ACSM1

Hardware Manual
ACSM1-04 Drive Modules (0.75 to 45 kW)

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Hardware Manual

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Safety instructions

What this chapter contains

This chapter contains the safety instructions which you must follow when installing, operating and servicing the drive. If ignored, physical injury or death may follow, or damage may occur to the drive, the motor, or driven equipment. Read the safety instructions before you work on the unit.

Use of warnings and notes

There are four types of safety instructions used in this manual:

Dangerous voltage warning warns of high voltage which can cause physical injury and/or damage to the equipment.

General warning warns about conditions, other than those caused by electricity, which can result in physical injury and/or damage to the equipment.

Electrostatic discharge warning warns of electrostatic discharge which can damage the equipment.

Hot surface warning warns of component surfaces that may become hot enough to cause burns if touched.

Installation and maintenance work

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

WARNING! Ignoring the following instructions can cause physical injury or death, or damage to the equipment.

Only qualified electricians are allowed to install and maintain the drive.

- Never work on the drive, the motor cable or the motor when input power is applied. After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, the motor or the motor cable.

  Always ensure by measuring with a multimeter (impedance at least 1 Mohm) that:

  1. There is no voltage between the drive input phases U1, V1 and W1 and the ground.
  2. There is no voltage between terminals UDC+ and UDC– and the ground.
  3. There is no voltage between terminals R+ and R– and the ground.

- Drives controlling a permanent magnet motor: A rotating permanent magnet motor feeds power to the drive causing the drive to become live even when it is stopped and the supply power switched off. Before maintenance work on the drive,
  – disconnect the motor from the drive by using a safety switch
  – prevent the start-up of any other motors in the same mechanical system
  – lock the motor shaft
  – measure that the motor is in fact de-energised, then connect the U2, V2 and W2 terminals of the drive to each other and to the PE.

- Do not work on the control cables when power is applied to the drive or to the external control circuits. Externally supplied control circuits may carry dangerous voltages even when the input power of the drive is switched off.

- Do not make any insulation or voltage withstand tests on the drive.

- If a drive whose varistors are not disconnected is installed on an IT power system (an ungrounded power system or a high resistance grounded [over 30 ohms] power system), the drive will be connected to earth potential through the varistors. This may cause danger or damage the drive.

- If a drive whose varistors (built-in) or mains filter (external option) are not disconnected is installed on an corner-grounded TN system, the drive will be damaged.

Notes:

- Even when the motor is stopped, dangerous voltages are present at the power circuit terminals U1, V1, W1 and U2, V2, W2, and UDC+, UDC–, R+, R–.

- Depending on the external wiring, dangerous voltages (115 V, 220 V or 230 V) may be present on the terminals of the relay output(s) of the drive.
- The drive supports the “Safe Torque Off” function. See page 40.

WARNING! Ignoring the following instructions can cause physical injury or death, or damage to the equipment.

- The drive is not field repairable. Never attempt to repair a malfunctioning drive; contact your local ABB representative or Authorized Service Center for replacement.
- Make sure that dust from drilling does not enter the drive during the installation. Electrically conductive dust inside the drive may cause damage or lead to malfunction.
- Ensure sufficient cooling.

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

Start-up and operation

These warnings are intended for all who plan the operation of the drive, start up or operate the drive.

WARNING! Ignoring the following instructions can cause physical injury or death, or damage to the equipment.

- Before adjusting the drive and putting it into service, make sure that the motor and all driven equipment are suitable for operation throughout the speed range provided by the drive. The drive can be adjusted to operate the motor at speeds above and below the speed provided by connecting the motor directly to the power line.
- Do not activate automatic fault reset functions if dangerous situations can occur. When activated, these functions will reset the drive and resume operation after a fault.
- Do not control the motor with an AC contactor or disconnecting device (disconnecting means); instead, use the control panel or external commands via the I/O board of the drive or a fieldbus adapter. The maximum allowed number of charging cycles of the DC capacitors (i.e. power-ups by applying power) is one per two minutes. The maximum total number of chargings is 100000 for frame sizes A and B, 50000 for frame sizes C and D.
- Drives controlling a permanent magnet motor: Do not run the motor over the rated speed. Motor overspeed leads to overvoltage which may permanently damage the drive.

Notes:

- If an external source for start command is selected and it is ON, the drive will start immediately after an input voltage break or a fault reset unless the drive is configured for 3-wire (pulse) start/stop.
- When the control location is not set to local, the stop key on the control panel will not stop the drive.

WARNING! The surfaces of drive system components (such as the mains choke and braking resistor, if present) become hot when the system is in use.

Table of contents

Mechanical installation

Planning the electrical installation

Electrical installation

Dimension drawings

About this manual

What this chapter contains

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.

Compatibility

The manual is compatible with ACSM1-04 (frame sizes A to D).

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 the frame size

Some instructions, technical data and dimensional drawings which concern only certain frame sizes are marked with the symbol of the frame size A, B, C or D. The frame size is not marked on the drive designation label. To identify the frame size of your drive, see the rating 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. The + code selections are listed in chapter *The ACSM1-04* under *Type code*.

Contents

The chapters of this manual are briefly described below.

Safety instructions give safety instructions for the installation, commissioning, operation and maintenance of the drive.

About this manual lists the steps in checking the delivery and installing and commissioning the drive and refers to chapters/sections in this manual and other manuals for particular tasks.

The ACSM1-04 describes the drive module.

Planning the cabinet assembly guides in planning the installation of the drive module into a user-defined cabinet.

Mechanical installation instructs how to place and mount the drive.

Planning the electrical installation instructs on the motor and cable selection, the protections and the cable routing.

Electrical installation instructs on how to wire the drive.

Installation checklist contains a list for checking the mechanical and electrical installation of the drive.

Maintenance lists periodic maintenance actions along with work instructions.

Technical data contains the technical specifications of the drive, e.g. the ratings, sizes and technical requirements, provisions for fulfilling the requirements for CE and other markings and warranty policy.

Mains chokes details the optional mains chokes available for the drive.

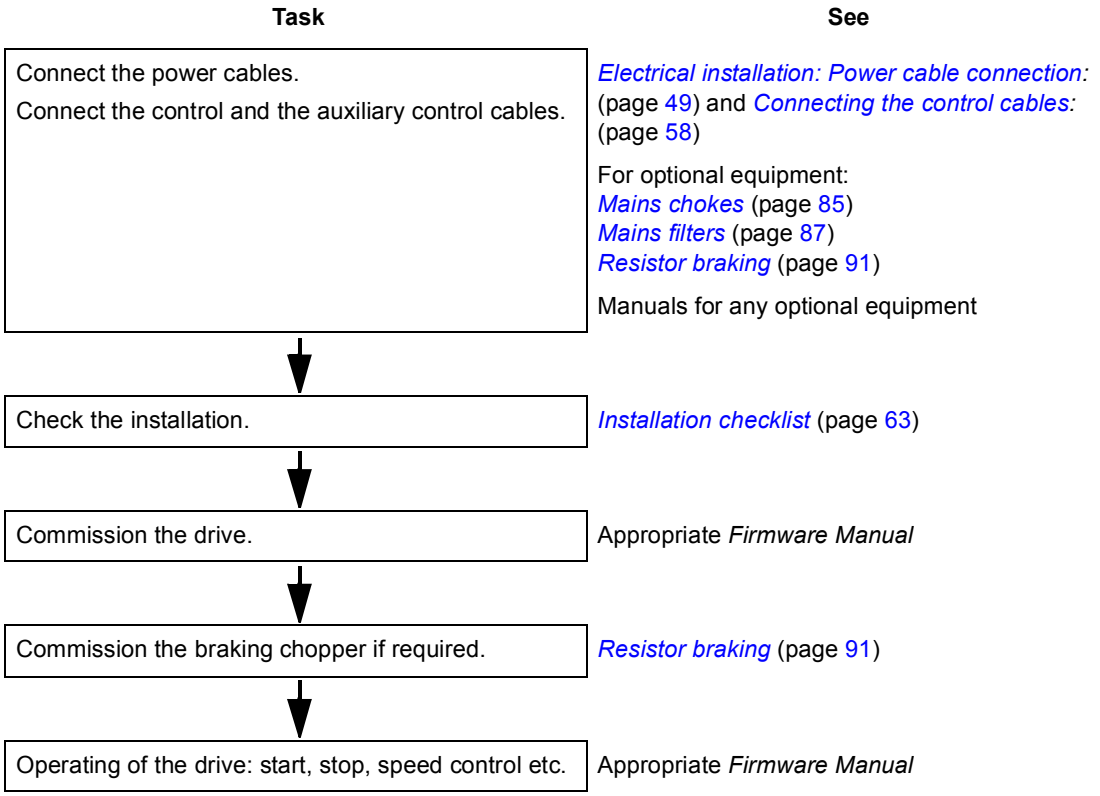
Mains filters details the optional mains filters available for the drive.

Resistor braking describes how to select, protect and wire braking resistors.

Dimension drawings contains the dimensional drawings of the drive and connected equipment.

Installation and commissioning flowchart

Task	See
Identify the frame size of your drive: A, B, C or D.	*Technical data: Ratings* (page 71)
Plan the installation. Check the ambient conditions, ratings, required cooling air flow, input power connection, compatibility of the motor, motor connection, and other technical data. Select the cables.	*Planning the cabinet assembly* (page 25) *Planning the electrical installation* (page 37) *Technical data* (page 71) Option manual (if optional equipment is included)
Unpack and check the units. Check that all necessary optional modules and equipment are present and correct. Only intact units may be started up.	*Mechanical installation*: *Contents of the package* (page 31) If the converter has been non-operational for more than one year, the converter DC link capacitors need to be reformed. Ask ABB for more information.
Check the installation site.	*Mechanical installation: Before installation* (page 33) *Technical data* (page 71)
If the drive is about to be connected to an IT (ungrounded) system, check that the screw(s) labelled VAR are removed. Also note that using a mains filter is not allowed in an IT (ungrounded] system.)	*Safety instructions: Installation and maintenance work* (page 6)
Install the drive in a cabinet.	*Mechanical installation*: *Installation procedure* (page 34)
Route the cables.	*Planning the electrical installation: Routing the cables* (page 44)
Check the insulation of the supply cable, the motor and the motor cable, and the resistor cable (if present).	*Electrical installation: Checking the insulation of the assembly* (page 47)



Inquiries

Address any inquiries about the product to the local ABB representative, quoting the type code and the serial number of the unit. If the local ABB representative cannot be contacted, address inquiries to the manufacturing facility.

Terms and abbreviations

Term/Abbreviation	Explanation
CHK-xx	Series of optional mains chokes for the ACSM1.
EMC	Electromagnetic Compatibility.
FIO-01	Optional digital I/O extension for the ACSM1.
FIO-11	Optional analogue I/O extension for the ACSM1.
FEN-01	Optional TTL encoder interface for the ACSM1.
FEN-11	Optional absolute encoder interface for the ACSM1.
FEN-21	Optional resolver interface for the ACSM1.
FCAN-0x	Optional CANopen adapter for the ACSM1.
FDNA-0x	Optional DeviceNet adapter for the ACSM1.
FENA-0x	Optional Ethernet/IP adapter for the ACSM1.
FPBA-0x	Optional PROFIBUS DP adapter for the ACSM1.
Frame (size)	Size of the drive module. This manual deals with ACSM1-04 frame sizes A, B, C or D. To determine the frame size of a drive module, refer to the rating tables in chapter *Technical data*.
IGBT	Insulated Gate Bipolar Transistor; a voltage-controlled semiconductor type widely used in inverters due to their easy controllability and high switching frequency.
I/O	Input/Output.
JBR-xx	Series of optional braking resistors for the ACSM1.
JCU	The control unit of the drive module. The JCU is installed on top of the power unit. The external I/O control signals are connected to the JCU, or optional I/O extensions mounted on it.
JFI-xx	Series of optional mains filters for the ACSM1.
JMU-xx	The memory unit attached to the control unit of the drive.
RFI	Radio-frequency interference.

The ACSM1-04

What this chapter contains

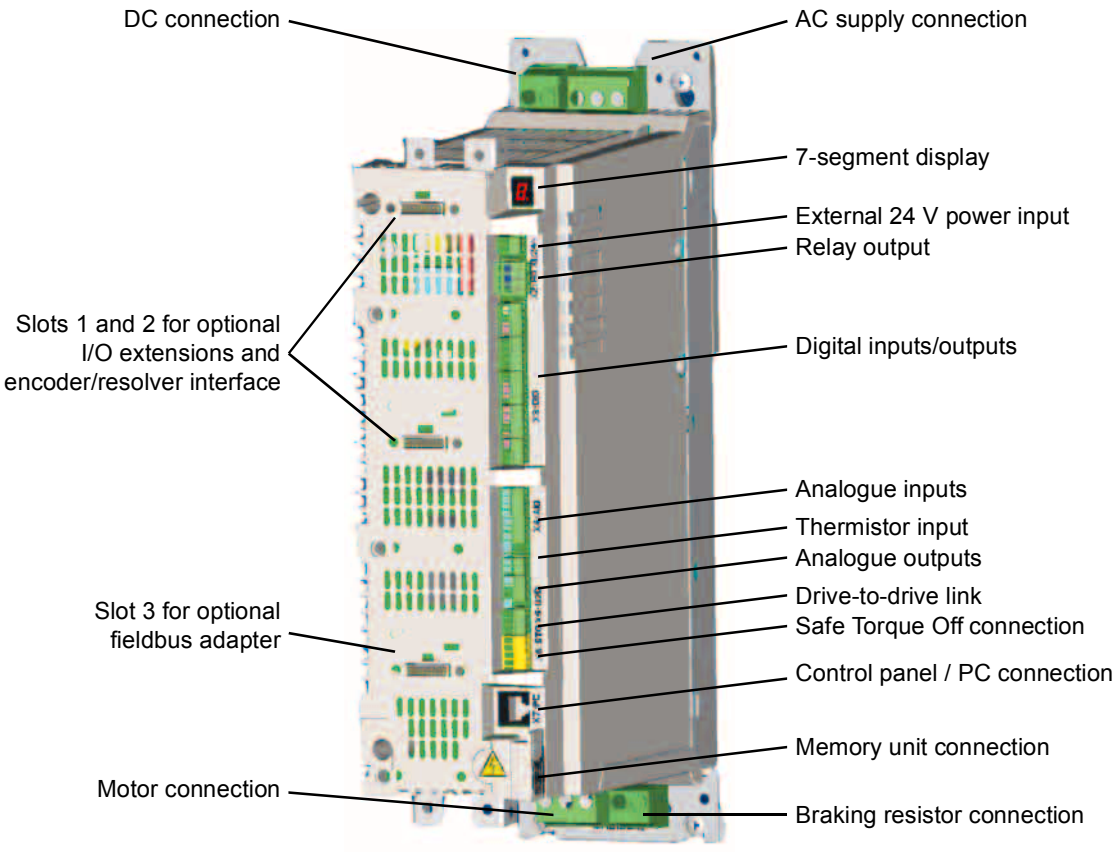
This chapter describes the construction and operating principle of the drive in short.

The ACSM1-04

The ACSM1-04 is an IP20 drive module for controlling AC motors. It is to be installed into a cabinet by the customer. The ACSM1-04 either has an air-cooled heatsink, or is to be installed on a “cold plate” cooling element.

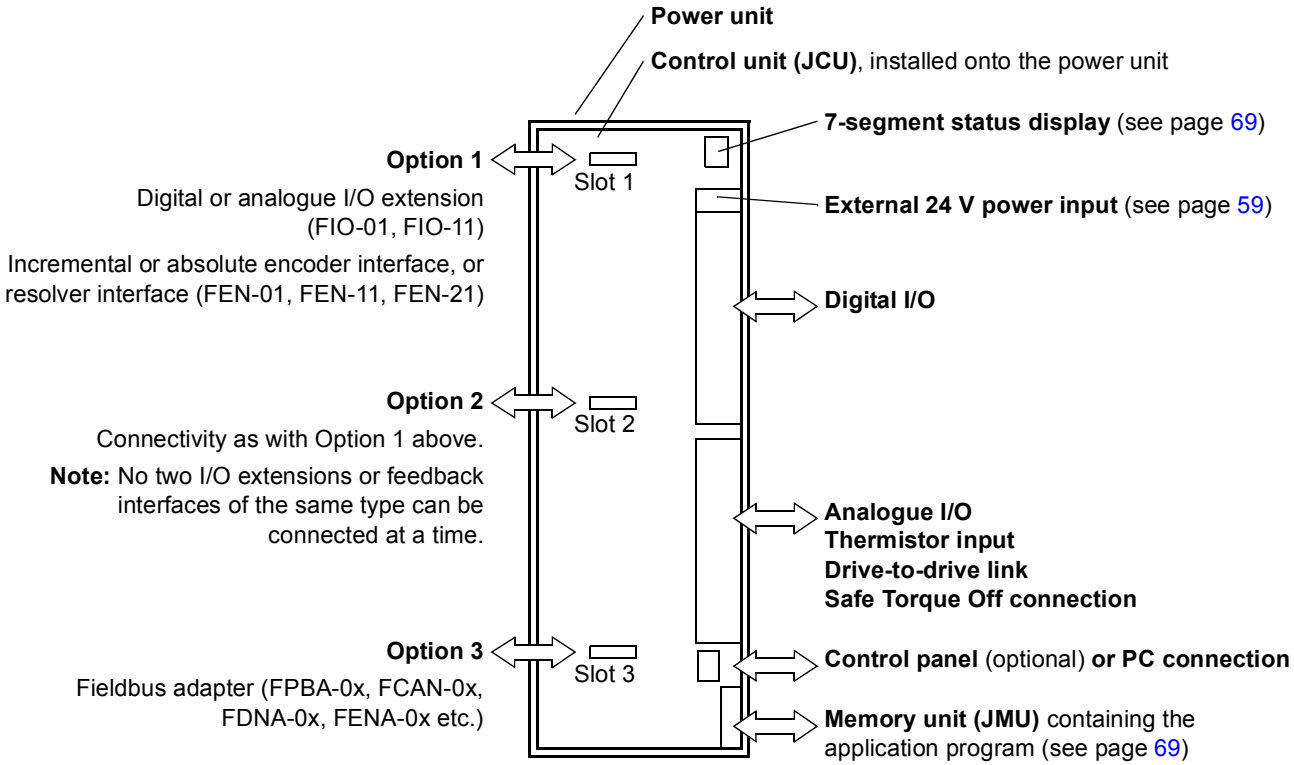
The ACSM1-04 is available in several frame sizes depending on output power. All frame sizes use the same control unit (type JCU).

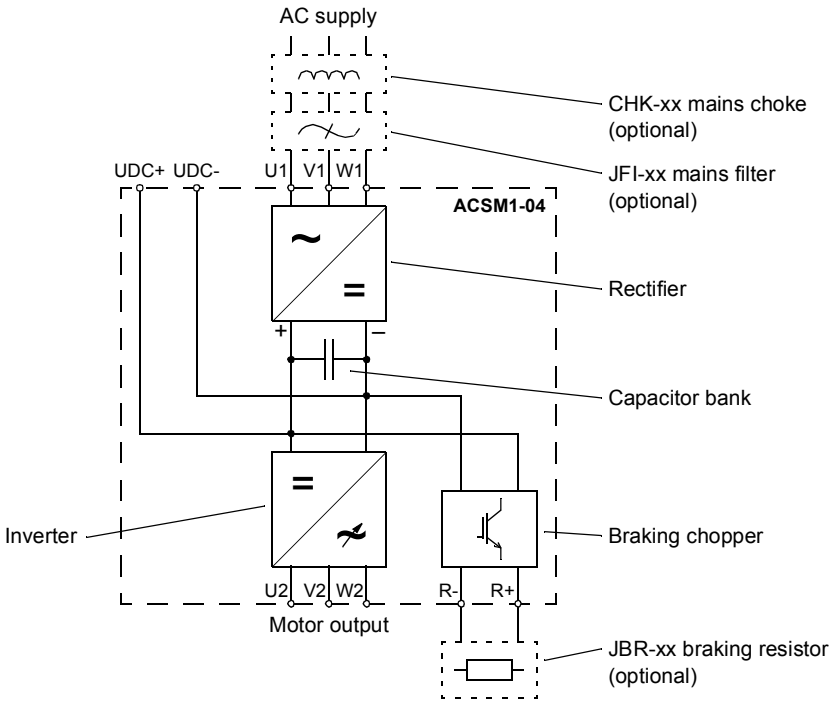
Layout (Frame A shown)



Main circuit and control interfaces

The diagram below shows the control interfaces and the main circuit of the drive. For further information on the JCU Control Unit, see the chapter *Electrical installation*.





Operation

This table describes the operation of the main circuit in short.

Component	Description
Braking chopper	Conducts the energy generated by a decelerating motor from the DC bus to a braking resistor. The braking chopper is built in the ACSM1; braking resistors are external options.
Braking resistor	Dissipates the regenerative energy by converting it to heat.
Capacitor bank	Energy storage which stabilizes the intermediate circuit DC voltage.
Inverter	Converts the DC voltage to AC voltage and vice versa. The motor is controlled by switching the IGBTs of the inverter.
Mains choke	See page 85.
Mains filter	See page 87.
Rectifier	Converts the three-phase AC voltage to DC voltage.

Type code

The type code contains information on the specifications and configuration of the drive. The first digits from left express the basic configuration (e.g. ACSM1-04AS-09A5-4). The optional selections are given thereafter, preceded by + signs (e.g. +L501). The main selections are described below. Not all selections are necessarily available for all types; refer to *ACSM1 Ordering Information*, available on request.

See also section *Delivery check and drive module identification* on page 33.

Selection	Alternatives	
Product series	ACSM1 product series	
Type (1)	04	Drive module. When no options are selected: IP20, no control panel, no mains choke, no mains filter, braking chopper, coated boards, Safe Torque Off, Quick Guide (multilingual), latest firmware version, Drive SP programming
Type (2)	A	Air-cooled module (with heatsink)
	C	Module for “cold plate” mounting (Frame C and D only)
Type (3)	S	Speed and torque control firmware
	M	Motion control firmware
Size	Refer to *Technical data: Ratings.*	
Voltage range	4	380 V, **400 V** (nominal rating), 415 V, 440 V, 460 V or 480 V AC
+ options		
Fieldbus	K...	+K451: FDNA-01 DeviceNet adapter +K454: FPBA-01 PROFIBUS DP adapter +K457: FCAN-01 CANopen adapter +K466: FENA-01 Ethernet/IP adapter
I/O extensions and feedback interfaces	L...	+L500: FIO-11 analogue I/O extension +L501: FIO-01 digital I/O extension +L516: FEN-21 resolver interface +L517: FEN-01 incremental encoder interface +L518: FEN-11 absolute encoder interface
Memory unit configuration	N...	Solution functions and programs

Planning the cabinet assembly

What this chapter contains

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. **Please note that the installation must, however, 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

The cabinet frame must be sturdy enough to carry the weight of the drive components, control circuitry and other equipment installed in it.

The cabinet must protect the drive module against contact and meet the requirements for dust and humidity (see the chapter *Technical data*).

Disposition of the devices

For easy installation and maintenance, a spacious layout is recommended. Sufficient cooling air flow, obligatory clearances, cables and cable support structures all require space.

For layout examples, see section *Cooling and degrees of protection* below.

