Reinstall the box cover: Slide the cover upwards (1a) and tighten the retaining screws (1b) with a T20 Torx screwdriver.
2. Reinstall the module cover: Press the cover at the bottom (2a) and tighten the retaining screws (2b).

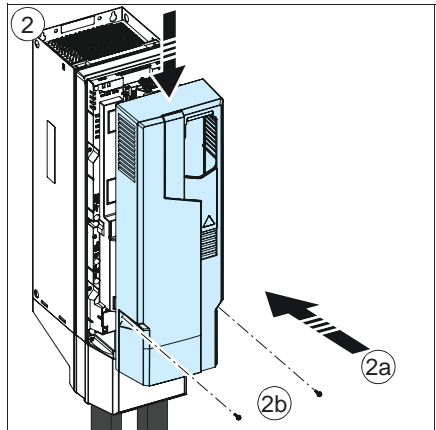
**IP55 (UL Type 12)**

1. Reinstall the front cover: Press the cover at the bottom (1a) and tighten the retaining screws (1b) with a T20 Torx screwdriver.

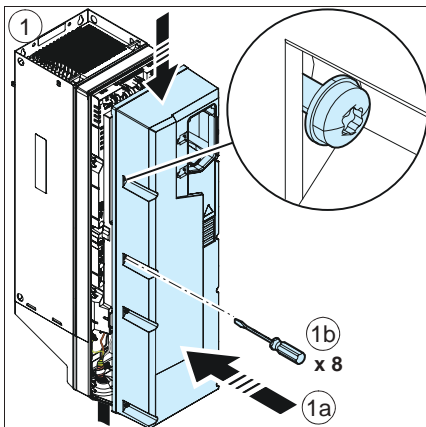
**IP21 (UL Type 1)**



**IP21 (UL Type 1)**



**IP55 (UL Type 12)**



■ **Reinstalling side plates and covers, frames R6...R9**

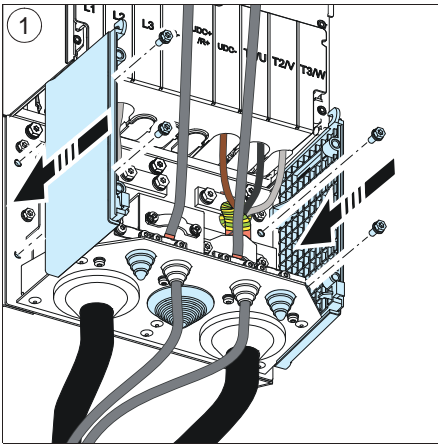
**IP21 (UL Type 1)**

1. Reinstall the side plates of the cable box. Tighten the retaining screws with a T20 Torx screwdriver.
2. Slide the cover of the cable box on the module from below until the cover snaps into place.
3. Reinstall the module cover. Tighten the two retaining screws with a screwdriver.

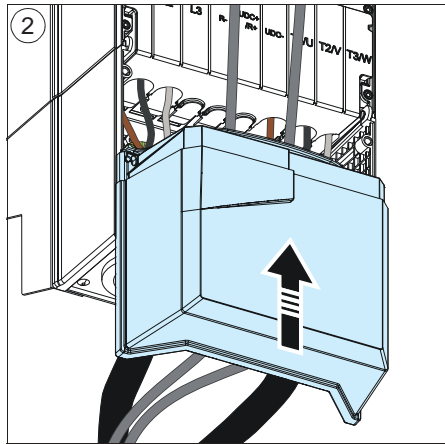
**IP55 (UL Type 12)**

1. Reinstall the module cover. Tighten the retaining screws with a T20 Torx screwdriver.

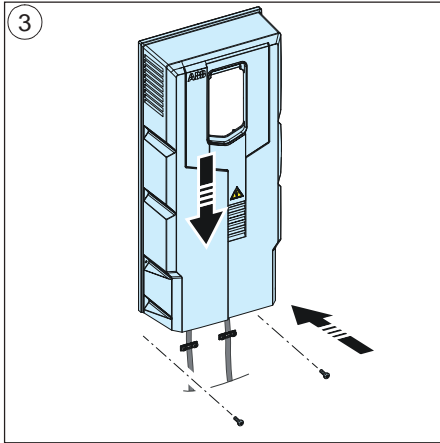
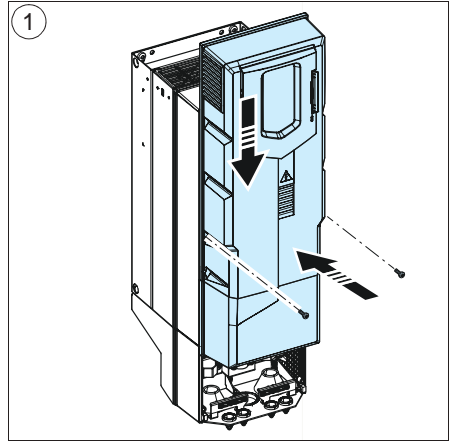
**IP21 (UL Type 1)**



**IP21 (UL Type 1)**





**IP21 (UL Type 1)****IP55 (UL Type 12)****Installing IP66 (UL Type 4X) sun shield**

Refer to [ACH580-01](#), [ACQ580-01](#), [ACS580-01 4X IP66 drives](#), [sun shield quick installation guide \(3AXD50001019006 \[English\]\)](#), included in the sun shield package.

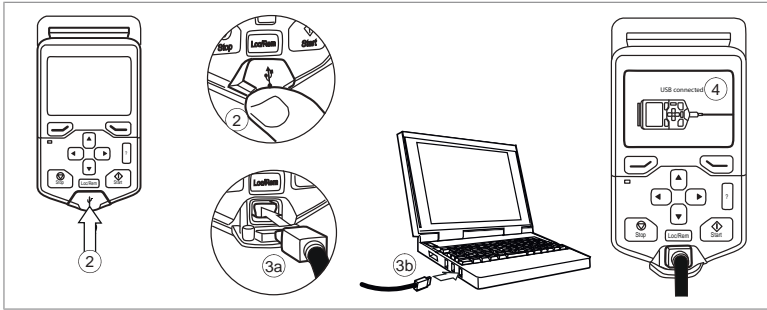
**Connecting a PC****WARNING!**

Do not connect the PC directly to the control panel connector of the control unit. It can cause damage.

A PC (with, for example, the Drive Composer PC tool) can be connected as follows:

1. To connect a control panel to the unit, either
  - insert the control panel into the panel holder or platform, or
  - use an Ethernet (eg, Cat 5e) networking cable.
2. Remove the USB connector cover on the front of the control panel.
3. Connect an USB cable (Type A to Type Mini-B) between the USB connector on the control panel (3a) and a free USB port on the PC (3b).
4. The panel will display an indication whenever the connection is active.
5. See the documentation of the PC tool for setup instructions.





**Note:** For IP66 (UL Type 4X) drive, the USB connection on the panel cannot be accessed while the cover is in place. Use the Bluetooth functionality to troubleshoot the drive using the DriveTune app from your phone.

## Connecting a remote panel, or chaining one panel to several drives

You can connect a drive control panel remotely to the drive, or chain the control panel or a PC to several drives on a panel bus with a CDPI-01 communication adapter module. See [CDPI-01 communication adapter module user's manual \(3AXD50000009929 \[English\]\)](#).



# 7

## Electrical installation – North America

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### 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.



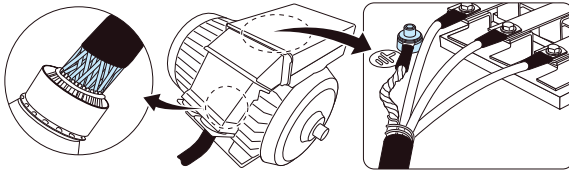
## Required tools

To do the electrical installation, you need these tools:

- wire stripper
- screwdriver set (Torx, Phillips, flat and/or Pozidriv, as appropriate)
- torque wrench.

## Grounding the motor cable shield at the motor end

For minimum radio-frequency interference, ground the cable shield 360° at the cable entry of the motor terminal box.



## Measuring the insulation

Measuring the insulation is typically not required in North American installations.

### ■ Measuring the insulation resistance of the drive

---

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

---

### ■ Measuring the insulation resistance of the input power cable

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

### ■ Measuring the insulation resistance of the motor and motor cable

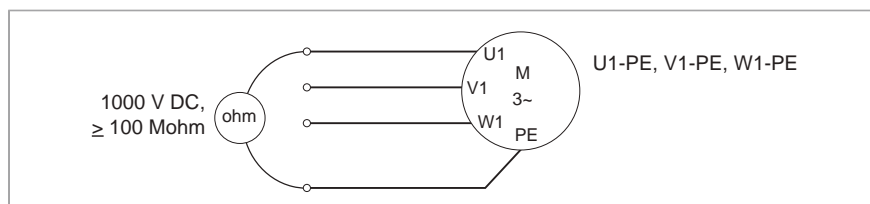
---

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

---

1. Do the steps in section [Electrical safety precautions \(page 22\)](#) 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.



### ■ Brake resistor assembly for R1...R3

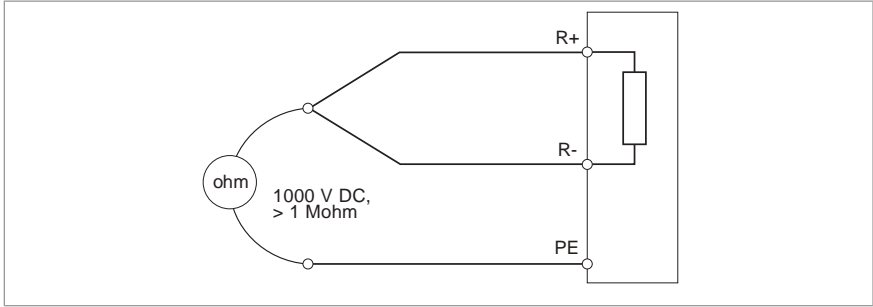


#### **WARNING!**

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 installation, commissioning or maintenance work.

1. Stop the drive and do the steps in section [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

The standard drive can be installed to a symmetrically grounded TN-S system.

For other systems, see sections [EMC filter](#) and [Ground-to-phase varistors \(VAR\)](#) below.

### ■ EMC filter

To connect the drive to symmetrically grounded TN-S systems, you should connect the internal EMC filter if you are concerned with EMC issues. See section [When to connect EMC filter or disconnect ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems \(page 175\)](#).



#### **WARNING!**

Do not install the drive with the EMC filter connected to a system that the filter is not suitable for. This can cause danger, or damage the drive.

**Note:** When the internal EMC filter is disconnected, the drive EMC compatibility is considerably reduced.

### ■ Ground-to-phase varistors (VAR)

A drive with the ground-to-phase varistor connected can be installed to a symmetrically grounded TN-S system. If you install the drive to another system, you may need to disconnect the varistor. See [When to connect EMC filter or disconnect ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems \(page 175\)](#), and [Guidelines for installing the drive to a TT system \(page 176\)](#).



#### **WARNING!**

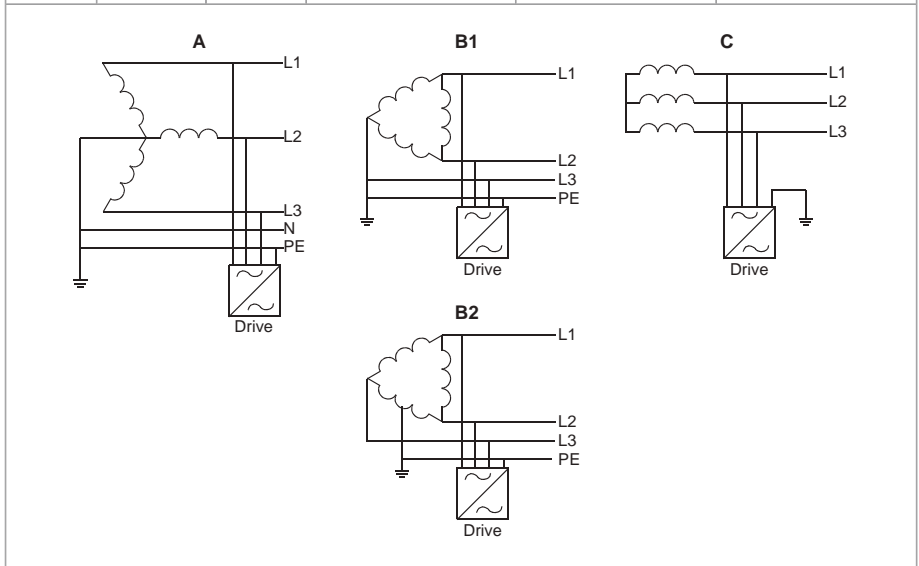
Do not install the drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. It can cause damage to the varistor circuit.

■ **When to connect EMC filter or disconnect ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems**

Requirements for disconnecting EMC filter and varistor and additional requirements for different electrical power systems are given below.

**Note:** Configure the EMC filter based on the electrical system of the installation site.

Frame size	Screw label	Factory default screw material	Symmetrically grounded TN systems (TN-S systems) ie. center-grounded wye (A)	Corner-grounded (B1) and midpoint-grounded delta systems (B2) ≤ 600 V	IT systems (un-grounded or high-resistance grounded [ $>30$ ohms]) (C)
R1...R3 R4 v2	EMC (DC)	None or plastic	Optional metal screw <sup>1)</sup>	None or plastic <sup>2)</sup>	None or plastic <sup>2)</sup>
	VAR	Metal	Do not disconnect the metal screw	None or plastic	Remove the metal screw
R4...R9 <sup>3)</sup>	EMC (AC)	None or plastic	Optional metal screw <sup>1)</sup>	None or plastic <sup>2)</sup>	None or plastic <sup>2)</sup>
	EMC (DC)	None or plastic	Optional metal screw <sup>1)</sup>	None or plastic <sup>2)</sup>	None or plastic <sup>2)</sup>
	VAR	Metal	Do not disconnect the metal screw	Do not disconnect the metal screw	Remove the metal screw



1) Install metal screw and connect the EMC filter for better noise filtering.



- 2) Metal screw must not be used.
- 3) Frames R4 and R5 are evaluated for use on corner-grounded delta networks by UL standards. (R4 and R5 frames are not to be used on IEC installations of corner grounded networks.)

**Note:** The VAR screw on R1...R3 also connects the EMC (AC) circuit internally within the drive.

**Note:** Failure to remove a metal screw, when indicated in the table above, may result in drive failure.

The table below shows the EMC filter and varistor screw kit parts by drive frame size.

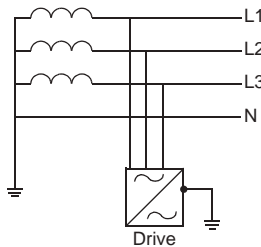
Frame size	EMC filter screws	Ground-to-phase varistor screws
R1...R3 R4 v2	Plastic EMC (DC)	Metal VAR
R4...R9	Plastic EMC (DC), plastic EMC (AC)	Metal VAR

■ **Guidelines for installing the drive to a TT system**

The drive can be installed to a TT system under these conditions:

1. Residual current device has been installed in the supply system.
2. EMC filter has been disconnected by removing the metal screw. Otherwise EMC filter leakage current will cause residual current device to trip. For R1...R3, the metal VAR screw must be removed or replaced with plastic. For R4...R9, the metal VAR screw must be installed.

Frame size	EMC filter screws	Ground-to-phase varistor (VAR) screw
R1...R3 R4 v2	None or plastic	Remove the metal screw
R4...R9	None or plastic (EMC DC or AC)	Metal





**Note:**

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

**■ Identifying the grounding system of the electrical power network**

---

**WARNING!**

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

---

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

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



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

$U_{L-L}$	$U_{L1-G}$	$U_{L2-G}$	$U_{L3-G}$	Electrical power system type
X	$0.58 \cdot X$	$0.58 \cdot X$	$0.58 \cdot X$	TN-S system (symmetrically grounded)
X	$1.0 \cdot X$	$1.0 \cdot X$	0	Corner-grounded delta system (nonsymmetrical)
X	$0.866 \cdot X$	$0.5 \cdot X$	$0.5 \cdot X$	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)

■ **Disconnecting internal EMC filter or ground-to-phase varistor - frames R1...R3**

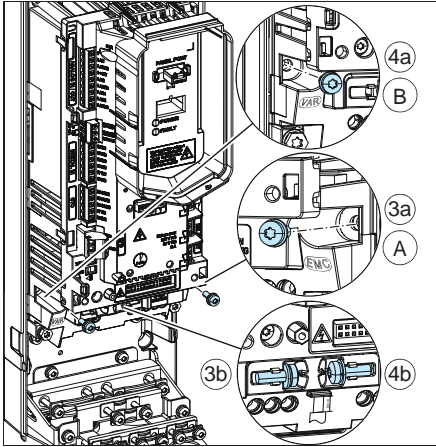
Extra screws to configure the drive for different networks are provided in the drive shipment, see the table in page 176.

To disconnect the internal EMC filter or ground-to-phase varistor:

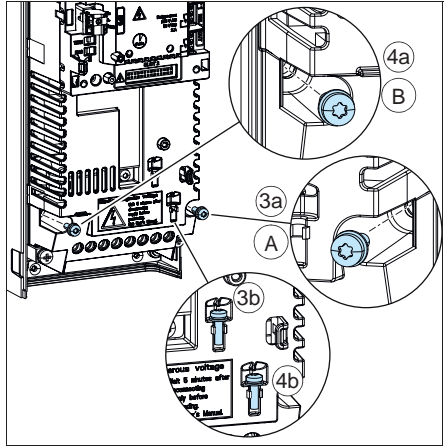
1. Do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Open the front cover, if not already opened, see page 184.
3. The internal DC EMC filter is disconnected by default with no screw or with a plastic screw (3a).
4. To disconnect the ground-to-phase varistor, remove the metal varistor screw (4a) and place it in the storage place (4b), or replace it with the plastic screw provided in the package.



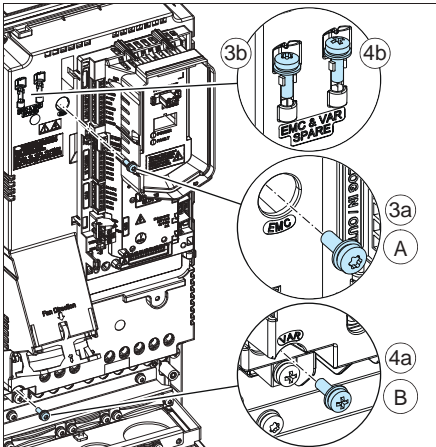
R1



R2



R3



	Screw	Default material
A	EMC (DC)	Plastic
B	VAR	Metal

■ **Disconnecting internal EMC filter or ground-to-phase varistor - frames R4...R9**

Extra screws to configure the drive for different networks are provided in the drive shipment, see the table in page 176.

To disconnect the internal EMC filter or ground-to-phase varistor:

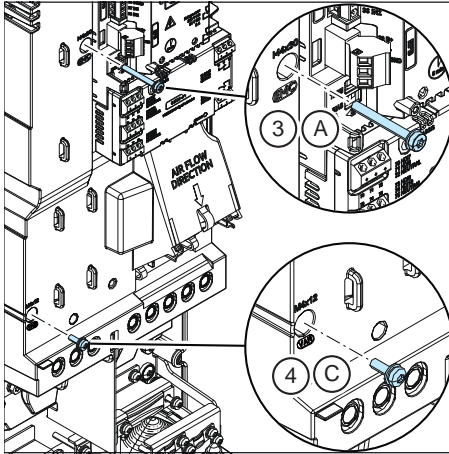
1. Do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.



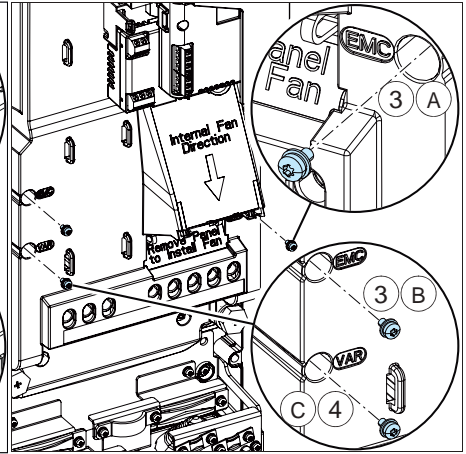
2. Open the cover, if not already opened. Frame R4: see page [184](#), frame R5: see page [192](#), frames R6...R9: see page [196](#).
3. To disconnect the internal EMC filters:  
The DC EMC filter is disconnected by default with no screw or with a plastic screw (3A).  
The AC EMC filter is disconnected by default with no screw or with a plastic screw (3B).
4. To disconnect the ground-to-phase varistor, remove the metal varistor screw (4) or replace it with the plastic screw provided in the package.



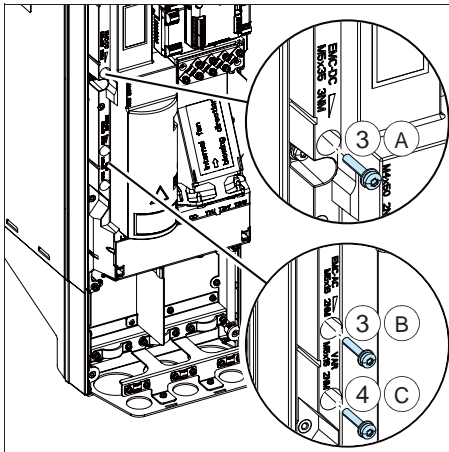
R4 v2



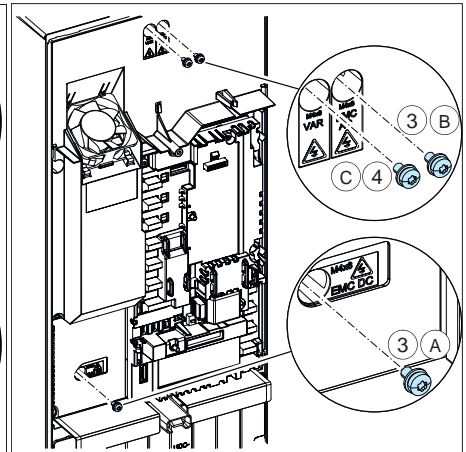
R4



R5



R6...R9

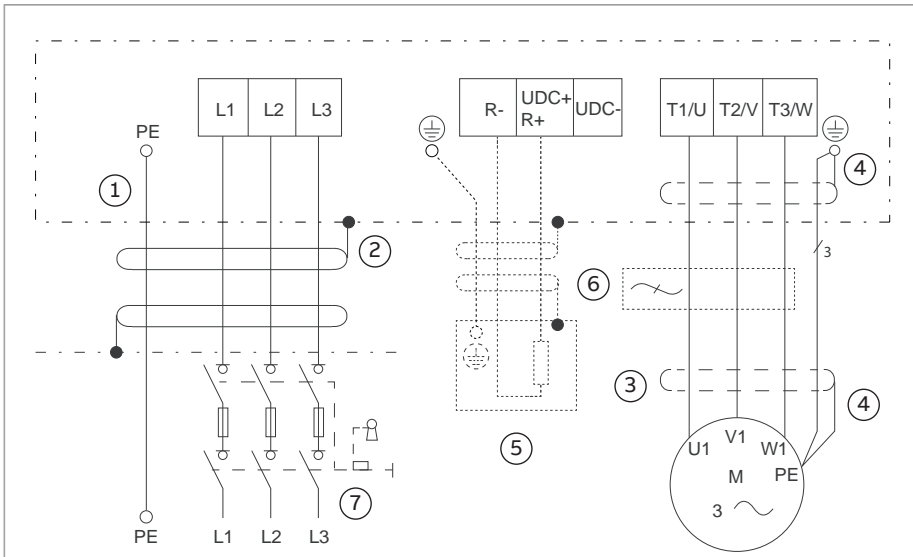


	Screw
A	EMC (DC)
B	EMC (AC)
C	VAR



## Connecting the power cables

### ■ Connection diagram



**Note:** UL (NEC) installation can include separate insulated conductors inside a conduit, shielded VFD cable in conduit, or shielded VFD cable without conduit. The normal dashed symbol (3) in this diagram represents the shield of shielded VFD cable. The same solid symbol (2) represents conduit.

- |   |  |
|---|--|
| 1 | <p><b>Insulated ground conductor in a conduit:</b> Ground to drive's PE terminal and to the distribution panel ground bus. For a VFD cable installation, see 4.</p> <p><b>Note:</b> If the cross-section of the Cu PE conductor is less than 8 AWG, install a second Cu PE conductor of the same cross-sectional area as the original PE conductor. Alternatively, you can use a Cu PE conductor with at least 10 mm<sup>2</sup> cross-section. See page 24.</p> |
| 2 | <p><b>Conduit ground:</b> Bond the conduit to the drive's conduit box and to the distribution panel enclosure. For a VFD cable installation, see 3.</p>  |
| 3 | <p><b>Shield of a VFD shielded cable:</b> Ground the shield 360° under drive's grounding clamp, then twist with the ground conductors and connect under the drive's ground terminal. Ground the shield also 360° at the motor end, then twist and connect under the motor's ground terminal. For a conduit installation see 2.</p>   |
| 4 | <p><b>Symmetrically constructed grounding conductors inside a VFD shielded cable:</b> Twist together, combine with the shield and connect under the drive's ground terminal and under the motor's ground terminal. For a conduit installation, see 1.</p>  |



5	External brake resistor connection (if used): For a conduit installation, see 1 and 2. For a VFD cable installation, see 3 and 4. In addition, cut the third phase conductor which is not needed for the brake resistor connection.
6	If necessary, install an external filter (du/dt, common mode, or sine filter). Filters are available from ABB.
7	For IP66 (UL Type 4X) drive with optional disconnect and fuses, wire to terminals 2T1, 4T2 and 6T3. External fused disconnect is not needed. Drive with this option (+F254) incorporates suitable branch circuit fuses. The UL98 disconnect is designed for feeder or branch applications and does not require upstream branch protection.

**Note:** Frames R1...R3 have a built-in brake chopper. If necessary, you can connect a brake resistor to terminals R- and UDC+/R+. The brake resistor is not included in the drive delivery. In frames R4...R9, you can connect an external brake chopper to terminals UDC+ and UDC-. The brake chopper is not included in the drive delivery.

All openings in the drive enclosure must be closed with UL listed devices having the same UL Type rating as the drive UL Type.

ABB does not recommend an asymmetrically constructed motor cable or a conduit for motor cabling for motors above 30 kW (40 hp) (see [General guidelines \(page 104\)](#)). Connecting its fourth conductor at the motor end increases bearing currents and causes extra wear.

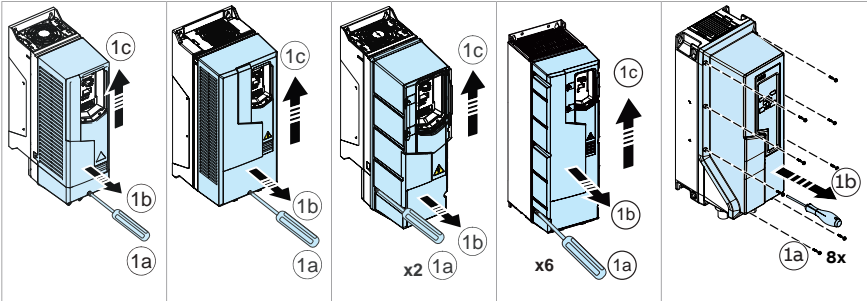
For a single phase connection, use terminals L1 and L2.



■ **Connection procedure, frames R1...R4**

1. Remove the front cover: Loosen the retaining screw with a T20 Torx screwdriver (1a) and lift the cover from the bottom outwards (1b) and then up (1c).  
IP66 (UL Type 4X): Loosen the retaining screws with a Pozidriv #2 screwdriver (1a) and take the cover off (1b).

IP21 (UL Type 1), R1...R2      IP21 (UL Type 1), R3...R4      IP55 (UL Type 12), R1...R3      IP55 (UL Type 12), R4      IP66 (UL Type 4X), R1...R3

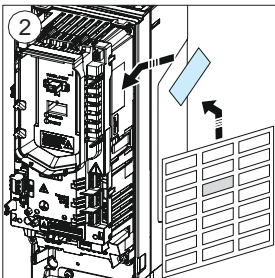


**WARNING!**

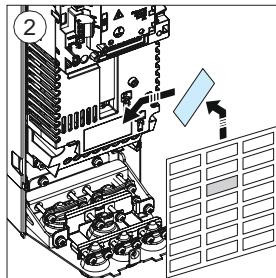
If you install the drive on any other system than symmetrically grounded TN-S system, see [Grounding system compatibility check \(page 174\)](#) if you have to disconnect the EMC filter and ground-to-phase varistor.

2. Attach the residual voltage warning sticker in the local language.

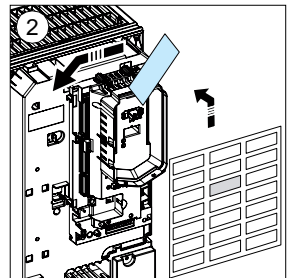
R1



R2



R3...R4



3. Remove the knockouts or rubber grommets for the motor and input power cables, as well as brake resistor cable, if used.  
 Remove the knockouts or grommets for the control cables when you are connecting them.
4. Prepare the power cables (shielded cable):



- Cut a sufficient hole in the rubber grommet. Slide the grommet onto the cable (4a).

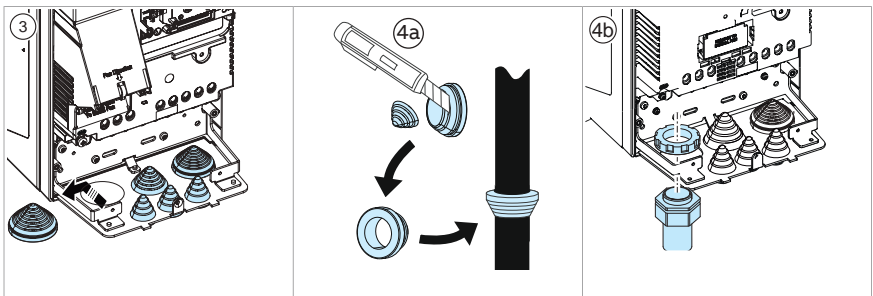
Prepare the power cables (conduit):

- Attach the cable conduit fittings (not included) to the cable entry holes in place of the removed grommets or knockouts (4b).



**WARNING!**

If you install IP66 (UL Type 4X) drive indoors or outdoors in a wet, dirty, dusty, corrosive or similar environment, all cables, conduits and fittings must be approved for use in this type of environment. Tighten the fittings properly to the drive to prevent leakage. If you ignore these instructions, injury or death, or damage to the equipment can occur.



**Note:** If the drive is shipped with grommet cones pointing up they must be removed and inserted back pointing down.

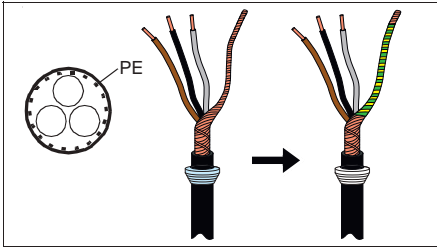
### Motor cabling

5. Prepare the ends of the cable as illustrated in the figure. In frames R1 and R2 there are markings on the drive frame near the power cable terminals helping you to strip the wires to the correct length of 8 mm.

IP66 (UL Type 4X) drives: Attach the cable gland to the hole and tighten nut on the inside.

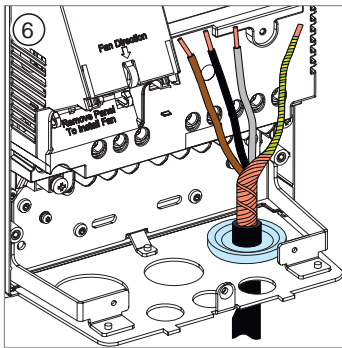
**Note:** The bare shield will be grounded 360 degrees. Mark the pigtail made from the shield as a PE conductor with yellow-and-green color.





6. Slide the cable through the hole in the cable entry and attach the grommet to the hole.

**IP66 (UL Type 4X) drives:** Tighten the cable gland nut on the outside.

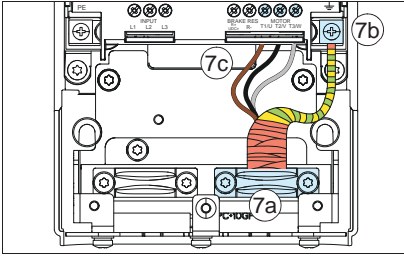


7. Connect the motor cable:

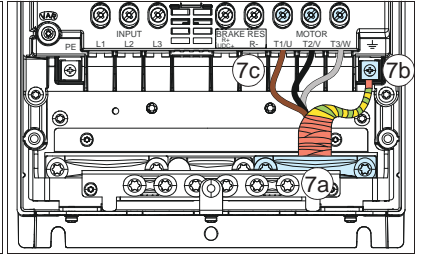
- Ground the shield 360 degrees by tightening the clamp of the power cable grounding shelf onto the stripped part of the cable (7a).
- **Frame R4 v2:** If you need more working space, open the screw (7d) and lift the EMC plate off. Remember to put it back after you have installed motor and input power cables.
- Connect the twisted shield of the cable to the grounding terminal (7b).
- Connect the phase conductors of the cable to the T1/U, T2/V and T3/W terminals. Tighten the screws to the torque given in the table below (7c).



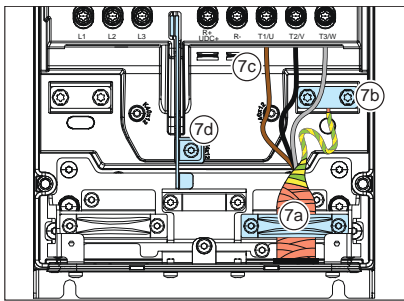
R1...R2



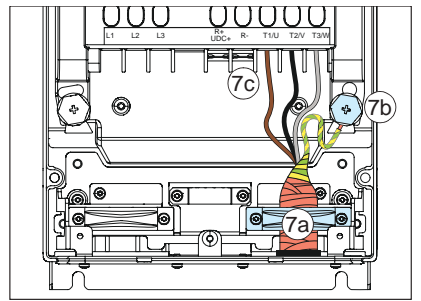
R3





R4 v2



R4

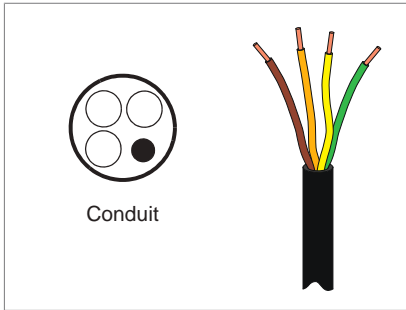


Frame size	R1		R2		R3		R4		R4 v2	
	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft
T1/U, T2/V, T3/W	1.0	0.7	1.5	1.1	3.5	2.6	4.0	3.0	5.5	4.0
PE, 	1.5	1.1	1.5	1.1	1.5	1.1	2.9	2.1	2.9	2.1
	1.2	0.9	1.2	0.9	1.2	0.9	1.2	0.9	1.2	0.9



### Input power cabling

8. Strip the ends of the conductors.



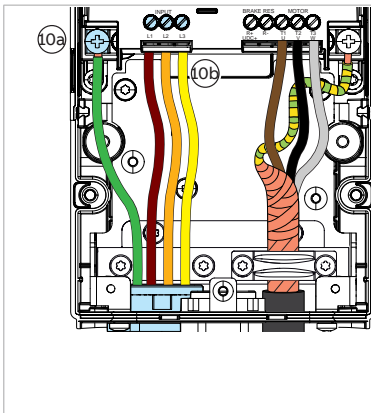
9. Slide the conductors through the conduit.

10. Connect the conductors:

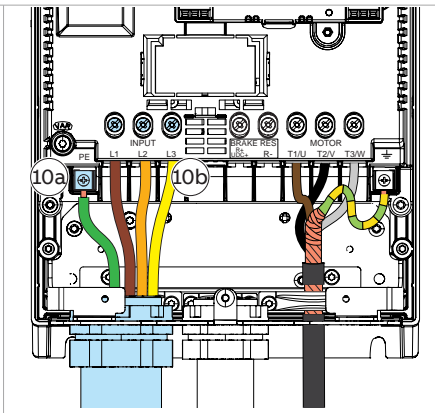
- Connect the grounding conductor to the grounding terminal. (10a)
- Connect the phase conductors to the L1, L2 and L3 terminals. Tighten the screws to the torque given in the table. (10b).

For IP66 (UL Type 4X) with disconnect: See torques in the table in page 330.

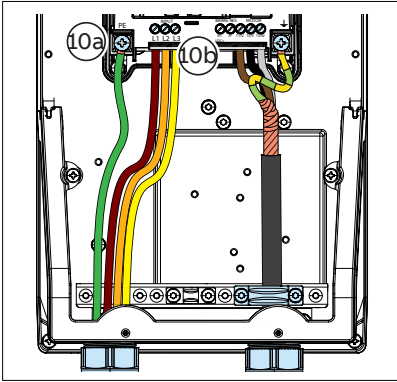
R1...R2



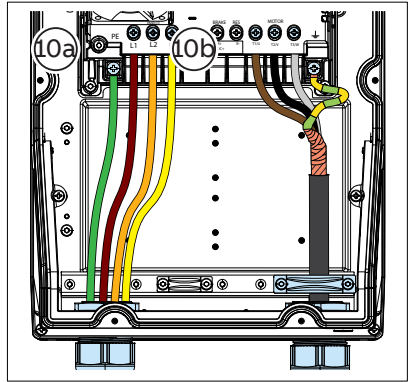
R3



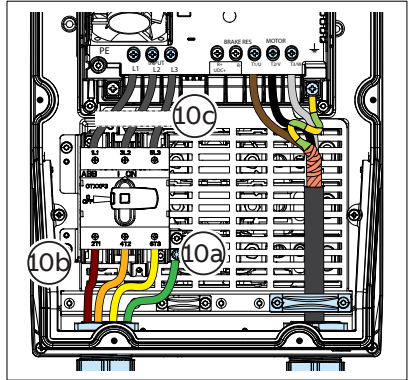
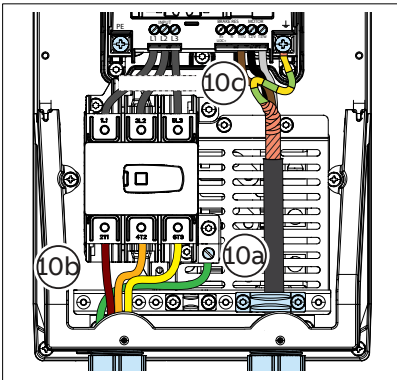
R1...R2 IP66 (UL Type 4X)



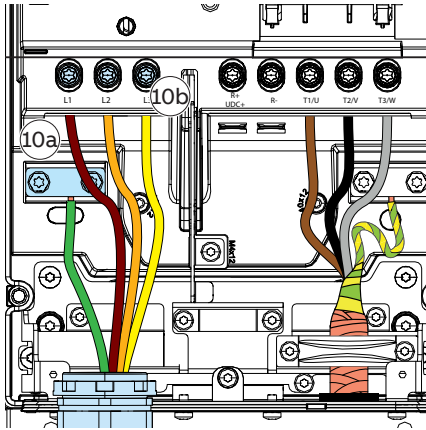
R3 IP66 (UL Type 4X)



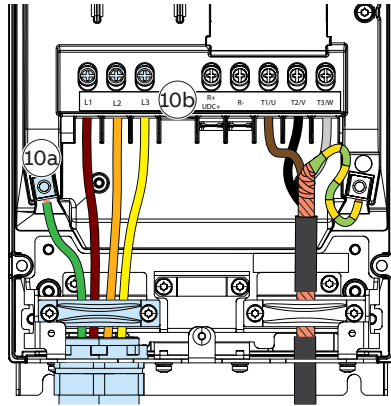
R1...R2 IP66 (UL Type 4X) with disconnect R3 IP66 (UL Type 4X) with disconnect




R4 v2



R4

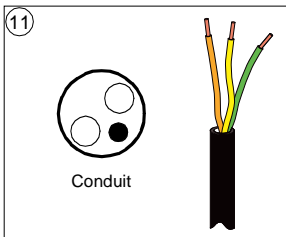


Frame size	R1		R2		R3		R4		R4 v2	
	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft
L1, L2, L3	1.0	0.7	1.5	1.1	3.5	2.6	4.0	3.0	5.5	4.0
PE, 	1.5	1.1	1.5	1.1	1.5	1.1	2.9	2.1	2.9	2.1

**Brake resistor cabling (if used)**

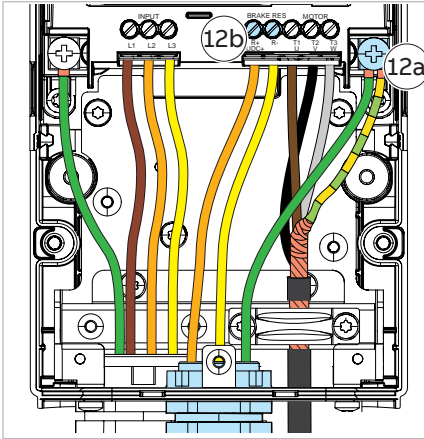
Frames R1...R3 only:

- Repeat steps 8...9 for the brake resistor conductors. Use only two phase conductors and the ground conductor.

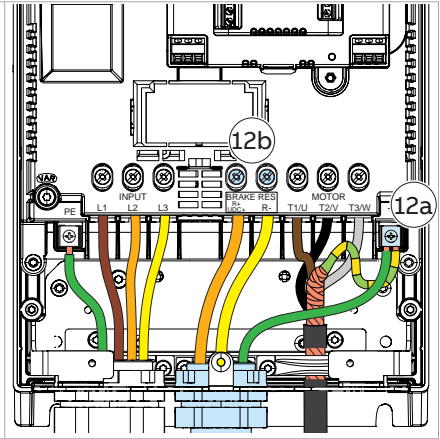


- Connect the grounding conductor to the grounding terminal (12a) and the other conductors to the R+ and R- terminals (12b). Tighten the screws to the torque given in the table.

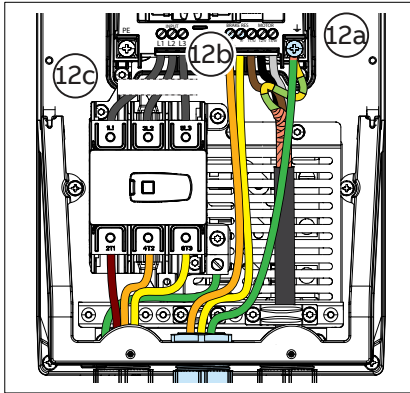
R1...R2



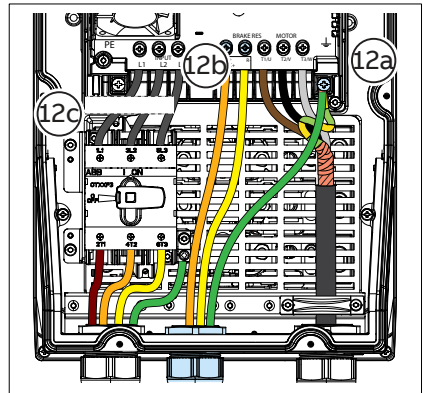
R3




R1...R2 IP66 (UL Type 4X)



R3 IP66 (UL Type 4X)



Frame size	R1		R2		R3	
	N-m	lbf-ft	N-m	lbf-ft	N-m	lbf-ft
R+, R-	1.0	0.7	1.5	1.1	3.5	2.6
PE, 	1.5	1.1	1.5	1.1	1.5	1.1

### Finalization

**Note:** Frame R1: You have to install any optional I/O extension module, if used, in options slot 2 at this point. See section [Installing option modules \(page 162\)](#).

- Secure the conduits outside the unit mechanically.



## ■ Connection procedure, frame R5

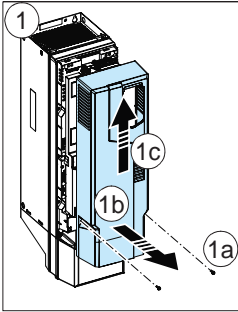
### IP21 (UL Type 1)

1. **Remove the module cover:** Loosen the retaining screws with a T20 Torx screwdriver (1a) and lift the cover from the bottom outwards (1b) and then up (1c).  
**Remove the box cover:** Loosen the retaining screws with a screwdriver (1d) and slide the cover downwards (1e).

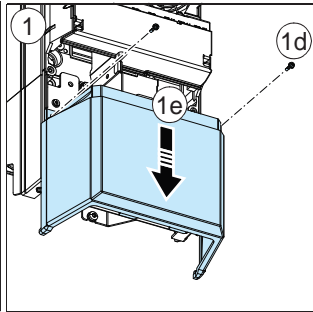
### IP55 (UL Type 12)

1. **Remove the front cover:** Loosen the retaining screws with a T20 Torx screwdriver (1a) and lift the cover from the bottom outwards (1b) and then up (1c).

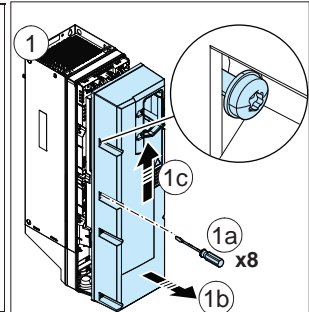
IP21 (UL Type 1)



IP21 (UL Type 1)



IP55 (UL Type 12)



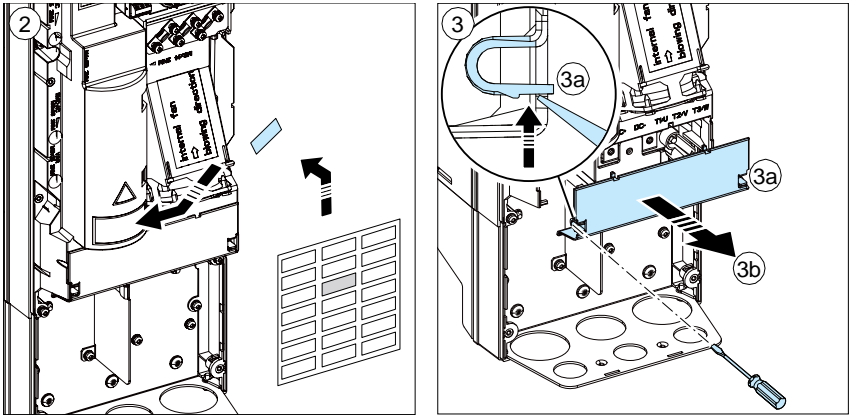
#### **WARNING!**

If you install the drive on any other system than symmetrically grounded TN-S system, see [Grounding system compatibility check \(page 174\)](#) if you have to disconnect the EMC filter and ground-to-phase varistor.

2. Attach the residual voltage warning sticker in the local language next to the control unit.
3. Remove the shroud on the power cable terminals by releasing the clips with a screwdriver (3a) and pulling the shroud out (3b).







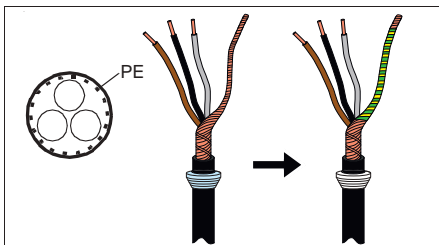
4. Remove the rubber grommets, if present, for the motor and input power cabling.  
Remove the grommets for the control cabling when you are connecting them.
5. Prepare the power cables as in [Connection procedure, frames R1...R4 \(page 184\)](#), step 4

**Note:** If the drive is shipped with grommet cones pointing up they must be removed and inserted back pointing down.

### Motor cabling

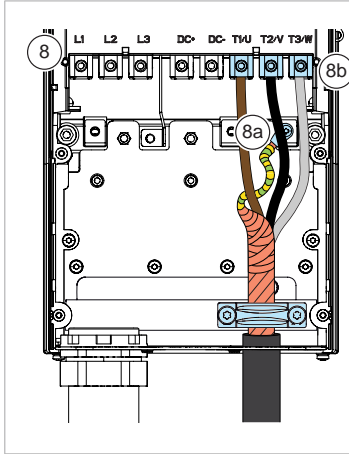
6. Prepare the ends of the cable as illustrated in the figure.


**Note:** The bare shield will be grounded 360 degrees. Mark the pigtail made from the shield as a PE conductor with yellow-and-green color.



7. Slide the cable through the hole of the bottom plate and attach the grommet to the hole.
8. Connect the motor cable:

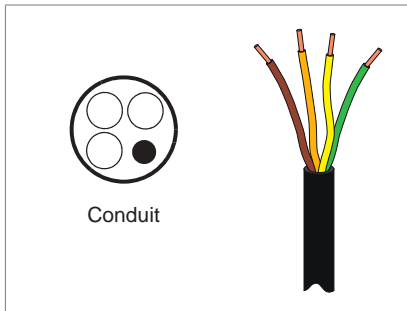
- Ground the shield 360 degrees by tightening the clamp of the power cable grounding shelf onto the stripped part of the cable (8a).
- Connect the twisted shield of the cable to the grounding terminal (8b).
- Connect the phase conductors of the cable to the T1/U, T2/V and T3/W terminals (8c). Tighten the screws to the torque given in the table.



Frame size	T1/U, T2/V, T3/W		PE, 		
	N-m	lbf-ft	M	N-m	lbf-ft
R5	15	11.1	M5	2.2	1.6

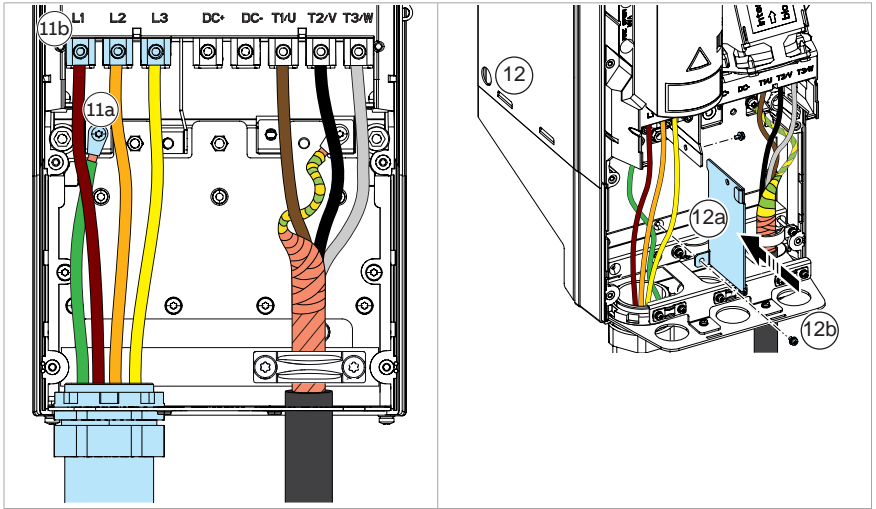
Input power cabling


9. Strip the ends of the conductors.



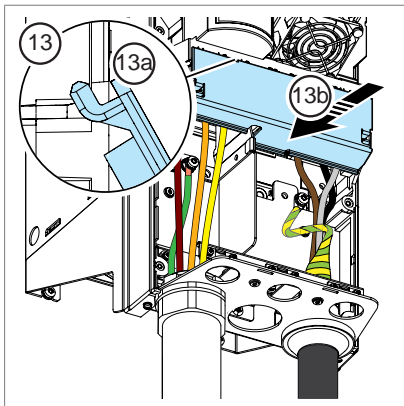
10. Slide the conductors through the conduit.
11. Connect the conductors:
- Connect the grounding conductor to the grounding terminal. (11a)
  - Connect the conductors as for the motor cabling. Use terminals L1, L2 and L3 (11b). Tighten the screws to the torque given in the table.
12. Install the cable box plate. Position the plate (12a) and tighten the screw (12b).





Frame size	L1, L2, L3		PE, 		
	N-m	lbf-ft	M	N-m	lbf-ft
R5	15	11.1	M5	2.2	1.6

- Reinstall the shroud on the power terminals by putting the tabs at the top of the shroud in their counterparts on the drive frame (13a) and then pressing the shroud in place (13b).



### Finalization

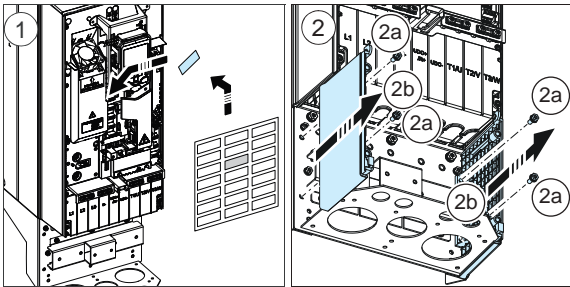
- Secure the conduits outside the unit mechanically.



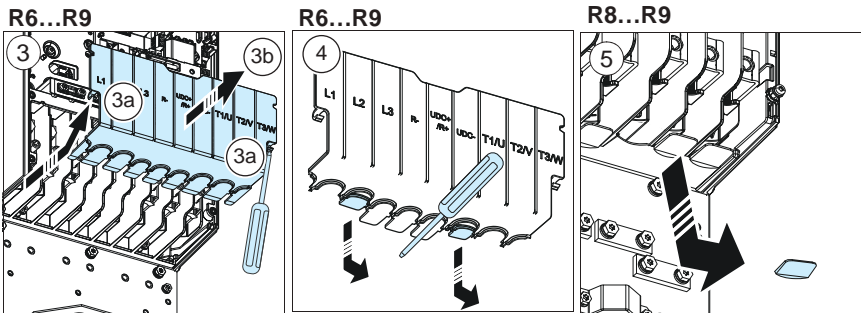
■ **Connection procedure, frames R6...R9**

**⚡ WARNING!**  
 If you install the drive on any other system than symmetrically grounded TN-S system, see see [Grounding system compatibility check \(page 174\)](#) if you have to disconnect the EMC filter and ground-to-phase varistor.

1. Attach the residual voltage warning sticker in the local language next to the control unit.
2. Remove the side plates of the cable box: Remove the retaining screws (2a) and slide the walls out (2b).



3. Remove the shroud on the power cable terminals by releasing the clips with a screwdriver (3a) and pulling the shroud out (3b).
4. Knock out holes in the shroud for the cabling to be installed.
5. Frames R8...R9: If you install parallel cabling, also knock out holes in the lower shroud.



6. Remove the rubber grommets, if present, for the motor and input power cabling.

Remove the grommets for the control cabling when you are connecting them.

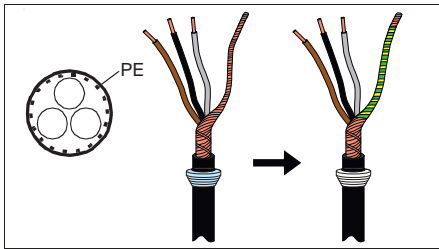
7. Prepare the power cables as in [Connection procedure, frames R1...R4 \(page 184\)](#), step 4

**Note:** If the drive is shipped with grommet cones pointing up they must be removed and inserted back pointing down.

### Motor cabling

8. Prepare the ends of the cable as illustrated in the figure.

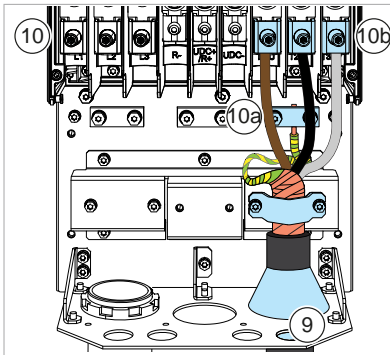
**Note:** The bare shield will be grounded 360 degrees. Mark the pigtail made from the shield as a PE conductor with yellow-and-green color.




9. Slide the cable through the hole of the bottom plate and attach the grommet to the hole.

10. Connect the motor cable:

- Ground the shield 360 degrees by tightening the clamp of the power cable grounding shelf onto the stripped part of the cable (10a).
- Connect the twisted shield of the cable to the grounding terminal (10b).
- Connect the phase conductors of the cable to the T1/U, T2/V and T3/W terminals (10c). Tighten the screws to the torque given in the table.



Frame size	L1, L2, L3, T1/U, T2/V, T3/W		PE, 	
	N-m	lbf-ft	N-m	lbf-ft
R6	30	22	9.8	7.2
R7	40	30	9.8	7.2
R8	40	30	9.8	7.2
R9	70	52	9.8	7.2

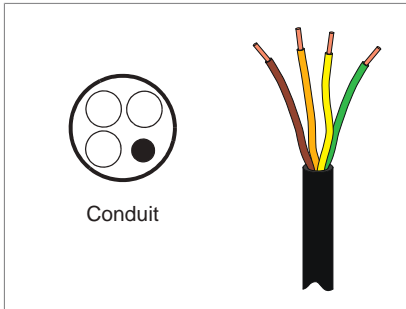


**Note 1 for frames R8...R9:** If you connect only one conductor to the connector, ABB recommends that you put it under the upper pressure plate. If you use parallel power cabling, put the first conductor under the lower pressure plate and the second under the upper one.

**Note 2 for frames R8...R9:** The connectors are detachable but ABB does not recommend that you detach them. If you do, detach and reinstall the connectors as described in [Detaching and reinstalling the connectors \(page 198\)](#).

**Input power cabling**

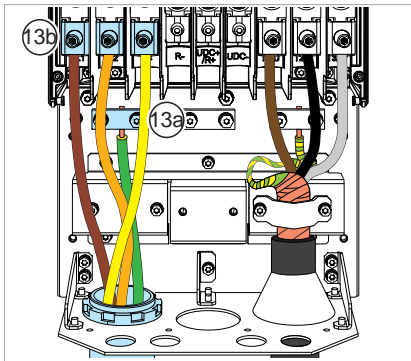
11. Strip the ends of the conductors.




12. Slide the conductors through the conduit.

13. Connect the conductors:

- Connect the grounding conductor to the grounding terminal (13a).
- Connect the conductors as for the motor cabling. Use terminals L1, L2 and L3. Tighten the screws to the torque given in the table (13b).



Frame size	L1, L2, L3, T1/U, T2/V, T3/W		PE, 	
	N-m	lbf-ft	N-m	lbf-ft
R6	30	22	9.8	7.2
R7	40	30	9.8	7.2
R8	40	30	9.8	7.2
R9	70	52	9.8	7.2

**Detaching and reinstalling the connectors**

This is possible but not recommended.

Terminals T1/U, T2/V and T3/W

- Remove the nut that attaches the connector to its busbar.
- Put the conductor under the connector pressure plate and pre-tighten the conductor.
- Put the connector back to its busbar. Start the nut, and turn it at least two rotations by hand.

**WARNING!**

Before you use tools, make sure that the nut or screw is not cross-threading. Cross-threading can damage the drive and cause danger.

- Tighten the nut to a torque of 30 N·m (22 lbf·ft).
- Tighten the conductor(s) to 40 N·m (30 lbf·ft) for frame R8 or to 70 N·m (52 lbf·ft) for frame R9.

Terminals L1, L2 and L3

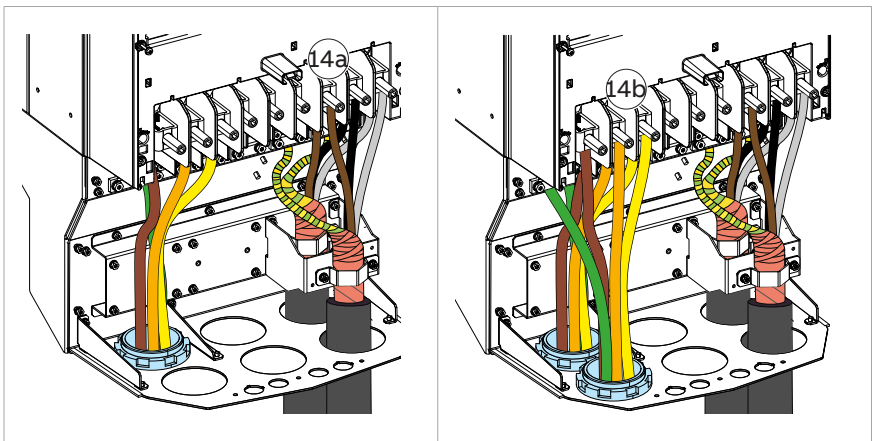
- Remove the combi screw that attaches the connector to its terminal post, and pull the connector off.
- Put the conductor under the connector pressure plate and pre-tighten the conductor.
- Put the connector back onto the terminal post. Start the combi screw, and turn it at least two rotations by hand.

**WARNING!**

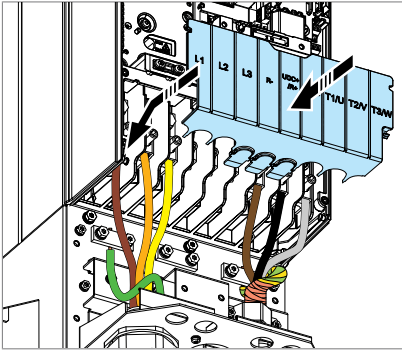
Before you use tools, make sure that the nut or screw is not cross-threading. Cross-threading can damage the drive and cause danger.

- Tighten the combi screw to a torque of 30 N·m (22 lbf·ft).
- Tighten the conductor(s) to 40 N·m (30 lbf·ft) for frame R8 or to 70 N·m (52 lbf·ft) for frame R9.

14. Frames R8...R9: Connect the parallel motor (14a) and input power (14b) cabling conductors, if used. Repeat steps 8...13.



15. Reinstall the shroud on the power terminals.



16. Secure the conduits outside the unit mechanically.

## DC connection

The UDC+ and UDC- terminals (as standard in frames R4...R9) are for using external brake chopper units.

## Connecting the control cables

### ■ Connection diagram


See [Default I/O connection diagram \(page 216\)](#) for the default I/O connections of the drive.

