ABB MACHINERY DRIVES

ACS880-M04 drive

Hardware manual

List of related manuals

Drive manuals and guides	Code (English)
ACS880-M04 firmware manual	*3AXD50000030629*
ACS880-M04 hardware manual	*3AXD50000028613*
ACS880-M04 quick installation guide	*3AXD50000032345*

Option manuals and guides	
ACX-AP-X Assistant control panels user's manual	*3AUA0000085685*
ACS-BP-S Basic control panel user's manual	*3AXD50000032527*
ACS880-01 drives and ACS880-04 drive modules Common DC systems Application guide	*3AUA0000127818*
Drive (IEC 61131-3) application programming manual	*3AUA0000127808*
FDPI-02 diagnostics and panel interface user's manual	*3AUA0000113618*
FSO-12 safety functions module user's manual	*3AXD50000015612*
Technical Guide No. 3 – EMC Compliant Installation and Configuration for a Power Drive System	*3AFE61348280*
Converter module capacitor reforming instructions	*3BFE64059629*
Manuals and quick guides for I/O extension modules, fieldbus adapters, safety options, etc.	

Tool and maintenance manuals and guides	
Drive composer PC tool user's manual	*3AUA0000094606*

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.

Hardware manual

ACS880-M04 machinery drive

3AXD50000028613 Rev B
EN
EFFECTIVE: 2024-01-24

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1

Safety instructions

Contents of this chapter

This chapter contains the safety instructions which you must follow 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 warning 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.
	**Hot surface warning** warns you of component surfaces that may become hot enough to cause burns if touched.

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

- Handle the drive carefully.
- Use safety shoes with a metal toe cap to avoid foot injury.
- 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. For more information, see sections *Checking the installation site* on page *49* and on page *128*.
- 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 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. If these functions are activated, the installation must be clearly marked as defined in IEC/EN 61800-5-1, subclause 6.5.3, for example, "THIS MACHINE STARTS AUTOMATICALLY".
- The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors. The maximum number of times the circuit can charge is: 100000 (frames R1-R2) and 50000 (frames R3-R4).

If you have connected safety circuits to the drive (for example, emergency stop and Safe torque off), validate them at the start up.

Note:

- If you select an external source for start command and it is On, the drive will start immediately after fault reset, unless you configure the drive for pulse start.
- When the control location is not set to Local, the stop key on the control panel will not stop the drive.

  Drives can be repaired only by an authorized person.

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! Follow these instructions. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrician, do not do the 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.
   - Open the main disconnector at the power supply of the drive.
   - Make sure that reconnection is not possible. Lock the disconnector to open position and attach a warning notice to it.
   - Disconnect any external power sources from the control circuits before you do work on the control cables.

   CAUTION - Risk of electric shock. After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized.
   - Use a multimeter with an impedance of at least 1 Mohm.
   - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding terminal (PE) is close to 0 V.
   - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding terminal (PE) is close to 0 V.
6. Install temporary grounding as required by the local regulations.
7. Ask for a permit to work from the person in control of the electrical installation work.

Additional instructions and notes

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

- If you install the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), disconnect the internal EMC filter; otherwise the system will be connected to ground potential through the EMC filter capacitors. This can cause danger or damage the drive. See page *78*.
  Note: Disconnecting the internal EMC filter increases the conducted emission and reduces the drive EMC compatibility considerably. See section *Compliance with the EN 61800-3:2004* on page *136*.
- 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.
- 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 components on the boards are 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! Follow 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 electrician, 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 *54*. 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.
- Standard IEC/EN 61800-5-1 (section 4.3.5.5.2.) requires 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,

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

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

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

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

Start-up and operation:

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

General safety in operation

These instructions are for all personnel that operate the drive.

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

- Do not control the motor with the disconnector at the drive power supply; instead, use the control panel start and stop keys or commands through the I/O terminals of the drive.
- 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. 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".

Note: When the control location is not set to Local, the stop key on the control panel will not stop the drive.

2

About the manual

Contents of this chapter

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

Applicability

This manual applies to the ACS880-M04 drive module of frame sizes R1 to R4.

Intended audience

This manual is intended for people who plan the installation, install, commission, use and service the drive. Read the manual before working on the drive. The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

This manual is written for readers worldwide. Both SI and imperial units are shown wherever appropriate.

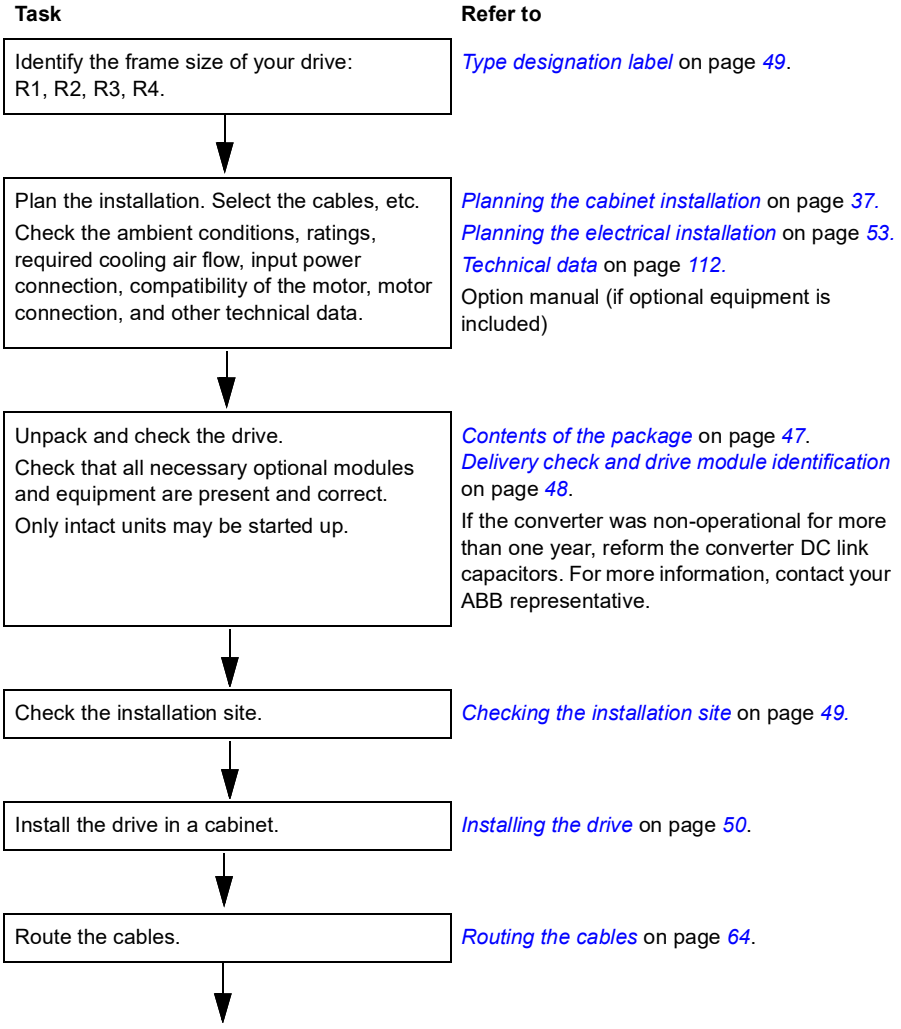
Categorization according to frame size

The ACS880-M04 drive is manufactured in frame sizes R1 to R4. Some instructions, technical data and dimensional drawings which concern only certain frame sizes are marked with the symbol of the frame size (R1, R2, R3, R4). The frame size is marked on the drive designation label. See also the frame size of each drive type in the ratings tables in chapter *Technical data*.

Categorization according to the + code

The instructions, technical data and dimensional drawings which concern only certain optional selections are marked with + codes, e.g. +L500. The options included in the drive can be identified from the + codes visible on the type designation label of the drive. See the + code selections listed in *Type designation label* on page *33*.

Quick installation and commissioning flowchart



Task	Refer to
Check the insulation of the supply cable, the motor and the motor cable, and the resistor cable (if present).	*Checking the insulation of the assembly* on page *77*.
If the drive is about to be connected to an IT (ungrounded) system, disconnect the internal varistors and EMC filters. Also note that using an EMC filter is not allowed in an IT (ungrounded) system.	*Electrical safety in installation, start-up and maintenance* on page *15*. *Checking the compatibility with IT (ungrounded) systems* on page *78*.
Connect the power cables.	*Connecting the power cables* on page *79*.
Connect the control and the auxiliary control cables.	*Connecting the control unit* on page *87*. For optional equipment: *Mains chokes* on page *163*. *EMC filters* on page *167*. *Resistor braking* on page *181*. Manuals for any optional equipment
Check the installation.	*Installation checklist* on page *101*.
Commission the drive.	*Start-up* on page *103*. Firmware manual [*3AXD50000030629* (English)]
Commission the brake chopper if required.	*Resistor braking* on page *181*.
Operate the drive: start, stop, speed control etc.	Firmware manual [*3AXD50000030629* (English)]

Terms and abbreviations

Term/Abbreviation	Explanation
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. Refer to *Brake chopper*.
Control board	Circuit board in which the control program runs.
Capacitor bank	Refer to DC link capacitors.
DC link	DC circuit between rectifier and drive
DC link capacitors	Energy storage which stabilizes the intermediate circuit DC voltage
Drive	Frequency converter for controlling AC motors
EFB	Embedded fieldbus
EMC	Electromagnetic compatibility
FBA	Fieldbus adapter
FCAN-01/-01-M	Optional CANopen adapter module
FCNA-01	ControlNet adapter module
FDNA-01	Optional DeviceNet adapter module
FECA-01/-01-M	Optional EtherCAT adapter module
FENA-01/-11/-21/-21-M	Optional Ethernet adapter module for EtherNet/IP, Modbus TCP and PROFINET IO protocols
FEPL-02	Ethernet POWERLINK adapter module
FPBA-01/-01-M	Optional PROFIBUS DP 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, refer to Type designation key on page 34.
FSCA-0x	Optional Modbus/RTU adapter module
IGBT	Insulated Gate Bipolar Transistor; a voltage-controlled semiconductor type widely used in drives due to their easy controllability and high switching frequency.
I/O	Input/Output
JBR-xx	Series of optional brake resistors
JFI-xx	Series of optional EMC filters
JPU/RPU	Power unit; see the definition below.
Power unit	Contains the power electronics and connections of the drive module. The ZCU is connected to the power unit.

Term/Abbreviation	Explanation
RFI	Radio-frequency interference
ZMU	The memory unit attached to the control unit of the drive.
ZCU	The control unit of the drive module. The ZCU is installed on top of the power unit. The external I/O control signals are connected to the ZCU, or optional I/O extensions mounted on it.

3

Operation principle and hardware description

Contents of this chapter

The chapter describes the operating principle and construction of the drive module.

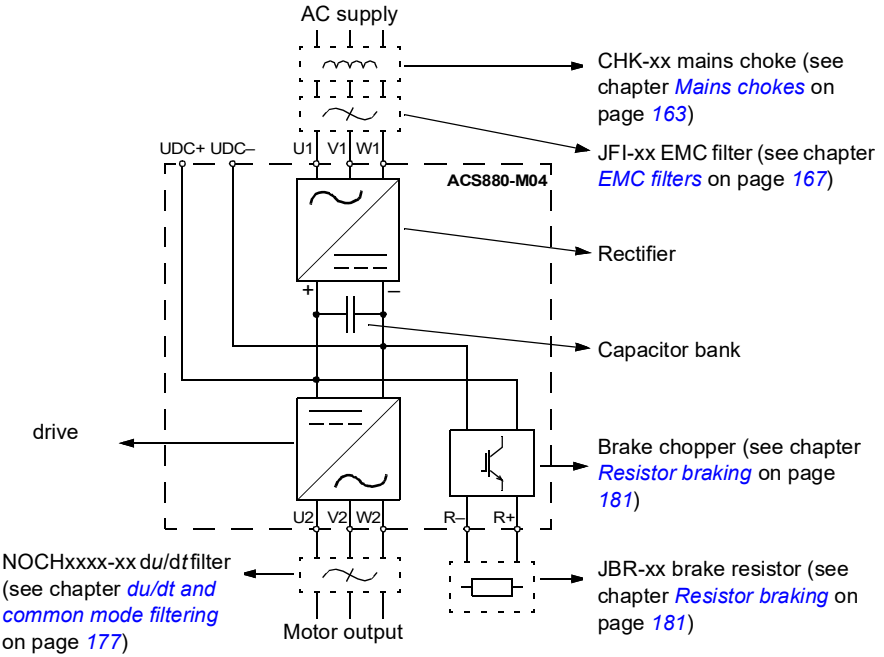
ACS880-M04 drive overview

The ACS880-M04 is an air-cooled IP20 drive module for controlling asynchronous induction motors, permanent magnet motors and ABB synchronous reluctance motors. It must be installed into a cabinet by the customer.

The drive is available in several frame sizes depending on the output power. All frame sizes use the same control unit of ZCU type.

Operation principle

Main circuit



Motor control

The motor control is based on direct torque control. Two phase currents and DC link voltage are measured and used for the control. The third phase current is measured for earth fault protection.

Layout

General

The DC input terminals are located at the top of the module and the AC output terminals are located at the bottom of the module.

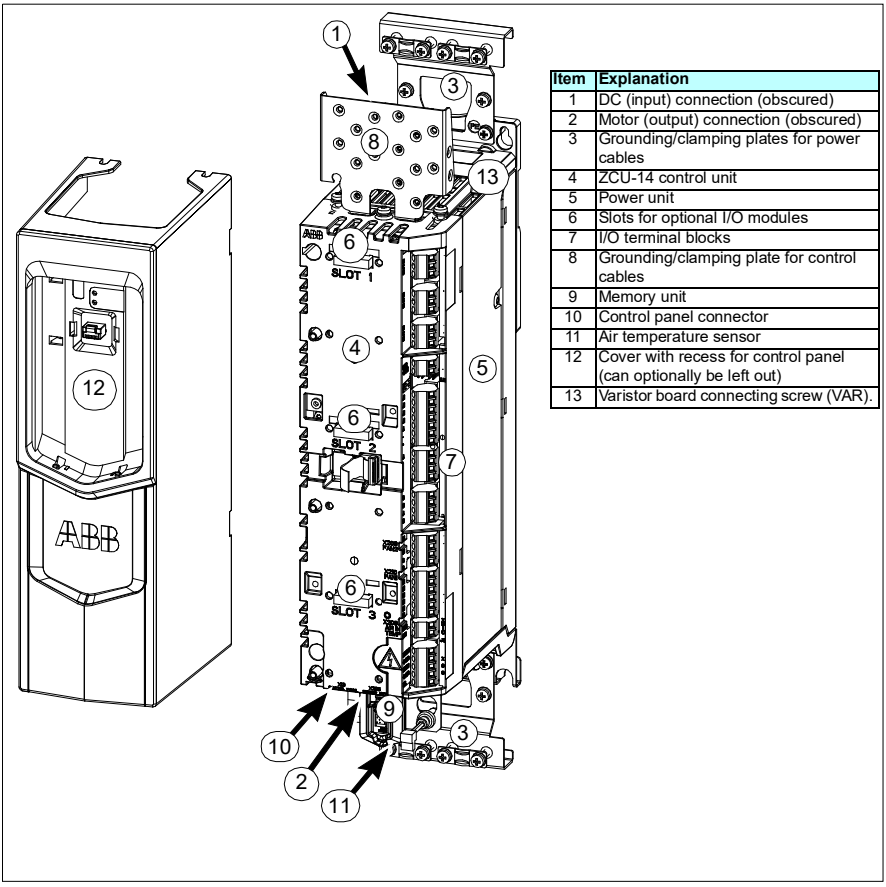
The ZCU-14 control unit is mounted onto the module. The control unit contains the basic I/Os and slots for optional I/O modules. For descriptions of the I/O terminals on the control unit, see *Connecting the control unit* on page *87*.

Other optional equipments are primarily installed on separate mounting plates.

The modules are fitted with external DC fuses. The frames R1...R4 modules have an internal capacitor pre-charge circuit.

Module layout – Frame R1

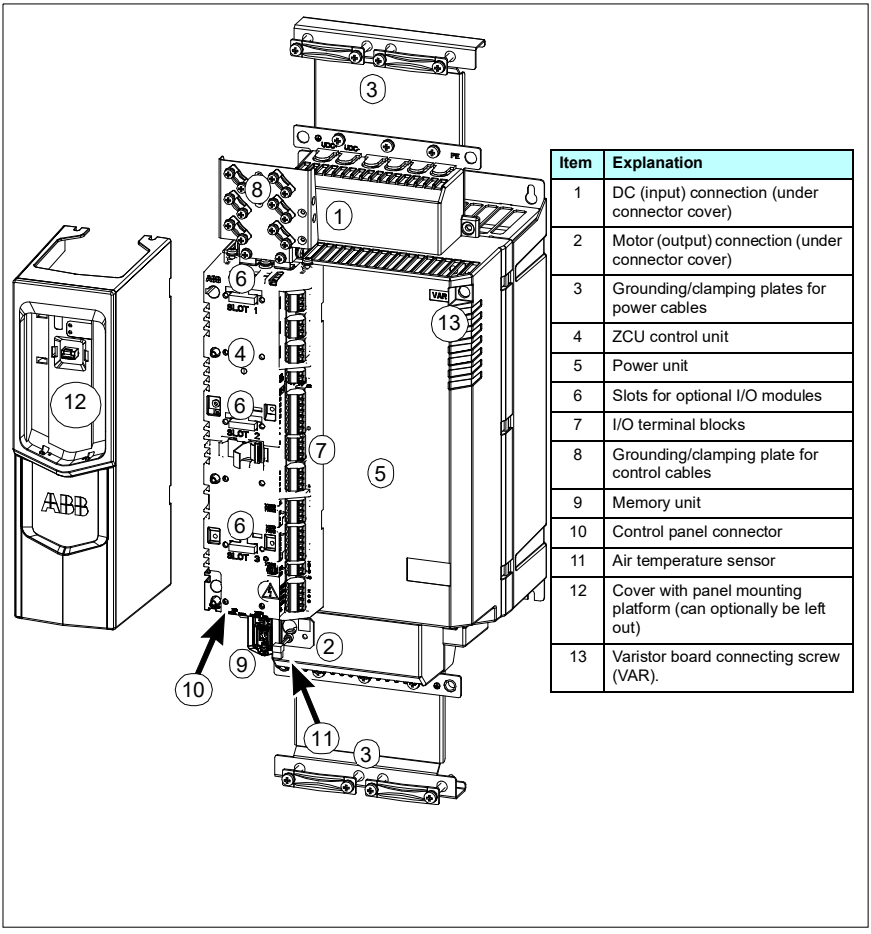
(Note that frame R2 has a similar layout)



Item	Explanation
1	DC (input) connection (obscured)
2	Motor (output) connection (obscured)
3	Grounding/clamping plates for power cables
4	ZCU-14 control unit
5	Power unit
6	Slots for optional I/O modules
7	I/O terminal blocks
8	Grounding/clamping plate for control cables
9	Memory unit
10	Control panel connector
11	Air temperature sensor
12	Cover with recess for control panel (can optionally be left out)
13	Varistor board connecting screw (VAR).

Module layout – Frame R4

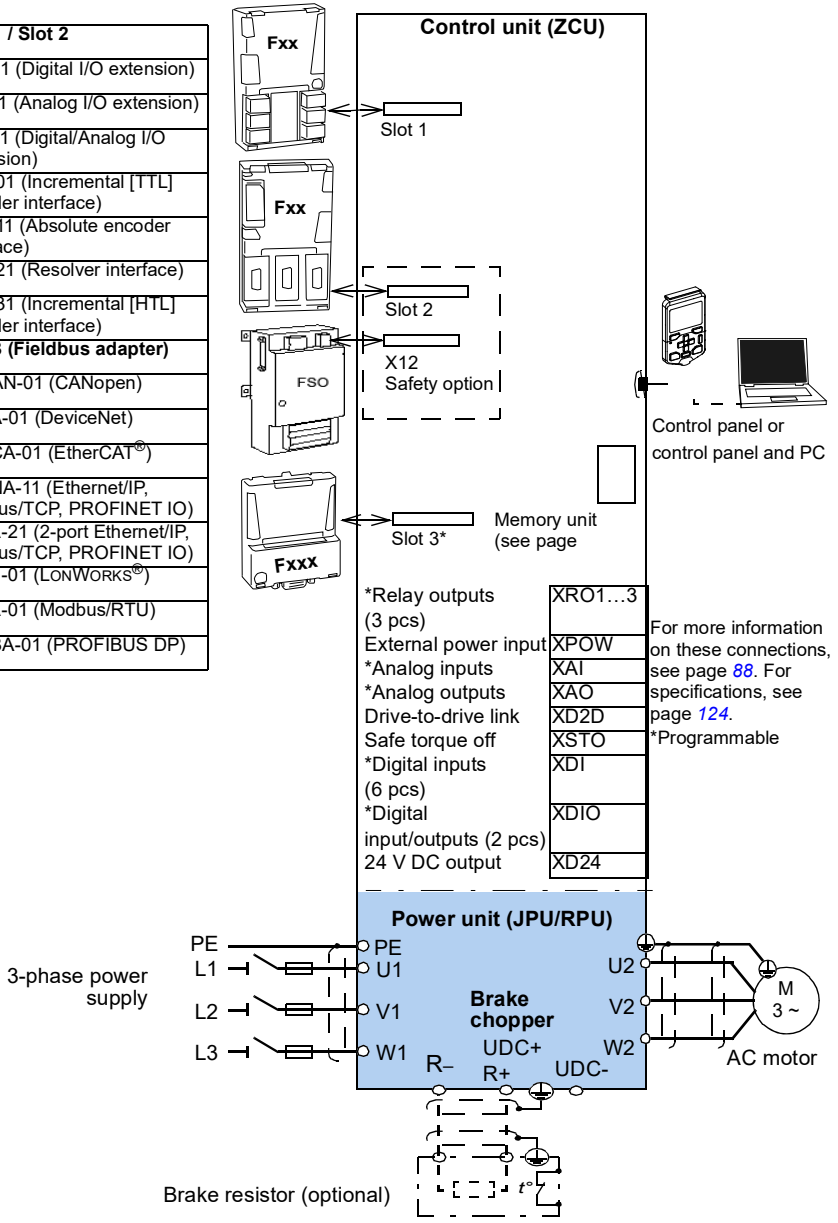
(Note that frame R3 has a similar layout.)



Item	Explanation
1	DC (input) connection (under connector cover)
2	Motor (output) connection (under connector cover)
3	Grounding/clamping plates for power cables
4	ZCU control unit
5	Power unit
6	Slots for optional I/O modules
7	I/O terminal blocks
8	Grounding/clamping plate for control cables
9	Memory unit
10	Control panel connector
11	Air temperature sensor
12	Cover with panel mounting platform (can optionally be left out)
13	Varistor board connecting screw (VAR).

Power connections and control interfaces

Slot 1 / Slot 2
FIO-01 (Digital I/O extension)
FIO-11 (Analog I/O extension)
FIO-21 (Digital/Analog I/O extension)
FEN-01 (Incremental [TTL] encoder interface)
FEN-11 (Absolute encoder interface)
FEN-21 (Resolver interface)
FEN-31 (Incremental [HTL] encoder interface)
Slot 3 (Fieldbus adapter)
**FCAN-01 (CANopen)
FDNA-01 (DeviceNet)
**FECA-01 (EtherCAT®)
**FENA-11 (Ethernet/IP, Modbus/TCP, PROFINET IO)
FENA-21 (2-port Ethernet/IP, Modbus/TCP, PROFINET IO)
FLON-01 (LONWORKS®)
FSCA-01 (Modbus/RTU)
**FPBA-01 (PROFIBUS DP)



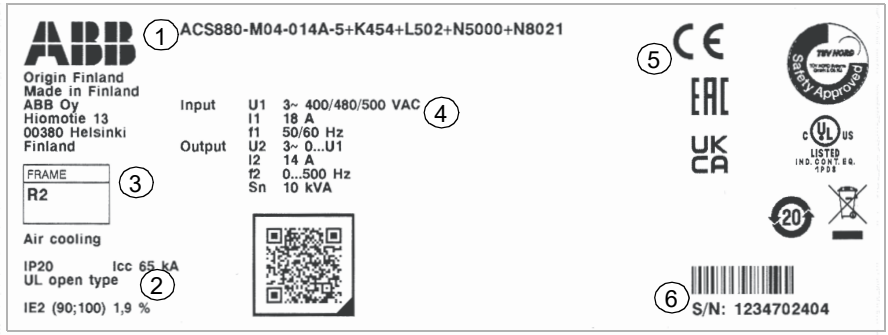
Note:

*Reserved for fieldbus is included in delivery.

**Also supports M-series fieldbuses.

Type designation label

This is a sample type designation label.



No.	Description
1	Type designation, see *Type designation key* below.
2	Degree of protection
3	Frame (size)
4	Nominal ratings, see *Ratings* on page *112*.
5	Valid markings
6	S/N: Serial number in format MYYWWXXXX, where M: Manufacturer YY: Year of manufacture: 15, 16, 17, ... for 2015, 2016, 2017, ... W: Week of manufacture: 01, 02, 03, ... for week 1, week 2, week 3, ... XXXX: Running item number starting each week from 0001.

Type designation key

The type designation key tells you the specifications and configuration of the drive. The table shows the primary drive variants.

Sample type code: ACS880-M04-04A8-5+XXXX

- The first digits from left indicate the basic configuration (ACS880-M04-04A8-5).
- The optional selections are given thereafter, preceded by + signs (e.g. +L501).

The main selections are described below.

Note: Not all selections are necessarily available for all types; refer to *ACS880-M04 ordering information*, available on request.

Selection	Alternatives	
Product series	ACS880	
Type	M04	Drive module. When no options are selected: IP20 (UL Open Type), plain front cover, no control panel, no mains choke (frames R1 and R2), internal mains choke (frames R3 and R4), no EMC filter, internal brake chopper, coated boards, Safe torque off, Primary control program, *Quick installation and start-up Guide*.
Current rating	04A8	For example, 04A8 refers to a nominal output current of 4.8 A. See *Ratings* on page *112*.
Voltage range	2 5	200…240 V 380…500 V
Option codes (plus codes)		
Filters	E...	+E200: EMC filter, C3, 2nd Environment, Unrestricted (Earthed network) (External with frames R1 and R2, internal with frames R3 and R4)
Control panel and front cover options	J...	+0C168: No drive module front cover, no control panel +J400: Control panel mounted on drive module front cover +J410: Control panel with door mounting platform kit including 3 m cable +J414: Control panel mounting platform on drive module (no control panel included)
Fieldbus	K...	+K451: FDNA-01 DeviceNet adapter module +K452: FLON-01 LonWorks® adapter module +K454: FPBA-01 PROFIBUS DP adapter module +K457: FCAN-01 CANopen adapter module +K458: FSCA-01 Modbus/RTU adapter module +K473: FENA-11 Ethernet/IP™, Modbus/TCP and PROFINET IO adapter module +K469: FECA-01 EtherCAT® adapter module

Selection	Alternatives	
I/O extensions and feedback interfaces	L...	+L500: FIO-11 analog I/O extension module +L501: FIO-01 digital I/O extension module +L502: FEN-31 HTL encoder interface module +L516: FEN-21 resolver interface module +L517: FEN-01 TTL encoder interface module +L518: FEN-11 absolute TTL encoder interface module +L519: FIO-21 analog/digital I/O extension module
Programs	N...	+N5050: Crane control program **Note:** The following technology library is required with the Crane control program: +N3050: Crane technology library +N5000: Winder control program +N8200 High-speed control program
Specialties		+P904: Extended warranty
Printed hardware and firmware manuals in specified language (The delivered manual set can include manuals in English if the translation is not available.)	R...	+R700: English +R701: German +R702: Italian +R703: Dutch +R704: Danish +R705: Swedish +R706: Finnish +R707: French +R708: Spanish +R709: Portuguese +R710: Portuguese spoken in Brazil +R711: Russian +R714: Turkish

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4

Planning the cabinet installation

Contents of this chapter

This chapter guides in planning the installation of a drive module into a user-defined cabinet. The issues discussed are essential for safe and trouble-free use of the drive system.

Note: The installation examples in this manual are provided only to help the installer in designing the installation.

⚠ **WARNING!** Installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations.

Cabinet construction

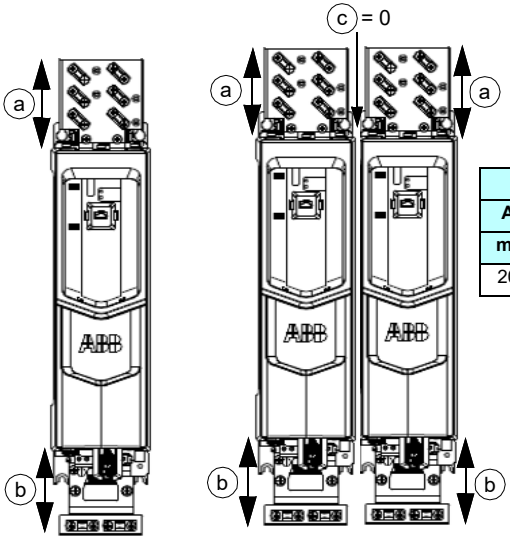
Cabinet frame	
Make sure...	☑
The cabinet frame is sturdy enough to carry the weight of the drive components, control circuitry and other equipment installed in it.	☐
The cabinet protects the drive module against contact and meets the requirements for dust and humidity. See data for relative humidity and contamination under *Ambient conditions* on page *132*.	☐
Disposition of devices	
Check that ...	
The layout is spacious enough for easy installation and maintenance. There should be sufficient space for cooling air flow, obligatory clearances, cables and cable support structures. See the layout example in *Cooling and degrees of protection* on page *42*.	☐
Grounding of mounting structures	
Make sure ...	
Proper grounding of • all cross-members or shelves on which the drive system components are mounted • the components through their fastening points to the installation base. **Note**: It is recommended to mount the EMC filter (if present) and the drive module on the same mounting plate.	☐
The connecting surfaces are left unpainted.	☐

Free space requirements

The drive modules can be installed side by side. The alternate ways to install the modules are illustrated below. See the free space requirements table below.

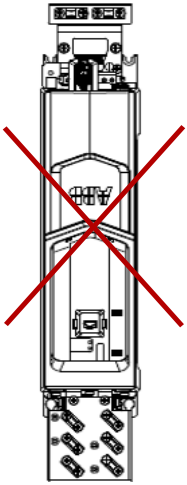
For dimensions of the drive modules, refer to chapter *Dimension drawings* on page *189*.

Vertically alone or side by side

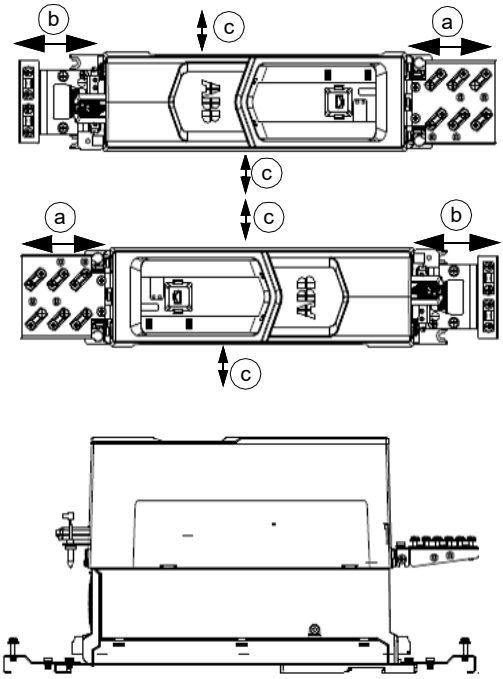


Free space requirement					
Above (a)		Below (b)		On the sides (c)	
mm	in	mm	in	mm	in
200	7.9	300	12	0	0

Do not install the drive upside down.

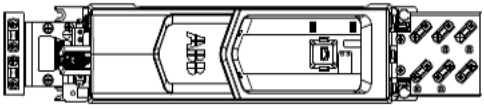


Horizontally alone or side by side back installation

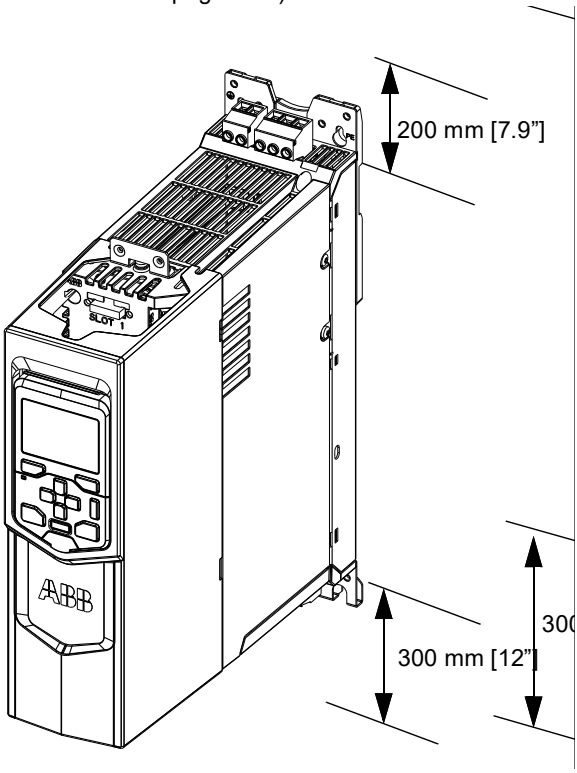


Horizontally alone side installation

This installation is recommended only with the R1 frame. For this kind of installation with other frames, use additional support.

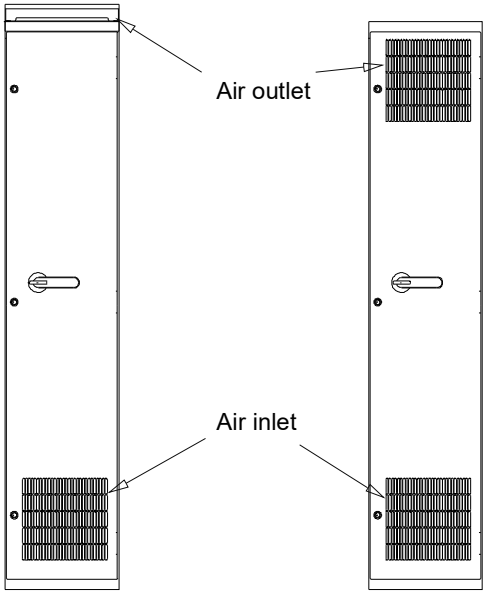


Note: EMC filters of type JFI-x1 mounted directly above the drive module do not increase the free space requirements. (For EMC filters of type JFI-0x, see the dimension drawing of the filters on page *193*.)