Grounding of mounting structures

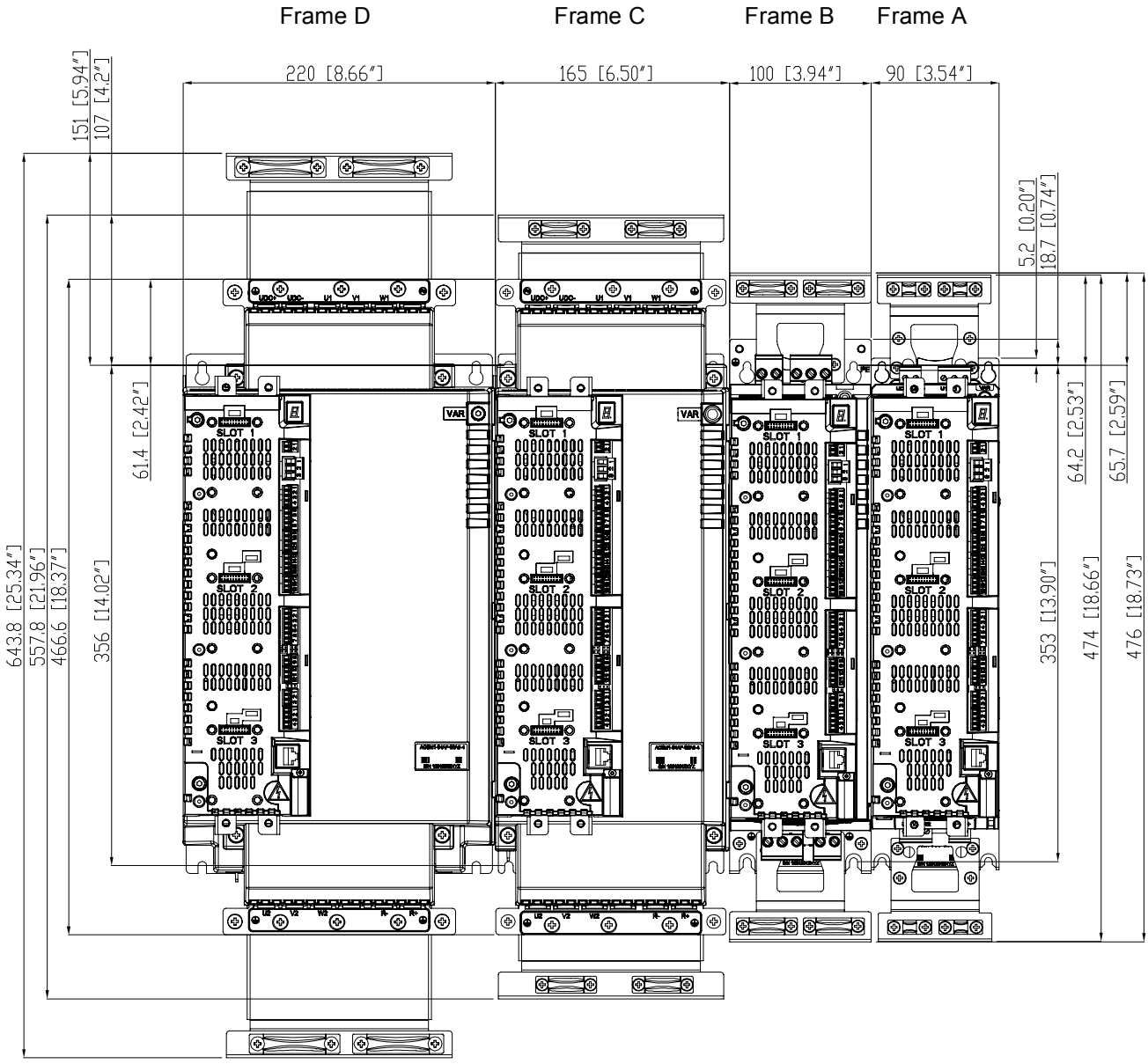
Make sure all cross-members or shelves on which drive system components are mounted are properly grounded and the connecting surfaces left unpainted.

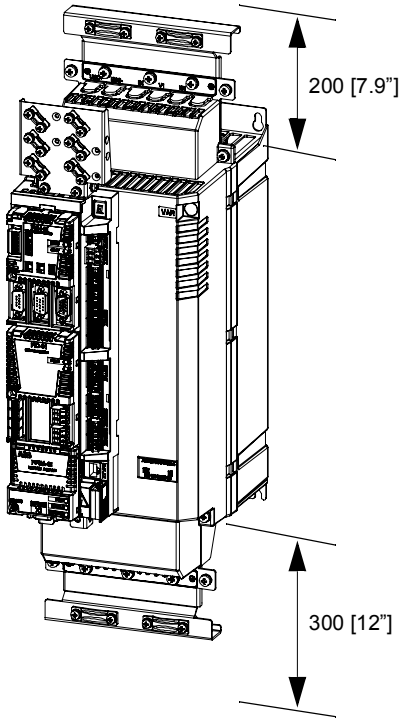
Note: Ensure that the components are properly grounded through their fastening points to the installation base.

Note: It is recommended that the mains filter (if present) and the drive module be mounted on the same mounting plate.

Main dimensions and free space requirements

The modules can be installed side by side. The main dimensions of the drive modules as well as free space requirements are shown below. For more details, refer to the chapter *Dimension drawings*.





The temperature of the cooling air entering the unit must not exceed the maximum allowed ambient temperature (see *Ambient conditions* in the chapter *Technical data*). Consider this when installing heat-generating components (such as other drives, mains chokes and braking resistors) nearby.

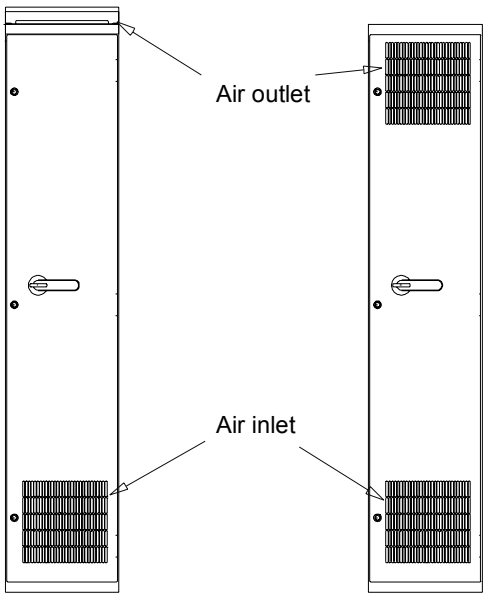
Cooling and degrees of protection

The cabinet must have enough free space for the components to ensure sufficient cooling. Observe the minimum clearances given for each component.

The air inlets and outlets must be equipped with gratings that

- guide the air flow
- protect against contact
- 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.



Arrange the cooling of the modules so that the requirements given in chapter *Technical data* are met:

- cooling air flow
  Note: The values in *Technical data* apply to continuous nominal load. If the load is less than nominal, less cooling air is required.
- allowed ambient temperature
- cold plate specification (for ACSM1-04Cx-xxxx-x only).

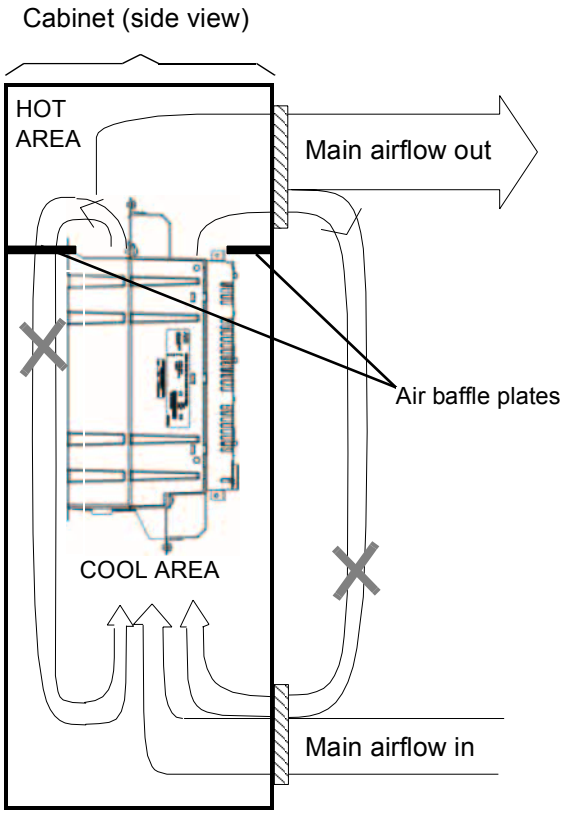
Make sure the air inlets and outlets are sufficient in size. Please note that in addition to the power loss of the drive module, the heat dissipated by cables and other additional equipment must also be ventilated.

The internal cooling fans of the modules are usually sufficient to keep the component temperatures low enough in IP22 cabinets.

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.

The installation site must be sufficiently ventilated.

Preventing the 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 air flow 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.

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.

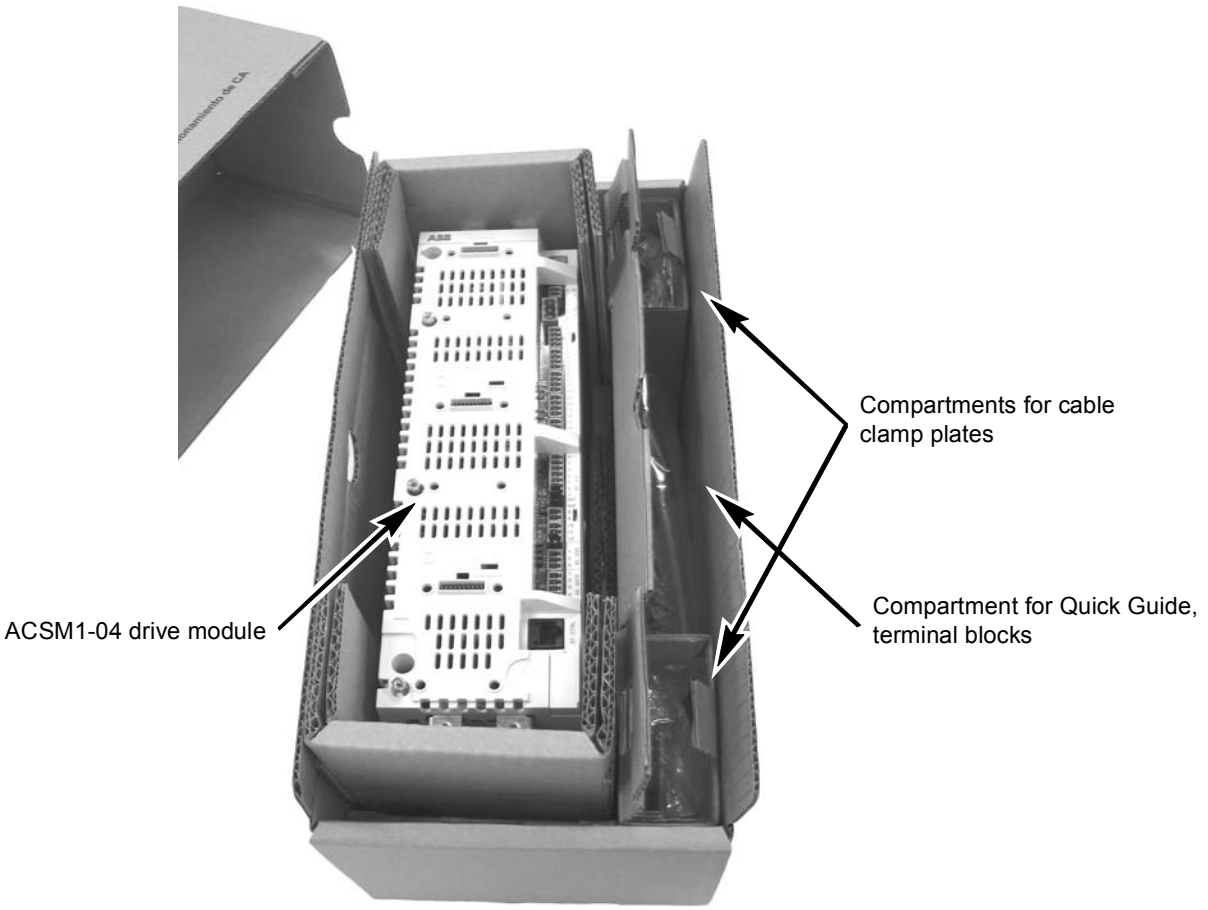
Mechanical installation

Contents of the package

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

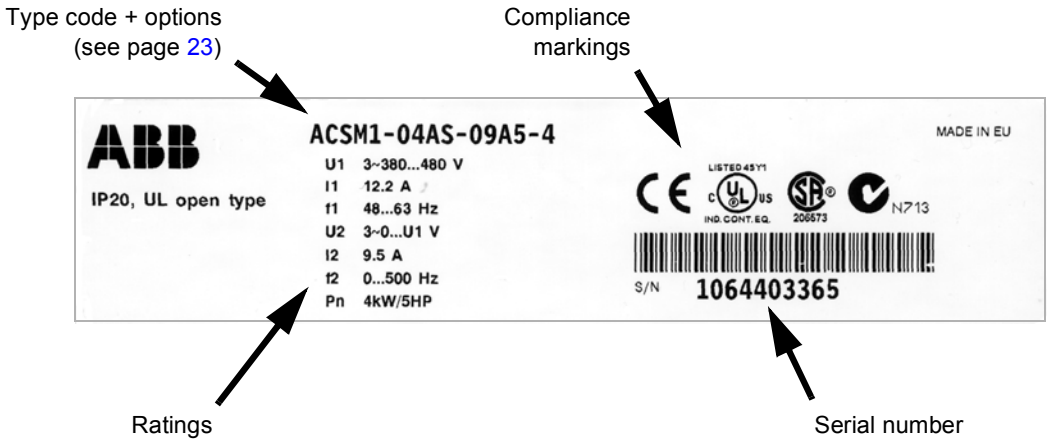
The box contains:

- ACSM1-04 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 JCU Control Unit and the power unit
- Quick Guide.



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. The label is located on the left-hand side of the drive module.



The first digit of the serial number refers to the manufacturing plant. The 2nd and 3rd digit indicate the year of manufacture, while the 4th and 5th digits indicate the week. Digits 6 to 10 are a running integer starting every week at 00001.

Before installation

Check the installation site according to the requirements below. Refer to *Dimension drawings* for frame details.

Requirements for the installation site

See *Technical data* for the allowed operation conditions of the drive.

The ACSM1-04 is to be mounted in an upright position. The wall the drive is to be mounted on must be as even as possible, of non-flammable material and strong enough to carry the weight of the drive. The floor/material below the drive must be non-flammable.

Installation procedure

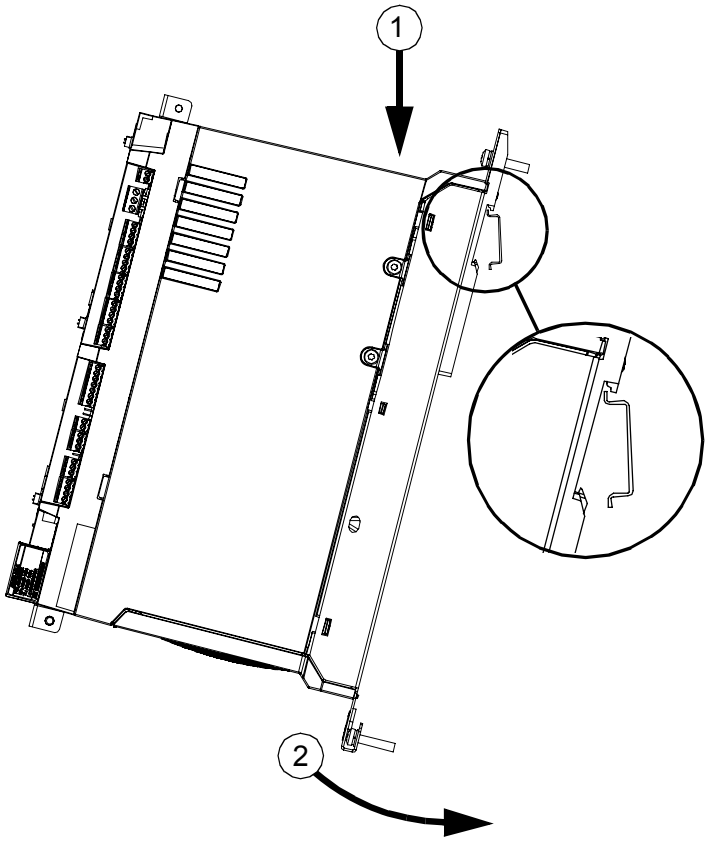
Direct wall mounting

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 wall. **Note:** Only lift the drive by its chassis.
4. Tighten the screws.

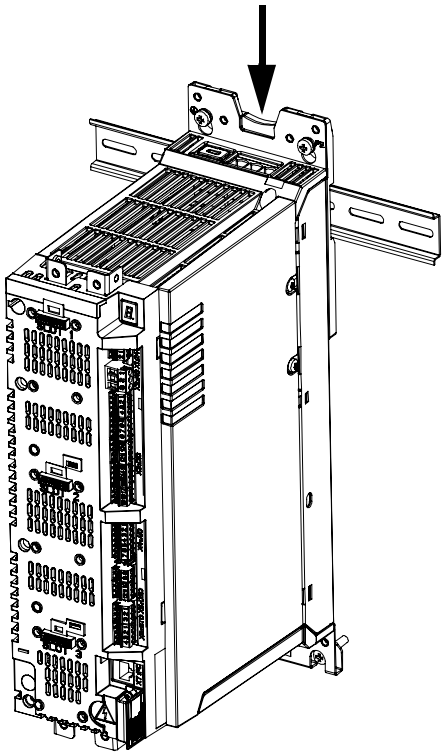
DIN rail mounting (Frames A and B only)

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

a



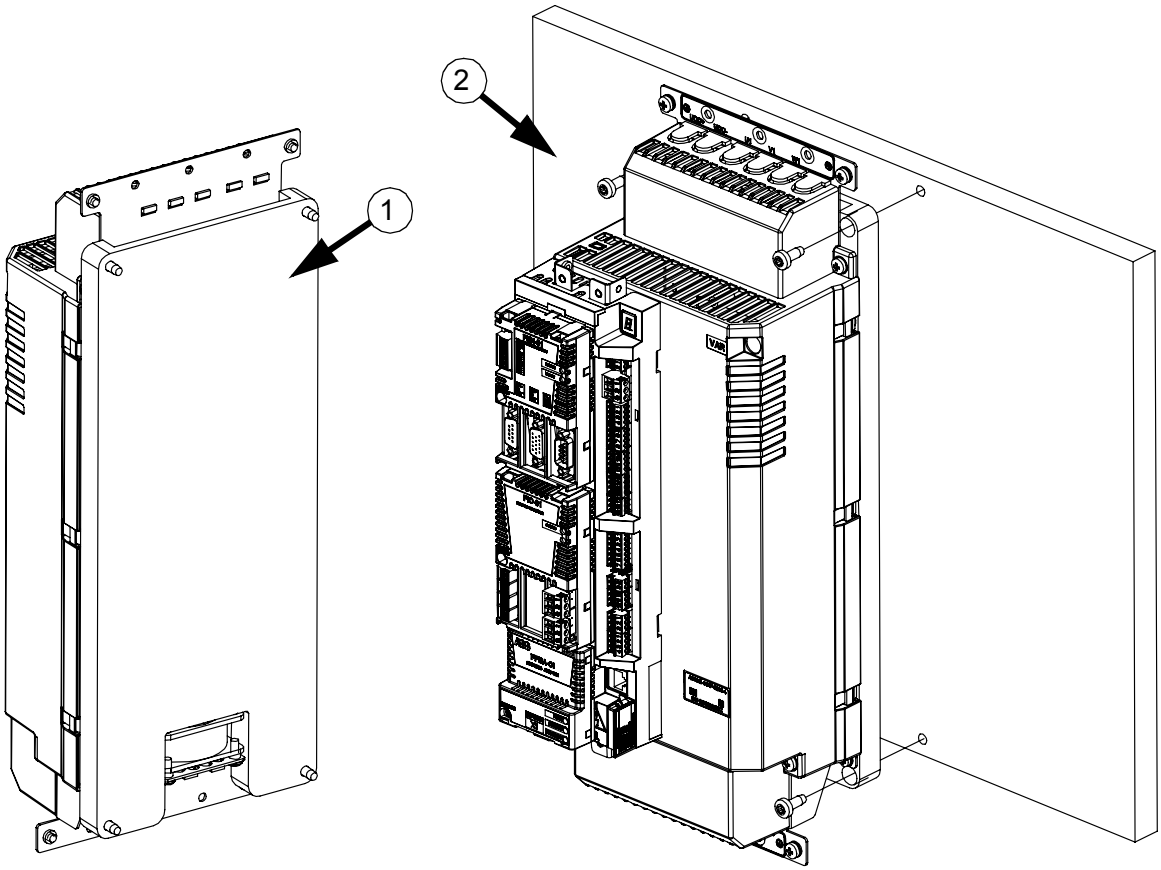
b



Cold plate mounting (ACSM1-04Cx-xxxx-x, frames C and D only)

For cold plate cooling characteristics, see page 74.

1. Determine the locations for the four fixing points on the cold plate. The fixing points of the drive module are shown in the dimension drawings on page 102 (frame C) or 104 (frame D).
2. Clean the surface of both the drive module bottom plate (1) and the cold plate (2) using a cloth and methylated spirit.
3. Apply a thin, uniform layer of thermal compound (e.g. WPS II from Austerlitz Electronic GmbH) over the entire area of the drive module bottom plate.
4. Use four M6 (with minimum length of 12 mm) screws to fasten the drive module to the cold plate. Tighten the screws to 0.5 N·m (4.4 lbf·in). Wait for at least five minutes to allow the thermal compound to spread out evenly.
5. Tighten the mounting screws to a final torque of 3 N·m (26.5 lbf·in). Wipe off excess thermal compound.



Mains choke installation

See the chapter *Mains chokes* on page 85.

Mains filter installation

See the chapter *Mains filters* on page *87*.

Braking resistor installation

See the chapter *Resistor braking* on page 91.

Planning the electrical installation

What this chapter contains

This chapter contains the instructions that you must follow when selecting the motor, cables, protections, cable routing and way of operation for the drive. If the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

Note: The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations.

Motor selection

Select the (3-phase AC induction) motor according to the rating table in the chapter *Technical data*. The table lists the typical motor power for each drive type.

Only one permanent magnet synchronous motor can be connected to the inverter output. It is recommended to install a safety switch between the permanent magnet motor and the drive output in order to isolate the motor from the drive during maintenance work on the drive.

Supply connection

Use a fixed connection to the AC power line.

WARNING! As the leakage current of the device typically exceeds 3.5 mA, a fixed installation is required according to IEC 61800-5-1.

Supply disconnecting device

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

Europe

If the drive is used in an application which must meet the European Union Machinery Directive according to standard EN 60204-1 Safety of Machinery, the disconnecting device must be one of the following types:

- a switch-disconnector of utilization category AC-23B (EN 60947-3)
- a 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)

- a circuit breaker suitable for isolation in accordance with EN 60947-2.

Other regions

The disconnecting means must conform to the applicable safety regulations.

Thermal overload and short circuit protection

Thermal overload protection

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

WARNING! If the drive is connected to multiple motors, a separate thermal overload switch or a circuit breaker must be used for protecting each cable and motor. These devices may require a separate fuse to cut off the short-circuit current.

Protection against short-circuit in motor cable

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

Protection against short-circuit in the supply cable or the drive

Protect the supply cable with fuses or circuit breakers. Fuse recommendations are given in the chapter *Technical data*. When placed at the distribution board, standard IEC gG fuses or UL type T fuses will protect the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short circuit inside the drive.

Operating time of the fuses and circuit breakers

Check that the operating time of the fuse is below 0.5 seconds. The operating time depends on the type, the supply network impedance, and the cross-sectional area, material and length of the supply cable. US fuses must be of the “non-time delay” type.

Circuit breakers

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

Motor thermal protection

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overloading 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 ACSM1-04 has a dedicated connection for PTC or KTY84 sensors. See page 60 in this manual, and the appropriate *Firmware Manual* for the parameter settings concerning motor thermal protection.

Ground fault protection

The drive is equipped with an internal ground fault protective function to protect the unit against ground faults in the motor and the motor cable. This is not a personal safety or a fire protection feature. The ground fault protective function can be disabled with a parameter, refer to the appropriate *Firmware Manual*.

The optional mains filter 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.

Emergency stop devices

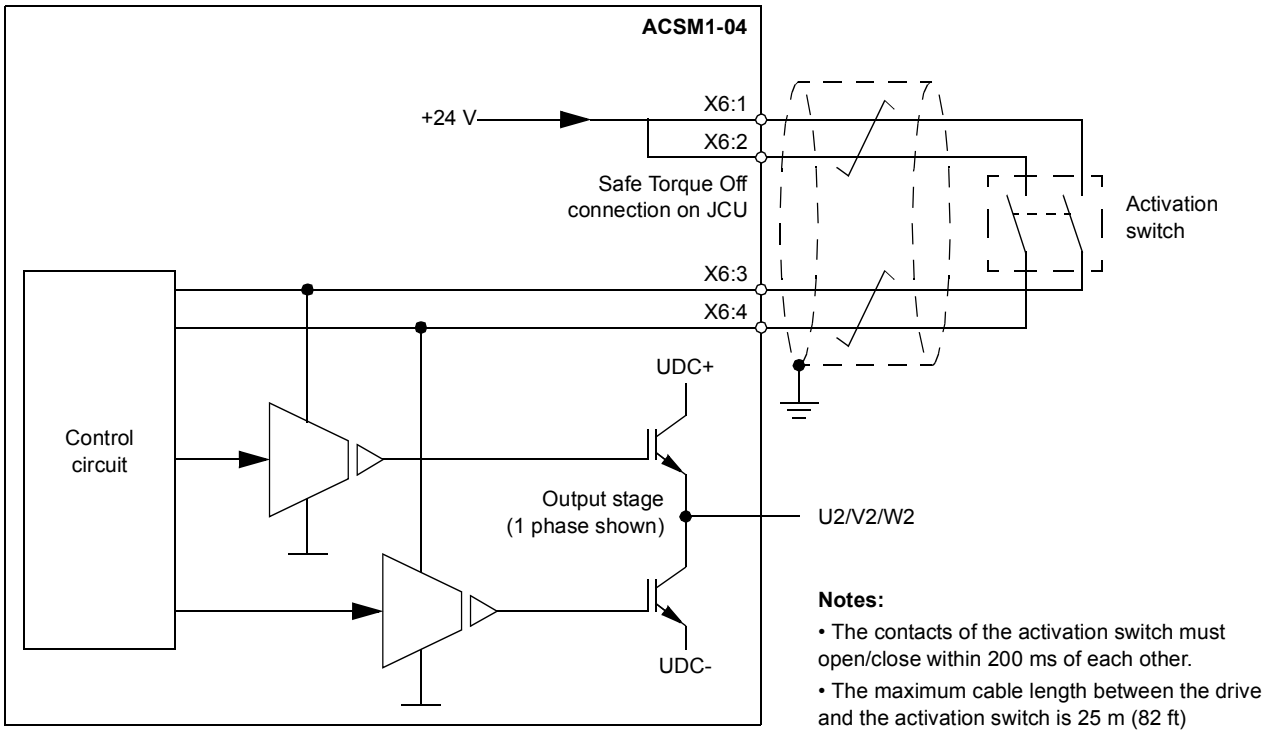
For safety reasons, install the emergency stop devices at each operator control station and at other operating stations where emergency stop may be needed.

