ABB DRIVES FOR HVAC

ACH580-01 drives

(0.75 to 250 kW, 1 to 350 hp)

Hardware manual



Related documents are listed on page 27.

Hardware manual

ACH580-01 drives
(0.75 to 250 kW, 1 to 350 hp)

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3AXD50000044839 Rev B
EN
EFFECTIVE: 2018-12-20

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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:

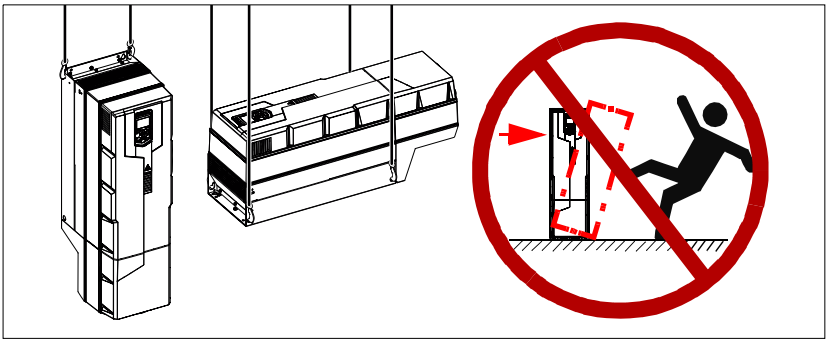
	**Electricity warning** tells about hazards from electricity which can cause injury or death, or damage to the equipment.
	**General warning** tells about conditions, other than those caused by electricity, which can cause injury or death, or damage to the equipment.
	**Electrostatic sensitive devices 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.
  - Frames R5…R9: Lift the drive with a lifting device. Use the lifting eyes of the drive.
  - Frames R5…R9: Do not tilt the drive. The drive is heavy and its center of gravity is high. An overturning drive can cause physical injury.



- 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 otherwise from dust and burr from drilling and grinding until you install it.
- Protect also the installed drive against dust and burr. Electrically conductive debris inside the drive may 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 *Checking the installation site* on page *54* and *Losses, cooling data and noise* on page *275* 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”.
- If you have connected safety circuits to the drive (for example, emergency stop and Safe torque off), validate them at the start up. For the validation of the Safe torque off, see *ACH580 HVAC control program firmware manual* (3AXD50000027537 [English]). For the validation of other safety circuits, see the instructions provided with them.

Note:

- If you select an external source for start command and it is on, and the start command is level-triggered, the drive will start immediately after fault reset. See parameters 20.02 Ext1 start trigger type and 20.07 Ext2 start trigger type in *ACH580 HVAC control program firmware manual* (3AXD50000027537 [English]).
- When the control location is not set to Local (text Hand is not shown on the top row of the panel and parameter 19.19 Off mode disable has value Off button disabled), the stop key on the control panel will not stop the drive.
- Frames R1…R5: Do not attempt to repair a malfunctioning drive; contact your local representative for replacement or repair by authorized persons.

  Frames R6…R9: Can be repaired by authorized persons.



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 drive DC voltage is close to 0 V.

     Frames R1…R3: Measure the voltage between the drive UDC+ terminal and grounding terminal (PE) with one multimeter. As there is no UDC- terminal, measure the voltage between the drive T1/U terminal and grounding terminal (PE) with another multimeter. Make sure that the voltage difference between the multimeters is close to 0 V.

     Frames R4…R9: Measure the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding terminal (PE) and make sure that it 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 internal 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
  - IEC: *When to disconnect EMC filter or ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems* on page *117*, and *Guidelines for installing the drive to a TT system* on page *118*.
  - North America: *When to connect EMC filter or disconnect ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems* on page *171*, and *Guidelines for installing the drive to a TT system* on page *172*.

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

  Note: When the internal EMC filter is disconnected, the EMC compatibility of the drive is considerably reduced. See section *EMC compatibility and motor cable length* on page *288*.
- 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
  - IEC: *When to disconnect EMC filter or ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems* on page *117*, and *Guidelines for installing the drive to a TT system* on page *118*.
  - North America: *When to connect EMC filter or disconnect ground-to-phase varistor: TN-S, IT, corner-grounded delta and midpoint-grounded delta systems* on page *171*, and *Guidelines for installing the drive to a TT system* on page *172*.

  WARNING! 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.
- 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 and brake resistor terminals (UDC+, UDC-, R+ and R-) 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. Proper 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 *89*. 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.
- Standards IEC/EN 61800-5-1 (section 4.3.5.5.2.) and UL 68100-5-1 require that 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. In addition,
  - install a second protective earth conductor of the same cross-sectional area as the original protective earthing conductor,

  or
  - install a protective earth conductor with a cross-section of at least 10 mm^2 Cu or 16 mm^2 Al (when aluminum cables are allowed),

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



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 can rotate the motor directly or through any mechanical connection.
- 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:

- Motor overspeed causes overvoltage that can damage or destroy the capacitors in the intermediate circuit of the drive.

General safety in operation

These instructions are for all personnel that operate the drive.



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

- Do not power up the drive more than five times in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors. If you need to start or stop the drive, use the control panel Hand, Off and Auto keys or commands through the I/O terminals of the drive.
- Give a stop command to the drive before you reset a fault. If you have an external source for the start command and the start is on, the drive will start immediately after the fault reset, unless you configure the drive for pulse start. See the firmware manual.
- Before you activate automatic fault reset 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.





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 ACH580-01 drives, including the new (2017) R1…R3 frames (see all applicable types in section *Electrical ratings* on page *244*).

Note: The manual does not apply to R0…R3 frames with type codes ACH580-01: 02A6-4, 03A3-4, 04A0-4, 05A6-4, 07A2-4, 09A-4, 12A6-4, 017A-4, 025A-4, 032A-4, 038A-4, 045A-4. For these types, see *ACH580-01 (0.75 to 250 kW, 1 to 350 hp) hardware manual* (3AUA0000076331[English]).

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.

Contents of this manual

The manual consists of the following chapters:

- *Safety instructions* (page *15*) gives safety instructions you must obey when installing, commissioning, operating and servicing the drive.
- *Introduction to the manual* (this chapter, page *25*) describes applicability, target audience, purpose and contents of this manual. It also contains a quick installation and commissioning flowchart. At the end, it lists terms and abbreviations.
- *Operation principle and hardware description* (page *35*) describes the operation principle, layout, power connections and control interfaces, type designation label and type designation information in short.
- *Mechanical installation* (page *53*) describes how to check the installation site, unpack, check the delivery and install the drive mechanically.
- *Guidelines for planning the electrical installation* (page *81*) describes how to plan the electrical installation of the drive, for example, how to check the compatibility of the motor and the drive and select cables, protections and cable routing.
- *Electrical installation – IEC* (page *113*) describes how to check the insulation of the assembly and the compatibility with other than symmetrically grounded TN-S systems. It then shows how to connect the power and control cables, install optional modules and connect a PC.
- *Electrical installation – North America* (page *167*) describes how to check the insulation of the assembly and the compatibility with other than symmetrically grounded TN-S systems. It then shows how to connect the power and control cables, install optional modules and connect a PC.
- *Installation checklist* (page *223*) contains a checklist for checking the mechanical and electrical installation of the drive before start-up.
- *Maintenance and hardware diagnostics* (page *225*) contains preventive maintenance instructions and LED indicator descriptions.
- *Technical data* (page *243*) contains technical specifications of the drive, eg, ratings, sizes and technical requirements as well as provisions for fulfilling the requirements for CE, UL and other marks.
- *Dimension drawings* (page *309*) shows dimension drawings of the drive.
- *Resistor braking* (page *337*) tells how to select the brake resistor.
- *Safe torque off function* (page *345*) describes STO features, installation and technical data.
- *Optional I/O extension modules* (page *363*) describes CMOD-01, CMOD-02, and CHDI-01 extension modules, their installation, start-up, diagnostics and technical data.
- *Common mode, du/dt and sine filters* (page *389*) describes selection of external filters for the drive.

- *Further information* (inside of the back cover, page *395*) tells how to make product and service inquiries, get information on product training, provide feedback on manuals and find documents on the Internet.

Categorization by frame (size)

The ACH580-01 is manufactured in frames (frame sizes) R1…R9. Some instructions and other information that only concern certain frames are marked with the symbol of the frame (R1…R9). The frame is marked on the type designation label attached to the drive, see section *Type designation label* on page *47*.

Related documents

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.

Drive manuals and guides	**Code (English)**
ACH580 HVAC control program firmware manual	*3AXD50000027537*
ACH580 HVAC control program firmware manual, Part 1	*3AXD50000209811*
ACH580 HVAC control program firmware manual, Part 2 Parameters	*3AXD50000209828*
ACH580-01 (0.75 to 250 kW, 1 to 350 hp) hardware manual	*3AXD50000044839*
ACH580-01 quick installation and start-up guide for frames R1 to R5	*3AXD50000044861*
ACH580-01 quick installation and start-up guide for frames R6 to R9	*3AXD50000036602*
ACH580 Installation, Operation, and Maintenance Manual (I, O & M) (North America only)	*3AXD50000049127*
ACX-AP-X assistant control panels user's manual	*3AUA0000085685*

Option manuals and guides	
ACS580, ACH580 and ACQ580 drive module frames R3 and R5 to R9 for cabinet installation (options +P940 and +P944) supplement	*3AXD50000210305*
ACS580-01, ACH580-01 and ACQ580-01 installation guide for UK gland plate (option +H358)	*3AXD50000034735*
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*
DPMP-01 mounting platform for control panels	*3AUA0000100140*
DPMP-02/03 mounting platform for control panels	*3AUA0000136205*
DPMP-06/07 mounting platform for control panels	*3AXD50000289561*
FBIP-21 BACnet/IP adapter module	*3AXD50000028468*
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*

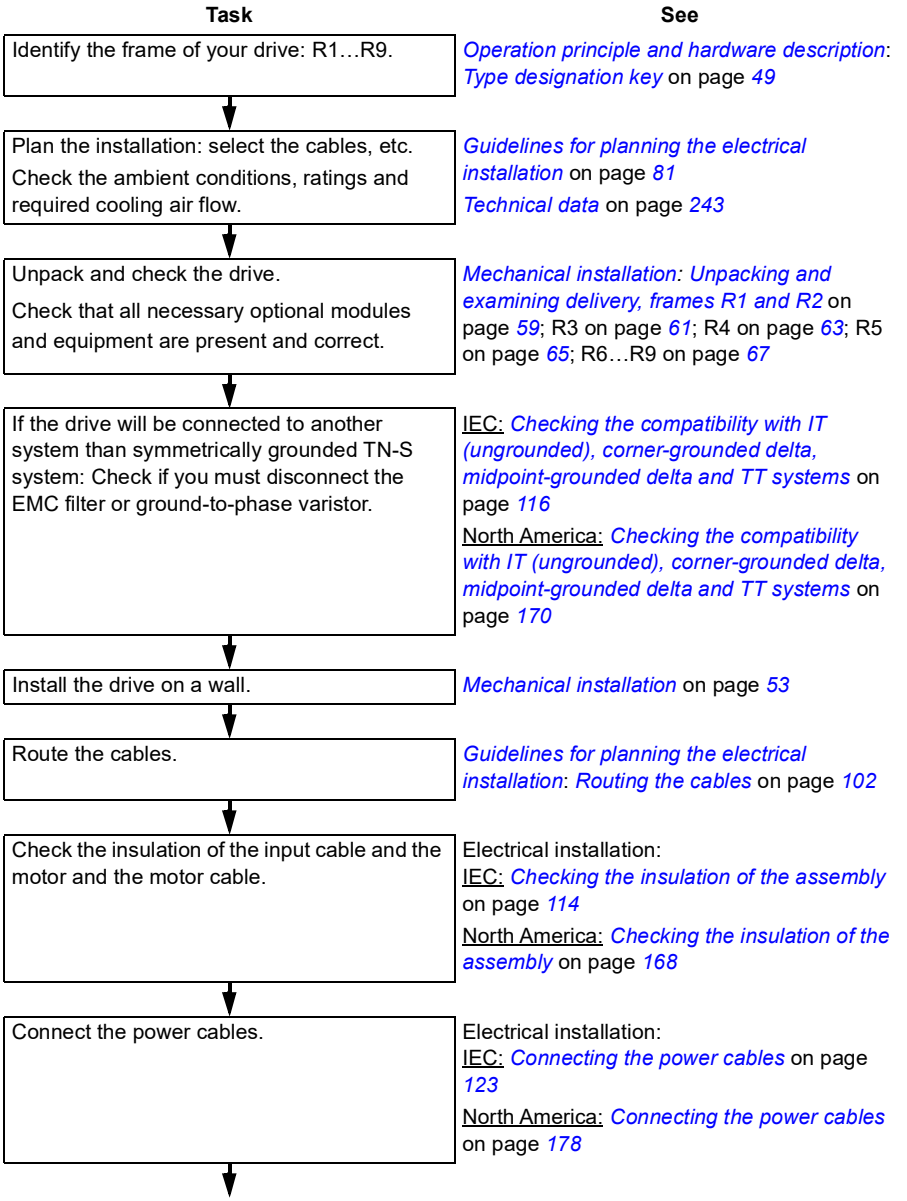
FEIP-21 Ethernet/IP adapter module user's manual	*3AXD50000158621*
FENA-01/-11/-21 Ethernet adapter module user's manual	*3AUA0000093568*
FEPL-02 Ethernet POWERLINK adapter module user's manual	*3AUA0000123527*
FLON-01 LONWORKS® adapter module user's manual	*3AUA0000041017*
FMBA-01 Modbus adapter module user's manual	*3AFE68586704*
FMBT-21 Modbus/TCP adapter module user's manual	*3AXD50000158607*
FPBA-01 PROFIBUS DP adapter module user's manual	*3AFE68573271*
FPNO-21 PROFINET adapter module user's manual	*3AXD50000158614*
FSCA-01 RS-485 adapter module user's manual	*3AUA0000109533*
Flange mounting kit installation supplement	*3AXD50000019100*
Flange mounting kit quick installation guide for ACx580-01 frames R1 to R3	*3AXD50000119172*
Flange mounting kit quick installation guide for ACx580-01 frames R4 to R5	*3AXD50000287093*
Flange mounting kit quick installation guide for ACS880-01 and ACX580-01 frames R6 to R9	*3AXD50000019099*
Main switch and EMC C1 filter options (+F278, +F316, +E223) installation supplement for ACS580-01, ACH580-01 and ACH580-01 frames R1 to R5	*3AXD50000155132*
UL Type 12 hood quick installation guide for ACS580-01, ACH580-01 and ACQ580-01 frames R1 to R9	*3AXD50000196067*

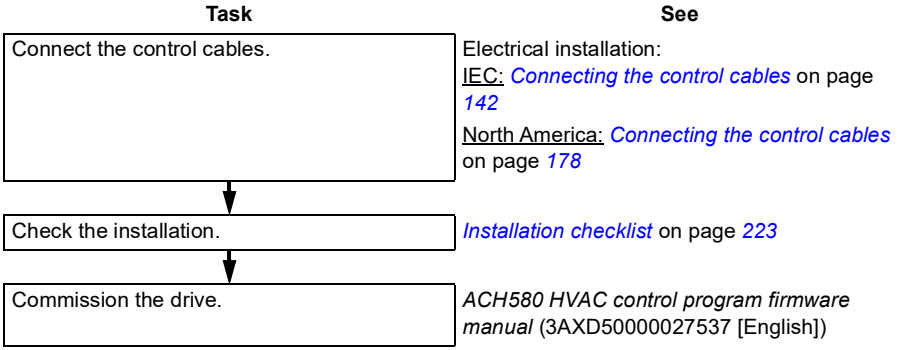
Tool and maintenance manuals and guides

Drive composer PC tool user's manual	*3AUA0000094606*
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*

ACH580-01 manuals

Quick installation and commissioning flowchart




Task
See
Connect the control cables.
Electrical installation:
IEC: Connecting the control cables on page 142
North America: Connecting the control cables on page 178
Check the installation.
Installation checklist on page 223
Commission the drive.
ACH580 HVAC control program firmware manual (3AXD50000027537 [English])

Terms and abbreviations

Term/abbreviation	Explanation
ACH-AP-H	Assistant control panel with Hand-Off-Auto functionality for the ACH580
ACH-AP-W	Assistant control panel with Hand-Off-Auto functionality and Bluetooth interface for the ACH580
Assistant control panel	Assistant control panel (ACH-AP-x) is an advanced operator keypad for communication with the drive.
BACnet™	BACnet™ is a registered trademark of American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
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 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 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-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
EFB	Embedded fieldbus
FBA	Fieldbus adapter

Term/abbreviation	Explanation
FBIP-21	Optional BACnet/IP adapter module
FCAN-01	Optional CANopen adapter module
FCNA-01	ControlNet adapter module
FDNA-01	Optional DeviceNet adapter module
FECA-01	Optional EtherCAT adapter module
FEIP-21	Optional two-port Ethernet/IP adapter module
FENA-21	Optional two-port Ethernet adapter module for EtherNet/IP, Modbus TCP and PROFINET IO protocols
FEPL-02	Optional Ethernet POWERLINK adapter module
FLON-01	LONWORKS® adapter module
FMBA-01	Optional Modbus RTU adapter module
FMBT-21	Optional two-port Modbus/TCP adapter module
FPBA-01	Optional PROFIBUS DP adapter module
FPNO-21	Optional PROFINET IO adapter module
Frame (size)	Refers to drive physical size, for example R1 and R2. The type designation label attached to the drive shows the frame of the drive, see section *Type designation key* on page *49*.
FSCA-01	Optional EIA-485 adapter module
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.
LONWORKS®	LONWORKS® (local operating network) is a networking platform specifically created to address the needs of control applications.
NEC 70	National Fire Protection Association (National Electric Code 70)
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]) • *FEIP-21 Ethernet/IP adapter module user's manual* (3AXD50000158621 [English]).
Parameter	User-adjustable operation instruction to the drive, or signal measured or calculated by the drive
PLC	Programmable logic controller

Term/abbreviation	Explanation
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.
R1, R2, …	*Frame (size)*
Rectifier	Converts alternating current and voltage to direct current and voltage.
SIL	Safety integrity level. See chapter *Safe torque off function* on page *345*.
STO	Safe torque off. See chapter *Safe torque off function* on page *345*.

