ABB DRIVES FOR WATER

ACQ580-31 drives

Hardware manual

ACQ580-31 drives

Hardware manual

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1

Safety instructions

Contents of this chapter

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

Use of warnings and notes in this manual

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

The manual uses these warning symbols:

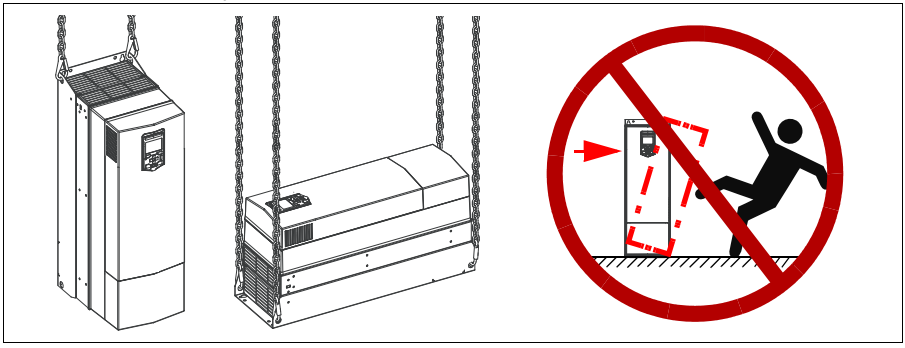
	**Electricity warning** tells about hazards from electricity which can cause injury or death, or damage to the equipment.
	**General warning** tells about conditions, other than those caused by electricity, which can cause injury or death, or damage to the equipment.
	**Electrostatic sensitive devices warning** tells you about the risk of electrostatic discharge which can cause damage to the equipment.

General safety in installation, start-up and maintenance

These instructions are for all personnel that install the drive and do maintenance work on it.

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

- Use safety shoes with a metal toe cap to avoid foot injury. Wear protective gloves and long sleeves. Some parts have sharp edges.
- Handle the drive carefully.
  - 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. It will overturn easily.



- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, remain hot for a while after disconnection of the electrical supply.
- Keep the drive in its package or protect it from dust and metal shavings from drilling and grinding until you install it. Protect the installed drive against dust and metal shavings. Electrically conductive debris inside the drive can cause damage or malfunction.
- Vacuum clean the area below the drive before the start-up to prevent the drive cooling fan from drawing the dust inside the drive.
- Do not cover the air inlet and outlet when the drive runs.
- Make sure that there is sufficient cooling. See sections *Examining the installation site* on page *37* and *Losses, cooling data and noise* on page *165* for more information.
- Before you connect voltage to the drive, make sure that the drive covers are on. Keep the covers on during the operation.
- Before you adjust the drive operation limits, make sure that the motor and all driven equipment can operate throughout the set operation limits.
- Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These

functions reset the drive automatically and continue operation after a fault or supply break. If these functions are activated, the installation must be clearly marked as defined in IEC/EN 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".

- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors.
- Make sure that any safety circuits (for example, emergency stop and Safe torque off) are validated at start-up. For the Safe torque off, see chapter *The Safe torque off function* page *197*. For other safety functions, see their separate instructions.

Note:

- Do not control the motor with the disconnector at the drive power supply; instead, use the control panel start and stop keys or commands through the I/O terminals of the drive.
- If you select an external source for the start command and it is on, the drive will start immediately after fault reset unless you configure the drive for pulse start. See the firmware manual.
- Depending on the wiring and parametrization of the drive, the stop key on the control panel may not stop the drive.
- Only authorized persons are allowed to repair a malfunctioning drive.

Electrical safety in installation, start-up and maintenance

Precautions before electrical work

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

WARNING! Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do electrical installation or maintenance work. Go through these steps before you begin any installation or maintenance work.

1. Clearly identify the work location.
2. Disconnect all possible voltage sources. Lock and tag.
   - Open the main disconnector at the power supply of the drive.
   - Make sure that reconnection is not possible.
   - Disconnect any external power sources from the control circuits.
   - After you disconnect the drive, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you continue.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized.
   - Use a multimeter with an impedance of at least 1 Mohm.
   - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding terminal (PE) is close to 0 V.
   - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding terminal (PE) is close to 0 V.
6. Install temporary grounding as required by the local regulations.
7. Ask for a permit to work from the person in control of 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.

- A drive with the EMC filter connected can be installed to a symmetrically grounded TN-S system. If you install the drive to another system, check if you must 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 and TT systems* on page *81* and *Identifying different types of electrical power systems* on page *83*.

  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 filteris disconnected, the drive EMC compatibility is considerably reduced. See section *EMC compatibility and motor cable length* on page *172*.
- 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, check if you must 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 and TT systems* on page *81* and *Identifying different types of electrical power systems* on page *83*.

  WARNING! Do not install the drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. If you do, the varistor circuit can be damaged.
- Use all ELV (extra low voltage) circuits connected to the drive only within a zone of equipotential bonding, that is, within a zone where all simultaneously accessible conductive parts are electrically connected to prevent hazardous voltages appearing between them. You can accomplish this by a proper factory grounding, that is, make sure that all simultaneously accessible conductive parts are grounded to the protective earth (PE) bus of the building.
- Do not do insulation or voltage withstand tests on the drive or drive modules.

Note:

- The motor cable terminals of the drive are at a dangerous voltage when the input power is on, regardless of whether the motor is running or not.
- The DC terminals (UDC+, UDC-) are at a dangerous voltage.
- External wiring can supply dangerous voltages to the terminals of relay outputs (RO1, RO2 and RO3).
- 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.

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

Grounding

These instructions are for all personnel who are responsible for the electrical installation, including 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 to the protective earth (PE) bus of the power supply. This is necessary for the personnel safety. Correct grounding also reduces electromagnetic emission and interference.
- In a multiple-drive installation, connect each drive separately to the protective earth (PE) bus of the power supply.
- Make sure that the conductivity of the protective earth (PE) conductors is sufficient. See section *Selecting the power cables* on page *56*. Obey the local regulations.
- Connect the power cable shields to the protective earth (PE) terminals of the drive.
- Make a 360° grounding of the power and control cable shields at the cable entries to suppress electromagnetic disturbances.

Note:

- You can use power cable shields as grounding conductors only when their conductivity is sufficient.
- As the normal touch current of the drive is higher than 3.5 mA AC or 10 mA DC, you must use a fixed protective earth (PE) connection. The minimum size of the protective earth conductor must comply with the local safety regulations for high protective earth conductor current equipment. See standard IEC/EN 61800-5-1, 4.3.5.5.2. and UL 68100-5-1, and the electrical planning instructions of the drive. In addition:
  - use a second protective earth conductor of the same cross-sectional area as the original protective earthing conductor,

  or
  - use a protective earth conductor with a cross-section of at least 10 mm^2 Cu or 16 mm^2 Al,

or

- use a device which automatically disconnects the supply if the protective earth conductor breaks.

If the protective earth conductor is separate (ie, it does not form part of the input power cable or the input power cable enclosure), the cross section must be at least:

- 2.5 mm2 (14 AWG) when the conductor is mechanically protected, or
- 4 mm2 (12 AWG) when the conductor is not mechanically protected.

Additional instructions for permanent magnet motor drives

Safety in installation, start-up and maintenance

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

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

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

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

- Stop the motor.
- Disconnect the motor from the drive with a safety switch or by other means.
- If you cannot disconnect the motor, make sure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, can rotate the motor directly or through any mechanical connection like felt, nip, rope, etc.
- Measure that the installation is de-energized.
  - Use a multimeter with an impedance of at least 1 Mohm.
  - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is close to 0 V.
  - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is close to 0 V.
  - Make sure that the voltage between the drive DC terminals (UDC+, UDC-) and the grounding (PE) terminal is close to 0 V.
- 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.

Start-up and operation:

- Make sure that the operator cannot run the motor over the rated speed. Motor overspeed causes overvoltage that can damage or destroy the capacitors in the intermediate circuit of the drive.

Additional instruction for DC connection

WARNING! Do not connect the drive DC link to a common DC system. The drive will get damaged.

2

Introduction to the manual

Contents of this chapter

The chapter describes applicability, target audience and purpose of this manual. It describes the contents of this manual and refers to a list of related manuals for more information. The chapter also contains a flowchart of steps for checking the delivery, installing and commissioning the drive. The flowchart refers to chapters/sections in this manual.

Applicability

The manual applies to the ACQ580-31 drives.

Target audience

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

The manual is written for readers worldwide. Both SI and imperial units are shown. Special instructions for installations in North America are given.

Purpose of the manual

This manual provides information needed for planning the installation, installing, and servicing the drive.

Categorization by frame (size)

The drive is manufactured in frames. Some instructions and other information which only concern certain frames are marked with the symbol of the frame, for example R3. The frame is marked on the type designation label attached to the drive, see section *Type designation label* on page *31*.

Quick installation and commissioning flowchart

Task	See
Identify the frame of your drive: R3, R6 or R8.	See the type designation label of the drive.
Plan the installation: select the cables, etc. Check the ambient conditions, ratings and required cooling air flow.	*Guidelines for planning the electrical installation* on page *49* *Technical data* on page *149*
Unpack and check the drive.	*Unpacking and examining delivery* on page *40*,
If the drive will be connected to an IT (ungrounded) system or corner-grounded delta system, check that the internal EMC filter and ground-to-phase varistor are not connected.	*Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* on page *80*
Install the drive on a wall.	*Mechanical installation* on page *35*
Route the cables.	*Routing the cables* on page *65*
Measure the insulation of the input cable and the motor and the motor cable.	*Measuring the insulation* on page *78*
Connect the power cables.	*Connecting the power cables* on page *87*
Connect the control cables.	*Connecting the control cables* on page *96*
Check the installation.	*Installation checklist* on page *131*
Commission the drive.	*Firmware manual* *Quick start-up guide for the drive*

Terms and abbreviations

Term/abbreviation	Explanation
ACH-AP-H	Control panel with Hand-Off-Auto functionality. The dedicated assistant control panel for the ACH580 and ACQ580 is ACH-AP-H (Hand-Off-Auto panel).

Term/abbreviation	Explanation
ACX-AP-x	Assistant control panel, advanced operator keypad for communication with the drive. ACQ580 offers limited support of ACS-AP-I and ACS-AP-W. The Start, Stop, Loc/Rem buttons on these panels act as Hand, Auto and Off buttons, respectively, when used with the ACQ580. You can use parameters and Primary settings menus with ACS-AP-I and parameters and I/O with ACS-AP-W.
Brake chopper	An external 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. Essential part of the brake circuit. See *Brake chopper*.
Control board	Circuit board in which the control program runs.
Capacitor bank	See *DC link capacitors*.
CCA-01	Configuration adapter
CDPI-01	Communication adapter module
CHDI-01	Optional 115/230 V digital input extension module
CMOD-01	Optional multifunction extension module (external 24 V AC/DC and digital I/O extension)
CMOD-02	Optional multifunction extension module (external 24 V AC/DC and isolated PTC interface)
CPTC-02	Optional multifunction extension module (external 24 V and ATEX 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 ACH-AP control panel (flange mounting). CDP-01 communication adapter module is needed to connect the DMP0-01 to the drive. For up to 32 (16 ACH58031 or ACQ580-31) drives on a panel bus with a single panel on cabinet door, one DMP-02 with one CDPI-01 per each drive are used.
DPMP-02	Mounting platform for ACH-AP control panel (surface mounting). CDP-01 communication adapter module is needed to connect the DMP0-02 to the drive. For up to 32 (16 ACH58031 or ACQ580-31) drives on a panel bus with a single panel on cabinet door, one DMP-02 with one CDPI-01 per each drive are used.
DPMP-04 DPMP05	Lockable door mounting platform for drive control panels in outdoor installations or harsh environments
DPMP-EXT	Door mounting kit for the panel. For one drive; contains both DPMP-02 and CDPI-01, which connects the DPMP-02 to the drive.
Drive	Frequency converter for controlling AC motors
EMC	Electromagnetic compatibility

Term/abbreviation	Explanation
EFB	Embedded fieldbus
FCAN-01	Optional CANopen adapter module
FCNA-01	ControlNet adapter module
FDNA-01	Optional DeviceNet adapter module
FECA-01	Optional EtherCAT adapter module
FENA-21	Optional Ethernet adapter module for EtherNet/IP, Modbus TCP and PROFINET IO protocols
FEPL-02	Optional Ethernet POWERLINK adapter module
FPBA-01	Optional PROFIBUS DP adapter module
Frame (size)	Refers to drive physical size, for example R3. The type designation label attached to the drive shows the frame of the drive, see section *Type designation key* on page *32*.
I/O	Input/Output
IGBT	Insulated gate bipolar transistor
Intermediate circuit	See *DC link*.
Inverter	Converts direct current and voltage to alternating current and voltage.
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 Net Ctrl and Net Ref objects of the ODVA AC/DC Drive Profile. For more information, see www.odva.org, and the following manuals: • *FDNA-01 DeviceNet adapter module user's manual* (3AFE68573360 [English]), and • *FENA-01/-11/-21 Ethernet adapter module user's manual* (3AUA0000093568 [English]).
Parameter	User-adjustable operation instruction to the drive, or signal measured or calculated by the drive
PLC	Programmable logic controller
PROFIBUS, PROFIBUS DP, PROFINET IO	Registered trademarks of PI - PROFIBUS & PROFINET International
PTC	Positive temperature coefficient (PTC) refers to materials that experience an increase in electrical resistance when their temperature is raised.
R3, R6, R8	*Frame (size)*
Rectifier	Converts alternating current and voltage to direct current and voltage.
STO	Safe torque off. See chapter *The Safe torque off function* on page *197*.

Related documents

Drive manuals and guides	Code (English)	
ACQ580 pump control program firmware manual	*3AXD50000035867*	
Quick start-up guide for ACQ580 pump control program	*3AXD50000048773*	
ACQ580-31 hardware manual	*3AXD50000045935*	
ACQ580-31 quick installation guide	*3AXD50000049859*	
ACx-AP-x Assistant control panels user's manual	*3AUA0000085685*	
Option manuals and guides		
ACS580, ACH580 and ACQ580 … +P940 and +P944 supplement	*3AXD50000210305*	
Drive modules cabinet design and construction instructions	*3AUA0000107668*	
ACS580-01…, ACH580-01… and ACQ580-01… +C135 drives with flange mounting kit supplement	*3AXD50000349821*	
ACS880-11…, ACS880-31…, ACH580-31… and ACQ580-31…+C135 frame R3 flange mounting kit quick installation guide	*3AXD50000181506*	
ACS880-11…+C135, ACS880-31…+C135, ACH580-31…+C135 and ACQ580-31…+C135 frames R6 and R8 flange mounting kit quick installation guide	*3AXD50000133611*	
Common mode filter kit for frames R7 and R8 (option +E208) installation guide	*3XD50000015179*	
UK gland plate (+H358) installation guide for ACS880-11, ACS880-31, ACH580-31and ACQ580-31	*3AXD50000110711*	
CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (+L537+Q971) user's manual	*3AXD50000030058*	
CDPI-01 communication adapter module user's manual	*3AXD50000009929*	
FCAN-01 CANopen adapter module user's manual	*3AFE68615500*	
FCNA-01 ControlNet adapter module user's manual	*3AUA0000141650*	
FDNA-01 DeviceNet™ adapter module user's manual	*3AFE68573360*	
FECA-01 EtherCAT adapter module user's manual	*3AUA0000068940*	
FENA-01/-11/-21 Ethernet adapter module user's manual	*3AUA0000093568*	
FEPL-02 Ethernet POWERLINK adapter module user's manual	*3AUA0000123527*	
FPBA-01 PROFIBUS DP adapter module user's manual	*3AFE68573271*	
FSCA-01 RS-485 adapter module user's manual	*3AUA0000109533*	
Tool and maintenance manuals and guides		
Drive composer PC tool user's manual	*3AUA0000094606*	

Drive manuals and guides	Code (English)	
Converter module capacitor reforming instructions	*3BFE64059629*	
NETA-21 remote monitoring tool user's manual	*3AUA0000096939*	
NETA-21 remote monitoring tool installation and start-up guide	*3AUA0000096881*	

You can find manuals and other product documents in PDF format on the Internet. See section *Document library on the Internet* on the inside of the back cover. For manuals not available in the Document library, contact your local ABB representative.The codes below open an online listing of the manuals applicable to the product.

ACQ580-31 manuals

3

Operation principle and hardware description

Contents of this chapter

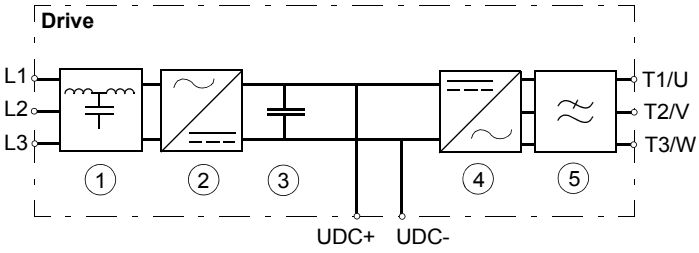
This chapter briefly describes the operation principle, layout, type designation label and type designation information. It also shows a general diagram of power connections and control interfaces.

Operation principle

The ACQ580-31 is a ultra-low harmonic drive for controlling asynchronous AC induction motors, permanent magnet motors in open loop control and synchronous reluctance motors.

The drive includes a line-side converter and a motor-side converter. The parameters and signals for both converters are combined into one primary user program.

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



1	LCL filter
2	Line-side converter
3	DC link. DC circuit between the line-side converter and motor-side converter.
4	Motor-side converter
5	Common mode filter

The line-side converter rectifies three phase AC current to direct current for the intermediate DC link of the drive. The intermediate DC link further supplies the motor-side converter that runs the motor.

Both converters consist of six insulated gate bipolar transistors (IGBT) with free wheeling diodes. The content of AC voltage and current harmonics is low. The LCL filter suppresses the harmonics further.

The line-side and motor-side converters have their own control programs. The parameters of both programs can be viewed and changed using a control panel.

DC connection

WARNING! Do not connect the drive DC link to a common DC system. The drive will get damaged.

Layout

The layout of the drive is shown below.

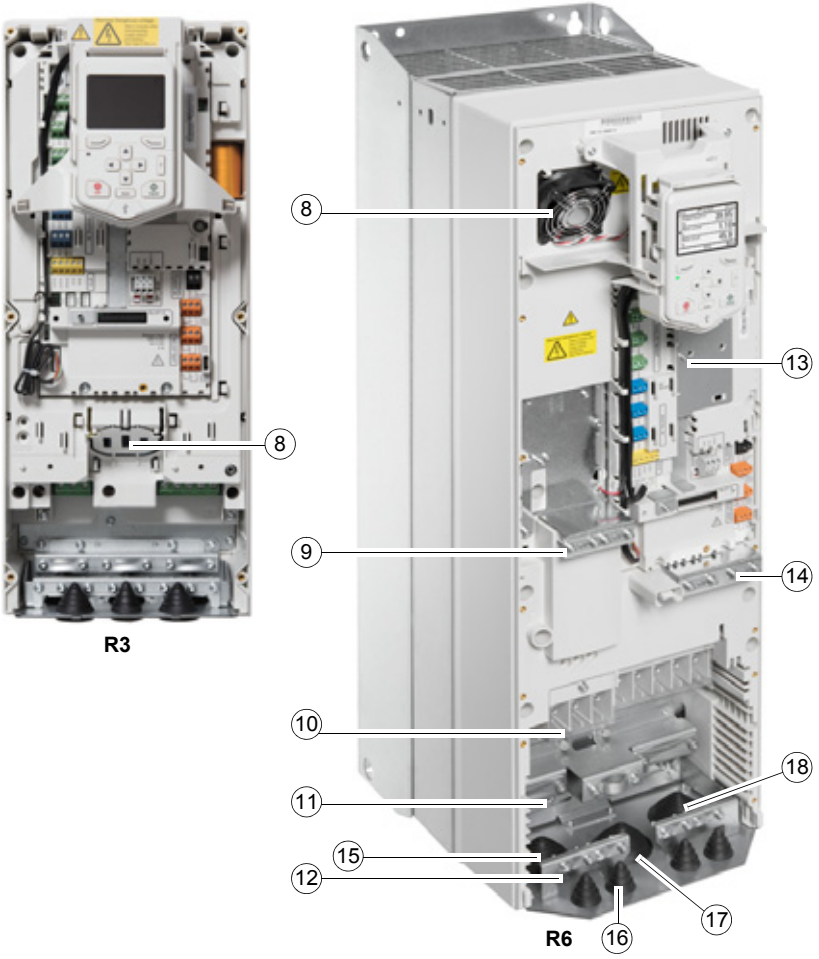
IP21 (UL Type 1) R6

IP55 (UL Type 12) option +B056, R6

UL Type 12 (R6)

IP20 (UL Type Open) option +P940, R3

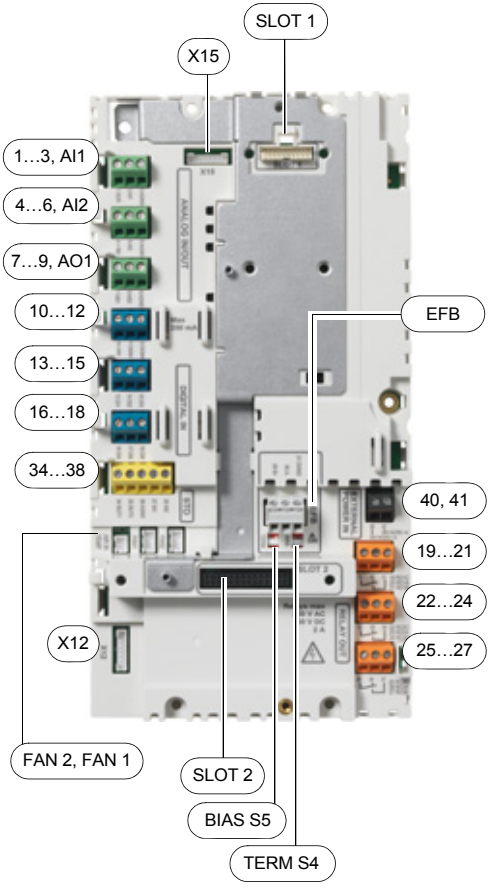
1	Lifting eyes (2 pcs in frame R3, 6 pcs in frames R6 and R8)	5	Front cover
2	Control panel	6	Control panel behind the control panel cover
3	Heatsink	7	Hood in frames R6 and R8.
4	Mounting points (4 pieces)	-	-



8	Auxiliary cooling fan. For frame R3 in IP55 (UL Type 12 drives) only.	14	Clamps for securing the control cables mechanically
9	Clamps for securing the FSO wiring mechanically	15	Input power cable entry behind the 360-degree grounding clamps
10	Power cable connection terminals behind the shroud	16	Control cable entry (4pcs)
11	360-degree grounding clamps for power cable shields	17	DC cable entry
12	360-degree grounding clamps for control cable shields	18	Motor cable entry behind the 360-degree grounding clamps
13	Control unit with I/O cable connection terminals	-	-

The main cooling fan is at the top of the drive in frame R3 and at the bottom in frames R6 and R8.

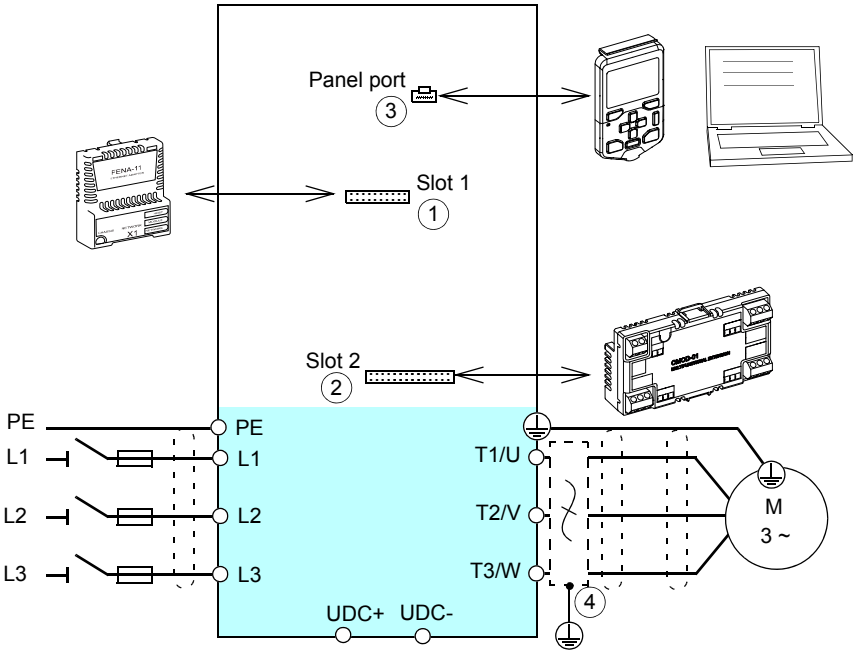
The figure below shows the layout of the external control connection terminals of the drive.



SLOT 1	
Option slot 1 (fieldbus adapter modules)	
ANALOG IN/OUT	
1…3	Analog input 1
AI1	Current/Voltage selection switch for analog input 1
4…6	Analog input 2
AI2	Current/Voltage selection switch for analog input 2
7…9	Analog outputs
AO1	Current/Voltage selection switch for analog output 1
10…12	Auxiliary voltage output
DIGITAL IN	
13…18	Digital inputs
STO	
34…38	Safe torque off 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.
EFB	
EIA/R5-485 fieldbus connector	
BIAS S5	Bias resistor switch
TERM S4	End termination switch
29…31	Connection terminals
SLOT 2	
Option slot 2 (I/O extension modules)	
40, 41	24 V AC/DC external power input
RO1 … R03	
19…21	Relay output 1 (RO1)
22…24	Relay output 2 (RO2)
25…27	Relay output 3 (RO3)

Overview of power and control connections

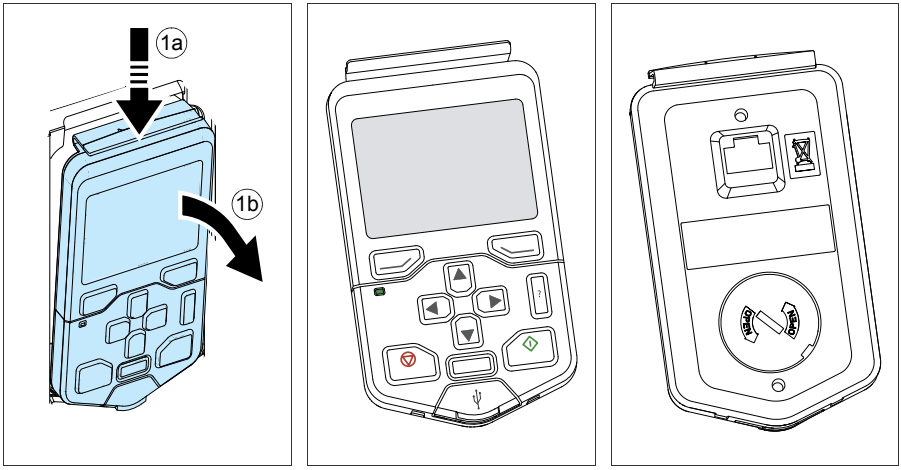
The logical diagram below shows the power connections and control interfaces of the drive.



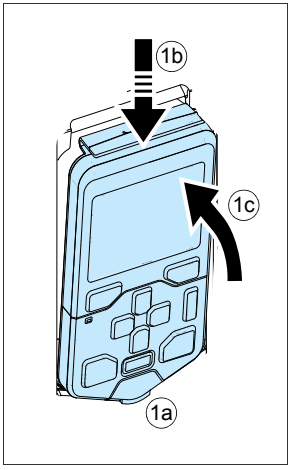
1	Option slot 1 for optional fieldbus adapter modules
2	Option slot 2 for optional I/O extension modules
3	Panel port
4	du/dt, common mode or sine filter (optional), see page *209*.

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 reinstall the control panel, put the bottom of the container in position (1a), press the retaining clip at the top (1b) and push the control panel in at the top edge (1c).



For the use of the control panel, see the firmware manual and *ACX-AP-x assistant control panels user's manual* (3AUA0000085685 [English]).

Control panel mounting platform cover (option +J424)

CDOM-01 control panel mounting platform cover can be used to cover the control panel mounting platform when no control panel is on it. Power and fault indication LEDs are visible on the cover.

Control panel door mounting kits

Door mounting kits for the control panel are available. For more information see *DPMP-01 mounting platform installation guide* (3AUA0000100140 [English]) or *DPMP-02/03 mounting platform installation guide* (3AUA0000136205 [English] or *DPMP-04/05 mounting platform installation guide* (3AXD50000308484 [English]).

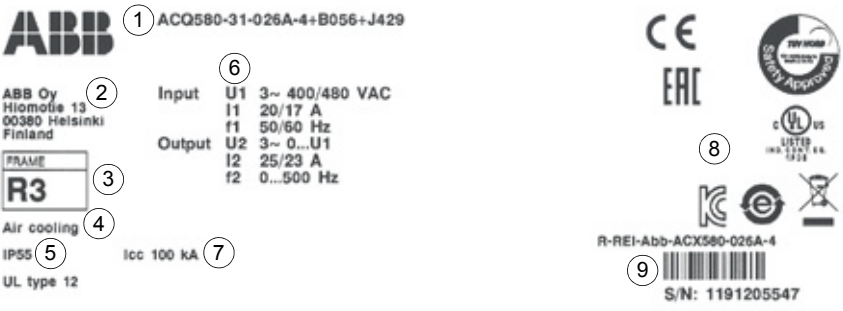
Remote control panel, panel bus

CDPI-01 communication adapter module can be used to connect a remote ACS-AP-x control panel to the drive, or to chain the control panel or a PC to several drives on a panel bus. The panel bus can have maximum 16 ACQ580-31 drives. For more information, see *CDPI-01 communication adapter module user's manual* (3AXD50000009929 [English]).

This photo shows the CDPI-01 communication adapter module. Its ordering code is 3AXD500000.

Type designation label

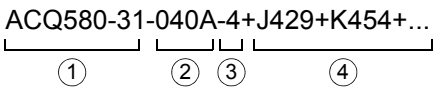
The type designation label includes IEC and UL (NEC) ratings, appropriate markings and the type designation and serial number, which allow identification of each drive. The type designation label is located on the left side of the drive. An example label is shown below.



1	Type designation, see section *Type designation key* on page *32*.
2	Name and address of the manufacturer
3	Frame (size)
4	Type of the drive, for example, with Air cooling
5	Degree of protection
6	Nominal ratings in the supply voltage range, see section *Ratings* on page*149*, section *Electrical power network specification* on page *170* and section *Motor connection data* on page *172*.
7	Rated conditional short-circuit current, see section *Electrical power network specification* on page *170*.
8	Valid markings
9	S/N: Serial number of format MYYWWXXXX, where M: Manufacturer YY: 16, 17, 18, … for 2016, 2017, 2018, … WW: 01, 02, 03, … for week 1, week 2, week 3, … XXXXX: Integer starting every week from 0001

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, ACQ580-31-040A-5. The optional selections are given after that, separated by plus signs, for example, +K454. The main selections are described below. Not all selections are available for all types.



	CODE	DESCRIPTION
	Basic codes	
1	ACQ580	Product series
	31	When no options are selected: Wall mounted, IP21 (UL Type 1), , ACH-AP-H control panel with a USB port, choke, internal EMC filter (C2 in frames R3 and R8, C3 in frame R6), internal common mode filter (to be installed by the customer for frame R8), Safe torque off, function, coated boards, cable entry from bottom, multilingual quick installation and start-up guides
2	**Size**	
	xxxx	Refer to the rating table, page *149*
3	**Voltage rating**	
	4	380…480 V. This is indicated in the type designation label as typical input voltage levels 3~ 400/480 V AC.
4	**Option codes (plus codes)**	
	Degree of protection	
	B056	IP55 (UL Type 12)
	Construction	
	C135	Flange mounting kit
	H358	UK gland plate
	P940	Drive without front covers and bottom plate for cabinet mounting. Includes control panel.
	Filters	
	Control panel	
	0J400	No control panel. Includes integrated panel holder cover. With + P940 panel holder cover is not included..
	J400	ACH-AP-H control panel (standard)
	J424	CDUM-01 Blank control panel cover, removes standard control panel)
	J429	ACH-AP-W Assistant control panel with a bluetooth interface

	CODE	DESCRIPTION
	I/O (one slot available for I/O options)	
	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 extension (6×DI and 2×RO)
	L523	CMOD-02 External 24 V AC/DC and isolated PTC interface
	L537	CPTC-02, ATEX certified thermistor protection module. Requires option Q971.
	Q971	ATEX certified safe disconnection function, EX II (2) GD. Requires option L537.
	Fieldbus adapters	
	K451	FDNA-01 DeviceNet™ adapter module
	K454	FPBA-01 PROFIBUS DP adapter module
	K457	FCAN-01 CANopen adapter module
	K458	FSCA-01 RS-485 adapter module
	K462	FCNA-01 ControlNet™ adapter module
	K469	FECA-01 EtherCAT adapter module
	K470	FEPL-02 Ethernet POWERLINK adapter module
	K475	FENA-21 2-port Ethernet adapter module for EtherNet/IP™, Modbus/TCP, PROFINET
	Embedded fieldbus	
		Embedded fieldbus, EIA-485 as standard
	Full set of printed manuals in selected language. Note: The delivered manual set may include manuals in English if the translation is not available.	
	R700	English
	R701	German
	R702	Italian
	R707	French
	R708	Spanish
	R709	Portuguese (Brazil))
	R711	Russian
	R712	Chinese
	R714	Turkish
	Specialities	
	P940	Drive without front covers and bottom plate. Includes panel holder and cable between panel holder and control unit. IP20 (UL type Open)
	P932	Extended warranty 60 months

3AXD10000790148

4

Mechanical installation

Contents of this chapter

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

Cabinet installation (option +P940)

See also ACS580, ACH580 and ACQ580…+P940 and +P944 supplement (3AXD50000210305 [English].

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

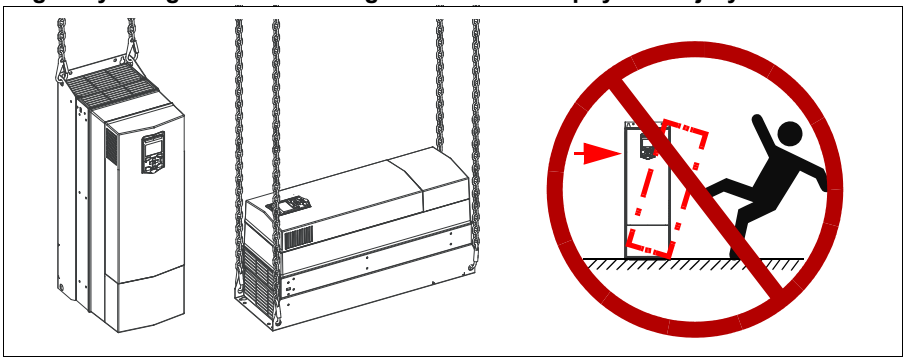
Flange mounting (option +C135)

See also:

- *ACS880-11…, ACS880-31…, ACH580-31… and ACQ580- 31…+C135 frame R3 flange mounting kit quick installation guide* (3AXD50000181506 [English],
- *ACS880-11…, ACS880-31…, ACH580-31… and ACQ580- 31…+C135* frames R6 and R8 *flange mounting kit quick installation guide* (3AXD50000133611 [English]
- *ACS580-01…, ACH580-01… and ACQ580-01… +C135 drives with flange mounting kit supplement* (3AXD50000349821[English])

Safety

WARNING! Frames R6 and R8: 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.**

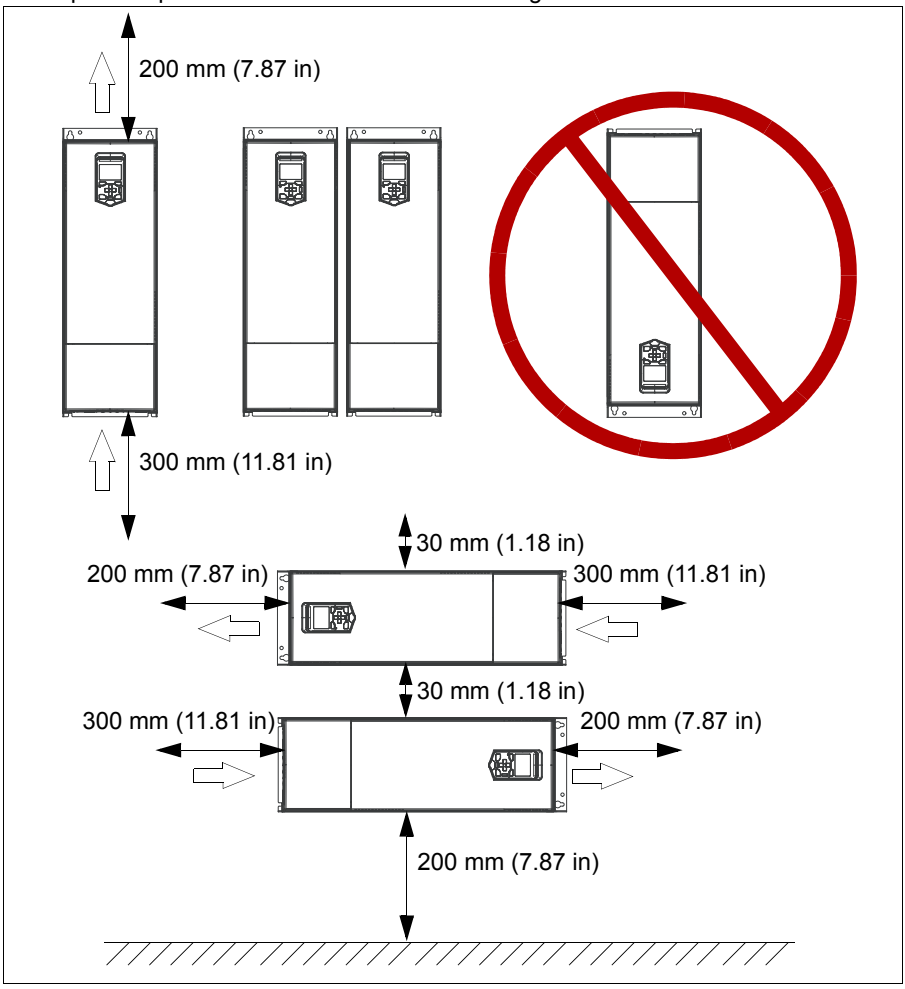


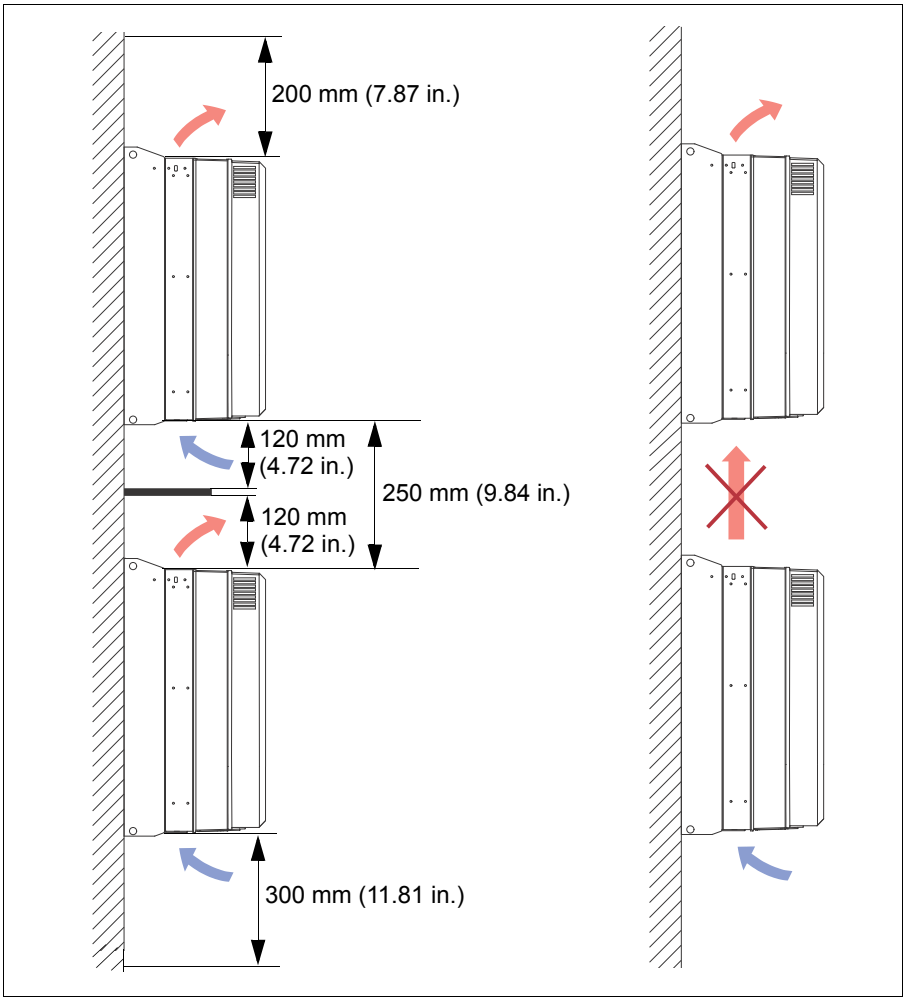
Examining the installation site

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

- vertically alone. Do not install the drive upside down
- vertically side by side
- horizontally alone, IP21 (UL Type 1) only.
  Note 1: The vibration specification in section *Ambient conditions* on page *181* may not be fulfilled.
  Note 2: IP21 (UL Type 1) construction only meets IP20 (UL Type Open) in horizontal orientation.

Free space requirements are shown in the drawings below.




200 mm (7.87 in.)
120 mm
(4.72 in.)
250 mm (9.84 in.)
120 mm
(4.72 in.)
300 mm (11.81 in.)

Make sure that

- installation site is sufficiently ventilated or cooled to remove heat from the drive. See section *Losses, cooling data and noise* on page *165*.
- operation conditions of the drive meet the specifications given in section *Ambient conditions* on page *181*.
- wall is as close to vertical as possible, of non-flammable material and strong enough to carry the weight of the drive.
- floor/material below the installation is non-flammable.
- there is enough free space above and below the drive to enable cooling air flow, service and maintenance. See the required free space tables for each of the different mounting alignments on page *37*.

Required tools

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

- drill with suitable bits
- screwdriver and/or wrench with a set of suitable bits (as appropriate for the installation hardware used)
- tape measure, if you will not be using the provided mounting template.

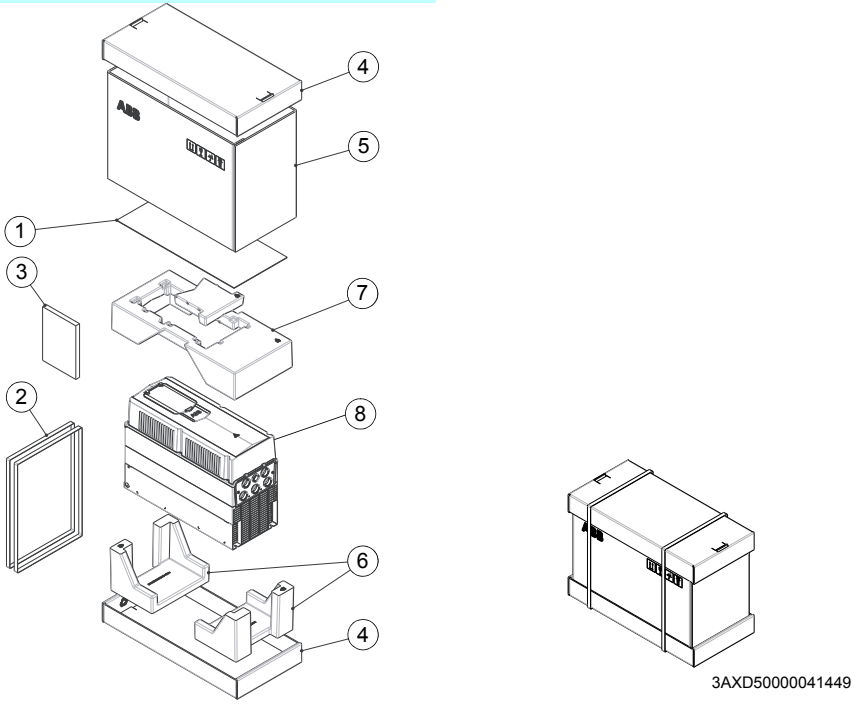
Moving the drive

Move the drive in its transport package to the installation site. Use a pallet truck when you move a heavy drive package.