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.

Safe Torque Off

The drive supports the Safe Torque Off function according to standards prEN 61800-5-2; EN 954-1 (1997); IEC/EN 60204-1: 1997; EN 61508: 2002 and EN 1037: 1996.

The Safe Torque Off function disables the control voltage of the power semiconductors of the drive output stage, thus preventing the inverter from generating the voltage required to rotate the motor (see diagram below). By using this function, short-time operations (like cleaning) and/or maintenance work on non-electrical parts of the machinery can be performed without switching off the power supply to the drive.



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 system from the main supply.

Note: It is not recommended to stop the drive by using the Safe Torque Off function. If a running drive is stopped by using the Safe Torque Off function, the drive will stop by coasting. If this is not acceptable (e.g. causes danger), the drive and machinery must be stopped using the appropriate stopping mode before using this function.

For further information on the function, refer to *Safe Torque Off Function, Application Guide* (3AFE68929814 [English]).

Selecting the power cables

General rules

Dimension the supply (input power) and motor cables **according to local regulations**.

- The cable must be able to carry the drive load current. See the chapter *Technical data* for the rated currents.
- The cable must be rated for at least 70 °C (US: 75 °C [167 °F]) maximum permissible temperature of conductor in continuous use.
- The conductivity of the PE conductor must be equal to that of a phase conductor (ie. same cross-sectional area).
- 600 VAC cable is accepted for up to 500 VAC.
- Refer to the chapter *Technical data* for EMC requirements.

Symmetrical shielded motor cable must be used (see the figure below) to meet the EMC requirements of the CE and C-tick marks.

A four-conductor system is allowed for input cabling, but shielded symmetrical cable is recommended. Compared to a four-conductor system, the use of symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as motor bearing currents and wear.

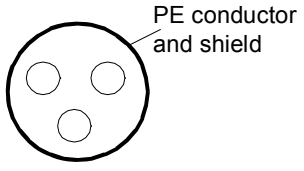
The motor cable and its PE pigtail (twisted shield) should be kept as short as possible in order to reduce electromagnetic emission.

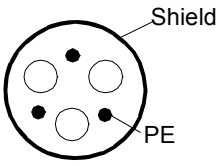
Alternative power cable types

Power cable types that can be used with the drive are represented below.

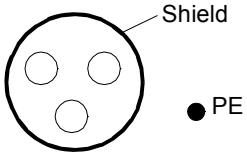
Motor cable
(also recommended for supply cabling)

Symmetrical shielded cable: three phase conductors and a concentric or otherwise symmetrically constructed PE conductor, and a shield



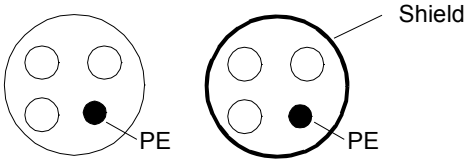


Note: A separate PE conductor is required if the conductivity of the cable shield is not sufficient for the purpose.



Allowed for supply cabling

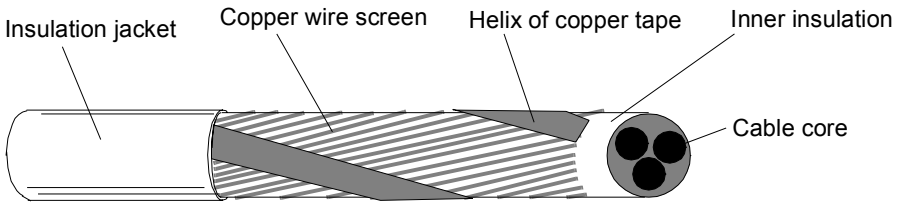
A four-conductor system: three phase conductors and a protective conductor.



Motor cable shield

To function as a protective conductor, the shield must have the same cross-sectional area as a phase conductor when they are made of the same metal.

To effectively suppress radiated and conducted radio-frequency emissions, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminium 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. The better and tighter the shield, the lower the emission level and the bearing currents.

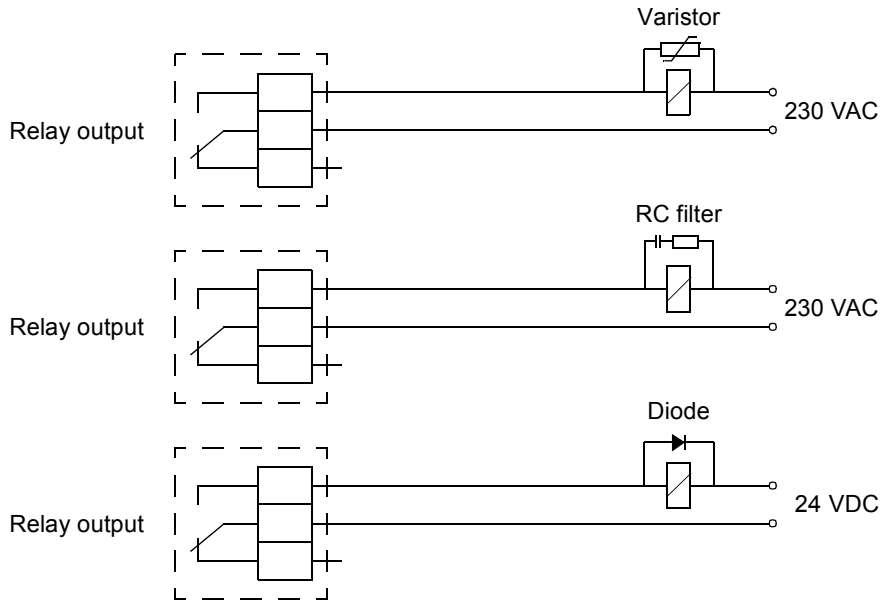


Protecting the relay output contacts and attenuating disturbances in case of inductive loads

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

The relay output on the drive is protected with varistors (250 V) against overvoltage peaks. In addition, it is highly recommended to equip inductive loads with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) in order to minimize the electromagnetic emissions at switch-off. If not suppressed, the disturbances may connect capacitively or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

Install the protective component as close to the inductive load as possible, not at the relay output.



Residual current device (RCD) compatibility

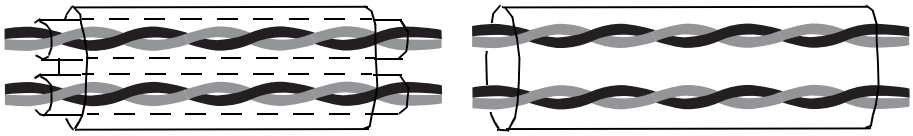
ACSM1-04 drives are suitable to be used with residual current devices of Type B. Other measures for protection in case of direct or indirect contact, such as separation from the environment by double or reinforced insulation or isolation from the supply system by a transformer, can also be applied.

Selecting the control cables

It is recommended that all control cables be shielded.

Double-shielded twisted pair cable is recommended for analogue signals. For pulse encoder cabling, follow the instructions given by the encoder manufacturer. Use one individually-shielded pair for each signal. Do not use a common return for different analogue signals.

Double-shielded cable is the best alternative for low-voltage digital signals but single-shielded twisted multipair cable (Figure *b*) is also usable.



a
Double-shielded twisted pair cable

b
Single-shielded twisted multipair cable

Run analogue and digital signals in separate cables.

Relay-controlled signals, providing their voltage does not exceed 48 V, can be run in the same cables as digital input signals. It is recommended that the relay-controlled signals be run as twisted pairs.

Never mix 24 VDC and 115/230 VAC signals in the same cable.

Relay cable

The cable type with braided metallic screen (e.g. ÖLFLEX by Lapp Kabel, Germany) has been tested and approved by ABB.

Control panel cable

The cable connecting the control panel to the drive must not exceed 3 metres in length. The cable type tested and approved by ABB is used in control panel option kits.

Connection of a motor temperature sensor to the drive I/O

See page 60.

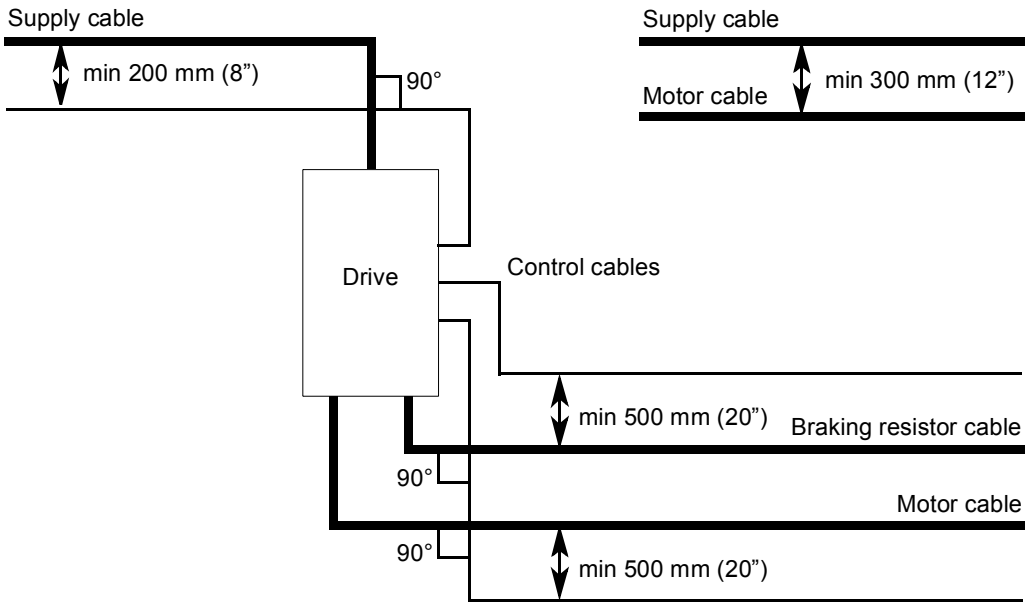
Routing the cables

Route the motor cable away from other cable routes. Motor cables of several drives can be run in parallel installed next to each other. It is recommended that the motor cable, input power cable and control cables be installed on separate trays. Avoid long parallel runs of motor cables with other cables in order to decrease electromagnetic interference caused by the rapid changes in the drive output voltage.

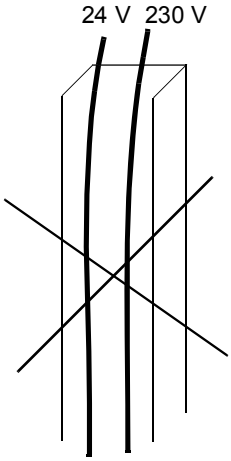
Where control cables must cross power cables make sure they are arranged at an angle as near to 90 degrees as possible. Do not run extra cables through the drive.

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

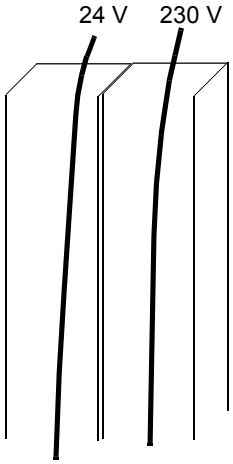
A diagram of the cable routing is below.



Control cable ducts



Not allowed unless the 24 V cable is insulated for 230 V or insulated with an insulation sleeving for 230 V.



Lead 24 V and 230 V control cables in separate ducts inside the cabinet.

Electrical installation

What this chapter contains

This chapter describes the electrical installation procedure of the drive.

WARNING! The work described in this chapter may only be carried out by a qualified electrician. Follow the *Safety instructions* on the first pages of this manual. Ignoring the safety instructions can cause injury or death.

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

Checking the insulation of the assembly

Drive

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

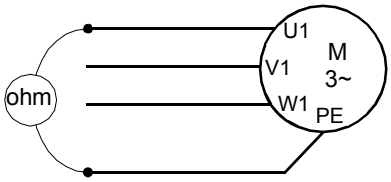
Supply cable

Check the insulation of the supply (input) cable according to local regulations before connecting to the drive.

Motor and motor cable

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

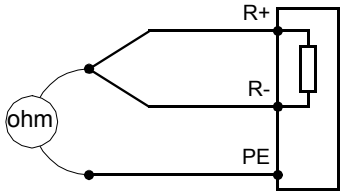
1. Check that the motor cable is connected to the motor, and disconnected from the drive output terminals U2, V2 and W2.
2. Measure the insulation resistance between each phase and the motor PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.



Braking resistor assembly

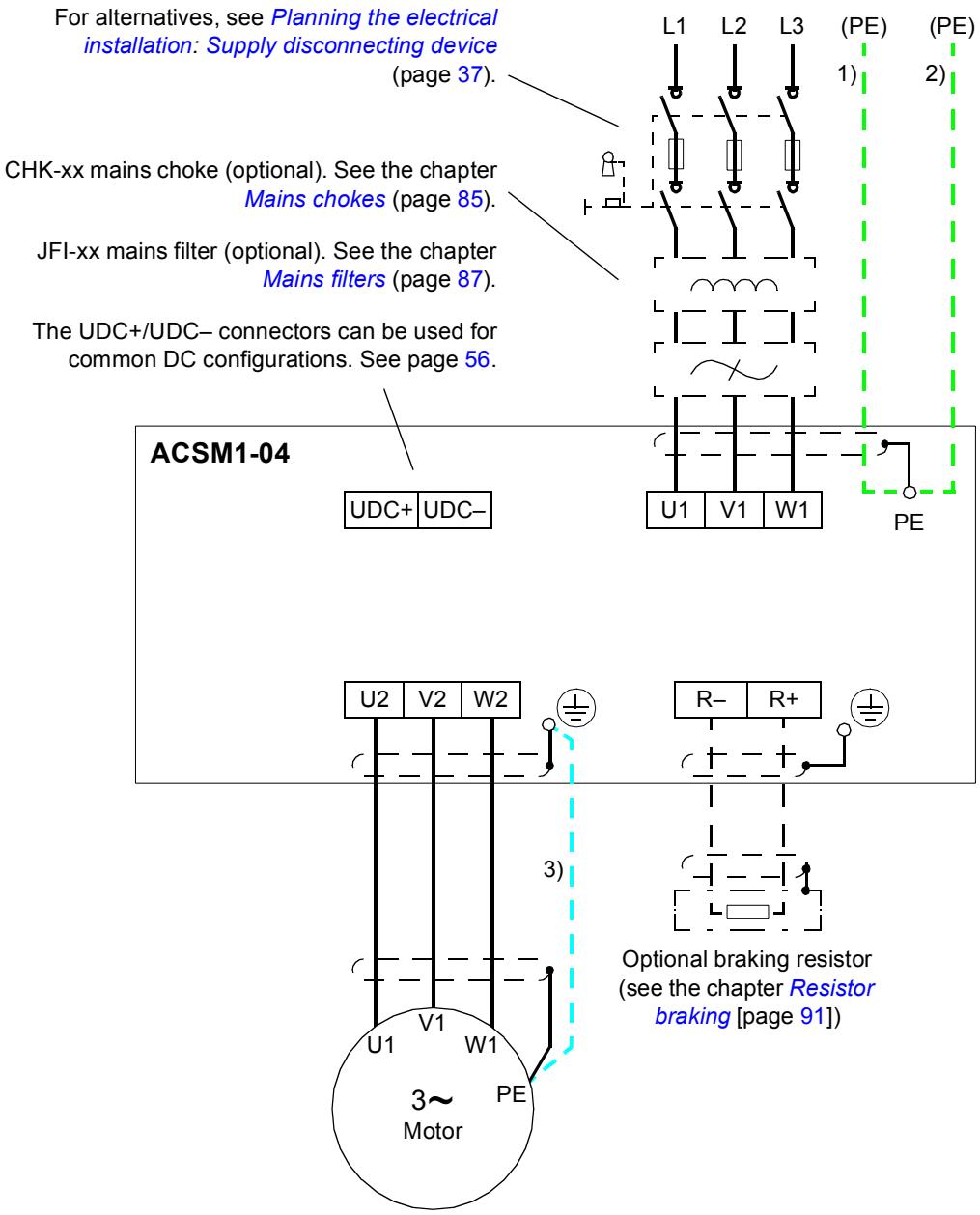
Check the insulation of the braking resistor assembly (if present) as follows:

1. Check that the resistor cable is connected to the resistor, and disconnected from the drive output terminals R+ and R-.
2. 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.



Power cable connection

Power cable connection diagram



Notes:
– If shielded supply (input) cable is used, and the conductivity of the shield is less than 50% of the conductivity of a phase conductor, 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 less than 50% of the conductivity of a phase conductor and the cable has no symmetrical ground conductors. See also section *Selecting the power cables* on page 41.

Procedure

Cabling drawings with tightening torques for each frame size are presented on pages 53 to 55.

1. Frame sizes C and D 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 and corner grounded TN systems, disconnect the internal varistors by removing the screw labelled VAR (located close to the supply terminals on the power unit).

WARNING! If a drive whose varistors 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 will be connected to earth potential through the varistors of the drive. This may cause danger or damage the drive.

If a drive whose varistors are not disconnected is installed on a corner grounded TN system, the drive will be damaged.

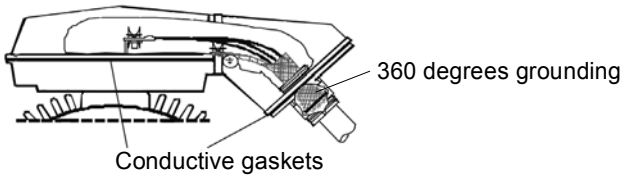
---

3. Fasten the two cable clamp plates included to the drive (see page 52), 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 phase conductors of the supply cable to the U1, V1 and W1 terminals of the drive.
   Connect the phase conductors of the motor cable to the U2, V2 and W2 terminals.
   Connect the conductors of the resistor cable (if present) to the R+ and R– terminals.
   With frame size C or D, attach the screw terminal lugs included to the conductors first. Crimp lugs can be used instead of the 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 C or D, cut suitable slots on the edges of the connector covers to accommodate the supply and motor cables. Refit the covers. (Tighten the screws to 3 N·m [25 lbf·in]).
12. Secure the cables outside the unit mechanically.

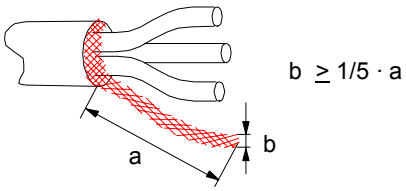
13. Ground the other end of the supply cable shield or PE conductor(s) at the distribution board. In case a mains choke and/or a mains filter is installed, make sure the PE conductor is continuous from the distribution board to the drive.

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



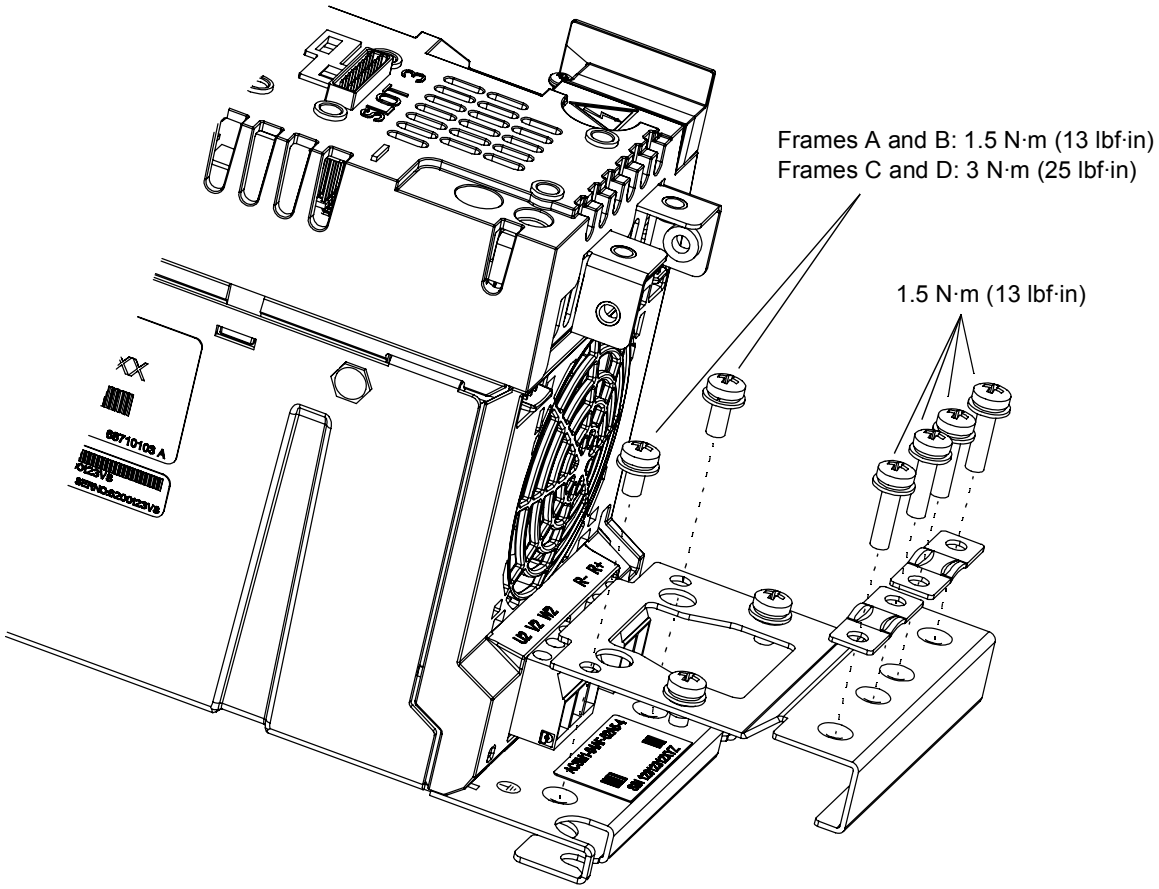
or ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.