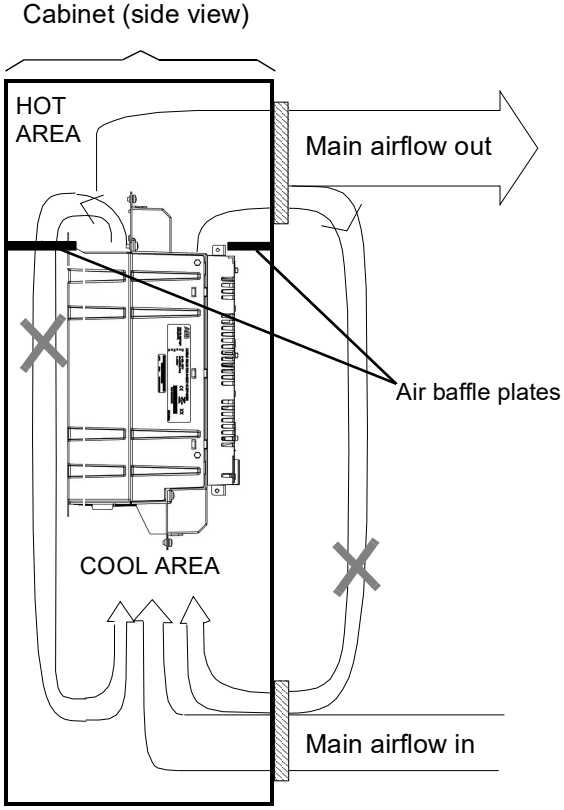


Note: The temperature of the cooling air entering the unit must not exceed the maximum allowed ambient temperature (see *Ambient conditions* on page *132*). Consider this when installing heat-generating components (such as other drives, mains chokes and brake resistors) nearby.

Cooling and degrees of protection

Check that...	☑
The cabinet has enough free space for the components for sufficient cooling. Observe the minimum clearances given for each component.	☐
The air inlets and outlets are equipped with gratings that guide the airflow, protect against contact, and prevent water splashes from entering the cabinet. The drawing below shows two typical cabinet cooling solutions. The air inlet is at the bottom of the cabinet, while the outlet is at the top, either on the upper part of the door or on the roof.  	☐
The air inlets and outlets are sufficient in size. **Note**: In addition to the power loss of the drive module, ventilate the heat dissipated by cables and other additional equipment.	☐
Cooling of the modules is arranged such that the requirements meet the data in *Cooling* on page *130*. **Note**: The values apply to continuous nominal load. If the load is less than nominal, less cooling air is required.	☐
Ambient temperature is within the limits specified in *Ambient conditions* on page *132*.	☐
The installation site is sufficiently ventilated.	☐
In IP22 cabinets, the internal cooling fans of the modules are usually sufficient to keep the component temperatures low enough.	☐
In IP54 cabinets, thick filter mats are used to prevent water splashes from entering the cabinet. This entails the installation of additional cooling equipment, such as a hot air exhaust fan.	☐

Preventing recirculation of hot air



Outside the cabinet

Prevent hot air circulation outside the cabinet by leading the outcoming hot air away from the area where the inlet air to the cabinet is taken. Possible solutions are listed below:

- gratings that guide airflow at the air inlet and outlet
- air inlet and outlet at different sides of the cabinet
- cool air inlet in the lower part of the front door and an extra exhaust fan on the roof of the cabinet.

Inside the cabinet

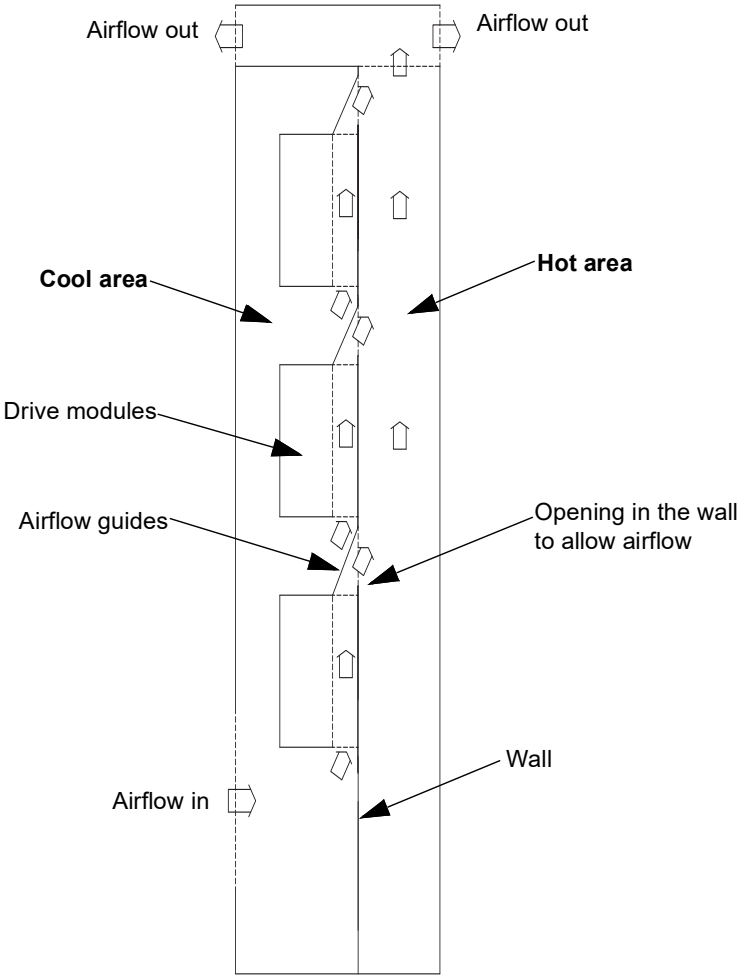
Prevent hot air circulation inside the cabinet with leak-proof air baffle plates. No gaskets are usually required.

Cabinets with multiple modules

The hot air from a drive module must not enter another module. In a cabinet with multiple modules, the practical way is to install a wall to separate the cool area (at the front part of the cabinet) from the hot area (back part). The wall can be fastened to two vertical pillars on both left and right.

Since the air outlet at the top of the modules points directly upwards, the air must be guided to the hot area using separate airflow guides. See the example below.

SIDE VIEW



Cabinet heaters

Use a cabinet heater if there is a risk of condensation in the cabinet. Although the primary function of the heater is to keep the air dry, it may also be required for heating at low temperatures. When placing the heater, follow the instructions provided by its manufacturer.

5

Mechanical installation

Contents of this chapter

The chapter describes the mechanical installation procedure of the drive.

Contents of the package

The drive is delivered in a cardboard box. To open, remove any banding and lift the top off the box.

Check that the box contains...	☑
ACS880-M04 drive module, with factory-installed options	☐
Three cable clamp plates (two for power cabling, one for control cabling) with screws	☐
Screw-type terminal blocks to be attached to the headers on the ZCU control unit and the power unit	☐
EMC filter (+E200) if ordered (with frames R1 and R2 only)	☐
Control panel mounting kit (+J410) if ordered	☐
Printed quick guides	☐
Printed manuals if ordered	☐

Delivery check and drive module identification

Check that there are no signs of damage. Before attempting installation and operation, check the information on the type designation label of the drive module to verify that the unit is of the correct type. See *Type designation label* on page *33.*

Before installing the drive

Checking the installation site

Before installation, check the installation site according to the requirements below. For frame details, refer to *Dimension drawings* on page *189*.

Check that...	☑
The frame details are according to the *Dimension drawings* from page *189*.	☐
The operational conditions of the drive meets the *Ambient conditions* on page *132*.	☐
The surface on which the drive is to be mounted on is • even as possible • of non-flammable material • strong enough to carry the weight of the drive. See sections *Dimensions and weights* (page *122*) and *Free space requirements* (page *39*).	☐
The installation site is sufficiently ventilated or cooled to transfer away the drive losses. See section on page *128*.	☐
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 requirements* (page *39*) for each of the different mounting alignments and *Cooling and degrees of protection* (page *42*).	☐

Required tools for installing the drive

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

- A drill and suitable drill bits
- A screwdriver or wrench with a set of suitable bits (as appropriate for the installation hardware used)
- A tape measure and spirit level
- Personal protective equipment.

Installing the drive

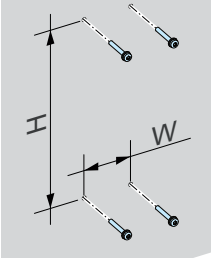
You can install the drive:

- With screws on to a wall
- To a DIN installation rail with the integrated lock.

See the possible installation directions and free space requirements on page 39.

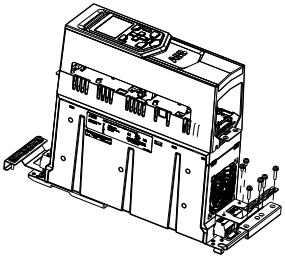
Installing the drive with screws

1. Mark the locations for the four holes. The mounting points are shown in *Dimension drawings*.



2. Fix the screws or bolts to the marked locations.
3. Position the drive onto the screws on the surface.

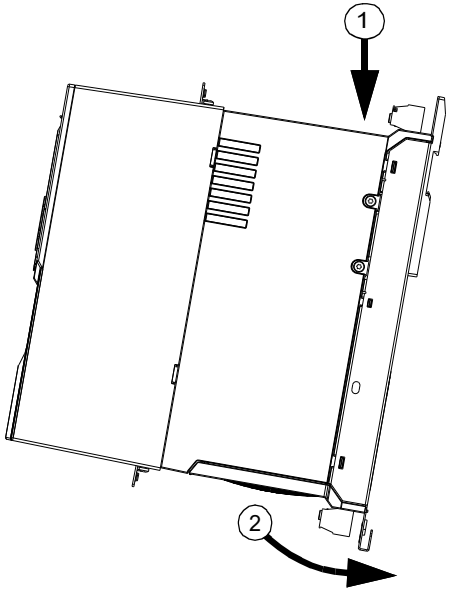
   Note: Lift the drive only by its chassis.



4. Tighten the screws.

Installing drive to a DIN installation rail – Frames R1 and R2 only

1. Click the drive to the rail. To detach the drive, press the release lever on top of the drive as shown in the figure.
2. Fasten the lower edge of the drive to the mounting base through the two fastening points.



Installing mains choke

See chapter *Mains chokes* on page *163*.

Installing EMC filter

See chapter *EMC filters* on page *167*.

Installing brake resistor

See chapter *Resistor braking* on page *181*.

6

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.

WARNING! Installation must be designed and done according to the applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations.
If recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

Checking the compatibility of the motor and drive

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

Make sure that the motor and the drive are compatible according to the *Ratings* on page *112*. The ratings table lists the typical motor power for each drive type.

Selecting the supply disconnecting device

According to safety regulations, equip each drive with a supply disconnecting device. Install a hand-operated input disconnecting device between the AC power source and the drive.

Note: You must be able to lock the disconnecting device to the open position for installation and maintenance work.

Requirements in European Union (EU) countries

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.

Requirements in non-EU countries

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

Selecting the power cables

General guidelines

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

- **Current:** Select a cable capable of carrying the maximum load current and suitable for the prospective short-circuit current provided by the supply network. The method of installation and ambient temperature affect the cable current carrying capacity. Obey local regulations and laws.
- **Temperature:** For an IEC installation, select a cable rated for at least 70 °C (158 °F) maximum permissible temperature of conductor in continuous use. For North America, select a cable rated for at least 75 °C (167 °F).
  Important: For certain product types or option configurations higher temperature rating may be required. See the technical data for details.
- **Voltage:** 600 V AC cable is accepted for up to 500 V AC. 750 V AC cable is accepted for up to 600 V AC. 1000 V AC cable is accepted for up to 690 V AC.

To comply with the EMC requirements of the CE mark, use one of the preferred cable types. See *Preferred power cable types (page 56)*.

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

Typical power cable sizes

The table below gives typical copper cable types with concentric copper shield for the drives with nominal current. For terminal and entry data for power cables, see *Terminal and lead-through data for power cables* (page *124*).

Note: Aluminum cables are not allowed in UL (NEC) installations.

Type ACS880-M04-	Frame size	Cable size, Cu (mm^2)[1)]	Conductor size, Cu (AWG) [2)]
-03A0-2/5	R1	3×1.5 + 1.5	14
-03A6-2/5	R1	3×1.5 + 1.5	14
-04A8-2/5	R1	3×1.5 + 1.5	14
-06A0-2/5	R1	3×1.5 + 1.5	14
-08A0-2/5	R1	3×1.5 + 1.5	14
-010A-2/5	R2	3×2.5 + 2.5	14
-014A-2/5	R2	3×2.5 + 2.5	14
-018A-2/5	R2	3×6 + 6	10
-025A-2/5	R3	3×6 + 6	10
-030A-2/5	R3	3×10 + 10	8
-035A-2/5	R3	3×10 + 10	8
-044A-2/5	R3	3×16 + 16	6
-050A-2/5	R3	3×16 + 16	6
-061A-2/5	R4	3×25 + 16	4
-078A-2/5	R4	3×35 + 16	2
-094A-2/5	R4	3×50 + 25	1

[1)]) The cable sizing is based on max. 9 cables laid on a cable ladder side by side, three ladder type trays one on top of the other, 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.

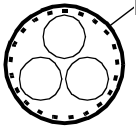
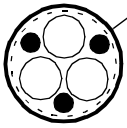
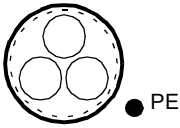
[2]The cable sizing is based on NEC Table 310-16 for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly buried). For other conditions, size the cables according to local safety regulations,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

Temperature: For **IEC**, select a cable rated for at least 70 °C maximum permissible temperature of conductor in continuous use. For North America, power cables must be rated for 75 °C (167 °F) or higher.
Voltage: 600 V AC cable is accepted for up to 500 V AC.
See also *Supply cable fuses* on page *118*.

Power cable types

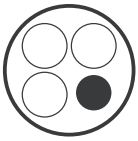
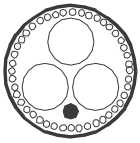
Preferred power cable types

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

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

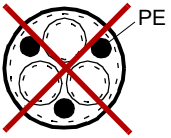
[1)] A separate PE conductor is required if the conductivity of the shield (or armor) is not sufficient for the PE use.

Alternate power cable types

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

[1)]Armor may act as an EMC shield, as long as it provides the same performance as a concentric EMC shield of a shielded cable. To be effective at high frequencies, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The effectiveness of the shield can be evaluated based on the shield inductance, which must be low and only slightly dependent on frequency. The requirements are easily met with a copper or aluminum shield/armor. The cross-section of a steel shield must be ample and the shield helix must have a low gradient. A galvanized steel shield has a better high-frequency conductivity than a non-galvanized steel shield.

Not allowed power cable types

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

Additional guidelines – North America

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

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

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

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

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

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

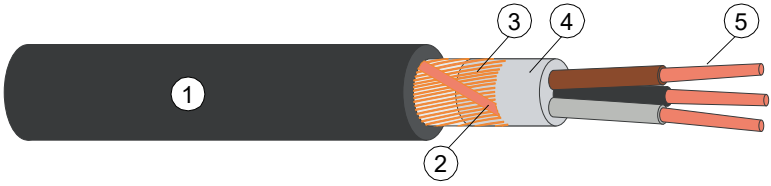
Metal conduit

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

Power cable shield

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

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



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

Grounding requirements

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

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

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

This table shows the minimum cross-sectional area of the protective earth conductor related to the phase conductor size according to IEC/UL 61800-5-1 when the phase conductor(s) and the protective earth conductor are made of the same metal. If this is not so, the cross-sectional area of the protective earth 76 Guidelines for planning the electrical installation conductor must be determined in a manner which produces a conductance equivalent to that which results from the application of this table.

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

[1)] For the minimum conductor size in IEC installations,refer to *Additional grounding requirements – IEC*.

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

- 2.5 mm^2

if the conductor is mechanically protected,

or

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

Additional grounding requirements – IEC

This sectiongivesgroundingrequirements accordingtostandardIEC/EN 61800-5-1.

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

- the minimum size of the protective earth conductor must comply with the local safety regulations for high protective earth conductor current equipment, and
- you must use one of these connection methods:

1. a fixed connection and:
   - a protective earth conductor with a minimum cross-sectional area of 10 mm^2 Cu or 16 mm^2 Al (as an alternative when aluminum cables are permitted), or
   - a second protective earth conductor of the same cross-sectional area as the original protective earth conductor,
     or
   - a device that automatically disconnects the supply if the protective earth conductor is damaged.
2. a connection with an industrial connector according to IEC 60309 and a minimum protective earth conductor cross-section of 2.5 mm^2 as part of a multi-conductor power cable. Sufficient strain relief must be provided.

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

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

Additional grounding requirements – UL (NEC)

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

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

For cord-connectedequipment, it must notbepossible todisconnect theprotective earth conductor before power is removed.

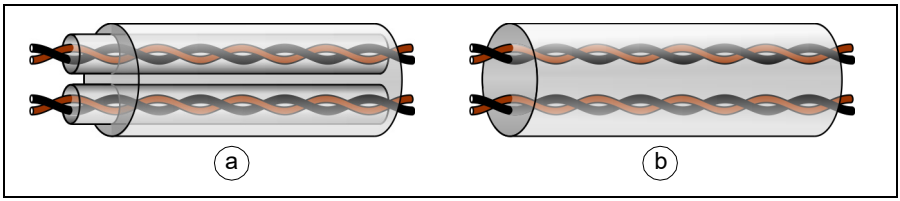
Selecting the control cables

Shielding

Use only shielded control cables.

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

A double-shielded cable (figure *a*) is the best alternative for low-voltage digital signals, but a single-shielded twisted pair cable (figure *b*) 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 run in the same cable

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

Relay cable

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

Control panel cable

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

The cable type tested and approved by ABB 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…R4: The following connector types were tested to fit in the tight space for option slot 1.

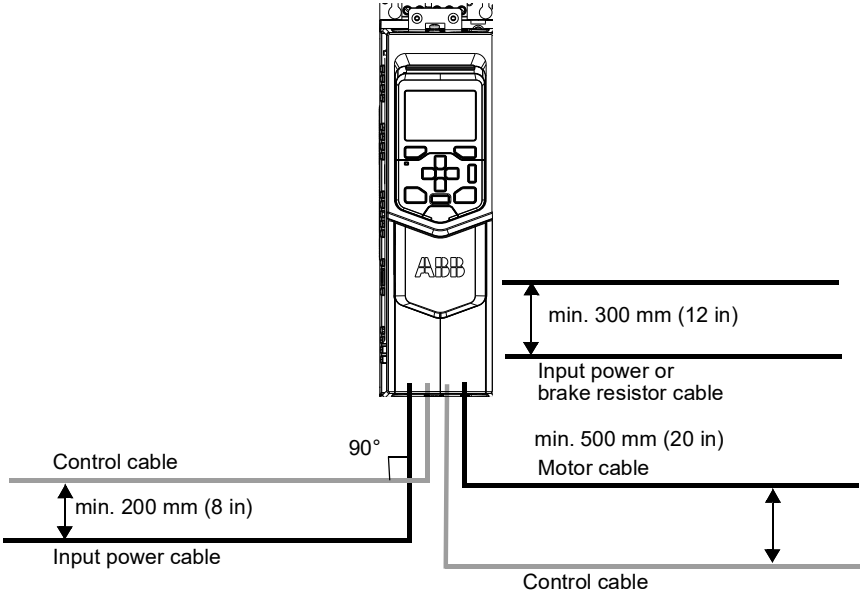
- Phoenix Contact SUBCON-PLUS-PROFIB/PG/SC2, part number 2708245. Lead the cable through the control cable hole on the right in the lead-through plate (1).
- Siemens, part number 6GK1 500 0EA02. Lead the cable through the middle control cable hole in the lead-through plate (2).

Routing the cables

General rules

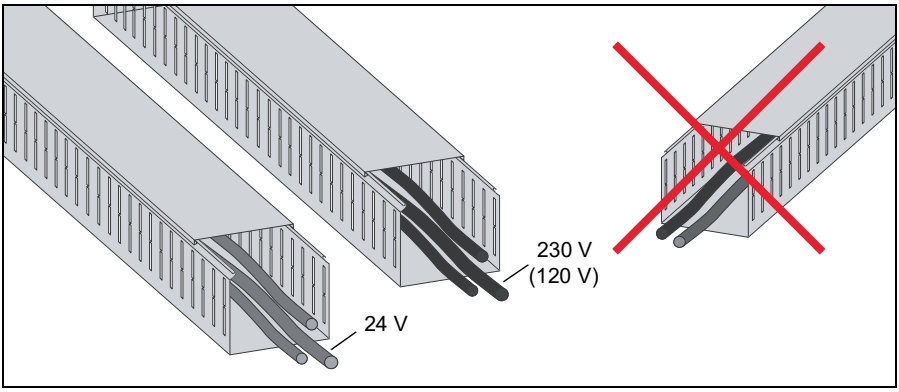
- Route the motor cable away from other cables. The motor cables of several drives can be put in parallel next to each other.
- Install the motor cable, input power cable and control cables on separate trays.
- Avoid long parallel runs of motor cables with other cables to decrease electromagnetic interference 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.
- Make sure the cable trays have good electrical bonding to each other and to the grounding electrodes. Aluminum tray systems can be used to improve local equalizing of potential.

Cable routing diagram



Separate control cable ducts

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



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

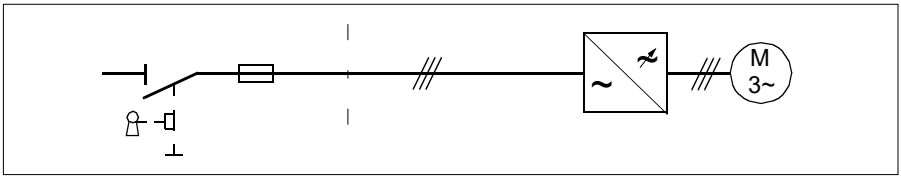
To minimize the emission level when there are safety switches, contactors, connection boxes or similar equipments on the motor cable between the drive and the motor:

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

Implementing thermal overload and short-circuit protection

Protecting the drive and input power cable in short-circuits

Protect the drive and input cable with fuses as follows:



Size the fuses at the distribution board according to instructions given in chapter *Technical data* on page *111*. The fuses 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.

Note: If you want to use circuit breakers, contact ABB for more information.

Protecting the motor and motor cable in short-circuits

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

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

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

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

Protecting the motor against thermal overload

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value, the function either monitors a calculated temperature value (based on a motor thermal model) or an actual temperature indication given by motor temperature sensors. The user can tune the thermal model further by feeding in additional motor and load data.

The most common temperature sensors are:

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

For more information, see *ACS880-M04 firmware manual* (3AXD50000030629 [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 reduced with a parameter 31.20 Earth fault.

For more information, see *ACS880-M04 firmware manual* (3AXD50000030629 [English]).

Residual current device compatibility

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

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

Implementing a motor temperature sensor connection

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

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

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

You have these implementation alternatives to comply with IEC 61800-5-1:

1. If there is double or reinforced insulation between the sensor and the live parts of the motor: You can connect the sensor directly to the analog/digital input(s) of the drive. See the control cable connection instructions. Make sure that the voltage is not more than the maximum allowed voltage over the sensor.
2. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect the sensor to the drive via an option module. The sensor and the module must form a double or reinforced insulation between the motor live parts and the drive control unit. See *Connecting a motor temperature sensor to the drive trough an option module (page 68)*. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.
3. If there is basic insulation between the sensor and the live parts of the motor, or if the insulation type is not known: You can connect a sensor to a digital input of the drive via an external relay. The sensor and the relay must form a double or reinforced insulation between the motor's live parts and the digital input of the drive. Make sure that the voltage does not exceed the maximum allowed voltage over the sensor.

Connecting a motor temperature sensor to the drive trough an option module

This table shows:

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

Option module		**Temperature sensor type**			**Temperature sensor insulation requirement**
Type	**Insulation/Isolation**	**PTC**	**KTY**	**Pt100, Pt1000**	
FIO-11	Galvanic isolation between sensor connector and drive control unit connector. No isolationbetweensensor connector and other I/O connectors.	x	x	x	Reinforced insulation
FIO-21	Galvanic isolation between sensor connector and other connectors (including drive control unit connector).	x	-	-	Reinforced insulation
FEN-01	Galvanic isolation between sensor connector and drive control unit connector. No isolationbetweensensor connector and TTL encoder emulation output.	x	-	-	Reinforced insulation
FEN-11	Galvanic isolation between sensor connector and drive control unit connector. No isolationbetweensensor connector and TTL encoder emulation output.	x	x	-	Reinforced insulation
FEN-21	Galvanic isolation between sensor connector and drive control unit connector. No isolationbetweensensor connector and TTL encoder emulation output.	x	x	-	Reinforced insulation
FEN-31	Galvanic isolation between sensor connector and drive control unit connector. No isolation between sensor connector and other connectors.		x	-	Reinforced insulation
FAIO-01	Basic insulation between sensor connector and drive control unit connector. No insulation between sensor connector and other I/O connectors.	x	x	x	Reinforced or basic insulation. With basic insulation, the other I/O connectors of the option module must be kept disconnected.
FPTC01/02 [1)]	Reinforced insulation between sensor connector and other connectors (including drive control unit connector).	x	-	-	No special requirement

[1)] Suitable for use in safety functions (SIL2 / PL c classified).

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

Implementing the Safe torque off function

See chapter *The Safe torque off function* on page *141*.

Implementing the Power-loss ride-through function

See *ACS880-M04 firmware manual* (3AXD50000030629 (English]).

Using a safety switch between the drive and the motor

Install a safety switch between the permanent magnet motor and the drive output. The safety switch isolates the motor from the drive during maintenance work on the drive.

Using a contactor between the drive and the motor

The control of the output contactor depends on how you use the drive. See also *Implementing a bypass connection* on page *71*.

When you use the vector control mode and motor ramp stop, open the contactor as follows:

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

When you use the vector control mode and motor coast stop or the scalar control mode, open the contactor as follows:

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

WARNING! In vector control mode, do not open the output contactor when the drive controls the motor. The vector control operates faster than the contactor opens its contacts.
If the contactor starts to open when the drive controls the motor, the vector control tries to maintain the load current and increases the drive output voltage to the maximum. This can cause damage to the contactor.

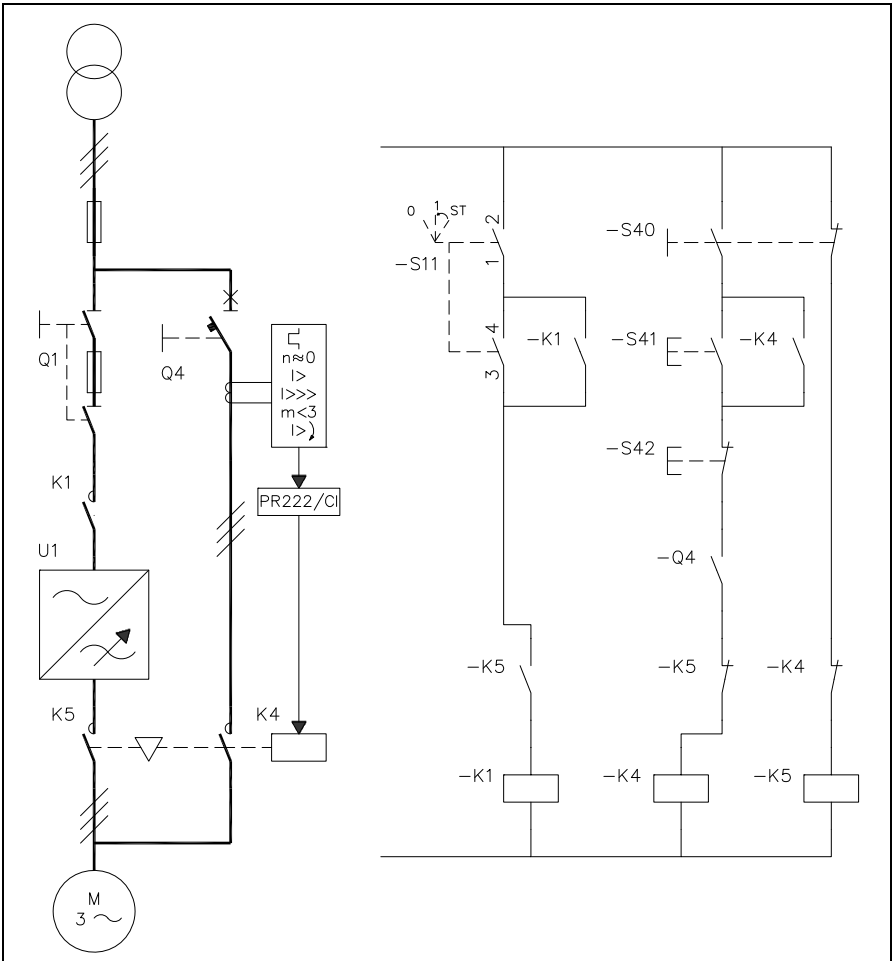
Implementing a bypass connection

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

For more information refer to the example below.

WARNING! Do not connect the drive output to the electrical power network. This can cause damage to the drive.

Example of a bypass connection



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

Changing the motor power supply from the drive to direct-on-line

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

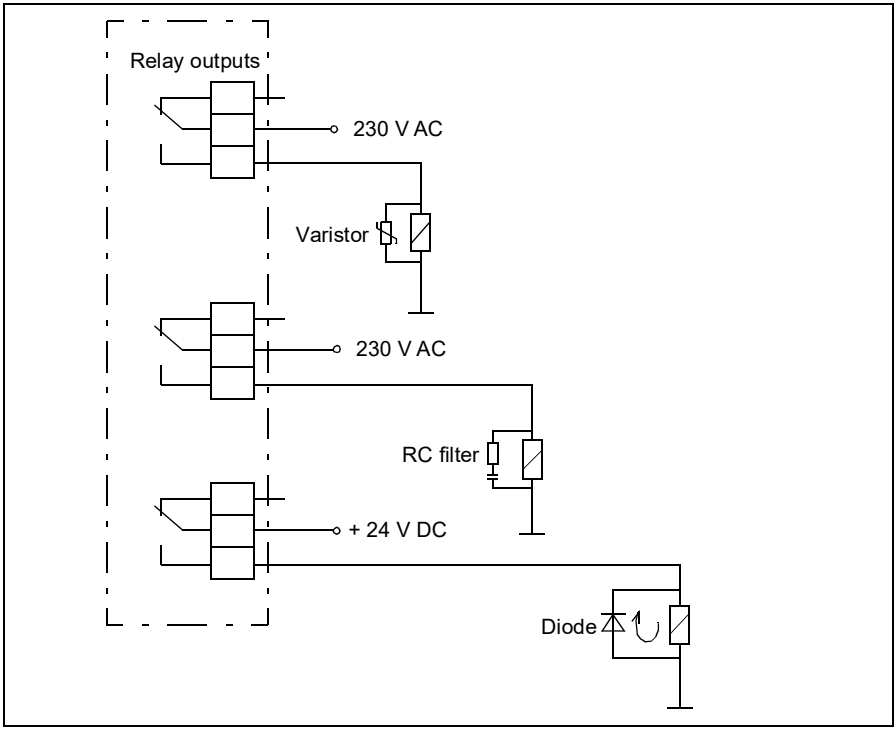
Changing the motor power supply from direct-on-line to the drive

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

Protecting the contacts of relay outputs

Inductive loads (relays, contactors, motors) cause voltage transients when switched off. The voltage transients can connect capacitively or inductively to other conductors and cause a malfunction in the system. To protect the contacts of relay outputs,

- Use a noise attenuating circuit (varistors, RC filters [AC] or diodes [DC]) which minimizes the EMC emission of inductive loads at switch-off.
- Install the noise attenuating circuit as close as possible to the inductive load.
- Do not install a noise attenuating circuit at the relay output.



7

Electrical installation

Contents of this chapter

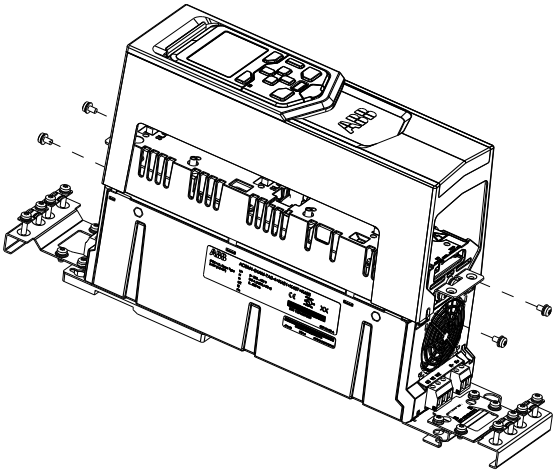
The chapter describes the electrical installation procedure of the drive.

WARNING! Only qualified electricians are allowed to do the work described in this chapter. Follow the *Safety instructions* on page *13*. If you ignore them, injury or death, or damage to the equipment can occur.
Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.

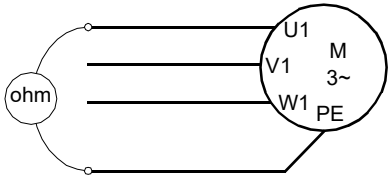
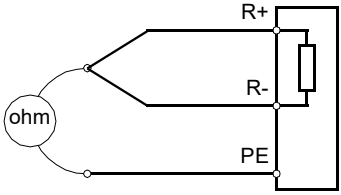
WARNING! Installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation that breaches the local laws and/or other regulations. If recommendations given by ABB are not followed, the drive system may experience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

Removing the cover assembly

Remove the cover assembly from the ZCU control unit, before installing the option modules or before connecting the control cables. See also the module layout diagram on page *29*.



Checking the insulation of the assembly

Drives	☑
⚠ Do not make any voltage tolerance or insulation resistance tests on any part of the drive as testing can damage the drive. Every drive has been tested for insulation between the main circuit and the chassis at the factory. There are also, voltage-limiting circuits inside the drive which cuts down the testing voltage automatically.	☐
Input power cable	
Check the insulation of the input cable according to local regulations before connecting it to the drive.	☐
Motor and motor cable insulation	
Check that the motor cable is disconnected from the drive output terminals T1/U, T2/V and T3/W.	☐
Measure the insulation resistance between the phase conductors and between each phase conductor and the Protective Earth conductor. Use a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must exceed 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, please consult the manufacturer's instructions. **Note:** Moisture inside the motor casing will reduce the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement. 	☐
Break resistor assembly insulation	
Check that the resistor cable is connected to the resistor, and disconnected from the drive output terminals R+ and R-.	☐
At the drive end, connect the R+ and R- conductors of the resistor cable together. Measure the insulation resistance between the combined conductors and the PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.. 	☐

Checking the compatibility with IT (ungrounded) systems

The internal EMC filter is not suitable for use on an IT (ungrounded) system. Disconnect the EMC filter before connecting the drive to the supply network. For instructions on how to do this, see page *78*.

