ABB motion control drives

Hardware manual
ACSM1-04 drive modules (200 to 355 kW, 250 to 450 hp)

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ACSM1-04 drive modules (200 to 355 kW, 250 to 450 hp)

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, motor or driven equipment. Read the safety instructions before you work on the unit.

Use of warnings

Warnings caution you about conditions which can result in serious injury or death and/or damage to the equipment and advise on how to avoid the danger. The following warning symbols are used in this manual:

Electricity warning warns of hazards from electricity 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 sensitive devices 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.

Safety in installation and maintenance

Electrical safety

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, motor cable or motor when main power is applied. After disconnecting the input power, always wait for 5 min to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable.

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

  1. voltage between drive input phases U1, V1 and W1 and the frame is close to 0 V.
  2. voltage between terminals UDC+ and UDC- and the frame is close to 0 V.
- 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 cause dangerous voltages inside the drive even when the main power on the drive is switched off.
- Do not make any insulation or voltage withstand tests on the drive or drive modules.

Note:

- The motor cable terminals on the drive are at a dangerously high voltage when the input power is on, regardless of whether the motor is running or not.
- The brake control terminals (UDC+, UDC-, R+ and R- terminals) carry a dangerous DC voltage (over 500 V).
- Depending on the external wiring, dangerous voltages (115 V, 220 V or 230 V) may be present on the terminals of relay outputs (X2) or Safe torque off (X6).
- The Safe torque off function does not remove the voltage from the main and auxiliary circuits.

Grounding

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

WARNING! Ignoring the following instructions can cause physical injury, death, increased electromagnetic interference and equipment malfunction:

- Ground the drive, motor and adjoining equipment to ensure personnel safety in all circumstances, and to reduce electromagnetic emission and interference.
- Make sure that grounding conductors are adequately sized as required by safety regulations.
- In a multiple-drive installation, connect each drive separately to protective earth (PE).
- Where EMC emissions must be minimized, make a 360° high frequency grounding of cable entries at the cabinet lead-through in order to suppress electromagnetic disturbances. In addition, connect the cable shields to protective earth (PE) in order to meet safety regulations.

Note:

- Power cable shields are suitable for equipment grounding conductors only when adequately sized to meet safety regulations.
- As the normal leakage current of the drive is higher than 3.5 mA AC or 10 mA DC, a fixed protective earth connection is required by EN 61800-5-1, 4.3.5.5.2.

Permanent magnet synchronous motor drives

These are additional warnings concerning permanent magnet synchronous motor drives.

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

- Do not work on the drive when the permanent magnet synchronous motor is rotating. Also, when the supply power is switched off and the inverter is stopped, a rotating permanent magnet motor feeds power to the intermediate circuit of the drive and the supply connections become live.

Before installation and maintenance work on the drive:

- Stop the motor.
- Ensure that there is no voltage on the drive power terminals according to step 1 or 2, or if possible, according to the both steps.

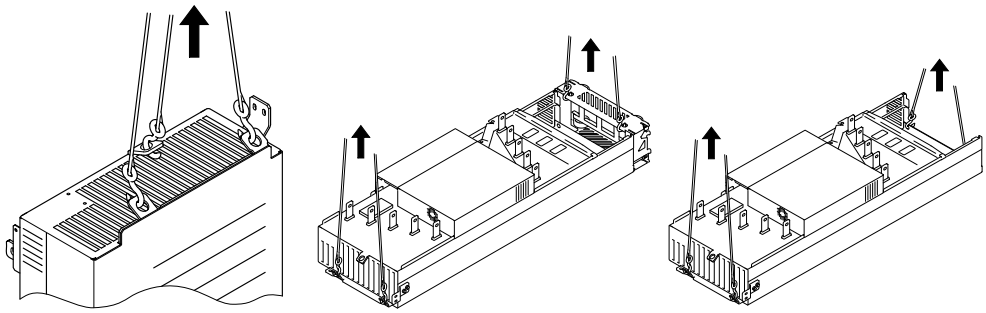
1. Disconnect the motor from the drive with a safety switch or by other means. Measure that there is no voltage present on the drive input or output terminals (U1, V1, W1, U2, V2, W2, UDC+, UDC-).
2. Ensure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, is able to rotate the motor directly or through any mechanical connection like felt, nip, rope, etc. Measure that there is no voltage present on the drive input or output terminals (U1, V1, W1, U2, V2, W2, UDC+, UDC-). Ground the drive output terminals temporarily by connecting them together as well as to the PE.

General safety

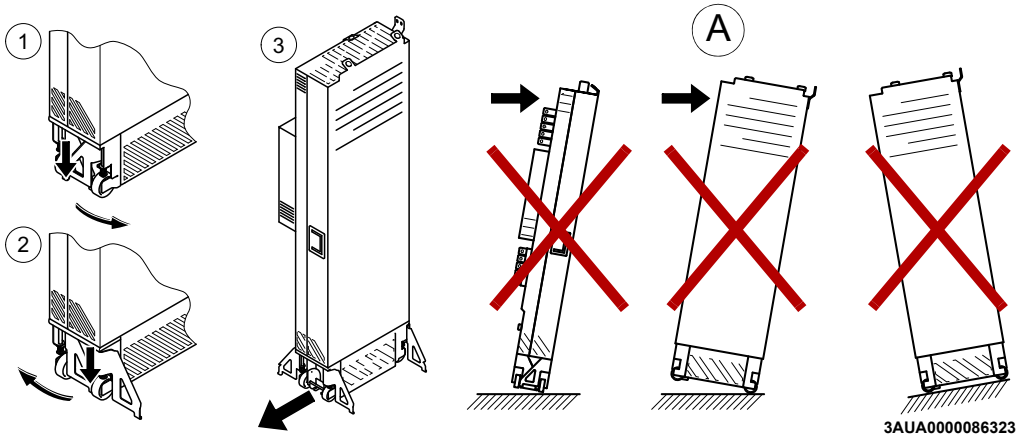
These instructions are intended for all who install and service the drive.

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

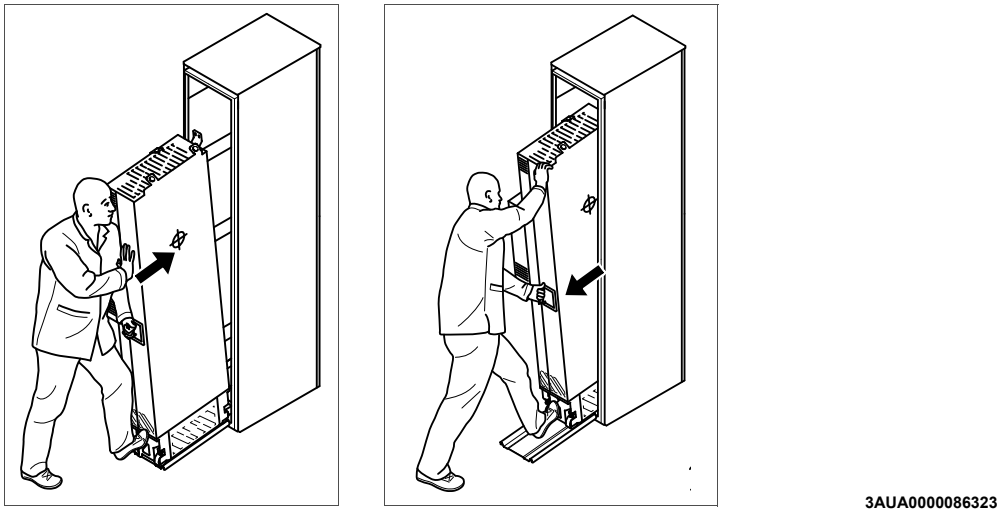
- - Lift the drive module using the lifting lugs attached to the top and base of the unit.



- Handle the drive module carefully. Make sure that the module does not fall down when moving it on the floor and during installation and maintenance work: Open the support legs by pressing each leg a little down (1, 2) and turning it aside. When ever possible secure the module also with chains.
- Do not tilt the drive module (A). It is **heavy** (over 160 kg [350 lb]) and its **center of gravity is high.** The module will overturn from a sideways tilt of 5 degrees. Do not leave the module unattended on a sloping floor.



- Push the drive module into the cabinet and pull it from the cabinet carefully preferably with help from another person as shown below. Keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back. Use safety shoes with metal toe cap to avoid foot injury. Do not use the ramp with plinth heights which exceed the maximum height marked on the ramp next to the fastening screw. (The maximum plinth height is 50 mm when the telescopic ramp is shortest and 150 mm when the ramp is longest.) Tighten the two fastening bolts of the ramp carefully.



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- Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, remain hot for a while after disconnection of the electrical supply.
- Make sure that dust from borings and grindings does not enter the drive when installing. Electrically conductive dust inside the unit may cause damage or malfunctioning.
- Ensure sufficient cooling.
- Do not fasten the drive by riveting or welding.

Fiber optic cables

WARNING! Ignoring the following instructions can cause equipment malfunction and damage to the fiber optic cables:

- Handle the fiber optic cables with care. When unplugging optic cables, always grab the connector, not the cable itself. Do not touch the ends of the fibers with bare hands as the fiber is extremely sensitive to dirt. The minimum allowed bend radius is 35 mm (1.4 in.).

Printed circuit boards

WARNING! Ignoring the following instructions can cause damage to the printed circuit boards:

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

Safe start-up and operation

General safety

These warnings are intended for all who plan the operation of the drive 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 any automatic fault reset functions of the drive control program 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; instead, use the control panel keys ◇ and ▽, or commands via the I/O board of the drive. The maximum allowed number of charging cycles of the DC capacitors, ie, power-ups by applying power, is five in ten minutes.

Note:

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

Permanent magnet synchronous motor drives

WARNING! Do not run the motor over the rated speed. Motor overspeed leads to overvoltage which may damage or explode the capacitors in the intermediate circuit of the drive.

Introduction to the manual

What this chapter contains

This chapter describes the intended audience and contents of the 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.

Target audience

This manual is intended for persons who

- plan the cabinet assembly of the drive module and install the module into a user-defined cabinet
- plan the electrical installation of the drive cabinet
- make instructions for the end user of the drive concerning the mechanical installation of the drive cabinet, connection of power and control cables to the cabinet-installed drive and maintenance of the drive.

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

The manual is written for readers worldwide. Both SI and imperial units are shown.

Contents of the manual

This manual contains the instructions and information for the basic drive module configuration. The chapters of the manual are briefly described below.

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

Introduction to the manual introduces the manual.

Operation principle and hardware description describes the drive module.

Planning the cabinet installation guides in planning drive cabinets and installing the drive module into a user-defined cabinet. The chapter gives cabinet layout examples and free space requirements around the module for cooling.

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

Installation describes how to install the drive module into a cabinet and connect the cables to the drive.

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

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

Fault tracing describes the LED indications and refers to the fault tracing instructions of the drive.

Maintenance contains preventive maintenance instructions.

Technical data contains the technical specifications of the drive module, eg, the ratings, sizes and technical requirements, provisions for fulfilling the requirements for CE and other markings.

Dimension drawings contains dimension drawings of the drive module installed into a Rittal TS 8 cabinet.

Example circuit diagram shows an example circuit diagram for a cabinet-installed drive module.

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

Safe torque off (STO) function describes the Safe torque off function of the drive and gives instructions on its implementing.

Categorization by frame size and option code

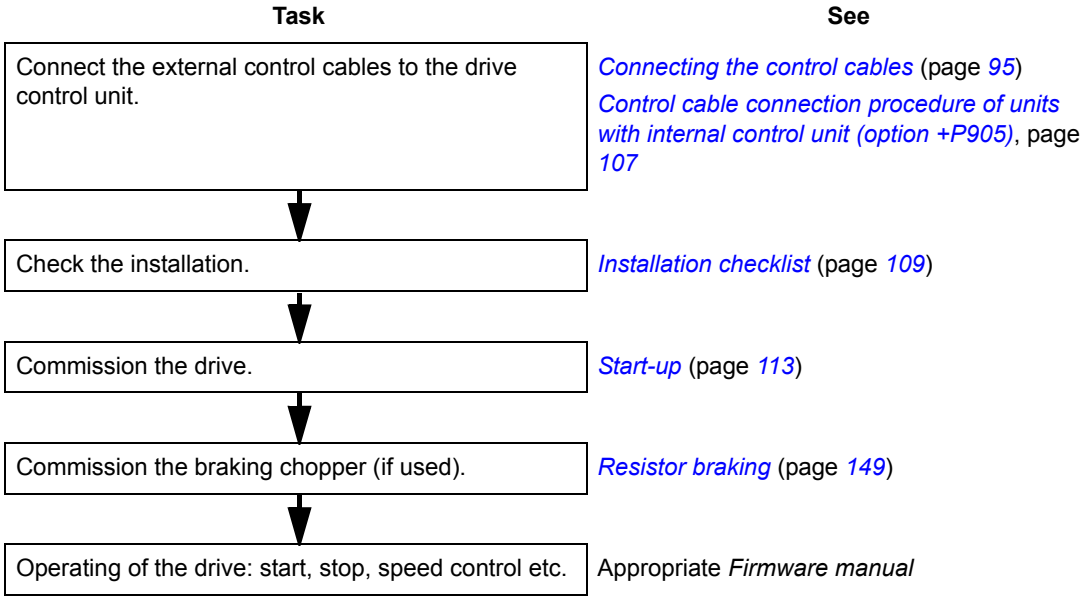
The instructions, technical data and dimension drawings which concern only certain drive frame sizes are marked with the symbol of the frame size (G1 or G2). The frame size is marked on the type designation label.

The instructions and technical data which concern only certain optional selections are marked with option codes, eg, +H381. The options included in the drive can be identified from the option codes visible on the type designation label. The option selections are listed in section *Type designation key* on page *34*.

Quick installation, commissioning and operating flowchart

Task	See
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 installation* (page *37*) *Planning the electrical installation* (page *49*) *Technical data* (page *125*) *Resistor braking* (page *149*) 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.	*Moving and unpacking the unit* (page *74*) *Checking the delivery* (page *76*) If the drive module has been non-operational for more than one year, the converter DC link capacitors need to be reformed. (*Reforming the capacitors*, page *124*)
↓	

Task	See
Check the installation site. Fasten the base of the cabinet to floor.	*Checking the installation site* (page *73*) *Ambient conditions* (page *133*) *Planning the cabinet installation* (page *37*)
Route the cables.	*Routing the cables* (page *59*)
Check the insulation of the supply cable, the motor and the motor cable and the resistor cable (if present).	*Checking the insulation of the assembly* (page *76*)
Units with optional cabling panels (+H381) • Install the cabling panels into the cabinet. • Install the additional components into the cabinet (composition varies, for example: main disconnector, main contactor, main AC fuses, etc.). • If the main disconnector is installed into the cabinet, connect the input power cabling to it. • Connect the input power cables and motor cables to the cabling panel terminals. • Connect the braking resistor and DC connection cables (if any) to the cabling panel terminals. • Install the drive module into the cabinet. • Fasten the cabling panel busbars to the drive module busbars. • If external drive control unit, connect the power supply and fiber optic cables from the drive module to the control unit and install the control unit into the cabinet. Units without optional cabling panels (no +H381) • Install the additional components into the cabinet (composition varies, for example: main PE busbar, main disconnector, main contactor, main AC fuses, etc.). • Install the drive module into the cabinet. • Connect the power cabling between the drive module and the rest of the main circuit components in the cabinet (if any). • Connect the input power cables and motor cables to the drive cabinet. • Connect the braking resistor and DC connection cables to the drive cabinet. • If external drive control unit, connect the power supply and fiber optic cables from the drive module to the control unit and install the control unit into the cabinet.	*Installing the mechanical accessories into the cabinet* (page *80*) *Connecting the power cables* (page *84*) *Mounting the drive module into the cabinet* (page *89*) *Connecting the external control unit to the drive module* (page *97*) *Mounting the external control unit*, page *99* Manuals for any optional equipment



Terms and abbreviations

Term/Abbreviation	Explanation
AIBP	Input bridge protection board
APOW	Power supply board
BFPS	Power supply board
CCF	Common Cause Failure (%)
DC	Diagnostic Coverage
DTC	Direct torque control
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
FCAN-01	Optional CANopen fieldbus adapter module
FDNA-01	Optional DeviceNet™ fieldbus adapter module
FECA-01	Optional EtherCAT® fieldbus adapter module
FEN-01	Optional TTL encoder interface module
FEN-11	Optional absolute encoder interface module
FEN-21	Optional resolver interface module
FEN-31	Optional HTL incremental encoder interface module
FENA-11	Optional Ethernet/IP™, Modbus/TCP and PROFINET IO fieldbus adapter module
FIO-01	Optional digital I/O extension module
FIO-11	Optional analog I/O extension module

FIT	Failure In Time: 1E-9 hours
FPBA-01	Optional PROFIBUS DP fieldbus adapter module
Frame (size)	Size of the drive module. The drive modules described in this manual are of frame size G1 and G2.
FSCA-01	Optional Modbus fieldbus adapter
HFT	Hardware Fault Tolerance
HTL	High-threshold logic
I/O	Input/Output
IGBT	Insulated gate bipolar transistor; a voltage-controlled semiconductor type widely used in converters due to their easy controllability and high switching frequency.
JCU	The control unit of the drive module. The external I/O control signals are connected to the JCU, or to optional I/O extension modules mounted on it.
JGDR	Gate driver board
JINT	Main circuit board
JMU-xx	The memory unit attached to the control unit (JCU)
JRIB	Adapter board connected to the control board in the control unit (JCU)
$MTTF_D$	Mean Time To dangerous Failure: (The total number of life units) / (the number of dangerous, undetected failures) during a particular measurement interval under stated conditions
PFD	Probability of Failure on Demand
PFHd	Probability of Dangerous Failures per Hour
PL	Performance Level: Corresponds SIL, Levels a-e
PTC	Positive temperature coefficient
RFI	Radio-frequency interference
SFF	Safe Failure Fraction (%)
SIL	Safety Integrity Level
STO	Safe torque off
TTL	Transistor-transistor logic

Operation principle and hardware description

What this chapter contains

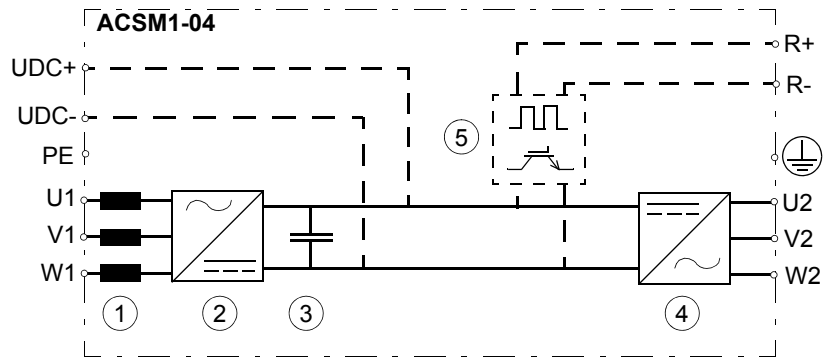
This chapter describes the operating principle and construction of the drive module in short.

Product overview

ACSM1-04 is a drive module for controlling asynchronous motors (standard induction, servo) and synchronous motors (servo, high torque).

ACSM1-04 is available in several frame sizes depending on output power. All frame sizes use the same control unit (type JCU). This manual deals only with ACSM1-04 frame sizes G1 and G2.

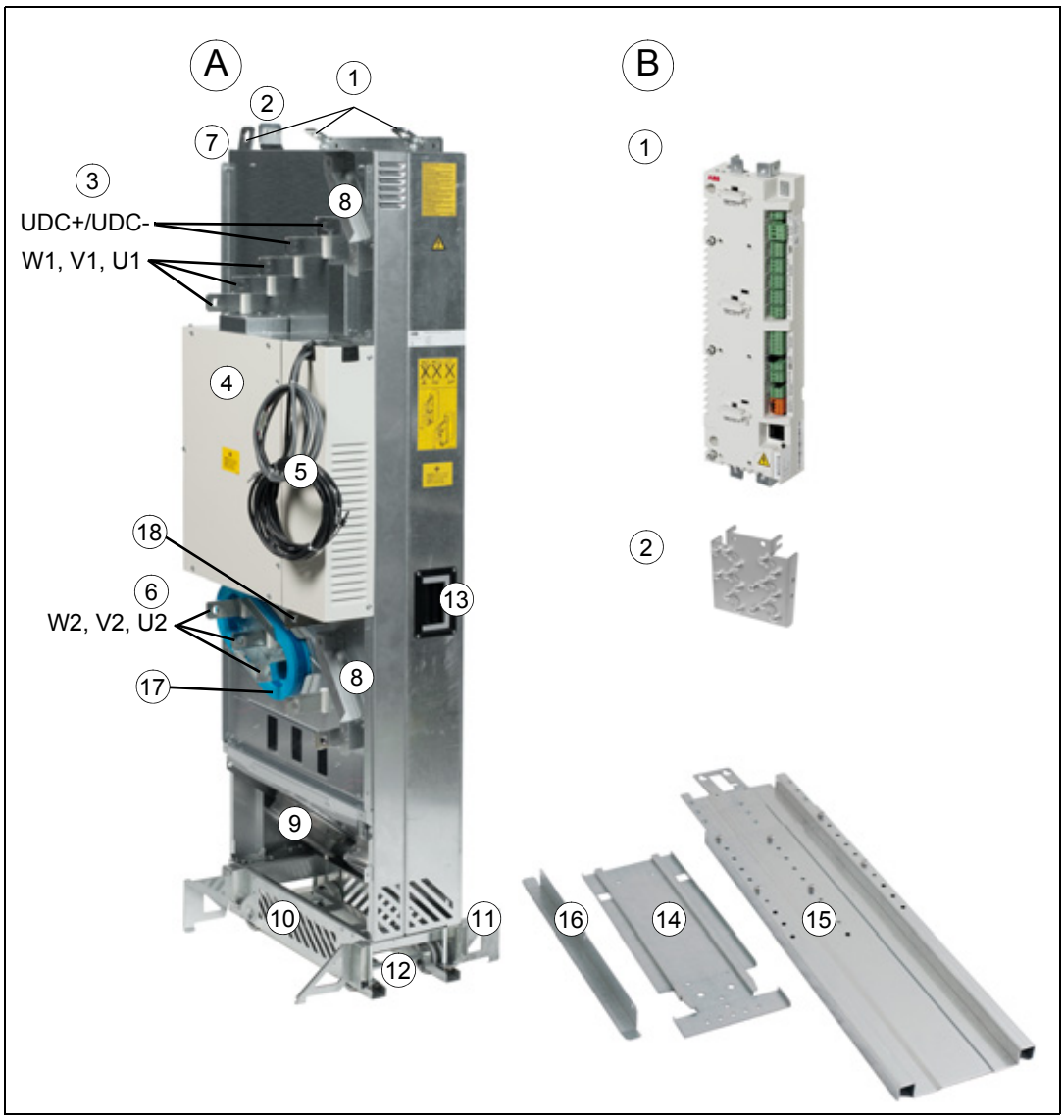
The main circuit of the drive module is shown below.



1	AC choke
2	Rectifier. Converts alternating current and voltage to direct current and voltage.
3	DC link. DC circuit between rectifier and inverter
4	Inverter. Converts direct current and voltage to alternating current and voltage.
5	Braking chopper. Conducts the surplus energy from the intermediate circuit of the drive to the braking resistor when necessary. The chopper operates when the DC link voltage exceeds certain maximum limit. The voltage rise is typically caused by deceleration (braking) of a high inertia motor.

Layout

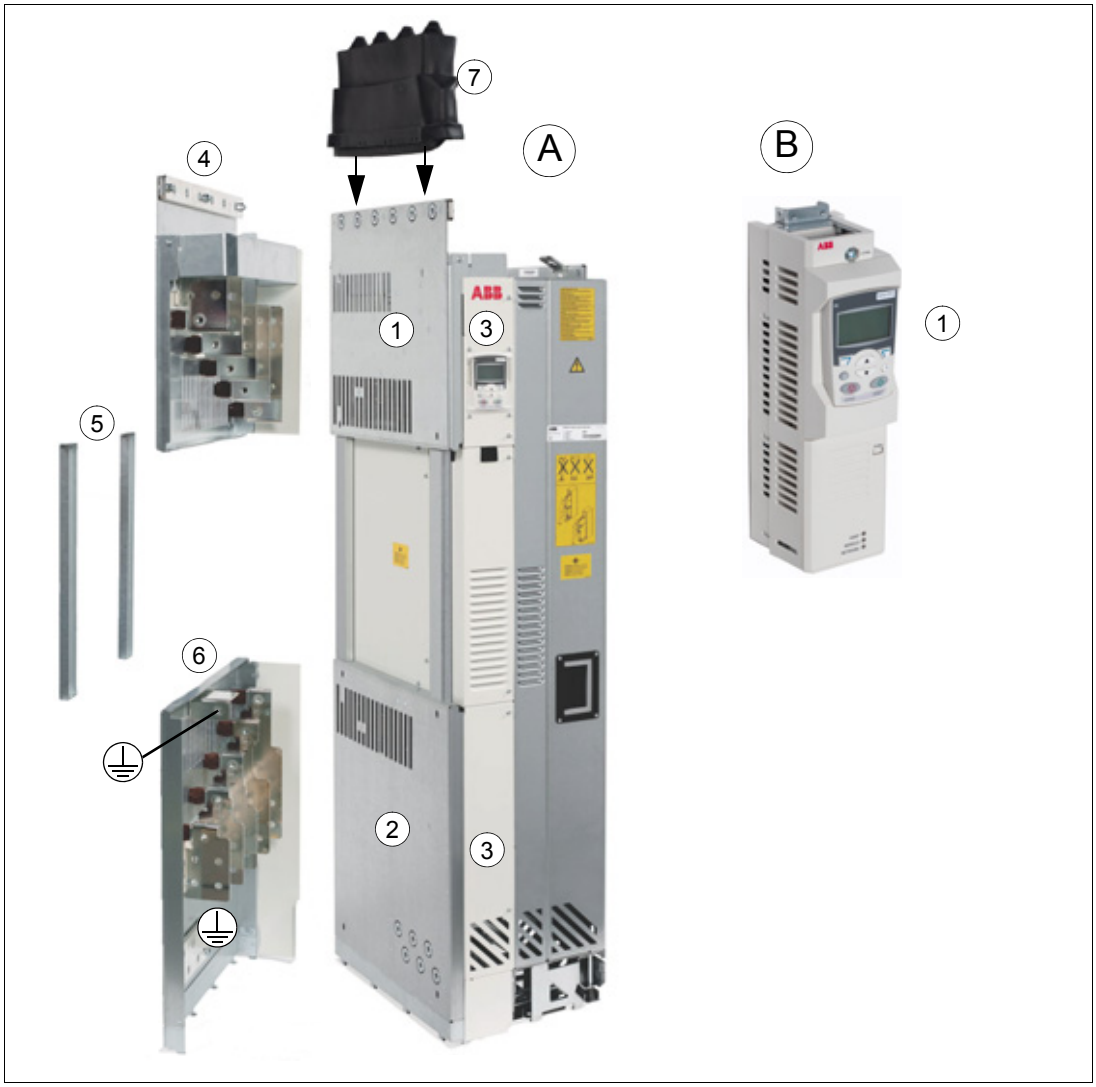
The components of the standard unit are shown below.



Item	Description
A	**Drive module**
1	Lifting lugs
2	Fastening bracket
3	Input cable connection busbars and UDC+ and UDC- busbars
4	Circuit board compartment
5	Power supply and fiber optic cables to be connected to the external control unit
6	Output cable connection busbars and braking resistor connection busbars
7	PE terminal
8	Control cable duct
9	Main cooling fans
10	Pedestal
11	Retractable support legs

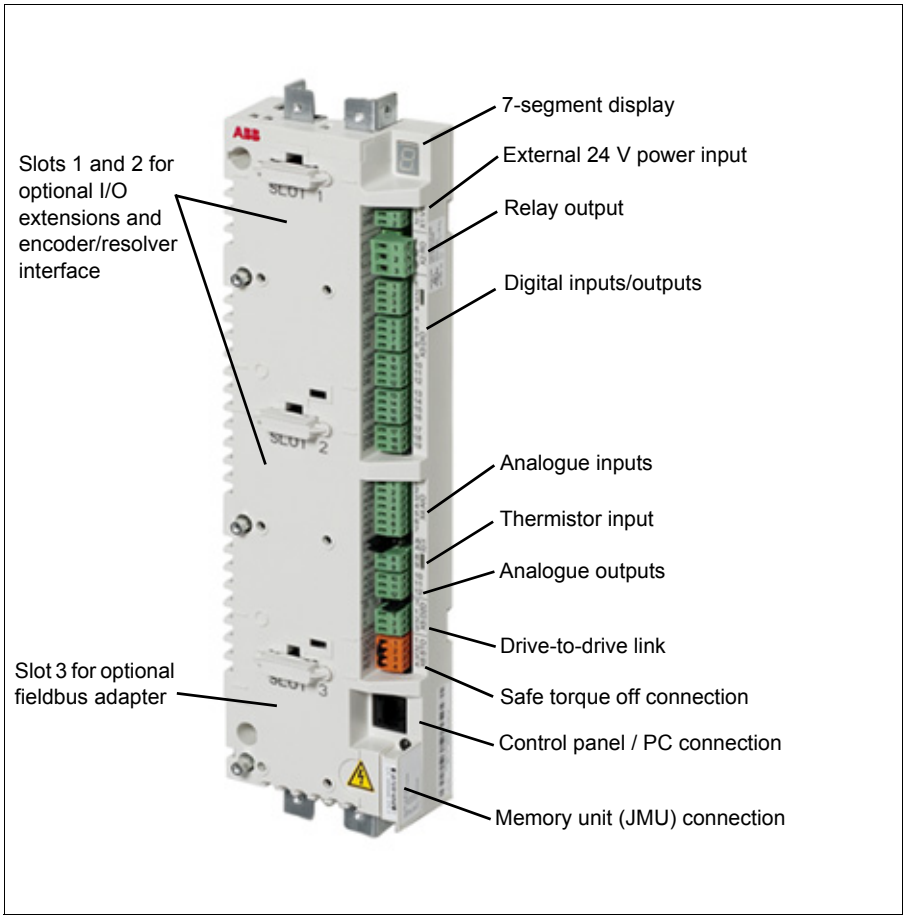
Item	Description
12	Base fastening screws
13	Handle for pulling the drive module out of the cabinet
14	Pedestal guide plate
15	Telescopic extraction and insertion ramp
16	Top guide plate
17	Optional common mode filter (+E208)
18	Grounding busbar for optional output cabling panel (+H381)
B	**Control unit (JCU)**
1	Control unit
2	Control cable clamp plate

The drive module and optional selections are shown below: control unit (+J400) and cabling panels (+H381).



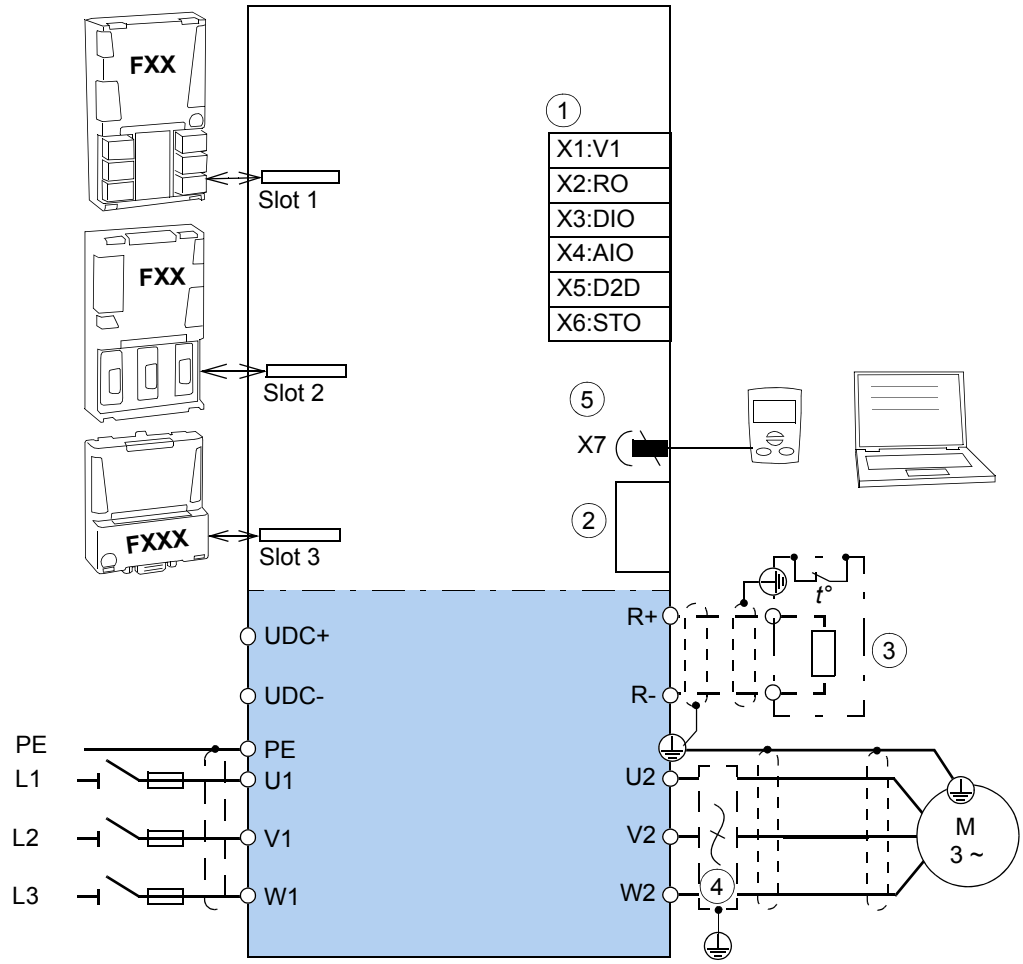
Item	Description
A	**Drive module**
1	Input power cabling panel (4) fastened to the drive module
2	Output power cabling panel (6) fastened to the drive module
3	With option +P905, the control panel is placed in the drive module.
4	Input power cabling panel (+H381)
5	Side guides (+H381)
6	Output power cabling panel (+H381).
7	Rubber grommet (+H381)
B	**Control unit**
	Control unit with control panel (+J400)

The control unit layout is shown below (protective coverings of the slots removed).



Power connections and control interfaces

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

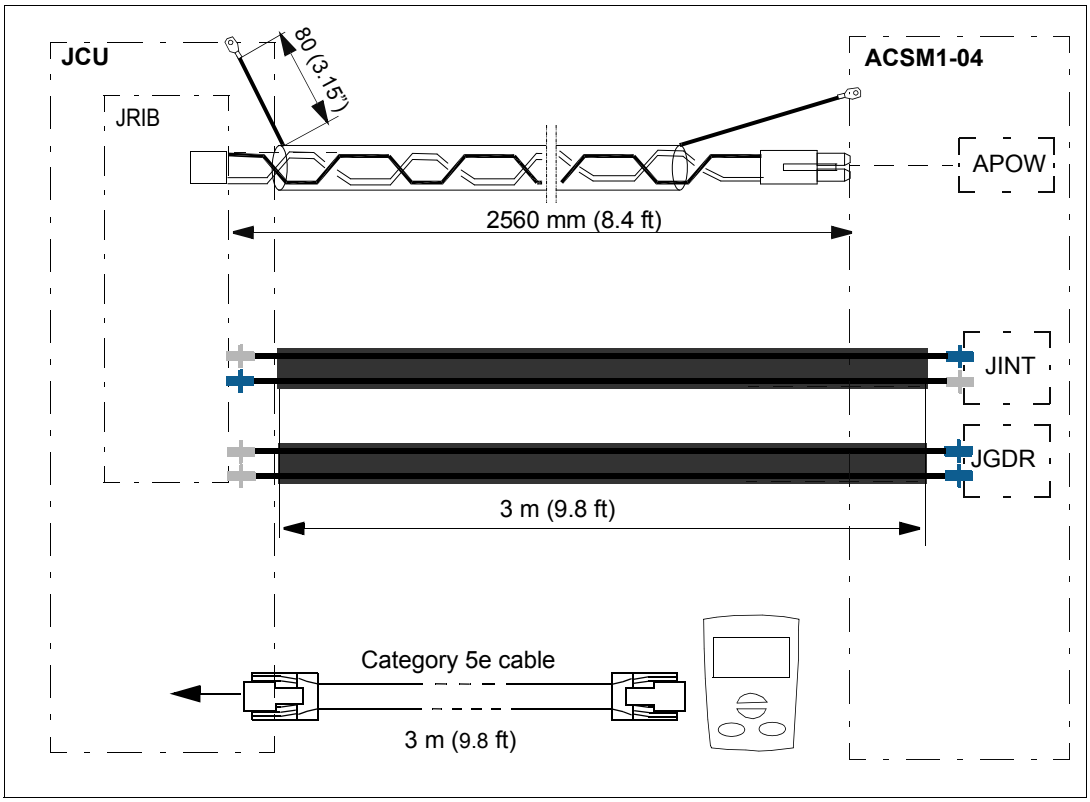


Slot 1 and Slot 2	I/O extension modules (FIO-01, FIO-11) and/or encoder or resolver interface modules (FEN-01, FEN-11, FEN-21, FEN-31)
Slot 3	Fieldbus adapter modules (FCAN-01, FDNA-01, FENA-11, FECA-01, FSCA-01, FPBA-01)
X1:V1	External power input
X2:RO	* Relay output
X3:DIO	24 V DC output, * Digital inputs (6 pcs), * Digital input/outputs (2 pcs)
X4:AIO	* Analog inputs (2 pcs), * Analog outputs (2 pcs)
X5:D2D	Drive-to-drive link
X6:STO	Safe torque off
	* programmable

1	For information on the default connections, see page *103*. For the specifications, see page *131*.
2	Memory unit, see page *124*.
3	Braking resistor (optional, see page *149*)
4	d*u*/d*t* or sine filter (optional)
5	PC connection, see page *107*.