Unpacking and examining delivery

The figure below shows the drive package with its contents. 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* on page *31*.

R3 IP21 (UL Type 1) and IP55 (UL Type 12)

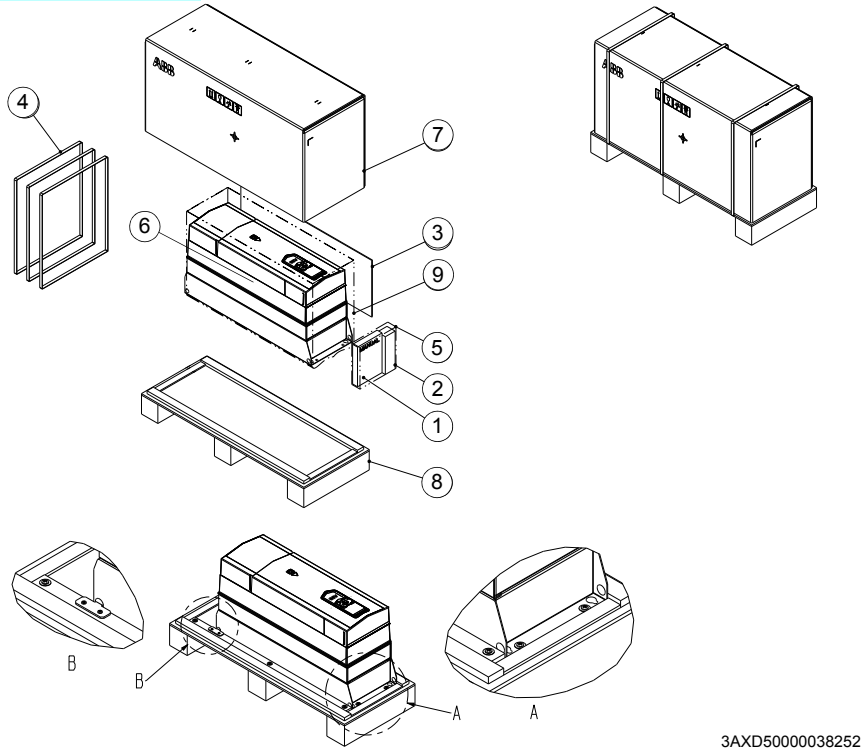


1	Mounting template	5	Sleeve
2	Package straps	6	Package cushion
3	Printed quick guides and manuals, multilingual residual voltage warning sticker, manuals CD	7	Foam cushion
4	Tray	8	Drive with factory installed options.

To unpack:

- Cut the straps (1).
- Remove the tray (4) and sleeve (5).
- Remove the cover protecting film.
- Lift the drive.

R6 IP21 (UL Type 1)



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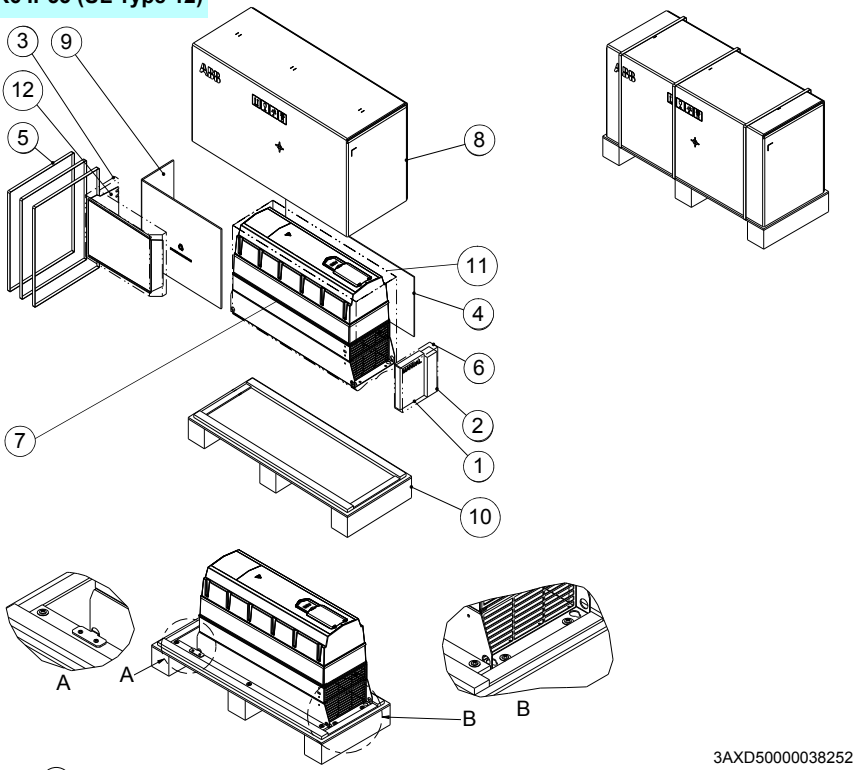
1	Printed quick guides and manuals, multilingual residual voltage warning sticker, Manuals CD	6	Drive with factory installed options
2	Accessories	7	Outer box
3	Mounting template	8	Pallet
4	Package straps	9	VCI bag
5	Plastic bag	-	-

To unpack:

- Cut the straps (4).
- Remove the outer box (7).
- Open the VCI bag (9).
- Undo the attaching screws (A, B).
- Lift the drive.

R6 IP55 (UL Type 12)



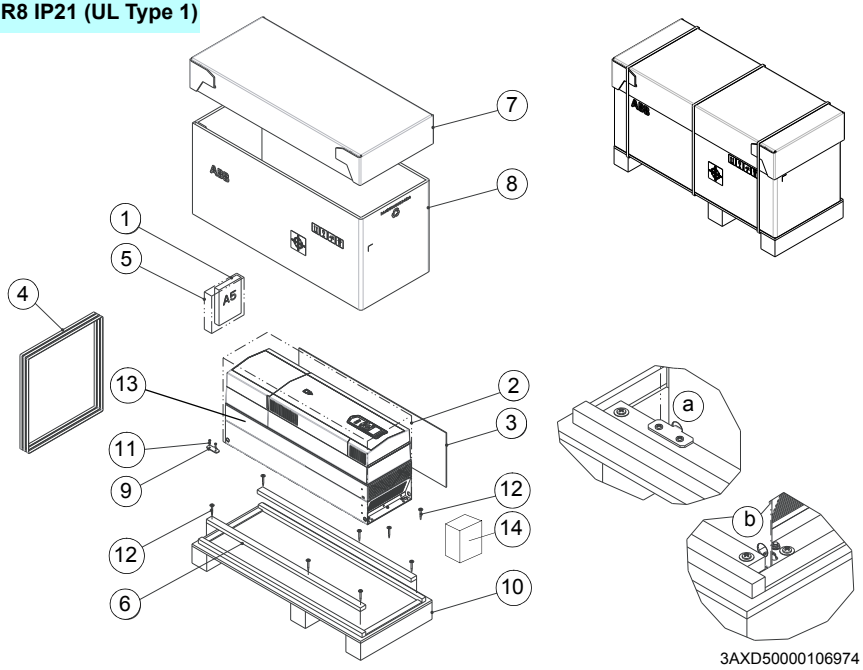
3AXD50000038252

1	Printed quick guides and manuals, multilingual residual voltage warning sticker, Manuals CD	7	Drive with factory installed options
2	Accessories	8	Outer box
3	Bubble wrap	9	Cardboard insert
4	Mounting template	10	Pallet
5	Package straps	11	VCI bag
6	Plastic bag	12	UL Type 12 hood

To unpack:

- Cut the straps (5).
- Remove the outer box (8).
- Remove the VCI bag (11).
- Undo the attaching screws (A, B).
- Lift the drive.

R8 IP21 (UL Type 1)

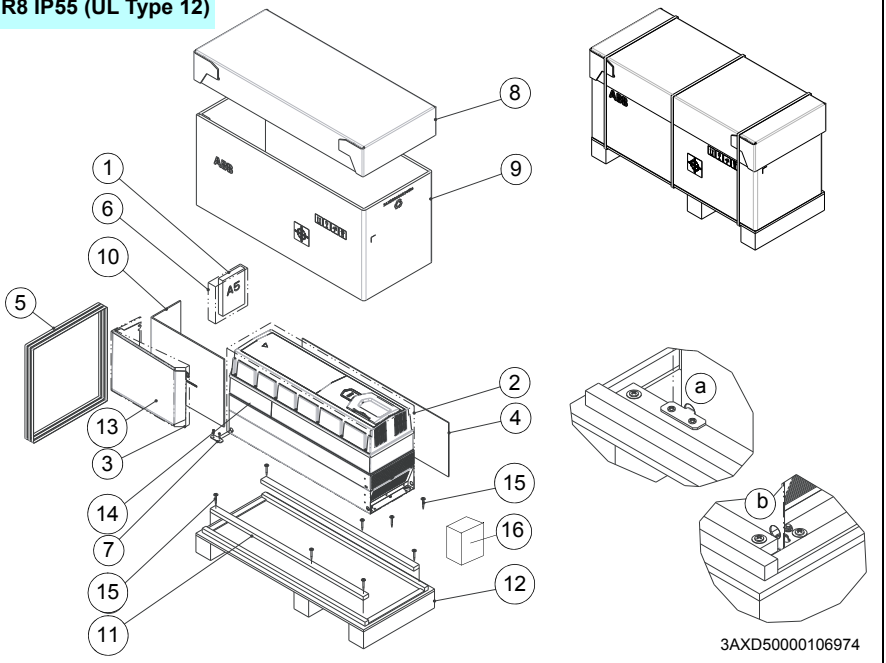


1	Printed quick guides and manuals, multilingual residual voltage warning sticker, Manuals CD	8	Cardboard sleeve
2	VCI bag	9	Plywood support
3	Mounting template	10	Pallet
4	Package straps	11, 12	Screw
5	Plastic bag	13	Drive with factory installed options
6	Packing bracket	14	Common mode filter (+E208)
7	Tray	-	-

To unpack:

- Cut the straps (4).
- Remove the tray (7) and cardboard sleeve (8).
- Open the VCI bag (2).
- Undo the attaching screws (a, b).
- Lift the drive.

R8 IP55 (UL Type 12)



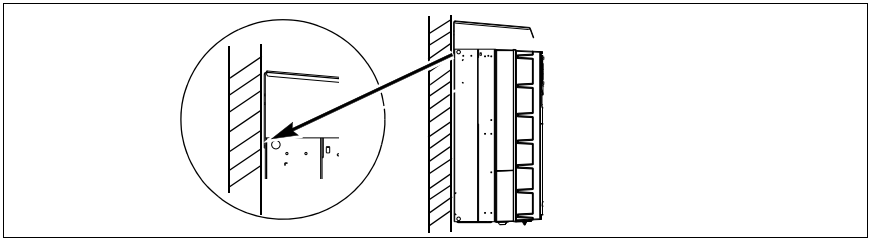
1	Printed quick guides and manuals, multilingual residual voltage warning sticker, Manuals CD	9	Cardboard sleeve
2	VCI bag	10	Not included
3	Bubble wrap	11	Plywood support
4	Mounting template	12	Pallet
5	Package straps	13	UL Type 12 hood
6	Plastic bag	14	Drive with factory installed options.
7	Packing bracket	15	Screws
8	Tray	16	Common mode filter (+E208)

To unpack:

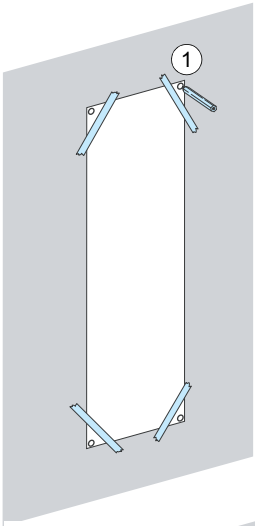
- Cut the straps (5).
- Remove the tray (8) and cardboard sleeve (9).
- Remove the VCI bag (2).
- Undo the attaching screws (a, b).
- Lift the drive.

Installing the drive vertically

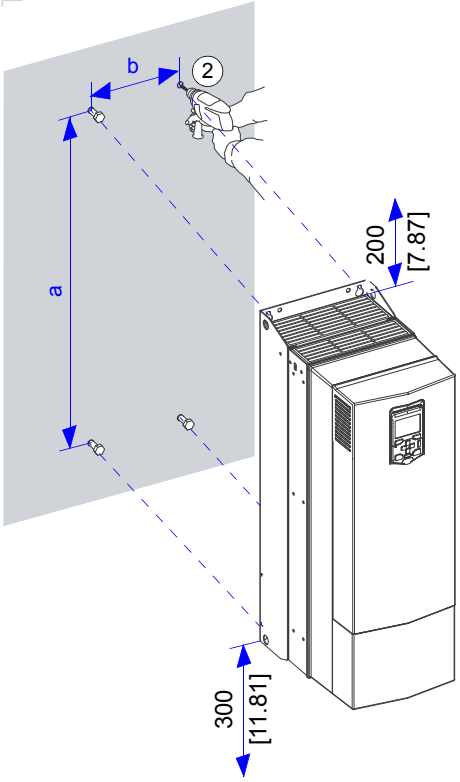
1. Mark the hole locations using the mounting template included in the package. See the next page. Do not leave the mounting template under the drive. The drive dimensions and hole locations are also shown in the drawings in chapter *Dimension drawings* on page *189*.
2. Drill the mounting holes.
3. Insert anchors or plugs into the holes and start the screws or bolts into the anchors or plugs. Drive the screws or bolts long enough into the wall to make them carry the weight of the drive.
4. Position the drive onto the bolts on the wall.
5. For R6 and R8 with option +B056 (UL Type 12), Install the hood on top of the drive before you tighten the upper fastening bolts. Place the vertical edge of the hood in between the wall and the drive back plate..

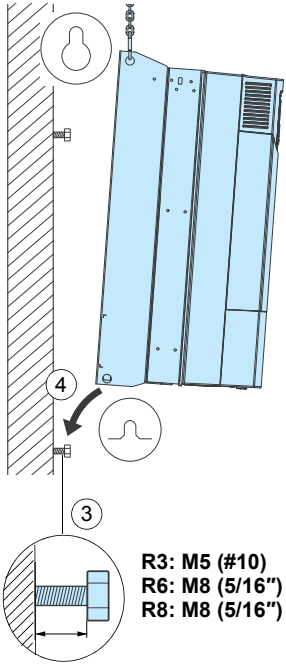


6. Tighten the bolts in the wall securely.



	R3		R6		R8	
	mm	in	mm	in	mm	in
a	474	18.7	753	29.6	945	37.2
b	160	6.3	213	8.4	263	10.3
IP21, UL Type 1	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
⚠	21.3	46.97	61.0	134.51	112	246.96
IP55, UL Type 12	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
⚠	23.3	51.38	63	138.92	118	260.19





Installing the drive vertically side by side

Drives can be installed side by side. Follow the steps in section *Installing the drive vertically* on page *45*.

Installing the drive horizontally

The drive can be installed either the left or right side up. Follow the step in section *Installing the drive vertically* on page *45*. For free space requirements, see section on *Examining the installation site* page *37*.

5

Guidelines for planning the electrical installation

Contents of this chapter

This chapter contains instructions for planning the electrical installation of the drive, for example, for checking the compatibility of the motor and drive, selecting cables, protections and cable routing.

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

Selecting the supply disconnecting device

Install a hand-operated input disconnecting device between the AC power source and the drive. The disconnecting device must be of a type that can be locked to the open position for installation and maintenance work.

European Union

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

- switch-disconnector of utilization category AC-23B (EN 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 EN 60947-2.

Other regions

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

Examining the compatibility of the motor and drive

Use an asynchronous AC induction motor, permanent magnet synchronous motor, or synchronous reluctance motor (SynRM) with the drive. Several induction motors can be connected to the drive at a time but only one permanent magnet motor.

Make sure that the motor and the drive are compatible according to the rating table in section *Ratings* on page *149*.

Make sure that the motor withstands the maximum peak voltage in the motor terminals. See the *Requirements table* on page *51*. For basics of protecting the motor insulation and bearings in drive systems, refer to section *Protecting the motor insulation and bearings* on page *50*.

Note:

- Consult the motor manufacturer before using a motor the nominal voltage of which 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 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 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.

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

Requirements table

The following table shows how to select the motor insulation system and when ABB requires optional drive du/dt and common mode filters and insulated N-end (non-drive end) motor bearings. Ignoring the requirements or incorrect installation can shorten motor life or damage the motor bearings, and voids the warranty.

Motor type	Nominal AC supply 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	100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400
			P_N < 134 hp and frame size < NEMA 500	134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580
ABB motors				
Random-wound M2_,M3_ and M4_	U_N ≤ 500 V	Standard	-	+ N
Form-wound HX_ and AM_	380 V < U_N ≤ 500 V	Standard	n.a.	+ N + CMF
Old* form-wound HX_ and modular	380 V < U_N ≤ 500 V	Check with the motor manufacturer.	+ N + CMF	
Random-wound HX_ and AM_ **	0 V < U_N ≤ 500 V	Enamelled wire with fiber glass taping	+ N + CMF	
HDP	Consult the motor manufacturer.			

Motor type	Nominal AC supply 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	100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400
			P_N < 134 hp and frame size < NEMA 500	134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580
Non-ABB motors				
Random-wound and form-wound	U_N ≤ 420 V	Standard: $\hat{U}_{LL}$ = 1300 V	-	+ N or CMF
	420 V < U_N ≤ 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ du/dt	+ du/dt + (N or CMF)
		or		
		Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 microsecond rise time	-	+ N or CMF

* manufactured before 1.1.1998

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

*** If the intermediate DC circuit voltage of the drive is increased from the nominal level by resistor braking or by the IGBT supply unit control program (parameter selectable function), check with the motor manufacturer if additional output filters are needed in the applied drive operation range.

The abbreviations used in the table are defined below.

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. Available from ABB as an optional add-on kit.
CMF	Common mode filter (internal as standard in all frames, delivered with the drive to be installed by the customer for R8)
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.

Additional requirements for explosion-safe (EX) motors

If you will use an explosion-safe (EX) motor, follow 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 the braking applications

When the motor brakes the machinery, the intermediate circuit DC voltage of the drive increases, the effect being similar to increasing the motor supply voltage 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 the regenerative and low harmonic drives

It is possible to increase the intermediate circuit DC voltage from the nominal standard level with a parameter in the control program. If you choose to do this, select the motor insulation system to withstand to the increased DC voltage level.

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 ABB random-wound motor series (for example, M3AA, M3AP and M3BP).

Nominal mains voltage (AC line voltage)	**Requirement for**			
	Motor insulation system	**ABB du/dt and common mode filters, insulated N-end motor bearings**		
		P_N < 100 kW	**100 kW ≤ P_N < 200 kW**	**P_N ≥ 200 kW**
		P_N < 140 hp	**140 hp ≤ P_N < 268 hp**	**P_N ≥ 268 hp**
U_N ≤ 500 V	Standard	-	+ N	+ N + CMF

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

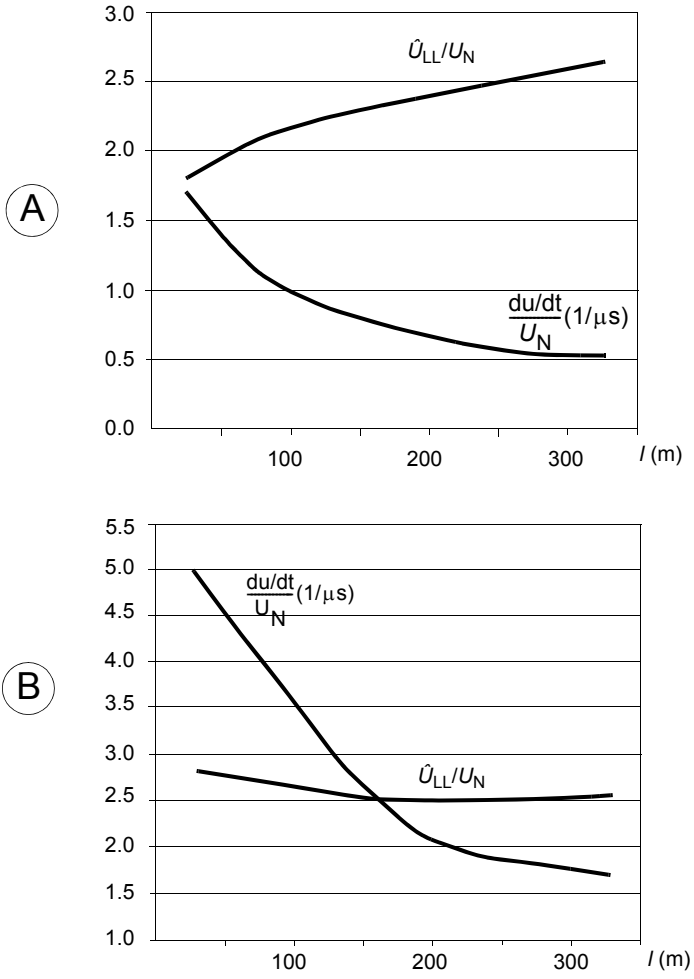
The rated output power of high output motors is higher than what is stated for the particular frame size in EN 50347 (2001). The table below shows the requirements for random-wound and form-wound non-ABB motors.

Nominal AC line voltage	Requirement for		
	Motor insulation system	ABB du/dt filter, insulated N-end bearing and ABB common mode filter	
		P_N < 100 kW or frame size < IEC 315	100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400
		P_N < 134 hp or frame size < NEMA 500	134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580
U_N ≤ 420 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ N or CMF	+ N + CMF
420 V < U_N ≤ 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ du/dt + (N or CMF)	+ du/dt + N + CMF
	or		
	Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 microsecond rise time	+ N or CMF	+ N + CMF

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

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 appropriate 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 appropriate diagram below. Multiply the values by the nominal supply voltage (U_N) and substitute into equation $t = 0.8 \cdot \hat{U}_{LL}/(du/dt)$.



A	Drive with du/dt filter
B	Drive without du/dt filter
l	Motor cable length
$\hat{U}_{LL}/U_N$	Relative peak line-to-line voltage
$(du/dt)/U_N$	Relative du/dt value
Note: ÛLL and du/dt values are approximately 20% higher with resistor braking.	

Additional note for sine filters

Sine filters protect the motor insulation system. Therefore, du/dt filter can be replaced with a sine filter. The peak phase-to-phase voltage with the sine filter is approximately $1.5 \cdot U_N$.

Selecting the power cables

General guidelines, IEC and North America

Select the input power and motor cables **according to local regulations**:

- **Current**: Select a cable capable of carrying the drive nominal current. See section *Ratings* (page *149*) for the rated currents.
- **Temperature:** For IEC, select a cable rated for at least 70 °C (90 °C for IP55 [UL Type 12]) 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 ambient temperatures above +40 °C (+104 °F), the power cables must be rated for 90 °C (194 °F) minimum.

  Note: For UL Type 12 drives of frame R6, the power cables must be rated for 90 °C (194 °F) minimum.
- **Voltage**: 600 V AC cable is accepted for up to 500 V AC.
- **Conductivity:** The conductivity of the PE conductor must be sufficient, see the table on page *57*.

To comply with the EMC requirements of the CE mark, use one of the approved cable types in section *Preferred power cable types* on page *57*.

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.

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

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

This table shows the minimum cross-sectional area related to the phase conductor size according to IEC 61800-5-1 when the phase conductor and the protective conductor are made of the same metal. If this is not so, the cross-sectional area of

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

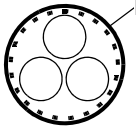
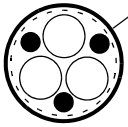
Cross-sectional area of the phase conductors S (mm^2)	Minimum cross-sectional area of the corresponding protective conductor S_p (mm^2)
$S \leq 16$	S
$16 < S \leq 35$	16
$35 < S$	S/2

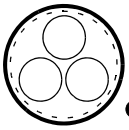
See the IEC/EN 61800-5-1 and UL 68100-5-1 requirement on grounding in the Note on page *14*.

Additional guidelines, IEC and North America

Preferred power cable types

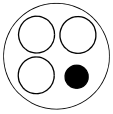
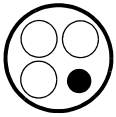
This table shows the preferred power cable types. Check with local/state/country electrical codes for allowance.

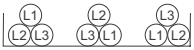
Cable type	Use as input power cabling	Use as motor cabling
 Symmetrical shielded (or armored) cable with three phase conductors and concentric PE conductor as shield (or armor)	Yes	Yes
 Symmetrical shielded (or armored) cable with three phase conductors and symmetrically constructed PE conductor and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

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

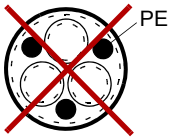
[1)] A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use. For IEC 61800-5-1 requirements, see page *61*.

Power cable types for limited use

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

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

Not allowed power cable types

	Symmetrical shielded cable with individual shields for each phase conductor is not allowed on any cable size for input or motor cabling.

Additional guidelines, North America

Obey these additional guidelines for North America with the general guidelines in section *General guidelines, IEC and North America* on page *56*.

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

The following tables show examples of various materials and methods for wiring the drive in the intended application. See NFPA (NEC 70)[1] along with state and local codes for the appropriate materials for your application.

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

In all applications, ABB prefers the use of VFD (variable-frequency drive) cable between drive and motor(s).

Conduit - Metallic[1, 3]	Notes
Electrical metallic tubing: Type EMT Rigid metal conduit: Type RMC Liquid-tight flexible metal electrical conduit: Type LFMC	• Symmetrical shielded VFD cable is preferred. • Use separate conduit run for each motor.[4] • Do not run power feed wiring and motor wiring in the same conduit.
Conduit - Non-metallic[2, 3]	**Notes**
Liquid-tight flexible nonmetallic conduit: Type LFNC	• Symmetrical shielded VFD cable is preferred. • Use separate conduit run for each motor.[4] • Do not run power feed wiring and motor wiring in the same conduit.[4]
Conduit - Non-metallic[2, 3]	**Notes**
Liquid-tight flexible nonmetallic conduit: Type LFNC	• Symmetrical shielded VFD cable is preferred. • Use separate conduit run for each motor.[4] • Do not run power feed wiring and motor wiring in the same conduit.[4]
Wireways[3]	**Notes**
Metallic	• Symmetrical shielded VFD cable is preferred. • Use output conductors require separation from motor feed and other low voltage conductors. • Do not run outputs of multiple drives in parallel. Bundle each cable together and use separator where possible.
Free air[3]	**Notes**
Enclosures, air handlers, etc.	• Symmetrical shielded VFD cable is preferred. • 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) 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 insure there is no intrusion of water/moisture.

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

4) See routing instructions in section *General guidelines, North America* on page *66*.

Conductor type, IEC and North America

The following table includes various conductor types that can be connected to the drive. For optimal drive performance, VFD cable is preferred. When not available, see the following standards in the footnotes below.

Conductor type		Notes[1, 2]
Copper	Allowed	All frames
Aluminum (UL installations)	Not allowed	All frames
Aluminum (IEC installations)	Not allowed	Frame R3
	Allowed	Frames R6 and R8

1) The selection of cable sizing/type is based on 70 (NEC) Table 310.15 (B) (16), formerly table 310.16, for copper wires is based on 75 °C (167 °F), and wire insulation at 30 °C (86 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly buried). For other ambient temperatures addition derating may be required. See 310.15(B)(2)(a) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).

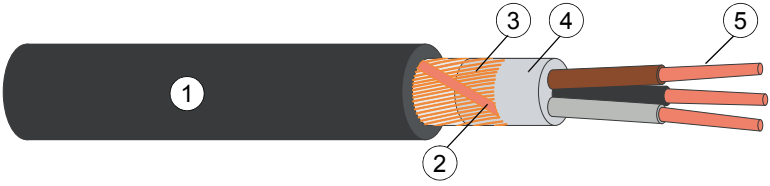
   See to 310.15(B)(3)(a) for more than three current-carrying conductors. For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive. See also page 297 for the accepted cable sizes of the drive

2) Select cable size/type based on CSA 22.1 latest acceptable revision for your area.

Power cable shield, IEC and North America

If the motor cable shield is used as the sole protective earth conductor of the motor, make sure that the conductivity of the shield is sufficient. See section *General guidelines, IEC and North America* on page *56*, or IEC 61800-5-1.

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



1	Sheath
2	Copper wire shield
3	Helix of copper tape or copper wire
4	Filling
5	Cable conductors

Typical power cable sizes

The table below gives cable types with concentric shield for the drives with nominal current.

IEC ratings

Drive type ACQ580-31	Frame size	IEC[1]		UL/NEC [4]	
		Cu cable type	Al cable type[2]	Cu cable type	Al cable type[3]
		mm^2	mm^2	AWG/kcmil	AWG/kcmil
IEC ratings U_N = 400 V					
09A5-4	R3	3×2.5+2.5	-	14	-
12A7-4	R3	3×2.5+2.5	-	14	-
018A-4	R3	3×2.5+2.5	-	14	-
026A-4	R3	3×6+6	-	10	-
033A-4	R6	3×10+10	3×16	8	-
039A-4	R6	3×10+10	3×16	8	-
046A-4	R6	3×16+16	3×25	6	-
062A-4	R6	3×25+16	3×35	4	-
073A-4	R6	3×35+16	3×50	2	-
088A-4	R6	3×50+25	3×70	1/0	-
106A-4	R8	3×70+35	3×70	2/0	-
145A-4	R8	3×95+50	3×120	3/0	-
169A-4	R8	3×120+70	3×150	250 MCM	-
206A-4	R8	3×150+70	3×240	300 MCM	-
IEC ratings U_N = 480 V					
09A5-4	R3	3×2,5+2,5	-	14	-
12A7-4	R3	3×2,5+2,5	-	14	-
018A-4	R3	3×2,5+2,5	-	14	-
026A-4	R3	3×6+6	-	10	-
033A-4	R6	3×10+10	3×16	8	-
039A-4	R6	3×10+10	3×16	8	-
046A-4	R6	3×16+16	3×25	6	-
062A-4	R6	3×25+16	3×35	4	-
073A-4	R6	3×35+16	3×50	2	-
088A-4	R6	3×50+25	3×70	1/0	-
106A-4	R8	3×70+35	3×70	2/0	-
145A-4	R8	3×95+50	3×120	3/0	-
169A-4	R8	3×120+70	3×150	250 MCM	-
206A-4	R8	3×150+70	3×240	300 MCM	-

3AXD00000586715

[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 also page *167* for the accepted cable sizes of the drive.

[2] Aluminum cables must not be used with drives of frame size R3.

[3] In the USA, aluminum cables must not be used.

[4] The cable sizing is based on NEC Table 310-16 for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly buried). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive. See also page *167* for the accepted cable sizes of the drive.

UL (NEC) ratings

Drive type ACQ580-31	Frame size	IEC[1]		UL/NEC [4]	
		Cu cable type	Al cable type[2]	Cu cable type	Al cable type[3]
		mm^2	mm^2	AWG/kcmil	AWG/kcmil
3-phase U_N = 480 V					
07A6-4	R3	3×2,5+2,5	-	14	-
012A-4	R3	3×2,5+2,5	-	14	-
014A-4	R3	3×2,5+2,5	-	14	-
023A-4	R3	3×6+6	-	10	-
027A-4	R6	3×10+10	3x16	8	-
034A-4	R6	3×10+10	3x16	8	-
044A-4	R6	3×16+16	3×25	6	-
052A-4	R6	3×25+16	3×35	4	-
065A-4	R6	3×35+16	3×50	2	-
077A-4	R6	3×35+16	3×70	2	-
096A-4	R8	3x50+25	3x70	1/0	-
124A-4	R8	3x70+35	3x95	2/0	-
156A-4	R8	3x95+50	3x150	4/0	-
180A-4	R8	3x120+70	3x185	250 MCM	-

3AXD00000586715

[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 also page *167* for the accepted cable sizes of the drive.

[2] Aluminum cables must not be used with drive types up to -034A-x.

[3] In the USA, aluminum cables must not be used.

[4] The cable sizing is based on NEC Table 310-16 for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly buried). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive. See also page *168* for the accepted cable sizes of the drive

See also section *Terminal and entry data for the power cables* on page *167*.

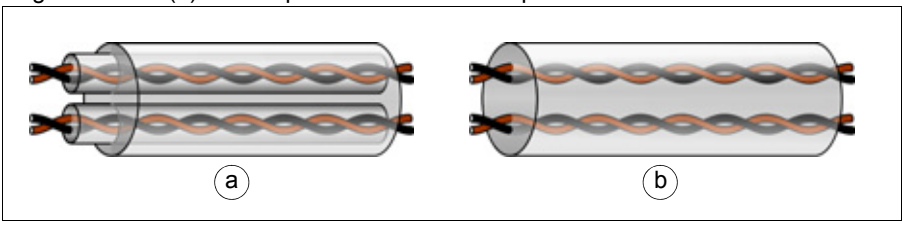
Selecting the control cables

Shielding

All control cables must be shielded.

Use a double-shielded twisted pair cable (figure a below) for analog signals. Employ one individually shielded pair for each signal. Do not use common return for different analog signals.

A double-shielded cable 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 AC/DC and 115/230 V AC signals in the same cable.

Signals allowed to be run in the same cable

Relay-controlled signals, providing their voltage does not exceed 48 V, 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 screen (for example ÖLFLEX by LAPPKABEL, Germany) has been tested and approved by the manufacturer.

Control panel cable

In remote use, the cable connecting the control panel to the drive must not exceed 100 m (330 ft). If multiple drives are connected, the total length of the panel bus must not exceed 100 m (330 ft).

The cable type tested and approved by the manufacturer is used in control panel option kits. Suitable cables are CAT 5e unshielded or shielded twisted pair cables.

Drive composer 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 B (control panel) cable. The maximum length of the cable is 3 m (9.8 ft).

Routing the cables

General guidelines, IEC

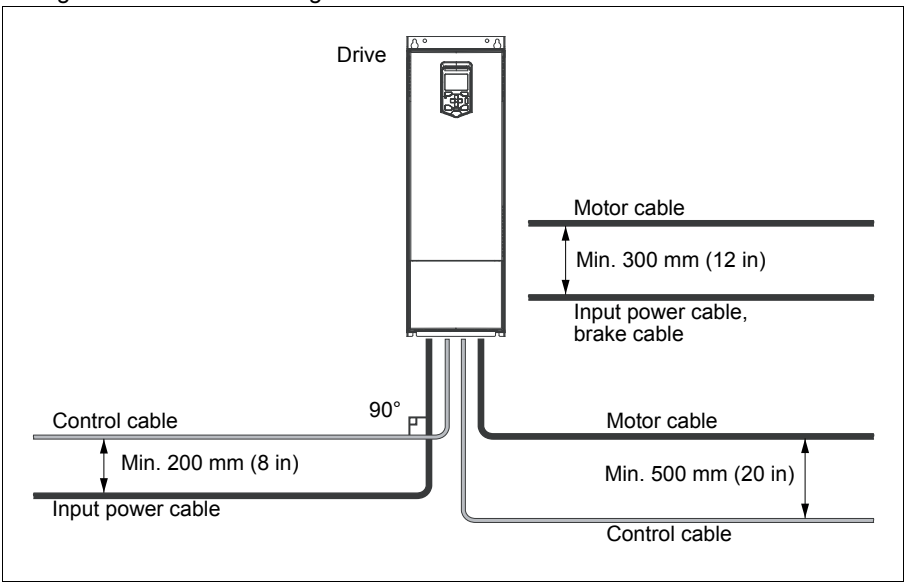
Route the motor cable away from other cable routes. Motor cables of several drives can be run in parallel installed next to each other. The motor cable, input power cable and control cables should be installed on separate trays. Avoid long parallel runs of

motor cables with other cables in order to decrease electromagnetic interference caused by the rapid changes in the drive output voltage.

Where control cables must cross power cables, make sure they are arranged at an angle as near to 90 degrees as possible. Do not run extra cables through the drive.

The cable trays must have good electrical bonding to each other and to the grounding electrodes. Aluminum tray systems can be used to improve local equalizing of potential.

A diagram of the cable routing is shown below.

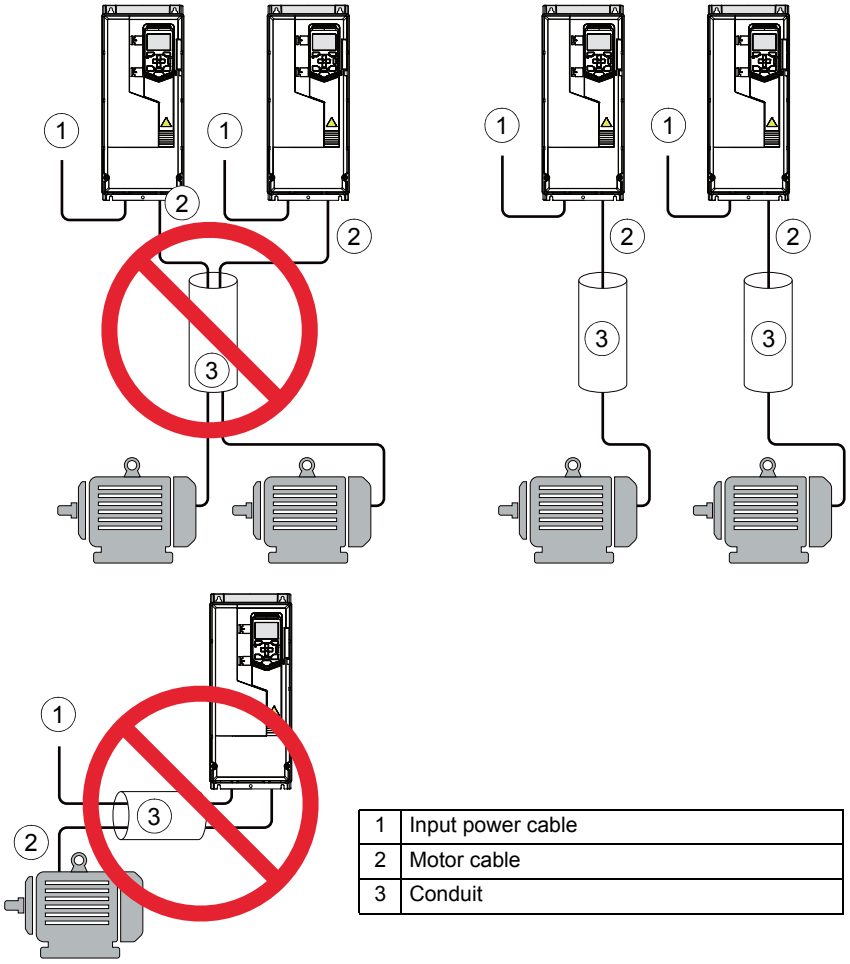


General guidelines, North America

Obey the these rules for routing with conduits:

- Do not run power supply wiring and motor wiring in the same conduit.
- Use separate conduit run for each motor.
- Do not run power feed and drive output in same conduit.
- Do not run multiple drive outputs in same conduit.

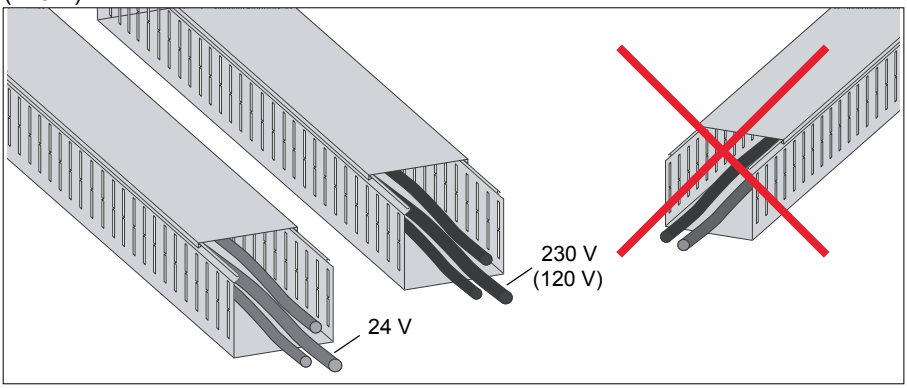
.



1	Input power cable
2	Motor cable
3	Conduit

Separate control cable ducts

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



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

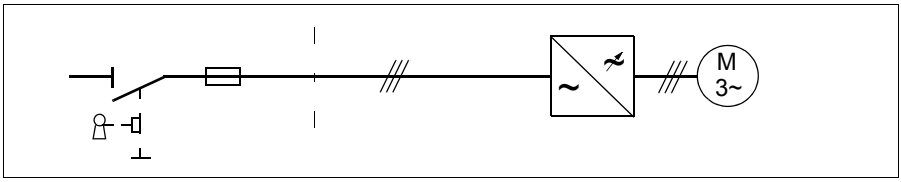
To minimize the emission level when safety switches, contactors, connection boxes or similar equipment are installed on the motor cable between the drive and the motor:

- European Union: Install the equipment in a metal enclosure with 360 degree grounding for the shields of both the incoming and outgoing cable, or connect the shields of the cables otherwise together.
- US: Install the equipment in a metal enclosure in a way that the conduit or motor cable shielding runs consistently without breaks from the drive to the motor.

Implementing thermal overload and short-circuit protection

Protecting the drive and input power cable in short-circuits

Protect the drive and input cable with fuses as follows:



Size the fuses at the distribution board according to instructions given in chapter *Technical data* The fuses will protect 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.

Circuit breakers

Circuit breakers are not allowed to be used without fuses.

Protecting the motor and motor cable in short-circuits

The drive protects the motor cable and motor in a short-circuit situation when the motor cable is sized according to the nominal current of the drive. No additional protection devices are needed.

Protecting the drive and the input power and motor cables against thermal overload

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

WARNING! If the drive is connected to multiple motors, use a separate circuit breaker or fuses for protecting each motor cable and motor against overload. The drive overload protection is tuned for the total motor load. It may not trip due to an overload in one motor circuit only.

Protecting the motor against thermal overload

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

temperature indication given by motor temperature sensors. The user can tune the thermal model further by feeding in additional motor and load data.

The most common temperature sensors are:

- motor sizes IEC180…225: thermal switch, eg, Klixon
- motor sizes IEC200…250 and larger: PTC or Pt100.

For more information, see the firmware manual.

Implementing a ground fault detection function

The drive has a function that detects ground faults in the motor and motor cable. The user can select how the drive reacts to a ground fault (parameter setting). Note that this function is not a personnel safety or a fire protection feature. See the firmware manual for more information.

Residual current device compatibility

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

Note: The EMC filter of the drive includes capacitors connected between the main circuit and the frame. These capacitors and long motor cables increase the ground leakage current and may cause fault current circuit breakers to function.

Implementing the Emergency stop function

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

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

Implementing the Safe torque off function

See chapter *The Safe torque off function* on page *197*.

Implementing the ATEX-certified Safe motor disconnection function (option +Q971)

With option +Q971, the drive supplies ATEX-certified safe motor disconnection without contactor that uses the drive Safe torque off function. For more information, see *CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (+L537+Q971) user's manual* (3AXD50000030058 [English]).

Implementing the undervoltage control (power-loss ride-through)

See the firmware manual.

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. This is needed to isolate the motor from the drive during maintenance work on the drive.

Using a contactor between the drive and the motor

Implementing the control of the output contactor depends on how you select the drive to operate.