3

Operation principle and hardware description

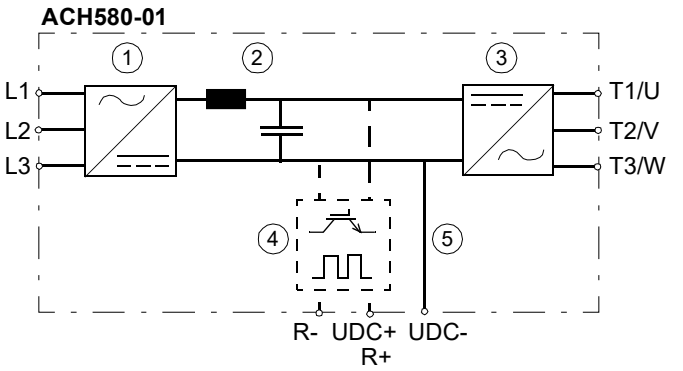
Contents of this chapter

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 ACH580-01 is a drive for controlling asynchronous AC induction motors, permanent magnet motors and synchronous reluctance motors (SynRM).

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



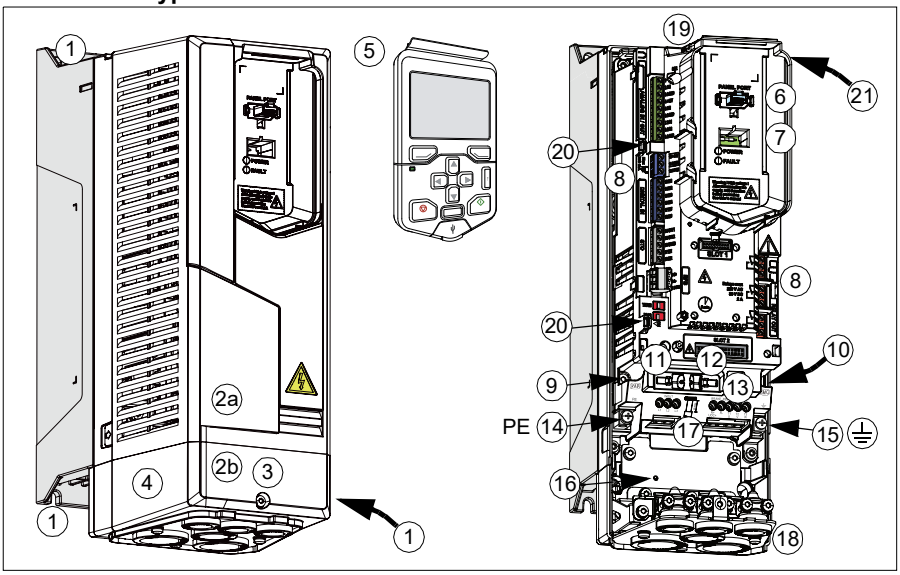
1	Rectifier. Converts alternating current and voltage to direct current and voltage.
2	DC link. DC circuit between rectifier and inverter.
3	Inverter. Converts direct current and voltage to alternating current and voltage.
4	Built-in brake chopper (R-, R+) in frames R1…R3. Conducts the surplus energy from the intermediate DC circuit of the drive to the brake resistor when necessary. The chopper operates when the DC link voltage exceeds a certain maximum limit. The voltage rise is typically caused by deceleration (braking) of a high inertia motor. The user obtains and installs the brake resistor when needed.
5	DC connection (UDC+, UDC-), for an external brake chopper in frames R4…R9.

Layout

Frames R1…R2

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

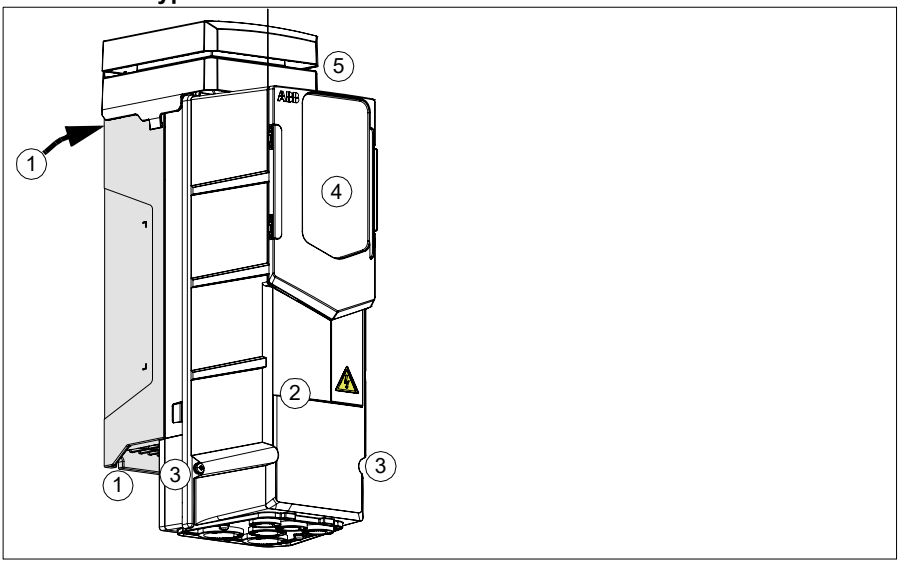
R1 IP21 / UL Type 1



1	Mounting points (4 pieces)
2	Cover: upper part (2a), lower part (2b)
3	Cover screw
4	Cable/conduit box
5	Control panel
6	Control panel connection
7	Cold configuration connection for CCA-01
7	Power OK and Fault LEDs. See section *LEDs* on page *240*.
8	I/O connections. See section *External control connection terminals, frames R1…R5* on page *44*.
9	Varistor grounding screw (VAR). See *Frames R1…R3* on page *120* (IEC) or *Frames R1…R3, disconnecting EMC or varistor screws* (North America) on page *174*.
10	EMC filter grounding screw (EMC (DC)). See *Frames R1…R3* on page *120* (IEC or *Frames R1…R3, disconnecting EMC or varistor screws* (North America) on page *174*.
11	Place for storing the removed VAR screw
12	Place for storing the removed EMC screw
13	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and brake connection (R-, R+)
14	PE connection (power line)
15	Grounding connection (motor)
16	Additional grounding connection
17	Stripping length (8 mm) checker
18	Cable entry
19	Main cooling fan
20	Cable tie mounts for /I/O cables
21	Auxiliary cooling fan connector

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

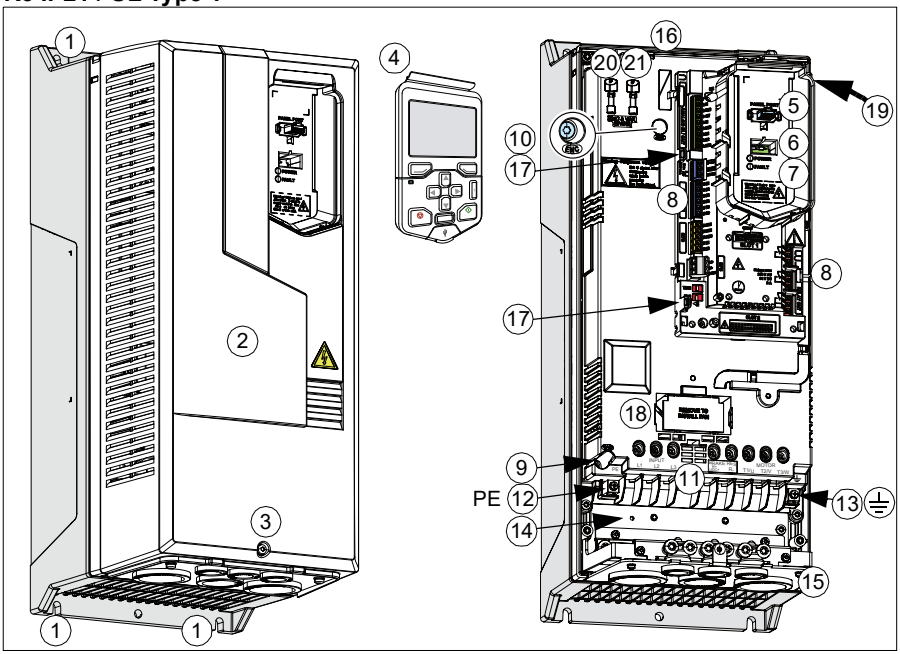
R1 IP55 / UL Type 12



1	Mounting points (4 pieces), top points are under the hood, which is installed last.
2	Front cover
3	Cover screws (2 pieces)
4	Control panel behind the transparent window
5	Hood, UL Type 12 only. Hood types vary by the frame size, see page 272.

Frame R3

R3 IP21 / UL Type 1

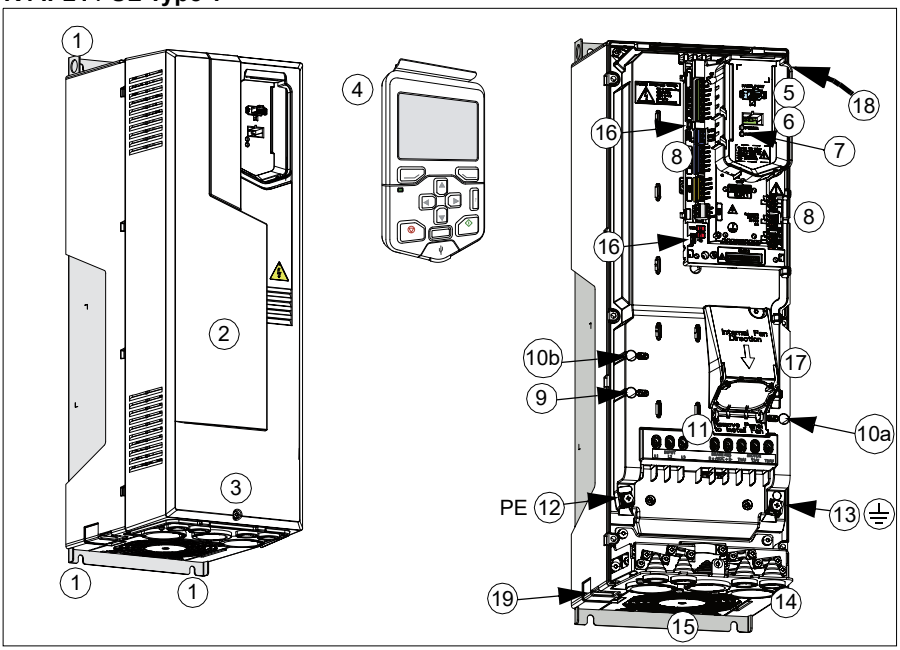


1	Mounting points (4 pieces)
2	Cover
3	Cover screw
4	Control panel
5	Control panel connection
6	Cold configuration connection for CCA-01
7	Power OK and Fault LEDs. See section *LEDs* on page *240*.
8	I/O connections. See section *External control connection terminals, frames R1…R5* on page *44*.
9	Varistor grounding screw (VAR). See *Frames R1…R3* on page *120* (IEC) or *Frames R1…R3, disconnecting EMC or varistor screws* (North America) on page *174*.
10	EMC filter grounding screw (EMC (DC)). See *Frames R1…R3* on page *120* (IEC) or *Frames R1…R3, disconnecting EMC or varistor screws* (North America) on page *174*.

11	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and brake connection (R-, R+)
12	PE connection (power line)
13	Grounding connection (motor)
14	Additional grounding connection
15	Cable entry
16	Main cooling fan
17	Cable tie mounts for I/O cables
18	Auxiliary cooling fan. For IP55/UL Type 12 drives only.
19	Auxiliary cooling fan connector
20	Place for storing the removed EMC screw
21	Place for storing the removed VAR screw

Frame R4

R4 IP21 / UL Type 1

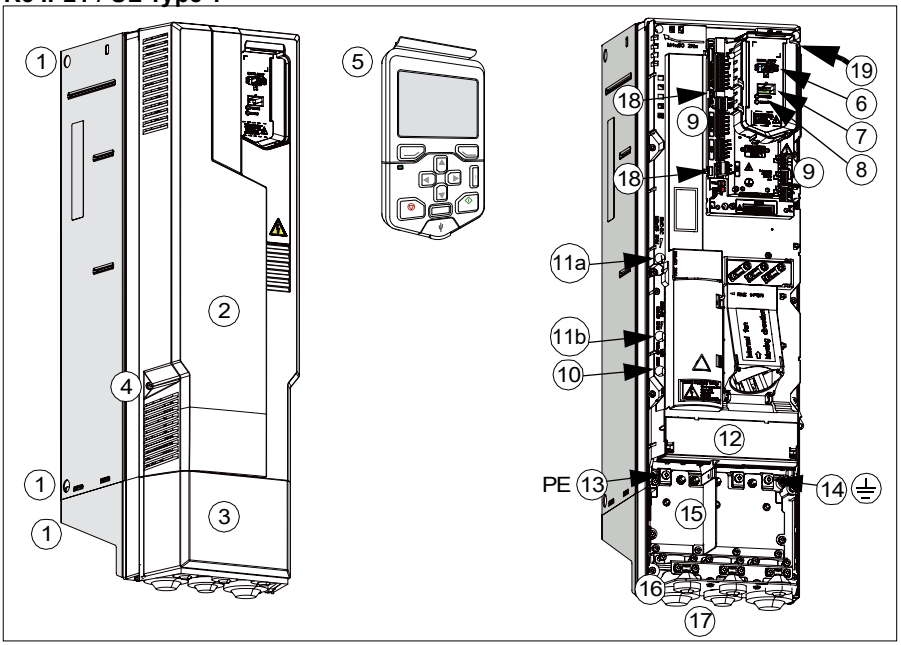


1	Mounting points (4 pieces)
2	Cover
3	Cover screw
4	Control panel
5	Control panel connection
6	Cold configuration connection for CCA-01
7	Power OK and Fault LEDs. See section *LEDs* on page *240*.
8	I/O connections. See section *External control connection terminals, frames R1…R5* on page *44*.
9	Varistor grounding screw (VAR). See *Frames R4…R9* on page *121* (IEC) or *Frames R4…R9, disconnecting EMC or varistor screws* (North America) on page *176*.