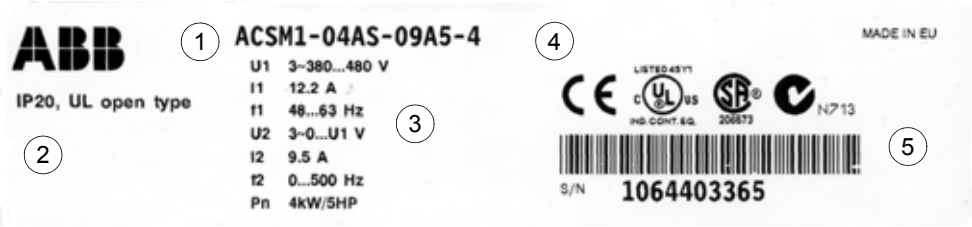
External control unit connection cables

The cables for connecting the drive module and control panel to the control unit are shown below. See sections *Connecting the external control unit to the drive module* (page *97*) and *Connecting a PC* (page *107*) for the actual connections.



Type designation label

The type designation label includes an IEC and NEMA rating, CE, C-UL US, and CSA markings, a type designation and a serial number, which allow individual recognition of each unit. The type designation label is located on the front cover. An example label is shown below.



No.	Description
1	Type designation, see section *Type designation key* on page *34*.
2	Frame size
3	Ratings
4	Valid markings
5	Serial number. The first digit of the serial number refers to the manufacturing plant. The next four digits refer to the unit's manufacturing year and week, respectively. The remaining digits complete the serial number so that there are no two units with the same number.

Type designation key

The type designation contains information on the specifications and configuration of the drive module. The first digits from left express the basic configuration. The optional selections are given thereafter, separated by plus signs, eg, +E208. The main selections are described below. Not all selections are available for all types. For more information, refer to *ACSM1 Ordering Information*, available on request.

Code	Description
Basic code, eg, ACSM1-04AS-390A-4	
Product series	
ACSM1	ACSM1 product series
Type	
04xx	Air-cooled drive module. When no options are selected: IP00 (UL type open), top entry and bottom exit for cables (terminals at the side of the module), external JCU control unit, no control panel, AC choke, braking chopper, DC busbars, coated boards, Safe torque off function, pedestal guide plate, extraction and insertion ramp, module fastening bracket and screws, Drive SP programming and multilingual *Quick Installation Guide*. 04AS: Speed and Torque control program 04AM: Motion control program
Size	
xxxA	Refer to the rating tables, page *125*.
Voltage range	
4	380…500 V AC

Code	Description
Options codes (plus codes)	
Resistor braking	
0D150	No braking chopper and no braking resistor connection busbars, and no R+ and R- terminals in the power cabling panel (+H381) if the panel is ordered
Filters	
E208	Common mode filter. Includes three extension busbars to the drive module output busbars with units without option +H381.
Cabling panels	
H381	Power cabling panels (U1, V1, W1, U2, V2, W2 terminals)
Pedestal	
0H354	No pedestal
Control panel and control unit	
J400	Control panel inserted onto the JCU control unit. Includes control panel mounting platform and internal cable.
P905	JCU control unit inside the circuit board compartment of drive module.
Fieldbus adapter modules	
K451	FDNA-01 DeviceNet™ fieldbus adapter module
K454	FPBA-01 PROFIBUS DP fieldbus adapter module
K457	FCAN-01 CANopen fieldbus adapter module
K458	FSCA-01 Modbus fieldbus adapter module
K466	FENA-11 Ethernet/IP™, Modbus/TCP and PROFINET IO fieldbus adapter module
K469	FECA-01 EtherCAT® fieldbus adapter module
I/O extension and feedback interface modules	
L500	FIO-11 analog I/O extension module
L501	FIO-01 digital I/O extension module
L502	FEN-31 HTL incremental encoder interface module
L516	FEN-21 resolver interface module
L517	FEN-01 TTL incremental encoder interface module
L518	FEN-11 TTL absolute encoder interface module
Control programs	
Nxxxx	Appropriate firmware version
Warranty	
P904	Extended warranty

Planning the cabinet installation

What this chapter contains

This chapter guides in planning drive cabinets and installing the drive module into a user-defined cabinet so that the front of the module faces the cabinet door. The chapter gives cabinet layout examples and free space requirements around the module for cooling. The issues discussed are essential for the safe and trouble-free use of the drive system.

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.

Basic requirements for the cabinet

Use a cabinet which:

- has a frame sturdy enough to carry the weight of the drive components, control circuitry and other equipment installed in it
- protects the user and drive module against contact and meets the requirements for dust and humidity
- has sufficient air inlet and outlet vents that allow free flow of the drive cooling air through the cabinet.

Planning the layout of the cabinet

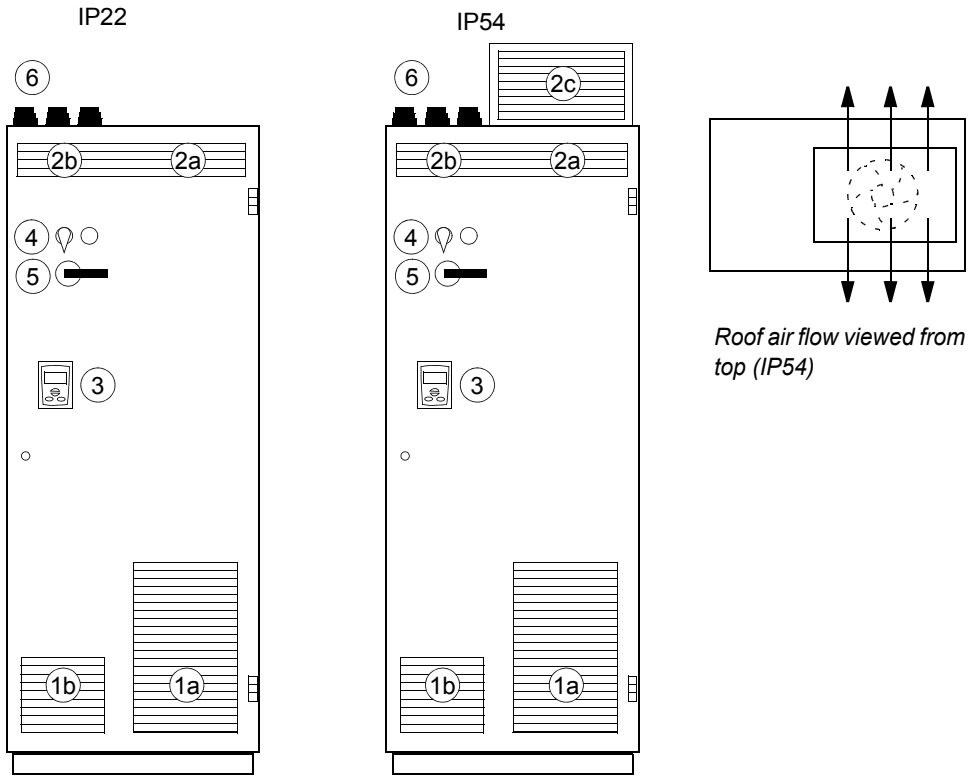
Design a spacious layout to ensure easy installation and maintenance. Sufficient cooling air flow, obligatory clearances, cables and cable support structures all require space.

Place the control board(s) away from:

- main circuit components such as contactor, switches and power cables
- hot parts (heat sink, air outlet of the drive module).

Layout examples, door closed

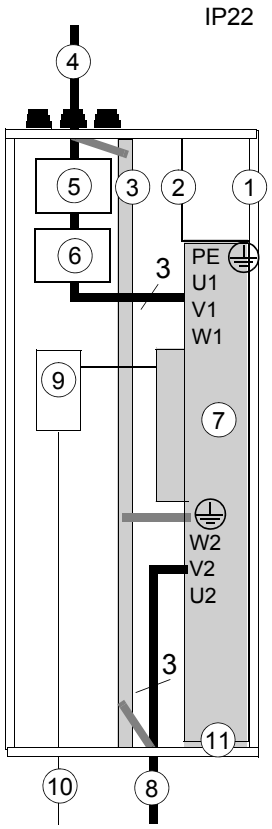
Layout examples for IP22 and IP54 cabinets are shown below (input power cable lead-through from top and motor cable lead-through from bottom).

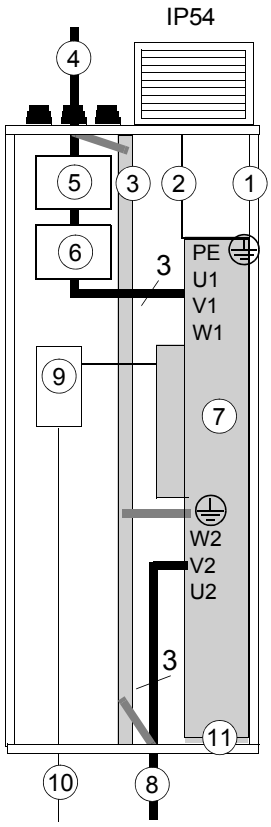


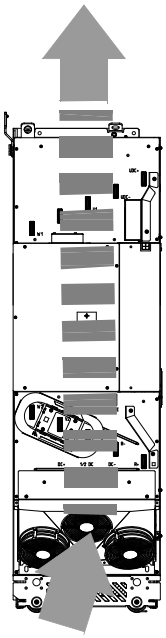
1a Air inlet for the drive module
1b Air inlet for the other equipment
2a Air outlet for the drive module
2b Air outlet for the other equipment
2c Air outlet for the drive module and the other equipment, an extra exhaust fan
3 Drive control panel (Control Panel Door Mounting kit, +J410). The control panel is connected to the JCU control unit inside the cabinet.
4 Contactor control switch and emergency stop switch (connected to the contactor control circuit inside the cabinet)
5 Operating handle of the disconnector
6 Rubber grommets for degree of protection

Layout examples, door open

Layout examples for units in IP22 and IP54 cabinets are shown below. Optional cabling panels (+H381) are not used.

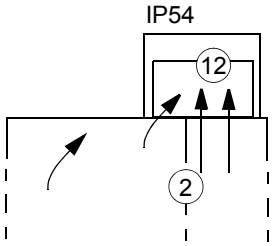






Air flow through the drive module (side view)

1 Supporting frame of the cabinet
2 Air baffles that separate the cool and hot areas (leak-proof lead-throughs)
3 Cabinet grounding busbar (PE)
4 Input power cable including the protective ground conductor (PE) of the drive
5 Disconnector and fuses
6 Contactor
7 Drive module
8 Motor cable including the protective ground conductor of the drive
9 JCU control unit
10 External control cables
11 Grounding screws
12 Fan



Air flow to the roof

Note 1: The power cable shields can also be grounded to the drive module grounding terminals.

Note 2: See also section *Required free space* on page *46*.

Arranging the grounding inside the cabinet

Arrange the grounding of the drive module by leaving the contact surfaces of the fastening points unpainted (bare metal-to-metal contact). The module frame will be grounded to the PE busbar of the cabinet via the fastening surfaces, screws and the cabinet frame. Alternatively, use a separate grounding conductor between the PE terminal of the drive module and the PE busbar of the cabinet.

Ground also the other components in the cabinet according to the principle above.

Selecting the busbar material and preparation of the joints

If planning the use of busbars, note the following:

- Tin-plated copper is recommended but aluminium can also be used.
- The oxide layer from aluminium busbar joints must be removed and suitable anti-oxidant joint compound applied.

Tightening torques

Apply the following torques to grade 8.8 screws (with or without joint compound) that tighten electric contacts.

Screw size	Torque
M5	3.5 N·m (2.6 lbf·ft)
M6	9 N·m (6.6 lbf·ft)
M8	20 N·m (14.8 lbf·ft)
M10	40 N·m (29.5 lbf·ft)
M12	70 N·m (52 lbf·ft)
M16	180 N·m (133 lbf·ft)

Planning the fastening of the cabinet

Note the following when planning the fastening of the cabinet:

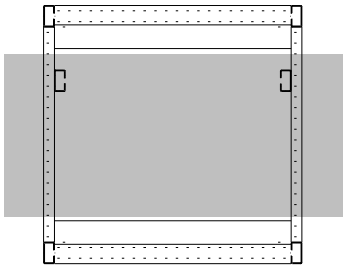
- Fasten the cabinet to the floor from the front and to the floor or wall from the back.
- Always fasten the drive module from its fastening points to the cabinet. For details, see the module installation instructions.

WARNING! Do not fasten the cabinet by electric welding. ABB does not assume any liability for damages caused by electric welding as the welding circuit may damage electronic circuits in the cabinet.

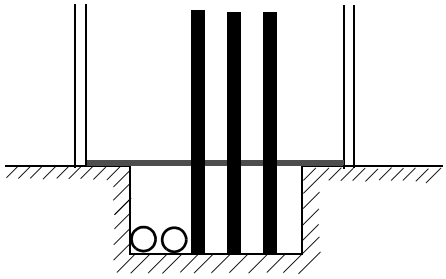
Planning the cabinet placement on a cable channel

Note the following when planning to place the cabinet on a cable channel:

- The cabinet structure must be sturdy enough. If the whole cabinet base will not be supported from below, the cabinet weight will lie on the sections that the floor carries.
- Equip the cabinet with a sealed bottom plate and cable lead-throughs to ensure the degree of protection and to prevent the cooling air flow from the cable channel into the cabinet.



The carrying structure on a cable channel



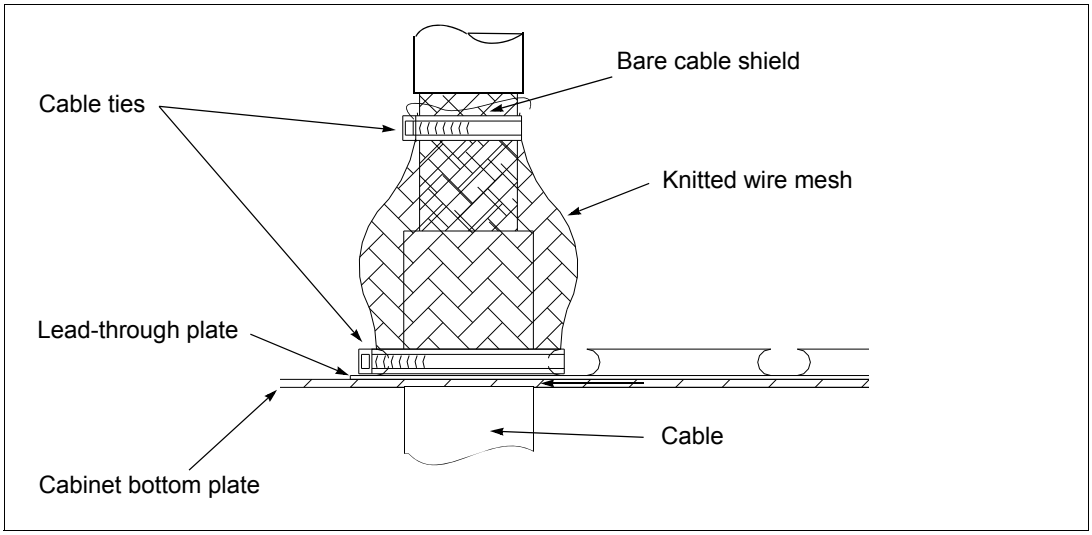
Cabinet side view with a bottom plate

Planning the electromagnetic compatibility (EMC) of the cabinet

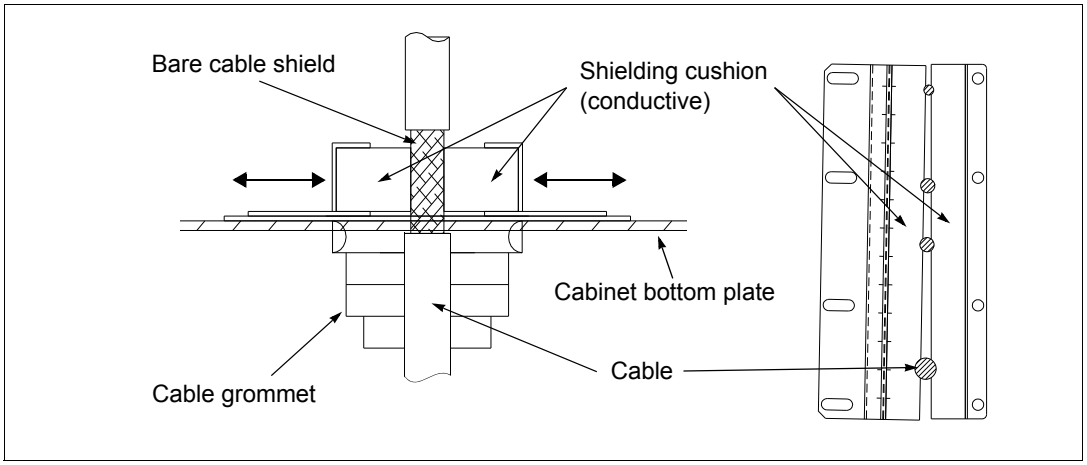
Note following when planning the electromagnetic compatibility of the cabinet:

- Generally, the fewer and smaller the holes in the cabinet, the better the interference attenuation. The maximum recommended diameter of a hole in galvanic metal contact in the covering cabinet structure is 100 mm. Pay special attention to the cooling air inlet and outlet gratings.
- The best galvanic connection between the steel panels is achieved by welding them together as no holes are necessary. If welding is not possible, the seams between the panels **are recommended to be left unpainted** and equipped with special conductive EMC strips to provide adequate galvanic connection. Usually, reliable strips are made of flexible silicon mass covered with a metal mesh. The non-tightened touch-contact of the metal surfaces is not sufficient, so a conductive gasket between the surfaces is required. The maximum recommended distance between assembly screws is 100 mm.
- Construct sufficient high-frequency grounding network in the cabinet to avoid voltage differences and forming of high-impedance radiator structures. A good high-frequency grounding is made with short flat copper braids for low inductance. One-point high-frequency grounding cannot be used due to the long distances inside the cabinet.

- 360° high frequency grounding of the cable shields at the cable lead-throughs improves the EMC shielding of the cabinet.
- 360° high frequency grounding of the motor cable shields at their entries is recommended. The grounding can be implemented by a knitted wire mesh screening as shown below.

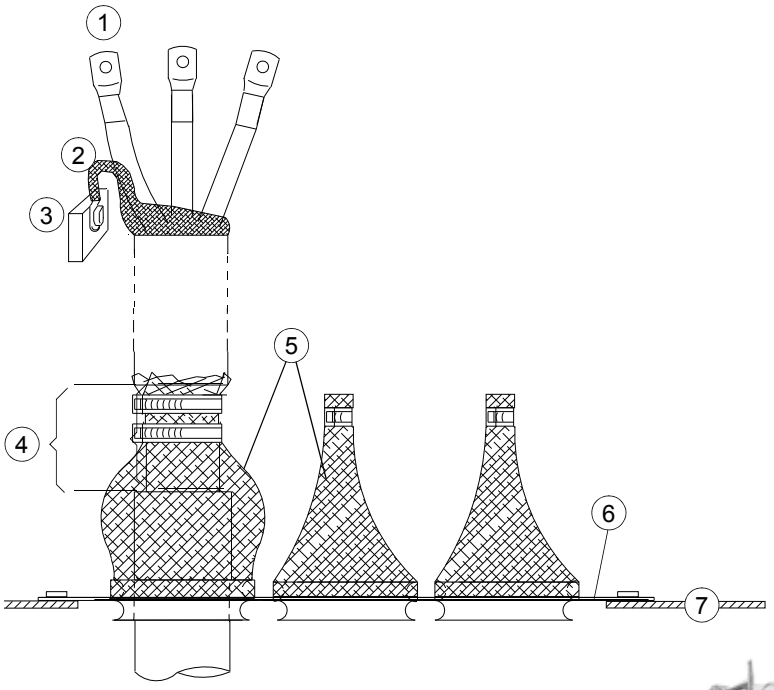


- 360° high frequency grounding of the control cable shields is recommended at their entries. The shields can be grounded by means of conductive shielding cushions pressed against the cable shield from both directions:

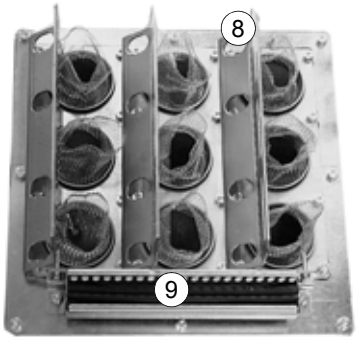


Planning the grounding of the cable shields at the cabinet lead-through

Follow the principle shown below when planning the grounding of the cable shields at the cabinet lead-through.



1 To power cable terminals
2 Cable shield
3 PE (ground) terminal of the cabinet, cabling panel or drive module
4 Stripped part of the cable
5 EMC sleeve
6 Lead-through plate
7 Base plate
8 Strain relief
9 Conductive shielding cushions for control cables



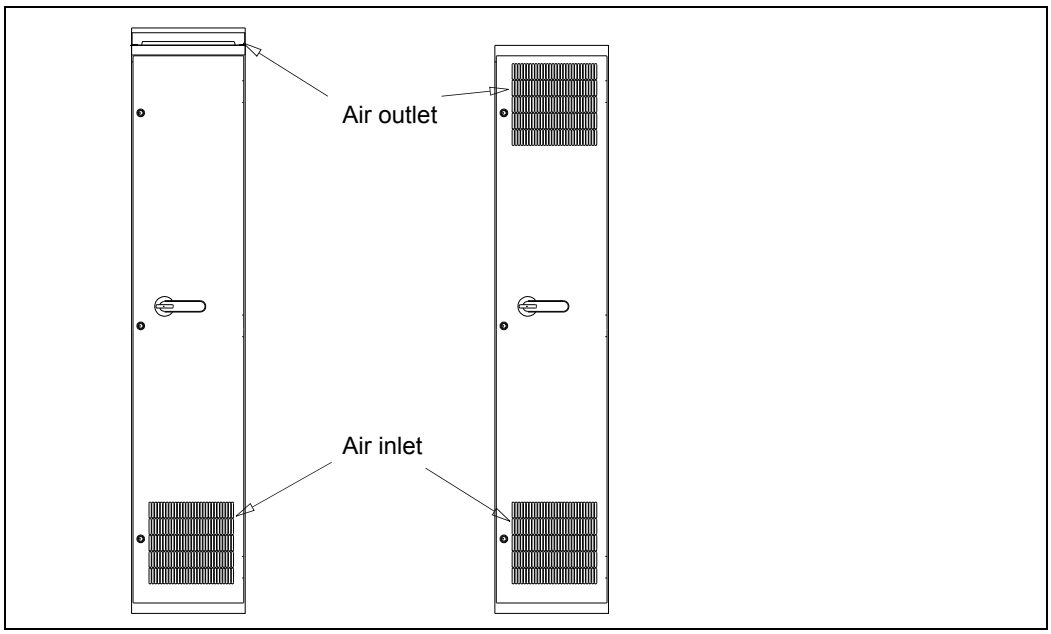
Example cable lead-through

Planning the cooling

Note following guidelines when planning the cooling of the cabinet:

- Ventilate the installation site sufficiently so that the cooling air flow and ambient temperature requirements of the drive module are met, see pages *129* and *133*. The internal cooling fan of the drive module rotates at a constant speed thus blowing constant air flow through the module. Whether the same amount of air must be replaced all the time in the facility depends on how much heat must be removed.

- Leave enough free space around the components to ensure sufficient cooling. Observe the minimum clearances given for each component. For the required free space around the drive module, see page *46*.
- Also ventilate the heat dissipated by cables and other additional equipment.
- Equip the air inlets and outlets 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.



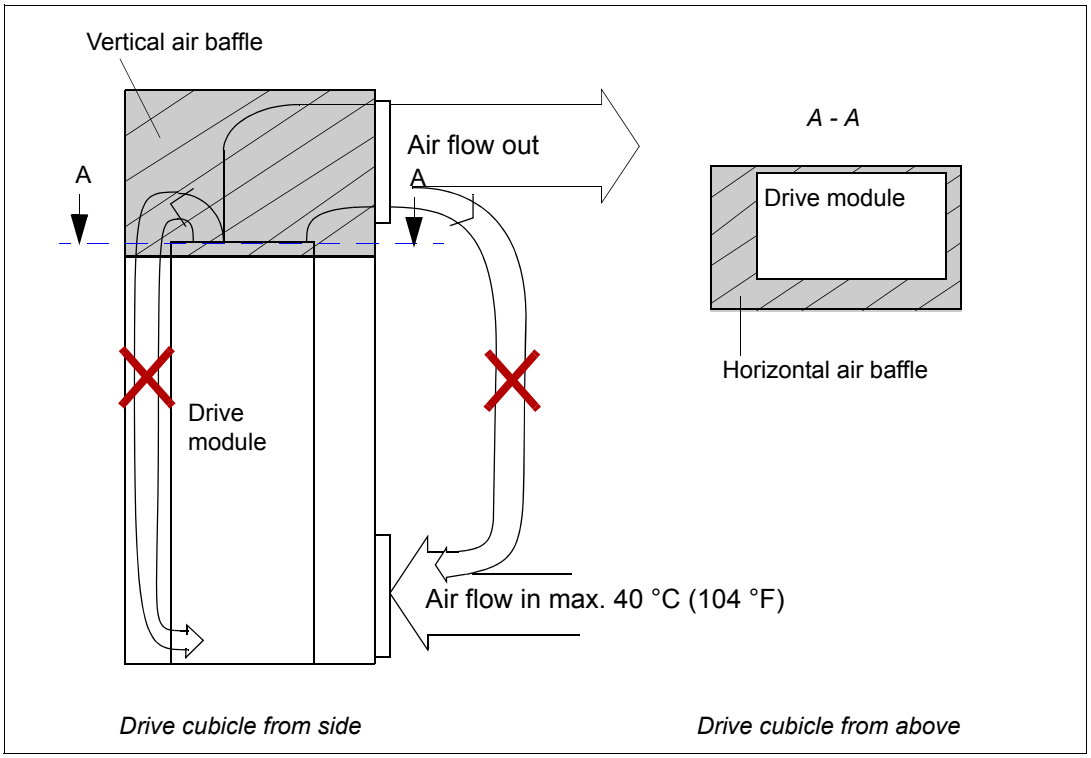
- The internal cooling fans of the drive modules and reactors/chokes are usually sufficient to keep the component temperatures low enough in IP22 cabinets.
- In IP54 cabinets, thick filter mats are used to prevent water splashes from entering the cabinet. This entails the installation of additional cooling equipment, such as a hot air exhaust fan.

Preventing the recirculation of hot air

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.

Prevent hot air circulation inside the cabinet with, for example, leak-proof air baffles at the positions shown below. No gaskets are usually required.

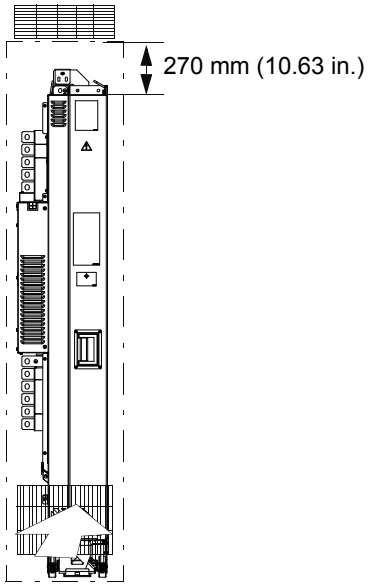


Required free space

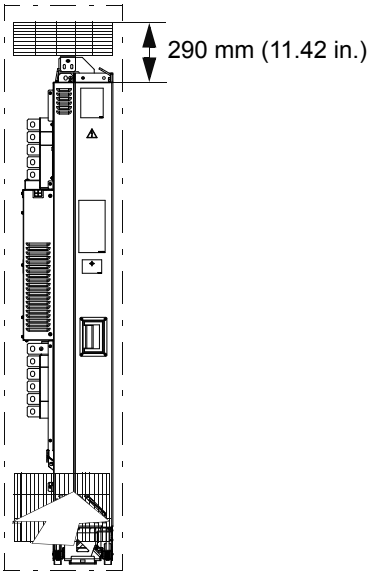
Free space around the drive module is needed for ensuring that sufficient cooling air flows through the module and the module cools properly.

Free space at top with air inlet gratings in the cabinet door

The required free space at the top of the module is shown below when the air inlet gratings are located only in the lower part of the cabinet door.



Air outlet on the cabinet roof



Air outlet in the cabinet door

Free space around the drive module

20 mm (0.79 in.) free space around the drive module is required from the cabinet back panel and front door. No free space for cooling is required on the left- and right-hand sides of the module.

The module is designed to be installed in a cabinet with the following measurements: width 400 mm (15.75 in.), depth 600 mm (23.62 in.) and height 2000 mm (78.74 in.).

Other installation positions

Contact your local ABB representative.

Planning the placement of the control panel

Note the following alternatives when planning the placement of the control panel:

- The control panel can be snapped on the control unit of the drive. See page 30.
- The control panel can be mounted onto the cabinet door using the control panel mounting kit. For the installation instructions, refer to *ACS-CP-U Control Panel IP54 Mounting Platform Kit (+J410) Installation Guide* (3AUA0000049072 [English]).

Planning the use of the cubicle heaters

Use a cubicle 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.

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 system.

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. Furthermore, if the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

Selecting the supply disconnecting device

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

European Union

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

- switch-disconnector of utilization category AC-23B (EN 60947-3)
- disconnector that has an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector (EN 60947-3)
- circuit breaker suitable for isolation in accordance with EN 60947-2.

Other regions

The disconnecting device must conform to the applicable safety regulations.

Selecting and dimensioning the main contactor

If a main contactor is used, its utilization category (number of operations under load) must be AC-1 according to IEC 60947-4, *Low-voltage switchgear and controlgear*. Dimension the main contactor according to the nominal voltage and current of the drive.

Protecting the motor insulation and bearings

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

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

Optional d*u*/d*t* filters protect motor insulation system and reduce bearing currents. Common mode filters mainly reduce bearing currents. Insulated N-end (non-drive) bearings protect the motor bearings. See section *Checking the compatibility of the motor and the drive* below for the required filters and N-end bearings to be used with the drive. Select and install the cables according to the instructions given in the *Hardware manual*.

Checking the compatibility of the motor and the drive

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

Select the motor and drive according to the rating tables in chapter *Technical data*. Use the DriveSize PC tool if the default load cycles are not applicable.

1. Check that the motor ratings lie within the allowed ranges of the drive control program:
   - nominal motor voltage is in the range of 1/2...2 · U_N
   - nominal motor current is 1/6 ... 2 · I_{Hd} of the drive in DTC control and 0 ... 2 · I_{Hd} in scalar control. The control mode is selected by a control program parameter.
2. Check that the motor voltage rating meets the application requirements:

When	… the motor voltage rating should be …
No resistor braking is in use	U_N
Frequent or long term brake cycles will be used	1.21 · U_N

U_N ≙ Input voltage of the drive

See section *Resistor braking of the drive* on page *54.*

3. Consult the motor manufacturer before using a motor in a drive system where the motor nominal voltage differs from the AC power source voltage.
4. Ensure that the motor insulation system withstands the maximum peak voltage in the motor terminals. See the *Requirements table* below for the required motor insulation system and drive filtering.

Example 1: When the supply voltage is 440 V and the drive is operating in the motor mode only, the maximum peak voltage in the motor terminals can be approximated as follows: 440 V · 1.35 · 2 = 1190 V. Check that the motor insulation system withstands this voltage.

Requirements table

The following table shows how to select the motor insulation system and when optional ABB d*u*/d*t* filters, insulated N-end (non-drive end) motor bearings and ABB common mode filters are required. Failure of the motor to fulfil the following requirements or improper installation may shorten motor life or damage the motor bearings and voids the warranty.

Manufacturer	Motor type	Nominal AC line voltage	Requirement for		
			Motor insulation system	ABB d*u*/d*t* and common mode filters and insulated N-end bearings	
				100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400	**P_N ≥ 350 kW or frame size ≥ IEC 400**
				134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580	**P_N ≥ 469 hp or frame size > NEMA 580**
ABB	Random-wound M2_, M3_ and M4_	U_N ≤ 500 V	Standard	+ N	+ N + CMF
		500 V < U_N ≤ 600 V	Standard	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF
			or		
			Reinforced	+ N	+ N + CMF
		600 V < U_N ≤ 690 V (cable length ≤ 150 m)	Reinforced	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF
		600 V < U_N ≤ 690 V (cable length > 150 m)	Reinforced	+ N	+ N + CMF
	Form-wound HX_ and AM_	380 V < U_N ≤ 690 V	Standard	+ N + CMF	P_N < 500 kW: + N + CMF
					P_N ≥ 500 kW: + N + CMF + d*u*/d*t*
	Old* form-wound HX_ and modular	380 V < U_N ≤ 690 V	Check with the motor manufacturer.	+ du/dt with voltages over 500 V + N + CMF	
	Random-wound HX_ and AM_ **	0 V < U_N ≤ 500 V	Enamelled wire with fiber glass taping	+ N + CMF	
		500 V < U_N ≤ 690 V		+ du/dt + N + CMF	

Manufacturer	Motor type	Nominal AC line voltage	Requirement for		
			Motor insulation system	ABB d*u*/d*t* and common mode filters and insulated N-end bearings	
				100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400	**P_N ≥ 350 kW or frame size ≥ IEC 400**
				134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size ≤ NEMA 580	**P_N ≥ 469 hp or frame size > NEMA 580**
NON-ABB	Random-wound and form-wound	U_N ≤ 420 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ N or CMF	+ N + CMF
		420 V < U_N ≤ 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF
				or	
				+ d*u*/d*t* + CMF	
			or		
			Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 microsecond rise time	+ N or CMF	+ N + CMF
		500 V < U_N ≤ 600 V	Reinforced: $\hat{U}_{LL}$ = 1600 V	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF
				or	
				+ d*u*/d*t* + CMF	
			or		
			Reinforced: $\hat{U}_{LL}$ = 1800 V	+ N or CMF	+ N + CMF
		600 V < U_N ≤ 690 V	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ d*u*/d*t* + N	+ d*u*/d*t* + N + CMF
			Reinforced: $\hat{U}_{LL}$ = 2000 V, 0.3 microsecond rise time ***	N + CMF	N + CMF

* manufactured before 1.1.1998

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

*** If the intermediate DC circuit voltage of the drive is increased from the nominal level by resistor braking, check with the motor manufacturer if additional output filters are needed in the applied drive operation range.

The abbreviations used in the table are defined below.

Abbreviation	Definition
U_N	Nominal voltage of the supply network
$\hat{U}_{LL}$	Peak line-to-line voltage at motor terminals which the motor insulation must withstand
P_N	Motor nominal power
d*u*/d*t*	d*u*/d*t* filter at the output of the drive
CMF	Common mode filter +E208
N	N-end bearing: insulated motor non-drive end bearing
n.a.	Motors of this power range are not available as standard units. Consult the motor manufacturer.

Explosion-safe (EX) motors

Consult the motor manufacturer regarding the construction of the motor insulation and additional requirements for explosion-safe (EX) motors.

Additional requirements for high-output motors and IP23 motors

If you will use a motor with the rated output power higher than what is stated for the particular frame size in EN 50347 (2001), or if the degree of protection is IP23, follow these guidelines when defining the protection of the motor:

- The table below shows the requirements for ABB random-wound motor series (for example, M3AA, M3AP and M3BP).

Nominal AC line voltage)	**Requirement for**		
	Motor insulation system	**ABB du/dt and common mode filters, insulated N-end motor bearings**	
		100 kW ≤ P_N < 200 kW	**P_N ≥ 200 kW**
		140 hp ≤ P_N < 268 hp	**P_N ≥ 268 hp**
U_N ≤ 500 V	Standard	+ N	+ N + CMF
500 V < U_N ≤ 600 V	Standard	+ du/dt + N	+ du/dt + N + CMF
	or		
	Reinforced	+ N	+ N + CMF
600 V < U_N ≤ 690 V	Reinforced	+ du/dt + N	+ du/dt + N + CMF

- The table below shows the requirements for random-wound and form-wound non-ABB motors with P_N < 350 kW. For motors with P_N ≥ 350 kW, consult the motor manufacturer.

Nominal AC line voltage	**Requirement for**	
	Motor insulation system	**ABB du/dt and common mode filters, insulated N-end motor bearings**
		100 kW ≤ P_N < 350 kW or IEC 315 ≤ frame size < IEC 400
		134 hp ≤ P_N < 469 hp or NEMA 500 ≤ frame size < NEMA 580
U_N ≤ 420 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ N + CMF
420 V < U_N ≤ 500 V	Standard: $\hat{U}_{LL}$ = 1300 V	+ d*u*/d*t* + N + CMF
	or	
	Reinforced: $\hat{U}_{LL}$ = 1600 V, 0.2 microsecond rise time	+ N + CMF
500 V < U_N ≤ 600 V	Reinforced: $\hat{U}_{LL}$ = 1600 V	+ d*u*/d*t* + N + CMF
	or	
	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ N + CMF
600 V < U_N ≤ 690 V	Reinforced: $\hat{U}_{LL}$ = 1800 V	+ d*u*/d*t* + N + CMF
	Reinforced: $\hat{U}_{LL}$ = 2000 V, 0.3 microsecond rise time ***	N + CMF

For *, ** and ***, see page 52.

HXR and AMA motors

All AMA machines (manufactured in Helsinki) for drive systems have form-wound windings. All HXR machines manufactured in Helsinki starting 1.1.1998 have form-wound windings.

*ABB motors of types other than M2_, M3_, M4_, HX_ and AM_*

Use the selection criteria given for non-ABB motors.