When you have selected to use

- Vector control mode and motor ramp stop,

open the contactor as follows:

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

When you have selected to use

- Vector control mode and motor coast stop; or scalar control mode,

open the contactor as follows:

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

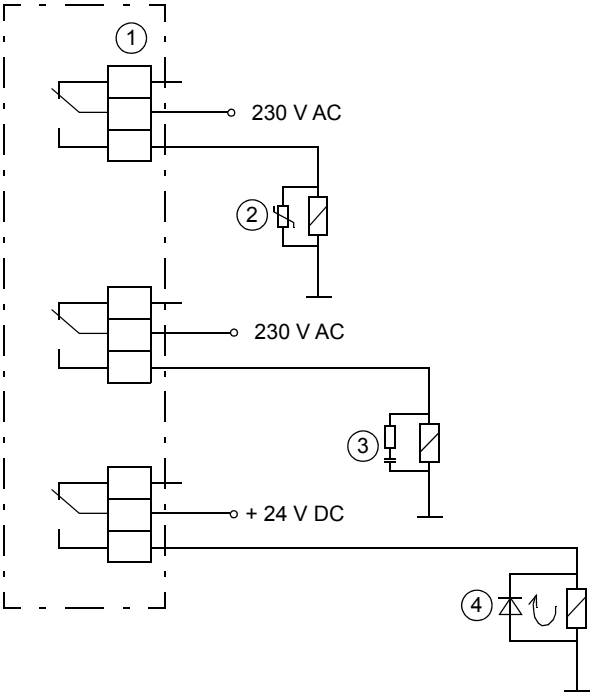
WARNING! When the vector control mode is in use, never open the output contactor while the drive controls the motor. The vector control operates extremely fast, much faster than it takes for the contactor to open its contacts. When the contactor starts opening while the drive controls the motor, the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

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]) in order to minimize the EMC emission at switch-off. If not suppressed, the disturbances may connect capacitively or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

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



1	Relay outputs
2	Varistor
3	RC filter
4	Diode

Limiting relay output maximum voltages at high installation altitudes

See section *Isolation areas* on page *176*.

Implementing a motor temperature sensor connection

WARNING! IEC 60664 and IEC 61800-5-1 require double or reinforced insulation between live parts and the surface of accessible parts of electrical equipment which are either non-conductive or conductive but not connected to the protective earth.

To connect a motor temperature sensor and other similar components to the drive, you have four 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 inputs of the drive.
2. If there is basic insulation between the sensor and the live parts of the motor, you can connect the sensor to the analog/digital inputs of the drive if all circuits connected to the drive's digital and analog inputs (typically extra-low voltage circuits) are protected against contact and insulated with basic insulation from other low-voltage circuits. The insulation must be rated for the same voltage level as the drive main circuit. Note that extra-low voltage circuits (such as 24 V DC) typically do not meet these requirements.
3. 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 section *Connection of motor temperature sensor to the drive via an option module* (page *74*).
4. You can connect the sensor to a digital input of the drive via a customer's external relay. The sensor and the relay must form a double or reinforced insulation between the motor live parts and the drive control unit. See section *Connection of motor temperature sensor to the drive via a relay* (page *75*).

Connection of motor temperature sensor to the drive via an option module

This table shows what temperature sensor types you can connect to the drive option modules as well as the insulation requirement for the sensor.

Option module		Temperature sensor type			Temperature sensor insulation requirement
Type	Insulation	PTC	KTY	Pt100, Pt1000	
CMOD-02	Reinforced insulation between the motor thermistor connector and the other connectors of the module (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	Reinforced insulation between the motor thermistor connector and the other connectors of the module (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

More information:

- *AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs (X1)* on page *102*
- *CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface)* on page *229*
- *CPTC-02 ATEX-certified thermistor protection module Ex II (2) GD (+L537+Q971) user's manual* (3AXD50000030058 [English].

Connection of motor temperature sensor to the drive via a relay

PTC (IEC 60800-5-1)

Class A. This table shows the insulation requirement for a customer's external relay, and the insulation requirement for the sensor to fulfill decisive voltage class A (double insulation).

PTC relay		Temperature sensor insulation requirement
Type	**Insulation**	
External relay	Basic insulation 6 kV	Basic insulation

Class B. Decisive voltage class B (basic insulation) is provided with a 6 kV relay. Circuits connected to all motor protection relay inputs and outputs must be protected against direct contact.

Pt100 (IEC 60800-5-1)

Class B. Decisive voltage class B (basic insulation) can be achieved when there is basic insulation between the sensor and live parts of the motor. Circuits connected to all motor protection relay inputs and outputs must be protected against direct contact.

Pt100 relay		Temperature sensor insulation requirement between sensor and live parts of motor
Type	**Insulation**	
External relay	Basic insulation 6 kV	Basic insulation

6

Electrical installation – IEC

Contents of this chapter

The chapter describes how to check the insulation of the assembly and the compatibility with grounding systems. It then shows how to connect the power and control cables, install optional modules and connect a PC.

Warnings

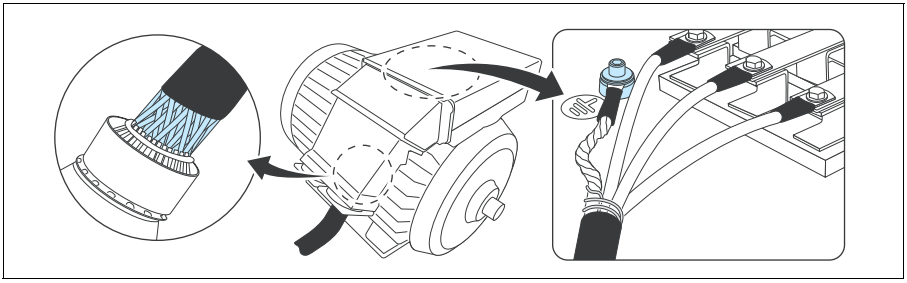
WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, injury or death, or damage to the equipment can occur.

Make sure that the drive is disconnected from the input power during installation. If you need to disconnect the drive, wait for 5 minutes after disconnecting the input power before you start the work.

IEC

Grounding the motor cable shield at the motor end

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.



Measuring the insulation

Drive

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

Input power cable

Measure the insulation of the input cable according to local regulations before connecting it to the drive.

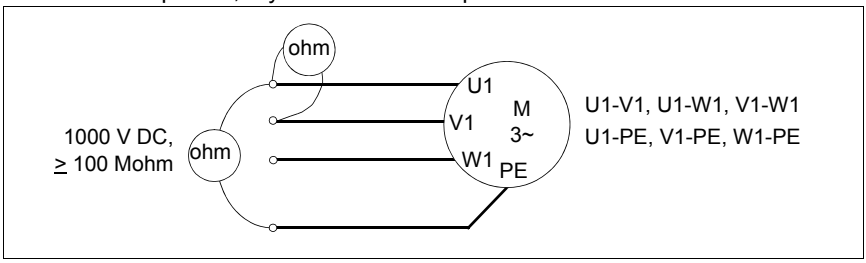
IEC

Motor and motor cable

Measure the insulation of the motor and motor cable as follows:

1. Stop the drive and do the steps in section *Precautions before electrical work* on page *12* before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals T1/U, T2/V and T3/W.
3. Measure the insulation resistance between the phase conductors and between each phase conductor and the Protective Earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of a motor must be greater than 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, please consult the manufacturer's instructions.

Note: Moisture inside the motor casing will reduce the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.



Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems

The standard drive can be an be installed to a symmetrically grounded TN-S system. For other systems, see sections *EMC filter* and *Ground-to-phase varistor* below.

EMC filter

A drive with the 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 section *When to disconnect EMC filter or ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems and TT systems* on page *81*.

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 filteris disconnected, the drive EMC compatibility is considerably reduced. See section *EMC compatibility and motor cable length* on page *172*.

Ground-to-phase varistor

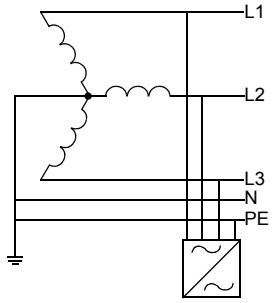
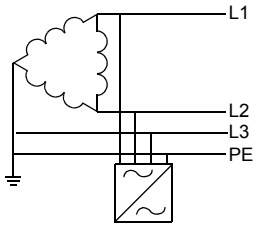
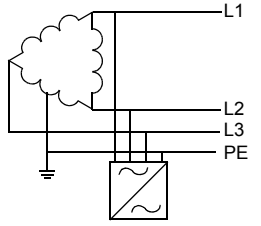
A standard drive with the ground-to-phase varistor connected can be installed to a symmetrically grounded TN-S system. If you install the drive to another system, you may need to disconnect the varistor. See sections *When to disconnect EMC filter or ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems and TT systems* on page *81*.

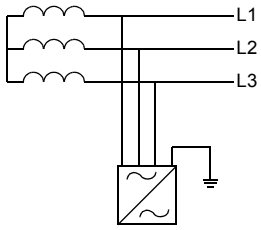
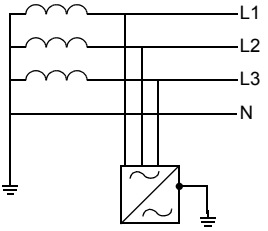
IEC

WARNING! Do not install the drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. If you do, the varistor circuit can be damaged.

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

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

Symmetrically grounded TN systems (TN-S systems (ie. center-grounded wye)	
	Do not disconnect EMC or VAR screws.
Corner-grounded delta systems	
	R3: Do not disconnect EMC or VAR screws. R6: Disconnect EMC DC screw. Do not disconnect EMC AC or VAR screws. See Note 1 below. R8: Disconnect EMC DC and VAR screws.
Midpoint-grounded delta systems	
	R3: Do not disconnect EMC or VAR screws. R6: Disconnect EMC DC screw. Do not disconnect EMC AC or VAR screws.See Note 1 below. R8: Disconnect EMC DC and VAR screws.

<table>
<tr><td colspan="2">IT systems (ungrounded or high-resistance grounded [>30 ohms])</td></tr>
<tr><td> 
</td><td>R3: Disconnect EMC and VAR screws.
R6: Disconnect EMC AC, EMC DC and VAR screws.
R8: Disconnect EMC DC and VAR screws.</td></tr>
<tr><td colspan="2">TT systems</td></tr>
<tr><td> 
</td><td>R3: Disconnect EMC and VAR screws.
R6: Disconnect EMC AC, EMC DC and VAR screws.
R8: Disconnect EMC DC and VAR screws.
Residual current device has to be installed in the supply system.
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 real reason.</td></tr>
</table>

Note 1: Frames R3 and R6 are evaluated for use on corner-grounded systems and midpoint-grounded delta systems by UL standards. They are not evaluated by IEC standards for use on corner-grounded or midpoint-grounded systems.

IEC

Note 2: These are the EMC filter and varistor screws of different drive frame sizes.

Frame size	EMC filter crews	Ground-to-phase varistor screws
R3	EMC	VAR
R6	EMC AC, EMC DC	VAR
R8	EMC DC	VAR*

*) VAR screw functions also as EMC AC screw in frame R8.

Identifying different types of electrical power systems

To identify the electrical power system type, find out the supply transformer connection. If that is not possible, measure these voltages at the distribution board .

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. Proceed only if you are an electrical professional certified for the work. Obey the local regulations. If you ignore them, injury or death can occur.

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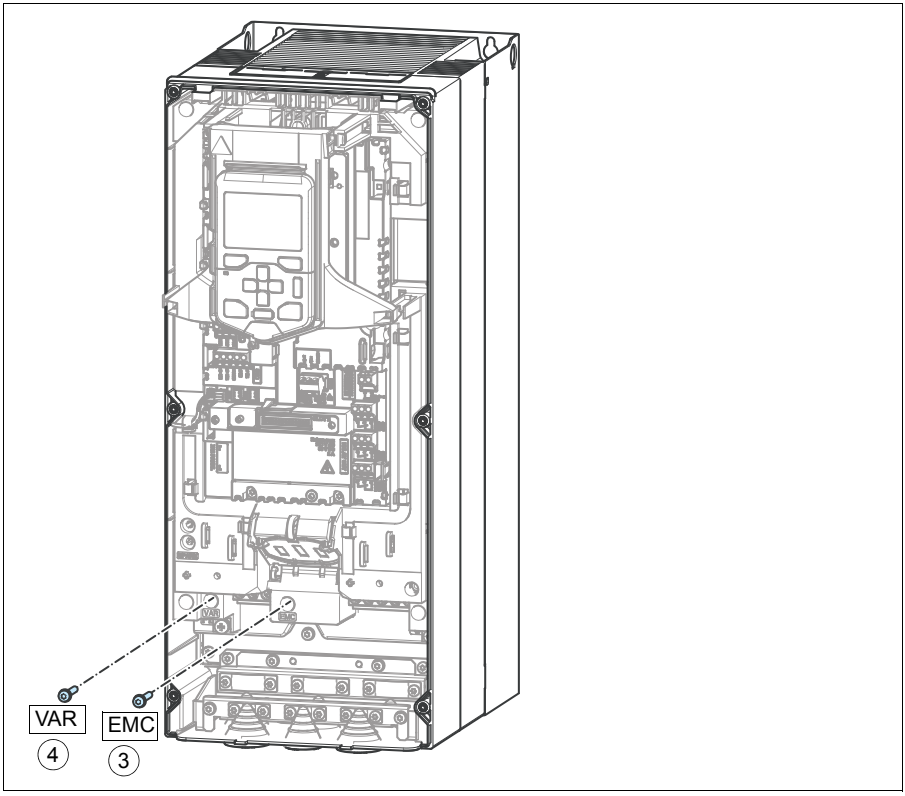
1. input voltage line to line ($U_{L\text{-}L}$)
2. input voltage line 1 to ground ($U_{L1\text{-}G}$)
3. input voltage line 2 to ground ($U_{L2\text{-}G}$)
4. input voltage line 3 to ground ($U_{L3\text{-}G}$).

The line-to-ground voltages of the electrical power system types in relation to the line-to-line voltage of the system are shown below.

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

Disconnecting internal EMC filter and ground-to-phase varistor – frame R3

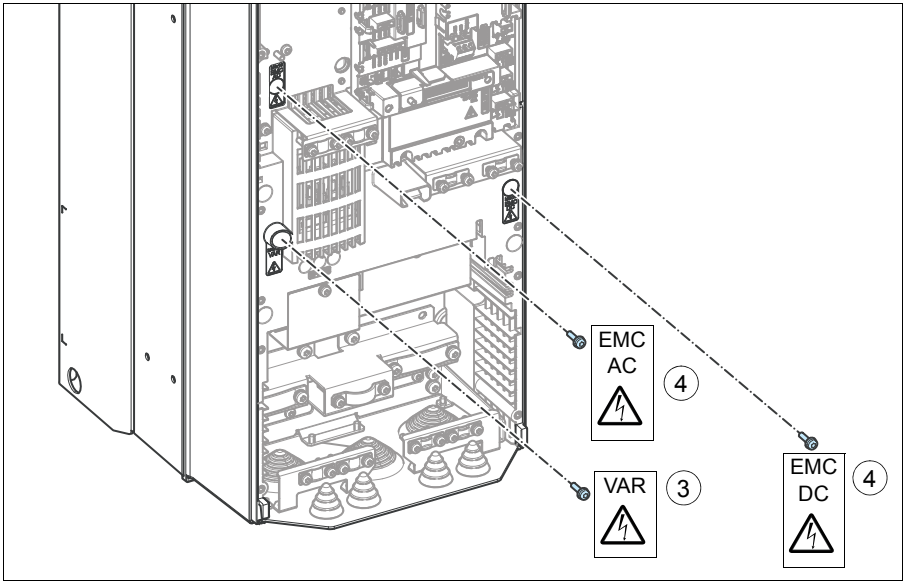
1. Stop the drive and do the steps in section *Precautions before electrical work* on page *12* before you start the work.
2. Remove the front cover. See page *88*.
3. Remove the EMC screw.
4. Remove the VAR screw.



IEC

Disconnecting internal EMC filter and ground-to-phase varistor – frame R6

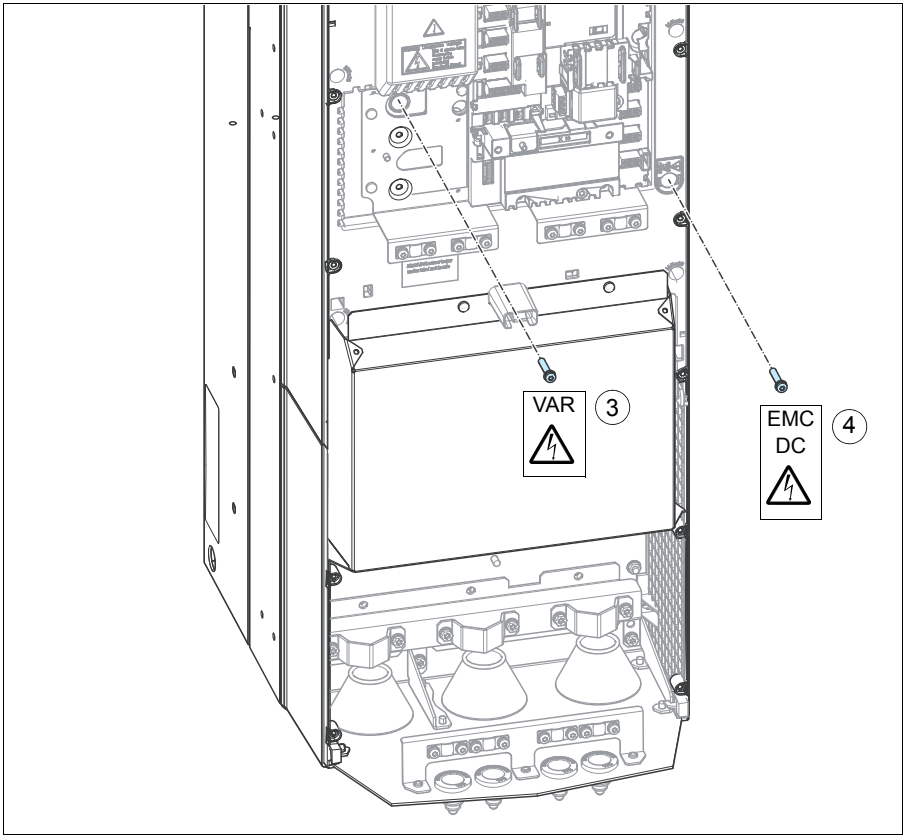
1. Stop the drive and do the steps in section *Precautions before electrical work* on page *12* before you start the work.
2. Remove the front cover. See page *88*.
3. Remove the VAR screw.
4. Remove the EMC AC and/or EMC DC screws.



IEC

Disconnecting internal EMC filter and ground-to-phase varistor – frame R8

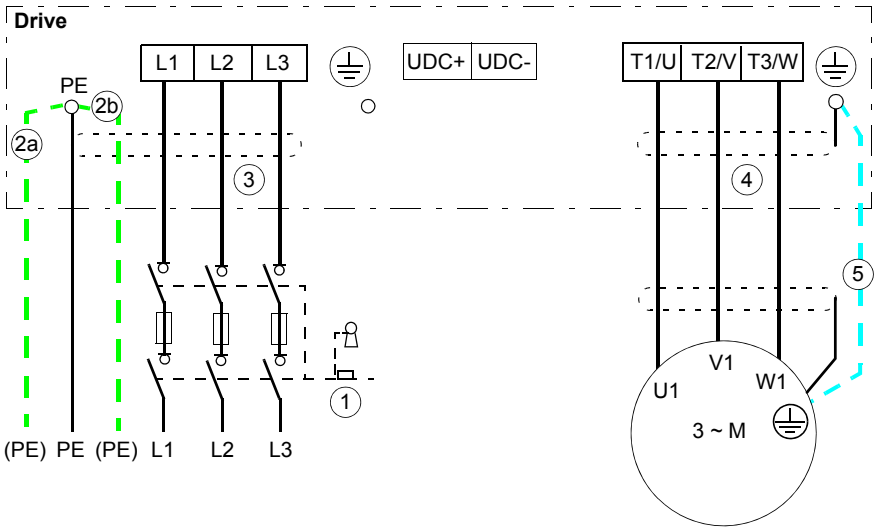
1. Stop the drive and do the steps in section *Precautions before electrical work* on page *12* before you start the work.
2. Remove the front cover if it is not already removed. See page *88*.
3. Remove the VAR screw.
4. Remove the EMC DC screw.



IEC

Connecting the power cables

Connection diagram



1	For alternatives, see section *Selecting the supply disconnecting device* on page *49*.
2	Use a separate grounding PE cable (2a) or a cable with a separate PE conductor (2b) if the conductivity of the shield does not meet the requirements for the PE conductor (see page *56*). If the protective PE conductor is smaller than 10 mm^2, you must use a second earthing conductor, see page *14*
3	ABB recommends 360-degree grounding if shielded cable is used. Ground the other end of the input cable shield or PE conductor at the distribution board.
4	ABB requires 360-degree grounding.
5	Use a separate grounding cable if the shield does not meet the requirements of IEC 61800-5-1 (see page *56*) and there is no symmetrically constructed grounding conductor in the cable (see page *61*).
6	External brake chopper (optional)
7	External brake resistor (optional)

Note:

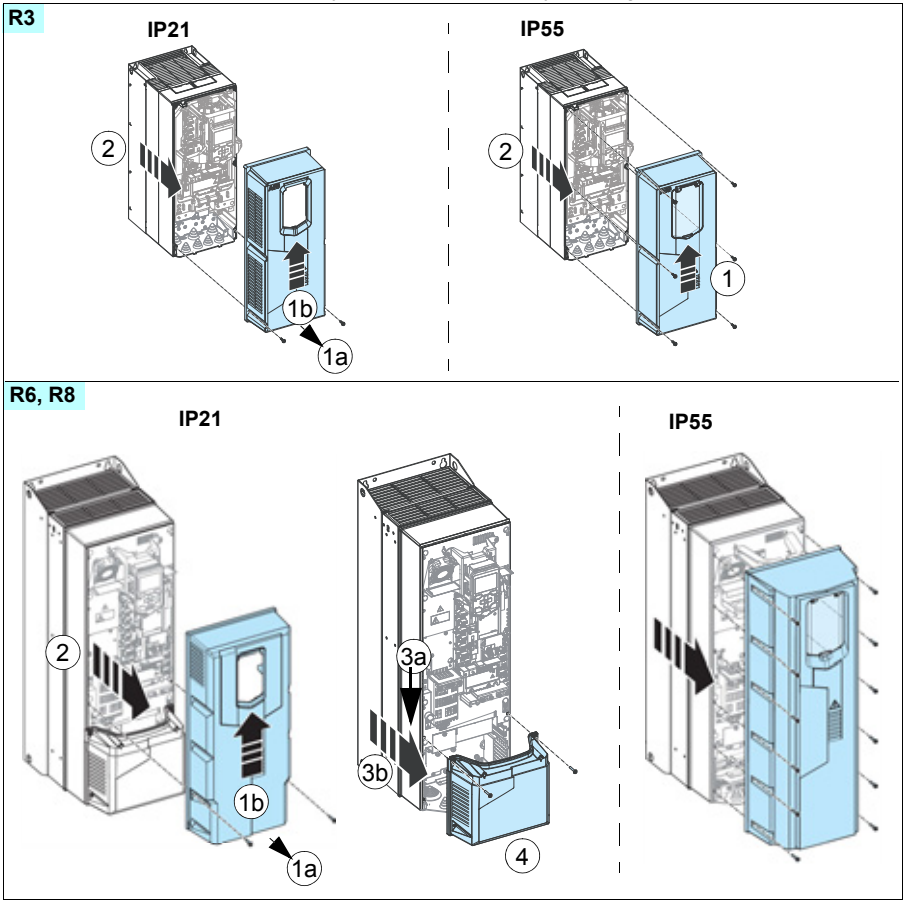
If there is a symmetrically constructed grounding conductor on the motor cable in addition to the conductive shield, connect the grounding conductor to the grounding terminal at the drive and motor ends.

Do not use an asymmetrically constructed motor cable for motors above 30 kW (see page *56*). Connecting its fourth conductor at the motor end increases bearing currents and causes extra wear.

Connection procedure

The procedure of connecting the power cables to the standard drive is described below. For the procedure with UK gland plate (option +H358), see also *UK gland plate installation guide* (3AXD50000110711 [English]).

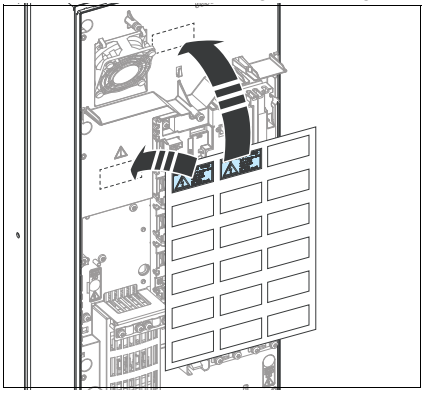
1. To remove the R3 front cover (R6 and R8 upper front cover), lift the cover from the bottom outwards (1a) and then up (1b). To remove the R6 and R8 lower front cover, slide it downwards (3a) and then forward (3b). For IP55 frame R8, disconnect the power supply wire of the auxiliary cooling fan.



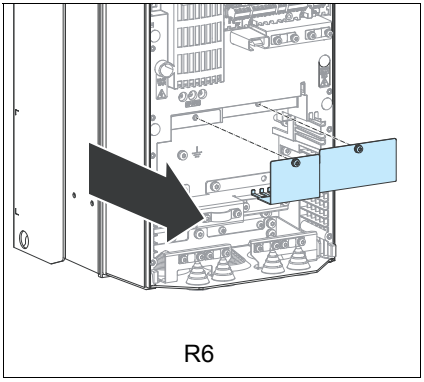
IEC

WARNING! Make sure you have disconnected the EMC filter and/or ground-to-phase varistor when necessary. See *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* page *80*.

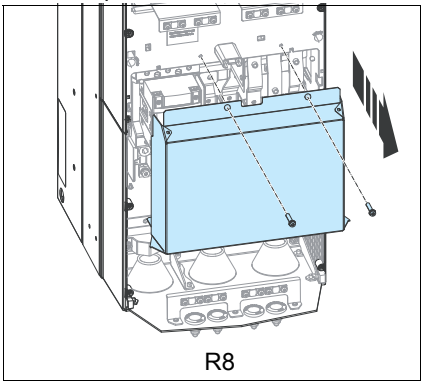
2. Attach the residual voltage warning sticker in the local language.



3. For frames R6 and R8: Remove the shroud on the power cable terminals,

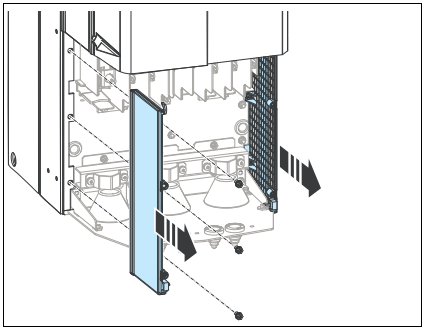


R6



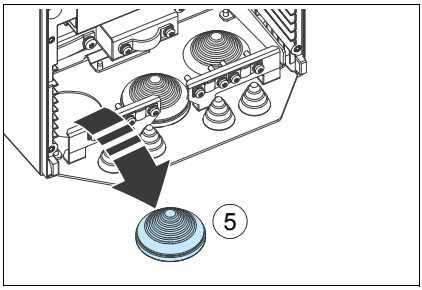
R8

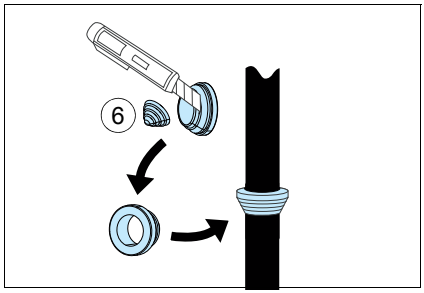
4. For frame R8: For easier installation, you can remove the side plates.



IEC

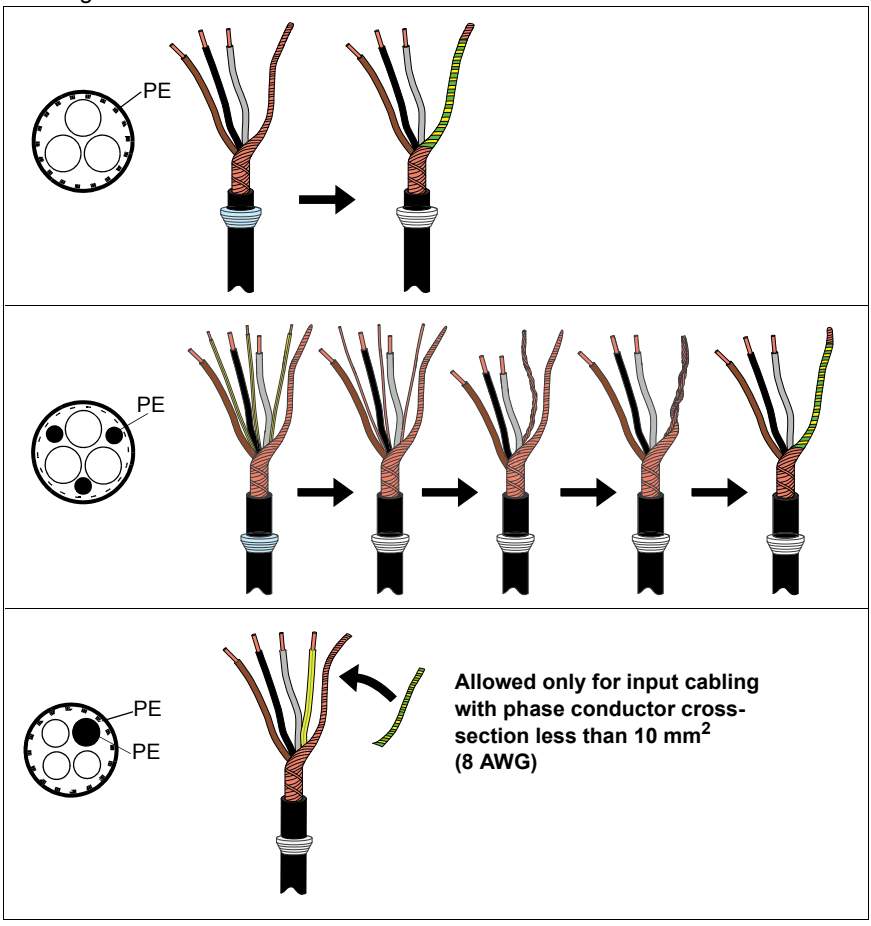
5. Remove the rubber grommets of the cables to be installed from the cable entry plate. Install the grommets downwards also in unused holes.
6. Cut an adequate hole into the rubber grommet. Slide the grommet onto the cable.





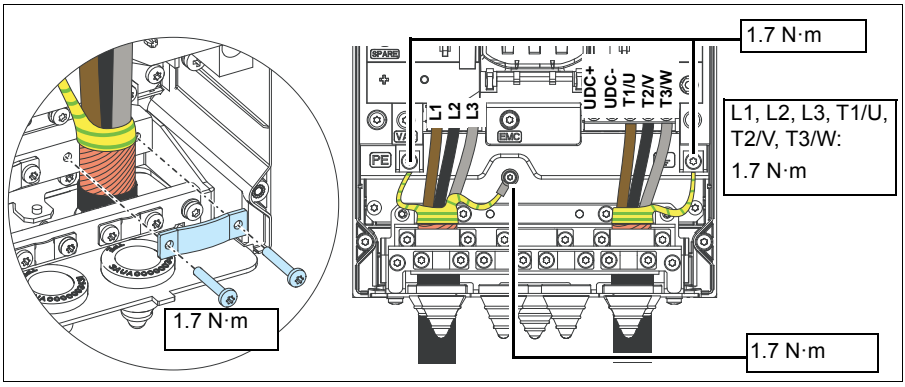
IEC

7. Prepare the ends of the cables as shown in the figure. Two different motor cable types are shown. If you use aluminum cables, put grease to the peeled aluminum cable before you connect it to the drive. **Note:** The bare shield will be grounded 360 degrees.



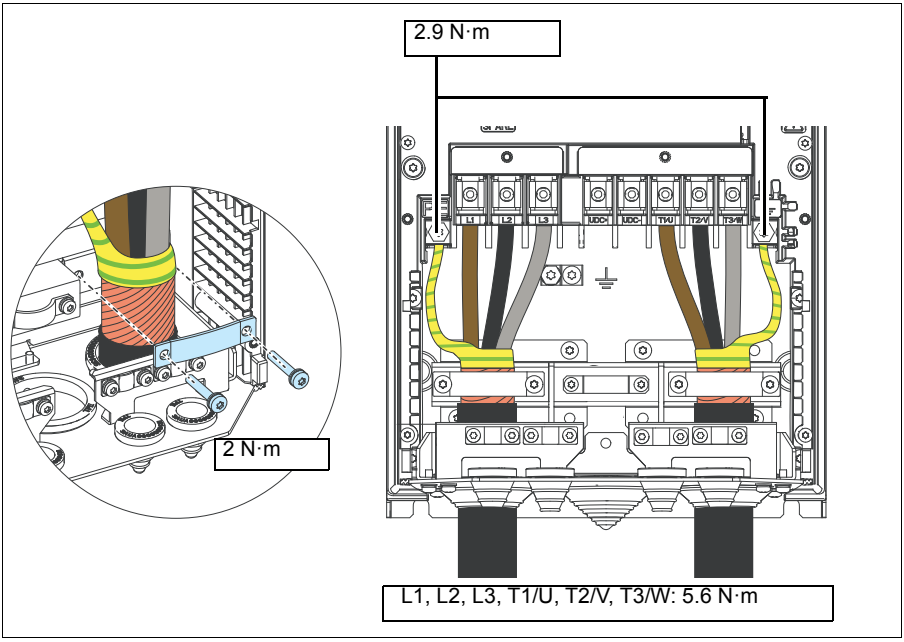
8. Put the cable through the hole of the cable entry plate and attach the grommet to the hole.
9. Connect the cables:
   - Ground the shield 360 degrees by tightening the clamp of the power cable grounding shelf onto the stripped part of the cable.
   - Connect the twisted shield of the cable to the grounding terminal.
   - Connect the additional PE conductors (if any).
   - Connect the phase conductors of the motor cable to the T1/U, T2/V and T3/W terminals and the phase conductors of the input cable to the L1, L2 and L3 terminals.
     For frame R8: Install the common mode filter. For instructions, see *Common mode filter kit for frames R7 and R8 (option +E208) installation guide* (3AXD50000015179 [English]).
   - Tighten the screws to the torque given in the installation drawing below.

R3

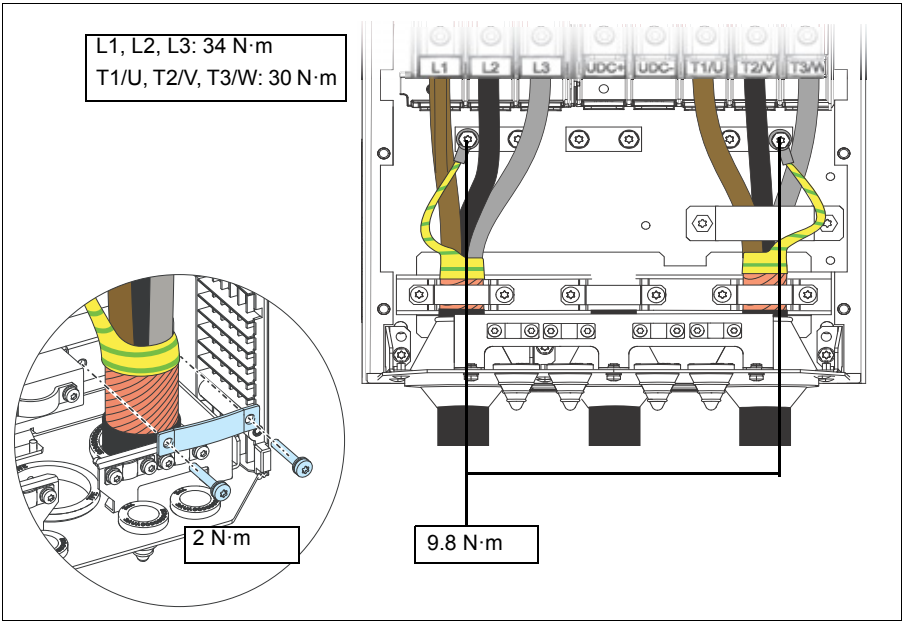


IEC

R6


2.9 N·m
2 N·m
L1, L2, L3, T1/U, T2/V, T3/W: 5.6 N·m

R8

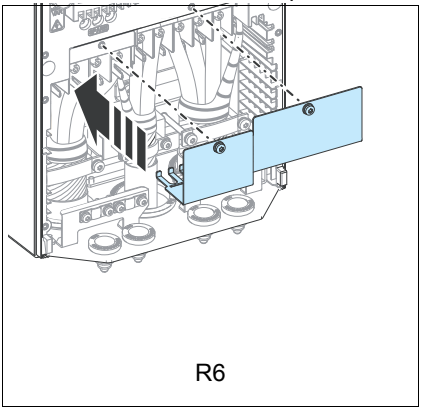

L1, L2, L3: 34 N·m
T1/U, T2/V, T3/W: 30 N·m
2 N·m
9.8 N·m

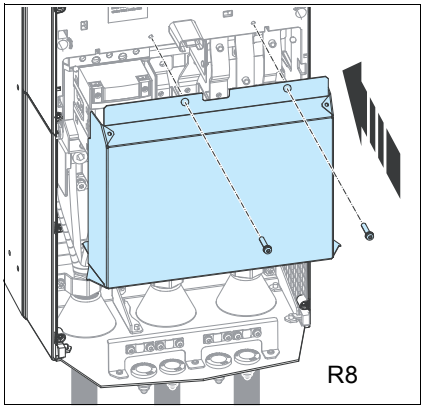
Note 1 for frame R8: Install the side plates if removed.

Note 2 for frame R8: The power cable connectors can be detached. For the instructions, see section *R8 power cable connection if you detach the cable connectors* on page *94*.

10. For frame R6 types bigger than -040A-x: Cut tabs in the shroud for the installed cables.

11. Install the shroud onto the power cable connection terminals.





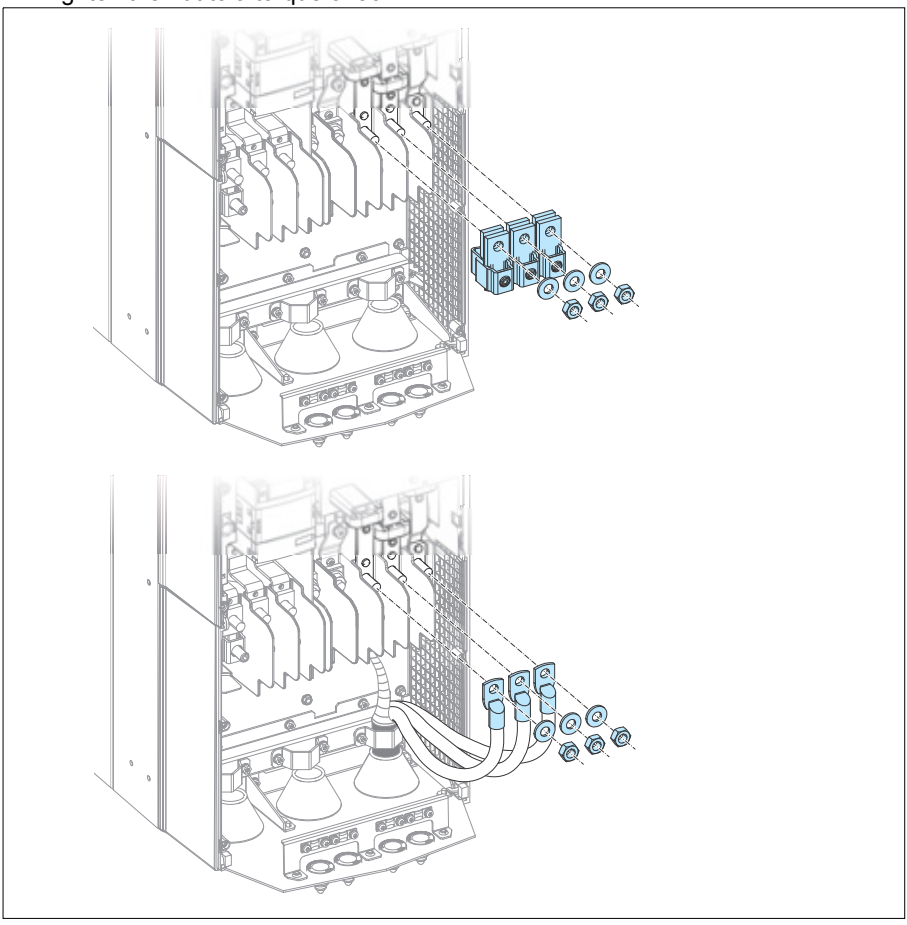
R8 power cable connection if you detach the cable connectors

The power cable connectors of frame R8 are detachable. If you detach them, you can connect the cables with cable lugs as follows:

IEC

- Remove the nut that attaches the connector to the terminal post and remove the connector.
- Alternative 1: Put the conductor to the connector. Tighten to a torque of 30 N·m. Put the connector back onto the post. Tighten the connector to 30 N·m.

Alternative 2: Attach a cable lug to the conductor. Put the cable lug onto the post. Tighten the nut to a torque of 30 N·m.



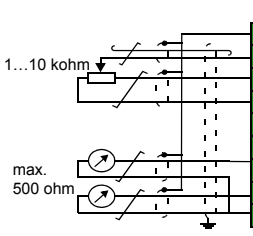
Connecting the control cables

See section *Default I/O connection diagram (Water default configuration)* on page *97* for the default I/O connections of the drive.

Connect the cables as described in section *Control cable connection procedure* on page *103*.

IEC

Default I/O connection diagram (Water default configuration)



X1	Reference voltage and analog inputs and outputs	
1	SCR	Signal cable shield (screen)
2	AI1	**Output frequency/speed reference**: 0…10 V[1)]
3	AGND	Analog input circuit common
4	+10V	Reference voltage 10 V DC
5	AI2	**Actual feedback:** 0…10 V[1)]
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
X2 & X3	Aux. voltage output and programmable digital inputs	
10	+24V	Aux. voltage output +24 V DC, max. 250 mA[2)]
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**[3)]
16	DI4	Not configured
17	DI5	Not configured
18	DI6	Not configured
X6, X7, X8	Relay outputs	
19	RO1C	**Ready run** 250 V AC / 30 V DC 2 A
20	RO1A	
21	RO1B	
22	RO2C	**Running** 250 V AC / 30 V DC 2 A
23	RO2A	
24	RO2B	
25	RO3C	**Fault (-1)** 250 V AC / 30 V DC 2 A
26	RO3A	
27	RO3B	
X5	Embedded fieldbus	
29	B+	Embedded fieldbus, EFB (EIA-485)
30	A-	
31	DGND	
S4	TERM	Termination switch
S5	BIAS	Bias resistors switch
X4	Safe torque off	
34	OUT1	Safe torque off. Factory connection. Both circuits must be closed for the drive to start. See chapter *The Safe torque off function* on page *197*.
35	OUT2	
36	SGND	
37	IN1	
38	IN2	
X10	24 V AC/DC	
40	24 V AC/DC+ in	Ext. 24V AC/DC input to power up the control unit when the main supply is disconnected.
41	24 V AC/DC- in	

See the next page for the notes.

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

Wire sizes: 0.14…2.5 mm^2: All terminals

Tightening torques: 0.5…0.6 N·m

IEC

Notes:

1) Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 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 degrees under the grounding clamp on the grounding shelf for the control cables.