WARNING! Do not install the drive with the internal EMC filter connected on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), otherwise the system will be connected to ground potential through the EMC filter capacitors of the drive. This can cause danger, or damage the drive.

Note: When the internal EMC filter is disconnected, the drive EMC compatibility is considerably reduced. See section *Compliance with the EN 61800-3:2004* on page *136*.

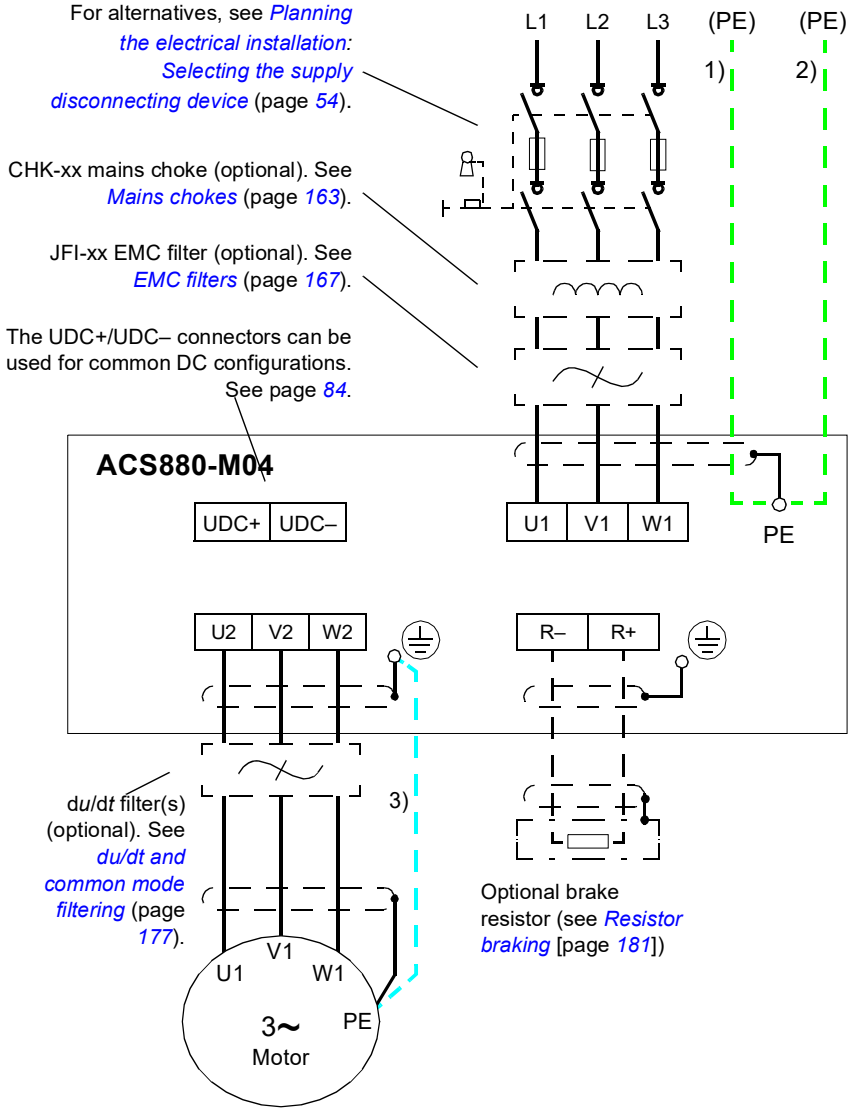
Disconnecting the internal EMC filter – all frame sizes

To disconnect the internal varistors and EMC filter (option +E200), in an IT (ungrounded), do as follows:

1. Switch off the power from the drive.
2. Remove the following screws:
   - VAR (frames R1 and R2, located close to the supply terminals)
   - EMC, VAR1 and VAR2 (frames R3 and R4, located on the front of the power unit).

Connecting the power cables

Power cable connection diagram



Notes:

• If shielded supply (input) cable is used, and the conductivity of the shield is not sufficient (see *Power cable shield* on page 59), use a cable with a ground conductor (1) or a separate PE cable (2).

• For motor cabling, use a separate ground cable (3) if the conductivity of the cable shield is not sufficient (see *Power cable shield* on page 59) and the cable has no symmetrical ground conductors.

Power cable connection procedure

See cabling drawing with tightening torques for all frame sizes on page 83.

WARNING! Follow all *Safety instructions* on page 13. If you ignore them, injury or death, or damage to the equipment can occur.

1. Frame sizes R3 and R4 only: Remove the two plastic connector covers at the top and bottom of the drive. Each cover is fastened with two screws.
2. On IT (ungrounded) systems, remove the following screws to disconnect the internal varistors and EMC filters (option +E200):
   - VAR (frames R1 and R2, located close to the supply terminals)
   - EMC, VAR1 and VAR2 (frames R3 and R4, located on the front of the power unit).

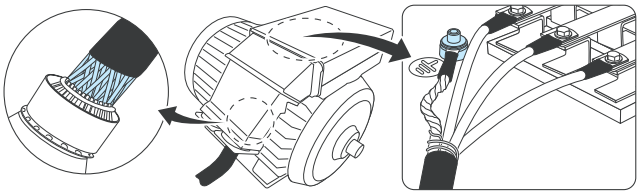
WARNING! If a drive whose varistors/filters are not disconnected is installed on an IT system (an ungrounded power system or a high resistance grounded [over 30 ohms] power system), the system is connected to ground potential through the varistors/filters of the drive. This may cause danger or damage to the drive.

3. Fasten the two cable clamp plates included to the drive (see page 82), one at the top, one at the bottom. The clamp plates are identical. Using the cable clamp plates as shown below will provide better EMC compliance, as well as act as a strain relief for the power cables.
4. Strip the power cables so that the shields are bare at the cable clamps.
5. Twist the ends of the cable shield wires into pigtails.
6. Strip the ends of the phase conductors.
7. Connect the following:
   - phase conductors of the supply cable to U1, V1 and W1 terminals of the drive.
   - phase conductors of the motor cable to U2, V2 and W2 terminals.
   - conductors of the resistor cable (if present) to R+ and R– terminals. With frame size R3 or R4: attach the screw terminal lugs included to the conductors first. Crimp lugs can be used instead of screw lugs.
8. Tighten the cable clamps onto the bare cable shields.

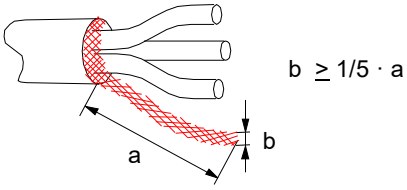
9. Crimp a cable lug onto each shield pigtail. Fasten the lugs to ground terminals. **Note:** Try to work out a compromise between the length of the pigtail and the length of unshielded phase conductors as both should ideally be as short as possible.
10. Cover visible bare shield and pigtail with insulating tape.
11. With frame size R3 or R4, cut suitable slots on the edges of the connector covers to accommodate the supply and motor cables. Install the covers again. (Tighten the screws to 3 N·m [25 lbf·in]).
12. Secure the cables outside the unit mechanically.
13. Ground the other end of the supply cable shield or PE conductor(s) at the distribution board. In case a mains choke and/or an EMC filter (option +E200) is installed, make sure the PE conductor is continuous from the distribution board to the drive.

Grounding the motor cable shield at the motor end

For minimum radio frequency interference, ground the cable shield 360 degrees at the lead-through of the motor terminal box



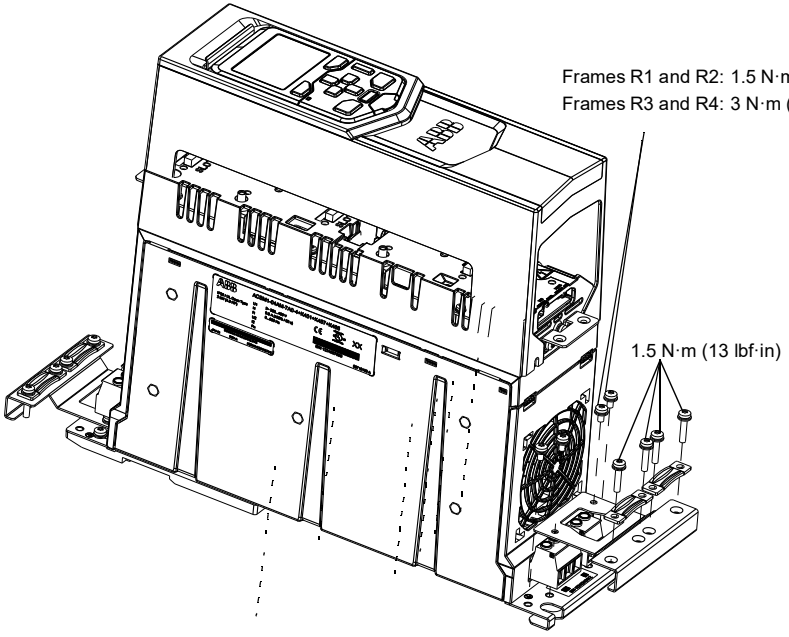
or ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.



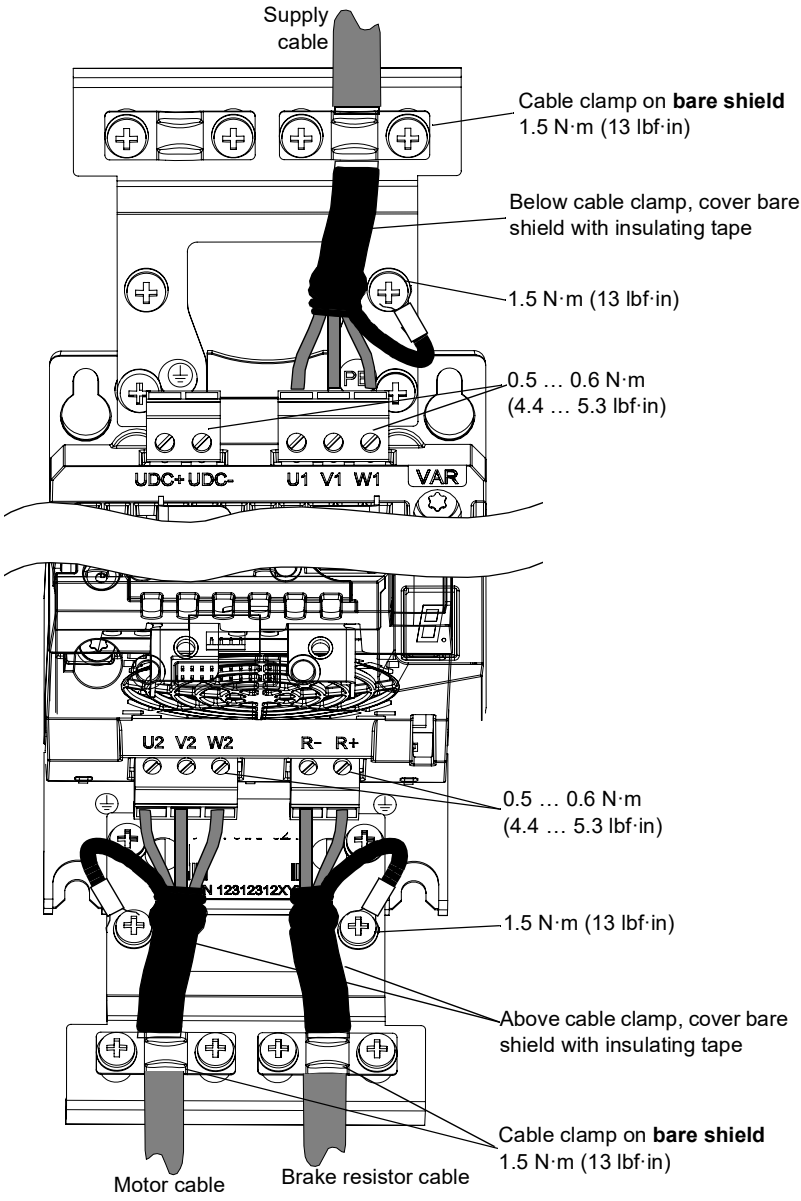
Installing the power cable clamp plates

Two identical power cable clamp plates are included with the drive. The picture below depicts a frame size R1 drive; the installation is similar with other frame sizes.

Note: Support the cables adequately within the installation enclosure, especially if not using the cable clamps.



Power cable connections

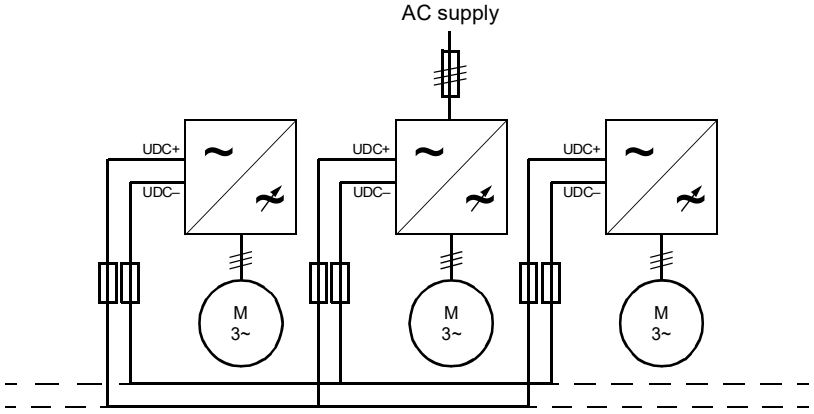


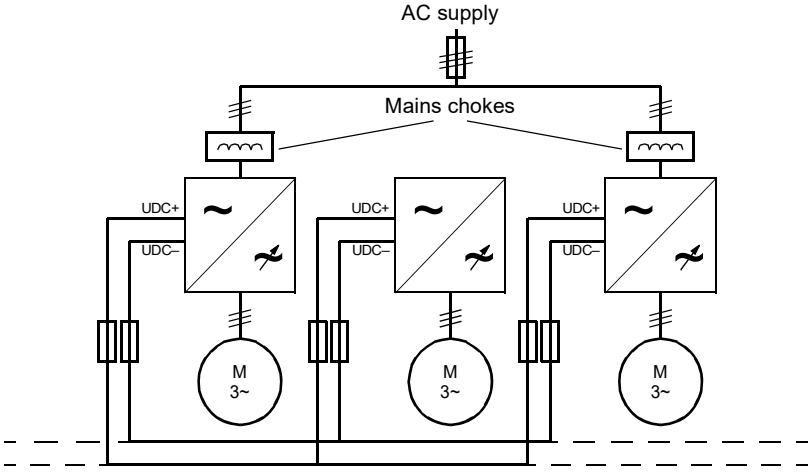
See page *128* for terminal wire size capacity.

DC connection

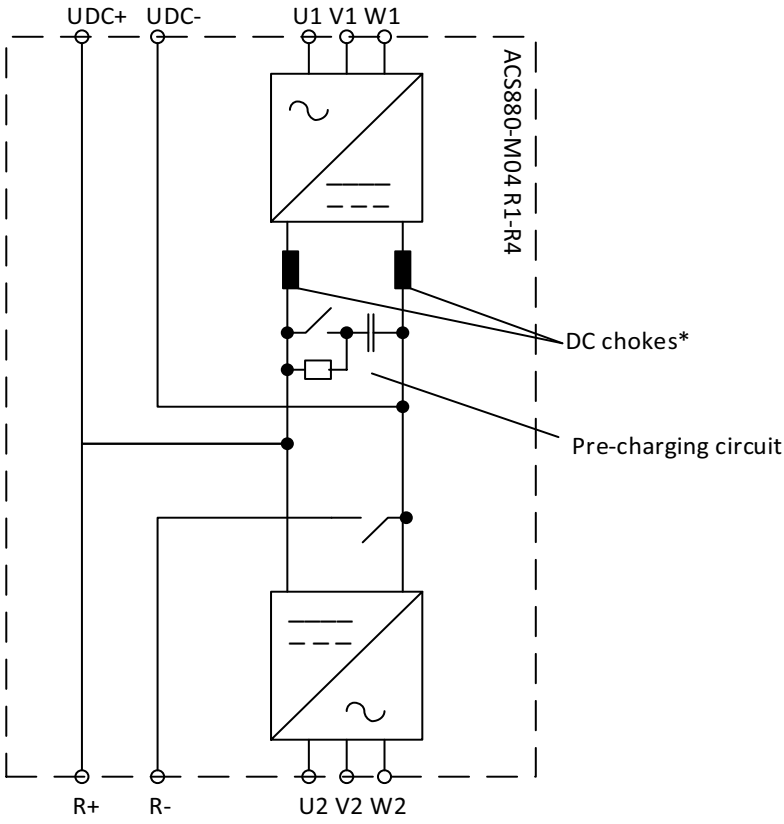
The UDC+ and UDC– terminals are intended for common DC configurations of a number of ACS880-M04 drives, allowing regenerative energy from one drive to be utilised by the other drives in motoring mode.

One or more drives are connected to the AC supply depending on the power requirement. In case two or more R1-R2 frames are connected to the AC supply, each AC connection must be equipped with a mains choke to ensure even current distribution between the rectifiers. The diagram below shows two configuration examples.





Each drive has an independent DC capacitor pre-charging circuit.



* only for frames R3 and R4.

See *DC connection* ratings on page *129*.

For more information on common DC configurations, see *ACS880-01 drives and ACS880-04 drive modules Common DC systems Application guide* (3AUA0000127818 [English]).

Installing the optional modules

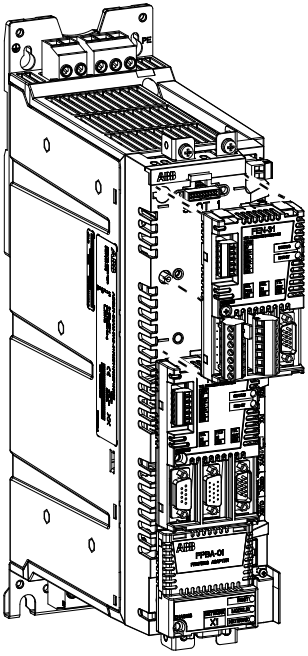
Optional modules such as fieldbus adapters, I/O extensions and encoder interfaces ordered using option codes (see *Type designation key* on page *34*) are pre-installed at the factory. Instructions for installing additional modules into the slots on the ZCU control unit (see page *32* for the available slots) are presented below.

To install the optional modules, proceed as follows:

1. Remove the cover assembly from the ZCU control unit. See *Removing the cover assembly* on page *76*.
2. Remove the protective cover (if present) from the connector of the slot.
3. Insert the module carefully into its position on the drive.
4. Fasten the screw.

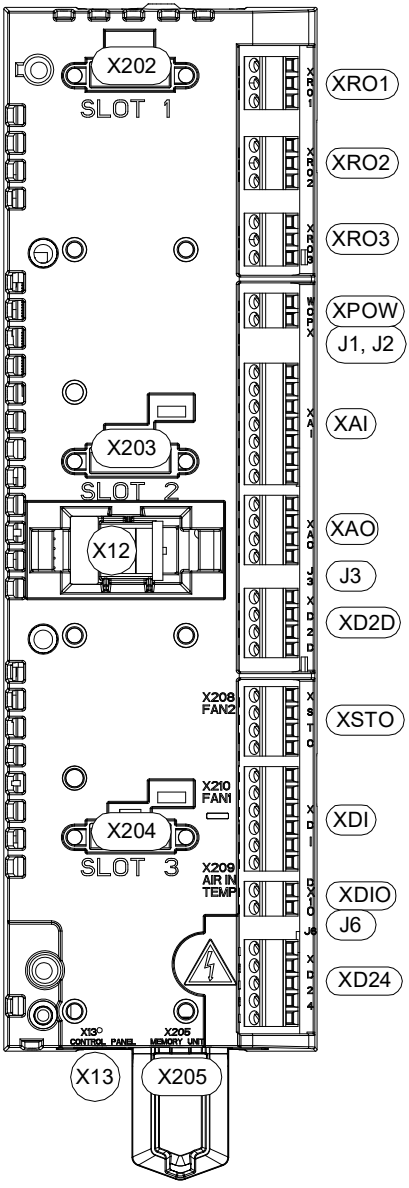
   Note: Fix the screws correctly for fulfilling the EMC requirements and for proper operation of the module.
5. Install the cover assembly again after any specific installation and wiring of the module is complete.

   See *Ground isolation diagram (ZCU)* on page *96* and the appropriate option manual for specific installation and wiring instructions.



Connecting the control unit

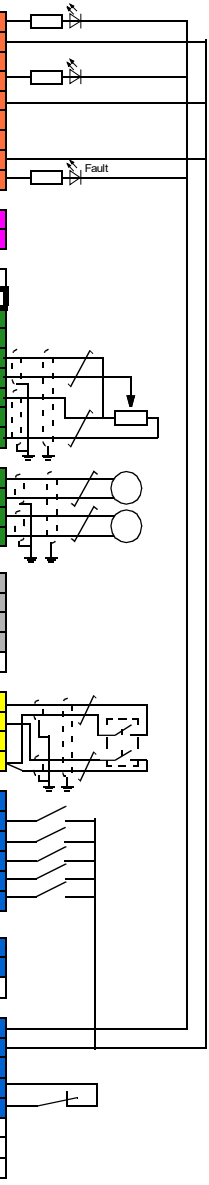
ZCU-14 layout and connections



Connections	Description
XPOW	External power input
XAI	Analog inputs
XAO	Analog outputs
XD2D	Drive to drive link
XRO1	Relay output RO1
XRO2	Relay output RO2
XRO3	Relay output RO3
XD24	Start interlock connection (DIIL) and +24 V output
XDIO	Digital input/outputs
XDI	Digital inputs
XSTO	Safe torque off connection
X12	Connector for FSO-xx safety functions module (optional)
X13	Control panel connection
X202	Option slot 1
X203	Option slot 2
X204	Option slot 3
X205	Memory unit connection (memory unit inserted in the drawing)
J1, J2	Voltage/Current selection jumpers (J1, J2) for analog inputs
J3	Drive-to-drive link termination jumper (J3)
J6	Common digital input ground selection jumper (J6). See the *Ground isolation diagram (ZCU)* (page *96*).

Control connections to the ZCU control unit

Relay outputs	**XRO1…XRO3**	
Ready 250 V AC / 30 V DC 2 A	NO	13
	COM	12
	NC	11
Running 250 V AC / 30 V DC 2 A	NO	23
	COM	22
	NC	21
Faulted(-1) 250 V AC / 30 V DC 2 A	NO	33
	COM	32
	NC	31
External power input	**XPOW**	
24 V DC, 2 A min. (without optional modules)	GND	2
	+24VI	1
Reference voltage and analog inputs	**J1, J2, XAI**	
AI1/AI2 current/voltage selection	AI1: U	AI2: U
	AI1: I	AI2: I
By default not in use. 0(4)…20 mA, R_{in} = 100 ohm [1]	AI2-	7
	AI2+	6
Speed reference 0(2)…10 V, R_{in} > 200 kohm [2]	AI1-	5
	AI1+	4
Ground	AGND	3
-10 V DC, R_L 1…10 kohm	-VREF	2
10 V DC, R_L 1…10 kohm	+VREF	1
Analog outputs	**XAO**	
Motor current 0…20 mA, R_L < 500 ohm	AGND	4
	AO2	3
Motor speed rpm 0…20 mA, R_L < 500 ohm	AGND	2
	AO1	1
Drive-to-drive link	**XD2D**	
Drive-to-drive link [3]	Shield	4
	BGND	3
	A	2
	B	1
Drive-to-drive link termination [3]	**J3**	
Safe torque off	**XSTO**	
Safe torque off. Both circuits must be closed for the drive to start. [4]	IN2	4
	IN1	3
	SGND	2
	OUT	1
Digital inputs	**XDI**	
By default not in use.	DI6	6
Constant speed 1 select (1 = on) [5]	DI5	5
Acceleration & deceleration select [6]	DI4	4
Reset	DI3	3
Forward (0) / Reverse (1)	DI2	2
Stop (0) / Start (1)	DI1	1
Digital input/outputs	**XDIO**	
Output: Running	DIO2	2
Output: Ready	DIO1	1
Ground selection [7]	**J6**	
Auxiliary voltage output, digital interlock [8]		**XD24**
Digital input/output ground	DIOGND	5
+24 V DC 200 mA [9]	+24VD	4
Digital input ground	DICOM	3
+24 V DC 200 mA [9]	+24VD	2
Run enable [8]	DIIL	1
Safety functions module connection	**X12**	
Control panel connection	**X13**	
Memory unit connection	**X205**	



Note: The wire size accepted by all screw terminals (for both stranded and solid wire) is 0.5 … 2.5 mm^2 (24…12 AWG). The torque is 0.5 N·m (5 lbf·in).

[1] Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by jumper **J2.**
Note: Changing the setting requires reboot of control unit.
[2] Current [0(4)…20 mA, R_{in} = 100 ohm] or voltage [0(2)…10 V, R_{in} > 200 kohm] input selected by jumper **J1**.
Note: Changing the setting requires reboot of control unit
[3] See section *Drive-to-drive link* (page *92*).
[4] See chapter *The Safe torque off function* (page *141*).
[5] Constant speed 1 is defined by parameter 22.26.
[6] 0 = Acceleration/deceleration ramps defined by parameters 23.12/23.13 in use.
1 = Acceleration/deceleration ramps defined by parameters 23.14/23.15 in use.
[7] Jumper/switch J6. Determines whether DICOM is separated from DIOGND (ie. common reference for digital inputs floats; in practice, selects whether the digital inputs are used in current sinking or sourcing mode). See *Ground isolation diagram (ZCU)* (page *96*).
[8] See section *DIIL input* (page *92*)
[9] Total load capacity of these outputs is 4.8 W (200 mA at 24 V) minus the power taken by DIO1 and DIO2.

External power supply for the control unit (XPOW)

By default, the ZCU control unit is powered from the power module. An external 24 V DC, 2 A power supply for the control unit can be connected to terminal block XPOW.

It is recommended to use an external supply if

- the control board needs to be kept operational during input power breaks, for example, because of uninterrupted fieldbus communication, or
- immediate restart is needed after power breaks (that is, no control board power up delay is allowed).

See also description of parameter *95.04 Control board supply* in the firmware manual.

DI6 as a PTC sensor input

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

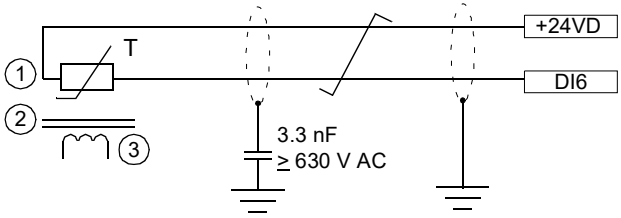
- the accessible parts are not conductive, or
- the accessible parts are conductive, but not connected to the protective earth.

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

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

You can connect PTC sensor to digital input DI6 of the drive only if there is double or reinforced insulation between the sensor and motor winding.

- Make sure that the voltage over the sensor is not more than the maximum value allowed for the sensor.
- Do not connect both ends of the cable shield directly to ground. If a capacitor cannot be used at one end, leave that end of the shield unconnected.
- See the firmware manual for the parameter settings.



1	PTC sensor
2	Double insulation
3	Motor winding

For the connection alternatives, refer to *Implementing a motor temperature sensor connection* on page *68*.

AI1 or AI2 as a Pt100 or KTY84 sensor input

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

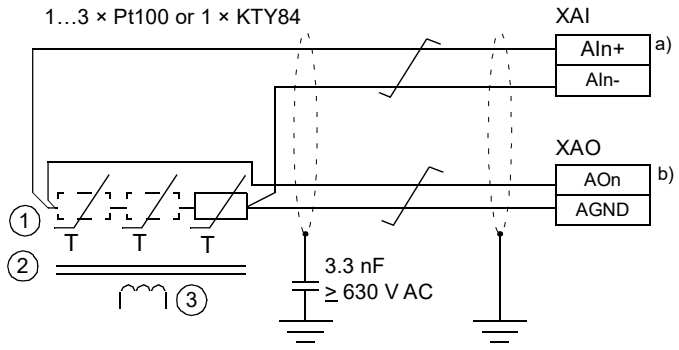
- the accessible parts are not conductive, or
- the accessible parts are conductive, but not connected to the protective earth.

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

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

You can connect Pt100 or KTY84 sensors between an analog input and output of the drive only if there is double or reinforced insulation between the sensor and the motor winding. It is possible to use one to three Pt100 sensors in series or one KTY84 sensor.

- Make sure that the voltage over the sensor is not more than the maximum value allowed for the sensor.
- Do not connect both ends of the cable shield directly to ground. If a capacitor cannot be used at one end, leave that end of the shield unconnected.
- See the firmware manual for the parameter settings.



1	Sensor(s)
2	Double insulation
3	Motor winding
a)	For AI1, set input type to voltage with switch/jumper J1 (ZCU) or switch AI1 (BCU). For AI2, set input type with J2 (ZCU) or AI2 (BCU). Set the appropriate analog input unit to V (volt) in parameter group *12 Standard AI*.
b)	Select the excitation mode in parameter group *13 Standard AO*.

For the connection alternatives, refer to *Implementing a motor temperature sensor connection* on page *68*.

DIIL input

The DIIL input can used for the connection of safety circuits. By default, the input is parametrized to stop the unit when the input signal is lost.

Drive-to-drive link

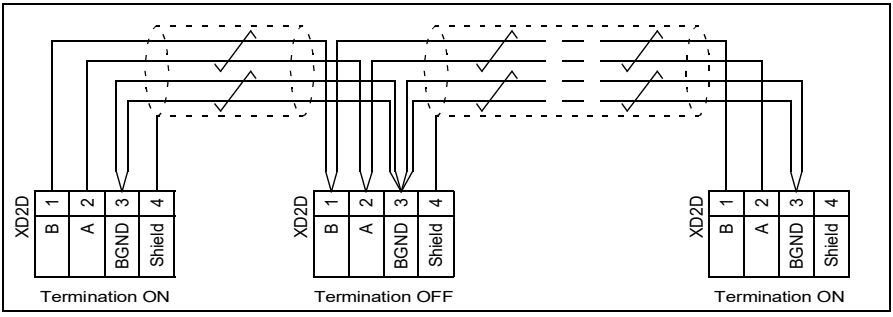
The drive-to-drive link is a daisy-chained RS-485 transmission line that allows basic master/follower communication with one master drive and multiple followers. Enable bus termination on the drives at the ends of the drive-to-drive link. On intermediate drives, disable bus termination.

The settings for each type of control unit are:

Control unit type	Switch/jumper designation	Settings
ZCU-14 (frame sizes R1…R4)	J3	• Termination enabled
		• Termination disabled

Use shielded twisted-pair cable with a twisted pair for data and a wire or another pair for signal ground (nominal impedance 100 … 165 ohm, for example Belden 9842) for the wiring. For best immunity, ABB recommends high quality cable. Keep the cable as short as possible. However, the minimum cable length is 1 m. Avoid unnecessary loops and parallel runs near power cables such as motor cables.

Example wiring diagram of drive-to-drive link



Safe torque off

For the drive to start, both connections (OUT1 to IN1 and IN2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting an external Safe torque off circuit to the drive.

For information on the implementation of Safe torque off function, see chapter *The Safe torque off function* (page *141*).

Safety functions (X12)

See the connections to the safety functions module on page *87* and *FSO-12 user's manual* (3AXD50000015612 [English])

Control unit connector data

Power supply (XPOW)	Connector pitch 5 mm, wire size 2.5 mm^2 24 V (±10%) DC, 2 A External power input. Two supplies can be connected to BCU for redundancy.
Relay outputs RO1…RO3 (XRO1…XRO3)	Connector pitch 5 mm, wire size 2.5 mm^2 250 V AC / 30 V DC, 2 A Protected by varistors
+24 V output (XD24:2 and XD24:4)	Connector pitch 5 mm, wire size 2.5 mm^2 Total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the power taken by DIO1 and DIO2.
Digital inputs DI1…DI6 (XDI:1…XDI:6)	Connector pitch 5 mm, wire size 2.5 mm^2 24 V logic levels: "0" < 5 V, "1" > 15 V R_{in}: 2.0 kohm Input type: NPN/PNP (DI1…DI5), NPN (DI6) Hardware filtering: 0.04 ms, digital filtering up to 8 ms DI6 (XDI:6) can alternatively be used as an input for a PTC thermistor. "0" > 4 kohm, "1" < 1.5 kohm I_{max}: 15 mA (DI1…DI5), 5 mA (DI6)
Start interlock input DIIL (XD24:1 [ZCU])	Connector pitch 5 mm, wire size 2.5 mm^2 24 V logic levels: "0" < 5 V, "1" > 15 V R_{in}: 2.0 kohm Input type: NPN/PNP Hardware filtering: 0.04 ms, digital filtering up to 8 ms

Digital inputs/outputs DIO1 and DIO2 (XDIO:1 and XDIO:2)

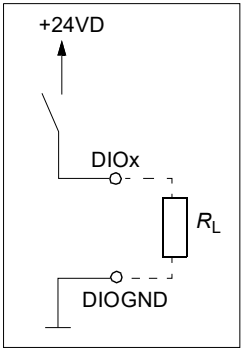
Input/output mode selection by parameters.

DIO1 can be configured as a frequency input (0…16 kHz with hardware filtering of 4 microseconds) for 24 V level square wave signal (sinusoidal or other wave form cannot be used). DIO2 can be configured as a 24 V level square wave frequency output. See the firmware manual, parameter group 11.

Connector pitch 5 mm, wire size 2.5 mm^2

As inputs:
24 V logic levels: “0” < 5 V, “1” > 15 V
R_{in}: 2.0 kohm
Filtering: 0.25 ms (ZCU)

As outputs:
Total output current from +24VD is limited to 200 mA



Reference voltage for analog inputs +VREF and -VREF (XAI:1 and XAI:2)

Connector pitch 5 mm, wire size 2.5 mm^2
10 V ±1% and –10 V ±1%, R_{load} 1…10 kohm

Analog inputs AI1 and AI2 (XAI:4 … XAI:7)

Current/voltage input mode selection by jumpers/switches.