### ■ Control cable connection procedure R1...R9



#### **WARNING!**

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

- 
1. Do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.
  2. Remove the front cover(s) if not already removed. See page [184 \(R1...R4\)](#), page [192 \(R5\)](#) or page [90 \(R6...R9\)](#).

#### Analog signals

The figures for frames R1...R2 and R3 (page [202](#)), R4 (page [203](#)), R5 (page [204](#)) and R6...R9 (page [205](#)) show an example of connecting a cable. Make the connections according to the default configuration.



3. Remove the rubber grommets from the cable entry for the cables to be connected. Attach cable conduits to the empty cable entry holes. Slide the cables through the cable conduits.
4. Frames R5...R9: Secure the cables mechanically at the clamps below the control unit.  
Ground also the pair-cable shields and grounding wire at the SCR terminal, or either, you may ground the shield at the source of the signal, but do not ground it at both the source of the signal and the SCR terminal.
5. Route the cable as shown in the figures for frames R1...R2 and R3 (page 202), R4 (page 203), R5 (page 204) and R6...R9 (page 205).
6. Connect the conductors to the appropriate terminals of the control unit and tighten to 0.5...0.6 N·m (0.4 lbf·ft).

#### Digital signals

The figures for frames R1...R2 and R3 (page 202), R4 (page 203), R5 (page 204) and R6...R9 (page 205) show an example of connecting a cable. Make the connections according to the default configuration.

7. Remove the rubber grommets from the cable entry for the cables to be connected. Attach cable conduits to the empty cable entry holes. Slide the cables through the cable conduits.
8. Frames R5...R9: Secure the cables mechanically at the clamps below the control unit.  
If you use double-shielded cables, ground also the pair-cable shields and grounding wire at the SCR terminal.
9. Route the cable as shown in the figures for frames R1...R2 and R3 (page 202), R4 (page 203), R5 (page 204) and R6...R9 (page 205).
10. Connect the conductors to the appropriate terminals of the control unit and tighten to 0.5...0.6 N·m (0.4 lbf·ft).
11. Tie all control cables to the provided cable tie mounts.

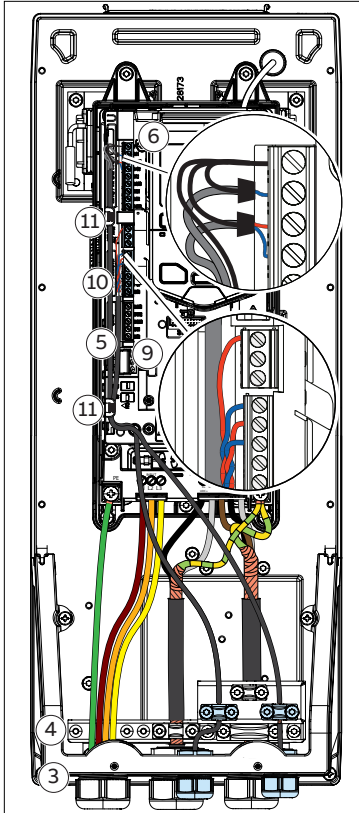
#### **Note:**

- Leave the other ends of the control cable shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, eg, 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are in the same ground line with no significant voltage drop between the end points.
- Keep any signal wire pairs twisted as close to the terminals as possible. Twisting the wire with its return wire reduces disturbances caused by inductive coupling.



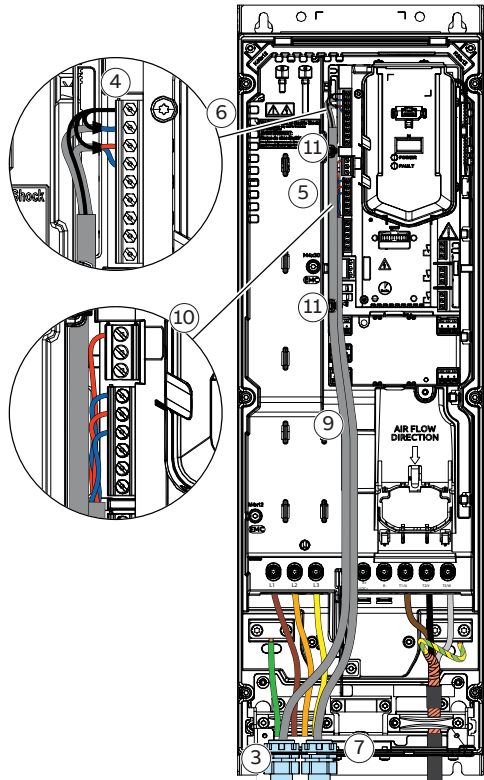


R1...R3 IP66 (UL Type 4X)



R1...R3: 0.4 lbf-ft

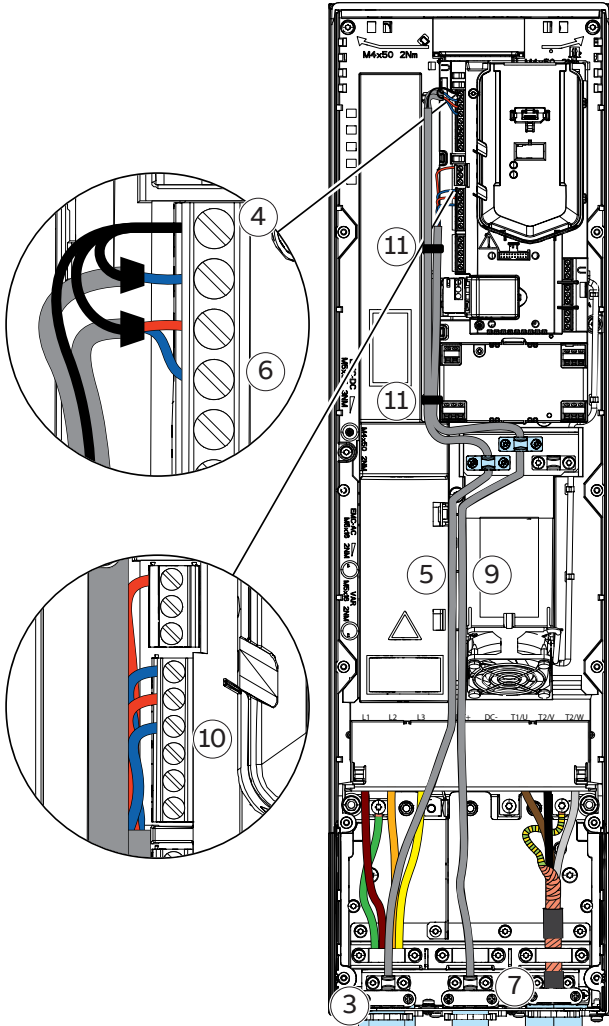
R4



R4: 0.4 lbf-ft

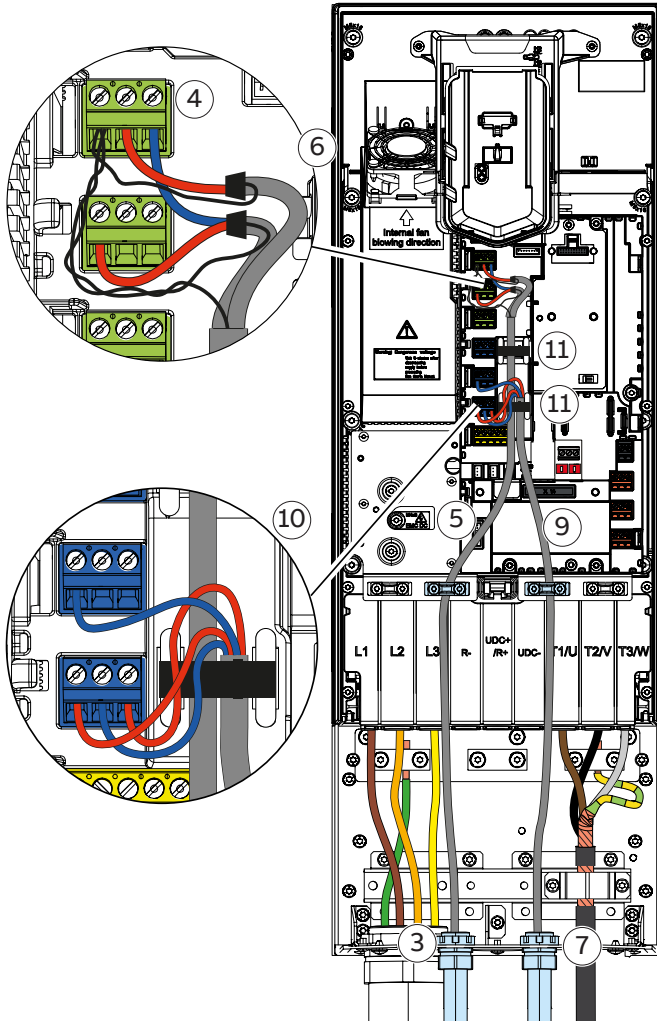


R5



R5: 0.4 lbf-ft

R6...R9



R6...R9: 0.4 lbf-ft

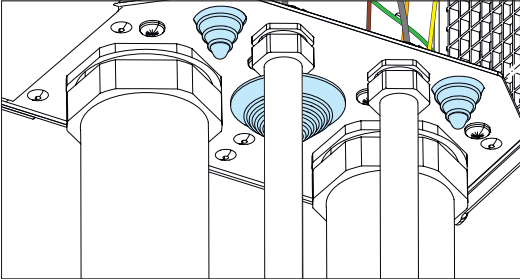


## Installing option modules

See section [Installing option modules \(page 162\)](#).

## Reinstalling grommets

**UL Type 12:** To maintain UL Type 12, reinstall grommets (top of the grommets downwards) to all cable entry holes without conduits.



**IP66 (UL Type 4X):** Plug unused holes with a hole plug with IP66 (UL Type 4X) or better protection rating and tighten securely.

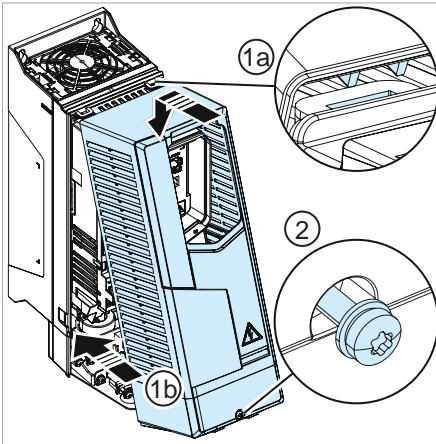


## Reinstalling covers

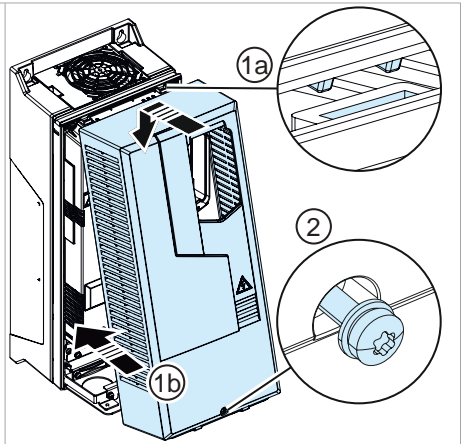
### ■ Reinstalling cover, frames R1...R4

1. Reinstall the cover: Put the tabs on the cover top in their counterparts on the housing (1a) and then press the cover (1b).  
IP66 (UL Type 4X): Reinstall the cover.
2. Tighten the retaining screw at the bottom with a T20 Torx screwdriver.  
IP66 (UL Type 4X): Tighten and secure the 8 screws to 2.5 N·m (1.8 lbf·in) with a Pozidriv #2 screwdriver.

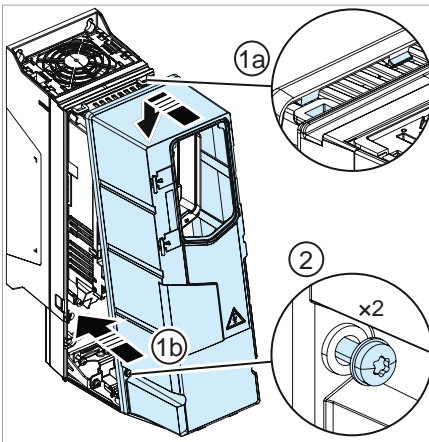
IP21 (UL Type 1) R1...R2



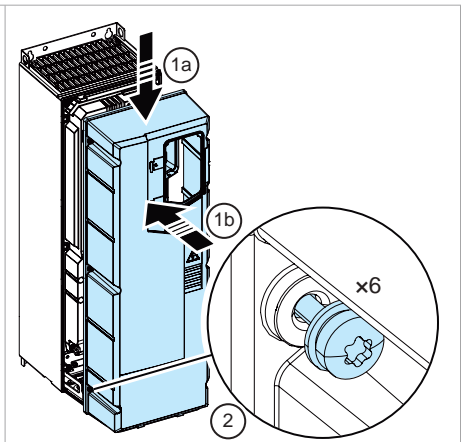
IP21 (UL Type 1) R3...R4



IP55 (UL Type 12) R1...R3



IP55 (UL Type 12) R4



■ Reinstalling covers, frame R5

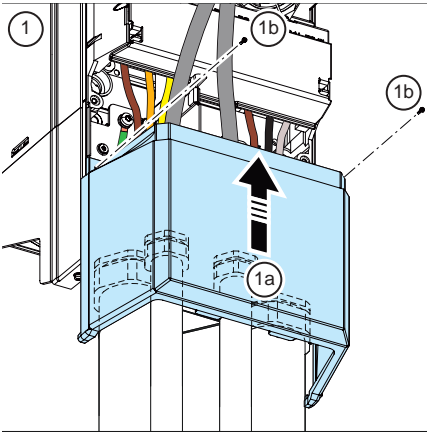
**IP21 (UL Type 1)**

1. Reinstall the box cover: Slide the cover upwards (1a) and tighten the retaining screws (1b) with a T20 Torx screwdriver.
2. Reinstall the module cover: Press the cover at the bottom (2a) and tighten the retaining screws (2b).

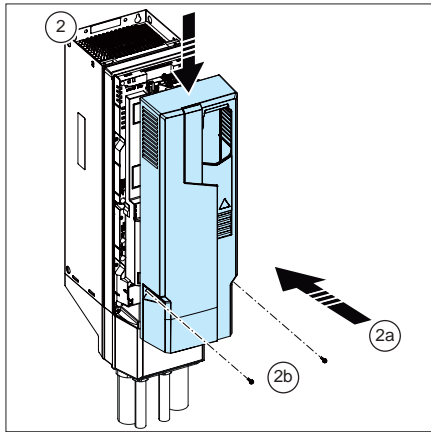
**IP55 (UL Type 12)**

1. Reinstall the front cover: Press the cover at the bottom (1a) and tighten the retaining screws (1b) with a T20 Torx screwdriver.

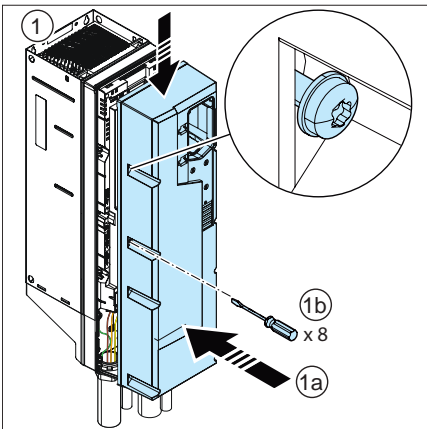
**IP21 (UL Type 1)**



**IP21 (UL Type 1)**



**IP55 (UL Type 12)**





## ■ Reinstalling side plates and covers, frames R6...R9

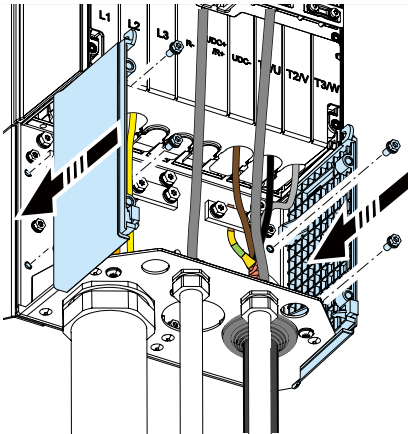
### IP21 (UL Type 1)

1. Reinstall the side plates of the cable box (1a). Tighten the retaining screws with a T20 Torx screwdriver (1b).
2. Slide the cover of the cable box on the module from below until the cover snaps into place.
3. Reinstall the module cover. Tighten the two retaining screws with a screwdriver.

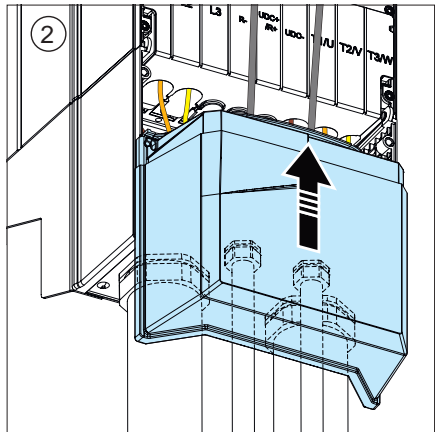
### IP55 (UL Type 12)

1. Reinstall the side plates of the cable box. Tighten the retaining screws with a T20 Torx screwdriver.

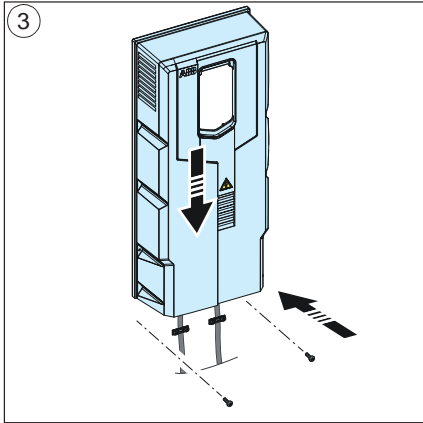
#### IP21 (UL Type 1)



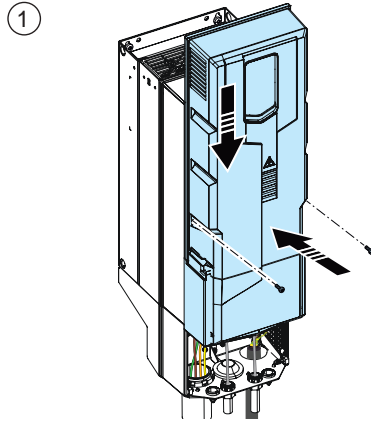
#### IP21 (UL Type 1)



### IP21 (UL Type 1)



### IP55 (UL Type 12)



## Installing UL Type 12 hood

See [UL Type 12 hood for ACS580-01, ACH580-01 and ACQ580-01](#), and for [ACH580-31 and ACQ580-31 frames R6 and R8 \(3AXD50000225972 \[English\]\)](#) which is included in the hood package.

## Installing IP66 (UL Type 4X) sun shield

Refer to [ACH580-01, ACQ580-01, ACS580-01 4X IP66 drives, sun shield quick installation guide \(3AXD50001019006 \[English\]\)](#), included in the sun shield package.

## Connecting a PC



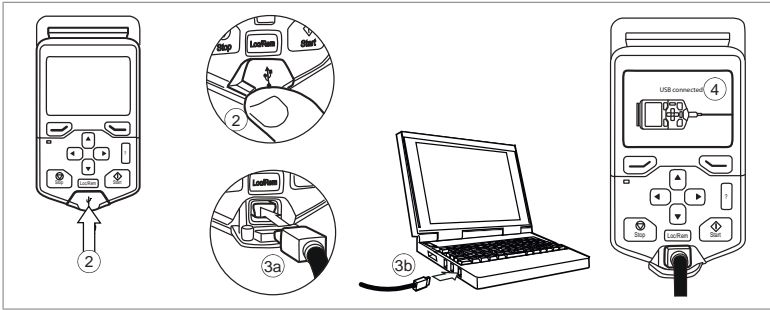
### WARNING!

Do not connect the PC directly to the control panel connector of the control unit. It can cause damage.



A PC (with, for example, the Drive Composer PC tool) can be connected as follows:

1. To connect a control panel to the unit, either
  - insert the control panel into the panel holder or platform, or
  - use an Ethernet (eg, Cat 5e) networking cable.
2. Remove the USB connector cover on the front of the control panel.
3. Connect an USB cable (Type A to Type Mini-B) between the USB connector on the control panel (3a) and a free USB port on the PC (3b).
4. The panel will display an indication whenever the connection is active.
5. See the documentation of the PC tool for setup instructions.



**Note:** For IP66 (UL Type 4X) drive, the USB connection on the panel cannot be accessed while the cover is in place. Use the Bluetooth functionality to troubleshoot the drive using the DriveTune app from your phone.

## Connecting a remote panel, or chaining one panel to several drives

You can connect a drive control panel remotely to the drive, or chain the control panel or a PC to several drives on a panel bus with a CDPI-01 communication adapter module. See [CDPI-01 communication adapter module user's manual \(3AXD50000009929 \[English\]\)](#).







# Control unit

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## Contents of this chapter

This chapter contains the default I/O connection diagram, descriptions of the terminals and technical data for the drive control unit (CCU-23 and CCU-24).

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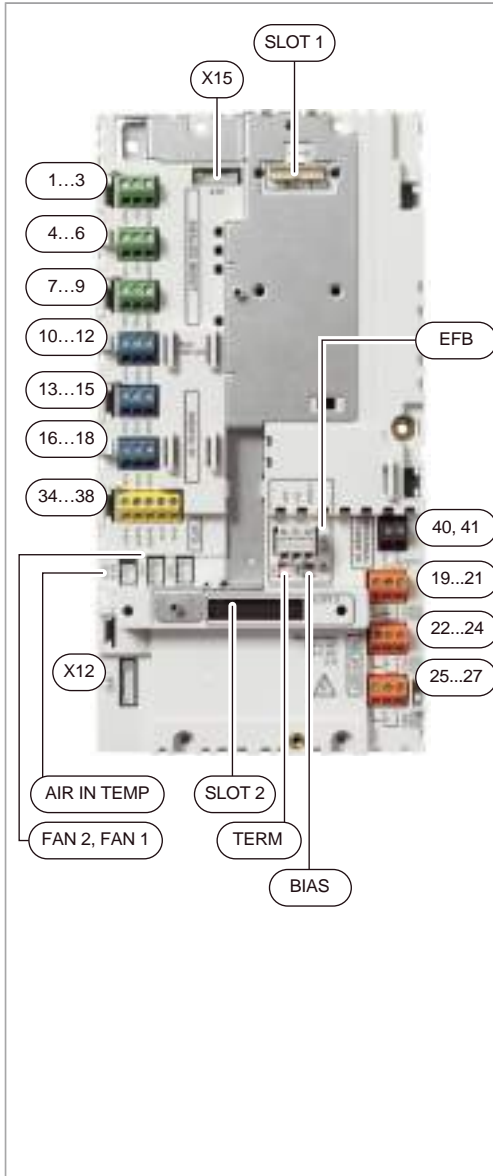
## Layout

The layout of the external control connection terminals on the drive module control unit is shown below.

### CCU-23 (R1...R5)

<b>SLOT 1</b>	
Option slot 1 (fieldbus adapter modules)	
<b>ANALOG IN/OUT</b>	
1...3	Analog input 1
4...6	Analog input 2
7...9	Analog outputs
10...12	Auxiliary voltage output, digital input common
<b>DIGITAL IN</b>	
13...18	Digital inputs
<b>STO</b>	
34...38	Safe torque off connection.
X12	Panel port (control panel connection, wired at the factory to the control panel)
<b>EFB</b>	
EIA/RS-485 fieldbus connector	
BIAS	Bias resistor switch
TERM	End termination switch
29...31	Connection terminals
<b>SLOT 2</b>	
Option slot 2 (I/O extension modules)	
<b>RO1 ... RO3</b>	
19...21	Relay output 1 (RO1)
22...24	Relay output 2 (RO2)
25...27	Relay output 3 (RO3)

## CCU-24 (R6...R9)



<b>SLOT 1</b>	
Option slot 1 (fieldbus adapter modules)	
<b>ANALOG IN/OUT</b>	
1...3	Analog input 1
4...6	Analog input 2
7...9	Analog outputs
10...12	Auxiliary voltage output, digital input common
<b>DIGITAL IN</b>	
13...18	Digital inputs
<b>STO</b>	
34...38	Safe torque off connection.
<b>AIR IN TEMP</b>	
Internal air temperature NTC sensor connection	
FAN2	Internal fan 2 connection
FAN1	Internal fan 1 connection
X12	Panel port (control panel connection, wired at the factory to the control panel)
X15	Reserved to internal use.
<b>EFB</b>	
EIA/RS-485 fieldbus connector	
BIAS	Bias resistor switch
TERM	End termination switch
29...31	Connection terminals
<b>SLOT 2</b>	
Option slot 2 (I/O extension modules)	
40, 41	24 V AC/DC external power input
<b>RO1 ... RO3</b>	
19...21	Relay output 1 (RO1)
22...24	Relay output 2 (RO2)
25...27	Relay output 3 (RO3)

## Default I/O connection diagram

The default control connections for the Water default are shown below.

CCU-23 (R1...R5)

Connection	Term	Description	
<b>X1 Reference voltage and analog inputs and outputs</b>			
	1	SCR	Signal cable shield (screen)
	2	AI1	Output frequency/speed reference: 0...10 V <sup>1)</sup>
	3	AGND	Analog input circuit common
	4	+10V	Reference voltage 10 V DC
	5	AI2	Actual feedback: 0...10 V <sup>1)</sup>
	6	AGND	Analog input circuit common
	7	AO1	Output frequency: 0...10 V
	8	AO2	Output current: 0...20 mA
	9	AGND	Analog output circuit common
<b>X2 &amp; X3 Aux. voltage output and programmable digital inputs</b>			
	10	+24V	Aux. voltage output +24 V DC, max. 250 mA <sup>2)</sup>
	11	DGND	Aux. voltage output common
	12	DCOM	Digital input common for all
	13	DI1	Stop (0) / Start (1)
	14	DI2	Not configured
	15	DI3	Constant frequency/speed selection <sup>3)</sup>
	16	DI4	Not configured
	17	DI5	Not configured
	18	DI6	Not configured
<b>X6, X7, X8 Relay outputs</b>			



Connection		Term	Description
Ready run status	← 19	19 RO1C	Ready run
	← 20	20 RO1A	250 V AC / 30 V DC
	← 21	21 RO1B	2 A
Run status	← 22	22 RO2C	Running
	← 23	23 RO2A	250 V AC / 30 V DC
	← 24	24 RO2B	2 A
Fault status	← 25	25 RO3C	Fault (-1)
	← 26	26 RO3A	250 V AC / 30 V DC
	← 27	27 RO3B	2 A
<b>X5 Embedded fieldbus</b>			
	29	B+	Embedded fieldbus, EFB (EIA-485)
	30	A-	
	31	DGND	
	S4	TERM	Termination switch
	S5	BIAS	Bias resistors switch
<b>X4 Safe Torque Off</b>			
	34	OUT1	Safe torque off. Factory connection. Both circuits must be closed for the drive to start. Refer to <a href="#">The Safe torque off function (page 407)</a> .
	35	OUT2	
	36	SGND	
	37	IN1	
	38	IN2	

Total load capacity of the Auxiliary voltage output +24V (X2:10) is 6.0 W (250 mA / 24 V DC).

Digital inputs DI1...DI5 also support 10...24 V AC.

Terminal sizes: 0.2 ... 2.5 mm<sup>2</sup> (24...14 AWG) (Terminals +24V, DGND, DCOM, B+, A-, DGND, Ext. 24V)

Terminal sizes: 0.14 ... 1.5 mm<sup>2</sup> (26...16 AWG) (Terminals DI, AI, AO, AGND, RO, STO)

Tightening torques: 0.5 ... 0.6 N·m (4.4 ... 5.3 lbf·in)

Wire strip length 7...8 mm (0.3 in)

CCU-24 (R6...R9)

Connection	Term	Description	
<b>X1 Reference voltage and analog inputs and outputs</b>			
	1	SCR	Signal cable shield (screen)
	2	AI1	Output frequency/speed reference: 0...10 V <sup>1)</sup>
	3	AGND	Analog input circuit common
	4	+10V	Reference voltage 10 V DC
	5	AI2	Actual feedback: 0...10 V <sup>1)</sup>
	6	AGND	Analog input circuit common
	7	AO1	Output frequency: 0...10 V
	8	AO2	Output current: 0...20 mA
	9	AGND	Analog output circuit common
<b>X2 &amp; X3 Aux. voltage output and programmable digital inputs</b>			
	10	+24V	Aux. voltage output +24 V DC, max. 250 mA <sup>2)</sup>
	11	DGND	Aux. voltage output common
	12	DCOM	Digital input common for all
	13	DI1	Stop (0) / Start (1)
	14	DI2	Not configured
	15	DI3	Constant frequency/speed selection <sup>3)</sup>
	16	DI4	Not configured
	17	DI5	Not configured
	18	DI6	Not configured
<b>X6, X7, X8 Relay outputs</b>			

Connection		Term	Description
Ready run status	← 19	19 RO1C	Ready run
	← 20	20 RO1A	250 V AC / 30 V DC
	← 21	21 RO1B	2 A
Run status	← 22	22 RO2C	Running
	← 23	23 RO2A	250 V AC / 30 V DC
	← 24	24 RO2B	2 A
Fault status	← 25	25 RO3C	Fault (-1)
	← 26	26 RO3A	250 V AC / 30 V DC
	← 27	27 RO3B	2 A
<b>X5 Embedded fieldbus</b>			
	29	B+	Embedded fieldbus, EFB (EIA-485)
	30	A-	
	31	DGND	
	S4	TERM	Termination switch
	S5	BIAS	Bias resistors switch
<b>X4 Safe Torque Off</b>			
	34	OUT1	Safe torque off. Factory connection. Both circuits must be closed for the drive to start. Refer to <a href="#">The Safe torque off function (page 407)</a> .
	35	OUT2	
	36	SGND	
	37	IN1	
	38	IN2	
<b>X10 24 V AC/DC</b>			
	40	24 V AC/DC+ in	External 24 V AC/DC input to power up the control unit when the main supply is disconnected. <sup>7)</sup>
	41	24 V AC/DC- in	

Total load capacity of the Auxiliary voltage output +24V (X2:10) is 6.0 W (250 mA / 24 V DC).

Digital inputs DI1...DI5 also support 10...24 V AC.

Terminal sizes (all terminals): 0.14 ... 2.5 mm<sup>2</sup> (26...14 AWG)


Tightening torques: 0.5 ... 0.6 N·m (4.4 ... 5.3 lbf·in)

Wire strip length 7...8 mm (0.3 in)

**Notes:**

- 1) Current [0(4)...20 mA,  $R_{in} = 100 \text{ ohm}$ ] or voltage [0(2)...10 V,  $R_{in} > 200 \text{ kohm}$ ]. Change of setting requires changing the corresponding parameter.
- 2) Total load capacity of the Auxiliary voltage output +24V (X2:10) is 6.0 W (250 mA / 24 V) minus the power taken by the option modules installed on the board.
- 3) In scalar control: See **Menu > Primary settings > Start, stop, reference > Constant speeds / constant frequencies** or parameter group 28 Frequency reference chain.  
In vector control: See **Menu > Primary settings > Start, stop, reference > Constant speeds / constant frequencies** or parameter group 22 Speed reference selection.

DI3	Operation/Parameter	
	Scalar control (default)	Vector control
0	Set frequency through AI1	Set speed through AI1
1	28.26 Constant frequency 1	22.26 Constant speed 1

- 4) Connected with jumpers at the factory.
- 5) Use shielded twisted-pair cables for digital signals.
- 6) Ground the outer shield of the cable 360° under the grounding clamp on the grounding shelf, and the pair-cable shields and grounding wire at the grounding terminal (SCR) of the control unit.
- 7)  **WARNING!** Connect an external AC power supply (24 V AC) only to control unit connectors 40 and 41. If you connect it to connector AGND, DGND or SGND, damage to the power supply or control unit can occur.

## Additional information on the control connections

### ■ Embedded EIA-485 fieldbus connection

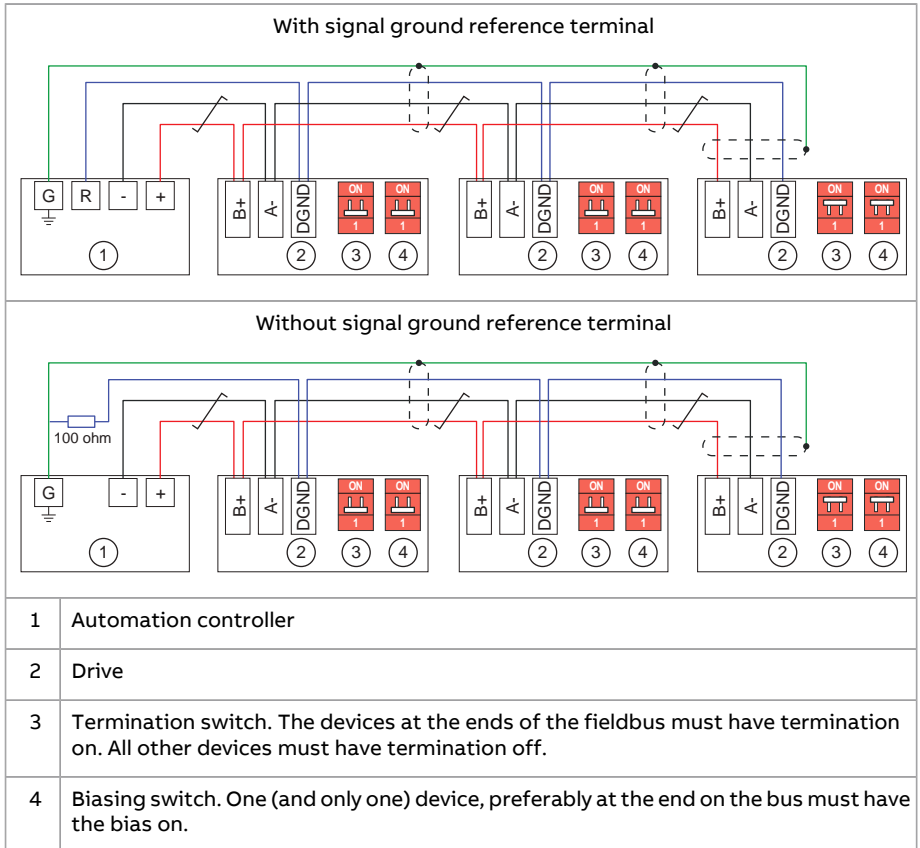
The EIA-485 network uses shielded, twisted-pair cable with a characteristic impedance of 100...130 ohm for data signaling. The distributed capacitance between conductors is less than 100 pF per meter (30 pF per foot). Distributed capacitance between conductors and shield is less than 200 pF per meter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

Connect the cable to the EIA-485 terminal on the control unit. Obey these wiring instructions:

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

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

Connection examples are shown below.



### ■ Connecting motor temperature sensors to the drive

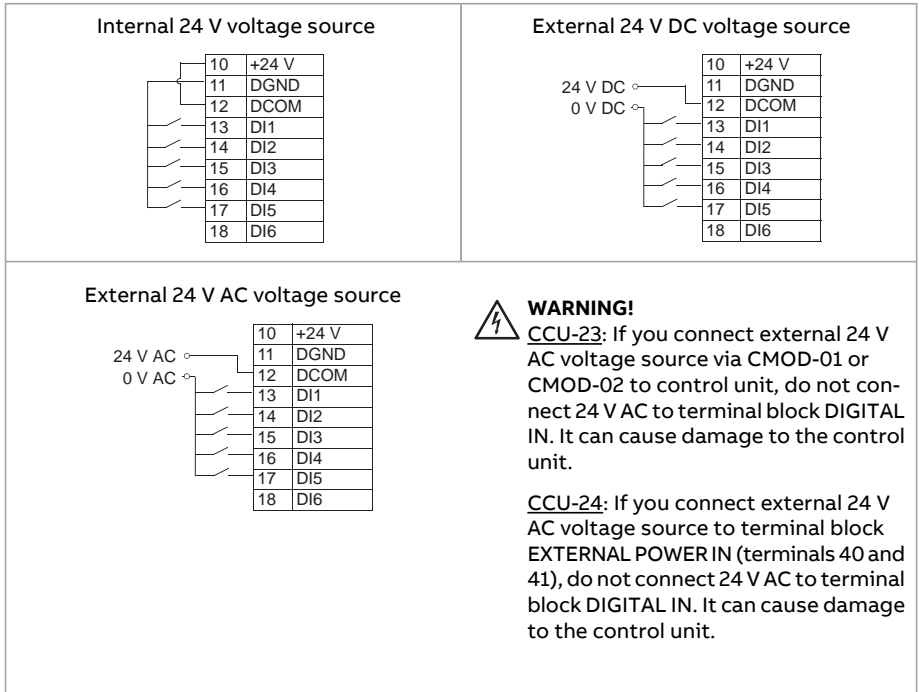
IEC/EN 60664 requires double or reinforced insulation between the control unit and the live parts of the motor. To achieve this, use an CMOD-02 I/O extension module or CPTC-02 ATEX-certified thermistor protection module. Refer to section [Implementing a motor temperature sensor connection](#) and chapter [CMOD-02](#)

multifunction extension module (external 24 V AC/DC and isolated PTC interface) (page 445).

■ PNP configuration for digital inputs (DIGITAL IN)

<p style="text-align: center;"><b>Internal 24 V voltage source</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>10</td><td>+24 V</td></tr> <tr><td>11</td><td>DGND</td></tr> <tr><td>12</td><td>DCOM</td></tr> <tr><td>13</td><td>DI1</td></tr> <tr><td>14</td><td>DI2</td></tr> <tr><td>15</td><td>DI3</td></tr> <tr><td>16</td><td>DI4</td></tr> <tr><td>17</td><td>DI5</td></tr> <tr><td>18</td><td>DI6</td></tr> </table>	10	+24 V	11	DGND	12	DCOM	13	DI1	14	DI2	15	DI3	16	DI4	17	DI5	18	DI6	<p style="text-align: center;"><b>External 24 V DC voltage source</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>10</td><td>+24 V</td></tr> <tr><td>11</td><td>DGND</td></tr> <tr><td>12</td><td>DCOM</td></tr> <tr><td>13</td><td>DI1</td></tr> <tr><td>14</td><td>DI2</td></tr> <tr><td>15</td><td>DI3</td></tr> <tr><td>16</td><td>DI4</td></tr> <tr><td>17</td><td>DI5</td></tr> <tr><td>18</td><td>DI6</td></tr> </table>	10	+24 V	11	DGND	12	DCOM	13	DI1	14	DI2	15	DI3	16	DI4	17	DI5	18	DI6
10	+24 V																																				
11	DGND																																				
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17	DI5																																				
18	DI6																																				
<p style="text-align: center;"><b>External 24 V AC voltage source</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>10</td><td>+24 V</td></tr> <tr><td>11</td><td>DGND</td></tr> <tr><td>12</td><td>DCOM</td></tr> <tr><td>13</td><td>DI1</td></tr> <tr><td>14</td><td>DI2</td></tr> <tr><td>15</td><td>DI3</td></tr> <tr><td>16</td><td>DI4</td></tr> <tr><td>17</td><td>DI5</td></tr> <tr><td>18</td><td>DI6</td></tr> </table> <p style="margin-top: 10px;"><b>Note:</b> DI6 is not supported with external 24 V AC voltage source.</p>	10	+24 V	11	DGND	12	DCOM	13	DI1	14	DI2	15	DI3	16	DI4	17	DI5	18	DI6	<p> <b>WARNING!</b></p> <p><b>CCU-23:</b> If you connect external 24 V AC voltage source via CMOD-01 or CMOD-02 to control unit, do not connect 24 V AC to terminal block DIGITAL IN. It can cause damage to the control unit.</p> <p><b>CCU-24:</b> If you connect external 24 V AC voltage source to terminal block EXTERNAL POWERIN (terminals 40 and 41), do not connect 24 V AC to terminal block DIGITAL IN. It can cause damage to the control unit.</p>																		
10	+24 V																																				
11	DGND																																				
12	DCOM																																				
13	DI1																																				
14	DI2																																				
15	DI3																																				
16	DI4																																				
17	DI5																																				
18	DI6																																				

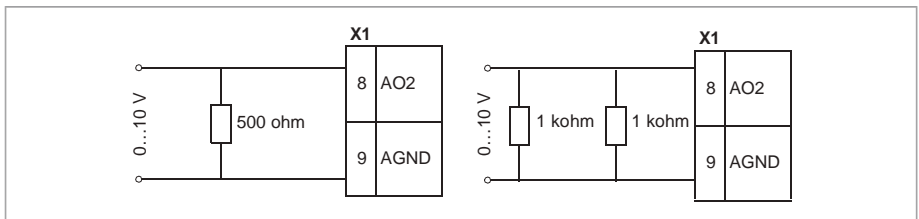
## ■ NPN configuration for digital inputs (DIGITAL IN)



**Note:** DI6 is not supported in the NPN configuration.

## ■ Connection for obtaining 0...10 V from analog output 2 (AO2)

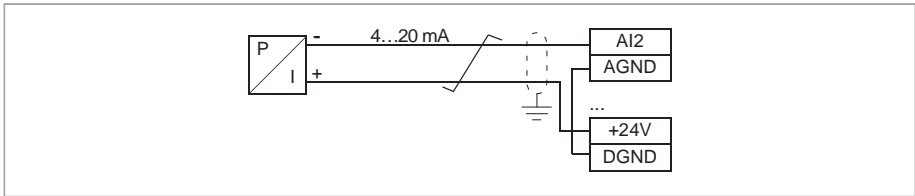
To obtain 0...10 V from analog output AO2, connect a 500 ohm resistor (or two 1 kohm resistors in parallel) between analog output AO2 and analog common ground AGND.



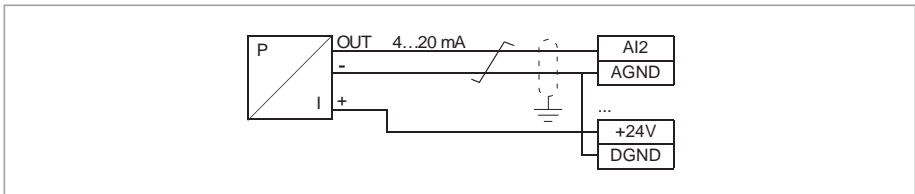
### ■ Connection examples of two-wire and three-wire sensors to analog input (AI2)

**Note:** The maximum capability of the auxiliary voltage output (24 V DC [250 mA]) must not be exceeded.

An example of a two-wire sensor/transmitter supplied by the drive auxiliary voltage output is shown below. Set the input signal to 4...20 mA, not 0...20 mA.



An example of a three-wire sensor/transmitter supplied by the drive auxiliary voltage output is shown below. The sensor is supplied through its current output and the drive feeds the supply voltage (+24 V DC). Thus the output signal must be 4...20 mA, not 0...20 mA.



### ■ DI5 as frequency input

For setting the parameters for the digital frequency input, see the firmware manual.

### ■ Safe torque off (X4)

For the drive to start, both connections (+24 V DC to IN1 and +24 V DC to IN2) must be closed. By default, the terminal block has jumpers to close the circuit.

Remove the jumpers before connecting an external Safe torque off circuitry to the drive. See also chapter [The Safe torque off function \(page 407\)](#).

**Note:** Only 24 V DC can be used for STO. Only PNP input configuration can be used.



## Technical data

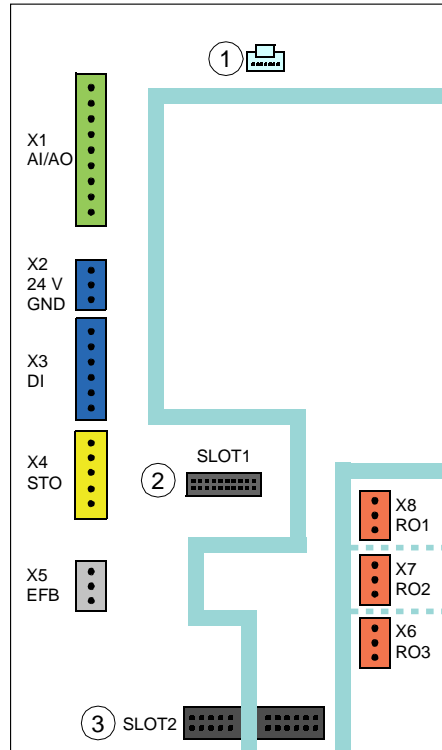
### CCU-23 (R1...R5)

External power supply through option module CMOD-01 or CMOD-02	Maximum power: 25 W, 1.04 A at 24 V AC/DC $\pm 10\%$ as standard Terminal size: 0.2 ... 2.5 mm <sup>2</sup> (24 ... 14 AWG)
+24 V DC output (Term. 10)	Total load capacity of this outputs is 6.0 W (250 mA / 24 V) minus the power taken by the option modules installed on board. Terminal size: 0.2 ... 2.5 mm <sup>2</sup> (24 ... 14 AWG)
Digital inputs DI1...DI6 (Term. 13...18)	<p>Input type: NPN/PNP Terminal size: 0.14 ... 1.5 mm<sup>2</sup> (26 ... 16 AWG)</p> <p><u>DI1...DI4 (Term. 13...16)</u> 12/24 V DC logic levels: "0" &lt; 4 V, "1" &gt; 8 V <math>R_{in}</math>: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling</p> <p><u>DI5 (Term.17)</u> Can be used as a digital or frequency input. 12/24 V DC logic levels: "0" &lt; 4 V, "1" &gt; 8 V <math>R_{in}</math>: 3 kohm Max. frequency: 16 kHz Symmetrical signal (duty cycle D = 0.50)</p> <p><u>DI6 (Term.18)</u> Can be used as a digital or PTC input. 12/24 V DC logic levels: "0" &lt; 3 V, "1" &gt; 8 V <math>R_{in}</math>: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling</p> <p><b>Note:</b> DI6 is not supported in the NPN configuration. PTC mode – PTC thermistor can be connected between DI6 and +24 V DC: &lt; 1.5 kohm = '1' (low temperature), &gt; 4 kohm = '0' (high temperature), open circuit = '0' (high temperature). DI6 is not a reinforced/double insulated input. Connecting the motor PTC sensor to this input requires usage of a reinforced/double insulated PTC sensor inside the motor</p>
Relay outputs RO1...RO3 (Term. 19...27)	250 V AC / 30 V DC, 2 A. Terminal size: 0.14 ... 1.5 mm <sup>2</sup> (26 ... 16 AWG)  See section <a href="#">Isolation areas (page 227)</a> .

## 226 Control unit

<p>Analog inputs AI1 and AI2 (Term. 2 and 5)</p>	<p>Current/voltage input mode selected with a parameter, see <a href="#">Connecting motor temperature sensors to the drive (page 221)</a>.            Current input: 0(4)...20 mA, <math>R_{in}</math>: 100 ohm            Voltage input: 0(2)...10 V, <math>R_{in}</math>: &gt; 200 kohm            Terminal size: 0.14 ... 1.5 mm<sup>2</sup> (26 ... 16 AWG)            Inaccuracy: typical <math>\pm 1\%</math>, max. <math>\pm 1.5\%</math> of full scale            Inaccuracy for Pt100 sensors: 10 °C (50 °F)</p>
<p>Analog outputs AO1 and AO2 (Term. 7 and 8)</p>	<p>Current/voltage output mode for AO1 selected with a parameter, see <a href="#">Connection for obtaining 0...10 V from analog output 2 (AO2) (page 223)</a>.            Current output: 0...20 mA, <math>R_{load}</math>: &lt; 500 ohm            Voltage input: 0...10 V, <math>R_{load}</math>: &gt; 100 kohm (AO1 only)            Terminal size: 0.14 ... 1.5 mm<sup>2</sup> (26 ... 16 AWG)            Inaccuracy: <math>\pm 1\%</math> of full scale (in voltage and current modes)</p>
<p>Reference voltage output for analog inputs +10V DC (Term. 4)</p>	<p>Max. 20 mA output            Inaccuracy: <math>\pm 1\%</math></p>
<p>Embedded fieldbus (X5)</p>	<p>Connector pitch 5 mm, maximum wire size 2.5 mm<sup>2</sup> (14 AWG)            Physical layer: EIA-485            Cable type: Shielded twisted pair cable with twisted pair for data and a wire or pair for signal ground, nominal impedance 100...165 ohms, for example Belden 9842            Transmission rate: 9.6 ... 115.2 kbit/s            Termination by switch</p>
<p>Safe torque off (STO) inputs IN1 and IN2 (Term. 37 and 38)</p>	<p>24 V DC logic levels: "0" &lt; 5 V, "1" &gt; 13 V  <math>R_{in}</math>: 2.47 kohm            Terminal size: 0.14 ... 1.5 mm<sup>2</sup> (26 ... 16 AWG)</p>
<p>Control panel - drive connection</p>	<p>EIA-485, male RJ-45 connector, max. cable length 100 m (328 ft)</p>
<p>Control panel - PC connection</p>	<p>USB Type Mini-B, max. cable length 3 m (9.8 ft)</p>

## Isolation areas



1

Panel port

2

Fieldbus extension

3

I/O extension



Reinforced insulation (IEC/EN 61800-5-1:2007, UL 61800-5-1 First edition)

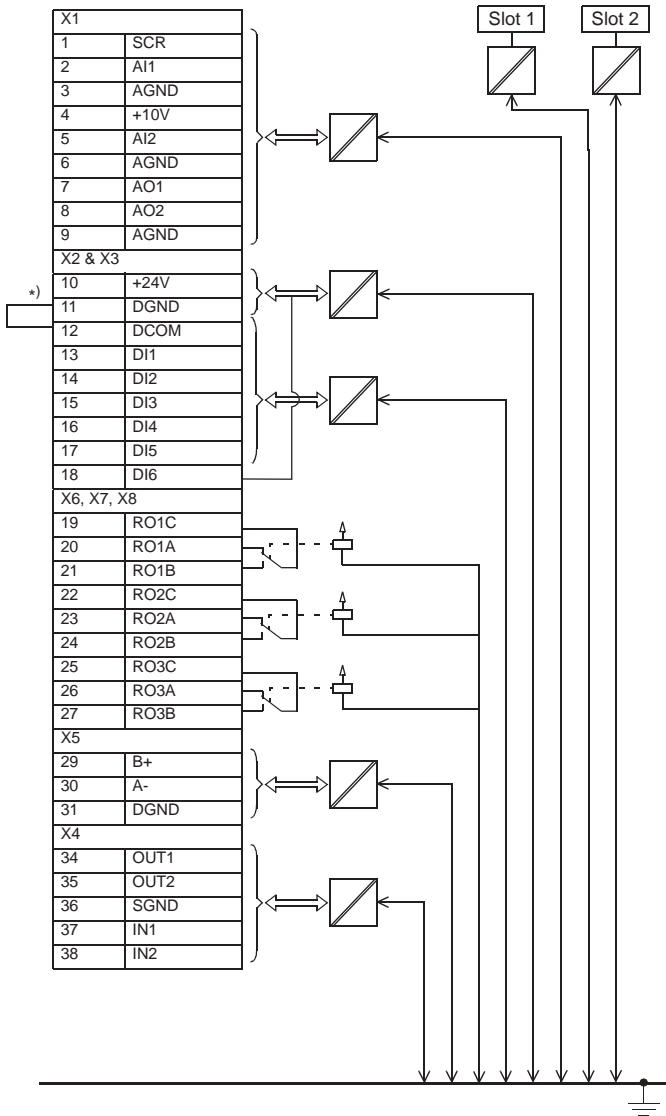


Functional insulation (IEC/EN 61800-5-1:2007, UL 61800-5-1 First edition)

**Below altitudes 4000 m (13123 ft):** The terminals on the control unit fulfill the Protective Extra Low Voltage (PELV) requirements (EN 50178): There is reinforced insulation between the user terminals which only accept ELV voltages and terminals that accept higher voltages (relay outputs).

## 228 Control unit

Ground isolation diagram



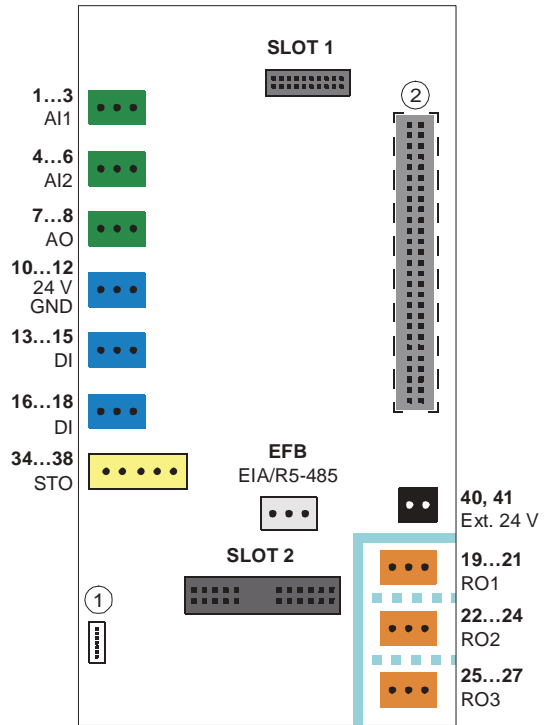
## CCU-24 (R6...R9)

External power supply Term. 40, 41	Maximum power: 36 W, 1.50 A at 24 V AC/DC $\pm 10\%$ as standard Terminal size: 0.14 ... 2.5 mm <sup>2</sup> (26 ... 14 AWG)
+24 V DC output (Term. 10)	Total load capacity of this output is 6.0 W (250 mA / 24 V) minus the power taken by the option modules installed on board. Terminal size: 0.14 ... 2.5 mm <sup>2</sup> (26 ... 14 AWG)
Digital inputs DI1...DI6 (Term. 13...18)	<p>Input type: NPN/PNP Terminal size: 0.14 ... 2.5 mm<sup>2</sup> (26 ... 14 AWG)</p> <p><u>DI1...DI4 (Term. 13...16)</u> 12/24 V DC logic levels: "0" &lt; 4 V, "1" &gt; 8 V <math>R_{iN}</math>: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling</p> <p><u>DI5 (Term.17)</u> Can be used as a digital or frequency input. 12/24 V DC logic levels: "0" &lt; 4 V, "1" &gt; 8 V <math>R_{iN}</math>: 3 kohm Max. frequency: 16 kHz Symmetrical signal (duty cycle D = 0.50)</p> <p><u>DI6 (Term.18)</u> Can be used as a digital or PTC input. 12/24 V DC logic levels: "0" &lt; 3 V, "1" &gt; 8 V <math>R_{iN}</math>: 3 kohm Max. frequency: 16 kHz Symmetrical signal (duty cycle D = 0.50) Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling</p> <p><b>Note:</b> DI6 is not supported in the NPN configuration. PTC mode – PTC thermistor can be connected between DI6 and +24 V DC: &lt; 1.5 kohm = '1' (low temperature), &gt; 4 kohm = '0' (high temperature), open circuit = '0' (high temperature). DI6 is not a reinforced/double insulated input. Connecting the motor PTC sensor to this input requires usage of a reinforced/double insulated PTC sensor inside the motor</p>
Relay outputs RO1...RO3 (Term. 19...27)	250 V AC / 30 V DC, 2 A. Terminal size: 0.14 ... 2.5 mm <sup>2</sup> (26 ... 14 AWG)  See section <a href="#">Isolation areas (page 231)</a> .
Analog inputs AI1 and AI2 (Term. 2 and 5)	Current/voltage input mode selected with a parameter, see <a href="#">Connecting motor temperature sensors to the drive (page 221)</a> . Current input: 0(4)...20 mA, $R_{iN}$ : 100 ohm Voltage input: 0(2)...10 V, $R_{iN}$ : > 200 kohm Terminal size: 0.14 ... 2.5 mm <sup>2</sup> (26 ... 14 AWG) Inaccuracy: typical $\pm 1\%$ , max. $\pm 1.5\%$ of full scale Inaccuracy for Pt100 sensors: 10 °C (50 °F)

## 230 Control unit

<p>Analog outputs AO1 and AO2 (Term. 7 and 8)</p>	<p>Current/voltage output mode for AO1 selected with a parameter, see <a href="#">Connection for obtaining 0...10 V from analog output 2 (AO2)</a> (page 223).            Current output: 0...20 mA, <math>R_{load} &lt; 500 \text{ ohm}</math>            Voltage input: 0...10 V, <math>R_{load} &gt; 100 \text{ kohm}</math> (AO1 only)            Terminal size: 0.14 ... 2.5 mm<sup>2</sup> (26 ... 14 AWG)            Inaccuracy: <math>\pm 1\%</math> of full scale (in voltage and current modes)</p>
<p>Reference voltage output for analog inputs +10V DC (Term. 4)</p>	<p>Max. 20 mA output            Inaccuracy: <math>\pm 1\%</math></p>
<p>Safe torque off (STO) inputs IN1 and IN2 (Term. 37 and 38)</p>	<p>24 V DC logic levels: "0" &lt; 5 V, "1" &gt; 13 V  <math>R_{in}: 2.47 \text{ kohm}</math>            Terminal size: 0.14 ... 2.5 mm<sup>2</sup> (26 ... 14 AWG)</p>
<p>Embedded fieldbus (X5)</p>	<p>Connector pitch 5 mm, maximum wire size 2.5 mm<sup>2</sup> (14 AWG)            Physical layer: EIA-485            Cable type: Shielded twisted pair cable with twisted pair for data and a wire or pair for signal ground, nominal impedance 100...165 ohms, for example Belden 9842            Transmission rate: 9.6 ... 115.2 kbit/s            Termination by switch</p>
<p>Control panel - drive connection</p>	<p>EIA-485, male RJ-45 connector, max. cable length 100 m (328 ft)</p>
<p>Control panel - PC connection</p>	<p>USB Type Mini-B, max. cable length 3 m (9.8 ft)</p>

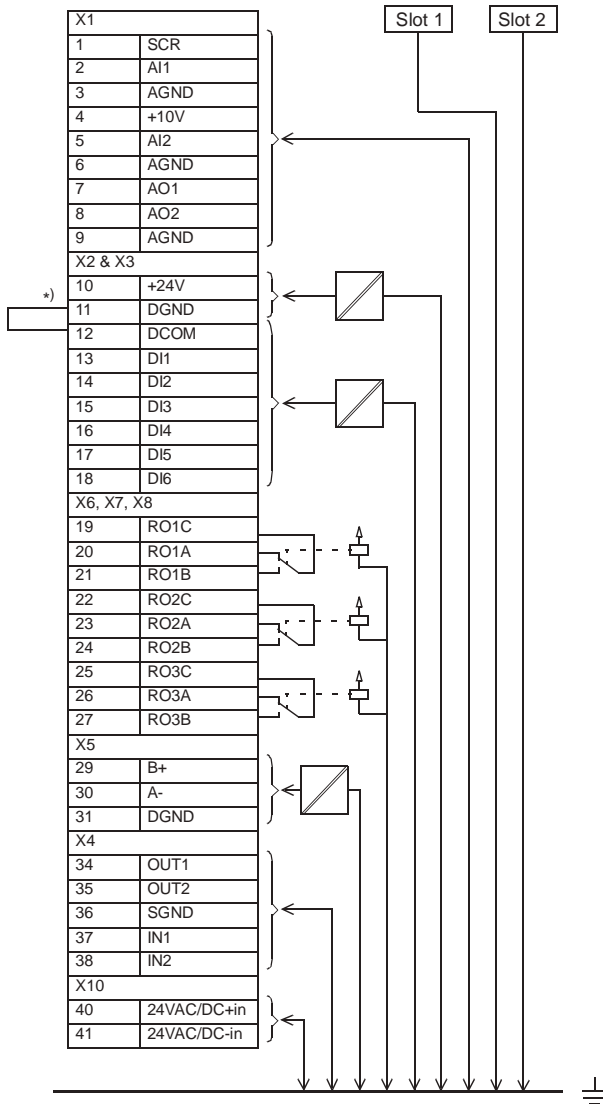
## Isolation areas



1	Panel port
2	Power unit connection at the bottom of the control unit
	Reinforced insulation (IEC/EN 61800-5-1:2007, UL 61800-5-1 First edition)
	Functional insulation (IEC/EN 61800-5-1:2007, UL 61800-5-1 First edition)
<p>The terminals on the control unit fulfill the Protective Extra Low Voltage (PELV) requirements (EN 50178): There is reinforced insulation between the user terminals which only accept ELV voltages and terminals that accept higher voltages (relay outputs).</p> <p><b>Note:</b> There is functional insulation also between the individual relay outputs.</p>	

**Note:** There is reinforced insulation on the power unit.

Ground isolation diagram





## 9

# Installation checklist

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## Contents of this chapter

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

## Checklist

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

---


**WARNING!**

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

---


**WARNING!**

Do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.