10	Two EMC filter grounding screws, 10a: EMC (DC) and 10b: EMC (AC). See *Frames R4…R9* on page *121* (IEC) or *Frames R4…R9, disconnecting EMC or varistor screws* (North America) on page *176*.
11	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and DC connection (UDC+, UDC-)
12	PE connection (power line)
13	Grounding connection (motor)
14	Cable entry
15	Main cooling fan
16	Cable tie mounts for I/O cables
17	Auxiliary cooling fan. For IP55/UL Type 12 drives only.
18	Auxiliary cooling fan connector
19	Additional grounding connection

Frame R5

R5 IP21 / UL Type 1

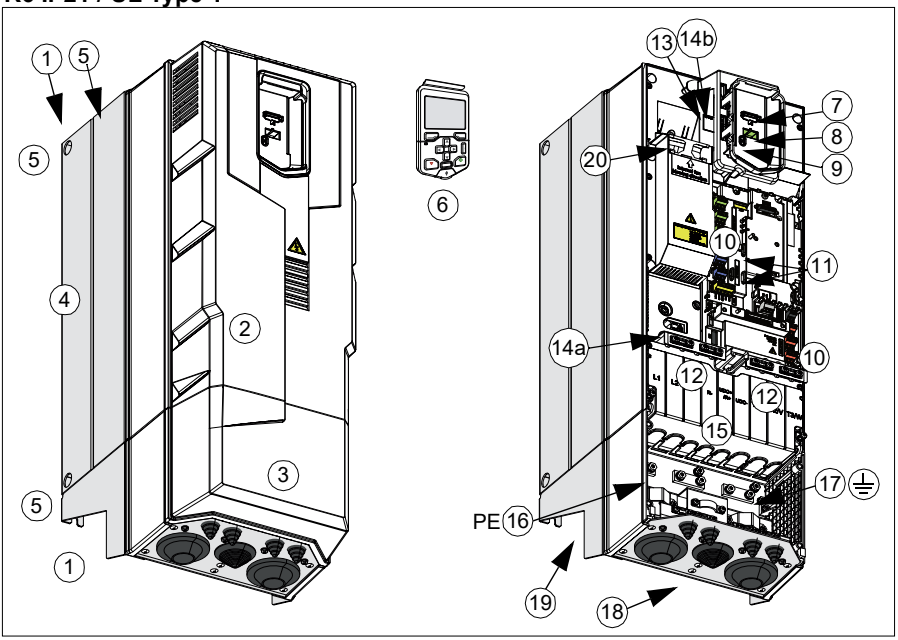


1	Mounting points (6 pieces: 2 at the top, 2 at the bottom of the main part of the frame, 2 at the top of the cable box)
2	Cover
3	Cable/conduit box
4	Cover screws (2 pieces)
5	Control panel
6	Control panel connection
7	Cold configuration connection for CCA-01
8	Power OK and Fault LEDs. See section *LEDs* on page *240*.
9	I/O connections. See section *External control connection terminals, frames R1…R5* on page *44*.
10	Varistor grounding screw (VAR). See *Frames R4…R9* on page *121* (IEC) or *Frames R4…R9, disconnecting EMC or varistor screws* (North America) on page *176*.
11	Two EMC filter grounding screws, 11a: EMC (DC) and 11b: EMC (AC). See *Frames R4…R9* on page *121* (IEC) or *Frames R4…R9, disconnecting EMC or varistor screws* (North America) on page *176*.
12	Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and DC connection (UDC+, UDC-) under the shroud
13	PE connection (power line)
14	Grounding connection (motor)
15	Cable box plate
16	Cable entry
17	Main cooling fan
18	Cable tie mounts for I/O cables
19	Auxiliary cooling fan connector

Frames R6…R9

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

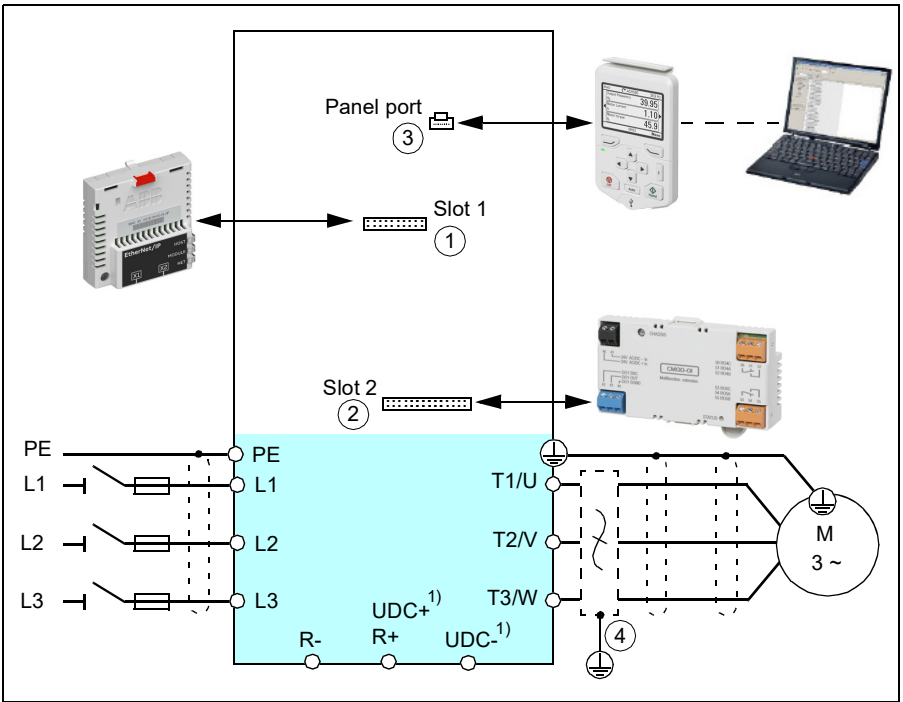
R6 IP21 / UL Type 1



1	Mounting points (6 pieces: 2 at the top, 2 at the bottom of the main part of the frame, 2 at the top of the cable box)
2	Cover
3	Cable/conduit box
4	Heatsink
5	Lifting holes (6 pieces)
6	Control panel
7	Control panel connection
8	Cold configuration connection for CCA-01
9	Power OK and Fault LEDs. See section *LEDs* on page *240*.
10	I/O connections. See section *External control connection terminals, frames R6…R9* on page *45*.
11	Cable tie mounts for I/O cables
12	Clamps for I/O cable mechanical support
13	Varistor grounding screw (VAR), under the control panel platform.
	See *Frames R4…R9* on page *121* (IEC) or *Frames R4…R9, disconnecting EMC or varistor screws* (North America) on page *176*.
14	Two EMC filter grounding screws, 14a: EMC (DC) under the control panel platform and 14b: EMC (AC) at the left, above the shroud. See *Frames R4…R9* on page *121* (IEC) or *Frames R4…R9, disconnecting EMC or varistor screws* (North America) on page *176*.
15	Shroud. Under the shroud: Input power connection (L1, L2, L3), motor connection (T1/U, T2/V, T3/W) and DC connection (UDC+, UDC-).
16	PE connection (power line)
17	Grounding connection (motor), under the shroud (15).
18	Cable entry
19	Main cooling fan
20	Auxiliary cooling fan

Overview of power and control connections

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

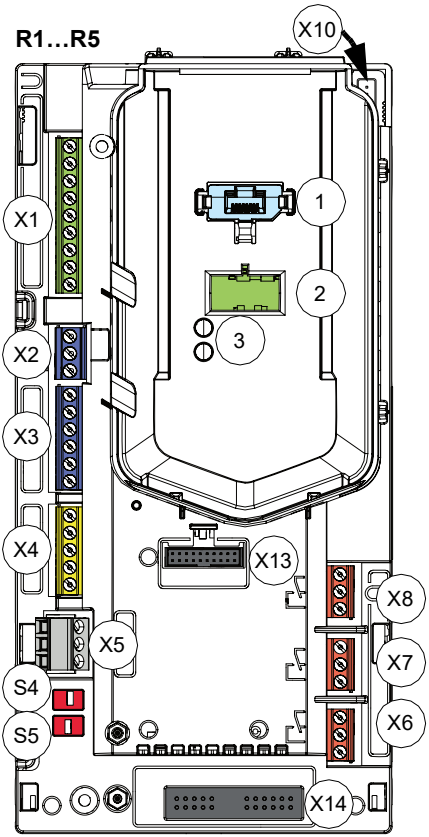


1	Option slot 1 for optional fieldbus adapter modules
2	Option slot 2 for optional I/O extension modules
3	Panel port.
4	d*u*/d*t* or common mode filter (optional), see page *389*.

1) Not in all frame sizes.

External control connection terminals, frames R1…R5

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

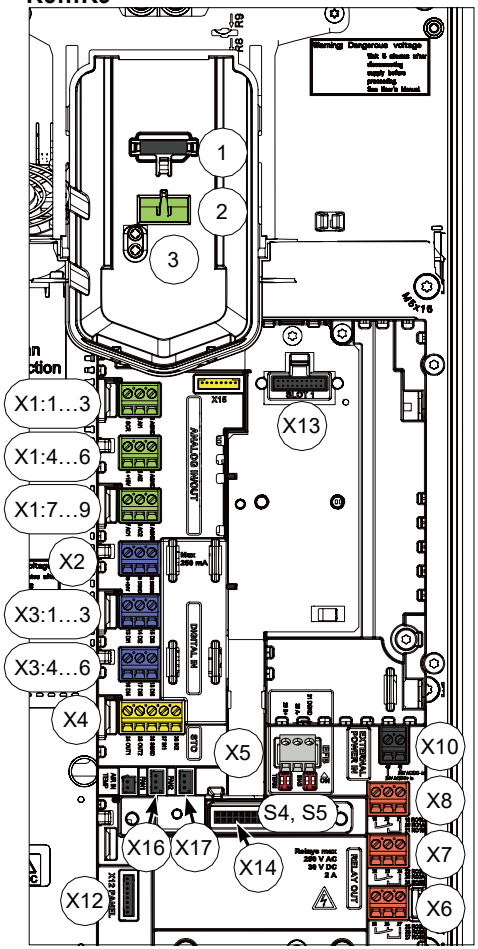


	Description
X1	Analog inputs and outputs
X2	Aux. voltage output
X3	Programmable digital inputs
X4	Safe torque off connection
X5	Embedded fieldbus
X6	Relay output 3
X7	Relay output 2
X8	Relay output 1
X10	Auxiliary fan connection (IP55)
X13	Option slot 1 (fieldbus adapter modules)
X14	Option slot 2 (I/O extension modules)
S4, S5	Termination switch (S4), bias resistor switch (S5), see section *Switches* on page *146* (IEC) or *Switches* on page *146* (North America)
1	Panel port (control panel connection)
2	Cold configuration connection. This connector is used with the CCA-01 configuration adapter.
3	Power OK and Fault LEDs. See section *LEDs* on page *240*.

External control connection terminals, frames R6…R9

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

R6…R9

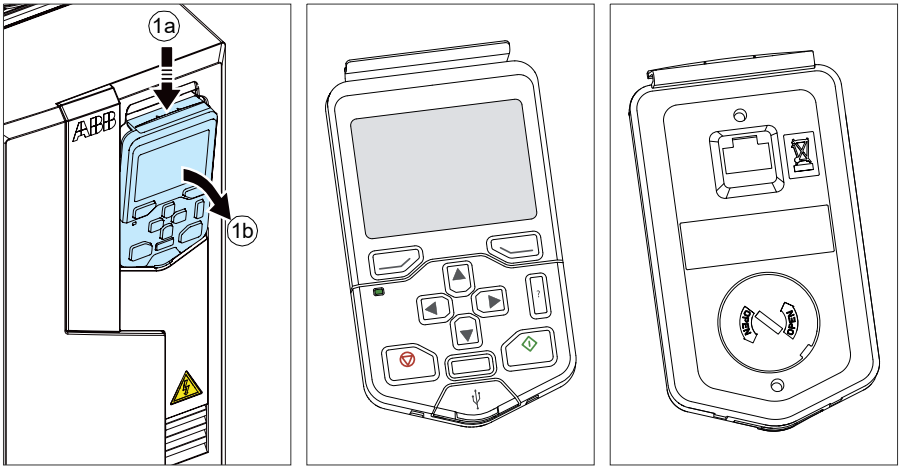


	Description
X1	Analog inputs and outputs
X2	Aux. voltage output
X3	Digital inputs
X4	Safe torque off connection
X5	Connection to embedded EIA-485 fieldbus adapter module
X6	Relay output 3
X7	Relay output 2
X8	Relay output 1
X10	External +24 V AC/DC input connection
X12	Panel connection
X13	Option slot 1 (fieldbus adapter modules)
X14	Option slot 2 (I/O extension modules)
X16	Auxiliary fan 1 connection
X17	Auxiliary fan 2 connection
S4, S5	Termination switch (S4), bias resistor switch (S5), see section *Switches* on page *146* (IEC) or *Switches* on page *146* (North America)
1	Panel port (control panel connection)
2	Cold configuration connection. This connector is used with the CCA-01 configuration adapter.
3	Power OK and Fault LEDs. See section *LEDs* on page *240*.

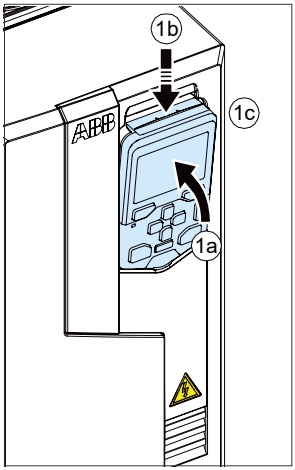
WARNING! Do not connect the +24 V AC cable to the control board ground when the control board is powered using an external 24 V AC supply.

Control panel

To remove the control panel, press the retaining clip at the top (1a) and pull it 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 *ACH580 HVAC control program firmware manual* (3AXD50000027537 [English]) and *ACX-AP-X assistant control panels user's manual* (3AUA0000085685 [English]).

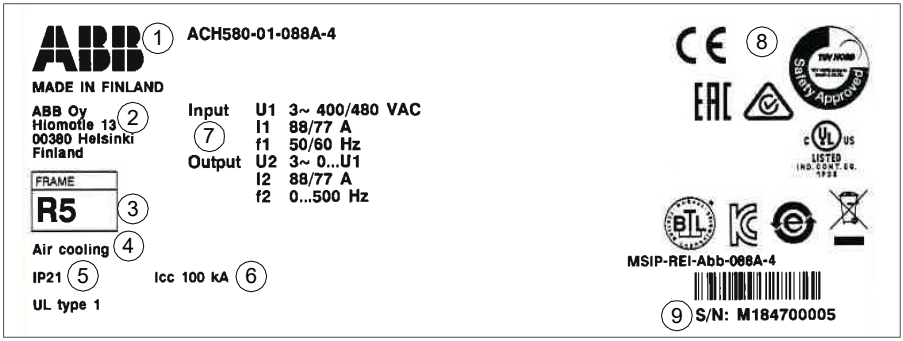
Control panel door mounting kits

Door mounting kits for the control panel are available.

For more information, see *DPMP-01 mounting platform for control panels* (3AUA0000100140 [English]), *DPMP-02/03 mounting platform for control panels* (3AUA0000136205 [English]) or *DPMP-06/07 mounting platform for control panels* (3AXD50000289561 [English]).