Connector pitch 5 mm, wire size 2.5 mm^2
Current input: –20…20 mA, R_{in} = 100 ohm
Voltage input: –10…10 V, R_{in} > 200 kohm
Differential inputs, common mode range ±30 V
Sampling interval per channel: 0.25 ms
Hardware filtering: 0.25 ms, adjustable digital filtering up to 8 ms
Resolution: 11 bit + sign bit
Inaccuracy: 1% of full scale range

Analog outputs AO1 and AO2 (XAO)

Connector pitch 5 mm, wire size 2.5 mm^2
0…20 mA, R_{load} < 500 ohm
Frequency range: 0…300 Hz (ZCU)
Resolution: 11 bit + sign bit
Inaccuracy: 2% of full scale range

Drive-to-drive link (XD2D)

Connector pitch 5 mm, wire size 2.5 mm^2
Physical layer: RS-485
Termination by switch or jumper

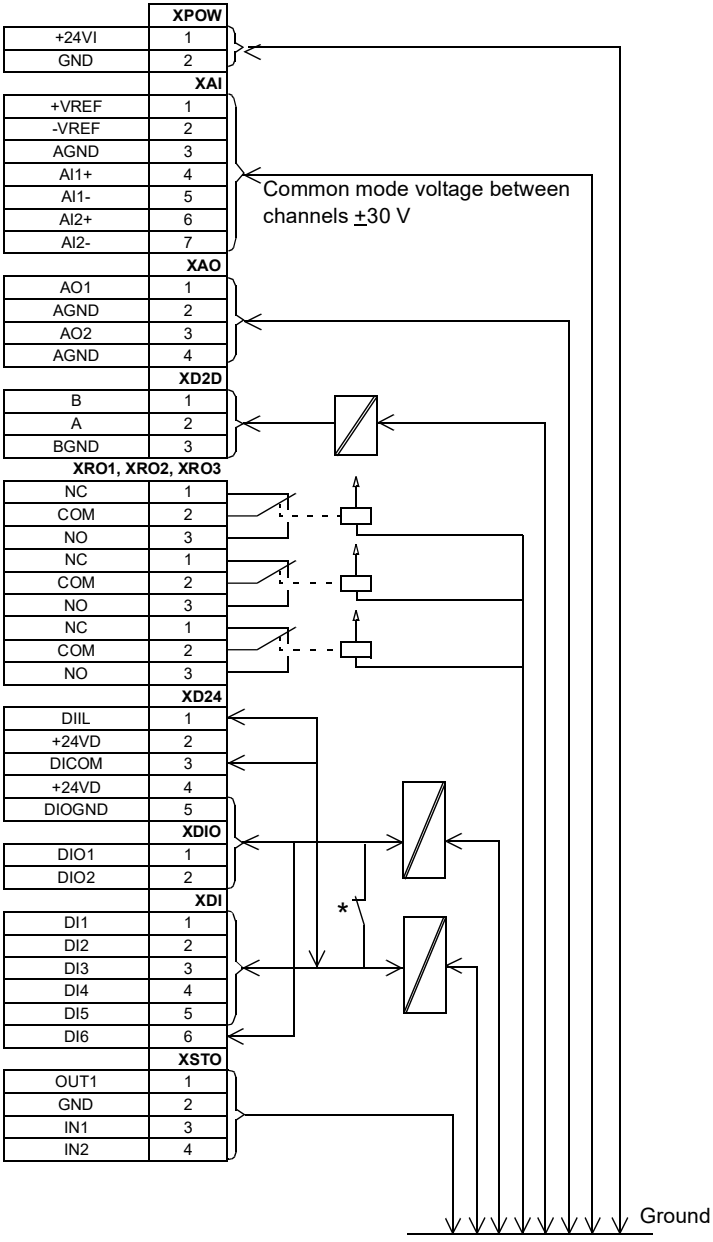
Safe torque off connection (XSTO)

Connector pitch 5 mm, wire size 2.5 mm^2
Input voltage range: -3…30 V DC
Logic levels: “0” < 5 V, “1” > 17 V
For the drive to start, both connections must be “1”
Current consumption: 66 mA (continuous) per STO channel per drive module
EMC (immunity) according to IEC 61326-3-1

Control panel connection (X13)	Connector: RJ-45 Cable length < 3 m

The terminals of the control unit fulfil the Protective Extra Low Voltage (PELV) requirements. The PELV requirements of a relay output are not fulfilled if a voltage higher than 48 V is connected to the relay output.

Ground isolation diagram (ZCU)



***Ground selector (J6) settings**

 •

All digital inputs share a common ground (DICOM connected to DIOGND). This is the default setting.

• 

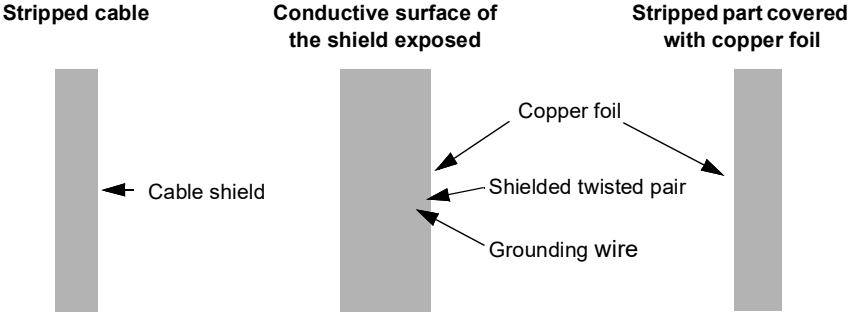
Ground of digital inputs DI1…DI5 and DIIL (DICOM) is isolated from DIO signal ground (DIOGND). Isolation voltage 50 V.

Connecting the control cables – all frame sizes

For technical data and default I/O connections of the drive control unit, refer to *Control connections to the ZCU control unit* (page *88*).

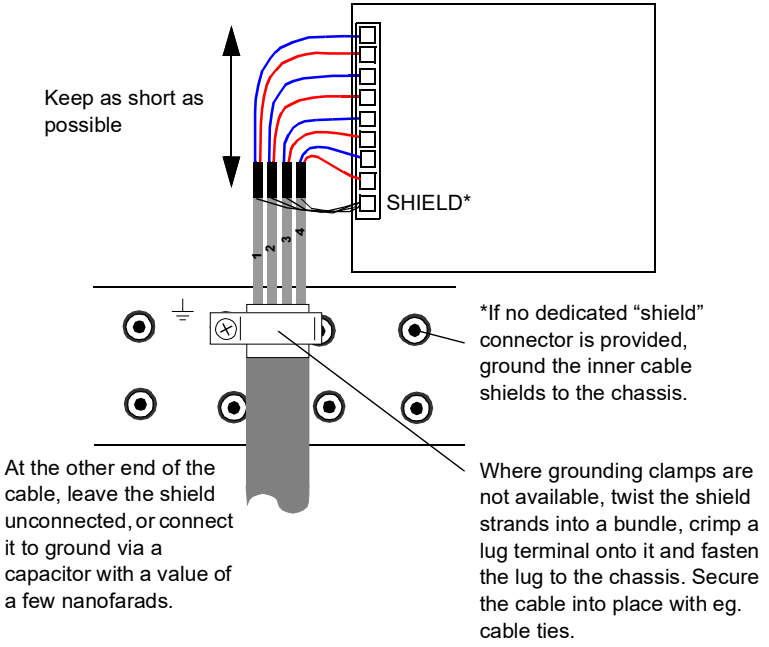
1. In the cabinet, remove shrouding wherever necessary to allow access to the cable entries and any trunking inside the cubicle.
2. Run the control cables into the cubicle. If possible, arrange for a 360° grounding of the cable shield at the cable entry.

   If the outer surface of the shield is non-conductive, turn the shield inside out as shown below and wrap copper foil around the cable to keep the shielding continuous. Do not cut the grounding wire (if present).



3. Run the cables to the control unit of the drive (or other connection point) using cable trunking wherever possible.
4. (Only when running the cable to the drive module) The drive control units have a clamp plate attached. Remove the outer sheathing of the cable at one of the clamps on the plate. Tighten the clamp onto the bare cable shield.
5. Cut the cables to suitable length.

6. Strip the cable ends and conductors. When connecting to the drive I/O, also remove the shield along with the outer sheathing, and use electrical tape or shrink tubing to contain the strands. Elsewhere, twist the outer shield strands into a bundle, crimp a lug onto it and connect it to the nearest chassis grounding point.



7. Connect the conductors to appropriate terminals (refer to chapter *Control connections to the ZCU control unit*).
8. Refit any shrouds removed earlier.

8

Installation checklist

Contents of this chapter

This chapter contains a list for checking the mechanical and electrical installation of the drive module.

Checklist

Check the mechanical and electrical installation of the drive module before start-up. Go through the checklist below together with another person. Read the *Safety instructions* on the first pages of this manual before you work on the unit.

Check that...	☑
MECHANICAL INSTALLATION	
The ambient operating conditions are allowable. (See *Mechanical installation, Technical data: Ratings, Ambient conditions*.)	☐
The unit is fastened properly to the cabinet. (See *Planning the cabinet installation* and *Mechanical installation*.)	☐
The cooling air will flow freely.	☐
The motor and the driven equipment are ready for start. (See *Planning the electrical installation, Technical data: Motor connection*.)	☐
ELECTRICAL INSTALLATION (See *Planning the electrical installation, Electrical installation*.)	
The VAR (frames R1 and R2) and EMC/VAR1/VAR2 (frames R3 and R4) screws are removed if the drive is connected to an IT (ungrounded) supply network.	☐
The capacitors are reformed if stored over one year (contact local ABB representative for more information).	☐
The drive is grounded properly.	☐
The supply (input power) voltage matches the drive nominal input voltage.	☐

Check that...	☑
The supply (input power) is connected to U1/V1/W1 (UDC+/UDC- in case of a DC supply) and the terminals are tightened to specified torque.	☐
Appropriate supply (input power) fuses and disconnector are installed.	☐
The motor is connected to U2/V2/W2, and the terminals are tightened to the specified torque.	☐
The brake resistor (if present) is connected to R+/R-, and the terminals are tightened to specified torque.	☐
The motor cable (and brake resistor cable, if present) is routed away from other cables.	☐
There are no power factor compensation capacitors in the motor cable.	☐
The external control connections to the ZCU control unit are OK.	☐
There are no tools, foreign objects or dust from drilling inside the drive.	☐
The supply (input power) voltage cannot be applied to the output of the drive through a bypass connection.	☐
Motor connection box and other covers are in place.	☐

9

Start-up

Contents of this chapter

This chapter refers to the start-up instructions of the cabinet-installed drive.

Start-up procedure

1. Make sure the installation of the drive is according to the *Installation checklist* on page *101*.
2. Check that the motor and driven equipment are ready for start.
3. Perform the start-up tasks instructed by the cabinet-installer of the drive module.
4. Switch On the power.
5. Set-up the drive control program according to the start-up instructions in the *Firmware manual*.
6. Validate the Safe torque off function according to the *Validation test procedure* on page *148*.

10

Maintenance

Contents of this chapter

This chapter contains preventive maintenance instructions.

Safety

WARNING! Read the *Safety instructions* on the first pages of this manual before performing any maintenance on the equipment.
Ignoring the safety instructions can cause injury or death.

Maintenance intervals

The table below show the maintenance tasks which can be done by the end user.

For the complete maintenance schedule contact the ABB service (https://new.abb.com/drives/services).

Maintenance task/object	Interval	Instruction
DC capacitor reforming	Every year of storage	See *Reforming the capacitors* on page *109*.
Heatsink temperature check and cleaning	**Every 6 to 12 months** depending on the dustiness of the environment	See *Heatsink* on page *106*.
Inspection of tightness of power connections	Every year	See page *Power cable connection procedure on page 80*.
Visual inspection of cooling fan		See *Cooling fan* on page *107*.

Maintenance task/object	Interval	Instruction
Cooling fan replacement	**Every 3 years** if used in clean operating environment. **Yearly inspection** is highly recommended if used in dusty, corroded or ambient temperature is higher than 40 °C (104 °F).	See *Cooling fan* on page *107*.
DC capacitor replacement	**Every 6 years** if the ambient temperature is higher than 40 °C (104 °F) or if the drive is subjected to cyclic heavy load or continuous nominal load. Otherwise, **every 9 years**.	Contact your local ABB Service representative.
Control panel battery replacement	Every 3 years	The battery is housed on the rear of the control panel. Replace with a new CR 2032 battery.
Control unit battery for real-time clock	Every 3 years	

Heatsink

The heatsink fins pick up dust from the cooling air. If the heatsink is not clean, the drive runs into overtemperature warnings and faults. In a normal environment, the heatsink should be checked annually and in a dusty environment it should it be checked more often.

Clean the heatsink as follows (when necessary):

1. Remove the cooling fan (see section *Cooling fan*).
2. Blow clean compressed air (not humid) from bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust.

   Note: If there is a risk of dust entering the adjoining equipment, perform the cleaning in another room.
3. Refit the cooling fan.

Cooling fan

The actual lifespan of the cooling fan depends on the drive usage and ambient temperature. Fan failure can be predicted by the increasing noise from fan bearings and the gradual rise in the heatsink temperature in spite of heatsink cleaning.

If the drive is operated in a critical part of a process, it is recommended to replace the immediately after these symptoms start appearing.

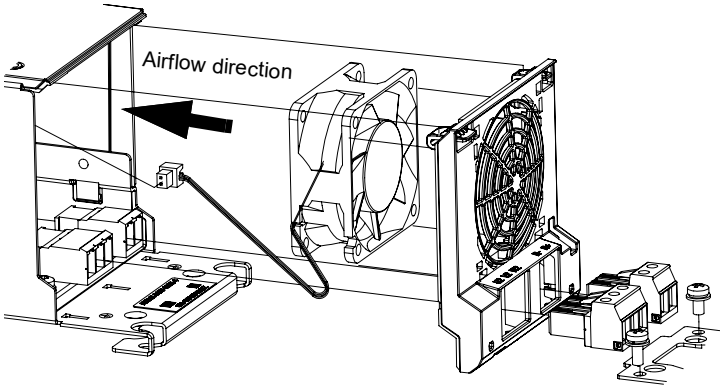
Note: Replacement fans are available from ABB. Do not use spare parts other than ABB-specified spare parts.

Replacing fan (Frames R1 and R2)

To replace the fan in frames R1 and R2, follow these steps:

1. Detach the power cable clamp plate and terminal blocks.
2. Release the retaining clips (arrowed) carefully using a screwdriver.
3. Pull the fan holder out.
4. Disconnect the fan cable.
5. Carefully bend the clips on the fan holder to free the fan.
6. Install the new fan in the reverse order.

Note: The airflow direction is bottom-to-top. Install the fan so that the airflow arrow points up.

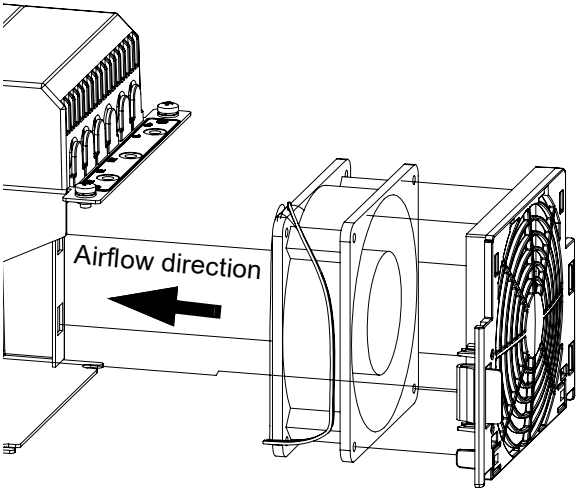


Replacing fan (Frames R3 and R4)

To repalce the fan in frames R3 and R4, follow these steps:

1. Remove the fan by releasing the retaining clip (arrowed) carefully using a screwdriver.
2. Pull the fan holder out.
3. Disconnect the fan cable.
4. Carefully bend the clips on the fan holder to free the fan.
5. Install the new fan in the reverse order.

Note: The airflow direction is bottom-to-top. Install the fan so that the airflow arrow points up.



Reforming the capacitors

The capacitors must be reformed if the drive has been stored for a year or more. See manufacturing date on the *Type designation label* (see page *33).*

For information on reforming the capacitors, see *Converter module capacitor reforming instructions* (3BFE64059629 [English]).

Memory unit

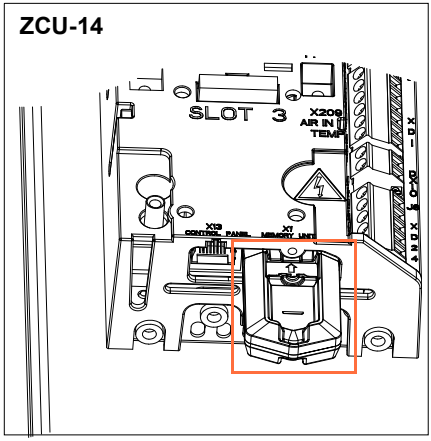
After replacing an inverter control unit, the existing parameter settings can be retained by transferring the memory unit from the defective unit to the new unit.

WARNING! Do not remove or insert the memory unit when the control unit is powered.

To remove the memory unit,

1. Undo the fastening screw.
2. Pull out the memory unit.

ZCU-14



After power-up, the drive scans the memory unit. If a different control program or different parameter settings are detected, they are copied to the drive. This takes about 10 to 30 seconds.

Note: Drive does not respond while copying is in progress.

11

Technical data

Contents of this chapter

This chapter contains the technical specifications of the drive.

Ratings

Nominal ratings with 230 V AC supply

Drive type ACS880-M04	Frame size	Input ratings		Output ratings									
				Nominal		No-overload use		Light-overload use			Heavy-duty use		
		I_{1N} A	*I_{1N} A	I_{2N} A	I_{Max} A	P_N kW	P_N hp	I_{Ld} A	P_{Ld} kW	P_{Ld} hp	I_{Hd} A	P_{Hd} kW	P_{Hd} hp
-03A0-2	R1	2.1	3.5	3.0	4.4	0.37	0.5	2.8	0.37	0.5	2.5	0.37	0.5
-03A6-2	R1	2.9	5.2	3.6	5.3	0.55	0.75	3.4	0.55	0.75	3.0	0.37	0.5
-04A8-2	R1	3.7	6.3	4.8	7.0	0.75	1	4.5	0.75	1	4.0	0.55	0.75
-06A0-2	R1	5.2	8.9	6.0	8.8	1.1	1.5	5.5	1.1	1.5	5.0	0.75	1
-08A0-2	R1	6.3	10.7	8.0	10.5	1.5	2	7.6	1.5	2	6.0	1.1	1.5
-010A-2	R2	8.3	13	10.5	13.5	2.2	3	9.7	2.2	3	9.0	1.5	2
-014A-2	R2	11	17	14	16.5	3	3	13.0	3	3	11.0	2.2	3
-018A-2	R2	15	21	18	21	4	5	16.8	4	5	14.0	3	3
-025A-2	R3	19	–	25	33	5.5	7.5	23	5.5	7.5	19.0	4	5
-030A-2	R3	26	–	30	36	7.5	10	28	7.5	10	24	5.5	7.5
-035A-2	R3	30	–	35	44	7.5	10	32	7.5	10	29	7.5	10
-044A-2	R3	35	–	44	53	11	15	41	11	15	35	7.5	10
-050A-2	R3	42	–	50	66	11	15	46	11	15	44	11	15
-061A-2	R4	54	–	61	78	15	20	57	15	20	52	11	15
-078A-2	R4	64	–	78	100	18.5	25	74	18.5	25	69	15	20
-094A-2	R4	81	–	94	124	22	30	90	22	30	75	18.5	25

3AXD10000434191

See symbol definitions on page 114.

Nominal ratings with 400 V AC supply

Drive type ACS880-M04	Frame size	Input ratings		Output ratings						
				Nominal		No-overload use	Light-overload use		Heavy-duty use	
		I_{1N} A	*I_{1N} A	I_{2N} A	I_{Max} A	P_N kW	I_{Ld} A	P_{Ld} kW	I_{Hd} A	P_{Hd} kW
-03A0-5	R1	2.3	3.8	3.0	4.4	1.1	2.8	1.1	2.5	0.75
-03A6-5	R1	3.1	5.6	3.6	5.3	1.5	3.4	1.5	3.0	1.1
-04A8-5	R1	4.0	6.8	4.8	7.0	2.2	4.5	1.5	4.0	1.5
-06A0-5	R1	5.5	9.4	6.0	8.8	2.2	5.5	2.2	5.0	2.2
-08A0-5	R1	6.6	11.2	8.0	10.5	3.0	7.6	3.0	6.0	2.2
-010A-5	R2	8.7	13	10.5	13.5	4.0	9.7	4.0	9.0	4.0
-014A-5	R2	12	18	14	16.5	5.5	13.0	5.5	11.0	5.5
-018A-5	R2	16	23	18	21	7.5	16.8	7.5	14.0	7.5
-025A-5	R3	20	–	25	33	11.0	23	11	19.0	7.5
-030A-5	R3	26	–	30	36	15.0	28	15	24	11.0
-035A-5	R3	30	–	35	44	18.5	32	15	29	15.0
-044A-5	R3	36	–	44	53	22	41	22	35	18.5

Drive type ACS880-M04	Frame size	Input ratings		Output ratings						
				Nominal		No-overload use	Light-overload use		Heavy-duty use	
		I_{1N} A	*I_{1N} A	I_{2N} A	I_{Max} A	P_N kW	I_{Ld} A	P_{Ld} kW	I_{Hd} A	P_{Hd} kW
-050A-5	R3	42	–	50	66	22	46	22	44	22
-061A-5	R4	55	–	61	78	30	57	30	52	22
-078A-5	R4	65	–	78	104	37	74	37	66	37
-094A-5	R4	82	–	94	124	45	90	45	75	37

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See symbol definitions on page *114*.

Nominal ratings with 460 V AC supply

Drive type ACS880-M04	Frame size	Input ratings		Output ratings						
				Nominal		No-overload use	Light-overload use		Heavy-duty use	
		I_{1N} A	*I_{1N} A	I_{2N} A	I_{Max} A	P_N hp	I_{Ld} A	P_{Ld} hp	I_{Hd} A	P_{Hd} hp
-03A0-5	R1	2.3	3.8	3.0	4.4	1.5	2.8	1.0	2.5	1.0
-03A6-5	R1	3.1	5.6	3.6	5.3	2.0	3.4	2.0	3.0	1.5
-04A8-5	R1	4.0	6.8	4.8	7.0	3.0	4.5	2.0	4.0	2.0
-06A0-5	R1	5.5	9.4	6.0	8.8	3.0	5.5	3.0	5.0	3.0
-08A0-5	R1	6.6	11.2	8.0	10.5	5.0	7.6	5.0	6.0	3.0
-010A-5	R2	8.7	13	10.5	13.5	5.0	9.7	5.0	9.0	5.0
-014A-5	R2	12	18	14	16.5	7.5	13.0	7.5	11.0	7.5
-018A-5	R2	16	23	18	21	10	16.8	10	14.0	10
-025A-5	R3	20	–	25	33	15	23	15	19.0	10
-030A-5	R3	26	–	30	36	20	28	20	24	15
-035A-5	R3	30	–	35	44	25	32	20	29	20
-044A-5	R3	36	–	44	53	30	41	30	35	25
-050A-5	R3	42	–	50	66	30	46	30	44	30
-061A-5	R4	55	–	61	78	40	57	40	52	40
-078A-5	R4	65	–	78	104	50	74	50	66	50
-094A-5	R4	82	–	94	124	60	90	60	75	50

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See symbol definitions on page *114*.

Nominal ratings with 500 V AC supply

Drive type ACS880-M04	Frame size	Input ratings		Output ratings						
				Nominal		No-overload use	Light-overload use		Heavy-duty use	
		I_{1N} A	*I_{1N} A	I_{2N} A	I_{Max} A	P_N kW	I_{Ld} A	P_{Ld} kW	I_{Hd} A	P_{Hd} kW
-03A0-5	R1	2.3	3.8	3.0	4.4	1.5	2.8	1.1	2.5	1.1
-03A6-5	R1	3.1	5.6	3.6	5.3	1.5	3.4	1.5	3.0	1.5
-04A8-5	R1	4.0	6.8	4.8	7.0	2.2	4.5	2.2	4.0	2.2
-06A0-5	R1	5.5	9.4	6.0	8.8	3.0	5.5	3.0	5.0	2.2
-08A0-5	R1	6.6	11.2	8.0	10.5	4.0	7.6	4.0	6.0	3.0
-010A-5	R2	8.7	13	10.5	13.5	5.5	9.7	5.5	9.0	4.0
-014A-5	R2	12	18	14	16.5	7.5	13.0	7.5	11.0	5.5
-018A-5	R2	16	23	18	21	11.0	16.8	7.5	14.0	7.5
-025A-5	R3	20	–	25	33	15.0	23	11.0	19.0	11.0
-030A-5	R3	26	–	30	36	18.5	28	15.0	24	15.0
-035A-5	R3	30	–	35	44	22	32	18.5	29	18.5
-044A-5	R3	36	–	44	53	30	41	22	35	22
-050A-5	R3	42	–	50	66	30	46	30	44	30
-061A-5	R4	55	–	61	78	37	57	37	52	30
-078A-5	R4	65	–	78	104	45	74	45	66	45
-094A-5	R4	82	–	94	124	55	90	55	75	45

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See symbol definitions below.

Definitions

I_{1N}	Nominal input current (rms) at 40 °C (104 °F). *Without mains choke.
I_{2N}	Nominal output current.
I_{Max}	Maximum output current. Available for at least 10 seconds at start, otherwise as long as allowed by drive temperature.
P_N	Typical motor power for no-overload use.
I_{Ld}	Continuous rms output current. 10% overload is allowed for 1 minute every 5 minutes.
P_{Ld}	Typical motor power for light-overload use.
I_{Hd}	Continuous rms output current. 50% overload is allowed for 1 minute every 5 minutes.
P_{Hd}	Typical motor power for heavy-duty use.

Note: To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current.

The DriveSize dimensioning tool available from ABB is recommended for selecting the drive, motor and gear combination.

The maximum allowed motor shaft power is limited to $1.5 \cdot P_{Hd}$, $1.1 \cdot P_N$ or $P_{cont.max}$ (whichever value is the greatest). If the limit is exceeded, motor torque and current are automatically restricted. The function protects the input bridge of the drive against overload.

Derating

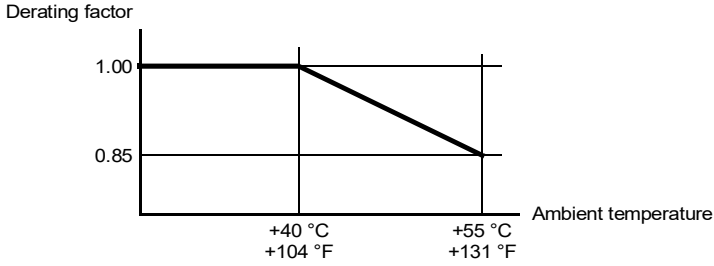
The continuous output currents stated above must be derated if any of the following conditions apply:

- ambient temperature exceeds 40 °C (+104°F)
- drive is installed higher than 1000 m above sea level
- parameter-adjustable motor noise level is set as low.

Note: The final derating factor is a multiplication of all applicable derating factors.

Ambient temperature derating

In the temperature range 40…55 °C (+104…131 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F) as follows:



Altitude derating

At altitudes from 1000 to 2000 m (3300 to 6562 ft) above sea level, the derating is 1% for every 100 m (328 ft). For a more accurate derating, use the DriveSize PC tool.

Low motor noise derating

Low motor noise is activated with a drive parameter (see the *firmware manual*). With low motor noise, drive loadability is reduced and derating must be applied if a certain constant output current is needed. See the derated values in the below tables.

For definitions of symbols used in the below tables, see *Definitions* on page *114*.

Deratings with 230 V AC supply in low motor noise mode

Drive type ACS880-M04	Frame size	Input ratings		Output ratings									
				Nominal		No-overload use		Light-overload use			Heavy-duty use		
		I_{1N}	$^*I_{1N}$	I_{2N}	I_{Max}	P_N		I_{Ld}	P_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}	P_{Hd}
		A	A	A	A	kW	hp	A	kW	hp	A	kW	hp
-03A0-2	R1	1.7	2.9	2.5	4.4	0.37	0.5	2.3	0.25	0.5	1.8	0.25	0.25
-03A6-2	R1	2.4	4.4	3	5.3	0.37	0.5	2.8	0.37	0.5	2.2	0.25	0.5
-04A8-2	R1	3.1	5.3	4	7.0	0.55	0.75	3.8	0.55	0.75	3.0	0.37	0.5
-06A0-2	R1	4.4	7.4	5	8.8	0.75	1	4.8	0.75	1	3.8	0.55	0.75
-08A0-2	R1	4.5	7.6	5.7	10.5	1.1	1	5.2	0.75	1	4.2	0.75	1
-010A-2	R2	7.5	11.5	9.5	13.5	1.5	2	9.0	1.5	2	6.8	1.1	2
-014A-2	R2	9.4	14	12	16.5	2.2	3	11.4	2.2	3	8.8	1.5	2
-018A-2	R2	11	15	13	21	3	3	12.2	2.2	3	9.9	2.2	3
-025A-2	R3	12	–	16	33	3	5	15.2	3	5	12	2.2	3
-030A-2	R3	17	–	20	36	4	5	19	4	5	14	3	3
-035A-2	R3	20	–	23	44	5.5	7.5	22	4	7.5	17	4	5
-044A-2	R3	23	–	29	53	5.5	10	27	5.5	7.5	22	5.5	7.5
-050A-2	R3	28	–	33	66	7.5	10	31	7.5	10	26	5.5	7.5
-061A-2	R4	37	–	42	78	7.5	15	37	7.5	10	31	7.5	10
-078A-2	R4	42	–	51	100	11	15	48	11	15	41	7.5	15
-094A-2	R4	53	–	61	124	15	20	58	15	20	45	11	15

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Deratings with 400 V AC supply in low motor noise mode

Drive type ACS880-M04	Frame size	Input ratings		Output ratings						
				Nominal		No-overload use	Light-overload use		Heavy-duty use	
		I_{1N}	$^*I_{1N}$	I_{2N}	I_{Max}	P_N	I_{Ld}	P_{Ld}	I_{Hd}	P_{Hd}
		A	A	A	A	kW	A	kW	A	kW
-03A0-5	R1	1.9	3.2	2.5	4.4	0.75	2.3	0.75	1.8	0.55
-03A6-5	R1	2.6	4.7	3	5.3	1.1	2.8	1.1	2.2	0.75
-04A8-5	R1	3.3	5.7	4	7.0	1.5	3.8	1.5	3	1.1
-06A0-5	R1	4.6	7.8	5	8.8	2.2	4.8	1.5	3.8	1.5
-08A0-5	R1	4.6	7.7	5.5	10.5	2.2	5.2	2.2	4.2	1.5
-010A-5	R2	7.9	12	9.5	13.5	4	9	4	6.8	3
-014A-5	R2	10	15	12	16.5	5.5	11.4	5.5	8.8	4
-018A-5	R2	11	16	13	21	5.5	12.2	5.5	9.4	4
-025A-5	R3	13	–	16	33	7.5	15	5.5	12	5.5
-030A-5	R3	17	–	20	36	7.5	19	7.5	14	5.5
-035A-5	R3	20	–	23	44	11	22	7.5	17	7.5
-044A-5	R3	24	–	29	53	11	27	11	21	7.5
-050A-5	R3	28	–	33	66	15	31	15	26	11
-061A-5	R4	36	–	40	78	18.5	37	18.5	31	15
-078A-5	R4	43	–	51	100	22	48	22	41	18.5
-094A-5	R4	53	–	61	124	30	58	30	44	22

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Deratings with 460 V AC supply in low motor noise mode

Drive type ACS880-M04	Frame size	Input ratings		Output ratings						
				Nominal		No-overload use	Light-overload use		Heavy-duty use	
		I_{1N} A	*I_{1N} A	I_{2N} A	I_{Max} A	P_N hp	I_{Ld} A	P_{Ld} hp	I_{Hd} A	P_{Hd} hp
-03A0-5	R1	1.6	2.7	2.1	4.4	1	1.9	0.75	1.5	0.5
-03A6-5	R1	2.3	4.1	2.6	5.3	1	2.4	1	1.9	0.75
-04A8-5	R1	2.8	4.8	3.4	7.0	2	3.2	1.5	2.6	1
-06A0-5	R1	4.0	6.7	4.3	8.8	2	4.1	2	3.3	1.5
-08A0-5	R1	4.0	6.7	4.8	10.5	3	4.4	2	3.6	2
-010A-5	R2	6.7	10	8	13.5	5	7.7	5	5.8	3
-014A-5	R2	9	13	10	16.5	5	9.7	5	7.6	5
-018A-5	R2	10	14	12	21	7.5	11	7.5	8	5
-025A-5	R3	11	–	14	33	10	13	7.5	11	7.5
-030A-5	R3	15	–	17	36	10	16	10	12	7.5
-035A-5	R3	18	–	21	44	15	20	10	15	10
-044A-5	R3	20	–	25	53	15	23	15	18	10
-050A-5	R3	24	–	29	66	20	27	20	22	15
-061A-5	R4	31	–	34	78	25	31	20	27	20
-078A-5	R4	36	–	43	100	30	41	30	34	25
-094A-5	R4	45	–	52	124	40	49	30	38	25

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Deratings with 500 V AC supply in low motor noise mode

Drive type ACS880-M04	Frame size	Input ratings		Output ratings						
				Nominal		No-overload use	Light-overload use		Heavy-duty use	
		I_{1N} A	*I_{1N} A	I_{2N} A	I_{Max} A	P_N kW	I_{Ld} A	P_{Ld} kW	I_{Hd} A	P_{Hd} kW
-03A0-5	R1	1.6	2.7	2.1	4.4	0.75	1.9	0.75	1.5	0.55
-03A6-5	R1	2.3	4.1	2.6	5.3	1.1	2.4	1.1	1.9	0.75
-04A8-5	R1	2.8	4.8	3.4	7.0	1.5	3.2	1.5	2.6	1.1
-06A0-5	R1	4.0	6.7	4.3	8.8	2.2	4.1	1.5	3.3	1.5
-08A0-5	R1	4.0	6.7	4.8	10.5	2.2	4.4	2.2	3.6	1.5
-010A-5	R2	6.7	10	8	13.5	4	7.7	4	5.8	3
-014A-5	R2	9	13	10	16.5	5.5	9.7	4	7.6	4
-018A-5	R2	10	14	12	21	5.5	11	5.5	8	4
-025A-5	R3	11	–	14	33	7.5	13	5.5	11	5.5
-030A-5	R3	15	–	17	36	7.5	16	7.5	12	5.5
-035A-5	R3	18	–	21	44	11	20	11	15	7.5
-044A-5	R3	20	–	25	53	11	23	11	18	7.5
-050A-5	R3	24	–	29	66	15	27	15	22	11
-061A-5	R4	31	–	34	78	18.5	31	18.5	27	15
-078A-5	R4	36	–	43	100	22	41	22	34	18.5
-094A-5	R4	45	–	52	124	30	49	30	38	22

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Supply cable fuses

Fuses for short circuit protection of the supply cable are listed below. The fuses also protect the adjoining equipment of the drive in case of a short circuit.

Check that the operating time of the fuse is below 0.5 seconds. The operating time depends on the supply network impedance and the cross-sectional area and length of the supply cable. See also chapter *Planning the electrical installation* on page *53*.

Note: Fuses with a higher current rating must not be used.