---

<b>Make sure that ...</b>	<input checked="" type="checkbox"/>
The ambient operating conditions meet the drive ambient conditions specification and enclosure rating (IP code).	<input type="checkbox"/>
The supply voltage matches the nominal input voltage of the drive. See the type designation label.	<input type="checkbox"/>

---

234 Installation checklist

<b>Make sure that ...</b>	<input checked="" type="checkbox"/>
The insulation resistance of the input power cable, motor cable and motor is measured according to local regulations and the manuals of the drive.	<input type="checkbox"/>
The drive is attached securely on an even, vertical and non-flammable wall.	<input type="checkbox"/>
The cooling air can flow freely in and out of the drive.	<input type="checkbox"/>
<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) the electrical installation instructions.	<input type="checkbox"/>
Appropriate AC fuses and main disconnecting device are installed.	<input type="checkbox"/>
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.	<input type="checkbox"/>
The input power cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	<input type="checkbox"/>
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.	<input type="checkbox"/>
The motor cable is connected to the correct terminals, the phase order is correct, and the terminals are tightened to the correct torque.	<input type="checkbox"/>
The motor cable is routed away from other cables.	<input type="checkbox"/>
No power factor compensation capacitors are connected to the motor cable.	<input type="checkbox"/>
<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.	<input type="checkbox"/>
<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.	<input type="checkbox"/>
<u>If an external brake resistor is connected to the drive:</u> The brake resistor cable is routed away from other cables.	<input type="checkbox"/>

<b>Make sure that ...</b>	<input checked="" type="checkbox"/>
The control cables are connected to the correct terminals, and the terminals are tightened to the correct torque.	<input type="checkbox"/>
<u>If a drive bypass connection will be used:</u> 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.	<input type="checkbox"/>
There are no tools, foreign objects or dust from drilling inside the drive.	<input type="checkbox"/>
The area in front of the drive is clean: the drive cooling fan cannot draw any dust or dirt inside.	<input type="checkbox"/>
Drive covers and the terminal box cover of the motor are in place.	<input type="checkbox"/>
IP66 (UL Type 4X) drives: All cable gland and conduit fittings are tightened sufficiently to prevent leaking into the drive. Cover and conduit box are installed and all screws are torqued to 2.5 N·m (1.8 lbf-in). For outdoor installation, the drive is shaded from direct sunlight to prevent excessive heating.	<input type="checkbox"/>
The motor and the driven equipment are ready for power-up.	<input type="checkbox"/>





# Start-up

---

## Contents of this chapter

This chapter describes the start-up procedure of the drive.

## Reforming the capacitors

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

## Start-up procedure

1. Run setup of the drive control program according to the start-up instructions given in [ACQ580-01 drives quick installation and start-up guide \(3AXD50000758692 \[English\]\)](#) or in the firmware manual.
  - For drives with resistor braking: See also chapter [Resistor braking \(page 397\)](#).
  - For SynRM motor drives: Set bit 2 of parameter 95.21 HW options word 2 to SynRM.
  - For sine filters: See [Sine filter hardware manual \(3AXD50000016814 \[English\]\)](#).
2. Validate the Safe torque off function according to the instructions given in chapter [The Safe torque off function \(page 407\)](#).
3. Validate the safety function (option +Q986) as described in [FSPS-21 PROFIsafe safety functions module user's manual \(3AXD50000158638 \[English\]\)](#).







# Maintenance

---

## Contents of this chapter

This chapter contains maintenance 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](http://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	
Action	Description
P	Quality of supply voltage
I	Spare parts
P	Capacitor reforming for spare modules and spare capacitors, see <a href="#">Capacitors (page 257)</a>
I	Tightness of terminals
I	Dustiness, corrosion or temperature
I	Heatsink cleaning
I	IP66 (UL Type 4X) frames R1...R3: Drive cover and gasket assembly

Component	Years from start-up						
	3	6	9	12	15	18	21
<b>Cooling</b>							
<b>Fans, IP21 (UL Type 1) frames R1 to R9</b>							
Main cooling fan R1...R4: page 247, R5: page 249		R		R		R	
Main cooling fan (LONGLIFE) R6...R8: page 249, R9; page 250			R			R	
Auxiliary cooling fan for circuit boards R4 v2 IP21 drive types 077A-4 and 089A-4: page 255		R		R		R	
Auxiliary cooling fan (LONGLIFE) for circuit boards, R5: page 255, R6...R9: page 251			R			R	
<b>Fans, IP55 (UL Type 12) frames R1 to R9</b>							
Main cooling fan R1...R4: page 247, R5: page 249		R		R		R	
Main cooling fan LONGLIFE R6...R8: page 249, R9; page 250			R			R	
Auxiliary cooling fan for circuit boards R1...R2: page 252		R		R		R	
Auxiliary cooling fan for circuit boards R4 v2: page 255		R		R		R	
Auxiliary cooling fan (LONGLIFE) for circuit boards R3: page 253, R4...R5: page 255, R6...R9: page 251			R			R	
Second auxiliary cooling fan (LONGLIFE) R8 and R9: page 256			R			R	



Component	Years from start-up						
	3	6	9	12	15	18	21
<b>Fans, IP66 (UL Type 4X) frames R1 to R3</b>							
Main cooling fan R1...R3: page <a href="#">247</a>		R		R		R	
Auxiliary cooling fan for circuit boards R3: page <a href="#">252</a>		R		R		R	
<b>Aging</b>							
Control panel battery: page <a href="#">257</a>			R			R	
<b>Functional safety</b>							
Safety function test	I See the maintenance information of the safety function.						
Safety component expiry (Mission time, $T_M$ )	20 years						

**Note:**

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

## Cleaning the exterior of the drive, IP21 and IP55 (UL Type 1 and UL Type 12)

---



**WARNING!**

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

---

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.
  2. Clean the exterior of the drive. Use:
    - vacuum cleaner with an antistatic hose and nozzle
    - soft brush
    - dry or damp (not wet) cleaning cloth. Moisten with clean water, or mild detergent (pH 5...9 for metal, pH 5...7 for plastic).
- 



**WARNING!**

Prevent water from entering the drive. Never use excessive amount of water, a hose, steam, etc.

---

## Cleaning the exterior of the drive, IP66 (UL Type 4X)

IP66 (UL Type 4X) drives have a degree of protection against dust, dirt, precipitation, salt spray, splashing water and hose-directed spray. In addition, the drive has been tested to not be damaged by occasional exposure to common cleaners and disinfectants, algaecides and microbicides at concentrations recommended by the manufacturer for general use. Do not use this procedure with IP21 and IP55 (UL Type 1 and UL Type 12) drives.

1. Clean the exterior of IP66 (UL Type4X) drive. Use:
  - soft brush
  - damp cleaning cloth. Gently spray surface with a common cleaner or disinfectant with ammonia, chlorine or detergent base. Wipe with a damp cloth.
  - if necessary, hose down the drive to wash or rinseAvoid prolonged contact with chemicals, especially to control panel surface.

The drive can be disassembled and cleaned by a qualified electrical professional as follows:

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.
  2. Make sure that the drive is dry.
  3. Remove the cover and cable glands or conduit fittings.
  4. Clean the components and gaskets with a damp, clean cloth. Be careful not to damage the gaskets.
  5. Reinstall the cover. Tighten screws to 2.5 N·m (1.8 lbf·ft).
  6. Reinstall the cable glands or conduit fittings. Tighten securely to prevent leakage.
  7. Clean exterior as above.
-

## Cleaning the heatsink, IP21, IP55 (UL Type 1, 12)

The heatsink of the power module (drive, supply, inverter, converter, etc.) pick up dust from the cooling air. This can cause overtemperature warnings and faults. When necessary, clean the heatsink as follows.

---



**WARNING!**

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

---



**WARNING!**

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

---

1. Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) 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 bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust.
  5. Reinstall the cooling fan.
-

## Cleaning the heatsink, IP 66 (UL Type 4X)

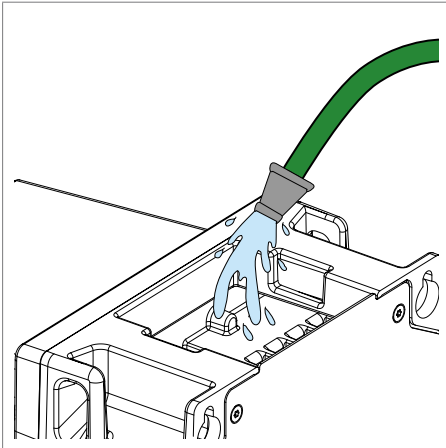
The drive module heatsink fins pick up dust from the cooling air. The drive runs into overtemperature warnings and faults if the heatsink is not clean. When necessary, clean Type 4X IP66 heatsinks as follows. Do not use this procedure for IP21 and IP 55 (UL Type 1 and 12) drives.

**WARNING!**

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 section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the fan but do not disconnect the wire. See page [247](#).
3. Apply cleaner down the heatsink channel. Rinse with water from a hose.



4. Remove insects and debris from bottom grate with soft brush or cloth and rinse.
5. Dry the fan wire connector and disconnect the fan.
6. Clean the fan with a brush or cloth under running water being careful to keep the wire connector dry.

**WARNING!**

Repeated exposure to water will cause connector to corrode and lead to premature fan failure.

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7. Dry and reinstall the fan.
-

## Fans

See [Maintenance intervals \(page 239\)](#) for the fan replacement interval in average operation conditions.

Parameter 05.04 Fan on-time counter indicates the running time of the cooling fan. Reset the counter after a fan replacement. See the firmware manual.

In a speed-controlled fan, the speed of the fan matches the cooling needs. This increases the life span of the fan.

Main fans are speed controlled. When the drive is stopped, the main fan runs at low speed until the drive cools down. IP21 (UL Type 1) frames R5...R9 and all IP55 (UL Type 12) frames have auxiliary fans that are not speed controlled and run all the time when the control unit is powered.

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

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## ■ Replacing the main cooling fan, IP21, IP55 and IP66 (UL Type 1, UL Type 12 and UL Type 4X) frames R1...R4



### WARNING!

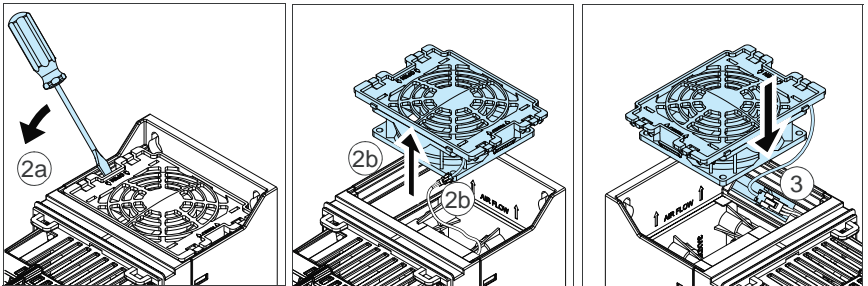
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.

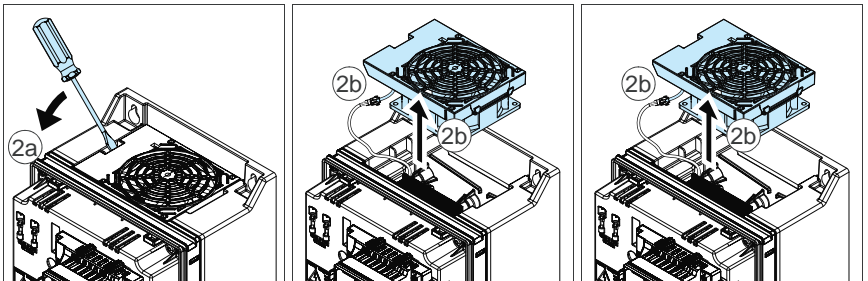
### R1...R3

2. Lever the fan assembly off the drive frame with for example a screwdriver (2a) and pull out the fan assembly (2b) until you can unplug the fan power supply wires from the fan assembly (2c).
3. Install the fan assembly in reverse order.  
R1...R2: Put the connector and extra length of wires in the groove so that the wires do not get caught in the revolving fan.  
R3: Put the extra length of wires under the fan assembly so that the wires do not get caught in the revolving fan.

### R1...R2

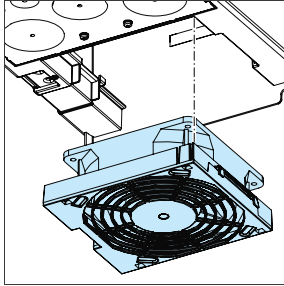
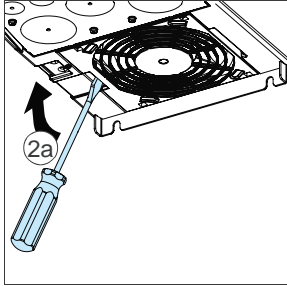


### R3



**R4**

1. Lever the fan assembly off the drive frame with for example a screwdriver (2a) and pull out the fan assembly (2b).
2. Install the fan assembly in reverse order.





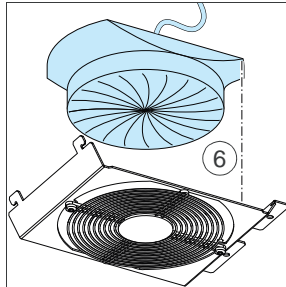
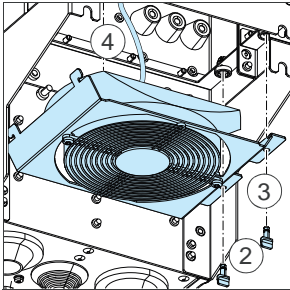
## ■ Replacing the main cooling fan, IP21 and IP55 (UL Type 1 and UL Type 12) frames R5...R8



### WARNING!

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

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the two mounting screws of the fan mounting plate at the bottom of the drive.
3. Pull the fan mounting plate down from the side edge.
4. Unplug the fan power supply wires from the drive.
5. Lift the fan mounting plate off.
6. Remove the fan from the mounting plate.
7. Install the new fan in reverse order.



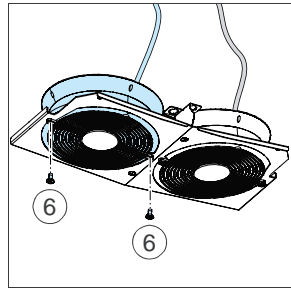
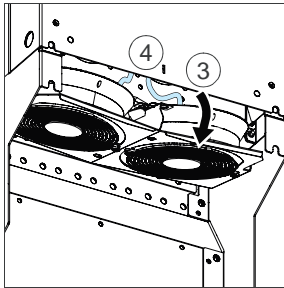
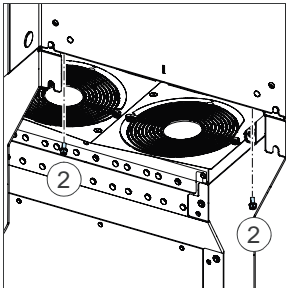
### ■ Replacing the main cooling fans, IP21 and IP55 (UL Type 1 and UL Type 12) frame R9



**WARNING!**

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

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the two mounting screws of the fan mounting plate.
3. Turn the mounting plate downwards.
4. Unplug the fan power supply wires from the drive.
5. Remove the fan mounting plate.
6. Remove the fans by removing the two mounting screws.
7. Install the new fans in reverse order.



## ■ Replacing the auxiliary cooling fan, IP21 and IP55 (UL Type 1 and UL Type 12) frames R6...R9

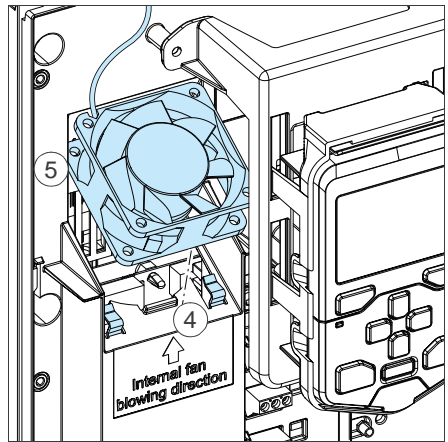
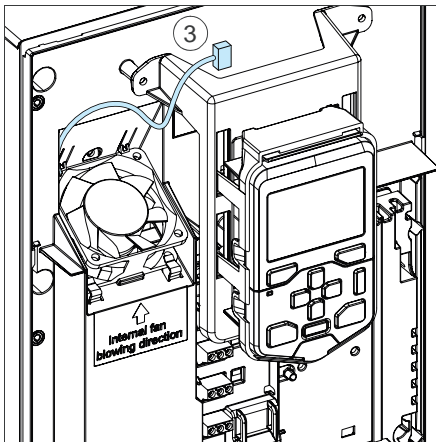


### WARNING!

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

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the front cover (see section [IP21 \(UL Type 1\) \(page 90\)](#)).
3. Unplug fan power supply wires from the drive.
4. Release the retaining clips.
5. Lift the fan off.
6. Install the new fan in reverse order.

**Note:** Make sure that the arrow on the fan points up.



■ Replacing the auxiliary cooling fan, IP55 (UL Type 12) frames R1...R2

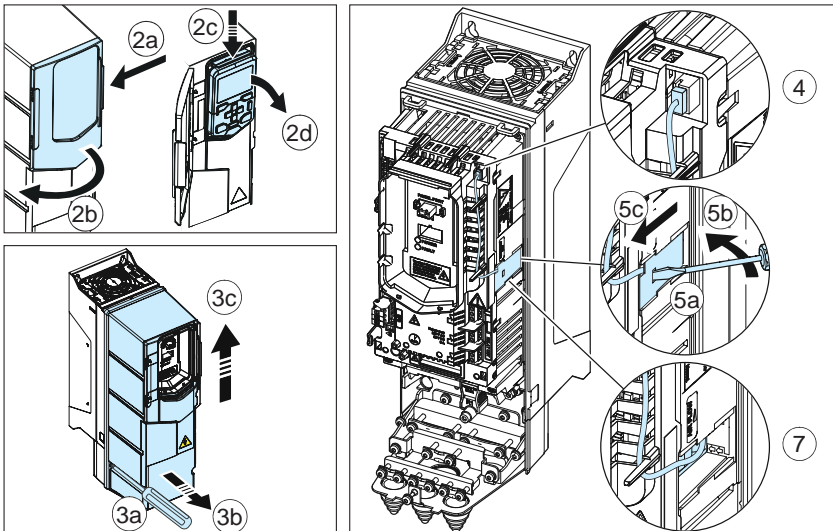


**WARNING!**

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

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the control panel: Press the retaining clip of the IP55 panel cover (2a) and open the cover (2b). Press the retaining clip of the control panel at the top (2c) and pull it forward from the top edge (2d).
3. Remove the front cover: Loosen the retaining screws with a screwdriver (3a) and lift the cover from the bottom outwards (3b) and then up (3c).
4. Unplug the fan power supply wires from the drive.
5. Remove the fingerguard: Insert a screwdriver into the hole of the fingerguard (5a), bend the front edge of the fingerguard a little away from the drive frame with the screwdriver (5b) and pull the fingerguard out of the groove (5c).
6. Pull off the fan.
7. Install the new fan assembly in reverse order. Route the wires round the pins.

**Note:** Make sure that the arrow on the fan points to the same direction as the arrow on the drive frame.



## ■ Replacing the auxiliary cooling fan, IP55 and IP66 (UL Type 12 and UL Type 4X) frame R3

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**WARNING!**

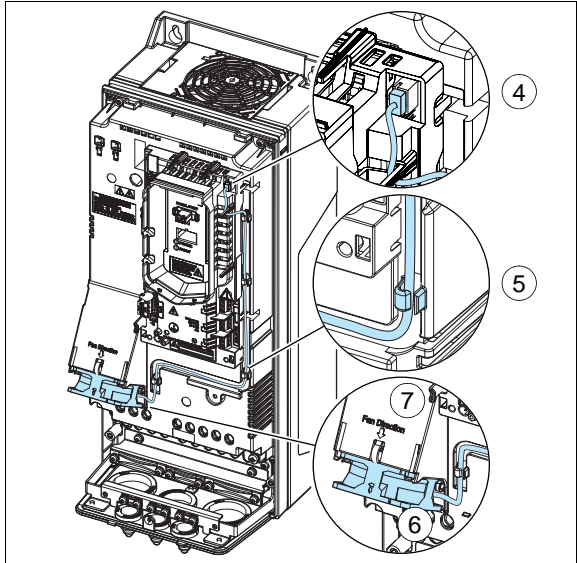
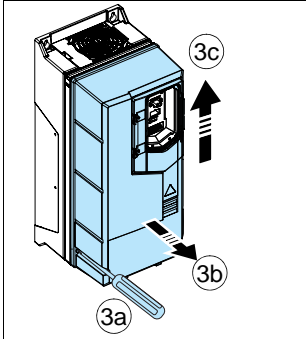
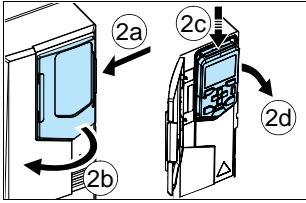
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

---

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the control panel: Press the retaining clip of the IP55 panel cover (2a) and open the cover (2b). Press the retaining clip of the control panel at the top (2c) and pull it forward from the top edge (2d).
3. IP55 (UL Type 12): Remove the front cover: Loosen the retaining screw with a screwdriver (3a) and lift the cover from the bottom outwards (3b) and then up (3c).  
IP66 (UL Type 4X): Remove the front cover: Loosen the 8 retaining screws with a Pozidriv #2 screwdriver.
4. Unplug the fan power supply wires from the drive.
5. Detach the fan cable from the holders.
6. Pull off the plastic housing.
7. Pull off the fan.
8. Install the new fan and housing in reverse order.

**Note:** Make sure that the arrow on the fan points to the same direction as the arrow on the plastic housing (down).

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## ■ Replacing the auxiliary cooling fan, IP55 (UL Type 12) frame R4; IP21 and IP55 (UL Type 1 and UL Type 12) frame R5

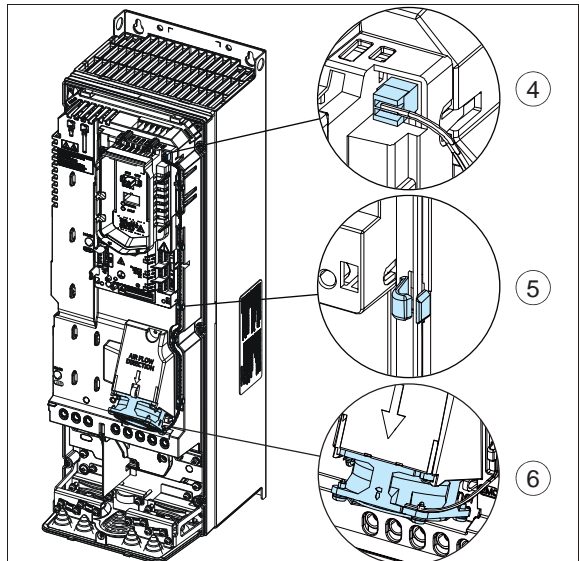
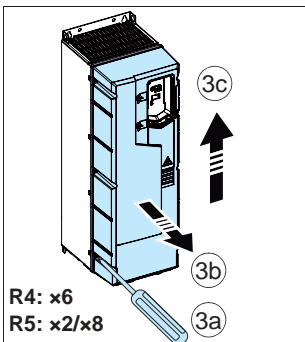
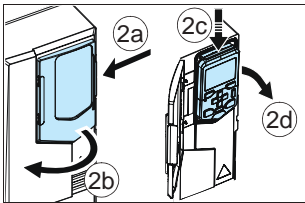


### WARNING!

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

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the control panel: Press the retaining clip of the IP55 panel cover (2a) and open the cover (2b). Press the retaining clip of the control panel at the top (2c) and pull it forward from the top edge (2d).
3. Remove the front cover: Loosen the retaining screws (R4: 6 pieces, R5: IP21 2 pieces; IP55 8 pieces) with a screwdriver (3a) and lift the cover from the bottom outwards (3b) and then up (3c).
4. Unplug the fan power supply wires from the drive.
5. Detach the fan cable from the clips.
6. Pull the fan off.
7. Install the new fan in reverse order.

**Note:** Make sure that the arrow on the fan points down.



## ■ Replacing the second auxiliary cooling fan, IP55 (UL Type 12) frames R8...R9

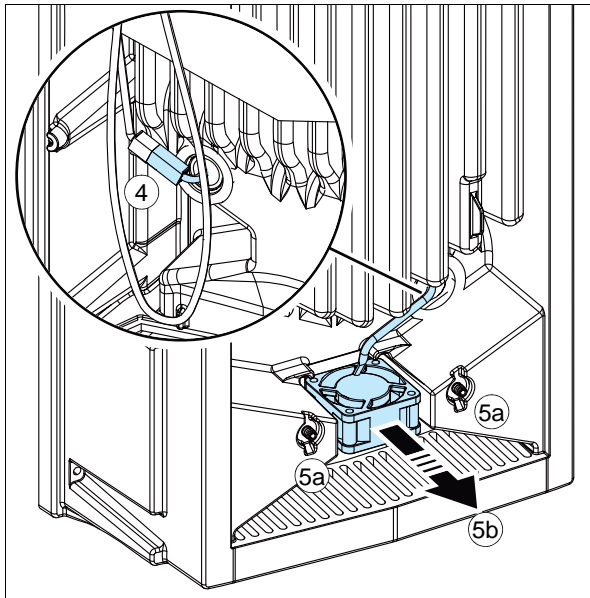
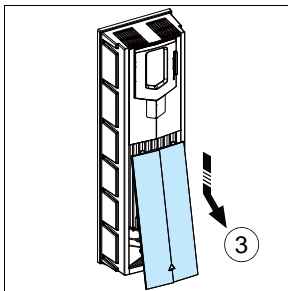
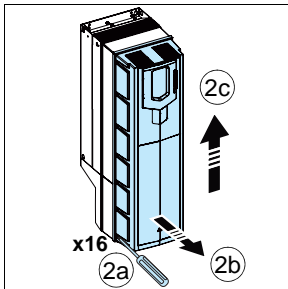


### WARNING!

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

1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section [Electrical safety precautions \(page 22\)](#) before you start the work.
2. Remove the front cover: Loosen the retaining screws (16 pieces) with a screwdriver (2a) and lift the cover from the bottom outwards (2b) and then up (2c).
3. Remove the lower cover panel from the cover.
4. Unplug the fan power supply wires from the connector on the other side of the IP55 (UL Type 12) front cover.
5. Remove the retaining screws (5a) and pull off the fan (5b).
6. Install the new fan in reverse order.

**Note:** Make sure that the arrow on the fan points up.





## Capacitors

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

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

### ■ Reforming the capacitors

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

## Control panel

Refer to [ACS-AP-I, -S, -W Assistant control panels user's manual \(3AUA0000085685 \[English\]\)](#).

Refer to [ACS-BP-S basic control panels user's manual \(3AXD50000032527 \[English\]\)](#).

---

## LEDs

### ■ Drive LEDs

There is a green POWER and a red FAULT LED on the front of the drive. They are visible through the panel cover but invisible if a control panel is attached to the drive. The table below describes the drive LED indications.

<b>Drive LEDs POWER and FAULT, on the front of the drive, under the control panel / panel cover</b>				
<b>If a control panel is attached to the drive, switch to remote control (otherwise a fault will be generated), and then remove the panel to be able to see the LEDs</b>				
<b>LEDs off</b>	<b>LED lit and steady</b>		<b>LED blinking</b>	
No power	Green (POWER)	Power supply on the board OK	Green (POWER)	<u>Blinking:</u> Drive in an alarm state <u>Blinking for one second:</u> Drive selected on the control panel when multiple drives are connected to the same panel bus.
	Red (FAULT)	Active fault in the drive. To reset the fault, press RESET from the control panel or switch off the drive power.	Red (FAULT)	Active fault in the drive. To reset the fault, switch off the drive power.

## ■ Control panel LEDs

The control panel has one LED. The table below describes the control panel LED indications. For more information see [ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual \(3AUA0000085685 \[English\]\)](#).

Control panel LED, at the left edge of the control panel				
LED off	LED lit and steady		LED blinking/flickering	
Panel has no power	Green	Drive functioning normally. Connection between the drive and control panel may be faulty or lost, or the panel and drive may be incompatible. Check the control panel display.	Green	<u>Blinking:</u> Active warning in the drive <u>Flickering:</u> Data transferred between the PC tool and drive through the USB connection of the control panel
	Red	Check the display to see where the fault is. <ul style="list-style-type: none"> <li>Active fault in the drive. Reset the fault.</li> <li>Active fault in another drive in the panel bus. Switch to the drive in question and check and re-set the fault.</li> </ul>	Red	Active fault in the drive. To reset the fault, cycle the drive power.
			Blue	Panels with a Bluetooth interface only. <u>Blinking:</u> Bluetooth interface is enabled. It is in discoverable mode and ready for pairing. <u>Flickering:</u> Data is transferred through the Bluetooth interface of the control panel.

## Functional safety components

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

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

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

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

Contact your local ABB service representative for more information.

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# Technical data

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## 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

ACQ580-01-...	Frame	Input rating	Max. current	Output ratings					
				Nominal use		Light-duty use		Heavy-duty use	
		$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
		A	A	A	kW	A	kW	A	kW
3-phase $U_n = 230\text{ V}$									
04A7-2	R1	4.7	6.3	4.7	0.75	4.6	0.75	3.5	0.55
06A7-2	R1	6.7	8.9	6.7	1.1	6.6	1.1	4.6	0.75
07A6-2	R1	7.6	11.9	7.6	1.5	7.5	1.5	6.6	1.1
012A-2	R1	12.0	19.1	12.0	3.0	11.8	3.0	7.5	2.2
018A-2	R1	16.9	22.0	16.9	4.0	16.7	4.0	10.6	3.0
025A-2	R2	24.5	32.7	24.5	5.5	24.2	5.5	16.7	4.0
032A-2	R2	31.2	43.6	31.2	7.5	30.8	7.5	24.2	5.5
047A-2	R3	46.7	62.4	46.7	11	46.2	11	30.8	7.5
060A-2	R3	60	83.2	60	15	59.4	15	46.2	11
076A-2	R4 v2	76	107	76	18.5	74.8	18.5	59.4	15
089A-2	R5	89	135	89	22	88	22	74.8	18.5
091A-2	R4 v2	91	134	91	22	88	22	74.8	18.5
115A-2	R5	115	158	115	30	114	30	88.0	22
144A-2	R6	144	205	144	37	143	37	114	30
171A-2	R7	171	257	171	45	169	45	143	37
213A-2	R7	213	304	213	55	211	55	169	45
276A-2	R8	276	380	276	75	273	75	211	55

ACQ580-01-...	Frame	Input rating	Output ratings	
		$I_1$	$I_2$	$P_n$
		A	A	kW
1-phase $U_n = 230\text{ V}$				
04A7-2	R1	3.3	2.2	0.37
06A7-2	R1	4.6	3.2	0.55
07A6-2	R1	6.3	4.2	0.75
012A-2	R1	8.9	6.0	1.1
018A-2	R1	11.8	6.8	1.5
025A-2	R2	17.3	9.6	2.2
032A-2	R2	30.4	15.2	4.0
047A-2	R3	42	22	5.5
060A-2	R3	55	28	7.5
076A-2	R4 v2	55	28	7.5
089A-2	R5	81	42	11
091A-2	R4 v2	81	42	11
115A-2	R5	111	54	15
144A-2	R6	137	68	18.5
171A-2	R7	153	80	22
213A-2	R7	209	104	30
276A-2	R8	258	130	37

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ACQ580-01-...	Frame	Input rating	Max. current	Output ratings					
				Nominal use		Light-duty use		Heavy-duty use	
		$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
		A	A	A	kW	A	kW	A	kW
3-phase $U_n = 400$ V (380...415 V)									
02A7-4	R1	2.6	3.2	2.6	0.75	2.5	0.75	1.8	0.55
03A4-4	R1	3.3	4.7	3.3	1.1	3.1	1.1	2.6	0.75
04A1-4	R1	4.0	5.9	4.0	1.5	3.8	1.5	3.3	1.1
05A7-4	R1	5.6	7.2	5.6	2.2	5.3	2.2	4.0	1.5
07A3-4	R1	7.2	10.1	7.2	3.0	6.8	3.0	5.6	2.2
09A5-4	R1	9.4	13.0	9.4	4.0	8.9	4.0	7.2	3.0
12A7-4	R1	12.6	15.3	12.6	5.5	12.0	5.5	9.4	4.0
018A-4	R2	17.0	22.7	17.0	7.5	16.2	7.5	12.6	5.5
026A-4	R2	25.0	30.6	25.0	11.0	23.8	11.0	17.0	7.5
033A-4	R3	32.0	44.3	32.0	15.0	30.4	15.0	24.6	11.0
039A-4	R3	38.0	56.9	38.0	18.5	36.1	18.5	31.6	15.0
046A-4	R3	45.0	67.9	45.0	22.0	42.8	22.0	37.7	18.5
062A-4	R4	62	81	62	30	58	30	45	22
062A-4	R4 v2	62	81	62	30	58	30	45	22
073A-4	R4	73	110	73	37	68	37	61	30
073A-4	R4 v2	73	110	73	37	68	37	61	30
088A-4	R5	88	130	88	45	83	45	72	37
089A-4	R4 v2	89	130	89	45	83	45	72	37
106A-4	R5	106	157	106	55	100	55	87	45
145A-4	R6	145	178	145	75	138	75	105	55
169A-4	R7	169	247	169	90	161	90	145	75
206A-4	R7	206	287	206	110	196	110	169	90
246A-4	R8	246	350	246	132	234	132	206	110
293A-4	R8	293	418	293	160	278	160	246 <sup>1)</sup>	132
363A-4	R9	363	498	363	200	345	200	293	160
430A-4	R9	430	545	430	250	400	200	363 <sup>2)</sup>	200
490A-4	R9	450	600	490	250	480	250	385	200



ACQ580-01-...	Frame	Input rating	Max. current	Output ratings							
				Light-duty use			Heavy-duty use				
				$I_L$	$I_{max}$	$I_{Ld}$	$P_{Ld}$		$I_{Hd}$	$P_{Hd}$	
				A	A	A	kW	hp	A	kW	hp
3-phase $U_n = 480\text{ V}$											
02A7-4	R1	2.1	2.9	2.1	0.75	1.0	1.6	0.55	0.75		
03A4-4	R1	3.0	3.8	3.0	1.1	1.5	2.1	0.75	1.0		
04A1-4	R1	3.4	5.4	3.5	1.5	2.0	3.0	1.1	1.5		
05A7-4	R1	4.8	6.1	4.8	2.2	3.0	3.4	1.5	2.0		
07A3-4	R1	6.0	7.2	6.0	3.0	3.0	4.0	2.2	3.0		
09A5-4	R1	7.6	8.6	7.6	4.0	5.0	4.8	3.0	3.0		
12A7-4	R1	11.0	13.7	12.0	5.5	7.5	7.6	4.0	5.0		
018A-4	R2	14.0	19.8	14.0	7.5	10.0	11.0	5.5	7.5		
026A-4	R2	21.0	25.2	23.0	11.0	15.0	14.0	7.5	10.0		
033A-4	R3	27.0	37.8	27.0	15.0	20.0	21.0	11.0	15.0		
039A-4	R3	34.0	48.6	34.0	18.5	25.0	27.0	15.0	20.0		
046A-4	R3	40.0	61.2	44.0	22.0	30.0	34.0	18.5	25.0		
062A-4	R4	52	76	52	30	40	40	22	30		
062A-4	R4 v2	52	72	52	30	40	40	22	30		
073A-4	R4	65	104	65	37	50	52	30	40		
073A-4	R4 v2	65	94	65	37	50	52	30	40		
088A-4	R5	77	122	77	45	60	65	37	50		
089A-4	R4 v2	77	117	77	45	60	65	37	50		
106A-4	R5	96	148	96	55	75	77	45	60		
145A-4	R6	124	178	124	75	100	96	55	75		
169A-4	R7	156	247	156	90	125	124	75	100		
206A-4	R7	180	287	180	110	150	156	90	125		
246A-4	R8	240	350	240	132	200	180	110	150		
293A-4	R8	260	418	260	160	200	240 <sup>1)</sup>	132	150		
363A-4	R9	361	542	361	200	300	302	160	250		
430A-4	R9	414	542	414	250	350	361 <sup>2)</sup>	200	300		
490A-4	R9	450	600	454	250	400	385	200	300		

**Definitions**

- $U_n$  Nominal output voltage of the drive. For input voltage range [ $U_1$ , see section [Electrical power network specification \(page 339\)](#)]. 50 Hz for IEC ratings and 60 Hz for UL (NEC) ratings.
- $I_1$  Nominal input current. Continuous rms input current (for dimensioning cables and fuses).
- $I_{max}$  Maximum output current. Available for two seconds at start.
- $I_2$  Nominal output current. Maximum continuous rms output current allowed (no overload).
- $P_n$  Nominal power of the drive. Typical motor power (no overload). The kilowatt ratings apply to most IEC 4-pole motors. The horsepower ratings apply to most NEMA 4-pole motors.
- $I_{Ld}$  Continuous rms output current allowing 10% overload for 1 minute every 10 minutes
- $P_{Ld}$  Typical motor power in light-duty use (10% overload). The horsepower (hp) ratings apply to most NEMA 4-pole motors.
- $I_{Hd}$  Continuous rms output current allowing 50% overload for 1 minute every 10 minutes
  - 1) Continuous rms output current allowing 30% overload for 1 minute every 10 minutes
  - 2) Continuous rms output current allowing 25% overload for 1 minute every 10 minutes
- $P_{Hd}$  Typical motor power in heavy-duty use (50% overload).

■ **UL (NEC)**

ACQ580-01-...	Frame size	Input rating	Output ratings						
			Max. current	Nominal use		Light-duty use		Heavy-duty use	
			$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$
		A	A	A	hp	A	hp	A	hp
3-phase $U_1 = 208...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz									
04A6-2	R1	4.6	6.3	4.6	1.0	4.6	1.0	3.5	0.8
06A6-2	R1	6.6	8.9	6.6	1.5	6.6	1.5	4.6	1.0
07A5-2	R1	7.5	11.9	7.5	2.0	7.5	2.0	6.6	1.5
10A6-2	R1	10.6	14.3	10.6	3.0	10.6	3.0	7.5	2.0

ACQ580-01-...	Frame size	Input rating	Output ratings						
			Max. current	Nominal use		Light-duty use		Heavy-duty use	
		$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
		A	A	A	hp	A	hp	A	hp
017A-2	R1	16.7	22.6	16.7	5.0	16.7	5.0	10.6	3.0
024A-2	R2	24.2	32.7	24.2	7.5	24.2	7.5	16.7	5.0
031A-2	R2	30.8	43.6	30.8	10	30.8	10	24.2	7.5
046A-2	R3	46.2	62.4	46.2	15	46.2	15	30.8	10
059A-2	R3	59.4	83.2	59.0	20	59.4	20	46.2	15
075A-2	R4	74.8	107	74.8	25	74.8	25	59.4	20
075A-2	R4 v2	74.8	107	74.8	25	74.8	25	59.4	20
088A-2	R5	88	135	88	30	88	30	74.8	25
090A-2	R4 v2	90	134	90	30	90	30	74.8	25
114A-2	R5	114	158	114	40	114	40	88.0	30
143A-2	R6	143	205	143	50	143	50	114	40
169A-2	R7	169	257	169	60	169	60	143	50
211A-2	R7	211	304	211	75	211	75	169	60
273A-2	R8	273	380	273	100	273	100	211	75
343A-2	R9	343	492	343	125	343	125	273	100
396A-2	R9	396	560	396	150	396	150	343	125

ACQ580-01-...	Frame size	Input rating	Output ratings		
		$I_1$	$I_2$	$P_n$	
		A	A	hp	
1-phase $U_1 = 240$ V, $P_n$ at $U_n = 230$ V, 60 Hz					
04A6-2	R1	3.3	2.2	0.5	
06A6-2	R1	4.6	3.2	0.75	
07A5-2	R1	6.3	4.2	1	
10A6-2	R1	8.9	6.0	1.5	
017A-2	R1	11.8	6.8	2.2	
024A-2	R2	17.3	9.6	3	
031A-2	R2	30.4	15.2	5	

ACQ580-01-...	Frame size	Input rating		Output ratings	
		$I_1$	$I_2$	$P_n$	
		A	A	hp	
046A-2	R3	42	22	7.5	
059A-2	R3	55	28	10	
075A-2	R4 v2	55	28	10	
075A-2	R4	55	28	10	
088A-2	R5	81	42	15	
090A-2	R4 v2	81	42	15	
114A-2	R5	111	54	20	
143A-2	R6	137	68	25	
169A-2	R7	153	80	30	
211A-2	R7	209	104	40	
273A-2	R8	258	130	50	
343A-2	R9	343	154	60	
396A-2	R9	396	192	75	

ACQ580-01-...	Frame size	Input rating		Output ratings					
				Nominal use		Light-duty use		Heavy-duty use	
		Max. current	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
		A	A	A	hp	A	hp	A	hp
3-phase $U_n = 480\text{ V (440...480 V)}$									
02A1-4	R1	2.1	2.9	2.1	1.0	2.1	1.0	1.6	0.75
03A0-4	R1	3.0	4.1	3.0	1.5	3.0	1.5	2.1	1.0
03A5-4	R1	3.5	5.4	3.5	2.0	3.5	2.0	3.0	1.5
04A8-4	R1	4.8	6.5	4.8	3.0	4.8	3.0	3.4	2.0
06A0-4	R1	6.0	8.6	6.0	3.0	6.0	3.0	4.0	3.0
07A6-4	R1	7.6	10.8	7.6	5.0	7.6	5.0	4.8	3.0
012A-4	R1	12.0	15.3	12.0	7.5	12.0	7.5	7.6	5.0
014A-4	R2	14.0	21.6	14.0	10.0	14.0	10.0	11.0	7.5
023A-4	R2	23.0	30.5	23.0	15.0	23.0	15.0	14.0	10.0
027A-4	R3	27.0	41.4	27.0	20.0	27.0	20.0	21.0	15.0

ACQ580-01-...	Frame size	Input rating	Output ratings							
			Max. current	Nominal use		Light-duty use		Heavy-duty use		
			$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
			A	A	A	hp	A	hp	A	hp
034A-4	R3	34.0	48.6	34.0	25.0	34.0	25.0	27.0	20.0	
044A-4	R3	44.0	61.2	44.0	30.0	44.0	30.0	34.0	25.0	
052A-4	R4	52	79	52	40	52	40	40	30	
052A-4	R4 v2	52	79	52	40	52	40	40	30	
065A-4	R4	65	94	65	50	65	50	52	40	
065A-4	R4 v2	65	94	65	50	65	50	52	40	
077A-4	R4	77	117	77	60	77	60	65	50	
077A-4	R4 v2	77	117	77	60	77	60	65	50	
078A-4	R5	77	117	77	60	77	60	65	50	
096A-4	R5	96	139	96	75	96	75	77	60	
124A-4	R6	124	173	124	100	124	100	96	75	
156A-4	R7	156	223	156	125	156	125	124	100	
180A-4	R7	180	281	180	150	180	150	156	125	
240A-4	R8	240	324	240	200	240	200	180	150	
260A-4	R8	260	418	260	200	260	200	240	150	
302A-4	R9	302	468	302	250	302	250	260	200	
361A-4	R9	361	468	361	300	361	300	302	250	
414A-4	R9	414	544	414	350	414	350	361	300	
477A-4	R9	450	600	477	400	454	350	385	300	

ACQ580-01-...	Frame size	Input rating	Max. current	Output ratings					
				Nominal use		Light-duty use		Heavy-duty use	
				$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
				A	hp	A	hp	A	hp
3-phase $U_n = 575$ V (525...600 V)									
02A7-6	R2	2.7	4.3	2.7	2.0	2.7	2.0	2.4	1.5
03A9-6	R2	3.9	5.3	3.9	3.0	3.9	3.0	2.7	2.0
06A1-6	R2	6.1	8.2	6.1	5.0	6.1	5.0	3.9	3.0

ACQ580-01-...	Frame size	Input rating	Max. current	Output ratings							
				Nominal use		Light-duty use		Heavy-duty use			
				$I_1$	$I_{max}$	$I_2$	$P_n$	$I_{Ld}$	$P_{Ld}$	$I_{Hd}$	$P_{Hd}$
				A	A	A	hp	A	hp	A	hp
09A0-6	R2	9.0	12.2	9.0	7.5	9.0	7.5	6.1	5.0		
011A-6	R2	11.0	16.2	11.0	10	11.0	10	9.0	7.5		
017A-6	R2	17.0	23.0	17.0	15	17.0	15	11.0	10		
022A-6	R3	22.0	30.6	22.0	20	22.0	20	17.0	15		
027A-6	R3	27.0	39.6	27.0	25	27.0	25	22.0	20		
032A-6	R3	32.0	48.6	32.0	30	32.0	30	27.0	25		
041A-6	R5	41.0	58	41.0	40	41.0	40	32.0	30		
052A-6	R5	52	74	52	50	52	50	41.0	40		
062A-6	R5	62	94	62	60	62	60	52	50		
077A-6	R5	77	112	77	75	77	75	62	60		
099A-6	R7	99	139	99	100	99	100	77	75		
125A-6	R7	125	178	125	125	125	125	99	100		
144A-6	R8	144	225	144	150	144	150	125	125		
192A-6	R9	192	259	192	200	192	200	144	150		
242A-6	R9	242	346	242	250	242	250	192	200		
271A-6	R9	271	411	271	250	271	250	242	250		

**Definitions**

- $U_n$  Nominal output voltage of the drive. For input voltage range [ $U_1$ ], see section [Electrical power network specification \(page 339\)](#). 50 Hz for IEC ratings and 60 Hz for UL (NEC) ratings.
- $I_1$  Nominal input current (rms) at 40 °C (104 °F).  
Nominal input current. Continuous rms input current (for dimensioning cables and fuses).
- $I_{max}$  Maximum output current. Available for two seconds at start.
- $I_2$  Nominal output current. Maximum continuous rms output current allowed (no overload).
- $P_n$  Nominal power of the drive. Typical motor power (no overload). The horsepower ratings apply to most NEMA 4-pole motors.

- $I_{Ld}$  Continuous rms output current allowing 10% overload for 1 minute every 10 minutes
- $P_{Ld}$  Typical motor power in light-duty use (10% overload). The horsepower (hp) ratings apply to most NEMA 4-pole motors.
- $I_{Hd}$  Continuous rms output current allowing 50% overload for 1 minute every 10 minutes
- $P_{Hd}$  Typical motor power in heavy-duty use (50% overload).

**UL listed multiple ratings**

Refer to the manual supplement [Multiple ratings for ABB ACS380-04, ACS580-01, ACQ580-01 and ACS880-01 drives \(3AXD50000916184 \[English\]\)](#).

■ **Conversion tables for IEC and North American type codes**

IEC type ACQ580-01-...	North American type ACQ580-01-...	Frame size
3-phase $U_n = 230\text{ V}$		
04A7-2	04A6-2	R1
06A7-2	06A6-2	R1
07A6-2	07A5-2	R1
012A-2	10A6-2	R1
018A-2	017A-2	R1
025A-2	024A-2	R2
032A-2	031A-2	R2
047A-2	046A-2	R3
060A-2	059A-2	R3
076A-2	075A-2	R4, R4 v2
089A-2	088A-2	R5
091A-2	090A-2	R4 v2
115A-2	114A-2	R5
144A-2	143A-2	R6
171A-2	169A-2	R7
213A-2	211A-2	R7
276A-2	273A-2	R8
346A-2	343A-2	R9

<b>IEC type ACQ580-01-...</b>	<b>North American type ACQ580-01-...</b>	<b>Frame size</b>
400A-2	396A-2	R9

<b>IEC type ACQ580-01-...</b>	<b>North American type ACQ580-01-...</b>	<b>Frame size</b>
3-phase $U_n = 480$ V		
02A7-4	02A1-4	R1
03A4-4	03A0-4	R1
04A1-4	03A5-4	R1
05A7-4	04A8-4	R1
07A3-4	06A0-4	R1
09A5-4	07A6-4	R1
12A7-4	012A-4	R1
018A-4	014A-4	R2
026A-4	023A-4	R2
033A-4	027A-4	R3
039A-4	034A-4	R3
046A-4	044A-4	R3
062A-4	052A-4	R4, R4 v2
073A-4	065A-4	R4, R4 v2
088A-4	078A-4	R5
089A-4	077A-4	R4 v2
106A-4	096A-4	R5
145A-4	124A-4	R6
169A-4	156A-4	R7
206A-4	180A-4	R7
246A-4	240A-4	R8
293A-4	260A-4	R8
363A-4	302A-4	R9
363A-4	361A-4	R9
430A-4	414A-4	R9
490A-4	477A-4	R9



## ■ Sizing

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

**Note:** The ratings apply at ambient temperature of 40 °C (104 °F) for  $I_2$  ( $I_{Ld}$  for UL (NEC)). Above these temperatures derating is required.

**Note:** The DriveSize dimensioning PC tool available from ABB (<http://new.abb.com/drives/software-tools/drivesize>) is recommended for selecting the drive, motor and gear combination.

## ■ Deratings

The output load capacity ( $I_2$ ,  $I_{Ld}$ ,  $I_{Hd}$ ; note that  $I_{max}$  is not derated) decreases in certain situations. In situations, where full motor power is required, oversize the drive so that the total derated output current provides sufficient capacity to supply the required nominal voltage to run the motor.

**Note:** The DriveSize dimensioning PC tool available from ABB (<http://new.abb.com/drives/software-tools/drivesize>) is also suitable for derating.

**Note:** If several situations are present at a time, the effects of derating are cumulative:

$I_2$  (derated) or  $I_{Ld}$  (derated) = ( $I_2$  or  $I_{Ld}$ ) × (switching frequency derating) × (altitude derating) × (ambient temperature derating), where no derating = 1.0.

**Note:** The motor may have a derating on it too.

### Example 1, IEC: How to calculate the derated current

The IP21 / UL Type 1 drive type is ACQ580-01-062A-4, which has drive output current of 62 A. Calculate the derated drive output current ( $I_2$ ) at 4kHz switching frequency, at 1500 m altitude and at 50 °C ambient temperature as follows:

1. **Switching frequency derating (page 280):**  
No derating needed for 4 kHz.
2. **Altitude derating (page 279):**  
The derating factor for 1500 m is  $1 - 1/10\,000 \text{ m} \cdot (1500 - 1000) \text{ m} = 0.95$ .  
The derated drive output current becomes  $I_2 = 0.95 \cdot 62 \text{ A} = 58.9 \text{ A}$ .
3. **Surrounding air temperature derating, IP21 (UL Type 1) (page 275):**  
The derating factor for 50 °C ambient temperature = 0.90.  
The derated drive output current becomes then  $I_2 = 0.90 \cdot 58.9 \text{ A} = 53.01 \text{ A}$ .

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

The IP21 / UL Type 1 drive type is ACQ580-01-052A-4, which has drive output current of 52 A. Calculate the derated drive output current ( $I_{Ld}$ ) at 4kHz switching frequency, at 4921 ft (1500 m) altitude and at 50 °C ambient temperature as follows:

1. **Switching frequency derating (page 280):**  
No derating needed for 4 kHz.
2. **Altitude derating (page 279):**  
The derating factor for 4921 ft (1500 m) is  $1 - 1/10\ 000\ m \cdot (1500 - 1000)\ m = 0.95$ .  
The derated drive output current becomes  $I_{Ld} = 0.95 \cdot 52\ A = 49.4\ A$ .
3. **Surrounding air temperature derating, IP21 (UL Type 1) (page 275):**  
The derating factor for 50 °C ambient temperature = 0.90.  
The derated drive output current becomes then  $I_{Ld} = 0.90 \cdot 49.4\ A = 44.46\ A$ .

**Example 2, IEC:** How to calculate the required drive

If your application requires continuous 12.0 A of motor current ( $I_2$ ) at 8 kHz switching frequency, the supply voltage is 400 V and the drive is situated at 1500 m altitude and at 35 °C ambient temperature, calculate the appropriate IP21 / (UL Type 1) drive size requirement as follows:

1. **Switching frequency derating (page 280):**  
The minimum size required is  $I_2 = 12.0\ A / 0.65 = 18.46\ A$ ,  
where 0.65 is the derating for 8 kHz switching frequency (frames R2...R3).
2. **Altitude derating (page 279):**  
The derating factor for 1500 m is  $1 - 1/10\ 000\ m \cdot (1500 - 1000)\ m = 0.95$ .  
The minimum size required becomes then  $I_2 = 18.46\ A / 0.95 = 19.43\ A$ .
3. **Surrounding air temperature derating, IP21 (UL Type 1) (page 275):**  
No derating needed for 35 °C ambient temperature.

Referring to  $I_2$  in the ratings tables (starting from page 264), drive type ACQ580-01-026A-4 exceeds the  $I_2$  requirement of 19.43 A.

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

If your application requires continuous maximum current with 10% overload 12.0 A of motor current ( $I_{Ld}$ ) at 8 kHz switching frequency, the supply voltage is 480 V and the drive is situated at 4921 ft (1500 m) altitude and at 35 °C ambient temperature, calculate the appropriate IP21 / UL Type 1 drive size requirement as follows:

1. **Switching frequency derating (page 280):**  
The minimum size required is  $I_{Ld} = 12.0\ A / 0.65 = 18.46\ A$ ,  
where 0.65 is the derating for 8 kHz switching frequency (frames R2...R3).

2. **Altitude derating (page 279):**

The derating factor for 4921 ft (1500 m) is  $1 - 1/10\,000 \text{ m} \cdot (1500 - 1000) \text{ m} = 0.95$ .

The minimum size required becomes then  $I_{LD} = 18.46 \text{ A} / 0.95 = 19.43 \text{ A}$ .

3. **Surrounding air temperature derating, IP21 (UL Type 1) (page 275):**

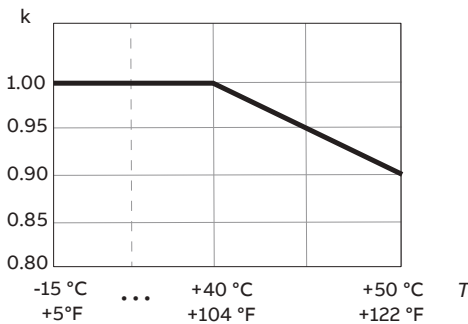
No derating needed for 35 °C ambient temperature.

Referring to  $I_{LD}$  in the ratings tables (starting from page 268), drive type ACQ580-01-026A-4 exceeds the  $I_{LD}$  requirement of 19.43 A.

**Surrounding air temperature derating, IP21 (UL Type 1)**

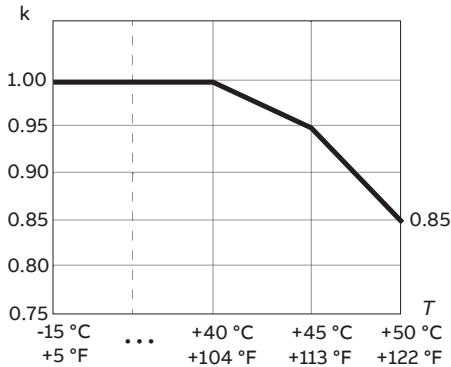
IP21 (UL Type 1) drive types, other than the exceptions below

In the temperature range +40...50 °C (+104...122 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k, in the diagram below).

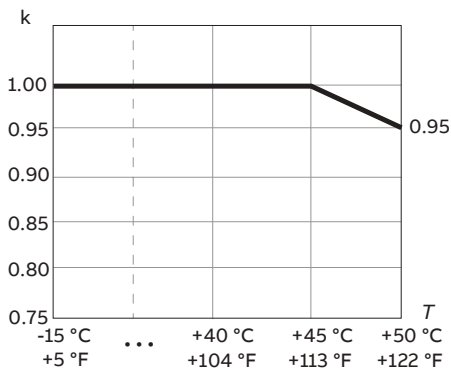


IP21 (UL Type 1) drive type -078A-4; -099A-6, -125A-6, -144A-6

**-078A-4:** In the temperature range +40...45 °C (+104...113 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). In the temperature range +45...50 °C (+113...122 °F), the rated output current is derated by 2% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k):



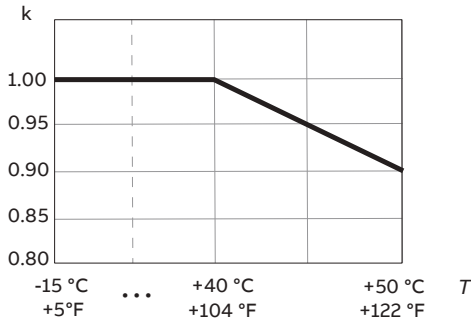
-099A-6, -125A-6, -144A-6: In the temperature range +40...45 °C (+104...113 °F), the rated output current is not derated at all. In the temperature range +45...50 °C (+113...122 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k):



### **Surrounding air temperature derating, IP55 (UL Type 12)**

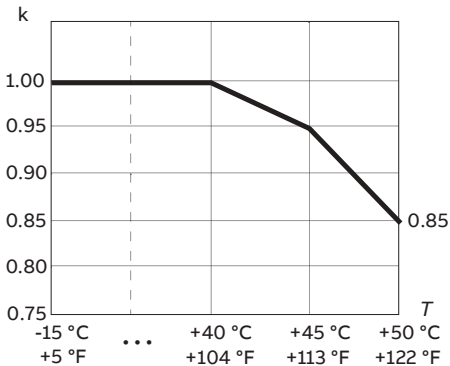
IP55 (UL Type 12) drive types, other than the exceptions below

In the temperature range +40...50 °C (+104...122 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k):

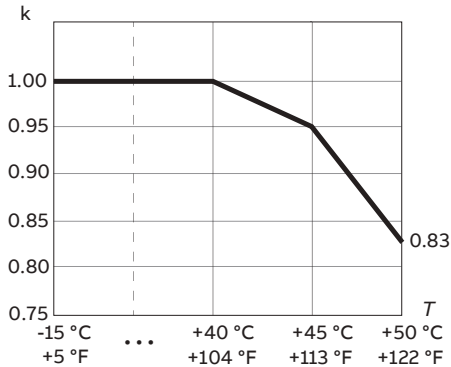


IP55 (UL Type 12) drive type -077A-4, -078A-4, -260A-4, -293A-4; -075A-2 (R4), -273A-2, -276A-2; -099A-6, -125A-6, -144A-6

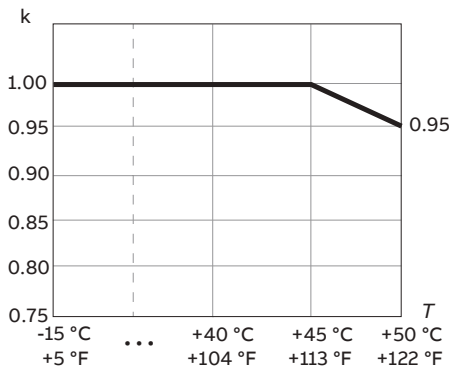
-077A-4 and -078A-4; -075A-2 (R4): In the temperature range +40...45 °C (+104...113 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). In the temperature range +45...50 °C (+113...122 °F), the rated output current is derated by 2.5% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k):



-260A-4, -293A-4; -273A-2, -276A-2: In the temperature range +40...45 °C (+104...113 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). In the temperature range +45...50 °C (+113...122 °F), the rated output current is derated by 2.5% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k):



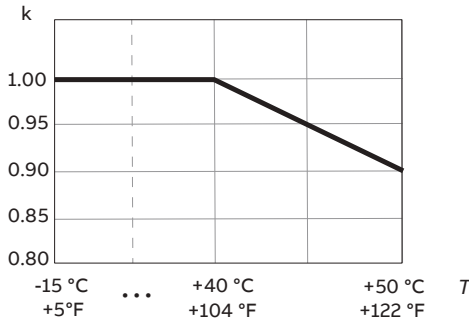
-099A-6, -125A-6, -144A-6: In the temperature range +40...45 °C (+104...113 °F), the rated output current is not derated at all. In the temperature range +45...50 °C (+113...122 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k):



### **Surrounding air temperature derating, IP66 (UL Type 4X)**

#### IP66 (UL Type 4X) drive types

In the temperature range +40...50 °C (+104...122 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor (k, in the diagram below).



### Altitude derating

In altitudes 1000...4000 m (3300...13120 ft) above sea level, the derating is 1% for every 100 m (330 ft).

**Note:** There are special considerations in corner-grounded installations above 2000 m. Contact your local ABB representative for further information.

The output current is calculated by multiplying the current given in the rating table by the derating factor k, which for x meters (1000 m ≤ x ≤ 4000 m) is:

$$K = 1 - 1/10000m * (X - 1000)m$$

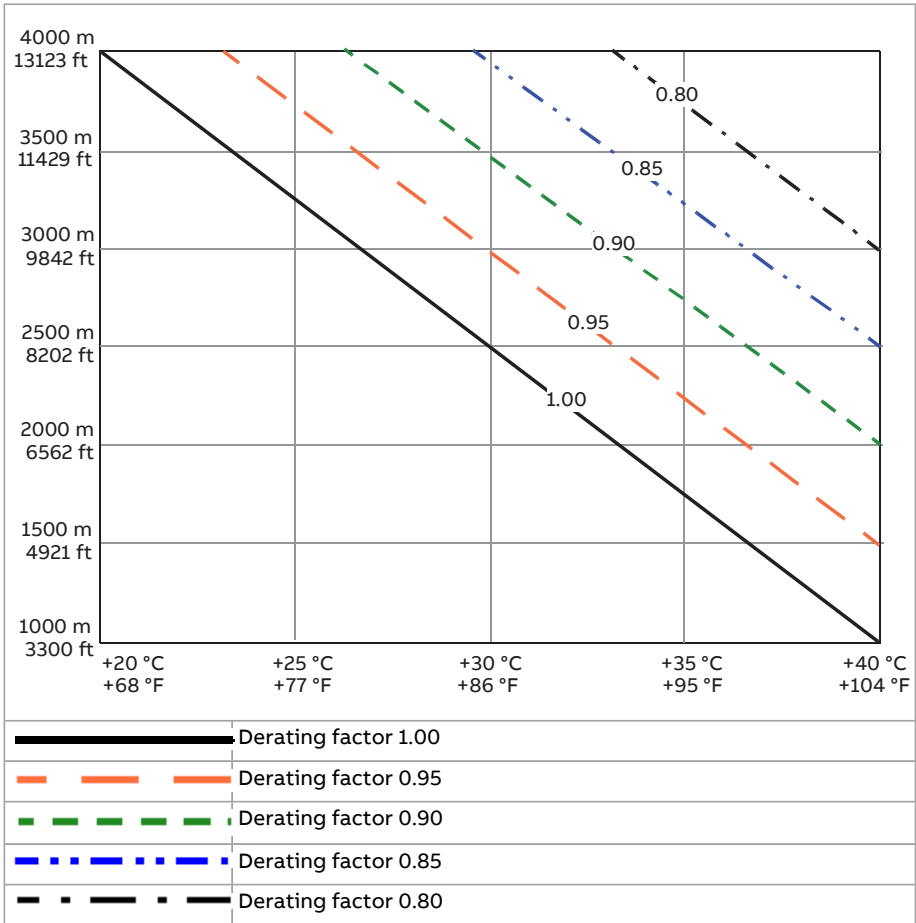
### Altitude and surrounding air temperature

At altitudes from 1000...4000 m (3281...13123 ft) above sea level and temperature +40 °C (+104 °F), the derating is 1 percentage point for every additional 100 m (328 ft).