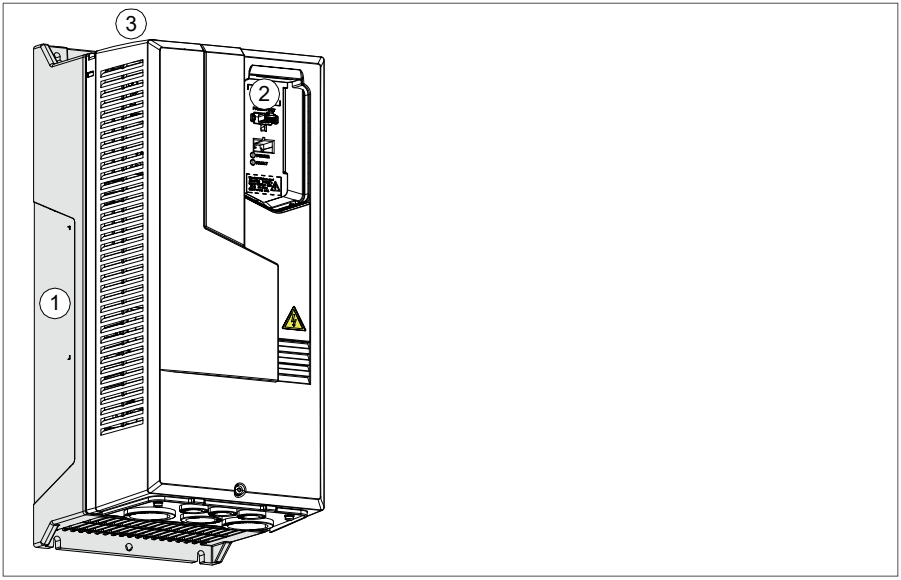
Type designation label

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



No.	Description
1	Type designation, see section *Type designation key* on page *49*.
2	Name and address of the manufacturer
3	Frame (size)
4	Type of the drive, for example, with Air cooling or Liquid cooling, and so on.
5	Degree of protection
6	IEC: Icc (Rated conditional short-circuit current) = 100 kA, UL (NEC): SCCR (Short circuit current rating) = 100 kA
7	Nominal ratings in the supply voltage range, see section *Electrical ratings* on page *244*, section *Electrical power network specification* on page *286* and section *Motor connection data* on page *286*. See page *286* for further information on input voltage range.
8	Valid markings
9	S/N: Serial number of format MYYWWXXXX, where M: Manufacturing plant YY: 16, 17, 18, … for 2016, 2017, 2018, … WW: 01, 02, 03, … for week 1, week 2, week 3, … XXXXX: Digits making the serial number unique

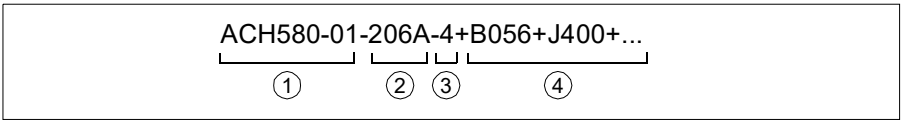
Locations of the labels on the drive



1	ABB MADE IN FINLAND ABB Oy Hiomotie 13 00380 Helsinki Finland FRAME R5 Air cooling IP21 Icc 100 kA UL type 1 ACH580-01-088A-4 Input U1 3~ 400/480 VAC I1 88/77 A f1 50/60 Hz Output U2 3~ 0...U1 I2 88/77 A f2 0...500 Hz MSIP-REI-Abb-068A-4 S/N: M184700005
2	ACH580-01-088A-4 S/N: M184700005 SW v2.07.0.2
3	U1 3~ 400/480 VAC I2 88/77 A Pn 45 kW/60 hp ACH580-01-088A-4 S/N: M184700005 **Note:** Pn is not shown in UL (NEC) drive labels.

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, ACH580-01-12A7-4. The optional selections are given after that, separated by plus signs, for example, +L501. The main selections are described below. Not all selections are available for all types.



	CODE	DESCRIPTION
	Basic codes	
1	ACH580	Product series
	01	When no options are selected: Wall mounted, IP21 (UL Type 1), control panel with a USB port, choke, EMC C2 filter (internal EMC filter), safe torque off, coated boards, cable lead through entry from the bottom, cable box or the conduit plate with cable entries, quick installation and start-up guide (multilingual).
2	**Size**	
	xxxx	Refer to the rating table, page *244*
3	**Voltage rating**	
	4	2 = 200…240 V 4 = 380…480 V 6 = 575…600 V See page *286* for further information.
4	**Option codes (plus codes)**	
	Control panel and panel options	
	J400	ACH-AP-H Hand-Off-Auto control panel (as standard)
	J424	CDUM-01 Blank control panel cover (no control panel)
	J429	ACH-AP-W Hand-Off-Auto control panel with a Bluetooth interface
	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 PTC interface and external 24 V. Requires option Q971. Europe only.
	Safety	
	Q971	ATEX certified safe disconnection function, EX II (2) GD. Available only with option L357. Europe only.

	CODE	DESCRIPTION
	Fieldbus adapters	
	K451	FDNA-01 DeviceNet™
	K452	FLON-01 LONWORKS®
	K454	FPBA-01 PROFIBUS DP
	K455	FMBA-01 Modbus
	K457	FCAN-01 CANopen
	K458	FSCA-01 Modbus/RTU
	K462	FCNA-01 ControlNet™
	K465	FBIP-21 BACnet/IP (2-port)
	K469	FECA-01 EtherCAT
	K470	FEPL-02 Ethernet POWERLINK
	K475	FENA-21 Two-port Ethernet (EtherNet/IP™, Modbus/TCP, PROFINET)
	K490	FEIP-21 Two-port EtherNet/IP
	K491	FMBT-21 Two-port Modbus/TCP
	K492	FPNO-21 Two-port PROFINET IO
	Embedded fieldbus	
		Embedded fieldbus, EIA-485 as standard
	Construction	
	B056	IP55 (UL type 12). Factory option, retro-fit not possible.
	C135	Flange mounting kit. Flange mounting kit is ordered separately North America, not with a plus code.
	E223	EMC filter, category C1 for earthed network. For frame sizes R1…R5. Requires option B056. IEC only.
	F278	Main switch. For frame sizes R1…R5. Requires option B056. IEC only. Valid for APAN region.
	F316	Main switch and EMC filter, category C1 for earthed network. For frame sizes R1…R5. Requires option B056. IEC only.
	H358	Cable conduit plate, blank.

	CODE	DESCRIPTION
	Full set of printed manuals in selected language. **Note:** The delivered manual set may include manuals in English if the translation is not available. **Note:** These options are not available in North America. You can find manuals in PDF format on the Internet. See section *Document library on the Internet* on the inside of the back cover.	
	R700	English
	R701	German
	R702	Italian
	R703	Dutch
	R704	Danish
	R705	Swedish
	R706	Finnish
	R707	French
	R708	Spanish
	R709	Portuguese (Brazil)
	R711	Russian
	R712	Chinese
	R714	Turkish

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4

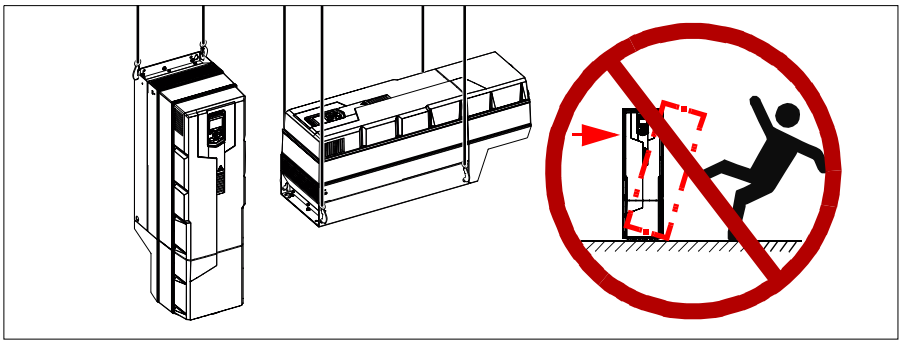
Mechanical installation

Contents of this chapter

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

Safety

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

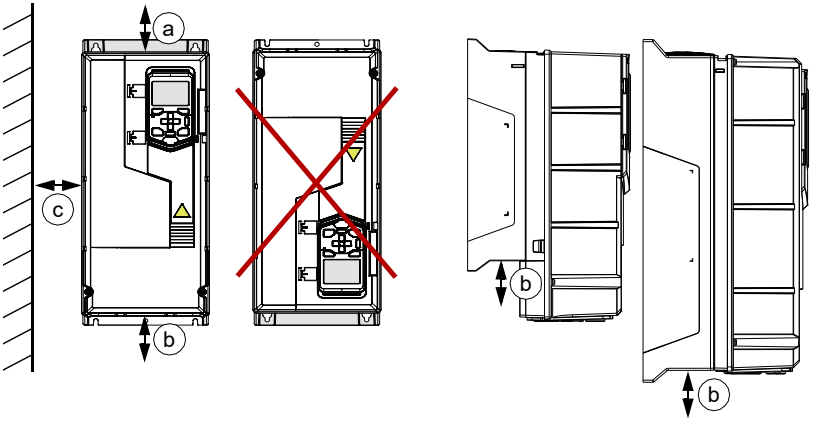


Checking the installation site

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

- Vertical.

  Note: Do not install the drive upside down.



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

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[1] Free space above is measured from the frame, not from the hood used in UL Type 12 frames.
Note: The height of the hood for frames R4 and R9 exceeds the requirement of free space above for these frames

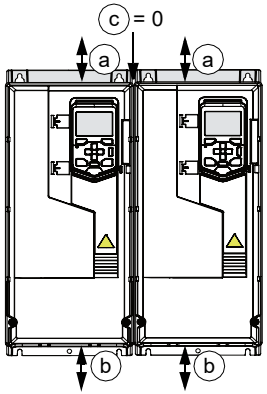
Frame size	R4	R9
Hood height (in)	2.83	9.06
Hood height (mm)	72	230

[2] Free space below is always measured from the drive frame, not from the cable box

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

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

- Vertical side by side



Frame size	Vertical installation side by side - Free space, IP21 (UL Type 2) and IP55 (UL Type 12)					
	Above (a)[1]		Below (b)[2]		Between (c)[3]	
	mm	in	mm	in	mm	in
R1	200	7.87	200	7.87	0	0
R2	200	7.87	200	7.87	0	0
R3	200	7.87	200	7.87	0	0
R4	200	7.87	200	7.87	0	0
R5	200	7.87	200	7.87	0	0
R6	200	7.87	300	11.81	0	0
R7	200	7.87	300	11.81	0	0
R8	200	7.87	300	11.81	0	0
R9	200	7.87	300	11.81	0	0

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1) Free space above is measured from the frame, not from the hood used in UL Type 12 frames.
Note: The height of the hood for frames R4 and R9 exceeds the requirement of free space above for these frames.

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

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

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

Notes for IP55 (UL Type 12) frames R1…R3:

- Auxiliary fan maintenance cannot be performed without removing every second drive from installation to get access to the fan.
- The cover fastening clips can be removed to make the front cover opening easier.

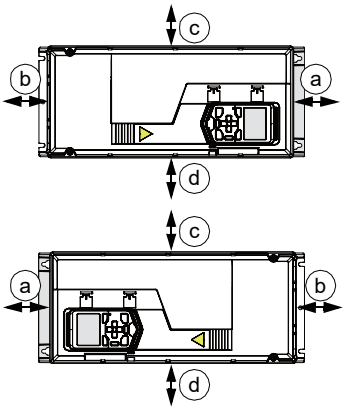
- Horizontal, IP20 and IP55, R1…R5 only

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

  Note 2: IP55/Type 12 drive mounted horizontally meet IP21/Type 1 ratings.

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

  Note 4: The vibration specification in section *Ambient conditions* on page *296* may not be fulfilled.



Frame size	Horizontal installation - Free space							
	IP21 (IP20)				IP55 (UL Type 12)			
	Above (a)		Below (b)[1)]		Above (a)		Below (b)[1)]	
	mm	in	mm	in	mm	in	mm	in
R1	150	5.91	86	3.39	137	5.39	116	4.57
R2	150	5.91	86	3.39	137	5.39	116	4.57
R3	200	7.87	53	2.09	200	7.87	53	2.09
R4	30	1.18	200	7.87	30	1.18	200	7.87
R5	30	1.18	200	7.87	30	1.18	200	7.87
Frame size	Side up (c)		Side down (d)		Side up (c)		Side down (d)	
	mm	in	mm	in	mm	in	mm	in
R1	30	1.18	200	7.87	30	1.18	200	7.87
R2	30	1.18	200	7.87	30	1.18	200	7.87
R3	30	1.18	200	7.87	30	1.18	200	7.87
R4	30	1.18	200	7.87	30	1.18	200	7.87
R5	30	1.18	200	7.87	30	1.18	200	7.87

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

Check the installation site according to the requirements below:

- The installation site is sufficiently ventilated or cooled to remove the heat away from the drive. See section *Losses, cooling data and noise* on page *275*.
- The operation conditions of the drive meet the specifications given in section *Ambient conditions* on page *296*.
- The wall is as close to vertical as possible, of non-flammable material and strong enough to carry the weight of the drive, see section *Dimensions, weights and free space requirements* on page *270*.
- The 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 *54* (or page *270*).

Required tools

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

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

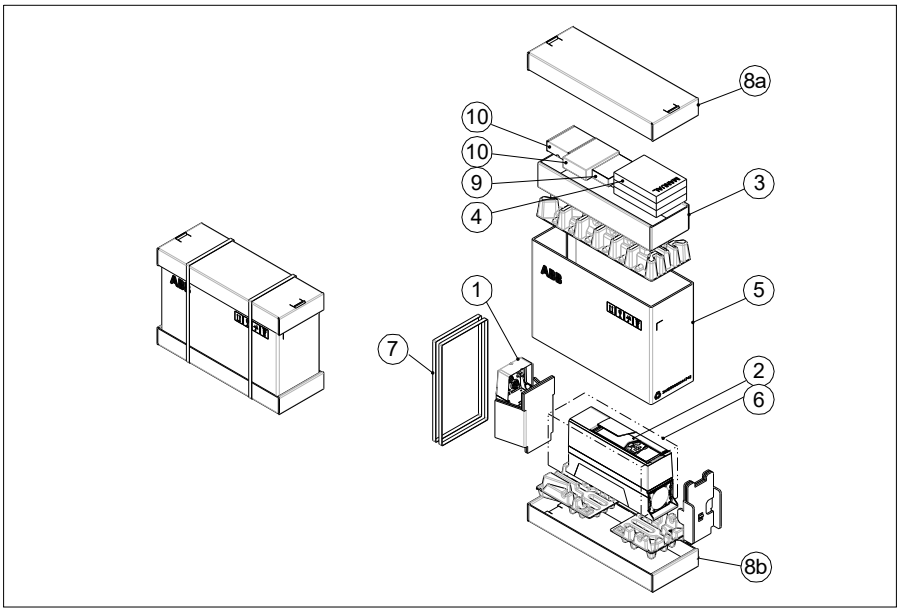
Moving the drive



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

Unpacking and examining delivery, frames R1 and R2

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section *Type designation label* on page *47*.



1	Cable box package. **Note:** The cable box is mounted to the IP55 drive module frame at the factory.
2	Drive
3	Option tray
4	In the option tray • Europe: Multilingual quick installation and start-up guide (always), and Hardware and firmware manuals (if ordered with a plus code) • North America: English Installation, Operation, and Maintenance manual (I, O & M) • Multilingual residual voltage warning stickers
5	Cardboard box. Mounting template in the cardboard box.

6	Plastic bag
7	Straps
8	Tray
9	Control panel selected in the order (in a separate package) in the option box. North America: Control panel factory installed.
10	Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port EtherNet/IP adapter module) in the option box. North America: Options may be ordered as factory installed.
Note: Hood included with option +B056 (IP55/UL Type 12) in North America	

To unpack:

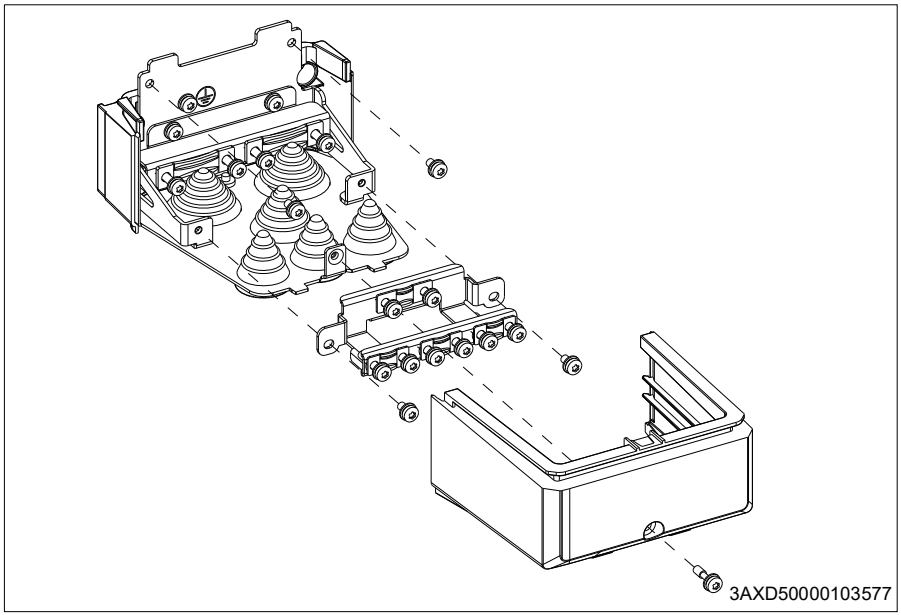
- Cut the straps (7).
- Remove the upper tray (8a) and option tray (3).
- Remove the cardboard box (5).
- Remove the plastic bag (6).
- Lift the drive (2).