Drive type ACS880-M04	Input current (A)	IEC fuse			UL fuse			Cross-sectional area of cable	
		Rated current (A)	Volt-age (V)	Class	Rated current (A)	Volt-age (V)	UL class	mm^2	AWG
-03A0-2, -03A0-5	4.0*	6	500	gG	6	600	T	1.5…4	16…12
-03A6-2, -03A6-5	6.0*	6	500	gG	6	600	T	1.5…4	16…12
-04A8-2, -04A8-5	7.0*	10	500	gG	10	600	T	1.5…4	16…12
-06A0-2, -06A0-5	9.0*	10	500	gG	10	600	T	1.5…4	16…12
-08A0-2, -08A0-5	11*	16	500	gG	15	600	T	1.5…4	16…12
-010A-2, -010A-5	13*	16	500	gG	15	600	T	1.5…10	16…8
-014A-2, -014A-5	18*	20	500	gG	20	600	T	1.5… 0	16…8
-018A-2, -018A-5	23*	25	500	gG	25	600	T	1.5…10	16…8
-025A-2, -025A-5	20	25	500	gG	25	600	T	6…35	9…2
-030A-2, -030A-5	26	32	500	gG	35	600	T	6…35	9…2
-035A-2, -035A-5	30	40	500	gG	35	600	T	6…35	9…2
-044A-2, -044A-5	36	50	500	gG	45	600	T	6…35	9…2
-050A-2, -050A-5	42	50	500	gG	50	600	T	10…70	6…2/0
-061A-2, -061A-5	55	63	500	gG	70	600	T	10…70	6…2/0
-078A-2, -078A-5	65	80	500	gG	80	600	T	10…70	6…2/0
-094A-2, -094A-5	82	100	500	gG	100	600	T	10…70	6…2/0

*Without mains choke

AWG cable sizing is based on NEC Table 310-16 for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) surrounding air temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly burried). For other conditions, dimension the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

gG fuses

Drive type ACS880-M04	*A	A^2s (@500V)	V	Manufacturer	Type	Fuse size DIN
UN = 230 V						
-03A0-2	6	110	500	ABB	OFAF000H6	000
-03A6-2	6	110	500	ABB	OFAF000H6	000
-04A8-2	10	360	500	ABB	OFAF000H10	000
-06A0-2	10	360	500	ABB	OFAF000H10	000
-08A0-2	16	750	500	ABB	OFAF000H16	000
-010A-2	16	750	500	ABB	OFAF000H16	000
-014A-2	20	1500	500	ABB	OFAF000H20	000
-018A-2	25	2550	500	ABB	OFAF000H25	000
-025A-2	25	2550	500	ABB	OFAF000H25	000
-030A-2	32	4500	500	ABB	OFAF000H35	000
-035A-2	40	7800	500	ABB	OFAF000H40	000
-044A-2	50	16000	500	ABB	OFAF000H50	000
-050A-2	50	16000	500	ABB	OFAF000H50	000
-061A-2	63	20000	500	ABB	OFAF000H63	000
-078A-2	80	37000	500	ABB	OFAF000H80	000
-094A-2	100	65000	500	ABB	OFAF000H100	000
UN = 400 V						
-03A0-5	6	110	500	ABB	OFAF000H6	000
-03A6-5	6	110	500	ABB	OFAF000H6	000
-04A8-5	10	360	500	ABB	OFAF000H10	000
-06A0-5	10	360	500	ABB	OFAF000H10	000
-08A0-5	16	750	500	ABB	OFAF000H16	000
-010A-5	16	750	500	ABB	OFAF000H16	000
-014A-5	20	1500	500	ABB	OFAF000H20	000
-018A-5	25	2550	500	ABB	OFAF000H25	000
-025A-5	25	2550	500	ABB	OFAF000H25	000
-030A-5	32	4500	500	ABB	OFAF000H35	000
-035A-5	40	7800	500	ABB	OFAF000H40	000
-044A-5	50	16000	500	ABB	OFAF000H50	000
-050A-5	50	16000	500	ABB	OFAF000H50	000
-061A-5	63	20000	500	ABB	OFAF000H63	000
-078A-5	80	37000	500	ABB	OFAF000H80	000
-094A-5	100	65000	500	ABB	OFAF000H100	000

gR fuses

Drive type ACS880-M04	*A	A^2s (@500V)	V	Manufacturer	Type	Fuse size DIN
UN = 230 V						
-03A0-2	20	70	690	Bussmann	170M2693	00
-03A6-2	20	70	690	Bussmann	170M2693	00
-04A8-2	20	70	690	Bussmann	170M2693	00
-06A0-2	20	70	690	Bussmann	170M2693	00
-08A0-2	20	70	690	Bussmann	170M2693	00
-010A-2	20	70	690	Bussmann	170M2693	00
-014A-2	25	125	690	Bussmann	170M2694	00
-018A-2	32	275	690	Bussmann	170M2695	00
-025A-2	32	275	690	Bussmann	170M2695	00
-030A-2	32	275	690	Bussmann	170M2695	00
-035A-2	50	1000	690	Bussmann	170M2697	00
-044A-2	50	1000	690	Bussmann	170M2697	00
-050A-2	63	1800	690	Bussmann	170M2698	00
-061A-2	80	3600	690	Bussmann	170M2699	00
-078A-2	100	6650	690	Bussmann	170M2700	00
-094A-2	125	12000	690	Bussmann	170M2701	00
UN = 400 V						
-03A0-5	25	125	690	Bussmann	170M2694	00
-03A6-5	25	125	690	Bussmann	170M2694	00
-04A8-5	25	125	690	Bussmann	170M2694	00
-06A0-5	25	125	690	Bussmann	170M2694	00
-08A0-5	25	125	690	Bussmann	170M2694	00
-010A-5	25	125	690	Bussmann	170M2694	00
-014A-5	40	490	690	Bussmann	170M2696	00
-018A-5	40	490	690	Bussmann	170M2696	00
-025A-5	40	490	690	Bussmann	170M2696	00
-030A-5	40	490	690	Bussmann	170M2696	00
-035A-5	63	1800	690	Bussmann	170M2698	00
-044A-5	63	1800	690	Bussmann	170M2698	00
-050A-5	63	1800	690	Bussmann	170M2698	00
-061A-5	80	3600	690	Bussmann	170M2699	00
-078A-5	100	6650	690	Bussmann	170M2700	00
-094A-5	125	12000	690	Bussmann	170M2701	00

aR fuses

Drive type ACS880-M04	*A	A^2s (@500V)	V	Manufacturer	Type	Fuse size DIN
UN = 230 V						
-03A0-2	25	130	690	Bussmann	170M1561	000
-03A6-2	25	130	690	Bussmann	170M1561	000
-04A8-2	25	130	690	Bussmann	170M1561	000
-06A0-2	25	130	690	Bussmann	170M1561	000
-08A0-2	25	130	690	Bussmann	170M1561	000
-010A-2	25	130	690	Bussmann	170M1561	000
-014A-2	40	270	690	Bussmann	170M1563	000
-018A-2	40	270	690	Bussmann	170M1563	000
-025A-2	40	270	690	Bussmann	170M1563	000
-030A-2	40	270	690	Bussmann	170M1563	000
-035A-2	63	1450	690	Bussmann	170M1565	000
-044A-2	63	1450	690	Bussmann	170M1565	000
-050A-2	80	2550	690	Bussmann	170M1566	000
-061A-2	100	4650	690	Bussmann	170M1567	000
-078A-2	125	8500	690	Bussmann	170M1568	000
-094A-2	160	16000	690	Bussmann	170M1569	000
UN = 400 V						
-03A0-5	25	130	690	Bussmann	170M1561	000
-03A6-5	25	130	690	Bussmann	170M1561	000
-04A8-5	25	130	690	Bussmann	170M1561	000
-06A0-5	25	130	690	Bussmann	170M1561	000
-08A0-5	25	130	690	Bussmann	170M1561	000
-010A-5	25	130	690	Bussmann	170M1561	000
-014A-5	40	270	690	Bussmann	170M1563	000
-018A-5	40	270	690	Bussmann	170M1563	000
-025A-5	40	270	690	Bussmann	170M1563	000
-030A-5	40	270	690	Bussmann	170M1563	000
-035A-5	63	1450	690	Bussmann	170M1565	000
-044A-5	63	1450	690	Bussmann	170M1565	000
-050A-5	80	2550	690	Bussmann	170M1566	000
-061A-5	100	4650	690	Bussmann	170M1567	000
-078A-5	125	8500	690	Bussmann	170M1568	000
-094A-5	160	16000	690	Bussmann	170M1569	000

Dimensions and weights

See the *Dimension drawings* on page *189*.

Frame size	Height (without cable clamp plates) H1		Height (with cable clamp plates) H2		Width[1] W		Depth[2] (without options, cover and control panel) D1		Depth (+J400 / with cover and control panel) D2	
	mm	in	mm	in	mm	in	mm	in	mm	in
R1	364	14.33	474	18.66	90	3.54	157	6.18	237	9.33
R2	380	14.96	476	18.74	100	3.94	234	9.21	315	12.40
R3	567	22.32	658	25.91	165	6.50	235	9.25	316	12.44
R4	567	22.32	744	29.29	220	8.66	235	9.25	316	12.44

[1] With option +J400 (with cover and control panel) the width is increased by 5 mm (0.20 in)
[2] Depth is increased with options (Fieldbus communication, I/O extension, encoder interface and their cabling

Frame size	Weight	
	kg	lbs
R1	3.4	7.50
R2	5.6	12.35
R3	15.8	34.83
R4	21.5	47.40

Losses, cooling data and noise

Drive type ACS880-M04	Power loss[1] W (BTU/h)					Airflow m^3/h (ft^3/min)	Noise dB(A)
	Load						
	0%	25%	50%	75%	100%		
-03A0-2	66 (226)	71 (244)	77 (264)	84 (287)	91 (312)	24 (14)	47
-03A6-2	66 (226)	73 (247)	80 (272)	88 (300)	97 (332)	24 (14)	47
-04A8-2	72 (245)	80 (273)	90 (307)	101 (346)	114 (390)	24 (14)	47
-06A0-2	72 (245)	83 (284)	97 (332)	114 (390)	134 (457)	24 (14)	47
-08A0-2	72 (245)	87 (298)	106 (363)	129 (439)	154 (526)	24 (14)	47
-010A-2	72 (245)	91 (311)	116 (395)	147 (500)	183 (626)	48 (28)	39
-014A-2	76 (259)	100 (342)	132 (449)	170 (579)	215 (733)	48 (28)	39
-018A-2	76 (259)	109 (371)	152 (520)	208 (709)	274 (936)	48 (28)	39
-025A-2	92 (314)	137 (469)	191 (653)	254 (867)	325 (1109)	142 (84)	71
-030A-2	92 (314)	152 (520)	227 (776)	317 (1082)	421 (1438)	142 (84)	71
-035A-2	95 (323)	160 (545)	239 (816)	333 (1137)	442 (1507)	142 (84)	71
-044A-2	97 (332)	167 (570)	251 (856)	349 (1192)	462 (1576)	200 (118)	71
-050A-2	97 (332)	182 (620)	286 (975)	410 (1400)	555 (1894)	200 (118)	71
-061A-2	115 (393)	224 (763)	362 (1236)	531 (1812)	730 (2492)	290 (171)	70
-078A-2	115 (393)	249 (851)	423 (1444)	636 (2172)	889 (3034)	290 (171)	70
-094A-2	115 (393)	272 (929)	481 (1641)	741 (2530)	1054 (3597)	290 (171)	70
-03A0-5	68 (233)	75 (256)	83 (282)	91 (310)	100 (340)	24 (14)	47
-03A6-5	68 (233)	76 (261)	86 (292)	96 (326)	106 (363)	24 (14)	47
-04A8-5	74 (252)	84 (288)	97 (330)	110 (376)	126 (430)	24 (14)	47
-06A0-5	74 (252)	88 (302)	106 (361)	126 (429)	148 (504)	24 (14)	47
-08A0-5	74 (252)	93 (319)	116 (397)	142 (486)	172 (586)	24 (14)	47
-010A-5	77 (261)	101 (345)	132 (450)	169 (576)	212 (722)	48 (28)	39
-014A-5	80 (273)	112 (382)	151 (515)	197 (672)	250 (852)	48 (28)	39
-018A-5	80 (273)	122 (418)	176 (601)	241 (823)	318 (1084)	48 (28)	39
-025A-5	98 (333)	154 (525)	219 (747)	293 (1000)	375 (1282)	142 (84)	63
-030A-5	98 (333)	172 (588)	262 (893)	366 (1249)	485 (1654)	142 (84)	63
-035A-5	100 (342)	181 (619)	277 (947)	388 (1323)	513 (1750)	142 (84)	63
-044A-5	103 (351)	191 (651)	293 (1000)	410 (1398)	541 (1846)	200 (118)	71
-050A-5	103 (351)	209 (712)	335 (1142)	481 (1641)	646 (2205)	200 (118)	71
-061A-5	126 (430)	259 (884)	422 (1441)	616 (2101)	840 (2867)	290 (171)	70
-078A-5	126 (430)	290 (990)	494 (1685)	737 (2514)	1020 (3481)	290 (171)	70
-094A-5	126 (430)	317 (1081)	560 (1910)	854 (2915)	1200 (4096)	290 (171)	70

[1] The losses are not calculated according to the ecodesign standard IEC 61800-9-2.

Terminal and lead-through data for power cables

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

Frame size	U1/2, V1/2, W1/2, UDC+/-, R+/-		Grounding terminals
	Max wire size	T	T
	mm^2	N·m	N·m
R1	4	0.5 ... 0.6	1.5
R2	10	1.2 ... 1.5	1.5
R3	70	15	3
R4	70	15	18

Screwdrivers for the terminals of main circuit

Frame size	Screwdrivers
R1	4 mm slot
R2	5 mm slot
R3	4 mm Allen key (hexagonal socket)
R4	4 mm Allen key (hexagonal socket)

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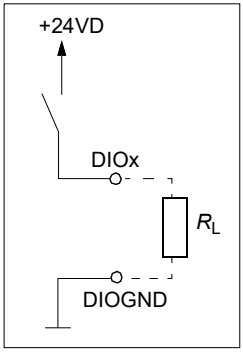
ZCU control unit

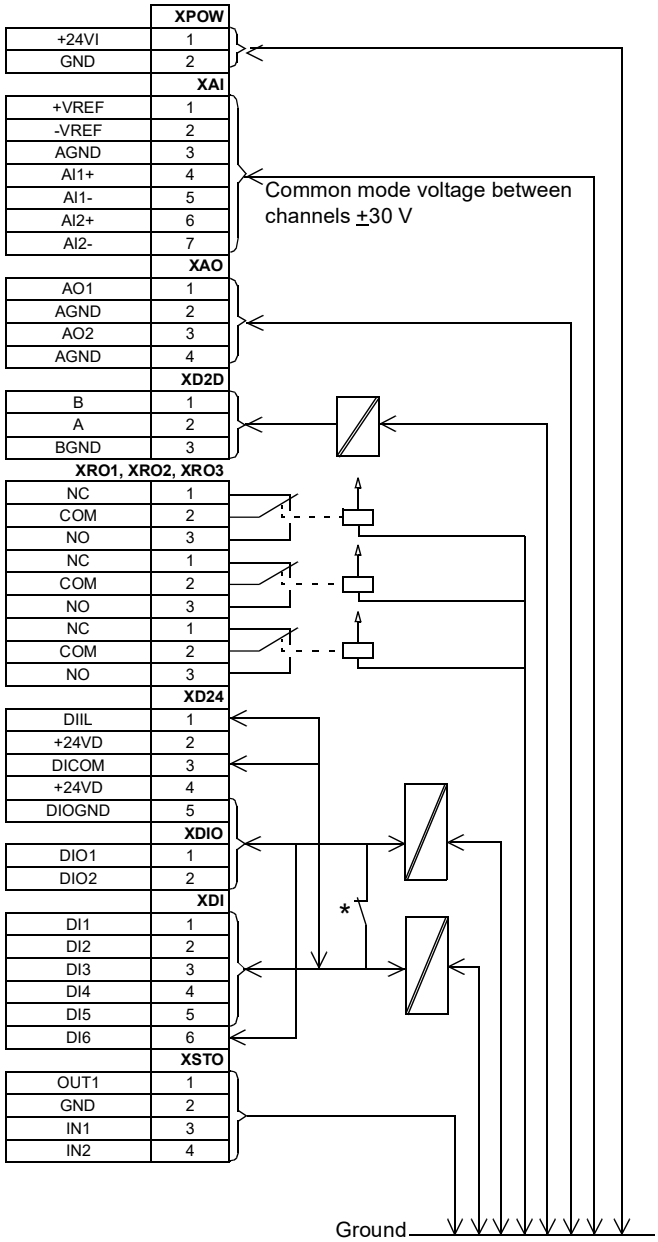
Power supply (XPOW)	Connector pitch 5 mm, wire size 2.5 mm^2 24 V (±10%) DC, 2 A External power input. Two supplies can be connected to BCU for redundancy.
Relay outputs RO1…RO3 (XRO1…XRO3)	Connector pitch 5 mm, wire size 2.5 mm^2 250 V AC / 30 V DC, 2 A Protected by varistors
+24 V output (XD24:2 and XD24:4)	Connector pitch 5 mm, wire size 2.5 mm^2 Total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the power taken by DIO1 and DIO2.

Digital inputs DI1…DI6 (XDI:1…XDI:6)	Connector pitch 5 mm, wire size 2.5 mm^2 24 V logic levels: “0” < 5 V, “1” > 15 V R_{in}: 2.0 kohm Input type: NPN/PNP (DI1…DI5), NPN (DI6) Hardware filtering: 0.04 ms, digital filtering up to 8 ms DI6 (XDI:6) can alternatively be used as an input for a PTC thermistor. “0” > 4 kohm, “1” < 1.5 kohm I_{max}: 15 mA (DI1…DI5), 5 mA (DI6)
Start interlock input DIIL (XD24:1 [ZCU])	Connector pitch 5 mm, wire size 2.5 mm^2 24 V logic levels: “0” < 5 V, “1” > 15 V R_{in}: 2.0 kohm Input type: NPN/PNP Hardware filtering: 0.04 ms, digital filtering up to 8 ms
Digital inputs/outputs DIO1 and DIO2 (XDIO:1 and XDIO:2) Input/output mode selection by parameters. DIO1 can be configured as a frequency input (0…16 kHz with hardware filtering of 4 microseconds) for 24 V level square wave signal (sinusoidal or other wave form cannot be used). DIO2 can be configured as a 24 V level square wave frequency output. See the firmware manual, parameter group 11.	Connector pitch 5 mm, wire size 2.5 mm^2 As inputs: 24 V logic levels: “0” < 5 V, “1” > 15 V R_{in}: 2.0 kohm Filtering: 0.25 ms (ZCU), 1 ms (BCU) As outputs: Total output current from +24VD is limited to 200 mA 
Reference voltage for analog inputs +VREF and -VREF (XAI:1 and XAI:2)	Connector pitch 5 mm, wire size 2.5 mm^2 10 V ±1% and –10 V ±1%, R_{load} 1…10 kohm

Analog inputs AI1 and AI2 (XAI:4 … XAI:7) Current/voltage input mode selection by jumpers/switches.	Connector pitch 5 mm, wire size 2.5 mm^2 Current input: –20…20 mA, R_{in} = 100 ohm Voltage input: –10…10 V, R_{in} > 200 kohm Differential inputs, common mode range ±30 V Sampling interval per channel: 0.25 ms Hardware filtering: 0.25 ms, adjustable digital filtering up to 8 ms Resolution: 11 bit + sign bit Inaccuracy: 1% of full scale range
Analog outputs AO1 and AO2 (XAO)	Connector pitch 5 mm, wire size 2.5 mm^2 0…20 mA, R_{load} < 500 ohm Frequency range: 0…300 Hz (ZCU), 0…500 Hz (BCU) Resolution: 11 bit + sign bit Inaccuracy: 2% of full scale range
Drive-to-drive link (XD2D)	Connector pitch 5 mm, wire size 2.5 mm^2 Physical layer: RS-485 Termination by switch or jumper
Safe torque off connection (XSTO)	Connector pitch 5 mm, wire size 2.5 mm^2 Input voltage range: -3…30 V DC Logic levels: “0” < 5 V, “1” > 17 V For the drive to start, both connections must be “1” Current consumption: 66 mA (continuous) per STO channel per drive module EMC (immunity) according to IEC 61326-3-1
Control panel connection (X13)	Connector: RJ-45 Cable length < 3 m

The terminals of the control unit fulfill the Protective Extra Low Voltage (PELV) requirements. The PELV requirements of a relay output are not fulfilled if a voltage higher than 48 V is connected to the relay output.

Ground isolation diagram (ZCU)



***Ground selector (J6) settings**

	All digital inputs share a common ground (DICOM connected to DIOGND). This is the default setting.
	Ground of digital inputs DI1…DI5 and DIIL (DICOM) is isolated from DIO signal ground (DIOGND). Isolation voltage is 50 V.

AC input (supply) connection

Voltage (U_1)	200…240 V AC +/-10%, 3-phase 380…500 V AC +10%/-15%, 3-phase
Network type	Symmetrically grounded TN-S system, IT (ungrounded)
Short-circuit withstand strength (IEC 60439-1	100 kA when protected by fuses given in the on page 128. Frames R1 and R2: Thermal dimensioning of the DC capacitors is based on max. 5 kA short-circuit current. An input choke should be used to achieve 100 kA.
Short-circuit current protection (UL 61800-5-1, CSA C22.2 No. 274-13)	US and Canada: The drive is suitable for use on a circuit capable of delivering not more than 100 kA symmetrical amperes (rms) at 500 V maximum when protected by fuses given in the on page 128.
Frequency	50…60 Hz ±5%
Imbalance	Max. ±3% of nominal phase to phase input voltage
Fundamental power factor (cos phi$_1$)	0.98 (at nominal load)
Terminals	Frame R1: Detachable screw terminal block for 0.25…4 mm^2 wire. Frame R2: Detachable screw terminal block for 0.5…6 mm^2 wire. Frames R3 and R4: Screw lugs for 6…70 mm^2 wire included. Suitable crimp lugs can be used instead.

DC connection

Voltage

243…356 V DC (ACS880-M04-xxxx-2 drives)

436…743 V DC (ACS880-M04-xxxx-5 drives)

Ratings, fuse recommendations

Drive type ACS880-M04 -xxxx-2/5	I_{dcN} (A)	C (µF)	IEC fuse			UL fuse		
			Rated current (A)	Voltage (V)	Class	Rated current (A)	Voltage (V)	Class
-03A0	3.3	120	16	690	aR	12	690	URC
-03A6	3.9	120	16	690	aR	12	690	URC
-04A8	4.8	240	16	690	aR	12	690	URC
-06A0	6.5	240	16	690	aR	12	690	URC
-08A0	8.7	240	16	690	aR	12	690	URC
-010A	12	370	20	690	aR	16	690	URC
-014A	15	740	32	690	aR	32	690	URD
-018A	20	740	32	690	aR	32	690	URD
-025A	29	670	63	690	aR	63	690	URQ
-030A	38	670	63	690	aR	63	690	URQ
-035A	44	1000	100	690	aR	100	690	URQ
-044A	54	1000	100	690	aR	100	690	URQ
-050A	54	1000	100	690	aR	100	690	URQ
-061A	73	1340	160	690	aR	160	690	URQ
-078A	85	2000	160	690	aR	160	690	URQ
-094A	98	2000	160	690	aR	160	690	URQ

I_{dcN}	Average DC input current requirement when running a typical induction motor at P_N at a DC link voltage of 540 V (which corresponds to an AC input voltage of 400 V).
C	Capacitance of DC link.

Terminals

Frame R1: Detachable screw terminal block for 0.25…4 mm^2 wire.
Frame R2: Detachable screw terminal block for 0.5…6 mm^2 wire.
Frames R3 and R4: Screw lugs for 6…70 mm^2 wire included. Suitable crimp lugs can be used instead.

Motor connection

Motor types	Asynchronous induction motors, permanent magnet motors, ABB synchronous reluctance motors
Frequency	0…500 Hz
Current	See section *Ratings.*
Switching frequency	3 kHz (default)
Maximum motor cable length	Frames R1 and R2: 150 m (492 ft)* Frames R3 and R4: 300 m (984 ft)* *100 m with EN 61800-3 Category C3 filter Longer cables cause a motor voltage decrease which limits the available motor power. The decrease depends on the motor cable length and characteristics. Contact ABB for more information. Note that a sine filter (optional) at the drive output also causes a voltage decrease.
Terminals	Frame R1: Detachable screw terminal block for 0.25…4 mm^2 wire. Frame R2: Detachable screw terminal block for 0.5…6 mm^2 wire. Frames R3 and R4: Screw lugs for 6…70 mm^2 wire included. Suitable crimp lugs can be used instead.

Efficiency

Approximately 98% at nominal power level

The efficiency is not calculated according to the ecodesign standard IEC61800-9-2.

Energy efficiency data (ecodesign)

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

Cooling

Method	Internal fan, flow from bottom to top. Air-cooled heatsink. See *Cooling and degrees of protection* on page *42*.
Free space around the unit	See *Free space requirements* on page *39*.

Protection classes

	Environmental limits for the drive are given below. The drive must be used in a heated, indoor, controlled environment.
Degree of protection (IEC/EN 60529)	IP20 / UL open type. See *Cooling and degrees of protection* on page *42*.
Overv. cat. (IEC 60664-1)	III
Pollution degr. (IEC 60664-1)	2

Ambient conditions

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

	Operation installed for stationary use	**Storage** in the protective package	**Transportation** in the protective package
Installation site altitude	0 to 2000 m (6561 ft) above sea level. Above 1000 m (3281 ft), see section *Altitude derating* on page *115*.	-	-
Air temperature	-10 to +55°C (14 to 131°F). No frost allowed. See section *Derating* on page *115*.	-40 to +70°C (-40 to +158°F)	-40 to +70°C (-40 to +158°F)
Relative humidity	0 to 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination levels (IEC 60721-3-3, IEC 60721-3-2, IEC 60721-3-1)	No conductive dust allowed.		
	According to IEC 60721-3-3: Chemical gases: Class 3C2 Solid particles: Class 3S2 The drive must be installed in clean air according to enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust.	According to IEC 60721-3-1: Chemical cases: Class 1C2 Solid particles: Class 1S2	According to IEC 60721-3-2: Chemical cases: Class 2C2 Solid particles: Class 2S2

Sinusoidal vibration (IEC 60721-3-3)	Tested according to IEC 60721-3-3, mechanical conditions: Class 3M4 2…9 Hz: 3.0 mm (0.12”) 9…200 Hz: 10 m/s^2 (33 ft/s^2)	–	–
Shock (IEC 60068-2-27, ISTA 1A)	–	According to ISTA 1A. Max. 100 m/s^2 (330 ft/s^2), 11 ms	According to ISTA 1A. Max. 100 m/s^2 (330 ft/s^2), 11 ms
Free fall	Not allowed	76 cm (30”)	76 cm (30”)

Materials

Drive enclosure
- PC/ABS, colour NCS 1502-Y (RAL 9002 / PMS 420 C)
- hot-dip zinc coated steel sheet
- extruded aluminium AlSi.

Packaging Corrugated cardboard, PP bands.

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

Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and large electrolytic capacitors need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code.

Contact your local ABB distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations.

Applicable standards

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

EN 61800-5-1:2016	*Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy.*
EN 61800-3:2004 + A1:2012	*Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods.*
EN 60204-1:2006 + A1:2009 + AC:2010	*Safety of machinery. Electrical equipment of machines.* *Part 1: General requirements. Provisions for compliance*: The final assembler of the machine is responsible for installing • emergency-stop device • supply disconnecting device • the drive module into a cabinet
EN 61800-5-1:2007+A1:2017+A11:2021	*Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy*
EN 61800-3:2004+A1:2012	*Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods*
EN IEC 63000:2018	*Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances*
EN 61800-9-2:2017	*Adjustable speed electrical power drive systems - Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications - Energy efficiency indicators for power drive systems and motor starters*
EN 60529:1991 + A1:2000 + A2:2013	*Degrees of protection provided by enclosures (IP code)*
UL 61800-5-1:2012	*UL Standard for Safety. Adjustable speed Electrical Power Drive Systems – Part 5-1:* Safety *Requirement – Electrical, Thermal and Energy.*
CSA C22.2 No. 274-13	*Adjustable speed drives*

Markings

	CE mark Product complies with the applicable European Union legislation. For fulfilling the EMC requirements, see the additional information concerning the drive EMC compliance (IEC/EN 61800-3).
	TÜV Safety Approved mark (functional safety) Product contains Safe torque off and possibly other (optional) safety functions which are certified by TÜV according to the relevant functional safety standards.
	UKCA (UK Conformity Assessed) mark Product complies with the applicable United Kingdom's legislation (Statutory Instruments). Marking is required for products being placed on the market in Great Britain (England, Wales and Scotland).
	UL Listed mark for USA and Canada Product has been tested and evaluated against the relevant North American standards by the Underwriters Laboratories.
	EAC (Eurasian Conformity) mark Product complies with the technical regulations of the Eurasian Customs Union. EAC mark is required in Russia, Belarus and Kazakhstan.
	Electronic Information Products (EIP) symbol including an Environment Friendly Use Period (EFUP). Product is compliant with the People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) about hazardous substances. The EFUP is 20 years.China RoHS II Declaration of Conformity is available from https://library.abb.com.
	WEEE mark At the end of life the product should enter the recycling system at an appropriate collection point and not placed in the normal waste stream.

Compliance with the EN 61800-3:2004

Definitions

EMC stands for **E**lectro**m**agnetic **C**ompatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

Environment/ Category	Description
First environment	Includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.
Second environment	Includes establishments connected to a network not supplying domestic premises.
Drive of category C2	Drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment. **Note**: A professional is a person or organization having necessary skills in installing and/or starting up power drive systems, including their EMC aspects.
Drive of category C3	Drive of rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.
Drive of category C4	Drive of rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

Category C2

The drive complies with the standard with the following provisions:

1. The drive is equipped with external EMC filter JFI-0x (optional accessory to be ordered separately, see *EMC filters* on page *167*).
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. The maximum motor cable length does not exceed 100 meters (328 ft).

⚠ **WARNING!** The drive may cause radio interference if used in residential or domestic environment. The user is required to take measures to prevent interference, in association to the requirements for the CE compliance listed above, if necessary.

Note: Do not install a drive with the internal or external EMC filter (+E200) on IT (ungrounded) systems. The supply network connects to the ground potential through the internal EMC filter capacitors which may cause danger or damage to the drive. For disconnecting the EMC filter, see instructions on page *78*.

Category C3

The drive complies with the standard with the following provisions:

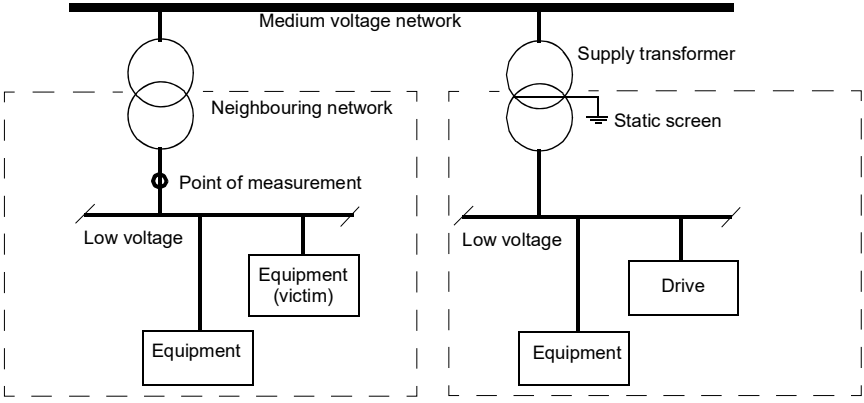
1. The drive is equipped with filtering option +E200.
2. The motor and control cables are selected as specified in this manual.
1. The drive is installed according to the instructions given in this manual.
3. Motor cable length does not exceed 100 metres (328 ft).

WARNING! A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

Category C4

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

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



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

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

WARNING! A drive of category C4 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

An RCM mark is attached on each drive to verify its compliance with the EMC product standard (EN 61800-3:2004), required under the Trans-Tasman Electromagnetic Compatibility Scheme for levels 1, 2 and 3 in Australia and New Zealand.

For fulfilling the requirements of the standard, see section *Compliance with the EN 61800-3:2004* on page *136*.

UL checklist

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

- Make sure that the drive type designation label includes the applicable marking.
- **DANGER - Risk of electric shock.** After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.
- The drive is to be used in a heated, indoor controlled environment. The drive must be installed in clean air according to the enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust.
- The maximum surrounding air temperature is 40 °C at rated output current. The output current is derated for 40…55 °C.
- The drive is suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes, 500 V (or 240V) maximum when protected by the UL fuses given elsewhere in this chapter.
- The cables located within the motor circuit must be rated for at least 75 °C in UL-compliant installations.
- The input cable must be protected with fuses or circuit breakers. These protective devices provide branch circuit protection in accordance with the national regulations (National Electrical Code (NEC) or Canadian Electrical Code). Obey also any other applicable local or provincial codes.

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

- The drive provides motor overload protection. The protection is not enabled when the drive leaves the ABB factory. For enabling the protection, see the firmware manual.
- The drive overvoltage category according to IEC 60664-1 is III.

Disclaimers

Generic disclaimer

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

Cyber security disclaimer

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

12

The Safe torque off function

Contents of this chapter

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

Description

WARNING!
In case of parallel-connected drives or dual-winding motors, the STO must be activated on each drive to remove the torque from the motor.

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

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

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

The Safe torque off function complies with these standards:

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

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

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

The Declarations of conformity are shown at the end of this chapter.’

Wiring

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

Activation switch

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

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

Cable types and lengths

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

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

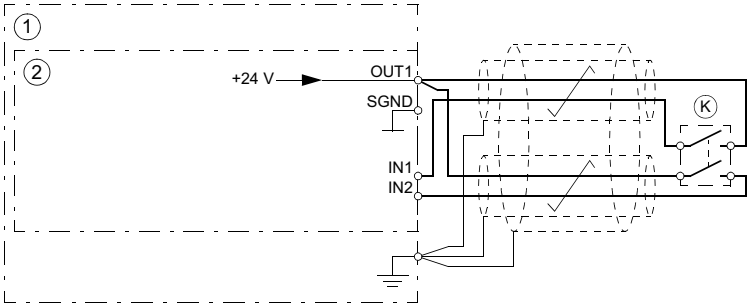
Note: The voltage at the STO input terminals of the control unit must be at least 17 V DC to be interpreted as “1”.
The pulse tolerance of the input channels is 1 ms.