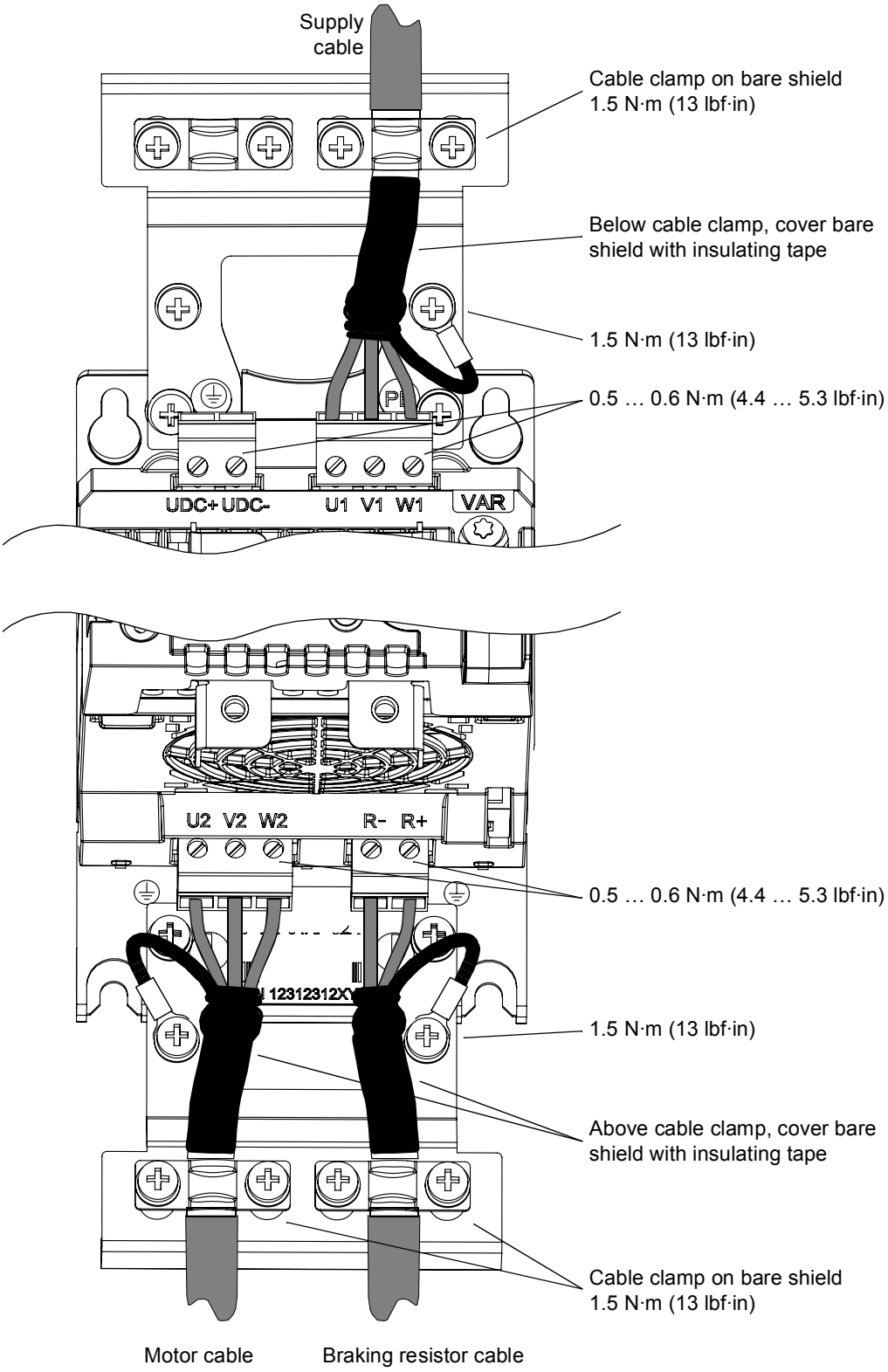
Installation of power cable clamp plates

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

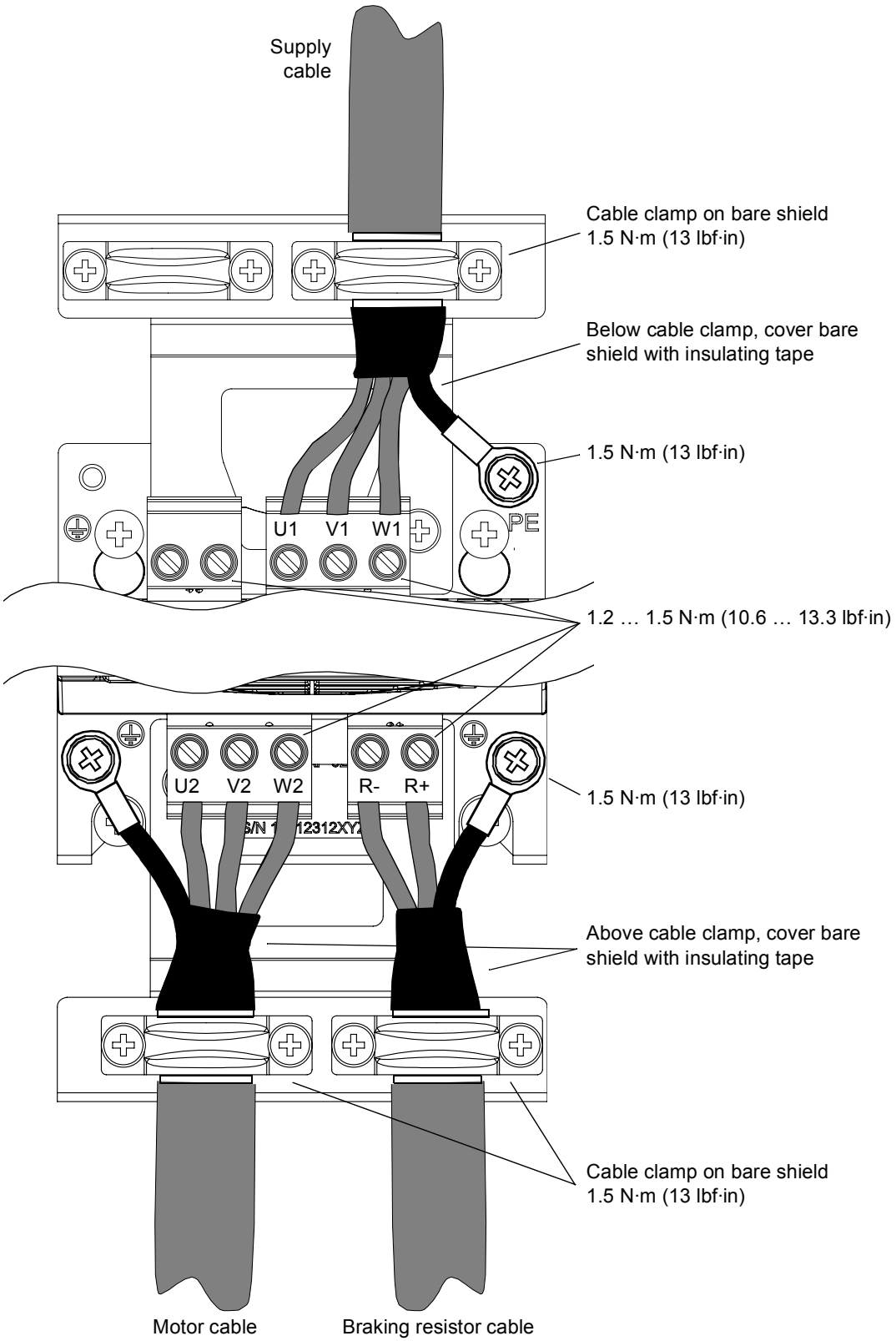
Note: Pay attention to supporting the cables adequately within the installation enclosure especially if not using the cable clamps.



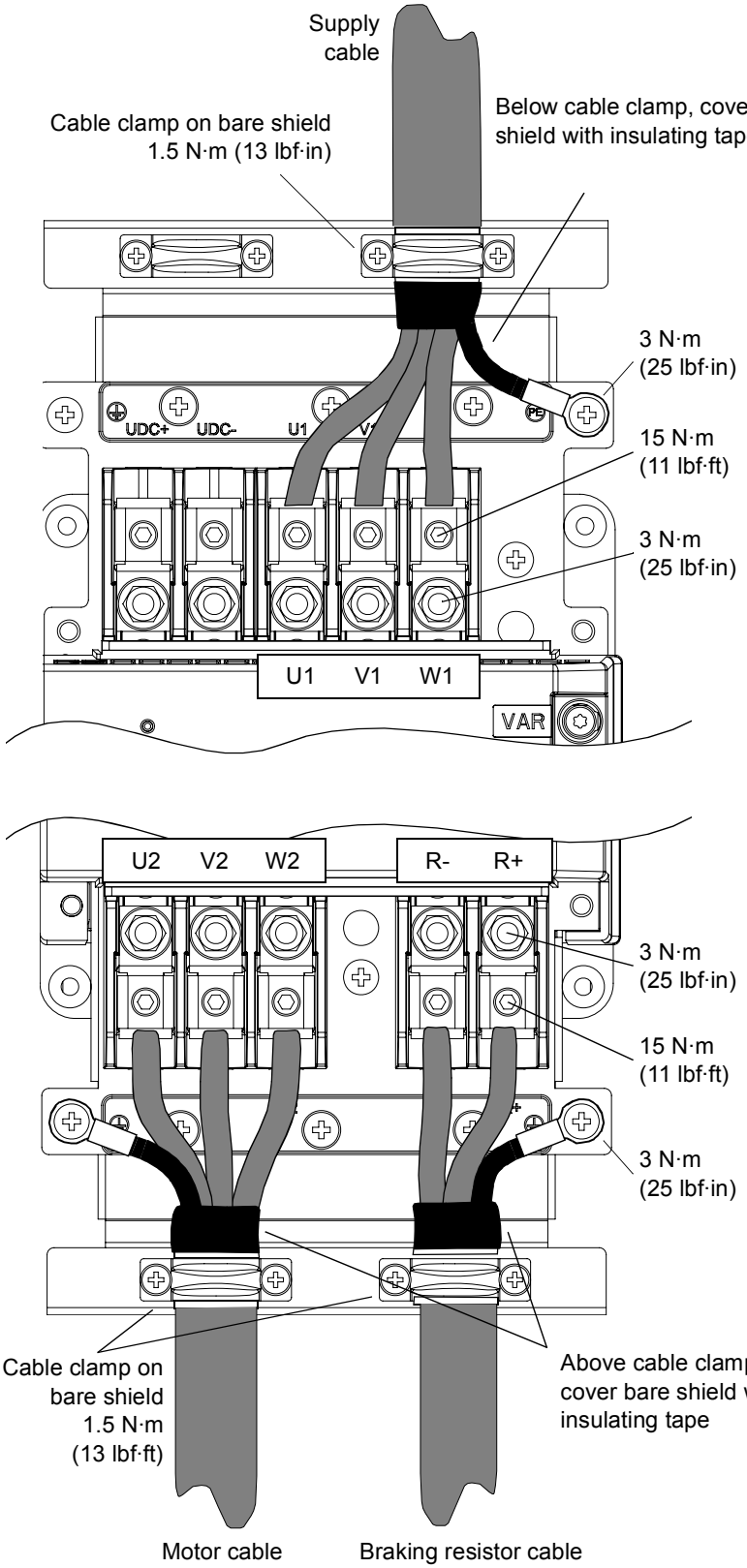
Power cable connection – frame size A



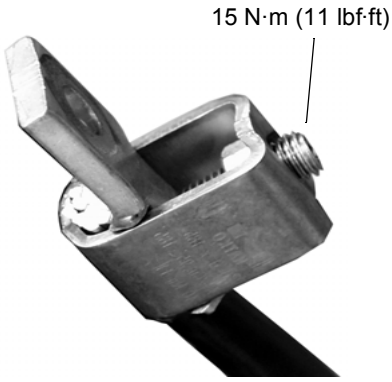
Power cable connection – frame size B



Power cable connection – frame sizes C and D (connector covers removed)

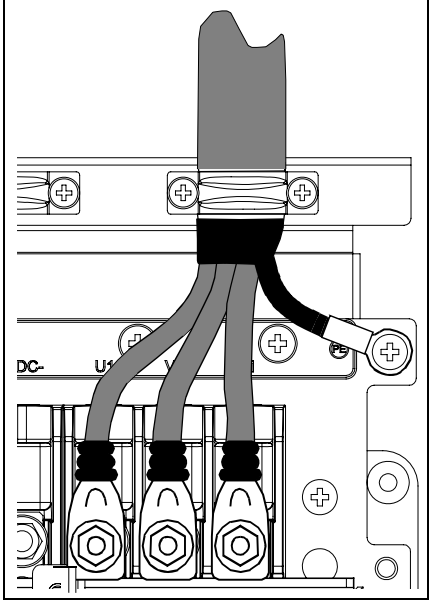


Screw lug detail



Direct lug connection

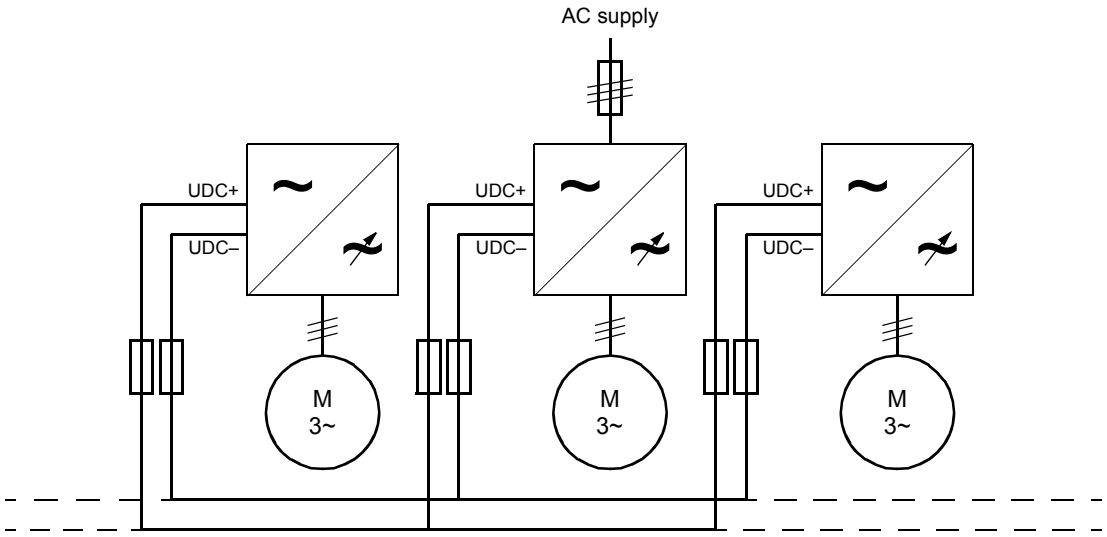
Instead of using the screw lugs included, the conductors of power cables can be connected to the drive terminals by removing the screw lugs and using crimp lugs.

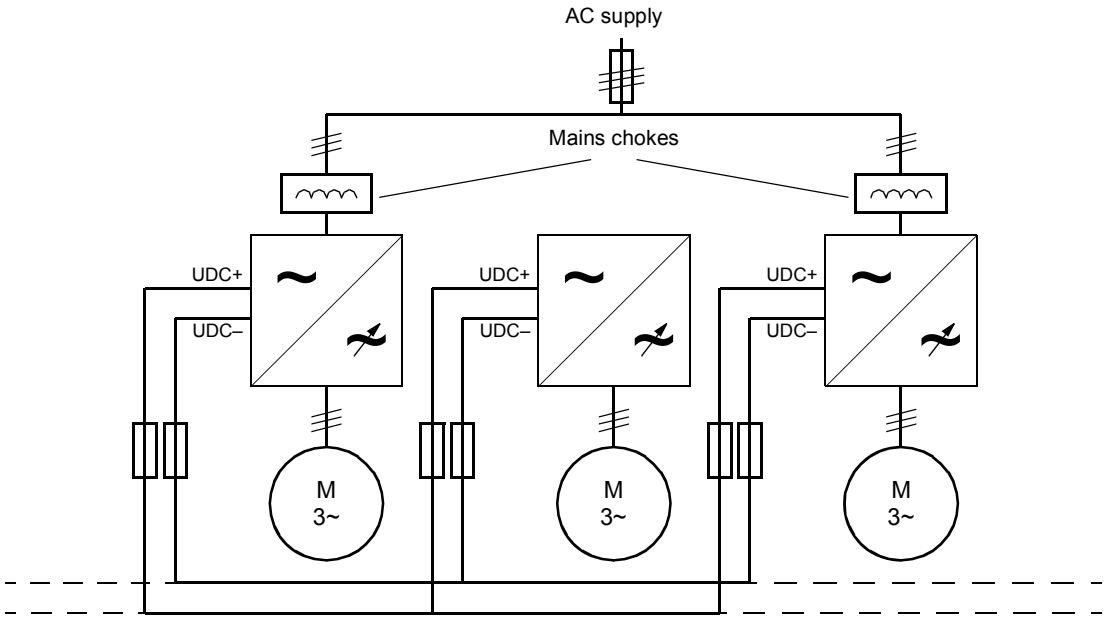


DC connection

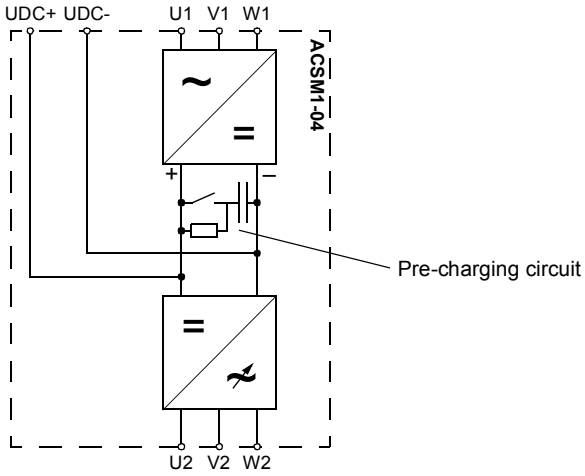
The UDC+ and UDC– terminals are intended for common DC configurations of a number of ACSM1 drives, allowing regenerative energy from one drive to be utilised by the other drives in motoring mode.

One or more drives are connected to the AC supply depending on the power requirement. In case two or more drives 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.



The ratings of the DC connection are given on page 76.

Connecting the control cables

Control connections to the JCU Control Unit

Notes:

*Total maximum current: 200 mA

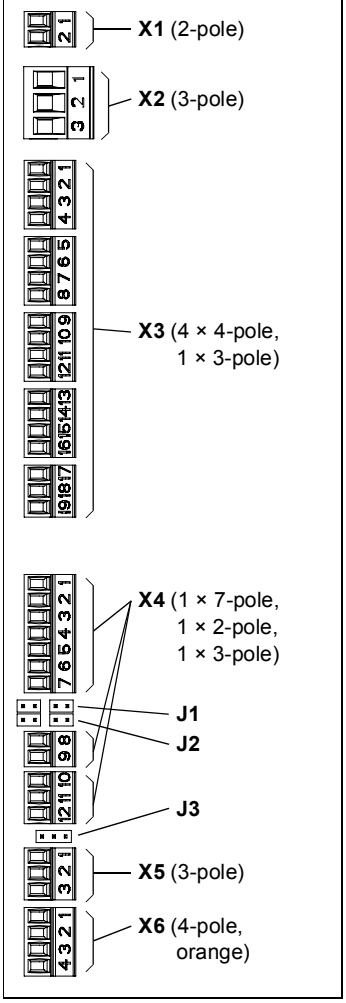
The wiring shown is for demonstrative purposes only. Refer to the appropriate *Firmware Manual* for default I/O assignments.

Further information of the usage of the connectors and jumpers are given in the text; more details are available in the chapter *Technical data*.

Wire sizes and tightening torques:

X2: 0.5 … 2.5 mm^2 (24…12 AWG).
Torque: 0.5 N·m (5 lbf·in)
X3, X4, X5, X6:
0.5 … 1.5 mm^2 (28…14 AWG).
Torque: 0.3 N·m (3 lbf·in)

Order of terminal headers and jumpers

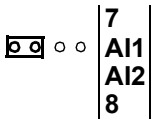


X1		
External power input 24 V DC, 1.6 A	+24VI	1
	GND	2
X2		
Relay output 250 V AC / 30 V DC 2 A	NO	1
	COM	2
	NC	3
X3		
+24 V DC*	+24VD	1
Digital I/O ground	DGND	2
Digital input 1	DI1	3
Digital input 2	DI2	4
+24 V DC*	+24VD	5
Digital I/O ground	DGND	6
Digital input 3	DI3	7
Digital input 4	DI4	8
+24 V DC*	+24VD	9
Digital I/O ground	DGND	10
Digital input 5	DI5	11
Digital input 6	DI6	12
+24 V DC*	+24VD	13
Digital I/O ground	DGND	14
Digital input/output 1	DIO1	15
Digital input/output 2	DIO2	16
+24 V DC*	+24VD	17
Digital I/O ground	DGND	18
Digital input/output 3	DIO3	19
X4		
Reference voltage (+)	+VREF	1
Reference voltage (–)	-VREF	2
Ground	AGND	3
Analogue input 1 (Current or voltage, selectable by jumper J1)	AI1+	4
	AI1-	5
Analogue input 2 (Current or voltage, selectable by jumper J2)	AI2+	6
	AI2-	7
AI1 current/voltage selection		J1
AI2 current/voltage selection		J2
Thermistor input	TH	8
Ground	AGND	9
Analogue output 1 (current)	AO1 (I)	10
Analogue output 2 (voltage)	AO2 (U)	11
Ground	AGND	12
X5		
Drive-to-drive link termination		J3
Drive-to-drive link. See separate section below.	B	1
	A	2
	BGND	3
X6		
Safe Torque Off. Both circuits must be closed for the drive to start. See separate section below.	OUT1	1
	OUT2	2
	IN1	3
	IN2	4
Control panel connection		
Memory unit connection		

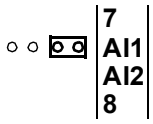
Jumpers

J1 – Determines whether Analogue input AI1 is used as a current or voltage input.

Current

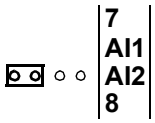


Voltage

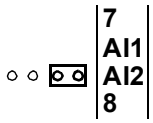


J2 – Determines whether Analogue input AI2 is used as a current or voltage input.

Current

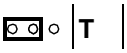


Voltage



J3 – Drive-to-drive link termination. Must be set to the ON position when the drive is the last unit on the link.

Termination ON



Termination OFF

External power supply for the JCU Control Unit (X1)

External +24 V (minimum 1.6 A) power supply for the JCU Control Unit can be connected to terminal block X1. Using an external supply is recommended if

- the application requires fast start after connecting the drive to the main supply
- fieldbus communication is required when the input power supply is disconnected.

Drive-to-drive link (X5)

Reserved.

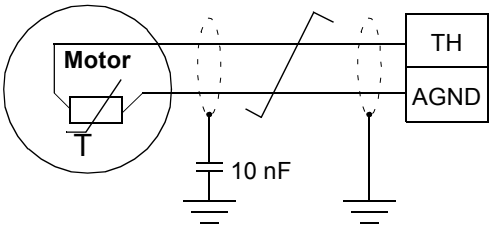
Safe Torque Off (X6)

For the drive to start, both connections (OUT1 to IN1, and OUT2 to IN2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting an external Safe Torque Off circuitry to the drive. See page 40.

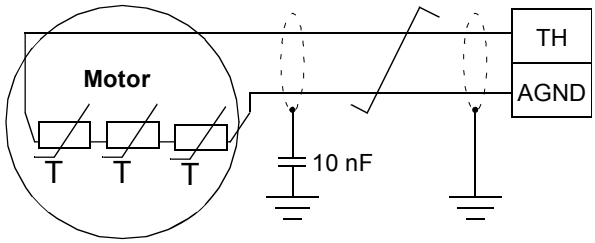
Thermistor input (X4:8…9)

Motor temperature can be measured using PTC or KTY84 sensors connected to the thermistor input.

One PTC or KTY84 sensor



Three PTC sensors



WARNING! As the thermistor input on the JCU Control Unit is not insulated according to IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. If the assembly does not fulfil the requirement,

- the I/O board terminals must be protected against contact and must not be connected to other equipment

or

- the temperature sensor must be isolated from the I/O terminals.

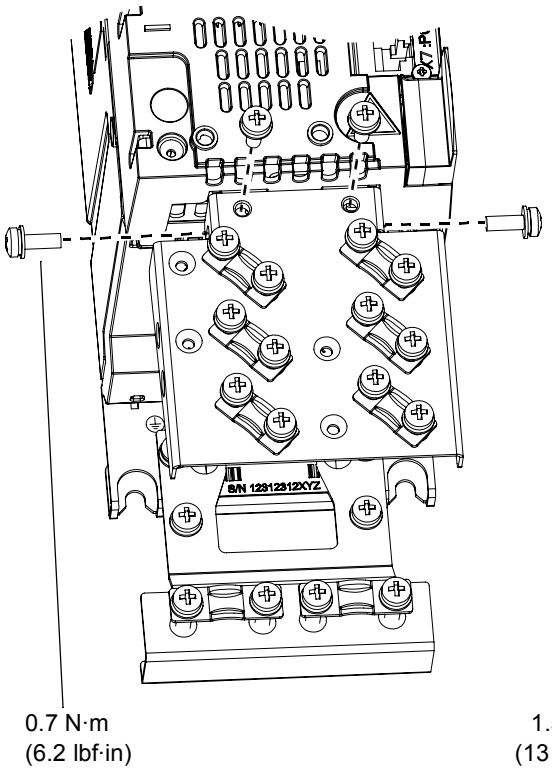
Control cable grounding

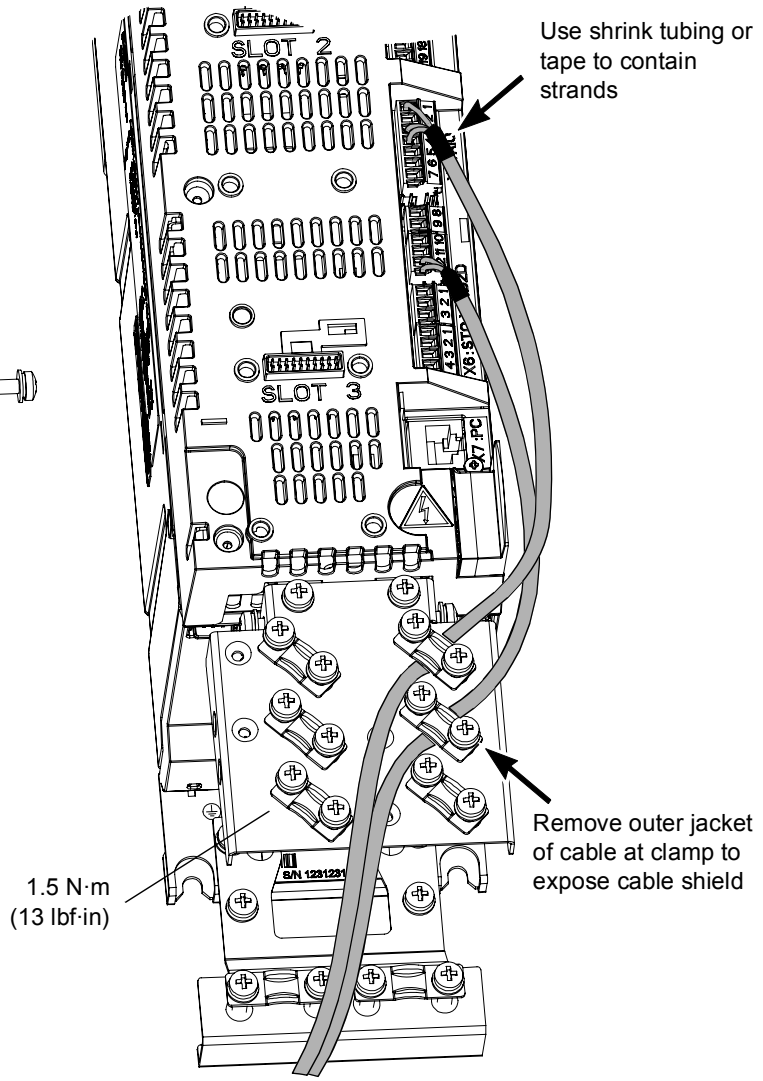
The shields of all control cables connected to the JCU Control Unit must be grounded at the control cable clamp plate. Use four M4 screws to fasten the plate as shown below left. The plate can be fitted either at the top or bottom of the drive.