Recycle the package material according to local regulations.

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

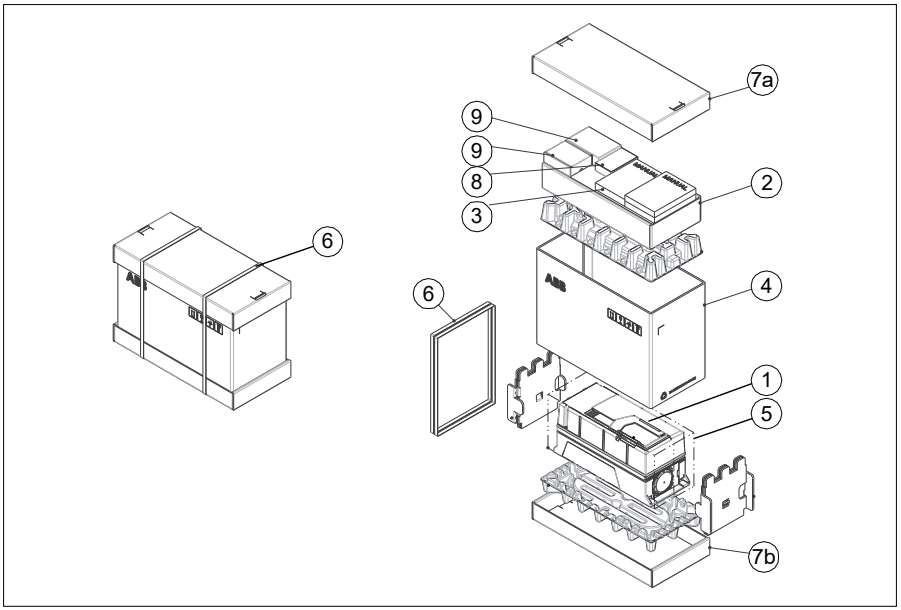
This illustration shows the contents of the cable box package. The package also includes an assembly drawing which shows how to install the cable box to the drive module frame.

Follow the installation instructions in section *Installing the drive vertically, frames R1…R4* on page *73*.



Unpacking and examining delivery, frame R3

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section *Type designation label* on page *47*.



1	Drive
2	Option tray
3	In the option tray • Europe: Multilingual quick installation and start-up guide (always), and Hardware and firmware manuals (if ordered with a plus code) • North America: English Installation, Operation, and Maintenance manual (I, O & M) • Multilingual residual voltage warning stickers • Mounting template
4	Cardboard box.

5	Plastic bag
6	Straps
7	Tray
8	Control panel selected in the order (in a separate package) in the option box. North America: Control panel factory installed.
9	Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port EtherNet/IP adapter module) in the option box. North America: Options may be ordered as factory installed.
Note: Hood included with option +B056 (IP55/UL Type 12) in North America	

To unpack:

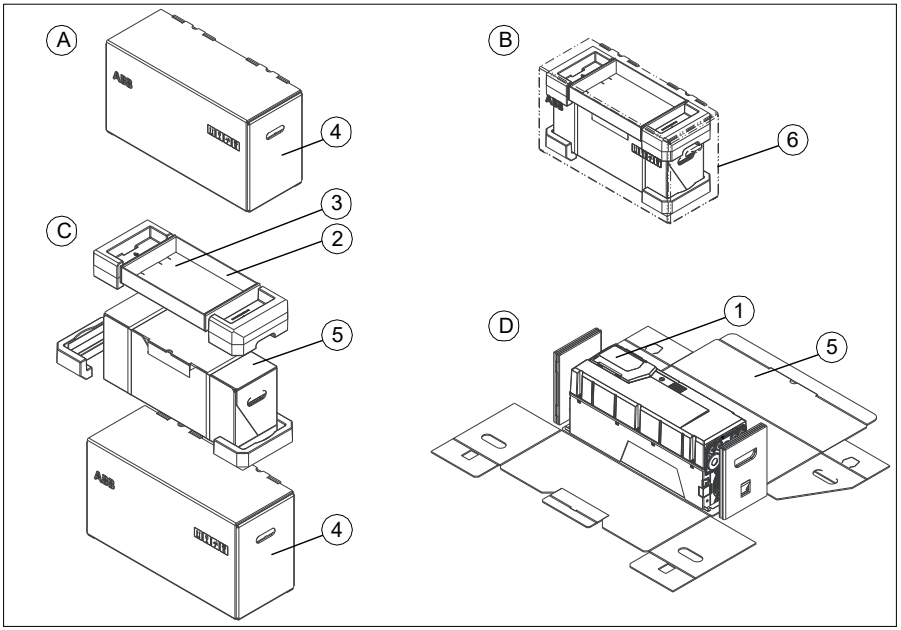
- Cut the straps (6).
- Remove the upper tray (7a) and option tray (2).
- Remove the cardboard box (4).
- Remove the plastic bag (5).
- Lift the drive (2).

Recycle the package material according to local regulations.



Unpacking and examining delivery, frame R4

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section *Type designation label* on page *47*.



1	Drive
2	Option tray
3	In the option tray • Europe: Multilingual quick installation and start-up guide (always), and Hardware and firmware manuals (if ordered with a plus code) • North America: English Installation, Operation, and Maintenance manual (I, O & M) • Multilingual residual voltage warning stickers • Control panel selected in the order (in a separate package) in the option box. North America: Control panel factory installed. • Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port EtherNet/IP adapter module) in the option box. North America: Options may be ordered as factory installed.
4	Cardboard box
5	Inner box with edge boards and cushions. Mounting template in the inner box.
6	Plastic bag
Note: Hood included with option +B056 (IP55/UL Type 12) in North America	

To unpack:

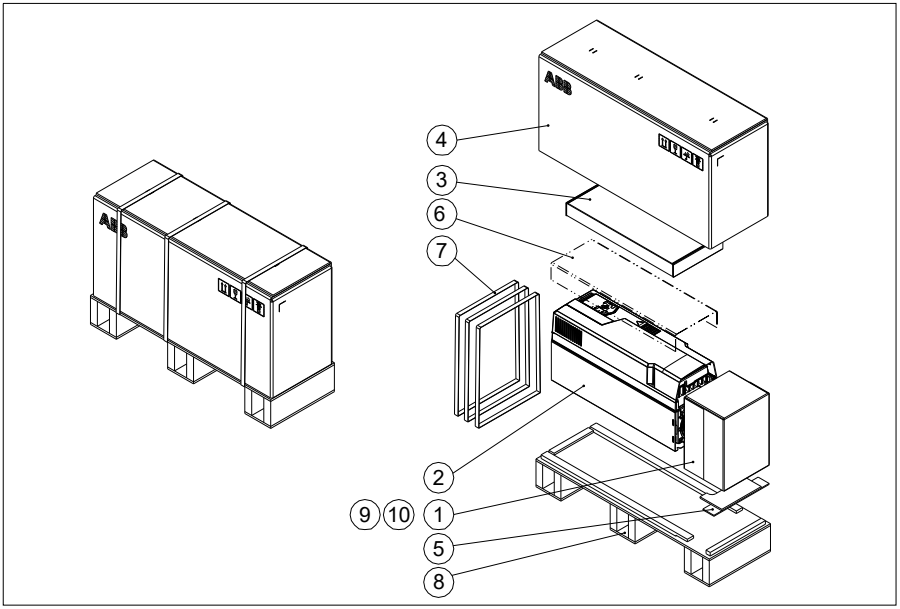
- Cut the straps.
- Open box (4) and remove top cushions and option tray (2).
- Lift out the inner box (5).
- Open the inner box (5), lift the drive (1) and remove plastic bag (7).

Recycle the package material according to local regulations.



Unpacking and examining delivery, frame R5

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section *Type designation label* on page *47*.



1	Cable box package. **Note:** The cable box is mounted to the IP55 drive module frame at the factory.
2	Drive
3	In the option box • Europe: Multilingual quick installation and start-up guide (always), and Hardware and firmware manuals (if ordered with a plus code) • North America: English Installation, Operation, and Maintenance manual (I, O & M) • Multilingual residual voltage warning stickers
4	Cardboard box. Mounting template in the cardboard box.

5	Stopper
6	Cover protecting film
7	Straps
8	Pallet
9	Control panel selected in the order (in a separate package) in the option box. North America: Control panel factory installed.
10	Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port EtherNet/IP adapter module) in the option box. North America: Options may be ordered as factory installed.
Note: Hood included with option +B056 (IP55/UL Type 12) in North America	

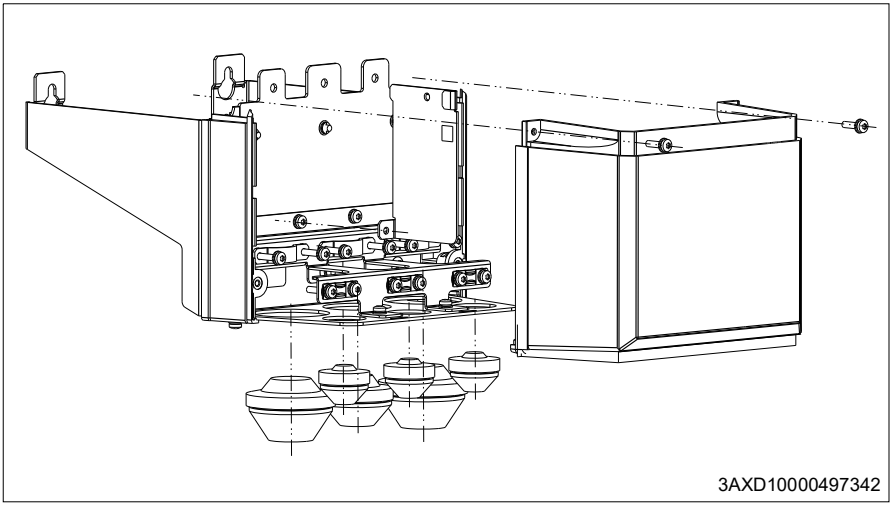
To unpack:

- Cut the straps (7).
- Remove the cardboard box (4) and option box (3).
- Remove the cover protecting film (6).
- Lift the drive (2).

Recycle the package material according to local regulations.

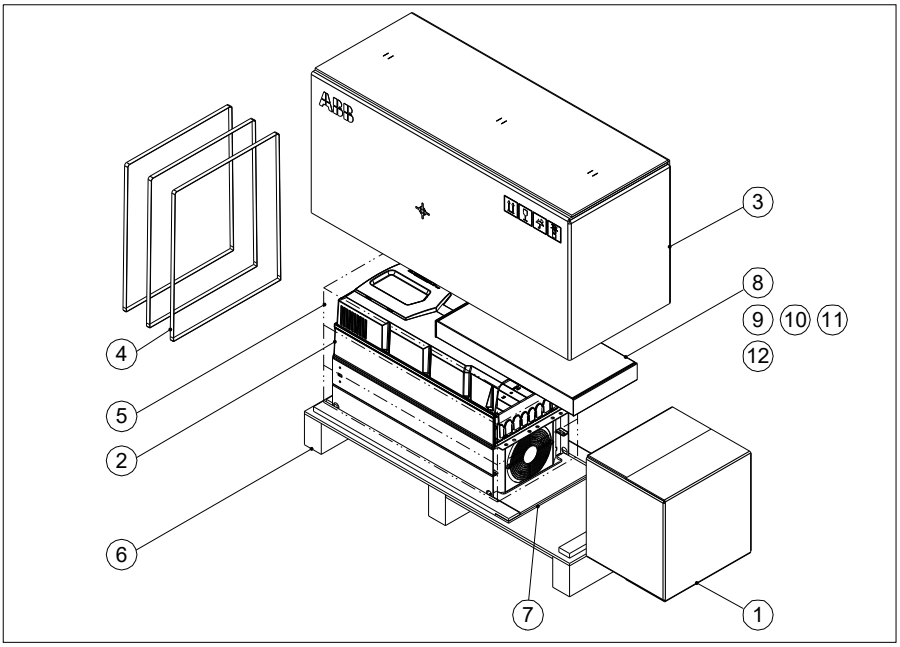
Frame R5 cable box (IP21, UL Type 1)

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



Unpacking and examining delivery, frames R6…R9

The figure below shows the layout of the transport package. Examine that all items are present and there are no signs of damage. Read the data on the type designation label of the drive to make sure that the drive is of the correct type. See section *Type designation label* on page *47*.



1	Cable box. Power and control cable grounding shelves in a plastic bag, assembly drawing. **Note**: The cable box is mounted to the IP55 drive module frame at the factory.
2	Drive with factory installed options.
3	Cardboard box
4	Straps
5	VCI bag for protecting against corrosion
6	Pallet
7	Stopper
8	Option tray
9	In the option tray • Europe: Multilingual quick installation and start-up guide (always), and Hardware and firmware manuals (if ordered with a plus code) • North America: English Installation, Operation, and Maintenance manual (I, O & M) • Multilingual residual voltage warning stickers
10	Control panel selected in the order (in a separate package) in the option tray. North America: Control panel factory installed.
11	Possible options in separate packages, if they have been ordered with a plus code, such as for example +K490 (FEIP-21 Two-port EtherNet/IP adapter module) in the option tray. North America: Options may be ordered as factory installed.
12	Mounting template on top of the option tray
Note: Hood included with option +B056 (IP55/UL Type 12) in North America	

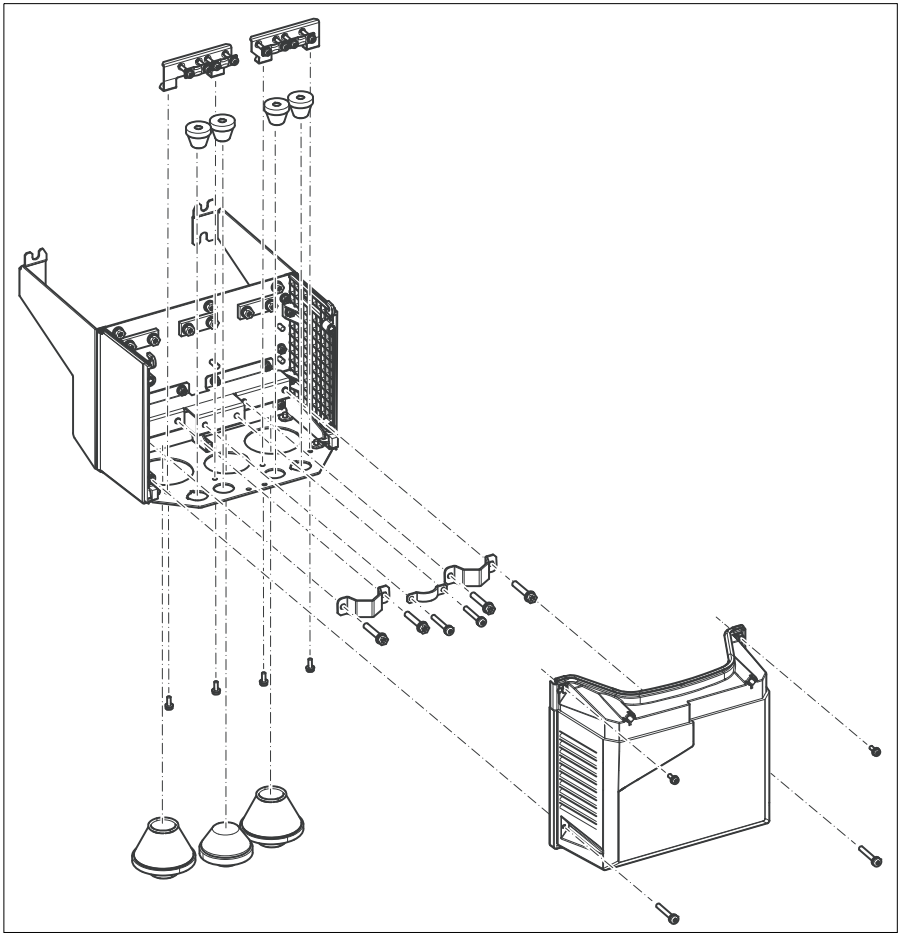
To unpack:

- Cut the straps (4).
- Remove the cardboard box (3) and option tray (8).
- Remove the VCI bag (5).
- Attach lifting hooks to the lifting eyes of the drive (see the figure on page *53*). Lift the drive with a hoist.