Grounding of protective shields

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

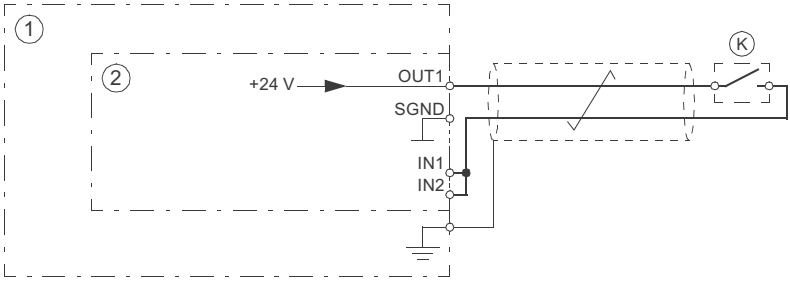
Single drive (internal power supply)

Dual-channel connection



1	Drive
2	Control unit
K	Activation switch

Single-channel connection



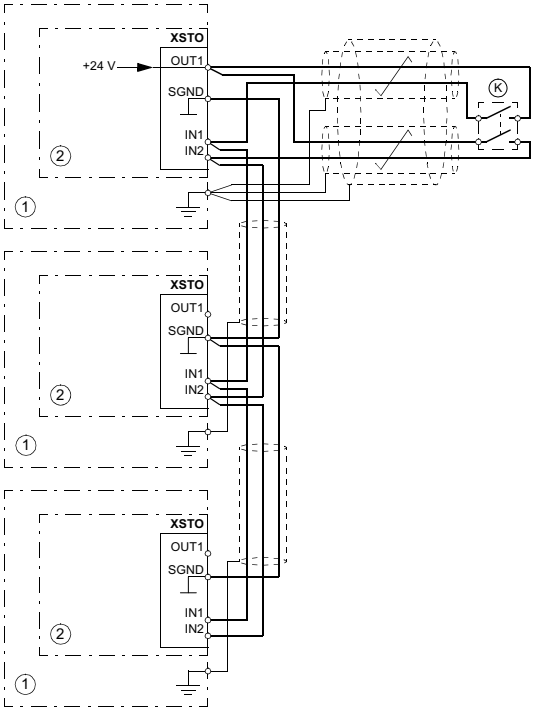
Note:

- Both STO inputs (IN1, IN2) must be connected to the activation switch. Otherwise, no SIL/PL classification is given.
- Pay special attention to avoiding any potential failure modes for the wiring. For example, use shielded cable. For measures for fault exclusion of wiring, see eg. EN ISO 13849-2:2012, table D.4.

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

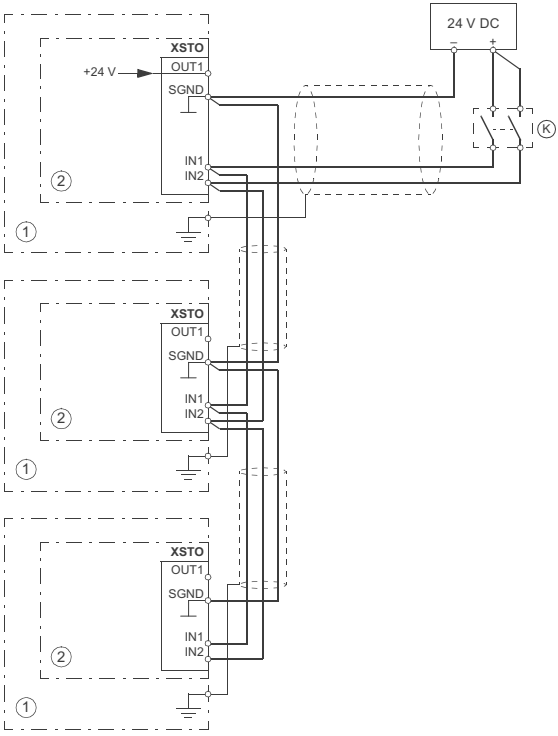
Multiple drives

Internal power supply



1	Drive
2	Control unit
K	Activation switch

External power supply



1	Drive
2	Control unit
K	Activation switch

Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety relay contacts open).
2. The STO inputs on the drive control unit de-energize.
3. The control unit cuts off the control voltage from the drive IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (see the firmware manual of the drive).

The parameter selects which indications are given when one or both STO signals are switched off or lost. The indications also depend on whether the drive is running or stopped when this occurs.
Note: This parameter does not affect the operation of the STO function itself. The STO function will operate regardless of the setting of this parameter: a running drive will stop upon removal of one or both STO signals, and will not start until both STO signals are restored and all faults reset.
Note: The loss of only one STO signal always generates a fault as it is interpreted as a malfunction of STO hardware or wiring.

5. The motor coasts to a stop (if running). The drive cannot restart while the activation switch or safety relay contacts are open. After the contacts close, a reset may be needed (depending on the setting of parameter 31.22). A new start command is required to start the drive.

Start-up including validation test

To ensure the safe operation of a safety function, validation is required. The final assembler of the machine must validate the function by performing a validation test. The test must be performed

1. at initial start-up of the safety function
2. after any changes related to the safety function (circuit boards, wiring, components, settings, replacement of inverter module, etc.)
3. after any maintenance work related to the safety function
4. after a drive firmware update
5. at the proof test of the safety function

Competence

The validation test of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

Validation test reports

Signed validation test reports must be stored in the logbook of the machine. The report shall include documentation of start-up activities and test results, references to failure reports and resolution of failures. Any new validation tests performed due to changes or maintenance shall be logged into the logbook.

Validation test procedure

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

Note: If the drive is equipped with safety option +Q972, +Q973 or +Q982, also do the

procedure shown in the FSO module documentation.

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

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

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

Use

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

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

WARNING!
The drive cannot detect or memorize any changes in the STO circuitry when the drive control unit is not powered or when the main power to the drive is off. If both STO circuits are closed and a level-type start signal is active when the power is restored, it is possible that the drive starts without a fresh start command. Take this into account in the risk assessment of the system.

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

Notes:

- If a running drive is stopped by using the Safe torque off function, the drive will cut off the motor supply voltage and the motor will coast to a stop. If this causes

danger or is not otherwise acceptable, stop the drive and machinery using the appropriate stop mode before activating the Safe torque off function.

- The Safe torque off function overrides all other functions of the drive.
- The Safe torque off function is ineffective against deliberate sabotage or misuse.
- The Safe torque off function has been designed to reduce the recognized hazardous conditions. In spite of this, it is not always possible to eliminate all potential hazards. The assembler of the machine must inform the final user about the residual risks.

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 10 years; see section Safety data (page 285).

There are two alternative procedures for proof testing:

1. Perfect proof testing. It is assumed that all dangerous failures of the STO circuit are detected during the test. PFDavg values for STO with the perfect proof testing procedure are given in the safety data section.
2. Simplified proof testing. This procedure is faster and simpler than perfect proof testing. Not all dangerous failures of the STO circuit are detected during the test. The PFDavg value for STO with the simplified proof testing procedure is given in the safety data section.

Note: The proof testing procedures are only valid for proof testing (periodic test, item 5 under section Start-up including validation test) but not for re-validation after changes made in the circuit. Re-validation (items 1…4 under Start-up including validation test) must be done according to the initial validation procedure.

Note: See also the Recommendation of Use CNB/M/11.050 (published by the European co-ordination of Notified Bodies) concerning dual-channel safety-related systems with electromechanical outputs:

- When the safety integrity requirement for the safety function is SIL 3 or PL e (cat. 3 or 4), the proof test for the function must be performed at least every month.
- When the safety integrity requirement for the safety function is SIL 2 (HFT = 1) or PL d (cat. 3), the proof test for the function must be performed at least every 12 months.

The STO function of the drive does not contain any electromechanical components.

In addition to proof testing, it is a good practice to check the operation of the function when other maintenance procedures are carried out on the machinery.

Include the Safe torque off operation test described above in the routine maintenance program of the machinery that the drive runs.

If any wiring or component change is needed after start-up, or the parameters are restored, do the test given in section Validation test procedure (page 279).

Use only spare parts approved by ABB.

Record all maintenance and proof test activities in the machine logbook.

Competence

The maintenance and proof test activities of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6.

Perfect proof test procedure

- .

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Test the operation of the STO function. If the motor is running, it will stop during the test. • Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Make sure that the drive operates as follows: • Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter 31.22 (see the firmware manual). • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
• Test the operation of the failure detection of the drive. The motor can be stopped or running. • Open the 1st input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA81 fault indication (see the firmware manual). • Open the STO circuit (both channels). • Give a reset command. • Close the STO circuit (both channels). • Reset any active faults. • Open the 2nd input channel of the STO circuit. If the motor was running, it should coast to a stop. The drive generates an FA82 fault indication (see the firmware manual). • Open the STO circuit (both channels). • Give a reset command. • Close the STO circuit (both channels). • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Document and sign the test report to verify that the safety function has been tested according to the procedure.	☐

Simplified proof test procedure

- .

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Test the operation of the STO function. If the motor is running, it will stop during the test. • Give a stop command for the drive (if running) and wait until the motor shaft is at a standstill. Make sure that the drive operates as follows: • Open the STO circuit. The drive generates an indication if one is defined for the 'stopped' state in parameter 31.22 (see the firmware manual). • Close the STO circuit. • Reset any active faults. Restart the drive and check that the motor runs normally.	☐
Document and sign the test report to verify that the safety function has been tested according to the procedure.	☐

Fault tracing

The indications given during the normal operation of the Safe torque off function are selected by drive control program parameter 31.22.

The diagnostics of the Safe torque off function cross-compare the status of the two STO channels. In case the channels are not in the same state, a fault reaction function is performed and the drive trips on an FA81 or FA82 fault. An attempt to use the STO in a non-redundant manner, for example activating only one channel, will trigger the same reaction.

See the firmware manual of the drive control program for the indications generated by the drive, and for details on directing fault and warning indications to an output on the control unit for external diagnostics.

Any failures of the Safe torque off function must be reported to ABB.

Safety data

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

Note: The safety data is calculated for redundant use, and applies only if both STO channels are used.

Frame size	SIL	SC	PL	PFH (1/h)	PFD_{avg}			$MTTF_D$ (a)	DC (%)	SFF (%)	Cat.	HFT	CCF	T_M (a)	PFH_{diag} (1/h)	λ_{Diag_s} (FIT)	λ_{Diag_d} (FIT)
					Perfect proof test		Simplified proof test										
					T_1=5a	T_1=10a	T_1= 5 or 10a										
R1	3	3	e	3.23E-09	9.66E-06	1.93E-05	3.85E-05	24293	≥90	98,80	3	1	80	20	1.20E-11	82.44	1.20
R2	3	3	e	3.23E-09	9.45E-06	1.89E-05	3.77E-05	24293	≥90	98,80	3	1	80	20	1.20E-11	82.44	1.20
R3	3	3	e	3.23E-09	9.45E-06	1.89E-05	3.77E-05	24293	≥90	98,80	3	1	80	20	1.20E-11	82.44	1.20
R4	3	3	e	3.23E-09	9.45E-06	1.89E-05	3.77E-05	24293	≥90	98,80	3	1	80	20	1.20E-11	82.44	1.20
3AXD10001616871 A																	

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

Terms and abbreviations

Term of abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common cause failure (%)
DC	EN ISO 13849-1	Diagnostic coverage
HFT	IEC 61508	Hardware fault tolerance
$MTTF_D$	EN ISO 13849-1	Mean time to dangerous failure: (The total number of life units) / (the number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD_{avg}	IEC 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time
PFH_{diag}	IEC/EN 62061	Average frequency of dangerous failures per hour for the diagnostic function of STO
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL
Proof test	IEC 61508, IEC 62061	Periodic test performed to detect failures in a safety-related system so that, if necessary, a repair can restore the system to an "as new" condition or as close as practical to this condition
SC	IEC 61508	Systematic capability (1…3)
SFF	IEC 61508	Safe failure fraction (%)
SIL	IEC 61508	Safety integrity level (1…3)
SILCL	IEC/EN 62061	Maximum SIL (level 1…3) that can be claimed for a safety function or subsystem
STO	IEC/EN 61800-5-2	Safe torque off
T_1	IEC 61508-6	Proof test interval. T_1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T_1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid

Term of abbreviation	Reference	Description
T_M	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any T_M values given cannot be regarded as a guarantee or warranty.
λ_{Diag_d}	IEC 61508-6	Dangerous failure rate (per hour) of the diagnostics function of STO
λ_{Diag_s}	IEC 61508-6	Safe failure rate (per hour) of the diagnostics function of STO

TÜV certificate

The TÜV certificate is available on the Internet at www.abb.com/drives/documents.

Declarations of conformity

EU Declaration of Conformity

Machinery Directive 2006/42/EC

We

Manufacturer:	ABB Oy
Address:	Hiomotie 13, 00380 Helsinki, Finland.
Phone:	+358 10 22 11

declare under our sole responsibility that the following products:

Frequency converters

ACS880-01/-11/-31
ACS880-04/-04F/-M04/-14/-34

with regard to the safety functions

- **Safe Torque Off**
- **Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Prevention of unexpected start-up (with FSO-12 option module, +Q973, encoderless)**
- **Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Safe speed monitor, Safe direction, Prevention of unexpected start-up (with FSO-21 and FSE-31 option modules, +Q972 and +L521, encoder supported)**
- **Safe motor temperature (with FPTC-01 thermistor protection module, +L536)**
- **Safe stop 1 (SS1-t, with FSPS-21 PROFIsafe module, +Q986)**

are in conformity with all the relevant safety component requirements of EU Machinery Directive 2006/42/EC, when the listed safety functions are used for safety component functionality.

The following harmonized standards have been applied:

EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional
EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems. Part 1: General requirements
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of the control systems. Part 2: Validation
EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements

The following other standards have been applied:

IEC 61508:2010, parts 1-2	Functional safety of electrical / electronic / programmable electronic safety-related systems
IEC 61800-5-2:2016	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional

The product(s) referred in this Declaration of conformity fulfil(s) the relevant provisions of other European Union Directives which are notified in Single EU Declaration of conformity 3AXD10000497831.

Authorized to compile the technical file: ABB Oy, Hiomotie 13, 00380 Helsinki, Finland.

Helsinki, August 31, 2022
Signed for and on behalf of:

Mika Vartiainen
Local Division
Manager
ABB Oy

Aaron D. Wade
Product Unit Manager
ABB Oy

Document number 3AXD10000099646

Declaration of Conformity

Supply of Machinery (Safety) Regulations 2008

We

Manufacturer:	ABB Oy
Address:	Hiomotie 13, 00380 Helsinki, Finland.
Phone:	+358 10 22 11

declare under our sole responsibility that the following products:

Frequency converters

ACS880-01/-11/-31
ACS880-04/-04F/-M04/-14/-34

with regard to the safety functions

- **Safe Torque Off**
- **Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Prevention of unexpected start-up (with FSO-12 option module, +Q973, encoderless)**
- **Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Safe speed monitor, Safe direction, Prevention of unexpected start-up (with FSO-21 and FSE-31 option modules, +Q972 and +L521, encoder supported)**
- **Safe motor temperature (with FPTC-01 thermistor protection module, +L536)**
- **Safe stop 1 (SS1-t, with FSPS-21 PROFIsafe module, +Q986)**

are in conformity with all the relevant safety component requirements of the Supply of Machinery (Safety) Regulations 2008, when the listed safety functions are used for safety component functionality.

The following designated standards have been applied:

EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional
EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems. Part 1: General requirements
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of the control systems. Part 2: Validation
EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements

The following other standards have been applied:

EN 61508:2010, parts 1-2	Functional safety of electrical / electronic / programmable electronic safety-related systems
EN 61800-5-2:2017	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional

The product(s) referred in this declaration of conformity fulfil(s) the relevant provisions of other UK statutory requirements, which are notified in a single declaration of conformity 3AXD10001326405.

Authorized to compile the technical file: ABB Limited, Daresbury Park, Cheshire, United Kingdom, WA4 4BT.

Helsinki, August 31, 2022
Signed for and on behalf of:

Mika Vartiainen
Local Division Manager
ABB Oy

Aaron D. Wade
Product Unit Manager
ABB Oy

Document number 3AXD10001329538

13

Mains chokes

Contents of this chapter

This chapter describes how to select and install mains chokes for the drive module. The chapter also contains the relevant technical data.

When is a mains choke required?

With frames R1 and R2, the need for an external choke should be determined on a case-by-case basis. With frames R3 and R4, the drive modules have an internal mains choke.

The main choke typically

- reduces harmonics in the input current
- reduces the r.m.s. input current
- reduces supply disturbance and low-frequency interference
- increases the allowed DC bus continuous power
- ensures even current distribution in common DC configurations (see page *84*).

Selecting a mains choke

Drive type ACS880-M04	Type	Inductance µH
-03A0-2, -03A0-5	CHK-01	6370
-03A6-2, -03A6-5		
-04A8-2, -04A8-5	CHK-02	4610
-06A0-2, -06A0-5		
-08A0-2, -08A0-5		
-010A-2, -010A-5	CHK-03	2700
-014A-2, -014A-5		
-018A-2, -018A-5	CHK-04	1475
-025A-2, -025A-5	(Internal choke as standard)	
-030A-2, -030A-5		
-035A2, -035A-5		
-044A-2, -044A-5		
-050A-2, -050A-5		
-061A-2, -061A-5		
-078A-2, -078A-5		
-094A-2, -094A-5		

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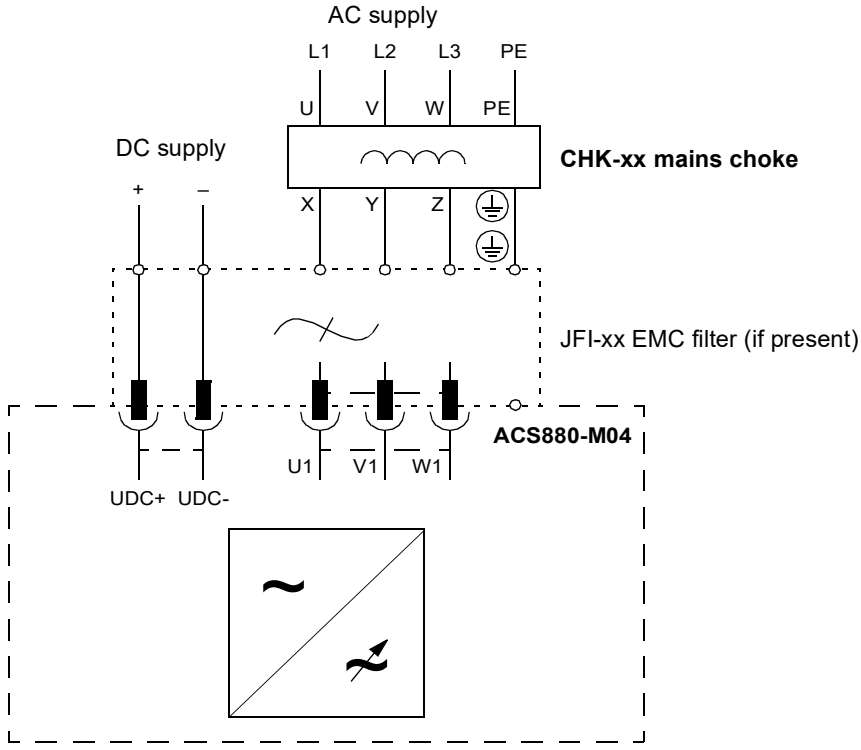
The mains chokes are protected to IP20. For dimensions, wire sizes and tightening torques, refer *Mains choke – CHK-xx dimensions* on page *200*.

Guidelines for installing the mains choke

- If an EMC filter is also installed, the mains choke is connected between the supply and the EMC filter. See the connection diagram below.
- For optimal operation of the choke, the drive and the choke must be mounted on the same conductive surface.
- Ensure the choke does not block the airflow through the drive module, and that the air rising from the choke is deflected away from the air inlet of the drive module
- Keep the cable between the drive and the choke as short as possible.

WARNING! The surface of the mains choke becomes hot when in use.

Connecting the mains choke



14

EMC filters

Contents of this chapter

This chapter describes how to select and install EMC filters for the drive module. The chapter also contains the relevant technical data.

EMC standards

The EMC product standard (EN 61800-3:2004) covers the specific EMC requirements stated for drives (tested with motor and cable) within the EU.

Standard	Description
EN 55011 or EN 61000-6-3/4	These EMC standards • apply to industrial and household equipments and systems including drive components inside. • neither specify cable length nor require a motor to be connected as a load.
EN 61800-3	Drive units complying with this standard are always compliant with comparable categories in EN 55011 and EN 61000-6-3/4, but not necessarily vice versa.

EMC filter emission limits

The emission limits are comparable according to the following general EMC standards.

EN 61800-3:2004, product standard	EN 55011, product family standard for industrial, scientific and medical (ISM) equipment
Category C1	Group 1 Class B
Category C2	Group 1 Class A
Category C3	Group 2 Class A
Category C4	Not applicable

EMC filtering option

Filtering option +E200 is required to meet the category C3 level with the drive module installation, including a motor with a max. 100 m cable. This level corresponds to the A limits for Group 2 equipment according to EN 55011.

With frame sizes R1 and R2, option +E200 is an external filter of type JFI-A1 or JFI-B1.

With frame sizes R3 and R4, the EMC filter is internal.

An external EMC filter of the type JFI-0x is required in order to meet the category C2 level with the drive module installation, including a motor with a max. 100 m cable. This level corresponds to the A limits for Group 1 equipment according to EN 55011.

WARNING! An EMC filter must not be installed if the drive is connected to an IT power system (i.e. an ungrounded, or a high resistance grounded [over 30 ohm] power system).

Selecting EMC filters

Drive type ACS880-M04	Filter type	
	EN 61800-3:2004 Category C3	EN 61800-3: 2004 Category C2
-03A0-2, -03A0-5	Option code +E200 (external filter JFI-A1)	JFI-02*
-03A6-2, -03A6-5		
-04A8-2, -04A8-5		
-06A0-2, -06A0-5		
-08A0-2, -08A0-5		
-010A-2, -010A-5	Option code +E200 (external filter JFI-B1)	JFI-03*
-014A-2, -014A-5		
-018A-2, -018A-5		
-025A-2, -025A-5	Option code: +E200 (internal filter)	JFI-05*
-030A-2, -030A-5		
-035A2, -035A-5		
-044A-2, -044A-5		
-050A-2, -050A-5		
-061A-2, -061A-5		JFI-07*
-078A-2, -078A-5		
-094A-2, -094A-5		

*External filter; to be ordered separately

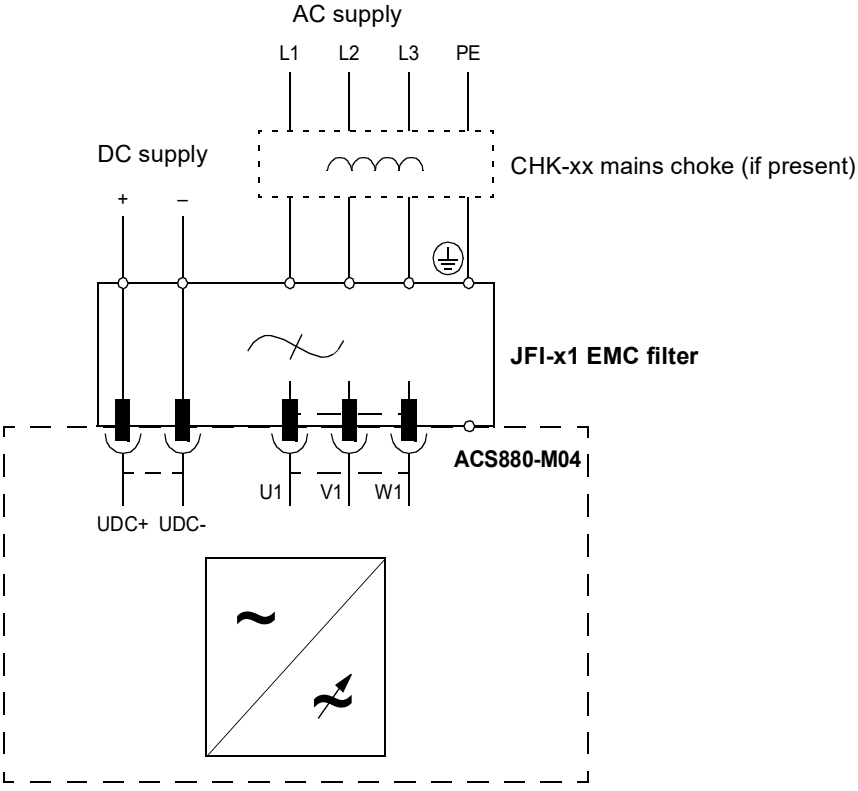
All EMC filters are protected to IP20. See dimension drawings of *EMC filters (type JFI-x1)* (page *191*) and *EMC filters (type JFI-0x)* (page *193*). For details of dimensions, wire sizes and tightening torques see *EMC filter – JFI-xx dimensions* on page *194*.

Installing EMC filters – JFI-A1/JFI-B1 (Frame R1/R2, category C3)

JFI-x1 filter installation guidelines

- Connect the filter directly to the drive input connectors.
- For optimal operation of the filter, mount the drive and the filter on the same conductive surface.

JFI-x1 filter connection diagram

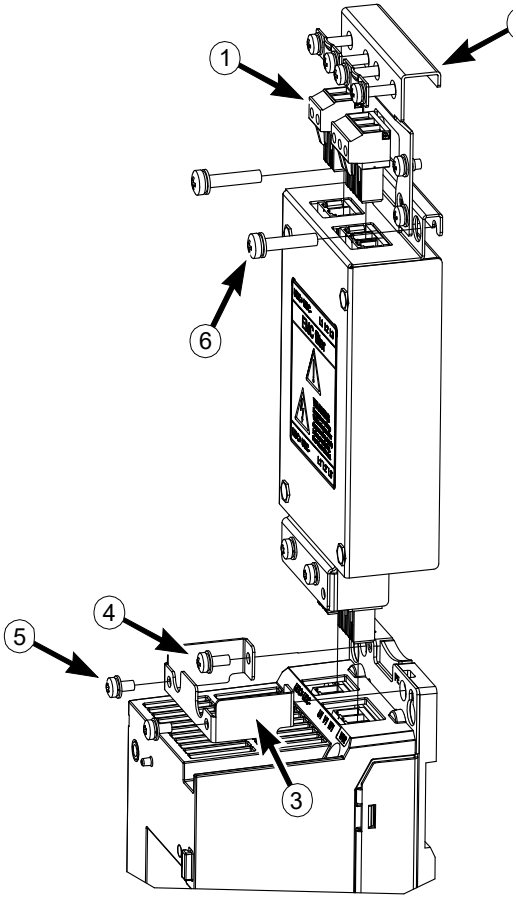


Installing the JFI-A1 filter

To install the JFI-A1 EMC filter,

1. Remove the UDC+/- and U1/V1/W1 terminal blocks (1), and the upper power cable clamp plate (2) from the drive.
2. Fasten the mounting bracket (3) to the drive module base with two screws (4). Tighten to 1.5 N·m (13 lbf·in).
3. Push the filter into place through the mounting bracket.
4. Fasten the filter to the mounting bracket with two screws (5). Tighten to 1.5 N·m (13 lbf·in).
5. Fasten the top edge of the filter to the mounting base with two screws (6).
6. Fasten the power cable clamp plate at the top of the filter. Tighten to 1.5 N·m (13 lbf·in).

7. Attach the terminal blocks to the filter.

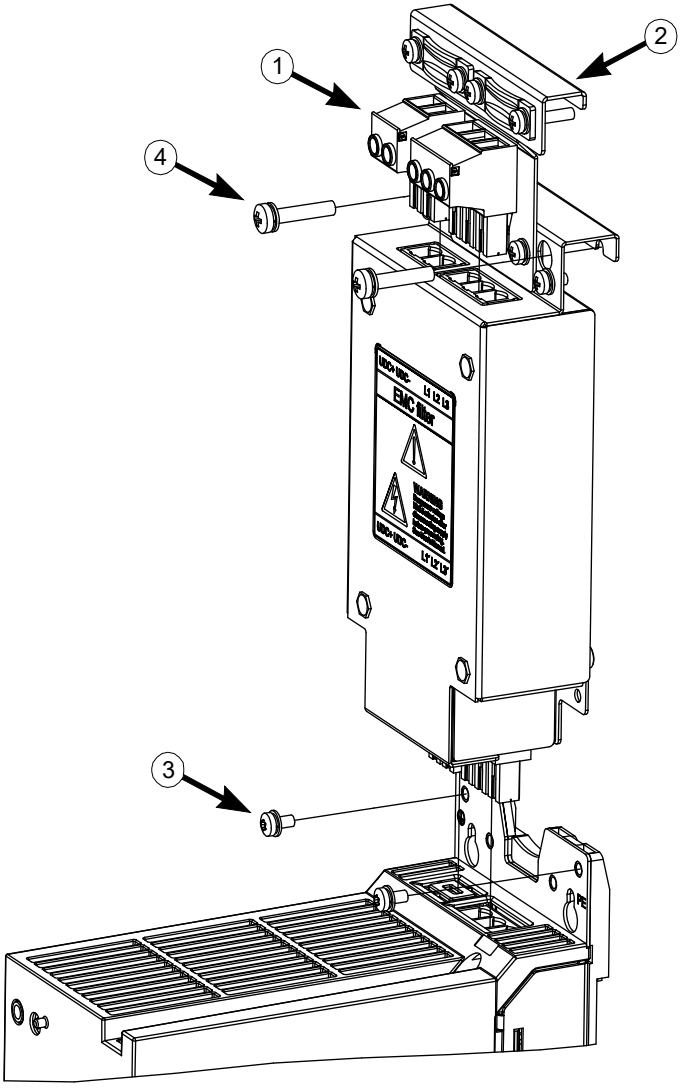


Installing the JFI-B1 filter

To install the JFI-B1 EMC filter,

1. Remove the UDC+/- and U1/V1/W1 terminal blocks (1), and the upper power cable clamp plate (2) from the drive.
2. Push the filter into the connectors.
3. Fasten the filter to the drive module base with two screws (3). Tighten to 1.5 N·m (13 lbf·in).
4. Fasten the top edge of the filter to the mounting base with two screws (4).
5. Fasten the power cable clamp plate at the top of the filter. Tighten to 1.5 N·m (13 lbf·in).

6. Attach the terminal blocks to the filter.

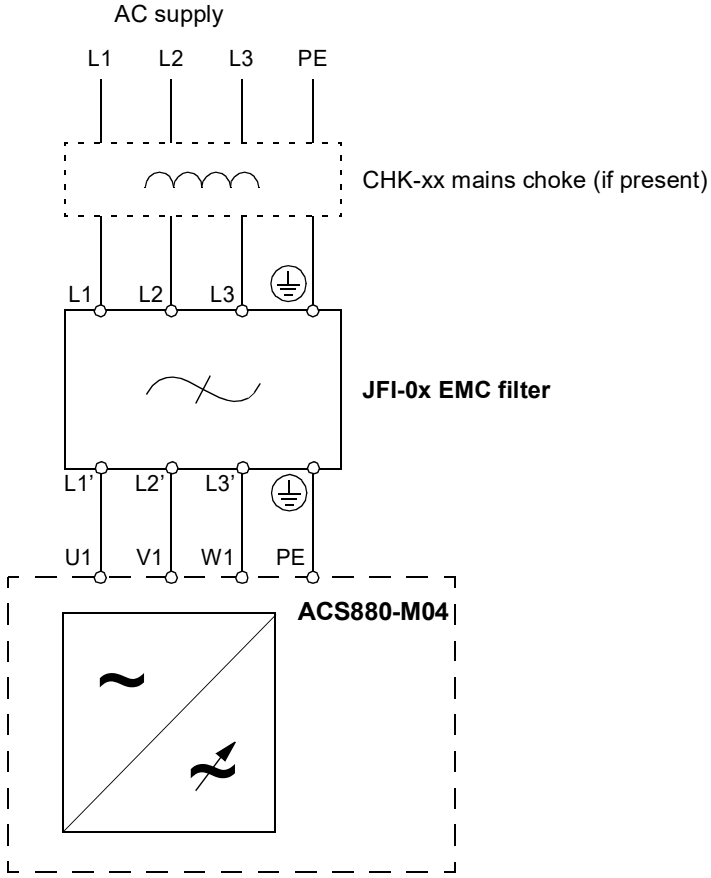


Installing EMC filter – JFI-0x (Frames R1…R4, category C2)

JFI-0x filter installation guidelines

- If a mains choke is also installed, the EMC filter is connected between the mains choke and the drive module. See the connection diagram below.
- For optimal operation of the filter, the drive and the filter must be mounted on the same conductive surface.
- Ensure the filter does not block the airflow through the drive module.
- Keep the cable between the drive and the filter as short as possible.

JFI-0x filter connection diagram



15

d*u*/d*t* and common mode filtering

Contents of this chapter

This chapter describes how to select d*u*/d*t* and common mode filtering for the drive module. The chapter also contains the relevant technical data.

When is d*u*/d*t* or common mode filtering required?

The output of the drive comprises – regardless of output frequency – pulses of approximately 1.35 times the equivalent supply voltage with a very short rise time. This is the case with all drives employing modern IGBT drive technology. The motor and motor cable insulation may undergo the following situation:

- The voltage of the pulses can be almost double at the motor terminals, depending on the attenuation and reflection properties of the motor cable and the terminals. This in turn 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, which can gradually erode the bearing races and rolling elements.

Use the,

- optional ABB d*u*/d*t* filters to avoid stress on motor insulation
- common mode filters to reduce bearing currents.

Note: To avoid damage to the motor bearings, select and install the cables according to the instructions given in *Electrical installation* on page *75*.

Selecting the d*u*/d*t* filters

Warning! Use the d*u*/d*t* filtering, common mode filtering, and insulated N-end bearings according to the following table.
If you ignore these requirements, the motor life can shorten or damage to the motor bearings can occur, and the warranty is not applicable.

d*u*/d*t* filters are optional accessories and to be ordered separately. For more information on common mode filtering, contact your local ABB representative. Contact the motor manufacturer for information on the motor construction.

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
			P_N < 134 hp and frame size < NEMA 500
ABB motors			
Random-wound M2_, M3_ and M4_	$U_N \leq 500$ V	Standard	-
Form-wound HX_ and AM_	$U_N \leq 500$ V	Standard	-
Old* form-wound HX_ and modular	$U_N \leq 500$ V	Check with the motor manufacturer.	+ N + CMF
Random-wound HX_ and AM_ **	0 V < $U_N \leq$ 500 V	Enamelled wire with fiber glass taping	+ N + CMF
Non-ABB motors			
Random-wound and form-wound	$U_N \leq 420$ V	Standard: $\hat{U}_{LL}$ = 1300 V	-
	420 V < $U_N \leq$ 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ d*u*/d*t*
		or	
		Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 microsecond rise time	-

*manufactured before 1.1.1998

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

The abbreviations used in the table are defined below.

Abbreviation	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
CMF	Common mode filter
N	N-end bearing: insulated motor non-drive end bearing

Additional requirements for ABB motors of types other than M2_, M3_, M4_, HX_ and AM_

Use the selection criteria given for non-ABB motors.