If surrounding air temperature is below +40 °C, the derating can be reduced by 1.5 percentage point for every 1 °C reduction in temperature.

A few combined altitude and temperature derating curves for 1000...4000 m are shown below. For example, if the temperature is 30 °C, the derating factor is 1 - 1.5% · 10 = 0.85.

For a more accurate derating, use the DriveSize PC tool.



**Note:** Check the supply network compatibility restrictions above 2000 m (6562 ft), see [Installation site altitude \(page 346\)](#). Check also PELV limitation on relay output terminals above 2000 m (6562 ft), see sections [Isolation areas \(page 227\)](#) for frames R1...R5 and [Isolation areas \(page 231\)](#) for frames R6...R9.

**Switching frequency derating**

The output current is calculated by multiplying the current given in the rating table by the derating factor given in the table below.

**Note:** If you change the minimum switching frequency with parameter 97.02, derate according to the table below. Changing parameter 97.01 does not require derating.



**IEC**

Frame size	ACQ580-01-...	Derating factor (k) for the switching frequencies at 40 °C (+104 °F)											
		1.5 kHz	2 kHz	3kHz	4kHz	5kHz	6kHz	7kHz	8kHz	9kHz	10kHz	11kHz	12kHz
3-phase $U_n = 230$ V													
R1	04A7-2...18A2-2	N/A	1	1	1	0.96	0.94	0.90	0.89	0.85	0.84	0.81	0.80
R2	025A-2...032A-2	N/A	1	1	1	0.95	0.92	0.88	0.86	0.82	0.79	0.76	0.74
R3	047A-2...060A-2	N/A	1	1	1	0.95	0.92	0.87	0.85	0.81	0.78	0.74	0.72
R4 v2	076A-2...091A-2	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.55	0.51	0.47
R5	089A-2...115A-2	N/A	1	1	1	0.96	0.94	0.90	0.89	0.85	0.83	0.80	0.79
R6	144A-2	1	1	1	1	0.96	0.94	0.91	0.90	0.86	0.84	0.81	0.80
R7	171A-2...213A-2	1	1	1	1	0.96	0.94	0.91	0.90	0.86	0.84	0.81	0.80
R8	276A-2	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3-phase $U_n = 400$ V													
R1	02A7-4...12A7-4	N/A	1	1	1	0.90	0.83	0.74	0.67	0.62	0.58	0.53	0.50
R2	018A-4...026A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.56	0.51	0.48
R3	033A-4...046A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.56	0.51	0.48
R4	062A-4	N/A	1	1	1	0.94	0.90	0.85	0.82	0.76	0.72	0.67	0.64
R4 v2	062A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.56	0.51	0.48
R4	073A-4	N/A	1	1	1	0.92	0.86	0.79	0.73	0.67	0.63	0.59	0.55
R4 v2	073A-4...089A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.55	0.51	0.47
R5	088A-4...106A-4	N/A	1	1	1	0.91	0.85	0.77	0.71	0.67	0.63	0.60	0.57
R6	145A-4	1	0.97	0.91	0.84	0.78	0.74	0.69	0.66	0.62	0.58	0.55	0.52
R7	169A-4...206A-4	1	0.98	0.94	0.89	0.83	0.79	0.74	0.71	0.66	0.61	0.57	0.53
R8	246A-4...293A-4	1	0.96	0.89	0.82	0.76	0.71	0.65	0.61	0.56	0.52	0.48	0.45
R9	363A-4...430A-4	1	0.95	0.87	0.79	0.73	0.68	0.62	0.58	0.53	0.50	0.46	0.43
R9	490A-4	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**UL (NEC)**

Frame size	ACQ580-01-...	Derating factor (k) for the switching frequencies at 40 °C (+104 °F)											
		1.5 kHz	2kHz	3kHz	4kHz	5kHz	6kHz	7kHz	8kHz	9kHz	10kHz	11kHz	12kHz
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz													
R1	04A6-2...17A2-2	N/A	1	1	1	0.96	0.94	0.90	0.89	0.85	0.84	0.81	0.80
R2	024A-2...031A-2	N/A	1	1	1	0.95	0.92	0.88	0.86	0.82	0.79	0.76	0.74
R3	046A-2...059A-2	N/A	1	1	1	0.95	0.92	0.87	0.85	0.81	0.78	0.74	0.72
R4	075A-2	N/A	1	1	1	0.95	0.92	0.88	0.86	0.82	0.79	0.76	0.74

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Frame size	ACQ580-01-...	Derating factor (k) for the switching frequencies at 40 °C (+104 °F)											
		1.5kHz	2kHz	3kHz	4kHz	5kHz	6kHz	7kHz	8kHz	9kHz	10kHz	11kHz	12kHz
R4 v2	075A-2...090A-2	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.55	0.51	0.47
R5	088A-2...114A-2	N/A	1	1	1	0.96	0.94	0.90	0.89	0.85	0.83	0.80	0.79
R6	143A-2	1	1	1	1	0.96	0.94	0.91	0.90	0.86	0.84	0.81	0.80
R7	169A-2...213A-2	1	1	1	1	0.96	0.94	0.91	0.90	0.86	0.84	0.81	0.80
R8	273A-2	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
R9	343A-2...396A-2	1	1	1	1	0.96	0.94	0.91	0.90	0.86	0.84	0.81	0.80
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz													
R1	02A1-4...012A-4	N/A	1	1	1	0.90	0.83	0.74	0.67	0.62	0.58	0.53	0.50
R2	014A-4...023A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.56	0.51	0.48
R3	027A-4...044A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.56	0.51	0.48
R4	052A-4...065A-4	N/A	1	1	1	0.94	0.90	0.85	0.82	0.76	0.72	0.67	0.64
R4 v2	052A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.56	0.51	0.48
R4	077A-4	N/A	1	1	1	0.92	0.86	0.79	0.73	0.67	0.63	0.59	0.55
R4 v2	065A-4...077A-4	N/A	1	1	1	0.90	0.82	0.73	0.65	0.60	0.55	0.51	0.47
R5	078A-4...096A-4	N/A	1	1	1	0.91	0.85	0.77	0.71	0.637	0.63	0.60	0.57
R6	124A-4	1	0.97	0.91	0.84	0.78	0.74	0.69	0.66	0.62	0.58	0.55	0.52
R7	156A-4...180A-4	1	0.98	0.94	0.89	0.83	0.79	0.74	0.71	0.66	0.61	0.57	0.53
R8	240A-4...260A-4	1	0.96	0.89	0.82	0.76	0.71	0.65	0.61	0.56	0.52	0.48	0.45
R9	302A-4	1	1	1	1	0.88	0.78	0.67	0.58	0.53	0.50	0.46	0.43
R9	361A-4...414A-4	1	0.95	0.87	0.79	0.73	0.68	0.62	0.58	0.53	0.50	0.46	0.43
R9	477A-4	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz													
R2	02A7-6...017A-6	N/A	1	1	1	0.92	0.85	0.78	0.72	0.67	0.62	0.58	0.54
R3	022A-6...032A-6	N/A	1	1	1	0.92	0.86	0.79	0.74	0.67	0.61	0.55	0.50
R5	041A-6...077A-6	N/A	1	1	1	0.91	0.84	0.76	0.70	0.64	0.60	0.55	0.51
R7	099A-6...125A-6	1	1	1	1	0.90	0.82	0.73	0.66	0.61	0.57	0.53	0.50
R8	144A-6	1	1	1	1	0.90	0.82	0.73	0.66	0.61	0.57	0.53	0.50
R9	192A-6	1	1	1	1	0.90	0.82	0.73	0.66	0.61	0.57	0.53	0.50
R9	242A-6	1	1	0.92	0.83	0.78	0.74	0.69	0.66	0.61	0.57	0.53	0.50
R9	271A-6	1	1	0.87	0.74	0.71	0.69	0.67	0.66	0.61	0.57	0.53	0.50

## Output frequency derating

Output frequency derating applies for ratings up to ACQ580-01-106A-4 (R5). Inverter output current is limited by the following factor  $k$  below 5 Hz absolute inverter output frequency  $f_{abs}$ .

$$k = 2/3 + 1/3 \cdot (f_{abs} / 5 \text{ Hz})$$

## Fuses (IEC)

gG as well as uR or aR fuses for protection against short-circuit in the input power cable or drive are listed below. Either fuse type can be used for frames R1...R9 if it operates rapidly enough. The operating time depends on the supply network impedance and the cross-sectional area and length of the supply cable.

**Note 1:** See also [Implementing short-circuit and thermal overload protection \(page 115\)](#).

**Note 2:** Fuses with higher current rating than the recommended ones must not be used.

**Note 3:** Fuses from other manufacturers can be used if they meet the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

### ■ gG fuses

Check on the fuse time-current curve to ensure the operating time of the fuse is below 0.5 seconds. Obey the local regulations.

ACQ580-01...	Min. short-circuit current <sup>1)</sup>	Input current	gG (IEC 60269)				
			Nominal current	$I^2t$	Voltage rating	ABB type	IEC 60269 size
			A	A <sup>2</sup> s	V		
3-phase $U_n = 230 \text{ V}$							
04A7-2	200	4.7	25	2500	500	OFAF000H25	000
06A7-2	200	6.7	25	2500	500	OFAF000H25	000
07A6-2	200	7.6	25	2500	500	OFAF000H25	000
012A-2	200	12.0	25	2500	500	OFAF000H25	000
018A-2	200	16.9	25	2500	500	OFAF000H25	000
025A-2	320	24.5	40	7700	500	OFAF000H40	000
032A-2	320	31.2	40	7700	500	OFAF000H40	000
047A-2	500	46.7	63	20100	500	OFAF000H63	000

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ACQ580-01-...	Min. short-circuit current <sup>1)</sup>	Input current	gG (IEC 60269)				
			Nominal current	$I^2t$	Voltage rating	ABB type	IEC 60269 size
			A	A <sup>2</sup> s	V		
060A-2	500	60	63	20100	500	OFAF000H63	000
076A-2	1000	76	100	65000	500	OFAF000H100	000
089A-2	1300	89	125	103000	500	OFAF000H125	00
091A-2	1300	91	125	103000	500	OFAF000H125	00
115A-2	1300	115	125	103000	500	OFAF000H125	00
144A-2	1700	144	200	300000	500	OFAF00H200	0
171A-2	2300	171	250	600000	500	OFAF00H250	0
213A-2	3300	213	315	710000	500	OFAF1H315	1
248A-2	-	273	-	-	-	-	-
276A-2	5500	276	400	110000	500	OFAF2H400	2
3-phase $U_n = 400$ or $480$ V							
02A7-4	32	2.6	4	55	500	OFAF000H4	000
03A4-4	48	3.3	6	110	500	OFAF000H6	000
04A1-4	48	4.0	6	110	500	OFAF000H6	000
05A7-4	80	5.6	10	360	500	OFAF000H10	000
07A3-4	80	7.2	10	360	500	OFAF000H10	000
09A5-4	128	9.4	16	740	500	OFAF000H16	000
12A7-4	128	12.6	16	740	500	OFAF000H16	000
018A-4	200	17.0	25	2500	500	OFAF000H25	000
026A-4	256	25.0	32	4000	500	OFAF000H32	000
033A-4	320	32.0	40	7700	500	OFAF000H40	000
039A-4	400	38.0	50	16000	500	OFAF000H50	000
046A-4	500	45.0	63	20100	500	OFAF000H63	000
062A-4	800	62	80	37500	500	OFAF000H80	000
073A-4	1000	73	100	65000	500	OFAF000H100	000
088A-4	1000	88	100	65000	500	OFAF000H100	000
089A-4	1000	89	100	65000	500	OFAF000H100	000
106A-4	1300	106	125	103000	500	OFAF000H125	00

ACQ580-01-...	Min. short-circuit current <sup>1)</sup>	Input current	gG (IEC 60269)				
			Nominal current	$I^2t$	Voltage rating	ABB type	IEC 60269 size
			A	A <sup>2</sup> s	V		
145A-4	1700	145	160	185000	500	OFAF00H160	00
169A-4	3300	169	250	600000	500	OFAF0H250	0
206A-4	5500	206	315	710000	500	OFAF1H315	1
246A-4	6400	246	355	920000	500	OFAF1H355	1
293A-4	7800	293	425	1300000	500	OFAF2H425	2
363A-4	9400	363	500	2000000	500	OFAF2H500	2
430A-4	10200	430	630	2800000	500	OFAF3H630	3
490A-4	10200	450	630	2800000	500	OFAF3H630	3

1) Minimum short-circuit current of the installation

## ■ uR and aR fuses

ACQ580-01-...	Min. short-circuit current <sup>1)</sup>	Input current	uR or aR (DIN 43620 blade style)				
			Nominal current	$I^2t$	Voltage rating	Bussmann type	IEC 60269 size
			A	A <sup>2</sup> s	V		
3-phase $U_n = 230$ V							
04A7-2	120	4.7	40	460	690	170M1563	000
06A7-2	120	6.7	40	460	690	170M1563	000
07A6-2	120	7.6	40	460	690	170M1563	000
012A-2	120	12.0	40	460	690	170M1563	000
018A-2	120	16.9	40	460	690	170M1563	000
025A-2	170	24.5	63	1450	690	170M1565	000
032A-2	170	31.2	63	1450	690	170M1565	000
047A-2	280	46.7	80	2550	690	170M1566	000
060A-2	280	60	80	2550	690	170M1566	000
076A-2	480	76	125	8500	690	170M1568	000
089A-2	700	89	200	15000	690	170M3815	1
091A-2	700	91	160	16000	690	170M1569	000

ACQ580-01-...	Min. short-circuit current <sup>1)</sup>	Input current	uR or aR (DIN 43620 blade style)				
			Nominal current	$I^2t$	Voltage rating	Bussmann type	IEC 60269 size
			A	A <sup>2</sup> s	V		
115A-2	700	115	200	15000	690	170M3815	1
144A-2	1000	144	315	46500	690	170M3817	1
171A-2	1280	171	450	105000	690	170M5809	2
213A-2	1450	213	500	155000	690	170M5810	2
276A-2	2050	276	630	220000	690	170M6810	3
3-phase $U_n = 400$ or $480$ V							
02A7-4	65	2.6	25	130	690	170M1561	000
03A4-4	65	3.3	25	130	690	170M1561	000
04A1-4	65	4.0	25	130	690	170M1561	000
05A7-4	65	5.6	25	130	690	170M1561	000
07A3-4	65	7.2	25	130	690	170M1561	000
09A5-4	65	9.4	25	130	690	170M1561	000
12A7-4	65	12.6	25	130	690	170M1561	000
018A-4	120	17.0	40	460	690	170M1563	000
026A-4	120	25.0	40	460	690	170M1563	000
033A-4	170	32.0	63	1450	690	170M1565	000
039A-4	170	38.0	63	1450	690	170M1565	000
046A-4	280	45.0	80	2550	690	170M1566	000
062A-4	380	62	100	4650	690	170M1567	000
073A-4	480	73	125	8500	690	170M1568	000
088A-4	700	88	160	16000	690	170M1569	000
089A-4	700	89	160	16000	690	170M1569	000
106A-4	1280	106	315	46500	690	170M3817	1
145A-4	1280	145	315	46500	690	170M3817	1
169A-4	1800	169	450	105000	690	170M5809	2
206A-4	2210	206	500	145000	690	170M5810	2
246A-4	3010	246	630	275000	690	170M5812	2
293A-4	4000	293	800	490000	690	170M6812D	3

ACQ580-01-...	Min. short-circuit current <sup>1)</sup>	Input current	uR or aR (DIN 43620 blade style)				
			Nominal current	$I^2t$	Voltage rating	Bussmann type	IEC 60269 size
			A	A <sup>2</sup> s	V		
363A-4	5550	363	1000	985000	690	170M6814D	3
430A-4	7800	430	1250	2150000	690	170M8554D	3
490A-4	7800	450	1250	2150000	690	170M8554D	3

1) Minimum short-circuit current of the installation

ACQ580-01-...	Min. short-circuit current <sup>1)</sup>	Input current	uR or aR (DIN 43653 bolted tags)				
			Nominal current	$I^2t$	Voltage rating	Bussmann type	IEC 60269 size
			A	A <sup>2</sup> s	V		
3-phase $U_n = 400$ or $480$ V							
02A7-4	65	2.6	25	130	690	170M1311	000
03A4-4	65	3.3	25	130	690	170M1311	000
04A1-4	65	4.0	25	130	690	170M1311	000
05A7-4	65	5.6	25	130	690	170M1311	000
07A3-4	65	7.2	25	130	690	170M1311	000
09A5-4	65	9.4	25	130	690	170M1311	000
12A7-4	65	12.6	25	130	690	170M1311	000
018A-4	120	17.0	40	460	690	170M1313	000
026A-4	120	25.0	40	460	690	170M1313	000
033A-4	170	32.0	63	1450	690	170M1315	000
039A-4	170	38.0	63	1450	690	170M1315	000
046A-4	280	45.0	80	2550	690	170M1316	000
062A-4	380	62	100	4650	690	170M1417	000
073A-4	480	73	125	8500	690	170M1318	000
088A-4	700	88	160	16000	690	170M1319	000
089A-4	700	88	160	16000	690	170M1319	000
106A-4	700	106	200	15000	690	170M3015	1
145A-4	1000	145	250	28500	690	170M3016	1
169A-4	1280	169	315	46500	690	170M3017	1
206A-4	1520	206	350	68500	690	170M3018	1
246A-4	2050	246	450	105000	690	170M5009	2
293A-4	2200	293	500	145000	690	170M5010	2
363A-4	3100	363	630	275000	690	170M5012	2
430A-4	3600	430	700	405000	690	170M5013	2
490A-4	3600	450	700	405000	690	170M5013	2

<sup>1)</sup> Minimum short-circuit current of the installation



## ■ Calculating the short-circuit current of the installation

Make sure that the short-circuit current of the installation is at least the value given in the fuse table.

The short-circuit current of the installation can be calculated as follows:

$$I_{k2-ph} = \frac{U}{2 \cdot \sqrt{R_c^2 + (Z_k + X_c)^2}}$$

where

$I_{k2-ph}$	Short-circuit current in symmetrical two-phase short-circuit
$U$	Network line-to-line voltage (V)
$R_c$	Cable resistance (ohm)
$Z_k$	$Z_k = z_k \cdot U_n^2 / S_n =$ transformer impedance (ohm)
$z_k$	Transformer impedance (%)
$U_n$	Transformer rated voltage (V)
$S_n$	Nominal apparent power of the transformer (kVA)
$X_c$	Cable reactance (ohm)

### Calculation example

Drive:

- ACQ580-01-145A-4
- supply voltage = 410 V

Transformer:

- rated power  $S_n = 600$  kVA
- rated secondary voltage (supply for drive supply)  $U_n = 430$  V
- transformer impedance  $z_k = 7.2\%$

Supply cable:

- length = 170 m
- resistance/length = 0.398 ohm/km
- reactance/length = 0.082 ohm/km.

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$$Z_k = z_k \cdot \frac{U_N^2}{S_N} = 0.072 \cdot \frac{(430 \text{ V})^2}{600 \text{ kVA}} = 22.19 \text{ mohm}$$

$$R_c = 170 \text{ m} \cdot 0.398 \frac{\text{ohm}}{\text{km}} = 67.66 \text{ mohm}$$

$$X_c = 170 \text{ m} \cdot 0.082 \frac{\text{ohm}}{\text{km}} = 13.94 \text{ mohm}$$

$$I_{k2\text{-ph}} = \frac{410 \text{ V}}{2 \cdot \sqrt{(67.66 \text{ mohm})^2 + (22.19 \text{ mohm} + 13.94 \text{ mohm})^2}} = 2.7 \text{ kA}$$

The calculated short-circuit current 2.7 kA is higher than the minimum short-circuit current of the drive aR fuse type 170M3016 (1000 A). -> The 690 V aR fuse (Bussmann 170M3016) can be used.

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## Circuit breakers (IEC)

This section does not apply to the North American market. See section Circuit breakers (UL).

The protective characteristics of 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.



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

ACQ580-01-...	MCBs and MCCBs					
	ABB type <sup>1)</sup>	Max. short-circuit	T <sub>max</sub> frame XT / T class	T <sub>max</sub> rating	Electronic release	SACE ordering code for breaker and release unit
		I <sub>sc</sub>				
3-phase U <sub>n</sub> = 400 or 480 V						
02A7-4	S 303P-B/C/Z 10	20	N/A	N/A	N/A	N/A
03A4-4	S 303P-B/C/Z 10	20	N/A	N/A	N/A	N/A
04A1-4	S 303P-B/C/Z 10	20	N/A	N/A	N/A	N/A
05A7-4	S 303P-B/C/Z 10	20	N/A	N/A	N/A	N/A
07A3-4	S 303P-B/C/Z 10	20	N/A	N/A	N/A	N/A
09A5-4	S 303P-B/C/Z 10	20	N/A	N/A	N/A	N/A
12A7-4	S 303P-B/C/Z 16	20	N/A	N/A	N/A	N/A
018A-4	S 303P-B/C/Z 20	20	N/A	N/A	N/A	N/A
026A-4	S 303P-B/C/Z 25	20	N/A	N/A	N/A	N/A
033A-4	S 303P-B/C/Z 32	12	N/A	N/A	N/A	N/A
039A-4	S 303P-B/C/Z 40	12	N/A	N/A	N/A	N/A
046A-4	S 303P-B/C/Z 50	12	N/A	N/A	N/A	N/A

ACQ580-01-...	MCBs and MCCBs					
	ABB type <sup>1)</sup>	Max. short-circuit	T <sub>max</sub> frame XT / T class	T <sub>max</sub> rating	Electronic release	SACE ordering code for breaker and release unit
		I <sub>sc</sub>				
		kA	A	A	A	
062A-4	S 803S-B/C 80	50	N/A	N/A	N/A	N/A
073A-4	S 803S-B/C 80	50	N/A	N/A	N/A	N/A
088A-4	S 803S-B/C 100	50	N/A	N/A	N/A	N/A
089A-4	S 803S-B/C 100	50	N/A	N/A	N/A	N/A
106A-4	S 803S-B/C 125	50	N/A	N/A	N/A	N/A
145A-4	XT4 L 250 Ekip LS/I In=250 3p F F	65	XT4	250	250	1SDA068555R1
169A-4	XT4 L 250 Ekip LS/I In=250 3p F F	65	XT4	250	250	1SDA068555R1
206A-4	T4 L 320 PR221DS-LS/I In=320 3p F F	65	T4	320	320	1SDA054141R1
246A-4	T5 L 400 PR221DS-LS/I In=400 3p F F	65	T5	400	400	1SDA054365R1
293A-4	T5 L 630 PR221DS-LS/I In=630 3p F F	65	T5	630	630	1SDA054420R1
363A-4	T5 L 630 PR221DS-LS/I In=630 3p F F	65	T5	630	630	1SDA054420R1
430A-4	T5 L 630 PR221DS-LS/I In=630 3p F F	65	T5	630	630	1SDA054420R1
490A-4	-	-	-	-	-	-

<sup>1)</sup> Trip characteristic Z is recommended

## Fuses (UL)

Fuses for branch circuit protection per NEC are listed below. ABB recommends fast acting class T or faster fuses in the USA. Obey local regulations.

For IP66 (UL Type 4X) drives that include the disconnect and fuse option, no branch circuit protection is required external to the drive. Fuses shown in this table are included inside the drive.

ACQ580-01...	Input current	Maximum current	Voltage rating	Bussmann type	UL class <sup>1)</sup>
	A	A	V		
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz					
04A6-2	4.6	15	600	JJS-15	T
06A6-2	6.6	15	600	JJS-15	T
07A5-2	7.5	15	600	JJS-15	T
10A6-2	10.6	15	600	JJS-15	T
017A-2	16.7	30	600	JJS-30	T
024A-2	24.2	40	600	JJS-40	T
031A-2	30.8	40	600	JJS-40	T
046A-2	46.2	80	600	JJS-80	T
059A-2	59.4	80	600	JJS-80	T
075A-2	74.8	100	600	JJS-100	T
088A-2	88.0	150	600	JJS-150	T
090A-2	90	150	600	JJS-150	T
114A-2	114	150	600	JJS-150	T
143A-2	143	200	600	JJS-200	T
169A-2	169	250	600	JJS-250	T
211A-2	211	300	600	JJS-300	T
273A-2	273	400	600	JJS-400	T
343A-2	343	500	600	JJS-500	T
396A-2	396	600	600	JJS-600	T
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz					
02A1-4	2.1	15	600	JJS-15	T
03A0-4	3.0	15	600	JJS-15	T
03A5-4	3.5	15	600	JJS-15	T
04A8-4	4.8	15	600	JJS-15	T
06A0-4	6.0	15	600	JJS-15	T
07A6-4	7.6	15	600	JJS-15	T
012A-4	12.0	15	600	JJS-15	T
014A-4	14.0	30	600	JJS-30	T
023A-4	23.0	30	600	JJS-30	T

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ACQ580-01-...	Input current	Maximum current	Voltage rating	Bussmann type	UL class <sup>1)</sup>
	A	A	V		
027A-4	27.0	40	600	JJS-40	T
034A-4	34.0	60	600	JJS-60	T
044A-4	44.0	60	600	JJS-60	T
052A-4	52	80	600	JJS-80	T
065A-4	65	100	600	JJS-100	T
077A-4	77	110	600	JJS-110	T
078A-4	78	110	600	JJS-110	T
096A-4	106	150	600	JJS-150	T
124A-4	124	200	600	JJS-200	T
156A-4	156	225	600	JJS-225	T
180A-4	180	300	600	JJS-300	T
240A-4	240	350	600	JJS-350	T
260A-4	260	400	600	JJS-400	T
302A-4	302	500	600	JJS-500	T
361A-4 <sup>2)</sup>	361	500	600	JJS-500	T
414A-4 <sup>2)</sup>	414	600	600	JJS-600	T
477A-4	450	600	600	JJS-600	T
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz					
02A7-6	2.7	15	600	JJS-15	T
03A9-6	3.9	15	600	JJS-15	T
06A1-6	6.1	15	600	JJS-15	T
09A0-6	9.0	15	600	JJS-15	T
011A-6	11.0	15	600	JJS-15	T
017A-6	17.0	30	600	JJS-30	T
022A-6	22.0	40	600	JJS-40	T
027A-6	27.0	40	600	JJS-40	T
032A-6	32.0	40	600	JJS-40	T
041A-6	41.0	100	600	JJS-100	T
052A-6	52.0	100	600	JJS-100	T
062A-6	62.0	100	600	JJS-100	T

ACQ580-01-...	Input current	Maximum current	Voltage rating	Bussmann type	UL class <sup>1)</sup>
	A	A	V		
077A-6	77.0	100	600	JJS-100	T
099A-6	99.0	150	600	JJS-150	T
125A-6	125	200	600	JJS-200	T
144A-6	144	250	600	JJS-250	T
192A-6	192	300	600	JJS-300	T
242A-6	242	400	600	JJS-400	T
271A-6	271	400	600	JJS-400	T

1) Class J, CC, and CF fuses are also allowed at the same nominal current and voltage ratings

2) See note 8 below

### Notes for all drives except IP66 (UL Type 4X) drives with disconnect and fuse option:

- Fuses are required as part of the installation, are not included in the base drive configuration and must be provided by others.
- Fuses with a higher current rating than specified must not be used.
- The UL listed fuses recommended by ABB are the required branch circuit protection per NEC. Circuit breakers listed in section Circuit breakers (UL) are also acceptable as branch circuit protection.
- 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.
- 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 is not greater than that of the specified fuse.
- 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.
- When you install a drive, always obey ABB installation instructions, NEC requirements and local codes.
- Only 480 V R9 drives with serial numbers beginning 1204109256 when built in Finland and beginning 22106xxxxx when built in the U.S. may be protected with fuses other than Class T fuses.
- Alternative fuses can be used if they meet certain characteristics. For permitted fuses, see [Branch Circuit Protection for ABB drives manual supplement \(3AXD50000645015\)](#).

## Circuit breakers (UL)

These drives are suitable for use on a circuit capable of delivering not more than 65 kA symmetrical amperes (rms) at 240 / 480 / 600 V maximum (100 kA symmetrical amperes (rms) for IP66 (UL Type 4X) drives with disconnector and fuse option at 240 / 480 / 600 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.

Notes below the tables must be followed when using these breakers.

ACQ580-01-...	Frame size	Input current	CB maximum current	CB voltage	Enclosure minimum volume	Drive volume	ABB circuit breaker
		A	A	V	in <sup>3</sup>	in <sup>3</sup>	65 kA @ 240 V
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz							
04A6-2	R1	4.6	25	240	‡	561	XT2Nαβ025#*****
06A6-2	R1	6.6	25	240	‡	561	XT2Nαβ025#*****
07A5-2	R1	7.5	25	240	‡	561	XT2Nαβ025#*****
10A6-2	R1	10.6	25	240	‡	561	XT2Nαβ025#*****
017A-2	R1	16.7	25	240	‡	561	XT2Nαβ025#*****
024A-2	R2	24.2	40	240	‡	737	XT2Nαβ040#*****
031A-2	R2	30.8	40	240	‡	737	XT2Nαβ040#*****
046A-2	R3	46.2	100	240	‡	1390	XT2Nαβ100#*****
059A-2	R3	59.4	100	240	‡	1390	XT2Nαβ100#*****
075A-2	R4	74.8	100	240	‡	2027	XT2Nαβ100#*****
088A-2	R5	88.0	150	240	‡	2181	XT4Nαβ150#*****
114A-2	R5	114	150	240	‡	2181	XT4Nαβ150#*****
143A-2	R6	143	200	240	‡	2880	XT4Nαβ200#*****
169A-2	R7	169	300	240	‡	3369	XT5Nαβ30A#*****
211A-2	R7	211	300	240	‡	3369	XT5Nαβ30A#*****
273A-2	R8	273	400	240	‡	3858	XT5Nαβ40A#*****

‡ Enclosure minimum volume is not applicable

See notes 1-11 below



ACQ580-01-...	Frame size	Input current	CB maximum current	CB voltage	Enclosure minimum volume	Drive volume	ABB circuit breaker	Maximum $I^2t$	Maximum $I_{peak}$
		A	A	V	in <sup>3</sup>	in <sup>3</sup>	65 kA @ 240 V	A <sup>2</sup> s	kA
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz									
02A1-4	R1	2.1	20	480	6480	506	XT2Hαβ020#*****	$0.512 \times 10^6$	23.2
03A0-4	R1	3.0	20	480	6480	506	XT2Hαβ020#*****	$0.512 \times 10^6$	23.2
03A5-4	R1	3.5	20	480	6480	506	XT2Hαβ020#*****	$0.512 \times 10^6$	23.2
04A8-4	R1	4.8	20	480	6480	506	XT2Hαβ020#*****	$0.512 \times 10^6$	23.2
07A6-4	R1	7.6	20	480	6480	506	XT2Hαβ020#*****	$0.512 \times 10^6$	23.2
012A-4	R1	12.0	20	480	6480	506	XT2Hαβ020#*****	$0.512 \times 10^6$	23.2
014A-4	R2	14.0	35	480	16200	684	XT2Hαβ035#*****	$0.512 \times 10^6$	23.2
023A-4	R2	23.0	35	480	16200	684	XT2Hαβ035#*****	$0.512 \times 10^6$	23.2
027A-4	R3	27.0	70	480	27720	1011	XT2Hαβ070#*****	$0.512 \times 10^6$	23.2
034A-4	R3	34.0	70	480	27720	1011	XT2Hαβ070#*****	$0.512 \times 10^6$	23.2
044A-4	R3	44.0	70	480	27720	1011	XT2Hαβ070#*****	$0.512 \times 10^6$	23.2
052A-4	R4 R4 v2	52	125	480	30240	1669	XT2Hαβ125#*****	$0.512 \times 10^6$	23.2
065A-4	R4 R4 v2	65	125	480	30240	1669	XT2Hαβ125#*****	$0.512 \times 10^6$	23.2
077A-4	R4 R4 v2	77	125	480	30240	1669	XT2Hαβ125#*****	$0.512 \times 10^6$	23.2
078A-4	R5	78	150	480	30240	2030	XT4Hαβ150#*****	$0.98 \times 10^6$	30
096A-4	R5	96	150	480	30240	2030	XT4Hαβ150#*****	$0.98 \times 10^6$	30
124A-4	R6	124	225	480	16200	2880	XT4Hαβ225#*****	$0.98 \times 10^6$	30
156A-4	R7	156	250	480	18900	3369	XT4Hαβ250#*****	$0.98 \times 10^6$	30
180A-4	R7	180	250	480	18900	3369	XT4Hαβ250#*****	$0.98 \times 10^6$	30
240A-4	R8	240	400	480	32400	3858	XT5Hαβ40A#*****	$4.2 \times 10^6$	47.9
260A-4	R8	240	400	480	32400	3858	XT5Hαβ40A#*****	$4.2 \times 10^6$	47.9
302A-4	R9	302	600	480	32400	5226	XT5Hαβ60B#*****	$4.2 \times 10^6$	47.9
361A-4	R9	361	600	480	32400	5226	XT5Hαβ60B#*****	$4.2 \times 10^6$	47.9
414A-4	R9	414	600	480	32400	5226	XT5Hαβ60B#*****	$4.2 \times 10^6$	47.9

See notes 1-9 and 12-16 below

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ACQ580-01-...	Frame size	Input current	CB maximum current	CB voltage	Enclosure minimum volume	Drive volume	ABB circuit breaker	Maximum $I_{t}^2$	Maximum $I_{peak}$
		A	A	V	in <sup>3</sup>	in <sup>3</sup>	65 kA @ 240 V	A <sup>2</sup> <sub>s</sub>	kA
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz									
02A7-6	R2	2.7	25	600	16200	684	XT4Vαβ025#*****	$1.2 \times 10^6$	31.5
03A9-6	R2	3.9	25	600	16200	684	XT4Vαβ025#*****	$1.2 \times 10^6$	31.5
06A1-6	R2	6.1	25	600	16200	684	XT4Vαβ025#*****	$1.2 \times 10^6$	31.5
09A0-6	R2	9	25	600	16200	684	XT4Vαβ025#*****	$1.2 \times 10^6$	31.5
011A-6	R2	11	25	600	16200	684	XT4Vαβ025#*****	$1.2 \times 10^6$	31.5
017A-6	R2	17	25	600	16200	684	XT4Vαβ025#*****	$1.2 \times 10^6$	31.5
022A-6	R3	22	50	600	16200	684	XT4Vαβ050#*****	$1.2 \times 10^6$	31.5
027A-6	R3	27	50	600	16200	1011	XT4Vαβ050#*****	$1.2 \times 10^6$	31.5
032A-6	R3	32	50	600	16200	1011	XT4Vαβ050#*****	$1.2 \times 10^6$	31.5
041A-6	R5	41	125	600	16200	2030	XT4Vαβ125#*****	$1.2 \times 10^6$	31.5
052A-6	R5	52	125	600	16200	2030	XT4Vαβ125#*****	$1.2 \times 10^6$	31.5
062A-6	R5	62	125	600	16200	2030	XT4Vαβ125#*****	$1.2 \times 10^6$	31.5
077A-6	R5	77	125	600	16200	2030	XT4Vαβ125#*****	$1.2 \times 10^6$	31.5
099A-6	R7	99	200	600	18900	3369	XT4Vαβ200#*****	$1.2 \times 10^6$	31.5
125A-6	R7	125	200	600	18900	3369	XT4Vαβ200#*****	$1.2 \times 10^6$	31.5
144A-6	R7	144	250	600	32400	3858	XT4Vαβ200#*****	$1.2 \times 10^6$	31.5
192A-6	R9	192	400	600	32400	5226	XT5Lαβ40A#*****	$4.2 \times 10^6$	51.4
242A-6	R9	242	400	600	32400	5226	XT5Lαβ40A#*****	$4.2 \times 10^6$	51.4
271A-6	R9	271	400	600	32400	5226	XT5Lαβ40A#*****	$4.2 \times 10^6$	51.4

See notes 1-9, 12-13 and 17 below

### Notes for all drives except IP66 (UL Type 4X) with disconnect and fuse option:

1. Drives that have an enclosure minimum volume listed must be mounted in an enclosure  $\geq$  enclosure minimum volume specified in the tables above.
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 the largest enclosure minimum volume of the drives to be placed in the enclosure, plus the volume(s) of each additional drive. i.e. for the 480 V R6 and R3 drive select enclosure with the volume  $\geq 16200+1011 = 17211$  in<sup>3</sup>.

3. For UL Open Type, UL Type 1 or UL Type 12 drives, or UL Type 4X drives without disconnect and fuse option, that have a minimum enclosure volume indicated with ‡ , no minimum enclosure volume is required but the drive must be mounted inside an enclosure.
  4. If combining a drive with an enclosure minimum volume specified and others with an enclosure minimum volume indicated with ‡ , start with the largest specified enclosure minimum volume listed and add the drive volumes for the other drives.
  5. If you are only mounting drives with no enclosure minimum volume specified, you have no restrictions on the enclosure size, but follow air clearances specified in the drive hardware manuals for sufficient ventilation around each drive.
  6. UL Open Type, UL Type 1 and UL Type 12 drives, and UL Type 4X drives without disconnect and fuse option, can be used inside of the enclosure. Use drive volume for all three types listed in the table when installing multiple drives in the enclosure.
  7. The ABB circuit breaker part number listed in the table is a base part number.
    - Symbol  $\alpha$  represents 80% or 100% allowable continuous current. Options allowed are U, Q, C and D.
    - Symbol  $\beta$  represents the number of poles for the breaker. Options allowed are 3 and 4.
    - Symbol # represents trip units. Trip units allowed include A thru C, E thru L, P thru Z. If using Ekip breakers, set the overload current of the circuit breaker equal to or less than the value shown in the “CB Maximum Current” column in the tables above.
    - The digits indicated with an “\*” represent accessories for the breakers and have no impact on the drive UL listing or performance or rating of the breaker.
    - For the ABB circuit breaker configurator refer to:  
[https://lowvoltage-configurator.tnb.com/configurator/#/config/tmax\\_xt](https://lowvoltage-configurator.tnb.com/configurator/#/config/tmax_xt).
  8. Ratings in the tables are maximum for the given circuit breaker frame size. Breakers of the same frame size and interrupting rating with lower current ratings are also allowed.
  9. Do not use a circuit breaker with a lower KAIC rating even if the available short-circuit current is less than 65 kA.
  10. **For 230 V drives:** 230 V drives were tested with ABB inverse time circuit breakers rated at 65 kA and 240 V. Other manufacturers' inverse time circuit breakers can be used if they are UL 489 listed, they are 240 V or higher, they have a 65 kA or higher interrupting rating and they have the same or lower nominal current rating than the ABB specified circuit breaker.
  11. **For 230 V drives:** Current limiting inverse time circuit breakers must not be used.
-

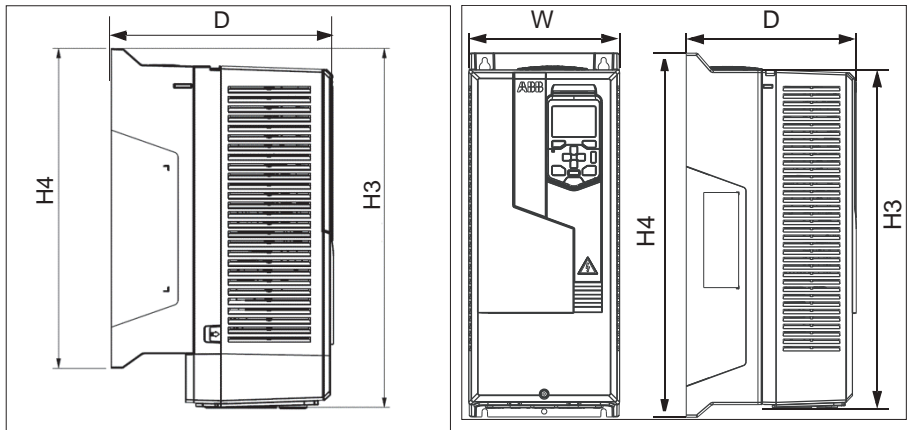
12. **For 480 V and 600 V drives:** When designing UL508A panels, Article SB 4.2.3 Exception No. 3 allows the use of other manufacturers' current limiting inverse time circuit breakers which have same voltage, current and interrupting rating, if  $I_{peak}$  and  $I^2t$  are the same or less than the ABB specified circuit breaker.
  13. **For 480 V and 600 V drives:** Do not use non-current limiting inverse time circuit breakers.
  14. **For 480 V drives:** Enclosures for frames R1, R3, and R9 must have a solid bottom directly below the drive. i.e. fans, filters or louvers cannot be mounted directly below the drive but can be mounted in adjacent areas on the bottom of the enclosure.
  15. **For 480 V drives:** Enclosures for frame R6 must have a solid top directly above the drive. Fans, filters our louvers cannot be mounted directly above the drive.
  16. **For 480 V drives:** Only R8 frame drives with serial numbers beginning 1204301926 when built in Finland and 2205002140 when built in the U.S. may be protected with circuit breakers listed in the tables above.
  17. **For 480 V drives:** Only R9 frame drives with serial numbers beginning 1204109256 when built in Finland and beginning 22106xxxxx when built in the U.S. may be protected with circuit breakers listed in the tables above.
  18. **For 600 V drives:** Enclosures for frames R2, R3, R5 and R9 must have a solid bottom directly below the drive. i.e. fans, filters or louvers cannot be mounted directly below the drive but can be mounted in adjacent areas on the bottom of the enclosure.
  19. You can use alternative circuit breakers if they meet certain characteristics. For acceptable breakers, refer to [Branch Circuit Protection for ABB drives manual supplement \(3AXD50000645015 \[English\]\)](#).
-

## Dimensions, weights and free space requirements

Frame size	Dimensions and weights													
	IP21							UL Type 1						
	H1	H2	H3	H4	W	D	Weight	H1	H2	H3	H4	W	D	Weight
	mm	mm	mm	mm	mm	mm	kg	in	in	in	in	in	in	lb
R1	-	-	373	331	125	223	4.6	-	-	14.69	13.03	4.92	8.78	10.1
R2	-	-	473	432	125	229	6.6	-	-	18.62	17.01	4.92	9.00	14.6
R3	-*)	-*)	454	490	203	229	11.8	-*)	-*)	17.87	19.29	7.99	9.02	26.0
R4	-*)	-*)	600	636	203	257	19.0	-*)	-*)	23.62	25.04	7.99	10.12	41.9
R4 v2	-*)	-*)	601	636	203	257	20.0	-*)	-*)	23.66	25.04	7.99	10.12	44.1
R5	596	596	732	633	203	295	28.3	23.46	23.46	28.82	24.90	7.99	11.61	62.4
R6	548	549	727	589	252	369	42.4	21.57	21.63	28.62	23.20	9.92	14.53	93.5
R7	600	601	880	641	284	370	54	23.62	23.67	34.65	25.25	11.18	14.57	119.1
R8	680	677	965	721	300	393	69	26.77	26.66	37.99	28.39	11.81	15.47	152.1
R9	680	680	955	741	380	418	97	26.77	26.77	37.60	29.19	14.96	16.46	213.9

\*) Frames with an integrated cable/conduit box

**IP21 (UL Type 1) & IP55 (UL Type 12), R1...R2 IP21 (UL Type 1), R3...R4**

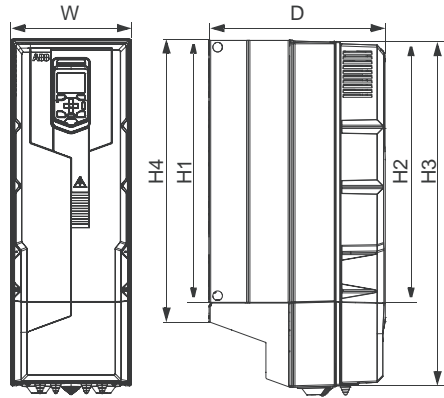


**Symbols**

**IP21 (UL Type 1), R1...R2, R5...R9**

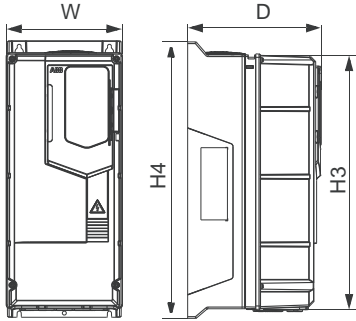
**IP21 / UL Type 1**

- H1** R5....R9: Height back without cable/conduit box
- H2** R5....R9: Height front without cable/conduit box
- H3** R3....R4: Height front, R1...R2, R5....R9:  
Height front with cable/conduit box
- H4** R3....R4: Height back, R1...R2, R5....R9:  
Height back with cable/conduit box
- W** Width
- D** Depth

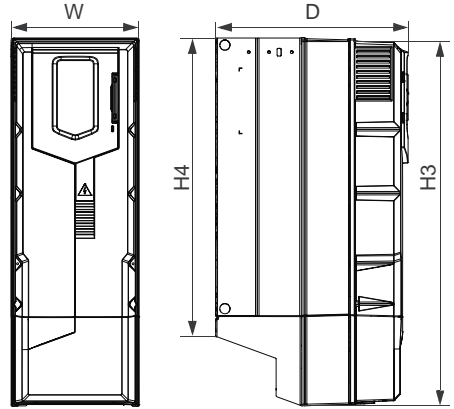


Frame size	Dimensions and weights												
	IP55					UL Type 12							
	H3	H4	W	D	Weight	H3	H4	H5	W	D	Weight	HH	HW
	mm	mm	mm	mm	kg	in	in	in	in	in	lb	in	in
R1	403	331	128	233	4.8	15.87	13.03	17.78	5.04	9.17	10.6	2.56	5.09
R2	503	432	128	239	6.8	19.80	17.01	21.49	5.04	9.41	15.0	2.56	5.10
R3	456	490	206	237	13.0	17.95	19.29	20.93	8.11	9.33	28.7	2.52	8.16
R4	600	636	203	265	20.0	23.62	25.04	27.03	7.99	10.43	44.1	2.83	8.59
R4 v2	601	636	203	265	21.0	23.66	25.04	27.05	7.99	10.43	46.3	2.83	8.59
R5	732	633	203	320	29.0	28.82	24.90	32.01	7.99	12.60	64.0	3.15	8.58
R6	726	589	252	380	43.0	28.58	23.20	34.81	9.92	14.96	94.8	6.10	11.46
R7	880	641	284	381	56.0	34.65	25.25	40.86	11.18	15.00	123.5	6.10	12.76
R8	965	721	300	452	77	37.99	28.39	44.23	11.81	17.80	169.8	6.10	13.80
R9	955	741	380	477	103	37.60	29.19	46.75	14.96	18.78	227.1	9.06	16.95

**IP55 (UL Type 12)<sup>1)</sup>, R3...R4**



**IP55 (UL Type 12)<sup>1)</sup>, R1...R2, R5...R9**



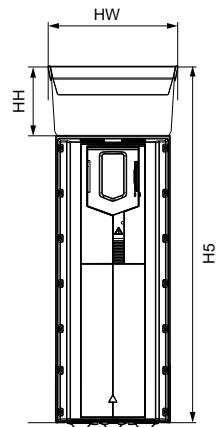
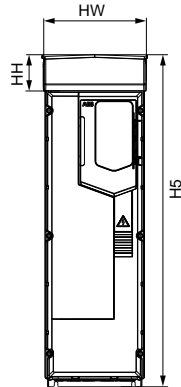
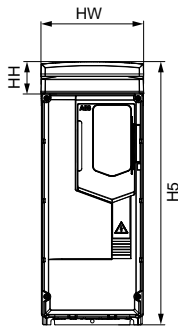
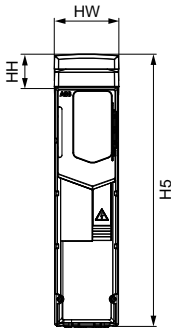
<sup>1)</sup> IP55 / UL Type 12 without hood

**UL Type 12, R1...R3**

**UL Type 12, R1...R3**

**UL Type 12, R4...R5**

**UL Type 12, R6...R9**



**Symbols**

**H3** R3...R4: Height front, R1...R2<sup>1)</sup> and R5...R9: Height front with cable/conduit box

**H4** R3...R4: Height back, R1...R2<sup>1)</sup> and R5...R9: Height back with cable/conduit box

**W** Width

**D** Depth

**Symbols**

**HH** Hood height

**HW** Hood width

1) See H3 and H4 location for R1...R2 in the figure on page 301

Frame size	Dimensions and weights									
	IP66					UL Type 4X				
	H	W	D1	D2	Weight	H	W	D1	D2	Weight
	mm	mm	mm	mm	kg	in	in	in	in	lb
R1	522	208	249	281	12.7	20.55	8.19	9.79	11.05	28
R2	606	208	260	292	15.5	23.86	8.19	10.22	11.48	34
R3	647	277	260	289	25.5	25.47	10.91	10.25	11.40	56

**Symbols**

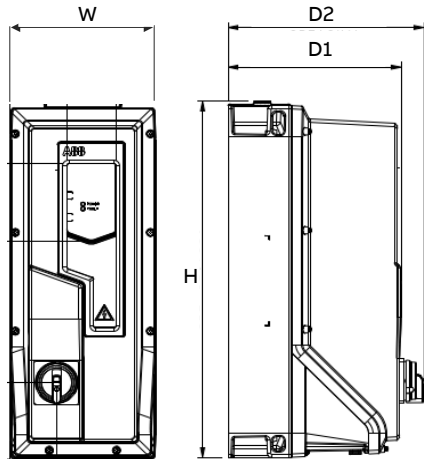
**IP66 (UL Type 4X), R1...R3**

**H** Height back with cable/conduit box

**W** Width

**D1** Depth without disconnect

**D2** Depth with disconnect





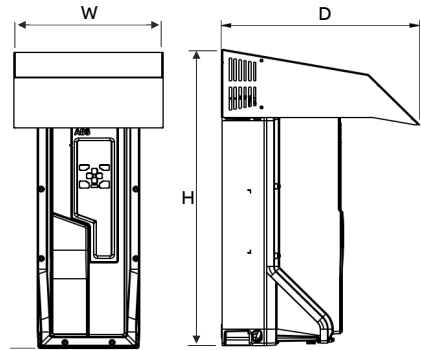
Frame size	Dimensions and weights							
	IP66 with sun shield				UL Type 4X with sun shield			
	H	W	D	Weight	H	W	D	Weight
	mm	mm	mm	kg	in	in	in	lb
R1	619	304	407	16.0	24.35	11.98	16.00	35
R2	703	304	407	18.8	27.66	11.98	16.00	41
R3	744	396	417	29.4	29.27	15.60	16.40	65

**Symbols**

**H** Height back with cable/conduit box

**W** Width

**D** Depth

**IP66 (UL Type 4X), R1...R3 with sun shield**


Frame size	Dimensions and weights with main switch and EMC C1 filter options (+F278, +F316, +E223), IP55									
	H3		H4		W		D		Weight	
	mm	in	mm	in	mm	in	mm	in	kg	lb
R1	403	18.87	331	13.03	128	5.04	255	10.03	5.4	11.8
R2	503	19.80	432	17.01	128	5.04	257	10.12	7.4	16.4
R3	733	28.86	519	20.43	207	8.15	258	10.16	15.0	33.1
R4	879	34.61	665	26.18	206	8.11	286	11.26	23.3	51.5
R5	1023	40.28	626	24.65	203	7.99	342	13.46	33.0	72.8

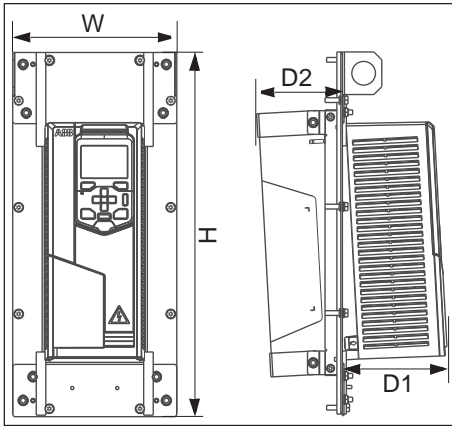
■ **Dimensions with flange**

Frame size	Dimensions with flange option kit (+C135), IP21 (UL Type 1) & IP55 (UL Type 12)								UL Type 12 hood	
	H		W		D1		D2		D3	
	mm	in	mm	in	mm	in	mm	in	mm	in
R1	461	18.15	206	8.12	133	5.22	109	4.28	126	4.95
R2	551	21.69	206	8.12	130	5.13	114	4.51	126	4.95
R3	613	24.13	290	11.42	118	4.65	116	4.58	191	7.53
R4	776	30.55	290	11.42	120	4.74	137	5.41	191	7.53
R5	776	30.55	290	11.42	124	4.89	173	6.81	191	7.53
R6	672	26.46	374	14.72	194	7.63	170	6.67	191	7.53
R7	722	28.43	406	15.98	19	7.67	169	6.65	211	8.32
R8	814	32.01	433	17.46	202	7.95	184	7.22	209	8.22
R9	804	31.65	502	19.76	204	8.03	209	8.21	226	8.91

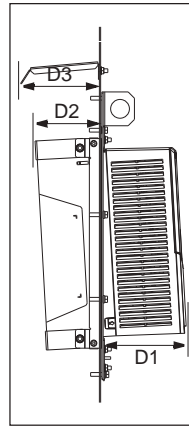
**Symbols**

- H** Height with flange
- W** Width with flange
- D1** Depth of the drive outwards from the outer surface of the flange plate
- D2** Depth of the drive inwards from the outer surface of the flange plate
- D3** Depth of the hood inwards from the outer surface of the flange plate (UL Type 12 only)

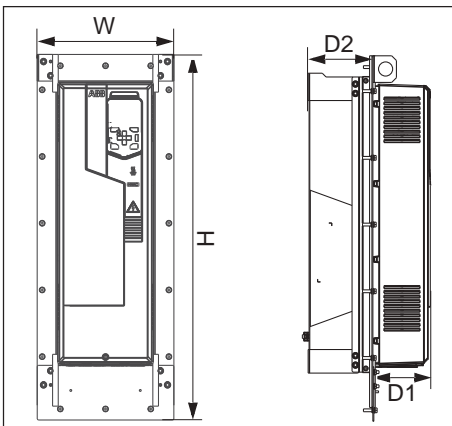
R1...R3 IP21 (UL Type 1)



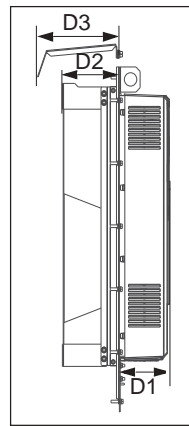
R1...R3 IP55 (UL Type 12)



R4...R9 IP21 (UL Type 1)



R4...R9 IP55 (UL Type 12)

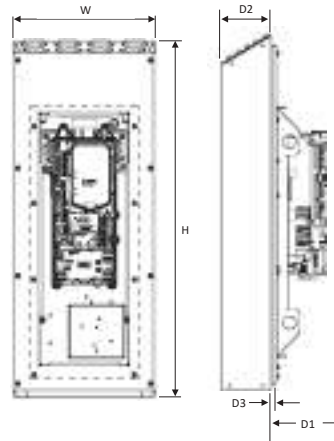


Frame size	Dimensions and weights with flange option kit (+C135), IP66 (UL Type 4X)											
	H		W		D1		D2		D3		Weight, flange and drive	
	mm	in	mm	in	mm	in	mm	in	mm	in	kg	lb
R1	673	26.49	272	10.71	143	5.63	97	3.81	7	0.26	17.1	38
R2	754	29.68	272	10.71	141	5.54	111	4.36	10	0.39	20.4	45
R3	797	31.38	341	13.43	133	5.24	111	4.36	10	0.39	31.8	70

**Symbols**

- H** Height back with cable/conduit box
- W** Width
- D1** Depth of the drive inwards from the mounting surface of the flange plate
- D2** Depth of the drive outwards from the mounting surface of the flange plate
- D3** Thickness of the flange plate

**IP66 (UL Type 4X), R1...R3 with flange option kit (+C135)**



**Note:**

1. For the actual degree of protection that can be achieved with flange for each frame size (on the back and front sides of the drive), see [ACS580-01...](#), [ACH580-01...](#) and [ACQ580-01...+C135 drives with flange mounting kit supplement \(3AXD50000349821 \[English\]\)](#).
2. Regarding flange mounting:
  - The outside of the cabinet sets the limit for vertical positioning, since that is where the cooling is required
  - There are no limitations inside the cabinet; practically the outside positioning defines the distance between drives
  - The space inside the cabinet can be used as long as the following requirements are still met:
    - Heat loss dissipation inside the cabinet per the hardware manual
    - Sufficient space for the maintenance operations
    - Wire bending radius rules according to UL when planning routing for mains and motor cables.

Frame size	Free space, IP21 (UL Type 1)											
	Vertical mounting stand alone						Vertical mounting side by side					
	Above		Below		Beside		Above		Below <sup>1)</sup>		Between	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
R1	65	2.56	86	3.39	150	5.91	200	7.87	200	7.87	0	0
R2	65	2.56	86	3.39	150	5.91	200	7.87	200	7.87	0	0
R3	65	2.56	53	2.09	150	5.91	200	7.87	200	7.87	0	0
R4	53	2.09	200	7.87	150	5.91	200	7.87	200	7.87	0	0
R5	75	2.95	200	7.87	150	5.91	200	7.87	200	7.87	0	0
R6	155	6.10	300	11.8	150	5.91	200	7.87	300	11.8	0	0
R7	155	6.10	300	11.8	150	5.91	200	7.87	300	11.8	0	0
R8	155	6.10	300	11.8	150	5.91	200	7.87	300	11.8	0	0
R9	200	7.87	300	11.8	150	5.91	200	7.87	300	11.8	0	0

1) Free space below is always measured from the drive frame, not from the cable box.

Frame size	Free space, IP21 (UL Type 1) <sup>1)</sup>					
	Horizontal mounting					
	Above <sup>2)</sup>		Below <sup>2), 3)</sup>		Between <sup>2)</sup>	
	mm	in	mm	in	mm	in
R1	150	5.91	86	3.39	30/200	1.18/7.87
R2	150	5.91	86	3.39	30/200	1.18/7.87
R3	200	7.87	53	2.09	30/200	1.18/7.87
R4	30	1.18	200	7.87	30/200	1.18/7.87
R5	30	1.18	200	7.87	30/200	1.18/7.87

1) **Note:** Horizontal installation meets IP20 requirements only.

2) For definition, see the figure on page 62

3) Free space below is always measured from the drive frame, not from the cable box.

Frame size	Free space, IP55 (UL Type 12)											
	Vertical mounting stand alone						Vertical mounting side by side					
	Above		Below		Beside		Above		Below <sup>1)</sup>		Between	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
R1	137	5.39	116	4.57	150	5.91	200	7.87	200	7.87	0	0
R2	137	5.39	116	4.57	150	5.91	200	7.87	200	7.87	0	0
R3	200	7.87	53	2.09	150	5.91	200	7.87	200	7.87	0	0
R4	53	2.09	200	7.87	150	5.91	200	7.87	200	7.87	0	0
R5	100	3.94	200	7.87	150	5.91	200	7.87	200	7.87	0	0
R6	155	6.10	300	11.8	150	5.91	200	7.87	300	11.8	0	0
R7	155	6.10	300	11.8	150	5.91	200	7.87	300	11.8	0	0
R8	155	6.10	300	11.8	150	5.91	200	7.87	300	11.8	0	0
R9	200	7.87	300	11.8	150	5.91	200	7.87	300	11.8	0	0

1) Free space below is always measured from the drive frame, not from the cable box.

Frame size	Free space, IP55 (UL Type 12) <sup>1)</sup>					
	Horizontal mounting					
	Above <sup>2)</sup>		Below <sup>2), 3)</sup>		Between <sup>2)</sup>	
	mm	in	mm	in	mm	in
R1	150	5.91	86	3.39	30/200	1.18/7.87
R2	150	5.91	86	3.39	30/200	1.18/7.87
R3	200	7.87	53	2.09	30/200	1.18/7.87
R4	30	1.18	200	7.87	30/200	1.18/7.87
R5	30	1.18	200	7.87	30/200	1.18/7.87

1) **Note:** IP55/UL Type 12 drive mounted horizontally meets IP21/ UL Type 1 ratings.

2) For definition, see the figure on page 62

3) Free space below is always measured from the drive frame, not from the cable box.