The shields should be continuous as close to the terminals of the JCU as possible. Only remove the outer jacket of the cable at the cable clamp so that the clamp presses on the bare shield. At the terminal block, use shrink tubing or insulating tape to contain any stray strands. The shield (especially in case of multiple shields) can also be terminated with a lug and fastened with a screw at the clamp plate. Leave the other end of the shield unconnected or ground it indirectly via a few nanofarads high-frequency capacitor (e.g. 3.3 nF / 630 V). The shield can also be grounded directly at both ends if they are *in the same ground line* with no significant voltage drop between the end points.

Keep any signal wire pairs twisted as close to the terminals as possible. Twisting the wire with its return wire reduces disturbances caused by inductive coupling.

Mounting the clamp plate





Installation of options

Options such as fieldbus adapters, I/O extensions and encoder interfaces are inserted into slots on the JCU Control Unit. See page 22 for the available slots; see the appropriate option manual for specific installation and wiring instructions.

Installation checklist

Checklist

Check the mechanical and electrical installation of the drive 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
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 assembly* 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 screw is removed if the drive is connected to an IT (ungrounded) supply network.
☐	The capacitors are reformed if stored over one year (ask local ABB representative for more information).
☐	The drive is grounded properly.
☐	The supply (input power) voltage matches the drive nominal input voltage.
☐	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 specified torque.
☐	The braking resistor (if present) is connected to R+/R-, and the terminals are tightened to specified torque.
☐	The motor cable (and braking 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 JCU Control Unit are OK.
☐	There are no tools, foreign objects or dust from drilling inside the drive.

	Check
☐	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.

Maintenance

What this chapter contains

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

If installed in an appropriate environment, the drive requires very little maintenance. This table lists the routine maintenance intervals recommended by ABB.

Maintenance	Interval	Instruction
Capacitor reforming	Every year of storage	See *Reforming the capacitors*.
Heatsink temperature check and cleaning	Depends on the dustiness of the environment (every 6 to 12 months)	See *Heatsink*.
Cooling fan change	**Every 6 years** if the ambient temperature does not exceed 40 °C (104 °F). **Every 3 years** if the ambient temperature is higher than 40 °C (104 °F).	See *Cooling fan*.

Heatsink

The heatsink fins pick up dust from the cooling air. The drive runs into overtemperature warnings and faults if the heatsink is not clean. In a normal environment, the heatsink should be checked annually, in a dusty environment 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 the dust entering adjoining equipment, perform the cleaning in another room.
3. Replace the cooling fan.

Cooling fan

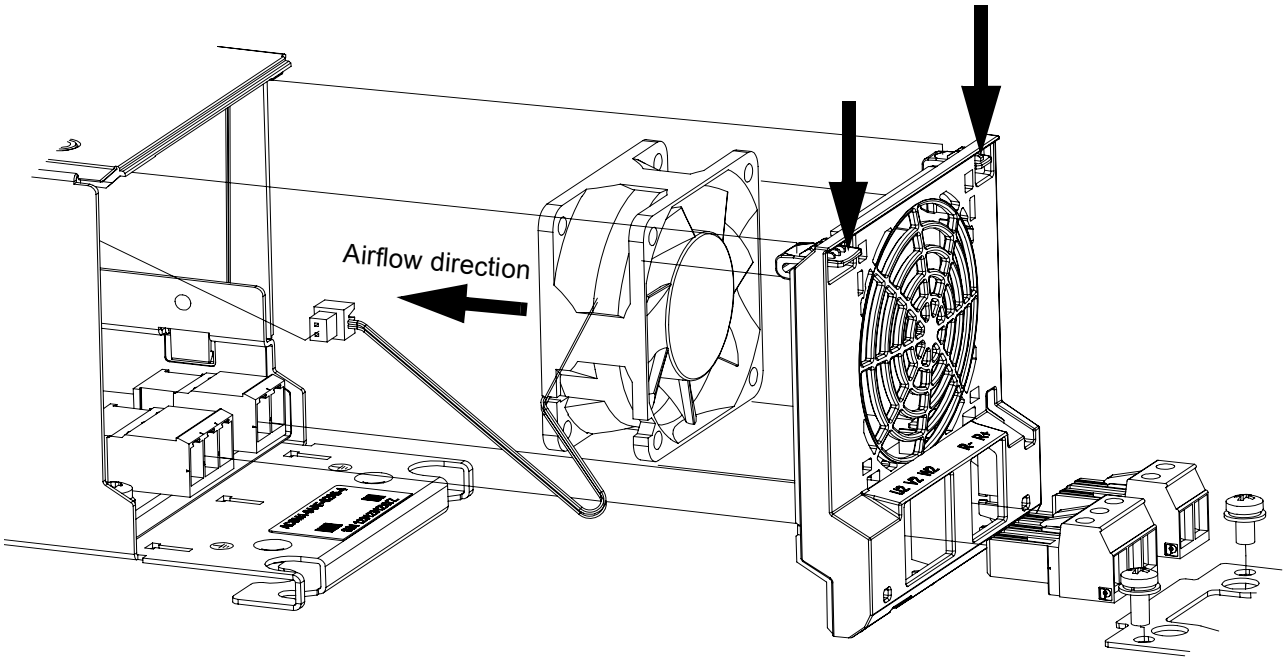
The actual lifespan of the cooling fan depends on the drive usage and ambient temperature. Fan failure can be predicted by the increasing noise from fan bearings and the gradual rise in the heatsink temperature in spite of heatsink cleaning. If the drive is operated in a critical part of a process, fan replacement is recommended once these symptoms start appearing. Replacement fans are available from ABB. Do not use other than ABB-specified spare parts.

Fan replacement (Frames A and B)

Detach the power cable clamp plate and terminal blocks. Release the retaining clips (arrowed) carefully using a screwdriver. Pull the fan holder out. Disconnect the fan cable. Carefully bend the clips on the fan holder to free the fan.

Install new fan in reverse order.

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

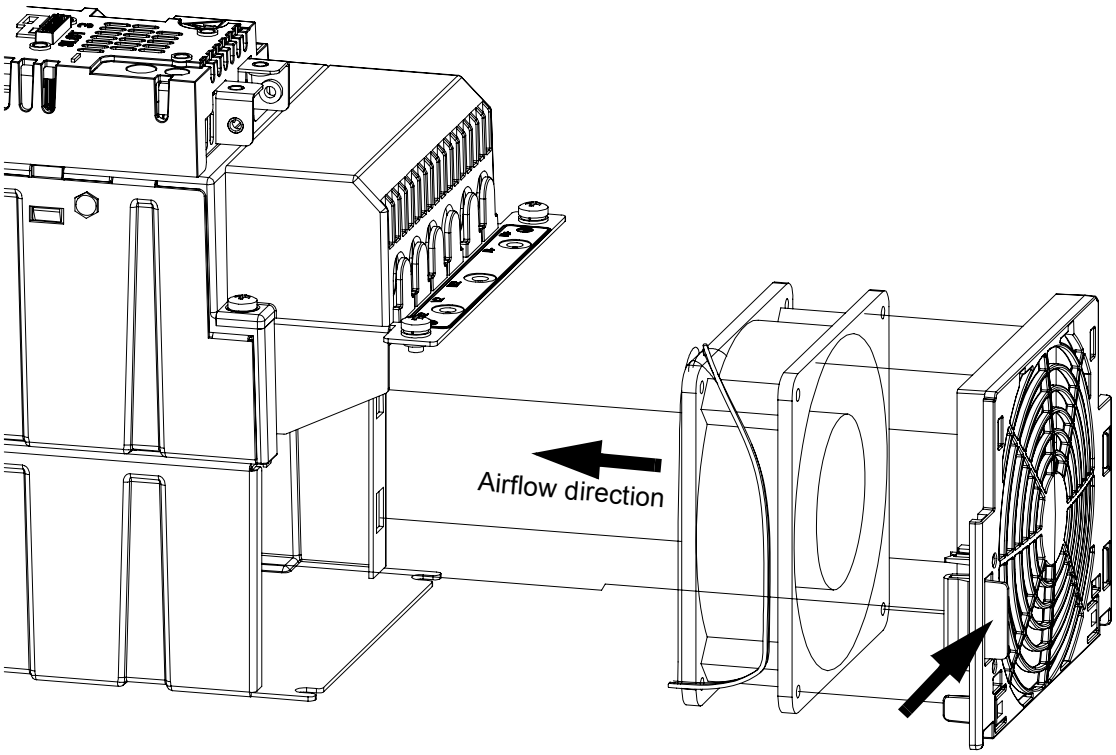


Fan replacement (Frames C and D, ACSM1-04Ax-xxxx-x)

To remove the fan, release the retaining clip (arrowed) carefully using a screwdriver. Pull the fan holder out. Disconnect the fan cable. Carefully bend the clips on the fan holder to free the fan.

Install new fan in reverse order.

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

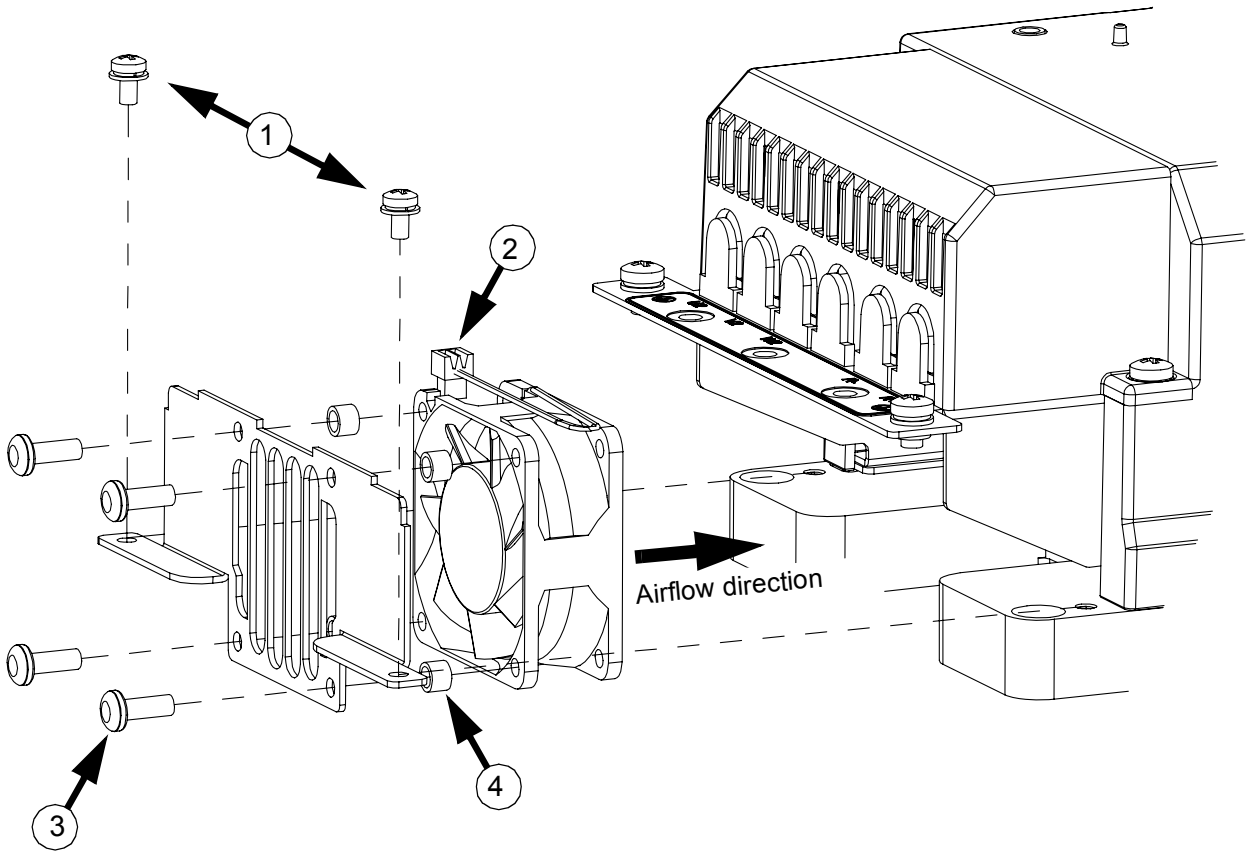


Fan replacement (Frames C and D, ACSM1-04Cx-xxxx-x)

Unfasten the fan holder by removing the two screws marked (1) in the drawing below. Pull the fan holder out and disconnect the wire plug (2). Remove the four screws (3) to release the fan from the holder. Use the spacers (4) to mount the new fan.

Install new fan in 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 page 33 for information on finding out the manufacturing date. For information on reforming the capacitors, contact your local ABB representative.

Other maintenance actions

Transferring the memory unit to a new drive module

When a drive module is replaced, the parameter settings can be retained by transferring the memory unit from the defective drive module to the new module.

WARNING! Do not remove or insert a memory unit when the drive module is powered.

After power-up, the drive will scan the memory unit. If a different application program or different parameter settings are detected, they are copied to the drive. This may take a few moments; the LED display will read “L” while copying is in progress.

The 7-segment display on the JCU Control Unit

The following table describes the indications given by the 7-segment display on the JCU Control Unit. Multi-character indications are displayed as repeated sequences of characters.

Display	Meaning
L	Loading application program or data from the memory unit. This is the normal display immediately after powering up the drive.
□	Normal operation – drive stopped.
↖□	(Rotating display) Normal operation – drive running.
“E” followed by four-digit error code	System error. 9001, 9002 = Control unit hardware failure. 9003 = No memory unit connected. 9004 = Memory unit failure. 9007, 9008 = Loading of firmware from memory unit failed. 9009…9018 = Internal error. 9019 = Contents of memory unit corrupted. 9020 = Internal error. 9021 = Program versions of memory unit and drive incompatible. 9102…9108 = Internal error.
“A” followed by four-digit error code	Alarm generated by the application program. For error codes, see the Firmware Manual.
“F” followed by four-digit error code	Fault generated by the application program. For error codes, see the Firmware Manual.

Technical data

What this chapter contains

This chapter contains the technical specifications of the drive, e.g. the ratings, sizes and technical requirements, and provisions for fulfilling the requirements for CE and other markings.

Ratings

The nominal current ratings for the ACSM1-04 with 400 V AC supply are given below.

Drive type ACSM1-04xx…	Frame size	Input ratings		Output ratings						
		I_{1N}	*I_{1N}	I_{2N}	$I_{2cont4k}$	$I_{2cont8k}$	$I_{2cont16k}$	I_{2max}	P_N	
		A	A	A	A	A	A	A	kW	HP
-02A5-4	A	1.9	3.2	2.5	3.0	2.5	2.0	5.3	0.75	1
-03A0-4	A	2.6	4.7	3.0	3.6	3.0	2.2	6.3	1.1	1.5
-04A0-4	A	3.3	5.7	4.0	4.8	4.0	2.4	8.4	1.5	2
-05A0-4	A	4.6	7.8	5.0	6.0	5.0	2.5	10.5	2.2	3
-07A0-4	A	5.8	9.8	7.0	8.0	5.5	3.0	14.7	3	3
-09A5-4	B	7.9	12	9.5	10.5	9.5	5.0	16.6	4	5
-012A-4	B	10	15	12	14	12	6.0	21	5.5	7.5
-016A-4	B	14	20	16	18	13	7.5	28	7.5	10
-024A-4	C	20	21	24	27	24	18	42	11	15
-031A-4	C	27	26	31	35	31	20	54	15	20
-040A-4	C	33	29	40	44	35	22	70	18.5	25
-046A-4	C	39	35	46	50	38	24	80	22	30
-060A-4	D	55	45	60	65	55	28	105	30	40
-073A-4	D	65	51	73	80	60	31	128	37	50
-090A-4	D	78	58	90	93	65	34	150	45	60

*Without mains choke

PDM-00425726

I_{1N}	Nominal input current (rms) at 40 °C (104 °F).
I_{2N}	Nominal output current at 40 °C (104 °F).
$I_{2contxk}$	Continuous output current at a switching frequency of 4/8/16 kHz at 40 °C (104 °F).
P_N	Typical motor power.
I_{2max}	Maximum short-time output current. See section *Cyclic loads* below.

Note: Frame sizes C and D can be used continuously without a mains choke at up to 50% of nominal shaft power (i.e. at continuous nominal torque up to 50% of rated speed).

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 for the required motion profile.

Derating

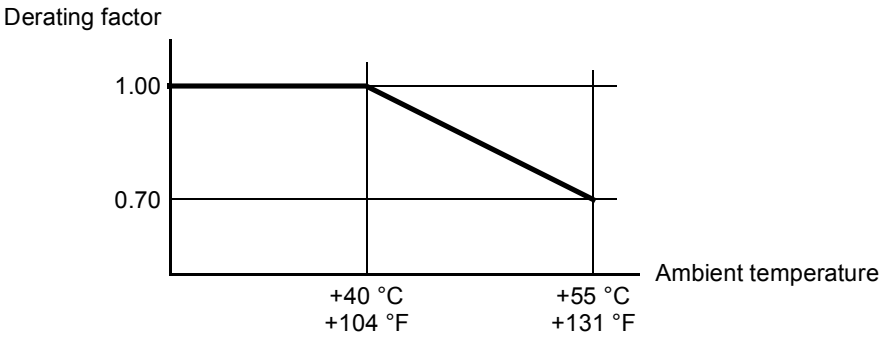
The continuous output currents stated above must be derated if any of the following conditions apply:

- the ambient temperature exceeds +40 °C (+104°F)
- the AC supply voltage is higher than 400 V
- the drive is installed higher than 1000 m above sea level.

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

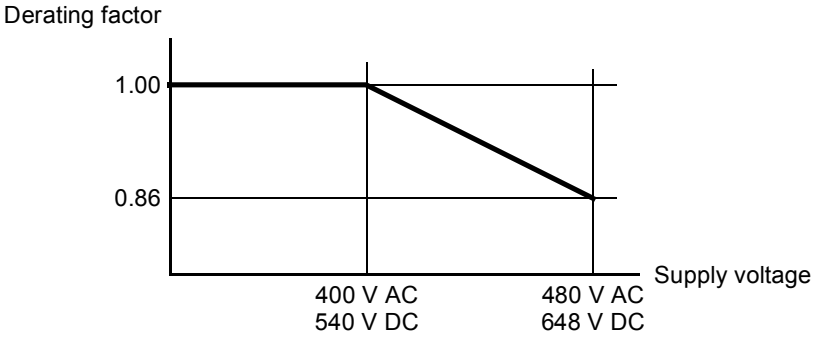
Ambient temperature derating

In the temperature range +40…55 °C (+104…131 °F), the continuous output current is derated linearly as follows:



Supply voltage derating

With supply voltages above 400 V AC or 540 V DC, the continuous output current is derated linearly as follows:



Altitude derating

At altitudes from 1000 to 4000 m (3300 to 13123 ft) above sea level, the derating is 1% for every 100 m (328 ft). For a more accurate derating, use the DriveSize PC tool.

Note: If the installation site is higher than 2000 m (6600 ft) above sea level, connection of the drive to an ungrounded (IT) or corner-grounded delta network is not allowed.

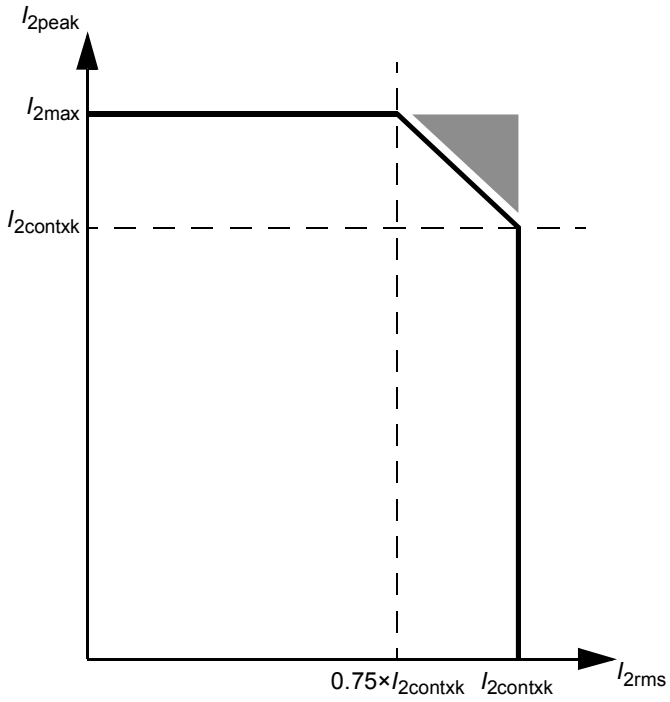
Cyclic loads

If the load cycle is shorter than 10 seconds, the thermal time constant of the heatsink (approximately 80 seconds) can be ignored, and the following simple procedure can be applied to find out whether the drive can handle the cycle.

1. Determine the rms value (I_{2rms}) of the output current over the whole load cycle.
2. Determine the maximum instantaneous rms value (I_{2peak}) of the output current during the load cycle.
3. Determine the point (I_{2rms}, I_{2peak}) on the graph below.

If the point falls within the region bordered by a solid line, the load cycle is safe. For $I_{2contxk}$ and I_{2max}, use the ratings stated for the drive type and switching frequency used.

If the point falls within the shaded area, a more detailed study is required.



The above procedure can also be applied to longer load cycles by dividing the cycle into subcycles no longer than 10 seconds. If any of the subcycles fail the test, a more detailed study is required.

The DriveSize dimensioning tool available from ABB is recommended for more detailed dimensioning.

Dimensions and weights

See also the chapter *Dimension drawings*.

Frame size	**Height** (without cable clamp plates) mm (in.)	**Height** (with cable clamp plates) mm (in.)	**Width** mm (in.)	**Depth** (without options installed on JCU) mm (in.)	**Depth** (with options installed on JCU) mm (in.)	**Weight** kg (lbs)
A	364 (14.33)	474 (18.66)	90 (3.54)	146 (5.75)	169 (6.65)	2.8 (6.2)
B	380 (14.96)	476 (18.74)	100 (3.94)	223 (8.78)	246 (9.69)	4.8 (10.6)
C	467 (18.39)	558 (21.97)	165 (6.50)	235 (9.25)	248 (9.76)	10 (22)
D	467 (18.39)	558 (21.97)	220 (8.66)	235 (9.25)	248 (9.76)	17 (37.5)

Note: The wiring to the I/O options requires some 50 mm (2”) of additional depth.

Cooling characteristics, noise levels

Drive type ACSM1-04xx…	**Power loss** W	**Air flow** (ACSM1-04A…) m^3/h	**Air flow** (ACSM1-04C…) m^3/h	**Noise level** dBA
-02A5-4	100	24	N/A	47
-03A0-4	106	24	N/A	47
-04A0-4	126	24	N/A	47
-05A0-4	148	24	N/A	47
-07A0-4	172	24	N/A	47
-09A5-4	212	48	N/A	39
-012A-4	250	48	N/A	39
-016A-4	318	48	N/A	39
-024A-4	375	142	24	63
-031A-4	485	142	24	63
-040A-4	541	200	24	71
-046A-4	646	200	24	71
-060A-4	840	290	24	70
-073A-4	1020	290	24	70
-090A-4	1200	290	24	70

Cold plate cooling characteristics (ACSM1-04Cx-xxxx-x only)

The ratings stated at the beginning of this chapter are achieved provided that the hot-spot temperature of the cold plate is kept below 65 °C (140 °F) and that the drive is installed according to the instructions in this manual.

A suitable cold plate is, for example, the Rittal DCP 8616.xxx (Direct Cooling Package) intended for Rittal TS8 enclosures. If the incoming coolant temperature is below 50 °C (122 °F), and the flow is at least 5 dm^3/min, the cooling is adequate. The temperature rise of the coolant due to the drive is approximately 1…2 K maximum.

The ACSM1-04Cx-xxxx-x has an internal fan to cool the circuit boards. The heat dissipation into air is approximately 200 W.

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*.