Further information on the usage of the connectors and switches is given in the sections below

Switches

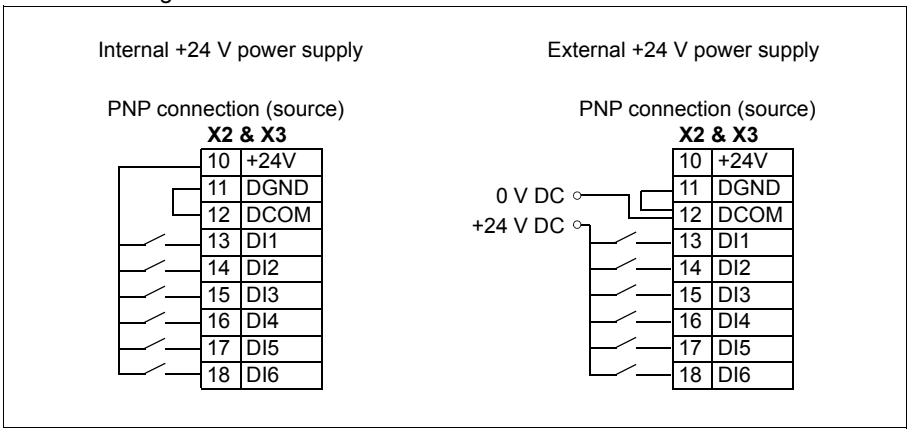
Switch	Description	Position	
TERM S4	EFB link termination. Must be set to the terminated (ON) position when the drive is the first or last unit on the link.		Bus not terminated (**default**)
			Bus terminated
BIAS S5	Switches on the biasing voltages to the bus. One (and only one) device, preferably at the end of the bus must have the bias on.		Bias off (**default**)
			Bias on

IEC

Additional information on I/O connections

PNP configuration for digital inputs

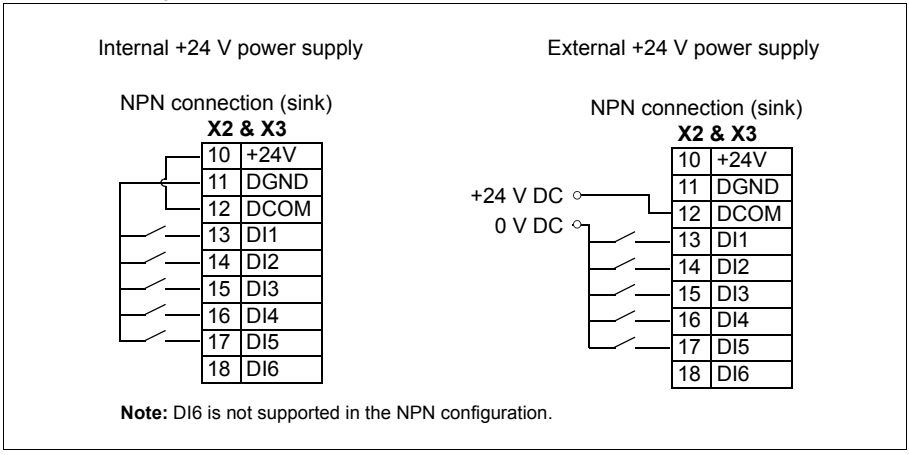
Internal and external +24 V power supply connections for PNP configuration are shown in the figure below.



WARNING! Do not connect the +24 V AC cable to the control board ground when the control board is powered using an external 24 V AC supply.

NPN configuration for digital inputs

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



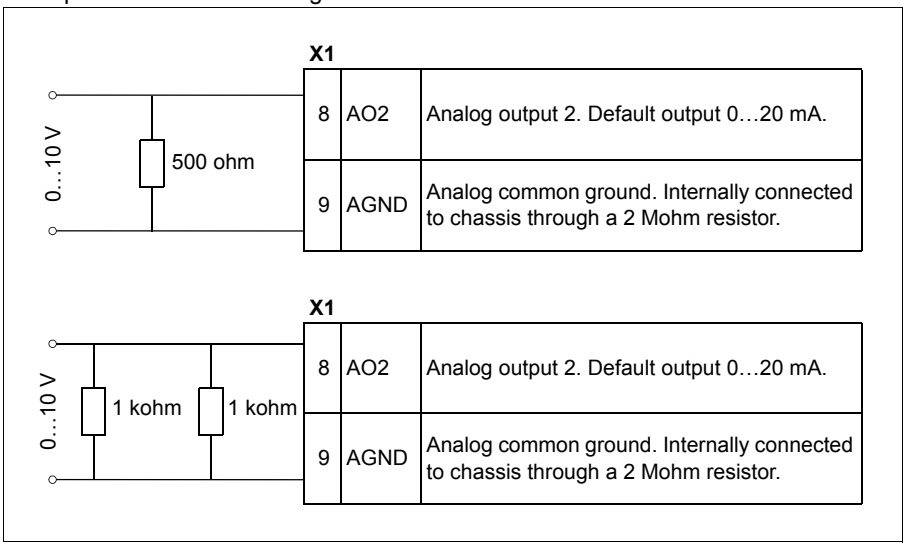
Note: DI6 is not supported in the NPN configuration.

WARNING! Do not connect the +24 V AC cable to the control board ground when the control board is powered using an external 24 V AC supply.

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 the analog output 2 AO2 and analog common ground AGND.

Examples are shown in the figure below.

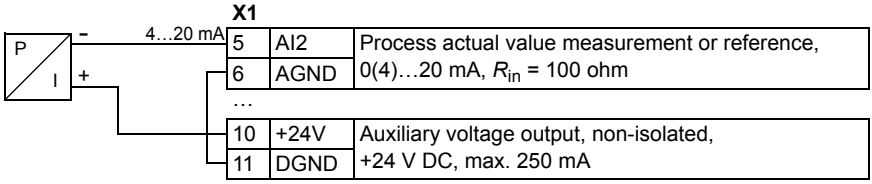


IEC

Connection examples of two-wire and three-wire sensors

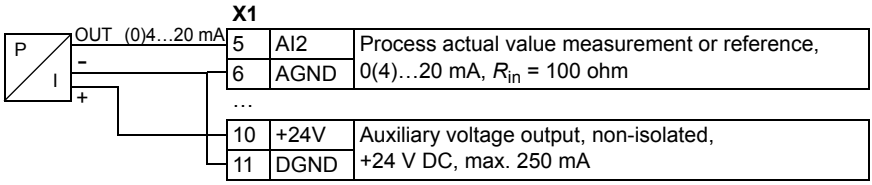
Note: Maximum capability of the auxiliary 24 V DC (250 mA) output must not be exceeded.

Two-wire sensor/transmitter



Note: 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.

Three-wire sensor/transmitter



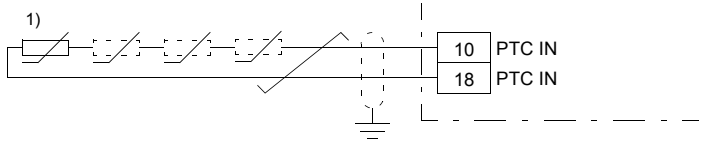
DI5 as frequency input

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

DI6 as PTC input

If DI6 is used as a PTC input, see the firmware manual for how to set parameters accordingly.

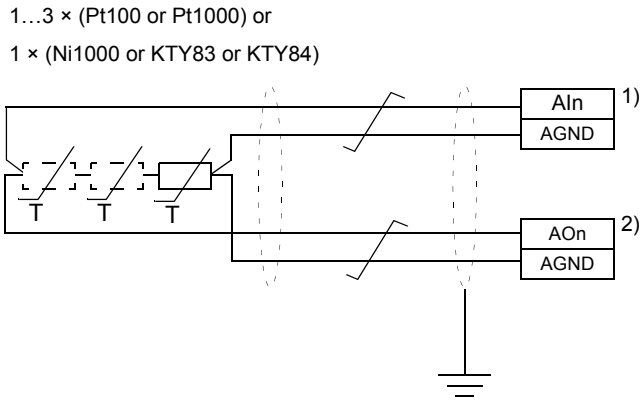
Note: If DI6 is used as PTC input, the wiring and the PTC sensor need to be double isolated. Otherwise the CMOD-02 I/O extension module must be used.



1) One to six PTC thermistors connected in series.

AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs (X1)

One, two or three Pt100 sensors; one, two or three Pt1000 sensors; or one Ni1000, KTY83 or KTY84 sensor for motor temperature measurement can be connected between an analog input and output as shown below. Do not connect both ends of the cable shields directly to ground. If a capacitor cannot be used at one end, leave that end of the shield unconnected.



1) Select the input type to voltage for analog input AI1 or AI2 with parameters. Set the appropriate analog input unit to V (volt) in parameter group 12 Standard AI.
2) Select the excitation mode in parameter group 13 Standard AO.

IEC

WARNING! As the inputs shown above are not insulated according to IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. If the assembly does not fulfill the requirement, the control unit I/O terminals must be protected against contact and must not be connected to other equipment or the temperature sensor must be isolated from the I/O terminals.

Safe torque off (X4)

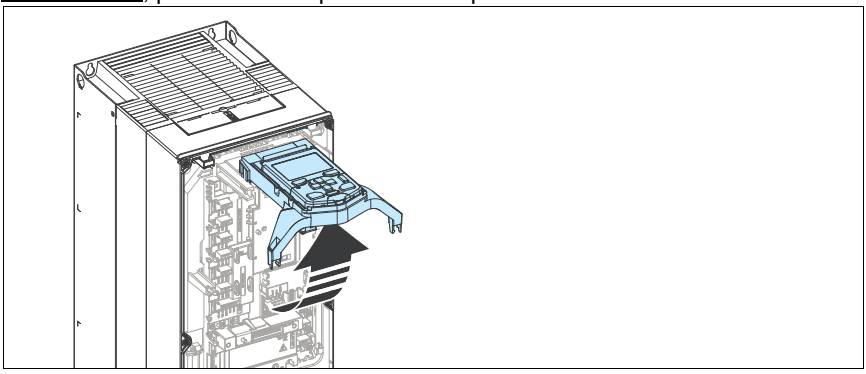
For the drive to start, both connections (+24 V DC to IN1 and +24 V DC to IN2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting an external Safe torque off circuitry to the drive. See chapter *The Safe torque off function* on page *197*.

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

Control cable connection procedure

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section *Precautions before electrical work* on page *12* before you start the work.
2. Remove the front cover(s) if not already removed. See page *88*.
3. For frame R3, pull the control panel holder up.



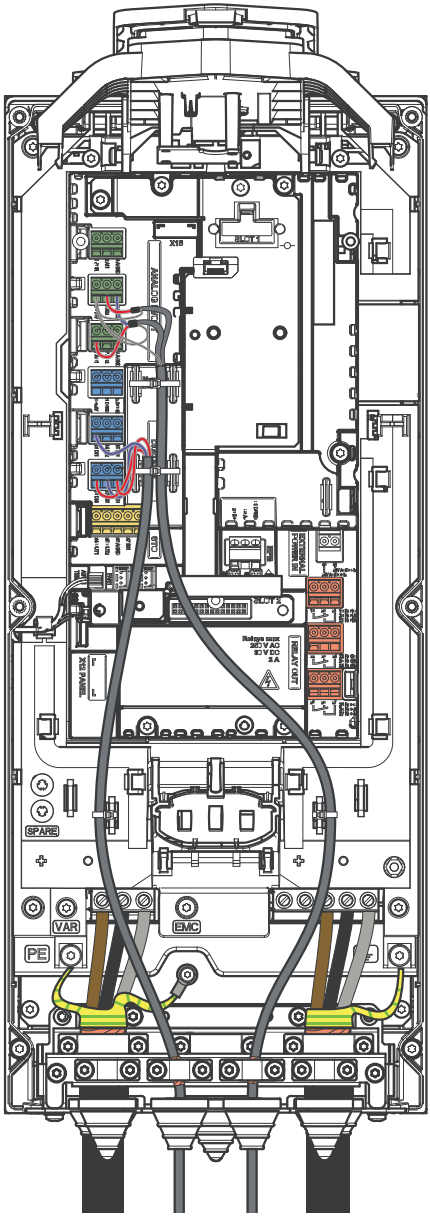
4. Cut an adequate hole into the rubber grommet and slide the grommet onto the cable. Slide the cable through a hole in the bottom plate and attach the grommet to the hole.
5. Route the cable as shown in the figures below.
6. Ground the outer shield of the cable 360 degrees under the grounding clamp at the cable entry. Keep the cable unstripped as close to the terminals of the control unit as possible. Secure the cables inside the drive mechanically.
7. Ground the pair-cable shields and grounding wire at the grounding terminal (SCR) of the control unit.
8. Connect the conductors to the appropriate terminals of the control unit (see page *97*) and tighten to 0.5…0.6 N·m.

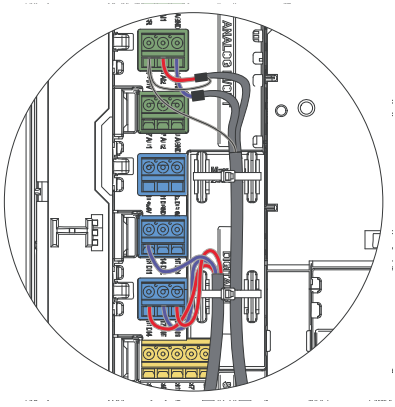
IEC

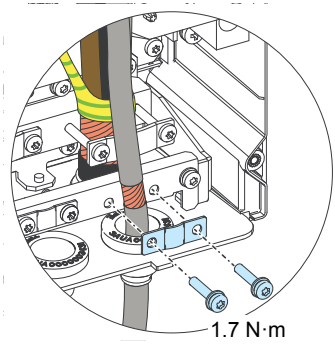
Note:

- 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.

R3

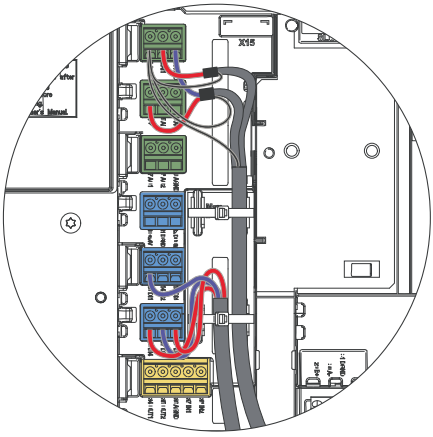


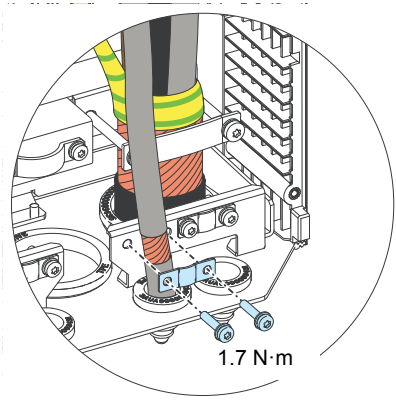


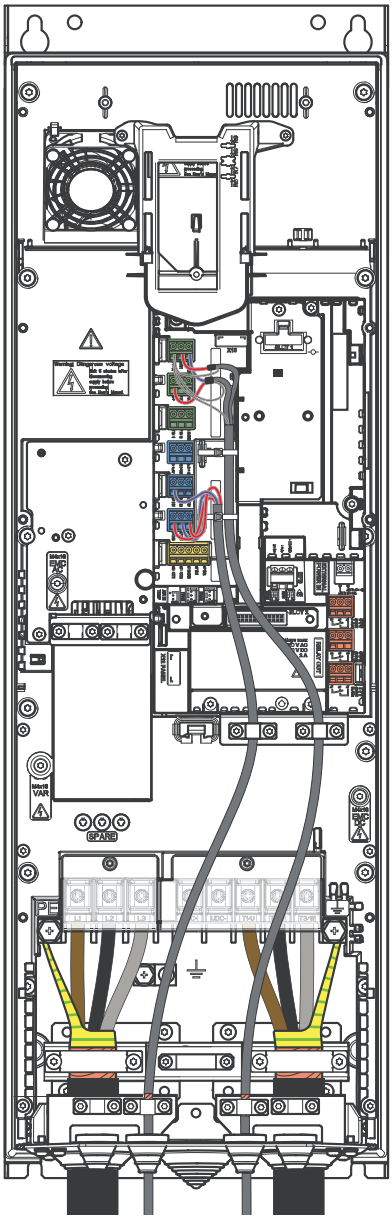


IEC

R6

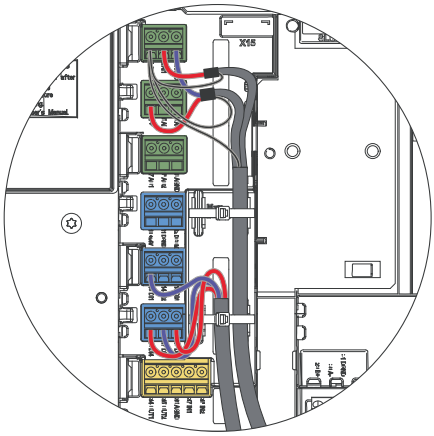


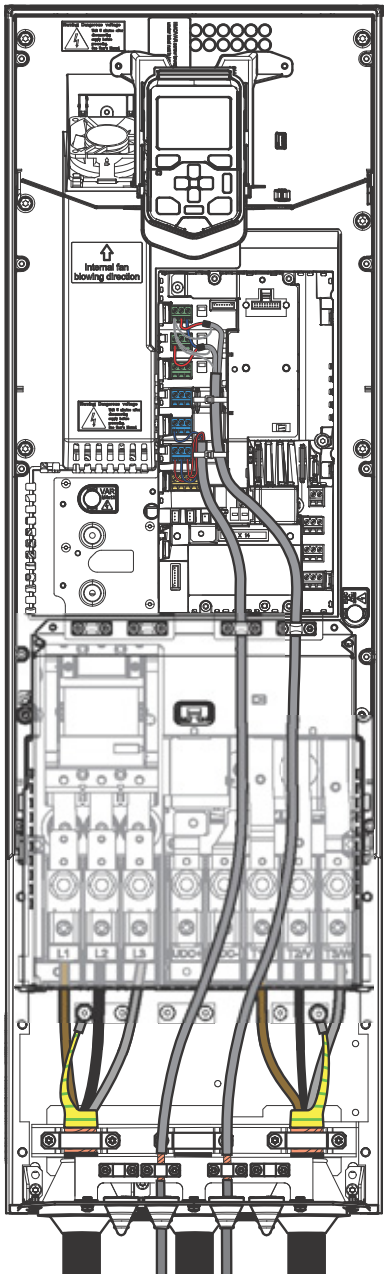




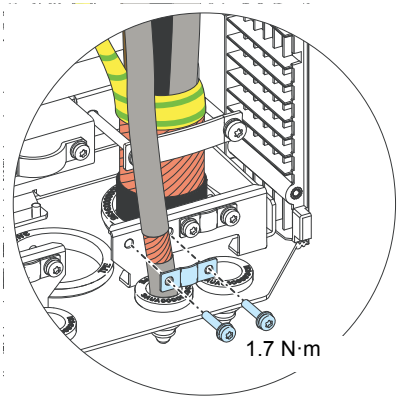
IEC

R8





IEC



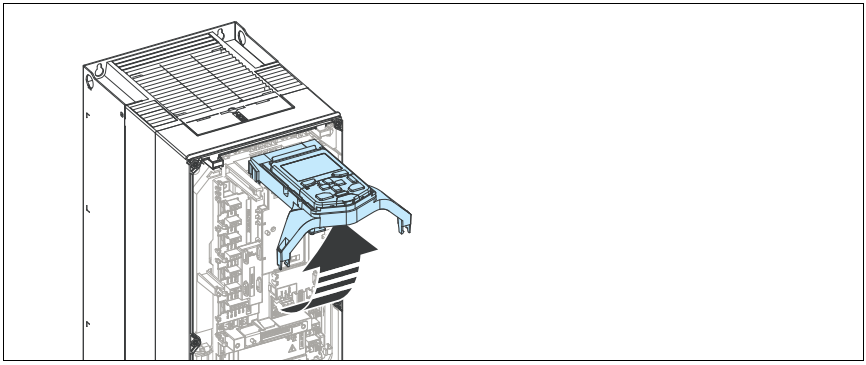
Installing optional modules

Mechanical installation of option modules

See section *Overview of power and control connections* page *28* for the available slots for each module. Install the option modules as follows:

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, physical 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 *Precautions before electrical work* on page *12* before you start the work.
2. Remove the front cover(s) if not already removed (see page *87*).
3. For frame R3, pull the control panel holder up.



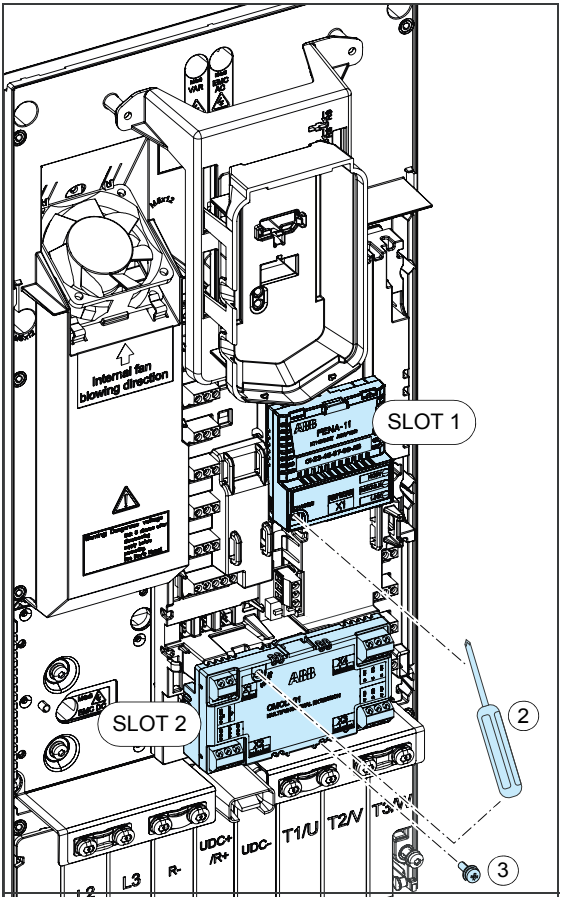
IEC

Option slot 2 (I/O extension modules)

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. **Note:** The screw grounds the module. It is necessary for fulfilling the EMC requirements and for correct operation of the module.

Option slot 1 (fieldbus adapter modules)

1. Put the module carefully into its position on the control unit.
2. Tighten the mounting screw (CHASSIS) to **0.8** N·m. **Note:** The screw tightens the connections and grounds the module. It is necessary for fulfilling the EMC requirements and for correct operation of the module.

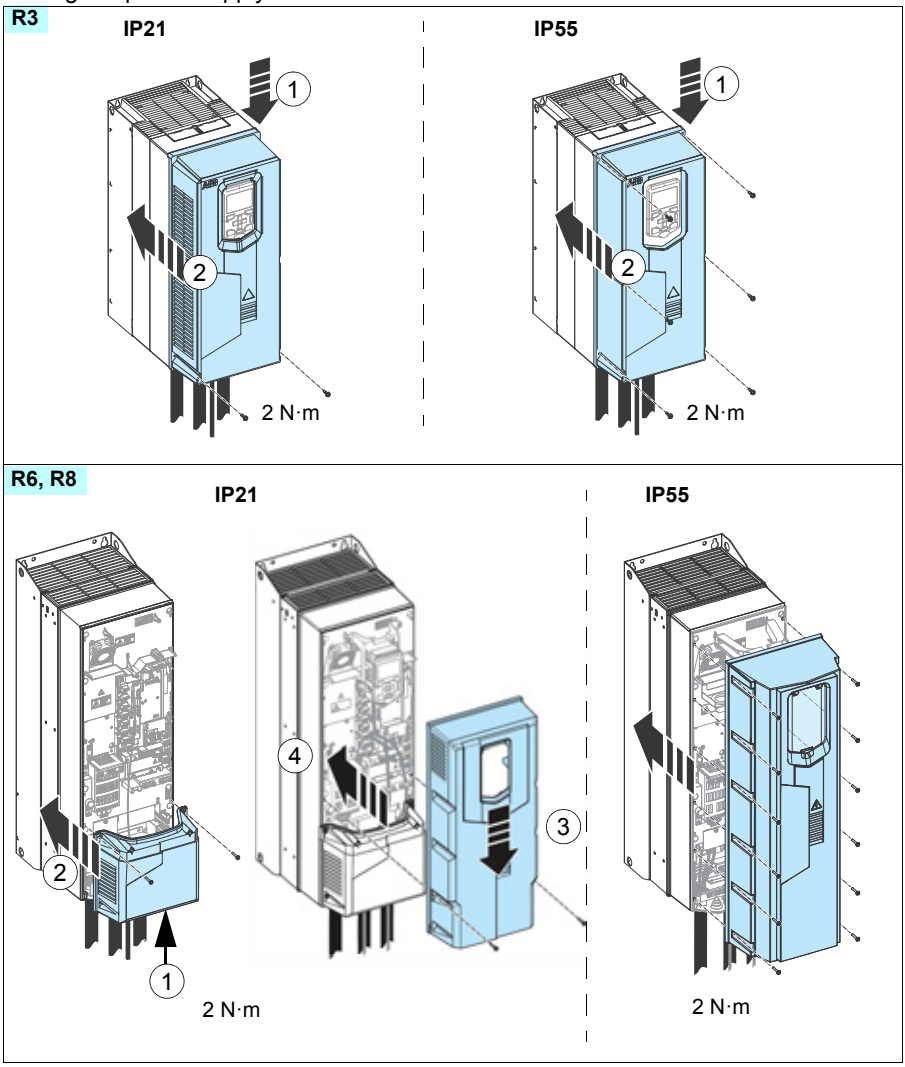


Wiring the optional modules

See the appropriate optional module manual for specific installation and wiring instructions.

Reinstalling cover(s)

After installation, reinstall the covers. For UL Type 12 frame R8, connect the auxiliary cooling fan power supply wire.



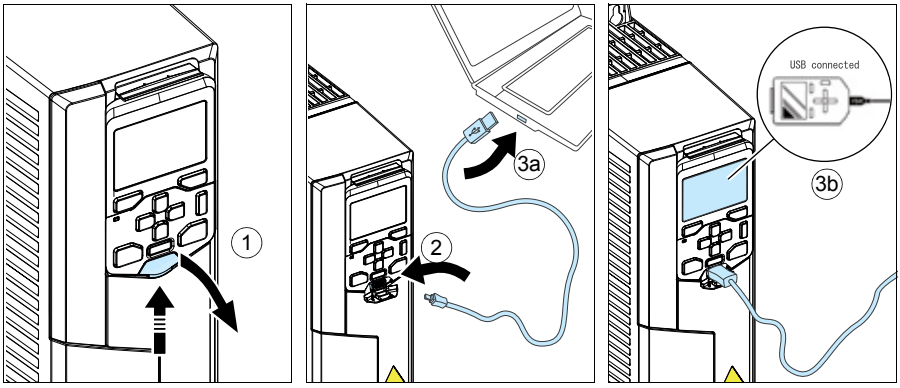
Connecting a PC

To be able to connect a PC to the drive, you need an assistant control panel (ACH-AP-H or ACH-AP-W). It is also possible to use CCA-01 configuration adapter.

Connect a PC to the drive with a USB data cable (USB Type A <-> USB Type Mini-B) as follows:

1. Lift the USB connector cover from bottom upwards.
2. Put the USB cable Mini-B plug in the control panel USB connector.
3. Put the USB cable A-plug in the USB connector of the PC (3a). The panel displays text “USB connected” (3b).

Note: Panel keys cannot be used when a USB data cable is connected to the panel.



IEC

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

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

You can connect a remote ACH-AP-H control panel to the drive, or to 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

Contents of this chapter

The chapter describes how to check the insulation of the assembly and the compatibility with other than symmetrically grounding TN-S systems. It then shows how to connect the power and control cables, install optional modules and connect a PC.

Warnings

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, injury or death, or damage to the equipment can occur.

Make sure that the drive is disconnected from the input power during installation. If you need to disconnect the drive, wait for 5 minutes after disconnecting the input power before you start the work.

UL NEC

Required tools

- wire stripper
- screwdriver and/or wrench with a set of suitable bits

Measuring the insulation

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

Drive

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

Input power cable

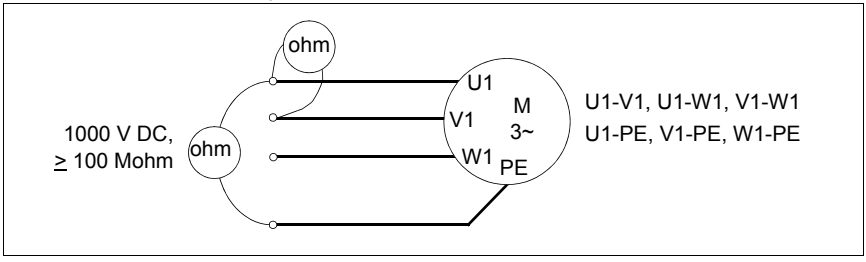
Measure the insulation of the input power cable according to local regulations before you connect it to the drive.

Motor and motor cable

Measure the insulation of the motor and motor cable as follows:

1. Stop the drive and do the steps in section *Precautions before electrical work* on page *12* before you start the work.
2. Make sure that the motor cable is disconnected from the drive output terminals T1/U, T2/V and T3/W.
3. Measure the insulation resistance between the phase conductors and between each phase conductor and the Protective Earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of a motor must be greater than 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, please consult the manufacturer's instructions.

   Note: Moisture inside the motor casing will reduce the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.



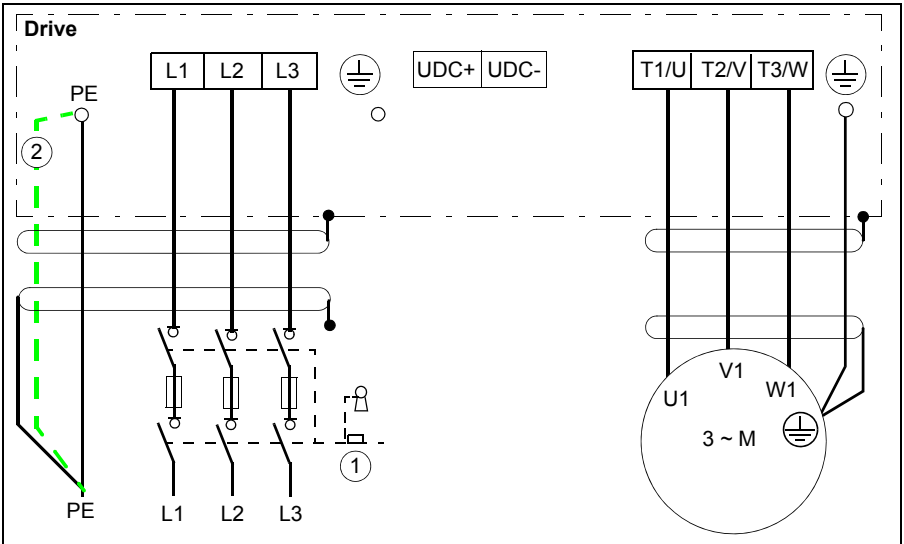
UL NEC

Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems

See section *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* on page *80*.

Connecting the power cables

Connection diagram



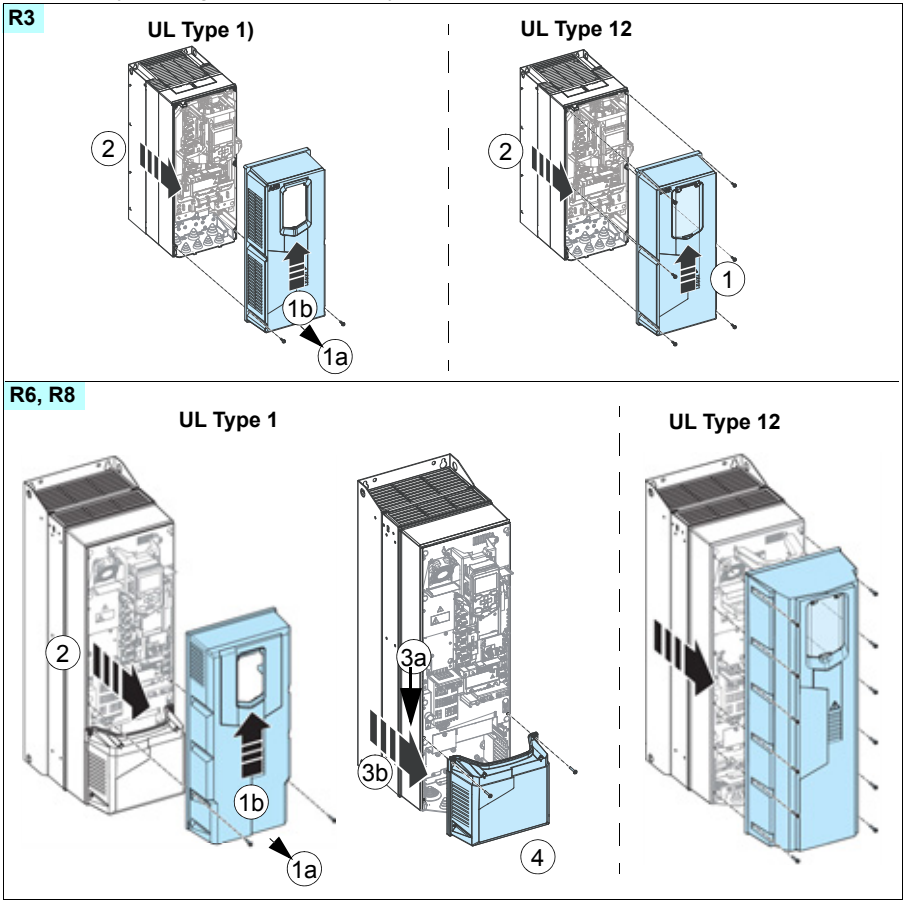
1	For alternatives, see section *Selecting the supply disconnecting device* on page *49*.
2	If the protective PE conductor is smaller than 10 mm^2, you must use a second earthing conductor (2), see page *14*.
3	External brake chopper (optional)
4	External brake resistor (optional)

UL
NEC

Connection procedure

The procedure of connecting the power cables to the standard drive is described below.

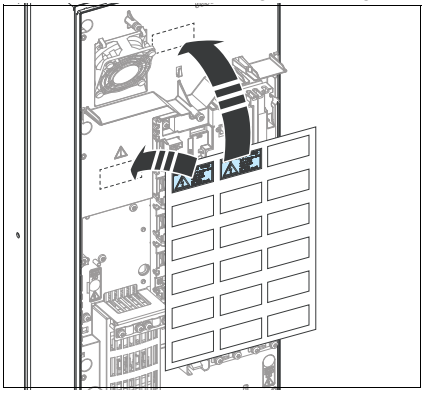
1. To remove the R3 front cover (R6 and R8 upper front cover), lift the cover from the bottom outwards (1a) and then up (1b). For UL Type 12 frame R8, disconnect the auxiliary cooling fan power supply wire.



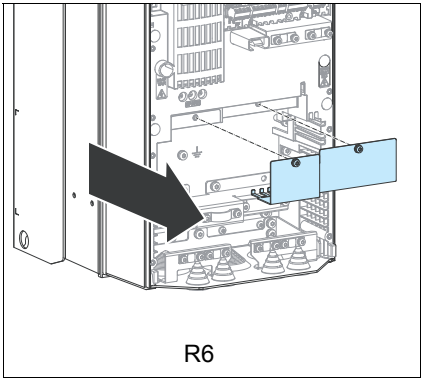
UL NEC

WARNING! Make sure you have disconnected the EMC filter and/or ground-to-phase varistor when necessary. See *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* page *80*.

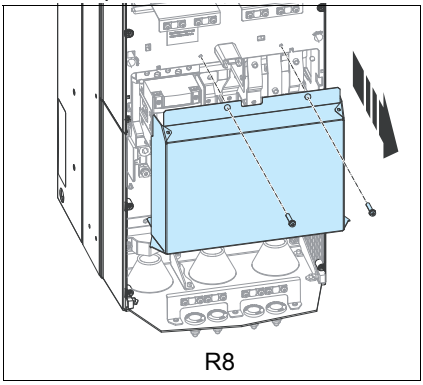
2. Attach the residual voltage warning sticker in the local language.



3. For frames R6 and R8: Remove the shroud on the power cable terminals,

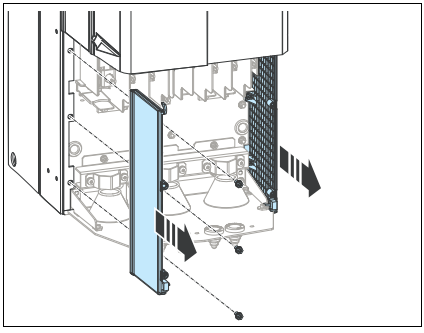


R6



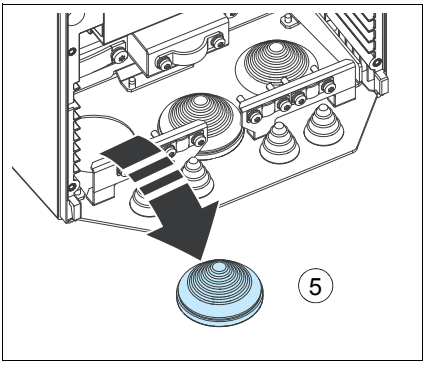
R8

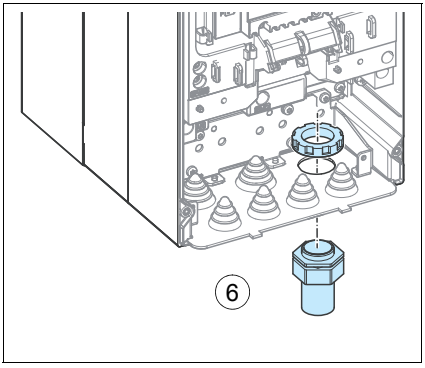
4. For frame R8: For easier installation, you can remove the side plates.



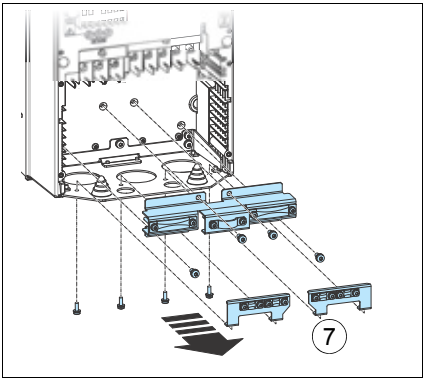
UL NEC

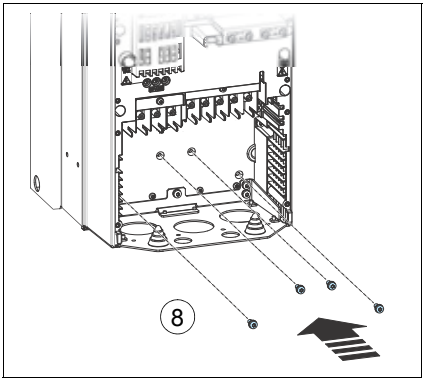
5. Remove the rubber grommets of the cables to be installed from the cable entry plate. Install the grommets downwards also in unused holes.
6. Attach the cable conduits to the bottom plate holes.





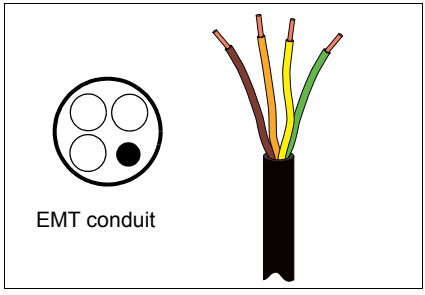
7. Remove the cable shelves.
8. Reinstall the four screw plugs to avoid moisture exchange through the empty holes!





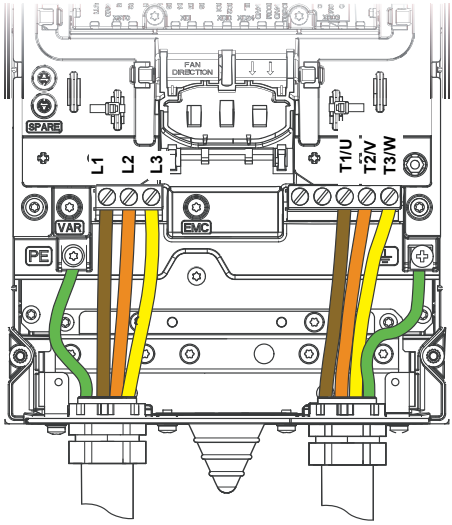
UL NEC

9. Strip the cable ends. Note the extra length of the grounding conductors. Slide the cables through the conduit.



10. Connect the cables:
    - Connect the grounding conductors to the ground terminals.
    - Connect the phase conductors of the motor cable to the T1/U, T2/V and T3/W terminals and the phase conductors of the input cable to the L1, L2 and L3 terminals.
      For frame R8: Install the common mode filter. For instructions, see *Common mode filter kit for frames R7 and R8 (option +E208) installation guide* (3AXD50000015179 [English]).
    - Tighten the screws to the torque given in the installation drawing below.

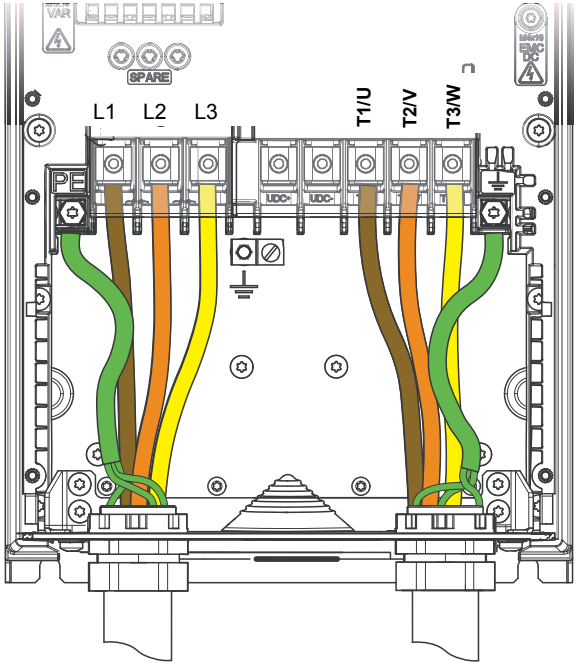
R3



Frame size	L1, L2, L3, T1/U, T2/V, T3/W		PE, ⏚	
	N·m	lbf·ft	N·m	lbf·ft
R3	1.7	1.2	1.7	1.2

UL NEC

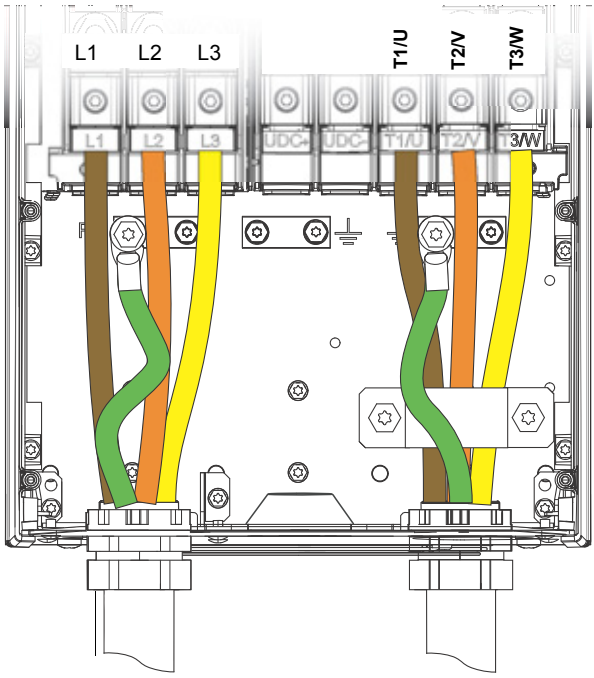
R6



Frame size	L1, L2, L3, T1/U, T2/V, T3/W		PE, ⏚	
	N·m	lbf·ft)	N·m	lbf·ft)
R6	5.6	4.1	2.9	2.1

UL NEC

R8



Frame size	L1, L2, L3, T1/U, T2/V, T3/W		PE, ⏚	
	N·m	lbf·ft)	N·m	lbf·ft)
R8	30	22 5	9.8	7.2

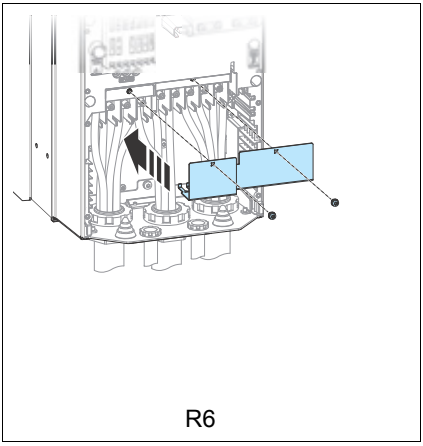
Note 1 for frame R8: Install the side plates if removed.