**Note:** IP55 (UL Type 12) does not imply that the drive can be installed outside/outdoors. To install outside, contact your local ABB representative directly for specific instructions (3AXD10000425906). The warranty will be void if installed outdoors without using these special instructions.

See the figures in section [Installation alternatives \(page 59\)](#).

	Free space, IP66 (UL Type 4X)													
	Weight		Vertical mounting stand alone						Vertical mounting side by side <sup>1)</sup>					
			Above		Below		Beside		Above		Below		Beside	
	kg	lb	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
R1	11.8	26	65	2.6	50	2.0	150	5.9	200	7.9	200	7.9	0	0
R2	14.5	32	65	2.6	50	2.0	150	5.9	200	7.9	200	7.9	0	0
R3	26.4	58	65	2.6	50	2.0	150	5.9	200	7.9	200	7.9	0	0

<sup>1)</sup> Without free space on the sides.

Frame size	Free space, IP66 (UL Type 4X), horizontal mounting								
	Fan side		Cable box side		Above		Below		
	mm	in	mm	in	mm	in	mm	in	
R1	150	5.9	50	2.0	30	1.2	200	7.9	
R2	150	5.9	50	2.0	30	1.2	200	7.9	
R3	200	7.9	50	2.0	30	1.2	200	7.9	

## Losses, cooling data and noise

The air flow direction is from bottom to top.

### ■ Cooling air flow, heat dissipation and noise for stand-alone drives

This table shows typical heat loss values, required air flow and noise at the nominal ratings of the drive. The heat loss values can vary depending on voltage, cable conditions, motor efficiency and power factor. To obtain more accurate values for given conditions, use ABB DriveSize tool

(<http://new.abb.com/drives/software-tools/drivesize>).

### IEC - IP21 and IP55 (UL Type 1 and 12)

ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
3-phase $U_n = 230\text{ V}$						
04A7-2	53	181	43	25	59	R1
06A7-2	72	246	43	25	59	R1
07A6-2	82	280	43	25	59	R1
012A-2	143	488	43	25	59	R1
018A-2	230	785	43	25	59	R1
025A-2	255	870	101	59	64	R2
032A-2	359	1225	101	59	64	R2
047A-2	533	1819	179	105	76	R3
060A-2	781	2665	179	105	76	R3
076A-2	811	2769	159	94	70	R4 v2
089A-2	876	2989	139	82	63	R5
091A-2	917	3129	159	94	70	R4 v2
115A-2	1285	4385	139	82	63	R5
144A-2	1932	6592	435	256	67	R6
171A-2	2000	6824	450	265	67	R7
213A-2	2854	9738	450	265	67	R7
276A-2	3571	12185	550	324	65	R8
3-phase $U_n = 400\text{ or }480\text{ V}$						
02A7-4	44	150	43	25	59	R1
03A4-4	51	174	43	25	59	R1



ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
04A1-4	60	205	43	25	59	R1
05A7-4	85	290	43	25	59	R1
07A3-4	98	334	43	25	59	R1
09A5-4	136	464	43	25	59	R1
12A7-4	213	727	43	25	59	R1
018A-4	240	819	101	59	64	R2
026A-4	383	1307	101	59	64	R2
033A-4	492	1678	179	105	76	R3
039A-4	523	1785	179	105	76	R3
046A-4	672	2293	179	105	76	R3
062A-4	873	2978	134	79	69	R4
062A-4	776	2649	150	88	70	R4 v2
073A-4	1120	3821	134	79	69	R4
073A-4	858	2927	150	88	70	R4 v2
088A-4	1139	3886	139	82	63	R5
089A-4	1028	3507	159	94	70	R4 v2
106A-4	1290	4402	139	82	63	R5
145A-4	1960	6688	435	256	67	R6
169A-4	2021	6896	450	265	67	R7
206A-4	2785	9503	450	265	67	R7
246A-4	3131	10683	550	324	65	R8
293A-4	4071	13891	550	324	65	R8
363A-4	4834	16494	1150	677	68	R9
430A-4	6072	20719	1150	677	68	R9
490A-4	5831	19896	1150	677	68	R9

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

**IEC - IP66 (UL Type 4X)**

ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
3-phase $U_n = 230\text{ V}$						
04A7-2+B063	51	174	43	25	59	R1
06A7-2+B063	70	239	43	25	59	R1
07A6-2+B063	80	273	43	25	59	R1
012A-2+B063	142	485	43	25	59	R1
018A-2+B063	228	778	43	25	59	R1
025A-2+B063	253	863	179	105	64	R2
032A-2+B063	358	1222	179	105	64	R2
047A-2+B063	527	1798	179	105	76	R3
060A-2+B063	775	2644	179	105	76	R3
3-phase $U_n = 400\text{ or }480\text{ V}$						
02A7-4+B063	42	143	43	25	59	R1
03A4-4+B063	50	171	43	25	59	R1
04A1-4+B063	59	201	43	25	59	R1
05A7-4+B063	83	283	43	25	59	R1
07A3-4+B063	97	331	43	25	59	R1
09A5-4+B063	135	461	43	25	59	R1
12A7-4+B063	211	720	43	25	59	R1
018A-4+B063	238	812	179	105	64	R2
026A-4+B063	382	1303	179	105	64	R2
033A-4+B063	486	1658	179	105	76	R3
039A-4+B063	517	1764	179	105	76	R3
046A-4+B063	667	2276	179	105	76	R3

<sup>1)</sup> When disconnect option is included, add 5 W (17 BTU/h) for R1 and R2; add 12 W for R3 (41 BTU/h)

**UL (NEC) - IP21 and IP55 (UL Type 1 and 12)**

ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz						
04A6-2	50	171	43	25	59	R1
06A6-2	69	235	43	25	59	R1
07A5-2	79	270	43	25	59	R1
10A6-2	120	409	43	25	59	R1
017A-2	203	693	43	25	59	R1
024A-2	247	843	101	59	64	R2
031A-2	348	1187	101	59	64	R2
046A-2	518	1767	179	105	76	R3
059A-2	762	2600	179	105	76	R3
075A-2	809	2760	288	170	69	R4
075A-2	804	2745	159	94	70	R4 v2
088A-2	861	2938	139	82	63	R5
090A-2	918	3132	159	94	70	R4 v2
114A-2	1268	4327	139	82	63	R5
143A-2	1916	6538	435	256	67	R6
169A-2	1965	6705	450	265	67	R7
211A-2	2809	9585	450	265	67	R7
273A-2	3518	12004	550	324	65	R8
343A-2	2547	8691	1150	677	68	R9
396A-2	3060	10441	1150	677	68	R9
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz						
02A1-4	37	126	43	25	59	R1
03A0-4	47	160	43	25	59	R1
03A5-4	52	177	43	25	59	R1
04A8-4	71	242	43	25	59	R1
07A6-4	103	351	43	25	59	R1
012A-4	200	682	43	25	59	R1
014A-4	238	812	101	59	64	R2

ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
023A-4	342	1167	101	59	64	R2
027A-4	386	1317	179	105	76	R3
034A-4	446	1522	179	105	76	R3
044A-4	656	2238	179	105	76	R3
052A-4	671	2290	134	79	69	R4
052A-4	618	2109	150	88	70	R4 v2
065A-4	719	2453	134	79	69	R4
065A-4	738	2517	150	88	70	R4 v2
077A-4	853	2911	159	94	70	R4 v2
078A-4	941	3211	139	82	63	R5
096A-4	1127	3845	139	82	63	R5
124A-4	1563	5333	435	256	67	R6
156A-4	1815	6193	450	265	67	R7
180A-4	2285	7797	450	265	67	R7
240A-4	3039	10369	550	324	65	R8
260A-4	3398	11594	550	324	65	R8
302A-4	3253	11100	1150	677	68	R9
361A-4	4836	16501	1150	677	68	R9
414A-4	5691	19418	1150	677	68	R9
477A-4	5598	19101	1150	677	68	R9
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz						
02A7-6	66	225	101	59	64	R2
03A9-6	84	287	101	59	64	R2
06A1-6	133	454	101	59	64	R2
09A0-6	174	594	101	59	64	R2
011A-6	228	778	101	59	64	R2
017A-6	322	1099	101	59	64	R2
022A-6	430	1467	179	105	75	R3
027A-6	524	1788	179	105	75	R3
032A-6	619	2112	179	105	75	R3

ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
041A-6	835	2849	139	82	63	R5
052A-6	1024	3494	139	82	63	R5
062A-6	1240	4231	139	82	63	R5
077A-6	1510	5152	139	82	63	R5
099A-6	2061	7032	450	265	67	R7
125A-6	2466	8414	450	265	67	R7
144A-6	3006	10257	550	324	65	R8
192A-6	4086	13942	1150	677	68	R9
242A-6	4896	16706	1150	677	68	R9
271A-6	4896	16706	1150	677	68	R9

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

**UL (NEC) - IP66 (UL Type 4X)**

ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz						
04A6-2+B066	50	171	43	25	59	R1
06A6-2+B066	69	235	43	25	59	R1
07A5-2+B066	79	270	43	25	59	R1
10A6-2+B066	120	409	43	25	59	R1
017A-2+B066	203	693	43	25	59	R1
024A-2+B066	247	843	179	105	64	R2
031A-2+B066	348	1187	179	105	64	R2
046A-2+B066	518	1767	179	105	76	R3
059A-2+B066	762	2600	179	105	76	R3
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz						
02A1-4 +B066	37	126	43	25	59	R1
03A0-4 +B066	47	160	43	25	59	R1
03A5-4 +B066	52	177	43	25	59	R1
04A8-4 +B066	71	242	43	25	59	R1
07A6-4 +B066	103	351	43	25	59	R1
012A-4 +B066	200	682	43	25	59	R1
014A-4 +B066	238	812	179	105	64	R2
023A-4 +B066	342	1167	179	105	64	R2
027A-4 +B066	386	1317	179	105	76	R3
034A-4 +B066	446	1522	179	105	76	R3
044A-4 +B066	656	2238	179	105	76	R3
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz						
02A7-6 +B066	66	225	179	105	64	R2
03A9-6 +B066	84	287	179	105	64	R2
06A1-6 +B066	133	454	179	105	64	R2
09A0-6 +B066	174	594	179	105	64	R2
011A-6 +B066	228	778	179	105	64	R2
017A-6 +B066	322	1099	179	105	64	R2

ACQ580-01-...	Typical heat dissipation <sup>1)</sup>		Air flow		Noise	Frame size
	W	BTU/h	m <sup>3</sup> /h	CFM	dB(A)	
022A-6 +B066	430	1467	179	105	75	R3
027A-6 +B066	524	1788	179	105	75	R3
032A-6 +B066	619	2112	179	105	75	R3

<sup>1)</sup> When disconnect and fuse option is included, add 8 W (27 BTU/h) for R1; 11 W (38 BTU/h) for R2; 24 W (82 BTU/h) for R3

### ■ Cooling air flow and heat dissipation for flange mounting (option +C135)

Flange mounting kit is ordered separately in North America, not with a plus code.

### IEC - IP21 and IP55 (UL Type 1 and 12)

ACQ580-01-...	Heat dissipation (+C135)		Air flow (+C135)				Frame size
	Heatsink	Front	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
3-phase $U_n = 400$ or $480$ V							
02A7-4	20	23	TBA	TBA	TBA	TBA	R1
03A4-4	28	23	TBA	TBA	TBA	TBA	R1
04A1-4	36	23	TBA	TBA	TBA	TBA	R1
05A7-4	60	23	TBA	TBA	TBA	TBA	R1
07A3-4	72	24	TBA	TBA	TBA	TBA	R1
09A5-4	109	25	TBA	TBA	TBA	TBA	R1
12A7-4	181	28	TBA	TBA	TBA	TBA	R1
018A-4	192	43	TBA	TBA	TBA	TBA	R2
026A-4	322	54	TBA	TBA	TBA	TBA	R2
033A-4	418	71	TBA	TBA	TBA	TBA	R3
039A-4	439	82	TBA	TBA	TBA	TBA	R3
046A-4	578	92	TBA	TBA	TBA	TBA	R3
062A-4	729	127	TBA	TBA	TBA	TBA	R4
062A-4	661	105	TBA	TBA	TBA	TBA	R4 v2
073A-4	947	151	TBA	TBA	TBA	TBA	R4

ACQ580-01-...	Heat dissipation (+C135)		Air flow (+C135)				Frame size
	Heatsink	Front	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
073A-4	728	118	TBA	TBA	TBA	TBA	R4 v2
088A-4	977	141	TBA	TBA	TBA	TBA	R5
089A-4	858	151	TBA	TBA	TBA	TBA	R4 v2
106A-4	1099	165	TBA	TBA	TBA	TBA	R5
145A-4	1733	188	435	256	52	31	R6
169A-4	1758	223	450	265	75	44	R7
206A-4	2464	266	450	265	75	44	R7
246A-4	2743	326	550	324	120	71	R8
293A-4	3601	391	550	324	120	71	R8
363A-4	4220	524	1150	677	170	100	R9
430A-4	5330	623	1150	677	170	100	R9
490A-4	5190	713	1150	677			

**IEC - IP66 (UL Type 4X)**

ACQ580-01-...	Heat dissipation (+C135)		Air flow (+C135)				Frame size
	Heatsink	Front <sup>1)</sup>	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
3-phase $U_n = 230\text{ V}$							
04A7-2+B063	53	12	34	20	0	0	R1
06A7-2+B063	72	12	34	20	0	0	R1
07A6-2+B063	82	12	34	20	0	0	R1
012A-2+B063	144	12	34	20	0	0	R1
018A-2+B063	230	12	34	20	0	0	R1
025A-2+B063	269	12	135	79	0	0	R2
032A-2+B063	374	12	135	79	0	0	R2
047A-2+B063	533	12	161	95	0	0	R3
060A-2+B063	781	12	161	95	0	0	R3
3-phase $U_n = 400\text{ or }480\text{ V}$							



ACQ580-01-...	Heat dissipation (+C135)		Air flow (+C135)				Frame size
	Heatsink	Front <sup>1)</sup>	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
02A7-4+B063	44	12	34	20	0	0	R1
03A4-4+B063	51	12	34	20	0	0	R1
04A1-4+B063	60	12	34	20	0	0	R1
05A7-4+B063	85	12	34	20	0	0	R1
07A3-4+B063	98	12	34	20	0	0	R1
09A5-4+B063	136	12	34	20	0	0	R1
12A7-4+B063	213	12	34	20	0	0	R1
018A-4+B063	254	12	135	79	0	0	R2
026A-4+B063	397	12	135	79	0	0	R2
033A-4+B063	492	12	161	95	0	0	R3
039A-4+B063	523	12	161	95	0	0	R3
046A-4+B063	672	12	161	95	0	0	R3

<sup>1)</sup> When the disconnect option is included, add 5 W (17 BTU/h) for R1 and R2; add 12 W for R3 (41 BTU/h).

### UL (NEC) - IP21 and IP55 (UL Type 1 and 12)

ACQ580-01-...	Heat dissipation (with flange kit)		Air flow (with flange kit)				Frame size
	Heatsink	Front	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
3-phase $U_1 = 440 \dots 480 \text{ V}$ , $P_n$ at $U_n = 480 \text{ V}$ , 60 Hz							
02A1-4	20	23	TBA	TBA	TBA	TBA	R1
03A0-4	28	23	TBA	TBA	TBA	TBA	R1
03A5-4	36	23	TBA	TBA	TBA	TBA	R1
04A8-4	60	23	TBA	TBA	TBA	TBA	R1
06A0-4	72	24	TBA	TBA	TBA	TBA	R1
07A6-4	109	25	TBA	TBA	TBA	TBA	R1
012A-4	181	28	TBA	TBA	TBA	TBA	R1
014A-4	192	43	TBA	TBA	TBA	TBA	R2
023A-4	322	54	TBA	TBA	TBA	TBA	R2

ACQ580-01-...	Heat dissipation (with flange kit)		Air flow (with flange kit)				Frame size
	Heatsink	Front	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
027A-4	418	71	TBA	TBA	TBA	TBA	R3
034A-4	439	82	TBA	TBA	TBA	TBA	R3
044A-4	578	92	TBA	TBA	TBA	TBA	R3
052A-4	729	127	TBA	TBA	TBA	TBA	R4
052A-4	518	94	TBA	TBA	TBA	TBA	R4 v2
065A-4	947	151	TBA	TBA	TBA	TBA	R4
065A-4	621	109	TBA	TBA	TBA	TBA	R4 v2
077A-4	707	130	TBA	TBA	TBA	TBA	R4 v2
078A-4	977	141	TBA	TBA	TBA	TBA	R5
096A-4	1099	165	TBA	TBA	TBA	TBA	R5
124A-4	1733	188	435	256	52	31	R6
156A-4	1758	223	450	265	75	44	R7
180A-4	2464	266	450	265	75	44	R7
240A-4	2743	326	550	324	120	71	R8
260A-4	3601	391	550	324	120	71	R8
302A-4	2849	340	1150	677	170	100	R9
361A-4	4220	524	1150	677	170	100	R9
414A-4	5330	623	1150	677	170	100	R9
477A-4	5190	713	1150	677	170	100	R9

**UL (NEC) - IP66 (UL Type 4X)**

ACQ580-01-...	Heat dissipation (+C135)		Air flow (+C135)				Frame size
	Heatsink	Front <sup>1)</sup>	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
3-phase $U_1 = 200...240$ V, $P_N$ at $U_N = 208/230$ V, 60 Hz							
04A6-2+B066	50	12	34	20	0	0	R1
06A6-2+B066	69	12	34	20	0	0	R1
07A5-2+B066	79	12	34	20	0	0	R1

ACQ580-01-...	Heat dissipation (+C135)		Air flow (+C135)				Frame size
	Heatsink	Front <sup>1)</sup>	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
10A6-2+B066	120	12	34	20	0	0	R1
017A-2+B066	203	12	34	20	0	0	R1
024A-2+B066	247	12	135	79	0	0	R2
031A-2+B066	348	12	135	79	0	0	R2
046A-2+B066	518	12	161	95	0	0	R3
059A-2+B066	762	12	161	95	0	0	R3
3-phase $U_1 = 440 \dots 480$ V, $P_n$ at $U_n = 480$ V, 60 Hz							
02A1-4 +B066	37	12	34	20	0	0	R1
03A0-4 +B066	47	12	34	20	0	0	R1
03A5-4 +B066	52	12	34	20	0	0	R1
04A8-4 +B066	71	12	34	20	0	0	R1
07A6-4 +B066	103	12	34	20	0	0	R1
012A-4 +B066	200	12	34	20	0	0	R1
014A-4 +B066	238	12	135	79	0	0	R2
023A-4 +B066	342	12	135	79	0	0	R2
027A-4 +B066	386	12	161	95	0	0	R3
034A-4 +B066	446	12	161	95	0	0	R3
044A-4 +B066	656	12	161	95	0	0	R3
3-phase $U_1 = 525 \dots 600$ V, $P_n$ at $U_n = 575$ V, 60 Hz							
02A7-6 +B066	66	12	135	79	0	0	R2
03A9-6 +B066	84	12	135	79	0	0	R2
06A1-6 +B066	133	12	135	79	0	0	R2
09A0-6 +B066	174	12	135	79	0	0	R2
011A-6 +B066	228	12	135	79	0	0	R2
017A-6 +B066	322	12	135	79	0	0	R2
022A-6 +B066	430	12	161	95	0	0	R3
027A-6 +B066	524	12	161	95	0	0	R3

ACQ580-01-...	Heat dissipation (+C135)		Air flow (+C135)				Frame size
	Heatsink	Front <sup>1)</sup>	Heatsink		Front		
	W	W	m <sup>3</sup> /h	CFM	m <sup>3</sup> /h	CFM	
032A-6 +B066	619	12	161	95	0	0	R3

<sup>1)</sup> When the disconnect and fuse option is included, add 8 W (27 BTU/h) for R1; 11 W (38 BTU/h) for R2 and 24 W (82 BTU/h) for R3.

## Terminal and entry data for the power cables

### ■ IEC

Input (except IP66 (UL Type 4X) with disconnect), motor, resistor and DC cable entries, maximum wire sizes (per phase) and terminal screw sizes and tightening torques (T) are given below.

Frame size	Cable entries		L1, L2, L3, T1/U, T2/V, T3/W terminals			Grounding terminals	
	Per cable type	∅ <sup>1)</sup>	Min wire size (solid/stranded) <sup>2)</sup>	Max wire size (solid/stranded)	T	Max wire size	T
	pcs	mm	mm <sup>2</sup>	mm <sup>2</sup>	N-m	mm <sup>2</sup>	N-m
3-phase $U_n = 230\text{ V}$							
R1	1	30	0.2/0.2	6/4	1.0	16/16	1.5
R2	1	30	0.5/0.5	16/16	1.5	16/16	1.5
R3	1	30	0.5/0.5	35/35	3.5	35/35	1.5
R4 v2	1	45	1.5/1.5	70	5.5	35/35	2.9
R5	1	45	6	70	15	35/35	2.2
R6	1	45	25	150	30	180	9.8
R7	1	54	95	240	40	180	9.8
R8	2	45	2×50	2×150	40	180	9.8
3-phase $U_n = 400\text{ or }480\text{ V}$							
R1	1	30	0.2/0.25	6/4	1.0	16/16	1.5
R2	1	30	0.5/0.5	16/16	1.5	16/16	1.5
R3	1	30	0.5/0.5	35/25	3.5	35/35	1.5
R4	1	45	0.5/0.5	50	4.0	35/35	2.9
R4 v2	1	45	1.5/1.5	70	5.5	35/35	2.9

Frame size	Cable entries		L1, L2, L3, T1/U, T2/V, T3/W terminals			Grounding terminals	
	Per cable type	Ø <sup>1)</sup>	Min wire size (solid/stranded) <sup>2)</sup>	Max wire size (solid/stranded)	T	Max wire size	T
	pcs	mm	mm <sup>2</sup>	mm <sup>2</sup>	N·m	mm <sup>2</sup>	N·m
R5	1	45	6	70	15	35/35 <sup>3)</sup>	2.2
R6	1	45	25	150	30	185 <sup>3)</sup>	9.8
R7	1	54	95	240	40	185 <sup>3)</sup>	9.8
R8	2	45	2×50	2×150	40	2×185 <sup>3)</sup>	9.8
R9	2	54	2×95	2×240	70	2×185 <sup>3)</sup>	9.8

1) Maximum cable diameter accepted. For the entry plate hole diameters, see chapter [Dimension drawings](#) (page 361).

2) **Note:** Minimum wire size does not necessarily have enough current capability for full load. Make sure the installation complies with local laws and regulations.

3) **Note:** Either cable lug (R5, see page 150) or clamp (R6...R9, see page 153) is used for grounding.

For IP66 (UL Type 4X) with disconnect option, input cable entries, maximum wire sizes (per phase), terminal screw sizes and tightening torques (T) are given below.

Frame size	Cable entries		2T1, 4T2, 6T3 Terminals			Grounding terminals	
	Per cable type	Ø <sup>1)</sup>	Min. wire size (solid/stranded) <sup>2)</sup>	Max. wire size (solid/stranded)	T	Cable lug <sup>3)</sup>	T
	pcs	mm	mm <sup>2</sup>	mm <sup>2</sup>	N·m	mm <sup>2</sup>	N·m
3-phase $U_n = 230\text{ V}$							
R1	1	32	2.5	25	6.2	2.5 10 35	2.9
R2	1	32	2.5	25	6.2		3.3
R3	1	40	2.5	25	6.2		3.8
3-phase $U_n = 400\text{ or }480\text{ V}$							

Frame size	Cable entries		2T1, 4T2, 6T3 Terminals			Grounding terminals	
	Per cable type	Ø <sup>1)</sup>	Min. wire size (solid/stranded) <sup>2)</sup>	Max. wire size (solid/stranded)	T	Cable lug <sup>3)</sup>	T
	pcs	mm	mm <sup>2</sup>	mm <sup>2</sup>	N-m	mm <sup>2</sup>	N-m
R1	1	32	2.5	25	6.2	2.5 10 35	2.9
R2	1	32	2.5	25	6.2		3.3
R3	1	40	2.5	25	6.2		3.8

1) Maximum cable diameter accepted. For the entry plate hole diameters, see chapter [Dimension drawings \(page 361\)](#)

2) **Note:** Minimum wire size does not necessarily have enough current ampacity for full load. Make sure the installation complies with local laws and regulations.

3) Same ground lug for all three frame sizes capable of clamping solid or stranded wires from 2.5 to 35 mm (14 to 2 ga). Different wire sizes require different tightening torque as shown in table.

**Note:** For the tightening torques of the grounding terminals, see sections [Connection procedure, frames R1...R4 \(page 138\)](#), [Connection procedure, frame R5 \(page 146\)](#) and [Connection procedure, frames R6...R9 \(page 151\)](#).

Frame size	Cable entries		R+, R-, UDC+ and UDC- terminals			
	Per cable type	Ø <sup>1)</sup>	Min wire size (solid/stranded) <sup>2)</sup>	Max wire size (solid/stranded)	T (Wire screw)	
	pcs	mm	mm <sup>2</sup>	mm <sup>2</sup>	Screw/Bolt	N-m
3-phase $U_n = 230$ V						
R1	1	23	0.2/0.2	6/4	3)	1.0
R2	1	23	0.5/0.5	16/16	3)	1.5
R3	1	30	0.5/0.5	35/35	3)	3.5
R4 v2	1	39	1.5/1.5	70	M5	5.5
R5	1	39	6	70	M5	15
R6	1	45	25	150	M8	30
R7	1	54	95	240	M10	30
R8	2	45	2×50	2×150	M10	40
3-phase $U_n = 400$ or $480$ V						

Frame size	Cable entries		R+, R-, UDC+ and UDC- terminals			
	Per cable type	Ø <sup>1)</sup>	Min wire size (solid/stranded) <sup>2)</sup>	Max wire size (solid/stranded)	T (Wire screw)	
	pcs	mm	mm <sup>2</sup>	mm <sup>2</sup>	Screw/Bolt	N-m
R1	1	23	0.20/0.25	6/4	3)	1.0
R2	1	23	0.5/0.5	16/16	3)	1.5
R3	1	23	0.5/0.5	35/25	3)	3.5
R4	1	39	0.5/0.5	50	3)	4.0
R4 v2	1	39	1.5/1.5	70	3)	5.5
R5	1	39	6	70	M5	15
R6	1	45	25	150	M8	30
R7	1	54	95	240	M10	30
R8	2	45	2×50	2×150	M10	40
R9	2	54	2×95	2×240	M12	70

1) Maximum cable diameter accepted. For the entry plate hole diameters, see chapter [Dimension drawings](#) (page 361).

2) **Note:** Minimum wire size does not necessarily have enough current capacity for full load. Make sure the installation complies with local laws and regulations.

3) Either cable lug (R5) or clamp (R6...R9) is used for grounding.

Frame size	Screwdrivers for the terminals of the main circuit
R1	Combo: Slot 4 mm and PH1
R2	Combo: Slot 4.5 mm and PH2
R3, R4	PH2
R4 v2	Torx

## ■ UL (NEC)

Input (except IP66 (UL Type 4X) with disconnect), motor, resistor and DC cable entries, maximum wire sizes (per phase) and terminal screw sizes and tightening torques (7) are given below.

Frame size	Cable entries		L1, L2, L3, T1/U, T2/V, T3/W terminals			Grounding terminals		
	Per cable type	Ø <sup>1)</sup>	Wire range (stranded/solid) <sup>2)</sup>		T	Wire range (stranded/solid)		T
			Min	Max		Min	Max	
	pcs	in	AWG	AWG	lbf·ft	AWG	AWG	lbf·ft
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz								
R1	1	1.38	24	10	0.7	18	6	1.1
R2	1	1.38	20	6	1.1	18	6	1.1
R3	1	1.73	20	2	2.6	18	2	1.1
R4	1	1.98	20	1	3.0	12	2	2.1
R4v2	1	2.01	20	1	4.0	12	2	2.1
R5	1	2.01	6	1/0	11.1	3)	3)	1.6
R6	1	2.44	4	300 MCM	22.1	3)	350 MCM	7.2
R7	1	2.99	3/0	500 MCM	29.5	3)	350 MCM	7.2
R8	2	2.44	2×1/0	2×300 MCM	29.5	3)	2×350 MCM	7.2
R9	2	2.44	2×3/0	2×500 MCM	51.6	3)	2×350 MCM	7.2
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz								
R1	1	1.38	24	10	0.7	18	6	1.1
R2	1	1.38	20	6	1.1	18	6	1.1
R3	1	1.73	20	2	2.6	18	2	1.1
R4	1	1.98	20	1	3.0	12	2	2.1
R4v2	1	2.01	20	1	4.0	12	2	2.1
R5	1	2.01	6	1/0	11.1	3)	3)	1.6
R6	1	2.44	4	300 MCM	22.1	3)	350 MCM	7.2
R7	1	2.99	3/0	500 MCM	29.5	3)	350 MCM	7.2
R8	2	2.44	2×1/0	2×300 MCM	29.5	3)	2×350 MCM	7.2
R9	2	2.44	2×3/0	2×500 MCM	51.6	3)	2×350 MCM	7.2
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz								
R2	1	1.38	20	6	1.1	18	6	1.1
R3	1	1.73	20	2	2.6	18	2	1.1



Frame size	Cable entries		L1, L2, L3, T1/U, T2/V, T3/W terminals			Grounding terminals		
	Per cable type	Ø <sup>1)</sup>	Wire range (stranded/solid) <sup>2)</sup>		T	Wire range (stranded/solid)		T
			Min	Max		Min	Max	
	pcs	in	AWG	AWG	lbf·ft	AWG	AWG	lbf·ft
R5	1	2.01	6	1/0	11.1	3)	3)	1.6
R7	1	2.99	4	300 MCM	29.5	3)	350 MCM	7.2
R8	2	2.44	2×1/0	2×300 MCM	29.5	3)	2×350 MCM	7.2
R9	2	2.44	2×3/0	2×500 MCM	51.6	3)	2×350 MCM	7.2

1) Diameter of the cable entry plate hole.

2) **Note:** Minimum wire size does not necessarily have enough current capability for full load. Make sure the installation complies with local laws and regulations.

3) Either cable lug, not provided (R5) or cable clamp (R6...R9) is used for grounding.

For IP66 (UL Type 4X) with disconnect option, input cable entries, maximum wire sizes (per phase), terminal screw sizes and tightening torques (T) are given below.

Frame size	Cable entries		2T1, 4T2, 6T3 Terminals			Grounding terminals		
	Per cable type	Ø <sup>1)</sup>	Min. wire size (solid/stranded) <sup>2)</sup>	Max. wire size (solid/stranded)	T	Cable lug <sup>3)</sup>	T	
								pcs
3-phase $U_1 = 200...240$ V, $P_N$ at $U_N = 208/230$ V, 60 Hz								
R1	1	0.87 <sup>4)</sup>	14	4	4.6	14	4.0	
R2	1	0.87 <sup>4)</sup>	14	4	4.6		8	4.5
R3	1	1.12 <sup>5)</sup>	14	4	4.6		2	5.1
3-phase $U_1 = 440...480$ V, $P_N$ at $U_N = 480$ V, 60 Hz								
R1	1	0.87 <sup>4)</sup>	14	4	4.6	14	4.0	
R2	1	0.87 <sup>4)</sup>	14	4	4.6		8	4.5
R3	1	1.12 <sup>5)</sup>	14	4	4.6		2	5.1
3-phase $U_1 = 525...600$ V, $P_N$ at $U_N = 575$ V, 60 Hz								

Frame size	Cable entries		2T1, 4T2, 6T3 Terminals			Grounding terminals	
	Per cable type	∅ <sup>1)</sup>	Min. wire size (solid/stranded) <sup>2)</sup>	Max. wire size (solid/stranded)	T	Cable lug <sup>3)</sup>	T
		pcs					
R1	1	0.87 <sup>4)</sup>	14	4	4.6	14	4.0
R2	1	0.87 <sup>4)</sup>	14	4	4.6	8	4.5
R3	1	1.12 <sup>5)</sup>	14	4	4.6	2	5.1

- 1) Diameter of the cable entry plate hole.
- 2) **Note:** Minimum wire size does not necessarily have enough current ampacity for full load. Make sure the installation complies with local laws and regulations.
- 3) Same ground lug for all three frame sizes capable of clamping solid or stranded wires from 14 to 2 ga (2.5 to 35 mm). Different wire sizes require different tightening torque as shown in table
- 4) 1/2" conduit. Hole size can be increased to 1.38 in. (1" conduit)
- 5) 3/4" conduit. Hole size can be increased to 2.0 in. (1-1/2" conduit)

**Note:** For the tightening torques of the grounding terminals, see sections [Connection procedure, frames R1...R4 \(page 184\)](#), [Connection procedure, frame R5 \(page 192\)](#) and [Connection procedure, frames R6...R9 \(page 196\)](#).

Frame size	Cable entries		R+, R-, UDC+ and UDC- terminals			
	Per cable type	∅ <sup>1)</sup>	Wire range size (stranded/solid) <sup>2)</sup>		T	
		pcs	in	Min	Max	Screw/Bolt
			AWG	AWG		
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz						
R1	1	1.11	24	10	3)	0.7
R2	1	1.11	20	6	3)	1.1
R3	1	1.38	20	2	3)	2.6
R4	1	1.73	20	1	3)	3.0
R4 v2	1	1.73	20	1	3)	4.1
R5	1	1.73	6	1/0	M5	11.1
R6	1	1.97	4	300 MCM	M8	22.1
R7	1	2.44	3/0	500 MCM	M10	29.5
R8	2	2.44	2×1/0	2×300 MCM	M10	29.5

Frame size	Cable entries		R+, R-, UDC+ and UDC- terminals			
	Per cable type	$\varnothing$ <sup>1)</sup>	Wire range size (stranded/solid) <sup>2)</sup>		T	
			Min	Max	Screw/Bolt	lbf-ft
	pcs	in	AWG	AWG		
R9	2	2.44	2×3/0	2×500 MCM	M12	51.6
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz						
R1	1	1.11	24	10	3)	0.7
R2	1	1.11	20	6	3)	1.1
R3	1	1.38	20	2	3)	2.6
R4	1	1.73	20	1	3)	3.0
R4 v2	1	1.73	20	1	3)	4.1
R5	1	1.73	6	1/0	M5	11.1
R6	1	1.97	4	300 MCM	M8	22.1
R7	1	2.44	3/0	500 MCM	M10	29.5
R8	2	2.44	2×1/0	2×300 MCM	M10	29.5
R9	2	2.44	2×3/0	2×500 MCM	M12	51.6
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz						
R2	1	1.11	20	6	3)	1.1
R3	1	1.38	20	2	3)	2.6
R5	1	1.73	6	1/0	M5	11.1
R7	1	2.44	3/0	500 MCM	M10	29.5
R8	2	2.44	2×1/0	2×300 MCM	M10	29.5
R9	2	2.44	2×3/0	2×500 MCM	-	51.6

1) Diameter of the cable entry plate hole.

2) **Note:** Minimum wire size does not necessarily have enough current capability for full load. Make sure the installation complies with local laws and regulations.

3) See the table below

Frame size	Screwdrivers for the terminals of the main circuit
R1	Combo: Slot 4 mm and PH1
R2	Combo: Slot 4.5 mm and PH2
R3, R4	PH2
R4 v2	Torx

## Power cables

### ■ Typical power cables, IEC

The table below gives copper cable types with concentric copper shield for the drives with nominal current. The value separated by the plus sign means the diameter of the PE conductor.

See page 324 for the cable entry sizes allowed for the selected drive frame size (except IP66 (UL Type 4X) drives with disconnect option (+F253)).

ACQ580-01-...	Frame size	Cu cable type <sup>1)</sup>	Al cable type <sup>1), 2)</sup>
		mm <sup>2</sup>	mm <sup>2</sup>
3-phase $U_n = 230\text{ V}$			
04A7-2	R1	3×1.5 + 1.5	-
06A7-2	R1	3×1.5 + 1.5	-
07A6-2	R1	3×1.5 + 1.5	-
012A-2	R1	3×1.5 + 1.5	-
018A-2	R1	3×2.5 + 2.5	-
025A-2	R2	3×4.0 + 4.0	-
032A-2	R2	3×6.0 + 6.0	-
047A-2	R3	3×10 + 10	-
060A-2	R3	3×16 + 16	-
076A-2	R4 v2	3×35 + 16	-
089A-2	R5	3×35 + 16	3×50 + 25
091A-2	R4 v2	3×50 + 25	3×70 + 35
115A-2	R5	3×50 + 25	3×70 + 35
144A-2	R6	3×70 + 35	3×120 + 70
171A-2	R7	3×95 + 50	3×150 + 70
213A-2	R7	3×120 + 70	3×240 + 120
276A-2	R8	2×(3×70 + 35)	2×(3×95 + 50)
3-phase $U_n = 400\text{ V}$			
02A7-4	R1	3×1.5 + 1.5	-
03A4-4	R1	3×1.5 + 1.5	-
04A1-4	R1	3×1.5 + 1.5	-
05A7-4	R1	3×1.5 + 1.5	-

ACQ580-01-...	Frame size	Cu cable type <sup>1)</sup>	Al cable type <sup>1), 2)</sup>
		mm <sup>2</sup>	mm <sup>2</sup>
07A3-4	R1	3×1.5 + 1.5	-
09A5-4	R1	3×2.5 + 2.5	-
12A7-4	R1	3×2.5 + 2.5	-
018A-4	R2	3×2.5 + 2.5	-
026A-4	R2	3×6 + 6	-
033A-4	R3	3×10 + 10	-
039A-4	R3	3×10 + 10	-
046A-4	R3	3×10 + 10	-
062A-4	R4, R4 v2	3×25 + 16	-
073A-4	R4, R4 v2	3×35 + 16	-
088A-4	R5	3×50 + 25	-
089A-4	R4 v2	3×50 + 25	-
106A-4	R5	3×70 + 35	-
145A-4	R6	3×95 + 50	-
169A-4	R7	3×120 + 70	-
206A-4	R7	3×150 + 70	-
246A-4	R8	2×(3×70+35)	-
293A-4	R8	2×(3×95+50)	-
363A-4	R9	2×(3×120+70)	-
430A-4	R9	2×(3×150+70)	-
490A-4	R9	2×(3×240+120)	-

1) The cable sizing is based on max. 6 cables laid on a cable ladder side by side, ambient temperature 30 °C, PVC insulation, surface temperature 70 °C (EN 60204-1 and IEC 60364- 5-52/2001). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive. See page 324 for the accepted cable sizes of the drive.

2) Aluminum cables can be used with  $U_n = 230$  V frames R5...R8 only.

### IP66 (UL Type 4X) with disconnect option (+F253)

ACQ580-01-...	Frame size	Cu cable type <sup>1)</sup>	Note
		mm <sup>2</sup>	
3-phase $U_n = 230$ V			
04A7-2	R1	3×6.0 + 6.0	2)

ACQ580-01-...	Frame size	Cu cable type <sup>1)</sup>	Note
		mm <sup>2</sup>	
06A7-2	R1	3×6.0 + 6.0	2)
07A6-2	R1	3×6.0 + 6.0	2)
012A-2	R1	3×6.0 + 6.0	2)
018A-2	R1	3×6.0 + 6.0	2)
025A-2	R2	3×6.0 + 6.0	3)
032A-2	R2	3×6.0 + 6.0	-
047A-2	R3	3×10 + 10	-
060A-2	R3	3×16 + 16	-
3-phase $U_n = 400$ V			
02A7-4	R1	3×6.0 + 6.0	2)
03A4-4	R1	3×6.0 + 6.0	2)
04A1-4	R1	3×6.0 + 6.0	2)
05A7-4	R1	3×6.0 + 6.0	2)
07A3-4	R1	3×6.0 + 6.0	2)
09A5-4	R1	3×6.0 + 6.0	2)
12A7-4	R1	3×6.0 + 6.0	2)
018A-4	R2	3×6.0 + 6.0	2)
026A-4	R2	3×6.0 + 6.0	-
033A-4	R3	3×10 + 10	-
039A-4	R3	3×10 + 10	-
046A-4	R3	3×10 + 10	-

1) The cable sizing is based on max. 6 cables laid on a cable ladder side by side, ambient temperature 30 °C, PVC insulation, surface temperature 70 °C (EN 60204-1 and IEC 60364- 5-52/2001). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive. See page 324 for the accepted cable sizes of the drive.

2) While 6 mm<sup>2</sup> is typical, minimum 2.5 mm<sup>2</sup> is allowed when acceptable according to note 1.

3) While 6 mm<sup>2</sup> is typical, minimum 4.0 mm<sup>2</sup> is allowed when acceptable according to note 1.

**■ Typical power cables UL (NEC)**

ACQ580-01-...	Frame size	Cu cable type
		AWG/kcmil
3-phase $U_1 = 200...240$ V, $P_n$ at $U_n = 208/230$ V, 60 Hz		
04A6-2	R1	14
06A6-2	R1	14
07A5-2	R1	14
10A6-2	R1	14
017A-2	R1	10
024A-2	R2	8
031A-2	R2	8
046A-2	R3	6
059A-2	R3	4
075A-2	R4, R4 v2	3
090A-2	R4 v2	2
088A-2	R5	2
114A-2	R5	1/0
143A-2	R6	3/0
169A-2	R7	4/0
211A-2	R7	300 MCM
273A-2	R8	2×2/0
343A-2	R9	2×250 MCM
396A-2	R9	2×300 MCM
3-phase $U_1 = 440...480$ V, $P_n$ at $U_n = 480$ V, 60 Hz		
02A1-4	R1	14
03A0-4	R1	14
03A5-4	R1	14
04A8-4	R1	14
06A0-4	R1	14
07A6-4	R1	14
012A-4	R1	14
014A-4	R2	12

ACQ580-01-...	Frame size	Cu cable type
		AWG/kcmil
023A-4	R2	10
027A-4	R3	8
034A-4	R3	8
044A-4	R3	6
052A-4	R4, R4 v2	4
065A-4	R4, R4 v2	4
077A-4	R4 v2	3
078A-4	R5	3
096A-4	R5	1
124A-4	R6	2/0
156A-4	R7	3/0
180A-4	R7	4/0
240A-4	R8	2×1/0 or 350 MCM
260A-4	R8	2×2/0
302A-4	R9	2×3/0
361A-4	R9	2×4/0
414A-4	R9	2×300 MCM
477A-4	R9	2×500 MCM
3-phase $U_1 = 525...600$ V, $P_n$ at $U_n = 575$ V, 60 Hz		
02A7-6	R2	14
03A9-6	R2	14
06A1-6	R2	14
09A0-6	R2	14
011A-6	R2	14
017A-6	R2	10
022A-6	R3	10
027A-6	R3	8
032A-6	R3	8
041A-6	R5	6
052A-6	R5	4



ACQ580-01-...	Frame size	Cu cable type
		AWG/kcmil
062A-6	R5	2
077A-6	R5	2
099A-6	R7	1/0
125A-6	R7	3/0
144A-6	R8	4/0
192A-6	R9	300 MCM
242A-6	R9	500 MCM
271A-6	R9	2×250 MCM

**Temperature:** For IEC, select a cable rated for at least 70 °C maximum permissible temperature of conductor in continuous use. For North America, power cables must be rated for 75 °C (167 °F) or higher.

**Note:** For drives with option +B056 (IP55, UL Type 12), select a cable rated for at least 90 °C (194 °F) maximum permissible temperature of conductor in continuous use.

**Note:** For drives with option +B063 or +B066 (IP66, UL Type 4X), with voltage rating 575 V AC (-6) running above 40 °C ambient temperature, select a cable rated of at least 90 °C (194 °F) maximum permissible temperature of conductor in continuous use.

**Voltage:** 600 V AC cable is accepted for up to 500 V AC.

## Terminal and entry data for the control cables

### ■ IEC

Control cable entries, wire sizes and tightening torques ( $T$ ) are given below.

Frame size	Cable entries		Control cable entries and terminal sizes			
	Holes	Max cable size	+24V, DCOM, DGND, EXT. 24V terminals		DI, AI/O, AGND, RO, STO terminals	
			Wire size	$T$	Wire size	$T$
	pcs	mm	mm <sup>2</sup>	N·m	mm <sup>2</sup>	N·m
R1	3	17	0.2...2.5	0.5...0.6	0.14...1.5	0.5...0.6
R2	3	17	0.2...2.5	0.5...0.6	0.14...1.5	0.5...0.6
R3	3	17	0.2...2.5	0.5...0.6	0.14...1.5	0.5...0.6

## 338 Technical data

Frame size	Cable entries		Control cable entries and terminal sizes			
	Holes	Max cable size	+24V, DCOM, DGND, EXT. 24V terminals		DI, AI/O, AGND, RO, STO terminals	
			Wire size	<i>T</i>	Wire size	<i>T</i>
	pcs	mm	mm <sup>2</sup>	N·m	mm <sup>2</sup>	N·m
R4, R4 v2	4	17	0.2...2.5	0.5...0.6	0.14...1.5	0.5...0.6
R5	3	17	0.2...2.5	0.5...0.6	0.14...1.5	0.5...0.6
R6	4	17	0.14...2.5	0.5...0.6	0.14...2.5	0.5...0.6
R7	4	17	0.14...2.5	0.5...0.6	0.14...2.5	0.5...0.6
R8	4	17	0.14...2.5	0.5...0.6	0.14...2.5	0.5...0.6
R9	4	17	0.14...2.5	0.5...0.6	0.14...2.5	0.5...0.6

## ■ UL (NEC)

Control cable entries, wire sizes and tightening torques (T) are given below.

Frame size	Cable entries		Control cable entries and terminal sizes			
	Holes	Max cable size	+24V, DCOM, DGND, EXT. 24V terminals		DI, AI/O, AGND, RO, STO terminals	
			Wire size	T	Wire size	T
	pcs	in	AWG	lbf-ft	AWG	lbf-ft
R1	3	0.67	24...14	0.4	26...16	0.4
R2	3	0.67	24...14	0.4	26...16	0.4
R3	3	0.67	24...14	0.4	26...16	0.4
R4, R4 v2	4	0.67	24...14	0.4	26...16	0.4
R5	3	0.67	24...14	0.4	26...16	0.4
R6	4	0.67	26...14	0.4	26...16	0.4
R7	4	0.67	26...14	0.4	26...16	0.4
R8	4	0.67	26...14	0.4	26...16	0.4
R9	4	0.67	26...14	0.4	26...14	0.4

## Electrical power network specification

### Voltage ( $U_1$ )

- ACQ580-01-xxxx-2 drives:** Input voltage range 3~208...240 V AC +10%...-15%.  
IEC: This is indicated in the type designation label as typical input voltage levels 3~ 230 V AC.  
North America: This is indicated in the type designation label as typical input voltage levels 1~ 208/230 V AC and 3~ 208/230 V AC.
- ACQ580-01-xxxx-4 drives:** Input voltage range 3~380...480 V AC +10%...-15%.  
 This is indicated in the type designation label as typical input voltage levels 3~ 400/480 V AC.
- ACQ580-01-xxxx-6 drives:** Input voltage range 3~525...600 V AC +10%...-15%.  
 This is indicated in the type designation label as typical input voltage level 3~ 600 V AC.

<b>Network type</b>	<p>Public low voltage networks. Symmetrically grounded TN-S system, IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems, see sections:</p> <p><u>IEC</u>: <a href="#">When to disconnect EMC filter or ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems (page 130)</a> and <a href="#">Guidelines for installing the drive to a TT system (page 131)</a>.</p> <p><u>North America</u>: <a href="#">When to connect EMC filter or disconnect ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems (page 175)</a> and <a href="#">Guidelines for installing the drive to a TT system (page 176)</a>.</p> <p><b>Note:</b> Frames R4 and R5 cannot be used in corner-grounded or midpoint-grounded delta systems.</p>
<b>Rated conditional short-circuit current <math>I_{CC}</math> (IEC 61800-5-1)</b>	Maximum allowable prospective short-circuit current is 65 kA when protected by fuses given in the fuse tables
<b>Maximum prospective short-circuit current rating (SCCR) (UL 61800-5-1, CSA C22.2 No. 274-17)</b>	<p>US and Canada: The drive is suitable for use on a circuit capable of delivering not more than 100 kA symmetrical amperes (rms) at 480 V maximum when protected by fuses given in the fuse table.</p> <p>US and Canada: The drive is suitable for use on a circuit capable of delivering not more than 65 kA symmetrical amperes (rms) maximum when protected by circuit breakers given in the circuit breaker table.</p>
<b>Frequency (<math>f_1</math>)</b>	47 to 63 Hz. This is indicated in the type designation label as typical input frequency level f1 (50/60 Hz).
<b>Imbalance</b>	Max. $\pm$ 3% of nominal phase to phase input voltage
<b>Fundamental power factor (<math>\cos \phi_{11}</math>)</b>	0.98 (at nominal load)

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**Minimum short-circuit power (IEC/EN 61000-3-12)**

The minimum short-circuit power  $S_{sc}$  given for each drive type for the  $R_{sc}$  (transformer short circuit ratio) value of 350. Above 75 A standard IEC/EN 61000-3-12 does not apply.

ACQ580-01-...	Input rating	Min. short circuit power		Frame size
		400 V	480 V	
	$I_1$	Ssc	Ssc	
	A	MVA	MVA	
<b>3-phase <math>U_n = 400</math> V and 480 V, IEC ratings</b>				
02A7-4	2.6	0.6	0.6	R1
03A4-4	3.3	0.8	0.9	R1
04A1-4	4.0	1.0	1.0	R1
05A7-4	5.6	1.4	1.4	R1
07A3-4	7.2	1.8	1.8	R1
09A5-4	9.4	2.3	2.2	R1
12A7-4	12.6	3.1	3.5	R1
018A-4	17.0	4.1	4.1	R2
026A-4	25.0	6.1	6.7	R2
033A-4	32.0	7.8	7.9	R3
039A-4	38.0	9.2	9.9	R3
046A-4	45.0	10.9	12.8	R3
062A-4	62	15.0	15.1	R4, R4 v2
073A-4	73	17.7	18.9	R4, R4 v2

## Motor connection data

**Motor types**

Asynchronous AC induction motors, permanent magnet motors and synchronous reluctance motors

**Short-circuit current protection (IEC/EN 61800-5-1)**

The drive provides solid state short circuit protection for the motor connection per IEC/EN 61800-5-1 and UL 61800-5-1.

**Frequency ( $f_2$ )**

0...598 Hz. This is indicated in the type designation label as output frequency level  $f_2$  (0...598 Hz).

**Frequency resolution**

0.01 Hz

**Current**

See section [Electrical ratings \(page 262\)](#).

**Switching frequency**

R1...R5 drives: 2...12 kHz with 1 kHz steps, factory setting 4 kHz

R6...R9 drives: 1.5 kHz, 2...12 kHz with 1 kHz steps, factory setting 4 kHz

**Maximum recommended motor cable length** **Operational functionality and motor cable length**

The drive is designed to operate with optimum performance with the following maximum motor cable lengths.

**Note:** Conducted and radiated emissions of these motor cable lengths do not comply with EMC requirements.

Frame size	Maximum motor cable length, 4 kHz			
	Scalar control		Vector control	
	m	ft	m	ft
<b>Standard drive, without external options</b>				
R1	100	330	100	330
R2*	200	660	200	660
R3*	300	990	300	990
R4, R4 v2	300	990	300	990
R5	300	990	300	990
R6	300	990	300	990
R7	300	990	300	990
R8	300	990	300	990
R9	300	990	300	990

\*For 600 V drives the maximum motor cable length is 100 m (330 ft) for frame R2 and 200 m (660 ft) for frame R3.

**Note:**

1. In multimotor systems, the calculated sum of all motor cable lengths must not exceed the maximum motor cable length given in the table.
2. Longer motor cables cause a motor voltage decrease which limits the available motor power. The decrease depends on the motor cable length and characteristics. Contact your local ABB representative for more information.
3. When using longer motor cables than 50 m (165 ft), 8...12 kHz switching frequencies are not allowed. With motor cable length over 100 m, disconnect EMC DC screw if applicable.
4. Acceptable motor cable length for motor manufacturers may be different. Check with specific motor manufacturer for maximum allowable distance.

**EMC compatibility and motor cable length**

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

Frame size	Maximum motor cable length, 4 kHz	
	m	ft
<b>EMC limits for Category C2<sup>1)</sup></b>		
<b>Standard drive with an internal EMC filter.</b>		
<b>See notes 1, 2 and 3.</b>		
R1	100	330
R2	100	330
R3	100	330
R4, R4 v2	100	330
R5	100	330
R6	150	492
R7	150	492
R8	150	492
R9	150	492
<b>EMC limits for Category C3<sup>1)</sup></b>		
<b>Standard drive with an internal EMC filter.</b>		
<b>See notes 3 and 4.</b>		
R1	150	492
R2	150	492
R3	150	492
R4, R4 v2	150	492
R5	150	492
R6	150	492
R7	150	492
R8	150	492
R9	150	492

<sup>1)</sup> See the terms in section [Definitions \(page 354\)](#)

**Note:**

1. Radiated and conducted emissions are according to category C2 with an internal EMC filter. The internal EMC filter must be connected.
2. Categories C1 and C2 meet requirements for connecting equipment to the public low-voltage networks.
3. Not applicable to 600 V ratings.
4. Radiated and conducted emissions are according to category C3 with an internal EMC filter. The internal EMC filter must be connected.

## Brake resistor connection data for frames R1...R3

**Short-circuit protection (IEC/EN 61800-5-1, IEC 61439-1)** The brake resistor output is conditionally short-circuit proof by IEC/EN 61800-5-1. Rated conditional short-circuit current as defined in IEC 61439-1.

## Auxiliary circuit power consumption

Maximum external power supply:  
Frames R1...R5: 25 W, 1.04 A at 24 V AC/DC (with option modules CMOD-01, CMOD-02)  
Frames R6...R9: 36 W, 1.50 A at 24 V AC/DC (as standard, terminals 40...41)

## Efficiency

Approximately 98% at nominal power level. The efficiency is not calculated according to IEC 61800-9-2.

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## Energy efficiency data (ecodesign)

Energy efficiency data according to IEC 61800-9-2 is available from the ecodesign tool (<https://ecodesign.drivesmotors.abb.com>). The drive complies with the IE efficiency class IE2.



## Protection classes

Degrees of protection (IEC/EN 60529)	IP21 (standard) IP20 (option +P940, +P944) IP55 (option +B056)
Enclosure types (UL 50/50E)	UL Type 1 UL Open Type (option +P940, +P944) UL Type 12 (option +B056)
Overvoltage category (IEC/EN 60664-1)	III
Protective class (IEC/EN 61800-5-1)	I

## Ambient conditions

Environmental limits for the drive, including installed options, are given below. The drive is to be used in a heated, indoor, controlled environment. IP66 (UL Type 4X) drive can be used outdoors if protected from the heat of the sun and indoors or outdoors in a dusty environment.

	<b>Operation</b> installed for stationary use	<b>Storage</b> in the package	<b>Transportation</b> in the package
<b>Installation site altitude</b>	<ul style="list-style-type: none"> <li>• 0...4000 m (13123 ft) above sea level <sup>1)</sup></li> <li>• 0...2000 m (6561 ft) above sea level <sup>2)</sup></li> </ul> <p>Above 1000 m (3281 ft), see section <a href="#">Altitude derating</a> (page 279).</p>	-	-
<b>Air temperature</b>	<p>-15...+50 °C (5...122 °F). 0...-15 °C (32...5 °F): No frost allowed. See section <a href="#">Electrical ratings</a> (page 262).  Above 40 °C (104 °F) see section <a href="#">Surrounding air temperature derating, IP21 (UL Type1)</a> (page 275).</p>	-40...+70 °C (-40...+158 °F)	-40...+70 °C (-40...+158 °F)
<b>Relative humidity</b>	5...95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% <sup>3)</sup> in the presence of corrosive gases at level C4.		
<b>Contamination levels</b>	IEC 60721-3-3:2019 and ISO9223: ANSI-ISA 71.04	IEC 60721-3-1:2018	IEC 60721-3-2:2018

Chemical gases	Base drive: IEC Class C3 <sup>4)</sup> ANSI G2  +B056/+B063/+B066: IEC Class C4 ANSI G3/GX up to 2300 Å /30d corrosivity	Class 1C2	Class 2C2
	Conformal coated circuit boards as standard on all drives		
Solid particles	Class 3S6. No conductive dust allowed.	Class 1S3 (packaging must be Class 2S2, otherwise this is 1S2)	Class 2S2
<b>Pollution degree</b> (IEC/EN 60664-1) <b>IP66 (UL Type 4X):</b> IEC/EN 61800-5-1 UL 61800-5-1	2  <u>IP66 (UL Type 4X): 4</u>	-	-
<b>Atmospheric pressure</b>	70...106 kPa 0.7...1.05 atmospheres	70...106 kPa 0.7...1.05 atmospheres	60...106 kPa 0.6...1.05 atmospheres
<b>Vibration</b> (IEC 60068-2)	Max. 1 mm (0.04 in) (5...13.2 Hz), max. 7 m/s <sup>2</sup> (23 ft/s <sup>2</sup> ) (13.2...100 Hz) sinusoidal	-	-
<b>Vibration</b> (ISTA)	-	<u>R1...R4</u> (ISTA 1A): Displacement, 25 mm peak to peak, 14200 vibratory impacts <u>R5...R9</u> (ISTA 3E): Random, overall Grms level of 0.52	

Shock/Drop (ISTA)	Not allowed	R1...R4 (ISTA 1A): Drop, 6 faces, 3 edges and 1 corner		
		Weight range	mm	in
		0...10 kg (0...22 lb)	760	29.9
		10...19 kg (22...42 lb)	610	24.0
		19...28 kg (42...62 lb)	460	18.1
		28...41 kg (62...90 lb)	340	13.4
		R5...R9 (ISTA 3E): Shock, incline impact: 1.1 m/s (3.61 ft/s) Shock, rotational edge drop: 200 mm (7.9 in)		

- 1) For symmetrically grounded TN-S systems, TT systems, and ungrounded or symmetrically high-resistance grounded IT systems. See also section [Limiting relay output maximum voltages at high installation altitudes \(page 123\)](#).
- 2) For corner-grounded delta systems, midpoint-grounded delta systems and corner-grounded (via high resistance) IT systems.
- 3) Contact ABB for higher humidity levels than 60% in the presence of corrosive gases.
- 4) For IEC60721-3-3:2002, the level is 3C2 as standard and 3C3 for +B056/+B063/+B066.

IP66 (UL Type 4X) drive can be used outdoors if protected from the heat of the sun and indoors or outdoors in a dusty environment.

**Note:** There are special considerations in corner-grounded installations above 2000 m. Contact your local ABB representative for further information.

## Storage conditions

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

## Colors

- Drive enclosure**
- NCS 1502-Y (RAL 9002 / PMS 1C Cool Grey), RAL 9002 and PMS 653 C.
  - NCS 1502-Y

## Materials

### ■ Drive

Refer to [ACS580-01, ACQ580-01 and ACH580-01 drives recycling instructions and environmental information \(3AXD50000040612 \[English\]\)](#).

### ■ Package materials for small wall-mounted drives and converter modules

- Cardboard

- Molded pulp
- EPP (foam)
- PP (strapping)
- PE (plastic bag).

#### ■ **Package materials for large wall-mounted drives and converter modules**

- Cardboard heavy duty quality with wet strength glue
- Plywood
- Wood
- PP (strapping)
- PE (VCI foil)
- Metal (fixing clamps, screws).

#### ■ **Package materials for options, accessories and spare parts**

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

Materials vary according to the item type, size and shape. Typical package consists of a cardboard box with paper filling or bubble wrap. ESD-safe packing materials are used for printed circuit boards and similar items.

#### ■ **Materials of manuals**

Printed product manuals are made of recyclable paper. Product manuals are available on the Internet.

## **Disposal**

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

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

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

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

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

For more information on ABB end of life services, refer to [new.abb.com/service/end-of-life-services](http://new.abb.com/service/end-of-life-services).

## Applicable standards

The drive complies with the following standards. The compliance with the European Low Voltage Directive is verified according to standard EN 61800-5-1.





<b>EN 60204-1:2018, EN 60204-1:2006 + AC:2010</b>	Safety of machinery. Electrical equipment of machines. Part 1: General requirements. Provisions for compliance: The final assembler of the machine is responsible for installing <ul style="list-style-type: none"><li>• emergency-stop device</li><li>• supply disconnecting device.</li></ul>
<b>IEC 60146-1-1:2009 EN 60146-1-1:2010</b>	Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements
<b>IEC 60529:1989 + AMD1:1999 + AMD2: 2013, EN 60529:1991 + A1:2000 + A2: 2013</b>	Degrees of protection provided by enclosures (IP code)
<b>IEC 61000-3-2:2018, EN 61000-3-2:2014</b>	Electromagnetic compatibility (EMC) – Limits for harmonic current emissions (input current > 16 A per phase)
<b>EN 61000-3-12:2011</b>	Electromagnetic compatibility (EMC) – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and < 75 A per phase  This drive complies with the standard provided that the short-circuit power $S_{sc}$ is greater than or equal to the minimum short-circuit power given for the drive (listed for each drive type on page 341) at the interface point between the user's supply and the public system. It is the responsibility of the installer or user of the drive to ensure, by consultation with the distribution network operator if necessary, that the drive is connected only to a supply with a short-circuit power $S_{sc}$ greater than or equal to the minimum short-circuit power given for the drive.