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

Drive type ACSM1-04xx…	**Input current** (A)	**IEC fuse**			**UL fuse**			**Cross-sectional area of cable**	
		Rated current (A)	Voltage (V)	Class	Rated current (A)	Voltage (V)	UL Class	mm^2	AWG
-02A5-4	3.2*	6	500	gG	6	600	T	1.5 … 4	16…12
-03A0-4	4.7*	6	500	gG	6	600	T	1.5 … 4	16…12
-04A0-4	5.7*	10	500	gG	10	600	T	1.5 … 4	16…12
-05A0-4	7.8*	10	500	gG	10	600	T	1.5 … 4	16…12
-07A0-4	9.8*	16	500	gG	15	600	T	1.5 … 4	16…12
-09A5-4	12*	16	500	gG	15	600	T	1.5 … 10	16…8
-012A-4	15*	20	500	gG	20	600	T	1.5 … 10	16…8
-016A-4	20*	25	500	gG	25	600	T	1.5 … 10	16…8
-024A-4	20	25	500	gG	25	600	T	6…35	9…2
-031A-4	27	32	500	gG	35	600	T	6…35	9…2
-040A-4	33	40	500	gG	45	600	T	6…35	9…2
-046A-4	39	50	500	gG	50	600	T	6…35	9…2
-060A-4	55	63	500	gG	70	600	T	10…70	6 … 2/0
-073A-4	65	80	500	gG	80	600	T	10…70	6 … 2/0
-090A-4	78	100	500	gG	100	600	T	10…70	6 … 2/0

*Without mains choke

PDM-00425726

AC input (supply) connection

Voltage (U_1)	380 … 480 V AC +10%/-15%, 3-phase
Frequency	50 … 60 Hz ±5%
Network type	Grounded (TN, TT) or ungrounded (IT). **Note:** Connection to an ungrounded (IT) or corner-grounded delta network is not allowed at altitudes of 2000 m (6600 ft) or higher.
Imbalance	Max. ±3% of nominal phase to phase input voltage
Fundamental power factor (cos phi$_1$)	0.98 (at nominal load)
Terminals	Frame A: Detachable screw terminal block for 0.25 … 4 mm^2 wire. Frame B: Detachable screw terminal block for 0.5 … 6 mm^2 wire. Frames C and D: Screw lugs for 6…70 mm^2 wire included. Suitable crimp lugs can be used instead.

DC connection

Voltage 436 … 712 V DC

Ratings

Drive type ACSM1-04xx…	I_{dcN} (A)	C (µF)
-02A5-4	3.3	120
-03A0-4	3.9	120
-04A0-4	4.8	240
-05A0-4	6.5	240
-07A0-4	8.7	240
-09A5-4	12	370
-012A-4	15	740
-016A-4	20	740
-024A-4	29	670
-031A-4	38	670
-040A-4	44	1000
-046A-4	54	1000
-060A-4	73	1340
-073A-4	85	2000
-090A-4	98	2000

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.

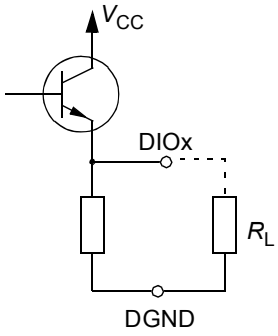
Terminals Frame A: Detachable screw terminal block for 0.25 … 4 mm^2 wire.
Frame B: Detachable screw terminal block for 0.5 … 6 mm^2 wire.
Frames C and D: Screw lugs for 6…70 mm^2 wire included. Suitable crimp lugs can be used instead.

Motor connection

Motor types	Asynchronous induction motors, asynchronous servo motors, synchronous permanent magnet motors
Frequency	0 … 500 Hz
Current	See section *Ratings*.
Switching frequency	Selectable between 2 … 16 kHz. Default: 4 kHz, above which output current derated
Maximum motor cable length	50 m (164 ft) with screened cable 75 m (246 ft) with unscreened cable

Terminals	Frame A: Detachable screw terminal block for 0.25 … 4 mm^2 wire. Frame B: Detachable screw terminal block for 0.5 … 6 mm^2 wire. Frames C and D: Screw lugs for 6…70 mm^2 wire included. Suitable crimp lugs can be used instead.

JCU Control Unit

Power supply	24 V (±10%) DC, 1.6 A Supplied from the power unit of the drive, or from external power supply through connector X1 (pitch 3.5 mm, wire size 1.5 mm^2).
Relay output (X2)	Connector pitch 5 mm, wire size 2.5 mm^2 250 V AC / 30 V DC, 2 A Protected by varistors
Digital inputs DI1…DI6 (X3)	Connector pitch 3.5 mm, wire size 1.5 mm^2 Logic levels: “0” < 5 V, “1” > 15 V R_{in}: 2.0 kohm Filtering: Adjustable, 0.25 ms min. (see also *Firmware Manual)*
Digital inputs/outputs DIO1…DIO3 (X3). Input/output mode selection by parameters. DIO2 can be configured as a frequency input (0…32 kHz). DIO3 can be configured as a frequency output. See *Firmware Manual,* parameter group 12.	Connector pitch 3.5 mm, wire size 1.5 mm^2 As inputs: Logic levels: “0” < 5 V, “1” > 15 V R_{in}: 2.0 kohm Filtering: Adjustable, 0.25 ms min. (see also *Firmware Manual)* As outputs: Total output current limited by auxiliary voltage outputs to 200 mA Output type: Open emitter 
Analogue inputs AI1 and AI2 (X4). Current/voltage input mode selection by jumpers. See page 59.	Connector pitch 3.5 mm, wire size 1.5 mm^2 Current input: –20…20 mA, $R_{in:}$ 100 ohm Voltage input: –10…10 V, R_{in}: 200 kohm Differential inputs, common mode ±20 V Sampling interval per channel: 0.25 ms Filtering: Adjustable, 0.25 ms min. (see also *Firmware Manual)* Resolution: 11 bit + sign bit Inaccuracy: 1% of full scale range
Thermistor input (X4)	Connector pitch 3.5 mm, wire size 1.5 mm^2 Input devices: PTC or KTY84 thermistor Up to three PTCs can be connected in series KTY84 thermistor: Inaccuracy 5 °C No safety insulation (see page 60)
Analogue outputs AO1 and AO2 (X4)	Connector pitch 3.5 mm, wire size 1.5 mm^2 AO1 (current): 0…20 mA, R_{load} < 500 ohm AO2 (voltage): –10…10 V, R_{load} > 1 kohm Frequency range: 0…800 Hz Resolution: 11 bit + sign bit Inaccuracy: 2% of full scale range

Reference voltage (VREF) for analogue inputs	Connector pitch 3.5 mm, wire size 1.5 mm^2 10 V ±1% and –10 V ±1%, R_{load} > 1 kohm
Drive to drive link (X5)	Connector pitch 3.5 mm, wire size 1.5 mm^2 Physical layer: RS-485 Termination by jumper
Safe Torque Off connection (X6)	Connector pitch 3.5 mm, wire size 1.5 mm^2 For the drive to start, both connections (OUT1 to IN1, and OUT2 to IN2) must be closed
Control panel / PC connection (X7)	Connector: RJ-45 Cable length < 3 m

Efficiency

Approximately 98% at nominal power level

Cooling

Method	Internal fan, flow from bottom to top. Air-cooled heatsink, or cold plate mounting.
Free space around the unit	See chapter *Planning the cabinet assembly*.

Degrees of protection

IP20 (UL open type). *See chapter Planning the cabinet assembly.*

Ambient conditions

Environmental limits for the drive are given below. The drive is to 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 4000 m (6600 ft) above sea level. [See also section *Altitude derating* on page 72.]	-	-
Air temperature	-10 to +55°C (14 to 131°F). No frost allowed. See section *Derating* on page 72.	-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 drive contains raw materials that should be recycled to preserve energy and natural resources. The package materials are environmentally compatible and recyclable. All metal parts can be recycled. The plastic parts can either be recycled or burned under controlled circumstances, according to local regulations. Most recyclable parts are marked with recycling marks.

If recycling is not feasible, all parts excluding electrolytic capacitors and printed circuit boards can be landfilled. The DC capacitors contain electrolyte, which is classified as hazardous waste within the EU. They must be removed and handled according to local regulations.

For further information on environmental aspects and more detailed recycling instructions, please contact your local ABB distributor.

Applicable standards

	The drive complies with the following standards. The compliance with the European Low Voltage Directive is verified according to standards EN 50178 and EN 60204-1.
• EN 50178 (1997)	Electronic equipment for use in power installations
• IEC 60204-1 (2005), modified	Safety of machinery. Electrical equipment of machines. Part 1: General requirements. *Provisions for compliance:* The final assembler of the machine is responsible for installing - an emergency-stop device - a supply disconnecting device - the ACSM1-04 into a cabinet.
• EN 60529: 1991 (IEC 60529)	Degrees of protection provided by enclosures (IP code)
• IEC 60664-1 (2007), Edition 2.0	Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests.
• IEC 61800-3 (2004)	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods.
• EN 61800-5-1 (2003)	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements. Electrical, thermal and energy *Provisions for compliance:* The final assembler of the machine is responsible for installing the ACSM1-04 in a cabinet that is protected to IP2X (IP3X for top surfaces for vertical access).
• prEN 61800-5-2	Adjustable speed electrical power drive systems. Part 5-2: Safety requirements. Functional
• UL 508C (2002), Third Edition	UL Standard for Safety, Power Conversion Equipment
• NEMA 250 (2003)	Enclosures for Electrical Equipment (1000 Volts Maximum)
• CSA C22.2 No. 14-05 (2005)	Industrial Control Equipment

CE marking

A CE mark is attached to the drive to verify that the drive follows the provisions of the European Low Voltage and EMC Directives (Directive 73/23/EEC, as amended by 93/68/EEC, and Directive 89/336/EEC, as amended by 2004/108EC).

Compliance with the European Low Voltage Directive

The compliance with the European Low Voltage Directive has been verified according to standards EN 50178, EN 61800-5-1 and EN 60204-1.

Compliance with the European EMC Directive

The cabinet builder is in responsible for the compliance of the drive system with the European EMC Directive. For information on items to consider, see:

- Subsections *Compliance with EN 61800-3 (2004), category C2*; *Compliance with EN 61800-3 (2004), category C3*; and *Compliance with EN 61800-3 (2004), category C4* below
- The chapter *Planning the electrical installation* in this manual
- *Technical Guide No. 3 – EMC Compliant Installation and Configuration for a Power Drive System* (3AFE61348280 [English]).

Definitions

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

First environment includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low-voltage network which supplies buildings used for domestic purposes.

Second environment includes all establishments other than those directly connected to a low-voltage network which supplies buildings used for domestic purposes.

Drive of category C2. Power drive system with rated voltage less than 1000 V which is neither a plug-in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional.

Drive of category C3. Power drive system with 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. Power drive system with 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.

Compliance with EN 61800-3 (2004), category C2

The drive meets the requirements of the EMC Directive with the following provisions:

1. The drive is equipped with optional mains filter JFI-xx.
2. The motor and control cables are selected as specified in the chapter *Planning the electrical installation*.
3. The drive is installed according to the instructions given in this manual.
4. Motor cable length does not exceed 50 metres (164 ft).

Note: It is not allowed to use the optional mains filter on IT (ungrounded) systems. The supply network becomes connected to ground potential through the mains filter capacitors which may cause danger or damage the drive.

Note: It is not allowed to use the optional mains filter on a corner-grounded TN system as this would damage the drive.

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

Compliance with EN 61800-3 (2004), category C3

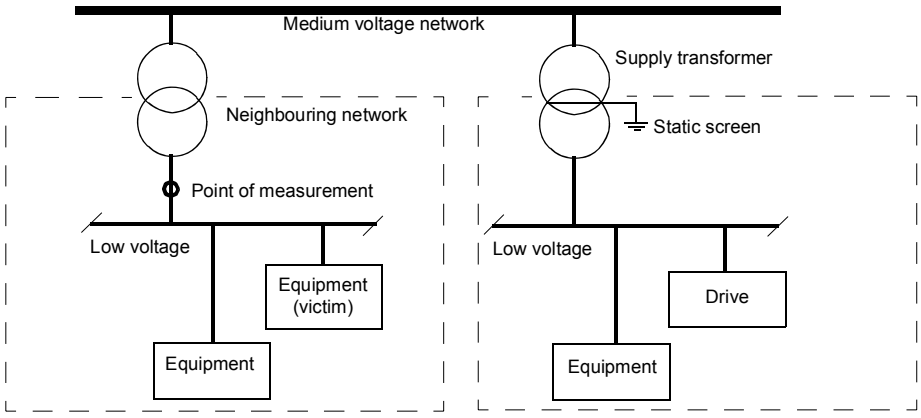
The drive meets the requirements of the EMC Directive with the following provisions:

1. The drive is equipped with optional mains filter JFI-xx.
2. The motor and control cables are selected as specified in the chapter *Planning the electrical installation*.
3. The drive is installed according to the instructions given in this manual.
4. Motor cable length does not exceed 50 metres (164 ft).

Compliance with EN 61800-3 (2004), category C4

The drive meets the requirements of the EMC Directive with the following provisions:

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



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 the chapter *Planning the electrical installation*.
4. The drive is installed according to the instructions given in this manual.

Compliance with the Machinery Directive

The drive is intended to be incorporated into machinery to constitute machinery covered by Machinery Directive (98/37/EC) and does therefore not in every respect comply with the provisions of the directive. For more information, see the Declaration of Incorporation by ABB Drives (code 64652770).

C-Tick marking

Pending.

UL marking

See the type designation label for the valid markings of your drive.

UL checklist

Input power connection – See section *AC input (supply) connection* on page 76.

Disconnecting device (Disconnecting means) – See section *Supply disconnecting device* on page 37.

Ambient conditions – The drive is to be used in a heated indoor controlled environment. See section *Ambient conditions* on page 79 for specific limits.

Input cable fuses – For installation in the United States, branch circuit protection must be provided in accordance with the National Electrical Code (NEC) and any applicable local codes. To fulfill this requirement, use the UL classified fuses given in section *Supply cable fuses* on page 75.

For installation in Canada, branch circuit protection must be provided in accordance with the Canadian Electrical Code and any applicable provincial codes. To fulfil this requirement, use the UL classified fuses given in section *Supply cable fuses* on page 75.

Power cable selection – See section *Selecting the power cables* on page 41.

Power cable connections – For the connection diagram and tightening torques, see section *Power cable connection* on page 49.

Control connections – For the connection diagram and tightening torques, see section *Connecting the control cables* on page 58.

Overload protection – The drive provides overload protection in accordance with the National Electrical Code (US).

Braking – The ACSM1-04 has an internal braking chopper. When applied with appropriately sized braking resistors, the braking chopper will allow the drive to dissipate regenerative energy (normally associated with quickly decelerating a motor). Braking resistor selection is discussed in the chapter *Resistor braking* on page 91.

UL standards – See section *Applicable standards* on page 80.

U.S. patents

This product is protected by one or more of the following US patents:

4,920,306	5,301,085	5,463,302	5,521,483	5,532,568	5,589,754
5,612,604	5,654,624	5,799,805	5,940,286	5,942,874	5,952,613
6,094,364	6,147,887	6,175,256	6,184,740	6,195,274	6,229,356
6,252,436	6,265,724	6,305,464	6,313,599	6,316,896	6,335,607
6,370,049	6,396,236	6,448,735	6,498,452	6,552,510	6,597,148
6,741,059	6,774,758	6,844,794	6,856,502	6,859,374	6,922,883
6,940,253	6,934,169	6,956,352	6,958,923	6,967,453	6,972,976
6,977,449	6,984,958	6,985,371	6,992,908	6,999,329	7,023,160
7,034,510	7,036,223	7,045,987	7,057,908	7,059,390	7,067,997
7,082,374	7,084,604	7,098,623	7,102,325	D503,931	D510,319
D510,320	D511,137	D511,150	D512,026	D512,696	D521,466

Other patents pending.

Mains chokes

What this chapter contains

This chapter describes how to select and install mains chokes for the ACSM1-04. The chapter also contains the relevant technical data.

When is a mains choke required?

The ACSM1-04 does not necessarily require a mains choke for operation; the need for a choke should be determined on a case-by-case basis. Mains chokes are typically used to

- reduce harmonics in the input current
- achieve a reduction in the r.m.s. input current
- reduce supply disturbance and low-frequency interference
- increase the allowed DC bus continuous power
- ensure even current distribution in common DC configurations (see page 56).

Selection table

Mains chokes for ACSM1-04		
Drive type ACSM1-04xx…	**Type**	**Inductance µH**
-02A5-4	CHK-01	6370
-03A0-4		
-04A0-4		
-05A0-4	CHK-02	4610
-07A0-4		
-09A5-4	CHK-03	2700
-012A-4		
-016A-4	CHK-04	1475
-024A-4	CHK-05	1130
-031A-4		
-040A-4	CHK-06	700
-046A-4		
-060A-4	CHK-07	450
-073A-4	CHK-08	355
-090A-4		

PDM-00425726

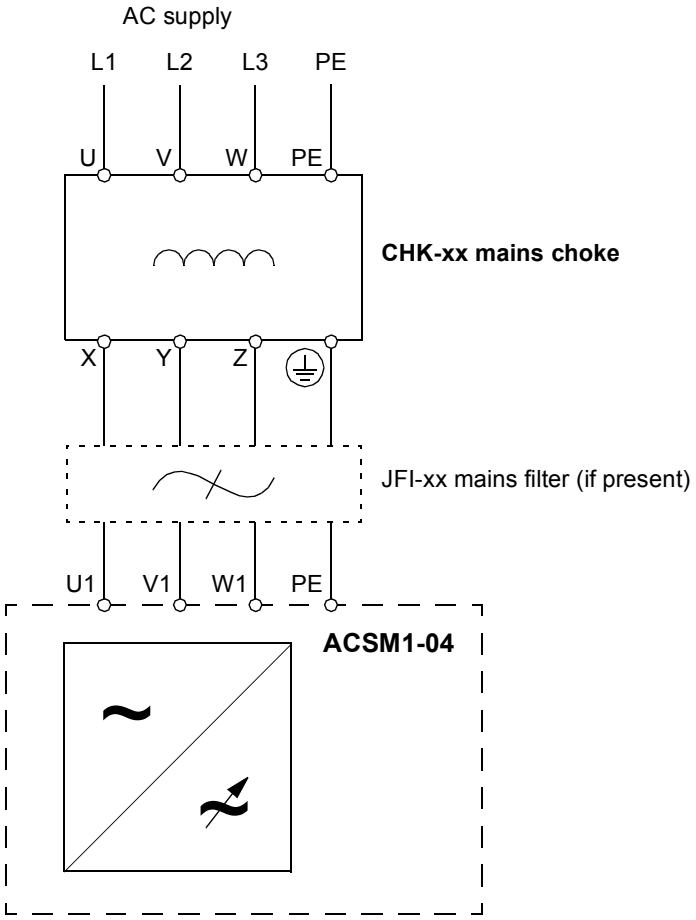
The mains chokes are protected to IP20. Refer to page 105 for dimensions, wire sizes and tightening torques.

Installation guidelines

- If a mains filter is also installed, the mains choke is connected between the supply and the mains filter. See the 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.

Connection diagram



Mains filters

What this chapter contains

This chapter describes how to select and install mains filters for the ACSM1-04. The chapter also contains the relevant technical data.

When is a mains filter required?

The EMC product standard (EN 61800-3 + Amendment A11 (2000)) covers the specific EMC requirements stated for drives (tested with motor and cable) within the EU. The new revision of 61800-3 (2004) product standard can be applied from now on, but from 1st October 2007 at the latest. EMC standards such as EN 55011 or EN 61000-6-3/4 apply to industrial and household equipments and systems including drive components inside. Drive units complying with the requirements of EN 61800-3 are always compliant with comparable categories in EN 55011 and EN 61000-6-3/4, but not necessarily vice versa. EN 55011 and EN 61000-6-3/4 do neither specify cable length nor require a motor to be connected as a load. The emission limits are comparable according to the following table.

EMC standards in general		
EN 61800-3/A11 (2000), product standard	**EN 61800-3 (2004), product standard**	**EN 55011, product family standard for industrial, scientific and medical (ISM) equipment**
1st environment, unrestricted distribution	Category C1	Group 1 Class B
1st environment, restricted distribution	Category C2	Group 1 Class A
2nd environment, unrestricted distribution	Category C3	Group 2 Class A
2nd environment, restricted distribution	Category C4	Not applicable

A mains filter is required in order to meet the category C2 level with the ACSM1 drive installation, including a motor with a max. 50 m cable. This level corresponds to the A limits for Group 1 equipment according to EN 55011.

WARNING! A mains 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).

Selection table

Mains filters for ACSM1-04	
Drive type ACSM1-04xx…	**Filter type**
-02A5-4	JFI-02
-03A0-4	
-04A0-4	
-05A0-4	
-07A0-4	
-09A5-4	JFI-03
-012A-4	
-016A-4	
-024A-4	JFI-05
-031A-4	
-040A-4	
-046A-4	
-060A-4	JFI-07
-073A-4	
-090A-4	

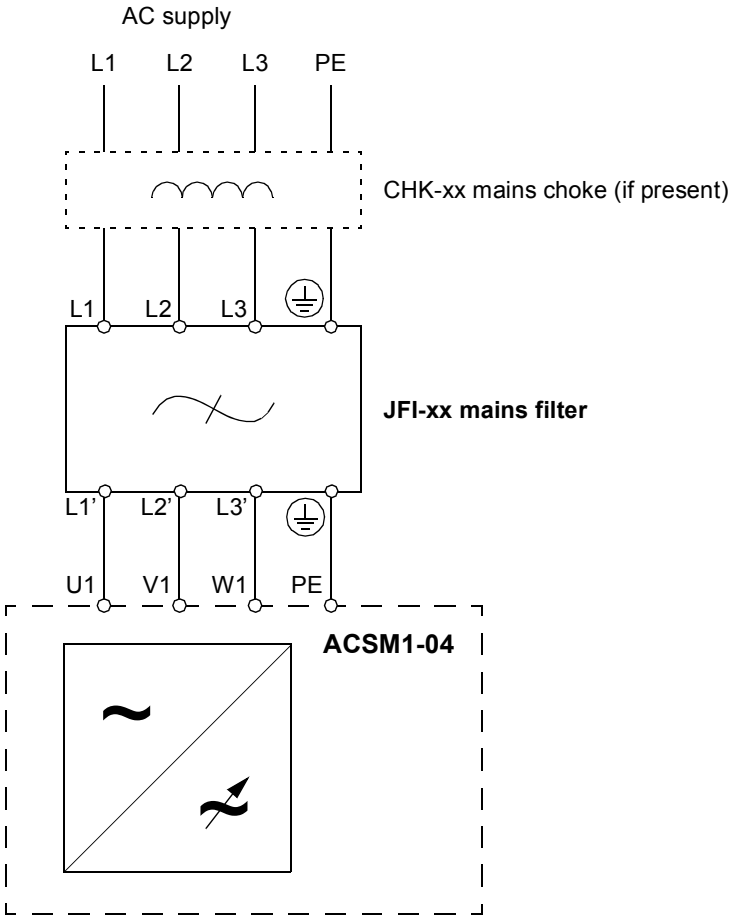
PDM-425726

The mains filters are protected to IP20. Refer to page 106 for dimensions, wire sizes and tightening torques.

Installation guidelines

- If a mains choke is also installed, the mains filter is connected between the mains choke and the drive module. See the 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.

Connection diagram



Resistor braking

What this chapter contains

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

Braking choppers and resistors with the ACSM1-04

Braking choppers

ACSM1-04 drives have a built-in braking chopper as standard equipment to handle the energy generated by a decelerating motor.

When the braking chopper is enabled and a resistor connected, the chopper will start conducting when the DC link voltage of the drive reaches 780 V. The maximum braking power is achieved at 840 V.

Braking resistor selection

To select a braking resistor:

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

Pre-selected resistors are available from ABB as shown in the table below. If the listed resistor is not sufficient for the application, a custom resistor can be selected within the limits imposed by the internal braking chopper of the ACSM1-04. 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

$$P_{max} < \frac{U_{DC}^2}{R}$$

where UDC equals 840 V.

WARNING! Never use a braking 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
- It is highly recommended that the resistor be protected from thermal overload; see the section *Contactor protection of drive* below.

Chopper data / Resistor selection table

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

Drive type ACSM1-04xx…	*Internal braking chopper*			*Example braking resistor*			
	P_{brcont} (kW)	P_{brmax} (kW)	R_{min} (ohm)	Type	R (ohm)	P_n (W)	E_{pulse} (kJ)
-02A5-4	0.9	5.5	120	JBR-01 (Danotherm CAR 155 D T 414 120R)	120	105	22
-03A0-4	1.3						
-04A0-4	1.8						
-05A0-4	2.6						
-07A0-4	2.6						
-09A5-4	4.8	7.9	80	JBR-03 (Danotherm CAR 200 D T 415 80R)	80	135	40
-012A-4	7.0	14.6	40	JBR-04 (Danotherm CBR-V 210 D T 415 40R)	40	360	73
-016A-4	9.0						
-024A-4	13.2	30.7	20	JBR-05 (Danotherm CBR-V 330 D T 415 20R)	20	570	77
-031A-4	18.0						
-040A-4	22.2	43.9	13	JBR-06 (Danotherm CBR-V 460 D HT 415 13R)	13	790	132
-046A-4	26.4						
-060A-4							
-073A-4							
-090A-4							

PDM-425726

P_{brcont} The internal chopper will withstand this continuous braking power. The braking is considered continuous if the braking time exceeds 30 seconds.