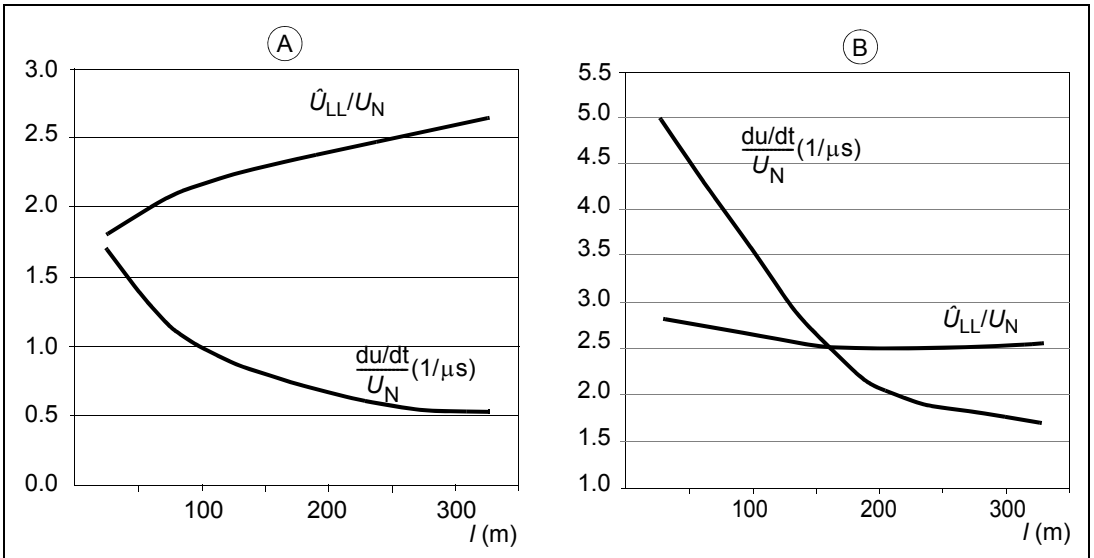
Resistor braking of the drive

When the drive is in the braking mode for a large part of its operation time, the intermediate circuit DC voltage of the drive increases, the effect being similar to increasing the supply voltage by up to 20 percent. Take voltage increase into consideration when determining the motor insulation requirement.

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

Calculating the rise time and the peak line-to-line voltage

The peak line-to-line voltage at the motor terminals generated by the drive as well as the voltage rise time depend on the cable length. The requirements for the motor insulation system given in the table are “worst case” requirements covering installations with 30 meter and longer cables. The rise time can be calculated as follows: $\triangle t = 0.8 \cdot \hat{U}_{LL}/(du/dt)$. Read $\hat{U}_{LL}$ and du/dt from the diagrams below. Multiply the values of the graph by the supply voltage (U_N). In case of drives with resistor braking, the $\hat{U}_{LL}$ and du/dt values are approximately 20% higher.



l	Motor cable length
A	Graph for calculating the rise time of units with du/dt filter
B	Graph for calculating the rise time of units without du/dt filter

Sine filters

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

Common mode filters

Common mode filter is available as a plus code option (+E208).

Selecting the power cables

General rules

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

- Dimension the cable to carry the drive load current. See chapter *Technical data* for the rated currents.
- Select a cable rated for at least 70 °C (158 °F) maximum permissible temperature of conductor in continuous use. For US, see *Additional US requirements* on page *58*.
- The inductance and impedance of the PE conductor/cable (grounding wire) must be rated according to permissible touch voltage appearing under fault conditions (so that the fault point voltage will not rise excessively when a ground fault occurs).
- 600 V AC cable is accepted for up to 500 V AC.

Use symmetrical shielded motor cable, see page *57*.

Note: When continuous metal conduit is employed, shielded cable is not required. The conduit must have bonding at both ends as with cable shield.

A four-conductor system is allowed for input cabling, but shielded symmetrical cable is recommended. To operate as a protective conductor, the shield conductivity requirements according to IEC 60439-1 are shown below when the protective conductor is made of the same metal as the phase conductors:

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

Compared to a four-conductor system, the use of symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as the stress on motor insulation, bearing currents and wear.

Keep the motor cable and its PE pigtail (twisted shield) as short as possible to reduce high-frequency electromagnetic emissions.

Typical power cable sizes

The table below gives copper and aluminium cable types with concentric copper shield for the drives with nominal current. See also *Terminal and lead-through data for the power cables* on page *129.*

ACSM1-04Ax…	IEC [1]		US [2]	
	Cu cable type	Al cable type	Cu cable type	Al cable type
	mm^2	mm^2	AWG/kcmil	AWG/kcmil
-390A-4	2 × (3×120)	3 × (3×120)	2 × 250 MCM	2 × 350 MCM
-500A-4	3 × (3×95)	3 × (3×150)	2 × 500 MCM or 3 × 250 MCM	2 × 600 MCM or 3 × 300 MCM
-580A-4	3 × (3×120)	3 × (3×185)	2 × 500 MCM or 3 × 250 MCM	2 × 700 MCM or 3 × 350 MCM
-635A-4	3 × (3×150)	3 × (3×240)	2 × 600 MCM or 3 × 300 MCM	3 × 400 MCM or 4 × 250 MCM

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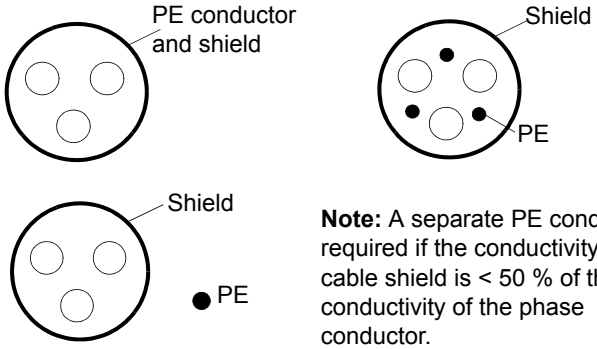
1) The cable sizing is based on max. 9 cables laid on a cable ladder side by side, three ladder type trays one on top of the other, ambient temperature 30 °C (86 °F), PVC insulation, surface temperature 70 °C (158 °F) (EN 60204-1 and IEC 60364-5-52). For other conditions, dimension the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

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

Alternative power cable types

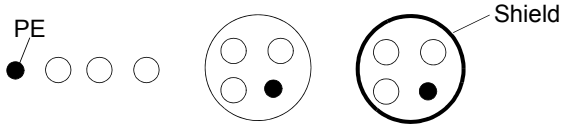
The power cable types that can be used with the drive are represented below.

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

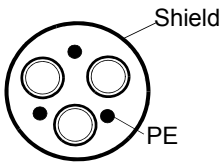


Note: A separate PE conductor is required if the conductivity of the cable shield is < 50 % of the conductivity of the phase conductor.

Not allowed for motor cabling: A four-conductor system (three phase conductors and a protective conductor)

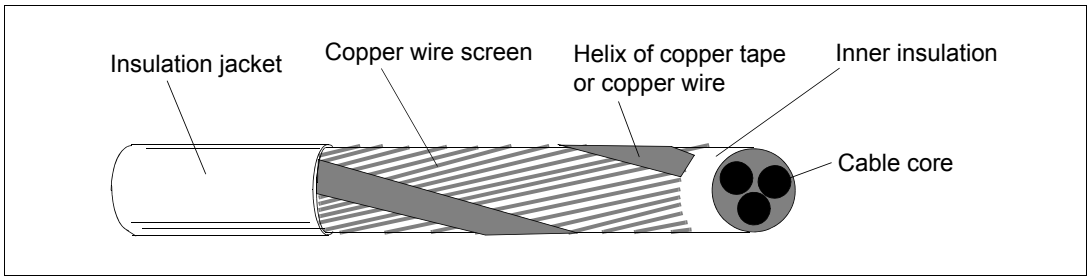


Not allowed for input or motor cabling: Symmetrical cable with individual shields for each phase conductor



Motor cable shield

If the motor cable shield is used as the sole protective earth conductor of the motor, ensure that the conductivity of the shield is sufficient. See subsection *General rules* above or IEC 60439-1. 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 or copper wire. The better and tighter the shield, the lower the emission level and bearing currents.



Additional US requirements

Use type MC continuous corrugated aluminum armor cable with symmetrical grounds or shielded power cable for the motor cables if metallic conduit is not used. For the North American market, 600 V AC cable is accepted for up to 500 V AC. For drives rated over 100 amperes, the power cables must be rated for 75 °C (167 °F).

Conduit

Couple separate parts of a conduit together: bridge the joints with a ground conductor bonded to the conduit on each side of the joint. Bond the conduits also to the drive enclosure and motor frame. Use separate conduits for input power, motor, braking resistor, and control wiring. When conduit is employed, type MC continuous corrugated aluminium armor cable or shielded cable is not required. A dedicated ground cable is always required.

Note: Do not run motor wiring from more than one drive in the same conduit.

Armored cable / shielded power cable

Six conductor (3 phases and 3 ground) type MC continuous corrugated aluminum armor cable with symmetrical grounds is available from the following suppliers (trade names in parentheses):

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

Shielded power cables are available from Belden, LAPPKABEL (ÖLFLEX) and Pirelli.

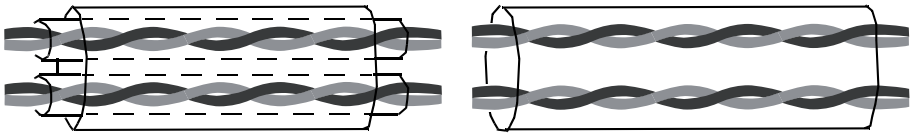
Selecting the control cables

Shielding

All control cables must be shielded.

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

A double-shielded cable is the best alternative for low-voltage digital signals but single-shielded twisted pair cable is also usable.



Double-shielded twisted pair cable

Single-shielded twisted pair cable

Signals in separate cables

Run analog and digital signals in separate, shielded cables.

Never mix 24 V DC and 115/230 V AC signals in the same cable.

Signals allowed to be run in the same cable

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

Relay cable type

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

Control panel cable length and type

In remote use, the cable connecting the control panel to the drive must not exceed 3 meters (10 ft). The cable type tested and approved by ABB is used in control panel option kits.

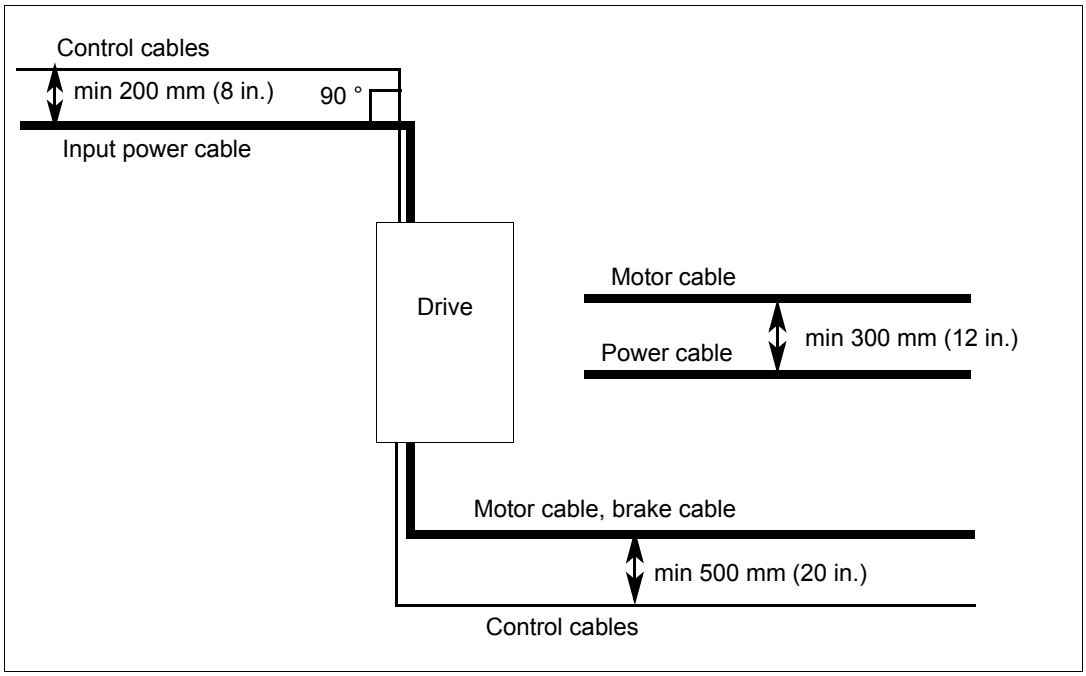
Routing the cables

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.

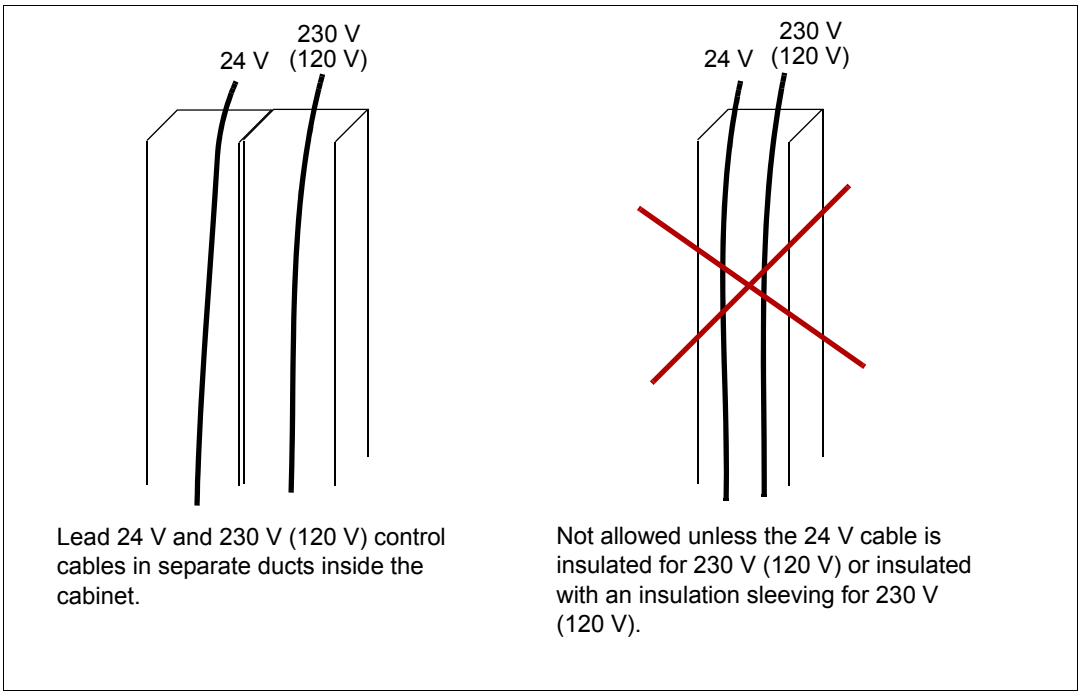
Where control cables must cross power cables ensure that they are arranged at an angle as near to 90 degrees as possible. Do not run extra cables through the drive.

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 shown below.



Separate control cable ducts



Lead 24 V and 230 V (120 V) control cables in separate ducts inside the cabinet.

Not allowed unless the 24 V cable is insulated for 230 V (120 V) or insulated with an insulation sleeving for 230 V (120 V).

Continuous motor cable shield or enlosure for equipment in the motor cable

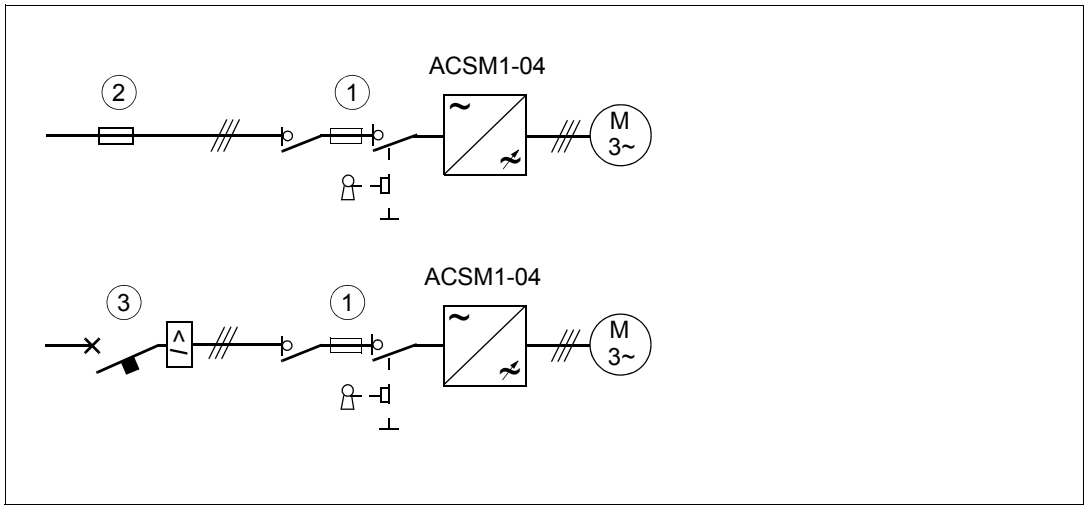
To ensure safety and minimize the emission level when safety switches, contactors, connection boxes or similar equipment are installed in the motor cable between the drive and the motor:

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

Implementing thermal overload and short-circuit protection

Protecting the drive and input power cable in short-circuits

Protect the drive with fuses (1) and the input cable with fuses (2) or a circuit breaker (3) as shown below:



Size the fuses or circuit breaker at the distribution board according to local regulations for the input cable protection. Select the fuses for the drive according to the instructions given in chapter *Technical data*. The fuses for the drive protection will restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive.

Note 1: If the fuses for the drive protection are placed at the distribution board and the input cable is dimensioned according to the nominal input current of the drive given in the rating table on page *125*, the fuses will protect also the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive. No separate fuses for the input cable protection are needed.

Note 2: Circuit breakers must not be used without fuses.

Protecting the motor and motor cable in short-circuits

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

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

The drive protects itself and the input and motor cables against thermal overload when the cables are 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, use a separate circuit breaker or fuses for protecting each motor cable and motor against overload. The drive overload protection is tuned for the total motor load. It may not trip due to an overload in one motor circuit only.

Protecting the motor against thermal overload

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

The most common temperature sensors are:

- motor sizes IEC 180…225: thermal switch, eg, Klixon
- motor sizes IEC 200…250 and larger: PTC or Pt100.

See the *Firmware manual* for more information on the motor thermal protection, and the connection and use of the temperature sensors.

Protecting the drive against ground faults

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

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 be applied.

Residual current device compatibility

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

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

Implementing the Emergency stop function

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

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

Implementing the Safe torque off function

See chapter *Safe torque off (STO) function*.

Implementing the Power loss ride-through function

Implement the power loss ride-through function as follows:

1. Activate the power loss ride-through function of the drive (parameter **47.02 Undervolt ctrl** in the ACSM1 Motion control program and ACSM1 Speed and Torque control program).
2. If the installation is equipped with a main contactor, prevent its tripping at the input power break. For example, use a time delay relay (hold) in the contactor control circuit.

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

Using power factor compensation capacitors with the drive

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

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

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

1. Do not connect a high-power capacitor to the power line while the drive is connected. The connection will cause voltage transients that may trip or even damage the drive.

2. If capacitor load is increased/decreased step by step when the AC drive is connected to the power line, ensure that the connection steps are low enough not to cause voltage transients that would trip the drive.
3. Check that the power factor compensation unit is suitable for use in systems with AC drives, ie, harmonic generating loads. In such systems, the compensation unit should typically be equipped with a blocking reactor or harmonic filter.

Implementing a safety switch between the drive and the motor

It is recommended to install a safety switch between the permanent magnet synchronous motor and the drive output. The switch is needed to isolate the motor during any maintenance work on the drive.

Using a contactor between the drive and the motor

Arrange the control of the output contactor by applying one of the alternatives described below.

Alternative 1: When you have selected to use the default motor control mode (DTC) and motor coast stop in the drive, open the contactor as follows:

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

Alternative 2: When you have selected to use the default motor control mode (DTC) and motor ramp stop in the drive, open the contactor as follows:

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

Alternative 3: When you have selected to use the scalar motor control mode in the drive, open the contactor as follows:

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

WARNING! When you have the default motor control mode (DTC) in use, never open the output contactor while the drive rotates the motor. The DTC motor control operates extremely fast, much faster than it takes for the contactor to open its contacts. When the contactor starts opening while the drive rotates the motor, the DTC will try to maintain the load current by immediately increasing the drive output voltage to the maximum. This will damage, or even burn the contactor completely.

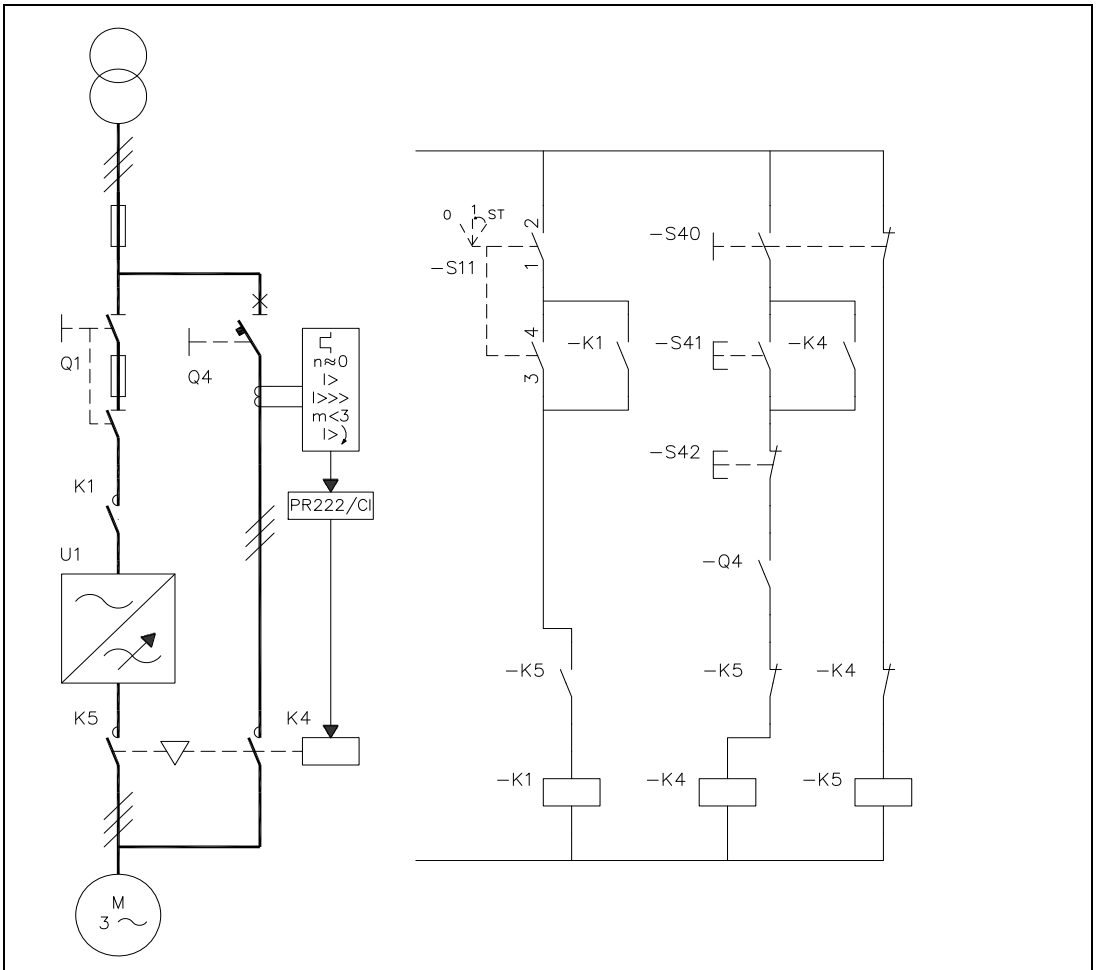
Implementing a bypass connection

If bypassing is required, employ mechanically or electrically interlocked contactors between the motor and the drive and between the motor and the power line. Ensure with interlocking that the contactors cannot be closed simultaneously.

WARNING! Never connect the supply power to the drive output terminals U2, V2 and W2. Line voltage applied to the output can result in permanent damage to the unit.

Example bypass connection

An example bypass connection is shown below.



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

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

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

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

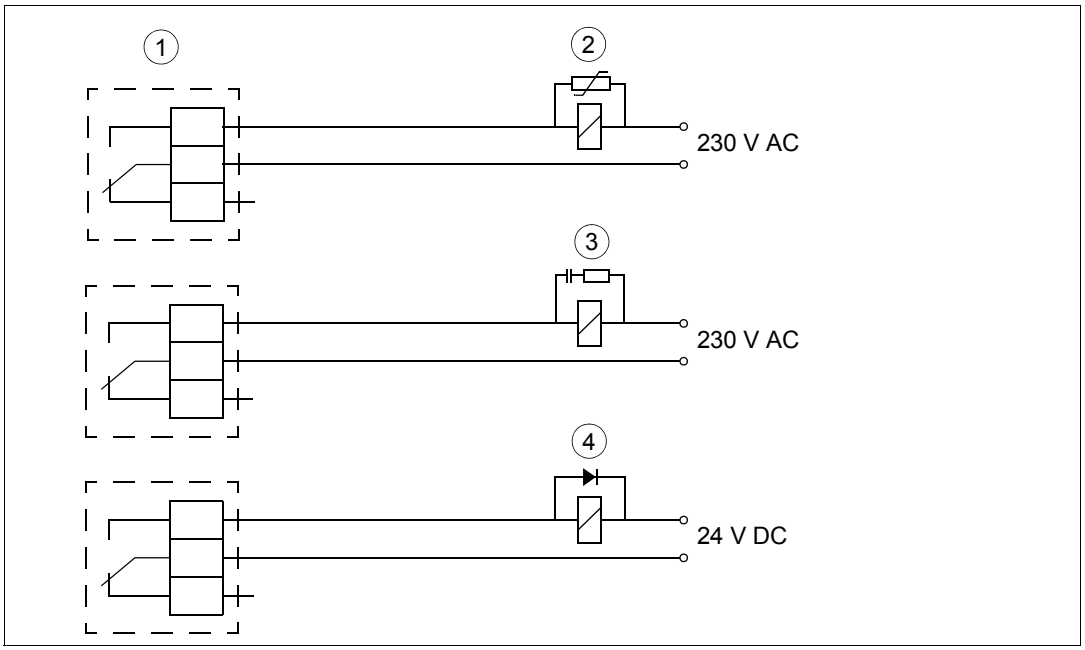
1. Stop the motor with S42.
2. Switch the motor power supply from direct-on-line to the drive with S40.
3. Close the main contactor of the drive with switch S11 (-> turn to position ST for two seconds and leave to position 1).
4. Start the drive and the motor with the drive control panel (drive in the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

Protecting the contacts of relay outputs

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

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

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



1) Relay outputs; 2) Varistor; 3) RC filter; 4) Diode

Connecting a motor temperature sensor to the drive I/O

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

To fulfil this requirement, the connection of a thermistor (and other similar components) to the digital inputs of the drive can be implemented in three alternate ways:

1. There is double or reinforced insulation between the thermistor and live parts of the motor.
2. Circuits connected to all digital and analog inputs of the drive are protected against contact and insulated with basic insulation (the same voltage level as the drive main circuit) from other low voltage circuits.
3. An external thermistor relay is used. The insulation of the relay must be rated for the same voltage level as the main circuit of the drive. For connection, see *Firmware manual*.

Example circuit diagram

See page *148*.

Installation

What this chapter contains

In this chapter, the drive module is installed in a 400 mm wide Rittal TS 8 cabinet in a bookshelf way of mounting: The module is placed in an upright position on the cabinet bottom with its front facing the cabinet door. The following Rittal parts and drive module options are used in the installation examples:

Drive module standard parts		
• Drive module • Top guide plate • Fastening bracket • Grounding busbar • Pedestal guide plate • Telescopic extraction and insertion ramp • Fastening screws in a plastic bag • External control unit		
Drive module options		
Option code	**Qty (pcs)**	**Description**
+H381	1	Power cabling panels
+P905	1	Internal control unit
Rittal parts		
Rittal part code	**Qty (pcs)**	**Description**
TS 8406.510	1	Enclosure without mounting plate. Includes frame, door, side and back panels.
TS 8612.160	5	Punched section with mounting flange, outer mounting level for 600 mm horizontal
TS 8612.140	1	Punched section with mounting flange, outer mounting level for 400 mm horizontal
3243.200	2	Air filter 323 mm × 323 mm
Customer-defined parts		
Cabinet bottom plate	1	The delivery does not include a cabinet bottom plate. The customer must provide a bottom plate to the cabinet for ensuring the degree of protection. See *Bottom plate* on page *146*.

Always follow the general rules given in this chapter and local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches local laws and/or other regulations.

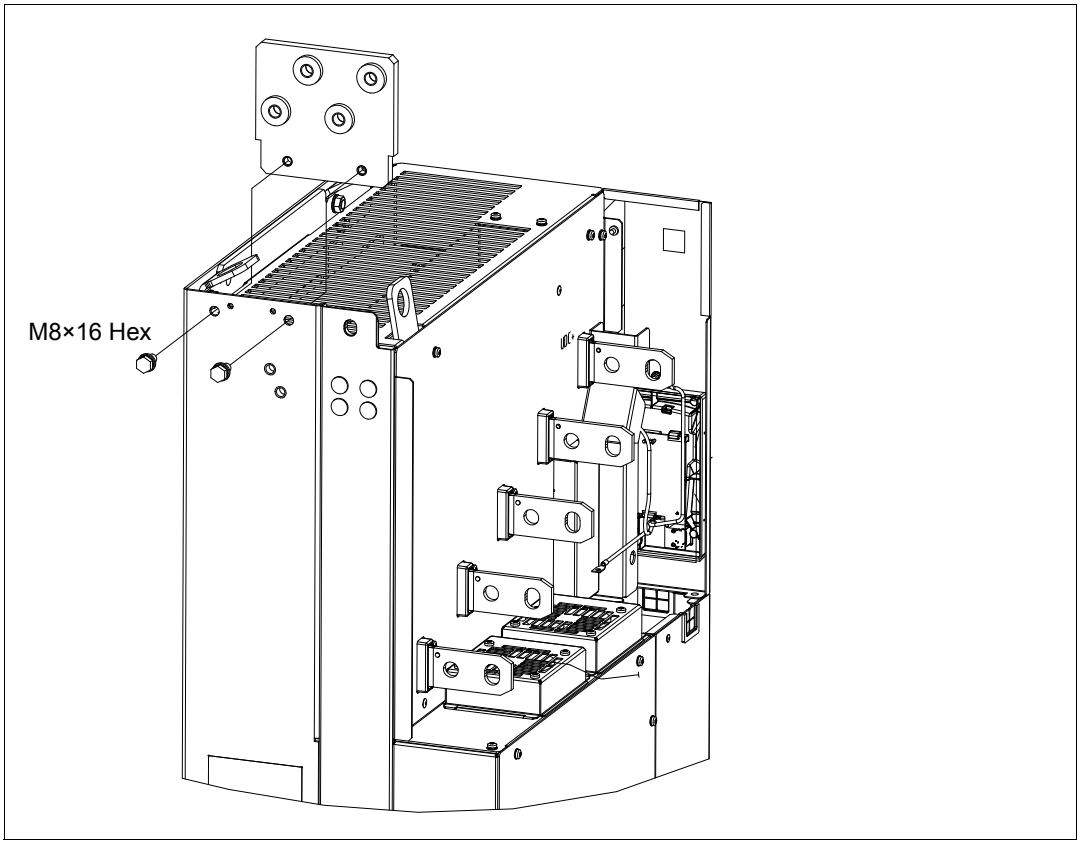
Note 1: The drive module can also be installed in other than Rittal TS 8 cabinets.

Note 2: Installations with input and motor cables of size 4 × 240 mm^2 per phase

If resistor cables are to be connected, the lower side plate of the output cabling panel must be removed and the resistor cables lead from side to the terminals of the output cabling panel.

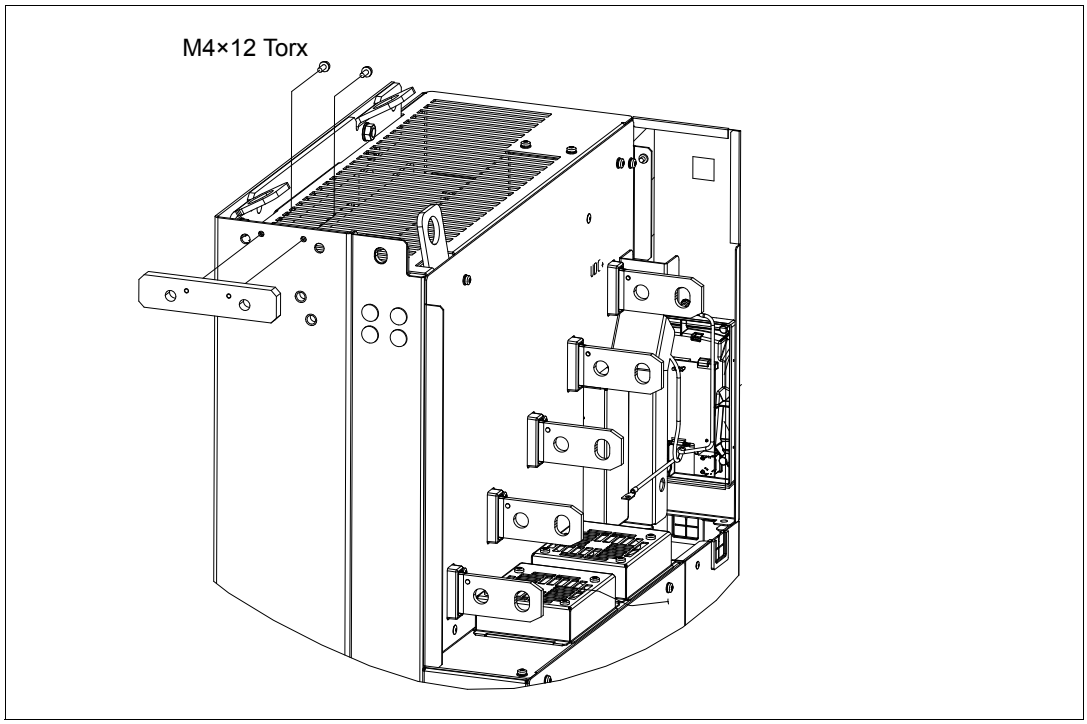
Note 3: Installations without the optional cabling panels (+H381)

Install the PE terminal as shown below.



Note 4: Mounting the drive module to an assembly panel

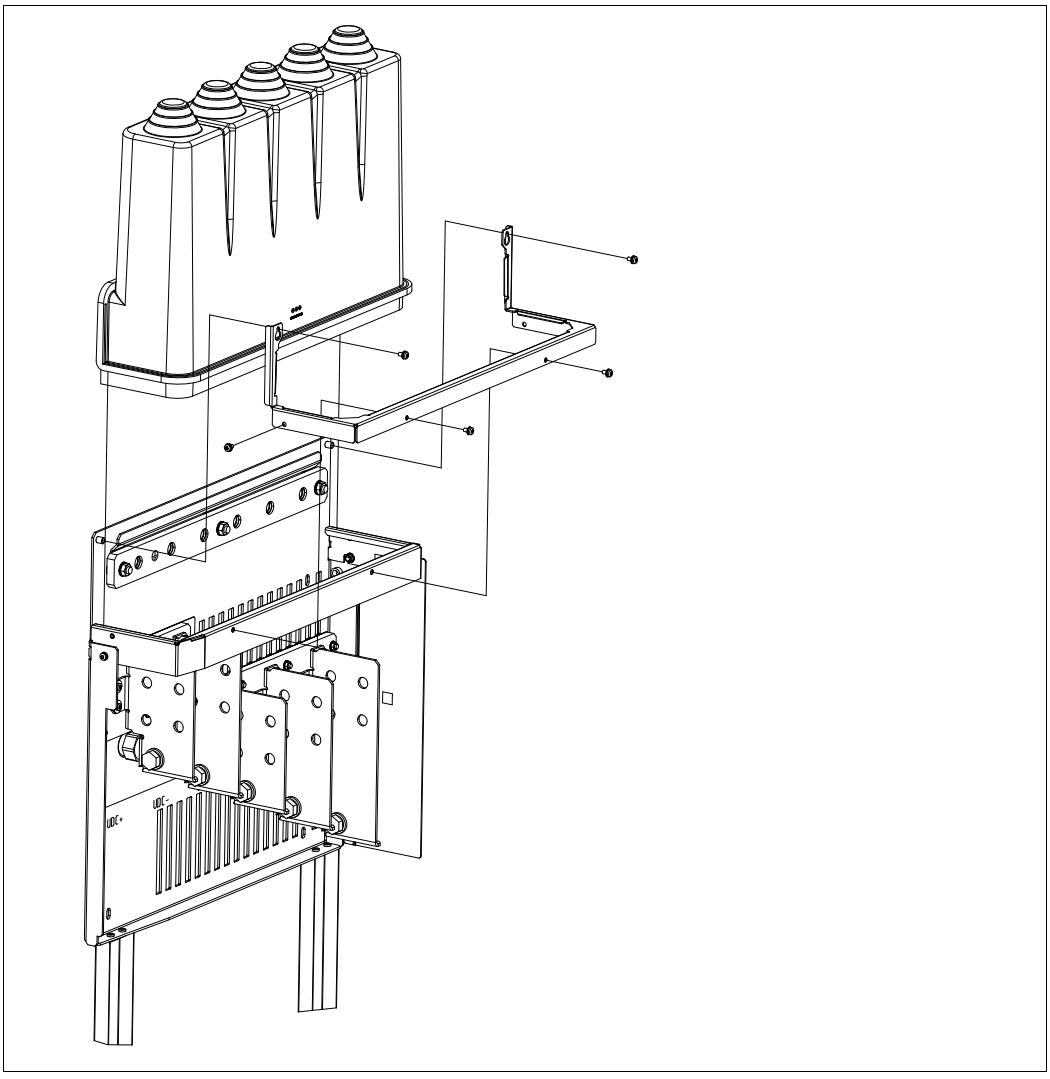
Mount the assembly support as shown below.



Note 5: Mounting the rubber grommet of units with optional cabling panels (+H381)

Installing the input power cables through the rubber grommet of optional cabling panels provides the degree of protection of IP20 for the unit. Mount the grommet (if used) as follows:

1. Cut adequate holes into the grommet for the input power cables.
2. Lead the cables through the grommet.
3. Mount the grommet to the input cabling panel with five M4x8 Torx T20 screws as shown below.