Note 2 for frame R8: The power cable connectors can be detached. For the instructions, see section *R8 power cable connection if you detach the connectors* on page *120*.

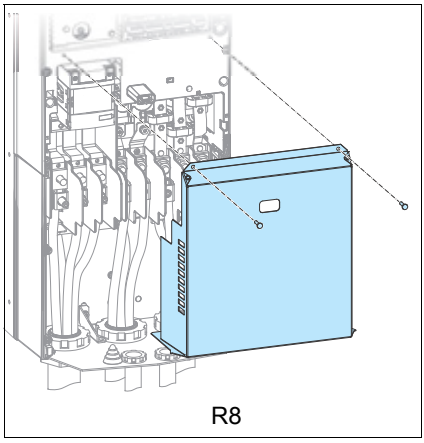
UL NEC

11. For frame R6 types bigger than -040A-x: Cut tabs in the shroud for the installed cables.

12. Install the shroud onto the power cable connection terminals.



R6



R8

R8 power cable connection if you detach the connectors

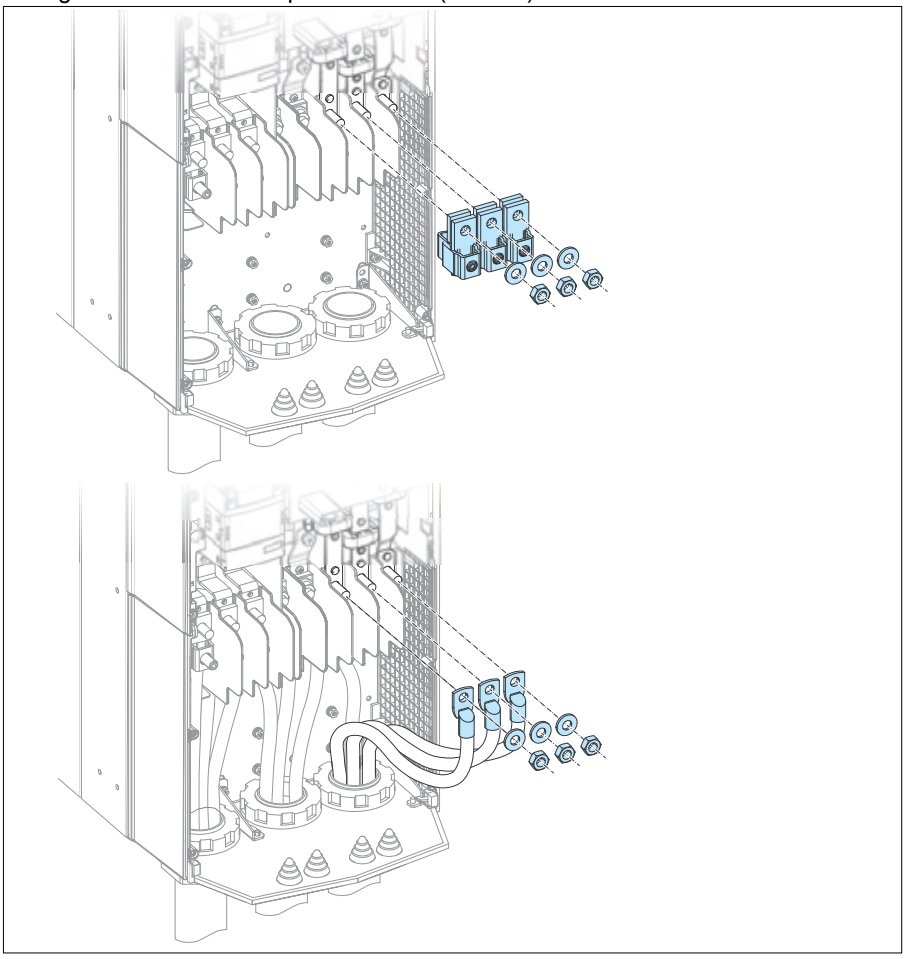
The power cable connection connectors of frame R8 are detachable. If you detach them, you can connect the cables with cable lugs as follows. For UL installations, see also section *UL listed cable lugs and tools* on page *169*.

Cable lug installation for T1/U, T2/V, T3/W, UDC+ and UDC-:

- Remove the nut that attaches the connector to its terminal post and remove the connector.
- Alternative 1: Put the conductor to the connector. Tighten to a torque of 30 N·m (22 lbf·ft). Put the connector back onto the post. Tighten the connector to 30 N·m. (22 lbf·ft).

UL NEC

Alternative 2: Attach a cable lug to the conductor. Put the cable lug onto the post. Tighten the nut to a torque of 30 N·m (22 lbf·ft). .



UL
NEC

Connecting the control cables

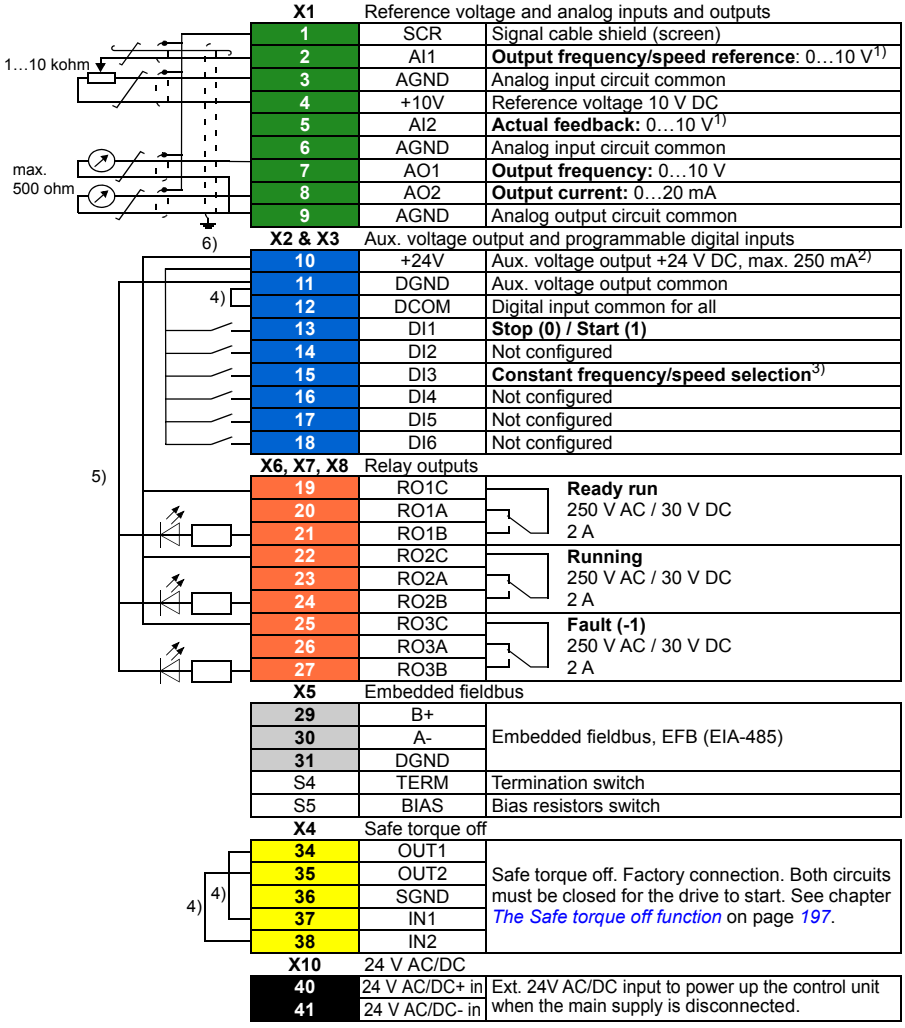
See section *Default I/O connection diagram (Water default configuration)* on page *123* for the default I/O connections of the drive.

Connect the cables as described under *Control cable connection procedure* on page *125*.

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.

UL NEC

Default I/O connection diagram (Water default configuration)



X1	Reference voltage and analog inputs and outputs	
1	SCR	Signal cable shield (screen)
2	AI1	**Output frequency/speed reference**: 0…10 V[1)]
3	AGND	Analog input circuit common
4	+10V	Reference voltage 10 V DC
5	AI2	**Actual feedback:** 0…10 V[1)]
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
X2 & X3	Aux. voltage output and programmable digital inputs	
10	+24V	Aux. voltage output +24 V DC, max. 250 mA[2)]
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**[3)]
16	DI4	Not configured
17	DI5	Not configured
18	DI6	Not configured
X6, X7, X8	Relay outputs	
19	RO1C	**Ready run** 250 V AC / 30 V DC 2 A
20	RO1A	
21	RO1B	
22	RO2C	**Running** 250 V AC / 30 V DC 2 A
23	RO2A	
24	RO2B	
25	RO3C	**Fault (-1)** 250 V AC / 30 V DC 2 A
26	RO3A	
27	RO3B	
X5	Embedded fieldbus	
29	B+	Embedded fieldbus, EFB (EIA-485)
30	A-	
31	DGND	
S4	TERM	Termination switch
S5	BIAS	Bias resistors switch
X4	Safe torque off	
34	OUT1	Safe torque off. Factory connection. Both circuits must be closed for the drive to start. See chapter *The Safe torque off function* on page *197*.
35	OUT2	
36	SGND	
37	IN1	
38	IN2	
X10	24 V AC/DC	
40	24 V AC/DC+ in	Ext. 24V AC/DC input to power up the control unit when the main supply is disconnected.
41	24 V AC/DC- in	

See the notes on page on the next page..

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

Wire sizes: 0.14…2.5 mm^2 (26…14 AWG): All terminals

Tightening torques: 0.5…0.6 N·m (0.4 lbf·ft)

UL NEC

Notes:

1) Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 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 degrees under the grounding clamp on the grounding shelf for the control cables.

Further information on the usage of the connectors and switches is given in the sections below

Switches

Switch	Description	Position	
BIAS S101	EFB link termination. Must be set to the terminated (ON) position when the drive is the first or last unit on the link.	ON TERM	Bus not terminated (**default**)
		ON TERM	Bus terminated
TERM S100	Switches on the biasing voltages to the bus. One (and only one) device, preferably at the end of the bus must have the bias on.	ON BIAS	Bias off (**default**)
		ON BIAS	Bias on

UL NEC

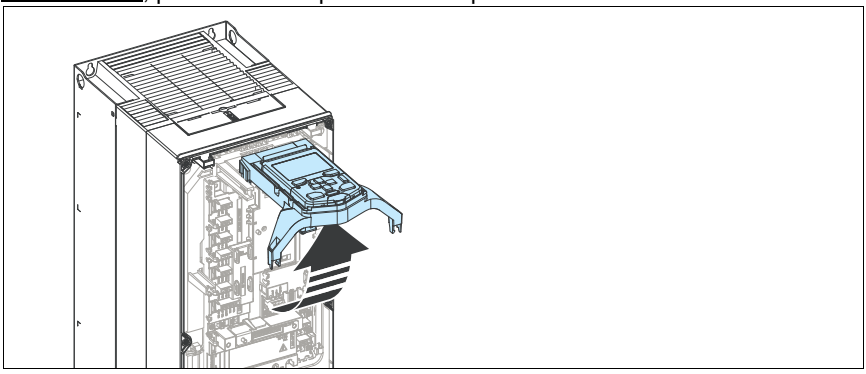
Additional information on control connections

See section *Additional information on I/O connections* on page *98*.

Control cable connection procedure

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section *Precautions before electrical work* on page *12* before you start the work.
2. Remove the front cover(s) if not already removed. See page *114*.
3. For frame R3, pull the control panel holder up.



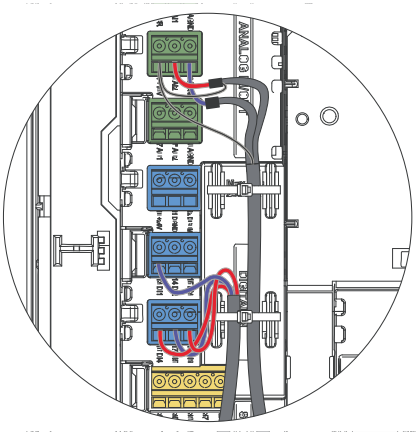
4. Cut an adequate hole into the rubber grommet and slide the grommet onto the cable. Slide the cable through a hole in the bottom plate and attach the grommet to the hole.
5. Route the cable as shown in the figures below.
6. Secure the cables inside the drive mechanically.
7. Ground the pair-cable shields and grounding wire at the grounding terminal (SCR) of the control unit.
8. Connect the conductors to the appropriate terminals of the control unit (see page *123*) and tighten to 0.5…0.6 N·m (0.4 lbf·ft).

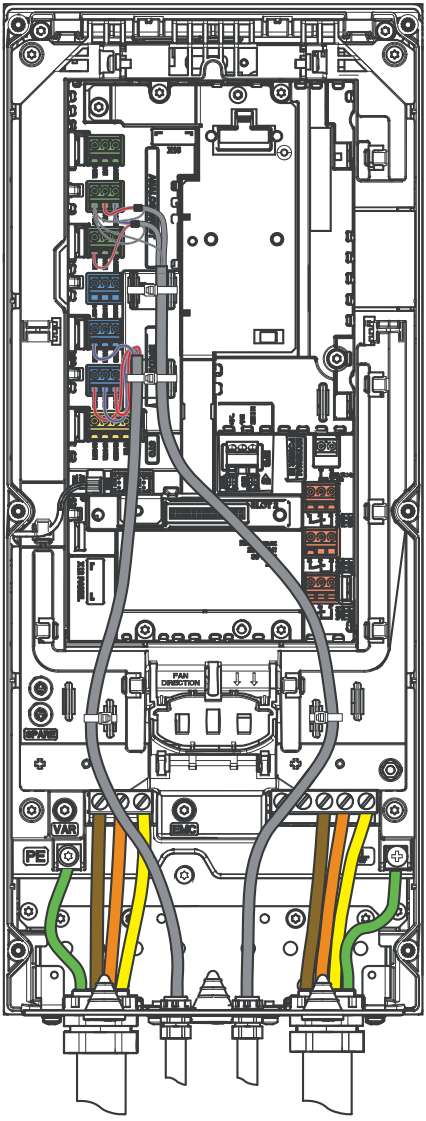
UL NEC

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.

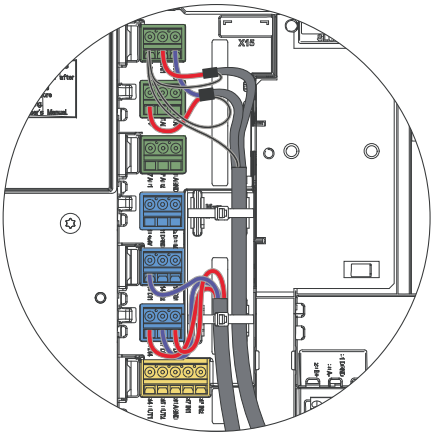
R3

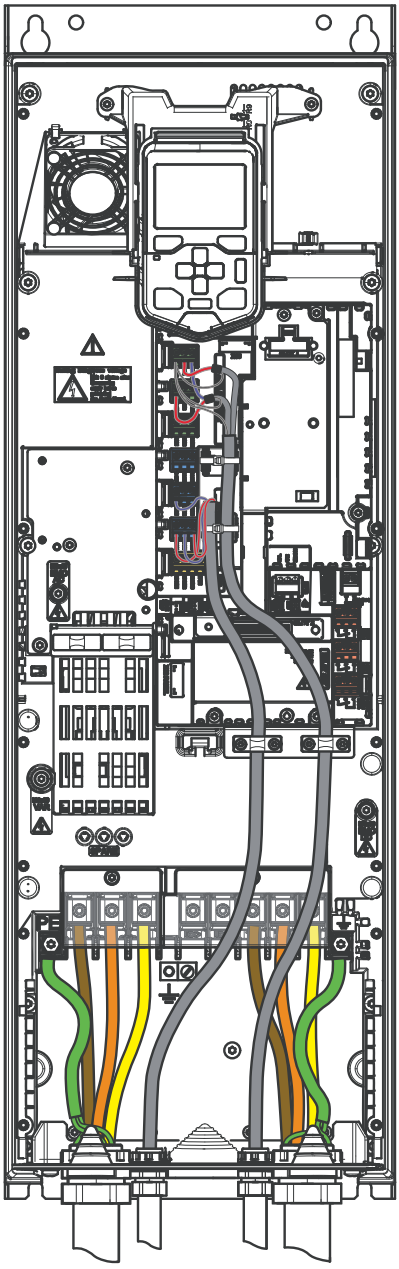




UL NEC

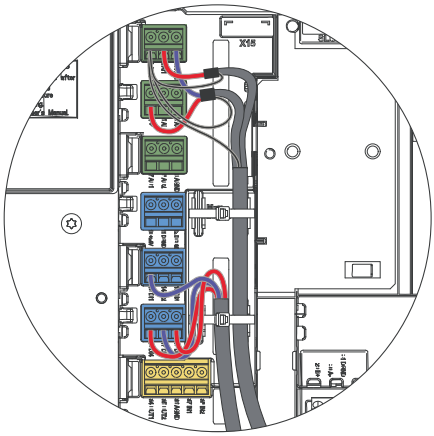
R6

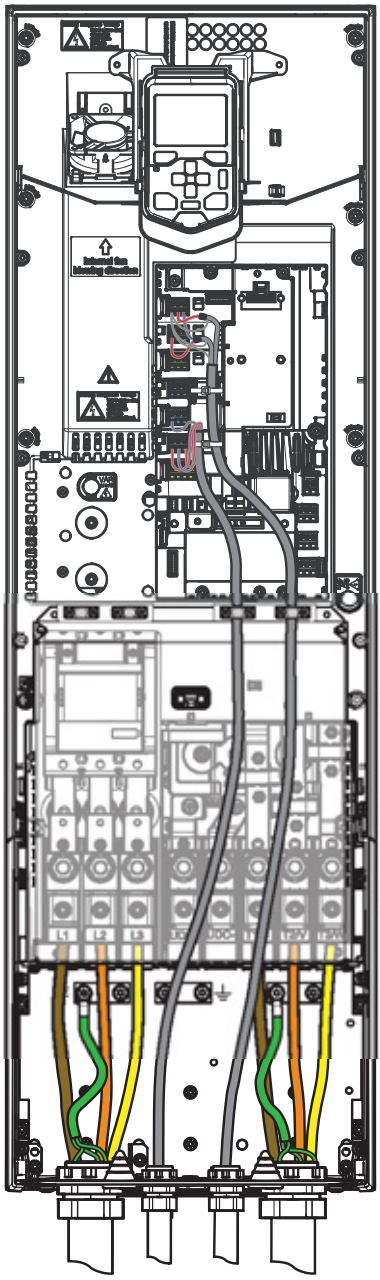




UL
NEC

R8





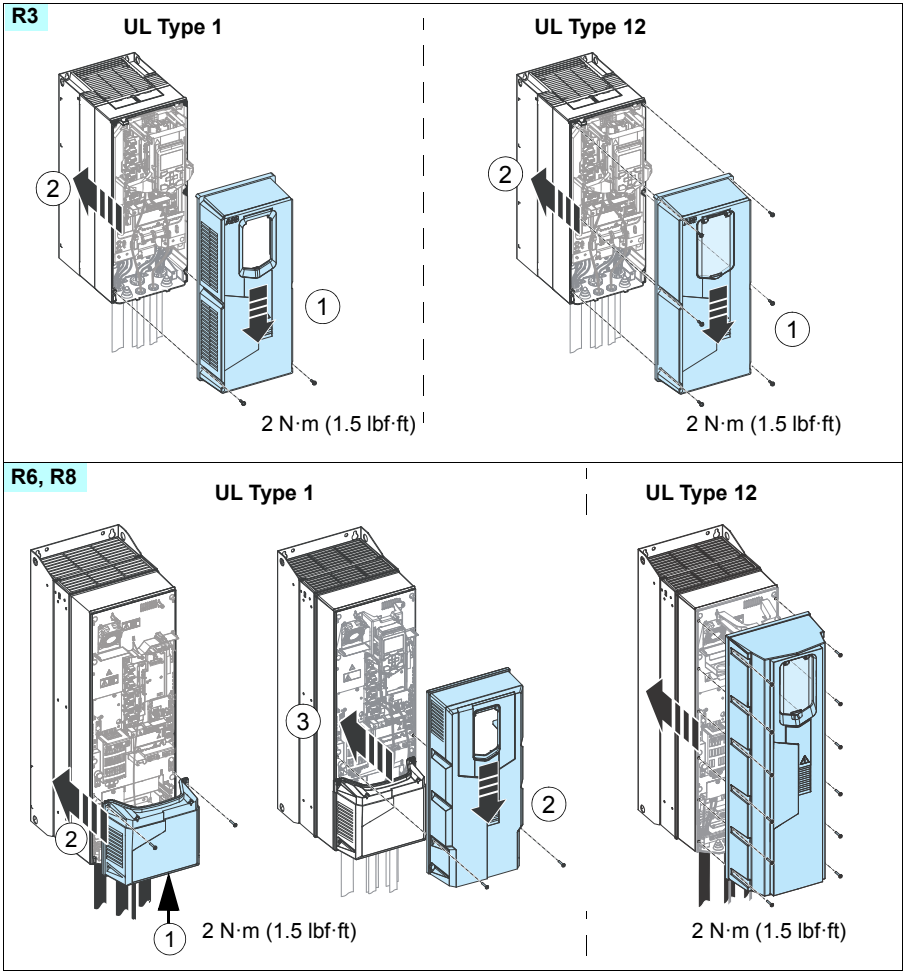
UL NEC

Installing optional modules

See section *Installing optional modules* on page *107*.

Reinstalling cover(s)

After installation, reinstall the covers. For UL Type 12 frame R8, connect the auxiliary cooling fan power supply wire.



UL NEC

Connecting a PC

See section *Connecting a PC* on page *110*.

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

See section *Connecting a remote panel, or chaining one panel to several drives* on page *110*.

8

Installation checklist

Contents of this chapter

This chapter contains an installation checklist which you must complete before you start up the drive.

Warnings

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, injury or death, or damage to the equipment can occur.

Checklist

Do the steps in section *Precautions before electrical work* on page *12* before you start the work. Go through the checklist together with another person.

Make sure that …	☑
The ambient operating conditions meet the specification in section *Ambient conditions* on page *181*.	☐
If the drive will be connected to a corner-grounded TN system: The internal EMC filter has been disconnected. See section *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* on page *80*.	☐
If the drive will be connected to an IT (ungrounded) system: The internal EMC filter and the ground-to-phase varistor has been disconnected. See section *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* on page *80*.	☐

Make sure that …	☑
If the drive has not been powered (either in storage or unused) over tree years: The electrolytic DC capacitors in the DC link of the drive have been reformed. See section *Reforming the capacitors* on page *146*.	☐
There is an adequately sized protective earth (ground) conductor between the drive and the switchboard.	☐
There is an adequately sized protective earth (ground) conductor between the motor and the drive.	☐
All protective earth (ground) conductors have been connected to the appropriate terminals and the terminals have been tightened (pull conductors to check).	☐
The supply voltage matches the nominal input voltage of the drive. Check the type designation label.	☐
The input power cable has been connected to appropriate terminals, the phase order is correct, and the terminals have been properly tightened. (Pull conductors to check.)	☐
Appropriate supply fuses and disconnector have been installed.	☐
The motor cable has been connected to appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull conductors to check.)	☐
The motor cable (and brake resistor cable, if present) has been routed away from other cables.	☐
The control cables (if any) have been connected to the control unit.	☐
If a drive bypass connection will be used: The direct-on-line contactor of the motor and the drive output contactor are either mechanically or electrically interlocked (cannot be closed simultaneously).	☐
There are no tools, foreign objects or dust from drilling inside the drive.	☐
Drive and motor connection box covers are in place.	☐
The motor and the driven equipment are ready for start-up.	☐

9

Start-up

Contents of this chapter

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

Start-up procedure

1. Run setup of the drive control program according to the start-up instructions given in *Quick start-up guide for ACQ580 pump control program* (3AXD50000048773 [English]) or in the firmware manual.
2. Validate the Safe torque off function according to the instructions given in chapter *The Safe torque off function* on page *197*.

10

Maintenance and hardware diagnostics

Contents of this chapter

The chapter contains preventive maintenance instructions and LED indicator descriptions.

Maintenance intervals

The table below shows the maintenance tasks which can be done by the end user. The complete maintenance schedule is available on the Internet (www.abb.com/drivesservices). For more information, consult your local ABB Service representative (www.abb.com/searchchannels).

Maintenance and component replacement intervals are based on the assumption that the equipment is operated within the specified ratings and ambient conditions. ABB recommends annual drive inspections to ensure the highest reliability and optimum performance.

Note: Long term operation near the specified maximum ratings or ambient conditions may require shorter maintenance intervals for certain components. Consult your local ABB Service representative for additional maintenance recommendations.

Description of symbols

Action	Description
I	Visual **I**nspection and maintenance action if needed
P	**P**erformance of on/off-site work (commissioning, tests, measurements or other work)
R	**R**eplacement of component

Recommended annual maintenance actions by the user

Action	Description
P	Quality of supply voltage
I	Spare parts
P	Capacitor reforming, spare modules and spare capacitors (page *146*)
I	Tightness of terminals
I	Dustiness, corrosion or temperature
P	Heat sink cleaning (page *137*)

Recommended maintenance actions by the user

Component	Years from start-up						
	3	6	9	12	15	18	21
Cooling							
Main cooling fan							
Main cooling fans			R			R	
Auxiliary cooling fan							
Auxiliary cooling fan			R			R	
Second auxiliary cooling fan (IP55, UL Type 12)			R			R	
Aging							
Control panel battery (real-time clock)			R			R	

4FPS10000309652

Heatsink

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

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

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

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 *Precautions before electrical work* on page *12* before you start the work.
2. Remove the cooling fan(s). See section *Fans* on page *137*.
3. Blow clean, dry and oil free compressed air from bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust.

   Note: If there is a risk of dust entering adjoining equipment, perform the cleaning in another room.
4. Reinstall the cooling fan(s).

Fans

See section *Maintenance intervals* on page *135* for the fan replacement interval in average operation conditions.

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

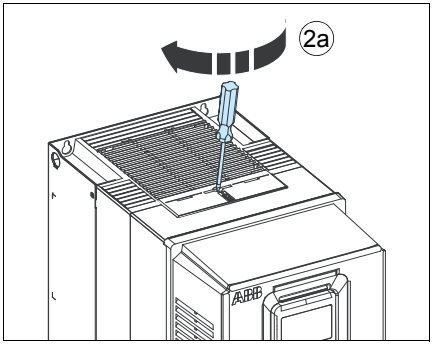
Main fans are speed controlled. When the drive is stopped, the main fan is kept running at low speed to cool the control unit. IP21 (UL Type 1) frames R6 and R8 and all IP55 (UL Type 12) frames have auxiliary fans that are not speed controlled and run all the time when the control unit is powered.

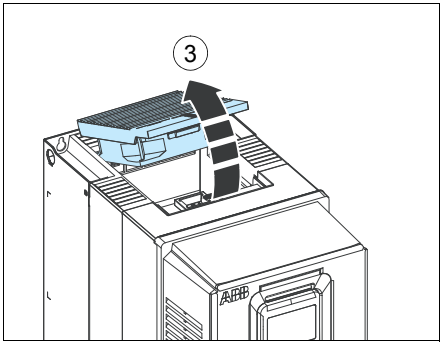
Replacement fans are available from the manufacturer. Do not use other than specified spare parts.

Replacing the main cooling fan, frame R3

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, physical 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 *Precautions before electrical work* on page *12* before you start the work.
2. To release the locking, turn clockwise with a screwdriver.
3. Turn the fan assembly off.
4. Install the new fan in reverse order.

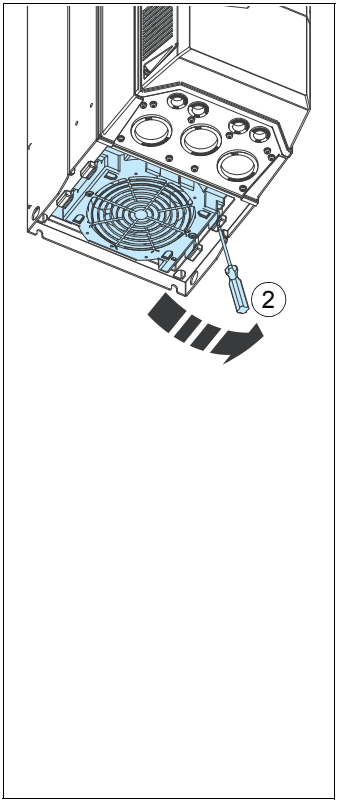


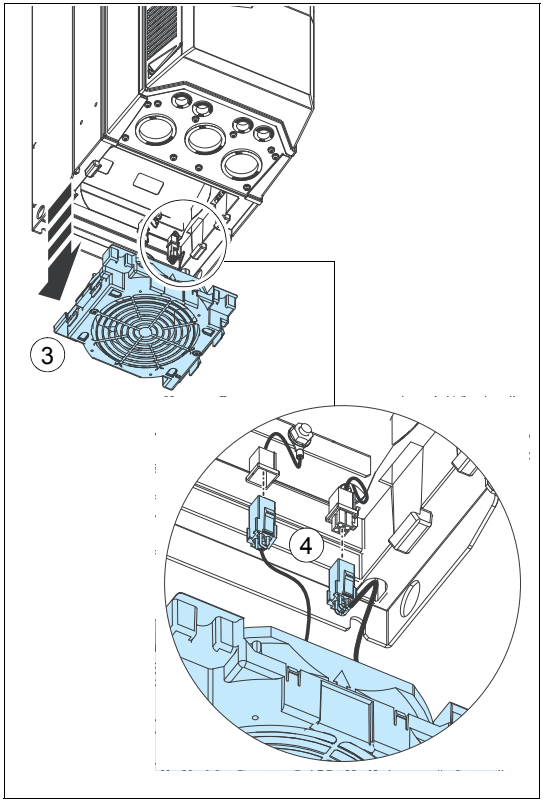


Replacing the main cooling fan, frame R6

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, physical 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 *Precautions before electrical work* on page *12* before you start the work.
2. Lever the fan assembly off the drive frame with for example a screwdriver (2a) and pull out the fan assembly (2b)
3. Pull the fan assembly down.
4. Unplug the fan power supply and grounding wires from the drive.
5. Install the new fan in reverse order.

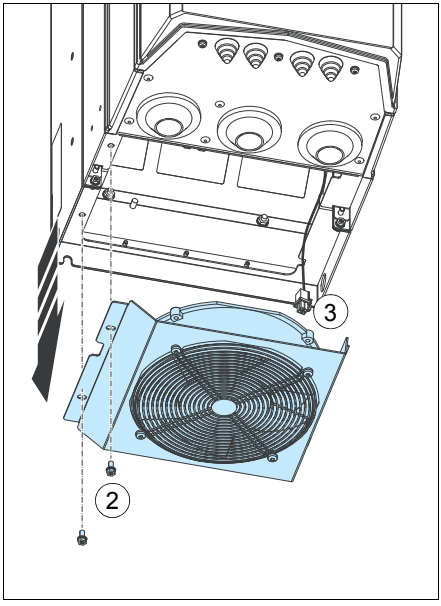


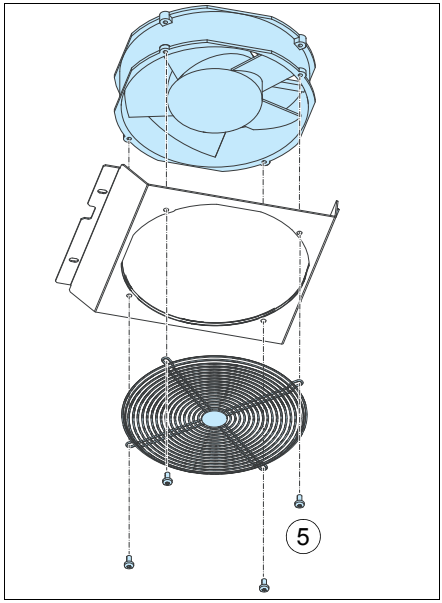


Replacing the main cooling fan, frame R8

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

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 *Precautions before electrical work* on page *12* before you start the work.
2. Undo the mounting screws of the fan assembly.
3. Unplug the fan power supply and grounding wires from the drive.
4. Pull the fan assembly down.
5. Undo the mounting screws of the fan.
6. Install the new fan in reverse order.

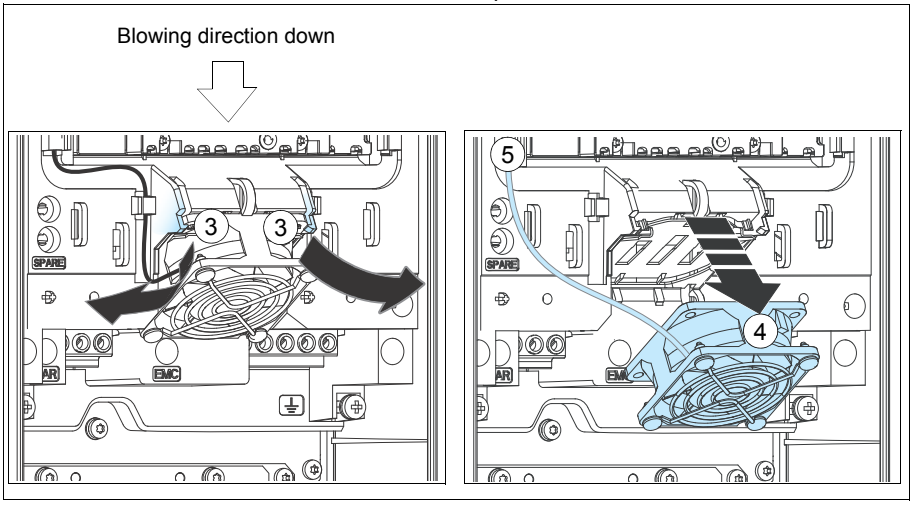




Replacing the auxiliary cooling fan, IP55 (UL Type 12) frame R3

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, physical injury or death, or damage to the equipment can occur.

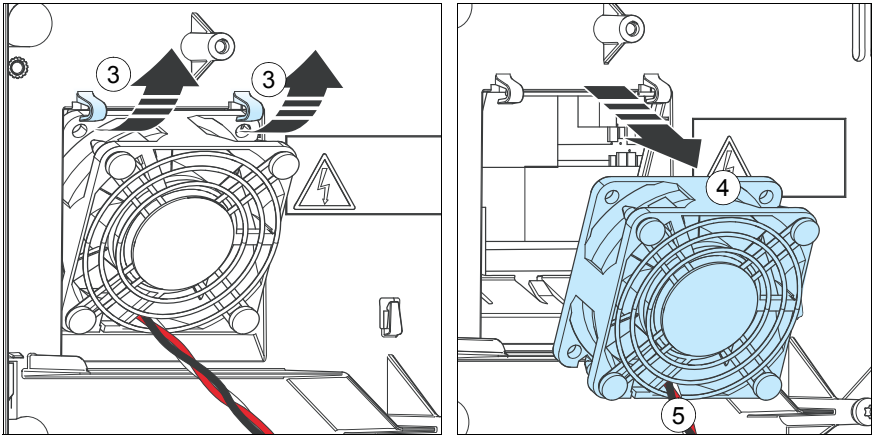
1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section *Precautions before electrical work* on page *12* before you start the work.
2. Remove the front cover (see page *88*).
3. Release the retaining clips.
4. Lift the fan off.
5. Unplug fan power supply wires.
6. Install the new fan in reverse order.
   Note: Make sure that the arrow on the fan points down.



Replacing the auxiliary cooling fan, frame R6

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, physical injury or death, or damage to the equipment can occur.

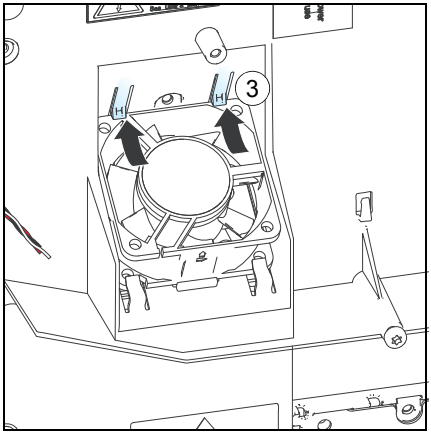
1. Stop the drive and disconnect it from the power line. Wait for 5 minutes and then make sure by measuring that there is no voltage. See section *Precautions before electrical work* on page *12* before you start the work.
2. Remove the upper front covers. See section *Connection procedure* on page *88*.
3. Release the retaining clips.
4. Lift the fan off.
5. Unplug fan power supply wires.
6. Remove the grille from the fan.
7. Install the new fan in reverse order.
   Note: Make sure that the arrow on the fan points up.
8. Reinstall the front covers. See section *Reinstalling cover(s)* on page *109*.

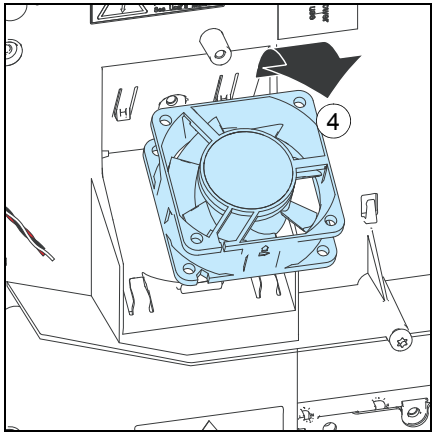


Replacing the auxiliary cooling fan, frame R8

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, physical 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 *Precautions before electrical work* on page *12* before you start the work.
2. Remove the upper front covers. See section *Connection procedure* on page *88*.
3. Release the retaining clips.
4. Lift the fan off.
5. Unplug fan power supply wires.
6. Remove the grille.
7. Install the new fan in reverse order.
   Note: Make sure that the arrow on the fan points up.
8. Replace the front covers.

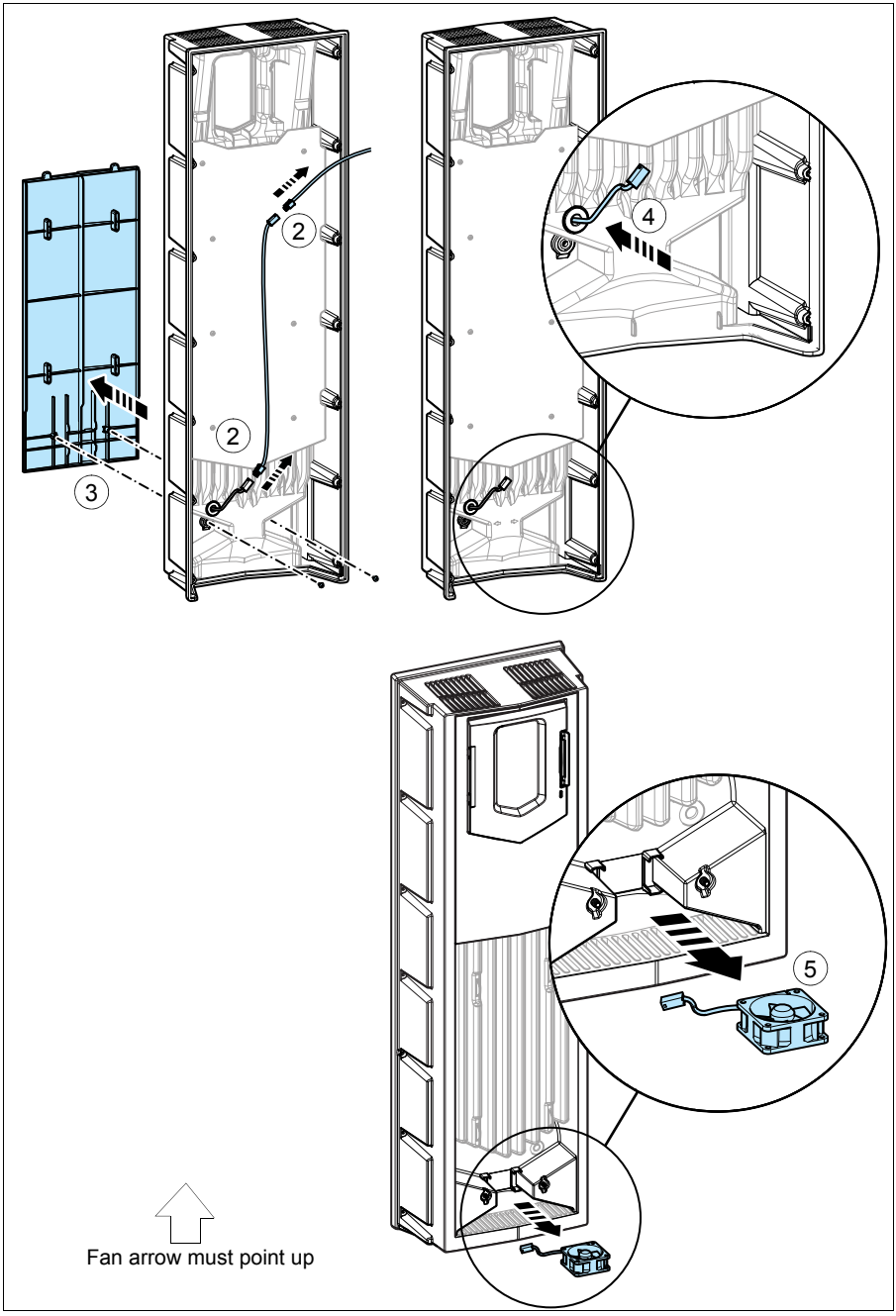




Replacing the second auxiliary cooling fan IP55 (UL Type 12), frame R8

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. If you ignore them, physical 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 *Precautions before electrical work* on page *12* before you start the work.
2. Remove the IP55 front cover. Unplug the auxiliary cooling fan power supply wire.
3. Remove the lower front cover from the IP55 cover.
4. Pull the fan supply wire through the grommet.
5. Remove the fan.
6. Install the new fan in reverse order. Make sure that the arrow on the fan points up.


2
2
3
4
5
Fan arrow must point up

Capacitors

The drive intermediate DC circuit employs several electrolytic capacitors. Their lifespan depends on the operating time of the drive, loading and ambient temperature. Capacitor life can be prolonged by lowering the ambient temperature.

Capacitor failure is usually followed by damage to the drive and an input cable fuse failure, or a fault trip. Contact ABB if capacitor failure is suspected. Replacements are available from the manufacturer. Do not use other than specified spare parts.

Reforming the capacitors

Reform the capacitors if the drive has not been powered (either in storage or unused) for a year or more. See section *Type designation label* on page *31* for how to find out the manufacturing date from the serial number.

For information on reforming the capacitors, see *Converter modules with electrolytic DC capacitors in the DC link capacitor reforming instructions* (3BFE64059629 [English]).