Additional requirements for the braking applications

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

Example: Select the motor insulation system for a 400 V AC line voltage application as if the drive were supplied with 480 V.

Installing d*u*/d*t* and common mode filters

Follow the instructions provided with the filters.

d*u*/d*t* filters data

d*u*/d*t* filter types

Drive type ACS880-M04	Filter type
-03A0-2, -03A0-5	NOCH0016-60 (3-phase)
-03A6-2, -03A6-5	
-04A8-2, -04A8-5	
-06A0-2, -06A0-5	
-08A0-2, -08A0-5	
-010A-2, -010A-5	
-014A-2, -014A-5	
-018A-2, -018A-5	
-025A-2, -025A-5	NOCH0030-60 (3-phase)
-030A-2, -030A-5	
-035A2, -035A-5	
-044A-2, -044A-5	NOCH0070-60 (3-phase)
-050A-2, -050A-5	
-061A-2, -061A-5	
-078A-2, -078A-5	
-094A-2, -094A-5	NOCH0120-60 (1-phase; three filters included in kit)

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Common mode filter types

Contact your local ABB representative.

du/dt filters dimensions and weights

Filter type	Height mm (inches)	Width mm (inches)	Depth mm (inches)	Weight kg (lbs)
NOCH0016-60	195 (7.68)	140 (5.51)	115 (4.53)	2.4 (5.3)
NOCH0030-60	215 (8.46)	165 (6.50)	130 (5.12)	4.7 (10.4)
NOCH0070-60	261 (10.28)	180 (7.09)	150 (5.91)	9.5 (20.9)
NOCH0120-60*	200 (7.87)	154 (6.06)	106 (4.17)	7.0 (15.4)

*Dimensions given are per phase

du/dt filters degree of protection

IP00

16

Resistor braking

Contents of this chapter

This chapter describes how to select, protect and wire brake choppers and resistors. The chapter also contains the technical data.

Selecting brake choppers and resistors

Brake choppers

The ACS880-M04 (frames R1…R4) drives have a built-in brake chopper as standard equipment to handle the energy generated by a decelerating motor.

When the brake chopper is enabled and a resistor is connected, the chopper starts conducting when the DC link voltage of the drive reaches U_{DC_BR} - 30 V.

The maximum braking power is achieved at U_{DC_BR} + 30 V. Pre-selected resistors

U_{DC} = 1.35 × Used AC supply voltage

U_{DC_BR} = 1.25 × U_{DC}

See the available ABB brake choppers shown in the *Brake choppers data table* on page *183*.

Brake resistors

To select a brake resistor, calculate the following:

1. maximum power generated by the motor during braking
2. continuous power based on the braking duty cycle
3. braking energy during the duty cycle.

Pre-selected resistors are available from ABB as shown in the *Brake resistors data table* on page *185*. If the listed resistor is not sufficient for the application, a custom resistor can be selected within the limits imposed by the internal brake chopper of the ACS880-M04. The following rules apply:

- The resistance of the custom resistor must be at least R_{min}. The braking power capacity with different resistance values can be calculated from the following formula:

$$P\text{max} < \frac{(U_{DC\_BR} + 30\ \text{V})^2}{R}$$

WARNING! Never use a brake resistor with a resistance below the value specified for the particular drive type. The drive and the chopper are not able to handle the overcurrent caused by the low resistance.

- The maximum braking power must not exceed P_{brmax} at any point
- The average braking power must not exceed P_{brcont}
- The braking energy must not exceed the energy dissipation capacity of the selected resistor
- The resistor must be protected from thermal overload; see section *Contactor protection of drive* on page *186*.

Brake choppers data table

The ratings apply at an ambient temperature of 40 °C (104 °F).

Drive type ACS880-M04	Internal brake chopper							
	P_{br5} (kW)	P_{br5} (kW) L	*P*br10 (kW)	*P*br10 (kW) L	P_{brcont} (kW)	P_{brcont} (kW) L	P_{brmax} (kW)	R_{min} (ohm)
-03A0-2	0.5	0.2	0.5	0.2	0.45	0.15	2.75	120
-03A6-2	0.75	0.3	0.7	0.25	0.65	0.2		
-04A8-2	1.0	0.3	1.0	0.3	0.9	0.25		
-06A0-2	1.5	0.8	1.4	0.75	1.3	0.35		
-08A0-2								
-010A-2	2.8	1.0	2.7	0.9	2.25	0.75	4.0	80
-014A-2	4.1	1.3	3.9	1.2	3.3	1.1	7.3	40
-018A-2	5.3	1.7	5.1	1.6	4.25	1.4		
-025A-2	6.8	3.8	6.5	3.4	5.25	2.7	15.4	20
-030A-2	7.8	4.4	7.4	4.0	6	3.1		
-035A-2								
-044A-2	11.4	6.4	10.8	5.7	8.75	4.5	22.0	13
-050A-2								
-061A-2	20.2	14.0	20.0	11.8	18	8		
-078A-2								
-094A-2								
-03A0-5	1.0	0.4	1.0	0.4	0.9	0.3	5.5	120
-03A6-5	1.5	0.5	1.4	0.5	1.3	0.4		
-04A8-5	2.0	0.6	1.9	0.6	1.8	0.5		
-06A0-5	3.0	1.6	2.8	1.5	2.6	0.7		
-08A0-5								
-010A-5	5.5	1.9	5.3	1.8	4.5	1.5	7.9	80
-014A-5	8.2	2.6	7.8	2.4	6.6	2.1	14.6	40
-018A-5	10.5	3.4	10.1	3.2	8.5	2.7		
-025A-5	13.6	7.6	12.9	6.8	10.5	5.4	30.7	20
-030A-5	15.5	8.8	14.7	7.9	12	6.2		
-035A-5								
-044A-5	22.7	12.7	21.5	11.4	17.5	9	43.9	13
-050A-5								
-061A-5	40.4	28.0	40.0	23.6	36	16		
-078A-5								
-094A-5								

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L = Low motor noise mode. See section *Low motor noise derating* on page *115*.

P_{br5} = The drive (drive and chopper) withstands this braking power for 5 seconds per minute.

P_{br10} = The drive (drive and chopper) withstands this braking power for 10 seconds per minute.

P_{brcont} = The drive (drive and chopper) withstands this continuous braking power. Braking is considered continuous if braking time exceeds 30 seconds.

P_{brmax} = Maximum braking power of the drive (drive and chopper). The drive (drive and chopper) withstands this braking power for 1 second within every 10 seconds.
Note: The listed resistors withstand this braking power for 1 second within every 120 seconds.

R_{min} = The minimum allowed resistance of the brake resistor.

Brake resistors data table

The ratings apply at an ambient temperature of 40°C (104°F).

Drive type ACS880-M04	Example brake resistor JBR-xx				Example brake resistor SACExxxxx			
	Type	R (ohm)	P_n (W)	E_{pulse} (kJ)	Type	R (ohm)	P_{Rcont} (kW)	E_R (kJ)
-03A0-2, -03A0-5	JBR-01	120	105	22	-	-	-	-
-03A6-2, -03A6-5								
-04A8-2, -04A8-5								
-06A0-2, -06A0-5								
-08A0-2, -08A0-5								
-010A-2, -010A-5	JBR-03	80	135	40	-	-	-	-
-014A-2, -014A-5	JBR-04	40	360	73	SACE08RE44	44	1	210
-018A-2, -018A-5								
-025A-2, -025A-5	JBR-05	20	570	77	SACE15RE22	22	2	420
-030A-2, -030A-5								
-035A-2, -035A-5								
-044A-2, -044A-5	JBR-06	13	790	132	SACE15RE13	13	2	435
-050A-2, -050A-5								
-061A-2, -061A-5								
-078A-2, -078A-5								
-094A-2, -094A-5								

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R = Resistance of the listed resistor.

P_n = Continuous power (heat) dissipation of the listed resistor when cooled naturally in a vertical position.

E_{pulse} = Energy pulse the listed resistor will withstand.

P_{Rcont} = Continuous power (heat) dissipation of the resistor when placed correctly. Energy E_R dissipates in 400 seconds.

E_R= Short energy pulse that the resistor assembly withstands every 400 seconds. This energy will heat the resistor element from 40°C (104°F) to the maximum allowable temperature.

Note: All brake resistors must be installed outside the drive module.

Brake resistors degree of protection

Resistor type	Degree of protection
JBR-xx	IP20
SACE	IP21

Note: The SACE resistors are not UL listed.

Brake resistors dimensions

See dimensions drawings of *Brake resistors (type JBR-xx)* on page *195*. For details of dimensions, wire sizes and tightening torques, see *Brake resistor - JBR-xx dimensions* on page *196*.

Installing and wiring brake resistors

All resistors must be installed outside the drive module in a place where they are cooled sufficiently, do not block the airflow to other equipment, or dissipate hot air into the air inlets of other equipment.

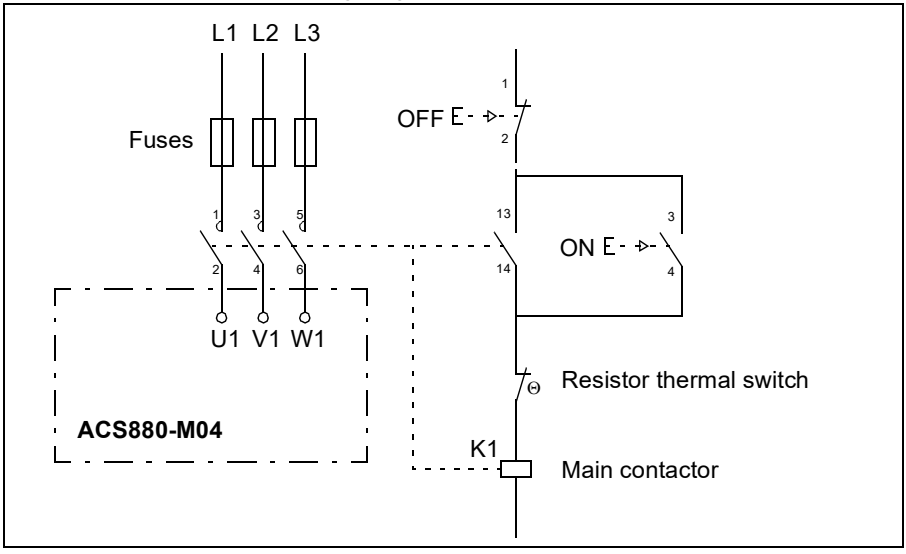
WARNING! The materials near the brake resistor must be non-flammable. The surface temperature of the resistor may rise above 200 °C (400 °F), and the temperature of the air flowing from the resistor is hundreds of degrees Celsius. Protect the resistor against contact.

The maximum length of the resistor cable(s) is 20 m (65 ft). For the connections, see *Cable routing diagram* on page *64*.

Contactor protection of drive

The drive must be equipped with a main contactor for safety reasons. Wire the contactor so that it opens in case the resistor overheats. This is essential for safety since the drive will not otherwise be able to interrupt the main supply if the chopper remains conductive in a fault situation.

Below is a simple example wiring diagram.



Commissioning the braking circuit

For more information, see the *firmware manual*.

1. Enable the brake chopper function. Please note that a brake resistor must be connected when the chopper is enabled from group *43 Brake chopper*.
2. Switch Off the overvoltage control of the drive with parameter *30.30 Overvoltage control*.
3. Adjust any other relevant parameters in group *43 Brake chopper*.

WARNING! If the drive is equipped with a brake chopper but the chopper is not enabled by the parameter setting, the internal thermal protection of the drive against resistor overheating is not in use. In this case, the brake resistor must be disconnected.

Note: Some brake resistors are coated with oil film for protection. At the start-up, the coating burns off and produces a little bit of smoke. Ensure proper ventilation at the start-up.

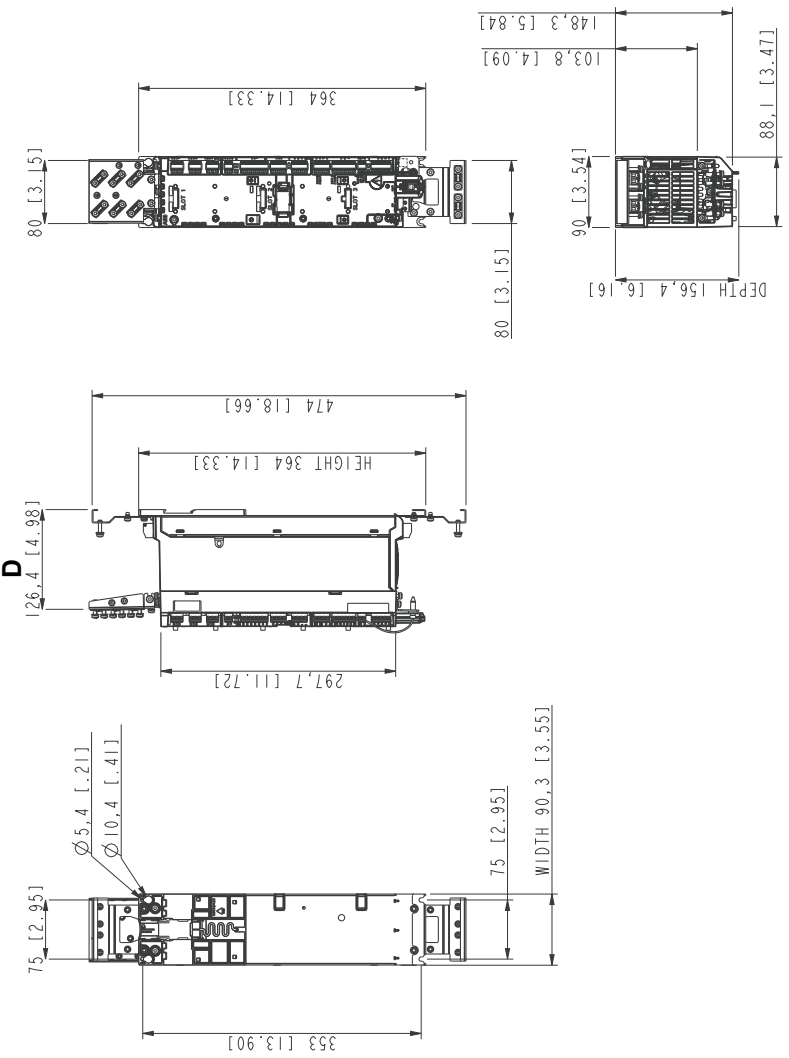
17

Dimension drawings

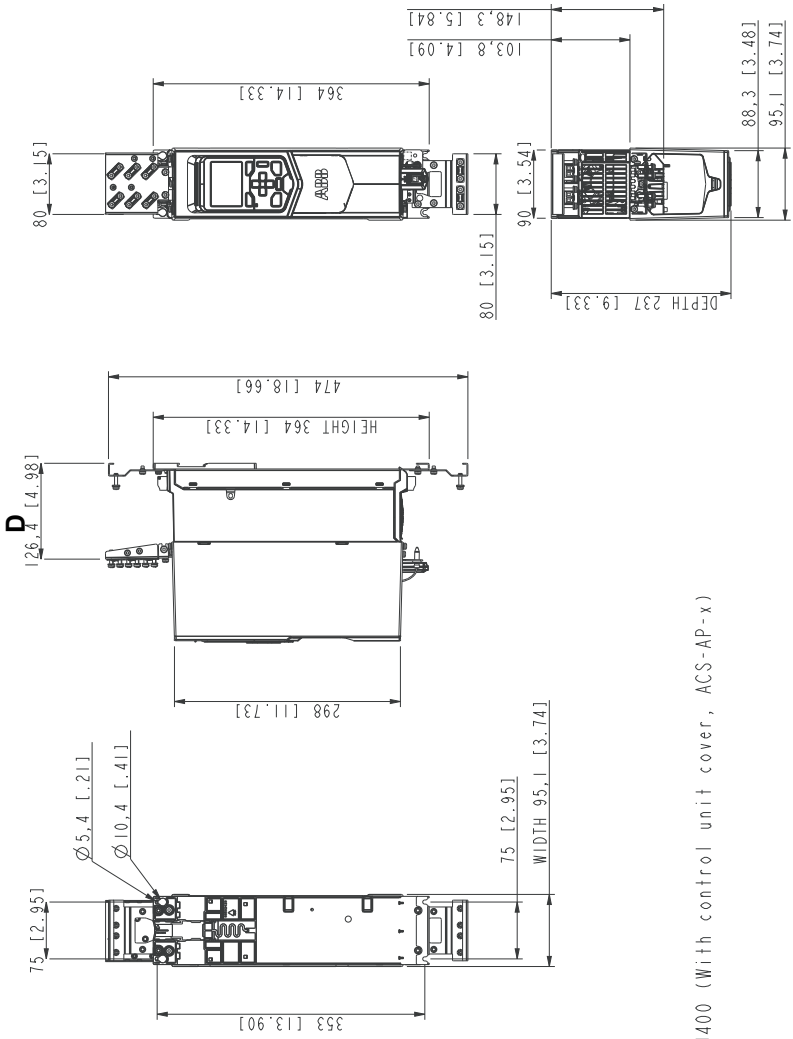
Contents of this chapter

The dimension drawings of the ACS880-M04 drive (frame sizes R1, R2, R3 and R4) and the related accessories are show below. The dimensions are given in millimetres and inches.

Frame size R1



DMS:3AXD10000466877



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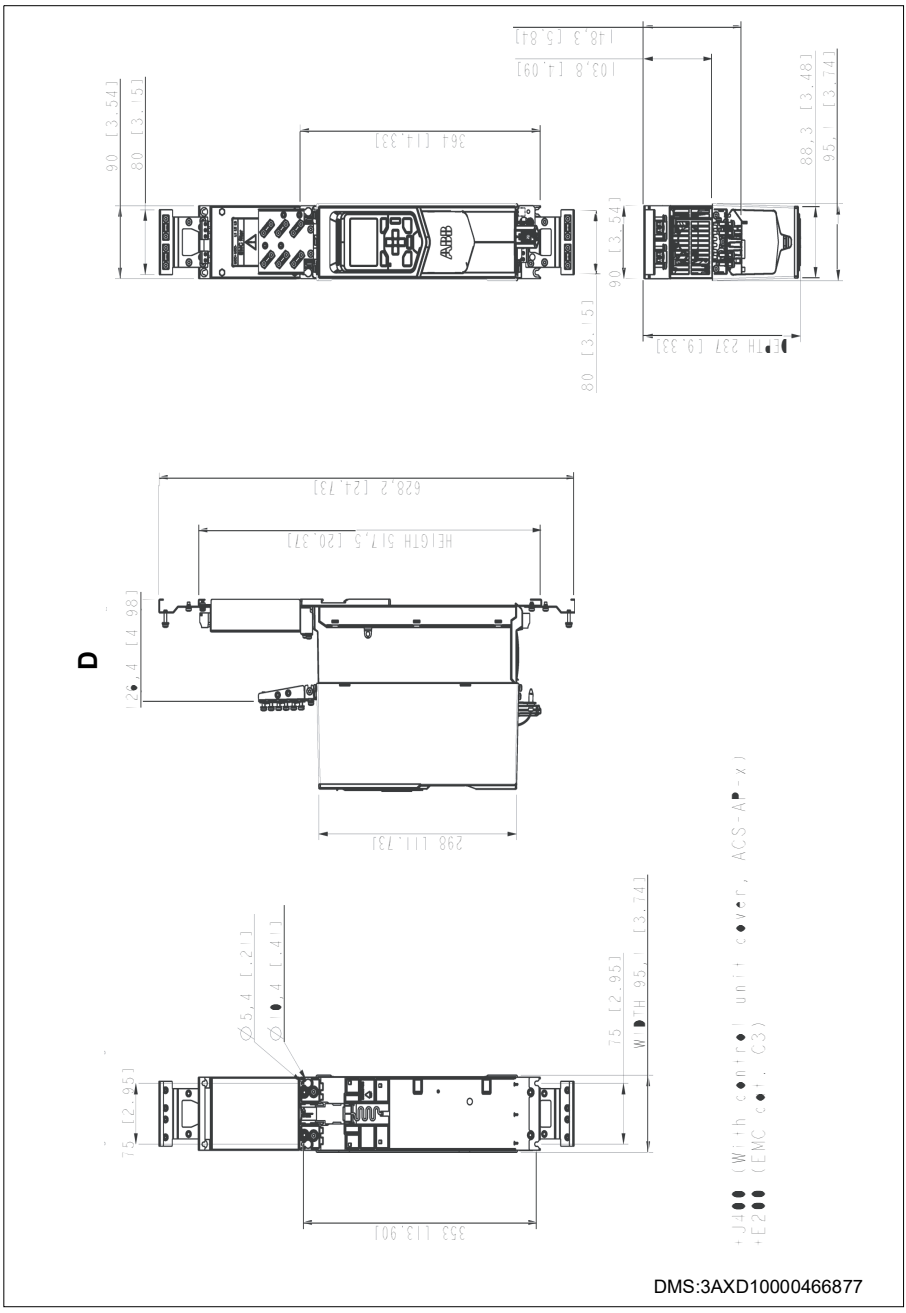
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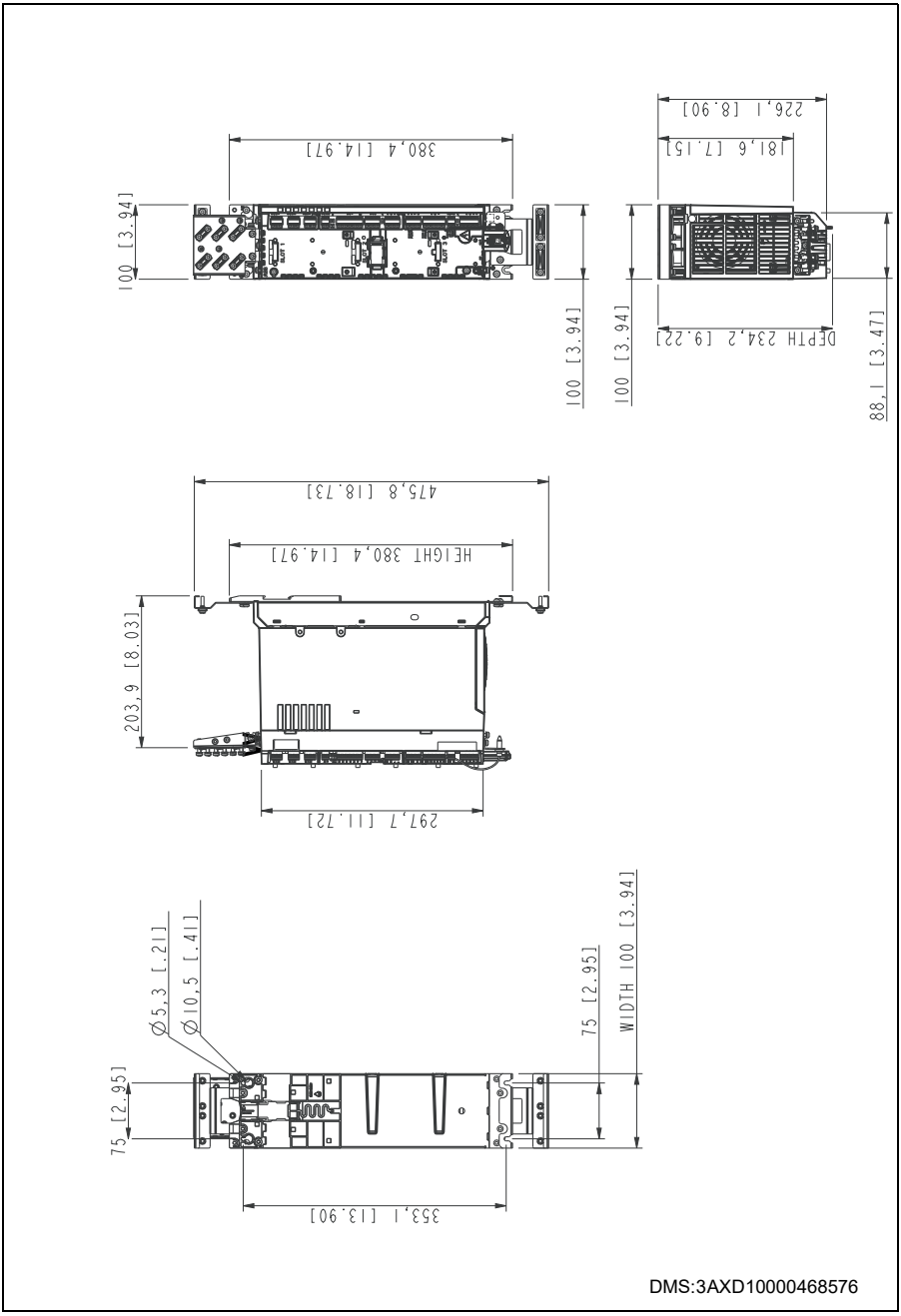
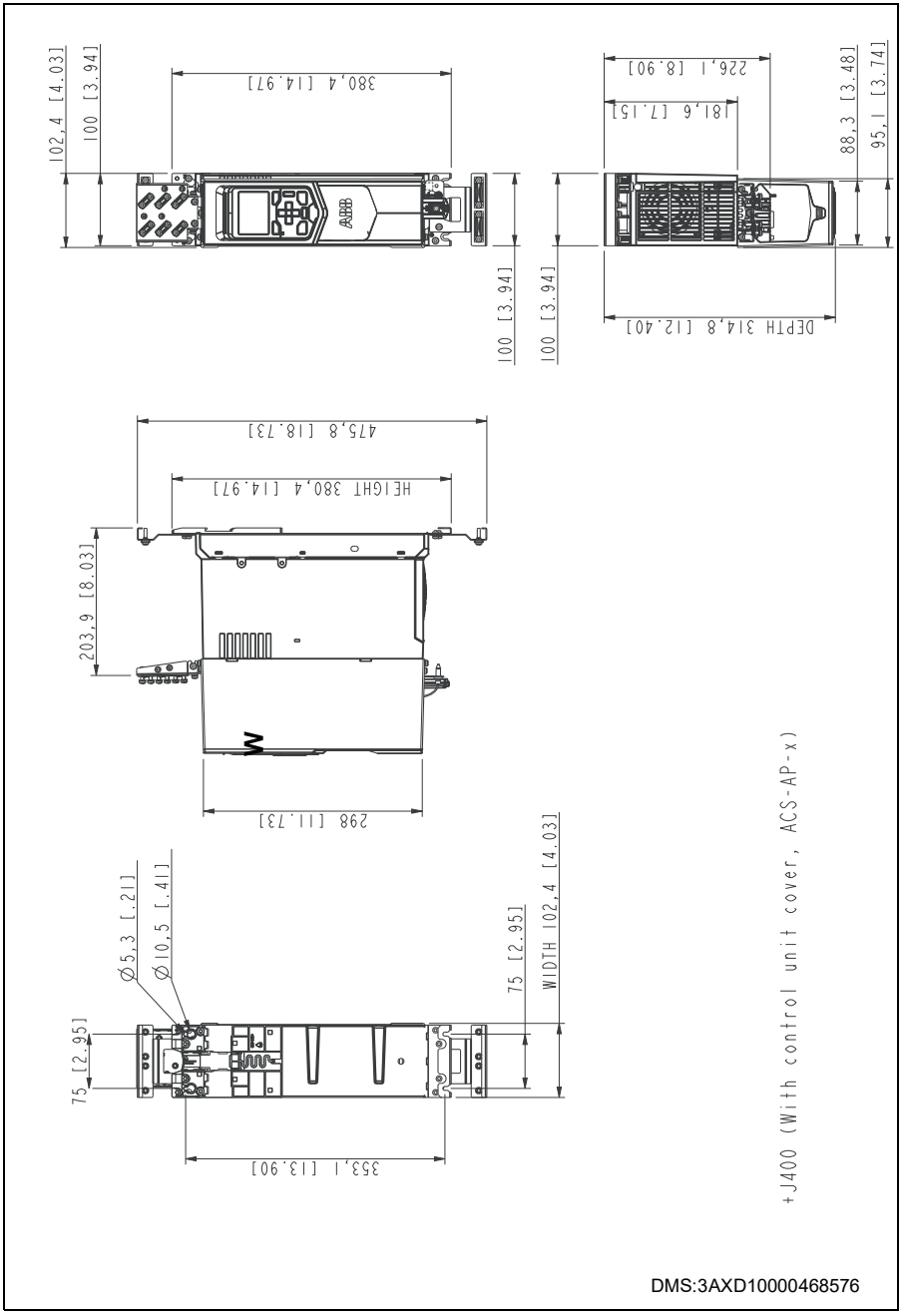
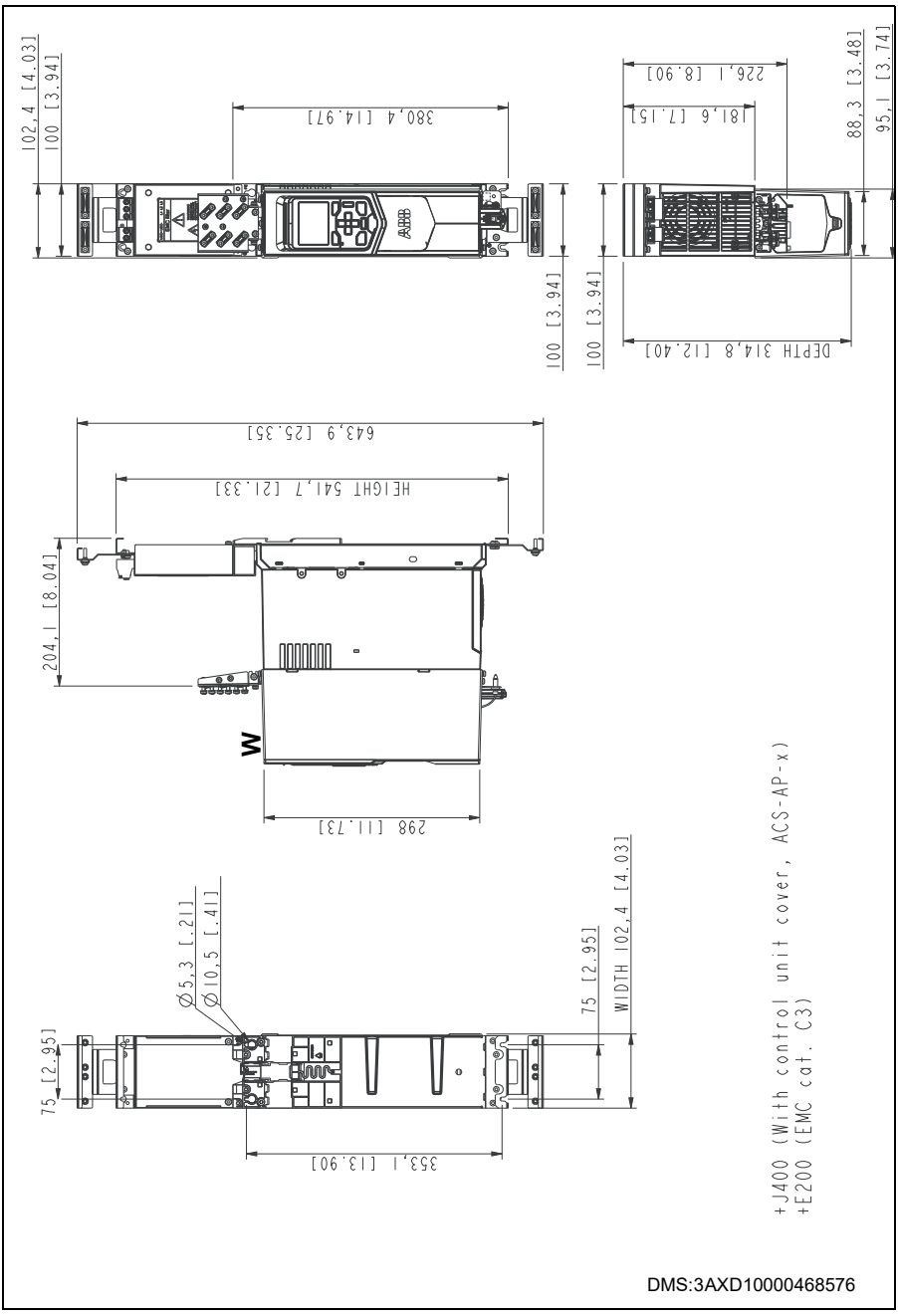
DMS:3AXD10000466877