Note 6: Alternative installation means

In addition to the installation examples presented in this chapter, there are a few alternative installation means, such as:

- The power cables can be connected directly to the drive module input and output terminals with cable lugs or by busbars. The drive module can also be installed self standing to the floor in an electrical equipment room when the power cable terminals and electrical parts are protected against contact and the unit is grounded properly.
- The drive module without pedestal (option +0H354) can be mounted on wall or cabinet with four screws through the fastening holes at the top and bottom of the right-hand side of the module.

Safety

WARNING! Only qualified electricians are allowed to carry out the electrical installation work described in this chapter. Follow the *Safety instructions* on the first pages of this manual. Ignoring the safety instructions can cause injury or death.

Checking the installation site

The material below the drive must be non-flammable and strong enough to carry the weight of the drive.

See section *Ambient conditions* on page *133* for the allowed ambient conditions and section *Losses, cooling data and noise* on page *129* for the required cooling air.

Required tools

- Set of screw drivers (Torx and Pozidrive)
- Torque wrench with a 500 mm (20 in.) or 2 × 250 mm (2 × 10 in.) long extension bar
- 17 mm (11/16 in.) magnetic-end socket for mounting the drive module busbars to the optional cabling panels (+H381)
- 10 mm magnetic-end socket or a torx screw driver for mounting the drive module top fastening bracket to the cabinet back and for mounting the optional cabling panels (+H381) to the cabinet side panels
- 13 mm socket for mounting the drive module to the cabinet bottom plate or floor
- 22 mm magnetic-end socket for mounting the cable lugs to the terminals (M12 bolt).

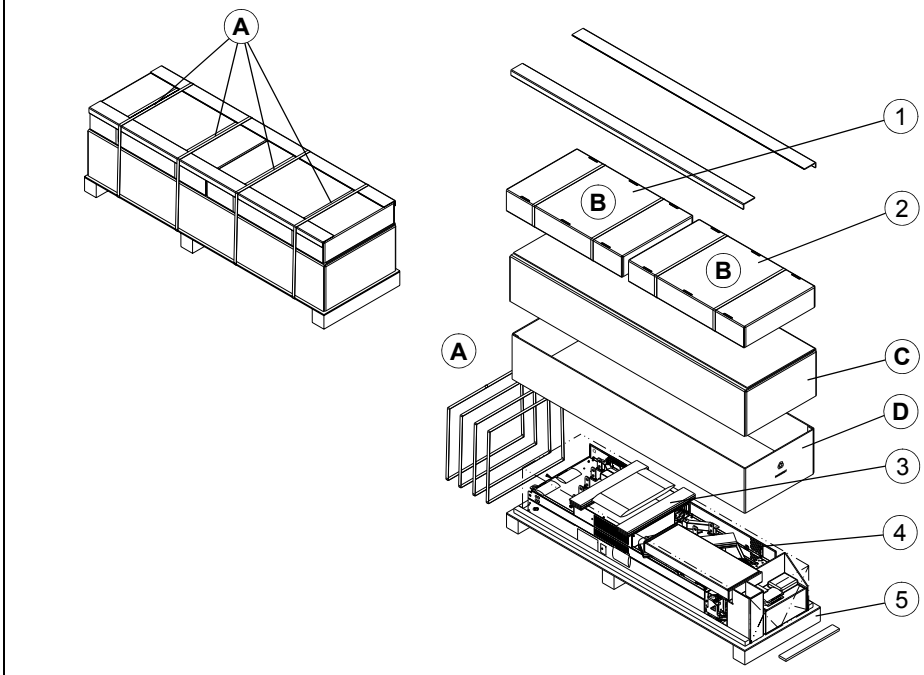
Moving and unpacking the unit

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment

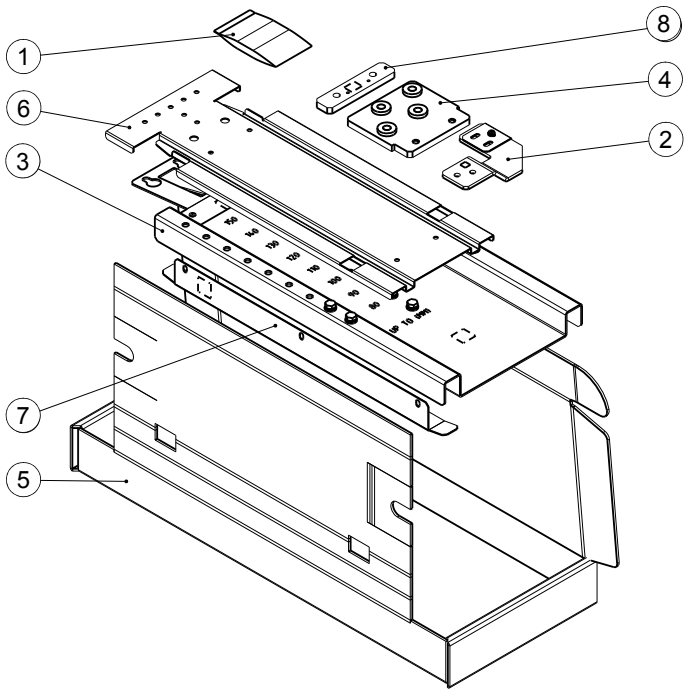
Move the transport package by pallet truck to the installation site.

Unpack the package as follows:

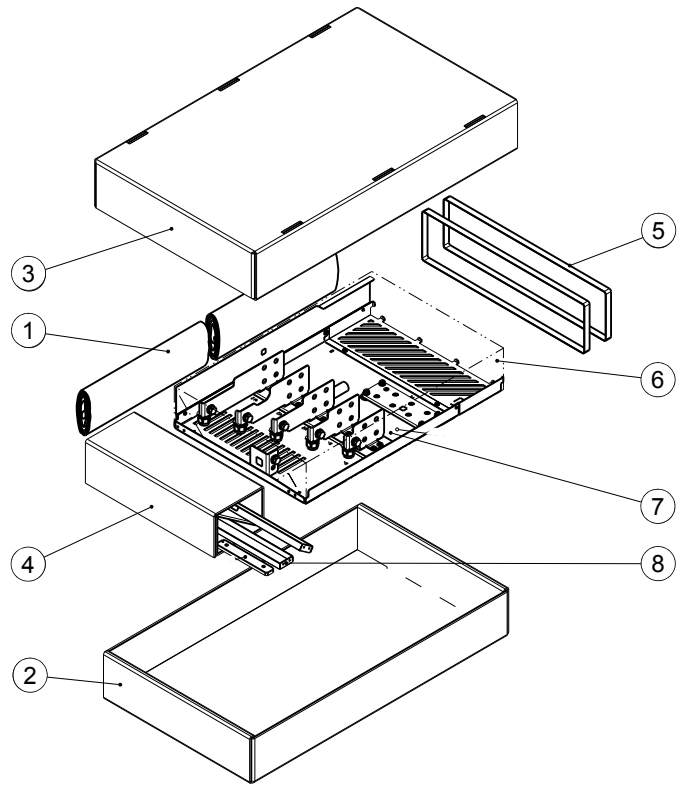
- Cut the bands (A).
- Unpack the additional boxes (B).
- Remove the outer sheathing by lifting it (C).
- Remove the sheathing by lifting it (D).
- Insert lifting hooks to the drive module lifting eyes and lift the module to the installation place.



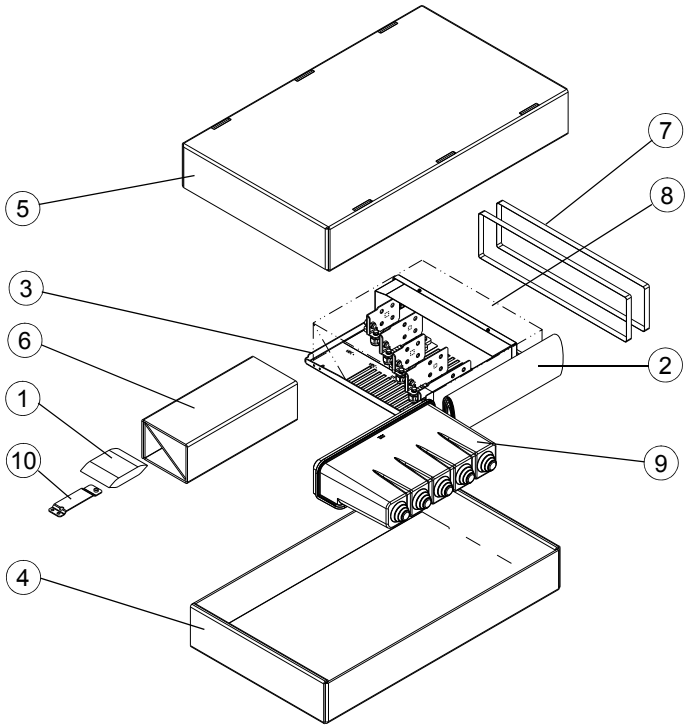
	Description of the package contents
1	Input cabling panel (option +H381), see contents below.
2	Output cabling panel (option +H381), see contents below.
3	Plywood support
4	Drive module with factory installed options and multilingual residual voltage warning sticker, top guide plate, pedestal guide plate, telescopic ramp package, fastening screws in a plastic bag, external control unit with control cable clamp plate and factory installed optional modules and delivery documents.
5	Pallet



Ramp package contents	
1	Screw package
2	Fastening bracket
3	Telescopic extraction and insertion ramp
4	PE terminal
5	Cardboard box
6	Pedestal guide plate
7	Top guide plate
8	Support



Output power cabling panel (option +H381) package contents	
1	Paper fill
2	Cardboard tray
3	Top cardboard cover
4	Support
5	Bands
6	Plastic bag
7	Output power cabling panel
8	Side guides for Rittal cabinet assembly



Input power cabling panel (option +H381) package contents	
1	Screw package
2	Paper fill
3	Input power cabling panel
4	Cardboard tray
5	Top cardboard cover
6	Support
7	Bands
8	Plastic bag
9	Rubber grommet
10	Grounding busbar to be connected to the input power cabling panel and the drive module *)

*) If you cannot find the busbar in this package, it can be found in the output power cabling panel package.

Checking the delivery

Check that all items listed under section *Moving and unpacking the unit* are present.

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

Checking the insulation of the assembly

Drive

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

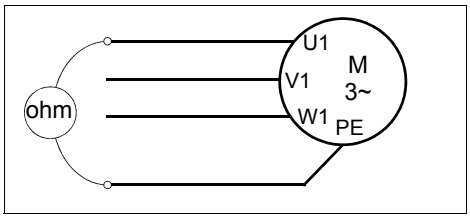
Input cable

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

Motor and motor cable

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

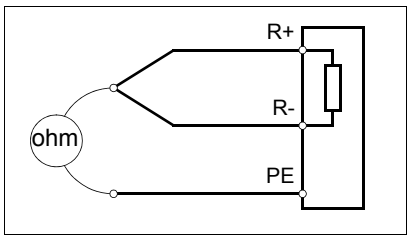
1. Check that the motor cable is disconnected from the drive output terminals U2, V2 and W2.
2. Measure the insulation resistance between each phase conductor and the Protective Earth conductor using a measuring voltage of 500 V DC. The insulation resistance of an ABB motor must exceed 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, please consult the manufacturer's instructions. **Note:** Moisture inside the motor casing will reduce the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.



Braking resistor and resistor cable

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 conductors and the PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.



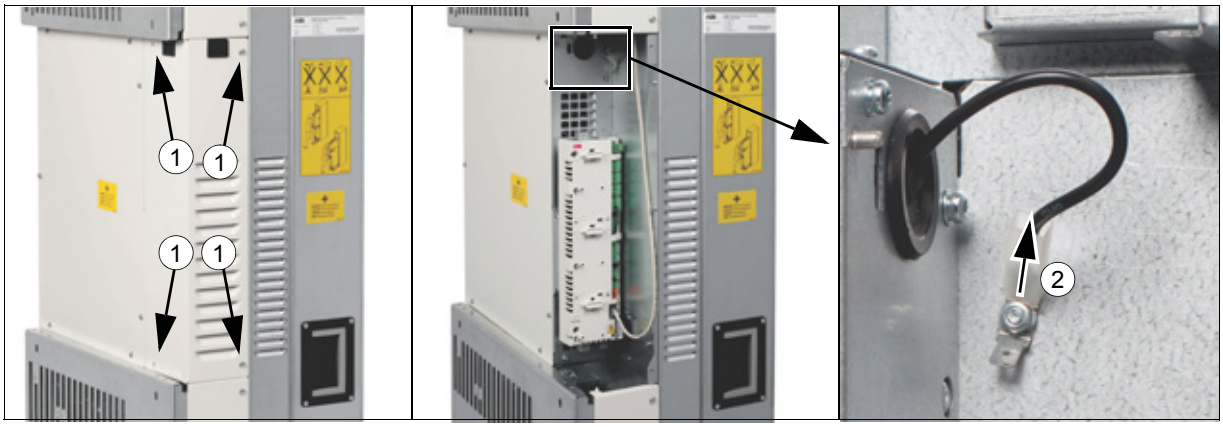
Checking the compatibility with IT (ungrounded) systems

The drive is not suitable for use in an IT (ungrounded) system as standard. Disconnect the grounding wire of the AIBP board before connecting the drive to the supply network as instructed below.

WARNING! If a drive is installed on an IT system (an ungrounded power system or a high resistance-grounded [over 30 ohm] power system) without disconnecting the AIBP board grounding wire, the system will be connected to earth potential through the varistors of the board. This may cause danger or damage the unit.

---

1. Open the screws and remove the cover.
2. Disconnect the grounding wire.



Overall flowchart of the installation process

This flowchart describes the installation process of the units listed under *What this chapter contains* on page *69*.

Step	Task	For instructions, see
1	Install the Rittal parts, cabinet bottom plate, drive bottom guide plate and top guide and loose drive options (cabling panels, option +H381) in the drive module cubicle.	*Installing the mechanical accessories into the cabinet,* page *80*
2	Install the auxiliary components (such as mounting plates, air baffles, switches, busbars etc.).	The component manufacturer's instructions *Layout examples, door open*, page *39*
3	Connect the power cables to the cabling panels.	*Connecting the power cables,* page *84*
4	Mount the drive module into the cabinet.	*Mounting the drive module into the cabinet,* page *89*
5	Drive modules with an external control unit: Mount the external control unit.	*Mounting the external control unit,* page *99*
6	Connect the control cables.	*Connecting the power cables,* page *95*
7	Install the remaining parts, for example, cabinet doors, side plates, etc.	The component manufacturer's instructions

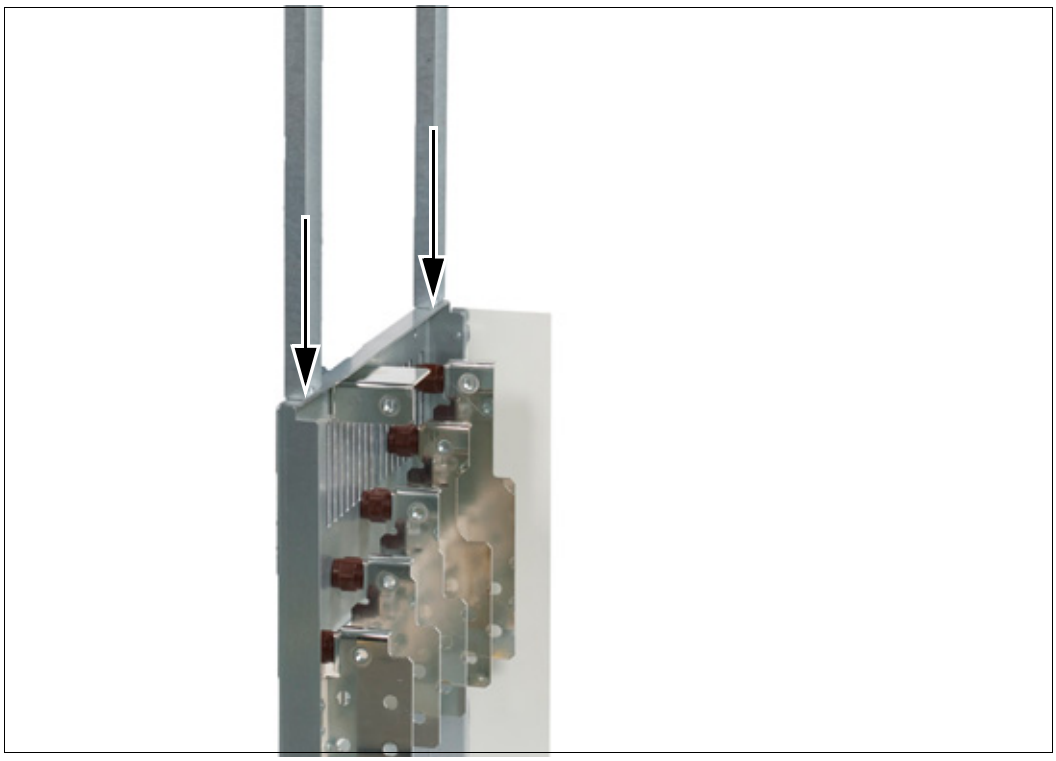
Installing the mechanical accessories into the cabinet

For frame G1, see the assembly drawing on page *82*. For frame G2, see the assembly drawing on page *83*. Install the mechanical accessories into the cabinet as follows:

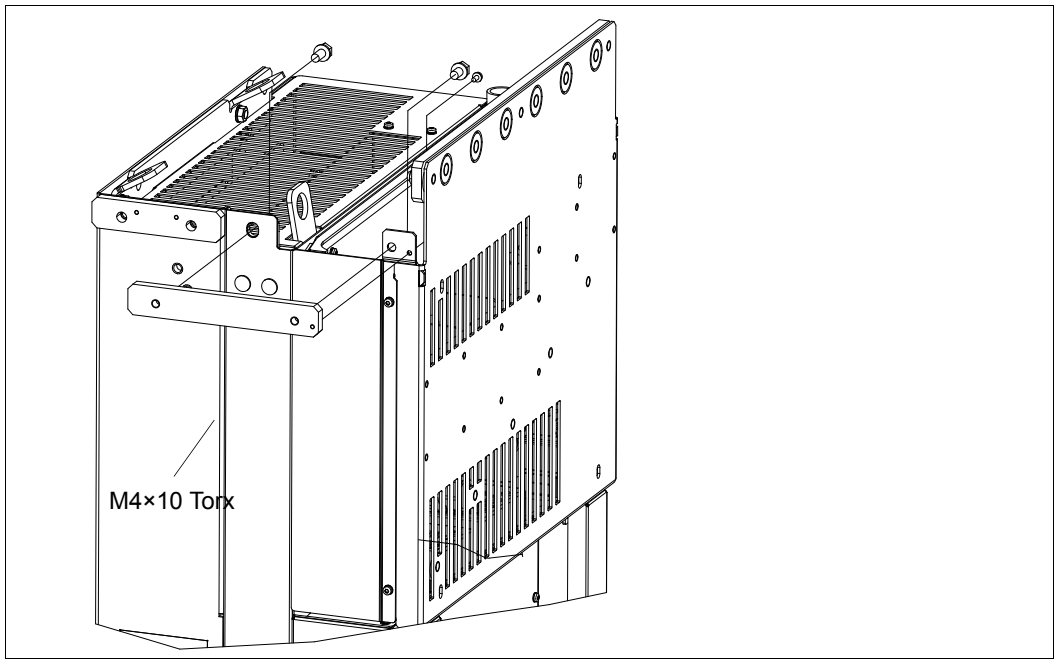
1. Install the bottom plate (not included in delivery, see dimension drawing on page *146*).
2. Install the pedestal guide onto the bottom plate.
3. Install the Rittal punched sections TS 8612.610 (5 pcs) and TS8612.140 (1 pcs) and the top guide plate according to the dimension drawing on page *141* (frame G1) or page *145* (frame G2).

Note: If the thickness of the bottom plate is not 2.5 mm (0.1 in.), adjust the dimensions accordingly.

4. Install the output cabling panel.
5. Install the side guides to the output cabling panel (2 screws for each side guide).



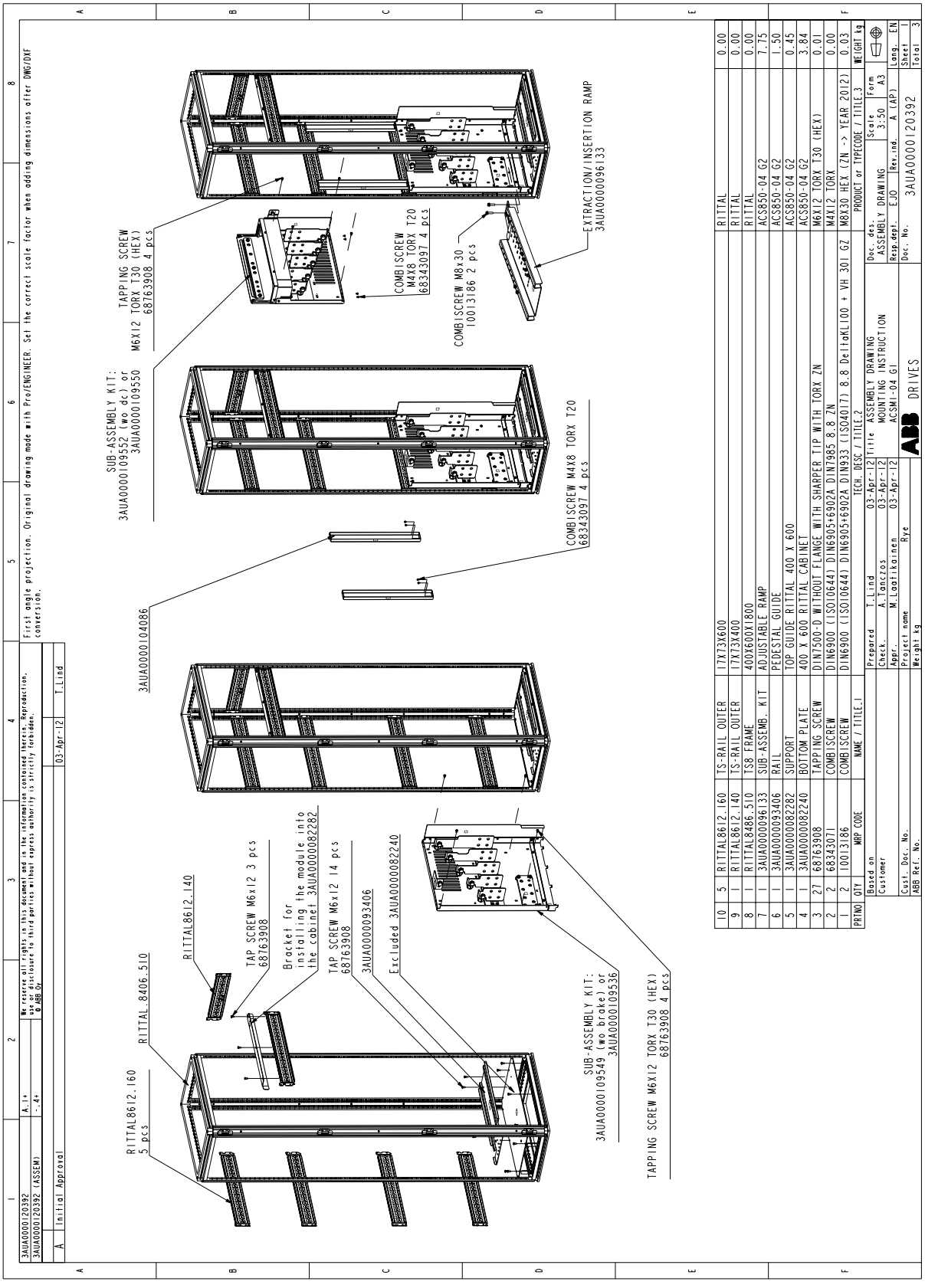
6. Mount the grounding busbar to the input cabling panel (option +H381). Back view is shown below.



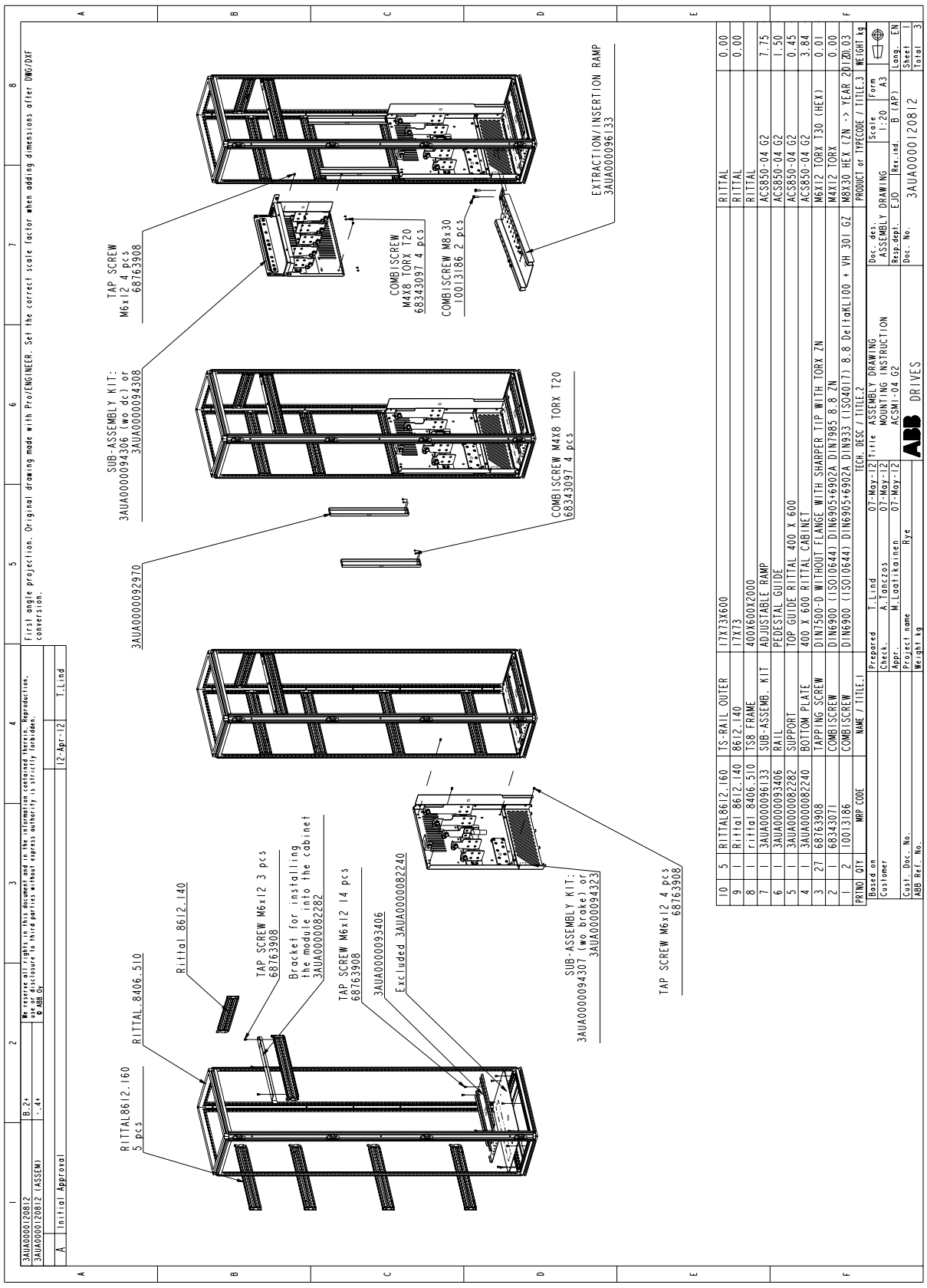
Note: The design of the grounding busbar may differ from what is shown in the figure.

7. Mount the side guides to the input cabling panel (2 screws for each side guide) and mount the input cabling panel to the punched section.

Assembly drawing (frame G1)



Assembly drawing (frame G2)



ITEM	QTY	MRP CODE	NAME / TITLE.1	TECH. DESC / TITLE.2	PRODUCT or TYPECODE / TITLE.3	WEIGHT kg
10	5	RITTAL8612.160	TS-RAIL OUTER	17X73X600	RITTAL	0.00
9	1	Rittal 8612.140	8612.140	17X73	RITTAL	0.00
8	1	rittal 8406.510	TS8 FRAME	400X600X2000	RITTAL	
7	1	3AUA0000096133	SUB-ASSEMB. KIT	ADJUSTABLE RAMP	ACS850-04 G2	7.75
6	1	3AUA0000093406	RAIL	PEDESTAL GUIDE	ACS850-04 G2	1.50
5	1	3AUA0000082282	SUPPORT	TOP GUIDE RITTAL 400 X 600	ACS850-04 G2	0.45
4	1	3AUA0000082240	BOTTOM PLATE	400 X 600 RITTAL CABINET	ACS850-04 G2	3.84
3	27	68763908	TAPPING SCREW	DIN7500-D WITHOUT FLANGE WITH SHARPER TIP WITH TORX ZN	M6X12 TORX T30 (HEX)	0.01
2	1	68343071	COMBISCREW	DIN6900 (ISO10644) DIN6905+6902A DIN7985 8.8 ZN	M4X12 TORX	0.00
1	2	10013186	COMBISCREW	DIN6900 (ISO10644) DIN6905+6902A DIN933 (ISO4017) 8.8 DeltaKL100 + VH 301 GZ	M8X30 HEX (ZN -> YEAR 2012)0.03	

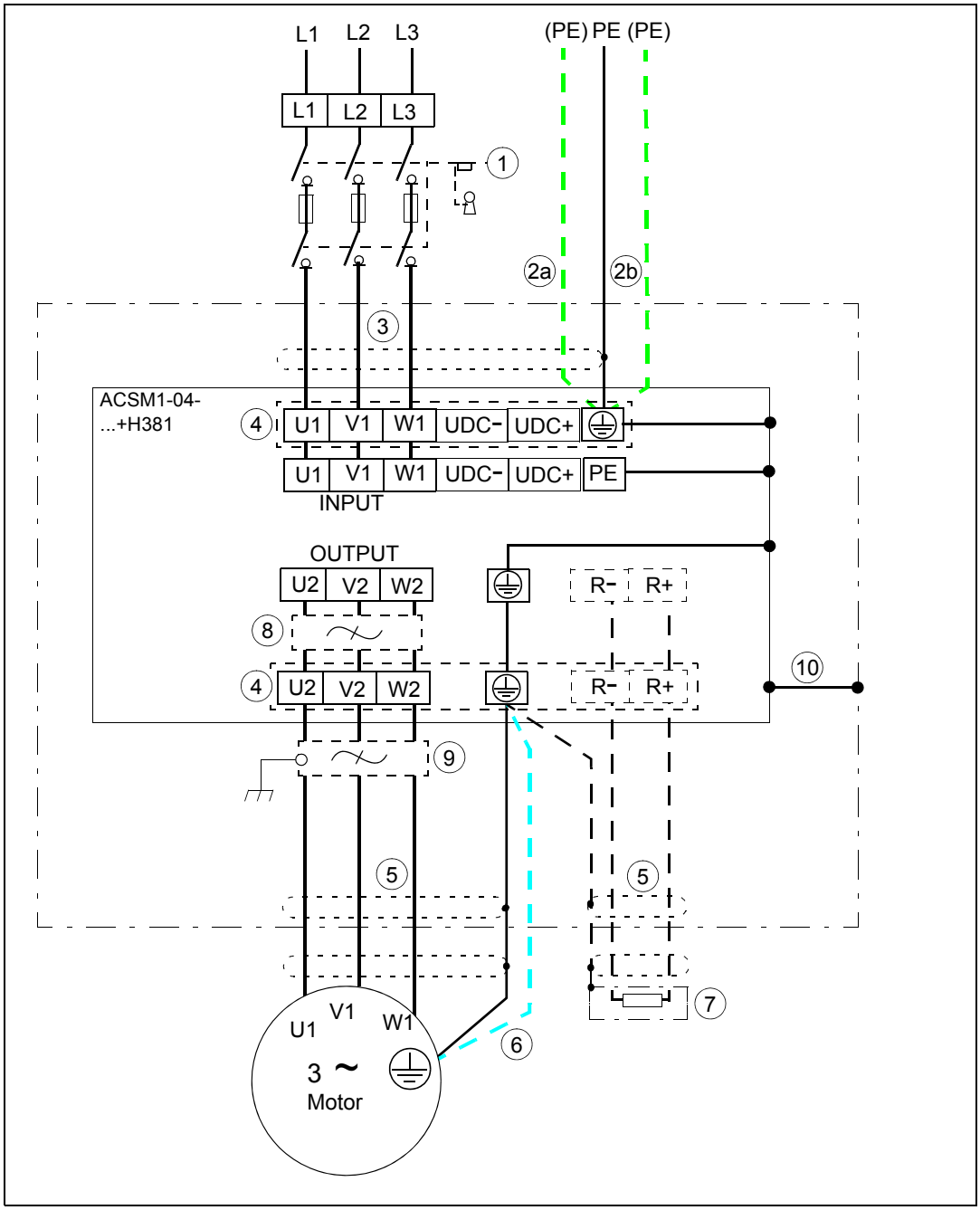
3AUA0000120812	B.2+	We reserve all rights in this document and in the information contained therein. Reproduction, use or disclosure to third parties without express authority is strictly forbidden. © ABB Oy	First angle projection. Original drawing made with Pro/ENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.	Based on	Prepared	T.Lind	07-May-12
3AUA0000120812 (ASSEM)	-.4+			Customer	Check.	A.Tanczos	07-May-12
					Appr.	M.Laatikainen	07-May-12
A	Initial Approval		12-Apr-12	T.Lind	Cust. Doc. No.	Project name	Rye
					ABB Ref. No.	Weight kg	

Title	ASSEMBLY DRAWING MOUNTING INSTRUCTION ACSMI-04 G2	Doc. des.	Scale 1:20 Form A3
		Resp.dept. EJO	Rev.ind. B (AP) Lang. EN
ABB DRIVES		Doc. No. 3AUA0000120812	Sheet 1 Total 3

Connecting the power cables

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment

Connection diagram



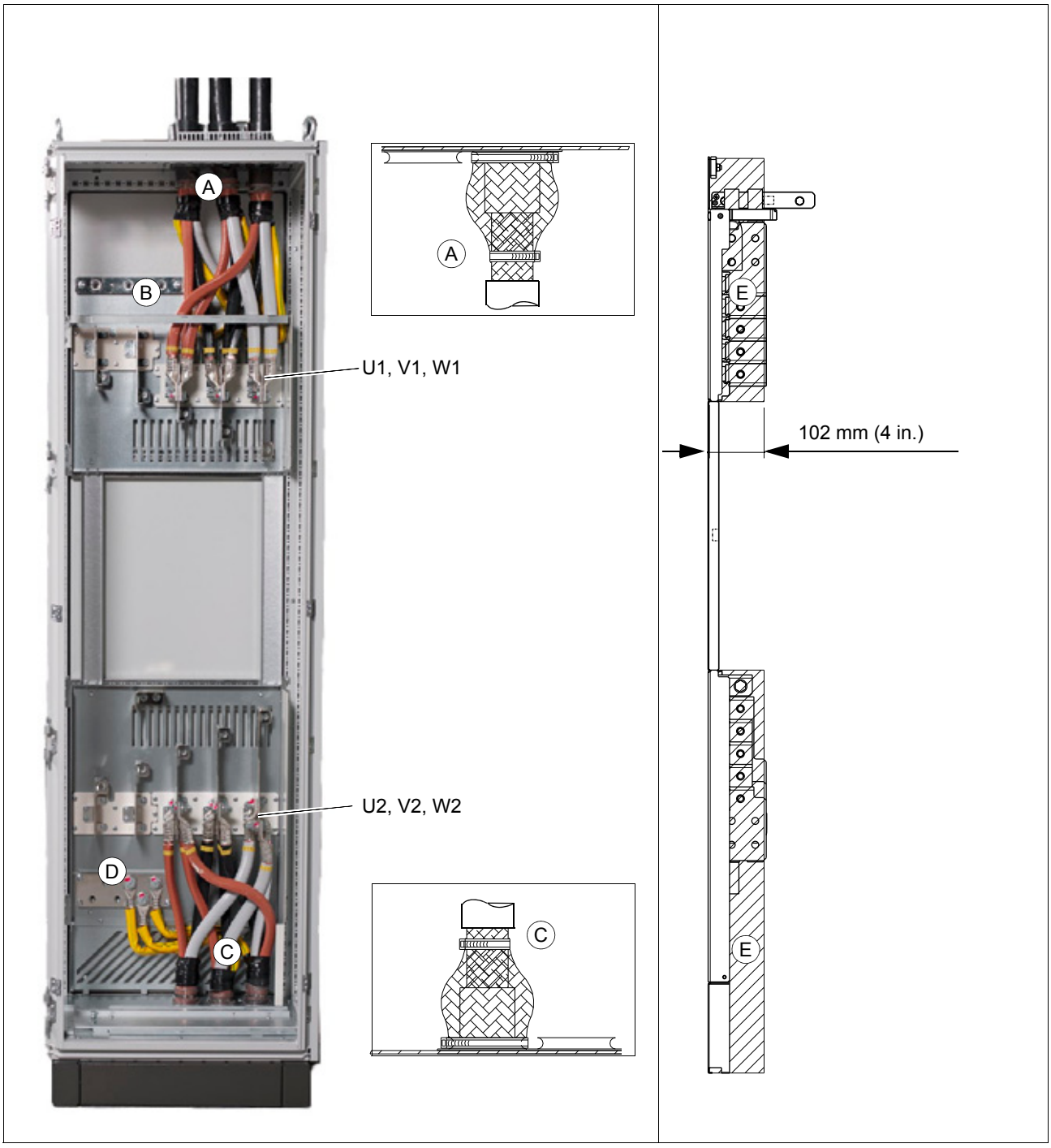
1	For alternatives, see section *Selecting the supply disconnecting device* on page *49*. In the mounting example of this chapter, the disconnecting device is not in the same cubicle with the drive module.
2	If a shielded cable is used (not required but recommended) and the conductivity of the shield is < 50% of the conductivity of the phase conductor, use a separate PE cable (2a) or a cable with a grounding conductor (2b).
3	360-degree grounding is recommended at the cabinet entry if a shielded cable is used. Ground the other end of the input cable shield or PE conductor at the distribution board.
4	Input and output power cabling panels (option +H381).
5	360-degree grounding at the cabinet entry is recommended, see page *41*.
6	Use a separate grounding cable if the conductivity of the cable shield is < 50% of the conductivity of the phase conductor and there is no symmetrically constructed grounding conductor in the cable (see page *57*).
7	External braking resistor, see page *149*.
8	Common mode filter (option +E208), see page *51*.
9	d*u*/d*t* filter (optional).
10	The drive module frame must be connected to the cabinet frame. See section *Arranging the grounding inside the cabinet* on page *40*.
Note: If there is a symmetrically constructed grounding conductor in the motor cable in addition to the conductive shield, connect the grounding conductor to the grounding terminal at the drive and motor ends. Do not use an asymmetrically constructed motor cable. Connecting its fourth conductor at the motor end increases bearing currents and causes extra wear.	