Control panel

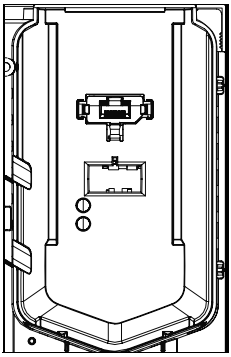
See *ACx-AP-x Assistant control panels user's manual* (*3AUA0000085685* [English]

- for the meaning of the control panel LED indications
- for instructions on cleaning of the control panel and battery replacement.

For removing the control panel from the drive, see section *Control panel* on page *29*.

Drive LEDs

There is a green POWER and a red FAULT LED visible when the control panel is removed. 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. See the firmware manual on how to switch to remote control.



The table below describes the drive LED indications.

LEDs off	**LED lit and steady**		**LED blinking**	
No power	Green (POWER)	Power supply on the unit OK	Green (POWER)	Blinking: Drive in an alarm state Blinking for one second: 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.

11

Technical data

Contents of this chapter

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

Ratings

IEC ratings

Type ACQ580 -31-	Input rating	Max. current	App. power	Output ratings				Frame size
				Nominal use		Light-duty use		
	I_1	I_{max}	S_N	I_2	P_N	I_{Ld}	P_{Ld}	
	A	A	kVA	A	kW	A	kW	
3-phase U_N = 400 V								
09A5-4	8.0	12.2	6.5	9.4	4.0	8.9	4.0	R3
12A7-4	10.0	16.0	8.7	12.6	5.5	12.0	5.5	R3
018A-4	14.0	21.4	11.8	17.0	7.5	16.2	7.5	R3
026A-4	20.0	28.9	17.3	25.0	11.0	23.8	11.0	R3
033A-4	27	42.5	22.2	32.0	15.0	30.4	15.0	R6
039A-4	33	54.4	26.3	38.0	18.5	36.1	18.5	R6
046A-4	40	64.6	31.2	45.0	22.0	42.8	22.0	R6
062A-4	51	76.5	43.0	62.0	30.0	58.9	30.0	R6
073A-4	63	105.4	50.6	73.0	37.0	69.4	37.0	R6
088A-4	76	124.1	61.0	88.0	45.0	83.6	45.0	R6
106A-4	94	150	73.4	106	55	101	55	R8
145A-4	128	181	100.5	145	75	138	75	R8
169A-4	154	247	117.1	169	90	161	90	R8
206A-4	188	287	142.7	206	110	196	110	R8

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Type ACQ580 -31-	Input rating	Max. current	App. power	Output ratings		Frame size
				Light-duty use		
	I_1	I_{max}	S_N	I_{Ld}	P_{Ld}	
	A	A	kVA	A	hp	
3-phase U_N = 480 V						
09A5-4	7.0	12.2	6.3	7.6	5.0	R3
12A7-4	9.0	16.0	10.0	12.0	7.5	R3
018A-4	12.0	21.4	11.6	14.0	10.0	R3
026A-4	17.0	28.9	19.1	23.0	15.0	R3
033A-4*	24	42.5	22.4	27	20.0	R6
039A-4*	29	54.4	28.3	34	25.0	R6
046A-4*	34	64.6	36.6	44	30.0	R6
062A-4*	44	76.5	43.2	52	40.0	R6
073A-4*	54	105.4	54.0	65	50.0	R6
088A-4*	66	124.1	64.0	77	60.0	R6
106A-4	82	150	79,8	96	75	R8
145A-4	111	181	103,1	124	100	R8
169A-4	134	247	129,7	156	125	R8
206A-4	163	287	149,6	180	150	R8

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* These ratings are not to be used for drives with degree of protection of IP55 (UL Type 12) option +B056.

See definitions and notes on page 151.

UL (NEC) ratings

Type ACQ580 -31-	Input rating	Max. current	App. power	Output ratings		Frame size
				Light-duty use		
	I_1	I_{max}	S_N	I_{Ld}	P_{Ld}	
	A	A	kVA	A	hp	
3-phase U_N = 480 V						
07A6-4	7.0	9.5	6.3	7.6	5.0	R3
012A-4	9.0	15.0	10.0	12.0	7.5	R3
014A-4	12.0	20.4	11.6	14.0	10.0	R3
023A-4	17.0	28.8	19.1	23.0	15.0	R3
027A-4*	24	39.1	22.4	27	20.0	R6
034A-4*	29	45.9	28.3	34	25.0	R6
044A-4*	34	57.8	36.6	44	30.0	R6
052A-4*	44	74.8	43.2	52	40.0	R6
065A-4*	54	88.4	54.0	65	50.0	R6
077A-4*	66	110.5	64.0	77	60.0	R6
096A-4	82	130.9	79,8	96	75	R8
124A-4	111	163.2	103,1	124	100	R8
156A-4	134	210.8	129,7	156	125	R8
180A-4	163	265.2	149,6	180	150	R8

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* These ratings are not to be used for drives with degree of protection of IP55 (UL Type 12) option +B056.

Definitions

U_N	Nominal input voltage of the drive. For input voltage range, see section *Electrical power network specification* on page *170*. 50 Hz for IEC ratings, 60 Hz for UL (NEC) ratings.
I_1	Nominal input current (rms) at 40 °C (104 °F). Continuous rms input current (for dimensioning cables and fuses).
I_2	Nominal output current (available continuously with no over-loading)
I_{max}	Maximum output current. Available for two seconds at start. Then as long as allowed by drive temperature.
I_{Ld}	Maximum current with 10% overload, allowed for one minute every ten minutes when parameter 97.02 Minimum switching frequency is set to 2 kHz or less
P_{Ld}	Typical motor power in light-duty use (10% overload). The kilowatt ratings apply to most IEC 4-pole motors. The horsepower ratings apply to most NEMA 4-pole 460 V motors.

Sizing

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

Note: ABB recommends the DriveSize dimensioning tool (available from (ttp://new.abb.com/drives/software-tools/drivesize) for selecting the drive, motor and gear combination.

Derating

The load capacity (I_2, I_{Ld},; note that I_{max} is not derated) decreases for certain situations, as defined below. In such situations, where full motor power is required, oversize the drive so that the derated value provides sufficient capacity.

Derating in case of several situations

If several situations are present at a time, the effect of derating for each situation is cumulative.

Example:

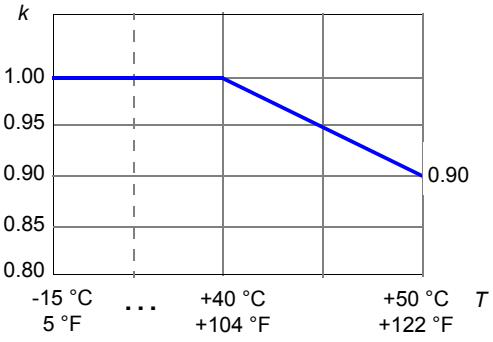
If your application requires continuous 12.0 A of motor current at 8 kHz switching frequency, the supply voltage is 400 V and the drive is situated at 1500 m, calculate the appropriate drive size as follows:

Switching frequency derating (see page *157*):
The minimum required current is 12.0 A / 0.7 = 17.2 A,
where 0.7 is the derating factor for 8 kHz switching frequency for frame R3 drives.

Altitude derating (see page *155*):
The derating factor for 1500 m is 1 - 1/10 000 m · (1500 - 1000) m = 0.95.
The minimum current becomes then 17.2 A / 0.95 = 18.1 A.

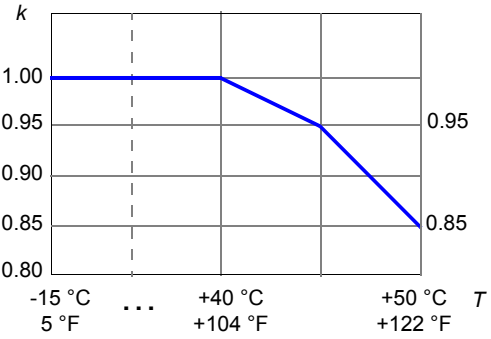
Nominal current of drive type -025A-4 exceeds the current requirement of 18.1 A.

Ambient temperature derating, IP21 (UL Type 1)

Temperature range	Derating
up to +40 °C up to +104 °F	No derating
+40…+50 °C +104…+122 °F	Derate 1% for every 1 °C (1.8 °F): Calculate the output by multiplying the current given in the rating table by the derating factor (k, in the diagram below). 

Ambient temperature derating, IP55 (UL Type 12)

The derating is the same as for degree of protection of IP21 (UL Type 1) except for drive types shown below.

Temperature range	Derating
up to +40 °C up to +104 °F	No derating
+40…+50 °C +104…+122 °F	Derate 1% for every 1 °C (1.8 °F) up to 45 °C (113 °F): Derate 2% for every 1 °C (1.8 °F) up to 50 °C (122 °F). Calculate the output by multiplying the current given in the rating table by the derating factor (k, in the diagram below). 

Note: For ambient temperatures above +40 °C (+104 °F), the power cables must be rated for 90 °C (194 °F) minimum.

Ambient temperature derating in table format

Type ACQ580 -31-	≤ 40 °C IP21, IP55		45 °C IP21, IP55		50 °C IP21, IP55	
	%	I_2 (A)	%	I_{out} (A)	%	I_{out} (A)
IEC ratings: 3-phase U_N = 400 V						
09A5-4	100	9.4	95	8.9	90	8.5
12A7-4	100	12.6	95	12.0	90	11.3
018A-4	100	17.0	95	16.1	90	15.3
026A-4	100	25.0	95	23.8	90	22.5
033A-4	100	32.0	95	30.4	90	28.8
039A-4	100	38.0	95	36.1	90	34.2
046A-4	100	45.0	95	42.8	90	40.5
062A-4	100	62.0	95	58.9	90	55.8
073A-4	100	73.0	95	69.4	90	65.7
088A-4	100	88.0	95	83.6	90/85*	79.2/74.8*
106A-4	100					
145A-4	100					
169A-4	100					
206A-4	100					
IEC ratings: 3-phase U_N = 480 V						
09A5-4	100	9.4	95	8.9	95	8.5
12A7-4	100	12.6	95	12.0	95	11.3
018A-4	100	17.0	95	16.1	95	15.3
026A-4	100	25.0	95	23.8	95	22.5
033A-4	100	32.0	95	30.4	95	28.8
039A-4	100	38.0	95	36.1	95	34.2
046A-4	100	45.0	95	42.8	95	40.5
062A-4	100	62.0	95	58.9	95	55.8
073A-4	100	73.0	95	69.4	95	65.7
088A-4	100	88.0	95	83.6	90/85*	79.2/74.8*
106A-4						
145A-4						
169A-4						
206A-4						

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* IP55

Type ACQ580 -31-	≤ 40 °C UL Type 1, UL Type 12		45 °C UL Type 1, UL Type 12		50 °C UL Type 1, UL Type 12	
	%	I_{Ld} (A)	%	I_{out} (A)	%	I_{out} (A)
UL (NEC) ratings: 3-phase U_N = 480 V						
07A6-4	100	7.6	95	7.22	90	6.84
012A-4	100	12.0	95	11.4	90	10.8
014A-4	100	14.0	95	13.3	90	12.6
023A-4	100	23.0	95	21.85	90	20.7
027A-4	100	27	95	25.65	90	24.3
034A-4	100	34	95	32.3	90	30.6
044A-4	100	44	95	41.8	90	39.6
052A-4	100	52	95	49.4	90	46.8
065A-4	100	65	95	61.75	90	58.5
077A-4	100	77	95	73.15	90/85*	69.3/65.5*
096A-4	100					
124A-4	100					
156A-4	100					
180A-4	100					

* UL Type 12

Altitude derating

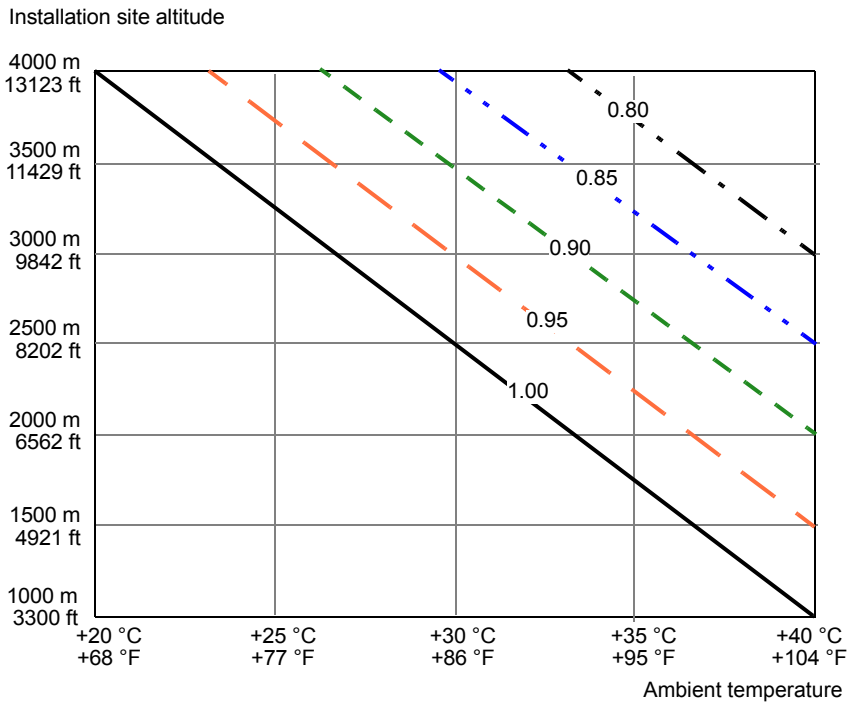
In altitudes 1000…4000 m (3300…13120 ft) above sea level, the derating is 1% for every 100 m (330 ft).

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:

$$k = 1 - \frac{1}{10\,000\ \text{m}} \cdot (x - 1000)\ \text{m}$$

Check the network compatibility restrictions above 2000 m (6562 ft), see *Installation site altitude* on page *181*. Check also PELV limitation on relay output terminals above 2000 m (6562 ft), see *Isolation areas* on page *176*.

A few altitude derating curves are shown below. For a more accurate derating, use the DriveSize PC tool.



	Derating factor 1.00
	Derating factor 0.95
	Derating factor 0.9
	Derating factor 0.85
	Derating factor 0.80

The altitude derating can be reduced if the temperature is below +40 °C, for example, if the temperature is 30 °C, the derating factor is 1 - 1.5% · 10 = 0.85. You can reduce the output current by 35% instead of 40% at 4000 meter above the see level.

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 Minimum switching frequency, derate according to the table below. Changing parameter 97.01 Switching frequency reference does not require derating.

Frame size	Type ACQ580 -31	Derating factor (k) for the minimum switching frequencies				
		1 kHz	2 kHz	4kHz	8 kHz	12 kHz
IEC ratings: 3-phase U_N = 400 V						
R3	09A5-4	1.0	1.0	1.0	0.74	0.52
R3	12A7-4	1.0	1.0	1.0	0.74	0.52
R3	018A-4	1.0	1.0	1.0	0.74	0.52
R3	026A-4	1.0	1.0	1.0	0.74	0.52
R6	033A-4	1.0	1.0	1.0	0.67	0.52
R6	039A-4	1.0	1.0	1.0	0.67	0.52
R6	046A-4	1.0	1.0	1.0	0.67	0.52
R6	062A-4	1.0	1.0	1.0	0.67	0.52
R6	073A-4	1.0	1.0	1.0	0.67	0.52
R6	088A-4	1.0	1.0	1.0	0.67	0.52
R8	106A-4	1.0	1.0	1.0	1.00	-
R8	145A-4	1.0	1.0	1.0	0.84	-
R8	169A-4	1.0	1.0	1.0	0.72	-
IEC ratings: 3-phase U_N = 480 V						
R3	09A5-4	1.0	1.0	1.0	0.74	0.52
R3	12A7-4	1.0	1.0	1.0	0.74	0.52
R3	018A-4	1.0	1.0	1.0	0.74	0.52
R3	026A-4	1.0	1.0	1.0	0.74	0.52
R6	033A-4	1.0	1.0	1.0	0.67	0.52
R6	039A-4	1.0	1.0	1.0	0.67	0.52
R6	046A-4	1.0	1.0	1.0	0.67	0.52
R6	062A-4	1.0	1.0	1.0	0.67	0.52
R6	073A-4	1.0	1.0	1.0	0.67	0.52
R6	088A-4	1.0	1.0	1.0	0.67	0.52
R8	106A-4	1.0	1.0	1.0	1.00	-
R8	145A-4	1.0	1.0	1.0	0.84	-
R8	169A-4	1.0	1.0	1.0	0.72	-
R8	206A-4	1.0	1.0	1.0	0.63	-
UL (NEC) ratings: 3-phase U_N = 480 V						
R3	07A6-4	1.0	1.0	1.0	0.74	0.52
R3	012A-4	1.0	1.0	1.0	0.74	0.52
R3	014A-4	1.0	1.0	1.0	0.74	0.52
R3	023A-4	1.0	1.0	1.0	0.74	0.52
R6	027A-4	1.0	1.0	1.0	0.67	0.52
R6	034A-4	1.0	1.0	1.0	0.67	0.52
R6	044A-4	1.0	1.0	1.0	0.67	0.52
R6	052A-4	1.0	1.0	1.0	0.67	0.52

Frame size	Type ACQ580 -31	Derating factor (k) for the minimum switching frequencies				
		1 kHz	2 kHz	4kHz	8 kHz	12 kHz
R6	065A-4	1.0	1.0	1.0	0.67	0.52
R6	077A-4	1.0	1.0	1.0	0.67	0.52
R8	096A-4	1.0	1.0	1.0	1.00	-
R8	124A-4	1.0	1.0	1.0	0.84	-
R8	156A-4	1.0	1.0	1.0	0.72	-
R8	180A-4	1.0	1.0	1.0	0.63	-

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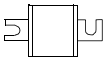
Fuses (IEC)

Fuses protect the input cable in short-circuit situations. They also restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive. ABB recommends the high speed aR fuses specified below. The gG fuses can be used for frames R3 and R6 if they operate rapidly enough (max. 0.1 seconds). The operating time depends on the supply network impedance and the cross-sectional area and length of the supply cable. Obey the local regulations.

Note: 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.

aR fuses DIN 43653 stud-mount

Type ACQ580 -31-	Min. short-circuit current[1)]	Input current	Ultra-rapid (aR) fuses stud-mount (one fuse per phase)				
			Nominal current	I^2t	Voltage rating	Bussmann type	Type DIN 43653
	A	A	A	A^2s	V		
IEC ratings: 3-phase U_N = 400 V							
09A5-4	70	8.0	10	25,5	690	170M1308	000
12A7-4	70	10.0	16	48	690	170M1309	000
018A-4	70	14.0	25	130	690	170M1311	000
026A-4	100	20.0	25	130	690	170M1311	000
033A-4	110	27.0	40	460	690	170M1313	000
039A-4	210	33.0	63	1450	690	170M1315	000
046A-4	300	40.0	63	1450	690	170M1315	000
062A-4	300	51.0	80	2550	690	170M1316	000
073A-4	400	63.0	100	4650	690	170M1317	000
088A-4	400	76.0	125	8500	690	170M1318	000
106A-4	700	94	160	16000	690	170M1319	000
145A-4	970	128	200	15000	690	170M3015	1*
169A-4	1100	154	250	28500	690	170M3016	1*
206A-4	1600	188	315	46500	690	170M3017	1*

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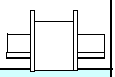
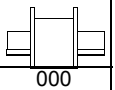
[1)] Minimum short-circuit current of the electrical power system

aR fuses DIN 43620 blade style

Type ACQ580 -31-	Min. short-circuit current[1)]	Input current	Ultra-rapid (aR) fuses blade style (one fuse per phase)				
			Nominal current	I^2t	Voltage rating	Bussmann type	Type DIN 43620
	A	A	A	A^2s	V		
IEC ratings: 3-phase U_N = 400 V							
09A5-4	65	8.0	25	130	690	170M1561	000
12A7-4	65	10.0	25	130	690	170M1561	000

Type ACQ580 -31-	Min. short-circuit current[1)]	Input current	Ultra-rapid (aR) fuses blade style (one fuse per phase)				
			Nominal current	I^2t	Voltage rating	Bussmann type	Type DIN 43620 
	A	A	A	A^2s	V		
018A-4	120	14.0	40	460	690	170M1563	000
026A-4	120	20.0	40	460	690	170M1563	000
033A-4	170	27.0	63	1450	690	170M1565	000
039A-4	170	33.0	63	1450	690	170M1565	000
046A-4	280	40.0	80	2550	690	170M1566	000
062A-4	380	51.0	100	4650	690	170M1567	1
073A-4	500	63.0	125	8500	690	170M1568	1
088A-4	500	76.0	125	8500	690	170M1568	1
106A-4	700	94	160	16500	690	170M1569	000
145A-4	900	128	315	46500	690	170M3817	1
169A-4	1900	154	400	79000	690	170M5808	2
206A-4	2200	188	450	155000	690	170M5809	2

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[1)] Minimum short-circuit current of the electrical power system

gG fuses DIN 43620 blade style

gG fuses can be used for frames R3 and R6 if they operate rapidly enough (max. 0.1 seconds ABB recommends, however, aR fuses. gG fuses are not allowed for frame R8.

Type ACQ580 -31-	Min. short-circuit current[1)]	Input current	gG (IEC 60269)				
			Nominal current	I^2t	Voltage rating	ABB type	IEC 60269 size
	A	A	A	A^2s	V		
IEC ratings: 3-phase U_N = 400 V							
09A5-4	128	8.0	16	740	500	OFAF000H16	000
12A7-4	128	10.0	16	740	500	OFAF000H16	000
018A-4	200	14.0	25	2500	500	OFAF000H25	000
026A-4	256	20.0	32	4000	500	OFAF000H32	000
033A-4	320	27.0	40	7700	500	OFAF000H40	000
039A-4	400	33.0	50	16000	500	OFAF000H50	000
046A-4	504	40.0	63	20100	500	OFAF000H63	000
062A-4	640	51.0	80	37500	500	OFAF000H80	000
073A-4	800	63.0	100	65000	500	OFAF000H100	000
088A-4	800	76.0	100	65000	500	OFAF000H100	000

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[1)] Minimum short-circuit current of the installation

Calculating the short-circuit current of the installation

Check 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:

$$I_{k2\text{-}ph} = \frac{U}{2 \cdot \sqrt{R_c^2 + (Z_k + X_c)^2}}$$

where

$I_{k2\text{-}ph}$	Short-circuit current in symmetrical two-phase short-circuit
U	Network line-to-line voltage (V)
R_c	Cable resistance (ohm)
Z_k	$z_k \cdot U_N^2/S_N$ = 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:

- ACQ580-31-145A-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.

$$Z_k = z_k \cdot \frac{U_N^2}{S_N} = 0.072 \cdot \frac{(430\ \text{V})^2}{600\ \text{kVA}} = 22.19\ \text{mohm}$$

$$R_c = 170\ \text{m} \cdot 0.398\ \frac{\text{ohm}}{\text{km}} = 67.66\ \text{mohm}$$

$$X_c = 170\ \text{m} \cdot 0.082\ \frac{\text{ohm}}{\text{km}} = 13.94\ \text{mohm}$$

$$I_{k2\text{-}ph} = \frac{410\ \text{V}}{2 \cdot \sqrt{(67.66\ \text{mohm})^2 + (22.19\ \text{mohm} + 13.94\ \text{mohm})^2}} = 2.7\ \text{kA}$$

The calculated short-circuit current 2.7 kA is higher than the minimum short-circuit current of the drive gG fuse type OFAF000H100 (1000 A). -> The 500 V gG fuse (ABB Control OFAF000H100) can be used.

Fuses (UL)

The UL listed fuses in the table are required for branch circuit protection per NEC.

Type ACQ580 -31-	Input current	UL (one fuse per phase)			
		Nominal current	Voltage rating	Bussmann type	UL class
	A	A	V		
UL (NEC) ratings: 3-phase U_N = 480 V					
07A6-4	7.0	15	600	JJS-15	T
012A-4	9.0	20	600	JJS-20	T
014A-4	12.0	25	600	JJS-25	T
023A-4	17.0	35	600	JJS-35	T
027A-4	24	40	600	JJS-40	T
034A-4	29	50	600	JJS-50	T
044A-4	34	60	600	JJS-60	T
052A-4	44	80	600	JJS-80	T
065A-4	54	90	600	JJS-90	T
077A-4	66	110	600	JJS-110	T
096A-4	82	150	600	JJS-150	T
124A-4	111	200	600	JJS-200	T
156A-4	134	225	600	JJS-225	T
180A-4	163	300	600	JJS-300	T
IEC ratings: 3-phase U_N = 480 V					
09A5-4	7.0	15	600	JJS-15	T
12A7-4	9.0	20	600	JJS-20	T
018A-4	12.0	25	600	JJS-25	T
026A-4	17.0	35	600	JJS-35	T
033A-4	24	40	600	JJS-40	T
039A-4	29	50	600	JJS-50	T
046A-4	34	60	600	JJS-60	T
062A-4	44	80	600	JJS-80	T
073A-4	54	90	600	JJS-90	T
088A-4	66	110	600	JJS-110	T
106A-4	82	150	600	JJS-150	T
145A-4	111	200	600	JJS-200	T
169A-4	134	225	600	JJS-225	T
206A-4	163	300	600	JJS-300	T

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

Notes:

- Fuses are required as part of the installation. Fuses are not included in the purchased drive and must be provided by others.
- Fuses with higher current rating than the specified ones must not be used.
- The specified fuses must be used in order to maintain drive UL listing. Additional protection can be used. When installing a drive always follow installation instructions and NEC requirements. Refer to local codes and regulations. For alternate recommended fuses, contact ABB.

Circuit breakers

Fuses must be used with circuit breakers.

Dimensions, weights and free space requirements

Frame size	Height	Width	Depth	Weight	Height	Width	Depth	Weight
	mm	mm	mm	kg	mm	mm	mm	kg
	IP21				IP55 (option +B056) *			
R3	495	205	349	21.3	490	205	360	23.3
R6	771	252	392	61.0	771	252	448	63
R8	965	300	438	112	965	300	496	118
	IP20 (option +P940)							
R3	490	203	349	18.3				
R6	771	252	358	59				
R8	965	300	430	109				

Frame size	Height	Width	Depth	Weight	Height	Width	Depth	Weight
	in	in	in	lb	in	in	in	lb
	UL Type 1				UL Type 12 (option +B056) *			
R3	19.49	8.07	13.74	46.97	19.29	8.07	14.17	51.38
R6	30.35	9.92	15.44	134.51	30.35	9.92	17.65	138.92
R8	37.99	11.81	17.24	246.96	37.99	11.81	19.53	260.19
	IP20 (option +P940)							
R3	19.49	8.07	13.74	40.34				
R6	30.35	9.92	15.44	130.07				
R8	37.99	11.81	40.34	240.30				

* Hood not included

Frame size	Drive weight with flange kit (option +C135)			
	IP21 (UL Type 1)		IP55 (UL Type 12)	
	kg	lb	kg	lb
R3	25.45	56.11	27.45	60.52
R6	66.80	147.27	68.88	151.85
R8	119.90	264.33	125.90	277.56

Free space requirements

See section *Examining the installation site* on page *37*.

Losses, cooling data and noise

The air flow direction is from bottom to top.

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)

Type ACQ580 -31-	Heat dissipation				Air flow		Noise	Frame size
	Main circuit at rated I_1 at I_2	Control circuit minimum	Control circuit maximum	Main circuit and control boards				
	W	W	W	W	m^3/h	ft^3/min	dB(A)	
IEC ratings U_N = 400 V								
09A5-4	190	4.1	36	226	361	212	57	R3
12A7-4	293	4.1	36	329	361	212	57	R3
018A-4	359	4.1	36	395	361	212	57	R3
026A-4	543	4.1	36	579	361	212	57	R3
033A-4	589	4.1	36	625	550	324	71	R6
039A-4	715	4.1	36	751	550	324	71	R6
046A-4	876	4.1	36	912	550	324	71	R6
062A-4	1052	4.1	36	1088	550	324	71	R6
073A-4	1466	4.1	36	1502	550	324	71	R6
088A-4	1868	4.1	36	1904	550	324	71	R6
106A-4	1841	4.1	36	1877	800	412	68	R8
145A-4	2927	4.1	36	2963	800	412	68	R8
169A-4	3132	4.1	36	3168	800	412	68	R8
206A-4	3954	4.1	36	3990	800	412	68	R8
IEC ratings U_N = 480 V								
09A5-4	183	4.1	36	219	361	212	57	R3
12A7-4	242	4.1	36	278	361	212	57	R3
018A-4	285	4.1	36	321	361	212	57	R3
026A-4	437	4.1	36	473	361	212	57	R3
033A-4	589	4.1	36	625	361	212	65	R6
039A-4	675	4.1	36	711	550	324	71	R6
046A-4	771	4.1	36	807	550	324	71	R6
062A-4	924	4.1	36	960	550	324	71	R6
073A-4	1187	4.1	36	1223	550	324	71	R6
088A-4	1524	4.1	36	1560	550	324	71	R6
106A-4	1642	4.1	36	1678	550	324	68	R8
145A-4	2201	4.1	36	2237	800	412	68	R8
169A-4	2760	4.1	36	2796	800	412	68	R8
206A-4	3320	4.1	36	3356	800	412	68	R8

Type ACQ580 -31-	Heat dissipation				Air flow		Noise	Frame size
	Main circuit at rated I_1 at I_2	Control circuit minimum	Control circuit maximum	Main circuit and control boards				
	W	W	W	W	m^3/h	ft^3/min	dB(A)	
UL (NEC) ratings U_N = 480 V								
07A6-4	183	4.1	36	219	361	212	57	R3
012A-4	242	4.1	36	278	361	212	57	R3
014A-4	285	4.1	36	321	361	212	57	R3
023A-4	437	4.1	36	473	361	212	57	R3
027A-4	589	4.1	36	625	550	324	71	R6
034A-4	675	4.1	36	711	550	324	71	R6
044A-4	771	4.1	36	807	550	324	71	R6
052A-4	924	4.1	36	960	550	324	71	R6
065A-4	1187	4.1	36	1223	550	324	71	R6
077A-4	1524	4.1	36	1560	550	324	71	R6
096A-4	1642	4.1	36	1678	800	412	68	R8
124A-4	2201	4.1	36	2237	800	412	68	R8
156A-4	2760	4.1	36	2796	800	412	68	R8
180A-4	3320	4.1	36	3356	800	412	68	R8

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Cooling air flow and heat dissipation for flange mounting (option +C135)

Contact ABB.

Type ACS580 -01-	Heat dissipation (option +C135)		Air flow (option +C135)				Frame size
	Heatsink	Front	Heatsink		Front		
	W	W	m^3/h	ft^3/min	m^3/h	ft^3/min	
IEC ratings U_N = 400 V							
09A5-4			361	212	0	0	R3
12A7-4			361	212	0	0	R3
018A-4			361	212	0	0	R3
026A-4			361	212	0	0	R3
033A-4			498	293	52	31	R6
039A-4			498	293	52	31	R6
046A-4			498	293	52	31	R6
062A-4			498	293	52	31	R6
073A-4			498	293	52	31	R6
088A-4			498	293	52	31	R6
106A-4			740	436	60	35	R8
145A-4			740	436	60	35	R8
169A-4			740	436	60	35	R8
206A-4			740	436	60	35	R8

Type ACS580 -01-	Heat dissipation (option +C135)		Air flow (option +C135)				Frame size
	Heatsink	Front	Heatsink		Front		
	W	W	m^3/h	ft^3/min	m^3/h	ft^3/min	
IEC ratings U_N = 480 V							
09A5-4			361	212	0	0	R3
12A7-4			361	212	0	0	R3
018A-4			361	212	0	0	R3
026A-4			361	212	0	0	R3
033A-4			498	293	52	31	R6
039A-4			498	293	52	31	R6
046A-4			498	293	52	31	R6
062A-4			498	293	52	31	R6
073A-4			498	293	52	31	R6
088A-4			498	293	52	31	R6
106A-4			740	436	60	35	R8
145A-4			740	436	60	35	R8
169A-4			740	436	60	35	R8
206A-4			740	436	60	35	R8
UL (NEC) ratings U_N = 480 V							
07A6-4			361	212	0	0	R3
012A-4			361	212	0	0	R3
014A-4			361	212	0	0	R3
023A-4			361	212	0	0	R3
027A-4			498	293	52	31	R6
034A-4			498	293	52	31	R6
044A-4			498	293	52	31	R6
052A-4			498	293	52	31	R6
065A-4			498	293	52	31	R6
077A-4			498	293	52	31	R6
096A-4			740	436	60	35	R8
124A-4			740	436	60	35	R8
156A-4			740	436	60	35	R8
180A-4			740	436	60	35	R8

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Terminal and entry data for the power cables

IEC

Input, motor and DC cable entries, maximum wire sizes (per phase) and terminal screw sizes and tightening torques are given below.

Frame size	Cable entries		L1, L2, L3, T1/U, T2/V, T3/W, UD+, UDC- terminals		
		Ø[1]	Min wire size (solid/stranded)[2]	Max wire size (solid/stranded)	Tightening torque
	pcs	mm	mm^2	mm^2	N·m
R3	3	23	0.5	16.0	1.7
R6	3	45	6.0	70.0	5.6

Frame size	Cable entries		L1, L2, L3, T1/U, T2/V, T3/W, UD+, UDC- terminals		
		Ø[1]	Min wire size (solid/ stranded)[2]	Max wire size (solid/ stranded)	Tightening torque
	pcs	mm	mm^2	mm^2	N·m
R8	3	45	25	150	30

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[1] Maximum cable diameter accepted. For the bottom plate hole diameters, see chapter *Dimension drawings* on page *189*.
[2] Minimum wire size does not necessarily have enough current capability for full load. Make sure the installation complies with local laws and regulations.
Note: Only copper cables are allowed for drive types up to -039A-4.

For tightening torques of grounding terminals, see section *Connection procedure*, page *88*.

Frame size	Screwdrivers for the terminals of the main circuit
R3	Flat blade 0.6 x 3.5 mm

UL

Input, motor and DC cable entries, maximum wire sizes (per phase) and terminal screw sizes and tightening torques are given below.

Frame size	Cable entries		L1, L2, L3, T1/U, T2/V, T3/W, UDC+, UDC- terminals		
		Ø[1]	Min wire size (solid/ stranded)[2]	Max wire size (solid/ stranded)	Tightening torque
	pcs	in	AWG	AWG	lbf·ft
R3	3	0.91	20	6	1.3
R6	3	1.77	10	2/0	4.1
R8	3	1.77	4	300	22.5

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[1] Maximum cable diameter accepted. For the bottom plate hole diameters, see chapter *Dimension drawings* on page *189*..
[2] Minimum wire size does not necessarily have enough current capability for full load. Make sure the installation complies with local laws and regulations.
Note: Only copper cables are allowed for drive types up to -039A-4.

For tightening torques of grounding terminals, see section *Connection procedure*, page *114*.

UL listed cable lugs and tools

Wire size	Compression lug		Crimping tool		
kcmil/AWG	Manufacturer	Type	Manufacturer	Type	No. of crimps
6	Thomas & Betts	E10731 54136	Thomas & Betts	TBM4S TBM45S	1
	Burndy	YAV6C-L2	Burndy	MY29-3	1
	Ilsco	CCL-6-38	Ilsco	ILC-10	2
4	Thomas & Betts	54140	Thomas & Betts	TBM4S	1
	Burndy	YA4C-L4BOX	Burndy	MY29-3	1
	Ilsco	CCL-4-38	Ilsco	MT-25	1
2	Thomas & Betts	54143TB 54142TB	Thomas & Betts	TBM4S TBM4S	1
	Burndy	YA2C-L4BOX	Burndy	MY29-3	2
	Ilsco	CRC-2	Ilsco	IDT-12	1
	Ilsco	CCL-2-38	Ilsco	MT-25	1
1	Thomas & Betts	54148	Thomas & Betts	TBM-8	3
	Burndy	YA1C-L4BOX	Burndy	MY29-3	2
	Ilsco	CRA-1-38	Ilsco	IDT-12	1
	Ilsco	CCL-1-38	Ilsco	MT-25	1
1/0	Thomas & Betts	54109	Thomas & Betts	TBM-8	3
	Burndy	YA25-L4BOX	Burndy	MY29-3	2
	Ilsco	CRB-0	Ilsco	IDT-12	1
	Ilsco	CCL-1/0-38	Ilsco	MT-25	1
2/0	Thomas & Betts	54110	Thomas & Betts	TBM-8	3
	Burndy	YAL26T38	Burndy	MY29-3	2
	Ilsco	CRA-2/0	Ilsco	IDT-12	1
	Ilsco	CCL-2/0-38	Ilsco	MT-25	1

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^2	N·m	mm^2	N·m
R3	4	17	0.2…2.5	0.5…0.6	0.14…2.5	0.5…0.6
R6	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

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US

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
R3	4	0.67	24…14	0.4	26…14	0.4
R6	4	0.67	26…14	0.4	26…14	0.4
R8	4	0.67	26…14	0.4	26…14	0.4

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Electrical power network specification

Voltage (U_1)	ACQ580-31 drives: 380…480 V AC 3-phase +10%…-15%. This is indicated in the type designation label as typical input voltage level 3~ 400/480 V AC.
Network type	Public low voltage networks. TN (grounded), IT (ungrounded), corner-grounded delta and TT systems. IEC: See section *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* on page *80*.
Rated conditional short-circuit current (IEC 60439-1)	65 kA when protected by fuses given section *Fuses (IEC)* on page *159*
Short-circuit current protection (UL 61800-5-1)	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, see section *Fuses (UL)* on page *163*.

Frequency (f_1)	47 to 63 Hz. This is indicated in the type designation label as typical input frequency level f1 (50/60 Hz).
Imbalance	Max. ± 3% of nominal phase to phase input voltage
Fundamental power factor (cos phi$_1$)	1 (at nominal load)
Harmonic distortion	Harmonics are below the limits defined in IEEE 519-2014, and G5/4. The drive complies with IEC 61000-3-2, IEC 61000-3-4 and IEC 61000-3-12.

The table below shows typical values of the drive for short-circuit ratio (I_{sc}/I_1) of 20 to 100. The values will be met if the supply network voltage is not distorted by other loads and the drive operates at the nominal load.

Nominal bus voltage V at PCC	THDi (%)	THDv (%)
V ≤ 690 V	3*	< 3*

THDv Indicates the total magnitude of the voltage distortion. This value is defined as the ratio (in %) of the harmonic voltage to the fundamental (non-harmonic) voltage:

$$\text{THDv} = \frac{\sqrt{\sum_{2}^{40} U_n^2}}{U_1} \cdot 100\ \%$$

THDi Indicates the total harmonic current distortion of the wave form. This value is defined as the ratio (in %) of the harmonic current to the fundamental (non-harmonic) current measured at a load point at the particular moment when the measurement is taken:

$$\text{THDi} = \frac{\sqrt{\sum_{2}^{40} I_n^2}}{I_1} \cdot 100\ \%$$

PCC Point on a public power supply system, electrically nearest to a particular load, at which other loads are, or could be, connected. The PCC is a point located upstream of the considered installation.

I_{sc}/I_1 Short-circuit ratio

I_{sc} Maximum short-circuit current at PCC

I_1 Continuous rms input current of the drive

I_n Amplitude of the current harmonic n

U_1 Supply voltage

U_n Amplitude of the voltage harmonic n

* Other loads and short-circuit ratio can influence the THD values

Motor connection data

Motor types

Asynchronous AC induction motors, permanent magnet synchronous motors in open loop control, synchronous reluctance motors

Short-circuit current protection (UL/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….500 Hz

Frequency resolution

0.01 Hz

Current

See section *Ratings* on page *149*.

Maximum recommended motor cable length

Operational functionality and motor cable length

The drive operates with optimum performance with the following maximum motor cable lengths. 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 ABB for more information. Note that a sine filter (optional) at the drive output also causes a voltage decrease.

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
Standard drive, without external options				
R3	200	656	200	656
R6	300	990	300	990
R8	300	990	300	990

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

EMC compatibility and motor cable length

To comply with the 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
EMC limits for Category C2 [1] **Standard drive with an internal EMC filter. See notes 2 and 4**		
R3	100	330
R8	100	330
EMC limits for Category C3 [1] **Standard drive with an internal EMC filter. See notes 3 and 4.**		
R3	100	330
R6	100	330
R8	100	330

3AXD00000586715

[1] See the terms in section *Definitions* on page *.183*

Note 1: Radiated emissions are not compatible when measured with a standard emission measurement setup and should be checked or measured on cabinet and machine installations case by case. Radiated emissions are according to Category C2 with internal EMC filter.

Note 2: The internal EMC filter must be connected.

Note 3: Radiated and conducted emissions are according to category C3 with an internal filter and these cable lengths.

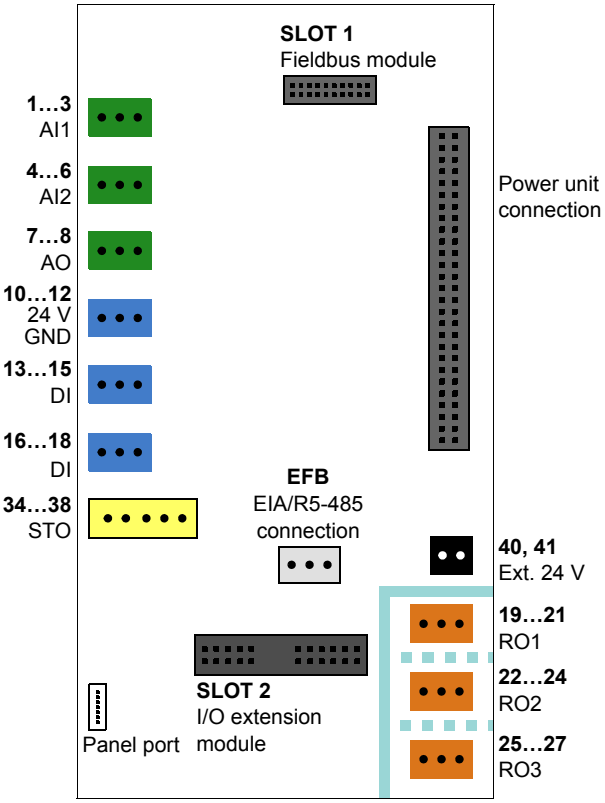
Note 4: Category C2 meets requirements for connecting equipment to the public low-voltage networks.