Recycle the package material according to local regulations.

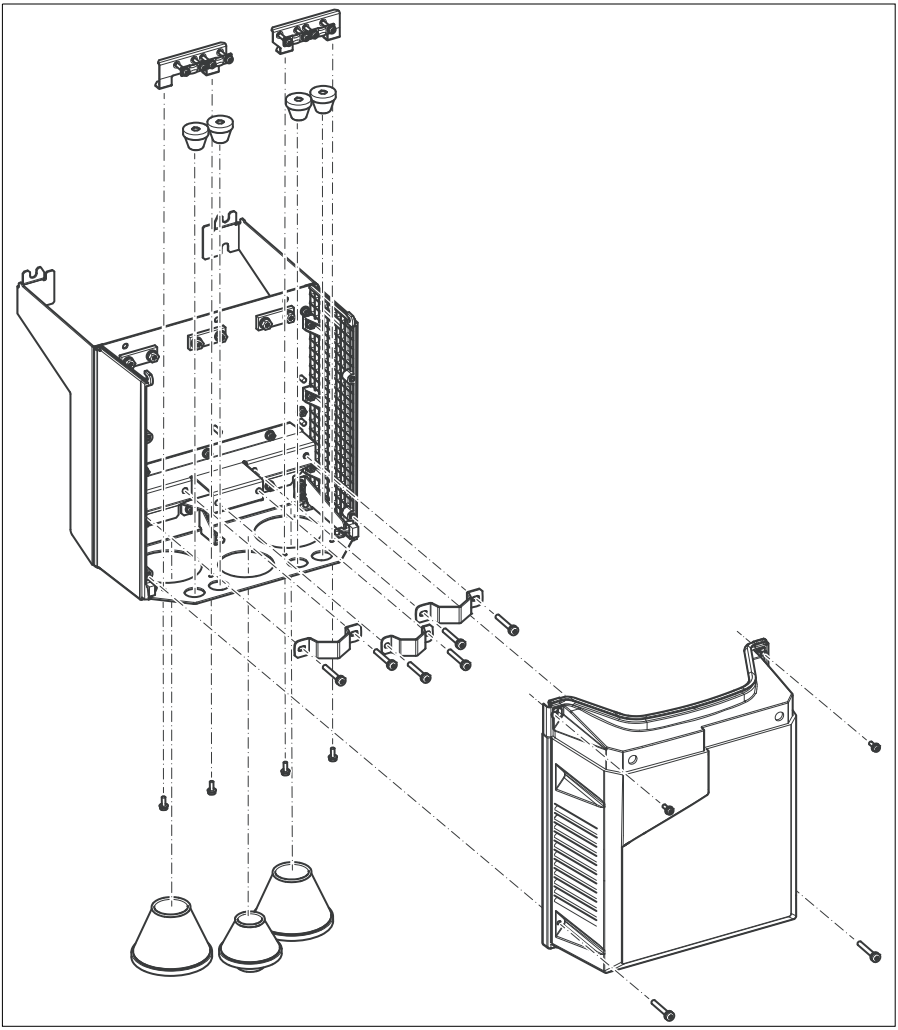
Frame R6 cable box (IP21, UL Type 1)

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



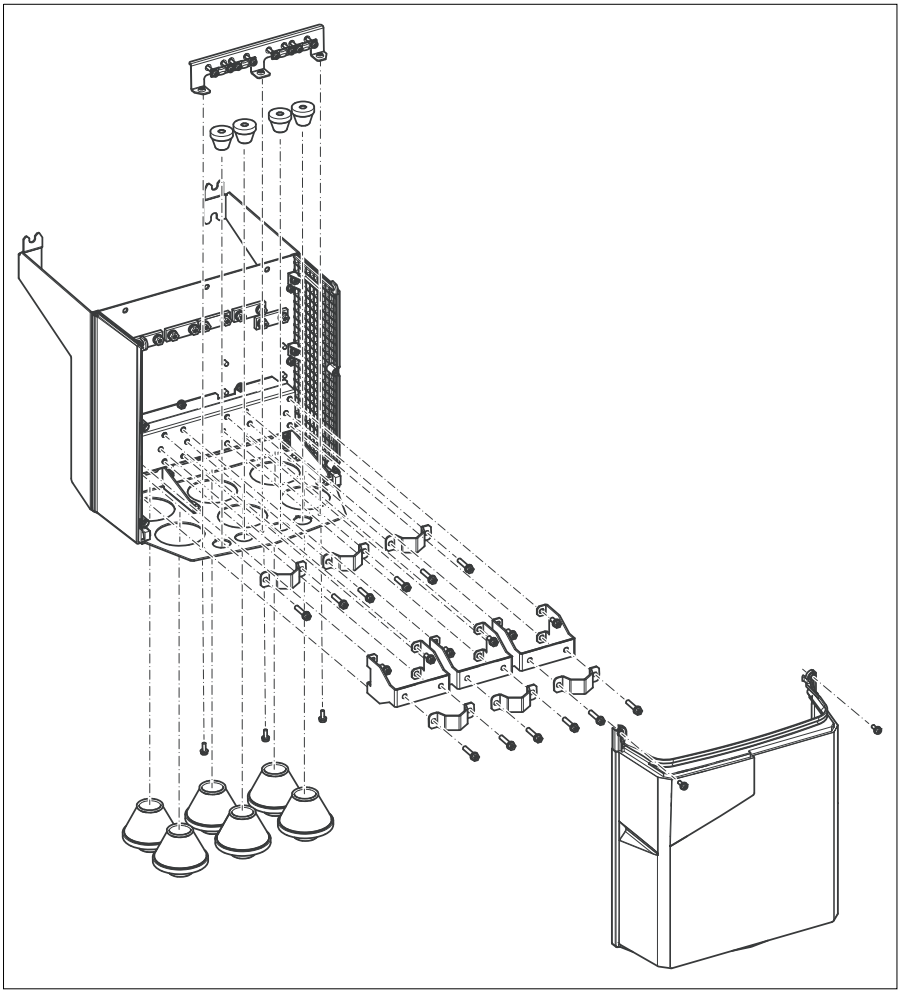
Frame R7 cable box (IP21, UL Type 1)

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



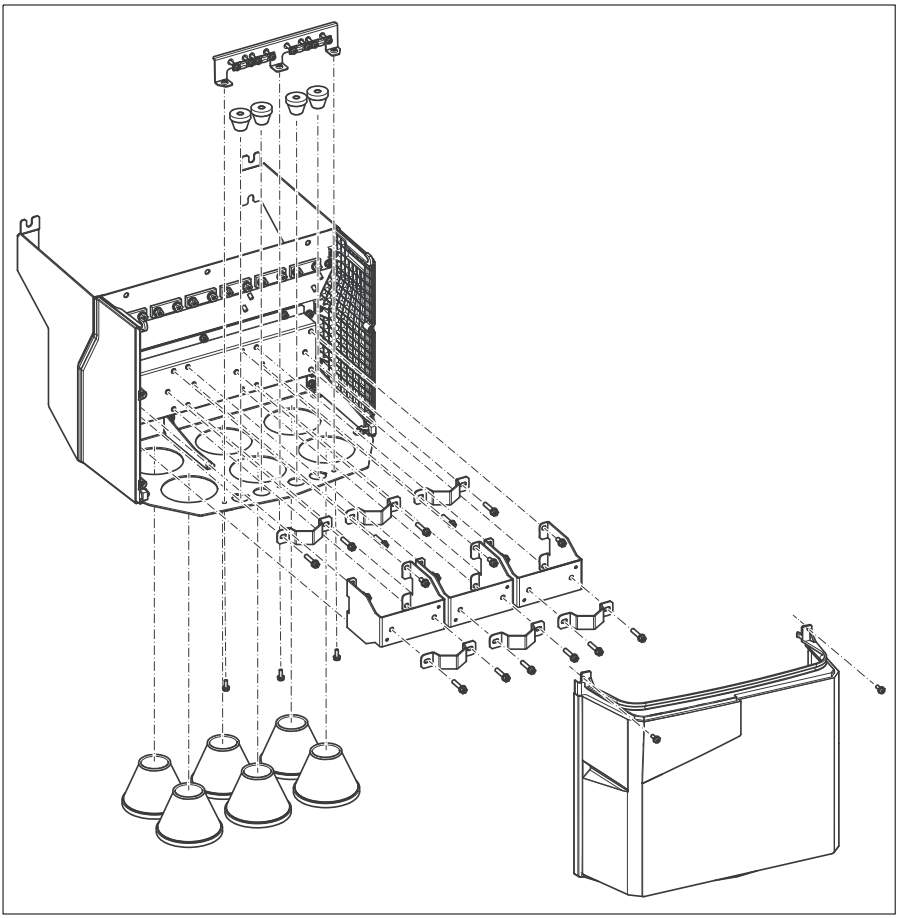
Frame R8 cable box (IP21, UL Type 1)

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



Frame R9 cable box (IP21, UL Type 1)

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



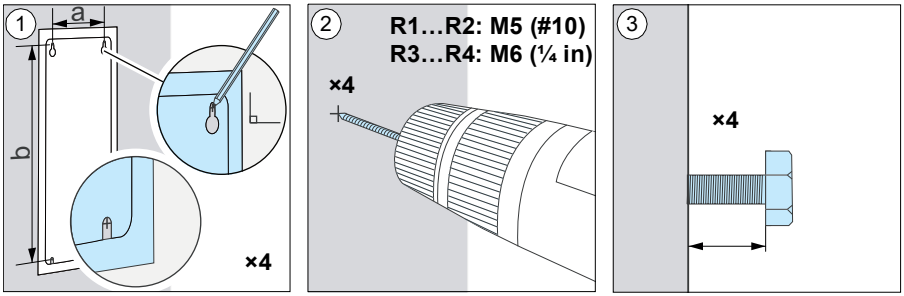
Installing the drive

Installing the drive vertically, frames R1…R4

The figures show frame R3 as an example.

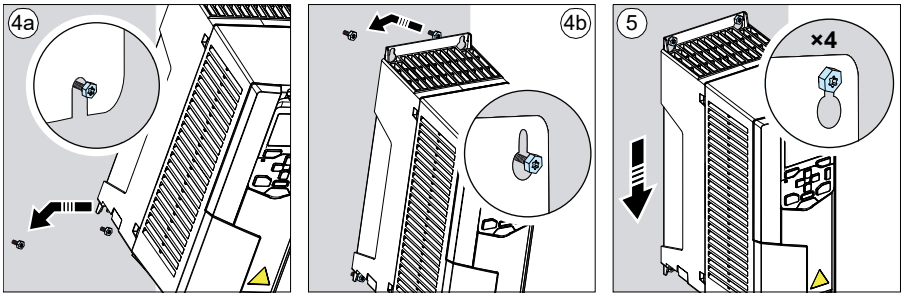
Select fasteners and their application to meet local requirements appropriate to wall surface materials, drive weight and application.

1. Mark the hole locations using the mounting template included in the package. Do not leave the mounting template under the drive. The drive dimensions and hole locations are also shown in the drawings in chapter *Dimension drawings* on page *309*.
2. Drill the mounting holes.
3. Insert anchors or plugs into the holes and start the bolts into the anchors or plugs.



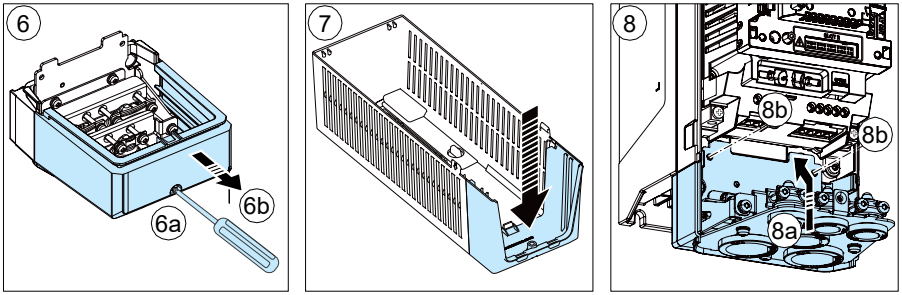
	R1		R2		R3		R4	
	mm	in	mm	in	mm	in	mm	in
a	98	3.86	98	3.86	160	6.30	160	6.30
b	317	12.48	417	16.42	473	18.62	619	24.37
Weight IP21 (UL Type 1)	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
	4.6	10.1	6.6	14.6	11.8	26.0	19.0	41.9
Weight IP55 (UL Type 12)	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**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

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



Install the cable box, frames R1…R2

6. Remove the screw (6a) and lift the cover off (6b) from the separate cable box.
7. Attach the cable box cover to the front cover.
8. Install the cable box to the frame. Position the cable box (8a) and tighten the screws (8b).

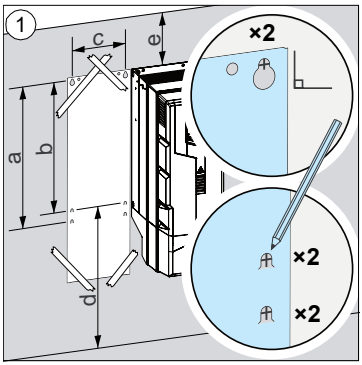


Note: Install the hood to UL Type 12 drives after you have installed the drive electrically and reinstalled covers, see page *220*.

Installing the drive vertically, frame R5

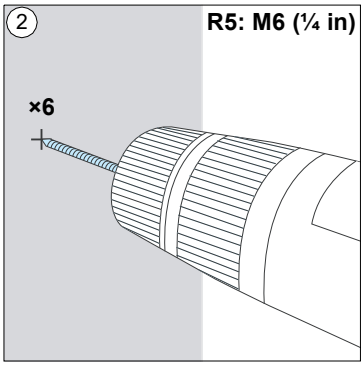
Select fasteners and their application to meet local requirements appropriate to wall surface materials, drive weight and application.

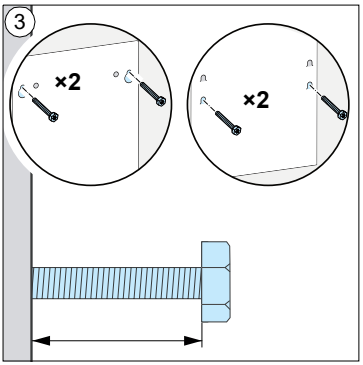
1. Mark the hole locations using the mounting template included in the package. Do not leave the mounting template under the drive. The drive dimensions and hole locations are also shown in the drawings in chapter *Dimension drawings* on page *309*.
2. Drill the mounting holes.
3. Insert fixing anchors or plugs into the holes. Start the two upper bolts and the two lowest bolts into the anchors or plugs.



	R5 IP21 (UL Type 1)		R5 IP55 (UL Type 12)	
	mm	in	mm	in
a	612	24.09	612	24.09
b	581	22.87	581	22.87
c	160	6.30	160	6.30
d >	200	7.87	200	7.87
e >	100	3.94	100	3.94

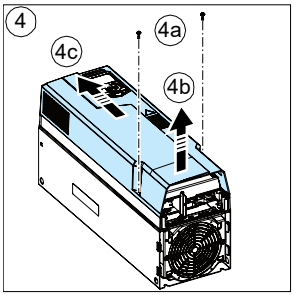
	R5 IP21 (UL Type 1)		R5 IP55 (UL Type 12)	
	kg	lb	kg	lb
	28.3	62.4	29.0	64.0

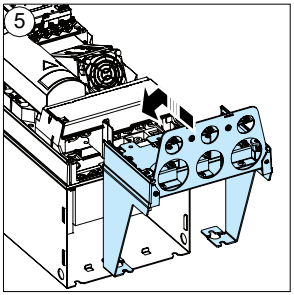


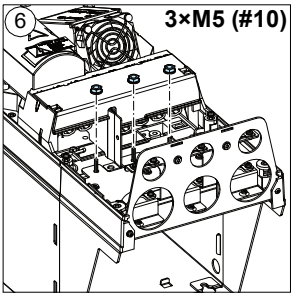


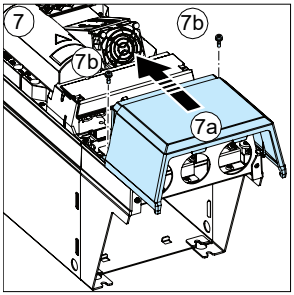
IP21 (UL Type 1)

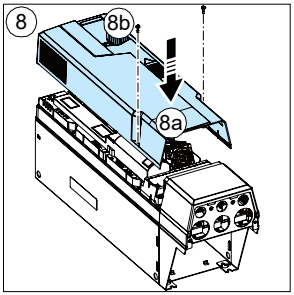
4. Remove the front cover: Remove the fastening screws (4a) with a T20 Torx screwdriver and lift the cover from the bottom upwards (4b) and then to the top side (4c).
5. Attach the cable box to the drive frame.
6. Tighten the box nuts.
7. Slide the box cover from the bottom (7a) and tighten the retaining screws (7b).
8. Put the tabs at the top of the front cover in their counterparts on the housing and then press at the bottom (8a) and tighten the retaining screws (8b).