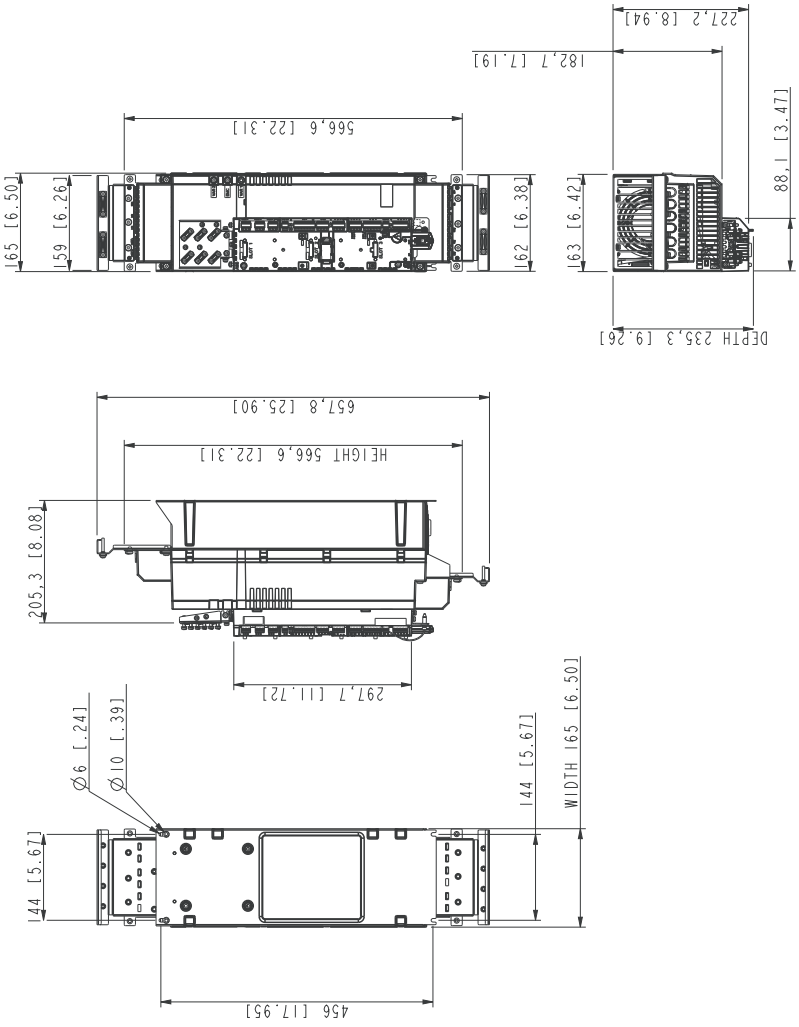
Frame size R2



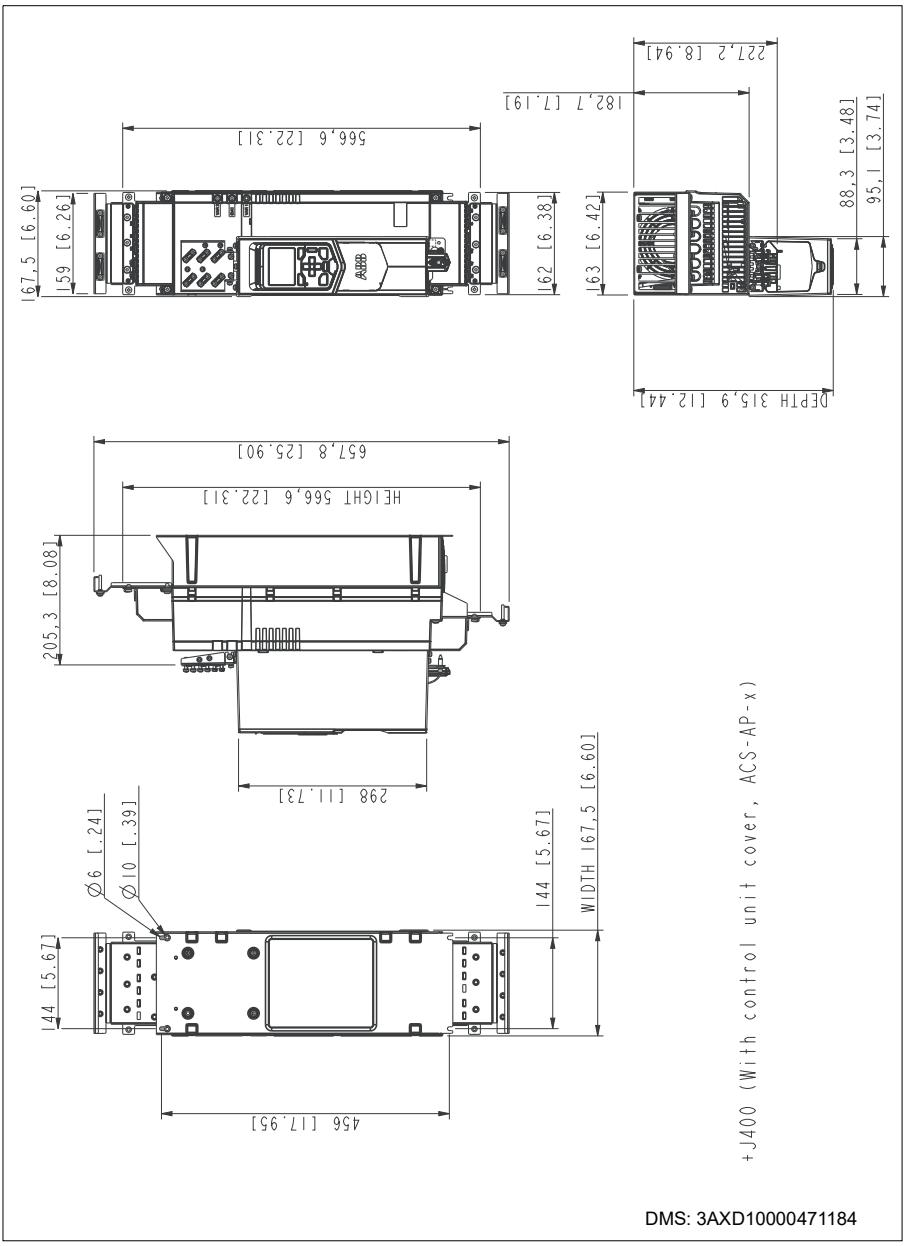

102,4 [4.03]
100 [3.94]
380,4 [14.97]
100 [3.94]
226,1 [8.90]
181,6 [7.15]
88,3 [3.48]
95,1 [3.74]
100 [3.94]
DEPTH 314,8 [12.40]
475,8 [18.73]
HEIGHT 380,4 [14.97]
203,9 [8.03]
298 [11.73]
Ø5,3 [.21]
Ø10,5 [.41]
75 [2.95]
WIDTH 102,4 [4.03]
75 [2.95]
353,1 [13.90]
+J400 (With control unit cover, ACS-AP-x)
DMS:3AXD10000468576


102,4 [4.03]
100 [3.94]
380,4 [14.97]
100 [3.94]
226,1 [8.90]
181,6 [7.15]
88,3 [3.48]
95,1 [3.74]
100 [3.94]
DEPTH 314,8 [12.40]
643,9 [25.35]
HEIGHT 541,7 [21.33]
204,1 [8.04]
W
298 [11.73]
Ø5,3 [.21]
Ø10,5 [.41]
75 [2.95]
WIDTH 102,4 [4.03]
75 [2.95]
353,1 [13.90]
+J400 (With control unit cover, ACS-AP-x)
+E200 (EMC cat. C3)
DMS:3AXD10000468576

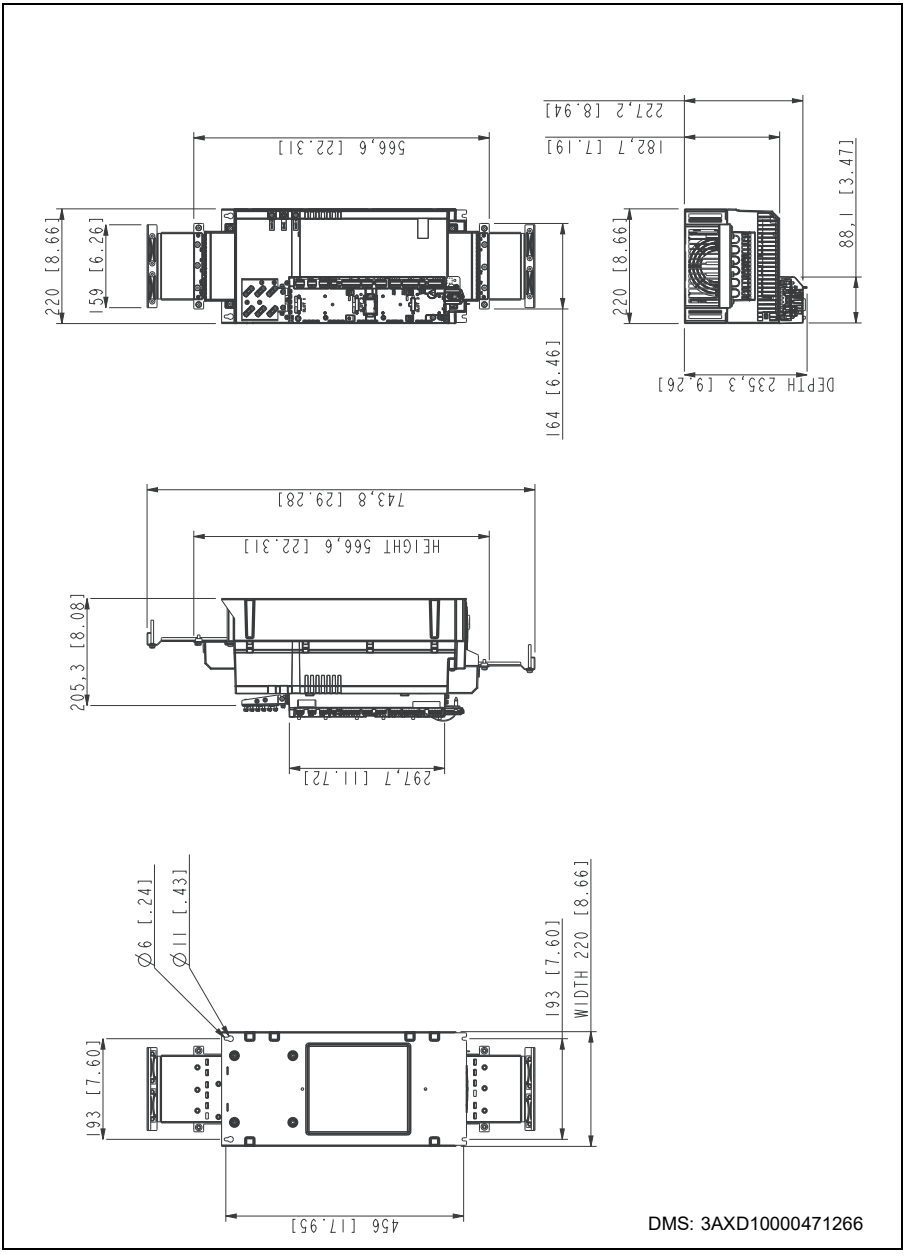
Frame size R3



DMS: 3AXD10000471184


227,2 [8.94]
182,7 [7.19]
566,6 [22.31]
88,3 [3.48]
95,1 [3.74]
167,5 [6.60]
159 [6.26]
162 [6.38]
163 [6.42]
DEPTH 315,9 [12.44]
657,8 [25.90]
HEIGHT 566,6 [22.31]
205,3 [8.08]
298 [11.73]
Ø6 [.24]
Ø10 [.39]
144 [5.67]
WIDTH 167,5 [6.60]
144 [5.67]
456 [17.95]
+J400 (With control unit cover, ACS-AP-x)
DMS: 3AXD10000471184

Frame size R4



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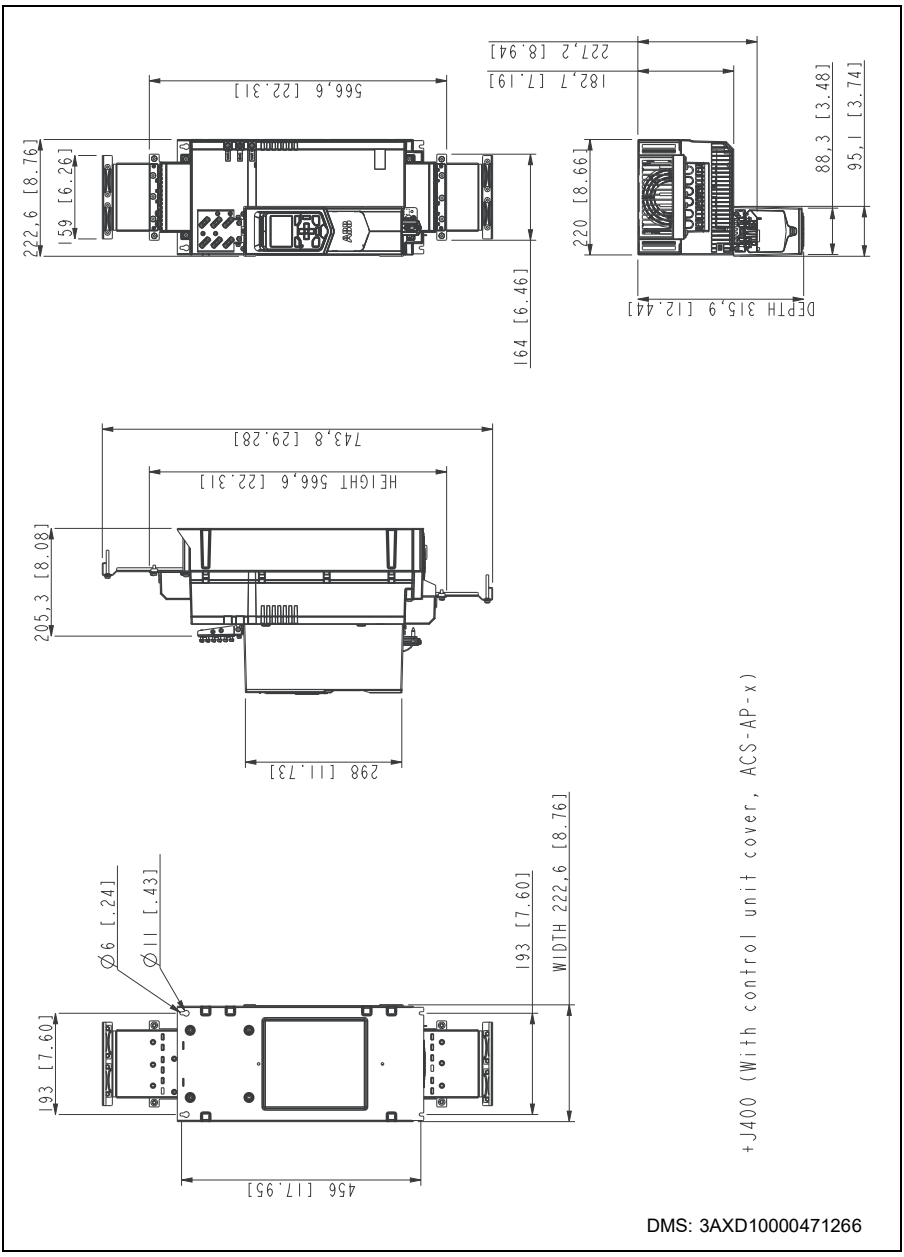
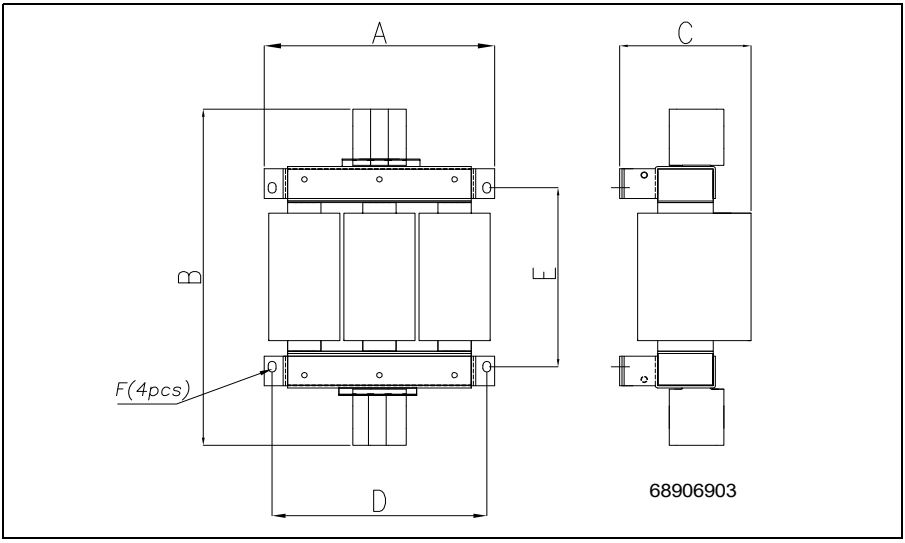

227,2 [8.94]
182,7 [7.19]
566,6 [22.31]
222,6 [8.76]
159 [6.26]
164 [6.46]
220 [8.66]
88,3 [3.48]
95,1 [3.74]
DEPTH 315,9 [12.44]
743,8 [29.28]
HEIGHT 566,6 [22.31]
205,3 [8.08]
298 [11.73]
Ø6 [.24]
Ø11 [.43]
193 [7.60]
WIDTH 222,6 [8.76]
193 [7.60]
456 [17.95]
+J400 (With control unit cover, ACS-AP-x)
DMS: 3AXD10000471266

Mains chokes (type CHK-0x)

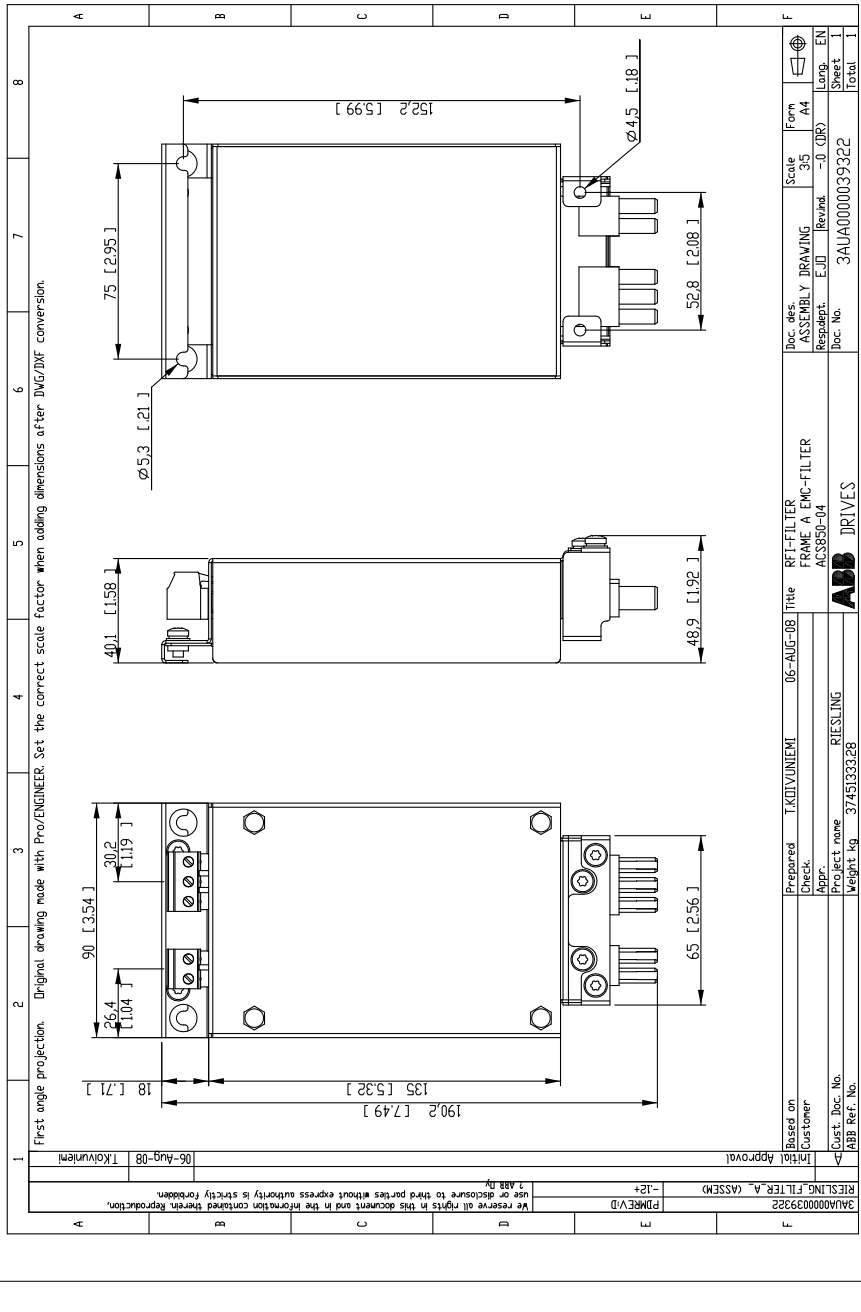


Mains choke – CHK-xx dimensions

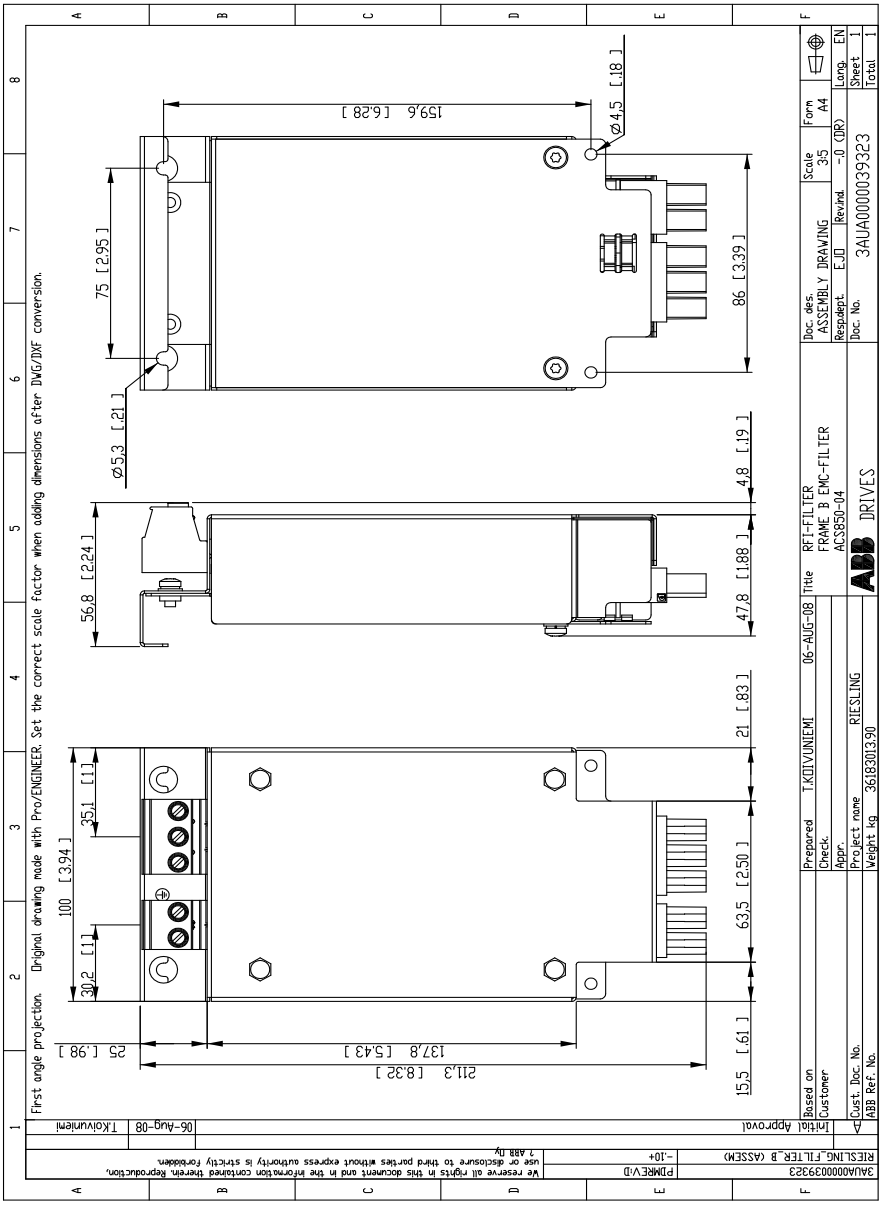
Parameter	Choke type			
	CHK-01	CHK-02	CHK-03	CHK-04
dim A mm (in.)	120 (4.72)	150 (5.91)	150 (5.91)	150 (5.91)
dim B mm (in.)	146 (5.75)	175 (6.89)	175 (6.89)	175 (6.89)
dim C mm (in.)	79 (3.11)	86 (3.39)	100 (3.94)	100 (3.94)
dim D mm (in.)	77 (3.03)	105 (4.13)	105 (4.13)	105 (4.13)
dim E mm (in.)	114 (4.49)	148 (5.83)	148 (5.83)	148 (5.83)
F screw size	M5	M5	M5	M5
Weight kg (lbs)	1.8 (4.0)	3.8 (8.4)	5.4 (11.9)	5.2 (11.5)
Wire size – Main terminals mm^2 (AWG)	0.5 … 10 (20…6)	0.5 … 10 (20…6)	0.5 … 10 (20…6)	0.5 … 10 (20…6)
Tightening torque – Main terminals N·m (lbf·in)	1.5 (13)	1.5 (13)	1.5 (13)	1.5 (13)
PE/Chassis terminals	M4	M5	M5	M5
Tightening torque – PE/Chassis terminals N·m (lbf·in)	3 (26)	4 (35)	4 (35)	4 (35)

EMC filters (type JFI-x1)

JFI-A1



JFI-B


159,6 [6,28]
Ø4,5 [.18]
75 [2,95]
86 [3,39]
Ø5,3 [.21]
56,8 [2,24]
4,8 [.19]
47,8 [1,88]
21 [.83]
35,1 [1,38]
100 [3,94]
30,2 [1,19]
63,5 [2,50]
25 [.98]
137,8 [5,43]
211,3 [8,32]
15,5 [.61]
First angle projection. Original drawing made with Pro/ENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.
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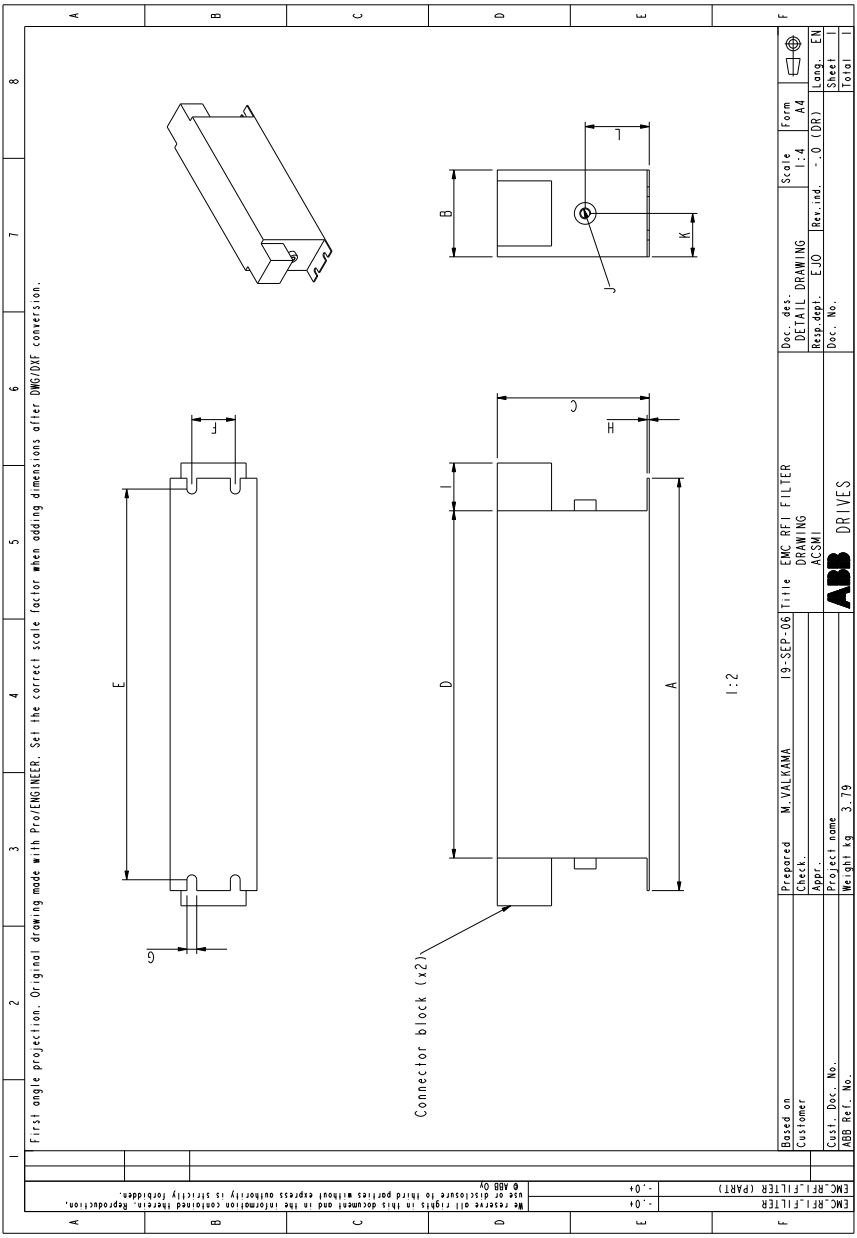
3AUA0000039323
RFI-FILTER
FRAME B EMC-FILTER
ACS850-04
ABB DRIVES
RIESLING_FILTER_B (ASSEM)
Prepared T.KOIVUNIEMI 06-AUG-08
Check.
Appr.
Project name RIESLING
Weight kg 3618301390
Based on
Customer
Cust. Doc. No.
ABB Ref. No.
Initial Approval
T.Koivuniemi 06-Aug-08
Doc des. ASSEMBLY DRAWING
Respdept. EJO Revind. -0 (DR)
Doc. No. 3AUA0000039323
Scale 3:5
Form A4
Lang. EN
Sheet 1
Total 1

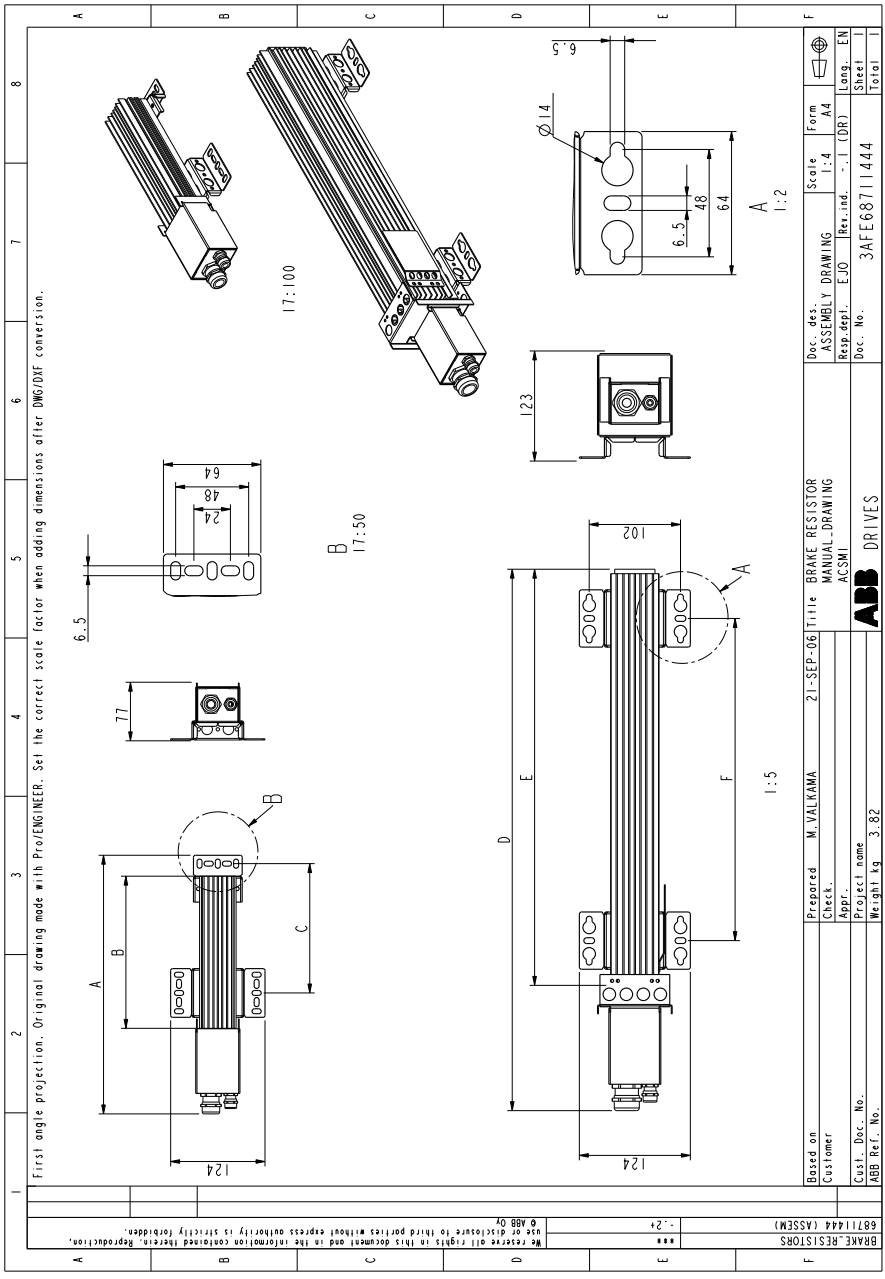
EMC filters (type JFI-0x)



EMC filter – JFI-xx dimensions

Parameter	Filter type			
	JFI-02	JFI-03	JFI-05	JFI-07
Dim. A mm (in.)	250 (9.84)	250 (9.84)	250 (9.84)	270 (10.63)
Dim. B mm (in.)	45 (1.77)	50 (1.97)	85 (3.35)	90 (3.54)
Dim. C mm (in.)	70 (2.76)	85 (3.35)	90 (3.54)	150 (5.91)
Dim. D mm (in.)	220 (8.66)	240 (9.45)	220 (8.66)	240 (9.45)
Dim. E mm (in.)	235 (9.25)	255 (10.04)	235 (9.25)	255 (10.04)
Dim. F mm (in.)	25 (0.98)	30 (1.18)	60 (2.36)	65 (2.56)
Dim. G mm (in.)	5.4 (0.21)	5.4 (0.21)	5.4 (0.21)	6.5 (0.26)
Dim. H mm (in.)	1 (0.04)	1 (0.04)	1 (0.04)	1.5 (0.06)
Dim. I mm (in.)	22 (0.87)	25 (0.98)	39 (1.54)	45 (1.77)
Dim. J	M5	M5	M6	M10
Dim. K mm (in.)	22.5 (0.89)	25 (0.98)	42.5 (1.67)	45 (1.77)
Dim. L mm (in.)	29.5 (1.16)	39.5 (1.56)	26.5 (1.04)	64 (2.52)
Weight kg (lbs)	0.8 (1.75)	1.1 (2.4)	1.8 (4.0)	3.9 (8.5)
Wire size (solid) mm^2 (AWG)	0.2 … 10 (AWG24…8)	0.5 … 16 (AWG20…6)	6…35 (AWG8…2)	16…50 (AWG4…1/0)
Wire size (stranded) mm^2 (AWG)	0.2 … 6 (AWG24…10)	0.5 … 10 (AWG20…8)	10…25 (AWG6…4)	16…50 (AWG4…1/0)
Tightening torque of terminals N·m (lbf·in)	1.5 … 1.8 (13.3 … 15.9)	1.5 … 1.8 (13.3 … 15.9)	4.0 … 4.5 (35 … 40)	7…8 (60…70)

Brake resistors (type JBR-xx)



Brake resistor - JBR-xx dimensions

Parameter	Resistor type				
	JBR-01	JBR-03	JBR-04	JBR-05	JBR-06
Dim. A mm (in.)	295 (11.61)	340 (13.39)	–	–	–
Dim. B mm (in.)	155 (6.10)	200 (7.87)	–	–	–
Dim. C mm (in.)	125 (4.92)	170 (6.69)	–	–	–
Dim. D mm (in.)	–	–	345 (13.58)	465 (18.31)	595 (23.43)
Dim. E mm (in.)	–	–	210 (8.27)	330 (12.99)	460 (18.11)
Dim. F mm (in.)	–	–	110 (4.33)	230 (9.06)	360 (14.17)
Weight kg (lbs)	0.75 (1.7)	0.8 (1.8)	1.8 (4.0)	3.0 (6.6)	3.9 (8.6)
Max. wire size – Main terminals	10 mm^2 (AWG6)				
Tightening torque – Main terminals	1.5 … 1.8 N·m (13 … 16 lbf·in)				
Max. wire size – Thermal switch terminals	4 mm^2 (AWG12)				
Tightening torque – Thermal switch terminals	0.6 … 0.8 N·m (5.3 … 7.1 lbf·in)				

Further information

Product and service inquiries

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