CCU-24 control unit connection data

External power supply	Maximum power: 36 W, 1.50 A at 24 V AC/DC ±10% as standard Terminal size: 0.14…2.5 mm^2
+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 the board. Terminal size: 0.14…2.5 mm^2
Digital inputs DI1…DI6 (Term. 13…18)	Input type: NPN/PNP Terminal size: 0.14…2.5 mm^2 DI1…DI5 (Term.13…17) 12/24 V DC logic levels: “0” < 4 V, “1” > 8 V R_{in}: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling DI5 (Term.17) Can be used as a digital or frequency input. 12/24 V DC logic levels: “0” < 3 V, “1” > 8 V R_{in}: 3 kohm Max. frequency 16 kHz Symmetrical signal (duty cycle D = 0.50) DI6 (Term. 18) Can be used as a digital or PTC input. Digital input mode 12/24 V DC logic levels: “0” < 4 V, “1” > 8 V R_{in}: 3 kohm Hardware filtering: 0.04 ms, digital filtering: 2 ms sampling **Note:** DI6 is not supported in the NPN configuration. PTC mode – PTC thermistor can be connected between DI6 and +24VDC: < 1.5 kohm = ‘1’ (low temperature), > 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.
Relay outputs RO1…RO3 (Term. 19…27)	250 V AC / 30 V DC, 2 A Terminal size: 0.14…2.5 mm^2 See section *Isolation areas* on page *176*.
Analog inputs AI1 and AI2 (Term. 2 and 5)	Current/voltage input mode selected with a parameter. 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^2 Inaccuracy: typical ±1%, max. ±1.5% of full scale

Analog outputs AO1 and AO2 (Term. 7 and 8)	Current/voltage input mode for AO1 selected with a parameter. Current output: 0…20 mA, R_{load}: < 500 ohm Voltage output: 0…10 V, R_{load}: > 100 kohm (AO1 only) Terminal size: 0.14…2.5 mm^2 Inaccuracy: ±1% of full scale (in voltage and current modes)
Reference voltage output for analog inputs +10V DC (Term. 4)	Max. 20 mA output Inaccuracy: ±1%
Safe torque off (STO) inputs IN1 and IN2 (Term. 37 and 38)	24 V DC logic levels: “0” < 5 V, “1” > 13 V R_{in}: 2.47 kohm Terminal size: 0.14…2.5 mm^2
STO cable	Maximum cable length 300 m (984 ft) between activation switch (K) and drive control board, see sections *Wiring examples* on page *200* and *Safety data (SIL, PL)* on page *207*.
Embedded fieldbus (Term. 29 to 31)	Connector pitch 5 mm, wire size 2.5 mm^2 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 Mbit/s Termination by switch
Control panel - drive connection	EIA-485, male RJ-45 connector, max. cable length 100 m
Control panel - PC connection	USB Type Mini-B, max. cable length 2 m

Isolation areas



Reinforced insulation (IEC/EN 61800-5-1:2016)

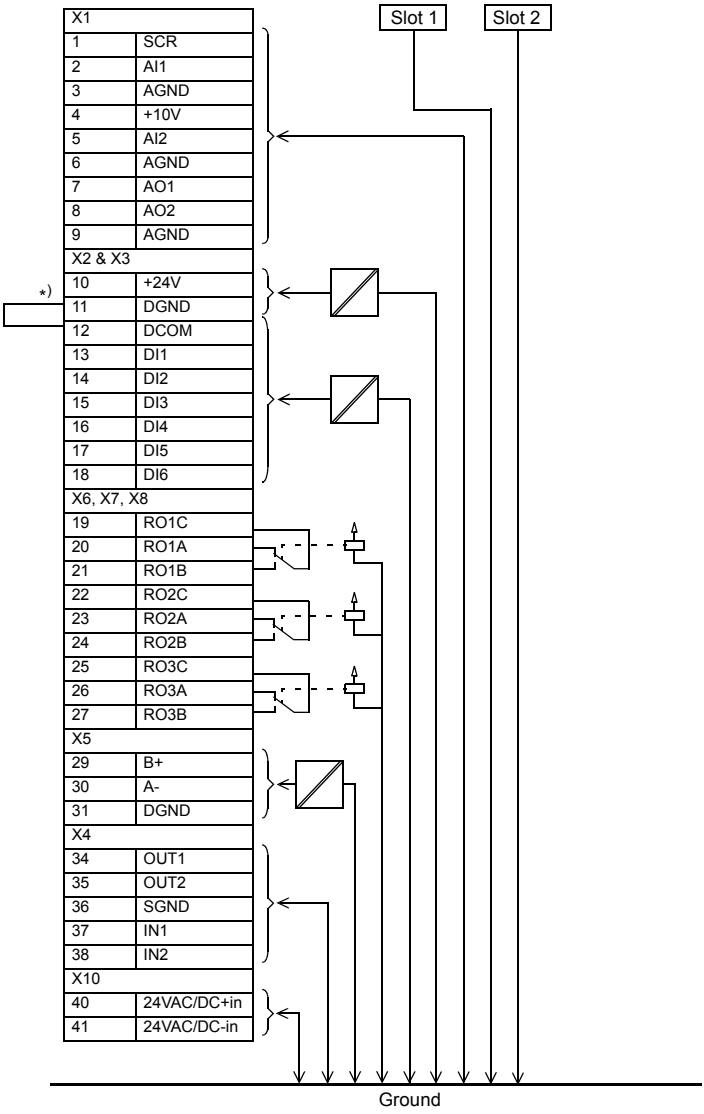
Functional insulation (IEC/EN 61800-5-1:2016)

The terminals on the control board 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).

Note: There is functional insulation also between the individual relay outputs.

Note: There is reinforced insulation on the power unit.

Ground isolation diagram



*) Jumper installed at factory

Efficiency

Efficiency at nominal power level:
Approximately 96% for frame R3
Approximately 96.5% for frame R6
Approximately 97% for frame R8

Degree of protection

Degree of protection (IEC/EN 60529): IP20, IP21, IP55

Enclosure types (UL 61800-5-1): UL Type 1, UL Type 12, UL Type Open

Drive types not available for IP55 (UL Type 12)

IEC	UL (NEC)
ACQ580 -31-	**ACQ580 -31-**
033A-4	027A-4
039A-4	034A-4
046A-4	044A-4
062A-4	052A-4
073A-4	065A-4
088A-4	077A-4

Overvoltage category (IEC 60664-1): III

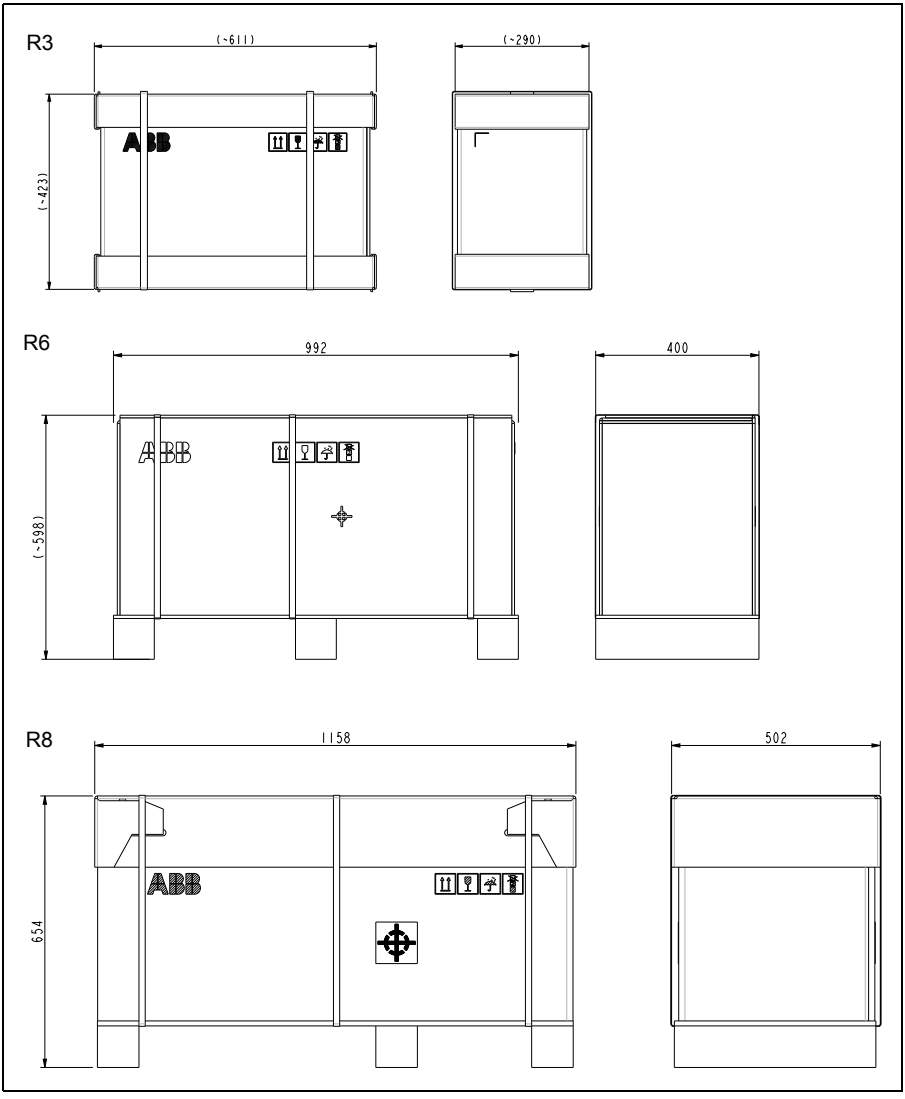
Protective classes (IEC/EN 61800-5-1): I

Materials

Drive enclosure

- PC/ABS 3 mm, color RAL 9002, RAL 9002 and PMS 653 C
- PC+10%GF 3.0mm, color RAL 9002 (in two smallest R3 frames only)
- Plastic parts are made of UV resistant f1 classified plastics
- Zinc coated steel sheet 1.5 to 2.5 mm, thickness of coating 100 micrometers, color RAL 9002

Package Plywood, cardboard and molded pulp. Foam cushions PE, PP-E, bands PP.



Disposal	The main parts of the drive can be recycled to preserve natural resources and energy. Product parts and materials should be dismantled and separated. Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and large electrolytic capacitors need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code. Contact your local distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations.

Applicable standards

The drive complies with the following standards. The compliance with the European Low Voltage Directive is verified according to standard EN 61800-5-1.

EN 60204-1:2006 + AI:2009 + AC:2010	*Safety of machinery. Electrical equipment of machines. Part 1: General requirements. Provisions for compliance:* The final assembler of the machine is responsible for installing - emergency-stop device - supply disconnecting device.
IEC/EN 60529:1981 +A1:1999 + A2: 2013	*Degrees of protection provided by enclosures (IP code)*
IEC 61000-3-2:2018,	*Electromagnetic compatibility (EMC) – Limits for harmonic*
EN 61000-3-2:2014	*current emissions (input current < 16 A per phase)*
IEC/EN 61000-3-12:2011	*Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and < 75 A per phase.*
IEC 61000-3-4:1998	*Limits - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A*
IEC/EN 61800-3:2004 + A1:2012	*Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods*
IEC/EN 61800-5-1:2007	*Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy*
IEC/EN 60664-1:2007	*Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests.*
UL 61800-5-1: First edition 2012	*Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy*
NEMA 250:2014	*Enclosures for Electrical Equipment (1000 Volts Maximum)*
CSA C22.2 No. 274-17	*Industrial control equipment*

Ambient conditions

Environmental limits for the drive are given below. The drive is to be used in a heated, indoor, controlled environment. All printed circuit boards are conformal coated.

	Operation installed for stationary use	**Storage** in the protective package	**Transportation** in the protective package
Installation site altitude	• 0 to 4000 m (13123 ft) above sea level [1)] • 0 to 2000 m (6561 ft) above sea level [2)] Output derated above 1000 m (3281 ft), see page *155*.	-	-
Surrounding air temperature	-15 to +50 °C (5 to 122 °F). No frost allowed. See section *Ratings*.	-40 to +70 °C (-40 to +158 °F)	-40 to +70 °C (-40 to +158 °F)
Relative humidity	5 to 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination levels (IEC 60721-3-x)	IEC 60721-3-3: 2002	IEC 60721-3-1: 1997	IEC 60721-3-2: 1997
Chemical gases	Class 3C2	Class 1C2	Class 2C2
Solid particles	Class 3S2. No conductive dust allowed.	Class 1S3 (packing must support this, otherwise 1S2)	Class 2S2
Pollution degree (IEC/EN 61800-5-1)	Pollution degree 2	-	-
Atmospheric pressure	70 to 106 kPa 0.7 to 1.05 atmospheres	70 to 106 kPa 0.7 to 1.05 atmospheres	60 to 106 kPa 0.6 to 1.05 atmospheres

	Operation installed for stationary use	**Storage** in the protective package	**Transportation** in the protective package
Vibration (IEC 60068-2:6)	10...150 Hz Amplitude ±0.075 mm, 10...57.56 Hz Constant peak acceleration 10 m/s² (1 gn), 57.56...150 Hz	-	-
Vibration (ISTA)	-	R3: Displacement, 25 mm peak to peak, 14200 vibratory impacts R6, R8 ISTA 3E): Random, overall Grms level of 0.54	
Shock/Drop (ISTA)	Not allowed	R3 (ISTA 1A): Drop, 6 faces, 3 edges and 1 corner, 460 mm (18.1 in) R6, R8 (ISTA 3E): Shock, incline impact: 1.2 m/s (3.94 ft/s) Shock, rotational edge drop: 230 mm (9.1 in)	

[1] For neutral-grounded TN and TT systems and non-corner grounded IT systems.
See also section *Limiting relay output maximum voltages at high installation altitudes* on page *72*.
[2] For corner-grounded TN, TT and IT systems

Markings

These markings are attached to the drive:

Mark	Description
CE	CE mark Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see section *EMC compliance (IEC/EN 61800-3:2004 + A1:2012)* on page *183*.
TÜV NORD Safety Approved	TÜV Nord Safety Approved mark (functional safety) Product contains Safe Torque Off and possibly other (optional) safety functions which are certified by TÜV Nord according to the relevant functional safety standards.
c UL us LISTED	UL Listed mark for USA and Canada Product has been tested and evaluated against the relevant North American standards by Underwriters Laboratories.

	RCM mark Product complies with Australian and New Zealand requirements specific to EMC, telecommunications and electrical safety. For fulfilling the requirements of the standard, see section *EMC compliance (IEC/EN 61800-3:2004 + A1:2012)* on page *183*.
	Eurasian Conformity mark Product complies with technical regulations of the Eurasian Customs Union. EAC marking is required in Russia, Belarus and Kazakhstan.
	The KC (Korea Certification) certification Product complies with Korea's product safety requirements for electrical and electronic equipment and components that utilize power from 50…1000 V AC.
	EIP (Electronic Information Products) mark Product does not contain toxic and hazardous substances or elements above the maximum concentration values, and that it is an environmentally-friendly product which can be recycled and reused. The People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) specifies the marking requirements for hazardous substances in electronic and electrical products.
	WEEE mark At the end of life the product should enter the recycling system at an appropriate collection point and not placed in the normal waste stream. See *Disposal* on page *180*.

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

Definitions

EMC stands for **E**lectro**m**agnetic **C**ompatibility. 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 directly supplying domestic premises.

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, intended for use in the second environment and not intended for use in the first environment.

Category C2

The emission limits are complied with the following provisions (frames R3 and R8):

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 *172*.

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.

Note: Do not install a drive with the internal 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 a drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. If you do, the varistor circuit can be damaged.

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 section *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* on page *159*.

Category C3

The drive complies with the standard with the following provisions:

4. The motor and control cables are selected as specified in this manual.
5. The drive is installed according to the instructions given in this manual.
6. For the maximum motor cable length with 4 kHz switching frequency, see page *172*

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.

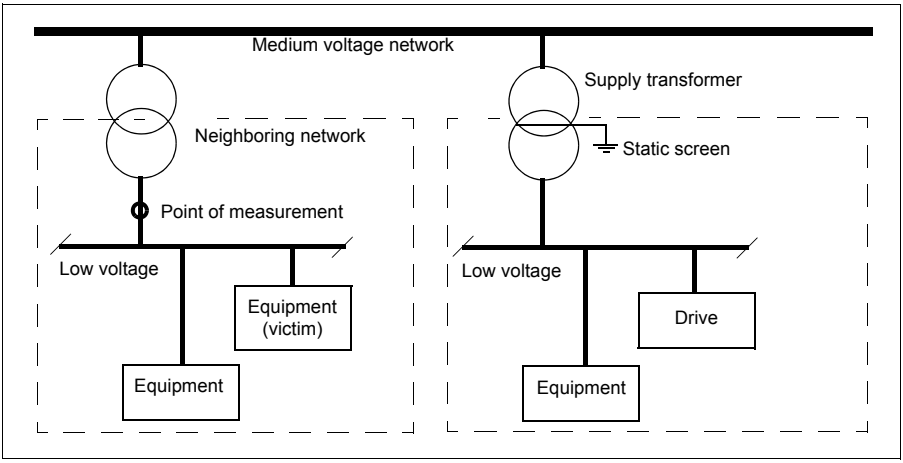
Note: Do not install a drive with the ground-to-phase varistor connected to a system that the varistor is not suitable for. If you do, the varistor circuit can be damaged.

If you install the drive to any other system than symmetrically grounded TN-S system, you may need to disconnect the ground-to-phase varistor. See section *Compatibility with IT (ungrounded), corner-grounded delta, midpoint-grounded delta and TT systems* on page *159*.

Category C4

If the provisions under *Category C3* cannot be met, the requirements of the standard can be met as follows:

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



2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available in *Technical guide No. 3 EMC compliant installation and configuration for a power drive system* (3AFE61348280 (English).
3. The motor and control cables are selected as specified in this manual.
4. The drive is installed according to the instructions given in this manual.

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.

UL checklist

WARNING! Operation of this drive requires detailed installation and operation instructions provided in the hardware and software manuals. The manuals are provided in electric format in the drive package or on the Internet. Retain 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 cULus Listed 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. UL Type 12 (IP55) enclosure provides protection from airborne dust and light sprays or splashing water from all directions.
- The maximum surrounding air temperature is 50 °C (122°F) at rated current. The current is derated for 40 to 50 °C (104 to 122 °F).
- The drive is suitable for use in a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 480 V maximum when protected by the UL fuses on page *163*. The ampere rating is based on tests done according to the appropriate UL standard.
- The cables located within the motor circuit must be rated for at least 75 °C (167 °F) in UL-compliant installations. For UL Type 12 drives of frame R6, the power cables must be rated for 90 °C (194 °F) minimum. For ambient temperatures above +40 °C (+104 °F), the power cables must be rated for 90 °C (194 °F) minimum.
- The input cable must be protected with fuses. The fuses must 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.

  Note: Circuit breakers must not be used without fuses in the USA. Consult ABB for suitable circuit breakers.

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

- The drive provides motor overload protection. For the adjustments, see the firmware manual.
- For drive overvoltage category, see page *178*. For pollution degree, see page *181*.

EU Declaration of Conformity (Machinery Directive)

See the quick installation guide.

Disclaimers

General disclaimer

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

Cybersecurity disclaimer

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

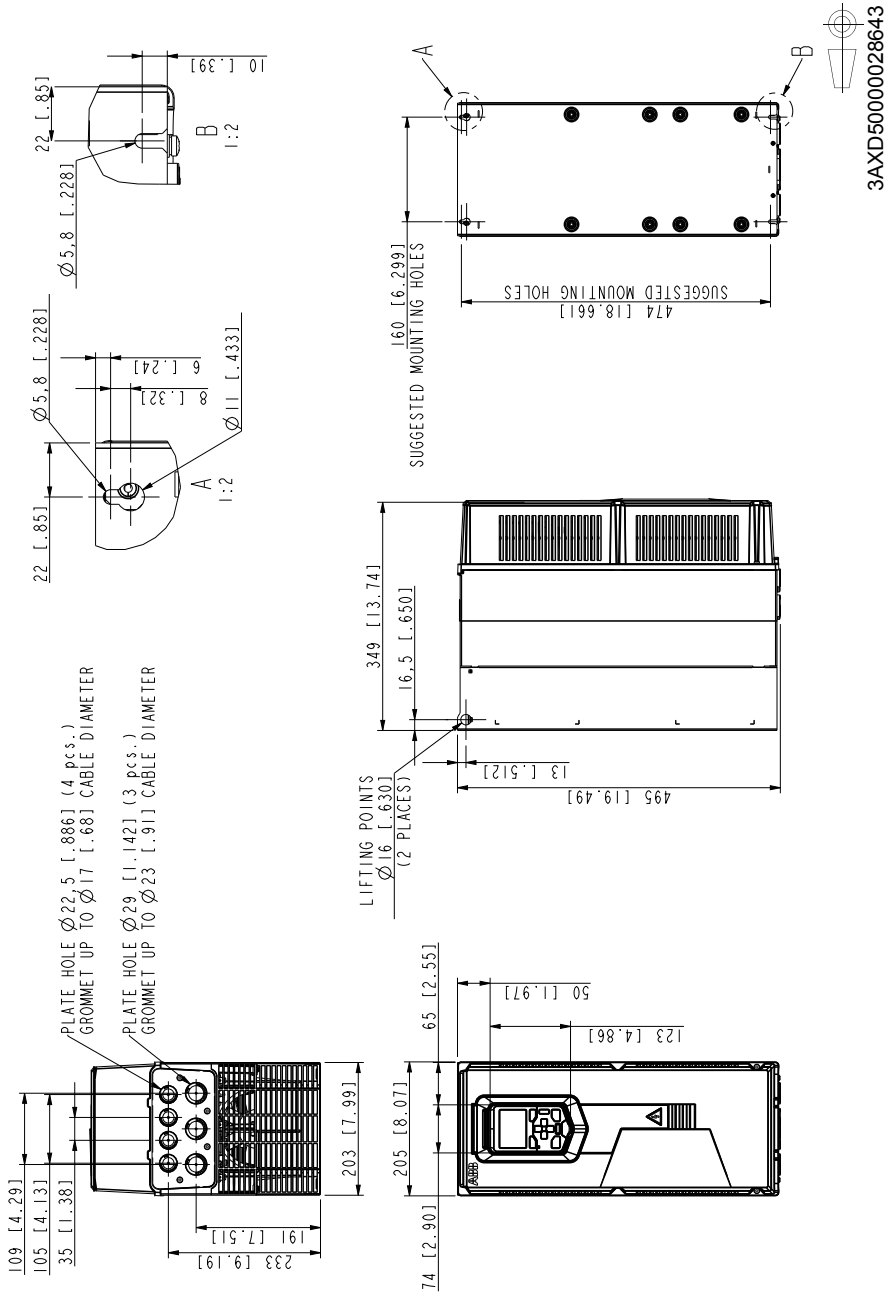
12

Dimension drawings

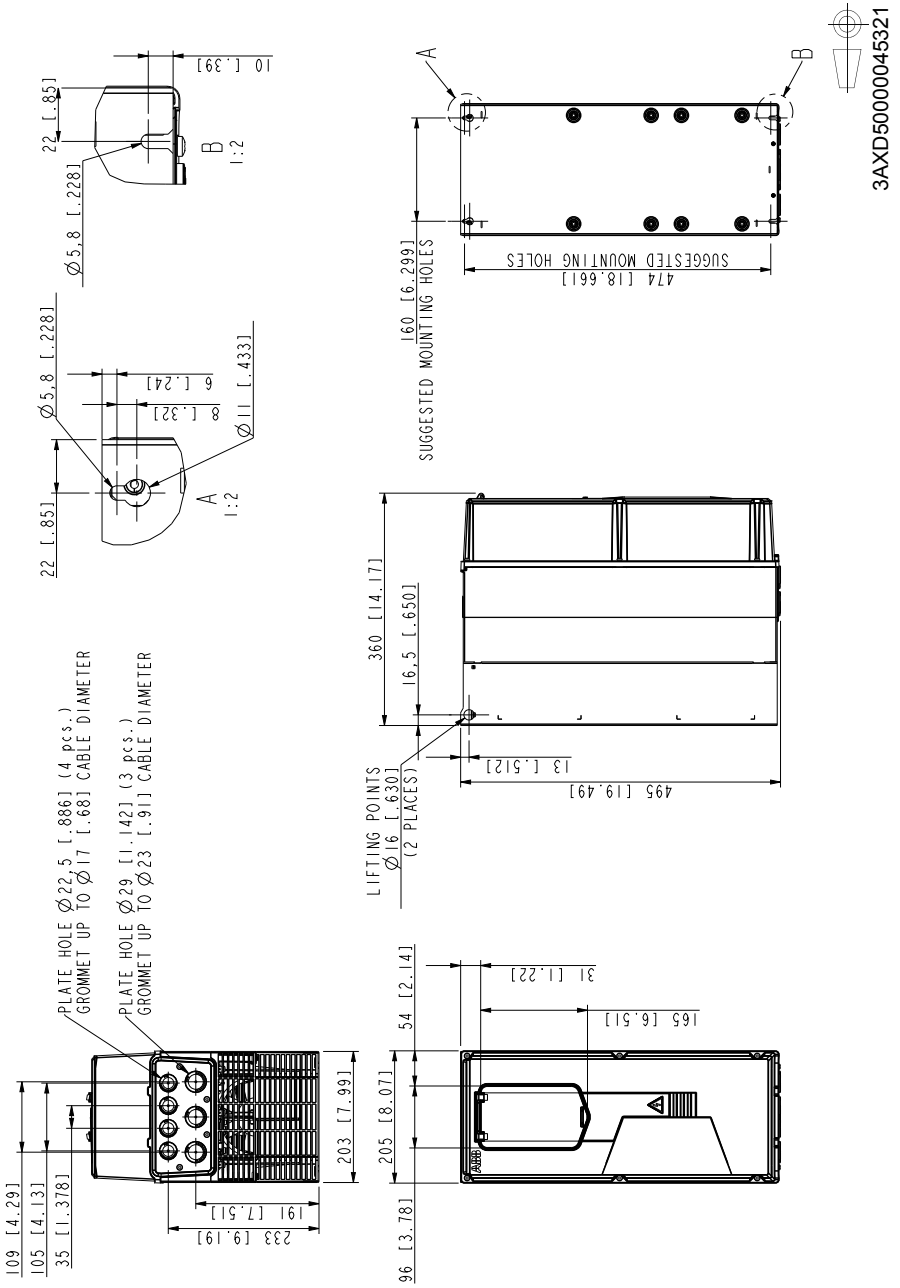
Contents of this chapter

This chapter shows the dimension drawings of the drive. The dimensions are given in millimeters and [inches].

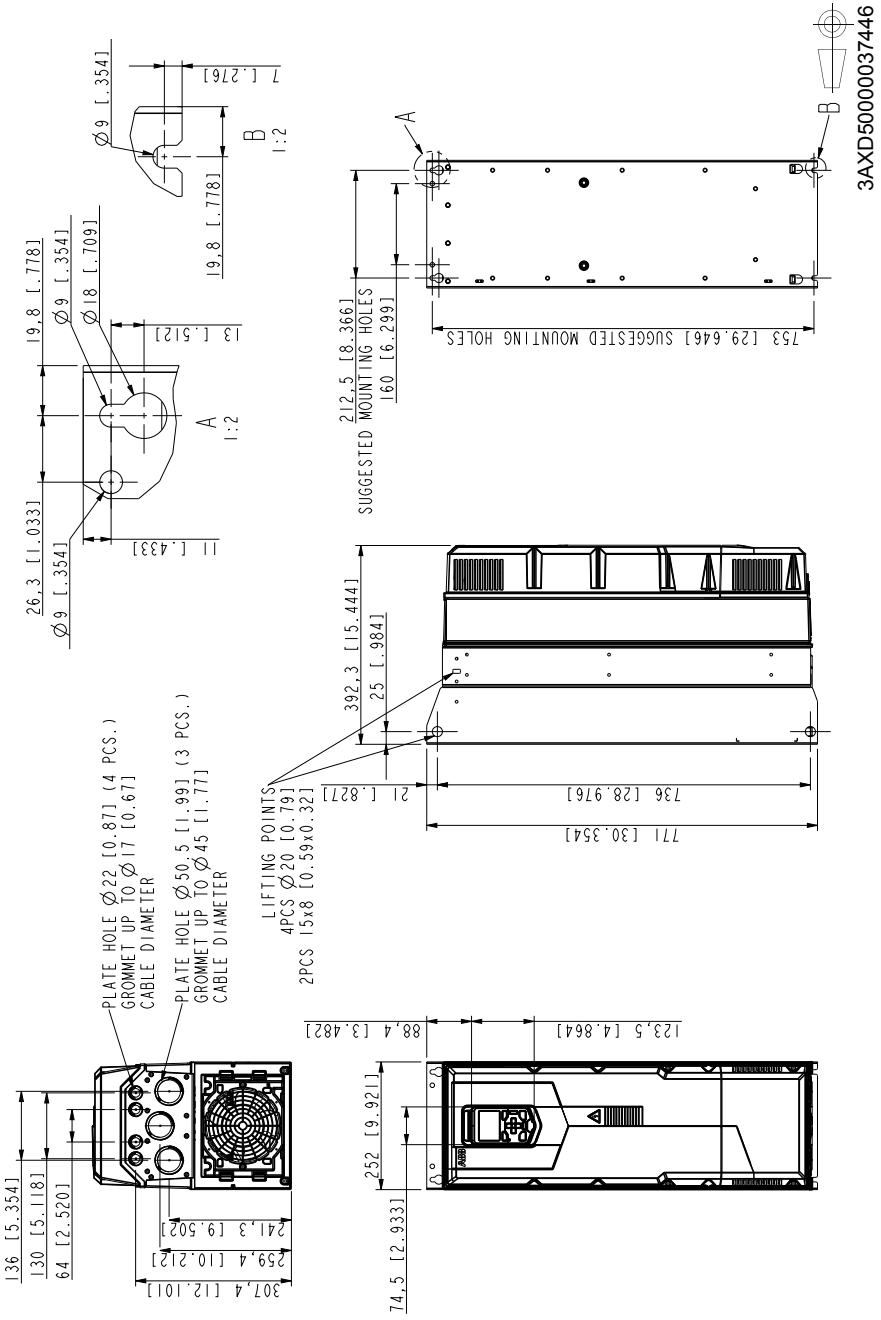
R3, IP21 (UL Type 1)



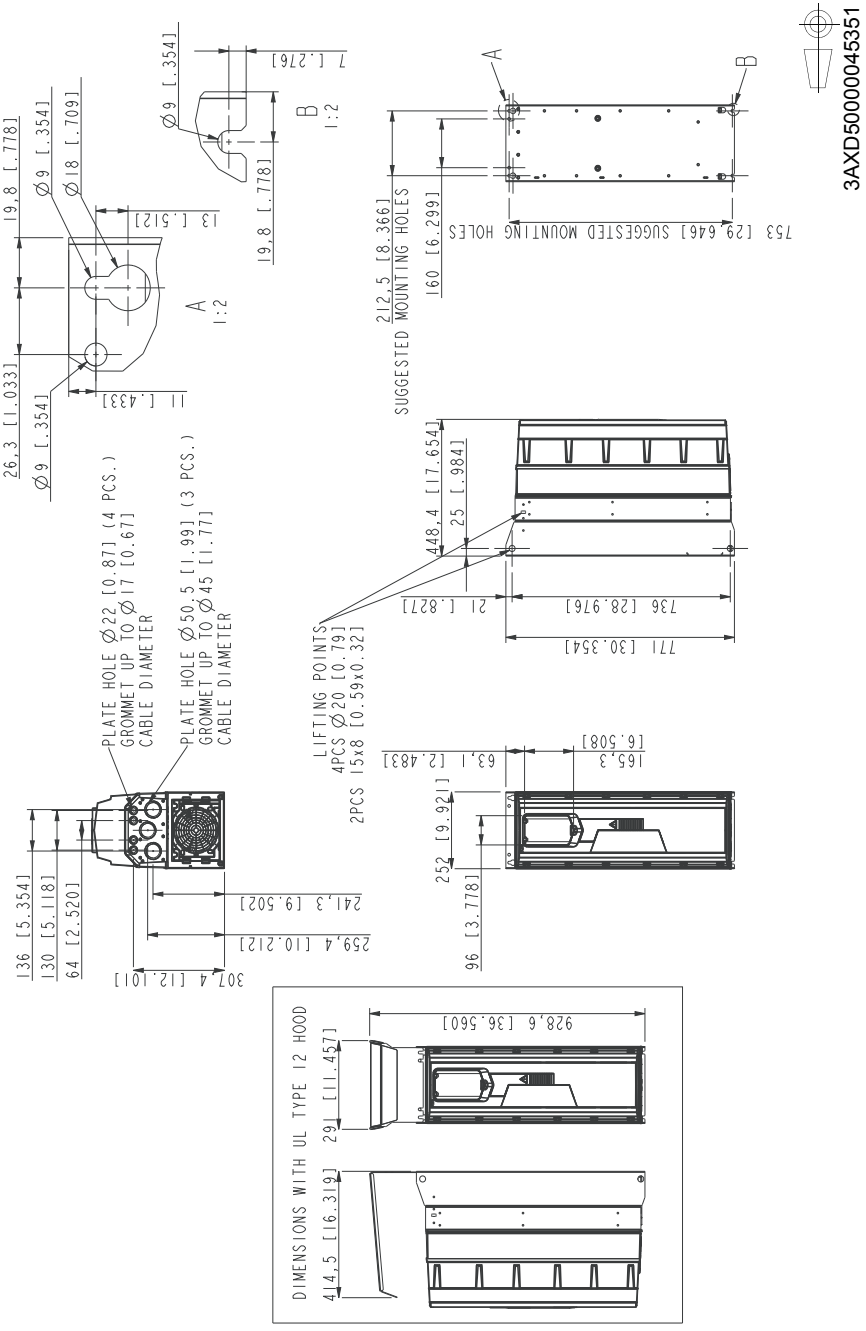
R3 – Option +B056 (IP55, UL Type 12)



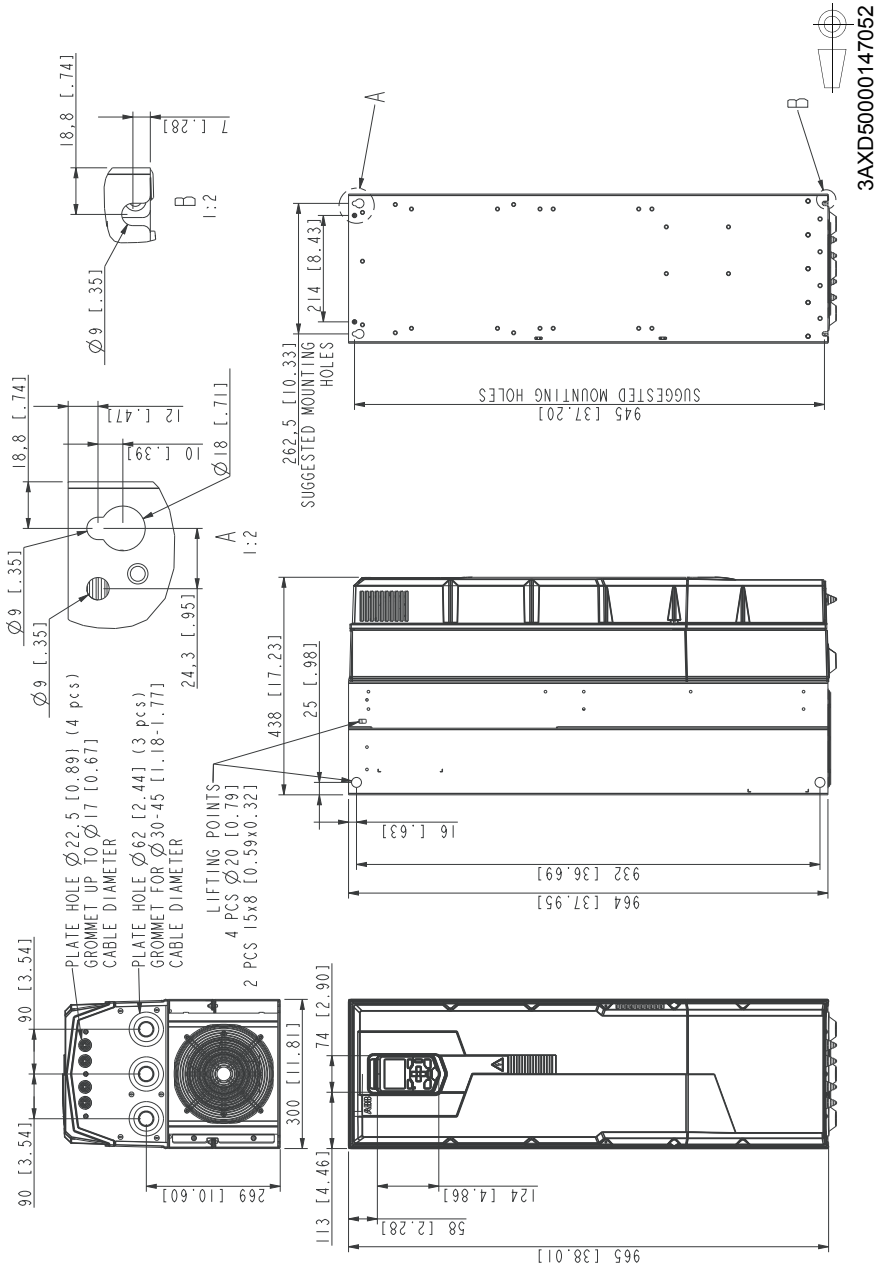
R6, IP21 (UL Type 1)



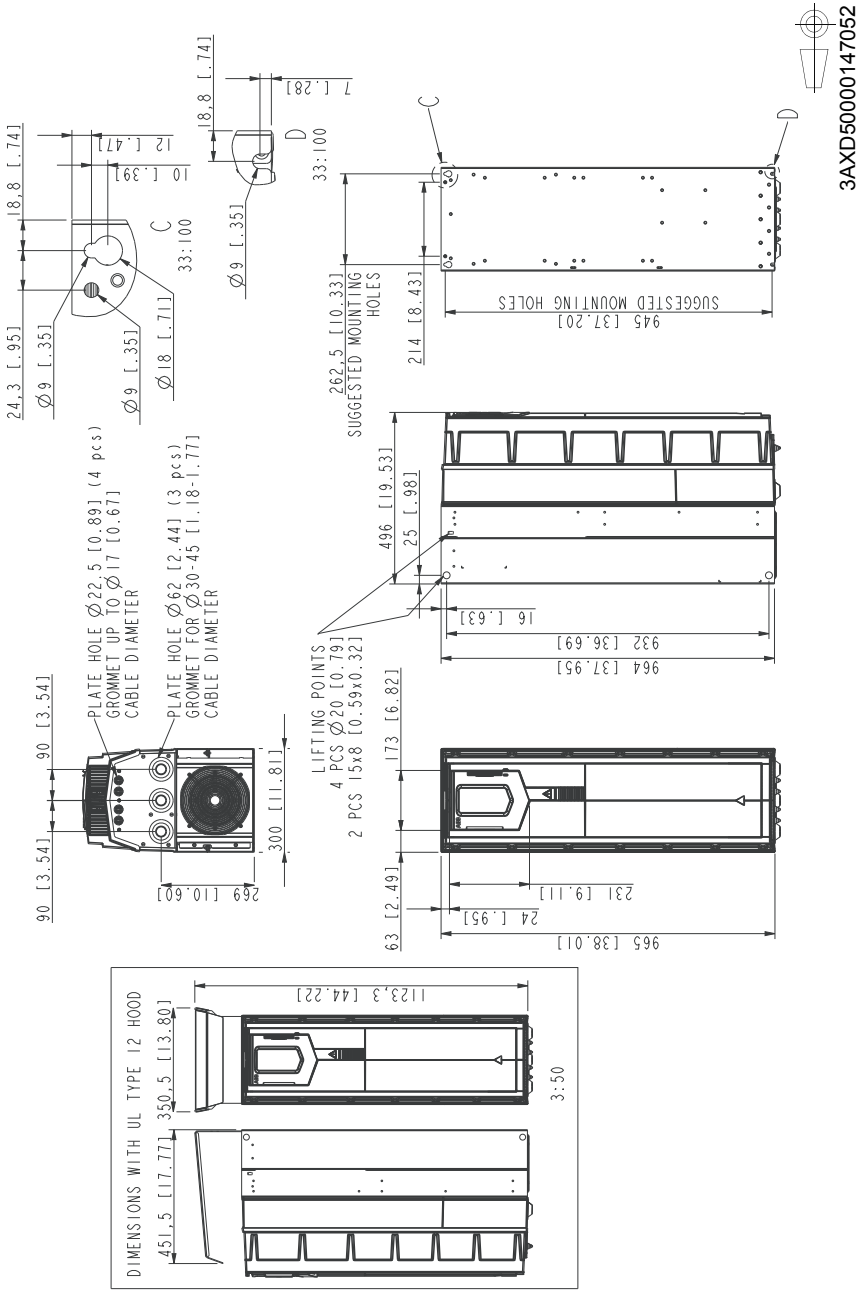
R6 – Option +B056 (IP55, UL Type 12)



R8, IP21 (UL Type 1)



R8 – Option +B056 (IP55, UL Type 12)



13

The Safe torque off function

Contents of this chapter

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

Description

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

When activated, the Safe torque off function disables the control voltage of the power semiconductors of the drive output stage , 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 of the drive complies with these standards:

Standard	Name
IEC 60204-1:2016 EN 60204-1:2006 + A1:2009 + AC:2010	*Safety of machinery – Electrical equipment of machines – Part 1: General requirements*
IEC 61326-3-1:2017	*Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications*
IEC 61508-1:2010	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*
IEC 61508-2:2010	*Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*
IEC 61511-1:2016	*Functional safety – Safety instrumented systems for the process industry sector*
IEC 61800-5-2:2016 EN 61800-5-2:2007	*Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional*
IEC 62061:2005 + A1:2012 + A2:2015 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	*Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*
EN ISO 13849-1:2015	*Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*
EN ISO 13849-2:2012	*Safety of machinery – Safety-related parts of control systems – Part 2: Validation*

The function also corresponds to Prevention of unexpected start-up as specified by EN 1037:1995 + A1:2008 and Uncontrolled stop (stop category 0) as specified in EN/IEC 60204-1.

Compliance with the European Machinery Directive

See section *EU Declaration of Conformity (Machinery Directive)* on page 187.

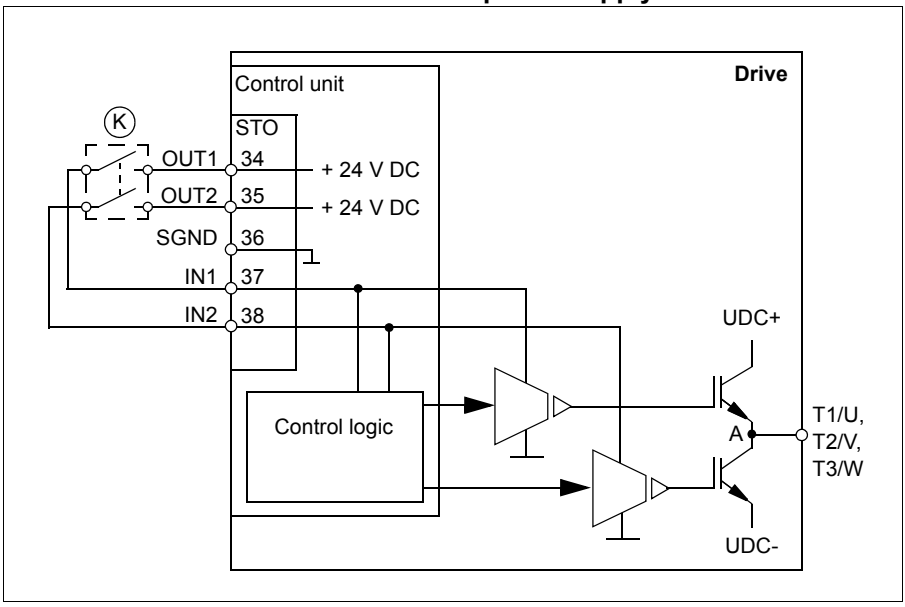
Wiring

The following diagrams show examples of Safe torque off wiring for

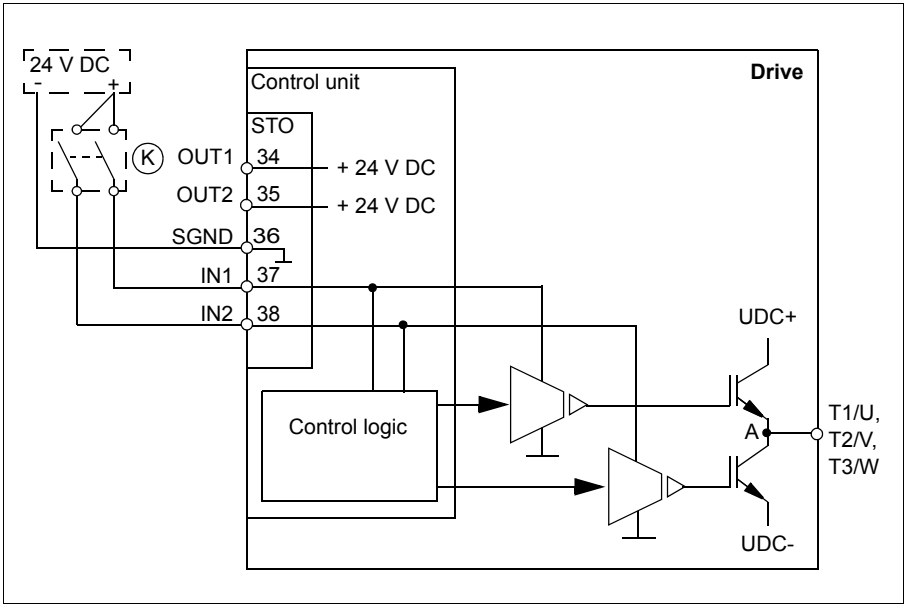
- a single drive with internal power supply (page 199)
- a single drive with external power supply (page 200)
- wiring examples (page 200)

For drives with option +L537+Q971, see *CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (+L537+Q971) user's manual* (3AXD50000030058 [English]).