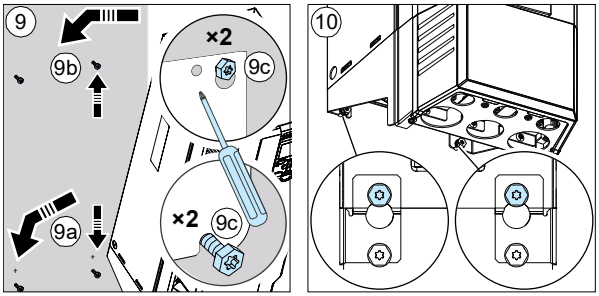




IP21 (UL Type 1), IP55 (UL Type 12)

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

10. Tighten the two remaining bolts securely.



Note: Install the hood on UL Type 12 drives after you have installed the drive electrically and reinstalled covers, see page *220*.

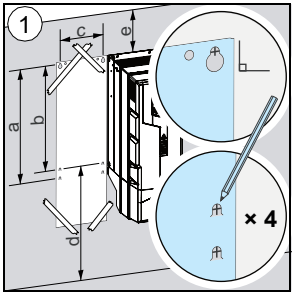
Installing the drive vertically, frames R6…R9

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

1. Mark the hole locations for the six mounting holes using the mounting template included in the package. Do not leave the mounting template under the drive.

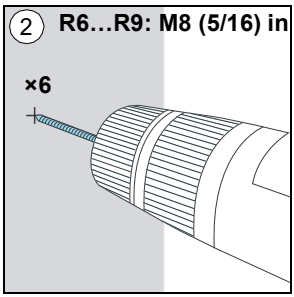
   The drive dimensions and hole locations are also shown in the drawings in chapter *Dimension drawings* on page *309*.

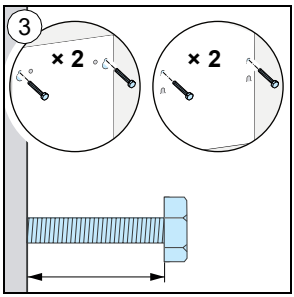
Note: You can use only two bolts instead of four to attach the lower part of the drive.

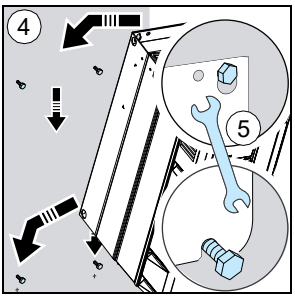


	R6		R7		R8		R9	
	mm	in	mm	in	mm	in	mm	in
a	571	22.5	623	24.5	701	27.6	718	28.3
b	531	20.9	583	23.0	658	25.9	658	25.9
c	213	8.4	245	9.7	263	10.3	345	13.6
d	300	11.8	300	11.8	300	11.8	300	11.8
e	155	6.1	155	6.1	155	6.1	200	7.9
IP21, UL Type 1	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
⚠	42.4	93.5	54	119.1	69	152.2	97	213.9
IP55, UL Type 12	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**	**kg**	**lb**
⚠	43.0	94.8	56	123.5	77	169.8	103	227.1

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

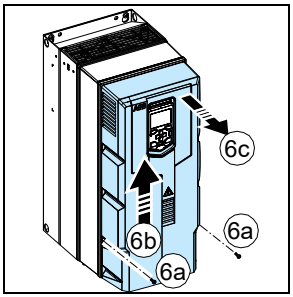


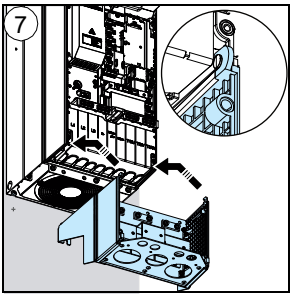


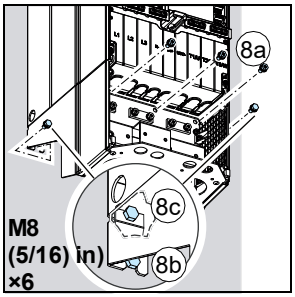


IP21 (UL Type 1)

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

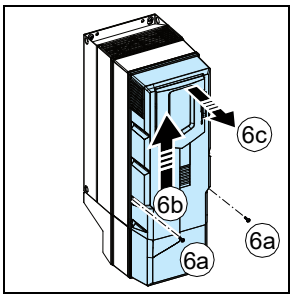






IP55 (UL Type 12)

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



Note: Install the hood for UL Type 12 drives after you have installed the drive electrically and reinstalled covers, see page *220*.

Installing the drive vertically side by side

Install the drive following the steps in the appropriate section *Installing the drive vertically, frames R1…R4* (page *73*), *Installing the drive vertically, frame R5* (page *75*) or *Installing the drive vertically, frames R6…R9* (page *78*).

Installing the drive horizontally, frames R1…R5

Install the drive following the steps in the appropriate section *Installing the drive vertically, frames R1…R4* (page 73) or *Installing the drive vertically, frame R5* (page 75). The drive can be installed either the left or right side up.

Flange mounting

Instructions for flange mounting are delivered with the flange mounting kit: *Flange mounting kit quick installation guide for ACX580-01 frames R1 to R3* (3AXD50000119172 [English]), *Flange mounting kit quick installation guide for ACX580-01 frames R4 to R5* (3AXD50000287093 [English]) or *Flange mounting kit quick installation guide for ACS880-01 and ACX580-01 frames R6 to R9* (3AXD50000019099 [English]). For more information on flange mounting, see *Flange mounting kit installation supplement* (3AXD50000019100 [English]).

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.

Limitation of liability

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.

North America

Installations must meet the requirements of UL (UL 508C) and/or CSA (C22.2 No. 14) and be compliant with NFPA 70 (NEC)[1)] and/or Canadian Electrical Code (CE) along with state and local codes for your location and application.

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

Other regions

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

Checking the compatibility of the motor and drive

Use an asynchronous AC induction motor, permanent magnet motor or synchronous reluctance motor (SynRM) with the drive. Several induction motors can be operated at a time when using scalar mode. Operation of permanent magnet motors is limited to one connection to the drive at a time.

Check that the motor and the drive are compatible according to the rating table in section *Electrical ratings* on page *244*. The table lists the typical motor power for each drive type.

Ensure that the motor withstands the maximum peak voltage in the motor terminals. See the *Requirements table* on page *84*. For basics of protecting the motor insulation and bearings in drive systems, refer to section *Protecting the motor insulation and bearings* below.

Note:

- Consult the motor manufacturer before using a motor whose nominal voltage 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.
- If the motor and drive are not of the same size, consider the following operation limits of the drive control program:
  - motor nominal voltage range 1/6 ... 2 · U_N
  - motor nominal current range 1/6 ... 2 · I_N (IEC), or 1/6 ... 2 · I_{LD} (North America), of the drive in vector control and 0 ... 2 · I_N in scalar control. The control mode is selected by a drive parameter.

Protecting the motor insulation and bearings

In North America a d*u*/d*t* filter is typically not used unless the application has very long cable lengths or when they have problems occurring.

The drive employs modern IGBT inverter technology. Regardless of frequency, the drive output comprises pulses of approximately the drive DC 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 d*u*/d*t* 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 an optional drive d*u*/d*t* and common mode filters and insulated N-end (non-drive end) motor bearings are required. Ignoring the requirements or improper installation may shorten motor life or damage the motor bearings and voids the warranty.

Motor type	Nominal AC supply voltage	Requirement for		
		Motor insulation system	ABB d*u*/d*t* 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 ≤ 690 V	Standard	n.a.	+ N + CMF
Old* form-wound HX_ and modular	380 V < U_N ≤ 690 V	Check with the motor manufacturer.	+ d*u*/d*t* with voltages over 500 V + N + CMF	
Random-wound HX_ and AM_ **	0 V < U_N ≤ 500 V	Enameled wire with fiber glass taping	+ N + CMF	

* manufactured before 1.1.1998

** For motors manufactured before 1.1.1998, contact your local ABB representative.

Motor type	Nominal AC supply voltage	Requirement for		
		Motor insulation system	ABB d*u*/d*t* 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	+ d*u*/d*t*	+ d*u*/d*t* + (N or CMF)
		or		
		Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 microsecond rise time	-	+ N or CMF

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
d*u*/d*t*	d*u*/d*t* filter at the output of the drive. Available from ABB as an optional add-on kit.
CMF	Common mode filter. Depending on the drive type, CMF is available from ABB as an optional add-on kit.
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 the braking applications

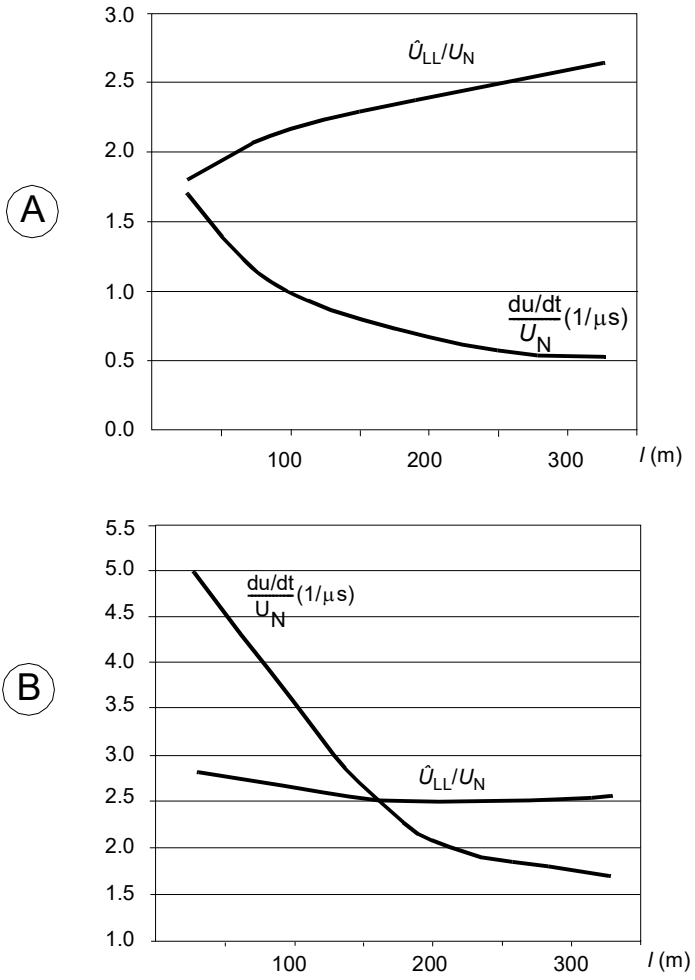
When the motor brakes the machinery, the intermediate circuit DC voltage of the drive increases, the effect being similar to increasing the motor supply voltage by up to 20 percent. Consider this voltage increase when specifying the motor insulation requirements if the motor will be braking a large part 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 data for calculating the rise time and the 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 on page 87. 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 d*u*/d*t* filter
B	Drive without d*u*/d*t* filter
l	Motor cable length
$\hat{U}_{LL}/U_N$	Relative peak line-to-line voltage
(d*u*/d*t*)/U_N	Relative d*u*/d*t* value
Note: ÛLL and d*u*/d*t* values are approximately 20% higher with resistor braking.	

Additional note for sine filters

Sine filters protect the motor insulation system. Therefore, a d*u*/d*t* filter can be replaced with a sine filter. The peak phase-to-phase voltage with the sine filter is approximately 1.5 · 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 *Electrical ratings* (page *244*) 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 90 °C (194 °F) or higher with derating.
- **Voltage:** 600 V AC cable is accepted for up to 500 V AC. 1000 V AC cable is required above 500 V AC.
- **Conductivity:** The conductivity of the PE conductor must be sufficient, see the table on page *90*.

To comply with the EMC requirements of the CE mark, use one of the approved cable types in section *Preferred power cable types, IEC and North America* on page *91*.

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.

The protective conductor must always have an adequate conductivity.

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.

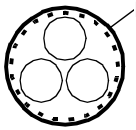
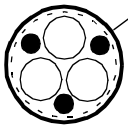
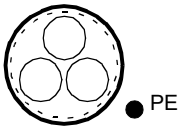
Cross-sectional area of the phase conductors S (mm^2)	**Minimum cross-sectional area of the corresponding protective conductor S_p (mm^2)**
$S \leq 16$	S
$16 < S \leq 35$	16
$35 < S$	S/2

Note: See the IEC/EN 61800-5-1 requirement on grounding in the Note on page *21*.

Power cable types

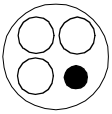
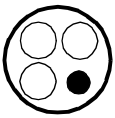
Preferred power cable types, IEC and North America

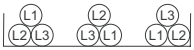
Recommended cable types are presented here. Check with local / state / country electrical codes for allowance.

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
 Symmetrical shielded (or armored) cable with three phase conductors and a shield (or armor), and separate PE conductor/cable[1)]	Yes	Yes

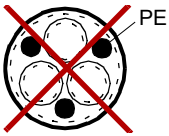
[1)] A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use. For IEC 61800-5-1 requirements, see page *90*.

Alternate power cable types

Cable type	Use as input power cabling	Use as motor cabling
 PVC 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
 EMT 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

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

Additional guidelines, North America

Follow these additional guidelines for North America with the general guidelines in section *General guidelines, IEC and North America* on page *89*.

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 NEC 70 along with state and local codes for the appropriate materials for your application.

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

Conduit - Metallic[1, 3)]	Notes
Electrical metallic tubing: Type EMT	• 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.
Rigid metal conduit: Type RMC	
Liquid-tight flexible metal electrical conduit: Type LFMC	

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 ensure there is no intrusion of water/moisture.

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

4) See routing instructions in section *General guidelines, North America* on page *103*.

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	Frames R1…R4
	Allowed	Frames R5…R8 (for U_N = 230 V only)

[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.

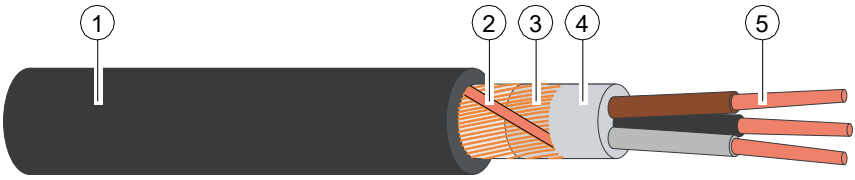
For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive. See also page 297 for the accepted cable sizes of the drive

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

Power cable shield, IEC and North America

If the cable shield is used as the sole PE conductor, make sure that the conductivity agrees with the PE conductor requirements. See section *General guidelines, IEC and North America* on page *89*, 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	Insulation jacket

2	Helix of copper tape or copper wire
3	Copper wire screen
4	Inner insulation
5	Cable core

Typical power cable sizes, IEC

The table below gives copper cable types with concentric copper shield for the drives with nominal current. The value separated by the plus sign means the diameter of the PE conductor.

See page *280* for the cable lead-through sizes allowed for the selected drive frame size.