<b>IEC/EN 61800-3:2017</b>	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods
<b>IEC/EN 61800-5-1:2007</b>	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy
<b>IEC/EN 61800-9-2:2017</b>	Adjustable speed electrical power drive systems. Part 9-2: Eco-design for power drive systems, motor starters, power electronics and their driven applications – Energy efficiency indicators for power drive systems and motor starters
<b>IEC 60664-1:2007</b>	Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests.
<b>UL 61800-5-1: 1st edition</b>	Standard for Safety, Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy
<b>CSA C22.2 No. 274-17</b>	Adjustable speed drives

**Note:** US variants 343A-2 and 396A-2 have not been verified to comply with CSA, CE or IEC directives or any standard other than UL 61800-5-1: 1st edition.

## Markings

These markings are attached to the drive:

	<p>CE mark</p> <p>Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).</p>
	<p>TÜV Safety Approved mark (functional safety)</p> <p>Product contains Safe torque off and possibly other (optional) safety functions which are certified by TÜV according to the relevant functional safety standards. Applicable to drives and inverters; not applicable to supply, brake or DC/DC converter units or modules.</p>
	<p>UL Listed mark for USA and Canada</p> <p>Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories. Valid with rated voltages up to 600 V.</p>
	<p>CSA certification mark for USA and Canada</p> <p>Product has been tested and evaluated against the relevant North American standards by the CSA Group. Valid with rated voltages up to 600 V.</p>

	<p>EAC (Eurasian Conformity) mark</p> <p>Product complies with the technical regulations of the Eurasian Customs Union. EAC mark is required in Russia, Belarus and Kazakhstan.</p>
	<p>Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP).</p> <p>Product is compliant with the People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) about hazardous substances. The EFUP is 20 years. China RoHS II Declaration of Conformity is available from <a href="https://library.abb.com">https://library.abb.com</a>.</p>
	<p>UKCA (UK Conformity Assessed) mark</p> <p>Product complies with the applicable United Kingdom's legislation (Statutory Instruments). Marking is required for products being placed on the market in Great Britain (England, Wales and Scotland).</p>
	<p>KC mark</p> <p>Product complies with Korean Registration of Broadcasting and Communications Equipment Clause 3, Article 58-2 of Radio Waves Act.</p>
	<p>RCM mark</p> <p>Product complies with Australian and New Zealand requirements specific to EMC, telecommunications and electrical safety. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).</p>
	<p>WEEE mark</p> <p>At the end of life the product should enter the recycling system at an appropriate collection point and not placed in the normal waste stream.</p>
	<p>CMIM mark</p> <p>Product complies with Morocco's safety standard for marketing of toys and electrical products.</p>

**Note:** The ACQ580-01 230 V 3-phase R9 drives have NOT been verified to comply with CSA, CE or IEC directives or any other world standards outside of North America.



**Note:** The ACQ580-01 IP66 (UL Type 4X) drives do NOT have these markings: CSA, China ROHS, KC, EAC. They do have NSF mark.

## CE marking

A CE mark is attached to the drive to verify that the drive follows the provisions of the European Low Voltage, EMC and RoHS Directives. The CE marking also verifies that the drive, in regard to its safety functions (such as Safe torque off), conforms with the Machinery Directive as a safety component.

### ■ Compliance with the European Low Voltage Directive

The compliance with the European Low Voltage Directive has been verified according to standard EN 61800-5-1:2007. The declaration of conformity (3AXD10000486283) is available on the Internet. See section *Document library on the Internet* on the inside of the back cover.

### ■ Compliance with the European EMC Directive

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard (EN 61800-3:2004 + A1:2012) covers requirements stated for drives. See section [Compliance with the EN 61800-3:2004 + A1:2012](#) below. The declaration of conformity (3AXD10000486283) is available on the Internet. See section *Document library on the Internet* on the inside of the back cover.

### ■ Compliance with the European ROHS II Directive 2011/65/EU

The RoHS II Directive defines the restriction of the use of certain hazardous substances in electrical and electronic equipment. The declaration of conformity (3AXD10000486283) is available on the Internet. See section *Document library on the Internet* on the inside of the back cover.

### ■ Compliance with the European WEEE Directive 2002/96/EC

The WEEE Directive defines the regulated disposal and recycling of electric and electrical equipment.

### ■ Compliance with the European Machinery Directive 2006/42/EC 2nd Edition – June 2010

The drive is a machinery component that can be integrated into a wide range of machinery categories as specified in European Commission's *Guide to application of the Machinery Directive 2006/42/EC 2nd Edition – June 2010*. See chapter [The Safe torque off function \(page 407\)](#).

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## Validating the operation of the Safe torque off function

See chapter [The Safe torque off function \(page 407\)](#).

## Compliance with the EN 61800-3:2004 + A1:2012

### ■ Definitions

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

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

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

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

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

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

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

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

### ■ Category C1

The emission limits are complied with the following provisions:

1. The optional EMC C1 filter is selected according to the documentation and installed as specified in the EMC C1 filter manual. See [Main switch and EMC C1 filter options \(+F278, +F316, +E223\) installation supplement for ACS580-01, ACH580-01 and ACQ580-01 frames R1 to R5 \(3AXD50000155132 \[Multilingual\]\)](#). Only available for IP55 (+B056) frames R1...R5, up to 55 kW.
  2. The motor and control cables are selected as specified in this manual.
  3. The drive is installed according to the instructions given in this manual.
  4. The maximum motor cable length with 2 kHz switching frequency is 10 m.
-

**WARNING!**

In a domestic environment, this product may cause radio inference, in which case supplementary mitigation measures may be required.

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**■ Category C2**

The emission limits are complied with the following provisions:

1. The motor and control cables are selected as specified in this manual.
  2. The drive is installed according to the instructions given in this manual.
  3. For the maximum motor cable length with 4 kHz switching frequency, see **Maximum recommended motor cable length** (page 342).
- 

**WARNING!**

The drive may cause radio interference if used in residential or domestic environment. The user is required to take measures to prevent interference, in association to the requirements for the CE compliance listed above, if necessary.

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**Note:** Do not install a drive with the EMC filter connected to a system that the filter is not suitable for. This can cause danger, or damage the drive.

**Note:** 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.

If you install the drive to any other system than symmetrically grounded TN-S system, you may need to disconnect the EMC filter or the ground-to-phase varistor. See sections:

[IEC: Grounding system compatibility check \(page 129\)](#)

[North America: Grounding system compatibility check \(page 174\)](#)

**■ Category C3**

The drive complies with the standard with the following provisions:

1. The motor and control cables are selected as specified in this manual.
  2. The drive is installed according to the instructions given in this manual.
  3. For the maximum motor cable length with 4 kHz switching frequency, see page **Maximum recommended motor cable length** (page 342)
-



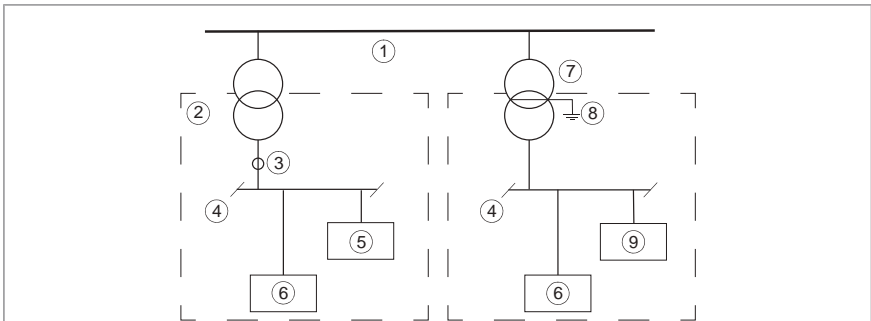
**WARNING!**

A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

■ **Category C4**

The drive complies with the C4 category with these provisions:

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



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

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, and routed according to the electrical planning guidelines of the drive. The EMC recommendations are obeyed.
4. The drive is installed according to its installation instructions. The EMC recommendations are obeyed.

**WARNING!**

A drive of category C4 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

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## UL checklist

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**WARNING!**

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

---

- Make sure that the drive type designation label includes the applicable marking.
  - **DANGER - Risk of electric shock.** After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
  - The drive is to be used in a heated, indoor controlled environment. The drive must be installed in clean air according to the enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust.
  - For IP66 (UL Type 4X drives): The drive can be used outdoors if protected from the heat of the sun and indoors or outdoors in a dusty environment. The surface has been tested against exposure to corrosive agents such as salt spray, cleaners containing ammonia and chlorine, algaecides and microbicides.
  - The maximum surrounding air temperature is 40 °C at rated output current. The output current is derated for 40...50 °C.
  - The drive is suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes, 600 V maximum when protected by the UL fuses given elsewhere in this chapter.
  - The drive is suitable for use in a circuit capable of delivering not more than 65 kA rms symmetrical amperes, 600 V maximum when protected by the UL circuit breakers given elsewhere in this chapter.
  - The cables located within the motor circuit must be rated for at least 75 °C in UL-compliant installations.
  - The input cable must be protected with fuses or circuit breakers. These protective devices provide branch circuit protection in accordance with the national regulations (National Electrical Code (NEC) or Canadian Electrical Code). Obey also any other applicable local or provincial codes.
-

Suitable UL fuses are listed in section [Fuses \(UL\) \(page 292\)](#) and circuit breakers in section [Circuit breakers \(IEC\) \(page 291\)](#).

---



**WARNING!**

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

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- The integral solid state short circuit protection of the drive does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes. (Exception: IP66 (UL Type 4X) drive with disconnect and fuse option (+F254) incorporates suitable branch circuit fuses. UL98 disconnect is designed for feeder or branch applications and so does not require upstream branch protection.)
- The drive provides motor overload protection. For adjustments, see the firmware manual.
- The drive overvoltage category according to IEC 60664-1 is III.
- To maintain the environment integrity of the enclosure, replace the cable grommets with field-installed industrial conduit hubs or closure plates required by the enclosure type (or better).

## Design lifetime expectancy

The design lifetime expectancy of the drive and its overall components exceeds ten (10) years in normal operating environments. In some cases, the drive can last 20 years or more. To achieve a long lifetime for the product the manufacturer's instructions for sizing the drive, installation, operational conditions and preventive maintenance schedule shall be followed.

## Disclaimers

### ■ Generic disclaimer

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

### ■ Cyber security disclaimer

This product is designed to be connected to and to communicate information and data via a network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer

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

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

## Declarations of conformity



[Link to Declaration of conformity according to EU Machinery Directive 2006/42/EU \(3AXD10000486283\)](#)



[Link to Declaration of conformity according to UK Supply of Machinery \(Safety\) Regulations 2008 \(3AXD10001329525\)](#)



[Link to Declaration of China RoHS II conformity \(3AXD10001497389\)](#)

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# 13

## Dimension drawings

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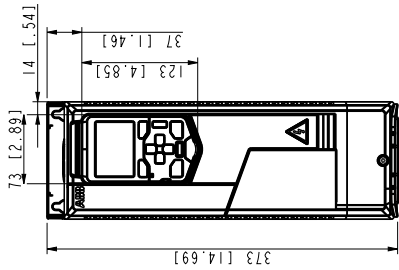
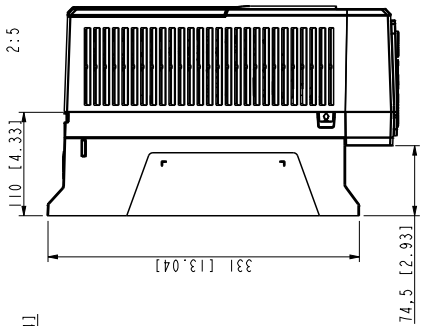
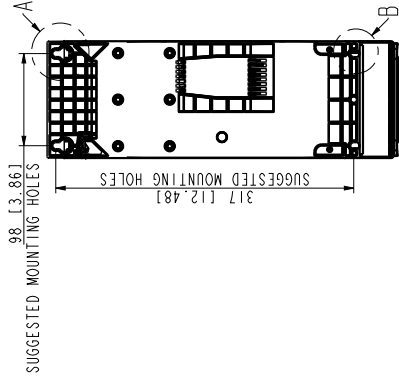
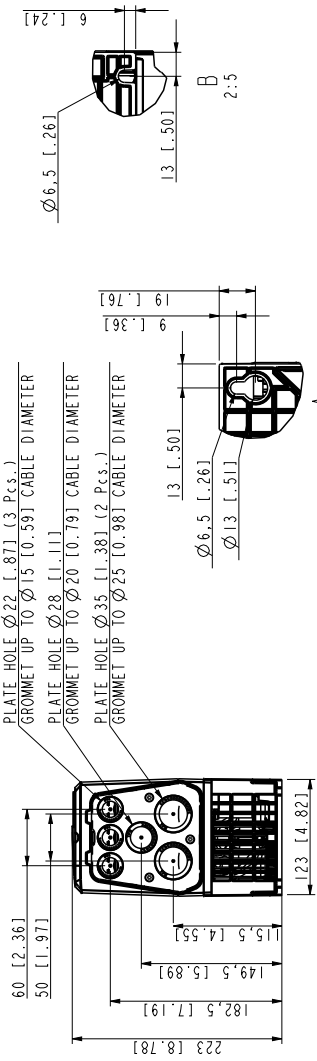
### Contents of this chapter


This chapter shows the dimension drawings of the ACQ580-01.

**Note:** The dimensions are given in millimeters and [inches].

# Frame R1, IP21 (UL Type 1)

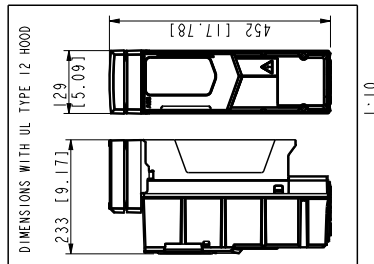
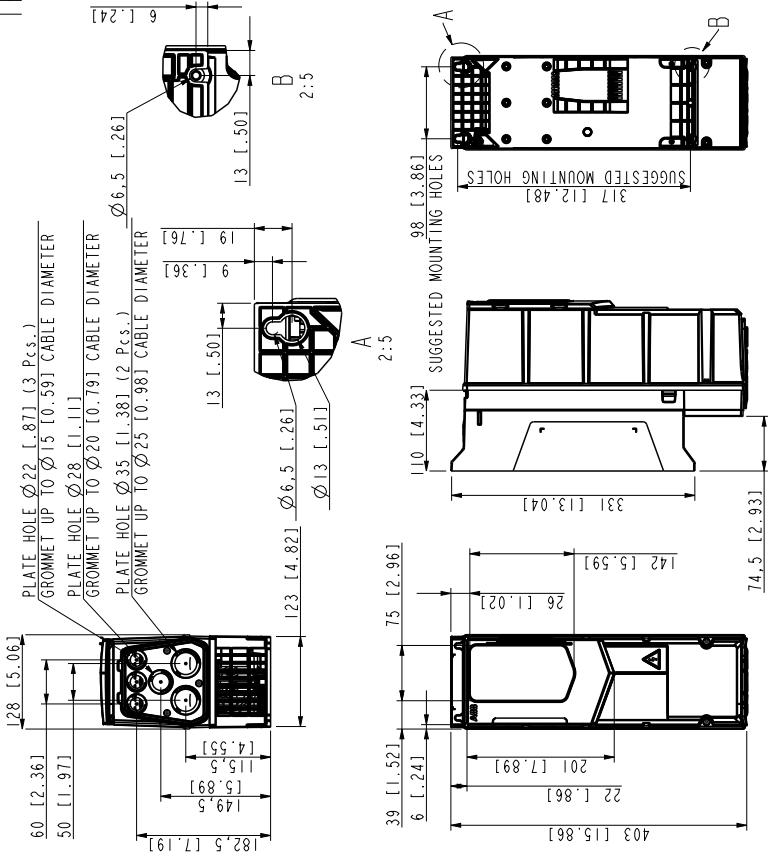
IP21



  
 3AXD10000601652

# Frame R1, IP55 (UL Type 12)

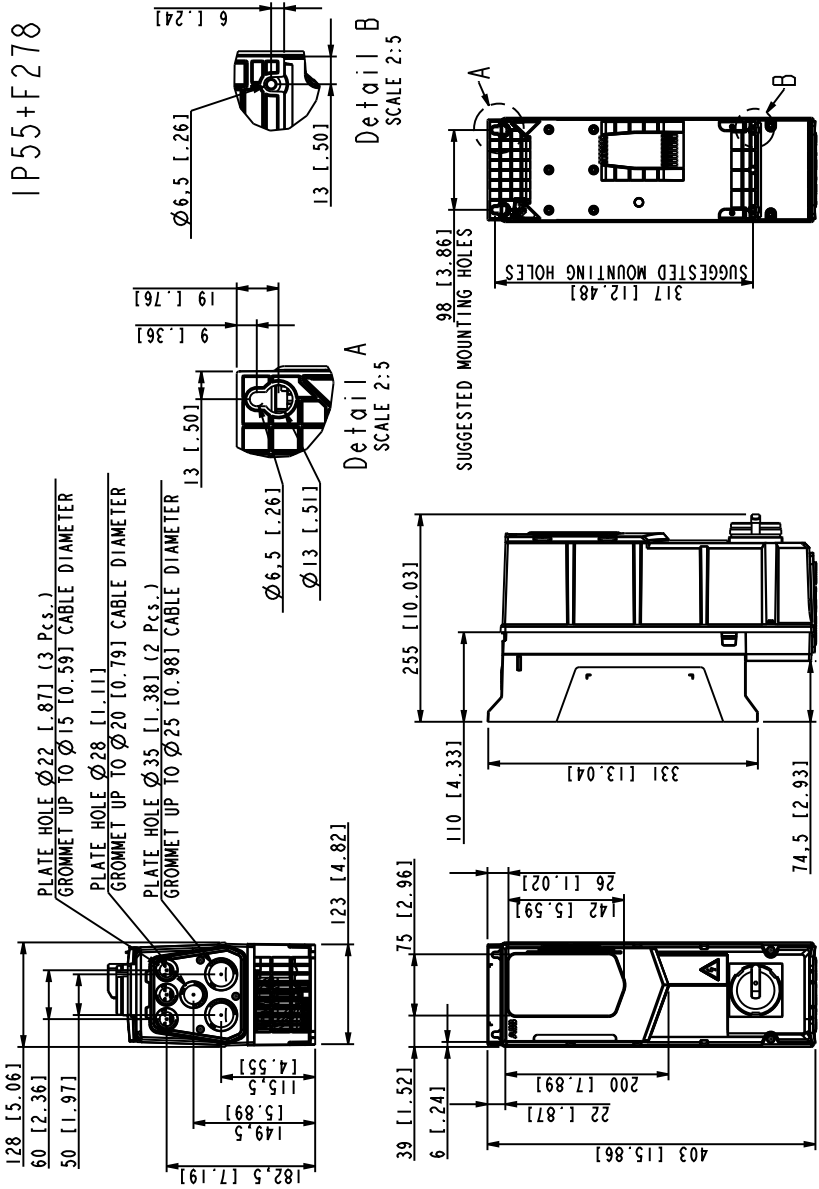
IP55



3AXD10000601699

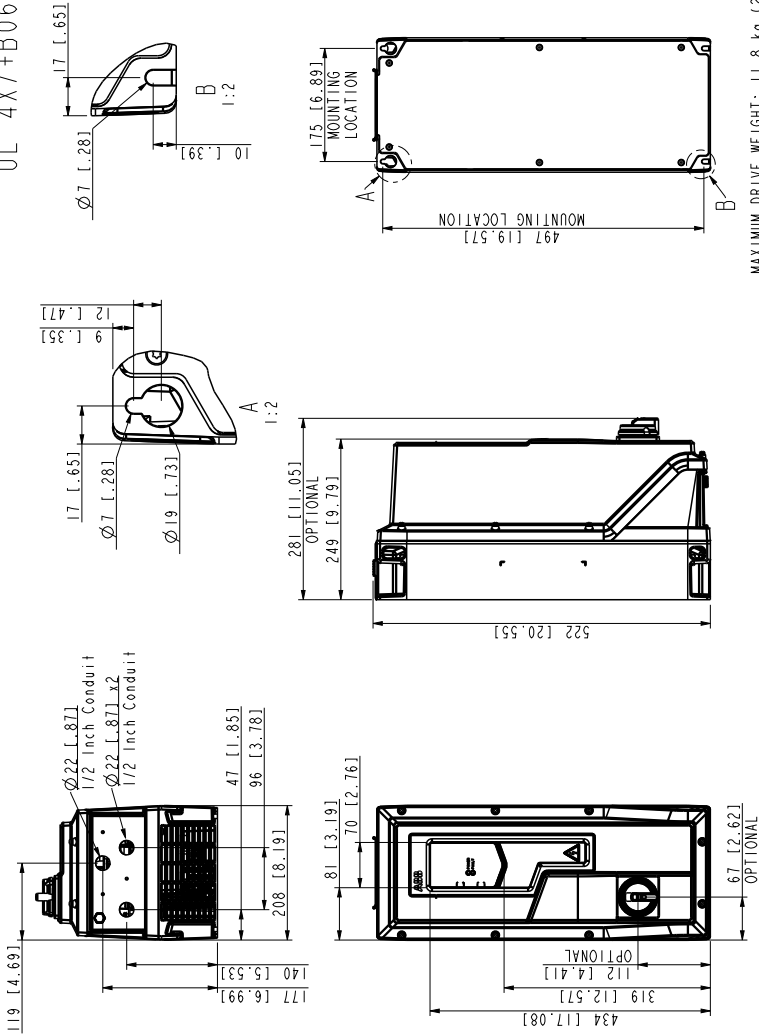
# Frame R1, IP55+F278 (UL Type 12)

IP55+F278



# Frame R1, IP66 (UL Type 4X) +B066

UL 4X/+B066



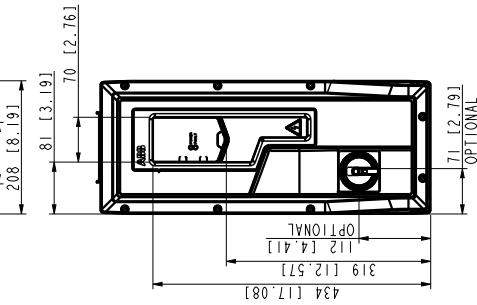
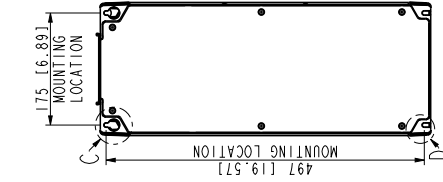
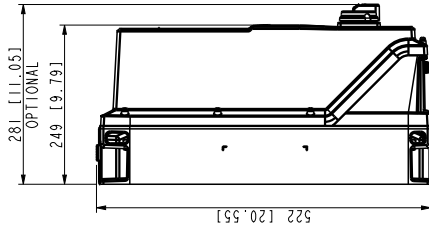
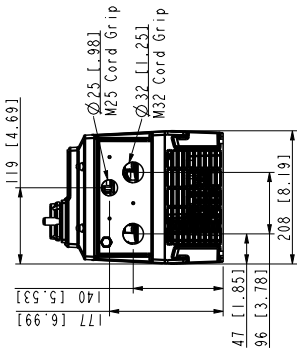
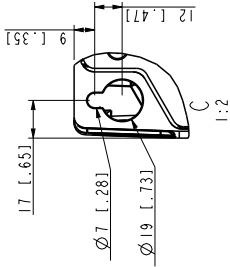
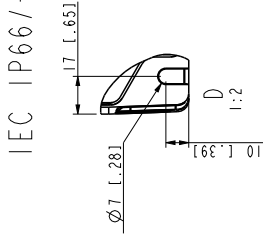
MAXIMUM DRIVE WEIGHT: 11.8 kg (26 lb)



3AXD50001012694

# Frame R1, IP66 (UL Type 4X) +B063

IEC IP66/+B063



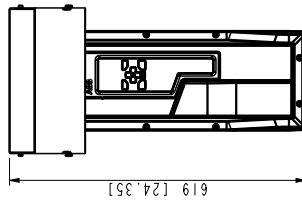
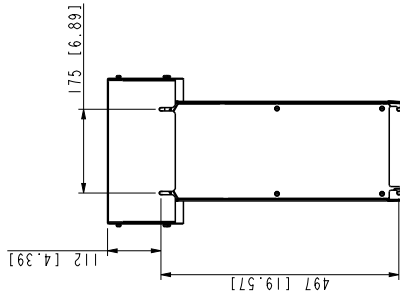
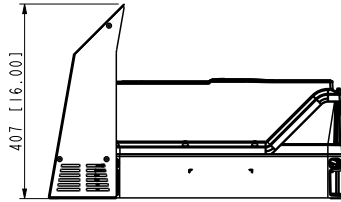
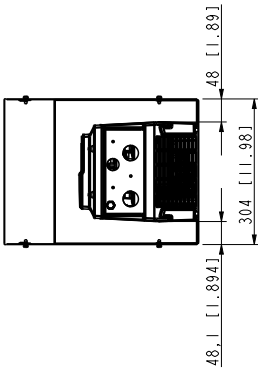
MAXIMUM DRIVE WEIGHT: 11.8 kg (26 lb)



3AXD50001012694

# Frame R1, IP66 (UL Type 4X) +C193

SUN SHIELD/+C193

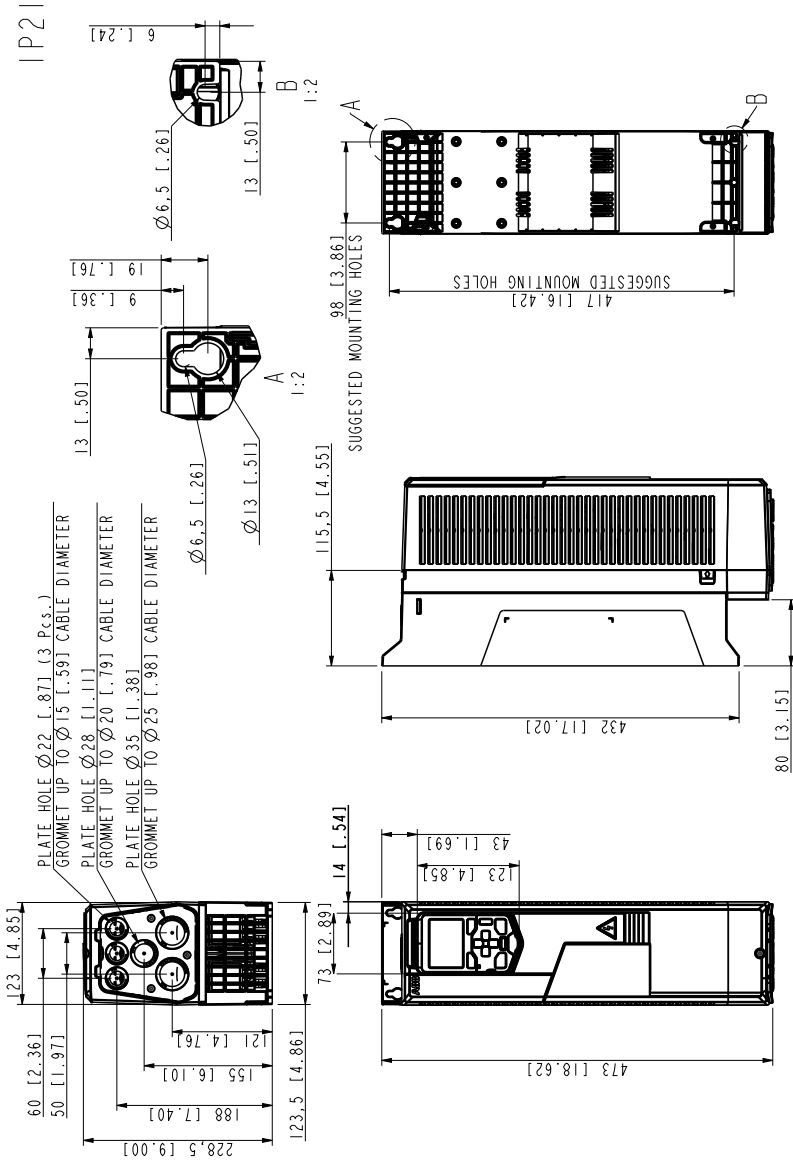


MAXIMUM DRIVE WEIGHT WITH SUN SHIELD: 15.1 kg (33.3 lb)



3AXD50001012694

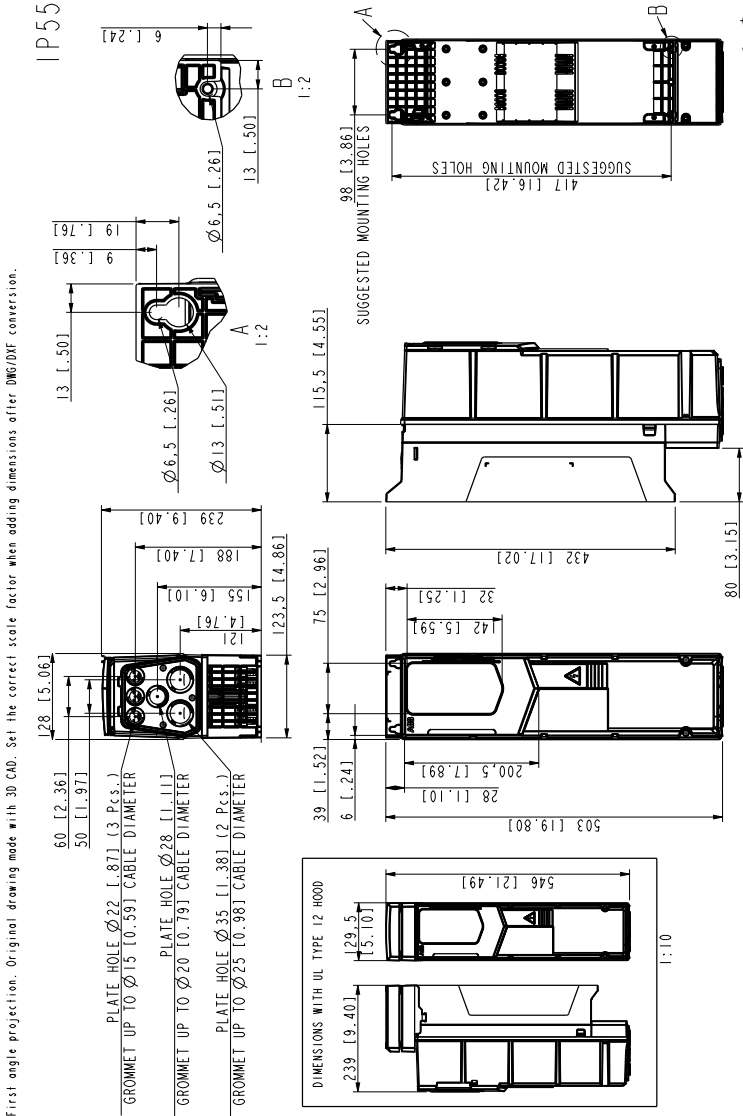
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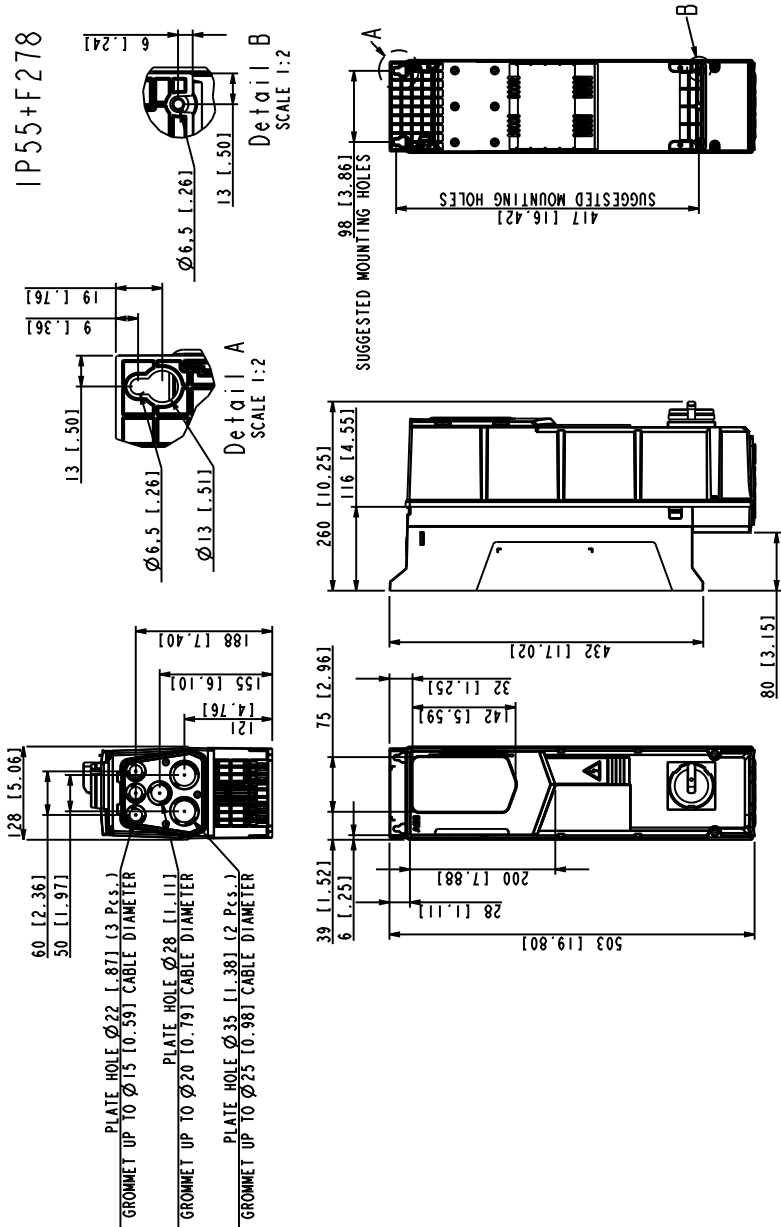
3AXD10000602398



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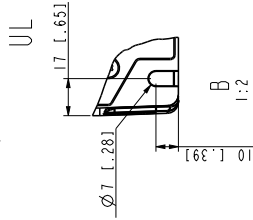


# Frame R2, IP55+F278 (UL Type 12)

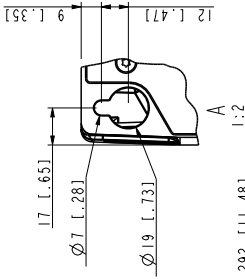


# Frame R2, IP66 (UL Type 4X) +B066

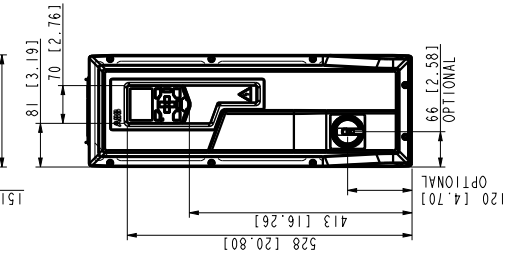
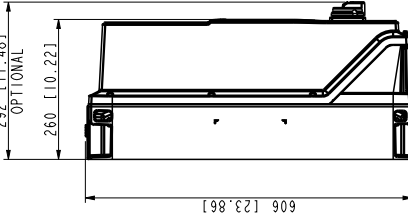
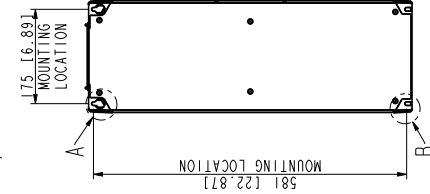
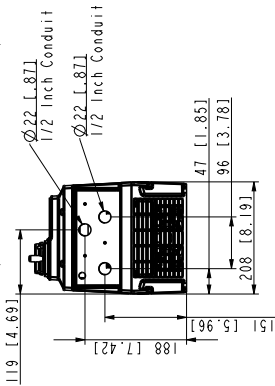
UL 4X/+B066



B  
1:2



A  
1:2



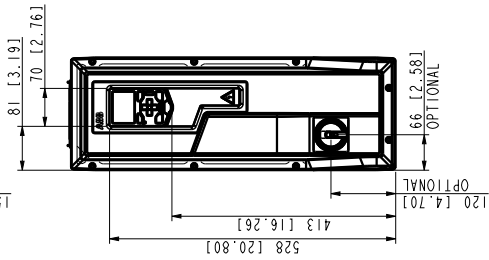
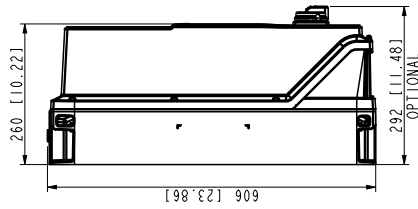
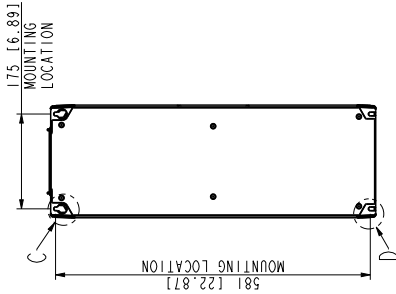
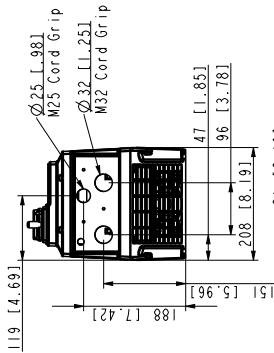
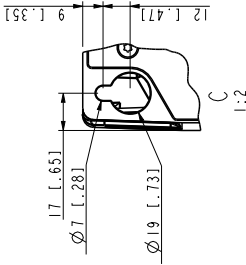
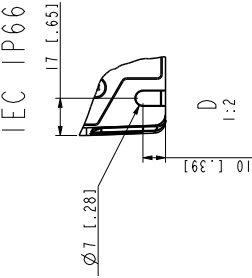
MAXIMUM DRIVE WEIGHT: 14.5 kg (32 lb)



3AXD5000099286

# Frame R2, IP66 (UL Type 4X) +B063

IEC IP66/+B063



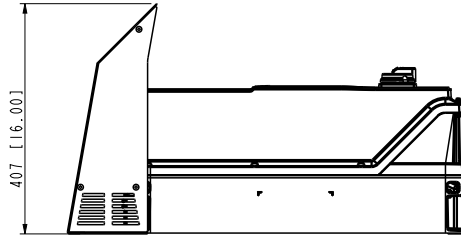
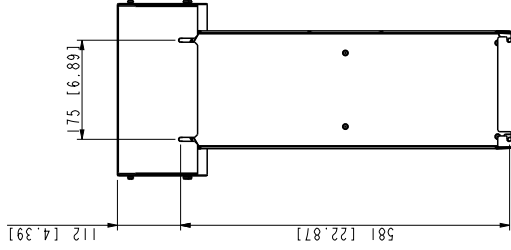
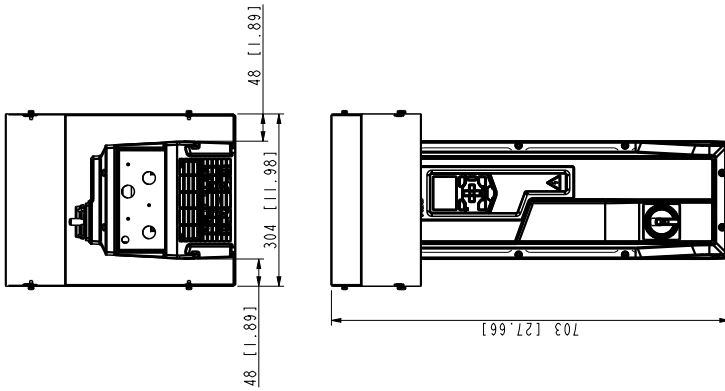
MAXIMUM DRIVE WEIGHT: 14.5 kg (32 lb)



3AXD50000999286

# Frame R2, IP66 (UL Type 4X) +C193

SUN SHIELD/+C193

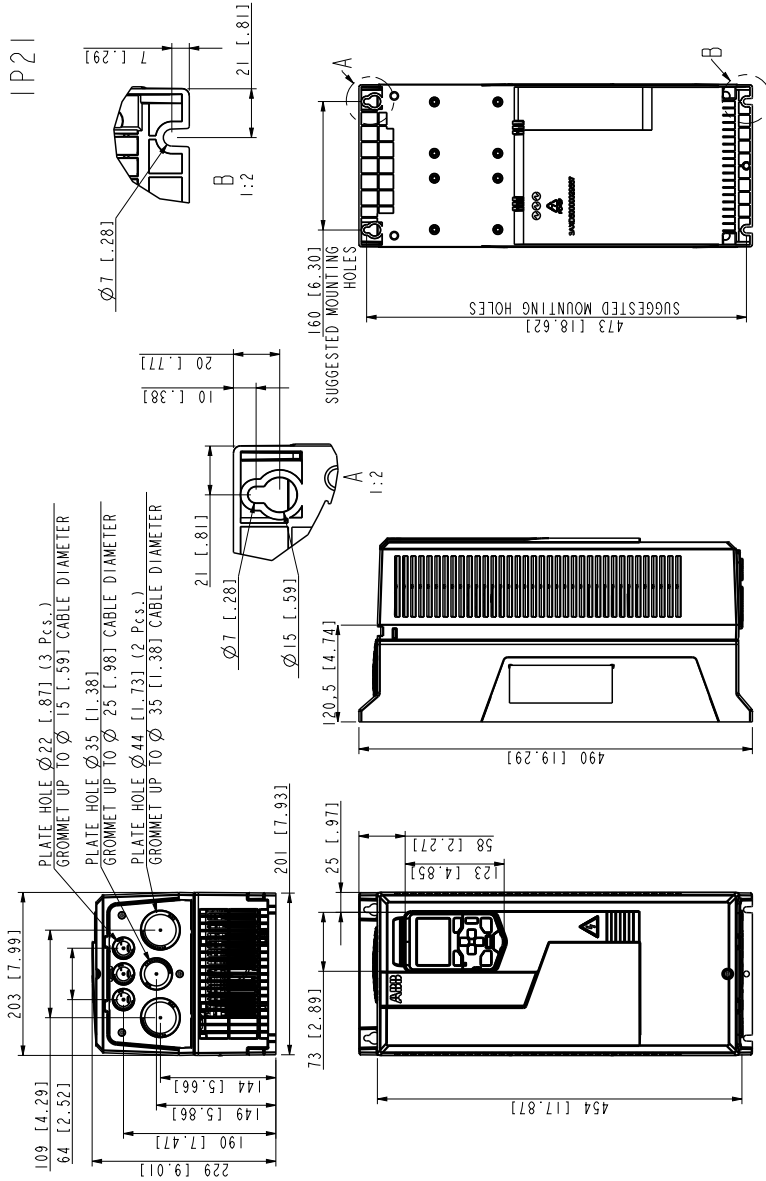


MAXIMUM DRIVE WEIGHT WITH SUN SHIELD: 17.7 kg (39 lb)



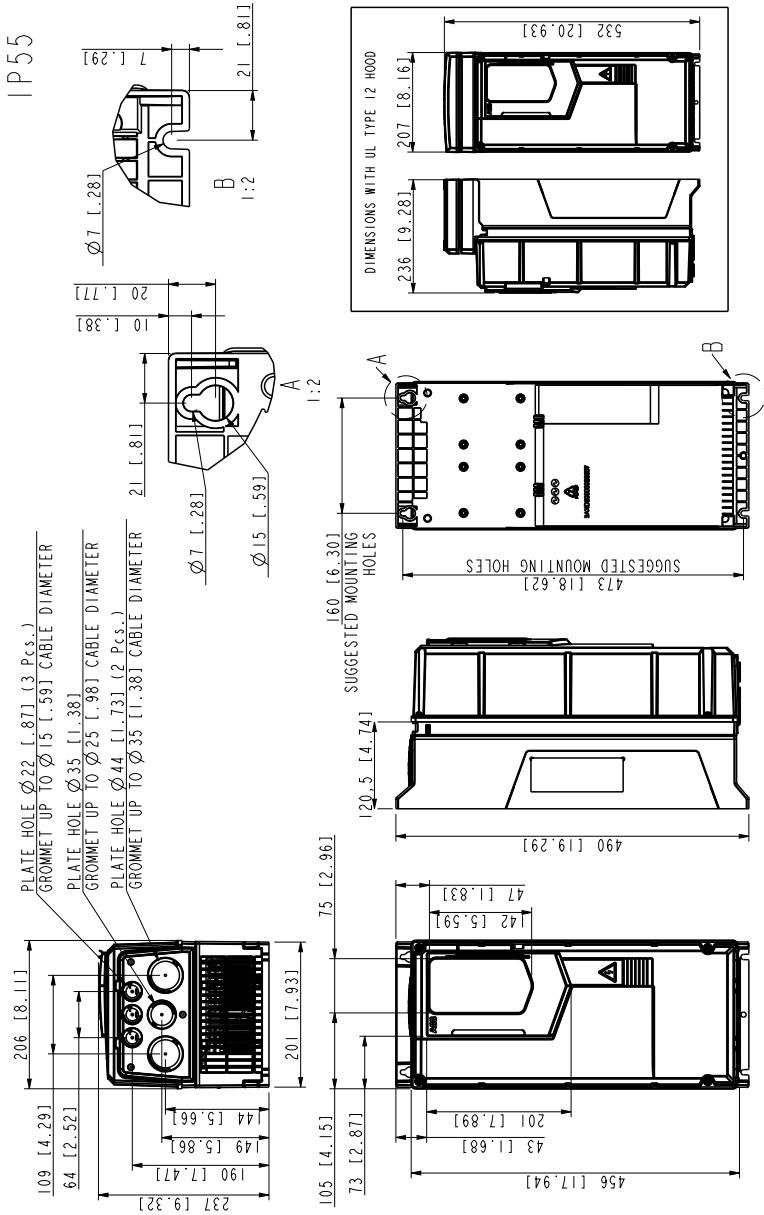
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# Frame R3, IP21 (UL Type 1)



3AXD10000602466

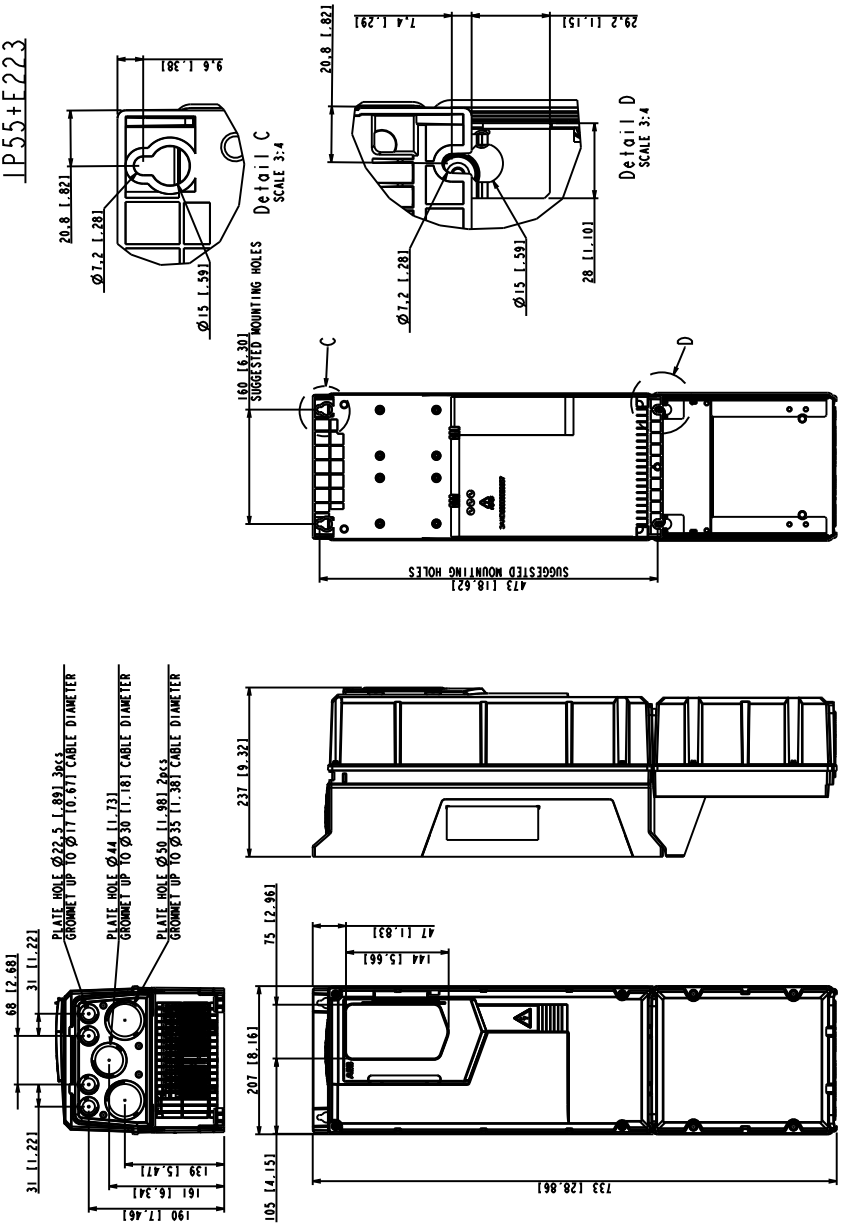
# Frame R3, IP55 (UL Type 12)



3AXD10000602519

# Frame R3, IP55+E223 (UL Type 12)

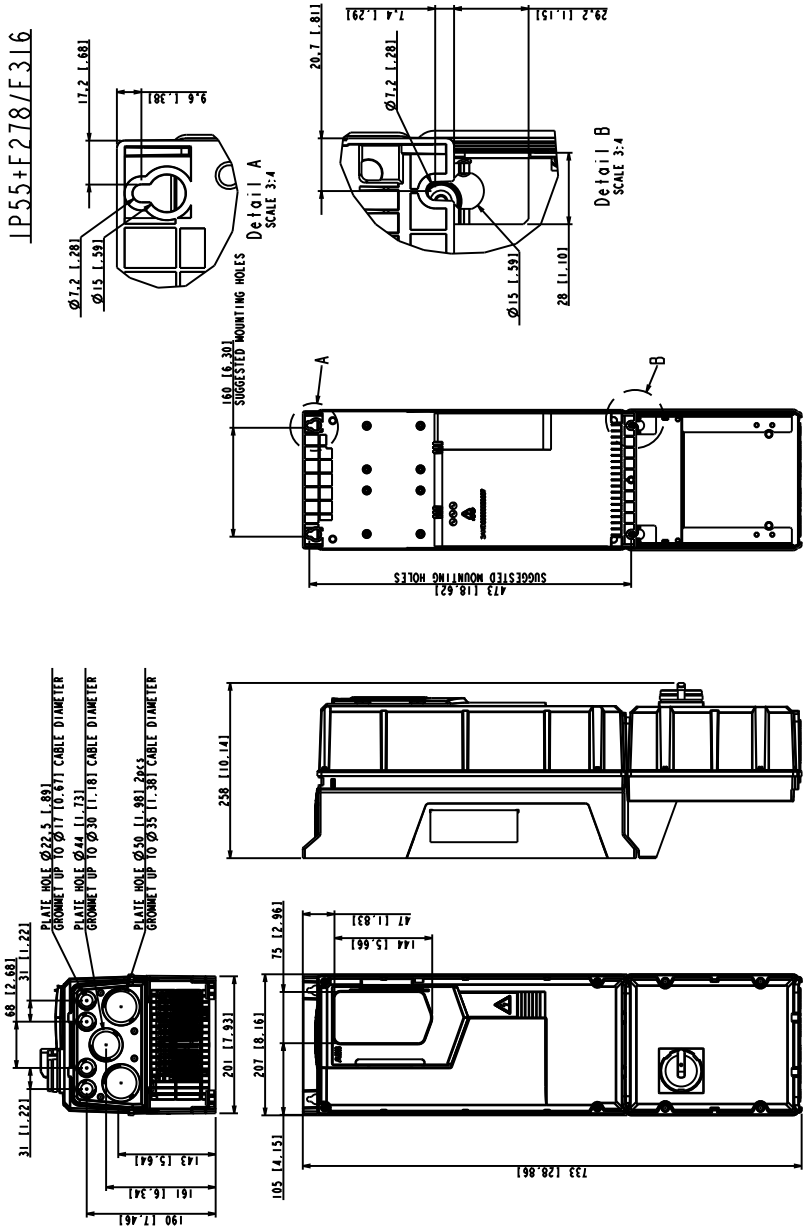
IP55+E223



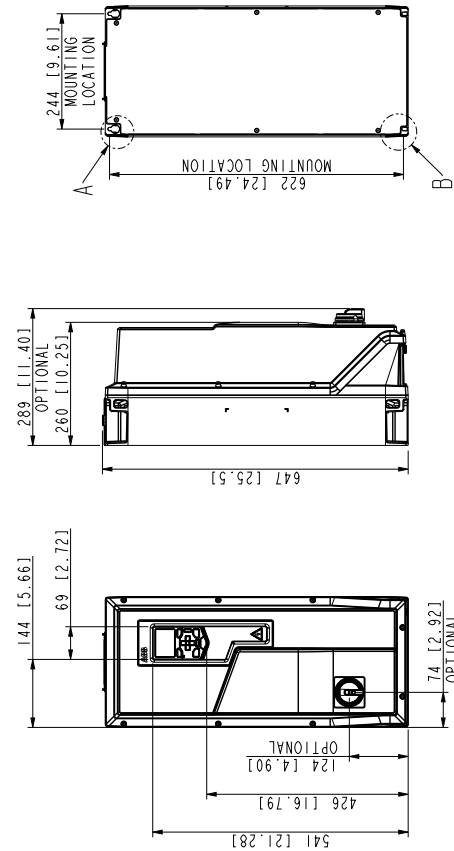
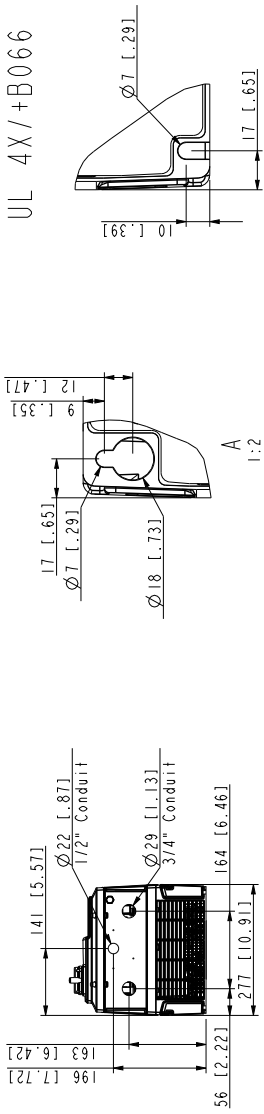


# Frame R3, IP55+F278/F316 (UL Type 12)

IP55+F278/F316



# Frame R3, IP66 (UL Type 4X) +B066



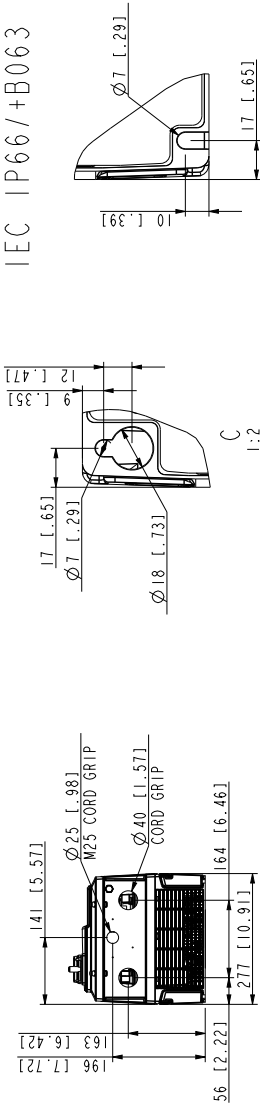
MAXIMUM DRIVE WEIGHT: 26.4 kg (58 lb)



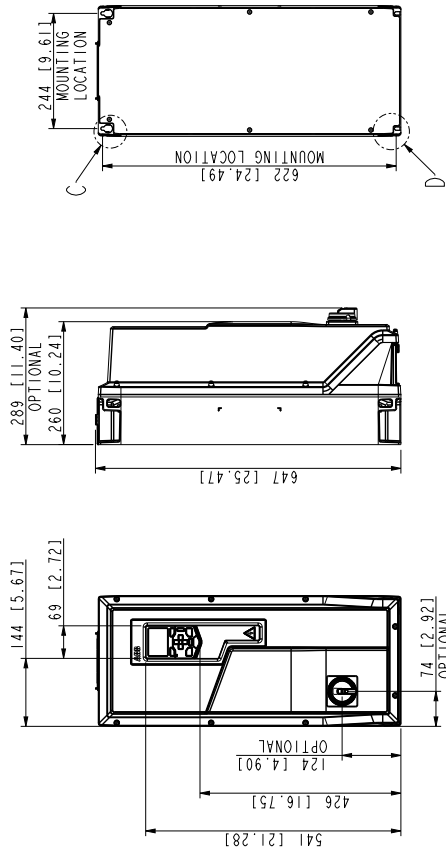
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# Frame R3, IP66 (UL Type 4X) +B063

IEC IP66 / +B063



D  
1:2



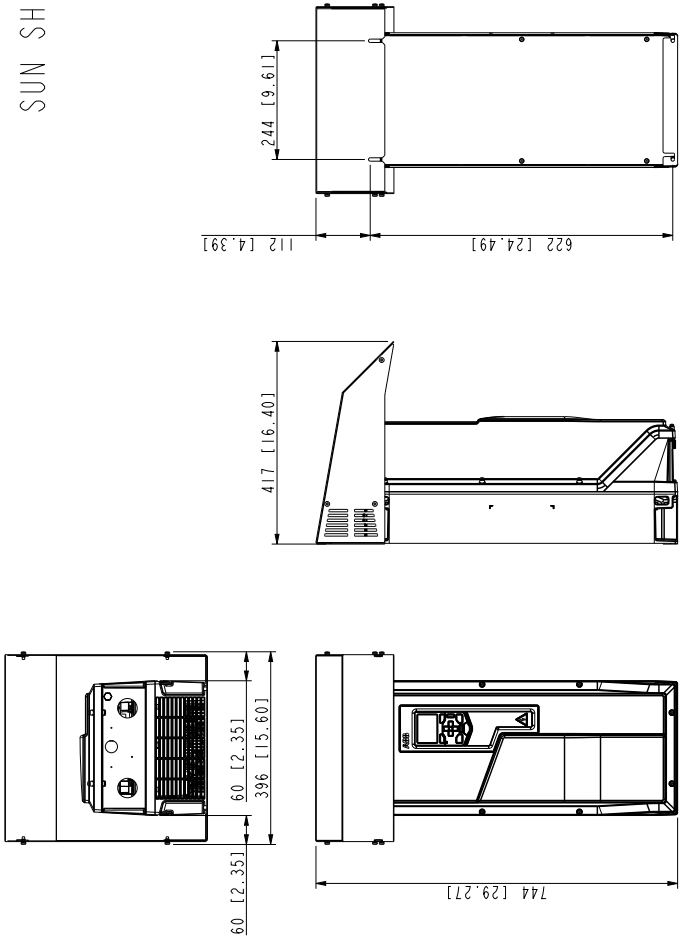
MAXIMUM DRIVE WEIGHT: 26.4 kg (58 lb)



3AXD50001013059

# Frame R3, IP66 (UL Type 4X) +C193

SUN SHIELD/ +C193

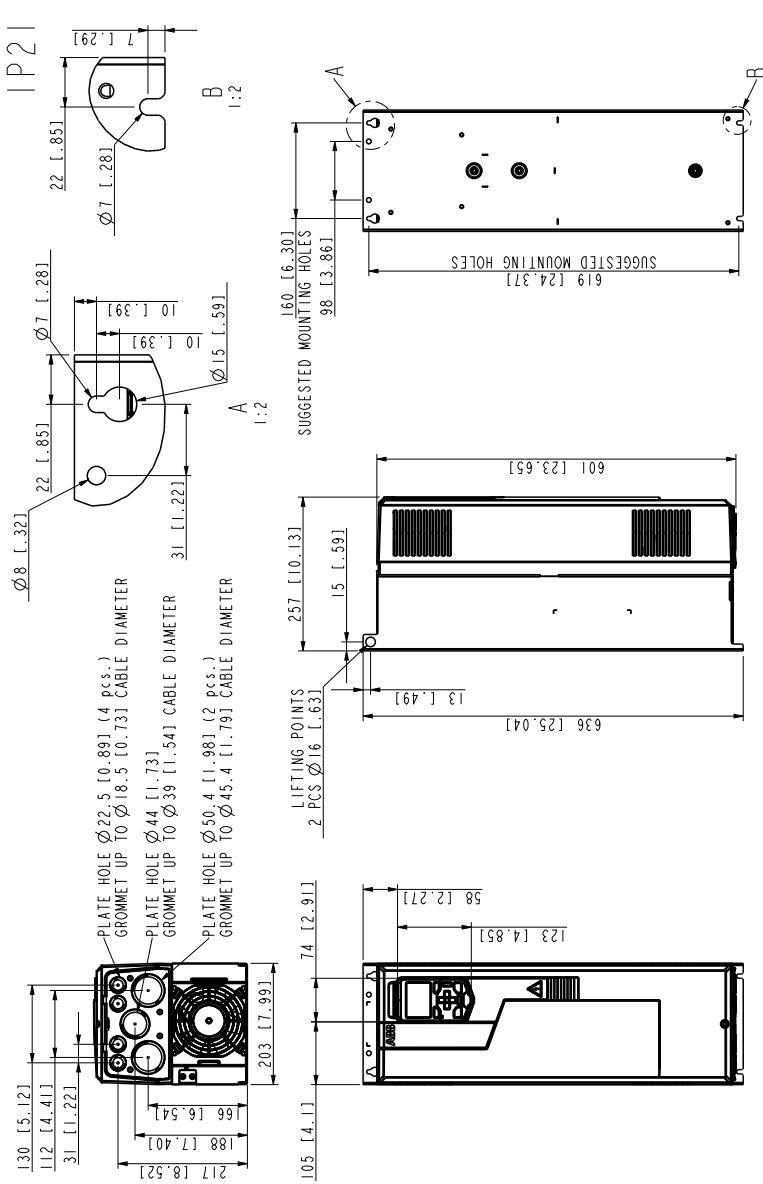


MAXIMUM DRIVE WEIGHT WITH SUN SHIELD: 34.3 kg (76 lb)