Power cable connection procedure

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

1. Lead the input cables into the inside of the cabinet. Ground the cable shield 360° at the lead-through plate.
2. Twist the cable shields of the input cables into bundles and connect them and any separate ground conductors or cables to the PE (ground) terminal of the input power cabling panel.
3. Connect the phase conductors of the input cables to terminals U1, V1 and W1 of the input cabling panel. For the tightening torques, see page *129*.
4. Lead the motor cables into the inside of the cabinet. Ground the cable shield 360° at the lead-through plate.
5. Twist the cable shields of the motor cables into bundles and connect them and any separate ground conductors or cables to the PE (ground) terminal of the output power cabling panel.
6. Connect the phase conductors of the motor cables to terminals U2, V2, W2 of the output cabling panel. For the tightening torques, see page *129*.

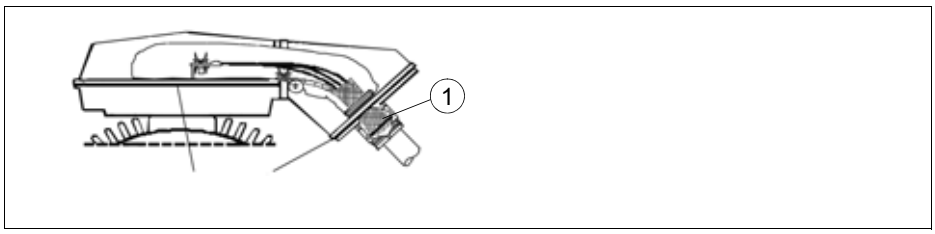
Note: The input and output power cables must fit inside the area marked with diagonal lines in the image below to avoid chafing of the cables when the drive module is inserted into the cabinet.



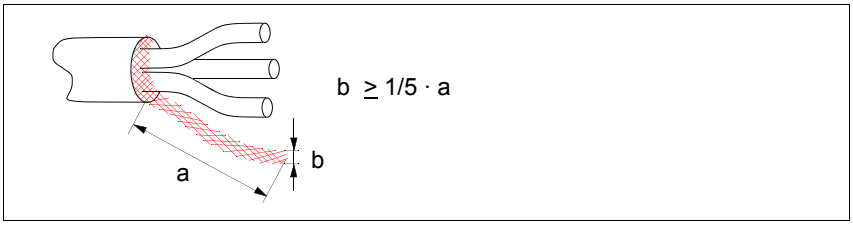
View without cabinet side plate in place. A) 360-degree grounding at the lead-through plate for the input power cables; B) Grounding busbar of the input power cabling panel; C) 360-degree grounding at the lead-through plate for the output power cables; D) Grounding busbar of the output power cabling panel; E) Allowed space for power cables

Ground the motor cable shield at the motor end as follows:

- 360 degrees at the lead-through of the motor terminal box (1)



- or by twisting the shield as follows: flattened width ≥ 1/5 · length.



DC connection

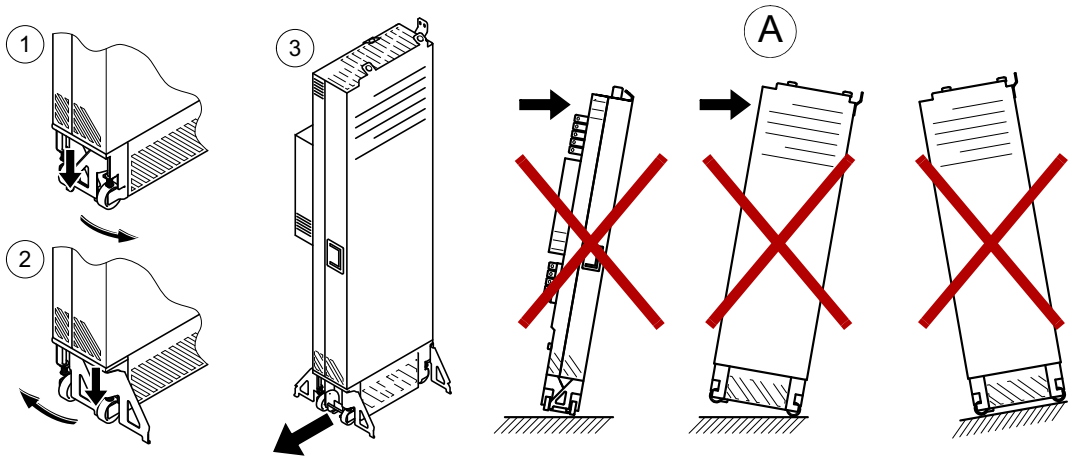
The UDC+ and UDC– terminals are intended for common DC configurations of a number of drives, allowing regenerative energy from one drive to be utilised by the other drives in the motoring mode. For more information, see *Common DC configuration for ACSM1-04 drives application guide* (3AFE68978297 [English]).

Mounting the drive module into the cabinet

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

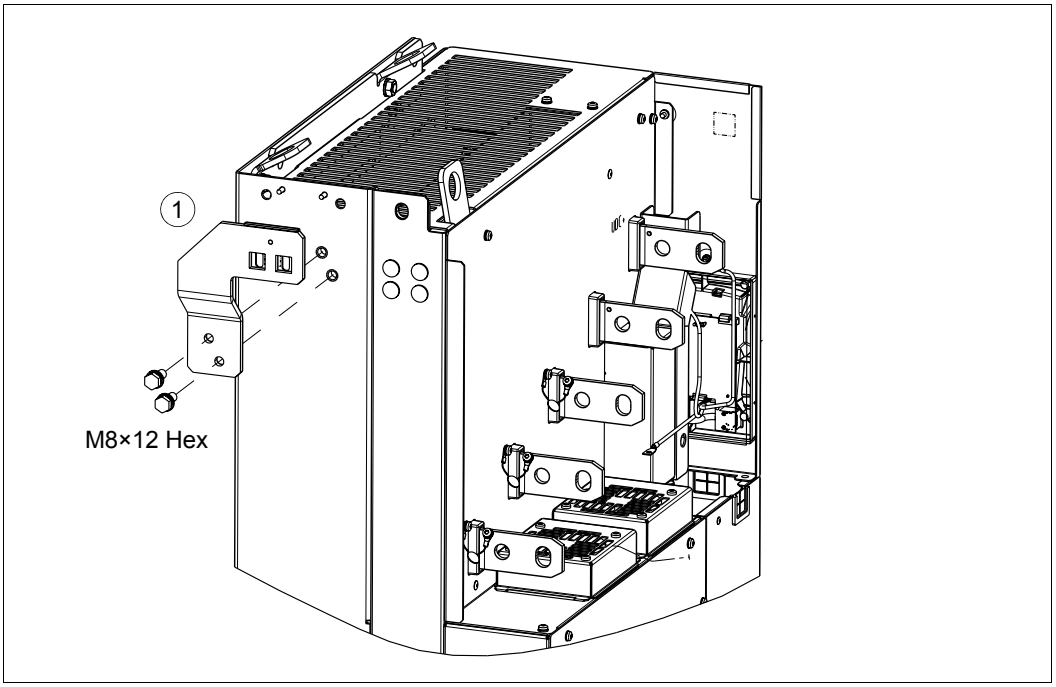
Handle the drive module carefully. Make sure that the module does not fall down when moving it on the floor and during installation and maintenance work: Open the support legs by pressing each leg a little down and turning it aside (1, 2). When ever possible secure the module also with chains from top.

Do not tilt the drive module (A). It is **heavy** (over 160 kg [350 lb]) and its **center of gravity is high.** The module will overturn from a sideways tilt of 5 degrees. Do not leave the module unattended on a sloping floor.

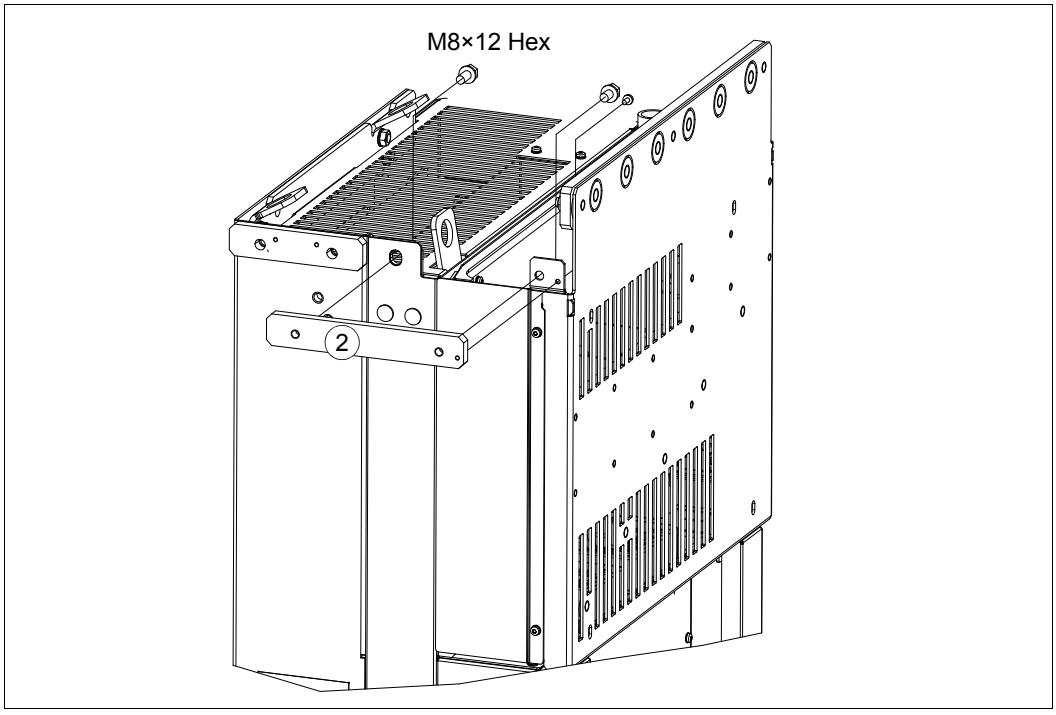


Mounting procedure

1. Mount the fastening bracket to the drive module.



2. Mount the grounding busbar that has been previously mounted to the input cabling panel to the drive module.

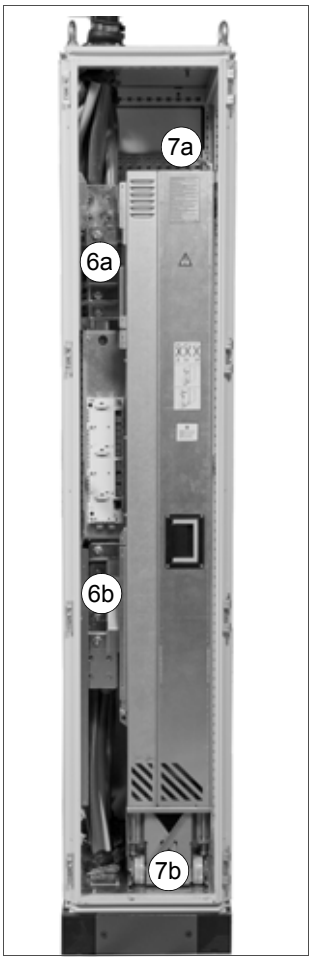


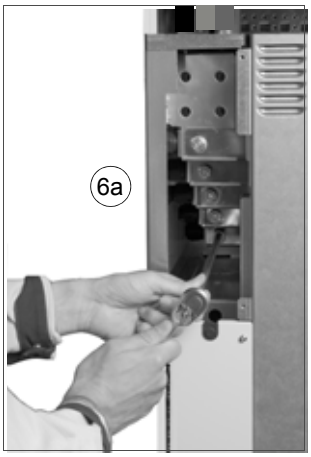
3. Install the extraction and insertion ramp to the cabinet base with two screws.
4. Remove the upper and lower left-side front covers of the drive module. M4×8 combi screws, 2 N· m.
5. Push the drive module carefully into to the cabinet preferably with help from another person.
6. Connect the busbars of the drive module to the busbars of the cabling panels. combi screw M12, 70 N·m (52 lbf·ft).
7. Mount the drive module to the cabinet from top and bottom as shown below and in the assembly drawing on page *93* (frame G1) or page *94* (frame G2). **Note**: The screws ground the module to the cabinet frame.
8. Units with external control unit: Put back the removed front covers of the drive module on the power cable sections.
   Units with internal control unit (option +P905): Put back the removed front covers of the drive module on the power cable sections after connecting the control cables to the control unit.

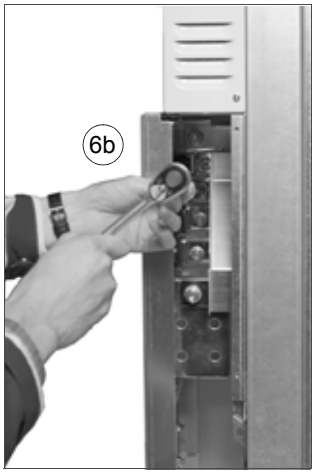

3

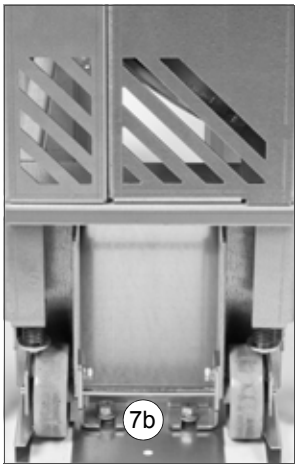

4
8
4
8


5

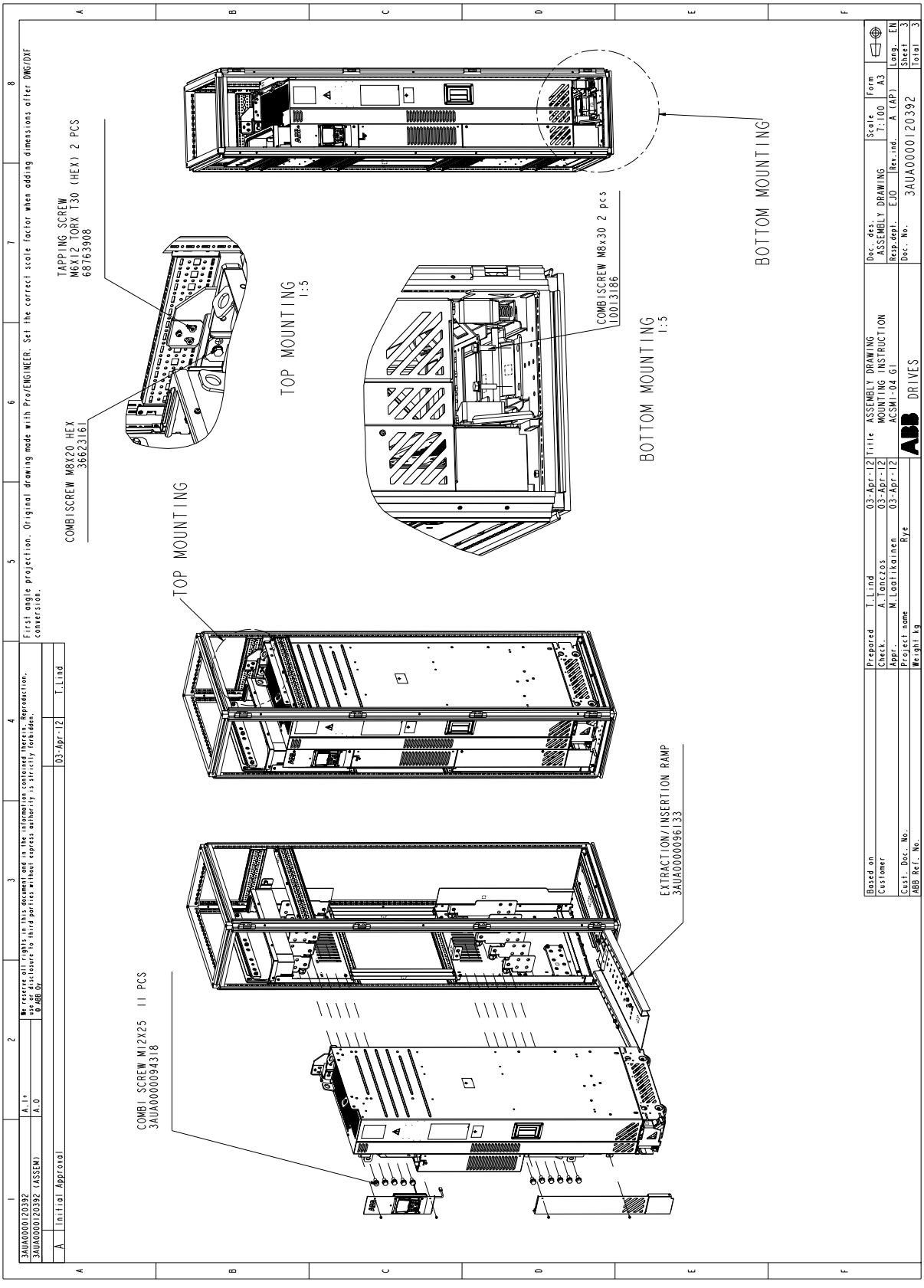

7a
6a
6b
7b


6a

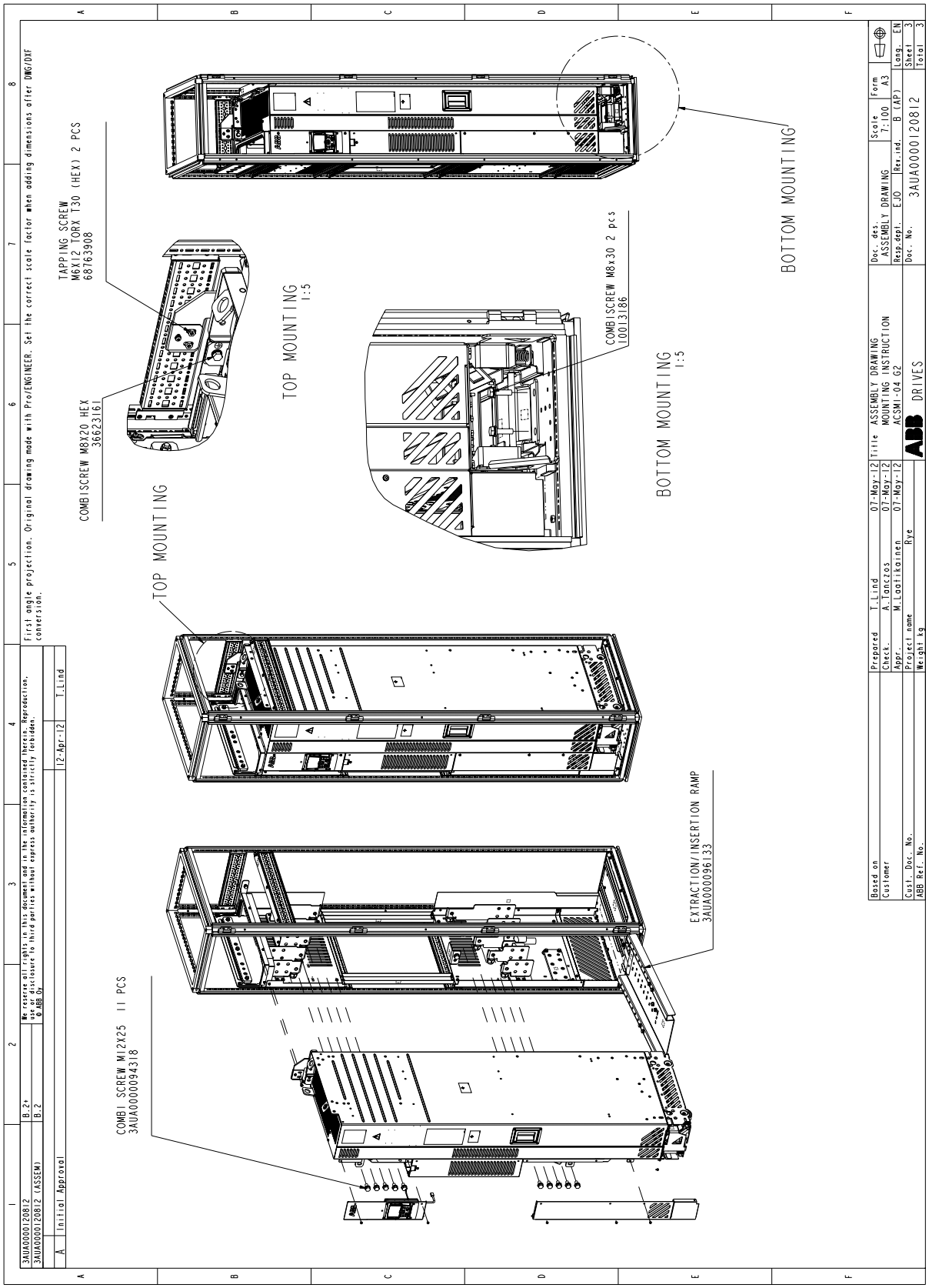

6b


7b

Assembly drawing of installing the drive module to the cabinet (frame G1)



Assembly drawing of installing the drive module to the cabinet (frame G2)



Removing the protective covering from the module air outlet

WARNING! Remove the protective covering from the top of the drive module after the installation. If the covering is not removed, the cooling air cannot flow freely through the module and the drive will run to overtemperature.

Connecting the control cables

Flowchart of the control cable installation process (external control unit)

Step	Task	For instructions, see section
1	Remove the cover assembly of the control unit.	*Removing the cover assembly of the external control unit,* page *96*
2	Fasten the control cable clamp plate to the control unit.	*Fastening the control cable clamp plate,* page *97*
3	Install the optional modules to the control unit (if not mounted yet).	*Installing optional modules,* page *101*
4	Connect the power supply and fiber optic cables between the control unit and the drive module.	*Connecting the external control unit to the drive module,* page *97*
5	Mount the control unit to the wall or DIN rail.	*Mounting the external control unit,* page *99*
6	Connect the external control cables to the control unit and the optional modules.	*Connecting the control cables to the terminals of the control unit,* page *102*
7	Refit the control unit cover assembly	*Removing the cover assembly of the external control unit,* page *96*

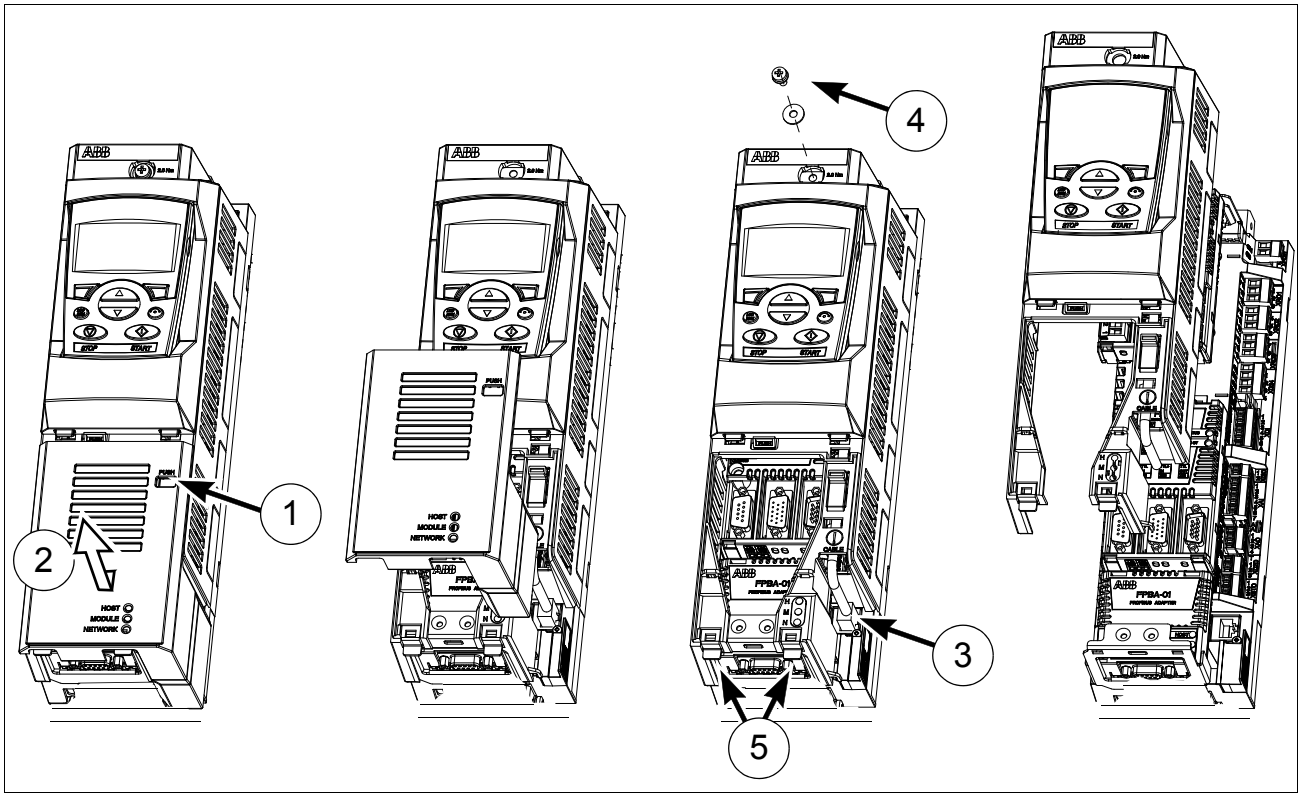
Flowchart of the control cable installation process (internal control unit, option +P905)

Step	Task	For instructions, see section
1	Route the control cables inside the cabinet and connect them.	*Control cable connection procedure of units with internal control unit (option +P905),* page *107*

Removing the cover assembly of the external control unit

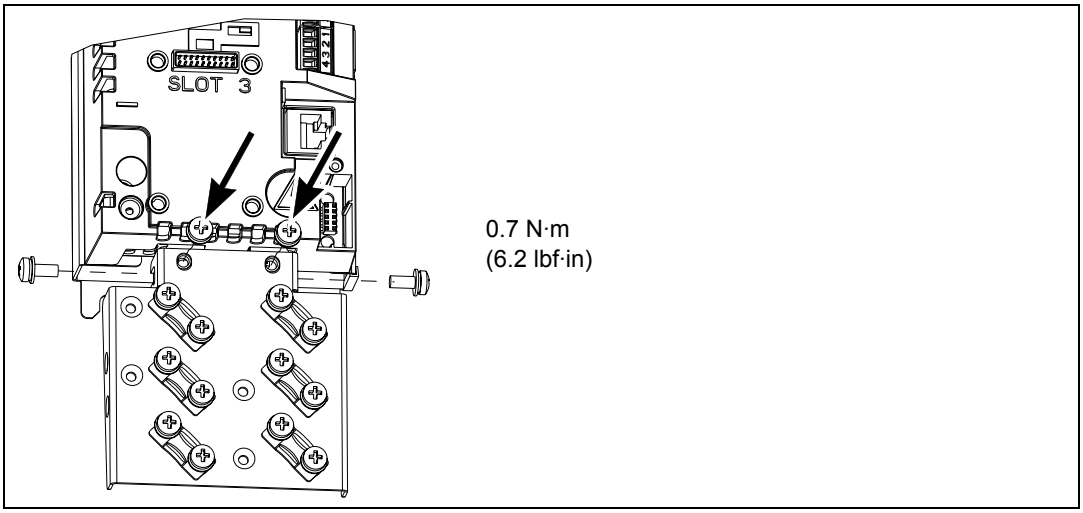
The cover assembly needs to be removed before the installation of optional modules and the connection of control cabling. Follow this procedure to remove the cover assembly. The numbers refer to the illustrations below.

1. Press the tab slightly with a screwdriver.
2. Slide the lower cover plate slightly downwards and pull it out.
3. Disconnect the panel cable if present.
4. Remove the fastening screw at the top of the cover assembly.
5. Carefully pull the lower part of the base outwards by the two tabs.
6. Refit the cover in reverse order to the above when the control cables have been connected.



Fastening the control cable clamp plate

Fasten the control cable clamp plate either to the top or base of the control unit with four screws as shown below.



Connecting the external control unit to the drive module

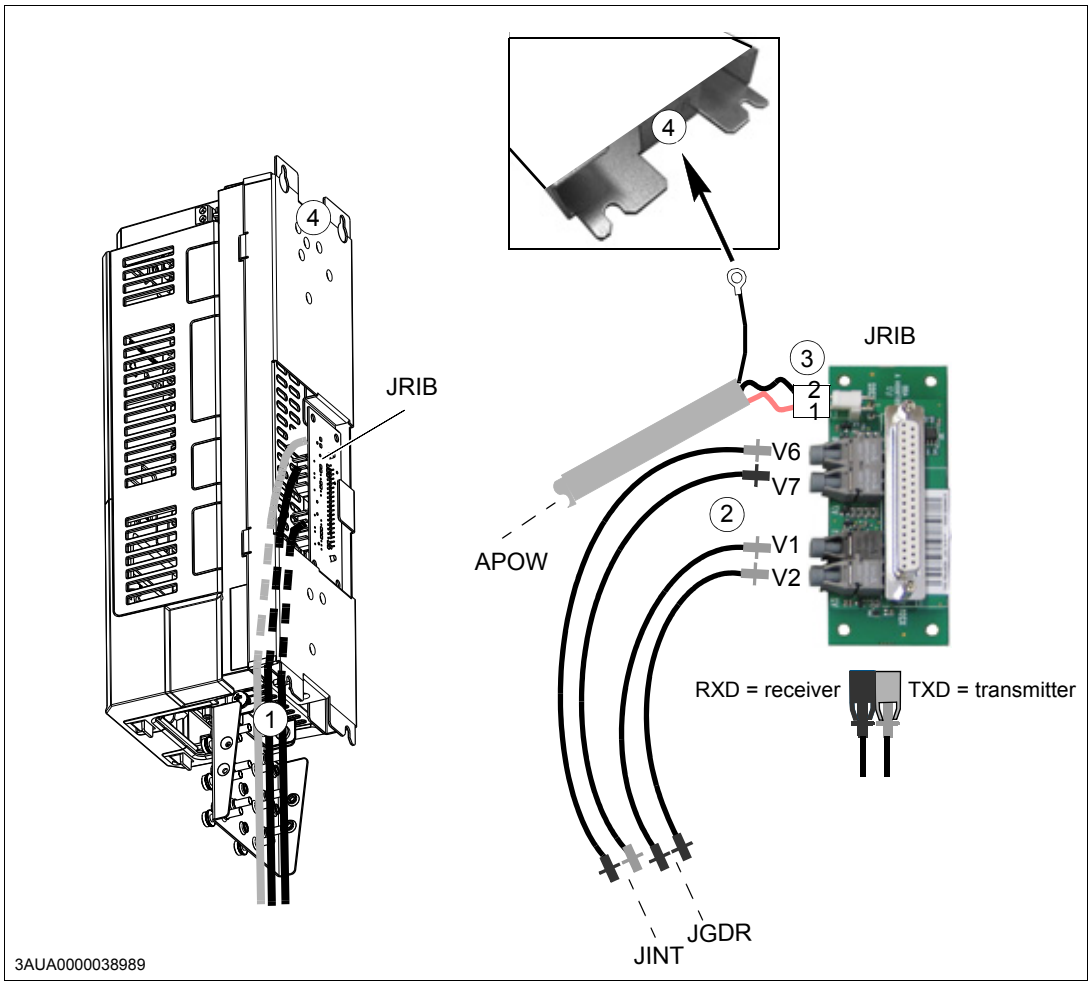
WARNING! Handle the fiber optic cables with care. When unplugging optic cables, always grab the connector, not the cable itself. Do not touch the ends of the fibers with bare hands as the fiber is extremely sensitive to dirt.

Connect the fiber optic cables and power supply cable coming from the drive module through the U-hole in the circuit board compartment cover to the external control unit as follows:

1. Thread the cables inside the back frame of the control unit as shown below.
2. Insert the fiber optic cables to the JRIB board terminals.
3. Connect the power supply wires to the JRIB board terminals.

Connection table	
APOW	JRIB
X3: 1	X202: 1
X3: 2	X202: 2
JINT	JRIB
V1	V1
V2	V2
JGDR	JRIB
V6	V6
V7	V7

4. Connect the APOW cable grounding wire to the grounding terminal at the back top or bottom of the control unit.

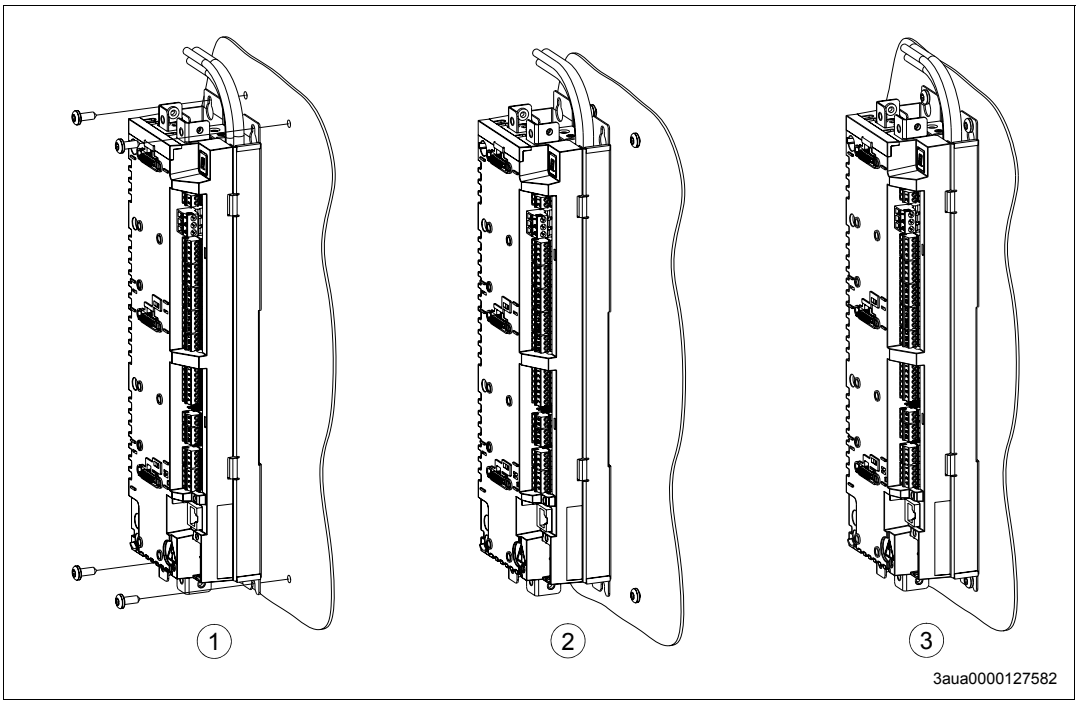

4
JRIB
1
4
JRIB
3
2
1
V6
V7
2
V1
V2
APOW
RXD = receiver
TXD = transmitter
JGDR
JINT
3AUA0000038989

Mounting the external control unit

The drive control unit can be fastened on a mounting plate through the fastening holes in its back or by using a DIN rail.