Connection with internal +24 V DC power supply

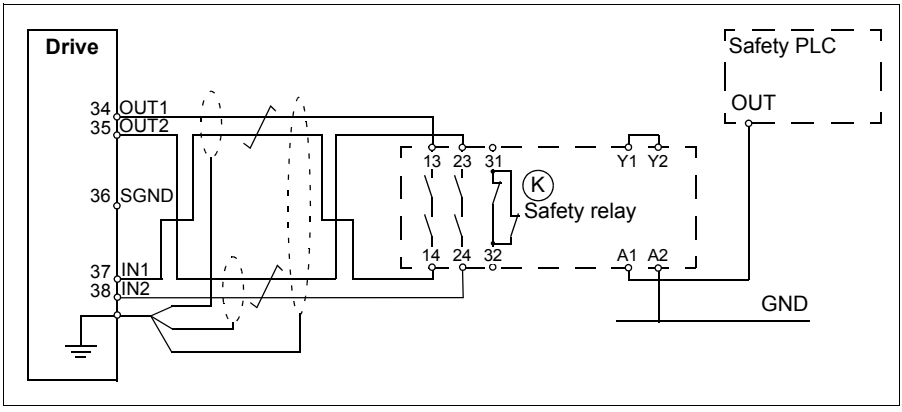


Connection with external +24 V DC power supply

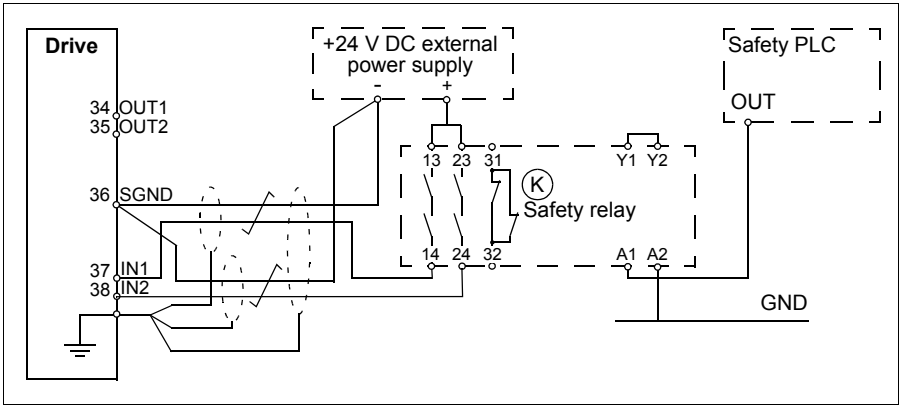


Wiring examples

An example of a Safe torque off wiring with internal +24 V DC power supply is shown below.



An example of a Safe torque off wiring with external +24 V DC power supply is shown below.



For information on the specifications of the STO input, see chapter *CCU-24 control unit connection data* (page *174*).

Activation switch

In the wiring diagrams above 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.

- If 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-02 thermistor protection module can also be used. For more information, see the module documentation.

Cable types and lengths

- Double-shielded twisted-pair cable is recommended.
- Maximum cable length
  - 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 drive.

Note: A short-circuit in the wiring between the switch and an STO terminal causes a dangerous fault and 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 INx terminals of the control unit must be at least 13 V DC to be interpreted as “1”.

Grounding of protective shields

- Ground the shield in the cabling between the activation switch and the control unit at the control unit.
- 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 on the drive control unit de-energize.
3. The control unit cuts off the control voltage from the output IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (refer to the firmware manual of the drive).
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 acceptance 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 an acceptance test. The acceptance test must be performed

- at initial start-up of the safety function
- after any changes related to the safety function (circuit boards, wiring, components, settings, etc.)
- after any maintenance work related to the safety function.

Competence

The acceptance 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.

Acceptance test reports

Signed acceptance 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 acceptance tests performed due to changes or maintenance shall be logged into the logbook.

Acceptance test procedure

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

Note: If a CPTC-02 module is installed, refer to its documentation.

Action	☑
WARNING! Follow the *Safety instructions*, page 9. If you ignore the instructions physical injury or death, or damage to the equipment can occur.	☐
Ensure that the drive can be run and stopped freely during start-up.	☐
Stop the drive (if running), switch the input power off and isolate the drive from the power line by a disconnector.	☐
Check the Safe torque off circuit connections against the wiring diagram.	☐
Close the disconnector and switch the power on.	☐
Test the operation of the STO function when the motor is stopped. • Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Ensure that the drive operates as follows: • Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter 31.22 (see the firmware manual). • Give a start command to verify that the STO function blocks the drive's operation. The drive displays a warning. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Test the operation of the STO function when the motor is running. • Start the drive and ensure the motor is running. • Open the STO circuit. The motor should stop. The drive generates an indication if one is defined for the 'running' state in parameter 31.22 (see the firmware manual). • Reset any active faults and try to start the drive. • Ensure that the motor stays at a standstill and the drive operates as described above in testing the operation when the motor is stopped. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐

Action	☑
Test the operation of the failure detection of the drive. The motor can be stopped or running. • Open the 1st channel of the STO circuit (wire coming to IN1). If the motor was running, it should coast to a stop. The drive generates a *FA81 Safe torque off 1 loss* fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally. • Open the 2nd channel of the STO circuit (wire coming to IN2). If the motor was running, it should coast to a stop. The drive generates a *FA82 Safe torque off 2 loss* fault indication (see the firmware manual). • Give a start command to verify that the STO function blocks the operation. The motor should not start. • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	
Document and sign the acceptance test report which verifies that the safety function is safe and accepted for operation.	☐

Use

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

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

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

Notes:

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

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 5 or 2 years; see section *Safety data (SIL, PL)* (page *207*). It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the *Acceptance test procedure* (page *202*).

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, follow the test given in section *Acceptance test procedure* on page *202*.

Use only ABB approved spare parts.

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 parameter 31.22.

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

See the drive firmware manual 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 (SIL, PL)

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

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

Frame size	SIL/ SILCL	PL	SFF (%)	PFH (T_1 = 20 a) (1/h)	PFD_{avg} (T_1 = 2 a)	PFD_{avg} (T_1 = 5 a)	$MTTF_D$ (a)	DC (%)	Cat.	SC	HFT	CCF	T_M (a)
U_N = 400 V, U_N = 500 V													
R3	3	e	88,0	3.91E-09	3.26E-05	8.15E-05	27033	≥90	3	3	1	80	20
R6	3	e	88.0	3.91E-09	3.26E-05	8.15E-05	27033	≥90	3	3	1	80	20
R8	3	e	>99	4.22E-09	3.69E-05	9.24E-05	8792	≥90	3	3	1	80	20

R3 and R6: 3AXD10000606249 B, R8: 3AXD10000015777 M

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with $\triangle T$ = 71.66 °C
  - 1340 on/off cycles per year with $\triangle T$ = 61.66 °C
  - 30 on/off cycles per year with $\triangle T$ = 10.0 °C
  - 32 °C board temperature at 2.0% of time
  - 60 °C board temperature at 1.5% of time
  - 85 °C board temperature at 2.3% of time.
- The STO is a type A safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested

  A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO reaction time (shortest detectable break): 1 ms
- STO response time R3 and R6: 2 ms (typical), 10 ms (maximum)
- STO response time R8: 2 ms (typical), 15 ms (maximum)
- Fault detection time: Channels in different states for longer than 200 ms
- Fault reaction time: Fault detection time + 10 ms
- STO fault indication (parameter 31.22) delay: < 500 ms
- STO warning indication (parameter 31.22) delay: < 1000 ms

Abbreviations

Abbr.	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	EN ISO 13849-1	Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD_{avg}	IEC 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL
SC	IEC 61508	Systematic capability
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1…3)
SILCL	IEC/EN 62061	Maximum SIL (level 1…3) that can be claimed for a safety function or subsystem
STO	IEC/EN 61800-5-2	Safe torque off
T_1	IEC 61508-6	Proof test interval. T_1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T_1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. Note that any T_1 values given cannot be regarded as a guarantee or warranty. See also section *Maintenance* (page *205*).
T_M	EN ISO 13849-1	Mission time, ie, period of time that covers the intended use of safety function/device. After the mission time the safety device(s) must be replaced. Note that any TM values given cannot be regarded as a guarantee or warranty.

14

Common mode, du/dt and sine filters

Contents of this chapter

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

Common mode filters

For need of common mode filter, see section *Examining the compatibility of the motor and drive*, page *50*.

For installation instructions of frame R8 common mode filter, see chapter *Electrical installation – IEC* on page *77* or *Electrical installation – North America* on page *111* and *Common mode filter kit for frames R7 and R8 (option +E208) installation guide* (3AXD50000015179 [English]).

du/dt filters

When is a du/dt filter needed?

See section *Examining the compatibility of the motor and drive*, page *50*.

du/dt filter types

Type ACQ580 -31-	du/dt filter type
IEC ratings: U_N = 400 V	
09A5-4	NOCH0016-6x
12A7-4	NOCH0016-6x
018A-4	NOCH0016-6x or NOCH0030-6x [1)]
026A-4	NOCH0030-6x
033A-4	NOCH0070-6x
039A-4	NOCH0070-6x
046A-4	NOCH0070-6x
062A-4	NOCH0070-6x
073A-4	NOCH0070-6x or NOCH0120-6x [2)]
088A-4	NOCH0120-6x
106A-4	NOCH0120-6X
145A-4	FOCH0260-70
169A-4	FOCH0260-70
206A-4	FOCH0260-70
IEC ratings: U_N = 480 V	
09A5-4	NOCH0016-6x
12A7-4	NOCH0016-6x
018A-4	NOCH0016-6x or NOCH0030-6x [1)]
026A-4	NOCH0030-6x
033A-4	NOCH0070-6x
039A-4	NOCH0070-6x
046A-4	NOCH0070-6x
062A-4	NOCH0070-6x
073A-4	NOCH0070-6x or NOCH0120-6x [2)]
088A-4	NOCH0120-6x
106A-4	NOCH0120-6x
145A-4	FOCH0260-7X
169A-4	FOCH0260-7X
206A-4	FOCH0260-7X

3AXD00000586715

[1)] NOCH0016-6x can be used if full load current is not needed

[2] NOCH0070-6x can be used if full load current is not needed

Type ACQ580 -31-	du/dt filter type
UL (NEC) ratings: U_N = 480 V	
07A6-4	NOCH0016-6x
012A-4	NOCH0016-6x
014A-4	NOCH0016-6x or NOCH0030-6x [1]
023A-4	NOCH0030-6x
027A-4	NOCH0070-6x
034A-4	NOCH0070-6x
044A-4	NOCH0070-6x
052A-4	NOCH0070-6x
065A-4	NOCH0070-6x or NOCH0120-6x [2]
077A-4	NOCH0120-6x
096A-4	NOCH0120-6X
124A-4	FOCH0260-7X
156A-4	FOCH0260-7X
180A-4	FOCH0260-7X

3AXD00000586715

[1] NOCH0016-6x can be used if full load current is not needed

[2] NOCH0070-6x can be used if full load current is not needed

Description, installation and technical data of the filters

See *AOCH and NOCH du/dt filters hardware manual* (3AFE58933368 [English]) or *FOCHxxx-xx du/dt filters hardware manual* (3AFE68577519 [English]).

Sine filters

See section *Examining the compatibility of the motor and drive*, page *50*.

Contact ABB for sine filter specifications.

Derating

See section *Switching frequency derating* on page *157*.

15

Optional I/O extension modules

What this chapter contains

This chapter describes how to install and start up the optional CHDI-01, CMOD-01 and CMOD-02 IO multifunction extension modules. The chapter also contains diagnostics and technical data.

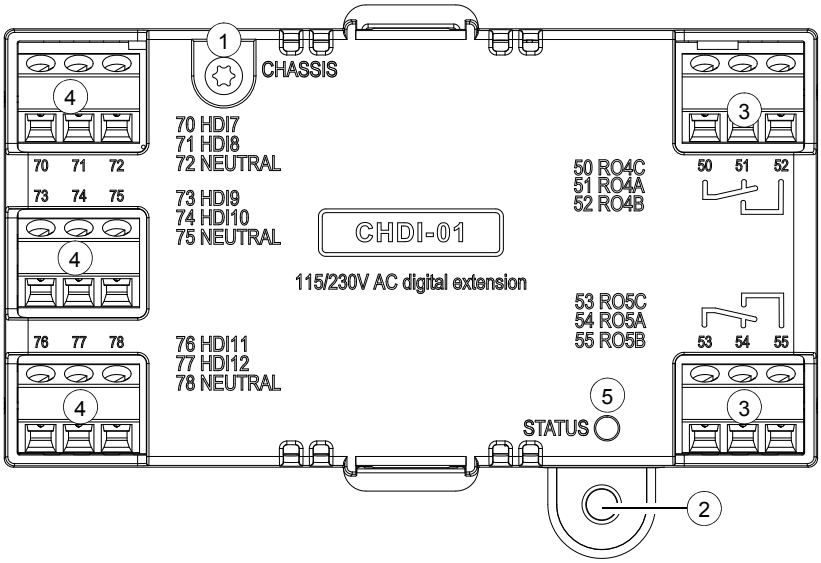
CHDI-01 115/230 V digital input extension module

Hardware description

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



1	Grounding screw	-
2	Hole for mounting screw	-
3	3-pin terminal blocks for relay outputs	Terminal descriptions on page *215*
4	3-pin terminal block for 115/230 V inputs	Terminal descriptions on page *215*
5	Diagnostic LED	Terminal descriptions on page *217*

Mechanical installation

Necessary tools and instructions

- Screwdriver and a set of suitable bits.

Unpacking and checking the delivery

1. Open the option package.
2. Make sure that the package contains:
   - CHDI-01 high voltage digital extension module
   - mounting screw
   - support part (**Note**: The support part is needed only for the following frame R1 drive types -02A7, -03A4, -04A1, -05A7, -07A3, -09A5 and -12A7).
3. Make sure that there are no signs of damage.

Installing the module

See section *Installing optional modules* on page *107*.

Electrical installation

Warnings

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. 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 work.

Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.

Necessary tools and instructions

- Screwdriver and a set of suitable bits
- Cabling tools

Terminal designations

For more detailed information on the connectors, see section *Technical data* on page *227*.

Relay outputs

Marking		Description
50	RO4C	Common, C
51	RO4A	Normally closed, NC
52	RO4B	Normally open, NO
53	RO5C	Common, C
54	RO5A	Normally closed, NC
55	RO5B	Normally open, NO

115/230 V inputs

Marking		Description
70	HDI7	115/230 V input 1
71	HDI8	115/230 V input 2
72	NEUTRAL[1)]	Neutral point
73	HDI9	115/230 V input 3
74	HDI10	115/230 V input 4
75	NEUTRAL[1)]	Neutral point

Marking		Description
76	HDI11	115/230 V input 5
77	HDI12	115/230 V input 6
78	NEUTRAL[1)]	Neutral point

[1)] Neutral points 72, 75 and 78 are connected.

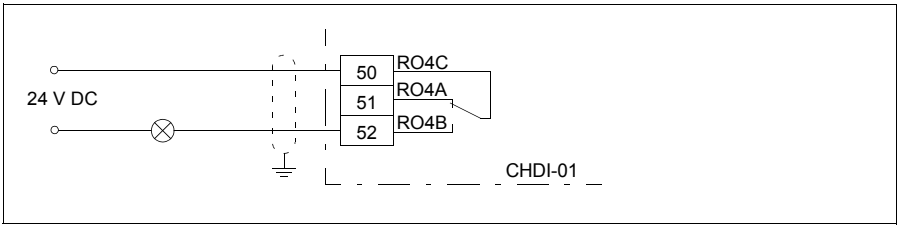
General cabling instructions

Obey the instructions given in chapter *Guidelines for planning the electrical installation* on page *49*.

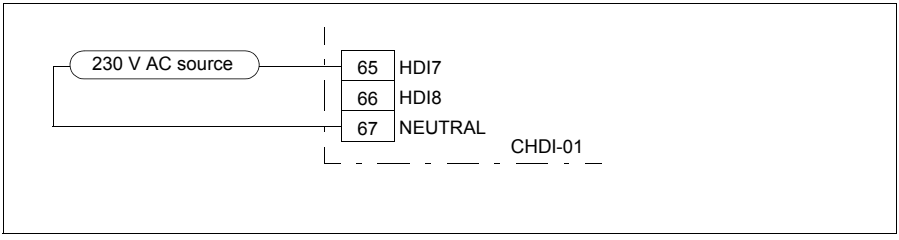
Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the cables 360 degrees under a grounding clamp on the grounding shelf of the control cables.

Relay output connection example



Digital input connection example



Start-up

Setting the parameters

1. Power up the drive.
2. If no warning is shown,
   - make sure that the value of both parameter 15.02 Detected extension module and parameter 15.01 Extension module type is CHDI-01.

   If warning A7AB Extension I/O configuration failure is shown,
   - make sure that the value of parameter 15.02 Detected extension module is CHDI-01.
   - set parameter 15.01 Extension module type 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 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

Diagnostics

Faults and warning messages

Warning A7AB Extension I/O configuration failure.

LEDs

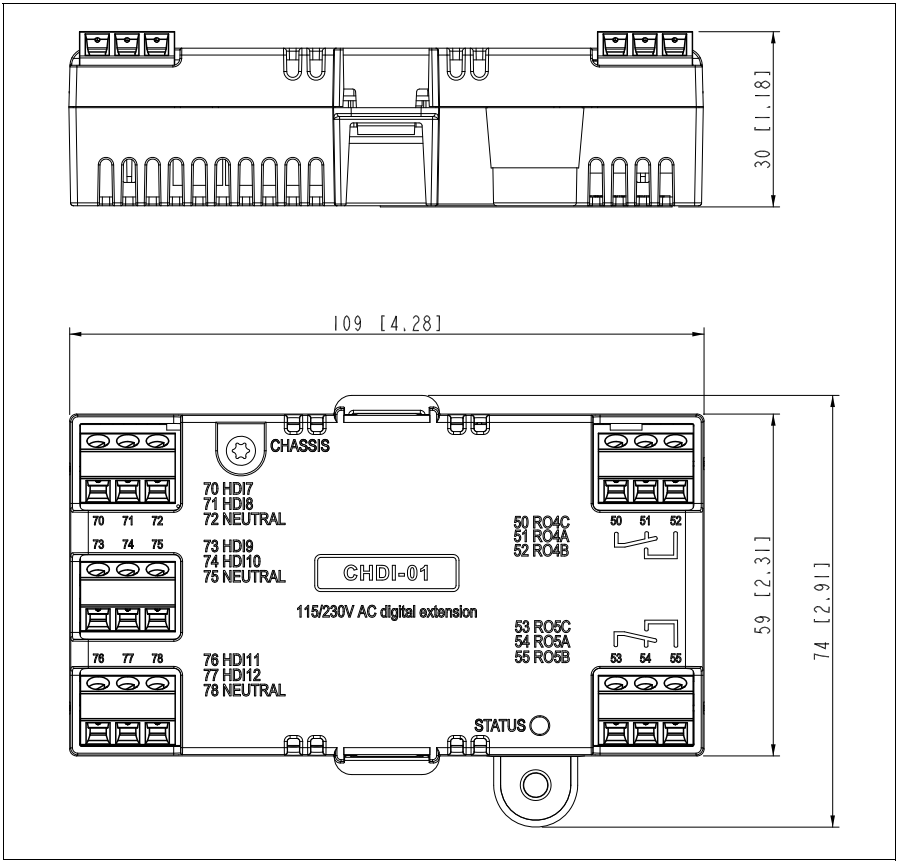
The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

Technical data

Dimension drawing:

The dimensions are in millimeters and [inches].



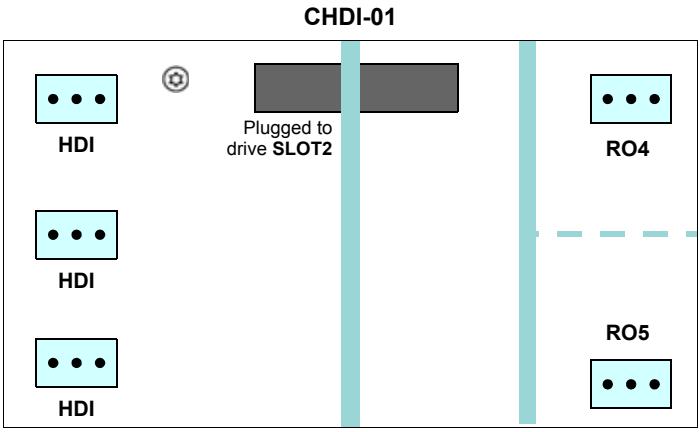
Installation: Into an option slot on the drive control unit

Degree of protection: IP20

Ambient conditions: See the drive technical data.

Package: Cardboard

Isolation areas:



Symbol	Description
	Reinforced insulation (IEC 61800-5-1:2016)
	Functional insulation (IEC 61800-5-1:2016)

Relay outputs (50…52, 53…55):

- Wire size max. 1.5 mm^2
- Minimum contact rating: 12 V / 10 mA
- Maximum contact rating: 250 V AC / 30 V DC / 2 A
- Maximum breaking capacity: 1500 VA

115/230 V inputs (70…78):

- Wire size max. 1.5 mm^2
- Input voltage: 115 to 230 V AC ±10%
- Maximum current leakage in digital off state: 2 mA

CMOD-01 multifunction extension module (external 24 V AC/DC and digital I/O)

Hardware description

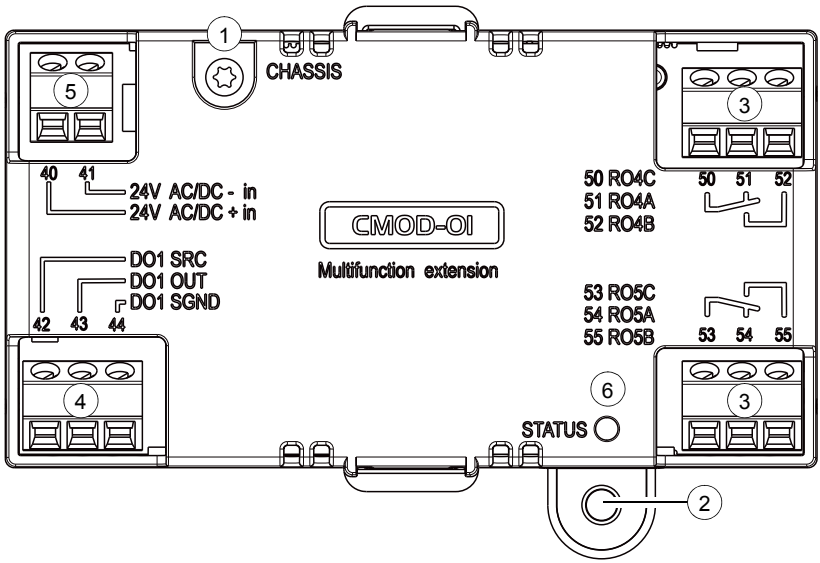
Product overview

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 function 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 back-up power supply, you do not have to connect it because the module is powered from the drive control unit by default.

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.

Layout



1	Grounding screw	Mechanical installation on page *221*
2	Hole for mounting screw	Mechanical installation on page *221*
3	3-pin terminal blocks for relay outputs	Terminal descriptions on page *222*
4	3-pin terminal block for transistor output	Terminal descriptions on page *222*
5	2-pin terminal block for external power supply	Terminal descriptions on page *222*
6	Diagnostic LED	LEDs on page *226*

Mechanical installation

Necessary tools and instructions

- Screwdriver and a set of suitable bits.

Unpacking and checking the delivery

1. Open the option package.
2. Make sure that the package contains:
   - CMOD-01 multifunction extension module
   - mounting screw
   - support part (**Note**: The support part is needed only for the following frame R1 drive types -02A7, -03A4, -04A1, -05A7, -07A3, -09A5 and -12A7).
3. Make sure that there are no signs of damage.

Installing the module

See section *Installing optional modules* on page *107*.

Electrical installation

Warnings

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. 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 work.

Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.

Necessary tools and instructions

- Screwdriver and a set of suitable bits
- Cabling tools

Terminal designations

For more detailed information on the connectors, see section *Technical data* on page *227*.

Relay outputs

Marking		Description
50	RO4C	Common, C
51	RO4A	Normally closed, NC
52	RO4B	Normally open, NO
53	RO5C	Common, C
54	RO5A	Normally closed, NC
55	RO5B	Normally open, NO

Transistor output

Marking		Description
42	DO1 SRC	Source input
43	DO1 OUT	Digital or frequency output
44	DO1 SGND	Ground (earth) potential

External power supply

The external power supply is needed only if you want to connect an external back-up power supply for the drive control unit.

Note: CMOD external +24 V power supply terminals are not in use with CCU-24 control unit. External power supply to CCU-24 is connected to terminals 40 and 41 on the control unit.

Marking		Description
40	24V AC/DC + in	External 24 V (AC/DC) input
41	24V AC/DC - in	External 24 V (AC/DC) input

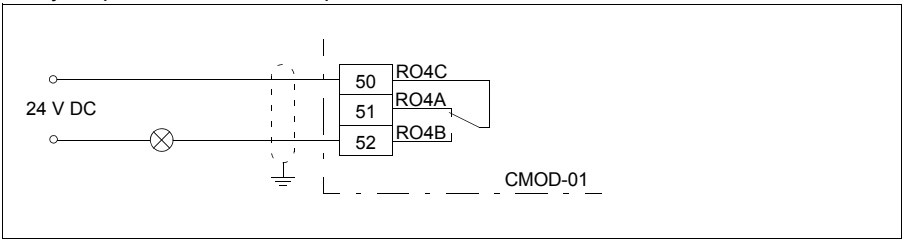
General cabling instructions

Obey the instructions given in chapter *Guidelines for planning the electrical installation* on page *49*.

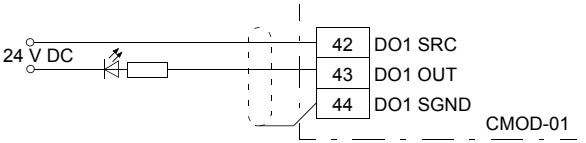
Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the cables 360 degrees under a grounding clamp on the grounding shelf of the control cables.

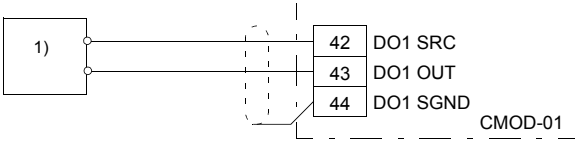
Relay output connection example



Digital output connection example

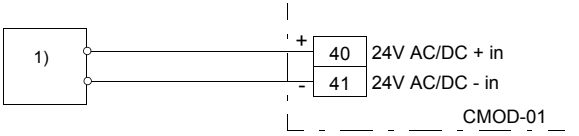


Frequency output connection example



1) 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).

External power supply connection example



1) External power supply, 24 V AC/DC

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 parameter 15.02 Detected extension module and parameter 15.01Extension module type is CMOD-01.

   If warning A7AB Extension I/O configuration failure is shown,
   - make sure that the value of parameter 15.02 Detected extension module is CMOD-01.
   - set parameter 15.01 Extension module type 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.

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

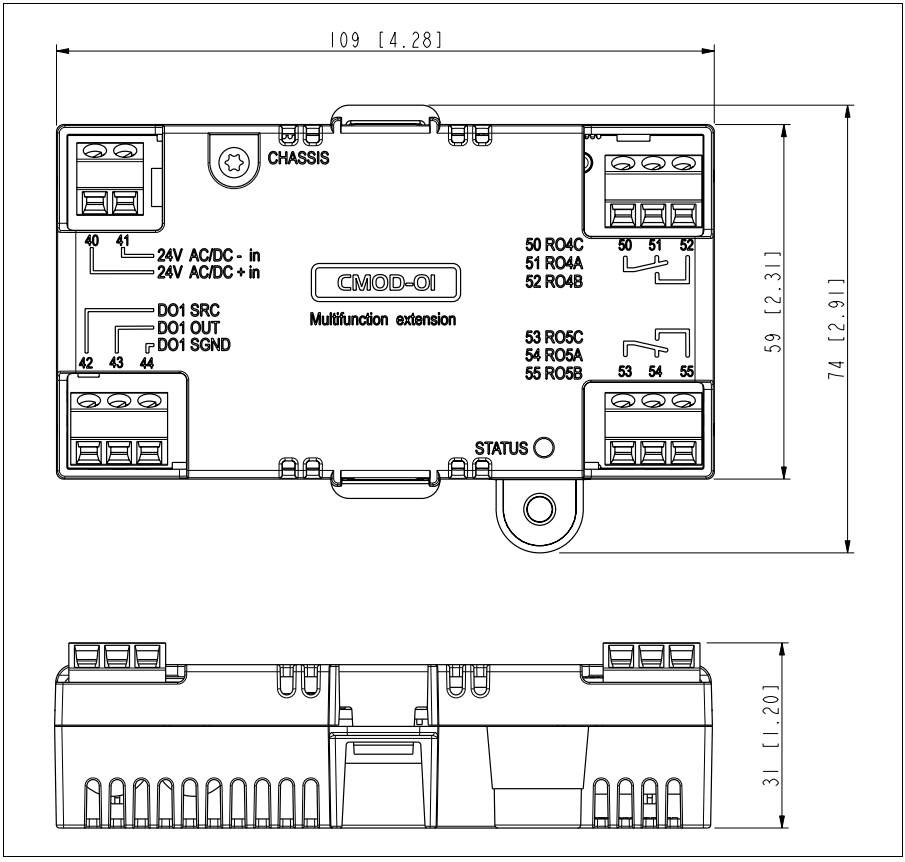
The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

Technical data

Dimension drawing:

The dimensions are in millimeters and [inches].



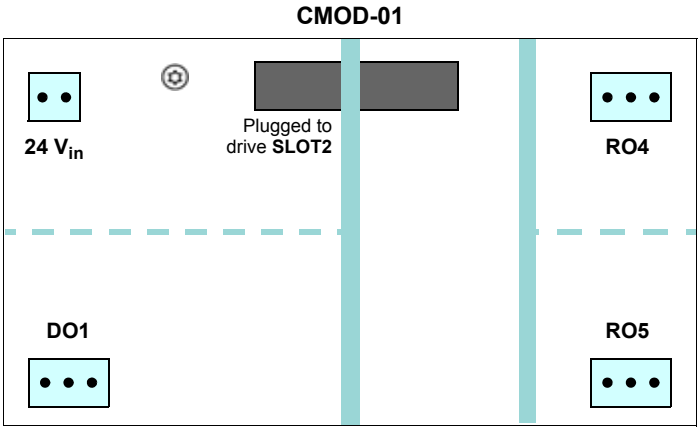
Installation: Into an option slot on the drive control unit

Degree of protection: IP20

Ambient conditions: See the drive technical data.

Package: Cardboard

Isolation areas:



Symbol	Description
	Reinforced insulation (IEC 61800-5-1:2016)
	Functional insulation (IEC 61800-5-1:2016)

Relay outputs (50…52, 53…55):

- Wire size max. 1.5 mm^2
- Minimum contact rating: 12 V / 10 mA
- Maximum contact rating: 250 V AC / 30 V DC / 2 A
- Maximum breaking capacity: 1500 VA6

Transistor output (42…44):

- Wire size max. 1.5 mm^2
- 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%

External power supply (40…41):

- Wire size max. 1.5 mm^2
- 24 V AC / V DC ±10% (GND, user potential)
- Maximum power consumption: 25 W, 1.04 A at 24 V DC

CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface)

Hardware description

Product overview

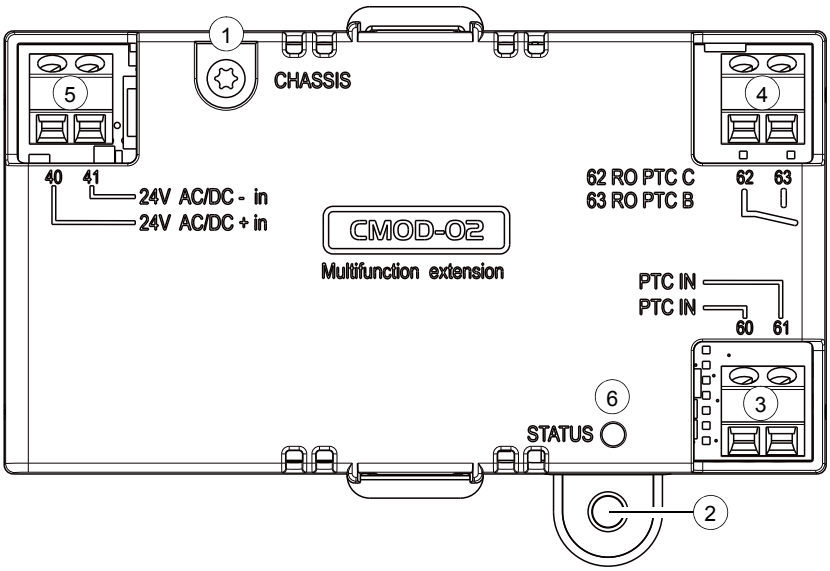
The CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface) has a motor thermistor connection for supervising the motor temperature and one relay output, which indicates the thermistor status. In case the thermistor overheats, the drive trips on motor overtemperature. 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 in 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.

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.

Layout



1	Grounding screw	Mechanical installation on page *230*
2	Hole for mounting screw	Mechanical installation on page *230*
3	2-pin terminal block for motor thermistor connection	Terminal descriptions on page *231*
4	2-pin terminal block for relay output	Terminal descriptions on page *231*
5	2-pin terminal block for external power supply	Terminal descriptions on page *231*
6	Diagnostic LED	LEDs on page *234*

Mechanical installation

Necessary tools and instructions

- Screwdriver and a set of suitable bits

Unpacking and checking the delivery

1. Open the option package.
2. Make sure that the package contains:
   - CMOD-02 multifunction extension module
   - mounting screw
   - support part (**Note**: The support part is needed only for the following frame R1 drive types -02A7, -03A4, -04A1, -05A7, -07A3, -09A5 and -12A7).
3. Make sure that there are no signs of damage.

Installing the module

See section *Installing optional modules* on page *107*.

Electrical installation

Warnings

WARNING! Obey the instructions in chapter *Safety instructions* on page *9*. 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 work.

Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.

Necessary tools and instructions

- Screwdriver and a set of suitable bits
- Cabling tools

Terminal designations

For more detailed information on the connectors, see section *Technical data* on page *234*.

Motor thermistor connection

Marking		Description
60	PTC IN	PTC connection
61	PTC IN	Ground (earth) potential

Relay output

Marking		Description
62	RO PTC C	Common, C

Marking		Description
63	RO PTC B	Normally open, NO

External power supply

The external power supply is needed only if you want to connect an external back-up power supply for the drive control unit.

Note: CMOD external +24 V power supply terminals are not in use with CCU-24 control unit. External power supply to CCU-24 is connected to terminals 40 and 41 on the control unit. .

Marking		Description
40	24V AC/DC + in	External 24 V (AC/DC) input
41	24V AC/DC - in	External 24 V (AC/DC) input

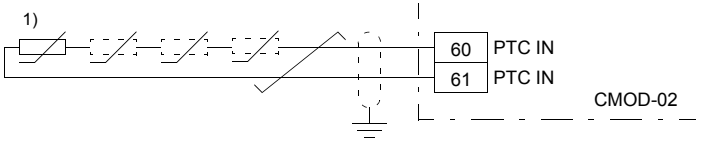
General cabling instructions

Obey the instructions given in chapter *Guidelines for planning the electrical installation* on page *49*.

Wiring

Connect the external control cables to the applicable module terminals. Ground the outer shield of the cables 360 degrees under a grounding clamp on the grounding shelf of the control cables

Motor thermistor connection example

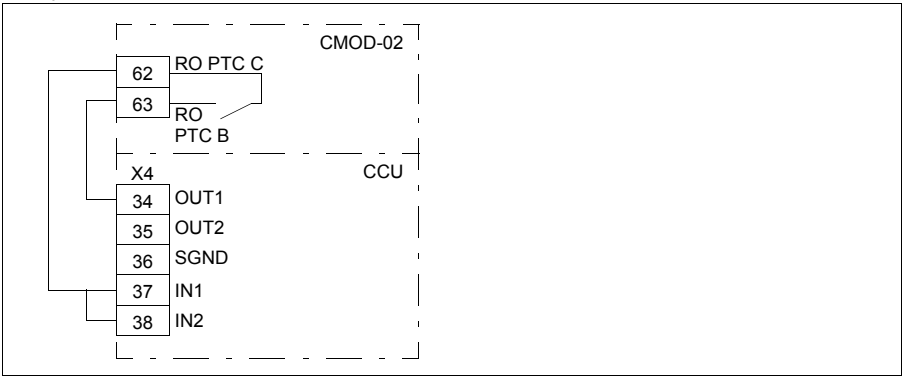


1) One or 3…6 PTC thermistors connected in series.

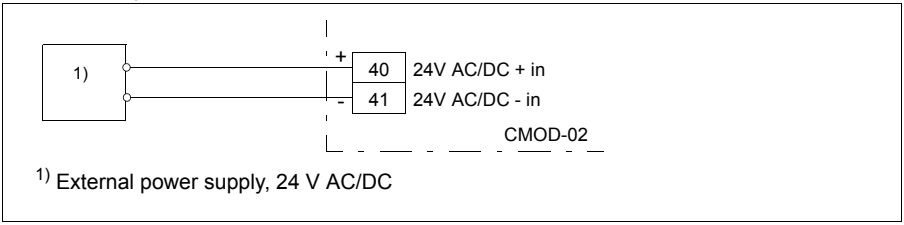
The PTC input is reinforced/double insulated. If the motor part of the PTC sensor and wiring are reinforced/double insulated, voltages on the PTC wiring are within SELV limits.

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.

Relay output connection example



Power supply connection example



1) External power supply, 24 V AC/DC

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 parameter 15.02 Detected extension module and parameter 15.01 Extension module type is CMOD-02.

   If warning A7AB Extension I/O configuration failure is shown,
   - make sure that the value of parameter 15.02 Detected extension module is CMOD-02.
   - set parameter 15.01 Extension module type 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

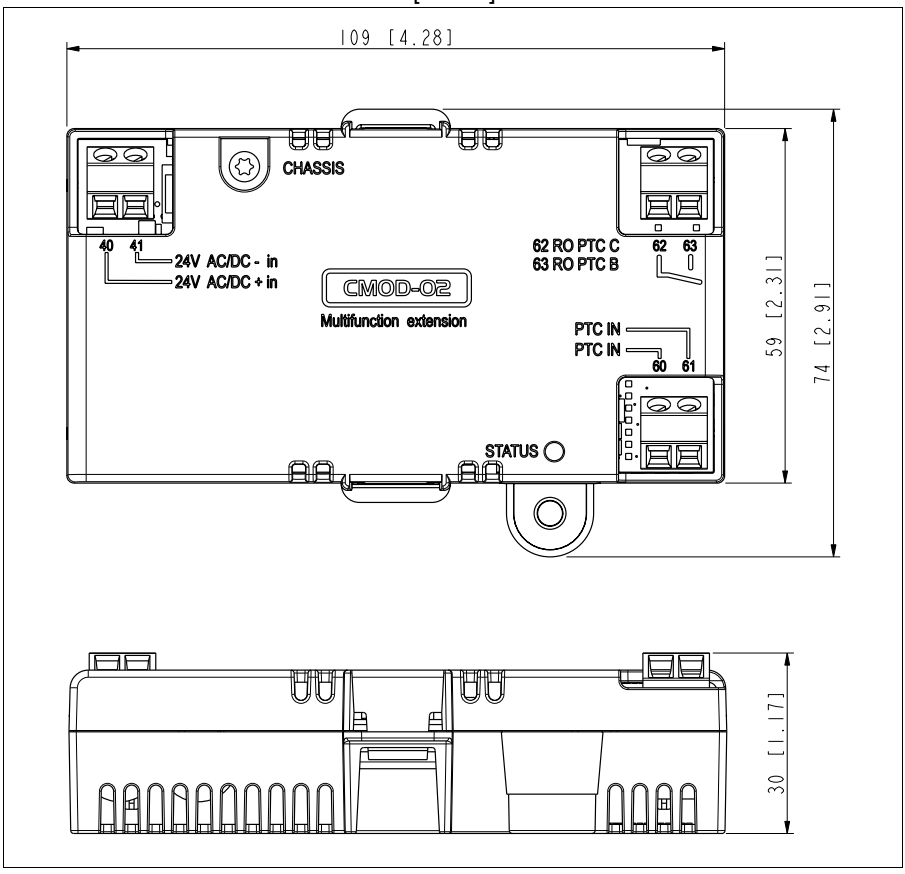
The extension module has one diagnostic LED.

Color	Description
Green	The extension module is powered up.

Technical data

Dimension drawing:

The dimensions are in millimeters and [inches].



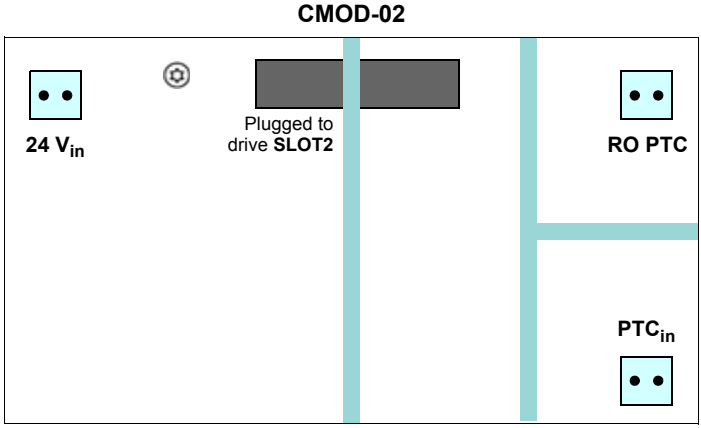
Installation: Into an option slot on the drive control unit

Degree of protection: IP20

Ambient conditions: See the drive technical data.

Package: Cardboard

Isolation areas:



Symbol	Description
	Reinforced insulation (IEC 61800-5-1:2016)
	Functional insulation (IEC 61800-5-1:2016)

Motor thermistor connection (60…61):

- Wire size max. 1.5 mm^2
- Supported standards: DIN 44081 and DIN 44082
- Number of PTC thermistor relays: 1 or 3…6 in series
- Triggering threshold: 3.6 kohm
- Recovery threshold: 1.6 kohm
- PTC terminal voltage: $\leq$ 5.0 V
- PTC terminal current: < 1 mA
- Short-circuit detection: < 50 ohm

Relay output (62…63):

- Wire size max. 1.5 mm^2
- Maximum contact rating: 250 V AC / 30 V DC / 5 A
- Maximum breaking capacity: 1000 VA

External power supply (40…41):

- Wire size max. 1.5 mm^2
- 24 V AC / V DC ±10% (GND, user potential)
- Maximum power consumption: 25 W, 1.04 A at 24 V DC

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 abb.com/searchchannels.

Product training

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

Providing feedback on ABB Drives manuals

Your comments on our manuals are welcome. Navigate to new.abb.com/drives/manuals-feedback-form.

Document library on the Internet

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