3AXD50001013059

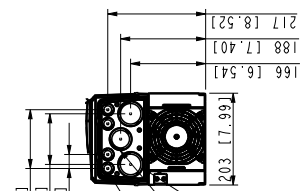
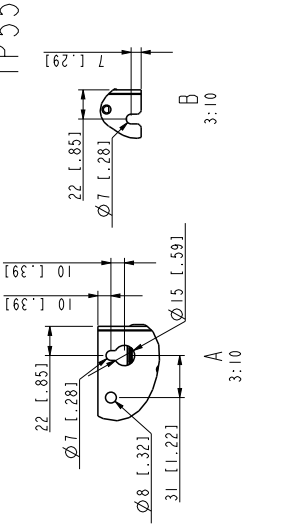
# Frame R4, IP21 (UL Type 1)



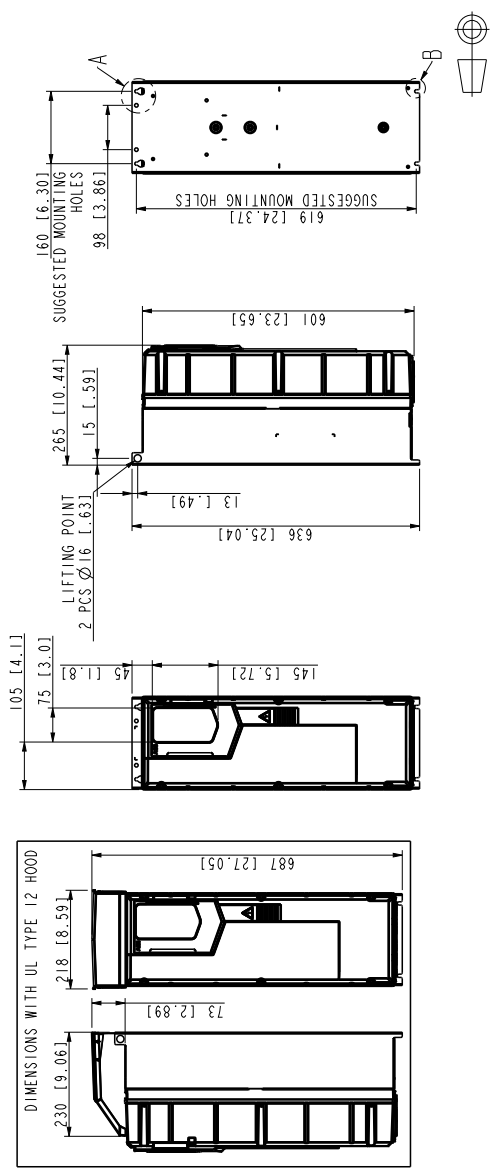
3AXD10001330082

# Frame R4, IP55 (UL Type 12)

IP55



- PLATE HOLE  $\varnothing 22.5$  (10.89) (4 pcs.)
- GROMMET UP TO  $\varnothing 18.5$  (10.73) CABLE DIAMETER
- PLATE HOLE  $\varnothing 44$  (1.73)
- GROMMET UP TO  $\varnothing 39$  (1.54) CABLE DIAMETER
- PLATE HOLE  $\varnothing 50.4$  (1.98) (2 pcs.)
- GROMMET UP TO  $\varnothing 45.4$  (1.79) CABLE DIAMETER

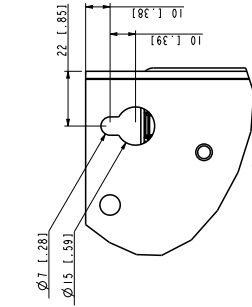


3AXD10001330271



# Frame R4, IP55+E23 (UL Type 12)

IP55+E23



C  
3:4

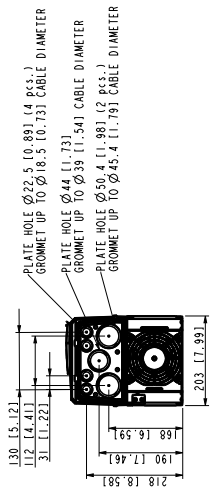
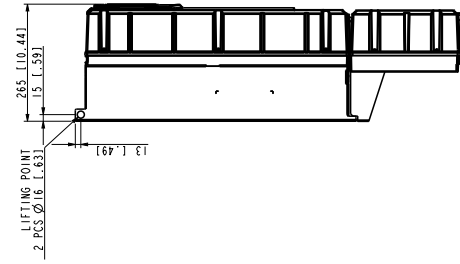
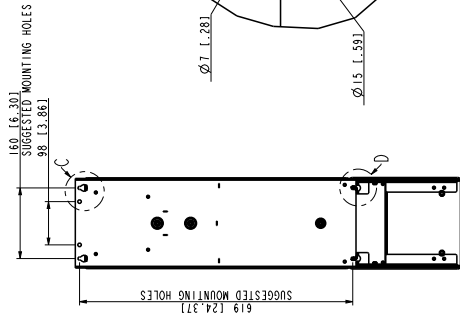
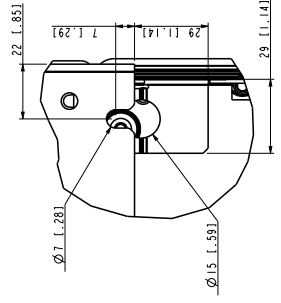
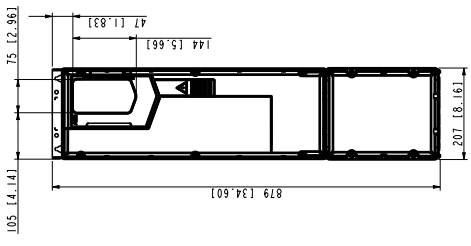


PLATE HOLE Ø22.5 [0.89] (4 PCS.)  
GROMMET UP TO Ø18.5 [0.73] CABLE DIAMETER  
PLATE HOLE Ø4.4 [1.73]  
GROMMET UP TO Ø39 [1.54] CABLE DIAMETER  
PLATE HOLE Ø50.4 [1.98] (2 PCS.)  
GROMMET UP TO Ø45.4 [1.79] CABLE DIAMETER



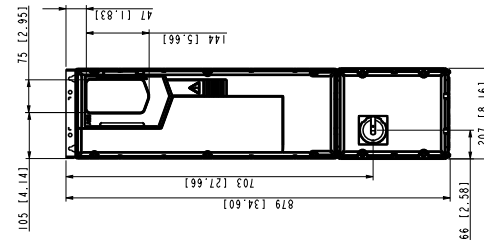
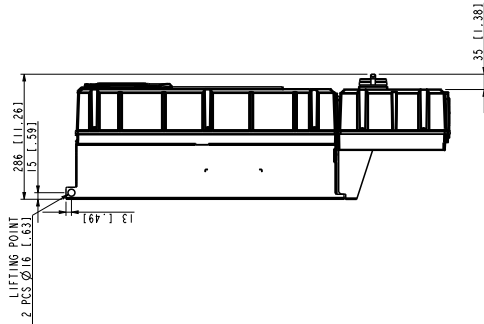
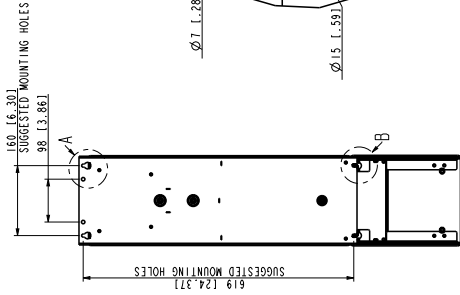
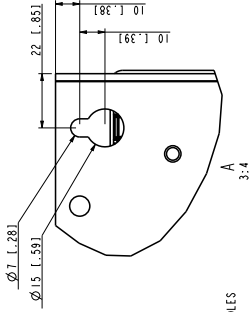
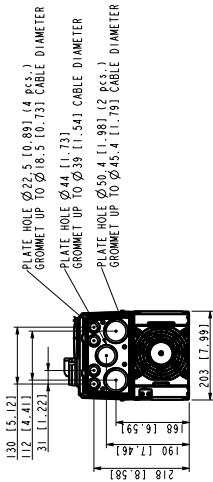
D  
3:4



3AXD10001373680

# Frame R4, IP55+F278/F316 (UL Type 12)

JP55+F278/F316



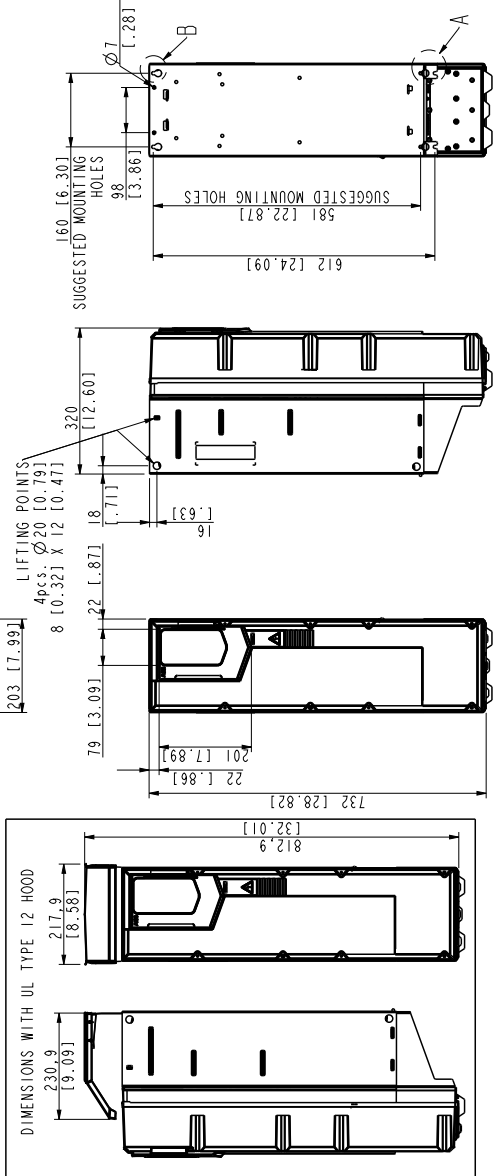
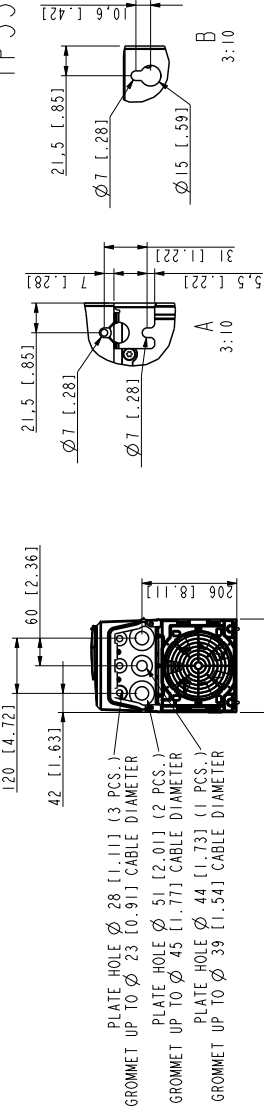
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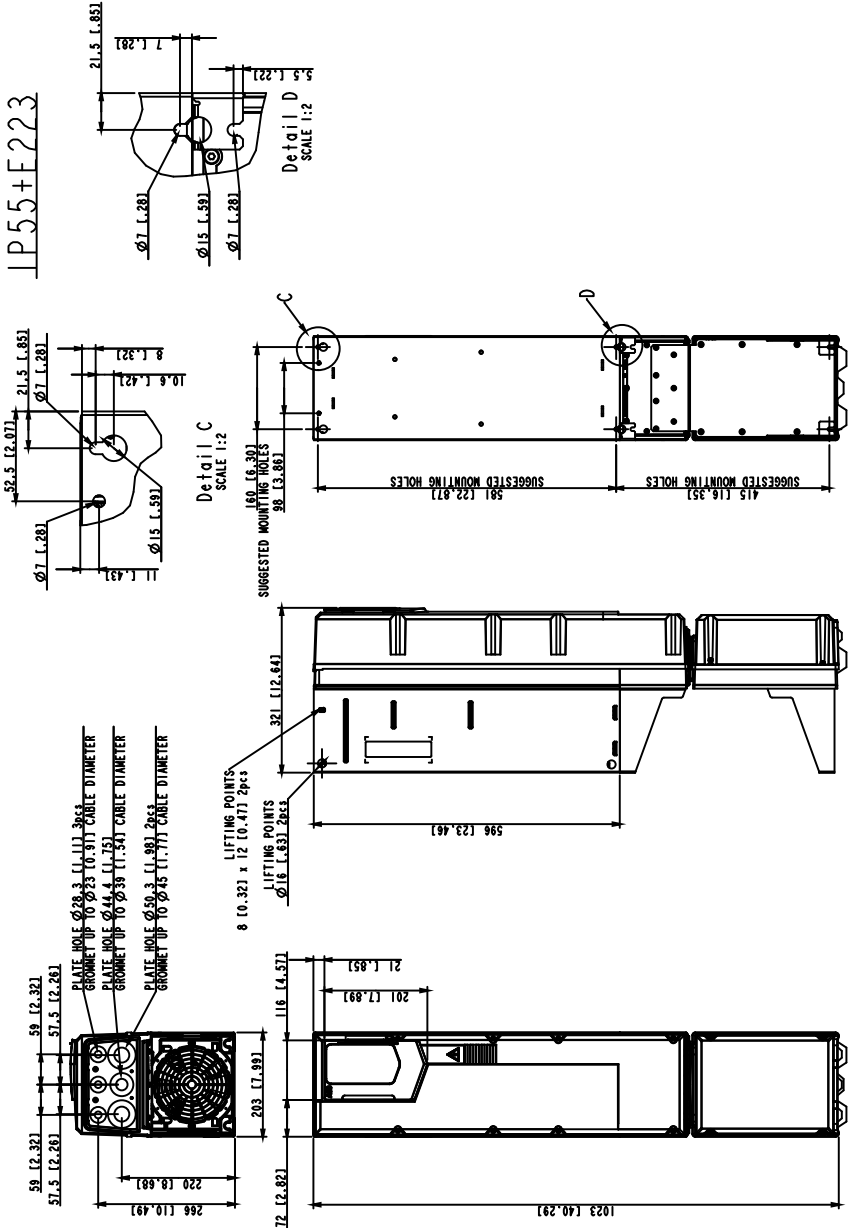
# Frame R5, IP55 (UL Type 12)

IP55



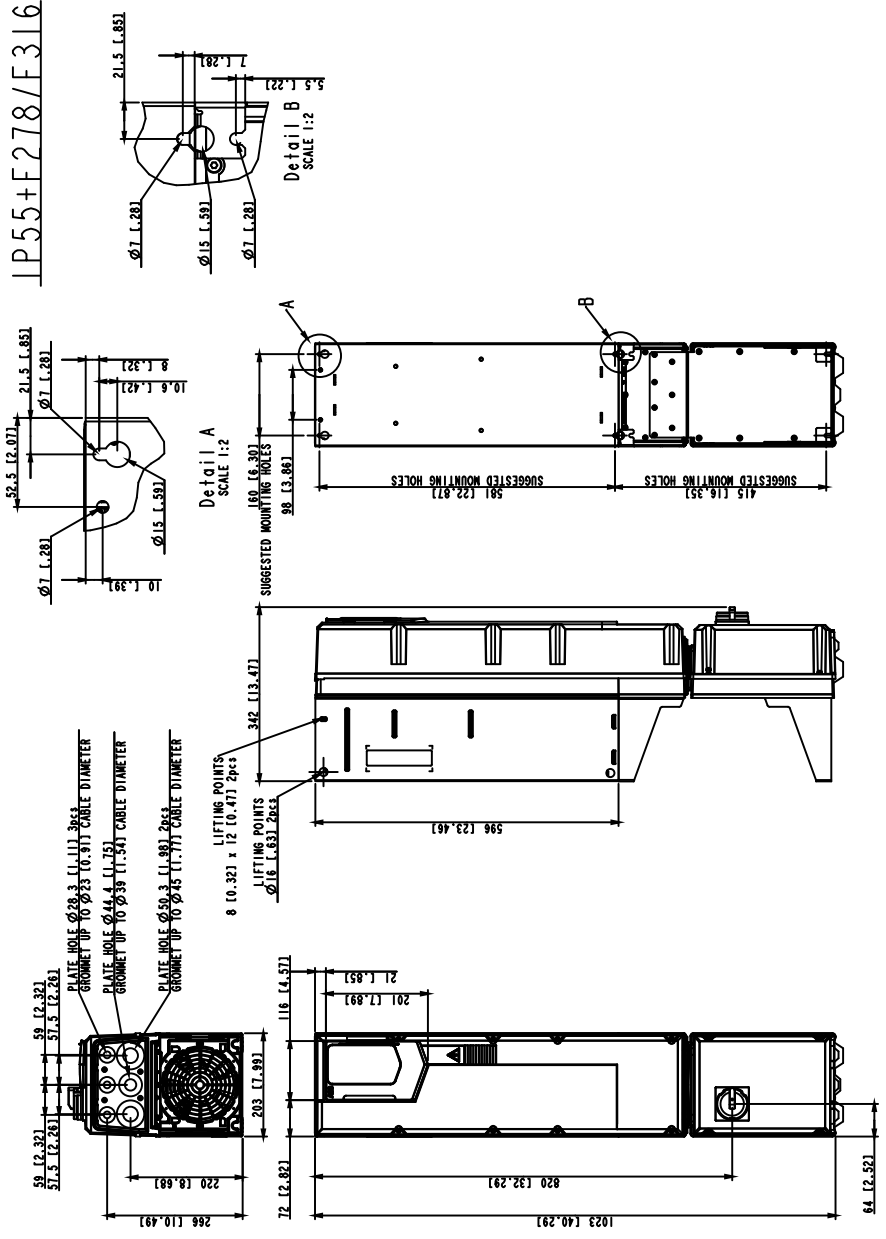
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# Frame R5, IP55+E223 (UL Type 12)



# Frame R5, IP55+F278/F316 (UL Type 12)

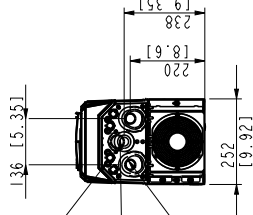
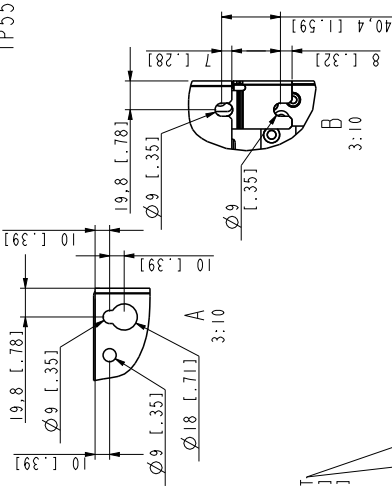
IP55+F278/F316





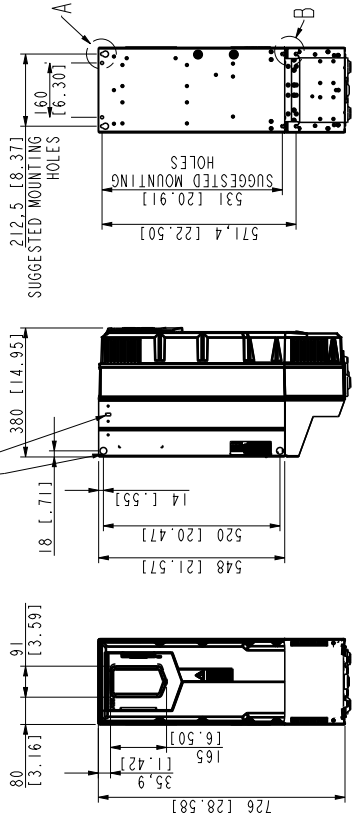
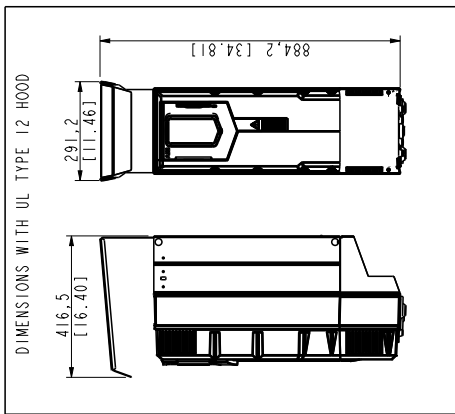
# Frame R6, IP55 (UL Type 12)

IP55



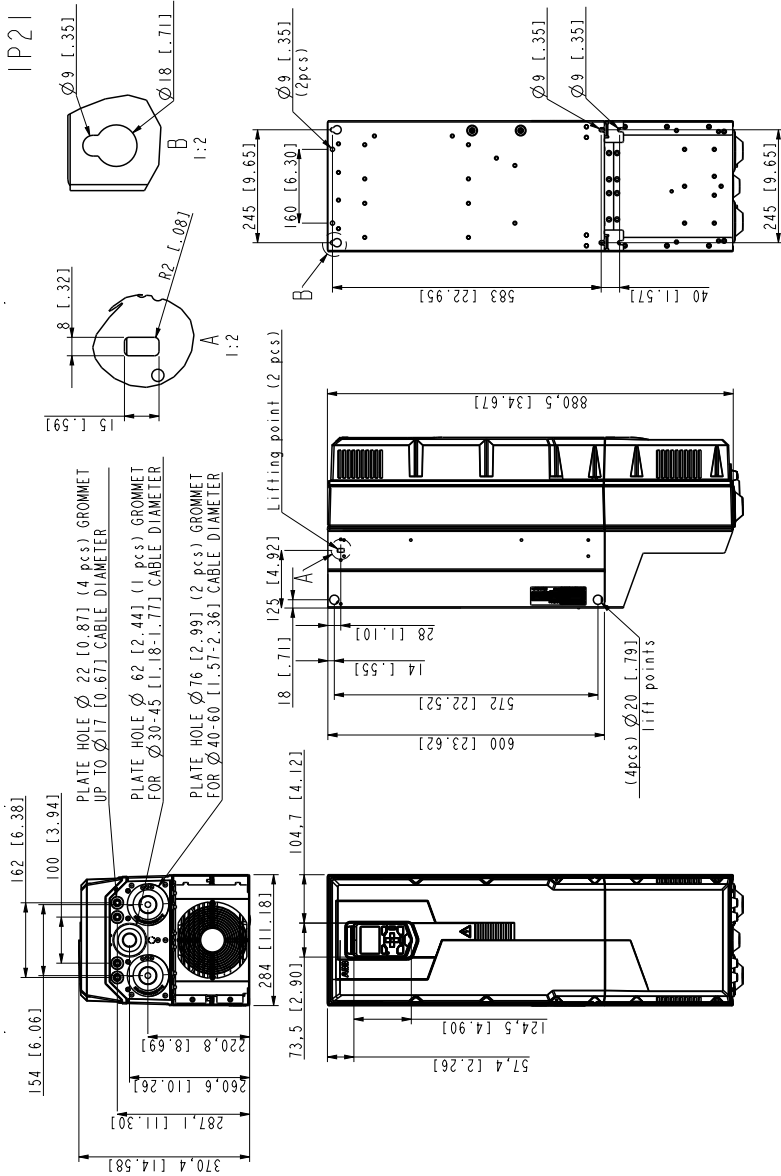
- PLATE HOLE  $\varnothing 22.5$  [0.89] (4PCS)  
GROMMET UP TO  $\varnothing 17$  [0.67]  
CABLE DIAMETER
- PLATE HOLE  $\varnothing 50$  [1.97]  
GROMMET FOR  $\varnothing 26-35$  [1.02-1.38]  
CABLE DIAMETER
- PLATE HOLE  $\varnothing 62$  [2.44]  
GROMMET FOR  $\varnothing 30-45$  [1.18-1.77]  
CABLE DIAMETER

- LIFTING POINT  
4 PCS  $\varnothing 20$  [0.79]  
2 PCS 15x8 [0.59x0.32]



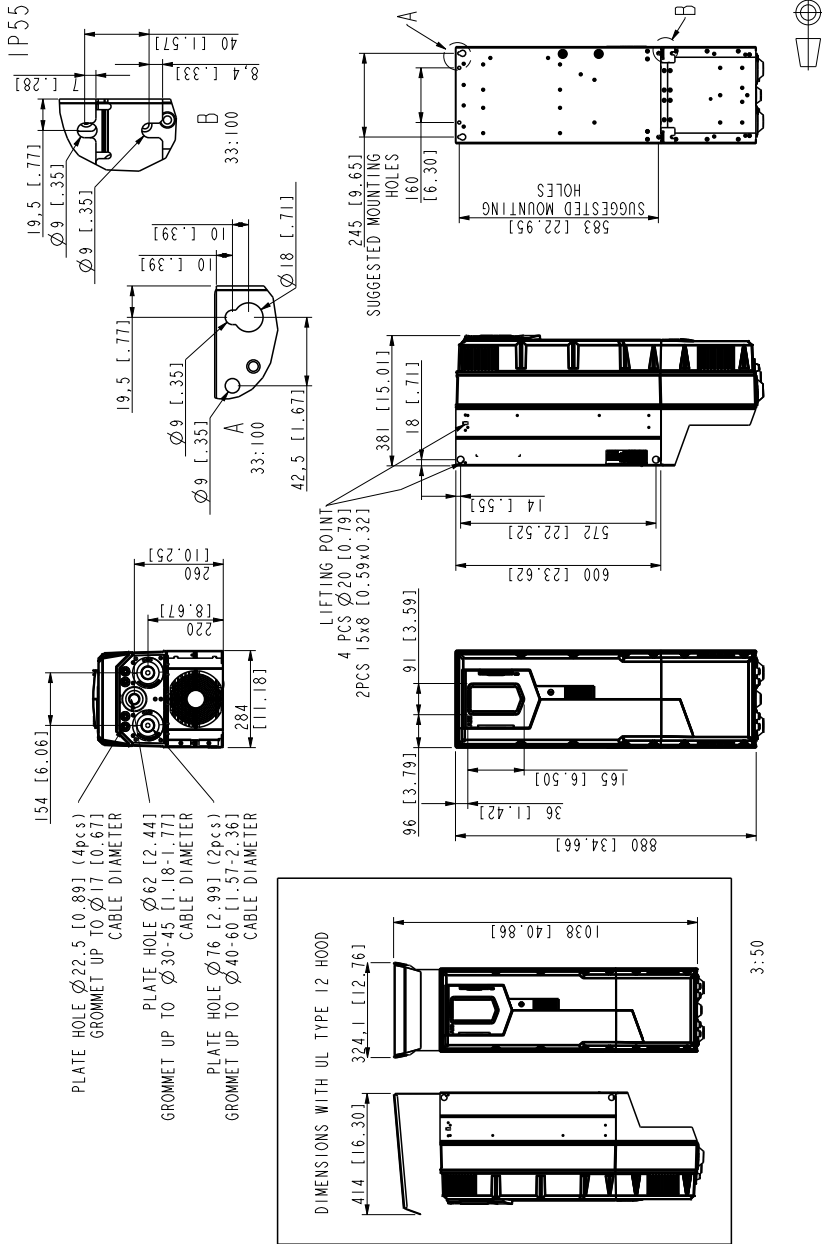
3AXD10000330667

# Frame R7, IP21 (UL Type 1)



3AXD1000258995

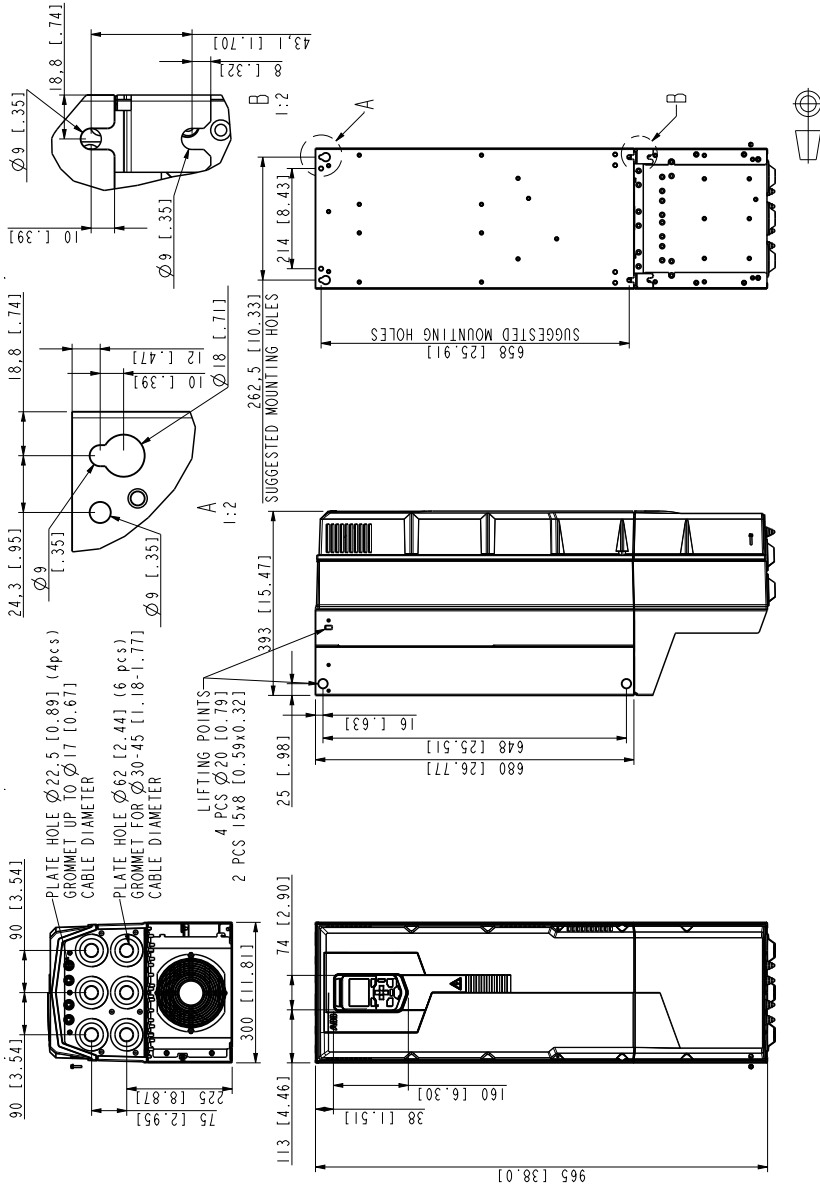
# Frame R7, IP55 (UL Type 12)



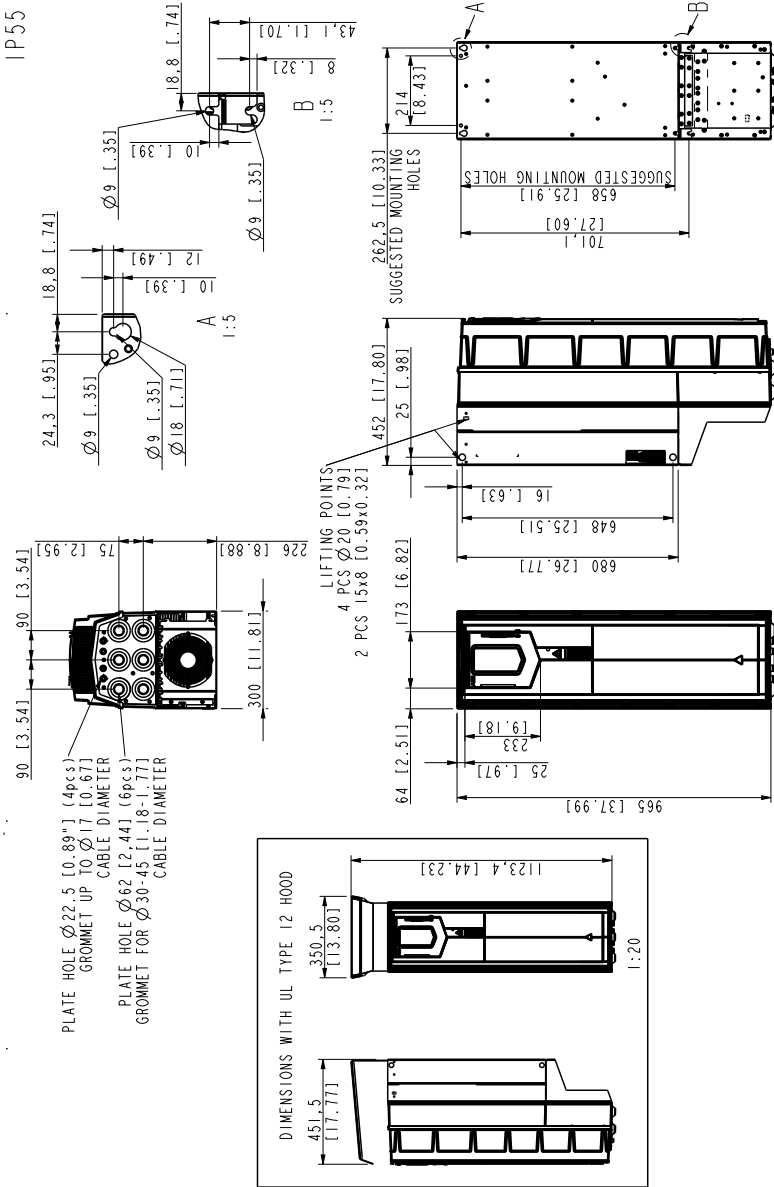
3AXD1000030932



# Frame R8, IP21 (UL Type 1)

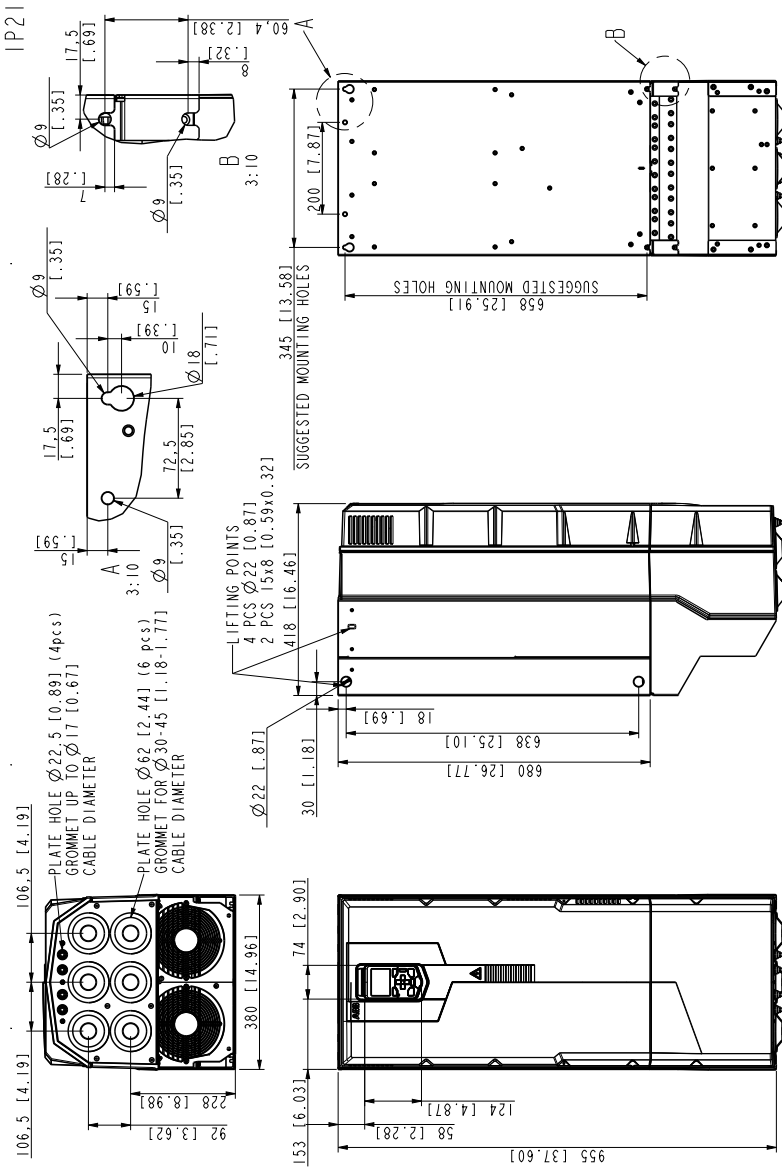


# Frame R8, IP55 (UL Type 12)



3AXD10000332446

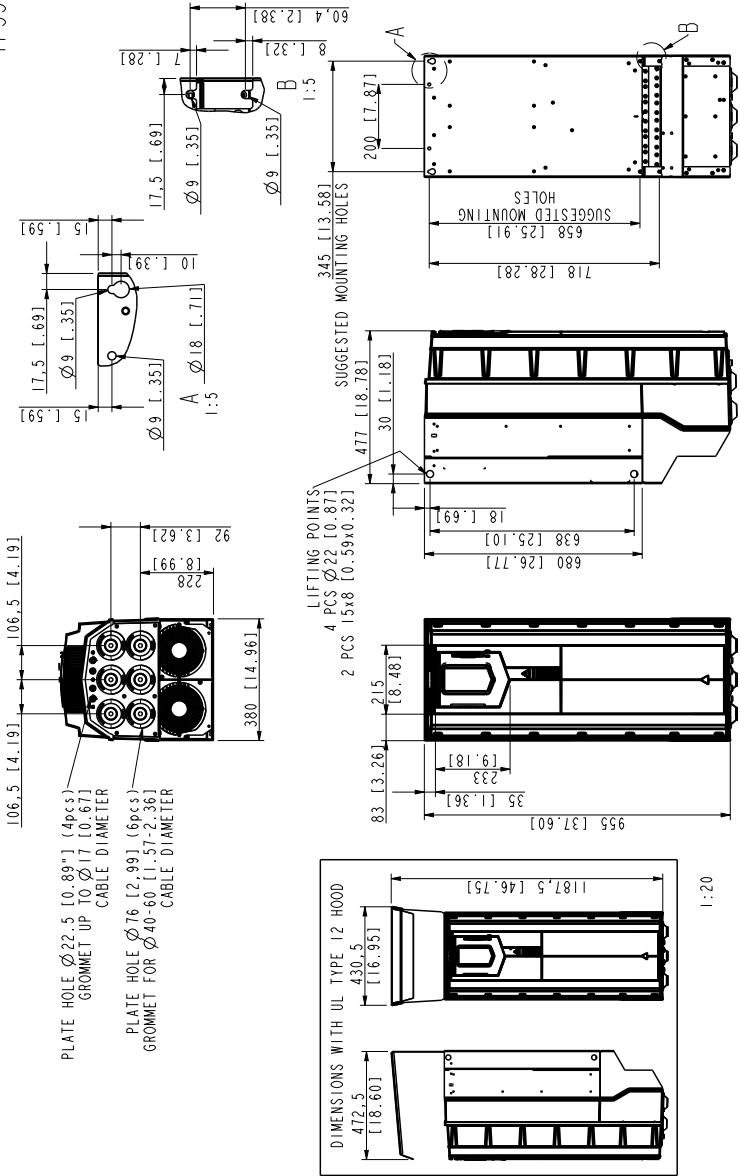
# Frame R9, IP21 (UL Type 1)



3AXD10000287428

# Frame R9, IP55 (UL Type 12)

IP55



3AXD10000334310

# 14

## Resistor braking

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### Contents of this chapter

This chapter contains information and instructions on resistor braking, brake choppers and brake resistors.

### Operation principle

The brake chopper handles the extra energy generated by motor during a quick deceleration. The extra energy increases the drive DC link voltage. The chopper connects the brake resistor to the DC link whenever the voltage is greater than the limit defined by the control program. Energy consumption by the resistor losses lowers the voltage until the resistor can be disconnected.

### Resistor braking, frames R1...R3

#### ■ Planning the braking system

#### Selecting the brake resistor

Frames R1...R3 have an built-in brake chopper as standard equipment. The brake resistor is selected using the table and equations presented in this section.

1. Determine the required maximum braking power  $P_{Rmax}$  for the application.  $P_{Rmax}$  must be smaller than  $P_{BRmax}$  given in the table on page 398 for the used drive type.
  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 greater 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  $T$ .

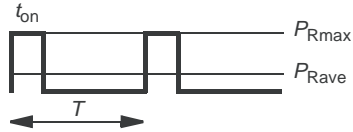
Equations for selecting the resistor:

Eq. 1.  $U_N = 400V : R = \frac{450000}{P_{Rmax}}$

$U_N = 480V : R = \frac{615000}{P_{Rmax}}$

Eq. 2.  $E_{Rpulse} = P_{Rmax} \cdot t_{on}$

Eq. 3.  $P_{Rave} = P_{Rmax} \cdot \frac{t_{on}}{T}$



For conversion, use 1 hp = 746 W.

where

$R$  = 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)

$t_{on}$  = length of the braking pulse (s)

$T$  = length of the braking cycle (s).

The tables below show reference resistor types for the maximum braking power.

IEC

ACQ580-01-...	$R_{min}$	$R_{max}$	$P_{BRmax}$	Reference resistor types
	ohm	ohm	kW	
<b>3-phase <math>U_n = 230 V</math></b>				
04A7-2	25	205	0.7	Danotherm CBR-V 330 D T 406 78R UL
06A7-2	25	130	1.1	Danotherm CBR-V 330 D T 406 78R UL
07A6-2	25	95	1.5	Danotherm CBR-V 560 D HT 406 39R UL
012A-2	25	48	3.0	Danotherm CBR-V 560 D HT 406 39R UL
018A-2	25	35	4.1	-
024A-2	14	26	5.4	Danotherm CBT-H 560 D HT 406 19R
032A-2	14	19	7.4	Danotherm CBT-H 760 D HT 406 16R

ACQ580-01-...	$R_{min}$	$R_{max}$	$P_{BRmax}$	Reference resistor types
	ohm	ohm	kW	
047A-2	6.0	13	11	SAFUR90F575
060A-2	6.0	9.0	16	SAFUR90F575
<b>3-phase <math>U_n = 400</math> or <math>480</math> V</b>				
02A7-4	52	864	0.6	Danotherm CBH 360 C T 406 210R
03A4-4	52	582	0.9	Danotherm CBH 360 C T 406 210R
04A1-4	52	392	1.4	Danotherm CBH 360 C T 406 210R
05A7-4	52	279	2.0	Danotherm CBH 360 C T 406 210R
07A3-4	52	191	2.9	Danotherm CBR-V 330 D T 406 78R UL
09A5-4	52	140	3.9	Danotherm CBR-V 330 D T 406 78R UL
12A7-4	52	104	5.3	Danotherm CBR-V 330 D T 406 78R UL
018A-4	31	75	7.3	Danotherm CBR-V 560 D HT 406 39R UL
026A-4	22	52	10	Danotherm CBR-V 560 D HT 406 39R UL
033A-4	16	37	15	Danotherm CBT-H 560 D HT 406 19R
039A-4	10	27	20	Danotherm CBT-H 760 D HT 406 16R
046A-4	10	22	25	Danotherm CBT-H 760 D HT 406 16R

UL (NEC)

ACQ580-01-...	$R_{min}$	$R_{max}$	$P_{BRmax}$		Reference resistor types
	ohm	ohm	kW	hp	
<b>3-phase <math>U_1 = 208...240</math> V, <math>P_n</math> at <math>U_n = 208/230</math> V</b>					
04A6-2	25	205	0.7	0.9	Danotherm CBR-V 330 D T 406 78R UL
06A6-2	25	130	1.1	1.5	Danotherm CBR-V 330 D T 406 78R UL
07A5-2	25	95	1.5	2.0	Danotherm CBR-V 560 D HT 406 39R UL
10A6-2	25	65	2.2	2.9	Danotherm CBR-V 560 D HT 406 39R UL
017A-2	25	35	4.0	5.4	TBD
024A-2	14	26	5.4	7.2	Danotherm CBT-H 560 D HT 406 19R
031A-2	14	19	7.4	9.9	Danotherm CBT-H 560 D HT 406 16R
046A-2	7	13	11	14.7	SAFUR90F575
059A-2	7	9	16	21.4	SAFUR90F575
<b>3-phase <math>U_1 = 440...480</math> V, <math>P_n</math> at <math>U_n = 480</math> V</b>					

## 400 Resistor braking

ACQ580-01-...	$R_{min}$	$R_{max}$	$P_{BRmax}$		Reference resistor types
	ohm	ohm	kW	hp	
02A1-4	52	864	0.6	0.8	Danotherm CBH 360 C T 406 210R
03A0-4	52	582	0.9	1.2	Danotherm CBH 360 C T 406 210R
03A5-4	52	392	1.4	1.9	Danotherm CBH 360 C T 406 210R
04A8-4	52	279	2.0	2.7	Danotherm CBH 360 C T 406 210R
06A0-4	52	191	2.9	3.9	Danotherm CBR-V 330 D T 406 78R UL
07A6-4	52	140	3.9	5.2	Danotherm CBR-V 330 D T 406 78R UL
012A-4	52	104	5.3	7.1	Danotherm CBR-V 330 D T 406 78R UL
014A-4	31	75	7.3	9.8	Danotherm CBR-V 560 D HT 406 39R UL
023A-4	22	52	10	13.6	Danotherm CBR-V 560 D HT 406 39R UL
027A-4	16	37	15	20.1	Danotherm CBT-H 560 D HT 406 19R
034A-4	10	27	20	26.8	Danotherm CBT-H 760 D HT 406 16R
044A-4	10	22	25	33.5	Danotherm CBT-H 760 D HT 406 16R
<b>3-phase <math>U_1 = 525...600</math> V, <math>P_n</math> at <math>U_n = 575</math> V</b>					
02A7-6	60	600	1.5	2.09	Danotherm CBR-V 330 D T 406 78R UL
03A9-6	60	450	2.2	2.7	Danotherm CBR-V 330 D T 406 78R UL
06A1-6	60	225	4.0	5.4	Danotherm CBR-V 330 D T 406 78R UL
09A0-6	60	165	5.4	7.2	Danotherm CBR-V 330 D T 406 78R UL
011A-6	60	120	7.4	9.9	Danotherm CBR-V 330 D T 406 78R UL
017A-6	60	82	11	14.7	Danotherm CBR-V 330 D T 406 78R UL
022A-6	25	56	16	21.4	Danotherm CBR-V 560 D HT 406 39R UL
027A-6	25	43	21	28.2	Danotherm CBR-V 560 D HT 406 39R UL
032A-6	25	35	26	34.9	TBD

### Symbols

$R_{min}$  = minimum allowed brake resistor that can be connected to the brake chopper

$R_{max}$  = maximum allowed brake resistor that allows  $P_{BRmax}$

$P_{BRmax}$  = maximum braking capacity of the drive, must exceed the desired braking power.



### WARNING!

Do not use a brake resistor with a resistance below the minimum value specified for the particular drive. The drive and the internal chopper are not able to handle the overcurrent caused by the low resistance.



## Selecting and routing the brake resistor cables

Use a shielded cable with the conductor size specified in section Terminal and entry data for the power cables on page [Terminal and entry data for the power cables \(page 324\)](#).

### Minimizing electromagnetic interference

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

- Install the cables away from other cable routes.
- Avoid long parallel runs with other cables. The minimum parallel cabling separation distance should be 0.3 meters.
- Cross the other cables at right angles.
- Keep the cable as short as possible in order to minimize the radiated emissions and stress on chopper IGBTs. The longer the cable the higher the radiated emissions, inductive load and voltage peaks over the IGBT semiconductors of the brake chopper.

**Note:** ABB has not verified that the EMC requirements are fulfilled with external user-defined brake resistors and cabling. The EMC compliance of the complete installation must be considered by the customer.

### Maximum cable length

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

## Placing the brake resistor

Install the resistors outside the drive in a place where they will cool.

Arrange the cooling of the resistor in a way that:

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

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



### **WARNING!**

The materials near the brake resistor must be non-flammable. The surface temperature of the resistor is high. 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

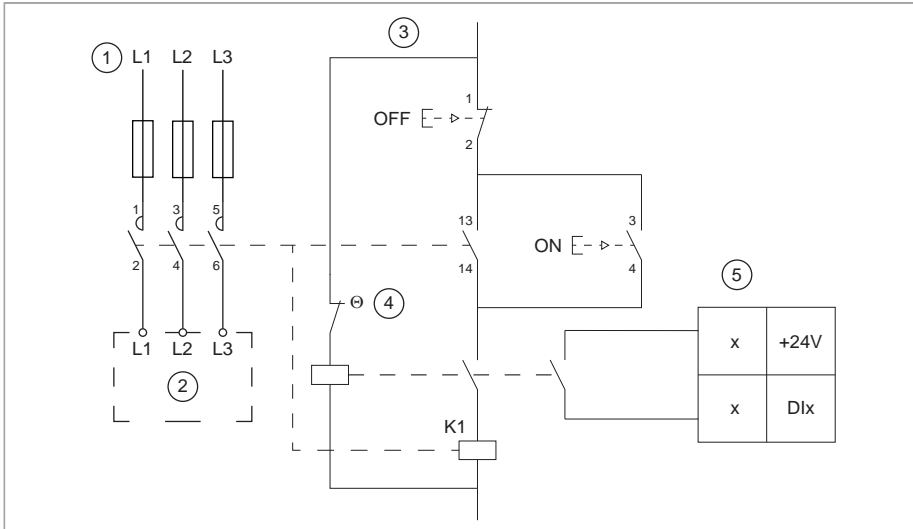
The drive input fuses will also protect the resistor cable when it is identical with the input power cable.

Protecting the system against thermal overload

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

ABB recommends to equip the drive with a main contactor for safety reasons even when you have enabled the resistor thermal model. Wire the contactor so that it opens in case the resistor overheats. This is essential for safety since the drive will not otherwise be able to interrupt the main supply if the chopper remains conductive in a fault situation. An example wiring diagram is shown below. ABB recommends that you use resistors equipped with a thermal switch (1) inside the resistor assembly. The switch indicates overtemperature.

ABB recommends that you also wire 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 installation

All brake resistors must be installed outside the drive. Follow the resistor manufacturer's instructions.

## ■ Electrical installation

### Checking the insulation of the assembly

Follow the instructions given in section [Brake resistor assembly for R1...R3 \(page 129\)](#) or [Brake resistor assembly for R1...R3 \(page 173\)](#) (North America).

### Connection diagram

See section [Connection diagram \(page 137\)](#) (IEC) or [Connection diagram \(page 182\)](#) (North America).

### Connection procedure

See section [Grounding shelf \(page 144\)](#).

Connect the thermal switch of the brake resistor as described in [Protecting the system against thermal overload \(page 402\)](#).

## ■ Start-up

### Start-up

---



#### **WARNING!**

Make sure that there is sufficient ventilation. New brake resistors can have a protective grease coating. When the resistor warms up for the first time, the grease burns off and can produce some smoke.

---

Set the following parameters (Pump control program):

- Set parameter 30.30 Overvoltage control to disable.
- Set parameter 31.01 External event 1 source to point to the digital input where the thermal switch of the brake resistor is wired.
- Set parameter 31.02 External event 1 type to Fault.
- Set parameter 43.06 Brake chopper function to Enable. If you select Enabled with thermal model, set also the brake resistor overload protection parameters 43.08 and 43.09 according to the application.
- Check the resistance value of parameter 43.10 Brake resistance.

With these parameter settings, the drive stops by coasting on brake resistor overtemperature.

---

**WARNING!**

If you disable the brake chopper by parameter, also disconnect the brake resistor cable from the drive. Otherwise, there is a risk of resistor overheating and damage.

## Resistor braking, frames R4...R9

### ■ Planning the braking system

Frames R4...R9 need external brake choppers and resistors. The table below lists suitable choppers and resistors.

#### IEC

ACQ580-01-...	Brake chopper	R <sub>min</sub>	R <sub>max</sub>	P <sub>BRmax</sub>	Reference resistor types <sup>1)</sup>
		ohm	ohm	kW	
<b>3-phase U<sub>n</sub> = 230 V</b>					
076A-2	NBRA-658	2.6	7.0	21	SAFUR125F500
089A-2	NBRA-658	2.0	5.6	26	SAFUR125F500
115A-2	NBRA-658	2.0	4.7	31	SAFUR125F500
144A-2	NBRA-658	2.0	3.4	43	SAFUR200F500
171A-2	NBRA-658	1.3	2.8	53	SAFUR200F500
213A-2	NBRA-658	1.3	2.3	64	2xSAFUR210F575
276A-2	NBRA-658	0.9	1.9	78	2xSAFUR210F575
<b>3-phase U<sub>n</sub> = 400 or 480 V (380...415 V, 440...480 V)</b>					
062A-4	ACS-BRK-D	7.8	18.1	30	Built in with the brake chopper
073A-4	ACS-BRK-D	7.8	13.1	42	Built in with the brake chopper
089A-4	ACS-BRK-D	7.8	10.7	51	Built in with the brake chopper
106A-4	NBRA-658	1.3	8.7	63	SAFUR125F500
145A-4	NBRA-658	1.3	7.1	77	SAFUR125F500
169A-4	NBRA-658	1.3	5.2	105	SAFUR200F500
206A-4	NBRA-658	1.3	4.3	126	SAFUR200F500
246A-4	NBRA-658	1.3	3.5	156	2xSAFUR125F500
293A-4	NBRA-658	1.3	2.9	187	2xSAFUR210F575
363A-4	NBRA-659	0.7	2.4	227	2xSAFUR200F500
430A-4	NBRA-659	0.7	1.9	284	2xSAFUR200F500

ACQ580-01-...	Brake chopper	R <sub>min</sub>	R <sub>max</sub>	P <sub>BRmax</sub>	Reference resistor types <sup>1)</sup>
		ohm	ohm	kW	
490A-4	NBRA-659	0.7	1.9	332	2xSAFUR200F500

<sup>1)</sup> Other resistors can be used if they meet the minimum resistance value and required power values.

## UL (NEC)

ACQ580-01-...	R <sub>min</sub>	R <sub>max</sub>	P <sub>BRmax</sub>	Reference resistor types
	ohm	ohm	kW	
<b>3-phase U<sub>1</sub> = 208...240 V, P<sub>n</sub> at U<sub>n</sub> = 208/230 V</b>				
075A-2	2.6	7.0	21	SAFUR125F500
088A-2	2	5.6	26	SAFUR125F500
114A-2	2	4.7	31	SAFUR125F500
143A-2	2	3.4	43	SAFUR200F500
169A-2	1.3	2.8	53	SAFUR200F500
211A-2	1.3	2.3	64	2xSAFUR210F575
273A-2	0.9	1.9	78	2xSAFUR210F575
343A-2	0.65	1.8	106	2x(2xSAFUR210F575)
396A-2	0.65	1.1	133	2x(2xSAFUR210F575)
<b>3-phase U<sub>1</sub> = 440...480 V, P<sub>n</sub> at U<sub>n</sub> = 480 V</b>				
052A-4	7.8	18.1	30	Built in with the brake chopper
065A-4	7.8	13.1	42	Built in with the brake chopper
077A-4	-	-	-	-
078A-4	7.8	10.7	51	Built in with the brake chopper
096A-4	1.3	8.7	63	SAFUR125F500
124A-4	1.3	7.1	77	SAFUR125F500
156A-4	1.3	5.2	105	SAFUR200F500
180A-4	1.3	4.3	126	SAFUR200F500
240A-4	1.3	3.5	156	2xSAFUR125F500
260A-4	1.3	2.9	187	2xSAFUR210F575
302A-4	-	-	-	-
361A-4	0.7	2.4	227	2xSAFUR200F500
414A-4	0.7	1.9	284	2xSAFUR200F500
<b>3-phase U<sub>1</sub> = 525...600 V, P<sub>n</sub> at U<sub>n</sub> = 575 V</b>				

## 406 Resistor braking

ACQ580-01-...	$R_{min}$	$R_{max}$	$P_{BRmax}$	Reference resistor types
	ohm	ohm	kW	
041A-6	6.5	30	31	SAFUR90F575
052A-6	6.5	21	43	SAFUR90F575
062A-6	6.5	17	53	SAFUR90F575
077A-6	6.5	14	64	SAFUR90F575
099A-6	4.3	11.5	78	SAFUR80F500
125A-6	4.3	8.5	107	SAFUR80F500
144A-6	3.2	7.0	128	SAFUR80F500
192A-6	2.2	5.8	157	SAFUR125F500
242A-6	2.2	4.8	188	2xSAFUR200F500
271A-6	2.2	4.0	228	2xSAFUR200F500

### Symbols

$R_{min}$	= minimum allowed brake resistor that can be connected to the brake chopper
$R_{max}$	= maximum allowed brake resistor that allows $P_{BRmax}$
$P_{BRmax}$	= maximum braking capacity of the drive, must exceed the desired braking power.



### WARNING!

Do not use a brake resistor with a resistance below the minimum value specified for the particular drive. The drive and the internal chopper are not able to handle the overcurrent caused by the low resistance.

### ■ Parameter settings for external braking chopper and resistor

Disable the overvoltage control of the drive with parameter 30.30 Overvoltage control.

Disable parameter 43.06 Braking chopper function as parameter group 43 Brake chopper is used for internal braking chopper and resistor only.

For more information, see *NBRA-6xx Braking Choppers Installation and start-up guide* (3AFY58920541 [English]) and *ACS-BRK Brake Units Installation and start-up guide* (3AFY61514309 [English]).

# 15

## The Safe torque off function

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### Contents of this chapter

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

### Description

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

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

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

---

The Safe torque off function complies with these standards:

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

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

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

See the technical data.