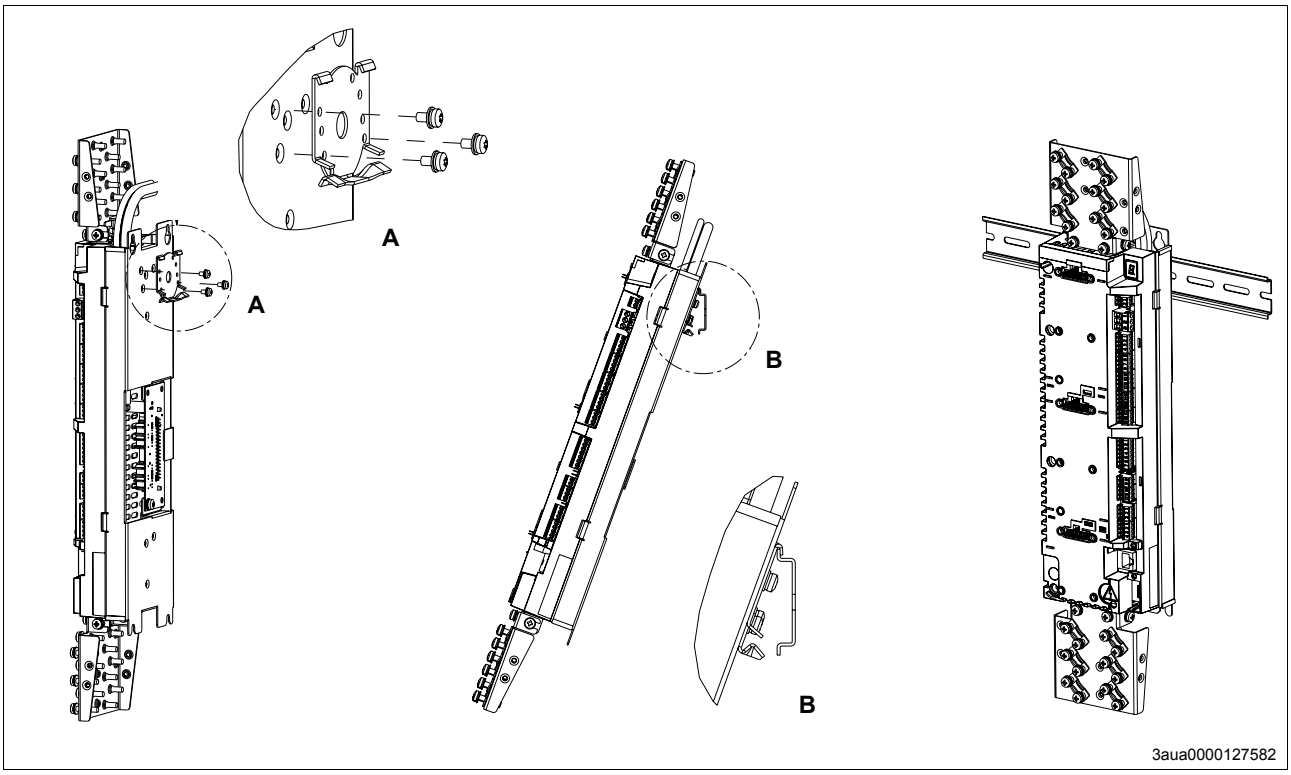
Mounting the external control unit to the wall

1. Fasten the fastening screws in the wall.
2. Lift the unit onto the screws.
3. Tighten the screws.



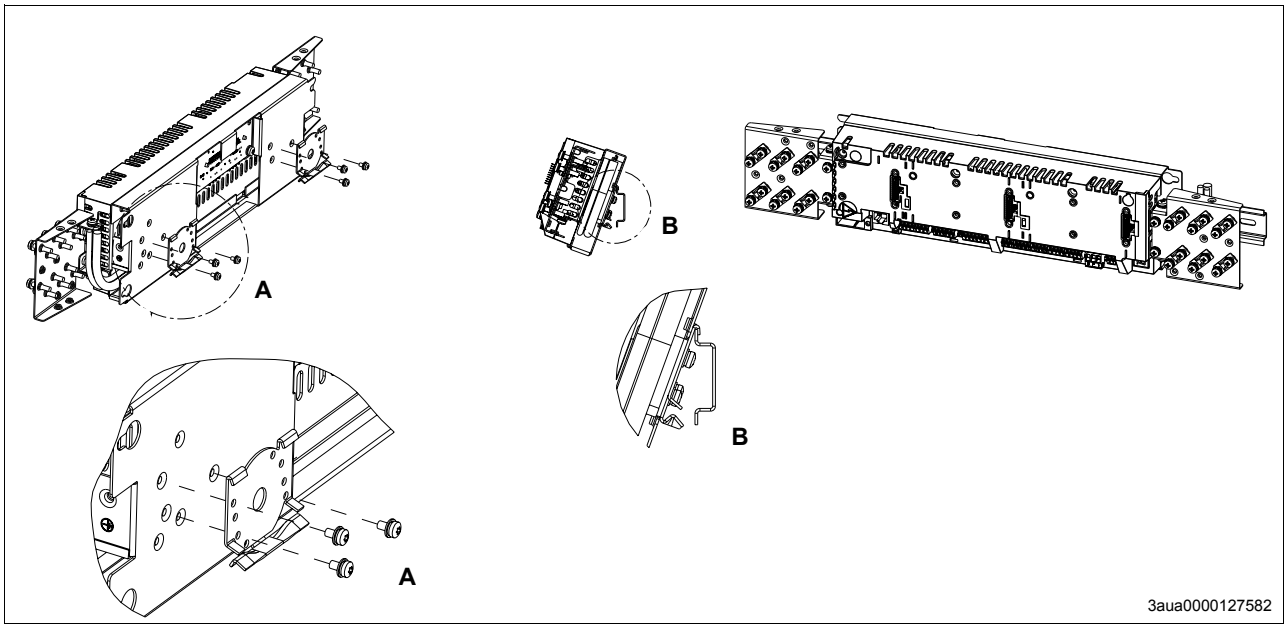
Mounting the external control unit vertically on a DIN rail

1. Fasten the latch (A) to the back of the control unit with three screws.
2. Click the control unit to the rail as shown below (B).



Mounting the control unit horizontally on a DIN rail

1. Fasten the latches (A) to the back of the control unit with three screws.
2. Click the control unit to the rail as shown below (B).



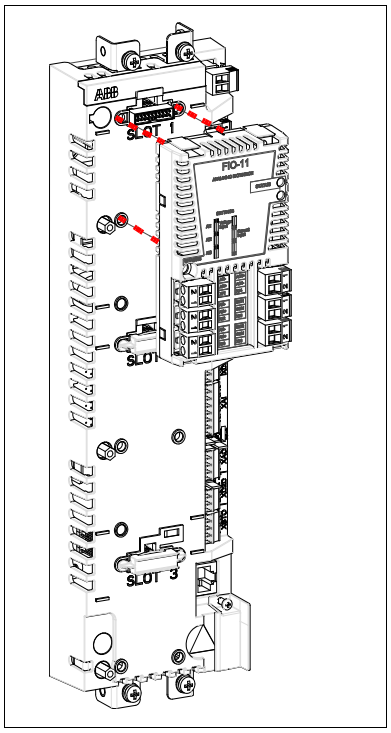
Installing optional modules

Mechanical installation

Optional modules such as a fieldbus adapters, an I/O extensions and the pulse encoder interfaces are inserted in the optional module slot on the control unit. See page *32* for the available slots.

1. Remove the control unit cover.
2. Remove the protective cover (if present) from the connector of the slot.
3. Insert the module carefully into its position on the control unit.
4. Fasten the screw.

Note: Correct installation of the screw is essential for fulfilling the EMC requirements and for proper operation of the module.

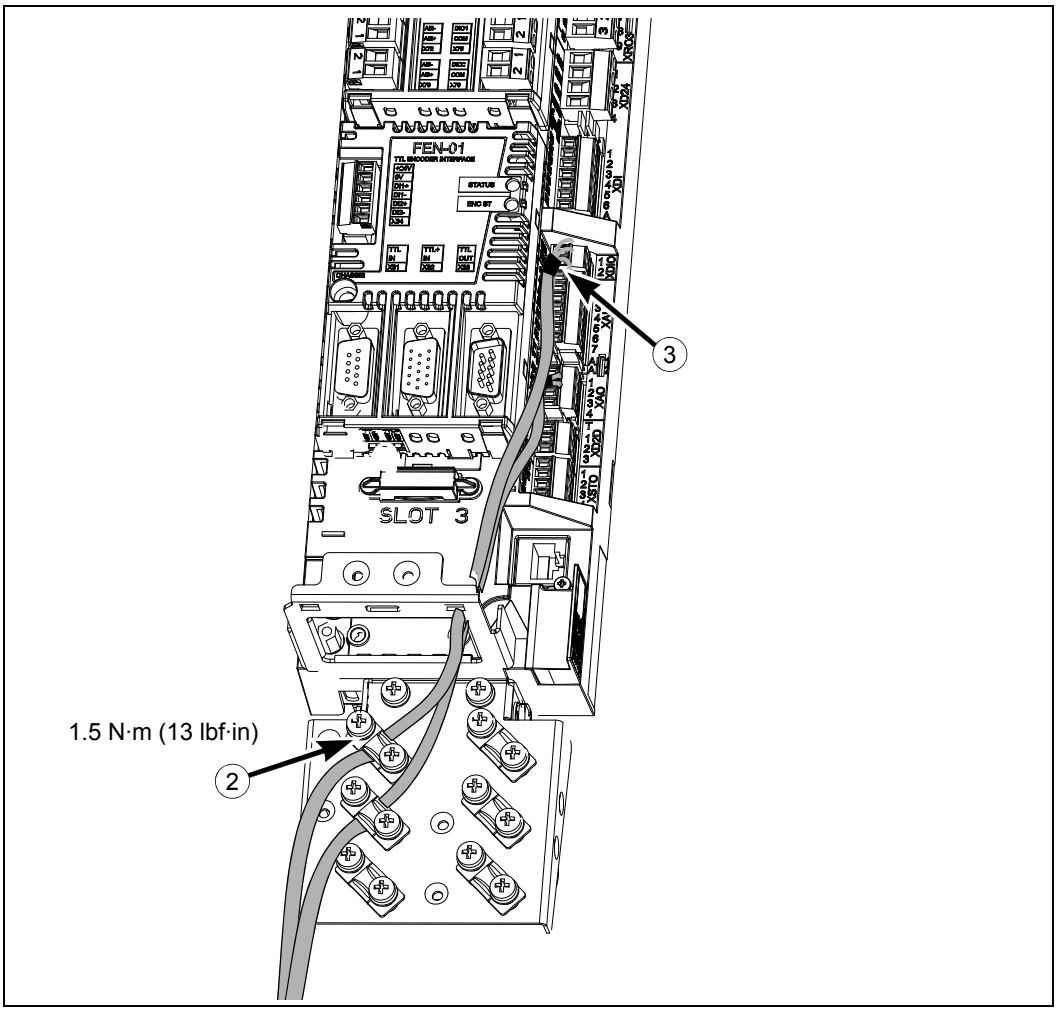


Wiring the modules

See the appropriate optional module manual for specific installation and wiring instructions. See page *102* for routing the cables.

Connecting the control cables to the terminals of the control unit

1. Route the cables to the control unit as shown below.



2. Ground the shields of the control cables at the clamp plate. The shields should be continuous as close to the terminals of the control unit as possible. Only remove the outer jacket of the cable at the cable clamp so that the clamp presses on the bare shield. 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 eg, 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are *in the same ground line* with no significant voltage drop between the end points.Tighten the screws to secure the connection.
3. Connect the conductors to the appropriate detachable terminals of the control unit. See section *Default I/O connection diagram,* page *103.* Use shrink tubing or insulating tape to contain any stray strands.
   Note: 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.

Default I/O connection diagram

Notes:

[Default setting]

*Total maximum current: 200 mA

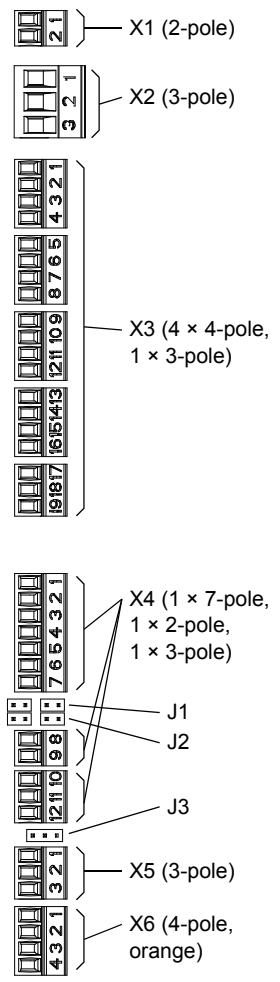
**Default assignment with ACSM1 Motion Control Program

The wiring shown is for demonstrative purposes only. Further information of the usage of the connectors and jumpers are given in the text; see also 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

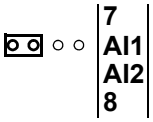


X1		
External power input 24 V DC, 1.6 A	+24VI	1
	GND	2
X2		
Relay output 250 V AC / 30 V DC 2 A	NO	1
	COM	2
	NC	3
X3		
+24 V DC*	+24VD	1
Digital I/O ground	DGND	2
Digital input 1 [Stop/Start]	DI1	3
Digital input 2 [EXT1/EXT2]	DI2	4
+24 V DC*	+24VD	5
Digital I/O ground	DGND	6
Digital input 3 [Fault reset]	DI3	7
Digital input 4 [Positioning start]**	DI4	8
+24 V DC*	+24VD	9
Digital I/O ground	DGND	10
Digital input 5 [Position ref. set 1/2]**	DI5	11
Digital input 6 [Homing start]**	DI6	12
+24 V DC*	+24VD	13
Digital I/O ground	DGND	14
Digital input/output 1 [Ready]	DIO1	15
Digital input/output 2 [Running]	DIO2	16
+24 V DC*	+24VD	17
Digital I/O ground	DGND	18
Digital input/output 3 [Fault]	DIO3	19
X4		
Reference voltage (+)	+VREF	1
Reference voltage (–)	-VREF	2
Ground	AGND	3
Analogue input 1 (Current or voltage, selectable by jumper J1) [Speed reference]	AI1+	4
	AI1-	5
Analogue input 2 (Current or voltage, selectable by jumper J2) [Torque reference]	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) [Output current]	AO1 (I)	10
Analogue output 2 (voltage) [Actual speed]	AO2 (U)	11
Ground	AGND	12
X5		
Drive-to-drive link termination		J3
Drive-to-drive link.	B	1
	A	2
	BGND	3
X6		
Safe torque off. Both circuits must be closed for the drive to start.	OUT1	1
	OUT2	2
	IN1	3
	IN2	4
Control panel connection		
Memory unit connection		

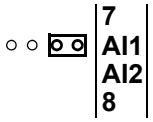
Jumpers

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

Current

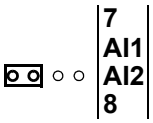


Voltage

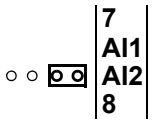


J2 – Determines whether Analogue input AI2 is used as a current or voltage input.

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

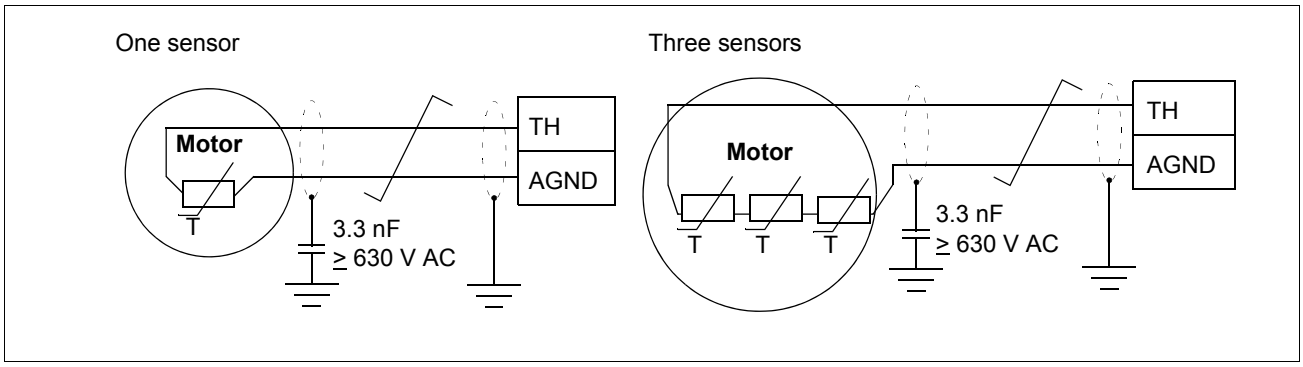
External power supply for the JCU control unit (X1)

External +24 V (minimum 1.6 A) power supply for the 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.

Thermistor input (X4:8...9)

1…3 PTC sensors can be connected to this input for motor temperature measurement.



Notes:

- Do not connect both ends of the cable shields directly to ground. If a capacitor cannot be used at one end, leave that end of the shield unconnected.
- The connection of temperature sensors involves parameter adjustment. See the *Firmware manual* of the drive.
- PTC (as well as KTY84) sensors can alternatively be connected to a FEN-xx encoder interface. See the *User's manual* of the interface for wiring information.

WARNING! As the inputs pictured above are not insulated according to IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. If the assembly does not 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.

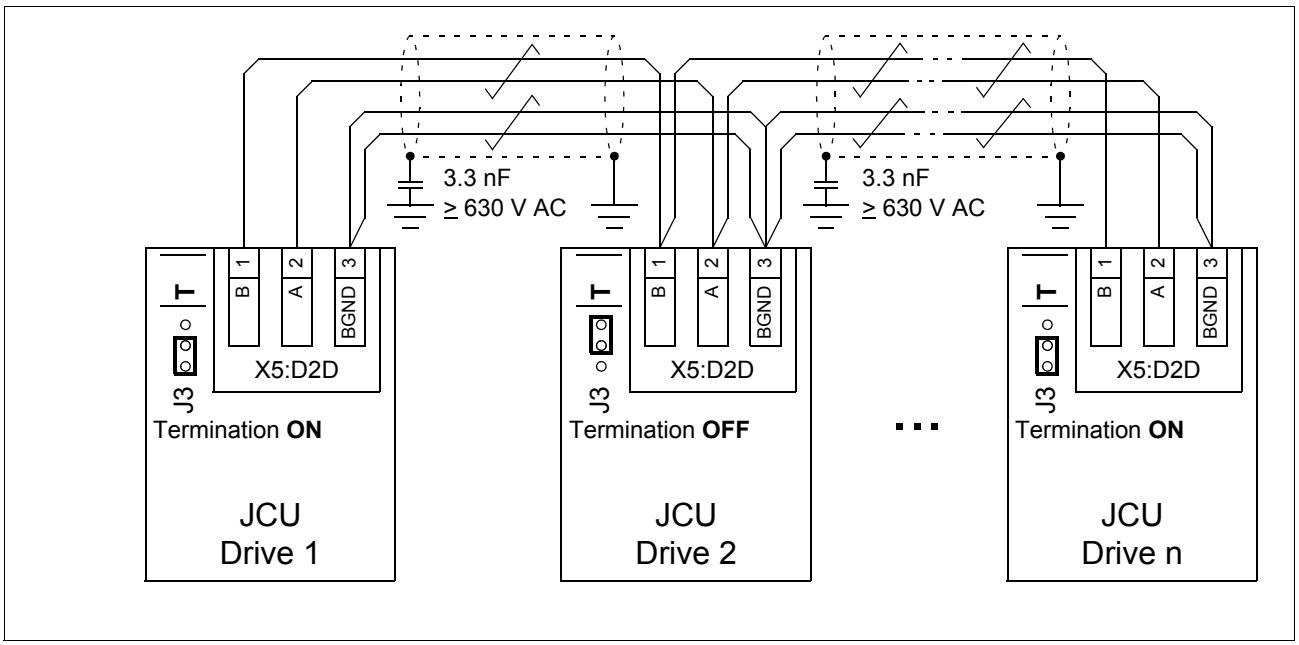
Drive-to-drive link (X5)

The drive-to-drive link is a daisy-chained RS-485 transmission line that allows basic master/follower communication with one master drive and multiple followers.

Termination activation jumper J3 (see section *Jumpers* above) next to this terminal block must be set to the ON position on the drives at the ends of the drive-to-drive link. On intermediate drives, the jumper must be set to the OFF position.

Shielded twisted-pair cable (~100 ohm, for example PROFIBUS-compatible cable) must be used for the wiring. For best immunity, high quality cable is recommended. The cable should be kept as short as possible; the maximum length of the link is 50 meters (164 ft). Unnecessary loops and running the cable near power cables (such as motor cables) must be avoided. The cable shields must to be grounded to the control cable clamp plate on the drive as shown on page *102*.

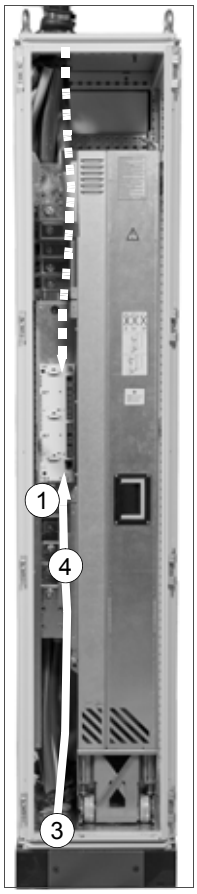
The following diagram shows the wiring of the drive-to-drive link.



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 chapter *Safe torque off (STO) function* on page *155*.

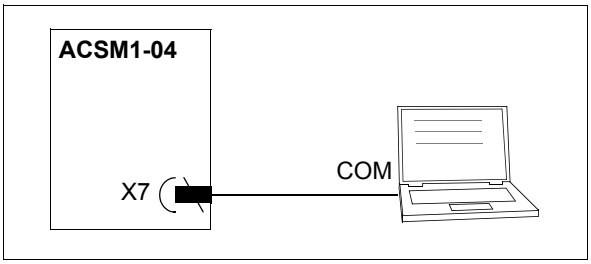
Control cable connection procedure of units with internal control unit (option +P905)



1. Fasten the clamp plate to the control unit with two screws from front, see *Fastening the control cable clamp plate* on page *97*.
2. Fasten the optional modules if not fastened already.
3. Lead the control cables inside the drive cabinet.
4. Route the control cables along the control cable duct from bottom or top to the control unit.
5. Ground the outer control cable shields 360 degrees at the cabinet lead-through plate (recommendation).
6. Ground the control cables at the clamp plate as described in bullet 2 under *Connecting the control cables to the terminals of the control unit* on page *103*.
7. Connect the conductors to the appropriate detachable terminals of the control unit (see page *103)*. Use shrink tubing or insulating tape to contain any stray strands. Tighten the screws to secure the connection.
   Note: 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.

Connecting a PC

Connect the PC to the drive control unit as follows:.



Installation checklist

What this chapter contains

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

Installation checklist

Go through the checklist below together with another person.

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment

☑	**Check that …**
Cabinet construction	
☐	The drive module is fastened properly to the cabinet. (See chapters *Planning the cabinet installation* and *Installation*.)
☐	Mechanical joints are tightened and not broken.
☐	Parts are clean and painted surfaces not scratched. The cabinet frame and parts which are in metal to metal contact with the frame (for example seams, component fixing points on assembly plates, back of control unit mounting plate) are **not** finished with non-conducting paint or material.
☐	Degree of protection (IPxx)
Drive option modules and other components	
☐	Type and number of option modules and other equipment is correct. Option modules and other equipment are not damaged.
☐	Option modules and terminals are labelled correctly.
☐	The placement of option modules and other equipment inside the cabinet and on the cabinet door is correct.
☐	The mounting of option modules and other equipment is correct.
Internal cabling of the cabinet assembly	
☐	Main circuit: • AC supply input cabling is ok. • AC output cabling is ok. • Supply for braking resistor (if used) is ok.
☐	Cable types, cross-sections, colours and optional markings are correct.
☐	Cabling is not susceptible to interference. Check the twisting of cables and cable routes.

☑	Check that …
☐	Connection of cables to devices, terminal blocks and drive module circuit boards: • Cables are connected to terminals tight enough by pulling the cable. • Cable termination on terminals chaining is done correctly. • Bare conductors are not too far outside the terminal causing an insufficient clearance or loss of shielding against contact. • JCU control unit is wired properly to the drive module. • Control panel cable is connected properly.
☐	Cables are not lying against sharp edges or bare live parts. Bending radius of fiber optic cables at least 3.5 cm (1.38 in.).
☐	The type, markings, insulation plates and cross connections of terminal blocks are correct.
Grounding and protection	
☐	The grounding colors, cross-section and grounding points of modules and other equipment match the circuit diagrams. No long routes for pigtails.
☐	Connections of PE cables and busbars are tight enough. Pull the cable to test that it does not loosen. No long routes for pigtails.
☐	Doors equipped with electrical equipment are grounded. No long grounding routes. From EMC standpoint best result is achieved with a flat copper braid.
☐	Fans that can be touched are shrouded.
☐	Live parts inside the doors are protected against direct contact to at least IP2x.
Labels	
☐	The type designation labels and warning and instruction stickers are made according to the local regulations and placed correctly.
Switches and doors	
☐	Mechanical switches, main disconnecting switch and cabinet doors function properly.
Installation of the cabinet	
☐	The drive cabinet has been fixed to floor and also from top to the wall or roof.
☐	The ambient operating conditions meet the specifications given in chapter *Technical data*.
☐	The cooling air will flow freely in and out of the drive cabinet, and air recirculation inside the cabinet will not be possible (air baffle plates are on place).
☐	If the drive has been stored over one year: The electrolytic DC capacitors in the DC link of the drive have been reformed. See page *124*.
☐	There is an adequately sized protective ground conductor between the drive and the switchboard.
☐	There is an adequately sized protective ground conductor between the motor and the drive.
☐	All protective ground conductors have been connected to the appropriate terminals and the terminals have been tightened. (Pull the conductors to check.)
☐	The enclosures of the equipment in the cabinet have proper galvanic connection to the cabinet protective earth (ground) busbar; The connection surfaces at the fastening points are bare (unpainted) and the connections are tight, or separate grounding conductors have been installed.

☑	**Check that …**
☐	The supply voltage matches the nominal input voltage of the drive. Check the type designation label.
☐	The input power cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull the conductors to check.)
☐	Appropriate AC fuses and main disconnector have been installed.
☐	The motor cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull the conductors to check.)
☐	The braking resistor (if present) has been connected to the appropriate terminals, and the terminals have been tightened. (Pull the conductors to check.)
☐	The motor cable (and braking resistor cable, if present) has been routed away from other cables.
☐	The braking resistor cable has been routed away from other cables.
☐	No power factor compensation capacitors have been connected to the motor cable.
☐	The control cables (if any) have been connected to the appropriate terminals, and the terminals have been tightened. (Pull the conductors to check.)
☐	If a drive bypass connection will be used: The direct-on-line contactor of the motor and the drive output contactor are either mechanically or electrically interlocked, ie, cannot be closed simultaneously.
☐	There are no tools, foreign objects or dust from drilling inside the drive.
☐	All shrouds and cover of the motor connection box are in place. Cabinet doors have been closed.
☐	The motor and the driven equipment are ready for start.

Start-up

What this chapter contains

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

Start-up procedure

1. Ensure that the installation of the drive has been checked according to the checklist in chapter *Installation checklist,* and that the motor and driven equipment are ready for start.
2. Perform the start-up tasks instructed by the cabinet-installer of the drive module.
3. Switch the power on and set-up the drive control program according to the start-up instructions given in the drive *Firmware manual*.

Fault tracing

What this chapter contains

This chapter describes the fault tracing possibilities of the drive.

LEDs

This table describes LEDs of the drive module.

Where	LED	When the LED is lit
JINT board	V204 (green)	+5 V voltage of the board is OK.
	V309 (red)	Not in use.
	V310 (green)	IGBT control signal transmission to the gate driver control boards is enabled.
BFPS board	V79 (green)	+5 V voltage of the board is OK.

Warning and fault messages

See the *Firmware manual* for the descriptions, causes and remedies of the control program warning and fault messages.

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.

Display	Meaning
“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*.

Maintenance

What this chapter contains

This chapter contains preventive maintenance instructions of the drive module.

Applicability

The drive module replacement described in this chapter applies to the Rittal TS 8 example installation of chapter *Installation*. The other maintenance instructions are general.

Maintenance intervals

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

Interval	Maintenance	Instruction
Every year	Checking main cooling fan and circuit board cooling fan, tightness of terminals, dustiness, corrosion, temperature and quality of supply voltage.	Maintenance if needed. See sections *Cabinet* and *Heatsink* on page *119*.
Every year when stored	Capacitor reforming	See section *Reforming the capacitors* on page *124*.
Every 3 years	Checking the condition of fiber optic cables	See the fault logger. If PPCC LINK faults have recurred, change the fiber optic cables.
Every 3 years	Circuit board compartment cooling fan	See *Fans* on page *120*.
Every 9 years. **Every 6 years** if ambient temperature in continuous operation is over 40 °C (104 °F).	Main cooling fan change	See *Fans* on page *120*.
Every 6 years **Every 3 years** if the ambient temperature is 40 °C (104 °F) or cyclic heavy load or continuous nominal load.	Change of DC circuit electrolytic capacitors and discharging resistors	Contact ABB.
Every 9 years	JINT board and flat cable change, BFPS board, BGAD board and JGDR board change	Contact ABB.

Every 9 years	Control panel battery replacement.	The battery is housed on the rear of the control panel. Replace with a new CR 2032 battery.

Consult your local ABB Service representative for more details on the maintenance. On the Internet, go to http://www.abb.com/drivesservices.

Cabinet

Cleaning the interior of the cabinet

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

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

1. Ensure that the drive is disconnected from the power line and all other precautions described under *Safety in installation and maintenance* on page *14* have been taken into consideration.
2. When necessary, clean the interior of the cabinet with a soft brush and a vacuum cleaner.

Heatsink

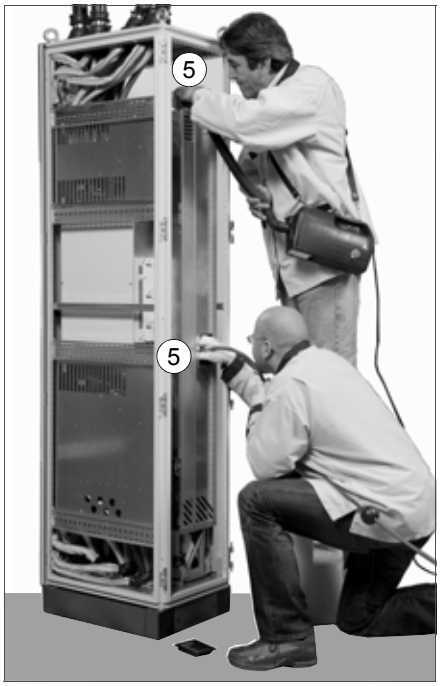
The module heatsink fins pick up dust from the cooling air. The drive runs into overtemperature warnings and faults if the heatsink is not clean.

Cleaning the interior of the heatsink

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

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

1. Ensure that the drive is disconnected from the power line and all other precautions described under *Safety in installation and maintenance* on page *14* have been taken into consideration.
2. Undo the fastening screws of the handle plate of the drive module.
3. Remove the handle plate.
4. Vacuum the interior of the heatsink from the opening.
5. Blow compressed air upwards from the opening and, at the same time, vacuum from the top of the drive module.



Fans

The actual lifespan depends on the running time of the fan, ambient temperature and dust concentration. See the *Firmware manual* for the actual signal which indicates the running time of the cooling fan. For resetting the running time signal after a fan replacement, please contact ABB.

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

Replacing the circuit board compartment cooling fan

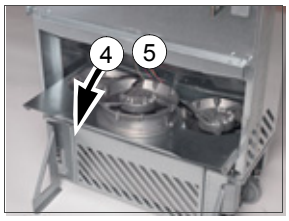
WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

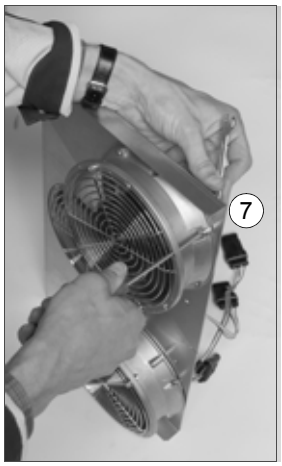
1. Remove the drive module out of the cabinet as described in section *Replacing the drive module* on page *122*.
2. Undo the fastening screw of the fan enclosure.
3. Unplug the power supply cable of the fan.
4. Install the new fan in reverse order to the above.

Replacing the main cooling fans

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Remove the drive module out of the cabinet as described in section *Replacing the drive module* on page *122*.
2. Open the support legs of the pedestal.
3. Undo the two screws that fasten the fan assembly plate.
4. Tilt the fan assembly plate down.
5. Disconnect the power supply wires of the fans.
6. Remove the fan assembly from the drive module.
7. Undo the fastening screws of the fan(s) and remove the fan(s) from the assembly plate.
8. Install the new fan(s) in reverse order to the above.



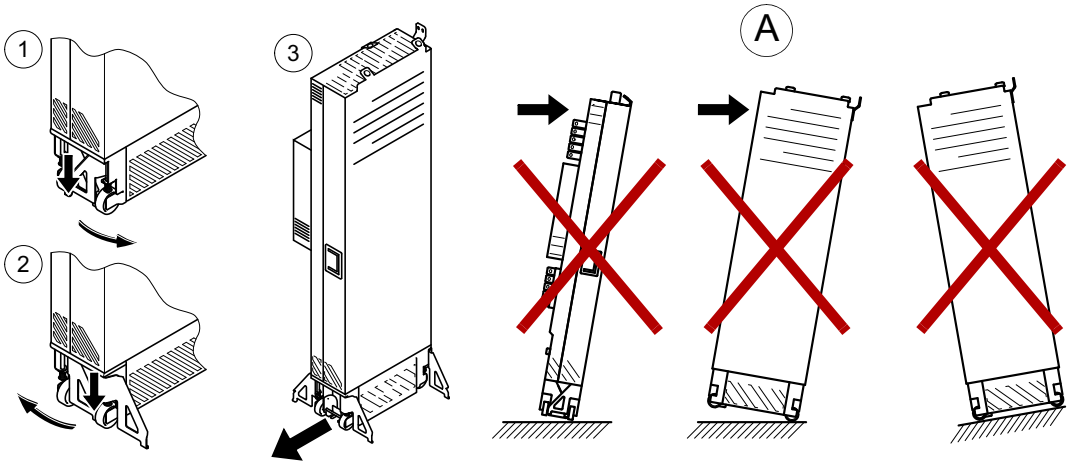


Replacing the drive module

WARNING! Follow the safety instructions on page *14*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

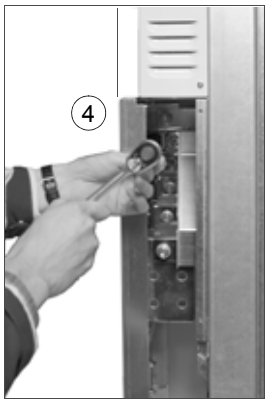
Handle the drive module carefully. Make sure that the module does not fall down when moving it on the floor and during installation and maintenance work: Open the support legs by pressing each leg a little down and turning it aside (1, 2). When ever possible secure the module also with chains.

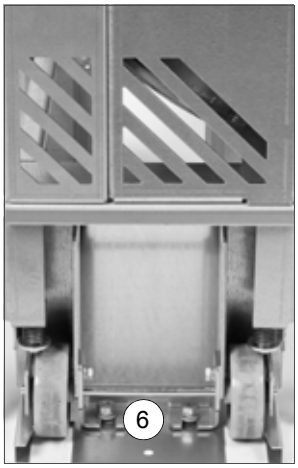
Do not tilt the drive module (A). It is **heavy** (over 160 kg [350 lb]) and its **center of gravity is high.** The module will overturn from a sideways tilt of 5 degrees. Do not leave the module unattended on a sloping floor.



1. Ensure that the drive is disconnected from the power line and all other precautions described under *Safety in installation and maintenance* on page *14* have been taken into consideration.
2. Remove the left-hand side upper and lower front covers of the drive module by undoing the fastening screws. M4×8 combi screws, 2 N·m.
3. Disconnect the drive module busbars from the input cabling panel. Combi screw M12, 70 N·m (52 lbf·ft).
4. Disconnect the drive module busbars from the output cabling panel. Combi screw M12, 70 N·m (52 lbf·ft).
5. Undo the screws that fasten the drive module to the cabinet at the top and behind the front support legs.
6. Fasten the extraction ramp to the cabinet base with two screws.
7. Disconnect the power supply cable and the fibre optic cables from the external control unit and coil them on the top of the drive module. If you have an internal control unit (+P905), detach the control unit from the drive module by undoing the fastening screws below the optional modules and turn the control unit and the cables aside. (Alternatively remove the clamp plate, and disconnect the cables from the control unit.)

8. Pull the drive module carefully out of the cabinet preferably with help from another person.
9. Install the new module in reverse order to the above.





Capacitors

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

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

Reforming the capacitors

The capacitors must be reformed if the drive module has been stored for a year or more. See page *34* for information on finding out the manufacturing date. For the reforming instructions, see *Converter modules with electrolytic DC capacitors in the DC link, capacitor reforming instructions* (3BFE64059629 [English]).

Memory unit

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. The memory unit is located in the JCU control unit, see page *31*.

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 several minutes.

Technical data

What this chapter contains

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

Ratings

The ratings of the drive modules with 400 V, 480 V and 500 V (50 Hz and 60 Hz) supply with 4 kHz switching frequency (f_{sw}) are given below.

Drive type ACSM1-04Ax…	**Frame size**	**Input rating**		**Output ratings / f_{sw} = 4 kW**					
				Nominal use		150% heavy-duty use		200% heavy-duty use	
		I_{1N}	$I_{2,max}$	I_{2N}	P_N	$I_{2Hd,max}$ / I_{2Hd}	P_{Hd}	$I_{2Hd,max}$ / I_{2Hd}	P_{Hd}
		A	**A**	**A**	**kW / hp**	**A**	**kW / hp**	**A**	**kW / hp**
U_N = 400 V									
-390A-4	G1	390	560	390	200 / -	450 / 300	160 / -	560 / 280	132 / -
-500A-4	G1	500	660	500	250 / -	555 / 370	200 / -	660 / 330	160 / -
-580A-4	G2	580	850	580	315 / -	720 / 480	250 / -	850 / 425	200 / -
-635A-4	G2	635	900	635	355 / -	760 / 507	250 / -	900 / 450	250 / -
U_N = 480 V									
-390A-4	G1	350	560	350	- / 250	400 / 267	- / 200	500 / 250	- / 200
-500A-4	G1	450	660	450	- / 350	500 / 333	- / 250	600 / 300	- / 200
-580A-4	G2	530	850	530	- / 450	654 / 436	- / 350	774 / 387	- / 300
-635A-4	G2	580	900	580	- / 450	700 / 467	- / 350	840 / 420	- / 350
U_N = 500 V									
-390A-4	G1	350	560	350	200 / -	400 / 267	160 / -	500 / 250	160 / -
-500A-4	G1	450	660	450	250 / -	500 / 333	200 / -	600 / 300	200 / -
-580A-4	G2	530	850	530	315 / -	654 / 436	250 / -	774 / 387	250 / -
-635A-4	G2	580	900	580	355 / -	700 / 467	315 / -	840 / 420	250 / -

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I_{1N}	Nominal input current (rms) at 40 °C (104 °F)
I_{max}	Maximum output current. Available for 10 seconds at start, otherwise as long as allowed by drive temperature.
I_{2N}	Continuous rms output current. No overload capability at 40 °C (104 °F)
P_N	Typical motor nominal power in no-overload use based on I_{2N}
$I_{2Hd,max}$ / I_{2Hd}	Output current for heavy-duty use with 150% I_{2Hd} and 200% I_{2Hd} overloads. 150% heavy-duty current ($I_{2Hd,max)}$ is allowed for 1 minute every 5 minutes. 200% heavy-duty current ($I_{2Hd,max}$) is allowed for 10 seconds every 60 seconds.
P_{Hd}	Typical motor power in heavy-duty use based on I_{2Hd}
Note: To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current. The power ratings apply to most IEC 34 motors at the nominal voltage of 400 V or 500 V. The DriveSize dimensioning tool available from ABB is recommended for selecting the drive, motor and gear combination for the required motion profile.	