IEC type ACH580-01-	Frame size	Cu cable type[1)]	Al cable type[1,2)]
		mm^2	mm^2
3-phase U_N = 230 V			
04A7-2	R1	3×1.5 + 1.5	-
06A7-2	R1	3×1.5 + 1.5	-
07A6-2	R1	3×1.5 + 1.5	-
12A0-2	R1	3×1.5 + 1.5	-
018A-2	R1	3×2.5 + 2.5	-
025A-2	R2	3×4.0 + 4.0	-
032A-2	R2	3×6.0 + 6.0	-
047A-2	R3	3×10 + 10	-
060A-2	R3	3×10 + 10	-
089A-2	R5	3×35 + 16	3×50 + 25
115A-2	R5	3×50 + 25	3×70 + 35
144A-2	R6	3×70 + 35	3×120 + 70
171A-2	R7	3×95 + 50	3×150 + 70
213A-2	R7	3×120 + 70	3×240 + 120
276A-2	R8	2×(3×70 + 35)	2×(3×95 + 50)
3-phase U_N = 400 V			
02A7-4	R1	3×1.5 + 1.5	-
03A4-4	R1	3×1.5 + 1.5	-
04A1-4	R1	3×1.5 + 1.5	-
05A7-4	R1	3×1.5 + 1.5	-
07A3-4	R1	3×1.5 + 1.5	-
09A5-4	R1	3×2.5 + 2.5	-
12A7-4	R1	3×2.5 + 2.5	-
018A-4	R2	3×2.5 + 2.5	-
026A-4	R2	3×6 + 6	-
033A-4	R3	3×10 + 10	-
039A-4	R3	3×10 + 10	-
046A-4	R3	3×10 + 10	-
062A-4	R4	3×25 + 16	-
073A-4	R4	3×35 + 16	-
-	R4	-	-
088A-4	R5	3×50 + 25	-
106A-4	R5	3×70 + 35	-
145A-4	R6	3×95 + 50	-
169A-4	R7	3×120 + 70	-
206A-4	R7	3×150 + 70	-
246A-4	R8	2×(3×70+35)	-

IEC type ACH580-01-	Frame size	Cu cable type[1)]	Al cable type[1,2)]
		mm^2	mm^2
293A-4	R8	2×(3×95+50)	-
-	R9	-	-
363A-4	R9	2×(3×120+70)	-
430A-4	R9	2×(3×150+70)	-

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[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 *280* for the accepted cable sizes of the drive.

[2)] Aluminum cables can be used with U_N = 230 V frames R1…R4, only.

See also section *Terminal and lead-through data for the power cables* on page *280*.

Typical power cable sizes, UL/NEC

See page *282* for the cable lead-through sizes allowed for the selected drive frame size.

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 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 *282* for the accepted cable sizes of the drive

Note: In UL installations, aluminum cables are not allowed.

Armored cable / shielded power cable, IEC and North America

Six-conductor (three phases and three ground) type MC continuous corrugated armor cable with symmetrical grounds is available from the following suppliers (trade names in parentheses):

- Anixter Wire & Cable (Philsheath)
- BICC General Corp (Philsheath)
- Rockbestos Co. (Gardex)
- Oaknite (CLX).

Shielded power cables are available from the following suppliers:

- Belden
- LAPPKABEL (ÖLFLEX)
- Pirelli.

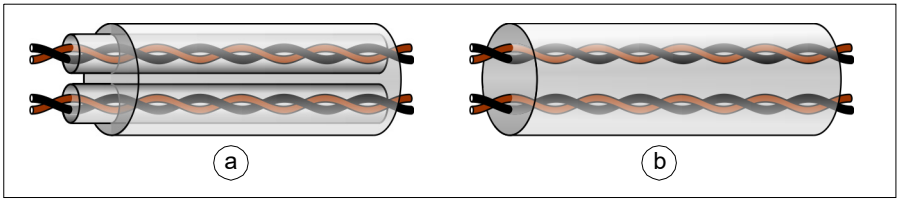
Selecting the control cables, IEC and North America

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.

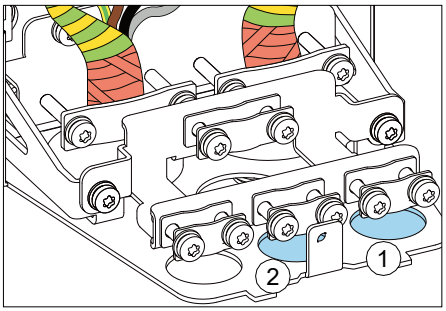
Drive composer PC tool cable

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).

FPBA-01 PROFIBUS DP adapter module connectors

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

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



Routing the cables

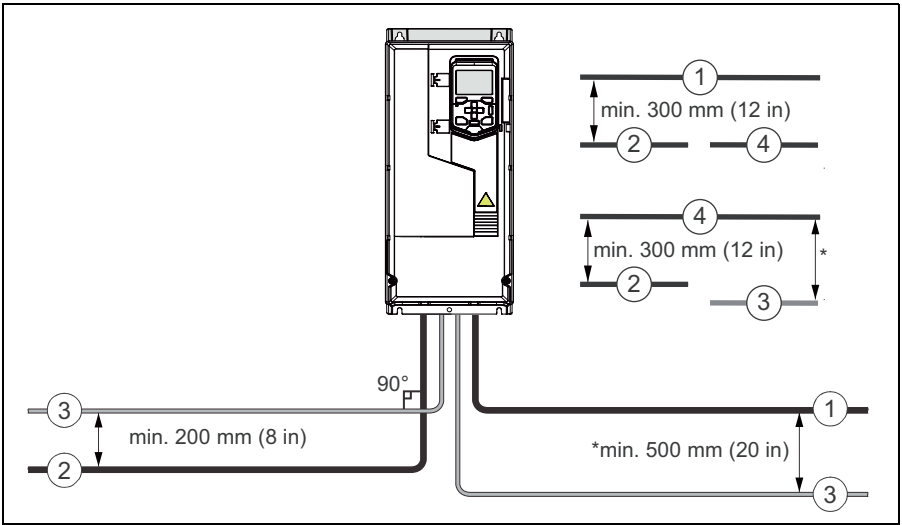
General guidelines, IEC

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.

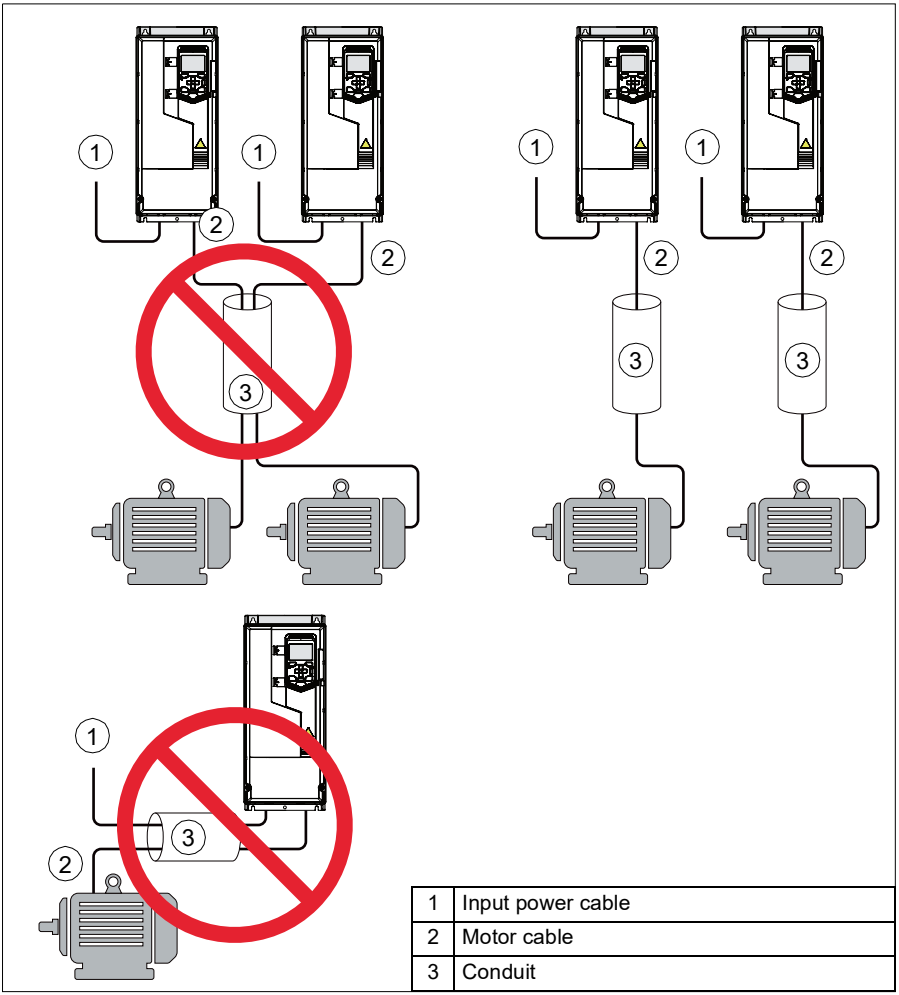


1	Motor cable. When the motor cable is symmetrical and shielded, distances between the motor cable and other cables can be reduced by half.
2	Input power cable
3	Control cable
4	Brake resistor/chopper cable

General guidelines, North America

The following illustrates general guidelines for routing power and motor cabling in conduit. Ensure the installation of your application is in accordance with national and local codes

- Do not run input power cable and motor cable in the same conduit.
- Use separate conduit for each motor cable run.



1	Input power cable
2	Motor cable
3	Conduit

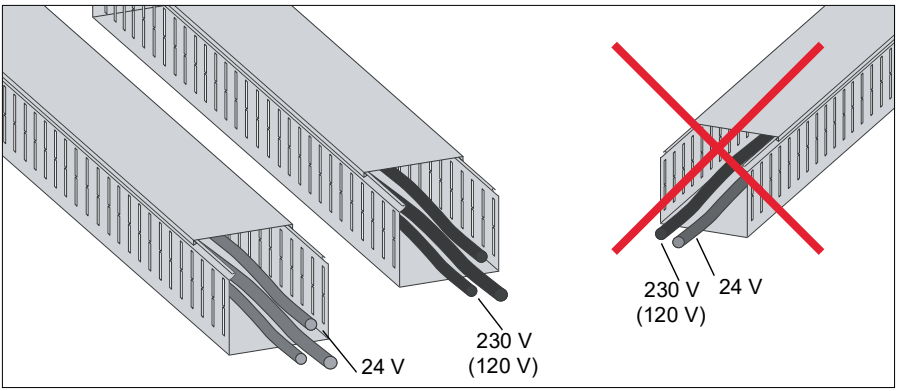
Continuous motor cable shield or enclosure for equipment on the motor cable

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.
- North America: Install the equipment in a way that the conduit or motor cable shielding runs continuously without breaks from the drive to the motor and is earthed at only the drive and motors ends.

Separate control cable ducts, IEC and North America

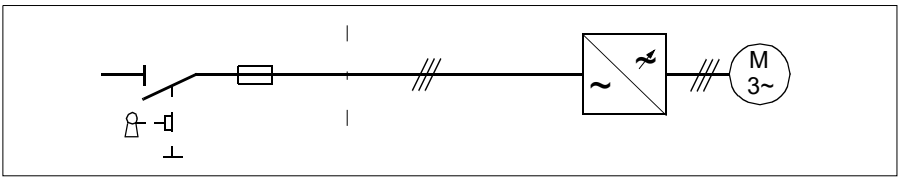
Wire 24 V and 230 V (120 V) control cables in separate ducts unless the 24 V cable is insulated for 230 V (120 V) or insulated with an insulation sleeving for 230 V (120 V).



Implementing short-circuit and thermal overload 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*, page *262*. 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, IEC

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

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

You can use the circuit breakers listed in chapter *Circuit breakers (IEC)*, page *266*. Other circuit breakers can be used with drive if they provide the same electrical characteristics. ABB does not assume any liability whatsoever for the correct function and protection with circuit breakers not listed below. Furthermore, if the recommendations given by ABB are not obeyed, the drive can experience problems that warranty does not cover.

Protecting the motor and motor cable in short-circuits

The drive protects the motor cable and a single 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 motor thermal overload device for protecting each motor cable and motor against overload. The drive overload protection is for the sum of the total motor load. It may not trip due to an overload in one motor.

Protecting the motor against thermal overload

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value, the function either monitors a calculated temperature value (based on a motor thermal model, which in turn is based on the motor nominal current) 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 *ACH580 HVAC control program firmware manual* (3AXD50000027537 [English]).

Protecting the drive against ground faults

The drive is equipped with an internal ground fault protective function to protect the unit against ground faults in the motor and motor cable. This is not a personnel safety or a fire protection feature. The ground fault protective function can be changed with a parameter 31.20 Earth fault.

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 nuisance faults in circuit breakers.

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 *Safe torque off function* on page *345*.

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

Note: Option +Q971 is not available for North America.

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]).

Using a safety switch between the drive and the motor

It is recommended 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 the motor control mode and stopping method selected.

When you have selected

- Vector control mode and motor ramp stop, use the following operational sequence to open the contactor.

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

When you have selected

- Vector control mode and motor coast stop; or scalar control mode, use the following operational sequence to open the contactor.

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 operate 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.

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

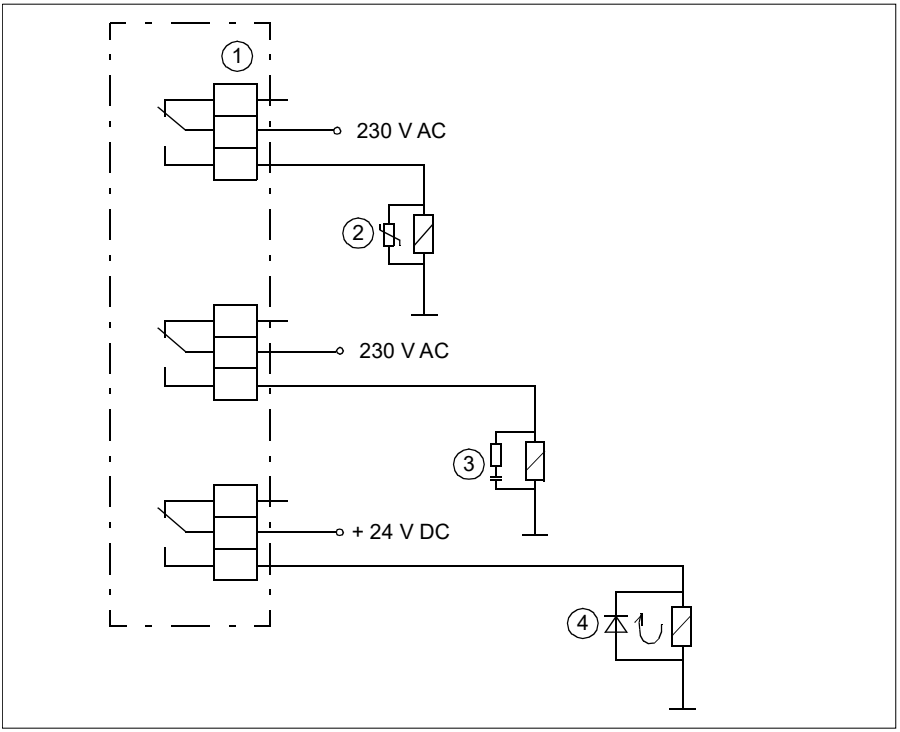
See *ACH580 HVAC control program firmware manual* (3AXD50000027537 [English]).

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 sections *Isolation areas, R1…R5* on page *292* and *Isolation areas, R6…R9* on page *293*.

Implementing a motor temperature sensor connection

WARNING! IEC 60664 requires 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 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 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 an extension module with reinforced insulation (eg, CMOD-02) between the sensor connector and the other connectors of the module. See the table below for the sensor insulation requirement. For sensor connection to the extension module, see its manual.
4. You can connect a sensor to an external thermistor relay the insulation of which is rated for the main circuit voltage of the drive.

See:

- section *AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs (X1)* on page *152* (IEC) or *AI1 and AI2 as Pt100, Pt1000, Ni1000, KTY83 and KTY84 sensor inputs (X1)* on page *206* (North America)
- section *CMOD-02 multifunction extension module (external 24 V AC/DC and isolated PTC interface)* on page *379*
- *CPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (+L537+Q971) user's manual* (3AXD50000030058 [English]).

The table shows what temperature sensor types you can connect to the drive I/O extension modules as well as the insulation requirement for the sensor.

Extension module		**Temperature sensor type**		
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). –> No special requirements for the thermistor insulation level. (The drive control board is PELV compatible also when the module and a thermistor protection circuit are installed.)	X	-	-
CPTC-02		X	-	-