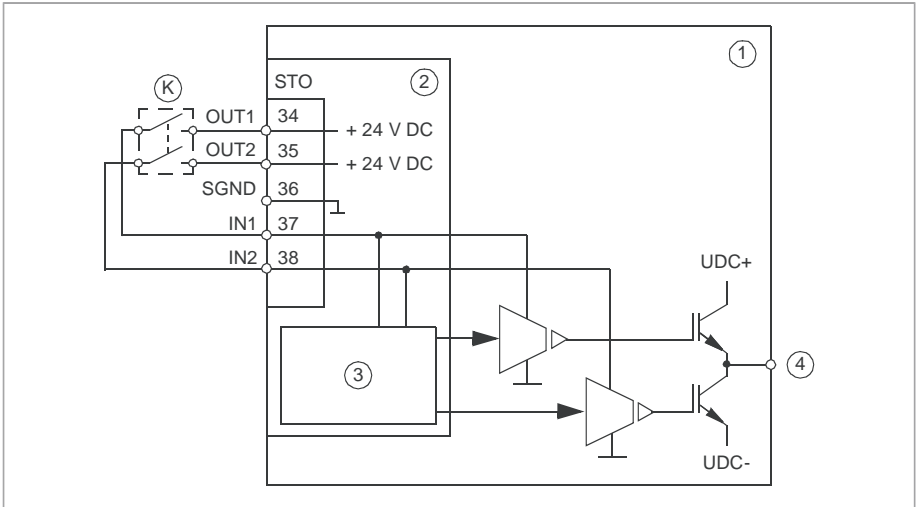


## Wiring

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

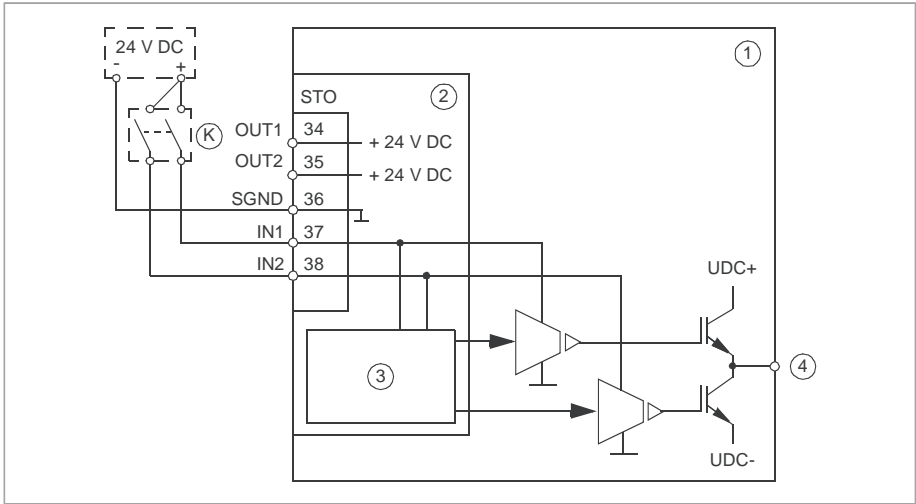
### ■ Connection principle

#### Single ACQ580-01 drive, internal power supply



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

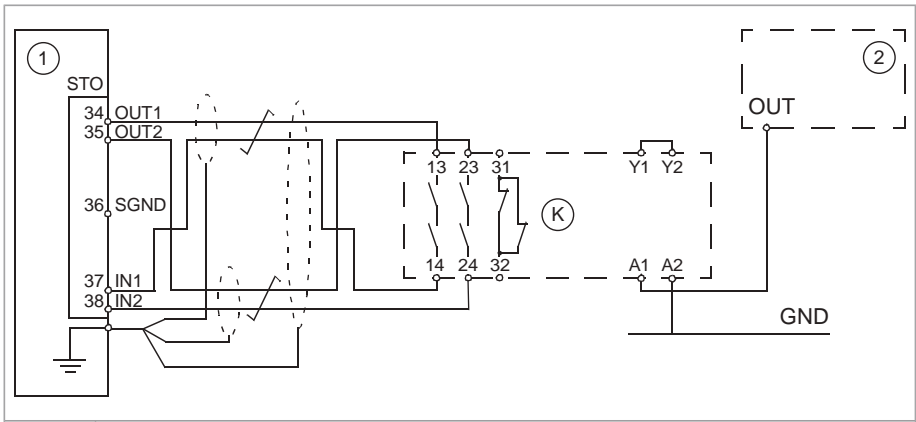
**Single ACQ580-01 drive, external power supply**



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

■ **Wiring examples**

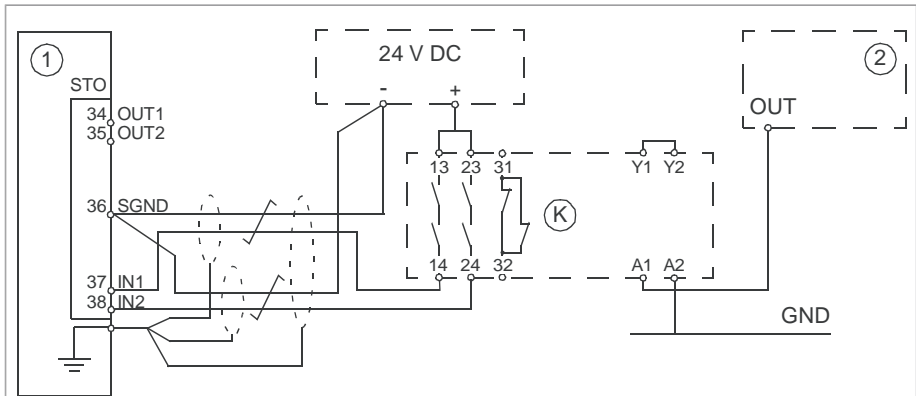
**Single ACQ580-01 drive, internal power supply**



1	Drive
---	-------

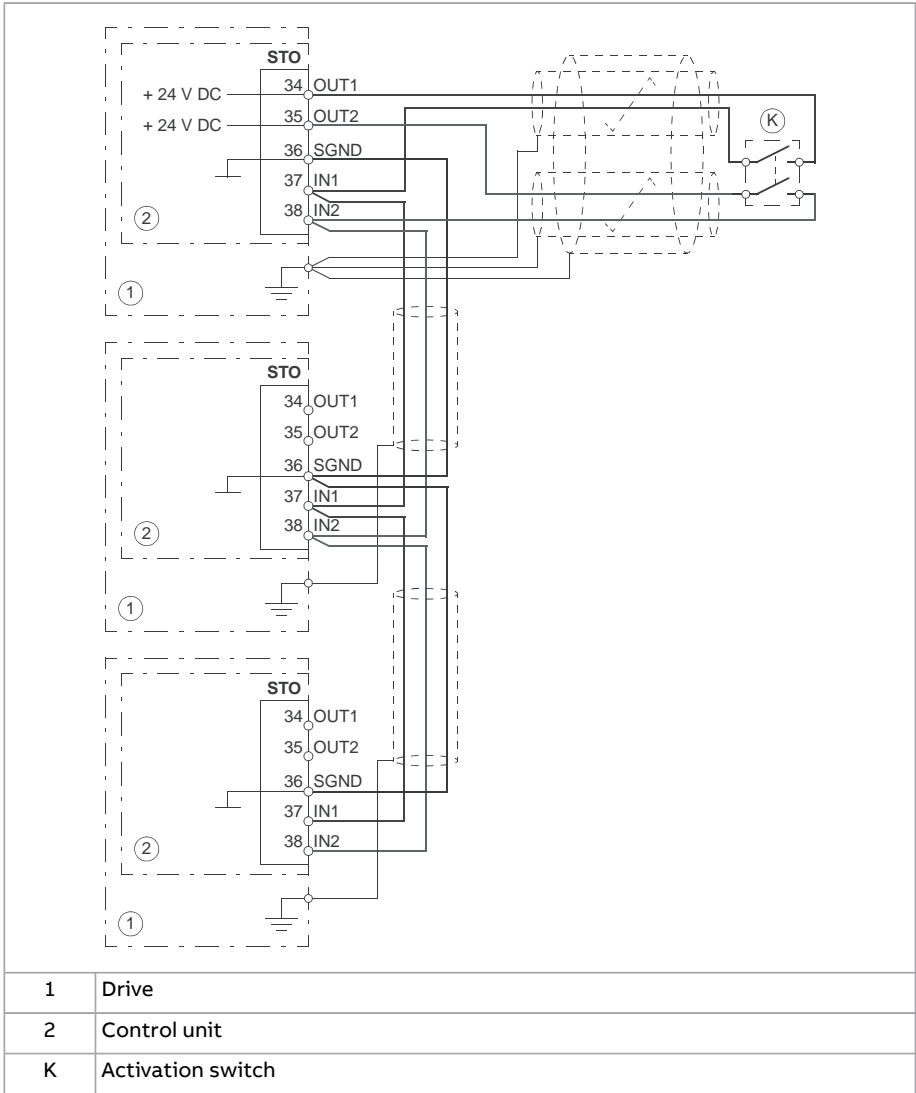
2	Safety PLC
K	Safety relay

**Single ACQ580-01 drive, external power supply**

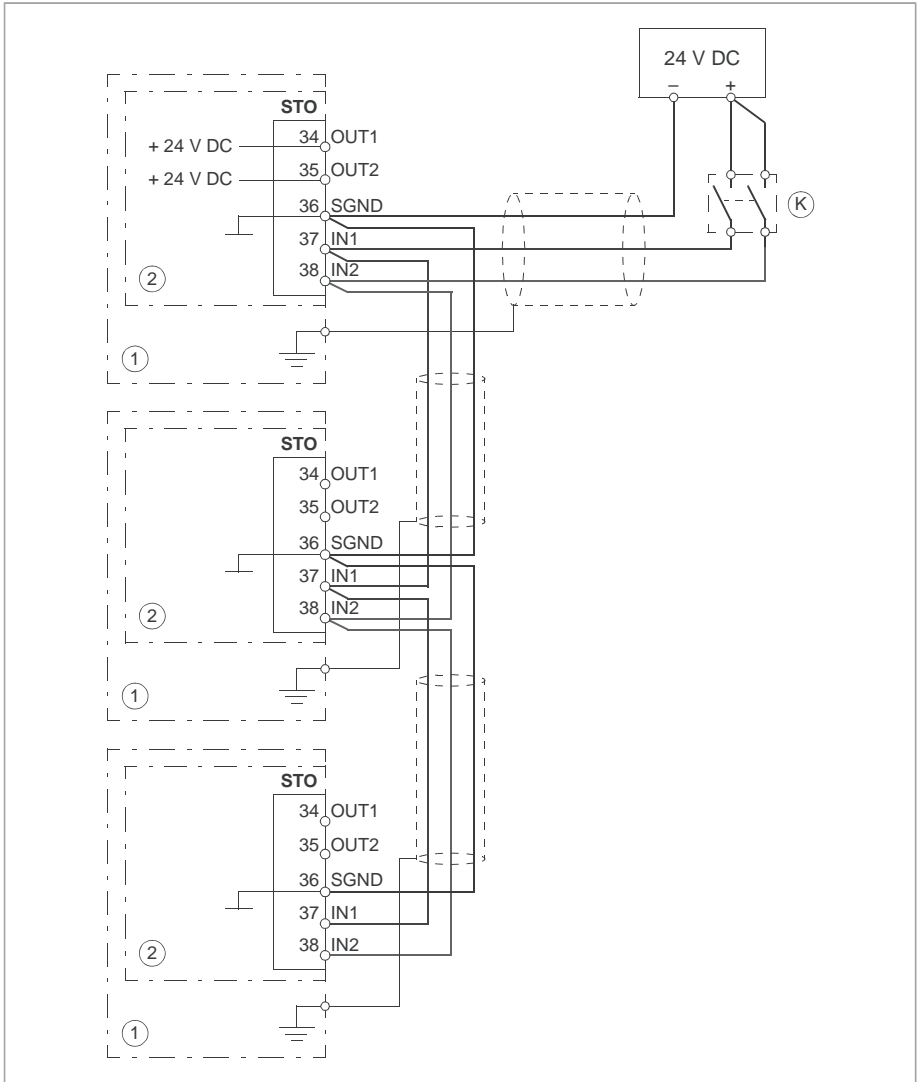


1	Drive
2	Safety PLC
K	Safety relay

**Multiple ACQ580-01 drives, internal power supply**



Multiple ACQ580-01 drives, external power supply



1	Drive
2	Control unit
K	Activation switch

### ■ Activation switch

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

- In case a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.
- The contacts of the switch or relay must open/close within 200 ms of each other.
- A CPTC thermistor protection module or an FSPS safety functions 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 relay contacts open).
2. The STO inputs of the drive control unit de-energize.
3. The control unit cuts off the control voltage from the output IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (see the firmware manual of the drive).

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

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

**Note:** The loss of only one STO signal always generates a fault as it is interpreted as a malfunction of STO hardware or wiring.

5. The motor coasts to a stop (if running). The drive cannot restart while the activation switch or safety relay contacts are open. After the contacts close, a reset may be needed (depending on the setting of parameter 31.22). A new start command is required to start the drive.
-

## Start-up including validation test

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

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

### ■ Competence

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


### ■ Validation test reports

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

### ■ Validation test procedure

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

**Note:** If a CPTC-02 or an FSPS-21 module is installed, refer to its documentation.

<b>Action</b>	<input checked="" type="checkbox"/>
 <b>WARNING!</b> Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	<input type="checkbox"/>
Make sure that the motor can be run and stopped freely during start-up.	<input type="checkbox"/>
Stop the drive (if running), switch the input power off and isolate the drive from the power line using a disconnecter.	<input type="checkbox"/>
Check the STO circuit connections against the wiring diagram.	<input type="checkbox"/>



<b>Action</b>	<input checked="" type="checkbox"/>
Close the disconnecter and switch the power on.	<input type="checkbox"/>
<p>Test the operation of the STO function when the motor is stopped.</p> <ul style="list-style-type: none"> <li>• Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill.</li> </ul> <p>Make sure that the drive operates as follows:</p> <ul style="list-style-type: none"> <li>• Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter 31.22 (see the firmware manual).</li> <li>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.</li> <li>• Close the STO circuit.</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> </ul>	<input type="checkbox"/>
<p>Test the operation of the STO function when the motor is running.</p> <ul style="list-style-type: none"> <li>• Start the drive and make sure the motor is running.</li> <li>• Open the STO circuit. The motor should stop. The drive generates an indication if one is defined for the 'running' state in parameter 31.22 (see the firmware manual).</li> <li>• Reset any active faults and try to start the drive.</li> <li>• 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.</li> <li>• Close the STO circuit.</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> </ul>	<input type="checkbox"/>
<p>Test the operation of the failure detection of the drive. The motor can be stopped or running.</p> <ul style="list-style-type: none"> <li>• Open the 1st input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA81 fault indication (see the firmware manual).</li> <li>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.</li> <li>• Open the STO circuit (both channels).</li> <li>• Give a reset command.</li> <li>• Close the STO circuit (both channels).</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> <li>• Open the 2nd input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA82 fault indication (see the firmware manual).</li> <li>• Give a start command to verify that the STO function blocks the drive's operation. The motor should not start.</li> <li>• Open the STO circuit (both channels).</li> <li>• Give a reset command.</li> <li>• Close the STO circuit (both channels).</li> <li>• Reset any active faults. Restart the drive and check that the motor runs normally.</li> </ul>	<input type="checkbox"/>
Document and sign the validation test report which verifies that the safety function is safe and accepted for operation.	<input type="checkbox"/>

## Use

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



### WARNING!

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

---



### WARNING!

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

This is also valid when the drive is only powered by a CMOD-xx multifunction 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  $180/2p$  degrees (with synchronous reluctance [SynRM] motors) regardless of the activation of the Safe torque off function.  $p$  denotes the number of pole pairs.

---

### Notes:

- If a running drive is stopped by using the Safe torque off function, the drive will cut off the motor supply voltage and the motor will coast to a stop. If this
-

causes danger or is not otherwise acceptable, stop the drive and machinery using the appropriate stop mode before activating the Safe torque off function.

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

## Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 10 years; see section [Safety data \(page 422\)](#). 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 \(page 416\)](#).

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

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

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

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

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

If any wiring or component change is needed after start-up, or the parameters are restored, do the test given in section [Validation test procedure \(page 416\)](#).

Use only spare parts approved by ABB.

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

### ■ Competence

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

---

## **Fault tracing**

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

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

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

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

## Safety data

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

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



Frame size	SIL	SC	PL	PFH ( $T_1 = 20$ a) (1/h)	PFDavg ( $T_1 = 2$ a) ( $T_1 = 5$ a)	PFDavg ( $T_1 = 5$ a)	PFDavg $T_1 = 10$ a	MTTFD (a)	DC (%)	SFF (%)	Cat.	HFT	CCF	$T_M$ (a)	PFHdiag (1/h)	$\lambda_{Diag_s}$ (1/h)	$\lambda_{Diag_d}$ (1/h)
$U_n = 600$ V																	
R2	3	3	e	2.67E-09	2.24E-05	5.57E-05	1.12E-04	2920	$\geq 90$	>99	3	1	80	20	1.53E-08	6.06E-08	2.89E-08
R3	3	3	e	2.61E-09	2.30E-05	5.72E-05	1.15E-04	2840	$\geq 90$	>99	3	1	80	20	1.53E-08	6.06E-08	2.89E-08
R5	3	3	e	2.59E-09	2.28E-05	5.69E-05	1.14E-04	2856	$\geq 90$	>99	3	1	80	20	1.53E-08	6.06E-08	1.36E-08
R7																	
R8	3	3	e	4.25E-09	3.72E-05	9.29E-05	1.86E-04	2805	$\geq 90$	>99	3	1	80	20	3.00E-12	1.96E-07	3.00E-10
R9																	
3AXD10001613533 C																	



- The STO is a type B safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested
  - A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO response times:
  - STO reaction time (shortest detectable break): 1 ms
  - STO response time: 2 ms (typical), 5 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 <sub>D</sub>	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 <sub>avg</sub>	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 <sub>diag</sub>	IEC/EN 62061	Average frequency of dangerous failures per hour for the diagnostic function of STO
PL	EN ISO 13849-1	Performance level. Levels a...e correspond to SIL
Proof test	IEC 61508, IEC 62061	Periodic test performed to detect failures in a safety-related system so that, if necessary, a repair can restore the system to an "as new" condition or as close as practical to this condition
SC	IEC 61508	Systematic capability (1...3)
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1...3)
STO	IEC/EN 61800-5-2	Safe torque off
$T_1$	IEC 61508-6	Proof test interval. $T_1$ is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of $T_1$ is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. See also section Maintenance.
$T_M$	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any $T_M$ values given cannot be regarded as a guarantee or warranty.
$\lambda_{\text{Diag}_d}$	IEC 61508-6	Dangerous failure rate (per hour) of the diagnostics function of STO
$\lambda_{\text{Diag}_s}$	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

## Optional I/O extension and adapter modules

---

### Contents of this chapter

This chapter describes how to install and start up the optional CAIO-01, CHDI-01, CMOD-01 and CMOD-02 IO multifunction extension modules. The chapter also contains diagnostics and technical data.

### CAIO-01 bipolar analog I/O adapter module

#### ■ Contents of this chapter

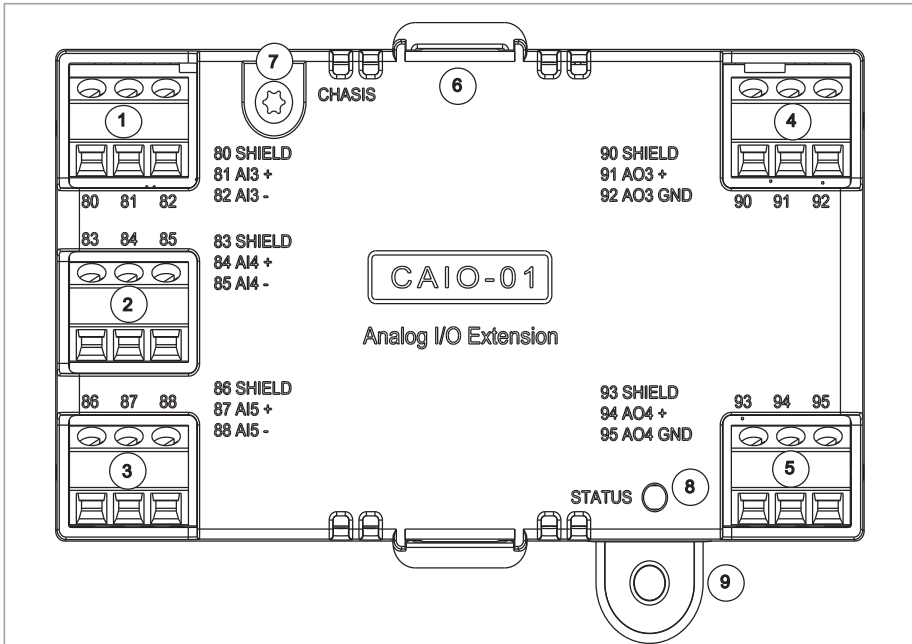
This chapter describes how to install and start up the optional CAIO-01 multifunction extension module. The chapter also contains diagnostics and technical data.

#### ■ Product overview

The CAIO-01 bipolar analog I/O module expands the inputs and outputs of the drive control unit. It has three bipolar current/voltage inputs and two unipolar current/voltage outputs. The inputs can handle positive and negative signals. The way the drive interprets the negative range of the inputs depends on the parameter settings of the drive. The voltage/current selection of the inputs is done with a parameter.

---

■ **Layout**



1, 2, 3	Analog inputs		4, 5	Analog outputs	
80	SHIELD	Cable shield connection	90	SHIELD	Cable shield connection
81	AI3+	Analog input 3 positive signal	91	AO3	Analog output 3 signal
82	AI3-	Analog input 3 negative signal	92	AGND	Analog ground potential
83	SHIELD	Cable shield connection	93	SHIELD	Cable shield connection
84	AI4+	Analog input 4 positive signal	94	AO4	Analog output 4 signal
85	AI4-	Analog input 4 negative signal	95	AGND	Analog ground potential
86	SHIELD	Cable shield connection			
87	AI5+	Analog input 5 positive signal			
88	AI5-	Analog input 5 negative signal			
6	Control unit slot interface				
7	Grounding hole				
8	Diagnostic LED				
9	Mounting hole				

## ■ Mechanical installation

### Necessary tools

- Screwdriver and a set of suitable bits.

### Unpacking and examining the delivery

1. Open the option package. Make sure that the package contains:
  - the option module
  - a mounting screw.
2. Make sure that there are no signs of damage.

### Installing the module

See section [Installing option modules \(page 162\)](#).

## ■ Electrical installation

---



### **WARNING!**

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

---

Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.

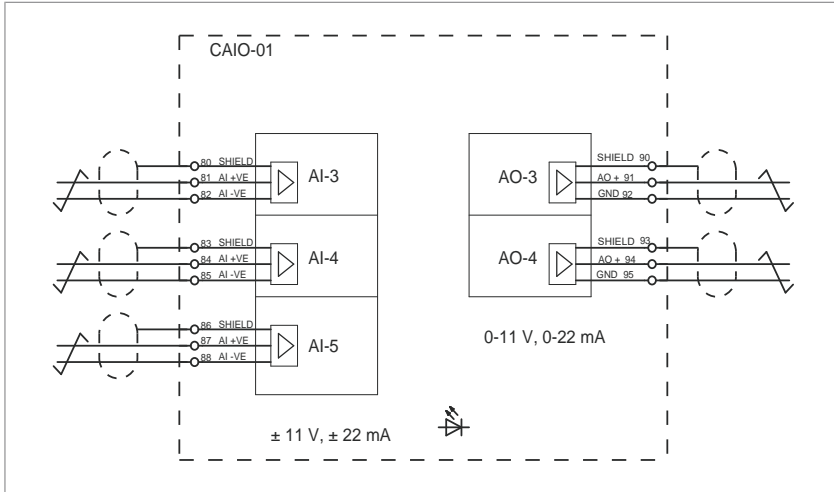
### Necessary tools

- Screwdriver and a set of suitable bits.

### Wiring

Connect the external cables to the applicable module terminals. Ground the outer shield of the cables to the SHIELD terminal.

---



■ **Start-up**

**Setting the parameters**

1. Power up the drive.
2. If no warning is shown,
  - make sure that the value of both parameters 15.01 Extension module type and 15.02 Detected extension module is CAIO-01.
 If warning A7AB Extension I/O configuration failure is shown,
  - make sure that the value of 15.02 is CAIO-01
  - set the value of parameter 15.01 to CAIO-01.
 You can now see the parameters of the extension module in group 15 I/O extension module.
3. Set the parameters of analog inputs AI3, AI4, AI5 or analog outputs AO3 or AO4 to applicable values, see the firmware manual.

Example: To connect supervision 1 to AI3 of the extension module:

- Select the mode of the supervision function (32.05 Supervision function 1).
- Set limits for the supervision function (32.09 Supervision 1 low and 32.10 Supervision 1 high).
- Select the supervision action (32.06 Supervision 1 action).
- Connect 32.07 Supervision 1 signal to 15.52 AI3 scaled value.

## ■ Diagnostics

### LEDs

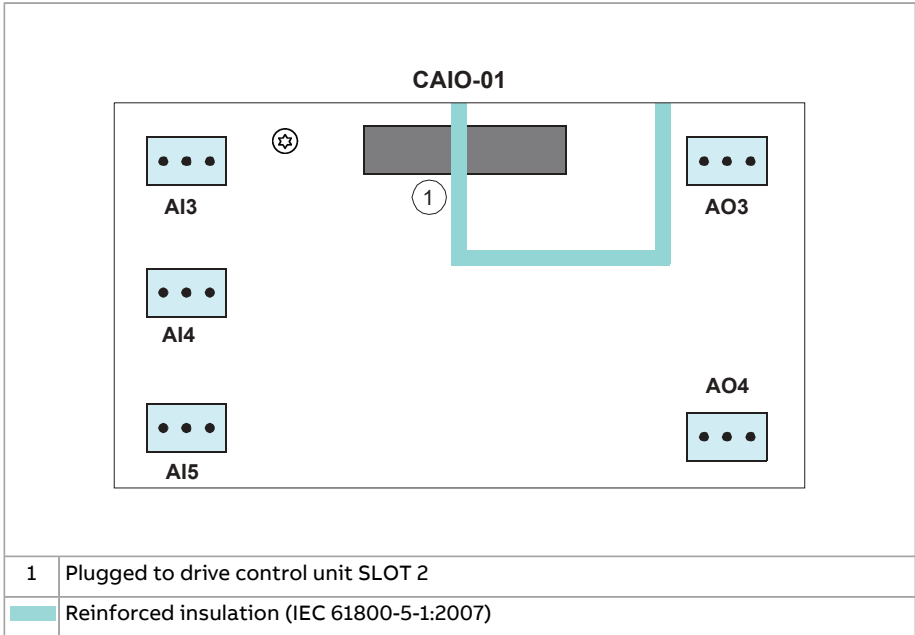
The adapter module has one diagnostic LED.

Color	Description
Green	The adapter module is powered up.
Red	There is no communication with the drive control unit or the adapter module has detected an error.

## ■ Technical data

Installation	Into slot 2 of drive control unit
Degree of protection	IP20 / UL 1 Type
Ambient conditions	See the drive technical data.
Package	Cardboard
<b>Analog inputs (80..82, 83..85, 86..88)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Input voltage ( AI+ and AI-)	-11 V ... +11 V
Input current ( AI+ and AI-)	-22 mA ... +22 mA
Input resistance	>200 kohm (voltage mode), 100 ohm (current mode)
Optional cable shield connections	
<b>Analog outputs (90..92, 93..95)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Output voltage (AO+ and AO-)	0 V ... +11 V
Output current (AO+ and AO-)	0 mA ... +22 mA
Output resistance	< 20 ohm
Recommended load	>10 kohm
Inaccuracy	± 1% Typical, ± 1.5% Max of full-scale value
Optional cable shield connections	

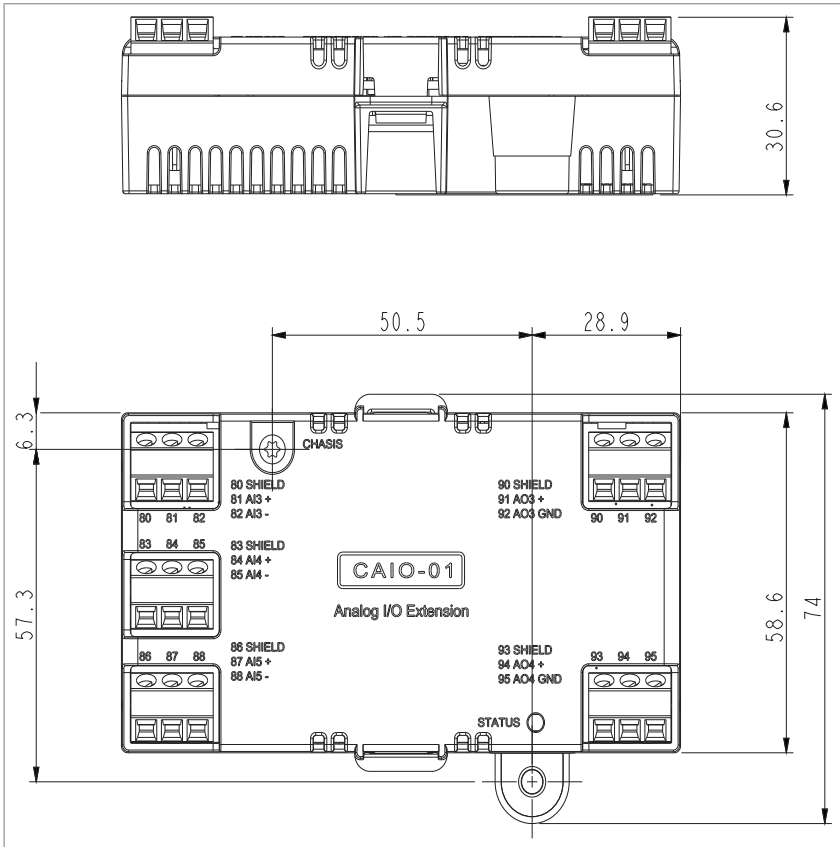
**Isolation areas**





■ Dimension drawings

The dimensions are in millimeters.



## **CHDI-01 115/230 V digital input extension module**

### ■ **Contents of this chapter**

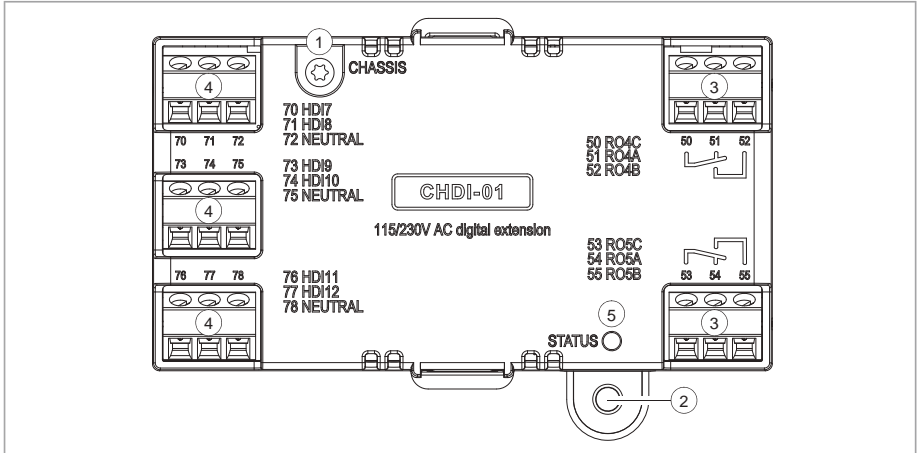
This chapter describes how to install and start up the optional CHDI-01 multifunction extension module. The chapter also contains diagnostics and technical data.

### ■ **Product overview**

The CHDI-01 115/230 V digital input extension module expands the inputs of the drive control unit. It has six high voltage inputs and two relay outputs.

---

■ Layout and connection examples



<b>4</b>	<b>3-pin terminal blocks for 115/230 V inputs</b>		<b>3</b>	<b>Relay outputs</b>	
70	HDI7	115/230 V input 1	50	RO4C	Common, C
71	HDI8	115/230 V input 2	51	RO4B	Normally closed, NC
72	NEUTRAL <sup>1)</sup>	Neutral point	52	RO4A	Normally open, NO
73	HDI9	115/230 V input 3	53	RO5C	Common, C
74	HDI10	115/230 V input 4	54	RO5B	Normally closed, NC
75	NEUTRAL <sup>1)</sup>	Neutral point	55	RO5A	Normally open, NO
76	HDI11	115/230 V input 5	<b>1 Grounding screw</b>		
77	HDI12	115/230 V input 5	<b>2 Hole for mounting screw</b>		
78	NEUTRAL <sup>1)</sup>	Neutral point	<b>5 Diagnostic LED.</b> Green = The extension module is powered up.		
<sup>1)</sup> Neutral points 72, 75 and 78 are connected.					

## ■ Mechanical installation

### Necessary tools

- Screwdriver and a set of suitable bits.

### Unpacking and examining the delivery

1. Open the option package. Make sure that the package contains:
  - the option module
  - a mounting screw.
2. Make sure that there are no signs of damage.

### Installing the module

See section [Installing option modules \(page 162\)](#).

## ■ Electrical installation

---



### WARNING!

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

---

Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.

### Necessary tools

- Screwdriver and a set of suitable bits.

### Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the control cables 360° under the grounding clamp on the grounding shelf.

## ■ Start-up

### Setting the parameters

1. Power up the drive.
2. If no warning is shown,
  - make sure that the value of both parameters 15.01 Extension module type and 15.02 Detected extension module is CHDI-01.

If warning the A7AB Extension I/O configuration failure is shown,

- make sure that the value of parameter 15.02 is CHDI-01.
- set parameter 15.01 value to CHDI-01.

You can now see the parameters of the extension module in parameter group 15 I/O extension module.

---

3. Set the parameters of the extension module to applicable values.

#### Parameter setting example for relay output

This example shows how make the relay output RO4 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

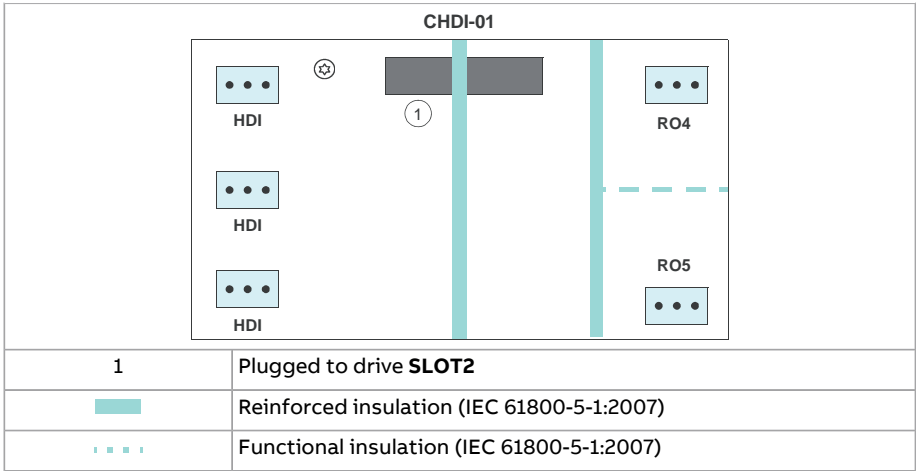
Parameter	Setting
15.07 RO4 source	Reverse
15.08 RO4 ON delay	1 s
15.09 RO4 OFF delay	1 s

#### ■ Fault and warning messages

Warning A7AB Extension I/O configuration failure.

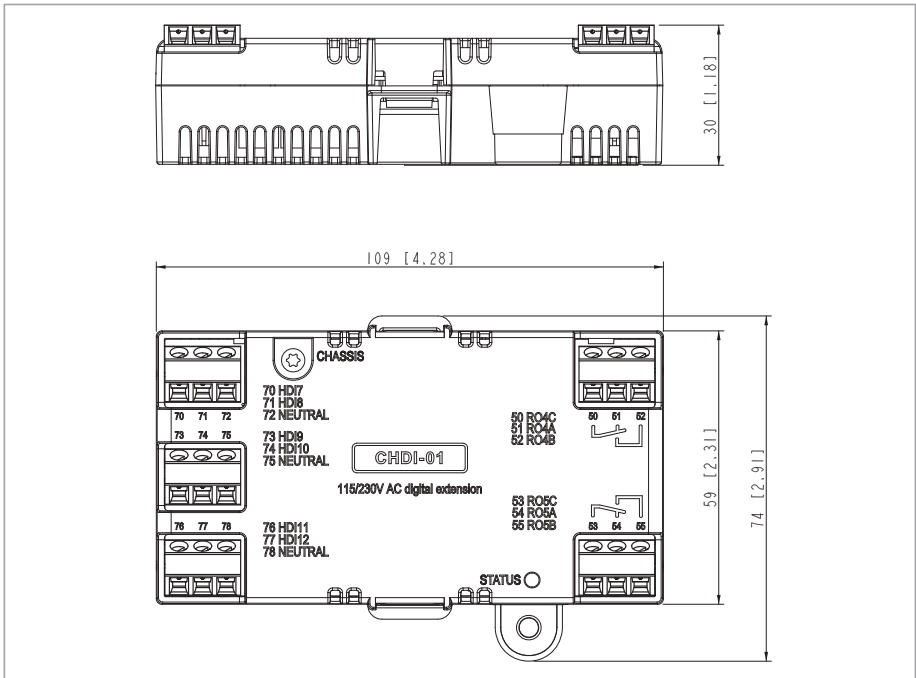
#### ■ Technical data

Installation	Into an option slot on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
<b>Relay outputs (50...52, 53...55)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Minimum contact rating	12 V / 10 mA
Maximum contact rating	250 V AC / 30 V DC / 2 A
Maximum breaking capacity	1500 VA
<b>115/230 V inputs (70...78)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Input voltage	115 to 230 V AC ±10%
Maximum current leakage in digital off state	2 mA
<b>Isolation areas</b>	



■ **Dimension drawing**

The dimensions are in millimeters and [inches].



## CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O)

### ■ Contents of this chapter

This chapter describes how to install and start up the optional CMOD-01 multifunction extension module. The chapter also contains diagnostics and technical data.

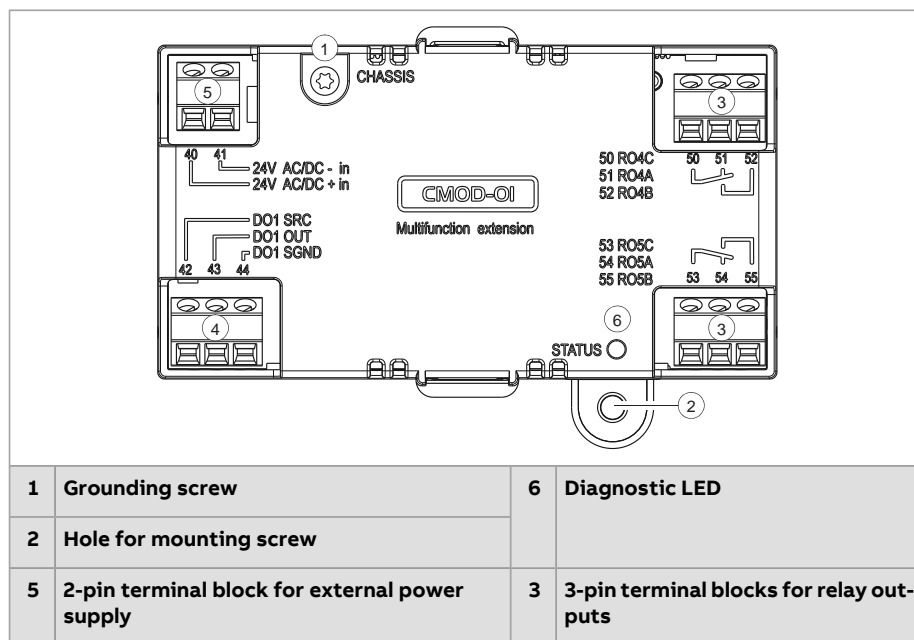
### ■ Product overview

The CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O) expands the outputs of the drive control unit. It has two relay outputs and one transistor output, which can operate as a digital or frequency output.

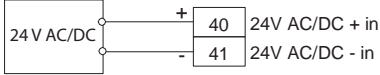
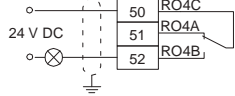
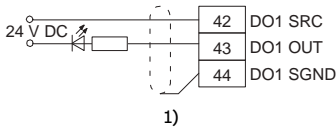
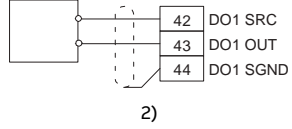
In addition, the extension module has an external power supply interface, which can be used to power up the drive control unit in case the drive power supply is not on. If you do not need the backup power supply, you do not have to connect it because the module is powered from the drive control unit by default.

With CCU-24 control unit, a CMOD-01 module is not necessary for external 24 V AC/DC supply connection. The external supply is connected directly to terminals 40 and 41 on the control unit.

### ■ Layout and example connections



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40	24 V AC/DC + in	External 24 V (AC/DC) input	50	RO4C	Common, C
41	24 V AC/DC - in	External 24 V (AC/DC) input	51	RO4A	Normally closed, NC
<b>4</b>	<b>3-pin terminal block for for transistor output</b>		52	RO4B	Normally open, NO
 <p>1)</p>					
 <p>2)</p>					
42	DO1 SRC	Source input	53	RO5C	Common, C
43	DO1 OUT	Digital or frequency output	54	RO5A	Normally closed, NC
44	DO1 SGND	Ground (earth) potential	55	RO5B	Normally open, NO

1) Digital output connection example

2) An externally supplied frequency indicator which provides, for example:

- a 40 mA / 12 V DC power supply for the sensor circuit (CMOD frequency output)
- suitable voltage pulse input (10 Hz ... 16 kHz).

### ■ Mechanical installation

#### Necessary tools

- Screwdriver and a set of suitable bits.

#### Unpacking and examining the delivery

1. Open the option package. Make sure that the package contains:
  - the option module
  - a mounting screw.
2. Make sure that there are no signs of damage.



## Installing the module

See section [Installing option modules \(page 162\)](#).

### ■ Electrical installation

---



#### **WARNING!**

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

---

Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.

### **Necessary tools**

- Screwdriver and a set of suitable bits

### **Wiring**

Connect the external control cables to the applicable module terminals. Ground the outer shield of the control cables 360° under the grounding clamp on the grounding shelf

---



#### **WARNING!**

Do not connect the +24 V AC cable to the control unit ground when the control unit is powered using an external 24 V AC supply.

---

### ■ Start-up

#### **Setting the parameters**

1. Power up the drive.
2. If no warning is shown,
  - make sure that the value of both parameters 15.01 Extension module type and 15.02 Detected extension module is CMOD-01.
 If the warning A7AB Extension I/O configuration failure is shown,
  - make sure that the value of parameter 15.02 is CMOD-01.
  - set the parameter 15.01 value to CMOD-01.
 You can now see the parameters of the extension module in parameter group 15 I/O extension module.
3. Set the parameters of the extension module to applicable values.

Examples are given below.

#### Parameter setting example for relay output

This example shows how make relay output RO4 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

---

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Parameter	Setting
15.07 RO4 source	Reverse
15.08 RO4 ON delay	1 s
15.09 RO4 OFF delay	1 s

### Parameter setting example for digital output

This example shows how to make digital output DO1 of the extension module indicate the reverse direction of rotation of the motor with a one-second delay.

Parameter	Setting
15.22 DO1 configuration	Digital output
15.23 DO1 source	Reverse
15.24 DO1 ON delay	1 s
15.25 DO1 OFF delay	1 s

### Parameter setting example for frequency output

This example shows how to make digital output DO1 of the extension module indicate the motor speed 0...1500 rpm with a frequency range of 0...10000 Hz.

Parameter	Setting
15.22 DO1 configuration	Frequency output
15.33 Freq out 1 source	01.01 Motor speed used
15.34 Freq out 1 src min	0
15.35 Freq out 1 src max	1500.00
15.36 Freq out 1 at src min	0 Hz
15.37 Freq out 1 at src max	10000 Hz

## **Diagnostics**

### Faults and warning messages

Warning A7AB Extension I/O configuration failure.

### LEDs

The extension module has one diagnostic LED.

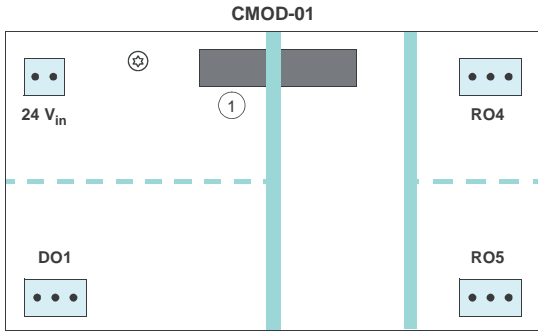
---

Color	Description
Green	The extension module is powered up.

### ■ Technical data

Installation	Into an option slot on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
<b>Relay outputs (50...52, 53...55)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Minimum contact rating	12 V / 10 mA
Maximum contact rating	250 V AC / 30 V DC / 2 A
Maximum breaking capacity	1500 VA
<b>Transistor output (42...44)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Type	Transistor output PNP
Maximum load	4 kohm
Maximum switching voltage	30 V DC
Maximum switching current	100 mA / 30 V DC, short-circuit protected
Frequency	10 Hz ... 16 kHz
Resolution	1 Hz
Inaccuracy	0.2%
<b>External power supply (40...41)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Input voltage	24 V AC / V DC ±10% (GND, user potential)
Maximum power consumption	25 W, 1.04 A at 24 V DC

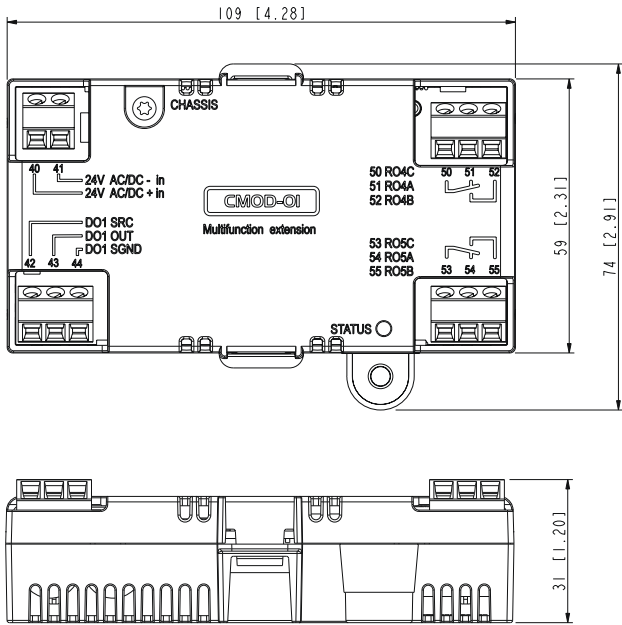
**Isolation areas**



1	Plugged to drive <b>SLOT2</b>
	Reinforced insulation (IEC 61800-5-1:2007)
	Functional insulation (IEC 61800-5-1:2007)

**Dimension drawing**

The dimensions are in millimeters and [inches].



## **CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface)**

### ■ **Contents of this chapter**

This chapter describes how to install and start up the optional CMOD-02 multifunction extension module. The chapter also contains diagnostics and technical data.

### ■ **Product overview**

The CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface) has a motor thermistor connection for supervising the motor temperature and one relay output, which indicates the thermistor status. In case the thermistor overheats, the drive trips on motor overtemperature. If Safe torque off tripping is required, the user must wire the overtemperature indication relay to the certified Safe torque off input of the drive.

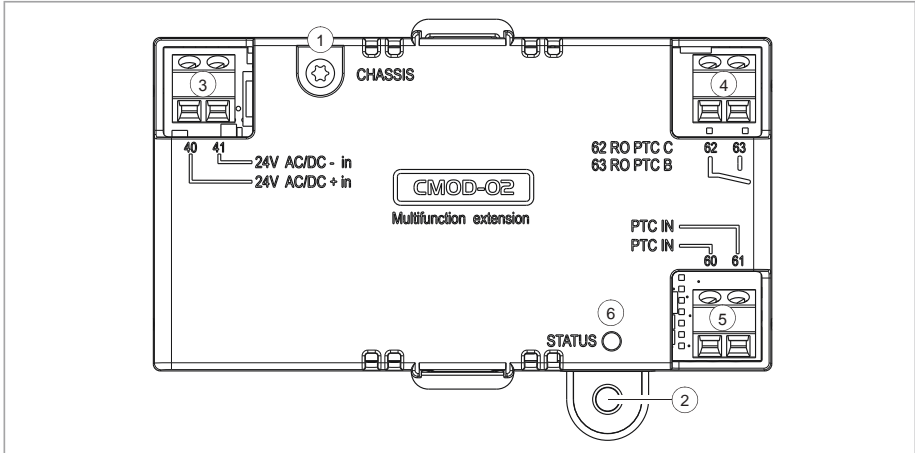
In addition, the extension module has an external power supply interface, which can be used to power up the drive control unit in case the drive power supply is not on. If you do not need the back-up power supply, you do not have to connect it because the module is powered from the drive control unit by default.

There is reinforced insulation between the motor thermistor connection, the relay output and the drive control unit interface. Thus, you can connect a motor thermistor to the drive through the extension module.

With CCU-24 control unit, a CMOD-02 module is not necessary for external 24 V AC/DC supply connection. The external supply is connected directly to terminals 40 and 41 on the control unit.

---

■ **Layout and example connections**



<b>3 2-pin terminal block for external power supply</b>			<b>4 2-pin terminal block for relay output</b>		
<p>24V AC/DC</p> <p>40 24V AC/DC + in</p> <p>41 24V AC/DC - in</p>			<p>62 RO PTC C</p> <p>63 RO PTC B</p> <p>X4</p> <p>34 OUT1</p> <p>35 OUT2</p> <p>36 SGND</p> <p>37 IN1</p> <p>38 IN2</p> <p>CMOD-02</p> <p>CCU</p>		
40	24 V AC/DC + in	External 24 V (AC/DC) input	62	RO PTC C	Common, C
41	24 V AC/DC - in	External 24 V (AC/DC) input	63	RO PTC B	Normally open, NO
<b>5 Motor thermistor connection</b>			<b>1 Grounding screw</b>		
<p>60 PTC IN</p> <p>61 PTC IN</p> <p>One to six PTC thermistors connected in series.</p>					
60	PTC IN	PTC connection	<b>2 Hole for mounting screw</b>		
61	PTC IN	Ground (earth) potential	<b>6 Diagnostic LED</b>		

## ■ Mechanical installation

### Necessary tools

- Screwdriver and a set of suitable bits.

### Unpacking and examining the delivery

1. Open the option package. Make sure that the package contains:
  - the option module
  - a mounting screw.
2. Make sure that there are no signs of damage.

### Installing the module

See section [Installing option modules \(page 162\)](#).

## ■ Electrical installation



### WARNING!

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

---

Stop the drive and do the steps in section [Electrical safety precautions \(page 22\)](#) before you start the work.

### Necessary tools

- Screwdriver and a set of suitable bits

### Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the control cables 360° under the grounding clamp on the grounding shelf



### WARNING!

Do not connect the +24 V AC cable to the control unit ground when the control unit is powered using an external 24 V AC supply.

---

## ■ Start-up

### Setting the parameters

1. Power up the drive.
  2. If no warning is shown,
    - make sure that the values of both parameters 15.01 Extension module type and 15.02 Detected extension module are CMOD-02.
-

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If the warning A7AB Extension I/O configuration failure is shown,

- make sure that the value of parameter 15.02 is CMOD-02.
- set the parameter 15.01 value to CMOD-02.

You can now see the parameters of the extension module in parameter group 15 I/O extension module.

### ■ Diagnostics

#### Faults and warning messages

Warning A7AB Extension I/O configuration failure.

#### LEDs

The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

### ■ Technical data

Installation	Into option slot 2 on the drive control unit
Degree of protection	IP20 / UL Type 1
Ambient conditions	See the drive technical data.
Package	Cardboard
<b>Motor thermistor connection (60...61)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Supported standards	DIN 44081 and DIN 44082
Triggering threshold	3.6 kohm ±10%
Recovery threshold	1.6 kohm ±10%
PTC terminal voltage	≤ 5.0 V
PTC terminal current	< 1 mA
Short-circuit detection	< 50 ohm ±10%
The PTC input is reinforced/double insulated. If the motor part of the PTC sensor and wiring are reinforced/double insulated, voltages on the PTC wiring are within SELV limits. If the motor PTC circuit is not reinforced/double insulated (ie, it is basic insulated), it is mandatory to use reinforced/double insulated wiring between the motor PTC and CMOD-02 PTC terminal.	
<b>Relay output (62...63)</b>	
Maximum wire size	1.5 mm <sup>2</sup>

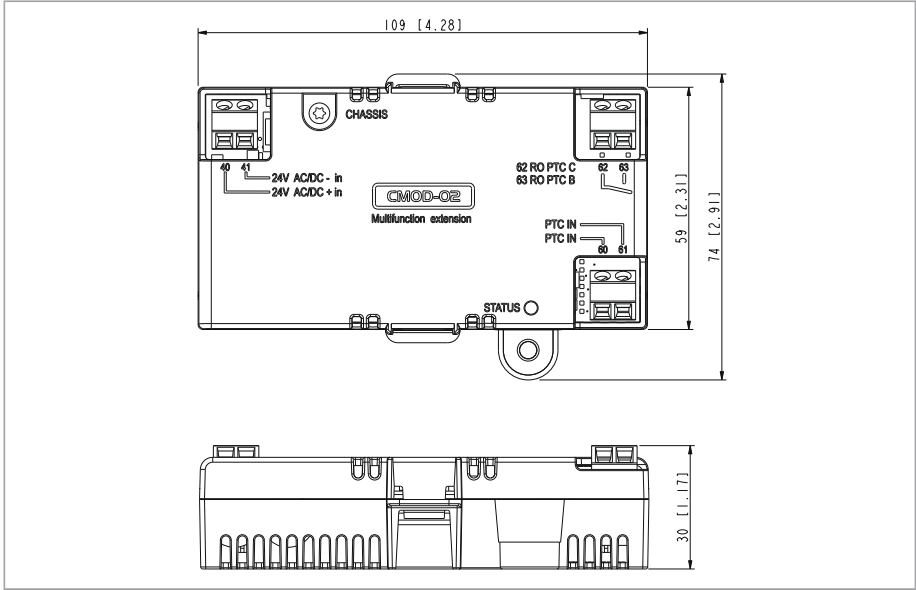


Maximum contact rating	250 V AC / 30 V DC / 5 A
Maximum breaking capacity	1000 VA
<b>External power supply (40...41)</b>	
Maximum wire size	1.5 mm <sup>2</sup>
Input voltage	24 V AC / V DC ±10% (GND, user potential)
Maximum power consumption	25 W, 1.04 A at 24 V DC
<b>Isolation areas</b>	
1	Plugged to drive <b>SLOT2</b>
	Reinforced insulation (IEC 61800-5-1:2007)
	Functional insulation (IEC 61800-5-1:2007)

■ **Dimension drawing**

The dimensions are in millimeters and [inches].

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## 17

# Common mode, du/dt and sine filters

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## Content of this chapter

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

## Common mode filters

### ■ When is a common mode filter needed?

See section [Examining the compatibility of the motor and drive \(page 94\)](#).

Common mode filter kits are available from ABB, see the table on page 451. A kit includes three wound cores. For installation instructions of the cores, see the instruction included in the core package.

### ■ Common mode filter types

**IEC ratings at  $U_n = 400\text{ V}$  and  $480\text{ V}$ , UL (NEC) ratings at  $U_n = 480\text{ V}$**

For common mode filters for smaller drive types, contact your local representative.

IEC type ACQ580-01-...	Common mode filters ABB drives	Frame size	North American type ACQ580-01-
062A-4	64315811	R4, R4 v2	052A-4
073A-4	64315811	R4, R4 v2	065A-4

---

IEC type ACQ580-01-...	Common mode filters ABB drives	Frame size	North American type ACQ580-01-
088A-4	64315811	R5	078A-4
089A-4	-	R4 v2	077A-4
106A-4	64315811	R5	096A-4
145A-4	3AXD50000017269	R6	124A-4
169A-4	3AXD50000017270	R7	156A-4
206A-4	3AXD50000017270	R7	180A-4
246A-4	3AXD50000018001	R8	240A-4
293A-4	3AXD50000018001	R8	260A-4
363A-4	3AXD50000017940	R9	361A-4
430A-4	3AXD50000017940	R9	414A-4
490A-4	-	R9	477A-4

## du/dt filters

### ■ When is a du/dt filter needed?

See section [Examining the compatibility of the motor and drive \(page 94\)](#).

### ■ du/dt filter types

IEC ratings at  $U_n = 230\text{ V}$ , UL (NEC) ratings at  $U_n = 208/230\text{ V}$

IEC type ACQ580-01-...	Frame size	du/dt filters ABB drives	North American type ACQ580-01-...
04A7-2	R1	NOCH0016-6x	04A6-2
06A7-2	R1	NOCH0016-6x	06A6-2
07A6-2	R1	NOCH0016-6x	07A5-2
012A-2	R1	NOCH0016-6x	10A6-2
018A-2	R1	NOCH0016-6x	017A-2
025A-2	R2	NOCH0030-6x	024A-2
032A-2	R2	NOCH0030-6x	031A-2
047A-2	R3	NOCH0070-6x	046A-2
060A-2	R3	NOCH0070-6x	059A-2

IEC type ACQ580-01-...	Frame size	du/dt filters ABB drives	North American type ACQ580-01-...
076A-2	R4	NOCH0070-6x	075A-2
089A-2	R5	NOCH0070-6x	088A-2
115A-2	R5	NOCH0120-6x	114A-2
144A-2	R6	FOCH0260-70	143A-2
171A-2	R7	FOCH0260-70	169A-2
213A-2	R7	FOCH0260-70	211A-2
276A-2	R8	FOCH0260-70	273A-2
-	R9	FOCH0320-50	343A-2
-	R9	FOCH0320-50	396A-2

**IEC ratings at  $U_n = 400$  and 480 V, UL (NEC) ratings at  $U_n = 480$  V**

IEC type ACQ580-01-...	Frame size	du/dt filters ABB drives	North American type ACQ580-01-...
02A7-4	R1	NOCH0016-6x	02A1-4
03A4-4	R1	NOCH0016-6x	03A0-4
04A1-4	R1	NOCH0016-6x	03A5-4
05A7-4	R1	NOCH0016-6x	04A8-4
07A3-4	R1	NOCH0016-6x	06A0-4
09A5-4	R1	NOCH0016-6x	07A6-4
12A7-4	R1	NOCH0016-6x	012A-4
018A-4	R2	NOCH0016-6x or NOCH0030-6x	014A-4
026A-4	R2	NOCH0030-6x	023A-4
033A-4	R3	NOCH0070-6x	027A-4
039A-4	R3	NOCH0070-6x	034A-4
046A-4	R3	NOCH0070-6x	044A-4
062A-4	R4	NOCH0070-6x	052A-4
073A-4	R4	NOCH0070-6x or NOCH0120-6x	065A-4
088A-4	R5	NOCH0120-6x	078A-4
089A-4	R4 v2	-	077A-4
106A-4	R5	NOCH0120-6x	096A-4

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IEC type ACQ580-01-...	Frame size	$du/dt$ filters ABB drives	North American type ACQ580-01-...
145A-4	R6	FOCH0260-70	124A-4
169A-4	R7	FOCH0260-70	156A-4
206A-4	R7	FOCH0260-70	180A-4
246A-4	R8	FOCH0260-70	240A-4
293A-4	R8	FOCH0260-70	260A-4
-	R9	-	302A-4
363A-4	R9	FOCH0320-50	361A-4
430A-4	R9	FOCH0320-50	414A-4
490A-4	R9	-	477A-4

**UL (NEC) ratings at  $U_n = 600$  V**

North American type ACQ580-01-...	Frame size	$du/dt$ filters ABB drives
02A7-6	R2	NOCH0016-6x
03A9-6	R2	NOCH0016-6x
06A1-6	R2	NOCH0016-6x
09A0-6	R2	NOCH0016-6x
011A-6	R2	NOCH0016-6x
017A-6	R2	NOCH0016-6x
022A-6	R3	NOCH0030-6x
027A-6	R3	NOCH0030-6x
032A-6	R3	NOCH0070-6x
041A-6	R5	FOCH0070-6x
052A-6	R5	FOCH0070-6x
062A-6	R5	FOCH0070-6x
077A-6	R5	FOCH0120-6x
099A-6	R7	FOCH0260-70
125A-6	R7	FOCH0260-70
144A-6	R8	FOCH0260-70
192A-6	R9	FOCH0260-70

North American type ACQ580-01-...	Frame size	du/dt filters ABB drives
242A-6	R9	FOCH0260-70
271A-6	R9	FOCH0260-70

### ■ Description, installation and technical data of the FOCH filters

Refer to [FOCH du/dt filters hardware manual \(3AFE68577519 \[English\]\)](#).

### ■ Description, installation and technical data of the NOCH filters

Refer to [AOCH and NOCH du/dt filters hardware manual \(3AFE58933368 \[English\]\)](#).

## Sine filters

### ■ IEC ratings at $U_n = 400$ V, UL (NEC) ratings at $U_n = 480$ V

**Note:** Sine filter node supports only scalar control.

$f_{out\ max}$  in sine filter mode is 120 Hz.

231-series sine filters are rated for 230/400 V.

229-series sine filters are rated for 300/520 V.

IEC type ACQ580- 01-...	Current sine filter mode	Sine filter type		Frame size	North American type ACQ580-01-...	
		I <sub>2</sub> , sine	IP00			IP21/UL Type 1
02A7-4	2.6	B84143V0004R229	B84143V0004R229 + B84143Q0002R229	R1	02A1-4	
03A4-4	3.3	B84143V0004R229	B84143V0004R229 + B84143Q0002R229	R1	03A0-4	
04A1-4	4.0	B84143V0004R229	B84143V0004R229 + B84143Q0002R229	R1	03A5-4	
05A7-4	5.6	B84143V0006R229	B84143V0006R229 + B84143Q0002R229	R1	04A8-4	
07A3-4	7.2	B84143V0011R229	B84143V0011R229 + B84143Q0004R229	R1	06A0-4	
09A5-4	9.4	B84143V0011R229	B84143V0011R229 + B84143Q0004R229	R1	07A6-4	
12A7-4	12.6	B84143V0016R229	B84143V0016R229 + B84143Q0006R229	R1	012A-4	

## 456 Common mode, du/dt and sine filters

018A-4	17.0	B84143V0025R229	B84143V0025R229 + B84143Q0008R229	R2	014A-4
026A-4	25.0	B84143V0025R229	B84143V0025R229 + B84143Q0008R229	R2	023A-4
033A-4	32.0	B84143V0033R229	B84143V0033R229 + B84143Q0008R229	R3	027A-4
039A-4	38.0	B84143V0050R229	B84143V0050R229 + B84143Q0010R229	R3	034A-4
046A-4	45.0	B84143V0050R229	B84143V0050R229 + B84143Q0010R229	R3	044A-4
062A-4	62.0	B84143V0066R229	B84143V0066R229 + B84143Q0010R229	R4, R4 v2	052A-4
073A-4	73.0	B84143V0075R229	B84143V0075R229 + B84143Q0010R229	R4, R4 v2	065A-4
088A-4	88.0	B84143V0095R229	B84143V0095R229 + B84143Q0012R229	R5	078A-4
089A-4	-	B84143V0095R229	B84143V0095R229 + B84143Q0012R229	R4 v2	077A-4
106A-4	106.0	B84143V0130S230	B84143V0130S230 + B84143Q0020R229	R5	096A-4
145A-4	121.8	B84143V0162S229	B84143V0162S229 + B84143Q0014R229	R6	124A-4
169A-4	150.4	B84143V0162S229	B84143V0162S229 + B84143Q0014R229	R7	156A-4
206A-4	183.4	B84143V0230S229	B84143V0230S229 + B84143Q0016R229	R7	180A-4
246A-4	201.7	B84143V0230S229	B84143V0230S229 + B84143Q0016R229	R8	240A-4
293A-4	240.3	B84143V0390S229	B84143V0390S229 + B84143Q0018R229	R8	260A-4
-	-	B84143V0390S229	B84143V0390S229 + B84143Q0018R229	R9	302A-4
363A-4	286.8	B84143V0390S229	B84143V0390S229 + B84143Q0018R229	R9	361A-4
430A-4	339.7	B84143V0390S229	B84143V0390S229 + B84143Q0018R229	R9	414A-4



490A-4	-	-	-	R9	477A-4
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■ **Description, installation and technical data**

Refer to *Sine filters hardware manual* (3AXD50000016814 [English]).

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## Further information

### Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to [www.abb.com/contact-centers](http://www.abb.com/contact-centers).

### Product training

For information on ABB product training, navigate to [new.abb.com/service/training](http://new.abb.com/service/training).

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