Derating

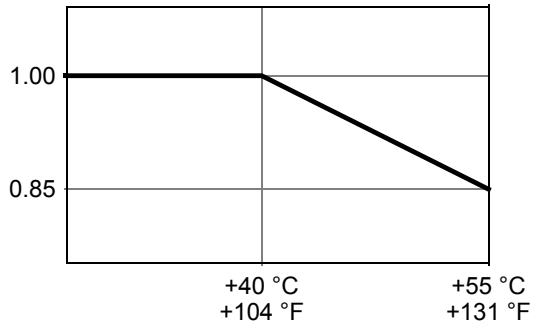
The continuous output currents stated above must be derated if any of the following conditions apply:

- ambient temperature exceeds +40 °C (+104°F)
- drive is installed higher than 1000 m (3280 ft) 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 rated output current is derated by 1% for every added 1 °C (1.8 °F) 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.

Fuses (IEC)

Ultrarapid (aR) fuses							
Drive type ACSM1-04Ax…	**Input current** A	**Fuse**					
		A	A^2s	V	Manufacturer	Type DIN 43620 	Size
-390A-4	390	630	220000	690	Bussmann	170M6810D	DIN3
-500A-4	500	800	490000	690	Bussmann	170M6812D	DIN3
-580A-4	580	1000	985000	690	Bussmann	170M6814D	DIN3
-635A-4	635	1000	985000	690	Bussmann	170M6814D	DIN3

Note 1: See also *Implementing thermal overload and short-circuit protection* on page *61*.

Note 2: In multicable installations, install only one fuse per phase (not one fuse per conductor).

Note 3: Larger fuses than the recommended ones must not be used.

Note 4: Fuses from other manufacturers can be used if they meet the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

Note 5: For UL fuses, contact ABB.

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Dimensions, weights and free space requirements

Drive type ACSM1-04Ax…	H1 mm	H2 mm	W1 mm	W2 mm	D1 mm	D2 mm	Weight 1 kg
-390A-4	1462	1560	305	329	505	515	171
-500A-4	1462	1560	305	329	505	515	171
-580A-4	1662	1710	305	329	505	515	208
-635A-4	1662	1710	305	329	505	515	208

Drive type ACSM1-04Ax…	H1 in.	H2 in.	W1 in.	W2 in.	D1 in.	D2 in.	Weight 1 lb
-390A-4	57.56	61.42	12.01	12.95	19.88	20.28	377
-500A-4	57.56	61.42	12.01	12.95	19.88	20.28	377
-580A-4	65.43	67.32	12.01	12.95	19.88	20.28	459
-635A-4	65.43	67.32	12.01	12.95	19.88	20.28	459

H1 Height of the basic unit.

H2 Height of the unit with optional cabling panels (+H381).

Note: The no pedestal option (+H354) reduces the height of the unit by 125 mm (4.92 in).

W1 Width of the basic unit.

W2 Width of the unit with optional cabling panels (+H381).

D1 Depth of the basic unit.

D2 Depth of the unit with optional cabling panels (+H381).

Weight Weight of the basic unit with pedestal, braking chopper and DC terminals. The weights of additional options are shown below in the table. The weights of options +D150 and +H381 vary depending on what other options are installed. The lower portion of the table shows the total weight of the two options when installed in combinations.

E208	0D150	H381	0H354	Weight (G1)		Weight (G2)	
				kg	lb	kg	lb
x				+3	+6.6	+3	+6.6
	x			-10	-22	-9	-20
		x		+30	+66	+30	+66
			x	-7	-15	-7	-15

For requirements of free space around the drive module, see page 46.

Losses, cooling data and noise

Drive type ACSM1-04Ax…	Frame size	Air flow		Heat dissipation	Noise
		m^3/h	ft^3/min	W	dB(A)
-390A-4	G1	1200	707	4950	72
-500A-4	G1	1200	707	6365	72
-580A-4	G2	1200	707	7495	72
-635A-4	G2	1420	848	8200	71

Terminal and lead-through data for the power cables

The maximum accepted cable size is 4 × (3 × 240) mm^2 or 4 × (3 × 500 AWG). Screw size for connecting busbars to the drive module input and output busbars: M12, tightening torque 50...75 N·m.

Units with optional common mode filter (+E208)

When common mode filter +E208 is selected, it is not possible to use the maximum accepted cable size 4 × (3 × 240) mm2 or 4 × (3 × 500 AWG) without the optional cabling panels (option +H381).

Units with optional cabling panels (+H381)

The maximum accepted cable size is 4 × (3 × 240) mm^2 or 4 × (3 × 500 AWG). The cabling panels are connected to the drive module busbars with M12 serpress nuts, tightening torque 30 N·m (20 lbf·ft).

Input, motor and braking resistor cable terminal sizes and tightening torques are given below.

U1, V1, W1, U2, V2, W2, UDC+, UDC-, R+, R-		Grounding busbar	
Screw	Tightening torque N-m	Screw	Tightening torque N-m
M12	50...75	M10	30...44

U1, V1, W1, U2, V2, W2, UDC+, UDC-, R+, R-		Grounding busbar	
Screw	Tightening torque lbf·ft	Screw	Tightening torque lbf·ft
1/2	37...55	3/8	22...32

Two-hole 1/2 inch diameter cable lugs can be used.

Units without optional cabling panels (no +H381)

In units without optional cabling panels (option +H381 not selected), it is possible to use the maximum cable size (4 × (3 × 240) mm2 or 4 × (3 × 500 AWG) only with special cable lugs and additional insulation. For more information, contact your local ABB representative.

Terminal data for the control cables

See page 103.

Electrical power network specification

Voltage (U_1)	380...500 VAC 3-phase ± 10%
Rated conditional short-circuit current (IEC 60439-1)	65 kA when protected by fuses given in the fuse tables
Frequency	48 to 63 Hz, maximum rate of change 17%/s
Imbalance	Max. ± 3% of nominal phase to phase input voltage
Fundamental power factor (cos phi$_1$)	0.98 (at nominal load)

Motor connection data

Motor types	Asynchronous motors (standard induction, servo) and synchronous motors (servo, high torque)
Voltage (U_2)	0 to U_1, 3-phase symmetrical, U_{max} at the field weakening point
Frequency	DTC mode: 0 to 3.2 · f_f. Maximum frequency 500 Hz (120 Hz with du/dt or sine filter). $f_f = \frac{U_N}{U_m} \cdot f_m$ f_f: frequency at field weakening point; U_N: electrical power system voltage; U_m: nominal motor voltage; f_m: nominal motor frequency
Frequency resolution	0.01 Hz
Current	1/6 • I_{2N} … 2 • I_{2N}
Nominal motor frequency	0…500 Hz max
Switching frequency	Selectable between 1...4 kHz (default 4 kHz)
Maximum recommended motor cable length	

DTC control	Scalar control
300 m (984 ft)	300 m (984 ft)

Note: With motor cable longer than 100 m (328 ft) the EMC Directive requirements of Category C3 may not be fulfilled, see page 135.

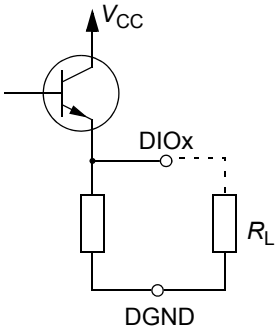
Braking resistor connection data

See page 153.

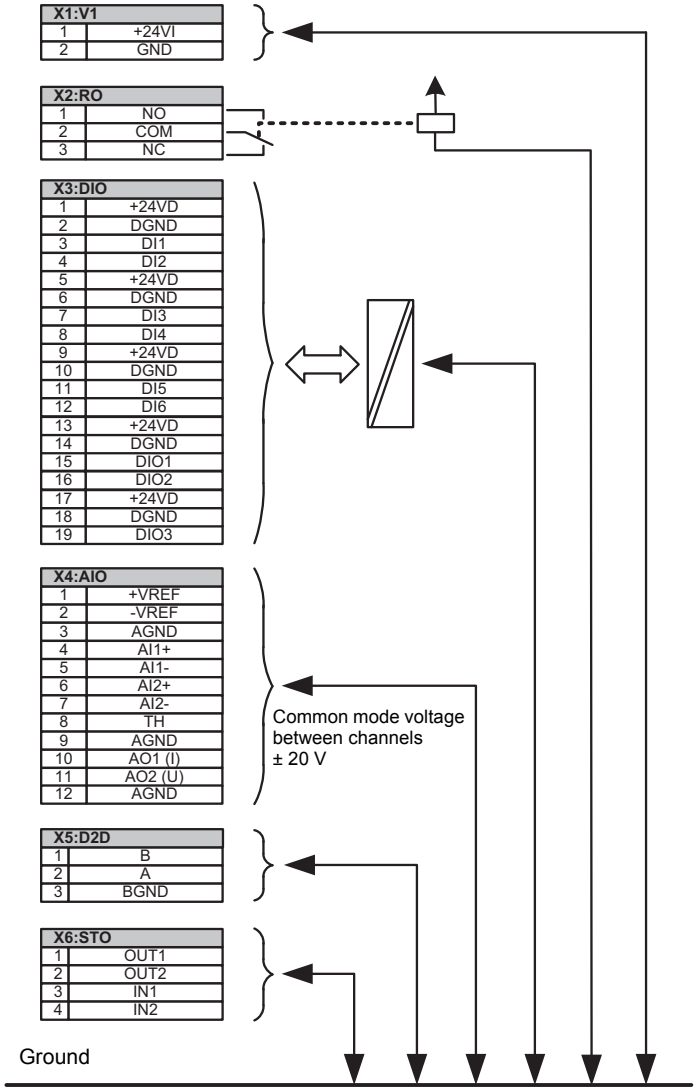
DC connection data

Drive module type	I_{DC} (A)	Capacitance (mF)
-390A-4	478	14
-500A-4	613	14
-580A-4	711	21
-635A-4	778	21

Control unit (JCU-01) connection data

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 *104*.	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 *105*)
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
Isolation and grounding diagram	



Efficiency

Approximately 98% at nominal power level

Degree of protection

Without optional cabling panels IP00 (UL type open). IP20 (UL type open) with optional cabling panels (+H381).

Note: The degree of protection of IP20 requires that the input power cables are installed through rubber grommet mounted on top of the module.

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	Non-corner grounded TN and TT systems: 0 to 4000 m (13123 ft) above sea level. Other systems: 0 to 2000 m (6561 ft) above sea level. Above 1000 m (3281 ft), see section *Derating*.	-	-
Air temperature	-10 to +55 °C (14 to 131 °F). No frost allowed. See section *Derating*.	-40 to +70 °C (-40 to +158 °F)	-40 to +70 °C (-40 to +158 °F)
Relative humidity	5 to 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination levels (IEC 60721-3-3, IEC 60721-3-2, IEC 60721-3-1)	No conductive dust allowed.		
	Chemical gases: Class 3C2 Solid particles: Class 3S2	Chemical gases: Class 1C2 Solid particles: Class 1S3	Chemical gases: Class 2C2 Solid particles: Class 2S2
Atmospheric pressure	70 to 106 kPa 0.7 to 1.05 atmospheres	70 to 106 kPa 0.7 to 1.05 atmospheres	60 to 106 kPa 0.6 to 1.05 atmospheres
Vibration (IEC 60068-2-6. Test Fc)	Max. 0.1 mm (0.004 in.) (10 to 57 Hz), max. 10 m/s^2 (33 ft/s^2) (57 to 150 Hz) sinusoidal	Max. 1 mm (0.04 in.) (5 to 13.2 Hz), max. 7 m/s^2 (23 ft/s^2) (13.2 to 100 Hz) sinusoidal	Max. 3.5 mm (0.14 in.) (2 to 9 Hz), max. 15 m/s^2 (49 ft/s^2) (9 to 200 Hz) sinusoidal
Shock (IEC 60068-2-27)	Not allowed	Max. 100 m/s^2 (330 $ft./s^2$), 11 ms	Max. 100 m/s^2 (330 $ft./s^2$), 11 ms
Free fall	Not allowed	100 mm (4 in.) for weight over 100 kg (220 lb)	100 mm (4 in.) for weight over 100 kg (220 lb)

Materials

Drive enclosure	• PC/ABS 2.5 mm, color NCS 1502-Y (RAL 9002 / PMS 420 C) • hot-dip zinc coated steel sheet 1.5 to 2.5 mm, thickness of coating 100 micrometers, color NCS 1502-Y
Package	Plywood and cardboard, bands PP.
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 (C1-1 to C1-x) contain electrolyte and the printed circuit boards contain lead, both of which are 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 61800-5-1 and EN 60204-1.
EN 61800-5-1:2007	*Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy*
EN 60204-1:2006	*Safety of machinery. Electrical equipment of machines. Part 1: General requirements*. Provisions for compliance: The final assembler of the machine is responsible for installing - emergency-stop device - supply disconnecting device - IP00 drive module into a cabinet.
EN 60529:1992 (IEC 60529)	*Degrees of protection provided by enclosures (IP code)*
IEC 60664-1:2007	*Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests.*
EN 61800-3:2004	*Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods*
EN 61800-5-2:2007	*Adjustable speed electrical power drive systems. Part 5-2: Safety requirements – Functional*
UL 508C (2002)	*UL Standard for Safety, Power Conversion Equipment, second edition*
CSA C22.2 No. 14-05	*Industrial control equipment*

CE marking

A CE mark is attached to the drive to verify that the unit follows the provisions of the European Low Voltage and EMC Directives.

Compliance with the European Low Voltage Directive

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

Compliance with the European EMC Directive

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard (EN 61800-3:2004) covers requirements stated for drives. See section *Compliance with EN 61800-3:2004* below.

Compliance with the European Machinery Directive

The drive is a machinery component that can be integrated into a wide range of machinery categories as specified in European Commission's *Guide to application of the Machinery Directive 2006/42/EC 2nd Edition – June 2010.*

Compliance with EN 61800-3:2004

Definitions

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

First environment includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

Second environment includes establishments connected to a network not supplying domestic premises.

Drive of category C3: drive of rated voltage less than 1000 V and intended for use in the second environment and not intended for use in the first environment.

Drive of category C4: drive of rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

Category C3

The drive complies with the standard with the following provisions:

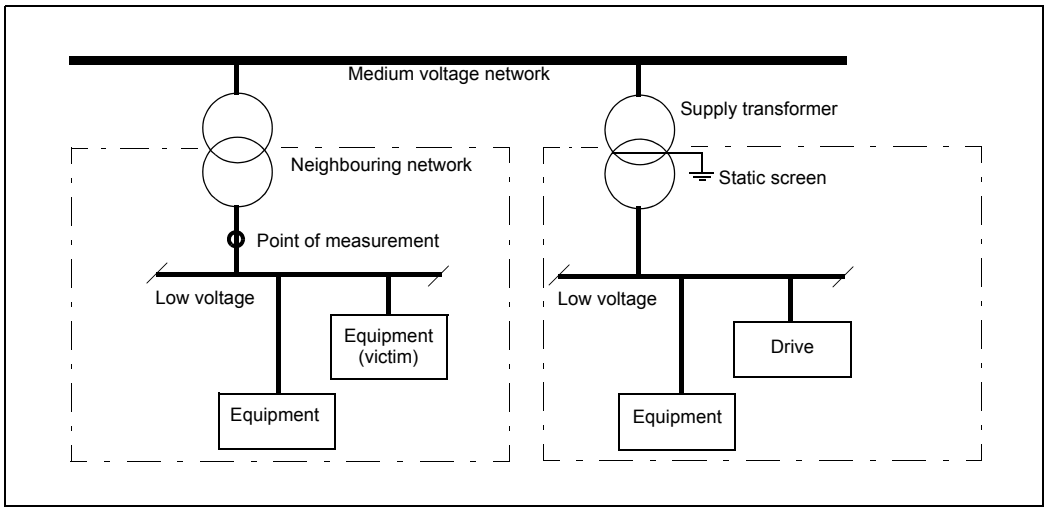
1. The motor and control cables are selected as specified in the *Hardware manual*.
2. The drive is installed according to the instructions given in the *Hardware manual*.
3. Maximum cable length is 100 metres.

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

Category C4

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

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



2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available from the local ABB representative.
3. The motor and control cables are selected as specified in the *Hardware manual*.
4. The drive is installed according to the instructions given in the *Hardware manual*.

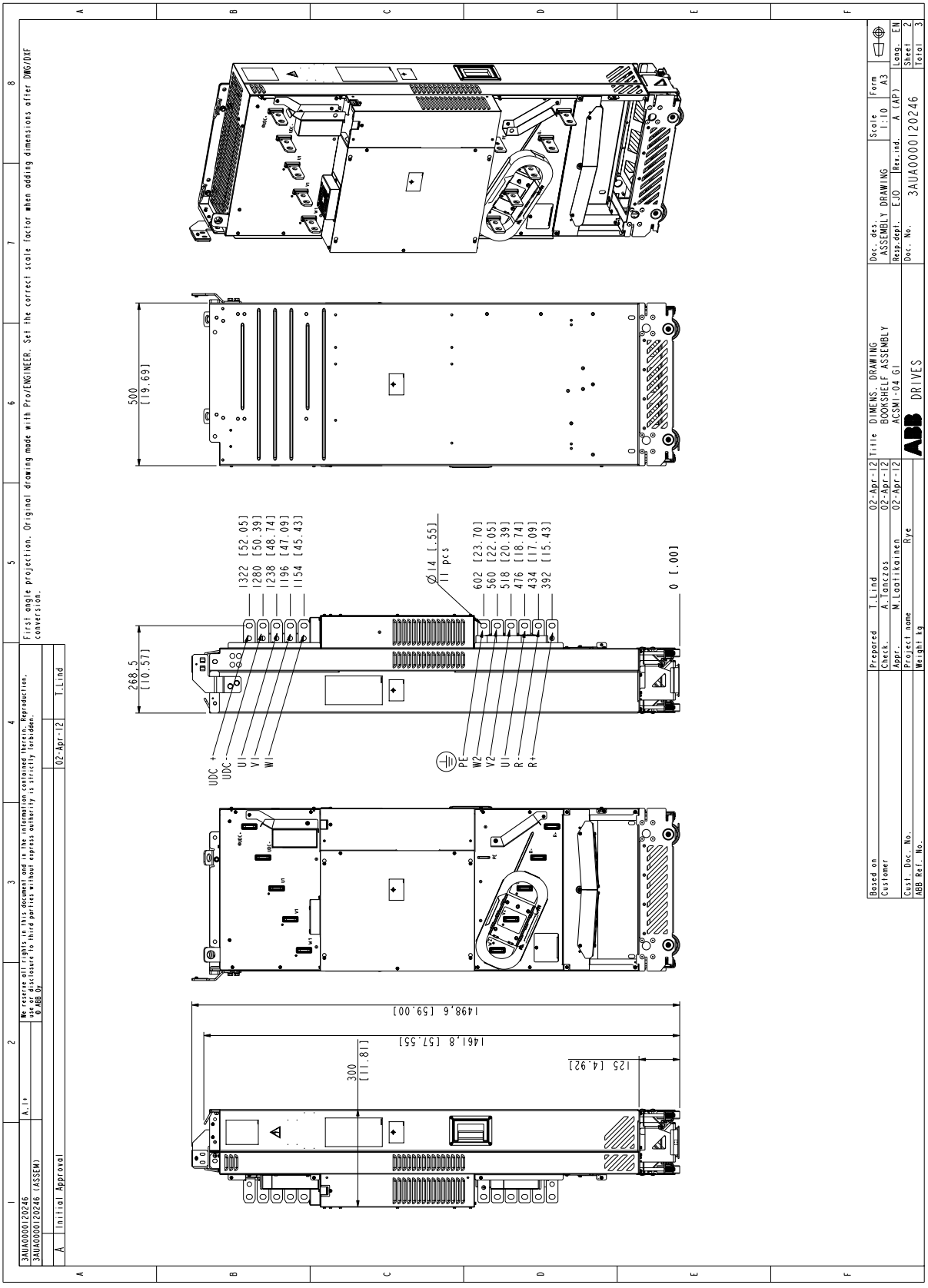
WARNING! A drive of category C4 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

Dimension drawings

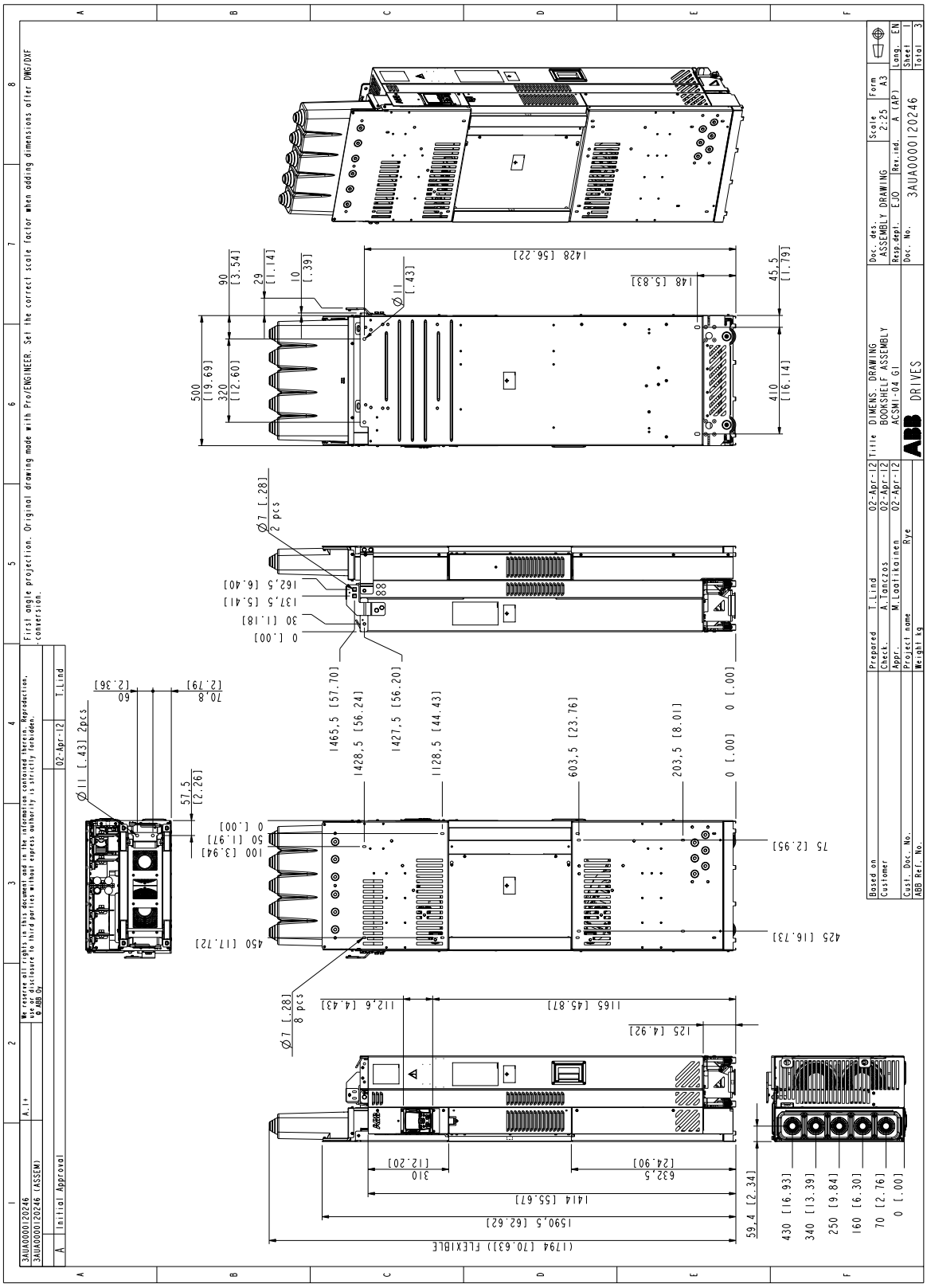
What this chapter contains

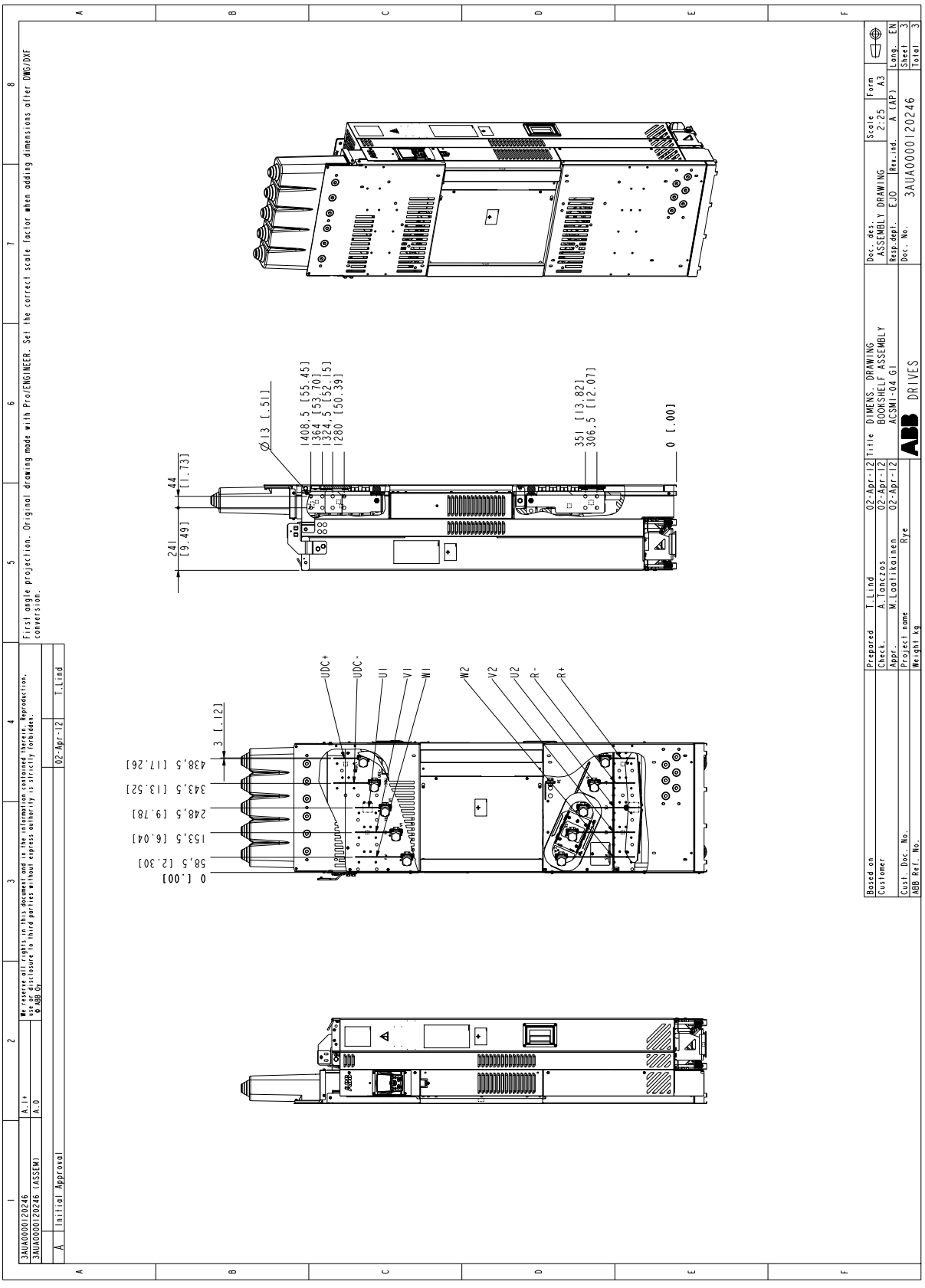
This chapter contains dimension drawings of the drive modules with optional parts for Rittal TS 8 cabinet assembly.

Frame G1 – Drive module dimensions

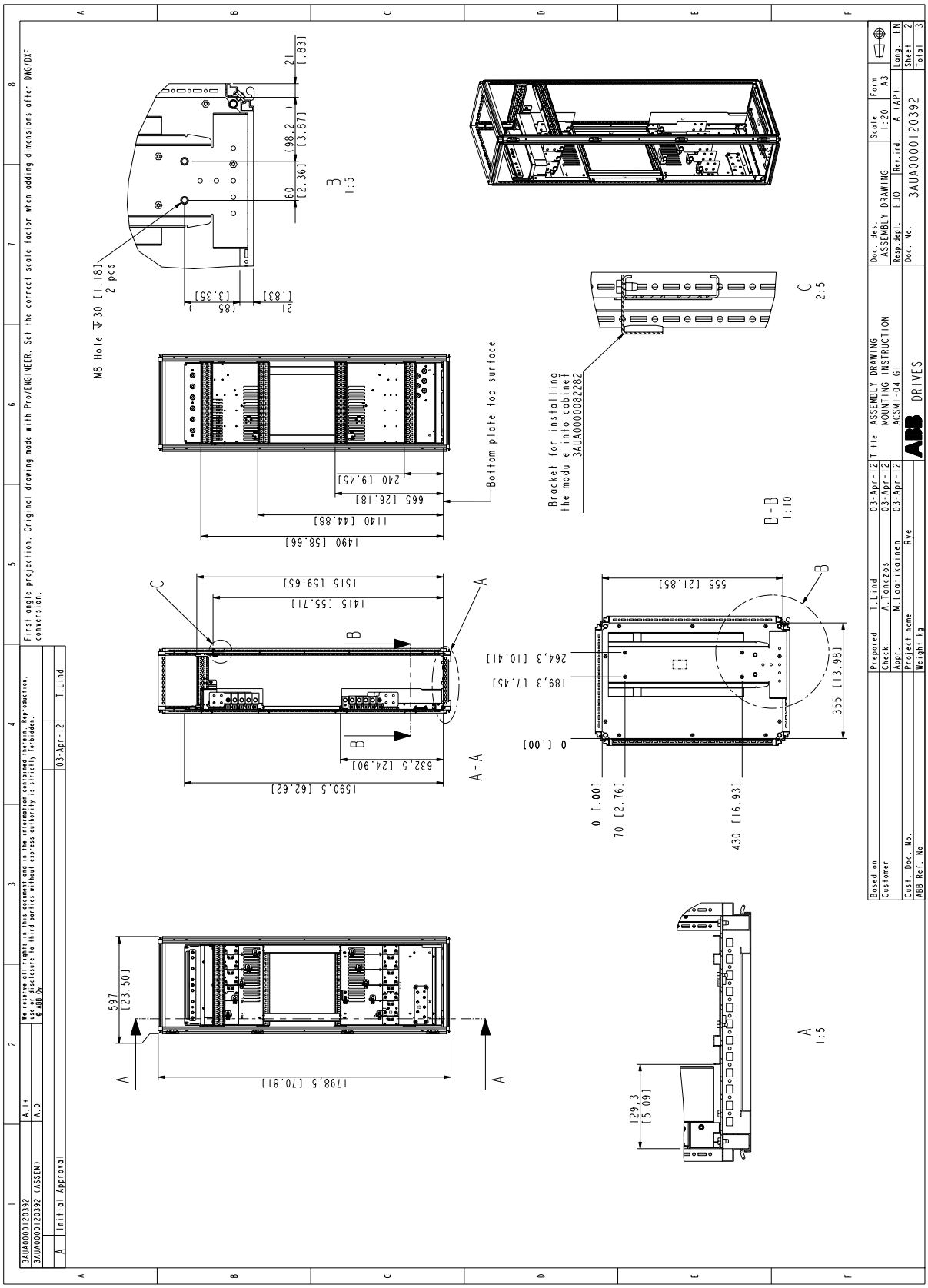


Frame G1 – Drive module dimensions with optional cabling panels (+H381)

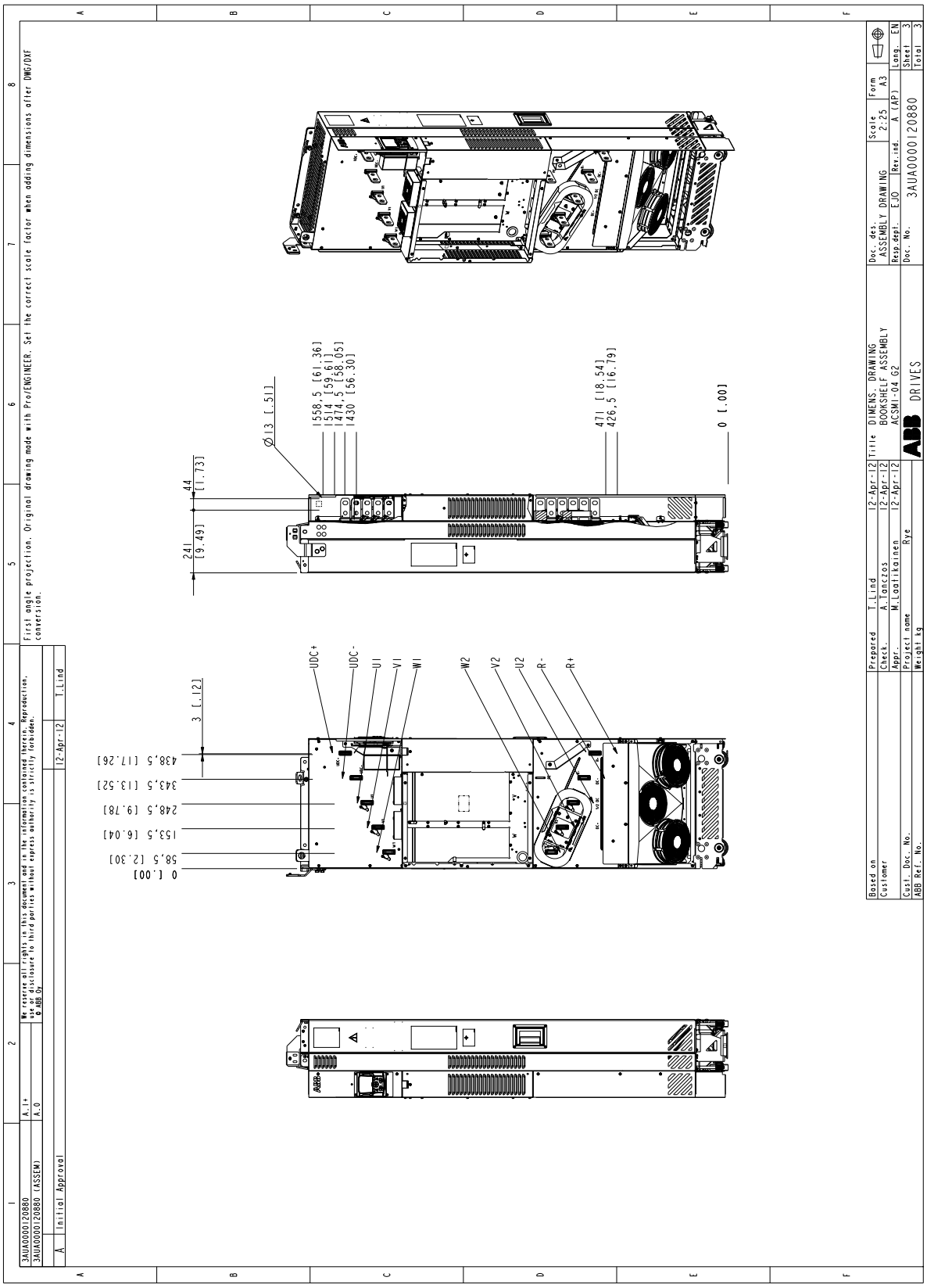



UDC+
UDC-
U1
V1
W1
W2
V2
U2
R-
R+
Ø13 [.51]
1408,5 [55.45]
1364 [53.70]
1324,5 [52.15]
1280 [50.39]
351 [13.82]
306,5 [12.07]
0 [.00]
44 [1.73]
241 [9.49]
3 [.12]
438,5 [17.26]
343,5 [13.52]
248,5 [9.78]
153,5 [6.04]
58,5 [2.30]
0 [.00]
ABB DRIVES
ASSEMBLY DRAWING
3AUA0000120246
First angle projection. Original drawing made with ProENGINEER. Set the correct scale factor when adding dimensions after DWG/DXF conversion.