P_{brmax} Maximum braking power of the chopper. The chopper will withstand this braking power for 1 second within every 10 seconds. **Note:** The listed resistors will withstand this braking power for 1 second within every 120 seconds.

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

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.

The braking resistors are protected to IP20. Refer to page 108 for dimensions, wire sizes and tightening torques for the resistors.

Resistor installation and wiring

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.

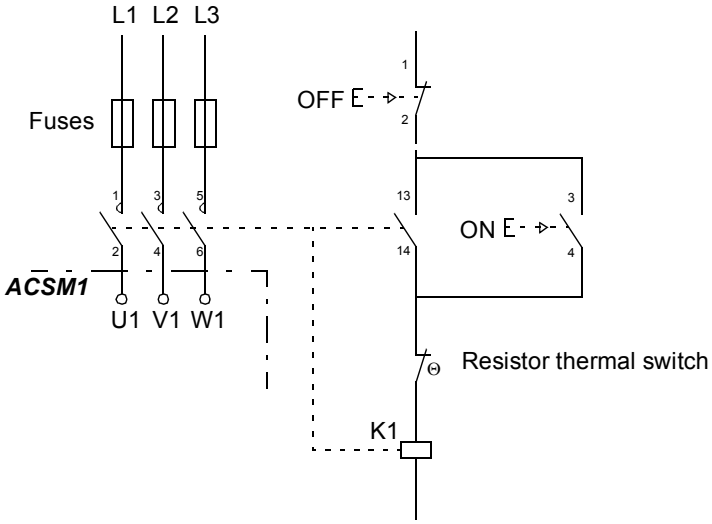
WARNING! The materials near the braking resistor must be non-flammable. The surface temperature of the resistor may rise above 200 °C (400 °F), and the temperature of the air flowing from the resistor is hundreds of degrees Celsius. Protect the resistor against contact.

The maximum length of the resistor cable(s) is 20 m (65 ft). For the connections, see section *Power cable connection* on page 49.

Contactor protection of drive

It is highly recommended to equip the drive 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.



Braking circuit commissioning

For more information, see the appropriate *Firmware Manual*.

- Enable the braking chopper function. Please note that a braking resistor must be connected when the chopper is enabled
- Switch off the overvoltage control of the drive
- Adjust any other relevant parameters in group 48.

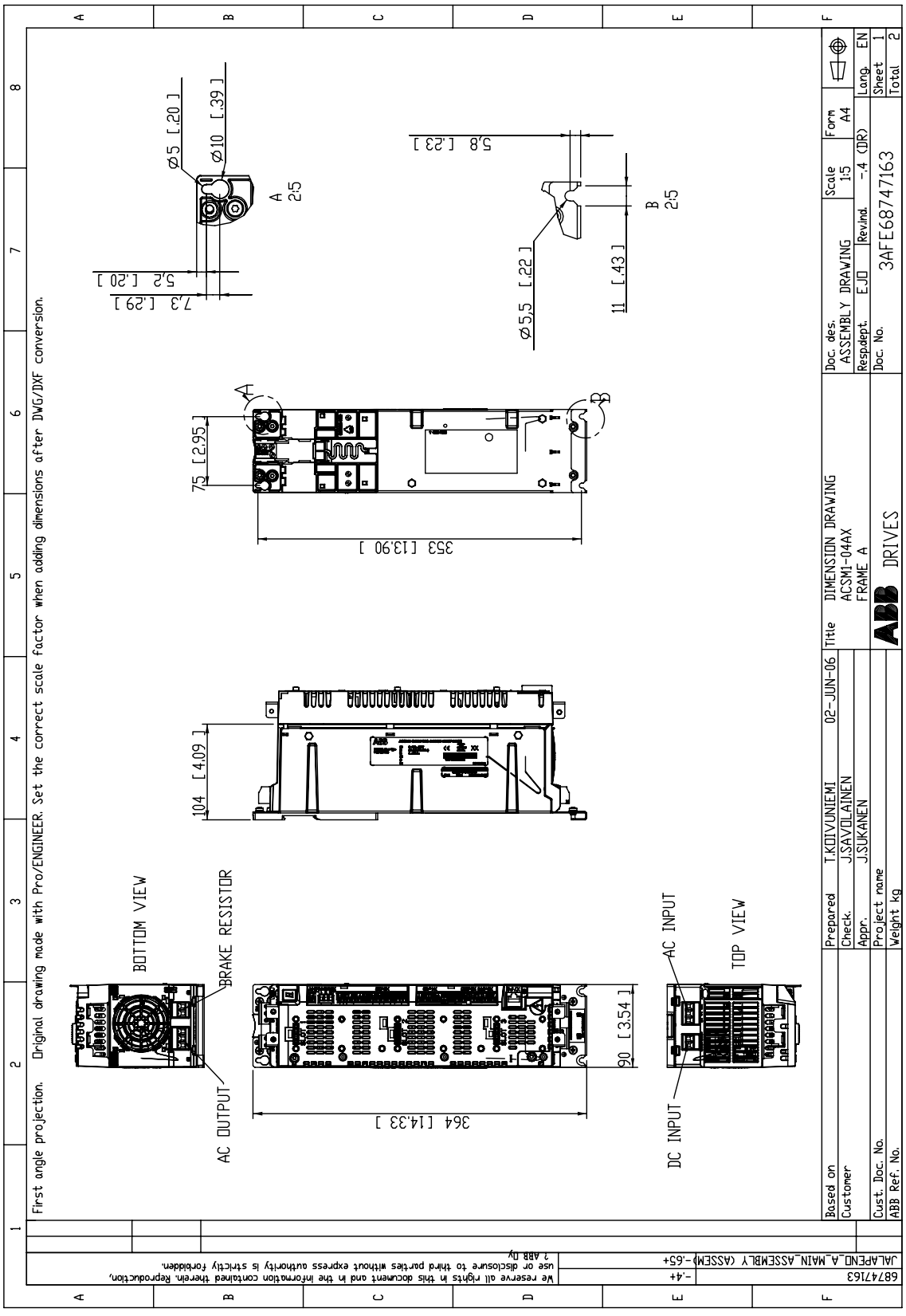
WARNING! If the drive is equipped with a braking chopper but the chopper is not enabled by parameter setting, the braking resistor must be disconnected because the protection against resistor overheating is then not in use.

Dimension drawings

What this chapter contains

Dimension drawings of the ACSM1-04 and related accessories are shown below. The dimensions are given in millimetres and [inches].

Frame size A


Ø5 [.20]
Ø10 [.39]
A
2:5
5,2 [.20]
7,3 [.29]
5,8 [.23]
B
2:5
Ø5,5 [.22]
11 [.43]
75 [2.95]
353 [13.90]
104 [4.09]
BOTTOM VIEW
BRAKE RESISTOR
AC OUTPUT
90 [3.54]
364 [14.33]
AC INPUT
DC INPUT
TOP VIEW
First angle projection. Original drawing made with Pro/ENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.
Prepared T.KOIVUNIEMI 02-JUN-06
Check. J.SAVOLAINEN
Appr. J.SUKANEN
Based on
Customer
Cust. Doc. No.
ABB Ref. No.
Project name
Weight kg
Title DIMENSION DRAWING
ACSM1-04AX
FRAME A
ABB DRIVES
Doc. des. ASSEMBLY DRAWING
Respdept. EJO
Doc. No. 3AFE68747163
Revind. -4 (DR)
Scale 1:5
Form A4
Lang. EN
Sheet 1
Total 2
68747163 JALAPEND_A_MAIN_ASSEMBLY (ASSEM) -.65+ -.4+
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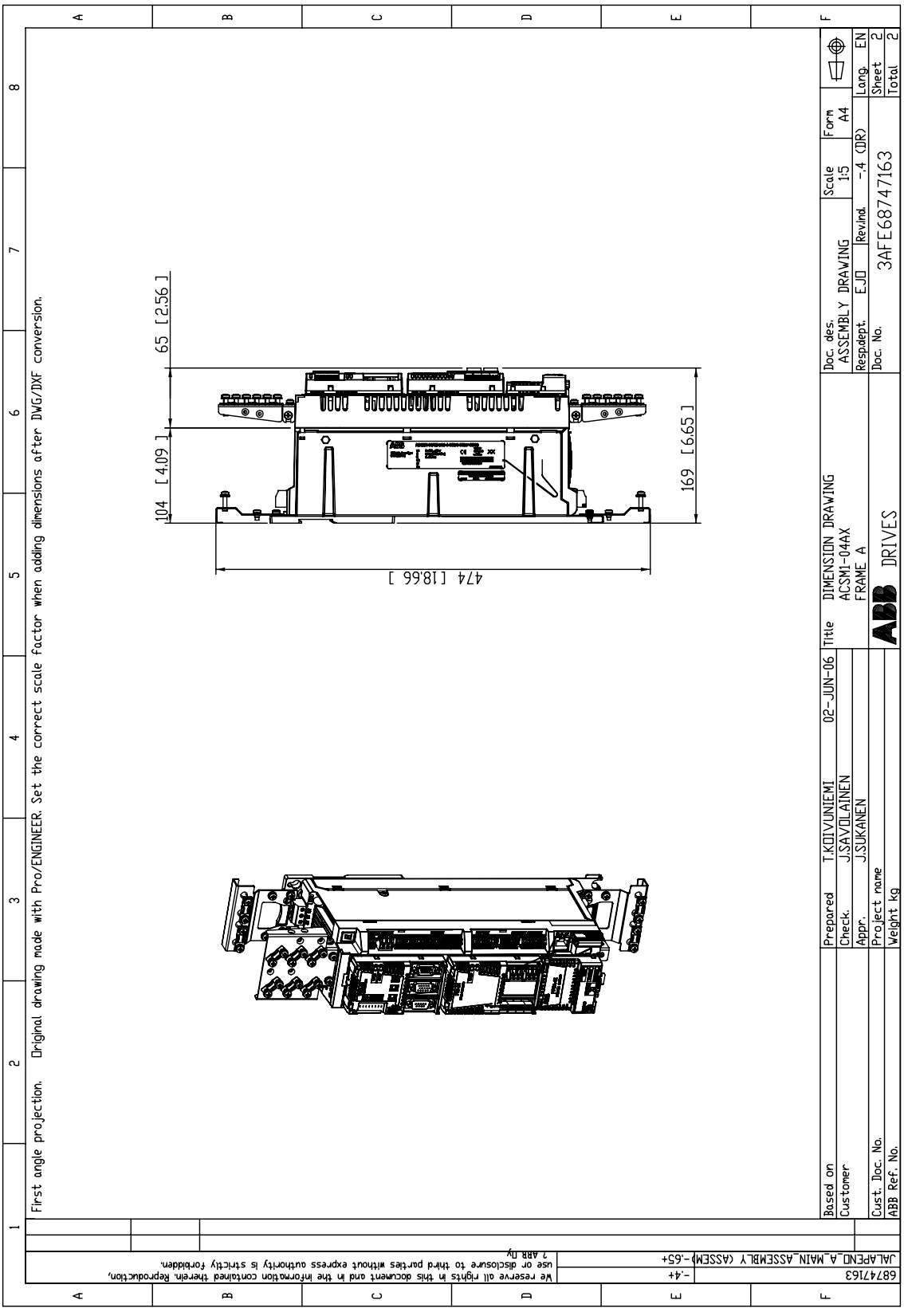
65 [2.56]
104 [4.09]
169 [6.65]
474 [18.66]
First angle projection. Original drawing made with Pro/ENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.
Based on
Customer
Cust. Doc. No.
ABB Ref. No.
Prepared T.KOIVUNIEMI 02-JUN-06
Check. J.SAVOLAINEN
Appr. J.SUKANEN
Project name
Weight kg
Title DIMENSION DRAWING ACSM1-04AX FRAME A
ABB DRIVES
Doc des. ASSEMBLY DRAWING
Resp.dept. EJDI Rev.ind. -4 (DR)
Doc. No. 3AFE68747163
Scale 1:5
Form A4
Lang. EN
Sheet 2
Total 2
3AFE68747163 -.4+
JALAPEND_A_MAIN_ASSEMBLY (ASSEM)-.65+
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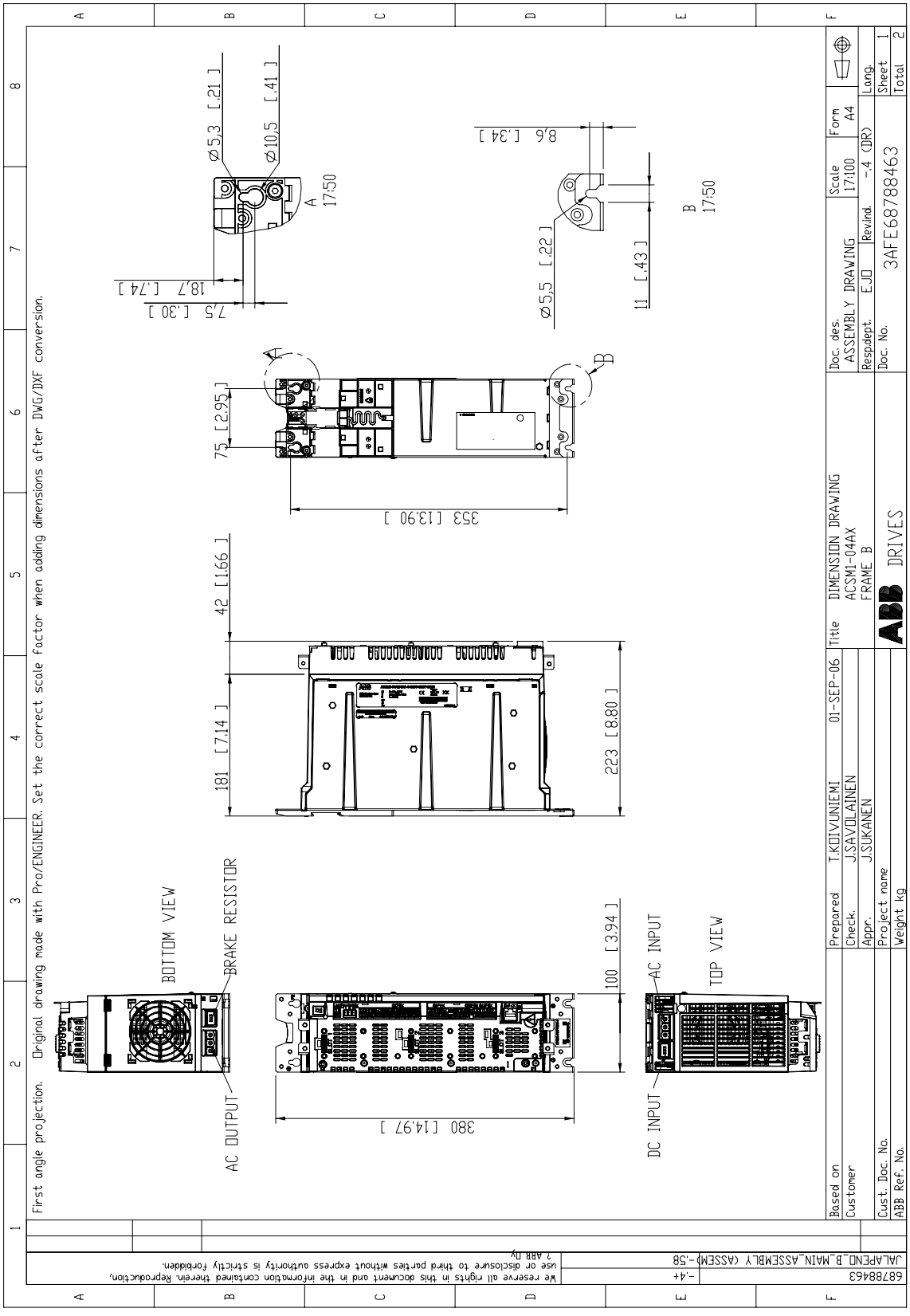
Frame size B


Ø5,3 [.21]
Ø10,5 [.41]
A
17:50
18,7 [.74]
7,5 [.30]
8,6 [.34]
B
17:50
Ø5,5 [.22]
11 [.43]
75 [2.95]
353 [13.90]
42 [1.66]
181 [7.14]
223 [8.80]
BOTTOM VIEW
BRAKE RESISTOR
AC OUTPUT
100 [3.94]
380 [14.97]
AC INPUT
TOP VIEW
DC INPUT
First angle projection. Original drawing made with Pro/ENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.
Prepared T.KOIVUNIEMI 01-SEP-06
Check. J.SAVOLAINEN
Appr. J.SUKANEN
Project name
Weight kg
Based on
Customer
Cust. Doc. No.
ABB Ref. No.
Title DIMENSION DRAWING
ACSM1-04AX
FRAME B
ABB DRIVES
Doc. des. ASSEMBLY DRAWING
Respdept. EJO
Rev.ind. -4 (DR)
Doc. No. 3AFE68788463
Scale 17:100
Form A4
Lang.
Sheet 1
Total 2
687884G3
JALAPEND_B_MAIN_ASSEMBLY (ASSEM) -.58
-.4+
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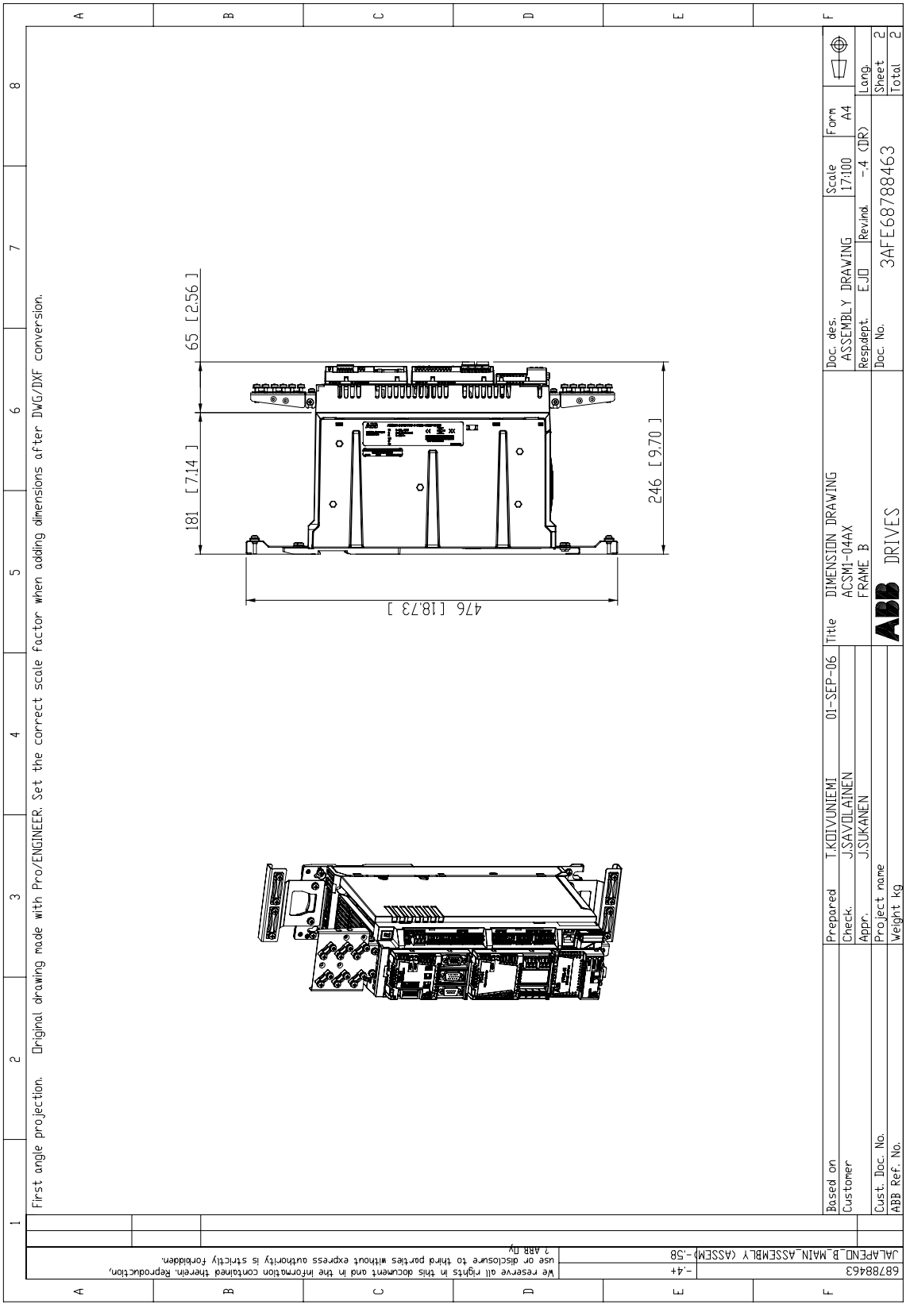
65 [2.56]
181 [7.14]
246 [9.70]
476 [18.73]
First angle projection. Original drawing made with Pro/ENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.
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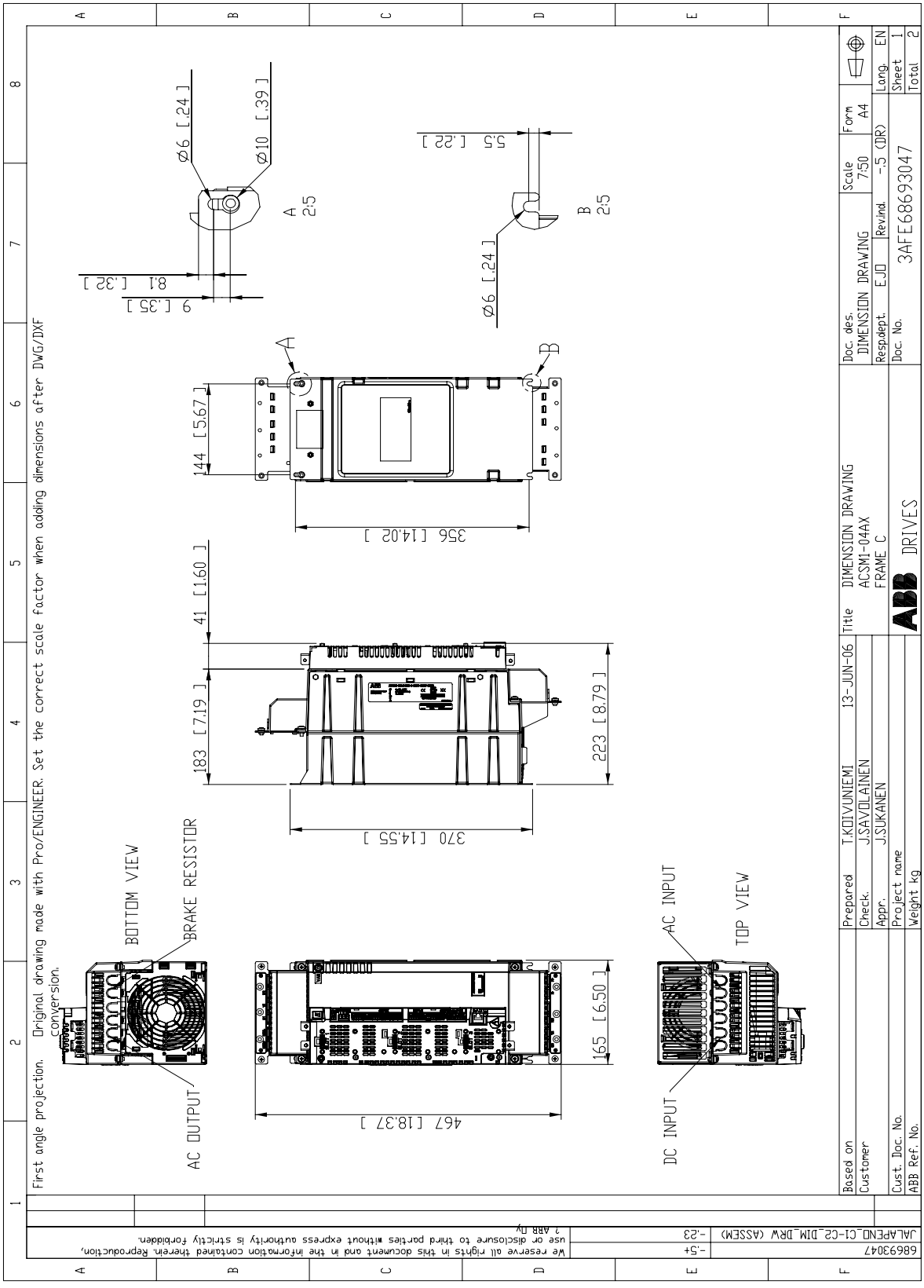
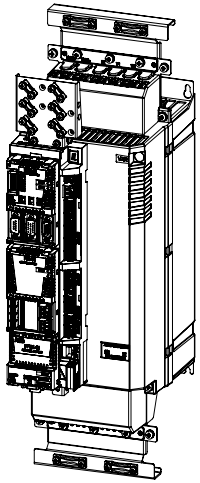
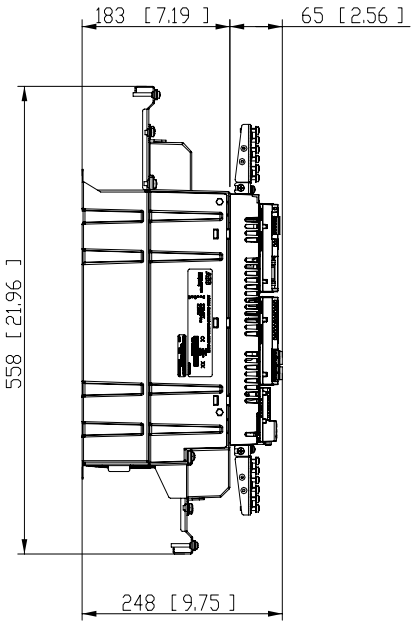
Based on
Customer
Cust. Doc. No.
ABB Ref. No.
Prepared T.KOIVUNIEMI 01-SEP-06
Check. J.SAVOLAINEN
Appr. J.SUKANEN
Project name
Weight kg
Title DIMENSION DRAWING ACSM1-04AX FRAME B
ABB DRIVES
Doc. des. ASSEMBLY DRAWING
Resp.dept. EJD Rev.ind. -4 (DR)
Doc. No. 3AFE68788463
Scale 17:100
Form A4
Lang.
Sheet 2
Total 2
68788463 -4+
JALAPENO_B_MAIN_ASSEMBLY (ASSEM) -.SB

Frame size C (air-cooled module)



First angle projection. Original drawing made with Pro/ENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.