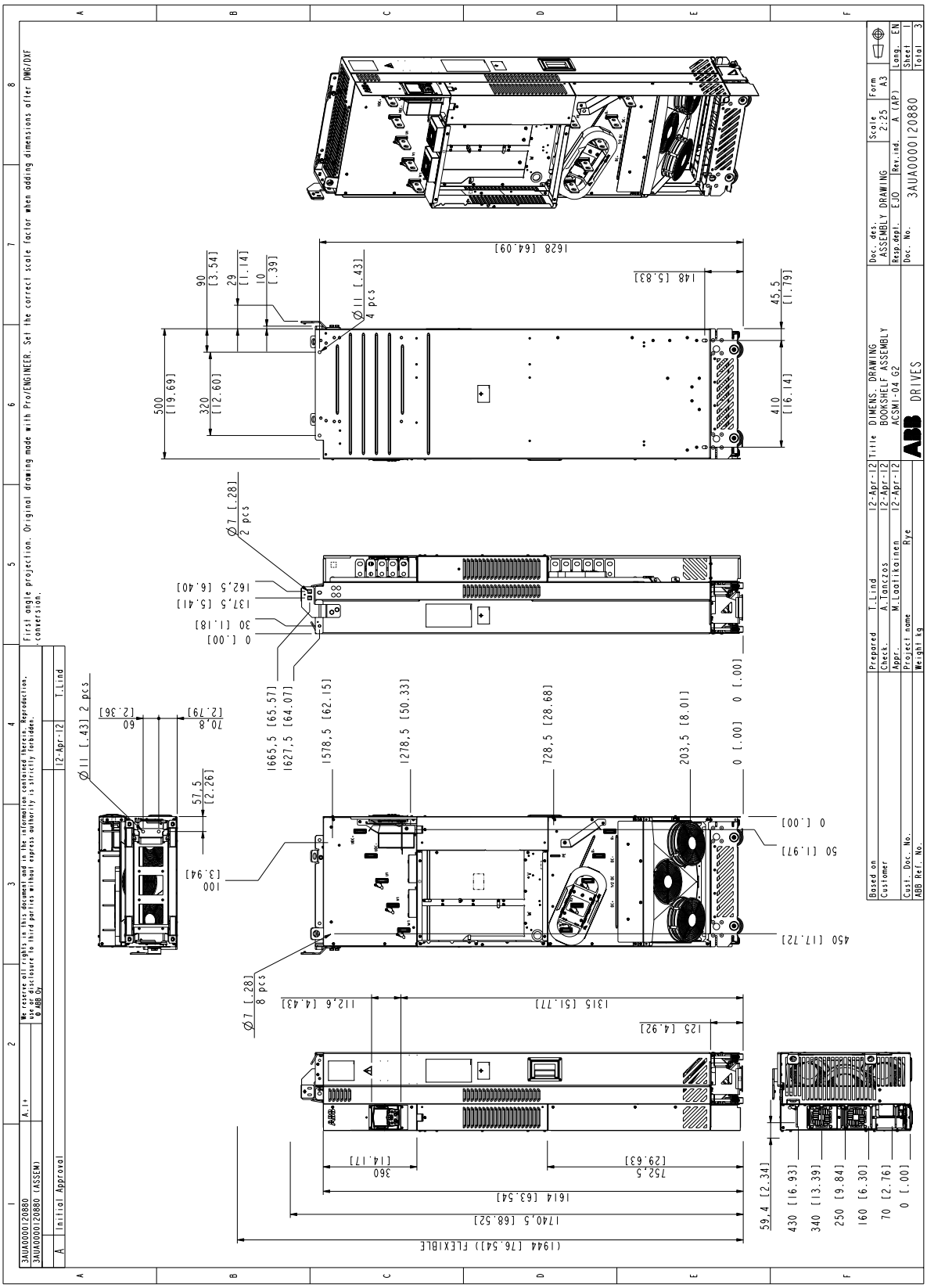
Frame G1 – Cabling panels (+H381) installed into a Rittal TS 8 cabinet

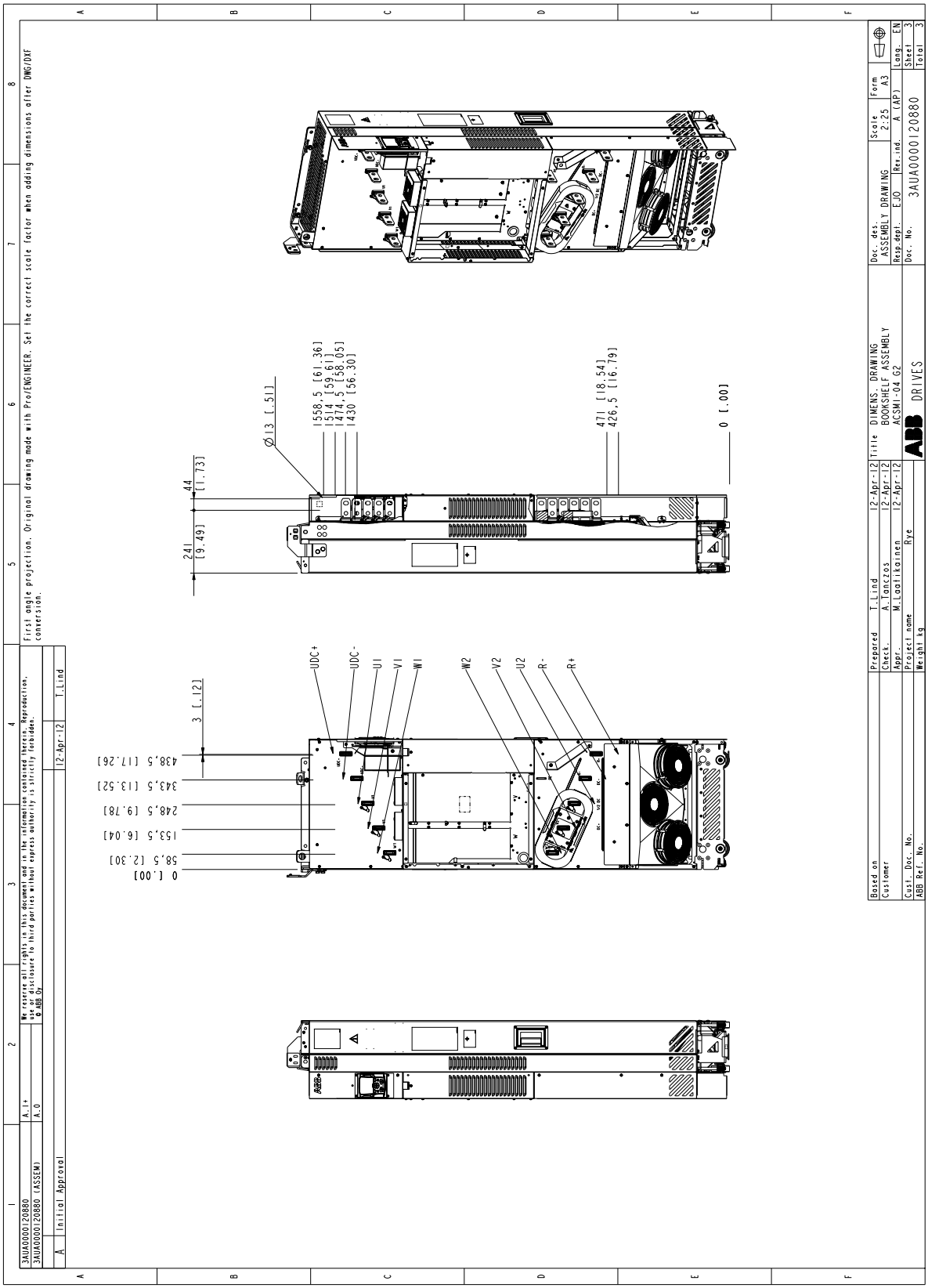


Frame G2 – Drive module dimensions



Frame G2 – Drive module dimensions with optional cabling panels (+H381)




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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3AUA0000120880
3AUA0000120880 (ASSEM)
A Initial Approval
A.1+
A.0
12-Apr-12
T.Lind
Ø13 [.51]
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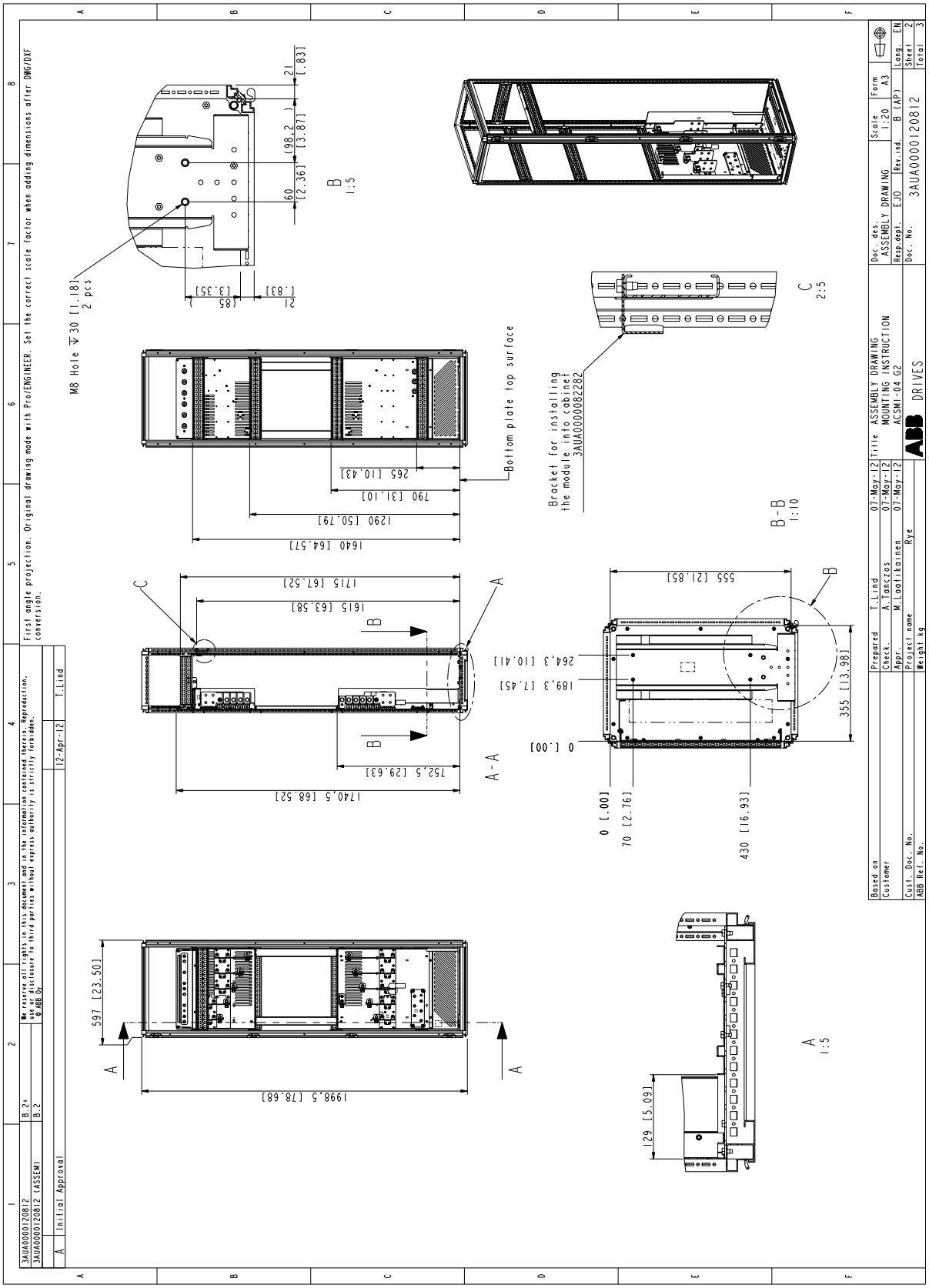
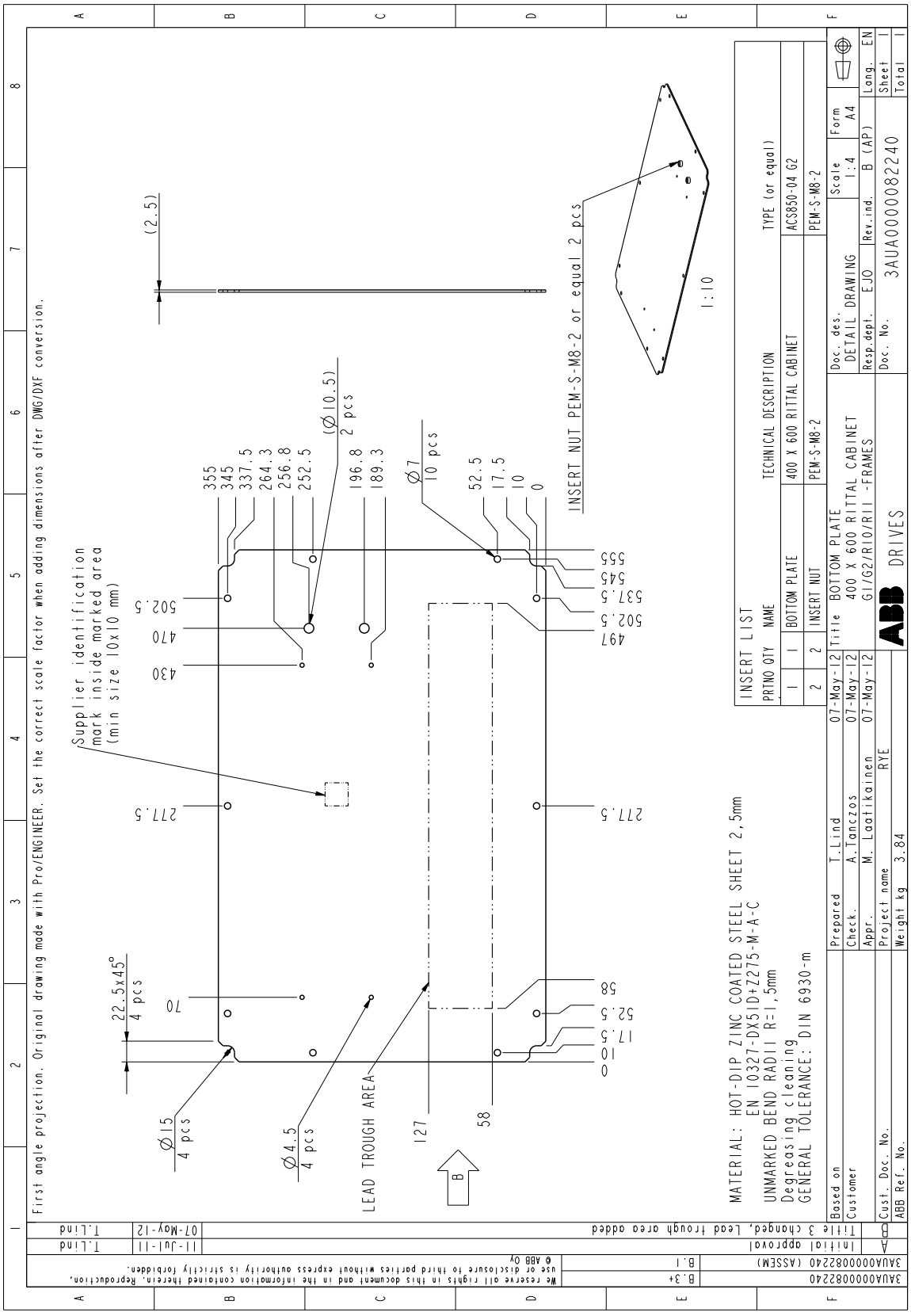
514 [59.61]
474,5 [58.05]
430 [56.30]
471 [18.54]
426,5 [16.79]
0 [.00]
44 [1.73]
241 [9.49]
3 [.12]
UDC+
UDC-
U1
V1
W1
W2
V2
U2
R-
R+
438,5 [17.26]
343,5 [13.52]
248,5 [9.78]
153,5 [6.04]
58,5 [2.30]
0 [.00]
Based on
Customer
Cust. Doc. No.
ABB Ref. No.
Prepared T.Lind 12-Apr-12
Check A.Tanczos 12-Apr-12
Appr. M.Laatikainen 12-Apr-12
Project name Rye
Weight kg
Title DIMENS. DRAWING BOOKSHELF ASSEMBLY ACSM1-04 G2
ABB DRIVES
Doc. des. ASSEMBLY DRAWING
Resp.dept. EJO
Doc. No. 3AUA0000120880
Scale 2:25
Form A3
Rev.ind. A (AP)
Lang. EN
Sheet 3
Total 3

Frame G2 – Cabling panels (+H381) installed into a Rittal TS 8 cabinet



Bottom plate



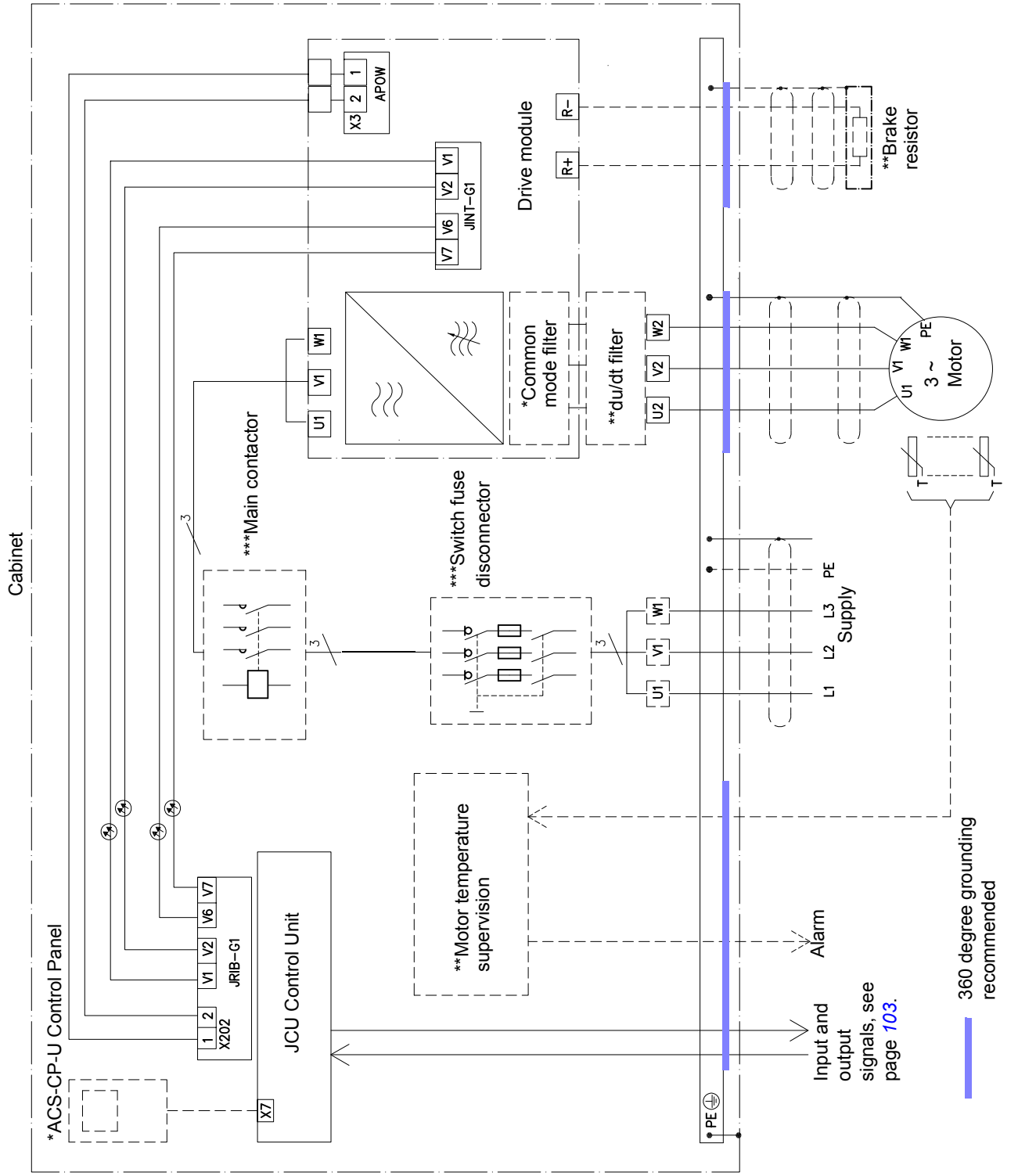
Example circuit diagrams

What this chapter contains

This chapter shows an example circuit diagram for a cabinet-installed drive module.

Example circuit diagram

This diagram is an example for the main wiring of a drive cabinet. Note that the diagram includes components which are not included in a basic delivery (* plus code options, ** other options, *** to be acquired by the customer).



Resistor braking

What this chapter contains

This chapter describes how to select, protect and wire braking resistors.

Availability of braking choppers and resistors

A braking chopper is a standard feature in ACSM1-04 drives, but they can also be delivered without a braking chopper (option +0D150). External resistors are available on request from ABB.

When is resistor braking needed

Typically, a drive system is equipped with braking choppers and resistors if:

- high capacity braking is needed and the drive cannot be equipped with a regenerative supply unit
- a backup for the regenerative supply unit is needed.

Operation principle

The energy generated by the motor during a fast deceleration of the drive typically causes the voltage to rise in the drive module intermediate DC circuit. The chopper connects the braking resistor to the intermediate DC circuit whenever the voltage in the circuit exceeds its maximum limit. Energy consumption by the resistor losses lowers the voltage until the resistor can be disconnected.

Planning the braking system

Selecting the brake circuit components

1. Calculate the maximum power *(P_{max})* generated by the motor during braking.
2. Select a suitable drive and braking resistor combination for the application according to the rating table on page *153*. Take also account of other factors in the drive selection. The braking power must be greater than or equal to the maximum power generated by the motor during braking:

   $$P_{br} \geq P_{max}$$

3. Check the resistor selection. The energy generated by the motor during a 400-second period must not exceed the resistor heat dissipation capacity E_R.

   Note: If the E_R value is not sufficient, it is possible to use a four-resistor assembly in which two standard resistors are connected in parallel, two in series. The E_R

value of the four-resistor assembly is four times the value specified for the standard resistor.

A resistor other than the standard resistor can be used provided that:

- its resistance is not lower than the resistance of the standard resistor

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

- the resistance does not restrict the braking capacity needed, ie,

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

where

P_{max}	Maximum power generated by the motor during braking
U_{DC}	Voltage over the resistor during braking, eg, 1.35 · 1.2 · 415 V DC when supply voltage is 380 to 415 VAC 1.35 · 1.2 · 500 V DC when supply voltage is 440 to 500 VAC
R	Resistor resistance (ohm)

- the heat dissipation capacity *(E_R)* is sufficient for the application, see step 3 above.

Placing the braking resistors

All resistors must be installed outside the drive module in a place where they will cool and the maximum allowed cable length (10 m [33 ft]) is not exceeded.

Arrange the cooling of the resistor in a way that:

- no danger of overheating is caused to the resistor or nearby materials
- the temperature of the room the resistor is located in does not exceed the allowed maximum.

Supply the resistor with cooling air/water according to the resistor manufacturer's instructions.

WARNING! The materials near the braking resistor must be non-flammable. The surface temperature of the resistor is high. Air flowing from the resistor is of hundreds of degrees Celsius. If the exhaust vents are connected to a ventilation system, ensure that the material withstands high temperatures. Protect the resistor against contact.

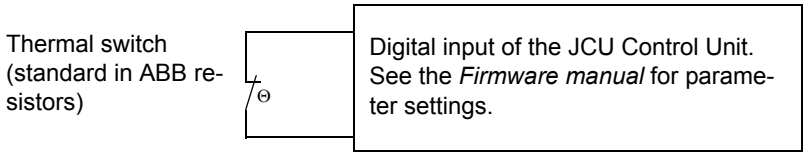
Protecting the system in fault situations

Thermal overload protection

The braking chopper protects itself and the resistor cables against thermal overload when the cables are dimensioned according to the nominal current of the drive. The drive control program includes a resistor and resistor cable thermal protection function which can be tuned by the user. See the *Firmware manual*.

A main contactor is not required for protecting against resistor overheating when the resistor is dimensioned according to the instructions and the internal braking chopper is in use. The drive will disable power flow through the input bridge if the chopper remains conductive in a fault situation but the charging resistor may fail. **Note:** If an external braking chopper (outside the drive module) is used, a main contactor is always required.

A thermal switch (standard in ABB resistors) is required for safety reasons. The cable must be shielded and not longer than the resistor cable.



Short-circuit protection

The input fuses will also protect the resistor cable when it is dimensioned according to the input cable.

Selecting and routing the brake circuit cables

Use the cable type used for drive input cabling (see page 56*)* to ensure that the input fuses will also protect the resistor cable. Alternatively, two-conductor shielded cable with the same cross-sectional area can be used.

Minimizing electromagnetic interference

Follow these rules in order to minimise electromagnetic interference caused by the rapid current changes in the resistor cables:

- Shield the braking power line completely, either by using shielded cable or a metallic enclosure. Unshielded single-core cable can only be used if it is routed inside a cabinet that efficiently suppresses the radiated RFI emissions.
- Install the cables away from other cable routes.
- Avoid long parallel runs with other cables. The minimum parallel cabling separation distance should be 0.3 meters.
- Cross the other cables at right angles.
- Keep the cable as short as possible in order to minimise the EMC emissions and stress on chopper IGBTs. The longer the cable the higher the EMC emissions, inductive load and voltage peaks over the IGBT semiconductors of the braking chopper.

Maximum cable length

The maximum length of the resistor cable(s) is 10 m (33 ft).

EMC compliance of the complete installation

Note: ABB has not verified that the EMC requirements are fulfilled with external user-defined braking resistors and cabling. The EMC compliance of the complete installation must be considered by the customer.

Mechanical installation

See the resistor manufacturer's instructions.

Electrical installation

Connection diagram

See the power cable connection diagram of the drive, page *84*.

Connection procedure

- Connect the resistor cables to the R+ and R- terminals in the same way as the other power cables. If a shielded three-conductor cable is used, cut the third conductor and ground the twisted shield of the cable (protective earth conductor of the resistor assembly) at both ends.
- Connect the thermal switch of the braking resistor as described in section *Thermal overload protection* on page *151*.

Brake circuit commissioning

- 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.

For more information, see the *Firmware manual*.

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.

Technical data

Ratings

The ratings for selecting the brake system components are given below at an ambient temperature of 40 °C (104 °F). **Check that the braking energy transmitted to the specified resistor(s) in 400 seconds does not exceed E_R.** See page *149*.

Drive module type ACSM1-04Ax...	Internal braking chopper		Example braking resistors			
	P_{brcont} (kW)	R_{min} (ohm)	Type *	R (ohm)	E_R (kJ)	P_{Rcont} (kW)
380…500 V						
-390A-4	315	1.3	2 × SAFUR200F500	1.35	10800	27
-500A-4	315	1.3	2 × SAFUR200F500	1.35	10800	27
-580A-4	400	0.7	3 × SAFUR200F500	0.90	16200	40
-635A-4	400	0.7	3 × SAFUR200F500	0.90	16200	40

3AXD00000425726

P_{brcont}	The internal braking chopper will withstand this continuous braking power. The braking is considered continuous if the braking time exceeds 30 seconds.
R_{min}	The minimum allowed resistance value of the braking resistor
R	Resistance value for the resistor assembly.
E_R	Short energy pulse that the resistor assembly withstands every 400 seconds.
P_{Rcont}	Continuous power (heat) dissipation of the resistor when placed correctly.
*	The resistors are connected in parallel.

Braking resistor connection data

Voltage over the resistor during braking is 1.35 · 1.2 · 415 V DC when the supply voltage is 380 to 415 VAC and 1.35 · 1.2 · 500 V DC when the supply voltage is 440 to 500 V AC.

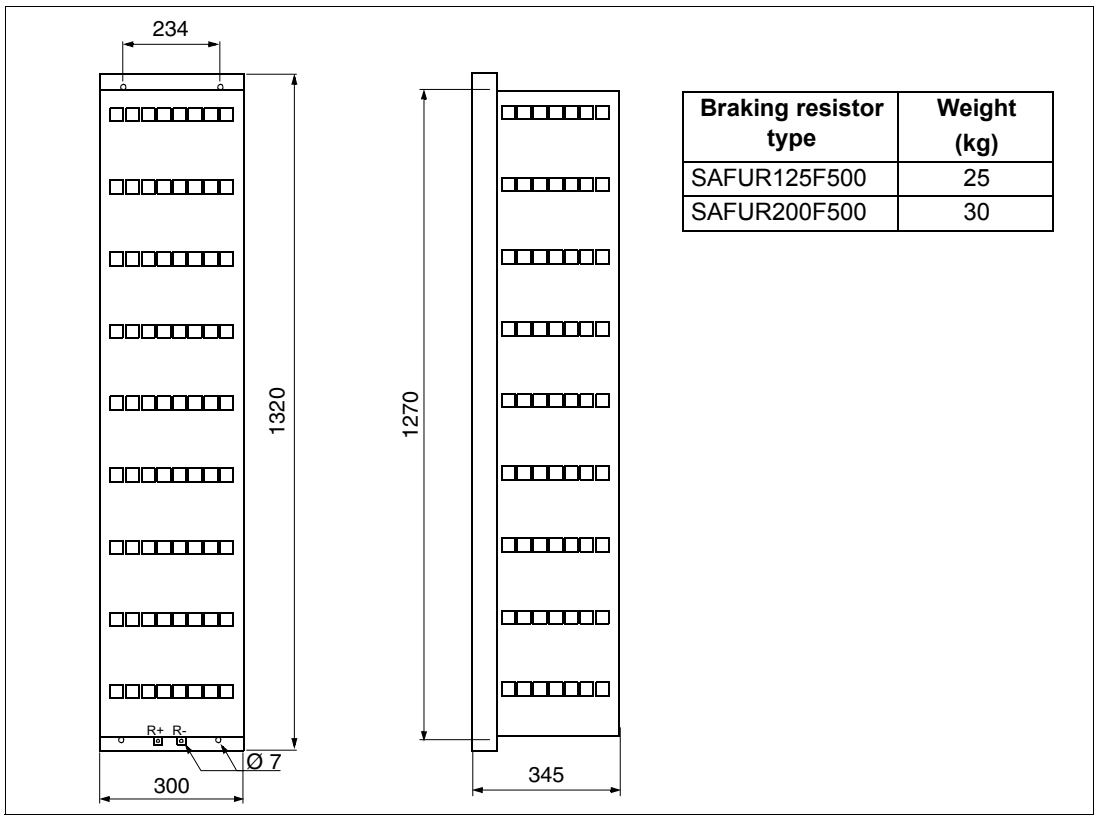
SAFUR resistors

Degree of protection: IP00. The resistors are not UL listed.

Maximum resistor cable length

10 m (33 ft)

Dimensions and weights



Braking resistor type	Weight (kg)
SAFUR125F500	25
SAFUR200F500	30

Safe torque off (STO) function

What this chapter contains

This chapter describes the Safe torque off function of the drive and gives instructions on its implementing.

Description

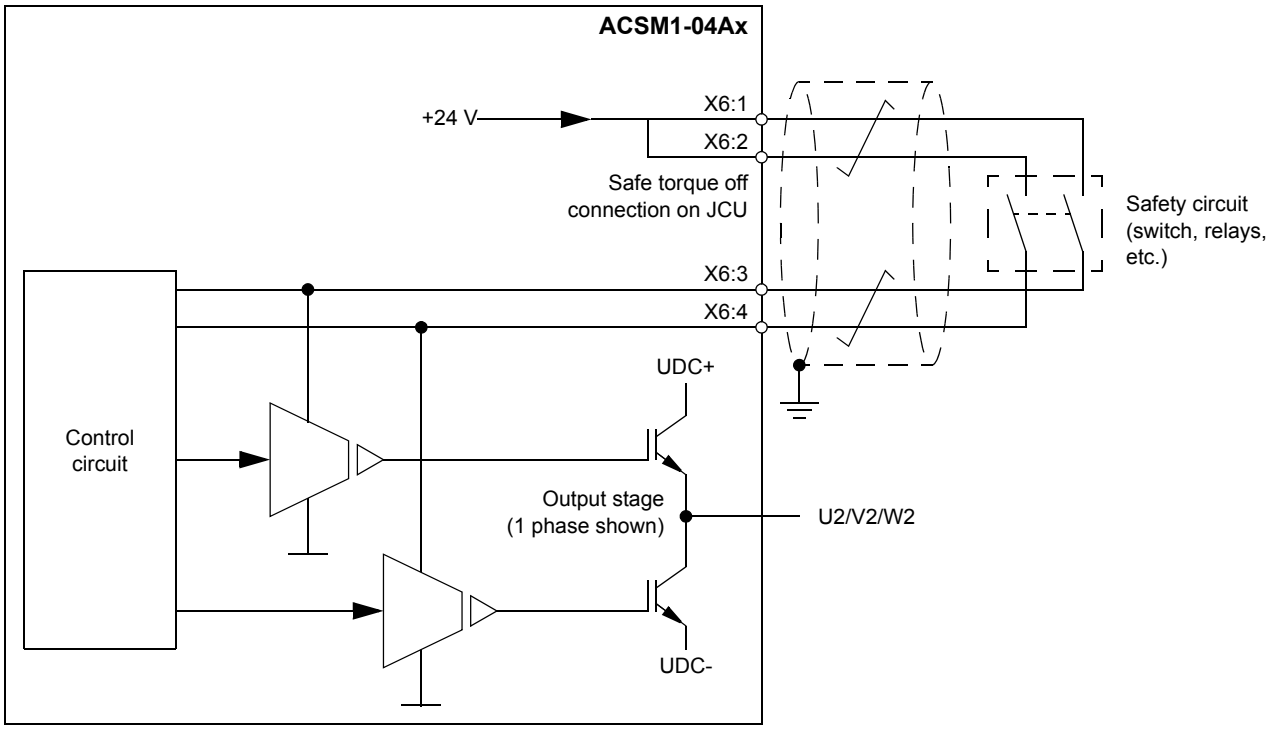
The drive supports the Safe torque off function according to standards EN 61800-5-2:2007; EN ISO 13849-1:2008, IEC 61508, IEC 61511:2004 and EN 62061:2005. The function also corresponds to Prevention of unexpected start-up of EN 1037.

The Safe torque off function disables the control voltage of the power semiconductors of the drive output stage (A, see diagram below), thus preventing the inverter from generating the voltage required to rotate the motor. This is the safe state of the drive. 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.

The Safe torque off function is ineffective against deliberate sabotage or misuse.

Wiring

Safe torque off connection on the JCU control board is shown below.



1) **Activation switch**

- The switch must be of a type that can be locked to the open position.
- The contacts of the activation switch must open/close within 200 ms of each other.
- The maximum allowed cable length between the drive and the activation switch or safety PLC is 25 m (82 ft).

Operation principle

1. User turns the Safe torque off (STO) switch to open (0) position.
2. STO input on the drive JCU board de-energizes.
3. Drive JCU board cuts off the control voltage from the inverter IGBTs within 50 ms.
4. Motor coasts to stop (if running) and cannot start while the STO switch is in 0 position.

Start-up including acceptance test

To ensure safe operation of the Safe torque off function, validation is required. IEC 61508 and EN IEC 62061 require that the final assembler of the machine validates the operation of the safety function with an acceptance test.

The acceptance test must be performed:

- at initial start-up of the safety function

- after any changes related to the safety function (wiring, components, settings, etc.)
- after any maintenance work related to the safety function.

Authorized person

The acceptance test of the safety function must be carried out by an authorized person with expertise and knowledge of the safety function. The test must be documented and signed by the authorized person.

Acceptance test reports

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

Acceptance test procedure

After wiring the Safe torque off function, validate its operation as follows. Setting of the control program parameters is not needed.

☑	**Action**
☐	**WARNING!** Follow the *Safety instructions* on page *13*. Ignoring the instructions can cause physical injury or death, or damage to the equipment.
☐	Ensure that the drive can be run and stopped freely during start-up.
☐	Stop the drive (if running), switch the input power off and isolate the drive from the power line by a disconnector.
☐	Check the Safe torque off (STO) circuit connections against the circuit diagram.
☐	Close the disconnector and switch the power on.
☐	Test the operation of the STO function when the motor is stopped. • Give a stop command for the drive (if running) and wait until the motor shaft is at standstill. Ensure that the drive operates as follows: • Open the STO circuit with the STO switch. The drive displays a warning. For description of the warning, see the *Firmware manual*. (Depending on a parameter setting, the drive may indicate a warning or fault. For more information, see the *Firmware manual*.) • Check that the STO function blocks the drive operations: Start the drive. The drive displays a warning. The motor should not start rotating. • Close the STO circuit with the STO switch. • Check that the STO function allows the normal operation of the drive: start, control of the motor speed and stop.
☐	Restart the drive and check that the motor runs normally.

☑	Action
☐	Test the operation of the STO function when the motor is running: • Start the drive and ensure the motor is running. • Open the STO circuit with the STO switch. (Depending on a parameter setting, the drive may indicate a warning or fault. For more information, see the *Firmware manual*.) • Ensure that the motor stops and the drive trips. • Reset the fault and try to start the drive. • Ensure that the motor stays at standstill and the drive operates as described above in testing the operation when the motor is stopped. • Close the STO circuit with the STO switch.
☐	Restart the drive and check that the motor runs normally.
☐	Document and sign the acceptance test report which verifies that the safety function is safe and accepted for operation.

Use

Activate the function as follows:

- Stop the drive. Use the stop key of the control panel (local mode) or give the stop command through the I/O or fieldbus interface.
- Open the switch activating the Safe torque off of the drive.
- Lock the switch to the open position.
- Before starting work on the machinery, ensure that the motor shaft is at standstill (not freely rotating).

Deactivate the function in reverse order.

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 cut off the motor supply voltage and the motor will coast to a stop. If this causes danger or is not acceptable, stop the drive and machinery using the appropriate stopping mode before using the Safe torque off function.

Note concerning permanent magnet synchronous motor drives in case of a multiple IGBT power semiconductor failure: In spite of the activation of the Safe torque off function, the drive system can produce an alignment torque which maximally rotates the motor shaft by 180/p degrees. p denotes the pole pair number.

Maintenance

After the operation of the circuit is verified at start-up, it does not need any maintenance. However, it is a good practice to check the operation of the function when the other maintenance procedures are carried out on the machinery.

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

If any wiring or component change is needed after start up, or the parameters are restored, follow the test given in section *Start-up including acceptance test* on page *156*.

Fault tracing

See the drive *Firmware manua*l for the warning and fault messages generated by the drive.

Safety data (SIL, PL)

The safety data for the Safe torque off function is given below. The function is regarded as type A according to IEC 61508-2. The following temperature profile is used in safety value calculations:

- 670 on/off cycles per year with $\triangle T$ = 71.66 °C
- 1340 on/off cycles per year with $\triangle T$ = 61.66 °C
- 30 on/off cycles per year with $\triangle T$ = 10.0 °C
- 32 °C board temperature at 2.0% of time
- 60 °C board temperature at 1.5% of time
- 85 °C board temperature at 2.3% of time.

Frame	IEC 61508-2					
	SIL	PFH_d (1/h)	HFT	SFF (%)	T1 (Years)	PFD
G1	3	7.47E-10 (0.747 FIT)	1	99.59	20	1.38E-05
G2	3	7.47E-10 (0.747 FIT)	1	99.59	20	1.38E-05

Frame	EN/ISO 13849-1					IEC 62061	IEC 61511
	PL	CCF (%)	$MTTF_d$ (Years)	DC* (%)	Cat.	SILCL	SIL
G1	e	80	5644	> 99	3	3	3
G2	e	80	5644	> 99	3	3	3

* according to Table E.1 in EN/ISO 13849-1

Certificate

The certificate for the Safe torque off function of the drive is pending.

Further information

Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/drives and selecting *Sales, Support and Service network*.

Product training

For information on ABB product training, navigate to www.abb.com/drives and select *Training courses*.

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