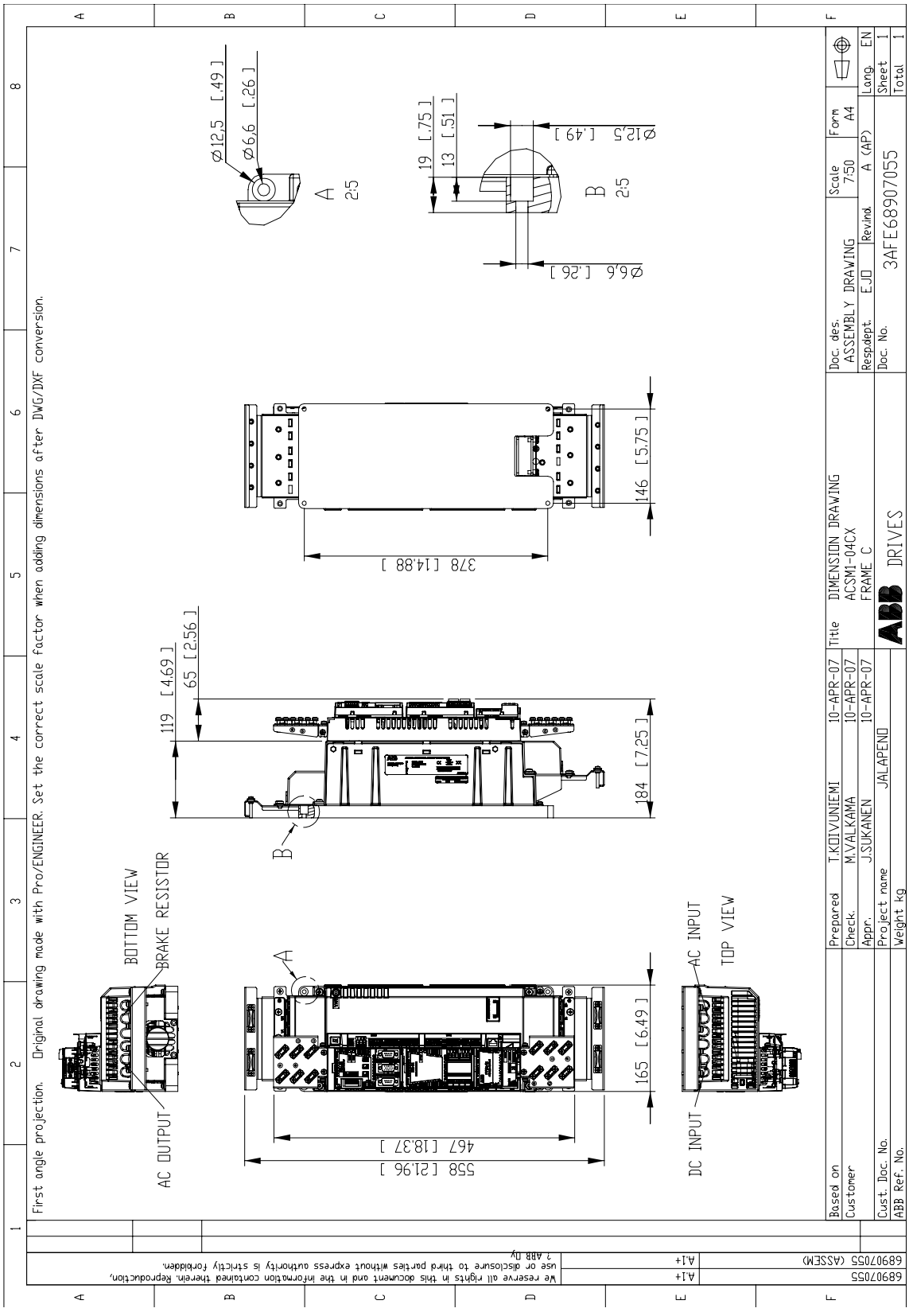




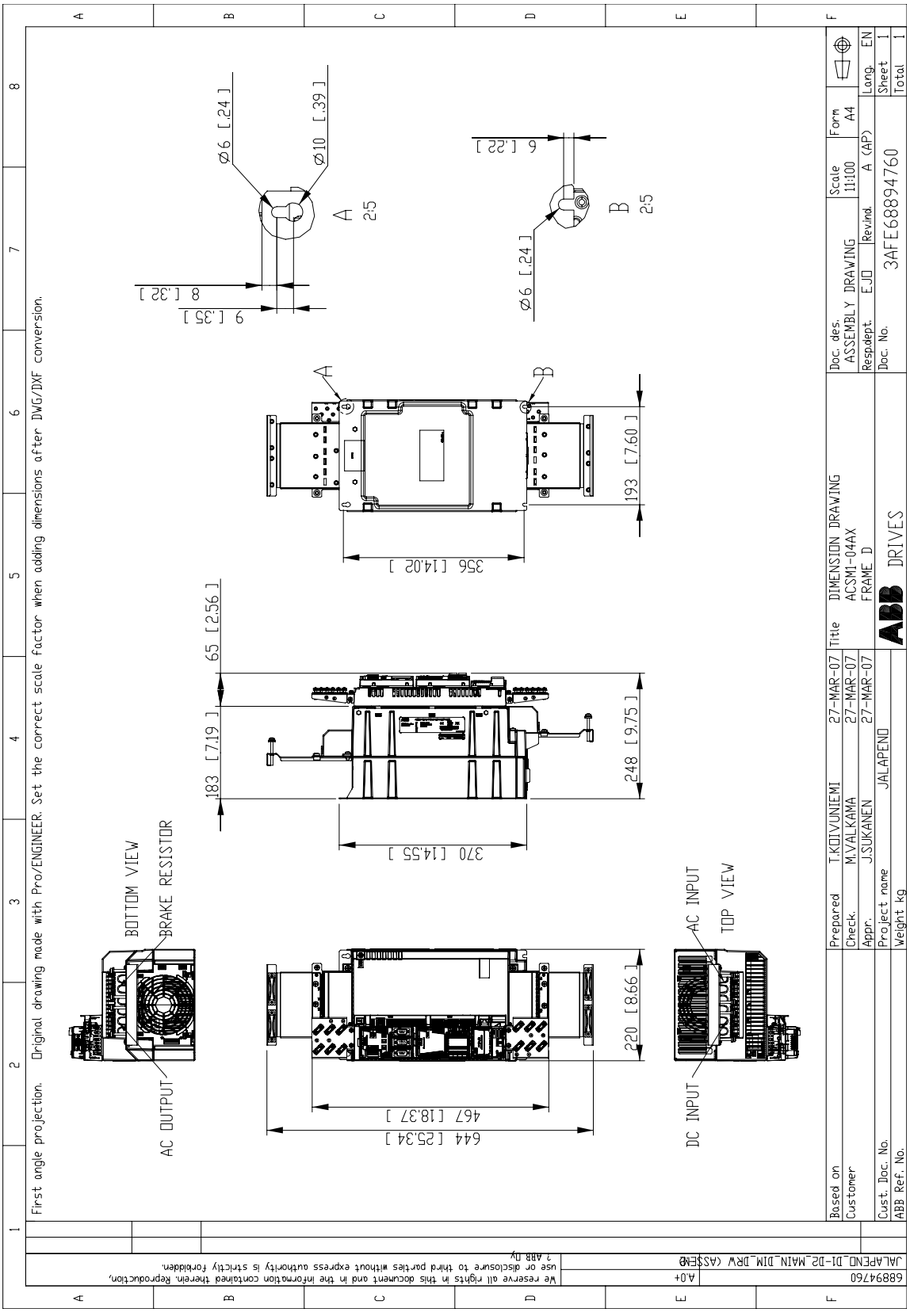
Based on	Prepared T.KOIVUNIEMI 13-JUN-06	Title	DIMENSION DRAWING	Doc. des. DIMENSION DRAWING	Scale 7:50	Form A4	
Customer	Check. J.SAVOLAINEN		ACSM1-04AX				
	Appr. J.SUKANEN		FRAME C	Resp.dept. EJO	Rev.ind. -.5 (DR)	Lang. EN	
Cust. Doc. No.	Project name	ABB DRIVES		Doc. No. 3AFE68693047		Sheet 2	
ABB Ref. No.	Weight kg					Total 2	

68693047 JALAPENO_C1-C2_DIM_DRW (ASSEM) -.5+ -.23

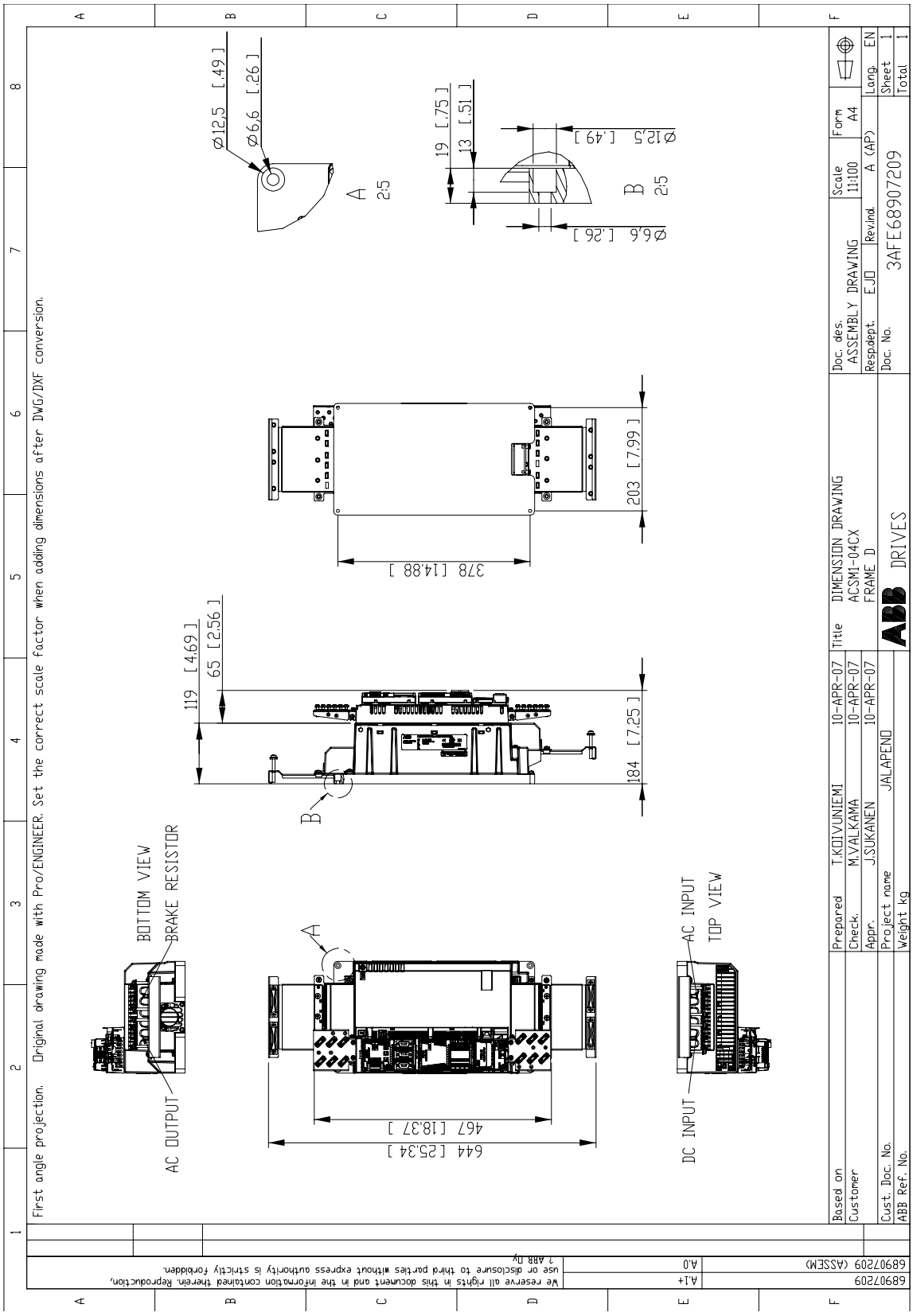
Frame size C (for cold plate mounting)



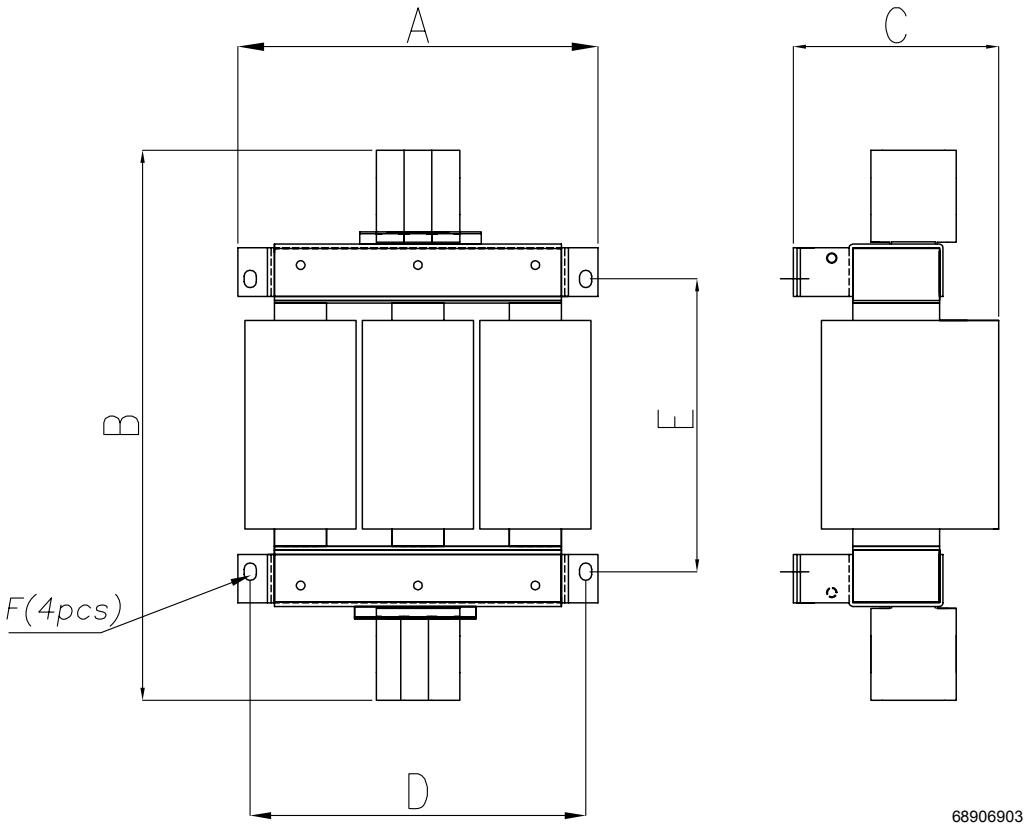
Frame size D (air-cooled module)



Frame size D (for cold plate mounting)

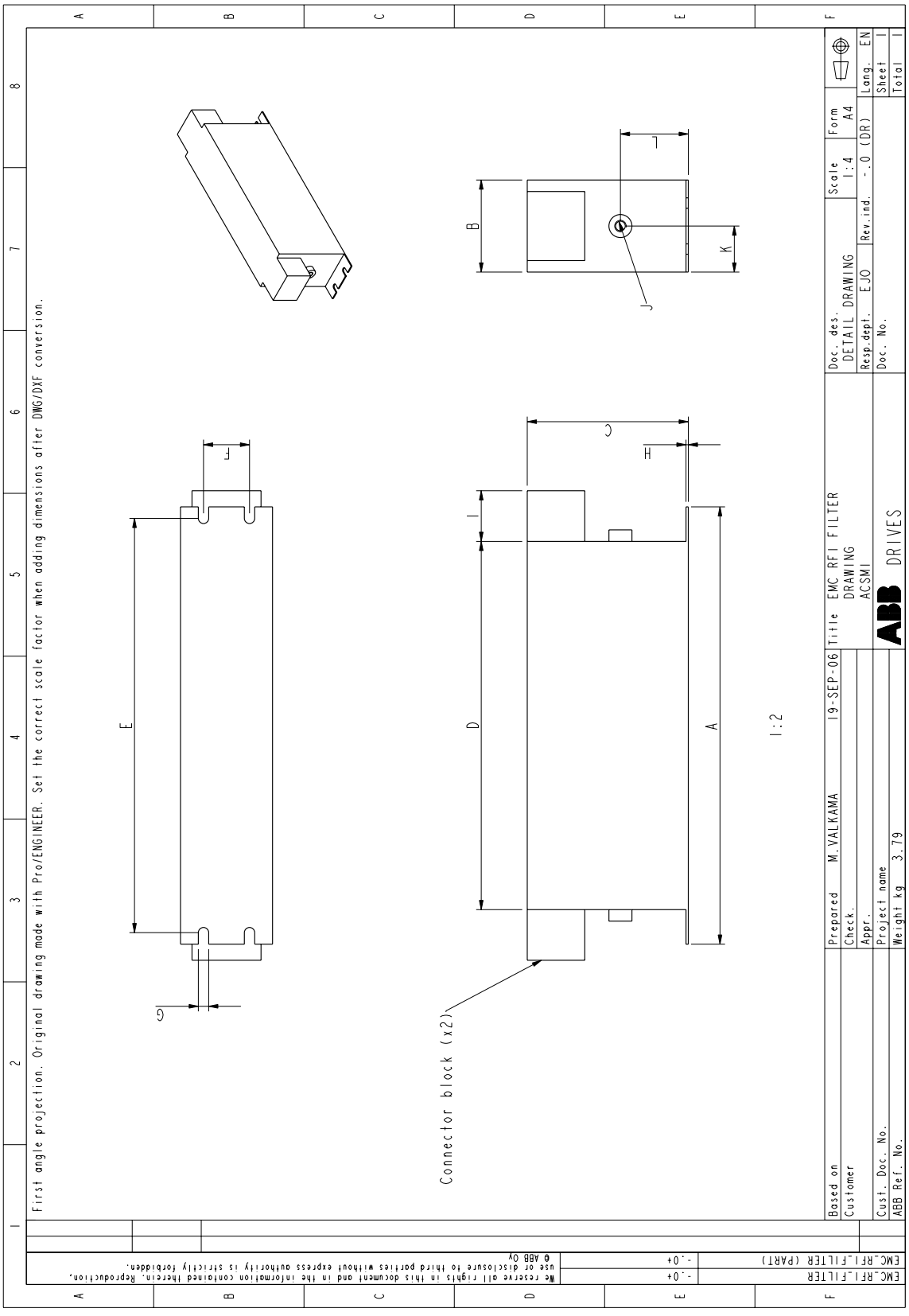


Mains chokes (type CHK-0x)



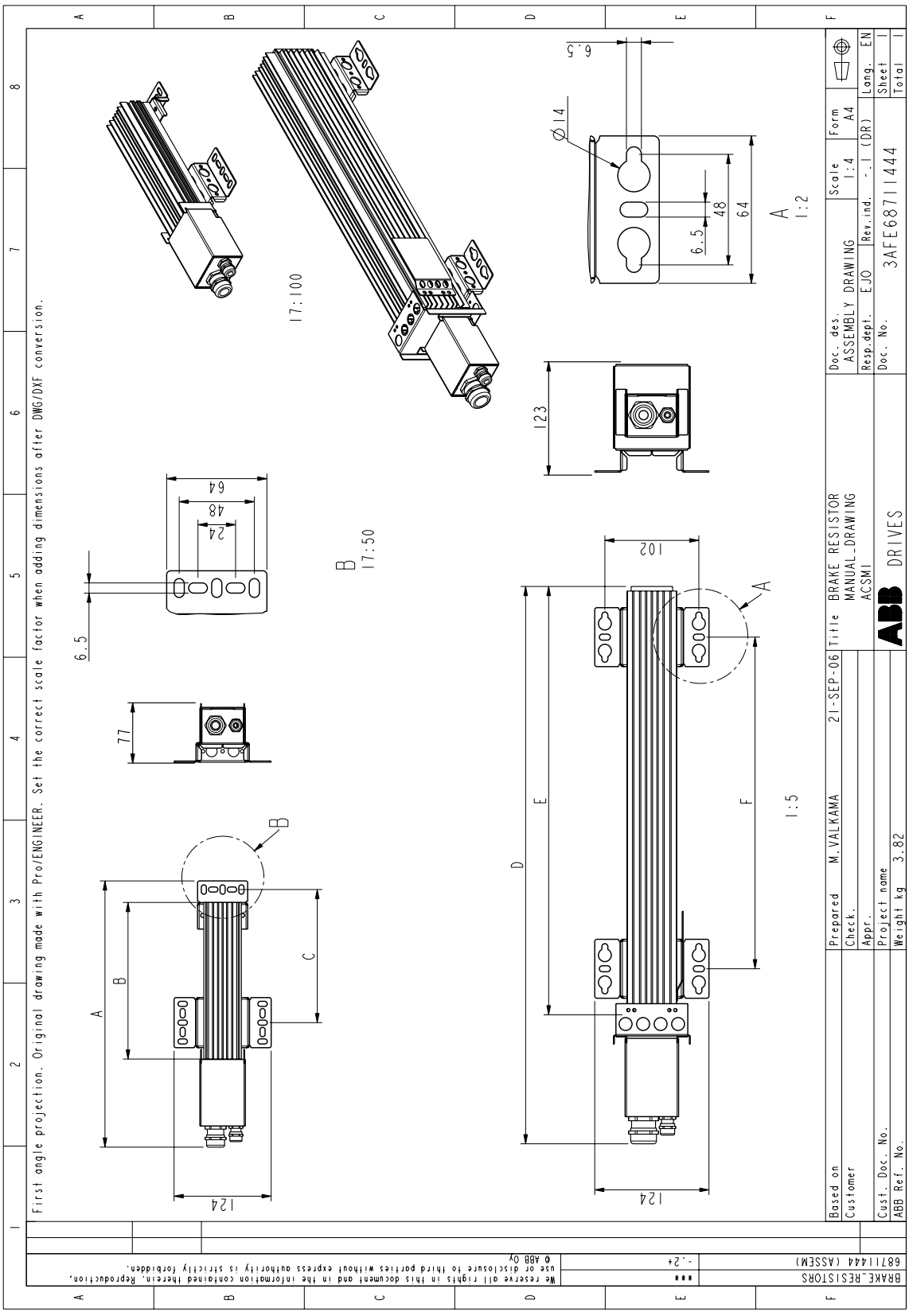
CHK-xx dimensions								
Parameter	**Choke type**							
	CHK-01	**CHK-02**	**CHK-03**	**CHK-04**	**CHK-05**	**CHK-06**	**CHK-07**	**CHK-08**
dim **A** mm (in.)	120 (4.72)	150 (5.91)	150 (5.91)	150 (5.91)	207 (8.15)	207 (8.15)	249 (9.80)	249 (9.80)
dim **B** mm (in.)	146 (5.75)	175 (6.89)	175 (6.89)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

Mains filters (type JFI-xx)



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)

Braking resistors (type JBR-xx)



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)				

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EFFECTIVE: 11.6.2007

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